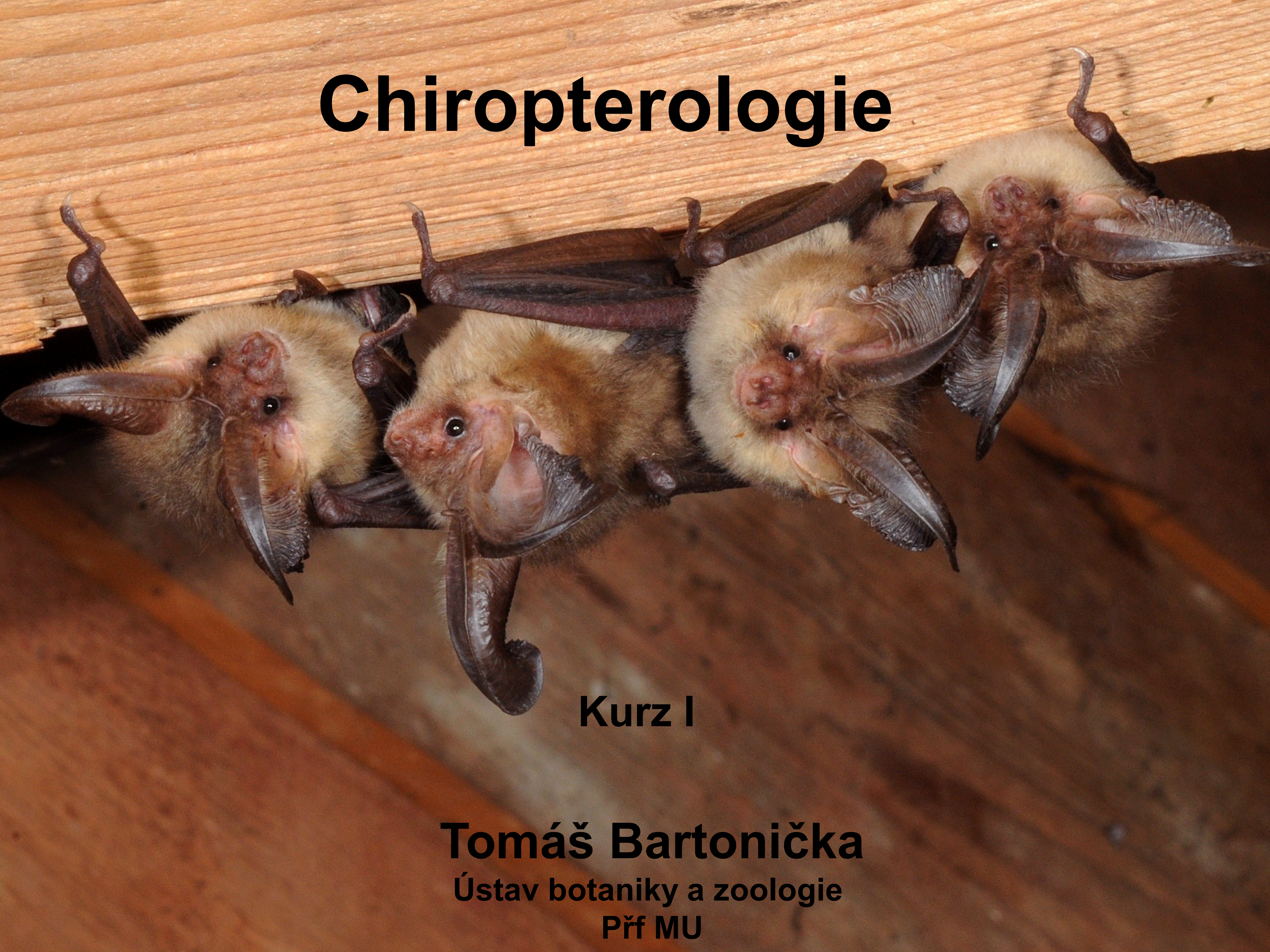


Chiropterologie

Kurz I

Tomáš Bartonička
Ústav botaniky a zoologie
Přf MU

Struktura kurzu

1. Informační zdroje. Chiropterologie jako vědní obor. Vymezení skupiny Chiroptera a peripetie jejího vzniku. Nejstarší fosilní záznam a bazální radiace. Strukturní charakteristiky a diversita základních adaptací.

2.- 3. Přirozená biodiversita skupiny a přehled jednotlivých vývojových linií, systém.

4. Ochrana netopýrů, současná rizika.

Důraz na metodické souvislosti a case examples

Význam a rizika letounů jako modelu

letouni - netopýři - dlouhověkost, 1-2 mláďata, vysoká socialita, specifické adaptace

monitoring a bioindikace - vysoká specializovanost

právní ochrana –
vyhláška č. 395/1992 Sb., zákon č. 114/1992 Sb., o ochraně přírody a krajiny.
Dohoda o ochraně netopýrů v Evropě (EUROBATS), dodatkem
Úmluvy o ochraně stěhovavých druhů volně žijících živočichů (Bonská úmluva).

kadavery po kolizi s automobilovou dopravou

Leptonycteris obalená pylem Agave

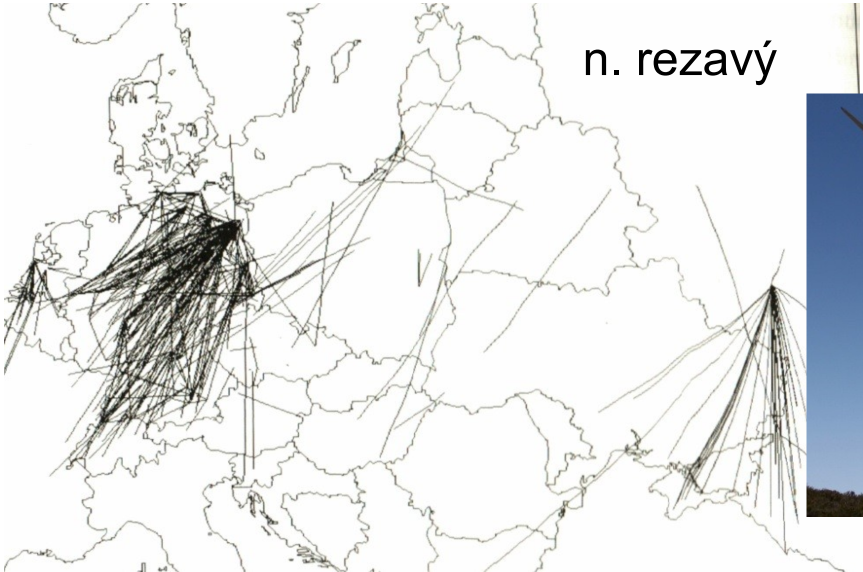
Význam a rizika letounů jako modelu

Ale...

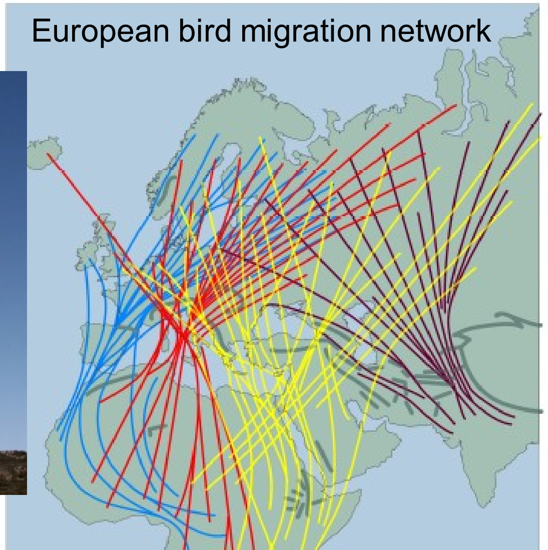
obtížně dostupné údaje o biologii ⇒ mnoho neznámého ⇒ **strach**

zásadní rozdílnosti v úrovni poznání - migrační koridory netopýrů a ptáků

Netopýři



Ptáci



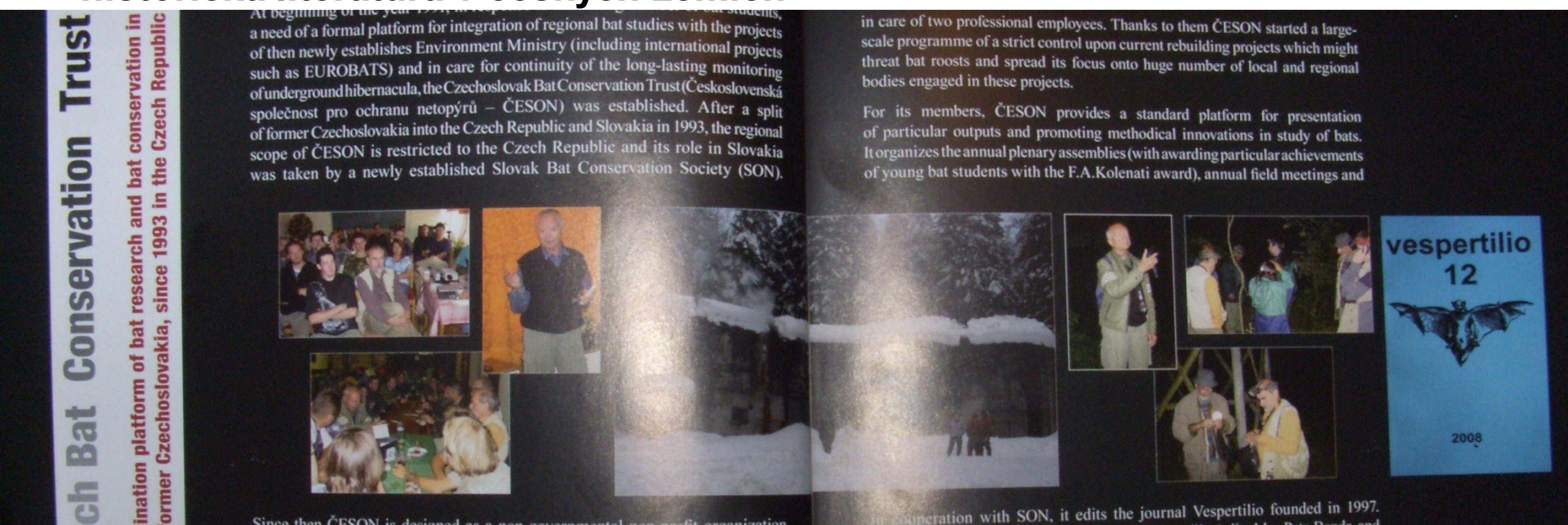
Zdroje informací

domácí knihy - Poznáváme naše savce, Létající savci, Naši netopýři, A tribute to bats

zahraniční knihy - atlasy poznávací, distribuční
tématické knihy - echolokace, ekologie, biogeografie

časopisy a sborníky - Acta Chiropterologica, Acta Theriologica, Journal of Mammalogy, Myotis, Nyctalus, Folia Zoologica, Vespertilio, Lynx, informační letáky a brožury

historická literatura v českých zemích



15th International Bat Research Conference

*** The Biology of Bats at the Onset of the 21st Century ***

Prague, Czech Republic, 23-27 August 2010

15th IBRC Prague 2010

15 IBRC Prague 2010

LIST OF INTERNATIONAL BAT RESEARCH CONFERENCES

1ST	1968	CZECHOSLOVAKIA, HLUBOKA N. V.
2ND	1970	THE NETHERLANDS, AMSTERDAM
3RD	1972	YUGOSLAVIA, PLITVICE
4TH	1975	KENYA, NAIROBI
5TH	1978	USA, ALBUQUERQUE
6TH	1982	NIGERIA, IFE
7TH	1985	UK, ABERDEEN
8TH	1989	AUSTRALIA, SYDNEY
9TH	1992	INDIA, MADURAI
10TH	1995	USA, BOSTON
11TH	1998	BRAZIL, PIRENOPOLIS
12TH	2001	MALAYSIA, BANGI
13TH	2004	POLAND, MIKOLAJKI
14TH	2007	MEXICO, MERIDA
15TH	2010	CZECH REPUBLIC, PRAHA

Chiropterologie

… samostatná zoologická disciplina ?

Google Scholar:

Bat 1.720.000

Mammal(s) 1.870.000

Rodent 813.000

Bird(s) 2.350.000

Fish 2.560.000

Bat Research 675.000

Mammal research 437.000

Mammalogy 64.200

Rodent research 531.000

Ornithology 133.000

Bird research 2.180.000

Ichthyology 121.000

Fish research 2.110.000




Vrchol rozmanitosti přizpůsobení mezi savci




Pictures:/www.itsnature.org, F. Krüger, A. Seebens

Historie oboru – tradiční důrazy na specifika netopýrů

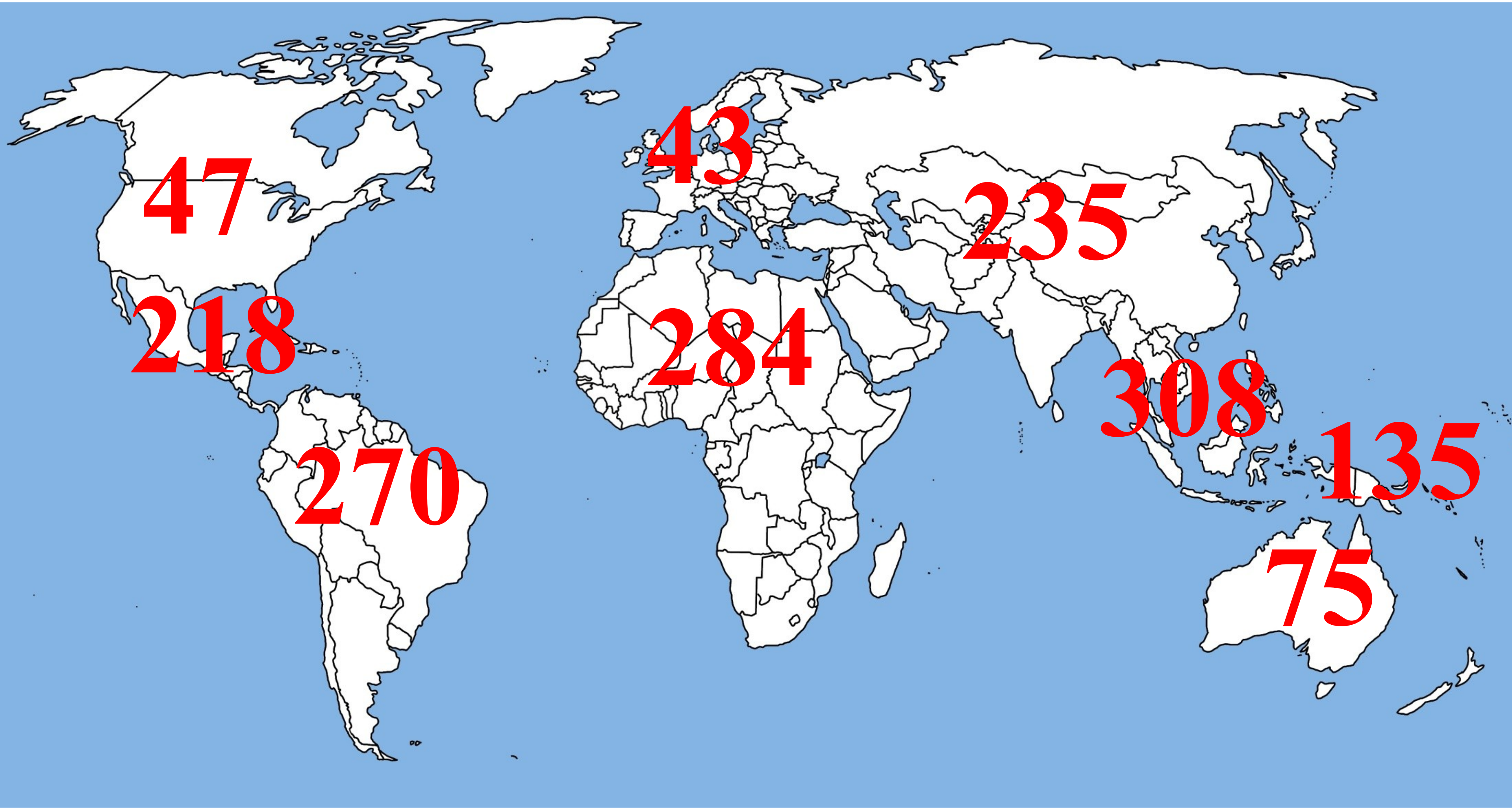
(A)19.stol. H.Kühl, Koch, Blasius, Kolenati …

(B) Základy moderní chiropterologie (klasická díla): 30-50.léta 20. století
M.Eisentraut: Die deutsche Fledermäuse
G.M.Allen: Bats
A.P.Kuzyakin: Letučije myši
O.Ryberg: Studies on bats and bat parasites
…..
(C) Explosivní nárůst informací s novými technikami
70. léta – sítě
80. leta - detektory
90. leta – DNA

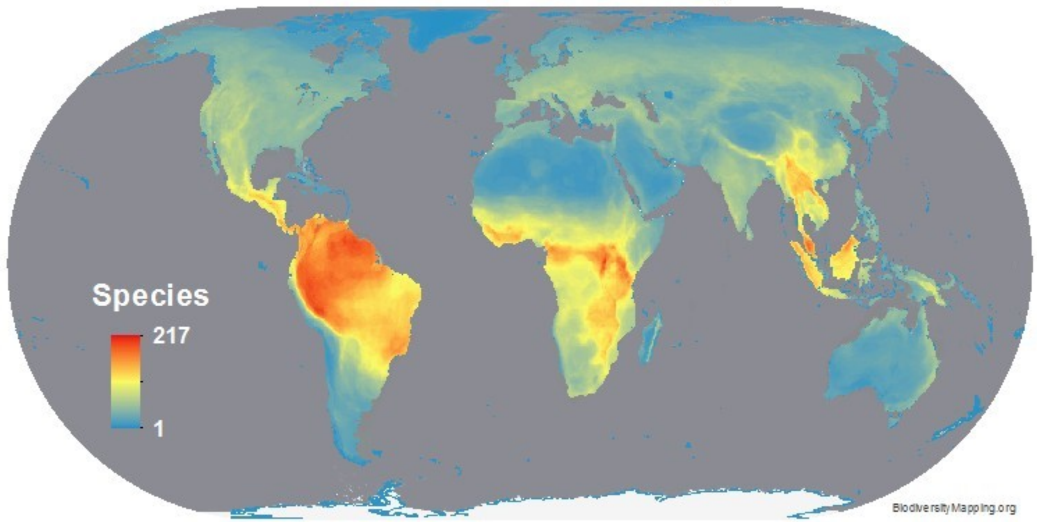
(D) Nyní: nejdynamičtější součást výzkumu savců

Letouni (Chiroptera) – druhý nejpočetnější řád savců

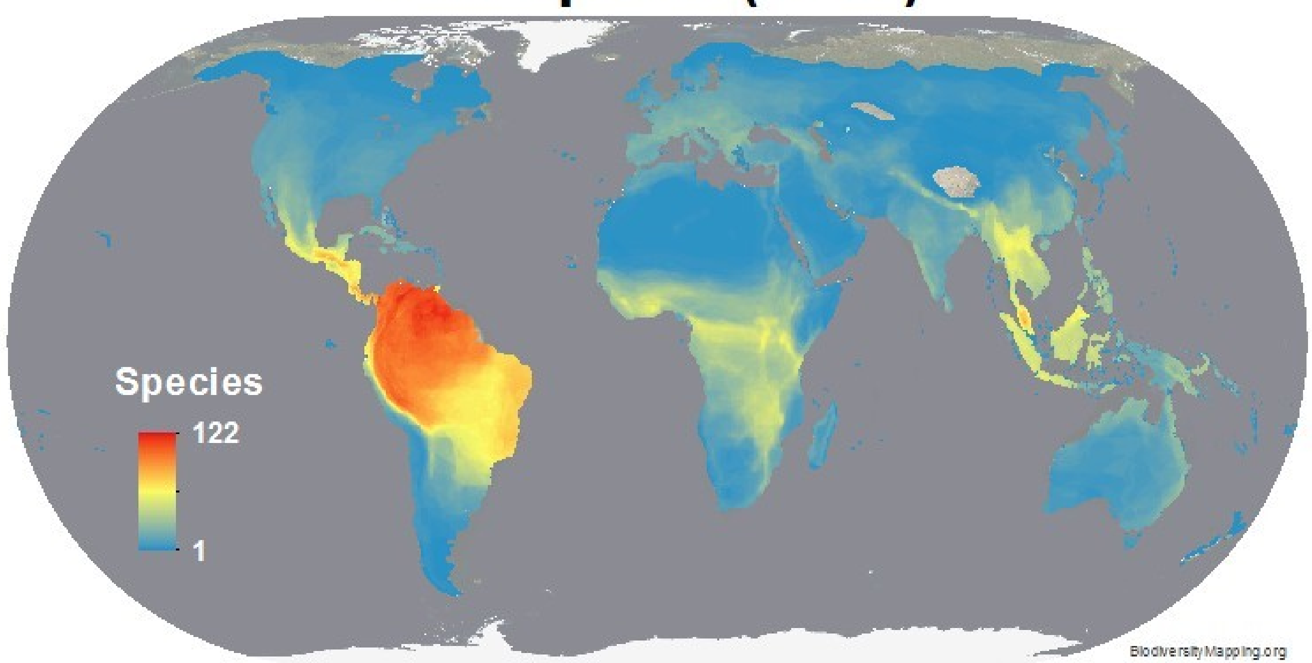
1250 druhů


43
47
235
218
284
308
135
270
75

Mammal Diversity



Chiroptera (Bats)



Naprostá většina netopýrů žije v tropech

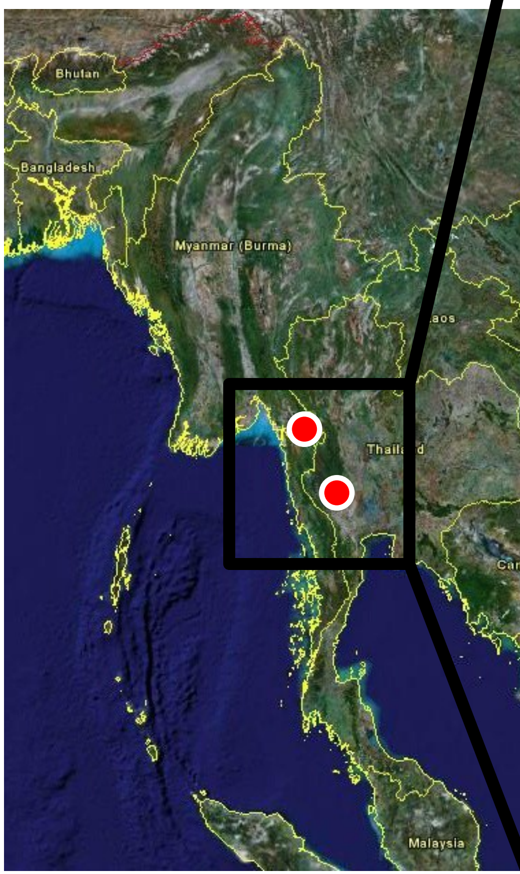
Craseonycteris thonglongyai – příklad « nej »

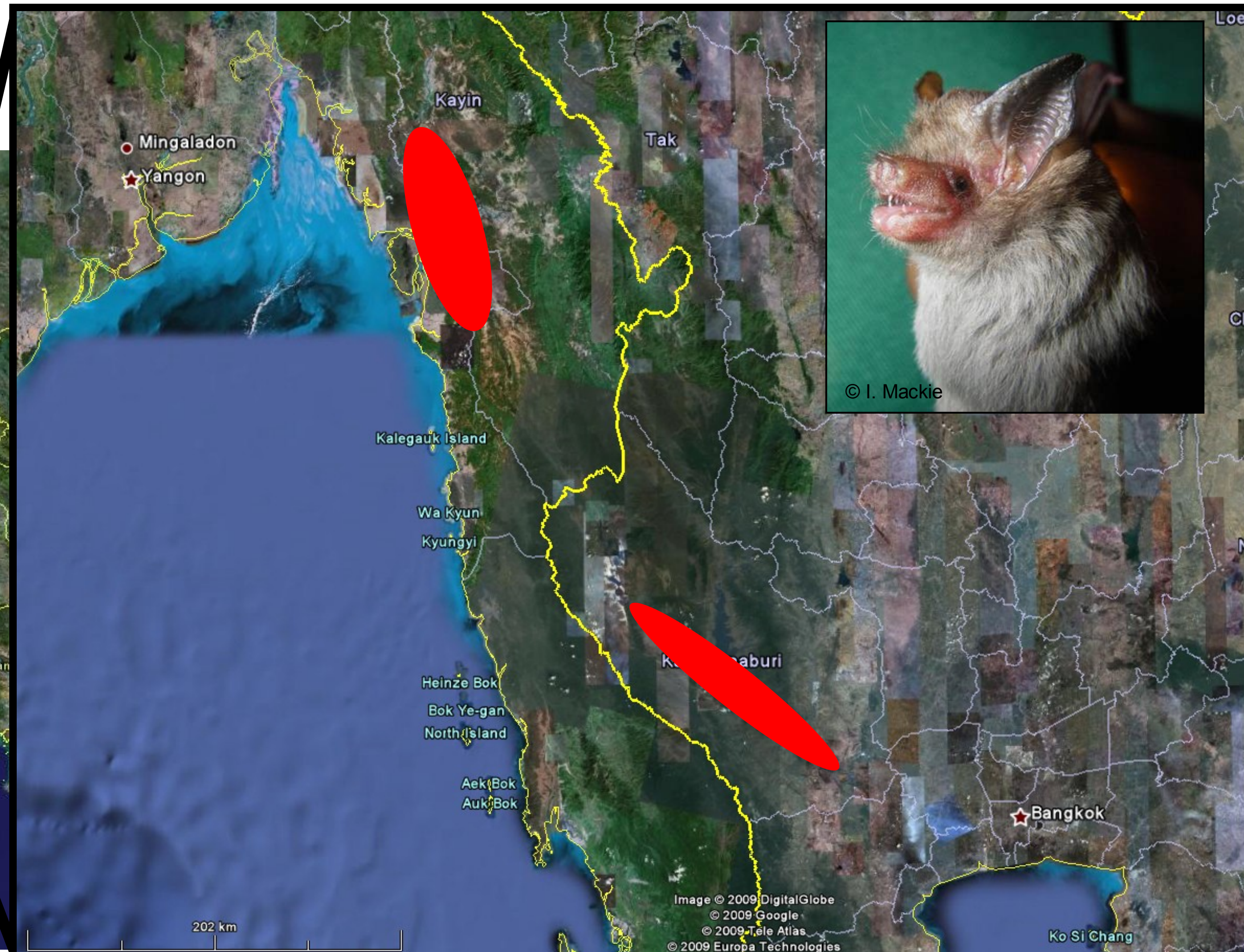
tělo cca 3 cm, váha 2-2,5 g, rozpětí 12 cm, nejmenší savec světa

Pteropus vampyrus - kaloň malajský

rozpětí křídel až 1,7 m, hmotnost až 1,6 kg, největší letoun světa

Craseonycteris thonglongyai – příklad « nej »





Acta Chiropterologica

Published by: **Museum and Institute of Zoology, Polish Academy of Sciences**

Acta Chiropterologica 4(2):107-120. 2002

https://doi.org/10.3161/001.004.0201

Craseonycteris thonglongyai (Chiroptera: Craseonycteridae) is a Rhinolophoid: Molecular Evidence from Cytochrome *b*

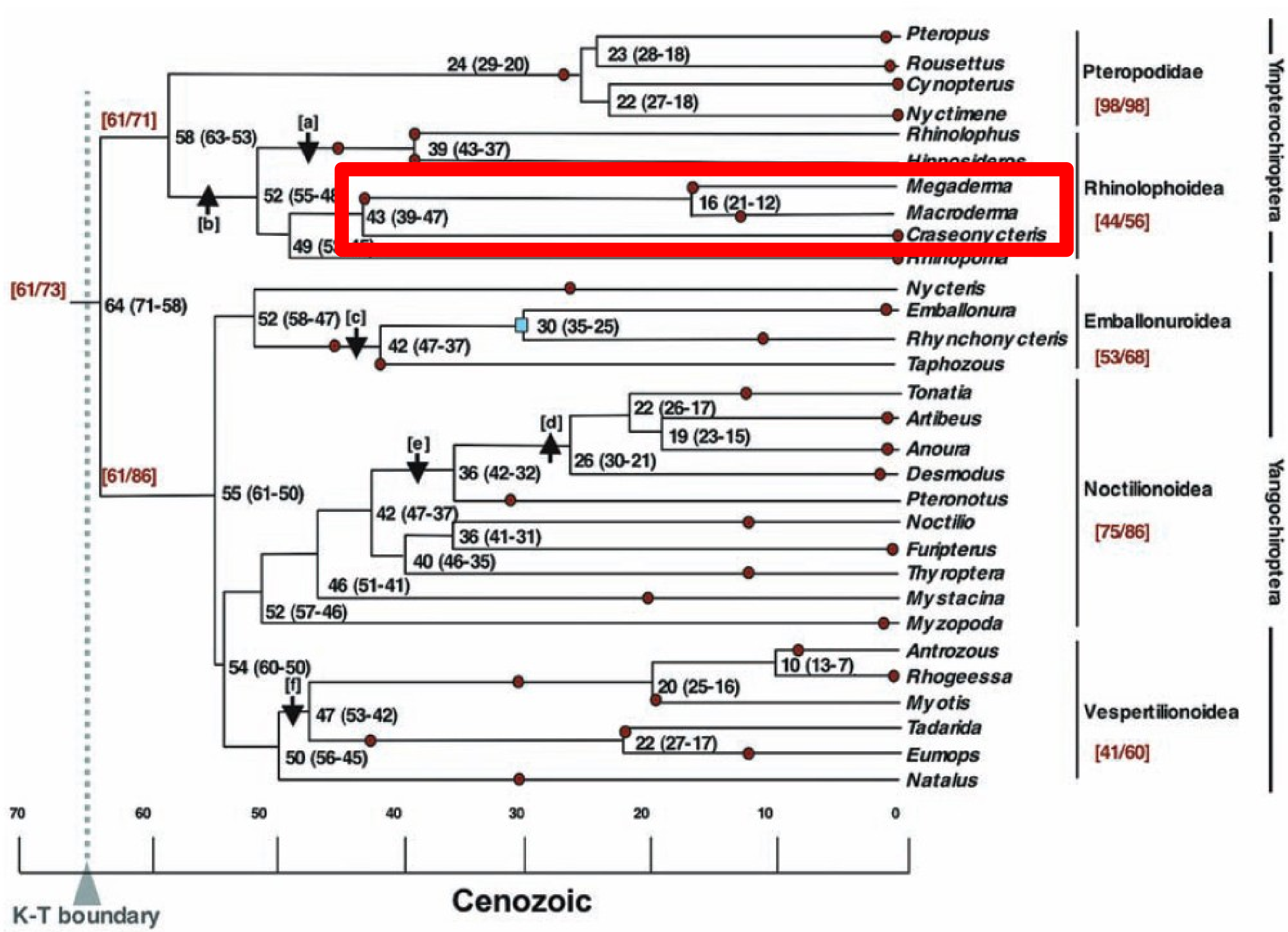
Pavel Hulva and Ivan Horáček

Received: May 25, 2002; **Accepted:** October 11, 2002

[+] Author & Article Info

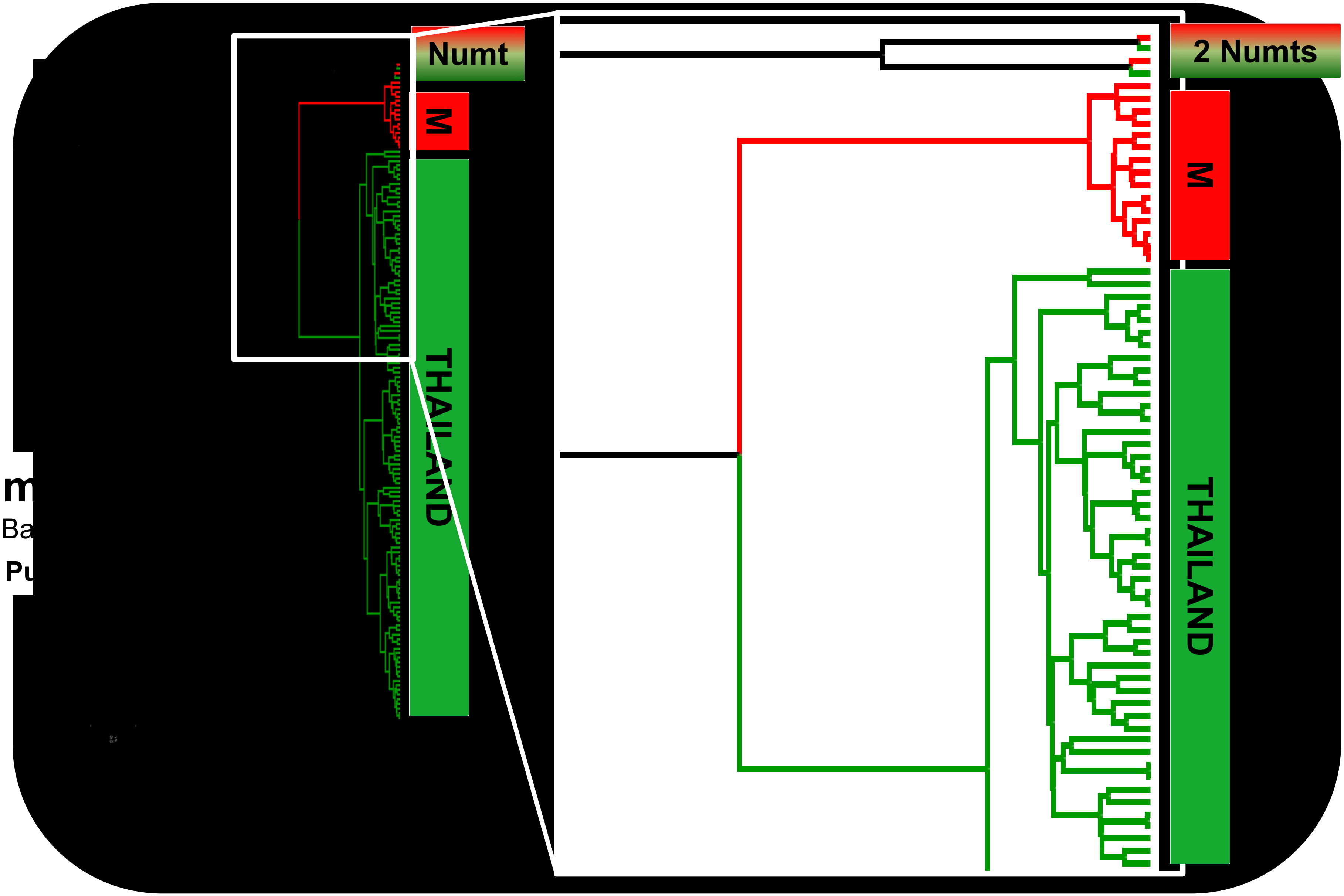
Craseonycteris thonglongyai (Chiroptera: Craseonycteridae), an enigmatic taxon which shares morphological traits with both Rhinopomatidae and Emballonuridae was for the first time investigated with the aid of molecular phylogenetic techniques. Three methods of phylogenetic inference,

Craseonycteridae

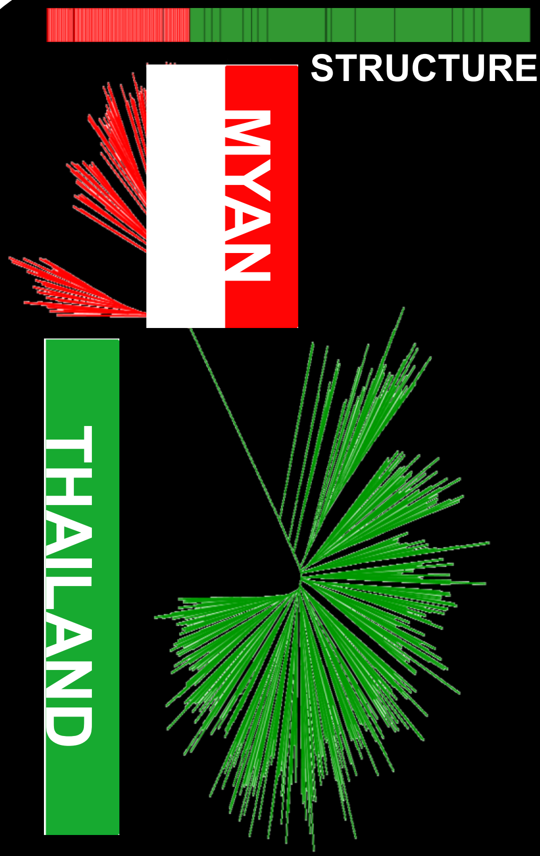


Miller-Butterworth et al. 2007

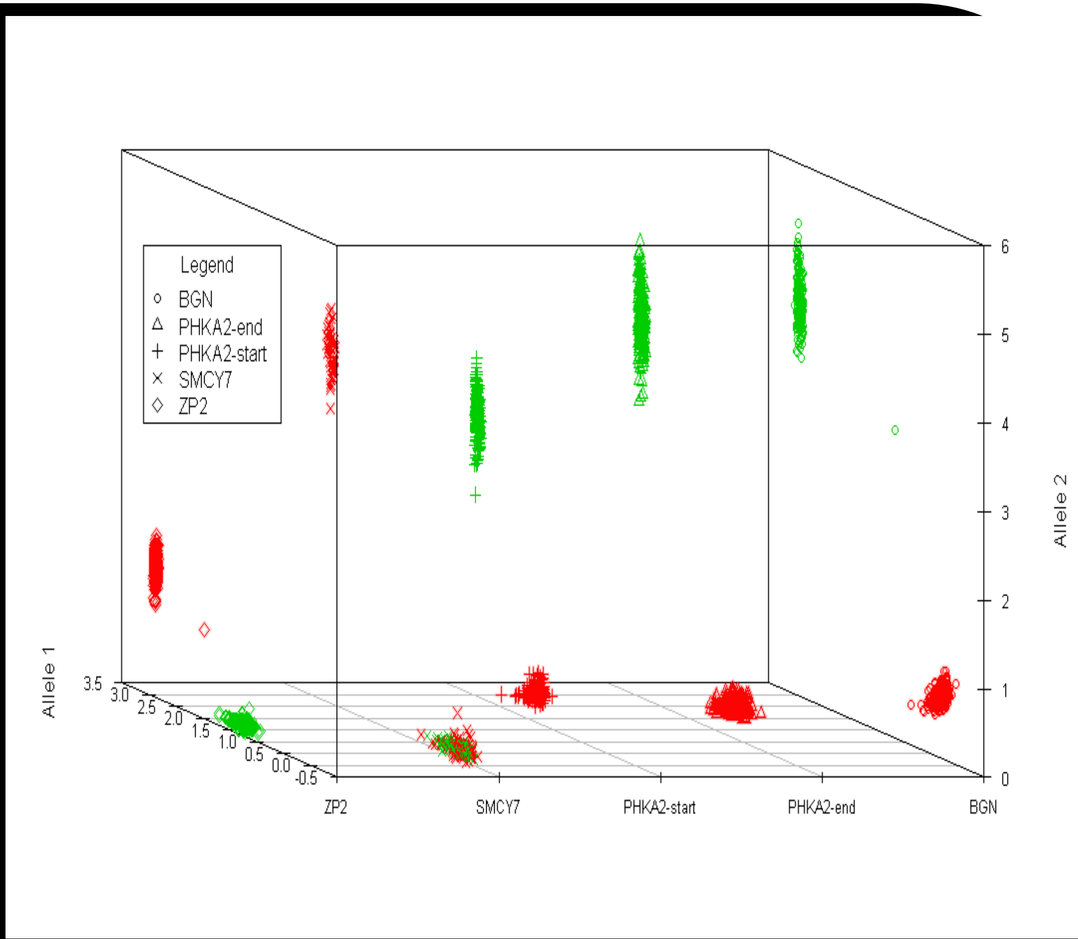
Thailand *versus* Myanmar ...



Nuclear support



Microsatellites (n=659)



5 SNPs (n=659) (**463 Thai**, **196 Myanmar**)

Considering only emergence counts, 80% of the colonies in Thailand included between 100 and 400 ind. (n = 20, range = 11 to 856). In Myanmar, emergence counts at 4 caves furnished estimates of 40, 600, 1100 and 2000 ind.

Vymezení (ideologické) netopýra

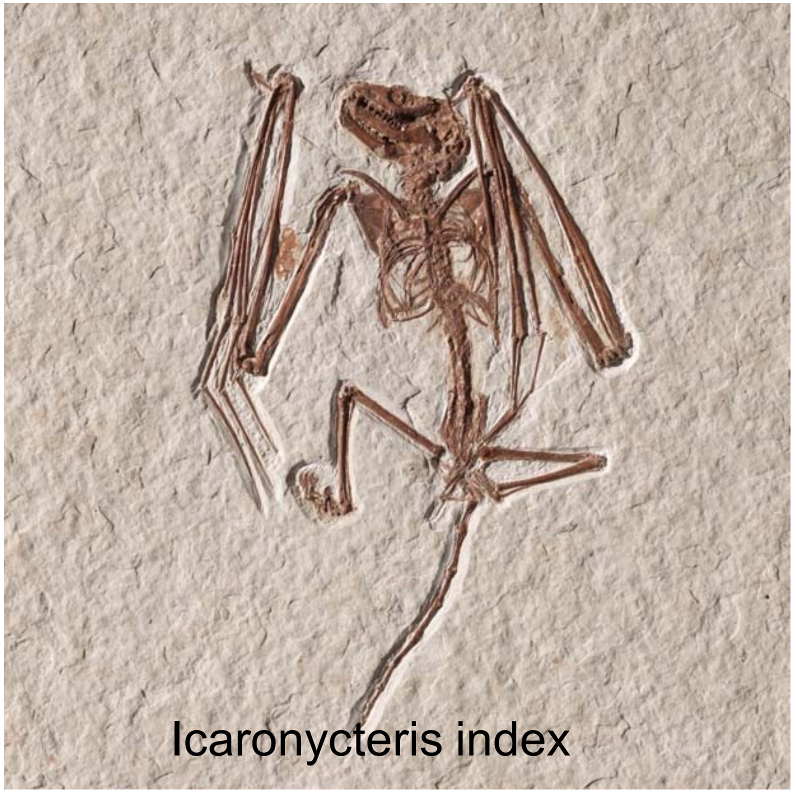
Schopnost aktivního letu

70% fosilního záznamu chybí

ale Eocén

Icaronycteris, Palaeochiropteryx, Archaeonycteris, Hassianycteris, Tachypteron

Wyoming, USA, 52,2 mya



schopnost letu i laryngeální echolokace

kosti křídla, hlemýžď, kladívko...

Ale...Onychonycteris finneyi

nemá základní struktury nutné pro echolokaci

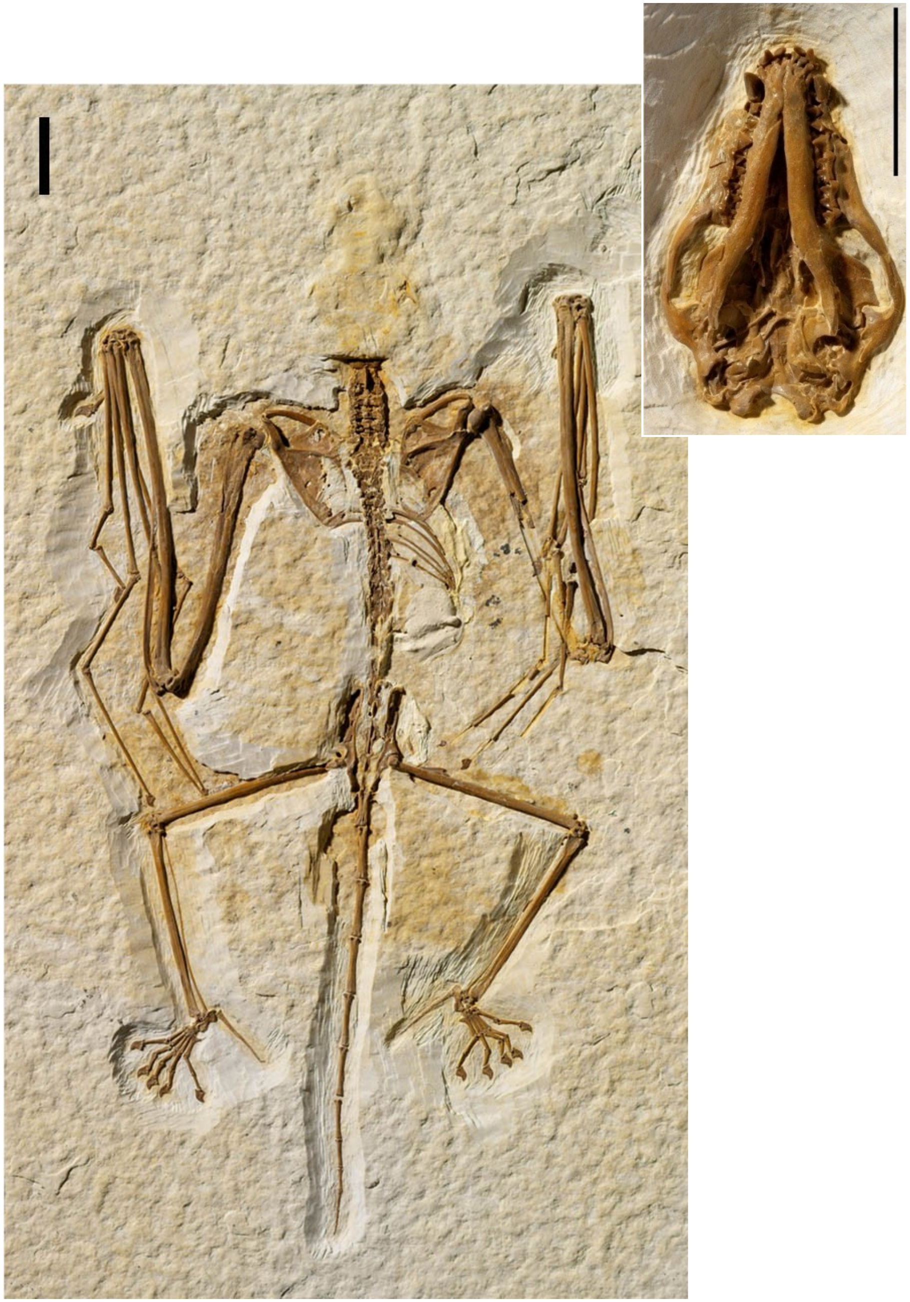
u kaloňů a neecholokujících stylohyal (bodcovitý výběžek jazylky) není pevně spojen s tympanem

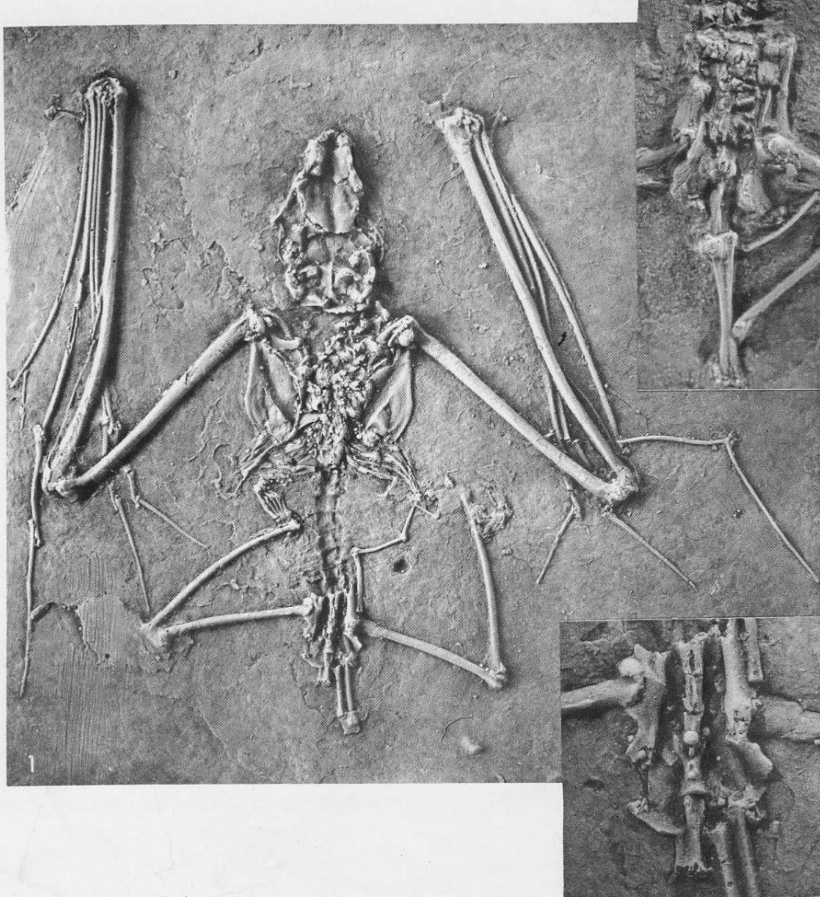
ale Onychonycteris spoj má!

Veselka et al. 2010

vědecký koncensus

neuměl echolokovat !!!





1917Palaeochiropteryx tupaiodon Revilliod

Messel, Darmstadt, NE, zachovaná fosilie s potravou v žaludku, široká křídla, lesní gleaner, lov nízko nad zemí podobně jako pavrápenci

Phosphorites du **Quercy**

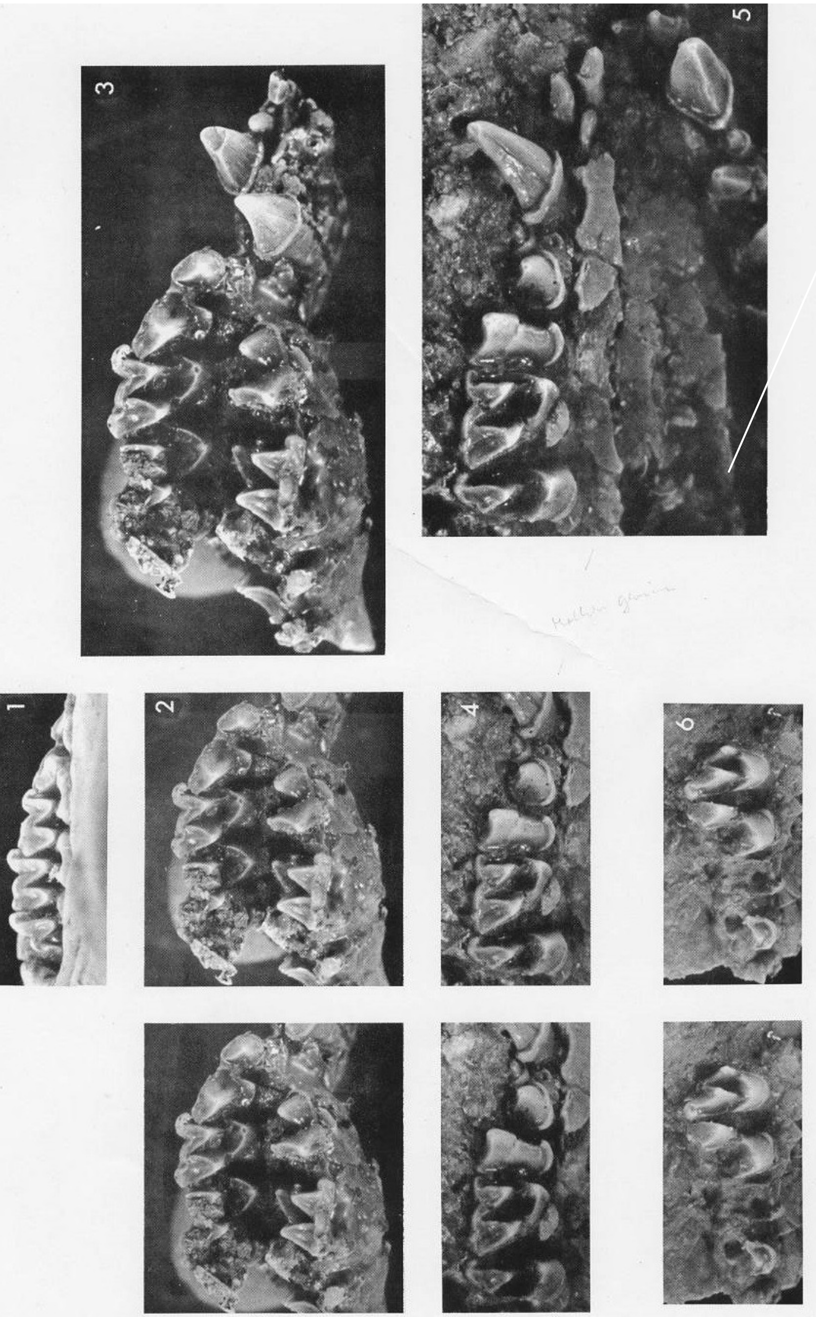
Montpellier a Paříž Quercy phosphorites formace více než 100 fosilií v perfektním stavu. late Eocene and the beginning of the late Oligocene

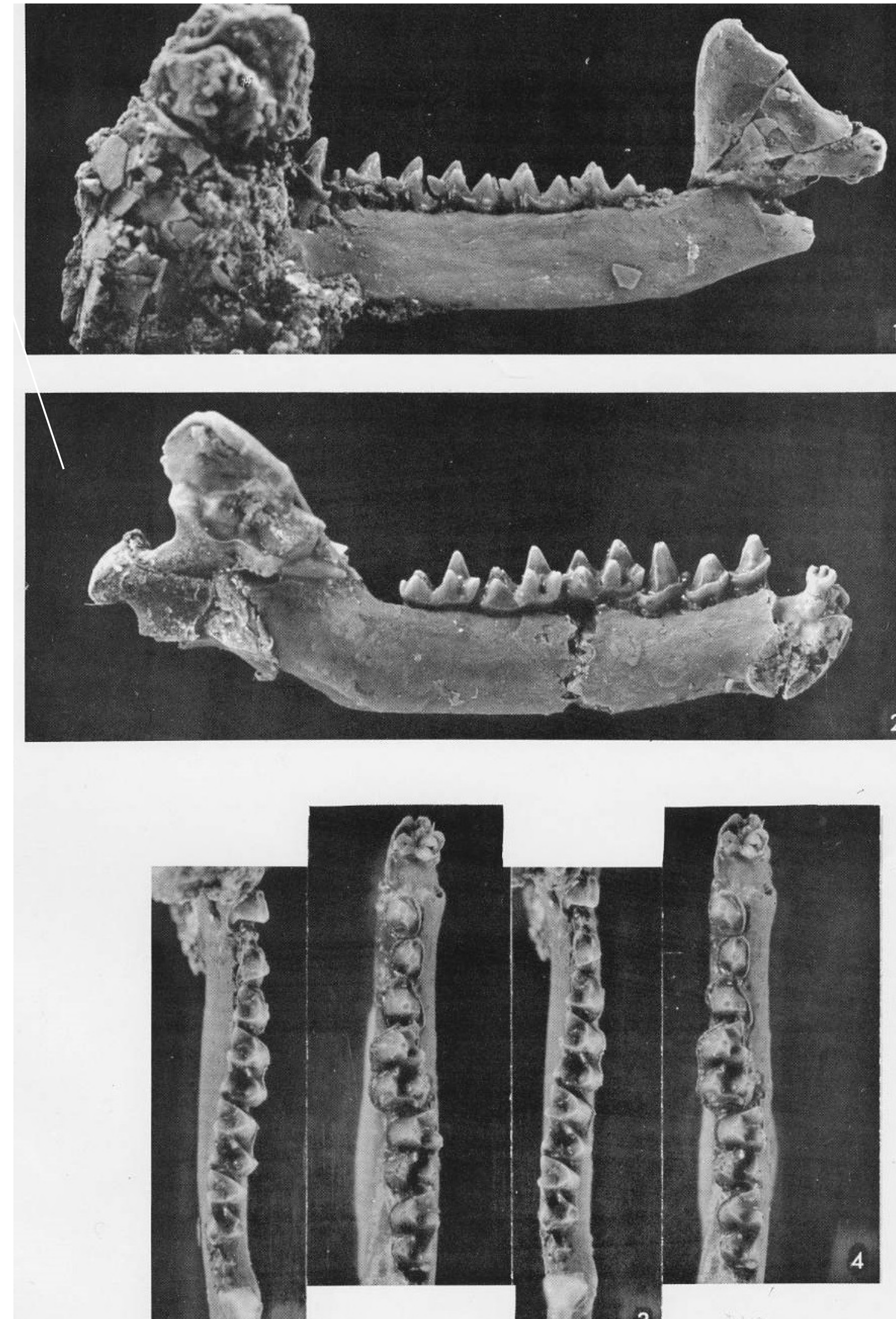
Messel Pit (near Darmstadt, Germany)

Messel Bats - Palaeochiropterygididae

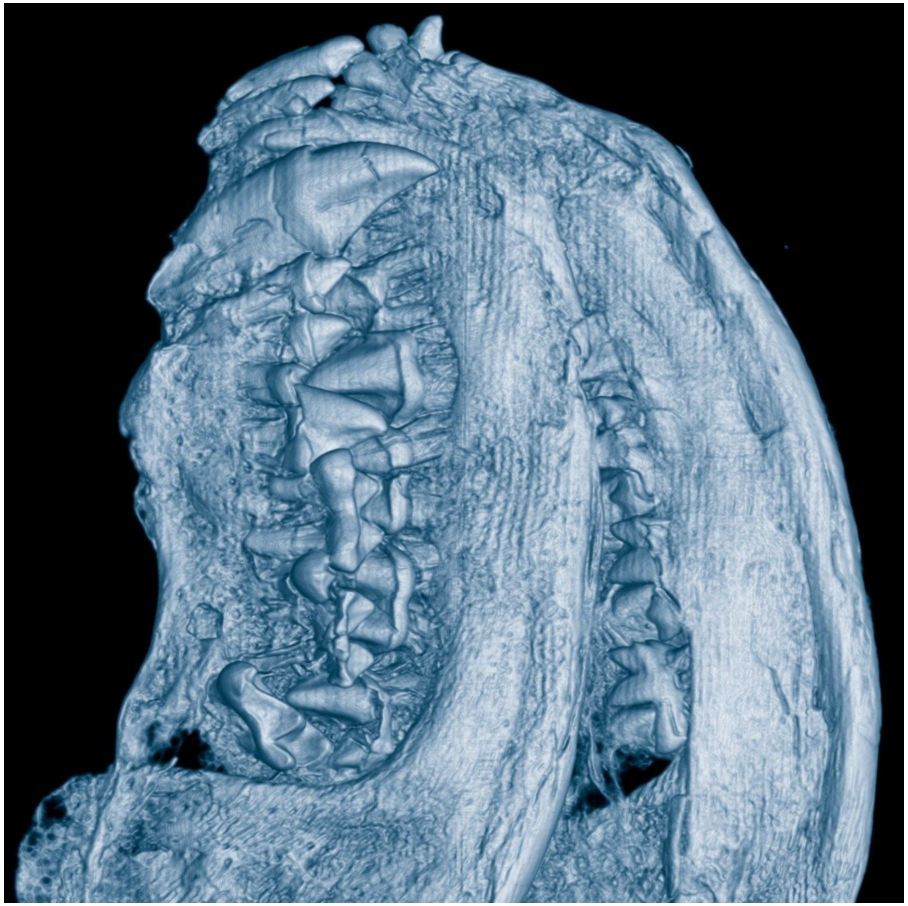
Palaeochiropteryx tupaiodon **(SMF 2022)**

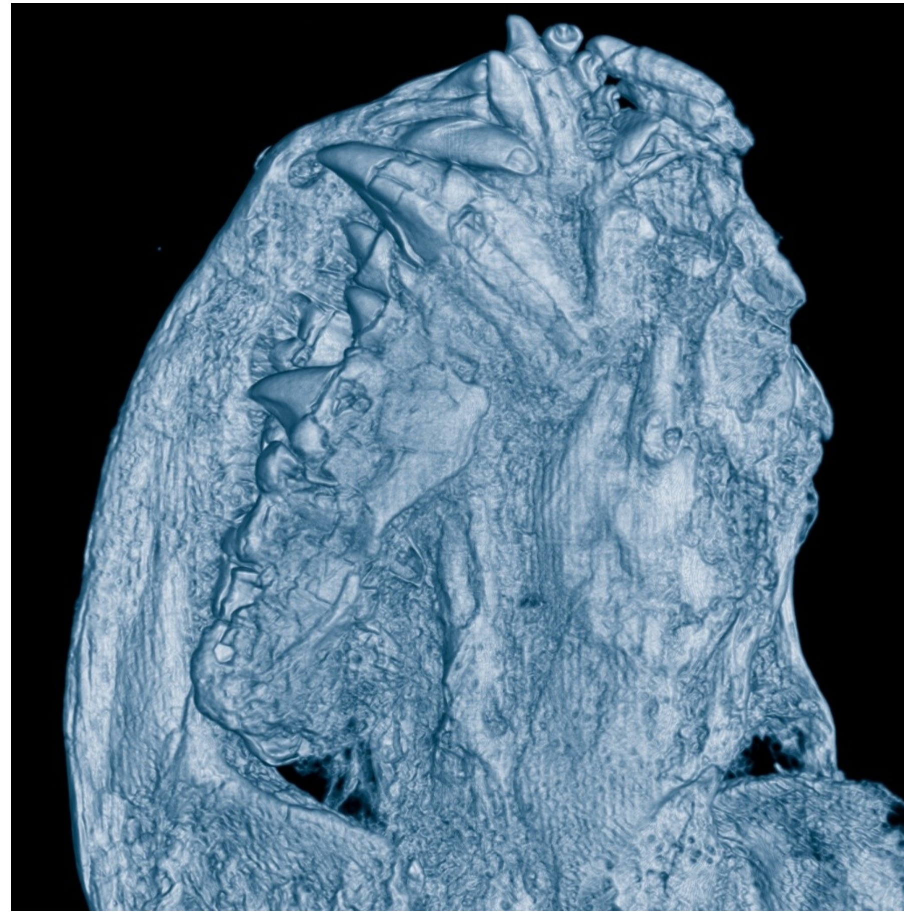
Geiseltal: *Cecilionycteris prisca, Matthesia insolita*





Archaeonycteris Dentition

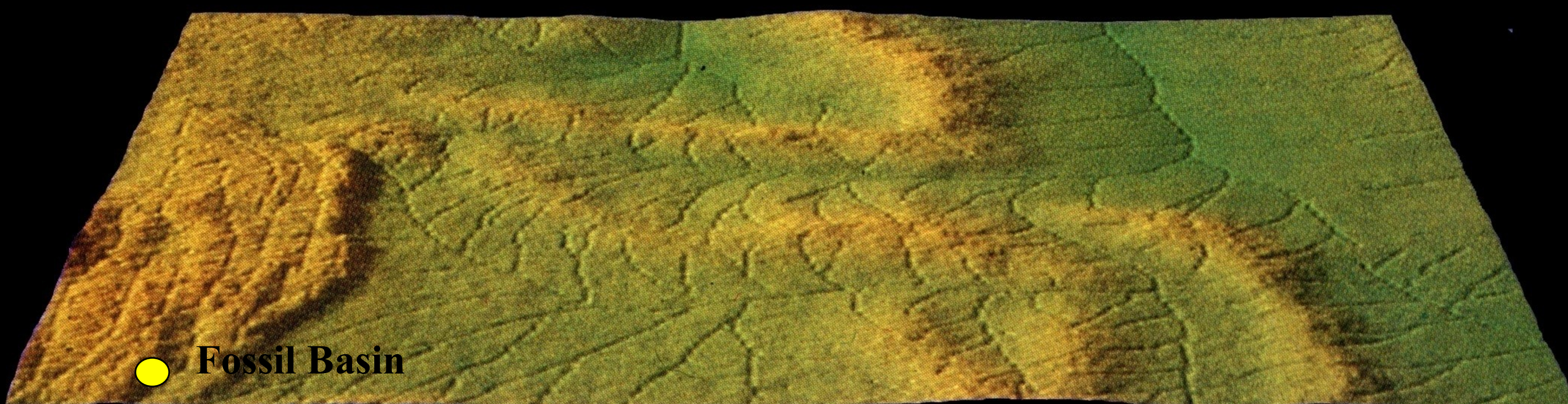




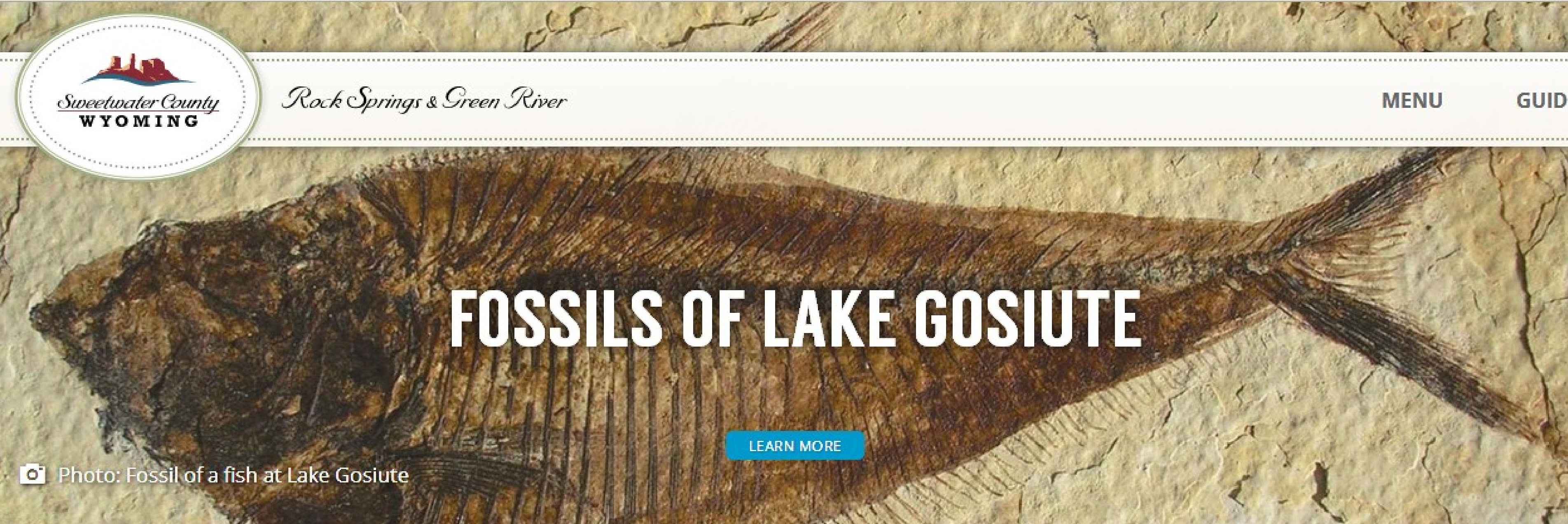
čel. Archaeonycteridae

Wyoming

Late Early - Middle Eocene



Early Eocene



FOSSILS OF LAKE GOSIUTE Time Travel to the Eocene Era

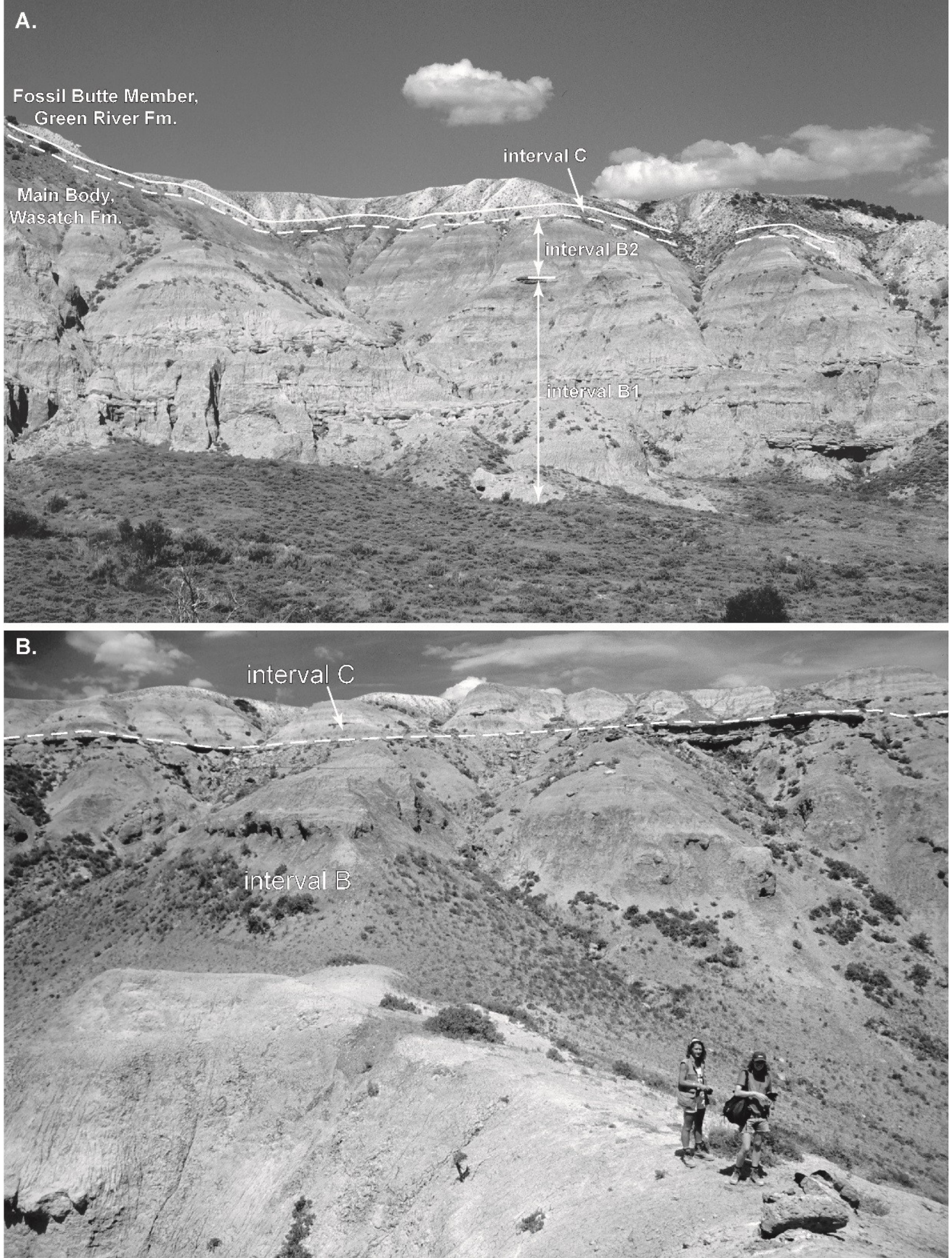
Lake Gosiute was home to a diverse population of strange creatures that flourished in the lush vegetation of its tropical shores. Fast-forward 58 million years to

SWEETWATER COUNTY TRAVEL TOOLS

yoming, and it's an archaeologist's paradise with fossil-rich soil and stones that tell tales of ecosystems past.

Green river formation

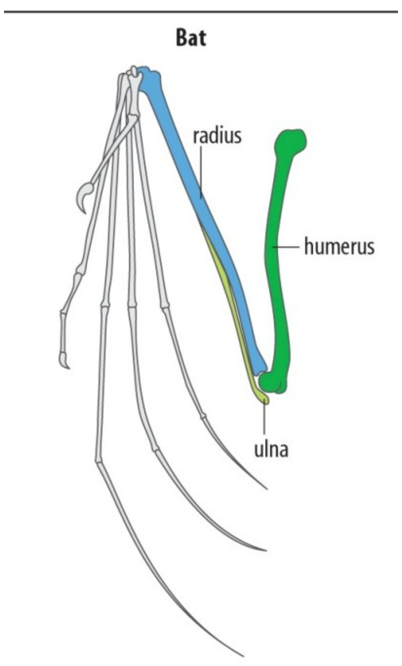
The earliest known bats (*Icaronycteris index* and *Onychonycteris finneyi*), already full-developed for flight,



A.
Fossil Butte Member,
Green River Fm.
Main Body,
Wasatch Fm.
interval C
interval B2
interval B1
B.
interval C
interval B

Icaronycteris index

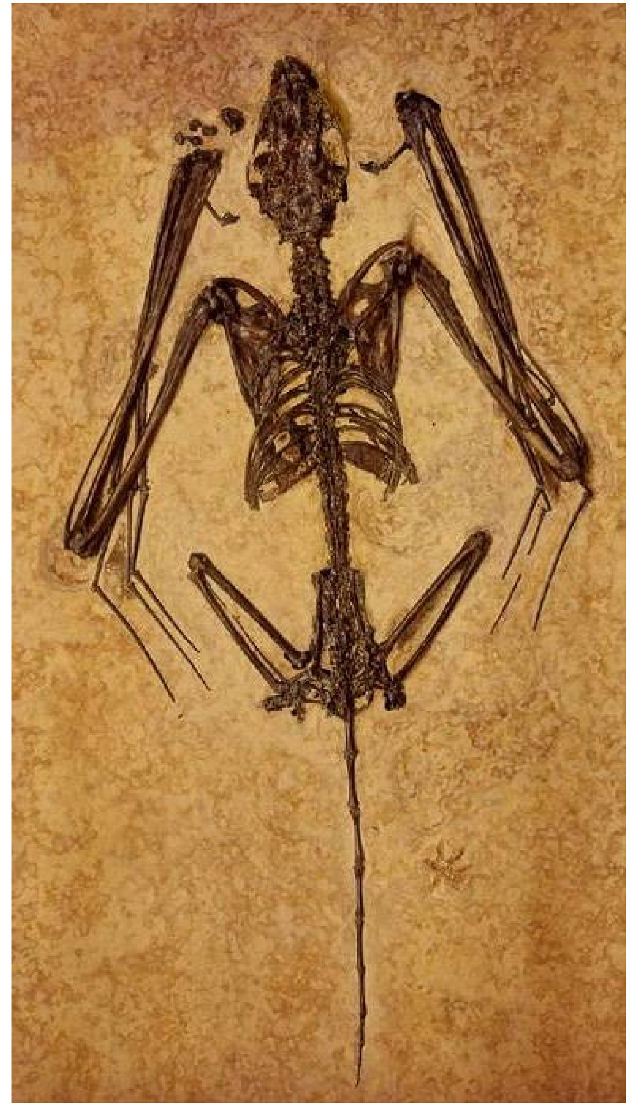
Do nedávna nejstarší známá fosilie, sp. Eocén.
Už hotový netopýr, mj. malá redukce ulny



Onychonycteris finneyi

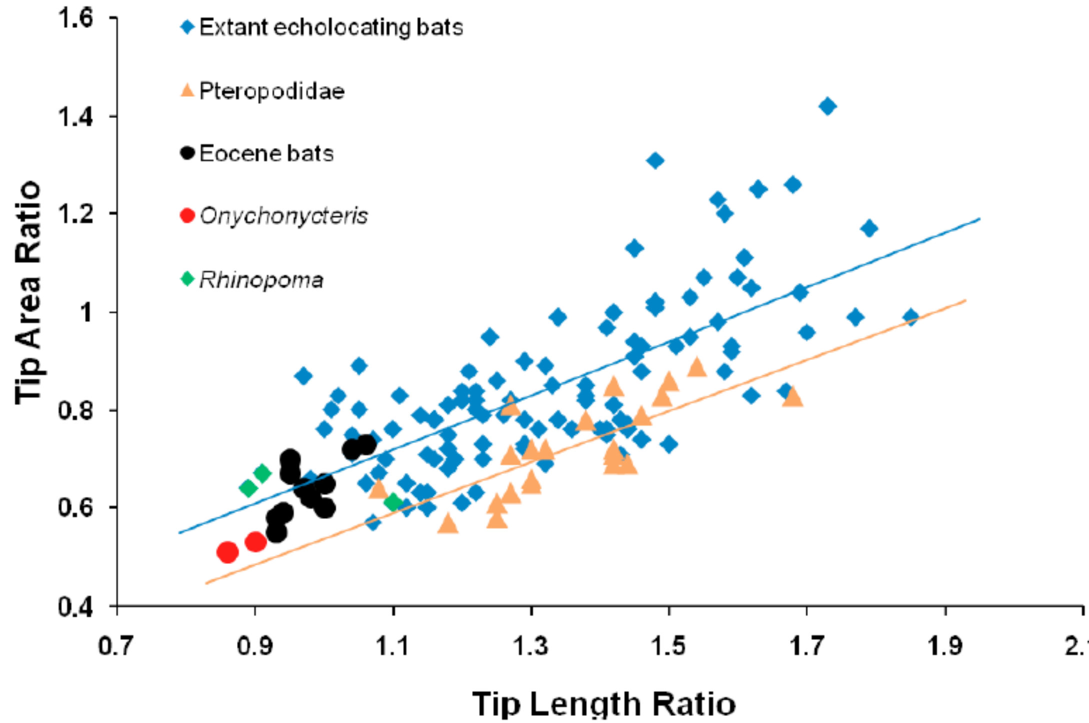
Paratype (Private Collection))

Icaronycteris index

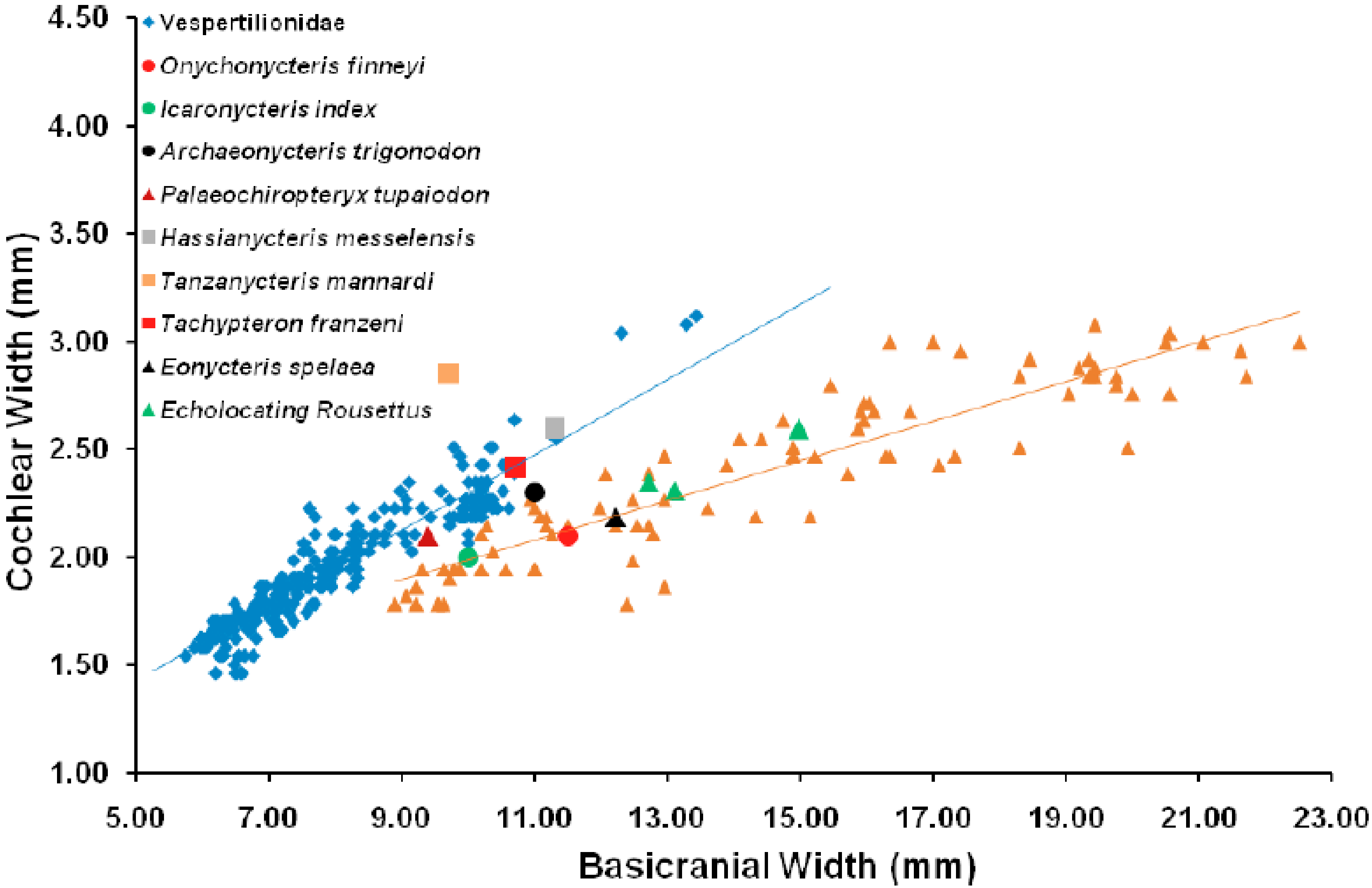


Holotype (YPM-PU 18150)

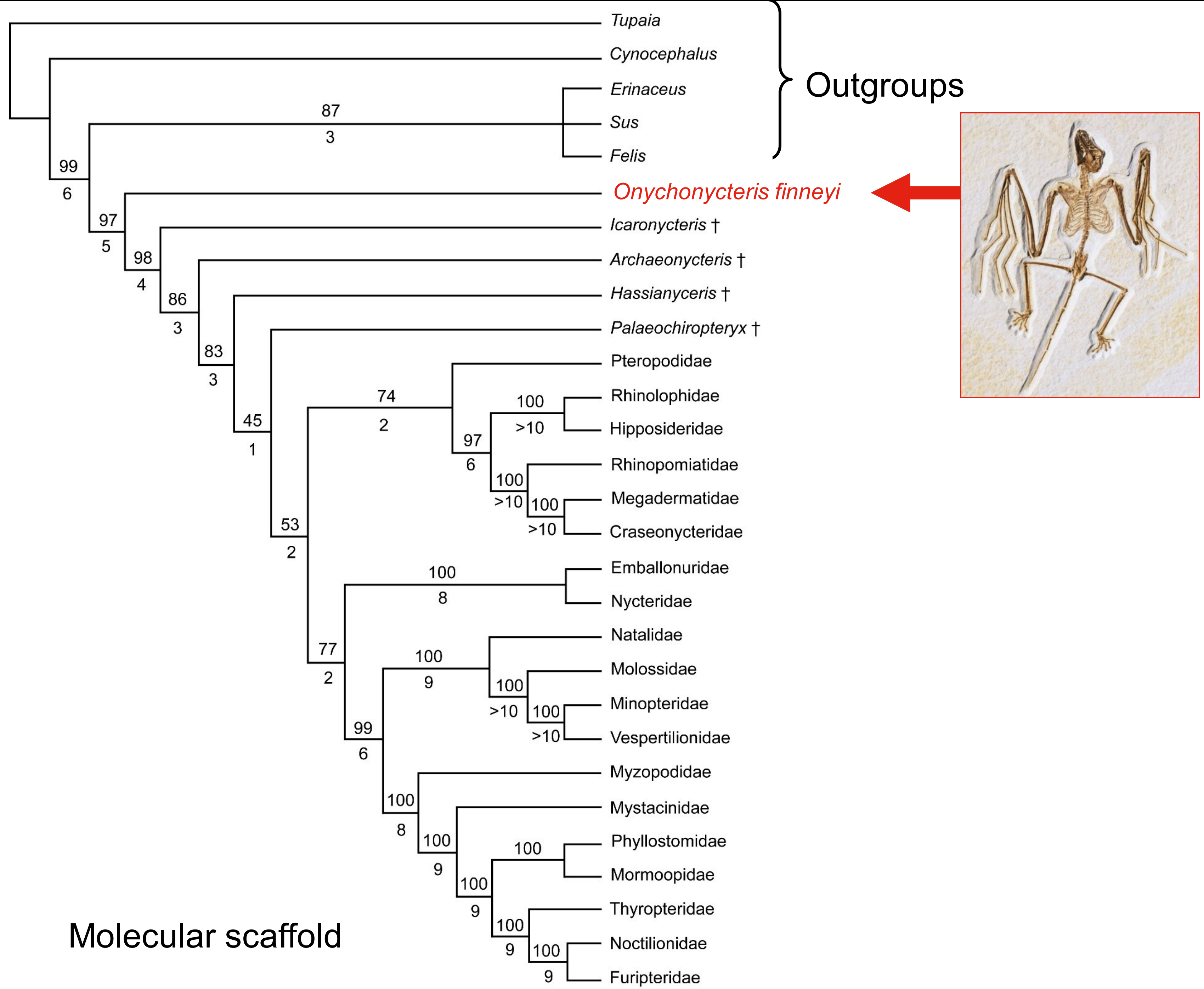
Taxon	Aspect Ratio Index	Data Source
Onychonycteris finneyi	1.74	
Icaronycteris index	1.97	
Archaeonycteris trigonodon	1.87	
Palaeochiropteryx tupaiodon	2.04	
Palaeochiropteryx spiegeli	2.06	
Hassianycteris messelensis	2.51	
Hassianycteris magna	2.66	
Tachypteron franzeni	2.75	
Pteropodidae	2.16-2.21	
Rhinopomatidae	2.11	
Megadermatidae	2.19	
Rhinolophidae	2.14	
Emballonuridae	2.39	40
Nycteridae	2.00	40
Noctilionidae	2.53	40
Mormoopidae	2.22	40
Phyllostomidae	1.99-2.20	40



Široká a krátká křídla



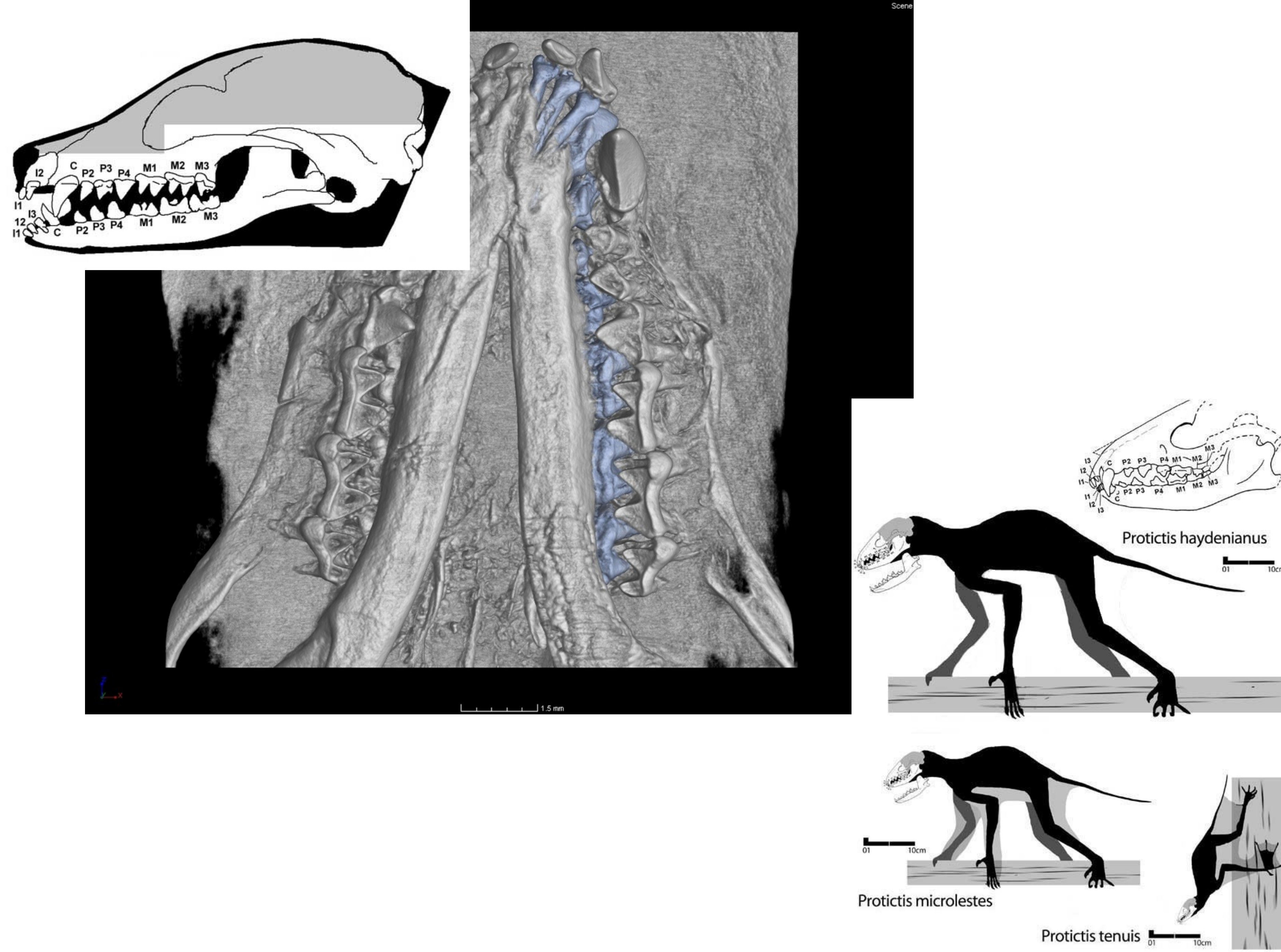
Vespertilionidae
Onychonycteris finneyi
Icaronycteris index
Archaeonycteris trigonodon
Palaeochiropteryx tupaiodon
Hassianycteris messelensis
Tanzanycteris mannardi
Tachypteron franzeni
Eonycteris spelaea
Echolocating Rousettus
Cochlear Width (mm)
Basicranial Width (mm)
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
5.00
7.00
9.00
11.00
13.00
15.00
17.00
19.00
21.00
23.00

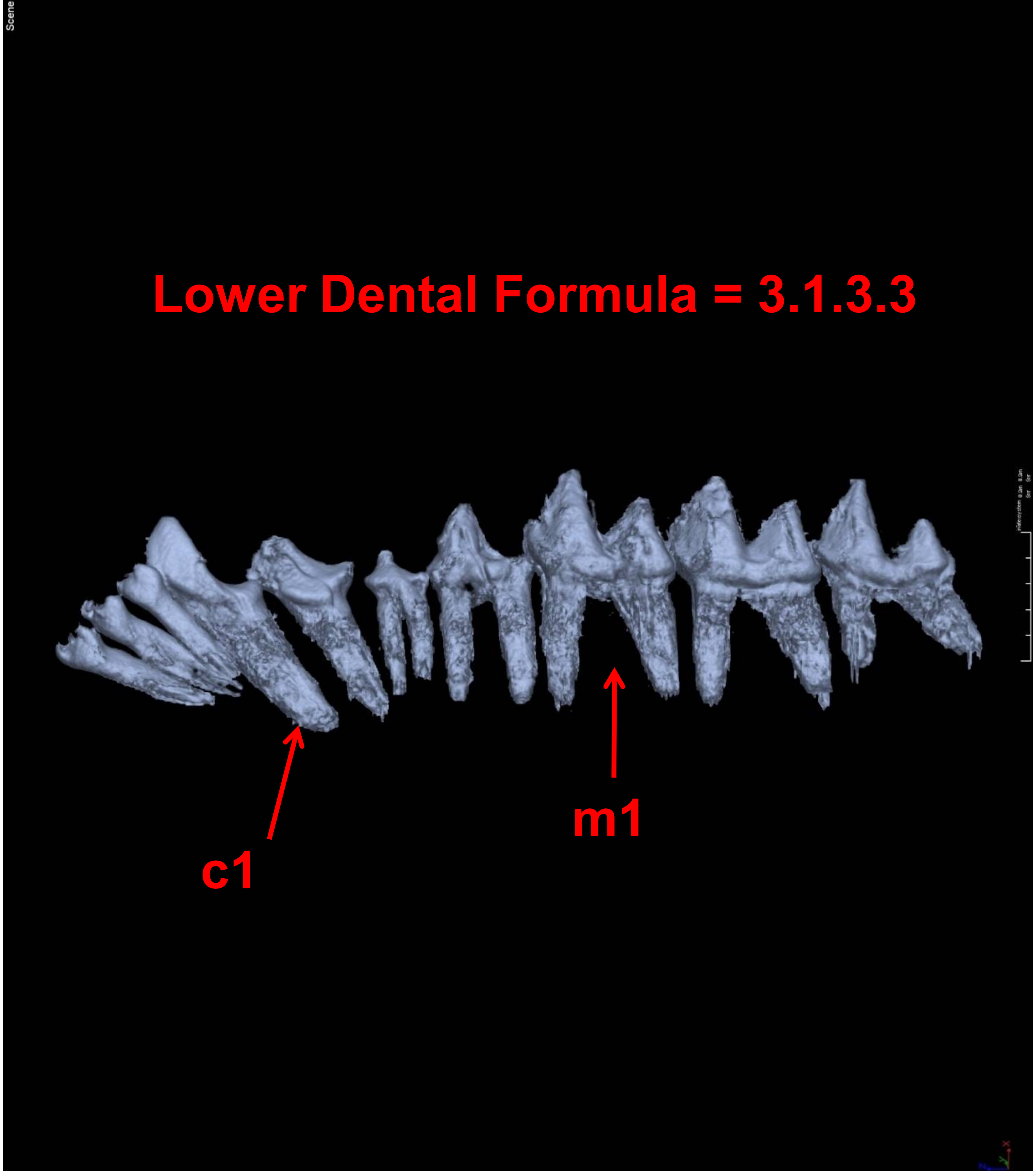

Tupaia
Cynocephalus
Erinaceus
Sus
Felis
Outgroups
Onychonycteris finneyi
Icaronycteris †
Archaeonycteris †
Hassianyceris †
Palaeochiropteryx †
Pteropodidae
Rhinolophidae
Hipposideridae
Rhinopomiatidae
Megadermatidae
Craseonycteridae
Emballonuridae
Nycteridae
Natalidae
Molossidae
Minopteridae
Vespertilionidae
Myzopodidae
Mystacinidae
Phyllostomidae
Mormoopidae
Thyropteridae
Noctilionidae
Furipteridae
Molecular scaffold

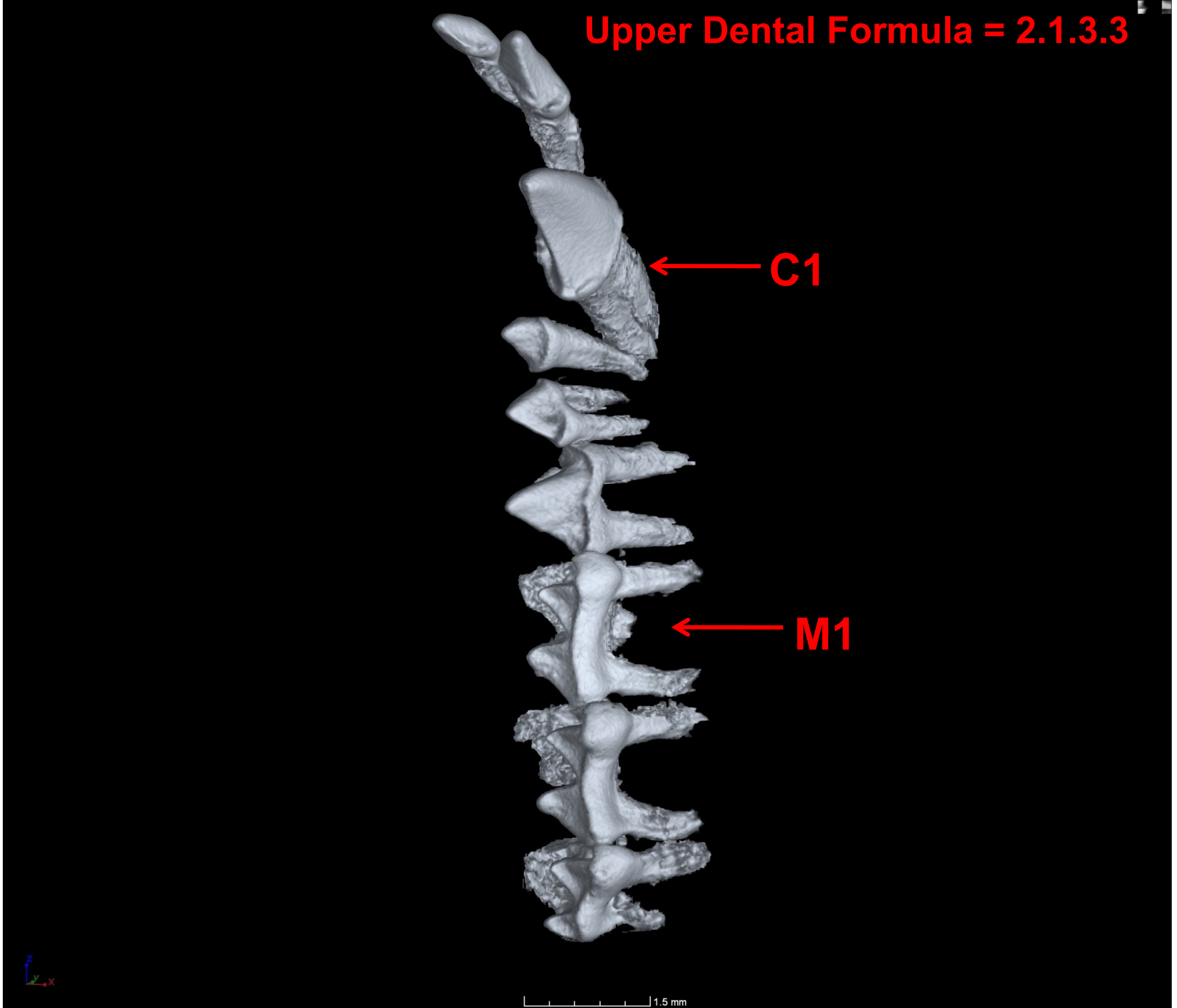
Onychonycteris Dentition

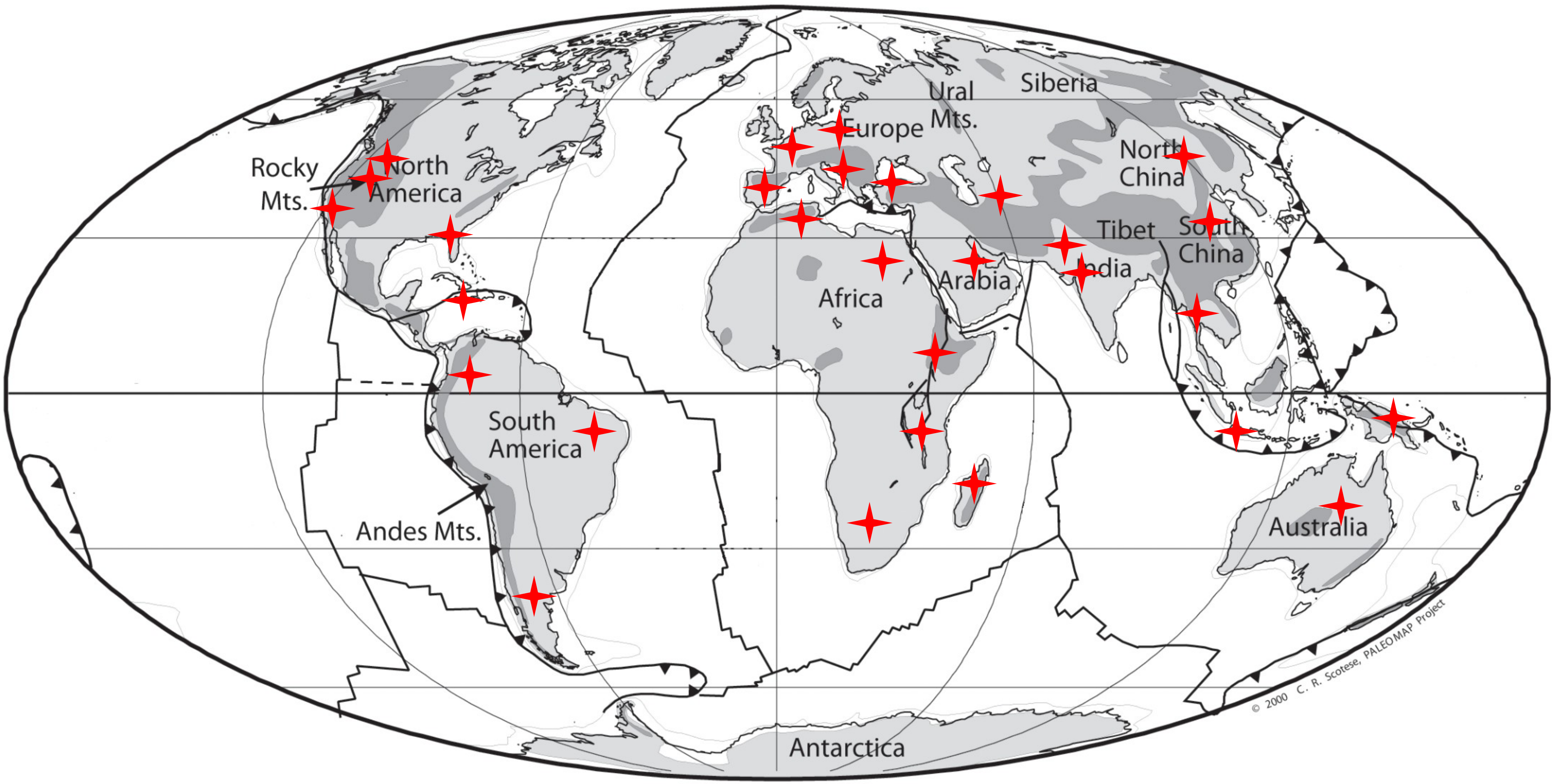
Paratype (Unaccessioned)

Holotype ROM 55351A)


I2
C P2 P3 P4 M1 M2 M3
I1
I3
I2
I1
C P2 P3 P4 M1 M2 M3
Scene
1.5 mm
I3 I2 I1 C P2 P3 P4 M1 M2 M3
I1 I2 I3 C P2 P3 P4 M1 M2 M3
Protictis haydenianus
01
10cm
01
10cm
Protictis microlestes
Protictis tenuis
01
10cm


Lower Dental Formula = 3.1.3.3
c1
m1


Upper Dental Formula = 2.1.3.3
C1
M1
1.5 mm


Rocky
Mts.
North
America
South
America
Andes Mts.
Europe
Ural
Mts.
Siberia
North
China
South
China
Tibet
India
Arabia
Africa
Australia
Antarctica
© 2000 C. R. Scotese, PALEOMAP Project

Létání: omezení tělesné velikosti

Letouni: 1.9 g - 1.5 kg

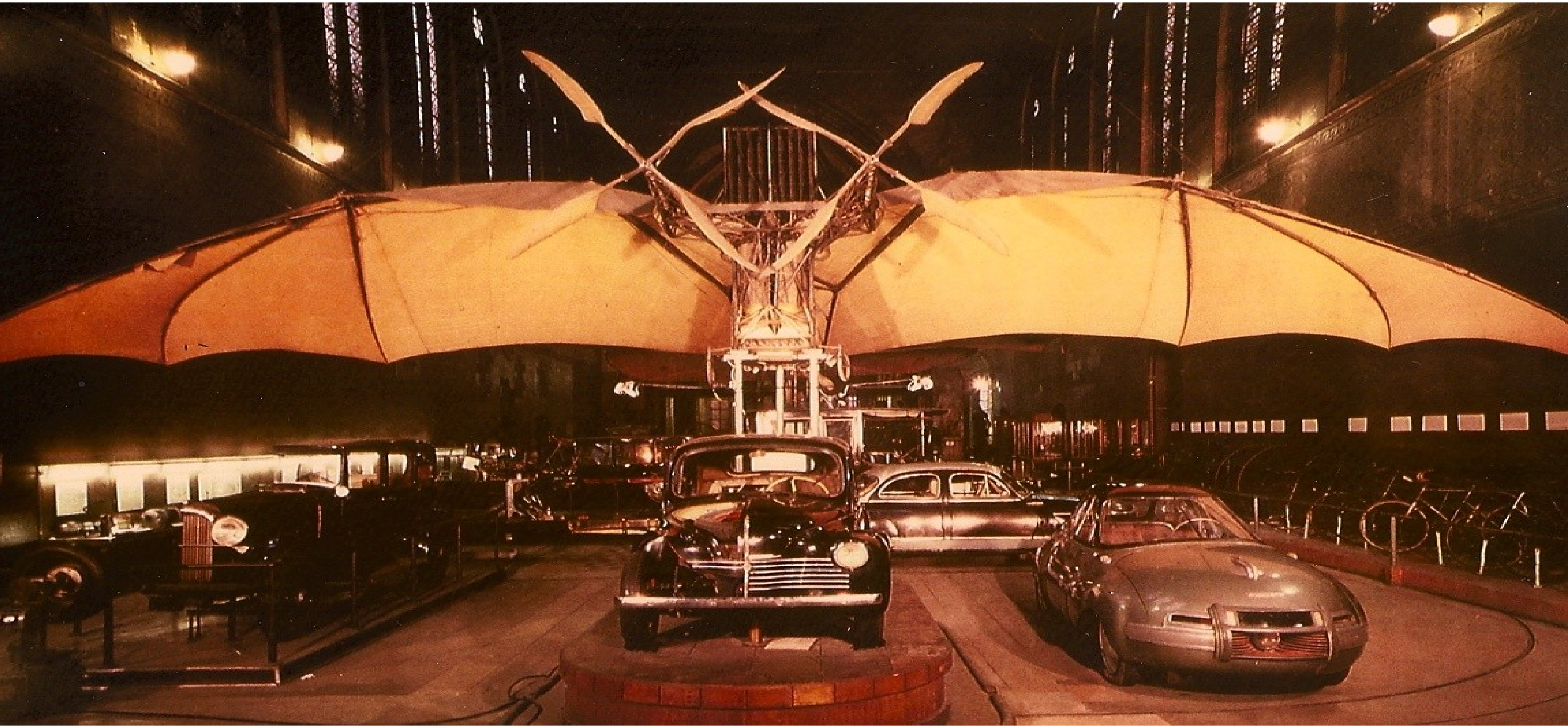
Ptáci: 1.5 g - 16 kg

Hmyz: 0.01 -200 g

Pterosauři 4 g - 100 kg

Pteropus vampyrus

… netopýr velikosti člověka



Chiroptera – nejmenší genom mezi savci

- 1.63 pg in *Lophostoma carrikeri* to 3.17 pg in *Rhinopoma hardwickii* , averaging 2.35 pg ± 0.02SE.
- Pteropodidae: variabilita velikosti genomu výrazně omezena

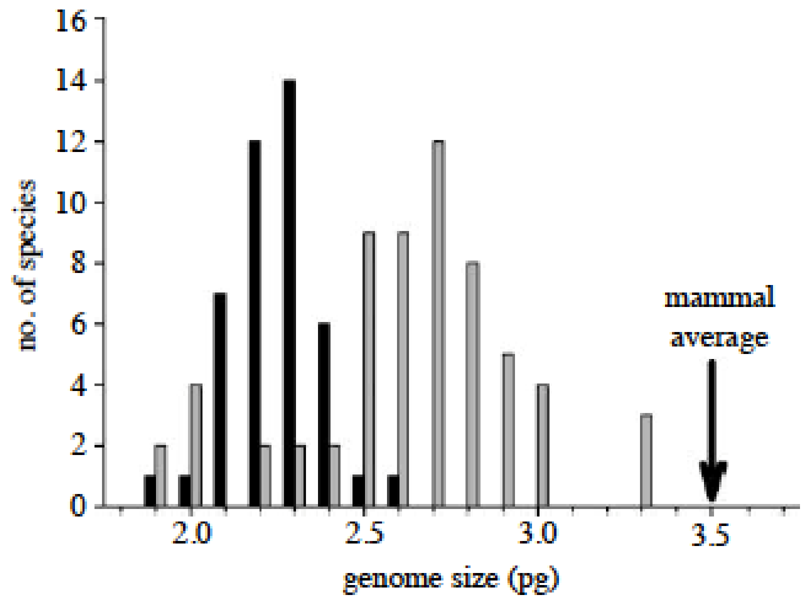
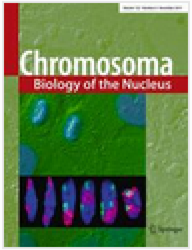


Figure 1. Summary of genome size diversity in 43 species of megabats of the family Pteropodidae (black bars, present study) and 62 species from six families of microbats (grey bars, Gregory 2009).



Chromosoma
December 2013, Volume 122, Issue 6, pp 535–540 | Cite as

The bat genome: GC-biased small chromosomes associated with reduction in genome size

Authors Authors and affiliations

Fumio Kasai, Patricia C. M. O'Brien, Malcolm A. Ferguson-Smith

Research Article
First Online: 24 July 2013

Abstract

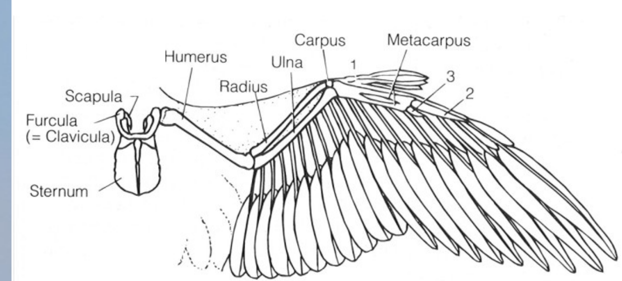
Bats are distinct from other mammals in their small genome size as well as their high metabolic rate, possibly related to flight ability. Although the genome sequence has been published in two species, the data lack cytogenetic information. In this study, the size and GC content of each chromosome are measured from the flow karyotype of the mouse-eared bat, *Myotis myotis* (MMY). The sm

relative proportions of homologous segments between MMY and human differ among the MMY

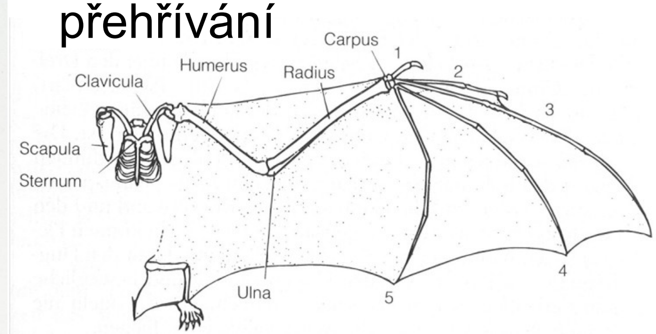
Letouni jsou výlučně noční

m.j. i z energetických důvodů:

Peří – izolace proti přehřívání



Velká plocha neizolovaného povrchu – riziko denního přehřívání



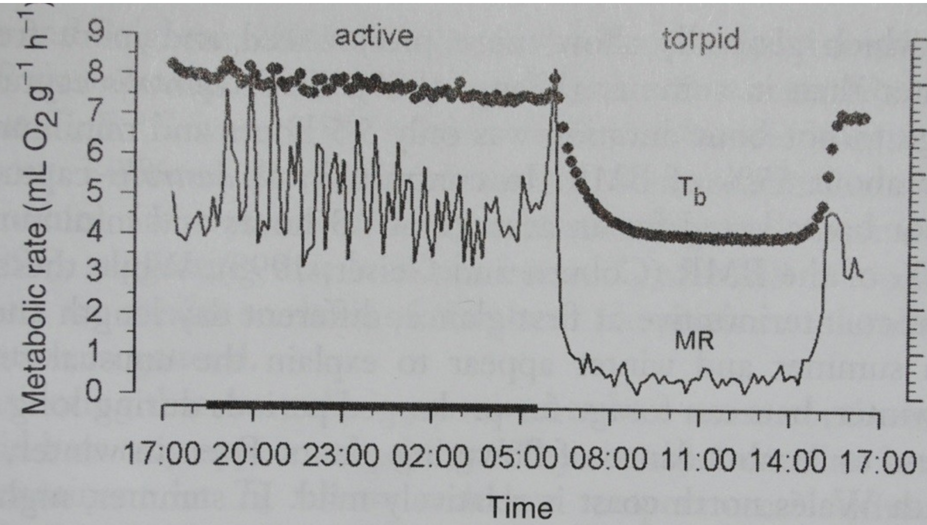
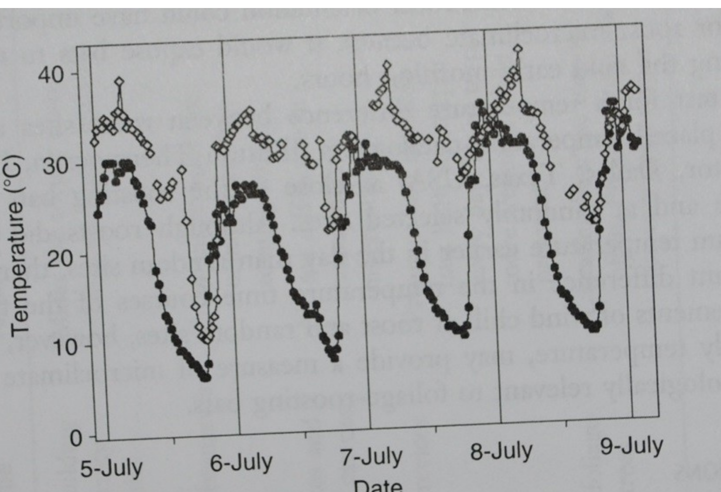
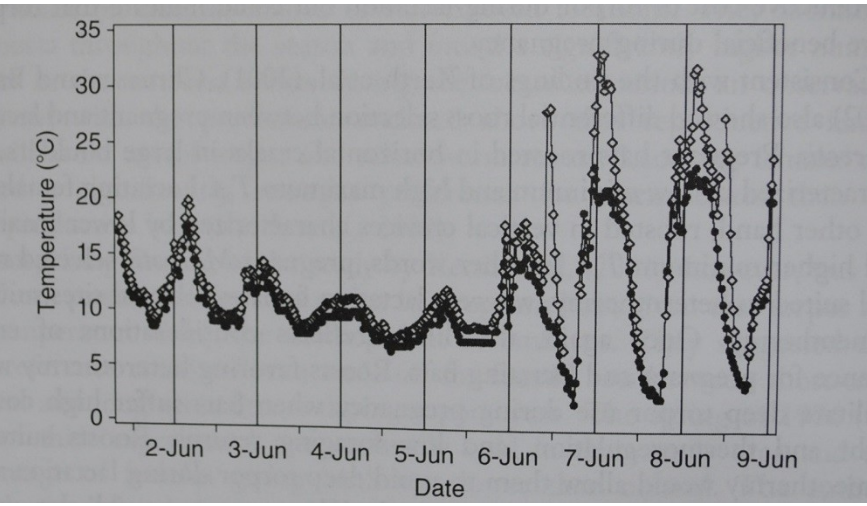


Figure 1.3 Daily fluctuations of body temperature (T_b, broken line) and metabolic rate (MR, continuous line) of a common blossom-bat, *Syconycteris australis*. Torpor entry occurred after lights on in the morning and spontaneous arousal in the afternoon.

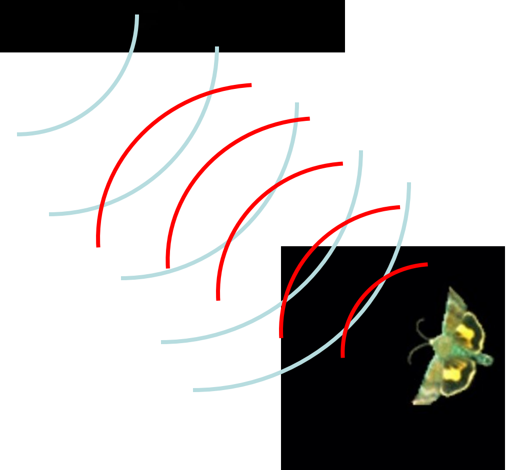
Heterotermie, denní strnulost, hibernace

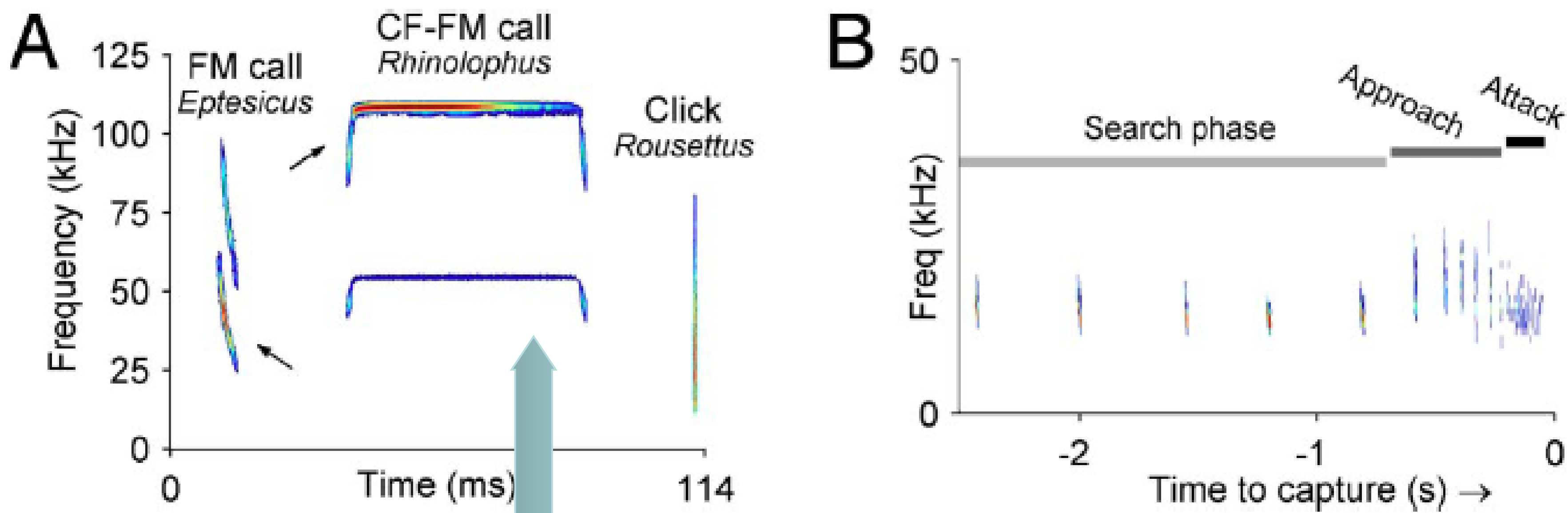




rozdělení potravních nik souvisí s letovými a senzorickými omezeními/dispozicemi k potravní základně

Echolokace





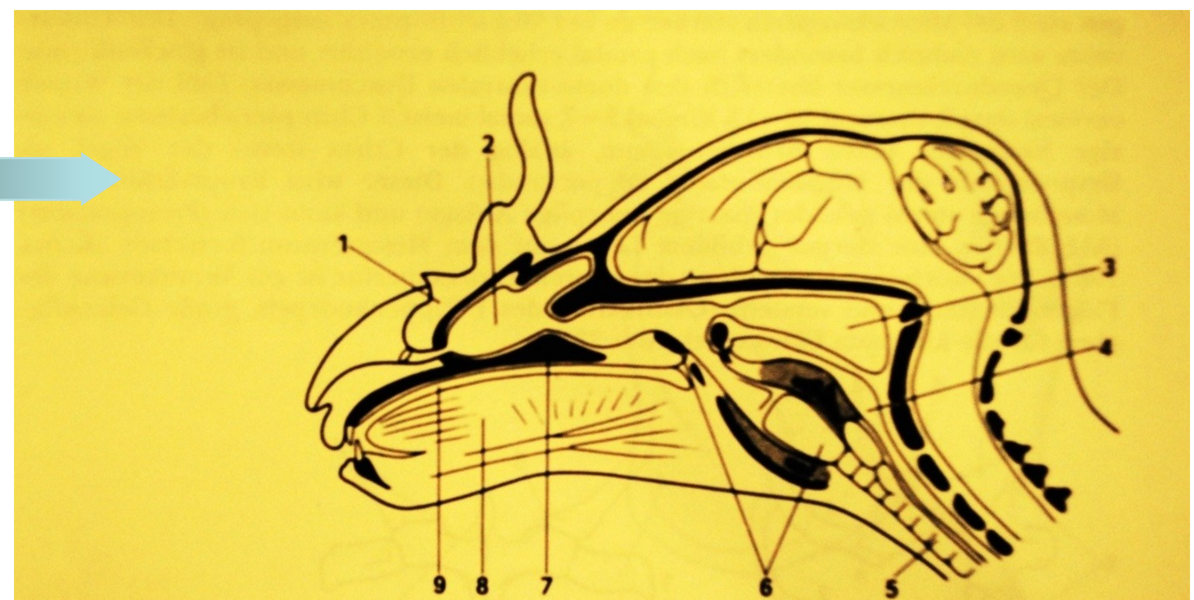
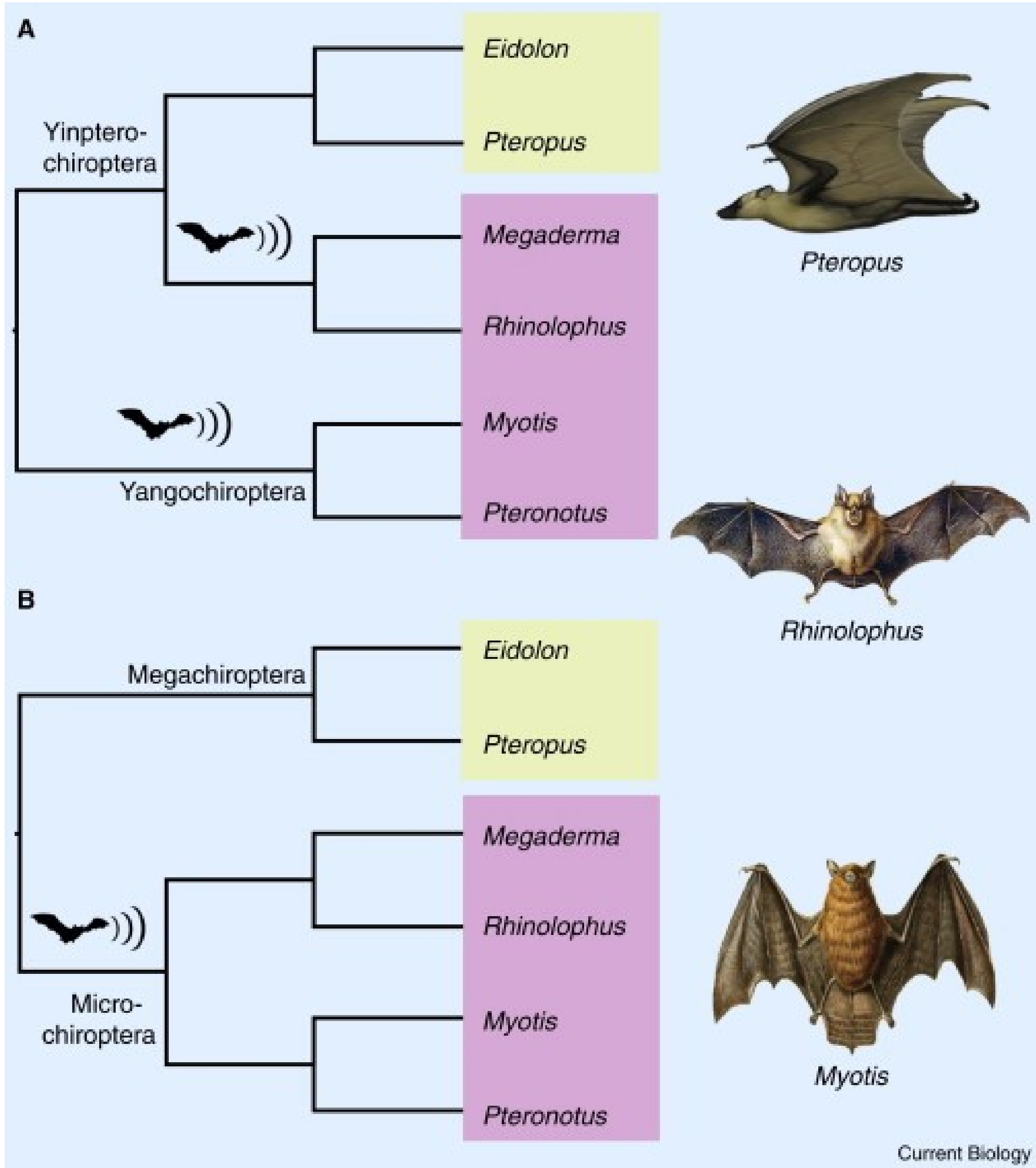


Abb. 230. Parasagittalschnitt durch den Kopf einer Kleinen Hufeisennase, *Rhinolophus hipposideros* (Microchiroptera, Rhinolophidae). Nach Möhres 1952.
1. Hufeisen, 2. Nasenhöhle, 3. Bursa pharyngica (Rec. pharyngis), 4. Oesophagus, 5. Trachea, 6. Larynx, 7. Gaumen, 8. Zunge, 9. Mundhöhle.

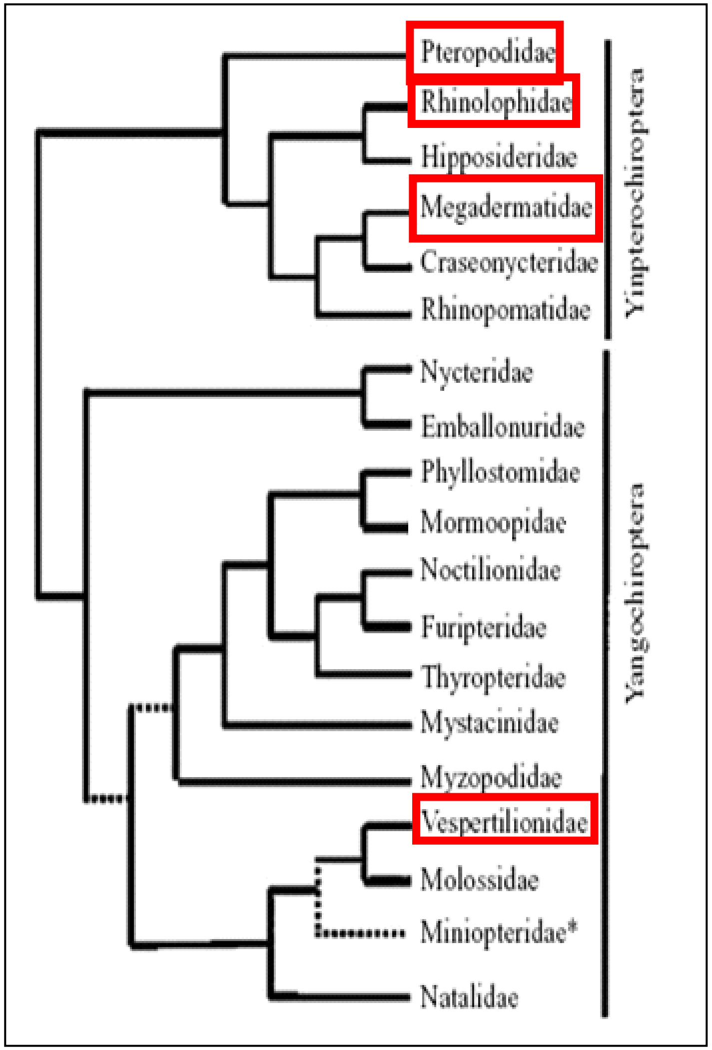
laryngeální echolokace
tlamkou, nozdrami

Otázka vzniku echolokace

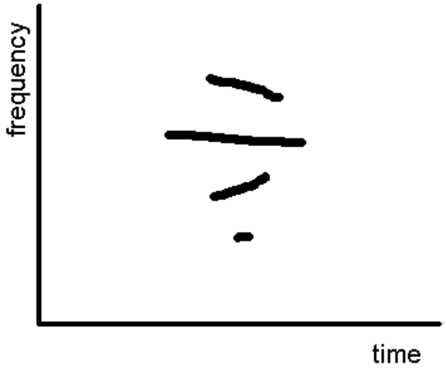


echolokační gen FOXP2 – velmi variabilní (vocal learning gen u člověka a ptáků)

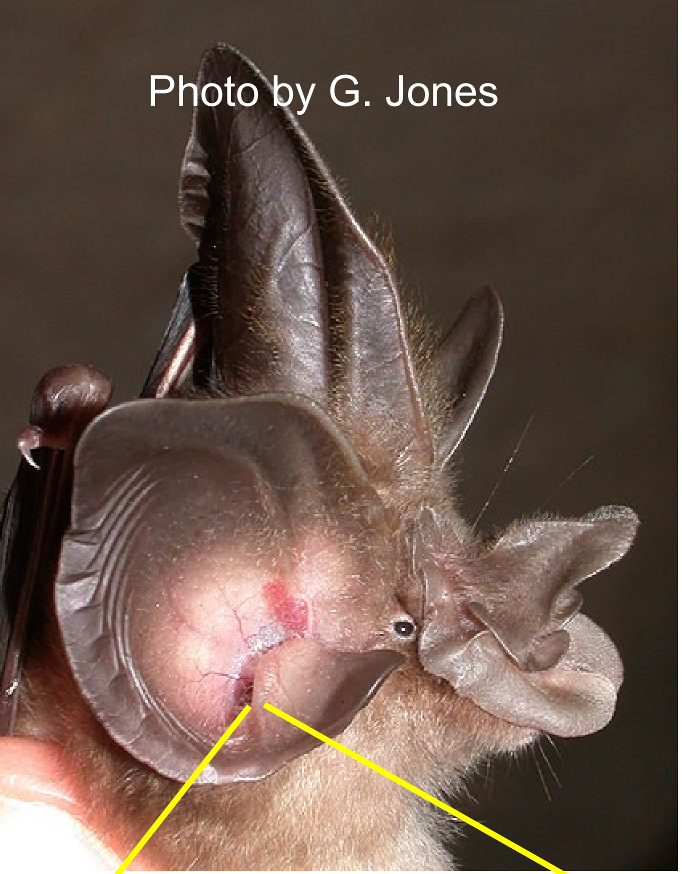
konvergentní evoluce mezi vrápenci, pavrápenci a kytovci (Odontoceti)



Megadermatidae (Old World false vampire bats)



Li et al 2008



Prestin is the motor protein of cochlear outer hair cells

Jing Zheng*, Weixing Shen*, David Z. Z. He*, Kevin B. Long†, Laird D. Madison† & Peter Dallos*

* *Auditory Physiology Laboratory (The Hugh Knowles Center), Departments of Neurobiology and Physiology and Communciation Sciences and Disorders, Northwestern University, Evanston, Illinois 60208, USA*
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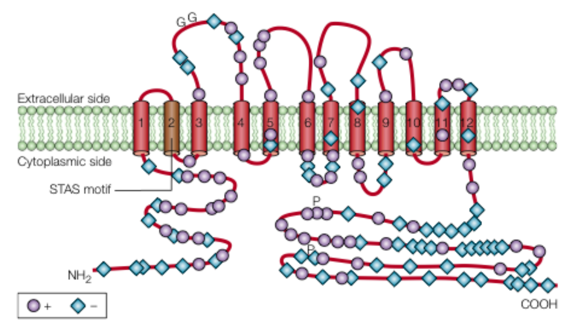
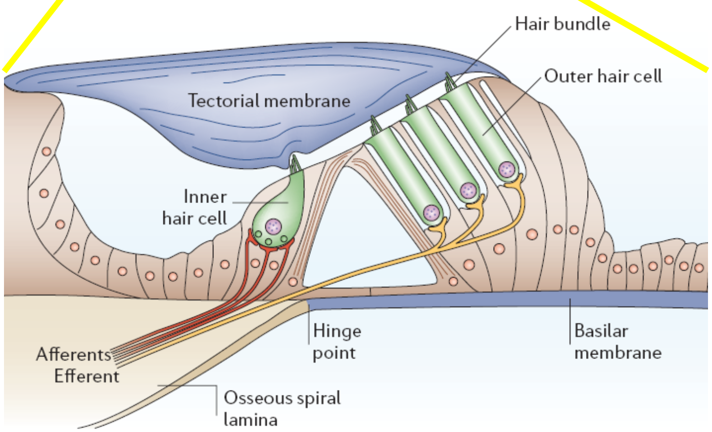
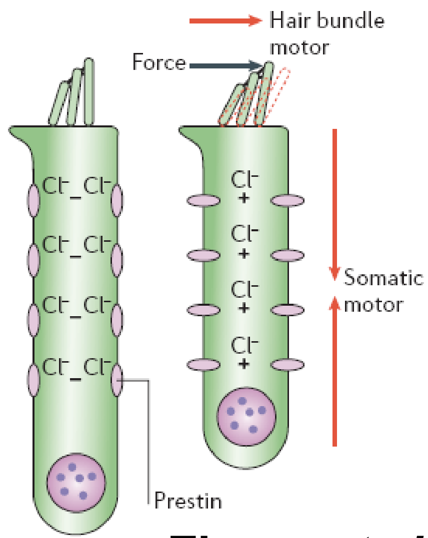
The outer and inner hair cells of the mammalian cochlea perform different functions. In response to changes in membrane potential, the cylindrical outer hair cell rapidly alters its length and stiffness. These mechanical changes, driven by putative molecular motors, are assumed to produce amplification of vibrations in the cochlea that are transduced by inner hair cells. Here we have identified an abundant complementary DNA from a gene, designated *Prestin*, which is specifically expressed in outer hair cells. Regions of the encoded protein show moderate sequence similarity to pendrin and related sulphate/anion transport proteins. Voltage-induced shape changes can be elicited in cultured human kidney cells that express prestin. The mechanical response of outer hair cells to voltage change is accompanied by a 'gating current', which is manifested as nonlinear capacitance. We also demonstrate this nonlinear capacitance in transfected kidney cells. We conclude that prestin is the motor protein of the cochlear outer hair cell.



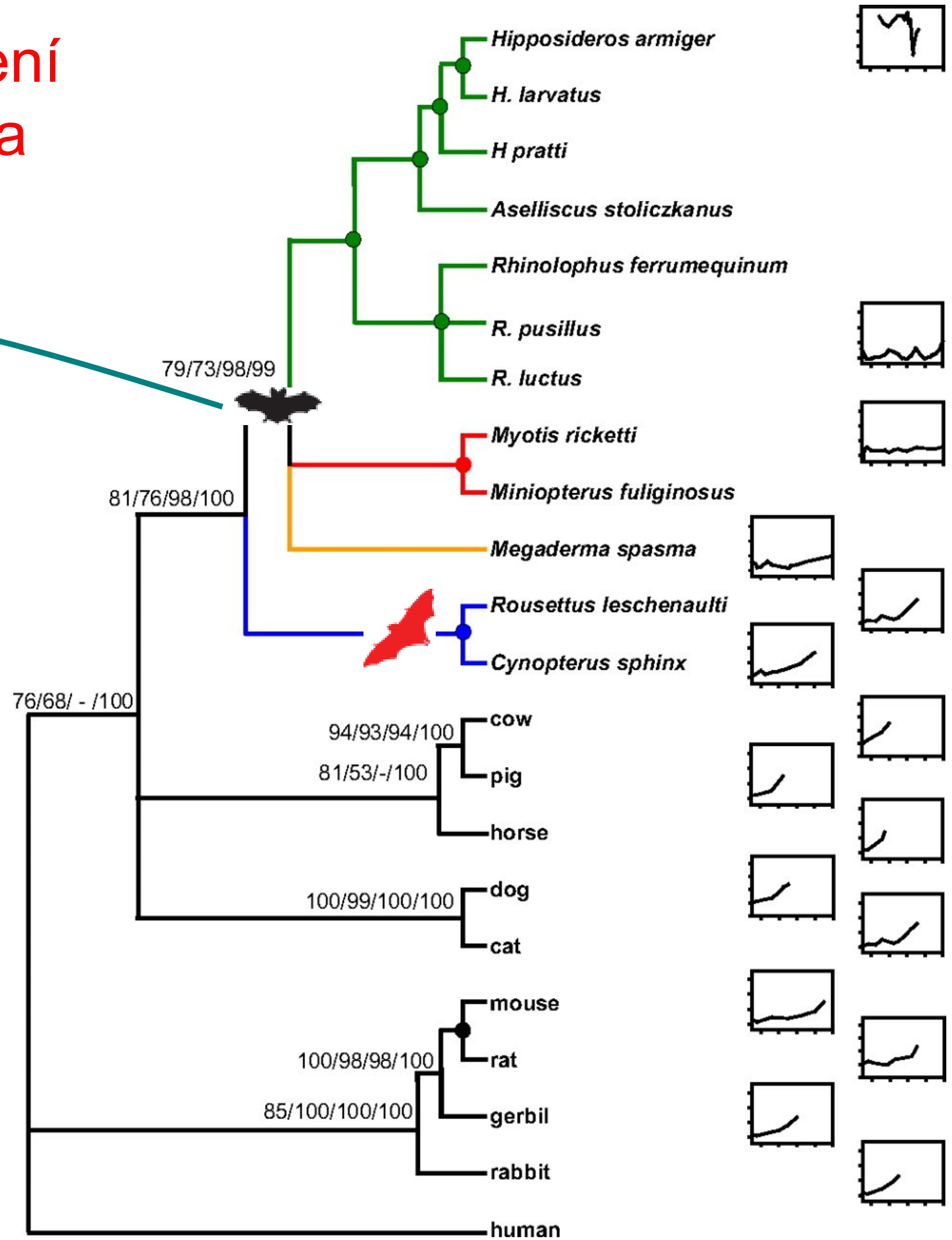




Record holder for highest frequency contraction of a motor protein

Zheng *et al* (2000) Nature 405: 149-155

Prestin! – bazální rozdělení na Mega a Microchiroptera



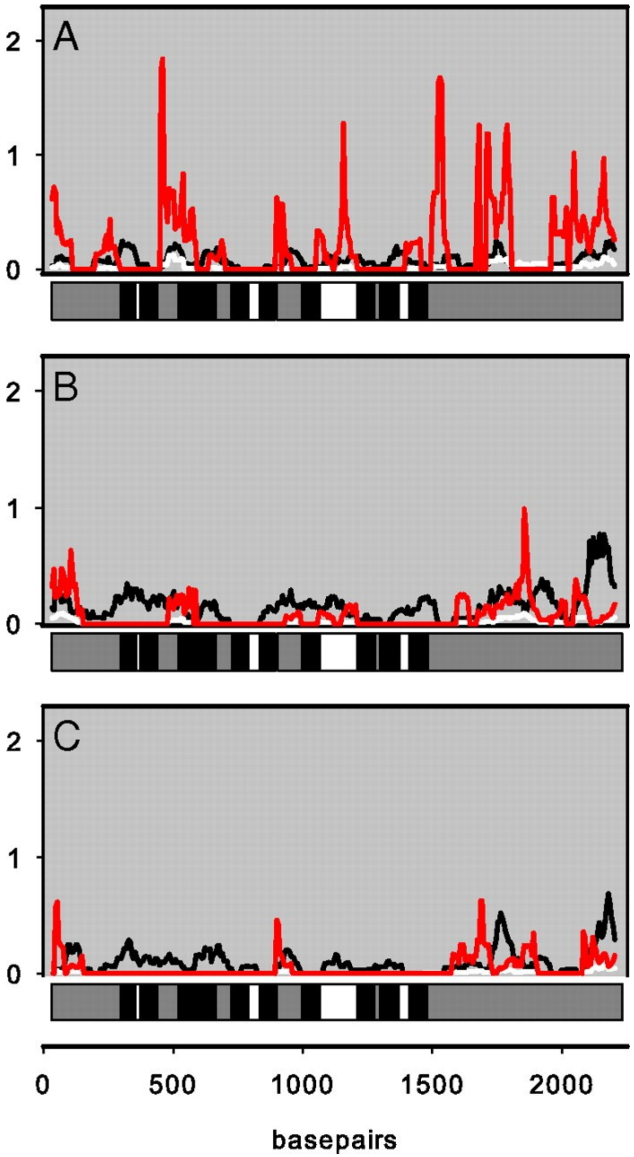
echolokující letouni tvoří monofyletickou skupinu

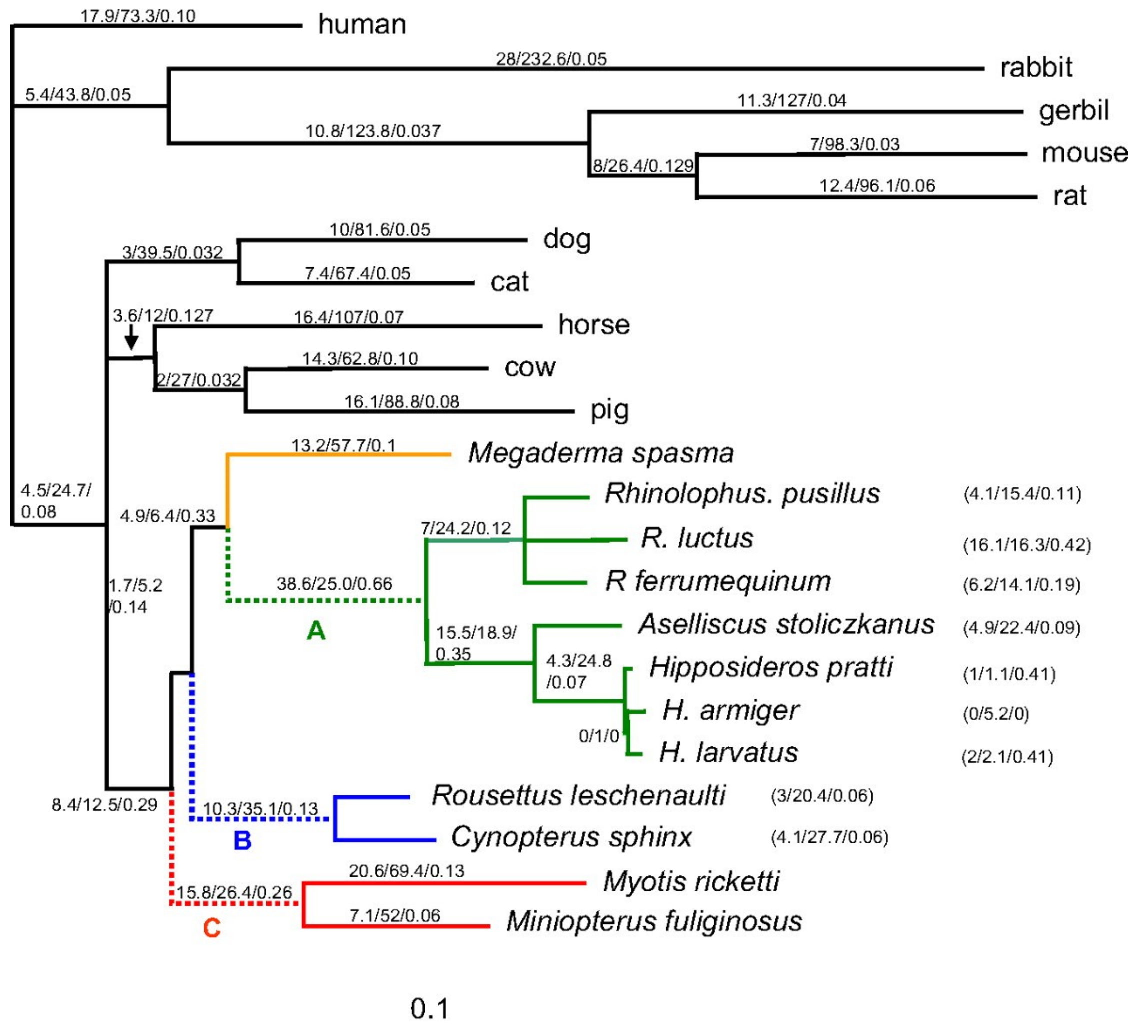
Prestin **kodující gen u 22 savců, genetický strom stejný i u kytovců**

Li *et al*. (2008) PNAS 105:13959-13964

dN/dS (red) along the ancestral branches of CF bats (A), Old World fruit bats (B) and Yangochiroptera (C)

Constrained species tree





Li *et al*. (2008) PNAS 105:13959-13964


frontiers in PHYSIOLOGY
REVIEW ARTICLE
published: 30 May 2013
doi: 10.3389/fphys.2013.00117

From the ultrasonic to the infrared: molecular evolution and the sensory biology of bats

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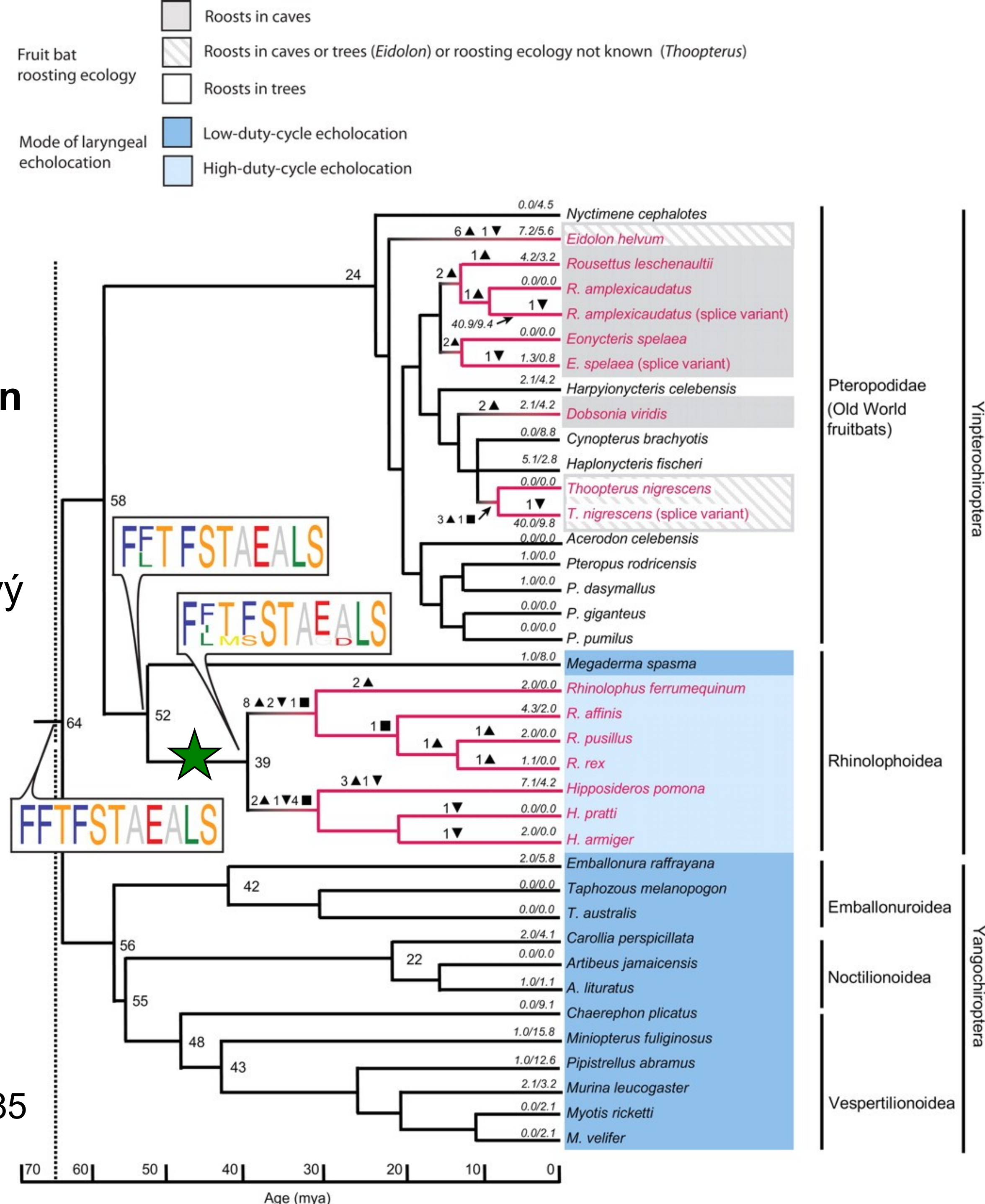
[2] UCD School of Biology and Environmental Science, University College Dublin, Dublin, Ireland
[3] School of Biological and Chemical Sciences, Queen Mary, University of London, London, UK

geny kódující **rhodopsin** a **opsin** (citlivý na dlouhé vlny) fungují u netopýrů

Ale..ty geny co kódují opsin citlivý na **krátké vlny** je u rhinolophoidních netopýrů (vysokofrekvenční echolokace) **nefunkční**

→ trade-off mezi zrakem a sluchem

Zhao *et al.* (2009) PNAS 106: 8980-8985



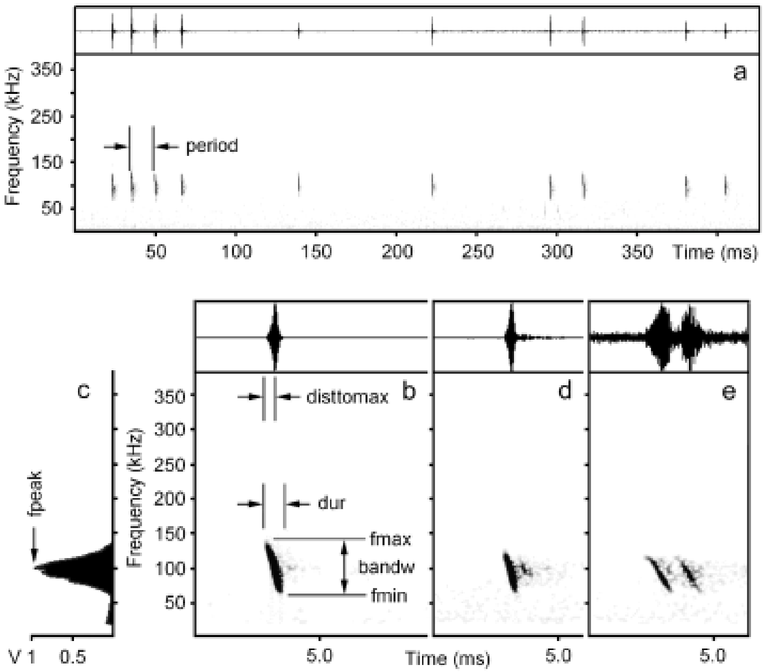


Figure 2 The waveforms, spectrograms and power spectrum (c) representing acoustic patterns and acoustic variables measured from the vocal pulses of *Typhlomys chapensis*. (a) Natural sequence of pulses, of which the first 4 comprise a typical bout; period, the period between pulses. (b) and (c) A pulse without echo; fmax, the maximum fundamental frequency; fmin, the minimum fundamental frequency; bandw, the pulse bandwidth; dur, the pulse duration; disttomax, the duration to the pulse maximum amplitude; fpeak, the peak frequency. (d) A pulse with weak echo. (e) A pulse with strong echo.

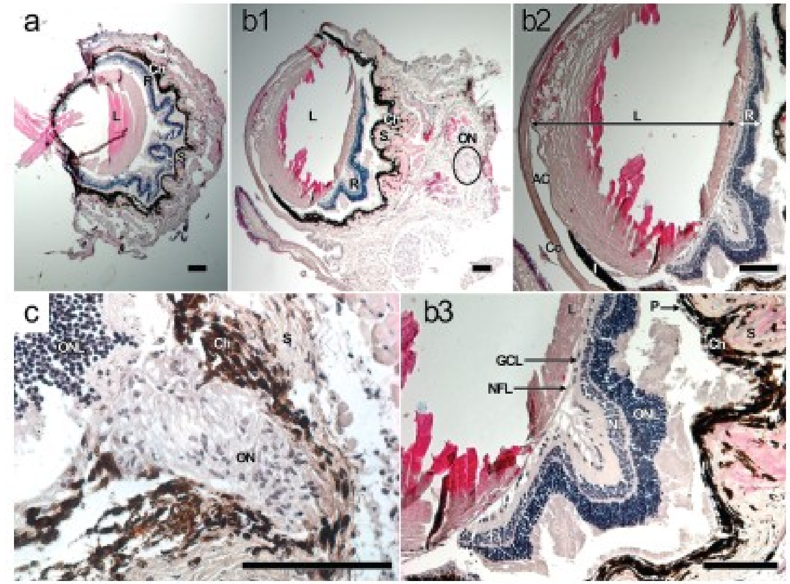


Figure 3 Eye structure in *Typhlomys chapensis*. (a) Section parallel to the optic axis stained according to Mallory represents extensive folding of retina. (b) Section through the optic axis stained according to Mallory at different magnifications: (b1) general eye composition, (b2) close-up view of the retina and (b3) close-up view of the retinal fold. (c) Longitudinal section of the optic nerve at its exit out of retina stained with hematoxylin–eosin shows gliosis of the optic nerve. AC, anterior chamber; Ch, choroid; Co, cornea; GCL, ganglion cell layer; I, iris; INL, inner nuclear layer; L, lens; NFL, nerve fiber layer; ON, optic nerve; ONL, outer nuclear layer (rod nuclei); P, pigment epithelium; R, retina; S, sclera. Scale bars 0.1 mm.

A blind climber: The first evidence of ultrasonic echolocation in arboreal mammals

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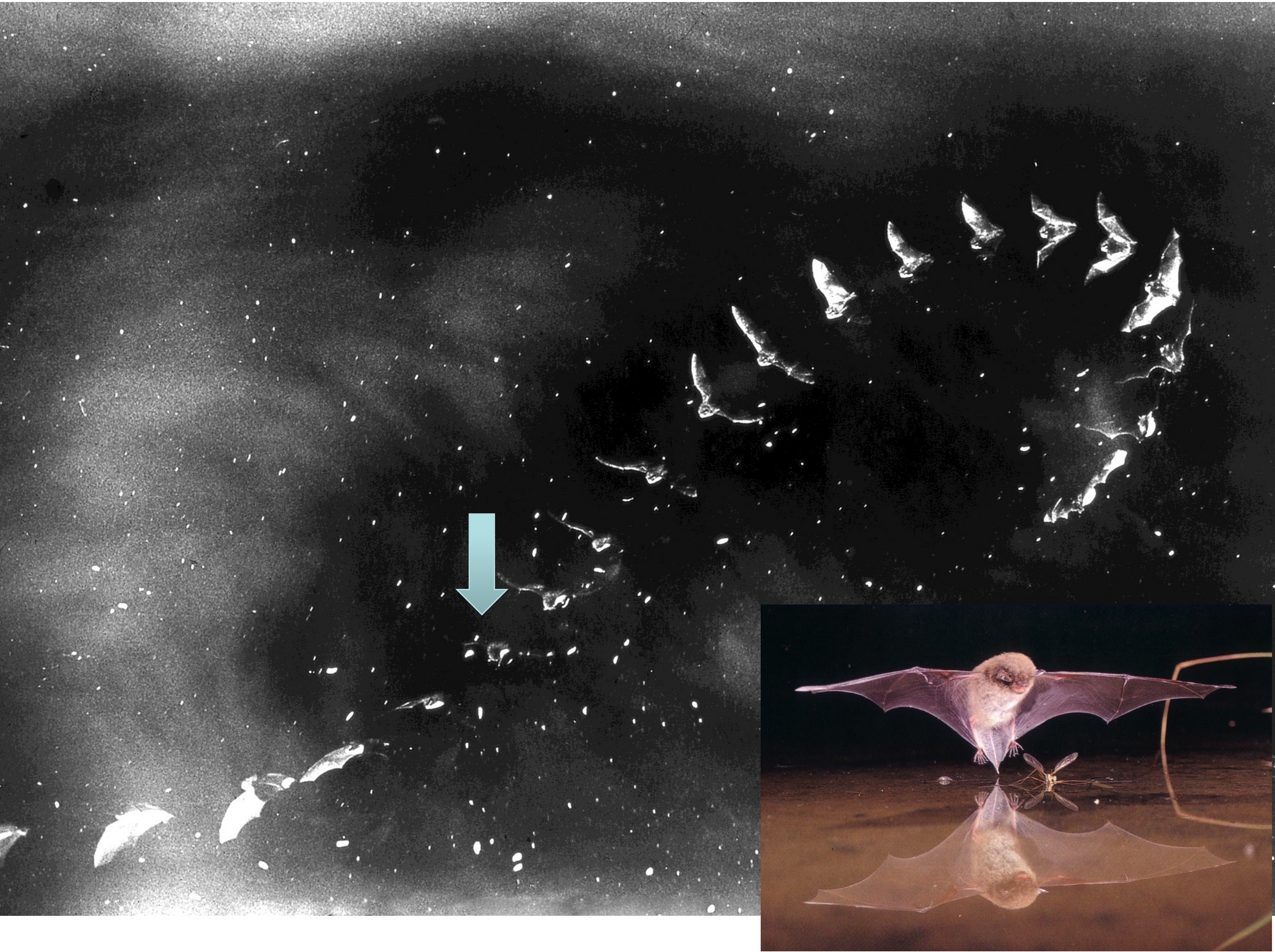
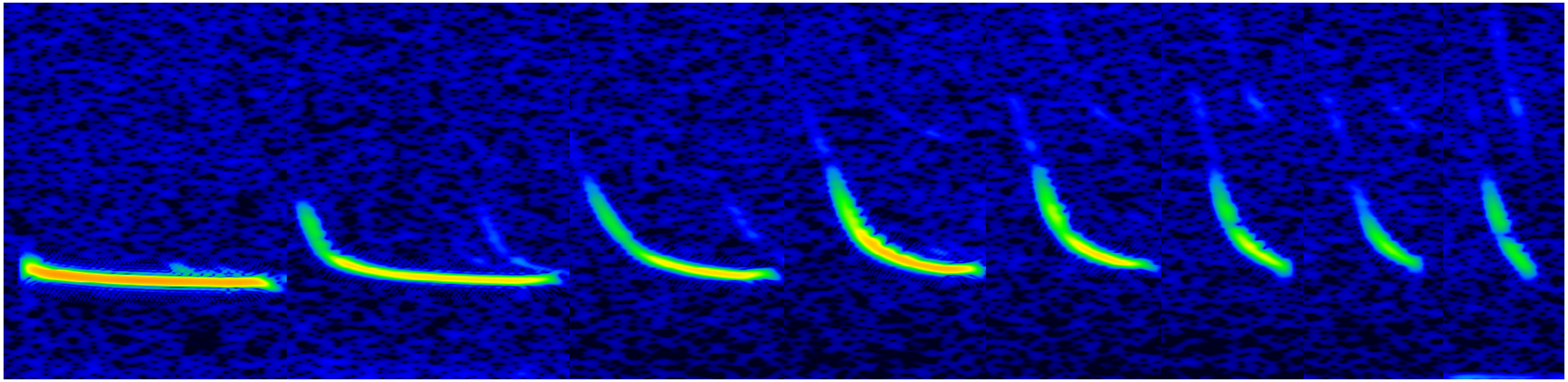
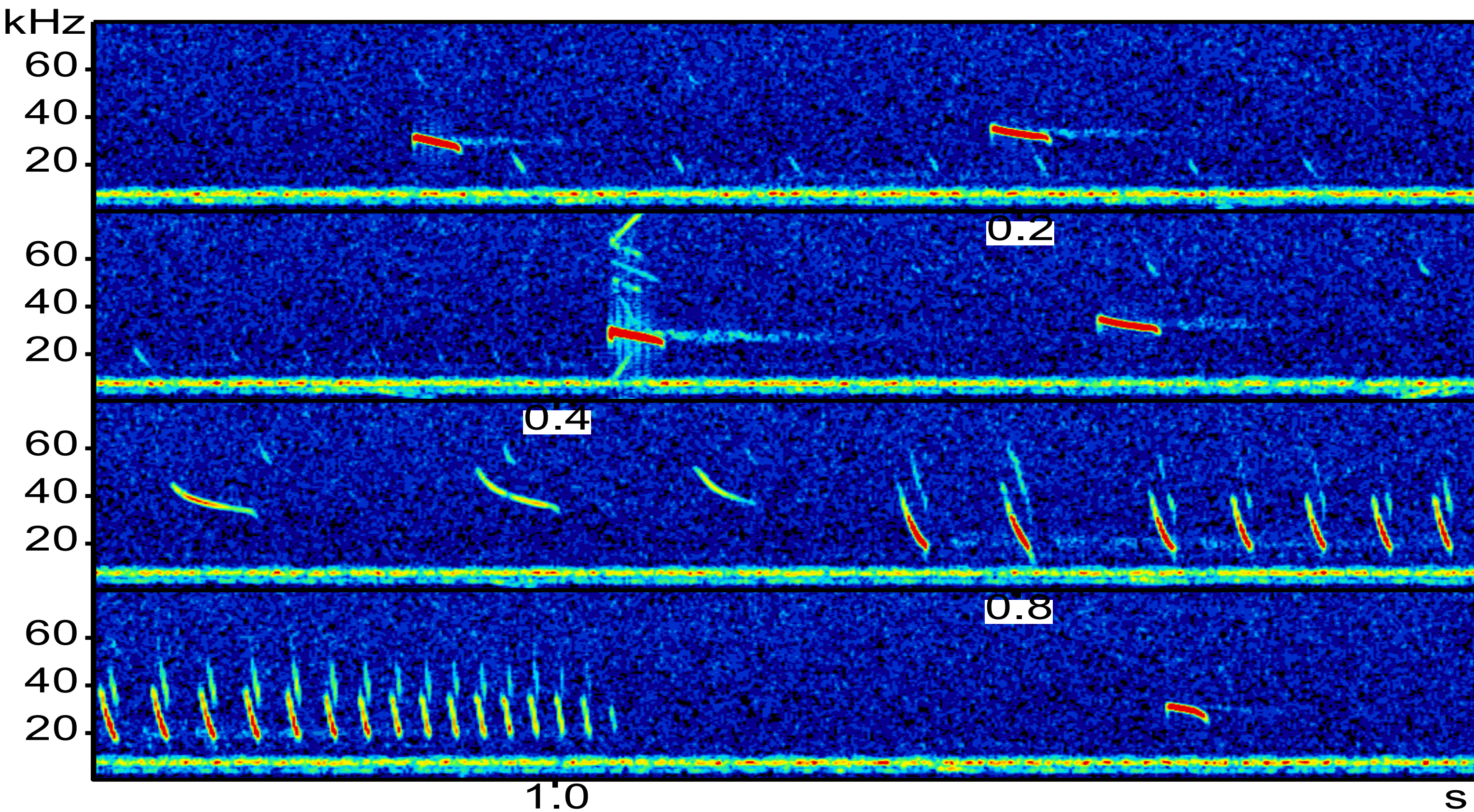
[1]Severtsov Institute of Ecology and Evolution, Russian Academy of Sciences, Moscow, Russia, [2]Department of Vertebrate Zoology, Faculty of Biology, Lomonosov Moscow State University, Moscow, Russia, [3]Scientific Research Department, Moscow Zoo, Moscow, Russia, [4]Zoological Institute, Russian Academy of Sciences, Saint Petersburg, Russia and [5]Joint Vietnam–Russian Tropical Research and Technological Centre, Hanoi, Vietnam

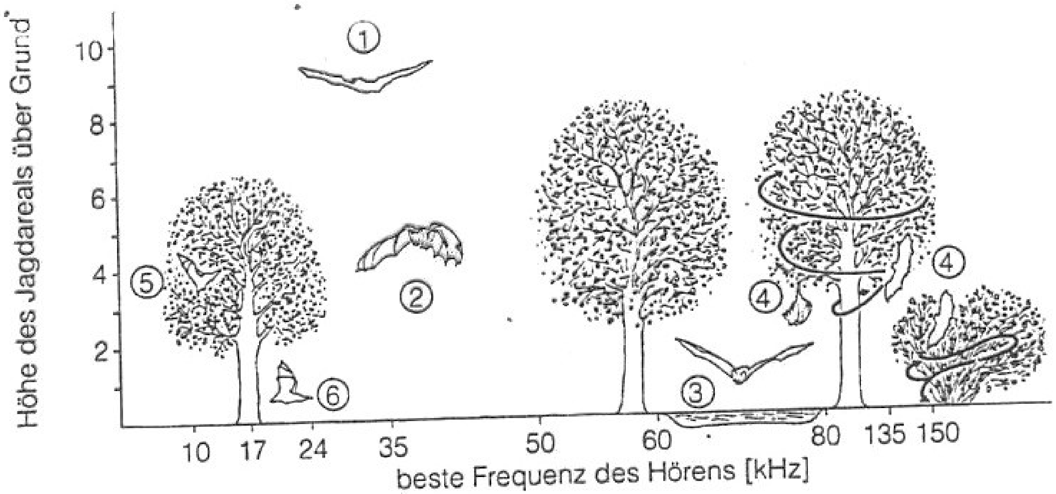
Figure 1 Vietnamese pygmy dormouse *Typhlomys chapensis*. Its reduced eyes are reflected in the generic name, which means "the blind mouse."

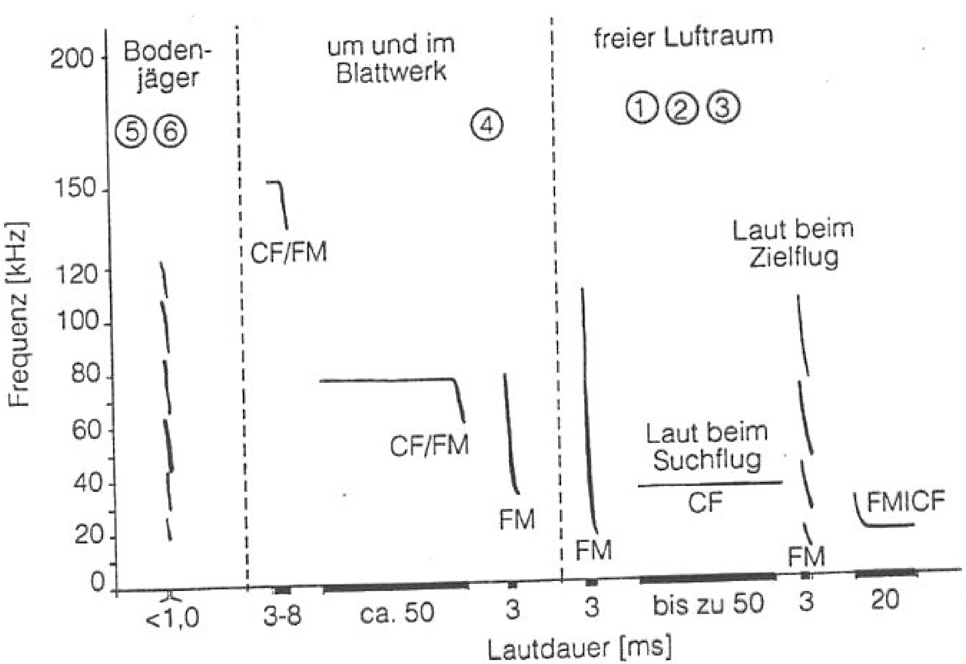






kHz
60
40
20
0.2
0.4
0.8
1.0
s

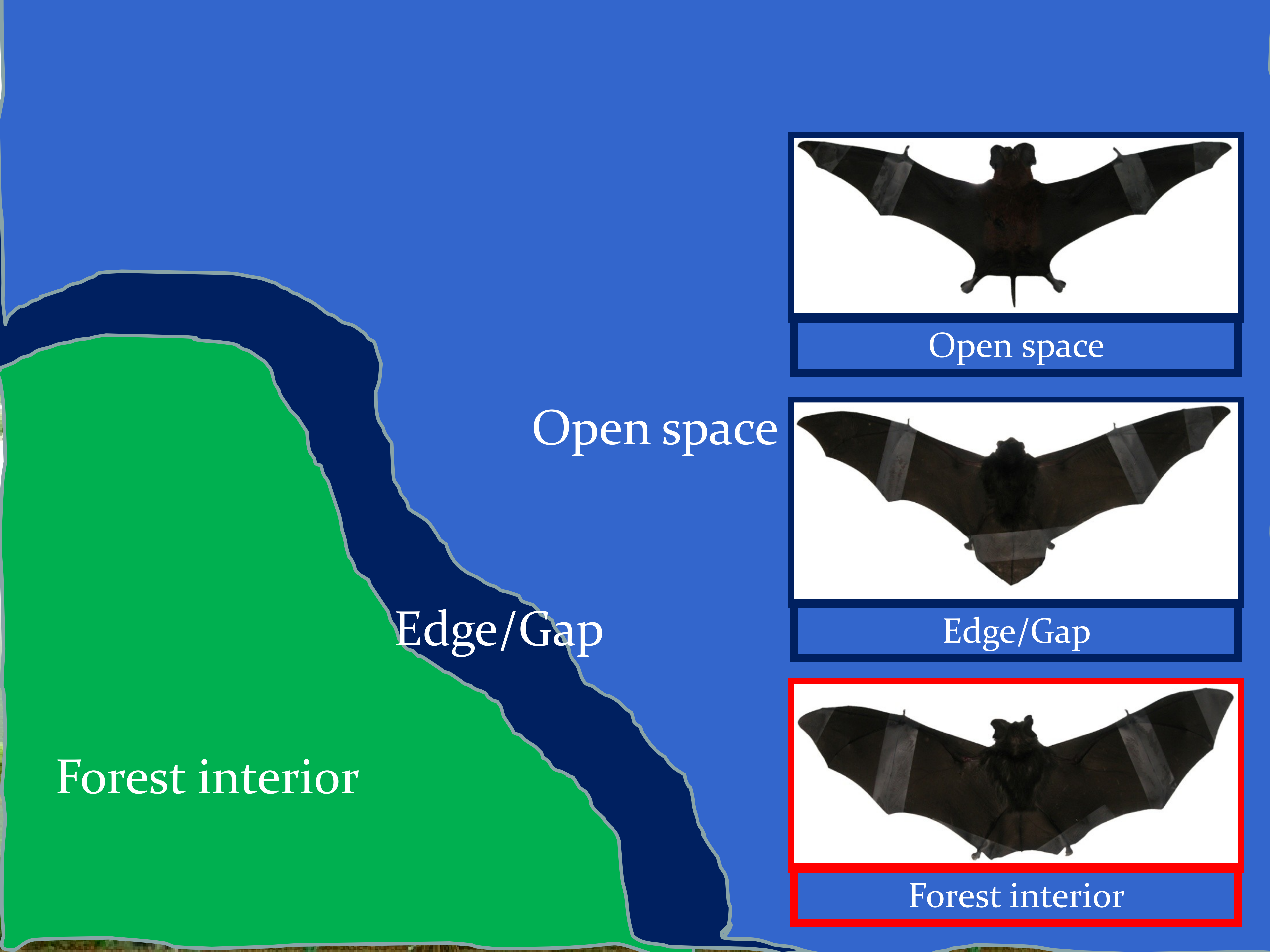




Vysoká frekvence – krátká vlnová délka: vysoká přesnost echolokační informace, ale krátký dosah

Nízké frekvence – dlouhé vlnové délky – rámcová informace, malé ztráty energie

Frekvence nejlepšího slyšení a frekvenční úprava echolokačních hlasů koreluje s loveckým prostředím a loveckou strategií



Open space
Edge/Gap
Forest interior
Open space
Edge/Gap
Forest interior

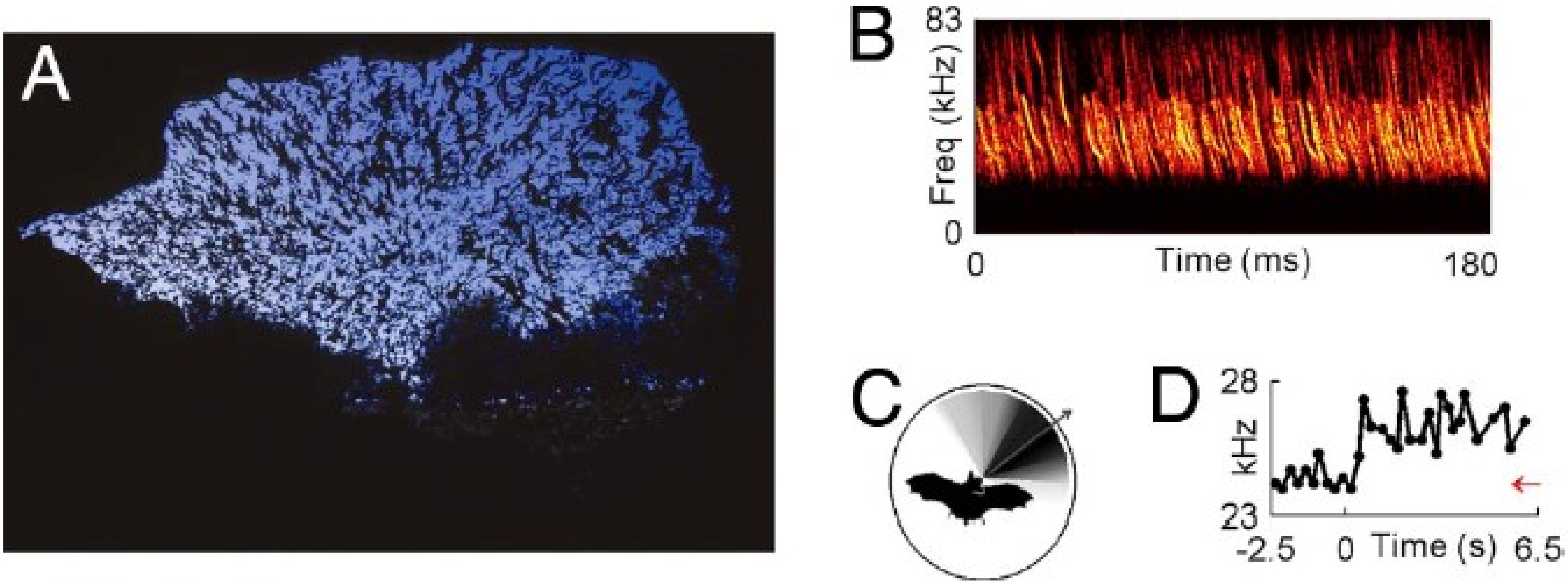


Fig. 3. The problem of auditory scene analysis in bats. (*A*) Millions of Brazilian free-tailed bats streaming out of Bracken Cave in Texas at dusk (photo courtesy of Merlin D. Tuttle, Bat Conservation International). (*B*) Spectrogram of calls produced by Brazilian free-tailed bats emerging from Ney Cave, another large bat colony in Texas. The extreme density of calls and echoes illustrates the problem of the ''cocktail-party nightmare'' (see *Difficult Problem no. 1*). Note that the average interval between calls of an individual bat in this species is ≈200 ms (ref. 64), longer than the 180 ms shown here (recording by E. Gillam). (*C*) The directional emission pattern of big brown bat: black color, high intensity of emissions; white, low intensity. Arrow shows the beam aim, direction of the sonar beam's maximal intensity. Beam shape was measured by K. Ghose, using an array of 16 microphones. (*D*) Example of jamming avoidance response in a Brazilian free-tailed bat that was suddenly presented at $t = 0$ with a sequence of echolocation calls at a frequency of 24.3 kHz (red arrow); in response to this stimulus, the bat rapidly shifted the frequency of its calls upward (black line) (data from experiment by E. Gillam (University of Tennessee, Knoxville), G. McCracken (University of Tennessee, Knoxville), and N.U. (64).

Can pipistrelles, Pipistrellus pipistrellus (Schreber, 1774) and Pipistrellus pygmaeus (Leach, 1825), foraging in a group, change parameters of their signals?

Article *in* Journal of Zoology 272(2):194 - 201 · February 2007
DOI: 10.1111/j.1469-7998.2006.00255.x

1st **Tomas Bartonicka**
29.26 · Masaryk University

2nd **Zdenek Rehak**
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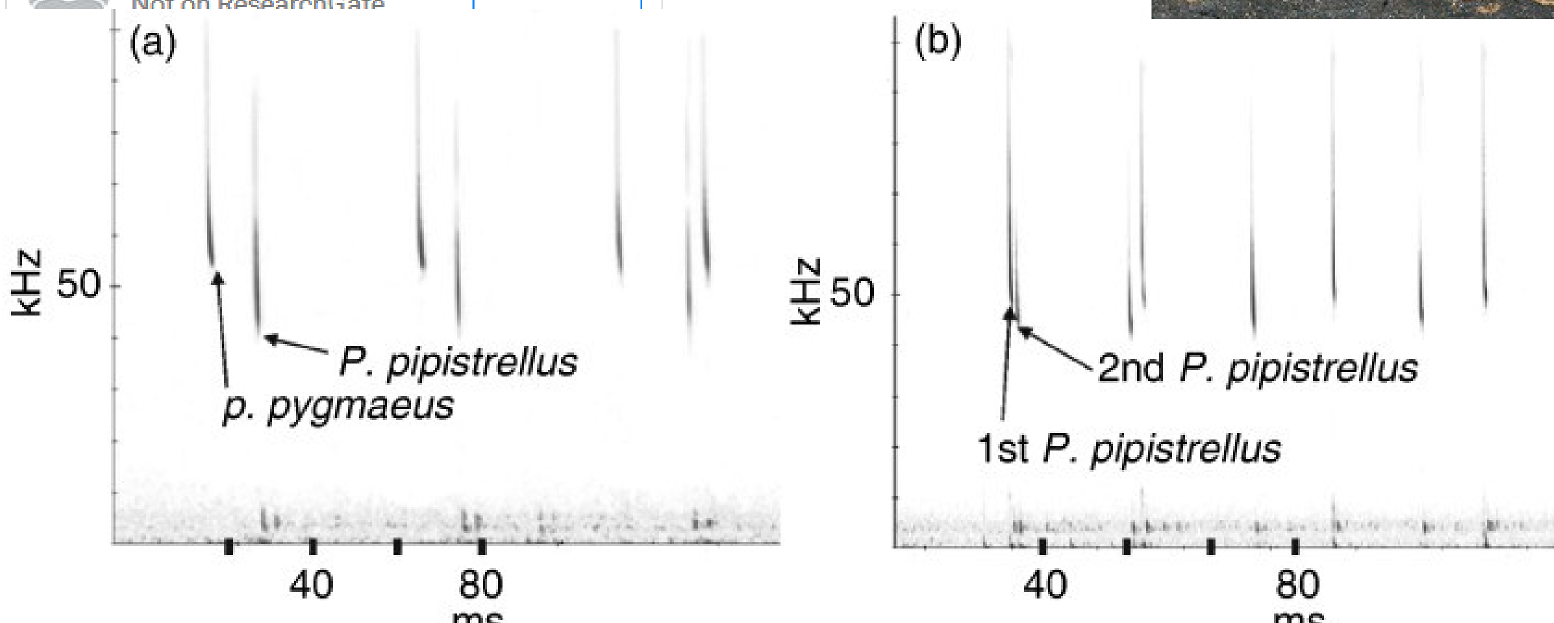
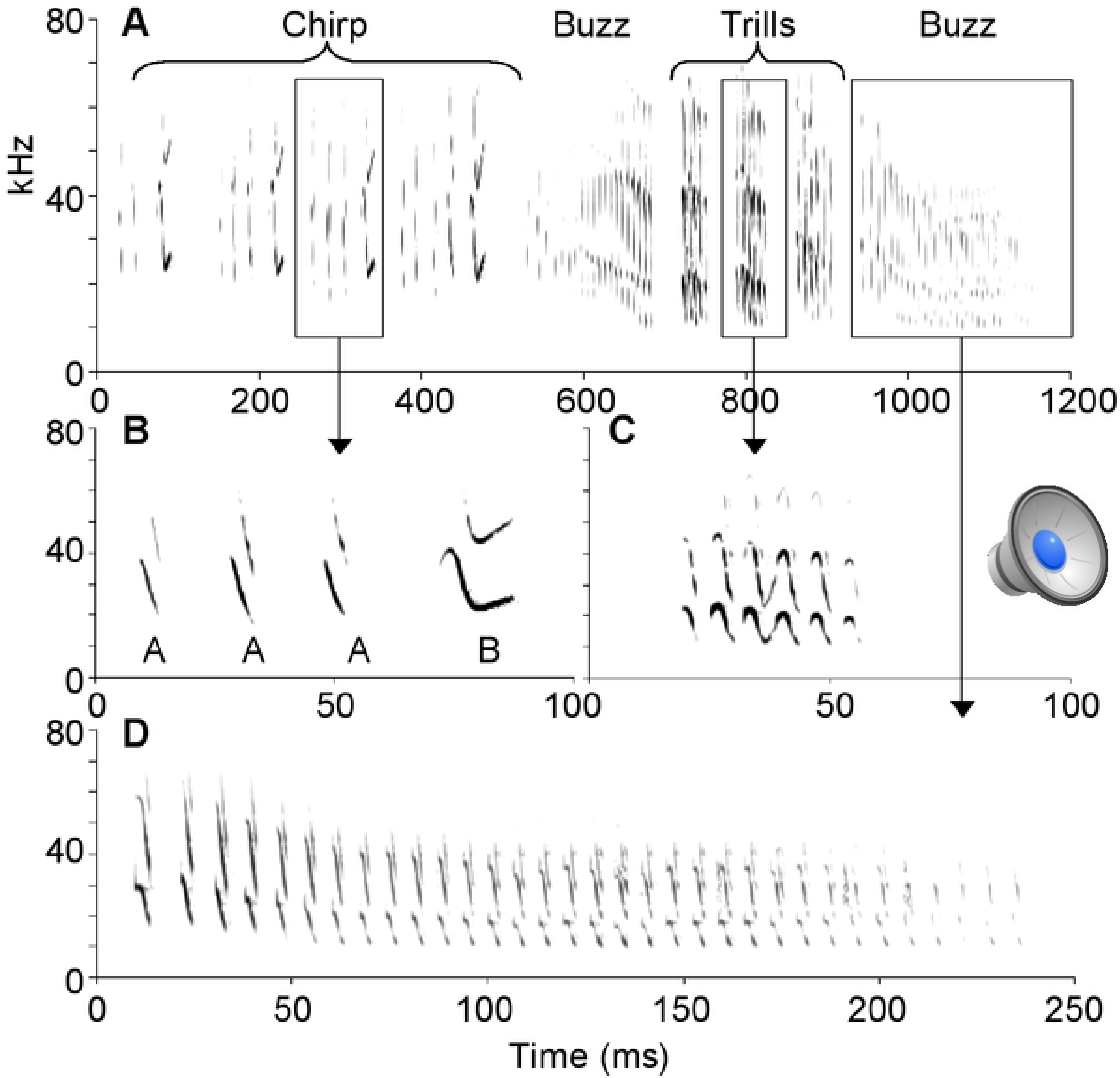
3rd **J. Gaisler**
Not on ResearchGate





Vysoká versatilita hlasových projevů – zpěvy samců

REPORT

Acoustic mirrors as sensory traps for bats

Stefan Greif[1,2,*,†], Sándor Zsebők[1,†,‡], Daniela Schmieder[1,§], Björn M. Siemers[1]
+ See all authors and affiliations

Science 08 Sep 2017:
Vol. 357, Issue 6355, pp. 1045-1047
DOI: 10.1126/science.aam7817

časoprostoprová paměť

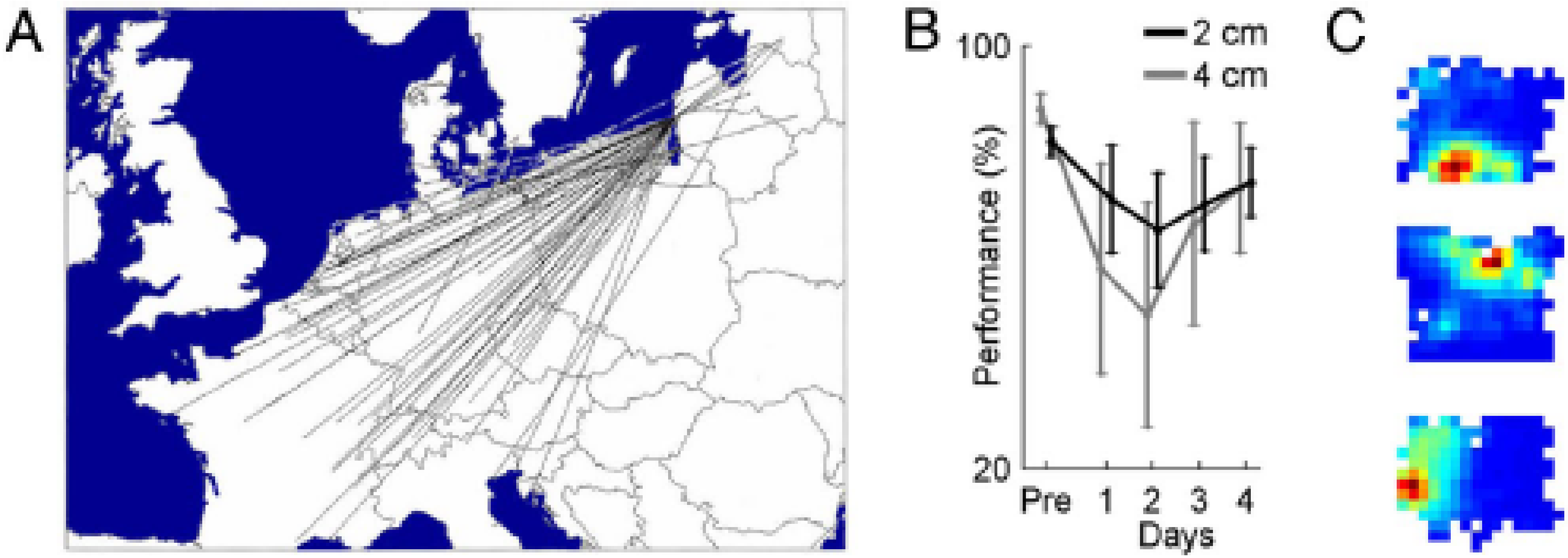


Fig. 5. Spatial memory and navigation in echolocating bats. (*A*) Example of long-range migration by the bat *P. nathusii*. Straight lines correspond to individual bats that were banded in Eastern Europe and then recaptured as far as Croatia, Italy, and France (adapted with permission from ref. 54). (*B*) Spatial memory for 3D flight paths, on the centimeter scale: echolocating bats (*M. lyra*) were trained to fly through an array of wires, and two bats flew through the wires without touching them on >85% of trials ("pre"); when the wires were moved by 4 or even 2 cm, the bats showed a significant drop in performance on days 1–2, followed by slow recovery. Data were measured from ref. 100 and reanalyzed. Error bars, mean ± SEM, computed over all wire-shift trials in these two bats. (*C*) Place fields of three "place cells," recorded from the hippocampus of big brown bats, a small bat species weighing ≈15 g, as the animal was crawling in a rectangular arena (103). Blue color, no spiking activity; red, maximum activity of the neuron (data recorded by N.U.).