15th IBRC - the Conference Manual:
Programme, abstracts, list of participants.
Volume of abstracts of the 15th International Bat Research Conference, held in Prague, 23 - 27 August 2010
380 pp.

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15th International Bat Research Conference

With about 500 participants, the present meeting may become the largest assembly of bat students that ever appeared. The organizers are very pleased to host such a meeting in Prague, the capital of the Czech Republic. This is already the second time that the most prominent assembly of bat specialists will appear in this country. The 15th IBRC will take place 42 years to the day after the 1st IBRC organized here by Vladimír Hanák and Jiří Gaisler, pioneer personalities of modern European bat research who both are taking an active role in the present meeting as well.

The reappearance of the IBRC in the place from which the tradition of bat research conferences first arose opens a good opportunity for comparisons with all that has changed in bat research and our understanding of bat biology during the intervening period between the two meetings. We believe that the 15th IBRC will provide a pleasant platform for presenting current state of scientific study of bats, discussions on future trends and conservation measures focused to one of the most exciting product of evolution: the flying mammals.

The organizers welcome you in Prague and wish you a pleasant stay in the Czech Republic.

**International Bat Research Conferences**

A conference series of considerable tradition * by its geographic and conceptual coverages, number of participated scientists, and/or by its impact upon the progress of the discipline often considered as the most important and respectful assembly of bat scientists * For more than 40 years, the IBRC series has mapped the pathways of development of the discipline, and has provided a prominent platform for introducing new conceptual and methodical issues and fruitful discussions on biology, taxonomy, biogeography, morphology, behaviour, evolution and all other topics in study of bats.

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Scientific Committee

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Ulm, Germany
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Boston, USA
Knoxville, USA
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Aberdeen, Great Britain
Seewiesen, Germany
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Berlin, Germany
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Local organizing committee

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Czech University of Life Sciences Prague
Czech University of Life Sciences Prague
Czech Nature Conservation Agency
Charles University in Prague
Charles University in Prague
Charles University in Prague
South Moravia Museum, Znojmo
Masaryk University Brno
Šafárik University Košice
ČESON
CAS Institute of Vertebrate Biology, Brno

ČESON - Czech Bat Conservation Trust
In general terms, everyone of the local organization committee is ready to help you in case of any problems. Nevertheless, the more serviceable will be to preferably contact (a) the conference administration where technical aspects of registration, accommodation, payment, etc. are concerned, and contact (b) the secretaries and/or chairman of the local committee if it should be program items or organisational proposals that are the matter of your communication.

Chairman of the Local Organizing Committee:

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**Your address in the Conference:**  
15th IBRC  
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(Czech University of Life Sciences)  
Kamýcká 129  
160 00 Prague 6 - Suchdol  
Czech Republic  
Phone: +420 224 381 111
Registration and local basics

The registration desk
will be the information and administration centre of the Conference. It will be open throughout the Conference each day from 8.00 to 20.00. Besides standard registration agenda the staff of the registration desk is ready to help you and advice in organizing your sight seeing program, gathering the travel information and help if any unexpected situation appear. In a limited extent you can purchase there also bus tickets and some supplementary conference items (T-shirts etc.). The book „A tribute to bats“ and DVD „Of bats and Darkness“ edited on occasion of the Conference will be available at the Registration room at special conference price. The computer room neighbouring the registration desk and opened simultaneously with the registration desk is also at your disposal. The computer room is primarily intended for uploading and control of your presentations but it also provides an instant internet access (besides the free wi-fi access point established for the Conference participants - see below).
Throughout the Conference also the technical staff of the organization committee (students wearing the yellow Conference shirts) are also at your disposal.

Local basics

Currency: Though many shops in the centre of Prague will accept EUR and common credit cards, in most instances you will need local currency CZK (Czech Crowns). You can use your credit card to get CZK from bank cash dispensers (ATMs), such as those situated in the Campus. Money exchange is also possible in banks and exchange offices or in regular hotels at reception desks (but not in the student residences).

Emergency aid: Emergency calls can be effected from any phone in the Czech Republic free of charge. Non-stop emergency phone number is 112 (Integrated Rescue System = Firefighters, Police, Emergency Medical Service) facilitates emergency calls for foreigners and it is possible to use in wide scale of emergencies (traffic accidents, fires, floods, flash floods, serious health injuries, leaks of dangerous chemical substances, offences against the law...). The operators speak Czech, English and German.

In any case, if any trouble do not hesitate to contact the Conference administration and/or the organizers for a help.
The Conference venue

Campus of
Czech University of Life Sciences
Kamýcká 129, 160 00 Praha 6 - Suchdol
Czech Republic

The Conference takes place in the modern campus of the Czech University of Life Sciences (Česká zemědělská universita), situated on the NW-outskirts of the city, nearby the former village of Suchdol (now part of Prague). The Campus includes a well-designed conference centre and provides all standard facilities (such as a number of satellite rooms open to symposia, workshops and informal gatherings, a student restaurant, pubs and snack counters, 3 ATMs, bank office, pharmacy and center of medical care, computer room, free wireless internet, sport facilities and last but not least some cheap accommodation in student hostels just next to the Conference venue).

WIFI Internet access within the Conference area in the Campus is for the participants available upon the following options:

ssid: IBRC
security: WPA2-PSK/AES
password: 15ibrc@p2010

Meals
Luncheons are available from 23 August to 27 August in the student restaurant (situated in the centre of the campus) at the price of 6 EUR each. The student restaurant also provides breakfast (for prepaid coupons). Several pubs and restaurants will be open at your disposal, either within the campus or in the close vicinity, hotel Wiena-Galaxy can be particularly recommended.

Coffee and snacks will be served during the breaks both in the morning and afternoon sessions on corridors neigbouring the lecture rooms.

City transportation
Prague has a comprehensive network of public transportation consisting of metro, trams and buses. Single 'transferable' tickets (valid for 90 min. after marking/validation in a tram/bus/Metro station at the start of your journey) cost 26 CZK. The ticket can be purchased from the coin machines at metro stations and at newspaper stands. Also the travel passes for 3 days (330 CZK) or 5 days (500 CZK) are available there and in a limited extent can be purchased also at the registration desk.

Prague is generally considered not to be a dangerous city. Nevertheless, be aware of pickpockets, particularly in the metro or trams, and of 'incorrect accounting' in taxis. The price of taxi transportation from the Airport or the city centre to Suchdol should not exceed some 400 to 500 CZK (ca 20 EUR). The phone taxi AAA (phone 14014) can be recommended.
The Campus is accessible by **buses No. 107 and 147** from metro station **Dejvická** (terminal station of **metro line A - green**) to the bus stop „**Zemědělská univerzita**“. Buses depart every 5-10 mins. After regular day/evening services cease, during night hours, the Campus is still accessible by bus no. **502** (details of time tables will be available at the registration desk). Using the bus and metro, the historical centre of the Prague is accessible in some 20 minutes. **Parking:** Parking in the area of the Czech University of Life Sciences is available free of charge. Parking in the centre of the city is much more complicated and in many places is only available for holders of special local permissions. In general, it is strongly recommended to avoid entering the town centre by car. Use of public transportation, though much less comfortable, can spare both time and money, and works quite efficiently.
Structure of the Conference

The 15th IBRC has been essentially organized as an open meeting: all submitted items were accepted including the form of presentation suggested by the authors.

The scientific programme of the Conference consists of (i) eight plenary keynote lectures by 15 leading personalities of the branch invited by the organizers, (ii) 247 oral presentations and 153 posters organized in (iii) 17 Symposia, 6 thematic sessions of contributed presentations and 3 Workshops. The orals presentations will appear in 4-5 parallel sessions, posters will be on display throughout duration of the Conference.

The programme includes an open meeting of the IUCN Chiroptera specialist group, concluding plenary session and evening public presentation by the special guest of the Conference, Merlin Tuttle (Thursday 20.00).

Student Award

The most valuable and impressive student presentations will be awarded by Student Award based on decision of ad hoc jury (members of the Scientific Committee of the Conference and chairpersons of the sessions). The awards (sponsored among other by Pettersson Elektronik, Eco-tone and Tom Kunz) will be declared at the Concluding plenary session on Friday afternoon.

Technicalities

Oral presentations

Except for few, all oral presentations (including discussion) are restricted to 20 min time slots and for the integrity of the Conference structure it is very important to respect time schedule of individual presentations quite strictly.

Uploading presentations

All presentations must be uploaded in advance, if possible a day prior to the scheduled term of presentation, in the computer room neighbouring the Registration desk (assistance of organizers is at your disposal).

Uploading a presentation at the lecture room during breaks is exceptionally also possible but not recommended. Please, do not forget to test complete functionality of your presentation prior uploading.

Posters

will be on display throughout the Conference in a rounded building called Rondel. Special poster session will take place on Tuesday evening. Posters are to be inserted at the beginning of the meeting in a self-helping way. Standard tools and fixation utilities will be available at the place.
Social events

SUNDAY 22 Aug.
*Welcome party - informal gathering
*Ceremonial opening with a performance by Paul and Kasandra EINSTEIN:
  Travels of Giovanni Pipistrelli, a bat extraordinaire,
  introduced by Elisabeth K.V. KALKO

TUESDAY 24 Aug.
*Poster session with serving snacks, beer and wine

WEDNESDAY 25 Aug.
*Conference Excursion terminating at a field party at the castle ruin Točník, barbecue, wine, local beer, bat detectors.

FRIDAY 27 Aug.
*The Conference Farewell reception and Concert in Karolinum, the historical seat of the Charles University (1348) - paid separally, not included in the Conference fee

Guided tours in Prague and tourist trips to other destinations (Kutná Hora, Carlsbad a.o.) can be separally ordered at the Registration desk. The representatives of Conference Partners Agency are ready to help in choosing the programme perfectly fitting to your wishes.

The current information on Prague, exhibitions etc. can be obtained from www.prague.cz or www.pis.cz (Prague Information Service).
Keynote lectures

MONDAY 08.40
Estimating diversity: how many bat species are there?
Nancy B. SIMMONS & Andrea L. WETTENER (USA)

MONDAY 13.40
Chiropteran ancestry and early divergences
Gregg GUNNELL (USA), Gerhard STORCH, Jörg HABERSETZER (GERMANY), & Bernard SIGÉ (FRANCE)

TUESDAY 08.40
Of bats and molecules: a genomics perspective
I. Karyotype evolution illuminated by FISH
Marianne VOLLETH (Germany)
II. The use of comparative genomics in the study of bats
Emma TEELING (Ireland)

TUESDAY 13.40
From sensory modalities to ecological processes, from temperate to tropical zones: Following Otto von Helversen’s legacy in bat research
Christian C. VOIGT & Elisabeth K.V. KALKO (Germany)

WEDNESDAY 08.40
The sensory world of bats
Björn M. SIEMERS (Germany) & Gareth JONES (United Kingdom)

THURSDAY 08.40
Life history and sociobiology of bats
Gerald KERTH (Germany)

THURSDAY 13.40
Advances in aeroecology: An emerging discipline
Thomas H. KUNZ (USA)

FRIDAY 08.40
Bat Conservation: Past, Present and Future
Paul A. RACEY (United Kingdom)

Symposia

S1 Past to Present: Fossils and the Evolutionary History of Bats.
Gregg GUNNELL
TUESDAY afternoon

S2 Adaptations and Evolutionary Ecology.
David JACOBS
TUESDAY morning-afternoon

S3 Gerhard Neuweiler Memorial Symposium on Echolocation in Bats.
Björn M. SIEMERS & Gareth JONES
WEDNESDAY morning THURSDAY morning

S4 Speciation dynamics and taxonomy.
Manuel RUEDI & Petr BENDA
MONDAY morning-afternoon
S5  Bat extinctions: past, present, and future.
    Nancy Simmons & Liliana Dávalos
    Tuesday afternoon

S6  Integrating information across multiple molecular markers -
current and future studies in bat genetic research.
    Stephen J. Rossiter & Pavel Hulva
    Thursday afternoon

S7  New Approaches in the Study of Bat Flight.
    Sharon Swartz & Anders Hedenström
    Monday afternoon

S8  Movement Ecology of Bats.
    Thomas H. Kunz & Paul M. Cryan
    Thursday afternoon - Friday morning

S9  Global bat Monitoring and Bioindication.
    Kate Jones & Tomáš Bartonička
    Thursday morning - afternoon

S10  Bat and parasites: implications for social life, disease transmission,
and co-evolution.
    Gerald Kerth & Philippe Christe
    Monday morning

S11  Bat-fruit interactions:
    new findings from individual to community level.
    Marco A.R. Mello & Elisabeth K.V. Kalko
    Monday afternoon

S12  Diversity Patterns and Processes:
    from Local Assemblages to Continental Gradients.
    Jakob Fähr & Tigga Kingston
    Monday afternoon

S13  Social and vocal complexity in bats.
    Mirjam Knörnschild & Martina Nagy
    Thursday afternoon

S14  Anthropogenic impact on bats:
    from fragmentation to urbanization.
    Kirsten Jung, Elisabeth K.V. Kalko & Raphael Arlettaz
    Monday morning - Tuesday afternoon

S15  Diversity, systematics and conservation of South American bats.
    Valéria C. Tavares, Ludmilla M.S. Aguiar, Enrico Bernard,
    & Renato Gregorin
    Wednesday morning, Friday morning

S16  Bats as inspiration for biomimetic robots.
    Annemarie Suryk & Elisabeth K. V. Kalko
    Tuesday morning

S17  Bats and pathogen emergence.
    Sébastien J. Puechmaillé & Meriadeq Ar Gouilh
    Tuesday afternoon
# Time Table of the Conference

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**SESSIONS:**
- **Morning:** 09.40
- **Afternoon:** 14.40

**Plenary lectures and Workshops:** 08.40 - 13.40

**Lunch time:** (12.00 - 13.40)

**Coffee breaks:** (10.40, 15.40)

**Symposia and Contributed sessions:**

**Posters Session:**

**Conference excursion:**

**Farewell Reception:** KAROLINUM
The 15th IBRC Programme in detail
MONDAY 23 Aug 2010

08.30  Plenary session  (Room A)
  Chairperson: Ivan Horáček

Keynote lecture K1:
Estimating diversity: how many bat species are there?  
by
Nancy B. Simmons, Andrea L. Wetterer (USA)

09.40-12.20  Morning sessions
  Room A: Symposium S4  (Speciation) - part I
  Room B: Symposium S14  (Conservation) - part I
  Room C: Contributed session ADAPTATIONS
  Room D: Symposium S10  (Parasites)

11.40-13.40  Lunch

13.40  Plenary session  (Room A)
  Chairperson: Suzanne Hand

Keynote lecture K2:
Chiropteran ancestry and early divergences  
by
Gregg Gunnell (USA), Gerhard Storch,  
Jörg Habersetzer (Germany), Bernard Sigé (France)

14.40-18.20  Afternoon sessions
  Room A: Symposium S12  (Diversity)
  Room B: Symposium S7  (Flight)
  Room C: Symposium S11  (Bat-Fruit)
  Room D: Symposium S4  (Speciation) - part II
  Room E: Contributed session BEHAVIOUR - part I

Evening free, optionally

20.00  Room A: Symposium S12 - round table discussion
20.00  Room B: CEI Workshop W1 on bat fauna, bat conservation  
  and monitoring in SE- Europe and Middle East
TUESDAY 24 Aug 2010

08.30 Plenary session (Room A)
Chairperson: Robert J. Baker

Keynote lecture K3:
Of bats and molecules: a genomics perspective
I. Karyotype evolution illuminated by FISH
Marianne Volleth (Germany)
II. The use of comparative genomics in the study of bats
Emma Teeling (Ireland)

09.40-12.20 Morning sessions
Room A: Symposium S2 (Adaptations) - part I
Room B: Contributed session CONSERVATION - part I
Room C: Symposium S16 (Robots)
Room D: Contributed session MONITORING
Room E: Contributed session TAXONOMY - part I

11.40-13.40 Lunch

13.40 Plenary session (Room A)
Chairperson: Paul A. Racey

Keynote lecture K2:
From sensory modalities to ecological processes, from temperate to tropical zones: Following Otto von Helversen’s legacy in bat research
Christian C. Voigt, Elisabeth K.V. Kalko (Germany)

14.40-18.20 Afternoon sessions
Room A: Symposium S17 (Epidemiology)
   Workshop 2 WNS in Europe
Room B: Symposium S14 (Conservation) - part II
Room C: Symposium S2 (Adaptations) - part II
Room D: Symposium S1 (Fossils)
Room E: Contributed session DISTRIBUTION

Evening

19.00-23.00 POSTER SESSION (Rondel)
with serving snacks etc.
WEDNESDAY 25 Aug 2010

08.30  Plenary session  (Room A)
Chairperson: Hans-Ulrich Schnitzler

Keynote lecture K5:
The sensory world of bats
by
Björn M. Siemers (Germany), Gareth Jones (United Kingdom)

09.40-12.20  Morning sessions
Room A: Symposium S3 (Echolocation) - part I
Room B: Symposium S5 (Extinctions)
Room C: Symposium S15 (South America) - part I
Room D: Contributed session CONSERVATION part II
Room E: Contributed session ECOLOGY - part II

11.40-13.30  Lunch

13.30 -?  CONFERENCE EXCURSION

A half-day Conference excursion (covered by the conference fee) will visit three separate areas close to Prague:

A) Bohemian karst - valley of the Berounka river, Koněpruské caves - the largest cave system in the area with about 2 km of passages, rich in hibernating bats and fossil bat assemblages from Miocene to Early Pleistocene.

B) Křivoklátsko UNESCO Biosphere Reserve - an extensive woodland complex preserved as a royal hunting forest of Czech kings since the early Middle Ages. A visit to the royal castle Křivoklát (13-14th Century architecture; important roost of Myotis myotis, Nyctalus noctula, Pipistrellus pipistrellus, etc.) and localities with peak numbers of the recently-described species Myotis alcathoe.

C) Příbramsko - mining region (silver, uranium, etc.) famous since the early Middle Ages, besides having a number of world ‘firsts’ in mining technology (the first mine deeper than 1 km, etc.). Passing through the town of Příbram, rich in baroque monuments, on the lower slopes of the forested Brdy mountains, the excursion will then visit a curious artificial underground water system (the hibernation roost of some bats) and will pass through impressive woodland stands across the highest peaks of central Bohemia.

All three excursions will rejoin together at the ruin of a Medieval royal castle, Točník, (the site of a continuously-studied breeding colony of M. myotis) where an evening banquet will take place, together with optional opportunity for some bat detectoring.

Departure is from the parking in front of the registration building (and room A) at 13.30.
Conference Excursion: alternatives A, B, C
THURSDAY  26 Aug 2010

08.30  Plenary session  (Room A)
Chairperson: Gary F. McCracken

Keynote lecture K6:
Life history and sociobiology of bats
by
Gerald Kerth (Germany)

09.40-12.20  Morning sessions
Room A: Symposium S9  (Monitoring) - part I
Room B: Contributed session ECOLOGY - part II
Room C: Symposium S3  (Echolocation) - part II
Room D: Symposium S15  (South America) - part II

11.40-13-40  Lunch

13.40  Plenary session  (Room A)
Chairperson: Wieslaw Bogdanowicz

Keynote lecture K7:
Advances in aeroecology: An emerging discipline
by
Thomas H. Kunz (USA)

14.40-18.20  Afternoon sessions
Room A: Symposium S8  (Movements) - part I
Room B: Symposium S6  (Molecules) - part I
Room C: Symposium S13  (Social vocalization)
Room D: Symposium S9  (Monitoring) - part II

Evening

20.00 - 21.30  An evening with Merlin Tuttle  (Room A)
introduced by Jiří Gaisler and Thomas H. Kunz

Conserving Bats:
Challenges and Opportunities
by
Merlin Tuttle (USA)
FRIDAY 27 Aug 2010

08.30  Plenary session  (Room A)
Chairperson: Raphael Arlettaz

Keynote lecture K8:
Bat Conservation: Past, Present and Future
by
Paul A. Racey (United Kingdom)

09.40-12.20  Morning sessions
Room A: Contributed session BEHAVIOUR - part II
Room B: Symposium S8 (Movements) - part II
Workshop W3  Rousettus
Room C: Contributed session ECOLOGY - part III
Room D: Contributed session CONSERVATION - part III

11.40-13.40  Lunch

13.40-14.40  Room B: Contributed session BEHAVIOUR - part III

13.40-14.40  Plenary session  (Room A)
Chairperson: Paul A. Racey
Open Meeting of
The IUCN Bat Specialist Group

14.40-15.00  coffee break

14.40-17.00  Plenary sessions  (Room A)
Concluding remarks by the Symposia Conveners
Student Awards
Proposals of the further Conferences
Closing the 15th IBRC

Evening

19.00 - 23.00  Farewell Reception and Concert
in
KAROLINUM
(historical seat of the Charles University)
Praha 1, Ovocný trh 3
Parallel sessions
MONDAY morning

S4 Speciation dynamics and taxonomy
Conveners: Manuel RUEDI and Peter BENDA

09.40 S4.0 Introduction to the symposium - Speciation and taxonomy in bats: challenges
Manuel RUEDI (Switzerland), Petr BENDA (Czech Republic)

10.00 S4.1 Allopatric, Ecological, Hybrid, etc. Speciation in bats: How do their wing prints differ?
Robert J. BAKER, Peter A. LARSEN, María R. MARCHÁN-RIVADENEIRA

10.20 S4.2 Is fixation of chromosomal rearrangements mediated by social structure? Perspectives from the Peter’s tent-roosting bat, Uroderma bilobatum
Maria SAGOT, Caleb PHILLIPS, Richard STEVENS, Robert BAKER

10.40 coffee

11.00 S4.3 Sibling species of Rhinolophus luctus from Peninsular Malaysia detected by karyologial analysis
Marianne VOLLETH, Frieder MAYER (Germany), Josef LOIDL (Austria), Hoi-Sen YONG (Malaysia), Klaus-Gerhard HELLER (Germany)

11.20 S4.4 Cryptic species of horseshoe bats (Rhinolophidae) of the R. hildebrandtii complex in southern Africa
Peter TAYLOR, Samantha STOFFBERG (South Africa), Ara MONADJEM (Swaziland), Corrie SCHOEMAN, Woody COTTERILL (South Africa)

11.40 S4.5 Speciation in progress? Phenotypes and genetic differences in two coexisting morphotypes of the bat Macrotus waterhousii minor
Anna BASTIAN (Germany), Emanuel MORA (Cuba), Sabine SCHMIDT (Germany)

12.00 S4.6 Restricted gene flow is required for sensory speciation in bats
Sebastien PUECHMAILLE (Ireland), Meriadeg AR GOULIH (France), Mehdi YOBUKOL, Piyathip PIYAPAN (Thailand), Khin MIE MIE (Myanmar), Paul J. BATES (UK), Eric J. PETIT (France), Iain J. MACKIE (UK), Emma C. TEELING (Ireland)
### Diversity Patterns and Processes – from Local Assemblages to Continental Gradients

**Conveners:** Jakob Fahr and Tigga Kingston

<table>
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<tr>
<th>Time</th>
<th>Session</th>
<th>Speaker</th>
<th>Title</th>
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<tr>
<td>14.40</td>
<td>S12.1 Bat distributions along elevational gradients and their implications for ecology and conservation</td>
<td>Bruce D. Patterson (USA)</td>
<td>Bat distributions along elevational gradients and their implications for ecology and conservation</td>
</tr>
<tr>
<td>15.00</td>
<td>S12.2 Species diversity of bats along an altitudinal gradient in southern Malawi.</td>
<td>Michael Curran, Mirjam Kopp, Jan Beck (Switzerland), Jakob Faehr</td>
<td>Species diversity of bats along an altitudinal gradient in southern Malawi.</td>
</tr>
<tr>
<td>15.20</td>
<td>S12.3 Landscape and temporal variability of insectivorous bat assemblages in a Malaysian rainforest: just what is a bat assemblage?</td>
<td>Tigga Kingston (USA), Rakhmad Sujarno Kudos, Juliana Senawi (USA), Zubaid Akbar, Rosli Hashim, Thomas Kunz (USA), Sucharita Gopal (Malaysia)</td>
<td>Landscape and temporal variability of insectivorous bat assemblages in a Malaysian rainforest: just what is a bat assemblage?</td>
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<tr>
<td>15.40</td>
<td>coffee</td>
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<tr>
<td>16.00</td>
<td>S12.4 Biome transitions as centres of diversity: Habitat heterogeneity and diversity patterns of West African bat assemblages across spatial scales.</td>
<td>Jakob Faehr, Elisabeth K. V. Kalko</td>
<td>Biome transitions as centres of diversity: Habitat heterogeneity and diversity patterns of West African bat assemblages across spatial scales.</td>
</tr>
<tr>
<td>16.20</td>
<td>S12.5 Latitudinal diversity gradients in New World bats: Are they a consequence of niche conservatism?</td>
<td>Maria J. Ramos Pereira, Jorge M. Palmeirim</td>
<td>Latitudinal diversity gradients in New World bats: Are they a consequence of niche conservatism?</td>
</tr>
<tr>
<td>16.40</td>
<td>S12.6 Stronger tests of mid-domain effects on latitudinal</td>
<td>Richard D. Stevens, J. Sebastian Tello &amp; Maria Mercedes Gavilanez</td>
<td>Stronger tests of mid-domain effects on latitudinal</td>
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<tr>
<td>17.00</td>
<td>S12.7 Where is my bat? Ground-validation of presence-only modelling and its integration with molecular techniques for the conservation of rare species</td>
<td>Hugo Rebelo (United Kingdom, Portugal), Elsa Froufe, Nuno Ferrand (Portugal), Gareth Jones (United Kingdom)</td>
<td>Where is my bat? Ground-validation of presence-only modelling and its integration with molecular techniques for the conservation of rare species</td>
</tr>
<tr>
<td>17.20</td>
<td>S12.8 Modelling continental species richness of African bats at high resolution</td>
<td>Matthias K. B. Herkt, Günter Barnikel, Martin Wegmann, Elisabeth K. V. Kalko, Jakob Faehr</td>
<td>Modelling continental species richness of African bats at high resolution</td>
</tr>
<tr>
<td>18.00</td>
<td>S12.10 Environmental correlates of bat species richness in Central and southern Africa: effects of spatial structure, taxonomy and model selection</td>
<td>M. Corrie Schoeman, F. D. P. Cotterill, Peter J. Taylor (South Africa), Ara Monadjem (Swaziland)</td>
<td>Environmental correlates of bat species richness in Central and southern Africa: effects of spatial structure, taxonomy and model selection</td>
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</table>
S14  Anthropogenic impact on bats: from fragmentation to urbanization

Conveners: Kirsten Jung, Elisabeth K.V. Kalko, Raphael Arlettaz

09.40  S14.1  Effects of tropical forest fragmentation on aerial insectivorous bats in a land-bridge island system
Sergio Estrada-Villegas (Canada), Brian J. McGill (USA), Christoph F. J. Meyer (Portugal), Elisabeth K. V. Kalko (Germany, Panama)

10.00  S14.2  Reconsidering the importance of harvested forests for the conservation of tree-dwelling bats
Danilo Russo (Italy, UK), Luca Cistrone, Antonio Pietro Garonna (Italy), Gareth Jones (UK)

10.20  S14.3  Structural heterogeneity affects bats occurrence and activity in Central European forest stands
Kirsten Jung, Sonja Kaiser, Stefan Boehm, Jens Nieschulze, Ernst-Detlef Schulze, Elisabeth K. V. Kalko (Germany)

10.40  coffee

11.00  S14.4  Effects of connectivity and shape of landscape elements on bats
Annie Ehrenbold, Fabio Bontadina, Raphaël Arlettaz, Martin K. Obrist (Switzerland)

11.20  S14.5  Resource selection by slow- and fast-flying insectivorous bats in a heavily urbanized landscape
Rafael Avila-Flores (Mexico)

11.40  S14.6  Bat’s exploitation of cities: the importance of spatial and environmental variables
Thomas Sattler, Martin K. Obrist, Raphaël Arlettaz, Marco Moretti, Fabio Bontadina (Switzerland)
afternoon

Room B

New Approaches in the Study of Bat Flight

Conveners: Sharon Swartz and Anders Hedenström

S7

14.40  Introduction to the Symposium.
Sharon Swartz and Anders Hedenström

15.00  S7.1  Mechanics of soft tissue wing structures and the flight of bats.
Sharon Swartz, Jorn Cheney, Andrew Bearnot, Joseph Bahlman, Hannah Lippe, Daniel Riskin, Kenneth Riskin (USA)

15.20  S7.2  Flight constrains maximum size in bats.
Ulla M. Lindhe Norberg, R. Åke Norberg (Sweden)

15.40  coffee

16.00  S7.3  Does use of the uropatagium during flight give insight into the origin of flight in bats?
Rick A. Adams (USA)

16.20  S7.4  The conundrum of limb motion-echolocation linkage. Nice idea but where’s the evidence?
Stuart Parsons, Daniel Riskin, John Hermanson

16.40  S7.5  Context-dependent energetically optimal flight speeds in bats.
Marc Holderied (United Kingdom)

17.00  S7.6  Studying flight energetics in-situ using field deployable stable isotope analyzers.
Christian C. Voigt, Daniel Lewanzik

17.20  S7.7  The Trinity of Energy Conversion - Kinematics, Aerodynamics and Energetics of Bat Flight.
Rhea von Busse (Germany), Christoffer Johansson, Florian Muñres (Sweden), York Winter (Germany), Anders Hedenström

17.40  S7.8  The aerodynamics of different bat species
Tatjana Y. Hubel (USA, UK), Nickolay I. Hristov, Daniel K. Riskin (Riskin), Sharon M. Swartz (USA, UK), Kenneth S. Breuer (USA, UK)

18.00  S7.9  Aerodynamic performance of flapping bat flight using time-resolved wake visualization
Florian T. Muñres, L. Christoffer Johansson, Anders Hedenström (Sweden)
CA1  Echolocation, Flight and Inner Ear Adaptation in Bats
Kalina Davies, Norman MacLeod, Paul Bates (United Kingdom), Emma Teeling (Ireland), Stephen Rossiter (United Kingdom)

CA2  Bat Facial and Lip Projections: Unique Integumentary Morphology
Gary Kwiecinski, Paul Homnick, Daniel Herr, Giuseppe Bongiorno (USA)

CA3  A digestive perspective on nectar-feeding specialization in phyllostomid bats
Jorge Ayala-Berdon, Jorge E. Schondube (Mexico)

10.40  coffee

CA4  High activity enables life on a high sugar diet in nectar-feeding bats
Detlev H. Kelm, Ralph Simon, Christian Voigt, Doreen Kuhlau, Michael Ristow (Germany)

CA5  Dietary differences among nectar-feeding bats in French Guiana
Cullen K Geiselman (USA)

CA6  The effect of tributyltin on the complement pathway and oxidative stress level of Daubenton’s bats
Thomas Lilley, Janina Stauffer, Mirella Kanerva, Tatu Hiitola, Mikko Nikinmaa (Finland)
afternoon

Room C

Bat-fruit interactions: new findings from individual to community level

Conveners: Marco Aurelio Ribeiro Mello and Elisabeth K. V. Kalko

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<th>Time</th>
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<tr>
<td>14.40</td>
<td>S11.1</td>
<td>Frugivory and the diversification of phyllostomid bats</td>
<td>Elizabeth R. Dumont, Liliana M. Dávalos, Aaron Goldberg, Christian C. Voigt, Katja Rex, Sharlene E. Santana (USA)</td>
</tr>
<tr>
<td>15.00</td>
<td>S11.2</td>
<td>Bat-fruit interactions in the Neotropics: cohesive and resilient subsystems within seed dispersal networks</td>
<td>Marco Mello (Germany), Flavia Marquitti, Paulo Guimaraes (Brazil), Elisabeth Kalko (Germany, Panama), Pedro Jordano (Spain), Marcus Aguiar (Brazil)</td>
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<tr>
<td>15.20</td>
<td>S11.3</td>
<td>Mutualistic networks in frugivorous bats: effects of perturbations</td>
<td>Jorge Galindo-González, Víctor Rico-Gray, Cecilia Díaz-Castelazo, Alejandro Castro-Luna, Jesús R. Hernández Montero (Mexico)</td>
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<td>15.40</td>
<td>coffee</td>
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<tr>
<td>16.00</td>
<td>S11.4</td>
<td>Switching gears: The evolution of plasticity in feeding behavior and performance in phyllostomids</td>
<td>Sharlene E. Santana, Elizabeth R. Dumont (USA)</td>
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<tr>
<td>16.20</td>
<td>S11.5</td>
<td>Availability of food for frugivorous bats in Neotropical rainforests: the influence of flooding and of river banks</td>
<td>J. Tiago Marques, Maria João Pereira, Jorge M. Palmeirim (Portugal)</td>
</tr>
<tr>
<td>16.40</td>
<td>student</td>
<td>Bats drink mineral enriched water with a grain of clay at salt licks in Amazonian rain forests</td>
<td>Simon J. Ghanem, Hans Ruppert (Germany), Thomas H. Kunz (USA), Christian C. Voigt (Germany)</td>
</tr>
<tr>
<td>17.00</td>
<td>student</td>
<td>Small bats disperse large seeds: re-evaluating the seed dispersal service of Neotropical bats</td>
<td>Felipe Melo, Bernal Rodríguez-Herrera, Robin Chazdon, Rodrigo A. Medellín, Gerardo Ceballos</td>
</tr>
<tr>
<td>17.20</td>
<td>S11.8</td>
<td>Ontogeny of foraging of the short-nosed fruit bat Cynopterus sphinx in captivity</td>
<td>Suthakar S. Isaac, P. Augustus Robincs (India)</td>
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<tr>
<td>17.40</td>
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<td>General discussion</td>
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MONDAY morning

S10 Bat and parasites: implication for social life, disease transmission, and co-evolution
Conveners: Gerald Kerth and Christe Philippe

09.40 S10.1 Evolution of bat flies (Diptera; Hippoboscoidea): Implications for host-pathogen co-evolution
Katharina Dittmar, Bruce D. Patterson, Carl W. Dick, Matthew Gruwell, Jason R. Mayberry, Solon Morse (USA)

10.00 S10.2 The importance of ecological, physiological and phylogeographical factors to explain parasite distribution among hosts: an example with Spinturnicid mites and their bat hosts
Christe Philippe, Olivier Glaizot, Nadia Bruyndonckx, Raphaël Arlettaz (Switzerland)

10.20 S10.3 A comparison of genetic population structure in two bat host-parasite systems
A.J. van Schaik, G. Kerth, (Germany)

10.40 coffee

11.00 S10.4 How did bat parasites evolved to successfully adapt to their hosts?
Sofia Lourenço, Jorge M. Palmeirim (Portugal)

11.20 S10.5 Bat bugs of the family Cimicidae (Heteroptera)
Ondřej Balvín, Jitka Vilimová (Czech Republic)

11.40 S10.6 Endoparasites of pipistrelle bats
Jennifer Lord, Nicole Dodd, Geoff Hide, Darren Brooks (United Kingdom)

12.00 S10.7 Occurrence of bat ectoparasites in the Urals
Oleg Orlov, Maria Orlova (Russia)
afternoon

Room D

Speciation dynamics and taxonomy
Conveners: Manuel RUEDI and Peter BENDA

14.40 S4.7 Speciation and systematics of Malaysian Kerivoula inferred from multiple datasets
Faisal Ali ANWARALI KHAN, Sergio SOLARI, Vicki J. SWIER, Peter A. LARSEN, M. T. ABDULLAH, Robert J. BAKER (USA, Malaysia, Colombia)

15.00 S4.8 Each flying fox on its own branch: a phylogenetic tree for Pteropus
Francisca ALMEIDA (Spain), Simone LOSS (USA), Norberto P. GIANNINI (Argentina, USA), Kris HELGEN, Nancy SIMMONS (USA)

15.20 S4.9 The pipistrelle bats of Macaronesia: a phylogeographic approach
Javier JUSTE, Domingo TRUJILLO, Carlos IBÁÑEZ (Spain)

15.40 coffee

16.00 S4.10 Mitochondrial DNA Relationships among North Palearctic Eptesicus species
Ilya ARTYUSHIN, Anna BANNIKOVA, Vladimir LEBEDEV, Sergey KRUSKOP (Russia)

16.20 S4.11 Deep differentiation between and within Mediterranean glacial refugia in the Myotis nattereri bat
Irene SALICINI, Carlos IBÁÑEZ, Javier JUSTE (Spain)

16.40 S4.12 Current challenges in the taxonomy of Vietnamese Myotis
Sergey KRUSKOP (Russia), Alex BORISENKO (Canada)

17.00 S4.13 What is new in systematics of the genus Scotophilus (Vespertilionidae) in Africa?
Peter VALLO, Petr BENDA, Petr KOUBEK (Czech Republic)
MONDAY

W1

MONDAY evening : Room B 20.00

W1: CEI Workshop

Bats of Balkans and Eastern Mediterranean: implementation of monitoring schemes and conservation measures

The long term monitoring, performed in central Europe for more than 40 years, revealed dramatic variations in population development of particular bat species and remarkable interspecific and interregional differences in the respective trends. Unfortunately, almost no such information is still available from SE Europe and Middle East. The present workshop is an attempt to find the measures to fill the gap.

The workshop sponsored by the CEI (Central European Initiative) funds that should provide a platform to the experts in bat research and bat conservation from Central, Eastern and Southern Europe as well as those from Middle East to share their experience in monitoring and conservation of bats in their countries and discuss possibilities of unifying the methods and concept of monitoring bat populations throughout the region. The workshop expects to (a) refine information on current distribution and conservation status of particular bat species in the region, and (b) establish a common scheme of long-term monitoring of bat populations in the region operating with unified methods and common outputs, and (c) propose a platform for further monitoring and cooperation in bat studies and bat conservation in the region.

Conveners:
Zdeněk Řehák, Radek K. Lučan, Tomáš Bartonička, Ivan Horáček (Czech Republic) Marcel Uhrin (Slovakia)

W2

TUESDAY evening : Room A 18.00

Workshop W2:
White Nose Syndrome in Europe: state of knowledge and the Action plan

An open platform for discussions on topics of WNS in Europe. The aim of the workshop is to refine the way of international co-operation, to survey the current status of knowledge across Europe and /or to specify issues of the Action plan and its implications if necessary.

W2 Conveners:
Sébastien Puechmaille (Ireland), Natália Martínková (Czech Republic)
Room E

Contributed session: BEHAVIOUR
Chairpersons: Ganapathy MARIMUTHU and Marc HOLDERIED

14.40 CB1 “Noisy neighbours”: Do long-tailed bats (Chalinolobus tuberculatus) alter their evening activity in response to aircraft noise?
Darren LE ROUX, Joseph R. WAAS (New Zealand)

15.00 CB2 Dynamics of roost entrance in a leaf-roosting bat
Gloriana CHAVERRI (USA), Karina MONTERO (Costa Rica)

15.20 CB3 Do bats recognize their predators?
Tess DRIESSENS (Belgium), Björn SIEMERS (Germany)

15.40 coffee

16.00 CB4 Sensory basis of habitat recognition in echolocating bats
Stefan GREIF, Björn M. SIEMERS (Germany)

16.20 CB5 The scanning behaviour of free ranging Barbastelle bats (Barbastella barbastellus)
Anna-Maria SEIBERT, Jens C. KOBLITZ, Annette DANZINGER, Hans-Ulrich SCHNITZLER (Germany)

16.40 CB6 Behavioral evidence for eavesdropping on prey song in two Palearctic sibling bat species
Patricia L. JONES (Germany, USA), Rachel A. PAGE (Germany)
Manfred HARTBAUER (Austria), Björn M. SIEMERS (Germany)

17.00 CB7 Echolocating bats achieve high prey detection performance with broadband calls
Daniela A. SCHMIEDER (Germany), Tigga KINGSTON (USA), Rosli HASHIM (Malaysia), Björn M. SIEMERS (Germany)

17.20 CB8 Source levels of echolocation signals vary in correlation with wing beat cycle in landing Big Brown bats (Eptesicus fuscus)
Jens C KOBLITZ, Peter STILZ, Hans-Ulrich SCHNITZLER (Germany)

17.40 CB9 Emission and echo SPL in foraging Greater Mouse-eared bats (Myotis myotis) at different target strength
Tobias BUDENZ, Annette DENZINGER, Hans-Ulrich SCHNITZLER (Germany)

18.00 CB10 Emitting echolocation calls through nose or mouth in Trachops cirrhosus (Phyllostomidae)
Line F. JOHANNESEN (Denmark), Elisabeth K. KALKO (Germany), Rachel PAGE (USA), Annemarie SURLYKKE
### S2: Adaptations and Evolutionary Ecology

**Convener:** David S. Jacobs

#### 09.40 S2.1 Adaptation of echolocation call intensity to ecological constraints in phyllostomid bats
Signe Brinklov, Elisabeth K. V. Kalko, Annemarie Surlykke (Germany)

#### 10.00 S2.2 Bat-frog interactions: Learning, categorization and memory
Rachel A. Page (Panama)

#### 10.20 S2.3 Spread your wings and fly: behavioural flexibility and niche breadth in a depauperate bat community
John Ratcliffe (Denmark), Reese McMillan (Canada), Jaime Tanner (USA), James Fullard (Canada)

#### 10.40 Coffee

#### 11.00 S2.4 The relationship between geographic range size and niche breadth in African Horseshoe bats
Jonathan Aronson, David Jacobs (South Africa)

#### 11.20 S2.5 Sensory escape from a predator-prey arms race: low amplitude biosonar beats moth hearing
Hannah M. ter Hofsteede, Holger R. Goerlitz, Matt R. K. Zeale, Gareth Jones, Marc W. Holderied (United Kingdom)

#### 11.40 S2.6 What, if anything, can variation in echolocation calls tell us about speciation in bats?
David Jacobs (South Africa)

#### 12.00 S2.7 Factors affecting the emergence times of several sympatric insectivorous bat species
Alicia Thomas, David Jacobs (South Africa)
### afternoon

**Room A**

#### Bats and pathogen emergence

**Conveners:** Sébastien J. Puechmaille and Meriadeg Ar Couil

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<tr>
<td>14.40</td>
<td>S17.1</td>
<td><strong>White-nose Syndrome in North America</strong></td>
<td>David Blehert, Carol Meteyer, Anne Ballmann, Jeff Lorch, Brenda Berlowski-Zier, Laura Muller, Paul Cryan (USA)</td>
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<tr>
<td>15.00</td>
<td>S17.2</td>
<td><strong>The Potential Threat of White Nose Syndrome to European Bats: An Action Plan</strong></td>
<td>Paul Racey (United Kingdom) on behalf of the White Nose Syndrome Consortium</td>
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<td>15.20</td>
<td>S17.3</td>
<td><strong>Detection of emerging viruses in bat guano</strong></td>
<td>L.L.M Poon, D.K.W Chu, J.S.M. Peiris (Hong Kong)</td>
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<td>16.00</td>
<td>S17.4</td>
<td><strong>Volant Viruses: a metaviromic study of a West African bat population</strong></td>
<td>KS Baker, M Caccamo, G Daly, N Bexfield, Kellam P (UK), Suu-Ire R (Ghana), Hayman DTS, Heeney J, Cunningham AA, Wood JLN, Murcia P (UK)</td>
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<td>16.20</td>
<td>S17.5</td>
<td><strong>Disease investigations in Straw Coloured Fruit Bats (Eidolon helvum) in the Gulf of Guinea islands</strong></td>
<td>Alison J. Peel, Loras Andrés Fernández, Kate S Baker, David T.S Hayman, Alexandra Kamins, Stephen J. Rossiter, David R. Sargan, Andrew A. Cunningham, James L.N Wood (United Kingdom)</td>
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<td>16.40</td>
<td>S17.6</td>
<td><strong>Human-made landscapes drive livestock rabies outbreaks transmitted by Desmodus rotundus in Mexico</strong></td>
<td>Rafael Avila-Flores, Alvaro Aguilar-Setién, Nidia Aréchiga-Ceballos, Alfonso De Vega, Dolores Manzano-Martínez, Rodrigo A. Medellín, Gerardo Suzán, Heliot Zarza (Mexico)</td>
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<td>17.00</td>
<td>S17.7</td>
<td><strong>Multi-spatial approach for monitoring and modeling bat rabies in Puebla México</strong></td>
<td>Gerardo Suzán, Rafael Ávila-Flores, Roberto Carrasco, Oscar Rico, Heliot Zarza, Angélica Menchaca, Guillermo Lacy, Brenda Cortés, Dolores Manzano-Martínez, Elizabeth Loza-Rubio, Edith Rojas, Nidia Aréchiga-Ceballos, Rodrigo A. Medellín (Mexico)</td>
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<td>17.20</td>
<td>S17.8</td>
<td><strong>Control of livestock paralytic rabies in eastern Mexico: an innovative scientific research-based approach</strong></td>
<td>Dolores Manzano-Martínez, Alvaro Aguilar-Setién, Nidia Aréchiga-Ceballos, Rafael Avila-Flores, Alfonso De Vega, Rodrigo A Medellín, Gerardo Suzán, Heliot Zarza (Mexico)</td>
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<td>17.40</td>
<td>S17.9</td>
<td><strong>Emerging infectious diseases as an opportunity for bat conservation</strong></td>
<td>Gary F. McCracken (USA)</td>
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</table>
09.40  CC1  Anthropogenic impacts on bat communities: demography and biotic homogenisation  Grégoire Lois, Christian KerBiriou, Jean-François Julien (France)

10.00  CC2  Recurring fires in Mediterranean habitats and their impact on bats  Xavier Puig-Montserrat, Carles Flaquer, Ruth G. Ràfols, Adrià L. Baucelets (Spain)

10.20  CC3  Roads and bats: landscape, road features and bat ecology effects on road kills and activity  Denis Medinas, Tiago Marques, António Mira (Portugal)

10.40  coffee

11.00  CC4  Hoary bat (Lasiurus cinereus) and Brazilian free-tailed bat (Tadarida brasiliensis) mortality at the Montezuma Hills wind energy region in Central California  Dave S. Johnston, Judd A. Howell, Nellie Thorngate, Scott B. Terrill, and James Castle (USA)

11.20  CC5  Barbed wire fences and Hawaiian hoary bats: what we know  Jeff Zimpfer, Frank Bonaccors (USA)
Anthropogenic impact on bats: from fragmentation to urbanization

Conveners: Kirsten Jung, Elisabeth K.V. Kalko, Raphael Arlettaz

14.40  S14.7 “Waiter, there’s a bat in my soup!” Implications of fruit bats as bushmeat in Ghana, West Africa
Alexandra Kamins, Olivier Restif, Marcus Rowcliffe, Andrew Cunningham (United Kingdom), Yaa Ntiamaa-Baidu (Ghana), James Wood (United Kingdom)

15.00  S14.8 Bats and Mine Closure: A Double-edged Sword
Patricia E. Brown (USA)

15.20  S14.9 Spatial activity and diet of Rousettus aegyptiacus on Cyprus: does conservation of the only European megabat depends on supporting alien plants?
Radek K. Lucan, Tomáš Bartoníčka, Martin Čížek, Petr Jedlička, Šimon Řeřucha, Martin Šálek, Haris Nicolaou, Ivan Horáček (Czech Republic and Cyprus)

15.40  coffee

16.00  S14.10 The importance of distance variables in the modelling of bat foraging habitat
Ana Rainho, Jorge M. Palmeirim (Portugal)

16.20  S14.11 Exposure of bats to endocrine disrupting chemicals at sewage treatment works
Kirsty J Park, CT Müller (United Kingdom), S Markman (United Kingdom, Israel), O Swinscow-Hall, D Pascoe (United Kingdom), K Buchanan (United Kingdom, Australia)

16.40  S14.12 Species-specific barrier effects of a motorway on the habitat use of two endangered bat species and the role of connecting elements
Markus Melber, Gerald Kerth (Germany)

17.00  S14.13 Bat traffic along Irish motorways - how to reduce the toll for commuting bats?
Isobel Abbott, Fidelma Butler, Simon Harrison (Ireland)

17.20  S14.14 Linking habitat loss and bat decline: the conservation biology of the grey long-eared bat in England
Orly Razgour, Gareth Jones (UK)

17.40  S14.15 A multi-faceted research programme deciphers the mechanism of decline of a rare European bat
Raphaël Arlettaz, Fabio Bontadina (Switzerland)
Bats as inspiration for biomimetic robots

Conveners: Annemarie SURLYKKE, Elisabeth K.V. KALKO

09.40 S16.1 Bats as inspiration for biomimetic robots
Annemarie SURLYKKE (Denmark)

10.20 S16.2 Task related flexibility in echolocation behaviour of Noctilio leporinus
Kirstin ÜBERNICKEL, Elisabeth K.V. KALKO (Germany)

11.00 S16.3 Echolocation strategies for object recognition in dense rainforest for two gleaning bats, Micronycteris microtis and Thyroptera tricolor
Inga GEIPEL, Elisabeth K. V. KALKO (Germany)

10.40 coffee

11.20 S16.4 Generating Rich Emission Beams for Echolocation
Roman KUC (USA)

11.40 S16.5 Dynamics of the echolocation beam shape in vespertilionid bats
Lasse JAKOBSEN, Annemarie SURLYKKE (Denmark)
### Adaptations and Evolutionary Ecology

**Convener:** David Jacobs

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Contributed session MONITORING
Chairpersons: Friederike SPITZENBERGER, Roger RANSOME

09.40  CM1  Bats and bat research in the Moravian Karst: 1850–2010
Jiří GAISLER, Miroslav KOVAŘÍK, Zdeněk ŘEHÁK, Jan ZIMA, Jan ZUKAL (Czech Republic)

10.00  CM2  A methodology for searching and monitoring diurnal roosts
Adalberto CESARI, Ana Carolina D’OLIVEIRA PAVAN, Guilherme Siniciato Terra GARIBINO, Carla Cristina AQUINO, Thalita Fonseca ALVES (Brazil)

10.20  student  CM3  Project PteroCount - an initiative towards the conservation of bats in South Asia
Joseph Reginald LOUIS, Sanjay MOLUR (India), Shahroukh MISTRY (USA)

10.40  coffee

11.00  student  CM4  Bats and Wind Farms: relationship between bat activity and fatalities, methodologies evaluation and influence of environmental and ecological factors on mortality
Francisco AMORIM, Luísa RODRIGUES (Portugal)

11.20  CM5  Results of the Indicator Bats (IbatsRo) programme in Romania between 2006–2009
Abigél SZODORAY-PÁRÁDI (Romania), Kate JONES (United Kingdom), Farkas SZODORAY-PÁRÁDI (Romania)

11.40  CM6  Climate change linked range expansion of Nathusius pipistrellus bat
Mathieu LUNDY, Ian MONTGOMERY, Jon RUSS (United Kingdom)
Past to Present: Fossils and the Evolutionary History of Bats
Convener: Gregg Gunnell

14.40 S1.0 Welcome and Introductory Remarks by Gregg Gunnell

15.00 S1.1 Dental characteristics of the most primitive known bat Onychonycteris finneyi
Gregg F. Gunnell, Nancy B. Simmons (USA), Jörg Habersetzer, (Germany), Paul M. Velazco, Peter D. Smits (USA)

15.20 S1.2 Evolution of body mass in Old and New-World Leaf-nosed bats
Norberto P. Giannini, Liliana M. Dávalos, Gregg Gunnell, Nancy B. Simmons (Argentina, USA)

15.40 coffee

16.00 S1.3 New data on the early Eocene bats of Vastan, India
Thierry Smith (Belgium), Rajendra Rana, Ashok Sahni, Kishor Kumar (India), Kenneth Rose (USA)

16.20 S1.4 An exceptionally well-preserved hipposiderid fauna from a middle Miocene cave deposit in the Riversleigh World Heritage Area, Queensland, Australia
Karen H. Black, Suzanne J. Hand, Mike Archer, Henk Godthelp (Australia)

16.40 S1.5 Multiple invasions of Australasia by New World bats? Evidence from the fossil record
Suzanne J. Hand, Trevor H. Worthy (Australia), Robin M.D. Beck (USA), Jennifer P. Jones (Australia), Alan J.D. Tennyson, R. Paul Scofield (New Zealand), Mike Archer (Australia)

17.00 S1.6 Inferring the evolutionary factors from rates of phenotypic divergence in Myotis
Igor Dzeverin, Maria Ghazali (Ukraine)

17.20 S1.7 A Phylogeny of the Neotropical stenodermatine bats (Chiroptera: Phyllostomidae): putting the fossils in the context
Valéria da C. Tavares (Brazil), F. Balseiro, C. Mancina, (Cuba)

18.00 S1.8 The Quaternary fossil record of Bats in Spain: an update
Paloma Sevilla, Juan Manuel López-García (Spain)

18.20 S1.C Summary Remarks by Gregg Gunnell

Page 41
09.40 CT1 Some difficulties of using integrated approach in bat taxonomy
Mikhail P. TIUNOV (Russia)

10.00 CT2 Should we standardize international English common names of bats?
Samantha STOFFBERG, Philip A.R HOCKEY, Corrie M. SCHOEMAN (South Africa)

10.20 CT3 Taxonomic Network for Southeast Asian Bats
Paul BATES (United Kingdom), Pipat SOISOOK ((Thailand), Bounsavane DOUANGBOUBPHA (Laos), Saveng ITH (Cambodia), Vu Dinh THONG (Vietnam), Si Si Hla Bu (Myanmar), Neil FUREY (Cambodia), Nikky HAMMOND (United Kingdom), Chutam SATASOOK (Thailand)

10.40 coffee

11.00 CT4 Taxonomic researches of some Southeast Asian Horseshoe bats
Pipat SOISOOK, Kwan NUALCHAROEN, Ariya DEJTARADOL (Thailand), Saveng ITH (Cambodia), Sara BUMRUNGSR, Chutamas SATASOOK (Thailand), Paul BATES (United Kingdom)

11.20 CT5 Acoustic and Genetic variation in Rhinolophus rouxii in South India
Balaji CHATTOPADHYAY, A Vinoth Kumar KUMARAVEL, Kritika M GARG, Paramanatha Swami DOSS DEVARAJ (India), Gerd SCHULLER (Germany), Uma RAMAKRISHNAN, Sripathi KANDULA (India)

11.40 CT6 Genetic variation in Cynopterus sphinx
Balaji CHATTOPADHYAY, M Kritika GARG, A Vinoth Kumar KUMARAVEL, Paramanatha Swami DOSS DEVARAJ (India), Uma RAMAKRISHNAN, Sripathi KANDULA (India)

12.00 CT7 Toward a molecular phylogeny for the Molossidae (Chiroptera) of Africa and the Western Indian Ocean region
Jennifer M. LAMB, Taryn M. C. RALPH, Theshnie NAIDOO, Peter J. TAYLOR, Fanja RATRIMOMANARIVO, William STANLEY, Steven M. GOODMAN
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<td>15.00</td>
<td>CD2</td>
<td>Phylogeography and Population Genetic Structure of <em>Rhinopoma microphyllum</em> in Iran</td>
<td>Vahid Akhani, Ali Farazmand, Jamshid Darvish, Mozafar Sharifi (Iran)</td>
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<td>15.20</td>
<td>CD3</td>
<td>Habitat and Morphology of emballonurids of Pakistan</td>
<td>Muhammad Mahmood-ul-Hassan, Arshad Javid, Sana Ashraf (Pakistan)</td>
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<td>16.00</td>
<td>CD4</td>
<td>Habitat and morphology of Greater Asiatic yellow house bat, <em>Scotophilus heathii</em> (Microchiroptera: Vespertilionidae)</td>
<td>Arshad Javid, Muhammad Mahmood-ul-Hassan (Pakistan)</td>
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<td>16.20</td>
<td>CD5</td>
<td><em>Miniopterus schreibersii</em> pallidus or <em>Miniopterus pallidus</em>: the current evidence</td>
<td>Andrzej Furman (Turkey), Tomasz Postawa (Poland), Emrah Coraman (Turkey)</td>
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<td>16.40</td>
<td>CD6</td>
<td>The Distribution of Genetic Diversity of <em>Miniopterus schreibersii</em>, in Europe and Anatolia</td>
<td>Rasit Bilgin, Onçü Maraci (Turkey), Sébastien J Puechmaille (Ireland), Primož Presetnik (Slovenia), Daniela Hamidovic, Norma Fressel (Croatia), Branko Karanpandža, Milan Paunović (Serbia), Carlos Ibañez (Spain), Benjamin Allegreni (France), Kanat Gürün (Turkey), Panagiotis Georganakis (Greece), Macel Uhrin (Slovakia), Petr Bend (Czech Republic), Javier Juste (Spain)</td>
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<td>CD7</td>
<td>Distribution and migratory status of <em>P. pipistrellus</em> and <em>P. pygmaeus</em> in the Russian Caucasus</td>
<td>Suren Gazaryan (Russia)</td>
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<td>17.20</td>
<td>CD8</td>
<td>Zoogeographical analysis of the Caucasian bat fauna</td>
<td>Irina K. Rakhatmulina (Azerbaijan)</td>
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<td>17.40</td>
<td>CD9</td>
<td>Spatial model of bovine rabies transmitted by <em>Desmodus rotundus</em>. Landscape structure and edges related to rabies risk</td>
<td>Roberto Carrasco-Hernández, María Dolores Manzano-Martinez, Carlos Bautista, Alfonso de Vega-García, Ana Flisser, Rodrigo A. Medellín, Gerardo Suzán (Mexico)</td>
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09.40  S3.0  Introduction: Gerhard Neuweiler and bat echolocation research
(Björn Siemers)

09.50  S3.1  In memory of Gerhard Neuweiler: The auditory fovea, an adaptation for flutter
detection in echolocating bats using CF-FM signals
Hans-Ulrich Schnitzler, Annette Denzinger (Germany)

10.20  S3.2  Role of FoxP2 expression in the control of vocalizations in echolocating and
non-echolocating bats
Walter Metzner (USA), Shuyi Zhang (China)

10.40  coffee

11.00  S3.3  Beyond echolocation: bats as models for acoustic communication
Sabine Schmidt (Germany)

11.20  S3.4  Foraging activity of Central European bats in winters of varying severity?
A study dedicated to the memory of Prof. Gerhard Neuweiler who long encouraged
ecological research in endangered European bats
Andreas Zahn, Eva Kriner, Robert Mayer (Germany)

11.40  S3.5  A bony connection signals laryngeal echolocation in bats
Paul A. Faure, Nina Veselka, David D. McEr lain, David W. Holdsworth, Judith L. Eger (Canada), Rethy Chhem (Austria),
Matthew J. Mason, Kirsty L. Brain (United Kingdom), M. Brock Fenton (Canada)
morning

Room B

Bat extinctions: past, present, and future
Conveners: Nancy SimmonS and Liliana DÁVAlOS

09.40  S5.1  Cenozoic patterns of origination and extinction in bat communities
Gregg F. GUNNELL, (USA)

10.00  S5.2  Historical and imminent bat extinctions: documenting extinctions and discerning patterns
Kristofer M. HELGEN (USA)

10.20  S5.3  Complementarity in extinction drivers among Caribbean endemic bats
Liliana DÁVAlOS, Amy L. RUSSELL (USA)

11.00  coffee

11.40  S5.6  The Status of White-Nose Syndrome in North America ¹)
Jeremy T.H.COLEMAN, Alan C. HICKS, David S.BLEHERT, Anne E.BALLMANN, Paul M. CRYAN, Noell L. RAYMAN (USA)

¹) abstract inserted at the end of the Book of abstracts

11.20  S5.5  Bat extinctions in the Australasian Region: view from the fourth dimension
Suzanne J. HAND, Michael ARCHER, Henk GODTHELP (Australia)

12.00  S5.7  Impacts of White-Nose Syndrome on Population Viability of Little Brown Myotis (Myotis lucifugus)
Winifred F. FRICK, Jacob F. POLLOCK, Kate E. LANGWIG, Thomas H. KUNZ (USA)

12.20  S5.8  Prioritising the unkown
K.E. JONES, K. SAFI (United Kingdom)
Room C  WEDNESDAY

S15 Diversity, systematics and conservation of South American bats.
Conveners: Valeria C.TAVARES, Ludmilla M.S. AGUIAR, Enrico BERNARD, Renato GREGORIN

09.40  S15.1  The diversity of Brazilian bats: an update with comments on species distribution and taxonomy
Valéria da C. TAVARES, Renato GREGORIN (Brazil)

10.00  S15.2  Biodiversity, systematics, and conservation of bats from the Guianan subregion of northern Amazonia
Burton K LIM. (Canada), Valéria da C. TAVARES (Brazil)

10.20  S15.3  Advances of the Colombian chiropterology, biodiversity, ecology, and conservation
Hugo MANTILLA-MELUK, Robert J. BAKER (USA), Alex Mauricio JiméNEZ (Mexico)

10.40  coffee

11.00  S15.4  Richness of bats in the Floresta Nacional Tapirape-Aquiri, State of Para, Northern Brazil
Adalberto CESARI, AnaCarolina D PAVAN, Marcus VB OLIVEIRA, Guilherme ST GARBINO, Carla C AQUINO, Luciana G PEREIRA, Simone S Martins, Thalita F. ALVES, Juliana G BARROS, Caroline C AIRES, Felipe M MARTINS, Fabio O NASCIMENTO (Brazil)

11.20  S15.5  The underestimated diversity of bats in Brazil: idiosyncratic limitations or shared concerns within South America about collection management and systematic practices?
Renato GREGORIN, Valéria Cunha TAVARES (Brazil)

11.40  S15.6  Better knowing the Brazilian bats: a 200-years task?
Enrico BERNARD, Ludmilla M.S. AGUIAR, Ricardo B. MACHADO (Brazil)

12.00  S15.7  Bat conservation in Brazil: the Lonchophylla dekeyseri Action Plan
Ludmilla M.S. AGUIAR, Ricardo B. MACHADO (Brazil)
morning

Contributed session  **CONSERVATION II**  
**Chairpersons:** Sripathi Kandula, Danilo Russo  

09.40 CC6  **Ecology of Bats of India: Synthesis for Future Directions**  
Joseph Reginald Louis, Riki Krishnan, Pramod Padmanabhan, Sanjay Molur (India)

10.00 CC7  **Role of Latidens salimalii (endemic endangered Fruit Bat of South India) in forest restoration of Southern Western Ghats, India**  
Juliet Vanitharani, Veliah Chelladurai (India)

10.20 CC8  **Bats: Conservation and Ecotourism, the experience at Tirimbina Rainforest**  
Carlos Chavarría, Bernal Rodríguez-Herrera (Costa Rica)

10.40  coffee

11.00 CC9  **Patterns of habitat use by bats in a mosaic of land-use types in a biodiversity hotspot in Southern Chile**  
Paul A. Heady III, Winifred F. Frick (USA), Mauricio Soto-Gamboa (Chile), Christine N. Meynard (France)

11.20 CC10  **Bat fauna in Chernobyl Exclusion Zone**  
Sergij Gashchak, Anton Vlaschenko, Alexander Naglov (Ukraine), Nicholas Beresford (United Kingdom)

11.40 CC11  **Bat communities in a fragmented landscape in southern Western Ghats: status, ecology and conservation**  
Eleni K. Fou (India), John D. Altringham (UK), Mahesh Sankaran (India), Christine Singfield (UK), Divya Mudappa (India), Jacobus Biesmeijer (UK)
Room E   WEDNESDAY

Contributed session  ECOLOGY I
Chairpersons: Hans Baагoe, Jorge Encarnacao

09.40  CE7  How hot is my home: Temperature of different types of tents
Bernal Rodríguez-Herrera, Viquez-R Luis (Costa Rica)

10.00  CE8  How affect the origin to thermal preference and hibernation period of Myotis formosus in Korea?
Sun-Sook Kim, Yu-Seong Choi, Bong-Hyeon Kim, Jeong-Chil Yoo (Korea)

10.20  CE9  One bushman and two quasi-villagers: roost selection in three cryptic whiskered bats (Myotis alcathe, Myotis mystacinus and Myotis brandtii)
Radek K. Lučan, Tomáš Bartoníčka, Tereza Brezinová, Helena Jahelková, Martin Šálek, Tereza Vlasatá (Czech Republic)

10.40   coffee

11.00  CE10 Between a rock and a wet place: Home range and habitat associations of a maternity colony of Myotis mystacinus (whiskered bat) in a lowland agricultural landscape
Daniel J. Buckley (Ireland), Mathieu G. Lundy (United Kingdom), Emma S.M. Boston (Ireland), David D Scott, Ian W. Montgomery, Paulo Prodöhl (United Kingdom), Ferdia Marnell, Emma C. Teeling (Ireland)

11.20  CE11 From crevice to edge: Ecology of Myotis brandtii in a landscape cultivated by man
Anika Lustig, Wigbert Schorchht, Andreas Zahn (Germany)

11.40  CE12 Habitat and breeding roost selection by Myotis bechsteinii. What limits the species distribution in the Mediterranean range?
María Napal, Inazio Garin, Urtzi Goiti, Egoitz Salsamendi, Joxerra Aihartza (Spain)

12.00  CE13 Patterns of habitat use by female Plecotus auritus and predicted negative impacts of woodland management
David A. Hill (Japan), Stephanie E Murphy, Frank Greenaway (United Kingdom)
morning
THURSDAY morning

S9 Global bat Monitoring and Bioindication

Conveners: Kate Jones and Tomáš Bartoníčka

09.40 S9.1 Ecosystem services provided by bats
Thomas H. Kunz, Elizabeth Braun de Torrez, Dana M. Bauer, Tatyana A. Lobova, Theodore H. Fleming (USA)

10.00 S9.2 Getting the measure of biodiversity: Bats and global biodiversity indicators
Ben Collen, Louise McRae, Jonathan Loh (Switzerland)

10.20 S9.3 Bat monitoring and the development of multi-species indicators
Karen A. Haysom (United Kingdom)

10.40 coffee

11.00 S9.4 Monitoring ultrasonic biodiversity: using bats as biodiversity indicators
K.E. Jones, J. Russ (United Kingdom)

11.20 S9.5 From revision of red list to bat biodiversity monitoring: procedures, first results, and projections
Martin K. Obriost, Fabio Bontadina, Thierry Bohnenstengel, Pascal Moeschler, Hubert Krättli (Switzerland)

11.40 S9.6 Czech and Slovak bat monitoring schemes: experiences, results, inspirations
Ivan Horáček, Tomáš Bartoníčka, Marcel Uhrin, Czech Bat Conservation Trust, Slovak Bat Protection Society
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<td>S8.1</td>
<td>Migratory structure and geographic origins of hoary bats (<em>Lasiurus cinereus</em>) inferred from stable isotope analysis</td>
<td>Paul M. CRYAN, Craig A. STRICKER, Michael B. WUNDER (USA)</td>
</tr>
<tr>
<td>15.00</td>
<td>S8.2</td>
<td>Using stable isotopes to trace bat migrations in Europe</td>
<td>Ana G. POPA-LISSEANU, Christian C. VOIGT (Germany)</td>
</tr>
<tr>
<td>15.20</td>
<td>S8.3</td>
<td>Physiological ecology of migration and stopover in North American tree bats</td>
<td>Liam P. MCGUIRE, M. Brock FENTON, Christopher G. GUGLIELMO (Canada)</td>
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<td>15.40</td>
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<tr>
<td>16.00</td>
<td>S8.4</td>
<td>Marco! Polo! Social calls used by <em>Thyroptera tricolor</em> for locating roostmates</td>
<td>Erin H. GILLAM, Glorianna CHAVERRI (USA)</td>
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<tr>
<td>16.20</td>
<td>S8.5</td>
<td>Spatio-temporal variability in nightly dispersal patterns of <em>Tadarida brasiliensis</em>: Modeling bat movements in 3D</td>
<td>Winifred F. FRICK, Kenneth W. HOWARD, Phillip B. CHILSON, Thomas H. KUNZ (USA)</td>
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<tr>
<td>16.40</td>
<td>S8.6</td>
<td>Bat-like creatures engaged in high-altitude migratory and feeding or reproductive behavior over temperate landscapes in North America</td>
<td>Ronald P. LARKIN, Alex R. HOAR, Louise C. ALLEN, Margrit BETKE, Nickolay I. HRISTOV, Thomas H. KUNZ (USA)</td>
</tr>
<tr>
<td>17.00</td>
<td>S8.7</td>
<td>Scales of movement by a long-distance migrant: the Brazilian free-tailed bat (<em>Tadarida brasiliensis</em>)</td>
<td>Nickolay I. HRISTOV, Margrit BETKE, Sharon M. SWARTZ, Thomas H. KUNZ (USA)</td>
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<tr>
<td>17.20</td>
<td>S8.8</td>
<td>Using satellite telemetry to assess movement patterns of <em>Pteropus</em> spp.</td>
<td>Jonathan H. EPSTEIN (USA), Craig S. SMITH (Australia), Andrew BREED (United Kingdom), Raina PLOWRIGHT (USA), Hume E. FIELD (Australia), Peter DASZAK (USA)</td>
</tr>
<tr>
<td>17.40</td>
<td>S8.9</td>
<td>The urban crowd: foraging ecology of straw-coloured fruit bats (<em>Eidolon helvum</em>) from the non-migratory subpopulation in Accra, Ghana</td>
<td>Dina K.N. DECHMANN (Germany), Richard SUU-IRE (Ghana), Martin WIKELSKI, Jakob FAHR (Germany)</td>
</tr>
</tbody>
</table>
CE3  Contributed session ECOLOGY II
Chairpersons: Luis Aguirre, Ran Nathan

09.40  CE14  Elliptic Fourier Descriptors (EFDs) discriminate the echolocation calls of myotine bats
Mathieu Lundy (United Kingdom), Emma Teeling, Emma Boston (Ireland), David Scott (United Kingdom), Daniel Buckley (Ireland), P. Prodöhl (United Kingdom), Ferdia Marnell (Ireland), Ian Montgomery (United Kingdom)

10.00  CE15  The white tent-making bat and the period of roost availability during forest succession
Melquisedec Gamba-Ríos, Eugenia Cordero Schmidt, Bernal Rodriguez Herrera (Costa Rica)

10.20  CE16  Dynamics of cave use by cave-dwelling bats in arid and semiarid zones in Northern Venezuela
Ariany García-Rawlins, Jafet M Nassar, Fernando Simal (Venezuela)

10.40  coffee

11.00  CE17  Insectivorous bat activity in habitats with water bodies in central and south Mexico
M. Cristina MacSwiney González, Antonio Guillén-Servent (Mexico)

11.20  CE18  Gallery forests boost bat diversity in southern Mali, West Africa
Natalie Weber (Germany), Laurent Granjon (Senegal), Jakob Fahr (Germany)

11.40  CE19  The use of natural and artificial bodies of water by desert and non desert species of bats
Carmi Korine, Orly Razgour, Uzi Shamir, David Saltz, Itzhak Benson (Israel)
### Integrating information across multiple molecular markers: current and future studies in bat genetic research

**Conveners:** Stephen J. Rossiter and Pavel Hulva

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<tr>
<td>14.40</td>
<td>S6.1</td>
<td>The impact of environmental niche specialisation on the evolution of olfaction in bats</td>
<td>Sara Hayden, Micheal Beakert, Emma C. Teeling (Ireland)</td>
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<td>15.00</td>
<td>S6.2</td>
<td>Variation in candidate genes for cranial evolution in phyllostomid bats</td>
<td>Caleb Phillips, Hugo Mantilla, Robert Baker (USA)</td>
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<tr>
<td>15.20</td>
<td>S6.3</td>
<td>Hearing genes: insights from phylogenetic discordance</td>
<td>Stephen Rossiter (United Kingdom), Yang Liu (China), Gang Li (USA), James Cotton (United Kingdom), Gareth Jones (UK), Shuyi Zhang (China)</td>
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<td>16.00</td>
<td>S6.4</td>
<td>Blind as a Bat? Comparative Genomics Brings Light to the Evolution of Color Vision in Bats</td>
<td>Bruno F. Simoes (Ireland), Huabin Zhao, Shuyi Zhang (China), Stephen Rossiter (UK), Emma C. Teeling (Ireland)</td>
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<td>16.20</td>
<td>S6.5</td>
<td>A phylogenetic analysis of Pteropodidae based on multi-locus molecular data</td>
<td>Francisca C. Almeida (Spain), Norberto P. Giannini (Argentina, USA), Nancy Simmons (USA)</td>
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<td>16.40</td>
<td>S6.6</td>
<td>Molecular phylogeny and systematics of Old World serotine bats (genus Eptesicus, Vespertilionidae, Chiroptera)</td>
<td>Javier Juste (Spain), Petr Benda (Czech Republic), Juan Luis Garcia-Mudarra, Carlos Ibáñez (Spain)</td>
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<td>17.00</td>
<td>S6.7</td>
<td>Hypothesis testing in genetic demography: using multilocus data to reconstruct evolutionary history</td>
<td>Amy L. Russell, Murray P. Cox, Veronica A. Brown, Gary F. McCracken (USA)</td>
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<td>17.20</td>
<td>S6.8</td>
<td>Population history of Craseonycteris thonglongyai</td>
<td>Sebastien J. Puechmaille (Ireland), Meriadeg Ar Gouilh (France), Medhi Yukubol, Piyathip Piyan (Thailand), Khin Mie Mie (Myanmar), Paul J. Bates (United Kingdom), Eric J. Petit (France), Iain J. Mackie (United Kingdom), Emma C. Teeling (Ireland)</td>
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<td>18.00</td>
<td>S6.9</td>
<td>Phylogeography of Pipistrellus pipistrellus species group: radiation and reticulation</td>
<td>Pavel Hulva, Alena Foruskova, Adela Chudarkova (Czech Republic), Benjamin Allegrini, Allowen Evin (France), Petr Benda, Ivan Horácek, Tomas Bartonička, Josef Bryja (Czech Republic)</td>
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<tr>
<td>18.20</td>
<td>S6.10</td>
<td>Phylogeography of Rhinolophus hipposideros</td>
<td>Serena E. Dool, Stephen J. Rossiter, Emma C. Teeling (Ireland)</td>
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</table>
**Gerhard Neuweiler Memorial Symposium on Echolocation in Bats.**

*Conveners: Björn Siemers and Gareth Jones*

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<th>Time</th>
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<tr>
<td>09.40</td>
<td>S3.6</td>
<td>Echo acoustic properties of bat-pollinated flowers and their recognition by glossophagine bats</td>
<td>Ralph Simon, Otto von Helversen (Germany)</td>
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<td>10.00</td>
<td>S3.7</td>
<td>Stroboscopic flow perception in free flying bats</td>
<td>Marc Holderied (United Kingdom)</td>
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<td>10.20</td>
<td>S3.8</td>
<td>Bat-moth interactions in the field: trajectory analysis reveals stereotypic yet effective evasive responses and their counter-responses</td>
<td>R. Holger Goerlitz, M. Hannah ter Hofsteede, Marc W. Holderied, (Germany)</td>
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<tr>
<td>11.00</td>
<td>S3.9</td>
<td>Adapting Echolocation call intensity and directionality to habitat and behavior</td>
<td>A. Surlykke, S. Brinkloev, L. Jakobsen (Denmark), E. K. V. Kalko (Germany), C. F. Moss (USA)</td>
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<td>11.20</td>
<td>S3.10</td>
<td>Understanding the impact of shared evolutionary history on echolocation call design</td>
<td>Alanna Maltby, Gareth Jones, Helen Chattergee, Kate Jones (UK)</td>
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<td>12.00</td>
<td>S3. C</td>
<td>Symposium summary and conclusions by Gareth Jones</td>
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<td>Time</td>
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<td>14.40</td>
<td>S13.1</td>
<td>Development of vocalization and social communication in a free-ranging nursing colony of the Lesser Roundleaf bat, <em>Hipposideros turpis</em></td>
<td>Sumiko Matsumura (Japan)</td>
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<td>15.00</td>
<td>S13.2</td>
<td>Learned vocal signatures in a polygynous bat</td>
<td>Mirjam Knörrnschild, Martina Nagy, Otto von Helversen (Germany)</td>
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<td>15.20</td>
<td>S13.3</td>
<td>Male greater sac-winged bats gain fitness benefits in larger colonies</td>
<td>Nagy Martina, Knörrnschild Mirjam, Voigt Christian C., Mayer Frieder (Germany)</td>
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<td>15.40</td>
<td>S13.4</td>
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<td>16.00</td>
<td>S13.5</td>
<td>Group decision-making in fission-fusion societies: Lessons from Bechstein’s bats and brown long-eared bats</td>
<td>Fleischmann Daniela, Kert Herald (Germany)</td>
</tr>
<tr>
<td>16.20</td>
<td>S13.6</td>
<td>Social calls are sufficient for locating conspecifics at roosts in a tree-dwelling bat <em>Nyctalus noctula</em></td>
<td>Furmaniakiewicz Ireneusz, Ruczyński (Poland), Jones Gareth (United Kingdom)</td>
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<td>16.40</td>
<td>S13.7</td>
<td>Do Bats Jazz? Song composition and syntax in the song of the common noctule bat</td>
<td>L. Voigt-Heucke, A. Thode, Kipper Silke (Germany)</td>
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<tr>
<td>17.00</td>
<td>S13.8</td>
<td>Advertisement calls of <em>Pipistrellus nathusii</em>: complex message of individual males</td>
<td>Jahelková Helena, Horacek Ivan, Bartonička Tomáš (Czech Republic)</td>
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<tr>
<td>17.20</td>
<td>S13.9</td>
<td>Categorization of affect intensity and individuality within call types emitted during agonistic interactions</td>
<td>Kastein Hanna (Germany), Kumar A.V. Kumar, Kandula Sripathi, Schmidt Sabine (Germany)</td>
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</tbody>
</table>
THURSDAY morning

S15² Diversity, systematics and conservation of South American bats.
Conveners: Valeria C. TAVARES, Ludmilla M.S. AGULAR, Enrico BERNARD, Renato GREGORIN

09.40 S15.8 Red Latinoamericana de Conservacion de Murciélagos
Rodrigo A. MEDELLIN (Mexico)

10.00 S15.9 Future scenarios caused by climate change on bat species from the Brazilian Cerrado: what if the species are not able to move?
Ricardo Bomfim MACHADO, Ludmilla Moura de Souza AGUIAR (Brazil)

10.20 S15.10 Habitat complexity: the importance of understory structure on the Phyllostomidae assemblages in the Brazilian Atlantic Forest
Julio BAUMGARTEN, Deborah FARIA, Eleonore SETZ (Brazil)

10.40 coffee

12.00 S15.11 Combined analyses of extant and fossil “phyllostomine” bats (Chiroptera, Phyllostomidae)
Paúl M. VELAZCO, Nancy B. SIMMONS, Peter D. SMITS, Susan TSANG, Liliana M. DÁVALOS (USA)
afternoon

Room D

Global bat Monitoring and Bioindication
Conveners: Kate Jones and Tomáš Bartonička

14.40 S9.7  25 years of bat monitoring in Bavaria/Germany - population trends and future tasks
Angelika Meschede (Canada), Matthias Hamme, Andreas Zahn, Bernd-Ulrich Rudolph (Germany)

15.00 S9.8  An assessment of the suitability of tropical bats for long-term monitoring
Christoph Meyer, Ludmilla Aguiar, Luis Aguirre, Julio Baumgarten, Frank Clarke, Jean-François Cosson, Sergio Estrada Villegas, Jakob Fahr, Deborah Faria, Neil Furey, Mickaël Henry, Robert Hodgkinson, Richard Jenkins, Kirsten Jung, Tigga Kingston, Thomas Kunz, Cristina MacSwiney Gonzalez, Isabel Moya, Bruce Patterson, Jean-Marc Pons, Paul Racey, Katja Rex, Erica Sampio, Sergio Solari, Kathryn Stoner, Christian Voigt, Dietrich von Staden, Christa Weise, Elisabeth Kalko

15.20 S9.9  Applying non-invasive genetic monitoring to bat populations
Emma S. M. Boston, Mathieu G. Lundy, Daniel L. Buckley, David Scott, Paulo A. Prodöhl, Ian Montgomery, Ferdia Marnell, Emma C. Teeling (Ireland)

15.40 coffee

16.00 S9.10 Predicting distributions of Asian bat species over 20000 years and solving zoo-geographic riddles
Alice C. Hughes (UK), Chutamas Satasook (Thailand), Paul J.J. Bates (UK), Pipat Soisook, Tuenjit Sritongchuay (Thailand), Gareth Jones (UK), Sara Bumrungsri (Thailand)
FRIDAY morning

**Contributed session BEHAVIOUR II**

**Chairpersons:** Rick Adams, Joanna Furmankiewicz

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<td>09.40</td>
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<td>10.00</td>
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**CB11**  
**Food Transfer By Mother To Pup In The Indian False Vampire Bat, Megaderma lyra**  
H. Raghuram, G. Marimuthu (India)

**CB12**  
**Concept learning in the nectar feeding bat Glossophaga soricina**  
Georgina Ross, Marc Holderied (United Kingdom)

**CB13**  
**Directional hearing by echolocating nectar-feeding bats (Glossophaga soricina)**  
Violaine Drapeau, Marc Holderied (United Kingdom)

**CB14**  
**Recent philopatry in Tadarida brasiliensis (Chiroptera: Molossidae) females in Mexico.**  
Ariadna E. Morales-Garcia, Daniel Pinero (Mexico)

**CB15**  
**Survival of young female greater horseshoe bats seems to be influenced by birth synchrony with other young, especially those from their own matriline.**  
Roger Ransome, Gareth Jones, Stephen Rossiter (United Kingdom)

**CB16**  
**Is harem size a predictor of male reproductive success across habitats and seasons?**  
Kritika M. Garg, Balaji Chattopadhyay, Vinoth Kumar Kumaravel, Paramanatha Swami Doss Devaraj, Sripathi Kandula, Uma Ramakrishnan (India)
Open Meeting of **IUCN Bat Specialist Group**

*Chairpersons: Paul A. Racey, Rodrigo A. Medellín*

13.40  News from EUROBATS  
Andreas Streit

13.50  **AGENDA OF IUCN BAT SPECIALIST GROUP**

14.40  *coffee*

**Closing plenary session of the Conference**

*Chairpersons: The organizers*

15.00  **Concluding remarks by the Symposia Conveners**  
and  
**Agenda of common interest**

16.00  **Declaring Student Award**

16.20  **Next Conferences**

16.40  **Closing the Conference**

19.30  **Farewell Reception and Concert in KAROLINUM**  
Praha 1, Ovocný trh 3  
(optional)

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**SATURDAY 28 August**

08.30  departure of the optional Post-Conference Excursions:

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<td><strong>B - Northern Bohemia</strong></td>
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S8² Movement Ecology of Bats
Coveners: Thomas H. Kunz and Paul M. CryAn

09.40 S8.10 Movement ecology of GPS-tracked Rousettus aegyptiacus: Unexpected foraging movements in a predictable heterogeneous landscape
Asaf Tsoar, Nachum Ulanovsky, Yoav Bartan, Ofir Altstein (Israel), Giacomo Dell’Omo (Italy), Alexei L. Vyssotski (Switzerland), Ran Nathan (Israel)

10.00 S8.11 GPS tracking of Egyptian fruit bats: First evidence for large-scale navigational map in a mammal
Nachum Ulanovsky, Asaf Tsoar, Yoav Bartan, Ofir Altstein (Israel), Giacomo Dell’Omo (Italy), Alexei L. Vyssotski (Switzerland), Yossi Yovel, Ran Nathan (Israel)

10.20 S8.12 Movement ecology of GPS-tracked Egyptian fruit bats: Bats as long-distance dispersal vectors of seeds
Ran Nathan, Asaf Tsoar, David Shohami, Yoav Bartan, Ofir Altstein, Nachum Ulanovsky (Israel)

10.40 coffee

11.00 S8.13 Impacts of Various Factors on Population Status and Movement of Rousettus aegyptiacus in Iran
Hossein Zohoori, Bahram H. Kiabi, Kourosh Kavousi (Iran)

W3 WORKSHOP 3 The Mediterranean Fruit bat, Rousettus aegyptiacus: distribution, abundance trends, monitoring
Conveners: Radek K. Lučan, Ivan Horáček

11.20 S5.6 Is the only European population of fruitbats close to extinction?
Haris Nicolaou, Eleftherios Hadjisterkotis, Elena Erotokritou (Cyprus), Radek K. Lučan, Tomáš Bartoníčka, Ivan Horáček (Czech Republic)

11.40 C81 The Mediterranean fruit bats, Rousettus aegyptiacus: distribution, chorologic status, and perspectives.
Ivan Horáček, Petr Benda, Pavel Huška (Czech Republic), Rasit Bilgin (Turkey), Mounir Abi-Said, Rena Karanouh (Lebanon), Nursel Asan, İrfan Albayrak, Ahmed Karataş (Turkey), Haris Nicolaou (Cyprus), Tomáš Bartoníčka, Radek Lučan (Czech Republic)
afternoon

Room B

Contributed session BEHAVIOUR III

Chairpersons: Stuart PARSONS, Sumiko MATSUMURA

13.40 CB17 Bats in snow: Do they hibernate?
Hirofumi HIRAKAWA, Dai FUKUI (Japan)

14.00 CB18 “Out for the count?” Winter torpor in Natterer’s bat Myotis nattereri
Paul HOPE, Gareth JONES (United Kingdom)

14.20 CB19 Does hibernation affect memory retention for a spatial foraging task in bats?
Ireneusz RUCZYŃSKI (Germany, Poland), Björn SIEMERS (Germany)
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<td>09.40</td>
<td>CE1</td>
<td>The bigger you are the harder you bite: linking form and function of forest interior insectivorous bats</td>
<td>Juliana Senawi (USA, Malaysia), Bjorn Siemers, Daniela Schmieder (Germany), Tigga Kingston (USA)</td>
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<td>10.00</td>
<td>CE2</td>
<td>DNA-based diet analysis of insectivorous bats</td>
<td>Matt RK Zeale, Roger K Butlin, Gary LA Barker, Gareth Jones (United Kingdom)</td>
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<td>10.20</td>
<td>CE3</td>
<td>Diet composition, resource partitioning and trophic niche overlap in forest foliage gleaning bats</td>
<td>Michal Andreas, Antonín Reiter, Petr Benda (Czech Republic)</td>
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<tr>
<td>11.00</td>
<td>CE4</td>
<td>Comparative diet analyse of the two sympatric European ‘trawling’ bat species, Myotis dasycneme and Myotis daubentonii</td>
<td>Frauke Krüger, Inka Harms, Robert Sommer (Germany)</td>
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<td>11.20</td>
<td>CE5</td>
<td>‘When and where’? Decisions of foraging bats in a forest landscape various among foraging groups</td>
<td>Milenka Mehr, Hans-Joachim Klemmt, Hans Pretzsch, Roland Brandl, Jörg Müller (Germany)</td>
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<td>11.40</td>
<td>CE6</td>
<td>What influence the selection of foraging sites in rhinolophids?</td>
<td>Egoitz Salsamendi, Inmaculada Arostegui, Joxerra Aihartza, David Almenar, Urtzi Goiti, Inazio Garin (Spain)</td>
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Room D

Contributed session CONSERVATION III
Chairpersons: Peter J. TAYLOR, Christine HARBUSCH

9.40 CC12 Population genetics and conservation status of cryptic species: the case of European Pipistrellus
Anna SZTENCEL-JABLONKA, Wieslaw BOGDANOWICZ (Poland)

10.00 CC13 The challenge posed by newly discovered cryptic species: disentangling the environmental niches of long-eared bats
Marianne D. RUTISHAUSER, Fabio BONTADINA, Veronika BRAUNISCH, Sohrab ASHRAFI, Raphaël ARLETTAZ (Switzerland)

10.20 CC14 The effect of bark beetle infestation and salvage logging on bat activity
Milenka MEHR, Roland BRANDL, Thomas KNEIB, Jörg MÜLLER (Germany)

10.40 coffee

11.00 CC15 The creation of new artificial lakes as a mitigation measure for bats
Ralf GYSSELINGS, Erika VAN DEN BERGH (Belgium)

11.20 CC16 Can organic farming help to conserve bats?
Fiona MATHEWS, Paul JOHNSON, David MACDONALD
List of Posters
The RoBat; a bat inspired flapper
Melanie STIJVER, Florian MUJRES, Anders HEDENSTRÖM (Sweden) & Bas VAN OUDHEUSDEN (Netherlands)

Comparative morphology of distal part of hind limb of bats with different ability to quadrupedal locomotion
Lucie ŠTORKOVÁ & Josef HOTOVÝ (Czech Republic)

Complexity of chiropteran dentition: the GIS approach
František ŠPOUTIL (Czech Republic), Jukka JERNVALL (Finland) & Alistair EVANS (Australia)

Looking at baculum function from a histomorphological perspective
Anna Nele HERDINA, Hanns PLENK Jr., Petra POKORNY, Helge HILGERS, Barbara HERZIG-STRASCHIL & Brian D. METSCHER (Austria)

Modularity and the evolutionary flexibility of the skull of chiropterans
A. PORTO, Daniela M. ROSSONI & Gabriel MARROIG (Brazil)

Sensory specializations compromise bite force in bats
Stefan GREIF (Germany), Anthony HERREL (France), Elisabeth R. DUMONT (USA), Ivailo BORISSOV (Bulgaria) & Björn M. SIEMERS (Germany)

“A peculiar bat”: are environment-specific adaptations of the New Zealand short-tailed bat (Mystacina tuberculata) associated with changes to conserved genetic sequences?
Darren LE ROUX, Claire MULHOLLAND, Joseph WAAS & Richard WILKINS (New Zealand)

Bats that walk: a new evolutionary hypothesis for the terrestrial behaviour of New Zealand’s endemic mystacinids
Suzanne J. HAND (Australia), Vera WEISBECKER (United Kingdom, Germany), Robin M. D. BECK (USA), Michael ARCHER, Henk GODTHELP (Australia), Alan J. D. TENNYSON (New Zealand) & Trevor H. WORTHY (Australia)

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Legal protection of all European bat species means that road management agencies are required to mitigate the potential negative impacts of roads on local populations. Many bat species are considered reluctant to fly over open ground, such that a wide road corridor may present a barrier to movement within a landscape. Linear landscape features such as hedgerows, treelines and waterways, act as shelter and navigational guides between habitats. To investigate the potential barrier effect of roads, and what road design features can mitigate it, we recorded bat activity at sites where a newly-constructed motorway (40–100 m wide) has severed linear landscape features. Using acoustic detectors, bat activity was recorded at four types of potential motorway crossing sites (underpasses, overbridges, river bridges, and severed treelines), and compared to simultaneous bat activity levels along connected linear landscape features in the adjacent habitat. For overbridges, underpasses and river bridges, the proportion of bat passes recorded above and below the structure was also quantified. Seven bat taxa were recorded. Bat activity was markedly higher beneath river bridges relative to other potential crossing routes, and was comparable with activity levels at reference river sites distant from the motorway. Few bats crossed at minor road overbridges, with reduced activity compared to that recorded at reference sites in the surrounding habitat. In contrast, underpasses generally had higher bat activity relative to control sites, suggesting the potential of these passages to maintain functional landscape connectivity for bats. Surprisingly, many bats also flew across the motorway, from a severed treeline on one side to another on the opposite side, in the absence of any connective element. This may place bats at risk from traffic mortality, depending on their characteristic flight behaviour and landscape context. Practical implications for the design of bat mitigation measures during road planning are discussed.

Does use of the uropatagium during flight give insight into the origin of flight in bats?

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The recent discovery of extensive and complex use of the uropatagium during flight in vespertilionid bats, along with morphological adaptations indicating ancient evolution of this flight mode, may give some added insight into the evolution of flight in bats. With the use of high-speed video (Casio EX-F1), I put forth a new interpretation of the uropatagium and its participation in flight dynamics by showing how this membrane may contribute lift and acceleration during platform takeoffs. I define this contribution to be Tail-Assisted-Flight Thrust or TAFT. TAFT locomotion may have been integral to the evolution of flight in bats and thus may suggest a new and novel scenario for flight evolution. I also use high-speed videography to investigate functional dynamics of flight ontogeny as a surrogate for understanding potential transitional stages from a nonvolant to volant mammal. Integration of TAFT locomotion and ontogeny of flight provides a unique hypothesis concerning origins of flight in mammals.
Bat conservation in Brazil: the *Lonchophylla dekeyseri* Action Plan

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Brazilian bats, though not much known, are already threatened due to habitat destruction. *Lonchophylla dekeyseri* is an endemic nectarivorous bat that occurs in low density in caverns and holes in forested and more open vegetation physiognomies of the Cerrado biome. This characteristic makes the species extremely sensitive to the loss and degradation of its habitat. Deforestation for agricultural and cattle expansion, coal-pit, construction of dams, mining and forest fires represents the most critical threats. At present, the ecological tourism, especially the speleological, can represent a significant threat. *L. dekeyseri* population is estimated at circa of 2,070 bats, all in the wild and none in captivity. There are confirmed records for *L. dekeyseri* in 23 Brazilian localities. Like other nectarivorous bats, the reproductive system is polygenic, with many females and few adult males. An action plan for the conservation of *L. dekeyseri* was concluded, composed of 10 basic actions including from activities of immediate implementation, such as the environmental monitoring of the species’ occurrence areas, to the implementation of mid-term activities (e.g. the creation of supplementary protected areas), and to long term activities, such as the realization of environmental education and the development of new studies on population dynamics. Suggested actions also includes the recuperation of degraded areas, control of hematofagous bats, control of cave visitation, the environmental management of vegetation remnants, and the increase of both the number of environmentally protected units and of new inventories in the data gap regions. In the existing protected areas, there is a need for research on the species’ ecology, using telemetry and population genetics, as well as the management of the already altered environments in such areas. Environmental education activities are urgent, with bats being used as flag species of ecological processes, such as pollination and seed dispersal.

New data on piscivory in *Myotis capaccinii*

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Long-fingered bat (*Myotis capaccinii*) forages almost exclusively over aquatic habitats and its main prey are insects that emerge from water. Nevertheless in three out of nine studies on its food habits fish appeared among consumed items. We present a long-term survey (2008 and 2009) on the seasonal frequency of fish remains in faeces of the long-fingered bat in the colony where piscivory for this species was firstly discovered in 2003 (Dénia, Alacant, Eastern Iberian Peninsula). Individuals roosted there from late April to late July in 2008, and from late March to late November in 2009. During these periods we collected samples of 50 pellets beneath the colony every two weeks in 2008 and weekly in 2009. We detected fish remains in two periods – out of 10 – in 2008, but in 2009 they occurred yearlong (80% of weeks); frequency of occurrence was 2% in 2008 and 4% in 2009. Quantity of fish remains per pellet varied from a single scale to 100% of the pellet volume. We observed two outstanding peaks in fish consumption in both years, the first upon arrival to the roost and the second around the beginning of summer. We identified consumed fish as belonging to the order Cyprinodontiformes, with three species re-
corded in the area, of which Gambusia holbrooki is the most abundant. These results confirm piscivory as a non-exceptional but common behaviour in Myotis capaccinii. Its occurrence is low, though varying, either within and between years. Thus, piscivory may easily slip researchers’ notice depending on the temporal pattern of sampling. Besides, the varying pattern of occurrence suggests that ecological factors affecting prey availability may play a role in it.

Phylogeography and population genetic structure of Rhinopoma microphyllum in Iran

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The greater mouse-tailed bat (Rhinopoma microphyllum) is a medium-sized bat with a free tail. It possesses a large geographical range, covering most of the arid and warm areas of the Old World. The taxonomic status of R. microphyllum in Iran is not so clear, as different researcher groups have reported only one or two subspecies. The nominotypical subspecies in Iran is R. m. microphyllum and a new subspecies R. m. harrisoni was reported in southern Iran. R. m. harrisoni is smaller than the nominotypical form, the skull lacks a prominent sagittal crest and the rostrum is triangular. However, the differences between the putative subspecies are very slim, the validity of R. m. harrisoni seems questionable and the name is considered a synonym of the nominotypical form. Here we present the results of phylogeography study of this species using 567 bp sequences of the mitochondrial control region examined in samples taken from several localities of Iran and throughout whole over range of this species. Based on the data of control region sequences, we found high gene diversity (0.86) among Iranian populations although there were not any significant differences between various colonies. The sequence data support separation between Iranian and Levantine populations. In the Bayesian phylogenetic tree, all Iranian samples were grouped in the same clade, while Levantine samples reported in study belonged to another clade. The statistical parsimony network analyses also showed no clear differentiation between the designated haplotypes among Iranian samples. These results support the division indicating that all Iranian populations belong to one subspecies, however we suggest that the Iranian form is different from that in the Levant and Africa and belongs to R. m. harrisoni.

Distribution and abundance of cave-dwelling bats in the Fars province, Iran: Implications for bat conservation

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The distribution and abundance of cave-dwelling bats were investigated in the Fars Province in Iran. Data were collected in February, March, April and May 2007 until 2010, from 16
caves, 14 of which had not been previously known as bat roosts. In this study 15 species were recorded; viz. *Rhinolophus ferrumequinum*, *R. hipposideros*, *R. euryale*, *R. mehelyi*, *R. blasii*, *Rhinopoma microphyllum*, *R. muscatellum*, *Taphozous perforatus*, *Myotis emarginatus*, *M. blythii*, *M. capaccinii*, *Miniopterus schrebersii*, *Rousettus aegyptiacus*, *Asellia tridens*, and *Triaenops persicus*. Estimates of bat abundance have been made on the basis of emerge count or direct measurements. The most abundant species were *Miniopterus schrebersii*, *Asellia tridens*, *Myotis blythii*, *Rhinopoma muscatellum*, *R. microphyllum* and *Rousettus aegyptiacus*. The roosts were evaluated for their conservation importance based on human disturbance, remains of vandalism and recent organized change in cave usage. The most important sites in the Fars Province were the Tadovan and Sang-Eshkan caves. The Tadovan and Manian caves serve as hibernacula to approximately five bat species. The Bushigan cave is a nursery roost to approximately 2000 individuals of *Rousettus aegyptiacus*. Presently, none of the caves in the province has adequate protection and some bat populations are under serious threat. Almost all caves have been excavated extensively and vandalism is a major threat to bat in caves. Moreover, in recent years important caves have lost their entire bat populations when the cave converted for tourism activities or used as water abstraction centre for human settlements. Comparing population estimates made in 4–5 decades ago with recent estimate in some caves indicate shocking loss in population of these animals.

**First confirmed record of *Vespertilio murinus* in the Pyrenees**

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In summer 2009 the bat research group of the University of the Basque Country captured a parti-colored bat in the Sahún mountain pass (2014 m, Central Pyrenees). The specimen was identified based upon the length of the forearm, coloration and tragus morphology. It is therefore the first confirmed record in the Iberian Peninsula and the southernmost record in Western Europe. The known distribution of the species extends from Central and Southwestern Europe to the east coast of Asia. The westernmost breeding colony of parti-colored bats is found in Switzerland over 700 km away. During the summer dispersive males have been cited in several places away from the usual distribution area of the species, such as northern Sweden, central England and Faroe Islands. Moreover, during the last years few male individuals were captured in Central France. The bat trapped in Sahún was a mature male. It was captured in a net extended along almost the whole mountain pass on 25 July at 23:20 at a height of 2.5 m above the ground. The heavy wind and the nature of the hill could have helped in the capture of the animal, since this species usually fly 20–40 m above the ground. Last records in Central France and Pyrenees indicate that the presence of *V. murinus* in Southwestern Europe may have been underestimated. It seems that the presence of male individuals in that area it is not as rare as believed, and further research will be needed to dilucidate if they are isolated vagrants or there is a seasonal population of males.

**A phylogenetic analysis of Pteropodidae based on multi-locus molecular data**

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Pteropodidae is among the most diverse bat families with approximately 180 species and 46 genera. The last formal classification into subfamilies and tribes was published in 1997 by Bergmans. Since then, a number of molecular phylogenetic studies have provided support for some of these groupings while others have been contradicted. Relationships among tribes and subfamilies remained largely unresolved. These studies, however, were based almost exclusively on mitochondrial markers and the most taxonomically inclusive analysis sampled only 26 of the 46 recognized genera. In order to develop a better picture of the evolutionary history of pteropodids, we carried out a phylogenetic study of the family based on newly-generated sequences of 4 nuclear loci as well as mitochondrial loci already available for species of the group. Our concatenated matrix included more than 8 kbp. Taxonomic sampling was increased to 42 pteropodid genera, represented by 56 species. In an attempt to improve resolution in contentious parts of the phylogeny, exhaustive statistical analyses were carried out to control for sequence bias and minimize systematic bias. Special attention was given to the choice of appropriate sequence evolution models for maximum likelihood analyses. The resulting trees showed high support and resolution of subfamilies and tribes, and suggest an early basal split of Pteropodidae into 7 (maybe 8) main clades. Nevertheless, relationships among these highly-supported groups were not well resolved despite the large amount of data and all analytical efforts. We discuss this result as an indication of an early explosive radiation of the pteropodid clade.

Each flying fox on its own branch: A phylogenetic tree for *Pteropus*

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*Pteropus* (flying foxes) is one of the most speciose genera of bats, with over 65 species presently recognized. The morphologic diversity of the *Pteropus* species has made recognition of phylogenetic species groups highly problematic and contentious. Speciation in *Pteropus* appears largely influenced by geographic distribution patterns. Most *Pteropus* species occur exclusively on islands, many are restricted to a few islands within an archipelago, and the range of the genus includes remote islands of the Indian and the Pacific Oceans. Large distances between islands and limited dispersal abilities provide a perfect scenario for the evolution of new species through allopatric speciation. *Pteropus* thus provides a very interesting context in which to studying genetic and morphologic differentiation during speciation. However, to pursue such research objectives, it is necessary first to have a good understanding of the phylogenetic relationships among species and levels of genetic differentiation. A species tree can provide clusters of closely related species, which should be ideally sampled in studies focused on speciation mechanisms. Here we present a phylogenetic study of *Pteropus* based on 2 mitochondrial genes (cytochrome b and 12S). We assembled matrices including all publicly available sequences and sequences generated specially for this study. Because some species are highly endangered and some are actually extinct, many of sequences presented here were obtained from wing punches of museum specimens. We were able to gather DNA
sequence information for 50 species, with sequence fragment sizes ranging from 300 bp to more than 2000 bp in the concatenated matrix. As expected, most phylogenetic clusters do not corroborate previous species group assignments based on morphology alone. The *Pteropus* phylogeny presented here suggests very low levels of genetic differentiation within some species groups, indicating very recent or incipient speciation. Biogeographic patterns and their implications for speciation are discussed for each species cluster.

**Molecular systematics of the family Molossidae based on nuclear and mitochondrial genes**

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Our current understanding of the relationships among genera of bats in the family Molossidae (100 species, 16 genera) is based largely on morphological data. Relationships among the genera of free-tailed bats have not been tested with molecular data and thus, the objective of this study was to construct a phylogeny of representative members of this family using DNA sequence data. We collected sequence data from one mitochondrial locus (ND1) and 3 nuclear loci (DMP1, FibI7, and RAG2) from members of the family Molossidae (subfamily Molossinae) and outgroups from the family Vespertilionidae and Natalidae. Taxonomic sampling was greatest for the ND1 dataset (12 genera, 32 species) and lowest in the Fibrinogen intron 7 dataset (10 genera, 21 species). Sequence from the 4 genes totaled 3028 bp. Each dataset was analyzed separately using maximum likelihood and Bayesian methods. Nuclear divergence values (uncorrected ‘p’) averaged 5% among molossid genera, while mitochondrial divergence in the ND1 dataset averaged 15%. Few intergeneric relationships were significantly supported by the mitochondrial data, however monophyly of most genera was supported. Nuclear results supported a “New World” clade consisting of *Eumops*, *Molossus*, *Promops*, *Molossops* (including *Neoplatymops*), *Cynomops* and *Nyctinomops*. Our analysis also showed significant support for a *Promops-Molossus* clade and a *Chaerephon-Mops* clade although the position of these clades in relation to the others is not well supported. We conclude that although additional data and taxonomic sampling will be necessary to completely understand relationships within the family Molossidae, the hypotheses of relationship supported by this analysis are inconsistent with published morphological phenograms.

**Bats and wind farms: Relationship between bat activity and fatalities, methodologies evaluation and influence of environmental and ecological factors on mortality**

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Currently we are facing an increase in wind energy production, and in many cases monitoring of wind farms facilities has revealed the occurrence of bat fatalities. The present study aims to
evaluate the effectiveness of widely spread methods in predicting the impacts of wind farms on bats and to understand how different types of variables influence fatalities. We also aim to evaluate if mortality is related to species ecology and behavior. The study area was a wind farm, with 20 turbines located in northern Portugal. The study was conducted from March to October 2007. Twenty sampling points, one at each wind turbine were used to evaluate bat activity. Fatalities searches were conducted in a 50 m radius plot around each turbine. Whenever possible these actions were performed weekly and activity sampling took place the night before fatalities search. Correlation analysis was used to evaluate the relationship between meteorological variables and activity and fatalities. A relationship between bat activity and fatalities was identified, in both cases Nyctalus leisleri and the Pipistrellus species were the most representative. The highest values of activity and mortality were register from August to October. Activity and mortality showed a significant correlation with wind speed, temperature and relative humidity; mortality seems also to be related with Southeast winds. These results allow us to identify the weather conditions favoring higher fatalities. Results highlight the need for further studies that help us to better understand which other factors contribute for higher collision risk. The results shown here are extremely important for the implementation of effective minimization measures and therefore for bat conservation in wind farm dominated landscapes.

Diet composition, resource partitioning and trophic niche overlap in forest foliage gleaning bats

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A diverse bat community was studied using netting. Faeces samples were collected for later diet composition analyses under binocular microscope. In order to compare in detail diet compositions, quantify trophic niche overlaps and illustrate resource partitioning, the species were studied in sympatry. Presented study is primarily aimed at forest bats applying foliage gleaning foraging strategy (Myotis nattereri, M. bechsteinii and Plecotus auritus). Previous studies demonstrated a big local and seasonal variation in their diets which consequently indicates certain flexibility of these species. Results of the presented study proved foliage gleaning foraging strategy of the species and relatively effective partition of resources. Once a certain diet item comprises for one bat species an important food resource, it is consequently usually exploited much fewer by the other two bat species. The diet compositions vary more distinctly among the entire guild of forest foliage gleaning bats than they differ between them and their morphological siblings or evolutionarily related species (e.g. Plecotus auritus vs P. austriacus or Barbastella barbastellus, Myotis nattereri vs M. emarginatus). Results are not fully consistent with prediction of sensory ecology presuming that bats with longer ears feeds more frequently on prey generating sounds. Results do not support a hypothesis that rare bats may exploit narrower range of prey. A relatively rarer Myotis bechsteinii has wider trophic niche, whereas more common Plecotus auritus exploits narrower range of prey. Comparison of diet composition and morphological and echolocation parameters shows that larger species is more durophagous, species with longer ears is moths eating specialist and species with higher call intensity and peak frequency exploits small dipterans probably in uncluttered habitats.
Speciation and systematics of Malaysian Kerivoula (Vespertilionidae) inferred from multiple datasets

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Examining species boundaries from multiple independent sources is an appropriate and robust method to identify genetically isolated evolutionary units. We used five datasets: cytochrome-b (cyt-b), cytochrome c oxidase-I (COI), Amplified Fragment Length Polymorphisms (AFLPs), karyotypes, and morphology to estimate phylogenetic relationships and species limits within Woolly bats, genus Kerivoula, from Southeast Asia. We genetically analyzed 54 specimens of Kerivoula from Malaysia, assigned to six of the 10 species currently reported from the country. Phylogenetic analyses of nuclear AFLPs and mitochondrial DNA sequences from cyt-b and COI resulted in similar species level clades with minimal change in branching order. Using comparisons of cranial and dental morphology, and original species descriptions, the resulting phylogenetic clades were assigned to Kerivoula hardwickii, K. intermedia, K. lenis, K. minuta, K. papillosa, K pellucida, and one unidentified species. Karyotypes further documented variability among the six clades. Five different karyotypes were identified; with two species having indistinguishable karyotypes. Our COI sequences were compared to 110 specimens of Kerivoula from Southeast Asia at the Barcode of Life Database. Our cyt-b and AFLP species identifications were congruent with those in the database. Intraspecific geographic variation of 5–7% sequence divergence was observed in cyt-b and COI within both K. hardwickii and K. minuta. Relaxed molecular clock analyses indicated a late Oligocene to early Miocene origin of the Kerivoulinae with intraspecific diversification events coinciding with late Pliocene and Pleistocene epochs in at least six species. Specimens from Sabah (northeast Borneo) showed relatively high genetic divergence compared to those between Peninsular Malaysia and Sarawak (southwest Borneo) indicating Pleistocene or Pliocene refugia in Borneo. We conclude that there is at least one distinct lineage of Kerivoula yet to be described from Borneo and the intraspecific geographic variation in some species agrees with previous studies on the diversification of flora and fauna in Borneo.

A multi-faceted research programme deciphers the mechanism of decline of a rare European bat

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Many bat species have suffered dramatic declines over the past decades, especially in the Western world, which has been attributed to major land-use changes in farmland and woodland. This has led to widespread local bat population decreases if not extinctions. In Europe, the lesser horseshoe bat Rhinolophus hipposideros is probably the bat species that has undergone the most dramatic population collapse since World War II. The causes of its decline have remained largely speculative, which impedes conservationists from taking
appropriate restoration action. We launched an integrated conservation biological programme («Rhippos») aiming at evaluating the contributions of different factors to that phenomenon. Based on a first appraisal of the most probable causes of decline by bat experts, we formulated a series of hypotheses that we tested in different research modules, from investigations of species’ basic ecological requirements to dispersal capacity. We present here the outcome of these different modules, concluding that the massive use of organochlorinated pesticides (DDT and allied) in the second half of the 20th century was the most likely cause involved. The banning of these pesticides in the seventies is probably the reason why most populations now show signs of progressive recovery. Targeted restoration measures are proposed for accelerating the recolonisation of species’ historical range.

The relationship between geographic range size and niche breadth in African horseshoe bats

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A fundamental question in ecology is why some species have larger geographic range sizes than others. For example, there are distinct differences in the geographic range sizes among African horseshoe bats (Rhinolophidae) with some species being widespread across the continent (e.g. Rhinolophus clivosus) while others have restricted distributions (e.g. Rhinolophus capensis). The aim of this research was to determine why these differences in range size exist among African Horseshoe bats. We tested the Niche Breadth Hypothesis which predicts that more widely distributed species will have a greater niche breadth resulting in a positive relationship between geographic range size and niche breadth. Niche breadth was measured along two axes namely habitat use and diet which are important factors that define bat niches. Habitat breadth was measured using acoustic monitoring to quantify microhabitat use in three habitat categories namely high-clutter, semi-clutter and edge. Dietary diversity was measured by analysing faecal pellets collected from captured bats for the diversity of prey taxa consumed and the diversity of prey size. In addition, bat niches were also investigated with computer modelling using the Ecological Niche Factor Analysis. The species with the largest range size, R. clivosus, had the greatest niche breadth on the habitat axis (Shannon-Wiener H’=0.9298) and on the diet axis (Simpson’s diversity index/FNB = 2.42) as predicted. However, the species with the smallest range size, R. capensis, did not have the lowest niche breadth (H’=0.5627, FNB=1.87) contrary to our prediction. These results suggest that niche breadth is an important factor determining the distribution of a species but that other factors are also likely to influence how species are distributed.

Mitochondrial DNA relationships among North Palearctic Eptesicus species

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Two most common North Palearctic Eptesicus species – E. serotinus and E. nilssonii demonstrated unusual pattern of mtDNA phylogeny, which could be explained by mitochondrial
introgression or rapid morphological evolution (like in the genus *Myotis*). Although some data, which argued for the second explanation are available, a further molecular studies based on nuclear markers are necessary to prefer one of scenarios. Two introns (THY and SPTBN) and Cytb mitochondrial gene were sequenced for *E. serotinus* ssp. specimens from western and south-western Russia, Ukraine, and Kazakhstan, and for several samples inter-MIR PCR was also performed. These genetic traits were compared with those of *E. nilssonii* (European and Siberian population studied), *E. bottae ognevi* and *E. gobiensis*. MtDNA analysis reveals two major *serotinus* haplogroups: western – closely related to *E. nilssonii*, and more diverged eastern, found on most territory of central Russia. Haplotypes from both groups were found in sympathy in Ukraine and on western borders of Russia. Taking into account similarity of nuclear markers from all studied *E. serotinus* samples, this means mitochondrial introgression rather than morphological convergence between *E. serotinus* and *E. nilssonii*. All assessed genetic traits of *E. s. turcomanus* samples denote their close relation to East European *E. s. serotinus* populations making doubtful proposed species status for this form.

Diseases of United Kingdom bats

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Bats host a wide range of pathogens and are a source of new and emerging zoonotic diseases. Research was undertaken during the summer of 2009 to study populations of *Myotis daubentonii*, *M. nattereri* and *Plecotus auritus* in a 600 hectare woodland in Oxfordshire, UK. Preliminary results show that coronaviruses are present in bats from the UK, including a new species specific clade from *M. nattereri*. The coronaviruses identified are closely related to other group 1 coronaviruses from Northern Europe. Concurrent work assessing infestation of bats with mites shows significant seasonal and demographic variation in infestation as well as a correlation between the level of infestation and host condition. Mites, a directly transmitted disease may provide a model for other directly transmitted diseases. Ongoing work aims to assess the pattern of coronavirus infection in the study bat population. By understanding the distribution of diseases in time and space and the ecological drivers behind the observed patterns it may be possible to better predict and avert disease emergence in the future.

Resource selection by slow- and fast-flying insectivorous bats in a heavily urbanized landscape

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An acoustic bat monitoring conducted in Mexico City in 2002 suggested that fast- and slow-flying insectivorous species exhibited different patterns of habitat use while foraging in the urban landscape. Based on a limited number of species detected, it was apparent that molossids were the most successful species in the city, presumably because the high flight altitude associated with fast flight would allow them to have access to virtually any place in the city. Small vespertilionids, on the other hand, seemed to be restricted to large vegetated
areas within the urban landscape (large parks) or off the city. In this study, I use historical records of bats collected in the Mexico City area (<10 km from the edge of the city) to test the hypothesis that fast- and slow-flying species select urban habitats differently. I found a similar number of individual records for slow and fast flyers, but most records from heavily urbanized locations belonged to only 3 species: molossids Tadarida brasiliensis and Nyctinomops macrotis, and vespertilionid Lasiuscinereus. Interestingly, the 3 species have a high wing aspect ratio (indicative of fast flight) and have been found flying at high altitudes. In contrast, most slow-flying vespertilionids were collected either before 1985 (when the city was less urbanized) or in the more rural suburbia. The few slow flyers that reached centric locations were collected within large vegetated areas or very close to them. The limited information on roost selection by bats indicates that roosts are not a limiting factor for molossids in the city, but they could be limiting for tree- and cave-dwelling vespertilionid species. This analysis suggests that a combination of flight performance and roost requirements explain the success of some insectivorous species in heavily urbanized landscapes.

Human-made landscapes drive livestock rabies outbreaks transmitted by Desmodus rotundus in Mexico

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Each year, paralytic rabies transmitted by the common vampire bat (Desmodus rotundus) causes millionaire economic losses to cattle ranchers in Mexico. Although it has been largely recognized that effective campaigns to control this infectious disease must be preventive rather than reactive, little is known about the factors that promote the start of a rabies outbreak. In this study, we refine previous modeling exercises intended to understand the environmental factors that release livestock paralytic rabies cases in eastern Mexico. We hypothesized that habitat fragmentation would play a prominent role on the occurrence of this disease by increasing vampire bat abundance and by favoring its movements. We recorded all confirmed cases of livestock rabies occurring in the state of Puebla between 2004 and 2010, and characterized the landscape structure and some human-made features surrounding each outbreak. By contrasting these landscape features to those surrounding an equivalent number of random locations, we modeled outbreak probabilities using logistic regression analysis. Our results indicate that rabies outbreaks are positively predicted by the level of fragmentation, the area covered by agrosystems, and the density of human populations. In contrast, the area covered by natural vegetation (tropical dry forests, cloud forests, temperate forests, and xerophytic scrubs) negatively predicts rabies outbreaks. The fact that tropical rainforest cover positively predicts rabies cases suggests that hot and humid environments may favor the emergence of paralytic rabies. Our results support the prediction that fragmentation facilitates the transmission of rabies from vampire bats to livestock. The logical association between human and livestock population sizes suggests that high prey abundance is a necessary condition to release rabies outbreaks. Based on these findings, we strongly recommend taking preventive livestock management actions in
the most fragmented tropical humid forests of Mexico, including conservation programs in public and animal health agenda.

A digestive perspective on nectar-feeding specialization in phyllostomid bats

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Floral nectar is one of the simplest foods in nature. It varies widely in sugar concentration, affecting the physiology and behavior of nectar-feeding animals. When nectar sugar concentration decreases, animals increase their food intake. In this behavior, named intake response, animals tend to achieve compensatory feeding. However, this behavior could be limited by physiological constraints. We hypothesized that the digestive capacities of bats affect their ability to acquire and store energy, and could modify the way they use the floral resources present in their environment. To test this idea we measured the intake responses and changes in body mass of the members of a community of nectar-feeding bats: Choeronycteris mexicana, Leptonycteris curasoae and Glossophaga soricina. We expected differences in the intake responses of the three species, with changes in body mass being independent of sugar concentration in bats achieving compensatory feeding, but positively correlated to sugar concentration in bats exhibiting physiological constraints. The three bat species presented different intake responses. Only C. mexicana, was able to achieve compensatory feeding. G. soricina and L. curasoae increased their sugar intake with sugar concentration. C. mexicana increased body mass independently of sugar concentration, while G. soricina presented a positive correlation between these two variables. Based on our results we generated a model relating digestive capacities and use of food resources in the field. In this model the physiologically-specialized bats (those able to perform compensatory feeding) should act as ecologically generalist capable of feeding on a wide range of nectar concentrations, while less-physiological specialized bats should act as ecologically specialists that use only concentrated nectars. Interestingly, bats that achieve compensatory feeding seem to be able to use a larger diversity of plants as food sources, supporting the idea that digestive traits affect the way these animals use food resources in the field.

The influence of abiotic factors on the distribution of bats in South Africa

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Identifying the factors influencing patterns of species distribution and richness is a challenging task. The complexity lies in that there is no single cause for the patterns of species distribution. However, the relationship between the environment and the distribution of organisms is considered a fundamental issue in ecology. This relationship is a central theme in ecology and is used to identify the limits to species distributions and species responses to environmental gradients. With increased rates of extinction as a result of anthropogenic habitat loss and climate change, practical understanding of how different aspects of the
environment affect distribution and abundance of species is vital. The evidence for the influence of biotic factors on bat community structure in South Africa is ambiguous. Therefore, abiotic factors might play a major role in determining patterns of bat species distribution and community structure in South Africa. Such data are crucial to the documentation of bat biodiversity in South Africa and for the development of effective conservation plans in the region. We report the effect of selected environmental variables on bat species range sizes in South Africa. Based on a marked east-west aridity gradient in South Africa, we hypothesize that vegetation type would affect the distribution of bats in South Africa. In addition, environmental variables related to precipitation should correlate positively with bat species range sizes, while temperature should correlate negatively, with bat species range size in South Africa. We use a correlative model; Maxent (Maximum Entropy method) to assess environmental factors that are expected to influence South African bat species based on their known distributional records.

**Greenbridges as crossovers for bats**

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We compared the use of nine greenbridges (constructed as wildlife overpasses), three road bridges and three road underpasses by bats in the federal state of Baden-Württemberg, south Germany in 2005. The highest bat activity per hour was recorded for the underpasses followed by the greenbridges. We studied the intensity of bat activity at the greenbridges in relation to overpass width, structures on the overpass and connectivity to the surrounding landscape. None of the variables alone explained the intensity of bat activity. Nevertheless Greenbridges with the highest values for all three variables showed the highest bat activity.

**Bat activity in different strata of a beech forest in Northwest Germany**

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We investigated the activity of bats at different heights above ground in a beech forest in Rotenburg (Germany, Lower Saxony) in 2008. To study the activity, three AnaBat detector systems were installed at three different heights (4 m, 15 m, 30 m). The detector at 30 m was installed above the canopy. We counted a total of 23,663 contacts. The majority of these originated from Pipistrellus pipistrellus. Other species recorded were Pipistrellus nathusii, P. pygmaeus, Eptesicus serotinus, Nyctalus noctula, and N. leisleri. When contacts could not be identified to species level, they were grouped as Eptesicus/Nyctalus, Pipistrellus sp. or Myotis/Plecotus sp. The results showed a significant difference in activity between the three height levels. The highest activity was at the lowest level (59%) and the activity deceased with height. Only 11% of all contacts were recorded above the canopy. The most remarkable result was that the seasonal change of activity differed between the area below and above the canopy. Whereas the activity in the forest decreased drastically from mid June onwards, it increased above the canopy from the beginning of August onwards. This was mainly due to the fact, that Pipistrellus pipistrellus, started to hunt above the canopy.
in August. This species was not recorded in high numbers below the canopy during that period. Temperature seemed to have no influence on bat activity above the canopy. The activity depended more on wind speed.

**Abandoned old mines in the Central Slovakia: Important bat hibernation sites**

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The mountains of the Banská Bystrica region (48°43’N, 19°08’E) represented very important copper deposit (Špania dolina, Žubietová and Osrblie) for the entire medieval Europe of the 14–16th centuries. Mining was abandoned at these sites approximately 200 years ago and some of the mines serve as bat hibernacula. Altitudinal distribution of these hibernation sites range from 440 to 850 m a.s.l. The analysed data were obtained in January and February (usually winter census) and cover a seven-year period (2003–2010). Altogether 714 inds. of 11 bat species (*Rhinolophus ferrumequinum, R. hipposideros, Myotis bechsteinii, M. blythii, M. myotis, M. mystacinus, M. brandii, M. daubentonii, M. emarginatus, Barbastella barbastellus, Plecotus auritus, and P. austriacus*) were recorded hibernating in seven old mines (mine length 50–1500 m). This number represents 39.3% of the bat fauna of Slovakia (n=28). The predominant species were *R. hipposideros* (d=69.6%; F=26.1%) and *M. myotis* (d=22.7%; F=13.0%). *Barbastella barbastellus* also ranked among abundant bats (d=3.8%; F=4.3%). With respect to the population trend of predominant species a moderate increase ($r^2=0.664; p=0.073$) was recorded. The main threat to the hibernating bats represent mineral collectors as the mines are type sites for three minerals.

**Volant Viruses: a metaviromic study of a West African bat population**

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Bats constitute a significant reservoir of pathogens that can spill-over and/or emerge in both animal and human populations. This is illustrated by past outbreaks of SARS and Ebola haemorrhagic fever in humans, as well as Hendra and Nipah virus diseases in humans, horses and pigs. Active surveillance to characterise the viral richness within bat populations is thus critical for determining the potential for the emergence of new and known viruses from these animals. In a recent review, multiple geographical regions were predicted as ‘hot-spots’ for infectious disease emergence from wildlife, including Ghana (West Africa). Populations of fruit bats roost in close association with people in Ghana, including large numbers (n=233,185 in January 2010) in the capital city, Accra. This fruit bat population has
already been demonstrated to have neutralising antibodies against both henipaviruses and a Type II Lyssavirus. Next generation sequencing (NGS) technology has greatly enhanced sequencing capabilities and has proved a unique tool for detecting previously-uncharacterized viruses. We applied a NGS approach to detect viruses in the Ghanaian fruit bat population, from which we have identified numerous novel viral sequences.

Allopatric, ecological, hybrid, etc. speciation in bats: How do their wing prints differ?

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Studying speciation in natural environments is a difficult endeavor, chiefly because a vast number of variables can contribute to cladogenesis. Proposed mechanisms or models of speciation (i.e. allopatric, centrifugal, ecological, parapatric, peripatric, reticulated, sympatric, etc.) frequently overlap and are intriguing and complicated. Application is frequently messy. To emphasize this observation, we provide an example of the complexity of the speciation process within a single group of non-model organisms, fruit-eating bats of the genus Artibeus (Phyllostomidae). Our data indicate that at least three speciation processes (allopatric, ecological, and hybrid speciation) have contributed to species-level diversity currently recognized within the genus. Each of these processes has resulted in distinct signatures (or wing prints) that could only have been discovered through detailed genetic and morphometric analyses. We hypothesize that empirical studies of recently evolved Chiropteran genera will document a similarly complex pattern underlying the origin of genetic isolation. What types of data are needed to elucidate these wing prints? Examples include: diversification time estimates, sister taxon status, sympatry, evidence of reciprocal monophyly in genomic, nuclear or mitochondrial genes, genetic distance values, presence/absence of hybridization, karyotypic uniqueness, presence/absence of morphological distinctness (size vs. shape or unique characters or presence of unique diagnostic characters), ecological tolerance, phylogroups, and behavioral observations. We conclude that the process of speciation is so variable and complex and the data for justification of recognition of species are so messy that no solution is without substantial problems.

Bat bugs of the family Cimicidae (Heteroptera)

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The family Cimicidae (Insecta: Heteroptera) represents one of the principal groups of bat ectoparasites. The relation of a part of the species to birds or man is believed to be secondary. The cimicids are obligatorily haematophagous and exhibit a specific host exploitation behavior: both adults and larvae of Cimicidae stay on the body of their host only when feeding, the rest of the time they hide nearby. Using molecular and morphometric methods we study the phylogeography, taxonomy, population structure and ecology of the Cimex and Oeciacus species originally distributed mostly in the Holarctic region. In case of material available the phylogenetic study is planned to comprise the whole family. Based on
sequences of two mitochondrial genes, we found a close relation between the species of the genus *Oeciacus* parasitizing birds from the family Hirundinidae and the species of the *Cimex pipistrelli* group that contains parasites of bats. The relations between particular taxa suggest that their evolution comprised multiple host switches from bats to swallows or the other way and that the morphological similarity of the taxa is associated rather with the host than their phylogeny. Based on the analysis of the same genes we found 21 mitochondrial haplotypes in the population of the common bed bug, *Cimex lectularius*, represented by 30 samples from man and 36 from bats collected in several European countries. Only one haplotype was shared between populations from man and from bats. The phylogenetic analyses revealed one supported clade comprising exclusively samples from bats. This suggests a large degree of isolation of the two subpopulations of the bed bug that may have persisted since the man left caves as his shelter shared with bats. The two subpopulations were found conspicuously distinct also morphologically.

**Pipistrellus kuhlii: Further range extension in Ukraine**

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The northern border of range of Kuhl’s pipistrelle *Pipistrellus kuhlii* is shifting rapidly northward and therefore insufficiently known. Until the 1980s, *P. kuhlii* has been considered as one of the rarest bat species in Ukraine, limited to Crimea and Azov Sea cost region. Supposedly, during about two decades, it has colonised the whole of the eastern and central Ukraine. The species has reached northernmost Ukraine already in 1998. The first records of *P. kuhlii* from western Ukraine and north of the Carpathians have extended the species’ range as well as confirm its further westward expansion. The species spreading in this part of the country is apparently facilitated by the river Dnister valley. Till the last times the occurrence of *P. kuhlii* were not confirmed in the north-western part of the country, despite of the special investigations. The first records of the species were noted in the “Prypiat-Stokhid” National Park and its neighbouring areas. Analyse of time dynamics of the *P. kuhlii* expansion process supports the hypothesis that the species has spread in Ukraine as well as in central-eastern Europe via the migration corridor along the valleys of the bog rivers (Dnipro, Dnister, Siverskyi Donets, etc.) and their tributaries, that may act as natural migration routs. The individuals had penetrated probably the area of the Western Polissia via Dnipro river valley and further by its tributary Prypiat. The spreading along the rivers may well explain the spatial and time dynamics of the species’ range extension.

**Speciation in progress? Phonotypes and genetic differences in two coexisting morphotypes of Macrotus waterhousii minor**

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Distinct morphotypes have been described for the bat genus *Macrotus*. To clarify the unsolved taxonomic status of two coexisting morphotypes on Cuba, we investigated if these morphotypes vary in further features crucial for speciation using a sensory ecology and a genetic approach. Echolocation call differences may indicate a habitat-adaptation barrier resulting in a driving force for speciation in bats, as the acoustic structure of echolocation calls reflects the preferred foraging habitats. We analyzed the acoustic structure of echolocation calls recorded in a standardized situation from 47 individuals sampled across the island. Besides a verification of the existence of two morphotypes, the results revealed two phonetic types differing in peak frequency, start frequency, call bandwidth and peak-, start-, and terminal frequency of the prominent harmonic. While each phenotype corresponded to a morphotype, the separating differences in call structure could be only partially explained by allometry, indicating a sensory adaptation to differing foraging habitats. Genetic sequence analysis of the mitochondrial Cytochrome b gene in the above specimens resulted in a phylogenetic tree which significantly separated three groups, the West Cuban small morphotype, as well as an East Cuban group and a group from a peninsula in Central Cuba, both belonging to the large morphotype. The present data, providing evidence for two phonotypes, and for three distinct genetic groups, disclose a divergence of *M. waterhousii minor* on Cuba which, in turn, may reflect a speciation in progress.

**Taxonomic network for Southeast Asian bats**

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With over 320 species Southeast Asia is a ‘hotspot’ for rare and endemic bat diversity. Unfortunately, some 40% of this fauna is threatened with regional extinction by the end of the century. However, although national governments, through the CBD, are committed to biodiversity conservation, there are few individuals who can identify and provide authoritative data on species composition, distribution, and status of this diverse and threatened group. Taxonomists (with their keys, databases, field studies and interpretive skills) are well qualified to identify, describe and document the region’s bat diversity; support the work of ecologists, conservationists, and molecular biologists; advise on priorities for species and site-based conservation initiatives; monitor bat diversity loss from the impacts of climate change, habitat fragmentation, and the spread of disease; and support environmental impact assessments. However, as the requirement for taxonomic expertise grows in the biodiversity-rich tropics, the availability of taxonomists from the traditional centres in the West is declining substantially. Supported by the Darwin Initiative and the Foreign and Commonwealth Office (UK Government), the Harrison Institute, together with its partners in Cambodia, Lao PDR, Myanmar, Thailand, and Vietnam is currently developing a university-based taxonomic network in Southeast Asia. This will enhance taxonomic capacity by counteracting the decline in western taxonomists; reduce the impediment of working...
in isolation by promoting regional and international collaboration; provide a focal point for Southeast Asian governments to access locally generated biodiversity information; promote regional centres of excellence in taxonomic training and research; and establish and enhance in-country taxonomic libraries and voucher specimen collections. Activities will include student and staff exchanges; trans-boundary field studies; hosting of workshops and conferences; and joint publications in international journals. We invite all those with an interest in Southeast Asia’s bat diversity to join the Network and thereby promote further collaborative research and conservation.

Habitat complexity: the importance of understorey structure on the Phyllostomidae assemblages in the Brazilian Atlantic Forest

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Habitat features play a major role influencing species richness and abundance in local communities. The association between a given organism and habitat types is closely determined by the way each species exploits the available resources. Phyllostomid bats may present great mobility, performing highly maneuverable flights through clutter vegetation in order to detect and access their main food resources. As conspicuous features of the Neotropical forests, these bats comprise speciose assemblages along the Brazilian Atlantic Rainforest, a biome drastically reduced, fragmented and disturbed. In the southern region of Bahia state lies the largest portion of the Atlantic Forest, although these remnants comprise a mosaic of native forest patches in different degree of disturbance and shade cacao plantations (*Theobroma cacao*), locally known as cabrucas. In the present study, we investigate whether the spatial arrangement of the understorey vegetation in a given site could influence the structure of Phyllostomidae bat assemblages, taking into account morphological features of the species locally present. To accomplish for this goal, we developed a new method based on photographs to extract a range of metrics to describe the complexity and clutter levels of vegetation at each sampling site. We found a significant negative correlation between bat richness and number of captures with the obstruction and complexity level of the understorey vegetation. Bat species with morphological features associated with flights that are energetically more costly tended to be absent from more dense and clutter habitats. The Phyllostominae gleaner bats, although usually referred as indicators of pristine forest, were strongly associated to the low-complex shade cacao plantation, indicating the importance of the understorey structure on the distribution of these species.

Three peas in a pod? Energetics of three sympatric gleaning bats

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We compared basal metabolic rate (BMR) of three ecologically and morphologically similar bats (Myotis nattereri, M. bechsteinii and Plecotus auritus; Vespertilionidae) which occur in sympatry in Central European mixed forests. Since all three species are gleaners and forage within cluttered habitats (forest) we expected similar BMRs. Interestingly, however, BMR in Natterer’s bat was significantly lower than in the other two species. Body mass could not be taken as a sole explanation as it was the same as in P. auritus and significantly lower than in Bechstein’s bats. Probably, the observed differences can be attributed to small but important differences in life style including foraging mode. Whereas Natterer’s bat gleans from flight and mainly uses echolocation for prey detection, the other two species also listen for prey generated sound and usually briefly land for prey attacks. Differences in BMR can also be caused by direct or indirect influence of parasites. In our study, we observed a significant increase in BMR for M. bechsteinii and M. nattereri with increasing numbers of wing mites. However, although Plecotus auritus harboured most mites and thus should have the highest BMR, it did not increase but remained at the same level regardless of numbers of mites. Probably, mite infestation rates and hence differences in BMR are also linked to differences in sociality. Bechstein’s and Natterer’s bats both live in fission and fusion societies that might enhance the possibilities of mites to spread fast and rather evenly throughout the population. In contrast, Plecotus auritus roosts in smaller and more stable groups. Higher mite loads might be a cost of this type sociality. Perhaps in order to balance their energetic budget the bats have found a way, i.e., a suppressed immune response to accommodate high numbers of mites without increasing BMR.

Noteworthy records of bats from Yemen

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New records of some previously rarely found bat species from Yemen are presented. Epomophorus labiatus and Neoromicia guineensis were recorded in Yemen for the first time, both species occur solely in the westernmost part of Yemen. The most important and/or numerous records were made for Rousettus aegyptiacus, Eptesicus nasitus, Hypsugo ariel, Scotophilus dinganii, Plecotus cf. balensis, Miniopterus natalensis, Tadarida aegyptiaca, and Chaerephon nigeriae. Additional distribution data are given also for Hipposideros tephrus, Taphozous perforatus, Coleura afra, Nycticeinops schlieffenii, and Chaerephon pumilus. Rousettus aegyptiacus was found in 15 new localities throughout the Yemeni mainland, it was previously known only from four sites localised in southwestern Yemen and in Hadramaut. Eptesicus nasitus, Plecotus cf. balensis and Chaerephon nigeriae had been known from one Yemeni site each. The former two species were evidenced from one new locality each, C. nigeriae was found in three new sites in western Yemen. Five new sites in Hadramaut and easternmost Yemen are reported for Hypsugo ariel.
Prehibernation habitat use, shelter selection and movements by *Myotis myotis*

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Annual cycle of temperate zone bats comprises two periods of roost permanency (summer nursery roosts, winter hibernacula) and periods of seasonal migrations between summer and hibernation sites, eventually mating (spring, autumn). Much of what is known about bat biology results from winter surveys and research on breeding colonies. There is still paucity of information on bat ecology during migrations. We monitored population dynamics and occupancy of a nursery roost during post-reproductive period (August–October), and examined aspects of prehibernal ecology of *M. myotis*. Sixteen bats (2 ♀♀ ad., 2 ♂♂ ad., 8 ♀♀ juv., 4 ♂♂ juv.) were radio tracked during post-lactation and pre-hibernation period (September and October 2001, September 2002 and August 2003). Our study was conducted in southern Moravia, the Czech Republic. (1) There was considerable variation in the number of bats in the colony. By the end of September, all adult females have abandoned the roost, but young remained longer. Adult females then appeared only sporadically, usually accompanied by adult, sexually active males. (2) We recorded movements of marked bats between neighboring colonies, over distances up to 17.1 km. These movements seem to have cyclic character. (3) Seven bats left the study area (approx. 1200 km²), at least temporarily. (4) Bats hunted almost exclusively on fields, in median distance 3.1 km (range 1.3–9.3 km) from the nursery roost, however, the area used by *M. myotis* during autumn is very extensive. (5) Foraging activity was concentrated mainly to the first half of the night. (6) Bats frequently used tree hollows both as night and alternative day roosts, without any associations between members of the maternity colony. (7) In case of persisting unfavourable weather, bats remained torpid in tree hollows. In juveniles, such lethargy may last for several days.

Better knowing the Brazilian bats: A 200-years task?

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Brazil is the second most bat species-rich country in the world, but the information on the occurrence and distribution of its species is still heterogeneous and fragmented. We compiled museum data and bibliographic search and identified at least 5502 formal bat records in Brazil. The spatial distribution of those records indicate that less than 10% of the country is minimally surveyed, and for nearly 60% of Brazil there is not a single record of bat species. Record coverage varies from 79% of the Atlantic Forest to 24% of Amazonia, but none of the five terrestrial biomes in the country is well surveyed for bats. Only 15% of the nearly 1450
priority areas for the conservation of biodiversity in Brazil have bat species recorded into them. If maintained the current increase of 3.0% per year in the filling of data empty areas, and only 0.8% per year in the number of areas reaching ≥20 species, it would be necessary other 33 years before the whole country had at least a single bat species record, and 200 years before we could consider Brazil minimally surveyed for its bat fauna. Alarmingly, most of the data poor areas are located at the expansion frontiers of the agro-business and its surrounding deforestation fronts. We identified factors contributing to the increase of the knowledge on the Brazilian bats, and make suggestions for continuing this momentum into the near future.

The distribution of genetic diversity of *Miniopterus schreibersii* in Europe and Anatolia

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Europe is probably the continent in which the glacial phylogeography of species have been investigated the most thoroughly. Until now, three main refugia have been identified in Europe, one in the Iberian Peninsula, one in Italy and the third one in the Balkans. In this study, we investigated the phylogeographic history of *Miniopterus schreibersii* (the bent-winged bat) in Europe and Anatolia using mitochondrial DNA D-loop sequences. New samples collected from Spain, France, Slovenia, Croatia, Serbia, Slovakia, Albania and Crete (Greece) were combined with previous published data from Portugal, Bulgaria, Greece (mainland) and Turkey for a comprehensive analysis. The results indicated a very shallow differentiation in Europe, with the highest diversity being found in the Balkans. The results also suggest that the rest of Europe was most probably populated from a Balkans refugium and the populations in the Iberian Peninsula likely went extinct. Further sampling from Italy will be necessary, to determine the fate of the populations in this refugial peninsula. This absence of large genetic differences within Europe contrasts with the recent phylogeographic work on *Miniopterus schreibersii* in Anatolia indicating mitochondrial, nuclear and morphological differentiation of parapatric populations, resulting in a suggested elevation of the subspecies *M. s. pallidus* to species level.
An exceptionally well-preserved hipposiderid fauna from a middle Miocene cave deposit in the Riversleigh World Heritage Area, Queensland, Australia

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At least six hipposiderid species of three genera (including Brachipposideros and Archerops) are known from well-preserved skulls recovered from AL90 Site, in the Riversleigh World Heritage Area, Lawn Hill National Park, northwestern Queensland, Australia (19°S, 139°E). AL90 Site is interpreted to represent the remains of a cave, developed in Oligo-Miocene freshwater limestone, whose roof and walls are now missing but whose floor and indurated cave-fill sediments remain intact. The AL90 cave appears to have had a restricted entrance (or been water-filled), and acted as a selective pitfall trap from which medium-large mammals (e.g. the sheep-sized wombat-like Nimbadon lavarackorum, several species of kangaroo and a primitive carnivorous Tasmanian tiger) were unable to escape. Small creatures (e.g. bandicoots and possums) are comparatively rare. Fossil bat material is abundant suggesting the bats roosted in the cave. Speleothems and associated karst structures cover the excavated walls of AL90 providing a rich legacy of clues to help reconstruct the internal environment and surrounding external environment of this fossil cave, as well as providing one of the first radiometric dates for any Tertiary fossil deposit in the Riversleigh WHA. The fauna, including the bats, dates from the Middle Miocene Climatic Oscillation, a critical time in global climate change history after which Australia began an inexorable transformation from lush, permanently wet forests to drier forests adapted to increased climatic variability. During this time many mammalian groups ultimately vanished from the Riversleigh and Australian record as a whole. Although almost as speciose as hipposiderids in Riversleigh’s early Miocene cave deposits, the AL90 species are taxonomically distinct and in some cases phylogenetically distant from the early Miocene forms; this faunal turnover appears to reflect Middle Miocene climatic change.

White Nose Syndrome in North America

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White Nose Syndrome (WNS) is a disease associated with unprecedented bat mortality in the eastern United States and Canada. Since the winter of 2006–2007, bat population declines approaching 100% have been documented at some long-surveyed hibernacula. At
least six species of hibernating bats are susceptible to WNS. Total estimated losses have exceeded one million bats over the past three years. This presentation summarizes disease investigation efforts underway at the USGS National Wildlife Health Center since January 2008. Affected hibernating bats often present with visually striking white fungal growth on their muzzles, ears, and/or wing membranes. However, severe microscopic wing damage associated with the disease is not always obvious to the naked eye. Histopathological and microbiological analyses demonstrated that WNS is characterized by a hallmark fungal skin lesion caused by a recently discovered species of psychrophilic (cold-loving) fungus, *Geomyces destructans*. The fungus invades and erodes living tissue and grows optimally between 5°C and 14°C, temperatures consistent with the body temperatures of hibernating bats. Laboratory infection trials indicated that *Geomycetes destructans* is transmissible from bat to bat. A genetic signature of the fungus has been identified in environmental samples collected from several bat hibernation caves within WNS-infested states. There is a growing body of evidence supporting an association between WNS and life-threatening cutaneous fungal infection by *G. destructans*, and this disease represents an unprecedented threat to bats of temperate regions of North America and beyond. The decline of North American bat populations may have far-reaching ecological consequences.

Capture success and efficiency of trawling bats

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To contribute to the understanding of food intake and ingested energy in trawling bats we study the capture success and -efficiency of *Myotis daubentonii*. This bat hunts prey either with a ‘high catch’ using the tail membrane alone/or in combination with the wing or gleans prey from the water surface using the ‘low catch’ method. We transfer free-living Daubenton’s bats into a flight tent (20 m²) with an artificial pond (10 m²). The observations begin soon after dusk and are designed to be able to evaluate the capture success and -efficiency of bats using the low-catch method gleaning prey from the artificial pond. To ensure that the prey stays on the water surface we use larvae of *Tenebrio molitor* and Terflies mutants (*Musca domestica*) which develop crippled wings. The prey attacks are divided in a successful capture, unsuccessful capture attempt and discontinued capture attempt. The behavior of the bats is videotaped using a digital infrared video camera system. We expect high capture success rates of about 80–90% for Daubenton’s bats under the conditions in the flight tent. Differences in foraging time and capture success may be caused by the two prey species since these differ in size and similarity to the natural prey of *Myotis daubentonii*. Furthermore, we expect different capture success rates in individuals due to differences in reproductive status, age and experiential skills. Preliminary results support our expectations since capture success rates differ for the two prey species as well as for different *Myotis daubentonii* individuals. With *Tenebrio molitor* as prey we observed 656 prey attacks and capture success ranged from 59.3% up to 71.7% on the individual level (64.2% successful; 33.5% unsuccessful and 2.3% discontinued capture attempts). In contrast with *Musca domestica* as prey success rates of single individuals ranged from 80.9% up to 89.5% (505 observed attacks; 85.9% successful, 12.9% unsuccessful and 1.2% discontinued capture attempts). These results obtained in the flight tent will be compared to field studies to determine if our observations can be compared to the natural foraging behavior of the bats.
Behavioural evidence for olfactory species discrimination in temperate bats

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At least some species of bat can use scent for mother-infant recognition, for discriminating colony members from strangers and for the detection and classification of food. One recent study indicates that bats female bats can discriminate between con- and heterospecific males based on glandular scent cues that are used during courtship. We have as yet no knowledge, however, whether bats can recognize species identity by olfaction in a non-mating context. In the present study, we tested whether female greater mouse-eared bats (Myotis myotis) discriminate between the scent of con- and heterospecific females. We ran five different behavioural experiments in a y-maze setup, each with a different set of wild bats. The bats were given the choice between two different odour sources at the end of the two choice arms. A CPU fan at the end of each arm created a moderate air flow to transport the scent cues from the probe to the bat. The M. myotis spent much more time in the arm with conspecifics scent as compared to the arm with scent of sympatric greater horseshoe bats (Rhinolophus ferrumequinum). This is clear evidence for olfactory species discrimination in a non-mating context. The M. myotis showed no preference when choosing between conspecifics scent and scent of the sympatric long fingered bat (Miniopterus schreibersii), however. They also showed no preference when choosing between an arm with an unscented blank control and an arm with either conspecifics smell or the smell of one of the other two species (R. ferrumequinum, M. schreibersii). At this stage, we can not decide whether the indifference in the bats’ time allocation to the maze arms is caused by a lack of discrimination ability or, which we consider somewhat more likely, is a result of similar behavioural relevance of the respective olfactory stimuli.

Applying non-invasive genetic monitoring to bat populations

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In response to the ever increasing threats to natural ecosystems internationally, the Convention on Biological Diversity (www.cbd.int) have established guidelines to monitor biological diversity towards the goal conservation and sustainable use of biological resources. Monitoring biodiversity at the ecosystem and species level already exist, however, at the level of genetic biodiversity little has been done. Most studies do not take full advantage of the potential afforded by molecular genetic markers to systematically monitor changes in genetic composition and diversity through time. Here we discuss the development of a genetic monitoring scheme applying microsatellite DNA fingerprinting through non-invasive
genetic mark-recapture techniques to monitor two of Ireland’s most elusive bat species, the Whiskered bat (Myotis mystacinus) and Natterer’s bat (Myotis nattereri). In Ireland these species are found in low abundance in the environment, are acoustically cryptic, and with no known hibernacula, traditional bat monitoring methods are made extremely difficult. We examine the utility of census population numbers from mark/recapture analyses, compared to effective population estimates as monitoring indices, as well as investigating the reliability of recording temporal patterns of genetic composition from faecal matter. These species will be used as a model to develop this methodology which could then be applied worldwide as a monitoring strategy for rare, endangered or indicator bat populations.

Obstacle avoidance in Eptesicus fuscus with increasing degree of difficulty

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Bats avoiding obstacles are forced to precisely localize their position. This is so much more crucial the narrower the space is through which the bat must manoeuvre. In an obstacle avoidance experiment we tested how the bats’ echolocation and flight behaviour changed with the degree of difficulty. We trained four Eptesicus fuscus to fly from a start position to a landing grid. Bats flew on a stereotyped flight path emitting single calls or groups with two signals. In the obstacle avoidance task we introduced a frame with vertically wires whose spacing was changed from 50 cm to 10 cm. The smaller the spacing, the poorer was the bats’ avoidance performance, ranging from 87% collision free passes at 50 cm to only 12% at 10 cm. The bats’ obstacle avoidance reaction in the echolocation and flight behaviour was strongest below 30 cm. In the flight behaviour bats reacted by flying upwards and/or to the side, thus decreasing flight speed. In the echolocation behaviour sound duration and pulse interval decreased and pulse density increased with decreasing wire spacing. Additionally, the number of calls per group increased, especially in the terminal group. The reaction to the obstacle was the longer, the more difficult the task was, due to both, an earlier start and a later end of the reaction. The reaction in flight and echolocation behaviour to the increasing degree of difficulty resulted in an increase of the overall information collected on the obstacle. We will also discuss the function of signal grouping in the approach behaviour.

Adaptation of echolocation call intensity to ecological constraints in phyllostomid bats

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In two previous papers we have shown, first, that two phyllostomids, the trawling bat, Macrophyllum macrophyllum and the fruit-eating bat, Artibeus jamaicensis can emit echolocation calls of considerable intensity and, second, that M. macrophyllum dynamically adapts call intensity to habitat complexity. Here, we investigate on a broader scale the ecological correla-
...tes of echolocation call intensity in phyllostomids. We recorded bats with multi-microphone arrays at several sites in Panamá and Cuba. For example, at cave openings as the bats left their day roost, at fruiting fig trees along a shoreline and at ca. 40 m height from a canopy crane immersed into a fruiting fig tree. Assuming that habitat does indeed act as a unifying constraint on call intensity, we expected to record relatively similar source levels at each individual site. The sites were chosen to represent different perceptual tasks (leaving the roost; approaching a foraging site) and thus different sonar challenges. We discuss flexibility in sonar call intensity of phyllostomid bats, which often forage in highly cluttered space, but also use echolocation range to orient in situations where intense calls might be advantageous, for example when commuting in open space to a feeding site.

Bats and mine closure: a double-edged sword

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Much of the Western United States was settled as a result of mining. When the mines were abandoned, bats colonized these new “caves”. Cities grew up around some mining districts. Even in remote areas, mines are visited by people exploring on off-highway vehicles. Abandoned mines can be hazardous, and accidents result. The recent influx of funds in the United States for mine closure has stimulated a rush to remediate mine hazards on federal lands. To attain the goal of the Economic Stimulus Package of putting more people to work, some people are involved who do not have experience in bat biology or bat-compatible closures. If done properly, bats in mines could be protected through the installation of bat gates and cupolas. However if bat habitat is not identified, mines could be closed through foam and backfill that would deprive bats of roosting habitat and potentially kill them, especially if exclusions are not done properly at the appropriate time of year. Most bat species use a variety of roosts throughout the annual cycle as dictated by physiological and behavioral needs. The timing of surveys will influence the ability to detect bat use of a mine feature, which can affect the treatment that a mine may receive (hard or bat-compatible closure). There is no substitute for site-specific bat surveys using established protocols to detect bat use, nor is there a universal style of mine closure. Some bat colonies do not accept culverts or even gates. To understand the importance of a single mine feature, most of the mines in a geographic unit may need to be evaluated in order to determine those with the most significant bat use at different times of the year. The scope of the “landscape” will depend on the species of bat and their dispersal ability. The goal is to identify and protect the most important bat mines, and to avoid killing bats if a non-wildlife compatible method is selected.

Between a rock and a wet place: Home range and habitat associations of a maternity colony of *Myotis mystacinus* in a lowland agricultural landscape

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Since the expansion of agriculture in Europe, forest habitats have been significantly reduced and altered leading to the marginalisation of woodland specialist plants and animals. Nowhere is this more evident than in Ireland, where native woodland cover now stands at less than one percent. Forest animals, such as bats, have been driven to utilise woodland ecotone habitats. The whiskered bat *Myotis mystacinus* is a woodland specialist species found throughout Europe. In Ireland it is widespread but localised and in low densities. To elucidate what habitats this species used in a heavily altered lowland agricultural environment, a maternity colony of *M. mystacinus* in Co. Cork, southern Ireland was chosen for a radio telemetry study. Eighteen bats were tagged and followed for a five night period from May to July in 2009. Location points were estimated by triangulation. This paper describes the results of this study and discusses their implications for agricultural landscape design and management through the identification of key habitat components that could be a conservation priority for this species.

**Tree surfing: The phylogeography of the woodland specialist, *Myotis mystacinus* in Ireland**

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Traditionally it was assumed that Ireland’s biota re-colonised the island after the Last Glacial Maximum (LGM) via Britain, however current research now discounts the existence of this land bridge. Conversely, some plants and animals such as the strawberry tree, *Arbutus unedo* and the Kerry slug *Geomalacus maculosus*, which are native to the Iberian Peninsula, are found in Ireland but not in Britain, suggesting an historical southern link between Ireland and mainland Europe. All Irish bats rely on trees and forests for either roosting and as a foraging habitat, so it is therefore likely, that bats would have only been able to re-colonise Ireland after forest cover was established at the end of the ice age, approx. 9000 yrs ago. The direction and route of tree migration across Europe and into Ireland may therefore indicate the route that bats also took to colonise the island. This project focuses on the phylogeography of the whiskered bat *Myotis mystacinus* in Ireland. *M. mystacinus* is a woodland specialist, foraging along woodland edge, riparian areas and hedgerows and so may be a good model species for elucidating whether the direction of whiskered bat colonisation is linked to the direction of tree colonisation in Ireland. A 295 bp of the mitochondrial control region (HVII) was sequenced from whiskered bats sampled from Ireland and across mainland Europe. Phylogenetic methods were used to reconstruct the evolutionary history of this species. Here we discuss the relationship between this phylogeographic data and tree movements at the end of the LGM in Europe.
Emission and echo SPL in foraging *Myotis myotis* at different target strength

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Four greater mouse-eared bats (*Myotis myotis*) foraging in the passive gleaning mode had learned to search for and to approach the one of four feeding dishes that contained mealworms. A small radio transmitter with microphone (telemike) was used to transmit the echolocation signals and the returning echoes to a digital recording device. Flight trajectories were reconstructed from recordings with two infrared video cameras. We analyzed the sound and video data and measured how relevant parameters of the echolocation signals correlated with distance to the feeding dish. We also investigated whether the sound pressure level (SPL) of echoes from the feeding dish influenced the emission SPL. A corner reflector in the feeding dish was used to change the echo strength. When searching for prey, the source level of the emitted calls was kept at about 86 dB SPL RMS at the microphone of the telemike. When approaching the dish without reflector, the bats reduced their emission SPL to values around 71–60 dB SPL RMS. First results with reflector suggest that the approach started earlier and that the SPL reduction was a few dB larger. So far, we have no indication for a tightly coupled feedback control system for intensity compensation which keeps the SPL of the echoes from the feeding dish constant. Signal parameters are not varied in relation to the distance to ground.

Spatial model of bovine rabies transmitted by *Desmodus rotundus*: Landscape structure and edges related to rabies risk

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Transmission of rabies from vampire populations to cattle is potentially related to fragmented landscapes with large amounts of edges that show high contact rates between domestic animals and wildlife. We built a model using MAXENT software, which relates environmental conditions in sites with species presence. We used 32 towns from the State of Puebla, Mexico, where bovine rabies cases had been reported by the Committee of Animal Health (CFSAP) and the State’s Health Department, from 1997 to 2000. Since transmission events will hardly occur in the central location of towns but in the surroundings, analyzing “in situ” environmental conditions for each town would be futile, therefore, we analyzed the structure of the landscape surrounding towns; to do so, we developed the Surrounding Landscape Analysis Method (SLAM) which consists in dividing the area around each town into concentric rings of different sizes, (in this case: 5 km, 10 km, 15 km and 20 km) and introducing the landscape information contained in each ring size as a different variable into MAXENT, this method introduces the landscape structure as an environmental factor. The increasing ring size incorporates the concept of “spatial correlation”, expecting that
larger rings would contribute less to the model, since they contain information further from the georeference. As environmental variables we used temperature, precipitation, elevation, slope, conserved vegetation cover and edge area, all were analyzed in the surrounding landscape. Model showed (Jackknife analysis) that edges are the most important variable describing rabies presence, conservation programs should be considered in rabies prevention. The modeled distribution of rabies matched with the empirical pattern obtained by CFSAP and identified some unstudied areas where potential rabies epizootics may occur. The model will be used as a tool in future programs for rabies epidemiological surveillance, control systems, outbreak control, as well as in educational and social training programs.

Enriching agroecosystems with fruit-producing tree species favors bat abundance and richness in Veracruz, Mexico

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To address the hypothesis that the richness and abundance of phyllostomid bats is higher at sites characterized by greater structural complexity and plant richness, we evaluated how bats use three types of common agroecosystems (diversified coffee plantations, simple coffee plantations and pastures) in central Veracruz, Mexico that represent a gradient of structural and floristic complexity. Using mixed effects models we demonstrated that both the richness and total abundance of phyllostomid bats were higher in agroecosystems with the highest plant diversity. We detected similar patterns on comparing the abundance of the four most abundant species. Neither season nor the season-agroecosystem interaction had any effect on the comparisons we made. Using multiple regressions we found that plant species richness had the most explanatory power for the richness and total abundance of phyllostomid bats and also for the abundance of *Carollia sowelli* and *Glossophaga soricina*. Species abundance for *Sturnira* was directly proportional to the richness of plants that are useful to both people and bats. Our results indicate that agroecosystems value for bat conservation increases as the floristic and structural complexity of the agroecosystem increases. For the effective conservation of bats and other vertebrate taxa in tropical agroecosystems, a strategy of diversification with fruit-bearing species is recommended; such a strategy would benefit both agricultural producers and wildlife.

A methodology for searching and monitoring diurnal roosts

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To estimate the amount of diurnal roosts that could be occupied by bats, percentage of occupancy, which species were using roosts and the impact of anthropic activities in the species and their shelter, we investigated a trail of 1800 meters in three areas under different levels of impact at Floresta Nacional Tapirapé-Aquiri (FLONATA), an area for multiple uses of
natural resources and research in the State of Para, Northern Brazil. We looked for eight kinds of roosts: old termite colonies, inside hollow logs, hollow standing trees, leaves of Musaceae, leaves of large palms, fallen trees, exposed roots and on open surfaces (such rocks or tree-stems). Over a course of 12 sampling days, from August 2009 to March 2010 we found 181 roosts. The most frequent were hollows in standing trees, especially those from the genus *Ficus* (54%), leaves of palm trees (14%) and hollow logs (10%). Evidence of bat occupancy (recent or past) such as feces or food remains was found in 30 roosts (16%). Bats were located in 15 roosts (8%) but only in six of them it was possible to identify the present specie – *Saccopteryx canescens*, *Micronycteris macrotis* and *Thyroptera tricolor*. In all fieldworks the permanent roosts, like hollow trees, found in August 2009, were occupied by the same species in March 2010, even in areas where the anthropic impacts were occurring continuously. We found no evidence of a direct correlation between the amount of roosts located in a given area and the richness of bats captured by mist-nets. One species was only registered by active search of roosts for the inventory of the FLONATA (*Micronycteris macrotis*). All nectarivorous bats (Glossophaginae and Lonchophyllinae) registered in diurnal roosts were found in hollow logs, possibly indicating a direct relationship of nectar-feeding bats with this kind of roost.

Richness of bats in the Floresta Nacional Tapirapé-Aquiri, State of Para, Brazil

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We present the results of a fieldwork for an inventory and monitoring of bats at Floresta Nacional Tapirapé-Aquiri (FLONATA), an area for multiple uses of natural resources and research in the State of Para, Northern Brazil. The area is part of the Carajas complex, a region of intensive anthropic activities, most notably mining. Over a course of 56 sampling nights and 12 sampling days, from November 2007 to March 2010 we captured 1,470 bats using mist nets, hand nets, searching for diurnal roosts along trails and occasional sightings. A total of 72 species was identified, including 10 Emballonuridae, 3 Mormoopidae, 50 Phyllostomidae, 1 Thyropteridae and 8 Vespertilionidae. Among the species captured, the presence of rare bats such as the Emballonurids *Cyttarops alecto*, *Centronycteris maximiliani* and *Saccopteryx gymnura* indicates that the area is a high diversity region of the Amazon.

It is also worthy registering the first capture of *Eptesicus andinus* in the State of Para and the extension range for 12 other species, including *Cormura brevirostris*, *Tonatia bidens*, *Saccopteryx canescens* and *Peropyrrhypus kappleri*. Considering that no Molosids were captured, the richness is underestimated and will be higher with the use of other methods such as harp-traps and bat-detectors. Of the 120 species registered for the State of Para, 60% were captured in our fieldwork. We compared our results with another three areas surveyed by other researchers in the Brazilian Amazon and found that the similarities and differences can not be explained only by intrinsic floristic components, but also by the methodology and sampling effort employed in each area.
Conservation of bats in Hong Kong

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Bats comprise an important part of the biodiversity in Hong Kong, making up over 50% of all local mammalian species. The Agriculture, Fisheries and Conservation Department of the Hong Kong Special Administrative Region (AFCD) has launched a long-term monitoring program of Hong Kong bats in 2002 with a view to establish ecological baseline information and effectively monitor and conserve bats in Hong Kong. An illustrated identification key to 22 bat species recorded in Hong Kong was first published in 2004 and is being revised with the addition of newly discovered species. Four bat species new to Hong Kong were found under the monitoring program. The new discovery raised the total number of bat species in Hong Kong from 22 to 26. With the baseline information collected, current status, rarity and conservation value of the bats were evaluated. Currently, over 40% of Hong Kong’s terrestrial areas are designated as country parks and special areas or legally protected for nature conservation purpose. All bat species recorded under AFCD’s monitoring program have representative populations in these protected areas. Further studies, such as acoustic monitoring and radio-tracking, would also be conducted to better understand and protect the bats in Hong Kong. Conservation measures and species action plan would also be continuously developed and implemented.

Genetic variation in Cynopterus sphinx

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Social structure, population dynamics and microevolutionary forces greatly influence pattern, structure and evolution of genetic variation. There have been few studies that have actually dealt with genetic variation, population differentiation and phylogeography of bats in the tropics. The pattern of isolation by distance, size dimorphism and possible sexual selection across latitudinal gradient, range and population contraction of the short nosed fruit bat Cynopterus sphinx, was documented in Southern and Western India, focusing specifically towards the rain shadow region of the peninsula bordering the Western Ghats. In South East Asia, it was documented phylogeography of the congeners C. sphinx, C. brachyotis and C. horsefeldii, and have suggested the presence of distinct lineages, in C. brachyotis. Amongst Pteropodidae bats of India, C. brachyotis is closely related to C. sphinx. While C. sphinx is distributed widely, C. brachyotis is found only at higher altitudes. Size overlap between C. sphinx and C. brachyotis in areas of cohabitation has made the taxonomy more complicated. As part of a long term study, genetic variation among populations of C. sphinx was assessed. An attempt was made to genetically characterize peripheral isolates at higher altitudes which retain morphological features of C. sphinx and C. brachyotis at areas where they cohabit. Besides, the extent and pattern of genetic differentiation among various populations of C. sphinx were also studied. Results reveal the absence of any interspecific hybrid zone.
Genetic differentiation among populations was found to be low and population subdivision was found to be associated more with the metapopulation model.

**Acoustic and genetic variation in *Rhinolophus rouxi* in South India**

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Our knowledge of biological diversity is based on the extent of our understanding of the natural processes that frame such diversity. As concepts evolve, so does our understanding. Same is the case regarding our evaluation of biodiversity. Biodiversity assessment based on morphological identifications have often failed to identify variations that do not reflect on morphology but are nevertheless significant enough to taxonomically discriminate between such morphologically identical groups. Presence of these cryptic variations also presents a practical problem for biodiversity and conservation. They represent undiscovered diversity, and demand for tailor made and specific conservation management techniques, case by case. Among microchiropteran bats in the Indian subcontinent, the Rufous horseshoe bat *Rhinolophus rouxi* makes a very interesting case as reports suggest some extent of acoustic diversity in this species and genetic studies have revealed that allopatric populations which were considered as subspecies are actually distinct species. It was suggested the presence of cryptic species in this bat. In the present study, an attempt was made to chart the acoustic, morphological and genetic segregation of various populations. Results reveal the presence of two distinct acoustic and genetic lineages. They share a sister taxa relationship and average genetic distance of more than 7% between them indicates that they are two distinct species.

**Bats: Conservation and ecotourism, the experience at Tirimbina Rainforest**

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Located in Costa Rica, Tirimbina Biological Reserve, is a nonprofit organization. We have been working for 10 years with the communities through an Environmental Education Program, trying to create conscience among students and their families about the importance of protecting the forest on the area. The program works with around 1500 kids per year from 10 different communities. It’s a free program for the students, it includes transportation, meals, and materials. To maintain the education program for a long-term, Tirimbina has developed different ecotourism programs. One of them it’s called “Bat Program”, and take advantage of a long term monitoring program on bats. The program is designed to provide information to our visitors about natural history of bats, through a multimedia presentation, but also with some “field work”: tourists visit the mist-nets that are used by the assistants of the monitoring programs, and explain them how to work with the nets, and the benefit of the scientific
research. Different issues are covered on the activity, from myths to environmental benefits provided by bats, to humans and ecology in general. The average tourist has few or wrong information about this group, this program contributes “cleaning” the bad reputation, which in general bats have. We generated a list of 62 bats, including rare species such as Vampyrum spectrum, Centurio senex and Eumops hansae. Not only the education and scientific aspect are important, financially on the period from September 2005 to August 2009, the program generates net earnings of $79,912.64, from 7733 people who took the activity. These visitors are from many different countries, including Costa Rica, USA, Canada, France, and Germany. Also a percentage of this has been donated to the Costa Rican Bats Conservation Association, to help on education programs in other regions in Costa Rica. This is an example of a model linking ecotourism for the benefit of research, education and finally conservation.

**Dynamics of roost entrance in a leaf-roosting bat**

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Bats have developed a series of morphological, physiological and behavioural characteristics that have allowed them to exploit diverse roosting structures. The disk-winged bat, Thyroptera tricolor, illustrates these adaptations by the presence of suction disks, which bats use to attach themselves to the inner sides of developing furled leaves of members of the order Zingiberales (primarily in the genera Heliconia and Calathea). Here we assessed the entrance behaviour of wild-caught bats in artificial tubular leaves that resemble the morphology of Heliconia and Calathea to determine if leaf morphology affects landing strategies. Furled leaves in Heliconia have a protruding long tip which Calathea lacks, so our experiments tested the approaching, landing, and entrance behaviour of bats using artificial leaves with and without a tip. Video recordings of bats demonstrate that the approaching behaviour of bats was not different among leaves with and without tips. However, the time required for landing on leaves lacking long tips was significantly higher. Moreover, the wing structures used for landing differed depending on the presence of long tips. Bats used the wrist disks to land on the area of the long tip, whereas the use of forearms and tail membrane was observed when landing in the edges of leaves lacking the tip. The differences found in the entrance dynamics of T. tricolor, depending on the presence of a landing structure, reflect the high behavioural plasticity necessary to overcome ecological pressures that result from roosting in highly ephemeral shelters.

**Understanding cooperation in the Neotropical leaf-roosting bat Thyroptera tricolor**

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*Thyroptera tricolor* is a neotropical insectivorous species specialized for roosting in the developing furled leaves of members of the order Zingiberales. This bat forms stable social groups that maintain a local distribution and small home range sizes. However, populations exhibit significant differences in home range size which correlate to the abundance of
Field observations have also demonstrated that *T. tricolor* uses specific vocalizations to help members of a group find a roost site once one has been located. Here we evaluate patterns of residency and dispersal in *T. tricolor* to assess the role of population dynamics in the evolution of this species’ cooperative signalling system. We discuss the possible consequences of spatial differences in roost abundance on *T. tricolor*’s cooperative behaviour and its effect on social cohesion. Our study analyzes long-term capture-recapture data to calculate emigration rates and residency time, and to address patterns of offspring retention, matrilineality, and group dispersal. We also analyze association data to understand the possible correlation between resource abundance and patterns of group cohesion. Results indicate that dispersal patterns of *T. tricolor* are characterised by low emigration rates, long residence times, high levels of offspring retention from both sexes within natal groups, and dispersal of small kin groups. The retention of offspring, and their subsequent reproduction within their social group, resulted in groups being formed primarily by one or two matrilines. These dispersal patterns can explain the prevalence of cooperative interactions among group members during the location of highly ephemeral roosts in *T. tricolor* because natal philopatry results in high intra-group genetic relatedness and opportunities for kin selection. We also found that individuals use larger home ranges and form less cohesive groups when roosting resources are scarcer, and argue that an inability to communicate effectively with other group members may explain this pattern.

**New data on hibernation sites of bats (Vespertilionidae) in the north-west of Russia**

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During 2000–2008, some new caves and artificial undergrounds in the Leningrad Region and the Republic of Karelia were surveyed for bats. In all these shelters hibernation of bats was revealed. We found seven bat species there (*Plecotus auritus*, *Myotis nattereri*, *M. daubentonii*, *M. brandtii*, *M. dasycneme*, *Eptesicus nilssonii*, *Vespertilio murinus*). All records are of particular interest in respect of the fact, that the hibernacula lie near the northern margins of the distribution ranges of these species. Among the most important records range the findings of wintering individuals of *Vespertilio murinus*, a species formerly unknown to hibernate in the region. We obtained also a new record of *Myotis brandtii*, although numbers of this species decreased in the last years in the region.

**Habitat use by bats in anthropogenically transformed mosaic landscape of northern Poland**

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Only few studies refer to large-scale habitat preferences of multi-species bat assemblages of temperate mainland Europe. The aim of the recent study was to describe habitat and landscape associations of foraging and commuting bats in postglacial lakelands and coastal plains of northern Poland. The study area, located in the vicinity of Gdańsk, comprises of 347 UTM squares (10×10 km), among which 100 squares were selected at random. In each square
2.2–3.4 km long transect was established and divided into sections, classified into 30 basic habitat types (and additional 26 sub-classes). Habitat availability was estimated based on 1:10 000 topographic maps. Bat calls were recorded using Pettersson D-980 and Pettersson D-1000x ultrasound detectors and analysed in Batsound 3.3 software. In total, 9 bat species were determined but only six taxa were numerous enough to analyse their habitat preferences. Bats appeared to prefer stagnant water bodies (lakes and ponds), to a lesser extent edges of deciduous and mixed forests and their interiors, but avoided coniferous forests, arable land, meadows and pastures. Built-up areas and tree lines were used according to their availability. *Eptesicus serotinus* strongly preferred villages, to a lesser extent coniferous forests and their edges and even treeless coastal dunes. *Nyctalus noctula* appeared to be an eurytopic species with broad spectrum of used habitats (including open fields), but also preferred stagnant waters, mixed and deciduous forests, their edges and clearings. *Pipistrellus pipistrellus*, also being eurytopic, preferred lakes and ponds, mixed forests and villages. On contrary, *Pipistrellus pygmaeus* and *P. nathusii* were stenotopic taxa, preferring water bodies (only *P. nathusii*) edges of deciduous forests, while avoiding built-up areas. *Myotis* species, represented mostly by *M. daubentonii*, were recorded almost exclusively over waters, sporadically also in forests. Multivariate approach is planned to test if similar *Pipistrellus* species differ in habitat preferences in presence or absence of their congenerics.

**Can bats count?**

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The ability to count has long been thought to be a cognitive skill unique to humans, but since about 30 years there is growing evidence for numerical abilities of other animal species. There is ongoing debate, however, how to classify animal numerical abilities. One way is to differentiate between subitizing (telling the number of up to about four items without counting), estimation (of the number of a greater amount of items) and recognition of rhythmic patterns on the one side and “real counting” on the other. Some species of primates, rats and pigeons, but also salamanders and honeybees have been shown to have at least a rudimentary concept of numbers. In primates there even is evidence for operations with abstract ciphers. Our study is the first attempt to investigate numerical skills in bats. We set up a sequential counting experiment to find out if greater mouse-eared bats (*Myotis myotis*) are able to learn to receive a specific number of rewards (mealworms of varying size) from one automated feeder and then to change to another feeder where again this specific number of rewards can be obtained. Our very preliminary results at the time of submission of this abstract suggest that *M. myotis* is able to correctly deal with up to two consecutive visits at each feeder. The bats seem to fail to learn a three-visit paradigm. Our preliminary results provide – at most – evidence for a limited numerical competence in bats. The mouse-eared bats’ performance might be explained by either the recognition of rhythmic patterns or by subitizing.

**Getting the measure of biodiversity: Bats and global biodiversity indicators**

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In 2002, world leaders committed through the Convention on Biological Diversity (CBD) to achieve a significant reduction in the rate of biodiversity loss by 2010. As we report on progress towards this target it is clear that biodiversity loss has not been slowed. Further, the coverage of biodiversity indicators is deficient in several areas. In this talk, we review how bats fit into the current CBD framework of indicators, identify gaps in indicator coverage, and assess how this important group might be incorporated in future. We present global, regional and national level indicators of biodiversity change across systems to illustrate this. In order to get the measure of biodiversity, and prescribe proactive ways in which to counter its loss, we must first have robust and representative indicators of biodiversity change. A truly global picture of biodiversity requires coverage of all major taxonomic groups. We can no longer afford to base conservation decisions on a restricted and non-representative subset of species.

The community structure of cave-dwelling bat populations in the Yildiz Mountains, Turkish Thrace

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In this study, the community composition, species richness, and abundance of cave-dwelling bat fauna of Yildiz Mountains is presented and our census data (2009) is compared with the results of the 2001 census to examine possible changes in populations’ abundance and structure over the last few years. Approximately 42,000 bats, representing nine species, were recorded in 22 caves and Miniopterus schreibersii was the most abundant species, followed by Rhinolophus ferrumequinum and large Myotis. For the comparison, we focused on 19 caves and analyzed abundance of nine taxa: Miniopterus schreibersii, Myotis capaccinii, M. emarginatus, M. blythii, M. myotis, Rhinolophus euryale, R. blasii, R. ferrumequinum, and R. hipposideros. Myotis blythii and M. myotis, and Rhinolophus euryale and R. blasii were pooled together as large Myotis and medium-size Rhinolophus species, respectively. In winter and in summer 2001 the total number of recorded bats was ca. 36,000 and 14,000, respectively. The total abundance in 2001 was somewhat larger than in 2009 (ca. 30,000 and 12,000). In both time periods, and in both seasons, all analyzed species showed similar clamped distribution (as estimated by high values of Green’s index). Similarly, the Hill’s diversity indices and evenness indices did not show any drastic differences. The observed discrepancy in the total abundance of bats, we link to almost twofold decrease in abundance Miniopterus schreibersii and medium-size Rhinolophus species during summer months from 2001 to 2009. In winter months, a similar trend was observed in large Myotis and again in medium-size Rhinolophus species. Whereas Miniopterus schreibersii and in large Myotis appear to show only seasonal changes, decrease in abundance of medium-size Rhinolophus species seem to be consistent and might indicate a population decline of these species. We also report the first record of White Nose Syndrome in Turkey, which has been detected in a cave close to the Bulgarian state border on a large Myotis species.

Migratory structure and geographic origins of Lasiurus cinereus inferred from stable isotope analysis

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Hoary bats (*Lasiurus cinereus*) may be the most wide-ranging land mammals in North America, yet details about their migratory movements are lacking. Wind turbines are disproportionately killing hoary bats that are presumably migrating; about half of all bats that die at wind turbines in North America are hoary bats found between July and October. To assess the potential impacts of such mortality a better understanding of where individual bats originate and the migratory structure of their populations is needed. Stable isotope analysis is a viable way of inferring the pre-migration origins of hoary bats because new fur is molten in during summer and known geographic patterns of stable hydrogen isotope ratios in precipitation are reflected in the newly grown fur. We analyzed the stable hydrogen isotope values of fur (dDf) from hoary bats to look for evidence of geographic structure and determine probable summer origins of individuals. We sampled 218 bats from 7 regions, spanning 10° of latitude. Stable hydrogen isotope ratios indicated that many bats grew their fur at locations away from where they were sampled. We derived relative probability density surfaces for the geographic origins of individual bats using a modeling approach that incorporated known sources of variation estimated from bat fur of known origin. We then used a Bayesian approach to incorporate prior information on sex-specific differences in geographic origin. Interpreted in the context of previous information on the seasonal distribution of this species, results indicate that there is little geographic structure to spring or autumn migration, that many bats found at turbines were indeed migrating, and that some individuals migrate in surprising directions.

**Species diversity of bats along an altitudinal gradient in southern Malawi**

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Altitudinal gradients are useful in ecological research for investigating general hypotheses on the environment-diversity relationship at a local scale. The traditional view that species diversity declines monotonically with altitude has been challenged in recent years by a range of empirical patterns and competing hypotheses. Efforts to explain altitudinal richness patterns have highlighted the importance of climate, and a global climate model was proposed using bats as a model group. Altitudinal studies of bat species diversity are, however, still sparse in the tropics (a region of particular interest in this respect) and skewed towards Asia and the Americas. Here we present results from an altitudinal study of species richness and assemblage structure from Mount Mulanje, Malawi. Using mist nets, harp traps and acoustic monitoring, we sampled nine sites across three altitudinal habitat zones (lowland forest, mid-altitude forest, and montane forest-scrubland mosaic). Our results show conflicting patterns between diversity indices, which decrease with altitude, and estimated species richness, which remains high until the mid altitudes before declining sharply. The location of the peak in species richness is largely congruent with predictions of a recently published model that assumed varying effects of water and temperature limitations depending on latitudinal position. In an effort to link large-scale climate influences to local predictors of species richness, we quantified habitat structure at each sample site with measures of
canopy cover and vegetation density. Local species richness was significantly correlated with habitat structure. Furthermore, changes in habitat structure explained the turnover of species between sites and indicated distinct altitudinal assemblages. We discuss various interpretations of possible mechanisms linking climate with increased species richness and functional foraging group diversity in relation to these results, and conclude with conservation recommendations in the face of continuing degradation of montane forest habitats across south-eastern Africa.

**Natura 2000 – proposal of protected areas for bats in Croatia**

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Project for making a proposal of a network of protected areas for bats in Croatia has been continuously conducted since 2006. It is based on 12 bat species that are on Annex II of the Habitat directive. This poster presents the distribution of these 12 bat species and the research level for each species. Also, it presents a map of important areas for each species and the percentage of important areas that are already inside some sort of protected areas. On the example of the *Rhinolophus ferrumequinum* detailed analysis about the number of nursery and winter colonies is made. Emphasis is on what proportion of the total population is already under protection and in which way Natura 2000 will improve the protection of the *R. ferrumequinum* and other species in Croatia.

**Evolution of nectarivory in phyllostomid bats**

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Bats of the family Phyllostomidae show a unique diversity in feeding specializations. This taxon includes species that are highly specialized on insects, blood, small vertebrates, fruits or nectar, and pollen. Feeding specialization is accompanied by morphological, physiological and behavioural adaptations. Several attempts were made to resolve the phylogenetic relationships within this family in order to reconstruct the evolutionary transitions accompanied by nutritional specialization. Nevertheless, the evolution of nectarivory remained equivocal. Phylogenetic reconstructions, based on a concatenated nuclear- and mitochondrial data set, revealed a paraphyletic relationship of nectarivorous phyllostomid bats. Our phylogenetic reconstructions indicate that the nectarivorous genera *Lonchophylla* and *Lionycteris* are closer related to mainly frugivorous phyllostomids of the subfamilies Rhinophyllinae, Stenodermatinae, Carollininae, and the insectivorous Glyphonycterinae rather than to nectarivorous bats of the Glossophaginae. This suggests an independent origin of morphological adaptations to a nectarivorous lifestyle within Lonchophyllinae and Glossophaginae. Molecular clock analysis revealed a relatively short time frame of about ten million years for the divergence of subfamilies. Our study provides strong support for diphyly of nectarivorous phyllostomids. This is remarkable, since their morphological adaptations to nutrition, like elongated...
rostrums and tongues, reduced teeth and the ability to use hovering flight while ingestion, closely resemble each other. However, more precise examinations of their tongues (e.g. type and structure of papillae and muscular innervation) revealed levels of difference in line with an independent evolution of nectarivory in these bats.

Complementarity in extinction drivers among Caribbean endemic bats

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Identifying drivers of extinction in natural populations has become critical in the face of widespread anthropogenic modifications of climate, landscapes, and availability of intact habitat. Understanding the mechanisms underlying extinction in the wild is complicated because external drivers – such as habitat loss or hunting pressure – and intrinsic traits – such as dispersal abilities and body size – and their interactions contribute to the eventual demise of a population. Most bat extinctions in the West Indies have been attributed to habitat loss caused by natural climate change or anthropogenic deforestation, but the role of intrinsic traits in the extinction of some species remains obscure. We analyzed regional patterns of extinction using two complementary approaches, island biogeography and phylogenetic generalized estimating equations, to investigate the relative contribution of extrinsic and intrinsic extinction drivers in this fauna. Glacial and post-glacial changes in surface area and distances between landmasses can explain up to 96% of the variation in extinction between islands, demonstrating the power of this null model to explain the number of species lost across communities. This island-based method cannot help identify vulnerable species, or traits that make populations more susceptible to extinction. Phylogeny-based analyses of the relationship between extinction and species traits suggests obligate hot cave dwellers and wide-ranging species were more vulnerable to extinction during the Pleistocene glaciations. These complementary approaches provide a framework for understanding the role of extrinsic and intrinsic drivers and their interaction in driving Holocene and Anthropocene extinctions.

Echolocation, flight and inner ear adaptation in bats

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The auditory systems of echolocating bats are remarkable among mammals with the upper hearing limit of many species being above 100 kHz, five times that of humans. In order to cope with the demanding high frequencies produced during echolocation, the inner ear of
these species has undergone substantial structural and functional modification. Furthermore, the sophisticated echolocation of bats, coupled with their innovation of powered flight, is cited as one of the main reasons for their global success. This study aims to explore and document the structural variation of inner ears displayed in over 50 species across 16 bat families. By studying these morphological features, inferences may be drawn regarding the associated adaptations of each of the major echolocation call types as well as understanding the evolutionary origins across the order. High resolution micro-computer tomography (CT) scans were taken of a variety of bat species representing a cross-section of bat diversity in terms of echolocation call type, geographical distribution and ecology. This method allows the reconstruction of three dimensional volumes representative of the internal voids of the inner ear in a repeatable and non-destructive manner. These volumes represent the form of the cochlea, and the semi circular canals – the two key elements of the mammalian inner ear responsible for audition and vestibular function respectively. The morphology of these two components was quantified using a variety of measurement strategies (e.g. inter-landmark distances, outline semi-landmarks) and these data tested for covariation with a variety of eco-morphological characters. We will discuss our results in the context of the evolution of echolocation and the diversification of bats.

The urban crowd: Foraging ecology of *Eidolon helvum* from the non-migratory subpopulation in Accra, Ghana

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*Eidolon helvum* is one of the most abundant African mammals as well as a key seed disperser and long-distance migrant, but details of the long- and short-distance movements remain largely unknown. We followed the nightly foraging movements of seven individuals when the majority of bats had left Accra for their yearly migration. We recorded high accuracy locations and acceleration data with miniaturized GPS-loggers. All bats foraged almost exclusively on introduced and/or cultivated fruit, especially neem (*Azadirachta indica*), but also papaya, mango, oil palm and banana. Only two individuals included wild figs in their diet. All bats performed highly stereotypic foraging flights (up to 4 nights per individual). Even though distances of up to 37 km from the roost were covered (mean 18.6±11.8 km), all except one bat foraged in urban or suburban surroundings, sometimes flying over forest to get there. Given the large body size of the bats (285–325 g), foraging areas (excluding roosting and commuting locations) were surprisingly small (core area: median = 3.9 ha, range 2.3–4.9 ha, 50% kernel density; foraging area: median = 23.9, range = 9.9–52.9 ha, 95% kernel density). In fact, the core area usually encompassed only a few food trees. Acceleration data revealed rather short foraging periods, with bats frequently returning to the roost at 2:30–3:00 (12.3±6.2% flying, 15.3±7.2% climbing or otherwise active on tree). We speculate that *E. helvum* may increasingly cover its energetic requirements from human-generated resources and thus not all individuals may need to migrate to follow the fruiting trees during the rainy season. State-of-the-art GPS technology, which yields data accurate enough for the identification of individual food trees, will help to shed more light on this important bat tracks spatio-temporal fluctuations in resource availability.
When size matters: The influence of competition on bat body size

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There is evidence that competition influenced the body size patterns of animalivorous bat ensembles at local and intermediate regional scales in southern Africa. However, only one savanna ensemble and one parameter of body size (mass) was investigated, despite the fact that the savanna biome covers 54% of southern Africa and body size of bats can be quantified by a variety of parameters. We investigated the influence of competition on different parameters that define body size of animalivorous bats (mass, forearm length, two wing parameters, and two skull parameters) at six study sites in the savanna biome of southern Africa. We used null models to simulate the random body size patterns expected in the absence of competition and analysed the deviations of the observed patterns from these expected random patterns. There was little evidence that competition influenced the body size distribution of ensembles and functional groups at local and regional scales. At a few (1–3) local study sites, wing area and skull size of bats classified to ensemble and open-air and clutter functional groups displayed non-random patterns consistent with predictions from competition theory. After controlling for phylogeny, only skull size of open-air bats at four local sites displayed non-random patterns. At the intermediate regional scale, wing area and skull size of bats belonging to the ensemble and the clutter functional group displayed nonrandom patterns consistent with predictions from competition theory and only after controlling for phylogeny. Moreover, biotic filters such as prey defences and abiotic filters such as the physics of flight and sound probably also interacted with competition at local and/or regional scales to influence the body size of sympatric bats. Future studies should investigate alternative parameters that define bat community structure such as echolocation parameters and skull shape to better determine the influence of competition on the phenotypic structure of animalivorous bat ensembles in the savannas of southern Africa.

Evolution of bat flies (Diptera: Hippoboscoidea): Implications for host-pathogen co-evolution

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Bat flies (Diptera: Streblidae and Nycteribiidae) are blood-feeding ectoparasites of bats. Like any other ectoparasite, they possess conspicuous adaptations, including a specialized reproductive strategy, reduction and loss of eyes and wings, flattening or narrowing of their bodies, and the development of ctenidea or holdfast organs. Their hosts – bats – constitute an enormous radiation of evolutionary lineages, with different trophic strategies, roosting structures, colonial attributes, and social behaviors. Together, these attributes and their
emergent properties have motivated research that has yielded many discoveries in this mammal-ectoparasite system. One particularly interesting avenue of research has been the recent repeated discovery of *Bartonella* spp. in bats, and bat flies worldwide. New phylogenetic evidence of bat fly and *Bartonella* evolution affords the opportunity for a large scale co-evolutionary comparison. In particular, we will present evidence from a worldwide, and a local sampling (Puerto Rico), which will for the first time elucidate long-term co-evolutionary processes, as well as local connectivity patterns in the context of ecology. Our results point to the wide zoonotic potential of *Bartonella* spp., and the fact that bats and their ectoparasites may act as substantial pathogen reservoirs.

**Phylogeography of *Rhinolophus hipposideros***

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The lesser horseshoe bat (*Rhinolophus hipposideros*) is one of only five species of Rhinolophidae present in Europe. The IUCN European status for this species is Near Threatened and it is protected under Annex II and IV of the EU Habitats Directive. Despite its conservation status within Europe, little genetic work has been carried out to assess population origins and demographies. Here we assessed the phylogeography of *Rhinolophus hipposideros* to determine the origins, divergence dates and relationships among populations, particularly following the Quaternary ice ages and subsequent recolonisation of Europe. We examined the evolutionary history of *Rhinolophus hipposideros* (n=307) throughout its range using a suite of molecular markers; maternally inherited mtDNA cytB and D-loop (1629 bp); a bi-parentally inherited X-linked nuclear intron (BGN; 600 bp) and a set of eight autosomal polymorphic microsatellite loci. To infer the demographic history of this species we constructed a phylogenetic haplotype network, and used summary statistics to analyse population structure under a neutral model of evolution. Divergence times (using mtDNA) of the major lineages identified were found to pre-date the last-glacial maximum. More recent expansion dates are inferred from the rapidly evolving microsatellites. Our results show that this species survived in the Iberian and Balkan peninsulas as well as in an eastern refuge, during and since the last glacial maximum around 20,000 years before present (BP). Subsequent recolonisation of the central and northern European ranges around 11,000 years BP was almost exclusively seeded from the Balkan refuge. Due to this rapid colonization there is a decrease in genetic diversity along an east-west gradient with maximum diversity in the Balkan region, and least diversity in Western Europe.

**Low genetic diversity in the last surviving population of *Rhinolophus mehelyi* from Romania***

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Mehely’s horseshoe bat Rhinolophus mehelyi is a vulnerable species with an increasingly fragmented distribution. The species is rare and poorly known but appears to be declining across its entire range. In Romania R. mehelyi is critically threatened and prone to extinction. The remnant population forms maternity and hibernation colonies in a single location (Limanu Cave) situated in southern Dobrogea. Following dramatic declines in the past fifty years, the current population size is estimated at only 100 adult individuals. In the present study we examined the consequences of population decline and limited dispersal on population genetic structure and variation. We compared patterns of genetic diversity of the Romanian population with that of two Bulgarian populations, using mitochondrial D-loop DNA sequences. The alignment of 40 R. mehelyi sequences resulted in 10 distinct haplotypes with a total number of 9 polymorphic sites, of which 5 were parsimony informative characters. The most abundant haplotype (RHm3) was the only lineage found in all sampled colonies. A single haplotype was found in the Romanian population compared to 10 in Bulgaria, suggesting genetic isolation. This study confirms for the first time the low genetic diversity of this species in Romania, a serious threat to the survival of this species in this part of its geographical range.

Directional hearing by echolocating nectar-feeding bats, Glossophaga soricina

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Echolocating nectar-feeding bats visit flowers and extract nectar with remarkable accuracy and agility. Their ability to localise and recognize their target is well documented and reflects the coevolution process that developed between these bats and their flowers. Indeed, these flowers exhibit a number of characteristics adaptations called “syndrome of chiropterophily”. For the foraging bats, object information lies in interference notches generated by the object’s shape and directional information is imprinted on the echo by the head related transfer function. Obviously, the bat can find as well as recognize its target, which shows that it can differentiate both types of information. In this experiment, we test captive trained bats during behavioural experiments with a two-alternative-forced-choice paradigm to quantify their accuracy in directional hearing. Using a phantom echo generator, bat calls are played back in real time to an individual using an array of loudspeakers. Bats perform a lateralization task between two distinct loudspeakers to determine the minimum audible angle relative to the frontal position. We also investigate frequency components involved in the directional hearing task by modifying the spectral bandwidth of phantom echoes played-back to the individual tested. Further experiments will be done to determine whether the directional hearing task is more challenging for our individuals when not performed in front.

Do bats recognize their predators?

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Recognizing predators is vital for survival, therefore many animals are capable of assessing cues signaling the presence of predators. For the large and ecologically important group
of bats, consistent knowledge about predator recognition is still lacking. In this study, we tested whether individual bats are able to recognize predators by visual, auditory or olfactory cues. Stuffed predator dummies and territorial calls of avian species known to prey on bats were presented in a flight room to both, wild Schreiber’s bats (Miniopterus schreibersii) and captive greater mouse-eared bats (Myotis myotis). In addition, wild mouse-eared bats were exposed to natural and synthetic olfactory cues of mustelids and fox, both potential day-roost predators, in y-maze experiments. Within all experiments, we scored for a variety of anti-predator responses, but in none of the cases the bats’ behavior was affected by the presented predator stimuli. Bats thus seem not to rely on vision, echolocation, hearing or olfaction for recognizing predators, although these sensory modalities are of key importance to them. We suggest that the lack of predator recognition abilities in individual bats is mainly due to the low predation pressure on bats, which likely is linked to their nocturnality and roosting habits.

Frugivory and the diversification of phyllostomid bats

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Bats comprise almost one quarter of all living mammals and exhibit the greatest diversity in dietary adaptations of any mammalian lineage, almost all of which is concentrated within the New World leaf-nosed bats (Phyllostomidae). We analyzed data on cranial morphology, diet and bite performance in a phylogenetic context to identify the drivers, mechanism, and consequences of diversification in New World leaf-nosed bats – the most ecologically diverse family of mammals. We found a significant increase in diversification rate at the most recent common ancestor of the predominantly frugivorous clade (Phyllostomidae: Stenodermatinae). This shift to a higher rate of diversification is correlated with increasing rates of evolution in diet and cranial morphology. The superior bite performance of stenodermatines provides the mechanism linking the cranial phenotype to ecological opportunity, explaining the increase in diversification. Analyses of the timing of peak rates of evolution in diet and morphology suggest that exploration of the frugivorous adaptive zone led to phenotypic evolution, as predicted by the behavioral drive model of speciation.

Inferring the evolutionary factors from rates of phenotypic divergence in Myotis

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The rates of divergence were analyzed for craniometric and odontometric characters of 34 extant and fossil Myotis and Myotis-like species (Vespertilionidae) from Western Palearctic using log-rate/log-interval test. The geological age of the studied species ranged from the
Oligocene till the present time. Five closely related extant forms (M. myotis, M. blythii oxygnathus, M. b. omari, M. b. blythii, and M. nattereri) from Western Palearctics were used for more detailed analysis. It was revealed that the pairwise rates decline systematically the longer the time interval being studied. Our results imply that a certain combination of the divergence (driven by directional selection or random genetic drift) with stasis was the most common pattern in Myotis evolution in Western Palearctics. M. myotis and M. blythii sharply differ from other Myotis species in size and even are treated sometimes as constituting the separate genus. However the observed differences among these and other studied species could be established by random drift or directional selection of quite moderate intensity. Cranial shape appear to be more conservative in evolution than cranial size. Probably the stabilizing selection was slowing down the divergence of skull characters in this group of bats. The effects of phenotypic plasticity are not likely in the divergence of the studied characters. Relative evolutionary conservatism of basic skeletal characters in bats can be explained by stabilizing and correlational selection rather than genetic or developmental constraints.

Effects of connectivity and shape of landscape elements on bats

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Agricultural intensification diminished structural elements in European landscapes, implicating lower landscape connectivity. Bats particularly suffer from this fragmentation as many species depend on contiguous vegetation structures for foraging and commuting. We investigated the impact of landscape connectivity and the effect of structure and shape of landscape elements on the activity and diversity of Swiss bat species. We expected species using short-ranging echolocation to be most sensitive to habitat fragmentation and searched for thresholds of isolation that exclude bats from accessing habitat patches. Furthermore, we examined bat activity at linear and patchy elements to determine habitat configurations advocating bats. Connectivity and shape of landscape elements were evaluated using GIS. Bat activity was quantified using stratified, repeated acoustic monitoring at 15 sites of varying connectivity and shape in each of 15 regions in the Swiss central plain. Spectrograms of bat calls were assigned to species with the software BATIT by means of image recognition and statistical approaches. Bat activity was significantly higher at landscape elements compared to open areas and, with increasing connectivity significantly increased in bats with short-ranging echolocation calls. We found dissimilar connectivity optima for the different species groups. While species richness increased significantly with increasing connectivity, Simpson diversity showed no effect. Shape of landscape elements did not affect total bat activity, but the dominant species Pipistrellus pipistrellus preferred linear elements. Bat activity increased with increasing area of landscape elements whereas the amount of pasture was the only habitat feature showing a negative effect. The study highlights the importance of landscape connectivity for bats, especially short range echolocators. In open agricultural landscapes, bats profit from single landscape elements, although predominant effects are achieved with optimally connected patches. An increase in structural landscape elements such as hedgerows or groves promotes bats and could help sustain bat populations.
Energy and nutritional demands in *Hipposideros bicolor* 142 kHz giving birth right on time

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The high energetic and nutritional demands of pregnancy and lactation in bats are presumed to require that species in seasonal habitats breed when food availability is greatest. Failure to match parturition with food availability could incur individual fitness costs and, should mismatches occur repeatedly, lead to population declines. In this study, we determine whether an insectivorous rainforest bat from Malaysia, *Hipposideros bicolor* 142 kHz, synchronizes reproductive activity with insect availability, and if insect availability correlates with local climate variables (temperature and rainfall). The study was conducted in lowland dipterocarp forest around Kuala Lompat Research Station (3°43’N, 102°10’E), Pahang, Malaysia between February and December 2009. Bats were trapped with four-bank harp traps in the forest understorey for five nights each week, and once a month at a nearby cave. A total of 180 female adults were captured, and within-month recaptures were excluded. Females were assigned to five major reproductive categories by examination of the condition of mammary glands and pubic nipples and abdominal palpation: not reproductive; early pregnancy; pregnant; lactating; post-lactating. Two light traps were run simultaneous to the trapping in order to correlate the presence of insects as food source for these small flying mammals. HOBO Automated Weather Station was used to monitor the temperature and rainfall in the study area. Our findings suggest that *Hipposideros bicolor* 142 kHz has a restricted seasonal monestry pattern of reproduction in which females produce one litter in a single season each year. Pregnancy was detected as early as February and lactating individuals recorded from April until September. The highest percentage of lactating individuals was recorded in May, which corresponded to the maximum mean rainfall and the highest mean insect dry biomass at the study site, suggesting that this species synchronizes parturition and lactation with the period of maximum food abundance in the habitat.

Mites, males and members – Parasitism in *Myotis daubentonii*

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This study investigates the factors driving mite infestation (*Spinturnix andegavinus*) of Daubentons’ bats (*Myotis daubentonii*). General linear models (GLM) were used to test effects of ‘Month’, ‘Group’ (1: adult males, 2: adult females, 3: juvenile males, 4: juvenile females), ‘Body Condition Index’ (BCI), and ‘Colony size’ (bats/roost), as well as specific interactions on parasite load. Bats were mist-netted and caught with funnel-shaped basket traps at roosts in central Germany (Hessen). In total, 2106 animals were captured and marked by forearm-banding. On capture, adult and juvenile bats were discriminated and measured for body mass, forearm length (to calculate BCI), and infestation with mites on both wings. General linear modeling showed that parasite load was related to ‘Month’, ‘Group’ and the interaction between ‘Group × BCI’. The model was best explained by ‘Group’ (approx. 51% of variation) and ‘Month’ (approx. 47% of variation). The interaction ‘Group × BCI’
had a marginal effect on level of infestation which explained only approx. 2% of variation. This effect can be assigned to positive correlations of ‘BCI’ and mite infestation in adult females and juveniles during nursery period. In adult males an effect of ‘BCI’ on parasite load could not be observed. Mite infestation in roosting individuals was related to ‘Group’, ‘Colony size’ and the interaction between ‘Group × Colony size’. The model was best explained by ‘Colony size’ which accounted for approx. 55% of variation. However, the explanatory value of the interaction ‘Group x Colony size’ is with approx. 29% of variation considerably higher than the value ‘Group’ (approx. 12% of variation). Following regression analysis showed sex and age specific effects of ‘Colony size’ on mite infestation. Whereas a positive correlation can be observed in adult females ($r^2=0.59$), juvenile males ($r^2=0.74$) and juvenile females ($r^2=0.65$), the infestation rate of adult males tended to decrease when ‘Colony size’ increased. The findings show that mite infestation in adult male Daubenton’s bats is neither influenced by ‘BCI’ nor ‘Colony size’, and only in July significantly higher than in other ‘Months’. On the basis of our results, we suppose that adult males never have to reduce their self grooming behavior like reproducing females and are therefore able to minimize parasite load during the whole seasonal activity period.

Why do bats fly far for dinner?

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This study investigates the factors driving foraging behavior in a population of Daubenton’s bats (Myotis daubentonii). We analysed the importance of food availability, energy demand and intraspecific competition in regulating foraging activity and selection between near and distant foraging sites. At two major foraging patches insect abundance, foraging activity and the number of foraging individuals was monitored via sticky traps, telemetry, spotlight counting, and chemiluminescent snap light-sticks, respectively. Population size was determined using flight path counting. General linear model analysis showed that the distribution among foraging patches was influenced by distance to day roosts, month, population size, and the displacement pressure within a patch. Factors affecting the foraging time were food resource accessibility and individual cost/benefit ratio. From June to August the population density was high and intraspecific competition, as indicated by chasing flights in foraging patches, was at its sharpest (play-off time). At the same time transfer flights between foraging patches and to day roosts were most frequent. Our results suggest that differences in foraging activity of Daubenton’s bats are mainly driven by differential energy demand and less by food availability. In times of high disposition to forage, hunting is avoided under shortage of prey. During play-off time, density spill-over in near foraging patches occurs and therefore more distant patches come into use in accordance with the ideal free distribution theory.

Using satellite telemetry to assess movement patterns of Pteropus spp.

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Migratory animals present specific management and conservation challenges. These include the need for large protected areas (e.g. ungulates in Africa or North America); poor knowledge of movement patterns and habitat use (e.g. sea turtles); different pressures on habitat in disparate regions within a species’ range (e.g. neotropical migrant songbirds); and inconsistent protection laws – particularly if a species’ range transcends national boundaries. Some treaties, such as the Convention on Migratory Species (CMS 1979) call for protection of migratory animals throughout their range, but large numbers of migratory species still lack comprehensive protection. Old World fruit bats of the family Pteropodidae are an ecologically significant group of animals that occupy broad, multi-national home ranges, yet largely lack regional protection as well as baseline population data. To better understand the local and particularly the long-range movements of several species of *Pteropus* in Bangladesh, Malaysia, Indonesia and Australia, we employed satellite telemetry. Pteropodid bats are important reservoirs of viral pathogens that have human health impacts such as Nipah virus, Hendra virus, and Australian Bat Lyssavirus. Understanding local and long-range movements not only provides critical information for a species’ ecology, but is increasingly important for understanding host-pathogen dynamics in an epidemiological context. Here we present movement data from several species of *Pteropus* in Bangladesh, Malaysia, Indonesia, Papua New Guinean, and Australia and discuss the utility of satellite telemetry for tracking these ecologically and epidemiologically important animals.

Trophic discrimination may obscure spatial information in stable hydrogen isotope ratios of bat hair

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Despite being relatively small, bats are exceptionally mobile. However, where and when bats move seasonally often remains enigmatic, particularly in bats migrating in elevation. Stable hydrogen isotopes have been utilized recently to infer the geographic origin of migratory animals based on the ratio of heavy and light hydrogen isotopes (δD) in metabolically inert material such as hair. This is possible because δD varies along latitudes and elevation. Yet, not much is known about trophic effects in the discrimination of heavy hydrogen isotopes that could interfere with movement related isotope signatures. This could obscure a geographical signature and complicate data interpretation. We measured δD in the hair of four frugivorous bat species (*Artibeus toltecus*, *A. jamaicensis*, *Sturnira ludovici*, *S. lilium*) and three insectivorous bat species (*Micronycteris microtis*, *Myotis keaysi* and *Molossus ater*) captured at two elevations (1000 m and 1500 m) in the Merendon Mountain Range in Honduras (Central America). Hair of insectivorous species was enriched in deuterium by about 40‰ relative to those of frugivorous species, suggesting that δD increases with trophic level. Mean δD in hair was significantly different among insectivorous but not among frugivorous species, probably because variation in δD was higher in frugivorous than in insectivorous species. Of all captured bat species, only *A. jamaicensis* and *S. lilium* were solely captured at lower elevations. For example, *A. toltecus* and *S. ludovici* were captured at high and low elevations, indicating a broader distribution of these two species. Isotopic similarity of frugivorous species may indicate overlapping feeding sites and possibly elevational movements of more than 500 m in *A. toltecus* and *S. ludovici*. In conclusion, despite distinct elevational
differences in climate and vegetation, the isotope signature of bat hair did not provide clear
evidence of elevational migration in the studied bats. In general, we urge for caution in the
interpretation of δD values and make a plea for more baseline studies.

**Tadovan Cave – a living ecosystem for study of bats in Iran**

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The Tadovan cave is locating in the village of Tadovan, about 65 km north of Jahrom in the
Fars province. The Tadovan cave is a large and complex cave inhabited by many species of
bats. The cave is a home to approximately 10,000 bats (at least eight species including Rhinopoma microphyllum, R. muscatellum, Myotis blythii, M. capaccinii, Rinolophus blasii, R. euryale, R. hipposideros, and Miniopterus schreibersii) in four seasons. In the first chamber,
we found approximately 300 Rhinopoma individuals of both species. In other parts of the
cave, Rinolophus euryale, R. blasii, R. hipposideros, Myotis blythii, M. capaccinii, and
Miniopterus schreibersii hung from the cave ceiling. Several bat specimens were surveyed
for ectoparasites. The found ectoparasites included the genera Spinturnix, Eyndhovenia,
Ixodes, Pencilidia, and the family Sterblidae. The inventory of the cave includes identification
of the bat species, population estimate, ectoparasite load and reproduction state in the bats
inhibiting the cave. This information are of particular interest as the cave could be impacted
by human disturbance including developmental projects of ecotourism.

**Effects of tropical forest fragmentation on aerial insectivorous bats in a land-bridge
island system**

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Anthropogenic climate change and landscape modifications are threatening species’ persist-
tence. Forest fragmentation negatively affects tropical bats, however not all guilds respond
equally. Moreover, detecting and predicting how climate change affects bats is important
but challenging. We acoustically determined species richness, composition, count abund-
dance and feeding activity of background-cluttered and highly-cluttered space bats (forest
species) and uncluttered space bats (open space species) in a land-bridge island system
and assessed the same characteristics for forest species along a rainfall gradient across the
Isthmus of Panama. We predicted negative effects of fragmentation on forest species while
open space species should remain essentially unaffected due to high mobility. As predicted,
forest species showed compositional differences between sites due to effects of isolation,
area and vegetation structure. Feeding activity of forest species decreased on far compared to near islands whereas count abundance was independent of island isolation or area. Conversely, open space species did not reveal negative responses to fragmentation. At the species level, forest species that responded negatively to fragmentation were also rare and had restricted distributions. Species that were more abundant on islands, irrespective of size or isolation, were also widely distributed across the gradient. The center of the Isthmus has been experiencing a drying trend for the last decades. We therefore predict a future shift in guild structure at the center of the Isthmus; species composition will resemble the current composition at the driest end of the gradient. If so, richness and evenness will decrease and rare species will become locally extinct. There is a need to address synergistic effects between forest fragmentation and climate change in future studies of bat assemblages and how these factors may interact to exacerbate local species declines.

Biome transitions as centres of diversity: habitat heterogeneity and diversity patterns of West African bat assemblages across spatial scales

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It is widely accepted that species diversity is contingent upon the spatial scale used to analyze patterns and processes. Recent studies using coarse sampling grains over large extents have contributed much to our understanding of factors driving global diversity patterns. This advance is largely unmatched on the level of local to landscape scales despite being critical for our understanding of functional relationships across spatial scales. In our study on West African bat assemblages we employed a spatially explicit and nested design covering local to regional scales. Specifically, we analyzed diversity patterns in two contrasting, largely undisturbed landscapes, comprising a rainforest area and a forest-savanna mosaic in Ivory Coast, West Africa. We employed additive partitioning, rarefaction, and species richness estimation to show that bat diversity increased significantly with habitat heterogeneity on the landscape scale through the effects of beta diversity. Within the extent of our study areas, habitat type rather than geographic distance explained assemblage composition across spatial scales. Null models showed structure of functional groups to be partly filtered on local scales through the effects of vegetation density while on the landscape scale both assemblages represented random draws from regional species pools. We present a mixture model that combines the effects of habitat heterogeneity and complexity on species richness along a biome transect, predicting a unimodal rather than a monotonic relationship with environmental variables related to water. The bat assemblages of our study by far exceed previous figures of species richness in Africa, and refute the notion of low species richness of Afrotropical bat assemblages, which appears to be based largely on sampling biases. Biome transitions should receive increased attention in conservation strategies aiming at the maintenance of ecological and evolutionary processes.
Bat species richness, diversity and abundance in a mosaic forest and cocoa plantation in southern Bahia, Brazil

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The southern Bahia state comprises the largest remnant forests in the Atlantic domain in the Brazilian Northeast. This forest is in fact a mosaic composed of native forests and shaded cacao plantations, known as cabrucas. Here we specifically investigate how richness, abundance, diversity and composition of bat species is influenced by: (1) the conversion of forests into cabrucas, (2) the distance from cabruca to the forest, and (3) whether these parameters change according to different intensification management procedures adopted among cabrucas, particularly the thinning of canopy layer. Our results corroborate previous studies showing that bat assemblages in cabrucas of southern Bahia are rich, diverse and abundant, although its species composition is different from the one of the forests. Contrary to what we expected, local management intensity did not affect the bat species composition, richness or abundance. Cabrucas are, thus, important matrices, which can hold a large number of species at the landscape scale.

A bony connection signals laryngeal echolocation in bats

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Echolocation is an active form of perception where animals emit sounds and then listen to the reflected echoes to form images of their environment in their brain. For the process to work outgoing sounds must be represented at a neuronal level for future comparison with returning echoes. The mechanism effecting this neuronal representation is presently unknown. The ability to echolocate has evolved at least four times in mammals (bats, whales, shrews, tenrecs) and twice in birds (oilbirds and cave swiftlets). Although echolocation is usually associated with bats, it is not characteristic of them. Most echolocating bats emit sounds from the larynx, but within one family of mainly non-echolocating bats (Pteropodidae), a few species emit broadband unstructured sounds by clicking their tongue. The diversity of echolocation is reflected in the variety of signals that bats emit, which can include constant frequency (CF-narrowband) and/or frequency modulated (FM-broadband) components that can be long or short in duration and emitted in varying temporal patterns. Using anatomical data obtained from micro-computed tomography scans of fluid preserved bats, we found that proximal articulation of the stylohyal bone with the tympanic bone always distinguishes
Laryngeally-echolocating bats from both non-echolocating and tongue-clicking pteropodid bats. The stylohyal bone is part of the mammalian hyoid apparatus and functions in breathing, swallowing and phonation; the tympanic bone surrounds and supports the tympanic membrane. In many high duty cycle species, the stylohyal was fused at a point or along the entire length of contact with the tympanic. A previous report on the stylohyal in the oldest known fossil bat (Onychonycteris finneyi) suggested that it did not echolocate; however, we speculate that O. finneyi may have had the capacity for laryngeal echolocation because its stylohyals may have articulated with its tympanics. A coupling of the larynx to the ear via a stylohyal-tympanic connection could serve multiple functions in hearing and echolocation, and provides an independent anatomical character to distinguish laryngeally-echolocating bats from all other bats. Our discovery reopens basic questions about the timing and the origin of flight and echolocation in the early evolution of bats.

Farmers encouraging bat conservation to fight Chilo suppressalis: An example to follow

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The average rice yield loss caused by the striped rice borer (Chilo suppressalis) is estimated to be 5–10 millions tones per year. New strategies to control insect plagues in Europe are applying to use just one insecticide per insect pest species combined with other natural methods. We have studied possible control of the striped rice borer populations by recovering bat populations in one of the most important rice paddies landscapes of Europe, located in Catalonia (NE Iberian Peninsula). Since 2000 we have monitored soprano pipistrelle (Pipistrellus pygmaeus) roosting in 69 bat boxes. We have also studied significant activity peaks of the striped rice borer along the study period and detecting temporal activity patterns of bats using bat detectors from July to September (2007), and from August to October (2009). During the same period we have also used DNA extraction techniques to look for the striped rice borer in bat droppings (n=80). Significant correlation between bat foraging activity and presence of the striped rice borer in rice paddies has been corroborated (ANOVA; F=4.66; g.l.=1, 37; p=0.03) as well as the presence of the moth in bat diet (50% of positive sample and doubts about negative samples due to possible low sensitivity of the analysis). A reduction of number of plants affected by the striped rice borer has also been observed near bat boxes (ca. 4.500 roosting bats). Pesticides and deforestation in rice paddies have caused a dramatic reduction of synanthropic bat species like Soprano Pipistrelle Bat. We have confirmed that these bats can be voracious predators of insect pests and so we have proposed to locate bat boxes in rice paddies as a natural strategy to control pests. Amazingly this strategy has already been adopted by farmers and they are sponsoring the study.
Group decision-making in fission-fusion societies: Lessons from *Myotis bechsteinii* and *Plecotus auritus*

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To benefit from group living, group members have to coordinate their behavior and make group decisions. We assessed group decision making in two syntopic bat species, Bechstein’s bats (*Myotis bechsteinii*) and brown-long eared bats (*Plecotus auritus*), both forming colonies of stable individual composition but with high fission-fusion dynamics. By supplying several wild colonies, comprising individually marked females of known age and relatedness, with new day roosts (bat boxes, monitored with automatic PIT-tag reading devices) we analyzed the individual exploring and roosting behavior of the PIT-tagged bats. Furthermore, by manipulating the provided boxes we generated strong conflicting information among colony members about the suitability of the boxes for day roosting and measured how the resulting information conflicts affect group decisions. Data from one field season show that Bechstein’s bats explored and occupied more potential day roosts than brown long eared bats did. Individuals of both species considered their own information about a potential roost as well as the behavior of colony members when deciding where to roost. In both species group decisions seem to be unanimously in a situation where information conflicts are very strong but at least in Bechstein’s bats individuals can avoid group decisions that are not in their interest by forming a subgroup in another roost. Comparing our data to previous field experiments with other types of roost manipulations (creating weaker information conflicts) suggests that the decision making process and the time to come to a decision depend on the type of manipulation of the potential day roosts, and hence on the strength of the information conflict among colony members.

Adaptive behavior of gleaning bats during spatial orientation and prey acquisition

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All micro-bats use echolocation to orient in space and most of them also to hunt for prey. Gleaning prey from surfaces such as vegetation or the ground confronts bats with masking background echoes concealing the prey. Greater mouse-eared bats (*Myotis myotis*) gleaning prey from the ground perform this foraging task by using prey generated rustling noises for prey detection and localization (passive gleaning). Echolocation is only used for spatial orientation. However, our bats also learned to use echolocation to detect and localize silent prey offered at varying positions on a flat surface producing almost no clutter (active gleaning). Echolocation is only used for spatial orientation. However, our bats also learned to use echolocation to detect and localize silent prey offered at varying positions on a flat surface producing almost no clutter (active gleaning). In these approaches flight and echolocation behaviour differed from the behaviour in passive gleaning experiments. The bats produced signals with a higher repetition rate while perching at high places and scanning the feeding area. Before landing on the silent prey the bats flew over the prey more often while scanning the prey site by emitting a series of sounds with short pulse intervals. Ensonification of the prey with a robot revealed prey specific angle dependent changes of the echo amplitude which might be used to separate the prey echo from
other background echoes with similar echo properties. During approach the pulse interval was lowered, and calls were often organized in groups. Passive gleaning approaches ended in less than 40% of all landings with a buzz II. After learning active gleaning bats produced in 94% of all observed landings a buzz II, which consisted of twice as much calls than in passive mode. Furthermore one individual developed a special call ending with a short shallowly modulated terminal component during active mode. Our data show that *Myotis myotis* is able to learn active gleaning under ideal acoustic conditions. We will discuss the observed changes as adaptations for the active detection and localization of prey.

**Bat communities in a fragmented landscape in southern Western Ghats: Status, ecology and conservation**

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Bats are an important component of ecosystems, performing significant ecological functions as predators, prey, seed dispersers and pollinators, thereby providing valuable ecosystem services. Possible negative effects of habitat fragmentation on bats could pose serious threats on ecosystem processes and other species. Our study area is located at southern Western Ghats biodiversity hotspot and is a highly fragmented landscape consisting mainly of privately owned rainforest fragments, tea monoculture plantations and shaded coffee plantations, as well as some areas of continuous rainforest. This study is the first attempt to explore bat communities in the Anamalai Hills, providing baseline information on a highly disturbed but important landscape. The main objectives are: to assess bat species richness in the area, produce an echolocation call library for the insectivorous species and also determine the effects of rainforest fragmentation on bat communities. Mist-netting and acoustic sampling are being carried out across ecological and anthropogenic habitat gradients. Thus far, 12 species have been captured and identified and the echolocation calls of 9 insectivorous species have been recorded for the library. However, acoustic sampling data suggest that there are many more insectivorous species in the area. A preliminary analysis based on ‘echolocating morphospecies’ highlights the importance of the forest fragments to bat abundance and diversity. Ongoing work is investigating the influence of factors such as fragment size, isolation and surrounding matrix and these will be discussed.

**Activity and roosting ecology of a mixed colony of Miniopterus schreibersii and Rhinolophus euryale in a cave near Zagreb: Improving current bat monitoring and cave management**

Norma Fressel¹, Petra Žvorc², Marina Kipson², Vida Zrnčić¹ & Daniela Hamidović²
The summer colony of two bat species inhabits the entrance part of the Veternica cave, a popular touristic destination of the Medvednica Nature park in Croatia. The monitoring of the size and status of the colony in the period of 6 months, from early spring until early autumn only confirmed a maternity status of the *Rhinolophus euryale* colony. Despite microclimatic conditions in the cave being suitable for both species, the sensitivity of the *Miniopterus schreibersii* to visitor disturbance might cause the species to desert the roost at the critical time just prior to giving birth. Suggestions are made to modify the monitoring programme and cave management to minimise the effects of disturbance on the bats.

**Spatio-temporal variability in nightly dispersal patterns of *Tadarida brasiliensis*: Modeling bat movements in 3D**

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We examine spatio-temporal variation in foraging dynamics of Brazilian free-tailed bats (*Tadarida brasiliensis*) in south-central Texas, demonstrating the potential of radar aerocology for advancing understanding of ecological interactions in the aerosphere. Brazilian free-tailed bats disperse nightly in dense columns from cave and bridge roosts and forage at high altitudes (300–2500 m AGL) over large spatial extents that are easily detectable with Doppler weather radar (WSR-88D) installations. Understanding variation in emergence behavior of Brazilian free-tailed bats provides a model system for testing hypotheses about the influence of abiotic factors on the dynamics of group behavior. Using high resolution Level II NEXRAD radar products, we test hypotheses about the influence of weather conditions such as surface temperature, precipitation and cloud cover on timing and relative density of bat emergences to determine how atmospheric cues determine group behavior and foraging dynamics of an aerial nocturnal predator. We visualize bat emergences in 3-dimensional space and investigate seasonal variation in emergence behavior. In addition, we highlight the utility of radar visualizations for generating new hypotheses about foraging behavior of aerial species by demonstrating how radar makes it possible to ‘observe’ behavior at temporal and spatial scales not previously possible.

**Impacts of White Nose Syndrome on population viability of *Myotis lucifugus***

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White Nose Syndrome (WNS) is an emerging infectious disease causing mass mortality and precipitous population declines of hibernating bats in eastern North America. WNS is spreading rapidly and currently occurs throughout the northeastern and mid-Atlantic regions of the U.S. and in Quebec and Ontario provinces of Canada, raising serious concerns about population viability of affected species. Six species are currently affected, but WNS now extends into the range of at least nine species of hibernating bats that could be vulnerable to infection, including several endangered species. The little brown myotis (*Myotis lucifugus*), one of the most abundant, widely distributed, and best-studied species of bat in North America, has suffered some of the highest observed mortality at hibernacula infected with WNS. Annual decreases in numbers of hibernating little brown myotis range from 30% to 99% at sites with WNS. Using population viability analysis (PVA), we estimate the probability of regional extinction of little brown myotis from disease-associated mortality to determine the impact of introduction of WNS on this species. Our model predicts that even if disease-mortality ameliorates with time that the regional population of little brown myotis in the northeastern U.S. could face extinction within 20–40 years. We estimate the potential impact of this rapid population crash on ecosystem integrity by estimating the loss of ecosystem services by this and other affected species. Novel diseases can have serious impacts on naïve wildlife populations, which in turn can have significant impacts on ecosystem integrity.

**Maternity roosts and behaviour of *Murina ussuriensis***

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The genus *Murina* consists of at least 22 species and is distributed from mainland Asia to north eastern Australia. Despite its wide range and relatively high species richness, the ecology and behaviour of most species are poorly understood. *Murina ussuriensis* is a small-sized tube-nosed bat distributed in north eastern Asia. Until recently the roosting ecology of this species was not well known, although there had been numerous capture records of flying bats. However, studies and reports of their roosts have rapidly increased over the past dozen years. According to previous reports, they use various types of roost including foliage, tree cavities, bark flaps, buildings, underground sites and in accumulated snow. However, almost all records were of non-maternity roosts, and only two short reports have described roosting infants based on incidental observations. In 2009, we conducted a radio telemetry survey to find a maternity colony and observe roosting behaviour of *M. ussuriensis* on Yakushima island, southern Japan. Six lactating females were successfully radio-tracked and four maternity roosts were filmed using an infra-red video camera. The roosts included a vertically suspended cluster of dead leaves, two tree hollows and an exposed site under a branch. The number of roosting individuals varied from two (mother and infant) to 22 (nine mothers and 13 infants), and all individuals changed roost every day. Mothers left the roosts about 15 minutes after sunset, and returned about 20 minutes later. On returning, the mothers flew close to the roosts, often landing on them and flying off again. During these behaviours, there was frequent emission of loud social calls of various types. Infants eventually flew, or were carried by the mothers, to unknown sites. Our results have shown an unusually high frequency of roost-switching for a maternity colony of insectivorous bats, and also suggest a fission-fusion grouping pattern.
Miniopterus schreibersii pallidus or Miniopterus pallidus: The current evidence

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About 100 years ago, in the south coast of Caspian Sea, Thomas examined a bat similar to Miniopterus schreibersii having a paler dorsal coloration. He identified it as a subspecies of M. schreibersii and called the bat Miniopterus schreibersii pallidus. Identification by dorsal coloration proved to be rather ambiguous and led in the following years to numerous disagreements regarding distribution of M. s. pallidus, or even its existence. The recent molecular studies found two genetically diverged lineages within M. schreibersii in Asia Minor, identified them as M. s. schreibersii and M. s. pallidus, and confirmed the existence of the former. The lineages are apparently allopatric and meet along a contact zone passing through Central Anatolia. Yet, the genetic divergence between lineages seems to suggest that they might represent two different species rather than subspecies. Here we examine all available evidence that might support or refute a full species status of M. s. pallidus. We assess the evidence derived from molecular data (cytochrome-b, NADH dehydrogenase subunit 2, d-loop, and microsatellites), morphological examination, echolocation data, population structure, and spatial distribution of the lineages. We conclude that in the light of available evidence, M. s. schreibersii and M. s. pallidus form two separately evolving lineages, distinction of which satisfies most of the currently recognized species criteria. Accordingly, we suggest that M. schreibersii in Asia Minor should be recognized as a cryptic species complex and M. s. pallidus should be granted a full species status. We also suggest that as the distributional range of the nominal species, M. s. schreibersii, seems to be confined almost exclusively to Europe and the coastal zones of Asia Minor, the current conservation status of this taxon might be in need of urgent revision.

Social calls are sufficient for locating conspecifics at roosts in a tree-dwelling bat Nyctalus noctula

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Tree-dwelling bat species form stable social groups with dynamic fission-fusion of subgroups. Individuals bats and subgroups change roosts frequently. Location of roosts or conspecifics after roost switching may be crucial for individuals, because they benefit from roosting in a group. We used playbacks of social calls of the noctule Nyctalus noctula produced in roosts, to show how bats might maintain such fission-fusion societies and to test the hypothesis that noctules can locate conspecifics when returning from foraging trips by eavesdropping on or communicating with roosting individuals. We played back noctule social calls from an artificial tree cavity (log). We used playbacks of background noise from a log, and empty log (no sound) as controls. We observed a significantly higher response of noctules to the log broadcasting social calls. Their reactions included inspections of the log and even landing on it during playbacks. Some approaching bats occasionally emitted social calls. Respon-
ses by other bat species to the noctule social calls were negligible. The results show that listening for social calls may be sufficient for locating tree roosts that contain conspecifics. The high amplitude, low-frequency vocalisation can be propagated over long distances and allows group members to announce their position. Therefore social calls can be important in maintaining the fission-fusion societies of tree roosting species that frequently switch roosts. Given that signallers and receivers both benefit from group cohesion, it is likely that the social calls studied here evolved specifically for communication with individuals from the same social group.

**Evolution of diets in Phyllostomidae: a contribution based on molecular phylogeny data**

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Phyllostomidae is one of the most exciting mammalian families to study given its high number of species and diversity of diets (e.g., frugivory, nectarivory, insectivory, carnivory, hematophagy). Understanding the modalities of diet evolution in phyllostomids requires a well-resolved picture of their phylogeny. Because phylogenetic relationships within this family have been difficult to solve using only morphological traits, we here used an approach based on DNA markers. We compiled a set of mitochondrial genes (cytochrome b, 12S and 16S rRNAs, and cytochrome oxidase I) plus a nuclear gene (RAG-2) for a maximum of 120 phyllostomid species and 3 outgroups, \( (\text{Pipistrellus abramus, Mystacina tuberculata and Pteronotus parnellii}) \) available in public databases. Using maximum likelihood, we reconstructed the phylogeny thanks to a supermatrix of the concatenated mitochondrial and nuclear sequences. From this highest-likelihood tree, we estimated the ancestral character states for diets. Our results suggest that the most recent common ancestor of Phyllostomidae was omnivorous. The evolution towards strict animalivory – vertebrates (e.g. bats, frogs, lizards) + non-vertebrates (e.g. insects, spiders) – is supposed to have appeared three times independently, including once for hematophagy. Strict phytophagy (flowers, nectar, pollen, leaves, seeds) probably evolved several times independently, including once for the last common ancestor of Rhinophyllinae + Stenodermatinae. Within this clade, at least five species show an omnivorous diet, adding insects to a frugivorous regime. This could reflect an opportunistic strategy to fulfill their nutritional requirements. This study emphasizes the need of a reasonable taxonomic and genomic sampling in phyllostomids in order to better understand the evolution of their life history traits. Our approach can be extrapolated for future investigations on systematics and evolutionary ecology of other bats.

**Bats and bat research in the Moravian Karst: 1850–2010**

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The Moravian Karst (MK) is a 24 km long and 2 to 6 km wide area of Devonian limestones with over 1,000 natural caves. Scientific interest in bats of these caves started after F. A.
Kolenati, a Czech physician and great naturalist, came to Brno in 1849. Within the 2nd half of the 19th century, 12 species, and, within the 1st half of the 20th century, 14 species of bats were recorded. At present, 22 bat species are known from the MK territory, 17 of them hibernating in caves. Among them, *Rhinolophus hipposideros*, *Myotis myotis*, *M. emarginatus* and *Barbastella barbastellus* are the most abundant. In the years 1957–1980 hibernating bats were marked and recaptured, since 1981 the numbers of bats found in underground shelters have been monitored without marking or other disturbance except by short-time illumination. In addition to caves, bats were sampled in buildings for various purposes, such as to study their reproduction, and in 1992–2001, summer occurrence of bats in buildings was recorded by checking 222 lofts, attics and similar roof spaces on the territory of the MK. Flight activity and seasonal changes in the visits to caves by bats have been studied since 1971 by mist-netting. In different habitats of the MK, flight activity of bats has been recorded by ultrasound detectors since 1991. New methods such as the double infrared light barrier have been applied to record seasonal and overnight changes in flight activity of bats since 1997, together with automatically recorded values of temperature and other climatic factors. In this paper, new results of monitoring the dynamics of bat numbers within the last decades and a recent discovery of a complete albino *R. hipposideros* will be reported.

### Mutualistic networks in frugivorous bats: Effects of perturbations

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Up to 90% of tropical trees depend on interactions with animals for their reproduction (pollination, and seed dispersal), forming complex interactions of mutualistic networks. Plant-animal interactions are shaped by the community context, both in time and space. We analyzed the structure of multispecific network of interacting frugivorous bats and plants (seeds dispersed by bats) in two habitats (conserved and perturbed), at two different ecosystems: tropical rainforest and grassland (200 m a.s.l.), and cloud forest and coffee plantation (1200 m a.s.l), Veracruz, México. We assessed the replicability of the number of interactions found among species, the network connectance and also whether there had been changes in the network structure associated with the habitat perturbations. Our results show that the nested topology of the network was similar between conserved and perturbed habitats, as well as between altitudinal localities. Generalist bat species (those with the most interactions links), interacts with the majority of plants, while specialist bat species, interacts with generalist plants, this is the nested topology. We found a highly significant nested topology (P<0.001) in three of the four networks. The number of interacting links and species decrease with perturbation. The overall network connectance values varied little among all networks (from 0.232 to 0.298). *Sturnira, Carollia* and *Artibeus* were the most generalist bats at all sites (lowland and mountain; perturbed and conserved) interacting with 6 to 17 plant species, while *Piper, Solanum, Ficus* and *Cecropia* were the most generalist plants. The roll of generalist bat and plant species in the network seems to be critical for the structural topology of the network; although natural circumstances changed (perturbation or altitude) the nestedness of the network remained unmodified, indicating that mutualistic networks bring network robustness to species loss and to habitat perturbation, very significant for the stability of the entire community.
A more efficient technique to collect seeds dispersed by bats

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Frugivory and seed dispersal, are essential on reproductive biology of many tropical plants; also critical of forest succession and plant diversity restoration in tropics. Studies on food habits of frugivorous are important for understanding ecological patterns and processes. Researchers keep bats captive in a canvas bag during 1–4 hours to obtain dispersed seeds. Young individuals, pregnant or lactating females may die during manipulation. It is important to reduce this lapse without sacrificing data quality. We compared effectiveness of two seed-collecting methods: the cotton bag method and our method: a plastic sheet band (1 m wide) placed under mistnets to collect bat droppings while entangled in the net. We captured 318 frugivorous bats and used both methods to collect faecal samples. Nets were checked every 30 min, so all bats were subjected for 0–30 min to the plastic sheet treatment, and 30–45 min to the cotton bag treatment. We obtained 181 faecal samples with seeds, 70.7% came from plastics sheets [12,141 seeds (83.2%), 30 morphospecies (93.7%)], and 29.3% from cotton bags [2,453 seeds (16.8%), 17 morphospecies (53.1%)]. The difference in the numbers of faecal samples and seeds were statistically significant (P<0.0001). Collecting methods were also sensitive to the sampling of unique morphospecies: 17 were exclusively collected by one method, 15 from the plastic sheets, while only two were exclusively obtained from the cotton bags, 15 species were shared between the two methods. Our results show the effectiveness of our plastic sheet method in collecting seeds dispersed by bats. We obtained more and better quality data, and manipulation time invested was considerable reduced, likely decreasing bat stress. Plastic sheet method should substitute the cotton bags in seed dispersal studies.

Ectophylla alba and the period of roost availability during forest succession

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Roost ecology is important for bats, they show preferences for specific roosts and adequate roost choice is related to reproductive success and survival. Ectophylla alba is a species that modifies mainly Heliconia leaves as roosts but only in areas with a low understory coverage (average: 39.2%) and a high canopy coverage (average: 83.1%), suggesting that this species uses a temporary window in forest succession. Our objective was to determine if the forest structure has changed after five years, affecting the availability of habitats for bats. The study area was within the Tirimbina Biological Reserve, Sarapiqui Costa Rica, in an area of 7 ha where 5 years ago censuses were held and measurements taken of the habitat structure. We conducted a census count of the roosts and leaves with known characteristics fitting to be modified as a roost. We measured the percentage of understory and the percen-
tage of canopy for each leaf, comparing these with the data taken five years ago. We found that the percentage of understory coverage is significantly different from 53.7% in 2005 to 73.2% in 2010 ($t_{1/37}=4.2750$, $P=0.0457$). All the tents present in 2005 were situated in areas with an understory coverage of less than 70%, from which 60% had a coverage under 50%. Canopy coverage has not changed significantly (92.6%) during this time period. This data shows that the structure of forest growth in understory coverage affects negatively the availability of roosts for this species, strengthening the idea of the use of a time window in the growth of the forest.

Dynamics of cave use by cave-dwelling bats in arid and semi-arid zones in northern Venezuela

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Like in the rest of the Neotropics, arid and semi-arid zones in Venezuela and the Caribbean are under variable degrees of threat, mainly produced by abrupt land cover changes and development. Bats generate important ecosystem services in these types of habitats, including pollination, seed dispersal and enormous consumption of insects. Cave-dwelling bats are the most affected for human activities, mainly because they can be grouped into large colonies, especially during the reproductive season, being more vulnerable to vandalism. In order to propose and implement management measures to protect cave-dwelling species in xeric ecosystems, we need to identify which caves are used as shelters and how these are being used throughout time. We identified 13 caves used as bat roosts among northern Venezuela (9) and Bonaire, Netherland Antilles (4). We monitored each cave bimonthly, during one year. Physical and microenvironmental characterization was made, simultaneously with bat captures using mist nets to determine species composition and estimate their relative abundance in each roost. A GIS was generated including location and biological information of each cave. A total of 14 bat species were registered (3–7 spp./cave). Temporal changes in bat presence and species composition in the caves were particularly evident in three of the surveyed caves (1 Bonaire, 2 Venezuela). These caves contain the largest colonies, in some cases, maternity colonies. Temporal differences are mainly caused by the migratory, nectar-feeding species, *Leptonycteris curasoae*. With the information obtained we are designing a calendar indicating periods at which each bat roost is more susceptible to human disturbances and an index to assess the levels of susceptibility. We determined that between June and August is the time window of highest sensitivity for many species in the region, therefore extreme protective measures should be applied in some of the caves.

Is harem size a predictor of male reproductive success across habitats and seasons?

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The short nosed fruit bat, *Cynopterus sphinx*, has polyestrous breeding cycle with two annual parturition periods. While certain roost types reveal variance in harem size between the mating seasons (kitul palm, 13.6 (dry season) to 6.2 (wet season)), others do not (Palmyra palm, 2.4 in both seasons). Increased harem size could increase the potential for polygamy, and previous work by Storz on kitul palm populations reveals harem size to be an accurate indicator of male reproductive success. We studied the mating system and male reproductive success in palmyra palm roosts, where the harem size does not change significantly across seasons. Using microsatellite data to determine paternity over 5 mating seasons spanning a 2.5 year period, we find that inspite of relatively constant harem size, variance in male reproductive success changes across seasons. Additionally, the harem males are not always the most reproductively successful. We also compare our results to those of Storz to investigate the implications of differences in mating systems (across populations) on future evolution, quantified in terms of effective size. In summary, our results suggest that in this species, the harem-like social organization at the roost might not be a good indicator of mating system. Our results highlight the importance of temporal variability.

Bat fauna in the Chernobyl Exclusion Zone

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The bat fauna in the Chernobyl zone (Ukraine) was studied in 2007–2009. The animals were mist-netted during May–August, mostly at their foraging places. A total of 1,352 bats of 12 species were recorded (*Myotis daubentonii, M. dasycneme, M. mystacinus, Plecotus auritus, Nyctalus leisleri, N. noctula, N. lasiopterus, Pipistrellus kuhlii, P. nathusii, P. pygmaeus, Vespertilio murinus, Eptesicus serotinus*). *Pipistrellus nathusii* (31.7%) and *Nyctalus noctula* (26.6%) were dominant, *Pipistrellus pygmaeus* (19.4%) and *N. leisleri* (9.5%) subdominant. Abundance of bats did not depend on the radiation level, and was defined rather by landscape features. The highest diversity and abundance were found at margins of deciduous or mixed forests, bordering water bodies or open landscape (10–27 individuals of 5–8 species per night were netted in July–August). Among the adult bats recorded, in six species females predominated (*Nyctalus leisleri, N. noctula, Pipistrellus kuhlii, P. nathusii, Plecotus auritus, Vespertilio murinus*), while in two others males (*Eptesicus serotinus, Myotis daubentonii*). Based on the appearance of immature individuals in July–August, reproduction in nine species is supposed in the area. No evidence of deviations in bat ecology and biology were found. A technique of live-estimation of 90Sr ? 137Cs in bat’s body was applied in the study. The contamination in average depended on the soil contamination and varied within three orders of magnitude, reaching 64–151 Bq/g near ChNPP. Several species, age and sex dependent features of contamination were found. On average, the bats were contaminated more than birds and lesser than rodents.
Distribution and migratory status of *Pipistrellus pipistrellus* and *P. pygmaeus* in the Russian Caucasus

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I analyzed 113 time-expanded records of echolocation calls, presumably emitted by *Pipistrellus pipistrellus* or *P. pygmaeus*, to clarify the distribution of these species in the Russian portion of the Caucasus and in Cis-Caucasia. Since 2006, the calls were recorded in 47 locations; bats of studied species were mist-netted in 28 of them. The following six parameters were measured from each call: start frequency (SF), end frequency (EF), middle frequency (MF), frequency of maximum energy (FMAX), duration (D) and inter-pulse interval (IPI). Calls of 20 hand-released bats of each species were used to classify the remaining field records with discriminant function analysis. As a result, presence of *P. pipistrellus* and *P. pygmaeus* were confirmed in 35 and 39 locations respectively, both species were found together in 17 locations. Occurrence of *P. pipistrellus* was revealed in all investigated parts of the Russian Caucasus, when *P. pygmaeus* wasn’t yet found in its central part. *P. pygmaeus* is similar with long-distance migrants by the seasonal variation in sex ratio. Female bats slightly predominate during spring and autumn, but are exceptionally rare from late May to mid-August. Moreover, I failed to reveal breeding colonies, lactating females or subadult bats in the studied area. This suggests species’ migrations outside the region. At the same time, lactating females and young bats prevailed in summer records of *P. pipistrellus*. Its breeding colonies are known from forests in the Caucasus and in the flood-planes of Ciscaucasia. Both species of pipistrelle hibernate in the Russian Caucasus. *P. pipistrellus* have been recorded hibernating in crevices of rocks and buildings, as well as in caves. Winter roosts of *P. pygmaeus* still unknown, but echolocation calls of active bats are often recorded during thaws. Probably, *P. pygmaeus* hibernates in tree holes in the areas with a mild climate, and this could explain its absence in the Central Caucasus.

A new morphological form of whiskered bat from the Caucasus

Suren Gazaryan

In 2006 I mist-netted several specimens of whiskered bats which are clearly distinct by their external characters from all known species, previously described in the Caucasus. With goal to confirm the presence of newly found form, I studied external morphology of Caucasian bats from the *Myotis mystacinus* morpho-group. Following external characters were measured: forearm (FA), lower leg (TIB), hind foot (HF), thumb (D1), ear length (EL) and tragus (TL). Because the differences in external dimensions, allowing clear distinction between *M. mystacinus* and *M. aurascens* are not described so far, for further statistical analysis I included bats, presumably belonging to these species, in the joint *M. mystacinus/aurascens* group. Altogether, 68 specimens from 23 sites in the Russian Caucasus and Abkhazia had been studied. The sample included 8 females and 4 males of *M. brandtii*, the rest belonged to the *M. mystacinus/aurascens* group (7 females, 15 males) and the newly identified form *Myotis* sp. (18 females, 16 males). The differences in external dimensions as well as the results of principal component and discriminant analyses confirm the presence
of new form, different both from *M. mystacinus/aurascens* and *M. brandtii* by its small size. External dimensions of *Myotis* sp. are almost completely compatible with those known for *M. alcathoe* von Helversen & Heller, 2001, with the exception of slightly shorter HF of Caucasian specimens. Till now, the new form was found in 9 locations, all of them are distributed within the deciduous forests’ belt of the Western Caucasus. Radio tracking of two female *Myotis* sp., conducted in 2009, confirmed the similarity of their roosting and foraging behavior with *M. alcathoe*. Nevertheless, studies on the genetics of the new form are needed to identify its correct taxonomical status.

**Spatial and temporal resolution of bat sonar**

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Ultrasonic echo imaging enables bats to identify three-dimensional objects in space as well as to orient through complex environments in total darkness. When a bat ensonifies a natural echo-acoustic scene, many echoes will impinge almost simultaneously from many different directions onto the bats’ ears. Thus, a bat hunting a flying insect in front of vegetation is faced with the problem of discriminating between the echoes reflected by the insect and the echoes reflected by the surrounding vegetation. The current study aims to investigate the bats’ capability to spatially resolve single reflectors from this multitude of echoes. The spatial resolution of bat sonar is investigated in a series of formal psychophysical phantom-target experiments: In a six-channel, two-alternative, forced-choice setup, the echolocating bat *Phyllostomus discolor* is trained to detect a rewarded phantom-target surrounded by masking phantom targets. The recruitment of multiple maskers allows quantifying sonar spatial receptive fields perceptually and comparing these with the directionality of the sonar beam, the directionality of the bats’ outer ears, and electrophysiologically measured spatio-temporal receptive fields. The phantom-target technique allows manipulating not only spatial but also temporal and spectral characteristics of the target and masker reflections. These experiments gain a detailed insight into how echolocating bats exploit the spatial characteristics of their sonar system to inspect complex echo-acoustic scenes in space.

**Echolocation strategies for object recognition in dense rainforest for two gleaning bats, *Micronycteris microtis* and *Thyroptera tricolor***

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Bats that fly and forage in the dense understory of tropical rainforests face various sensorial tasks as they have to orient in space and detect, classify and localize targets (food, roost
Dietary differences among nectar-feeding bats in French Guiana

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Multiple species of nectar-feeding bats frequently co-occur in lowland sites in the Neotropics. Though they vary in body size and level of specialization on nectar, many visit and potentially pollinate the same plant species. The aims of this study were to identify the plant species visited by glossophagine bats in a pristine rainforest in French Guiana and determine how the bats partitioned these resources. I captured a total of 536 individuals of three glossophagine bat species, collected 325 fecal samples from them, and identified 14 plant species in their diets. All three bat species showed evidence of feeding on insects and visiting flowers throughout the year, though the dominant life form of plants visited changed seasonally with epiphytes and lianas predominating in the wet and canopy trees in the dry season. Overall Anoura geoffroyi and Lionycteris spurrelli, the two species most commonly captured at the site, visited 12 plant species each, with ten in common, though the proportions in which these ten were visited differed between the two bat species. The results of a canonical discriminant analysis and a logistic regression analysis confirmed that A. geoffroyi and L. spurrelli had distinct diets. In some cases, these differences may be attributed to a lack of fit between flower and pollinator. However, flower morphology could explain why the two bat species differed significantly in their visitation to accessible flowers with large nectar rewards. I hypothesize that repetitive interactions with certain flowers may elicit flower constancy in nectar-feeding bats.
Hotspots of bat migration at lentic and lotic waters

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Many bat species conduct seasonal migrations to reach hibernation sites or habitats with an abundant food supply. However, the exact routes taken by the bats and the cues used for orientation and navigation during their migrations are largely unknown. For Central Europe it is assumed that rivers with their accompanying riparian forests are of great importance as guidelines for long-distance orientation and as feeding areas for migrating bats, but up to now date are sparse to prove this assumption. We investigate the importance of rivers for bats in the alpine range of southern Bavaria and northern Austria. We assume, that bat species which move along river valleys during migration, will be recorded more frequently in these linear habitats than in ecologically similar, insect rich habitats without proximity to rivers. To test this hypothesis we compare the bat activity during migratory and nursery seasons at paired sample sites: (a) at the river Inn, a linear landscape element and (b) at lakes in a distance of at least 4 km from the river which represent insect rich but isolated habitats. To sample bat activity we use two automatic recording systems (batcorder) fixed at different heights (15 m and 3 m). This sample method allows additionally the analyses of the bat activity at different recording heights.

Signal design of the sonar clicks of Rousettus aegyptiacus

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Echolocating bats of the genus Rousettus produce click-based sonar signals using their tongue (lingual echolocation). Click based sonar signals are often considered rudimentary and believed to enable only crude biosonar performance. However, the main argument supporting this belief, namely the click’s reported long duration, was recently shown to be an artifact: In fact, the sonar clicks of Rousettus bats are extremely short, ~50–100 microseconds, similar to the duration of biosonar clicks in dolphins. This poster will compare the signal-design characteristics of the biosonar vocalizations of Egyptian fruit bats (Rousettus aegyptiacus) to the „model species“ of laryngeal echolocation, the big brown bat (Eptesicus fuscus) by theoretically analyzing the autocorrelation function and the wideband ambiguity function of their sonar signals. These theoretical analyses are used to make experimental predictions about the sonar performance of these two bats, with the surprising result that - on some parameters – the Egyptian fruit bat may be as good as, or even better than the big brown bat. These predictions are in part confirmed by available empirical data showing that in tasks that are relevant for Egyptian fruit bats, such as accurate landing or detection of medium-sized objects in complete darkness, click-based echolocation enables performance similar to laryngeal echolocators. Therefore, our comparison suggests that click-based echolocation...
in bats should be regarded as a viable echolocation strategy, which is in fact similar to the biosonar used by most echolocating animals, including whales and dolphins.

**Bats drink mineral enriched water with a grain of clay at salt licks in Amazonian rain forests**


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The ingestion of soil, geophagy, is commonly observed in many vertebrate taxa, including humans. This behaviour has been related to mineral supplementation or detoxification of secondary plant metabolites. We captured bats at salt licks and control sites in the Amazon rainforests and found more frugivorous bats at salt licks than at open forest sites. Moreover, we observed a bias towards reproductive active females and this finding is supported by other studies. But the underlying reason for these patterns remains unclear. Frugivorous bats face two major physiological constraints during reproduction: a mineral depleted diet and an elevated exposure to secondary plant compounds. Video analyses and comparisons of soil tracer in bat faeces were used to assess whether bats visit salt licks for drinking water or ingesting clay. Peruvian lick water was reported to have high sodium content and showed that figs in Peru to have lower sodium concentrations compared to other tropical regions. We compared physiologically relevant nutrients in fruits from Costa Rica and Ecuador and in blood samples collected from bats at salt licks and at control sites. If bats visit licks for mineral enrichment, we predicted that bats captured at salt licks should have soil tracers in faeces and that their blood elemental composition should differ. We show that bats visiting salt licks drink water, but that some individuals have tracers of soil in their faeces as well. Furthermore, we found that blood elemental values differ between frugivorous bats captured at salt licks and at control sites. Fruit-eating bats of the Amazon probably suffer from severe mineral stress during reproduction. In addition, our comparisons of fruit nutrient content showed that fruits in Ecuador are insufficient to meet the mineral requirements of reproduction.

**Evolution of body mass in Old and New World leaf-nosed bats**

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The physics of flight and echolocation influence expression of size as an evolving character in bats. Bats span a range of body size from 2 to 1500 g with a median value of ca. 14 g. A previous study indicated that bats initially experienced phyletic nanism and reached the median value of 14 g at the base of the crown group Chiroptera that subsequently persisted...
along major bat lineages suggesting a strong functional constraint. Bat size variation thus occurred largely within families. Here we explore evolution of size in two contrasting lineages, Old and New World leaf-nosed bats. These bats provide contrasts in life history traits as well as convergent similarities, such as nasal emission of echolocation calls. In order to analyze body size in phylogenetic context we generated a molecular cladistic analysis of Rhinolophidae + Hipposideridae + outgroups, and used the most recent and comprehensive molecular study for Phyllostomidae + outgroups. Body mass of each terminal was obtained from the literature and museum specimens. Mapping body mass onto these two clades revealed contrasting patterns in Old versus New World leaf-nosed bats. Rhinolophoids experienced relatively small size variations with a balanced number of increases and decreases. Maximum size increases were primarily associated with predation of large insects. By contrast, size variation in phyllostomids was biased toward net mass increases. These increases occurred primarily in carnivorous and frugivorous bats and accumulated along branches, thus representing cases of phyletic giantism and suggesting a directional, sustained selective force for increasing body mass in those groups. Phyllostomids also showed patterns suggestive of disruptive selection in particular pairs of sister species. Overall the results of mapping offer rich interpretative grounds for understanding size in bats and great potential for association with fundamental life history traits as co-evolving characters.

Marco Polo! Social calls used by *Thyroptera tricolor* for locating roostmates

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Spix’s disc-winged bats, *Thyroptera tricolor*, form small, long-term social groups in which bats are loyal to a patch of forest but move on a daily basis between highly ephemeral roosting sites (partly unfurled leaves of *Heliconia* and *Calathea* species). Individuals that become separated from their social group face the challenge of relocating groupmates in a habitat where vegetation is dense and often several optimal roosting leaves are available at the same time. Under such conditions, a system where both the separated individuals and the roosting bats signal to each other would facilitate rapid relocation of groupmates. In this study, we examined the social calls emitted by *T. tricolor* when individuals search for members of their social group. For each group captured, we placed some bats in an optimal roosting leaf and held the remaining bats for individual release. Upon release, we recorded any sounds produced and noted if the released bat relocated the group. We recorded two distinct signals: (1) “inquiry” calls, which were produced by the released bat, and (2) “response” calls, which were emitted by bats within the roost. Inquiry calls were always produced first, followed rapidly by response calls from group mates. This calling system allowed bats to rapidly reform groups and provides a mechanism by which Spix’s disk-winged bats maintain associations with particular conspecifics despite regular roost movements.

Ukraine: Workshop “Bats and man: conservation and epidemiological aspects”

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Bats are still one of the least known mammals in Ukraine, both for the general public and the public health authorities dealing with bats (sanitary and epidemiological service (SES), epidemiologists etc.). Usually people finding bats in house apply to SES (considering bats as pests). In such cases SES and other health authorities have not had consistent answers adequate to the conservation status of bats. In the last 50 years Ukrainian public health authorities have dealt with three fatal human rabies cases following bat bites. These cases are regularly quoted but without information about the conservation status of bats and their vulnerability (which provokes a negative altitude to bats and is thus a threat). Until now in Ukraine no systematic bat rabies surveillance has been carried out and a current system of data collection can’t give a clear picture about bat rabies in Ukraine. In view of the above, a group of Ukrainian bat workers initiated a project with a workshop as a key event: (1) to improve bat conservation by circulating information through public health authorities about bats and the need for their protection and the development of collaboration between them and bat workers; (2) to discuss a new strategy and implementation of modern methods of bat rabies surveillance in Ukraine. The workshop, named “Bats and man: conservation and epidemiological aspects”, was held during two days in Kiev in 2009. It was attended by 44 bat workers, SES biologists, physicians, veterinarians, virologists. The workshop presentations had been divided into two topics: (1) Introduction to bats; (2) Rabies in bats. A round table discussion took place on consulting general public concerning bats in houses; actions of SES following incidents of contact of citizens with bats; concordance of tasks for nature conservation and sanitation education. Participants adopted a resolution stating a series of issues important for the improvement of bat conservation practice and bat rabies surveillance in Ukraine.

Bat key underground sites in eastern Crimea, Ukraine: Numbers, threats and future

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In 2000 Ukrainian bat-workers started a systematical work on survey and inventory of bat fauna of the Crimean peninsula (southern Ukraine), mainly in connection with bat underground roosts. Unique large bat aggregations were discovered in underground cavities of eastern Crimea: nine important bat sites were found. All of them are anthropogenic, mostly represented by limestone mines of different length (up to 50 km). In summer, the sites are used by ca. 26,000 bat individuals, represented mostly by maternity and male colonies of Myotis blythii and Rhinolophus ferrumequinum. The most detailed census in winter 2010 revealed more than 21,000 bat individuals (ca. 79% M. blythii, 20% R. ferrumequinum). Besides these two species three more were found regularly: Myotis mystacinus, Plecotus austriacus, Eptesicus serotinus. It was revealed that most of cavities are important bat mating sites. Evidently, all the sites are located at the relatively small area (a distance between the outermost sites is 75 km) and may create a united roost complex. The bat aggregations are the biggest in Ukraine. However, all of them are under constant threats. Among them there are: attendance cavities by people and directed full or partial blocking of entrances, leading to closing of cavities for bats or to critical changes in existing favorable for bats microclimatic conditions. A characteristic feature of many mine objects is presence of the great number of entrances. Thus, standard methods of protection (by putting grilles or fences at their entrances)
Bat-moth interactions in the field: Trajectory analysis reveals stereotypic yet effective evasive responses and their counter-responses

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Aerial hawking bats are confronted with evasive manoeuvres of eared prey. We recorded attack sequences of Pipistrellus kuhlii on several eared moth species in the field using two synchronised video cameras and an calibrated ultrasound microphone. We reconstructed the three dimensional flight paths of bats and moths based on the video recordings and used a three-dimensional fit to derive flight path parameters such as velocity, curvature and torsion. Based on the known positions of bat, moth and microphone, we also calculated source levels of echolocation calls and reconstructed the acoustic scene as experienced by the moth. Moths started evasive responses when the sound level at their position surpassed a certain threshold, which mostly happened before the bat’s approach phase (as indicated by a reduction in pulse interval). Surprisingly, all evasive responses of moths were stereotypic spirals. Despite being stereotypic and hence potentially predictable, spiralling flights effectively reduced capture success of the bats. Bat flight parameters such as height, velocity and curvature, often followed moth flight parameters with a certain lag, but when bats were not able to close in on evading moths, they abandoned the attack after one to several attempts. We further investigated potential differences in the bats’ flight and echolocation behaviour between successful and unsuccessful attacks.

Echolocation behaviour of the nectar-feeding bat Leptonycteris verbabuenae approaching natural and modified flowers

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Nectar-feeding bats need to find flowers in the dark to obtain food. How they detect, recognize and localize flowers is still poorly understood. Nectar-feeding bats are known to use...
olfactory and acoustic cues to find flowers. Scent cues do not allow the precise localization of a target, therefore echo-acoustic cues are likely to play a major role at close range. In order to better understand the role of echolocation for detection, identification and localization of flowers we conducted controlled behavioural experiments with the nectar-feeding bat *Leptonycteris verbauuenae* in a flight cage. During the experiments we offered the bats flowers with different acoustic characteristics and recorded their foraging behaviour with two infrared video cameras under stroboscopic illumination synchronized with ultrasound recordings. We worked with natural cactus flowers (*Pachycereus pringlei*), five types of modified natural flowers (e.g. without petals) and of two artificial flowers (hemisphere and triple mirror). In all cases the bats continuously emitted single, short, multi-harmonic, and frequency-modulated (FM) echolocation calls during search flight. The bats approached all targets except the plastic hemisphere and changed to a typical approach behaviour which is characterized by the emission of groups with a rising number of pulses of decreasing duration while closing in on the target. The approach sequences ended with a distinct terminal group of 10–20 short (< 1 ms) calls before the snout was inserted into the flower. The terminal group varied in length, most likely depending on the acoustic characteristics of the respective target. Based on these results we argue that specific echo-acoustic characteristics of flowers are crucial for *L. verbauuenae* for detection, precise localization and identification of flowers. Furthermore, the emission of a terminal group might indicate that the bats have taken the approached target for a real flower.

**A new acoustic method to study the area expansion of Pipistrellus kuhlii**

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A rapid range expansion can be observed in the case of *Pipistrellus kuhlii* based on new records from different parts of Europe. The data of new occurrence were obtained by different types of methods, resulting in a rough picture on the exact pattern of the expansion. To quantify this process we developed a survey protocol which is appropriate to produce high number of data in a relatively little time. As *Pipistrellus kuhlii* mainly roosts in buildings an acoustic survey was conducted in urban habitats. The main problem was the great overlap in the echolocation call parameters of *Pipistrellus kuhlii* and *Pipistrellus nathusii*. To solve this we used a support vector machine (SVM), which was taught with a sound library built from the calls of these two species. The identification accuracy was ~80% which seems to be enough for proportional investigations. Altogether 71 settlements were visited by car in the summer of 2008. We recorded the passing bats for 10 minutes in each village or town. These settlements were grouped by different latitude, altitude and size. The results of the SVM species identification showed that *Pipistrellus kuhlii* is one of the most common species in the settlements of the southern part of Hungary, while in the north-eastern part of the country in similar urban habitats the species is quite rare. There was no significant difference in the effects of size and altitude. Repeating this survey at regular intervals, we may get a good temporal pattern on the distributional change of this and probably other species, like *Hypsugo savii*. We propose this method for other research groups to get comparable results, which are neccessary to get a more precise picture on the range expansion of *Pipistrellus kuhlii*. 

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Assemblage of bats and ecological considerations in forest fragments in Southeastern Brazil

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The landscapes of southeastern Brazil have suffered human changes which increase the level of fragmentation leading to changes in the structures of landscapes, in the composition and diversity of communities, in the climate and the local extinction. This study focused the understanding of bat diversity in a highly fragmented, focusing the study on landscapes use and emphasizing on conservation issues. The study was conducted in Serra do Carrapato that comprised five fragments connected by a system of narrow ecological (ca. 4–6 m) and for a matrix compose mostly for pastor in southern Minas Gerais (21°17’ and 21°19’S, 44°58’ and 44°59’W). Were used five mist nets 3×12 m mounted inside and in the edge of the fragments for six hours after sunset, with a total sampling effort of 24,840 m²h. Were captured 99 individuals of 14 species belonging to three families (Phyllostomidae, Vespertilionidae and Molossidae). The Shannon index for the border and the fragment were 1.93 and 1.56, and the evenness 0.80 and 0.78, respectively. Of the recorded species are noteworthy Eptesicus chiriquinus, with considerable range extension in Brazil whose records are for the northern Amazon, Molossops neglectus, the first record for the state of Minas Gerais, and Chiroderma doriea, classified as vulnerable. The dominant species were Carollia perspicilata, Sturnira lilium and Artibeus lituratus with 72% of the total of captures. The recaptures were 4% and the use of the landscape was constant, since all recaptures were made on fragments of different locations of the first captures of individuals. The fragments and corridors, even in small sizes make up a refuge system of bats, mostly for housing rare and threatened species.

Structure of a bat assemblage in different landscapes in a region of high elevation in southeastern Brazil

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The high specific diversity in bats results in impressive morphological and ecological diversity, such as diet, roost ecology, and foraging modes, which enables them to occupy all kinds of habitat. The goal of this study was to compare the assemblages of bats in three distinct landscapes: rocky fields (Rf), cloud forest (Cf) and montane semideciduous forest (Msf). The study was conducted in the Chapada do Abanador, Minduri, state of Minas Gerais, southeastern Brazil (21°35’S, 46°33’W), whose altitude ranges from 1300 to 1580 m. The region is considered as a priority area for conservation because of the presence of important fragments that protect the headwaters of a river Capivari considered an important watershed in southern Minas Gerais. Were performed 30 nights of sampling using mist nets totaling a sampling effort of 3600 net-hours. We captured 69 bats belonging to two families and 11 species: Phyllostomidae – Anoura caudifer (Cf-Msf), A. geoffroyi (Cf-Msf), Artibeus fimbriatus (Cf-Msf-Rf), A. lituratus (Cf-Msf), Carollia perspicillata (Cf-Msf),
Chrotopterus auritus (Msf), Desmodus rotundus (Cf-Msf-Rf), Pygoderma bilabiatum (Cf) and Sturnira lilium (Cf) – Vespertilionidae – Histiotus velatus (Rf) and Myotis nigricans (Cf). The Shannon index was equal to 2.14 nats/ind and equitability of 0.89 which suggests uniformity in distribution of individuals among the species. The expected richness under the Jackniffe estimator of first order is 13.9 species. The results show the low diversity related to the altitude, with the absence of some common families; these results agree with other sampled sites in high elevation in southeastern Brazil that present very low richness and corroborate with the trophic structure of assemblages in tropical fragmented landscape, with the dominance of frugivores. Noteworthy is the high number of H. velatus (15 individuals) captured exclusively in rocky fields, and this species has the habit of foraging preferentially in open areas.

The underestimated diversity of bats in Brazil: Idiosyncratic limitations or shared concerns within South America about collection management and systematic practices?

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The number of bat species recorded in Brazil has considerably increased over the last decade as a result of descriptions of previously unknown or unrecognized taxa and of information originated from several inventories published in the last decade. However, it is noteworthy that these improvements have a slow pace, especially when compared to countries such as Peru, Venezuela and the Guianas. This situation could be attributed to several causes including the scarcity of collected material, but based in our survey over 100,000 specimens are currently deposited in Brazilian collections. Based upon these apparently contrasting scenarios we point out some possible, non-exclusive causes (1) lack of within country researches specialized in systematics working with bats, and low number of undergraduate and graduate disciplines and programs focused in systematics in Brazil, (2) lack of specialized professionals with adequate formation for curatorial jobs, (3) lack of conditions for collections, including specialized personnel exclusively devoted to collections, (4) scarce funding for systematic studies from Brazilian/International research agencies, and (5) little integration among collections within Brazil and abroad. The fact that there are large collections is surprising but there is a lot of deviation from suitable material for systematic studies such as (1) non systematically collected material originated from vampire control, environmental studies and others, resulting in large collections of most common species; lack of projects explicitly focused in inventoring and describing diversity, (2) collection sites concentrated close to large centers; remote places under or never sampled, low representation of less frequent and more sensitive taxa to disturbance, (3) lack of representatives from the distributional range of taxa for comparative studies. We suggest that adequate collection management and integrative procedures among collections, including perhaps all South American countries specially those having similar problems may be the greatest step to shed first lights to these problems.
**To buzz or not to buzz? Intentional control of echolocation in drinking bats**

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When approaching a surface or prey item, bats alter their echolocation calls by increasing call repetition rate. In the terminal phase of the approach, the pulse interval decreases to about 5 ms, bandwidth is shortened and call end frequency drops. This final phase is known as Buzz II. We confirmed the occurrence of Buzz II in both *Myotis capaccini* catching prey from a water surface and *Miniopterus schreibersii* landing on a surface. By contrast, both species did not emit Buzz II when approaching a water surface to drink. Prior to drinking, they only shortened pulse interval to about 10 ms and end frequency did not drop. Drinking *Rhinolophus ferrumequinum*, a species echolocating through the nose, also did not emit Buzz II. In contrast to the above oral emitters, *R. ferrumequinum* continued echolocating throughout the drinking bout and only paused, perhaps to swallow, when they rose from the water surface. Overall, an approach that requires precise target localization (e.g., capture, landing) is associated with Buzz II, but an approach to a surface for drinking, where less accurate localization is required, lacks Buzz II. Thus, bats appear to have intentional, behavioural control over the production of Buzz II in a context-dependent manner.

**Sensory basis of habitat recognition in echolocating bats**

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The correct identification of suitable habitats is critically important for animals. This is especially true for bats, as their use of echolocation restricts them to fill specific niches. However, how bats distinguish between various habitat types is not yet understood. Bodies of water represent a special case of habitat; they are not only used for drinking, but also for foraging and as landmarks for orientation. We investigated the hypothesis that bats recognize water surfaces echo-acoustically by relying on their mirror-like acoustic reflection properties. We mimicked the surface of water using smooth plates and presented them to bats simultaneously with textured ones of the same material. Our experimental data suggest that (1) bats recognize water surfaces echo-acoustically as an acoustically smooth, extended surface, (2) this recognition pattern is stereotypic and innate and (3) it is phylogenetically widespread across European bat species and families and thus likely an universal feature of bat echolocation. Furthermore (4) the minimum area for a smooth surface to be taken for water depends on the maneuverability and sonar ‘foot print’ of each tested species. (5) Bats integrate the available sensory stimuli with variable weighting to assess the presented multisensory situation and decide whether or not to drink.
Sensory specializations compromise bite force in bats

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The vertebrate head is a complex and highly integrated system that houses the masticatory apparatus and sensory organs each of which may impose very different constraints on skull design. For bats, the key sensory modality is echolocation, with special adaptations in the vocal tract and auditory system. Horseshoe bats (family Rhinolophidae) possess a highly specialized echolocation system characterized by the emission of very directional echolocation calls through the nostrils, as opposed to somewhat less focused calls emitted through the mouth typical for vespertilionids. Horseshoe bats are able to assess prey size from the echoes, find fluttering insects in echo-cluttering environments, and chew while still being able to echolocate. They have special nasal cavities and external structures that aid in sound filtering and beam directioning. We hypothesize that the structural design of the nasal region might impact the mechanical integrity of the skull and therefore result in a lower bite force. In the field in Bulgaria we measured bite force of 16 species of vespertilionid bats (158 individuals) and all 5 European species of rhinolophid bats (191 individuals). In support of our hypothesis, bite force in all Rhinolophus species was consistently lower than in similarly sized vespertilionids. We then measured jaw adductor muscle mass based on museum specimen for most of these species. Several muscles crucial for the generation of bite force – musculus temporalis, m. zygomaticomandibularis and m. pterygoideus – were consistently smaller in Rhinolophus than in similarly sized vespertilionids. Moreover, rhinolophids had relatively longer, shallower and narrower skulls. This provides an anatomical correlate for the bite force performance difference we measured in live bats. In a last step, we conducted finite element analysis of CT-scanned skulls to assess the mechanical stresses induced by biting on the rhinolophid and vespertilionid skull.

Plasma testosterone levels decrease after activation of skin immune system in a free-ranging mammal

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The immunocompetence handicap hypothesis (ICHH) postulates a trade-off between the display of androgen related, sexually selected traits and investment in immune functions, often summarized as immunosuppression by testosterone (TE). Such trade-offs may be particularly pronounced when resources become limited. Then animals have to balance conflicting demands by allocating acquired energy and nutrients dynamically to morphological, physiological and behavioural processes. The immunocompetence handicap hypothesis (ICHH) formulated by Folstad and Karter in 1992 proposes a dual effect of testosterone (TE) – enhancing sexual displays on the one hand but suppressing immune functions on the other hand. We investigated the relationship between delayed type hypersensitivity (DTH)
skin responses and the endocrine system in a free-ranging mammal and asked: (i) are high plasma TE levels related to a weak DTH response, or (ii) does an activation of the cellular immune system cause a decrease in plasma TE secretion? We studied these questions in the bat *Carollia perspicillata* and conducted an immune challenge (IC), a DTH skin test with the antigen 1,4-dinitrofluorobenzene (DNFB), as a measure for antigen-specific cell-mediated immunity. We found a high individual variance in DTH response irrespective of sex. In addition, pre-IC plasma TE did not affect the extent of DTH responses, but instead the IC lowered post-IC TE titres in both sexes. Our study does not support the presumption of an immunosuppressive effect of TE, but suggests that an activation of the immune system reduces plasma TE. This is still in line with the ICHH as originally formulated, because only immunocompetent animals are able to cope with pathogens effectively and to maintain high TE levels at the same time.

**Bat fauna primary inventory and monitoring using mist nets**

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Two main approaches for bat monitoring programs are applied in Europe: acoustic monitoring and visual monitoring with regular surveys of potential summer and winter roosts. These methods are remote techniques and provide only fragmentary data about bat number and relative abundance at a present moment, without data on the population structure. Thus we have tried to employ mist nets for a primary inventory of bats in woodlands of eastern Ukraine (Kharkov region: Gomolshanskie lesy National Nature Park and the Yaremovskoe Nature Reserve) in July 2008 and 2009. We selected July as the best period for primary inventory, since the young bats begin to fly. Mist nets were installed at nine points in different habitats in both of the study areas (about 400–500 ha in square). Two netting sessions were conducted an these points – in the first and second decades of July, in total 18 nights. The mist nets were always installed at the same places, from sunset till 10–30 minute before sunrise. Bags with captured bats were kept near the net all the night. In both the study areas we revealed 10 bat species, 504 captured individuals in the first session and 660 bats in the second sessions. The proposed technique could be used not only for inventory of bat fauna but also for studies of population structure and for multifactorial bat monitoring. The main advantages of the use of mist-nettings for primary inventories are relatively quick realisation and very low costs required.

**Cenozoic patterns of origination and extinction in bat communities**

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The Cenozoic record of fossil bats is not uniformly rich but does offer useful information about the origin and diversification of chiropterans. First and last appearance data (FADs and LADs) for known occurrences of bats were compiled at the generic level. 278 bat genera were recognized of which 138 represent living species only (nearly 50% of all bat genera lack
a fossil record). Occurrences of the remaining 140 genera were recorded from 16 binned time intervals beginning in the late early Eocene (52 mya) through the Pleistocene with resultant temporal ranges documenting bat origination (FADs) and extinctions (LADs). Only during the Oligocene (34 to 24 mya) do LADs outnumber FADs. In all other intervals except the Pleistocene, originations and extinctions track together with FADs always outnumbering LADs leading to a general increase in diversity throughout the Cenozoic. In the Pleistocene there is a dramatic increase in the number of FADs compared to LADs, probably reflecting the more complete fossil record. Range-through genera (genera occurring in more than one bin) remain at relatively low levels until the beginning of the middle Miocene (16 mya) when range-through taxa begin a steady increase in numbers with many modern genera becoming established by that time. Lazarus taxa (genera not continuously represented) are relatively rare, occurring only within three extant genera (Asellia, Megaderma, and Scotophilus). When plotted against a Cenozoic paleotemperature curve, the chiropteran pattern of FADs-LADs differs somewhat from non-volant mammals, especially from the late early through middle Eocene. Bat FADs and LADs both decrease through this interval while other mammals see increases in FADs initially followed by increases in LADs. Much of the difference between these records can be traced to the very poor bat fossil record from the early Cenozoic rather than necessarily reflecting differing responses to climate change.

Dental characteristics of the most primitive known bat *Onychonycteris finneyi*

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The most primitive known bat, *Onychonycteris finneyi* (early Eocene, Green River Formation, Wyoming, USA), is represented by two nearly complete skeletons which show that *Onychonycteris* was a relatively large bat (circa 40 g) that retained claws on all digits, had forelimbs only moderately longer than hind limbs, and was capable of powered flight but probably did not echolocate. Both skeletons have upper and lower dentitions in tight occlusion, making it difficult to document dental anatomy. Use of modified micro CT-scanning (RayScan 200 XE) has produced virtual images of some teeth from multiple CT-volumes. This approach has made it possible to begin to compare *O. finneyi* with other primitive bats in order to assess early chiropteran dental evolution. Comparisons with *Icaronycteris*, *Archaeonycteris*, *Palaeochiropteryx*, and *Hassianycteris* indicate that the most primitive known bats were primarily insectivorous and had a dental formula of 12/3, C1/1, P3/3, M3/3. We optimized dental character states on a phylogenetic tree derived from morphological data with a molecular backbone in order to reconstruct the primitive condition for Chiroptera. Results were not clear-cut and indicate that acquisition of dental features in early bats did not occur in a simple step-wise manner but instead was accomplished in a mosaic fashion. Two unambiguous character states were identified for the most recent common ancestor of all bats in our analysis: an upper third premolar (P3) much smaller than P4, and an upper first molar (M1) with a small and weakly curved parastyle. A third partially resolved character state that may have typified bats ancestrally was a straight or weakly invaginated ectoflexus on M1. It is clear that identification of the closest sister group of chiropterans is essential before it will be possible to recognize primitive bat dental character states with any certainty.

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The creation of new artificial lakes as a mitigation measure for bats

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Landscape modification is often considered as the principal cause of population decline in many bat species. Expanding harbours cause a severe change in the landscape structure. Since harbours are often situated in regions that accommodate many threatened and protected species and habitats, the conflict between economic expansion and nature conservation can become very apparent. A previous study indicated that bat activity and bat species diversity are low within the centre of the Antwerp harbour, but the outskirts of the harbour are intensively used by foraging bats due to the availability of canals and artificial lakes. Due to harbour expansion the canal system is changing and some of the lakes will disappear in the near future. A big part of the Antwerp harbour is lying in a Natura 2000 area, and new lakes have been created as a compensation for birds between 2001 and 2006. We examined to which extent these new lakes are used by foraging bats by measuring activity with bat detectors. We found that artificial lakes, even recently created, are used by foraging bats. Pipistrelle bats (Pipistrellus pipistrellus and P. nathusii) showed higher activity at an older lake with a better developed bank side vegetation. Myotis daubentonii and M. dascycneme were found at all new lakes. Activity of these species was not determined by the development of bank site vegetation, but the embedding of the lakes in the landscape seems to be more important for them compared to Pipistrelle bats. We concluded that creation of artificial lakes in a dynamically changing landscape like a harbour can act as a mitigation measure for foraging bats, if the landscape structure around them is also taken into account in the planning process.

Primitive and derived shoulder joints of Messel bats

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Four bat families are known from the Eocene Messel pit. Well preserved specimen of Palaechiropteryx, Archaeonycteris, Hassianycteris and Tachypteron show a broad variety of differently specialized shoulder joints. Internal bone structure has been rarely studied. For comparisons extant models with intact histology are required. Rhinopomatids are considered as basal microchiroptera, remarkable are intraspecific variability in echolocation calls when hunting in groups, and characteristic and uncommon flight style, series of glides interrupted by short fluttering sequences. External anatomy of their shoulder joint is similar to that of Megachiroptera. No functional specialisations are detectable from outside. By means of micro CT technology internal structures of the shoulder joint are studied and compared to those of extant (Emballonurids, Molossids) and fossil bats as well. The proximal end of the humerus of Rhinopoma hardwickei shows few and isolated trabecular struts in the shaft. Spongiosa of the humeral head consists mostly of big, often platelike trabeculae, fused partly to bigger units. The first preferred orientation is between head and crista pectoralis. A second preferred orientation of plates is parallel to the plane defined by the transition between head and shaft. Honeycomblike spongiosa, as seen in other extant bats and Tachypteron, is missing. A zone of transition (as observed directly underneath the joint surface in Molossus), is missing too. Corresponding to thick trabeculae there are large lacunae. 3D-histomorphometrical analyses
reveal high trabecular thickness, high spacing values and low number of trabeculae in Rhinopoma, but low trabecular thickness, low spacing values and high number of trabeculae in Taphozous melanopogon and Molossus ater. The shoulder region of Rhinopoma hardwickei is more robust and less differentiated compared to other bat species. According to previous studies also internal morphology gives no hints to functional specialisations. By this Rhinopoma appears to be a extant model for comparison, especially with Archaeonycteris.

The influence of landscape structure to the activity of bats

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In the last decades, human activities have caused changes in landscape structure, leading to the formation of barriers in landscape and the area of suitable habitats for various animal species is continually shrinking. The fragmentation of natural forest complexes is one of the results of the human activities. The presented research was carried out in SAC Martinský les (in the SW part of Slovakia) and its surroundings, where 22 categories of current landscape structure were identified. The largest area, up to 33.0% of the territory, is taken by forest; second largest area (30.1%) is arable land. The activity of bats was evaluated in three habitat types – forest interior (oak-turkey oak forest), ecotone zone (contact between forest and surrounded fields) and settled area (Svätý Martin village) altogether 15 detecting points. Inside the forest complex the stands were selected according to the age of trees and the number of tree cavities. The percentage of the landscape structure elements within the radius of 100 m from each monitoring site was evaluated on the basis of the current landscape structure map and compared with bat activity on the detecting points. In total, there were recorded 8 species of bats (Myotis myotis, M. emarginatus, M. mystacinus/brandtii, M. daubentonii, Nyctalus noctula, Eptesicus serotinus, Pipistrellus pipistrellus, P. nathusii). The highest number of species was determined within the forest complex. Three species (Nyctalus noctula, Eptesicus serotinus, Pipistrellus pipistrellus) were observed in all three types of observed habitats. The most used habitat was the ecotone zone, where the average activity of bats up to 33% was recorded.

Bat fauna of the Prague city

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We summarize all available data on bat occurrence in the territory of administrative unit Prague, including both historical and recent records, complemented with the data obtained
by bat banding. In total, 17 bat species were recorded from Prague (65% of the bat fauna of the Czech Republic). The most common species were *Nyctalus noctula* (29% of the record sites), *Eptesicus serotinus* (13%), *Myotis daubentonii* (11%), and *Vespertilio murinus* (11%). Records of other species were less numerous and they are arranged in following list accordance to their record numbers: *Pipistrellus nathusii*, *Myotis myotis*, *Plecotus austriacus*, *Myotis nattereri*, *Pipistrellus pipistrellus* (s. str.), *Myotis mystacinus*, *Plecotus auritus*, *Barbastella barbastellus*, *Pipistrellus pygmaeus*, *Myotis brandti*, *Rhinolophus hipposideros* (last record 1970), *Nyctalus leisleri*, and *Eptesicus nilssonii*. *Eptesicus serotinus* is a typical synurbised species in Prague, which occurs in the city centre during a whole year and also more frequently compared to migratory species which records are clearly concentrated in the late summer, autumn and winter period (*Nyctalus noctula*, *Vespertilio murinus*, *Pipistrellus nathusii*). The pipistrelles (i.e. both the cryptic species of *Pipistrellus pipistrellus* group) were long absent in Prague and Central Bohemia at all and started to appears some 10–15 years ago though still they both are rather rare in Prague in comparison to the other Central European large cities. The diversity of bat community in Prague is supposedly influenced by diversification of its suburban area, relatively high percentage of vegetation (parks, forests, cemeteries), presence of a large river passing a through the town and a proximity (about 30 km from city centre) of the Bohemian Karst where many bats hibernate.

The bat fauna of Mé Auré Cave, Moindou, New Caledonia: evidence of human consumption and a new species record from the recent past

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Vertebrate remains recovered from a cave near Mé Auré on the central south-western coast of the main island of New Caledonia (Grande Terre), south-west Pacific, include those of flying-foxes and smaller, insectivorous bats, as well as birds, frogs, rodents and humans. The Mé Auré Cave deposit accumulated over a period of some 3000 years, from before colonization of the area by Lapita people to the present. In the deposit’s upper levels, bat remains approximate the modern New Caledonian fauna, and probably represent bats that lived and died in the cave as well as those brought in as prey by barn owls. In the lowest levels, only flying-foxes are represented, their blackened remains and other evidence indicating they were cooked and eaten by people. Our data suggest that at least one insectivorous bat species has become extinct in New Caledonia during the last 250 years. Alternatively, it is possible that this bat continues to be part of the extant New Caledonian fauna but has yet to be recorded by modern faunal surveys.

Bat extinctions in the Australasian Region: View from the fourth dimension

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Australian Paleogene and Neogene bats enable study of patterns of extinction in Australasian bat communities throughout the Cenozoic. In particular, bat-rich fossil deposits in the Riversleigh World Heritage Area, north-western Queensland, are used to examine pre-human origination and extinction rates, as well as change in diversity and abundance of bat lineages and communities, during three greenhouse/icehouse cycles over the last 25 million years. The fossil record documents the pre-Pleistocene presence of five extant Australian bat families, with the notable exception of Rhinolophidae and, surprisingly, Pteropodidae. Archaeonycteridids, a radiation of mystacinids, and taxa yet to be assigned to family are also represented. Long term trends include an increase in diversity in vespertilionids, emballonurids, rhinolophids and pteropodids over time, steep decline in hipposiderids and mystacinids, and relatively stable diversity in megadermatids and molossids. Episodic expansion and contraction in distribution is also apparent in some lineages. The Riversleigh fossil bat record is most informative for the period from 25 to 10 million years ago during which Australia underwent an icehouse-greenhouse-icehouse cycle, the last phase being accompanied by markedly increased climatic variability and progressive loss of forests. This period also coincides with the tectonic crash of the leading edge of Australia into South-East Asia at around 15 million years ago. Significant changes in Riversleigh bat communities are apparent at species, genus and subfamilial levels, and the influence of both climate and palaeogeography on this faunal turnover is examined here. The fossil data provide a tool to help anticipate the response of Australian bat communities to current and future climate change and to inform development of effective conservation strategies.

Bats that walk: a new evolutionary hypothesis for the terrestrial behaviour of New Zealand’s endemic mystacinids

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The short-tailed bat, Mystacina tuberculata (Mystacinidae), is the sole surviving member of the only mammalian family endemic to New Zealand. It is one of only two extant bats to use a true walking gait when manoeuvring on the ground (the other being the American common vampire bat Desmodus rotundus). In the case of Mystacina, lack of snakes and ground-based predatory mammals in pre-Holocene New Zealand has been assumed to have facilitated the evolution of walking. Postcranial remains of an early Miocene mystacinid from continental Australia, Icarops aenae, offer an opportunity to test this hypothesis. Several distinctive derived features of the distal humerus are shared by the extant Mystacina tuberculata and the early Miocene Australian mystacinid Icarops aenae. Study of the myology of M. tuberculata indicates that these features are functionally correlated with terrestrial locomotion in this bat. Shared, highly derived bony features of the distal humer i Icarops aenae and Mystacina suggest that Australian Miocene mystacinids also used terrestrial locomotion – in the presence of ground-based reptilian and mammalian predators, and before the isolation of mystacinids in New Zealand. Contrary to existing hypotheses, our data suggest that bats are not overwhelmingly absent from the ground because of competition from, or predation by, other mammals. Rather, selective advantage appears to be the primary evolutionary driving
force behind habitual terrestriality in the rare bats that walk. Unlike for birds, there is currently no evidence that any bat has evolved a reduced capacity for flight as a result of isolation on islands. Habitual terrestrial locomotion by mystacinids may have been sustainable in Gondwanan forests, in which predators and prey were both diverse, but in insular New Zealand today survival of mystacinids is threatened by introduced predators and habitat clearance.

**Multiple invasions of Australasia by New World bats? Evidence from the fossil record**

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New Zealand’s first pre-Pleistocene bat fossils, from the Early Miocene (16–19 Ma) St Bathans Fauna, Central Otago, South Island, include two taxa referable to the diverse, American-centred superfamily Noctilionoidea. One species belongs to New Zealand’s endemic bat family Mystacinidae, fossil members of which are also known from the Oligo-Miocene of Australia. The other species is referable to a new bat family, more closely related to strictly New World noctilionoid lineages including phyllostomids. The bat fossils raise a number of alternate biogeographic hypotheses, some of which are similar to those posed for marsupials. Competing hypotheses include: that Australia, Antarctica and South America shared a single noctilionoid fauna during the early Palaeogene, with faunal differences between South America and Australasia developing subsequently as a result of differential extinctions; or that two separate colonizations of New Zealand by noctilionoid bats from South America (possibly via Australia) occurred sometime before the Early to Middle Miocene. The biogeographic hypotheses are evaluated and inferences about the persistence of emergent land during the Oligocene “drowning” of Zealandia explored. The St Bathans bats indicate that within the Australasian region the New Zealand and Australian bat faunas were quite different by the mid Cenozoic and that there have been substantial changes to the Region’s bat fauna since the Early Miocene, with a cooling and drying climate evidently contributing to this turnover. They also indicate that calculations of extinction risk and potential phylogenetic diversity loss for the threatened New Zealand *Mystacina tuberculata* should be weighted to reflect that it is the last surviving member of the noctilionoid superfamily in Australasia.

**Tell me what you eat, and I’ll tell you what you are – trophic niche comparison between Myotis dasycneme and Myotis daubentonii**

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A diet analysis of the two sympatric bat species Pond bat *Myotis dasycneme* and Daubenton’s bat *Myotis daubentonii* allows conclusions of their ecological niche structure. Animals were caught with mist nets over bodies of water in Northern Germany. A total of 323 faecal samples were collected and calculations of niche breadth and niche overlap, based on identified prey categories, were conducted. The results show that Pond bat and Daubenton’s bat feed mainly on Chironomidae and Trichoptera and further categories can be found in the diets of both species. Based on a similar prey composition, the niche overlap is relatively high, measuring at 0.97 following Pianka. Five taxa (Ephemeroptera, Hymenoptera, Homoptera, Aranea, Gerridae) can be identified only in the diet of Daubenton’s bat, which shows a wider food spectrum and therefore a wider niche breadth of the reciprocal Simpson Index of 5.58, compared to 3.85 for the Pond bat. This can be also explained by the behaviour of Daubenton’s bat, which use more foraging grounds in terrestrial habitats, allowing it to feed on additional terrestrial living prey categories when compared to the Pond bat, who basically feeds on insects with an aquatic background. The high niche overlap could influence the stable coexistence and there is no diet specialisation that it could be taken as predominant basis for the typal ecological niche of both species. Though Daubenton’s bat shows a more flexible and adaptable behaviour in reaction to environmental changes, which grants it feeding advantages when compared to the Pond bat with its more limited range of behaviour.

To the bat fauna of bozdags (grey hills) within the Greater Caucasus

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Bozdags are the specific habitats in the eastern part of the southern Caucasus. In total, 17 species of bats of the families Rhinolophidae and Vespertilionidae were registered in this area. The former family includes three species (*Rhinolophus hipposideros, R. ferrumequinum, R. mehelyi*), and the latter family 14 species of eight genera (*Myotis blythii, M. emarginatus, M. aurascens, M. mystacinus, Plecotus auritus, Barbastella leucomelas, Nyctalus noctula, Pipistrellus pipistrellus, P. nathusii, P. kuhlii, Hypsugo savii, Vespertilio murinus, Eptesicus bottae, E. serotinus*). The basis of bozdags bat fauna is composed of *Pipistrellus kuhlii* and *P. pipistrellus* as well as the *E. bottae* (10–15 individuals/ha) based on the encountering frequency and population density aspects. There is a significantly less encountering of *R. hipposideros* and *R. ferrumequinum, M. blythii* and *M. emarginatus* (less than 1 individual/ha). Other species are rare in bozdags, the identification of *M. aurascens* is ongoing. On the assumption of habitats association of particular bat species to southern Mediterranean regions, there is a potential of its determination in bozdags as well. The dominance of xerophilous and thermophilic representatives of Front-Asian and Turanian zoogeographical complexes should be particularly highlighted. Ten bat species (*Rhinolophus spp., Myotis blythii, M. emarginatus, M. aurascens, Barbastella leucomelas, Pipistrellus kuhlii, Hypsugo savii, Eptesicus bottae*) consist the 59% of all bats registered in these hottest ecosystems of South Caucasus. *Rhinolophus spp., M. blythii, M. emarginatus* and *Barbastella leucomelas* are considered vulnerable and were recommended to be protected by law.
The impact of environmental niche specialisation on the evolution of olfaction in bats

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Olfaction is considered as one of the most important modes of sensory perception in animals and provides the basis for the extraordinary sensitivity required for the discrimination of environmental and sexual cues. The olfactory receptors (ORs) are essential for the sense of smell; accordingly the ORs form the largest gene superfamily in the mammalian genome. Increasingly, environmental niche specialization is found to be reflected in mammalian genomes. A correlation between loss of function of olfactory receptors and the gain of full trichromatic vision has been shown in primates. Bats are nocturnal sensory specialists that can use sophisticated laryngeal echolocation to create an acoustic image of their environment, potentially negating the need for enhanced vision and olfaction. Initial studies on the functional OR gene repertoire of mammals showed that bats possessed a distinctly different OR gene repertoire than all other species studied. To investigate if the evolution of the OR gene repertoire within bats has been influenced by ecological niche specializations such as sensory-specialization, diet and other life history traits OR genes from 27 bats spanning the chiropteran tree were PCR amplified, cloned and sequenced. The class and familial composition of these ORs was also examined and compared to that of Myotis lucifugus the only bat with a genome sequenced at a high coverage, confirming the validity of our laboratory procedure. A wide range of variation was found in the functional and pseudogene OR gene repertoires within the order Chiroptera and also within the Phyllostomidae. No evidence was found for a sensory trade-off between echolocating and non-echolocating bats, also no link between OR gene repertoire and presence of a functional vomeronasal organ was found. Frugivory evolved twice in bats, once within Yinpterochiroptera and again, more recently, in the Phyllostomidae. These results show that the evolution of frugivory has had a major effect on the OR gene repertoire of bats with the same OR gene families being expanded within frugivores of both lineages.

Bat monitoring and the development of multi-species indicators

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The UK’s National Bat Monitoring Programme (NBMP) was established in 1996 and coordinates a network of more than 2000 skilled volunteers to survey bats at summer roosts, hibernacula and in the field using bat detectors. The NBMP aims to determine species status and, where possible, improve understanding of the factors affecting bat populations. The information NBMP provides is used to guide conservation action for bats and to service government stakeholder reporting needs in relation to country biodiversity strategies and obligations under the EU Habitats Directive. Currently population trends are reported annually for 11 of the UK’s 17 resident bat species. Pledges by governments to reduce or halt biodiversity loss have created an additional information need for biodiversity indicators that measure progress towards the target. Selected species from a small number of taxa, mainly birds and butterflies, have been used to represent trends in the abundance and distribution of biodiversity at a national level.
of specific groups in the UK and Europe. In response to a recent drive to expand the suite of taxa used as indicators, BCT used NBMP data to develop an indicator of widespread bat populations and this was incorporated into the UK government biodiversity indicators in May 2008. On behalf of the European Environment Agency, BCT undertook a study to scope the potential for a pan-European indicator utilising bat surveillance data and to propose a methodology for indicator development. Subsequently, BCT has continued to play a role in the development of indicators for various target audiences in the UK and Europe. This paper presents how logistical, scientific and technical challenges to operating large-scale bat surveillance programmes have been addressed in the UK, demonstrates example data uses including the UK biodiversity indicator and outlines new opportunities for bat monitoring in UK and Europe.

Conserving bats in partnership: The birth of BatLife Europe

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BatLife Europe is a network of like-minded conservation organisations dedicated to maintaining and enhancing the diversity, distribution, abundance and habitats of all bat species throughout Europe. The concept of BatLife Europe was first proposed by the IUCN Chiroptera Specialist Group at the European Bat Research Symposium in Le Havre in 2002. At the 11th meeting of the EUROBATS Advisory Committee in Luxembourg in 2006, the Bat Conservation Trust was invited to establish BatLife Europe and accepted. Subsequently BCT has been collaborating with partners across Europe to take forward the establishment of this new pan-European non-governmental organisation and BatLife Europe will be registered as a charity in 2010. This poster provides further information on the role and planned work areas of BatLife Europe and how national NGOs can become members.

Bats may be carriers of Campylobacter

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Since the contamination cycles of Campylobacter and Salmonella are not fully elucidated, it is useful to search for possible reservoirs in the environment. Bats are known to be potential carriers of viral pathogens and they might also be relevant in the contamination cycles of Campylobacter and Salmonella since they are warm blooded animals and could possibly act as hosts for these pathogens. In Western Europe, all bat species are insectivorous. Since it is known that insects are able to transmit Campylobacter and/or Salmonella for instance via faeces of farm animals or water birds, they might be a source of infection for bats. By contaminating water, crops, fruit, feed or soil with their faeces, infected bats might be a part of the contamination cycle of both pathogens. In this investigation, we examined wild bats for the presence of Campylobacter and Salmonella in 2007 and 2008. Fresh faecal samples
(<10 mg – 100 mg) were collected from live, wild bats with transport swabs (Copan Diagnostics Inc., 109.USE), kept at 0–7 °C and examined within two days for Campylobacter using Bolton Broth, Preston Broth and CCDA and for Salmonella using BPW, MSRV and BGA/XLD. Campylobacter was found in 17 out of 632 samples, in 6 (of 14) different bat species from diverse habitats. Salmonella, however, was never isolated. Since the aim was to determine the presence of both Campylobacter and Salmonella, splitting-up of the material and improvisations on the methods were necessary which could lead to an underestimation of the number of positive animals. The isolated strains are currently MLST-typed, preliminary results indicating C. jejuni strains similar to the types previously found in environmental waters, humans, wild birds, geese faeces and chicken. Bats should be considered as carriers of Campylobacter and, where possible, necessary action should be taken to avoid contact between bats (faeces) and food/feed.

Patterns of habitat use by bats in a mosaic of land-use types in a biodiversity hotspot in Southern Chile

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Very little is known about bat ecology in Chile despite the fact that Chile contains important global conservation priority areas and high endemism for other taxa. Landscape studies in other regions of the world demonstrate that bat activity may differ according to the habitat type and food availability and that bat species can be susceptible to landscape perturbations, such as forest fragmentation and degradation. In this study, we focus on characterizing bat diversity and occupancy patterns within three dominant habitats (native forest, plantation, grassland) in three distinct regions of the Valdivian watershed in Southern Chile, including the Andean mountains, central valley and coastal mountain range. We recorded bat echolocation activity with Anabat II monitoring stations to determine species presence and relative foraging activity in different habitat types. We conducted acoustic monitoring for seven consecutive nights at nine sites in each landscape during January and February of 2009. We compared recorded calls to a call library that we developed for the local fauna from hand-released bats captured during the study. We identified five bat species occurring in the Valdivian region during our study: Myotis chiloensis, Lasiurus varius, L. cinereus, Histiotus montanus, and Tadarida brasiliensis. Overall, M. chiloensis was the most common species in all three sites, and Lasiurus cinereus was the least frequently detected species. Our effort initiated a program of bat research in southern Chile in collaboration with local Chilean scientists and our results have broad implications regarding the impact of human land use on bat diversity patterns.

Perception of an object’s spatial extent in the echo-acoustic imaging of bats

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Bats can identify objects by analysing the echoes of their ultrasonic emissions. It has been shown that bats can behaviourally classify echoes of objects that vary in size. A larger object will create a louder echo but also the spread of angles of incidence, from which the echoes impinge on the bats’ ears, is larger. This spread of angles is called the spatial extent. To date, it is unclear whether bats use the echo loudness and/or the object’s spatial extent to estimate an object’s size. We trained echolocating bats (Phyllostomus discolor) to evaluate echoes of their sonar emissions. The emissions were picked up by an ultrasonic microphone and played back via an array of ultrasonic speakers which allowed controlling the echo loudness (the overall transmission loudness across the array) independent of the spatial extent (the number of speakers from which the echoes were transmitted). The experimental approach allows manipulating object size by the physically correct covariation of echo loudness and spatial extent (Exp. I), manipulating spatial extent while leaving overall echo loudness constant (Exp. II), or manipulating overall echo loudness while leaving spatial extent constant (Exp. III). Data from Exp. II show that in a two-alternative, forced-choice paradigm, the bats can detect changes in echo spatial extent even when the overall echo loudness is equalised: At perceptual threshold, the bats can discriminate an echo from a single speaker from an echo with the same overall loudness transmitted across a spatial extent of about 29°. Performance will be compared to data from the other two experiments which will allow quantifying the relative salience of echo loudness and echo spatial extent for the perceptual evaluation of object size in bat sonar.

Molecular phylogeny of African “pipistrelle” bats (Vespertilionidae) suggests new clades, rearrangement of genera, and extensive cryptic diversity within species

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The taxonomy and putative phylogenetic relationships of Pipistrellus species (sensu Hill & Harrison 1987) were based on morphologic characters in the past while several recent molecular studies indicated paraphyletic groups. So far, taxon sampling of African “pipistrelles” has been fairly limited. In our study, we included a broad taxonomic and geographic set of African Pipistrellus-like bats and analyzed their phylogenetic relationships with both mitochondrial (16S rRNA, tRNA-Leucin, ND1) and nuclear (RAG2 and vWF) genes. Our phylogeny reveals several deep nodes with high statistical support and confirms previous molecular studies in the delineation of two tribes: Pipistrellini and Vespertilionini. However, the broad taxon sampling shows that current definitions of the genera Neoromicia and Hypsugo are para- or polyphyletic. Monophyletic groups are achieved if African Hypsugo are transferred to the genus Nycticeinops. In addition, the taxa capensis and somalicus should be included in the genus Laephotis. We further suggest that the taxa nanus and rueppellii as well as a clade comprising brunneus, rendalli and tenuipinnis should be assigned to genera that need to be either newly created or resurrected from current synonymy. Based on the mitochondrial data of a larger data set of African pipistrelles, we document intraspecific
sequence divergences up to 10 percent within seven species: *bellieri, brunneus, grandidieri, guineensis, hesperidus, nanulus,* and *nanus.* These large genetic distances, which are partly mirrored in the biogeographic distribution of lineages, implicate extensive cryptic diversity within these clades and call for a broad geographic sampling to assess their taxonomic status.

**Historical and imminent bat extinctions: Documenting extinctions and discerning patterns**

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The magnitude and geographic distribution of bat extinction in the recent historical period (here, the last 200 years) is discussed. Special emphasis is placed on Pacific and Indian Ocean island bats, as it is in these broad island regions that extinctions are progressing especially rapidly. Two nineteenth century flying-fox extinctions from Samoa (*Pteropus allenorum* and *P. coxi*), documented for the first time in 2009, are highlighted as examples of overlooked century-old extinctions. The story of the Christmas Island Pipistrelle (*Pipistrellus murrayi*), which became extinct in 2009, is reviewed as an example of immediately recent but poorly studied extinction event. The plight of various critically endangered bat species is discussed in this context, and overall patterns and processes involved in island bat extinctions are distilled.

**Looking at baculum function from a histomorphological perspective**

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The baculum (os penis) serves as a macroscopic character for species identification in bats. Micromorphological features of bacula could help to differentiate cryptic species. Furthermore, the function of the penis bone in bats, as in other mammals, remains controversial. In an ongoing study, both X-ray microtomographic images (microCTs) and histomorphological images of undecalcified, surface-stained ground sections are used to gain a more comprehensive understanding of the three-dimensional shape and micromorphology of the baculum in relation to surrounding tissues of the penis. While microCT enables to examine and compare statistically relevant numbers of bat bacula and to return the specimens intact to the museum, invasive preparation of ground sections can confirm details on the cellular and tissue level. Whole specimens of the bat genera *Plecotus* and *Pipistrellus* (Mammal Collection, Natural History Museum Vienna), either in ethanol or as dry skins, are scanned with a high-resolution microCT scanner (Xradia MicroXCT). In unstained whole specimens, penis bone microstructures small as osteocyte lacunae (10×20 μm) are visible. After iodine blockstaining of resected bat penes, microCT shows the soft tissue microanatomy of the baculum. The tunica albuginea of both corpora cavernosa continues into the periosteum of the baculum, thus it can act as a stiffening element in the erect penis. Histomorphology shows fibrocartilage at the insertions of the tunica albuginea to the branches of the baculum, indicating the effect
of bending as well as compressive forces during erection and copulation. The Y-shaped baculum seems well-suited for transferring and distributing those forces to both corpora cavernosa or the other way round. Cement lines in the tubular bone of the bacula of *Plecotus auritus*, *P. austricus*, and *Pipistrellus pipistrellus* indicate functional bone remodeling. A caudal groove in the baculum seems to protect the embedded urethra from compression.

**Modelling continental species richness of African bats at high resolution**

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Revealing both current and historical factors driving species richness critically depends on the quality as well as the spatial resolution (grain) of primary data. Most previous approaches studying species richness from continental to global scales were based on generalized and coarse distribution ranges. This coarse resolution might preclude an understanding of drivers of species richness at finer scales. In order to circumvent these impediments, we established a comprehensive database comprising point records of all bat species (>240) occurring on mainland Africa. This database “AfriBats” integrates >100,000 records gathered from own field surveys, publications and >40 museum collections in Europe, North America and Africa. We produced species distribution models (SDMs) to predict potential distribution ranges with high resolution (1 km²), employing 18 environmental variables (representing topography, land cover, hydrology, and climate) and a filtered set of bat occurrences extracted from AfriBats. We first illustrate biases present in the occurrence data and their effects on predicted distribution ranges. Second, we propose a multi-criterion selection strategy that considers spatial accuracy, topicality and taxonomic certainty of records in order to increase the reliability of our models. Resulting single-species models were corrected to approximate realized niches using (1) expert knowledge to eliminate distant biogeographic regions predicted as suitable but hitherto not documented, and (2) a novel approach to correct for patches predicted as suitable habitat but deemed too isolated and/or too small to support viable populations. We combined the final models and present the resulting first high-resolution map of African bat richness with a continental extent, which forms the basis for ongoing analyses to identify drivers of bat diversity. We further show how patterns of species richness change when considering different taxonomic and functional subgroups only.

**Patterns of habitat use by female Plecotus auritus and predicted negative impacts of woodland management**

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Woodlands are the most important of habitats for bat conservation in the highly modified rural landscapes of Europe, but very few woodland nature reserves are managed specifi-
cally for bats. This may be because the consequences of various woodland management practices for bats are poorly understood. We studied *Plecotus auritus* in broadleaved woodlands to establish how patterns of habitat use were influenced by characteristics of woodland structure and composition that are altered by management. Across 65 woodland sites in south east England a strong association was found between the presence of *P. auritus* and oak woodland with a well-developed understorey. Radio-tracking of 38 adult females at 11 sites in Sussex showed that most foraging activity was in woodland. Each female used a foraging area of 1–10 ha (mean=4.4 ha) on successive nights, which included a more intensively used core foraging area of 0.7–9 ha (mean=2.1 ha). Core areas were characterised by more cover and greater species diversity in the understorey than more peripheral areas. Hedgerows were used as commuting routes throughout the study period, and also as foraging areas in late summer and autumn. Females roosted in both buildings and tree cavities, and 45% of individuals switched between roosts at least once during their tracking period (mean 5 days). Bats selected large trees for roosting and 27 of the 28 tree roosts found were in oaks. Most efforts to protect this species have involved colonies roosting in buildings. Conservation activities should also be focussed on woodlands, promoting the retention of mature trees (especially oaks), maintenance of good cover of native species in the understorey layer, and enhancement of hedgerows adjoining woodland. Our results strongly suggest that frequent conservation management practices, such as reinstating coppicing or grazing in semi-natural broadleaved woodlands, will reduce habitat value for *P. auritus*.

**Bats in snow: Do they hibernate?**

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On very rare occasions, Ussurian tube-nosed bats (*Murina ussuriensis*) have been found in torpor inside or on the surface of snow on the ground. To examine whether these findings indicate the hibernation of this species inside snow, we reviewed the findings and analysed which of the following two hypotheses better explains the formation of the snow dents and holes in which the bats were found in spring. One of the hypotheses is that the bats resided on the snow surface in spring and sank in the snow layer. The other hypothesis is that the bats occupied the snow on the ground during early winter and that the vertical, cylindrical chambers made by the bats within the snow layers were exposed during spring thaw. The analysis considered both the physical properties of snow and physiological properties of torpid bats. The results of the analysis refuted the sinking hypothesis and supported the exposure hypothesis, thus indicating that the bats hibernate inside snow. Thermal stability, high humidity, and minimum disturbance inside snow seem to contribute to longer torpor bouts and less frequent arousals; this leads to minimum energy expenditure during hibernation inside snow. Low risk of predation must also be taken into account. However, it remains to be elucidated how the bats cope with the limitations in the supply of oxygen and elimination of carbon dioxide within the snow. These requirements of the bats must be fulfilled by gas exchange through the wall of the snow chamber and molecular diffusion through the snow layer. To our knowledge, none of the bats of other species across the world have been reported to use the snow for hibernation. However, we suggest that this hibernation behaviour should not be restricted to *M. ussuriensis*. 
Take care and keep in touch! Constrains in the roost-site selection of the tree-dwelling *Myotis bechsteinii*

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The tree-dwelling European bat species, *Myotis bechsteinii*, occupies various types of forest habitats (from broadleaved oak forests to mountain spruce forests). We hypothesised that the determining roosting variables will have similar values regardless of the habitat structure. Due to fission-fusion behaviour of a tree-dwelling species, we also expected that commuting distances will constrain the selection of roosting sites too. In two distinct types of forest habitat we radio-tracked the adult post-lactating females (six ones in standard dense forest with low roost-site offer; five ones in sparse old woodland with high roost-site offer). Characteristics of the roost-sites as well as roosting and foraging territories were compared. Despite of significantly different structure of habitats (tree species composition, dimensions of trees, stand density, canopy closure) and potential roost-site offer, bats selected tree-hollows with similar features (e.g. minimal entrance dimension, internal depth over the entrance, height of entrance over the ground). Moreover, also the distance among the particular roosts did not differ. Although bats had less distant foraging sites in the dense forest, the calculated area of the near total home-range (Kernel 95%) or the core area (Kernel 50%) did not differ between two compared types of habitats. We suggest that given tree-hollows dimensions and commuting distances are determining and important for the protection from predators and the maintenance of social contacts in the Bechstein’s bat. However, these field-based observations should be experimentally tested.

Context-dependent energetically optimal flight speeds in bats

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Studying the causes and consequences of animal flight speed has long been a challenge in biology. Because bats are excellent model organisms for the study of adaptation, quantitative measures of flight performance can be used to test predictions generated by aerodynamic theory. In particular, a range of studies has focused on predicting behavior from flight morphology. Aerodynamic theory makes testable predictions as to “optimal” flight speeds for bats in different behavioral contexts and makes predictions about interspecific differences in manoeuvrability. The relationship between power required for flight in relation to forward speed in flying vertebrates has been modelled by several authors. It must be emphasised that power curves often assume that lift and drag estimated from a fixed, rigid wing will be indicative of lift and drag for flapping, flexible wings. Realistically, this may not be the case, and the models developed by Rayner include variation in periodic lift production from flapping wings. The most frequently used programme for predicting flight speeds however is “FLIGHT” by Pennycuick. Reconstructions of flight paths made by acoustical tracking can reveal tremendous detail about flight speeds, manoeuvrability and agility of bats while simultaneously allowing analysis of relationships between echolocation behavior and flight.

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We present foraging and commuting flight speeds for European bat species and compare them to different model predictions. Interestingly, predictions by the Pennycuick model are in very good agreement with observed flight speeds. We will also present an analysis of centripetal accelerations during curved flight and show how such accelerations are always kept below a critical value.

**Stroboscopic flow perception in free flying bats**

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The echoes of natural habitats are highly complex and for an echolocator converting a stream of multiple overlapping echoes into a workable spatial representation of the environment requires elaborate information selection and processing both by internal and external mechanisms. Behaviourally, call design, calling behaviour and flight patterns can be adjusted to maintain workable information flow. One potential mechanism is the control of optic flow, which is the pattern of apparent motion of objects in the visual scene caused by the motion of the observer. Optic flow is a very powerful tool in perceptual research but is also a well-studied concept in animal visual navigation. Visually guided animals often adjust their flight speed in response to their distance from obstacles in a manner that keeps the experienced optic flow constant. We studied vespertilionid bats in a natural flight corridor along a forest road, which was experimentally narrowed in several steps by a camouflage net. We used 3D laser scanning of the habitat as well as acoustic tracking of bat flights to relate the bats’ behaviour to the corridor dimensions. We found that bats – like so many other flying animals – flew slower in narrower corridors. However, in contrast to visually guided animals, in bats these reductions did not keep the flow rate of objects constant. Echolocation however is discontinuous and stroboscopic. The analogue to optic flow in echolocating animals would hence be the flow rate of echoes. We found that bats also called more frequently in narrower corridors, which resulted in an increased spatial calling density. Interestingly, that way bats kept the mean stroboscopic flow rate for the corridor walls constant for all corridor widths. Therefore, we introduce the concept of stroboscopic flow perception in bats and predict that more examples of this mechanism of information flow control will be discovered in the future.

**“Out for the count?” Winter torpor in Myotis nattereri**

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The frequent arousal of bats from torpor within winter hibernation sites was first documented in the early 1900s. Since then there has been much debate over the duration of torpor and possible reasons for arousal, but few studies have managed to quantify the use of torpor reliably in free-living bats. Do bats arouse to mate, change hibernation site, to feed, to drink, to sleep or to combat pathogens? Other researchers have found a significant negative correlation between temperature and torpor bout duration. Here we present findings from a study conducted over two winter periods 2008–2009 and 2009–2010. We used temperature sensing
radio transmitters to measure the skin temperature of 24 Natterer’s bats Myotis nattereri roosting within a hibernation site in the south of England. A total of 76 torpor bouts (39 from females, 37 from males) were recorded, and torpor bout duration ranged from 0.06 to 20.4 days. Factors affecting the use of torpor by hibernating Natterer’s bats are evaluated.

Czech and Slovak bat monitoring schemes: Experiences, results, inspirations

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In the former Czechoslovakia, the program of long-term monitoring of bat populations begun in 1969 as monitoring of underground hibernacula. A single control per winter by the end of January or beginning of February and the same way of each control were the major initial rules of the program. Since 1969 (when the program started with 16 sites controlled by five bat students) the extent of winter census increased considerably: recently more than 700 sites is monitored yearly by about 100 bat students in Czech Republic and about 400 sites in Slovakia. The winter census provided a large amount of reliable data on abundance trends in particular species, regions and hibernacula types which were several times summarized. The results that illustrated both the general trends and patterns of local and/or temporal variation revealed that realizability of the monitoring outputs is essentially dependent upon: (a) duration of the study period, (b) number of the localities incorporated in the program, (c) diversity of these sites as to types of hibernacula, their contextual setting and regional coverage. Without respecting these conditions, there is a little chance to filter out the effects of temporal and local variations. For these reasons, from 2005 the winter monitoring has been complemented with further standardized monitoring projects (each operating with a specific methodology) focused on (1) breeding colonies (200 colonies of 16 spp.), (2) structure of foraging communities (controlled with aid of bat detectoring at18 line transects in 10 regions), (3) structure of swarming communities (9 sites), and (4) bats in urban settlements.

Rousettus aegyptiacus in the Mediterranean: Distribution, chorology and perspectives

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The Mediterranean population of Rousettus aegyptiacus presents the only offshoot of the family Pteropodidae beyond limits of the tropical zone. In the pattern of its distribution throughout the Mediterranean region the species differs essentially from all other mammals. The extensive field study during last decades resulted in (a) nearly a complete revision of all known roosts in the region, (b) refining its distribution status and abundance trends in different parts of the region, (c) very fine DNA sampling for a detailed phylogeographic analysis, and (d) estimation of total population size and conservation problems of the species in the region. With more than 10% of mtDNA divergence from neighbouring sub-Saharan populations, the Mediterranean fruit bat can be looked upon as a separate species obviously endemic to the Mediterranean region. The genetic variation within that species is relatively low which suggests its spread from a single refugium, supposedly situated in Levant. In some regions (e.g. Turkey) the species exhibits a clear expansion during the recent decade (including the westward shift in the range margin), in others there is a clear population decline (Cyprus) or relatively stable population development (Lebanon, Jordan, Egypt). Using the refined distributional information we tried to estimate the total abundance of the Mediterranean species: against expectancy it can be even lesser than 75,000 individuals.

Scales of movement by a long-distance migrant: Tadarida brasiliensis

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Understanding the complexity of animal movements requires investigations at multiple temporal and spatial scales. Morphology, physiology, behavior, ecology and evolution of organisms each play important roles with respect to where, how and why bats move on daily, seasonal, and annual bases. Current technologies now make it possible to assess movements of individual organisms across multiple scales. Using advanced techniques such as thermal infrared imaging and computer vision analysis, high-speed videography, 3D motion capture and computer modeling, we present data on the Brazilian free-tailed bat (Tadarida brasiliensis) in the south-central United States and how different variables influence flight biomechanics and flight performance, formation flight and group behavior during mass emergences, as well as nightly, seasonal, and annual colony dynamics. Our analysis of flight biomechanics in the laboratory helps inform our understanding of the group behavior and flight performance of free-ranging bats. Additionally we demonstrate that seasonal variation in colony size and composition are more dynamic than previously thought. Much of the overt behavior of the bats appears to be explained by the subtle interplay between the reproductive cycles of the bats and the local and regional, annual weather variables. By integrating individual components of seemingly disparate disciplines, it is now possible to provide a composite view of the complex biology of this fascinating species. We highlight the importance of this integrative approach to advance our overall understanding of animal movement in this model species.
Impacts of land-use intensification on rainforest bat assemblages in Sumatra, Indonesia

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Tropical rainforests, where bat species richness is generally greatest, are likely to experience severe losses of bat diversity as a result of rapid deforestation. Of the threats to tropical forests, conversion to agricultural plantations is the most prevalent after logging. Agricultural land uses can result in significant losses and/or a modification of tropical biodiversity. In Indonesia the situation is critical as the region houses 225 species but relative rates of forest loss (up to 2.0% annually) are the highest among all tropical regions. However, the consequences of agricultural intensification on forest bat diversity in this region are virtually unknown. Here we study bat diversity along a gradient of agriculture intensification to understand how bat assemblages and functional groups respond to different land management strategies. We use harp traps and mist nets to conduct bat surveys in three habitat types in and around Bukit Barisan Selatan National Park southwest Sumatra, Indonesia: monocultural coffee farms; polycultural coffee farms (cultivation type comprises a variety of crops, such as coffee, cocoa, banana, rubber tree); and primary rainforests. The values of agroforests to conservation of bat diversity are also discussed. Future work will focus on how land uses shape ecological functions of insectivorous bat ensembles.

The aerodynamics of different bat species

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Differences among the 1100 extant bat taxa in ecology, wing morphology, and flight behaviour suggest that the wake patterns generated behind bats should vary as well. In this study, we investigated three species that vary substantially in foraging, roosting and migration ecology, and morphology, Cynopterus brachyotis (Pteropodidae), Myotis velifer (Vespertilionidae), and Tadarida brasiliensis (Molossidae), to learn whether the wake pattern varies among them in forward flight. We use high-speed videography to record the wing motion and synchronized Particle Image Velocimetry (PIV) to visualize the resulting air movement generated by the animals. This allowed us to investigate the development of the wake structure over the course of a wing beat cycle and to correlate aeromechanical forces with specific aspects of wing motion. All three species showed a recurring pattern of four distinct vortices developed over the course of each wing beat cycle. However, general appearance, relative strength, and duration of these vortices varied among species, and with speed within each species. In Myotis velifer, we were able to observe transitions between a ring vortex wake
structure and the generation of continuous vortex wakes; *Cynopterus brachyotis* showed little change in the wake pattern between low and higher speed. We conclude that no single bat species is fully representative enough of the diversity of wake patterns to serve sufficiently as a universal model of bat flight mechanics.

**Predicting distributions of Asian bat species over 20,000 years and solving zoogeographic riddles**

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Predictive maps were created of the current distributions and habitat requirements of >100 bat species within Southeast Asia, using presence-only data to generate these predictions. To create these predictions the known distribution of each species are paired with geological, physical and climatic maps of Southeast Asia in MaxEnt (http://www.cs.princeton.edu/~schapire/maxent/) which then uses these ecogeographic variables to determine niche requirements, and therefore extrapolate the current distribution. Using this information; extrapolative models were produced under projected future climate-change scenarios and predicted changes in land-cover (forecasting to the year 2100). Additionally predictions of the past distributions (hindcasting) of these species have been created to look at possible glacial refugia, ancient seaways and migration routes during the Last Glacial Maximum (21 kya) and the last Interglacial Period (120–140 kya). Species distribution predictions were combined to show “hotspots”, at each timeframe, to mediate conservation and research prioritization. We attempt to explain and elucidate on the zoogeographic divide which exists around the Isthmus of Kra in mid-peninsula Thailand. Principal Component Analyses of climate over the region reveals an intersection of climatic zones within this area. Furthermore, sea-level changes on the narrow isthmus may have caused high regional extinctions in response to post-glacial sea level rises, compounded by a lower probability of recolonisation due to the limited peninsular width (peninsula effect). These factors combined with geologic instability exacerbate the climatically mediated boundary. No physical division of the area would be necessary to cause the observed zoo-geographic divide.

**Phylogeography of Pipistrellus pipistrellus species group: Radiation and reticulation**

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We present a study of the *Pipistrellus pipistrellus* species complex, a bat group from a very speciose genus, radiated into the mosaic of lineages in different stages of diversification and secondary contacts in the rugged environment of the Mediterranean biodiversity hotspot. We use fast-evolving markers (mitochondrial D-loop sequence and 11 nuclear microsatellites) to describe the phylogeography, demography and population structure of this model and address details of its diversification. The overall pattern within this group comprises a mosaic of phylogenetically basal, often morphologically distant, relatively small and mostly allopatric demes in the Mediterranean Basin, as well as two sympatric sibling species in the large continental part of the range. The southern populations show constant size, whilst in the northern populations there is a growing demographic trend connected with range expansion, starting in the Eemian interglacial period. There is evidence of isolation by distance at large geographical scales and female philopatry in *P. pipistrellus* s.str. While the northern populations are reproductively isolated, we have detected introgression events among several Mediterranean lineages. This implies ancestral state and incomplete establishment of reproductive isolating mechanisms in these populations. We correlate these findings with other aspects of biology of this taxon.

### The potential communication value of species specific terminal frequencies in European pipistrelle bats

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Bats are well adapted to their nocturnal life by using echolocation for orientation in space and food acquisition. The strongest constraint on the design of the echolocation signals is exerted by the echolocation task a bat has to solve. However, there is evidence that echolocation calls are also used for communication. If communication is an important function of echolocation signals, it should exert a selection pressure on the signal design. Hence we assume that echolocation calls are species specific and used for species identification, leading to the selection of species specific communication channels for species specific terminal frequencies. Closely related, sympatric species should therefore show character displacement in terminal frequencies in order to maintain species specific communication channels. To test this hypothesis we measured terminal frequencies as a function of signals duration and calculated channel widths (i.e. standard deviation of the residuals) of sympatric and allopatric European pipistrelle bats, *Pipistrellus pygmaeus, P. pipistrellus, P. nathusii* and *P. kuhlii*. Terminal frequency channels were clearly separated in species, that have most likely been living sympatrically for a long time in the past. In all species channel width was 2.9–3.4% around their center frequency, independent of species composition, which may indicate the maximum tolerance of variance for species identification. Our results support the hypothesis that echolocation signals have a communication function and that the separation into species specific frequency bands and the channel width are the result of character displacement. We will also show data from Switzerland where the distribution area of *P. nathusii* and *P. kuhlii*, two species with very similar terminal frequencies, have started to overlap during the last decades and where we therefore expect ongoing character displacement.
Bats in the National Parks Thayatal and Podyjí

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A bilateral research project on bats was initiated in 2009 in the Thayatal National Park (Austria) and the adjacent Podyjí National Park (Czech Republic). Within the framework of this project intensive faunal and ecological research on bats was carried out in the Thayatal National Park. Several methods were applied in order to avoid the selectivity of any single method: mist netting, transects with ultrasound detectors, automatic recording devices for ultrasound calls, and visits of winter and summer roosts. A total of 230 individuals of 16 species were caught during mist netting at 20 different locations. Two additional bat species were recorded by the analysis of their calls and another two species were found in summer roosts. The most frequent species caught in the nets were Barbastella barbastellus and Myotis daubentonii followed by Myotis mystacinus, Myotis alcathoe, and Myotis myotis.

In the Podyjí National Park research of the bat fauna has been carried out since 1990 and a regular monitoring scheme has been established. During the course of the project in 2009, a total of 20 bat species were recorded in summer and winter roosts, and by mist netting at two important swarming sites. The list of species recorded in the two National Parks is identical. Woodland bats are dominating both in the Austrian as well as in the Czech part of the protected area. In addition to some common species like Myotis daubentonii, M. mystacinus, M. nattereri, M. brandtii, Plecotus auritus, and Barbastella barbastellus, some rarer species like Myotis alcathoe, and M. bechsteinii were recorded in surprisingly high numbers. The Czech part of the bilateral National park covers a larger area with a substantial proportion of open habitats which are inhabited by species like Myotis emarginatus and Plecotus austriacus.

Phylogeography of Miniopterus schreibersii schreibersii and M. s. pallidus in Asia Minor as inferred from climate modelling predictions

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In Asia Minor, Miniopterus schreibersii consists of two genetically diverged lineages: M. s. schreibersii and M. s. pallidus. The lineages are apparently allopatric and meet along a contact zone passing through Central Anatolia. Yet, the separation of the lineages does not follow any obvious geographical barriers. D-loop haplotypes of M. s. schreibersii are highly polymorphic and show distinct partitioning among three geographic regions: Thrace, the south of Turkey, and the eastern Black Sea cost. On the other hand, less polymorphic haplotypes of M. s. pallidus tend to be even more uniform in the south-eastern borders of its distribution. We hypothesize that genetic diversity of M. s. schreibersii haplotypes, and their spatial distribution, might indicate that M. s. schreibersii survived the Last Glacial Maximum (LGM) in multiple glacial refugia in the Anatolian region, whereas the pattern
observed within *M. s. pallidus* might imply its relatively recent south-western expansion. To examine our hypotheses, we use 19 bioclimatic variables derived from the precipitation, minimum, maximum, and mean temperature of monthly data, and a vegetation layer. We first construct and optimize models of localized distributions to provide a close fit to the current location records of the lineages (83 locations of *M. s. schreibersii* and 45 locations of *M. s. pallidus*), and then we allow for less localized projections. Finally, we project our models to the settings representing climatic conditions during the LGM using the past data provided by Community Climate System Model. We run our predictions on Maxent, using the climatic variables with a resolution of 2.5 min, a rough equivalent of 5 by 5 km grids. Our results suggest that whereas *M. s. schreibersii* in Asia Minor has already reached its easternmost limits of distribution, *M. s. pallidus* might still expand further westwards. The projection of our models to the past climatic conditions indicates that *M. s. schreibersii* might indeed endure the LGM in putative glacial refugia in Thrace and along coastal zones of the Mediterranean and Black Sea. *Miniopterus s. pallidus* possibly survived the LGM in a glacial refugium located somewhere near the southern coast of the Caspian Sea.

Ultrasound attenuation and bat detection in tropical rainforest canopies

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Detection of bats via echolocation monitoring is a commonly used technique in studies exploring microbat ecology, but our understanding of the manner in which echolocation calls propagate through different habitats is restricted. This study, conducted at the Australian Canopy Crane Research Station in the tropical rainforests of Northern Australia, investigated the way ultrasonic echolocation calls emitted by bats during navigation and foraging travelled through the rainforest canopy. Intensity of sound, how far calls travel, and how well different calls (CF, FM) can be detected were investigated from varying heights within the rainforest canopy using ultrasonic detectors and a bat call simulator. Physical characteristics of the forest were mapped, and a vertical array of six Anabat SD1 CF bat detector units (Titley Electronics, Ballina, NSW) were erected at heights of 0 m, 4 m, 10 m, 20 m, 30 m, and 40 m from the ground. An ultrasonic source (Chirp board, or ‘electronic bat’) was used to emit constant frequency and frequency modulated pulses, between 40 and 80 kHz, from varying heights within and above the canopy. Here we report how the detectability of a bat call varies with its type, and location within the canopy, and how this information is useful for the monitoring of naturally occurring bat activity in tropical forest environments.

Community structure of chiropterofauna of the Black River State Park

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This study presents partial information about a survey of bats made in Black River State Park (PERP) (18°06’S, 48°20’W; 800 m alt), Minas Gerais, Brazil. This Conservation Unit encom-
passes 10.755 ha. PERP is located about 60 km northeast of Diamantina. Different stages in savanna habit (“Campos de altitude”) characterize the park vegetation. Twelve field trips had been carried out monthly from May 2009 to April 2010 using five mist-nets. In this period, 61 bats were captured, 19 *Glossophaga soricina* (31.2%) and 10 *Anoura caudifer* (16.4%), both representing 47.5% of the survey. Yet, other 11 species were identified. Some of the species were considered uncommon. The richness of species found and the non-occurrence of phyllostomines suggest that further inventories are needed to know the PERP bat fauna.

**Ontogeny of foraging of Cynopterus sphinx in captivity**

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Postnatal growth and ontogeny of foraging of the short-nosed fruit bat, *Cynopterus sphinx* was studied from July 2005 through September 2006. Advanced pregnant females (*n*=13) were captured, by using mist-net from foraging area in St. John’s college campus, Palayamkottai [8°55’W, 77°16’E], South India. Each pregnant female was released into separate nylon-meshed cage (62×31×41.5 cm). The bats were fed with locally available fruits and water was provided *ad libitum*. Individuals were tagged with necklace fitted with colour beads for individual identification. Among 13 pups born, 3 were males and 10 were females. The forearm length (FA) of day-old pup was 31% (mean 21.3±0.38 mm; *n*=13) and body mass (BM) was 19.5% of postpartum females (mean 8.8±0.82 g; *n*=13). At the age of 20 days, pups started to roost separately adjacent to their mothers (FA 39±2.58 mm, BM 14±1.69 g; *n*=10) during the night hours. Pups were able to fly short distances at the age of 35 days, as they reached 71% FA and 41% BM of postpartum females (*n*=7). At this stage, the pups made foraging attempts by biting and licking fruit pieces. The pups were started foraging at the age of 39 days, as it was confirmed by the availability of rejecta fruit pellets of pups for the first time in each cage. Even after starting foraging, the pups engaged in both suckling the mother and feeding fruits. After the age of 60 days, the pups were completely weaned from their mothers during when they stopped suckling and engaged in independent foraging.

**What, if anything, can variation in echolocation calls tell us about speciation in bats?**

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The close correlation between echolocation and phenotypic traits directly involved in the production and reception of echolocation signals suggests that echolocation plays a significant role in speciation of bats. Analyses of echolocation variation may therefore illuminate the process of speciation in bats. I used echolocation variability amongst southern African rhinolophids to test two hypotheses on the divergence in these bats. Firstly, divergence was the result of harmonic hopping and secondly that selection favoured discreet frequency bands amongst species because it facilitated communication. Although the distribution of echolocation within clades loosely followed hypothetical harmonic series, species that echolocated close to the fundamental of the harmonic series were more derived, contrary
to the prediction of harmonic hopping. On the other hand species whose echolocation calls
deviated from allometry, used frequency bands not utilized by other species, as predicted
by a communication hypothesis. This suggests that these deviant frequencies allowed these
species to colonize habitats already occupied by congenerics, without compromising com-
munication. However, the overlapping distributions of species with similar frequencies and
the disjunct distribution of species with different frequencies contradict the communication
hypothesis. The validity of these analyses is dependent upon the robustness of the topography
of the phylogeny we used as well as on the accuracy of the species distributions.

Unusual social calls of Pipistrellus nathusii recorded in May and June

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The advertisement calls of Pipistrellus nathusii show a unified structure: three main motifs
with two accessory motifs which can be combined into various syntagmatic strings. In late
spring (May and June) was recorded apart from these standard calls, a continuous social
vocalization of quite unusual structure and composition. Most of these calls were designed
in a long “wavy line” pattern with the frequency of maximal energy 14–36 kHz (W-type),
and were accompanied by standard or modified echolocation calls. The second common
motif were steep FM calls (I-type) which probably originated from approaching or landing
echolocation calls. In one case were the acoustic records supplemented with a complete record
of behavioural details: two bats slowly flew and followed one another along circular path
around male’s roost, where they repeatedly performed false landings, and during approaching
one of them emitted these unusual social calls. Also, typical social calls composed of three
main motifs were recorded. This behaviour lasted for about 40% of whole-night activity.
The sex of individuals which emitted these unusual calls was unknown.

Social calls and behaviour of Rousettus aegyptiacus: First results

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Social calls and social behaviour was recorded in a captive colony of 30 to 50 individuals
of Rousettus aegyptiacus in Prague zoo. Flying foxes are kept in tropical nocturnal pavilion
designed as artificial cave with possibility of free flight across whole area. The calls and
respective behaviour were recorded 90 min prior the full “bat night” with use of infra-red
torch and camera with night shot. The calls were divided into five main categories: (a) tonal
calls with multiple harmonics (fundamental loudest frequency 0.75–1.16 kHz, frequency
with maximal energy 4.5–14.5 kHz, duration 34–251 ms), (b) broadband screech-like calls
(frequency with maximal energy 3.3–16.0 kHz, duration 32–348 ms), (c) series of converted
V-shaped high-pitched calls (fundamental loudest frequency 8–11 kHz), (d) series of weak
short steep FM calls, (e) tonal calls of juveniles (fundamental loudest frequency 1.5–3.0 kHz,
frequency with maximal energy 1.8–12.0 kHz). First two types were produced during face to
face (wrestling) or face to back (biting the neck, usually male – female) interaction. Besides
aggressive behaviour were recorded also grooming activities, cluster distribution, movements,
etc. During time of early lactation were observed protection of mother with juvenile by a male against other individuals and leaving off juveniles at nearby branches during time of feeding.

The variability of echolocation and social calls of cryptic pipistrelles across western Palaearctic

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Bats of the Pipistrellus pipistrellus group are represented by two widespread cryptic species living in sympatry in most of the Western Palaearctic (common pipistrelle P. pipistrellus s.str. and soprano pipistrelle P. pygmaeus s.str.), and several populations (often also phylogenetically basal and living in allopatry) including P. pygmaeus cyprius and P. hanaki inhabiting peninsulas and islands of the Mediterranean Basin, as was repeatedly referred by molecular studies. This level of diversification is in contrast with their great ability for flight and is probably connected with their puzzling social life. The two siblings in the Central and Western Europe can be simply distinguished by terminal frequency of their echolocation calls (ca. 46 kHz and 55 kHz). Also their social calls emitted during foraging or songflight differ. In the Mediterranean region, discrimination of local demes by terminal frequency of echolocation calls can be misleading, i.e., in P. pygmaeus cyprius and P. hanaki, frequency parameters span between 47–50 kHz, and resemble P. pipistrellus s.str. This probably reflects the plesiomorphic condition of whole radiation. However, social calls of both of this subspecies, playing important role as reproductive isolating mechanisms, were not described yet. In Cyprus we recorded 37 pipistrelle-like social calls (19 analyzed) in one locality, from which P. p. cyprius was confirmed by molecular analysis and four other localities during spring and autumn. These calls contained 3–7 notes, which frequency with maximal energy grew up from 13 to 31 kHz. During autumn were recorded also typical social calls of P. pipistrellus (4–5 notes, frequency with maximal energy of all components 15–18 kHz). We present also parameters of echolocation calls recorded in Mediterranean region supplemented with literature data.

Advertisement calls of Pipistrellus nathusii: Complex message of individual males

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Males of Nathusius’ pipistrelle (Pipistrellus nathusii) are well known for their complex acoustic advertisement behaviour produced during flight or from the entrance of their roost. Advertisement calls are composed of three main motifs (A, B, C) which can be supplemented

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by additional two motifs (D, E) or series of frequency modulated distress calls. We analyzed phonologic, syntactic and semantic characteristics of social calls based on acoustic records obtained from individual males during long-term study in South Bohemia (1999–2007 with occasional data recorded during 2008–2010). Besides the major syntagmatic string ABC we recorded further 15 syntagms containing the main motif a and 10 syntagms without this motif. At the peak of the mating season, when males perform mostly sedentary display, the complexity of the vocalization increase in both syntagmatic structure and syllabic composition of particular motifs. The motif a corresponds to social calls of congeneric European pipistrelle species, and B, C, D are specific for P. nathusii. B, composed of one steep frequency modulated signal and C, composed of series of V-shaped syllables, exhibit the largest between-individual but low within-individual variation, and their combination provides an acoustic signature of each particular male. Motif D, composed of tonal frequency modulated signals, corresponds to calls of mother-young communication and shows the largest syllabic variation. The individual characteristics of B, C and D motifs were found to be invariant both within a season and over a series of successive years. Motif E is a series of steep FM signals evocative of the act of landing. The message of a complete advertisement call (ABCDE) could be thus: ‘(A): Pay attention, here is P. nathusii, (B, C): I am male X, (E): land here, (D): we share a common social identity and common communication pool’.

Dynamics of the echolocation beam shape in vespertilionid bats

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Echolocating bats can navigate and forage by sound, emitting short high-frequency sound pulses and listening to echoes reflected from obstacles and prey. The shape or directionality of the emitted echolocation pulse for obvious reasons play a large role in what echo-information is available to the bat. Hence, the beam shape is very important for how the world is perceived through echolocation. While a highly directional beam has many advantages it will also restrict the bats “field of view” in certain situations and an adaptable system would seem highly advantageous to bats. We present evidence for dynamic changes in echolocation beam shape in multiple species of vespertilionid bats, both in response to a change in environment and in response to rapid behavioural changes. Furthermore, we present evidence that beam shape is adapted in a similar manner across species which indicates that directionality is an essential feature of the echolocation signals emitted by vespertilionid bats.

Habitat and morphology of Scotophilus heathii (Vespertilionideae)

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We captured twenty-one specimens of the greater Asiatic yellow house bat (Scotophilus heathii). Seven of these were captured from Bahawalpur Fisheries Complex, Bahawalpur (N 29°23.186, E 071°38.148), six from Islamabad Fish Hatchery, Islamabad (N 33°40.966 E 07°30.932), four from Dalwal Village, Chakwal (N 32°42.725, E 07°25.065) and four from Kalian Daas Village, Toba Tek Singh (N 31°12.037, E 07°24.0.487). External body measu-
Ratings of these four bat populations were compared using ANOVA to find out locality and sex-related variations. Head and body length ($F=23.45; \text{df}=20; P<0.05$) and wingspan ($F=3.34; \text{df}=20; P<0.05$) varied significantly at all localities. First phalanx of both fourth ($F=10.26; \text{df}=20; P<0.05$) and fifth ($F=5.07; \text{df}=20; P<0.05$) metacarpals in females respectively was longer than in males.

**BAARA Biological AutomAted RAdio-telemetry system: New technology in ecological field studies**

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Radiotelemetry became an important and often the only possible method to explore specific habits and behaviour of animals, but it has proven to be very demanding and time consuming especially when frequent positioning is required. Our aim was to address this issue by making the process partially automated in order to mitigate the demands and related costs. We have designed and developed new telemetry system called BAARA (Biological AutomAted RAdio-telemetry system). It consists of two principal components - a tag with transmitter and a tracking station. A set of the tracking stations is deployed in target area and after installation each station picks up signals from transmitters and estimates a distance and direction to the signal source (tagged animal). This information is stored together with a time stamp to a non-volatile memory so that the log can be later downloaded for further analyses. The station is capable to track up to 30 transmitters on different frequency channels in a sequence with period of 10–20 sec per channel. An ordinary transmitter that fits within supported frequency band might be used with BAARA, an extra option is usage of concurrently developed programmable transmitter with optimized performance and possibility to customize operational parameters such as precise frequency channel, active duty periods or the transmission parameters. BAARA has been tested within fieldwork explorations of *Rousettus aegyptiacus* on Cyprus where five stations were deployed on nine spots to cover an area of 80 km² during three weeks. It has shown that effective range is approximately 1–1.5 km depending on terrain profile. Of 24 tagged animals approximately 4000 of location fixes were recorded (compared to 500 from manual telemetry).

**Emitting echolocation calls through nose or mouth in Trachops cirrhosus (Phyllostomidae)**

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The frog-eating bat, *Trachops cirrhosus* (Phyllostomidae) is an omnivorous, gleaning bat. It uses passive hearing to listen in on the male mating calls from frogs, which constitute
a substantial part of its diet. However, *T. cirrhosus* is not limited to this strategy; it is also capable of eating insects, lizards, fruits and seeds, i.e. truly an opportunistic forager. It uses echolocation to localize silent prey. The ability of *T. cirrhosus* to exploit both foraging strategies is a strong indication for the flexibility of this bat. We hypothesize that the flexibility must be reflected in the echolocation call design of *T. cirrhosus*. We recorded of *T. cirrhosus* in Panama, on Barro Colorado Island, in 2008, in an outdoor flightcage. Behavioral observations indicated that *T. cirrhosus* sometimes echolocate with the mouth closed and sometimes with the mouth open. Our project focuses on (1) to determine whether sound is emitted through the mouth when it is open and (2) to see what effect on acoustic features (intensity, frequency, directionality) of the echolocation call the mode of emission has. Recordings of *T. cirrhosus* were made using a microphone array, a high speed video camera, and a microphone-diode-video system to directly visualize the echolocation sound beam axis synchronized with behavior. Our results show that there is a difference in the peak frequency (PF) of the echolocation calls depending on whether the bat is echolocating with its mouth open (PF~ 87 kHz) and with its mouth closed (PF~ 62 kHz). Other spectral features also changed, i.e. which harmonic has the highest intensity and low frequency cut-off. Our results indicate that by altering the mode of emission between nose and mouth the bat has a higher level of control over its echolocation calls. This study was funded by Research was funded by the Danish Natural Science Research foundation, the Smithsonian Tropical Research 321 Institute (STRI), the German Science Foundation (DFG).

*Lasiurus cinereus* and *Tadarida brasiliensis* mortality at the Montezuma Hills wind energy region in Central California

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Wind energy is becoming increasingly important as an alternative energy source, yet wind turbines in many areas of the United States and Canada are responsible for bat mortality. Most of the bats killed by wind turbines are migratory Lasurine bats (e.g., hoary bats [*Lasiurus cinereus*]) during their fall migration; however, a clear understanding about why bats are killed more at some areas than others has been elusive. Furthermore, few studies on wind turbine bat mortality have been conducted in California and none have included daily carcass searches to improve the accuracy of mortality assessment. Recent studies on wind energy impacts to bats in Alberta suggest that wind speed may influence bat mortality from turbines, and that by changing the cut-in speed at which point turbine rotors begin turning in low winds, bat mortalities can be reduced. As a part of a larger 2-year study to investigate wind energy impacts to birds and bats, we investigated the relationship between wind speed, distance and direction to tree groves, temperature, barometric pressure and bat mortality at Montezuma Hills near the confluence of the Sacramento and San Joaquin Rivers in Central California. This larger study comprised carcass searches at 48 turbines, radar sampling at 2 points, night vision observations at 2 points, and acoustic surveys at 8 stations for birds and 8 stations for bats using Avisoft full-spectrum software for recording and analysis. Survey techniques were conducted for 4, 10-day periods between August 15 and October 15, 2009. During the first season for this study, we found that the lack of high winds (coefficient = –0.48; df=18; p=0.03) and presence of a high barometric pressure (coefficient = 0.512; df=26; p=0.005) were important predictors of bat mortality for the hoary bat. The hoary bat mortalities were unevenly distributed temporally (Pearson chi-squared
in R, (X-squared = 80.6452; df=2; p<2.2e-16) but the Brazilian free-tailed bat (*Tadarida brasiliensis*) mortalities were distributed evenly. Furthermore, a relationship exists between turbine mortality locations and the distance and direction to the nearest clump of Fremont cottonwood (*Populus fremontii*) (Rayleigh Test for Uniformity, p=0.007) and for eucalyptus (*Eucalyptus globulus* and *E. camaldulensis*) trees (p=0.013).

**Prioritising the unkown**

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We evaluate the combined use of phylogeny and spatial proximity to derive expectations of extinction proneness in bats. Extinction risk and the human influence on population decline is not random neither in respected to the phylogenetic position of a species nor in respect to the geographic occurrence. Recent methodologic developments suggest that the use of phylogenetic information and spatial distribution can inform about the potential threat status of species. Here we assess the feasibility of using phylogenetic eigenvector analysis in combination with spatial filtering to fit predictive models of extinction risk for Chiroptera globally. We investigate the deviations of assessed species from the model predictions based on phylogeny and spatial proximity alone and make suggestions for which unassessed species should urgently be considered for a through assessment.

**Monitoring ultrasonic biodiversity: Using bats as biodiversity indicators**

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Bats leak information about themselves into the environment because they use ultrasound for communication, foraging and navigation. These sounds contain information about their habitat and foraging niches as well as species-specific characteristics. There is enormous potential for using ultrasound as a tool to monitor bat abundance, the status of their populations and geographic distributions. Ultrasonic biodiversity could be used as a biodiversity indicator of change because of widespread presence of bats in most landscapes and the critical role they play in providing ecosystem services (such as insect regulation, pollination and seed dispersal). Here we review the strengths and weakness of the approach and demonstrate this monitoring program working in Eastern Europe using networks of volunteers. A wider scale application of this program is dependent on the development of algorithms which can automatically detect and taxonomically identify ultrasonic bat sounds.

**Behavioral evidence for eavesdropping on prey song in two Palearctic sibling bat species**

Patricia L. Jones¹,², Rachel a. Page¹,³, Manfred Hartbauer⁴ & Björn M. Siemens¹
Eavesdropping behavior has never before been reported for a Palearctic bat species. In this study we investigated whether lesser and greater mouse-eared bats, *Myotis blythii oxygnathus* and *Myotis myotis*, find katydids (Tettigoniidae) by eavesdropping on their song. Tettigonids are known to be the most important prey item for *M. b. oxygnathus*, while carabid beetles and other epigaeic arthropods are the most important prey for its sibling species, *M. myotis* – in many places in Europe. *M. myotis* locates walking beetles by listening for their rustling sounds. We compared these two species’ response to four acoustic prey cues: calling song of two tettigonid species, the rustling sound made by walking carabid beetles, and a control tone. Individuals of both bat species attacked the speaker playing tettigonid song, which clearly indicates that both species eavesdrop on prey mate-attraction signals. There were, however, species differences in response. *M. b. oxygnathus* exhibited stronger predatory responses to the calling song of two species of tettigonid than to the beetle rustling sound or the control. *M. myotis*, in contrast, exhibited stronger predatory responses to the beetle rustling and to one tettigonid species but not the other tettigonid or the control. Our study (1) for the first time demonstrates eavesdropping on prey communication signals for Palearctic bats, and (2) gives preliminary evidence for sensory niche partitioning between these two sympatric sibling bat species.

Adaptability of Neotropical aerial insectivorous bats to urbanization

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Urbanization is a dominant demographic trend throughout the world that involves massive habitat alterations. Understanding how urbanization affects biota is a crucial prerequisite for development and application of effective species conservation programs. Our study focuses on Neotropical high flying aerial insectivorous bats, an ecologically important but so far seriously understudied group of vertebrates. Using acoustic monitoring we assessed and compared species occurrence, composition, and activity of aerial insectivorous bats at three site categories: forest, urban areas and a forest-town interface in the Panama Canal corridor, Republic of Panama. In two years of field work, we recorded 44,744 bat passes over the microphone and identified a total of 25 aerial insectivorous bat species. Species richness was highest in the forest, decreased towards the forest-town interface and was lowest at the urban sites, while dominance (Berger-Parker-Index) increased. Overall, urban sites revealed lowest total bat activity (passes / min). Multivariate analysis suggests compositional differences in species occurrence and activity among site categories, indicating differences in the potential of high flying aerial insectivorous bat species to adapt to human-modified areas. Our results provide crucial baseline data for the assessment of vulnerability and adaptability of high flying aerial insectivorous bats to urbanization in the Neotropics with a clear demonstration of species-specific differences. Our results underline the necessity for detailed monitoring programs across multiple sites to assess species-specific habitat requirements and dynamics of species occurrence and activity over time in order to develop meaningful conservation tools targeted at aerial insectivorous bat species.
Structural heterogeneity affects bats occurrence and activity in Central European forest stands

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In the cultural landscapes of Central Europe natural vegetation cover is nowadays restricted to very small and highly fragmented areas, whereas most of the previously forested area is replaced by agricultural landscapes or forest plantations. Existing European forest stands, due to differences in tree species composition and management intensities, reveal striking differences with regard to their structural complexity. In spite of the importance of habitat structure determining the intensity of animals-habitat interactions, parameters describing three-dimensional arrangements within differently composed and managed forest stands and their canopies are lacking as those have been impossible to assess with ground based measurements. LiDAR (light detection and ranging) has become a source of geospatial data that can provide fine-grained information about the 3-D structure of forested landscapes. We evaluated an array of structural parameters derived from LiDAR and linked them with the occurrence and activity patterns of bats in differently managed forest habitats in the biosphere reserve Schorfheide-Chorin, north-eastern Germany. Acoustic monitoring was used to investigate the composition and activity of free-flying aerial insectivorous bats on 50 one-ha plots within differently managed forest stands. Bats were identified to species or genus level by the signature of their echolocation calls. Our preliminary results clearly demonstrate that general occurrence and activity of bats differs between different forest stands. In addition, we were able to correlate specific structural parameters such as canopy roughness, regeneration and bole zone with the activity of individual bat species. Based on our preliminary results, we argue that certain structural features of forest stands are reliable predictors of occurrence and activity patterns for bats. Hence, assessment of habitat features by LiDAR represent a powerful tool as it may allow predictions of habitat value in terms of bat occupancy and delivers base data for effective recommendations towards forest management in light of conservation issues.

Molecular phylogeny and systematics of Old World serotine bats (Eptesicus, Vespertilionidae)

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The bat genus Eptesicus (Vespertilionidae) is considered to be highly successful due to its worldwide distribution (except for Australasia) and the considerable number of species it contains. Nevertheless, the traditional morphological distinctions between taxa and relationships within the genus Eptesicus are still controversial. On the basis of mitochondrial (mtDNA) and nuclear (nDNA) markers and extensive sampling from England to Laos, we
analyse in this study the Western Palaearctic species of this tangled bat genus. We study on the identity of *E. serotinus* throughout its vast distribution from the Atlantic to the Pacific Ocean and in particular we focus on most of the taxa described from and around the Mediterranean Basin with the aim of resolving their taxonomy and evolutionary relationships. The results of our molecular approach support restoring the genus *Rhynochetos*icus and several forms of controversial taxonomical position – traditionally associated with *E. serotinus* and/or with *E. bottae* (e.g. *E. isabellinus, E. andersoni, E. turcomanus*, and *E. anatolicus*) – are supported as unique evolutionary lineages deserving recognition at species level. Some inconsistencies found between the resulting mtDNA and nDNA phylogenetic hypotheses suggest possible mtDNA captures by *E. serotinus* that deserve more in-depth studies.

The pipistrelle bats of Macaronesia: A phylogeographic approach

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The distribution and taxonomical identity of the bats of Macaronesia is still being revised from molecular backgrounds. Recent studies have confirmed the endemic consideration of several taxa and the close biogeographic relationships both among the different archipelagos and with the Palaearctic fauna. Two pipistrelle species are known from these islands: *Pipistrellus kuhlii* and *P. maderensis* being the first widely distributed across Southern Europe whereas the second is considered as endemic from Madeira and the Canary islands. In this study we analyzed the phylogenetic and evolutionary relationships of the two species of the island *Pipistrellus* using a sampling representing all the archipelagos and in relation to mainland populations from Morocco and the Iberian Peninsula. Our phylogenetic hypotheses are based on sequences of two mtDNA and one nDNA markers and were obtained under several phylogenetic reconstructions criteria. Additional distribution comments and conservation considerations will be presented.

Waiter, there’s a bat in my soup!

Implications of fruit bat as bushmeat in Ghana, West Africa

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Hundreds of thousands of fruit bats (*Eidolon helvum*) line the city streets of Accra, the capital city of Ghana. These bats live in the heart of the metropolis, seeming quite content to feed on cultivated fruits and orchards. However, this urban environment comes with certain risks: 41 hunters we interviewed killed almost 35,000 bats in one year in southeastern Ghana, and the 95 meat vendors we interviewed sold over 100,000 bats as food each year. These bats travel a complex commodity chain, and can be hunted over 200 km away from the market in which they are eventually sold. The commonly perceived increase in bat numbers in
Accra and corresponding perception of reduction in heavily hunted areas suggests that the densely urban city may actually provide protection against hunting, of which these fruit bats are taking advantage. Understanding the connection between humans and bats in these urban environments is vital to proper conservation as well as prevention and management of bat-borne zoonotic diseases.

Categorization of affect intensity and individuality within call types emitted during agonistic interactions

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The Indian false vampire bat (Megaderma lyra) uses several call types with distinct time-frequency contours in agonistic interactions, aggression calls, whistles and response calls. Previous studies have revealed that aggression and response calls reflect affect intensity in their structure. In addition, response calls carry individual-specific signatures. In the present study, we wanted to know, to what extent M. lyra is able to perceive these differences in call structure to evaluate the affect intensity of an agonistic interaction, or to discriminate between individuals. In a first experiment, we tested spontaneous reactions to aggression and response stimuli, typical for agonistic interactions of different intensities, or for different individuals. Then we conducted a reciprocally designed habituation-dishabituation experiment, using the stimuli of the spontaneous reaction experiment as dishabituation stimuli. A frame by frame analysis of the parameters duration to maximum deflection, holding time and duration of the return movement, revealed that spontaneous reactions for both call types and different intensities, of agonistic interactions, were similar. First results of the habituation-dishabituation experiment suggest that the bats may evaluate different affect intensities, and distinguish between different individuals, in response calls.

High activity enables life on a high sugar diet in nectar-feeding bats

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In mammals, chronically elevated blood glucose levels and postprandial glucose spikes caused by high sugar consumption are detrimental to health and life expectancy and are linked to serious diseases, above all diabetes mellitus. Neotropical nectar-feeding bats (Glossophaginae) however, are long-lived, despite a diet comprising vast quantities of sugar-rich floral nectar. It is unclear how these animals regulate blood glucose during high sugar uptake or whether they are able to tolerate high blood glucose levels. We conducted
glucose tolerance tests and investigated blood glucose levels during rest and activity in the nectar-feeding bat *Glossophaga soricina*. We show that after consuming a typical sugar meal, blood glucose levels of over 20 mmol l\(^{-1}\) are among the highest ever recorded in mammals and blood glucose levels were positively correlated with glucose uptake in resting bats. During activity however, blood glucose decrease was fast and negatively correlated with flight time. However, only when bats spent at least 75% of their time in flight blood glucose dropped to more usual levels. We argue that high sugar ingestion may oblige high flight activity and related energy expenditure and is essential to prevent deleterious levels of blood glucose arising from an extraordinary sugar-rich diet. We argue that high activity was selected for as a mechanism regulating blood glucose during the evolutionary specialization on plant nectar, while simultaneously increasing the bats efficiency as pollinators.

**Life history and sociobiology of bats**

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Bats are among the most diverse and most gregarious of all mammals. This makes them highly interesting for research on the causes and consequences of sociality in animals. Despite a dramatic recent increase of studies dealing with bat sociobiology, detailed studies on bat sociality are still rare, when compared with the information available for other social mammals, such as primates, carnivores, ungulates, and rodents. Modern field technologies and new molecular methods are now providing opportunities to study aspects of bat biology that were previously inaccessible. Consequently, bat social systems are emerging as far more complex than had been imagined. Variable dispersal patterns, complex olfactory and acoustic communication, flexible context-related interactions, striking cooperative behaviors, and more or less cryptic colony structures in the form of fission-fusion systems have been documented. I will review some of the recent studies on bat sociobiology and present studies of my own research group to highlight topics and open questions where I think bat research can contribute further to the understanding of animal sociality. I will focus on several central topics in behavioral ecology and evolutionary biology, such as dispersal, fission-fusion behavior, group decision-making, and cooperation.

**How affect the origin to thermal preference and hibernation period of *Myotis formosus* in Korea?**

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The phylogenetical position of *Myotis formosus* in the Ethiopian clade suggests that they probably secondarily colonized these areas from the Ethiopian region in the tropical zone, although the bat is currently distributed from Afghanistan to Korea in the temperate zone. We therefore speculated the relationship between the origin of the species and the strategy of hibernation such as thermal preference and hibernation period including the geographical distribution of *M. formosus*. In Korea, *M. formosus* hibernated from mid-October to late-May for about 220 days where absolutely maintained with warmer temperature (12.86±0.06 °C,
range 11.8–13.0 °C) and highest humidity (>95%). The body temperature \( T_b \) of hibernating bats was identical with ambient \( T_a \) and rock temperature \( T_{surface} \), with the thermal differences of less than 0.1. The bats lost about 20.5% (about 3.08 g) of their body mass of early-winter for the hibernation period and expended 0.0138 g per a day. The bats arrived to the hibernacula in mid-October when the external minimum temperature dropped below the mean roost temperature 13 °C and left when temperature was again permanently above this level on late-May. Our results suggest that the insight of overwintering behaviors of \( M. \) formosus is presumably affected by their unique tropical origin. This clearly restricts their distribution to regions where temperatures are warm and the availability of food is relatively constant. This seems to be the major factor which has allowed \( M. \) formosus adapt in the given environment with isothermal 12–14 °C. It also emphasizes the importance of evolution of TMR (torpid metabolic rate) as an adaptation of \( M. \) formosus linked to their distribution into the temperate zone.

Landscape and temporal variability of insectivorous bat assemblages in a Malaysian rainforest: Just what is a bat assemblage?

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Tropical bat assemblages are among the most species-rich and trophically diverse vertebrate assemblages in the world. They are both a source of inspiration for community ecologists, and, given the rapid loss of tropical habitats, a cause for concern for conservation biologists. Confounding both research foci are practical issues concerning the delineation of assemblages in both time and space. Few studies have addressed the spatio-temporal variability of bat assemblages, particularly that within contiguous undisturbed habitats. In this study, we used a standardized harp-trapping protocol to sample insectivorous bat assemblages at five study sites within the contiguous, undisturbed lowland rainforest of Krau Wildlife Reserve, Malaysia. The study sites were a minimum of 6 km apart, and comprised trail networks of 14 km (one study site with an irregular grid) and 22 km (four 1 km² study sites). Over a period of seven years, each assemblage was sampled four times. After standardization for weather, total trap effort exceed 6600 harp-trap nights and generated over 16,000 captures of adults of 31 species from six families. Estimated species richness varied slightly across spaces and time, but spatio-temporal variability in the composition of the assemblages was pronounced, underpinned by complex and asynchronous interactions at the species level. These findings have important consequences for our understanding of the processes determining assemblage structure, the design of diversity surveys, and the conservation of species-rich assemblages in the face of habitat disturbance and fragmentation.
Social behavior and vocalization of two cryptic bat species (*Pipistrellus pipistrellus, P. pygmaeus*) in the vicinity of their hibernaculum

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Fenology of vocalization and swarming behaviour were studied using bat detector in the only known winter roost in the ruins of Nový Hrádek (Podyjí NP, CZ) castle where *Pipistrellus pipistrellus* and *P. pygmaeus* hibernate in species-mixed clusters. Bats were also netted to check sex ratio and age structure of their populations. During winter censuses number of hibernating bats and proportion of banded individuals were monitored. Most of hibernating bats were caught in spring 2010 to find relative species proportion. Study was focused on (i) if both species could mate in the vicinity of hibernaculum and (ii) if vocalizing males of both species share same time and space during advertisement behaviour. The highest social and echolocation activity were found between second half of August and half of September. Peak of social activity moved from the second third to the first third of night. We did not find nor time nor space species segregation during advertisement behaviour. Numbers of banded bats were similar during all winter checks (usualy 10% of all hibernating bats). Higher proportion of *P. pygmaeus* in hibernaculum (40.4%) than observed that in acoustic recordings (18.2%) or in netted bats (5.2%) shows different mating strategies between both pipistrelle species. Males of *P. pipistrellus* vocalized close to the hibernacula, while males of *P. pygmaeus* probably defend their territories near nursery colonies.

Learned vocal signatures in a polygynous bat

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We studied vocal production learning in the neotropical bat *Saccopteryx bilineata*, which exhibits a complex social life in a harem based resource-defence polygyny with patrilineal kin groups and female-biased natal dispersal. This species has a large and well studied vocal repertoire. One social call, the isolation call, is mainly produced by pups in order to elicit maternal care but it is also used by adult males, either when trying to appease more dominant males while queuing for harem access or when courting females for the first time. Comparisons of isolation calls from pups belonging to different social groups revealed that isolation calls not only exhibited an individual signature but also a group signature that became more prominent during ontogeny. Genetic effects on individual or group signatures were not found. Isolation calls converged towards both the isolation calls of fellow pups and towards the territorial song of the respective harem male. This call convergence through social modification created a ‘social badge’ that reliably associated individuals to their natal colony. We hypothesize that in *S. bilineata* the potential benefits associated with
a learned vocal group signature are shaped by both intra- and intersexual selection, namely male resource defence and female inbreeding avoidance.

**Source levels of echolocation signals vary in correlation with wing beat cycle in landing *Eptesicus fuscus***

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Landing *Eptesicus fuscus* exhibit the same typical approach pattern as other bats, which is characterized by a switch from single echolocation pulses to groups with two, three, or more pulses when the bats close in on the landing site. Recordings of the echolocation signals with a two dimensional 16 microphone array revealed that the source level reduction, which varies from 4 to 9 dB per halving of distance between individuals, is superimposed by a source level variation of up to 12 dB within single call groups. This variation is in correlation with the wingbeat cycle. It is presumed that this variation may be caused by changes in the subglottic pressure due to the contraction of major flight muscles. The pause between call groups is centred at the middle of the downstroke and indicates inspiration. Call emission and likely expiration extends from the end of the downstroke through the upstroke to the beginning of the downstroke. The timing of call emission correlates with call group size. First pulses of groups containing many calls are emitted earlier than first calls in groups with fewer calls or single calls. Single calls and call groups are centred at the middle of the upstroke. This timing suggests that the emission of pulse groups follows a fixed motor pattern where the information gained from the preceding pulse group determines how many calls will be emitted in the next group.

**The use of natural and artificial bodies of water by desert and non desert species of bats***

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Natural bodies of open water in desert landscapes, such as springs and ponds, and the vegetation they support, are important resources for the survival of animals in desert environments. Man-made water sources, like waste-water treatment ponds and water reservoirs, may be equally important. The distribution of bats in desert environments may be affected by both local and regional parameters of natural or anthropogenic origin. For instance, the physical characteristics of the pond may affect the local distribution of bats, while the occurrence of natural and artificial bodies of water may affect their regional distribution. We studied these effects by conducting sets of field observations, manipulation experiments, and by comparing data on bat distribution in the Negev Desert from the past 70 years to current distribution records around natural and artificial ponds. At the local spatial scale, bat species richness and
activity levels significantly increased with pond size, while the period a pond holds water (a measure for its temporality) did not affect bat species richness. At the regional scale, we found that artificial ponds may act as stepping stones for the colonization of desert habitats by non-desert bat species, affecting the desert bat community composition. These results suggest that in desert environments, natural permanent and temporary ponds, in particular large ponds, support high levels of bat species richness. In contrast, human habitation in desert environments creates water resources that are mainly used by non-desert bat species, and therefore facilitates range expansion of non-desert species into desert environments. This process not only changes the desert bat community composition, but may also lead to competition with desert species.

Protection of bats in the Košice city (eastern Slovakia)

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Košice is the second largest city in Slovakia with approximately 250,000 inhabitants. The city is characterized by vertical panel houses. These prefab houses provide suitable shelters for many semisynantropic species of bats. The most numerous species of bats in the urban ecosystems of Košice are common pipistrelles (Pipistrellus pipistrellus), noctules (Nyctalus noctula), parti-coloured bats (Vespertilio murinus) and serotines (Eptesicus serotinus). Bats often get stuck in the spaces and structures of buildings. Then problems arise between bats and people in prefabricated houses. Our submission documents these cases and deal with conflict situations. Every year we handle tens to hundreds of cases of situations where the professional help of bat workers and volunteers is needed. In residential areas bats are often recorded after the reproductive season during autumn migration and during the hibernation period. When necessary, we provide primary care and veterinary care and we try to return the bats to the environment as soon as possible.

Genetic diversity of vespertilionid bats from West Africa – preliminary results

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Phylogenetic studies of the family Vespertilionidae in Africa were performed mainly with the use of morphological and cytogenetic approach and the interest was focused especially on populations distributed in the northern and southern parts of the continent. In the region of West Africa, the family Vespertilionidae (not considering Miniopterinae) is represented by more than 50 species belonging to 11 genera, but despite of that the information about
their phylogeny and genetics is very scarce. The aim of our project is to analyse the genetic diversity of bats of the family Vespertilionidae from Senegal (West Africa) for the first time and to increase the amount of the scarce data from the whole West Africa. The samples were collected during seven expeditions at fourteen collecting sites mainly at the area of the Niokolo Koba National Park in the southeastern part of the country. Standard Giemsa-stained karyotypes of 50 specimens provisionally assigned to seven genera (Pipistrellus, Hypsugo, Neoromicia, Vespertilio, Scottoecus, Myotis, Nycticeinops) were described. Sequences of cytochrome b mitochondrial gene from more than 200 specimens from Senegal together with published data were used for the preliminary phylogenetic analysis. Variations at the molecular and karyotypic levels were compared and certain specimens were chosen for the final analysis which will be performed with the use of one additional mitochondrial and two nuclear genes.

Bat fauna research of Paklenica National Park with special emphasis on altitude distribution

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The Bat Research Group of the Biology Students Association – “BIUS” conducted additional field research of bat fauna in the Paklenica National Park, Croatia in the period between 15–20 August 2009. Considering former substantial results from the 2008 surveys, as well as high abundance and biodiversity of bat fauna in Paklenica NP, this field research was conducted in the summer of 2009, with special emphasis on altitude distribution. The aim was to determine unrecorded bat species for the Park by now and to detect potential differences in the bat fauna at different altitudes, as well as corresponding habitats. The survey was conducted by setting up mist nets on four research points near water at different altitudes in different habitats (380 m, 480m, 680m and 1230m above sea level). As a result, out of 12 bat species recorded two were registered for the first time for the Paklenica National Park (Myotis bechsteinii, Miniopterus schreibersii). Most of the captures at the 380 m altitude corresponds to Hypsugo savii (59%, 39 individuals). This species capture percentage declines with increasing altitude and at the 1253 m altitude it wasn’t mistnetted. At 480 m altitude, most of the capture (73%, 46 individuals) corresponds to Nyctalus noctula while at the altitude 676 m the majority (62%, 27 individuals) corresponds to Nyctalus leisleri. Myotis myotis was recorded only at 1253 m above sea level at the same time being the majority of the catch (40%, 10 individuals).

Basal metabolic rate of male Myotis daubentonii in relation to microclimate, habitat location and group size

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The aim of our study is to relate differences in basal metabolic rate (BMR) to differences in behaviour and habitat utilisation of male Daubenton’s bats. BMR is a well-suited indicator for comparison of energy demands between individuals and species and is measured with indirect calorimetry. We investigated the relationship of BMR in male Daubenton’s bats to climate, food availability and sociality. As low environmental temperature lead to elevated O2 consumption, male Daubenton’s bats living in colder regions, i.e., highlands, should therefore have an elevated BMR. Preliminary results revealed that indeed males from the highlands tended to have a higher BMR than similar-sized males inhabiting lowland habitats. Investigation of four males from the highlands showed variations of BMR between 0.16 ml/min and 0.3 ml/min O2 consumption while the BMR of four males from the lowlands ranged between 0.09 ml/min and 0.13 ml/min O2 consumption. Our results suggest an association between habitat characteristics, namely temperature and BMR. Furthermore, we tested whether males living in habitats with low food availability have evolved other strategies in addition to torpor for saving energy, such as lowering their BMR. Sociality is also likely to influence BMR. Clustering of bats in large groups leads to saving of energy as there are reduced costs of thermoregulation for each individual. Therefore, males roosting in larger groups might have a lower BMR than individuals roosting alone.

Comparative diet analysis of the two sympatric European ‘trawling’ bat species, Myotis dasycneme and Myotis daubentonii

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In Northern Europe the distribution area of Myotis dasycneme and Myotis daubentonii, is overlapping and both species can be found hunting in the same habitat. To draw conclusions on possible coexistence mechanisms and community structure of both species, their diet was studied by analysis of a total of 323 faecal samples from caught individuals. In this study M. dasycneme and M. daubentonii feed mainly on Chironomidae (M. dasycneme: 44.4%; M. daubentonii: 32.8%) and Trichoptera (M. dasycneme: 20.4%; M. daubentonii: 22.2%), which is also indicated by Pianka’s index, based on similar prey composition and preferences, estimated with 0.97. Nevertheless, there are differences in the diet of both species (Adonis: F=2.69, P=0.026*), also shown through reciprocal Simpson index and NMDS. Five of the identified 17 prey categories were found in the samples of M. daubentonii only. For six categories a significant difference in the frequency could be detected. From the results of this study it can be concluded that although M. dasycneme shows certain parallels with M. daubentonii, they do differ in the amount of single prey groups. Thus this study shows no evidence for high resource competition for prey between M. dasycneme and M. daubentonii. A different distribution of both species in time and space within the hunting habitats as well as preference of different hunting techniques (aerial hawking vs. trawling) is a possible coexistence scenario. Additionally there is evidence for intraspecific differences in the diet. At least for M. daubentonii we could show dietary differences between sexes. For both species we could show seasonal differences in the time from may to august 2010.
On the taxonomic position of *Pipistrellus stenopterus*

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Despite huge progress in systematics of bats and in particular Vespertilionidae family in latest years, taxonomic position of number of remarkable bat species was uncertain till the present time, partly because of limited acceptable comparative material. So called “*Pipistrellus* stenopterus” by various authors was placed into *Nyctalus* (because of common adaptive features) or *Pipistrellus* (on the grounds of karyology) or even in *Hypsugo*. It was usually treated as a member of its own species group, but name of genus rank was not ever suggested for it. Morphological comparison of “*P.*” *stenopterus* with members of *Nyctalus*, *Pipistrellus*, *Scotozous*, *Glischropus* and *Philetor*, as well as with some other Vespertilioninae demonstrate that on the one hand it is most probably member of the tribe Pipistrellini, i.e. by complex outer incisors, type of lower molars and general structure of baculum. Meantime it possess unique cranial proportions, dental and bacular features, which distinguish “*P.*” *stenopterus* from all the mentioned genera. At least on the base of morphology, “*stenopterus*” species group should be considered a separate genus, no less distinct from *Pipistrellus* as *Nyctalus* and *Glischropus* are.

Current challenges in the taxonomy of Vietnamese *Myotis*

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The increasing volume of focused ecological and taxonomic surveys of Chiroptera in Vietnam has contributed to the enrichment of the bat species list for this country by over 20% during the past decade, with the present tally estimated at over 110 species. This was a result of both new zoogeographic records and descriptions of new species. Furthermore, recent genetic studies have shown cryptic divergence within currently recognized morphological species, suggesting that the taxonomic diversity of Vietnamese bats may be substantially underestimated. The genus *Myotis*, notorious for its taxonomic complexity, remains one of the prominent taxonomic “hot spots” both within Vietnam and beyond. Our studies involving combined morphological and molecular (DNA barcoding) approaches propose several avenues for further taxonomic enquiry. *M. siligorensis* species group shows genetic phylogeographic and ecological structuring, with one geographically restricted population recently described as a separate species (*Myotis phanluongi*), based on a combination of morphological, genetic and ecological characters. Closely related *Myotis annamiticus* and *M. laniger*, while being morphologically discrete, have nearly identical COI sequences, suggesting recent mitochondrial introgression. Finally, two common and broadly distributed species, *Myotis horsfieldii* and *M. muricola* s. lato, showed deep genetic splits putatively connected with differences in morphology and geographic ranges and thus cryptic taxonomic diversity. Further complexity is added by the fact that Indochinese specimens of the latter demonstrate some morphological differences from those known from type locality in Napat, indicating that “true” *M. muricola* may be absent from Vietnam.
Generating rich emission beams for echolocation

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The Intelligent Sensors Lab at Yale University has been incorporating bat-motivated sonars in robots for over 25 years. Our biomimetic research proceeds in two directions: We take clues from biological sonar strategies in order to guide our sonar projects, and we also determine sensing parameters that our robots need to complete a task in order to guide our probes into biosonar behavior. Videos will demonstrate sonar-guided robots that track moving objects, differentiate the head and tail side of a coin, guide autonomous mobile robots and build maps. We will describe recent results that employ neuromorphic processing of sonar spikes to classify landmarks during flight and that show how to generate informationally-rich sonar emissions.

Roost fidelity and dispersal in Cynopterus sphinx

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Dispersal is a process that has three components, leaving the natal site or social group (emigration), travelling across unfamiliar territory (transience, or the process of immigrating), and arriving or/and settling (immigration) into a new home range or social group. Genetic and demographic characteristics of individuals are significantly influenced by dispersal behavior. In mammals, male-biased dispersal is well documented. Social structure, mating system and resource are major factors which influences dispersal. Cynopterus sphinx has a harem-based polygynous social structure. Reports suggest that juveniles of both sexes disperse from their natal group. If juveniles of both sexes disperse completely from the natal group, where do they go? In an uniformly distributed resource, (a) what is the extent of male roost fidelity and (b) pattern of female aggregation? We addressed these questions by investigating the group composition, harem structure, roost fidelity, movements of adults and juveniles in C. sphinx through seasonal mark-recapture and weekly census data.

Advances in aeroecology: An emerging discipline

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Every so often in the history of science and technology, empirical discoveries, theory, and technological developments converge, making it possible to establish a new discipline. Aeroecology is an emerging discipline that embraces and integrates the domains of atmospheric science, animal behavior, ecology, evolution, earth science, geography, computer science,
computational biology, and engineering. The unifying concept that underlies aerocology as an emerging discipline is its focus on the planetary boundary layer, or aerosphere, and the myriad of organisms that, in large part, depend upon this environment for their existence. The aerosphere influences both daily and seasonal movements of organisms, and its effects have both short- and long-term consequences for those that use this environment. The biotic interactions and physical conditions in the aerosphere represent important selective pressures that influence traits such as size and shape of organisms, which in turn facilitate both passive and active displacements. The aerosphere also influences the evolution of behavioral, sensory, metabolic, and respiratory functions of organisms in myriad ways. The aerosphere has direct and indirect effects on organisms, which often are more strongly influenced than those that spend significant amounts of time on land or in water. Future advances in aerocology will be made when research conducted by biologists is more fully integrated across temporal and spatial scales with advances made collaboratively with atmospheric scientists, engineers, and mathematical modelers. Ultimately, understanding how organisms such as bats, birds, and arthropods aloft are influenced by a dynamic aerosphere will be important for assessing, and maintaining ecosystem health, human health, and biodiversity. Answers to questions related to seasonal patterns of prey density and distribution, foraging behavior, and migration have enormous potential to engage the general public.

Ecosystem services provided by bats

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The current and expected impacts of climate change, emerging diseases, invasive species, unsustainable harvesting of bush meat, water and air pollution, increased use of pesticides, and introductions of genetically engineered crops are among the most important issues facing humanity. Throughout the world, bats have long provided essential services to natural ecosystems by suppressing insect populations, pollinating flowers, dispersing seeds, and redistributing essential nutrients from terrestrial and aquatic ecosystems to caves that support unique and endemic invertebrate and vertebrate faunas. However, the expected effects of climate change and the myriad of anthropogenic factors influencing flowering times, fruit production, insect production and migration, bat migration and distributions, and bat population densities remain largely unknown. With these actual and expected anthropogenic influences, it is unclear whether bat populations and species can be sustained, as we know them, under different predicted scenarios. Will insect populations increase or decrease in abundance, or will they spread beyond or contract from their current ranges? Can complex cave ecosystems be sustained when organic input of guano from bats becomes reduced? Can tropical forest ecosystems be sustained if pollination and seed dispersal activities are altered? Insectivorous bats are important in suppressing insects that feed on agricultural crops and disperse pathogens, causing economic losses to agriculture in the millions of dollars each year. Understanding the dynamics of insect and bat migration, nightly and seasonal dispersal of bats, dietary habits of bats, and the economic impact of these and related ecosystem services largely remain an elusive goal. Given these uncertainties, it is imperative that bat conservation be a top priority in the bat research community.
Bat facial and lip projections: Unique integumentary morphology

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Faces of phyllostomid bats have been previously noted to have varied epithelial patterns of projections associated with lips and chins (aka warts, verracue, bumps, facial projections, etc.). These projections are also found on bats of other families; suggesting common morphological and functional features that are shared. Facial and lip structures have received some attention from naturalists being described as glandular, although distinct morphological and functional investigations are lacking. As a first attempt to characterize lip-associated and chin projections, we describe scanning electron and light microscopic and immunohistochemical studies of epithelial and sub-epithelial structures from various bats, including individuals from Phyllostomidae, Mormoopidae, and Vespertilionidae. Tissues examined were from specimens collected, fixed, and preserved for other purposes but nonetheless were useful in revealing some unique integumentary characteristics heretofore not described in the literature. Histomorphological preparations revealed common architecture and nerve tissue components. Scanning electron microscopic studies revealed another type of structure on the inner surface of lips that project into the buccal cavity. Histological preparations revealed hairless and glandless integumentary features, scalloped epidermal-dermal junctions with well-defined epidermal pegs and dermal papillae, and abundant epidermal undifferentiated nerve endings. Epidermal pegs near the dermal-epidermal junction contained numerous, presumably mechanosensory, Merkel cells, but the arrangements of nerve endings and cellular contacts need transmission electron microscopic clarification. The lack of muscular and glandular efferently-controlled tissue in the epithelia and undifferentiated nerve endings and Merkel cells in the epidermis suggest mixed sensory functions. Remaining questions include TEM analyses, behavioral correlates, and selection for such traits between taxa and diverse trophic groups.

Surveillance project: EBLVs in bats in Finland

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Bat rabies was suspected in Finland already in 1985 when a bat researcher who had multiple bat bites died in Helsinki. The virus isolate from the researcher was characterized and was shown to be related to rabies virus detected in bats from Germany and was later typed belonging to EBLV type 2. An epidemiological study in bats was conducted in 1986 with no positive findings. Passive rabies surveillance since that has not provided any indications of EBLVs in Finland either. The first rabies case in Daubenton’s bat (Myotis daubentonii), one of the most common bat species in Finland, was confirmed in August 2009. The bat was caught in a mist net and may have been agitated by an ultrasonic lure, which it had flown
straight at. The bat was passive, occasionally crying and biting when approached and subsequently tested positive for rabies. The virus was typed to EBLV2. Phylogenetic analyses showed that Finnish EBLV-2 isolates both from the human in 1985 and from the bat in 2009 were genetically very closely related demonstrating that EBLV2 may have been circulating in Finland for years. After the finding of the rabid bat an active sampling programme has been initiated. Focus of sampling is on the areas where the sick bat was found and on the other hand on areas where the deceased bat researcher had worked. The aim of the project is to collect data on the prevalence of EBLVs in bats in Finland.

Genetic structure of *Myotis daubentonii* populations from Finland – possible effects of organic tin compounds

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Although there is a great concern for the toxic effects organic tin compounds on aquatic species, little is known about the consequences of organic tin compounds along the food chain and how this chemical exposure affects genetic variation in natural populations. This study examines the genetic structure of Daubenton’s bat (*Myotis daubentonii*) populations from Finland and possible effects of organic tin compounds on the population structure and overall condition of the species. Daubenton’s bats were caught with mist nets and harp traps in three locales; the Finnish Archipelago, South-East coast and central Finland in the summers of 2008 and 2009. Forearm length, weight, sex and age were recorded and wing biopsies were taken for genetic analyses. DNA was extracted from the biopsies and genotypes were determined for 263 individuals using eleven microsatellite loci. Also samples from Spain, Switzerland and England were included for comparison. Organic tin compound concentrations were determined from fur samples from Finnish bats. Population differentiation was calculated and isolation by distance was measured both population and individual level. A general linear model analysis was conducted between internal relatedness, body condition and mean organic tin compound concentrations per sampling location were used. The colonies had a high genetic diversity and little structure despite organic tin compound concentrations, which were high in some of the Daubenton’s bats. The lack of clear genetic structure across the studied geographic area suggests high gene flow between colonies.

Toward a molecular phylogeny for *Molossidae* of Africa and Western Indian Ocean region

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We present phylogenetic information based on new nuclear Rag2 and mitochondrial cytochrome *b* sequence data for 6 genera of *Molossidae* (*Chaerephon, Mops, Mormopterus,*...
Otomops, Sauromys, Tadarida) and 15 species, primarily from Africa and the Malagasy region (Madagascar and neighbouring islands), and further include sequences of 17 mainly New World taxa sourced from Genbank. There is strong support for the monophyly of the Molossidae included in this study. The monotypic genus, Tomopeas, is the most basal member of the extant Molossidae. The Malagasy region taxa Mormopterus jugularis and M. francoismoutoui are supported as a basal clade with an age of ~31.2 MYR, and are not monophyletic with the South American form, M. kalinowskii. Asian Otomops wroughtoni and O. formosus and Afro-Malagasy O. martiensseni and O. madagascariensis form a strongly-supported ~19.8 MYR-old clade whose broader relationships among Molossidae are not clearly defined. There is strong support for a ~17.2 MYR-old combined Chaerephon/Mops clade, in which members of these genera show some paraphyly. The monophyly of the genus Tadarida, represented in our analyses by T. brasiensis from the New World and T. fulminans, T. aegyptiaca and T. teniotis from the Old World, is not upheld, although there is good support for a geographically-disjunct 9.8 MYR-old grouping which includes Chaerephon jobimena (Madagascar), Tadarida aegyptiaca (Africa) and T. brasiensis (America). Sauromys is maintained as a monotypic genus, although there is support for its association with Tadarida fulminans and the Chaerephon/Mops clade, the latter of which comprises M. midas, M. leucostigma, M. condylurus, M. bakarii, C. pumilus, C. pusillus, C. leucogaster and C. nov. sp. (eastern Madagascar). An ~18.37 MYR-old New World clade comprising representatives of Eumops, Nyctinomops and Molossus was well-supported.

Variation in declines of six hibernating bat species from White Nose Syndrome in eastern North America

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Variation in susceptibility to infection among species can provide valuable insight into the causes and consequences of emerging infectious diseases. White Nose Syndrome (WNS) is a poorly understood disease currently devastating bat populations in parts of eastern North America. WNS is thought to be associated with the newly described psychrophilic fungus Geomyces destructans, with documented infections in all six hibernating bat species in the northeastern United States. The greatest prevalence of infection from WNS has been observed in the north eastern U.S., with overall declines at hibernation sites ranging from 70 to 100%. Based on surveys conducted at hibernacula during pre- and post-WNS periods, the little brown myotis (Myotis lucifugus), northern long-eared myotis (Myotis septentrionalis), and tri-colored bats (Perimyotis subflavus) have shown the largest population declines. Substantial declines in northern long-eared myotis at hibernacula have caused serious concern among natural resource managers that this species may be in immediate danger of regional extinction. Despite its highly gregarious winter roosting habits, the Indiana myotis (Myotis sodalis) has experienced less severe declines as compared to little brown myotis, northern long-eared myotis, and tri-colored bats. The relatively rare eastern small-footed myotis (Myotis leibii) is found in a small number of hibernation sites, and while overall region-wide decline has been observed, the impact WNS on this species, as well as the relatively abundant big brown bat (Eptesicus fuscus), is not yet clear. Variation in disease susceptibility among the six species of bats affected by WNS in North America suggests that behavioral,
environmental, physiological, and immunological factors may contribute to differences in susceptibility to infection from *Geomycetes destructans*.

**Bat-like creatures engaged in high-altitude migratory and feeding or reproductive behavior over temperate landscapes in North America**

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Detailed observations using two instrumentation radars in three regions of the eastern United States (Vermont, Pennsylvania, Illinois) reveal a “biological background” of migrating insects and birds but also a different kind of high-flying animal distinguished by a suite of characteristics consistent with bats (Chiroptera). In one recording from a high-resolution thermal camera, the identification is clear. We attribute these radar echoes to bats for several reasons. They appear before dusk or at night and are sometimes tracked rising from low height around dusk as consistent with departure on nocturnal migration. In Illinois, they disappear in very early October. Radar-estimated body sizes and measured flight speeds are those of small flying vertebrates. Radar return during brief or extended (some over 30 min) recordings of these animals shows irregular, “fluttery” 8-10/s oscillations whose waveform differs from the minority of birds that beat their wings at such rates. Their wing beats never exhibit the common flap-coasting or bounding pattern characteristic of most species of small birds engaged in prolonged flight. The radars cannot detect targets near the ground but heights were in all cases well above the canopy, often hundreds of meters or up to a kilometer high. Some flight paths are straight, similar to long-distance migrating birds, but others are exceedingly convoluted, with sharp turns, rapid dips, and hovers suggesting feeding or reproductive behavior or both, at great height. These radar observations suggest that many, perhaps all, of these radar targets were migrating bats (e.g. *Lasiurus* and *Lasionycteris*; molossids are not known from these northern areas) but a few kinds of aerial-feeding birds (caprimulgids, apodids, hirundinids) cannot be ruled out. Tracking radar and radiotelemetry (using GPS technology, and radiotracking from satellites and aircraft) are the only technologies currently available that can provide insight into the airborne behavior of individual migrating bats.

**Bats in the Bratislava city, Slovakia**

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Bratislava, the capital of Slovak Republic, offers to bats a plenty of sites with suitable conditions for their life. The Bratislava territory spreads on the banks of Danube River in the altitude of 126–514 m above sea level. Besides urban elements, it is possible to find here also plenty of natural complexes at which the majority of them belong to the
protected landscape area Malé Karpaty. In total, 19 bat species were recorded in Bratislava territory (68% of the bat fauna of the Slovak Republic) during last 15 years. Most of them (12) were determined inside buildings or in crevices in blocks of flats. Mostly there were solitary individuals, but also maternity colonies of 3 species (Eptesicus serotinus, Pipistrellus pipistrellus, P. pygmaeus) and several winter colonies of Nyctalus noctula were found. The most frequently observed species inside buildings was Vespertilio murinus. Foraging activity of 8 bat species was detected also by bat-detector. The most frequent species were Nyctalus noctula, Eptesicus serotinus, Pipistrellus pygmaeus, and P. nathusii. During winter, some of bats hibernate in underground spaces situated in surrounding forest – in cellars (4 species), caves (5 species), old mines (6 species) and old military shelters (bunkers), where 10 bat species were observed. Some of them (Rhinolophus hipposideros, M. bechsteinii, Myotis nattereri) were observed in Bratislava territory only in this habitat type. From the beginning of the 20th century there are data about occurrence of Miniopterus schreibersii, Myotis emarginatus and Eptesicus nilssonii; nowadays, the occurrence of these species in Bratislava was not confirmed. The results confirmed that the Bratislava territory represents a heterogeneous area, suitable for foraging and shelter of bats.

“Noisy neighbours”: Does Chalinolobus tuberculatus alter its evening activity in response to aircraft noise?  
Darren Le Roux & Joseph R. Waas  
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The effects that anthropogenic disturbance may have on the behaviour of wildlife is of growing concern, especially in urban ecosystems where usable habitat is limited. Noise, like vehicle traffic, is a form of disturbance that can alter the behaviour of a diverse range of animal taxa. We investigated the effect of both real and simulated (playback) aircraft noise on the evening activity patterns of free-ranging long-tailed bats (Chalinolobus tuberculatus). Playback trials were conducted at two sites with known long-tailed bat residency: (1) 1 ha forest fragment within Hamilton City with low levels of aircraft noise; and (2) a 1.2 ha forest fragment near Hamilton International Airport with high levels of aircraft noise. Playback trials revealed no major change in the average number of foraging echolocation sequences or in-flight social calls recorded before and after simulated aircraft noise. There was also little difference between responses to aircraft noise and control sounds (i.e.: blackbird calls and silence). However, by examining the relationship between real aircraft noise and the foraging echolocation sequences recorded at the airport site, we found that bat activity was reduced during and after aircraft passes.

“A peculiar bat”: Are environment-specific adaptations of Mystacina tuberculata associated with changes to conserved genetic sequences?  
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The short-tailed bat (STB) is a species endemic to New Zealand and has evolved in isolation for ca. 80 million years. This bat has a combination of peculiar behavioural and
morphological adaptations that sets it apart from other bat species, including walking and crawling on the ground and a generalist ecological niche. In order to ascertain whether or not an accelerated rate of amino acid (AA) substitution has occurred in this distinctive bat, we sequenced exons of three highly conserved genes. The *Prestin* and *Connexin 36* genes showed a high degree of conservation with other mammalian taxa; however, exon 7 of the *Foxp2* gene showed a similar rate of ‘accelerated’ AA replacement as observed in other bat species. Exon 17 was more highly conserved, being identical to 11 of the 42 deposited bat sequences, plus many other mammalian taxa. At the DNA level, homology comparisons tended to support the AA analyses, but also indicated that the STB genome may be more similar to other mammals than to other bats. These data support the hypothesis of an ancient divergence of the *Mystacina* genus from other Chiropterans.

**Maximum glucocorticoid levels vary with feeding habit and habitat seasonality in two phyllostomid species**

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The ability to respond to stressors via the release of glucocorticoid hormones, such as cortisol, enables vertebrates to cope with challenging situations. In this study, we examined the maximum cortisol release capacity (CortMax) after injection of adrenocorticotropic hormone (ACTH) in two phyllostomid bat species. We asked whether feeding habits and resource abundance affect CortMax. We studied CortMax in the common vampire bat (*Desmodus rotundus*), feeding almost exclusively on livestock blood, and the short-tailed fruit bat (*Carollia perspicillata*), feeding primarily on Piper infructescences. Foraging success varies much more for vampire bats than for fruit-eating bats on a daily basis, but seasonally, resource abundance is presumably more stable for vampire bats than for fruit-eating bats. Thus, we predicted *D. rotundus* to reach a higher CortMax than *C. perspicillata*, since *D. rotundus* should be more prone to starvation. Furthermore, CortMax should be higher in *C. perspicillata* of the dry forest offering low resource abundance than for conspecifics in the rainforest. In contrast, CortMax should not vary largely between respective subpopulations of *D. rotundus*. We found that CortMax of *D. rotundus* exceeded that of *C. perspicillata* in both habitats. This high CortMax of vampire bats may reflect the species’ reliance on a food source which may not be accessible each night. Additionally, CortMax of *D. rotundus* was higher in the rainforest than in the dry forest. Possibly, it is easier for vampire bats to obtain blood meals in the cattle-rich dry forest area, resulting in a lower CortMax. In contrast, *C. perspicillata* showed a higher CortMax in the dry forest than conspecifics in the rainforest. This discrepancy might have been caused by the lower fruit abundance in the dry forest. Thus, resource abundance seems to modulate the glucocorticoid release capacity of bats depending on what they feed on and where they live.

**The complement pathway and oxidative parameters of *Myotis daubentonii*, possible effects organic tin contamination**

Thomas Lilley, Janina Stauffer, Mirella Kanerva, Tatu Hiltola, Veronika Laine & Mikko Nikinmaa
Organic tin compounds, such as tributyltin, have harmful effects on the environment and it is known that these compounds accumulate in the food chain. There are significant concentrations of organic tin compounds in the sediments of the Archipelago Sea, S-W Finland. Many bat species such as the Daubenton’s bat prey on emerging chironomids above the water surface. The larval-stages of Chironomids develop in the sediment and are therefore exposed to organic tin compounds during this life stage. Bats prefer to prey in the same area in each summer and they hibernate during winter. Organic tin compounds have been measured from bats and they bioaccumulate organic tin compounds because of their distinct lifecycle. The aim of this research was to determine how organic tin compounds affect the oxidative stress level of Daubenton’s bats. Oxidative stress occurs when the balance between reactive oxygen species (ROS) and antioxidants is disturbed. We also wanted to study if there is a correlation between oxidative stress and immunocompetence through the alternative complement pathway. Over 100 blood samples were collected from 13 locations in the Archipelago Sea, S-W Finland, to measure several redox enzyme activities. The determined enzymes were glutathione-S-transferase, glutathione reductase, glutathione peroxidase, catalase, superoxidedismutase and glucose-6-phosphatedehydrogenase. We also measured the ratio between oxidased and reduced form of glutathione. We determined immunocompetence by measuring the activity of the complement system from plasma samples. The complement system is a part of the immunesystem and it causes opsonization or lysis of the pathogen.

The effect of tributyltin on the complement pathway and oxidative stress level of *Myotis daubentonii*

Thomas LILLEY, Janina STAUFFER, Mirella KANERVA, Tatu HIITOLA & Mikko NIKINMAA

Organic tin compounds, such a s tributyltin, have harmful effects on the environment and it is known that these compounds accumulate in the food chain. There are significant concentrations of organic tin compounds in the sediments of the Archipelago Sea, S-W Finland. Many bat species such as the Daubenton’s bat prey on emerging chironomids above the water surface. The larval-stages of Chironomids develop in the sediment and are therefore exposed to organic tin compounds during this life stage. Bats prefer to prey in the same area in each summer and they hibernate during winter. Organic tin compounds have been measured from bats and they bioaccumulate organic tin compounds because of their distinct lifecycle. The aim of this research was to determine how organic tin compounds affect the oxidative stress level of Daubenton’s bats. Oxidative stress occurs when the balance between reactive oxygen species (ROS) and antioxidants is disturbed. We also wanted to study if there is a correlation between oxidative stress and immunocompetence through the alternative complement pathway. Over 100 blood samples were collected from 13 locations in the Archipelago Sea, S-W Finland, to measure several redox enzyme activities. The determined enzymes were glutathione-S-transferase, glutathione reductase, glutathione peroxidase, catalase, superoxidedismutase and glucose-6-phosphatedehydrogenase. We also measured the ratio between oxidased and reduced form of glutathione. We determined immunocompetence by measuring the activity of the complement system from plasma samples. The complement system is a part of the immunesystem and it causes opsonization or lysis of the pathogen.
Biodiversity, systematics, and conservation of bats from the Guianan subregion of northern Amazonia

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There are 148 species of bats documented from the Guianan subregion of northern South America, of which half belong to the family Phyllostomidae. The study area includes all of French Guiana, Suriname and Guyana, Venezuela south of the Orinoco River (Delta Amacuro, Bolivar and Amazonas) and Brazil north of the Negro and lower Amazon Rivers (northeastern Amazonas, Roraima, northern Para and Amapá). This represents most of the ancient geological Guiana Shield except for parts of eastern Colombia. Six species of bats are endemic, whereas 32 species are widely distributed and occur in all countries and states of the Guianan subregion. The main topographic feature is the Guiana highlands, a plateau above 500 m with flat-topped tepuis reaching 3,000 m in elevation, that has influenced the biogeography of bats in the region. The only species of bat endemic to the highlands (Platyrrhinus aurarius) has a recent origin from the Andes during the Pleistocene. For emballonurid bats, the Guiana Shield acted as a stable core area during taxon pulse diversification in the northern Amazon beginning in the Miocene. Savanna habitats appeared for the first time within the predominantly tropical rainforest and marine incursions from the Caribbean resulted in changing and heterogeneous paleoenvironments in South America. There are two species of bats in the Guianan subregion with conservation concerns on the IUCN Red List of Threatened Species. Lonchorhina fernandezi is endemic to the Venezuelan savanna on the western edge of the Guianan subregion and is listed as endangered because it is known from only two localities where cattle grazing is on the increase. Lonchorhina orinocensis also occurs in the Venezuelan savanna but extends further west into forested habitats of eastern Colombia. It is listed as vulnerable because of declining populations in habitats that are threatened with degradation.

Rabies and bat conservation in Europe

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Despite two fatal human bat rabies cases in the former Soviet Union in respectively 1977 (Ukraine) and 1985 (Russia) the occurrence of rabies in European bats was regarded as unimportant and not a potential danger for public health until 1985. However, since in autumn of 1985 a woman in Denmark was bitten by a rabies-positive Serotine Bat, Eptesicus serotinus, and a bat scientist in Finland died from rabies the interest to test bats for rabies started in several countries. Bat rabies became a new phenomenon for many public health authorities and rabies researchers in Europe. But bat rabies became also a new problem in the world of bat conservation. Bats are legally protected in most European countries and some international treaties and the national nature conservation legislations prohibit the deliberate capture and killing of bats except with permission by the competent authorities. However, bat rabies research is necessary to gain an insight whether bat rabies is a real problem for public health and whether bat conservation is conflicting with public health in some occasions. Therefore, it is important to know which species have prevalence for rabies and in which
incidence. Passive surveillance of bat rabies in grounded bats can give information about such prevalence but additional active surveillance is required to identify the real incidence of rabies in particular species in natural situations. Some bat species are dwelling in houses and other buildings where men are living and working. The Serotine Bat, the main carrier of bat rabies in Europe, is such a building dwelling species. This species generally roosts well hidden in cavity wall, eaves or other inaccessible places for men and pets, and occasionally and by accident comes into rooms of buildings. Therefore they are seldom in direct contact with men. The conservation of building dwelling species depends to a large extent into the tolerance of tenants and other users of buildings. The knowledge about the occurrence of bat rabies, the prevalence of rabies in bat species, and the possible risk for public and animal health is also important for bat conservationists to improve public awareness for bat conservation in conjunction with public health. There should be, therefore, a good co-operation between bat conservationists and rabies research and public health bodies.

Flight constrains maximum size in bats

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The size range of flying birds spans four orders of magnitude, from about 1.5 g to around 16 kg, pterosaurs ranged from about 4 g to possibly 100 kg, whereas bats weigh from 1.9 g to 1.5 kg. By contrast, the lower size limit is strikingly similar for all three groups of flying vertebrates. Why are there no bigger bats? Suggested factors limiting maximum size in bats include food choice, roosting place, echolocation, physiology (oxygen uptake, available muscle power), and morphology (strength of tendons and skeleton). The ability to fly opens up opportunities for the shaping of an animal’s niche but it also imposes constraints, one of which is that the maximum body size must be kept under a rather low limit, determined by muscle energetics and flight mechanics. The muscle power available for flight depends on muscle mass and wingbeat frequency. We here explore the possibility that the maximum attainable and minimum required wingbeat frequencies set bounds to the maximum size of bats. This, in turn, depends on morphological and physiological factors. Here we report on wingbeat frequencies of 44 morphologically diverse bat species, weighing 2.5–870 g, representing nine families. For these, the fitted (RMA) power function for wingbeat frequency versus body mass is \( f_w = 2.85 M^{-0.289} \). The exponent is strikingly similar to \(-0.27\) for the size-dependency among birds. The observed frequencies, together with biomechanical theories of power required and power available for flight, suggest a maximum size for bats of about 1.5–1.9 kg. The largest bats, extinct or extant, weigh around 1.5 kg, so they would have sufficient power margins for flapping flight performance and manoeuvrability. This suggests that the range of achievable wingbeat frequencies sets the upper size limit for bats.

Anthropogenic impacts on bat communities: Demography and biotic homogenisation

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Analysis of data collected in the French bat monitoring program (ultrasounds recorded during repeated random sampled car trips) showed strong patterns suggesting strong anthropogenic
impacts. Even in habitats of a priori low human pressure such as forests, comparison of bat densities and bat communities within Paris neighborhood (region Ile-de-France, 12,000 km² covering 2% of French territory and hosting 20% of French population), and a 150 km buffer around this same area showed strong differences. Densities regularly decrease from rural habitats to urban areas with a magnitude varying from 55% to 85%. Both urbanization and fragmentation are suspected to drive the results which are astonishing: while densities are much lower both in agricultural and forest habitats. Furthermore, biotic homogenization appears to be strong: species replacement already happens, with Common Pipistrelle (CP) representing in forests almost 90% versus 45% in the buffer area while community impoverishment as Shannon diversity index (all species except CP) is significantly higher in that same area.

New evidence for *Barbastella barbastellus* in the latest Pleistocene of northeastern Iberia

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This work reports a new fossil evidence of the Barbastelle *Barbastella barbastellus* in the late Pleistocene of northeastern Iberian Peninsula (Catalonia, Spain). A fragment of a right mandible from this species was collected in layer CE15 from Cova Colomera cave. This cave is located in the Catalonian pre-Pyrenean region, 670 m a. s. l. and it has archaeological and paleontological record ranging from the latest Pleistocene to the beginning of the Holocene (Middle Bronze Age). The earliest records of Barbastelle bats are from early Pleistocene sites in Central and Eastern Europe, being relatively common in the fossil record in European sites up to the late Pleistocene. However, *B. barbastellus* is an infrequent species in the fossil assemblages of Iberia, where it is has been recorded in a few late Pleistocene localities of southern Spain. The recently discovered remains from Cova Colomera cave adds a new fossil evidence of *B. barbastellus* in the Iberian Peninsula and this new record represents, for the moment, the northernmost fossil remains of this species found in the Iberian Pleistocene. Currently *B. barbastellus* in Spain is a bat species linked to temperate habitats with oceanic influence and mountain forests and it presence in caves in the latest Pleistocene was probably related with the use of caves as a shelter in cold periods. It would also probably the case of the presence of *B. barbastellus* in the Cova Colomera cave layer CE15 situated in one of the last cold beats of the Pleistocene (Younger Dryas or Heinrich Event 1), between 14,000–11,000 year BP.

Endoparasites of pipistrelle bats

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Bats are one of the most successful and diverse of mammalian orders, with an estimated 1100 species worldwide. Due to protected species legislation, studies that focus upon bat
endoparasites are limited. As such, many fundamental questions concerning bat-parasite relationships remain unanswered, including evolutionary aspects of such associations, host-parasite interactions and factors that may influence the composition of bat parasite communities. To further knowledge of bat parasitology, one hundred bats, that had either died of natural causes, or had been euthanized due to severity of injury, were acquired across Greater Manchester and Lancashire (England), between September 2005 and September 2008. Ninety three specimens were confirmed to be *Pipistrellus pipistrellus*, six to be *Pipistrellus pygmaeus* and one to be *Myotis mystacinus*. Development of PCR-based methodologies, coupled when possible with morphological analyses, confirmed the presence of the following microparasites (prevalence data in parenthesis); *Babesia vesperuginis* (23%), *Trypanosoma* spp (36%), *Bartonella* sp. (2%) and *Eimeria* sp. (20%), and the following macroparasites; *Lecithodendrium linstowi* (80%), *Lecithodendrium spathulatum* (20%), *Prosthodendrium* sp. (35%), *Plagiorchis koreanus* (29%) and *Pycnoporus heteroporus* (10%). Potential factors affecting the parasite community composition, including host sex and age, season, year, geographic location and parasite co-infection will be discussed. Bat genotyping analyses are currently underway, and this data is expected to provide further insight into the relationship between bats and their parasites.

**Ecology of bats in India: Synthesis for future directions**

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Bats are the second most speciose order of mammals and are under significant threat throughout the world. In India, bats were contemplated from ancient times either as good or bad. In this paper, we aim to summarize the current understanding about the bat ecology in the country with scientific analysis and perspective and emphasis on the need of advancement (i.e. the use of modern protocols and the latest techniques) to study them in their natural environment. At Present, 114 species of bats from 8 families and 8 subfamilies are known to occur from the Indian region. However, there is a lot of ambiguity regarding diversity and the taxonomy is observed to be in a flux. The total number of species listed between 105 and 123 among the studies. Here, we highlight the confusion behind this uncertainty. The diversity and affinities between bat species composition and the different biogeographic zones within India are analyzed using cluster analysis. We have also analyzed the studies conducted on the Indian bats from over 700 published papers. It is evident that majority of publications on bats in India belong to any of the three, taxonomic collection-description, bat behavioral studies in laboratory condition or physiological studies. Limited studies were conducted on the ecology of bats in their natural environment. Bats’ being crepuscular or nocturnal in nature, the research on bats is often hampered by methodological constraints. But in recent years, significant developments in the techniques allow us to study bats in their natural environment with minimum disturbances. A few studies initiated recently in that direction gives some hope. Inclusion of fruit bats as vermin and no reference of all other bats except two species in the Wildlife Protection Act of India, highlight limited knowledge and hence low concern about the bats in India.
Project PteroCount – an initiative towards the conservation of bats in South Asia

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Project PteroCount aims to create awareness about bat conservation issues, involve and educate biologists and nature-lovers in studies about the biology of bats, and establish a conservation action plan for bats of the region as an initiative in citizen science. This programme was initiated in January 2005 and presently focuses on one species, the Indian flying fox (Pteropus giganteus) as it is one of the most common and easily recognizable bat species in South Asia. As a first step, a readily accessible web portal was developed with detailed methodologies along with data sheets for compilation by citizen scientists and biologists across the region. Eighty volunteers from seven countries expressed their interests, out of which 45 people actively participated in the monitoring programme and also studied the roost site characteristics. Presently, close to 150 P. giganteus roosts in five countries (India, Bangladesh, Nepal, Pakistan and Sri Lanka) have been reported by the volunteers of Project PteroCount either directly or through publications. The intention of the project is to gather data on presence/absence, distribution of roosts, roost characteristics and affiliations, and trends based on ongoing interactions in landscapes and perceived threats. Initial analysis indicates characteristic population fluctuations based on behaviours as well as threats. Roosts exhibit significant associations with human habitations as well as water bodies, and population trends are not necessarily related to roost disturbances. Although categorized as vermin in the Indian Wildlife (Protection) Act, some roosts are accorded protection due to religious beliefs.

How did bat parasites evolved to successfully adapt to their hosts?

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Parasitism is one of the most successful modes of life. The transition to a parasitic lifestyle is associated to many advantages to parasites, which may include a stable environment, passive mobility, and a lower investment in nutritional functions. However, it also involves a variety of adaptive challenges that had to be met by parasites: In some cases they had to evolve ways to disperse between hosts that are often discontinuously distributed in space and time; they had to adapt to the frequent presence of potential competing parasites within the confined space of the host’s body; and had to balance the exploitation of resources of a host with the need to keep it alive. The main aim of this five-year research work was to determine how bat ectoparasites have overcome some of these challenges and successfully adapted to their hosts, using two temperate-zone cave dwelling bats (Miniopterus schreibersii and Myotis myotis) and its ectoparasites as model systems. We found that a group of specific bat ectoparasites, the nycteribiids, was able to overcome the spatial unpredictability of its hosts within caves by evolving efficient sensorial mechanisms to locate them from a distance. In addition, some parasitic mites, ticks and nycteribiids were found to deal with...
Effect of weather on the timing of reproduction and reproductive success in a colony of *Myotis daubentonii*

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Weather plays an important role in the timing of reproduction and overall reproductive success in organisms. We analyzed the impact of local weather on the timing of births and reproductive success in a single colony of Daubenton’s bats occupying an artificial roost in the South Bohemia, Czech Republic. The date of first births was best correlated with April mean temperature (N=16 years). That means time of onset of seasonal activity plays the most important role in the timing of births. Proportion of females that gave birth in a given year (reproductive success) was negatively correlated with cumulative summer precipitation (N=11 years). Threefold increase in summer precipitation may cause decrease in reproductive success of the colony by up to 50%.

One bushman and two quasi-villagers: Roost selection in three cryptic whiskered bats (*Myotis alcatheoe, M. mystacinus* and *Myotis brandtii*)

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Using radiotracking, we followed 27 Alcathoe bats, 9 Whiskered bats and 4 Brandt’s bats to their day roosts in order to compare roost selection of these three cryptic but not closely related species living syntopically in our study area (central Moravia, Czech Republic). Altogether, we found 65 roosts of Alcathoe bats, 27 roosts of whiskered bats, and 7 roosts of Brandt’s bats. While all roosts of Alcathoe bats were in a forest and outside human settlements, 10/27 and 1/7 roosts were located in buildings, mostly outside forest, in whiskered bats and Brandt’s bats, respectively. Alcathoe bats roosted most frequently in crevices in...
a tree trunk or side branches located high in the canopy, whereas the two other species rather used exfoliating bark. Roosts in buildings were most frequently located under roofing in whiskered and Brandt’s bats. Our data suggest that, among European species, Alcathoe bat is one of the very few true forest bats and its reluctance to man-made roosts makes him particularly vulnerable to recent habitat loss and intensive forest management.

Spatial activity and diet of *Rousettus aegyptiacus* in Cyprus: Does conservation of the only European fruit bat depend on supporting alien plants?

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During the recent decade the Cypriot population of the Egyptian fruit bats, the only European megabat, dramatically decreased and active conservation management is urgently needed. However, quite a limited information is available on details of its life history and ecology. Our study focused on spatial activity and food habits of three nearby colonies of fruitbats in mid summer and late winter when food supply is supposed to be particularly limited. Using radio-tracking techniques (both manual and automatic), we investigated spatial activity and food habits of 43 fruitbats (summer: 8 females, 11 males; winter: 9 females, 15 males). Distances to which bats travelled largely varied and reflected availability of food supply. In mid summer, most bats foraged on flowering century plants (*Agave americana*) and switched to figs (*Ficus carica*) as soon as they became available. Late winter diet consisted of dates (*Phoenix dactylifera*), fruits of Persian lilac (*Melia azedarach*), flowers of eucalypts, fruits of garden cultivar of common myrtle (*Myrtus communis*), mandarines and lemons. Dates were most preferred but largely unavailable in that period. The most striking finding was that all but one plant species consumed by bats in any period were non-native to the island and their occurrence was mostly restricted to waste grounds or to decorative gardens in built-up areas. Flowers of *Agave americana* seemed to be a very important food item in mid summer, however, its distribution is very patchy, number of flowering plants highly varies between years and its persistence in the landscape is dependent on good will of land owners as this plant is considered as alien and invasive plant in the whole Mediterranean region. Therefore, active conservation management of Cypriot fruit bats may include controversial practices, such as enhancing food availability in critical times of the year through supporting the occurrence of an alien plant species.

Climate change linked range expansion of *Pipistrellus nathusii*

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Pipistrellus nathusii undertakes an annual seasonal migration between eastern and western Europe. Using continued accumulation of new records in the UK, we assess the possible role that climate change may have on the distribution and occurrence of this species and predict how the suitable range may change given future climate projections. The habitat and climatic associations of *P. nathusii* were modelled across the United Kingdom. Using ‘first’ records, for the period 1940–2006, a climatic colonisation history was characterised and habitat associations assessed. The resultant combined model of climate and habitat suitability was used to predict potential range change over time (1940–2080). The ability of the model to predict new records was tested with records in the UK post 2006. The model constructed from records in the UK was applied to the species’ core European to test the model fit and assess the status of the UK with respect to the species historic area. Records were shown to be positively related to areas of water bodies and woodland and small areas of urbanisation and negatively related to area of peat / heath land. With respect to climate variables, records were associated with higher minimum temperatures, areas with low seasonality and intermediate rainfall. Modelled habitat suitability suggests that while small pockets of suitable areas have existed since 1940 there has been a continual increase in suitable area until present. The model had high predictive power when fitted to new records 2006–2010, AUC=0.70. Climate projections suggest there may potentially be a twofold increase in the suitable area for *P. nathusii* by 2050 in the UK. When applied to Europe the model had best fit to western areas of the species range where the *P. nathusii* is present during winter.

Elliptic Fourier Descriptors (EFDs) discriminate the echolocation calls of myotine bats

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Bats of the genus *Myotis* cannot be identified reliably using conventional acoustic analyses. Here we use morphology of echolocation calls to discriminate *Myotis* spp. This method may be used to identify unknown roosts to species level in the field. Echolocation calls of *M. daubentonii*, *M. mystacinus* and *M. nattereri*, were recorded in emergence flights from roosts. Images of echolocation calls were extracted for morphological analysis performed in SHAPE, a program that transforms two-dimensional outline data into Elliptic Fourier Descriptors. Species typical call shapes were described with Mahalanobis models. Discriminant Function Analyses (DFA) were applied with Mahalanobis scores of typical shape alone and with a spectral call parameter, maximum frequency. DFA achieved an overall correct classification rate of 88.9% using typical outline shapes alone. Correct classification of 100% of both *M. daubentonii* and *M. mystacinus* was achieved by both typical call outlines. For *M. nattereri*, 78.8% of calls were correctly classified by call morphology, but the addition of maximum frequency improved this to 95.8%.
From crevice to edge: Ecology of *Myotis brandtii* in a landscape cultivated by man

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Brandt’s bat belongs to one of eight mammalian species which in Germany fall into the category of highest conservation requirements. To enable an adequate management of roosting sites and foraging habitats of *Myotis brandtii*, we obtained data about phenology, roosting and activity pattern from two Bavarian maternity colonies in 2009. Additionally we radio-tracked 7 females to get information about the foraging habitats. The bats occupied their roosts, the attics of a chapel and a manor house, between the beginning of May and the end of August, with maximum colony size at the end of May. In both colonies more than 60% of the maximum colony size left the roosts during cold weather in June, lactating females included. In the roosts narrow crevices, characterized by low variations in temperature, were favoured by the bats. To reach their foraging areas in distances up to 7.6 km, the bats used strictly linear woody vegetation along small creeks and outskirts of woodlands as flight paths. Moreover, edge structures were also of great importance for foraging. More than half of the foraging habitats were characterized by edge structures. Other foraging sites included mixed woodlands of a diverse vegetation structure, water bodies and farms with cowsheds. Our observations have shown, that this species is able to adapt its hunting techniques to different environmental conditions in a landscape cultivated by man. Therefore *M. brandtii* can be considered as a relative unspecialized species foraging at various “edge-structures”, connected among each other and with the roosting site by linear landscape elements.

Future scenarios caused by climate change on bat species from the Brazilian Cerrado: What if the species are not able to move?

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Future scenarios caused by climate change on bat species from the Brazilian Cerrado: Climate change is a frequent event on Earth’s history. At least four of these events have occurred on the last 200,000 years. Perhaps the most cited is the one that happened in the end of the Pleistocene, only 20,000 years ago. There are records of large mammals showing that some species tried to follow such climate change by moving their geographical, but they have failed. Nowadays another climate change event is about to occur, but the timeframe is projected to happen in a few decades. Will the species be able to change their geographical ranges? What if they do not? By using ecological niche models we mapped distribution patterns of 120 bats species that occurs in the Brazilian Cerrado and compared them with maps reflecting future condition (Scenario A2 for 2050). We evaluate the situation where species will not be able to change their geographical distribution against future scenarios where species will be able to move to suitable regions. Our results indicated that bat species will find similar future climate conditions in average 480 km apart from their current...
regions. For the majority of the species, these regions will be located in the South and to West. For two bat species there will be no future suitable condition in the Cerrado. For 96 species we can expect to have a significant contraction on their distribution (41% of actual distribution in average) due to climate change. We don’t know for sure if species like bats, with a relative ability to flight over large regions, will be able to support such rapid climate change. However, the urgent adoption measures to conserve natural areas and to restore degraded areas may increase their chances of surviving in the future.

Insectivorous bat activity in habitats with water bodies in central and south Mexico

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Insectivorous species represent nearly 70% of the Mexican bat fauna. However, information of the biology, habitat use and ecological role of this guild is scarce. We urgently need to determine which habitats are critical for insectivorous bat species in Mexico in order to conserve biodiversity and secure their effective roles in the ecosystems. Insectivorous species habitat use was monitored with ultrasonic equipment in various habitats in central and southeast Mexico, some associated to water bodies such as riparian vegetation and vegetation associated to ponds. We also sampled in forested sites. In the centre of Mexico, species of Mormoopidae showed greater activity in comparison to other families. In the south of Mexico, emballonurids showed the greatest activity. Habitats near water were the most important foraging habitat for insectivorous species (considering the high number of feeding buzzes) in comparison with habitats without water sources. We detected the foraging activity of 16 species of four families at habitats with water. Conservation of the water sources and the vegetation associated to these is a high priority to conserve bat diversity and allow movement of insectivorous bats across the landscape.

Habitat and morphology of emballonurids in Pakistan

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We captured eleven specimens of the naked-rumped tomb bat (Taphozous nudiventrous) and four specimens of the Egyptian tomb bat (T. perforatus) from Moijgarh village (N 29 01.132, E 072 08.427) and Derawer Fort (N 28 46.075 E 071 20.040) in Bahawalpur district and from outskirts of Ratwal village (N 33 28.644, E 072 43.638) in tehsil Fateh Jang of Rawalpinidi district. Of these fifteen, eleven were T. nudiventrous and the remaining were T. perforatus. Standard body measurements of all the specimens were made and compared using ANOVA. Ear length in three populations of T. nudiventrous varied significantly (F=5.47; df=10; p <0.05). Females T. nudiventrous (17.0±1.414 mm) had significantly longer ear than males (13.222±1.716 mm) (F=8.22; df=10; p<0.05). Taphozous perforatus were a new record from these areas.
Understanding the impact of shared evolutionary history on echolocation call design

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Fundamental questions about the evolution of echolocation in bats have yet to be answered, particularly in the light of recent molecular phylogenies. The structure of the echolocation calls used by different species varies widely despite their broadly similar aim. To investigate the evolutionary processes leading to this call variation I have built a worldwide echolocation call database, EchoBank, which contains 300 species from 100 genera and 18 families, collected from 15 echolocation researchers. Using a new supertree of the bats and phylogenetic comparative methods, I consider the influence of shared evolutionary history and environmental conditions on bat call structures at different taxonomic levels.

Advances of the Colombian chiropterology, biodiversity, ecology, and conservation

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A synopsis of the current state of the Colombian chiropterology is presented, with especial attention to the most recent advances in bat systematics, biogeography, and conservation. Although chiropterology as a field has experienced a great deal of advance during the last two decades in Colombia, large gaps of information for extensive portions of the country are still present. In addition, bat species natural environments in areas of high diversity in the country are under continuous threat of different natural anthropogenic pressure such as deforestation and global warming. Bat conservation issues in Colombia have tremendous implications since recent revisions of the bat families Phyllostomidae and Emballonuridae place Colombia as the most diverse Neotropical country in terms of number of species followed by countries with greater geographic areas and an older tradition of chiropterological studies. Colombian bat fauna is under the historical influence of the bidirectional exchange of fauna between North and South through the Panamanian Isthmus and in the influence of putative centers of bat speciation in South America, Central America, and the Caribbean. Another component of the Colombian bat diversity is the presence of the mountainous System of the Andes, which has promoted the subdivision of the Colombian chiroptera fauna into five natural regions (Amazon, Andean, Caribbean, Orinoquia, and Biogeographic Chocó), each one characterized by unique ecological conditions that has resulted in documented processes of allopatric speciation. Based upon the analysis of distributional patterns among members of the families Phyllostomidae and Emballonuridae in Colombia we defined areas of priority of bat conservation for each one of the bat natural regions of the country and point on the taxonomic groups that deserve special systematic attention in Colombia.
Control of livestock paralytic rabies in eastern Mexico: An innovative scientific research-based approach

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The Pan-American Health Organization (OPS) considers that rabies transmitted by the hematophagous bat Desmodus rotundus is a growing problem in Latin America for its strong economic and public health impact; in this region, rabies kills both animals and people. Nevertheless, current rabies control campaigns are hindered by serious difficulties related to poverty and low cultural and educational levels. It is, therefore, essential that these campaigns assume an interdisciplinary holistic approach. Since 2009, the State of Puebla Rabies Control Program has implemented this approach and is consolidating an inter-institutional group formed by ecologists, biologists, conservationists and veterinarians, all specialized in bats and rabies. The group has already generated a rabies control model based on social, epidemiologic, virologic and molecular tools. This model has been shaped according to technical scientific criteria resulting in a substantial improvement of the epidemiologic monitoring and control systems, anticipating outbreaks and planning suitable response actions. Additionally, they have developed educational strategies, information and social participation programs, and sanitary trainings for local people to control vampire bats and protect benefic species. The model involves: (1) Surveillance of the different bat species present at the time of livestock rabies outbreaks. (An initial epidemiologic surveillance has been conducted on 113 non-hematophagous and hematophagous bats – 4 families, 7 genera.) (2) Identification of high-priority foci for preventive control, based on the results of spatial predictive models. (3) Vaccination and sera sampling of workers exposed to cattle rabies or in the capture of bats in order to verify the adequate rabies neutralizing antibody titers. (4) Informative and educational videos directed to the exposed population. The model is first being implemented in Mexico, but later will be proposed to other Latin American countries. So far, the results have confirmed that multidisciplinary approaches are needed to understand rabies ecology and to develop holistic preventive health programs in rural communities.

The sympatry of Miniopterus schreibersii schreibersii and Miniopterus s. pallidus in three caves: The smoking gun for their elevation to full species status

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Miniopterus schreibersii is a complex, polytypic group with a wide natural distribution ranging from Southern Europe to Asia, Northern Africa, the Solomon Islands and Northern
Australia. In Turkey, two cave-dwelling subspecies have been recognized, *M. s. schreibersii* and *M. s. pallidus*. Research in the last decade within Anatolia showed that the populations of *M. s. schreibersii* and *M. s. pallidus* were differentiated from each other in nuclear and mitochondrial DNA, and morphology. These results suggested that the subspecies could represent different taxa, possibly species. However, as their distribution has been found to be primarily allopatric, and individuals of *M. s. schreibersii* and *M. s. pallidus* were never found in the same cave in sympatry, it has not been possible to elevate taxonomic levels of these subspecies to species. Here we present discovery of three caves, on the eastern Mediterranean coast of Turkey, where the two subspecies have been discovered in sympatry for the first time. These findings provide the final line of evidence, the smoking gun, for designation of *M. s. schreibersii* and *M. s. pallidus* as two separate species, *M. schreibersii* and *M. pallidus*.

**Availability of food for frugivorous bats in Neotropical rainforests: The influence of flooding and of river banks**

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The availability and distribution of food resources are important factors shaping foraging strategies and habitat utilization by bats. We studied the importance of seasonal forest inundation and of river bank vegetation in the availability of fruit resources for frugivorous bats in a lowland Amazonian region dominated by a mosaic of terra firme and two types of flooded forest – várzea and igapó. Sampling the bat community, fruit abundance, and bat diet at 10 sites representative of these three types of forest we (i) determined the guild structure of frugivorous bats, (ii) identified differences in food availability among forest types, and (iii) determined the importance of river bank vegetation to provide food for frugivorous bats. We found two distinct frugivore bat guilds in both terra firme and flooded forests: (1) canopy frugivores, feeding mainly on *Ficus* and *Cecropia* fruits, and (2) understory frugivores that feed mainly on *Vismia* and *Piper*. Fruits consumed by the canopy guild were most abundant in the flooded forest types, particularly in the nutrient-rich várzea, and in both flooded forests they were particularly abundant along stream banks. In contrast, fruits that dominated the diet of the understory frugivore guild were more abundant in terra firme that in the flooded forests. Fruits of *Vismia*, a key resource for several species of this guild, were also particularly abundant along river banks. We conclude that fruit availability for bats varies substantially among forest types, but the pattern of this variation is different for bats of the canopy and understory guilds. The observed differences in fruit abundance may explain variations in the species composition of the bat assemblages of the three forests. Finally, river banks, which are often under particularly heavy human pressure, seem to be very important for providing food for bats of both guilds.

**Cranial morphological diversity of Desmodus rotundus in Central and South America**

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The common vampire bat, *Desmodus rotundus*, is a species with a wide geographical distribution that occurs in a wide variety of habitats. A recent phylogeographical study using a mitochondrial marker described a scenario where this species is formed by five distinct geographically circumscribed mitochondrial clades that became separated in early to mid Pleistocene. The degree of genetic divergence between these clades for the marker used was unusually high for bats and suggests that this taxon could be formed by more than one species. Here we studied the cranial morphological variation of the common vampire bat to assess the amount of subdivision within this species and to test for the possibility of distinct morphological patterns associated with geographical lineages. We used 16 measurements from 1581 complete adult *D. rotundus* skulls representing 226 localities in South and Mesoamerica. Ward’s clustering method of Mahalanobis distances presented a pattern with three distinct clusters, similar to the one obtained by the molecular study. On the other hand, discrimination functions yielded very low percentage of correct classifications in three different hierarchical levels. A significant correlation was found between Mahalanobis distances and linear geographical distance, which coupled with the discrimination function is compatible with a scenario of isolation by distance process of morphological differentiation. We conclude that *D. rotundus* cranial morphology does not corroborate the previous suggestions that this taxon is formed by more than one operational taxonomic unit (OTU).

Flight activity of migratory bats on Estonian coasts

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During five seasons (2005–2009) flight activity of migratory bats was measured in Estonia. 20 counting points (CP) were chosen on five coasts (4 points on each coast), each point either on straight shoreline or riverbank close to the shore. Nighttime counts were carried out during the peak of late-summer migration in late August and early September, always in relatively good weather (low wind, air temperature at least +7 °C). Bats were counted and identified using Pettersson D240 and D240x detectors. At CPs the observer stood about 5 m away from shoreline or riverbank and counted bats heard from the detector. At each point counts lasted for 15 minutes; additional time was used to make sound recordings for species identification. On the basis of counts a flight activity index (FAI, the number of bat passes per 60 minutes) was calculated for each species, each coast and, cumulatively, for five coasts. In three migratory species (*Pipistrellus pipistrellus*, *Vespertilio murinus*, *Nyctalus noctula*) no more than only one pass (of either one or several individuals) was observed during a single minute of count. But in *Pipistrellus nathusii* sometimes several passes were recorded during a minute, which in this species resulted in higher FAI values compared with other species. During the five-year period the following cumulative FAI values were received from each species (min, max, mean; all coasts together): *Pipistrellus nathusii* (5.6, 19.8, 12.56), *P. pipistrellus* (0.0, 3.0, 0.88), *Vespertilio murinus* (1.4, 4.8, 3.40), *Nyctalus noctula* (0.8, 2.0, 1.16). The following FAI values were recieved from different coasts (min, max and mean of the five-year period; all species together): (1) southwestern coast (0.8, 13.2, 6.20); (2) northwestern coast (0.4, 2.4, 1.72); (3) northern coast (0.0, 3.6, 1.20); (4) eastern coast (4.0, 16.4, 7.88); (5) Saaremaa coast (0.0, 2.2, 1.08).
Can organic farming help to conserve bats?  

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Agricultural intensification has been linked anecdotally with population declines of many bat species. While organic farming is often seen as the antithesis of modern ‘industrial’ farming, it remains unclear whether any benefits to biodiversity relate to system differences (particularly the lack of synthetic chemical inputs rather than to differences in the amount and management of non-crop habitat). We compared bat activity on 65 organic and non-organic farm pairs in the UK, and explored the effects of both system and habitat. Bat species diversity was higher on organic farms, reflecting the greater diversity of habitats on organic holdings. There was also a general trend for higher bat activity on organic farms. The associations between bat activity and key habitat variables differed between the systems: whereas bat abundance increased with the availability of hedgerow and water on organic farms, these associations were not seen on conventional farms, possibly indicating differences in the quality of these habitat features between the systems. It is likely that some of the apparent differences between organic and conventional farming systems are due to off-farm influences. The mosaic of habitat surrounding the organic and non-organic farms differed, and predicted bat activity. Importantly, we also found that the differences in bat activity between conventional and organic farms were modest; and the levels of bat activity on all farms were low. Organic farming therefore does not offer a simple panacea to the decline in bat populations. We suggest that the transfer of hedgerow and waterway management techniques to conventional farming, and an overall increase in the number of ‘mixed’ rather than purely arable enterprises would be likely to yield benefits.

Development of vocalization and social communication in a free-ranging nursing colony of Hipposideros turpis  

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*Hipposideros turpis* is the only hipposiderid bat native to Japan. A long-term mark-recapture study in a nursing colony of this species has been conducted since 1983 on Iriomotejima Island, Okinawa Prefecture, Japan. There is great individual variation in the vocal signature of the attractive calls of new-born infants, which consist of one- or two-note syllables. The fundamental frequency of each note ranges 15–20 kHz and consists of 4 harmonic components with a maximum frequency of up to 80 kHz. Each infant repetitively emits its attractive call and, during growth, the fundamental frequency of each call increases, especially at the second note of two-note call of the Frequency Modulation (FM) type. Every night after foraging, the mother comes home and collects her own infant which has been left on the ceiling of the cave. Before the reunion for nursing, the mother touches the infant making it bark; this confirms by voice whether it is her own baby. At each reunion, the infant emits attractive calls and the mother emits intensive echolocation type calls. By the age of three weeks, infants developed to emit pure-tone type calls of 75–77 kHz, but the fundamental harmonic, which is a feature of the immature type of call, remains. The social
call of adults recorded in the nursing roost are mostly warning calls, which consist of a series of graded signals reflecting different degree of warriness. Clear differences were found in vocal character of these calls; (1) a harsh bark of low frequency (8~24 kHz) appears to be an urgent warning; (2) an FM type of call of long duration appeared to denote the need for caution; and (3) a rhythmic FM type call (trill or chirrup) appeared to denote a middle range of warning. These finding demonstrate that the vocal activity of this species is high and that vocalization is closely related to different phases of social contexts.

Report on fossil bats from Mumyo-Ana Cave, Akiyoshi-Dai Plateau, Yamaguchi Prefecture, Japan

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Akiyoshi-dai Plateau, having an area of 54 km², is the largest karst in Japan and about 400 caves have been found there. We guess that Mumyu-ana Cave, which is located on Akiyoshi-dai Plateau, is one of the old caves (high-level lime stone cave) connected to the Shuho-do Cave, the largest in that area. We found a layer contains small fossil bones on trench survey in Mumyou-ana Cave. The layer consisted of bat fossil bones and minute grains of clay. It was found under the hard travertine-covered floor at the cave entrance. The thickness of the layer is estimated to be 20~50 cm. It runs horizontally or slightly diagonally along the direction of the floor. Because the bones are horizontally piled, we assume that the layer was formed in a pool within the cave. The fossil bones are very well preserved. The fossil bats found in this layer belong to the following species: Myotis akiyoshiensis, Murina sp., Barbastella sp., Plecotus sp., Rhinolophus sp. and Miniopterus sp. Their form and the size of their various body parts (mandible, humerus, teeth, scapula etc.) are different from those of the species now inhabiting Japan. We herein report on the dimensions of the fossil bones as well as their form. Especially we could find the fossils of the mandible with all teeth as well as upper jaw of Myotis akiyoshiensis described as new species only humerus bones.

Emerging infectious diseases as an opportunity for bat conservation

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Rather than a threat to efforts for the conservation of bats, or at best a factor that “muddies” the message, I argue that the increasingly recognized associations of bats with numerous important and high-hazard pathogens of humans and livestock should provide opportunities for enhancing bat conservation. As recognized and addressed in the “One Health Initiative” http://www.onehealthinitiative.com/, human health, animal health and environmental health are inextricably linked – and will continue to be more so into the future. Many of the impacts that drive concerns for bat populations (e.g. fragmentation of populations, habitat degradation and encroachment of humans and livestock, “bushmeat”, illegal trade in animal parts, climate change) are demonstrably the same as those implicated in the movement of pathogens across species lines. Thus, efforts to protect public health and efforts for the conservation of
bats should not be in opposition, but should proceed hand-in-hand. Failure to do so is not an option; if public health concerns and efforts to conserve bats are in opposition, public health always will trump bats. The association of bats with emerging infectious diseases is receiving increasing public attention and increasing attention from well-funded agencies that are charged with protecting public health. If properly positioned, efforts to conserve bats can only benefit from a holistic, collaborative approach with highly visible, well-funded partners.

Dispersal of *Eumops* into the Greater Antilles: Impacts of Pleistocene sea level fluctuations

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The eustatic minima hypothesis has been used to explain diversification of bats in the Greater Antilles, although data pertaining to species that have a mainland origin is lacking. Bats of the *Eumops glaucinus* complex include a Pleistocene invasion into the Greater Antilles that is useful for testing this hypothesis. Here, we estimate divergence times between the islands and mainland using a coalescent approach and compare these results to sea level fluctuations over time. Relaxed molecular analyses indicate an early Pliocene origin of *Eumops glaucinus* complex with the intraspecific diversification events coinciding with the Pleistocene epoch. Results indicate that divergence times correspond to periods of low sea level during the Pleistocene. Eustatic minima during three Pleistocene glaciation events could have allowed *Eumops* to colonize Florida and the Greater Antilles. The first event resulted in the divergence of *Eumops* from Cuba, Jamaica, and Florida from a mainland common ancestor ~2.7 MYA. The next abrupt drop in sea level resulted in the divergence *Eumops floridanus* and *E. ferox* from Cuba and Jamaica from a common ancestor ~1.9 MYA. The final sea level drop resulted in the recent divergence between *E. floridanus* and *E. ferox* from Cuba and Jamaica ~1.1 MYA. The arrival of *E. floridanus* to Florida corresponds with fossil dating. Additionally, we found evidence for secondary contact between *E. floridanus* and *E. ferox* from Cuba that corresponds with a drop in sea level.

Physiological ecology of migration and stopover in North American tree bats

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Many species of bats make long-distance latitudinal migrations (>1000 km) between their summer and winter grounds. Extended periods of high intensity exercise (as in migration) may result in physiological and biochemical changes to meet the increased energetic demand. We tested this hypothesis by comparing body composition and organ size plasticity in summer resident and migrating hoary bats (*Lasiurus cinereus*). Furthermore, for nocturnal migrants it is not possible to complete a >1000 km migration in a single bout. Bats must stop along the way, whether to rest and refuel or simply to avoid diurnal periods. We used an automated digital telemetry array to study the stopover duration, movement patterns, roost selection and departure direction of migrating silver-haired bats (*Lasionycteris noctivagans*) at a geographic barrier (a
peninsula on the north shore of Lake Erie) during fall migration. For the same bats, we used quantitative magnetic resonance body composition analysis to measure fuel stores. Using the telemetry and body composition data, we developed some simple models to generate predictions about migration rate and the overall energetic cost of migration. Preliminary assessment of the models suggests that bats may accomplish their migration more efficiently than similar sized birds. Taken together, the results of our analyses suggest that migration may not be as energetically stressful to bats as may be predicted from the results of bird migration studies.

Roads and bats: Landscape, road features and bat ecology effects on road kills and activity

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Recent studies suggest that roads can significantly impact bat populations. Thought bats are one of the most threatened groups of European vertebrates, scientific information is still lacking to determine the main driving factors causing this impact and to effectively mitigate it. We daily surveyed road killed bats in 52 km of three roads with different traffic volumes in southern Portugal, between March and October 2009. We collected 154 bat casualties of 11 species of which Pipistrellus kuhlli and P. pygmaeus represented 64% of total specimens collected. We also found threatened and poorly known species conservation status: Barbastella barbastellus (3), Rhinolophus ferrumequinum (1) and R. hipposideros (5). A peak of mortality occurred mostly in late summer and early autumn. Males were killed more often than females, except in June, and juvenile mortality was a small percentage of total kills (approx. 16%). During the same period we also monitored bat activity in the study area and found a strong positive relationship between core activity areas and the hotspots of bat mortality. The relationship between total bat fatalities and different types of explanatory variables (landscape, bat ecology and road features) was assessed through generalized linear models (GLM) and variance partition techniques. Overall, landscape features were the most important variable set in explaining bat mortality (about 26% of variance), followed by road characteristics. The greatest incidence of casualties was recorded at places where roads crossed high quality habitats, (e.g. Mediterranean evergreen oak forests and water courses with developed vegetation gallery). Nevertheless, distance to known roosts, bat activity and traffic volume also had a significant influence on mortality. Concerning activity data, we found no clear evidence of road avoidance by bats. The importance of these findings for the correct management and implementation of effective mitigation measures of bat road kills will be discussed in this communication.

The effect of bark beetle infestation and salvage logging on bat activity

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The removing of disturbed forest stands after natural disturbance – salvage logging - releases many controversies. To investigate the impact of natural disturbance and salvage logging
we measured bat activity (28,971 records) at 32 plots during 221 all night surveys at beetle affected, salvage logged, one-storied and storied forest stands in a temperate mountain forest using batcorder 2.0. We used a generalized linear mixed model with multivariate normal random effects, to analyze the impact on foraging behaviour of different bat guilds. In our study salvage logging has a negative impact on the group of highly cluttered habitat (foliage gleaner) preferring beetle affected forests stands, while salvage logged areas were avoid. Furthermore salvage logging has no impact on the guild of uncluttered habitat (*Eptesicus nilssonii*, large Nytaloids) and no meaningful impact on the guild of background cluttered habitat (*Myotis brandti/mystacinus, Pipistrellus pipistrellus* and *Myotis daubentonii*). The general bat activity showed no significant differences between the surveyed habitat types. We conclude that management decisions have to consider the impact on single bat species even if salvage logging got no evident impact on the general bat activity.

“When and where”? Decisions of foraging bats in a forest landscape various among foraging groups

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The understanding of the complex decision process of bats, where and when to forage is of fundamental importance in bat biology and conservation strategies, but poorly understood, particularly due to methodological restrictions. We examined how three steps of decision from ambient temperature, over vegetation clutter on the forest landscape to prey density and humidity within a stand influences bat activity in different foraging guilds sampling simultaneous bat activity by batcorders (38,371 call sequences) at 42 plots in 7 repliacations together with prey activity, weather conditions and high resolution clutter measurement using terrestrial laser scanning. Conditional inference trees, path analyses and our final generalized linear mixed model revealed that temperature is of basic importance even independently from insect activity for the majority of species in all guilds. As second ecological filter we found clutter; which negatively influenced the guild of uncluttered space (<22% clutter), and partly positively the guild of highly cluttered space, while the guild of background clutter were less effected. Prey density revealed a positive influence only as interaction with open space, while in general the prey was positively correlated with the clutter of a forest, but not with bat activity. We conclude that bat activity in a cool temperate montane forest is influenced first by temperature, and second, dependent from guild, by clutter of the forest, while prey activity seems to play a minor importance enhancing bat activity only in open stands. Therefore forest management activities mainly affect availability, but also prey distribution in time and space in a forested landscapes.

Species-specific barrier effects of a motorway on the habitat use of two endangered bat species and the role of connecting elements

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It is generally recognized that roads can adversely affect local animal populations but little is known how roads affect bats. In particular, there is a lack of knowledge on the response of bats that differ in foraging ecology and wing morphology to motorways that cut through the breeding habitat. Using radio-telemetry and mark-recapture data we investigated the effects of a motorway with heavy traffic on the habitat use of two endangered, forest-living bats with different wing morphology and foraging ecology. We compared pointed-winged barbastelle bats (Barbastella barbastellus), which forage in open space, to broad-winged Bechstein’s bats (Myotis bechsteinii), which glean prey from the vegetation. In a second step we explored the acceptance of newly built small underpasses as connecting elements by different bat species. While almost all barbastelle bats crossed the motorway during foraging and roost switching, only 3 of 34 radio-tracked Bechstein’s bats crossed the motorway during foraging – through an underpass – but none of them crossed the motorway while roost switching. These findings show that motorways can restrict habitat accessibility for bats but the effect seems to depend on the species’ foraging ecology and wing morphology. We suggest that motorways have stronger barrier effects on bats that forage close to surfaces than on bats that forage in open space, whereas underpasses can partially reduce these barrier effects. The newly built underpasses for example have been discovered already in their first year after construction by bats of 4 different species. Building activities with a nearly total closure of one large underpass resulted in a strong decline of bats crossing.

Bat-fruit interactions in the Neotropics: Cohesive and resilient subsystems within seed dispersal networks

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Animal-plant mutualisms, such as seed dispersal, are crucial for ecosystem functioning. As mutualistic networks seem to be formed by a mosaic of subsystems, and as there is much more information available for birds than bats, two of the main groups of dispersers in the Neotropics, we investigated bat-fruit networks in greater detail. In summary, we tested whether dietary specialization and clustering observed at the population level also hold at the network level. Compilation of nine weighted datasets from the literature revealed a significant but intermediate degree of nestedness in all networks (0.56±0.12). Bat species were weakly specialized in particular subsets of fruit species (dietary specialization = 0.37±0.10). Furthermore, the degree of specialization was asymmetric as bats were more specialized on plants than plants on bats (specialization asymmetry = –0.21±0.10; bias = 0.14±0.07). Bats formed only a few cohesive subgroups associated with different subsets of plants (dietary clustering = 0.10±0.13). Although ecological redundancy was low in terms of clustering, it was relatively high in each network as a whole, as many bat species belonged to two or more subgroups. In most cases, removal of individual bat or plant species caused small changes (< 1%) in nestedness regardless of their degree of dietary specialization. But the higher the proportion of interactions of each species was, the greater were the changes caused by its...
removal. We conclude that local bat-fruit networks are highly cohesive and resilient systems, in which each species plays a rather redundant role. Therefore, bat-fruit interactions at the network level appear not as specialized as at the population level. Conservation plans targeting at the maintenance of seed dispersal services need to pay special attention to generalists, because they seem to be more important than specialists in maintaining the system.

**Small bats disperse large seeds: Re-evaluating the seed dispersal service of Neotropical bats**

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In Neotropical regions, fruit bats are among the most important components of the remaining fauna in disturbed landscapes. These relatively small-bodied bats are well-known dispersal agents for many small-seeded plant species, but are assumed to play a negligible role in the dispersal of large-seeded plants. We investigated the importance of the small tent-roosting bat Artibeus watsoni for dispersal of large seeds in the Sarapiquí Basin, Costa Rica. We registered at least 43 seed species 43 larger than 8 mm – length beneath bat roosts, but a species accumulation curve suggests that this number would increase with further sampling. Samples collected beneath bat feeding roosts had, on average, 10 times more seeds and species than samples collected 5 m away from bat feeding roosts. This difference was generally smaller in small, disturbed forest patches. Species-specific abundance of seeds found beneath bat roosts was positively correlated with abundance of seedlings, suggesting that bat dispersal may influence seedling recruitment. Our study demonstrates a greater role of small frugivorous bats as dispersers of large seeds than previously thought, particularly in regions where populations of large-bodied seed dispersers have been reduced or extirpated by hunting.

**25 years of bat monitoring in Bavaria, Germany: Population trends and future tasks**

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Bats of Bavaria (Germany) have been intensively investigated since 1985 when two centers for bat conservation (Koordinationsstellen für Fledermausschutz) were first installed. After 25 years of research and monitoring, the state-wide database provides for solid material for population trend analyses. Overall the database encompasses more than 103,000 records from almost 25,000 locations and 24 species. Monitoring data from 204 underground hibe-
nacula (ca. 10% of all known underground sites; controlled at least 8×/24 winters) and from 257 colonies of *Myotis myotis* were analysed using the modelling programme TRIM (vers. 3.53). Winter censuses of 14 species regularly hibernating underground show an overall strong increase averaging 6% per year with the strongest growth in natural caves. Trends for six bat species occurring in bigger numbers are positive: *Barbastella barbastellus*, *Myotis daubentonii*, *M. myotis*, *M. mystacinus/brandtii*, *M. nattereri*, *Plecotus auritus*. The winter population of *Pipistrellus pipistrellus/pygmaeus* has grown strongly (11%) due to an increase in a few sites. Winter numbers of *Rhinolophus ferrumequinum* have been rising as have the numbers in the only known nursery colony. Likewise the three colonies of *Rhinolophus hipposideros* are growing whereas the summer population of *Myotis emarginatus* stagnates after an increase until 2003. Summer counts of *Myotis myotis* increased until the early/mid 1990s remaining stable since. However, trends in the biogeographical regions reveal an overall moderate increase in only six of the 14 regions inhabited by *Myotis myotis* colonies. This might be due to food availability and presence/absence of suitable foraging habitats (predominantly deciduous-rich forests) remaining to be investigated. For the other species trends can neither be specified for summer nor for winter populations due to small sample sizes or lack of monitoring data. An urgent future task is to shed more light on hibernation sites and behaviour of the species occurring in low numbers.

**Current and potential distribution of Bavarian bats – effect of landscape and climate**

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Two aspects of bat distribution in Bavaria were studied: (1) The landscape and land use in the surroundings of nursery colonies, (2) the overall potential distribution considering land use and climatic variables. Landscape/land use was determined in eleven circles centered on colonies with radius between 500 m and 15 km by overlaying them with the Digital Landscape Model of Bavaria using the GIS MapInfo. Seven types of land use described the topography: agriculture, pasture/grassland, standing and flowing water bodies, settlement/roads, deciduous, coniferous, and mixed forest. By comparing the average proportion of each type of land use with the respective proportion of all of Bavaria, a preference index was calculated to identify which elements dominate the landscape. We present the results for all species and types of land use in a comparative way. We computed the potential distribution in a 2×2 km grid using the ecological niche modelling programme GARP. Fifty-one climate variables from the Bavarian Climate Atlas, elevation, and the seven types of land use served as environmental variables, all summer and colony data as bat records. We present the potential distributions of several bat species as well as the current knowledge including new data not included in the modelling.

**Bat diversity at Panguana Biological Station, Peru: 25 years ago and now**

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A primary rain forest area around the Biological Station Panguana (at Río Llullapichis, Departamento Huánuco) in the Amazonian lowland of Central Peru was – privately initiated – set aside for conservation in the late 1960s. From 1981 to 1984, 52 species of 6 families were recorded. Spread over all four years every month was covered at least once. In 2009, 25 years later, we visited Panguana again and started to repeat the survey. Although we only covered two weeks of the peak dry season in July, we found 28 species in 4 families, 18 of which were also recorded in the first study during this month. In total we confirmed 48% of all 52 species from the previous study and 56% of the 1980s July-species. In addition, we captured 3 species not previously recorded. Besides regular mist-nests we used a canopy mist-net in which we caught *Cyttarops alecto*, an emballonurid species newly recorded for Peru. Most likely this species has not expanded its area further south but is only hard to catch. Not surprisingly, phyllostomids were the most frequently captured bats in both studies, among them *Artibeus planirostris*, *A. lituratus*, *A. obscurus*, *Carollia perspicillata*, *Sturnira lilium*, *Rhinophylla pumilio* and *Uroderma bilobatum*. These seven species represented 63–71% of all bats caught in July. To detect potential changes in species composition and species diversity due to habitat changes, this investigation should be continued and expanded to cover the entire year. Not many areas in the Amazon and tropics in general provide for such a comprehensive data base dating almost 30 years back. This is not only a solid foundation for a comparative study on bat diversity at the very same site but also for addressing ecological questions such as the use of agricultural habitats as feeding grounds adjacent to primary rain forest.

Role of FoxP2 expression in the control of vocalizations in echolocating and non-echolocating bats

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FoxP2 is a transcription factor implicated in the development and neural control of vocalization. Recently it has been shown that it underwent accelerated evolution in bats employing different sonar systems, thus possibly playing a role in the evolution and development of echolocation. We investigated the expression of FoxP2 in different brain areas of bats using different echolocation systems by comparing three microchiropteran species with well-developed echolocation (*Rhinolophus ferrumequinum* and *Hipposideros armiger*, which exhibit Doppler-shift compensation (DSC) behavior, and *Myotis ricketti*) with two species of megachiropteran bats lacking laryngeal echolocation (*Rousettus leschenaulti*, which uses tongue-clicks for rudimentary echolocation, and *Cynopterus sphinx*, lacking any echolocation). The most striking differences in FoxP2 expression were seen in the anterior cingulate cortex (ACC), which exhibited significant expression in bats with laryngeal echolocation, but not in the group of megachiropteran bats. We then addressed the behavioral significance of this expression difference in *Hipposideros armiger*. Knocking-down (i.e., reducing) FoxP2 expression in the ACC of *Hipposideros* significantly altered DSC by reducing the amount of frequency compensation and the call activity. It had no effect on the bat’s resting frequency (i.e., the call frequency emitted when not performing DSC). This suggests that FoxP2...
An assessment of the suitability of tropical bats for long-term monitoring

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Bats are ecologically important mammals in tropical ecosystems; however, their populations face numerous environmental threats related to climate change, habitat loss, fragmentation, hunting, and emerging diseases. Thus, there is a pressing need to develop and implement large-scale networks for monitoring of tropical bats. Using data from a range of Neotropical and Paleotropical bat assemblages, we assessed the ability for long-term monitoring programs to reliably estimate trends in species richness and to detect temporal trends in species abundance. Specifically, we estimated species detectability and assessed how these detectability estimates were affected by external sources of variation relating to time, space, survey effort, and biological traits. We also explored the magnitude of within-site temporal variation in abundance and evaluated the statistical power of a suite of different sampling designs for several different bat species and ensembles. We found that species detectability is highly heterogeneous in surveys of tropical bats. Detectability estimates were sensitive

expression in the ACC of a bat with a highly sophisticated echolocation behavior, such as *Hipposideros*, is involved in controlling call parameters during more complex echolocation tasks (DSC), whereas it has no significant effect on the control of more basic vocalization parameters, such as the call frequency emitted when not performing DSC (i.e., the resting frequency). The difference in FoxP2 expression patterns in ACC between echolocating and non-echolocating bats may therefore indicate that the same higher-order structure (ACC), although present in both groups of bats, can play a significantly different role in call production, which is mediated by FoxP2.
to a range of external factors, highlighting the need to account for variation in detectability when comparing species richness estimates over time. For species with low detectability it will be essential to correct count data obtained in monitoring surveys for detection error. Despite pronounced temporal variation in abundance of most tropical bat species, power simulations suggest that long-term monitoring programs (≥20 years) can detect population trends of 5% per year or more with adequate statistical power (≥0.9). However, shorter monitoring programs (≤10 years) have insufficient power for trend detection. The likelihood of reaching adequate statistical power was sensitive to initial species abundance and the magnitude of count variation, stressing that only the most abundant species in an assemblage and those with generally low variation in abundance should be considered for detailed population monitoring.

Chiroptera of the Gali Region (Abkhazia, Georgia)

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While studying the fauna of Gali region (Abkhazia), we have also made an attempt to investigate the representatives of chiropterans. On the basis of generalization of already published data and the obtained research material, preliminary analysis for taxonomical belonging of Rhinolophus euryale and R. hipposideros, the inhabitants of the Gali region, was conducted. Field researches were carried in 2007. Small animals appeared to be found in the abandoned old houses left after Abkhazian-Georgian military actions. The number of small animals was considered in their shelters. To collect the data about these small animals inhabited there, the collections from the Georgian State museum were treated. The habitats of R. euryale and R. hipposideros are closely linked to the lowlands at the elevation of about less than 800 m a.s.l. Practically everywhere in Gali region this territory of bats habitation is covered with gardens, tea plantations and fields, rarely alternated with natural and artificial plantation. Bats have important function as they consume essentially crepusculars and night insects which are practically unavailable for birds. One cannot help mentioning cheiroptera – pollinizers and propagators of plant seeds. Both of them represent an organic part of biological community. Hereby, habitats of the south horseshoe bat and the little horseshoe bat have undergone anthropogenic transformation throughout many centuries. Probably, the population could decrease in the second half of the 20th century as a result of mass planting of the exotic tree cultures. In order to preserve this amazing group of living creatures, one things is to be done – “to let them live”, not to destroy their shelters, not to pursue the bats, these amazing animals.

The project of Myotis bechsteinii survey: Mapping the United Kingdom distribution of this rare species

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Bechstein’s bat (Myotis bechsteinii) is one of the UK’s rarest mammal species and is predominantly associated with ancient broadleaf woodlands. In the UK Bechstein’s bat
is restricted to parts of southern England and south Wales, which comprise the northwestern edge of its European range. The difficulties involved in detecting and surveying for Bechstein’s bat using traditional methods has resulted in a lack of basic knowledge of the species’ distribution and population size. Historically therefore, there was very little information on the habitat requirements of Bechstein’s bat, its conservation status or the threats to the population. Knowledge of the species has improved following the development of an ultrasound synthesizer (the Sussex Autobat) that acts as an acoustic lure and greatly enhances our ability to catch this species. In 2007 the Bat Conservation Trust launched a four-year Bechstein’s Bat Survey Project. The key aims of the project are to produce a more comprehensive distribution map based on systematically collected survey data, and to gather information to inform future conservation policy and woodland management. The survey method comprises an initial phase of site selection within the species’ known range in which target woodlands are selected that most closely match habitats where breeding colonies of the species have been recorded. The selected woodlands are then surveyed using the Sussex Autobat to produce simulated social calls of Bechstein’s bats. These calls attract the bats into harp traps in which they are caught. A key feature of the project is the special training and deployment of volunteers from the local bat group network, which allows us to survey woodlands over a large area. In this paper, we discuss the preliminary results of the 2008 and 2009 survey seasons, and make recommendations regarding the use of the results so far to inform future conservation policy and woodland management.

Recent fragmentation of a panmictic population of *Nyctinomops laticaudatus* (Molossidae) in Yucatan, Mexico

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*Nyctinomops laticaudatus* (Molossidae) is a bat species with wide distribution in America. In Mexico, it occurs from Tamaulipas to Yucatan. It has been considered a rare species, although it is frequently found in the Yucatan peninsula. One mitochondrial DNA (mtDNA) locus and nine nuclear microsatellite loci were used to analyze *N. laticaudatus* genetic structure and diversity in Yucatan. A total of 96 individuals from three different populations (Uxmal, Calcehtok and Tabi) were genotyped. Both markers revealed high genetic diversity (*Hd*=0.872, *HNEI*=0.758). While mtDNA marker showed no significant genetic structure between populations (*ΦST* = –0.01125), nuclear markers showed low genetic structure between the three populations (*FST*= 0.0321, *Dest*= 0.034). These data suggest that Calcehtok, Uxmal and Tabi were an ancestral panmictic population recently fragmented. The cause of this fragmentation is probably due to anthropogenic activities. For the last few decades a human settling between Uxmal and Tabi has expanded, acting as a geographic barrier. Genetic diversity has maintained gene flow between Calcehtok and Tabi through a corridor, a series of mountain elevations called Cordon Puc. *N. laticaudatus* can be used as a model to implement management and conservation strategies, design biological corridors, establish natural protected areas, and propose ecotouristic programs.

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Recent philopatry in *Tadarida brasiliensis* (Molossidae) females in Mexico

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*Tadarida brasiliensis* (Molossidae) is one of the most abundant bat species in the Western Hemisphere. This species occurs in all Mexico, except in most of the Yucatan peninsula. Migration patterns in North America appear to be female-biased with males moving shorter distances, but there is lack of solid evidence to support this assumption. One mitochondrial DNA (mtDNA) locus, one Y-chromosome (Y) locus and nine nuclear microsatellite (nDNA) loci were used to analyze *T. brasiliensis* phylogeographic patterns, genetic structure and diversity in populations that occur in Mexico. A total of 200 male and female individuals from 30 localities across the country were genotyped. The Y marker showed low polymorphism, thus genetic structure analysis could not be performed. mtDNA and nDNA markers revealed high genetic diversity. The mtDNA marker showed no significant genetic structure between geographic localities. Nonetheless, nDNA markers showed genetic structure and populations could be differentiated. These data suggest high gene flow levels in an ancestral panmictic population recently structured, at least in females. Nuclear microsatellite data better reflect the recent processes shaping the distribution of genes, while mtDNA data are more strongly dependent on historical events. The future development of polymorphic male-specific markers will provide more information about the sex-biased migration patterns and reproductive behavior of this species.

Structure of bat assemblages in different landscapes in a high elevation area in Southeastern Brazil

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Bats’ high species diversity results in an impressive morphological and ecological diversity, including different types of diet, roosting ecology, and foraging modes, allowing them to occupy a large variety of habitats. The goal of this study was to investigate and compare bat assemblages in three distinct landscapes: rocky fields (Rf), cloud forest (Cf) and montane semideciduous forest (Msf), in the Chapada do Abanador, southeastern Brazil (21°35'S, 46°33'W), an area with altitudes ranging from 1,300 to 1,580 m. The region is considered as a priority area for biodiversity conservation due to the presence of important Atlantic Forest fragments protecting rivers. Samplings were performed along 46 nights, using mist nets in a total effort of 5,220 net-hours. We captured 138 bats belonging to two families and 12 species: Phyllostomidae – *Anoura caudifer* (Cf-Msf-Rf), *A. geoffroyi* (Cf-Msf-Rf), *Artibeus fimbriatus* (Cf-Msf-Rf), *A. lituratus* (Cf-Msf-Rf), *Carollia perspicillata* (Cf-Msf-Rf), *Chrotopterus auritus* (Msf), *Desmodus rotundus* (Cf-Msf-Rf), *Pygoderma bilabiatum* (Cf), *Sturnira lilium* (Cf-Msf-Rf) and *Vampyressa* sp. (Msf); Vespertilionidae – *Histiotus velatus* (Rf) and *Myotis nigricans* (Cf-Msf). The high number of *H. velatus* (15 individuals) captured exclusively in the rocky fields is noteworthy, confirming that the species has the habit of foraging preferentially in open areas. The Shannon index for the three landscapes pooled together was 2.08, and equitability index 0.84, suggesting uniformity in distribution of individuals among the species. The expected richness based on Jackknife’s first order
estimator is 13.96 species. We attribute the low diversity observed to the altitude factor, which have a major role on the shaping of the local plant communities, which, in turn, may explain the absence of some common families. Our results agree with other high elevation sites sampled in southeastern Brazil, which also presented very low richness. Our data also corroborate with the trophic structure of bat assemblages in tropical fragmented landscape, with the dominance of frugivores.

Aerodynamic performance of flapping bat flight using time-resolved wake visualization

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Bats have, compared to birds, thin and flexible wings, which are assumed to make bats more manoeuvrable, but supposedly also make them fly energetically less efficient than birds. Here, we present time-resolved fluid wake data of two bat species (Glossophaga soricina and Leptonycteris yerbabuenae) flying freely across a range of flight speeds using high-speed stereoscopic Digital Particle Image Velocimetry in a wind tunnel. From these data we construct an average wake for each bat species and speed combination, which is used to determine the flight forces throughout the wingbeat. The results show that, although the two species differ by a factor two in weight, their wake dynamics are strikingly similar. From the temporal force distributions we estimated flight performance properties such as the Lift-to-Drag ratio. These are the first direct Lift-to-Drag estimates for flapping flight of bats, and comparing them to Lift-to-Drag estimates of flapping birds shows that bats perform at least as good as birds at the Reynolds numbers they operate at. This suggests that thin flexible bat wings are relatively well adapted to flight at low speeds (at low Reynolds numbers).

Saccopteryx bilineata males gain fitness benefits in larger colonies

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Social groups that are characterised by the presence of male kin are exceedingly rare in mammals. Their infrequency may partly be explained by the necessity to overcome the costs of competition with kin (local mate competition) in the generally polygynous or promiscuous mating systems of mammals. Due to female-biased dispersal and almost absent male immigration, male greater sac-winged bats (Saccopteryx bilineata) roosting together in colonies often belong to only a small number of patrilines. Thus, many males that defend harem territories in the same colony are close kin. These related males compete with each other for access to harem territories and to female mating partners, since about 70% of juveniles are fathered by extra-harem males. Given that local mate competition must be severe, we ask how roosting in colonies with several males might benefit the fitness of males, so as to overcome these costs. We used long-term behavioural observations and genetic data to investigate the factors affecting lifetime breeding success (LBS) of harem males living in colonies of different sizes. Our results show that tenure of harem males increased with the
number of male co-residents in the colony. In contrast an increase in colony size did not correlate to female colony tenure, suggesting that an increase in male tenure in larger colonies is not driven by habitat quality. LBS of males increased with male tenure duration, which provides evidence that males gain direct fitness benefits from associating with other harem and non-harem males. In the light of an existing vocal group signature and virtually absent immigration of males into established colonies, we speculate that colonies may function as cooperative alliances that exclude non-familiar males from settling.

**Habitat and breeding roost selection by *Myotis bechsteinii*: What limits the species distribution in the Mediterranean range?**

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Bechstein’s bat (*Myotis bechsteinii*) is a forest European species, with preference for mature deciduous woodlands in lowlands. Abundance in the fossil record contrasts with its present rarity, though it may be still common in optimal habitats. We studied habitat selection by 20 lactating females belonging to 8 maternity colonies in a Mediterranean landscape (Extremadura; Southwestern Iberian Peninsula), and characterized the 13 roosts they occupied. Deciduous forests (particularly *Quercus pyrenaica*) were positively selected, and coniferous forests were opportunistically used, whereas no foraging bouts occurred in the most abundant vegetation types, i.e. evergreen broadleaved woodlands and non-forested areas. Bats preferred to forage inside the forest, as compared to edges or clearings, as well as in stands of high canopy cover. The stronger influence of forest essence (deciduous over evergreen broadleaved woodlands), as compared to forest structure, suggests that other variables such as prey availability, rather than structural constraints, drove habitat selection. Similarly, all the 13 roosts occurred in *Q. pyrenaica* trees, within stands of very diverse structure. Roost trees had a higher proportion of dead branches, and ten of the roosts were former woodpecker holes, among which seven had their entrance amended by nuthatch. Roosts were located inside the forest, and close (<620 m) to permanent water sources. No other explored variables did differentiate roosts. In the present study, *Myotis bechsteinii*’s breeding roost preferences and habitat selection are examined for the first time in a Mediterranean landscape. The particularities of Mediterranean climate did not appear to promote a distinct pattern of selection. Instead, the species appears to be restricted to deciduous forests - which might relate to both roosts and prey abundance- and limited by roost availability- dependent on maturity of the stand and activity of primary excavators. Thus, the species’ distribution in the Mediterranean range might at present be to a great extent limited by habitat loss and degradation related to secular agricultural practices and deforestation.

**Movement ecology of GPS-tracked *Rousettus aegyptiacus*: Bats as long-distance dispersal vectors of seeds**

Ran Nathan1, Asaf Tsoar1, David Shohami1, Yoav Bartan1, Ofir Altstein1 & Nachum Ulanovsky2
The emerging movement ecology paradigm aims at integrating movement research, based on elementary components that have long been recognized in specific fields of research. The study of seed dispersal by animals inherently involves (at least) two key players – a dispersed plant and a dispersing animal – hence can be portrayed by a two-level nested design of the movement ecology framework. This facilitates the links among the apparently unrelated research fields of animal navigation, optimal foraging and passive seed dispersal. These fields of research have recently been revolutionized through recent advances in tracking technology, genetic markers and individual-based modeling. We outline the basic principles of this approach, and illustrate its application for a system of fleshy-fruited plants dispersed by Egyptian fruit bats. GPS-tracked Egyptian fruit bats flew long commuting flights, but foraged within a small area of 0.052 km² (median convex hull) per bat, strongly showing preferring human settlements (795±490 m from the nearest settlement center). A spatially-explicit simulation of the seed rain generated by bats revealed similar seed shadows around both fruiting and neighboring non-fruiting trees, and seed deposition mostly under trees other than the source tree. Mechanistically derived seed dispersal kernels, estimated from empirical measurements of gut retention time and bat tracks, showed a typical leptokurtic pattern with an exceptionally fat tail indicating high levels of long-distance dispersal of up to 21 km. A new allometric scaling of seed dispersal by animals shows that the mean and the maximum distances of seeds dispersed by the Egyptian fruit bat (and presumably other fruit bats as well) are considerably higher than expected for either nonvolant frugivorous mammals or flying frugivorous birds. The mechanistic approach demonstrated here demonstrated here can advance the study of plant-animal interactions and important ecosystem-level processes such as seed dispersal in general, and help elucidate the role of fruit bats as major dispersers of native and potentially invasive fruit-tree species in particular.

Is the only European population of fruit bats close to extinction?

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Although Cypriot population of Egyptian fruit bat (Rousettus aegyptiacus) steadily decreased over 20th century, there were still at least some 10,000 individuals at the beginning of 21st century. However, the situation has dramatically changed during just five years 2006–2010, when numbers of bats in all known roosts on the island had fallen to less than 1500 bats. Many of previously occupied roosts have been completely abandoned and the number of bats in the majority of remaining roosts decreased from many hundreds to just a few. Examination of the composition of some colonies revealed that males highly outnumbered females. Also, as compared to vital colonies examined in several Middle East countries, the age structure of Cypriot colonies is highly skewed towards young individuals. We hypothesize, that extremely hot and dry summers 2006–2008 may have impose the most significant driving force responsible for the observed dramatic decrease of resident fruitbat
population. However, there may have been several other factors involved, such as unknown epidemic disease, use of pesticides or changes in agriculture that may have influenced food supply in critical periods of the year, resulting in mortality or exodus of vast majority of Cypriot fruit bats.

From revision of red list to bat biodiversity monitoring: Procedures, first results, and projections

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Red Lists are generally accepted instruments for the appreciation of the protection needs of organismic groups. In Switzerland, all 30 species of bats were red-listed as late as 1994, strongly suggesting for a revision. To comply with the requirements of the IUCN for reproducible and quantifiable measures for red list status assessments, we first clarified combined occupancy and detectability rates of endemic species using data of a pilot study and previous habitat monitoring studies. Results were used to model different sampling schemes regarding their ability to sense changes in occupancy rates. The models led us to devise a five stage procedure for censing Swiss bats: (1) assess habitat use with bioacoustic methods using a newly developed automatic recording unit (www.batlogger.ch), (2) assess habitat use with mist-netting captures, (3) assess roost occupancy by monitoring selected species in man-made roosts (attics), (4) monitor swarming and hibernating bats at and in winter roosts (caves), (5) evaluate occupancy estimations resulting from the above assessments with habitat suitability models. Model evaluations resulted in an optimal sampling strategy using 100 squares of 1 km². At each site 10 locations were sampled for 15 minutes each. Sampling of a site is repeated four times, spread over two seasons, by two different observers. Two independent acoustic methods are applied: expert’s appreciation of bats heard real-time, and simultaneous automated recording and later machine-analysis of echolocation calls. Additionally, at each square kilometre, one mist-netting night takes place to complement species’ diversity. While the above surveys reveal data on distribution and ultimately occupancy of some species, abundance for species, which are challenging to detect acoustically, may be concealed. For these, we consult data from roost monitoring programs (e.g. Myotis spp., Rhinolophidae) for information on population changes. Time-series of catches at swarming sites (caves) and counts at hibernacula complete the assessment of the red list status of all Swiss bat species. We detail the study’s design, present first results of some completed samplings and elaborate on the possible inclusion of the automated acoustic sampling into the established biodiversity monitoring scheme in Switzerland.

Geographic variation in echolocation calls of the endemic Rhinolophus capensis

Lizelle Janine Odendall & David S. Jacobs
Investigating geographically divergent phenotypic traits within a species can provide insight into processes that eventually result in speciation. We investigated divergence in echolocation calls of populations of the Cape horseshoe bat, *Rhinolophus capensis*. Echolocation, body size, wing morphology and skull parameters associated with call production and reception, were compared amongst adults from three populations situated in the centre (mesic winter), western (arid winter rainfall) and eastern (mesic summer) limits of the species distribution. The latter two populations were situated in ecological transition zones (ecotones) between vegetation biomes. Ecotone populations deviated slightly from the allometric relationship between body size and peak frequency for the genus and there was no relationship between body size and peak frequency across populations. Ecotone populations were significantly heavier than the central population. However, one ecotone population used the highest call frequencies while the other used the lowest. Divergence in call frequency could not be explained by climatic or habitat differences. Instead, nasal chamber length was the best predictor of peak frequency and it was also not correlated to body size. Thus, selection may have acted directly on peak frequency altering skull parameters directly involved in echolocation independently of body size. The evolution of echolocation is thus uncoupled from body size in *R. capensis*. Within each population, females were larger and used higher frequencies than males, which implies a potential social role of peak frequency for *R. capensis*. Differences in frequencies among populations may have been initiated by random founder effects and compounded by genetic drift and/or natural selection, resulting in the evolution of local acoustic signatures.

**Occurrence of bat ectoparasites in the Urals**

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Fauna of the ectoparasites of the chiroptera in Central Russia, Volga region, Caucasus, Ural and Siberia is insufficiently studied. Our investigation aimed to describe the species of ectoparasites of bat of the Ural region. Bats were captured in the five localities in 2004–2010: Dvurechensk, Ekaterinburg, and in the Divia, Smolinskaya and Arakaevskaya caves. Altogether 71 bats of six species (*Myotis brandtii*, *M. dasycneme*, *M. daubentonii*, *Eptesicus nilssonii*, *Vespertilio murinus*, *Plecotus auritus*) were investigated for parasites. In total, 891 parasites (insects and mites) of 12 species belonging to eight families were found. Eight mite species were identified; *Spinturnix myoti* (Spinturnicidae) was collected from *M. brandtii*, *M. dasycneme* and *M. daubentonii*. *Spinturnix plecotinis* (Spinturnicidae) were found on *P. auritus* only. *Spinturnix kolenatii* (Spinturnicidae) was collected from *E. nilssonii*. The following species of the family Macronyssidae were found: *Macronyssus corethroproctus* on *M. dasycneme*; *Macronyssus ellipticus*, *M. granulosus*, *M. charusmurensis*, and *Steatonyssus* sp. on *M. brandtii*; *Macronyssus flavus* and *M. kolenatii* on *Eptesicus nilssonii*; *Macronyssus diversipilis* and *M. cyclaspis* on *M. daubentonii*. The larva of an acarian mite belonging to the family Trombiculidae was found on the long-eared bat. *Argas vespertilionis* (Argasidae) was collected from *Vesperilio murinus*. *Acantophthirius* sp. (Myobiidae) was found on *P. auritus* only. *Spinturnix kolenatii* (Spinturnicidae) was collected from *E. nilssonii*. The following species of the family Macrhythynchidae were found: *Macrhythynchus corethroproctus* on *M. dasycneme*; *Macrhythynchus ellipticus*, *M. granulosus*, *M. charusmurensis*, and *Steatonyssus* sp. on *M. brandtii*; *Macrhythynchus flavus* and *M. kolenatii* on *Eptesicus nilssonii*; *Macrhythynchus diversipilis* and *M. cyclaspis* on *M. daubentonii*. The larva of an acarian mite belonging to the family Trombiculidae was found on the long-eared bat. *Argas vespertilionis* (Argasidae) was collected from *Vesperilio murinus*. *Acantophthirius* sp. (Myobiidae) was found on *M. brandtii*. Two species of bat flies (Nycteribiidae) were collected. *Penicillidia monoceros* was found on *M. dasycneme*. *Nycteribia kolenatii* was collected from *M. daubentonii*. Three bat fleas (Ischnopsyllidae): *Ischnopsyllus hexactenus*, *I. obscurus* and *Myodopsylla trisellis* were recorded. *I. hexactenus* and *I. obscurus* were found on *Eptesicus nilssonii*, but *Myodopsylla trisellison* *M. brandtii*, *M. dasycneme* and *M. daubentonii*. The single specimen of *Cimex*
pipistrelli was collected from V. murinus. The Ural fauna of bat ectoparasites consists of 14 species of mites, 3 of bat fleas, 2 of two bat flies and 1 species of bat bug.

**Phylogeography of Musonycteris harrisoni along the Pacific coast of Mexico**

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The goal of this study was to assess the phylogeography of the trumpet nosed-bat (Musonycteris harrisoni) through an analysis of the phylogeographic relationship among populations over its entire distributional range along the Pacific Coast of Mexico. We used nucleotide sequence data from the mitochondrial cytochrome-b (~950 bp) and D-Loop to assess levels of intraspecific variation. DNA-samples of M. harrisoni were obtained from museums, own field collections and bats provided by other researchers. We analyzed samples collected from 21 different localities. Molecular sequence data were analyzed using neighbour-joining, maximum likelihood and Bayesian studies. Nested clades analyses were used to assess the cladistic arrangement of haplotypes. Across the 21 distinct localities, we found nine haplotypes using Cyt-b data, and eleven different haplotypes using the D-Loop. Nested clade analysis revealed a moderate level of molecular variance among localities. Localities were grouped into 2 clades, composed of individuals from either the northern or southern portion of the species’ range that accounted for 41% of the variance. The northern clade shows little phylogenetic structure and distribution seems to be restricted by the Sierra Madre mountain range. Our results suggest a pattern consistent with the vicariant allopatric divergence/speciation model, influenced by habitat loss and fragmentation.

**Bat-frog interactions: Learning, categorization and memory**

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To attract mates, males often find themselves in an evolutionary bind, subject to the opposing forces of sexual and natural selection. Males must produce advertisement signals that are conspicuous and attractive to females while avoiding the attention of eavesdropping predators. How predators learn, categorize and remember prey signals influences the costs incurred by signaling prey. Here I present studies from Trachops cirrhosus, a bat that feeds on frogs and uses frog advertisement calls to detect, assess and locate its prey. I show that bats have long retention periods even for novel prey cue/prey quality associations, they can quickly learn new prey signals, and they generalize from familiar to unfamiliar signals. In response to variation across a community of prey species, they are highly responsive to the calls of species that are palatable and easy to catch, and are less responsive to poisonous or difficult to catch prey. Responses to artificial calls created along gradients between the calls of palatable and unpalatable prey species reveal that bats show gradual, not stepwise, discrimination, and, in comparison to female frogs, the intended receivers of these mating signals,
bats are highly permissive in the signals they recognize. Together, these studies shed light on the evolutionary pressures eavesdropping bats place on their sexually advertising prey.

**Exposure of bats to endocrine disrupting chemicals at sewage treatment works**

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Endocrine disrupting chemicals (EDCs) constitute a diverse group of chemical compounds which can alter endocrine function in exposed animals. Whilst most studies have focussed on exposure of wildlife to EDCs via aquatic routes, there is the potential for transfer into the terrestrial food chain through consumption of contaminated prey items developing in sewage sludge and waste water at sewage treatment works. In this study, we determine levels of EDCs in aerial insects whose larval stages develop on percolating filter beds at sewage treatment works. We compare absolute concentrations of known EDCs with those collected from aquatic environments not exposed to sewage effluent outflow. Our findings document for the first time that aerial invertebrates developing on sewage filterbeds take up a range of chemicals thought to be incorporated from the sewage effluent, which act as endocrine disruptors. For two synthetic chemicals (17α-ethinylestradiol and butylated hydroxy aniline), concentrations were significantly higher in insects captured around percolating filter beds than sites over 2 km from the nearest sewage works. A number of species of insectivorous bats and birds, some of which are declining or threatened, use sewage works as principle foraging sites. We calculate approximate exposure levels for a species of bat known to forage within sewage works and suggest that further research is warranted to assess the ecological implications of consuming contaminated invertebrate prey.

**The conundrum of limb motion – echolocation linkage. Nice idea but where’s the evidence?**

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Most aerial hawking bats typically produce a single echolocation call per wingbeat cycle, with calls produced either late in the upstroke or early in the downstroke. The timing of call production correlates with the action of wing adductor muscles in the thorax. The contraction of adductor muscles is thought to increase abdomino-thoracic pressure, which should increase subglottal pressure for the production of high intensity echolocation calls. This is the theoretical mechanism by which the action of the wing muscles allows the bats to produce echolocation calls without any additional energetic input – bats are already compressing the thorax, so shouting at the right time costs almost nothing. However, closer inspection of
the literature highlights three major problems with the current linkage hypothesis, several of which have been evident since the earliest studies. First, bats inspire on the downstroke. Can echolocation calls be produced when bats are breathing in? Second, at least half the bat species studied to date do not produce echolocation calls at the predicted phase of the wingbeat cycle. Although these species do produce calls during expiration, production coincides with the contraction of muscles incapable of increasing subglottal pressure. Third, bats that are agile on the ground, such as the common vampire bat and the New Zealand lesser short-tailed bat, echolocate while on the ground at rates and intensities equivalent to those produced in flight. Is the cost of terrestrial locomotion so much lower than that of flight that bats can afford both without linkage, or could some other as yet undescribed mechanism be at work? In this talk we will review the anatomical, physiological and biomechanical evidence for linkage of echolocation call production with flight, and highlight where current theory falls short in providing an adequate explanation for observed phenomena. We will then propose new theories and new research that may help better explain the exceptions to the linkage rule. Finally, we will speculate about how terrestrially agile bats might afford biomechanically independent echolocation and locomotion.

Bat distributions along elevational gradients and their implications for ecology and conservation

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Flight represents a key innovation of bats that permits heightened trophic and habitat specializations and leads to strongly coarse-grained utilization patterns. Compared to non-volant mammals, bat species and assemblages are predicted to: reach higher species densities, exploit broader elevational ranges, show less heterogeneity in their responses to elevation, exhibit reduced degrees of elevational zonation, and show higher faunal similarity. These predictions are tested by comparing the elevational patterns of 92 species of bats along a 3000 m elevational gradient in the Peruvian Andes with those shown by 35 species of mice and 95 species of other mammals. Compared to other mammals, especially to mice, bat ranges fulfill all of these predictions. However, processes other than specialization and environmental grain may also contribute to these patterns. We still know too little about space-use of most tropical bat species to know whether their enhanced ability to exploit diffuse resources serves to buffer them from anthropogenic effects or instead may expose them to catastrophic population and range collapse.

Materials for Atlas of bats of Montenegro

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Montenegro is perhaps one of the least studied countries considering bats in Europe and very little has been published so far. Therefore data on bats are rare and scattered in sometimes obscure publications. The lack of data on important roost makes conservation actions difficult and estimations of the local threats almost impossible. To counter lack of knowledge, all available data literature (15 literature sources) and museum collections, as well as new unpublished data on bats have been collected in the frame work of preparation of Materials for Atlas of Bats of Montenegro. To our knowledge, the oldest published data on bats from Montenegro are reported in Miller’s Catalogue of the Mammals of Western Europe (specimens collected in 1905, published in 1912). From 20th century there are just sporadic data from few local and foreign researchers (app. 15 persons), who collected data mostly along other mammal research. In last decade, few specific surveys on bats were made, which included methods of mist netting and use of ultrasound detectors. Distribution of research efforts was uneven, the Mediterranean coast being the prime focus of research and National Park Durmitor in NW of the country being the second one. The need for detailed and systematic research is evident, concerning roost and feeding habitats as well. There are 25 bat species recorded in Montenegro so far: *Rhinolophus hipposideros, R. ferrumequinum, R. euryale, R. blasii, Myotis myotis, M. blythii/oxygnathus, M. nattereri, M. emarginatus, M. brandii, M. mystacinus* (forms *M. m. mystacinus* and *M. m. bulgaricus*), *M. capaccinii, Nyctalus leisleri, N. noctula, Pipistrellus pipistrellus, P. pygmaeus, P. kuhlii, P. nathusii, Hypsugo savii, Eptesicus serotinus, Vespertilio murinus, Plecotus auritus, P. macrobullaris, P. austriacus, Miniopterus schreibersii, and Tadarida teniotis*. *P. macrobullaris* is reported from Montenegro for the first time. This check list is only provisional as Montenegro has diverse landscape and climate and relatively well preserved natural ecosystems, therefore at least 6 more bat species are expected to be present in the country, based on their ecology and distribution range.

Roosting and reproductive ecology of *Plecotus macrobullaris* and *P. kolombatovici*

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Using several different methods a new insight in the ecology of the Balkan and Alpine long-eared bats in the area of Boljun, Istria in Croatia is presented. During the three years of investigation morphometric data of females has been analyzed along with data gained from DNA analysis which was used for confirmation of the species identification. Morphometric data shows great difference in size and separation is evident from the length of the tibia and the length of the row of the upper teeth. This poster also presents roost temperature of the nursery colonies, the importance of places to hide inside the roost and time of parturition for both species.

Disease investigations in *Eidolon helvum* in the Gulf of Guinea islands

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Ongoing studies in continental Africa have identified the straw-coloured fruit bat, *Eidolon helvum*, as a reservoir for potentially zoonotic viruses (henip- and lyssa-viruses) and a common source of bush meat. We have also determined that *E. helvum* exists as one large panmictic population with extensive gene flow throughout sub-Saharan Africa, with no evidence of segregation according to presumed North-South migration routes. This panmictic population structure appears to have resulted in widespread seroprevalence to henipavirus and Lagos Bat Virus (LBV) across Africa. Non-migratory island populations in the Gulf of Guinea, however, show evidence of genetic differentiation from the continental population, with two to three colonisation events to the islands. It is currently unknown if these small, isolated populations of *E. helvum* are reservoirs of the viruses found on the continent. Investigating this could provide great insight into infection dynamics and the ability for these viruses to persist in small, isolated populations, compared with the large continental metapopulation. *E. helvum* bats were sampled on each the islands of São Tomé and Príncipe, and Bioko and Annobón (Equatorial Guinea) to investigate further the genetic population structure, colonisation events, and to assess the henipa- and lyssa-virus infection status of these small, isolated populations.

**Latitudinal diversity gradients in New World bats: Are they a consequence of niche conservatism?**

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The increase in species diversity towards the equator is a major biogeographic pattern. One theory to explain how ecology and climate act on evolutionary and biogeographic processes to determine this pattern is niche conservatism. It is based on evidence that most components of the fundamental niche – the set of abiotic conditions in which a species persists – are often conserved over long evolutionary time scales. Assuming a tropical origin for most New World bat families, the theory predicts that more and ‘older’ taxa should be found in the neotropics, while ‘younger’ taxa, which evolved adaptations to survive colder climates, should prevail in temperate regions. We (i) mapped the latitudinal gradients in species richness and age of the species of New World bats, and (ii) tested if those gradients, in the light of the known evolutionary history of the Chiroptera, may be explained by niche conservatism. A molecular phylogeny resolved to the species level was used to establish an approximation to the age of each taxon. Generalised additive models were then used to determine the relationship between species richness and latitude, and the age of the taxa and latitude. Richness increased towards the equator in the whole of the Chiroptera, and in the Phyllostomidae and Molossidae, but not in the Vespertilionidae. Overall, the pattern in the age of the taxa showed ‘older’ species in higher latitudes, and ‘younger’ species in tropical areas, contradicting the predictions of niche conservatism. We concluded that niche conservatism may only partly explain the latitudinal diversity gradients, through the rarefaction of clades of tropical origin in temperate zones. Current biotic factors, such as competition, must also influence those gradients. The observed latitudinal patterns in the age of the taxa are better explained by alternative theories, such as latitudinal differences in rates of molecular evolution.
Mating system, swarming behavior and testosterone levels in a hibernating bat (*Myotis myotis*) from the temperate zone

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Reproduction in hibernating bats from the temperate zones bears unique features in several aspects. In many species females copulate with more than one male and store inseminated sperm in their genital tract over the hibernal period. Ovulation and fertilization occurs in spring. Some species display distinctive swarming behavior at caves in late summer to fall. These swarming sites may serve as rendezvous points where sexes meet for reproduction. In order to investigate the male reproductive cycle and mating activity, we mist-netted bats during their active season at a cave over three consecutive years. We inferred the male reproductive condition of the greater mouse-eared bat (*Myotis myotis*) from measuring testes sizes and enlargements of caudae epididymes. We additionally analyzed circulating testosterone levels from blood samples. Although spermatogenesis had already ceased at the peak of swarming activity, testosterone levels increased to high levels. We argue that these hormone concentrations are induced by intense sexual competition among males and through female choice. They also provide further evidence that swarming behavior has a reproductive function.

Influence of anthropogenic disturbance on cave-roosting bats and the potential emergence of associated zoonotic diseases

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Bats (Order Chiroptera) have long been recognized as natural reservoir hosts for viruses, but more recently, bats have been implicated as hosts for numerous emerging infectious diseases (EIDs) that have impacted other wildlife species, domestic livestock, and human populations. Bats exhibit life history characteristics that make them ideal reservoir hosts, particularly high species diversity, ability to travel long distances via powered flight, long life spans, and the formation of dense roosting aggregations. Within tropical caves, high colony densities coupled with high diversity of cave-roosting bat species, present ideal conditions for virus transmission between individuals and among species. In peninsular Malaysia, numerous bat species are dependent upon solution caves formed within limestone outcrop formations, known as karsts, which provide stable microclimates suitable for roosting and rearing young, as well as, shelter from climatic events and predators. Threats to karst formations, particularly commercial quarrying and logging operations, result in the direct loss of roosting and foraging sites. Such threats have detrimental effects on the viability of cave-roosting bat populations, and present a potential source of stress that may lead to a spillover event. Therefore, documenting ecological characteristics and infection rates.
of cave-roosting bat species across a landscape experiencing anthropogenic modification is crucial to understanding the relationship between human activities and the emergence of zoonotic diseases. Previous initiatives have acted retroactively, attempting to control or eradicate host populations after a spillover event has occurred. My objective is to document the host-virus relationship, specifically virus and bat diversity, across a spectrum of landscape modification in order to facilitate in a proactive approach to preventing potential spillover events.

The importance of ecological, physiological and phylogeographical factors to explain parasite distribution among hosts: An example with spinturnicid mites and their bat hosts

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Host-parasite interactions have emerged as an important research program in bat ecological studies. Because breeding bat females associate in close contact in nurseries, whereas males are most of the time solitary, bats represent an ideal model to study the mechanisms underlying host choice strategies. What are the factors responsible for the huge variation in parasite intensities observed among individuals within the same colony, between sexes or among different species? To address these questions, we combined data on prevalence and intensities collected on different bat species in the field with laboratory experiments using Spinturnix mites as a model system. Mites showed a clear preference for individuals with higher nutritional status. In years with high resource abundance, parasite intensities were higher than in low-resource years. This pattern was also replicated in the laboratory. When offered a choice, parasites always colonized better-fed individuals. In another experiment, parasitism was higher in adult females than in adult males we found that parasites prefer females than males, contrasting with results on other mammal species. In the last part of the presentation, we will present recent results showing that parasites may be used as biological tags of their hosts. Together, these results allow us to retrace the evolutionary history of these parasites, teaching us new lessons about subtle interactions between ecological features and the evolution of host choice strategies.

Variation in candidate genes for cranial evolution in phyllostomid bats

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Among phyllostomid bats examples of feeding specialization exist, including subsisting exclusively on insects, on blood, as well as primarily on fruit, nectar, frogs, rodents, and other vertebrates. Such specializations are remarkable when viewed in the context of the dental and cranial modifications required to take such food items, as well as the concomitant
suite of adaptations such as sensory apparatus, locomotion, digestion, kidney function, and reproduction, that must be favored by directional natural selection for successful exploitation on entirely ecological opportunity. No other clade of mammals with roots in the Eocene displays such radical evolutionary modifications. Most experimental studies of rapid morphological evolution are based on cultivars, lab animals, or human pets that have been analyzed in the context of artificial selection, where genetic abnormalities have a disproportionate probability of survival and reproduction. To better understand the evolution of biodiversity and adaptation, model systems are needed to study the significance of the above proposed mechanisms for facilitating rapid morphological and physiological change under the constraints and rigors of natural selection. Previous work in model systems provides a list of genes, putatively with a large effect in driving the evolution of craniofacial components as well as the dental structure. In this study four of the genes, PAX9, MSX1, BMP2, and BMP4 are being surveyed across Phyllostomid bats. Sequence data from translated and untranslated regions of these genes are presented focusing on nucleotide and amino acid differences among lineages and correlations with distinct morphologies in an established phylogenetic context. Discussion is given on the potential to understand the functional differences of gene products as well as the direction of future experiments.

National surveillance of bat rabies in France


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Rabies viruses belong to the genus Lyssavirus within the family Rhabdoviridae, which is subdivided into seven genotypes (Gt): the classical rabies virus (Gt 1) and rabies-related viruses (Gt 2 to 7). In Europe, bat rabies is caused by two specific virus genotypes, EBLV-1 (Gt 5) and EBLV-2 (Gt 6), identified in several European bat species. More than 700 infected bats were found in Europe since 1957 and more than 95% of the rabid bats were identified as Eptesicus serotinus, a common bat found everywhere in France and in Europe. All cases in Eptesicus serotinus were caused by EBLV-1, while EBLV-2 appears to infect only Myotis species. Infected bats have reported throughout Europe, from Russia to Spain, particularly in coastal regions, The Nederlands, Germany, Denmark, Poland, Spain, the United Kingdom, Switzerland, Ukraine and France, the first rabid bat was found in 1989 and was shown infected by an EBLV-1 b isolate.

Distribution pattern of hibernating bats in caves along Carpathians elevation gradient (Poland)

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The aim of the project was to determine the changes in the structure of bats assemblages wintering in caves at a variety of altitudes. The research was conducted in the Polish Carpathians in over 70 caves situated between 300 and 1930 m above sea level. Field surveys were carried out during consecutive hibernation periods between seasons 2003 and 2009.
Around 14,000 hibernating bats from 14 species were recorded. The most numerous species were *Rhinolophus hipposideros* and *Myotis mystacinus* complex. Relatively large numbers of greater mouse-eared bats *Myotis myotis* and northern bats *Eptesicus nilssonii* were recorded. The remaining species were observed in small numbers. Alongside the increase in altitude, there were clear changes in: species diversity, vertical spectrums, the structures of bats assemblages, the similarity between dominant structures, and so on. The variation in coenotic parameters for the assemblages of wintering bats allowed us to distinguish four levels in the hypsometric gradient. The fundamental causative factor in the similarity of dominant structures within a level and their distinction between levels is the thermal regime of the hibernacula. The differences in thermal conditions within the hibernacula are caused by the structure’s height above sea level, the area’s geological make-up, and the chimney effect.

**Prevalence of Spinturnicidae, Ixodidae and Argasidae in bats during spring and fall swarming in Southern Poland**

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The aim of the study was to determine the parameters for parasitisation by Ixodidae, Argasidae and Spinturnicidae in bats during the autumn and spring swarming. The research was conducted in 2008–2009 at the cave opening of the Zbójeckie Cave in Łopień (Beskid Wyspowy Mountain, Southern Poland). From 16 bat species the following parasites were collected: *Carios vespertilionis, Ixodes vespertilionis, I. ricinus, Spinturnix myoti, S. bechsteinii, S. emarginatus, S. kolenatii, S. andegavinus, S. plecotinus*, and *S. punctata*. In the case of the Spinturnicidae there were no differences confirmed in the parasitic invasion indicators for bats in the autumn and spring swarms. During the spring, a clear increase in the *Ixodes vespertilionis* parasitic infestation value was observed.

**Detection of emerging viruses in bat guano**

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Zoonotic diseases are the major source of emerging diseases in human and livestock. Coronaviruses and astroviruses, which can be detected from a wide range of mammals, were detected in bats. These bats viruses are genetically much diverse than those found in all the other mammalian species. Our surveillance data indicated that these bat viruses are persistent in bat populations throughout the year. In light of these findings, bats are proposed to be the nature reservoir of some mammalian viruses. These findings also shed light on our understanding of the evolution and characteristics of these viruses. Discoveries of diverse coronaviruses and astroviruses in bats reiterate the challenge of controlling infectious disease. Continuous surveillance for and monitoring of pathogens harbored in wildlife should be encouraged.
Using stable isotopes to trace bat migrations in Europe

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Bats are small and cryptic animals and their movements, particularly over long distances, are difficult to track using conventional methods. However, those bat species that carry out long migrations may be particularly prone to ecosystem deterioration. Therefore, we are in urgent need to increase our knowledge on the movement ecology of migrating bats. We used stable isotope analysis to reconstruct long-distance movements of European bats. In general, stable isotopes of local food and water are incorporated into animal tissues. If these tissues are metabolically inert, such as hair, nails or horn, their stable isotope signature will remain unchanged as the animal moves to a new location. We captured bats in autumn, winter and early spring in their wintering areas or along potential migration routes. We analyzed stable hydrogen isotope ratios of hair of captured bats, which is known to grow in summer and, therefore, in the areas where bats rear their young, to estimate breeding sites of migratory bats. First, we validated the method using hair samples of sedentary bats captured across Europe. The isotopic proportions in the hair of sedentary bats reflected those of local water and correlated strongly with the latitudinal gradient of hydrogen isotopes in rain water across Europe. Further, we also used carbon and nitrogen isotopes, which do not show consistent geographical patterns but locally varying signatures, to discriminate between potential sites of hair growth. We used this information to infer migratory strategies of several populations of the potentially migratory bat *Nyctalus leisleri* in Europe. These results could be an efficient tool to help to design trans-national protection plans for European migratory bats.

Modularity and the evolutionary flexibility of the skull of chiropterans

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Modularity can arguably be linked to the concept of evolvability, since changes in patterns and magnitudes of integration influence the ability of a species to respond to selection. Recent works regarding the evolution of modularity in the mammalian skull showed that larger magnitudes of integration among traits are associated with a blur of the developmental/functional modules of the skull and accordingly less evolutionary flexibility. Conversely, lower magnitudes of integration are associated with clearer modules in the skull and more evolutionary flexibility. This pattern was consistently observed for several orders of mammals, including taxa that diverged more than 140 million years ago. Even so, chiropterans, which represent the second most diverse order of mammals, were not sampled in these previous works, making it a glaring omission. Therefore, we here explored morphological integration patterns and magnitudes in several families of chiropterans, testing for the presence of specific developmental/functional cranial modules. We also used the multivariate equation of response to selection to simulate the behavior of representatives from these families in terms of their evolutionary flexibility. This analysis was carried for data both with and without variation in size, since size variation may obscure modules that would be, otherwise, apparent. Chiropteran families presented some of the lowest magnitudes of morphological
integration among all mammal groups, suggesting that they are highly flexible, in terms of their evolutionary response to selection. They also presented quite evident skull modules. Some modules (e.g., vault and neural) expected *a priori* from a developmental functional perspective couldn’t originally be detected due to size variation, but became quite evident once size was removed. Considering the phylogeny of mammals and the evolution of integration magnitudes, it seems that this group represents the extreme of a general trend towards reducing the integration among traits and increasing the level of modular distinctiveness.

**Patterns of ectoparasite abundance infecting distinct populations of Miniopterus species in their contact zone in Asia Minor**

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Closely related hosts species are similarly susceptible to infestations of parasites. However, even small differences in morphology or in feeding behavior may also result in differences in parasites infestation. *M. schreibersii* in Asia Minor forms a cryptic species complex: *Miniopterus pallidus* and *M. schreibersii*. We analysed abundance of 2 species of nycteribiid flies (Diptera, Nycteribiidae) and one wing mite (Mesostigmata: Spinturnicidae) infecting distinct population of *Miniopterus schreibersii* complex in their putative contact zone in Asia Minor (Central Anatolia). Studies were conducted during the maternity period, in cave colonies two genetically different/distinct lineages/haplotypes/haplogroups of *Miniopterus schreibersii* (3 caves vs one cave) and *M. pallidus* (3 caves). Only adult bats: males end females were investigated; all maternity aggregations were more numerous than a few hundred individuals. Between two main hosts: *M. schreibersii* and *M. pallidus*, we find no differences in flies abundance (without effect of host sex), and significant differences in wing mite abundance (with effect of host sex). Unexpectedly, the largest differences we find between two distinct population of *M. schreibersii*: in cave colony from Hatay there is complete lack of wing mites, and almost threefold largest abundance of flies than other bent-wing bat colonies. Because bats from this colony have a unique haplotype suggesting a relatively recent migration and isolation from the other *M. schreibersii* colonies, it is possible that during this episode had “lost” mites, and in their place, flies increased the number.

**Miniopterus schreibersii** – what is this cave-roosts flagship species doing in church attics?

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Bent-winged bats (Miniopteridae) are medium sized cave dwelling insectivorous bats of the Old World. The only species in Europe, *Miniopterus schreibersii*, is distributed in southern
Europe from Iberia to the Caucasus, south of the 48° parallel. It is predominately found in the relatively warm karst regions and almost exclusively roosts in large caves. Usually large colonies of several (even as much as ten) thousand animals can use specific underground shelters as nursery, hibernation, transitional or all year round roosts. It is no wonder that *M. schreibersii* has become a flagship species for the conservation of cave habitats for bats. However, at the northern edge of its range in Central Europe there had been sporadic reports of smaller nursery colonies also inhabiting attics. Unfortunately, these reports either referred to roosts that no longer existed, or no details were given. The intensive survey of church attics, which has occurred over the last decade in Slovenia and neighbouring Austria, has revealed that *M. schreibersii* forms nursery roosts in three attics: in the Slovenian village churches of Puščava and Završe; and in the priest’s house in Klösch, Austria. These buildings share remarkably similar conditions in that all: (i) have large windows in the attic or adjacent rooms; (ii) have relatively large attic spaces; (iii) but also have a more sheltered space free of draughts, and; (iv) importantly, all roosts were shared with large colonies of *Myotis myotis*. *M. schreibersii* were usually hidden in clusters of the larger species or formed small groups just beside the groups of *M. myotis*. In the summer of 2009 we counted in Puščava, Završe and Klösch approximately 60, 230 and 15 adult *M. schreibersii* and 460, 850 and 620 adult *M. myotis* respectively. Banding data shows that probably all the *M. schreibersii* from the above-mentioned attics hibernate in one cave. This could mean that these *M. schreibersii* are accustomed to using attics as nursery roosts and therefore more could be expected in similar buildings. The building descriptions given could also be used as practical guidelines for the restoration of former roost sites destroyed in previous decades.

**Restricted gene flow is required for sensory speciation in bats**

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Detecting factors influencing population structure and divergence is a long-standing question in evolutionary biology. The sensory drive theory of speciation predicts that populations of the same species inhabiting different environments can vary in sensory traits, a process that can ultimately drive speciation. However, even in the best known examples of sensory ecology driven speciation, it is uncertain whether the variation in sensory niche is the cause or the consequence of reduction in gene flow. Bats, which use echolocation to find their prey, are a group of particular interest to tackle this question as sensory ecology has been suggested to play a determinant role in speciation processes. We studied *Craseonycteris thonglongyai* (bumble-bee bat), the world’s smallest mammal, which belongs to the monospecific Craseonycteridae family that originated approximately forty three million years ago. Echolocation recordings and genetic data including mitochondrial DNA, Numts, autosomal, X- and Y-chromosome markers were gathered from the entire range of the species, covering the allopatric populations present in Thailand and Myanmar. Our results show a very clear
separation between the Thai and Myanmar populations suggesting they should be considered as separate species. The match between genetic separation and echolocation divergence may suggest that echolocation differences are playing an important role in the speciation process. However, our detailed analysis of population structure and echolocation differences within the Thai population show that geographic distance, rather than sensory ecology (echolocation), initially limits gene flow between populations. This creates the suitable conditions to promote secondary sensory niche differentiation via local adaptation, most likely driven by inter-specific competition with another bat species, *Myotis siligorensis*. We suggest that sensory ecology acts as a reinforcement-like mechanism in the speciation process rather than being the main driver.

**Population history of Craseonycteris thonglongyai**

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*Craseonycteris thonglongyai*, the world’s smallest mammal, is the sole representative in the Craseonycteridae family which diverged from the Megadermatidae around 43 MYA. The recent discovery of a new population in Myanmar showing differences in echolocation call peak frequency raised important questions about the possible presence of cryptic species, although, the two populations were very close to each other (200 km) and showed no significant morphological differences. Until recently, a large number of species descriptions or phylogeographical studies relied on one marker only, quite often mitochondrial DNA (mtDNA), to infer monophyletic clades and then putative species. This “one gene approach” has been criticized for various reasons that we will briefly mention. However, one important aspect that has been disregarded is the presence of Numts (Nuclear copies of mtDNA). If Numts are confounded with mtDNA sequences, their presence in a data set can lead to false inferences and unreliable conclusions. Nevertheless, if Numts are identified at an early stage and clearly differentiated from mtDNA, they have the potential to provide crucial information. Our results show that a mitochondrial DNA tree rooted using closely related taxa (*Megaderma, Rhinolophus, Hipposideros, Rousettus, Pteropus*) did not reveal a Thai/Myanmar split. However, integrating Numts in the data set changed the tree topology and suggested a clear split between the Thai and Myanmar mtDNA haplotypes. This split was also supported by microsatellites and nuclear SNPs (autosomal, X- and Y-Chromosome). We will discuss the usefulness of Numts but also the problems arising from their potential confusion with mtDNA. We further explored *Craseonycteris* mtDNA sequences within Thailand to infer past population expansion, with a special emphasis on separating signatures of demographic (increase in population size) versus spatial (increase in distribution) expansion. During the recent periods of climatic change, species have gone through phases of expansions/retractions and it is thought that after the last glacial maximum, species have increased their population size but also and more importantly, extended their distribution. However, to our knowledge, no studies in bats and very few studies in any living organism...
have differentiated the two modes of expansion. We show that demographic and spatial expansions can leave different genetic signatures at surprisingly small spatial scales and can provide valuable spatial information on past demographic history. The investigation of the present population structure using microsatellites brings more information regarding movements’ abilities in *Craseonycteris* and helps elucidate the past history of the species.

**Recurring fires in Mediterranean habitats and their impact on bats**

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The Mediterranean coastal belt habitats suffer of many human impacts due to its overpopulation: the repeated fires produced by human activity frequently affect the remnant natural habitats reducing the regeneration capacity of plant communities and thus relegating them to a permanent early stage of succession. Although such alteration is known to have an important effect on many plant and animal species, little attention has been paid to its consequences on bat populations. During years 2006–2009 a study on the foraging behaviour of a breeding colony of grey long-eared bats (*Plecotus austriacus*) was conducted in the Cap de Creus Natural Park (North-East of the Iberia) by radio-tracking 22 lactating females. The Natural Park is recurrently affected by fire. During the last three decades around 85% of its surface has at least burnt once, having some areas suffered from fire up to six times. Although shrubby communities cover over 80% of the nursery surroundings such habitats were barely used by bats, in fact the animals spent 92% of their foraging time in the scattered small Aleppo pine (*Pinus halepensis*) stands that survive in the remaining unburnt zones, accounting for less than 10% of the available area. Considering their low wing load long-eared bats are expected to be short distance flyers, probably the scarcity of their preferred feeding habitat explains the relatively long distances reported: average foraging distance from roost was 4.1 km (with minimum at 900 m and maximum at more than 14 km). The results stress the dependence of Mediterranean coastal grey long-eared bats on the scarce available pine stands, impaired due to recurrent fire: such circumstances may not be exclusive of the studied area but shared along the whole Mediterranean coastline, and can seriously compromise the survival of their grey long-eared bats populations.

**Bat conservation: Past, present and future**

Paul A. Racey

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Since most of those present know something about bat conservation past, I will only briefly consider conservation successes. Whoever would have predicted the occurrence of White Nose Syndrome and its devastating effects, so there is little point in speculating about the future? So I will concentrate mainly on the present and on shortcomings. I will consider the gaps in capacity-building, the disjunction between the excellent studies of bat conservation biology and practical conservation, which mirrors the equally relevant disjunction between science and politics. I’ll talk about scientific neo-colonialism, and even, sad to say, exploitation. And if all that sounds too negative, I’ll set out what I think we should do now.
And it will be my personal view and not that of any organisation with which I am now or have been associated.

The potential threat of White Nose Syndrome to European bats: An action plan

Paul A. Racey on behalf of the White Nose Syndrome Consortium

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Following extensive discussion of white nose syndrome during the Second Berlin Conference on Bat Biology in February 2010, a group of concerned bat biologists put together an action plan and recruited many colleagues to The White Nose Syndrome Consortium. The plan sets out four hypotheses: (1) Geomyces destructans has only recently arrived in Europe. (2) A non-lethal strain of G. destructans has long been present in the northern temperate zone, but a virulent strain arose recently in North America which can over-ride the immune response of its host. (3) G. destructans is an opportunistic pathogen and some other organism is killing the bats. (4) G. destructans has long been present in Europe but has recently arrived in North America. To address these hypotheses, data are needed on the following: (i) the natural distribution of G. destructans and the relationship between isolates from North America and Europe. (ii) the pathogenicity of G. destructans in European bats. (iii) whether American and European G. destructans are genetically identical. (iv) whether European bats are immune or resistant to G. destructans. (v) whether G. destructans is the primary mortality agent. (vi) population changes in European bats.

Food transfer by mother to pup in Megaderma lyra

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The Indian false vampire bat, Megaderma lyra lives in caves, unused buildings and temples. It feeds upon frogs, mice, geckos, etc. In order to detect and capture prey on ground M. lyra uses a combination of passively listening to prey-generated sound, echolocation and possibly vision also. But to capture prey (frog) at water surface, the bat uses echolocation. M. lyra gives birth to a single young from March to May. In a study under captive conditions, four out of eight young (Group 1) at 60–63 days of age began to capture dead frogs that we pulled with a long thread on the sandy floor of the flight room. However, the mothers continued to suckle until their young became 85 days old. The mothers of the remaining four young (Group 2) stopped sucking when their young attained the age of 60 days. Nevertheless, these mothers transferred either entire or partly consumed frogs (bodies with no head, half bodies, paired hind limbs and single hind limbs) to their young solicitors. Such food transfers occurred based on the body lengths of frogs. Mothers transferred small frogs entirely, but as the body length of frogs increased, mothers transferred smaller body parts to their young. Occasionally, audible vocalizations of mother and young were associated with food transfers. When these young bats became 74 days old, their mothers stopped food transfers.
It appears that lactating females of *M. lyra* take care of their young by supplementing milk with solid food, similar to other megadermatid bats.

**The importance of distance variables in the modelling of bat foraging habitat**

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Bats are colonial central-place foragers that usually return daily to their colony roosts, but thanks to their flying capacity they can reach distant high quality foraging sites, where they can maximise their food intake. However, flying is energetically expensive, so reaching these sites and other key resources, such as drinking water, may be costly. As a consequence, distance variables are likely to be critical determinants in bat habitat suitability. In order to evaluate how essential these distance variables are in modelling bat habitat suitability, we analysed habitat selection by two cave-dwelling species (*Rhinolophus mehelyi* and *Miniopterus schreibersii*), both of global conservation concern and among the least known bats in Europe. Habitat use was determined by radio tracking the two species during the spring, around a nursing colony located in Mediterranean southern Portugal. The role of various habitat and distance variables was tested using logistic regression modelling. The results confirmed the great importance of distance variables. Habitat suitability models that did not include distance variables had much lower performance and discrimination ability than those that included them. In fact, two of the distance variables analysed – distance to roost and to water – could alone explain as much as 86 and 73% of the habitat suitability for *Miniopterus schreibersii* and *Rhinolophus mehelyi* respectively. We also generated habitat suitability maps for both species in a GIS environment using models with and without distance variables. The resulting maps differed substantially, confirming the poor spatial performance of the models that did not include distance variables. We conclude that the inclusion of distance variables in habitat suitability modelling will not only allow a better understanding of the way bats select their foraging habitats, but also increase the quality of the maps used to plan the conservation and management of their habitat.

**Conservation status of bats of the island of São Tomé, Gulf of Guinea**

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The bat fauna of São Tomé is characterized by a remarkably high degree of endemism; four out of the ten species known to occur on this small oceanic island and one subspecies are endemic. However, while many bat species on the island are considered threatened, little is known about their distribution, population status and how they may be affected by human activities. Here, we report on the results of a survey that was conducted between September and November 2009. Our ultimate goal was to identify potential threats and priority areas for species protection such as important roosting sites – knowledge that can aid in the
planning and implementation of appropriate conservation measures. The study revealed the presence of a bat species not previously known to occur on the island, *Myotis tricolor*. Our findings suggest that the disturbance or destruction of roosts constitutes a threat to many of the bat species on São Tomé, especially cave-roosting ones, calling for legal protection of those species and monitoring of key roosting sites. Although the flying fox species *Eidolon helvum* and *Rousettus aegyptiacus* are seemingly abundant on the island and appear to be able to sustain current levels of exploitation, hunting may be a problem for the island endemic *Myonycteris brachycephala*, whose population size seems to be greatly reduced. To avoid overexploitation of these species, awareness campaigns among hunters are necessary, alongside legal protection measures such as the establishment of a closed season during the bats’ period of reproduction and prohibition of capturing bats in colonies. Finally, lack of knowledge about the general biology, ecology, and population status is a serious obstacle to the conservation of some of the bat species of São Tomé and there is a dire need for future research into little-known species such as the island endemic *Tadarida tomentis*.

**Zoogeographical analysis of the Caucasian bat fauna**

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35 bat species were registered in the Caucasus. This fauna is heterogeneous and refers mainly to four faunistic complexes: 1. Palaearctic: 9 spp. (*Myotis daubentonii*, *M. mystacinus*, *M. dasycneme*, *M. brandtii*, *Plecotus auritus*, *Nyctalus noctula*, *Vespertilio murinus*, *Eptesicus serotinus*, *E. nilssonii*); 2. Frontasian and Mediterranean: 17 spp. (*Rhinolophus hipposideros*, *R. blasii*, *R. euryale*, *R. mehelyi*, *R. ferrumequinum*, *Myotis blythii*, *M. nattereri*, *M. emarginatus*, *M. aurascens*, *M. schaubii*, *M. hajastanicus*, *Plecotus macrobularis*, *Miniopterus schreibersii*, *Hypsugo savii*, *Pipistrellus pipistrellus*, *P. kuhlii*, *Tadarida teniotis*); 3. Turanian: 3 spp. (*Barbastella leucomes*, *Eptesicus bobrinskoi*, *E. bottae*); 4. European: 6 spp. (*Myotis bechsteinii*, *Barbastella barbastellus*, *Nyctalus leisleri*, *N. lasiopterus*, *Pipistrellus pipistrellus*, *P. nathusii*, *P. pygmaeus*). The Frontasian and Mediterranean species predominate all over of the Isthmus. Distribution and number of species vary in different natural regions. From 23 species found in the territory of the Precaucasus, Palaearctical ones predominate (39.1%), Frontasian bats consist 34.8% and European representatives is 26.1%. In the Greater Caucasus from 33 noted species Frontasian and Mediterranean bats are predominants (45.4%), Palaearctical ones consist 27.3%, and European species is 18.2%. In the Lesser Caucasus and Transcaucasian Upland from 30 registered species Frontasian and Mediterranean bats consist 56.7%, Palaearctical and European ones have equal percentage (16.6), and Turanian species is 10%. In the Lenkoran region from 21 bat species zoogeographic representatives varies from 42.8% (Frontasian and Mediterranean complexes) to 33.4% (Palaearctical). European elements are 23.8%. In the Intermountain depression these complexes are accordingly 48.2, 25.9, 18.5%, and Turanian one is 7.4%.

**Short term observations of emergence and flight routes of Rhinolophus hipposideros from a summer roost in central Slovenia: Implications for conservation**

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Ljubljansko barje is a moor area in central Slovenia, that was designated as potential Site of Community Interest under European Habitats directive (Natura 2000 site) also due to presence of lesser horseshoe bats (*Rhinolophus hipposideros*). Nursery colonies are located in many churches, yet studies on their habitat use are lacking. Emergence and flight routes of a colony in the church Sv. Duh in village Vnanje Gorice in centre of the moors were observed on ten days in August and September 2009, with the use of ultrasound detectors. In August, there were 72 lesser horseshoe bats, which lowered to 25 in the beginning of September. They emerged from only one opening from the attic. The first bat flew out of the roost on average 16 minutes after the sunset, and the first left the roost without return 20 min after sunset. The bats were flying few meters above the ground, into the nearby forest patch on the northwestern side of the church. We observed flying bats in this patch and on the forest edge, where they probably foraged. Bats continued flying by the lit road next to houses, over the road and next to the railway, southwest from the church. This indicated the flight toward the larger forest patch about 2 km SW from the church. There lesser horseshoe bats were detected three times at max distance ca. 1.7 km away from the church. We propose a most likely part of flight route of lesser horseshoe bats from the church. Our observations present first information on the habitat use of the lesser horseshoe bats roosting in local area. Conservation of local populations is essential to preserve species on national level. Our preliminary study is an example where short term field work and simple methods can reveal important information for conservation.

### Survival of *Rhinolophus ferrumequinum*

**young females seems to be influenced by birth synchrony with other young, especially those from their own matriline**

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Mean birth timing, due to climatic differences among years, is an important factor influencing the survival rates of cohorts. Associations may occur among related bats of different ages at feeding and maternity sites in summer and hibernacula in winter. Relatives from one matriline (8144) preferentially shared hibernation sites in the mid-hibernation period. In this study we traced young bats born to 14 matrilines in 2007 to 18 associated hibernacula in winter 2007/8 to investigate their dispersion during hibernation. Thirty-one young born in 2007 were captured at 11 hibernacula. Most (70%) occupied three key hibernacula, located close together, where small clusters occurred in October, January and April. Birth timing and associations were analysed in the light of survival to July 2008. Two matrilines, 7336 and 8144, dominated the numbers at both the maternity site and the hibernacula. The 7336 young were found widely dispersed in more sites (n=4 bats in 6 sites) and associated least with others from their matriline. The 8144 young were found in fewer local sites (n=7 bats in 3 sites). Three young were found in clusters within the same sites in each month of the winter. These behavioural differences reflect the previous findings for older bats from these two matrilines. Survival rates were determined for these
two matrilines over their first year. Comparisons of survival rates were complicated by male and female differences; different levels of body reserves in October, and an inherited defect that significantly affected the 8144 matriline. Other matrilines also showed regular associations of young both among their own matriline, and with 8144 members at the key hibernacula. Their female offspring showed the highest survival rates. Survival seems to be highest in female young that are born in closest synchrony with other young, especially those from their own matriline.

**Spread your wings and fly: Behavioural flexibility and niche breadth in a depauperate bat community**

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Despite a diversity of habitat types, there are strikingly few residential bat species (≤6) found in northeastern North America, especially as compared to the numbers found at similar latitudes in Europe. Over much of their range, some of these species appear to be rather catholic in their diet and use of habitat (e.g., the little brown bat, Myotis lucifugus). To test the hypothesis that bats living in depauperate communities realize and perhaps exceed their fundamental ecological niche, we conducted acoustic surveys, dietary analysis, and flight room experiments to assess species-specific habitat use and foraging behaviour. For comparison, we collected data on the wing and skull morphology from each of the five bat species at our study site near Ottawa, Canada. While all species are known to be adept aerial hawkers, we found that individuals from four species were also able to glean prey. As evidenced by echolocation call recordings, bat activity peaked in late July and August. It was at this time that species tended to exhibit the most flexibility in foraging behaviours. We suggest that greater insect abundance and diversity encourages individual bats to explore alternative habitats and attempt to capture insects using seasonally-specific sensory cues and novel foraging strategies.

**An overview on BIUS research projects and its impact on existing and further bat research in Croatia**

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Croatian Chiropterofauna consists of 35 species, all of which are endangered. Research on bats in Croatia, however, has been sporadic and intermittent. This prompted the founding of the Bat research group within BIUS, a Biology Student Association, in 1999. Over the
past 11 years, this Group has been involved in 12 biology camps, hosted at various protected sites in Croatia such as nature parks and wildlife reserves, where members could conduct inventory and monitoring of flora and fauna. This research is fundamental, especially for bat fauna, since for most of these parks results obtained during these projects represent the only list of bat species for that area. Several times additional research projects were organized after the potential for the discovery of new species and colonies was observed, and every time several new species of bats were added to the park’s inventory list. Although, for the time being, the Group has no means for other in-depth projects, it has successfully collaborated with foreign institutions by collecting samples for their studies (e.g. hair samples were collected in a study regarding the isolation of hydrogen isotopes in determining migratory routes for certain species). Over the years the section has amassed a lot of data. Now, this data can be combined and contrasted with previous research conducted in Croatia. By doing so, we can determine which areas have been thoroughly investigated (e.g. the coastal region), which have not been investigated at all (e.g. the majority of the continental region), and which areas demand more comprehensive and in-depth research studies. Through the use of statistical models and the knowledge of ecology for each present species, as well as their standard migratory routes, we could predict their present and future potential colonies. These findings provide an enormous potential for further bat research in Croatia.

Linking habitat loss and bat decline:
The conservation biology of *Plecotus austriacus* in England

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Bats have undergone a global decline in the past century, primarily due to human population expansion and the associated habitat conversion and agricultural intensification. Understanding patterns of habitat selection by bats at finer spatial scales is essential for revealing the relationship between habitat loss and bat decline. We studied the ranging behaviour and patterns of foraging habitat selection by the grey long-eared bat, *Plecotus austriacus*, one of the rarest mammals in England, by radio-tracking 12 bats from a maternity colony in Devon between April and September 2009. We further used MaxEnt to model habitat suitability and determine factors that limit the distribution of the grey long-eared bat in Britain. Bat activity was affected by reproductive condition and minimum night ambient temperatures. Lactating females foraged for longer, had larger home ranges and travelled greater distances to foraging grounds than non-reproductive females. Approximately 50% of the colony core foraging areas were located more than 2 km away from the maternity roost. Compositional analysis revealed that grey long-eared bats primarily select unimproved grasslands (meadows and marshes), woody riparian vegetation, and suburban habitats within their foraging ranges, but avoid conifer woodlands, open water and arable land. Although habitat suitability modelling shows that climatic conditions are the principal factors restricting the distribution of the grey long-eared bat to the southern coast of England, this species is absent from parts of its suitable range and colonies have gone extinct in the past few decades from other parts. Patterns of fine-scale habitat selection, as revealed by radio-tracking, suggest that the decline of grey long-eared bats may be linked to the disappearance of their preferred foraging habitat, unimproved grasslands, from England due to changes in agricultural practices in the past century.
Where is my bat? Ground-validation of presence-only modelling and its integration with molecular techniques for the conservation of rare species

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Here we employ multiple approaches (population genetics, past and present predictive modelling) to determine the population structure and the potential distribution in Portugal of the \textit{Barbastella barbastellus}. First, we evaluated the accuracy of presence-only modelling for predicting the distribution of rare species, when data are scarce and usually collected with sampling biases. We modelled the potential distribution in Portugal of the bat and subsequently ground validated predictions by using acoustic transects. We used Ecological Niche Factor Analysis (ENFA) and Maximum entropy modelling (Maxent) to build distribution models. ENFA and Maxent models predicted similar areas of occurrence in central and northern regions of Portugal, although ENFA predicted suitable habitat over a wider range. Conversely, there was substantial disagreement on the location of high-suitability areas in the south. Native woodland and average temperature were the most relevant variables for Maxent, while in ENFA \textit{B. barbastellus} was linked to higher altitudes though avoiding production forests and infrastructures. Threshold-independent and dependent statistics showed that Maxent models outperformed ENFA, probably as a consequence of divergent predictions in the new areas of occurrence. Overall, 15 new \textit{B. barbastellus} sites were discovered and known distribution was extended approximately 100 km to the south. After model validation, population structure was analysed by sequencing two mitochondrial DNA fragments: cytochrome-\textit{b} and D-loop. The latter fragment showed almost no variation while 13 haplotypes were identified in cytochrome-\textit{b} sequences although without significant population structure, despite the existence of unique haplotypes in the northern and southern regions. Our bioclimatic models for the Last Glacial Maximum also suggest that some degree of isolation has existed between northern and southern populations. Nevertheless, the separation of these populations is not significant hence Portuguese populations should be managed as a single unit. The maintenance of the existing mature native woodland is paramount for conservation. In conclusion, this study illustrates how combining genetic analysis with predictive modelling can help conservation management of a poorly documented species in a rapid and low cost manner.

Temporal pattern of activity of \textit{Pipistrellus pipistrellus} in the Hranická Chasm

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In 2008 flight activity of common pipistrelles, \textit{Pipistrellus pipistrellus} was studied in the Hranická Chasm (near Hranice na Moravě, C Moravia, Czech Republic). The research was
focused on the overnight changes in activity during 17 monitored nights in approximately fourteen days intervals from April to November, and one night in March of subsequent year. Recordings of bat calls acquired by an automatic ultrasound detection afforded the main data source. The FD bat-detector and DAT recorder were always situated on the same detecting point located below the top edge of the chasm and recordings usually proceeded continually over the night. The length of the night was limited by the time of sunset and sunrise. Each night was divided into eight periods and the season of monitoring into five parts related to the reproductive cycle of bats. Relative activity defined as the number of minutes with the record of a pipistrelle call related to an hour of recording (min+/hour) reached the peak in July and August while it was the lowest in April. The highest level of the overnight activity was recorded around the midnight during most nights, but in the autumns’ nights the peak was already found earlier, in the 2nd and/or 3rd periods of the night. Bat activity was positively correlated with air temperature especially at the beginning and the end of the season. Activity occasionally recorded during winter can show, that at least some individuals can hibernate in deep crevices of rock walls. Acoustic monitoring suggests all the year round occurrence of pipistrelles in the study site but neither foraging or mating activity were confirmed here. The importance of the Hranická Chasm to bats is discussed.

Importance of forest fragments in agricultural landscape to bats

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The differences in utilization of 21 isolated forest fragments of three size categories, i.e. small (1; 0–100 ha), medium (2; 100–1000 ha) and large (3; >1000 ha), by bats were assessed to determine the impact of forest fragmentation on bat populations in the S-Moravian agricultural landscape. To analyse the flight activity and species diversity of bat assemblage inside forest fragments, point counting and line-transect methods of bat-detecting were used. The impact of the distance from the nearest waterside and human settlement was assessed as well significantly higher activity of bats was found in small fragments compared to medium and large fragments. Flight activity of the whole bat assemblage negatively correlated only with the distance to a water body and no correlation with the area of forest fragments and the distance to human settlements was found. The number of species was positively correlated with the area of the forest. Higher number of bat species was found in large fragments in comparison with lumped small and medium fragments. Likewise Shannon’s index (H’) was higher in large fragments. In total, 15 bat species or pairs of sibling species were identified. Pipistrellus pipistrellus was the most abundant, followed by Myotis myotis and M. mystacinus/brandtii. All three species were also eudominant in study area and found in the most fragments. Recorded species were divided into four ecological groups with respect to their foraging strategies and habitat use, i.e. “forest” bats (1), “open air” bats (2), hemi-synanthropic bats (3), and bats associated with waterside (4). The highest relative activity inside forest fragments was recorded among bats ranked to the “forest bats” represented by Barbastella barbastellus, Plecotus spp., Myotis mystacinus/brandtii, Myotis emarginatus/alcathoe, Myotis myotis and M. bechsteinii.
A picture of bat activity at a cave entrance in Austria

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We studied the activity of bats at a cave entrance in Styria, Austria from 13th of July until 28th of December 2009. Thus, we included the period for the autumnal swarming followed by the winter activity. The species assemblage of the cave includes species that are hard to capture like Rhinolophus hipposideros and species that are difficult/impossible to distinguish by their ultrasound calls like e.g. Myotis mystacinus and Myotis brandtii. Therefore we used infrared light beams and automatic photographing of bats to get reliable results for species which are poorly understood in terms of swarming and winter activity, respectively. More than 109,900 flights into the cave and 101,240 flights out of the cave were recorded during our study period, with 50% of the recordings between mid of August and mid of September. Subsequently the activity at the cave was continuously decreasing. However, we found bat activity on every single day of the study period, even at very low ambient temperatures. We were able to take 67,769 pictures of bats flying into the cave (=62% of all flights into the cave). The pictures were assigned to 11 bat species or species groups. By far the most numerous or active bat at the cave was Rhinolophus hipposideros (87.9% of all pictures). Other active species were Myotis emarginatus (4.4%), Pipistrellus spp. (3.3%), Barbastella barbastellus (1.6%) and Rhinolophus ferrumequinum (1.5%). The following species were photographed in much smaller numbers: Myotis daubentonii, M. mystacinus or M. brandtii, Eptesicus serotinus, Plecotus spp., Myotis myotis or M. oxygnathus and M. nattereri. For five bat species we present species specific activity patterns and we use the results of the activity recording for comparison with the visually counted bats during the hibernation count.

Population dynamics of four bat species in Austria

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We studied the population dynamics of bats in Austria over the last decade. Here we present data for four bat species: Rhinolophus hipposideros, Myotis emarginatus, M. myotis, and Barbastella barbastellus. Estimates of population trends were based on standardised counts in hibernation and maternity roosts. At maternity roosts bats were counted either inside the roosts or during their nightly emergence. All four bat species showed a positive population trend. However, there were differences in the magnitude of the increase as well as in the variability of the data. The most striking increase was found for Myotis emarginatus with a 2.5-fold increase over 10 years. However, the estimates for this species also showed the largest confidence intervals. For Rhinolophus hipposideros and Barbastella barbastellus the population increase was less pronounced but significant, with a 1.8-fold and 1.6-fold
population increase, respectively. The only species with a more or less constant population size was *Myotis myotis*. Interestingly the estimated population trends for *Rhinolophus hipposideros* differed depending on the method applied (i.e. hibernation vs. maternity roost counts). We provide possible explanations for these findings and discuss the results of all species with respect to methodological and conservation aspects.

**Circulation of group 2 coronaviruses in a bat species common to urban areas in Western Europe**

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Fecal samples of 211 bats representing 13 different bat species from 31 locations in the Netherlands were analysed for the presence of coronaviruses using a genus-wide RT-PCR. Coronaviruses are known for their high potential for interspecies transmission, including zoonotic transmission with bats as reservoir hosts. For the first time a group 2 coronavirus was found in a bat, *Pipistrellus pipistrellus*, in Europe. This is of particular interest for public health as the reservoir host is a species that is common to urban areas in most of Europe and notorious for its close interactions with humans. Four verspertilionid bat species were found to excrete group 1 coronaviruses, viz. *Myotis daubentoni*, *M. dasycneme*, *P. pipistrellus* and *Nyctalus noctula*. The last species is a newly identified reservoir. The overall prevalence was 16.9% and positive bats were found at multiple widespread locations. The circulating group 1 coronavirus lineages were rather species-associated than location-associated.

**Cotton balls, the trilogy: building process, habitat preference and social structure**

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Roosting ecology and its correlates are among the major forces driving the evolution of bats. Few species of bats in the world build their own roost (E.g. modified leaves as tents). *Ectophylla alba* is a white bat, endemic to Central America and uses only tents as roosts. Our main goal was to understand the relationship between this type of roost and the social system of the species. Between 2005 and 2007, in Tirimbina Biological Reserve (Sarapiquí, Costa Rica) we did surveys of tents (53 weeks in 9 ha), filmed the construction process, we determined micro-habitat selection through 7 micro-habitat variables, captured groups (N=38) and marked each individual (N=98) and with infrared lights filmed behavior at night.
How hot is my home: Temperature of different types of tents

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Twenty two species of bats are know to use modified leaves of “tents” as roost. According to the architecture, several kinds of tents can be distinguished depending on the leave and the cuts made on it. The microclimate of a roost is a determining factor because the temperature of it will be necessary to balance the daily energy metabolism of an individual which can be crucial to their survival. We were interested to know: (1) If the tents have different temperature than un-modified leaves (UM leaves) at field conditions because of the structure, (2) If the heating and cooling curve is different between the tent and the UM leave, (3) If the different types of tents (inverted boat, apical, pinnate, conical, bifid) are heating and cooling curves differ between tents. We work at Biol. Res. Tirimbina (Sarapiquí, Costa Rica). We conducted 3 different experiments using i-buttons: First we measure the temperature in situ of the UM leave and the tent in three types or tents for a week period (conical, boat and bifid). In ex situ conditions, heating and cooling curves were obtained using a standard 25 W lightbulb as a heat source. This comparison was made between tents and leaves and in between the different types of tents. In the in situ experiment we determine there was no difference between leaf temperature and tent in the three types of tents. On the other hand, the tents are capable of heating up more quickly than UM leaves. Among tent’s comparison, inverted boat and bifid type have a steeper slope in the heating and cooling curves than the other types of tents. Besides, inverted boat and bifid tents reach higher temperatures than the other two tents. The largest bat species and larger groups are using the cooler tents, while the smaller species use the tents that are heated faster.

Nectar amino acids modify food selection in nectarivorous bats

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Chiropterophilous flowers secrete sugar nectar with small amounts of amino acids; nevertheless their role on food selection by bats is unknown. We investigate: (a) the role of amino
acids in nectar as a nitrogen source, (b) the importance of amino acid concentration in relation to sugar concentration for food selection, and (c) the role of the flavour provided by amino acids to nectar on food selection in nectarivore bats. Using individual flight cages, we offered bats (Leptonycteris yerbabueanae and Glossophaga soricina) pairs of experimental diets in individual flight cages. We used artificial nectars mimicking the composition and concentration of amino acids found in flowers of the main plant species visited by these bats in the tropical dry forest. We found that under nitrogen enriched conditions bats showed no preference between diets with different nitrogen concentrations. L. yerbabueanae showed no preference for nectar supplemented with nitrogen; however under nitrogen depleted conditions, G. soricina showed a preference for the higher nitrogen diet when confronted with high and low nitrogen nectars. Both bat species were indifferent to changes in nitrogen and sugar concentrations, suggesting that the presence of nitrogen in nectar could reduce their ability to differentiate among sugar concentrations (18 vs. 27%). When evaluating the effect amino acids have on nectar flavor, we found that Leptonycteris yerbabueanae always preferred diets without amino acids, but preferred the taste of amino acids present in the nectar of Pachycereus pecten (Cactaceae) over Ceiba aesculifolia (Bombacaceae). In contrast, G. soricina had no preferences for the amino acid flavor present in their field diets. Our results suggest that nectar amino acids could affect the foraging decisions of nectar-eating bats, regardless of the low concentrations at which they are present in floral nectar.

Some new vespertilionid bats from the Late Miocene of Ukraine

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A new vespertilionid with two upper and three lower premolars was found in the Early Vallesian (MN 9) locality Gritsev in Ukraine. The cranial morphology of this fossil combines some plesiomorphic features (e.g. three lower premolars) with apomorphic (e.g. short incisive tooth row, reductions of P2). The morphology of new bat suggests its close relation to Paleptesicus priscus. But P. priscus has some advanced morphology (e.g. upper molars have no metalophs and open trigon basins) and only two lower premolars. The morphological peculiarities of new taxa show its ecological habit closes to recent Vespertilio or Eptesicus. Apparently during evolution of Eptesicus-Vespertilio group in Miocene the reduction of small premolars happened independently in several extinct taxa. It can be one of the reasons of mosaic combination of plesio- and apomorphic features in Paleptesicus and the fossil bat from Ukraine. Other new fossil species from Late Miocene of Ukraine is the biggest extinct Myotis from territory of Eastern Para-Tethys known up to now. In spite of the big size this fossil Myotis preserves big and not reduced p2, 3, the uncompressed M3 and well-developed talonid of m3. By these primitive characters it is most similar to the Pliocene (MN 13/14) M. podlesicensis from the Poland which, nevertheless, is much smaller in size.

Concept learning in the nectar feeding bat Glossophaga soricina

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The ability to form concepts has been widely regarded as a sign of ‘higher’ cognitive aptitude in animals. Concept learning is the judgement of the relationship between stimuli based on a rule (e.g. greater than) as opposed to categorizing stimuli based on specific features of objects or perceived similarity. Concept learning has been demonstrated in a small number of animal taxa including some primates, birds and rodents. However, this type of cognitive research has not been studied in bats which is surprising considering their use of sophisticated echolocation to solve many tasks, from distinguishing between insects to locating flowers in a cluttered rainforest. Nectar feeding bats are of particular interest to study in cognitive tasks because of the unique coevolution they have developed with the flowers they visit and the way this may have shaped the way they learn and behave. We test a captive colony of the nectar feeding bat *Glossophaga soricina* in a two alternative forced choice concept task where bats are trained to form a concept of size. These bats perform well in laboratory learning tasks and can be trained to make thousands of decisions per night. Bats visit a feeder corresponding to the larger of two objects of a variety of shapes and receive a small reward if correct. Performance in trial tests where bats are required to choose between objects they have never before encountered are used to assess if bats are able to conceptualize this task. We apply the results of these tasks in a comparison of the performance of nectar bats in relation to other mammalian species and consider the possible benefits that concept formation would bring to these bats in maximising foraging efficiency.

### Hearing genes: Insights from phylogenetic discordance

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Audiogram data suggest that echolocating bats are arguably equipped with the most sensitive auditory systems of all mammals. While the sensitivity of mammalian hearing has long been attributed to the amplification of sound waves by outer-hair cells in the cochlea, it was only recently that the protein Prestin was identified as the molecular motor driving this system. A phylogenetic reconstruction of bats based on Prestin coding sequences results in an erroneous monophyletic grouping of echolocating bats, thus conflicting with the true species tree in which echolocating species are paraphyletic. This gene tree-species tree conflict can be traced to sequence convergence in several key protein domains that are assumed to confer high frequency hearing. To test this assumption, we also compared the Prestin sequences of bats with those of echolocating and non-echolocating whales, and again found evidence of dramatic sequence convergence in key domains among echolocating taxa. Finally, we compared bat-bat convergence and bat-whale convergence, and found that both cases of convergence involved a subset of identical amino acid site replacements. Our findings – which represent the most dramatic case of parallel sequence convergence reported to date – show that bats represent powerful models for understanding the genetics of hearing, and also show how phylogenetic comparisons of functional and neutral genes can be used to identify adaptive changes that would otherwise be missed.
Establishing hypotheses of homology in phyllostomid bat skulls

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Phyllostomid bats are the most ecologically diverse family within the order Chiroptera, including taxa that variously feed on insects, fruit, pollen, nectar, vertebrates, and blood. The cranial diversity, the variety of life-histories and the long period of evolutionary diversification make phyllostomids an attractive group to investigate the evolution of complex characters. Although studies of functional cranial anatomy of phyllostomids have been made, this group and more specifically all microbats remains essentially unexplored with respect to detailed description of cranial osteology. The aim of our work is to establish hypotheses of homology for the skull bones of phyllostomid as part of a large scale study of modularity in bats. Here, we chose to focus our analysis on some phyllostomid species with different dietary habits. These species are well represented in Museu de Zoologia da Universidade de São Paulo. We established 34 homologous skull landmarks for each species from different dietary groups. These set of landmarks are well established in other groups of mammals studied in our laboratory and reflects important developmental/functional relationships among cranial structures. They are positioned at the intersection of sutures or other discrete and homologous cranial features. Because adult bats are characterized by a relatively complete fusion of cranial bones, we used young individuals as a model to define and understand the structures of bones and sutures in adults. This study provides information and establish homology hypotheses for the skull morphology of phyllostomid bats. These efforts represent a first step as part of a larger project in which our focus is to understand the evolution of cranial morphology in New World leaf-nosed bats and the potential evolution of the relationships among traits.

Does hibernation affect memory retention for a spatial foraging task in bats?

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Hibernating mammals display severe changes in brain structure and biochemistry during deep torpor which might result in memory impairment. Here we asked whether the energetic advantage of entering torpor for surviving prolonged period of food shortage thus comes at a severe cost in cognitive performance? We conducted the first behavioural study on memory retention in hibernating bats. Temperate bats lend themselves as ideal model system for this question, because they obligately hibernate for at least a few weeks every year. They have long lifespans, are highly mobile and return to previously known roosts and foraging areas after hibernation. Therefore, we hypothesized that bats have evolved mechanisms which protect their memory during hibernation. In a behavioural assay, we trained 13 individual greater mouse-eared bats, Myotis myotis, in a spatial foraging task. After training 7 bats hibernated for two month while the others were kept under conditions that prevented them
from going into hibernation. Based on the above hypothesis, we predicted that the hibernated group will perform at the same level as the control group in a memory retention test. And indeed, the hibernated bats performed at the same high level as before hibernation and not differently from the controls. In the light of the high mobility, ecology and long life of bats, we propose that maintenance of consolidated memory through hibernation is under strong natural selection.

Speciation and taxonomy in bats: Challenges

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Species are generally the units of evolution in many ecological or biodiversity studies. Yet, the fundamental question of what constitutes a species is much debated. The answer will be quite different if one considers external morphological resemblance (i.e. phenetic species concept), patterns of gene flow (genetic species concept), or how individuals interact with each other (biological species concepts). Because bats are very diverse and have elusive modes of life, interactions within or between species are extremely difficult to assess under natural conditions. In the lab as well, studies e.g. on mate preferences are virtually nonexistent. Hence, phenetic or genetic concepts are usually the only practical criteria used to delineate species in bats. Even less is known about how species evolve, how divergent lineages merge as a single evolutionary unit, or evolve isolating mechanisms that will lead eventually to the formation of distinct species. A literature search with the key words “speciation” and “chiroptera” combined leads to only 43 references, while “speciation” combined for instance with “drosophila” returns 1354 references. In this symposium, we will try to bring together expertise from various fields of research related to speciation or species recognition. Questions relevant to this symposium will include whether acoustic characters can be involved in species evolution (e.g. throughout harmonic hopping), or if chromosome rearrangement are important isolating mechanisms, or else if speciation can occur sympatrically, as is suggested by some speciose groups. We will also explore if popular mitochondrial genes are good markers to indicate if individuals or populations share a single gene pool or not, and thus can inform taxonomic decisions regarding difficult groups.

Assessing short-term extinction risks using genetic simulation analyses

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The monitoring of genetic diversity has become an important tool in conservation biology, with the loss of diversity at neutral loci being used as a proxy for the loss of individuals. Furthermore, corresponding decreases in genetic diversity at coding regions may lead directly to a loss of evolutionary responsiveness or cause detrimental effects from inbreeding in threatened species. While genetic data may provide a means of monitoring populations particularly when traditional mark-recapture methods are unsuitable, the utility of genetic tools under specific models of population decline have not been fully explored. I used coa-
lescent-based simulation analyses to determine the efficacy of genetic data as a monitoring tool for short-term population declines. Specifically, I addressed several questions: (1) which type of molecular marker (DNA sequence data vs. microsatellite genotypes) responds more quickly to population declines?, (2) over what time spans do population declines become statistically detectable?, (3) how does population structure affect the power to detect population declines?, and (4) which analytical tools are most useful for detecting population declines? These questions are addressed using biologically realistic population parameters from two species recently of conservation concern in North America, eastern red bats (*Lasiurus borealis*) and little brown bats (*Myotis lucifugus*).

**Hypothesis testing in genetic demography:**

**Using multilocus data to reconstruct evolutionary history**

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Roosting colonies of Brazilian free-tailed bats (*Tadarida brasiliensis mexicana*) form some of the largest assemblages of mammals in North America, hosting up to millions of individuals. Such large groups require a reliable base of insect prey to maintain their numbers, and in the modern era, major agricultural insect pests form an important food resource. However, predictable swarms of these insect pest species likely developed only recently, probably in association with European agricultural practices, but certainly no earlier than indigenous advances in agriculture during the mid- to late-Holocene. It is thus hypothesized that the growth of these insectivorous bat populations was coupled to this expansion of agricultural habitat. We sequenced haploid and autosomal loci to determine the rate and time of onset of population growth in Brazilian free-tailed bats. Using a suite of data summaries and advanced inferential statistics (approximate Maximum Likelihood), we have determined that Brazilian free-tailed bat populations began to grow ~220 kya from a relatively small ancestral effective size (~230 thousand) before reaching the large effective population size observed today (~12 million). Notably, the growth of Brazilian free-tailed bat population commenced long before the development of human agriculture in Central and North America. However, Brazilian free-tailed bats are a subtropical species, and we hypothesize that the observed signals of population growth may instead reflect range expansions of ancestral bat populations from southern glacial refugia during the tail end of the Pleistocene.

**Reconsidering the importance of harvested forests for the conservation of tree-dwelling bats**

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Intensively managed forests are often seen as of low priority to preserve forest bats. The main conservation strategy recommended, i.e. saving unmanaged “habitat islands” from
logging to preserve some suitable habitat, detracts conservationists’ attention from ameliorating conditions for bats in harvested sites. We studied the threatened bat *Barbastella barbastellus*, mostly roosting in snags, in two beech forests: an unmanaged forest – the main maternity site – and a nearby, periodically logged area. We compared roost availability, roost use, capture rates, food availability and movement between these areas. The managed forest had a greater canopy closure, fewer dead trees, a smaller tree diameter and trees bearing fewer cavities than the unmanaged one. These differences helped explain the larger number of bats recorded in the unmanaged forest, where the sex ratio was skewed towards females. Prey availability was similar in both areas. We radiotracked bats to 49 day roosts. Six individuals caught in the managed area roosted in the unmanaged one at 6.7–8.2 km from the capture site. Few bats roosted in the managed forest, but those doing so proved flexible, using live trees and even rock crevices. Therefore, bats utilise areas in the matrix surrounding optimal roosting sites and sometimes roost there, highlighting the conservation potential of harvested forests. Besides leaving unmanaged patches, at least small numbers of dead trees should be retained in logged areas to favour population expansion and landscape connectivity. Our findings also question the validity of adopting presence records as indicators of forest quality on a site scale.

**Out of the dark: Diurnal activity in *Hipposideros ruber* on São Tomé island, West Africa**

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Apart from sporadic cases of daytime flights, bats are strictly nocturnal. The hypothesis on the origin of bat nocturnality that has so far received more experimental support is that it has evolved to minimize the risk of predation by avian diurnal predators relying on vision. Geographical settings characterized by a lower risk of diurnal predation should in theory allow bats to be active in daytime too, especially to increase foraging success. Oceanic islands are ideal study areas to look for changes in bat temporal niche since they often feature simplified avian assemblages with fewer birds of prey. However, the cases so far documented concern the Samoan flying fox (*Pteropus samoensis*) and only one echolocating bat, the Azorean bat *Nyctalus azoreum*. We report on an insular population of *Hipposideros ruber* on the island of São Tomé (Gulf of Guinea) performing frequent diurnal flights in the absence of forest-dwelling avian predators. We carried out emergence counts at three roost sites from four hours after dawn until dark and found that although emergence peaked around sunset, diurnal activity was frequent at all sites. Heavy rain caused abrupt returns to roosts, so by counting returning bats we estimated that up to ca. a fifth of a colony may be out during daytime. Bat detector surveys showed that bats keep echolocating in daytime and may forage, as revealed by feeding buzzes occasionally recorded. Gaining extra-foraging time can be vital in areas such as São Tomé where in the rainy season heavy showers may strongly limit the time available for feeding. However, many daytime fliers chased each other and chases were apparently often the cause for bats leaving the roost to perform at least short flights, i.e. diurnal activity has also a social function. A comparison between the sex ratio of bats mistnetted while leaving the roost or returning to it in daytime and that estimated by sampling bats inside the roost suggests that daytime activity is mostly
The discovery of cryptic species poses new challenges for species conservation. Species distributions and conservation status have to be re-evaluated and the ecological requirements within the species complex have to be re-assessed to suggest adequate conservation guidelines. The recent discovery of the cryptic bat species *Plecotus macrobullaris* in Switzerland calls for a novel appraisal of all three indigenous *Plecotus* species. We investigated the environmental niches (Ecological Niche Factor Analysis; ENFA) of the three long-eared bat species at the landscape scale and modelled their potential distributions using DNA-assessed records. Discriminant analysis was used for interspecific comparisons of niches. The occurrence of all three species was best explained by proximity to rural settlements and warm summer temperature. *P. auritus* was positively associated with forest ecotonal structures and coniferous woodlands in heterogeneous landscape matrices; *P. austriacus* preferred orchards and vineyards and avoided open and coniferous forests and *P. macrobullaris* presence was linked mostly to deciduous forests, with an avoidance of shrubbery and meadowland. *P. auritus* had the broadest niche, with occurrence predicted in most forested regions throughout Switzerland. The slightly narrower niche of *P. macrobullaris* mainly encompassed areas in the Central and Southern Alps. *P. austriacus* showed a very narrow niche and was predicted mainly in the lowlands, with its habitat requirements overlapping with those of *P. macrobullaris*. Although a range overlap was predicted for these two species, current observations suggest a parapatric distribution in Switzerland, possibly evoked by interspecific competition over similar resources. The projected distributions confirm previous knowledge of *P. auritus*, but shed new light on the two other species. In contrast to the newly discovered *P. macrobullaris*, which is actually quite widespread, *P. austriacus* is restricted to warmer cultivated lowlands and thus may suffer from recent major land-use changes. We suggest reclassifying *P. austriacus* to a higher conservation status.
cluding several species pairs or groups of unknown taxonomic status) have been reported in the literature till 2003. In the last years we surveyed bat fauna in different parts of Albania during six field trips (spring–summer period). We recorded 31 species: *Rhinolophus ferrumequinum*, *R. hipposideros*, *R. euryale*, *R. mehelyi*, *R. blasii*, *Myotis myotis*, *M. oxygnathus*, *M. bechsteinii*, *M. emarginatus*, *M. nattereri*, *M. brandtii*, *M. mystacinus bulgaricus* (*M. aurascens*), *M. alcatheo*, *M. daubentoni*, *M. capaccini*, *Vespertilio murinus*, *Eptesicus serotinus*, *Pipistrellus pipistrellus*, *P. pygmaeus*, *P. nathusii*, *P. kuhlii*, *Hypsugo savii*, *Nyctalus noctula*, *N. leisleri*, *Plecotus auritus*, *P. macrobullaris*, *P. austriacus*, *P. kolombatovici*, *Barbastella barbastellus*, *Miniopterus schreibersii*, and *Tadarida teniotis*. For several species we extended their known distribution ranges in the Balkans. The project has been conducted in cooperation with Albanian partners, in the frame of the EUROBATS Project Initiative, since 2010. The main scientific aim of the project is to publish a monography of Albanian bats, planned for next years. Our poster presents the actual distributional and conservation status of Albanian bats.

Is fixation of chromosomal rearrangements mediated by social structure? Perspectives from *Uroderma bilobatum*

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Closely related mammalian species often differ karyotypically due to fixation of chromosomal rearrangements. Heterozygotes for rearrangements tend to be the least fit; therefore, the mechanism for fixation is unclear. It has been proposed that small and inbred social groups are necessary to promote these high rates of chromosomal evolution found in mammals. However, this hypothesis lacks empirical evidence and the role of molecular factors and positive selection driving chromosomal evolution has been overlooked. In the tent-roosting bat, *Uroderma bilobatum*, three chromosomal races have been described. In this species there is low genetic divergence between races and two hybridize, making this a suitable system to test proposed mechanisms leading to fixation of chromosomal races. If small isolated demes are required to fix chromosomal rearrangements, we expect to find social groups formed from single matrilineal lines. To test this hypothesis, we sequenced the cytochrome-b gene from 7 social groups of *U. bilobatum* captured from their roosts to determine the number of matrilineal genealogies present. We found that groups are composed by multiple matrilineal lines, implying that female assemblages are likely comprised of individuals that are not closely related and that female dispersal occurs among tents. Population sizes do not appear to be amenable to fixation of detrimental chromosomal rearrangements simply as a byproduct of demography and breeding structure. Our study will help to illuminate mechanisms that lead for fixation of different rearrangements and speciation in mammals.
Deep differentiation between and within Mediterranean glacial refugia in *Myotis nattereri*

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The role of glacial refugia and the geographical patterns of differentiation within refugia in the Western Palaearctic region have been discussed for several species. In this study we use the bats of the *Myotis nattereri* complex, widely distributed throughout Europe and North Africa, as models for analyzing the evolutionary processes that have taken place in this area. We analyzed the phylogeographic and genetic structure in three mitochondrial fragments from 137 samples of the *Myotis nattereri* complex taken from all over Europe and Morocco. Results reveal deep genetic structure and the presence of at least four deep clades corresponding to the four main glacial refugia (Iberia, Italy, Balkans and Morocco) and evidence of a rapid post-glacial recolonization of Central Europe from the Balkans refugium, with a profound split between central-eastern European regions and western Mediterranean areas. The same four main clades are also supported by nuclear markers. The time and depth of the diversification found clearly indicate the existence of long-term isolation in allopatric refugia over several glacial cycles and the persistence of pre-Pleistocene differentiation. The strong genetic structure within the Iberian and Italian peninsulas points to a clear pattern of refugia-within-refugia.

What influence the selection of foraging sites in rhinolophids?

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Identifying key factors that determine foraging site selection is central to bat ecology and conservation. However, how and to what extent these factors influence decisions regarding the selection of foraging sites by bats remains poorly understood. Insectivorous bats that rely on echolocation to detect and capture prey constitute suitable model species for examining this topic, because the structural complexity of habitat, as well as insect abundance may impose severe limitations on their behaviour. Here, our main aim was to evaluate the relative influence of these factors (i.e. habitat structure and insect abundance) on the behaviour of bats regarding the selection of foraging habitat. We selected the Mehely’s horseshoe bat, *Rhinolophus mehelyi*, as the study case; a European species largely restricted to the Mediterranean climatic region. Based on its echolocation and wing morphology, we predicted that *R. mehelyi* would forage in structurally complex environments (i.e. dense woodlands). Besides, in Mediterranean regions insect abundance is related with landscape patches associated with water. We therefore predicted that *R. mehelyi* would forage close to water bodies. *R. mehelyi* showed preference for structurally complex environments (riparian forests, broadleaved woodlands, and eucalypt plantations), but it also foraged in less complex environments (savannah-like woodlands and scrublands). Nevertheless, *R. mehelyi* always foraged close to water bodies. Our results indicate that habitat structure and insect abundance influence
the foraging behaviour of *R. mehelyi*, and that spatiotemporal variability on prey abundance may lead to shifts in the selection of foraging habitat by rhinolophids.

**Metabolic rates, nutritional state, and thermoregulatory behavior of *Molossus***

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Preliminary data is presented on metabolic rates and thermoregulatory behavior for two species of bats in the neotropical island of Puerto Rico in the West Indies, *Molossus molossus* (Molossidae) and *Brachyphylla cavernarum* (Phyllostomidae). *Molossus molossus* roosts predominantly in anthropogenic structures where it is exposed to wide variations in ambient temperature. *Brachyphylla cavernarum* is a cave dwelling species roosting in microclimatically stable environments. Body temperature was measured at the beginning and end of each experiment and, in the case of *M. molossus*, upon departure and return to the roost. Oxygen consumption experiments began eight to ten hours following capture and were terminated before the beginning of the next foraging period. All *B. cavernarum* were allowed to feed the night before the experiment. Half of all *M. molossus* were deprived of food the night before the experiments. Resting metabolic rate for *M. molossus* is 1.17 ml O$_2$ g$^{-1}$ hr$^{-1}$, and 1.01 ml O$_2$ g$^{-1}$ hr$^{-1}$ for *B. cavernarum*. Both species closely regulate body temperature. We found differences in oxygen consumption based on the nutritional state of bats.

**Switching gears: The evolution of plasticity in feeding behavior and performance in phyllostomids***

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The ecological radiation of phyllostomid bats is marked by specializations of the feeding apparatus that are associated with differences in diet, bite performance (bite force) and biting behavior. Although variation in bite force is strongly correlated with both cranial size and morphology, we don’t know whether or how bats modulate their bite force through variation in biting behavior, and whether evolutionary changes in biting behavior are associated with changes in bite force across species. We investigated the relationship between biting behavior and bite force among 20 species of ecologically diverse phyllostomids. We studied the patterns of evolution of plasticity in biting behavior and bite force, and reconstructed ancestral states for behavior and its plasticity. Both behavioral and performance plasticity exhibit accelerating evolution over time, and periods of rapid evolution coincided with major dietary shifts from insect-feeding to plant-feeding. We found a significant, positive correlation between behavioral plasticity and bite force. Bats modulate their performance by changing their biting behavior to maximize bite force when feeding on hard foods, and this trend is most pronounced in the frugivorous Stenodermatinae. The ancestor of phyllostomids was likely a generalist characterized by high behavioral plasticity, a condition that also evolved in specialized frugivores and potentially contributed to their diversification.
Bat’s exploitation of cities: The importance of spatial and environmental variables

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The worldwide expansion and densification of urban areas has caused major concern for the conservation of biodiversity. The effects of different urbanisation levels on bats that form colonies and exploit scattered habitat patches in large home ranges remain often unknown. We recorded bat occurrence and activity levels with repeated bioacoustic surveys in three Swiss cities at 96 sampling locations. Bat species were determined by pattern recognition algorithms which were visually controlled. We selected environmental variables (30 environmental predictors measured on four spatial scales) and spatial variables (Moran Eigenvector Maps) to explain echolocation activity. Combining the selected explaining variables of both variable groups and one predictor for food abundance in a variation partitioning analysis determined the relative importance of the three components. Fourteen bat species (half of the Swiss bat fauna) were recorded in the cities with six species (Hypsugo savii, Nyctalus noctula, Pipistrellus kuhlii, P. nathusii, P. pipistrellus and P. pygmaeus) occurring regularly. H. savii and P. kuhlii have recently invaded the study cities north of the Alps. We identified a diverse set of significant variables with often strong effect sizes to explain activity of bat species and call type groups in the cities. Variation partitioning revealed high proportions of up to 44% variance in bat activity explained by the three components (environment, spatial and food). A significant portion was explained by the spatial variables. We explain the high variability in the selected environmental variables with the opportunistic foraging behaviour of urban bats (aerial hawkers), and with the colonising species that exploit non-saturated habitats. The major contribution of spatial components, particularly in the reproduction season, underlines the importance of spatial aggregation in social animals. Bats, with their high level of social organisation, share common maternity roosts and offer a unique model to study the interplay of spatial and environmental variables.

Beyond echolocation: Bats as models for acoustic communication

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Bats rely on acoustic information for spatial orientation as well as for social organisation, which makes them interesting models for comparative studies on the evolution of vocal communication. Vocalisations may reflect a specific behavioural situation, but also the identity and emotional state of interacting individuals. To characterise the impact of these factors in bat communication, we studied call production, and perception, during different social interactions in Megaderma lyra. Social calls typically consisted of several elements with distinct frequency-time contours arranged in a situation-specific fashion. Some of these call types carried identity cues. A combined video and sound analysis of agonistic appro-
ach situations revealed that specific call types indicated the action of the respective caller while interaction intensity was encoded in characteristic parameter changes. Concerning perception, a series of playback experiments disclosed that the bats discriminated between call types and interaction intensities within a call type. However, they did not necessarily form categories corresponding to call type and interaction intensity within a call type in reciprocal habituation-dishabituation experiments, an evidence for a context-dependent evaluation of social calls. To identify the parameters used by the bats for a within call type discrimination of identity, or affect, we presented contact call series differing in frequency, rhythm on level of calls and rhythm on level of call series in a two-alternative, forced choice procedure. The bats used predominantly frequency and, independently, the rhythm on level of call series for classification. Our results show that bats use parameters corresponding to prosodic cues in human speech to govern intra-specific communication. This suggests that the prerequisites for a communication of identity and affect are rooted in mechanisms common to mammals.

Echolocating bats achieve high prey detection performance with broadband calls

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Finding arthropods close to vegetation, such as a spider in its web or a caterpillar on a thread, is a difficult task for echolocating bats. In this situation, arthropod echoes are overlapped by massive echoes from the vegetation background. Acoustic masking will interfere with prey detection. Studies on European bats of the genus *Myotis* (Vespertilionidae) had suggested that species with extremely broadband calls perform well at finding prey close to echo-cluttering background. The aim of the present study was to test whether the relation of call bandwidth and prey detection performance is a more general phenomenon in bat sensory ecology. In the Malaysian rainforest, we investigated eight species from the bat subfamilies Kerivoulinae and Murininae that were known to produce very broadband calls. In a performance test with a background designed to mimic vegetation, five species were tested and all were able to find prey by echolocation few centimetres from the background. Two differently-reflecting backgrounds were presented. We could confirm the extreme bandwidths (>90 kHz) and high frequencies for the first harmonic of the bats echolocation calls during search flight. Six centimeters and even closer to vegetation, the bats still found prey in 50% of the trials. A modification of the background echo reflecting properties affected capture performance, which indicates that sensory constraints are indeed a limiting factor. Interestingly, the bats maintained high bandwidth of the first harmonic throughout approach and prey capture. By contrast, all vespertilionid bats investigated to date reduce call bandwidth shortly before prey capture, when call repetition rate is drastically increased. The ability to maintain high call bandwidth even at high repetition rate likely indicates a special adaptation of these rainforest bats to foraging in dense vegetation. Our results underline the importance of sensory performance for resource access and potentially for structuring niche space in animal communities.
Occurrence of bats in prefab houses in the Czech Republic and their conservation

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Prefab houses are an important source of potential roosts for bats. Recent studies suggest that Central-European populations of some bat species have shifted their roosting strategy in the last decade, with prefab houses becoming places of their most frequent occurrence. Large-scale renovations of prefab houses, currently performed in the country, pose a serious threat to populations of these bat species. However, detailed data on the occurrence of bats are available only from a small fraction of the total amount of prefab housing estates in the Czech Republic. The aim of this project was to enlarge knowledge on the occurrence of bats in prefab houses in the Czech Republic, as an essential background for planning effective conservation action. Altogether 42 prefab housing estates in 22 towns were surveyed in 2009. Monitoring of bats was carried out four times per year (in April, June, September and November), based on direct observation with the help of an ultrasound detector. Occurrence of bats was confirmed in 57.5% of the total number of 188 checks. Altogether four bat species were recorded, with Nyctalus noctula being the most frequent (80% of positive records), followed by Eptesicus serotinus, Pipistrellus pipistrellus and Vespertilio murinus. Cavities behind air vents to loft spaces (71.1%), gaps between panels (13.1%) and fissures under sheeting (10.2%) were the most frequently used roosts. In most cases, the bats were present in the roost all year round. Thanks to a project supported by the DBU foundation, Ministry of Environment of the Czech Republic and Partnership Foundation, awareness of the public, construction companies and authorities about suitable bat conservation measures applicable during renovations of prefab houses was enhanced and the measures were implemented at a number of sites.

In memory of Gerhard Neuweiler:
The auditory fovea, an adaptation for flutter detection in echolocating bats using CF-FM signals

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Rhythmical modulations in echoes from flying insects caused by the moving wings are behaviourally relevant information for bats using CF-FM signals. Transmitter and receiver of the echolocation system in flutter detecting foragers are especially adapted for the processing of flutter information. The adaptations of the transmitter are indicated by a flutter induced increase in duty cycle, and by Doppler shift compensation (DSC) that keeps the carrier frequency of the insect echoes near a reference frequency. An adaptation of the receiver is...
the auditory fovea on the basilar membrane, a highly expanded frequency representation centred to the reference frequency. The afferent projections from the fovea lead to foveal areas with an overrepresentation of sharply tuned neurons with best frequencies near the reference frequency throughout the entire auditory pathway. These foveal neurons are very sensitive to stimuli with natural and simulated flutter information. The frequency range of the foveal areas with their flutter processing neurons overlaps exactly with the frequency range where DS compensating bats most likely receive echoes from fluttering insects. This tight match indicates that auditory fovea and DSC are adaptations for the detection and evaluation of insects flying in clutter.

Environmental correlates of bat species richness in Central and southern Africa: Effects of spatial structure, taxonomy and model selection

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Understanding patterns and drivers of species richness at broad geographic scales remains one of the most challenging but important goals of biogeography, and one that has recently come to utilize macroecological variables, which are invoked as proxies delimiting species’ niches. Although some consensus exists regarding the primary roles of hypotheses based on environmental determinants, most of the evidence comes from diversity patterns of conspicuous taxa from Europe and the New World. We tested five broad-scale hypotheses (ambient energy, productivity, habitat heterogeneity, climatic heterogeneity, and climate) based on known georeferenced collection data of 116 bat species occurring in Central and southern Africa. We analysed the trends between bat species richness and environmental variables for the order Chiroptera as a whole, and separately for eight families (Pteropodidae, Emballonuridae, Hipposideridae, Miniopteridae, Molossidae, Nycteridae, Rhinolophidae, and Vespertilionidae). Species richness of the order Chiroptera and all the animalivorous families correlated more significantly with longitude than latitude. Conversely, species richness of the fruit bats was more significantly correlated with latitude than longitude. Environmental variables contributed differentially to Maxent model development of ecological niches and potential geographic distributions of bat species, but Jackknife analyses showed that temperature seasonality, when used in isolation, contributed the most to model development for the majority of bat species (particularly if >20 collection records). Ordinary least squares regression, partial regression, and spatial autoregressive models indicated that environmental variables linked with (1) the ambient energy and climate hypotheses were the best predictors of the species richness of all bat species, fruit bats, vespertilionids, rhinolophids, and hipposiderids; (2) the productivity and climatic variability hypotheses were the best predictors of the species richness of emballonurids and nycterids; (3) the climatic variability and ambient energy hypotheses were the best predictors of miniopterid species richness and; (4) the climate hypothesis was the best predictor of the species richness of molossids. Our results reveal that the roles of environmental determinants of bat species richness gradients in the Old World are complex. This likely reflects the interplay between the different ecologies of bat families and biogeographic history, mediated by significant climatic and geological changes across Africa since the Eocene.
Gut capacity predicts geographic distribution in phyllostomid bats

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Ecological physiologists have studied organism function to explain mechanistically why animals and plants can survive in their environments. However, most quantitative models used to predict, the geographic distributions of organisms are based only on environmental elements. These models do not provide mechanistic explanations to understand why a species can be found under a certain set of conditions. In the last decades, several studies have shown that the physiological capacities of animals can limit the maximum amount of key resources they can process, like water, proteins, or energy, affect dramatically the way organisms interact with their environment, and could pose limits to their geographic distributions. In this study we measured, and used, the maximal gut capacity to obtain energy of three Neotropical bat species of the family Phyllostomidae (Leptonycteris curasoae, Glossophaga soricina and Artibeus jamaicensis) to determine their geographic distribution. To model the distribution we predicted the minimum temperature at which these species can survive given their maximum gut capacities to obtain energy and satisfy their energetic demands. Geographic distributions predicted by the digestive model include the tropical and subtropical areas of the Neotropics, from South America to the Southwest of the United States, excluding most mountain areas. Predicted distributions are very similar to the geographic distributions described for the species based on other methods, and include between 85 and 100% of the collection sites reported for the three species.

Do thermoregulatory behaviour and related costs reflect differences in geographic distribution between closely related bats, Myotis myotis and M. blythii oxygnathus, in Europe?

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Small endotherms are able to save energetic costs by controlling their metabolic rate and body temperature on a daily basis (i.e. use of torpor) and are thus able to persist in regions with unfavourable environmental conditions. The availability of suitable roosts that support optimal thermoregulation plays an important role for the geographical distribution of heterothermic mammals. It had previously been shown that differences in northerly distribution between two distantly related bat species, Nyctalus noctula and Tadarida teniotis, are reflected in differences in thermoregulatory abilities and related energetic costs. In our study, we investigated whether this also applies for two closely related European bat species, the greater and the lesser mouse-eared bats, Myotis myotis and M. blythii oxygnathus. These two
cryptic sibling species differ markedly in habitat preference, foraging ecology and northerly distribution. However, they are morphologically very similar and occur sympatrically over wide areas of southern Europe. Under controlled laboratory conditions, we simulated an unsuccessful foraging night followed by a cold day after which bats supposedly would expect low food abundance also for the following night. We measured energetic costs and water loss of 32 adult male bats of both species during torpor. Additionally, we quantified their thermo-regulatory strategy – stay torpid or warm up – in the evening hours. Our results provide no evidence for marked energetic differences during torpor between the two similar sized bat species. Furthermore, individuals of both species did not pursue different thermoregulatory strategies during and at the end of the experimental cold day. Therefore, we found no support for the hypothesis that differences in geographic distribution between the two mouse-eared bat species may be linked to differences in energetic costs and thermoregulatory behaviour.

The scanning behaviour of free ranging *Barbastella barbastellus*

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Bats use echoes of ultrasonic emissions for orientation and food acquisition. The design and pattern of their echolocation signals and their flight behavior have thoroughly been studied, especially in the laboratory. Yet little is known about the shape of the sonar beam and the scanning behavior in the bats’ natural environment. Recently, forthcoming technology has enabled us to study bat echolocation calls with 16 microphones arranged in a planar array to reconstruct the shape of the sonar beam, to specify the source level (SL) of the emitted signals, and to assess its direction in relation to the bat’s flight direction. The exact position of the calling bat is determined by time of arrival differences. Subject was the barbastelle bat (*Barbastella barbastellus*), which is known to alternate between two different echolocation call types. Type 2 has a larger bandwidth, sweeping from 46–31 kHz, than type 1 which sweeps from 37–30 kHz. When recorded from ground level, type 1 has a higher SL than type 2. This could either result from alternating emission levels, scanning movements, or two emitters of different emission direction. Recordings made with the microphone array show that the direction of emission changes between the two call types. In a straight approach towards the array, type 1 calls are directed downwards, while type 2 and approach calls point upwards. The angle between the two call types is at least 35°. Both call types have about the same SL of 80 dB re 20 μPa at 1 m, which excludes alternating signal intensities. We assume that two different emitters are involved: Type 1 calls are likely to be emitted through the bat’s mouth while type 2 and approach calls are likely to be emitted through the nose. The function of two different echolocation call types will be discussed.

The bigger you are the harder you bite: Linking form and function of forest interior insectivorous bats

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Malaysia’s rainforests are home to the greatest diversity of bat species in the Old World with over 70 species recorded at a single location, Krau Wildlife Reserve, Pahang. This outstanding diversity is likely achieved through an intricate partitioning of the available resources within the habitat. In insectivorous bat assemblages, niche partitioning of food resources is effected in large part by physical and sensory access to the insect prey base. Differences in wing morphology and echolocation signal design provide some separation of these species in niche space, but separation along explicitly trophic axes has yet to be considered. Maximum bite force influences the hardness of prey that can be eaten providing a further means by which bats in diverse assemblages may partition the resource base. However, experimental data documenting biting ability (bite force) at the assemblage level are limited. Here, we examine the relationship between bite force and CM3 (tooth row as a measure of head size) and forearm length (as a measure of body size) in 24 species from three families of forest interior insectivorous bats from Krau Wildlife Reserve. There was a highly significant relationship between bite force and forearm length and CM3 at the assemblage level (i.e., across all species), and within families. The consequences of these findings for structuring mechanisms in species-rich monophagous assemblages are discussed.

Rhinolophus euryale in Slovakia: Current status of a population living at the margin of the species distribution range

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Rhinolophus euryale reaches in the region between Western Carpathians and Pannonian Lowland northern margin of its distribution range. That population is isolated from the main range in the Mediterranean; it occurs in a geographically limited area of southern Slovakia and northeastern Hungary. Current data on its distribution (more than 600 records from almost 80 sites) including analysis of spatial and temporal population changes are presented. Slovakian population is divided to 2–3 (isolated?) subpopulations occurring in separated roost systems (hibernacula – transient roosts – maternity roosts). Based on a revision of data from maternity colonies, the process of synanthropisation is discussed. Among 16 maternity roosts, majority are situated in attics (10, i.e. 62.5%), while 6 in underground (4 caves, 2 mines). A question remains, if the increasing number of colonies detected in man-made aboveground roosts is a function of population growth or a change of roost strategy in this species at its distribution margin.
New records of bat ectoparasites (Nycteribiidae, Ixodidae, Argasidae, Spinturnicidae) from the Eastern Mediterranean and Middle East

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New records of bat ectoparasites collected in the Eastern Mediterranean and Middle East regions (Crete, Cyprus, Crimea, Egypt, Libya, Lebanon, Jordan, Oman, Yemen, Socorta and Iran) are presented. In total, 16 species (535 specimens) of ectoparasites were found on 22 hosts bat species (211 individuals). Among the parasites found, there were 13 members of the family Nycteribiidae (n=509) and by one species of families Spinturnicidae (n=17), Ixodidae (n=4), and Argasidae (n=5). Our data significantly enhance the knowledge on distribution of several parasite species in the regions of southwest Asia. For the first time, ectoparasites of Eptesicus anatolicus and Pipistrellus hanaki are reported.

The Plio-Pleistocene bat fossils of the Almenara-Casablanca Complex: Getting closer to a modern assemblage

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The Neogene record of bats in the Iberian Peninsula is comparatively poor when compared with other European regions, particularly with Central and Eastern Europe. Most of the available data belong to upper Miocene localities, where certain taxa belonging to the Megadermatidae (Megaderma, Miomegaderma) and Rhinolophoidea (Hipposideros, Pseudorhinolophus) are common. These are no more represented in the modern European faunas, where Vespertilionidae prevail. The way in which the transition from the “subtropical” Miocene assemblages to the “temperate” Pleistocene assemblages took place in Spain is unknown, due to the lack of Pliocene localities with fossil bats. In this sense, the remains of chiroptera identified in two of the infillings of the Almenara-Casablanca Karstic Complex, in eastern Spain, provide valuable information contributing to fill in this gap in the history of bats in Western Europe. Two of the fissure fillings from this karst system, ACB4 and ACB1, dated from the Plio-Pleistocene transition and earliest Pleistocene, have yielded abundant microvertebrate remains, among which bats are relatively abundant. The bat species found in both assemblages are mainly similar, though they differ in relative abundances; most remains are of either recent or close to recent forms, including species of extended record of the genera Rhinolophus, Myotis and Miniopterus. Together with these, remains of new yet undescribed fossil species have been found, as well as the earliest record of other modern species.
The Quaternary fossil record of bats in Spain: An update

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During the European Bat Research Symposium that took place in 1987 in Prague, we presented a review of the record of Quaternary fossil bats in Spain, with comments to their interest in paleoecology and biogeography. Though numerous Spanish Pleistocene localities with small mammals had been described at that time, few of them were known to have yielded bat fossils. Nevertheless, 19 out of the 26 species known to be distributed in the Iberian Peninsula had been recorded at least at some locality. More than twenty years have passed since, and an important increase in the data of concerning these mammals has taken place. Numerous new localities have been discovered, and the realisation that bats can provide important information leading to more precise reconstructions of past environments has contributed to this increase in the available information. The upper Pleistocene and early Holocene are the best documented at this moment, with numerous localities with precise dating, that provide an important perspective leading to a better understanding of how climate and vegetation changes during the last glacial and the Pleistocene to Holocene transition might have influenced in the recent patterns of distribution and abundance of bats in Spain. Comparatively, the data concerning the middle and lower Pleistocene show a less important increase, though several lower Pleistocene assemblages are yielding interesting information leading to a better understanding of the history of certain species in Europe.

The sensory world of bats

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Research into bat echolocation has flourished for many decades and our understanding of bat sonar systems is getting deeper and wider at a rapid pace. The investigation of other sensory modalities that bats use to perceive the world is at an earlier stage, but even more so prone for fascinating discoveries en route. Here we briefly review recent advances in vision, hearing, echolocation, olfaction, magnetoreception and mechanoreception in bats with respect to their roles in spatial orientation, food acquisition and communication. Understanding the molecular basis for sensory adaptations has made major advances in recent years. A gene associated with vocalization (FoxP2) shows accelerated evolution in echolocating bats. A gene that confers sensitive and acute hearing in mammals (Prestin) provides evidence for convergent molecular evolution among distantly related echolocating taxa, and shows accelerated evolution in rhinolophoid bats. The molecular evolution of genes associated with colour vision and olfaction has also elucidated the genetic basis for potential sensory performance in bats. Bats are sensitive to light pollution, although research on bat vision is often neglected. Field experiments show that slow-flying, manoeuvrable species such as lesser horseshoe bats, Rhinolophus hipposideros, reduce activity when artificial high-pressure sodium lights are placed along commuting routes. The use of microphone arrays has shown recently that bats actively focus their sonar beam on objects of interest in 3D space. Interestingly, Rousettus fruit bats optimize localization in sonar performance by pointing the sonar beam off axis – thus directing the maximum slope of the beam onto the target. Behavioural studies have
highlighted that bats do not only use the echoes of their own calls for orientation, but also eavesdrop on the calls of other bats, which bears interesting implications for call evolution. Few studies have investigated magnetoreception, but it is clear now that at least some bats use it for orientation. Astonishingly, two studies have shown that nocturnal bats calibrate a magnetic compass by the sun; i.e., by the position where it sets. Bats use a diverse range of sensory modalities to perceive the environment, and our understanding of ‘what is it like to be bat’ will become richer from research that integrates molecular mechanisms with behavioural experiments set in an evolutionary and ecological context.

Estimating diversity: How many bat species are there?

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The last comprehensive list of chiropteran species was published in Mammal Species of the World in 2005. This list included 1116 bat species and an additional 934 subspecies. Although this diversity is impressive and bats comprise around 20% of extant mammalian species, many new species remain to be discovered, and new analytical tools are increasing the pace of the discovery process. In the last decade many new bat species have been recognized based on combinations of genetic data (mostly mitochondrial gene sequences), morphology, and echolocation call structure. Although some new species are collected in the field and immediately recognized as new, many others are found in museum drawers or studies of populations thought to belong to other nominal taxa. Newly recognized species generally fall into two categories: (1) species new to science that have never before been captured or recognized, or (2) species previously thought to be subspecies or population variants but shown to be distinct based on genetic data. In many cases, morphological examination of populations found to be genetically distinct has confirmed that they are different and best treated as distinct species. However, studies of nuclear genes have shown that some instances of geographic partitioning detected using mitochondrial genes do not reflect speciation, but rather mitochondrial lineage sorting resulting from female philopatry. The majority of new taxa described recently come from diverse and poorly-known tropical faunas and/or regions where water barriers have made it difficult to interpret patterns of morphological variation. Rather than decreasing gradually over time, the pace of discovery of new species has remained relatively constant for most of the last 100 years, with a burst of recent discoveries in the last decade. We discuss the role that genetics, echolocation call recordings, online databases, and the Internet is having on perceived patterns of species diversity in bats.

Blind as a bat? Comparative genomics brings light to the evolution of color vision in bats

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Within mammals bats exhibit the greatest level of sensory specialization. The complex and highly evolved process of laryngeal echolocation, allied with the capability of flight have given bats the ability to exploit most ecological niches throughout the globe. The pteropodid bats have large eyes specialized for nocturnal vision, whereas the microbats rely more on laryngeal echolocation and have questionable visual capabilities. It has been argued that bats developed their echolocation at the expense of other senses such as vision, however this hypothesis has never been fully explored. Molecular phylogenetic data suggest that the ancestor of modern bats was most likely capable of echolocation and that the pteropidid bats may have lost this sense “trading” hearing for vision and olfaction. To date the molecular analysis of color vision in bats and other mammals has linked changes in opsin genes to differences in ecology as well as other sensory capabilities. With the aim of establishing the evolutionary patterns and functionality of the photoreceptor visual pigments, the short-wavelength opsin gene (UV/Violet/Blue; SWS) and the median to long-wavelength opsin gene (yellow/green, MWS/LWS) were amplified, cloned and sequenced in all bat families. This genomic data set covered bat species that exist in very divergent ecological niches (with different feeding and roosting habits) and that possess divergent sensory capabilities. Our data show that the short-wavelength opsin has undergone gene defects leading to loss-of-function in several yinpterochiropteran and yangochiropteran lineages. We will evaluate the genomic consequences of nocturnality, laryngeal echolocation type and ecological niche specialization on vision in bats.

Echo acoustic properties of bat-pollinated flowers and their recognition by glossophagine bats

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Angiosperm plants and their animal pollinators coevolved into a mutualistic relationship. The plants depend on and compete for the animals’ pollination services and evolved sophisticated flower signals to attract their pollinators. These flower signals may be extremely specialized to exclusively attract only a subset of pollinators to increase pollination success. Thus, flowers adapted their signals to the sensory capabilities of their pollinators. In bat plants, flowers may reflect an echo conspicuous to echolocating bats. So far, only few plant species were examined and only one species has been found to have acoustically signalling flowers. We screened flowers, inflorescences and leaves of 65 different plant species from 22 families for their echo acoustical properties. We used biomimetic sonar to measure the echoes of bat-, bird- and insect pollinated flowers of different shape. Furthermore, during behavioural experiments with flower visiting bats, we investigated how those animals perceive echo-acoustic stimuli. We found that (i) bat pollinated flowers are very constant regarding shape and size and therefore their echoes are easy to classify, (ii) bat pollinated flowers evolved highly sophisticated acoustically active morphologies to emit echo signals, (iii) flower visiting bats perceive an echo acoustic image of a flower and its surrounding of particular high resolution.

New data on the early Eocene bats of Vastan, India

Thierry Smith1, Rajendra Rana2, Ashok Saini3, Kishor Kumar4 & Kenneth Rose5
The oldest bats from Asia have recently been described from the early Eocene Vastan Lignite Mine in Gujarat, western India. The bats are the most abundant and diversified mammals of Vastan Mine, which may locally represent a mangrove environment. They are not older than the other earliest bats recorded from the other continents but they are more diversified in comparison with the early Eocene bats known from North America, Europe, Africa, and Australia. No confirmed bats have been found in the earliest Eocene anywhere in the world. Here we present new dental and postcranial bat material collected during the most recent excavations at Vastan. This includes well preserved jaws and typical limb bones. A new species of a relatively large archaeonycterid bat is also documented. In total, there are eight species belonging to at least five genera and four families that are present in the same level of the same locality. Among the families, Icaronycteridae and Archaeonycteridae present the most plesiomorphic features whereas Hassianycteridae and Palaeochiropterygidae are more derived. Other derived species are present but difficult to relate to a known family. Resemblances to European taxa in particular suggest earlier Eocene biotic contact between India and Europe before the Indian-Asian collision.

Taxonomic researches of some Southeast Asian horseshoe bats

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Southeast Asia has a high number of cryptic bat species. With a rich diversity of landscapes, climates and microhabitats, it appears to be one of the best regions to conduct taxonomic and zoogeographic studies. Recently, the taxonomy and distributions of some cryptic species of the Rhinolophus megaphyllus group, R. euryotis group and R. pusillus group have been reviewed. Morphometric, acoustic and molecular data were employed to resolve taxonomic confusions within these species complexes. Some of the taxonomic uncertainties were elucidated. However, the results also show that a number of isolated populations have been evolving locally and that there are more cryptic Rhinolophus species to be described.

Complexity of chiropteran dentition: The GIS approach

František Špoutil1, Jukka Jernvall2 & Alistair Evans3

Chiroptera represents the second largest mammalian order. Yet, most of its members bear the most primitive molar type, the tribosphenic one, which is the best type for insectivory.
(except myrmecophagy). Nevertheless, differences have occurred in the clade in various aspects of the molar shape during its evolutionary history: from differences in size and cusp height to finer changes, i.e. reorientation of shearing crests. The impact of these characters on the final dietary niche is not always easy to estimate. To attempt to do so, we have used GIS techniques (already tested on Rodentia and Carnivora) to describe overall complexity of molar rows in bats and so to quantify the impact of the differences in molar crown shape and size. In addition, great morphological similarity among various molar rows of bat species can help us to test limitations of this new method.

Variability of echolocation calls of bats from Madagascar as observed by the Expedition Biriki

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Expedition Biriky ran over the November 2008 (in the end of dry season) and its goal was to record as much sounds of Madagascar as possible, including bats. The records of echolocating bats were obtained almost every night in the time up to 3 hours from the dusk. The record spots were not only the main national parks and their surroundings, like Andasibe-Mantad, Ranomafana, Andringitra and Zombitse-Vohibasia, but also the passing cities (Antananarivo, Fiannarantsoa, and Toliara) and other places (the coastal area near St. Augustin). We have collected ca. 30 records of echolocation calls from the wide range of biotopes from coastal areas up to about 1500 m a. s. l. in the central mountains, and from the rain forest to arid south-western areas. Interestingly, just one record was obtained in the urban area, indicating (despite of imperfections in the recording method) less abundance of bat species and individuals in the cities of Madagascar.

Stronger tests of mid-domain effects on latitudinal biodiversity gradients of New World bats

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One of the most pervasive patterns in nature is the latitudinal gradient of species diversity. Numerous hypotheses have been proposed to explain why the number of species increases toward the equator. A prominent, elegant and well-tested hypothesis is the mid-domain effect, which proposes that the random placement of species’ geographic ranges within bounded continents creates peaks in diversity at the equator and latitudinal decreases toward the poles. Typically, this hypothesis is tested by estimating some measure of goodness of fit between species richness patterns based on empirical data and those generated from a null model. Nonetheless, as has been recently pointed out, such curve fitting represents only weak tests of macroecological hypotheses. One means of strengthening macroecological inference is
to examine interchangeability. Two characteristics are interchangeable if they are identical from the point of view of the hypothesis. Biodiversity is multifaceted thereby providing numerous characteristics from which to assess the interchangeability of mid-domain effects. Thus, added support for the mid-domain hypothesis would come from demonstration of good fit of empirical gradients of other characteristics of biodiversity with those produced by a null model generating a mid-domain effect. We examined the degree to which a mid-domain model recapitulates latitudinal gradients in other forms of biodiversity such as phylogenetic, phenetic and functional diversity. Mid-domain models exhibited good fit to a number of biodiversity characteristics but exhibited poor fit for others. Geometric constraints at the least can produce biodiversity gradients that are similar to those found in nature. Nonetheless, significant deviations suggest that more than mid-domain effects determine latitudinal gradients in biodiversity. Fuller understanding of latitudinal gradients of biodiversity will come from simultaneous examination of random, contemporary and historical mechanisms to better understand their relative effects on the distribution and abundance of the current biota.

Should we standardize international English common names of bats?

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The increasing rate at which new bat species are being described, coupled with the growing public involvement in bat interest groups and bat-related issues, provides us with an opportunity to reconsider the English common names used for bats. The scientific binomial ascribed to each species provides a means of unambiguously identifying a taxon: this protocol is regulated by the International Code of Zoological Nomenclature. However, no equivalent regulations, or even guidelines, govern the common names that are ascribed to species. This has resulted in many different names being used to describe a single bat species, or in some cases, even a single family of bats. Here we draw your attention to some of the severe inconsistencies associated with the current English common names of bat species, at levels ranging from species, through genera to families. We also propose a set of principles, based on those adopted by the Committee on English Names for (the more than 10 000 species of) Birds of the World, which could be used to develop a definitive list of international English names for the (ca. 1200) bats of the world, removing existing inconsistencies. Such standardization will benefit both scientists and the public in communicating unambiguously about bats and their identities.

The evolution of high-frequency echolocation in horseshoe bats: Moth hearing, body size or habitat?

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Horseshoe bats (family Rhinolophidae) are characterized by echolocation frequencies that are, on average, higher than those used by other bat families. Here we use a phylogenetic approach to investigate the ancestral echolocation condition in the Rhinolophidae to test three hypotheses regarding the evolution of high frequency echolocation in this group of bats: (1) the Allotonic Frequency Hypothesis (high frequency echolocation in the Rhinolophidae coevolved with moth hearing and there should be a trend of increasingly higher frequencies from older to more recent taxa); (2) the Allometry Hypothesis (echolocation frequency is negatively scaled with body size and evolutionary changes in echolocation frequencies are correlated with changes in body size in the Rhinolophidae); and (3) the Foraging Habitat Hypothesis (evolution of echolocation frequency is associated with changes in habitat type). We used a combined Bayesian tree based on multiple gene fragments and reconstructions of ancestral states were performed using both discrete and continuous characters. The Allometry and Foraging Habitat Hypotheses were specifically tested by investigating whether frequency and body size, and frequency and habitat, have coevolved.

Comparative morphology of distal part of hind limb of bats with different ability to quadrupedal locomotion

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We compared myology of crus and leg of two bat species of similar size from two families with different ability to quadrupedal locomotion: *Myotis myotis* (Vespertilionidae; quadrupedal), and *Rhinolophus ferrumequinum* (Rhinolophidae; unable of quadrupedal locomotion). We identified, described and photographically documented origin, insertion and course of all muscles of distal part of hind limb of both bats. Musculus popliteus is the only muscle unique to one of the studied species – *Myotis myotis*. Muscles of *R. ferrumequinum* are mostly less robust than muscles of *M. myotis*. We found out and documented many differences in origin (musculi extensores breves, m. abductor ossis metatarsi quinti, m. depressor ossis styloïdalis), insertion (musculus extensor hallucis longus, m. peroneus longus, m. flexor hallucis longus, m. tibialis posterior, m. flexor digitorum brevis), relative length (m. peroneus brevis, m. tibialis posterior) or course (musculus extensor hallucis longus, m. peroneus longus, m. flexor digitorum brevis) among muscles of both bat species. Some of the differences might influence the ability to quadrupedal locomotion. To determine extent of influence of origin, insertion, relative length or course of muscles of hind limb on ability to quadrupedal locomotion it will be necessary to compare myology of hind limb in wider spectrum of species.

Bat roost characteristics in Central Norway (62–64 degrees North)

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Seven bat species were found during mapping of bats in the two counties of Nord-Trøndelag and Sør-Trøndelag in the years 1995–2007. *Eptesicus nilssonii*, *Myotis brandti*, *Myotis*
mystacinus and Plecotus auritus were proven to have roosts. Eptesicus nilssonii and Myotis brandtii seemed to be preferring heated spots in inhabited houses. These spots could be in a roof, a wall, or an attic heated by the sun, or it could be a pipe. Heat from electric devices like ovens, refrigerators, hot water tanks situated close to a wall could apparently be detected by the bats, even if the bats entered the house at a totally different place. Individuals of Myotis mystacinus were only found in two localities with particularly good local climate. One of these colonies was using an attic in an unused wooden house. The Plecotus auritus colonies were most usually found in church attics or in food storage houses with spacious attics in farms.

The RoBat; a bat inspired flapper

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Windtunnel studies on live bats have significantly increased our knowledge on the aerodynamics and performance of bat flight, however the complexity of bat flight is still not fully understood. A mechanical flapper device based on a bat wing, where single parameters can be adjusted will be a step forward in understanding bat flight. With this flapper device; “the RoBat” the influence on flight performance and of different wing kinematics parameters on the aerodynamics and flight performance of bat flight can be tested. The RoBat is designed, built and eventually tested in the windtunnel. The RoBat is based on the hand wing of the nectar feeding bat Leptonycteris yerbabuenae, with a wingspan of approximately 30 cm. The thumb is omitted as it does not contribute significantly to the flight kinematics. The first and the second finger of the Robat are rigidly connected to be able to create a leading edge flap, further all fingers can be individually adjusted to change the camber of the wing. Materials are selected with properties as similar as possible to that of bat wings. For the bones carbon fibre rods are used, for the membrane a thin, elastic Stretchlon® bagging film is chosen. The high flapping frequency of approximately 12 Hz is obtained with high performance servo motors controlled by a preprogrammed Arduino board. With the RoBat a broader parameter space of movements than exists in nature can be explored, and a better repeatability is obtained. The influence of typical bat wing characteristics on the resulting aerodynamics are investigated, such as the highly changing camber and influence of the leading edge flap on the strength and stability of the leading edge vortex (LEV). This will be done in the Lund University windtunnel, using a high-speed Digital Particle Image Velocimetry (DPIV) system for flow visualization, in combination with force transducers for measuring flight forces.

Bats as inspiration for biomimetic robots

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The principal objective of the Chiroping project is to discover how to engineer active sonar perception systems in robots, which can serve as a complement to vision and facilitate the deployment of robotic systems in situations where vision is infeasible. For understanding
the implementation of sonar systems echolocating bats are an obvious source of ideas. Their astounding diversity of diet and habitat attests to their success in integrating morphological, acoustic and behavioural parameters to enable robust and versatile hunting behaviours. The project will implement and built biomimetic models of an insect gleaning and a water-trawling bat species respectively. It uses a classic biomimetic methodology, involving close collaboration between bat ethologists and roboticists. First we identify and measure the relevant acoustic and morphological parameters of a few carefully selected bat species, then reconstruct from that the bat’s acoustic experience as it flies through natural hunting tasks. From this data, computational models of how the bat coordinates its acoustic, behavioural and morphological choices during hunting are being elicited and implemented on appropriate robotic systems. The models will be evaluated from an engineering standpoint as example embodied active sonar perception systems, using tasks analogous to the hunting tasks of their living prototypes; evaluation from a biological standpoint will also be carried out.

Adapting echolocation call intensity and directionality to habitat and behavior

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Echolocating bats can orient by sound in a complex auditory world in complete darkness. Bats adaptively adjust the features of their sonar vocalizations, i.e. timing, duration, frequency content, intensity, beam aim, and beam width, in response to information obtained from echo returns. The bat’s sonar adaptations to challenges of habitat and behavioral task provide a window into its perceptual world. Intensity and directionality of sonar calls form a spatial filter defining the range and width of the sonar. We have studied these features in naturally behaving bats in the lab and field. Beam aim and beam width control the angle of space bats inspect. Bats control beam aim by moving the head, and in a complex environment they shift the directional aim of their sonar beam to sequentially point their sonar beam precisely in the direction of closely spaced objects. Beam width constrains the bat’s “field of view”. Bats modify beam aim to the task by changing emitter size or frequency. Emitted intensity directly impacts the sonar operating range. Bat species hunting out in the open emit significantly louder calls than species hunting in more confined environments. Flexible bats hunting in different habitat types adjust emitted intensity to the clutter level. Neuweiler described adaptations of spectral and temporal features and our data show how also intensity and directionality of echolocation calls vary with species and habitat. The flexibility within species emphasizes how important adaptive motor control of acoustic output is for bats using biosonar to face behavioral challenges in various and changing habitats.

Multi-spatial approach for monitoring and modeling bat rabies in Puebla México

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It is difficult to assess the distribution of paralytic rabies because outbreaks occur locally and are not distributed evenly across time and space. We used a multi-spatial approach to understand distribution, feeding habits, and rabies prevalence in vampire bats (*Desmodus rotundus*) in Puebla, Mexico. We identified relations in three spatial scales: (1) locally, we compared rabies prevalence and reservoir relative abundance from different caves and analyzed surrounding vegetation in a 2-km radius; (2) at landscape level, we analyzed the influence of vegetation and land use patch configuration (patch number, size, isolation, edges, species diversity, fragmentation index); and (3) regionally, we related rabies occurrence in Puebla with environmental variables to produce a spatial model. We analyzed feeding habits using PCR techniques to identify feeding host and used different lab tests to identify rabies prevalence in bats. Locally, we found that large vampire bat colonies are related to higher rabies prevalence. At the landscape and regional scale, our results showed that *D. rotundus* and rabies prevalence are associated to edges in highly fragmented areas. Finally, *D. rotundus* feeds mostly in domestic animals, generally in cows followed by horses, pigs, donkeys, goats, and dogs. Presence of domestic animals is related to highly fragmented landscapes where contact rates between them and vampire bats occur. Changes in land-use, fragmentation, and cattle expansion in tropical areas have promoted vampire bat population growth, and rabies prevalence. This project is a model that can be extended to other areas in Mexico and represents a transdisciplinary and inter-institutional study that may help health authorities to prevent rabies outbreaks. Conservation and livestock management programs should be considered in rabies outbreaks prevention.

**Are bats able to sniff out their roosts?**

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To optimize the roosts searching strategies, bats need an extensive knowledge of a wide spectrum of suitable roosts and they should be able to identify and discriminate between them. Mainly vocalizations being heard from inside of the roosts or from its surroundings have been described as main cues in the recognition process. However, the use of chemical signals by animals may represent the oldest form of communication and especially in bats, due to their nocturnal activity, olfactory cues are likely to be an important mode of gathering information. In tree-dwelling bats a lots of their faeces and urine are being left near the entries to the roosts which are changed by some bat species very often. For that reason the importance of faeces and urine as olfactory signals used for discrimination between bat roosts was tested in the soprano pipistrelle (*Pipistrellus pygmaeus*). For odour preference tests, we used two different methods (i) the bats were let to sniff the olfactory signal in a wooden cage with the walls made of a wire mesh and (ii) experimental equipment was represented by an Y-maze with two olfactory signals in the different arms of the maze. It was shown that bats payed more attention to the signals in an Y-maze. Therefore this design was used in later sessions. Adult females performed higher searching activity in tests with conspecific roosts compared to that with the scents of heterospecific roosts of the sibling species, *Pipistrellus pipistrellus*. It seems that this discrimination ability is also displayed in relation to their own species, i.e. at the intraspecific level examining different colonies. On the contrary, juvenile females at the age of three months are not capable of such discrimination. These results indicate that females learn the discrimination ability later in their ontogeny.
Mechanics of soft tissue wing structures and the flight of bats

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It has long been recognized that the wing membranes of bats are specialized with respect to the primitive mammalian condition. Among other traits, bats wing skin is reduced in thickness, greatly elaborated in surface area, and possesses unique intrinsic musculature. In addition, the wing membrane is characterized by a highly structured collagen-elastin network, and previous work by our lab has documented that wing membrane skin has distinctive mechanical characteristics. Using polarized light imaging, we show that the architecture of the collagen-elastin network varies little within species, but shows great interspecific variation in a number of features of likely functional importance. Number, size, and patterning of the intrinsic wing muscles, particularly the mm. plagiopatagiales and mm. tensor plagiopatagii, show similar patterning. We demonstrate that structure of the connective tissue network relates directly to the mechanical characteristics of the wing skin, which, in turn, relates directly to the patterns of wing skin strain during flight. We also report on detailed anatomical analysis of musculature of the handwing that demonstrates losses of both flexors and extensors of metacarpophalangeal and interphalangeal joints in multiple bat species. We hypothesize that the specialized structure of bat wing membrane skin is directly related to the evolutionary loss of handwing musculature.

Results of the Indicator Bats (IbatsRo) programme in Romania between 2006–2009

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Bats seem to be useful biodiversity monitoring indicator species. By applying synchronized global wide monitoring methods there is a chance to found out on how species abundances and distribution changes are related to the global change. Romania has been joined the international Indicator Bats programme from 2006 in order to meet its obligation to the Convention on Biological Diversity. Here we present the progress in establishing the car based national bat monitoring programme in Romania using a network of 89 volunteers to generate distributions and abundances of registered bat species. During the monitoring 9861 kilometers were driven and 226 events have been registered on 105 routes from which 39 are considered to be monitoring transects. Beside the acoustic records collected, data concerning the environment (humidity, weather condition) were measured. We discuss the results to date, compare relative species abundance rates along roadsides taking into account the effects of different habitat types and climate conditions, and the potential of the project to provide data on species distribution map, habitat preferences of bats and determination of changes of population trends.
Bat conservation programme in Padurea Craiului, Bihor, and Trascau Mountains, Romania

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In the frame of the poster the authors will present a plan of the complex conservation work concerning seven bat species (Myotis myotis, M. oxygnathus, Rhinolophus ferrumequinum, R. hipposideros, Miniopterus schreibersii, Barbastella barbastellus, Myotis bechsteinii) in the northwestern part of Romania. Data concerning all aspects of bat activity will be gathered. Will be checked roost sites used in different periods of the year, foraging habitats, connectivity structures used during flights between shelters and feeding areas, migration routes. In all cases, appropriate, cost-efficient methods will be used for data collection: visual observations and counts in roosts, evening emergence counts, capture of specimens near roosts, at foraging or drinking sites or along flight paths with mistnets, hand-nets and harp traps, use of ultrasound detectors and ringing. We expect that by the end of the project on the basis of collected data, knowledge will be acquired about existing relations between roosts used in different periods of the year and feeding habitats. Comprehensive management plans will be compiled for the bat species targeted concerning all important issues of bats’ seasonal activity and these management plans will be advanced to administrators and custodians of Natura 2000 sites and other protected areas to include them in the overall management plans of these sites. Beside this, specific conservation actions will be carried out: closing of 15 caves in a bat-friendly way, to minimize the disturbance of bat colonies, control of tourism and modification of lighting conditions in tourism oriented caves, placing out of artificial bat boxes to supply available shelters for forest dwelling bat species and to compensate in some measure the decline of old woodlands, and stop the human disturbance by warning signs.

Population genetics and conservation status of cryptic species: The case of European Pipistrellus

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We analyzed eight microsatellite loci of the nuclear DNA of 364 bats from the Polish populations of Pipistrellus pipistrellus and P. pygmaeus. Our aim was to resolve the population structure of the two cryptic species by means of cross-species comparisons, and to assess species status in general (e.g., effective population size, presence of a bottleneck effect, level of inbreeding). We document differences between the species in respect of genetic distances, isolation by distance, molecular variance and migratory patterns, finally pointing to P. pygmaeus as the more migratory of the two. We also present evidence for recent bottlenecks and high levels of inbreeding in both taxa, and discuss their status as “Least Concern” species.
The diversity of Brazilian bats: An update with comments on species distribution and taxonomy

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Brazil is home of an astonishing richness of mammal species and bats account for about 1/4 of the known diversity for the country being only surpassed by rodents in number of species. The diversity of bat species occurring in Brazil has however only recently started to be more appropriately revealed. Early reports on the number of bat species recorded for Brazil date from the 1920s and 1940s listed from 50 to 98 species occurring in the country, later works from the 1990s indicate about 144 species, and more recent works point to an absolute richness of 165 to 168 species known and documented for the Brazilian territory distributed in 64 genera and nine families. Moreover approximately 20 species occur in close to the Brazilian frontier borders, over 5 are undescribed, and other 5 may be revalidated, and several are in severe need of revision. As a result we predict that Brazil harbors over 200 species yet to be formally recorded and/or recognized and estimated a possible number of 210 species. From this total seven species are Brazilian endemics, from the Cerrado (4), the Atlantic forest (3) and one from the Caatinga. More than 80% of the Brazilian richness of bat species has been recorded in the Amazonian Brazil, approximately 60% in the Atlantic forest, and more than 50% in the Cerrado. Apparently there is no correlation of the remarkable raise in the number of Chiroptera species and the increase of distributional records in Brazil with conservation measurements, but rather with the progressive development and exponential growth of the community of Brazilian young scientists interested in studying bats.

A phylogeny of the Neotropical stenodermatine bats (Phyllostomidae): Putting the fossils in the context

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Stenodermatinae (Phyllostomidae) is one of the most morphologically diverse subfamily of Neotropical frugivorous bats, with many unresolved intraclade relationships. Only four fossil forms of stenodermatines are known from cave deposits in Cuba. To date no attempt has been made to placing these fossils in the context of a phylogeny for the clade. We studied 167 characters of the cranial and dental morphological systems of all the fossil species of stenodermatine bats presently known (Cubanycteris silvai, Phyllops silvai, and Phyllops vetus) based on a set of characters recently developed. In this paper, we present a phylogeny of 33 species of stenodermatine bats including species representative of all currently known Stenodermatinae genera and subgenera and all currently known fossil species based on 300 morphological characters, and molecular data (2503 bp; RAG2 and cytochrome b). Fossil species were coded as missing data for the molecular characters. Analyses were run using parsimony methods with and without constraints using best-resolved trees retrieved from either the combination of a robust set of morphological and
molecular data or from the analysis of all molecular data combined. In all resulting trees the fossil form *Cubanycteris* was placed basal to all other short-faced stenodermatines (Stenodermatina), the two fossil forms of *Phyllops* were sister and formed clades with extant *Phyllops falcatus*, and the fossil *Artibeus anthonyi* nested within the *Artibeus* clade. According to our observations, *Cubanycteris* may be one of the first documented cases of a remarkable dimorphism in size among the bat fossil record, as it is known for most short-faced species. This indicates that extreme size dimorphism is not an ancestral condition within Stenodermatines, but that it may be a basal condition present in the short-faced bats clade.

Cryptic species of horseshoe bats (Rhinolophidae) of the *Rhinolophus hildebrandtii* complex in southern Africa

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Hildebrandt’s Horseshoe Bat (*Rhinolophus hildebrandtii*), one of the three species in the *fumigatus*-group, is endemic to the Afrotropical region. These large species are easily distinguished from most sub-Saharan horseshoe bats on size and noseleaf width. This ongoing study is employing genetic and morphological characters to characterize cryptic diversity in what we now recognize as the *R. hildebrandtii* species complex. Our analyses reveal that cryptic populations have been overlooked in the *R. hildebrandtii* complex, which differ from the smaller *R. eloquens* and *R. fumigatus*. mtDNA molecular analyses demonstrated paraphyly among southern African specimens previously identified as *R. hildebrandtii*. Some extraordinarily large specimens with distinctive noseleaf and cranial characters (from two mountainous areas of northern Mozambique and eastern Mpumalanga, South Africa) form a monophyletic group distinct from *R. hildebrandtii* individuals collected from lowlands regions of southern Africa. This raises the question as to whether one or more undescribed species of *R. hildebrandtii* exist, or whether another recognised taxon of similar size (possibly *R. eloquens*) has been overlooked in southern Africa. The latter hypothesis was excluded by extensive morphometric analyses of museum specimens including holotypes and topotypes. These analyses distinguish morphologically and genetically distinct populations; the first from the two mountainous populations and the second from the lowland population. The two populations of this large montane form also exhibit cranial shape differences that concur with shallow genetic divergences between them. Sonotype differences distinguish Mpumalanga animals (PF=33) from those from lowland Mozambique belonging to the “common” clade (PF=35–38 kHz). Furthermore, additional sonotypes (PF of 38 and 46 kHz occurring sympatrically at two localities in Zimbabwe and PF=44 and 33 kHz in the Kruger National Park) suggests that additional undescribed taxa await description within the *R. hildebrandtii* species complex.
Of bats and molecules: A genomics perspective.

2. The use of comparative genomics in the study of bats

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Mammals are one of the most diverse groups of vertebrates, with large differences in body size, life span, ecological adaptation, metabolic rate, behavior, reproduction and locomotion. An examination of this variation using comparative genomics will improve our understanding of the molecular mechanisms underlying morphological and physiological adaptation. Details of functional gene diversification at the genomic level may allow some of the greatest insights into species level differentiation, and will help annotate and explain our own genome. Furthermore, evolutionary analyses of whole genomes and targeted genes sequenced in divergent species have advanced our understanding of the patterns of human disease mutations in many inherited diseases and cancers. Bats are a particularly important group of mammals to study at the genomic level. They are unique among mammals having gained the ability of true self-powered flight, developed unique sensory capabilities (laryngeal echolocation), maintained high metabolic requirements with no apparent consequence for their longevity and arguably have unique innate immune responses to infectious disease. Recently large molecular data sets have uncovered the evolutionary history of bats. Using these evolutionary trees as a basis to interpret the evolution of genes in bats I will review molecular findings that investigate: (1) The evolution of vision, olfaction and hearing in bats; (2) How comparative genomics can advance our understanding of bat disease; (3) The gain/loss of echolocation in pteropodids; (4) The future for bat functional genomics.

Sensory escape from a predator-prey arms race: Low amplitude biosonar beats moth hearing

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Many insects, including some moths, evolved ears to detect bat echolocation calls and thus evade capture. Strong evidence for a bat counterstrategy specific to this defence has been elusive. Combining genetic diet analysis with moth neurophysiology and flight-path tracking, we show that the bat *Barbastella barbastellus* captures mainly eared moths, remains undetected by moths until close, and uses unusually low amplitude calls compared to other aerial-hawking bats. A perceptual space model demonstrates that, at these low call amplitudes, bats hear moth echoes before calls are conspicuous to moths, but not at the high call amplitudes typical of other aerial-hawking bats, such as *Nyctalus leisleri*. This advantage over prey comes at the cost of decreased detection range. The rarity of this stealth biosonar strategy allows *B. barbastellus* to escape the predator-prey arms race and exploit food resources that are largely unavailable to bats emitting greater amplitude calls.
Factors affecting the emergence times of several sympatric insectivorous bat species

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The terrestrial environment is subject to constant rhythmic changes including light intensity, temperature, humidity, changes in day length and duration of twilight. Organisms have to adapt to these changing environmental conditions to survive and reproduce usually by limiting their activity to parts of the day or night when conditions are favourable. Factors that influence these rhythms can be divided into extrinsic environmental factors (e.g. predation, food availability and weather conditions) and intrinsic factors (e.g. foraging mode, diet and foraging habitat). The aim of this study was to test several hypotheses accounting for different emergence times amongst sympatric insectivorous bat species. We recorded the emergence times of several species of bats (Myotis tricolor, Rhinolophus capensis, R. clivosus, Miniopterus natalensis, Neoromicia capensis, Tadarida aegyptiaca) within the same community at De Hoop Nature Reserve in South Africa, by visual observation and recording echolocation calls as the bats emerged. We also measured predation risk, food availability, and recorded the weather conditions this community experienced during a single season (summer). These data will be used to determine the relationship, if any, between emergence times and both intrinsic and extrinsic factors to evaluate several hypotheses.

Some difficulties of using integrated approach in bat taxonomy

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Despite initial expectations, wide use of molecular methods in classic zoological studies did not produce a universal criterion for species limits. Results of mitochondrial DNA and morphological analyses are often contradictory. In my opinion, cases when some forms are very different morphologically, but indistinguishable by genetic distance, are most interesting. I present several detailed examples of this kind I deal with faced during a study on Chinese bat fauna. At the moment, there is no correct explanation to this fact. It is probable that those species are young and evolutionary rate of the molecular marker used for the analysis is slower than speciation rate. Perhaps, present views on the speciation process do not fully correspond to the facts, because molecular phylogeny reflects evolutionary history of a single or some genomic elements, but how it corresponds to phylogeny of organisms still is not clear.

Convergent evolution in nectar-feeding phyllostomid bats: Nectar lapping vs. nectar pumping

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Characteristic for all species of neotropical nectar-feeding bats (Phyllostomidae: Glossophaginae) is a long, protrusible tongue that is used for drinking nectar from flowers. However, within the subfamily there are distinct morphological differences between the currently recognized tribes Glossophagini and Lonchophyllini. Tongues of Glossophagini (e.g., Glossophaga, Leptonycteris, Hylonycteris) show filiform papillae near the tip of the tongue, while Lonchophyllini (e.g., Lonchophylla, Lionycteris, Platalina) tongues largely lack these hairs and show lateral grooves over the length of the tongue. We used high-speed video recordings to analyze tongue movement during nectar extraction of Glossophaga soricina and Lonchophylla robusta in experimental setups. While Glossophaga repeatedly inserted and retracted its tongue into the nectar, the tongue of Lonchophylla remained during the entire visit constantly in contact with the fluid and retracted the tongue only when leaving the feeder. Large filiform papillae of Glossophaga were actively erected near maximum extension of the tongue and nectar could adhere between these hairs through capillary action. In contrast Lonchophylla used peristaltic movements of the tongue to pump the nectar along the lateral grooves. Nectar extraction efficiency (mg nectar / msec hovering duration) was very similar between the two species. The pronounced differences in tongue morphology and drinking behaviour (lapping vs. pumping) suggest an independent evolution of these adaptations to nectarivory and support alternative views of the current Glossophagine systematics.

Movement ecology of GPS-tracked Rousettus aegyptiacus: Unexpected foraging movements in a predictable heterogeneous landscape

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Optimal foraging theory asserts that an optimal forager should minimize energetic and risk costs associated with movement while maximizing the gain from food consumption during the foraging bout. Therefore, all else being equal, nearby food sources are expected to be favored by central place foragers over distant ones. Recent miniaturization and power reduction in GPS technology enables us, for the first time, to assess this basic prediction by monitoring bat movements over relatively large spatial scales with high spatiotemporal resolution. Using a miniature GPS datalogger (mass range 6.9–11.1 g), we collected high resolution, three-dimensional, location data of Egyptian fruit bats (Rousettus aegyptiacus). Bats were captured upon departure from their cave, equipped with a GPS data logger on their back, and released at the capture site (N=28). Tracked fruit bats exhibited long (14.6±3.7 km), straight (straightness index: 0.96±0.03) and fast (33.0±5.2 km/hr) continuous commuting flights in relatively high altitudes above ground level (108±52.6 m) upon departing from their roost after sunset and while flying back from the foraging site to the roost before sunrise. Bats exhibited high fidelity to their foraging tree, returning to the same fruit tree night after night (97.5% of the foraging bats flew repeatedly to the same location within 3 consecutive nights), often using the same flyway. In all but one case, bats did not select the closest fruit tree to forage from, but flew to large distances passing on their way many trees of the same species and ripeness state. Bats were also found to be loyal to their
roost, yet occasionally switch to neighboring roosts. This roost switch might result from capture trauma or attributed to minimization of nightly foraging flights.

**Task related flexibility in echolocation behaviour of *Noctilio leporinus***

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Trawling bats hunting over water surfaces encounter prey in various positions, thus offering different cues for echolocation. The cues range from disturbances of the water surface (transient cues) to rather stationary cues from prey protruding the water surface up to cues produced by flying insects in the air. We hypothesized that differences in prey position and hence differences in cues available to the bat require task related adjustments in the acoustic behaviour. Prey items were offered to captive *Noctilio leporinus* under semi-natural conditions in a flight cage either potentially moving in two dimensions, that is on the water surface or moving in three dimensions such as tethered mealworms in mid air. Our study focused on the comparison of echolocation and hunting behaviour of *N. leporinus* when feeding on prey in the air and on the water surface using high speed videos synchronized with ultrasound recordings. Bats were recorded during approach to prey as well as during and after capture. Ongoing analysis indicates task related differences in both echolocation and hunting behaviour. Bats responded with typical hunting behaviour courses to each task. First analysis of the echolocation behaviour showed conspicuously louder final buzzes when approaching an aerial prey item, compared to prey protruding the water surface.

**Does *Tadarida teniotis* really occur in Crimea?**

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Echolocation calls identified as searching calls of *Tadarida teniotis* were recorded at two sites in the forested mountainous part of the Crimean Peninsula, Ukraine, in September 2009. Description of the records is given and possible occurrence of *T. teniotis* in Crimea is discussed.

**Relating presence of house-dwelling bat species to habitat features in heterogeneous landscape (central Europe)**

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Relation between landscape features and foraging activity of bats is well demonstrated, where woodland, water and altitude are considered as the main predictors explaining variance in bat occurrence. However, the influence of the landscape structure on the roost-site selection was assessed only exceptionally in the large scale. We analysed 10 environmental variables which characterised the habitat in a roost vicinity of house-dwelling bats (altitude, local climate, landscape heterogeneity, type of vegetation cover, water conditions). Data presented altogether 1967 species records from 1299 buildings, collected during 1970–2009 in Slovakia. Tested factors exhibited various significances among particular species, depending on their ecological requirements. In general, we determined two species groups of house-dwelling bats. The first group comprised lowland and more urbanized species (*Eptesicus serotinus*, *Plecotus austriacus*, *Pipistrellus pipistrellus* and *Myotis blythii*). The second group (*Plecotus auritus*, *Rhinolophus hipposideros*, *Myotis myotis*, *M. emarginatus*, *R. ferrumequinum* and *Rhinolophus euryale*) was composed of species which are preferring forested or more indigenous landscape. Moreover, some intra-specific variation, regarding to the reproduction status, was found there also. Such spatial relationships between the location of the species roost and its surrounding habitat demonstrated strong effect of the landscape structure on potential roost availability with consequences in conservation management.

GPS tracking of *Rousettus aegyptiacus*: First evidence for large-scale navigational map in a mammal

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The ability to navigate is crucial for animals, yet navigational mechanisms are poorly understood, especially in mammals. Here we report the first GPS-tracking of bats. Egyptian fruit bats commuted from their cave to a remote fruit-tree in high, fast and very straight flights, and returned to the same individual feeding-tree night after night. Bats that were displaced 44 km south homed to one of two goal locations – cave or feeding-tree – that allowed ruling out navigation based on beaconing, route-following, or path-integration mechanisms, and suggested instead map-based navigation. Bats released within a deep natural crater exhibited severe disorientation, while bats released atop crater-edge homed well – indicating navigation by the geometric configuration of distal visual landmarks. These results provide the first evidence for large-scale navigational map in mammals.
What is new in systematics of the genus *Scotophilus* (Vespertilionidae) in Africa?

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Palaeotropical genus *Scotophilus* belongs to systematically most complicated bat groups of the family Vespertilionidae. Sub-Saharan Africa and the adjacent region of Arabia inhabiting species *S. dinganii* consists of rather intuitively grouped forms with forearm lengths 51–58 mm and yellow coloration of their venters. Only recently, molecular analysis revealed paraphyly of this taxon and suggested an existence of cryptic species complex. Preliminary analysis of mitochondrial cytochrome *b* gene sequences obtained from new material and complemented with published data widens the information on phylogenetic arrangement of the complex with emphasis on so far little surveyed West African and South Arabian populations. However, this new phylogenetic reconstruction of the genus *Scotophilus* rather provokes further questions than yields final answers on systematics. It is caused mainly by controversial taxonomic affinities of some tested specimens, which implies limited validity of morphological traits currently acknowledged for determination. This in turn obscures boundaries among *S. dinganii* and so far apparently well defined African species *S. leucogaster* and *S. viridis*. Our results confirm the published existence of several unrelated mitochondrial lineages within current *S. dinganii* in further regions of Afrotropics. Genetic diversity revealed in African *Scotophilus* thus needs a more detailed investigation and formal revision of systematics, not only of the particular species *S. dinganii* but also of the whole intrageneric content.

Role of *Latidens salimalii* – an endemic endangered fruit bat of South India – in forest restoration of Southern Western Ghats, India

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Salim Ali’s fruit bat (*Latidens salimalii*) is endemic to southern India and is classified as critically endangered by IUCN. This paper documents the expansion in the known distribution range of *Latidens* and details of diet. The study was made on the discovered populations of *Latidens salimalii* in the Agasthiyar hill range and the High Wavy Mountains of southern Western Ghats, India. Seeds and partially eaten fruits gathered from the floor of the feeding roosts have been identified. Mist netting below and above canopy near the fruiting and flowering trees of their foraging area during their activity time confirmed their visits. The feedstuff identification confirms they forage for fruits in relatively tall trees of the evergreen forests in an elevation above 900 m. The seedlings from the floor of bat’s feeding roosts also helped to identify the plants benefited by the bats. The study has revealed *Latidens salimalii* is morphologically adapted to play a major role in the seed dispersal of economically important fruit trees; some of them are endemic to southern Western Ghats of...
India. Their species specific dietary preferences immensely help to restore and bring back the natural forest community structures.

**A comparison of genetic population structure in two bat host-parasite systems**

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It is well known that parasites can alter host physiology, ecology, behavior, and population dynamics and thereby have a considerable influence on host fitness. Moreover, previous studies have shown that host social structure and population dynamics strongly influence the diversity and abundance of ectoparasites. However, in vertebrate host systems with their often complex and variable social systems it is difficult to accurately characterize the dynamics of host- parasite relationships. As a consequence, the effect of different forms of host social systems on the genetic co-variation of either host or parasite has rarely been empirically investigated in free-ranging vertebrates. In this study, we analyzed the spatial and temporal population structure of the ectoparasitic mite *Spinturnix bechsteini* using mtDNA and 5 newly developed microsatellite loci and compared it to the genetic structure of its host, the Bechstein’s bat (*Myotis bechsteinii*). In addition, 9 microsatellites were developed and analyzed for sister species *Spinturnix myoti*, the mite of the greater mouse eared bat (*Myotis myotis*). Our results suggest that, in *S. bechsteini*, seasonal bottlenecks result in substantial local differentiation as well as long-range genetic similarity. Dispersal is limited by the social system of the host but is nonetheless present, and likely to occur during autumn swarming and/or winter hibernation. These results suggest that repeated bottlenecks do not cause successive reductions in genetic variation, but do homogenize diversity over long ranges. In *S. myoti*, where bottlenecks are less severe, local genetic population structure was radically different, yet long-range genetic similarity was once again present. We suggest that host social organization is optimized to minimize the opportunity for parasite local adaptation, thereby maintaining an advantage for the host in the evolutionary arms race despite it longer generation times compared to the parasite.

**Combined analyses of extant and fossil “phyllostomine” bats (Phyllostomidae)**

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The Neotropical family Phyllostomidae is the most ecologically diverse family within Mammalia. It has long been thought that insectivory is primitive within this family, and insectivorous species traditionally were placed in their own subfamily, Phyllostominae. Fossils of three taxa referred to Phyllostominae are known from Mid-Miocene deposits in Colombia. Previous morphological studies have suggested that Phyllostominae may be monophyletic. Molecular studies have split this subfamily into five clades interspersed
by groups with non-insect diets, sometimes suggesting that insectivory may have evolved secondarily within the family. In this study we evaluated the phylogenetic relationships of these bats using four genes (~3000 bp) from throughout the nuclear genome. To date, all analyses of the timing of phyllosomid diversification have relied on placing fossils based on a limited number of morphological characters. We developed a data set of 270 dental characters to help place the fossils using combined molecular and morphological phylogenetic analyses. We constrained morphological searches, including fossils, to the sample of trees resulting from molecular data. The results show that phyllostomines are not monophyletic, but rather paraphyletic, consistent with previous molecular trees based on independent loci. Our analyses provide the first robust phylogenetic context for studies of the tempo and mode of evolution in phyllostomids.

From sensory modalities to ecological processes, from temperate to tropical zones: Following Otto von Helversen’s legacy in bat research

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In early 2009, Prof. Dr. Otto von Helversen tragically died during heart surgery. We would like to commemorate our teacher and friend by highlighting specific aspects of his research that promoted a multifaceted and visionary approach to the study of bats. In his early career, Otto’s way of studying bat biology was sometimes discredited as unfocussed, because he worked on a wide range of aspects and topics in bat biology and made use of a whole array of different techniques ranging from doubly-labelled water to high-tech bat recording devices. In his later years, however, it was increasingly recognized and appreciated that his integrative approach – one can truly describe it as Humboldtian – bore promising fruits. Here, we will elaborate on two examples inspired by Otto’s heritage: The energetics and sensory ecology of foraging. Tropical biodiversity has ever fascinated biologists and recent surveys have highlighted that some Neotropical rainforests harbour more than 100 bat species. What mechanisms sustain and constrain this high diversity? The ability to find, harvest and process food efficiently seems to be the key in promoting bat populations. The major currency for food intake is energy expenditure. Neotropical nectar-feeding bats (Glossophaginae) have emerged as a model system for understanding guild structures in general and the co-evolutionary interaction between pollinators and plants in particular. Although flower exploitation is costly for hovering pollinators, bats are more efficient in stationary flight than hummingbirds and moths; thus enabling bats to displace other pollinators. Nonetheless, plants force nectar-feeding bats onto the fast line of life by offering only minute nectar rewards, which causes exceedingly high energy turnover rates in nectar-feeding bats. But this sugar rush is managed through the immediate oxidation of recently ingested nectar. Thus, nectar-feeding bats are able to refuel while foraging; a phenomenon not yet known for any non-Chiropteran mammal. Before a nectar-drinking bat can lap its nectar reward or an insect-eating bat can crunch a beetle, bats are challenged to find their food in the dark. Here, the use of sonar, i.e., echolocation, is the dominant feature by which bats find their way. As bats forage in a wide range of habitats ranging from the open skies high above the canopy down into the dense understory of a tropical rainforest they need to orient in space, avoid obstacles and differentiate between echoes from food from the surroundings. Often, this is not an easy task because, for example, flowers and fruits do not move and thus are poor targets in the
dense rainforest. Looking at the high species richness and ecological diversity of bats in the Neotropics, it becomes obvious that they have found successful solutions. Combining echolocation as an active system with other sensory modalities, in particular smell, vision and listening to prey produced calls or noise, Neotropical bats feast on a broad range of resources offered at night in the tropical rainforest. Interestingly, it is not only the consumer looking for products, plant-visiting bats benefit from the advertisement by bat-pollinated or -dispersed plants where certain odours signal ripeness or where modified leaf-structures of flowers act as acoustic cat-eyes, advertising to the bat that the flower has not been pollinated yet and hence is full of sweet nectar. Whereas foraging in the forest constrains bats in the use of signal types, limiting them mainly to short, steep frequency-modulated calls, hunting in open spaces opens up a whole selection of call types, all adhering to the same principle but bearing in addition to echolocation information more than that, including species identity and phylogenetic heritage.

**Studying flight energetics in-situ using field deployable stable isotope analyzers**

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Flapping flight is one of the key innovations during the evolution of Chiroptera. Yet, the study of flight energetics is still in its infancies. The major reason for this is methodological constraints. During the past, two methods have been mainly used to study flight energetics in bats: Respirometry and doubly-labelled water (DLW). When using respirometry, bats are either required to wear a head mask while flying or they need to remain in stationary flight in front of the mask. Thereby, O₂ consumption and/or CO₂ production rate are measured by collecting the animal’s breath. When using the DLW method, animals have to fly for at least an hour or even longer, because CO₂ production rate and water flux is small in relation to the animal’s body water pool. Altogether, the application of both methods is hampered by some severe constraints. The most promising method for the study of flight energetics in bats seems to be the Na-bicarbonate (NaB) method. Yet, this method has not been used at all in bats until recently. The NaB method involves three steps: (1) Injection of 13C-labeled NaB into an animal, (2) measurement of pre- and post-flight 13C enrichment in exhaled breath, (3) and respirometric measurements of post-flight animals. Here, we describe an approach that promises to revolutionize our ability to assess the energy costs of bat flight. We have used a field deployable laser isotope analyzer to quantify the loss of the isotopic label in the breath of 20 g Carollia perspicillata. Using the analyzer, we measured simultaneously and directly the CO₂ production rate and the 13C label of exhaled breath, thus, enabling us to quantify the flight costs of C. perspicillata in-situ. We conclude that laser isotope analyzers warrant the rapid and accurate quantification of flight costs in bats, both in the field and in the lab.

**Perch-hunting in Rhinolophus bats is related to the high energy costs of manoeuvring in flight**

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Foraging behaviour of bats is supposedly largely influenced by the high costs of flapping flight. Yet our understanding of flight energetics focuses mostly on continuous horizontal forward flight at intermediate speeds. Many bats, however, perform manoeuvring flights at suboptimal speeds when foraging. For example, members of the genus *Rhinolophus*, hunt insects during short sallying flights from a perch. Such flight manoeuvres include a large portion of descent and ascent below minimum power speed and are therefore considered to be energetically more expensive than flight at intermediate speed. We quantified the energy costs of short, manoeuvring flights (<2 min) using the Na-bicarbonate technique in two *Rhinolopus* species that differ in body mass but have similar wing shapes. We hypothesized that – similar to birds – energy costs of short flights should be higher than predicted by allometry equation derived from bats performing long, horizontal flights at intermediate speeds. We predicted that *R. mehelyi* should encounter higher flight costs than *R. euryale*, because of its higher wing loading. Although wing loading of *R. mehelyi* was only 20% larger than that of *R. euryale*, flight costs of *R. mehelyi* exceeded that of *R. euryale* by 50%. Measured flight costs were higher than predicted by allometry for *R. mehelyi* but not for *R. euryale*. Field observations indicate that *R. mehelyi* is more likely to forage in a perch-hunting mode than *R. euryale*. This pattern could be expected if *R. mehelyi* face elevated energy costs during short manoeuvring flights due to high wing loading.

The effects of flight energetics and echolocation on group-foraging and sociality of bats

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By evolving active flight in the darkness of night, bats have been exposed to two major constraints: The involvement of high energy costs for locomotion and the necessity to orientate and navigate with echolocation. We asked if these constraints shaped the foraging behaviour of lesser bulldog bats, *Noctilio albiventris*. Radiotracking in Central America revealed that *N. albiventris* forage for swarming insects during a short period after sunset. We measured the stable carbon isotope ratio of exhaled breath in foraging *N. albiventris* and show that bats fuelled their foraging flights directly with newly ingested insects. Thus, they depend on an almost continuous insect supply to support the energy requirements of foraging. This and the short activity period of swarming insects, forces *N. albiventris* to forage in a highly efficient manner. Using automated telemetry we found that *N. albiventris* forage as groups and that group members fly within hearing distance of each other. In addition, playback of echolocation calls demonstrated that *N. albiventris* are attracted to feeding buzzes of foraging conspecifics indicating that eavesdropping on echolocation calls of group members is the mechanism by which this bat coordinates group foraging. We conclude that the constraints in time and energy lead to the evolution of group foraging in *N. albiventris*, and that echolocation calls of bats may serve an additional intra-specific function in bats besides auto-communication during navigation.
Do bats jazz? Song composition and syntax in the song of *Nyctalus noctula*

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Complex vocalizations during the mating season are a common feature in birds, but only in few mammal species, males compete for females and defend their territories with song. Bird song has often been described to be characterised by syntax-like rules, e.g. in the order of elements, motives or songs. In bats, only few examples of songs have been studied to date. Here, we examine the song composition and syntax in the complex song of the common noctule (*Nyctalus noctula*). Male noctule bats establish mating roosts in autumn that they acoustically defend against other males. We analysed individual song characteristics of 12 male noctules of an individually marked population in Berlin. First, we found all males to produce strophic complex songs composed of overall 8 motives. We detected however considerable between and in-between individual variation of pause duration between strophes. Second, males differed markedly both in the number and combination of motives in their strophes. Third, we found no stereotypic and species-specific syntactic rules in noctule song. Instead, individuals seem to freely combine motives and pauses of different length in their song. We conclude that in contrast to many bird species and bat species studied so far, noctules are able to time, combine and order their motives to liberally compose individual songs. Individual song variation suggests that these differences offer great potential for pronounced female choice in the social system of the noctule bat.

Of bats and molecules: A genomics perspective.

1. Karyotype evolution illuminated by FISH

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Since more than three decades, karyotype analysis based on banded chromosomes is a useful tool for judging phylogenetic relationships in bats. For example, the diploid chromosome number and three characteristic Robertsonian fusion chromosomes helped to transfer all karyologically studied former African *Eptesicus* species except one (*E. hottentotus*) to a separate genus, *Neoromicia*, which is a member of the tribe Vespertilionini and therefore not closely related to the genus *Eptesicus*. In the early 1990th, a molecular-genetic technique called fluorescence in-situ hybridization (FISH) was developed. Denatured DNA of metaphase chromosomes and denatured probe DNA consisting of sequences of interest are allowed to hybridize „in-situ“ on the microscopic slide. Chromosomal segments harbouring DNA sequences homologous to the probe DNA are indicated by the emitted visible light of the fluorescent dye used for probe detection. The advantage of FISH compared to chromosome banding techniques is the identification of homologous chromosomal segments even when rearrangements have changed the banding pattern dramatically. Therefore, only FISH enables karyotype comparison of species belonging to different bat families. Probes containing DNA sequences of whole chromosomes from different species, e.g. human,
Myotis myotis or the lemur Eulemur macaco, have been used to compare the karyotypes of representatives of ten bat families. The most important result of this study is the detection of two cytogenetic characters serving as synapomorphies for Pteropodiformes (i.e. Rhinolophoidea plus Pteropodidae). The cytogenetic basis in both cases is a small paracentric inversion hardly detectable with banding techniques. On the other hand, no cytogenetic synapomorphy could be found for Vespertilioniformes, which are clearly of monophyletic origin based on the results of molecular genetic studies.

Sibling species of *Rhinolophus luctus* from Peninsular Malaysia detected by karyological analysis

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The role of chromosomal evolution in speciation is still a matter of debate. Definitely, speciation is possible without or with minimal chromosomal changes. Examples for Chiroptera are the genera of *Eptesicus* and *Myotis*. On the other hand, closely related species with different chromosomal numbers (2n), resulting often from Robertsonian translocations which leave the composition of chromosomal arms unchanged, have been reported. Genera with a remarkable karyotypic variability are the South-East Asian *Tylotonycteris* (2n=30, 32 and 46) and the African *Neoromicia* (2n between 26 and 38). A surprising karyotypic divergence was found in *Rhinolophus luctus* belonging to the *R. trifoliatus* clade (subgenus *Aquias*) which is morphologically characterized by lateral lappets at the sella and a long, fluffy fur. In the recent years, two taxa, previously included in *R. luctus*, have been elevated to species rank; *R. formosae* for the reason of a different chromosomal number, and *R. beddomei* from South India and Sri Lanka for the reason of size differences and the shape of the upper canine. The diploid chromosomal number of the Malayan specimens of *R. luctus* is 2n=32, as for specimens reported from Thailand and for *R. beddomei* from India. However, our banding studies revealed the existence of two largely differing karyotypes within a small geographic range. The karyotype of specimens caught at low elevations differs from that of specimens from higher elevations in nine of the total of 15 autosomal pairs. In addition, a Y-autosome translocation is present only in the lowland taxon. Further, analysis of mtDNA revealed sequence differences clearly larger than at subspecies level but somewhat smaller than at species level. This points to a relatively recent speciation process. To sum up, there exist two distinct, morphologically very similar sibling species of *R. cf. luctus* in Peninsular Malaysia.

The trinity of energy conversion: kinematics, aerodynamics and energetics of bat flight

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The aim of this study is to examine the interactions between kinematics, aerodynamics and energy consumption in bat flight. Which aerodynamic forces are produced, which movements of the flight apparatus generate these forces and how efficient is the conversion of the used metabolic energy? Here we present data from two individuals of a nectar-feeding bat species (*Leptonycteris verbabuenae*). The experiments were performed in a low-turbulence wind tunnel over the entire speed range for which the animals would fly. The vortices the bats created in the air to produce lift and thrust were visualized with SDPIV (stereo particle image velocimetry). The exact movements of the wings were recorded with high speed cameras and fast-response respirometry was used for measuring the flight metabolism. To link kinematics directly to the lift production from the aerodynamic analysis we examined several kinematic parameters, like the camber, the angle of attack and the wing area over the course of the wing stroke. Other parameters, like the angle of the leading edge flap and the bend and sweep of the wingtip, were examined for the first time in bats to find possible impacts on the vortex wake structure, especially potential connections to the leading edge vortex and the reversed vortex structure, which can be found at the end of the upstroke in bat wakes. From the comparison between the metabolic input and the aerodynamic force output, we could also estimate the efficiency of bat flight.

Big eyes, but for what? The role of vision, echolocation and olfaction in the foraging behaviour of the big-eyed bat *Chiroderma villosum* (Phyllostomidae)

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Bats foraging close to or within vegetation, such as frugivores, face interference of target echoes with clutter echoes. This makes detection of fruits by echolocation alone difficult. One way to overcome this problem is the use of multimodal cues. Some experiments have shown that frugivorous bats use scent to find ripe fruits. Until now most studies on bats have neglected the possible impact of vision for foraging. Here, the fig-eating bat *Chiroderma villosum* might be a good example as it has big eyes. Larger eye size is usually associated with increased visual performance compared to smaller eyes. We therefore hypothesized that foraging *C. villosum* depend more on visual cues than other species such as Artibeus watsoni with distinctly smaller eyes. We tested the use of different senses of *C. villosum* in behavioural experiments (1) by exposing them to scentless figs in a dark room where only echolocation cues were available, (2) by offering ripe figs in a cotton bag, broadcasting only olfactory cues, and (3) by offering figs tightly sealed in a clear plastic bag illuminated by artificial moonlight where only visual cues were available. The bats’ foraging and echolocation behaviour was recorded simultaneously. Interestingly, both species reacted strongest to scent cues. The presence of other cues did not improve their detection capabilities although eye size of *C. villosum* exceeded that of *A. watsoni* by far. We also checked fig fruits for possible UV marks that might deliver visual cues but did not find evidence. We conclude that, contrary to initial expectation, *C. villosum* uses mainly scent cues for detection and identification of ripe fig fruits. Perhaps visual cues play a role in orientation as *C. villosum* frequently flies long distances above the canopy and might use its eye sight for assessment of landmarks.
Current and future conservation of European bats

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Biodiversity is being lost at an unprecedented rate, with significant impacts on both natural systems and human well-being. In order to reduce the loss of biodiversity in line with CBD 2010 targets, it is important to understand and predict the effects of different human-induced environmental changes on biodiversity, to facilitate planning and implementing robust conservation measures. Bats are an important component of biodiversity, comprising a fifth of all mammal species and providing a number of essential ecosystem services such as pollination, insect regulation and seed dispersal. However many bat species are threatened by land use change, with climate change also posing a future threat due to further loss of suitable habitat. Understanding how climate and land use change may affect these species will be critical in conservation planning which is robust to predicted future changes. I will be using monitoring data collected throughout Europe, along with records of species occurrence from published literature and museum records, to determine the habitat and climate associations of European bats, and to investigate how distributions may change under future climate and land use scenarios. I will also look at whether current protected areas are sufficient to protect bats in Europe, where 45 species are protected under the Eurobats agreement, and how conservation areas may need to adapt in light of future climate and land use change.

Gallery forests boost bat diversity in southern Mali, West Africa

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It is commonly assumed that diversity of tropical bats decreases from forests to drier vegetation biomes. However, the transition zone between forests and savannas is characterized by a habitat mosaic, which offers suitable habitat patches for numerous forest species that have their centre of distribution in the forest zone. This vegetation mosaic is therefore expected to support high species richness of bats caused by habitat heterogeneity. To test this hypothesis, we assessed diversity and assemblage structure of bats in gallery and ravine forests in four regions in southern Mali. Our new surveys comprised 51 species, including 30 species recorded for the first time and increasing the total from 25 to 55 species for the country. Several new records constitute significant range extensions, mostly of species usually found in the forest biome further south. We further recorded several cave-roosting species that show an overall patchy distribution, with fragmented populations in the mountainous regions of West Africa. The four study regions differed in species richness and showed considerable species turnover, which might be caused by complex biogeographic and topographic connections with other (source) regions. On the larger scale, our data testify to the enormous importance of gallery and ravine forests, which despite their small area contribute significantly to bat diversity on the landscape scale. In view of current land use conflicts between national authorities and local communities, appropriate co-management plans need to be designed and implemented by the different stakeholders as to protect these keystone habitats in southern Mali on the long-term.
Public attitudes towards bats in Switzerland: How they are affected by experience and knowledge

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The populations of many of the 26 species of bat found in Switzerland have experienced dramatic losses in the recent past and protection interventions are necessary to prevent losses becoming irreversible. In many cases, the success of a strategy is dependent on the acceptance by the public who are expected to tolerate the restrictions that are inevitably associated with conservation interventions. Most species use the built environment for roosting and their continued use of buildings depends to a large extent on the tolerance of residents and building managers. Academic researchers and bat conservationists should be particularly interested in public attitudes when designing strategies and interventions to enhance bat conservation. Furthermore, there is reason to believe that increased ecological knowledge correlates with positive attitudes towards better quality habitats. However, the attitudes of people towards bats and the level of knowledge of bats in the community have remained unstudied. This study sought to address this knowledge gap by means of a mail out survey aiming to measure peoples experience, knowledge and attitudes towards bats in Switzerland. Experience and attitudes were measured using a scale developed and piloted in Switzerland in 2009. Knowledge was assessed by means of a series of questions related to the morphology, behaviour and conservation status of Swiss bats. Surprisingly few correlations between experience and knowledge were found although knowledge correlated strongly with most of the attitude items. Put simply, people who know more about bats are more predisposed to feel positively about bats. This result underlines the importance of public education campaigns. Furthermore this study identifies gaps and weaknesses in public knowledge, which would allow such information campaigns to be efficiently targeted.

Derived characters of higher-level chiropteran clades

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Recent molecular research into the relationships of mammals indicates that Chiroptera is part of a large clade - Laurasiatheria - that includes pholidotans, carnivores, cetaceans, artiodactyls, perissodactyls and eulipotyphlans. This is in contrast to the previously prevailing view, based on morphological data, that Chiroptera was part of Archonta. In light of this new view of higher-level relationships of Chiroptera, we provide a detailed list of chiropteran synapomorphies using the PhyloCode format. There appears to be a single dental synapomorphy and two postcranial synapomorphies of the clade that includes all extant bats, which we term Chiroptera. The remaining synapomorphies of the clade are soft tissue features that would not be preserved in fossils that we have therefore attributed to Chiroptera. We define the clade Apo-Chiroptera, which comprises Chiroptera as well as the Early to Middle Eocene fossil families Onychonycteridae, Icaronycteridae, Archaeonycteridae,
Hassianycteridae, and Palaeochiropterygidae. There are two craniodental characters that are unambiguously diagnostic of Apo-Chiroptera; all other known or putative apomorphies are postcranial features that are part of the flight apparatus. Within Chiroptera, the traditional arrangement of bats into two suborders (i.e., Megachiroptera and Microchiroptera), which is based on morphological data, has been strongly challenged by molecular data, which supports a conflicting hypothesis, identifying two groups of bats: Yinpterochiroptera comprises the non-echolocating Pteropodidae (formerly Megachiroptera) and the echolocating Rhinolophoidea, while Yangochiroptera includes the remaining echolocating taxa (formerly in Microchiroptera). We find few morphological characters that can be interpreted as unequivocal synapomorphies of either Yinpterochiroptera or Yangochiroptera; nearly all of the support for these two clades is molecular.

Geographic distribution of parasites of the insectivorous bat, *Miniopterus natalensis* (Miniopteridae), in South Africa

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Bat ectoparasites belong to five different Orders, with six families exclusive to bats, and so similarly do bat endoparasites represent a great diversity of species. These parasite communities can be so overwhelming that the bats may be forced to change their foraging habitats and their roosts to avoid them. With so many parasite species intimately related to bats, studies of them may offer valuable insight into the biological, systematic and phylogenetic aspects of their hosts. This study aimed to test several hypotheses on the factors which influence the geographic distribution of internal and external parasite species of the insectivorous bat, *Miniopterus natalensis* (Miniopteridae), in South Africa. The three main objectives were: (1) to identify species of internal and external parasites infecting *M. natalensis* colonies from selected localities in South Africa. (2) to investigate variation in relative parasite loads of the *M. natalensis* communities with regard to locality, climate and altitude. (3) to determine prevalence of infection and influence of host sex on species composition of parasite communities and parasite burden. I then hypothesized that: (1) both ecto- and endoparasite infection loads will vary between colonies in different geographical provinces. Predicting that bats occurring in those regions with more variable habitats will harbour (a) more varied ecto- and endo-parasite species, and (b) higher intensities of infection by those parasites. (2) host sex will have no effect on either ecto- or endoparasite infection intensity. Predicting that no differences between male and female host infection intensity or species diversity by either ecto- or endoparasites. (3) host body size affects the level of parasite infection. Predicting (a) that greater host body mass will correlate with greater ecto- and endoparasite species diversity, and (b) that greater host body mass will correlate with higher endoparasite load, but (c) that no such relationship exists in ectoparasitic bat flies.

New degrees of freedom in sonar-beam control by fruit bats

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Bats from the genus *Rousettus* use a unique strategy of echolocation. Instead of emitting tonal laryngeal calls like most bats, they emit wideband ultra-short clicks (~100 ms duration). In contrast to long-held previous beliefs, recent experimental and theoretical results suggest that click based echolocation used by the *Rousettus* genus cannot be regarded as primitive, but is in fact rather sophisticated. Here we present the echolocation behavior of six Egyptian fruit bats (*Rousettus aegyptiacus*) that were trained to detect, localize and land on a target in different acoustical scenes with varying levels of complexity. Using 2 video cameras and a 20-microphone array we tracked the position of the bats and estimated their beam shape and beam direction while they performed the task. The bats’ behavior in the simple acoustical scene (one target in the room) revealed an interesting pattern: Contradicting previous notion, the bats did not center their sonar beam on the target, but instead they pointed it off-axis, accurately directing the maximum-slope of the beam onto the target. Information-theoretic calculations showed that using this maximum-slope strategy is optimal for localizing the target – at the cost of detection (SNR). We further proposed and showed that there exists a tradeoff between detection (optimized at stimulus-peak) and localization (optimized at maximum-slope) and suggested that it is fundamental to spatial localization and tracking accomplished through various sensory systems. Further, comparing the bats’ behavior in scenes with varying levels of complexity (varying number of targets in the room) showed that these bats can modulate the spatial extent covered by their biosonar system, by altering both the direction of the beam as well as its width. These results suggest a new echolocation degree of freedom possessed by fruit bats.

**Foraging activity of Central European bats in winters of varying severity? a study dedicated to the memory of Prof. Gerhard Neuweiler who long encouraged ecological research in endangered European bats**

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The winter activity of bats was studied in an area of Bavaria, southern Germany, for three consecutive years (2007–2010). Echolocation calls were recorded in known foraging areas (the surroundings of water bodies) between October and March of each year, and bats were regularly seen on evenings with temperatures above +6 °C, except for the period between mid-December and mid-February, when even bouts of warm weather did not appear to trigger foraging activity. The most frequently recorded species were *Barbastella barbastellus*, *Nyctalus noctula*, *Pipistrellus pipistrellus*, *Pipistrellus nathusii*, and *Vespertilio murinus*, most of which hibernate in roosts of varying temperature. Final buzzes indicating attempts to catch prey were recorded for these species even in early December and late February, which supports the idea that the bats were not only in search of water or just moving between roosts. *Myotis* species, on the other hand, which hibernate in roosts offering more constant temperature conditions, were not observed at all between mid-November and mid-April. Further investigations have to show whether warmer winter evenings offer bats an opportunity for casual hunting or whether such winter foraging expresses an urgent need for nourishment in the case of some individuals due to unfavourable conditions.
Dynamics of emergence from roost and diet of *Myotis dasycneme* from nursery colony in Lubnia, northern Poland

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Despite the fact, that in some regions of Europe, numerous and easily available populations of the pond bat *Myotis dasycneme* still occur, research on ecology of that threatened species is relatively scarce. Moreover, most of that studies have been conducted in anthropogenically transformed, agricultural landscapes of western Europe, while analogous studies from eastern part of *M. dasycneme* geographical range are generally lacking. The aim of this study was to examine factors affecting dynamics of evening emergence of pond bats from one of the two known nursery roosts of that species in Poland, composition of their diet and its seasonal variation. In 2006, emerging animals were counted with help of heterodyne bat detector, ambient temperature, relative humidity, wind speed and light intensity were measured, bats’ faeces from the entrance of roost were collected (n=1725) and their content analyzed. The colony, consisting of about 370 individuals, was inhabited from April to September (the highest numbers recorded in the first ten days of June) and we did not record any significant increase in the size of colony after obtaining of flight ability by juvenile bats. Emergence started 24 minutes after sunset, on the average (range 1–44 min), and lasted about 53 minutes. Increase in colony size resulted in longer emergence and its earlier start. Pond bats emerged significantly earlier in period before obtaining of flight ability by their young. The main factor affecting dynamics of emergence from the colony was light intensity but not weather conditions. Diet of pond bat from Lubnia was dominated by non-biting midges Chironomidae (both pupae and imagines) and caddisflies Trichoptera. However, in total, 21 prey taxa were found in analyzed faeces, including 17 recorded for the first time in diet of *M. dasycneme*. Frequency of occurrence of particular taxa and their developmental stages varied in the course of the season. Frequencies of the two most numerous taxa, i.e. caddisflies and chironomids in diet of pond bat were negatively correlated with each other (rs= –0.75; p<0.05).

DNA-based diet analysis of insectivorous bats

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The determination of diet is central to understanding trophic relationships within biological communities. For many bat species it is also a fundamental part of their conservation management. Because direct observations of feeding events are at best extremely difficult, diets of insectivorous bats are conventionally studied by morphological identification of microscopic prey hard parts, primarily fragments of arthropod cuticle, that remain in faeces. However, thorough mastication and digestion of prey by bats coupled with low morphological disparity among related arthropods restricts most taxonomic identifications to Order. Accordingly, detailed trophic relationships can be extremely difficult to define in bats, thus directly im-
Pedaling their conservation management. DNA-based techniques provide new opportunities for the study of animal diets. Through polymerase chain reaction (PCR) amplification of DNA sequences unique to species, prey species identifications can be achieved even within highly degraded samples, such as those found in faeces. We present a universal PCR-based methodology for making species identifications of arthropod prey in bat faecal samples and show, using *Barbastella barbastellus* as a case study, how this methodology can provide new insights into the trophic relationships and predator-prey dynamics of bats. Due to the unprecedented resolution of prey, we expect this technique will also be of great benefit in the conservation of these ecologically important predators.

**Barbed wire fences and Hawaiian Lasiurus cinereus: What we know**

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Barbed wire is a common component of both conservation and livestock fences in Hawaii. The federally endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*) is endemic to the State. Hawaiian hoary bats roost in a variety of tree species during the day and forage over a wide range of habitat types during the night including open fields, forest edge, lava flows, near shore waters, streams and ponds. Several instances of Hawaiian hoary bats inadvertently caught on barbed wire are reported each year, highlighting the need to consider unanticipated impacts of conservation actions. For fences that have been monitored in Hawaii for at least 20 years, annual mortality estimates range from 0 to 1.3 Hawaiian hoary bats per 100 miles of barbed wire. It is believed Hawaiian hoary bats are more vulnerable to barbed wire fences that occur in open and forest edge areas than in heavily cluttered forested areas. Potential bat deterrents and fencing alternatives will be discussed.

**Impacts of various factors on population status and movement of Rousettus aegyptiacus in Iran**

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This study was done on Egyptian fruit bats in Iran from 2001–2007. We focused on 3 detected sites, selected based on old reports, climate (Ethiopian), cave (roosting area) and some plants such as *Phoenix dactylifora* and *Ziziphus spina-christi*. The sites were Baloochestan, Jahrom and Qeshm island. Our study has shown that the abundance of fruit bats in these 3 sites is different from each other, based on factors such as safety, food availability, climate, culture and economy. Qeshm has dry climate and is rich in fruit tree diversity but the number of trees of each kind is lowest. Jahrom has lowest safety (Cultural and Economic causes) among the three sites and least fruit tree diversity but the number of trees of each kind is highest. Baloochestan is in middle of 2 other sites. It seems Qeshm has to have better population and abundance but our observation is shown Jahrom has the highest then Baloochestan and
Qeshm is in the end. So this result led us to rank different factors and find in the sites that fruit tree abundance and climate is more important than safety and diversity. Our results showed that the population of Qeshm is separated from the two populations of Jahrom and Baluchestan, taking into account the time table of fruits presence in 3 sites, governing factors of environmental condition, indications of reproductive activities (in Jahrom) and combination of these mentioned facts together with statistical analysis of body and skull measurements. Therefore, the movement of Fruit bat between Mainland (2 sites) and the Qeshm Island could not be considered.

Population development of *Rhinolophus hipposideros* at the northern border of its range in Saxony (Germany) during the last thirty years

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The lesser horseshoe bat reaches in Saxony (Germany) the northern border of its range. Observations of adults and juveniles in nursery colonies have shown a dramatic decline of roosts and animals since regular countings started in the 1960s. The lowest number of 175 females was found in the early 1980s. After the population size remained at this level for several years, numbers have been increasing since the beginning of the 1990s and annual growth-rates of several nursery colonies went up to almost 10%. At present 13 maternity colonies with less than 10 up to 450 females and a total number of about 1,000 females are known. The remaining colonies inhabit about 2/3 of the former Saxonian distribution area. Nevertheless, during the last 10 years single hibernating Lesser Horseshoe bats were observed again in areas where the species had not been found since the 1980s. In Central Europe, maternity colonies of lesser horseshoe bats depend on buildings which offer special temperature conditions according to the species roosting ecology. Suitable buildings are not only scarce, but in most cases threatened by structural changes, reconstruction or deterioration. Due to its concentration in a small number of maternity roosts the species remains particularly endangered.

The effect of mirror orientation on bats’ perception of echoacoustic mirror images

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Smooth water surfaces are the only extended acoustic mirrors in nature. When echolocating down on a water surface at an acute angle, the echo from ahead is reflected away from...
a bat; it only receives a weak echo from straight below, considerably off-centre of its sonar beam aim. It was recently shown that bats recognize water bodies by their mirror-like echo reflection properties: bats try to drink from different solid materials, provided the surface is acoustically smooth and hence mirror-like (Greif & Siemers, this conference). In our modern world, we create many artificial smooth surfaces ranging from horizontal to vertical orientation. It is as yet unclear how bats react to such artificial echoacoustic mirrors. In the present study, we tested the significance of the absolute orientation of acoustic mirrors on the bats’ interpretation of the respective echo scenes. Vertical water surfaces do not exist in nature and we predicted that bats would perceive an extended vertical mirror as an open flyway, provided they approach at an acute angle. By contrast, we predicted that the very same bats would take extended horizontal acoustic mirrors for water and thus try to drink from them, but not try to fly through them. We set up a behavioural experiment with field experienced bats to test our predictions. The experimental data of our ongoing study, still rather preliminary at the time of submission of this abstract, fully corroborate our predictions. This would indicate that the absolute orientation of acoustic mirrors fundamentally changes the bats’ interpretation of echoacoustic mirror images.
The status of White Nose Syndrome in North America

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White Nose Syndrome (WNS) has continued to spread in 2010, and is anticipated to continue its rapid advance into new territory. In 2010, newly affected bat hibernacula were confirmed in Tennessee, Ontario, and Quebec, and the fungus Geomyces destructans has been detected farther west at 3 sites in Missouri and Oklahoma. The fungus and/or the disease have now been found at 13 U.S. states and 2 Canadian provinces. In 20 hibernation sites with both pre- and post-WNS infection bat population counts, the cumulative decline has been 92% in the 2 or 3 years since the sites were documented as infected, with colony losses at some sites exceeding 99%. Thus far there has been no clear evidence of resistance among affected bat species, and several smaller colonies are on the brink of extirpation. Mortality rates continue to vary between species and between sites, with Myotis lucifugus and Myotis septentrionalis being the species most notably affected and drier hibernacula appearing to be least affected sites. Six hibernating species in the eastern U.S. have been confirmed to be affected by WNS, and newly discovered sites in Missouri and Oklahoma will potentially add Myotis grisescens and Myotis velifer to the list of affected bats. The presence of the fungus G. destructans continues to be the common link between affected sites, and the implication that the fungus is the cause of WNS continues to provide the most parsimonious explanation. The need to further understand the etiology of WNS drives much of the WNS research currently underway, and the revelation that G. destructans has been found on bats in Europe without observed mortality has provided important new avenues of investigation. A National Plan is in development to guide the research and management of this disease, and a recent influx of funding has provided some much-needed support for these efforts. Projects underway include: video monitoring to analyze winter behaviors of infected and uninfected bats, an assessment of the role of hibernacula in WNS transmission, G. destructans laboratory infectivity studies, and initial efforts to develop chemical and biological controls.
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