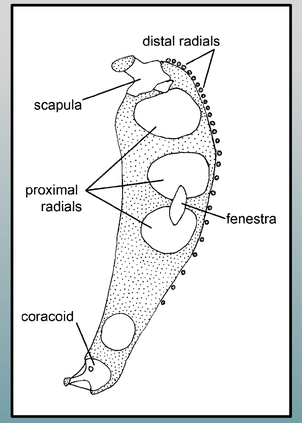
Distal Radials in the Pectoral Fin of Snailfishes (Liparidae): A New Character for Phylogenetic and Alpha-level Systematics

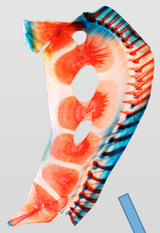
Katherine P. Maslenikov[1], James W. Orr[2], and Nirupam Nigam[1]

[1]University of Washington Burke Museum Fish Collection, School of Aquatic and Fishery Sciences, and [2]NOAA/National Marine Fisheries Service, Alaska Fisheries Science Center, Resource Assessment and Conservation Engineering Division, Seattle

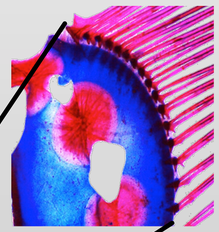
The phylogenetics of snailfishes (Liparidae) are poorly understood. Over 350 species are presently described in the family and many undescribed species are known. The family comprises several genera, many of which contain single or very few species while three (*Liparis*, *Paraliparis*, and *Careproctus*) contain the bulk of known species. Reasons for the lack of a clear phylogenetic hypothesis include the early state of alpha-level taxonomy, the poor preservation of many specimens, the rarity of both morphological and genetic material, and a lack of phylogenetically informative morphological characters.

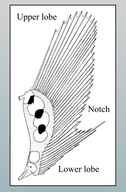


Among morphological characters, those associated with the pectoral girdle have been invaluable in diagnosing species and putative clades. However, early efforts described methods using only alizarin red stain for bone to identify and describe components of the girdle. While this led to significant advances in recognizing new species, as well as a better understanding of snailfish evolution, at least one set of cartilaginous components has been overlooked.

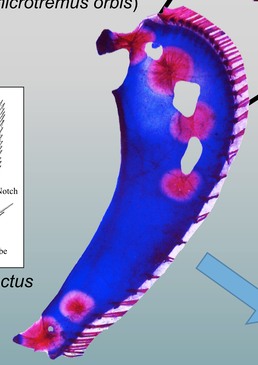


Cyclopteridae (*Eumicrotremus orbis*)

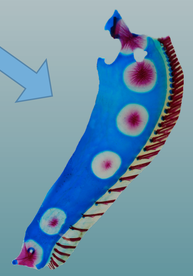




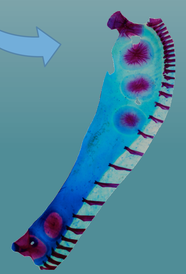
Allocareproctus



Careproctus acanthodes



Careproctus melanurus



Paraliparis dactylosus

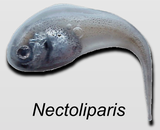
Cartilaginous distal radials were originally thought to be absent in the pectoral girdle of liparids. Recently, by using standard counterstaining techniques with alcian blue for cartilage, we found them to be present in nearly all species of snailfishes we examined from the eastern North Pacific. Moreover, numbers and sizes of distal radials exhibit little intraspecific variation but vary widely among species, providing a potentially useful character for alpha-level systematics as well as for higher-level phylogenetics.

Taxon	Distal radial distribution	Code	PR type	Code
Cyclopteridae				
Aptocyclus ventricosus	complete	1	short, stout, evenly spaced	1
Eumicrotremus orbis	complete	1	short, stout, evenly spaced	1
Liparidae				
Nectoliparis pelagicus	to PR 3	3	long, thin, large space	4
Liparis gibbus	complete	1	short, stout, evenly spaced	1
Allocareproctus spp.	to PR 3	3	long, thin, small space	3
Careproctus				
C. bowersianus	to PR 4	1	long, broad, evenly spaced	2
C. candidus	to PR 4	1	long, thin, small space	3
C. colletti	to between PR 3 and 4	2	long, broad, evenly spaced	2
C. melanurus	to PR 3	3	long, thin, small space	3
C. cypselurus	to PR 4	1	long, thin, small space	3
***C. comus* group**				
C. comus	to PR 3	3	long, thin, small space	3
C. faunus	to PR 3	3	long, thin, small space	3
***C. ovigerus* group**				
C. ovigerus	absent	5	long, thin, small space	3
C. kamikawai	absent	5	long, thin, small space	3
C. lycopersicus	absent	5	long, thin, small space	3
***C. rastrinus* group**				
C. acanthodes	complete	1	long, thin, large space	4
C. pellucidus	to PR 3	3	long, thin, large space	4
C. phasma	to PR 3	3	long, thin, large space	4
C. rastrinus	to PR 3	3	long, thin, large space	4
C. scottae	to PR 3	3	long, thin, large space	4
C. trachysoma	to PR 3	3	long, thin, large space	4
C. leptikimae	to PR 2	4	long, thin, large space	4
Crystallichthys cyclopsilus	to between PR 3 and 4	2	long, broad, evenly spaced	2
Elassodiscus caudatus	to PR 4	2	long, broad, evenly spaced	2
E. tremebundus	to PR 4	2	long, broad, evenly spaced	2
Liparisscus nanus	to PR 2	4	?	?
Paraliparis				
P. cephalus	absent?	5?	short, stout, evenly spaced	1
P. dactylosus	to PR 3	3	long, thin, large space	4
P. sp. cf. *dactylosus*	to PR 3	3	long, thin, large space	4
P. grandis	absent	5	long, thin, large space	4
P. holomelas	absent	5	long, broad, evenly spaced	2
P. pascidens	absent	5	long, thin, large space	4
P. pectoralis	to between PR 3 and 4	2	long, thin, large space	4
P. uloclio	absent?	5?	long, thin, large space	4
Rhinoliparis attenuatus	to PR 2	4	long, broad, evenly spaced	2

Distribution: 1--complete; 2--to between proximal radials (PR) 3 and 4; 3--to PR 3; 4--to PR 2; 5--absent.
PR type: 1--short, stout, evenly spaced; 2--long, broad, evenly spaced; 3--long, thin, small space; 4--long, thin, large space.

Functional aspects. Formed within the flexible fibrocartilage pad, distal radials are perichondral bones that stiffen the fin-ray base. Rarely lost dorsally, they typically support more dorsal rays that are used primarily for propulsion. In contrast, the radials are often lost from the more ventral notch and, particularly, lower lobe rays, which in most snailfishes are more mobile and used for sensory purposes.

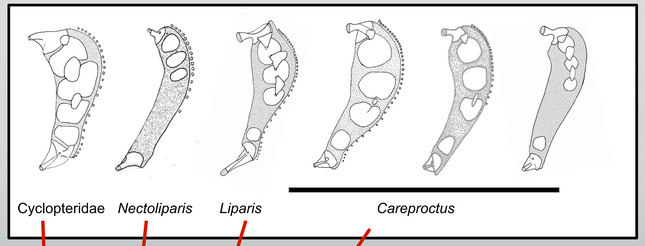
Eumicrotremus



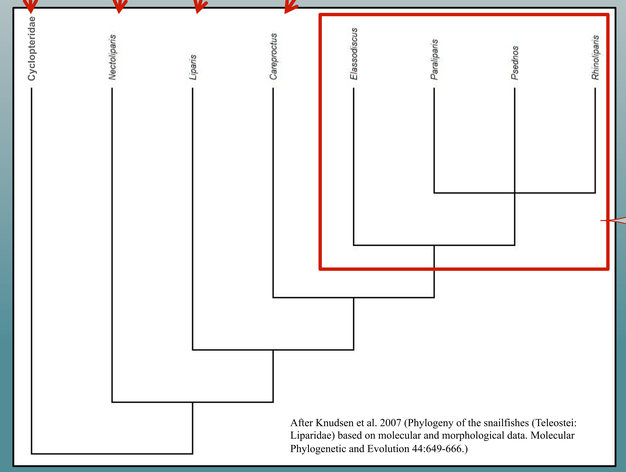
Nectoliparis

Liparis

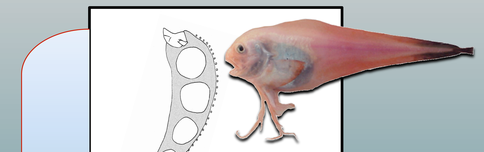
Careproctus spp.



Phylogenetic aspects. In outgroups and most basal taxa, along with other characteristics of the girdle such as larger proximal radials, distal radials form a complete series from dorsal- to ventralmost rays. Reduced distal and proximal radials in more derived taxa are generally related to evolution in a more pelagic habitat. However, the pelagic *Nectoliparis*, thought to be a basal liparid based on morphological and genetic analyses, has a reduced and apparently secondarily derived pectoral girdle, likely reflective of the selective pressures of its pelagic habit.



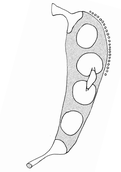
After Knudsen et al. 2007 (Phylogeny of the snailfishes (Teleostei: Liparidae) based on molecular and morphological data. Molecular Phylogenetic and Evolution 44:649-666.)



Elassodiscus

Paraliparis

Psednos



Rhinoliparis

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