



Mammalologie

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Petr Benda

Mammalologie?

- **Mammalogy**
- **Mammaliologie** (Mammalia-
- **Theriologie** -těriologija (therion- -logos):
Ognev 1928
- (Cabrera 1922: **Mastozoologie** - mastos *g*
=mamma *l*)

Historie mammalogie

- Přírodopisy - Histoire Naturelle
- Georges Buffon (1707-1788)
- Carl Linné (1707-1778): Systema Naturae X.ed. 1758: 86 spp. savců
- A. Blainville (1777-1850): zákl. klasifikace (Monotremata, Didelphida, Monodelphida)

Savci jako modelový taxon

- Georges Cuvier (1769-1832)
- Ernst Haeckel (cf. 1854)
- Charles Darwin (1809-1882)
- Alfred Russell Wallace (1823-1913)
- Weber M 1927,1928
- Cabrera A 1920, 1922
- Winge 1929
- GG.Simpson 1945

Savci: přirozená biodiversita soupisy faun a taxonomické přehledy

- Zvl. významné (sbírkově i jako ediční instituce)
- **BM (NH): katalogy sbírek a kurátorské soupisy**
- **AMNH a Smithsonian Institution N.Y.**
- Museum d Hist. Naturelle Paris
- Senckenberg Inst. Frankfurt a.M.
- ZIN St.Peterburg, MGU Moskva
- Zákl.soupisy:

Evropská / Palearktická fauna

- Blasius, první inventarisace a taxonomické přehledy, a rozvoj poznání v 19. stol.
- **Blasius** Johann Heinrich, Naturforscher, geb. 7. Okt. 1809 zu Eckerbach im Regierungsbezirk Köln, war Lehrer in Krefeld, erhielt 1836 die Professur für Naturgeschichte am Carolinum zu Braunschweig und ward auch Direktor des Naturhistorischen Museums und der Universität Braunschweig beschäftigt 1840-1841 machte er in Begleitung einiger anderer Naturforscher eine Reise durch das europäische Russland und berichtete darüber in einem besondern Werk (Braunschweig 1844, 2 Bände). Im J. 1866 ward er auch Direktor der Gemäldegalerie in Braunschweig und starb 27. Mai 1870. Er schrieb eine sehr geschätzte "Fauna der Wirbeltiere Deutschlands" (Braunschweig. 1857, Bd. 1: Säugetiere) und begann mit Graf Keyserling "Die Wirbeltiere Europas" (Bd. 1, das. 1840). Cf. Friedrich A.Kolenati (1812-1864)
- Miller G. S., 1912
- Ellerman & Morrison-Scott 1952
- 1960 - Verzeichniss
- Corbet G.B. 1978
- Corbet & JE Hill 1991, 1992:
- Harrison 1964 (Harrison & Bates 1992)

Rusko

- 1725 Akademia Nauk: expedice
- P.S. Pallas 1778: *Noveas species Quadrupedum e Glirium ordinae*
- S.G. Gmelin, A. Guldestedt, G.V. Steller
- F.F. Brandt 1855 *Materiali k poznaniu mlekopitajušich Rosii aj.*
- E.A. Eversmann, A.F. Middendorf, N.A. Sevcov, N.M. Przewalski
- S.I. Ognev 1886-1951: Zveri SSSR 1928-1950, A.P. Kuzjakin, Bobrinskij, Kuznecov, Naumov, Formosov, Nikiforov, Vinogradov, Gromov, Strelkov, Sokolov, Voroncov, atd.

Amerika

- John James Audubon (1785-1851): *The Viviparous Quadrupeds of North America*
- William Henry Flower and Rich. Lydekker: *Introduction to the Study of Mammals Living and Extinct* (1891) (750 pp.)
- Spencer Fullerton Baird (1823-1887): *General Report on Noth American Mammals* (1859: 730 spp.)
- C.Hart Merriam (1855-1942): *North American Fauna* (1899), 1. President ASM (1919)
- Joseph B. Grinnell (1877-1939): *niche*
- E.Raymond Hall (1902-1990): *The Mammals of NA*

Historie mammalogie: Střední Evropa

- Německo
- Polsko
- Uhry
- Čechy
- vs. Anglie, Francie, Nizozemí, Italie, Španělsko

Základní kompendia a učebnice (výběr)

- Anderson S. and J.K.Jones Jr., eds. *Orders and Families of Recent Mammals of the World*. New York: Wiley and Sons, 1984.
- Austen R. and R.V. Short, eds. *Reproduction in Mammals*. Vols. 1,2,3 and 4. Cambridge, UK: Cambridge University Press, 1985-1994.
- Chivers, R.E. and P. Lange. *The Digestive System in Mammals: Food, Form and Function*. New York: Cambridge University Press, 1994.
- Eisenberg, J.F. *The Mammalian Radiations, an Analysis of Trends in Evolution, Adaptation, and Behavior*. Chicago: University of Chicago Press, 1981.
- Feldhamer, G.A., L.C. Drickamer, A.H. Vesey and J.F. Merritt. *Mammalogy: Adaptations, Diversity, and Ecology*. Boston: McGraw Hill, 1999.
- Griffith, M. *The Biology of Monotremes*. New York: Academic Press, 1978.
- Kardong, K.V. *Vertebrates: Comparative Anatomy, Function, Evolution*. Dubuque, Iowa: William C. Brown Publishers, 1995.
- Kowalski, K. *Mammals: an Outline of Theriology*. Warsaw, Poland: PWN, 1976.
- Kunz, T.H., ed. *Ecology of Bats*. New York: Plenum Press, 1982.
- Lillegraven, J.A., Z. Kielan-Jaworska, and W.A. Clemens, eds. *Mesozoic Mammals: The First Two-Thirds of Mammalian History*. Berkeley: University of California Press, 1979.
- Macdonald, D., ed. *The Encyclopedia of Mammals*. New York: Facts on File Publications, 1984. 2005.
- Neuweiler, G. *Biologie der Fleidermäuse*. Stuttgart-New York: Georg Thieme Verlag, 1995.
- Nowak, R.M. and J.W. Walker, Jr. *Mammals of the World*. 5th ed. Baltimore and London: Johns Hopkins University Press, 1991.
- Pivetau, J. *Le Traité de paléontologie, Tome VII: Mammifères*. Paris: Masson et Cie, 1910.
- Pough, F.H., J.B. Janis and W.N. McFarland. *Vertebrate Life*. 4th ed. London: Prentice Hall Int., 1996.
- Ridgway, S.H. and R. Harrison, eds. *Handbook of Marine Mammals*. New York: Academic Press, 1985.
- Savage, R.J. G. and M. R. Long. *Mammal Evolution: an Illustrated Guide*. New York: Facts on File Publications, 1986.
- Starck, D. *Lehrbuch der Speziellen Zoologie Band II: Wirbeltiere*. 3. Teil: *Säugetiere*. Jena-Stuttgart: New York: Gustav Fischer Verlag, 1995.
- Schaff, J. M., M. Nowak and M. C.M. McKenna, eds. *Mammalian Phylogeny*. New York: Springer-Verlag, 1992.
- Thewissen, J. *Phylogenie der Mammalia: Summengeschichte der Säugetiere (Einschließlich der Homindidae)*. Berlin: Walter de Gruyter and Co, 1969.
- Vaughan, T.A., J. M. Johnson, and N. Crapkovská. *Mammalogy*. 4th ed. Belmont, CA: Brooks Cole, 1999.
- Wilson, D.E. and D.M. Reeder, eds. *Mammal Species of the World: a Taxonomic and Geographic Reference*. 3rd ed. Washington, D.C.: Smithsonian Institution Press, 1993.
- Nowak, R.M. *Walker's Mammals of the World*. 5th ed. Baltimore and London: Johns Hopkins University Press, 1991.
- McKenna MC, S.K. Bell 1998: Classification of Mammals Above Species Level. Columbia Univ. Press. NY

Autoritativní seznamy taxonů světové fauny

Specialisovaná mammalogická periodika (výběr)

- Journal of Mammalogy , Mammalian Species
- Mammalia
- Mammalian Biology (Z.f.Saugetierkunde)
- Acta Theriologica
- Mammal Review
- Lutra
- Hystrix
- Lynx
- Saugetierkundliche Mitteilungen
- Bat Res.News, Myotis, Nyctalus, Rhinolophus, Megaderma, Plecotus
- Acta Chiropterologica
- Folia Primatologica etc.

Výběr WWW stránek

- Obecné charakteristiky: www.ucmp.berkeley.edu/mammal.html
- University of Michigan Museum of Zoology. Animal Diversity Web. <<http://animaldiversity.ummz.umich.edu>>
- Animal Info —Information on Rare, Threatened and Endangered Mammals. <<http://www.animalinfo.org>>
- BIOSIS. <<http://www.biosis.org.uk>>
- Links of Interest in Mammalogy. <<http://www.il-st-acad.sci.org/mamalink.html>>
- The American Society of Mammalogists. <<http://www.mammalsociety.org>>
- Smithsonian National Museum of Natural History. <<http://www.nmnh.si.edu/vert/mammals>>
- World Wildlife Fund. <http://www.worldwildlife.org>
- [/www.ivanhoracek.com/](http://www.ivanhoracek.com/)



Savci - Mammalia

4600 spp. 1300 gen, 135 fam, 25 ordo



Vymezení taxonu

- Výčtem
- Rozdílem (diagnosou)
- Společným předkem
- Eidologicky:

Taxonomická diversita



Mammalia

• **Prototheria:** Monotremata

1 o., 2f., 3g., 3 spp. (Au-NG)

• **Theria**

– Metatheria (Marsupialia)

7 o., 16f., 78 g., 280 spp. (Au-W, SAM-NAm)

– Eutheria (Placentalia)

17 o., 117f., 1220 g., 4300 spp.

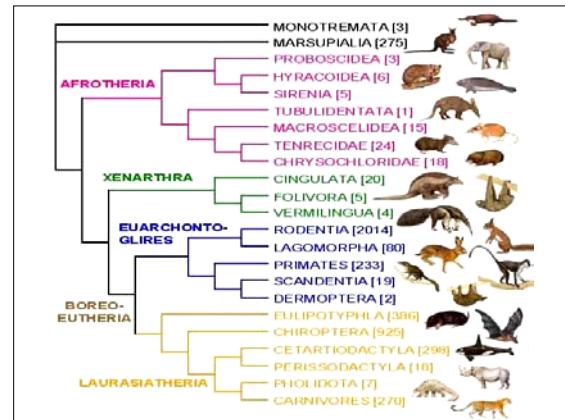
Největší řády:

- Rodentia 29 f, 426 gg, 1820 spp.
- Chiroptera 1000 spp.
- „Insectivora“ 400 spp.
- Cetartiodactyla (Artio- 180 spp., Cet. 80 spp.)
- Carnivora 270 spp.
- Primates 200 spp.
- Diprotodontia 200 spp.,
etc. ale
- 8 řádů méně než 10 spp.
- 4 řády monotypické

Nomenklatorická všuvka

- **Theria** Parker et Haswell 1897 =
- Gill 1872: Eutheria = **Marsupialia** Illinger, 1811 + **Placentalia** Owen, 1837
- Huxley 1880: **Eutheria** = Placentalia (Owen 1837) nec Metatheria (=Marsupialia) nec Prototheria (Monotremata)

Nejednotné označování vysokých taxonů -



Placentalia (*up to date*)

- **Xenarthra:** Edentata
- **Afroteria:** Tenrecoidea, Chyroschloroidea, Tubulidentata, Macroscelidea, Hyracoidea, Proboscidea, Sirenia
- **Glires:** Rodentia, Lagomorpha
- **Euarchonta:** Scandentia, Dermoptera, Primates
- **Laurasitheria:** Eulipotyphla, Pholidota, Carnivora, Cetartiodactyla, Perissodactyla, Chiroptera

Marsupialia (*up to date*)

- **Ameridelphia**
 - Didelphomorphia vačice 1f, 15g, 63 spp, S-N Am
 - Paucituberculata vačici 1f, 3g, 5 sp. S Am
- **Australidelphia** (Au)
 - Microbiotheria kolokolo 1f, 1g, 1sp. (S Am !)
 - Noryctemorphia vakokrti 1f, 1g, 1sp (vakokrt)
 - Dasyuromorpha kunovci
 - Myrmecobiidae - mravencojed, 1g, 1sp.
 - Dasyuridae - kunovci 15g, 61 sp. (vakoplši, vakomyši, d'ábel medvědovitý, +vakovlk)
 - Peramelemorphia - bandikuti Au-NG 2f, 7g, 19 sp.
 - Diprotodontia – Au 200 sp.

Savci - vrchol přirozené rozmanitosti?



- **Mammalia:**
- **4 600 spp., 1300 gg., 135 fam. 25 rec. Řádů**

- Aves 9 500 spp.
- Lepidosauria 6 000 spp.
- Anura 5 000 spp.
- Teleostomi 35 000 spp.
- Mollusca 100 000 spp.
- Insecta 6 000 000 spp.

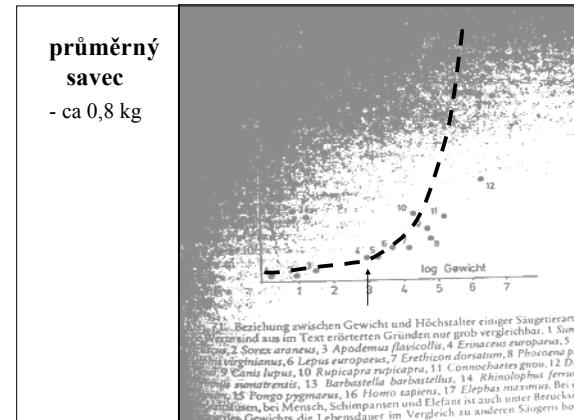
Ale:

- Tělesná velikost:

- *Suncus etruscus, Craseonycteris thonglongai, Microsorex hoyi* - 1,5-2 g, LC 3 cm
 - *Loxodonta africana* 6 tun (+*Baluchitherium* 18 tun), *Balaenoptera musculus* 30m, 180 tun
tj. min-max = **10⁹**
 - Srv. Aves, Reptilia - 10⁵
Amphibia, Insecta - 10⁴ etc.
- Dinosauria, Elasmobranchii - velké formy, K- strategové - ale chybí malé formy
- Savčí extremy - scaling /metabol.-organ.efektivity, (de)terminace růstu

průměrný savec

- ca 0,8 kg



Savci - Mammalia

4600 spp. 1300 gen, 135 fam, 25 ordo

Homeotermní Synapsida, srst, mléko, Placentární viviparie (partim), zuby, sekundární patro, smysly, mozek etc.

CO JE SAVEC?

Savci jako vývojová jednotka „therion“ vs. „mammal“

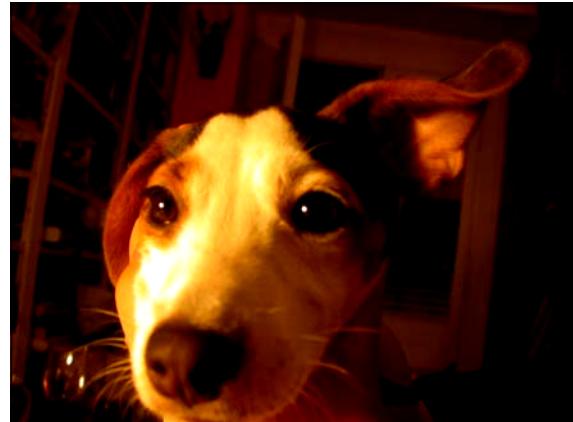
Rozlišení snadné a explicitní - elementární součást první orientace ve světě

Ale: jaká diskriminační kriteria fakticky užíváme?



Máme rádi zvířata, protože jsou chlupatá, mají hebkou srst ...

- **Srst** - endotermie, homeotermie
- **Versatilní kvadrupedie** - specifický postoj končetin - zásadní rozdíl od plazů: důsledky - přestavba biomechaniky tělního pohybu (apendikulárního i axiálního), přestavby pletenců, axiálního skeletu atd.: ale i dýchání atd.
- **Obličej**: oči, uši, nos, tváře, rty, vibrísy etc.



Vědecké vymezení taxonu: znaky

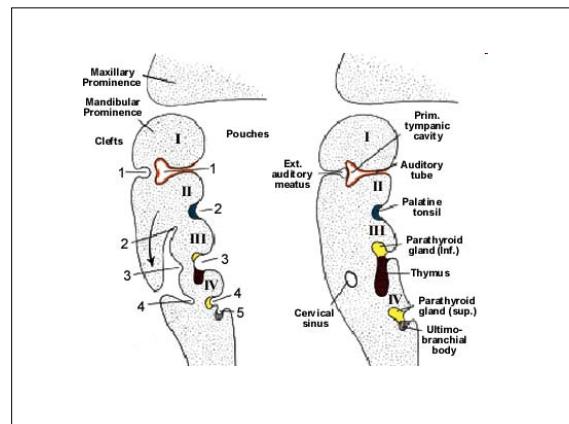
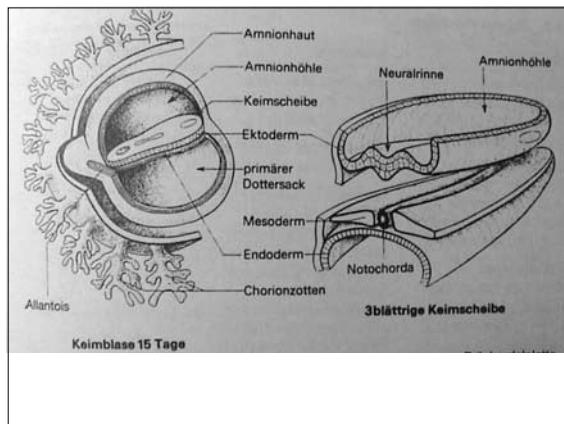
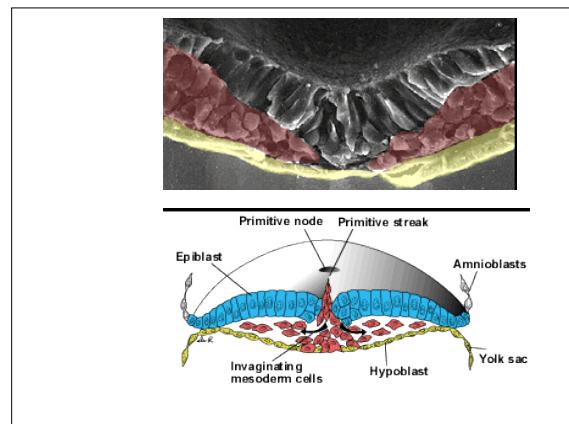
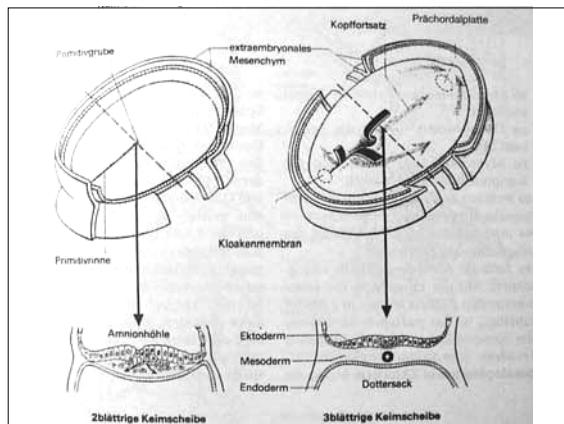
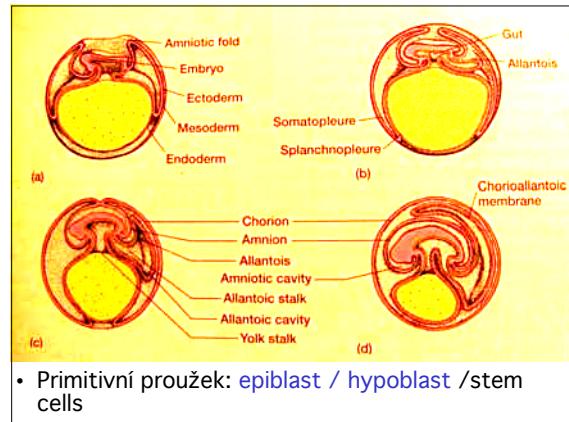
- **Plesiomorfie:** symplesiomorfie - Craniata, Tetrapoda (Sarcopterygii), Amniota
- **Apomorfie:** Synapomorfie vs. Autapomorfie
- Homoplasie: zejm. s Aves resp. Archosauria s.l.: endotermie, vysoká aktivita, extrémní BMR, smyslová výkonost etc.
- **Autapomorfie** – unikátní znaky taxonu (evol.novinky): vymezují taxon

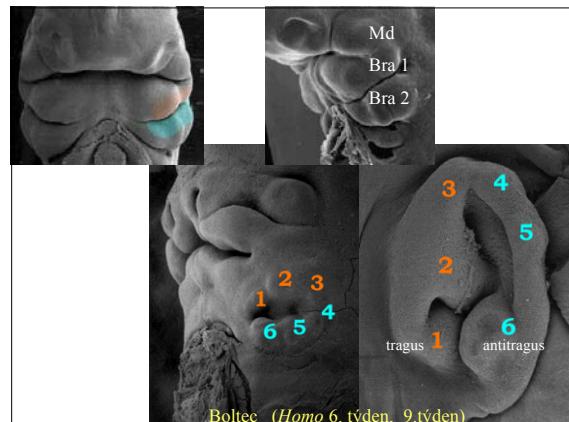
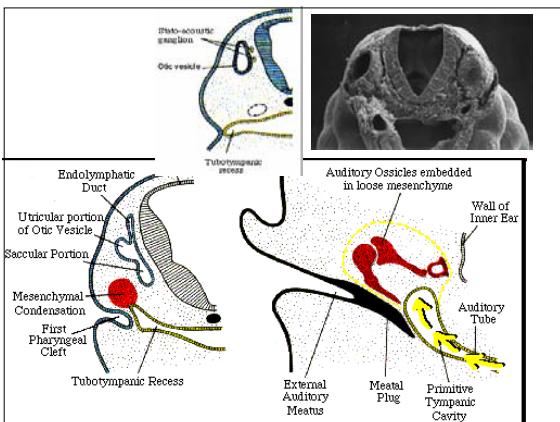
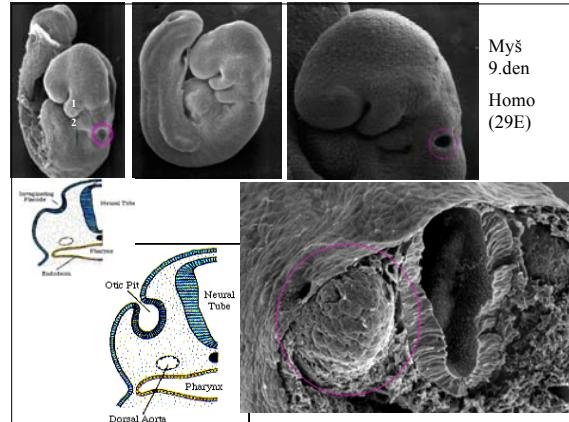
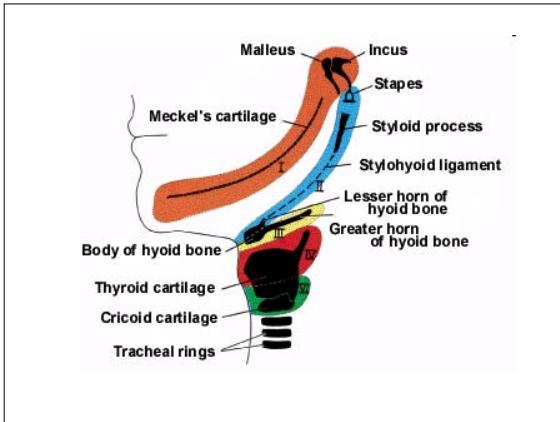
Symplesiomorfie Vertebrata

- Tělní plán : bilaterální souměrnost, tagmatisace: hlava, trup, ocas), pevná vnitřní kostra centralisovaná dorsální chordou, , metamerní segmentace (mesodermální struktury) - homeobox, absence exprese hox v hlavové (preotické) oblasti, humorální regulace (hypofýza etc.), endokrinní a lymfoidní orgány z base žab. Štěrbiny (thyreoidea, thymus etc.)
- neurální lišta, mineralisované tkáně různého typu, kůže
- Gnathostomata: čelisti, párové končetiny, septum horizontale etc.,

Synapomorfie Amniota (např.):

- Plodové obaly (amnion, chorion, allantois).
- specifické modifikace časné embryogenese - primitivní proužek - komplexní organizační uzel
- parental investment, internal fertilisation,
- keratinized skin derivates,
- Metanephros a ureter, not homologous with nephritic duct of non-amniotic vertebrates,
- advanced type of lung respiration (indirect),
- Zásadní role dermálních kostí v lebečné morfogenesi





poučení

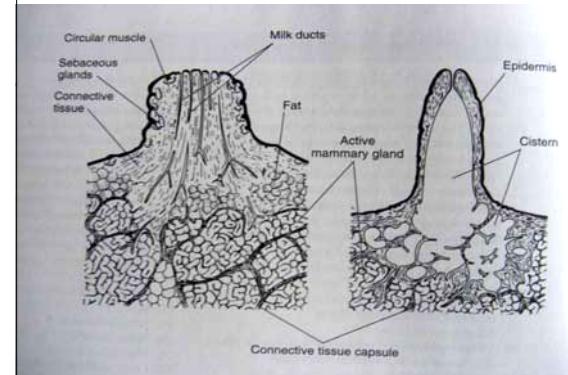
- Zásadní přestavby a taxonově specifické modifikace se ustavují v časné embryogenesi
- Embryologická data mají ve srovnávacím studiu zásadní význam

**Autapomorfie
Mammalia**
(zejm. rozdíly od plazů)

Reprodukce

- (1) Nourishing youngs with milk produced by
- (2) mammary glands, appearing in all females mammals, the structure by which the class Mammalia got its name. (3) obligatory vivipary (in Theria, i.e. marsupials and placentals) with a greatly specialized organ interconnecting the embryo and mother tissues, the *chorioallantoic placenta* (in Eutheria, i.e. placentals).

Eutheria – mléčné bradavky (obě pohlaví) → struky



Mléčné žlázy a jejich vyústění – vždy párové, ale

Umístění, typ a počet taxonově specifické:

- Abdominální EUL, ROD, CAR, PHO, ARTpart
- Abdominálně pectorální HYR
- Pectorální – PRI, CHI, DER, PRO, SIR,
- Inguinální – PER, CET, ART,

Složení mléka

	Water	Protein	Fat	Sugar	Ash
<i>Afroteroplati</i>					
Kangaroo (wallaby)	73.5	9.7	8.4	3.1	1.1
<i>Pinnipedi</i>					
Rhesus Monkey	88.4	2.2	1.1	6.4	0.2
Chimpanzee	88.3	1.1	1.1	6.1	0.2
Human	88.0	1.2	3.8	6.0	0.2
<i>Edentata</i>					
Giant anteater	65.0	11.0	2.0	14.8	0.8
<i>Lagomorpha</i>					
Rabbit	71.1	12.4	1.1	1.9	2.4
<i>Rodentia</i>					
Guinea pig	81.9	7.4	7.2	2.7	0.8
Rat	73.9	9.2	12.6	3.1	1.3
<i>Carnivores</i>					
Cat	81.6	10.1	6.3	4.4	0.7
Dog	76.1	10.1	7.5	4.0	1.1
European red fox	81.6	6.6	5.5	4.9	0.9
<i>Pinnipedi</i>					
California sea lion	47.1	11.5	15	0	0.1
Harp seal	41.8	11.9	42.8	0	0.9
Hooded seal	49.9	6.7	41.4	0	0.9
<i>Cetaceans</i>					
Bottle-nosed dolphin	44.9	10.6	14.9	11.9	0.5
Blue whale	47.2	12.8	38.1	0	1.4
Fin whale	54.1	11.3	39.6	0	1.4
<i>Ungulates</i>					
Indian elephant	70.7	3.6	17.6	5.6	0.6
Zebra	86.2	3.4	4.8	5.1	0.7
Black rhinoceros	1.5	0.3	6.5	0.3	
Colored peccary	5.8	1.5	6.5	0.6	
Hippopotamus	90.4	0.7	4.3	4.4	0.1
Giraffe	87.2	3.5	3.4	4.4	0.7
White-tailed deer	65.9	10.4	19.7	2.6	1.4
Reindeer	64.8	10.2	20.1	2.5	1.4

	Average Number of Days Needed to Double Birth Weight	Protein Content of Milk (g/1000)
Human	180	12
Sheep	60	26
Cow	47	33
Goat	18	37
Lamb	10	51
Dog	8	93
Cat	9	101
Porcupine	6	123
Harpy seal	5	119

Evoluce savčí reprodukce

(Blackburn et al. 1989. Renfree 1993)

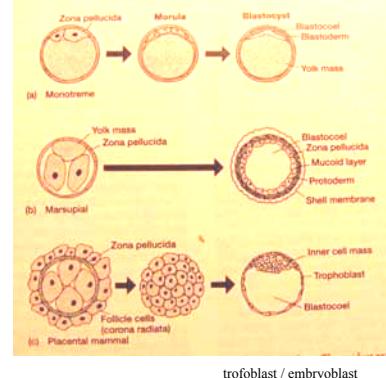
- Mléčné žlázy - potní a apokrinní : antimikrobiální sekret
- Koncentrace antimikrobiální sekrece v inkubačním vaku
- Požívání antimikrobiálního sekretu vylíhlými mláďaty zvyšuje jejich fitness (cf. též role IgA - imunisace , ochrana faryngeálních sliznic)
- Hypertrofie příslušných žláz a selekce sacího-lízacího reflexu

• Prototheria (Monotremata)
• Metatheria (Marsupialia)
• Eutheria (Placentalia)

Základní di(divergence) reprodukčních strategií - nejzřetelnější znaky v morfologii a fysiologii reprodukčního systému, obsahu žloutku a heterochroniích nejčasnější embryogenese

• Rýhování, vznik blastocysty

- Discoidální u Prototheria
- Totální u Eutheria



• Diferenciace blastocysty „gastrulace“

Trofoblast
Embryoblast
Gastrocoel-sekundární žloutkový váček
Extraembryonální epitely

The diagram illustrates the transition from a discoid blastoderm to a bilaminar embryoblast and endoderm, and finally to a trilaminar gastrula with a central gastrocoel.

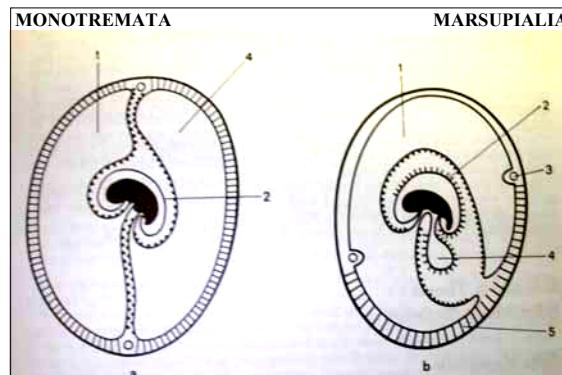


Abb. 168. Fetalmembran („Eihäute“) bei Monotremen und Marsupialia. a) *Tachyglossus* (Monotremata), b) *Didelphis* (Marsupialia).

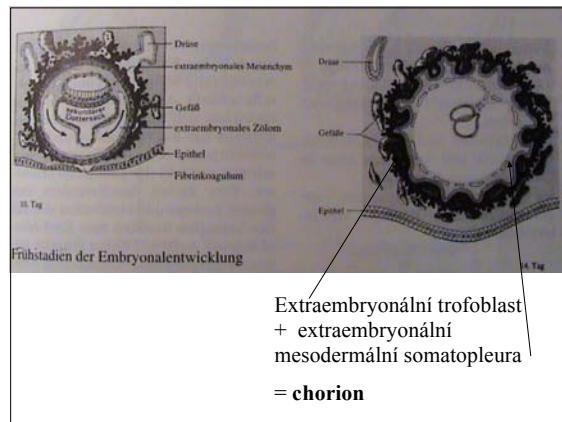
Furchung und Entstehung der Keimblase

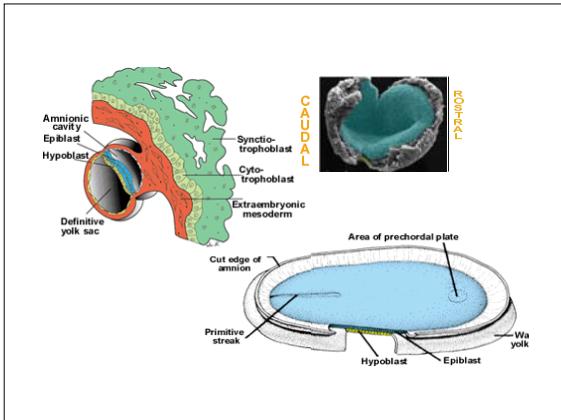
2-Zellenstadium 38 Stunden
4-Zellenstadium 40-50 Stunden
8-Zellenstadium 48 Stunden
Morula 3-4 Tage
Blastozyste 4-Stage

Einnistung der Keimblase

5. Tag: Drüsen, Kapillare, Epithel, Syncytiotrophoblast, Zytotrophoblast, Amnionhöhle, Endoderm, Endothel, Hesler-Membran, Blasenzytosphäre.
7. Tag: Ektoderm, Endoderm.
8. Tag: Blastozystenhöhle.

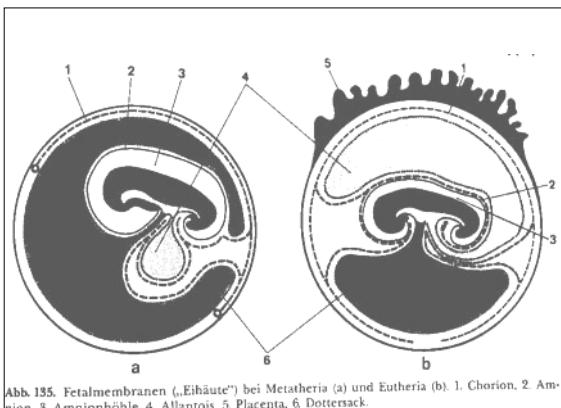
Blastocysta: trofoblast (-placenta) / embryoblast (embryo)
Eutheria: entypie embryoblastu (-růstová emancipace trofoblastu)





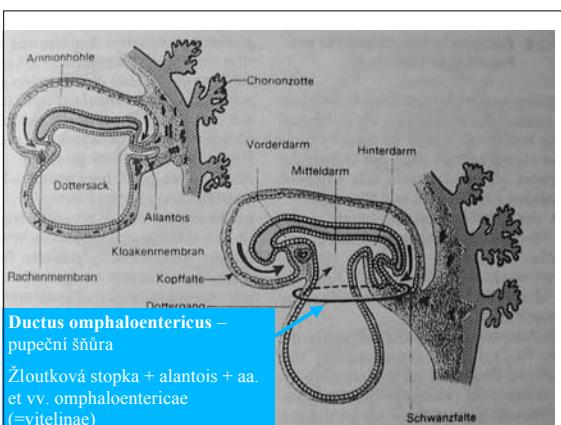
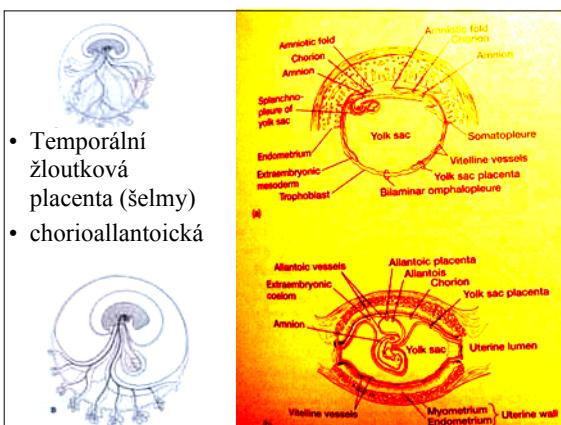
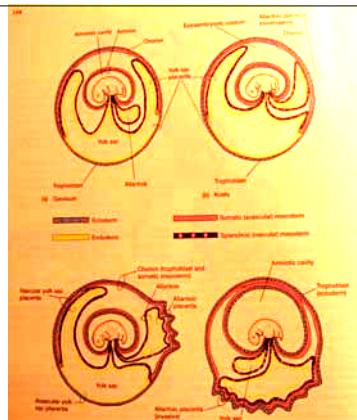
Nidace (implantace)

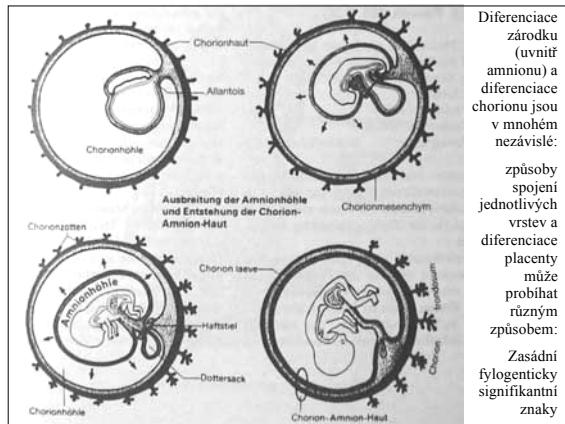
- Pozdní („*Bradytrophica*“ – Štěrba): zvětšování blastocysty, diferenciace trofoblastu (embryotrofě) – volná blastocysta, implantace zárodečným terčem, centrální posice v děloze, připojení k endometriu později : CETART, PER, CAR, PHO, AFROTH, SCA
- Zrychlená („*Tachysynaptica*“) – velmi rychle spojení diferenciace trofoblastu rychlejší než dif. Endometria CHI, DER, MAC, XEN, PRI, ROD
- Opožděná implantace – adaptivní prodloužení stádia volné blastocysty (některí CHI, srna, medvěd ...) ← regulace stavem endometria ← kontrola LTH (luteofrén H adenohypfyzy)



• Placenta

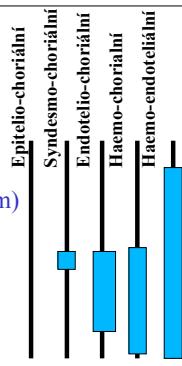
- Choriovitelliní*
- Vačice,
- Koala
- chorioallanoická*
- Bandikut
- Eutheria



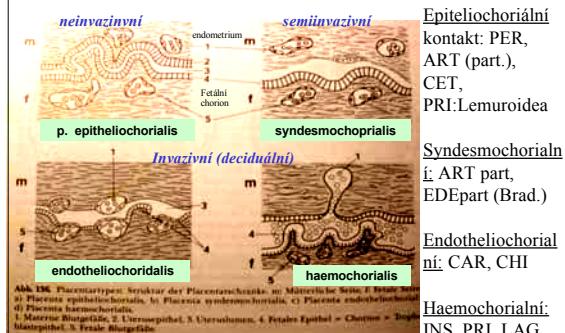


Placentární bariera

- | | | |
|------------|----------|--|
| Pars | Foetalis | • endotel cév choria |
| | | • Mesenchym chorionu (extraembryonální mesoderm) |
| | | • Povrchový epitel choria |
| Maternalis | | • Epitel endometria |
| | | • Vazivo děložní sliznice (mesenchym/mesoderm) |
| | | • Endotel cév matky |



Typy placenty: typ rozhraní



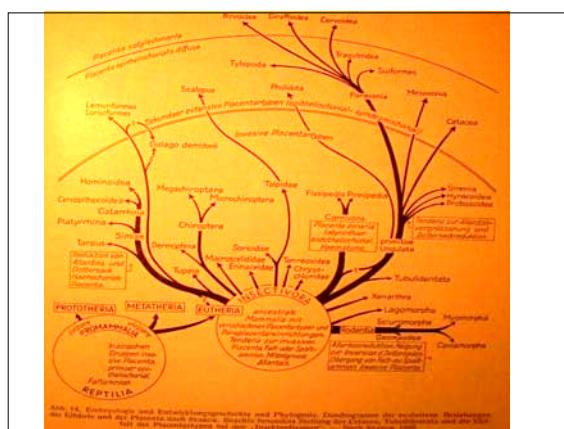
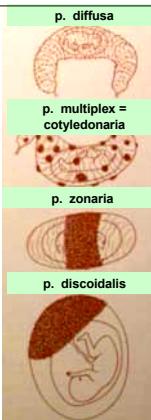
Typy placenty:

p. diffusa: ART: Suidae, Hippopotamidae, Tragulidae, Tylopoda, PER, CET, PHO, PRI: Lemuroidea

p. multiplex: XEN, ART
(pf.: *Capreolus* 5 placentomů ... *Bos* 40-120, *Giraffa* 180)

p. discoidalis: INS, CHI, PRI, ROD

p. zonaria: CAR (partim Ursidae, Mustelidae, Viv.), HYR



Fylogenetický význam embryogenetických znaků

- V minulosti chápány jako zásadní zdroj fylogenetické informace ale
- *Blastocysta a diferenciace trofoblastu / *růstová dynamika zárodku / *heterochronie růstu extraembryonálních epitelů / *sekreční vs. růstová skvělost endometria / *interakce endometria a trofoblastu/ *tvarový- a / *funkční design placentárního rozhraní ← víceméně nezávislé komponenty složitého komplexu reprodukčních adaptací → každá z nich je charakterisová specifickým rozvrhem taxonových / fylogenetických omezení a současně funkčními vazbami s jinými složkami komplexu

Každá z nich může být potenciálně modifikována a využita jako centrální položka či doplněk adaptivní reakce na velmi silný tlak ekologických souvislostí reprodukce

→Heterochronie Až velmi specifické úpravy (polyembryonie pásovců apod.)

Analogicky i v dalších krocích embryogenese..

- Pro savce obecně charakteristická: Časná diferenciace smyslových orgánů, zubních základů a specifických integumentárních derivátů

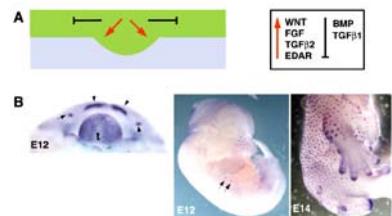
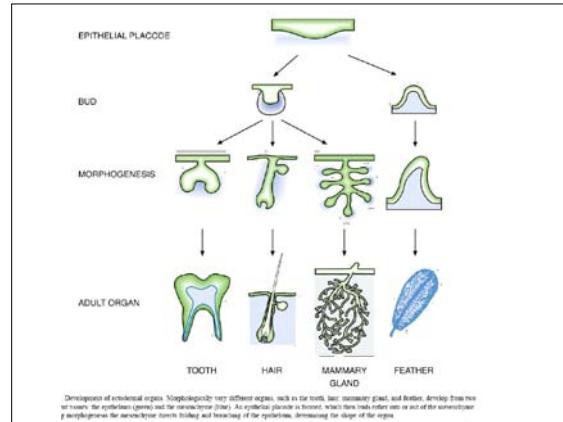
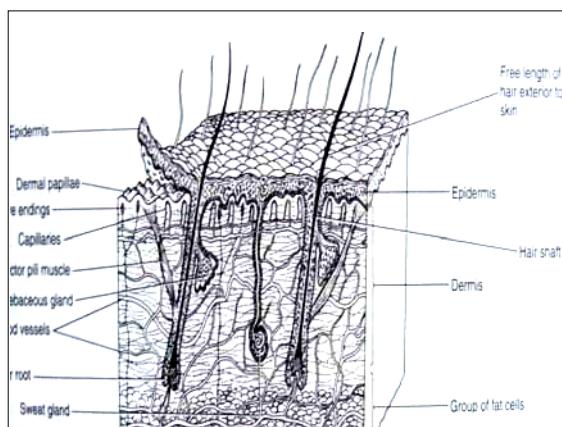


Fig. 2. Placodes as signaling centers. (A) Signaling at the hair and feather placode. Positive signaling (activation, red) promotes placode development whereas negative signaling (inhibition, black) represses it. The activity of the substances is believed to be prevented inside the developing placode, whereas they can diffuse outside the placode to mediate lateral inhibition. (B) Placodes can be visualized with whole mount *in situ* hybridization detecting the restricting expression of many signaling molecules. Molar (arrows) and incisor (arrowheads) tooth placodes express *Sih* (E12 mouse mandible; t. tropon). Vimentin and mammary gland placodes (arrows) are positive for *Edar* mRNA (E12 mouse embryo). Hair placodes express *Patched* (E14 mouse embryo; expression can also be seen at until 16 days).

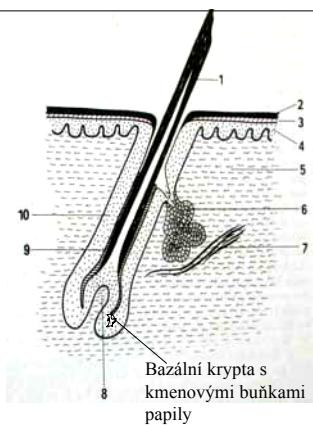
Integument

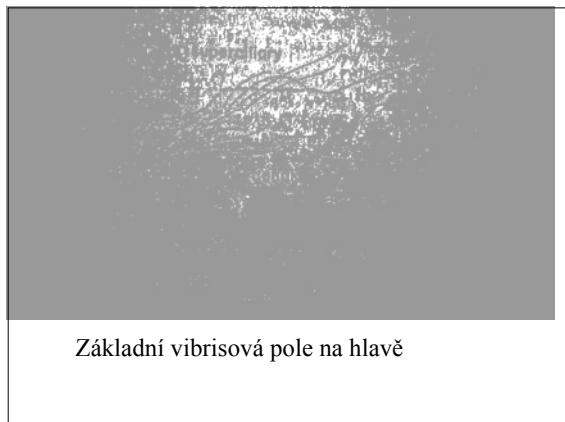
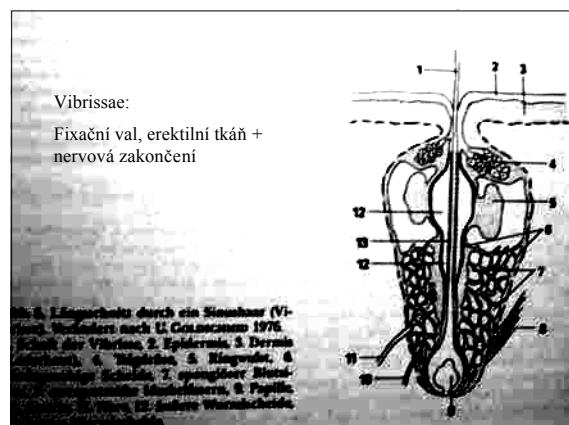
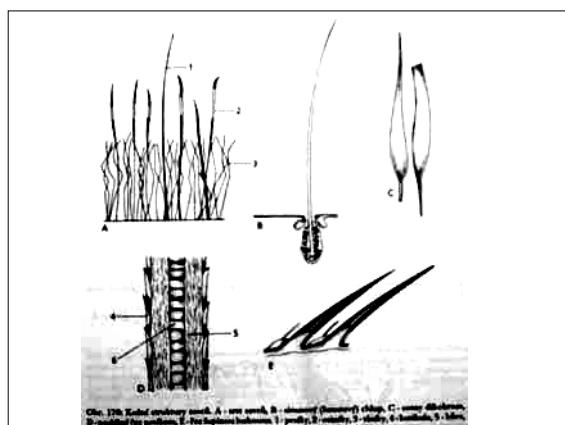
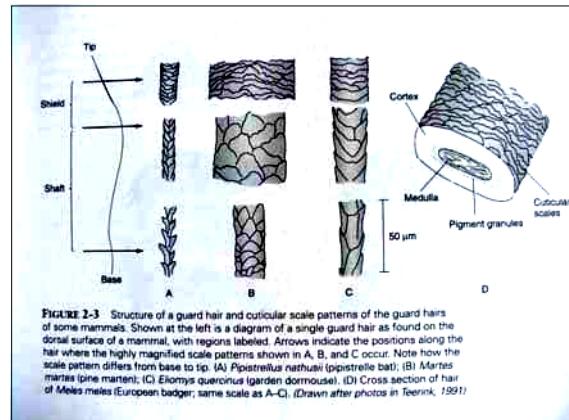
- (4) *Hairs*, covering the body, which grow from deep invaginations of the germinal layer of epidermis called *follicles*. The hair is composed of keratin and pigments, similarly as in other amniotes but its structure is unique for mammals.
- (5) *Skin is rich in various glands*. Most mammals have sweat glands (attributing to water balance and cooling body surface), scent glands and sebaceous glands.



Chlupy a chlupový folikul

- 2- stratum corneum
- 3- stratum granulosum
- 4- epidermis: stratum germinativum
- 5 - dermis
- 6 - mazová žláza
- 7 - musc.erector pili
- 8 - chlupová papila
- 9 - vnitřní kořenová pochva
- 10 - vnější pochva folikulu

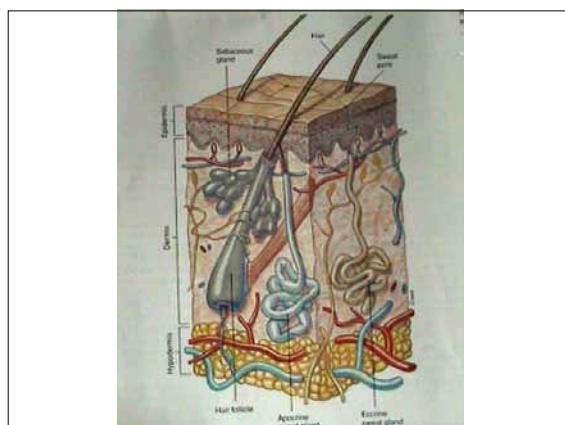
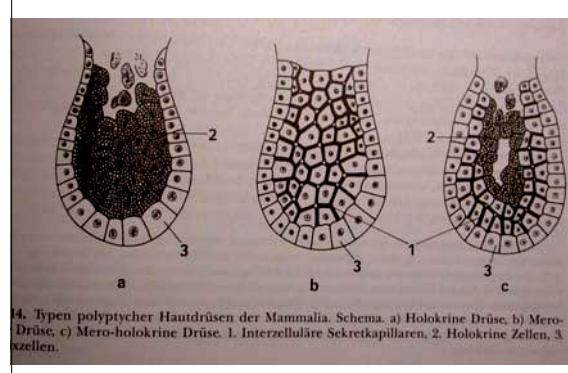






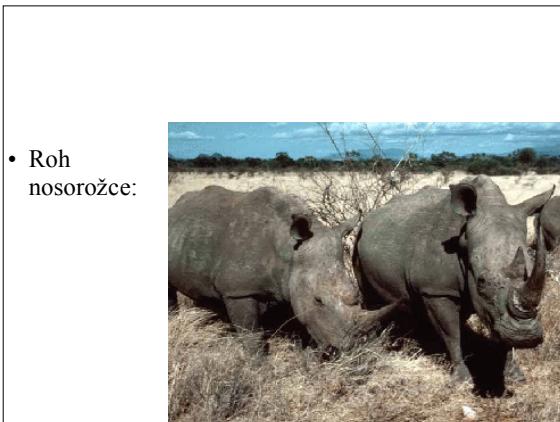
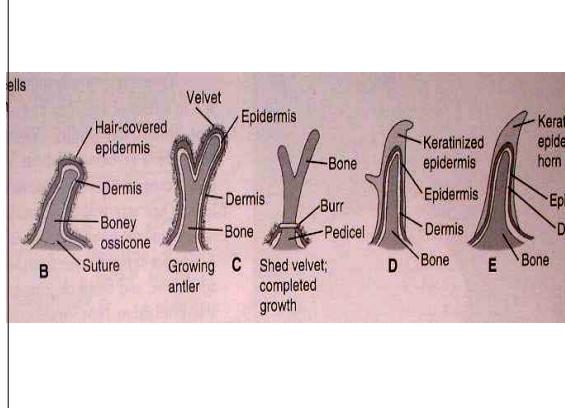
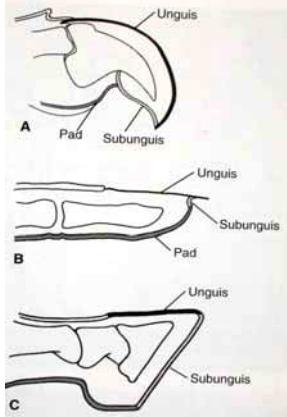
Žlázy

- Monoptychní - jednoduché, tubulosní a tubulosně alveolární : e-žlázy ekrinní (potní), a-žlázy - apokrinní sekrece (pachové, mléčné) odvozeny z chlupového základu (papily)
- Polyptychní, alveolární, často holokrinní sekrece (někdy ekrinní):
 - Holokrinní mazové (lipidy), též s pachovými efekty
 - Merokrinní (hepatroidní žlázy), sekreční kapiláry - analní žlázy Carnivora
 - Mero-holokrinní : fialka lišky, předočnicové žlázy Bovidae



- (6) The specific integumental derivatives, characteristic of particular groups of mammals, build either exclusively of keratine (such as claws, nails, and hoofs which protect the terminal phalanx of the digits and adapt them to a specific way of locomotion or foraging) or in combination with dermal bone structures (horns of bovid and antlers of cervid artiodactyls which play a considerable role in social signalling). A large variety of integumental derivatives is included in defending adaptations: dermal armours of armadillos or keratinised scales of pangolins, spines modified from hairs in echidna, hedgehogs, tenrecs, porcupines or in the spiny mice or the accumulations of hair-like fibers keratinised into a horn structure in rhinoceroses.

Integument:
Drápy
Nehy
Kopyta



Konstrukce těla a biomechanika

- (7) *Limb position and function* are modified to support specific locomotory modes of mammals like jumping, galloping or sustained running and/or are specifically rearranged. The extreme rearrangements are in bats which fly using fore-limb wing and in specialized marine mammals, pinnipedian carnivores, cetacean and sirenian, whose fore-limbs attain the shape of a fin while the external hind limbs are absent in the latter two groups.

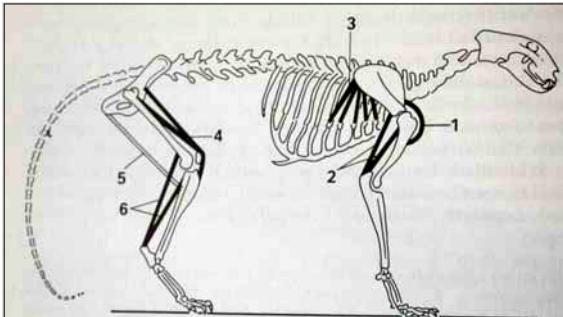


Abb. 22. Skelet eines quadrupeden Säugers (*Panthera tigris*). Aufhäng M. serratus lat. Einige wichtige Muskeln für Pro- und Retroversion d. 1. M. deltoideus, 2. M. triceps brachii, 3. M. serratus lat., 4. M. quadriceps, 5. M. triceps surae (= gastrocnemius). Nach B. KÜMMER 195

- (8) *Pectoral girdle is simplified* in comparison to the non-mammalian state: coracoid, precoracoid and interclavicle bones are lost (except for monotremes which retain them) or partly included in scapula. Also clavicle, the last skeletal element that fix the limb to axial and thoracic skeleton, is lost in many groups. With these rearrangements, the fore-limbs get new locomotory qualities (such as extensive protraction) supporting among other climbing and fine autopodial movements providing a new spectrum of manipulative functions from cleaning hair to a variety of a prey manipulations.

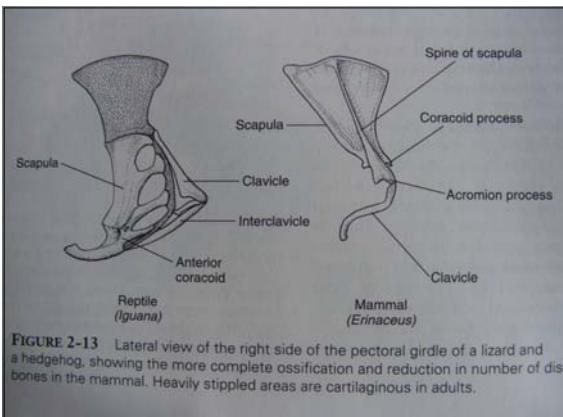


FIGURE 2-13 Lateral view of the right side of the pectoral girdle of a lizard and a hedgehog, showing the more complete ossification and reduction in number of disbones in the mammal. Heavily stippled areas are cartilaginous in adults.

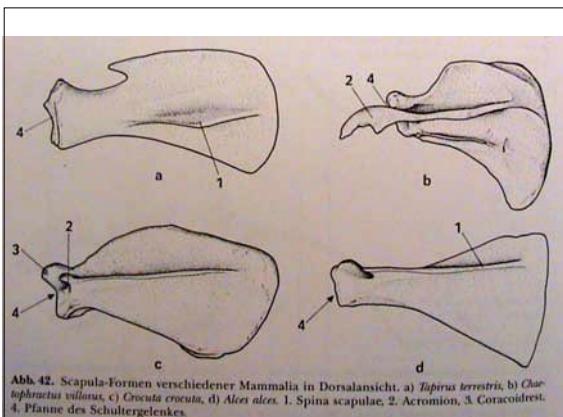
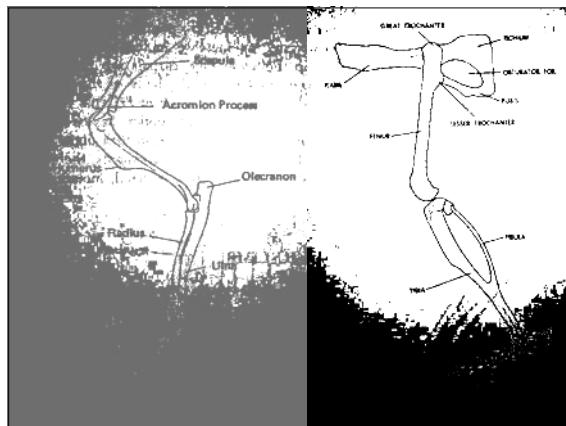


Abb. 42. Scapula-Formen verschiedener Mammalia in Dorsalsicht. a) *Tapirus terrestris*, b) *Chacotherium villosum*, c) *Crocuta crocuta*, d) *Alces alces*. 1. Spina scapulae, 2. Acromion, 3. Coracoidfrest, 4. Pfanne des Schultergelenkes.

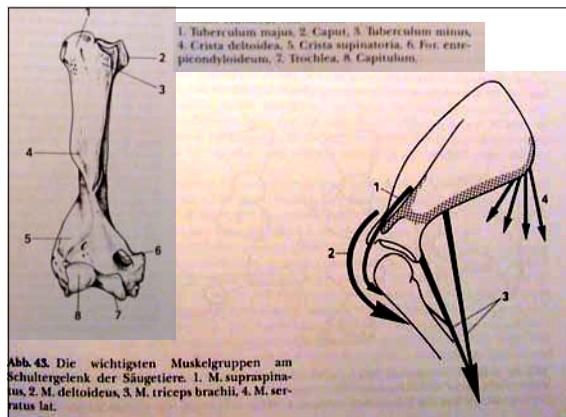
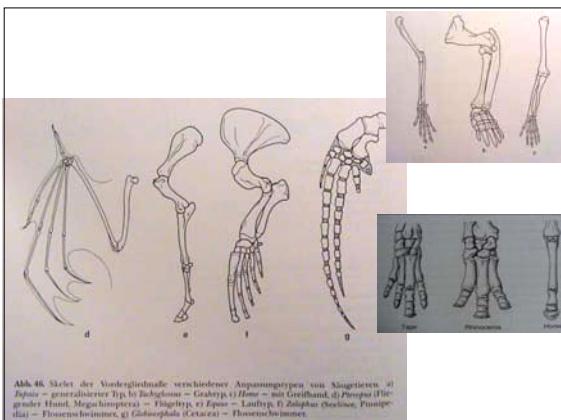
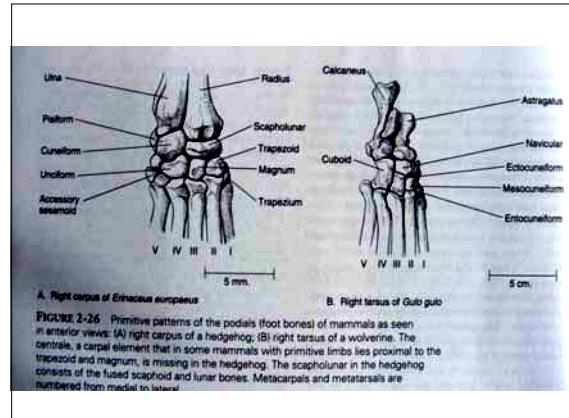
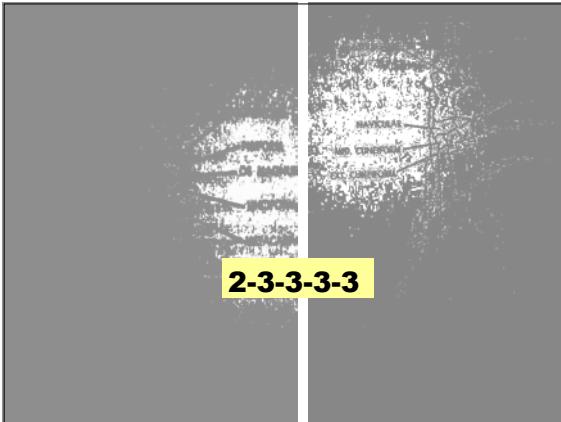
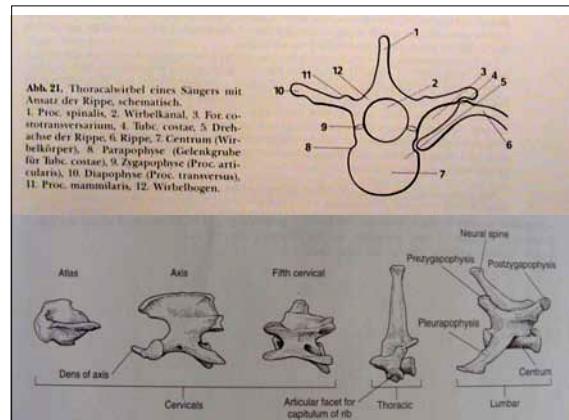
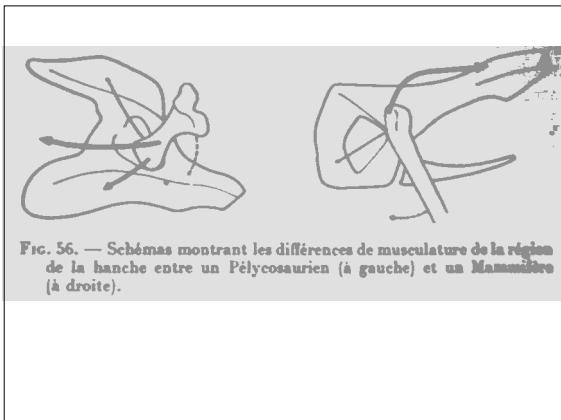
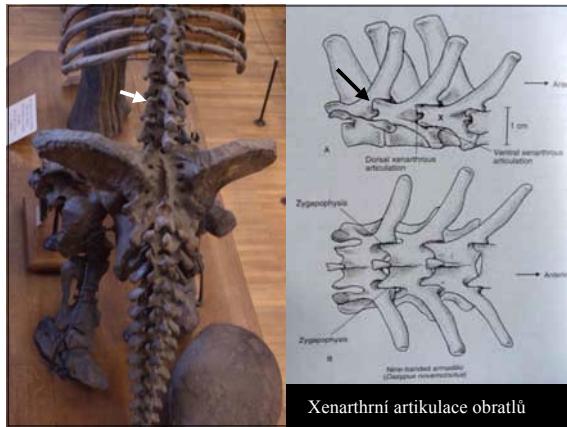


Abb. 43. Die wichtigsten Muskelgruppen am Schultergelenk der Säugetiere. 1. M. supraspinatus, 2. M. deltoideus, 3. M. triceps brachii, 4. M. serratus lat., 5. M. infraspinatus, 6. M. teres major, 7. Trochlea, 8. Capitulum.



- (9) The bones of pelvic girdle are fused into a single bone, with enlarged and horizontally prolonged ilium.
- (10) A great degree of regional differentiation of the vertebral column. All mammals (except some edentates and manatees) have seven cervical vertebrae with the first two (atlas and axis) specifically rearranged to support a powered head movements.
- (11) The vertebral column is strengthened against lateral movements but is greatly disposed to the vertical flexion. This is valid, first of all of the lumbar section whose vertebrae, in contrast to the non-mammalian ancestors, lack ribs.





- (12) The mammalian skull is *bicondylous* (the first vertebra, atlas joints the skull via paired occipital condyles located on lateral sides of the large occipital foramen), with
- (13) *enlarged braincase*,
- (14) *massive zygomatic arches* (formed by the bones named *jugale* and *squamosum*), and
- (15) *spacious nasal cavity with labyrinth of nasal turbinata covered by vascularized tissue important both for olfaction (ethmoidal turbinata) and/or for heat and water exchange during breathing (maxillary turbinata)*.

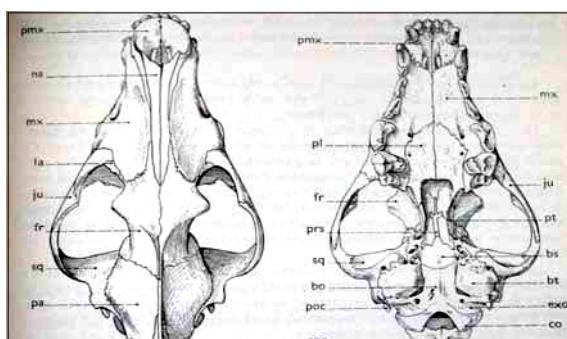
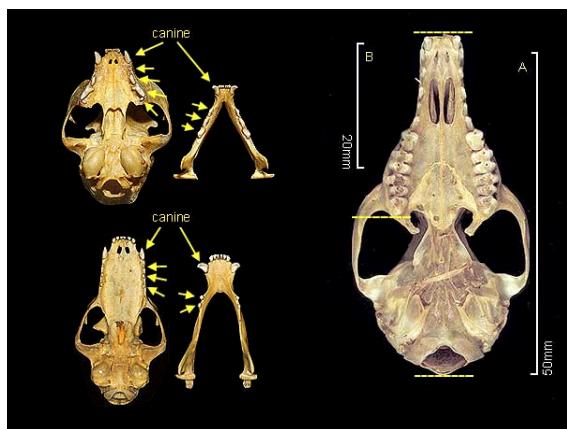
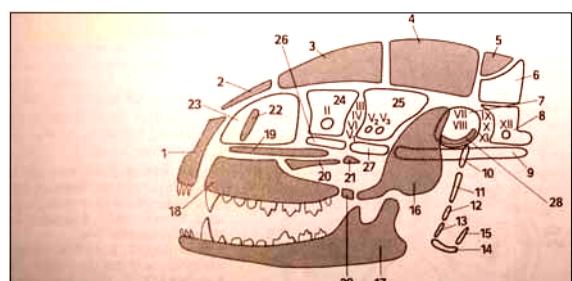
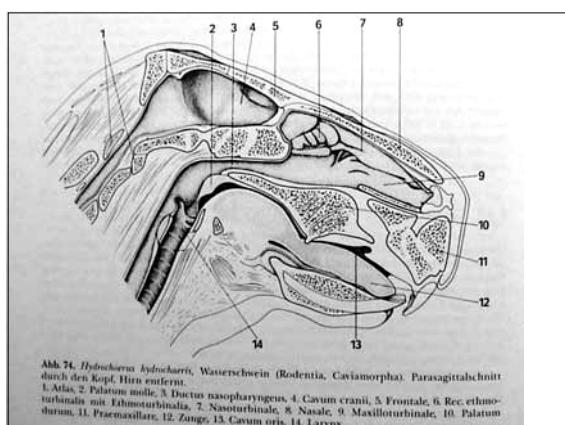
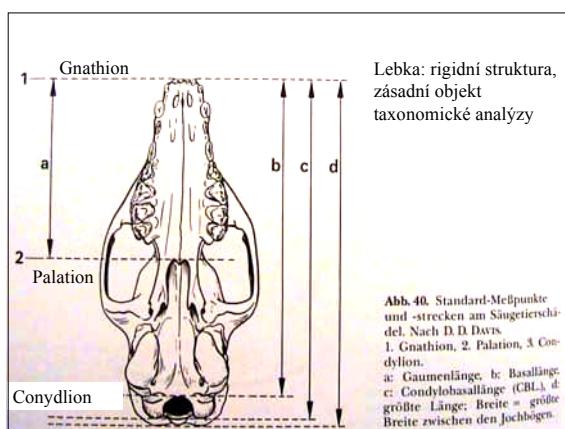
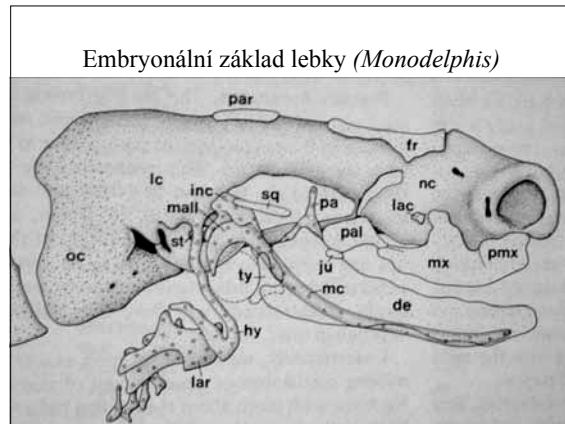


FIG. 3. — *Canis lupus*. Crâne vu par la face supérieure et par la face inférieure (d'après Scott).
ao, basioccipital; as, basisphénoid; M, bulle tympanique; co, condyle occipital; exo, exoccipital; fr, frontal; ia, lacrymal; ju, jugal ou malaire; mx, maxillaire; na, nasal; pa, parietal; pl, palatin; paex, prémaxillaire; poc, processus paroccipital; prs, préphénoid; pt, pterygoïde; sc, supraoccipital; sq, squamosal.

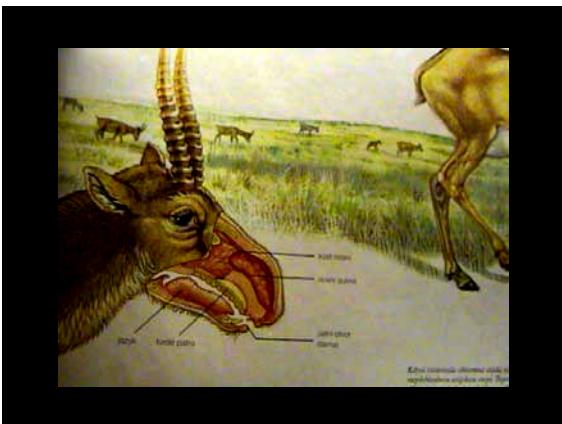
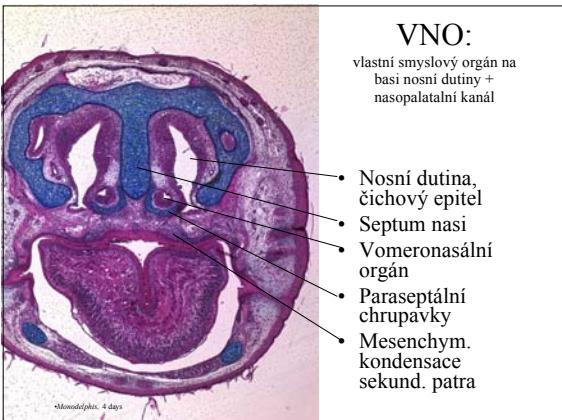
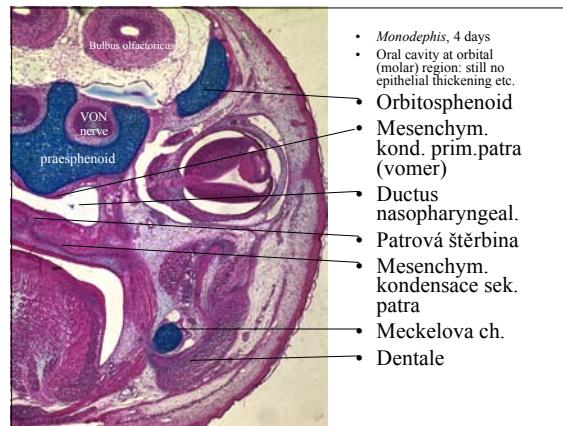
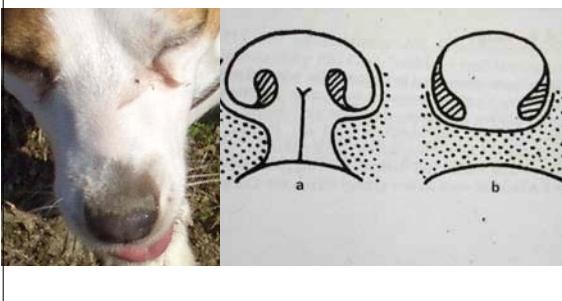


23. Schematische Darstellung der Skelettelemente des Schädels der Säugetiere. In Anlehnung an DE BURLET in M. WEBER 1928.
und konturiert: Ersatzknochen und Zähne. Raster: Deckknochen.
II: Austritt der Hirnnerven, 1. Praemaxillare, 2. Nasale, 3. Frontale, 4. Parietale, 5. Interparieto-Supraoccipitale, 7. Perioticum (= Petrosum), 8. Exoccipitale, 9. Basioccipitale, 10. Tympanale, 11. Stylohyale, 12. Epiphyale, 13. Hypophyale, 14. Basilhyale, 15. Corma branchiale, 16. Squamo-dentale (= Mandibula), 18. Maxillare, 19. Vomer, 20. Palatinum, 21. Pterygoid, 22. Lacrimale, 23. Ethmoid, 24. Orbitosphenoid, 25. Alisphenoid, 26. Praesphenoid, 27. Basisphenoid, imparicum (= Angulare), 29. Jugale.

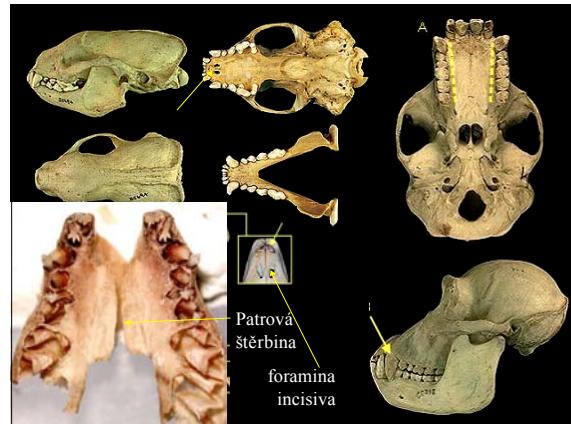


- (16) The nostrils open at a common structure called *nose*, obviously the most prominent point of the head. The ancestral form of the nose, *rhinarium*, is a hairless field of densely gyrified skin surrounding the nostril openings. Rhinarium is particularly large in macrosmatic mammals (such as in carnivores or artiodactyls), in lagomorphs, some rodents, bats and strepsirhine primates it is incised by a central groove, *philtrum*, while in some other groups the nose is prolonged in a *proboscis* such as in macroscelids or in elephants where it attains also a number of supplementary functions. In contrast, all these structures absent in cetaceans where nasal cavity is reduced and nostrils (or a single nostril opening in Odontoceti) appear at top of the head and their function is restricted to respiration.

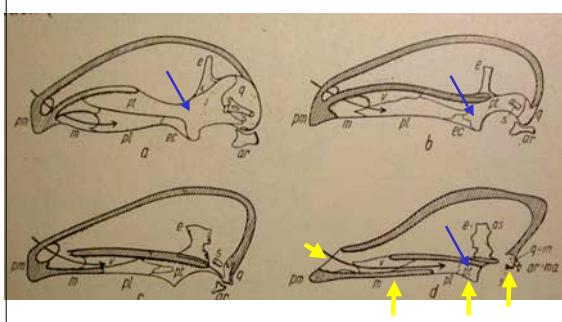
Rhinarium



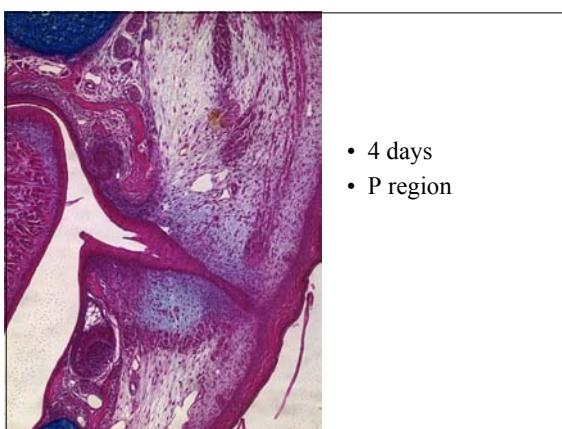
- (17) Left and right maxillary and palatal bones fused soon in ontogeny and form the *secondary bony palate* that is further extended posteriorly by a fleshy soft palate. These structures provide a complete separation of the respiration and alimentary tracts. The early appearance of such a separation is one of the essential pre-requisites for suckling milk by a newborn and, hence, it seems probable that the secondary palate first appeared just as an adaptation for that.



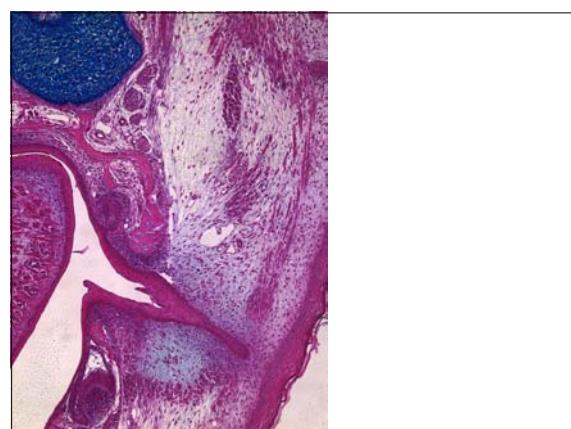
- Vývoj druhotného patra a base neurokrania v historii Amniota

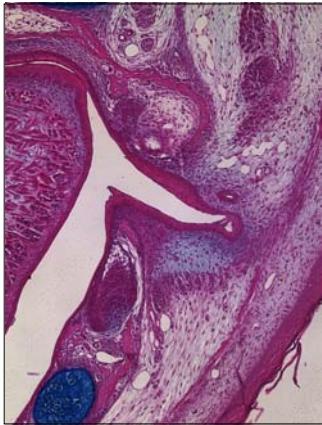


- Savci: souběžně s ontogenetickou diferenciací dermatokrania : rozvoj mozku, smyslů a měkkých tkání tvářové oblasti – vestibulum oris, rty, svaly tváře etc. – zásadní formativní význam koutku úst !



- 4 days
- P region





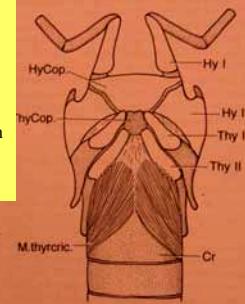
- 4 days
- P region

- (18) A large *four-chambered heart* (as in birds) with the *left aorta persistent* (not the right one like in birds).
- (19) *Erythrocytes, the red blood cells, are biconcave and lack nuclei.* Thrombocytes are transformed to nonnucleated *blood platelets*.

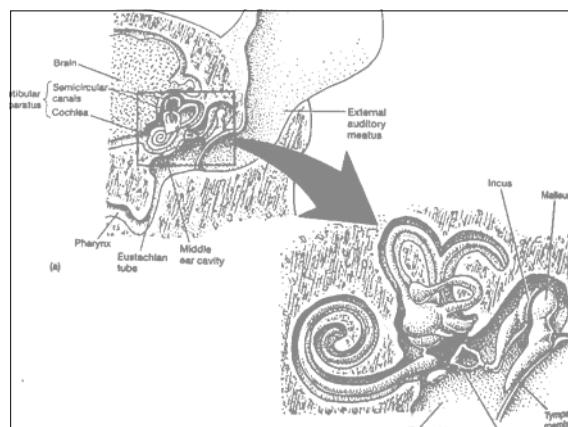
- (20) *Lungs of the alveolar structure*, ventilated by volume changes performed by the counter action of two independent muscular systems, viz. thoracic intercostal muscles, and
- (21) *muscular diaphragm*, unique for mammals. The breathing system is essentially independent upon locomotion or is synergistic with it (in contrast to e.g. reptiles).

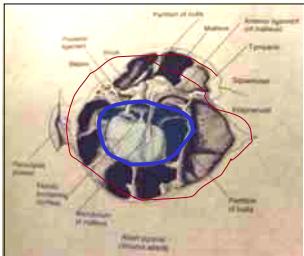
- (22) *Voice organ in larynx* with several pairs of membranous muscles, unique for mammals. It is capable of very specialized functions such as the production of various communicative signals or high frequency echolocation calls in bats of odontocetian cetaceans.

Abb. 518. *Tachyglossus aculeatus*. Zungenbein und Kehl-
körper ventralansicht. Die Branchialbögen II und III
(Thyreoideabögen) blättern bei den Monotremata ge-
genüber. HyCop. Hyolkopula, M. thyeric, M. thyro-
cricoides, ThyCop. Thyroidekopula. (Nach Gippert
1901).

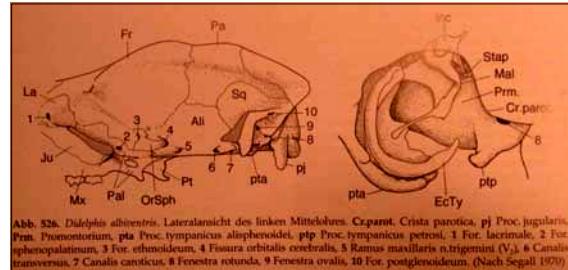


- (23) There are *three ossicles in the middle ear* (malleus, incus, stapes). The former two are unique for mammals, and are derived of the elements of the primary mandibular joint – articulare and quadratum which retain their original function still in the immediate mammalian ancestors. The third bone that was similarly like articulare included in mandible in the non-mammalian amniotes, the angulare, changes in mammals into the tympanic bone which fix the tympanum membrane and finally enlarges into a bony cover of the middle ear – bullae tympani.

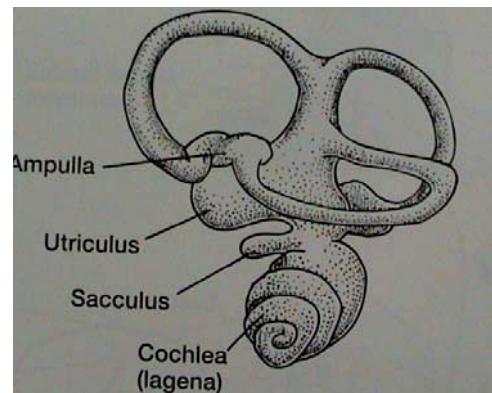




- Bubínek –tympanum fixován os tympanicum přecházející ve vnější kryt středoušní dutiny – bubinkové výdutě – **bulla auditiva** – u různých skupin jsou tvoreny různým způsobem (podíly ekto- a endotympanica apod.: mimořádně důležitý fylogenetický znak



- (24) The proper sensing organ of hearing (Corti's organ of inner ear) is quite long and spirally coiled in mammals (except for monotremes) and surrounded by a very compact bone originated by a fusion of several elements, *petrosum*.
- (25) With enlarged braincase, the middle ear and tympanal membrane are thus located deeper in the head and open to the external environment by *long auditory meatus* terminating with
- (26) *large movable external auricle*.

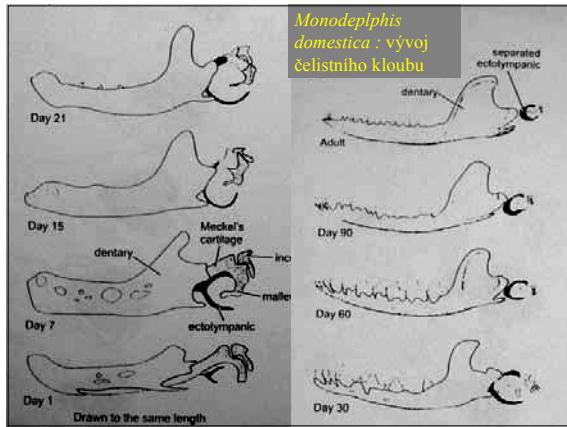


- (26) *large movable external auricle*. Auricles (pinnae) are specifically shaped in particular clades and contribute to the lateral discrimination of the auditory stimuli and directionality of hearing. They may be absent in some aquatic mammals (cetaceans, sirenians, walrus), while they are extremely enlarged and diversified in other groups, such as bats for which the acoustic stimuli (echoes of the ultrasonic calls they emit) are far the most important source of spatial information.

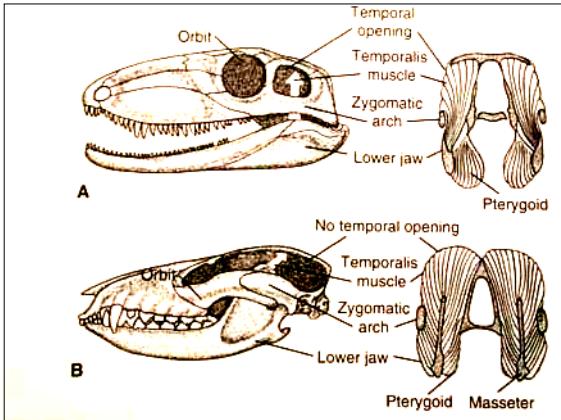




- (27) In contrast to other amniotes, *the lower jaw, mandible, is composed of a single bone element, dentary or dentale*, which directly articulates with the temporal bone of skull at
- (28) *dentary-squamosal joint*. This arrangement not only fastens the jaw joint to resist the forces exerted during strong biting but it also makes easier the functional rearrangements of jaw morphology responding to different demands of particular feeding specialisations.
- Squamo-dentalní artikulace umožňuje nebývalou vývojovou *flexibilitu posice a tvaru čelistního kloubu*



- (29) In all mammals, the posterior part of the mandible extends dorsally into *ramus mandibulae* or coronoid process which provides an area of attachment for the massive temporal muscles responsible for the powered adduction of mandible.



Čelistní a ústní svaly

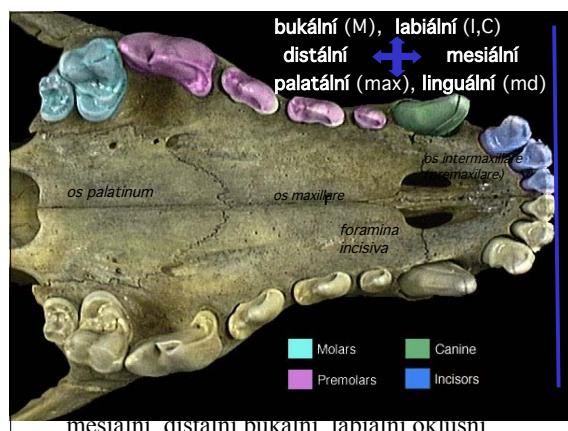
- CR-Md:
 - masseter (addukce md)
 - temporalis (addukce, retrakce)
 - pterygoideus medialis (addukce, mediopulse)
 - pterygoideus lateralis (protrakce, lateropulse)
 - digastricus, mylohyoideus, geniohyoideus (abdukce)
- svaly jazyka
 - genioglossus, hyoglossus, styloglossus, transversus linguuae, longitudinalis, verticalis linguae ...
- vestibulum oris a svaly ústní štěrbiny (Theria)
 - buccinator, orbicularis oris

Pohyby čelistního kloubu

- rotace (axiální cirkumdukce)
 - translace (posun)
- specializovaný kloubní design (Carnivora, Ruminantia, Rodentia) - bez discus articularis
- discus articularis - u primátů (versatilita kloubního pohybu)

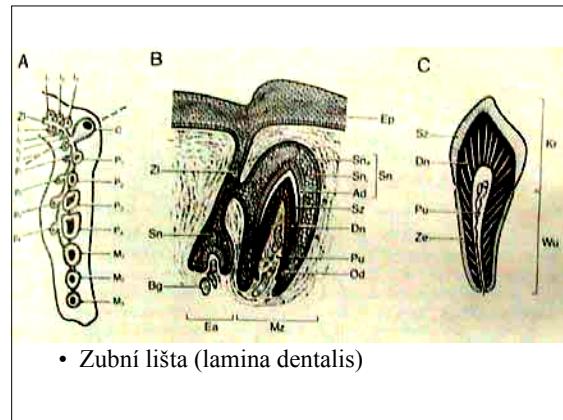
- (30) Essentially, all mammals have *large teeth* despite considerable variation in their number, shape and function in particular groups and/or the fact that some mammals secondarily lack teeth at all (anteaters of different groups, platypus). Teeth are deep rooted in bony sockets called alveoles. Only three bones host the teeth in mammals: premaxilla and maxilla in the upper jaw and dentary in the lower jaw.

- (31) Mammalian *dentition is heterodont*, besides of conical or unicuspitate teeth (incisors and a single pair of canines in each jaw) it includes the large complex multicuspidate molars (three in placentals, four in marsupials, in each jaw quadrant) and premolars situated between canines and molars whose shape and number varies considerably among particular groups. The latter two teeth types are sometimes termed as „postcanines“ or „cheekteeth“.
- Incisives, Caninus, Premolares, Molares
- Zubní vzorec a notace zubů (max/md)

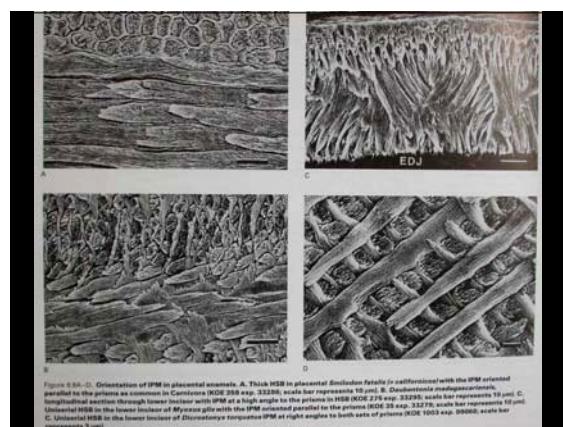
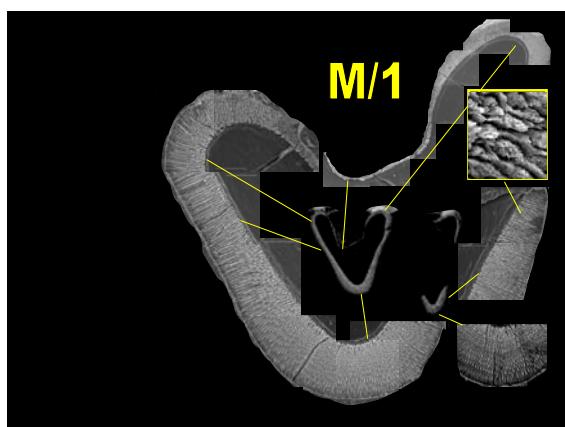
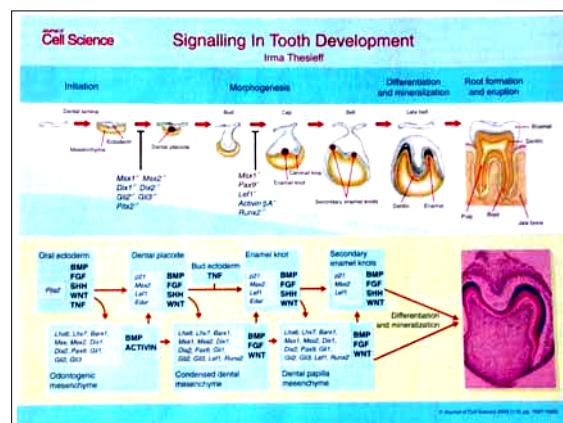


- (32) Mammalian dentition is *diphyodont*, this means that there are two generations at each tooth position (except for molars), the milk or deciduous teeth of a young and the permanent teeth of an adult mammal.

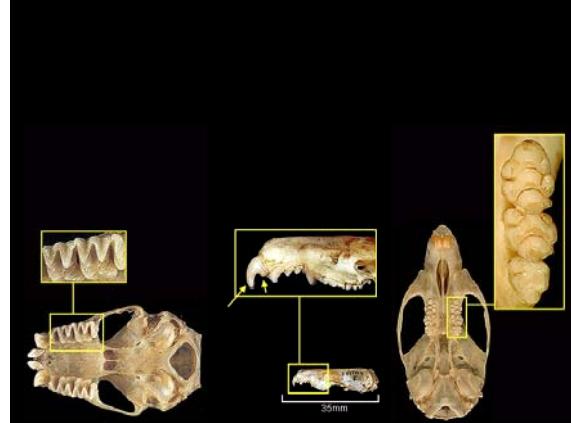
Diphyodonty solves a functional-morphological dilemma: size of teeth which is an essential factor of the feeding efficiency is limited by the size of the jaws while the jaws can grow extensively, the posteroer size of the teeth cannot be changed due to the rigity of their enamel cover which is of course just the essential quality of a tooth. With dphyodonty the size of the late erupting permanent teeth can be maximized and adapted to adult jaw size while the deciduous dentition provides a corresponding solution for the postweaning period. Dental morphology and the patterns of tooth replacement are specifically modified in some clades. In marsupials, only one milk tooth – the last premolar – comes in eruption, the other are resorbed prior eruption. Dolphins, aarkward or armadillos have a homodont dentition without any tooth replacement, no tooth replacement appears also in small sized and short living mammals with greatly specialized dentition like shrews or muroid rodents (deciduous teeth are resorbed instead of eruption), while in some large herbivores the teeth replacements can become a continuous process by which the teeth row enlarges gradually by subsequent eruption of still larger molar teeth appearing in the posterior part of jaws. In elephants and manatees this process includes a horizontal shift of the erupting tooth which replaces thus the preceding cheektooth. All these processes are well synchronized with the growth of jaws, the course of tooth wear and subsequent prolonging of time available for tooth development.



- (33) Zubní sklovina má *prismatickou* stavbu, tvorba skloviny a její maturace probíhá relativně dlouho,
- (34) V embryogenesi zuba se jako svébytné organizační centrum (zdroj morfogenetických signálů) uplatňuje sklovinnový uzel



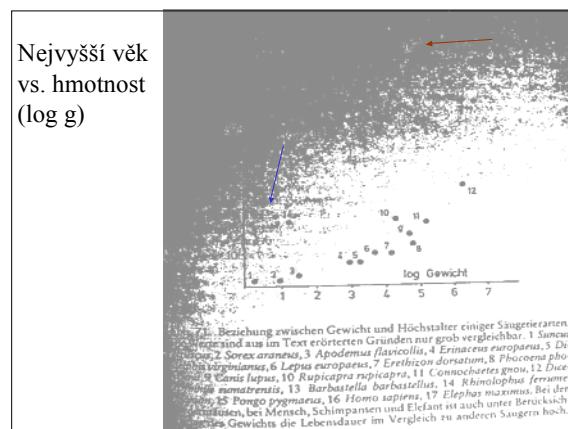
- (35) *The molars* are unique for mammals. The basic molar type ancestral to all particular groups of mammals is called tribosphenic. It consists of three sharp cones connected with sharp blades. In combination with the deep compression chambers between blades, such an arrangement, provides an excellent tool both for shearing soft tissues and crushing insect exoskeletons. This type of molars are retained in all groups feeding on insects, such as many marsupials, tenrecs, macroscelids, true insectivores such as moles, shrews or hedgehogs, bats, tree shrews, prosimian primates, but the design of the molar teeth is often extensively rearranged in other groups. The multicuspidate structure of molars bear enormous potential of morphogenetic and functional rearrangements, one of the prerequisites of the large diversity of feeding adaptations in



Regulace

- (36) *Growth is terminated* both by the hormonal control and structural factors. Most influencing structural aspect of body growth is the appearance of *cartilaginous epiphyseal plates separating diaphyses and epiphyses* of long bones. With completing ossification the discs disappear and the growth is finished. Corresponding mechanisms determine the size of the skull (except cetaceans which have telescopied skull in which posterior bones of cranium overlap each other).

Nejvyšší věk
vs. hmotnost
(log g)



- (37) A general *enlargement of the brain* related perhaps not only to an increase in the amount of sensoric information and/or a need to integrate sensoric information from different sources but also to an enlarged amount of locomotory activity, high versatility in locomotoric functions and, last but not least, to a greatly diversified social life, and a considerably enlarged role of social and individual learning. Among the brain structures which are particularly developed in mammals the following are particularly worth of mentioning:
- (38) *neocortex* of the forebrain,
- (39) *tectum mesencephali* is specialised into *superior* and *inferior colliculi* (responsible for semantics of optical and acoustic information, respectively),

- (40) cerebellum with *enlarged cerebellar hemispheres* and *gyrified transverse cerebellar components* between the vermis and paraflocculi (the central stem and the lateral centres of cerebellum). The cerebellar enlargement is apparently related to the high level of locomotory activity and an increase in its complexity.

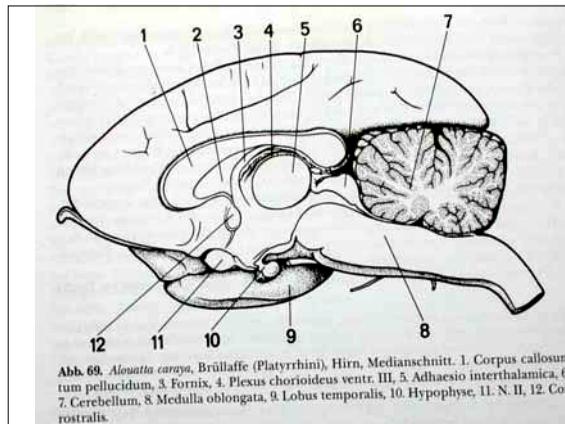


Abb. 69. *Alouatta caraya*, Brüllaffe (Platyrrhini), Hirn, Medianschnitt. 1. Corpus callosum, 2. Fornix, 3. Plexus chorioideus ventr. III, 4. Adhaesio interthalamica, 5. Thalamus, 6. Corpus subpellucidum, 7. Cerebellum, 8. Medulla oblongata, 9. Lobus temporalis, 10. Hypophyse, 11. N. II, 12. Commissura postrostralis.

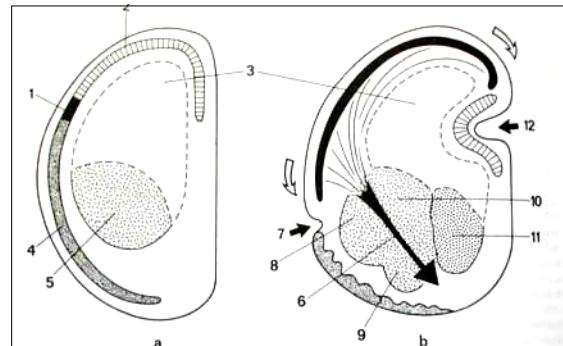


Abb. 70. Schematischer Querschnitt durch eine Hälfte des Vorderhirns, a) Reptil, b) basaler Säuger.
1. Opticallium, 2. Archipallium, 3. Ventrikel, 4. Palaeopallium, 5. Basalganglion, 6. Capula int., 7. Fiss. palaeo-neocorticalis, 8. Putamen, 9. Pallidum, 10. Caudatum, 11. Thalamus, 12. Fiss. hippocampal.

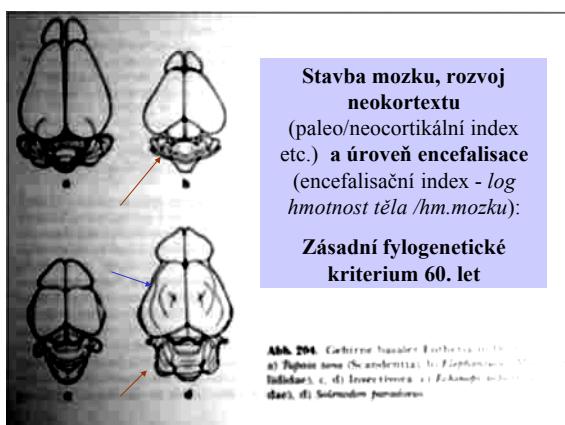
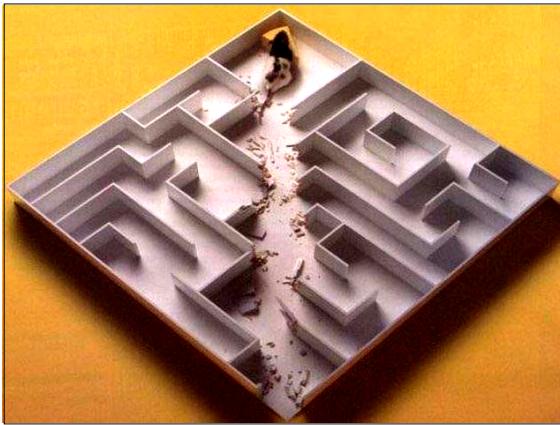


Abb. 204. Gehirne basaler Fortbewegungstiere:
a) Rajenartige (Cetaceidae); b) Elefantenartige (Mammalia, Elephantidae); c, d) Insektenfresser (Eulenfledgern, Streifvögel); e, f) Seelöwen (Loridae).

Mozek	Grad der Encephalisation bei primitivem Placentalia (Indices nach RAVKOVY & STEPAN 1966 aus dem sog. Verhältnis zwischen Körpergewicht und Hirngewicht)*	Encephalační index
Turritidae		
<i>Terebraria exsudans</i>	106	Macroscelidae
<i>Exochomus spiniger</i>	105	Indices
<i>Hemicentetes semispinosus</i>	105	Elaphantulus forsyrensis, <i>Rhinolophus schlesingeri</i>
<i>Sextius setosus</i>	105	241
<i>Opistognathus</i>	109	265
<i>Nesogaleus dubius</i>	144	Topiidae
<i>Myrophis porosus</i>	125	<i>Urogale rosenii</i>
<i>Lampris guttatus</i>	125	<i>Trapaena gibba</i>
<i>Pomacanthus velox</i>	150	315
Solenodontidae		Lemuridae
<i>Solenodon paradoxus</i>	147	<i>Cheirogaleus medius</i>
Chrysochloridae		<i>Cheirogaleus major</i>
<i>Cyclopes leucurus</i>	140	<i>Microcebus murinus</i>
<i>Chlorodrepanus chlorostictus</i>	140	<i>Lepilemur mustelinus</i>
<i>Galagoides senegalensis</i>	168	<i>Hapalemur sifaka</i>
Erinaceidae		<i>Lemur catta</i>
<i>Erinaceus europaeus</i>	110	<i>Lemur ruficaudatus</i>
Soricidae		429
<i>Shrews minuta</i>	80	Urotrichidae
<i>Blarinus armatus</i>	107	<i>Avahi laniger</i>
<i>Crocidura giffardi</i>	80	<i>Propithecus verreauxi</i>
<i>Crocidura russula</i>	97	304
<i>Oryzomys palustris</i>	120	Dipodontidae
<i>Suscus scrofa</i>	93	<i>Dipodomys madagascariensis</i>
<i>Hippotigris pyrenaicus</i>	123	704
<i>Peromyscus maniculatus</i>	123	Lorisidae
<i>Sylvilagus flavus</i>	125	<i>Loris tardigradus</i>
Tarsiidae		<i>Perodipithecus potto</i>
<i>Tarsius europaeus</i>	154	409
<i>Saguinus aquatica</i>	204	<i>Nycticebus coucang</i>
<i>Anubisops preussi</i>	240	515
<i>Dendouma maculata</i>	200	<i>Galegees crassicaudatus</i>
		441
		493
Tarsiidae		Tarsiidae
		<i>Tarsius spectrum</i>
		433
		<i>Tarsius striatus</i>
		503

(41) Endotermie, homeo- / heterotermie a související regulační mechanismy
Srv. adaptivní diversifikaci jednotlivých taxonů

• (42) Extended spectrum of behavioral reactions and their interconnections with an increased capacity of social and individual learning and interindividual discrimination.



- (43) Sex is determined by chromosomal constitution (*XY system, heterogametic sex is a male*).
- (44) Převažující typ chromosomálních přestaveb a zdroj neznedbatelný zdroj vnitrotaxonove diversifikace jsou Robersonské (centrometrické) translokace (srv. *Sorex, Microtus, Cervidae* etc.)

Reptiles	Mammals
More than one bone in mandible; with quadrate-articular articulation of jaw joint	Single bone in mandible; with squamosal-dentary articulation
One occipital condyle	Two occipital condyles
Long bones without epiphyses (indeterminant growth)	Long bones with epiphyses (determinant growth)
Unfused pelvic bones	Fused pelvic bones
Secondary palate usually absent	Secondary palate present
Middle ear with one ossicle (stapes-columella)	Middle ear with three ossicles (malleus, incus, and stapes)
Phalangeal formula 2-3-4-5-3 (4)	Phalangeal formula usually 2-3-3-3-3
Dentition homodont and polyphyodont	Dentition often heterodont and diphyodont
Epidermis with scales	Epidermis with hair
Oviparous or ovoviviparous	Viviparous (except for the monotremes)
Three-chambered heart in most	Four-chambered heart with left aortic arch
Ectothermic with low metabolic rate	Endothermic with high metabolic rate
Nonmuscular diaphragm	Muscular diaphragm
No mammary glands	Mammary glands present
Relatively small, simple brain	Relatively large, complex brain

Mammalia: Adaptivní strategie, obecné charakteristiky adaptivních radiací

