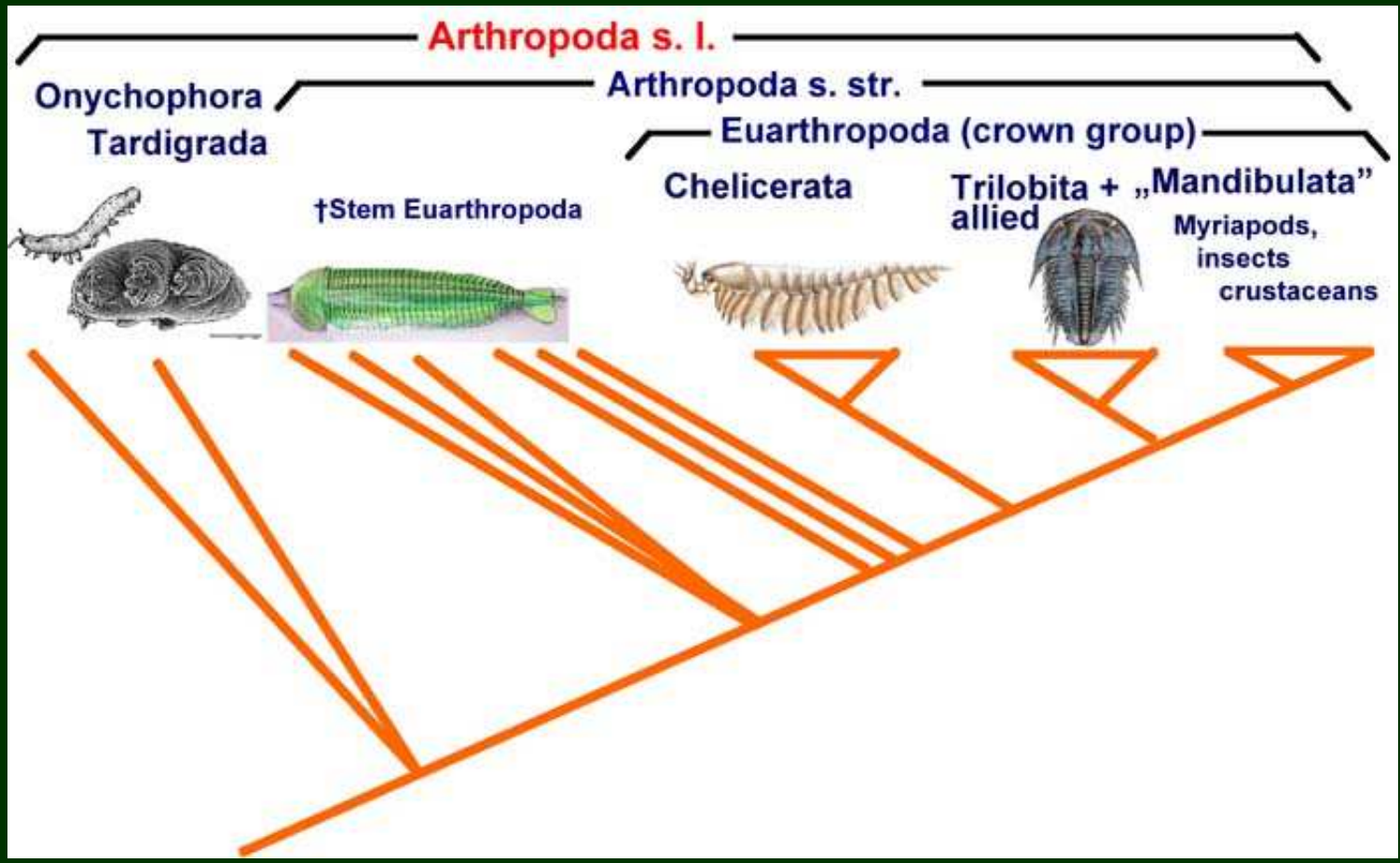
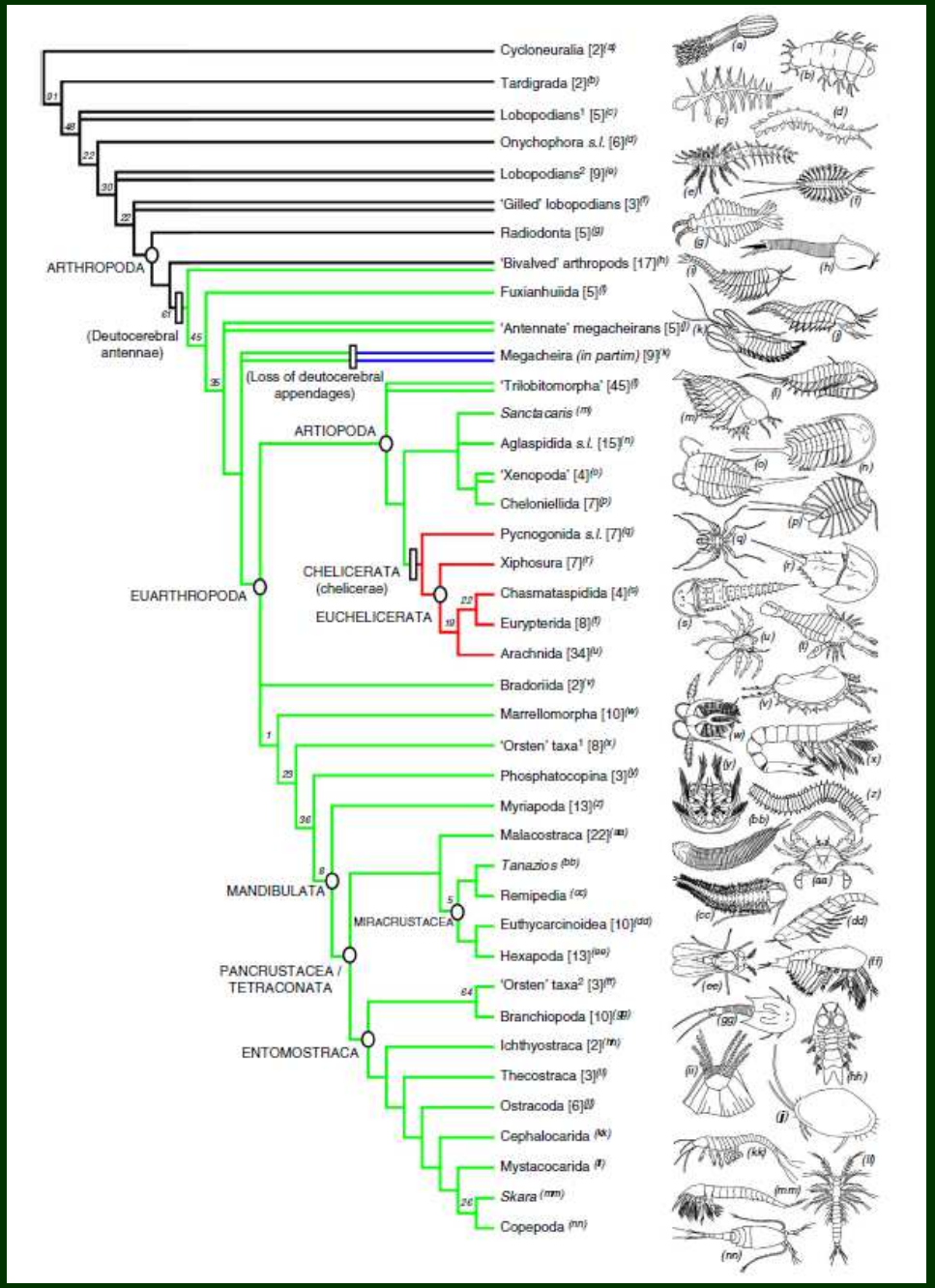
Panarthropoda

Panarthropoda

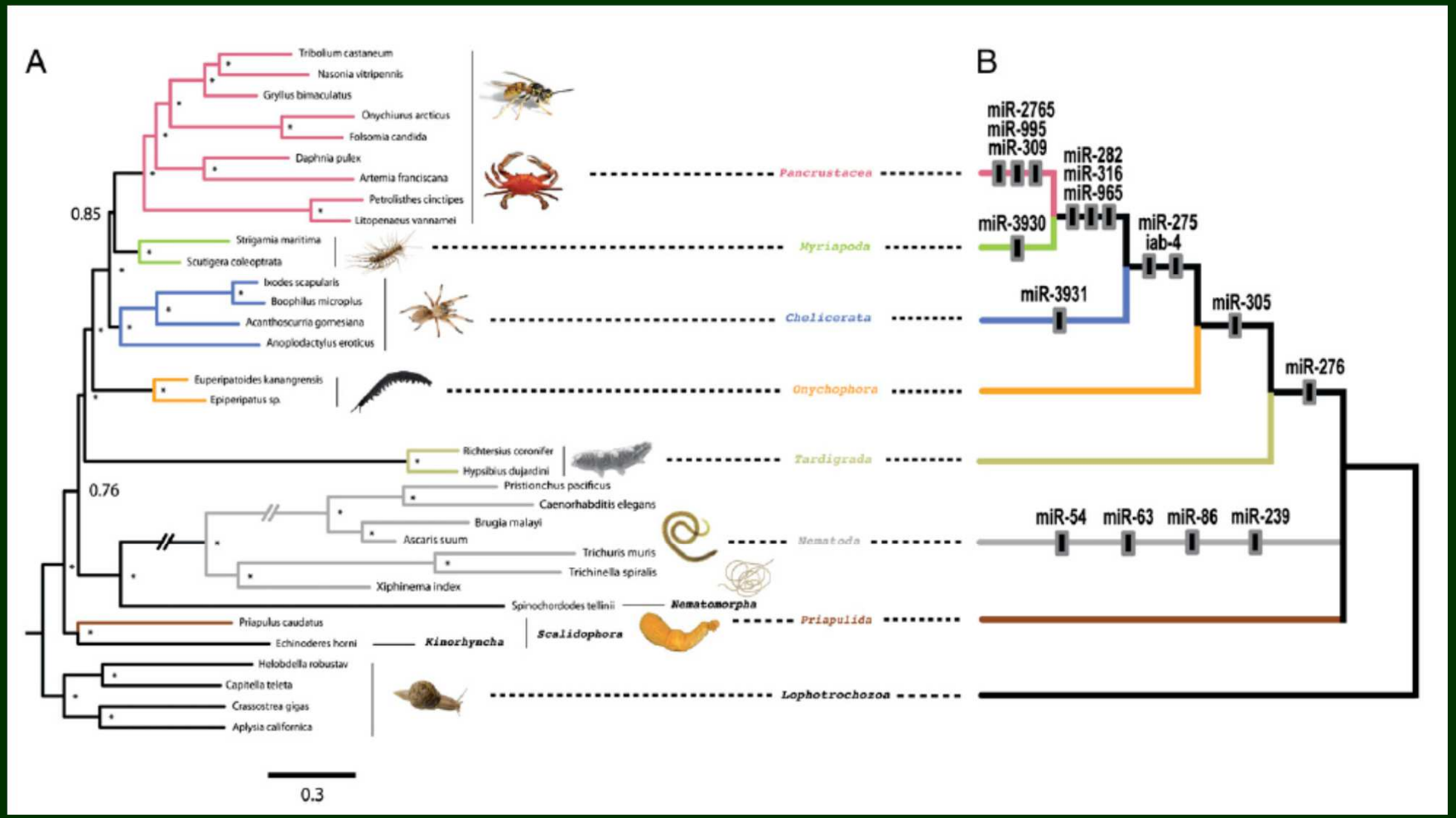


Panarthropoda

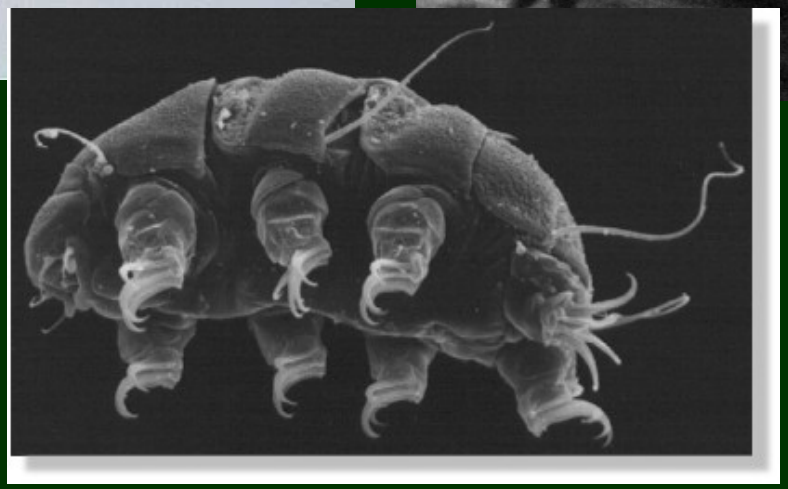
- 753 MOR znaků
- 309 druhů (včetně fosilií)

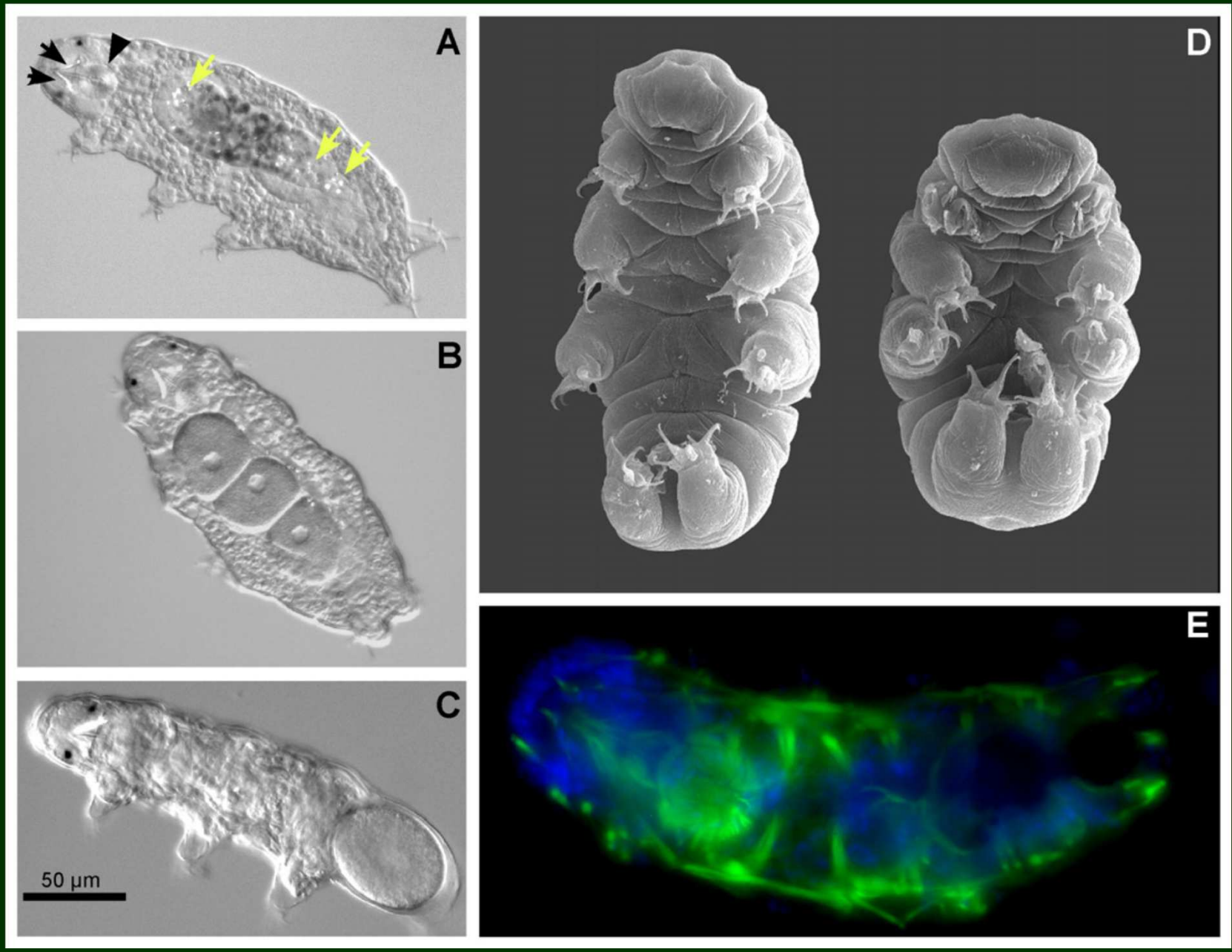


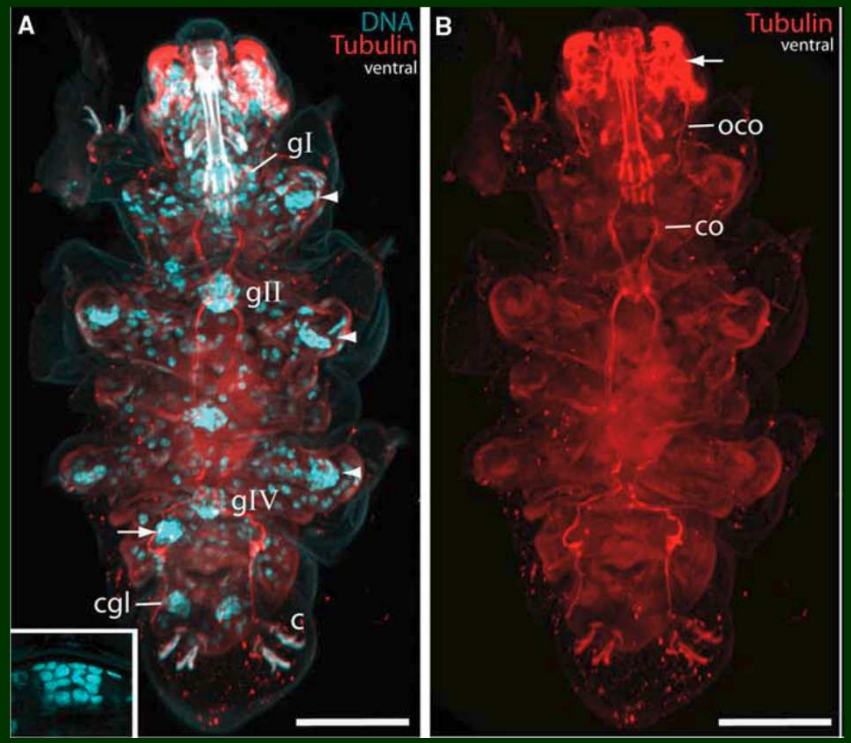
Panarthropoda
fylogenomika + miRNA



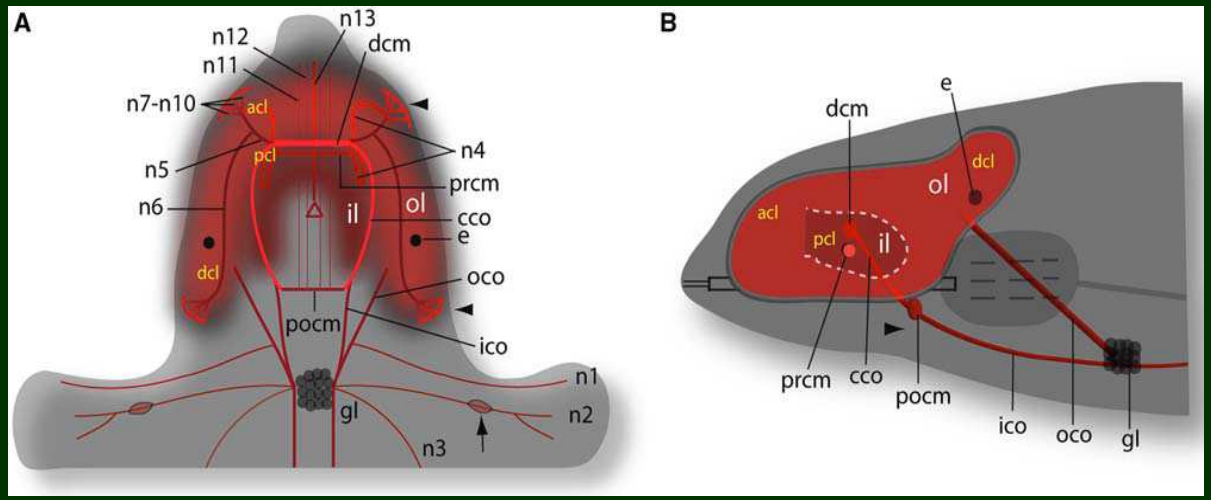
Tardigrada




A
B
C
50 µm
D
E

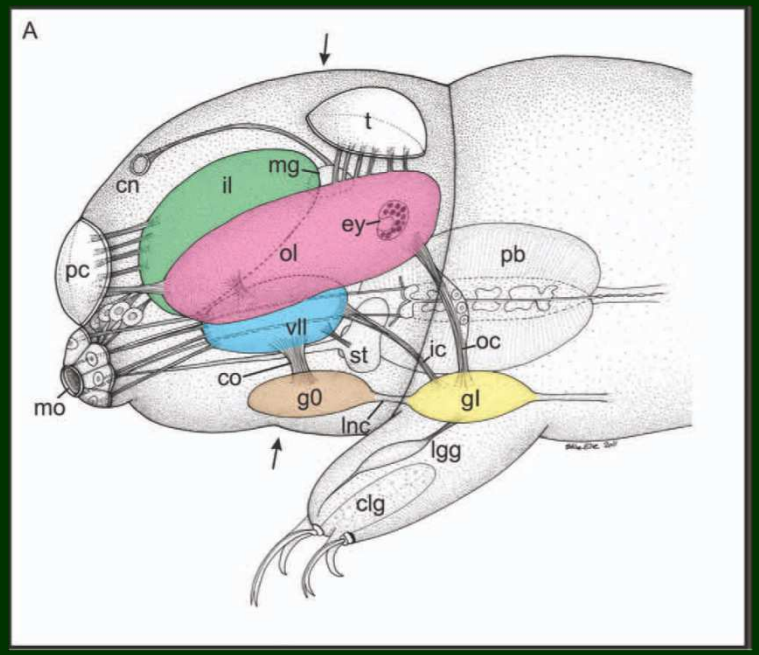


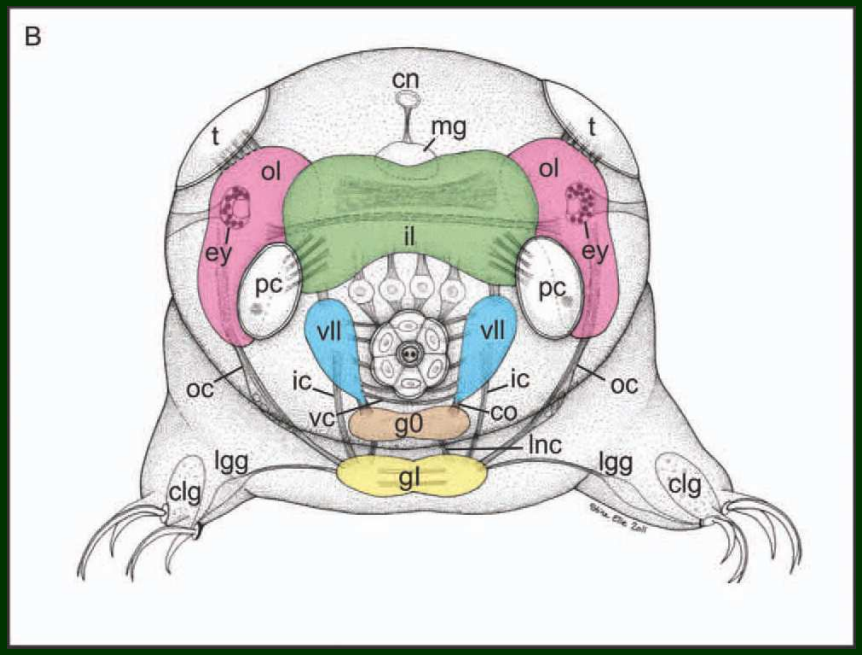
- mnohem jednodušší mozek než u drápkovců a členovců
- → tříčlánkový mozek pravděpodobně neexistuje



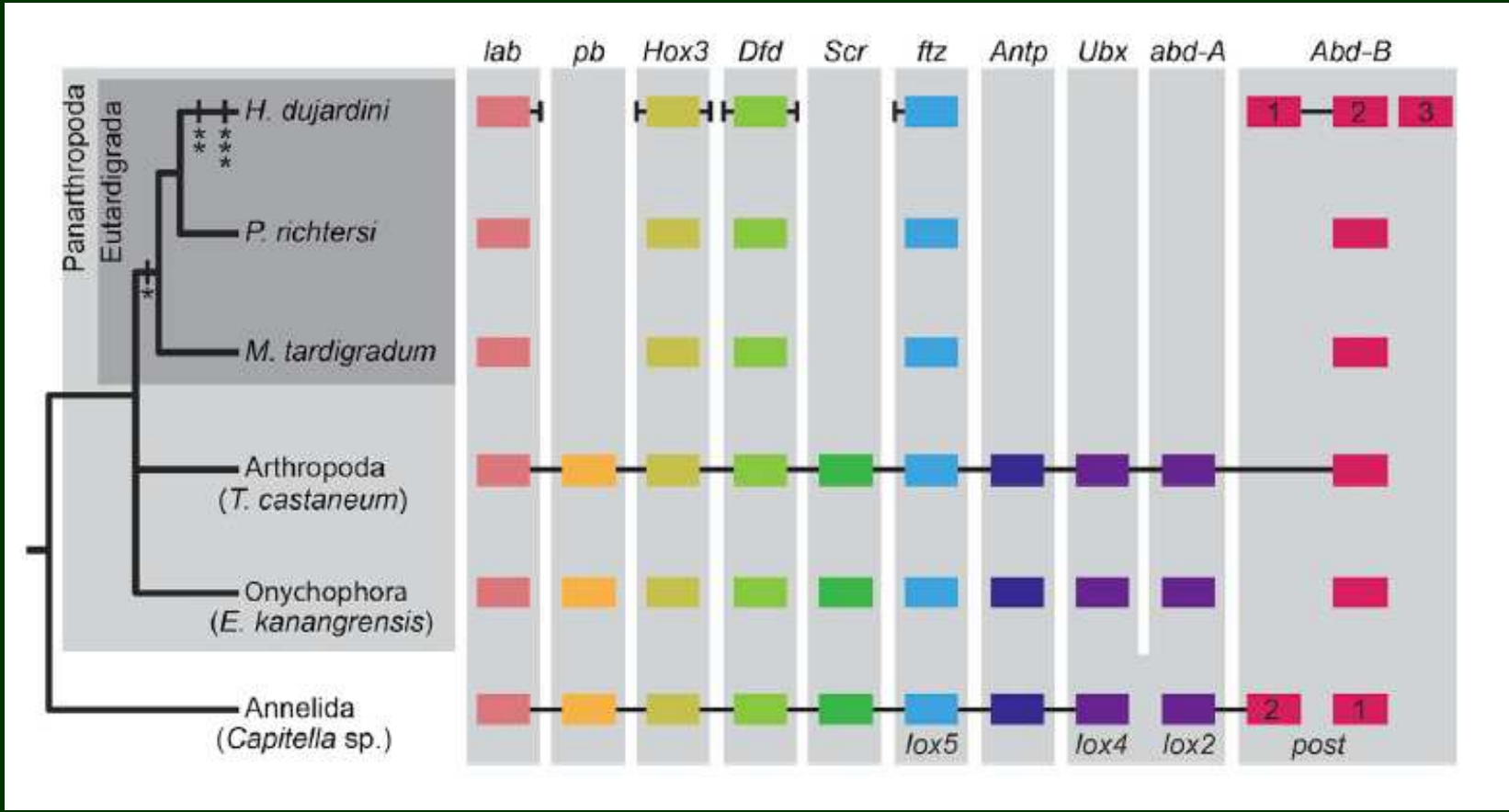
Mozek želvušek

- podrobnější studie: trojdílný mozek ~ Arthropoda
- protocerebrum: oči, vnější loby ~ oči (tykadla drápkovců)
- deutocerebrum ~ tykadla, chelicery (čelisti drápkovců)
- tritocerebrum: bukální lamela, stylety ~ 2. tykadla, pedipalpy (slinné papily drápkovců)

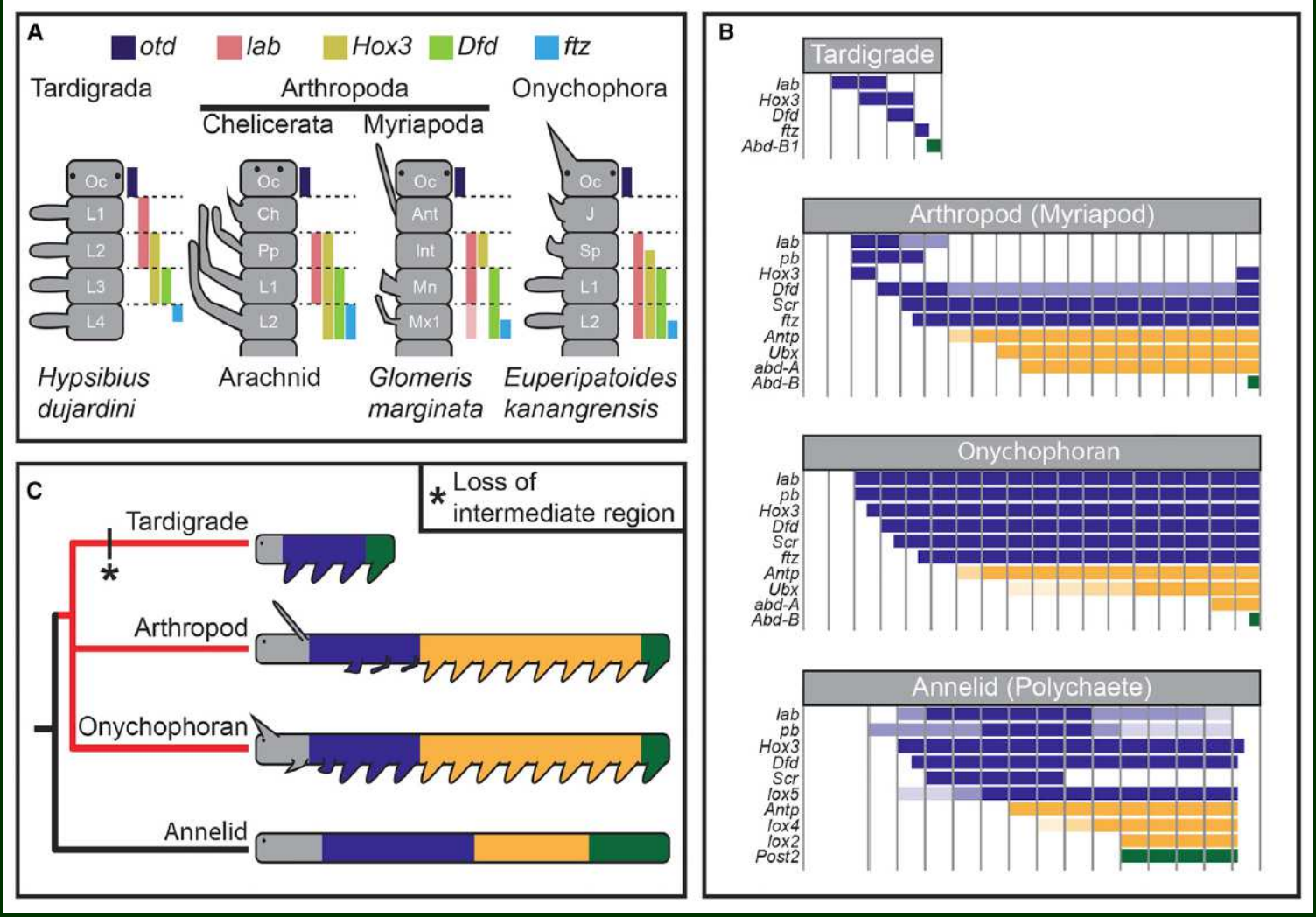




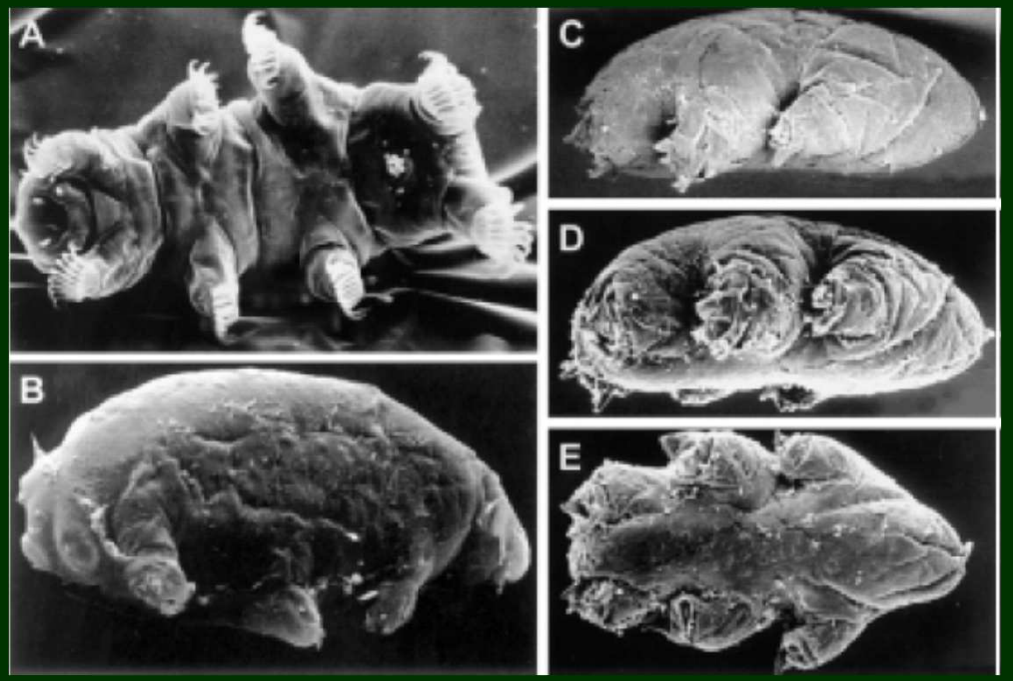
Tardigrada – Hox

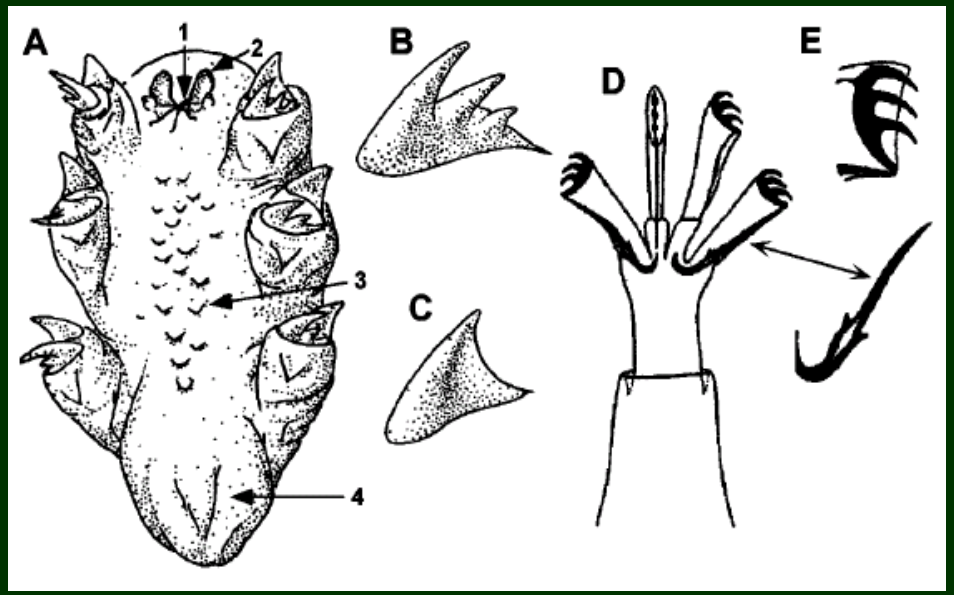


Tardigrada – genom



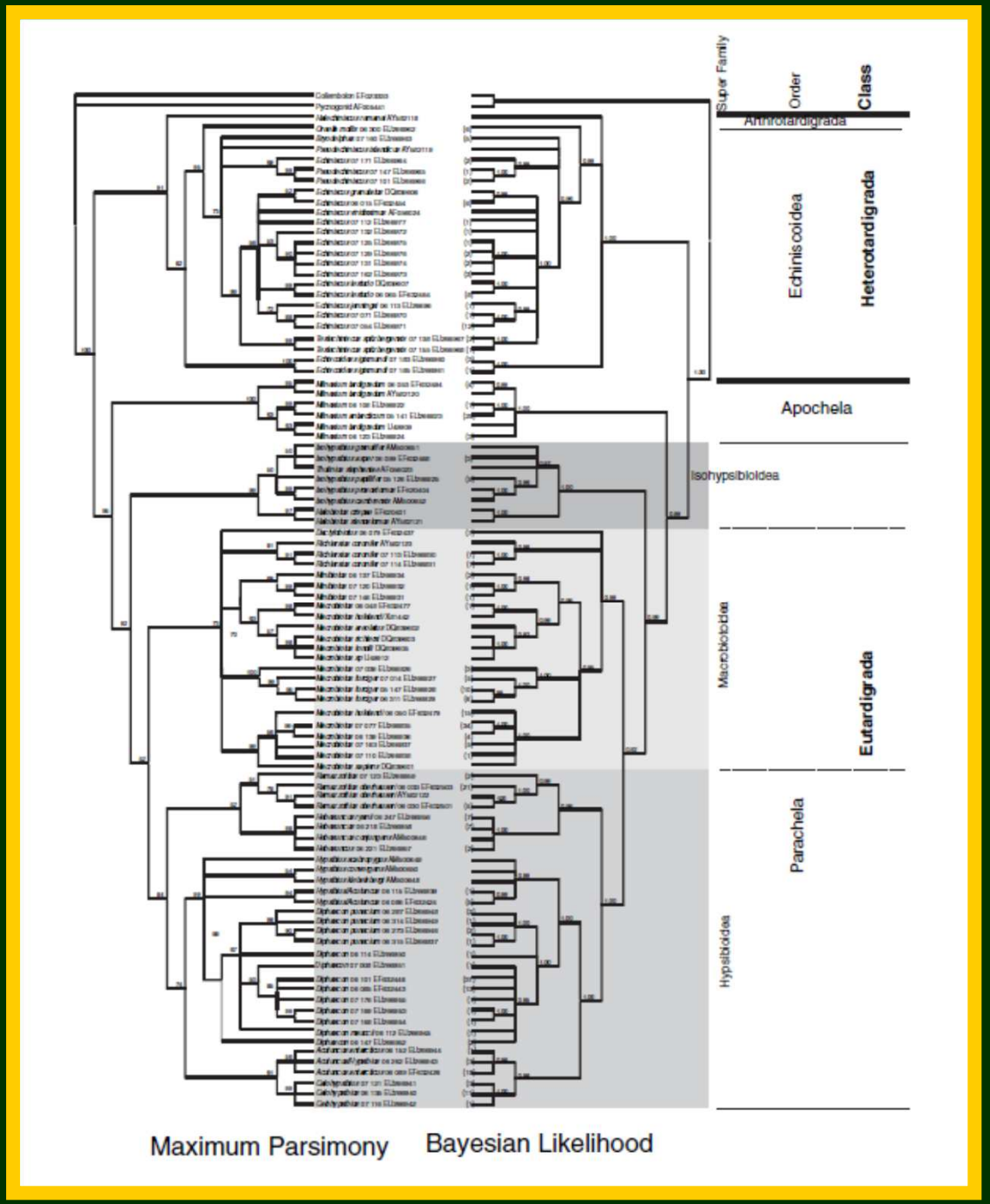
Fosilní želvušky (kambrium)



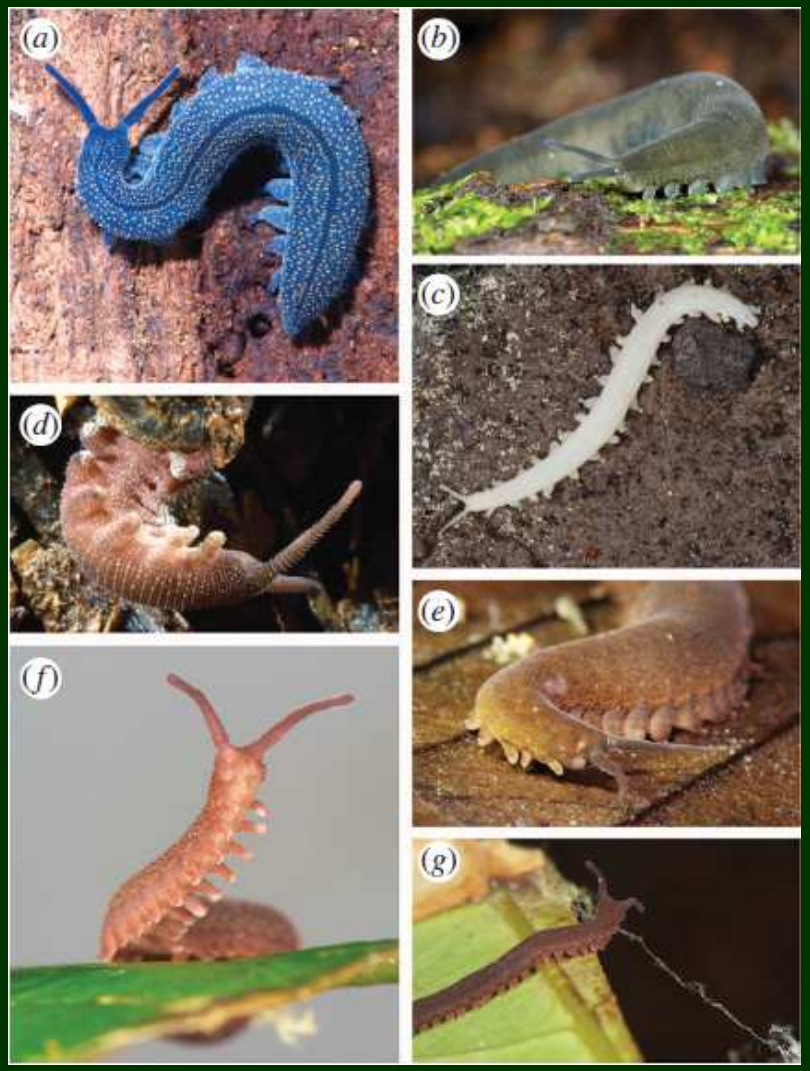


Fylogeneze želvušek

- Heterotardigrada
- Eutardigrada
- ? Mesotardigrada

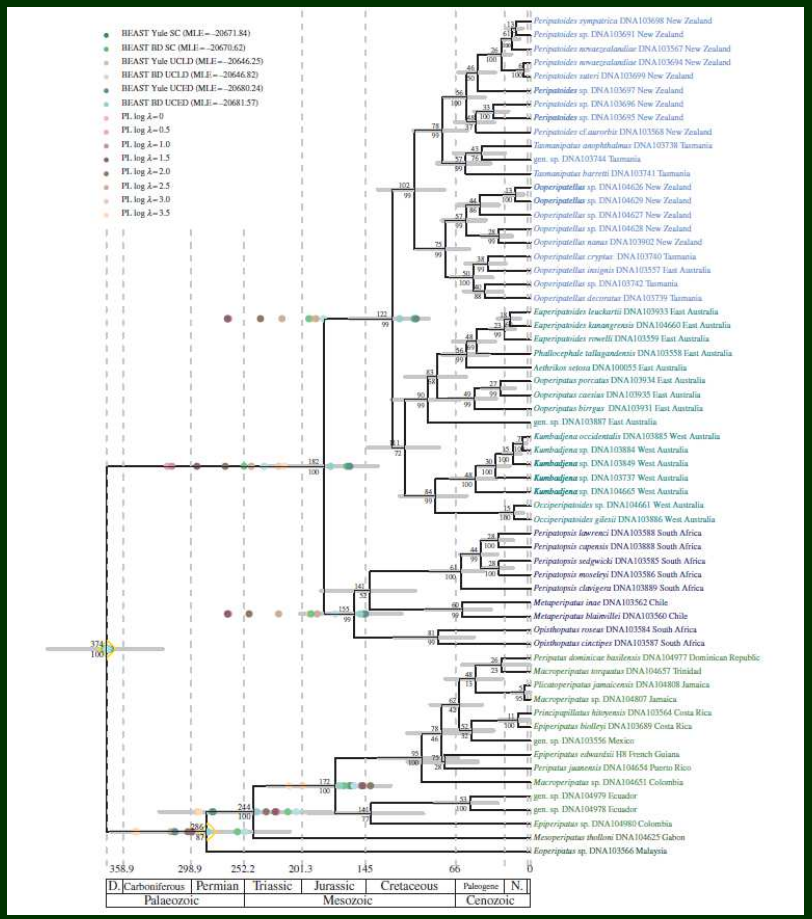


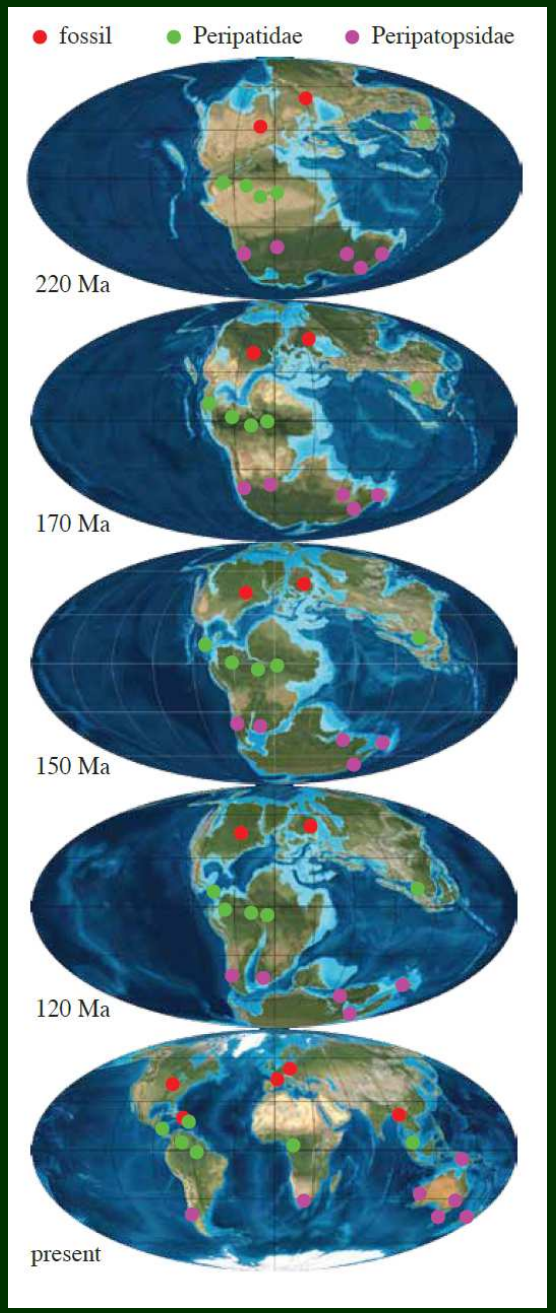
Onychophora



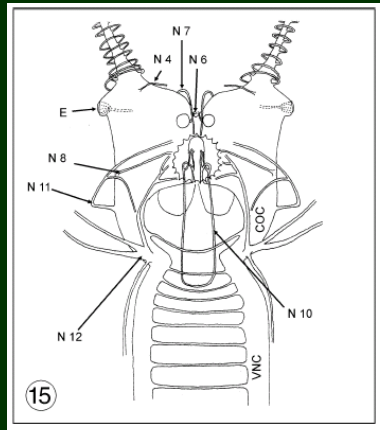
Onychophora

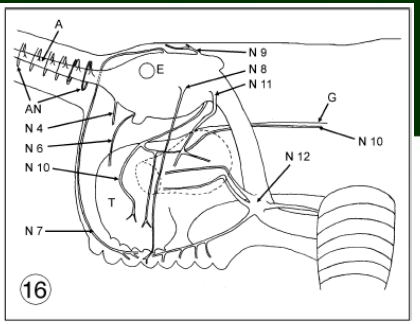
- diverzifikace předchází rozpadu Pangey

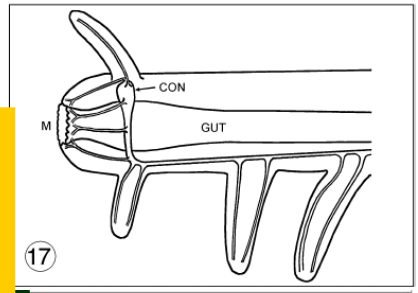


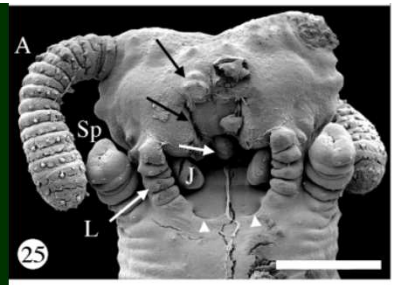


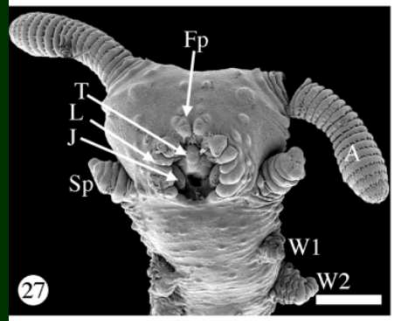

Sp
A
O
500 µm
3

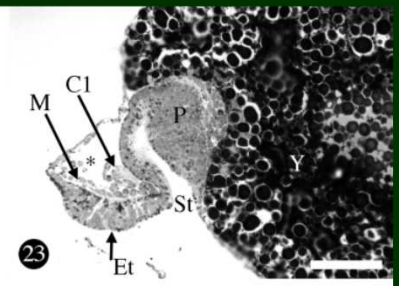

N 7
N 4
N 6
E
N 8
N 11
COC
N 10
N 12
VNC
15

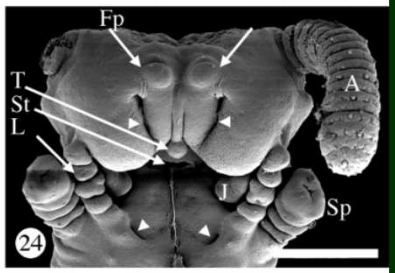

A
E
N 9
N 8
N 11
G
AN
N 4
N 6
N 10
N 10
N 12
T
N 7
16

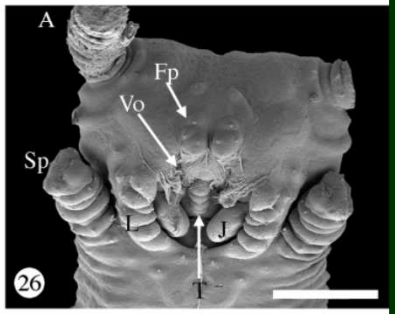

CON
M
GUT
17

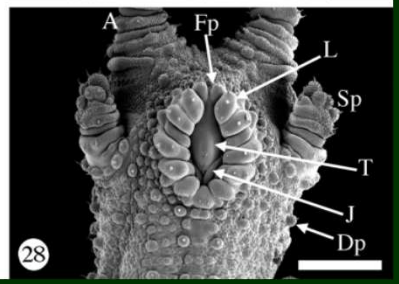

A
Sp
J
L
25


Fp
T
L
J
Sp
A
W1
W2
27


M
Cl
P
*
Y
St
Et
23

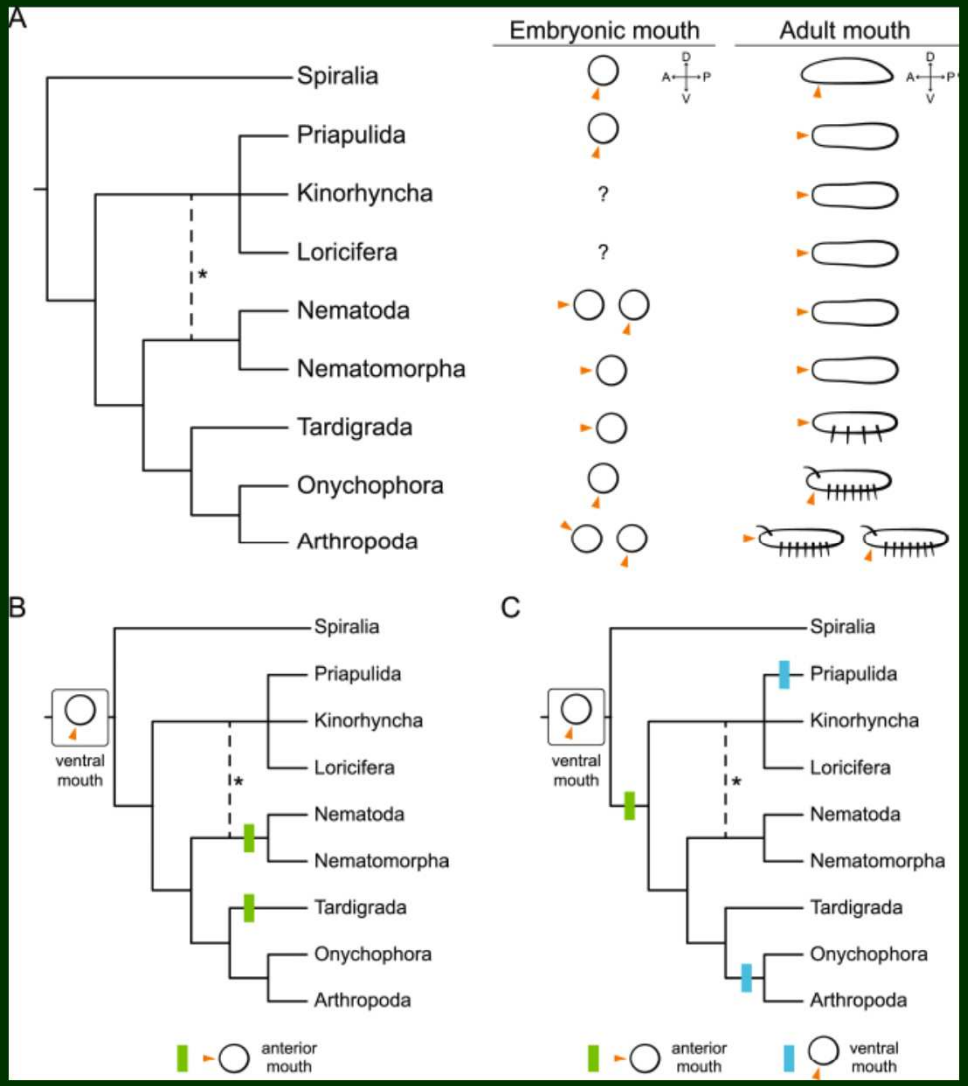

Fp
T
St
L
A
J
Sp
24


A
Fp
Vo
Sp
J
J
T
26


A
Fp
L
Sp
T
J
Dp
28

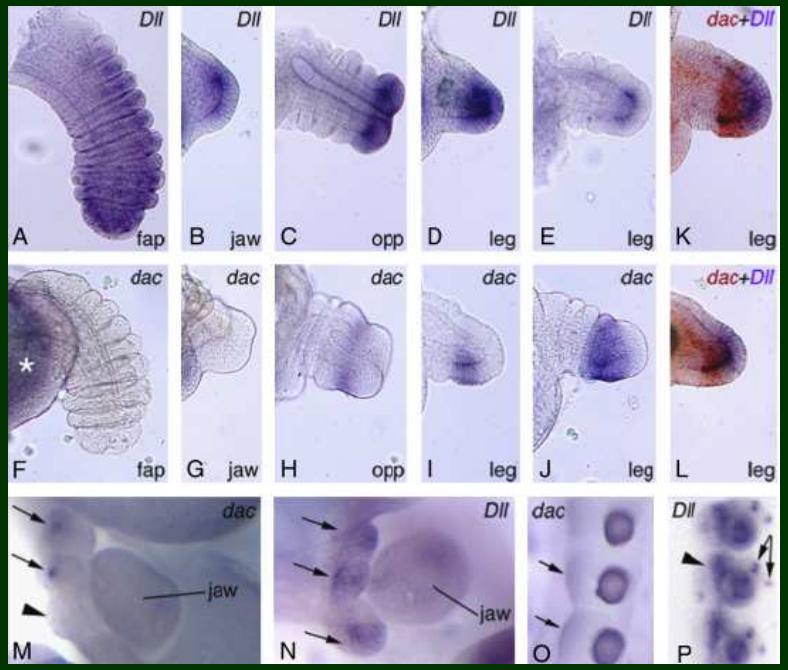
Ecdysozoa

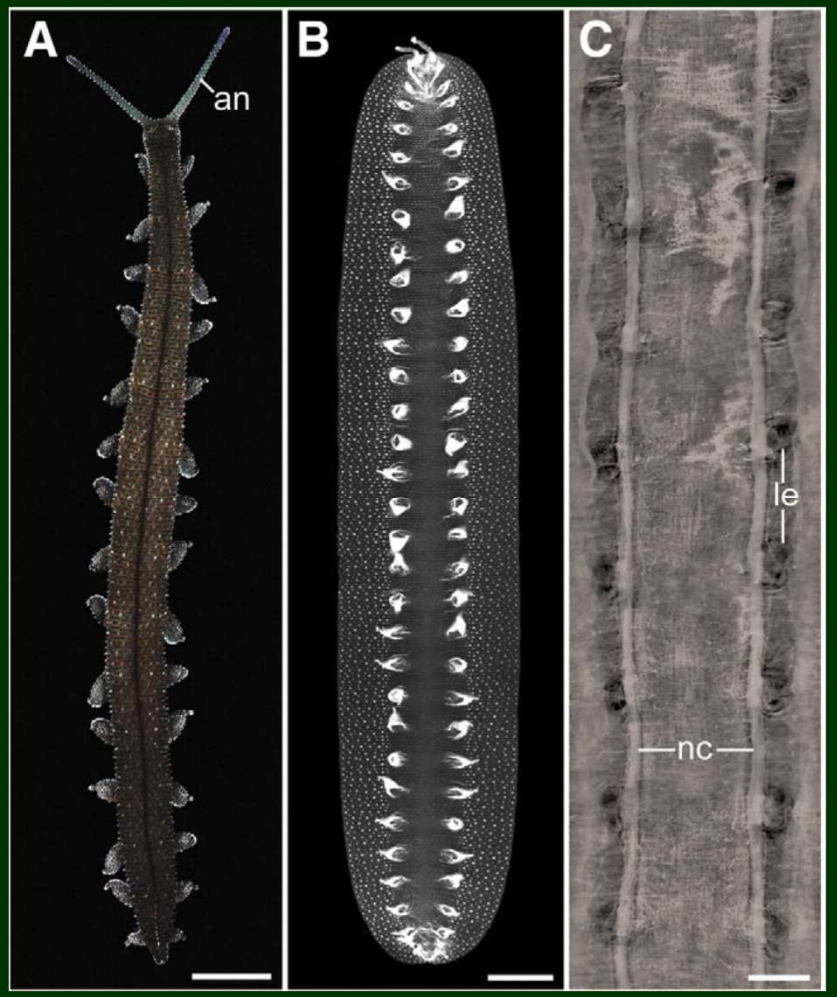
- původně ventrální ústa
- (apikální u většiny dospělců kromě drápkovců a většiny členovců)



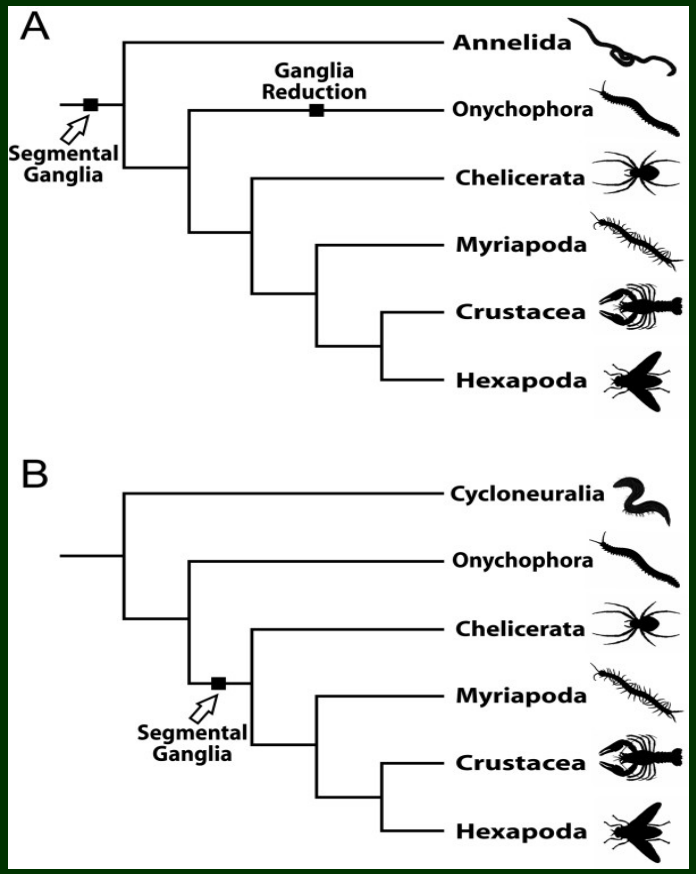
Onychophora

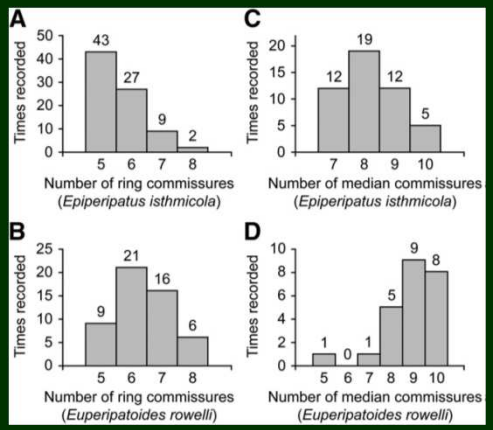
- žádná segmentace není navenek patrná
- regionalizace končetin předchází segmentaci

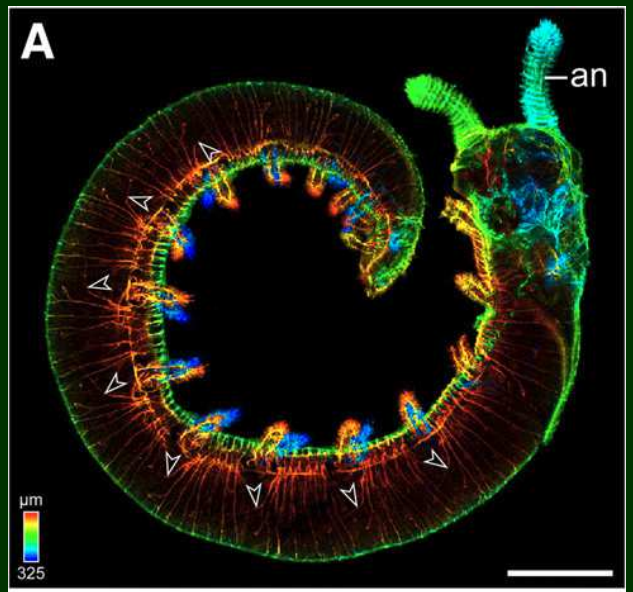


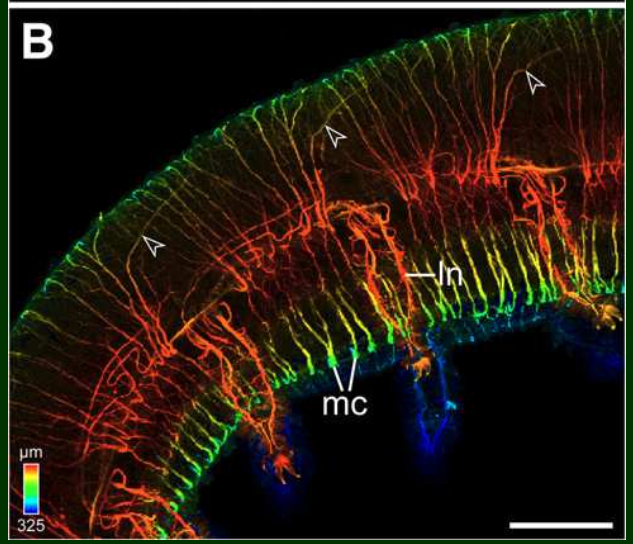


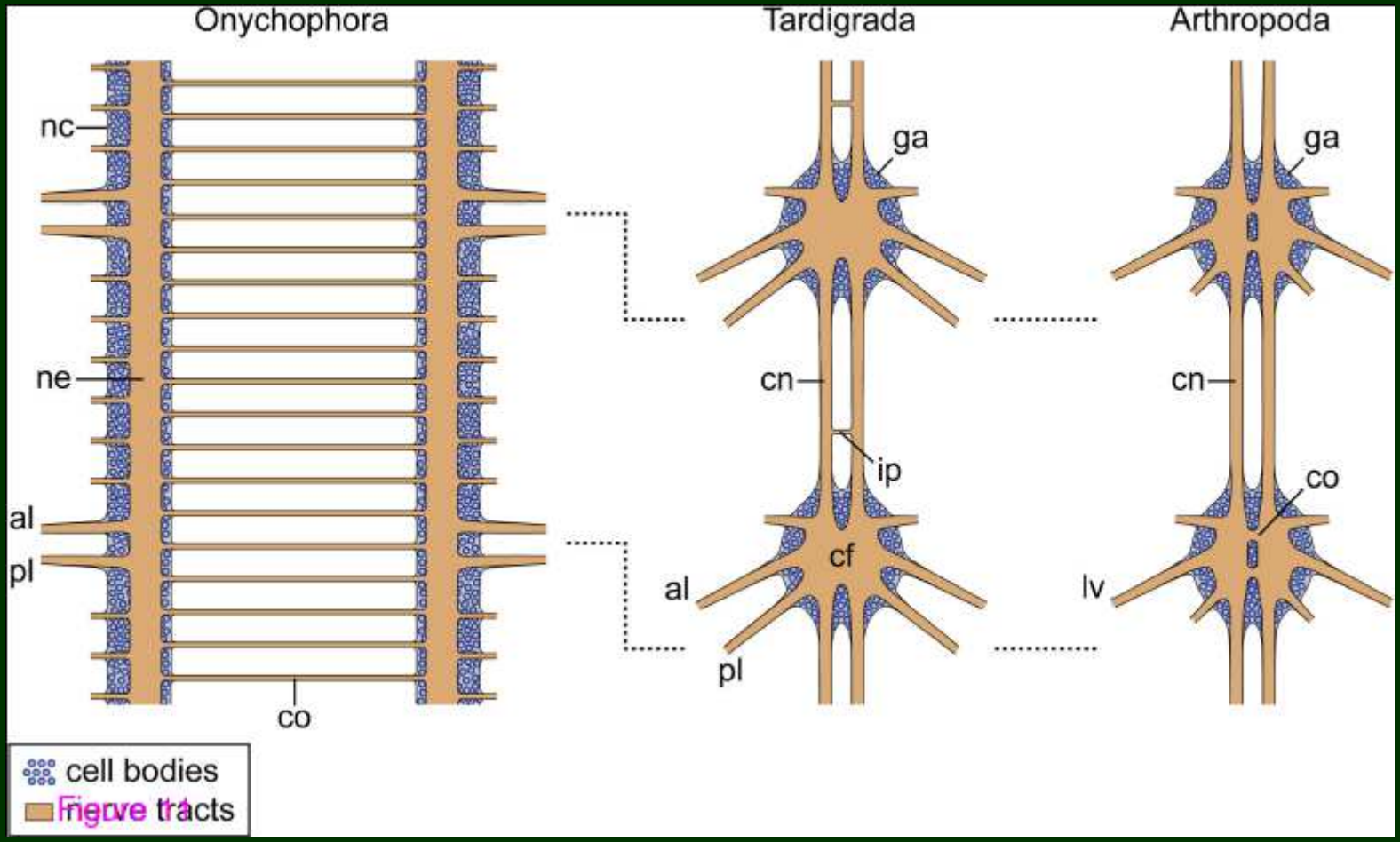
Metamerismus nervové soustavy drápkovců?





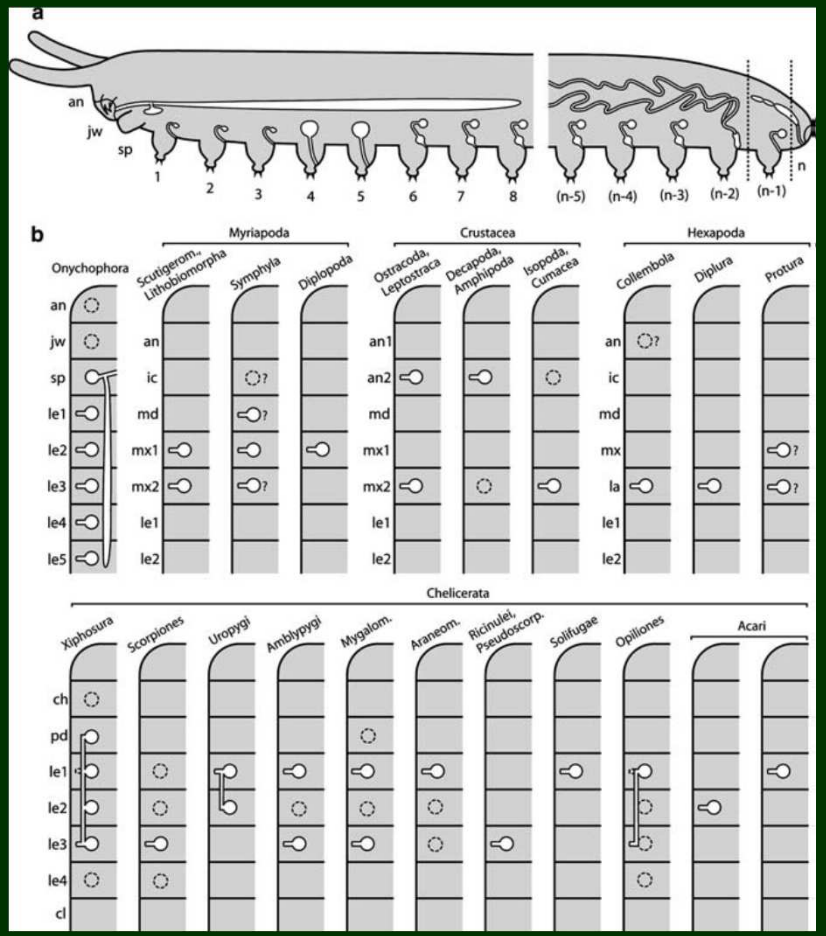





Onychophora
Tardigrada
Arthropoda
nc
ne
al
pl
co
ga
cn
ip
cf
al
pl
ga
cn
co
lv
cell bodies
nerve tracts
Figure 11

Segmentace drápkovců

- 1. kutikula: NE
- 2. nervová soustava: NE
- 3. svaly: NE
- 4. célom a nefridia: ANO
- 5. segmentační geny: v mezodermu ANO, v ektodermu ANO??? (nezávislé na segmentaci???)
- 6. končetiny: ANO



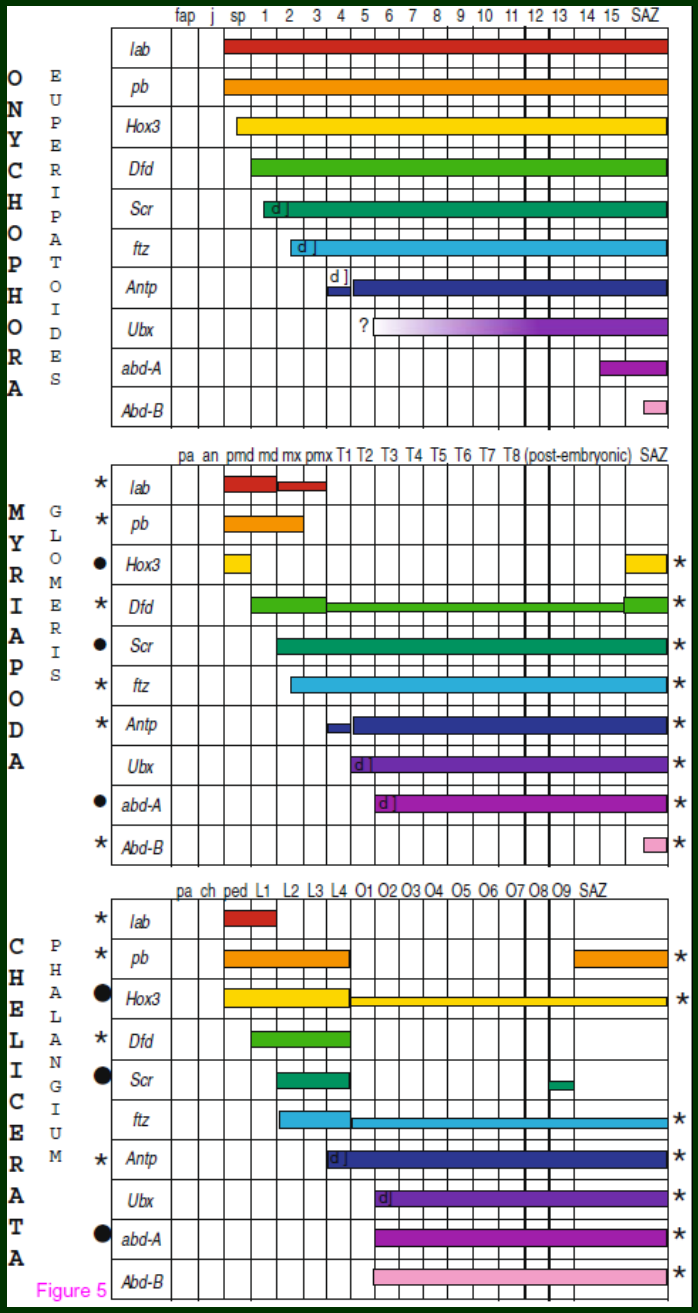


Figure 5

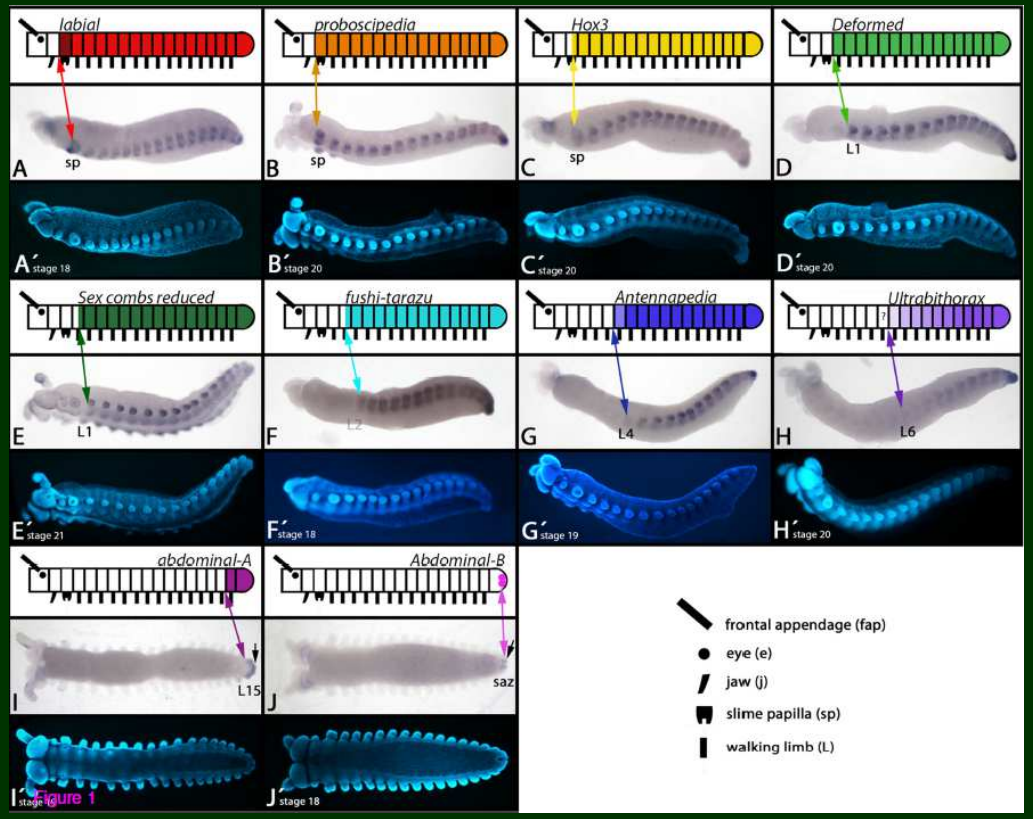
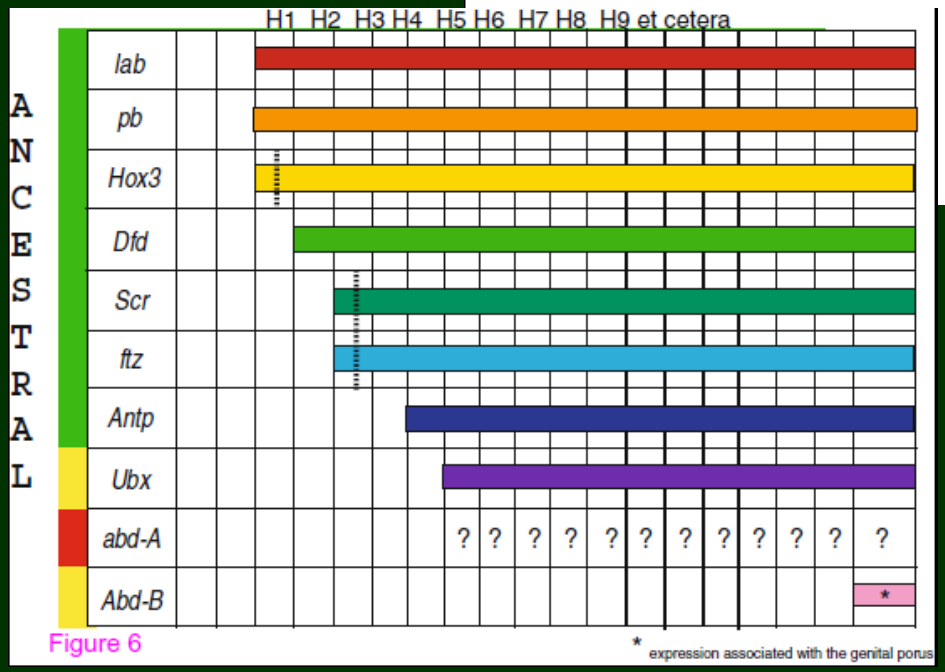


Figure 1


H1 H2 H3 H4 H5 H6 H7 H8 H9 et cetera
ANCESTRAL
lab
pb
Hox3
Dfd
Scr
ftz
Antp
Ubx
abd-A
Abd-B
? ? ? ? ? ? ? ? ? ? ?
*
* expression associated with the genital porus

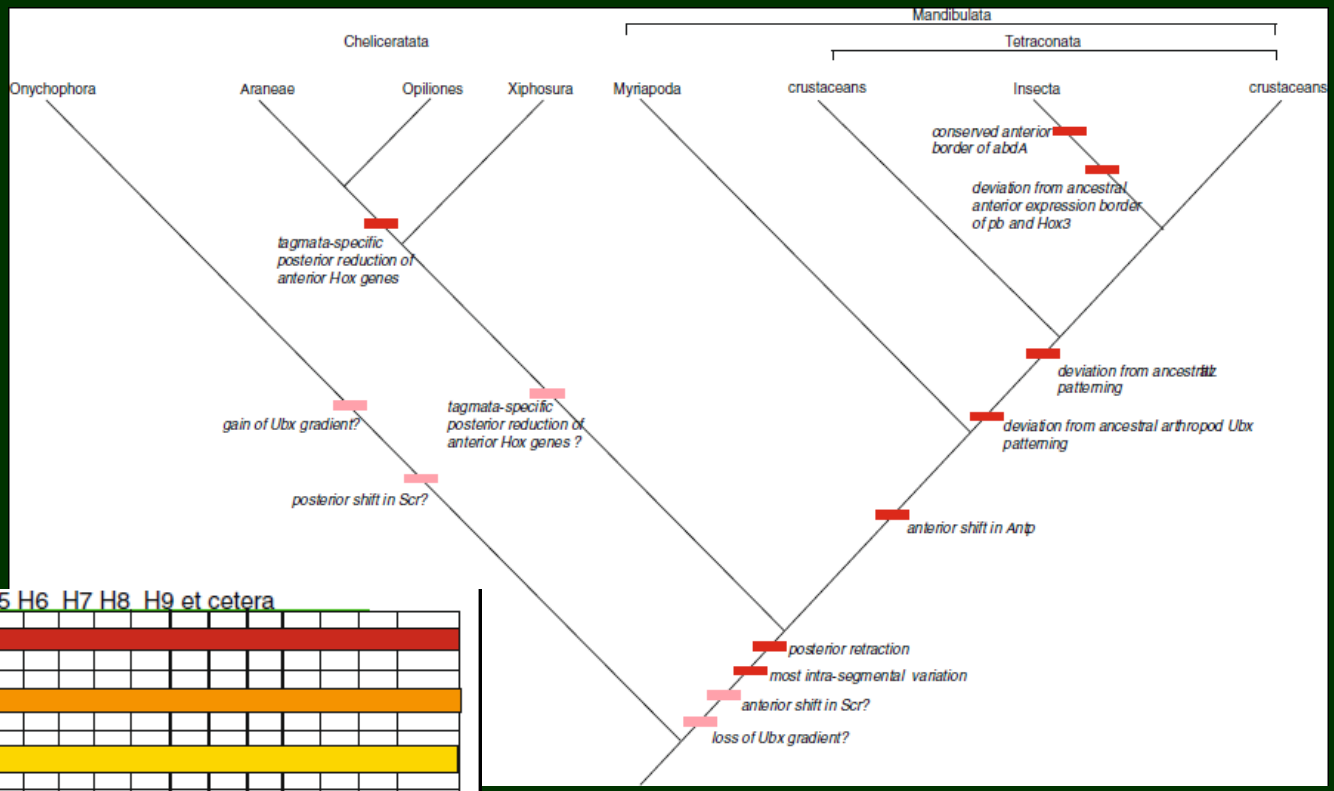
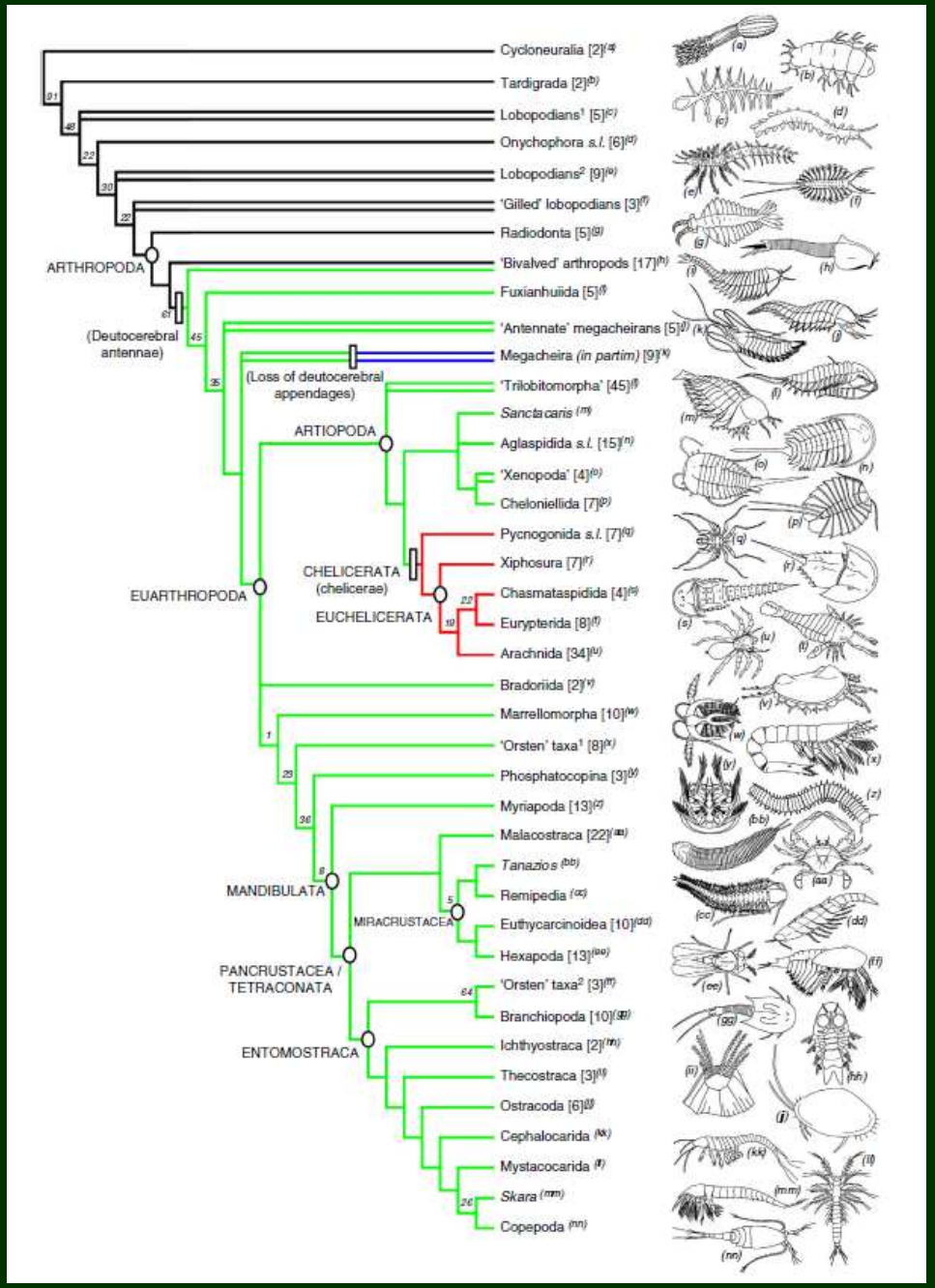

Mandibulata
Chelicerata
Tetraconata
Onychophora
Araneae
Opiliones
Xiphosura
Myriapoda
crustaceans
Insecta
crustaceans
conserved anterior border of abdA
deviation from ancestral anterior expression border of pb and Hox3
tagmata-specific posterior reduction of anterior Hox genes
deviation from ancestral ftz patterning
gain of Ubx gradient?
tagmata-specific posterior reduction of anterior Hox genes ?
deviation from ancestral arthropod Ubx patterning
posterior shift in Scr?
anterior shift in Antp
posterior retraction
most intra-segmental variation
anterior shift in Scr?
loss of Ubx gradient?

Figure 6

Panarthropoda



Artropodizace

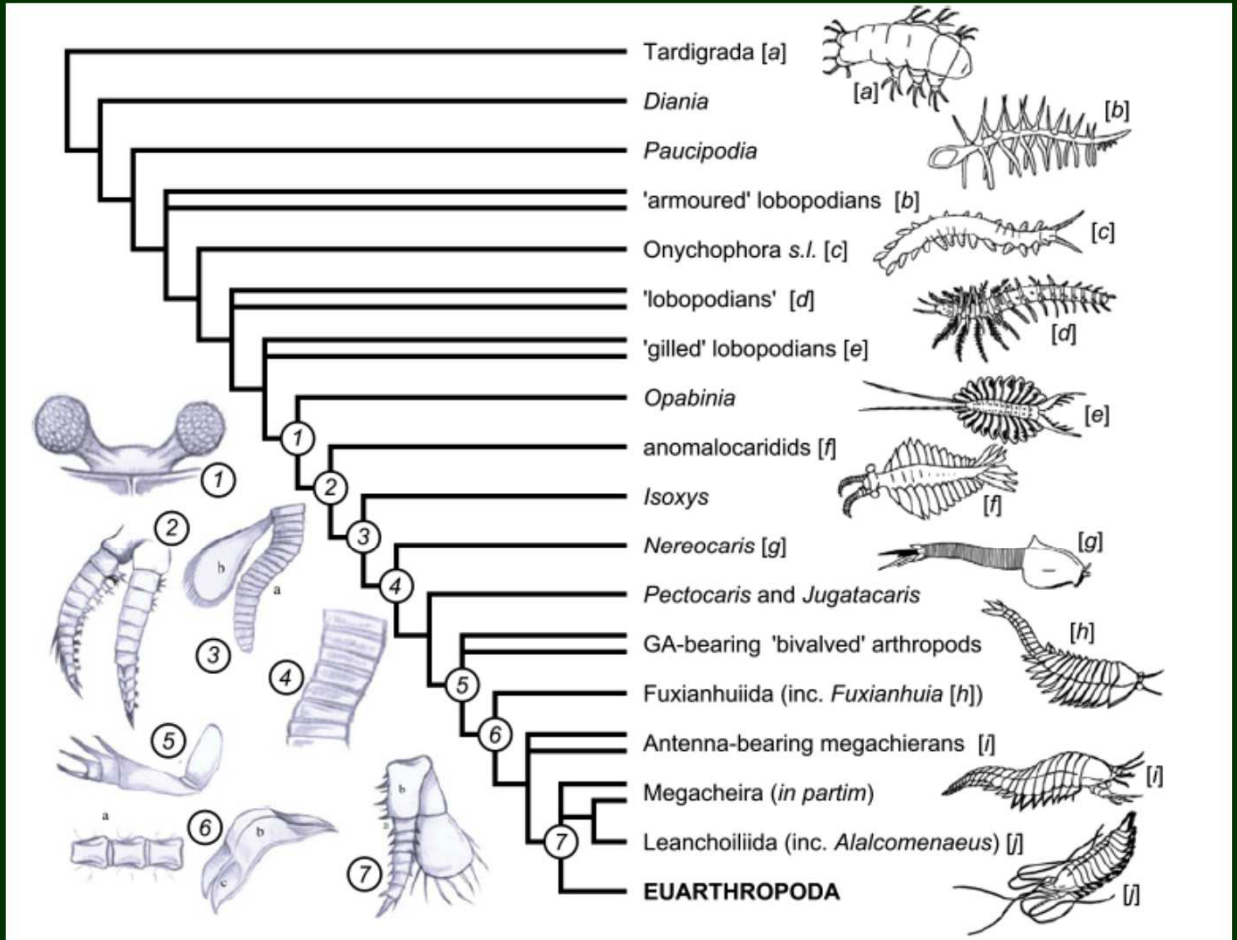
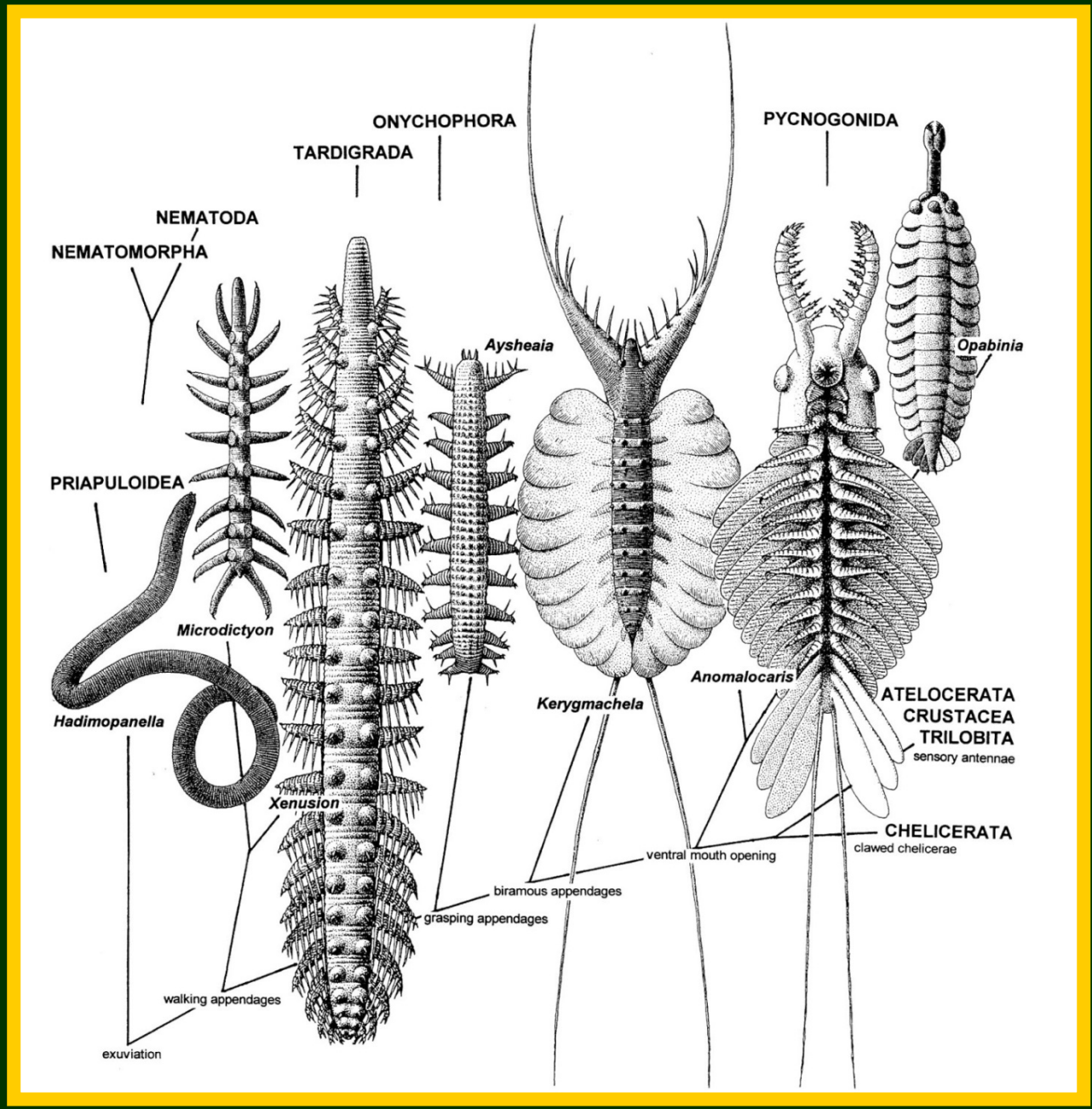
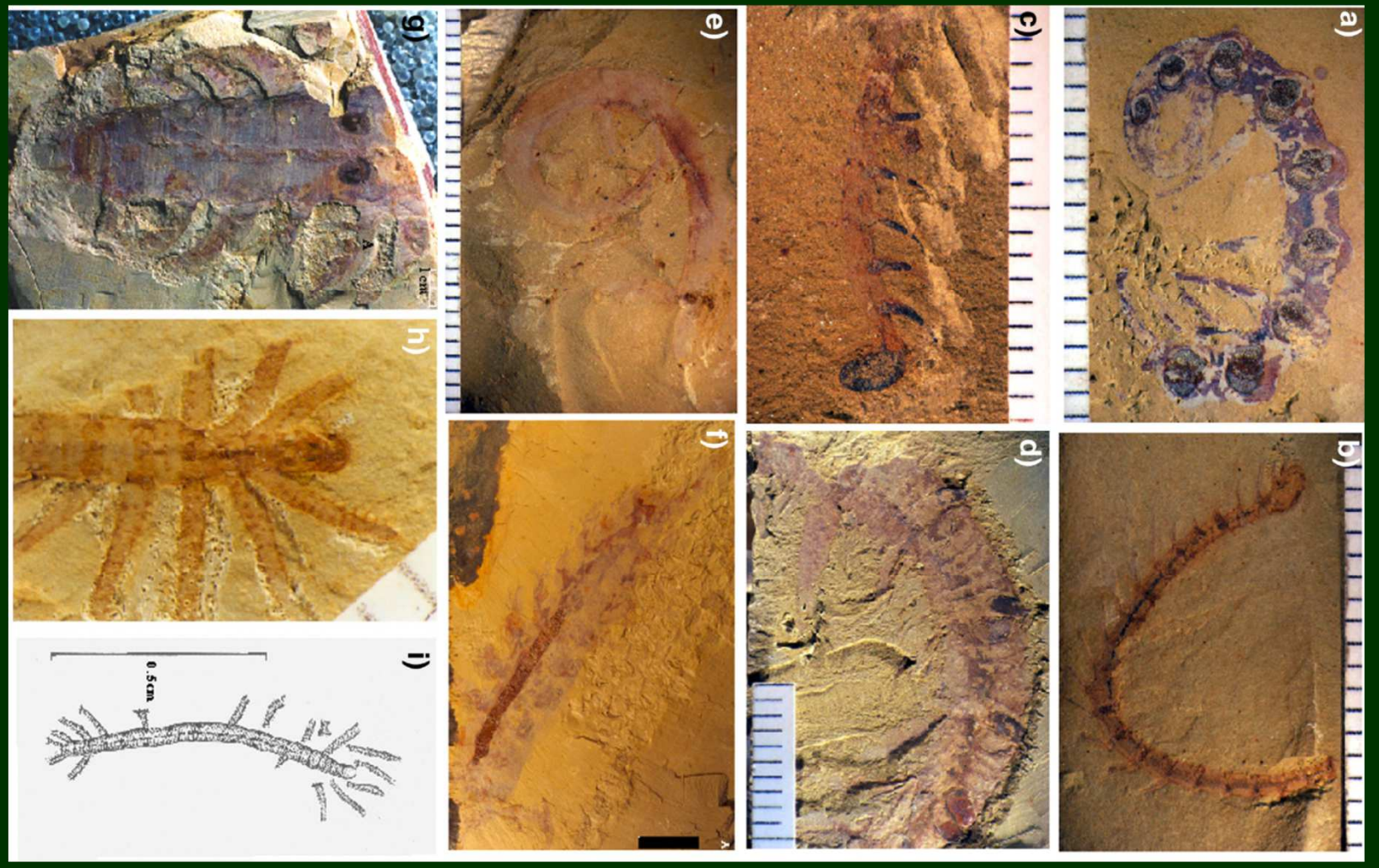


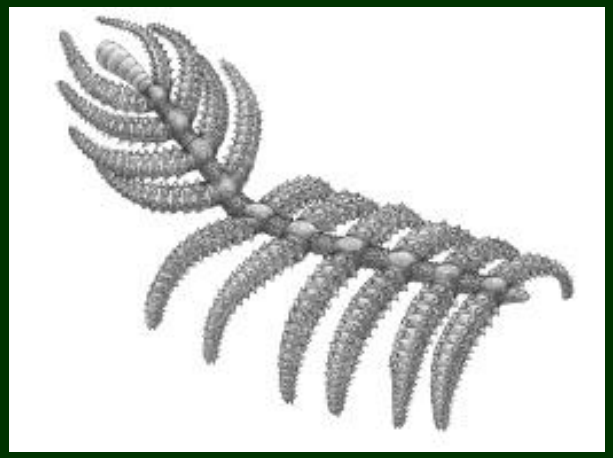
FIG. 4. The successive acquisition of key arthropod characteristics in the euarthropod stem lineage (based on Legg *et al*. 2012, 2013). Numbers indicate key innovations in the euarthropod stem lineage: (1) compound eyes; (2) arthropodized cephalic limbs; (3) arthropodized trunk limbs with an endopod (a) and exopod (b); (4) arthrodization; (5) specialized cephalic appendages; (6) differentiation of tergal exoskeleton into ventral sternites (a) and dorsal tergites (b) with paratergal folds (c); and (7) reduction in the number of endopod podomeres (a) associated with the acquisition of a gnathobasic basipodite (b).

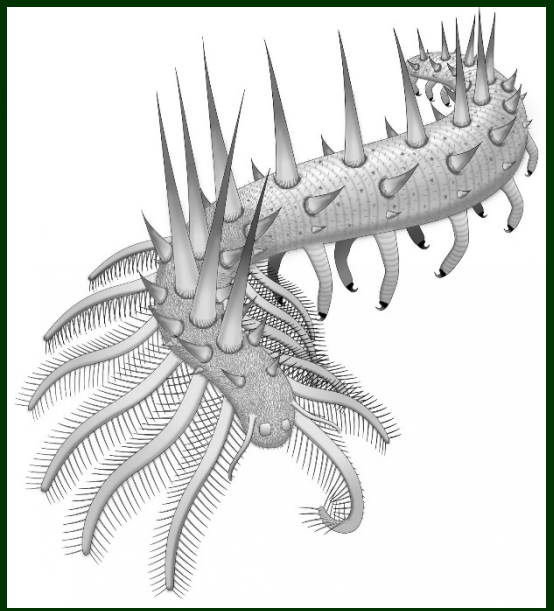

ONYCHOPHORA
TARDIGRADA
PYCNOGONIDA
NEMATODA
NEMATOMORPHA
Aysheaia
Opabinia
PRIAPULOIDEA
Microdictyon
Anomalocaris
Kerygmachela
ATELOCERATA
CRUSTACEA
TRILOBITA
sensory antennae
Hadimopanella
Xenusion
CHELICERATA
clawed chelicerae
ventral mouth opening
biramous appendages
grasping appendages
walking appendages
exuviation

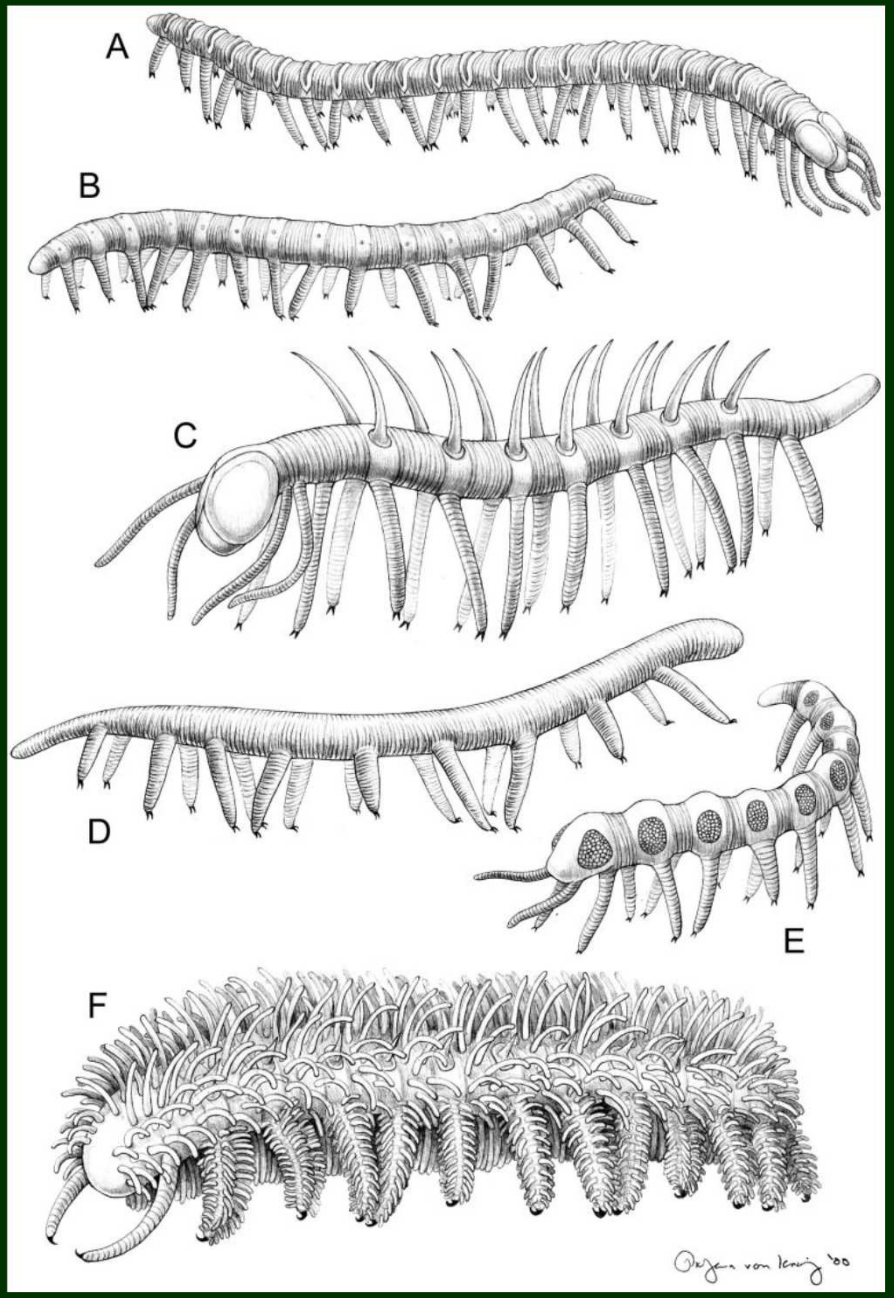
„Lobopodia“



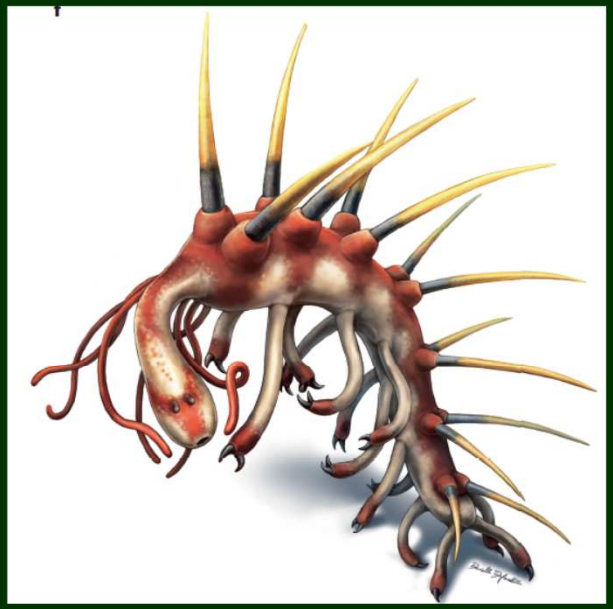
„Lobopodia“

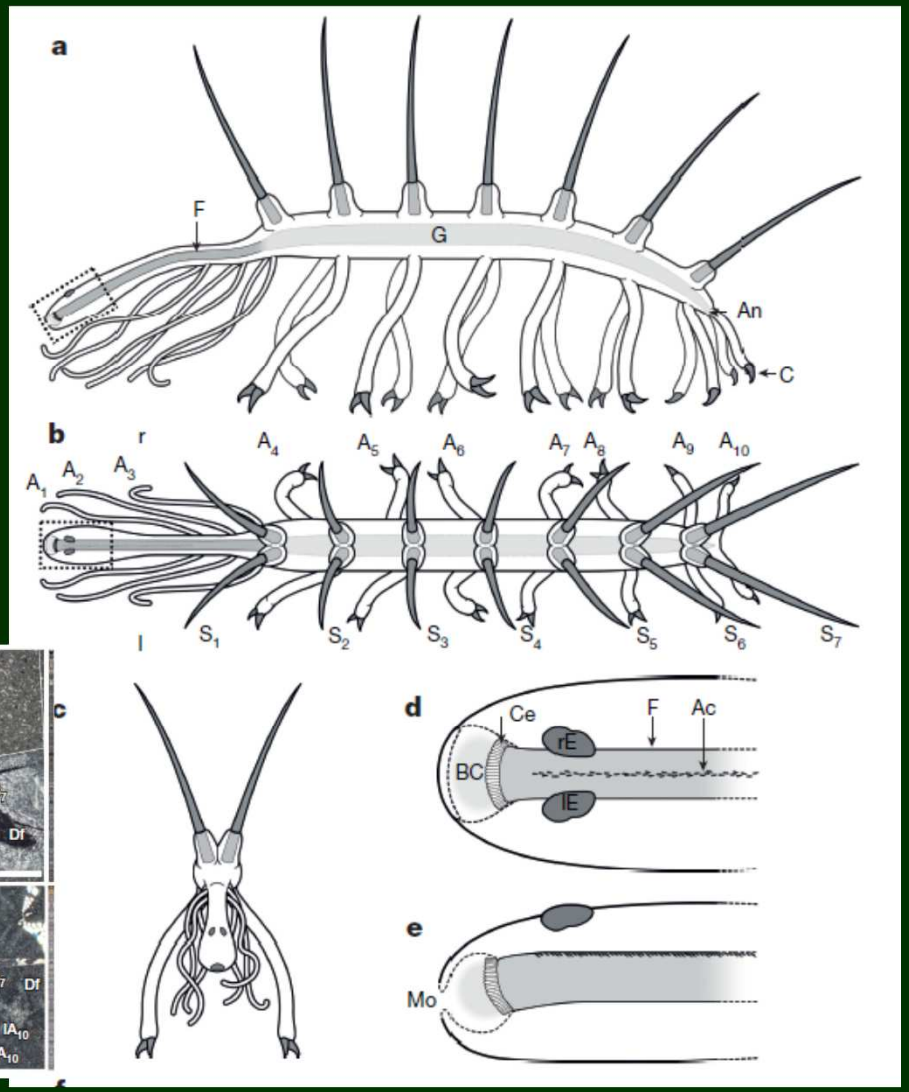


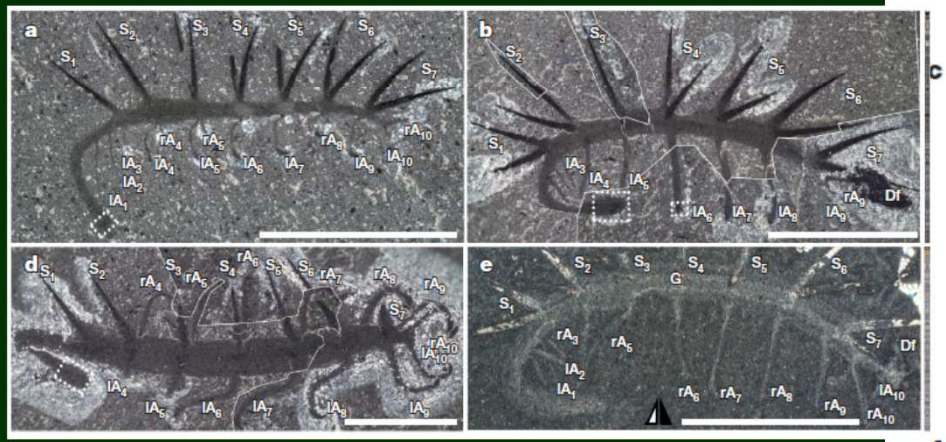




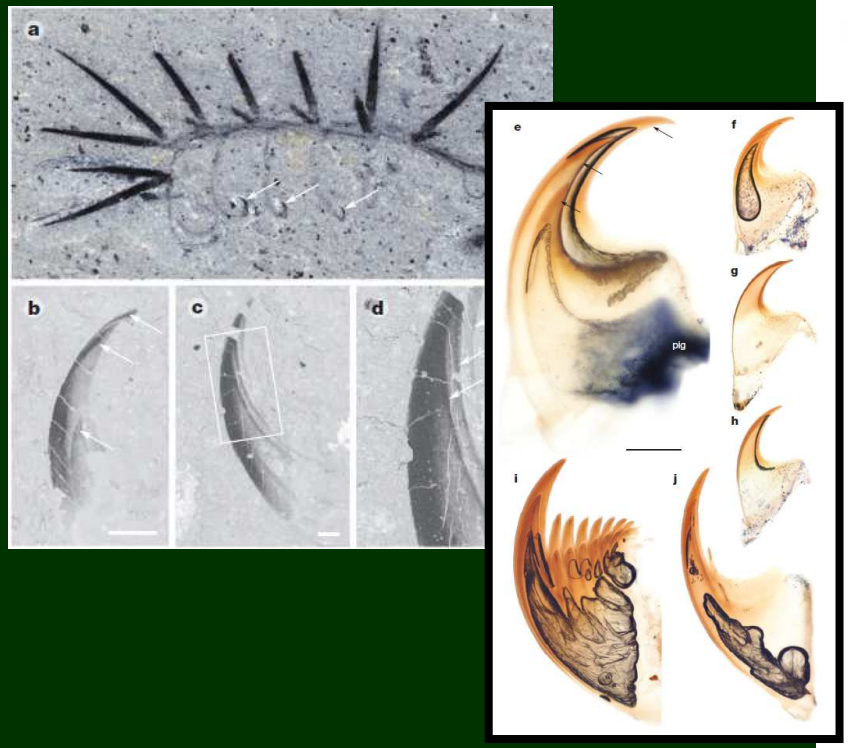
Hallucigenia

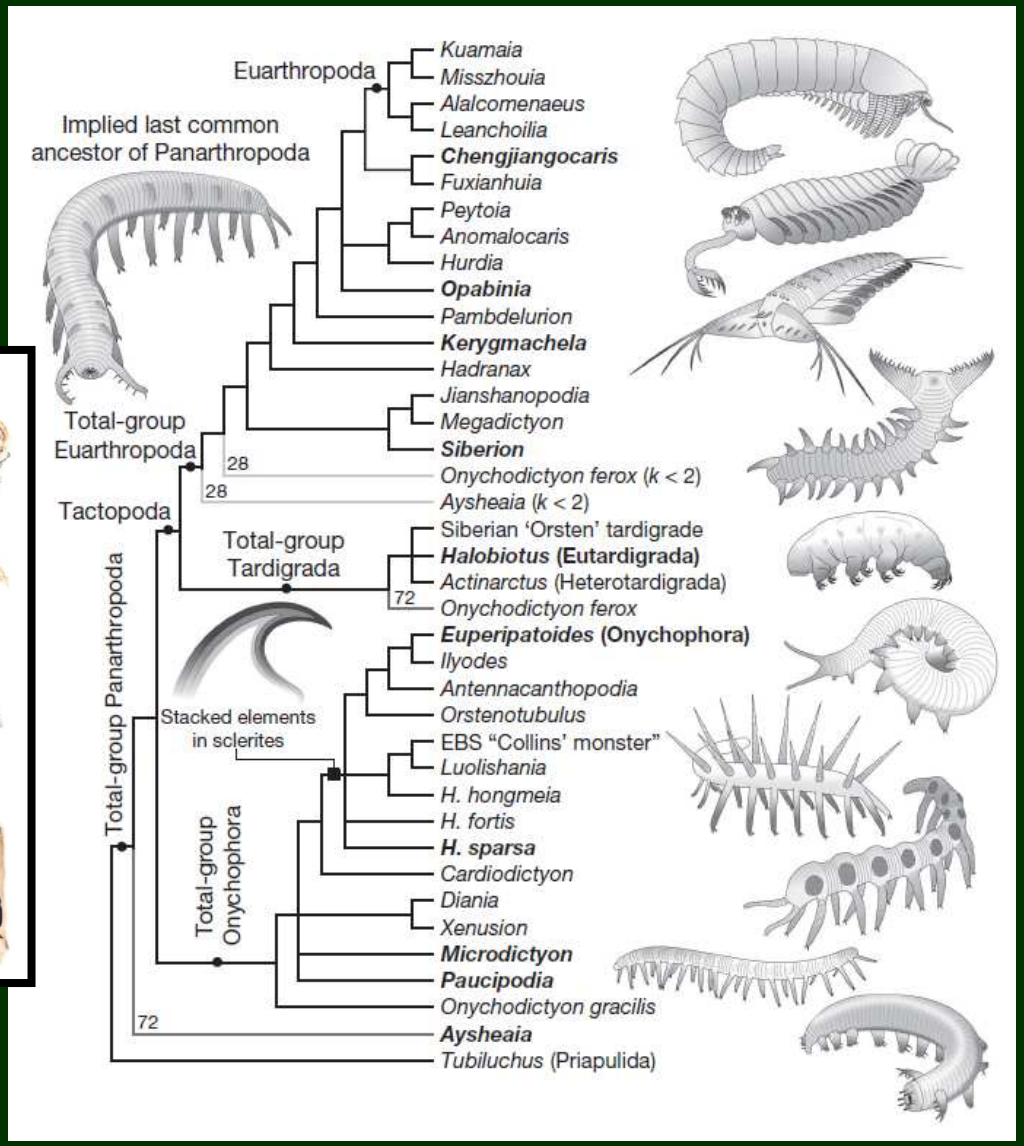






Panarthropoda

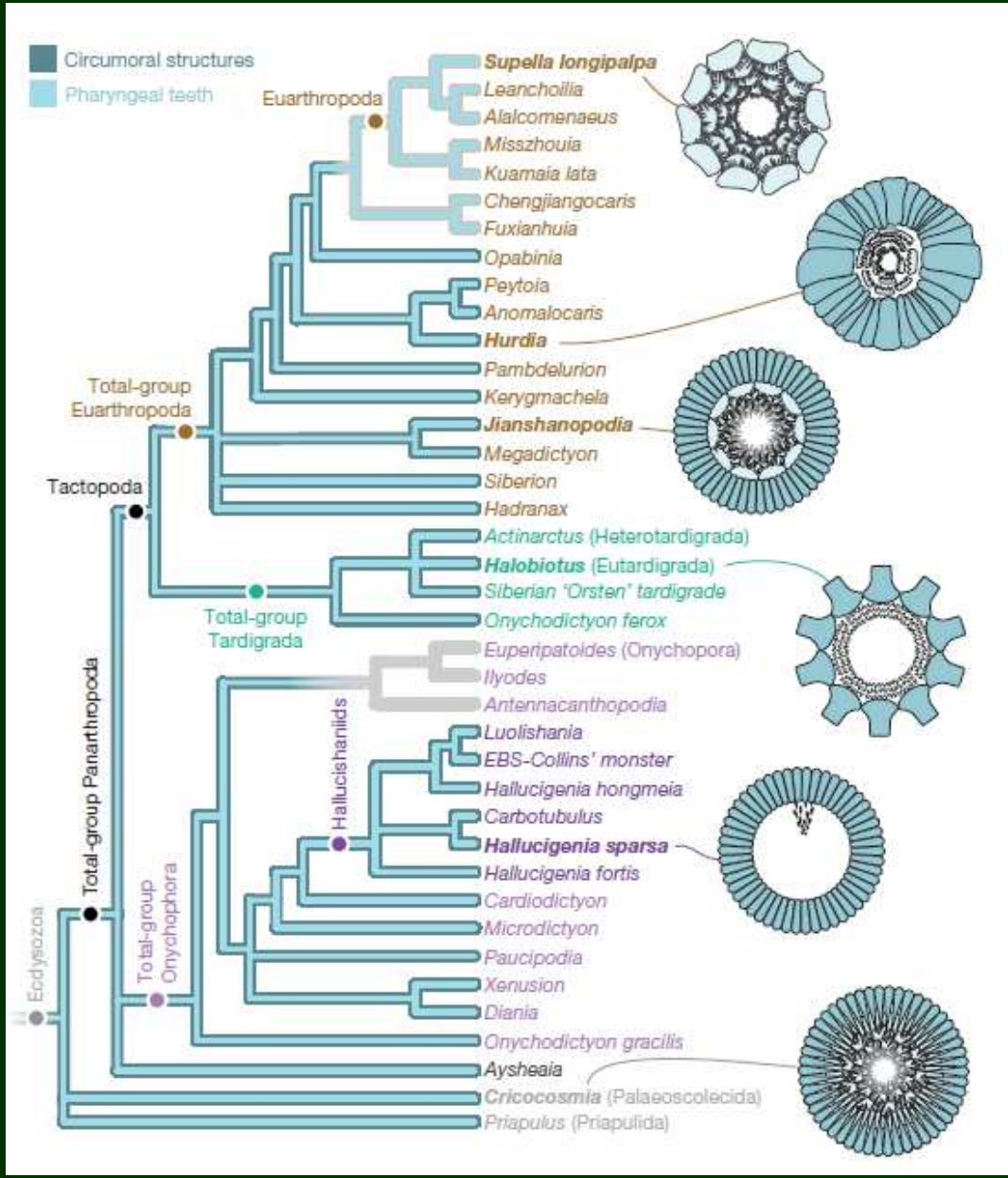


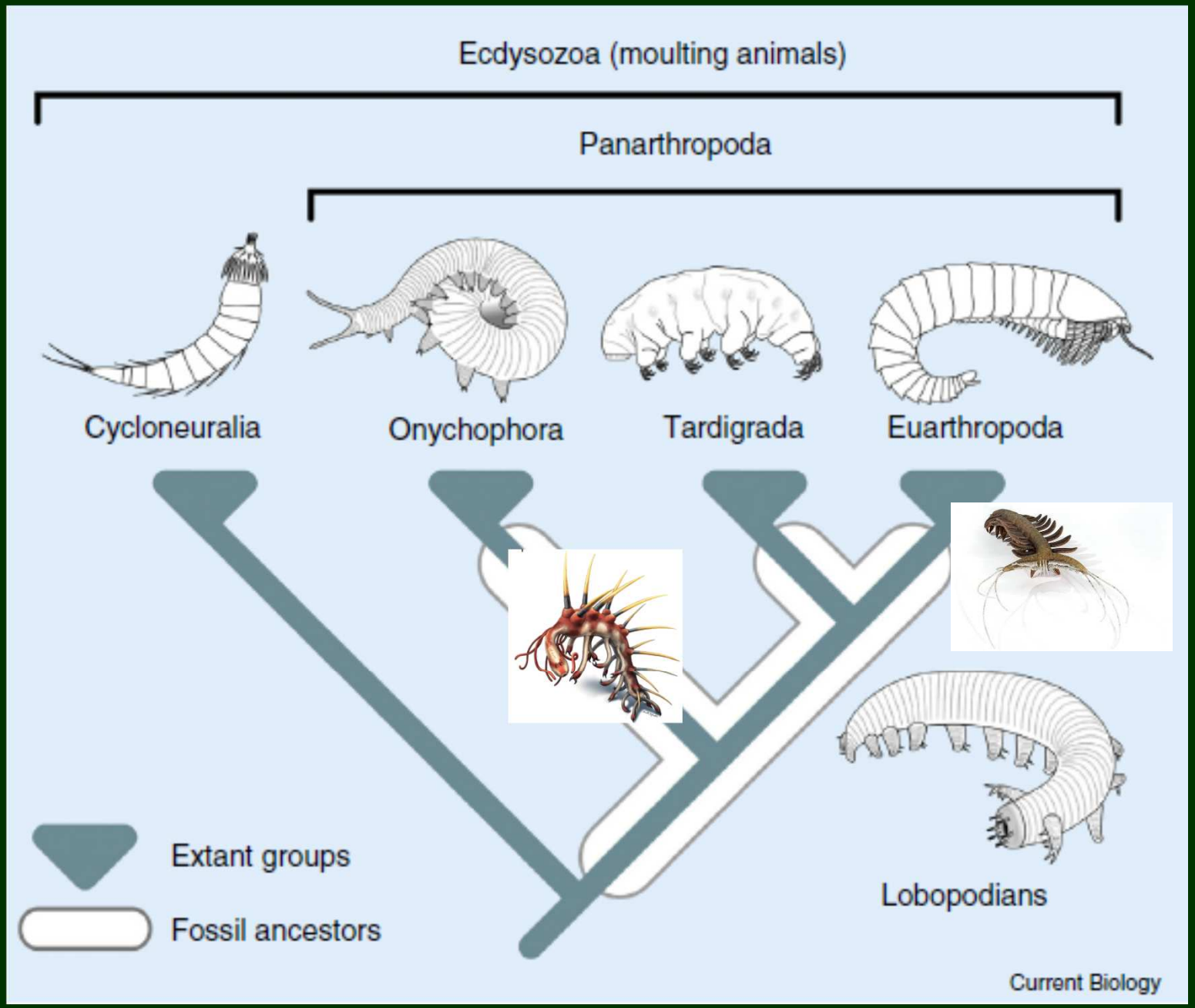


- *Hallucigenia* + *Euperipatoides*: drápky z několika elementů (x Tardigrada, Euarthropoda)

Lobopodia a Onychophora

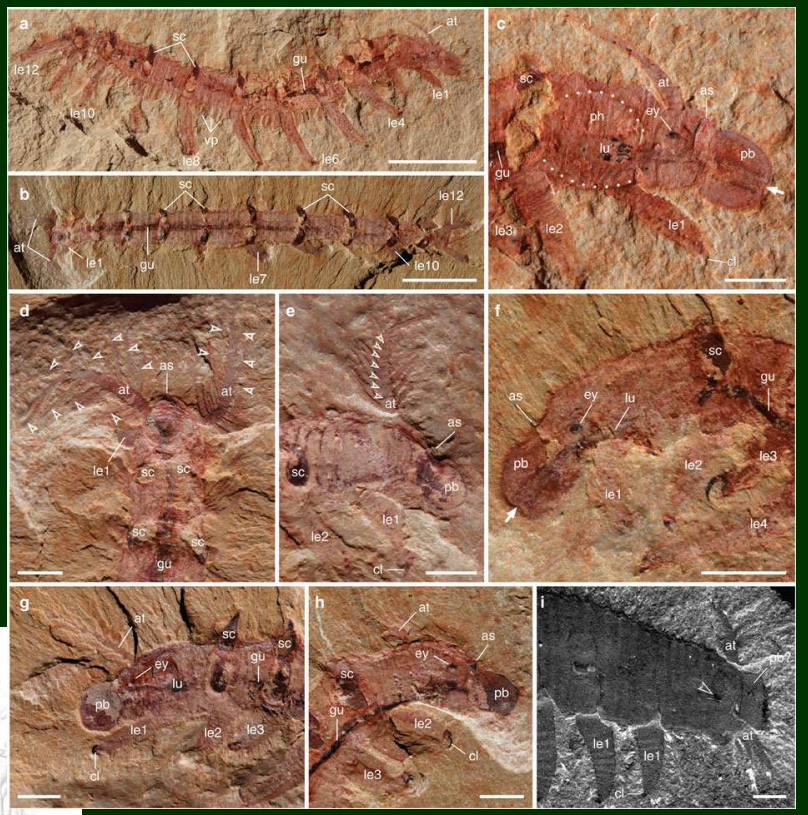
- homologie hltanu a cirkumorálních struktur všech ekdysozoí
- redukce u moderních drápkovců

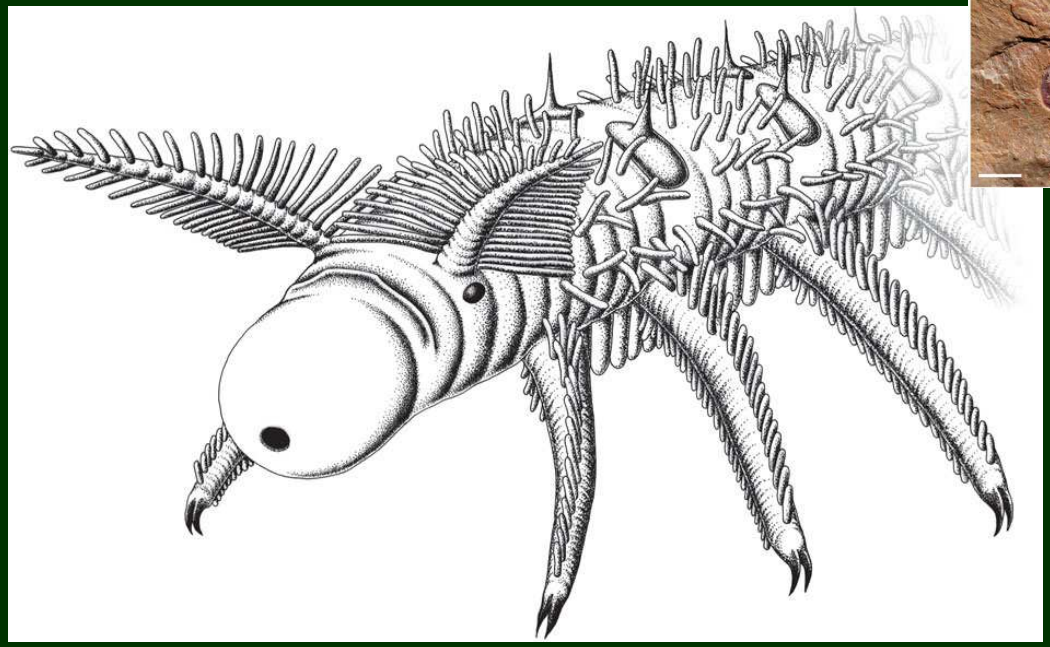



Ecdysozoa (moulting animals)
Panarthropoda
Cycloneuralia
Onychophora
Tardigrada
Euarthropoda
Lobopodians
Extant groups
Fossil ancestors
Current Biology

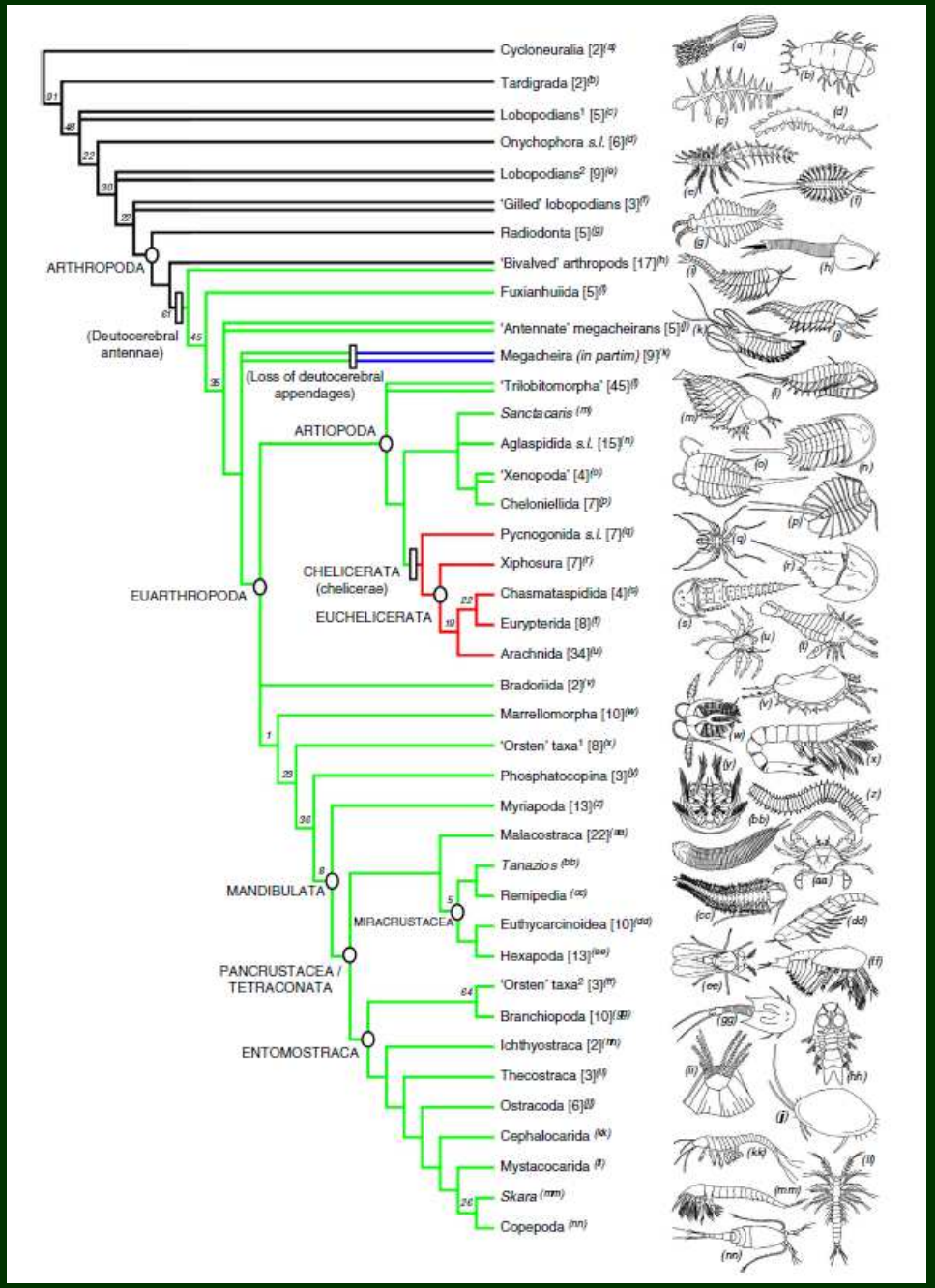
Onychodictyon

sesterská skupina
želvušek???

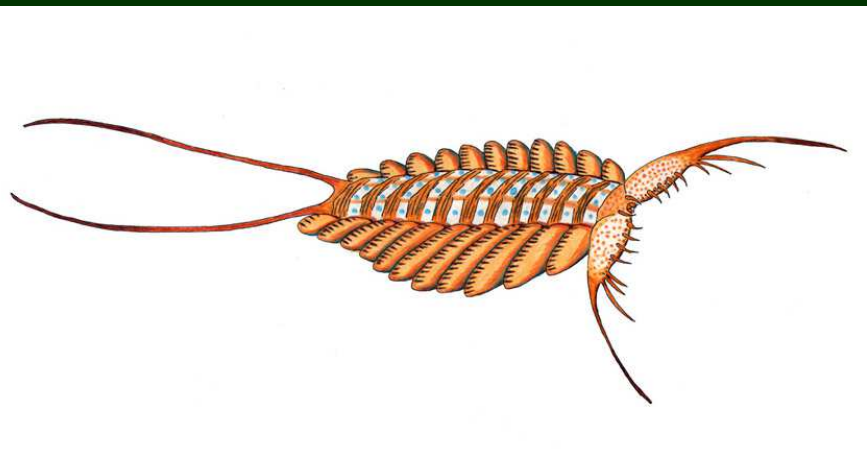




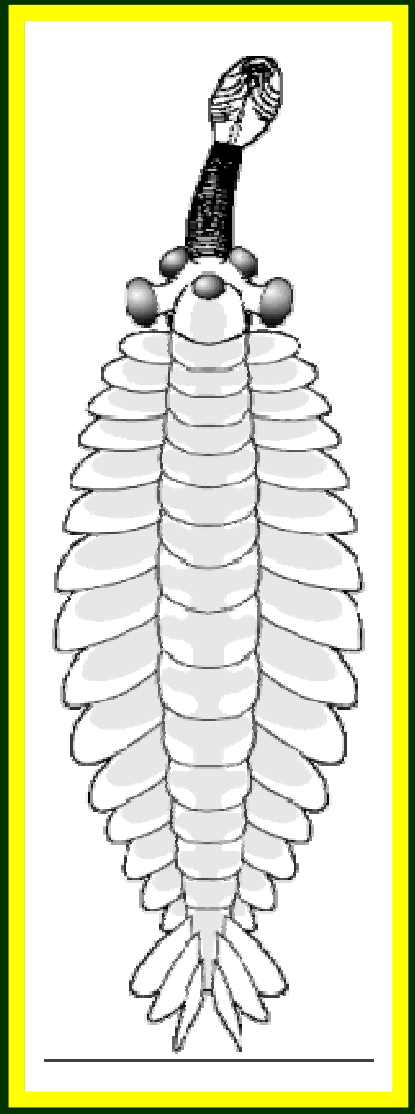
Panarthropoda

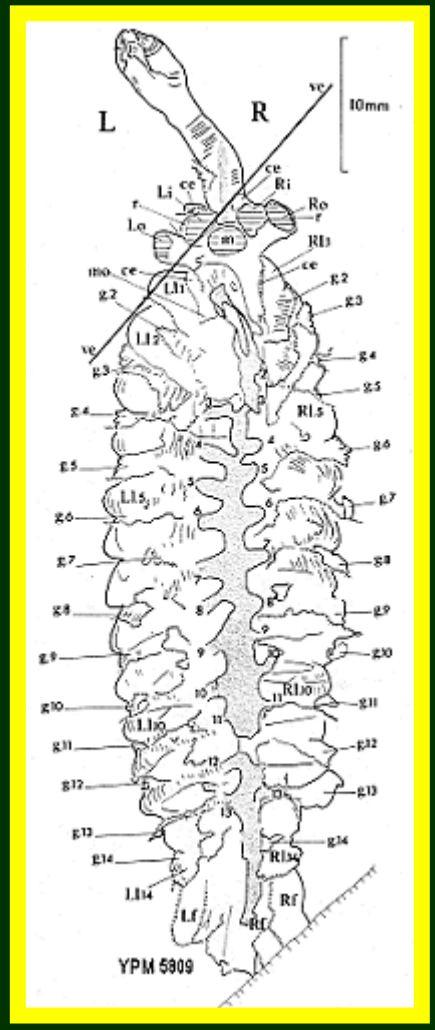


Kerygmachela

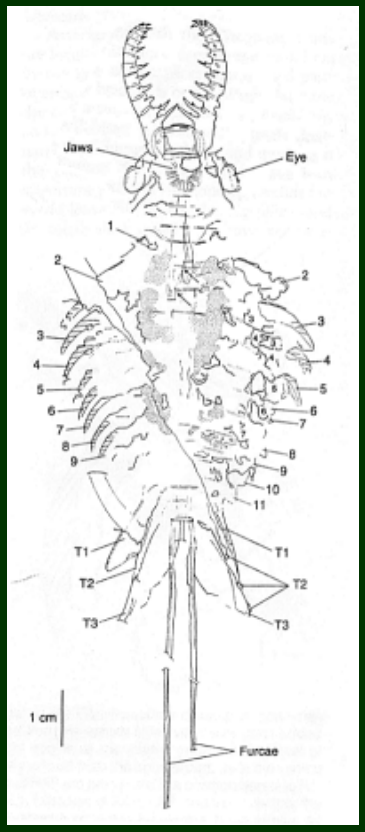


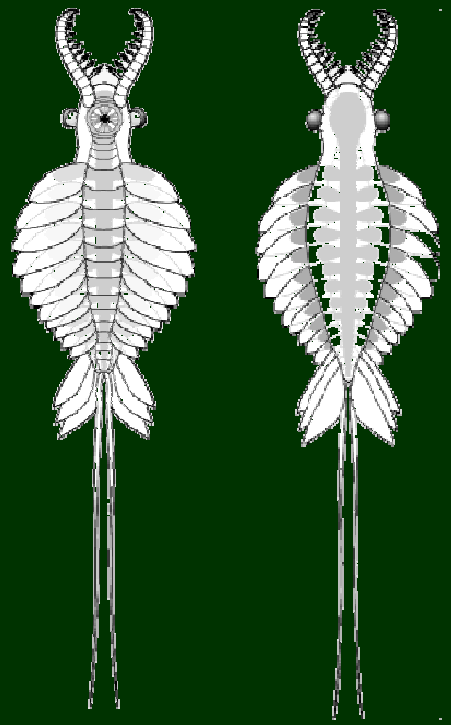
Rhinochelata (*Opabinia*)



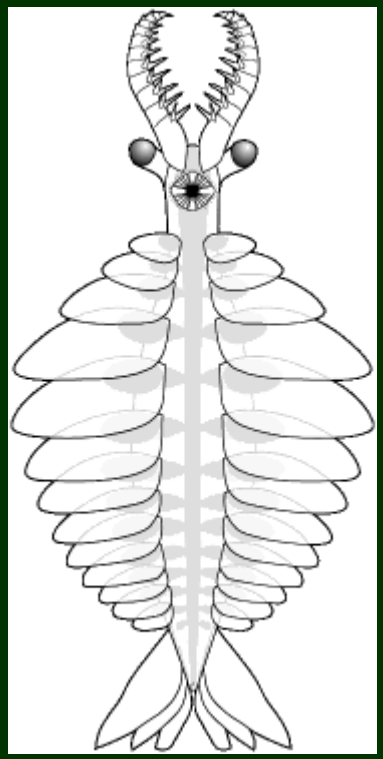


Radiodonta
Anomalocaris

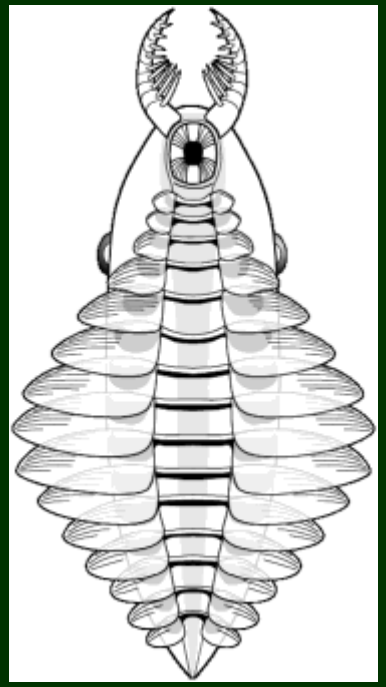




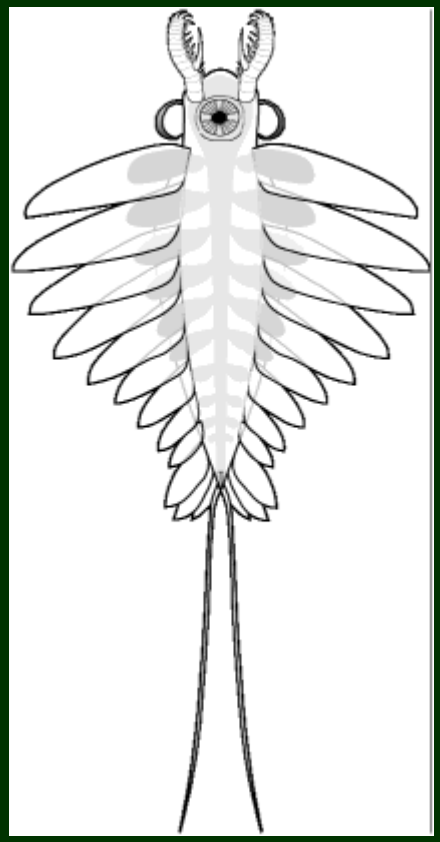
Radiodonta



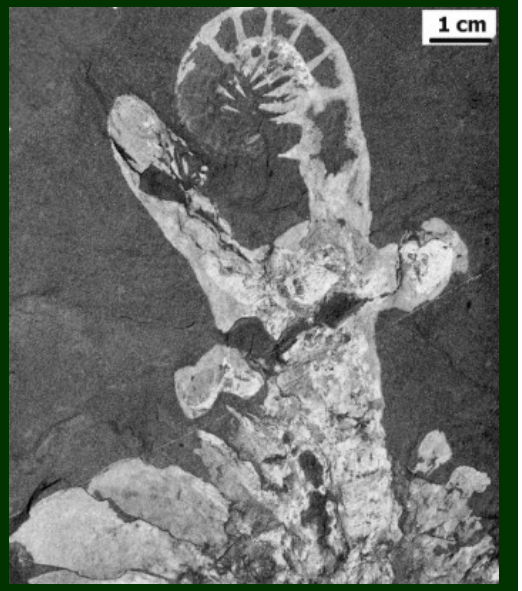
Anomalocaris

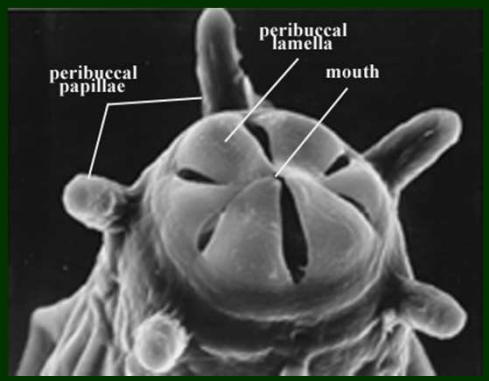


Laggania



Amplectobelua



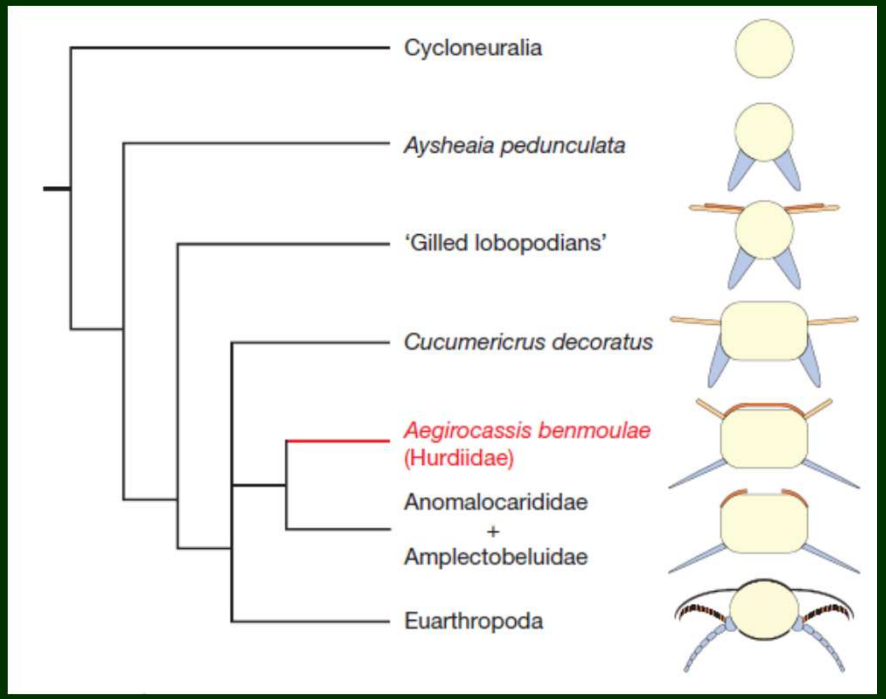


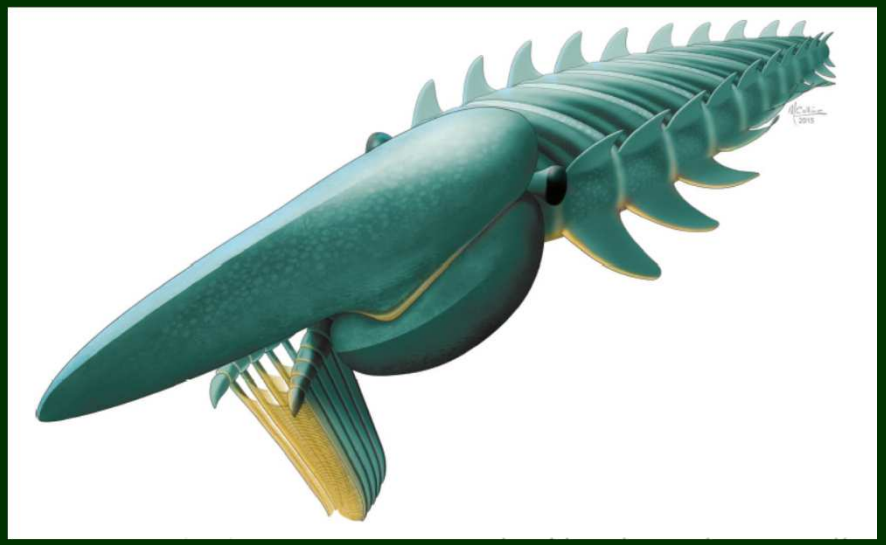
Tamisiocaris

- „velrybovitý“ planktonofág
- kambrium

Aegirocassis

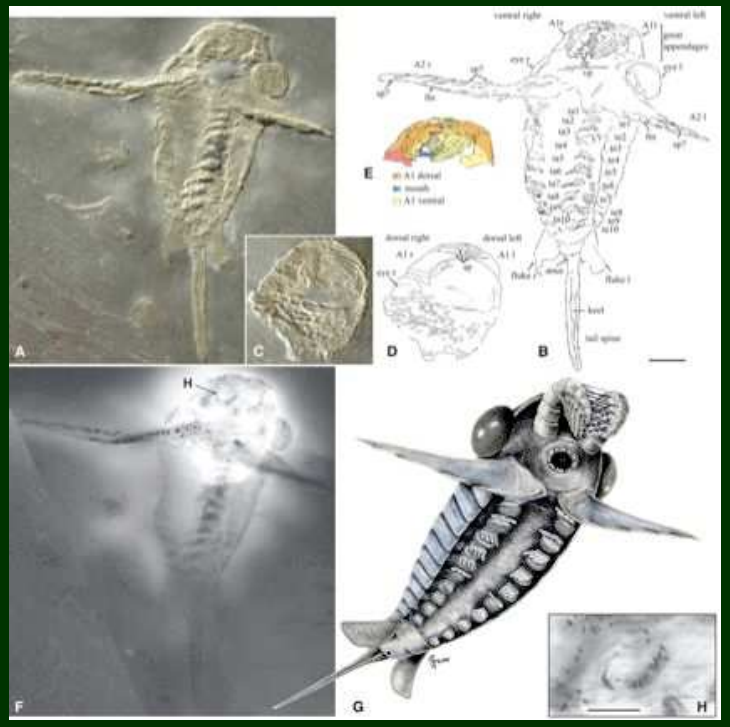
- ordovik (Maroko)
- až 2 m
- gigantičtí filtrátoři uvnitř dravých skupin (~ druhohorní pachycormidní ryby, třetihorní žraloci a kytovci)

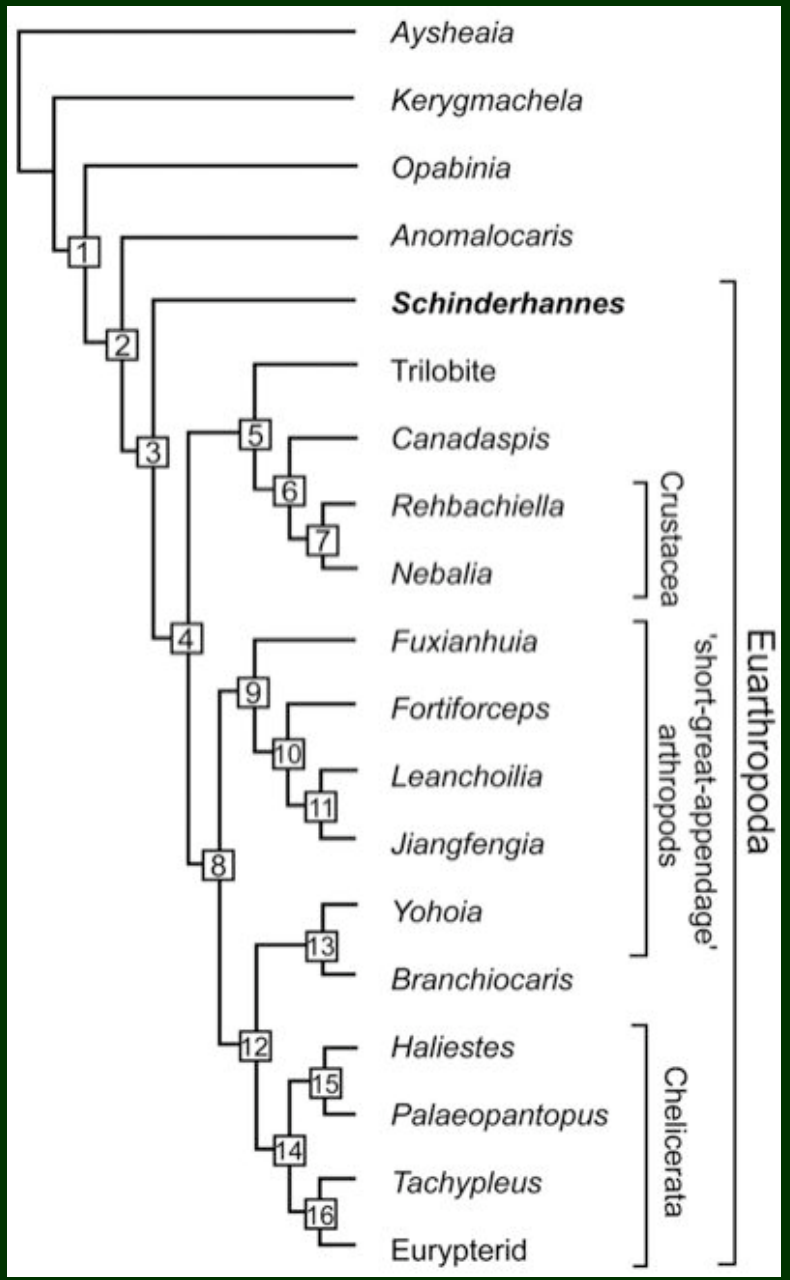




Schinderhannes

- *devonský* potomek radiodont – kombinuje radiodontní morfologii s dorsální sklerotizací a dvojvětevnými končetinami





Schinderhannes

- konflikt znaků – parafylie radiodont, nebo nezávislý vznik dvojvětevných končetin a dorsální arthrodizace?

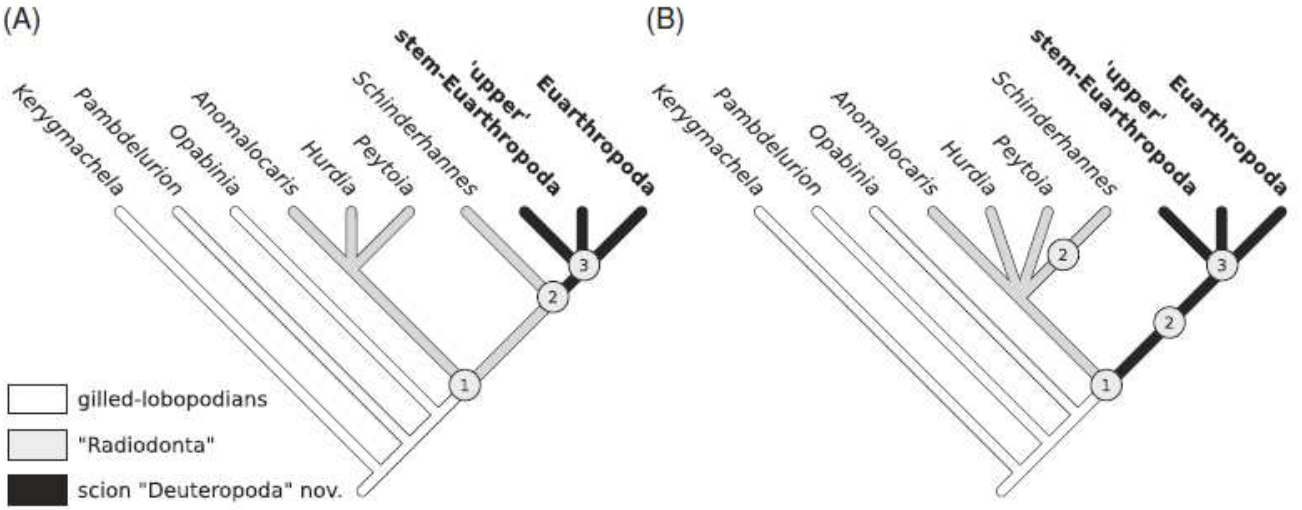
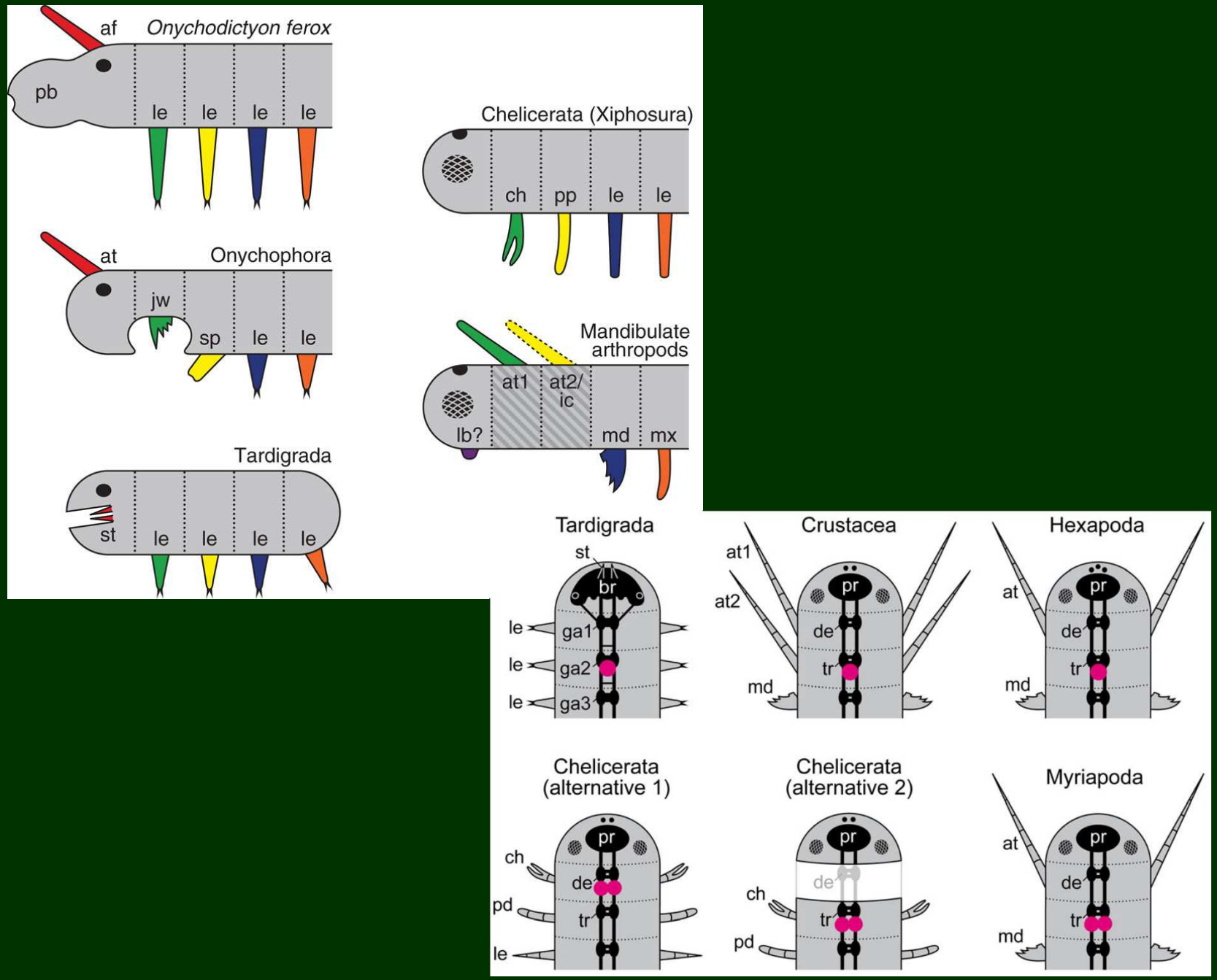
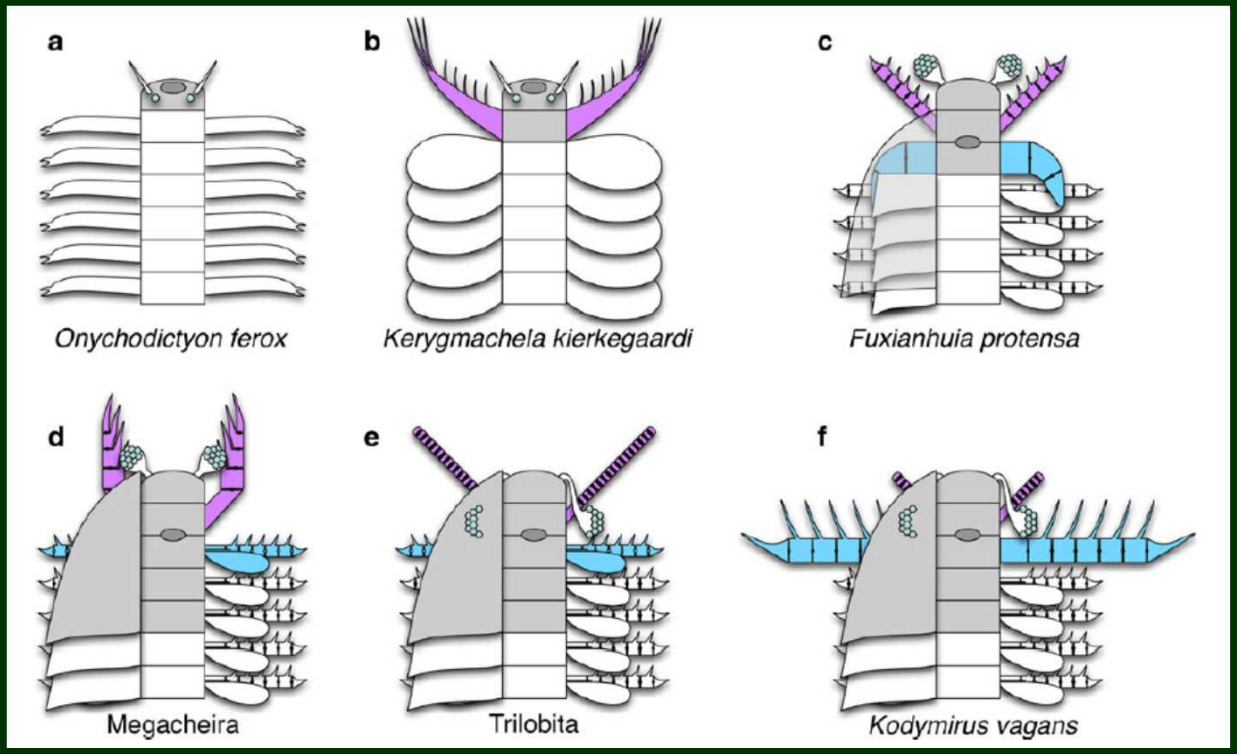


Fig. 3. Alternative phylogenetic positions of *Schinderhannes* Kühl *et al.*, 2009, and their evolutionary implications. (A) *Schinderhannes* as sister group to scion Deuteropoda nov. (see text for discussion), implying paraphyly of Radiodonta (*cf*. Kühl *et al.*, 2009; Liu *et al.*, 2011; Ma *et al.*, 2014). (B) *Schinderhannes* as a member of monophyletic Radiodonta (*cf*. Legg *et al.*, 2013; Cong *et al.*, 2014; Vinther *et al.*, 2014), indicating that the latter clade is the sister-group to scion Deuteropoda nov.; note that this topology implies multiple origins for dorsal body arthrodization and limb biramy based on the original morphological interpretation of *Schinderhannes* (Kühl *et al.*, 2009). Character numbering: 1, isolated cephalic sclerites, frontal appendages arthropodized, '*Peytoia*'-type mouthpart; 2, dorsal arthrodization, post-oral biramous limbs; 3, arthropodization of all limbs, multisegmented head, first limb pair (deutocerebral) structurally differentiated, hypostome/labrum complex.

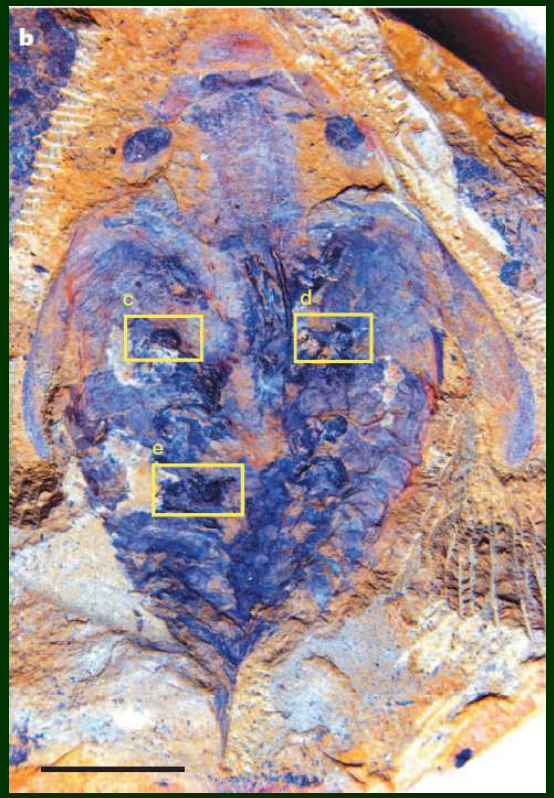

af
Onychodictyon ferox
pb
le
le
le
le
Chelicerata (Xiphosura)
ch
pp
le
le
at
Onychophora
jw
sp
le
le
Mandibulate arthropods
at1
at2/ ic
lb?
md
mx
Tardigrada
st
le
le
le
le
Tardigrada
st
br
le
ga1
le
ga2
le
ga3
Crustacea
at1
at2
pr
de
tr
md
Hexapoda
at
pr
de
tr
md
Chelicerata (alternative 1)
ch
pr
de
pd
tr
le
Chelicerata (alternative 2)
pr
de
ch
tr
pd
Myriapoda
at
pr
de
tr
md

„Velké končetiny“ („*great appendages*“)

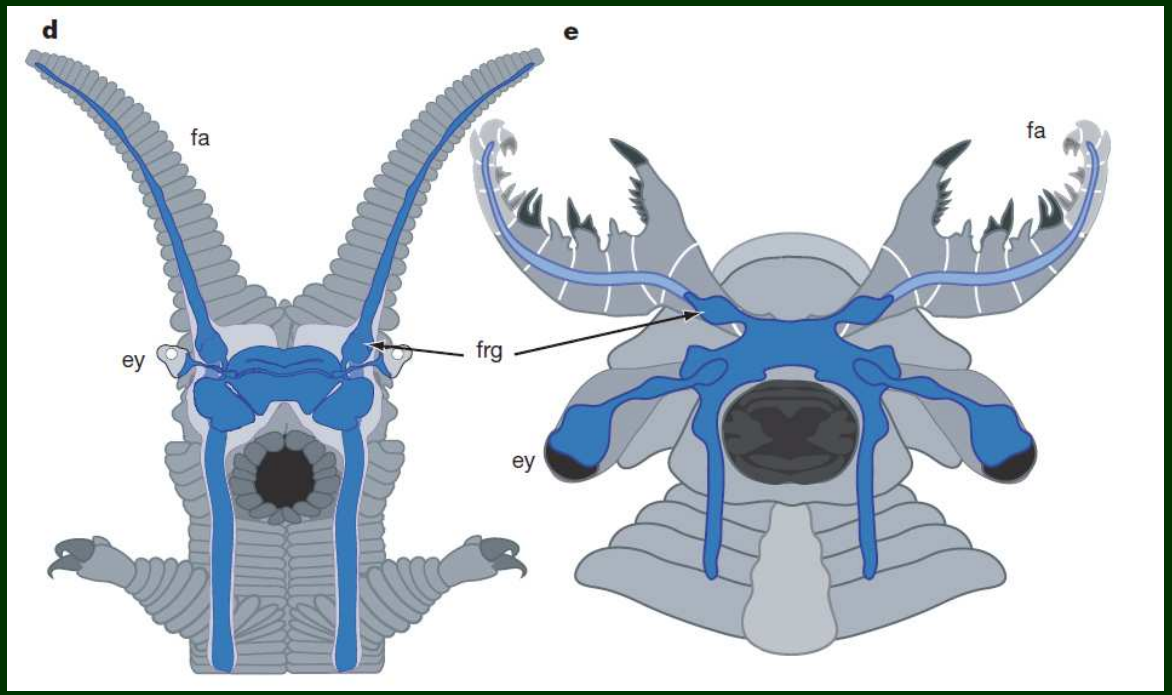
- konvergentní evoluce raptoriálních končetin

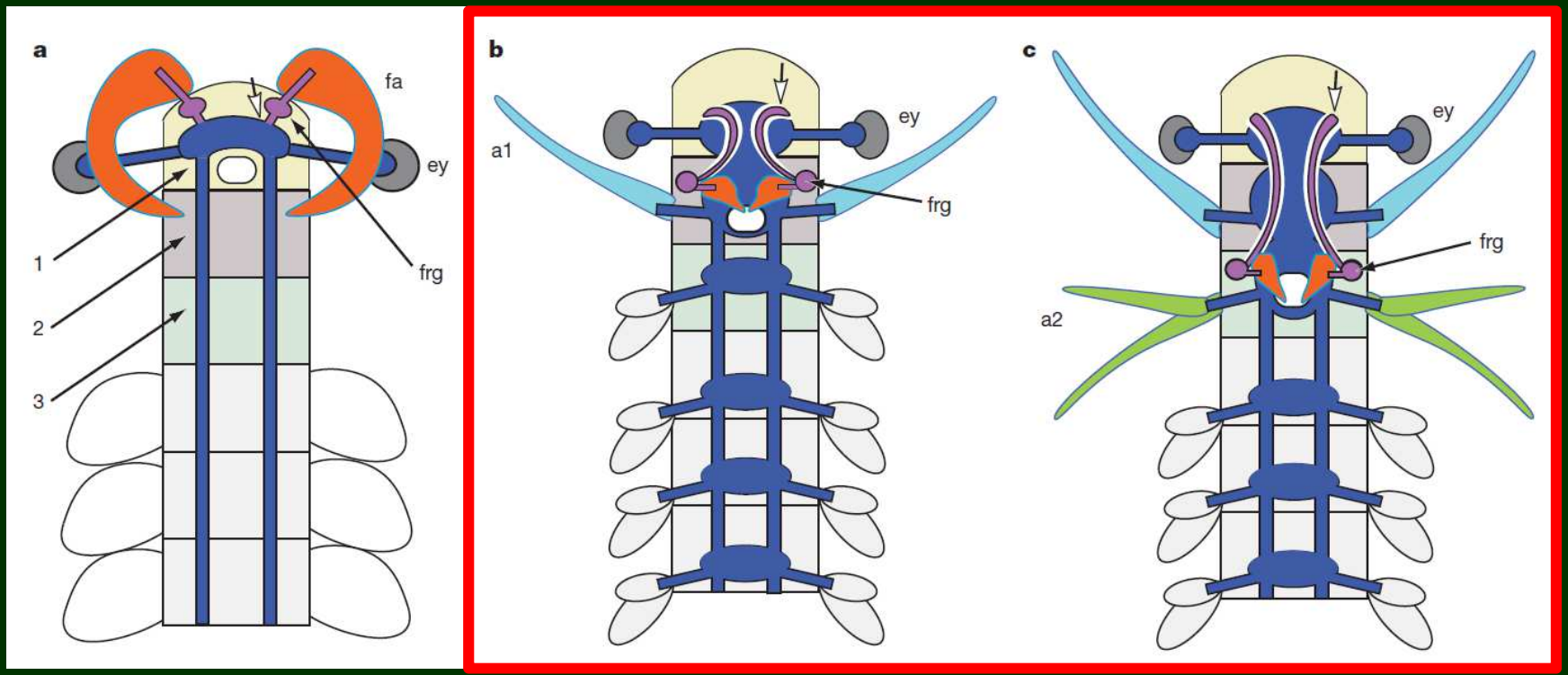


Onychophora + Radiodonta



Lyrarapax (kambrium, Chengjiang)





- Radiodonta – CNS jednoduchá odlišná od členovců (už od kambria: *Fuxianhuia*, *Alalcomenaeus*) ~ Onychophora
- „velké končetiny“ (pre)protocerebrální → nejsou homologické končetinám členovců (ani jejich „velkým končetinám“) x labrum (párové, inervované z protocerebra, odpovídá končetinám, migruje zpředu dozadu)