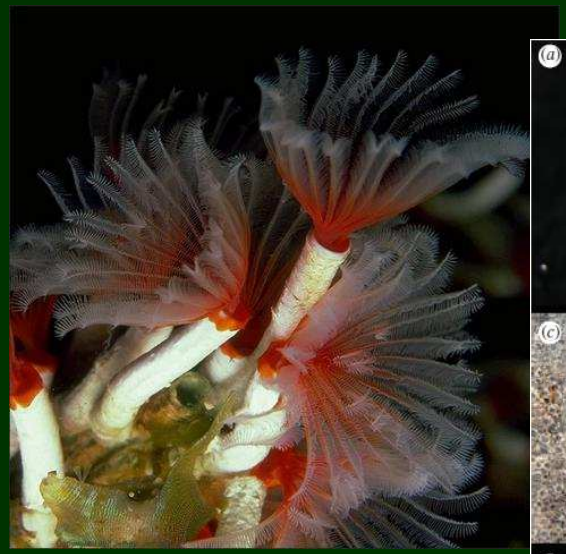
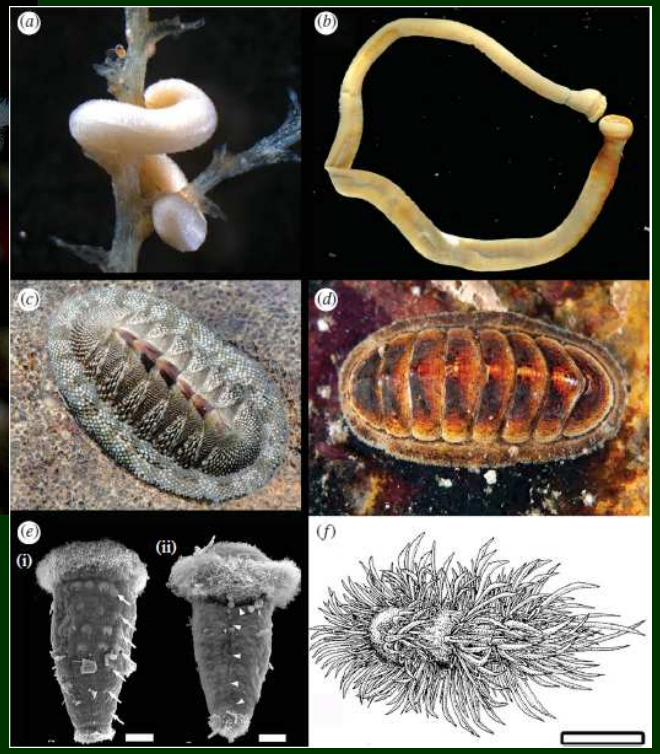
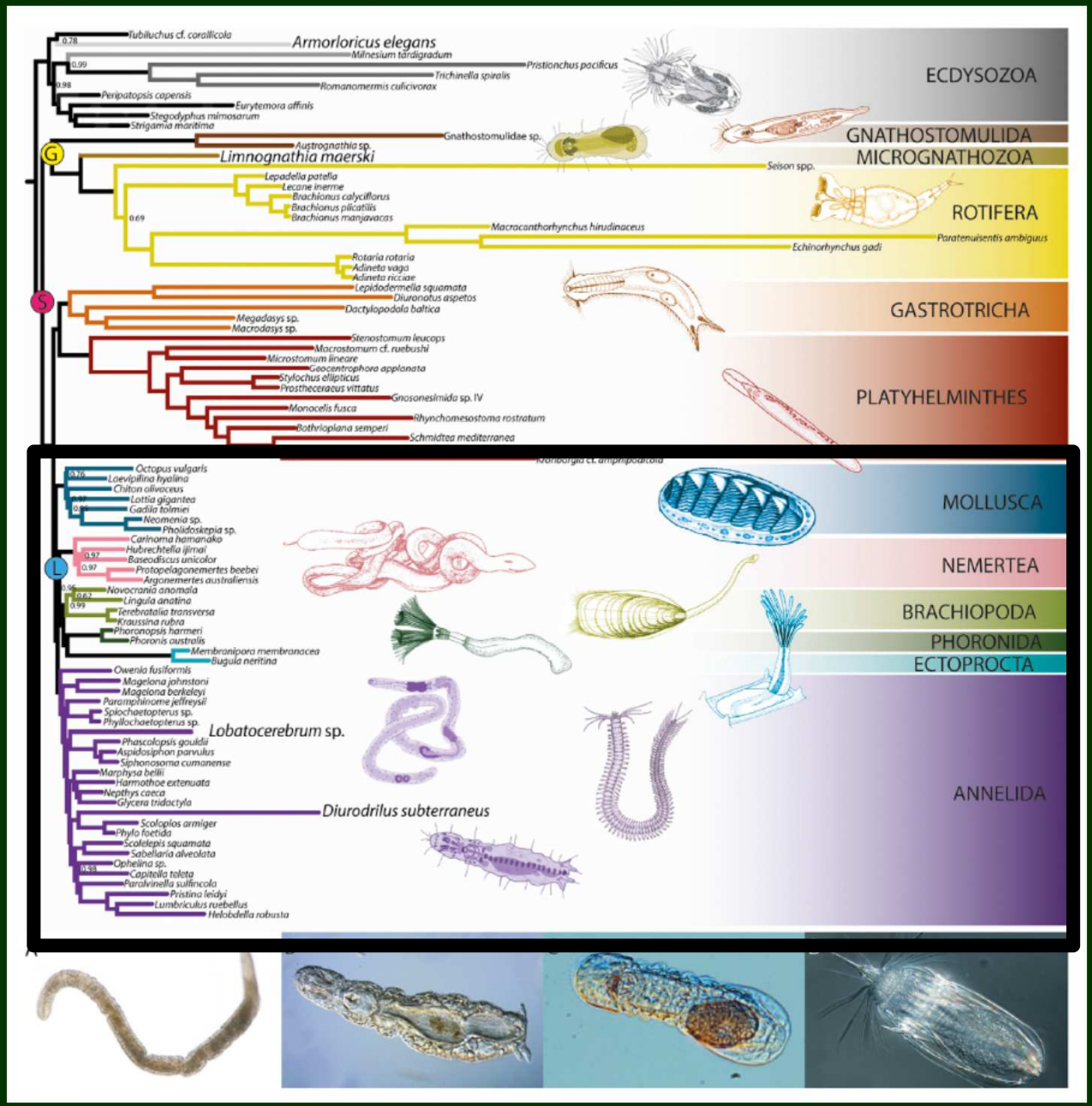
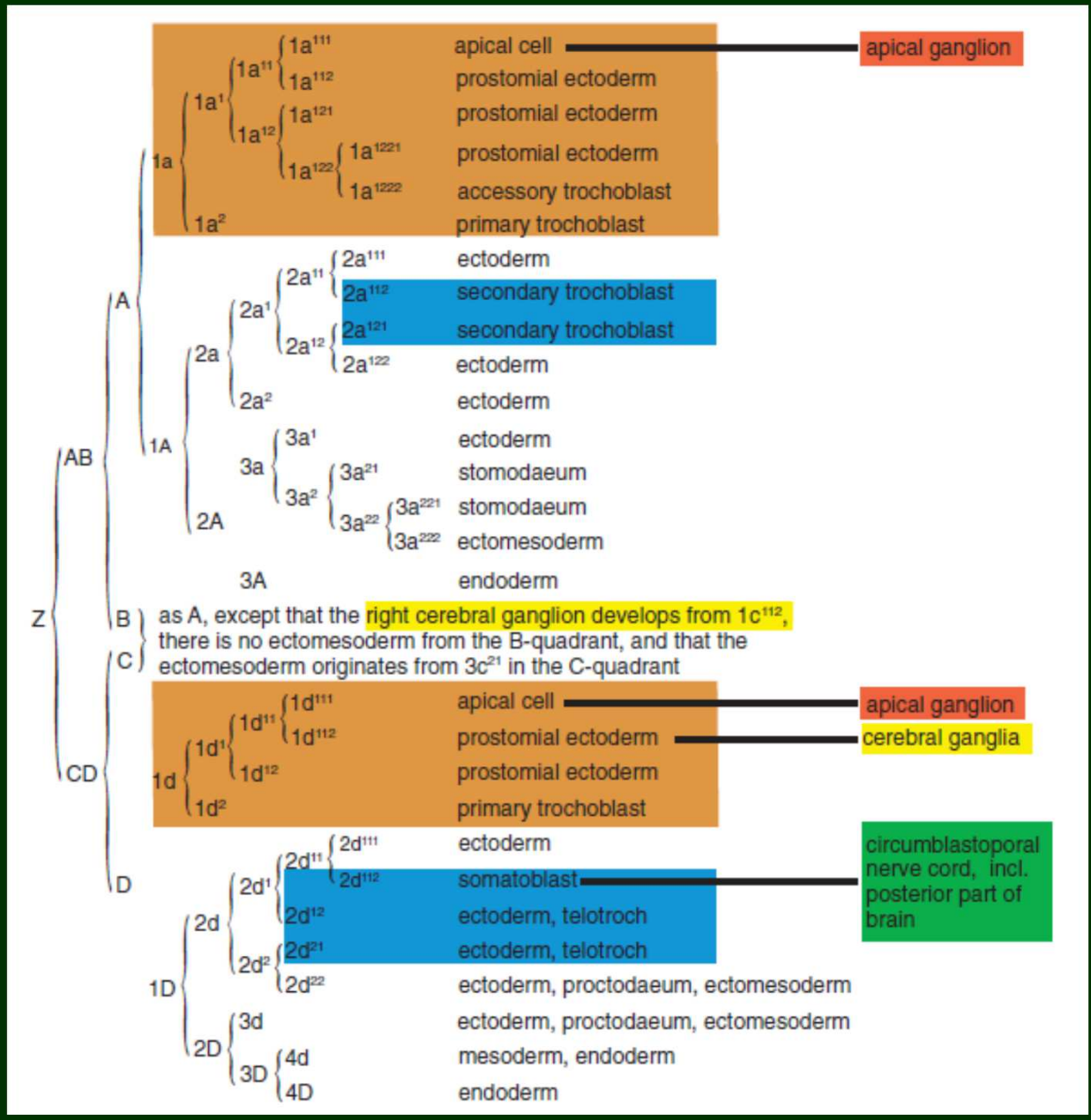
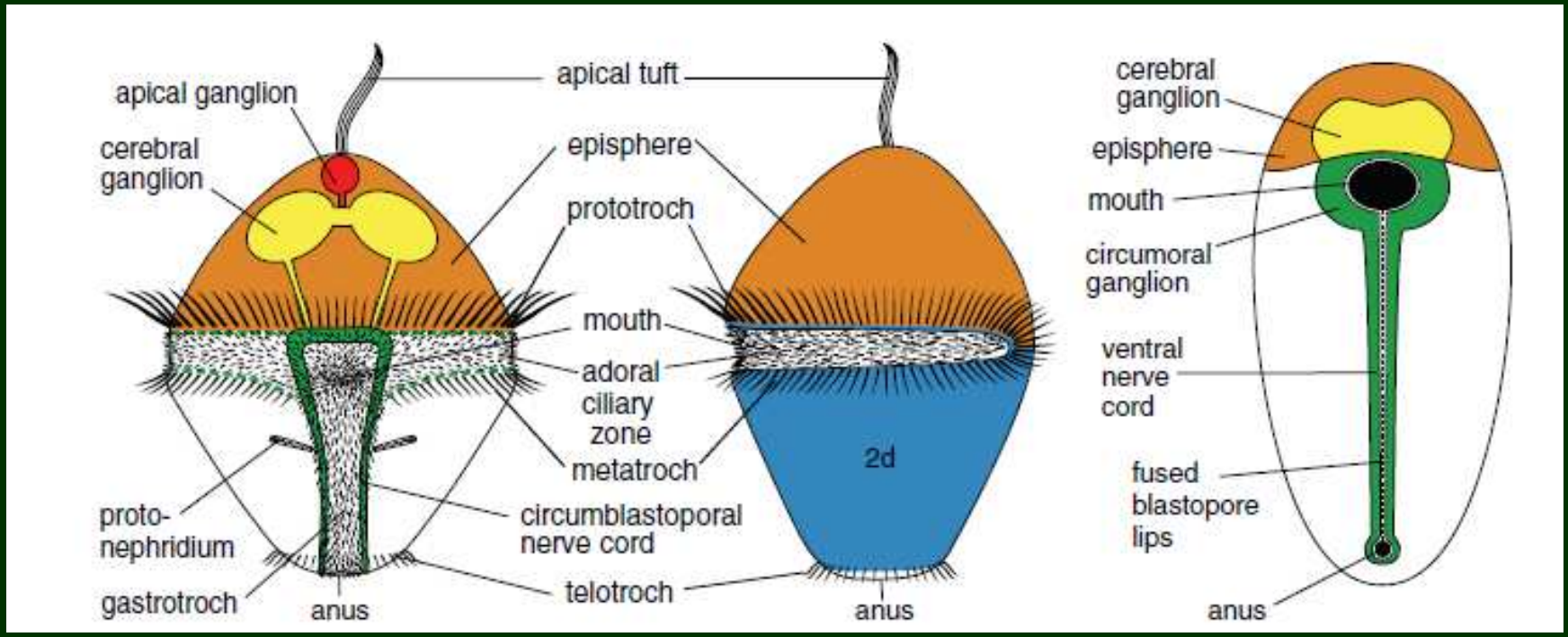
Spiralia: **Lophotrochozoa**






Tubiluchus cf. corallicola
Armorloricus elegans
Milnesium tardigradum
Pristionchus pacificus
Trichinella spiralis
Romanomermis culicivorax
Peripatopsis capensis
Eurytemora affinis
Stegodyphus mimosarum
Strigamia maritima
Gnathostomulidae sp.
Austrognathia sp.
Limnognathia maerski
Seison spp.
Lepadella patella
Lecane inermis
Brachionus calyciflorus
Brachionus plicatilis
Brachionus manjavacas
Macracanthorhynchus hirudinaceus
Paratenuisentis ambiguus
Echinorhynchus gadi
Rotaria rotaria
Adineta vaga
Adineta ricciae
Lepidodermella squamata
Diuronotus aspetos
Dactylopodola baltica
Megadasys sp.
Macrodasys sp.
Stenostomum leucops
Macrostomum cf. ruebushi
Microstomum lineare
Geocentrophora applanata
Stylochus ellipticus
Prosthecereaus vittatus
Gnosonesimida sp. IV
Monocelis fusca
Rhynchomesostoma rostratum
Bothrioplana semperi
Schmidtea mediterranea
Octopus vulgaris
Loevipilina hyalina
Chiton olivaceus
Lottia gigantea
Gadila tolmiei
Neomenia sp.
Pholidoskepia sp.
Carinoma hamanako
Hubrechtella ijimai
Baseodiscus unicolor
Protopelagonemertes beebei
Argonemertes australiensis
Novocrania anomala
Lingula anatina
Terebratalia transversa
Kraussina rubra
Phoronopsis harmeri
Phoronis australis
Membranipora membranacea
Bugula neritina
Owenia fusiformis
Magelona johnstoni
Magelona berkeleyi
Paramphinome jeffreysii
Spiochaetopterus sp.
Phyllochaetopterus sp.
Lobatocerebrum sp.
Phascolopsis gouldii
Aspidosiphon parvulus
Siphonosoma cumanense
Marphysa bellii
Harmothoe extenuata
Nepthys caeca
Glycera tridactyla
Diurodrilus subterraneus
Scalopios armiger
Phyllo foetida
Scalelepis squamata
Sabellaria alveolata
Ophelina sp.
Capitella teleta
Paralvinella sulfincola
Pristina leidyi
Lumbriculus rubellus
Helobdella robusta
ECDYSOZOA
GNATHOSTOMULIDA
MICROGNATHOZOA
ROTIFERA
GASTROTRICHA
PLATYHELMINTHES
MOLLUSCA
NEMERTEA
BRACHIOPODA
PHORONIDA
ECTOPROCTA
ANNELIDA


Z
AB
A
1a
1a1
1a11
1a111
apical cell
1a112
prostomial ectoderm
1a12
1a121
prostomial ectoderm
1a122
1a1221
prostomial ectoderm
1a1222
accessory trochoblast
1a2
primary trochoblast
1A
2a
2a1
2a11
2a111
ectoderm
2a112
secondary trochoblast
2a12
2a121
secondary trochoblast
2a122
ectoderm
2a2
ectoderm
3a
3a1
ectoderm
3a2
3a21
stomodaeum
3a22
3a221
stomodaeum
3a222
ectomesoderm
2A
3A
endoderm
B
as A, except that the right cerebral ganglion develops from 1c112,
there is no ectomesoderm from the B-quadrant, and that the
ectomesoderm originates from 3c21 in the C-quadrant
C
CD
1d
1d1
1d11
1d111
apical cell
1d112
prostomial ectoderm
1d12
prostomial ectoderm
1d2
primary trochoblast
D
1D
2d
2d1
2d11
2d111
ectoderm
2d112
somatoblast
2d12
ectoderm, telotroch
2d2
2d21
ectoderm, telotroch
2d22
ectoderm, proctodaeum, ectomesoderm
2D
3d
ectoderm, proctodaeum, ectomesoderm
3D
4d
mesoderm, endoderm
4D
endoderm
apical ganglion
apical ganglion
cerebral ganglia
circumblastoporal nerve cord, incl. posterior part of brain


apical ganglion
cerebral ganglion
apical tuft
episphere
prototroch
mouth
adoral ciliary zone
metatroch
proto-nephridium
circumblastoporal nerve cord
gastrotroch
anus
telotroch
2d
anus
cerebral ganglion
episphere
mouth
circumoral ganglion
ventral nerve cord
fused blastopore lips
anus

Mollusca

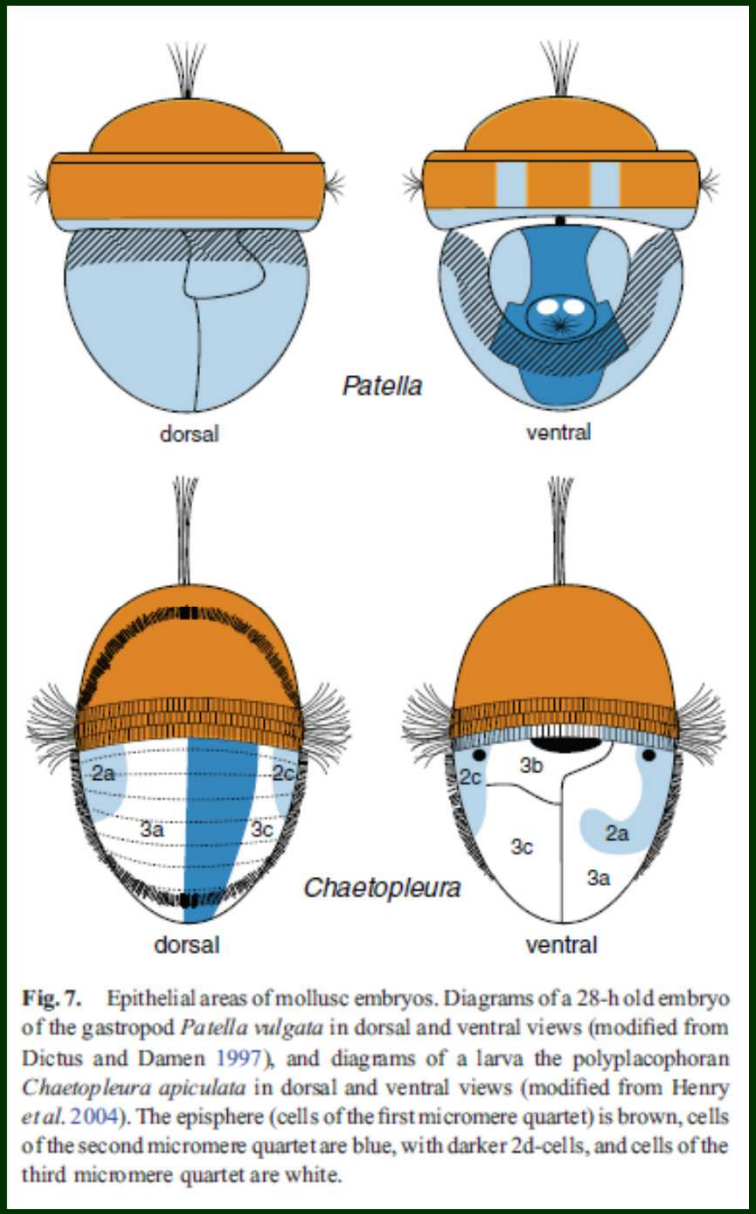
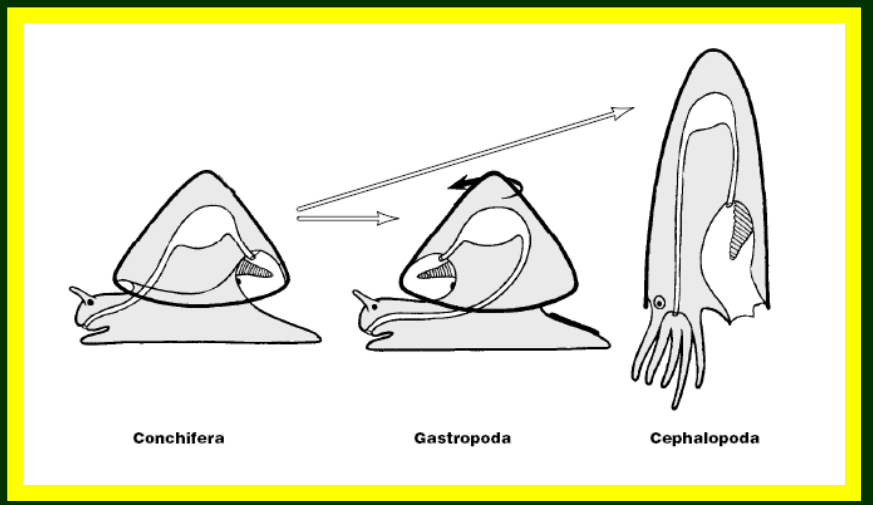


Fig. 7. Epithelial areas of mollusc embryos. Diagrams of a 28-h old embryo of the gastropod *Patella vulgata* in dorsal and ventral views (modified from Dictus and Damen 1997), and diagrams of a larva the polyplacophoran *Chaetopleura apiculata* in dorsal and ventral views (modified from Henry *et al.* 2004). The episphere (cells of the first micromere quartet) is brown, cells of the second micromere quartet are blue, with darker 2d-cells, and cells of the third micromere quartet are white.



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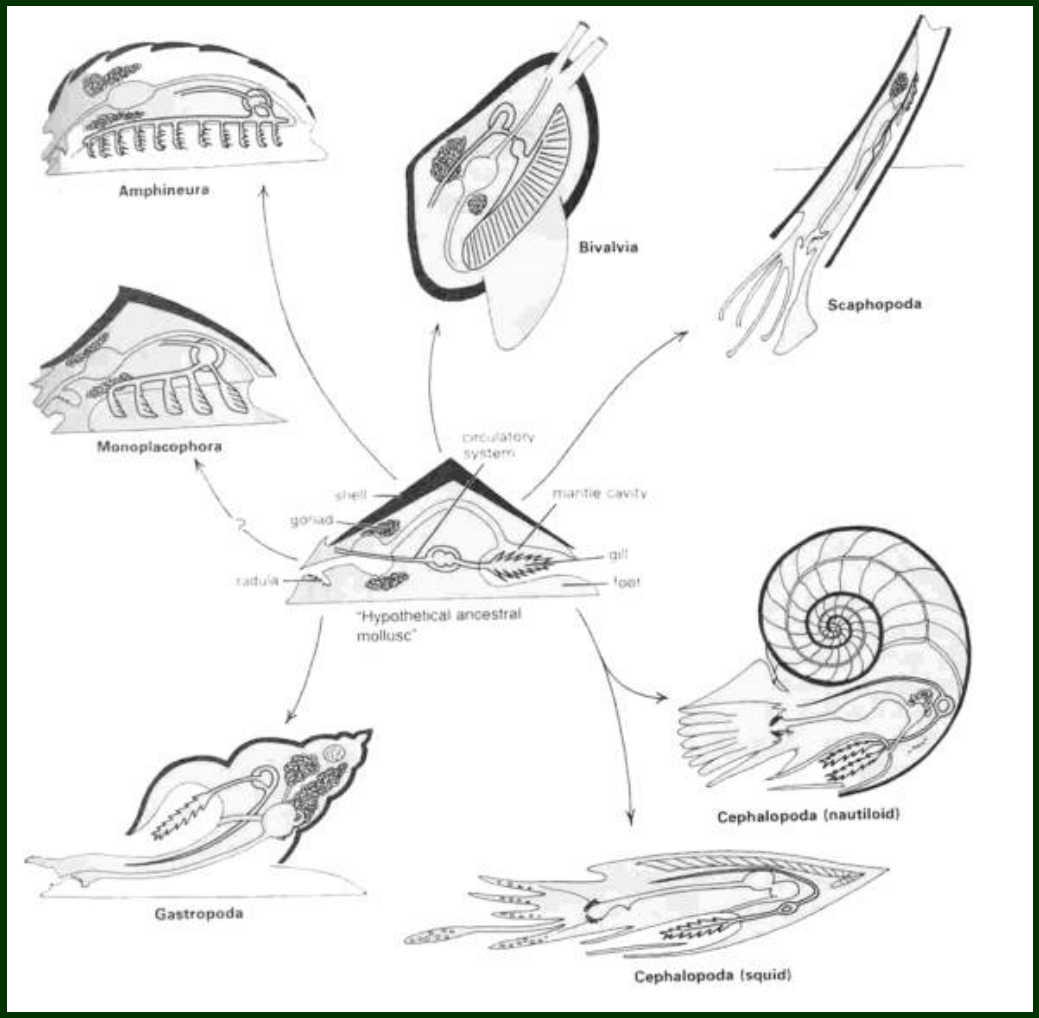
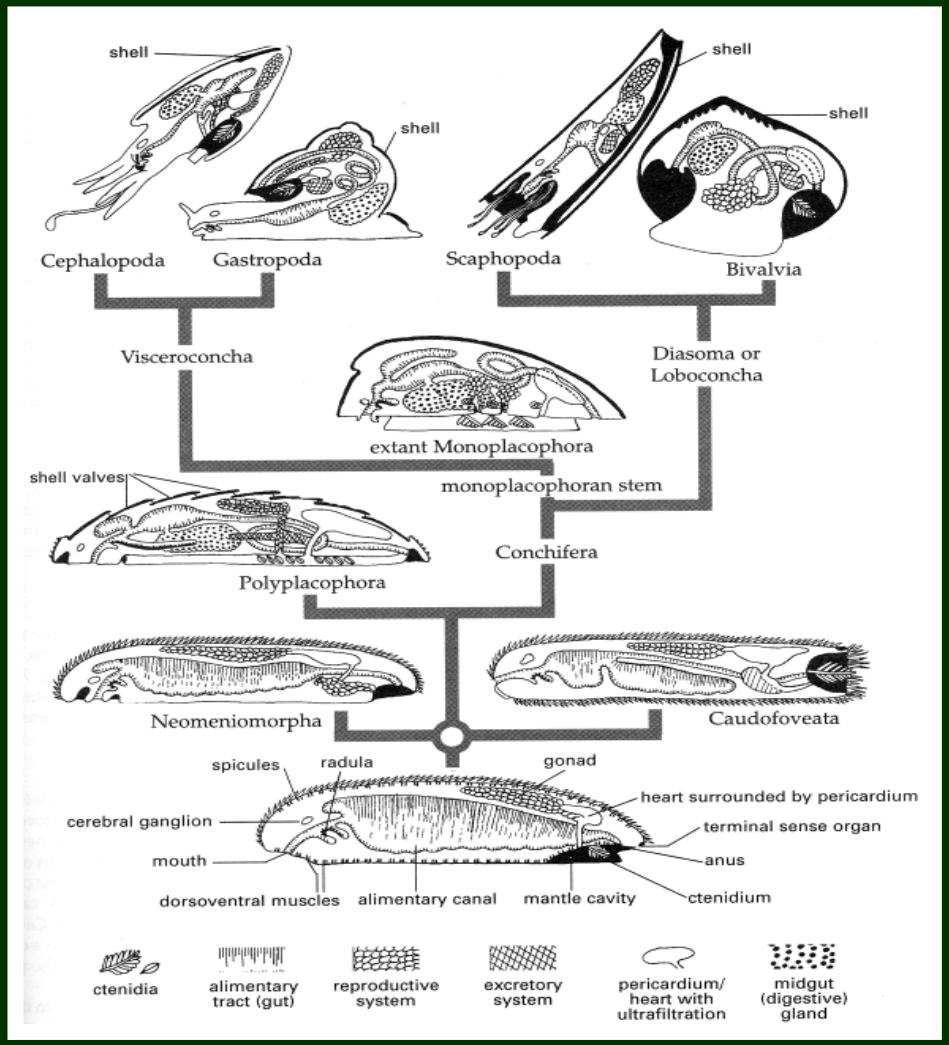
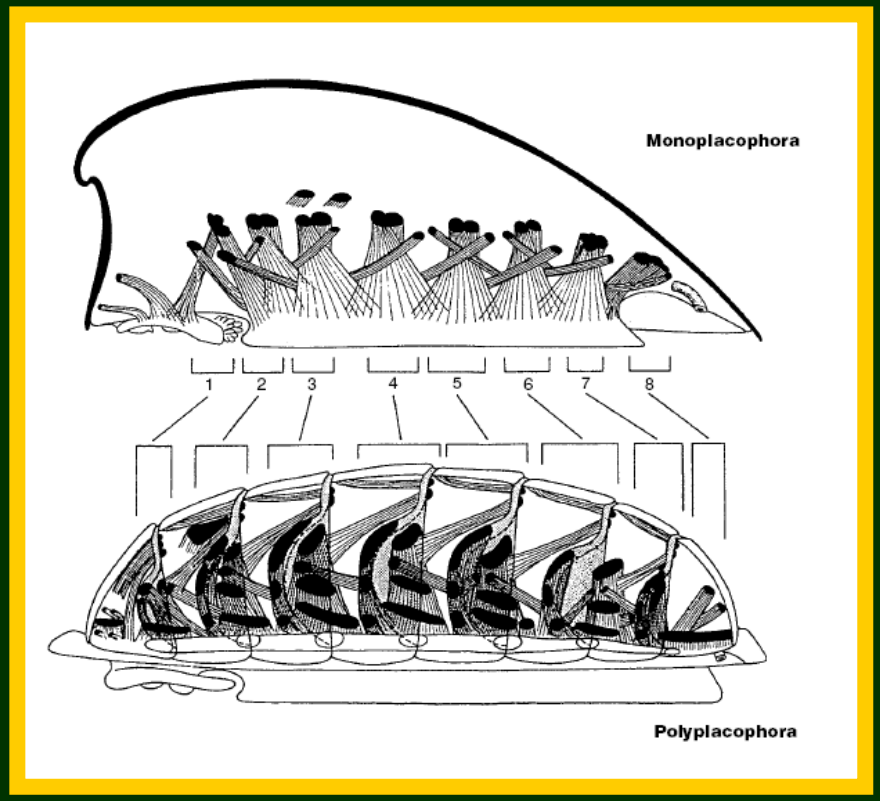
„Ur-Mollusk“

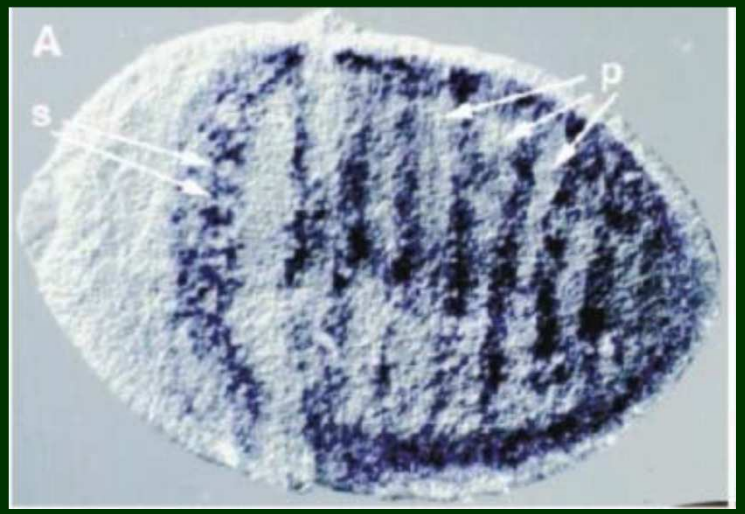

Amphineura
Bivalvia
Scaphopoda
Monoplacophora
circulatory system
shell
mantle cavity
gonad
gill
radula
foot
"Hypothetical ancestral mollusc"
Cephalopoda (nautiloid)
Gastropoda
Cephalopoda (squid)

Mollusca


shell
shell
shell
shell
Cephalopoda
Gastropoda
Scaphopoda
Bivalvia
Visceroconcha
Diasoma or
Loboconcha
extant Monoplacophora
shell valves
monoplacophoran stem
Conchifera
Polyplacophora
Neomeniomorpha
Caudofoveata
spicules
radula
gonad
heart surrounded by pericardium
cerebral ganglion
terminal sense organ
mouth
anus
dorsoventral muscles
alimentary canal
mantle cavity
ctenidium
ctenidia
alimentary tract (gut)
reproductive system
excretory system
pericardium/ heart with ultrafiltration
midgut (digestive) gland

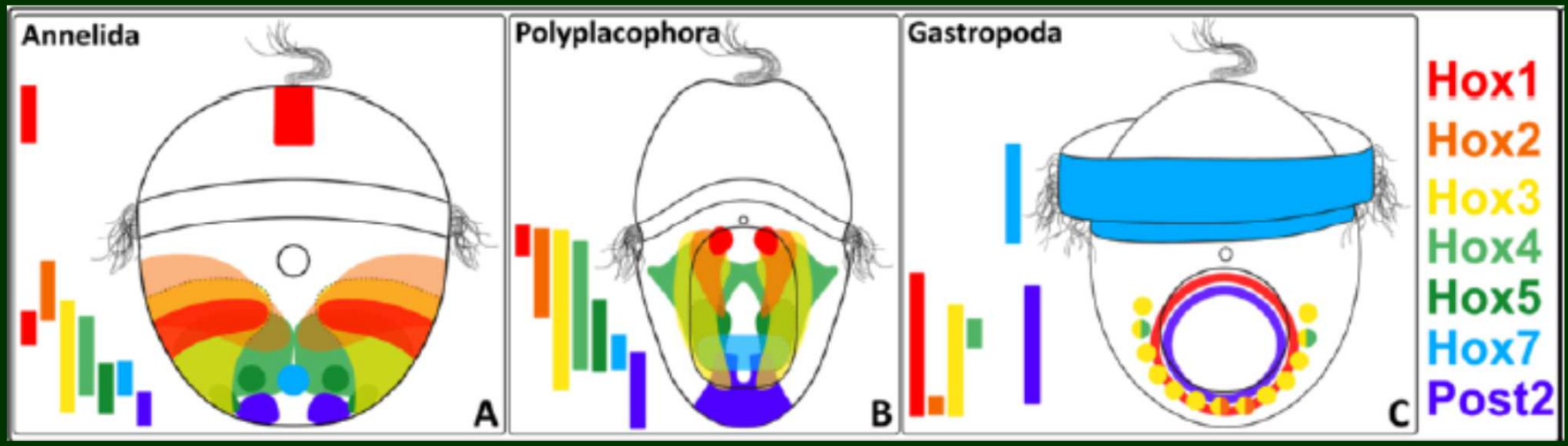
Mollusca – metamerismus?



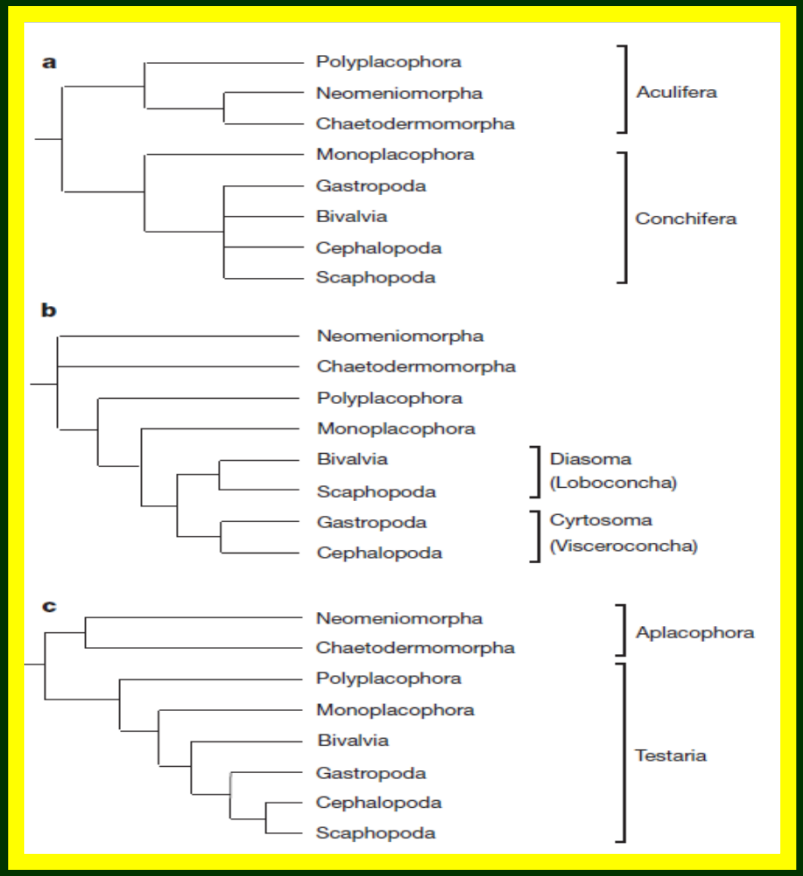


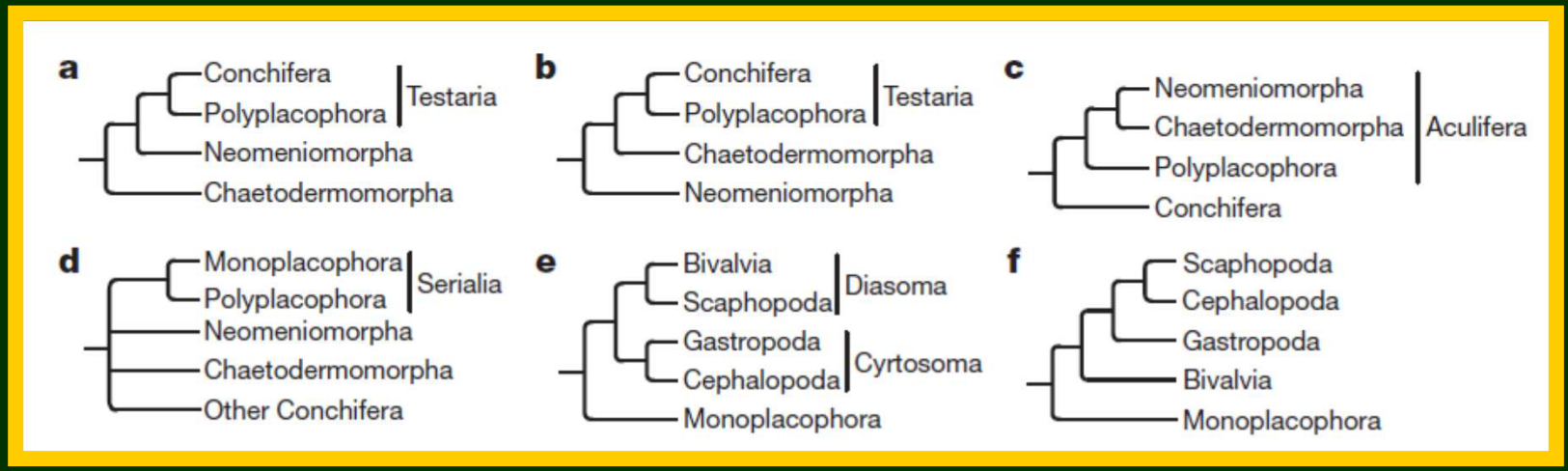
Hox geny měkkýšů

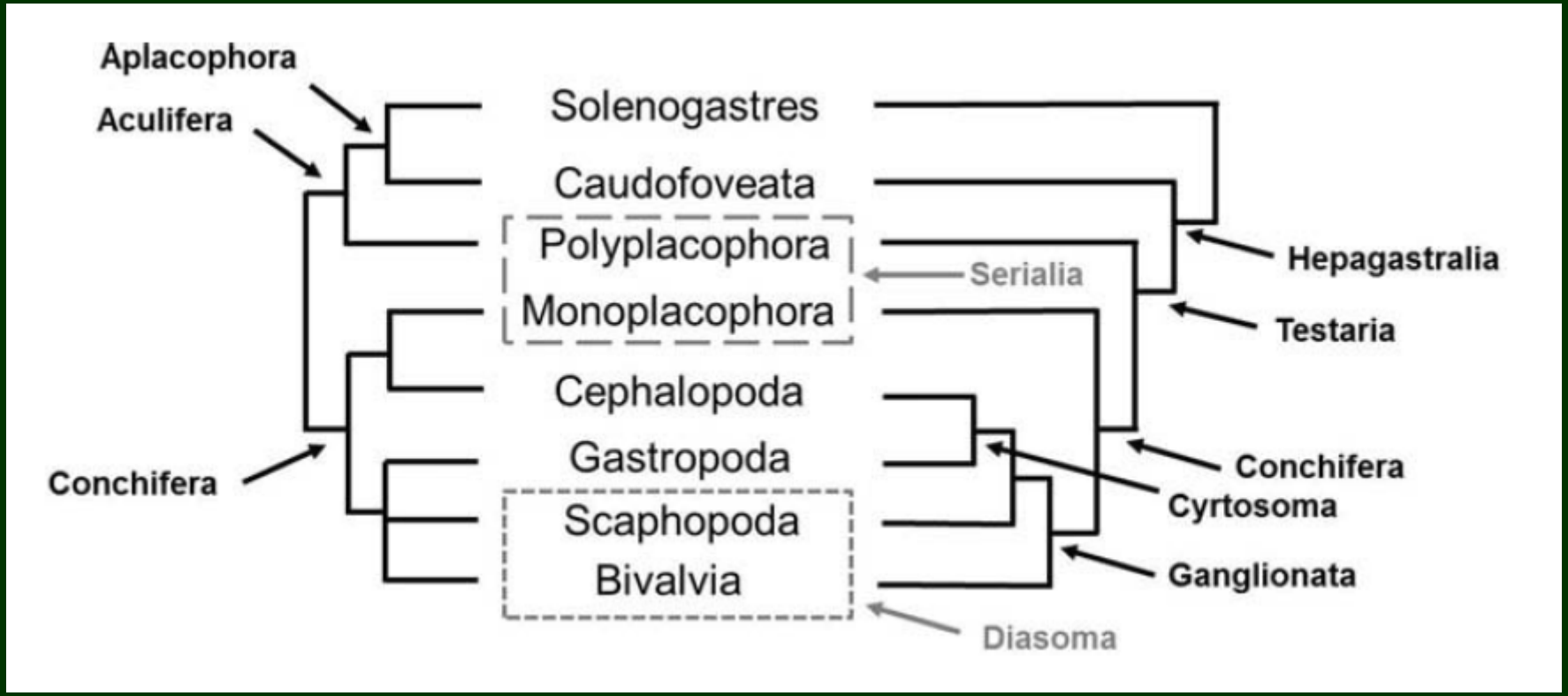
- původně AP jako u jiných bilaterií, u plžů a hlavonožců převzaly jiné funkce
- plži: prototroch a *shell field*
- (u ostatních skupin neznámé)



Mollusca

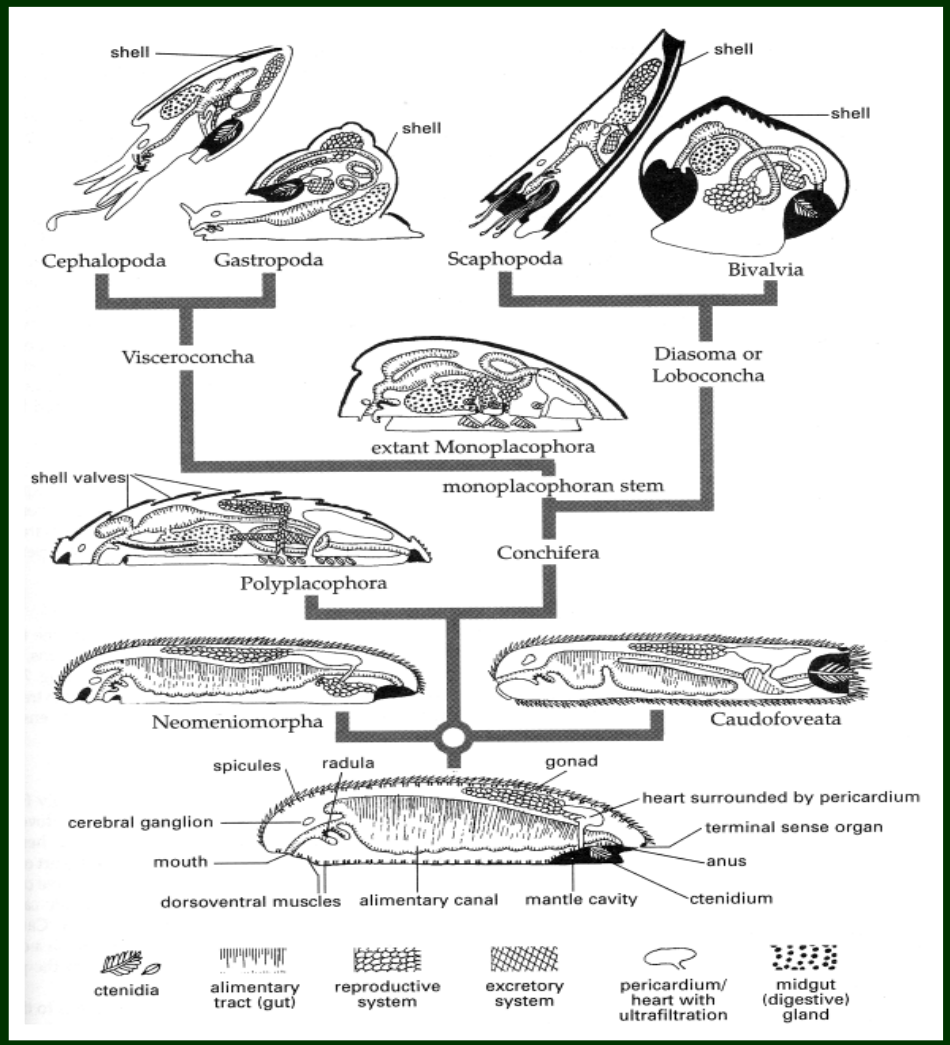

a
Polyplacophora
Neomeniomorpha
Chaetodermomorpha
Aculifera
Monoplacophora
Gastropoda
Bivalvia
Cephalopoda
Scaphopoda
Conchifera
b
Neomeniomorpha
Chaetodermomorpha
Polyplacophora
Monoplacophora
Bivalvia
Scaphopoda
Diasoma
(Loboconcha)
Gastropoda
Cephalopoda
Cyrtosoma
(Visceroconcha)
c
Neomeniomorpha
Chaetodermomorpha
Aplacophora
Polyplacophora
Monoplacophora
Bivalvia
Gastropoda
Cephalopoda
Scaphopoda
Testaria

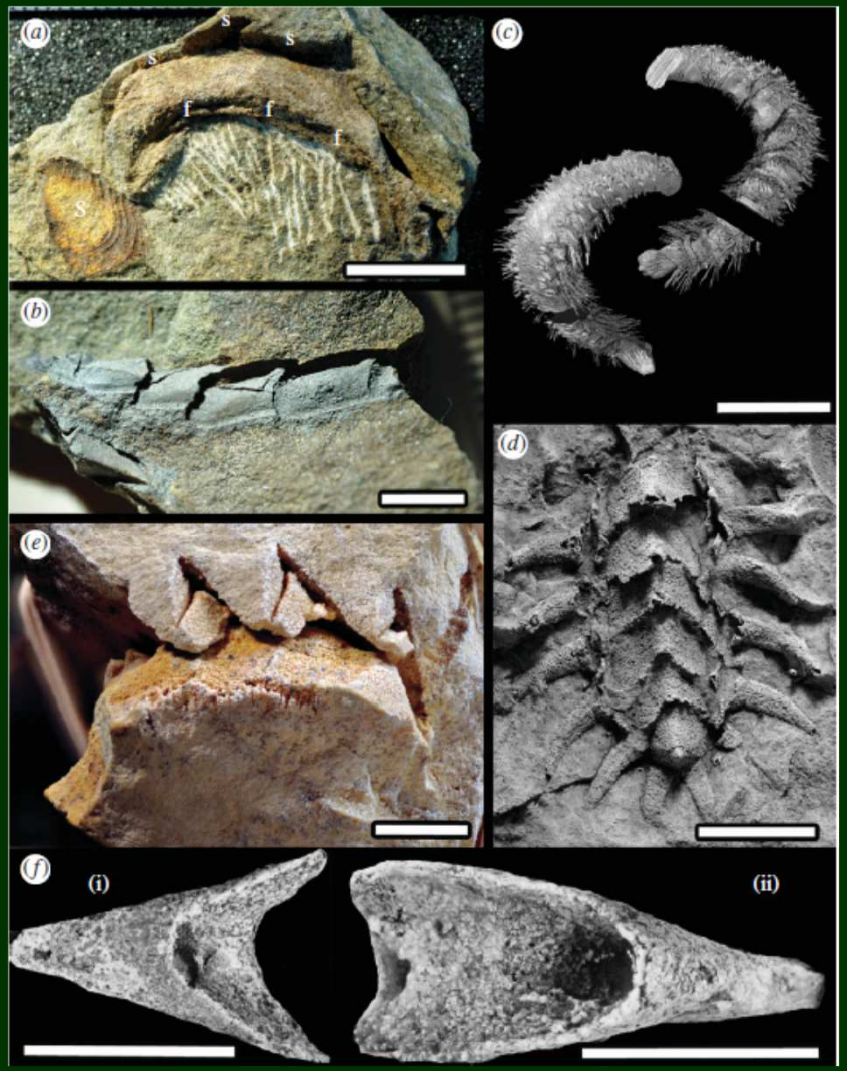

a
Conchifera
Polyplacophora
Testaria
Neomeniomorpha
Chaetodermomorpha
b
Conchifera
Polyplacophora
Testaria
Chaetodermomorpha
Neomeniomorpha
c
Neomeniomorpha
Chaetodermomorpha
Aculifera
Polyplacophora
Conchifera
d
Monoplacophora
Polyplacophora
Serialia
Neomeniomorpha
Chaetodermomorpha
Other Conchifera
e
Bivalvia
Scaphopoda
Diasoma
Gastropoda
Cephalopoda
Cyrtosoma
Monoplacophora
f
Scaphopoda
Cephalopoda
Gastropoda
Bivalvia
Monoplacophora

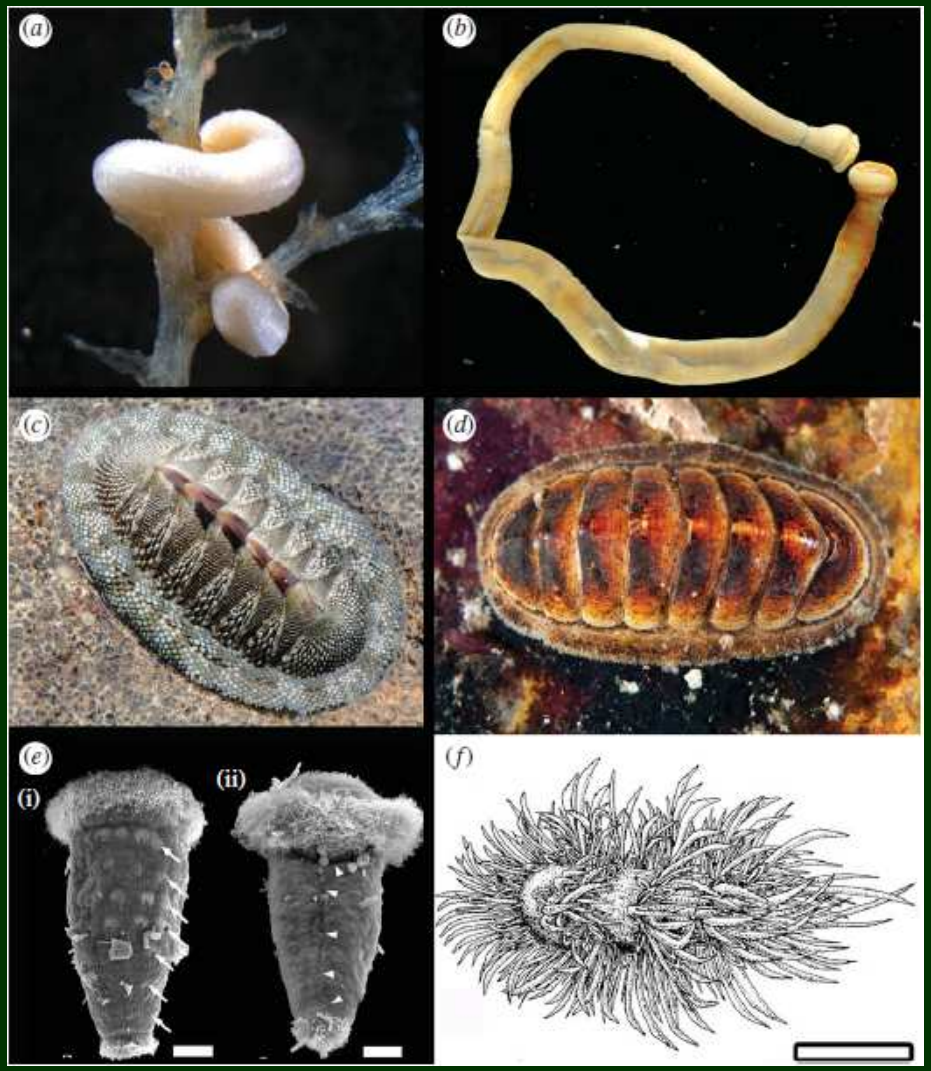

Aplacophora
Aculifera
Solenogastres
Caudofoveata
Polyplacophora
Monoplacophora
Serialia
Cephalopoda
Gastropoda
Scaphopoda
Bivalvia
Conchifera
Diasoma
Hepagastralia
Testaria
Conchifera
Cyrtosoma
Ganglionata

Mollusca

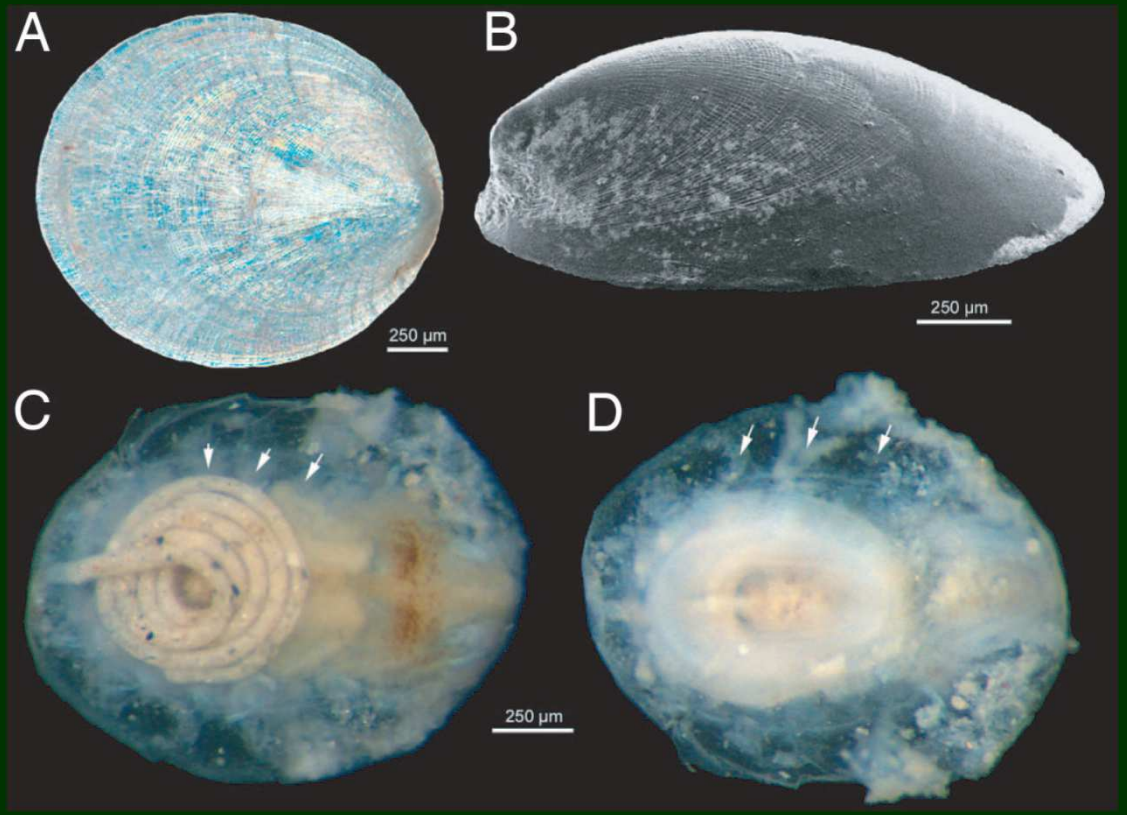
- klasická morfologická fylogeneze: parafyletická Aculifera, monofyletická Testaria (= Polyplacophora + Conchifera)



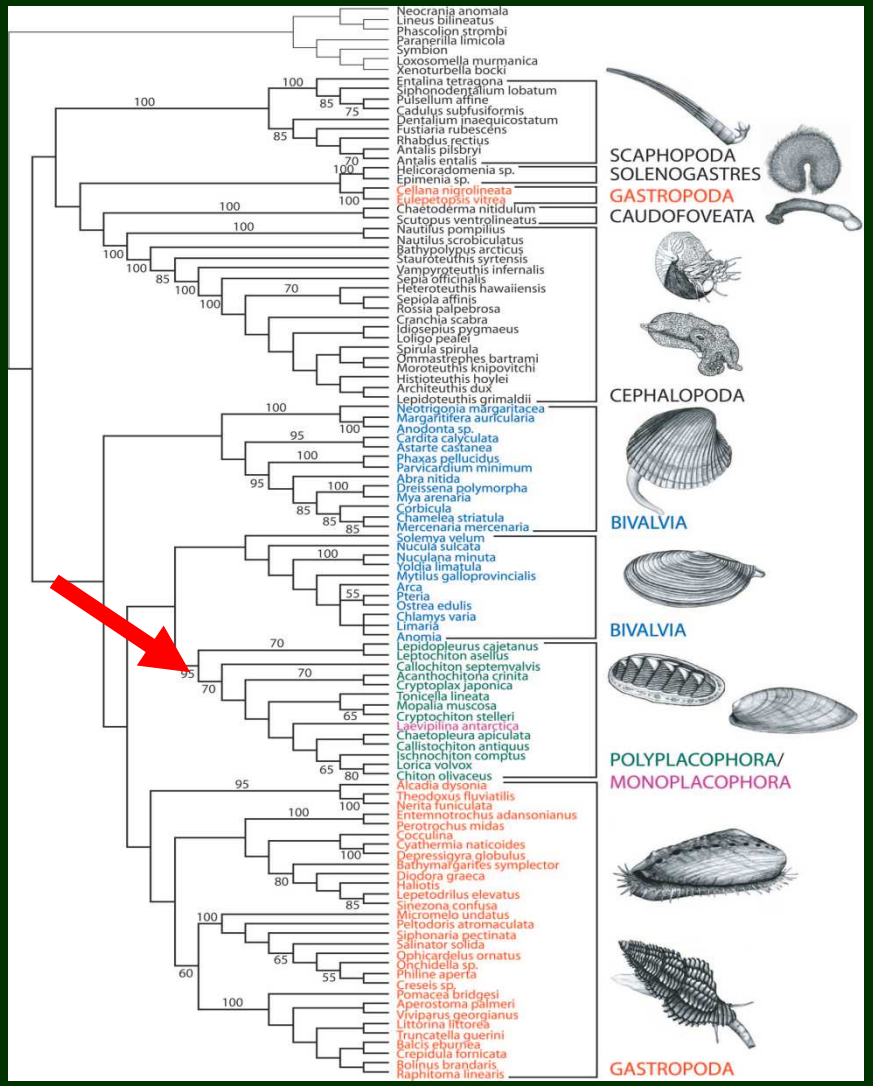

(a)
s
s
s
s
f
f
f
(b)
f
(c)
(d)
(e)
(f)
(i)
(ii)


(a)
(b)
(c)
(d)
(e)
(i)
(ii)
(f)

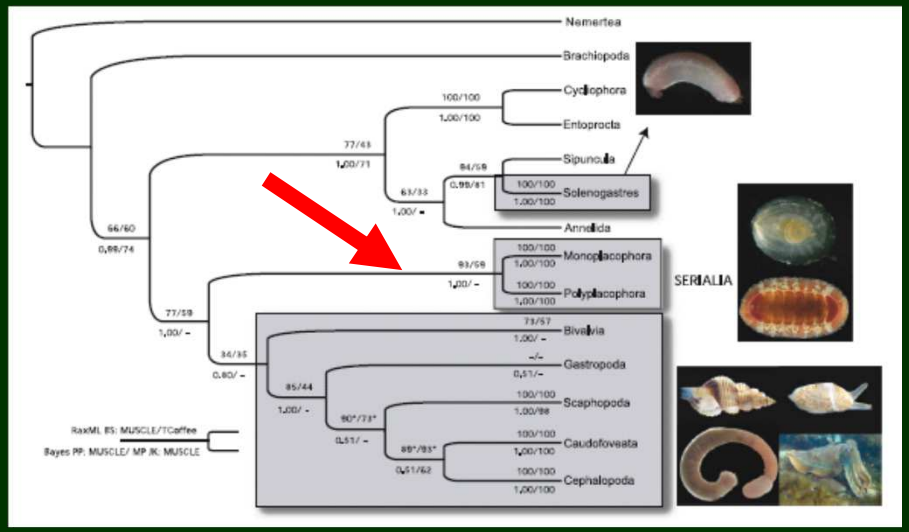
„Tryblidia“ = Neopilinomorpha (= “Monoplacophora”)



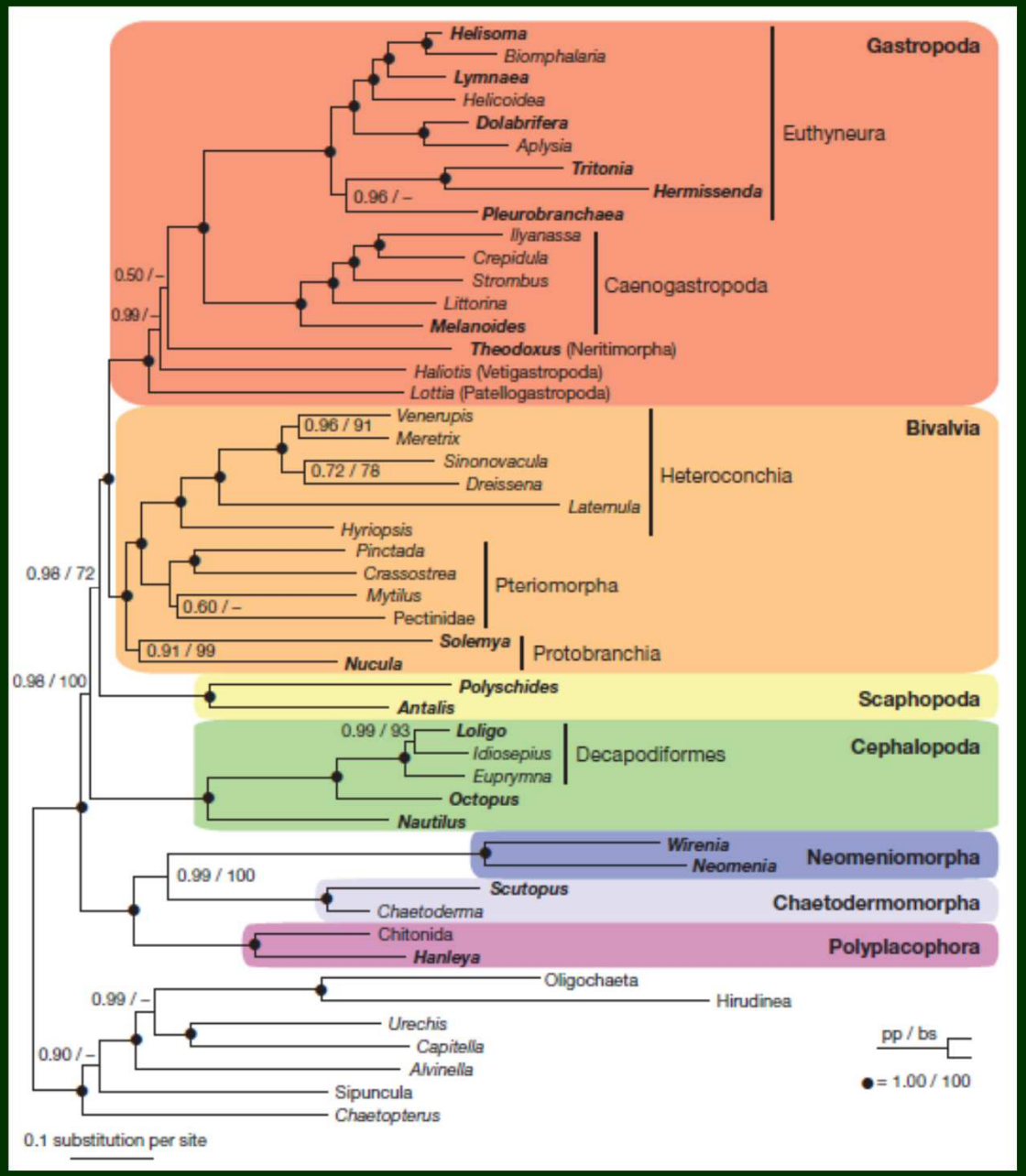
Mollusca: Serialia???

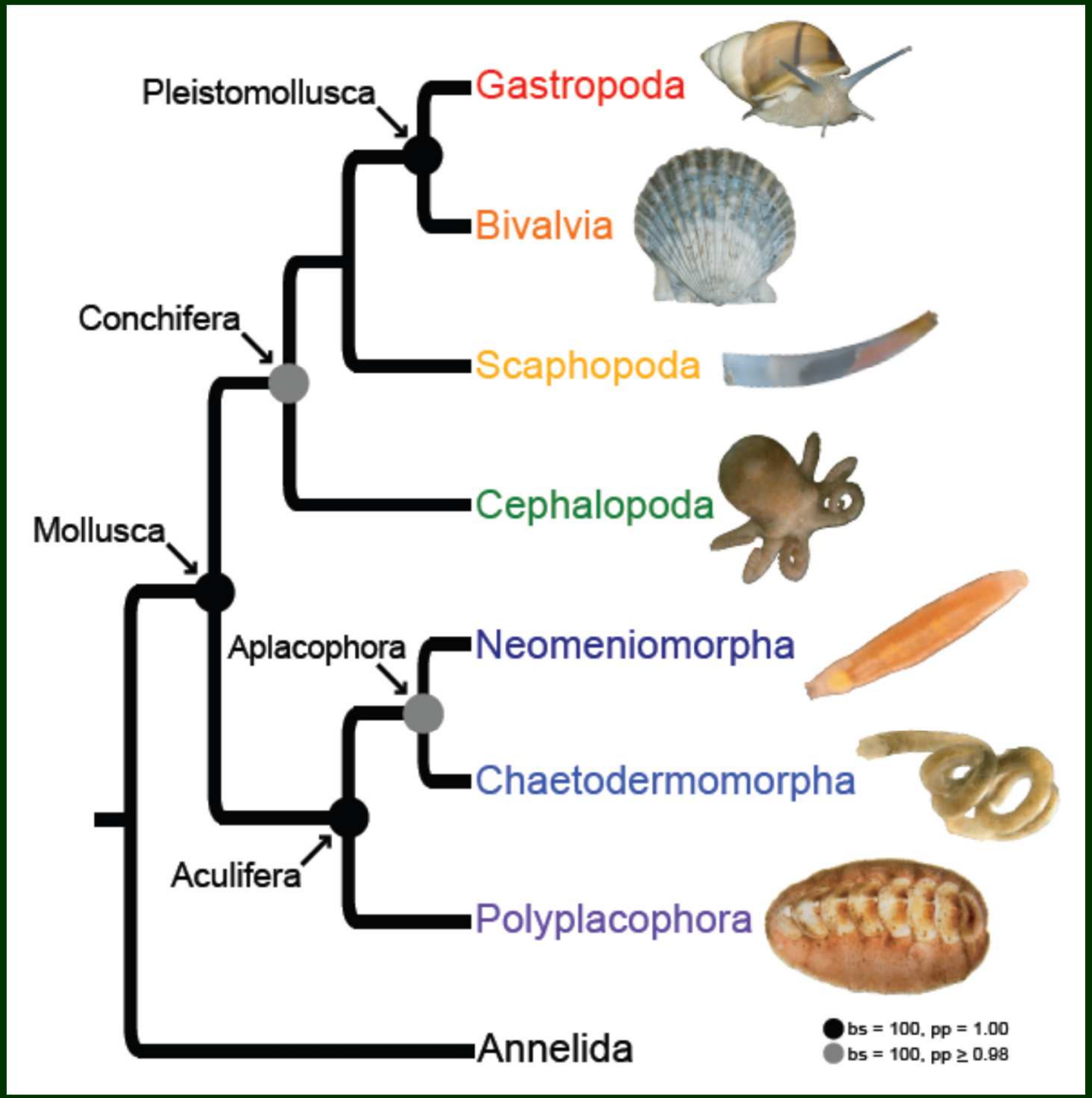


8 genů



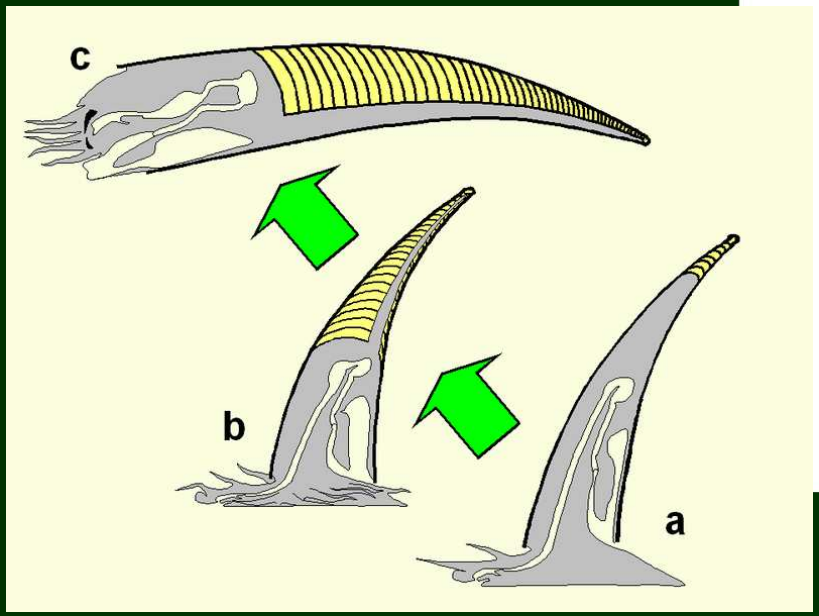
Mollusca fylogenomika 1

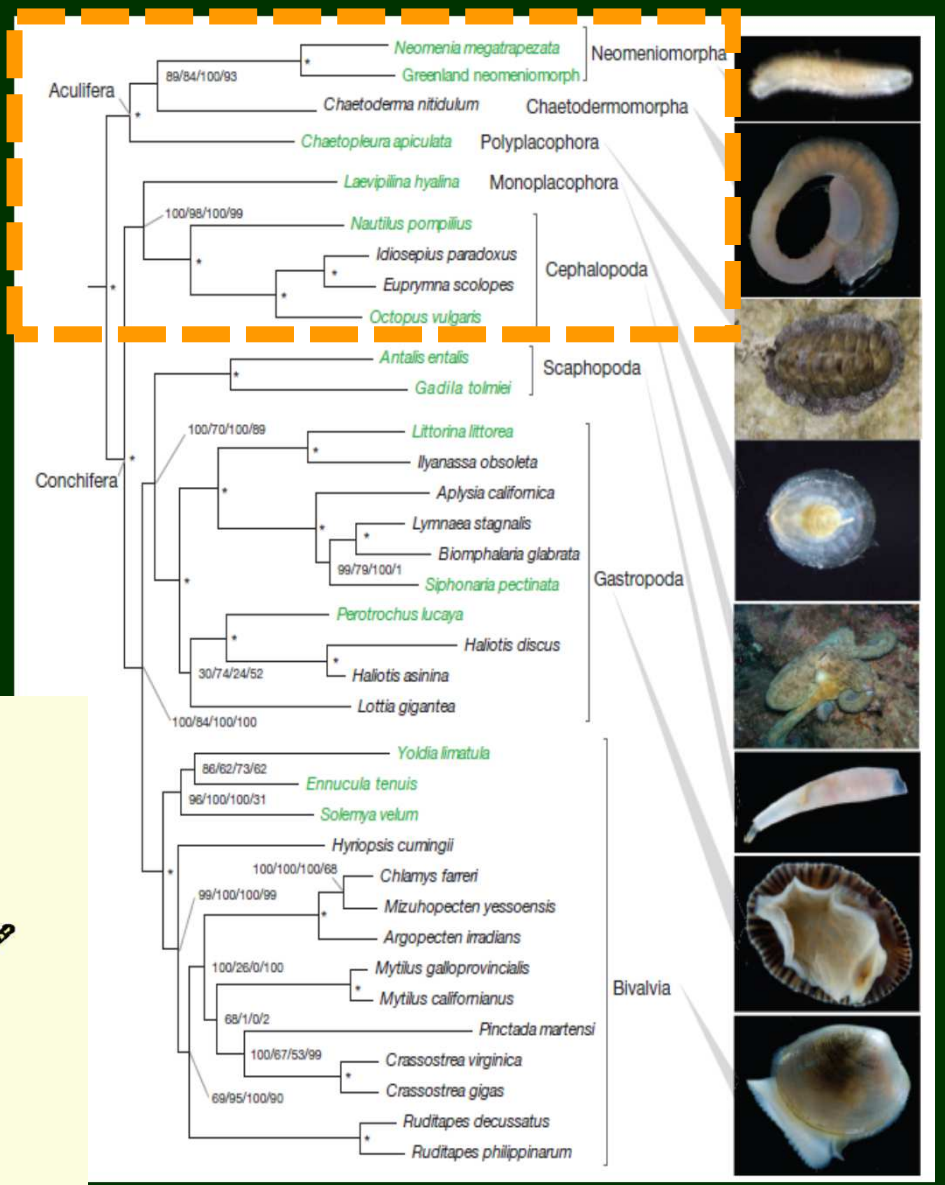



Pleistomollusca
Gastropoda
Bivalvia
Conchifera
Scaphopoda
Cephalopoda
Mollusca
Aplacophora
Neomeniomorpha
Chaetodermomorpha
Aculifera
Polyplacophora
Annelida
bs = 100, pp = 1.00
bs = 100, pp ≥ 0.98

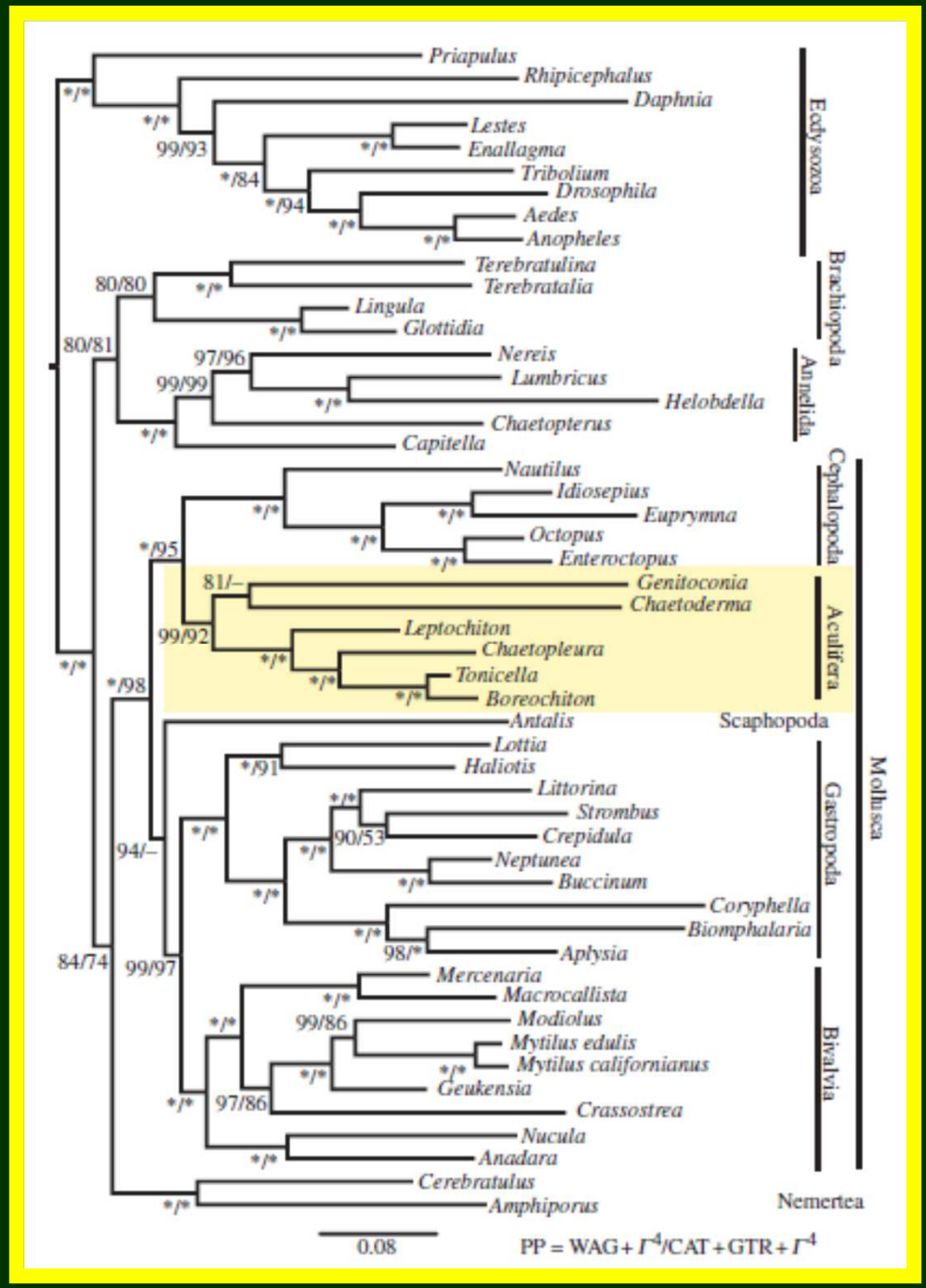
Mollusca fylogenomika 2

- multiseptátní schránky (*Nautilus* etc., Monoplacophora: Hypseloconidae)
- seriální uspořádání žaber, nefridií a srdečních atrií (*Nautilus*)

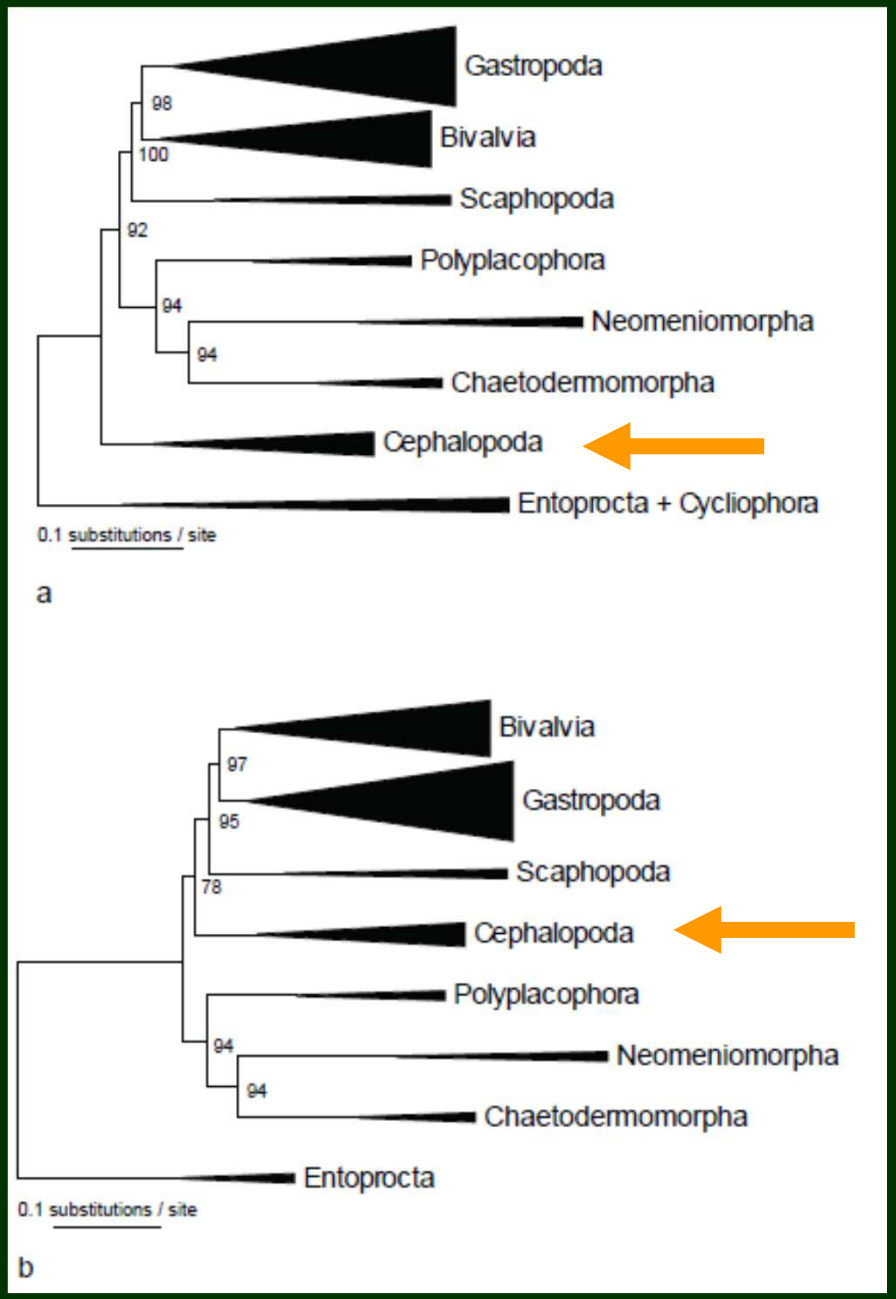




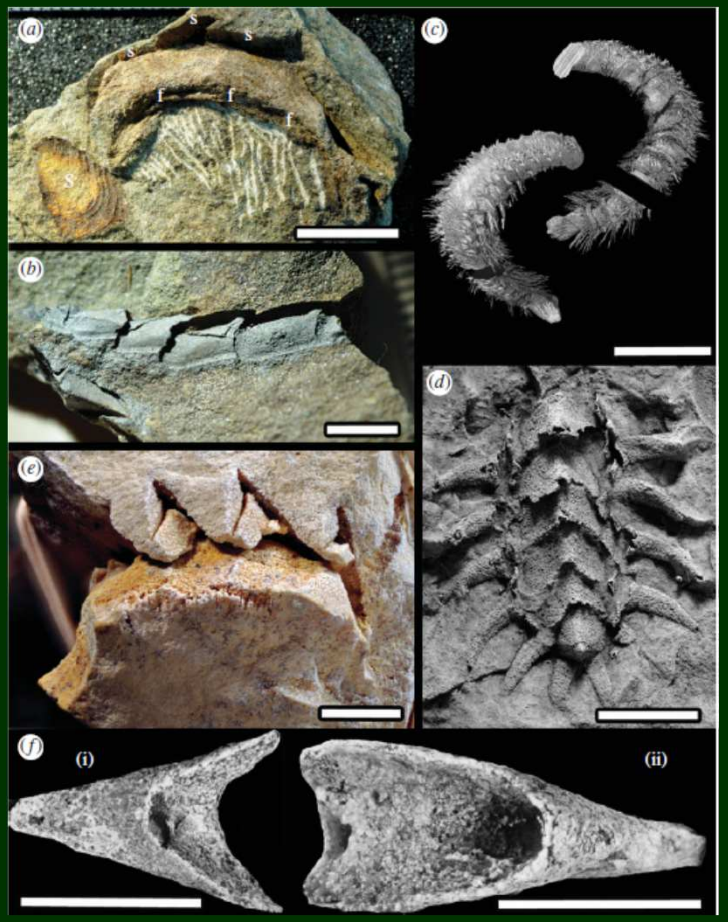
Mollusca fylogenomika 3

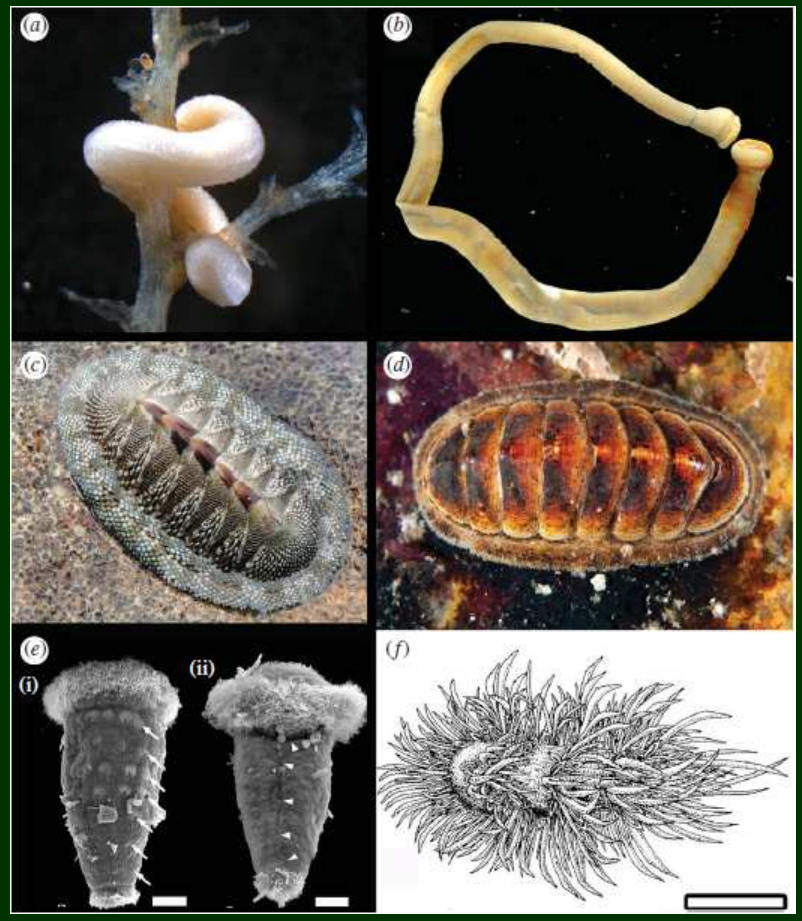


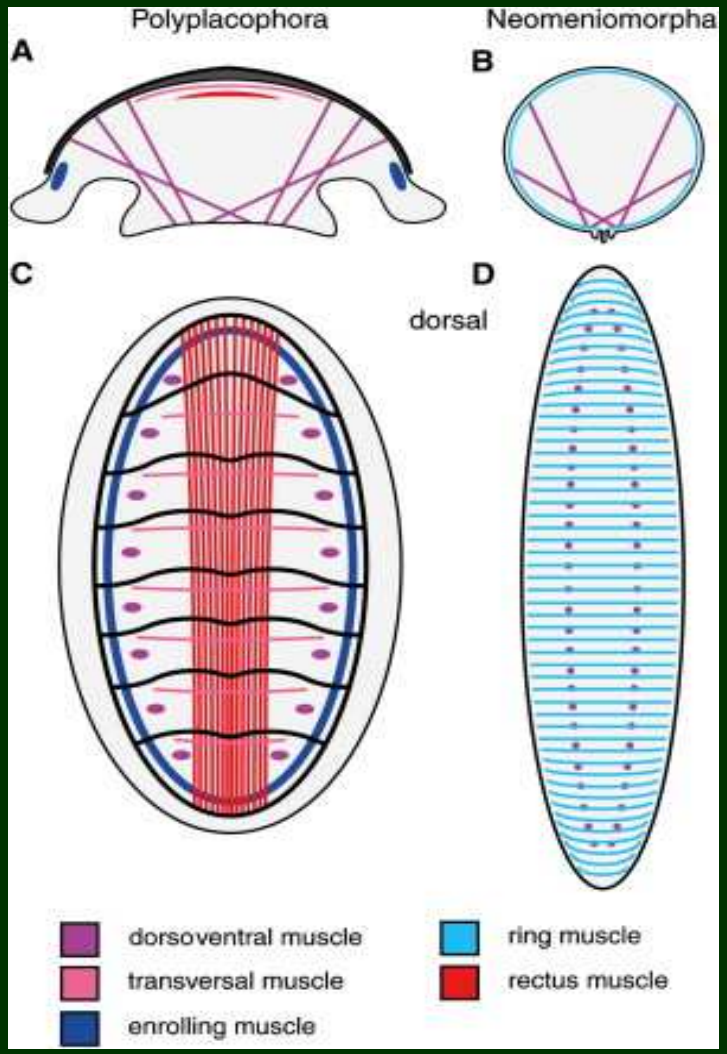
- nestabilní postavení hlavonožců

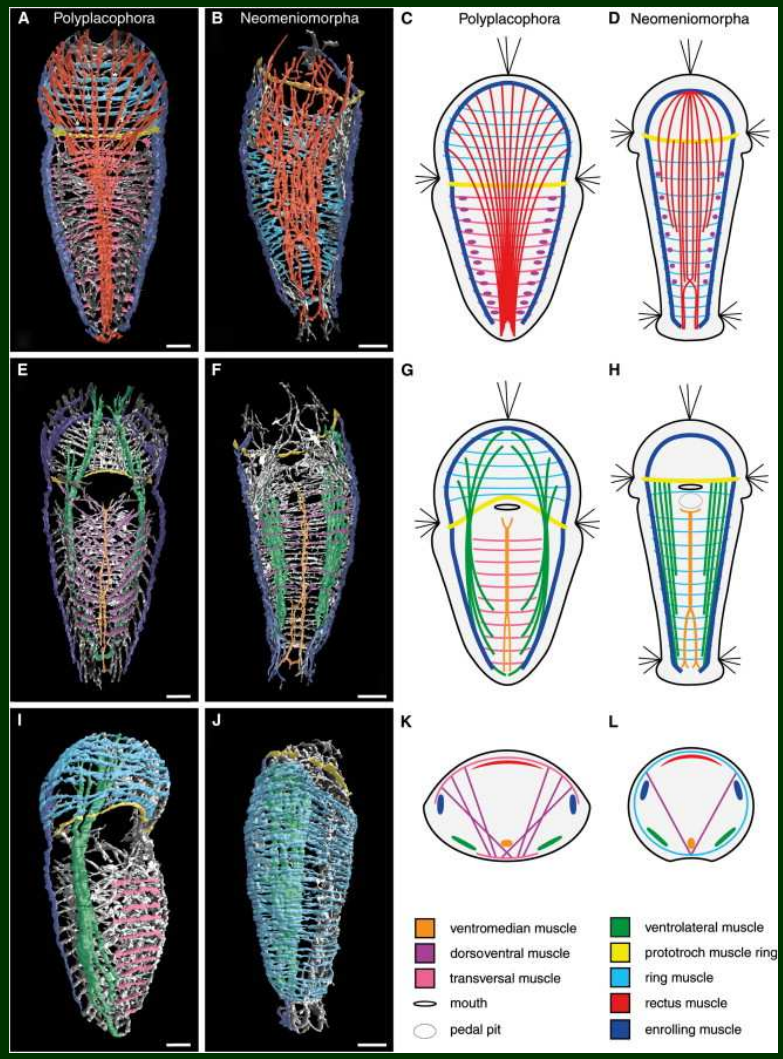


Aculifera









- Aculifera – původně válcovití (Aplacophora, larvy Polyplacophora, *Kulindroplax*) – plochý tvar polyplakofor druhotný?

Aculifera

- svalovina – zjednodušená tělní stavba aplakofor

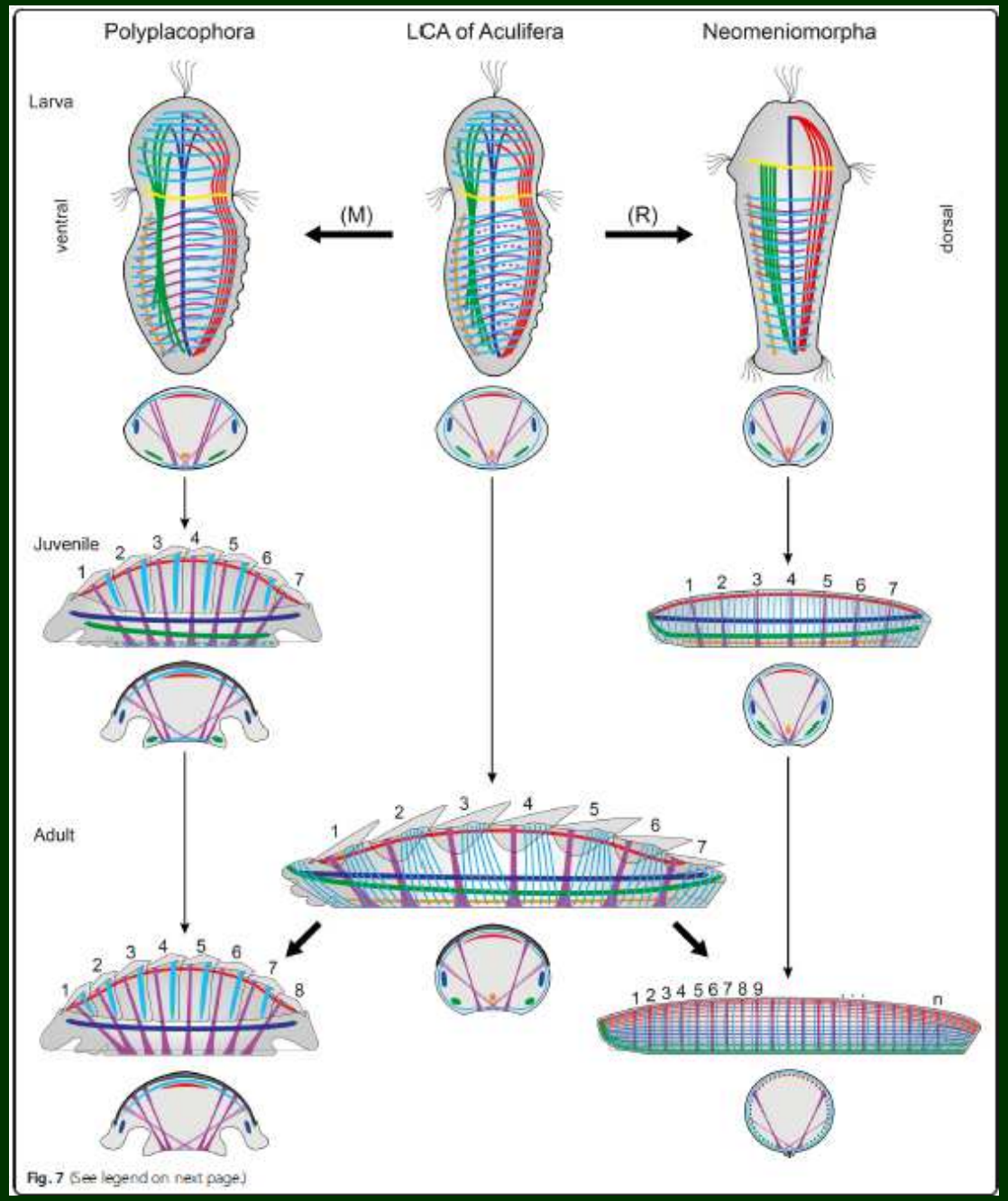
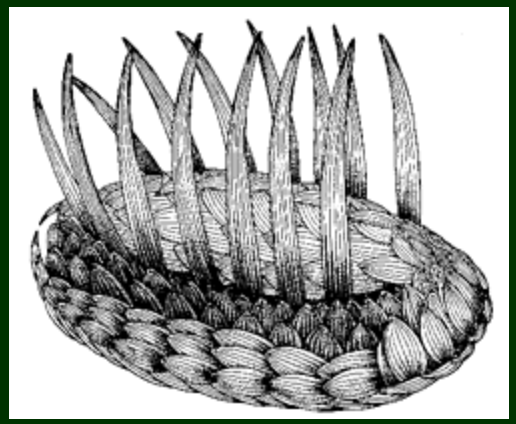
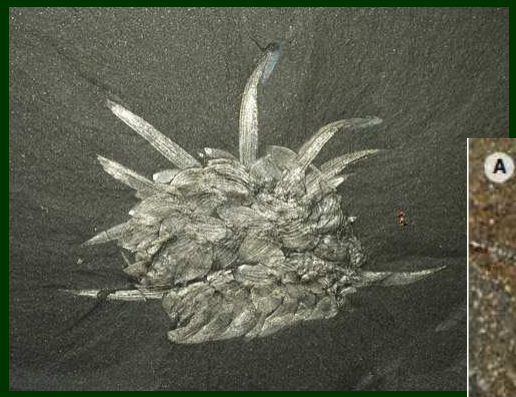
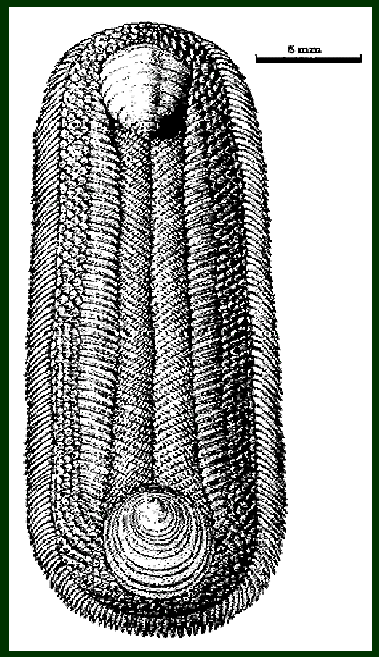


Fig. 7 (See legend on next page.)

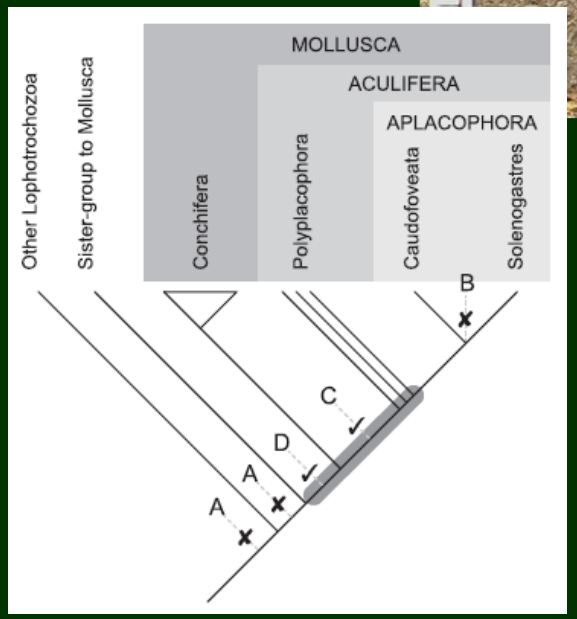


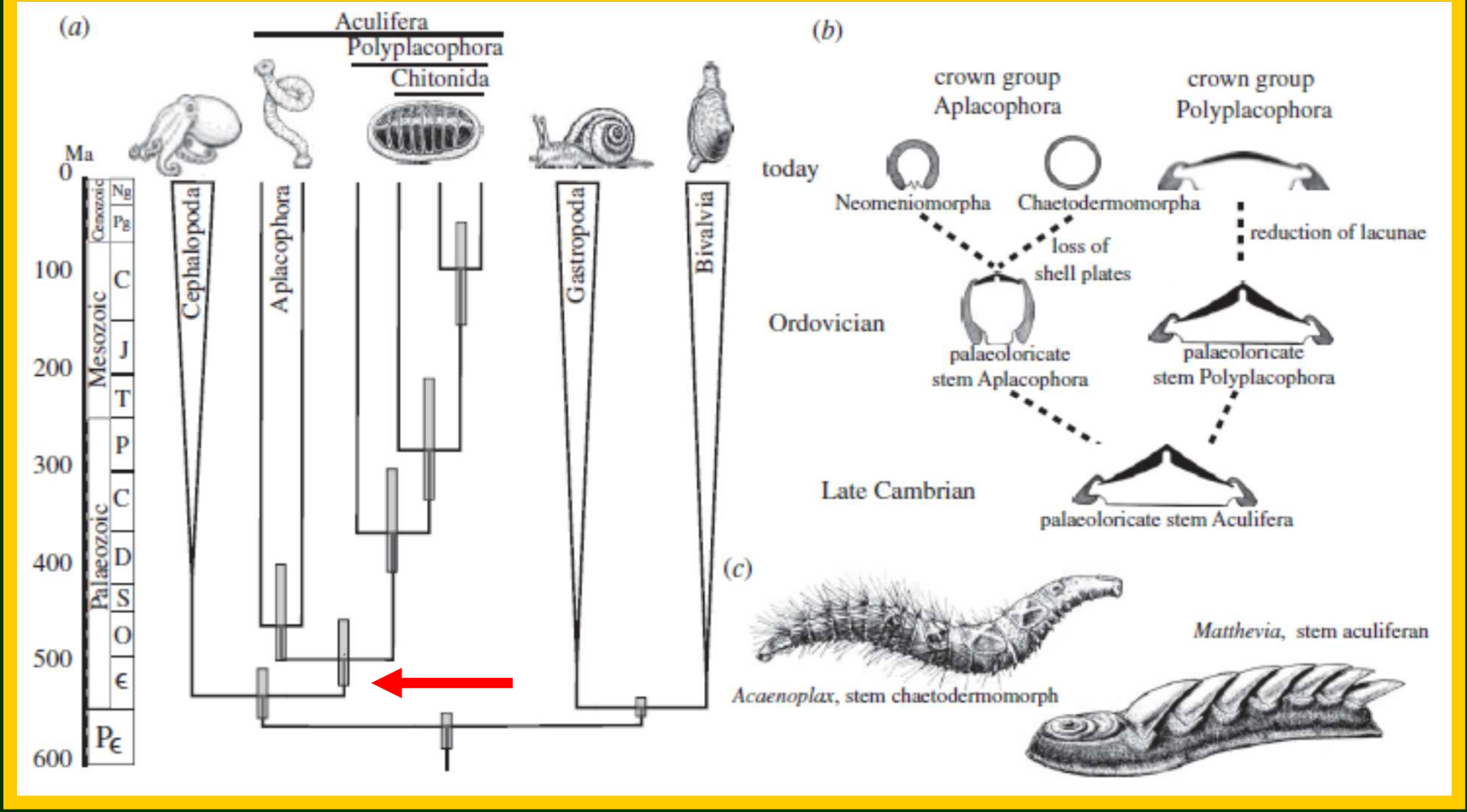


Wiwaxia



Halkieria

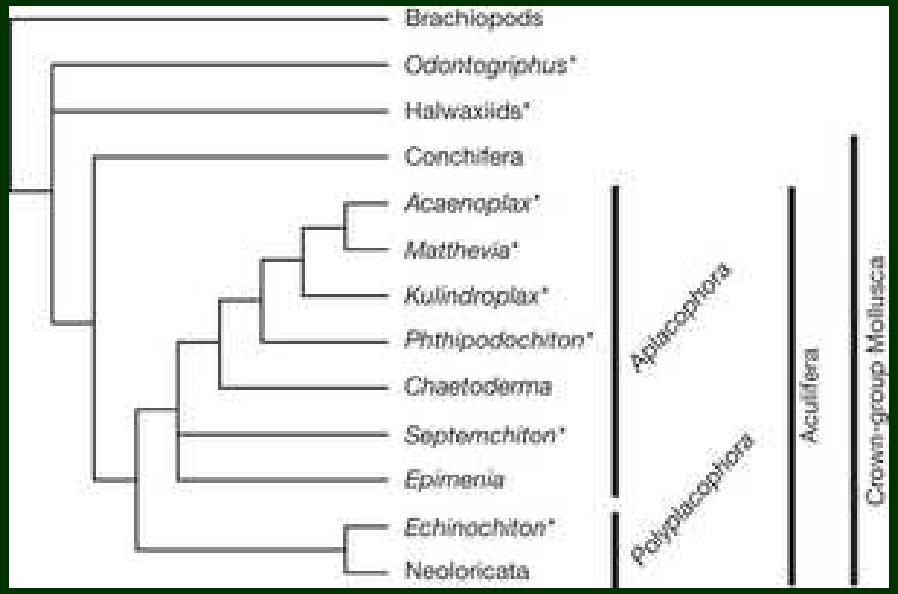




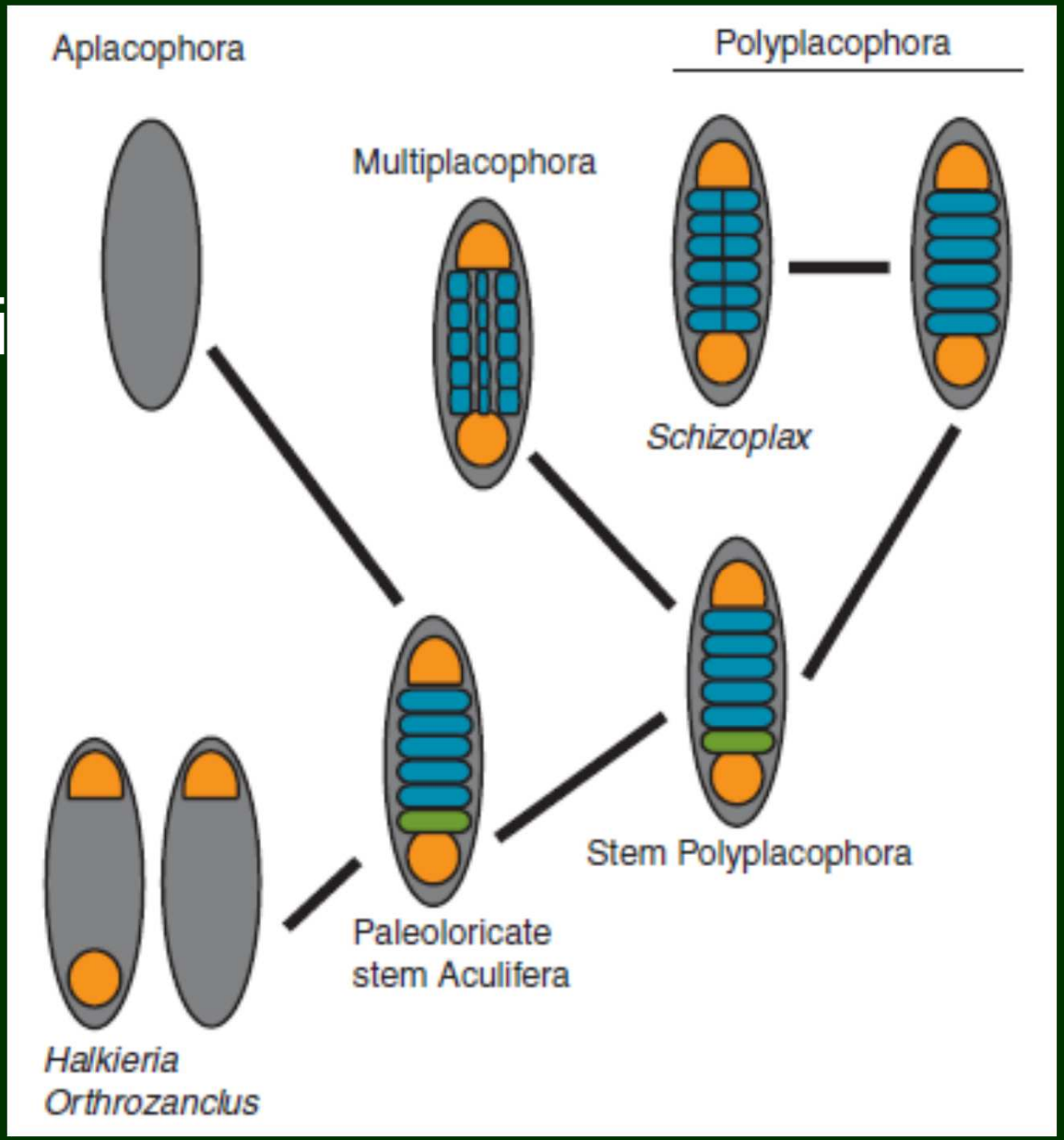
kambrijské formy *Halkieria*, *Wiwaxia* etc. patří mezi Aculifera?

Kulindroplax (silur)

- *Kulindroplax* (silur) – „aplakofor s polyplakoforními destičkami“
- „Palaeoloricata“ patří mezi Aplacophora?
- podpora pro monofylii Aculifera

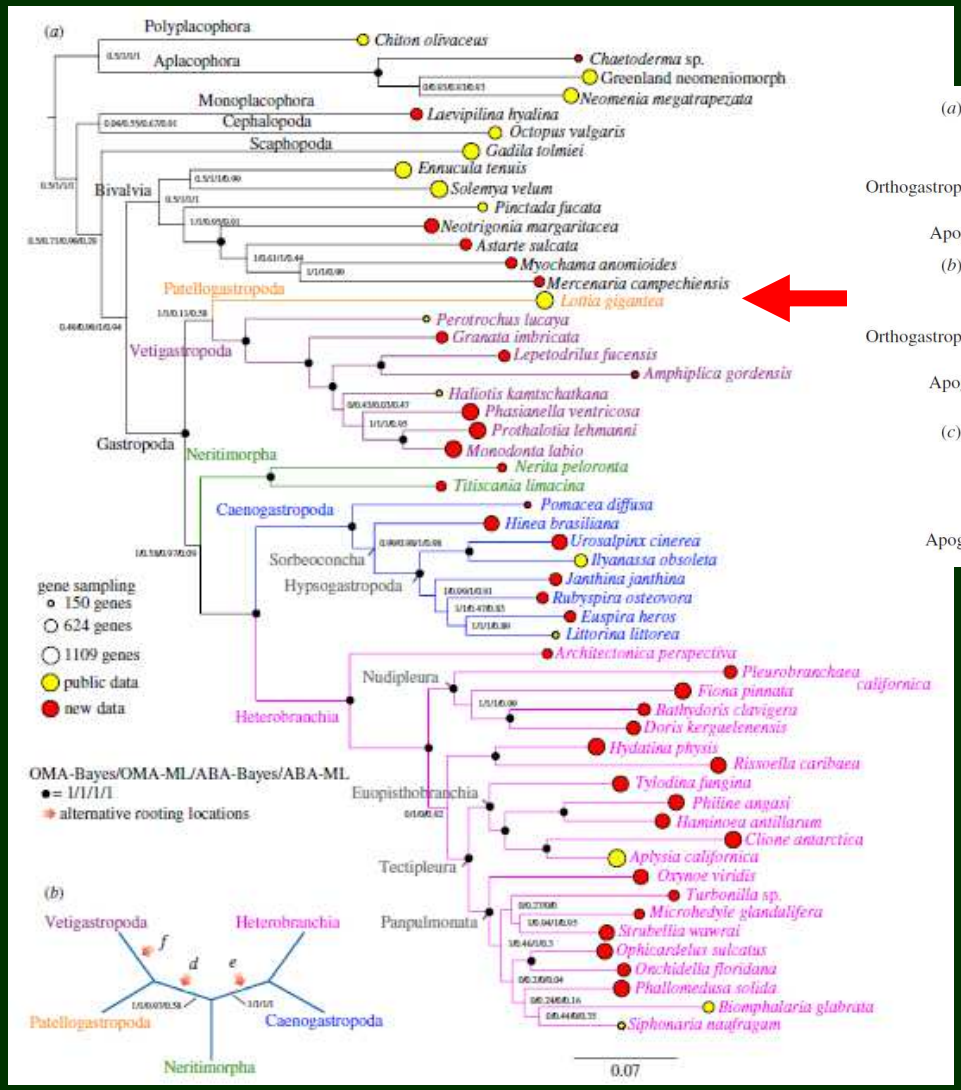


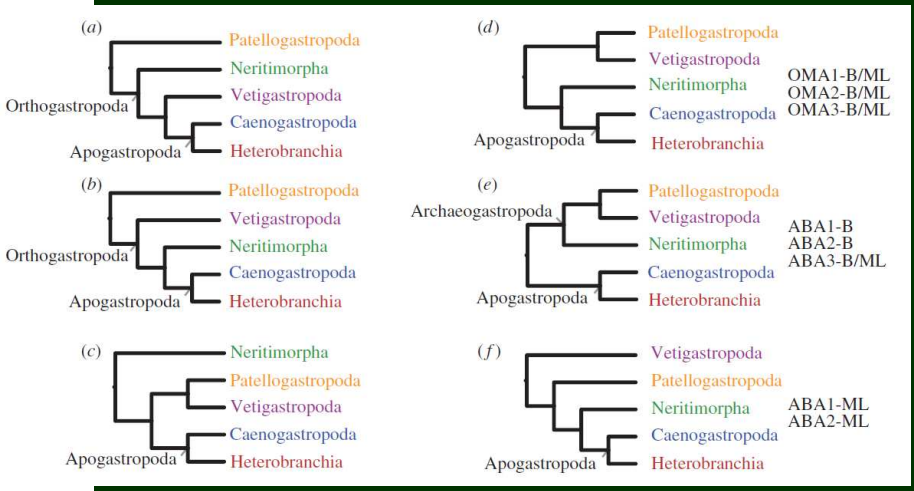
- Multi


Aplacophora
Polyplacophora
Multiplacophora
Schizoplax
Stem Polyplacophora
Paleoloricate
stem Aculifera
Halkieria
Orthrozanclus

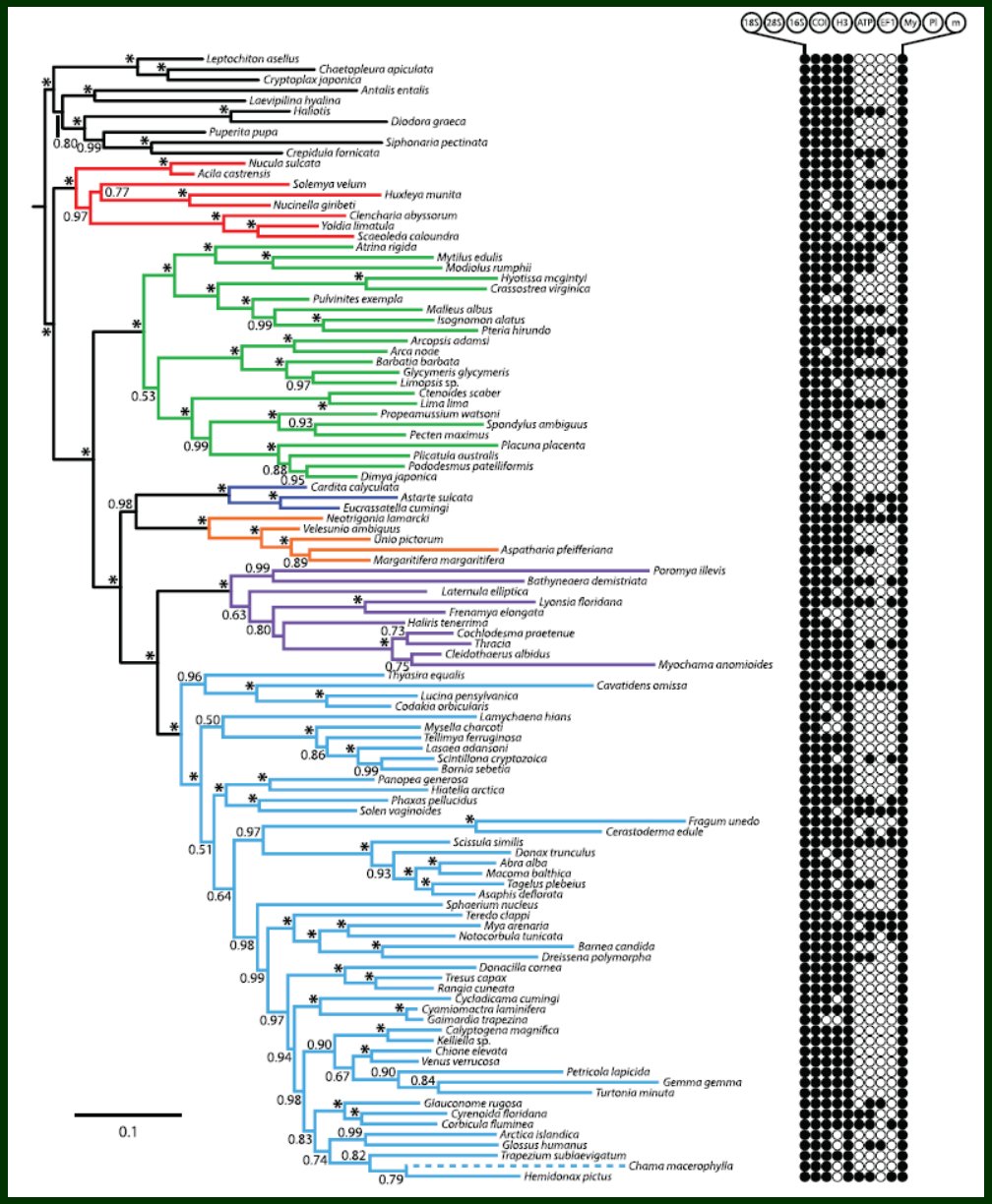
Gastropoda

Gastropoda


(a)
Polyplacophora
Chiton olivaceus
Aplacophora
Chaetoderma sp.
Greenland neomeniomorph
Neomenia megatrapezata
Monoplacophora
Laevipilina hyalina
Cephalopoda
Octopus vulgaris
Scaphopoda
Gadila tolmiei
Bivalvia
Ennucula tenuis
Solemya velum
Pinctada fucata
Neotrigonia margaritacea
Astarte sulcata
Myochama anomioides
Mercenaria campechiensis
Patellogastropoda
Lottia gigantea
Perotrochus lucaya
Vetigastropoda
Granata imbricata
Lepetodrilus fucensis
Amphiplica gordensis
Haliotis kamtschatkana
Phasianella ventricosa
Prothalotia lehmanni
Monodonta labio
Gastropoda
Neritimorpha
Nerita peloronta
Titiscania limacina
Caenogastropoda
Pomacea diffusa
Hinea brasiliana
Urosalpinx cinerea
Sorbeoconcha
Ilyanassa obsoleta
Hypsogastropoda
Janthina janthina
Rubyspira osteovora
Euspira heros
Littorina littorea
Architectonica perspectiva
Nudipleura
Pleurobranchaea californica
Fiona pinnata
Heterobranchia
Bathydoris clavigera
Doris kerguelenensis
Hydatina physis
Rissoella caribaea
Tylodina fungina
Philine angasi
Euopisthobranchia
Haminoea antillarum
Clione antarctica
Aplysia californica
Tectipleura
Oxynoe viridis
Turbonilla sp.
Microhedyle glandulifera
Pulmonata
Strubellia wareni
Ophicardelus sulcatus
Onchidella floridana
Phallomedusa solida
Biomphalaria glabrata
Siphonaria naufragum
0.07
gene sampling
150 genes
624 genes
1109 genes
public data
new data
OMA-Bayes/OMA-ML/ABA-Bayes/ABA-ML
= 1/1/1/1
alternative rooting locations
(b)
Vetigastropoda
Heterobranchia
f
d
e
Patellogastropoda
Caenogastropoda
Neritimorpha


(a)
Patellogastropoda
Neritimorpha
Vetigastropoda
Orthogastropoda
Caenogastropoda
Apogastropoda
Heterobranchia
(b)
Patellogastropoda
Vetigastropoda
Neritimorpha
Orthogastropoda
Caenogastropoda
Apogastropoda
Heterobranchia
(c)
Neritimorpha
Patellogastropoda
Vetigastropoda
Caenogastropoda
Apogastropoda
Heterobranchia
(d)
Patellogastropoda
Vetigastropoda
Neritimorpha
OMA1-B/ML
OMA2-B/ML
OMA3-B/ML
Caenogastropoda
Apogastropoda
Heterobranchia
(e)
Archaeogastropoda
Patellogastropoda
Vetigastropoda
Neritimorpha
ABA1-B
ABA2-B
ABA3-B/ML
Caenogastropoda
Apogastropoda
Heterobranchia
(f)
Vetigastropoda
Patellogastropoda
Neritimorpha
ABA1-ML
ABA2-ML
Caenogastropoda
Apogastropoda
Heterobranchia

Bivalvia



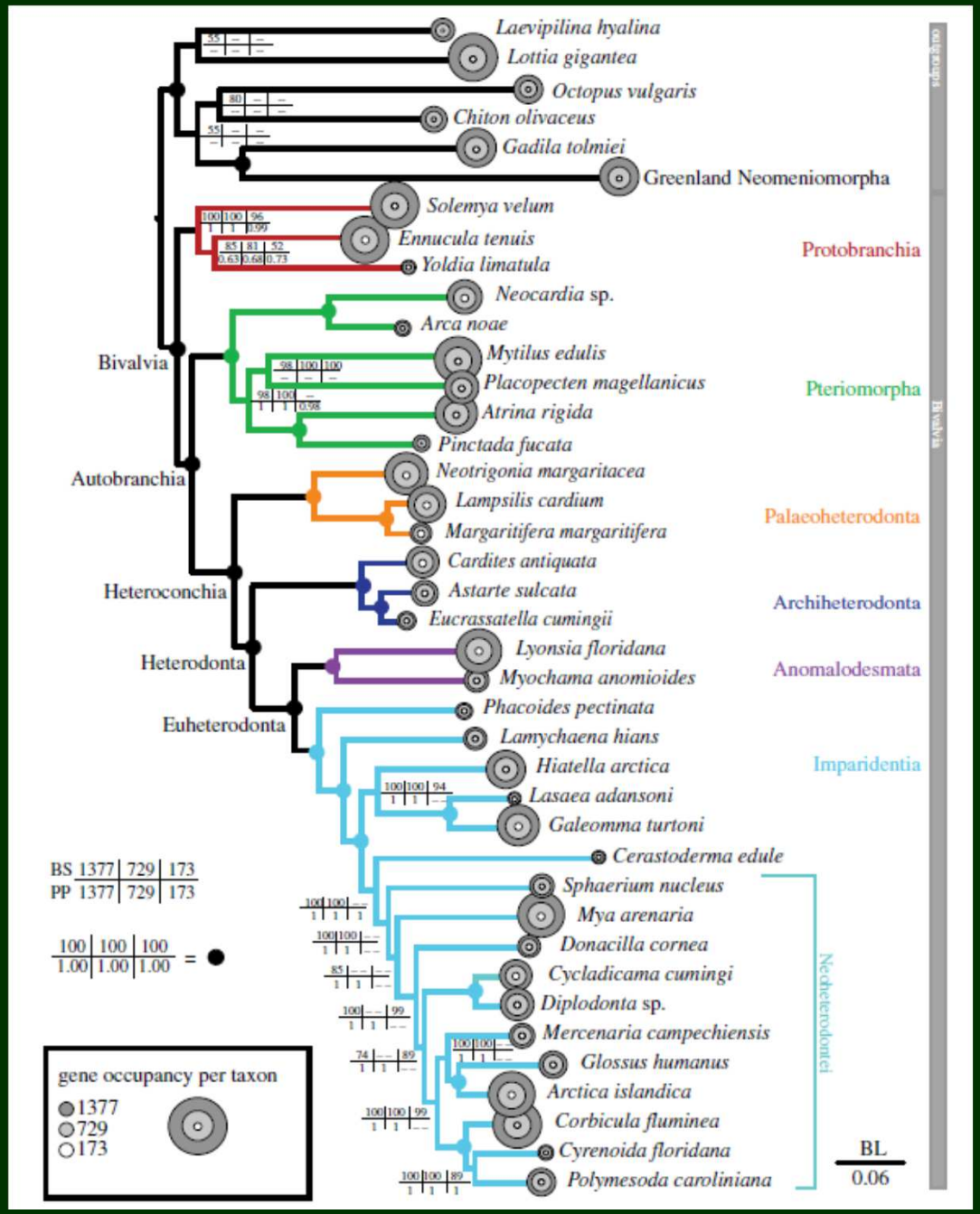
Protobranchia (red), Pteriomorphia (green), Palaeoheterodonta (orange), Archiheterodonta (dark blue), Anomalodesmata (purple), and Imparidentia (light blue). Outgroup taxa appear in black.

Bivalvia

5–9 genů + morfologie (210 znaků)

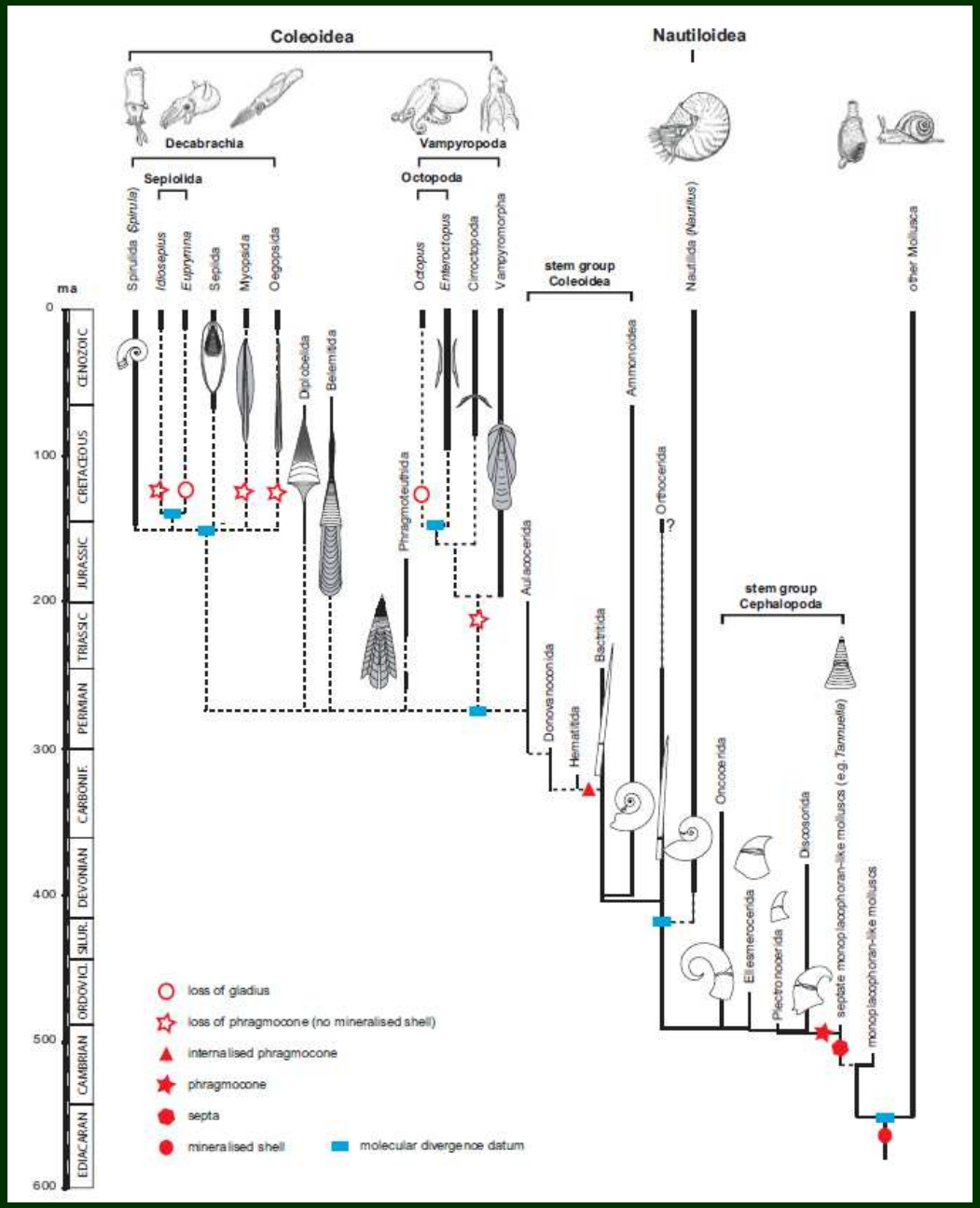
Bivalvia fylogenomika

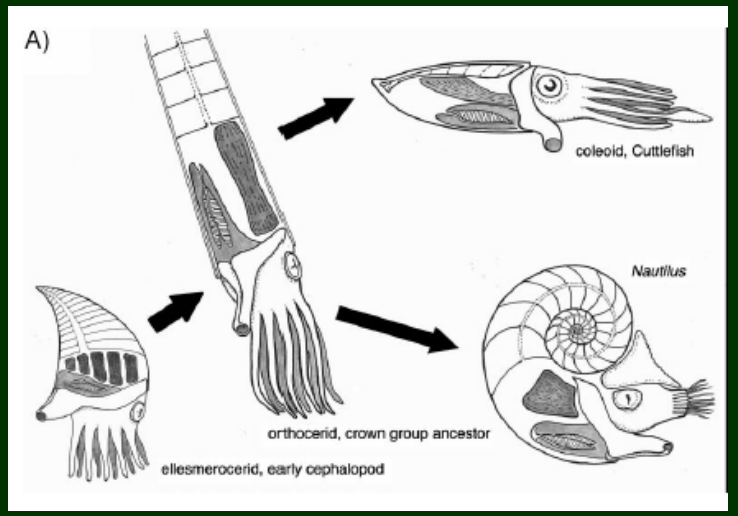
1377 genů

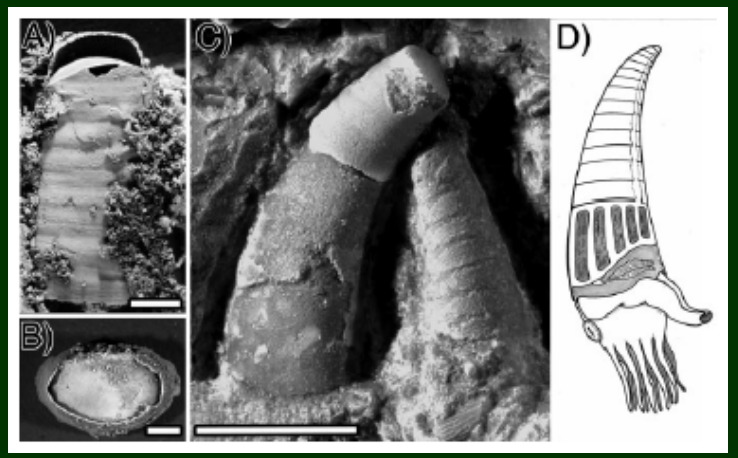


Cephalopoda

Cephalopoda

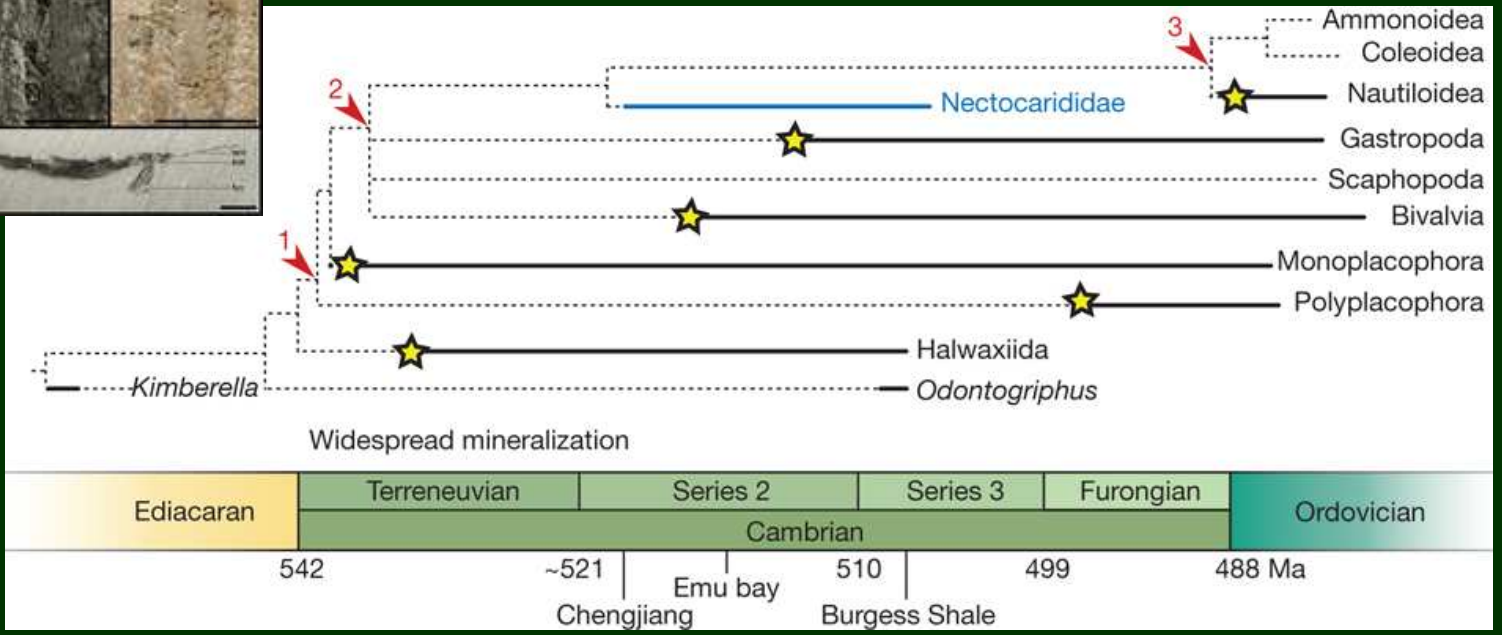


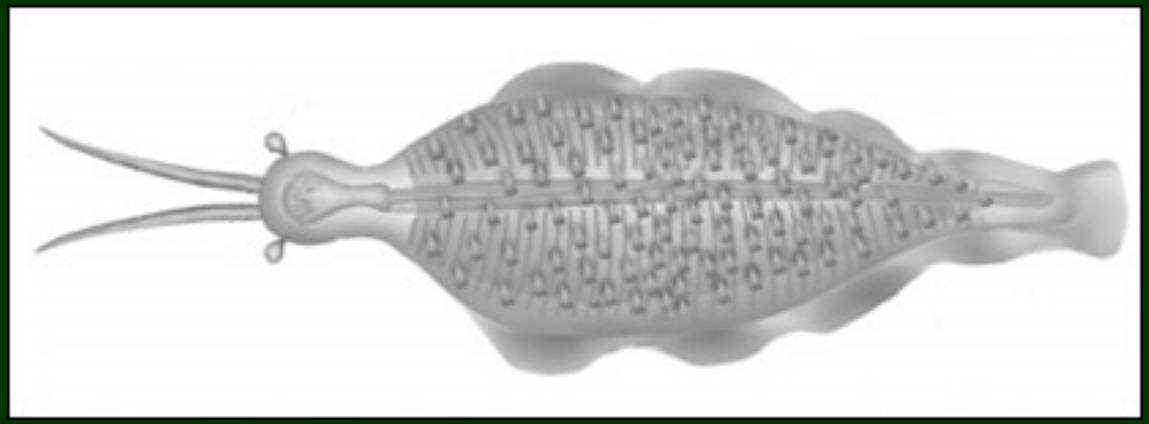




kambrium: *Plectronoceras*

Nectocaris jako hlavonožec?

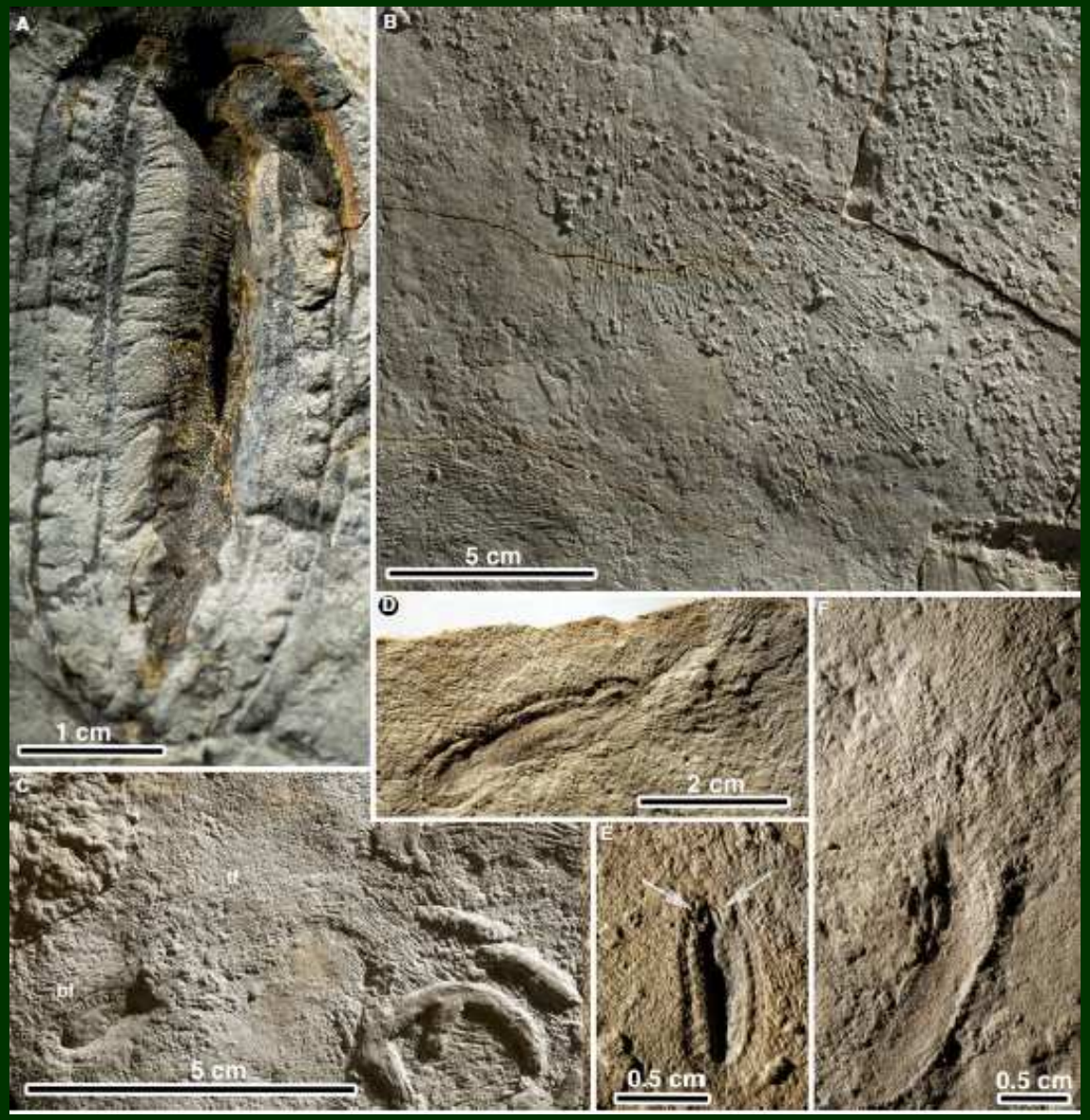




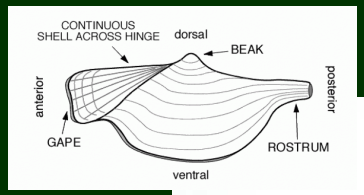
Vetustodermis

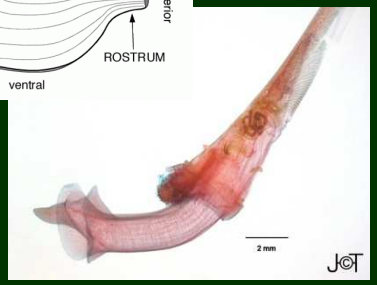
Ediakarští měkkýši?

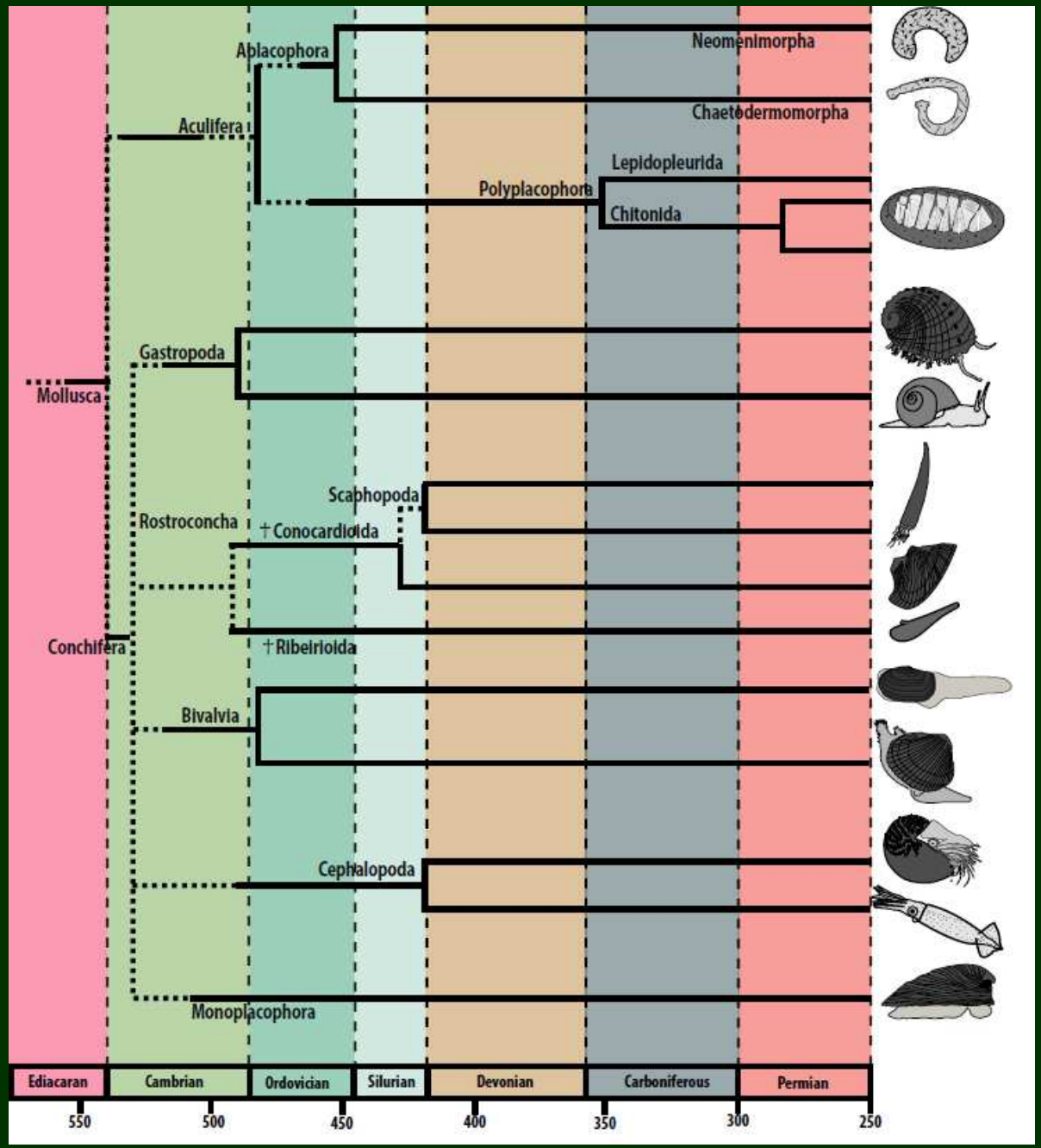
- *Kimberella*
- (+ *Kimberichnus*)



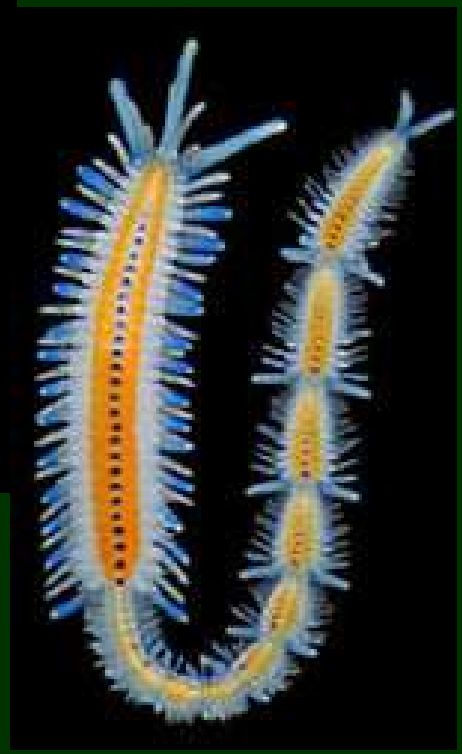
- Scaphopoda: z parafyletických rostrokonch (kambrium–perm)

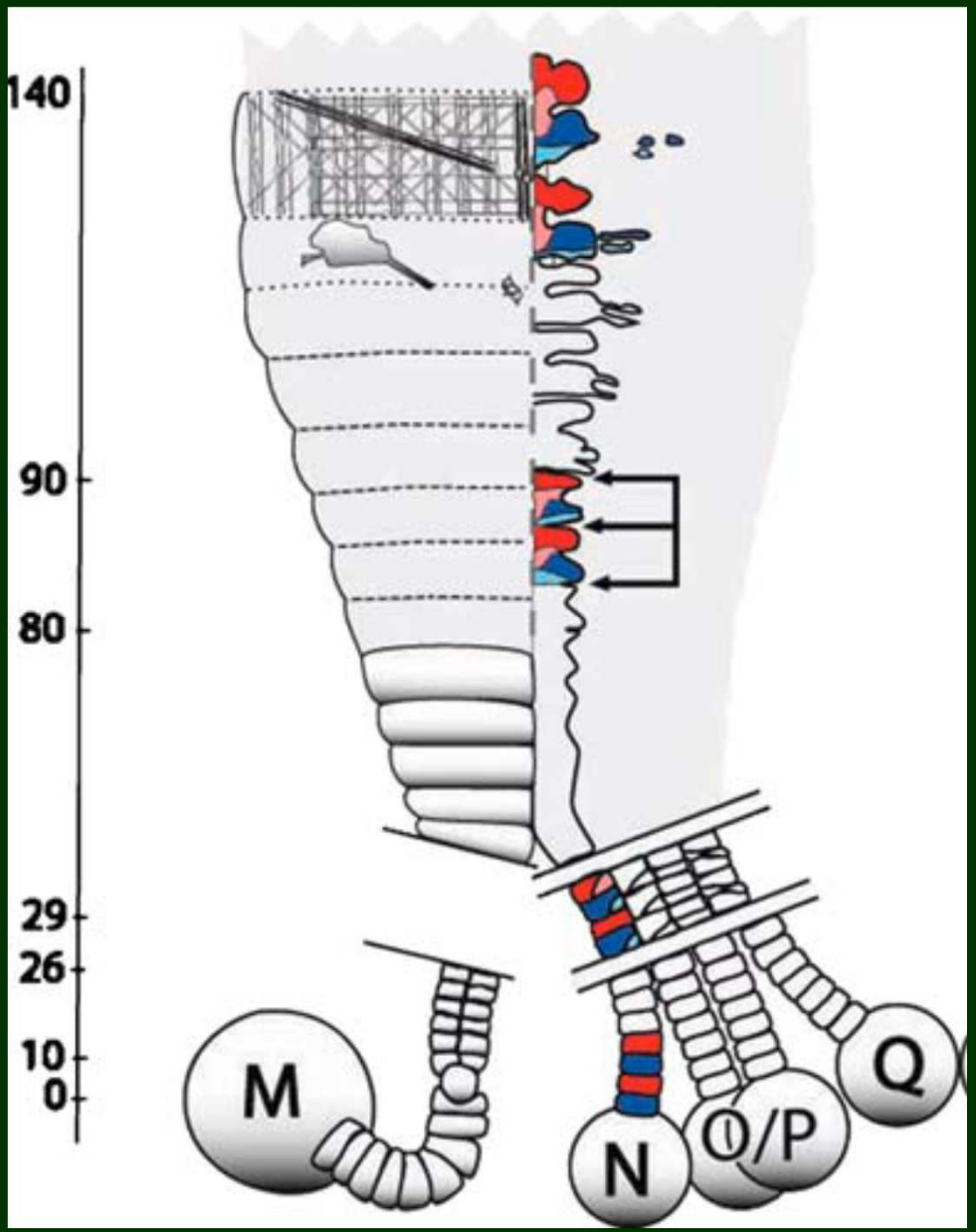






Annelida





Segmentace a teloblasty

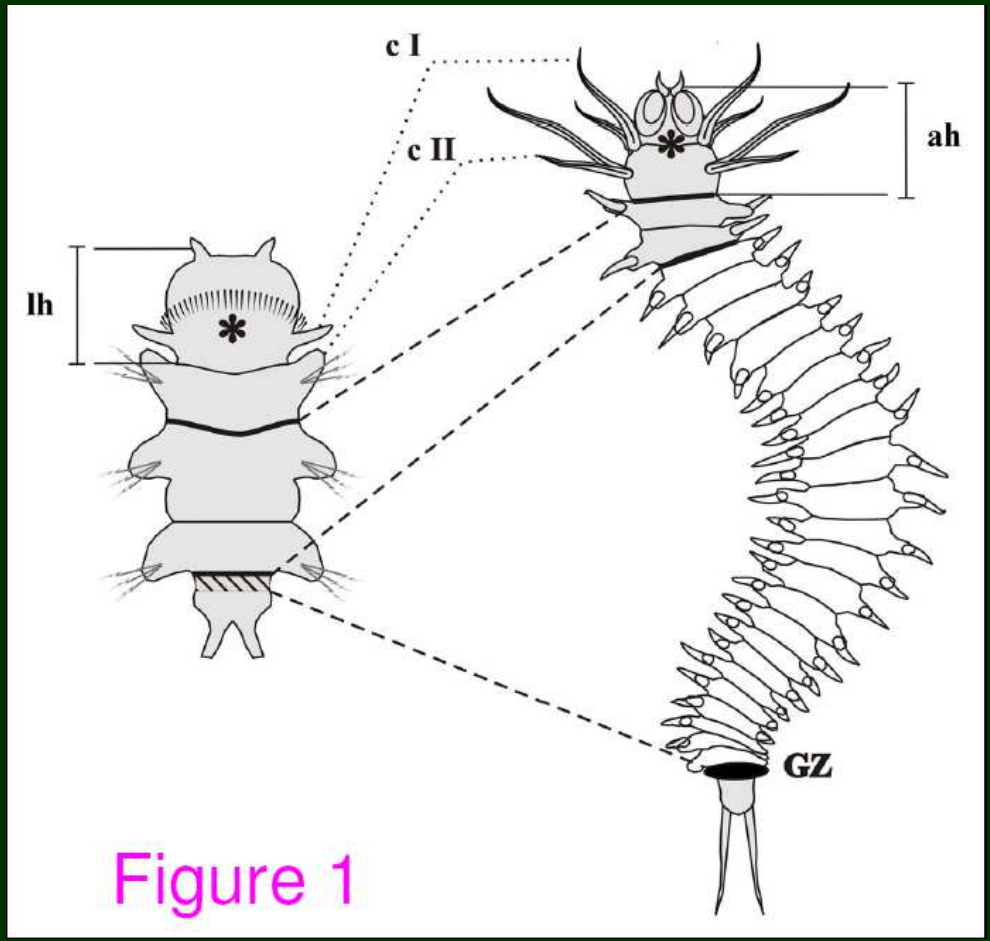


Figure 1

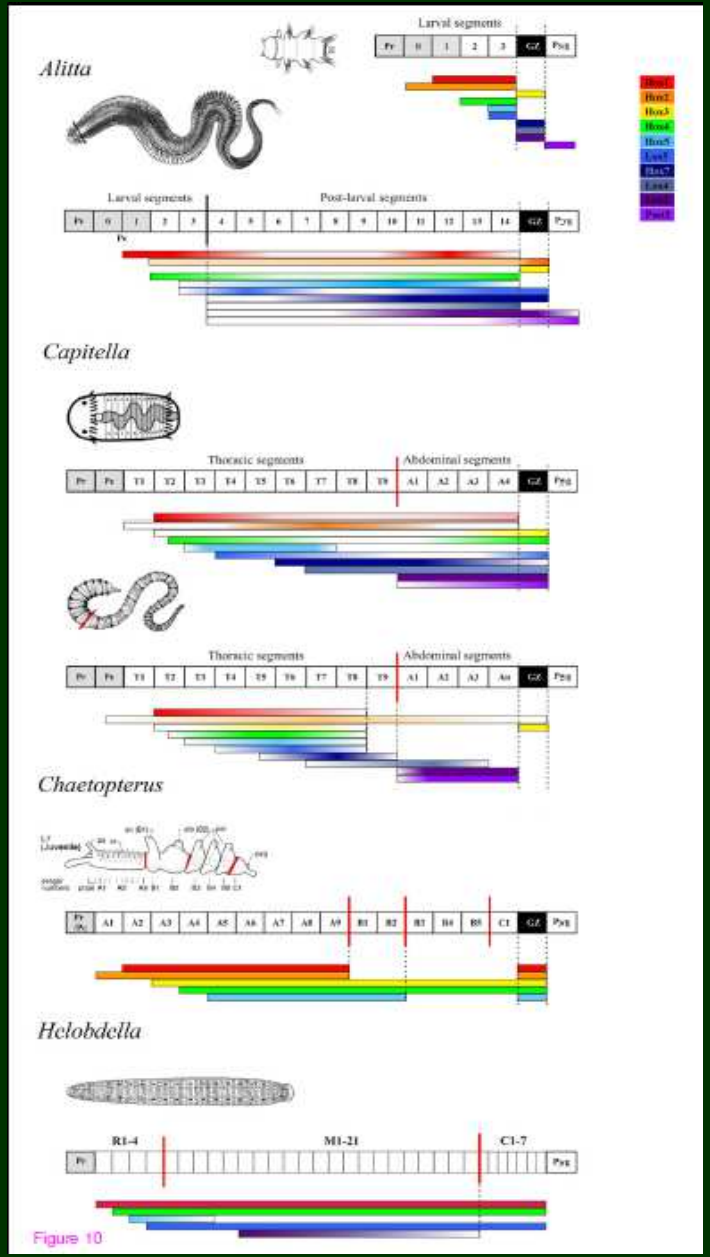


Figure 10

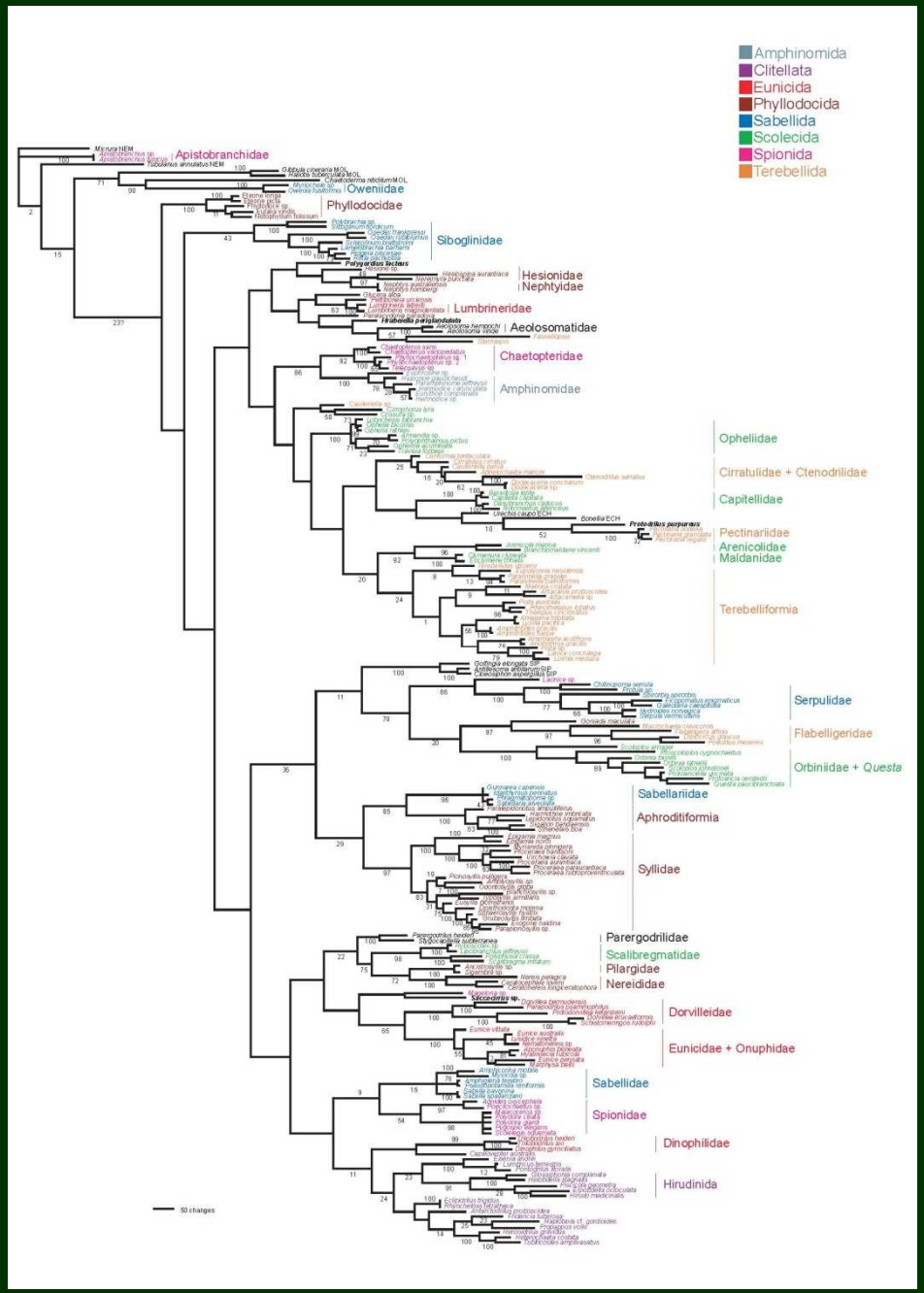
Annelida

Polychaeta

Clitellata

\+ *incertae sedis*

Canalipalpata

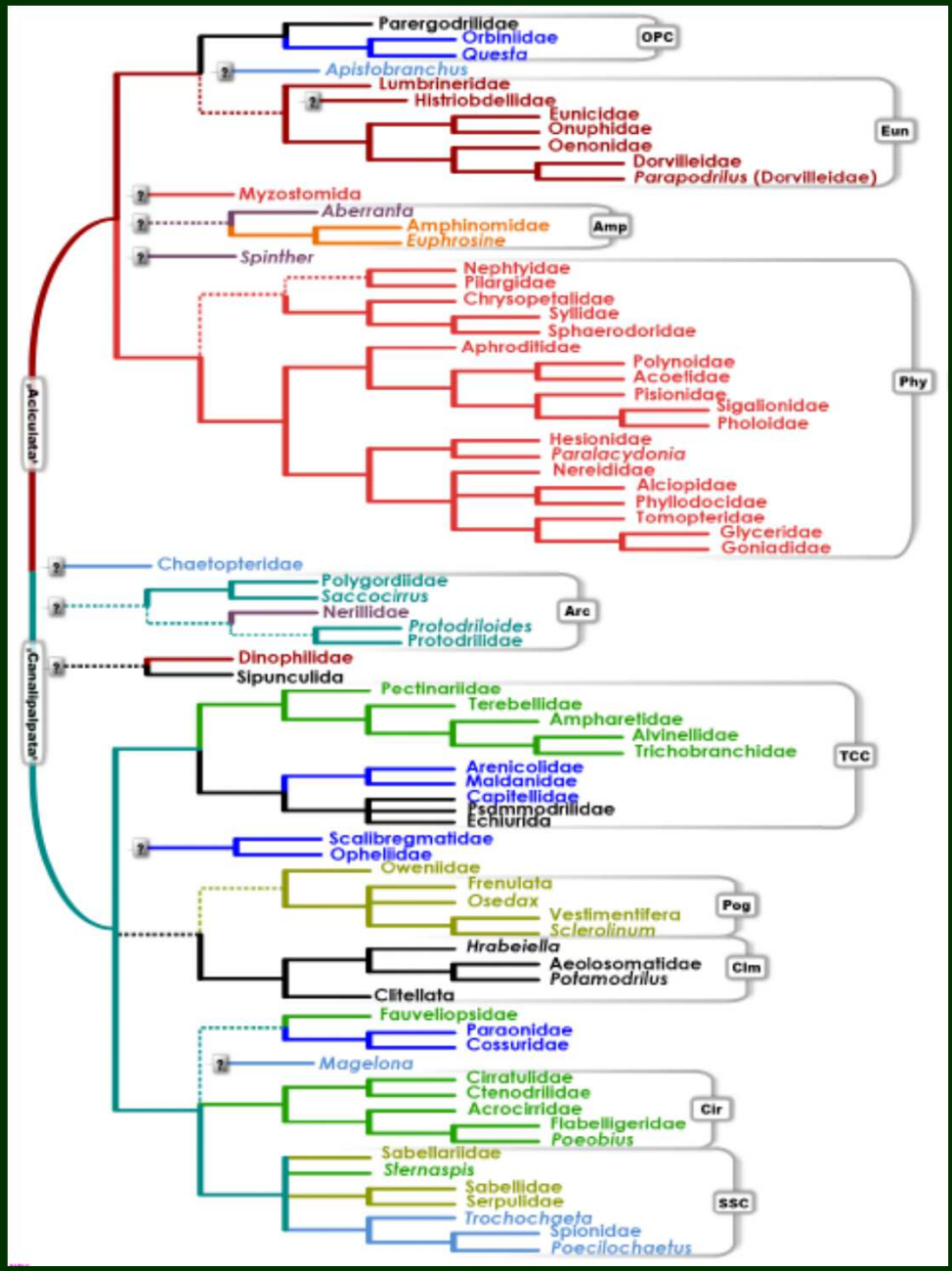


Annelida

- donedávna téměř neznámá fylogeneze (6 genů)

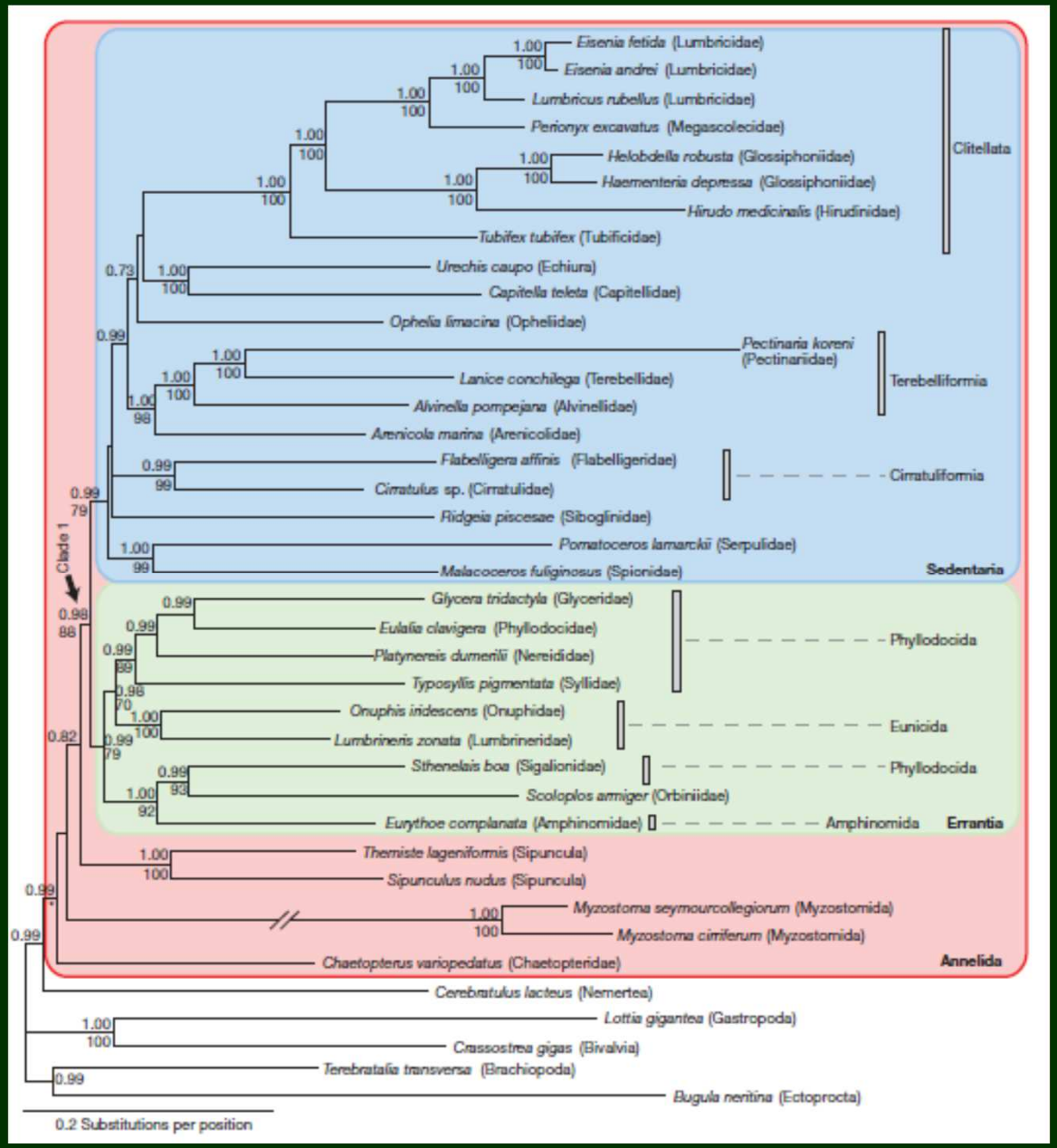
Fylogeneze kroužkovců

6 genů + morfologie

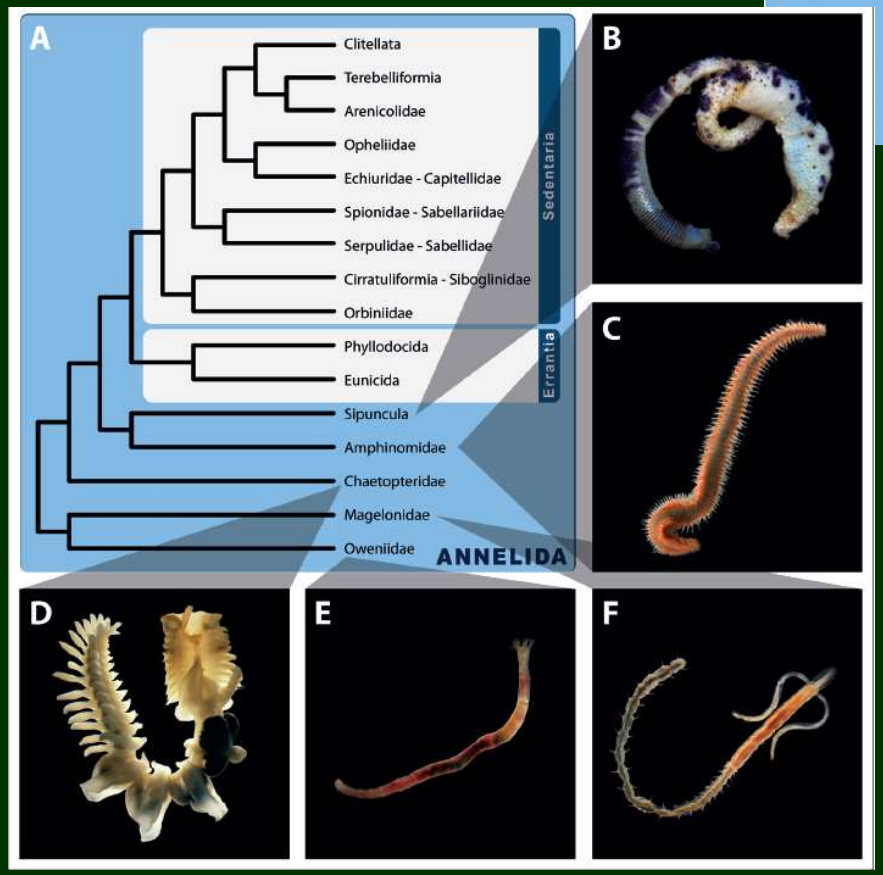


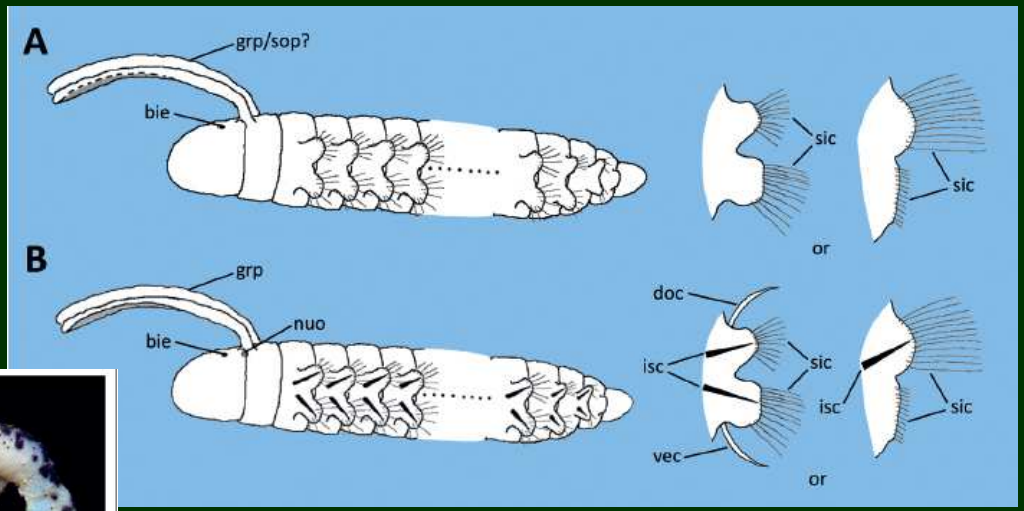
Annelida fylogenomika

- Annelida
- Pleistoannelida (= „Clade 1“):
- Errantia
- Sedentaria



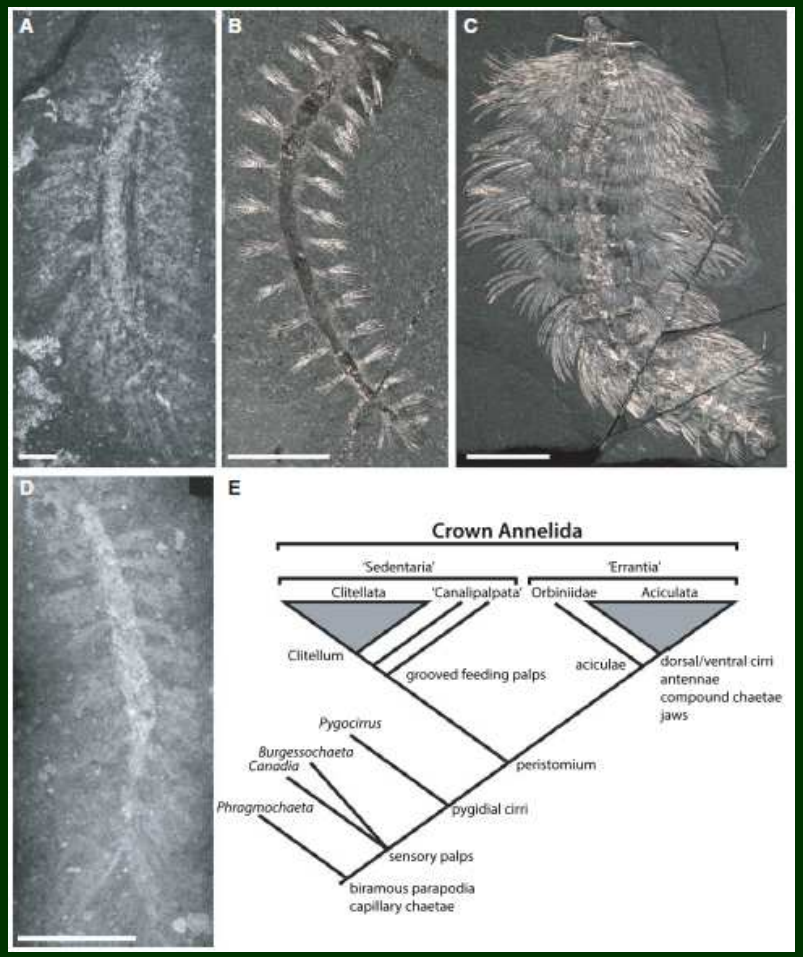
Annelida fylogenomika

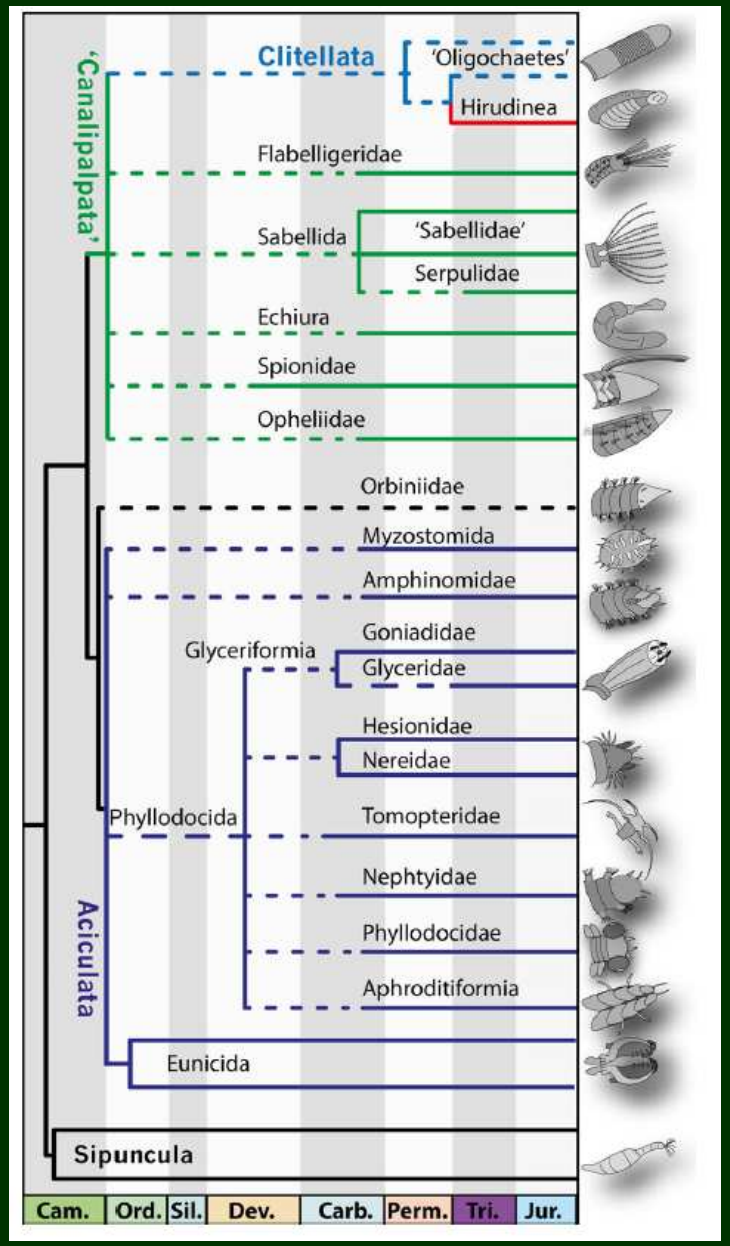




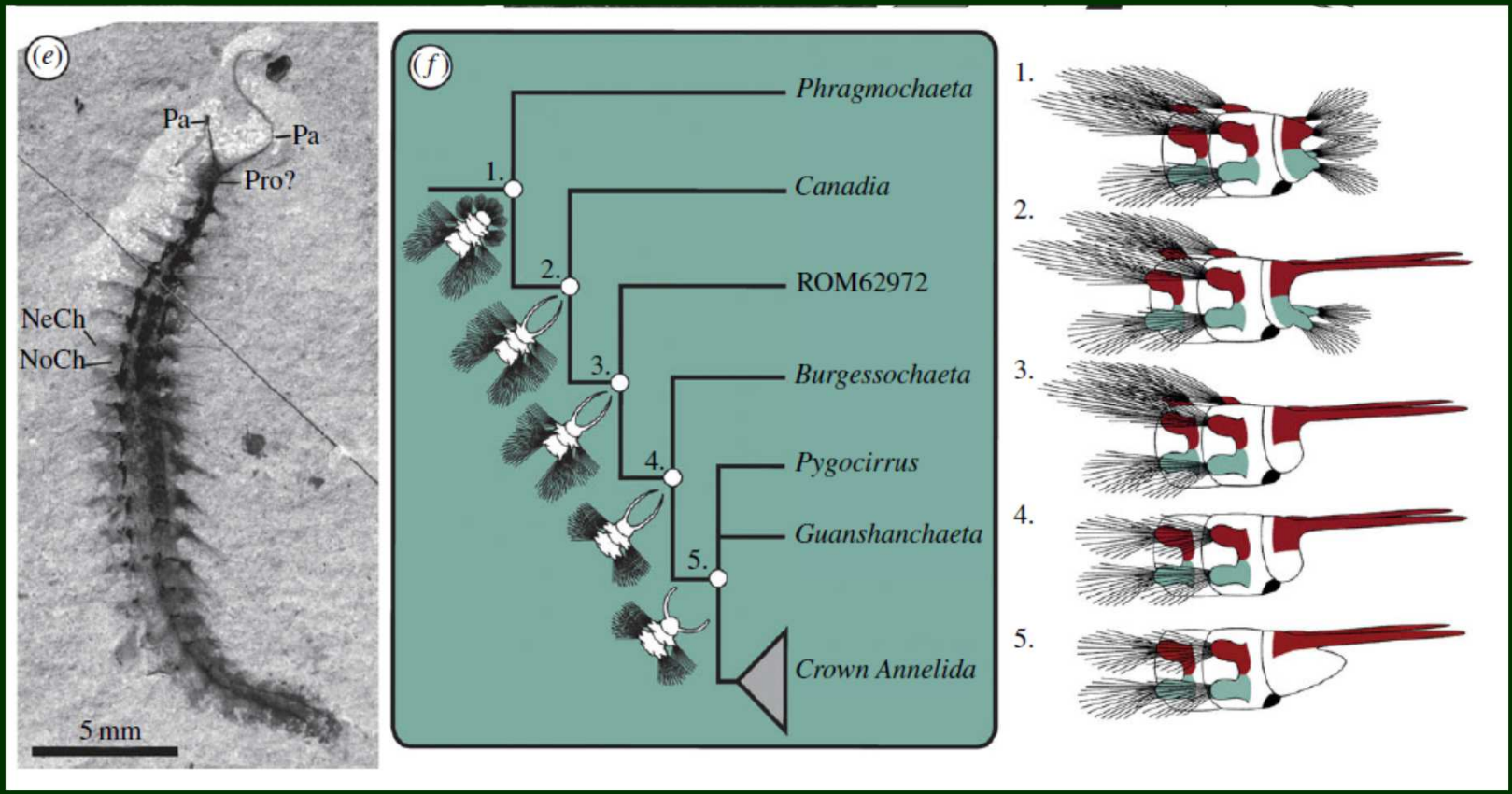
zahuštění samplingu (Myzostomida jako sesterská skupina errantií) → změna základního plánu (B → A): méně acikulátní

Annelida
fosilní záznam



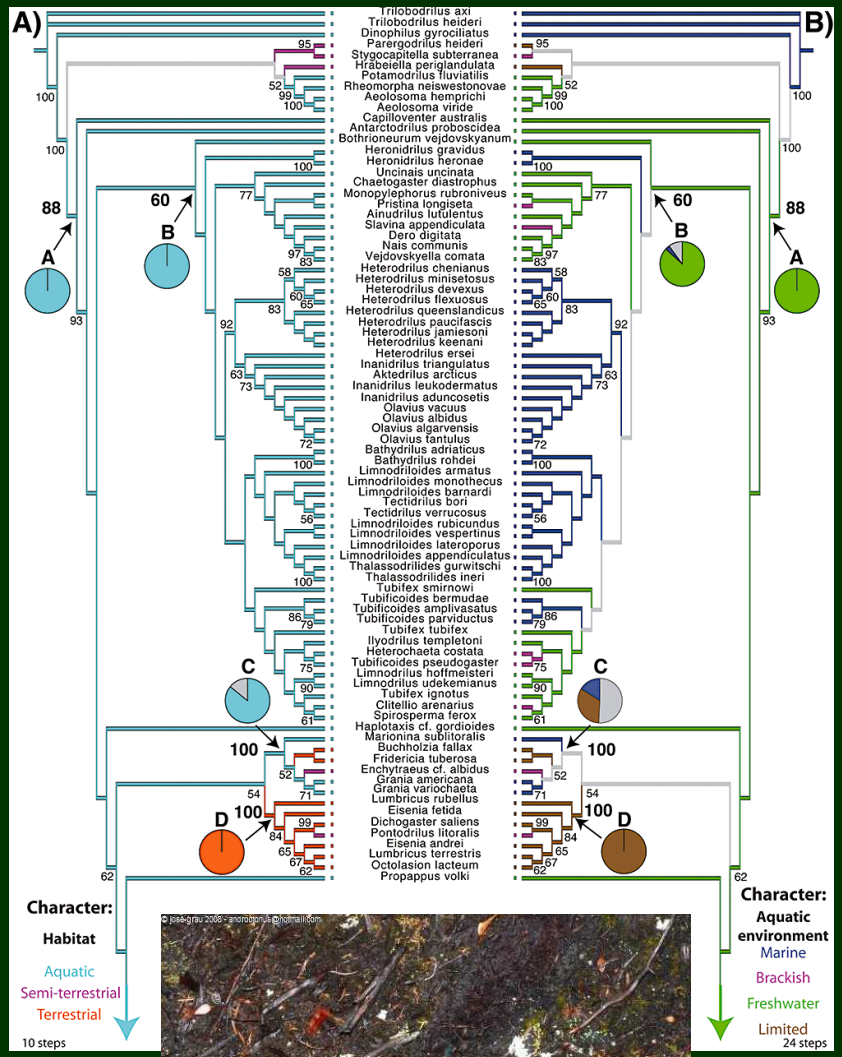


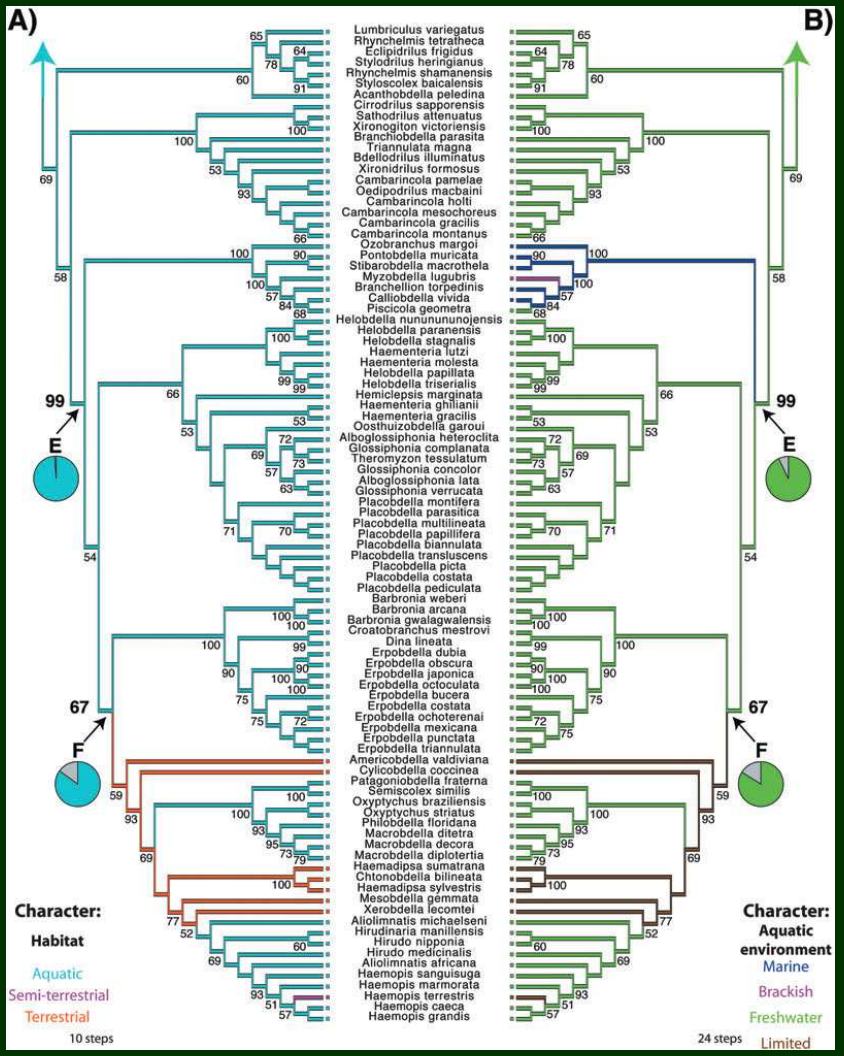
Annelida – kambrium



- kmenová linie – homonomní segmentace, hlava nerozdělená na pro- a peristomium, palpy notopodiálního původu
- → bazální praví kroužkovci (*Magelona*, *Owenia*) jsou morfologicky velmi odvození

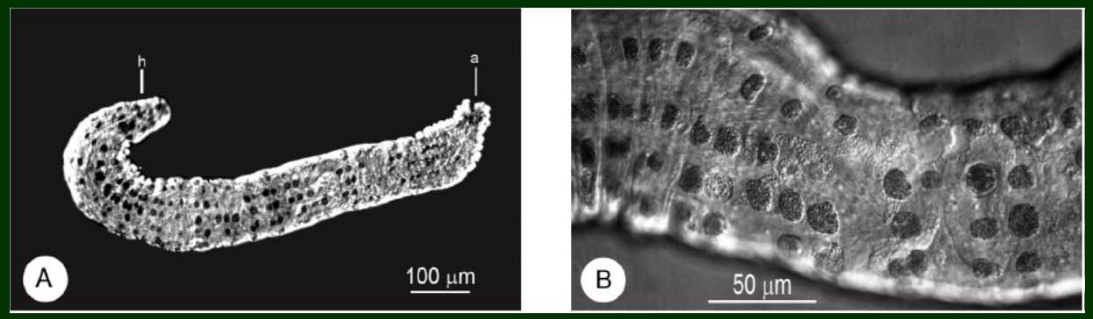
Clitellata

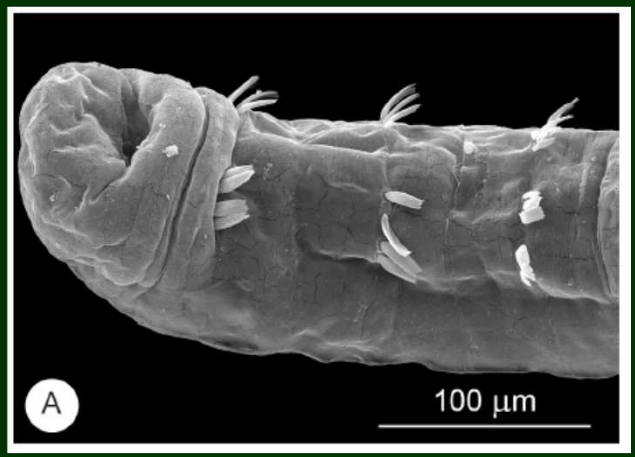

A)
B)
Character:
Habitat
Aquatic
Semi-terrestrial
Terrestrial
10 steps
Character:
Aquatic environment
Marine
Brackish
Freshwater
Limited
24 steps


A)
B)
Character:
Habitat
Aquatic
Semi-terrestrial
Terrestrial
10 steps
Character:
Aquatic environment
Marine
Brackish
Freshwater
Limited
24 steps

Annelida

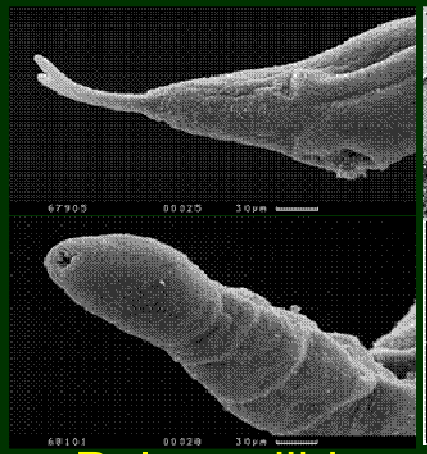
Hrabeiella (+ Clitellata = Dorsopharyngea), Aeolosomatida



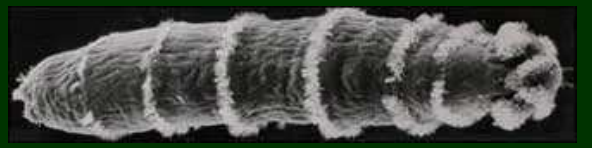


“Archiannelida”

Dinophilidae

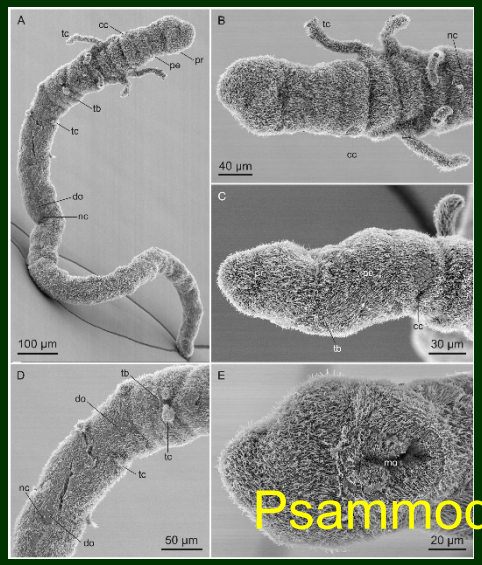


Polygordiidae



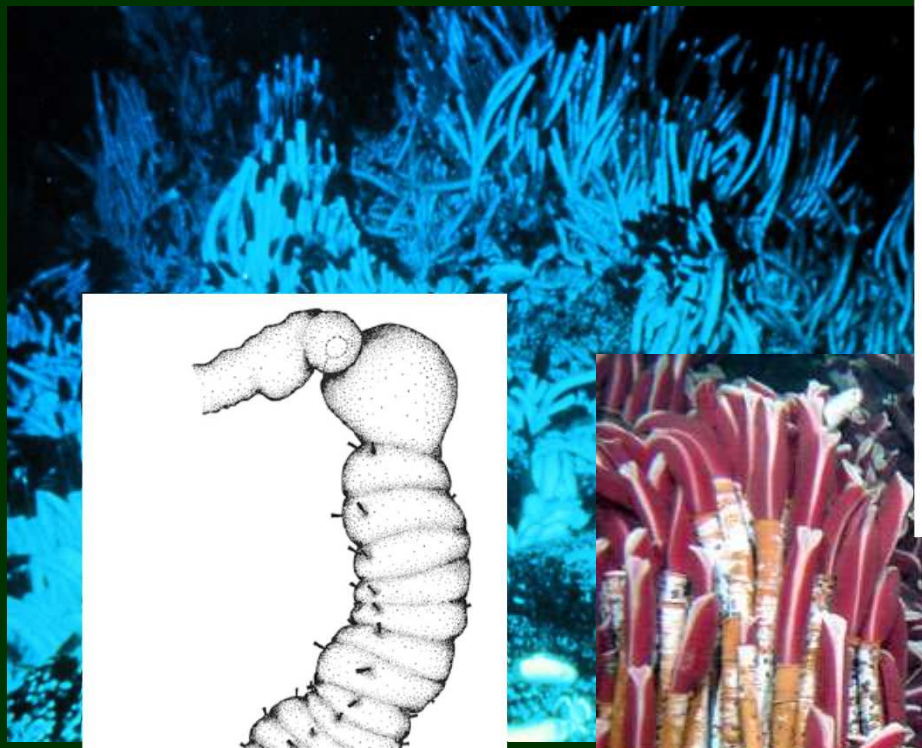
- *Dinophilus* není pedogenetický dorvilleid!

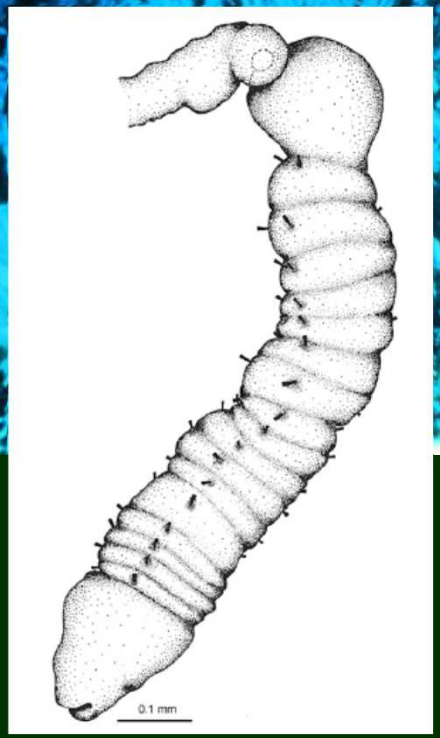
Nerillidae:
Troglochaetus

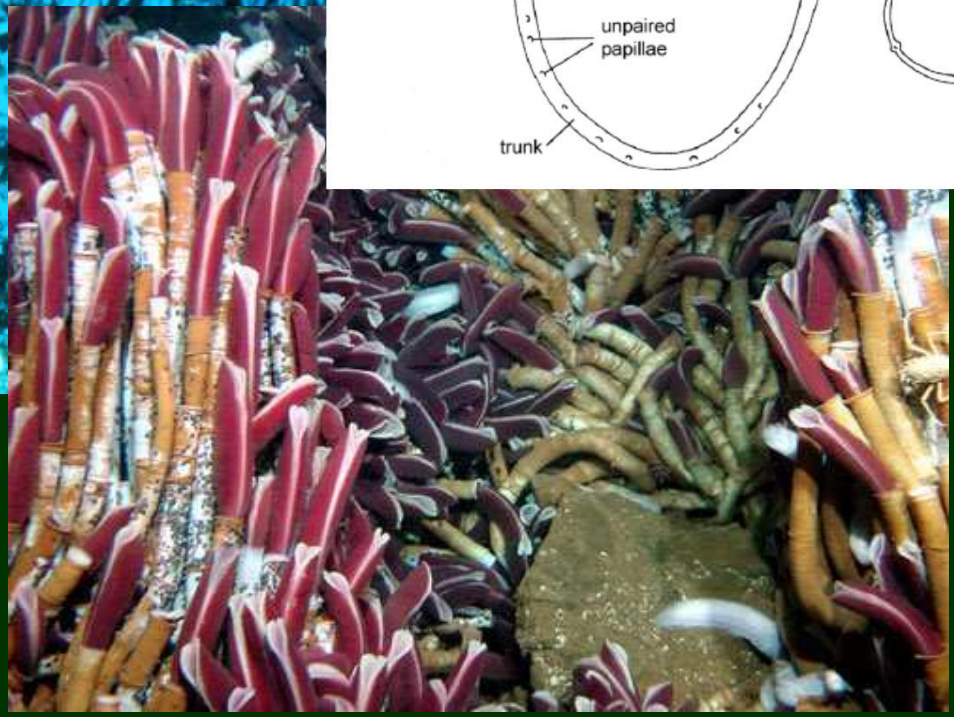


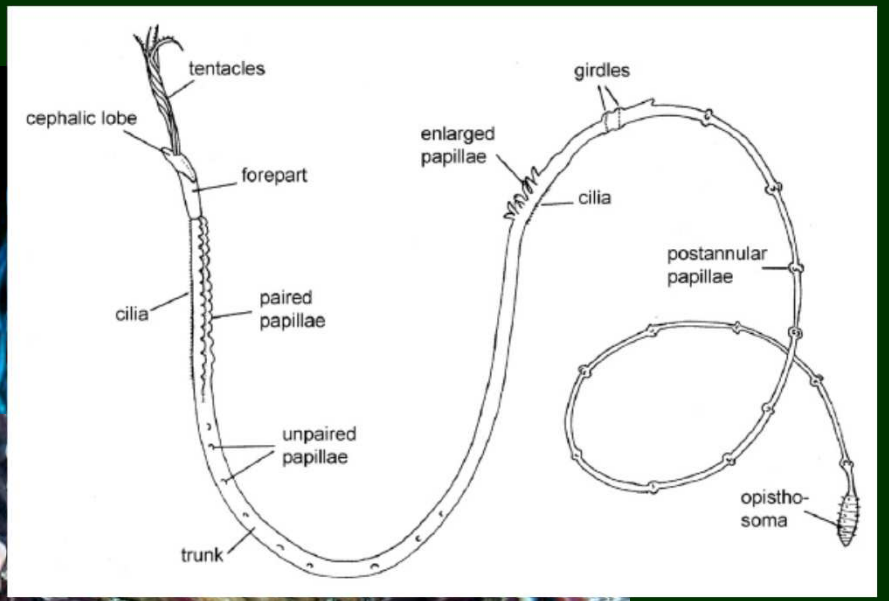
Psammodrilidae

Annelida: Pogonophora

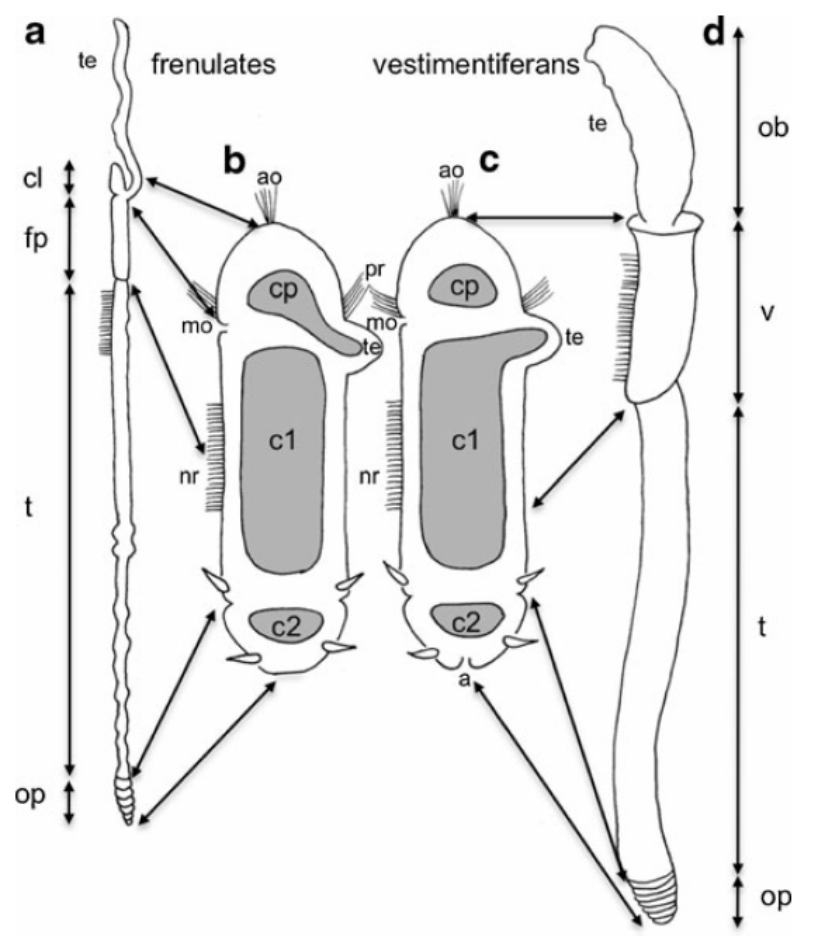


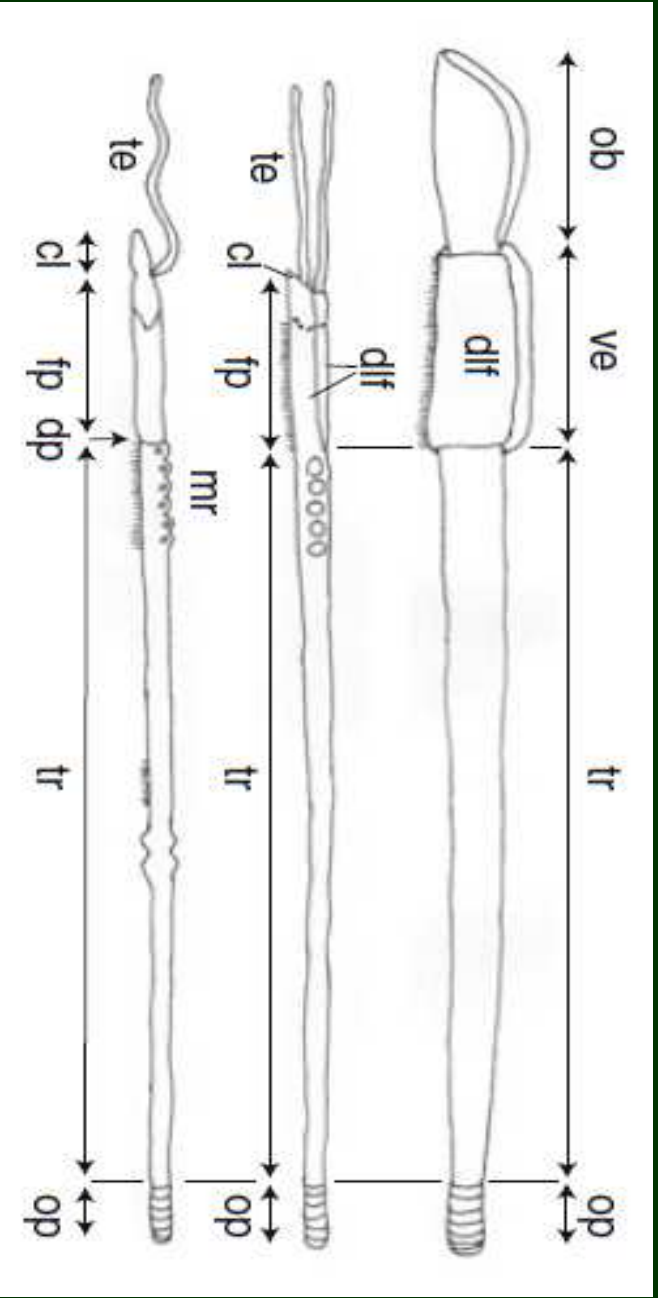




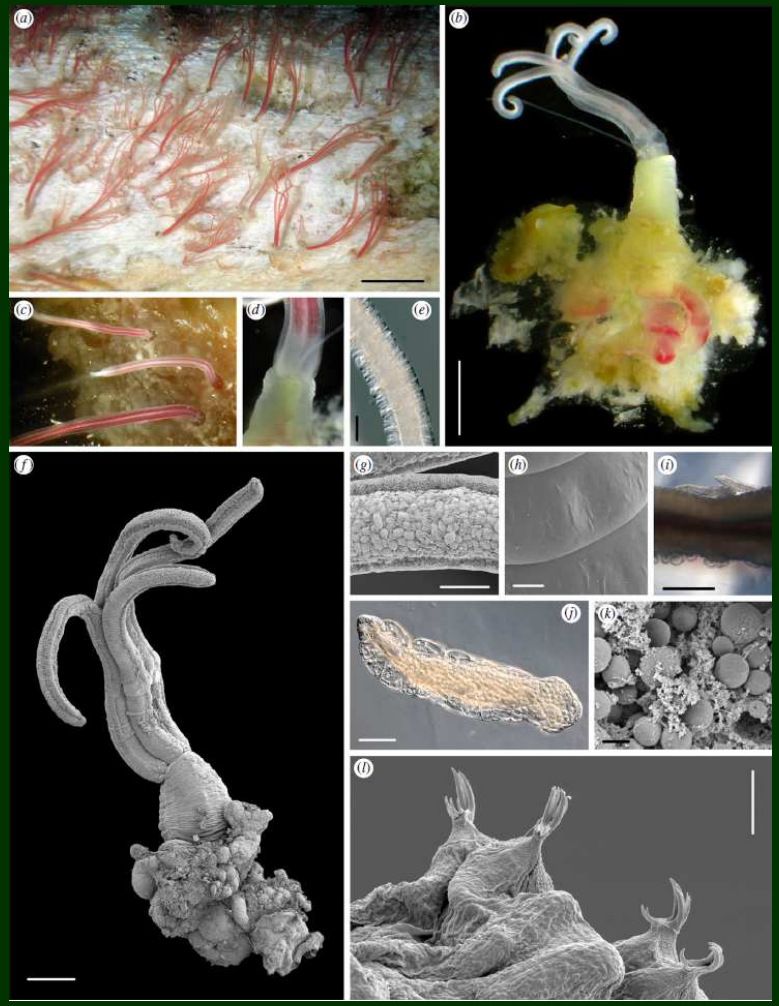


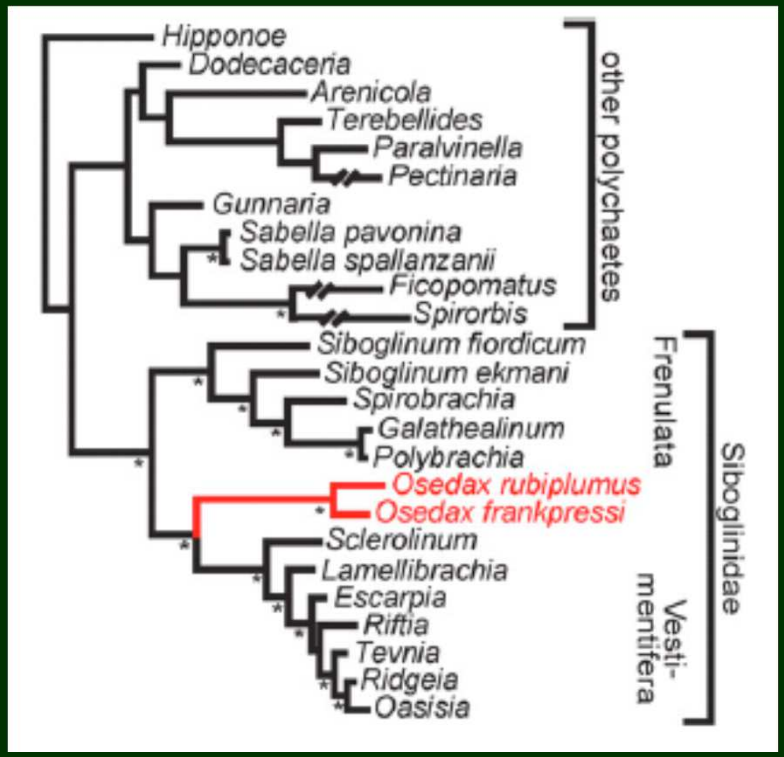
Pogonophora

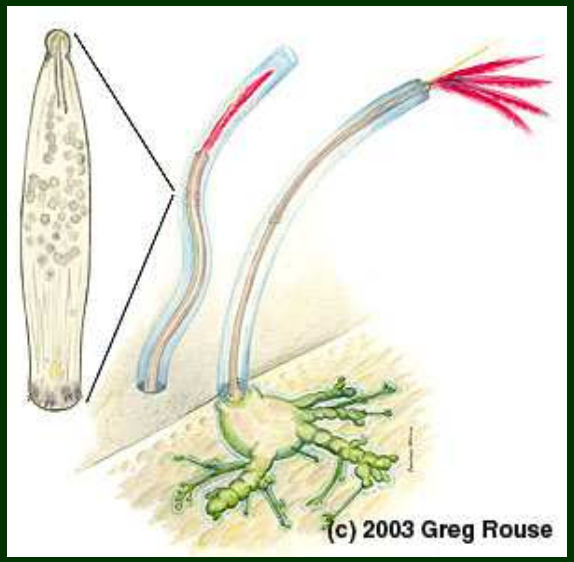


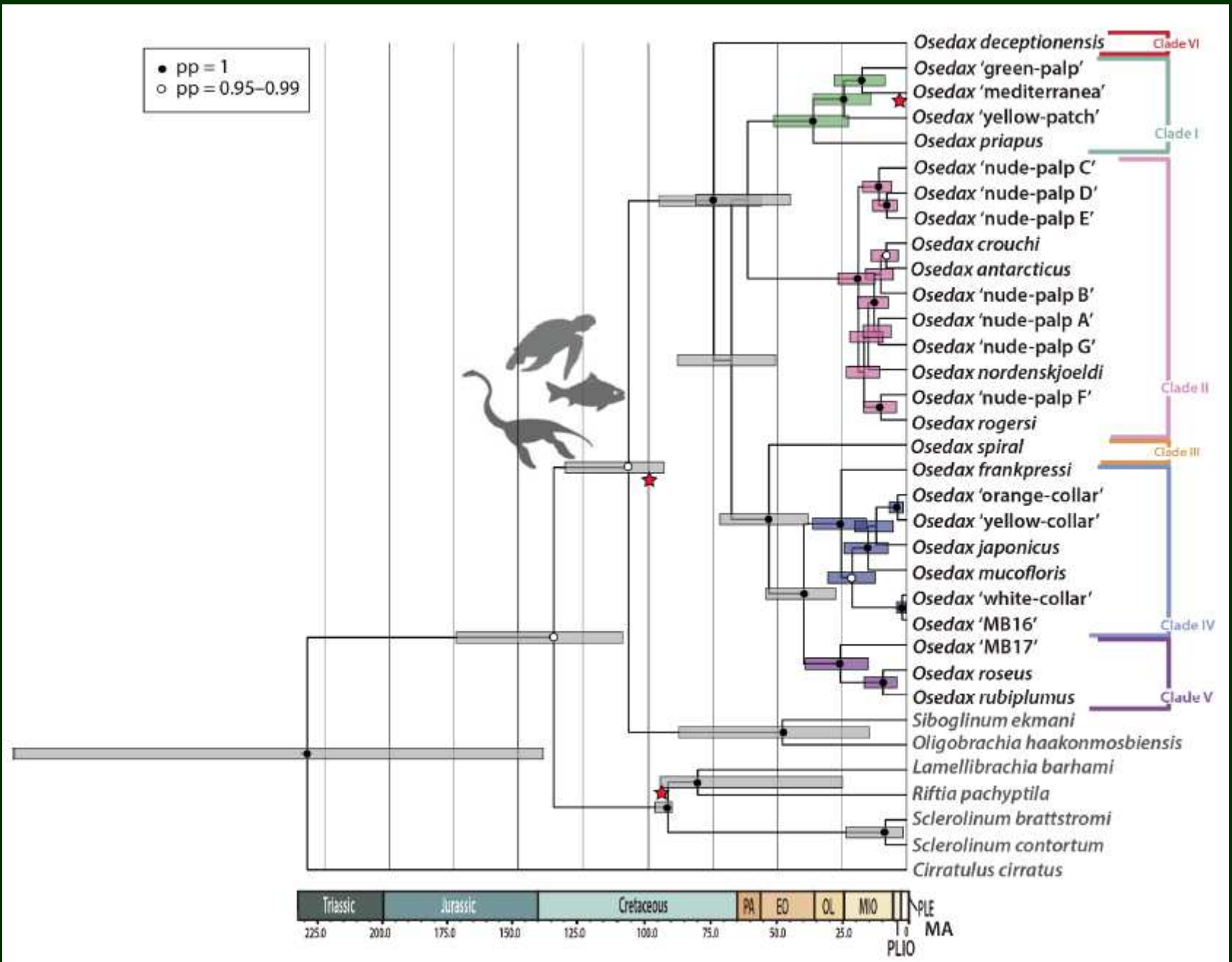


Pogonophora: *Osedax*

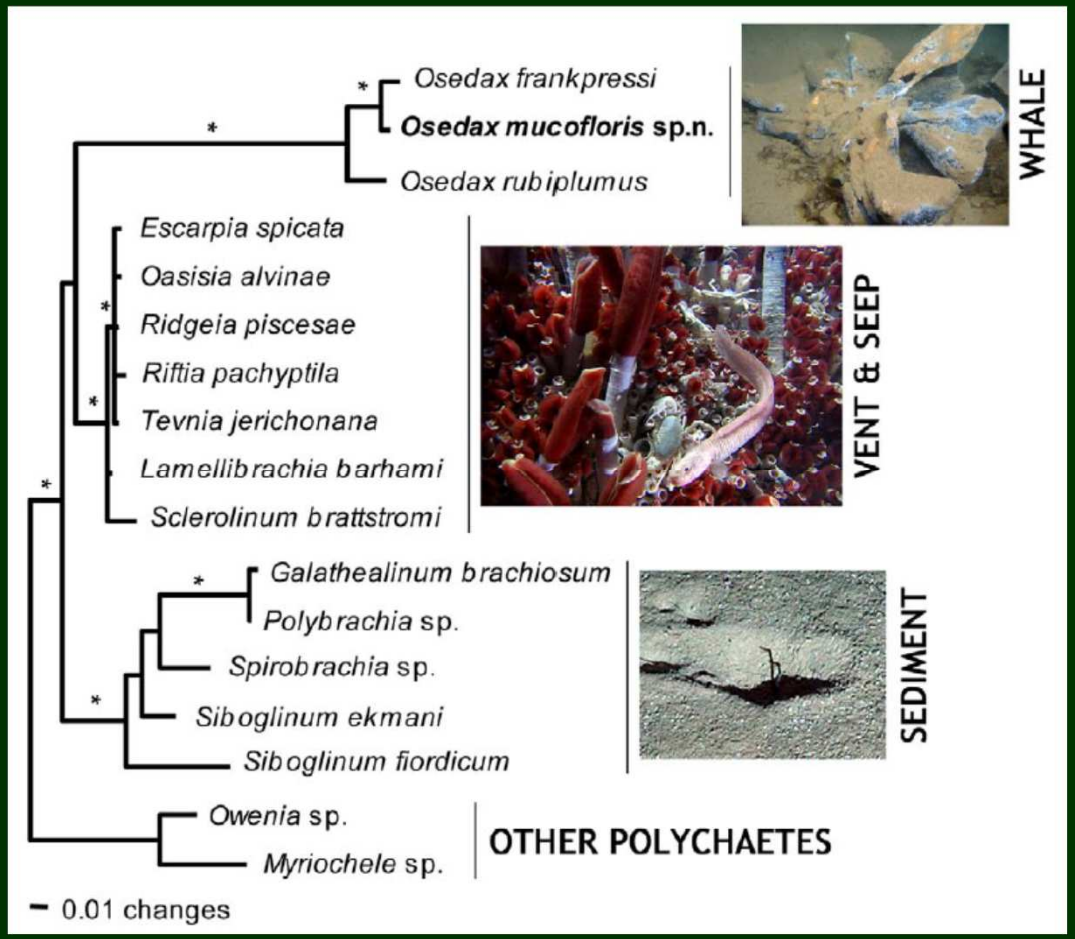


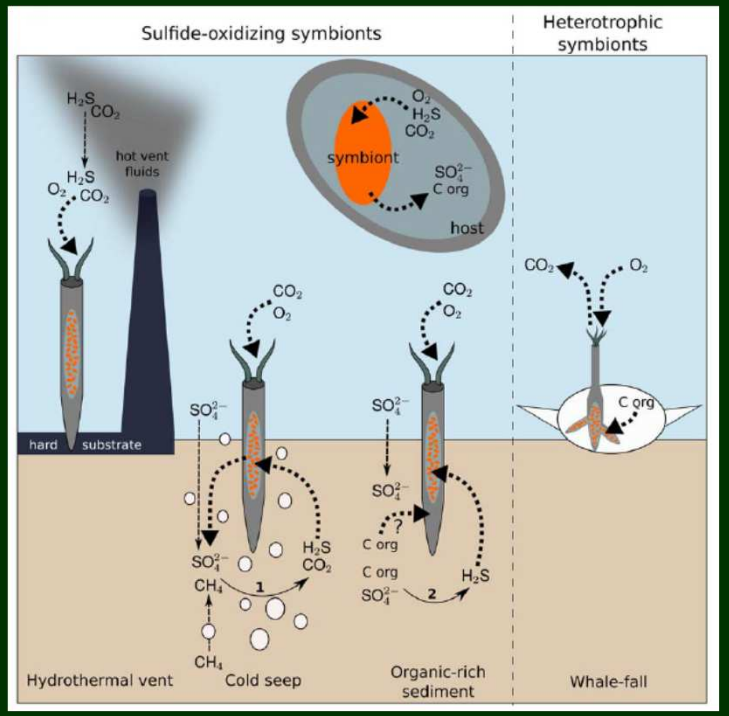


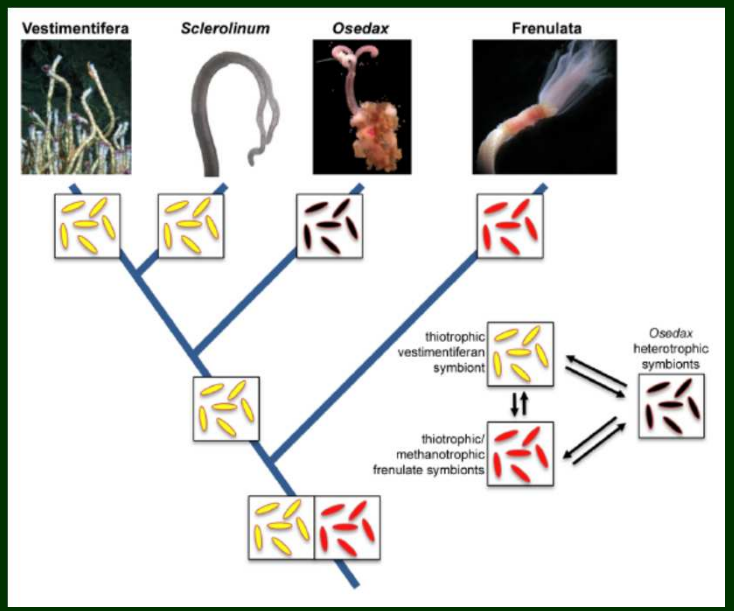



• pp = 1
○ pp = 0.95–0.99
Osedax deceptionensis
Osedax 'green-palp'
Osedax 'mediterranea'
Osedax 'yellow-patch'
Osedax priapus
Osedax 'nude-palp C'
Osedax 'nude-palp D'
Osedax 'nude-palp E'
Osedax crouchi
Osedax antarcticus
Osedax 'nude-palp B'
Osedax 'nude-palp A'
Osedax 'nude-palp G'
Osedax nordenskjoeldi
Osedax 'nude-palp F'
Osedax rogersi
Osedax spiral
Osedax frankpressi
Osedax 'orange-collar'
Osedax 'yellow-collar'
Osedax japonicus
Osedax mucofloris
Osedax 'white-collar'
Osedax 'MB16'
Osedax 'MB17'
Osedax roseus
Osedax rubiplumus
Siboglinum ekmani
Oligobrachia haakonmosbiensis
Lamellibrachia barhami
Riftia pachyptila
Sclerolinum brattstromi
Sclerolinum contortum
Cirratulus cirratus
Clade VI
Clade I
Clade II
Clade III
Clade IV
Clade V
Triassic
Jurassic
Cretaceous
PA
EO
OL
MIO
PLE
PLIO
MA
225.0
200.0
175.0
150.0
125.0
100.0
75.0
50.0
25.0
0

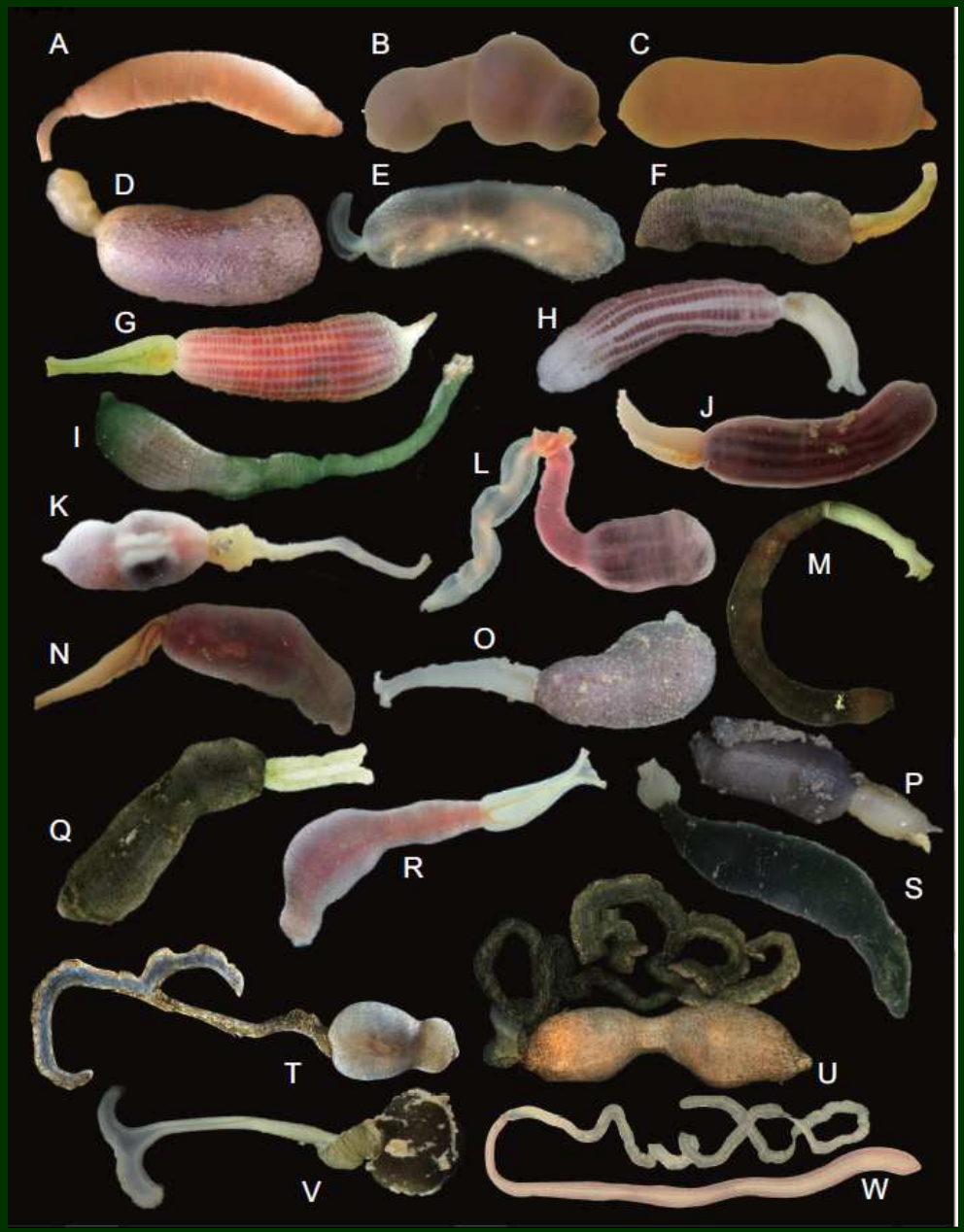
Pogonophora



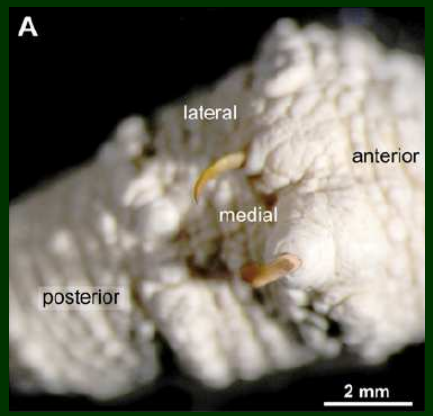


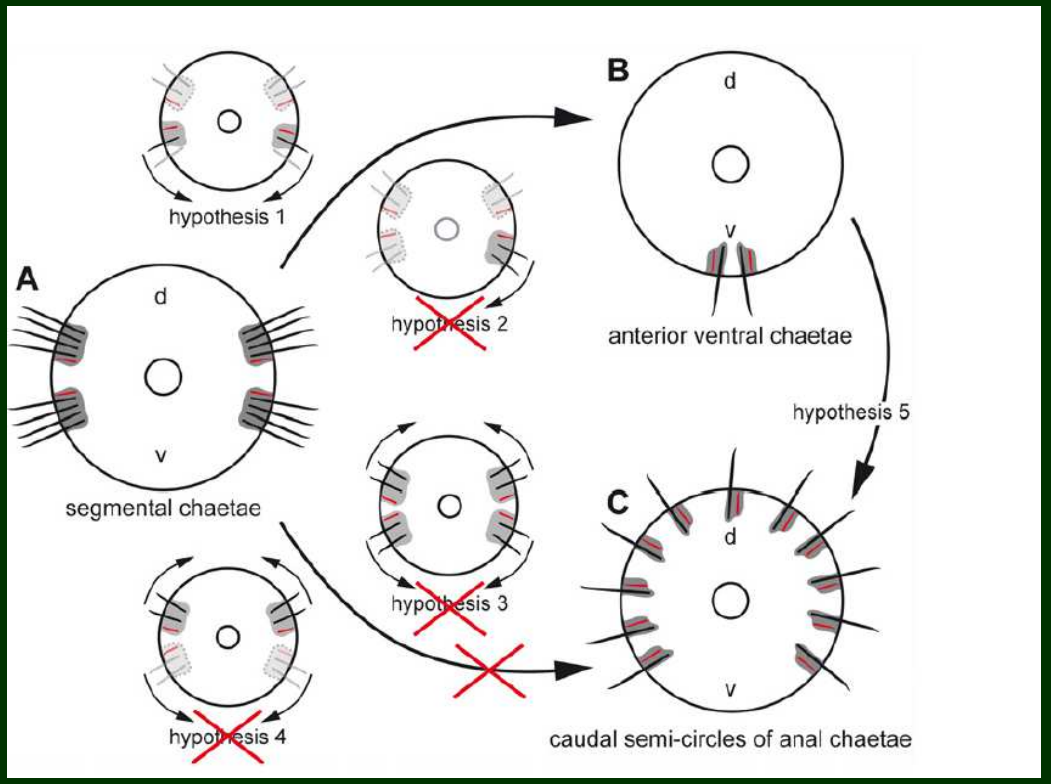


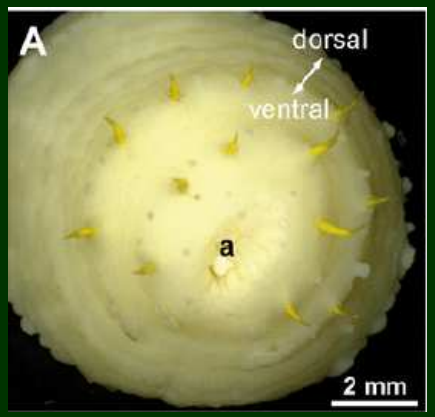
Echiurida



Echiurida

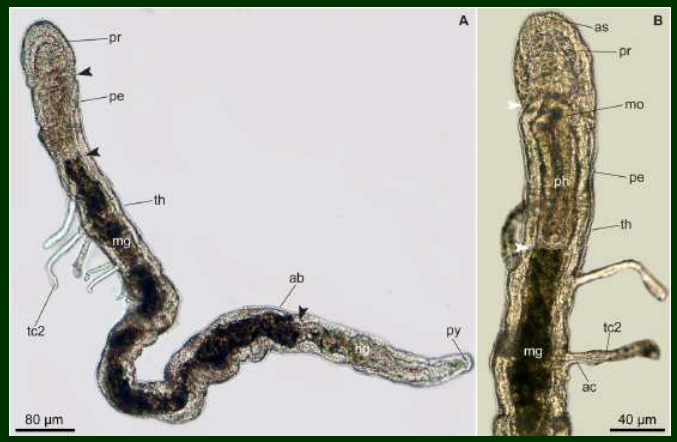


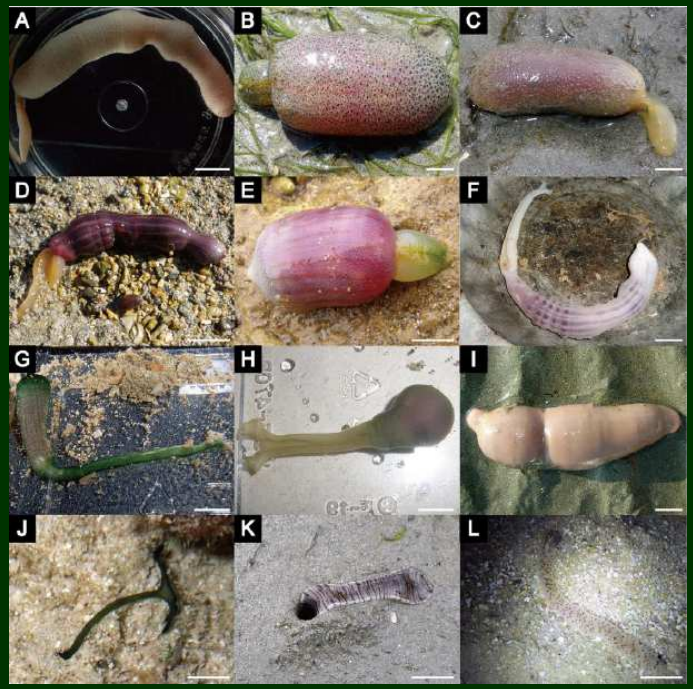




- chety nejsou segmentálně uspořádané jako u mnohoštětinatců
- x 1 pár ventrálních chet v přední části těla
- + 1–2 kruhy posteriorních chet (Urechidae, Echiurinae)

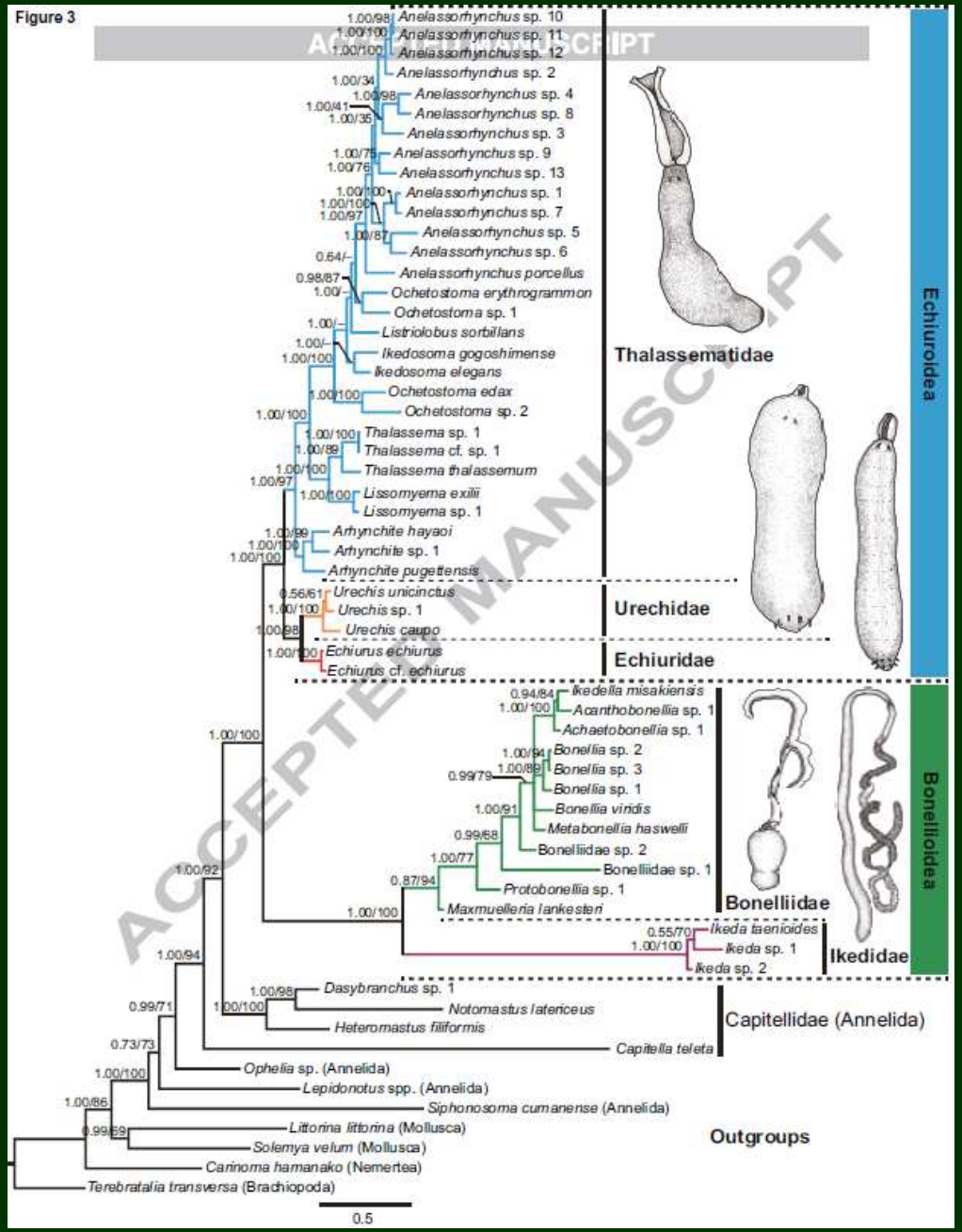
Annelida: Echiurida + Capitellida (+ Psammodrilidae?)



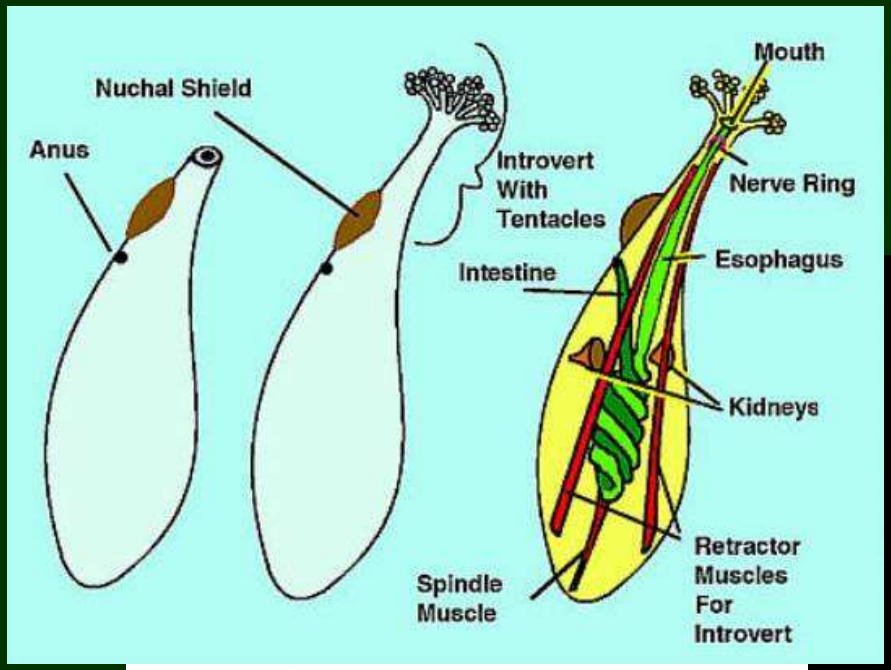


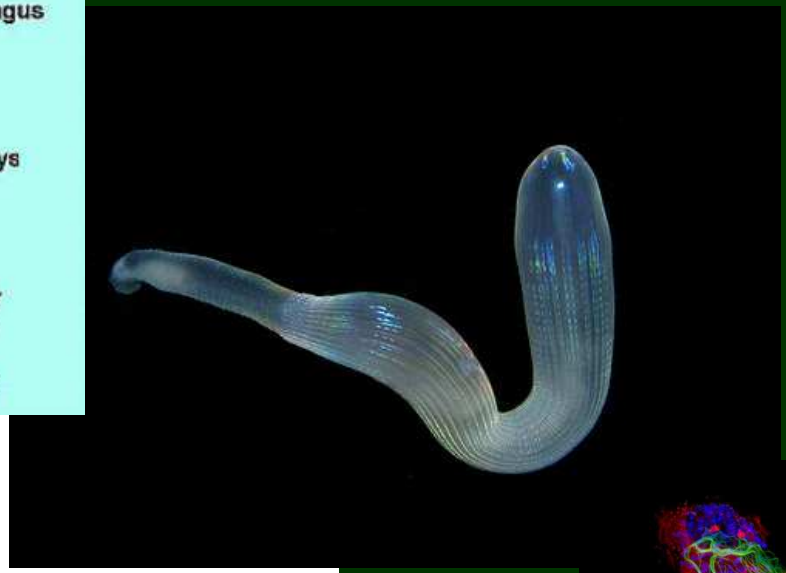
Echiurida

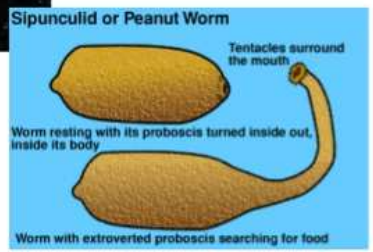
- Echiurida uvnitř capitellidů??? (x 5 genů)
- sexuální dimorfismus u Bonellioidea



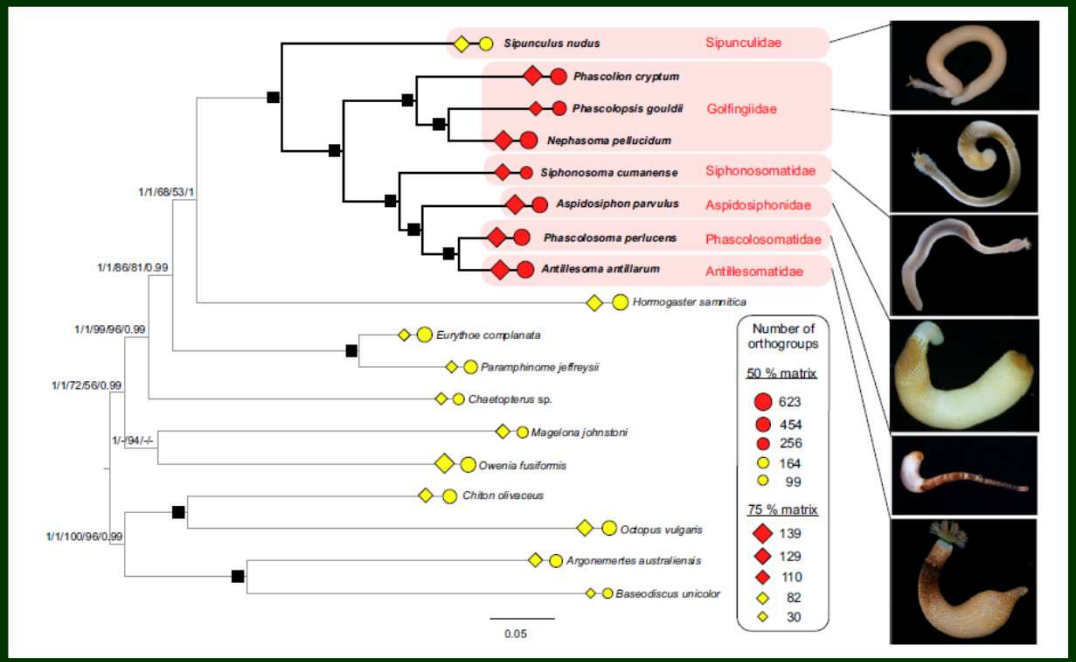
Sipunculida

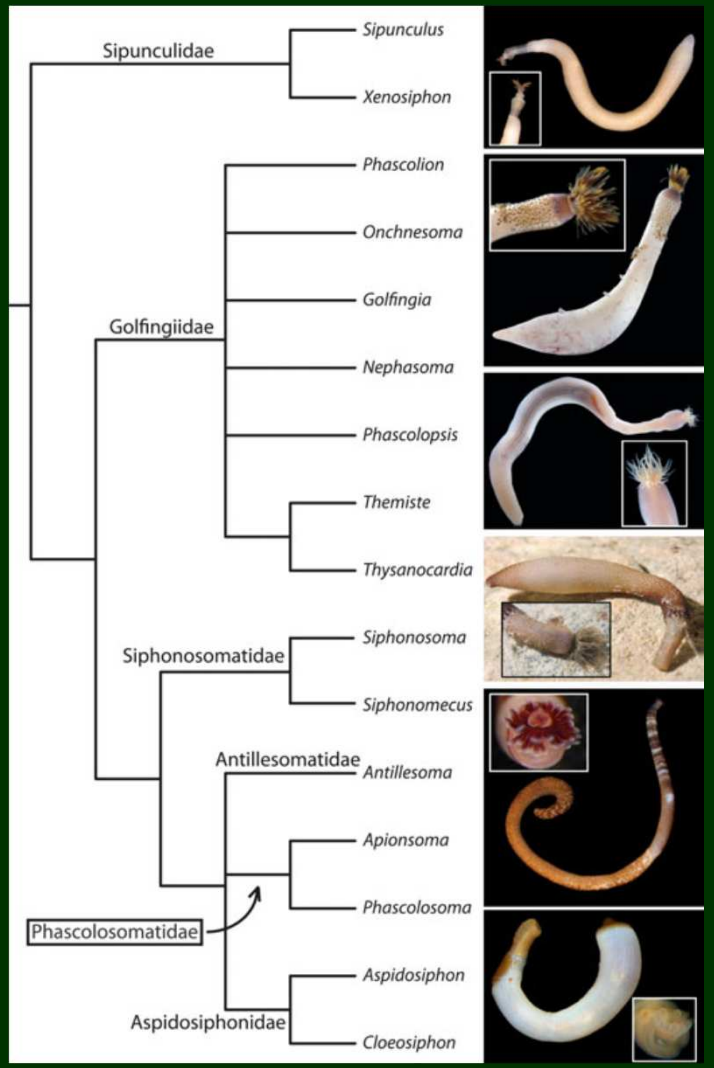




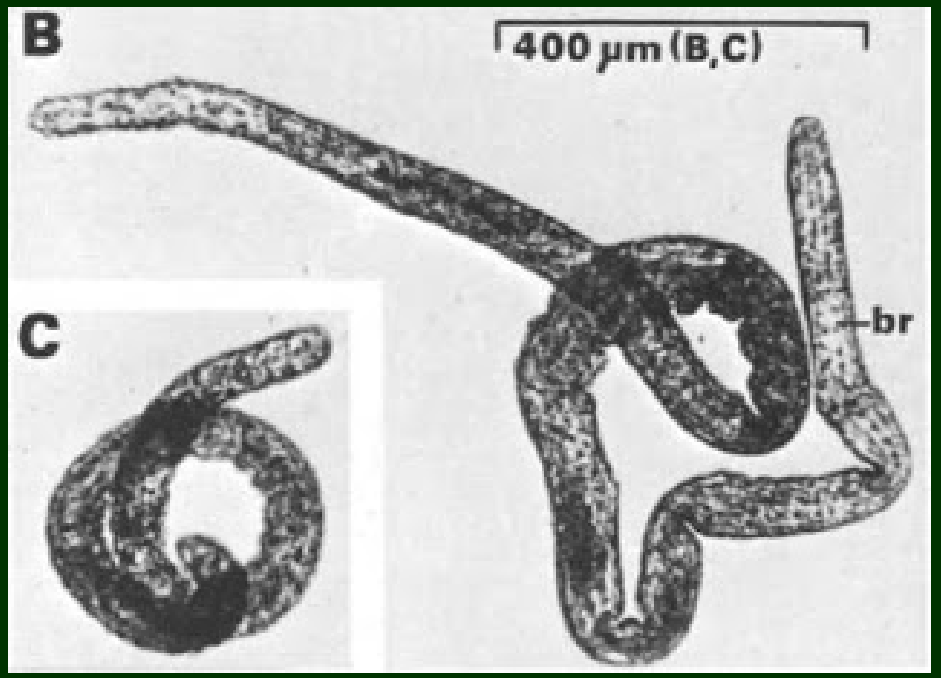


Sipunculida





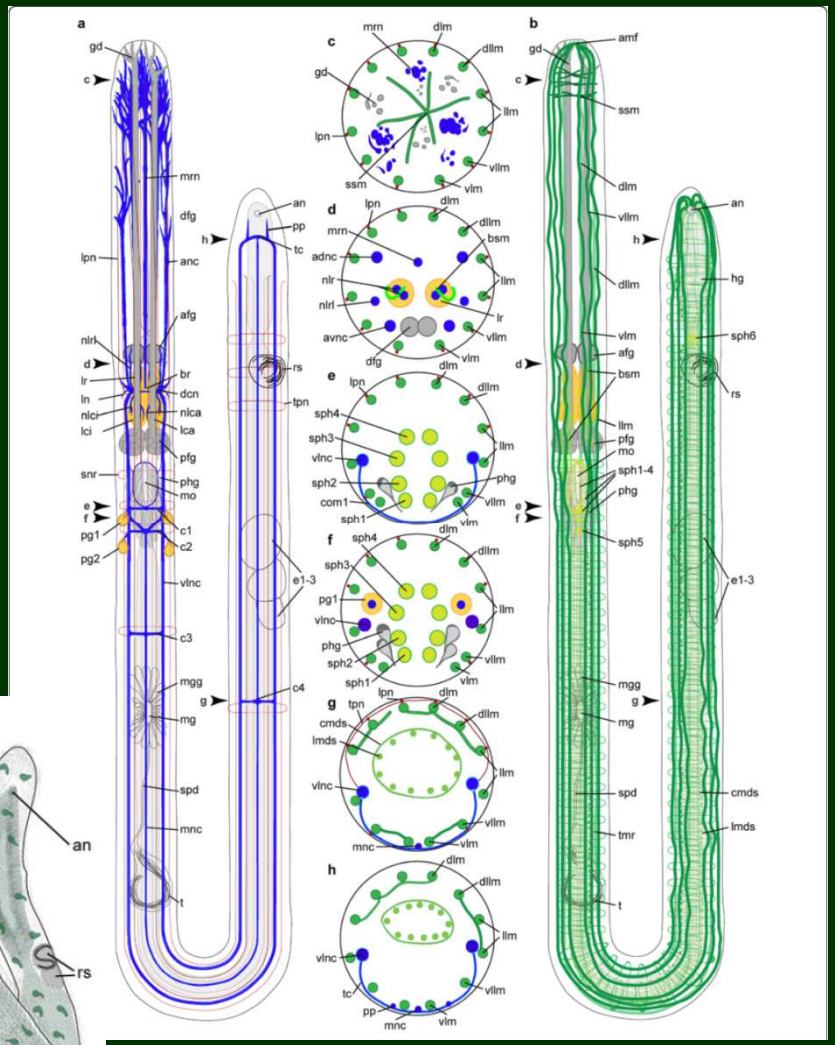
„*Problematica*“

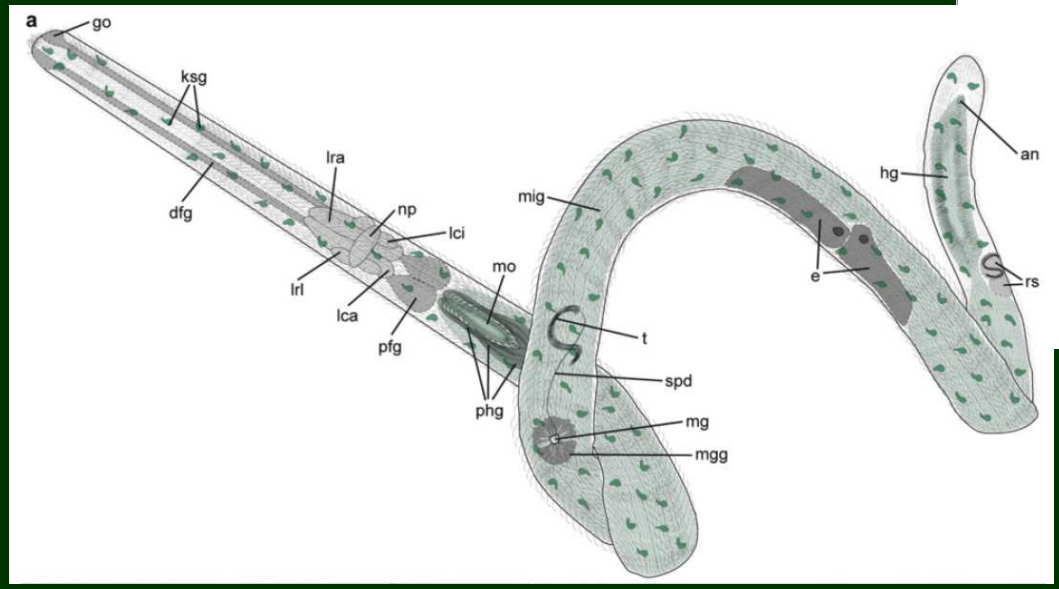


- *Lobatocerebrum*
- *Jennaria*
- mořští bentičtí červi bez segmentace a chet, známá částečně ultrastruktura, nic o ontogenezi, žádné molekulární údaje
- buď zjednodušení kroužkovci, nebo něco bazálního („mezi ploštěnci a kroužkovci“)

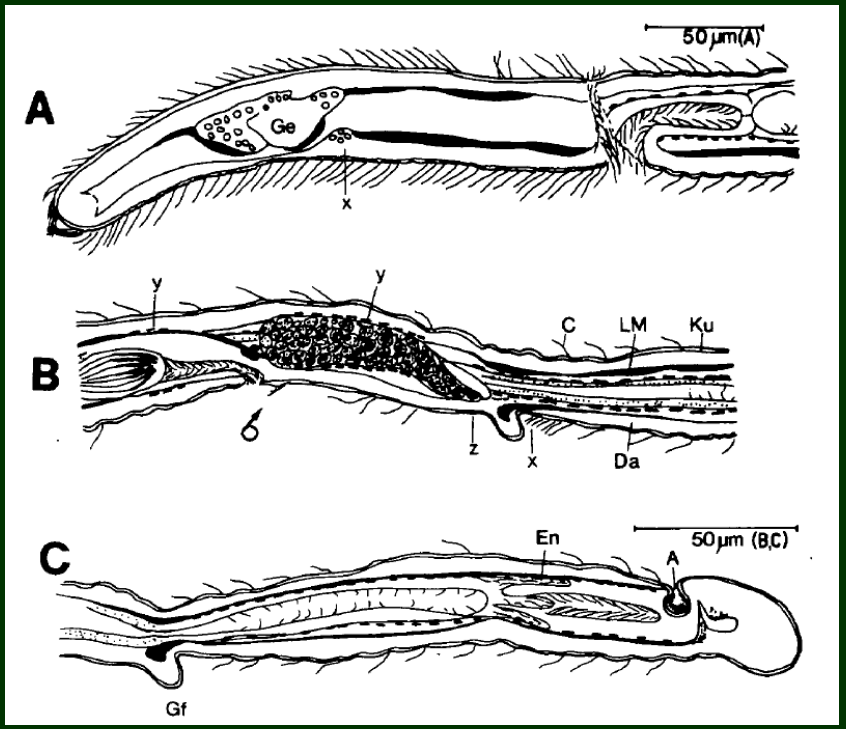
Lobatocerebrum

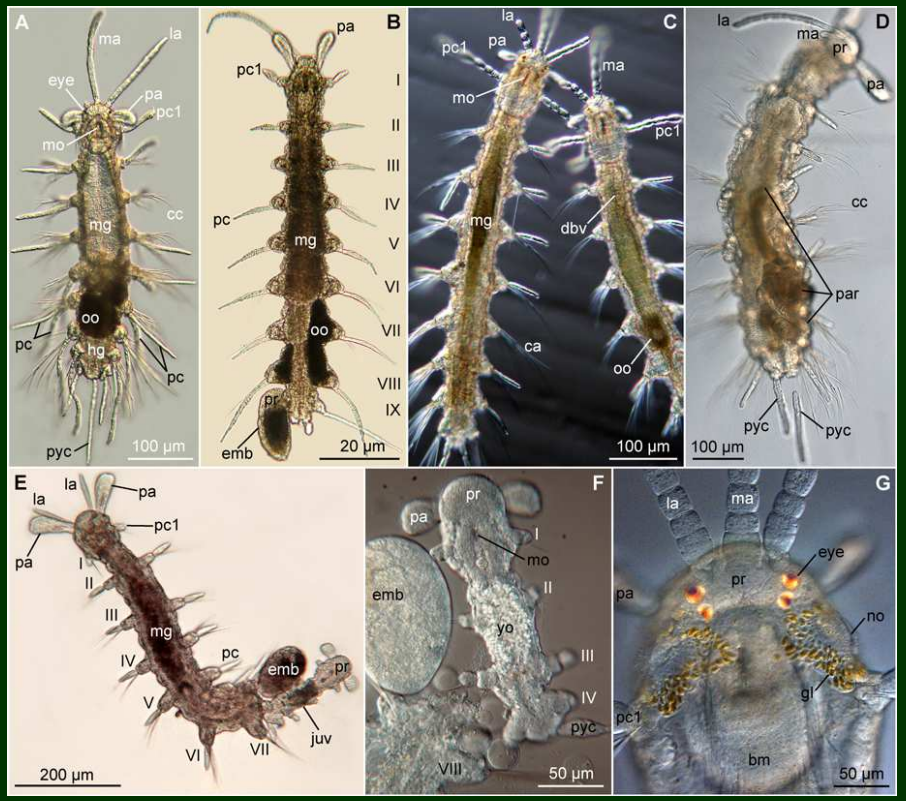
- nápadně složitý mozek (miniaturizace?)
- žádné známky segmentace



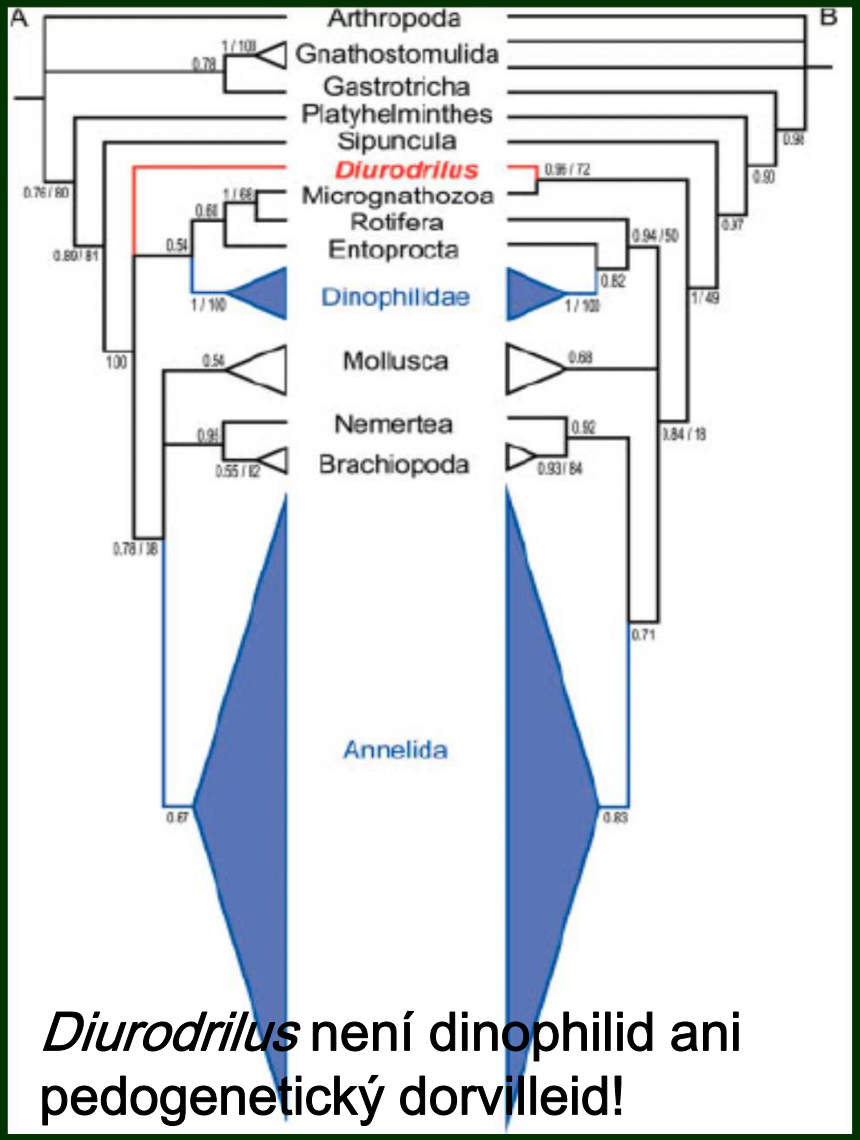


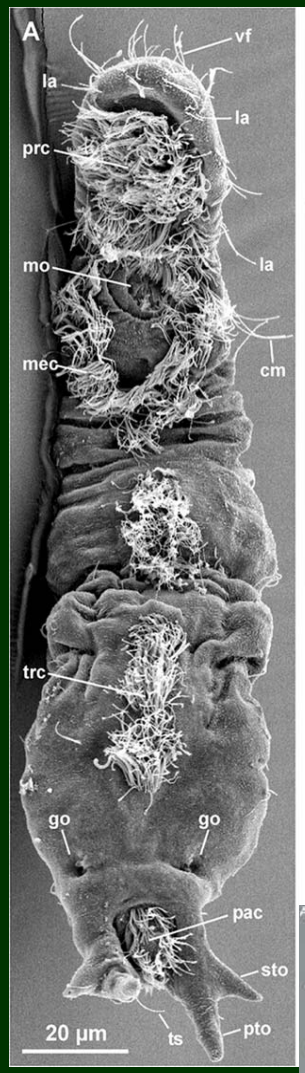
Jennaria a Nerillidae?

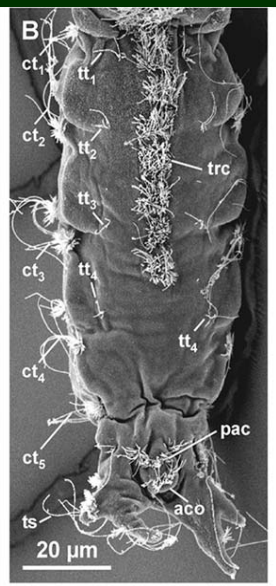


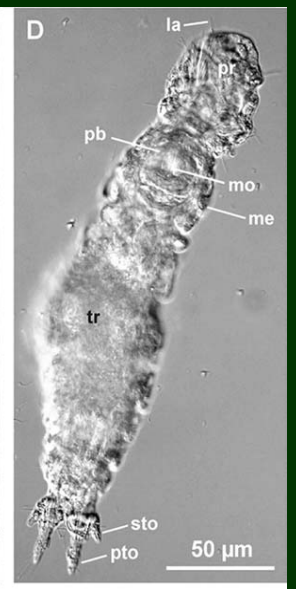


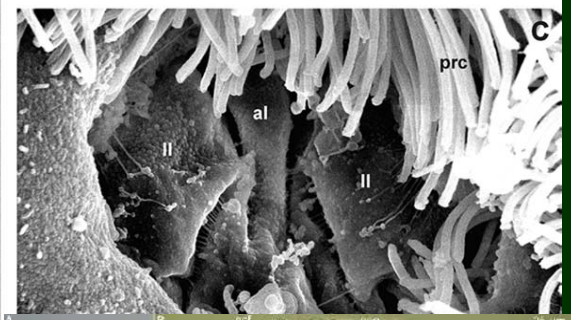
Diurodrilus





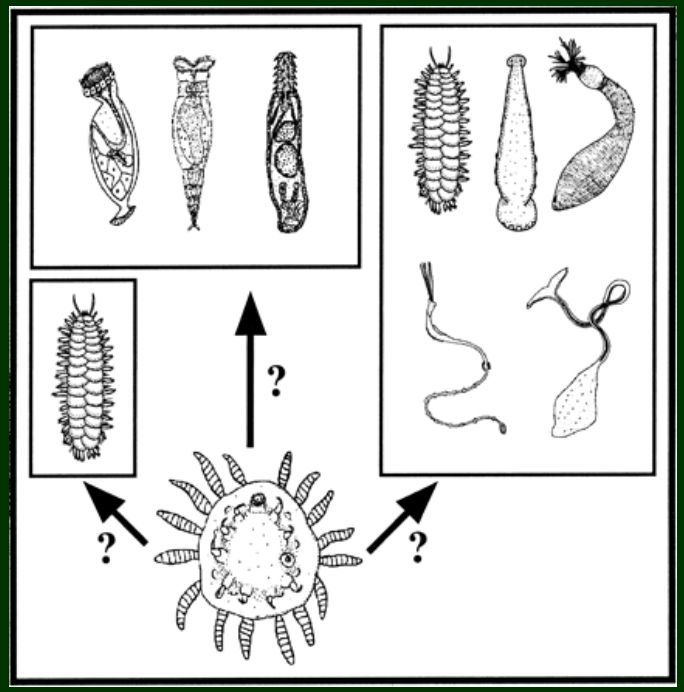


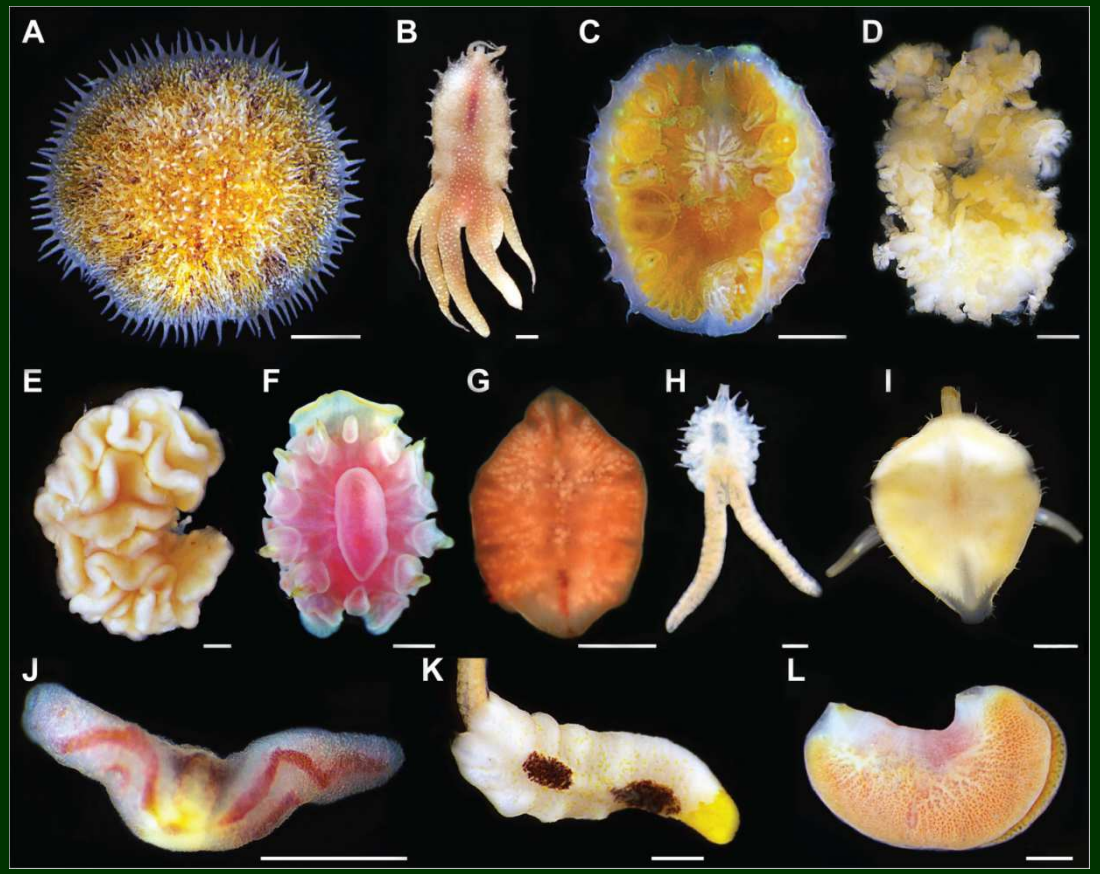




- *Diurodrilus* není dinophilid ani pedogenetický dorvilleid!

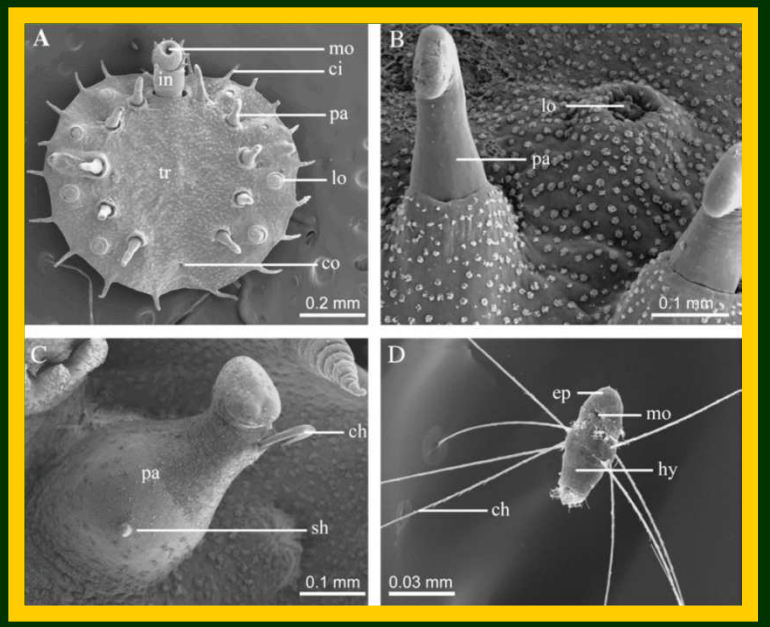
Myzostomida

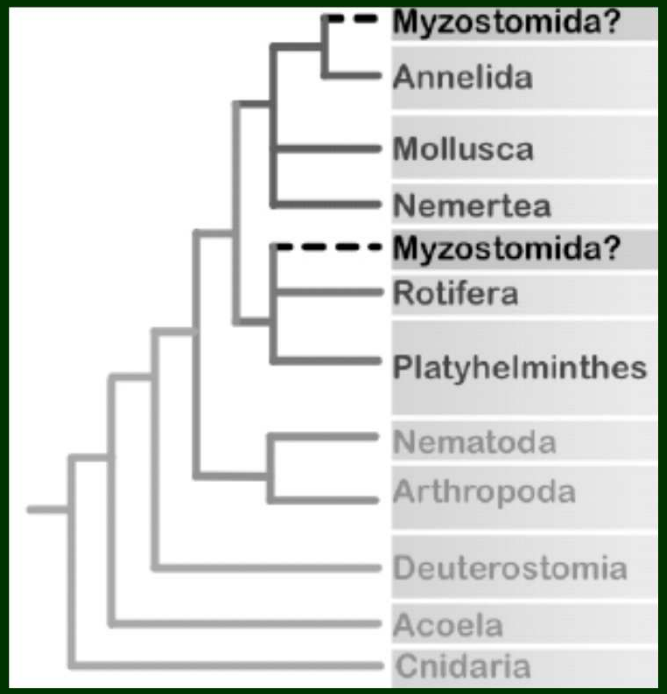




Myzostomida

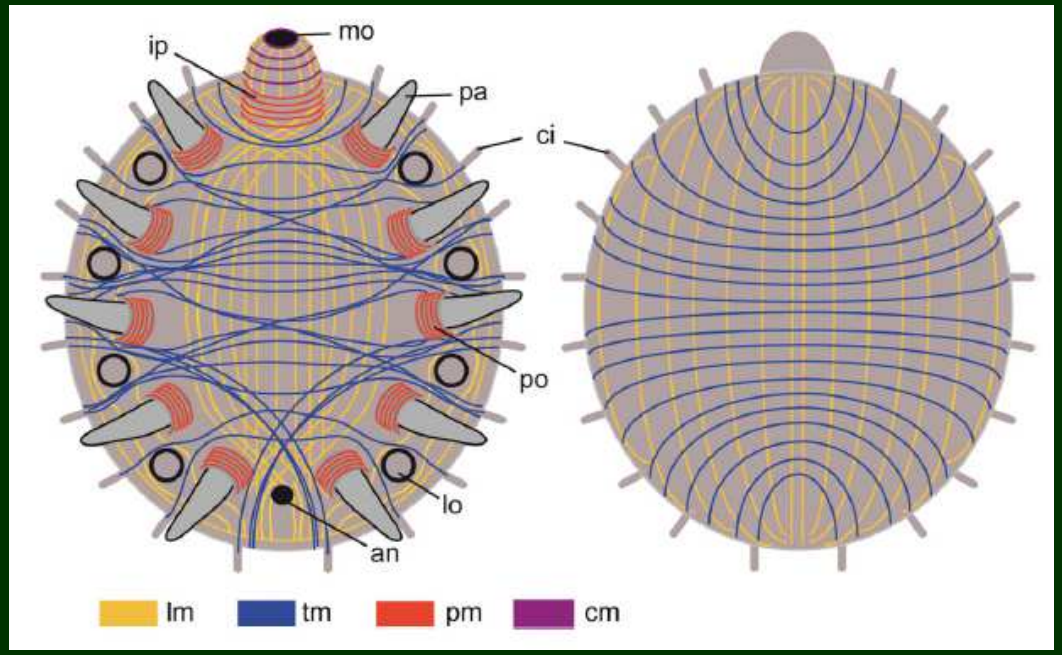
- hluboký konflikt mezi jednotlivými soubory genů:
- 1. Annelida (Hox, mitochondrie, morfologie, miRNA)
- 2. Platyzoa (ribosomální geny)

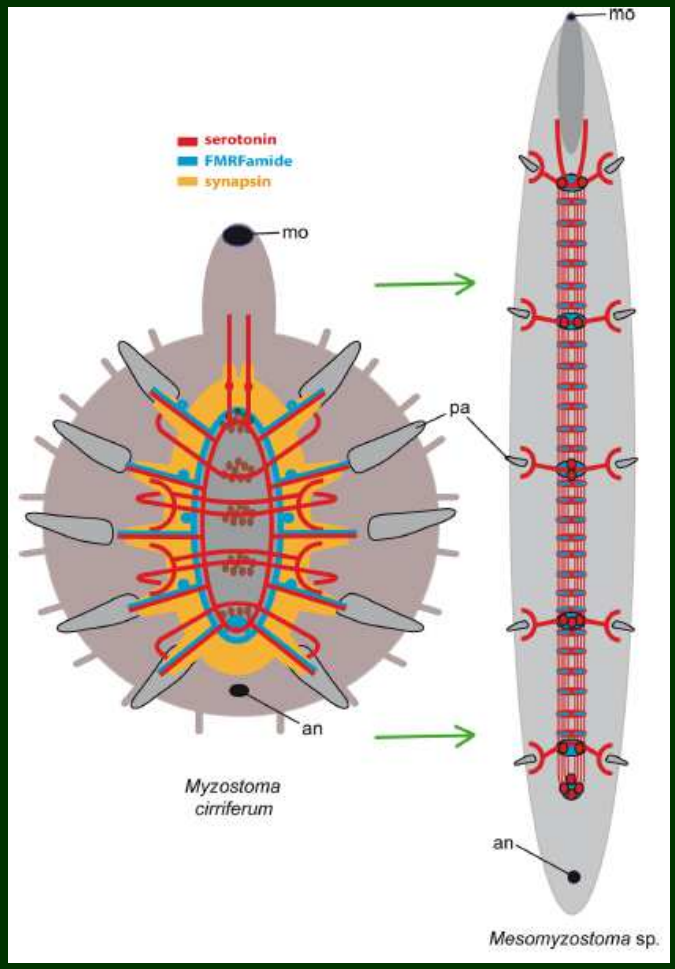




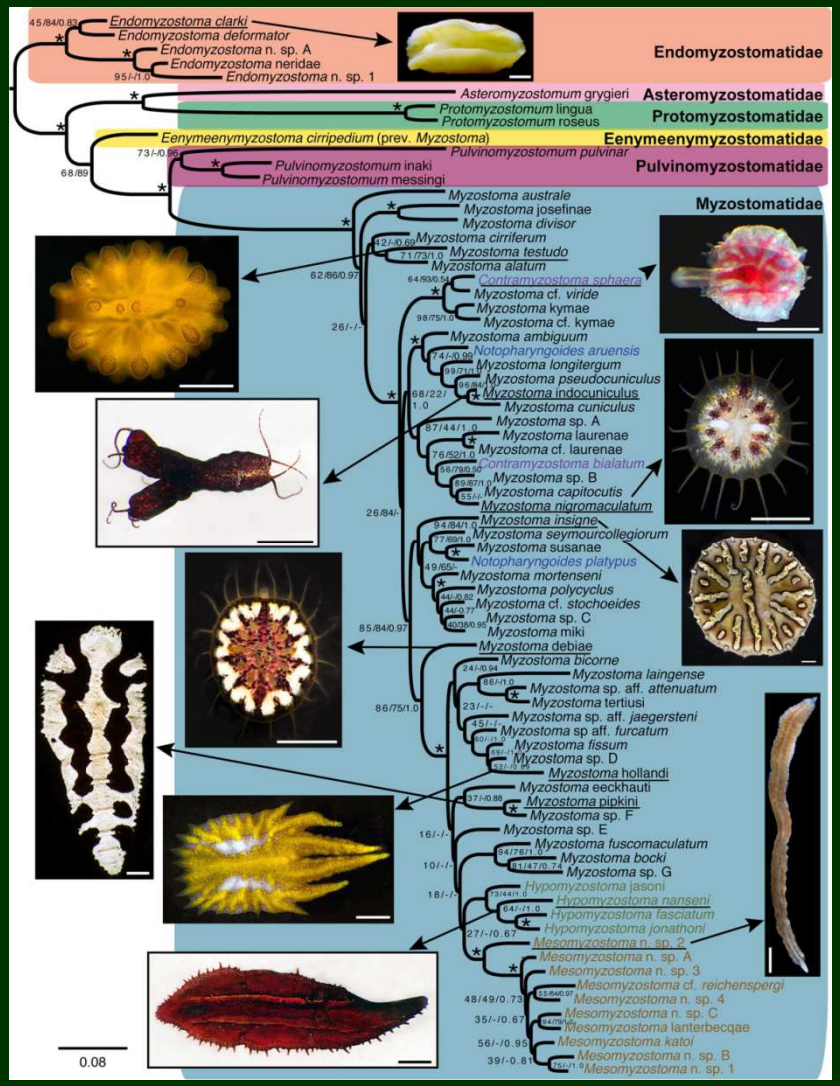
Myzostomida segmentace + svalovina

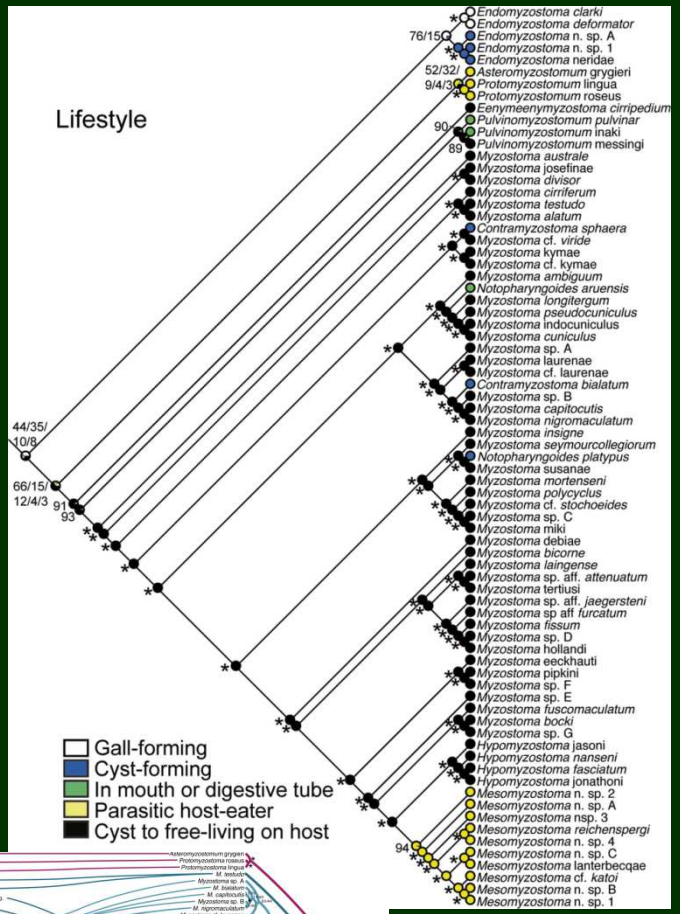
- druhotně radiální uspořádání svaloviny
- původně 6 (?) segmentů

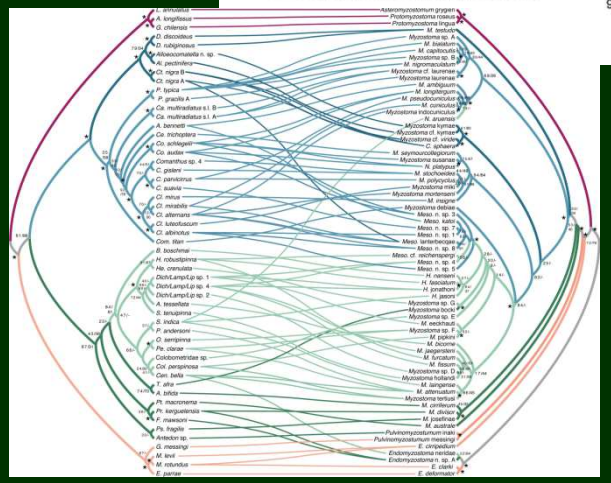




Myzostomida

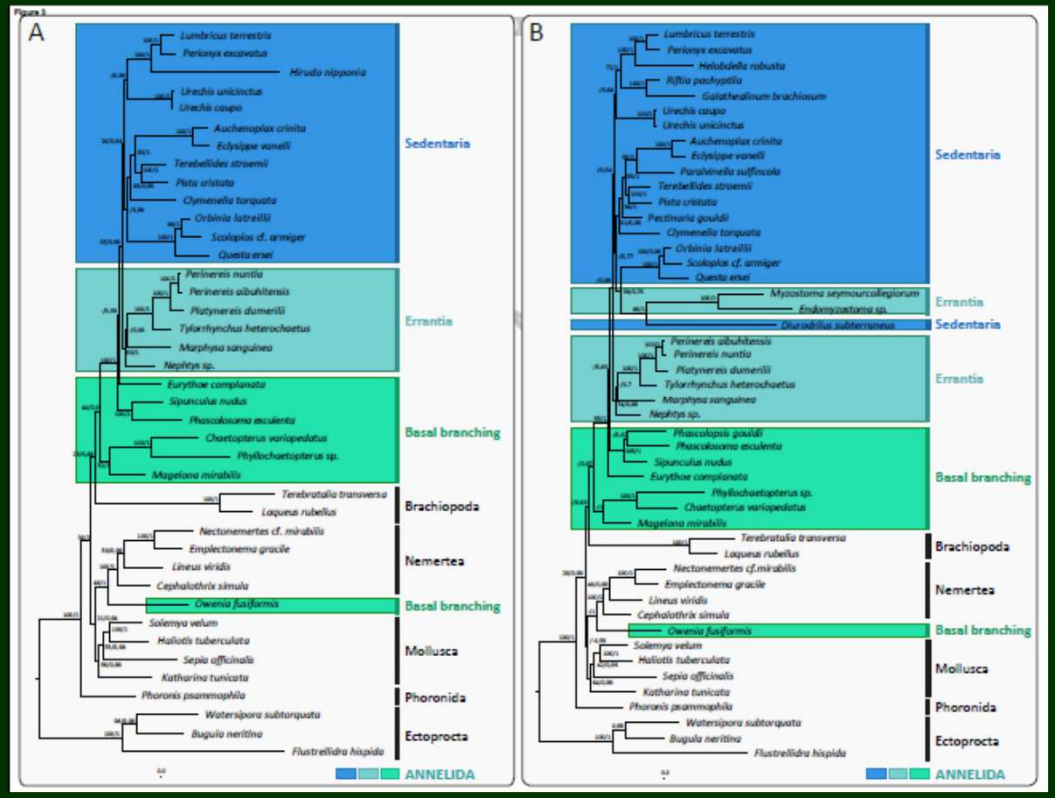


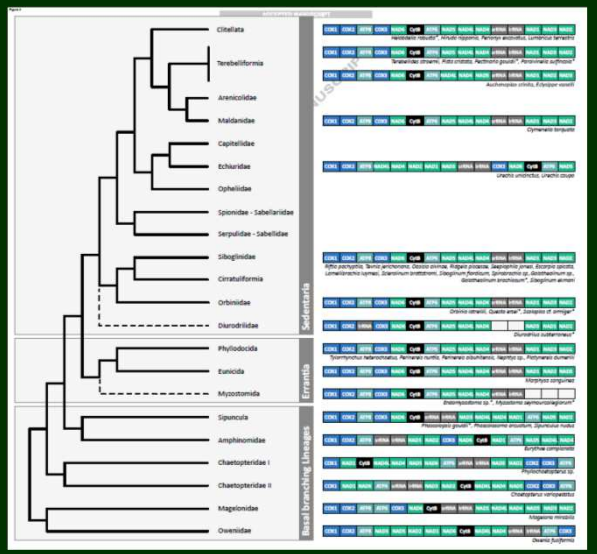




Kroužkovci a mtDNA

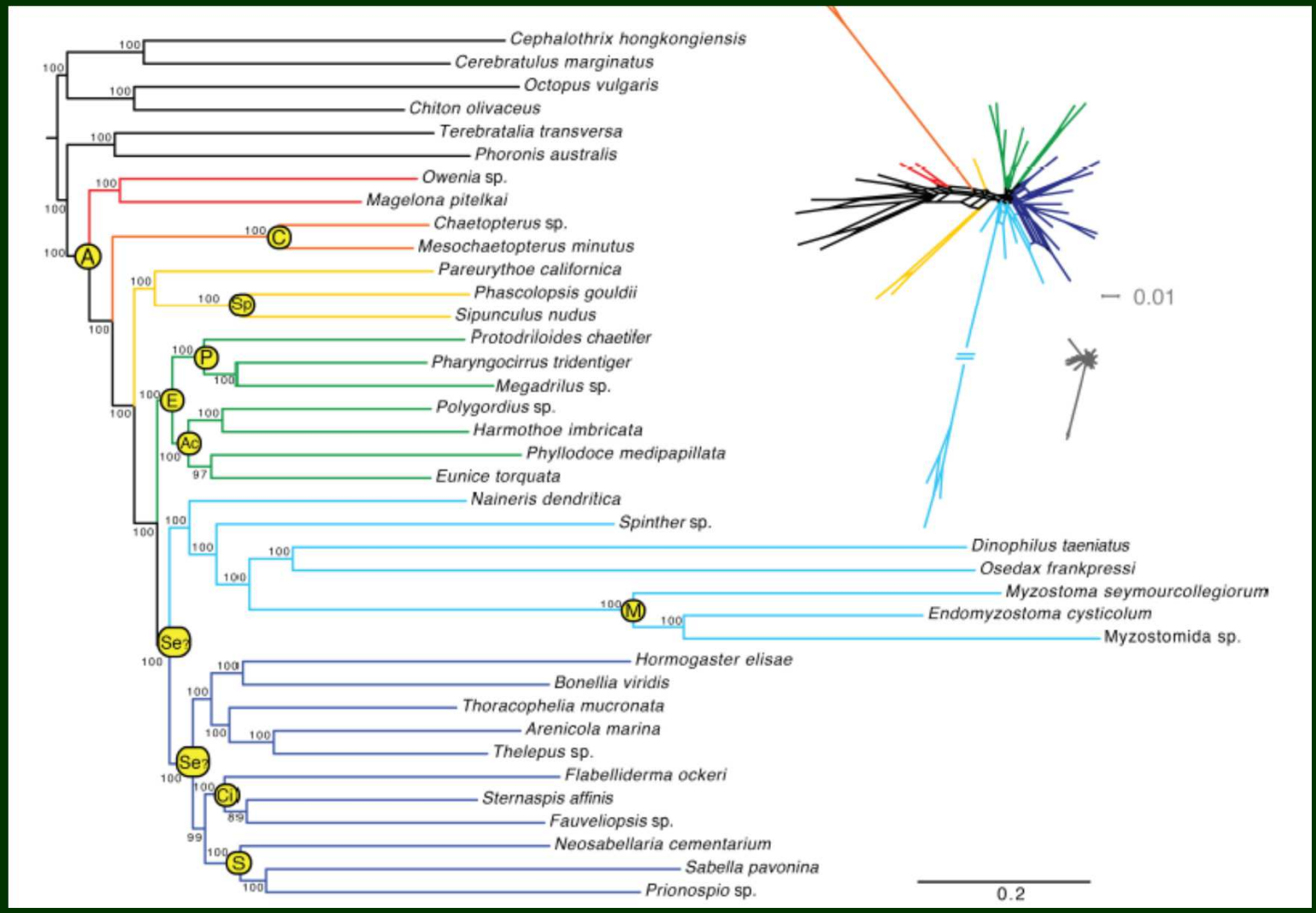
- konzervativní pořadí u Pleistoannelida (včetně myzostomidů)
- bazální kroužkovci jsou odlišní (a každý jiný)
- mitogenomika odpovídá fylogenomice (x Oweniidae)





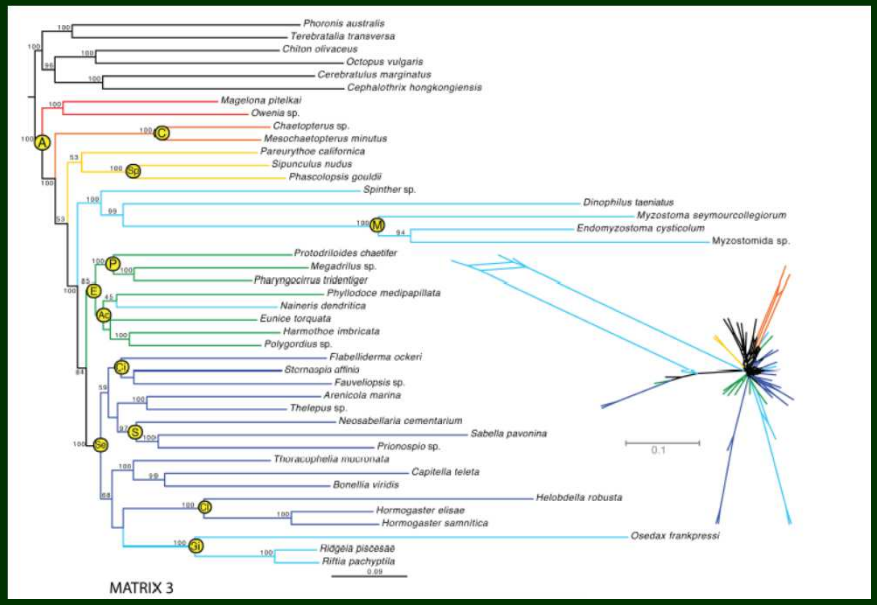
Fylogenomika kroužkovců

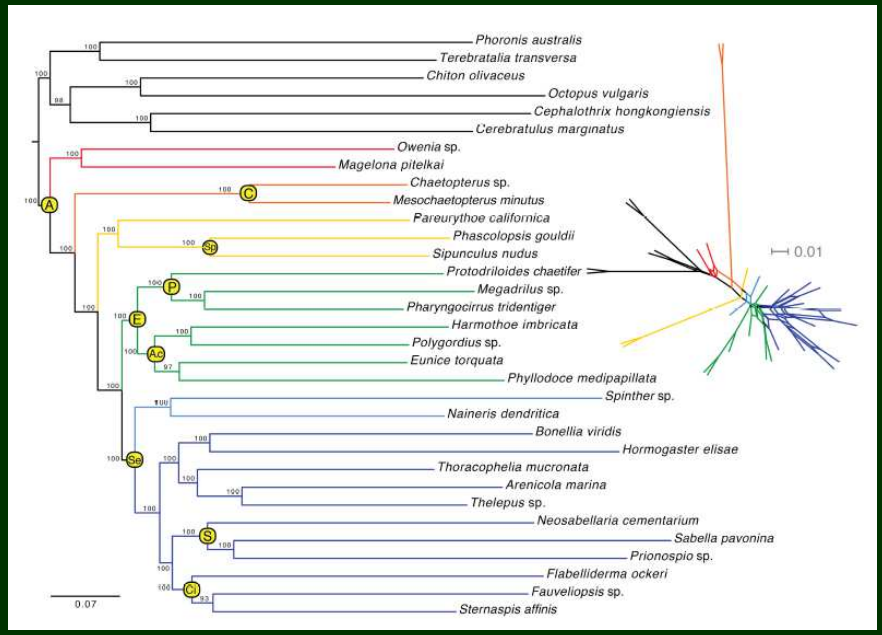
cca 800 genů



Fylogenomika kroužkovců

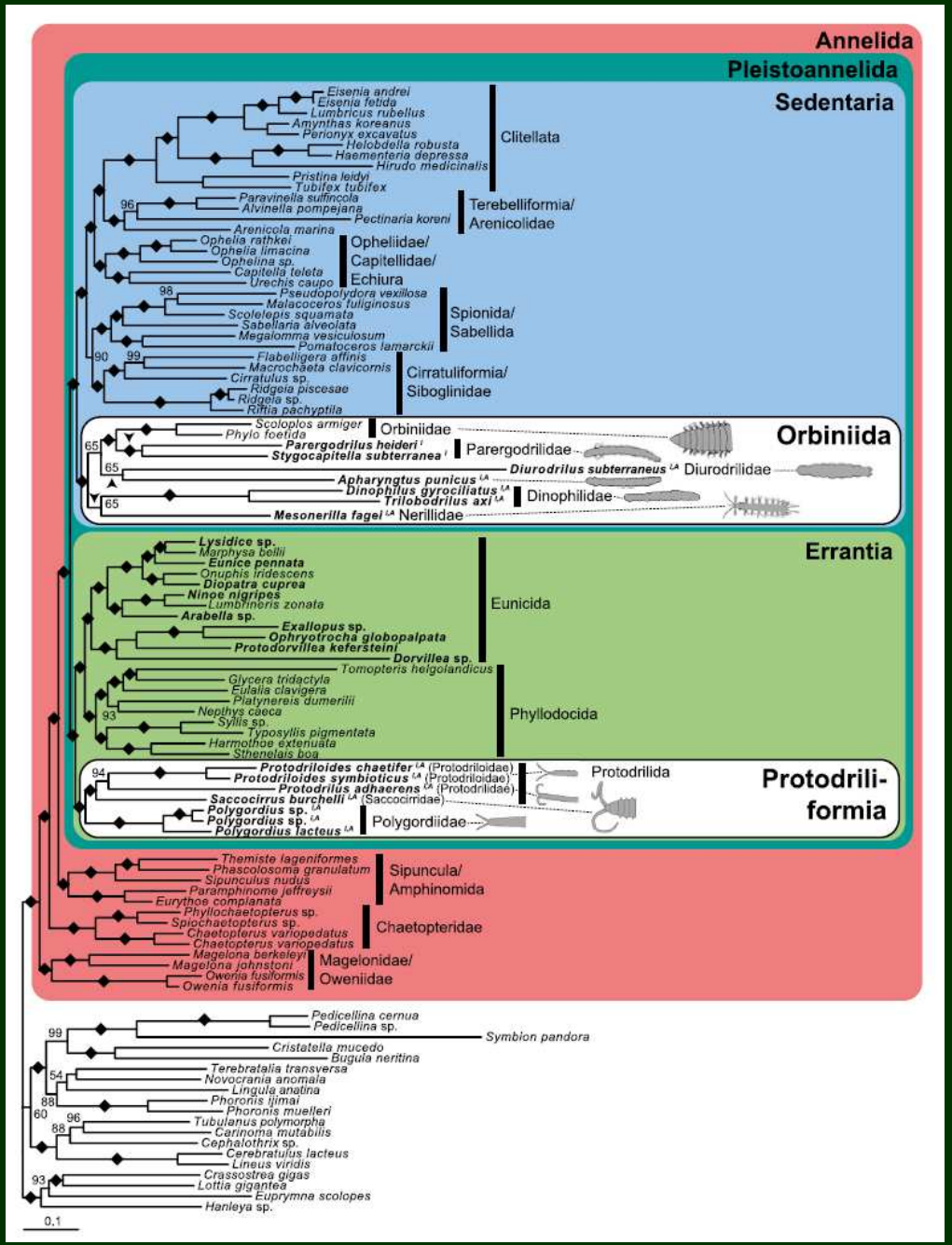
- *Osedax* = artefakt (+ Pogonophora)
- základní strom + přidávání po jednom: *Spinther* – Orbiniidae
- Myzostomida – Orbiniidae
- Dinophilidae – ? (Clitellata?)
- Polygordiidae – v rámci Aphroditiformia?



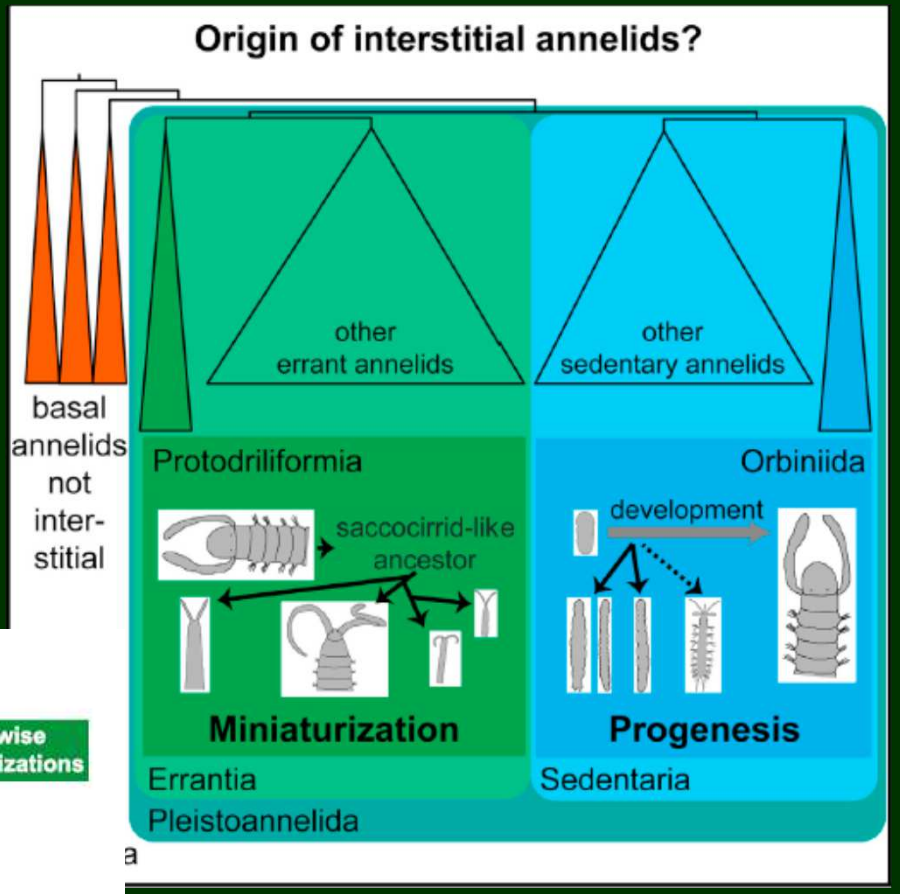


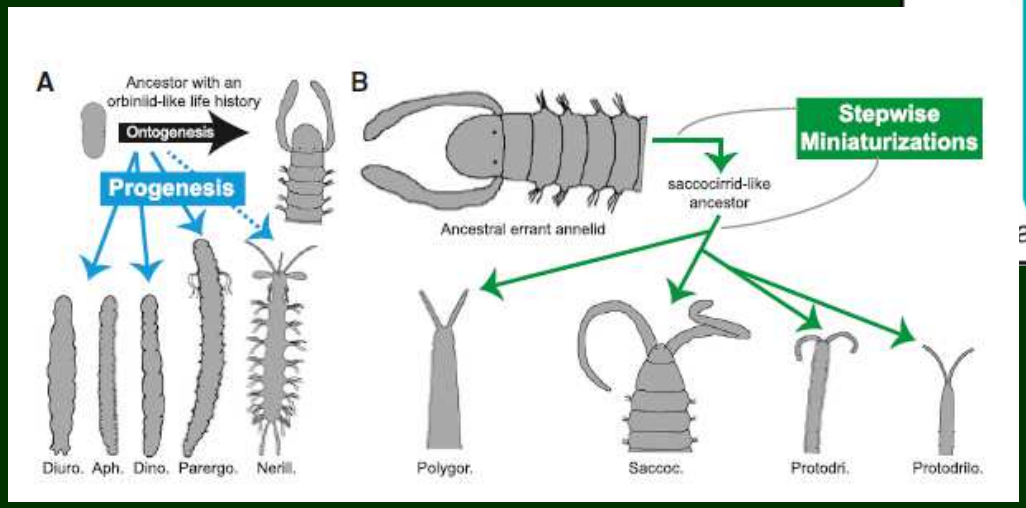
„Archiannelida“ fylogenomika

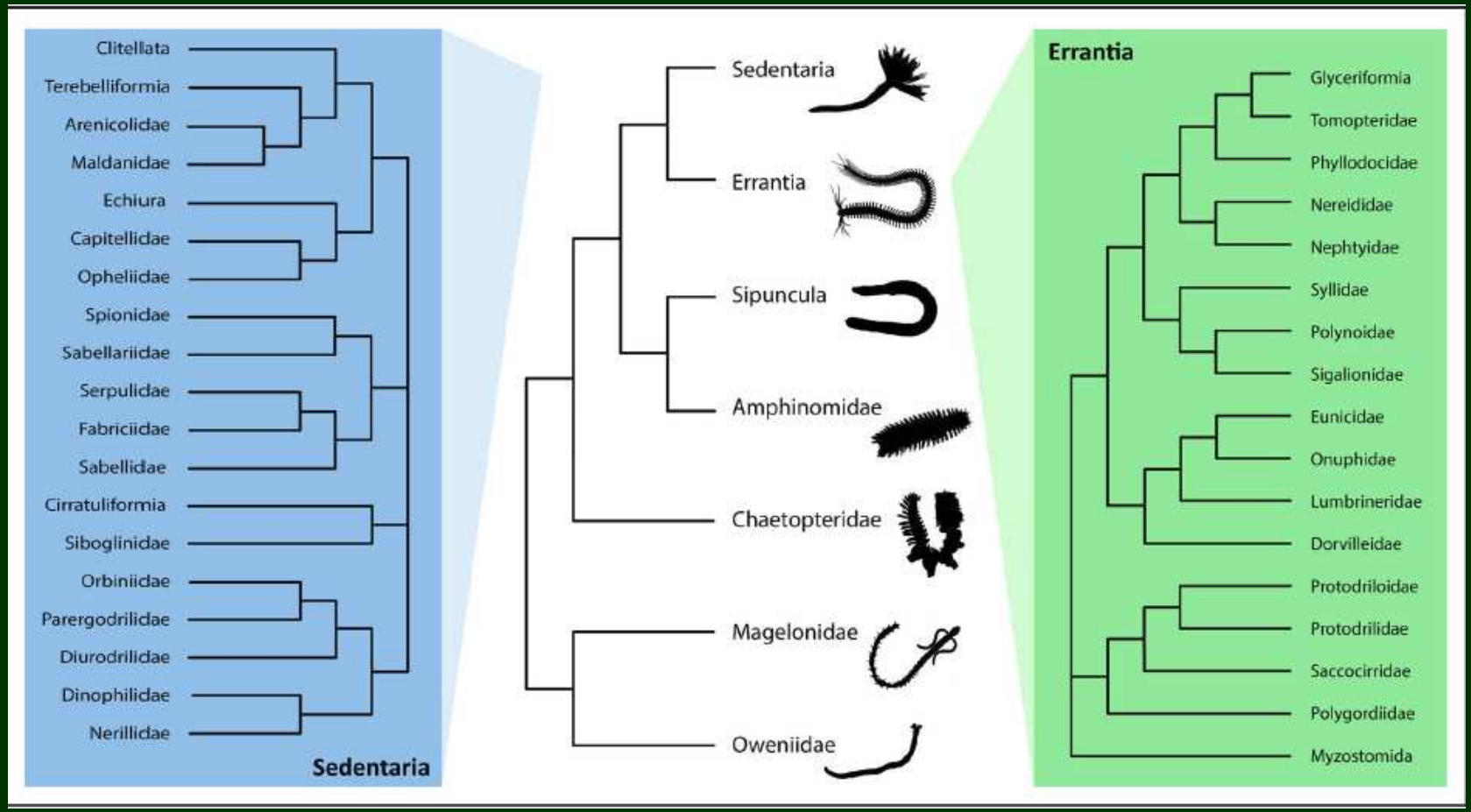
- 2 druhotně zjednodušené skupiny:
- Protodriliformia (vč. Polygordiidae): sesterská skupina Errantia
- Dinophilidae, Diurodrilida, Nerillidae: Orbiniida



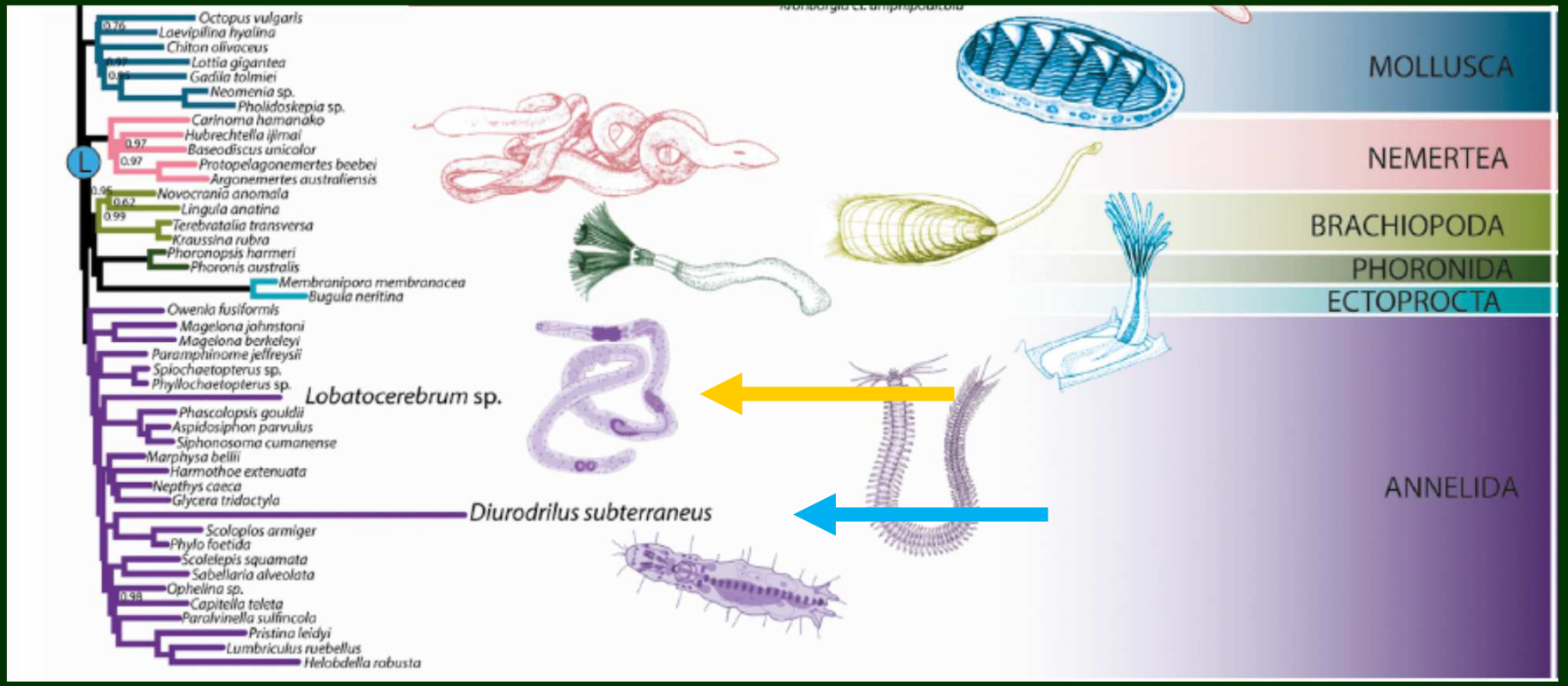
„Archiannelida“
dvě cesty do intersticiálu





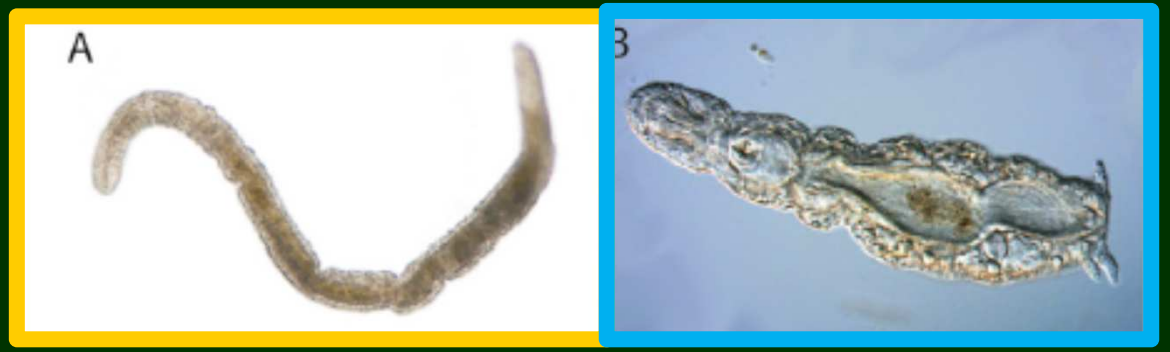

Clitellata
Terebelliformia
Arenicolidae
Maldanidae
Echiura
Capitellidae
Opheliidae
Spionidae
Sabellariidae
Serpulidae
Fabriciidae
Sabellidae
Cirratuliformia
Siboglinidae
Orbiniidae
Parergodrilidae
Diurodrilidae
Dinophilidae
Nerillidae
Sedentaria
Sedentaria
Errantia
Sipuncula
Amphinomidae
Chaetopteridae
Magelonidae
Oweniidae
Errantia
Glyceriformia
Tomopteridae
Phyllodocidae
Nereididae
Nephtyidae
Syllidae
Polynoidae
Sigalionidae
Eunicidae
Onuphidae
Lumbrineridae
Dorvilleidae
Protodriloidae
Protodrilidae
Saccocirridae
Polygordiidae
Myzostomida

„*Problematica*“ a fylogenomika



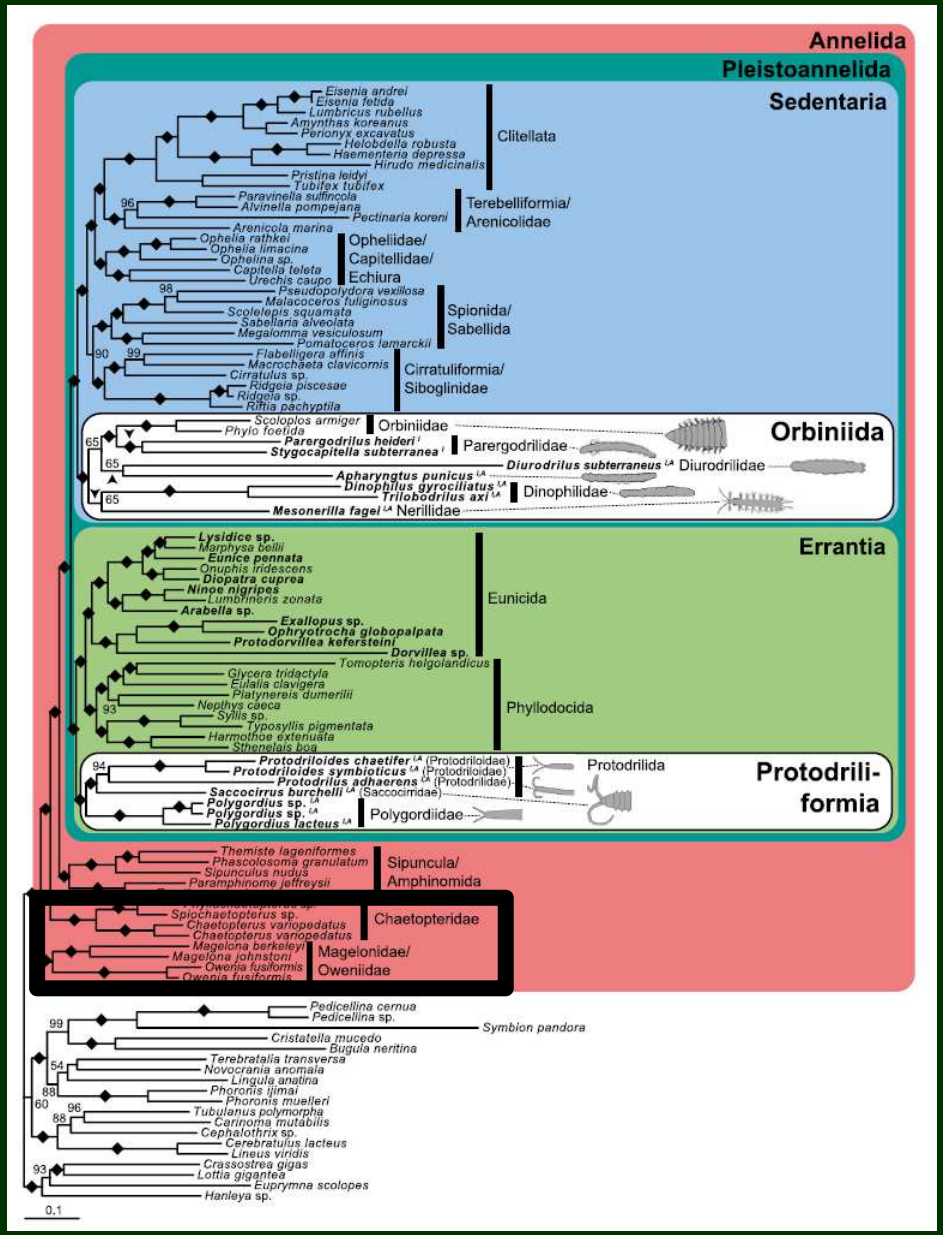
Lobatocerebrum

Diurodrilus



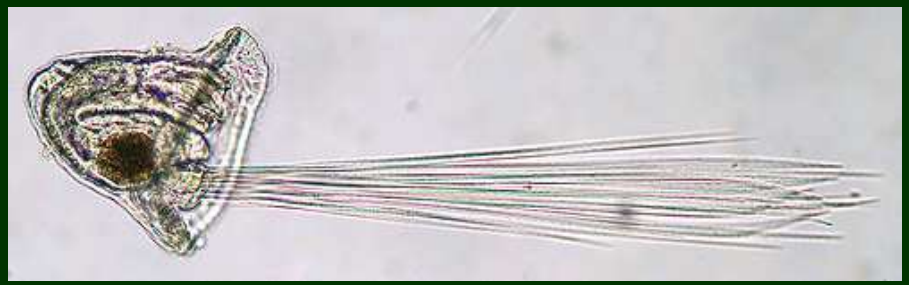
bazální Annelida („Sedentaria“)

- Oweniidae
- Magelonidae
- Chaetopteridae
- Apistobranchidae (???)



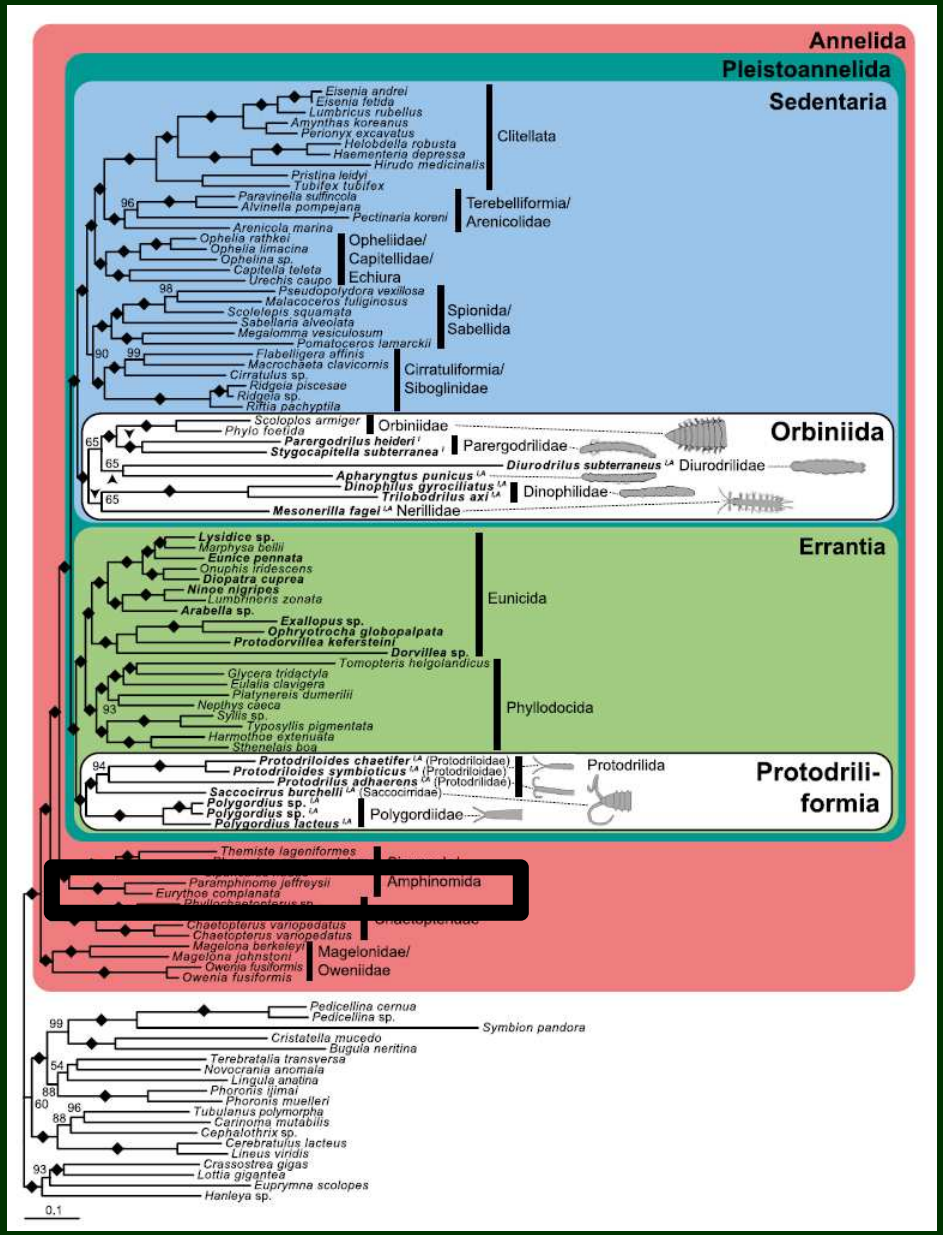
Oweniidae

- mitrariová larva
- bez disepimentů mezi články
- bez typické kroužkovčí kutikuly
- protonefridie „deuterostomního typu“
- intraepidermální NS (+ Magelonidae, Pogonophora) s podivnými synapsemi
- monociliátní epitely (ne u všech druhů)



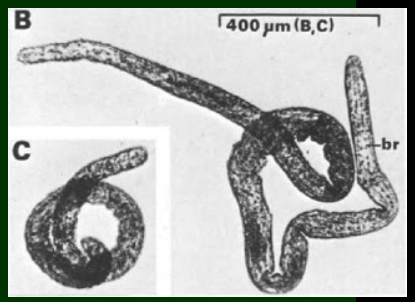
bazální Annelida („Errantia“)

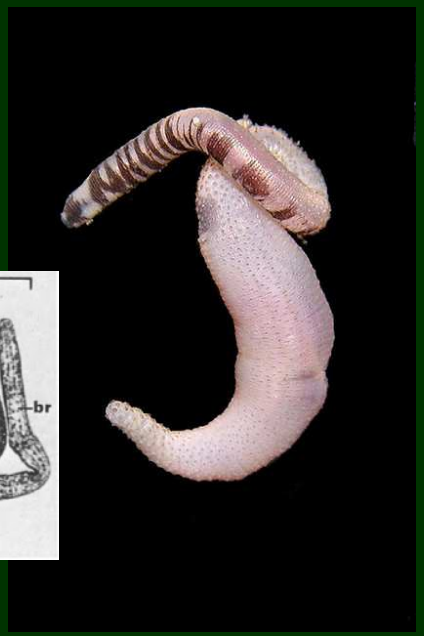
- Amphinomidae
- Aberrantidae (???)

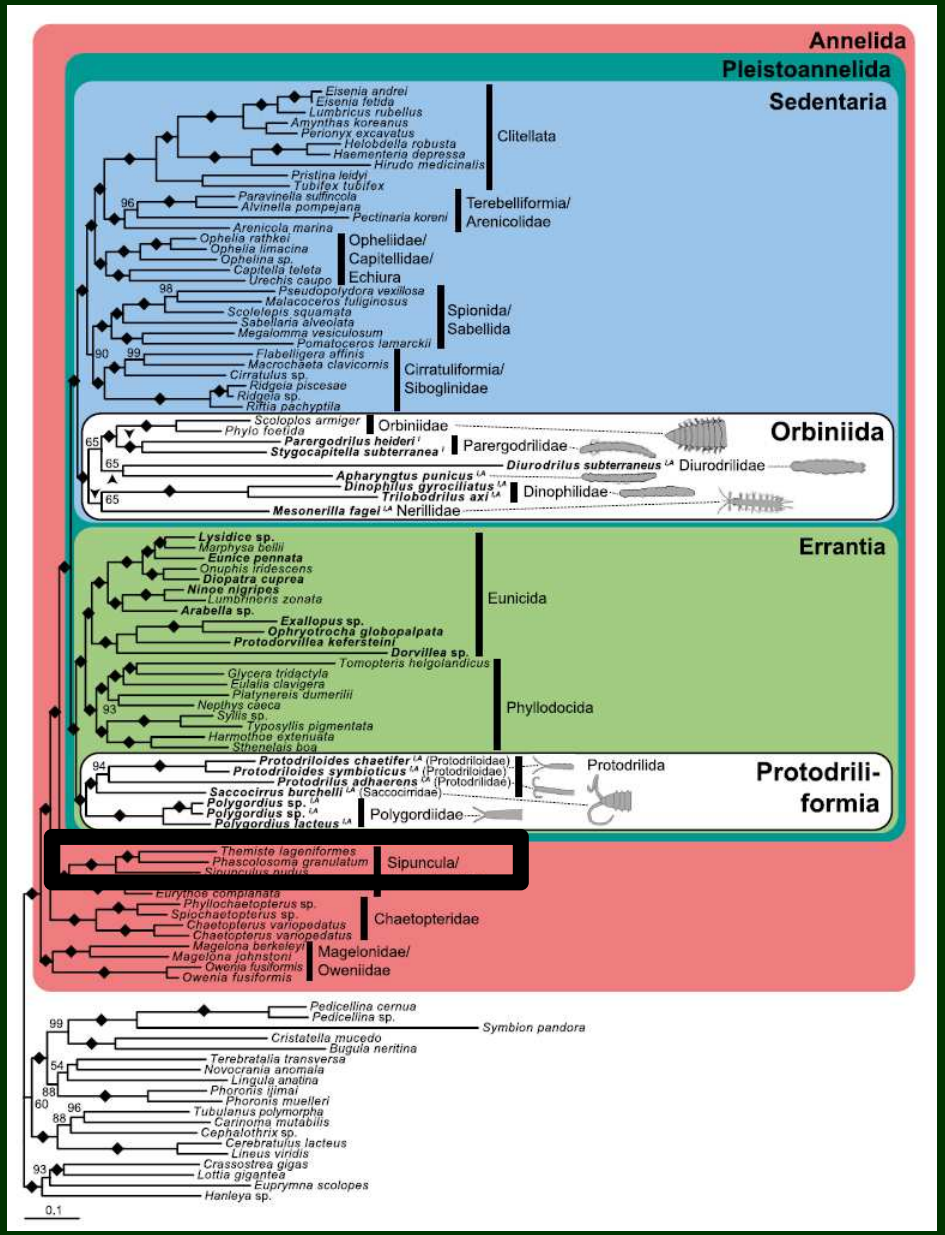


bazální Annelida: nesegmentovaní červi

- Sipunculida
- Lobatocerebromorpha (?)

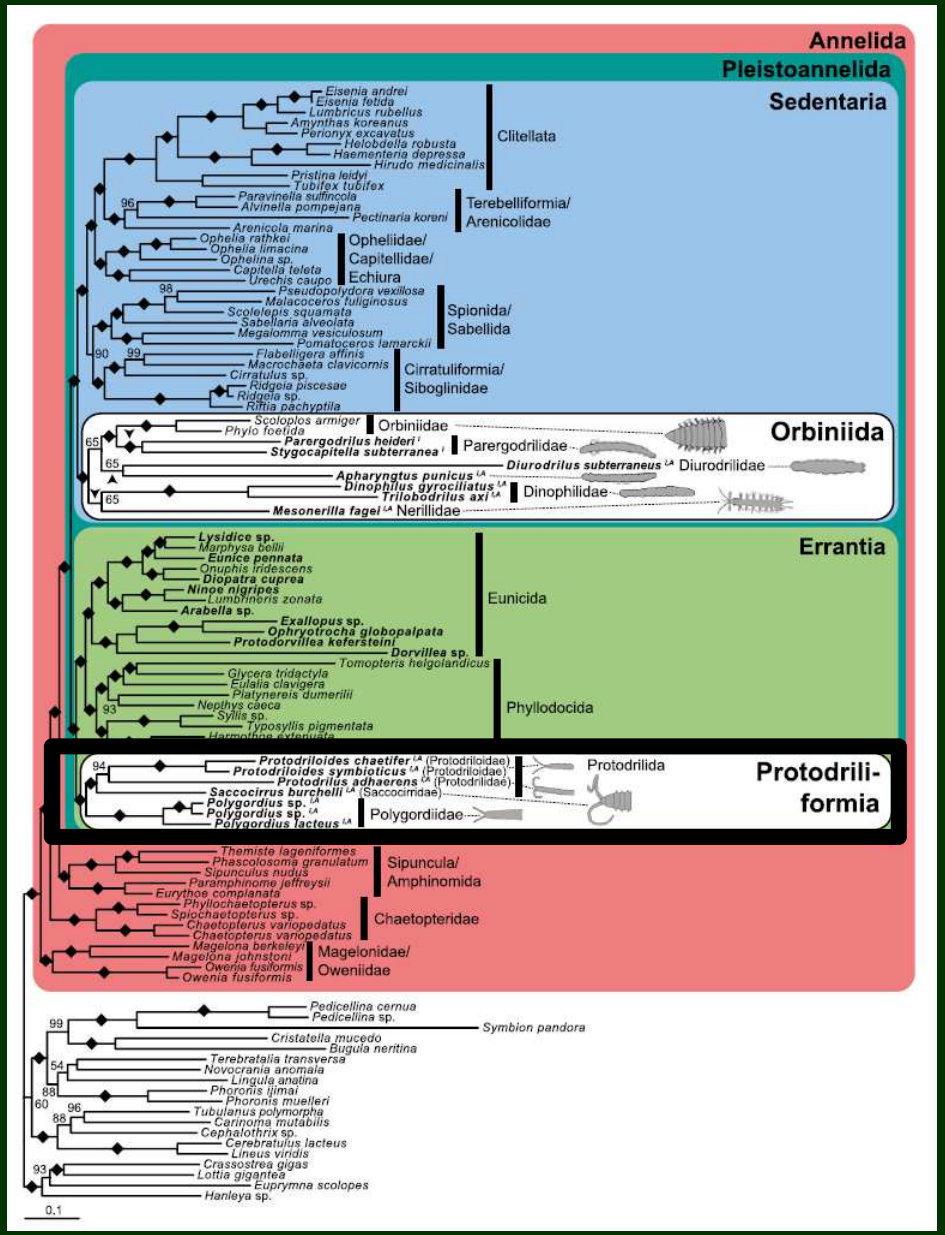






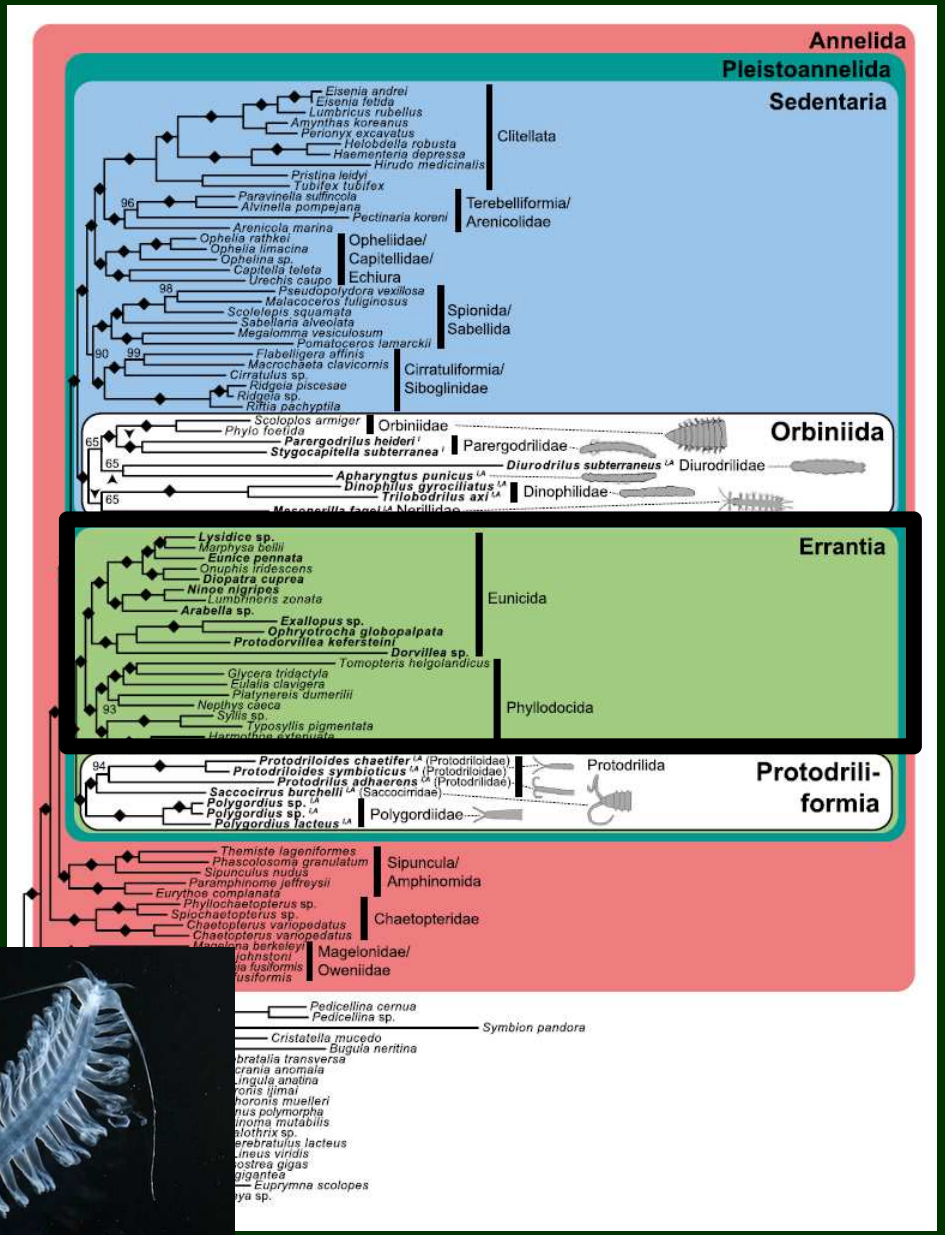
Protodriliformia

- Protodrilidae
- Protodriloididae
- Saccocirridae
- Polygordiidae (?)



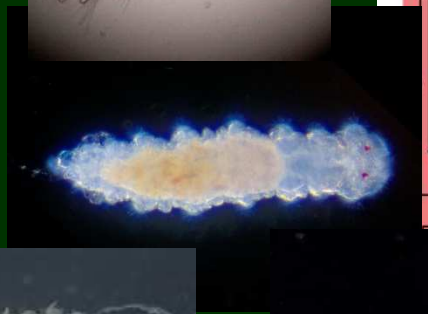
Errantia

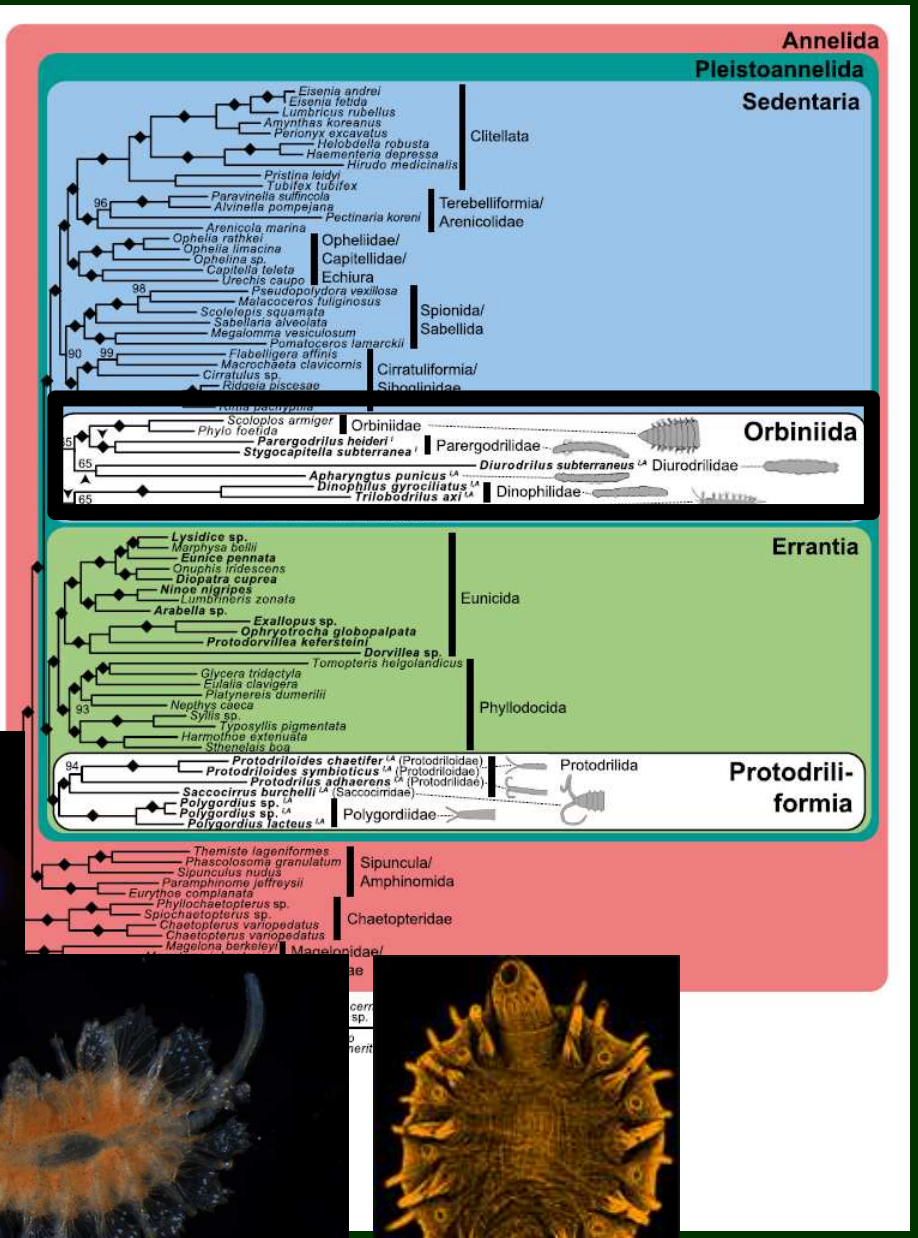
- Eunicida
- Phyllodocida



Sedentaria: Orbiniida

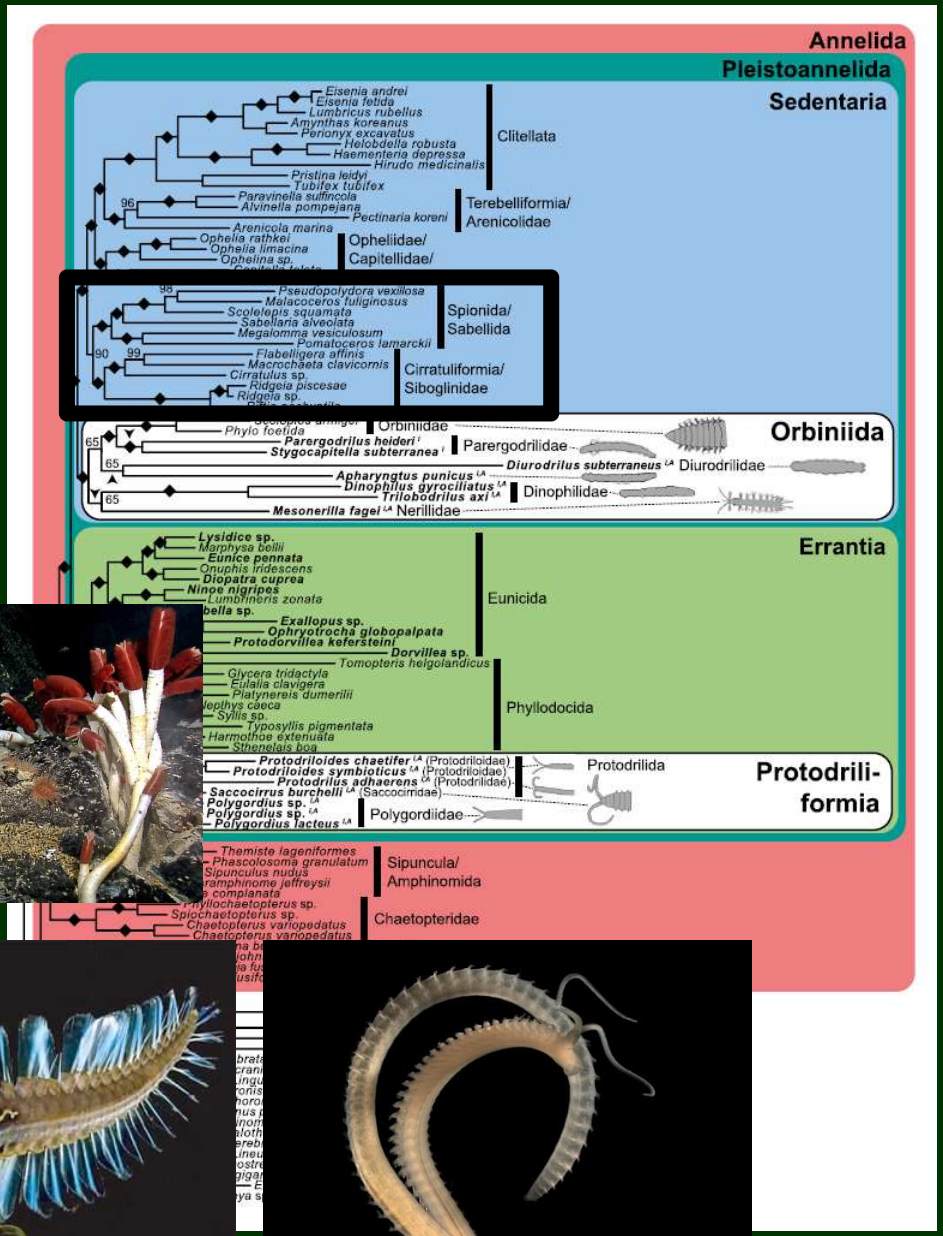
- Orbiniidae/ Questidae
- Parergodrilidae
- Diurodrilidae
- Dinophilidae (?)
- Nerillidae
- Spintheridae (?)
- Myzostomida (???)
- *Jennaria* (???)





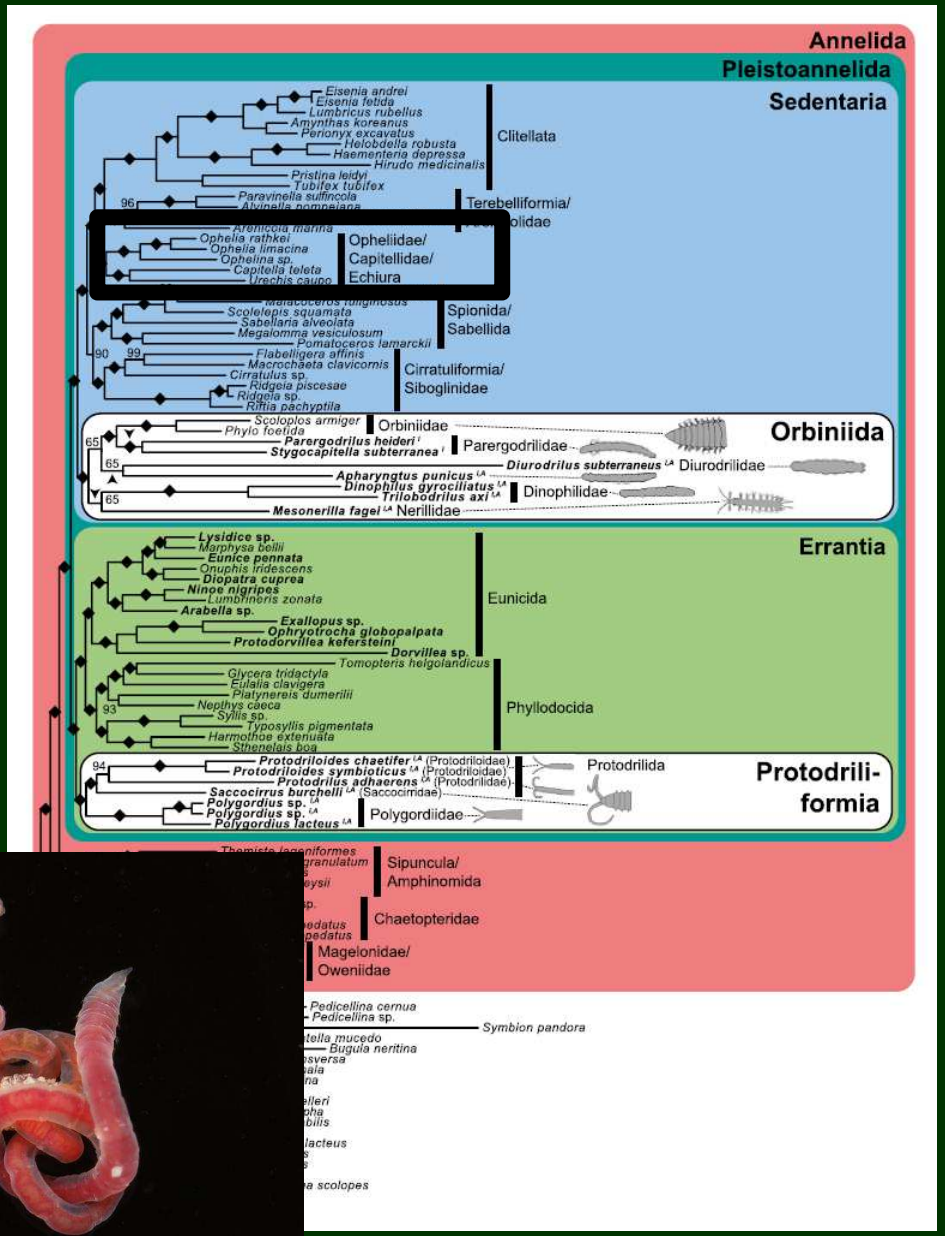
Sedentaria s. str. 1

- Sabellida/Spionida
- Cirratuliformia
- Pogonophora (?)



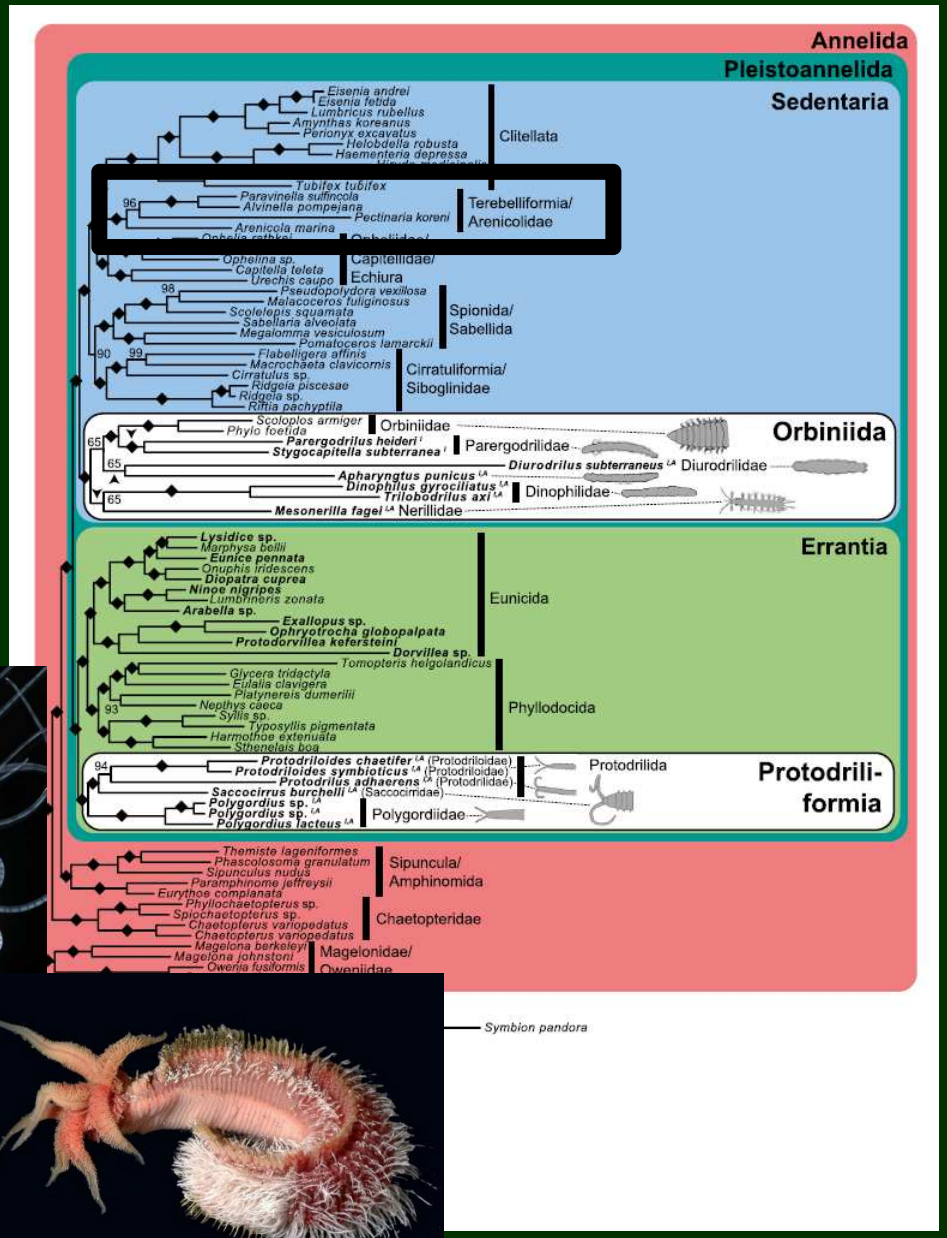
Sedentaria s. str. 2

- Opheliidae
- Capitellidae
- Echiurida
- Scalibregmatidae (?)
- Psammodrilidae (???)



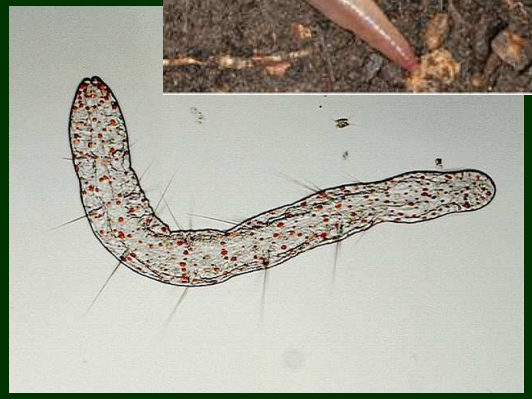
Sedentaria s. str. 3

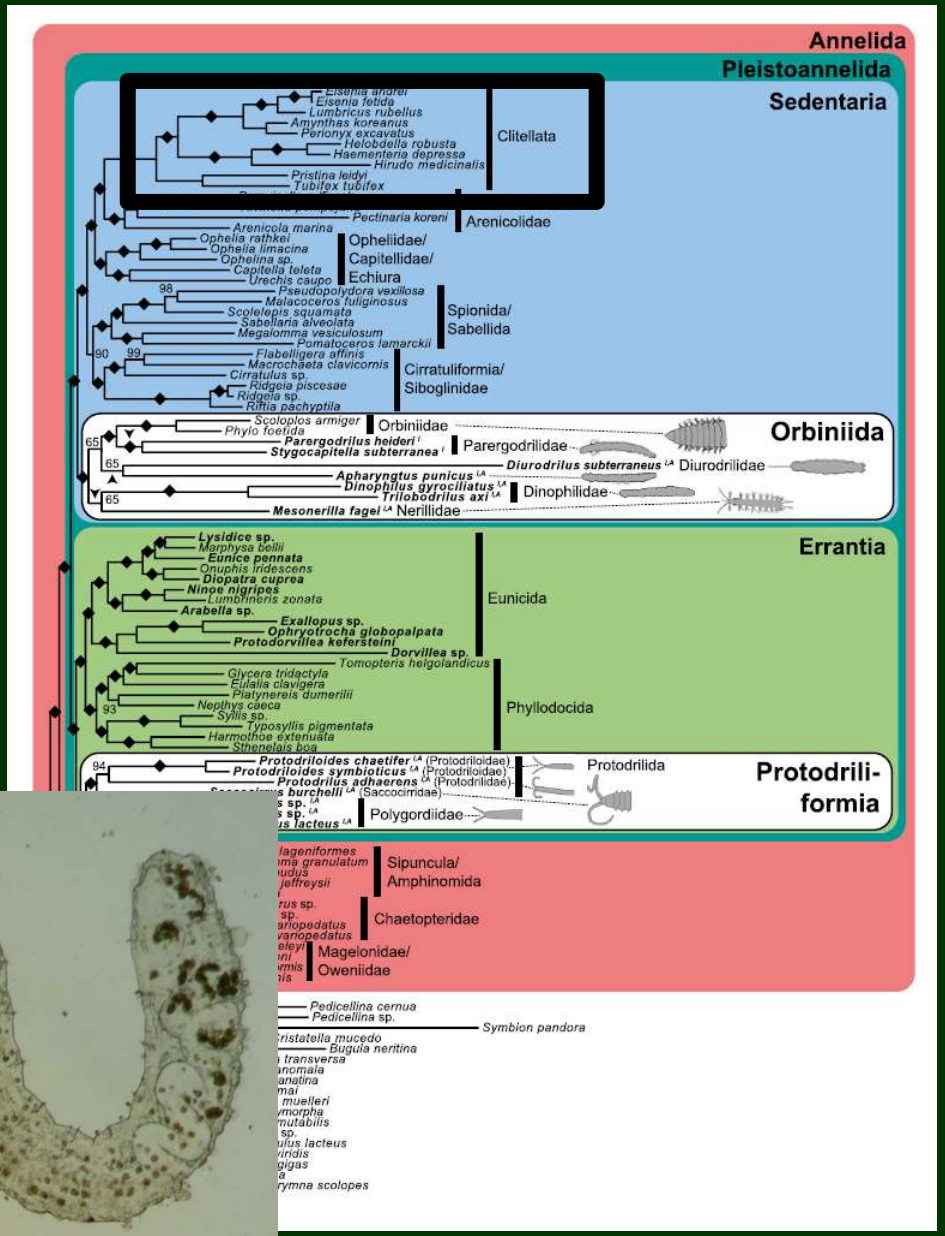
- Arenicolidae
- Maldanidae
- Terebellida
- Psammodrilidae (???)



Clitellatomorpha

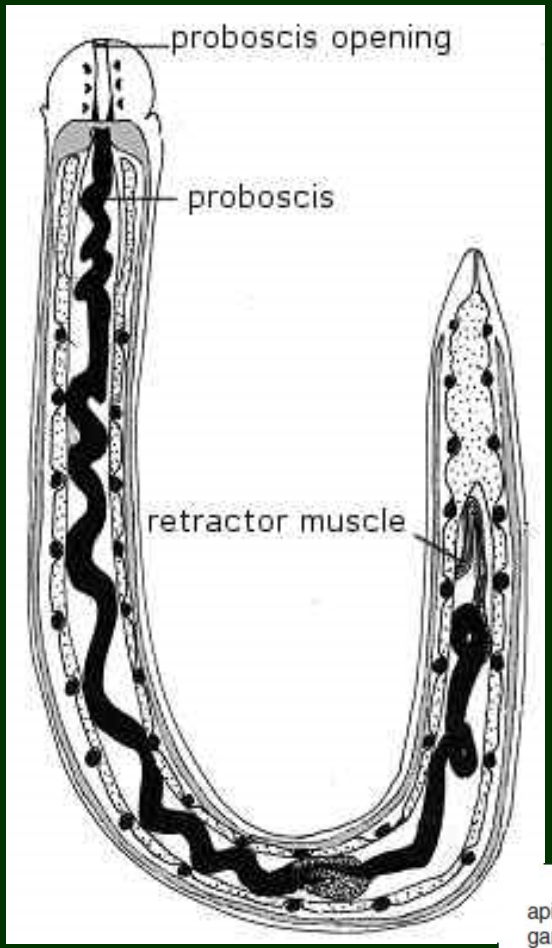
- Clitellata
- Hrabeiella (?)
- Aeolosomatidae (?)
- Potamodrilidae (?)

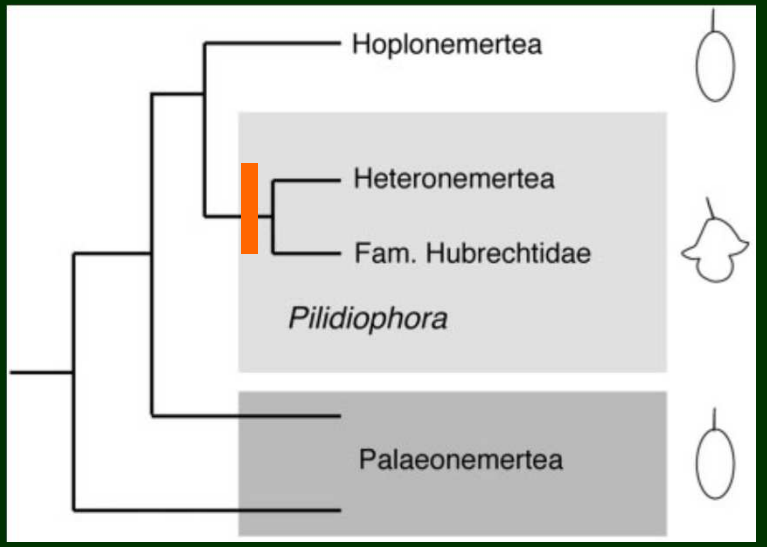


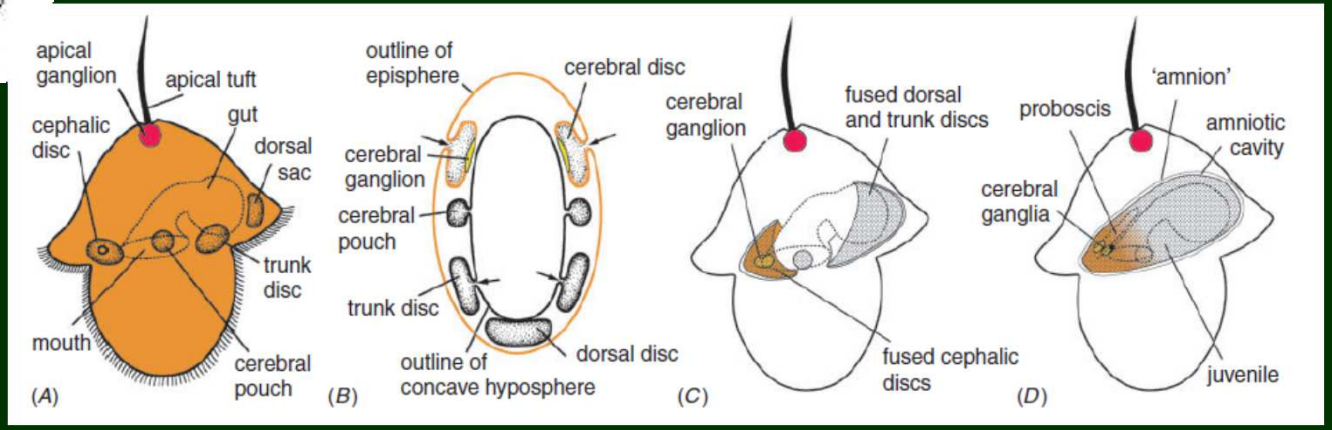


Nemertea

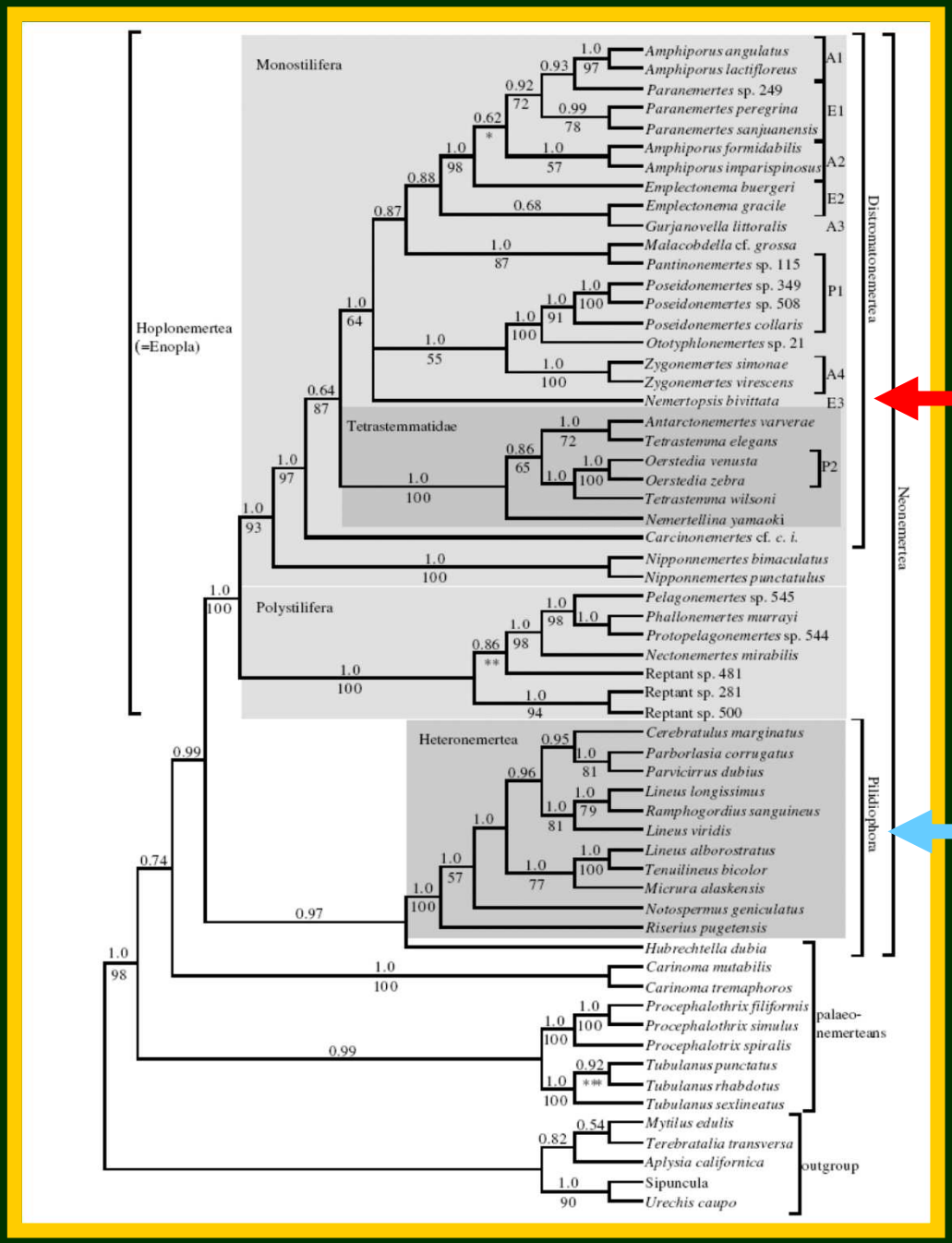
Nemertea


proboscis opening
proboscis
retractor muscle

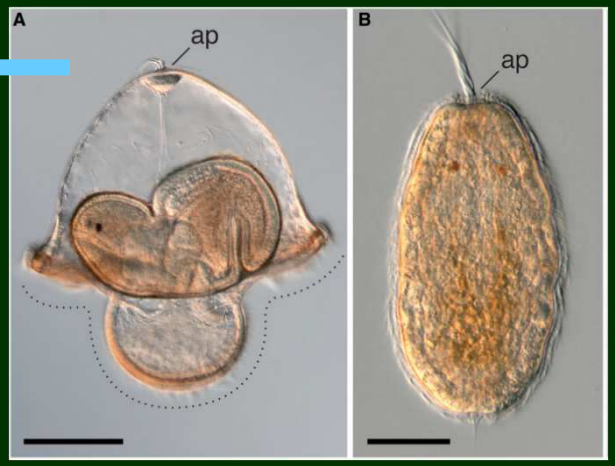

Hoplonemertea
Heteronemertea
Fam. Hubrechtidae
Pilidiophora
Palaeonemertea


apical ganglion
apical tuft
cephalic disc
gut
dorsal sac
trunk disc
mouth
cerebral pouch
(A)
outline of episphere
cerebral disc
cerebral ganglion
cerebral pouch
trunk disc
outline of concave hyposphere
dorsal disc
(B)
cerebral ganglion
fused dorsal and trunk discs
fused cephalic discs
(C)
'amnion'
proboscis
amniotic cavity
cerebral ganglia
juvenile
(D)

Fylogeneze pásnic

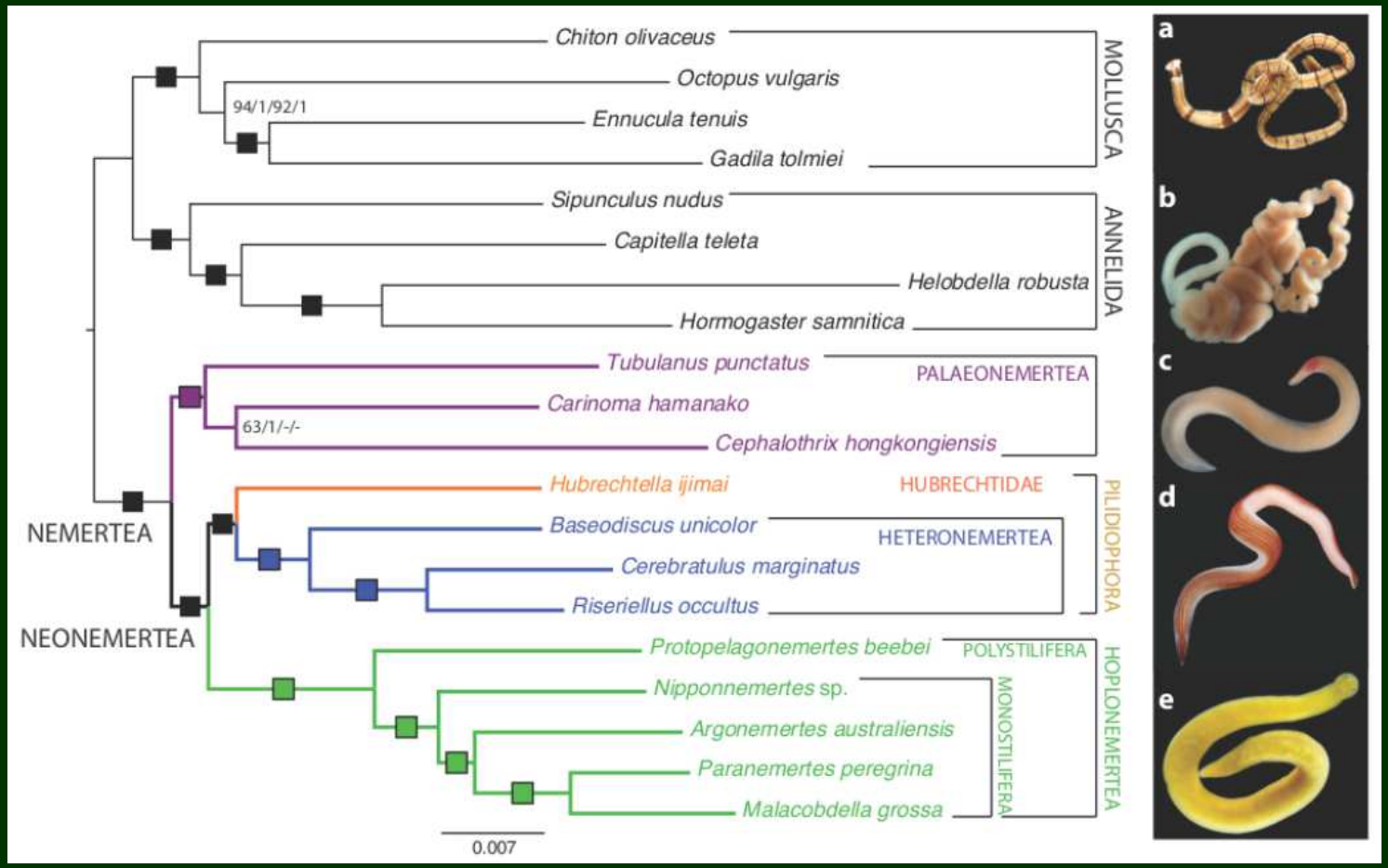


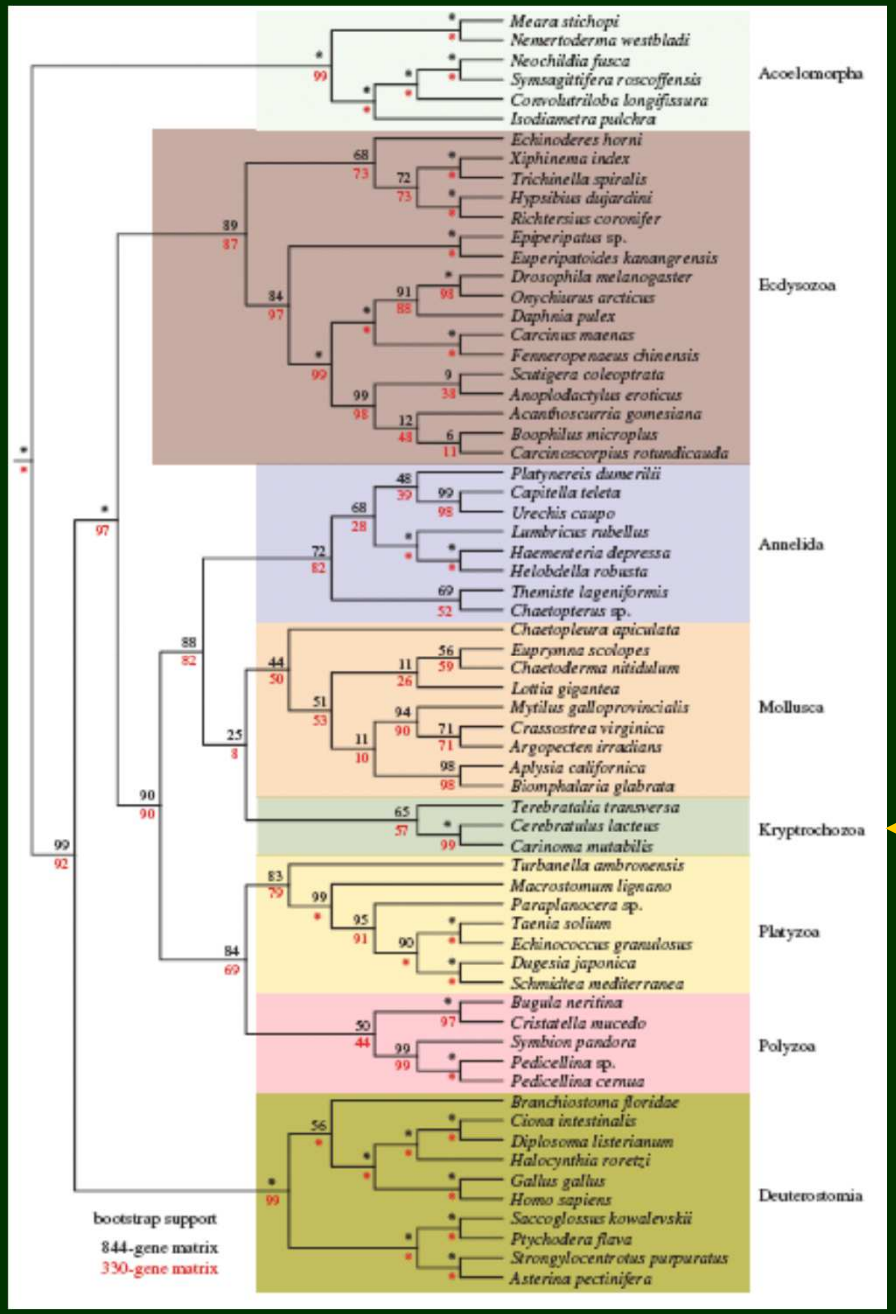
Annulonemertes (metamerismus → segmentace): odvozený druh hoplonemerteí

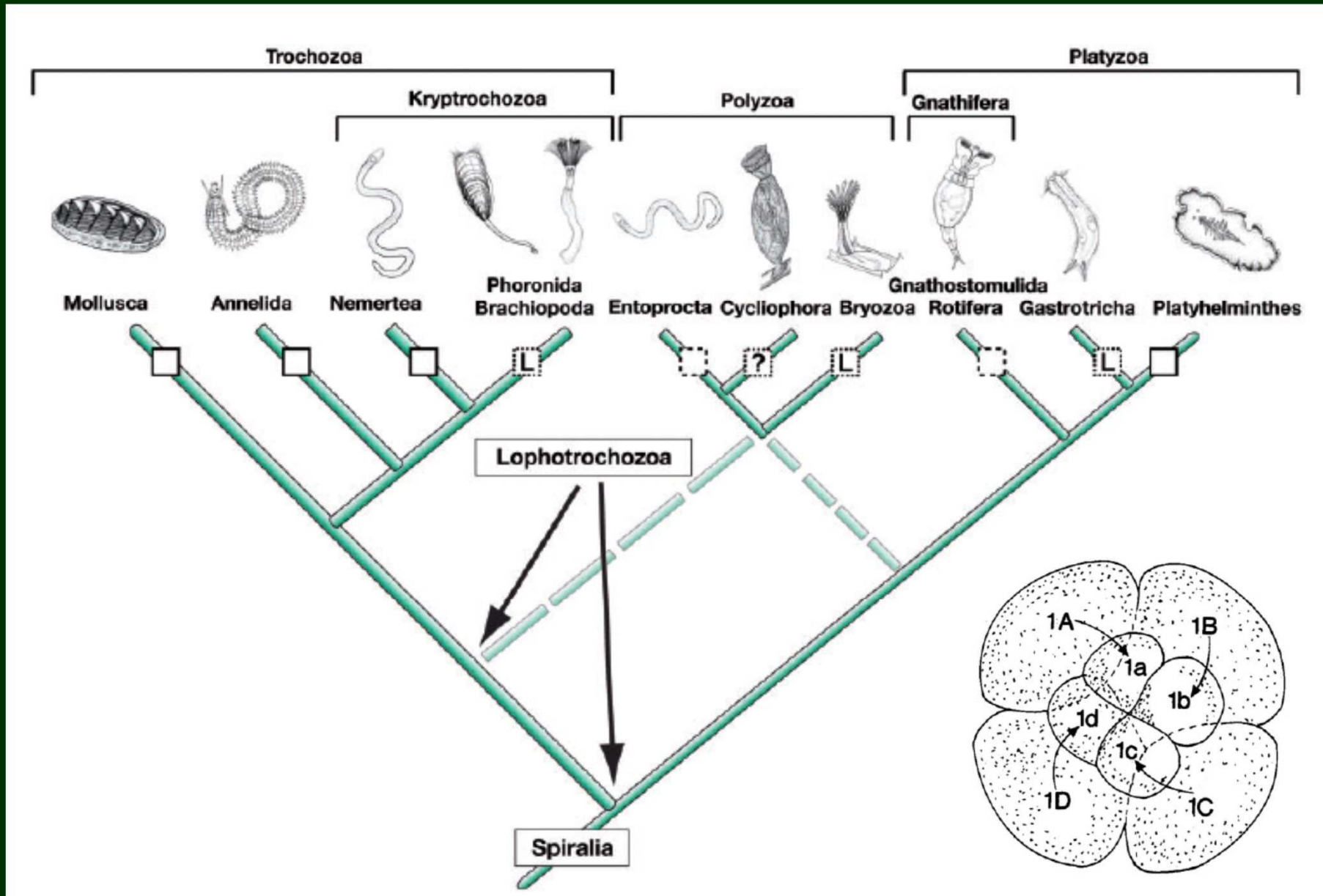


- *Malacobdella* („Bdellonemertea“ = symbionti měkkýšů) a *Annulonemertes* patří do Hoplonemertea
- *Arhynchonemertes*: nevíme

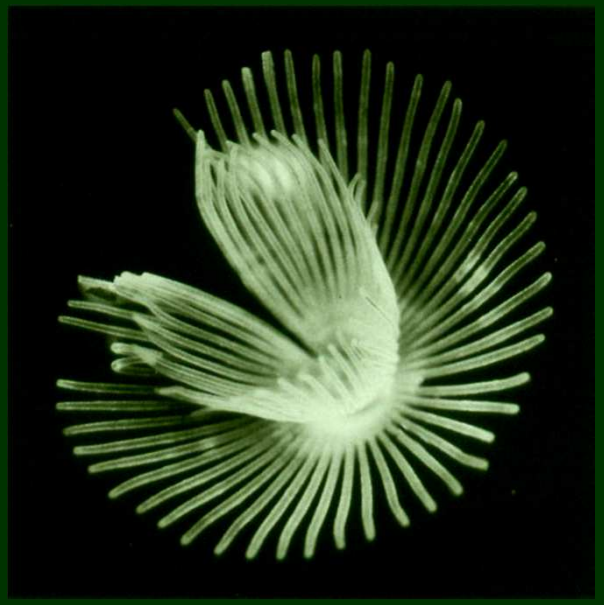
Nemertea fylogenomika



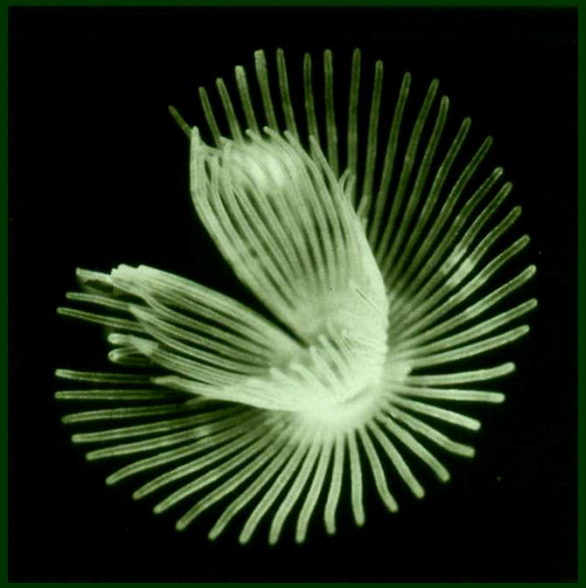

Meara stichopi
Nemertoderma westbladi
Neochildia fusca
Symsagittifera roscoffensis
Convolutriloba longifissura
Isodiametra pulchra
Acoelomorpha
Echinoderes horni
Xiphinema index
Trichinella spiralis
Hypsibius dujardini
Richtersius coronifer
Epiperipatus sp.
Esperipatoides kanangrensis
Drosophila melanogaster
Onychiurus arcticus
Daphnia pulex
Carcinus maenas
Fenneropenaeus chinensis
Scutigera coleoptrata
Anoplodactylus eroticus
Acanthoscurria gomesiana
Boophilus microplus
Carcinoscorpius rotundicauda
Ecdysozoa
Platynereis dumerilii
Capitella teleta
Urechis caupo
Lumbricus rubellus
Haementeria depressa
Helobdella robusta
Themiste lageniformis
Chaetopterus sp.
Annelida
Chaetopleura apiculata
Euprymna scolopes
Chaetoderma nitidulum
Lottia gigantea
Mytilus galloprovincialis
Crassostrea virginica
Argopecten irradians
Aplysia californica
Biomphalaria glabrata
Mollusca
Terebratalia transversa
Cerebratulus lacteus
Carinoma mutabilis
Kryptrochozoa
Turbanella ambronensis
Macrostomum lignano
Paraplanocera sp.
Taenia solium
Echinococcus granulosus
Dugesia japonica
Schmidtea mediterranea
Platyzoa
Bugula neritina
Cristatella mucedo
Symbion pandora
Pedicellina sp.
Pedicellina cernua
Polyzoa
Branchiostoma floridae
Ciona intestinalis
Diplosoma listerianum
Halocynthia roretzi
Gallus gallus
Homo sapiens
Saccoglossus kowalevskii
Ptychodera flava
Strongylocentrotus purpuratus
Asterina pectinifera
Deuterostomia
bootstrap support
844-gene matrix
330-gene matrix

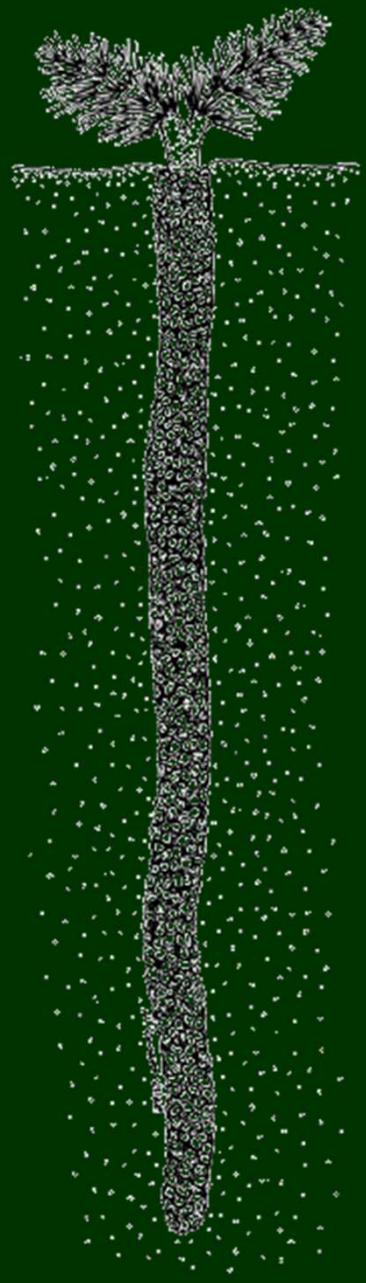

Trochozoa
Platyzoa
Kryptrochozoa
Polyzoa
Gnathifera
Mollusca
Annelida
Nemertea
Phoronida
Brachiopoda
Entoprocta
Cycliophora
Bryozoa
Gnathostomulida
Rotifera
Gastrotricha
Platyhelminthes
L
?
L
L
Lophotrochozoa
Spiralia
1A
1B
1a
1b
1d
1c
1D
1C

Brachiozoa = Phoronozoa = Brachiopoda s.lat.



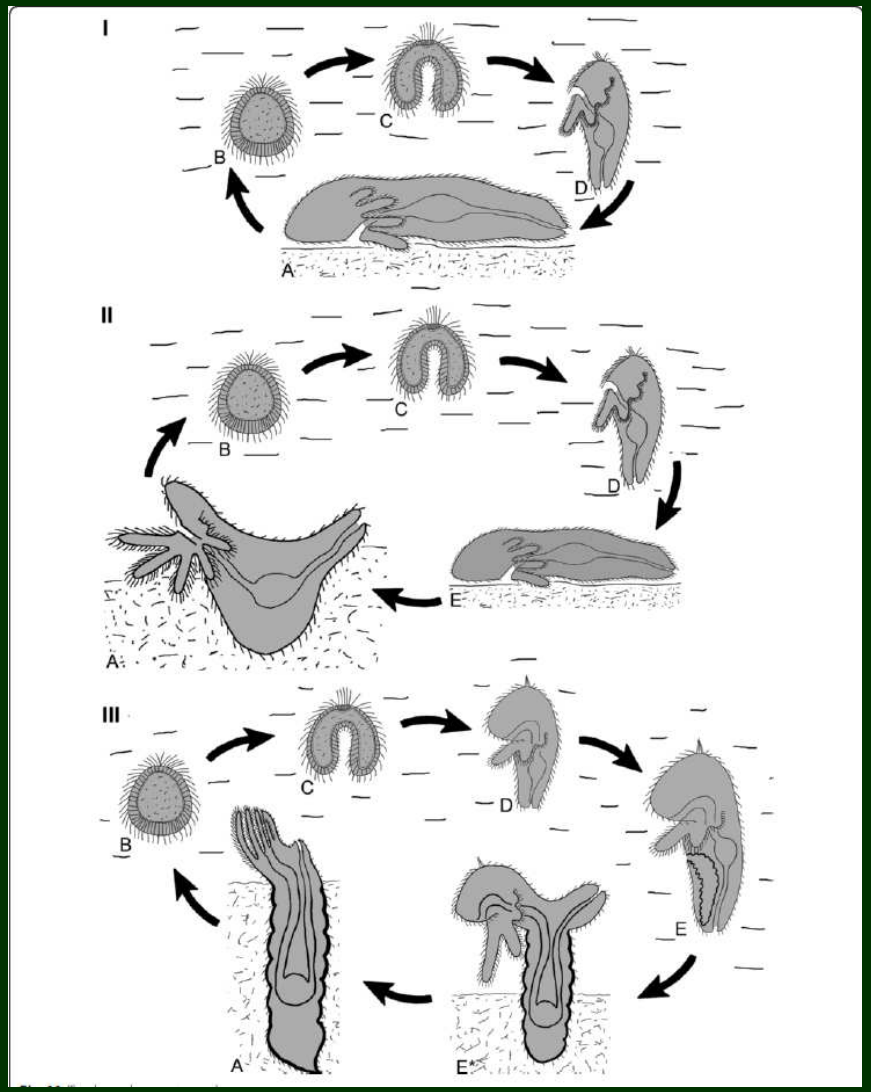
Phoronida





Phoronida

- aktinotrocha – jediná primární larva s krevním systémem, dobře vyvinutými nefridiálními kanály a metasomálním vakem
- tj. plantonní juvenil?



Phoronida

- párová břišní NS s metamerickými komisurami u larev, ztracené u dospělců

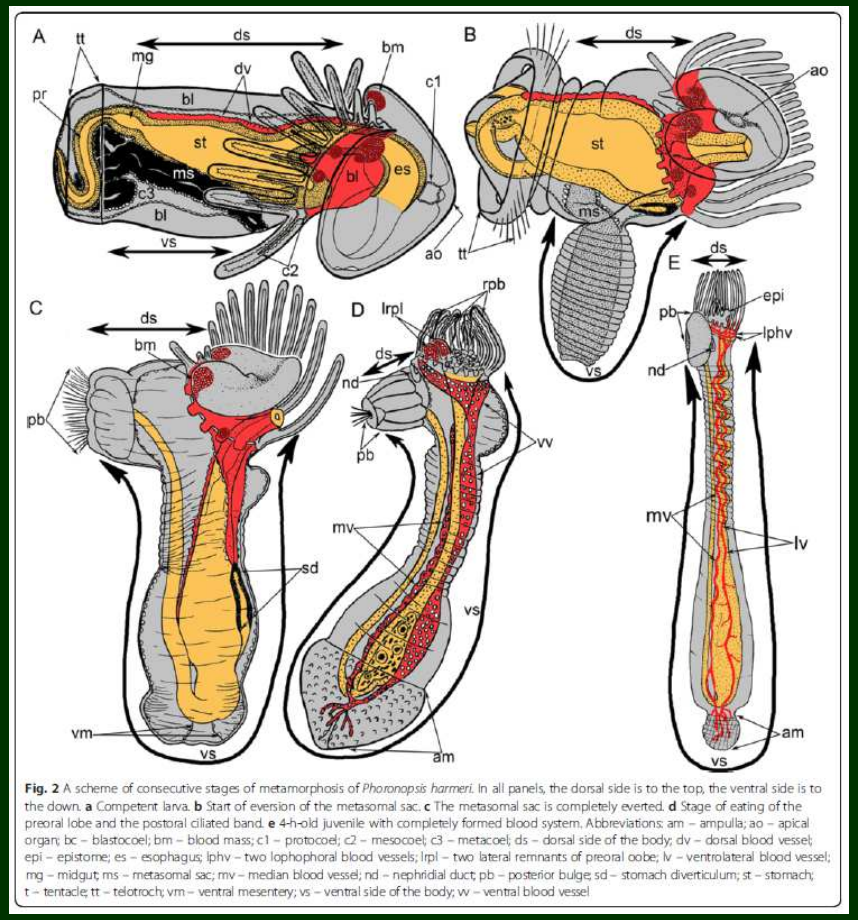
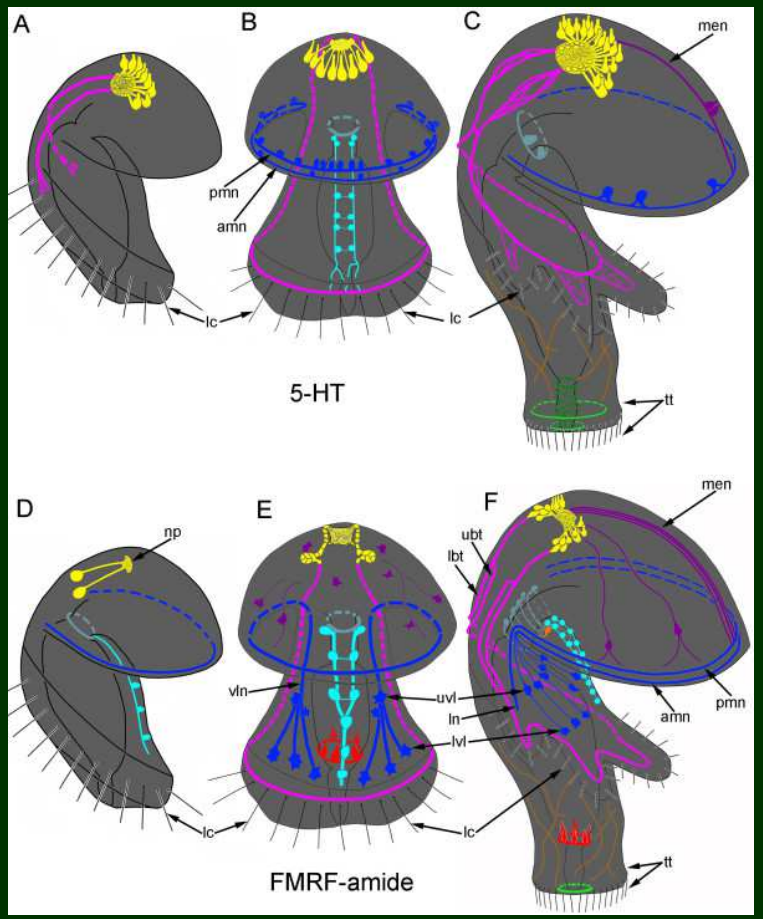
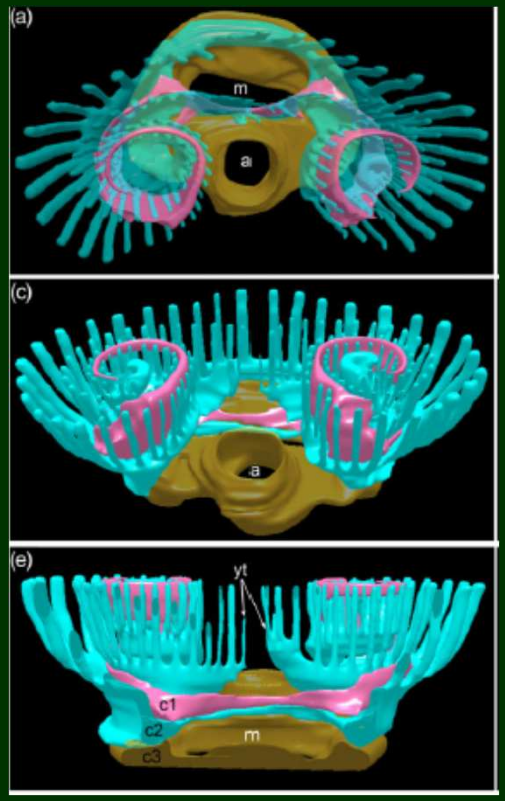


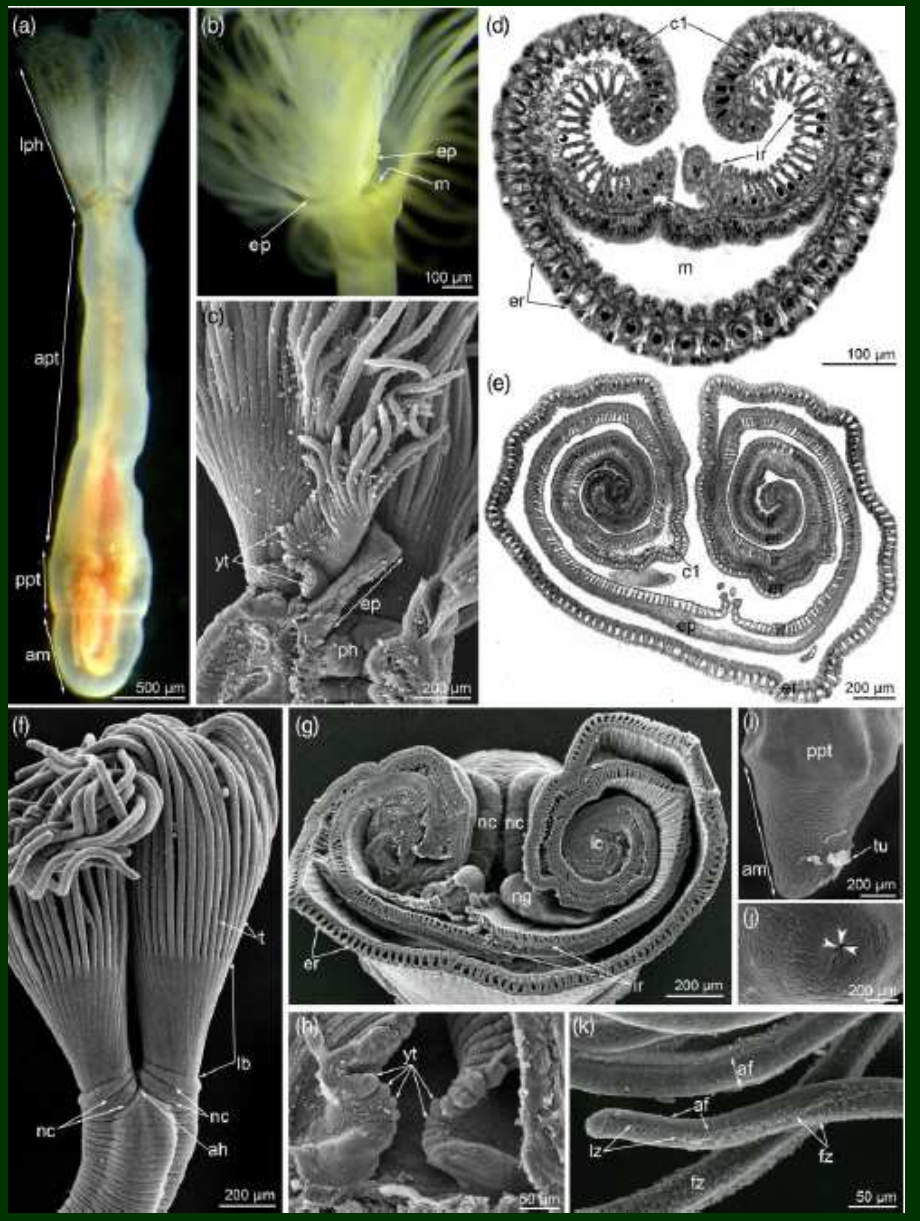
Fig. 2 A scheme of consecutive stages of metamorphosis of *Phoronopsis harmeri*. In all panels, the dorsal side is to the top, the ventral side is to the down. **a** Competent larva. **b** Start of eversion of the metasomal sac. **c** The metasomal sac is completely everted. **d** Stage of eating of the preoral lobe and the postoral ciliated band. **e** 4-h-old juvenile with completely formed blood system. Abbreviations: am – ampulla; ao – apical organ; bc – blastocoel; bm – blood mass; c1 – protocoel; c2 – mesocoel; c3 – metacoel; ds – dorsal side of the body; dv – dorsal blood vessel; epi – epistome; es – esophagus; lphv – two lophophoral blood vessels; lrpl – two lateral remnants of preoral oobe; lv – ventrolateral blood vessel; mg – midgut; ms – metasomal sac; mv – median blood vessel; nd – nephridial duct; pb – posterior bulge; sd – stomach diverticulum; st – stomach; t – tentacle; tt – telotroch; vm – ventral mesentery; vs – ventral side of the body; vv – ventral blood vessel



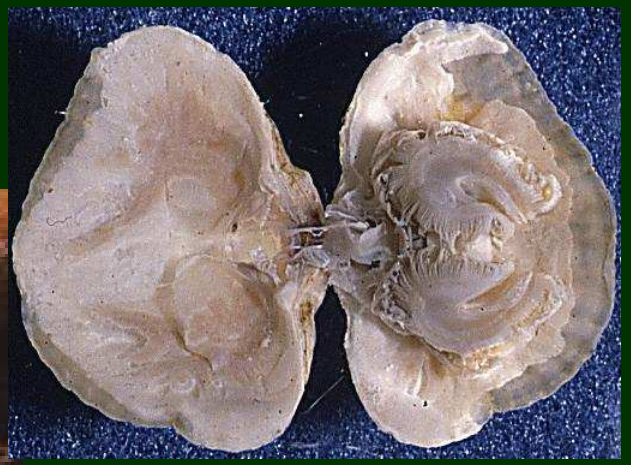
Phoronida

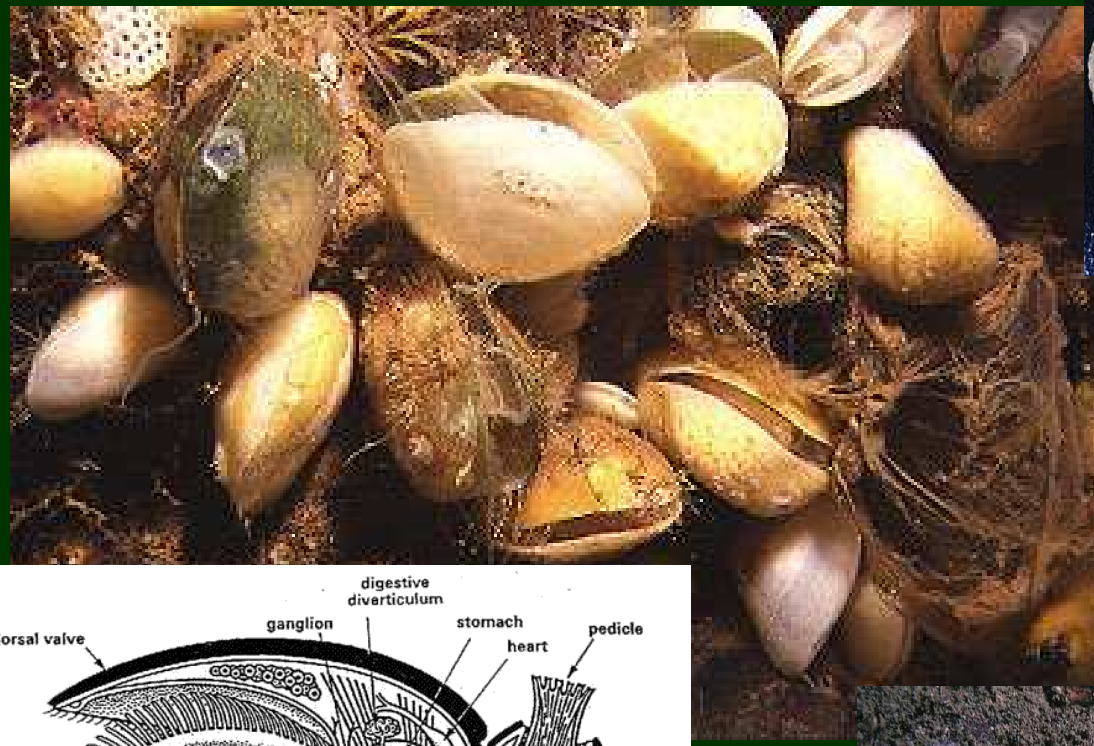
- celom tripartitní („archicelomátní“) – přítomnost protocelu záleží na velikosti těla!
- proto–mezo–meta

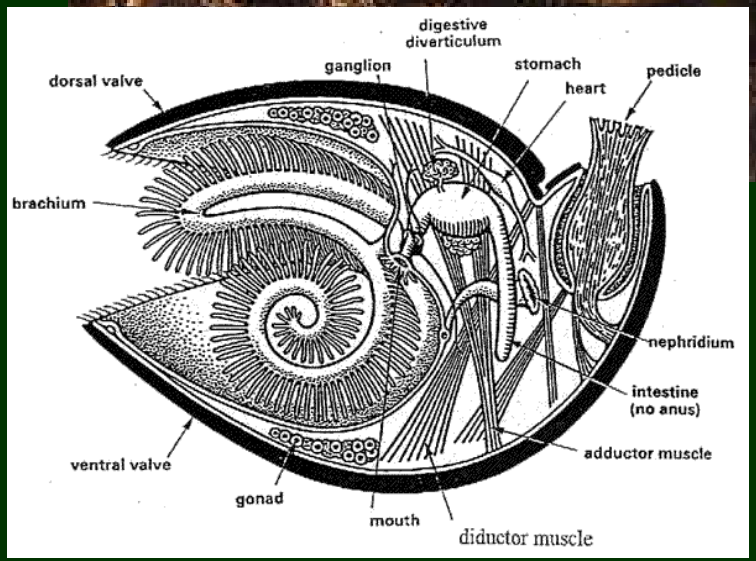


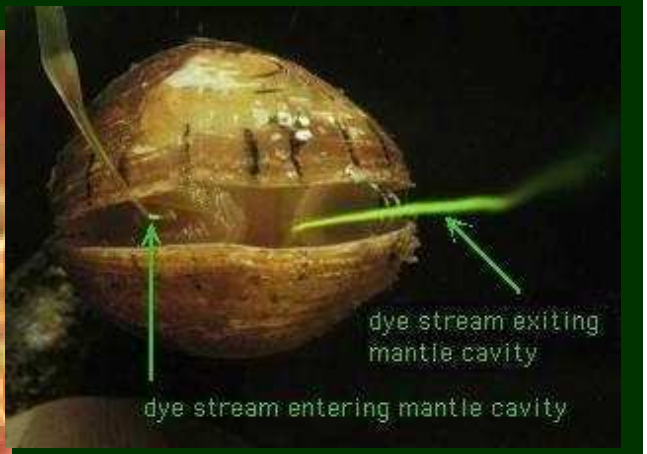


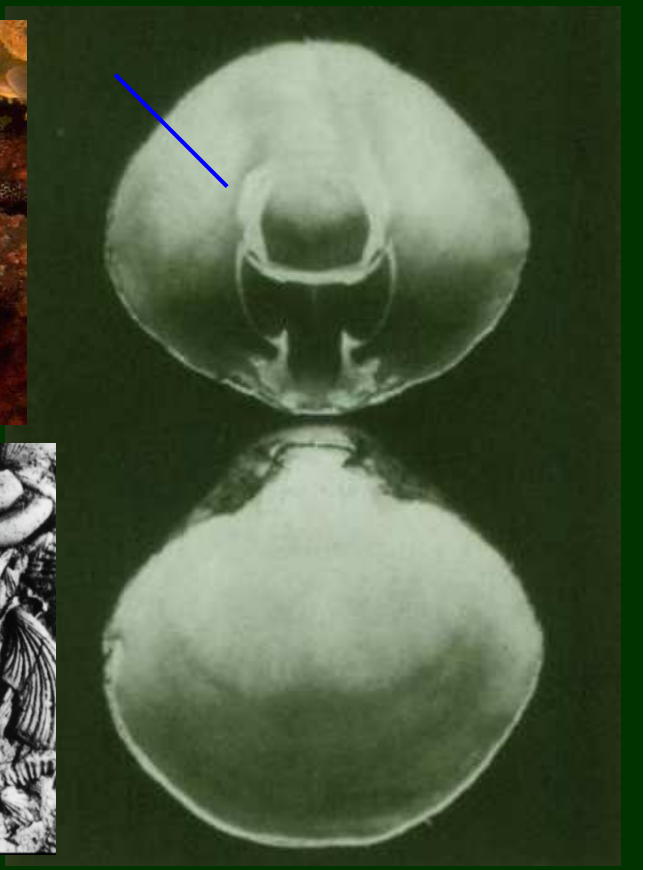
Brachiopoda








dye stream exiting
mantle cavity
dye stream entering mantle cavity



Brachiozoa

Phylum Brachiopoda Duméril, 1806
Diagnosis as in Cohen (2000), modified from Emig (1977b, 1982).

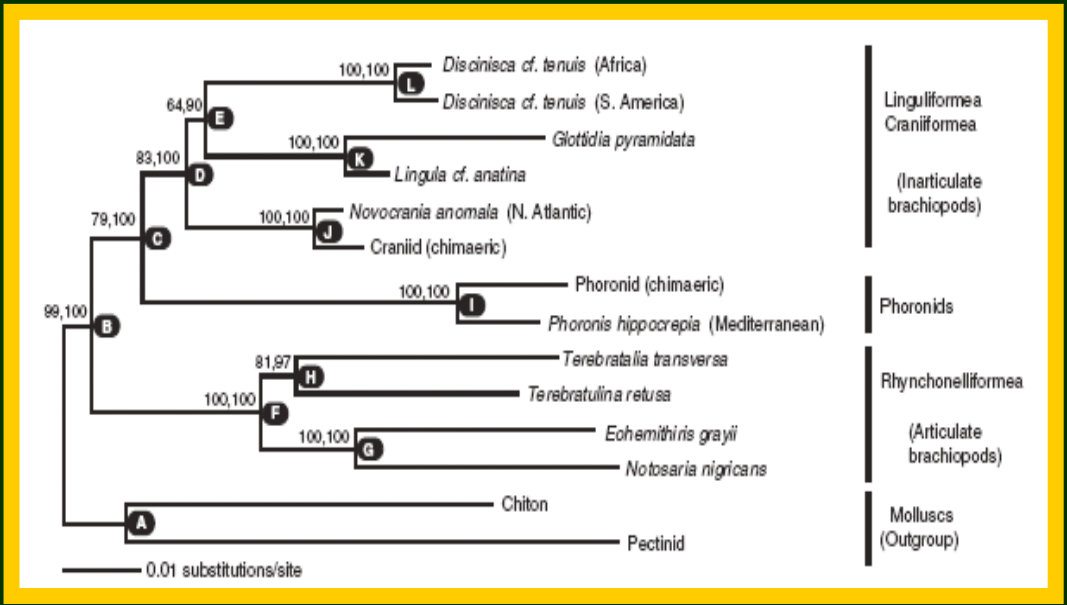
Subphylum Linguliformea Williams et al., 1996
Diagnosis as in Williams et al. (1996), with emendation "or in a cylindrical tube of their own secretion" (after Emig 1982).

Class Craniata Williams et al., 1996
Diagnosis as for subphylum Craniiformea and Class Craniata in Williams et al. (1996).

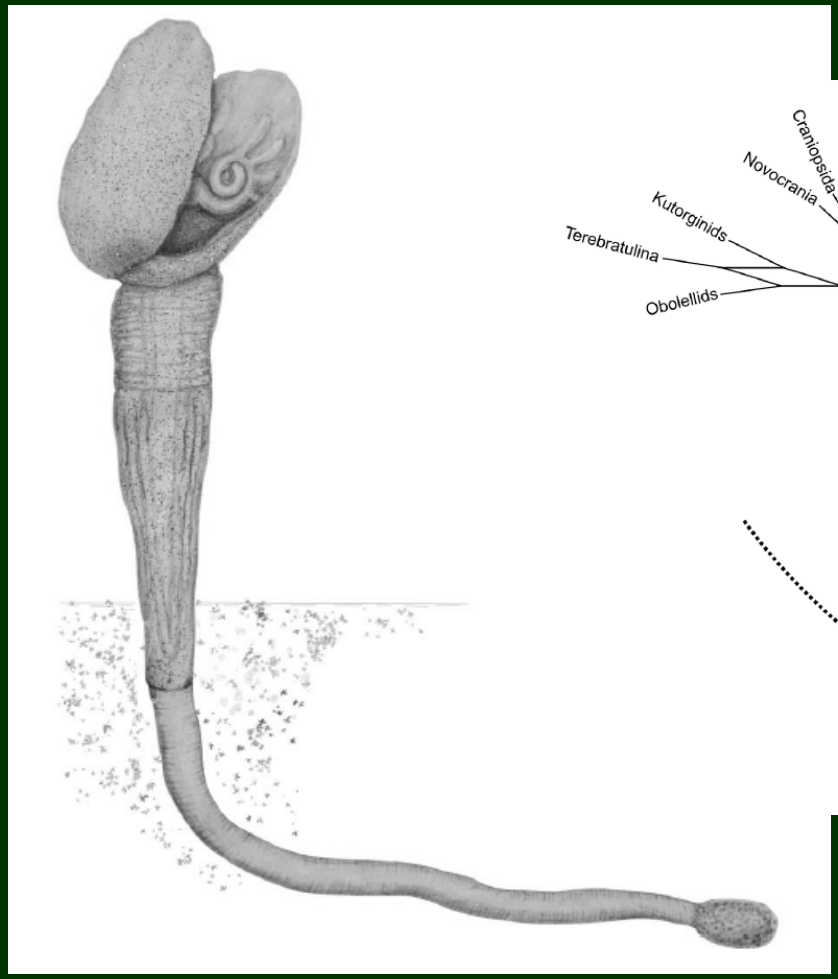
Class Phoronata cl. nov.
Diagnosis as for subphylum Phoroniformea in Cohen (2000).

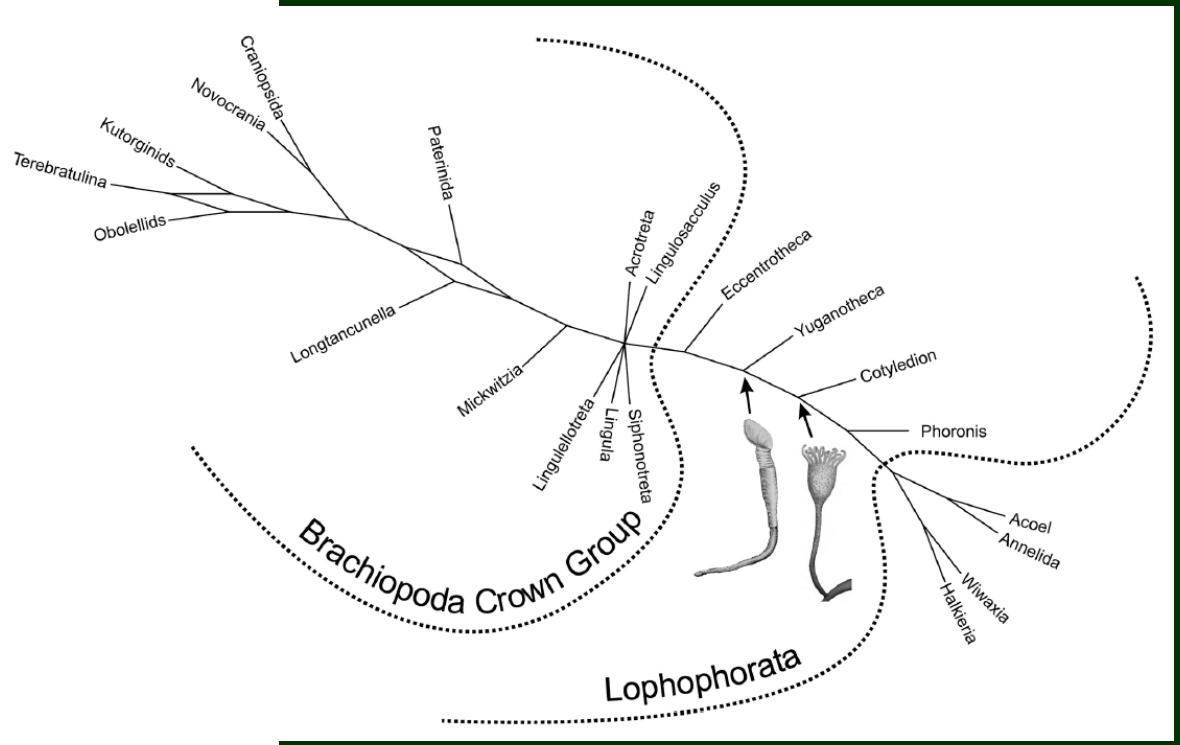
Class Lingulata Gorjansky & Popov, 1985
Diagnosis as in Williams et al. (1996).

Subphylum Rhynchonelliformea Williams et al., 1996
Class Rhynchonellata Williams et al., 1996
Order Rhynchonellida Kuhn, 1949
Order Terebratulida Waagen, 1883
Order Thecideida Elliot, 1958



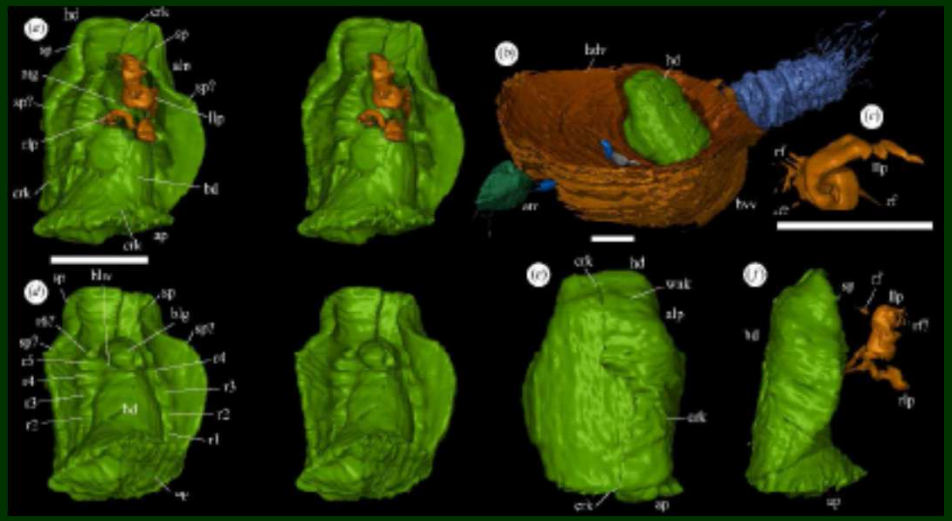
Yuganotheca

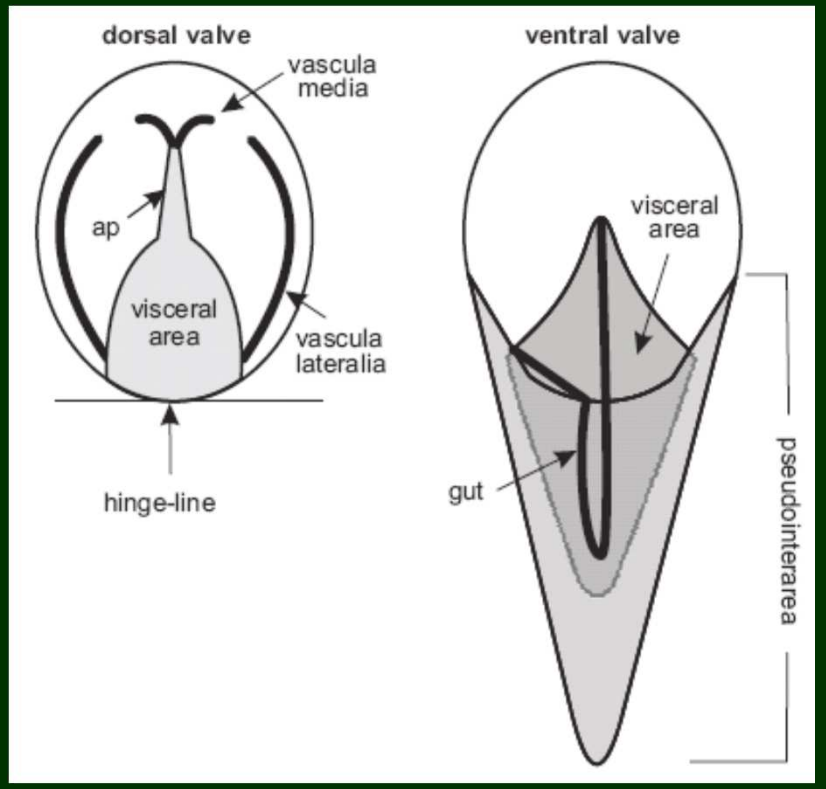


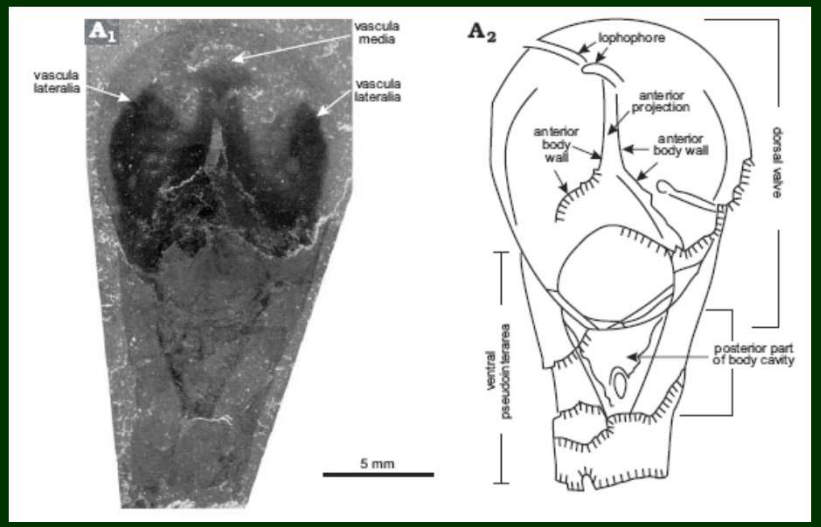


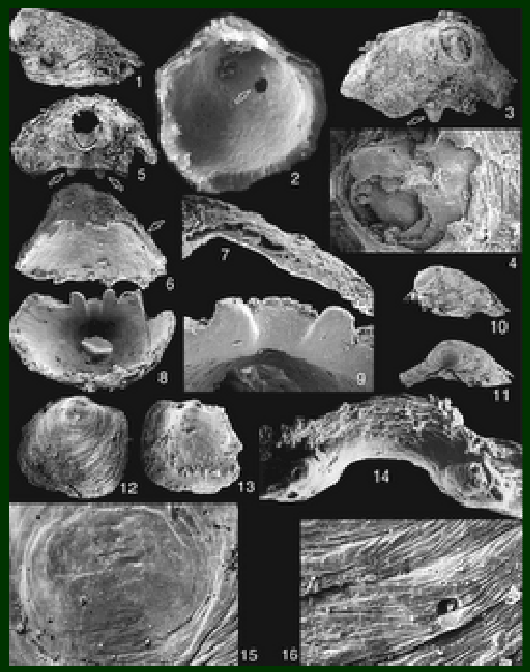
- kambrium (Chengjiang)
- bez schránek

- *Lingulosacculus* (kambrium) – „měkký“ ramenonožec → Phoronida
- *Drakozoon* (silur) – měkký, seriální

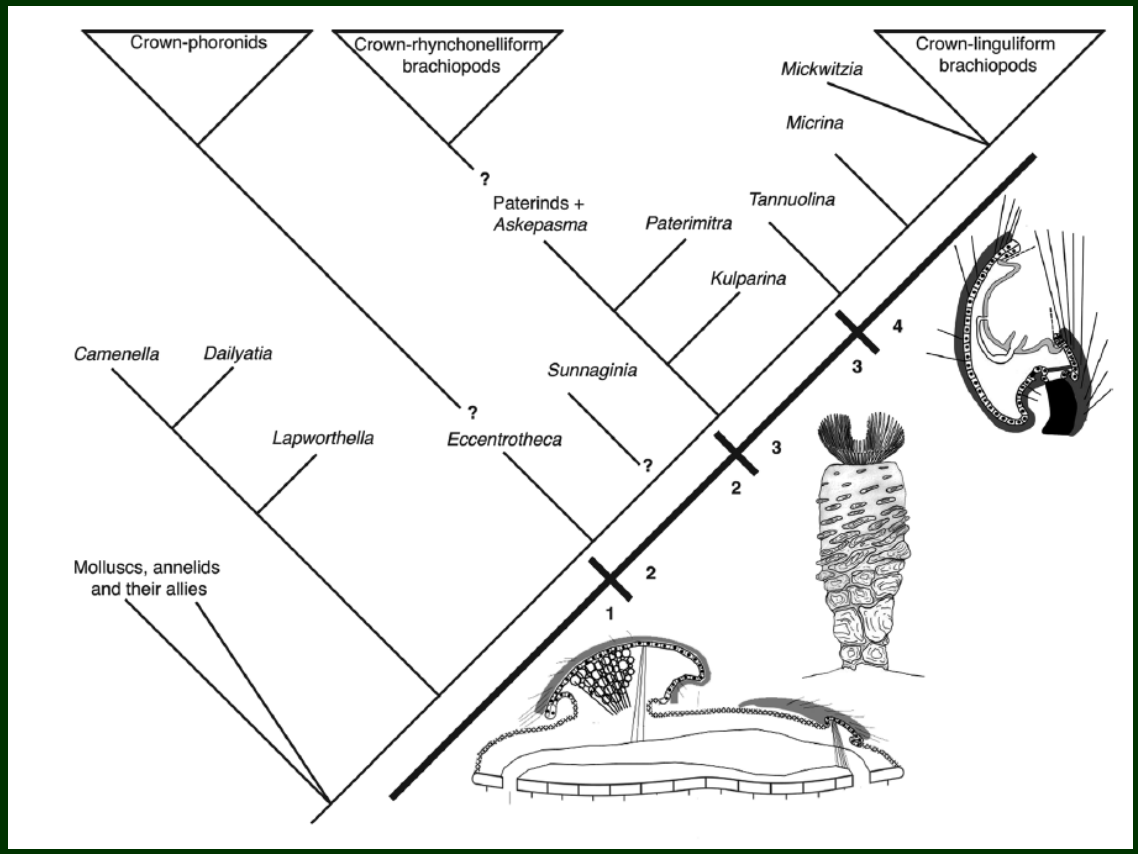




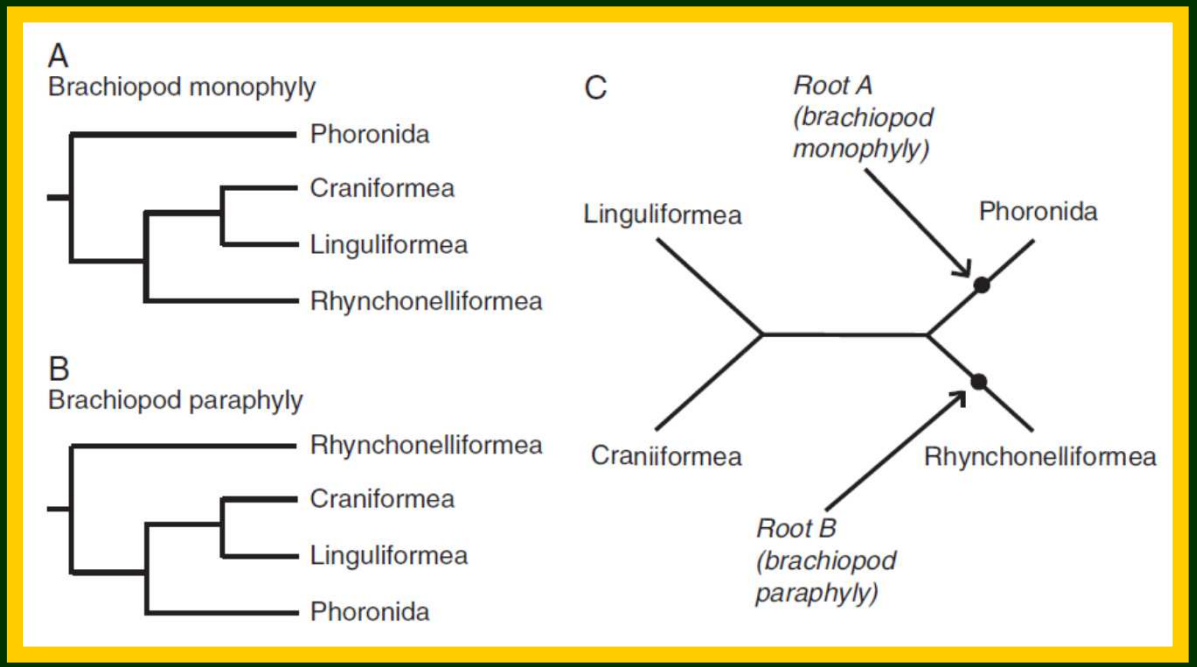


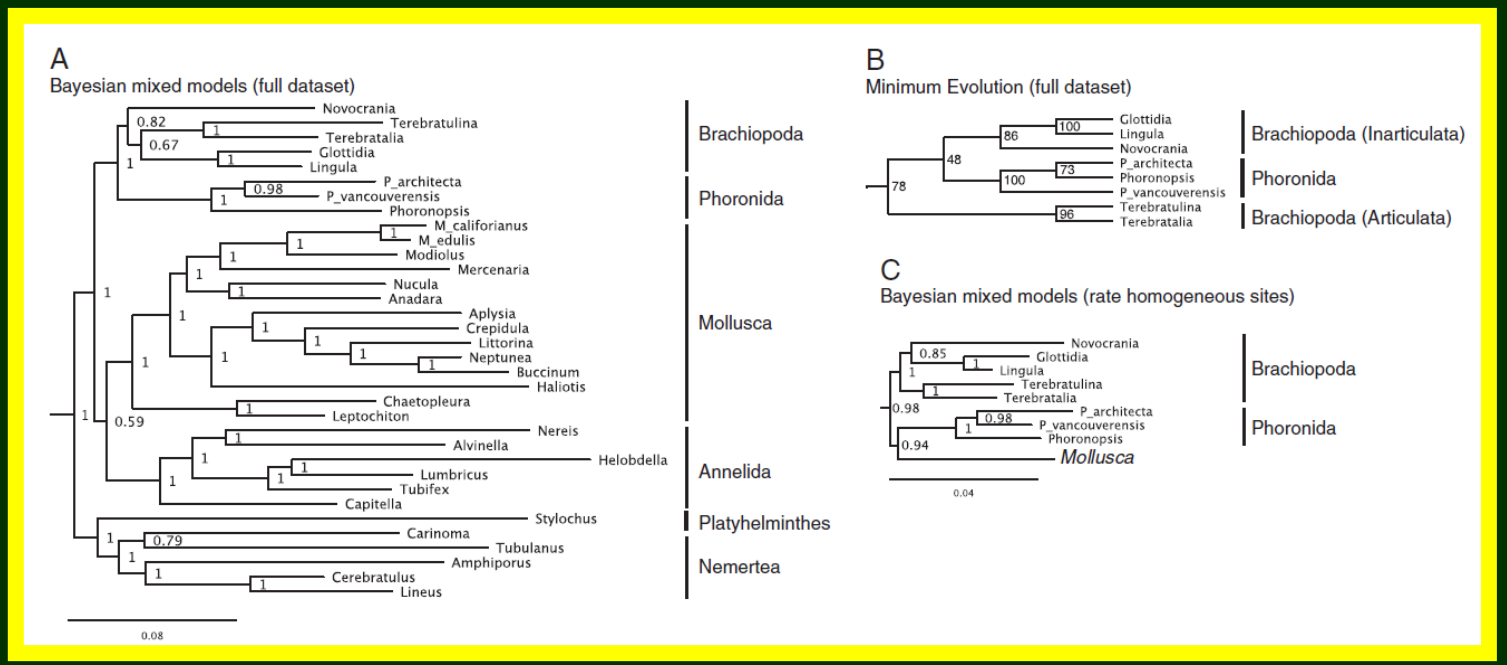


Brachiozoa a Tommotiida

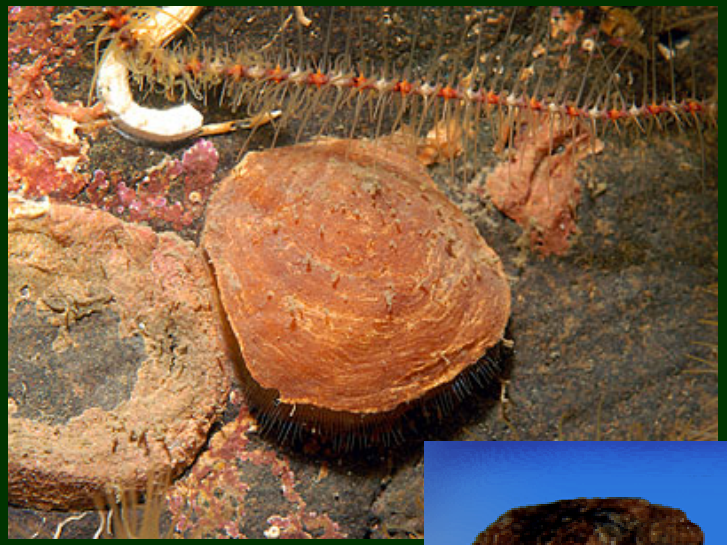


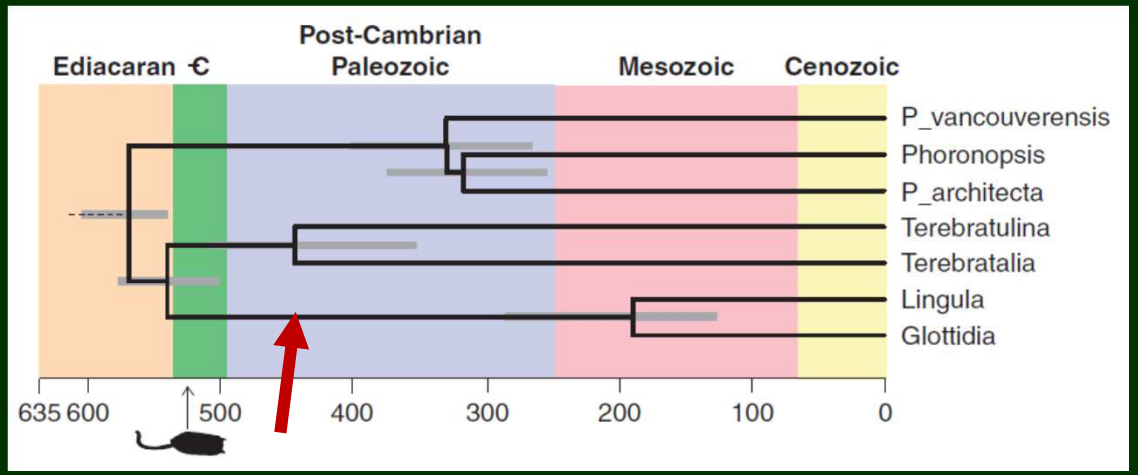
7 nukleárních proteinových genů + 3 rDNA



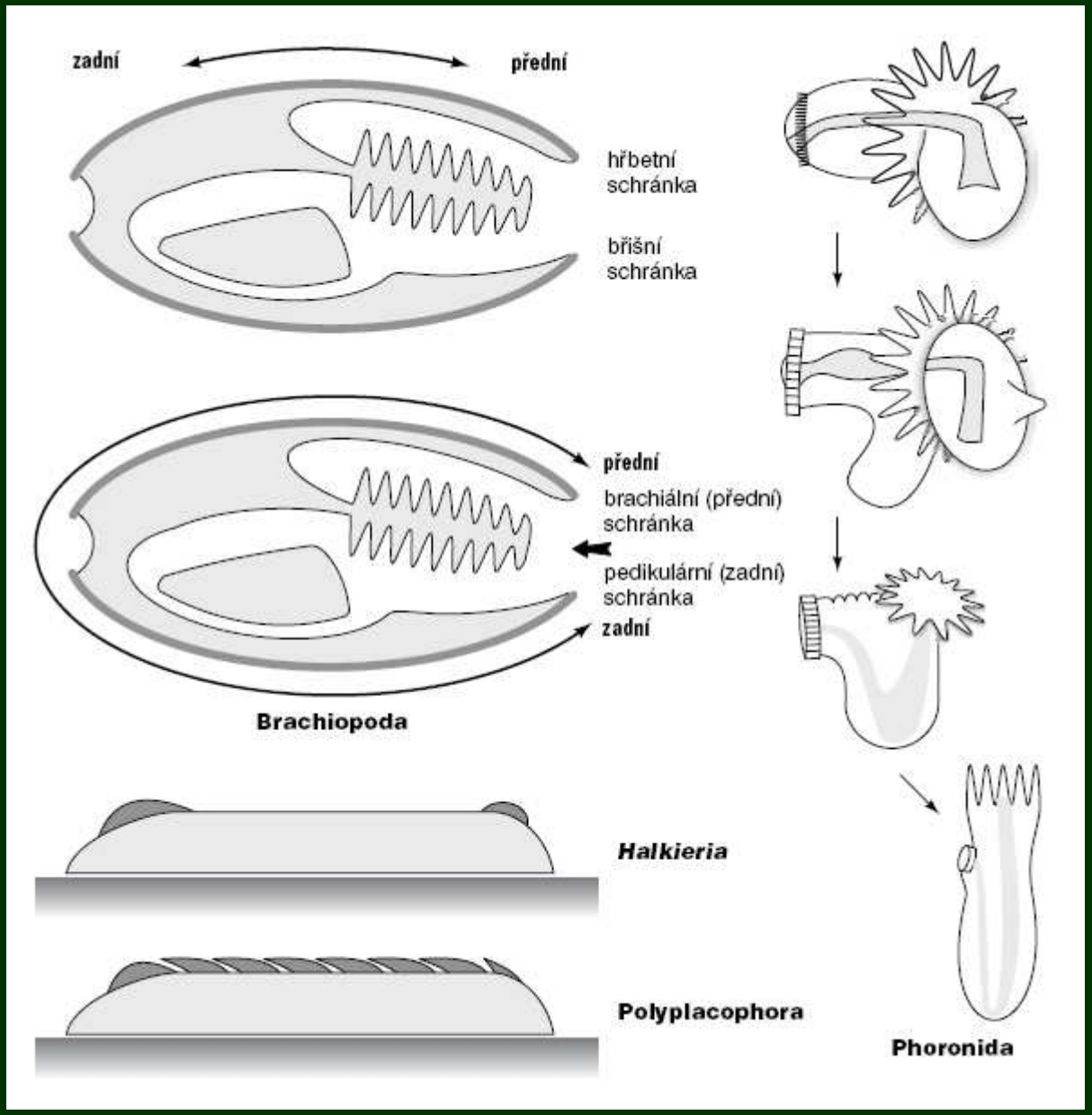


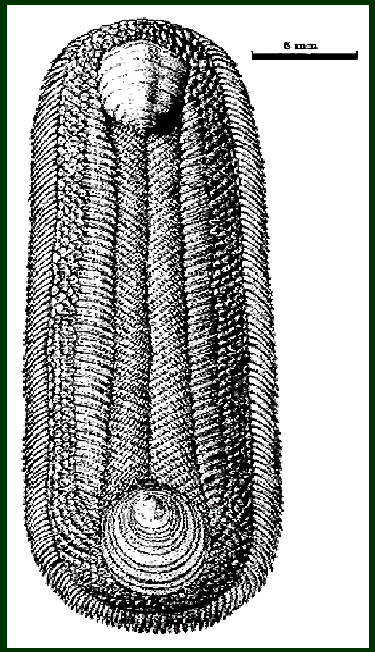
- slow-fast analýza: *Novocrania* je artificiálně přitahovaná k chapadlovkám → bazální postavení Craniiformea nevěrohodné → Inarticulata?
- monofylie ramenonožců podpořena i miRNA
- 2 přechody od fosfátů (~ Tomotiida?) k vápenci – unikátní v rámci metazoí...





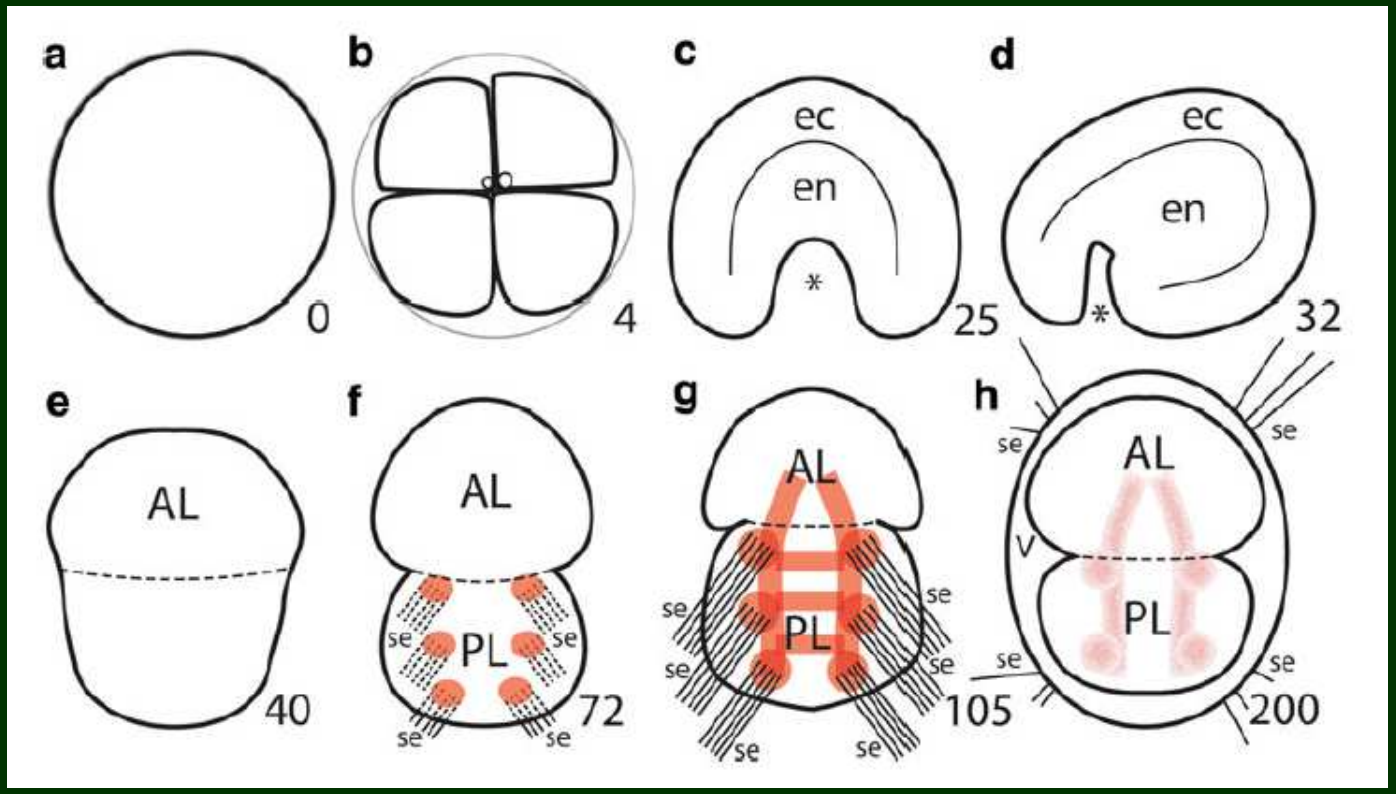
Halkieria


zadní
přední
hřbetní schránka
břišní schránka
přední
brachiální (přední) schránka
pedikulární (zadní) schránka
zadní
Brachiopoda
Halkieria
Polyplacophora
Phoronida



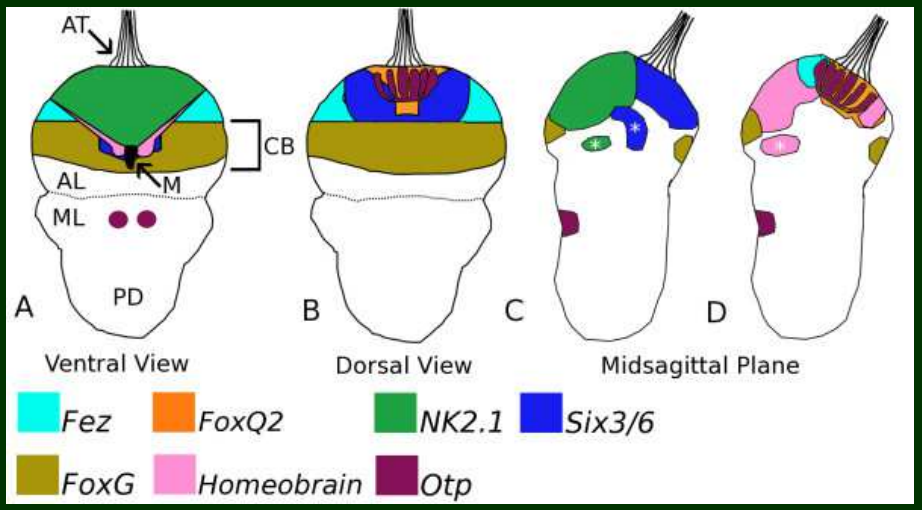
„*Brachiopod fold*“

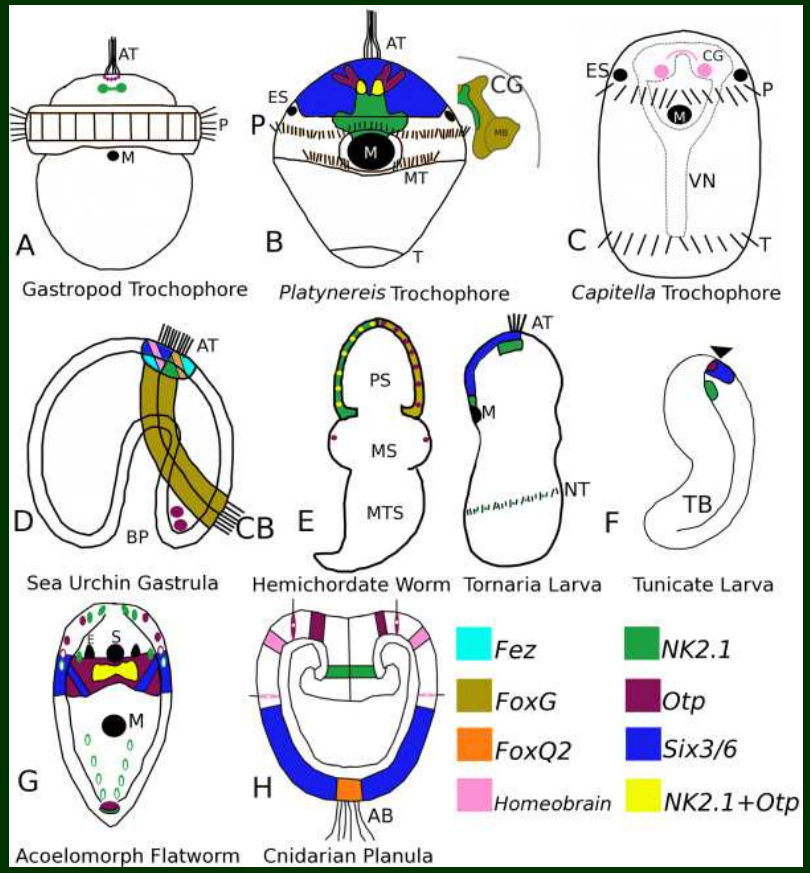
- údajně viditelný v metamorfóze craniidů
- x žádné náznaky „foldingu“ v metamorfóze *Novocrania*???



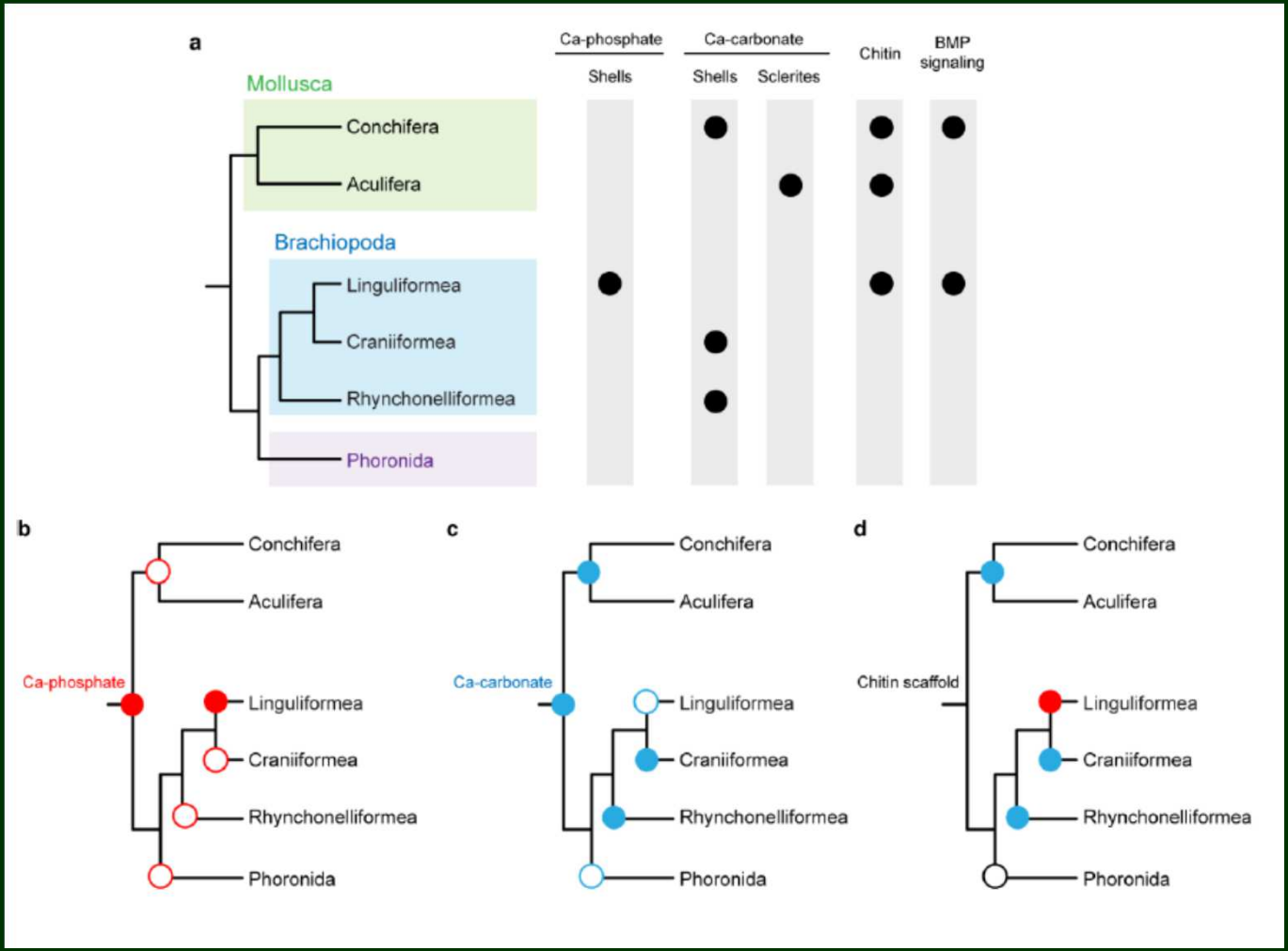
Brachiopoda a Spiralia

- *Terebratalia*
- dalekosáhlá homologie předních částí larev (*apical*, *mantle*, *pedicel lobes*)



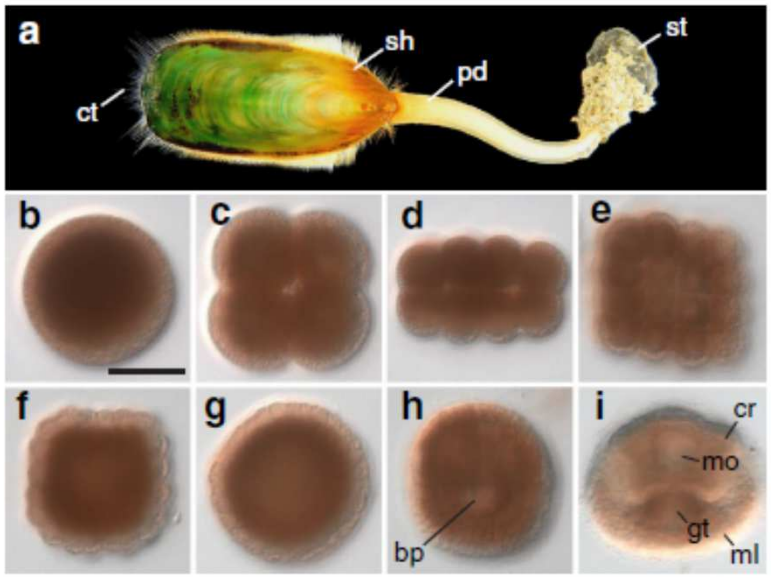


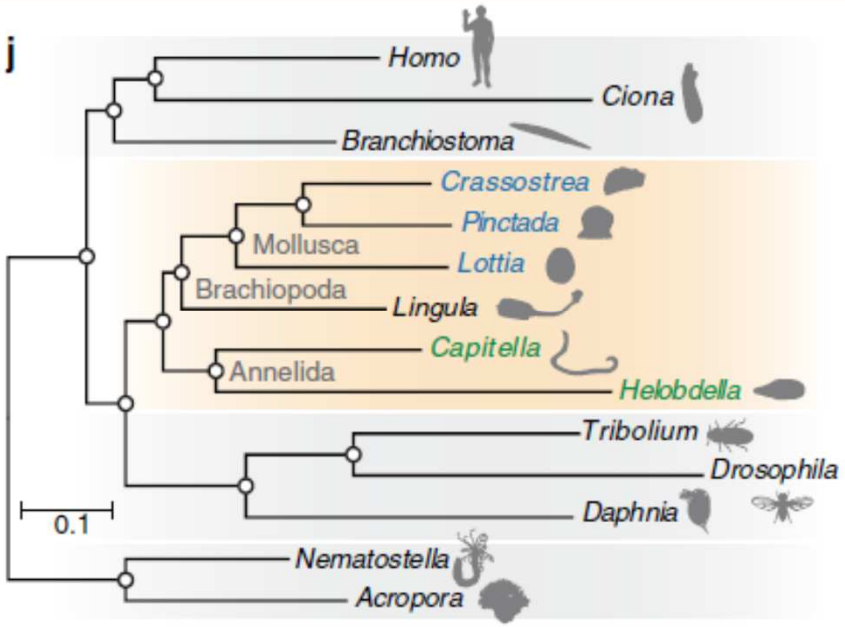
Evoluce biomineralizace



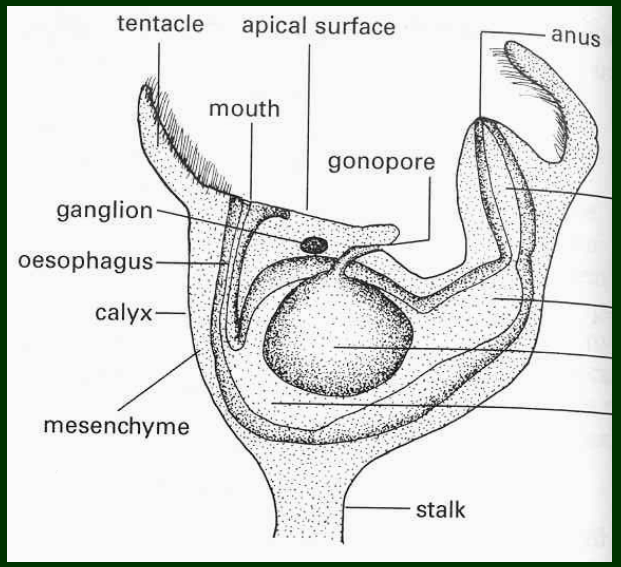
Brachiopoda: *Lingula* genom

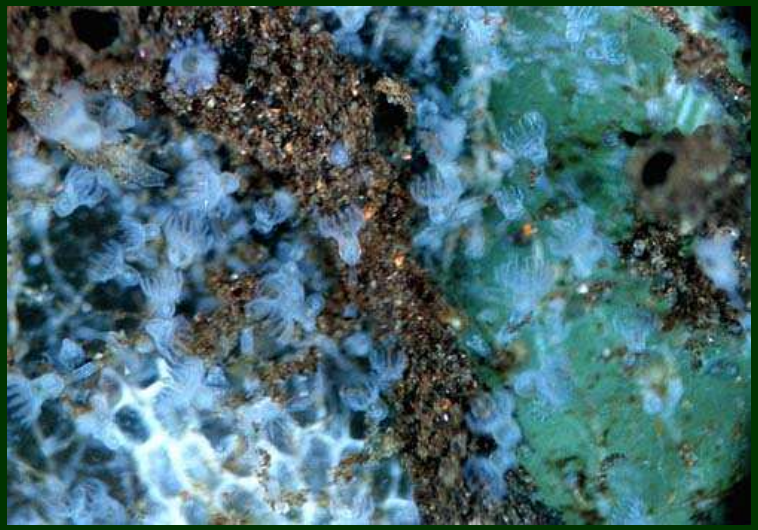
- *... ramenonožci jsou bližší měkkýšům než kroužkovcům...*
- Conchozoa???

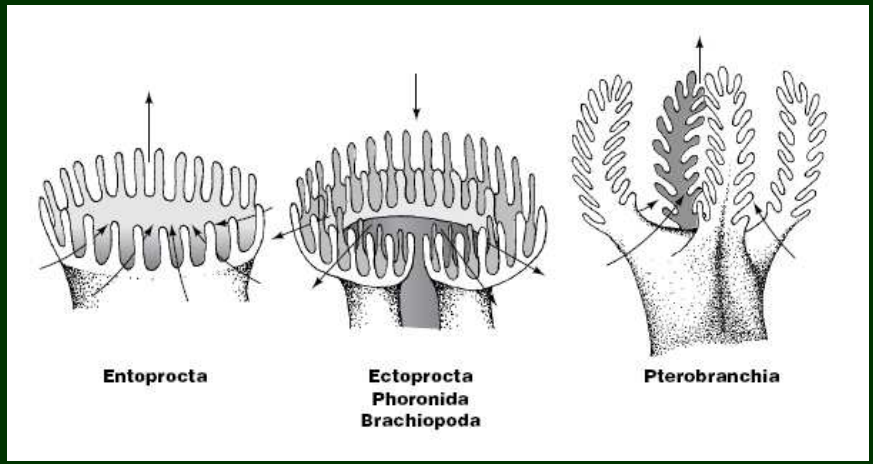




Kamptozoa = Entoprocta

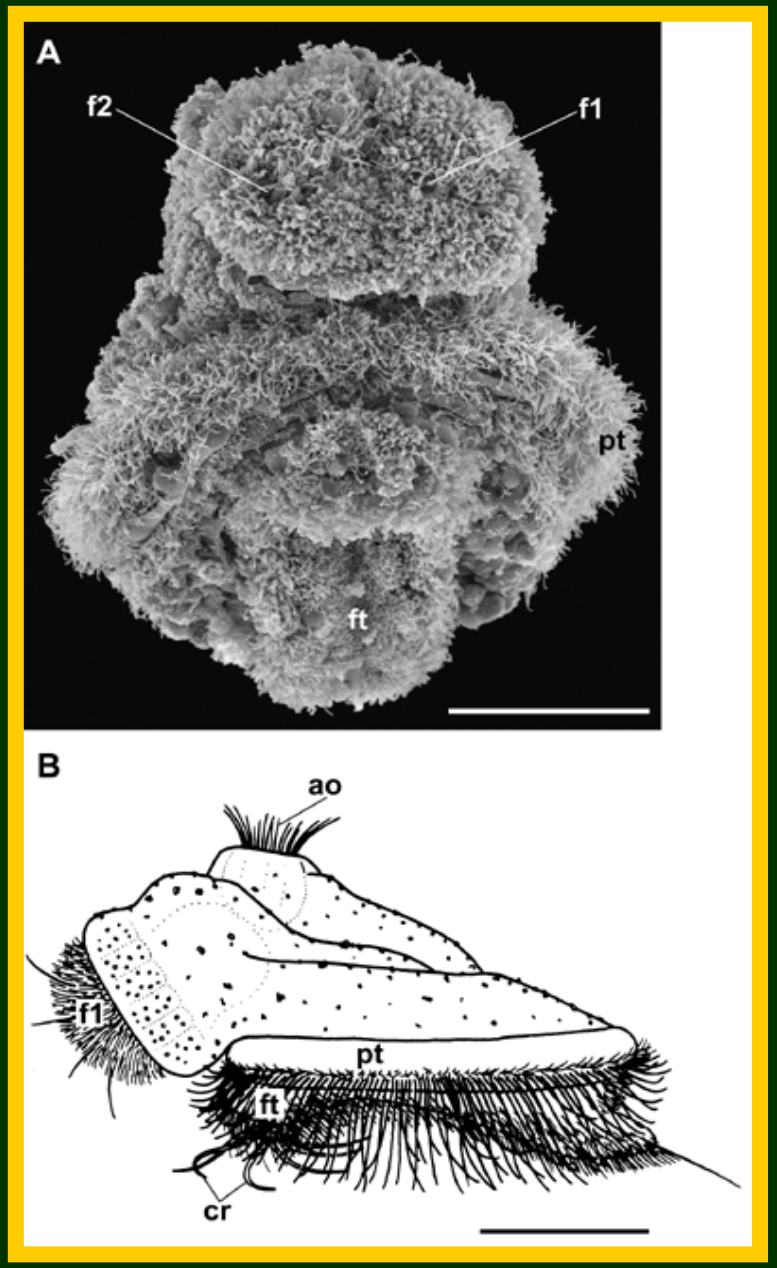


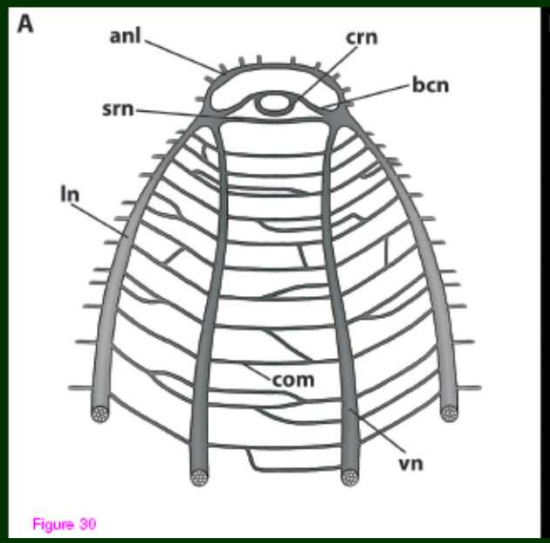


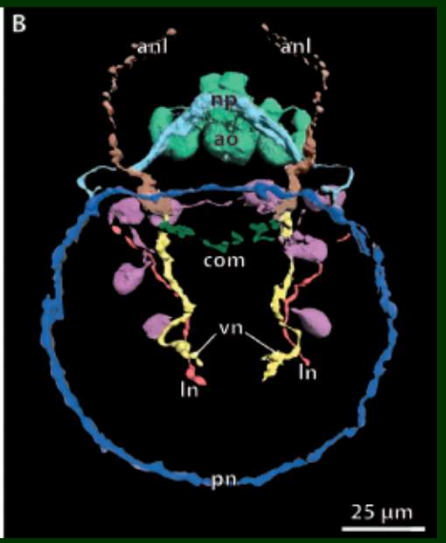


Entoprocta: plazivá larva

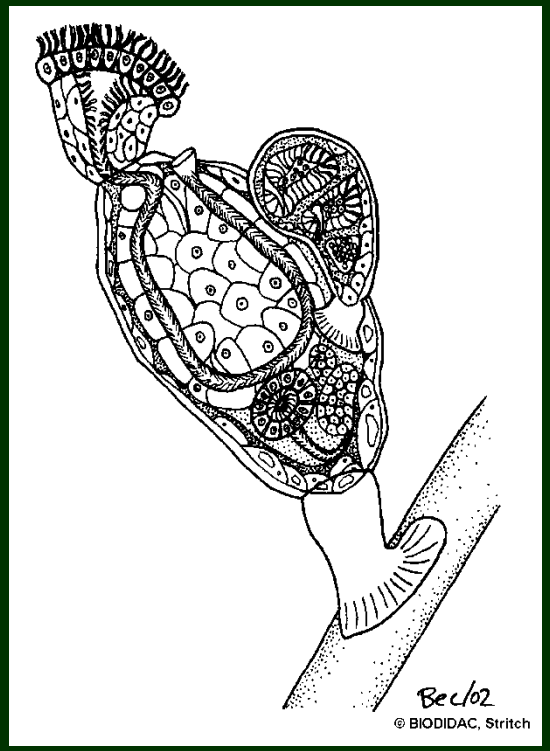
společné znaky s měkkýši (→ Lacunifera = Tetraneuralia)

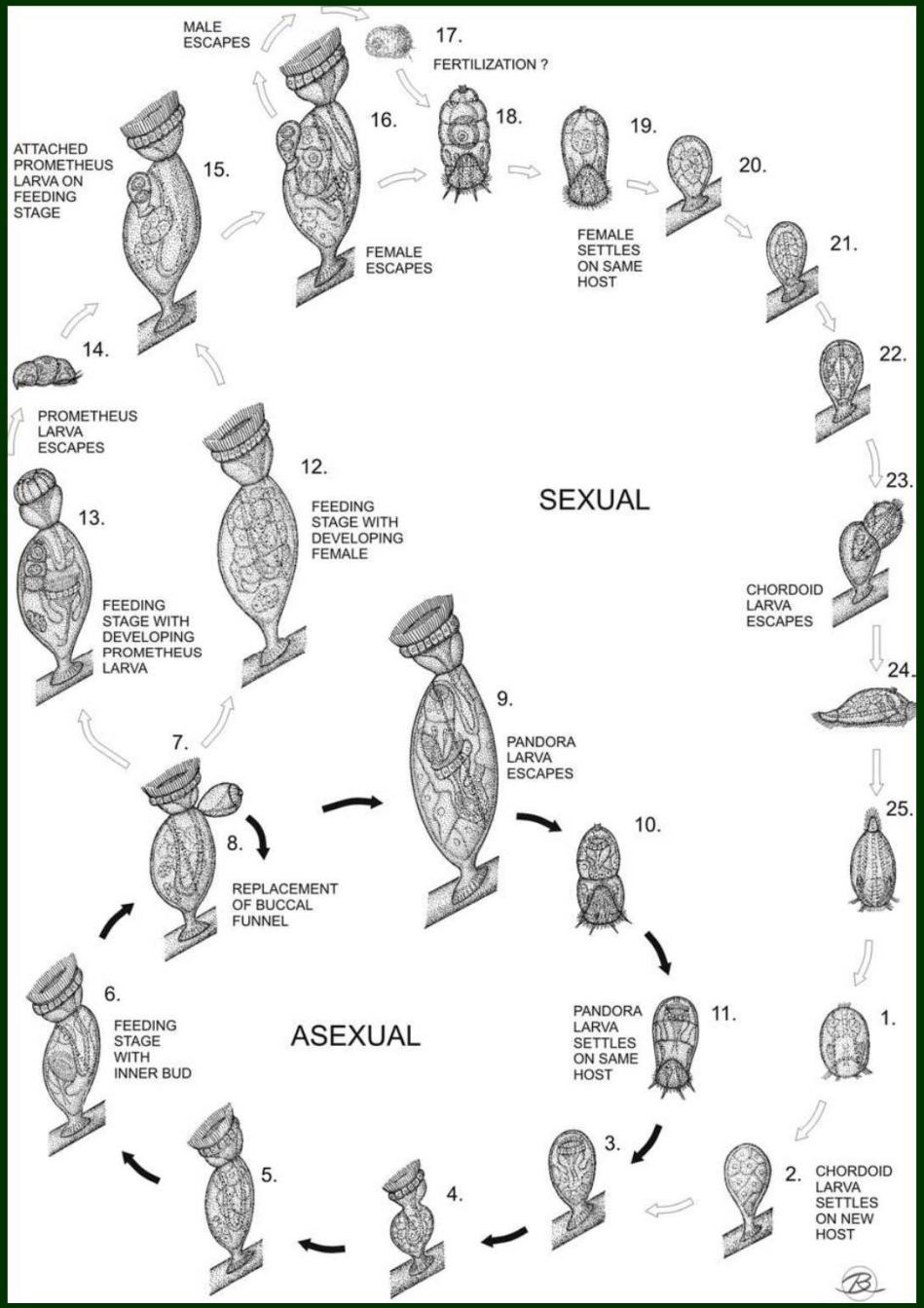




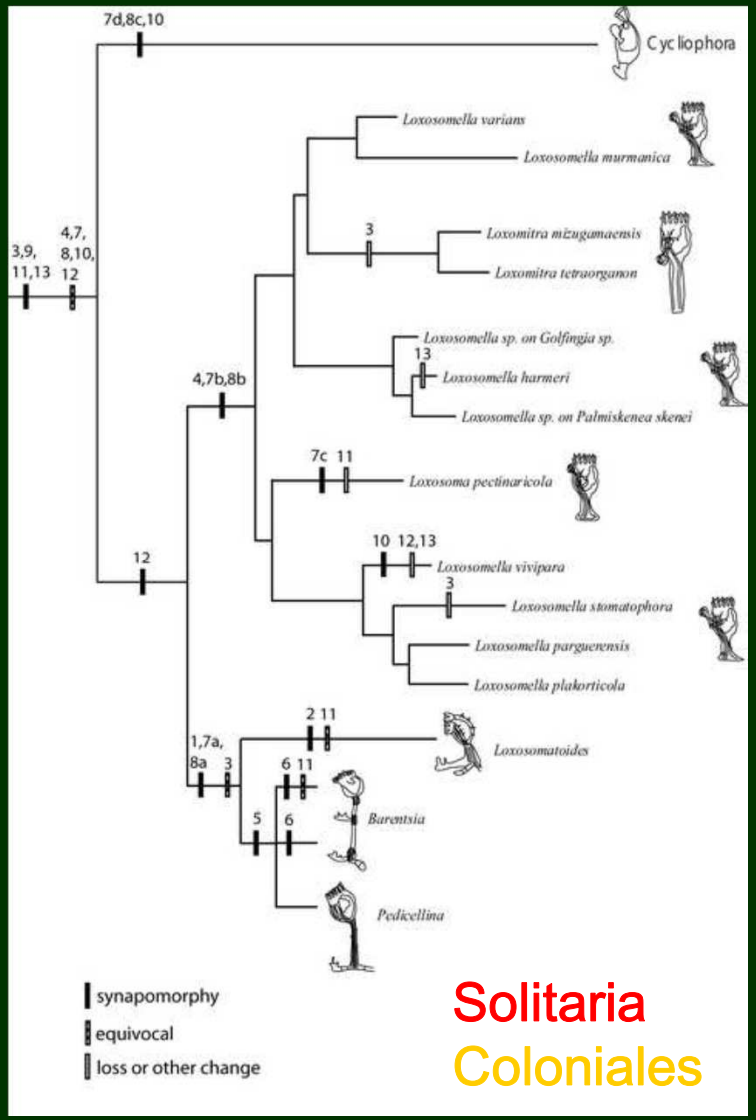


Cycliophora



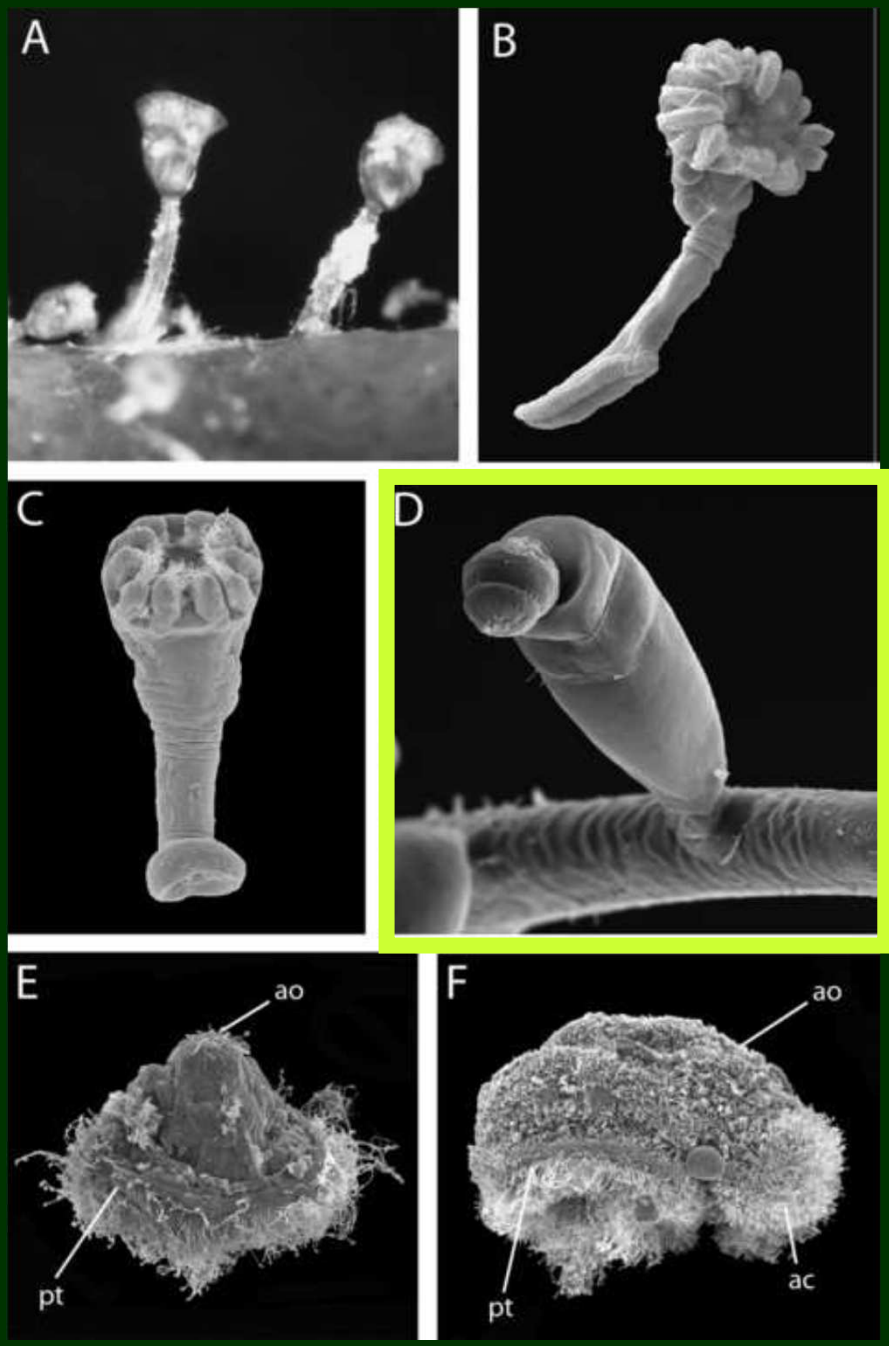

1.
CHORDOID LARVA SETTLES ON NEW HOST
2.
3.
4.
5.
6.
FEEDING STAGE WITH INNER BUD
7.
8.
REPLACEMENT OF BUCCAL FUNNEL
9.
PANDORA LARVA ESCAPES
10.
PANDORA LARVA SETTLES ON SAME HOST
11.
ASEXUAL
12.
FEEDING STAGE WITH DEVELOPING FEMALE
13.
FEEDING STAGE WITH DEVELOPING PROMETHEUS LARVA
14.
PROMETHEUS LARVA ESCAPES
15.
ATTACHED PROMETHEUS LARVA ON FEEDING STAGE
16.
FEMALE ESCAPES
17.
FERTILIZATION ?
18.
19.
FEMALE SETTLES ON SAME HOST
20.
21.
22.
23.
CHORDOID LARVA ESCAPES
24.
25.
SEXUAL
MALE ESCAPES

Entoprocta

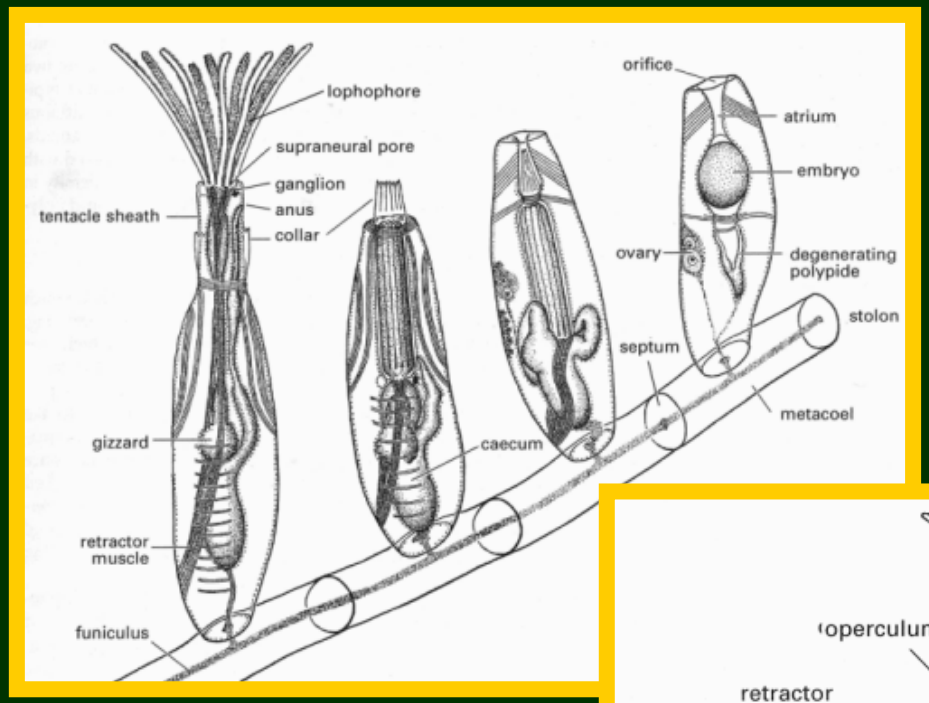


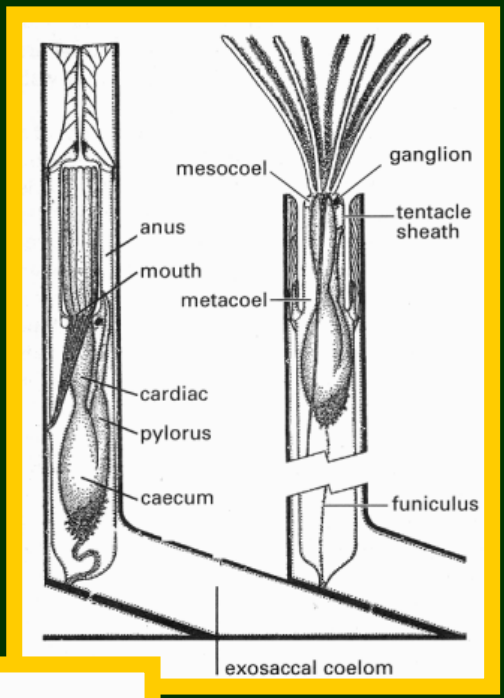
Solitaria

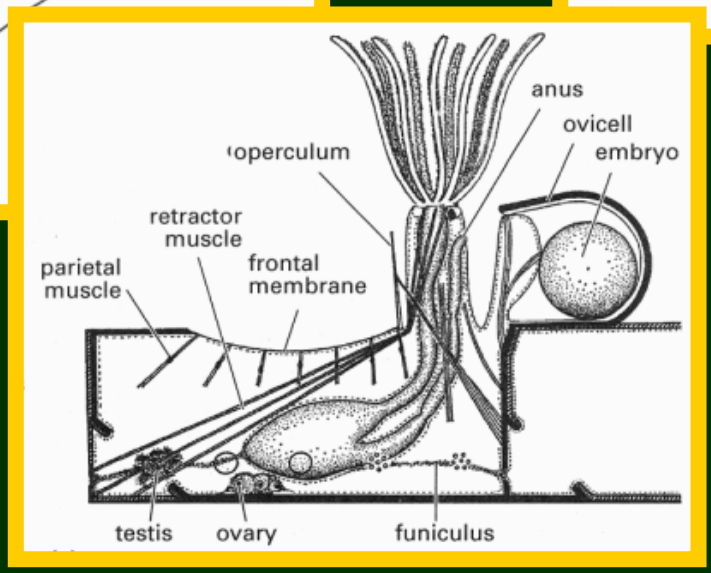
Coloniales

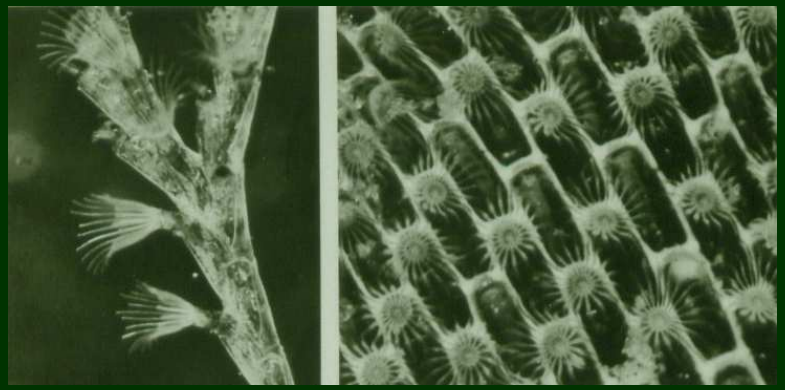


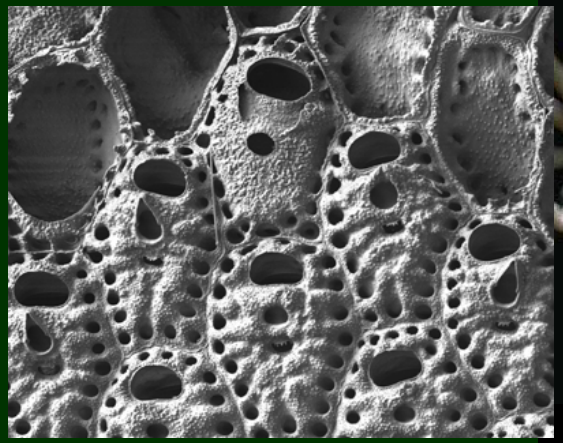
Bryozoa = Ectoprocta

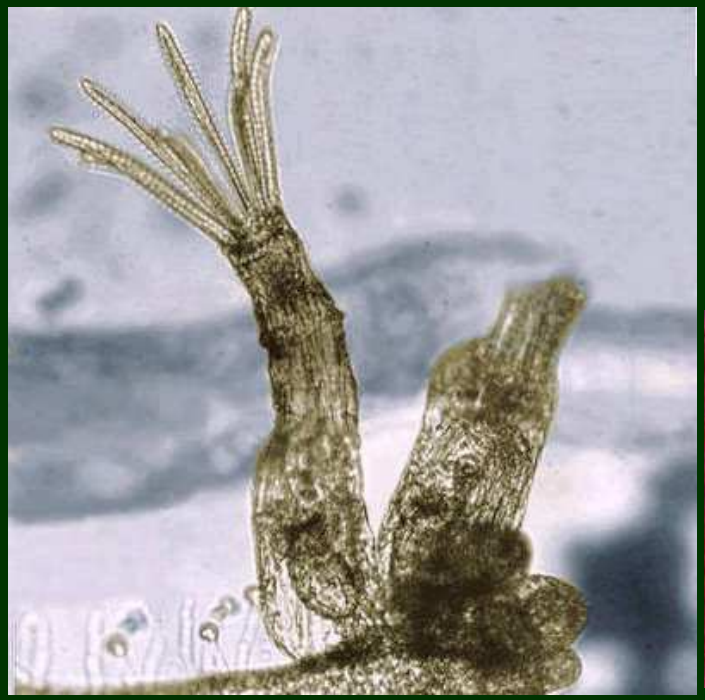


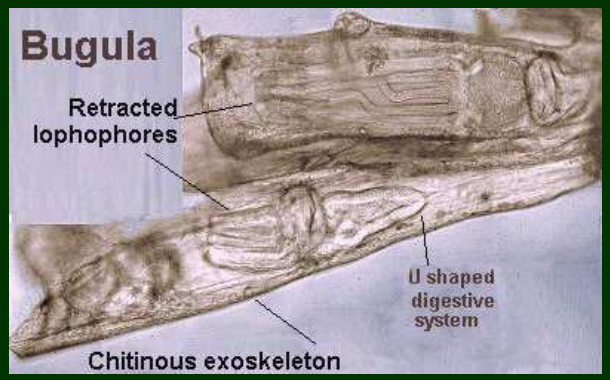




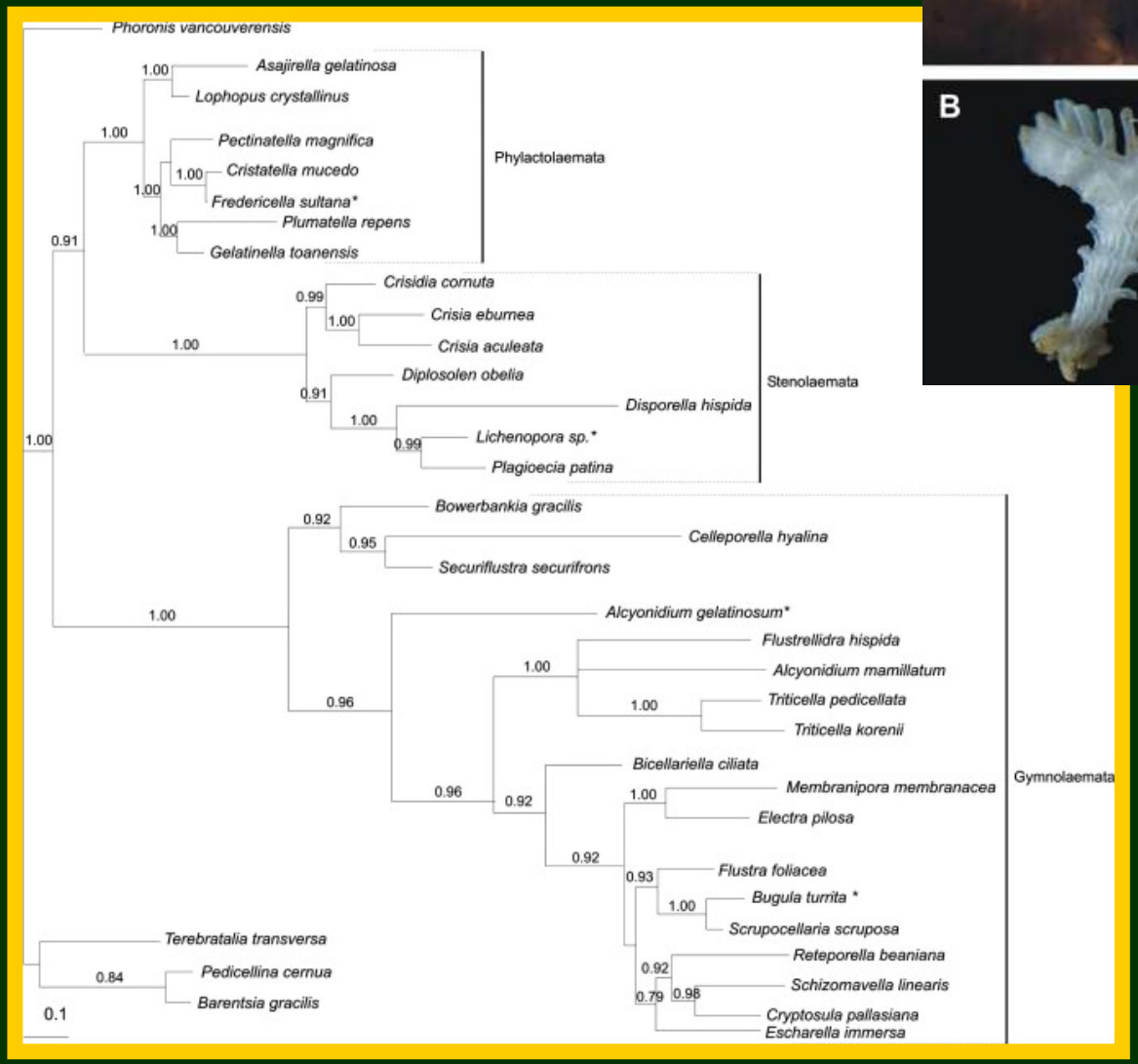


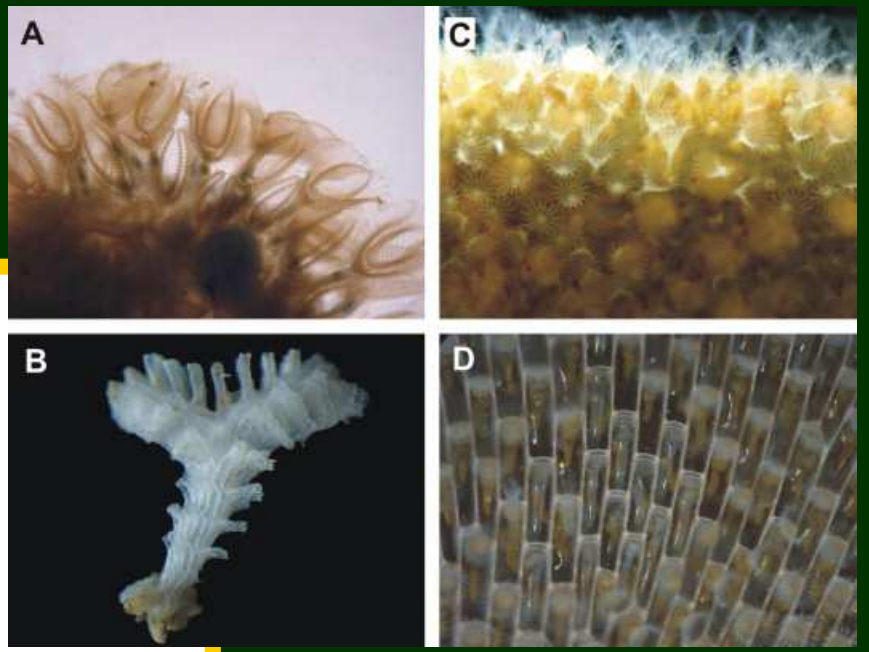


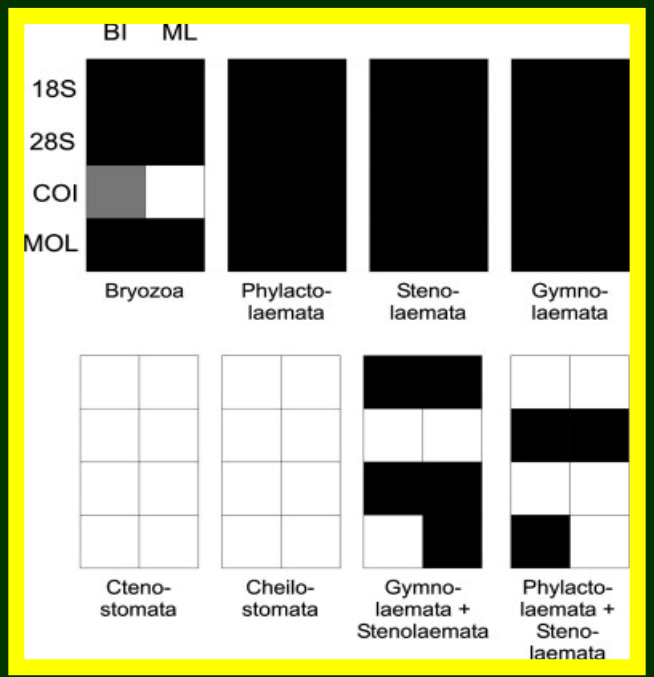



Bugula
Retracted lophophores
U shaped digestive system
Chitinous exoskeleton

Fylogeneze mechovek

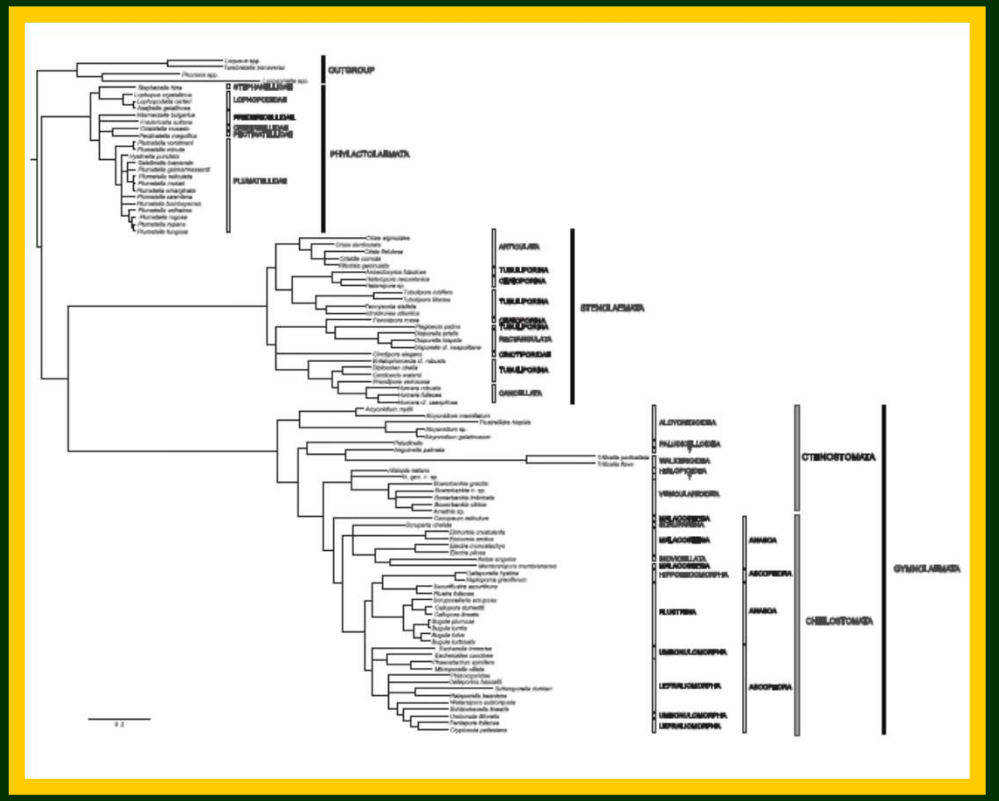






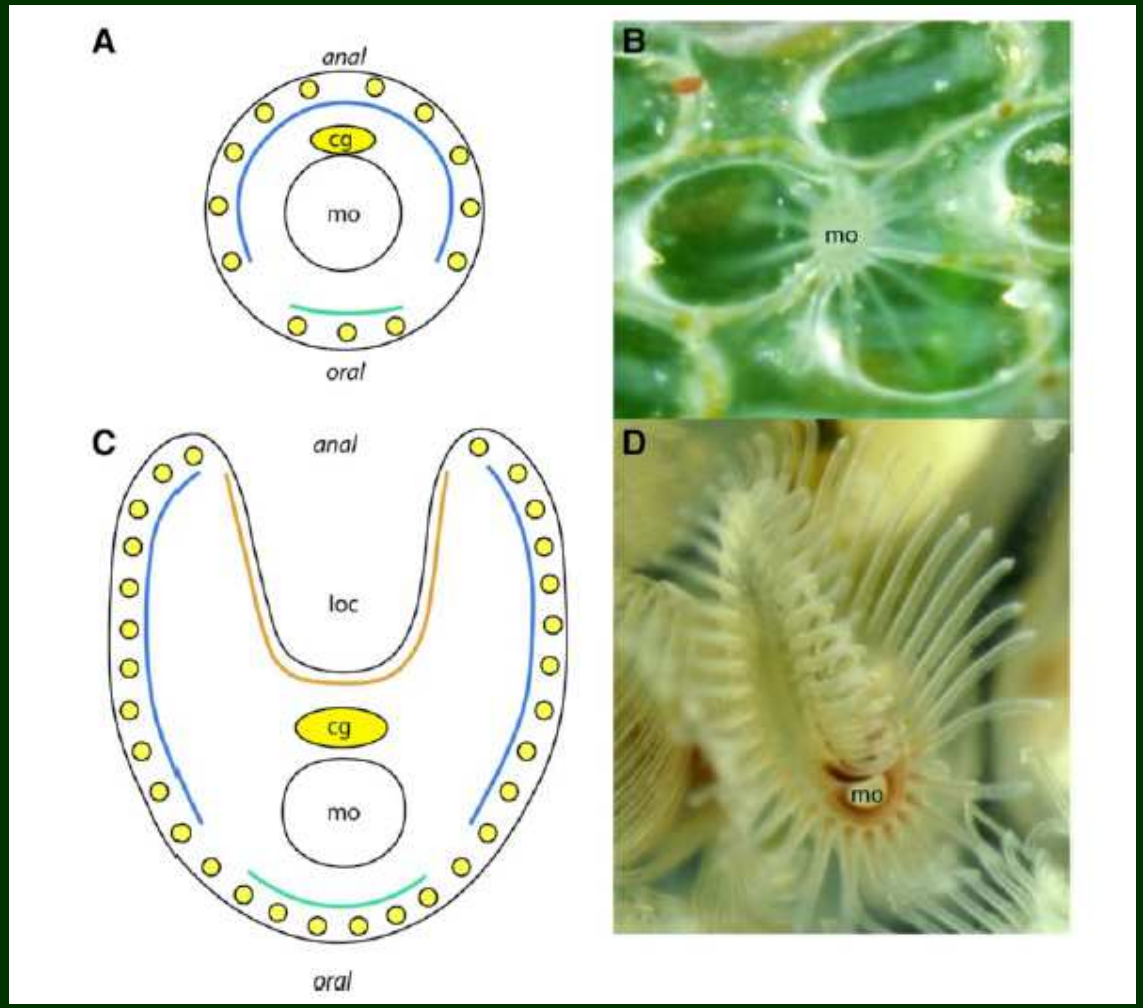
Fylogeneze mechovek

- 7 genů (rDNA + mtDNA)
- fylogeneze v rozporu s kladistickými analýzami morfologických dat → fylogeneticky významné jsou znaky z měkké anatomie, ne znaky skeletální

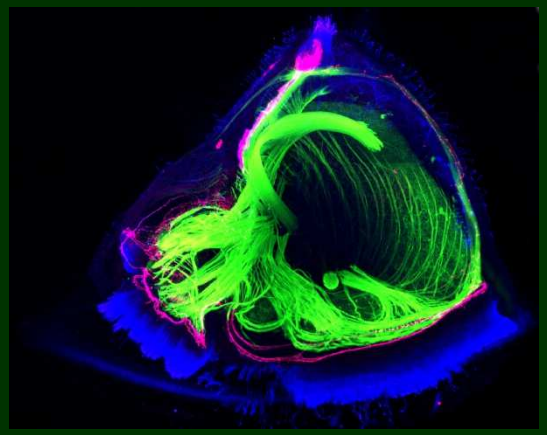


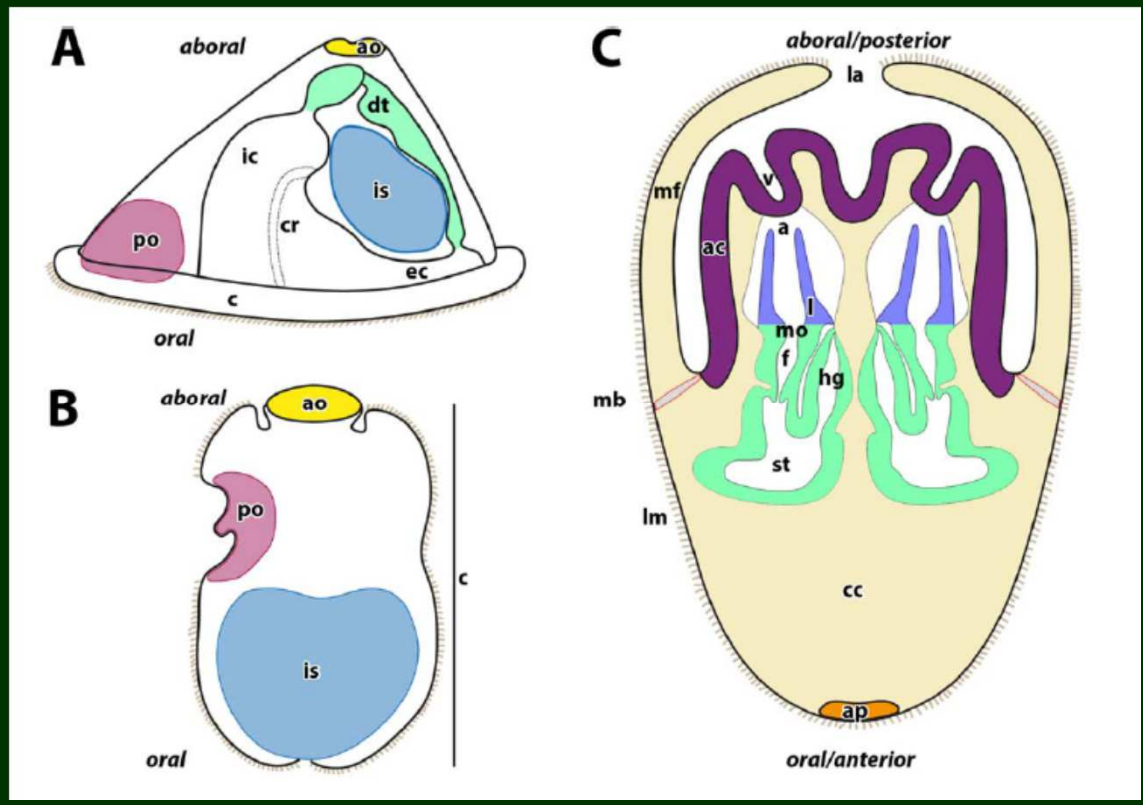
Ectoprocta – inervace lofoforu

- lofoforová konkavita u Phylactolaemata + vnitřní řada chapadel bez serotoninové inervace ← zvětšení lofoforu?
- Phylactolaemata odvozená?



Larvy mechovek

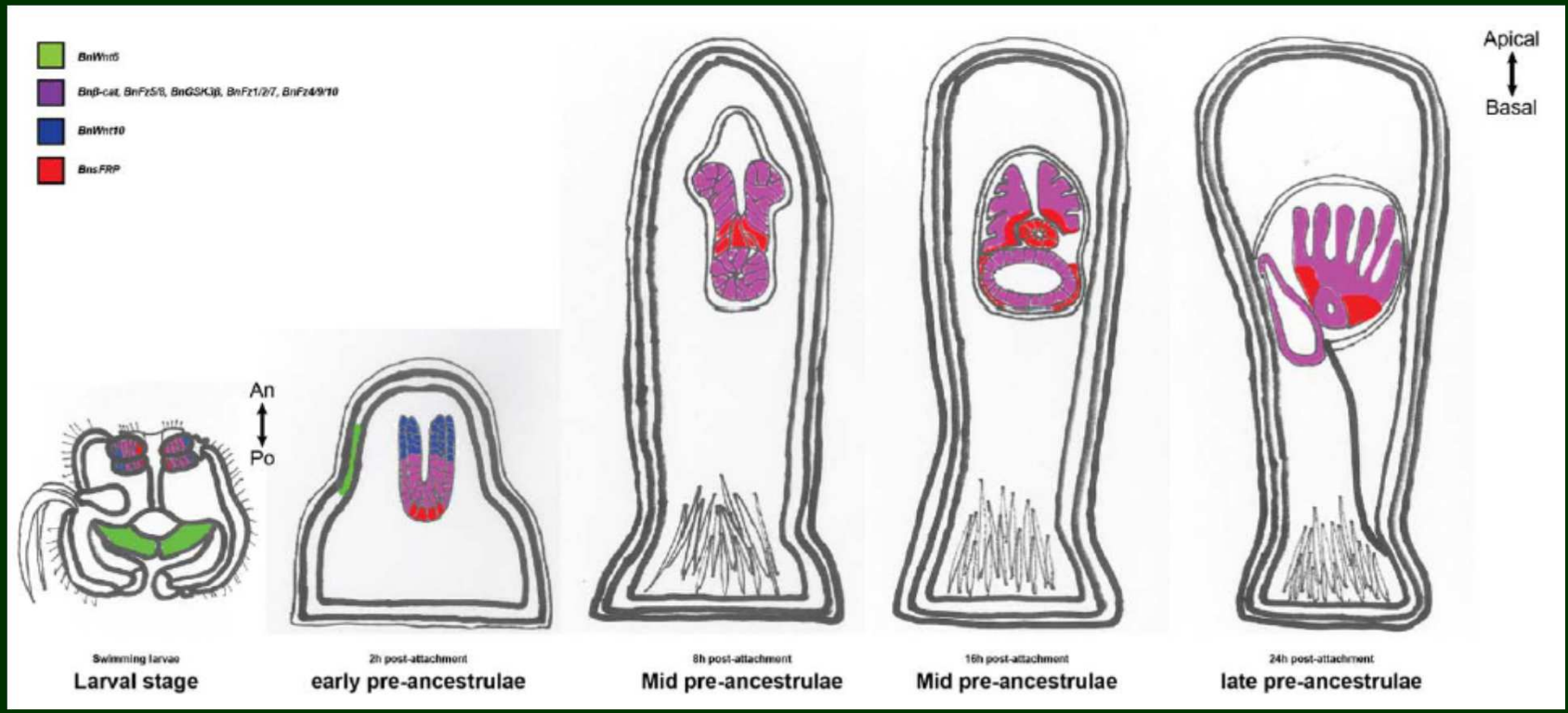




Phylactolaemata:
prekociální pučení
z episféry

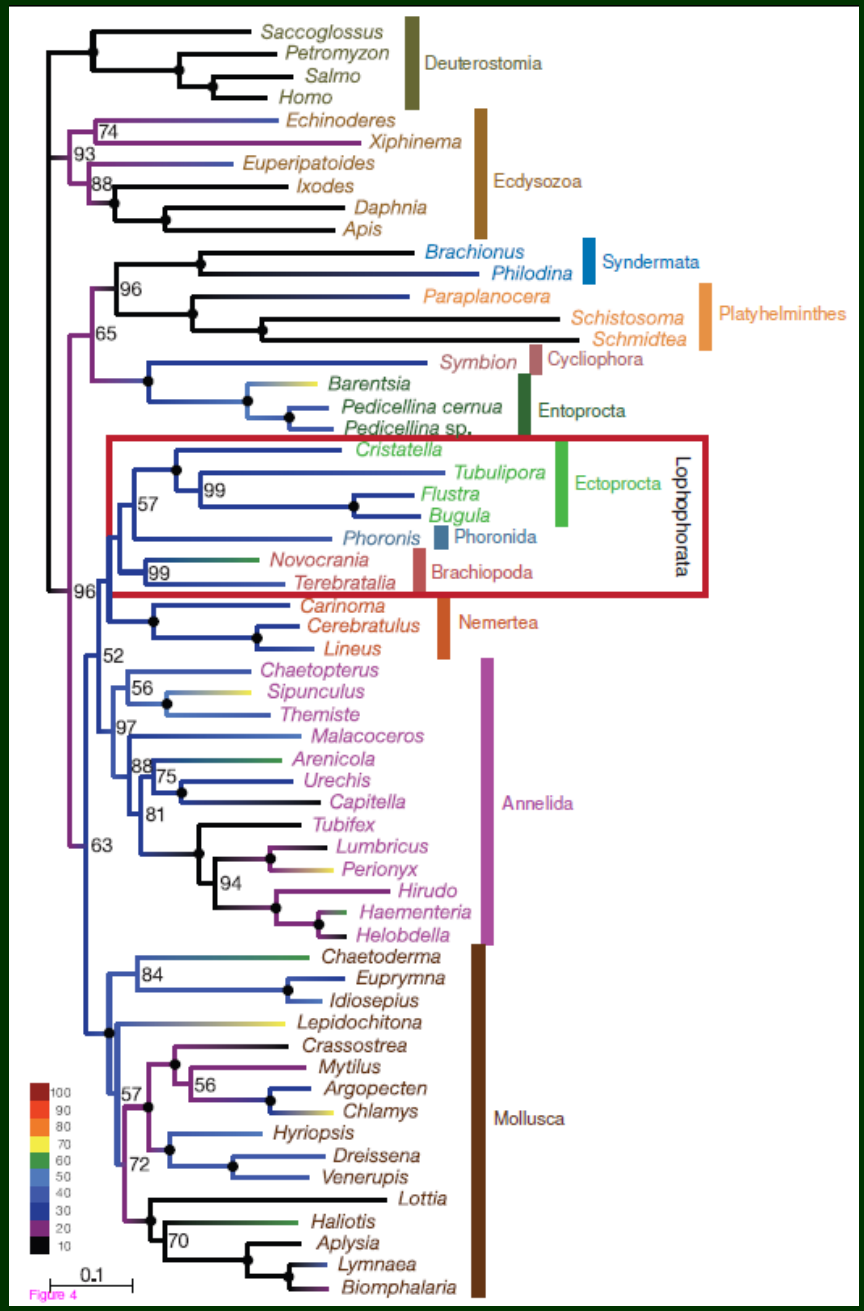
Metamorfóza mechovek

- exprese má pár společných znaků s ostatními bilaterii (tvorba polypida nebo aspoň lofoforu), ale A/P osu nelze jasně určit



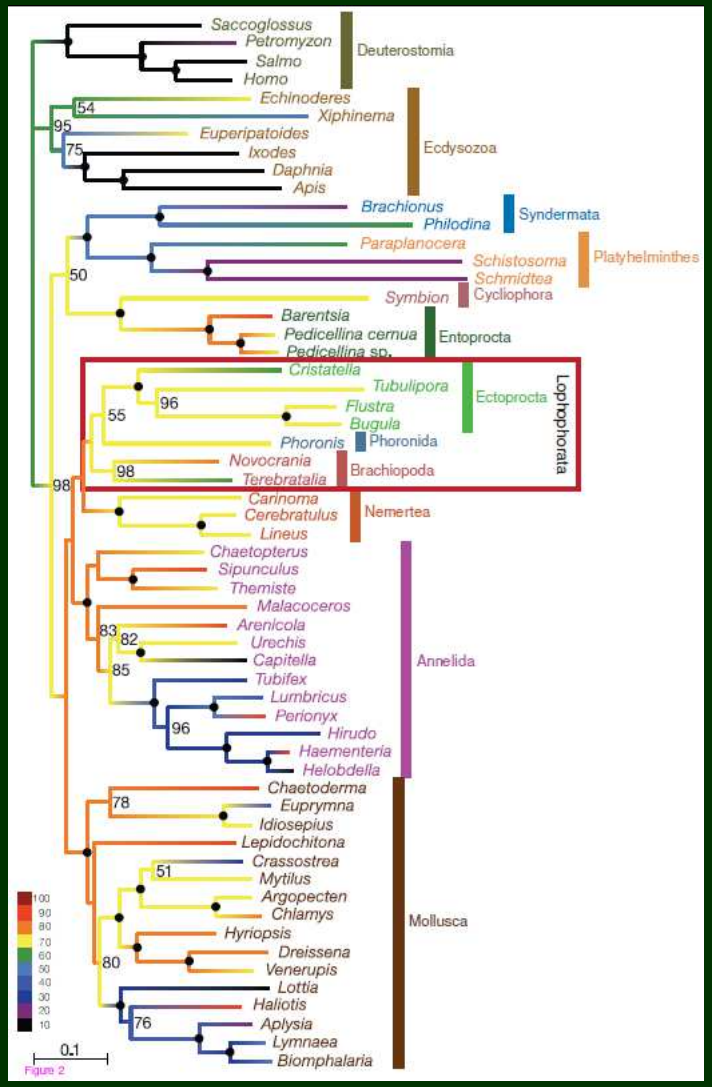
Lophophorata?

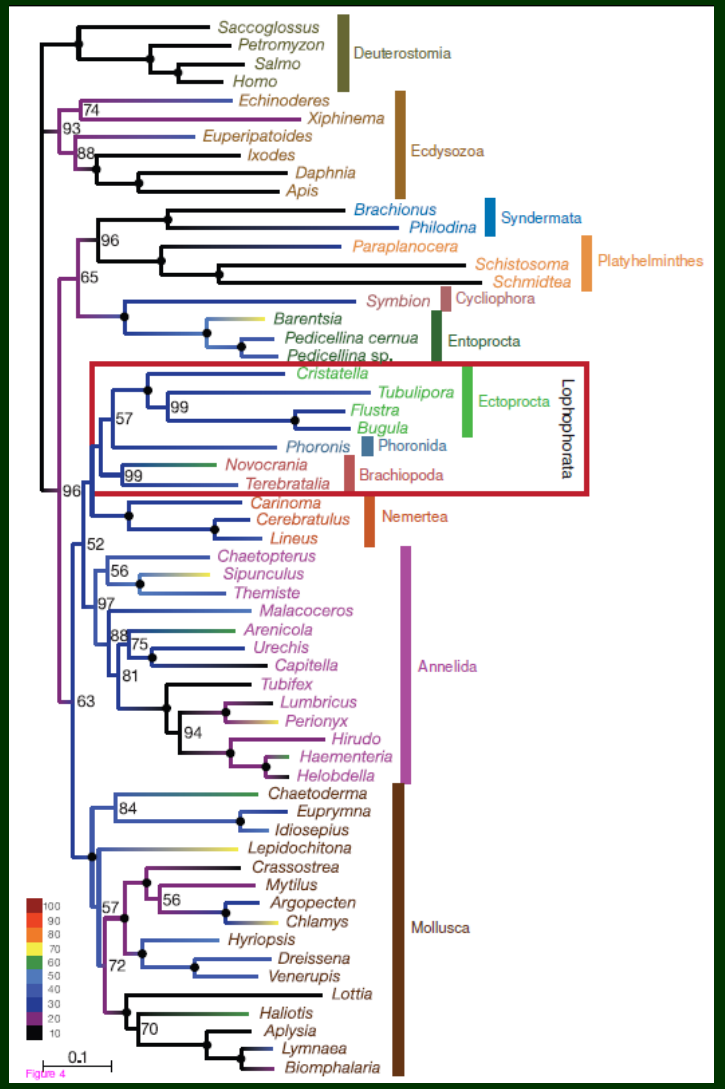
- Lophophorata: lofofor + epistom
- Bryozoa + Phoronida: evaginace ventrální vchlípeniny na počátku metamorfózy
- Phoronida + Phylactolaemata: svalovina trupu
- x Brachiozoa

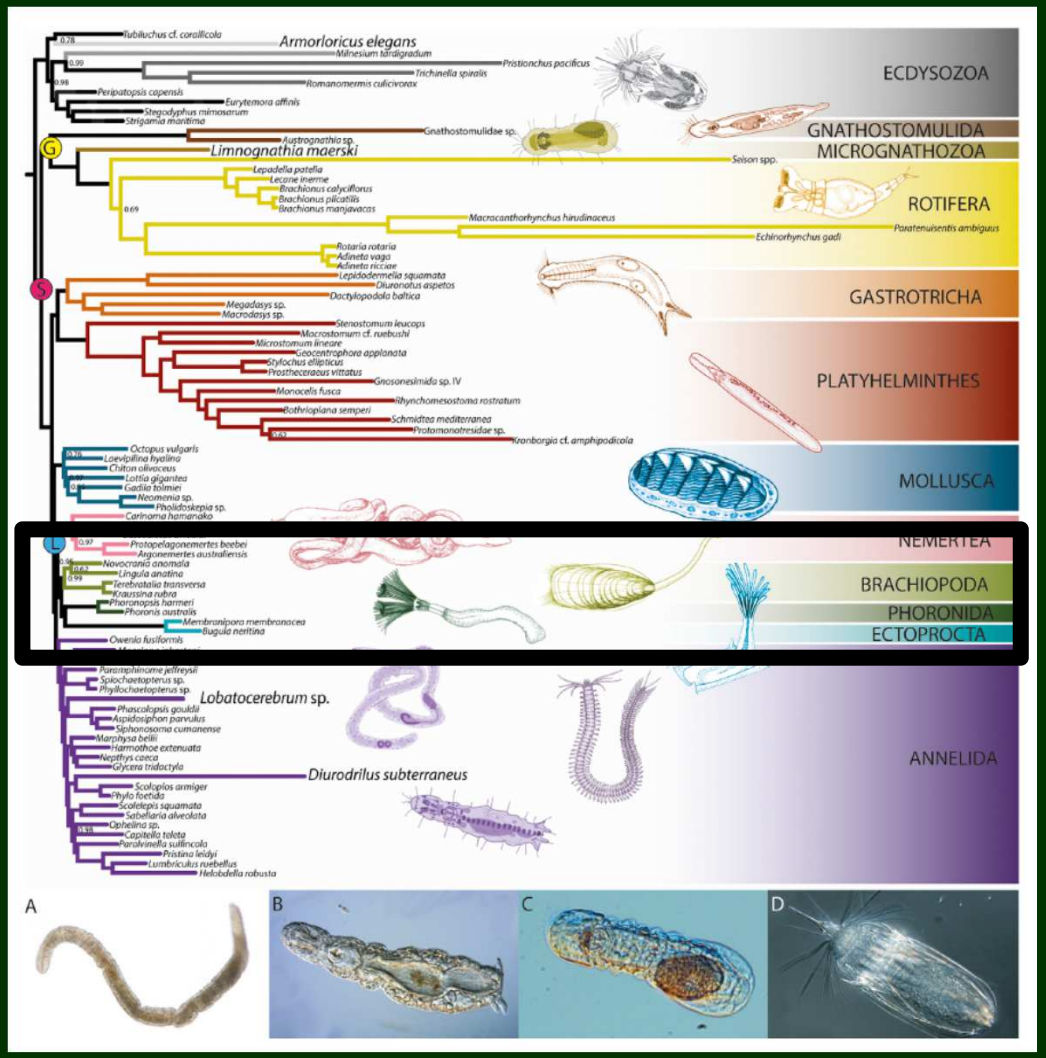


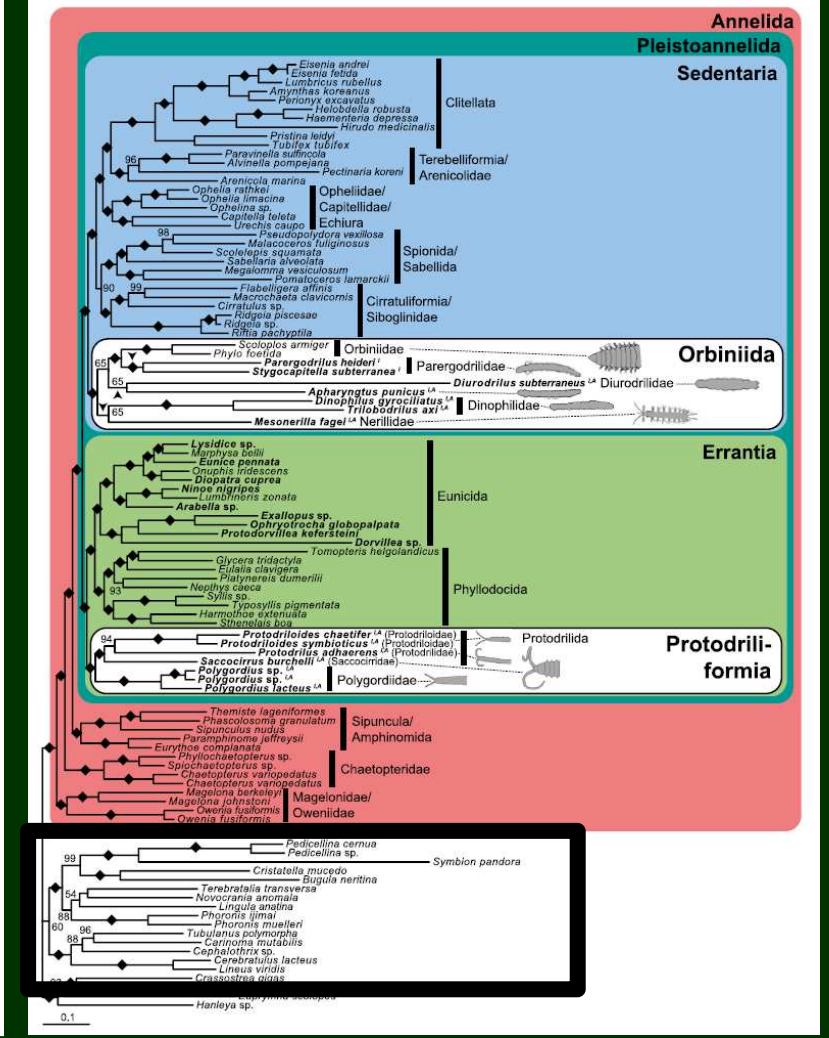
Lophophorata?

196 genů – všechny pozice x vyloučení znaků s nejvyšším procentem chybějících dat



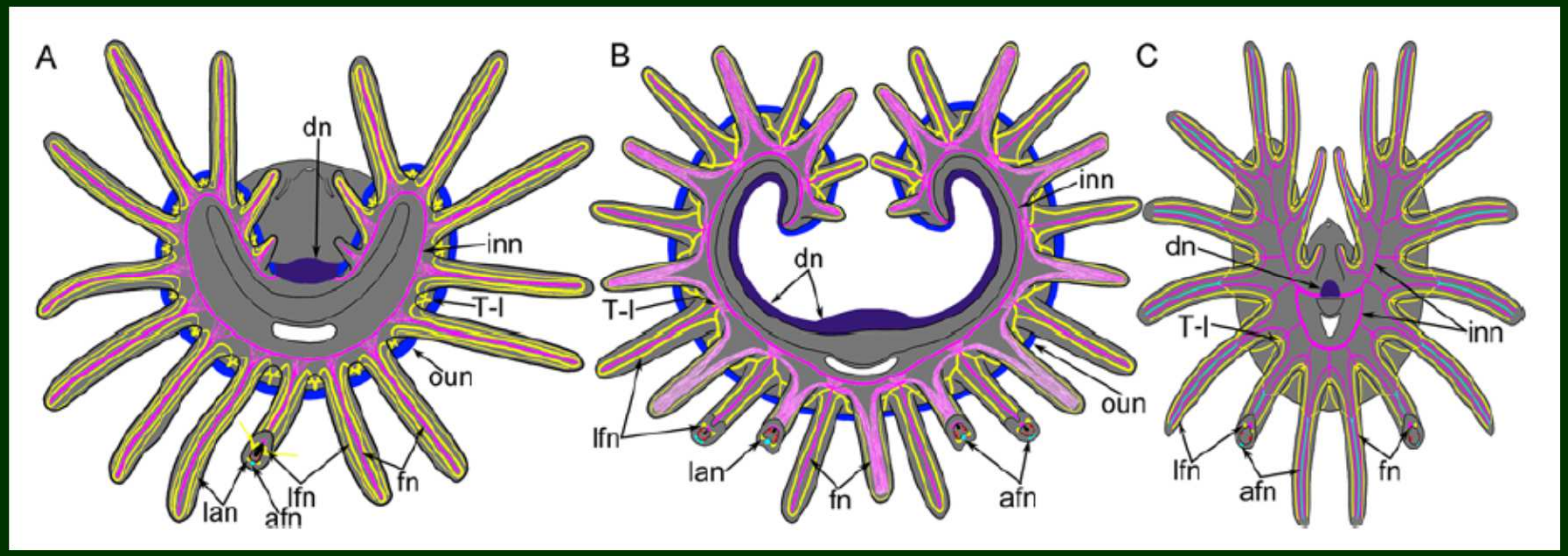


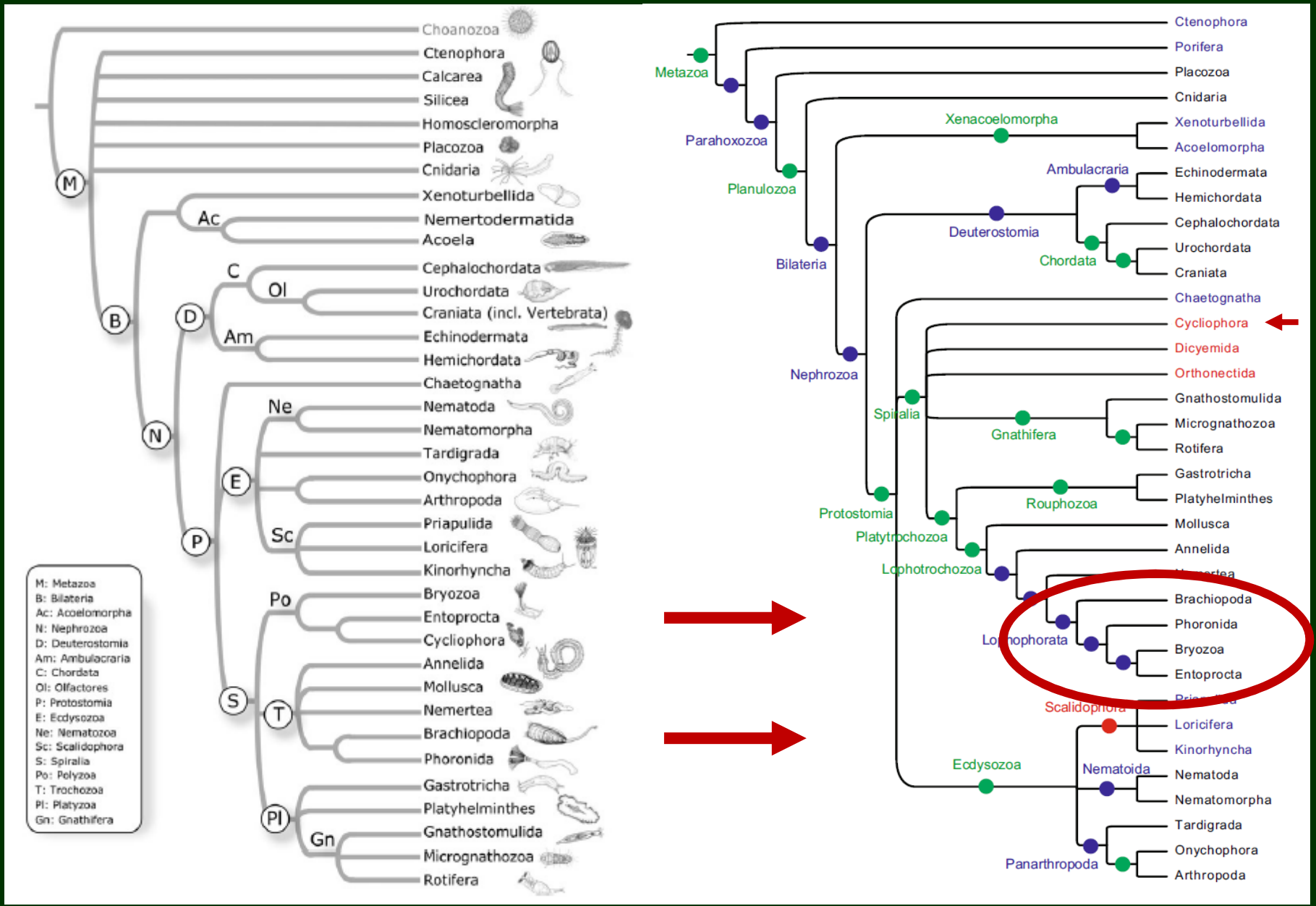

Armorloricus elegans
Limnognathia maerski
Lobatocerebrum sp.
Diurodrilus subterraneus
ECDYSOZOA
GNATHOSTOMULIDA
MICROGNATHOZOA
ROTIFERA
GASTROTRICHA
PLATYHELMINTHES
MOLLUSCA
NEMERTEA
BRACHIOPODA
PHORONIDA
ECTOPROCTA
ANNELIDA
A
B
C
D


Annelida
Pleistoannelida
Sedentaria
Clitellata
Terebelliformia/
Arenicolidae
Ophelliidae/
Capitellidae/
Echiura
Spionida/
Sabellida
Cirratuliformia/
Siboglinidae
Orbiniida
Orbiniidae
Parergodrilidae
Diurodrilidae
Dinophilidae
Nerillidae
Errantia
Eunicida
Phyllodocida
Protodrilida
Protodrilii-
formia
Polygordiidae
Sipuncula/
Amphinomida
Chaetopteridae
Magelonidae/
Oweniidae
Symbion pandora
0,1

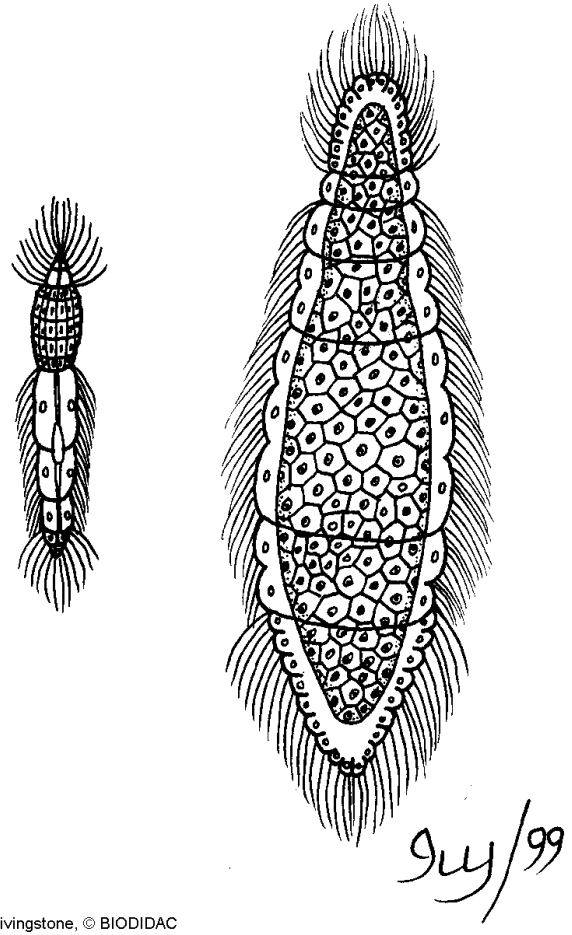
Lophophorata?

- protocel u Phylactolaemata? – celom ano, ale jeden (skrz celé tělo včetně epistomu)
- Brachiopoda – bi- i tripartitní (protocel u *Lingula*) ~ Phoronida
- homologická inervace lofoforu (Phoronida–Brachiopoda–Ectoprocta)



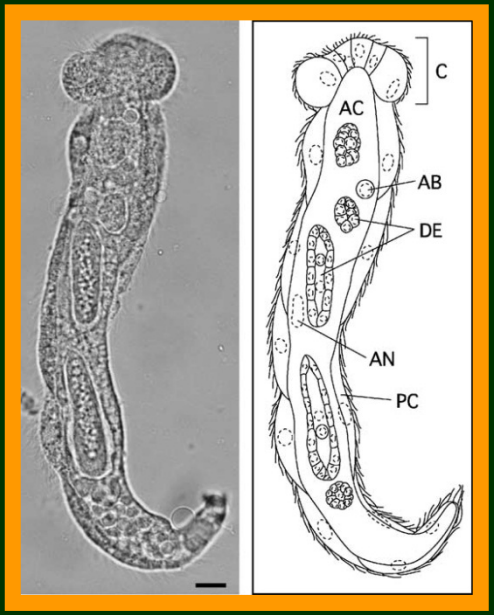

Choanozoa
Ctenophora
Calcarea
Silicea
Homoscleromorpha
Placozoa
Cnidaria
Xenoturbellida
Nemertodermatida
Acoela
Cephalochordata
Urochordata
Craniata (incl. Vertebrata)
Echinodermata
Hemichordata
Chaetognatha
Nematoda
Nematomorpha
Tardigrada
Onychophora
Arthropoda
Priapulida
Loricifera
Kinorhyncha
Bryozoa
Entoprocta
Cycliophora
Annelida
Mollusca
Nemertea
Brachiopoda
Phoronida
Gastrotricha
Platyhelminthes
Gnathostomulida
Micrognathozoa
Rotifera
M
B
Ac
D
C
Ol
Am
N
E
Ne
Sc
P
Po
S
T
Pl
Gn
M: Metazoa
B: Bilateria
Ac: Acoelomorpha
N: Nephrozoa
D: Deuterostomia
Am: Ambulacraria
C: Chordata
Ol: Olfactores
P: Protostomia
E: Ecdysozoa
Ne: Nematozoa
Sc: Scalidophora
S: Spiralia
Po: Polyzoa
T: Trochozoa
Pl: Platyzoa
Gn: Gnathifera
Metazoa
Parahoxozoa
Planulozoa
Bilateria
Nephrozoa
Protostomia
Spiralia
Platytrochozoa
Lophotrochozoa
Ecdysozoa
Xenacoelomorpha
Deuterostomia
Ambulacraria
Chordata
Gnathifera
Rouphozoa
Lophophorata
Scalidophora
Nematoida
Panarthropoda
Ctenophora
Porifera
Placozoa
Cnidaria
Xenoturbellida
Acoelomorpha
Echinodermata
Hemichordata
Cephalochordata
Urochordata
Craniata
Chaetognatha
Cycliophora
Dicyemida
Orthonectida
Gnathostomulida
Micrognathozoa
Rotifera
Gastrotricha
Platyhelminthes
Mollusca
Annelida
Brachiopoda
Phoronida
Bryozoa
Entoprocta
Loricifera
Kinorhyncha
Nematoda
Nematomorpha
Tardigrada
Onychophora
Arthropoda

„Mesozoa“



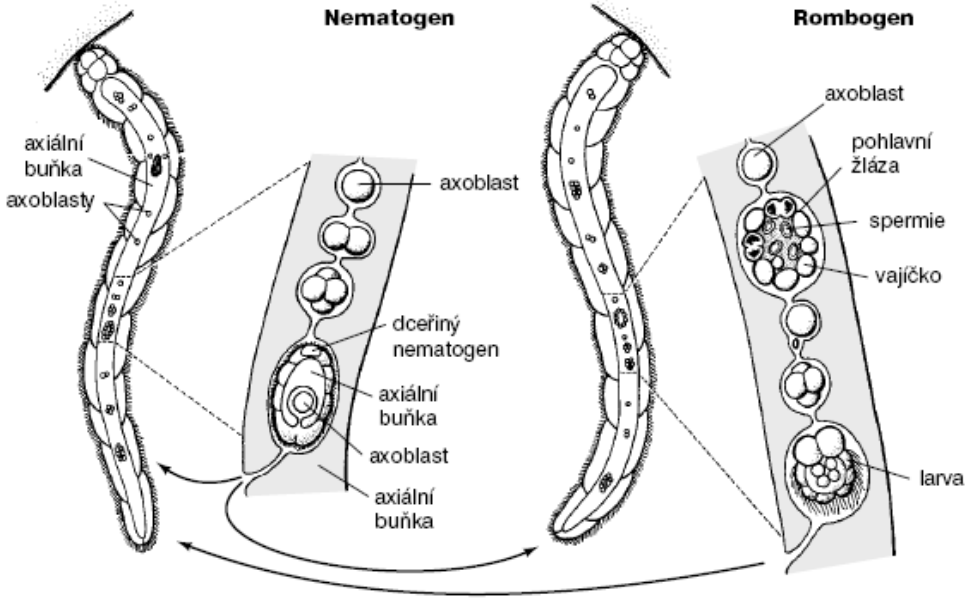
Orthonecta

(kroužkovci???)



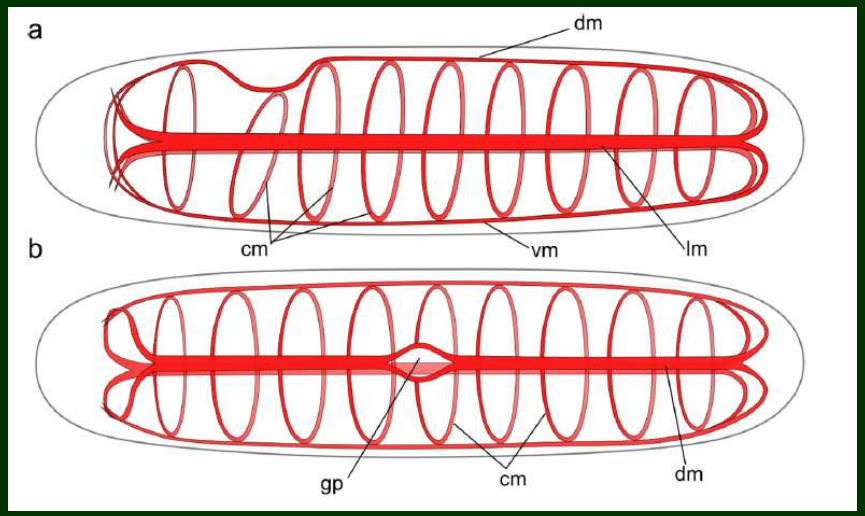
Rhombozoa

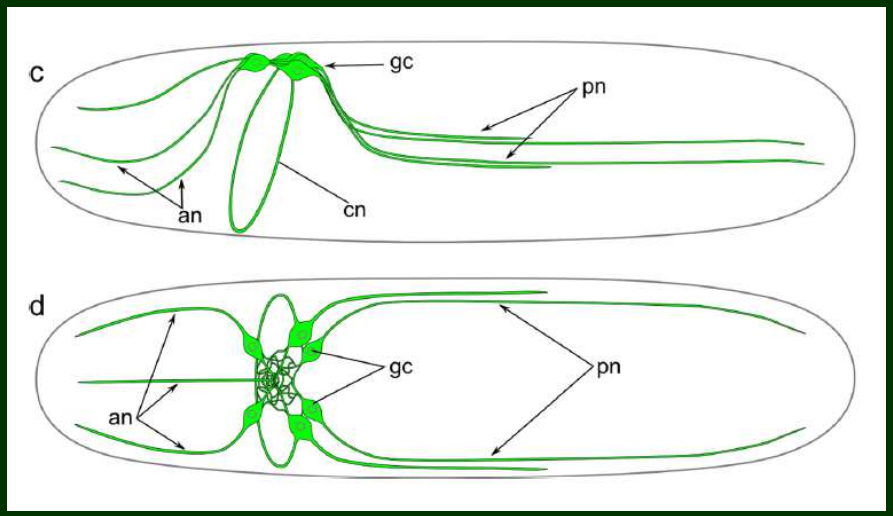
(ploštěnci???)



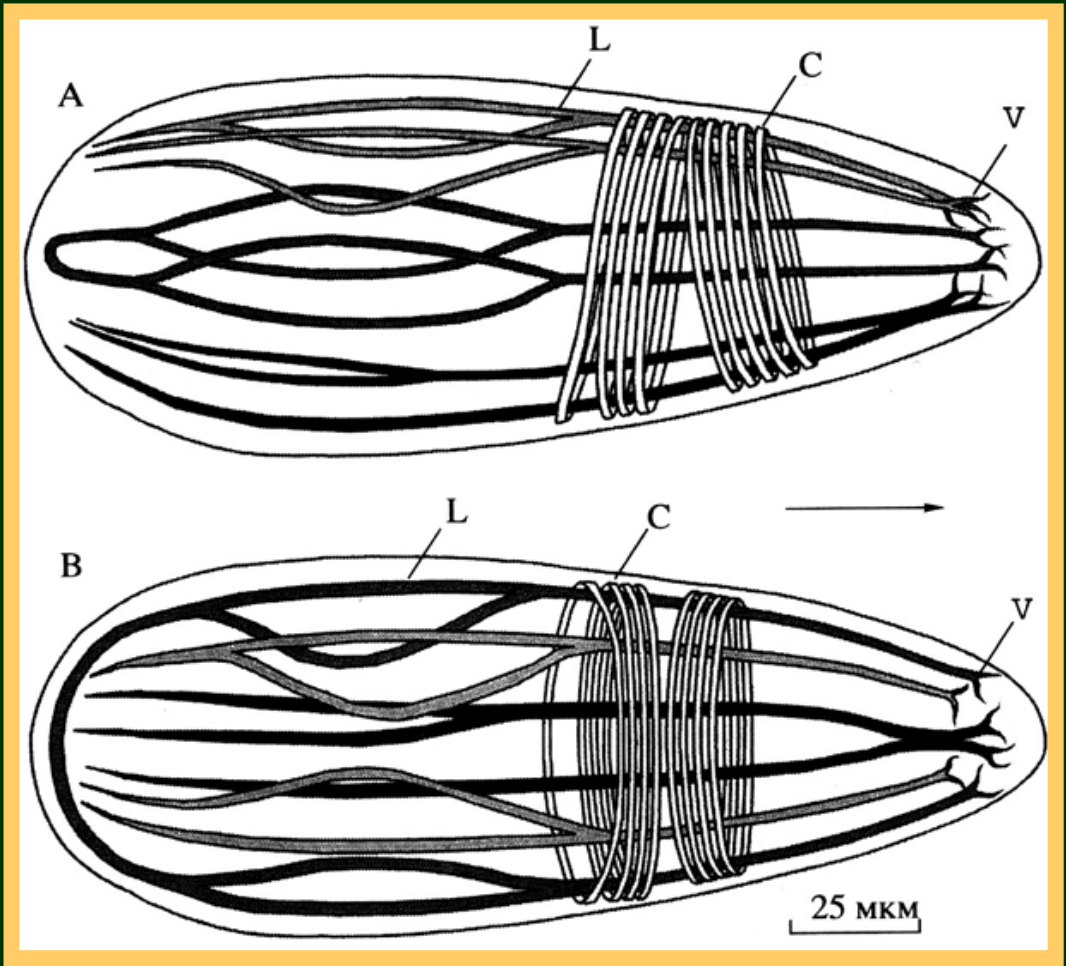
Orthonectida

- svaly + serotonergní NS
- podobá se larvám či trpasličím samcům?
- složité receptory
- nervová soustava – v přední části těla skupina malých buněk propojených synapsemi

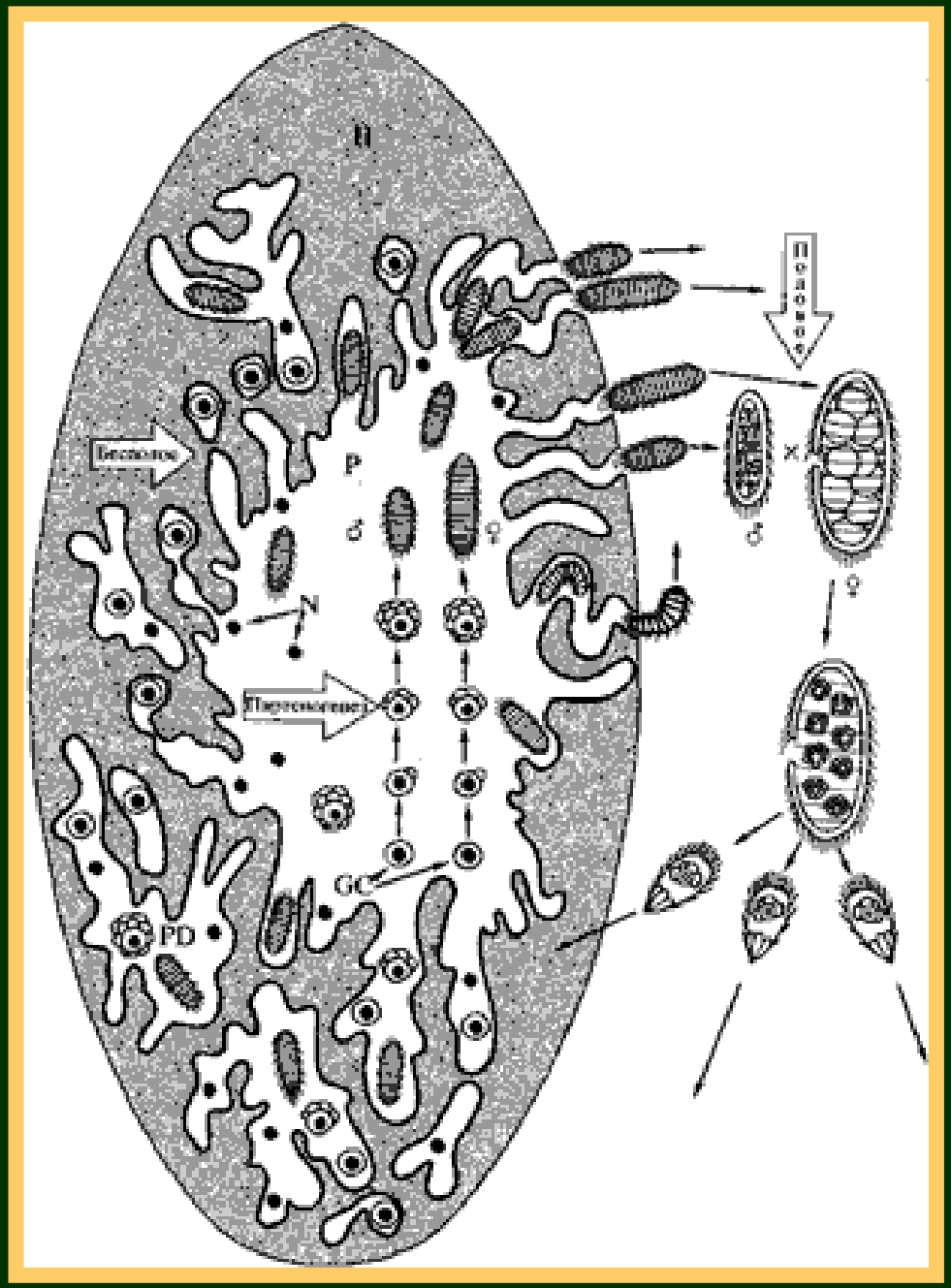




Orthonectida



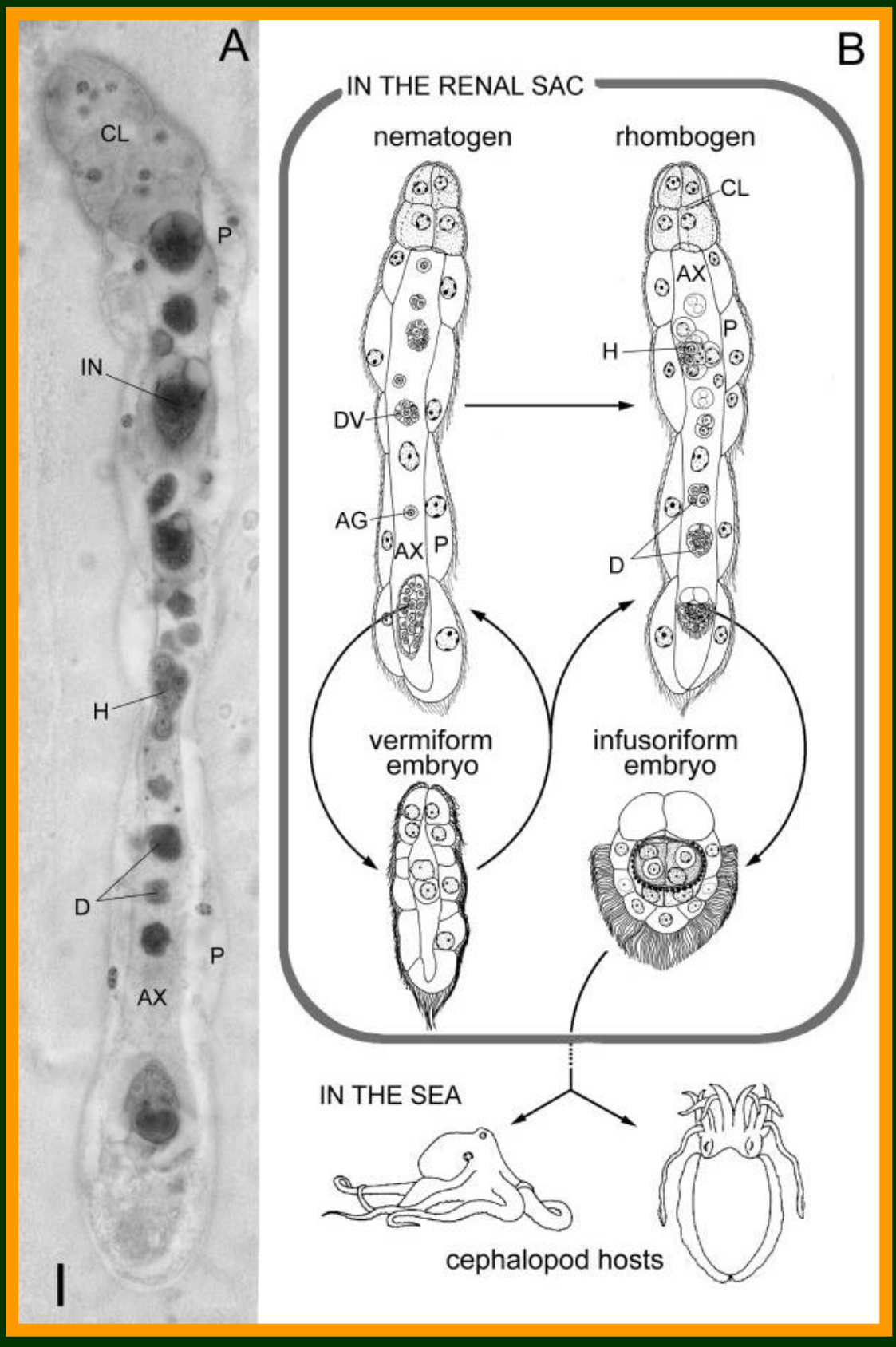
- bilaterální svalový systém
- složité receptory
- nervová soustava – v přední části těla skupina malých buněk propojených synapsemi



Orthonectida

- potravní plazmodium
- v něm vznikají pohlavní jedinci (partenogeneze?)
- ven se dostávají pomocí speciálních plazmodiálních kanálů
- nepohlavní dělení plazmodií

Rhombozoa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IN THE RENAL SAC
nematogen
rhombogen
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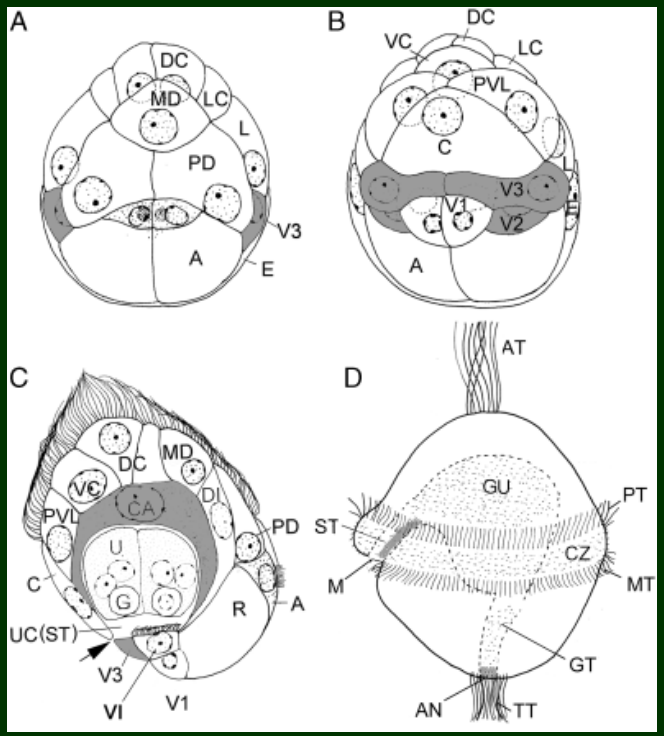
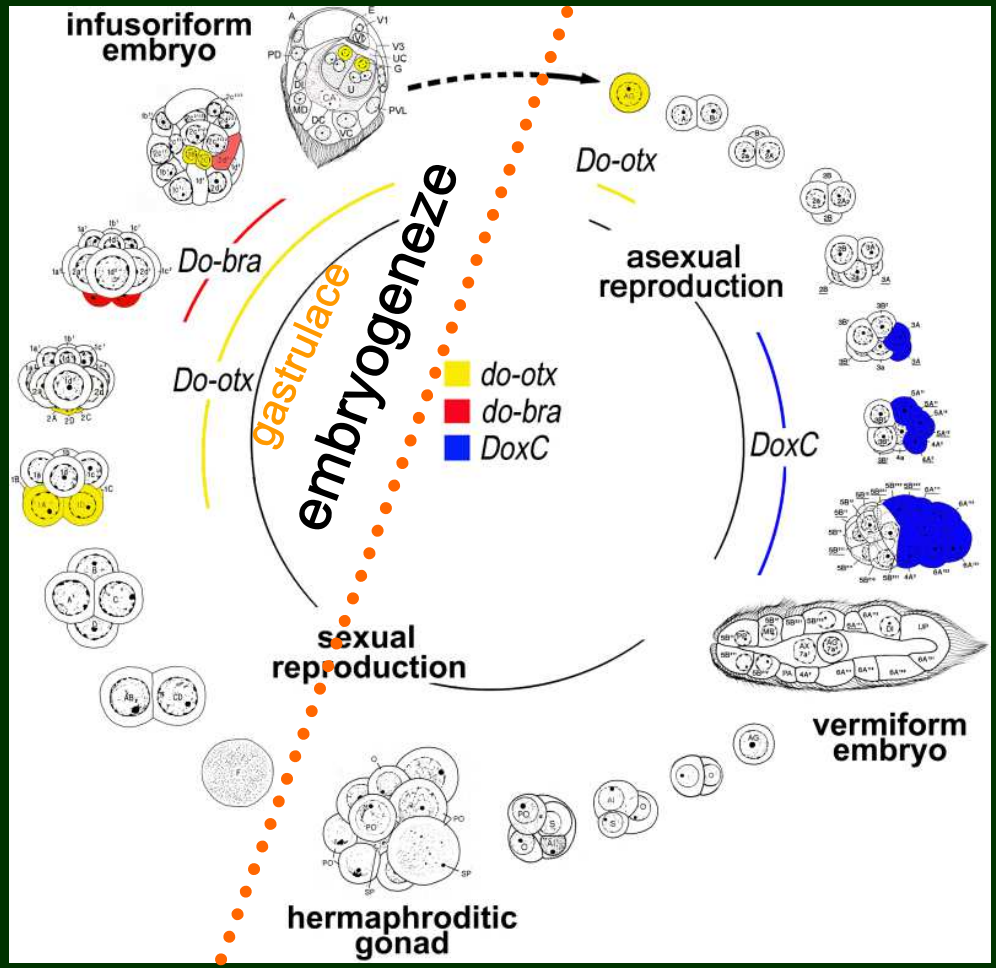
AX
P
D
vermiform
embryo
infusoriform
embryo
IN THE SEA
cephalopod hosts

Rhombozoa

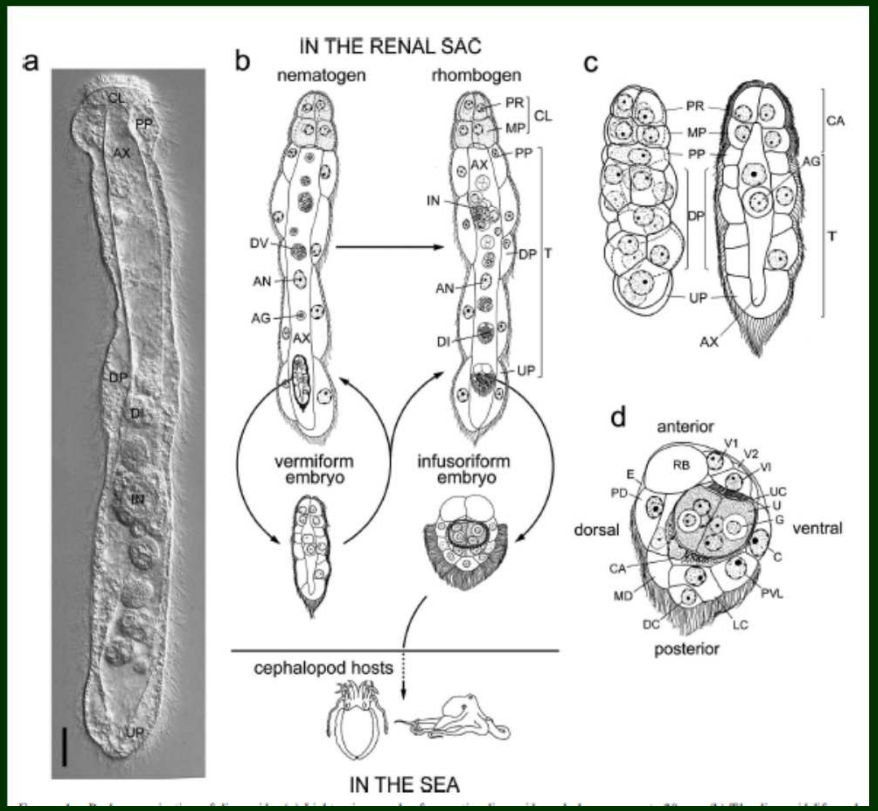
- exprese genů odpovídá trochoforové larvě
- Hox gen *DoxC* není aktivní ve vývoji infusoriformního stadia





Rhombozoa

Expression pattern	Gene
Vermiform embryo	
Calotte-specific	Chitinase-like protein (Ogino et al., 2007b)
Trunk-specific	Aquaglyceroporin
	Aspartate aminotransferase
	Cathepsin-L-like cysteine peptidase
	DoxC (Kobayashi et al., 2009)
	Glucose transporter
	Glycin transporter
Germ line cell-specific (agamete and germinal cell in infusoriform embryo)	Do-otx (Kobayashi et al., 2009)
Germ line cell-specific (agamete)	Ets domain-containing protein
	Rad 18 protein
Ubiquitous	F-actin capping protein
	Glucose dehydrogenase
	HSP 70
	HSP 90
	Isocitrate dehydrogenase
	Serine hydroxymethyltransferase
	Succinate-CoA ligase
	Valosin-containing protein
	14-3-3 protein
Infusoriform embryo	
Urn cell-specific	Aspartate aminotransferase
	Cathepsin-L-like cysteine peptidase
	F-actin capping protein
	HSP 70
	HSP 90
	Succinate-CoA ligase
	Valosin-containing protein
	14-3-3 protein
Ciliated cell-specific	Glucose dehydrogenase
Ubiquitous	Isocitrate dehydrogenase



Rhombozoa

- inexin (*gap junctions*)