Adaptive radiations of mesopelagic fishes: the role of key innovations

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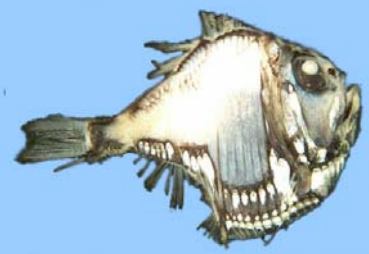
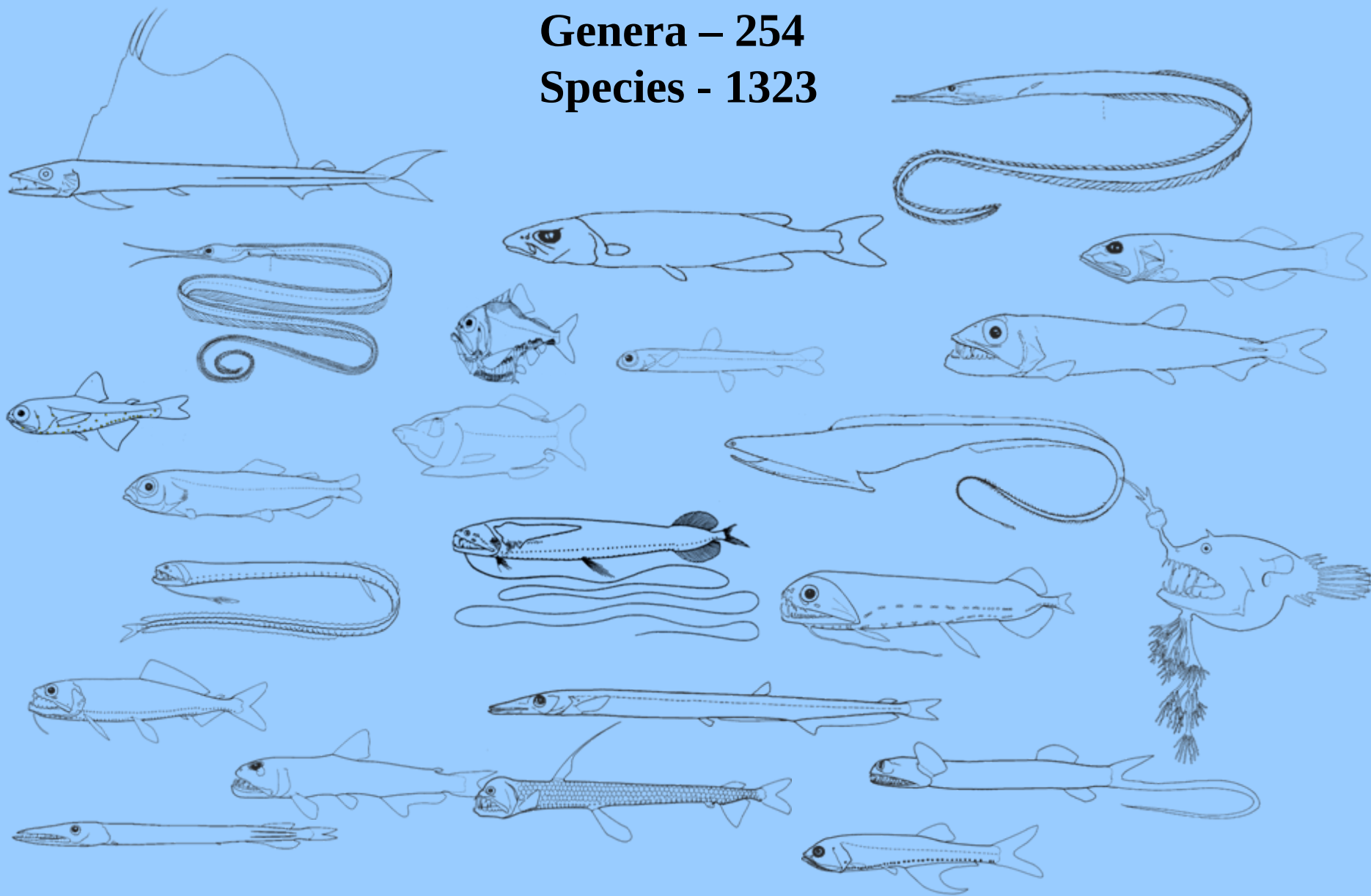
Northwest Fisheries Science Center, NOAA, Newport OR



Total deep-sea pelagic fish diversity

Families – 61
Genera – 254
Species - 1323

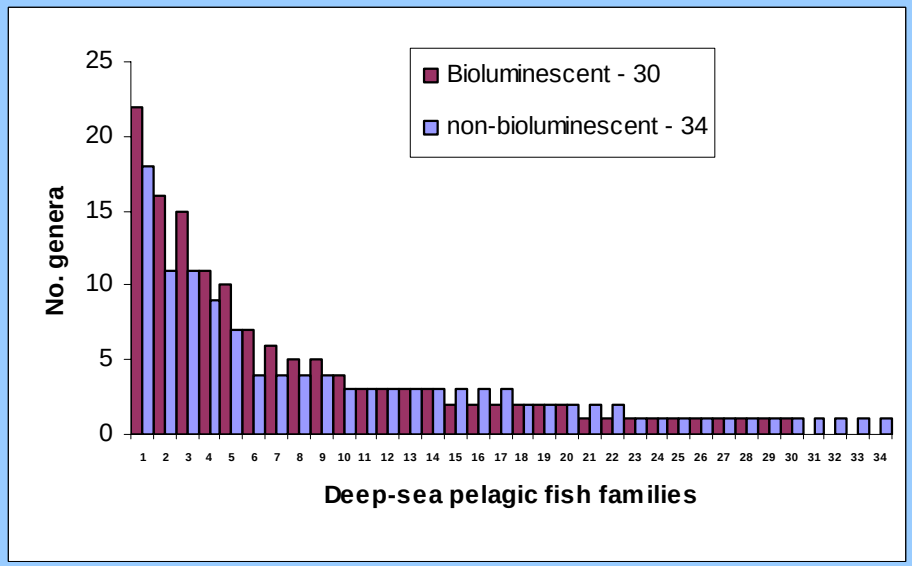


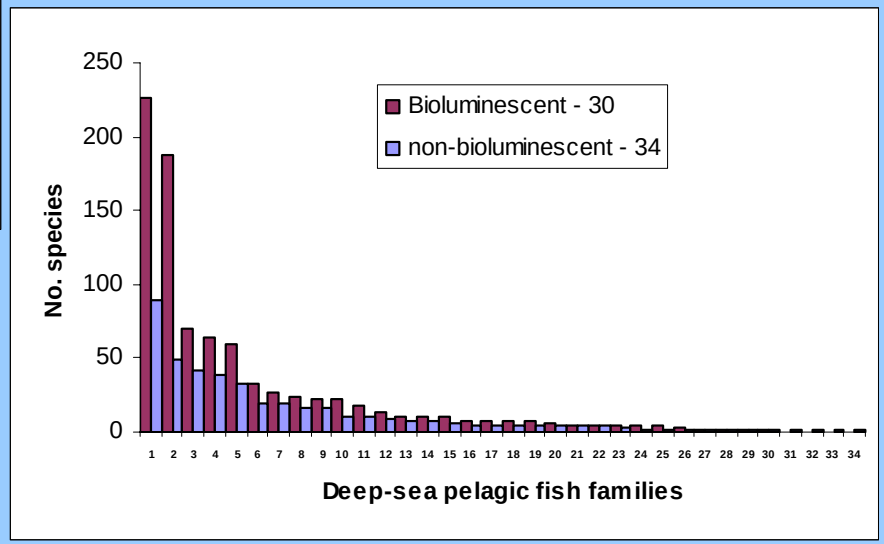
bioluminescent

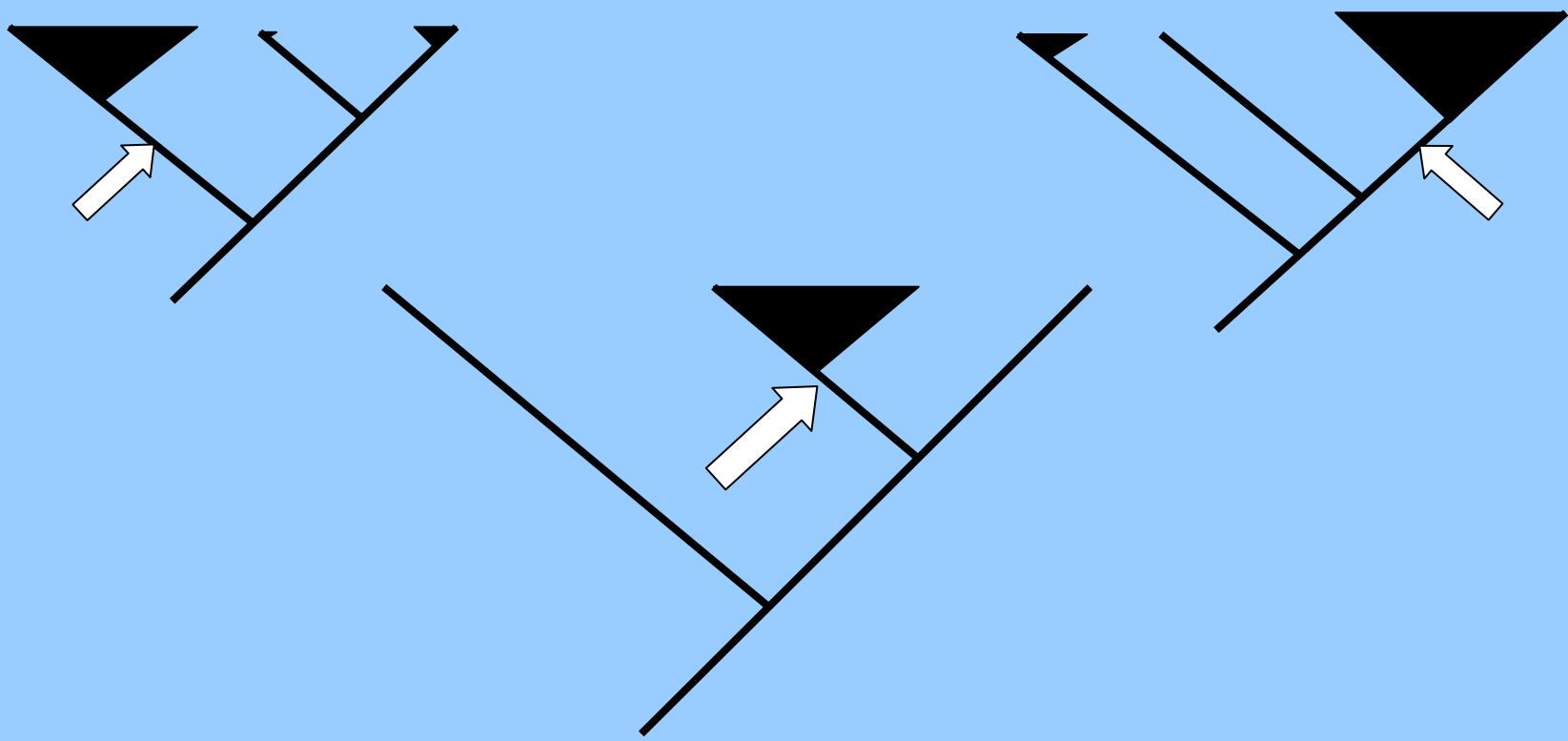
Families – 30
Genera – 135
Species - 868

non-bioluminescent

Families – 34
Genera – 119
Species - 455



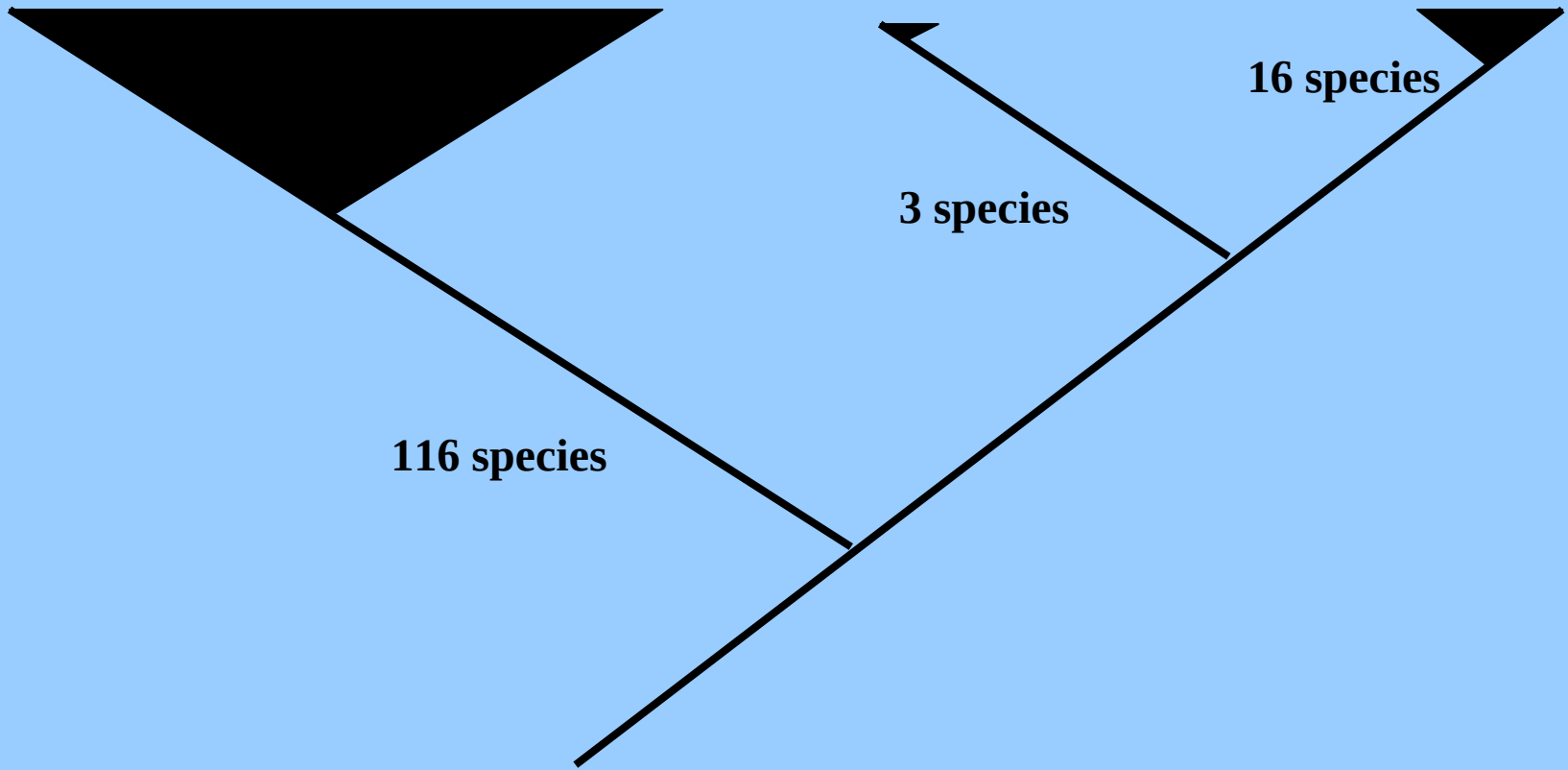




key innovation **– a novel morphological or behavioral feature characterizing a particular group and thought to be accelerating speciation rates**

Fam. Melanostomiidae – 187 species, 16 genera

Eustomias *Grammatostomias* *Bathophilus*



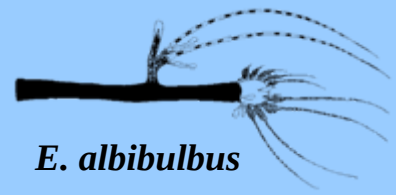
Cladogram after Fink, 1984

Diversity of luminous barbels in the genus *Eustomias*

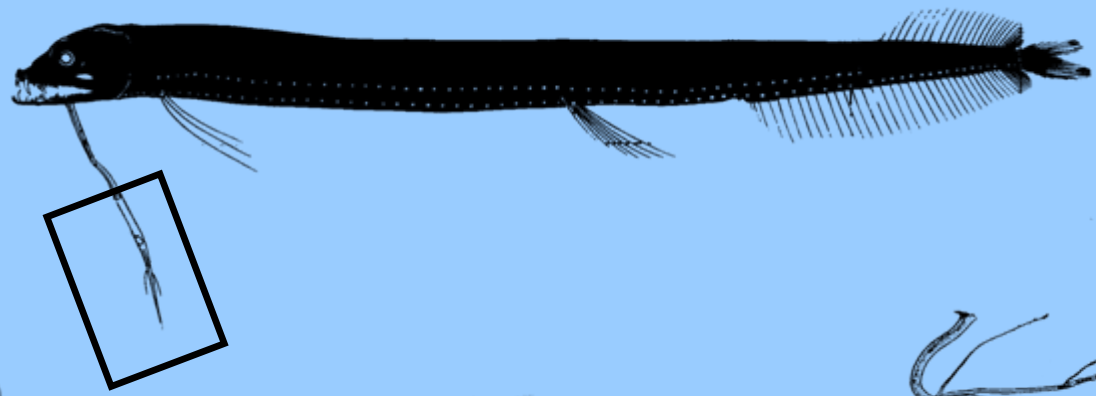
E. magnificus

E. elongatus

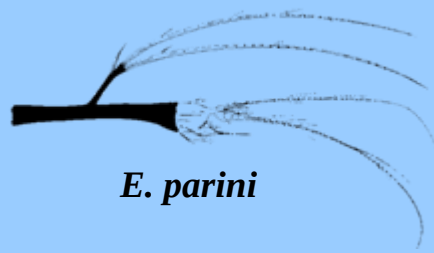
E. similis



E. albibulbus



E. vityazi



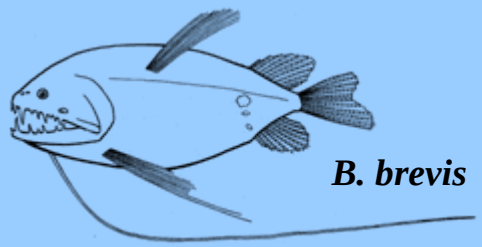
E. parini

E. monodactylus

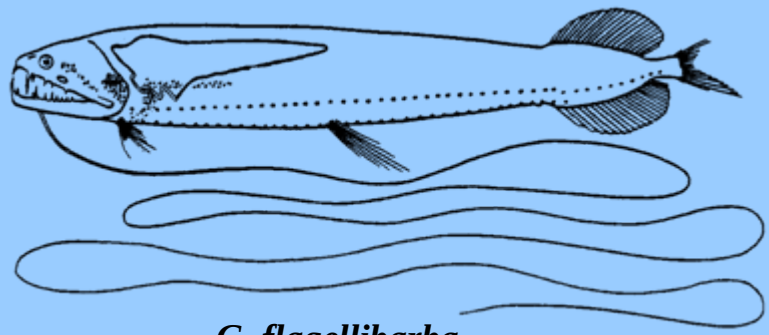
E. jimcraddocki

E. filifer

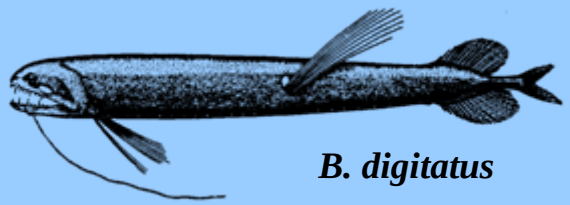
Species of *Bathophilus* and *Grammatostomias*



B. brevis

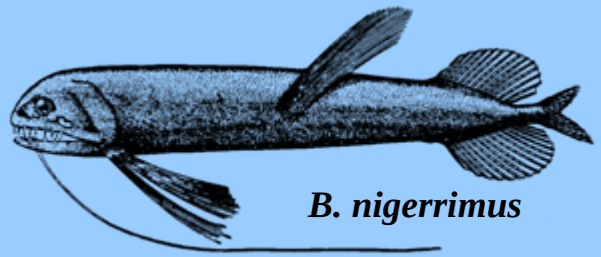


G. flagellibarba

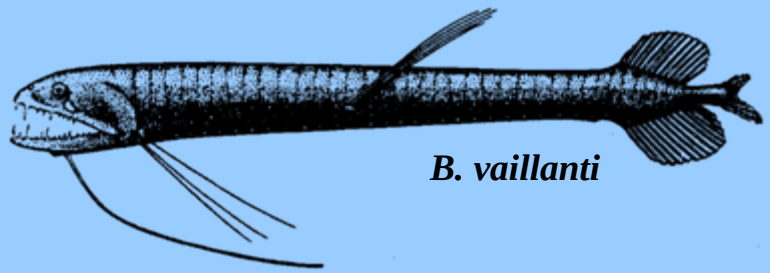


B. digitatus

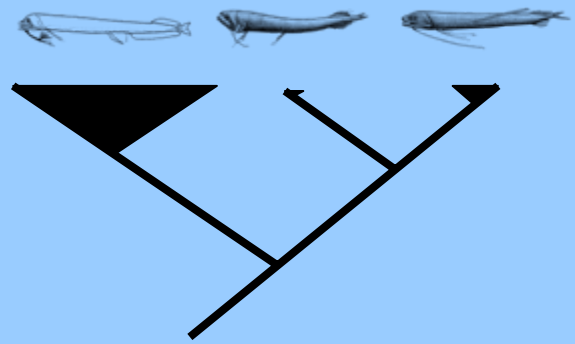
G. circularis



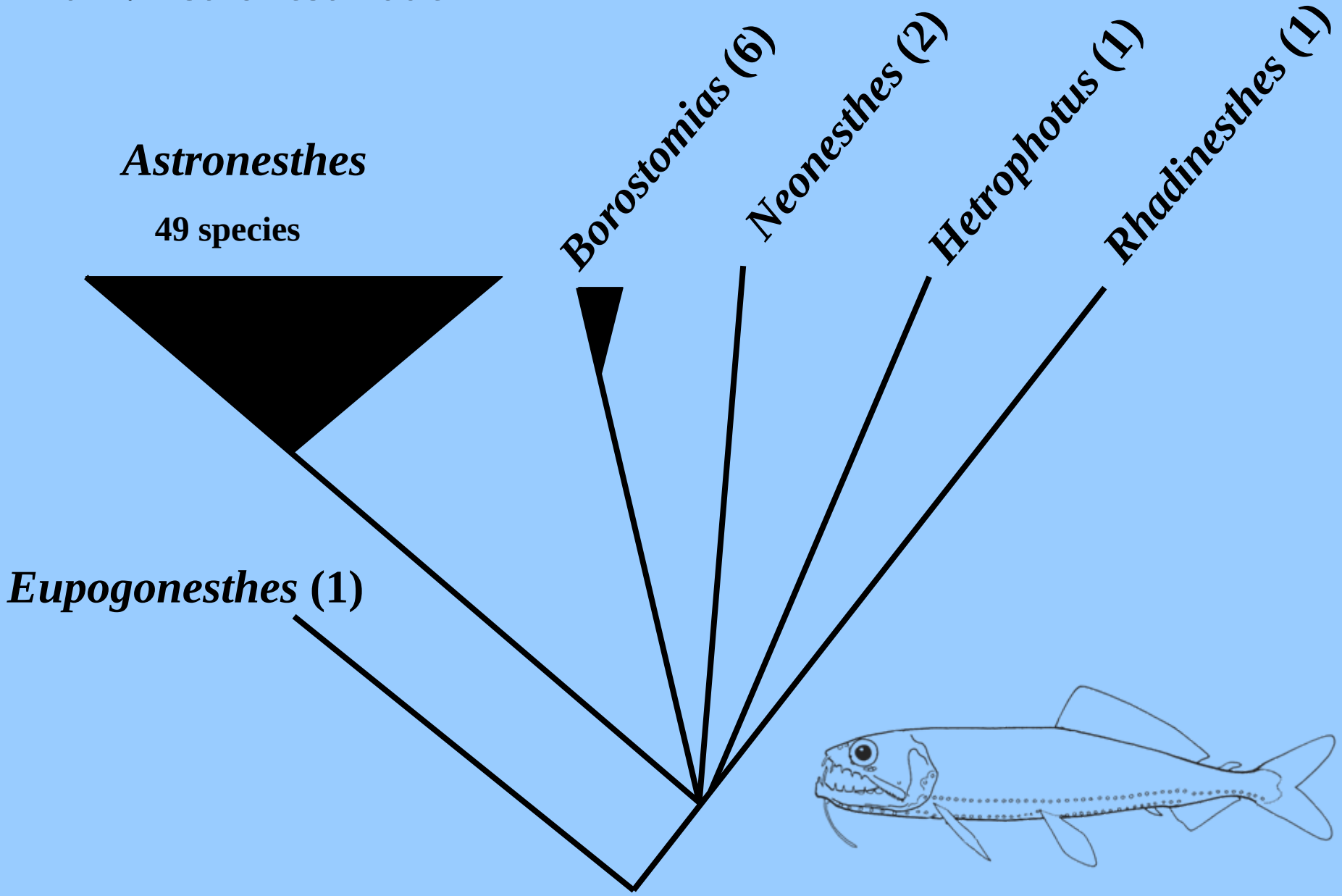
B. nigerrimus



B. vaillanti

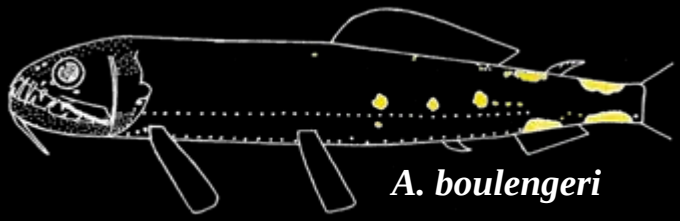


Fam. Astronesthidae

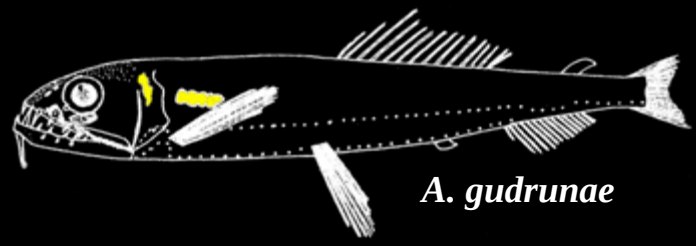


Speciation in the genus *Astronesthes* (fam. Astronesthidae)

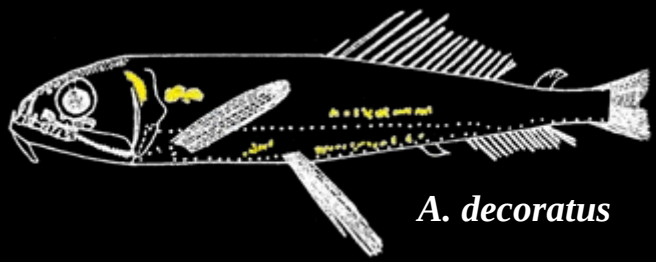
49 species



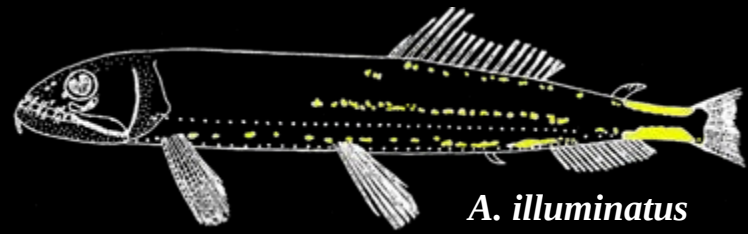
A. boulengeri



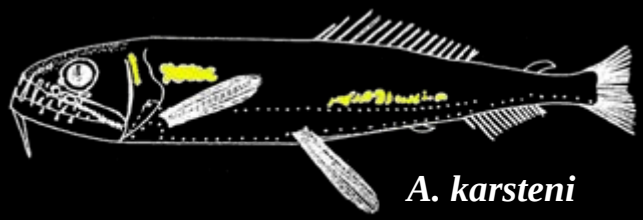
A. gudrunae



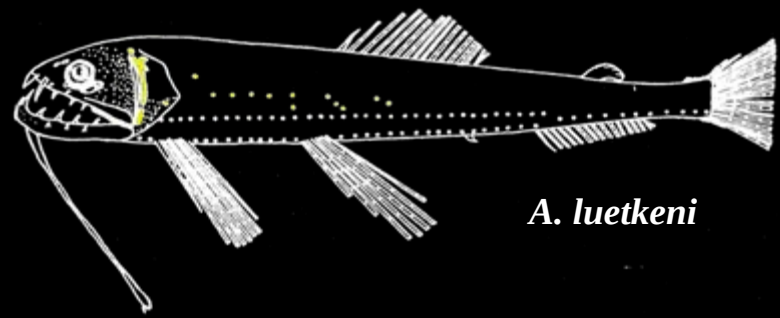
A. decoratus



A. illuminatus



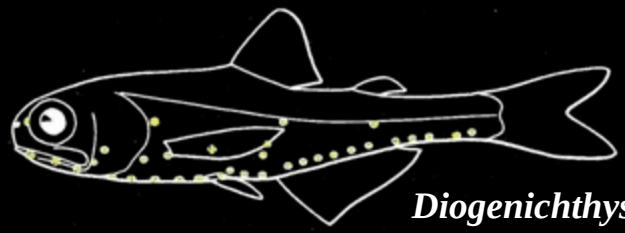
A. karsteni



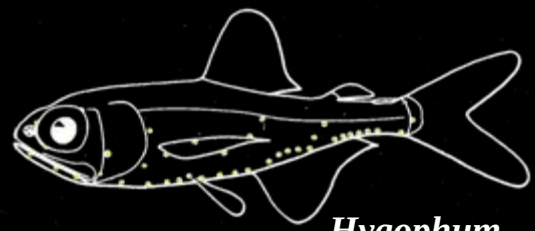
A. luetkeni

Fam. Myctophidae – 226 species

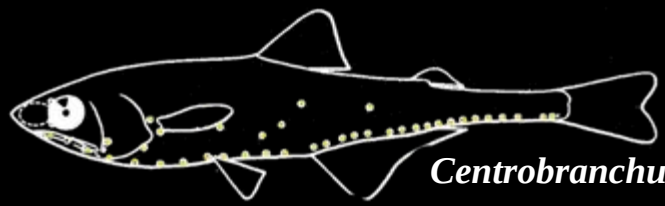
Benthosema



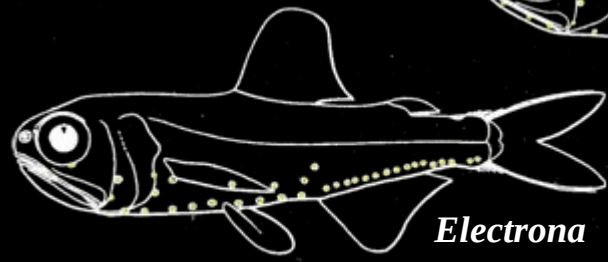
Diogenichthys



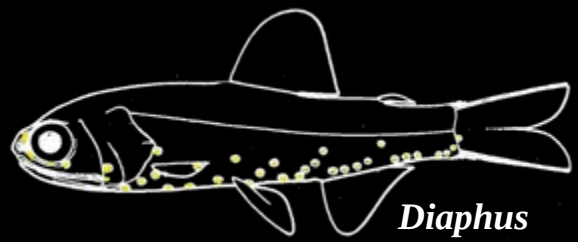
Hygophum



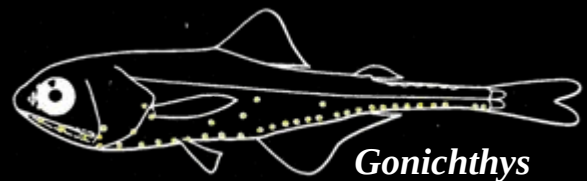
Centrobranchus



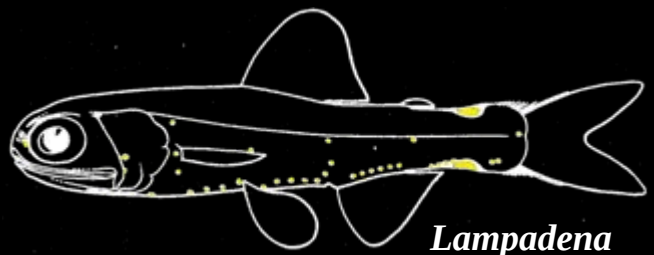
Electrona



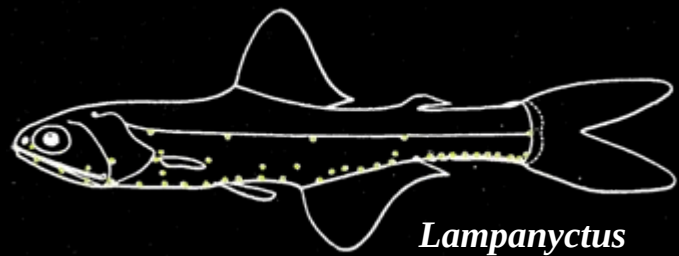
Diaphus



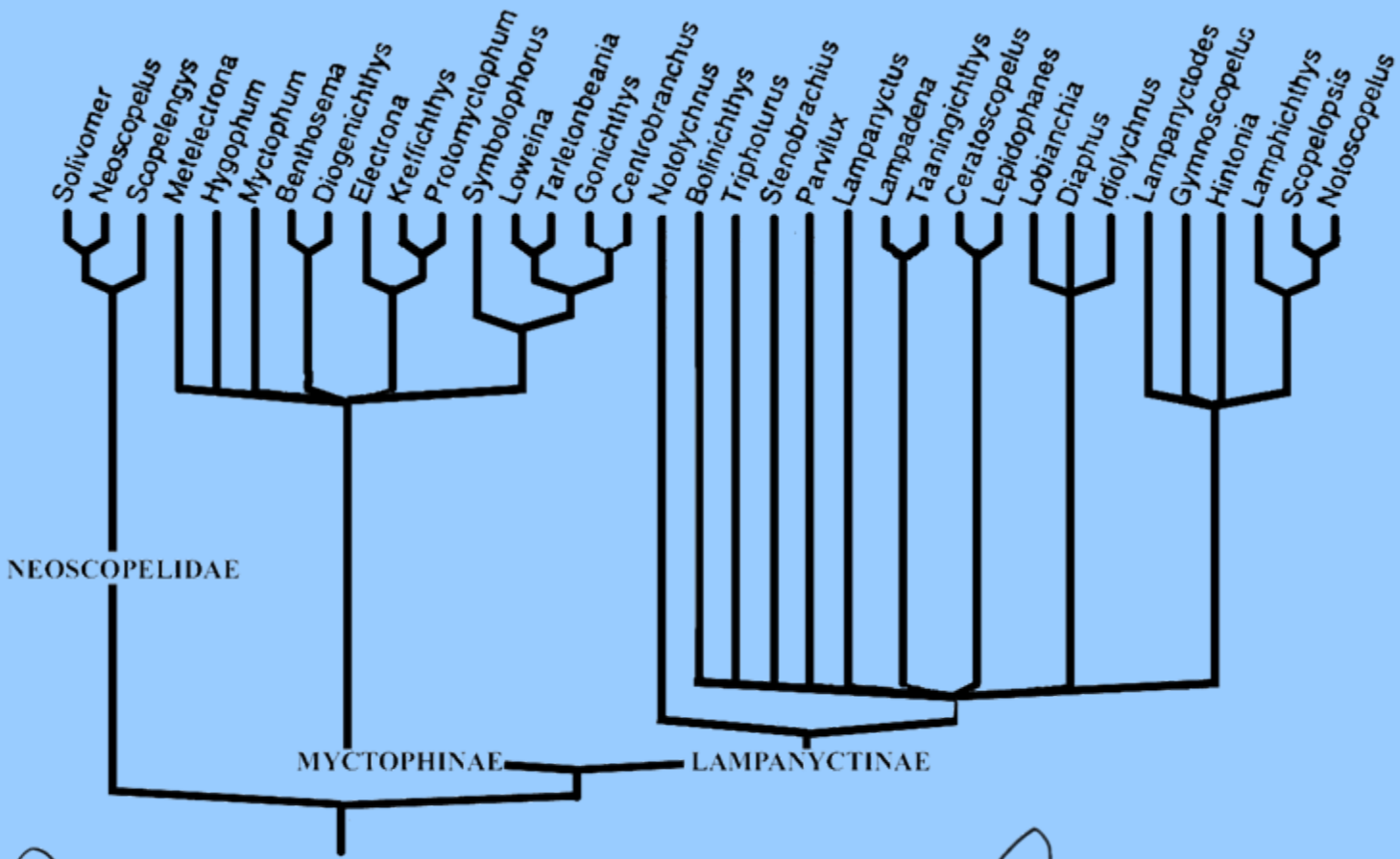
Gonichthys

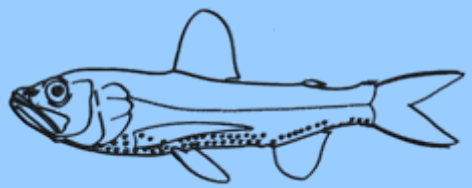


Lampadena

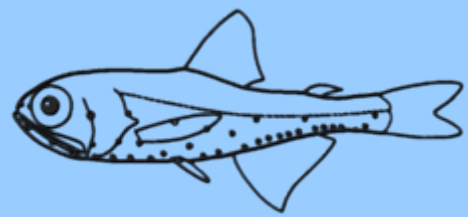


Lampanyctus





3 genera
6 species



22 genera
226 species

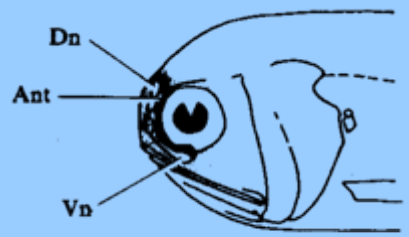
Cladogram after Stiassny, 1996

Genus *Diaphus* – 77 species,
34 % of total myctophid diversity

D. bertelseni

D. dumerilli

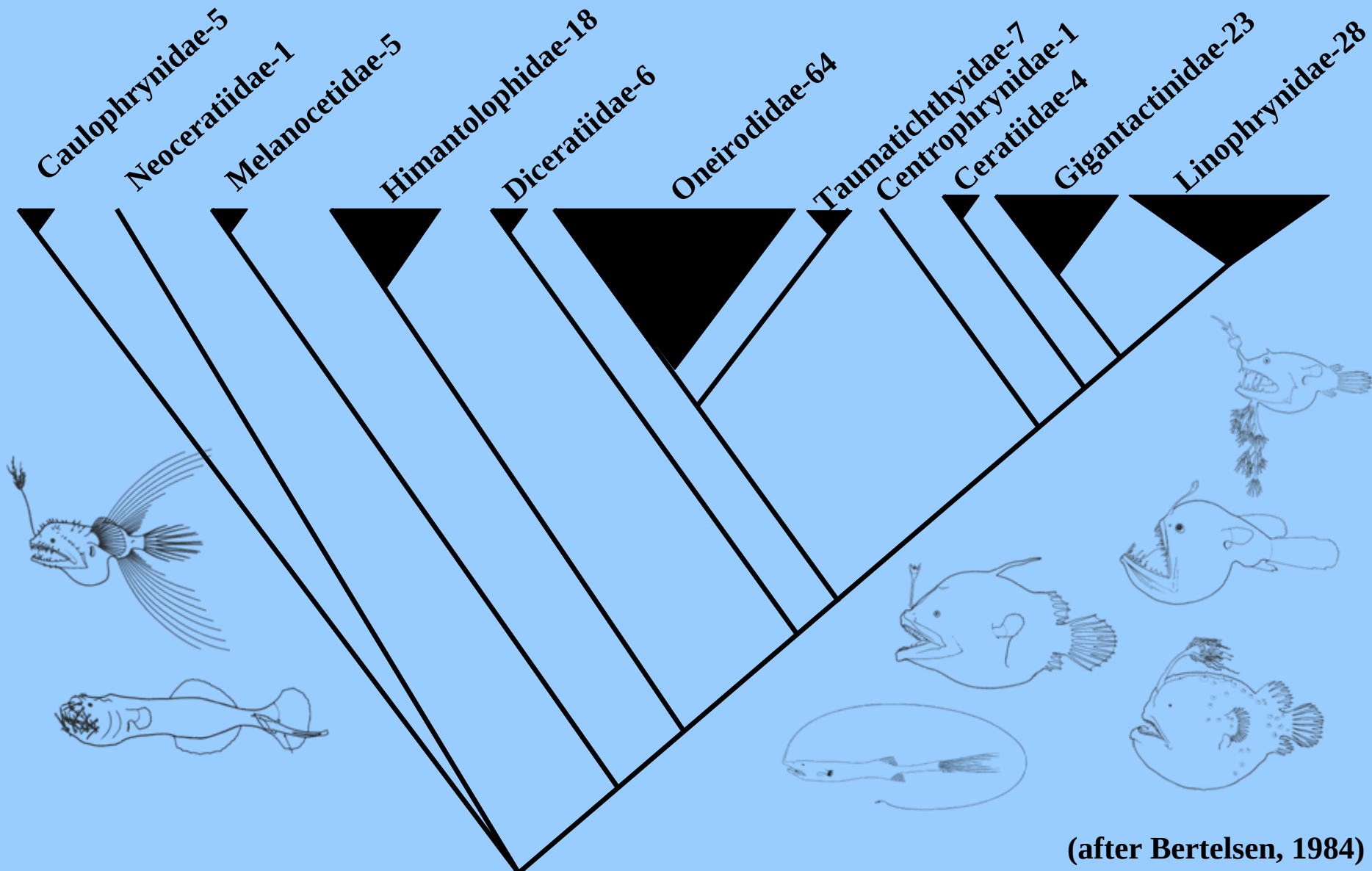
D. effulgens



D. metapoclampus

D. termophilus

Relationships among deep-sea anglerfishes -161 species



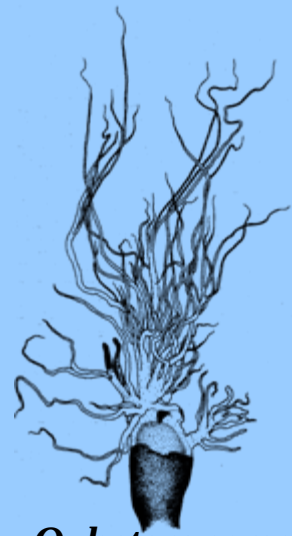
(after Bertelsen, 1984)

Escal diversity in the genus *Oneirodes* – 38 species

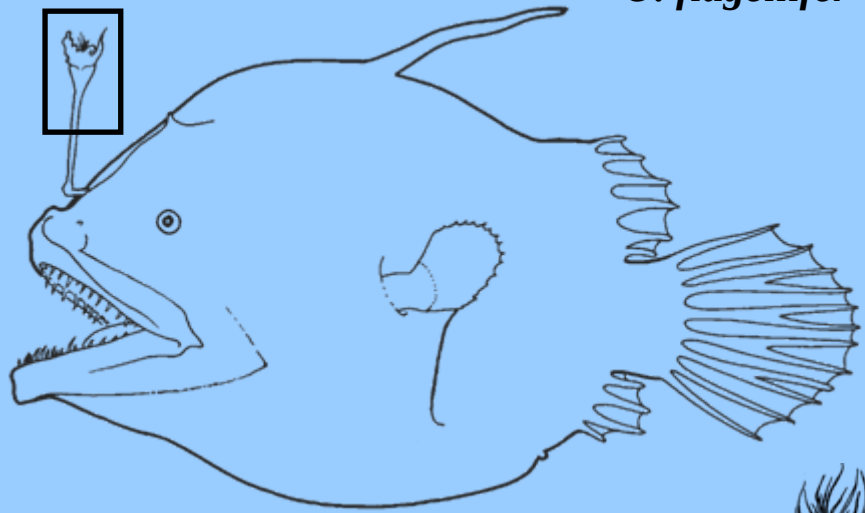
O. carlsbergi

O. eschrichti

O. flagellifer



O. heteronema



O. macronema

O. luetkeni

O. theodoritissieri

O. schmidtii

Fam. Linophrynidae

Linophryne

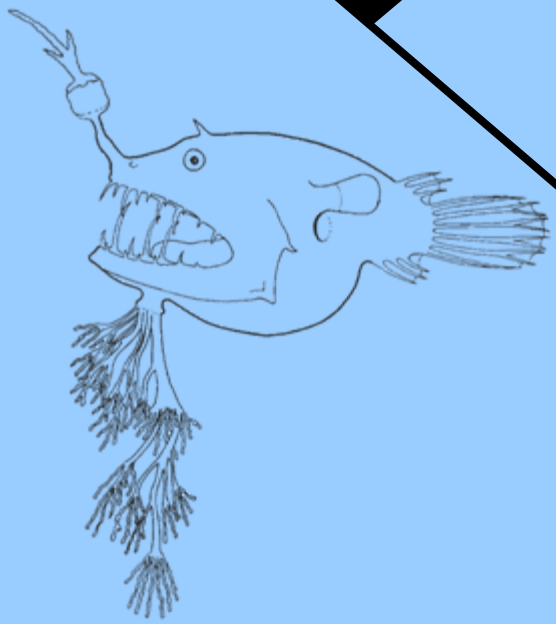
23 species

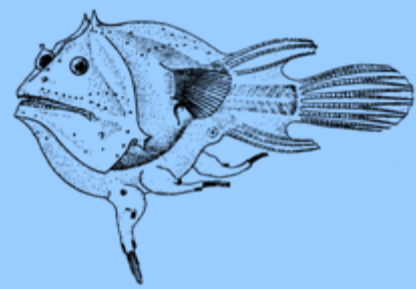
Acentrophryne (2)

Haplophryne (1)

Borophryne (1)

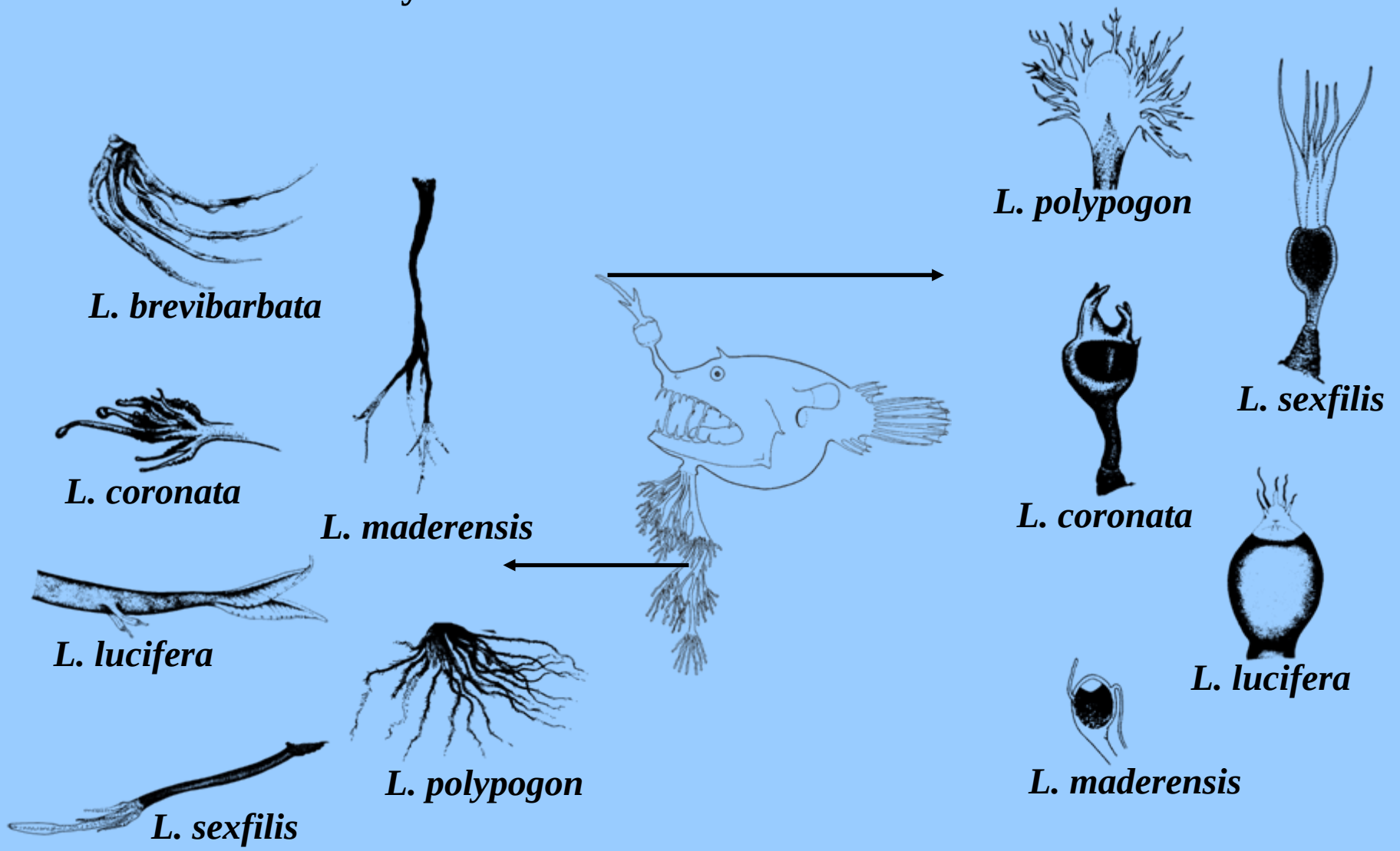
Photocorynus (1)





Morphological novelty in the genus *Lynophryne*

- **self-luminescent hyoid barbel**



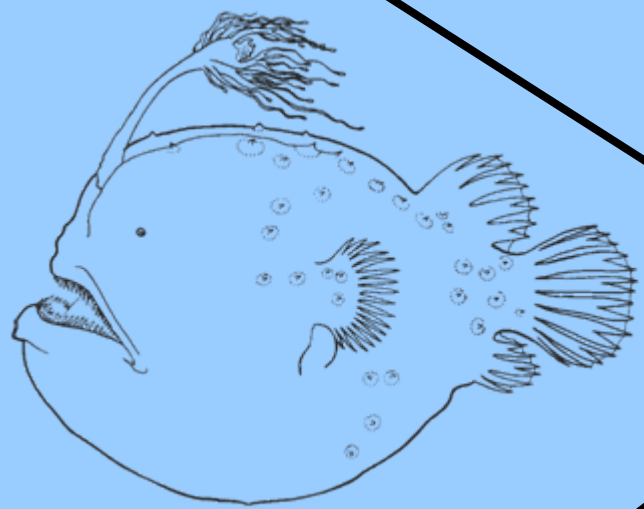
Sister clades Himantolophidae vs. Melanocetidae

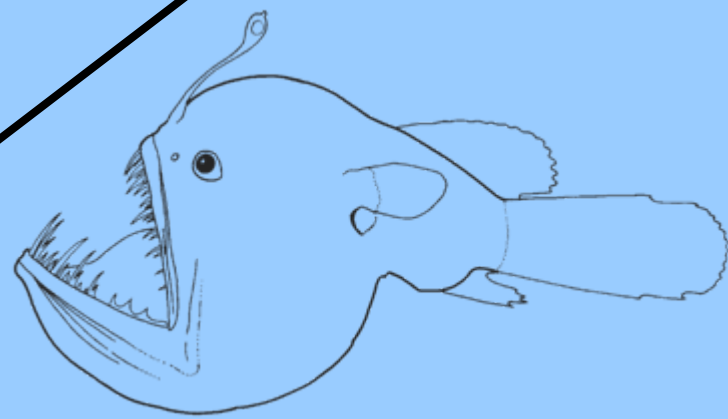
18 species

Himantolophus

5 species

Melanocetus





Cladogram after Shedlock et al., 2004

Escal morphology

Fam. Himantolophidae

high escal diversity

H. albinares

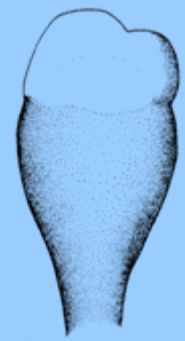
H. compressus

H. groenlandicus

Fam. Melanocetidae

low escal diversity

M. johnsoni



M. murrayi

M. niger

M. polyactis

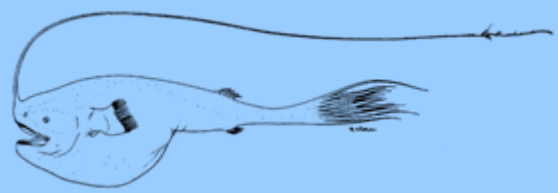
Family Gigantactinidae

Gigantactis

19 species

Rhynchactis

3 species

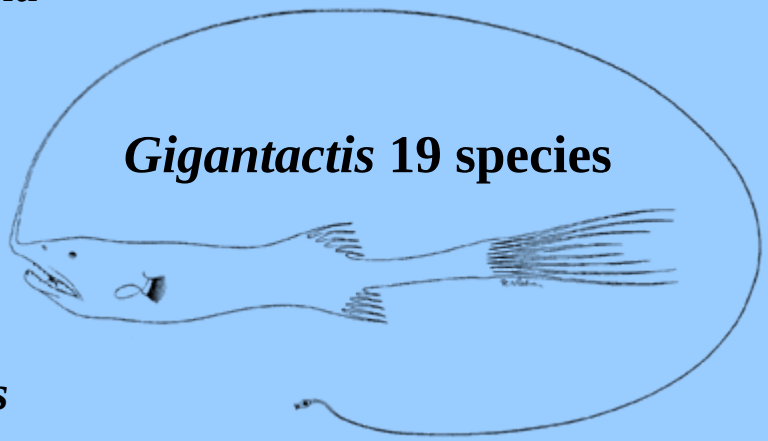


G. macronema

G. longicauda

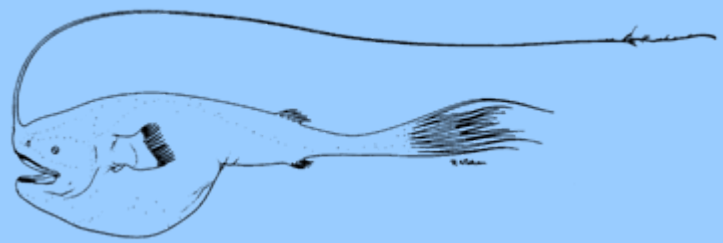
High morphological diversity of bioluminescent esca

G. microdontis



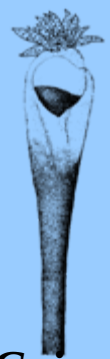
***Gigantactis* 19 species**

No escal photophore, bioluminescent bacteria absent



***Rhynchactis* – 3 species**

G. savagei



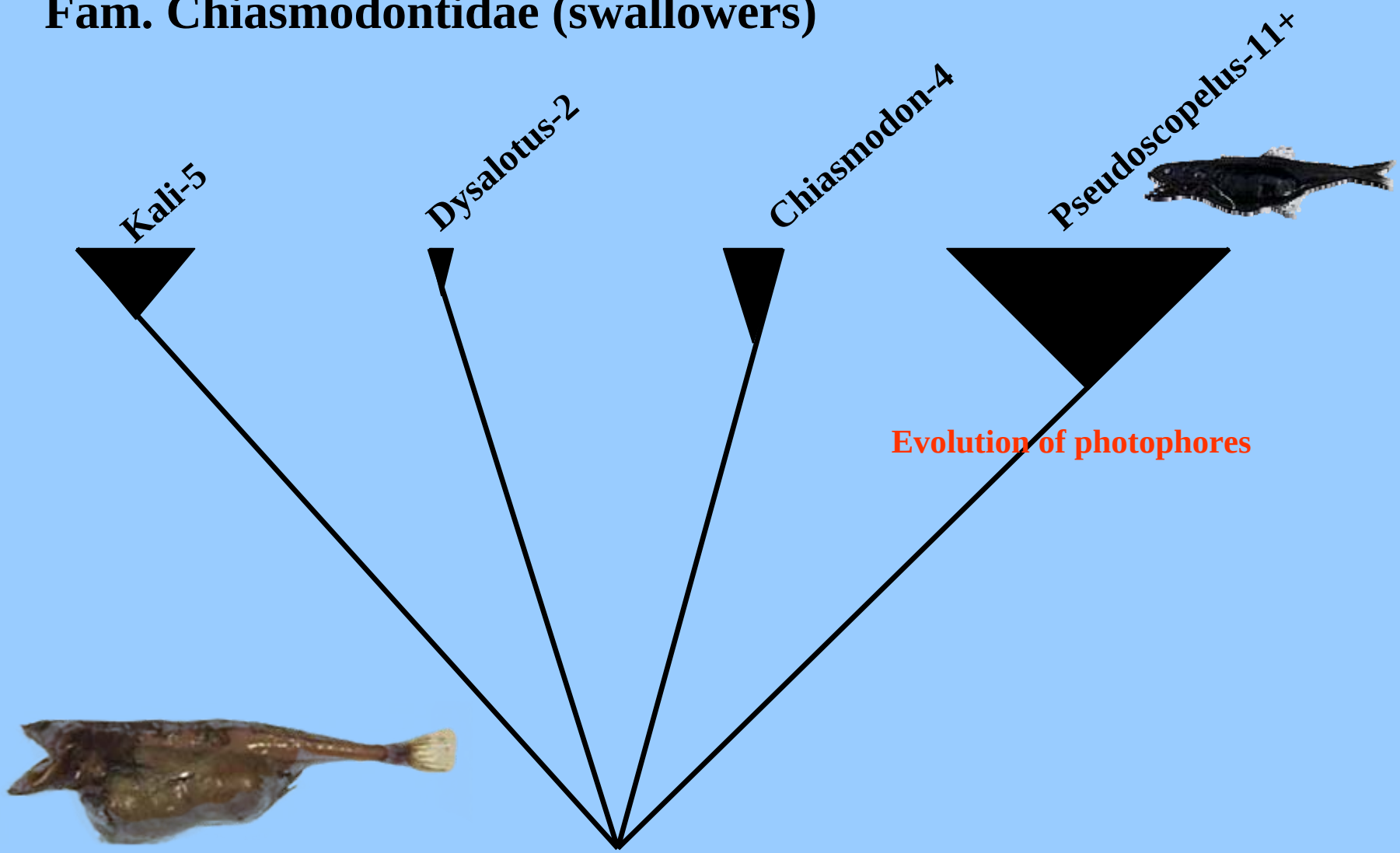
G. ios

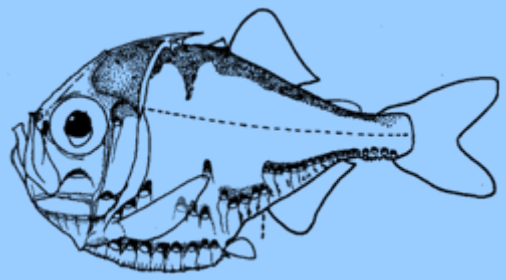
Possible expansion into a new (benthopelagic) ecological niche in *Gigantactis* species

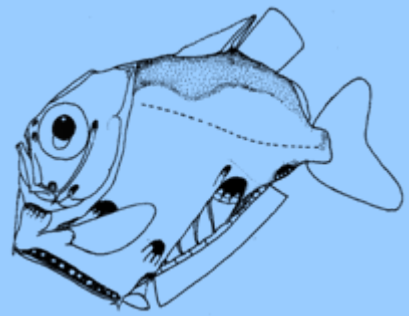
Video from Hawaii-2 Observatory, Moore, 2002

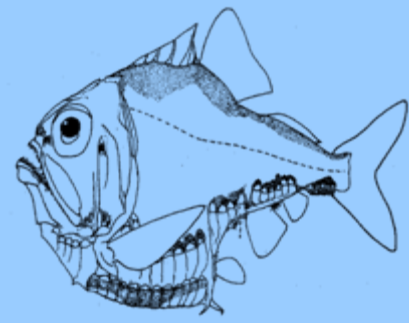
Diversification of more advanced perciforms

Fam. Chiasmodontidae (swallowers)









Polyipnys

Sternoptyx

Argyropelecus

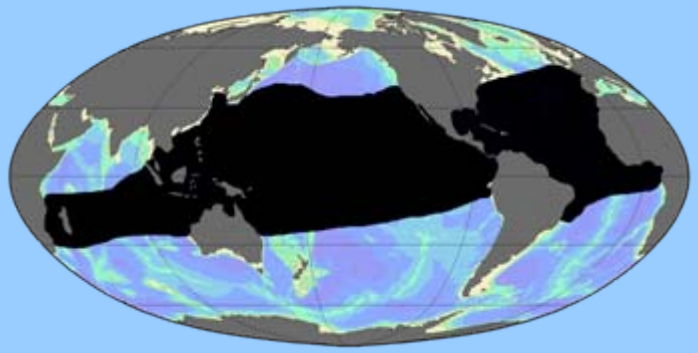
4 species

7 species

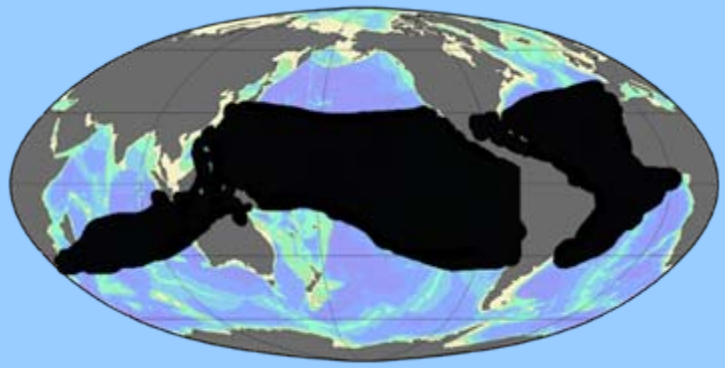
31 species

Cladogram after Harold and Weitzman, 1996

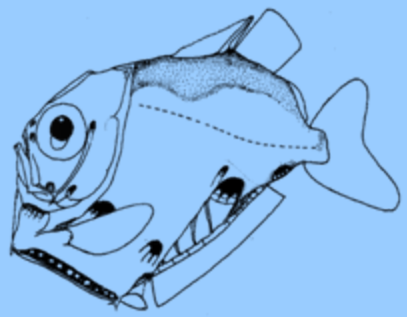
Worldwide distribution of 4 species of *Sternoptyx*

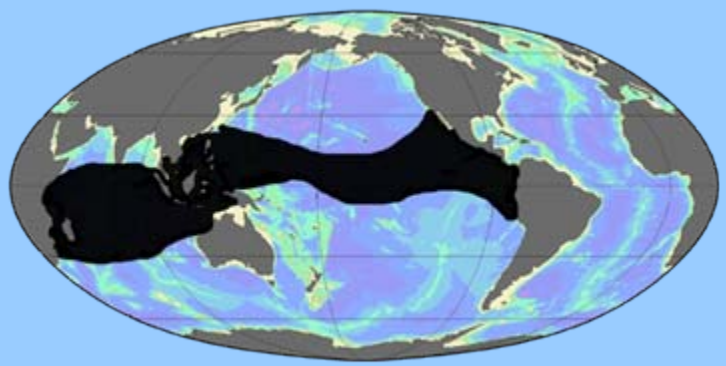


S. diaphana

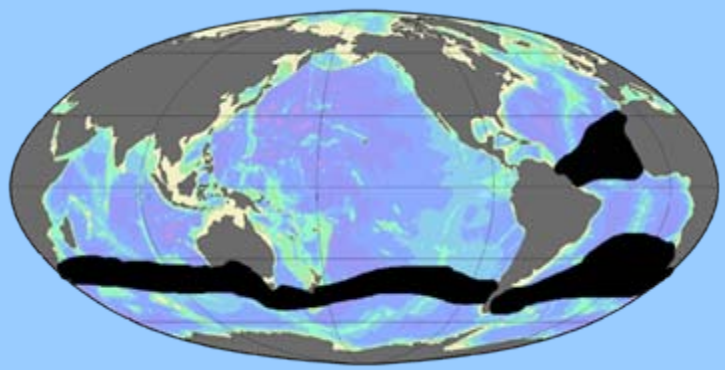


S. pseudoobscura



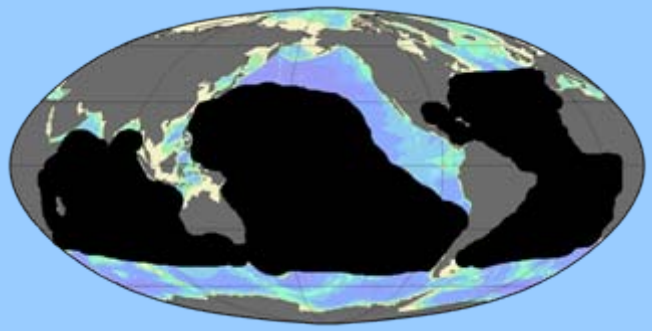


S. obscura

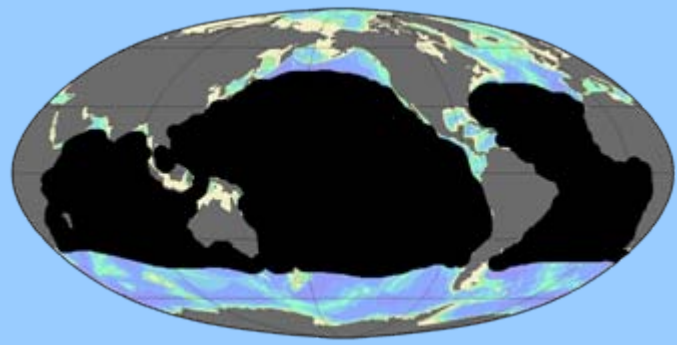


S. pseudodiaphana

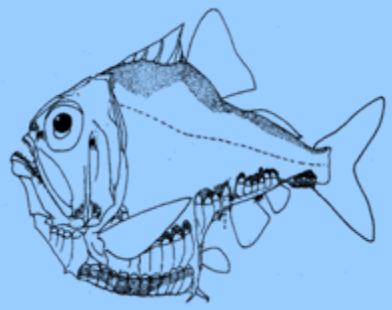
Distribution of *Argyropelecus* species

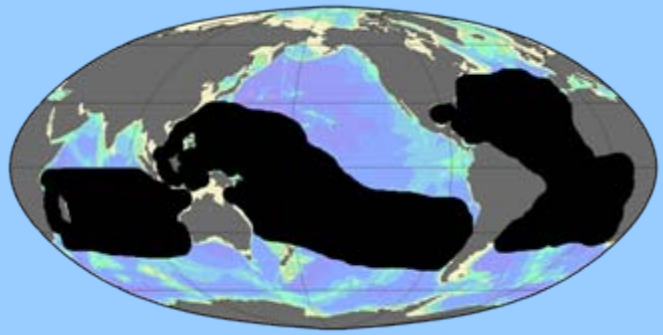


A. aculeatus

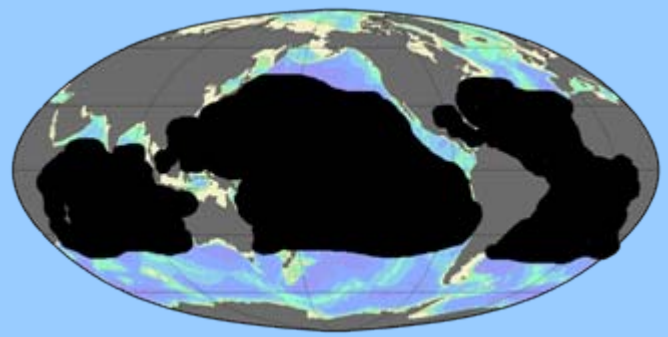


A. affinis

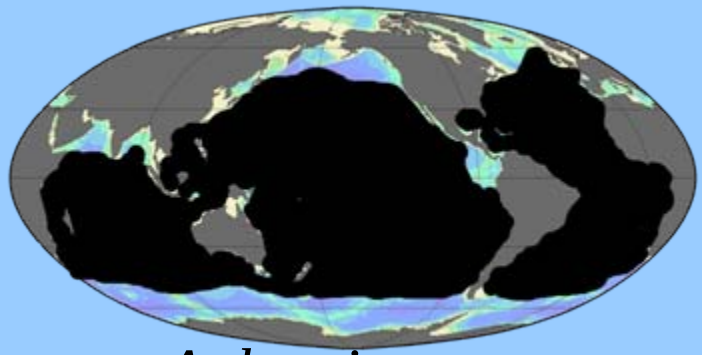




A. gigas

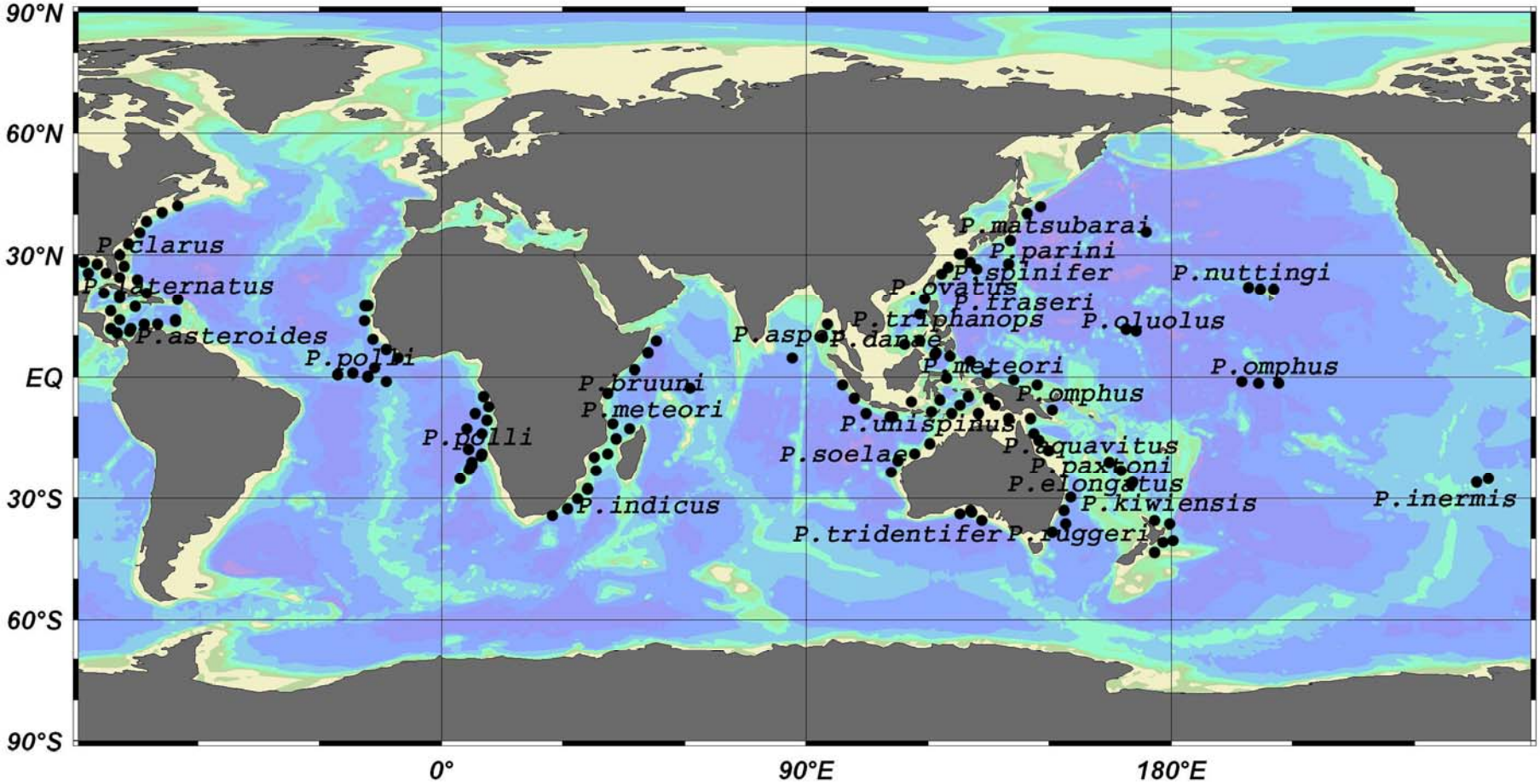


A. sladeni



A. hemigymnus

Worldwide distribution of *Polyipnus* species



modified after Harold, 1994

Maurolicus

Valenciennellus

Danaphos

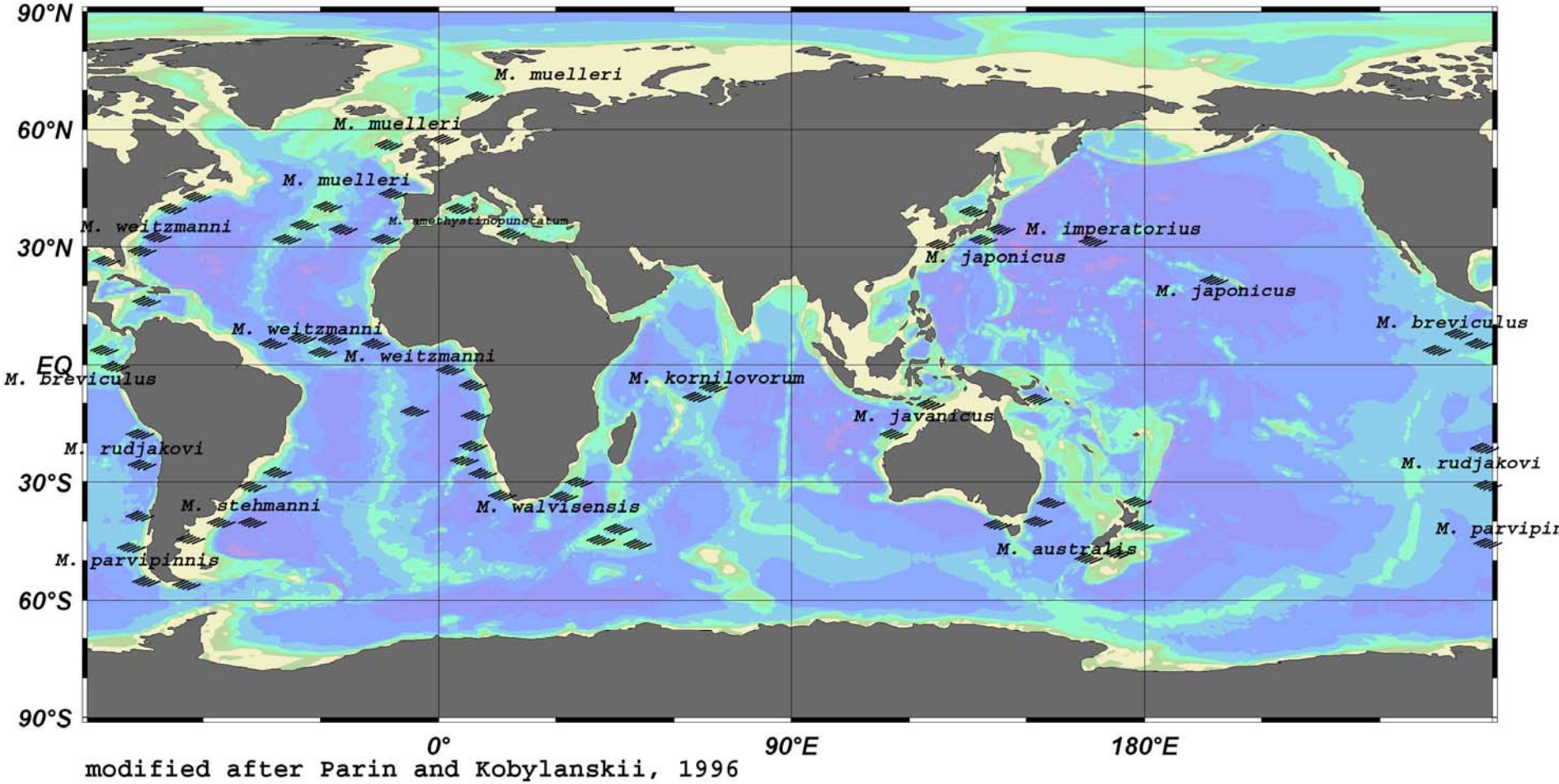
1 species

2 species

15 species

Cladogram after Harold and Weitzman, 1996

Worldwide distribution of 15 species of *Maurolicus*



modified after Parin and Kobylanskii, 1996

Summary

- **deep-sea pelagic ichthyofauna was under strong selection to evolve the ability to produce light and most “key adaptations” are bioluminescence related**
- **in deep-sea teleosts, diversification of bioluminescent displays often coincides with higher speciation rates**
- **elaboration of light producing structures is clearly selectively advantageous, enhancing the likelihood of reproductive isolation and divergence in sympatric open ocean populations**
- **certain deep-sea pelagic fish groups can experience higher speciation rates over the continental slope and underwater rises**