

Chiropterologie



Kurz II

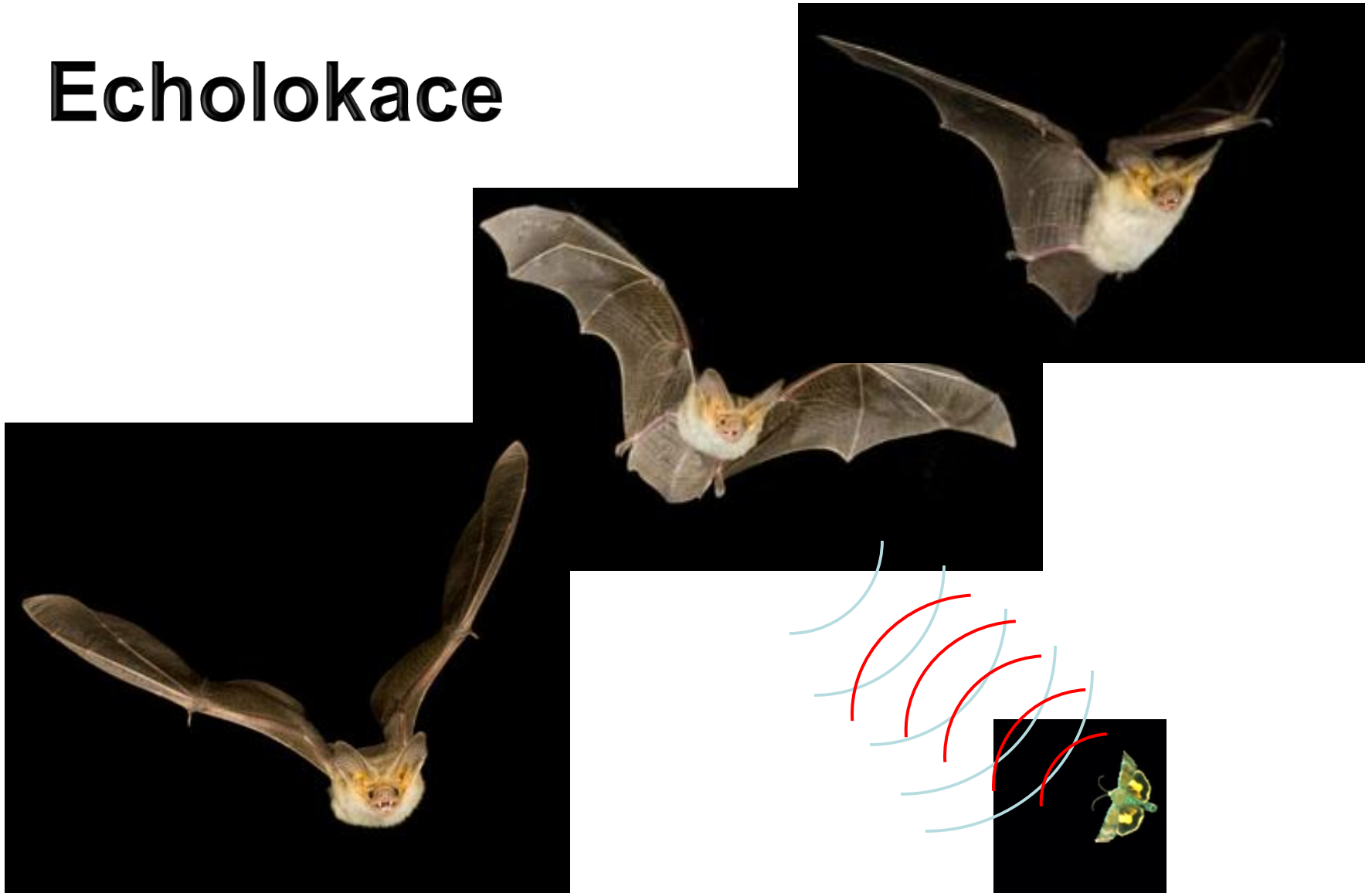
Tomáš Bartonička

Ústav botaniky a zoologie

Přf MU

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

Echolokace



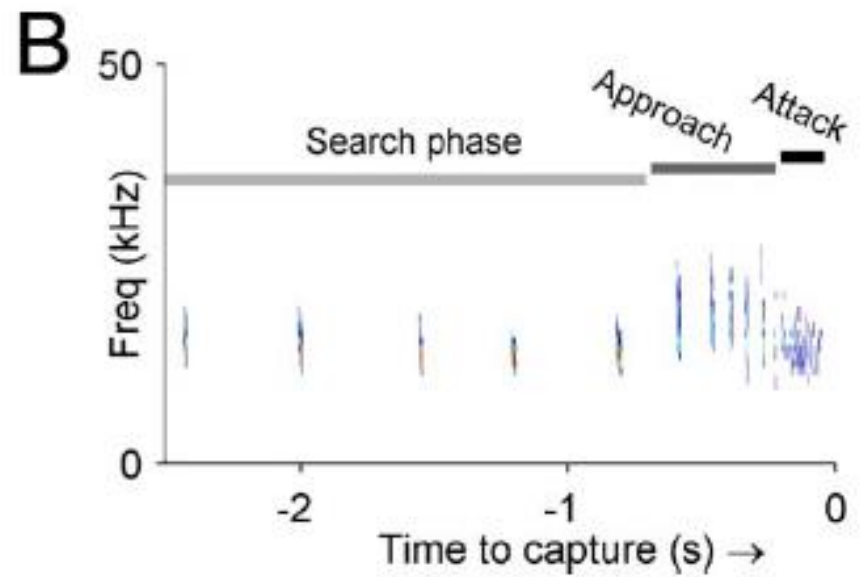
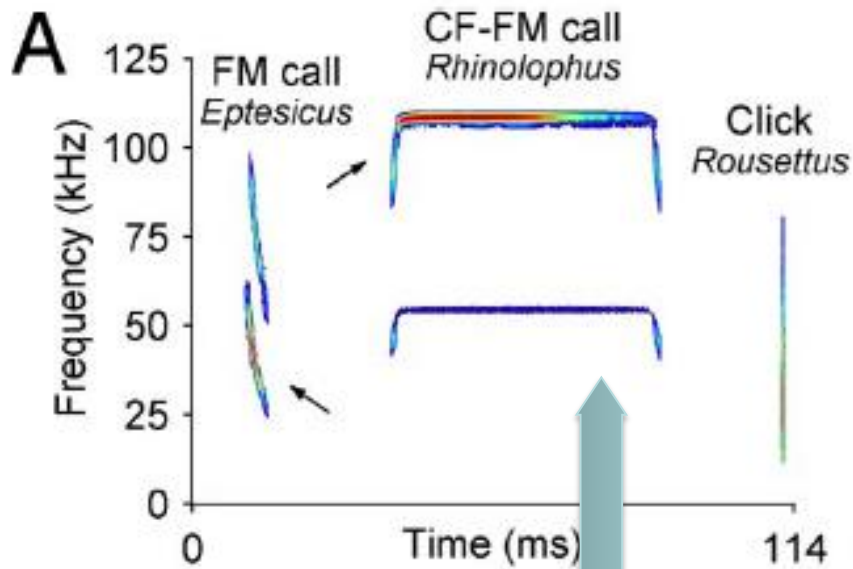
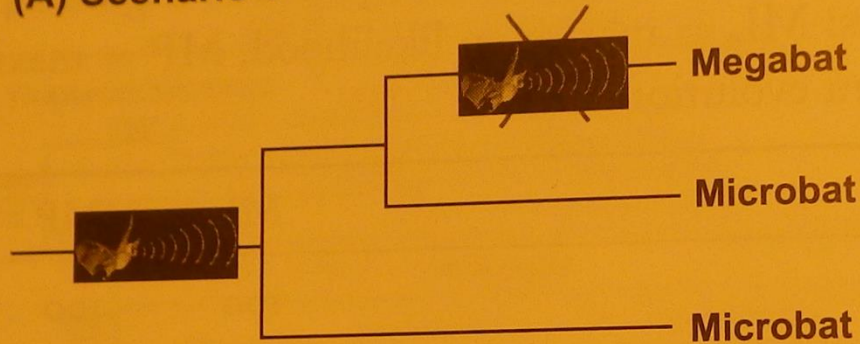


Abb. 230. Parasagittalschnitt durch den Kopf einer Kleinen Hufeisennase, *Rhinolophus hipposideros* (Microchiroptera, Rhinolophidae). Nach MÖHRES 1952.

1. Hufeisen, 2. Nasenhöhle, 3. Bursa pharyngica (Rec. pharyngis), 4. Oesophagus, 5. Trachea, 6. Larynx, 7. Gaumen, 8. Zunge, 9. Mundhöhle.

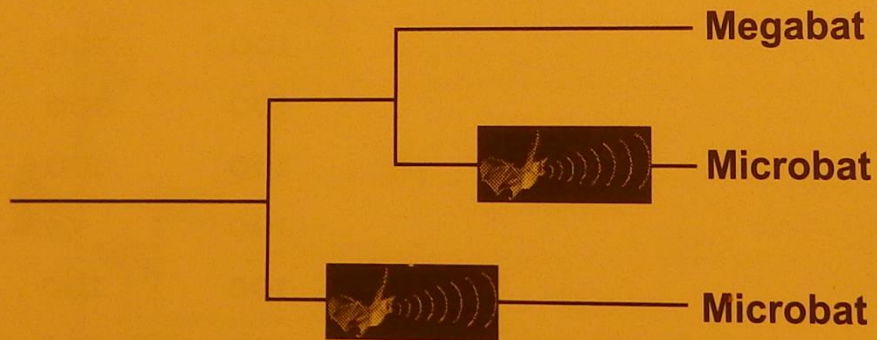
Otázka vzniku echolokace

(A) Scenario 1



Echolocation was gained once but was lost in megabats

(B) Scenario 2

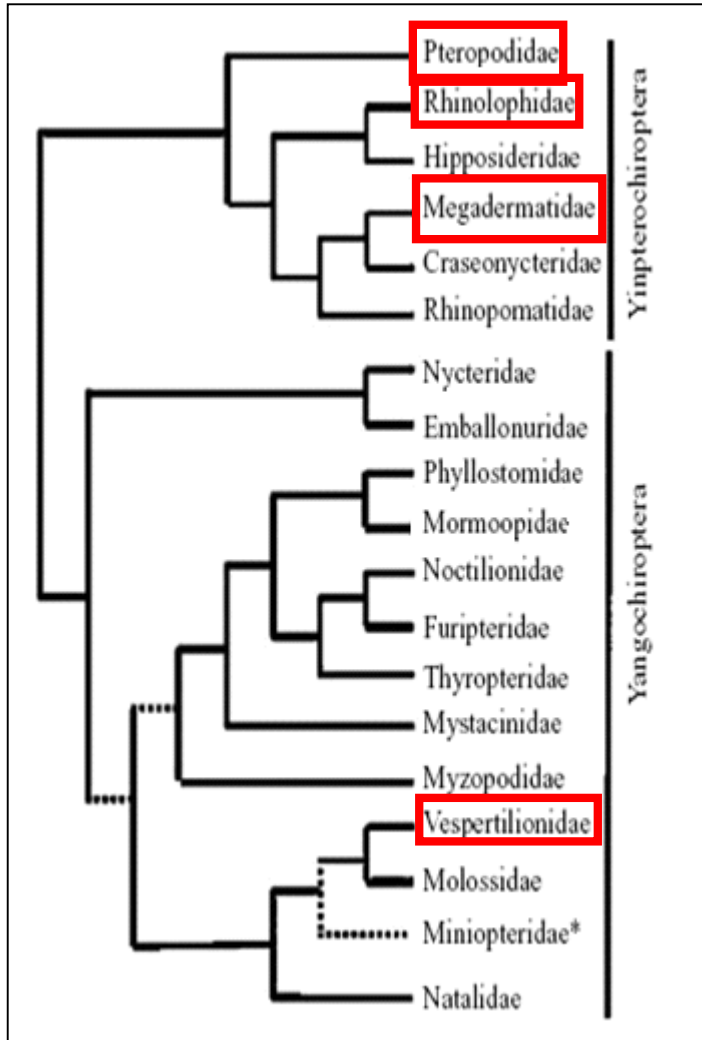


Echolocation was gained convergently at least more than once in bats

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



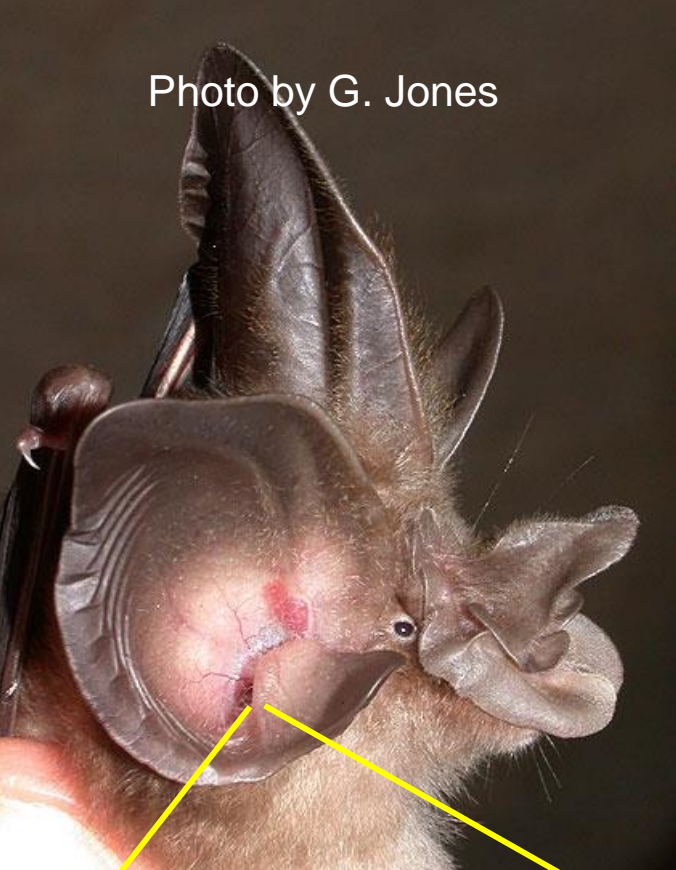
konvergentní evoluce mezi vrápenci, pvrápenci a kytovci (Odontoceti)



Megadermatidae (Old World false vampire bats)



Photo by G. Jones



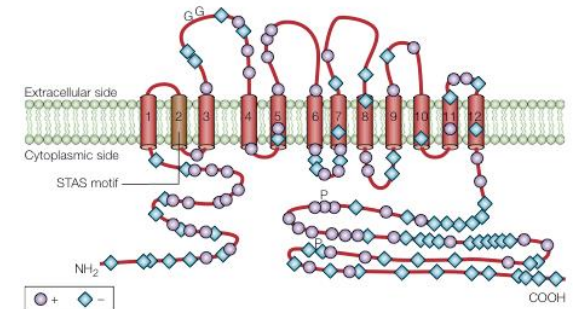
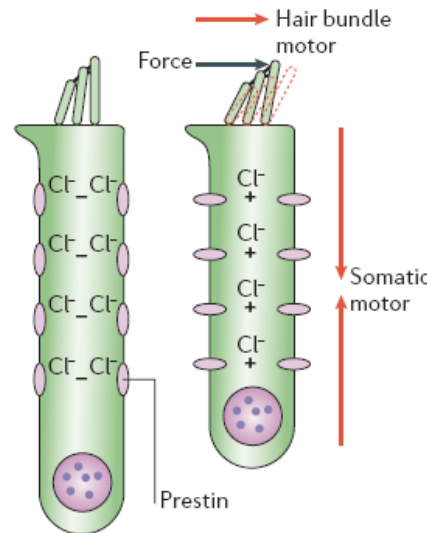
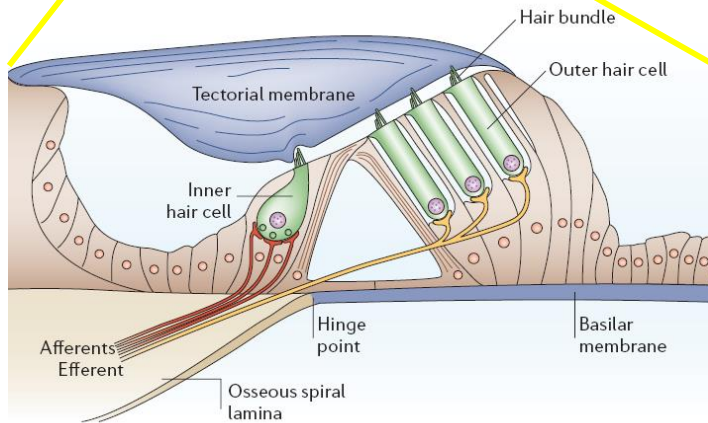
Prestin is the motor protein of cochlear outer hair cells

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 Communication Sciences and Disorders, Northwestern University, Evanston, Illinois 60208, USA

† Center for Endocrinology, Metabolism, and Molecular Medicine, Department of Medicine, Northwestern University Medical School, Chicago, Illinois 60611, USA

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.



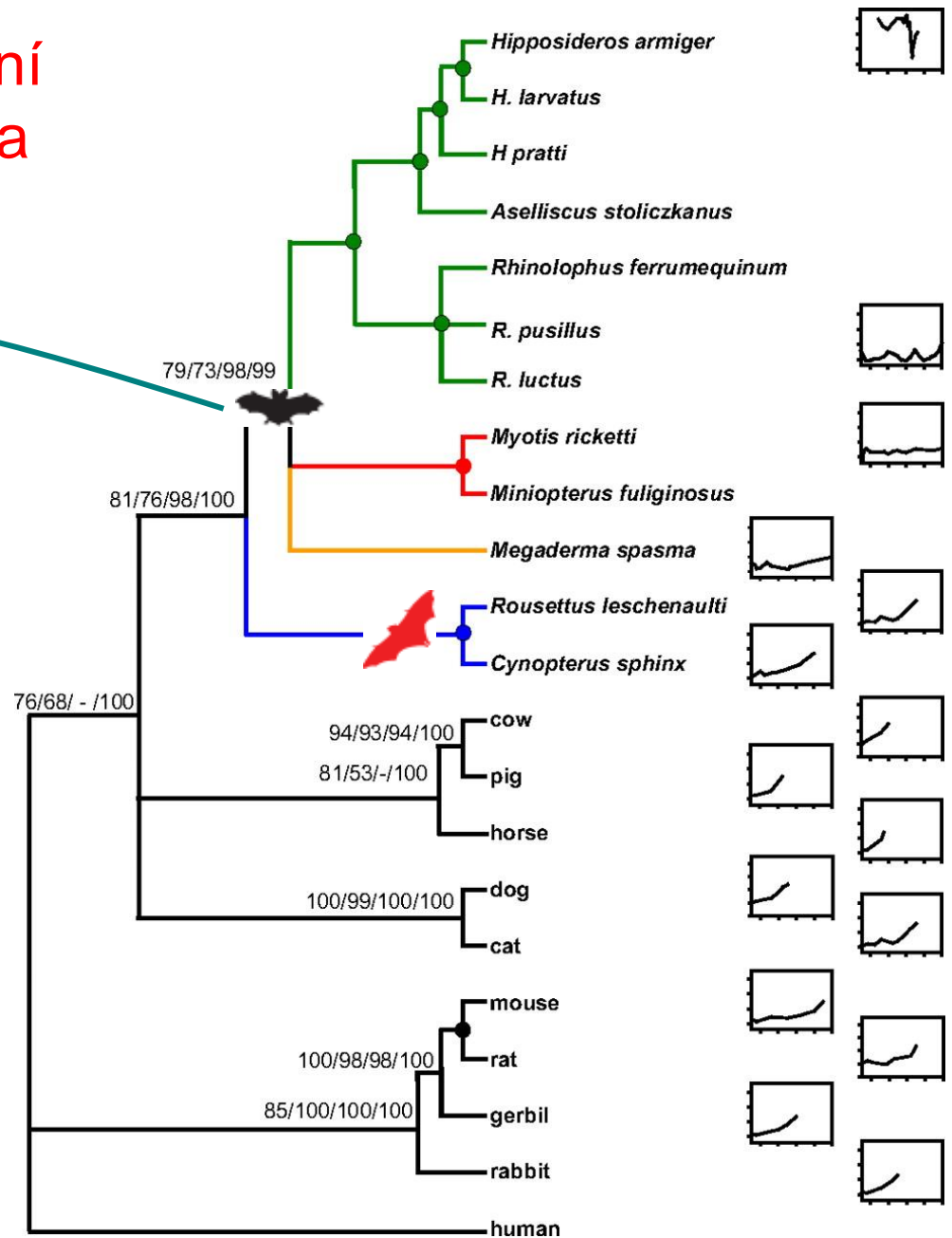
Record holder for highest frequency contraction of a motor protein

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

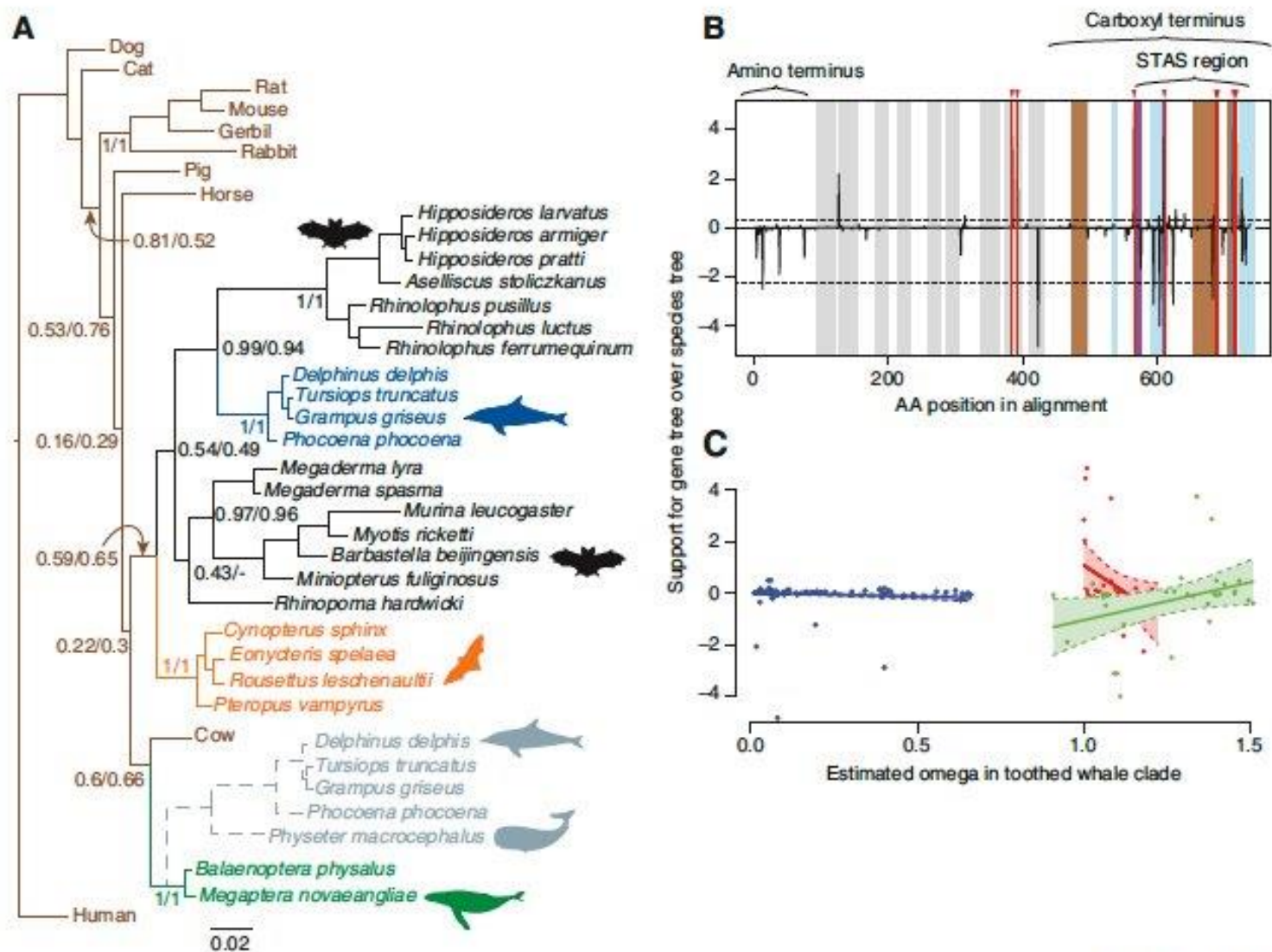
Prestin – bazální rozdělení na Mega a Microchiroptera

echolokující letouni tvoří monofyletickou skupinu

Prestin kodující gen u 22 savců, genetický strom

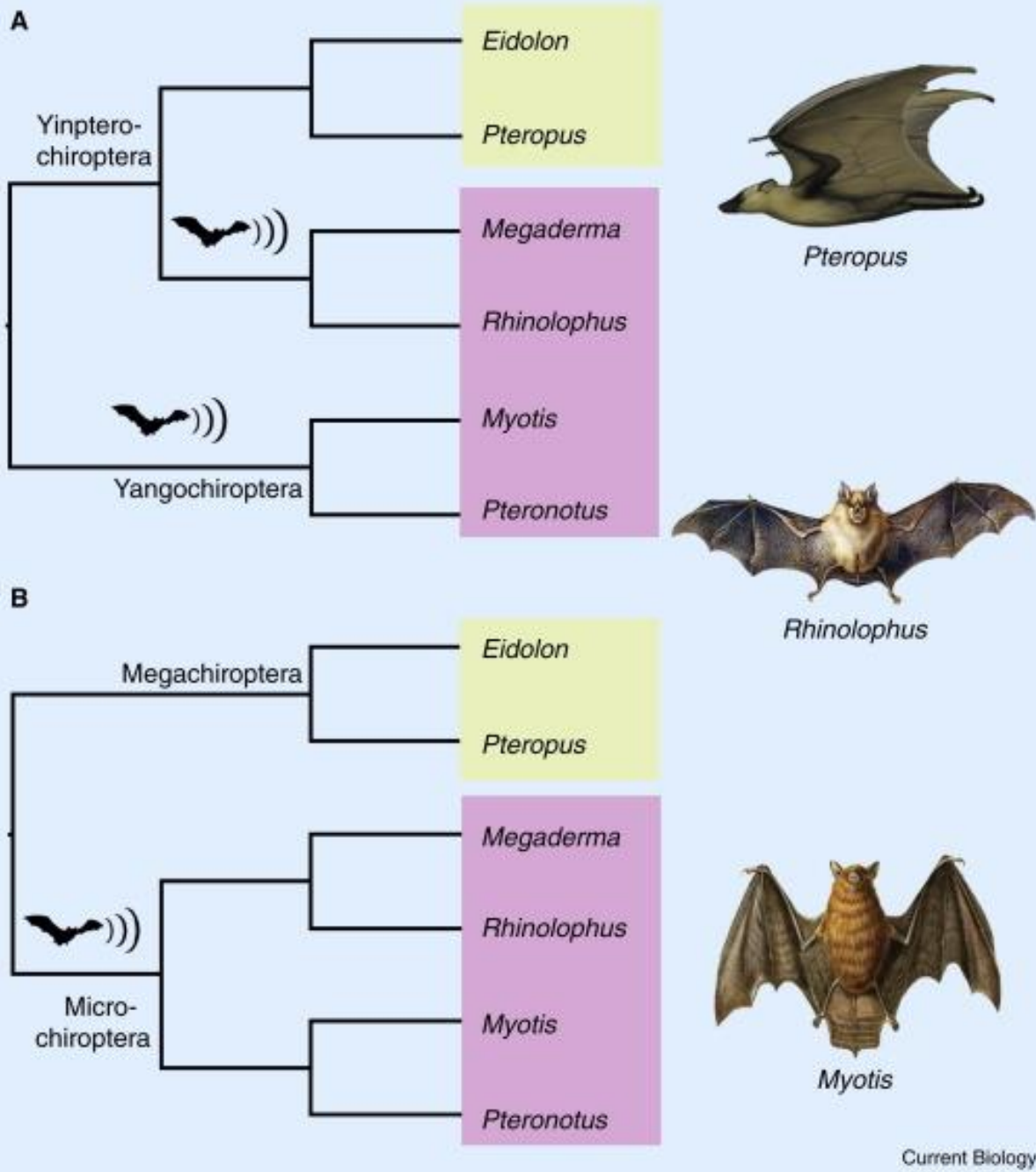


dolphins and porpoises share at least 14 derived amino acid sites in prestin with echolocating bats, including 10 shared with the highly specialized CF bats



Current Biology

Figure 1. Evidence of sequence convergence in the *Prestin* gene between dolphins and bats.





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

Gareth Jones^{1*}, Emma C. Teeling² and Stephen J. Rossiter³

¹ School of Biological Sciences, University of Bristol, Bristol, UK
² LCD 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

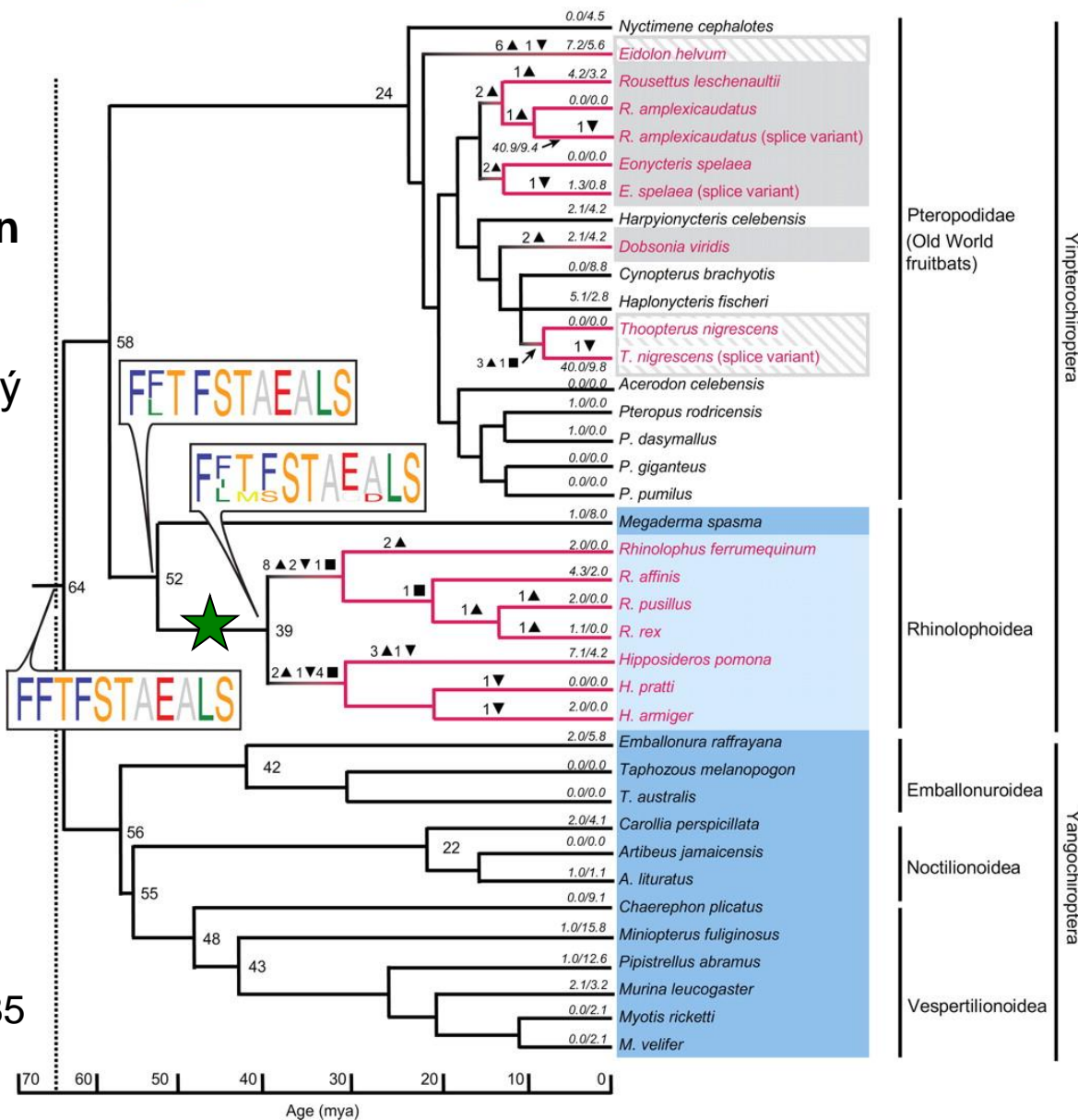
geny kódující rhodopsin a opsin
(citlivý na dlouhé a krátké vlny)

Ale..ty geny co kódují opsin citlivý
na **krátké vlny**

jsou u rhinolophoidních netopýrů
(vysokofrekvenční echolokace)
nefunkční

trade-off mezi
zrakem a sluchem

- Roosts in caves
- Roosts in caves or trees (*Eidolon*) or roosting ecology not known (*Thoopterus*)
- Roosts in trees
- Low-duty-cycle echolocation
- High-duty-cycle echolocation



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

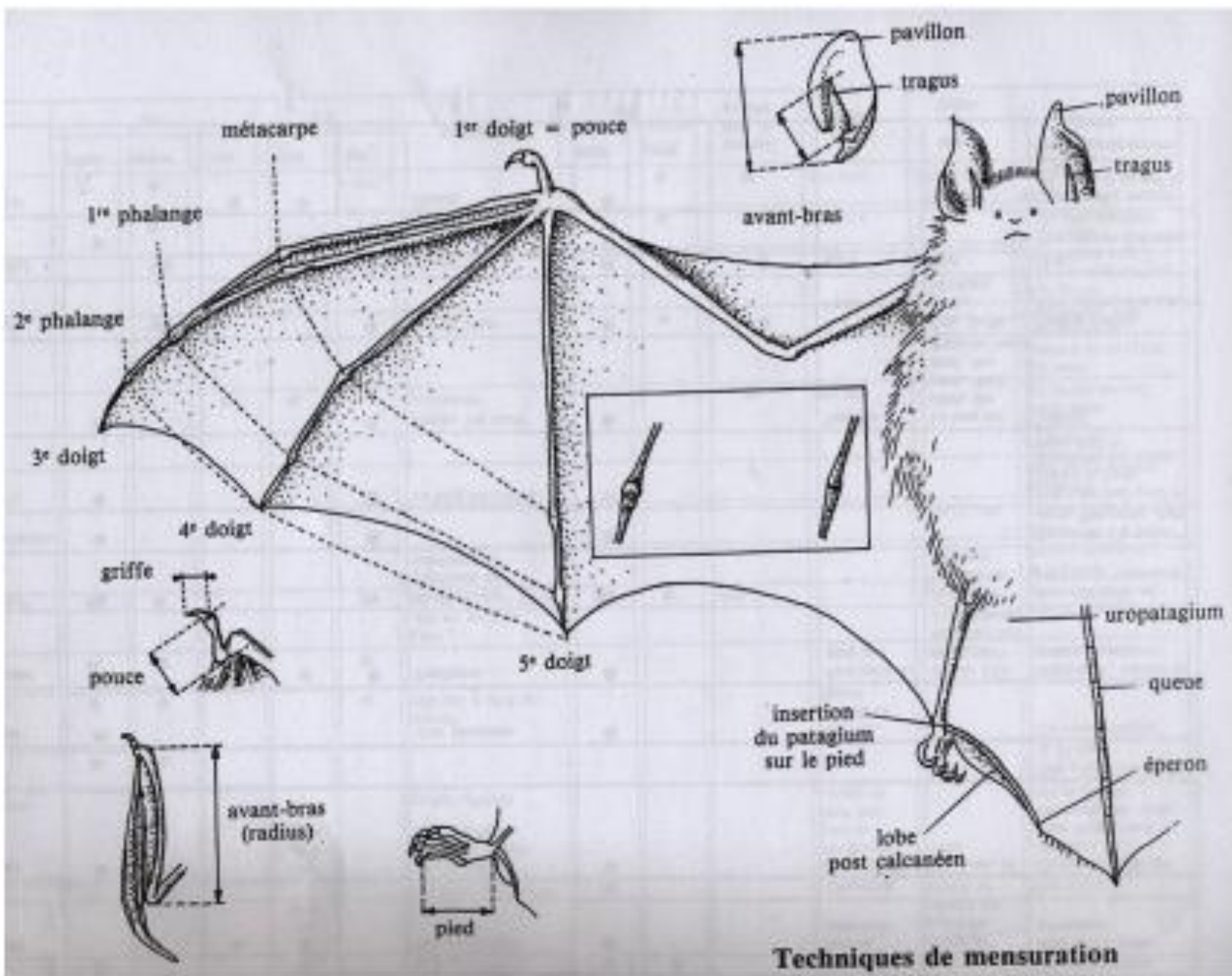
Zpět k morfologii

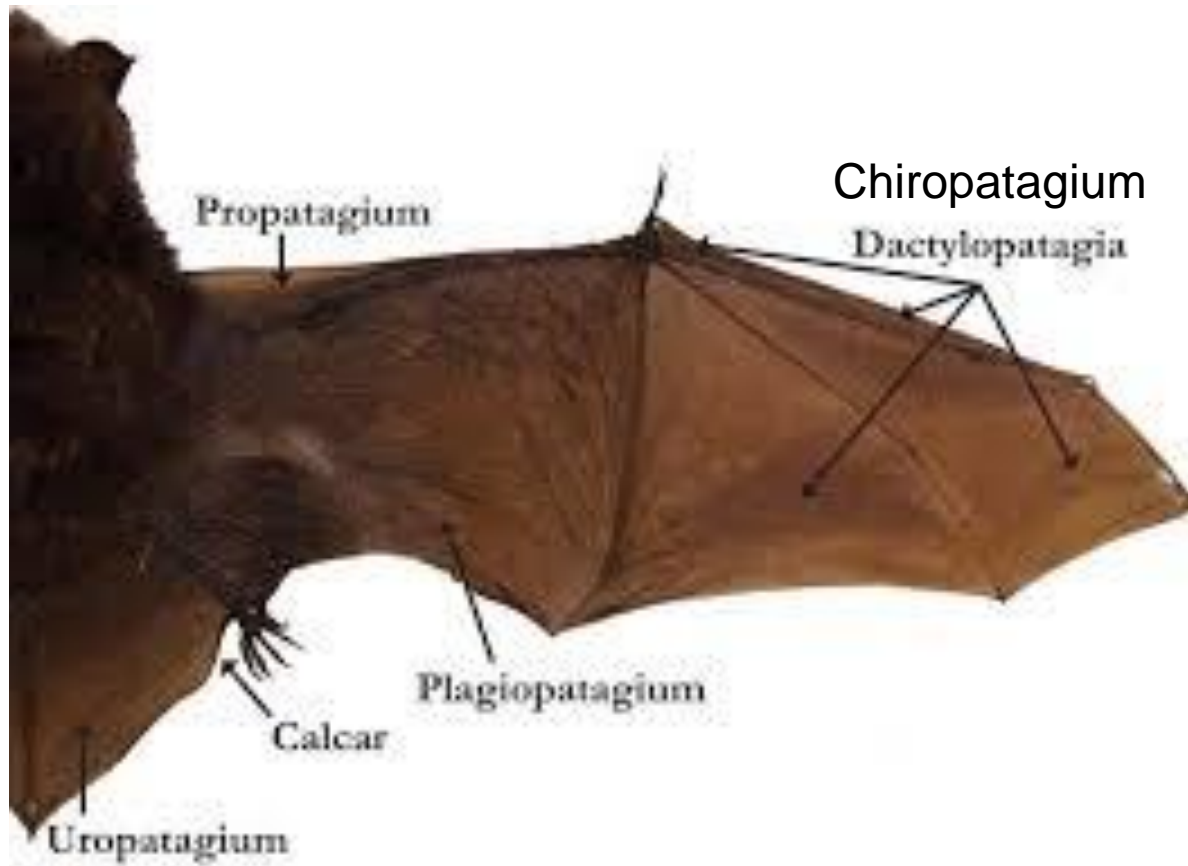


letouni (*Chiroptera*)

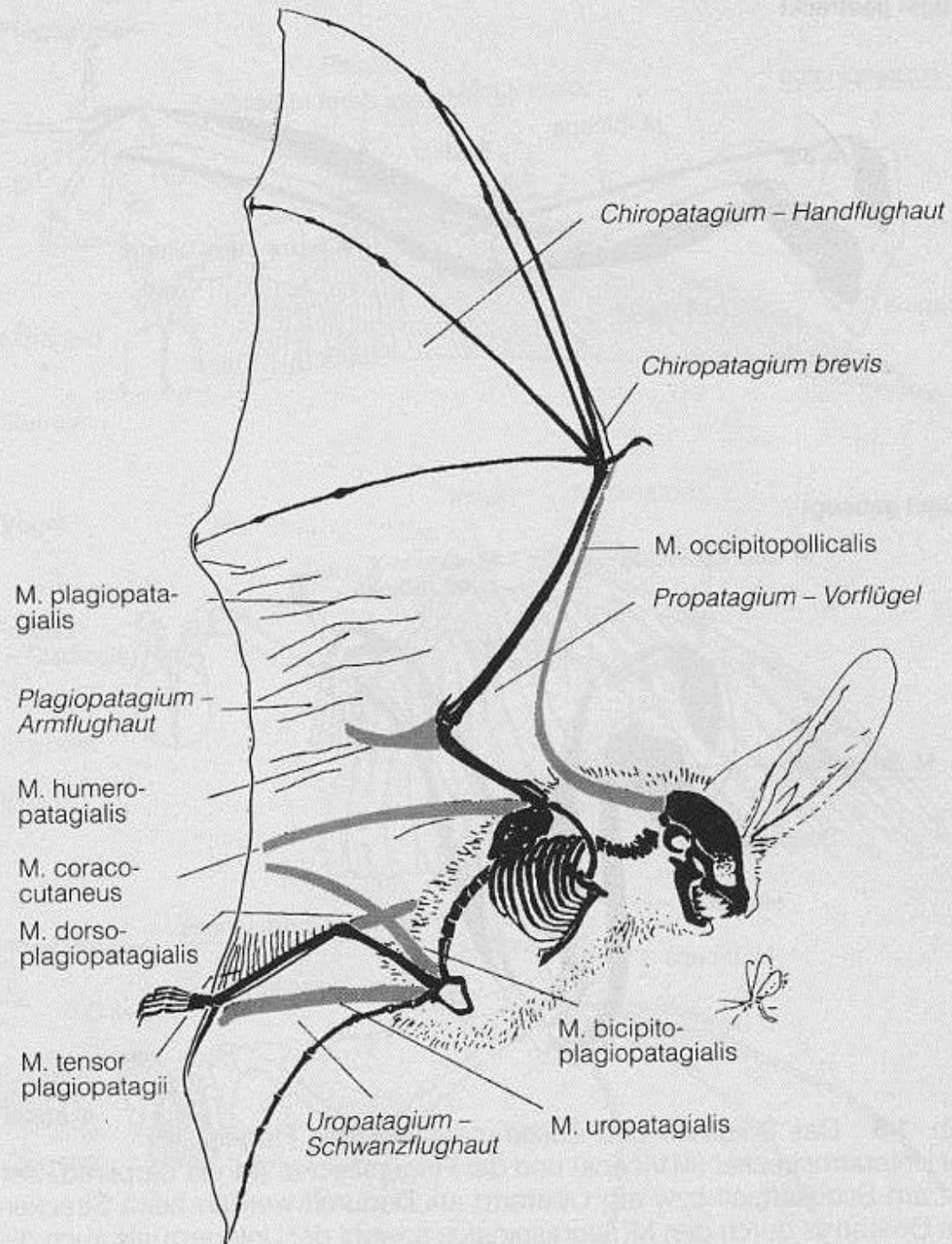
adaptace k letu

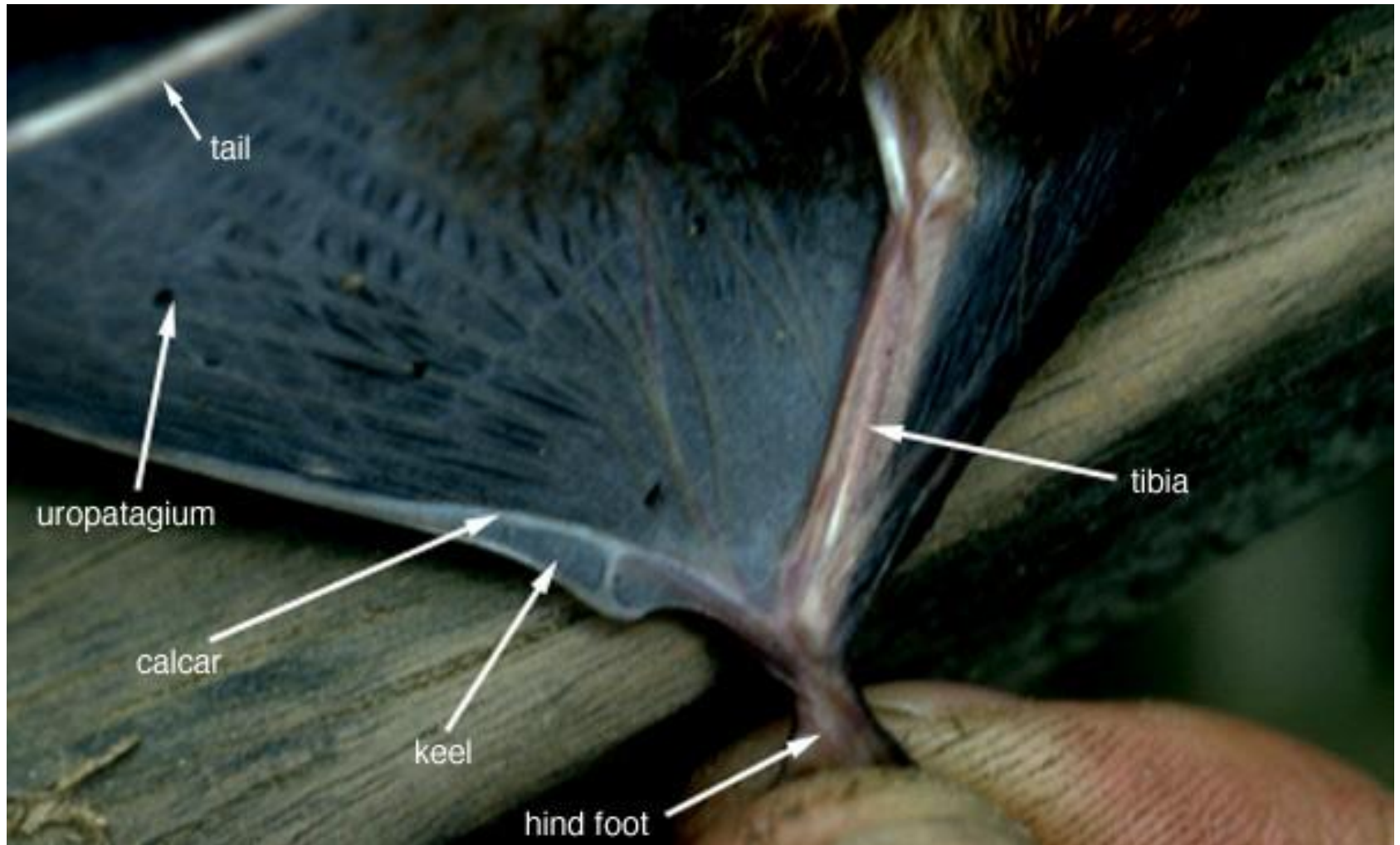
- přední končetina přeměněna v křídlo – kožní blána mezi předními a zadními končetinami (a ocasem), protažené články 2. a 3. prstu – kostra křídel
- zadní tlapky – k závěsu, pata směřuje dopředu



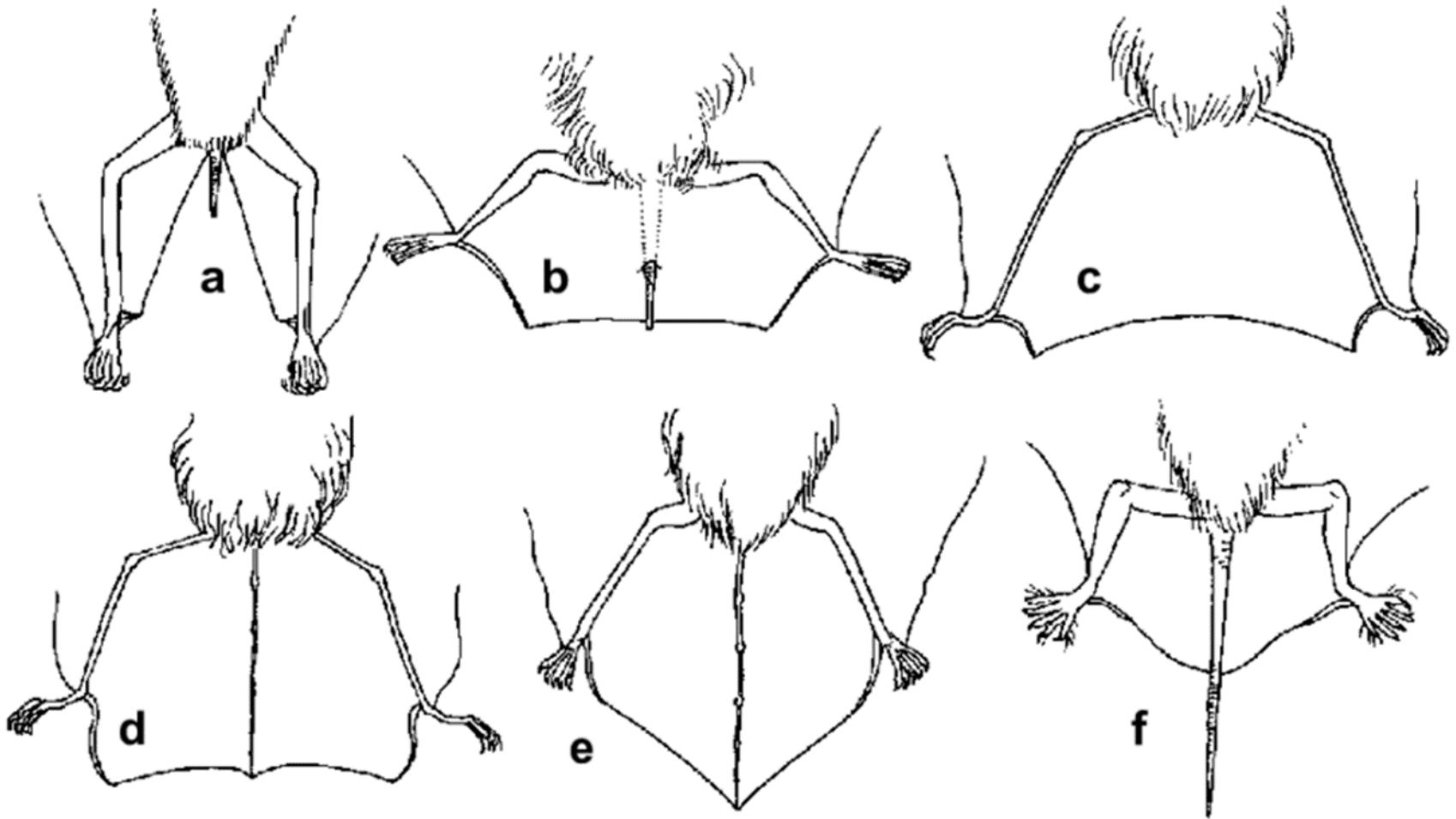


svalstvo





Keel (epiblema)



Structure of the interfemoral membrane (uropatagium) in Vietnamese bats (dorsal view). a) Pteropodidae (Eonycteris); b) Emballonuridae (Taphozous); c) Megadermatidae (Megaderma); d) Rhinolophidae (Rhinolophus); e) Vespertilionidae (Scotomanes); f) Molossidae (Chaerephon).

Cheiromeles torquatus

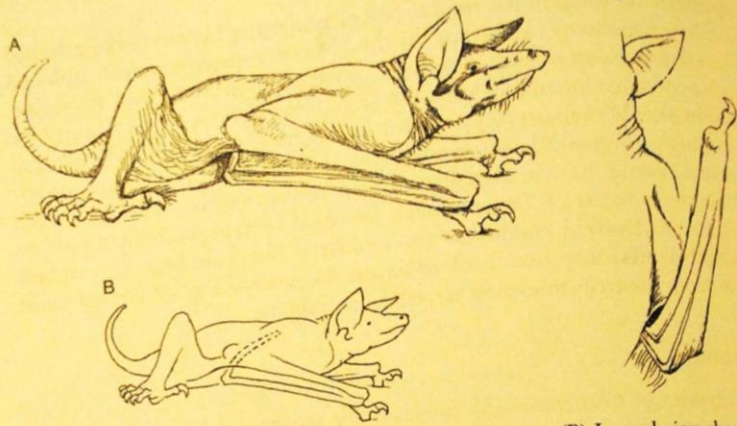


Figure 8.3 (A) Quadrupedal stance of *Cheiromeles torquatus*. (B) Lateral view showing the position of the phalanges III and IV inserted into the subaxillary "pouch." (C) Ventral view.

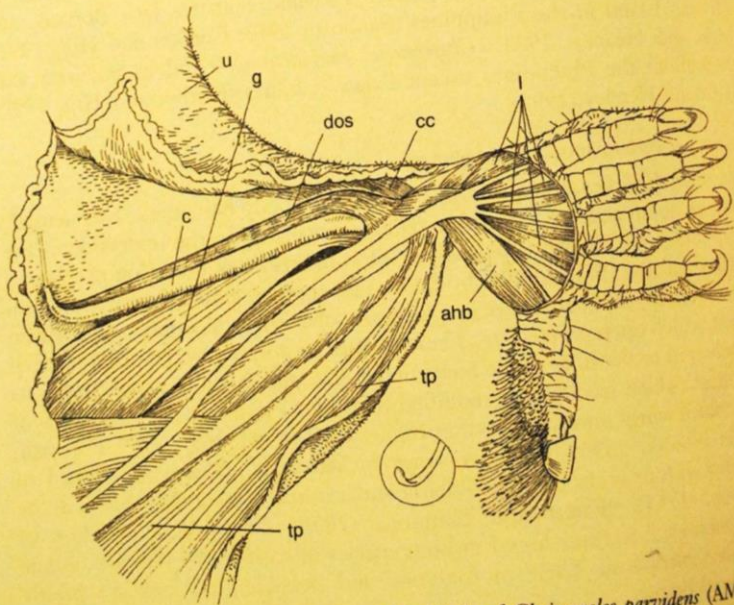
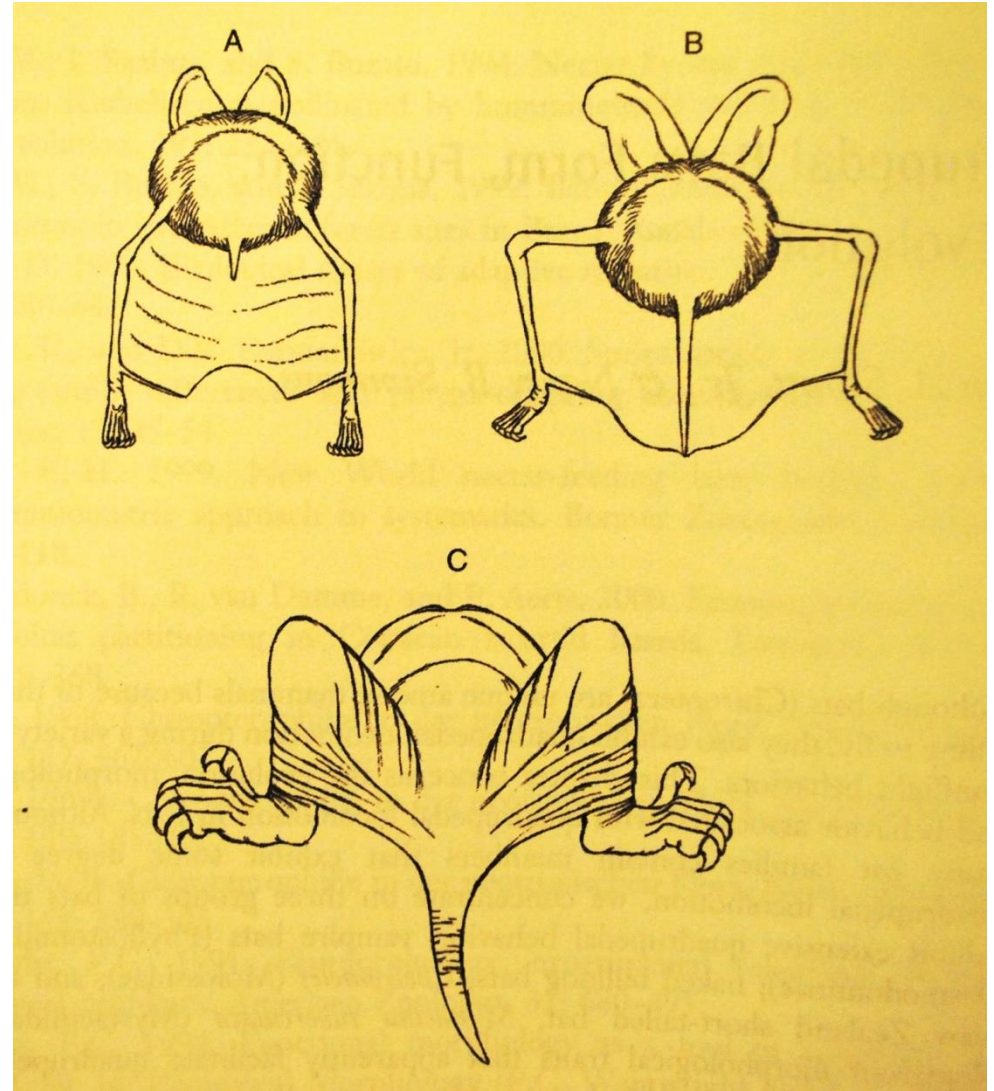


Figure 8.4 Plantar view of the dissected hindlimb of *Cheiromeles parvidens* (AM 241941). Note the position of the calcar, the opposable hallux (digit I), and spatulate bristles on digit I. The fascia binding the calcar to m. gastrocnemius has been removed. ahb, m. abductor hallucis brevis; c, calcar; cc, m. calcaneo-cutaneous; m. depressor ossis styliformis; g, m. gastrocnemius; l, mm. lumbricales; tp, m. plagiopatagium; u, uropatagium.

svalstvo zadní končetiny

1853
K. F. C. - 1107
Coast of St. Thomas, T.F.
COMMERSON, H.F.
MARUJGENSIS
of Natural History
1853

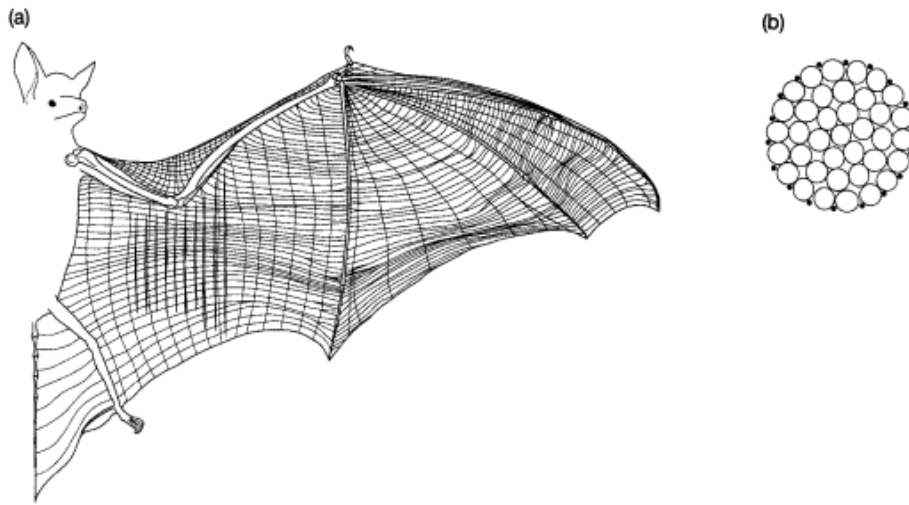


FIG. 2. (a) The layout of fibre bundles in a typical bat wing; craniocaudally running plagiopatagiales muscles are also illustrated. The details of this pattern vary among bat species. (b) Schematic of a cross-section through a typical wing membrane network fibre bundle; white fibres are elastin; black fibres are collagen (adapted from Holbrook & Odland, 1978).

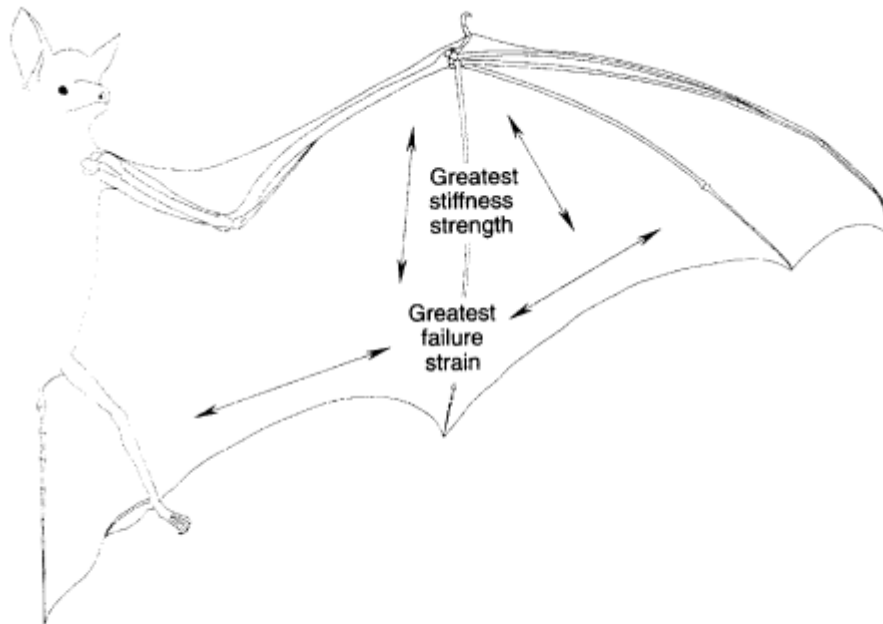


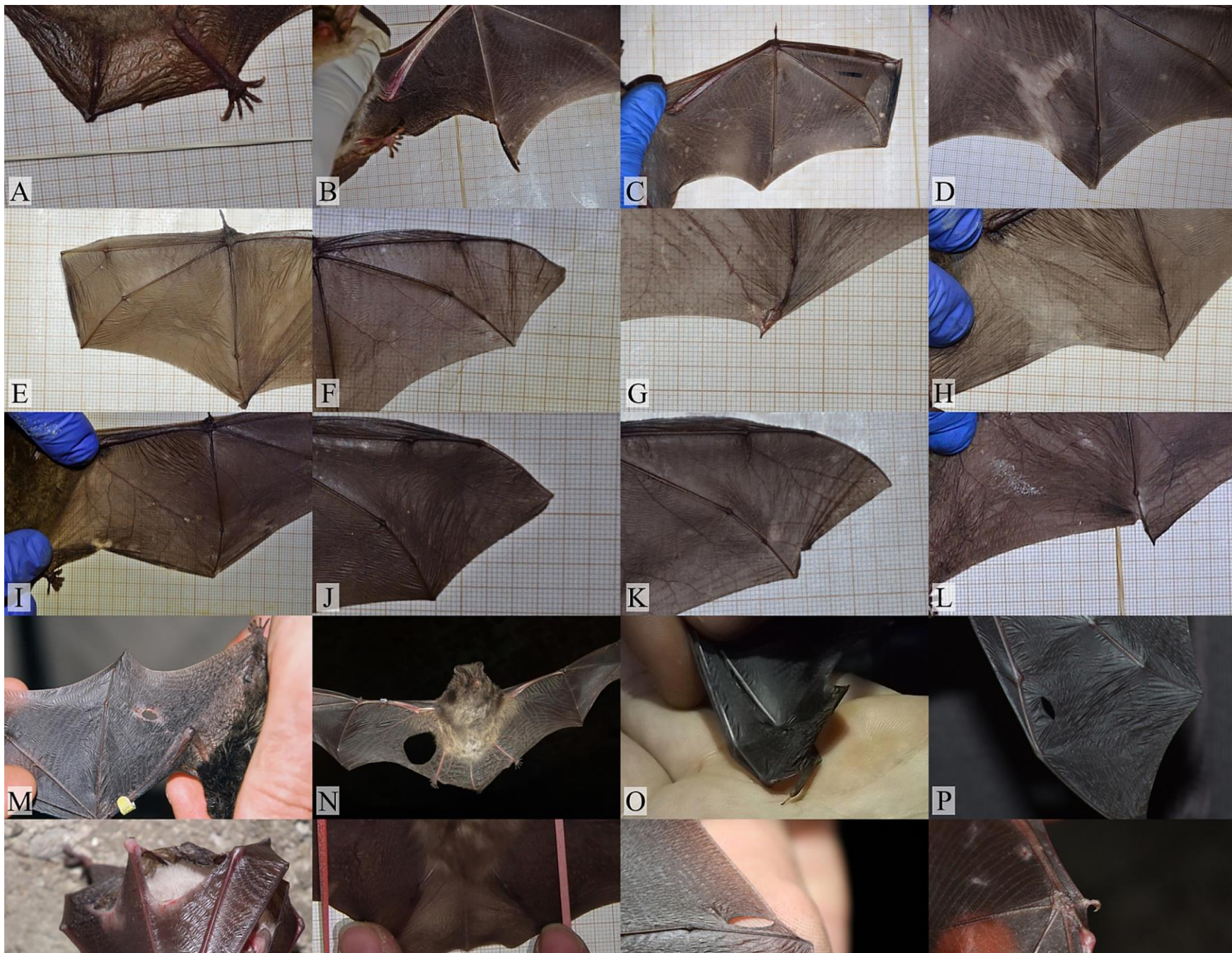
FIG. 7. Schematic of anisotropic variation in mechanical properties related to the wing's anatomical framework. Modulus, strength, maximum, and cross-sectional area are greatest parallel to the fifth digit; failure strain, in contrast, is greatest perpendicular to the fifth digit.

Přítomnost kolagenových vláken

Podél 5. prstu, největší síla a tuhost vláken

Na okraji největší odolnost proti protržení

Kožní membrána



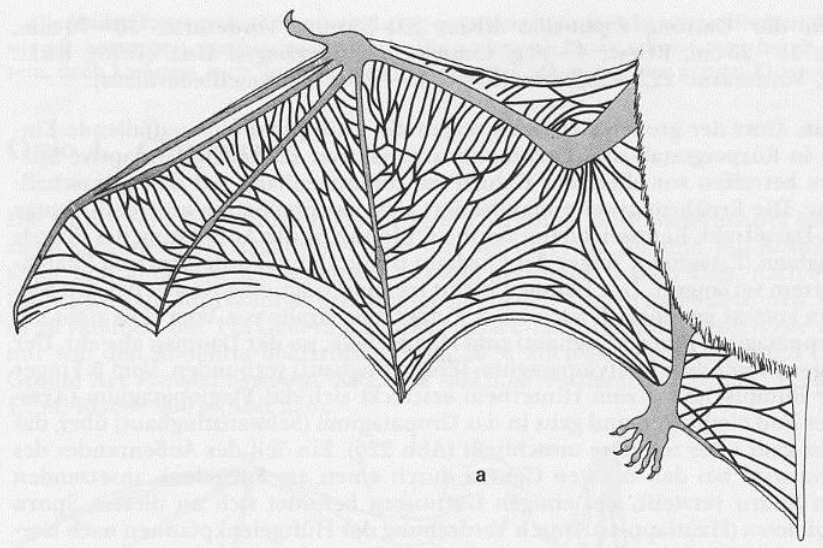
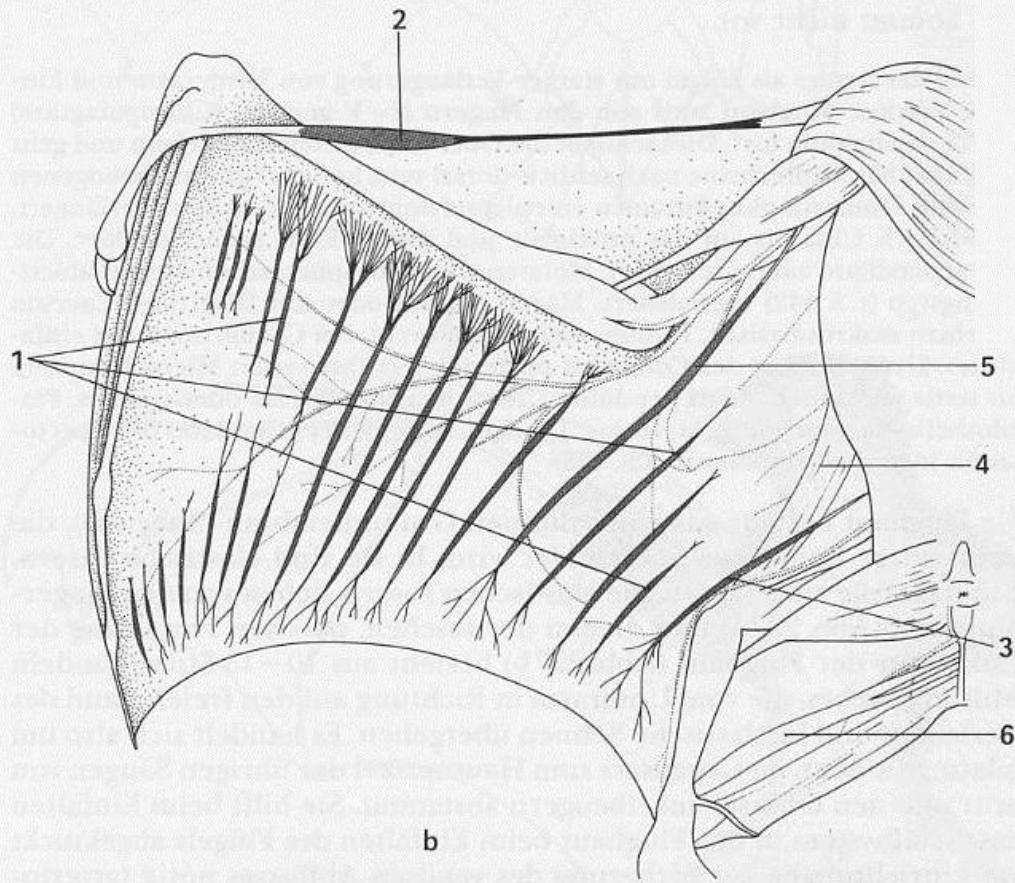


Abb. 227. a) *Vespertilio murinus* (Microchiroptera, Vespertilionidae). Darstellung der elastischen Balken in der Flughaut, b) *Pteropus* spec. (Megachiroptera), Muskulatur der Flughaut. Nach SCHUMACHER 1932.

1. Mm. plagiopatagii proprii, 2. M. propatagialis mit Sehne, 3. M. dorsoplagiopatagialis, 4. M. bicipitoplagiopatagialis, 5. M. coracoplagiopatagialis, 6. M. uropatagialis.



Sharon M.Schwartz

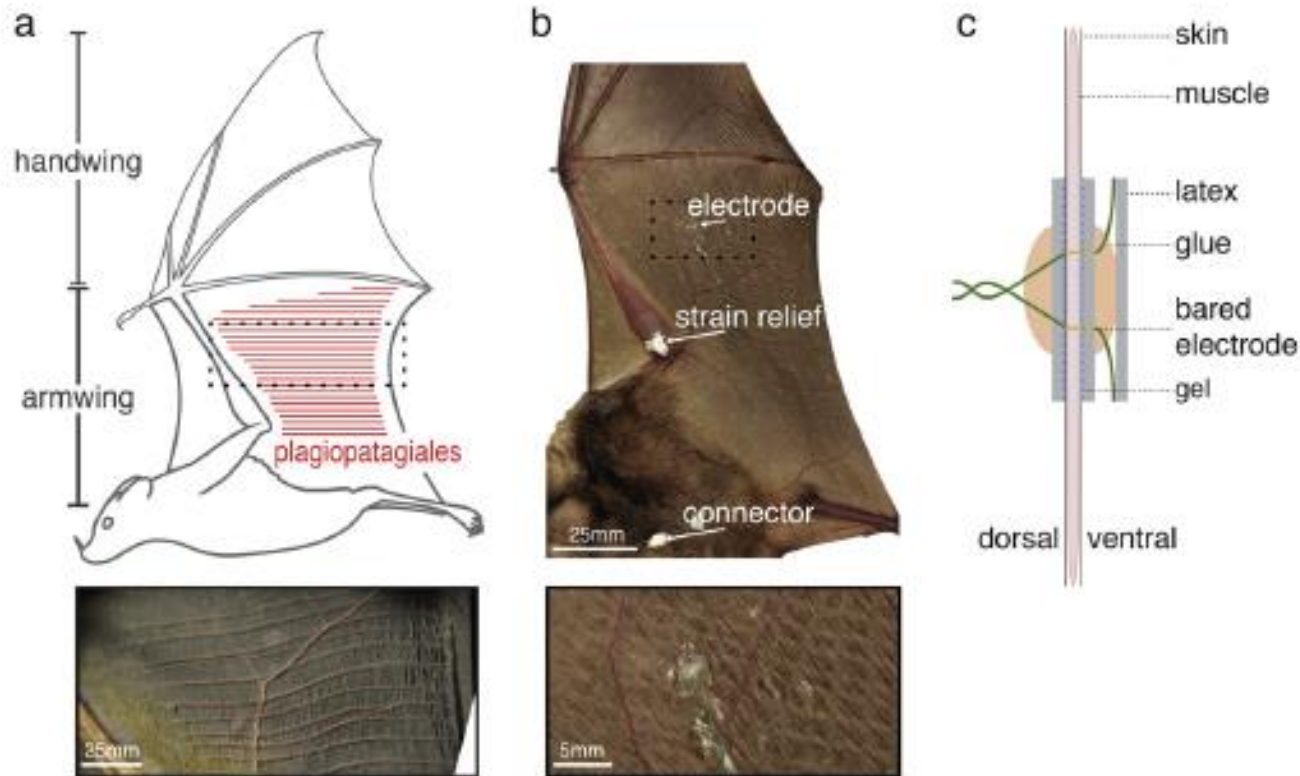


Figure 1. (a) Illustration of lateral view of flying bat at beginning of downstroke indicating location and orientation of the plagiopatagiales muscles. Dashed rectangle is location of plagiopatagiales photo, below, from a large pteropodid bat (*Eidolon helvum*; ~275 g). (b) *Arúbeus jamaicensis* experimental subject following EMG electrode implantation. The electrode was anchored to the back and forearm. At the forearm, the electrode wire was looped to allow for strain-free displacement. During experiments, the electrode was connected to a shielded cable running to an amplifier. Dashed rectangle is location of higher magnification photo below. (c) Design of EMG electrode as implanted in a wing cross-section.

plagiopatagiales proprii zvyšují tuhost membrány a snižují její deformaci, netopýr je může aktivovat synchronně, k maximalizaci sil (jeden je příliš slabý).

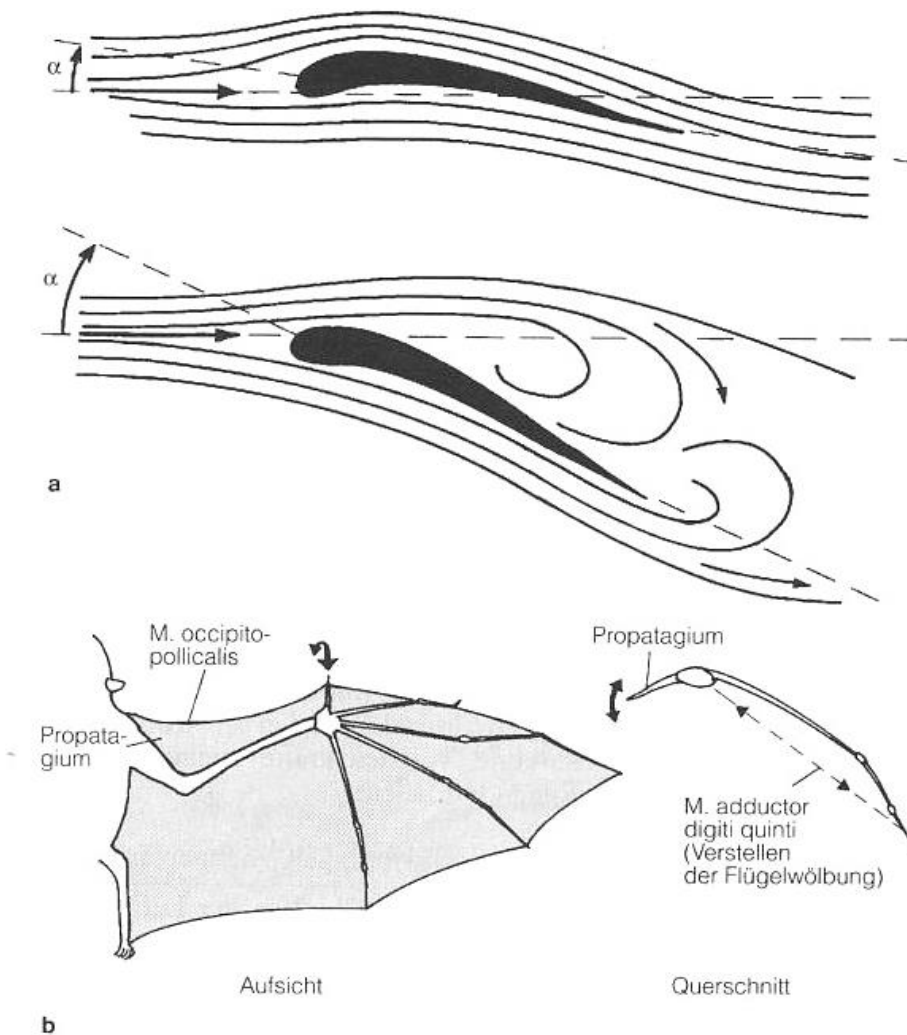
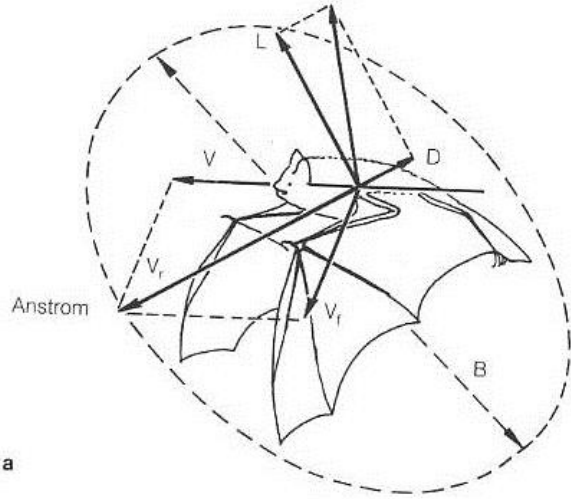
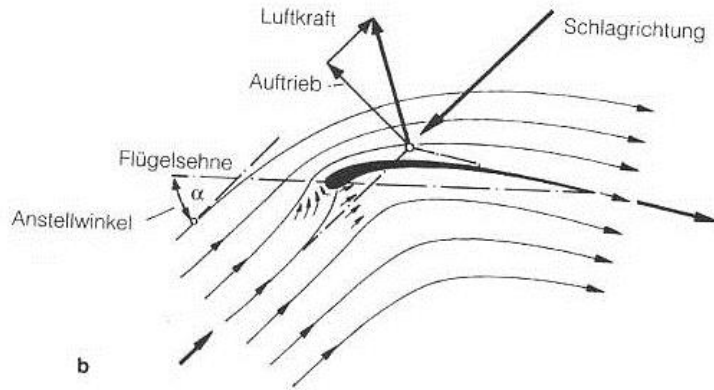


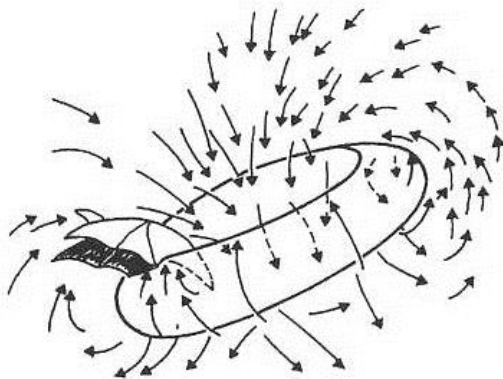
Abb. 1.11 Laminarer Luftstrom a: Laminarer Luftstrom bei flachem Anstellwinkel (oberes Bild) und Abreißen der Luftgrenzschicht durch Wirbelbildungen am Heck bei steilem Anstellwinkel (unteres Bild).
 b) Durch eine verstellbare „Flügel Nase“ kann das Abreißen auch bei steilem Anstellwinkel verhindert werden. Fledermäuse haben mit dem Propatagium (Vorflügel) eine solche Flügel Nase, deren Neigung durch die Stellung des Daumens verstellbar ist (Doppelpfeil). Der M.occipitopollicalis bildet dabei die harte Vorderkante der Flügel Nase. Die Flügelwölbung kann zusätzlich durch den Zug des M.adductor digiti quinti erhöht werden. Nach J.M.V.Rayner 1981 und C. J. Pennycuik 1971.



a



b



c

Das Abreißen des laminaren Luftstroms

An der Flügelfläche entsteht durch die Reibung eine Luftschicht verminderter Geschwindigkeit, die sogenannte Grenzschicht. Damit die Auftriebskräfte wirksam werden, muß diese Grenzschicht auf der Flügeloberfläche haften. Die Gefahr des Abreißen besteht, wenn der Flügel zu steil in den Wind steht (Abb. 1.11a), oder wenn ein Druckstau am vorderen Flügel die Luft von der Flughaut drängt. Im Horizontalflug ist der Druck auf den Flügel vorne am Bug am größten. Am Scheitelpunkt der Flügelwölbung, wo die Umströmungsgeschwindigkeit am größten ist, erreicht der Druck ein Minimum. Am Heck erzeugt die der Flügelunterseite hochgespülte Luft einen höheren Druck, durch den die laminar strömende Grenzschicht aufgestaut und von der Flughaut abgedrängt werden kann.

Aus strömungstechnischen Gründen muß der Anstellwinkel klein bleiben, da bei steiler Flügelstellung die Luftströmung auf der Flügeloberseite abreißen kann (Abb. 1.11).

Reynolds-Zahl. Die Gefahr des „laminaren Abreißen“ der Grenzschicht ist bei Fledermausflug besonders akut. Das hängt mit der sogenannten Reynolds-Zahl zusammen, die das Verhältnis der auf den Flügel einwirkenden Zähigkeits- und Trägheitskräfte zueinander ausdrückt. Sie berechnet sich folgendermaßen:

$$\text{Reynolds-Zahl} = \frac{\text{Anströmgeschwindigkeit} \cdot \text{Sehnenlänge}}{\text{kinematische Zähigkeit der Luft}}$$

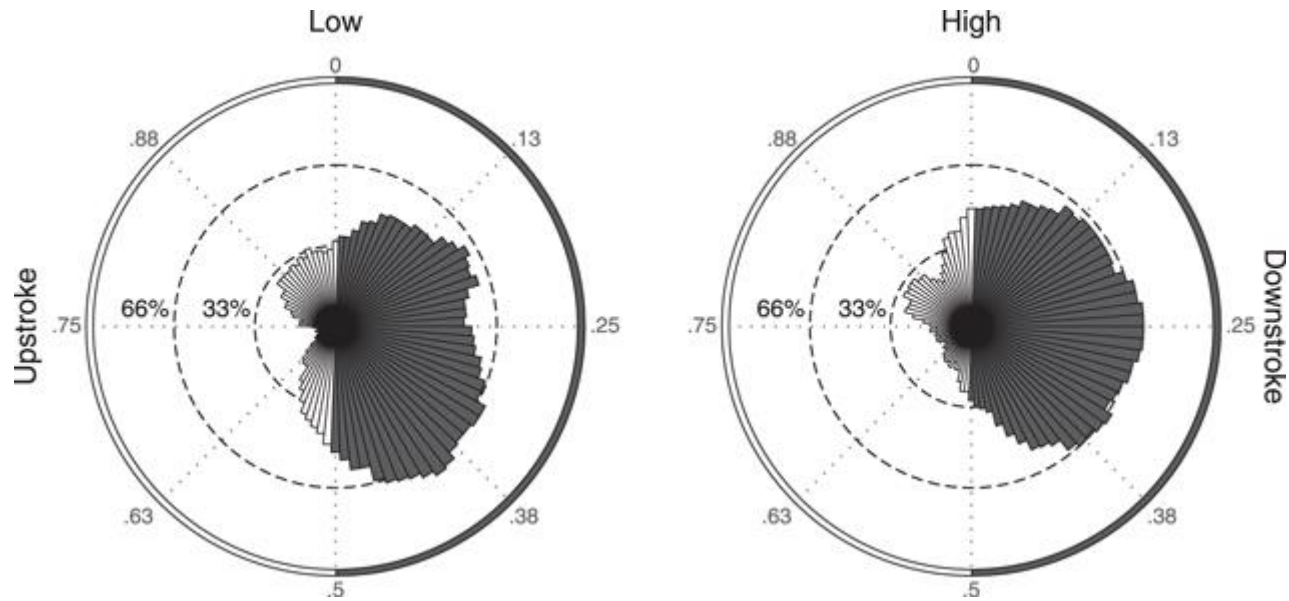
Abb. 1.10 Aerodynamik beim Horizontalflug.

a) Entstehung von Hub und Schub durch den Flügelschlag. D Luftkraft, A Auftrieb, R Luftkraft, V Fluggeschwindigkeit, V_f Geschw. des Flügels, V_r resultierende Geschwindigkeit. Der Durchmesser der Flügelscheitelchelte Oval) entspricht der Flügelspannweite B.

b) Erzeugung von Luftkraft am angeströmten Profil der „gewölbten“ Flügeloberseite (nach Hertel).

c) Luftwirbel, die eine mit 1,5 m/s fliegende Fledermaus (Plecotus Vespertilionidae) beim Abschlag erzeugt. Das Tier „reitet“ auf der Unterseite des schräg nach hinten und unten gerichteten Wirbelschlauches.

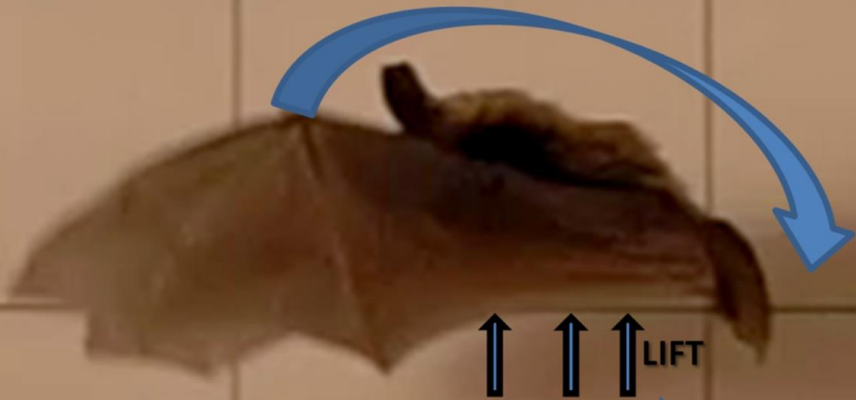
a nach U. Norberg 1986, b nach H. Hertel 1963, c nach J. M. V. Rayne und A. Thomas 1986.



Rose plot of activity distribution over the wingbeat cycle at low- (left) and high- (right) speed flight (mean 2.2 and 5.5 m s⁻¹, respectively). Column height indicates percentage of wingbeats that displayed activity during that portion of the wingbeat cycle. Gray columns indicate downstroke.

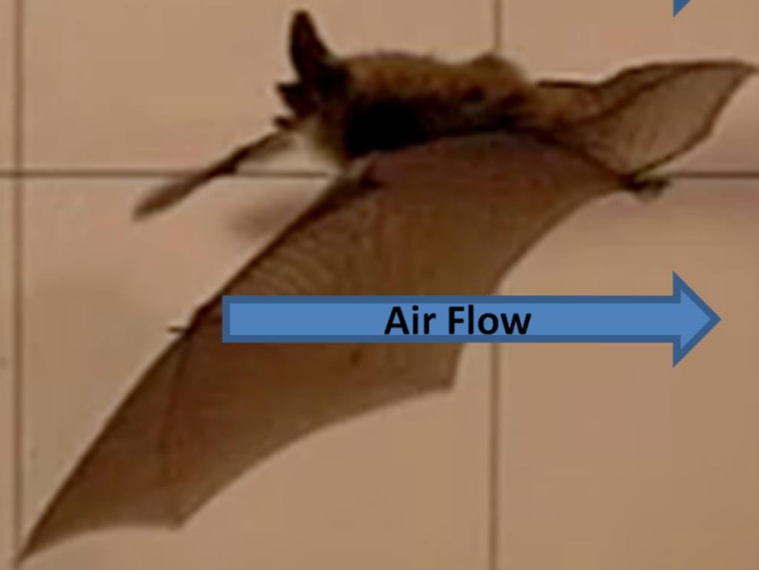
muscle activity increased between late upstroke and early downstroke
reduce passive membrane deformation

Faster Air Flow
Low Pressure



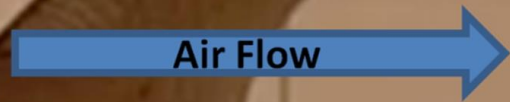
Slower Air Flow
High Pressure

Air Flow



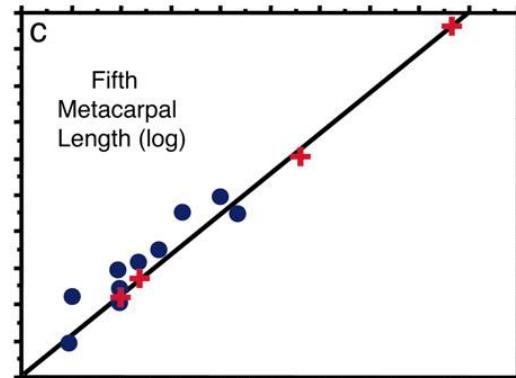
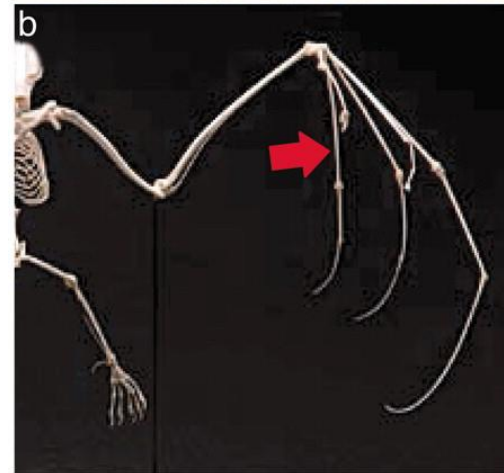
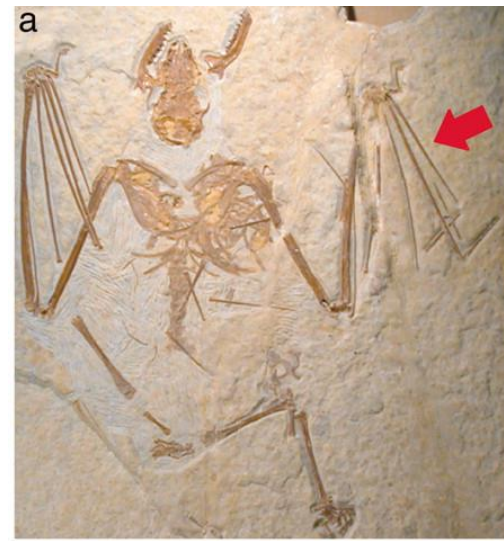
Thrust

Air Flow



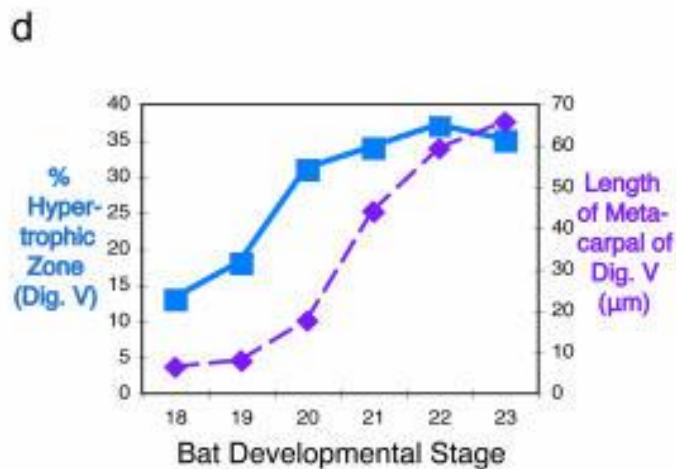
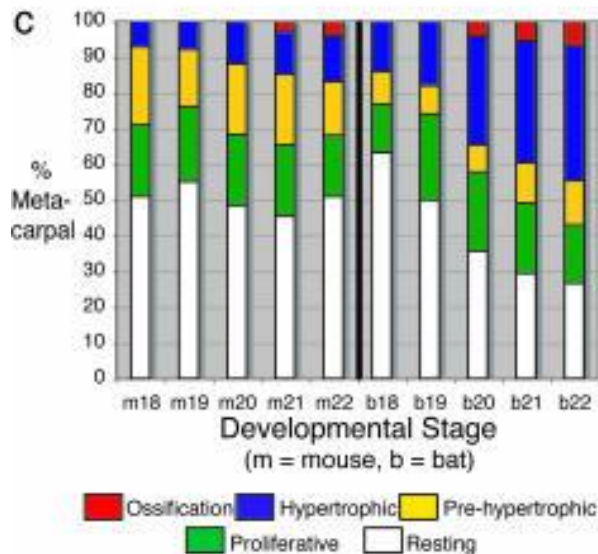
Délka prstů se nezměnila zásadně po dobu 50 milionů let

- (a) *Icaronycteris index* (American Museum of Natural History specimen no. 125000), which is a 50-million-year-old bat fossil.
- (b) Extant adult bat skeleton. The metacarpals (red arrows) of the first fossil bats are **already elongated and closely resemble modern bats**.
- (c) Results of regression analysis of the log of fifth metacarpal length versus a proxy for body size (PC1). (c and d) Extinct bats are indicated by red crosses, and modern bats are indicated by blue circles. Their **metacarpals are similar in relative length**.





Ontogenese křídla – velmi netriviální mechanismus



At stage 20, the **hypertrophic zone** greatly increases in size, along with the beginning of a phase of exponential lengthening of the bat digits.

odpovědnost za růst chrupavek

Bmp2

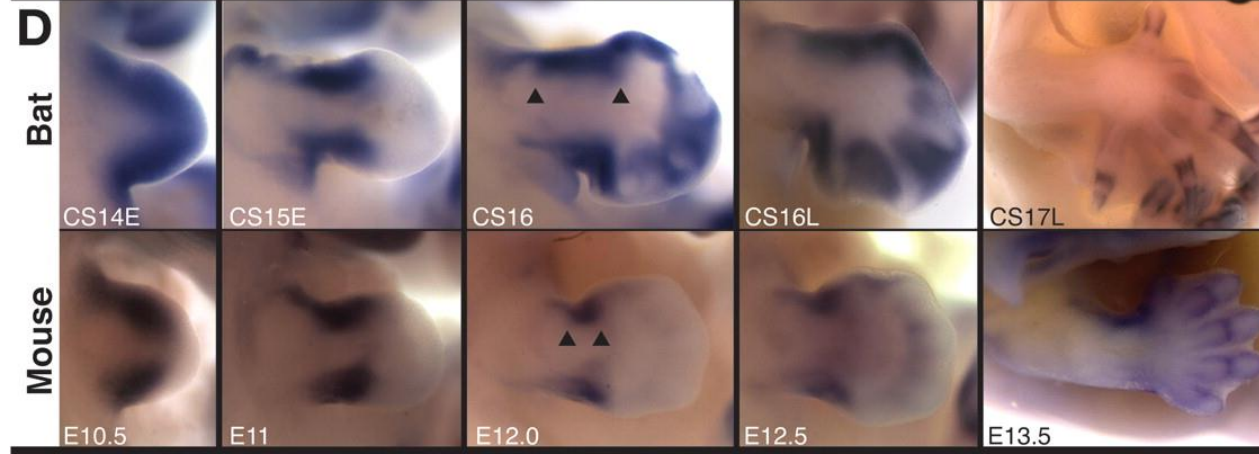
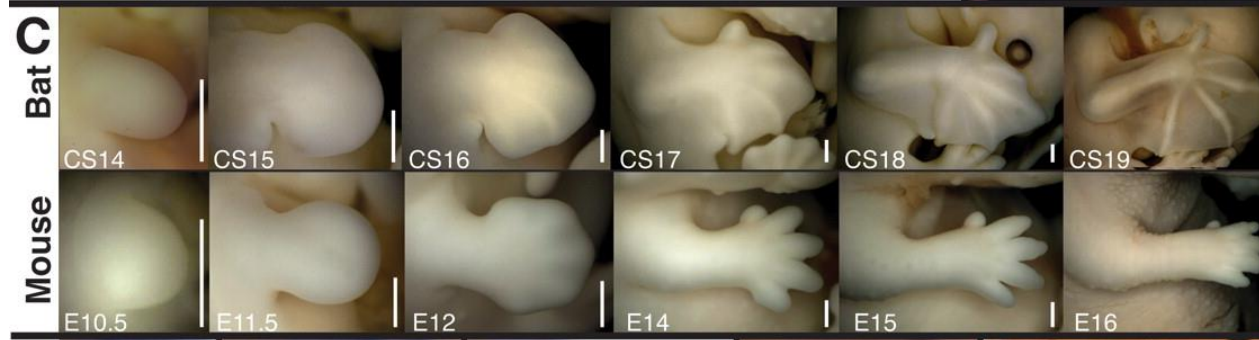
aktivizace chondrogeneze

Prx1 –

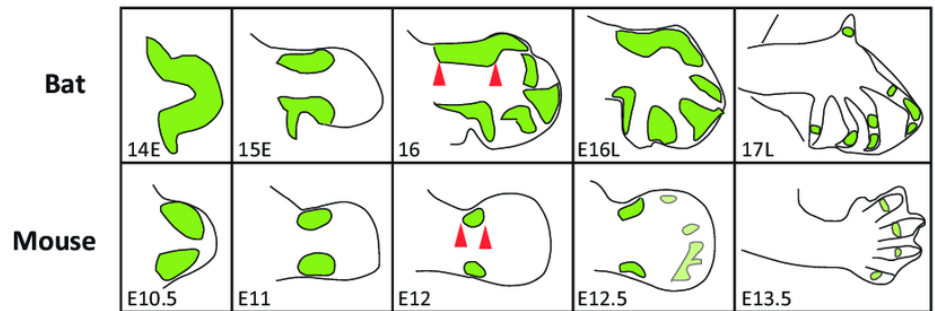
omezení růstu mezenchymu mezi klouby zadní končetiny je inhibováno u končetiny přední nohy

Small changes, big results: evolution of morphological discontinuity in mammals

Rodney L Honeycutt 2008 J.Biol



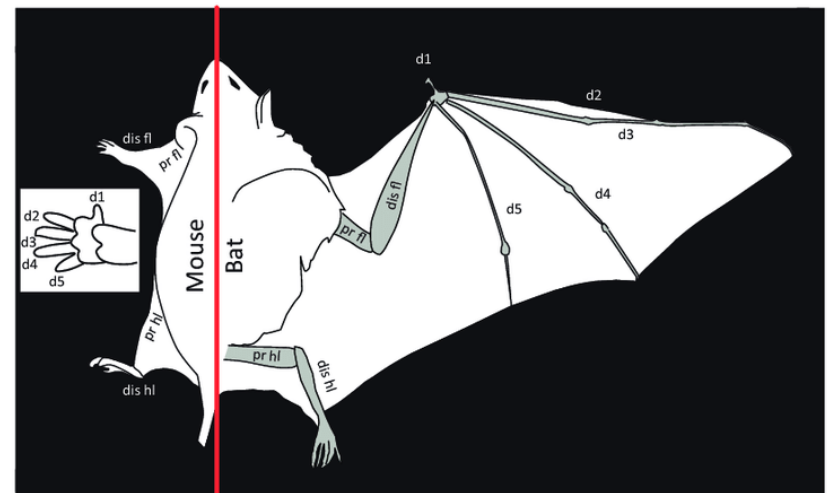
(A) Embryonic development of the forelimb: expression of *Prx1*



Cretekos et al., 2008

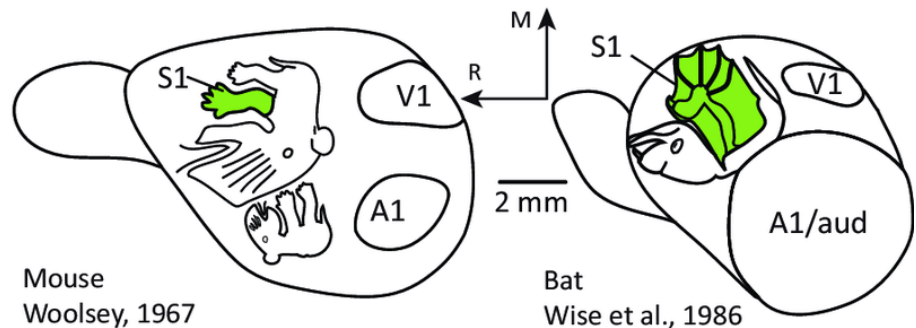
At middle stages of development, the spatial pattern of expression of *Prx1* (green) in the distal forelimb is expanded in bats (red arrows) compared to mice. This alteration, amongst a number of other molecular changes, accounts for the radical differences in the mouse forepaw compared to the bat wing. These morphological differences in the distal forelimb along with differential use of the paw versus the wing have likely contributed to the differences in size and internal organization of the forelimb representation in the primary somatosensory cortical area (C).

(B) Adult forelimb morphology



Cretekos et al., 2001

(C) Adult neocortex: magnification of forelimb representation



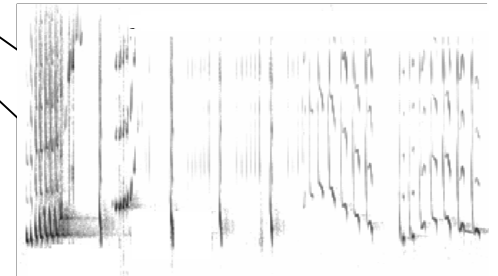
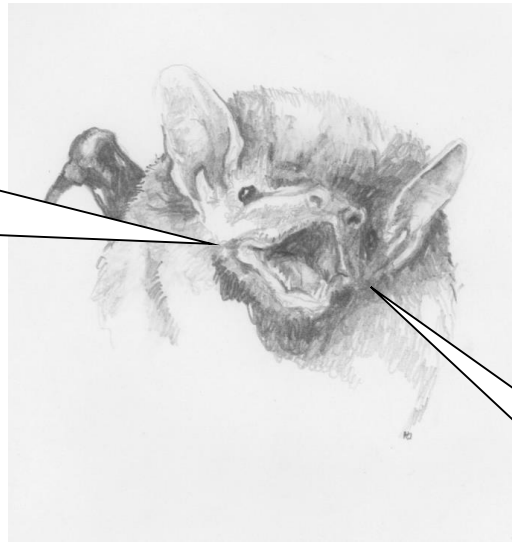
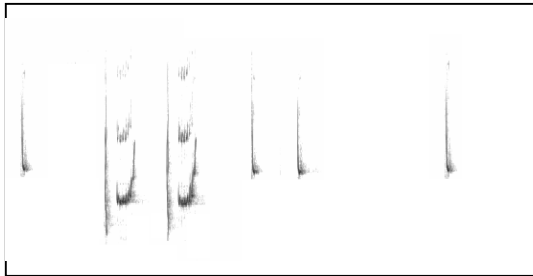
Konflikt pohlaví

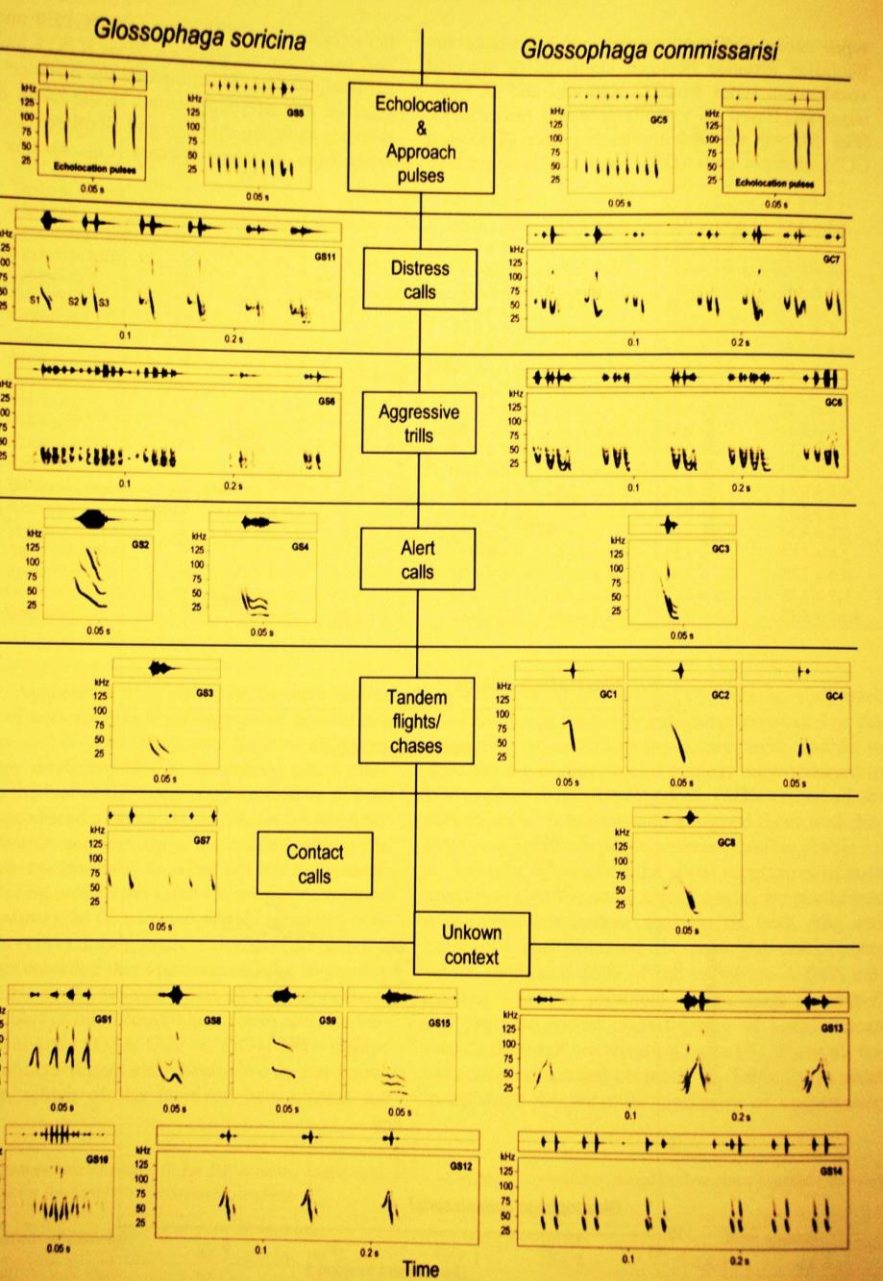
Pohlavní dvojtvárnost

Echolokační + sociální hlasy

vs.

Složitý zpěv v období páření

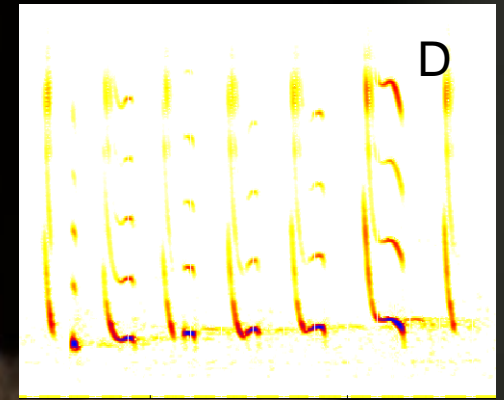
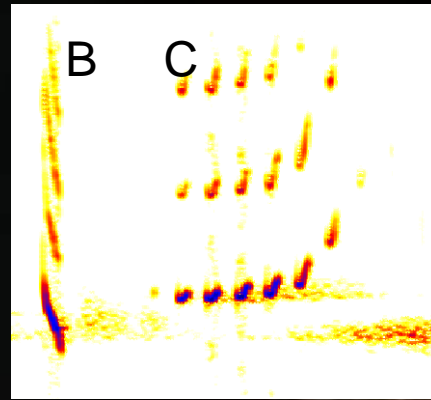
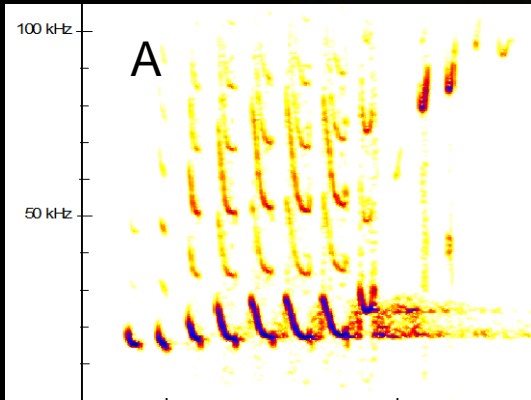




Komplexní vokální komunikace, členitý repertoár, druhově a individuálně specifické signály etc.

Spectrograms and sonograms depicting echolocation pulses and social calls of *G. soricina* and *G. commissarisi*. Sonograms were generated using a 1,024 point FFT and a Hamming window with 87.5% overlap. The social context in which each vocalization type occurred is stated whenever it is known. Echolocation pulses are shown for comparative reasons

The message of the call

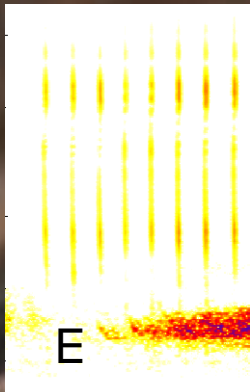


"Pay attention: here is
Pipistrellus"

nathusii, male Mufik

land here,

we share the common
social identity and
common communication
pool"





Kaloň kladivohlavý – *Hypsignathus monstrosus*
nejvyšší stupeň pohlavní dvojtvárnosti u savců



Úkrytové strategie

Morfologické adaptace



Tropy: široké spektrum sociálních uspořádání,
úkrytových strategií









Thyroptera tricolor

J.Amerika



Myzopodidae
Myzopoda aurita

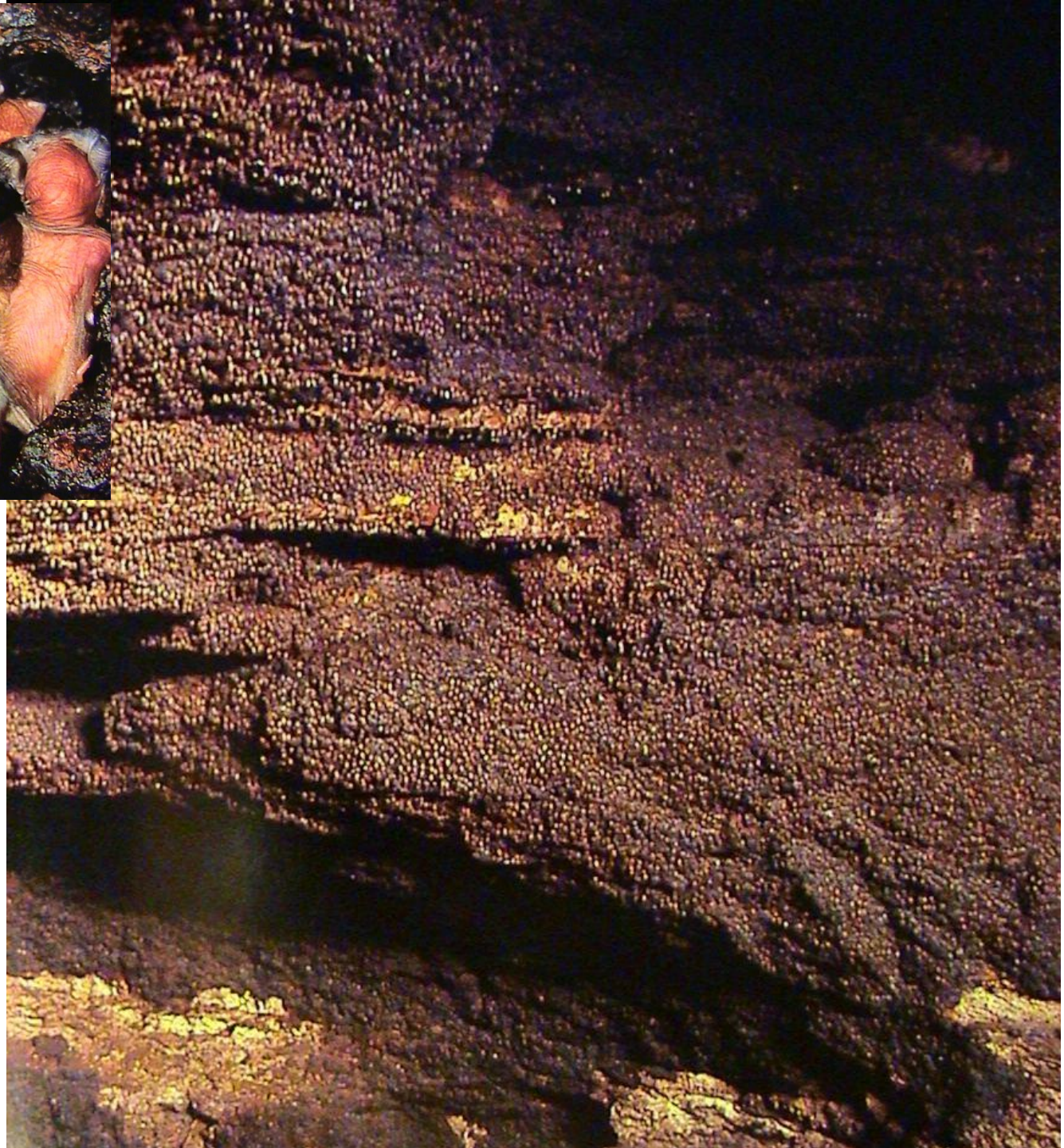
Madagascar





*Tadarida
brasiliensis:*

Interior kolonie

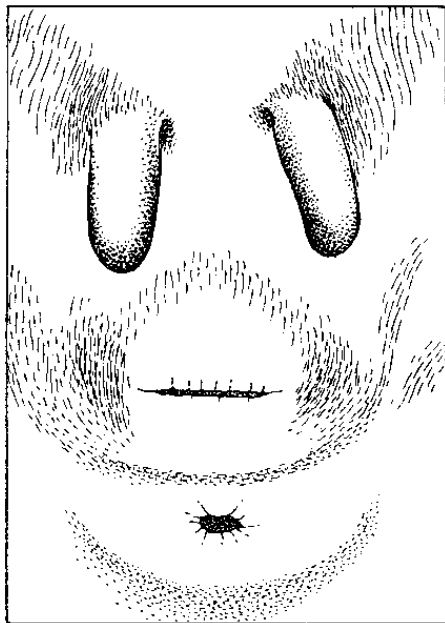


Letouni:

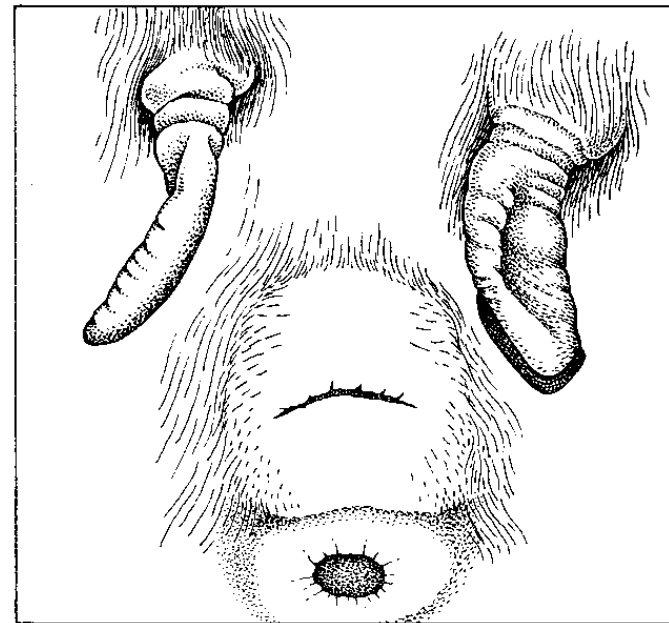
**dlouhověcí (až 40 let),
1 mládě ročně,
dokonalá paměť,
sociální tradice**

Netopýři se mohou dožít vysokého věku ve srovnání s jinými savci podobné velikosti. Dlouhodobé (v letech 1948-2000) kroužkování netopýřů na území bývalého Československa poskytlo různé údaje o velkém množství jedinců - okroužkováno 89 108 netopýřů 23 (resp. 24) druhů, 12 552 zpětných hlášení. U 10 druhů byl díky tomu zjištěn vyšší věk než u dosud známých zahraničních dat, u netopýra velkého (*Myotis myotis*) byl prokázán nejvyšší doložený věk (více než 37 let) netopýra v Evropě a druhý nejvyšší na světě.

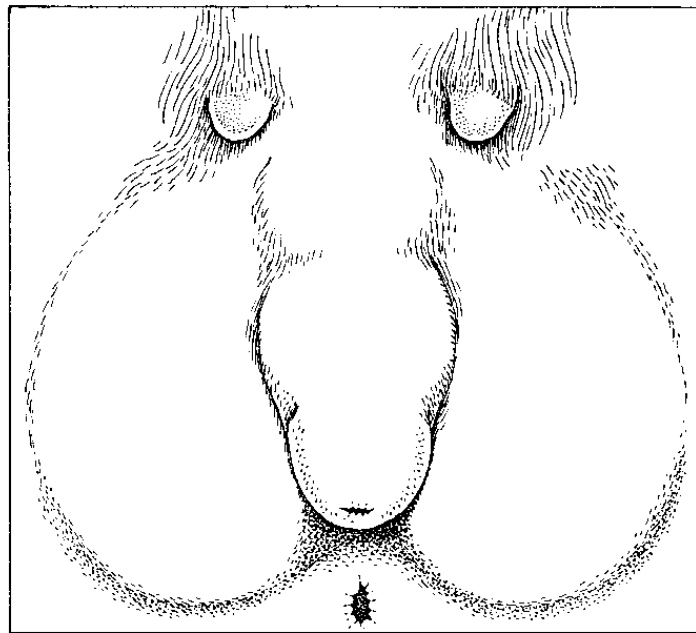
A



B



C



Pubic nipples in female and male
megadermatids

- Rhinolophus
- Hipposideros
- Megaderma
- Rhinopoma
- Aselliscus
- Craseonycteris

Taxon ^a	Females	Males
Rhinolophinae		
<i>Rhinolophus</i>		
<i>euryotis</i> group		
<i>Rhinolophus arcuatus</i>	present (8)	present (7)
<i>Rhinolophus canuti</i>	present (8)	present (3) absent (5)
<i>Rhinolophus coelophyllus</i>	present (3)	present (7)
<i>Rhinolophus creaghi</i>	present (2)	?
<i>Rhinolophus euryotis</i>	present (6)	present (9)
<i>Rhinolophus inops</i>	present (11)	present (3) absent (1)
<i>Rhinolophus rufus</i>	present (2)	present (5)
<i>Rhinolophus shameli</i>	?	present (4)
<i>ferrumequinum</i> group		
<i>Rhinolophus affinis</i>	present (14)	present (6) absent (2)
<i>Rhinolophus borneensis</i>	present (11)	present (9)
<i>Rhinolophus clivosus</i>	present (2)	present (20)
<i>Rhinolophus darlingi</i>	present (8)	present (4) absent (1)
<i>Rhinolophus deckenii</i>	present (4)	present (1)
<i>Rhinolophus denti</i>	?	present (1)
<i>Rhinolophus ferrumequinum</i>	present (3)	present (1)
<i>Rhinolophus malayanus</i>	present (1)	present (3)
<i>Rhinolophus megaphyllus</i>	present (27)	present (17) absent (1)
<i>Rhinolophus robinsoni</i>	?	present (1)
<i>Rhinolophus rouxi</i>	present (34)	present (5)
<i>Rhinolophus simplex</i>	present (2)	present (1)
<i>Rhinolophus simulator</i>	present (1)	?
<i>Rhinolophus stheno</i>	present (9)	present (6)
<i>Rhinolophus thomasi</i>	present (5)	present (1)
<i>Rhinolophus virgo</i>	present (3)	present (11)
<i>hipposideros</i> group		
<i>Rhinolophus hipposideros</i>	present (4)	present (6)
<i>luctus</i> group		
<i>Rhinolophus eloquens</i>	present (6)	present (6)
<i>Rhinolophus fumigatus</i>	present (9)	present (16)
<i>Rhinolophus hildebrandti</i>	present (1)	present (9)
<i>Rhinolophus luctus</i>	present (9)	present (7)
<i>Rhinolophus macrotis</i>	present (2)	present (7) absent (1)
<i>Rhinolophus pearsoni</i>	present (5)	present (3)
<i>Rhinolophus philippinensis</i>	present (2)	present (5)
<i>Rhinolophus rex</i>	present (1)	present (1)
<i>Rhinolophus sedulus</i>	present (3)	present (3)
<i>Rhinolophus trifoliatus</i>	present (6)	present (4)
<i>pusillus</i> group		
<i>Rhinolophus acuminatus</i>	present (5)	present (3)
<i>Rhinolophus alcyone</i>	present (3)	present (1)
<i>Rhinolophus blasii</i>	present (2)	present (2)
<i>Rhinolophus cornutus</i>	present (20)	present (3) absent (5)
<i>Rhinolophus euryale</i>	present (12)	present (14)
<i>Rhinolophus guineensis</i>	present (1)	present (1)
<i>Rhinolophus imaizumii</i>	?	present (4) absent (3)
<i>Rhinolophus landeri</i>	present (2)	present (3)
<i>Rhinolophus lepidus</i>	present (24)	present (29) absent (2)

Dyacopterus spadiceus

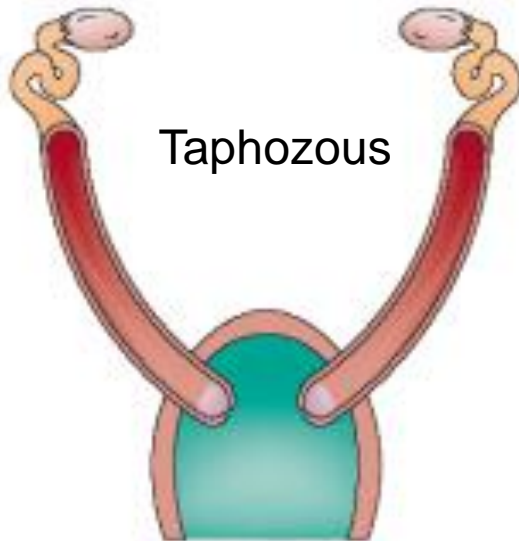
The male of the *D. spadiceus* species is one of the known natural occurrences of paternal lactation



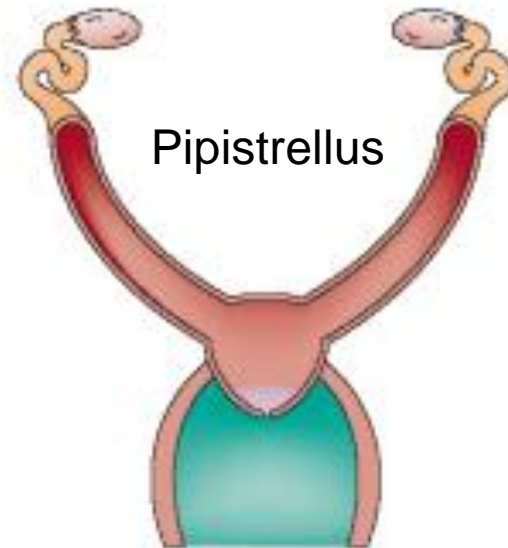
kolonie, samci a samice, sociální organizace



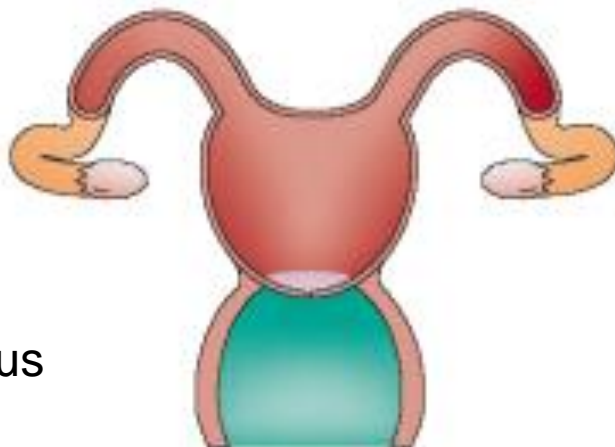
d Duplex uterus with a single vagina seen in rodents and rabbits



e Bipartite uterus seen in pigs, marine mammals and mice

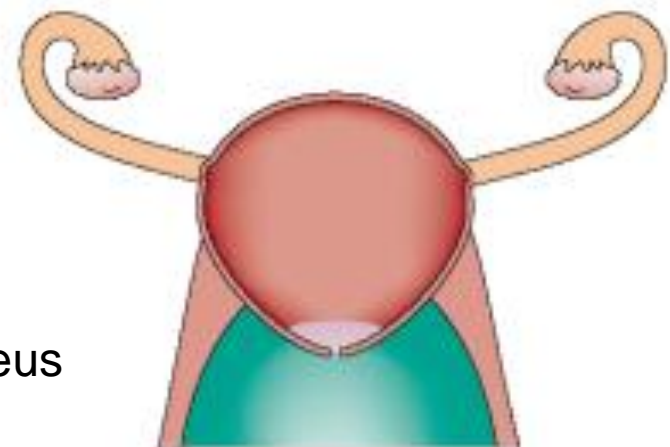


f Bicornuate uterus seen in most bats, cows and horses



Desmodus

g Simplex uterus seen in most higher primates, including humans



Artibeus

Zpožděná ovulace

týdny až měsíce, nastartování 1-3 dny po ukončení hibernace

estrus od srpna, vajíčka ale zůstávají ve folikulech, obklopena strukturou **discus proligerus**. Glykogen zdroj energie během hibernace

V průběhu hibernace

vajíčka pod vlivem FSH (folikulostimulační hormon) až do konce února, pak LH (luteinizační h.), jeho sekrece obnoví ovulaci.

Sperm storage

enables the bat to synchronise the above factors

Pipistrellus.

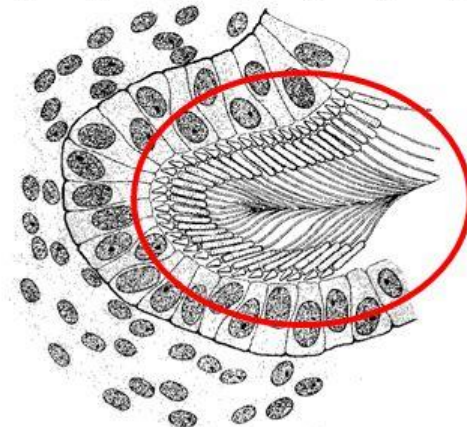
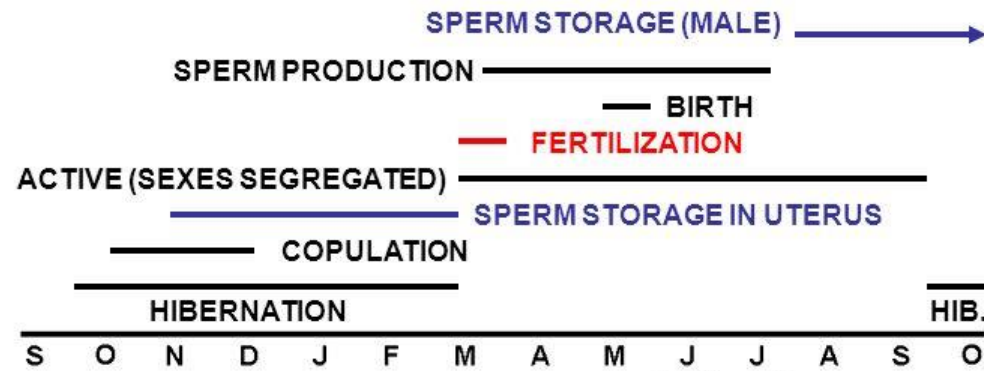
Ovulation and fertilization second half of May, give birth in late June.

in mid-December had uterus packed with spermatozoa **five months** in the female reproductive tract!

Tadarida, Rhinopoma, Hipposideros, Pteropus

Sperm storage and delayed fertilization

Antrozous pallidus (Pallid bat)



Delayed Implantation

Copulation is carried out in autumn and is followed immediately by ovulation, fertilization and initial embryogenesis.

hibernation

late autumn in a pregnant condition with unimplanted blastocysts

blastocyst implanting

Parturition in late spring, followed by a lactational anoestrous period.

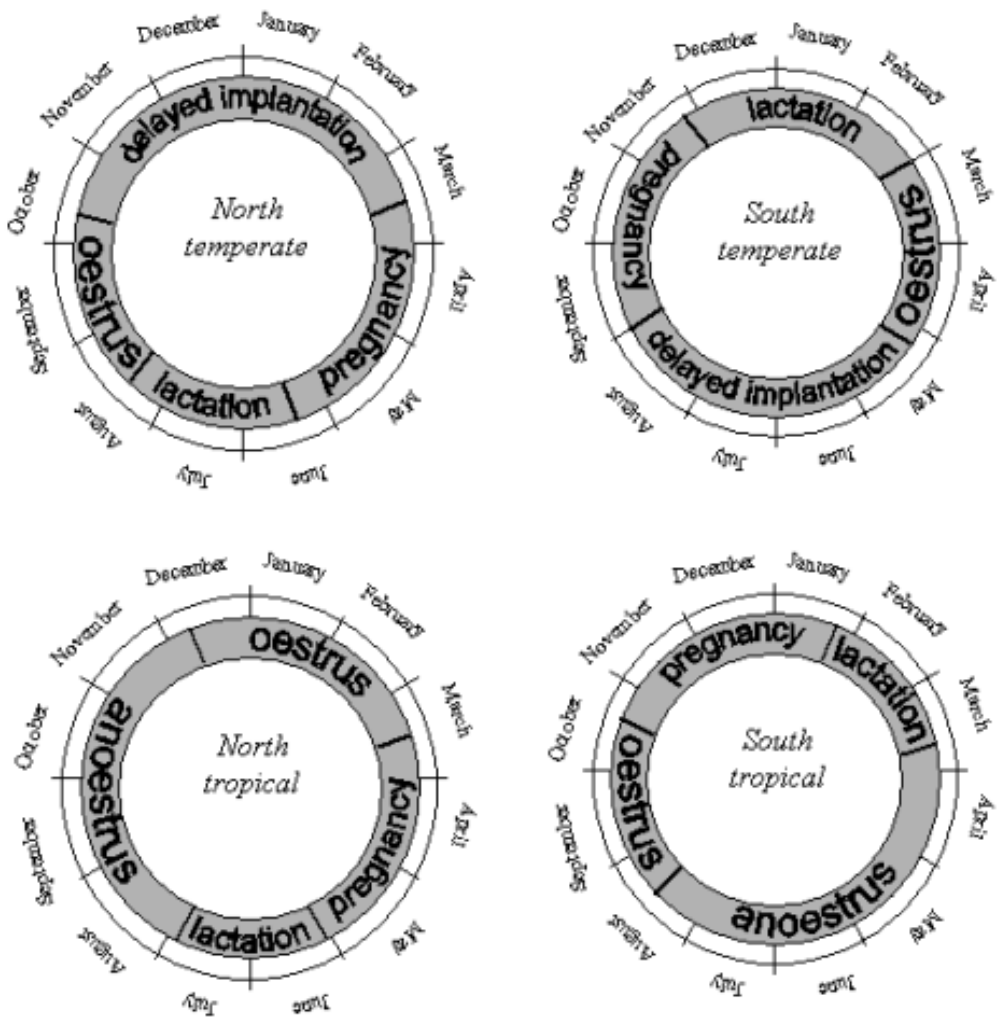


Figure 4 Various reproductive cycles of *Miniapterus schreibersii* in four different locations (Adapted from Altringham, 2001).

Počty mláďat

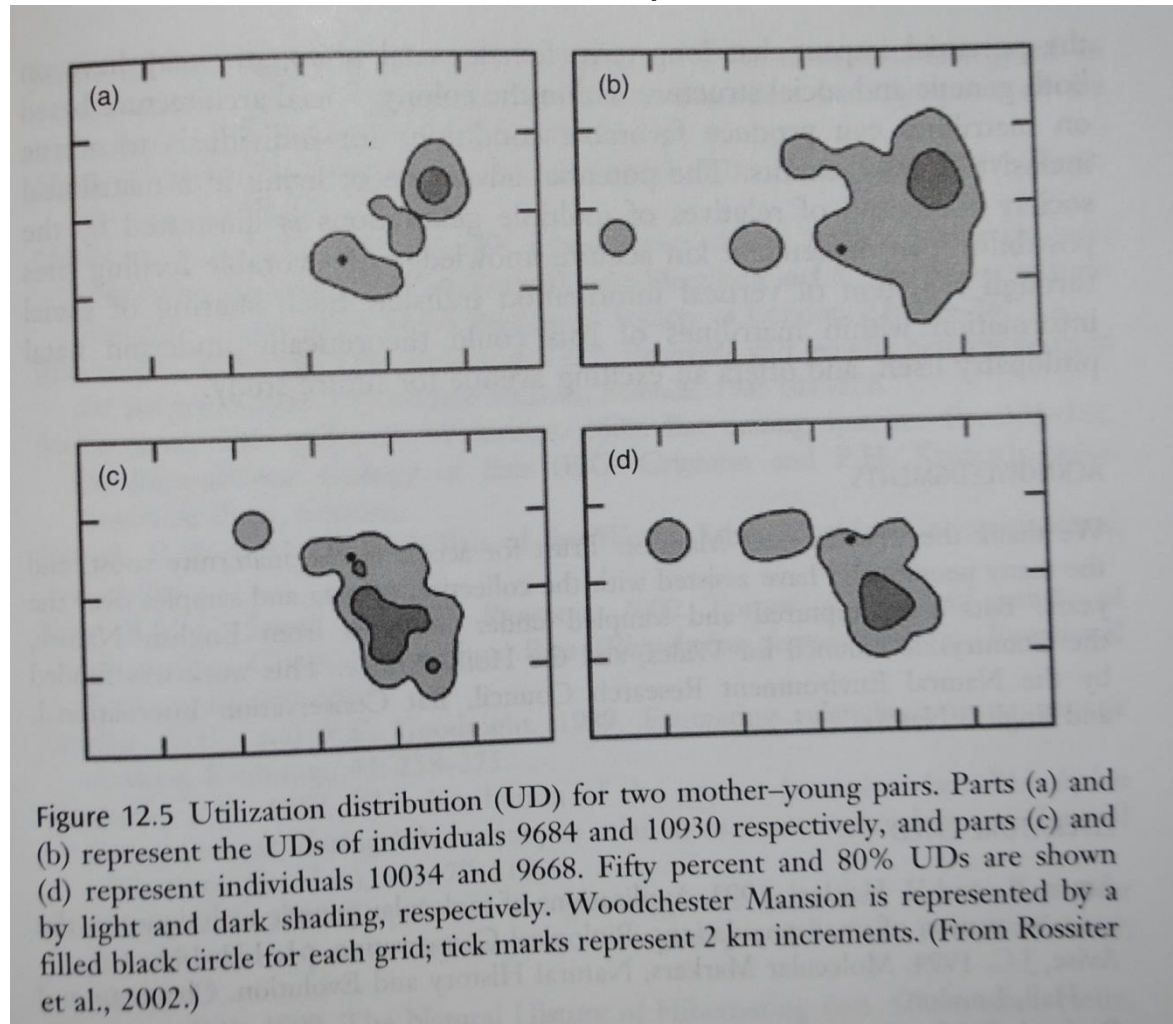


Lasiurus xanthinus – 2 až 4/rok
Obvykle 1 - 2

sociální tradice, sociální učení dlouhověkost, filopatrie, fidelita

Rfer - sdílení lovišť matkou a potomkem

poučení:
Chiroptera-
fenomenální
psychické,
sensorické a
somatomotorické
výkony ...



... ale: velmi nízká úroveň encephalisace, řada “plesiomorfii” ve stavbě CNS (zejména míchy)

Tabelle 5.1 Encephalisationsindices (EI) der Fledermausfamilien, bezogen auf basale Insektivoren (EI = 100 %)

Familie/ Unterordnung	EI [%]		
	Min	Max	Mittel
Megachiropteren	177	340	247
Mikrochiropteren			
Phyllostomatidae	148	284	235
Desmodontidae	216	243	232
Thyropteridae		230	
Megadermatidae	182	233	211
Nycteridae	182	233	211
Nycteridae	178	216	196
Mormoopidae	171	203	180
Noctilionidae	128	220	174
Rhinolophidae	139	186	164
Hipposideridae	87	174	164
Furipteridae	-	-	152
Emballonuridae	132	169	151
Molossidae	107	166	137
Vespertilionidae	77	179	128

-nur im Flug jagende, insektivore Mikrochir.	137
im Flug jagende und von Substrat ablesende Mikrochir.	156
nur von Substrat ablesende Mikrochiropteren	186
karnivore Mikrochiropteren	213

Aus H. Stephan 1977; H. Stephan und J. E. Nelson 1981; Stephan et al. 1987.

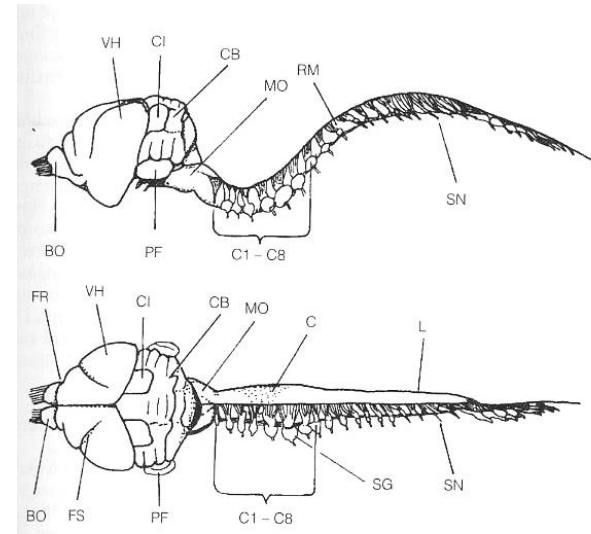


Abb. 5.3 Zentralnervensystem (ZNS) einer Fledermaus. Seiten- (oben) und Dorsalansicht (unten) auf das ZNS von *Pteronotus parnellii* (Mormoopidae). BO = Bulbus olfactorius, C = Halsaufreibung („Flügelgehirn“) des Rückenmarks, CB = Cerebellum, CI = Colliculus inferior (Mittelhirn), C1-C8 = Spinalnerven des 1.-8. Halswirbels, FS = Fissura Sylvii, FR = Fissura rhinalis, L = Lumlaufreibung des Rückenmarks, MO = Medulla oblongata (Nachhirn), PF = Fissura Sylvii (Kleinhirn), RM = Rückenmark, SG = Spinalganglion, SN = Spinalnerv, VH = Vorderhirn. Aus O. W. Henson in W. A. Wimsatt 1970.

Selekce na malý mozek...

Zvětšování mozku stejně často jako zmenšování

Stejně i encefalizace

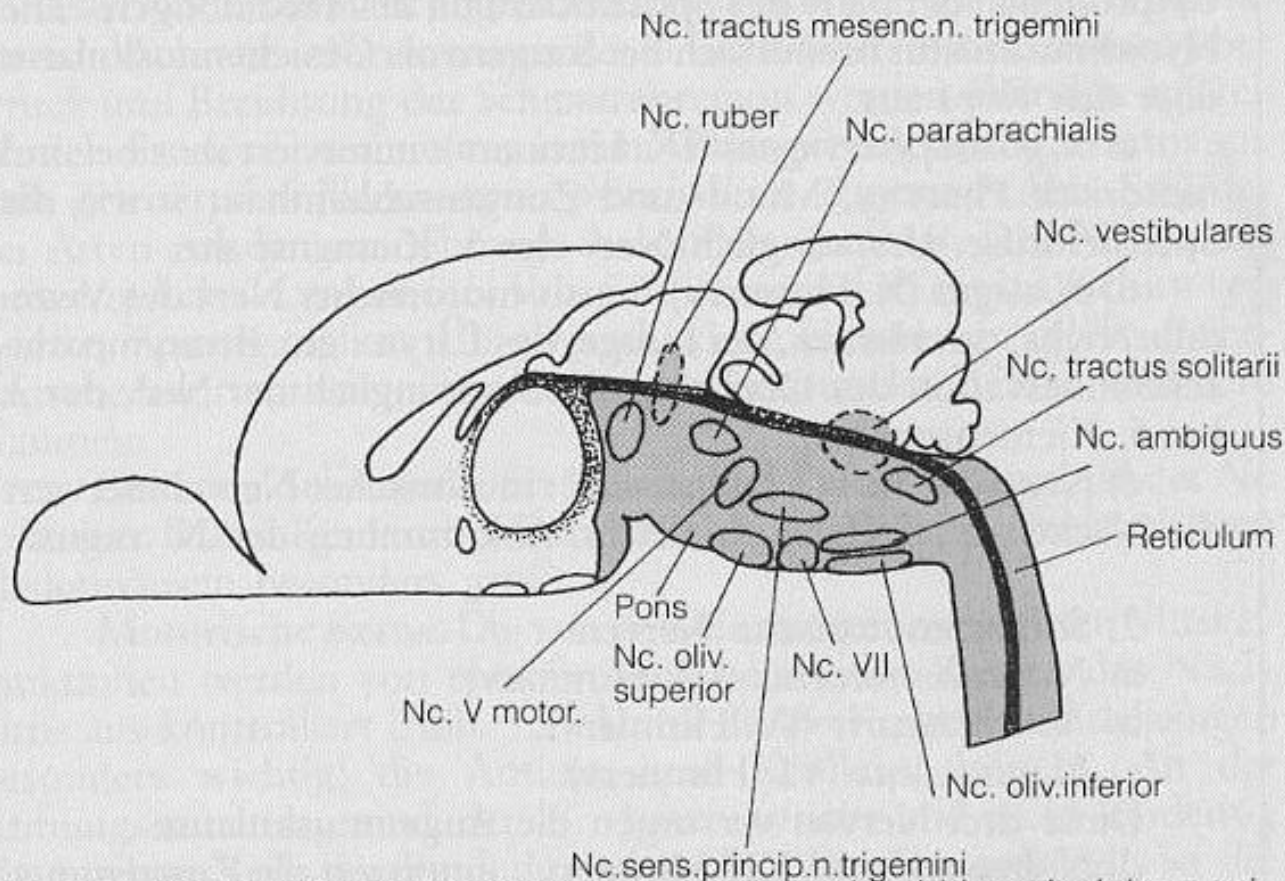
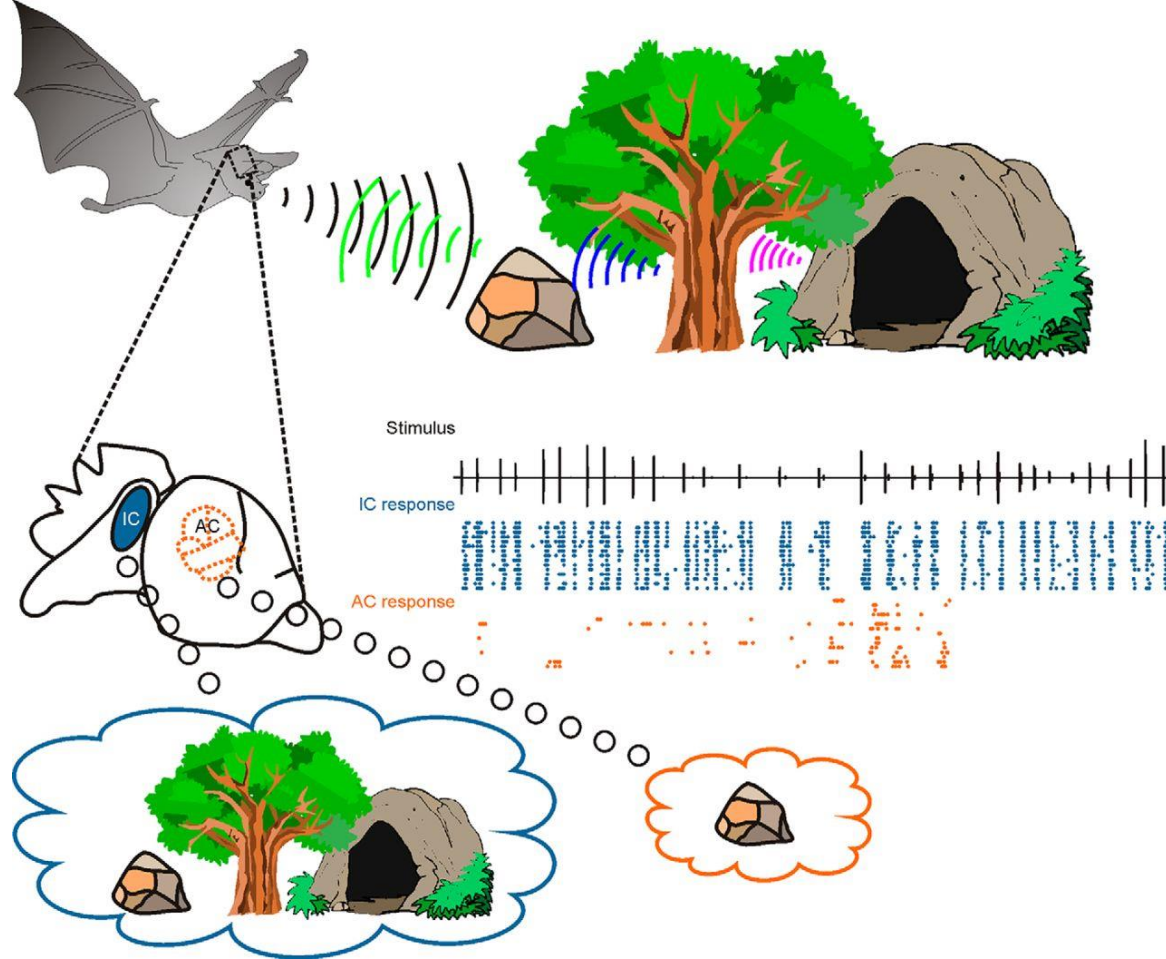


Abb. 5.5 Schematischer Medianschnitt durch das Nachhirn mit einigen seiner Kerne (Nc.). Grau das Reticulum des Nachhirns. Nc. V. motor. motorischer Kern des N. trigeminus, Nc. VII Kern des N. facialis.

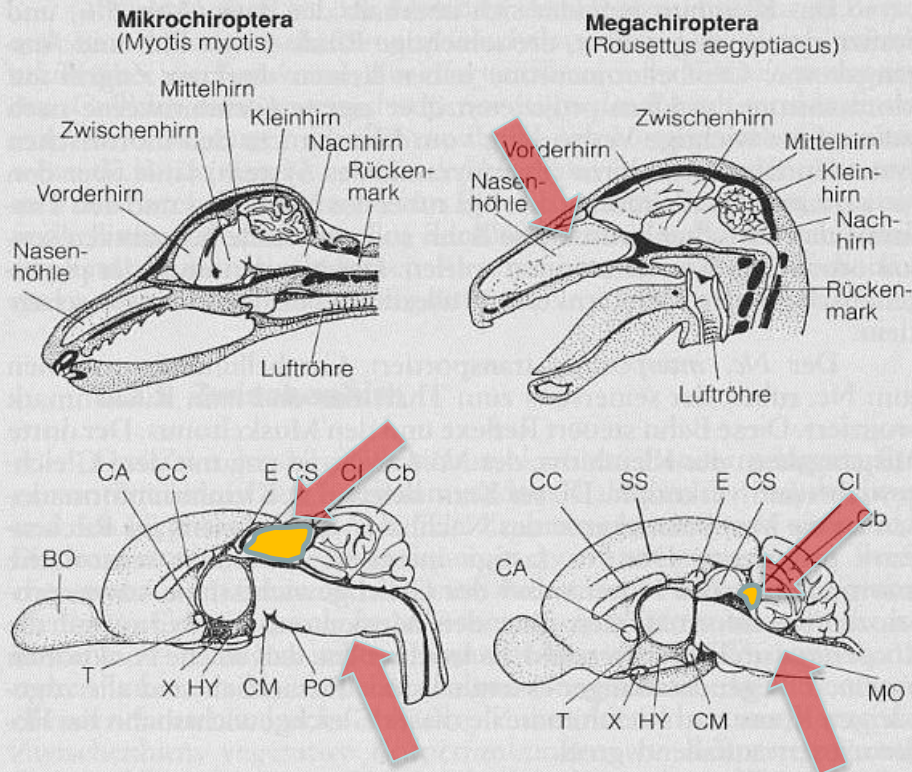
Objemově dominantní složkou mozku – mozkový kmen (myelencephalon + tegmentum) s excesivně zvětšenými jádry vestibulokochleárního aparátu uvnitř mohutného retikula



colliculus inferior (IC) - spodní párový hrbolek v oblasti lamina quadrigemina, součást sluchové dráhy – koordinace sluchových vjemů

represents an important auditory stage for initial processing of echolocation signals
temporally-precise neuronal responses in the IC could allow fast and parallel processing of multiple acoustic streams.

V případě vícenásobného echa – skládání „obrazu“ v auditory cortex (AC)



relativní velikost **tecta** a zejména **colliculus inferior**



výrazné rozdíly mezi Micro- a Megachiroptera

cf. Pettigrew (1994)

a návazné hypotézy

Němec et al. (1996, 2000)

mozeček

neokortex

redukce pyramidálního systému u netopýrů

Abb. 5.6 Gehirn der Mikrochiropteren (*Myotis myotis*, unten *Hipposideros commersoni*) und Megachiropteren (*Rousettus aegyptiacus*, unten *Eidolon helvum*).

oben: Lage des Gehirns im Schädel.

unten: Mediansagittalschnitt durch das Gehirn.

BO = Bulbus olfactorius, CA = Commissura anterior, Cb = Cerebellum, CC = Corpus callosum, CI = Colliculus inferior (Mittelhirn), CM = Corpus mamillare (Zwischenhirn), CS = Colliculus superior (Mittelhirn), E = Epiphyse, HY = Hypothalamus (Zwischenhirn), MO = Medulla oblongata, PO = Pons, SS = Sulcus splenialis, T = Thalamus, X = Chiasma opticum. Nach O.W. Henson in W. A. Wimsatt 1970 und R. Schneider 1957.

mozeček u kaloňů rýhován, u netopýrů hladký

neokortex u kaloňů tvoří až 18% velikosti mozku, u netopýrů jen 3-4%

kaloni mají též rozvinutou její týlní oblast – zrakové vjemy – jako primáti

retikulární formace v míše, podkorová centra a spojení s vnitřní částí čichového laloku = retrobulbární trakt telencephalonu – velmi rozvinuta u netopýrů

netopýrům chybí mimické svalstvo versus bohatý psychický život
ve stavbě senzomotorických listonosí spíše blíže kaloňům

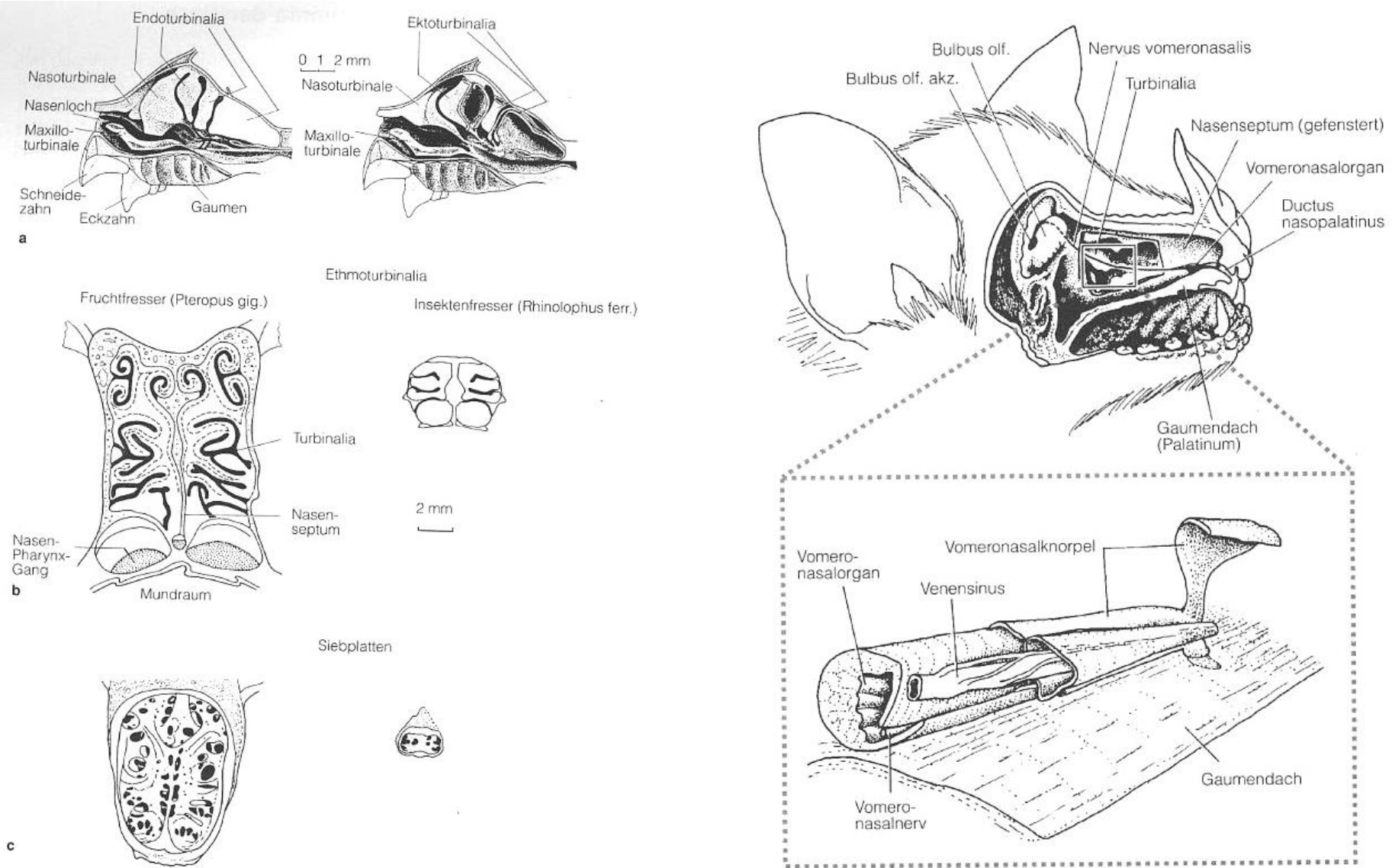


Abb. 77 Das Vomeronasalorgan (Jacobsonsches Organ) bei Phyllostomiden. Aus J. G. Cooper und K. P. Bhatnagar 1976; G. Mann 1961.

Extrémní čichové adaptace u kaloňů a listonosů

diff. Mega/Micro

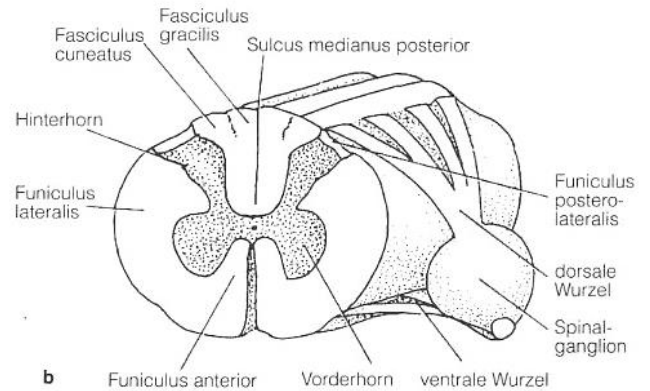
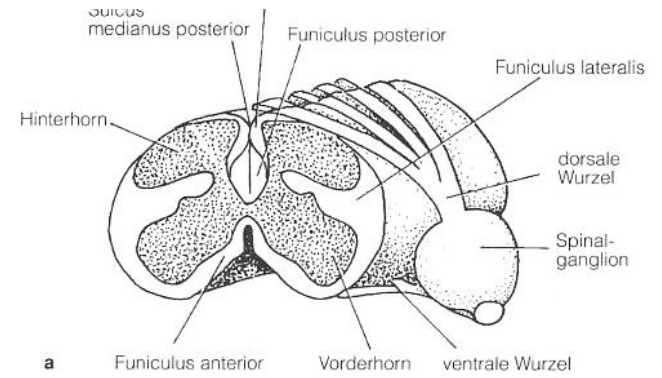
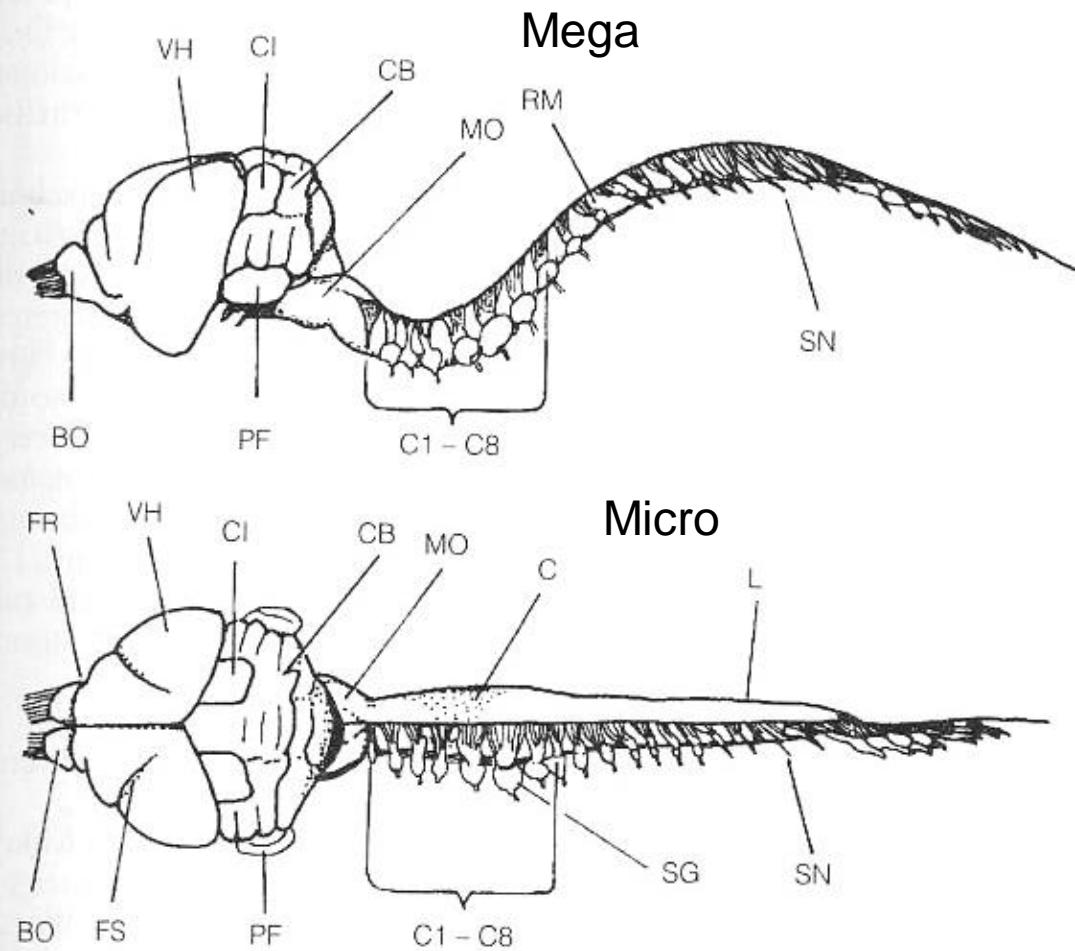


Abb. 5.4 Querschnitt durch das Rückenmark
 a) der Mikrochiropteren (*Pteronotus parnelli*) und
 b) der Megachiropteren (*Eidolon helvum*).
 (grau: graue Substanz, weiß: weiße Substanz)
 Funiculus anterior, Fasciculus cuneatus, F. gracilis sind sensorische Bahnen aus der hinteren Körperhälfte zum Gehirn, Funiculus posterior führt Informationen über Tast- und Tiefensensibilität zum Gehirn. Aus O.W. Henson in W. A. Wimsatt 1970.

krátká mícha

netopýři – zbytnělá šedá hmota, detritické výběžky soustředěny do bílé hmoty
koordinální funkce (létání) řízeno mimo mozek!

Shrnutí CNS letounů

1. Kompletní přítomnost obecných savčích znaků
2. Četné autapomorfie - výrazné adaptivní přestavby
 - senzomorická integrace sluchových a polohových vjemů v myelencephalonu,
 - prostředky semantické analýzy v colliculii a v cortexu
 - rozvoj míchy – koordinační centrum motoriky křídla
 - extrémně nízká exprese calpainu (klíčový faktor!): velikost, dlouhověkost, paměťová přesnost
3. Velikostní škálování (cf. objem bílé/šedé hmoty v míše)

Microchiroptera

Ears

- **External Ear**
- Ear canal
- Pinna is complex and does not form ring(1)
- Tragus
- Tympanic Membrane
- **Middle Ear**
- Chamber filled with air
- Muscles that contract and retract to control hearing sensitivity and avoids self-deafening
- Paaw's Cartilage present(2)
- **Inner ear**
- Basilar membrane: excites hair cells, leading to neuron firing due to neurotransmitters being released to the presynaptic cleft
- Cochlea: A coil with an approximate 2.5 loop coil filled with fluids. The pressure of these fluids provides information. (3)
- Inside the cochlea is a complex of sensory organs that use the fluid pressure information
- Cochlea of Microbats are generally larger and have an extra basal turn (4)
- Cochlea is acoustically separated from skull (5)

Eyes

- Poorly developed
- Tapetum Lucidum hardly present
- Ganglion cells streak is below optic disk
- Eyes open after birth

Teeth

- W-shaped cusps specialized for insects, fish, frogs. (1)

Limbs

- Metacarpals are long compared to first phalanges
- Minimal independence for thumb and forefinger
- Limbs can move independently, many microbats are easy-moving on the ground (3)

Megachiroptera

Ears

- **External Ear**
- Ear canal
- Pinna is simple and closes to form a ring
- No tragus (4)
- **Middle Ear**
- Chamber filled with air (3)
- No Paaw's Cartilage
- **Inner Ear**
- Size of cochlea is relevant to size of bat
- No extra basal turn (4)
- Cochlea is not acoustically separated from skull (6)

Eyes

- Well developed
- Tapetum Lucidum is usually present
- Ganglion cells streak is above optic disk (3)
- Some species can detect UV light (1)
- Eyes open after birth

Teeth

- No signs of w-shaped cusp

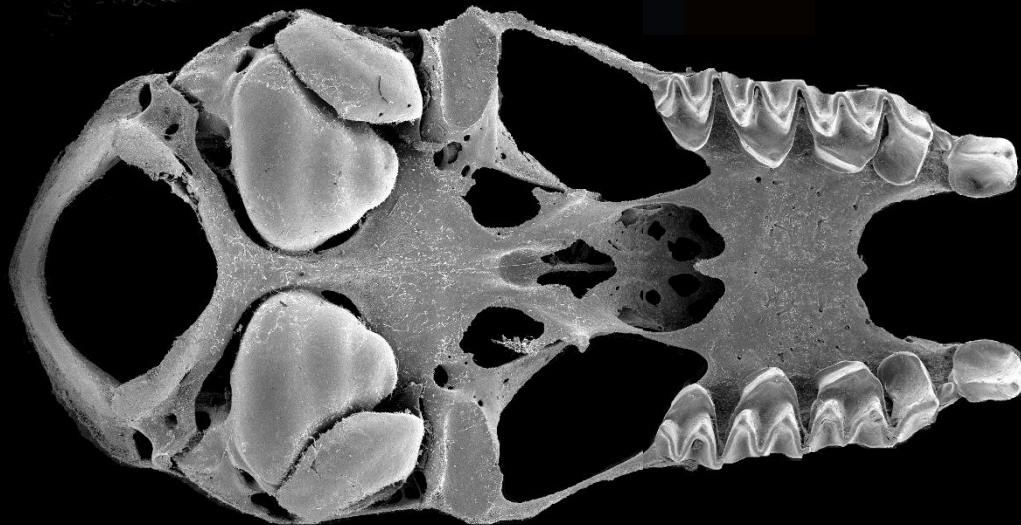
Limbs

- Metacarpals and phalanges are similar in length
- Opposable thumbs present
- Forefinger can move
- Forelimbs move together, so movement on the ground is sloppy (4)

Central Nervous System

- Pathway from eyes to brain is similar to Primates
- Low frequency sounds are mapped at the front of the auditory cortex
- Well-developed forebrain and cerebral cortex (4)

**Chiroptera: vysoce specialisovaná
vzdušná hmyzožravost**







Listonosi (Phyllostomidae)

Extrémní typy specialisací, nejpočetnější savci Jižní Ameriky



Listonosi (Phyllostomidae)

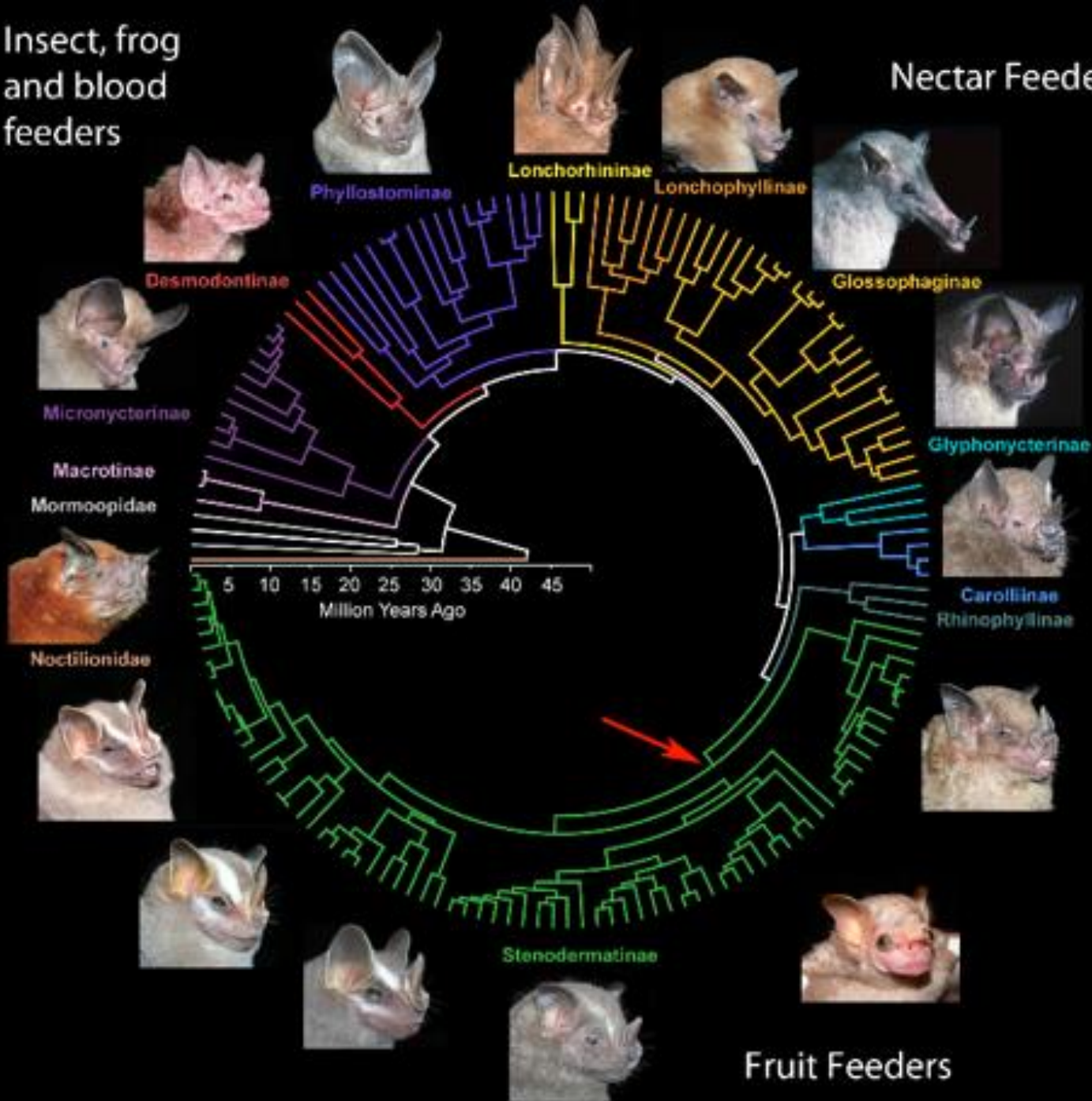
Rozsáhlé adaptivní přestavby lebečné morfologie



Listonosi (Phyllostomidae)

Insect, frog
and blood
feeders

Nectar Feeders



Potravní specializace

Hmyzožravost

Sanguivorie

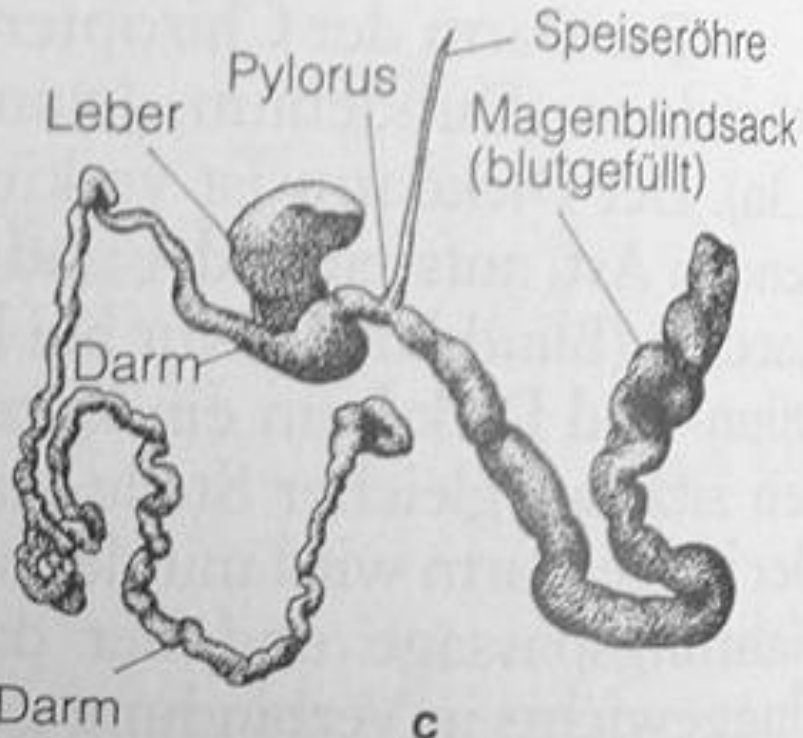
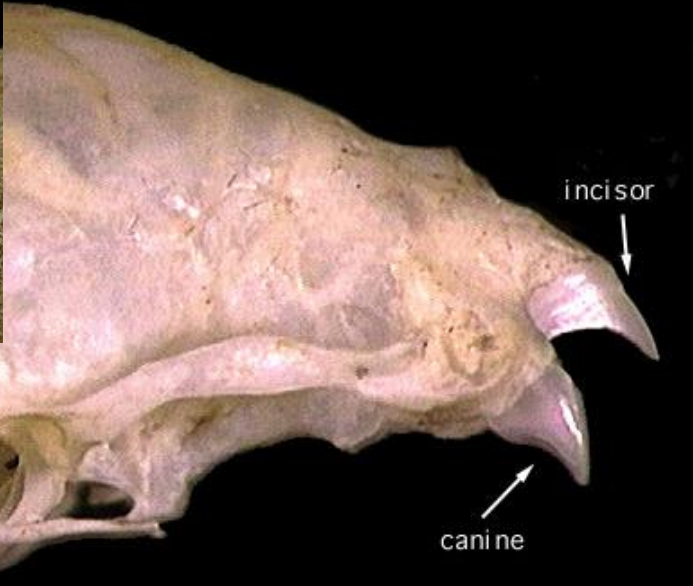


Macrophyllum macrophyllum



Desmodus rotundus

Listonosi (Phyllostomidae)



Listonosi (Phyllostomidae)

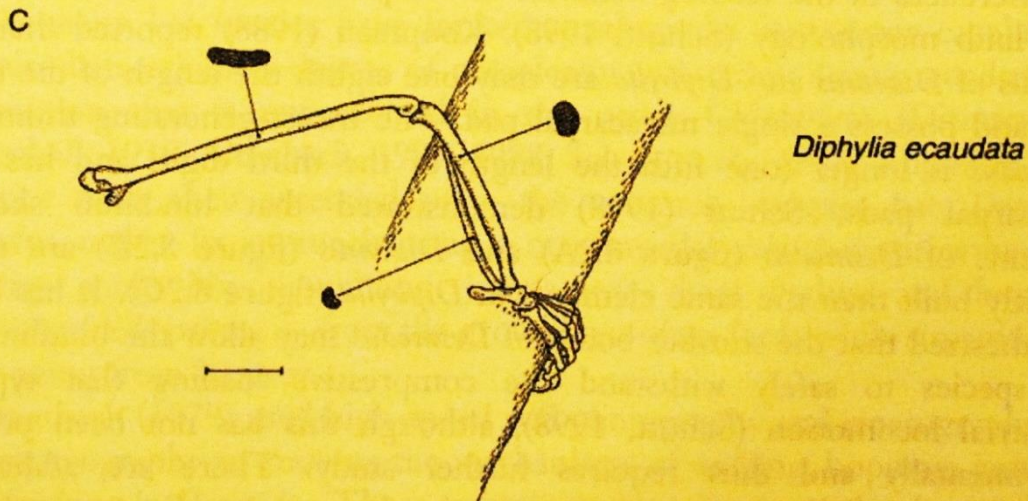
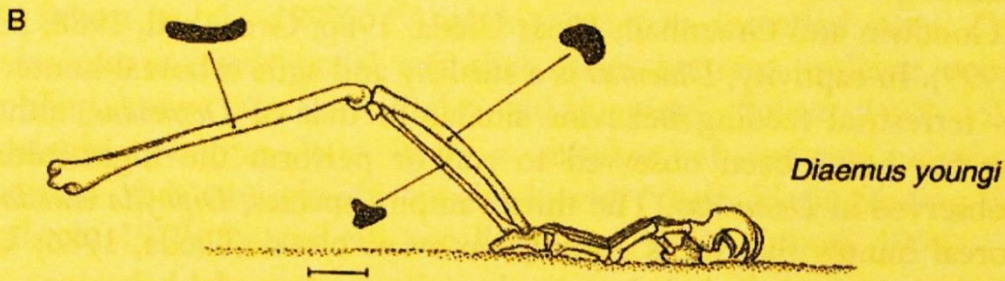
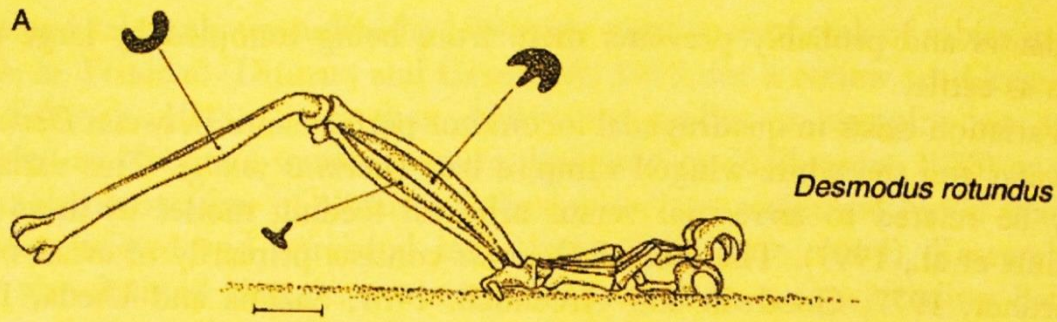


Figure 8.2 Hindlimb bones of (A) *Desmodus rotundus*, (B) *Diaemus youngi*, and (C) *Diphyllia ecaudata*. Dark shaded inserts represent cross-sectional views of the bone at the point indicated.



Potravní specializace

Frugivorie



© Dewynter

Ametrida centurio



Vampyroides caraccioli

Listonosi (Phyllostomidae)

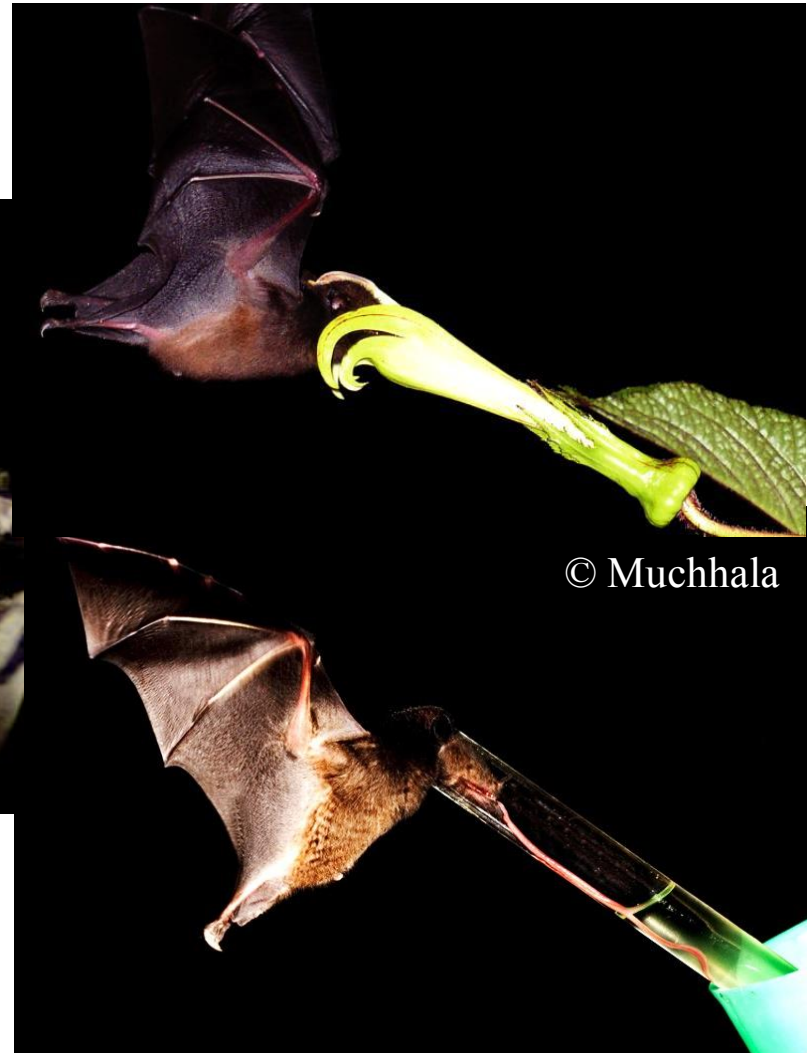
Potravní specializace

Karnivorie



Trachops cirrhosus

Nektarivorie



Anoura fistulata

Listonosi (Phyllostomidae)