



Title	PHYLOGENY OF THE FAMILY LIPARIDIDAE, WITH THE TAXONOMY OF THE SPECIES FOUND AROUND JAPAN
Author(s)	KIDO, Kaoru
Citation	MEMOIRS OF THE FACULTY OF FISHERIES HOKKAIDO UNIVERSITY, 35(2), 125-256
Issue Date	1988-12
Doc URL	http://hdl.handle.net/2115/21885
Type	bulletin (article)
File Information	35(2)_P125-256.pdf



[Instructions for use](#)

PHYLOGENY OF THE FAMILY LIPARIDIDAE, WITH THE TAXONOMY OF THE SPECIES FOUND AROUND JAPAN

By

Kaoru KIDO

*Laboratory of Marine Zoology, Faculty of Fisheries, Hokkaido
University, Hakodate, Hokkaido 041, Japan*

Contents

	Page
I. Introduction	127
II. Materials	127
III. Methods	129
IV. Systematic procedures	130
V. Comparative anatomy and discussion	131
1. Cranium	131
2. Infraorbital bones	138
3. Jaws	139
4. Suspensorium and opercular apparatus	140
5. Hyoid arch	144
6. Branchial apparatus	145
7. Pectoral girdle	148
8. Pelvic girdle	150
9. Vertebrae and their accessory bones	152
10. Dorsal and anal fins	153
11. Caudal complex	154
12. Others	157
VI. Phylogeny of the Liparididae	158
1. Monophyly of the Liparididae	158
2. Relationships within the Liparididae	158
3. Classification	163
VII. Taxonomy of the liparidid fishes found around Japan	164
1. Key to subfamilies	164
2. Subfamily Liparidinae	164
3. Key to genera of Liparidinae	164
4. Genus <i>Liparis</i> Scopoli	165
5. Key to species of <i>Liparis</i>	165
<i>Liparis burkei</i> (Jordan et Thompson)	166
<i>Liparis punctulatus</i> (Tanaka)	168

The present work was submitted as a partial fulfillment of the requirements for Doctor's degree in Fisheries Science at Hokkaido University in 1988.

Present address: Ishikawa Prefectural Fisheries High School, 106-7 Ushitsu, Noto-machi, Fugeshi-gun, Ishikawa Prefecture 927-04, Japan.

<i>Liparis bikunin</i> Matsubara et Iwai	171
<i>Liparis miostomus</i> Matsubara et Iwai	172
<i>Liparis frenatus</i> (Gilbert et Burke)	174
<i>Liparis tessellatus</i> (Gilbert et Burke)	176
<i>Liparis ochotensis</i> Schmidt	178
<i>Liparis latifrons</i> Schmidt	182
<i>Liparis agassizii</i> Putnam	185
<i>Liparis tanakai</i> (Gilbert et Burke)	187
<i>Liparis owstoni</i> (Jordan et Snyder)	189
6. Genus <i>Crystallichthys</i> Jordan et Gilbert	190
<i>Crystallichthys matsushima</i> (Jordan et Snyder)	190
7. Genus <i>Careproctus</i> Krøyer	192
8. Key to species of <i>Careproctus</i>	193
<i>Careproctus dentatus</i> sp. nov.	194
<i>Careproctus jordani</i> Burke	197
<i>Careproctus rhodomelas</i> Gilbert et Burke	198
<i>Careproctus marginatus</i> sp. nov.	200
<i>Careproctus segaliensis</i> Gilbert et Burke	202
<i>Careproctus sinensis</i> Gilbert et Burke	203
<i>Careproctus homopterus</i> Gilbert et Burke	205
<i>Careproctus mederi</i> Schmidt	206
<i>Careproctus macrodiscus</i> Schmidt	208
<i>Careproctus bathycoetus</i> Gilbert et Burke	210
<i>Careproctus furcellus</i> Gilbert et Burke	211
<i>Careproctus cypselurus</i> (Jordan et Gilbert)	213
<i>Careproctus cyclocephalus</i> Kido	215
<i>Careproctus rastrinus</i> Gilbert et Burke	217
<i>Careproctus trachysoma</i> Gilbert et Burke	220
<i>Careproctus nigricans</i> Schmidt	222
<i>Careproctus colletti</i> Gilbert	224
<i>Careproctus roseofuscus</i> Gilbert et Burke	227
9. Genus <i>Paraliparis</i> Collett	229
10. Key to species of <i>Paraliparis</i>	230
<i>Paraliparis barbulifer</i> (Gilbert)	231
<i>Paraliparis nanus</i> (Gilbert)	232
<i>Paraliparis mandibularis</i> Kido	234
<i>Paraliparis rosaceus</i> Gilbert	235
<i>Paraliparis atramentatus</i> Gilbert et Burke	237
<i>Paraliparis grandis</i> Schmidt	238
<i>Paraliparis meridionalis</i> Kido	240
<i>Paraliparis dipterus</i> sp. nov.	242
<i>Paraliparis entochloris</i> Gilbert et Burke	243
<i>Paraliparis melanobranchus</i> Gilbert et Burke	244
11. Subfamily Nectoliparidinae	245
12. Genus <i>Nectoliparis</i> Gilbert et Burke	245
<i>Nectoliparis pelagicus</i> Gilbert et Burke	246
13. Doubtful species	247
<i>Liparis sarasa</i> (Tanaka)	247
<i>Liparis furcatus</i> (Mori)	247
VIII. Summary	248
IX. Acknowledgments	248
X. Literature cited	249

I. Introduction

The fishes of the family Liparidae constitute a large group within the order Scorpaeniformes, including about 200 species in 19 genera. They are abundant in the North Pacific, North Atlantic and Antarctic, and inhabit from tidal zone to hadal zone over 7000 m (Andriashev, 1955, 1975; Rass, 1958). Most species are benthic with exceptions of some benthopelagic or pelagic species (Schmidt, 1950; Stein, 1978a; Peden, 1981).

The phylogeny of the liparidid fishes has never been studied except for Burke (1930) who discussed the relationships of the genera mainly on the basis of several external characters. The osteological studies have been made by several authors (e.g., Garman, 1982; Ueno, 1970; Andriashev et al., 1977; Andriashev, 1986), but those were very fragmentary. Though Able and McAllister (1980) and Andriashev (1986) discussed and suggested the polarities of external and meristic characters, they did not propose any phylogenetic relationships. As a result, Burke's view has been generally accepted in spite of vast addition of species since then.

This family has been often treated as a subfamily included in the Cyclopteridae. Nelson (1976) established the subfamily Rhodichthyinae within the Cyclopteridae, but later he reduced it to tribal level within the subfamily Liparidinae in 1984. In recent years, Yabe (1985) suggested that the liparidid and cyclopterid fishes form a sister group of the superfamily Cottoidea.

The Japanese liparidid fishes had been taxonomically studied by Jordan and Snyder (1902), Schmidt (1904a), Gilbert and Burke (1912b), Jordan and Thompson (1914) and Tanaka (1916). Burke (1930) made the most extensive revisional study of this family, including 114 species in 13 genera known up to that time from the world. On the basis of Burke's study, Okada and Matsubara (1938) gave a key to 38 species in 7 genera recorded from waters around Japan. Matsubara (1955) presented a key to 51 species in 8 genera of liparidid fishes from around Japan, Okhotsk and Bering Seas by adding new species described by Soldatov and Lindberg (1930), Abe (1950), Schmidt (1950) and Matsubara and Iwai (1954). More recently, based on Schmidt's manuscript, Krasyukova (1984) described 8 new species from the Japan and Okhotsk Seas. However, these studies were less than satisfactory, because many species were established on the basis of modest differences and limited specimens of small areas and are inadequately described with including many errors.

The purposes of this study are to demonstrate the monophyly of the family Liparidae, to clarify the outline of liparidid phylogeny by using internal and external characters on the basis of materials from the Northern Hemisphere, and to resolve the taxonomic problems of liparidids found from waters around Japan.

II. Materials

The specimens examined for this study are deposited in the following institutions: Department of Zoology, University of British Columbia, Vancouver (BC); British Columbia Provincial Museum, Victoria (BCPM); British Museum (Natural History), London (BMNH); Department of Biology, Faculty of Science, Kochi University, Kochi (BSKU); California Academy of Sciences, San Francisco (CAS)

and CAS-SU); Faculty of Agriculture, Kyoto University, Kyoto (FAKU and W); Field Museum of Natural History, Chicago (FMNH); Laboratory of Marine Zoology, Faculty of Fisheries, Hokkaido University, Hakodate (HUMZ); Museum of Comparative Zoology, Harvard University, Cambridge (MCZ); National Museum of Canada, Ottawa (NMC); Department of Zoology, National Science Museum, Tokyo (NSMT-P); College of Oceanography, Oregon State University, Corvallis (OSUO); National Museum of Natural History, Washington, D.C. (USNM); Zoological Institute, Academy of Sciences, Leningrad (ZIL); Department of Zoology, University Museum, University of Tokyo (ZUMT).

The specimens examined for the taxonomy are listed in the account of each species.

The osteological specimens are as follows (with number of specimens and size range in standard length):

LIPARIDIDAE

- Liparis tessellatus* : HUMZ 66177, 92934 (2 : 146–151 mm).
- L. montagui* : BMNH uncatalogued (1 : 48 mm).
- L. pulchellus* : CAS 21925 (2 : 93–124 mm).
- L. agassizii* : HUMZ 69964, 98214 (2 : 130 mm).
- L. atlanticus* : HUMZ 93773 (1 : 60 mm).
- L. callyodon* : BCPM 972-112 (2 : 70–72 mm).
- L. coheni* : NMC 79-0619 (1 : 98 mm).
- L. cyclopus* : CAS-SU 21335 (1 : 58 mm).
- L. dennyi* : BCPM 978-316 (1 : 61 mm); CAS-SU 21314 (1 : 76 mm).
- L. florae* : BCPM 977-180 (1 : 77 mm).
- L. frenatus* : HUMZ 98464 (1 : 35 mm).
- L. gibbus* : HUMZ 94344 (1 : 118 mm).
- L. inquilinus* : HUMZ 101174, 101179 (2 : 28–30 mm).
- L. liparis* : BMNH uncatalogued (1 : 67 mm); HUMZ 98230 (1 : 72 mm).
- L. miostomus* : HUMZ 75802 (1 : 54 mm).
- L. mucosus* : BCPM 972-105 (2 : 33–43 mm).
- L. ochotensis* : HUMZ 95529 (1 : 183 mm).
- L. punctulatus* : HUMZ 87442 (1 : 86 mm).
- L. tanakai* : HUMZ 71281 (1 : 171 mm).
- L. tunicatus* : HUMZ 82070 (1 : 89 mm).
- L. sp.* : CAS 25297 (1 : 78 mm).
- L. fabricii* : HUMZ 94343, 101169 (2 : 70–71 mm).
- L. greeni* : BC 65-29 (2 : 125–146 mm).
- Crystallichthys cyclospilus* : HUMZ 88352, 88434 (2 : 158–177 mm).
- Crystallichthys mirabilis* : HUMZ 46431, 46432, 55426 (3 : 230–264 mm).
- Crystallichthys matsushima* : HUMZ 42472, 75947 (2 : 219–221 mm).
- Careproctus bowersianus* : HUMZ 88485 (1 : 137 mm).
- C. candidus* : HUMZ 88549 (1 : 88 mm).
- C. colletti* : HUMZ 93353 (1 : 230 mm).
- C. cyclocephalus* : HUMZ 79718 (1 : 186 mm).
- C. cypselurus* : HUMZ 81963, 83355 (2 : 159–184 mm).
- C. furcellus* : HUMZ 88608, 88617 (2 : 122–169 mm).
- C. macrodiscus* : HUMZ 92711 (1 : 232 mm).
- C. marginatus* sp. nov. : HUMZ 72756 (1 : 136 mm).
- C. melanurus* : HUMZ 94279 (1 : 223 mm).
- C. rastrinus* : HUMZ 92718 (1 : 256 mm).

- C. roseofuscus* : HUMZ 92714 (1 : 256 mm).
C. simus : HUMZ 88528 (1 : 134 mm).
C. trachysoma : HUMZ 42747 (1 : 269 mm).
C. sp. A : HUMZ 88664 (1 : 125 mm).
C. mederi : HUMZ 77598 (1 : 231 mm).
C. ostentum : HUMZ 88465 (1 : 103 mm).
C. sp. B : HUMZ 81952, 84416 (2 : 127-155 mm).
C. reinhardtii : HUMZ 99461 (1 : 110 mm).
C. dentatus sp. nov. : HUMZ 77668, 77791 (2 : 234-251 mm).
Paraliparis tremebundus : HUMZ 81821, 81985 (2 : 174-193 mm).
P. pectoralis : HUMZ 81933 (1 : 127 mm).
P. grandis : HUMZ 77956, 78786, 78814, 78854 (4 : 252-343 mm).
P. dactylosus : HUMZ 88691 (1 : 124 mm).
P. ulochir : HUMZ 81953 (1 : 83 mm).
P. barbulifer : HUMZ 103286 (1 : 55 mm).
P. attenuatus : HUMZ 81865, 86531 (2 : ca. 122-140 m).
P. opercularis : OSUO uncatalogued (2 : 62-68 mm).
P. rosaceus : HUMZ 77802 (1 : 287 mm).
P. regina : HUMZ 99459, 99460 (2 : 173-186 mm).
P. garmani : MCZ 37629 (1 : 127 mm).
P. bathybius : BMNH uncatalogued (1 : 185 mm).
P. nanus : HUMZ 82513, 93189 (2 : 52-61 mm).
Osteodiscus cascadiae : OSUO uncatalogued (2 : 54-67 mm).
Nectoliparis pelagicus : HUMZ 82507, 92708 (2 : 51-61 mm).

Comparative material

CYCLOPTERIDAE

- Aptocyclus ventricosus* : HUMZ 68155, 93225 (2 : 81-199 mm).
Cyclopterus berqi : HUMZ 60908 (1 : 54 mm).
C. lindbergi : HUMZ 41546, 65649, 92666 (3 : 52-57 mm).
C. phrynoides : HUMZ 78570 (1 : 43 mm).
Cyclopsis tentacularis : HUMZ 72985 (1 : 72 mm).
Cyclopterus lumpus : HUMZ 98235, 99323 (2 : 80-110 mm).
Eumicrotremus andriashevi : HUMZ 54268 (1 : 80 mm).
E. birulai : HUMZ 56391 (1 : 94 mm).
E. derjagini : HUMZ 101183 (1 : 59 mm).
E. derjugini ochotensis : HUMZ 60904, 60907, 60956 (3 : 63-73 mm).
E. orbis : HUMZ 88533 (1 : 63 mm).
E. pacificus : HUMZ 92456, 92459, 92461 (3 : 50-67 mm).
E. schmidti : HUMZ 75493 (1 : 89 mm).
E. soldatovi : HUMZ 56421 (1 : 132 mm).
E. taranetzi : HUMZ 92686 (1 : 57 mm).
Lethotremus awae : HUMZ 79072, 79076 (2 : 20-21 mm).
L. muticus : HUMZ 89054 (1 : 43 mm).

III. Methods

Counts, measurements and terminology follow Stein (1978a) except that rays of the lower lobe of pectoral fin are counted from the anteriormost ray to the longest ray, that pectoral fin rays are counted on both sides of body, and that length of lower lobe of pectoral fin is the length of the longest ray of the lower lobe. The cephalic

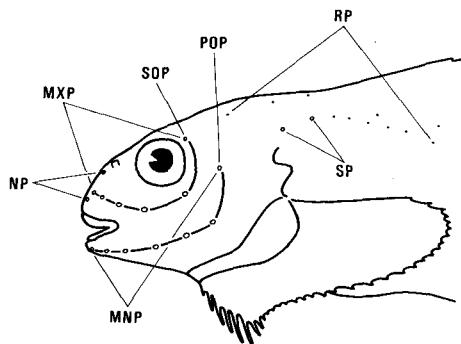


Fig. 1. Diagram showing the arrangement of cephalic and rudimentary pore series on a typical liparidid fish. MNP, mandibular pore; MXP, maxillary pore; NP, nasal pore; POP, postocular pore; RP, rudimentary pore; SOP, supraocular pore; SP, suprabranchial pore. (from Kido, 1985b).

pore formula lists the number of pores in each series in the following order: nasal, maxillary, mandibular and suprabranchial series. Their terminology and locations are shown in Fig. 1. Vertical fin rays and vertebrae were counted using radiographs. Caudal and total vertebral counts include the urostyle.

Osteological observations were made on specimens cleared and stained with alcian and alizarin (Dingerkus and Uhler, 1977). Osteological drawings were prepared with the aid of a Wild M8 stereomicroscope equipped with a camera lucida. The osteological terminology follows Collette and Russo (1984) and Yabe (1985). The lacrimal is referred to as the first infraorbital and the second suborbital sensu Matsubara (1943) as the third infraorbital.

IV. Systematic procedures

The phylogenetic relationships within the liparididae were estimated by cladistic analysis. Character polarity was established by outgroup comparison following the method of Sawada (1982). His criterion is as follows: "If two character states of two morphoclines found in a given group and its closest related group are identical, the identical character states are the most primitive." The most closely related group and the next closely related group to the family Liparididae were determined by the following unique unreversed character states (Wilson, 1965) within the order Scorpaeniformes: 1) the posttemporal fossa is shallow or absent; 2) the basisphenoid is absent (Figs. 3, 4, 6); 3) the epaxialis reaches almost above the middle of the orbit; 4) the myodome is absent; 5) the entopterygoid and the ectopterygoid fuse to each other (Fig. 10); 6) the first basibranchial is firmly attached to the dorsal facet of the urohyal; 7) the second and third basibranchials are cartilaginous (Fig. 12); 8) all actinosts are located between the scapula and the coracoid (Fig. 13); 9) the ethmoid cartilage forms a keel projecting anteriorly on the dorsal midline (Figs. 3, 4, 6A); 10) the ethmoid cartilage does not form a posterior expansion in the anterior portion of the orbit (Figs. 3-6A); 11) a narrow cartilage extends along the ventral ridge of the frontal in the dorsal orbital region of each side (Figs. 3, 4, 6A); 12) the third infraorbital is needle-like (Fig. 7); 13) the retroarticular is connected with the epihyal by a well developed ligament which is free from the interopercle (the ligament is attached to the medial surface of the interopercle in cyclopterids); 14) the ethmoid is located between anterior portions

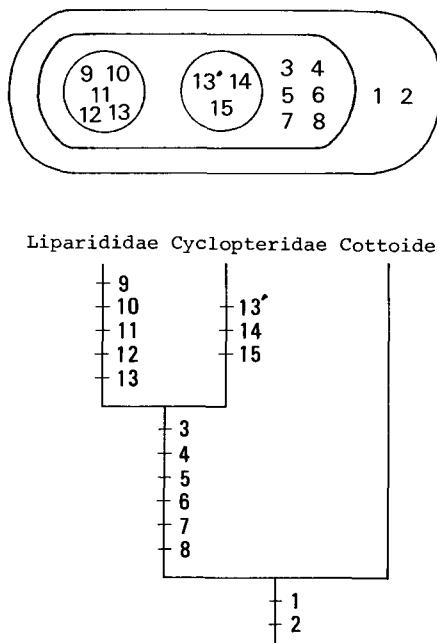


Fig. 2. Three groups based on 15 unique unreversed character states.
Numerals correspond to those of text.

of the both frontals (Fig. 6B); 15) a cartilaginous portion between the ceratohyal and the epihyal is extending dorsally or anterodorsally (Fig. 11E).

These character states passed the consistency test are summarized in Fig. 2. The first group with the character states 1-13 corresponds to the family Liparididae. The second group with the character states 1-8 and 13'-15 corresponds to the family Cyclopteridae sensu Ueno (1970). The third group with only the character states 1 and 2 corresponds to the superfamily Cottoidea sensu Yabe (1985). As a result, the family Cyclopteridae is most closely related to the family Liparididae, and the superfamily Cottoidea is next closely related to the family (Fig. 2). This result agrees with that of Yabe (1985).

The cladogram was constructed on the basis of parsimony argument without including reversals.

V. Comparative Anatomy and Discussion

1. CRANUM

DESCRIPTION. The cranium is composed of the prevomer, ethmoid, lateral ethmoid, frontal, parietal, sphenotic, pterosphenoid, prootic, pterotic, epiotic, intercalar, supraoccipital, exoccipital, basioccipital and parasphenoid. In all liparidids examined, the basisphenoid is absent. The nasal is described in this section.

In dorsal view, the liparidid cranium is more or less trapezoidal in shape. The dorsal surface is relatively flat by the low supraoccipital crest and a shallow groove on each side. Generally the liparidid cranium contains many cartilaginous components which frequently separate each bone.

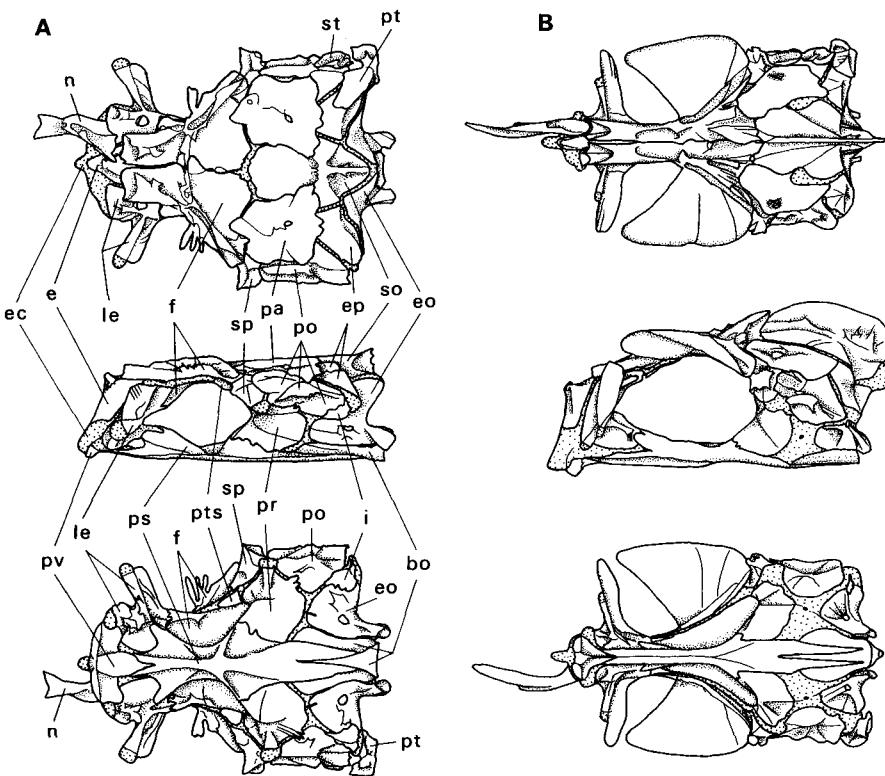


Fig. 3. Cranium of liparid fishes in dorsal (top), lateral (middle) and ventral (bottom) views. A, *Liparis liparis*; B, *Crystallichthys matsushima*. bo, basioccipital; e, ethmoid; ec, ethmoid cartilage; eo, exoccipital; ep, epiotic; f, frontal; i, intercalar; le, lateral ethmoid; n, nasal; pa, parietal; po, pterygoid; pr, prootic; ps, parasphenoid; pt, posttemporal; pts, pterosphenoid; pv, prevomer; so, supraoccipital; sp, sphenotic; st, supratemporal. Large dots represent cartilage. Bars are 5 mm.

The nasal (n) is a tubular or flat bone connected with the frontal posteriorly and attached to the ethmoid posteromedially. It bears the medial edge projecting dorsally, and is usually expanded laterally. The supraorbital sensory canal coming from the frontal passes anteriorly through its basal portion. In *Crystallichthys*, the nasal is very elongate, and its length is more than one-third of the cranium (Fig. 3B). In the remaining species examined, its length is less than one-third, mostly about one-fifth, of the cranium (Figs. 3A, 4, 6A).

The prevomer (pv) is an unpaired T-shaped or triangular bone. It forms the anteroventral portion of the cranium, and is attached to the ventral surface of the ethmoid cartilage (ec). It tapers posteriorly and is firmly attached to the parasphenoid. Posterolaterally it approaches or overlaps the lateral ethmoid. The lateral tip of the prevomer is ligamentously connected with the medial surface of the

palatine. This bone is toothless.

The ethmoid (e) is an unpaired bone lying on the anterodorsal midline of the cranium. Though it usually lies on the ethmoid cartilage (Figs. 3, 4B, 6A), in *Nectoliparis* the ethmoid cartilage is absent in this portion (Fig. 5). It is oval in dorsal view and located between lateral ethmoids on both sides. The anterior portion of the ethmoid is exposed in dorsal view, and the remaining portion is overlapped posteriorly by the frontal. It is attached to the nasal dorsolaterally. The ethmoid and ethmoid cartilage form a ridge on anterior dorsal midline for articulation with the rostral cartilage of the premaxillary. The median ridge of the ethmoid cartilage is present as a small process in dorsal and ventral views. Dorsolaterally it has a process on each side, from which a forked ligament extends to the maxillary head and palatine.

The lateral ethmoid (le) is a paired bone bearing a developed lateral wing to form the anterior margin of the orbit. The posterodorsal expansion of the wing is the membranous. This bone is completely separated from the ethmoid by the ethmoid cartilage or the ethmoid cartilage and a foramen for the olfactory nerve. It

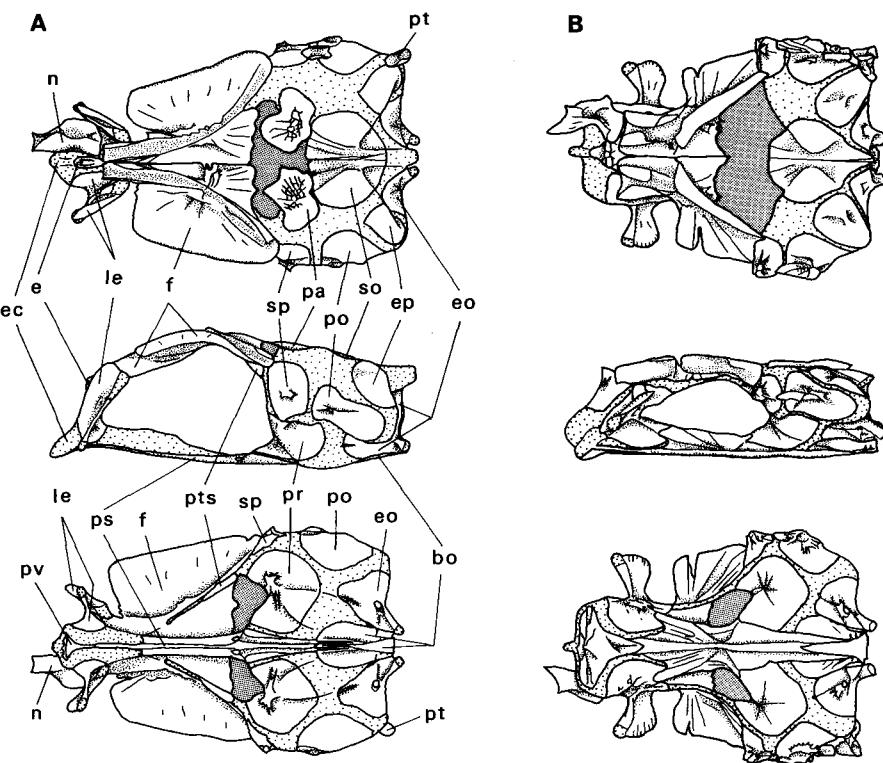


Fig. 4. Cranium of liparidid fishes in dorsal (top), lateral (middle) and ventral (bottom) views. A, *Nectoliparis pelagicus*; B, *Paraliparis regina*. Abbreviations as in Fig. 3. Large dots represent cartilage. Bars are 5 mm.

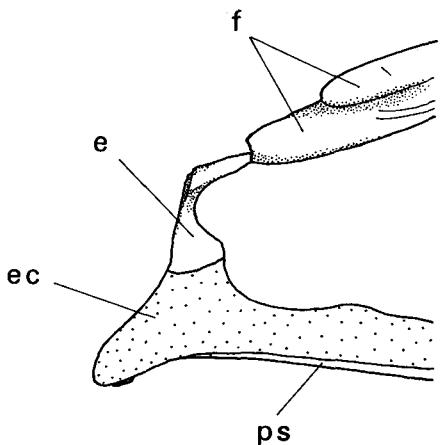


Fig. 5. Anterior portion of cranium of *Nectoliparis pelagicus* in lateral view. Lateral ethmoid is removed. Abbreviations as in Fig. 3. Large dots represent cartilage. Bar is 1 mm.

is usually sutured to the frontal posterodorsally and rarely separated from the bone by the interposition of the ethmoid cartilage. It approaches or contacts the prevomer anteroventrally, and is usually overlapped posteroventrally by the lateral process of the parashenoid. The cartilaginous articular head of the wing articulates with an facet of the first infraorbital. It articulates with an facet of the palatine at the ventrolateral articular head. The median half of the lateral ethmoid has a foramen of variable size and position for the olfactory nerve.

The frontal (f) is a paired bone forming the largest portion of the dorsal surface of the cranium. This bone meets its fellow on the dorsal midline to form the interorbital space. It bears laterally a developed membranous wing which forms the dorsal margin of the orbit. It overlaps the posterior portion of the ethmoid. Anteroventrally it approaches or is sutured to the lateral ethmoid. It abuts the medial side of the pterosphenoid by its ventrolateral ridge if the bone is present. Posteriorly it approaches or is overlapped by the parietal if the bone is present. Posteriorly it usually overlaps or is slightly separated from the supraoccipital (Figs. 3, 6A). While, in *Liparis fabricii*, *Careproctus reinhardti*, *Paraliparis bathybius*, *Paraliparis regina* and *Nectoliparis*, the posterior portion of the frontal is reduced, so that there is a gap between this bone and the supraoccipital (Fig. 4). The gap is covered with the membranous structure. Posterolaterally the frontal overlaps the anterior portion of the sphenotic. It has the tubular structure or a groove for the supraorbital and interorbital canals.

The parietal (pa) is a platelike paired bone forming the posterodorsal roof of the cranium. If present, it varies in size and shape. It overlaps or approaches the frontal anteriorly, the supraoccipital medially, the sphenotic anterolaterally, the pterotic laterally and the epiotic posteriorly. In *Paraliparis rosaceus*, *P. garmani*, *P. ulochir*, *P. bathybius*, *P. barbulifer*, *P. attenuatus*, *P. opercularis*, *P. regina*, *P. nanus* and *Osteodiscus*, it is absent (Figs. 4B, 6A). In these species, the cartilaginous interposition occupies the place. In most species of *Liparis*, which have the relatively large parietal (Fig. 3A), the ramus lateralis accessorius exits through this

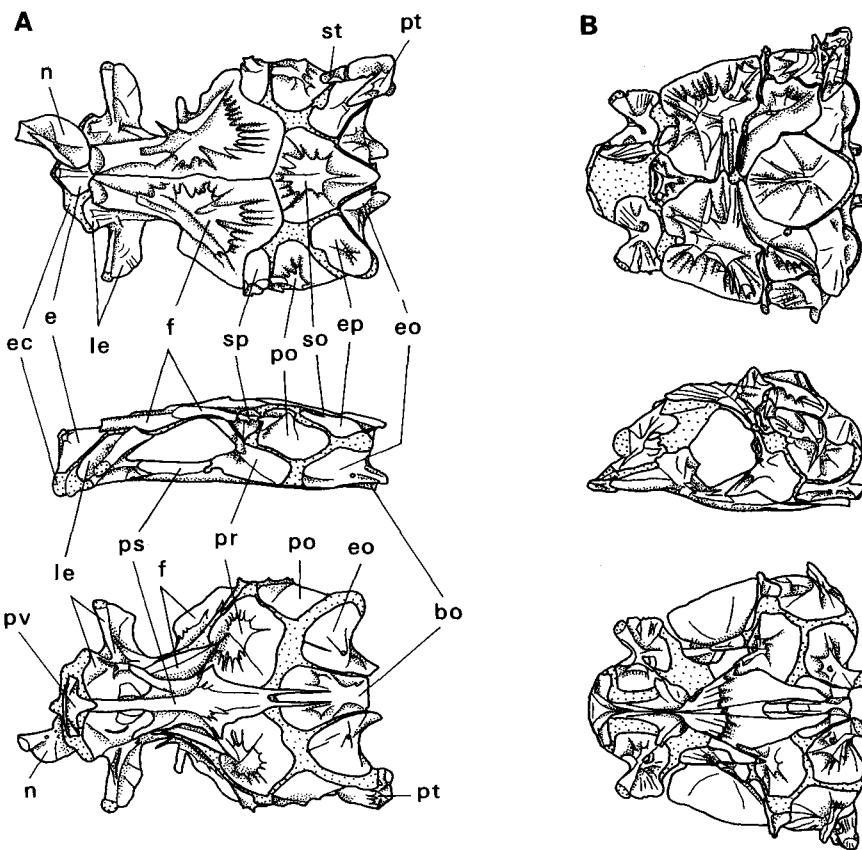


Fig. 6. Cranium of liparidid (A) and cyclopterid (B) fishes in dorsal (top), lateral (middle) and ventral (bottom) views. A, *Paraliparis opercularis*; B, *Eumicrotremus orbis*. Abbreviations as in Fig. 3. Large dots represent cartilage. Bars are 5 mm.

bone.

The sphenotic (sp) is a paired bone forming the most posterior dorsolateral portion of the roof of the orbit. It is overlapped by the frontal anteriorly, usually by the pterotic posteriorly and usually by the parietal posteromedially. It is separated from prootic ventrally and from the pterosphenoid anteromedially when the bone is present. Laterally it is connected with the fourth infraorbital. On this bone, the supraorbital, infraorbital and postorbital sensory canals are connected. The ventrolateral wall of this bone affords a segment of the articular fossa for the anterior head of the hyomandibular.

The pterosphenoid (pts) is a paired bone forming the posterodorsal region of the orbit. It is located on the posteriomost portion of the narrow cartilage which extends along the ventral ridge of the frontal in the dorsal orbital region. It abuts

the ventral ridge of the frontal dorsomedially. It is separated from the sphenotic posterolaterally and from the prootic posteroventrally. This bone is present only in *Liparis* and *Nectoliparis* (Figs. 3A, 4A).

The prootic (pr) is a paired bone forming the anterolateral portion of the otic capsule and the posterior margin of the orbit. It is separated from the pterosphenoid anterodorsally when the bone is present, from the exoccipital posteriorly and from the basioccipital posteromedially. It overlaps or approaches the pterotic dorsolaterally. It approaches or is overlapped by the parasphenoid ventromedially. The most lateral wall of this bone affords a segment of the articular fossa for the anterior head of the hyomandibular. The trigeminofacialis chamber is absent in liparidids.

The pterotic (po) is a paired bone forming the posterolateral corner of the cranium. It overlaps or approaches the sphenotic anteriorly. It approaches or is overlapped by the prootic anteromedially. Medially it is overlapped by the parietal or separated from the bone, when the bone is present. It is separated from the epiotic and exoccipital posteromedially. Posteromedially it is overlapped by the intercalar or separated from the bone, when the bone is present. The supratemporal lies on the posterodorsal surface of this bone. The anterodorsal surface of this bone forms the tubular structure or a groove in most liparidids. In *Paraliparis nanus* and *Nectoliparis*, this structure is present as a single bone. In *Liparis fabricii* this change is present as the intraspecific variation. The postorbital sensory canal coming from the supratemporal passes anteriorly through this structure. The anteroventral wall of this bone affords a segment of the articular fossa for the anterior condyle of the hyomandibular. Anterolaterally it bears the articular fossa for reception of the middle condyle of the hyomandibular. The posttemporal fossa is absent.

The epiotic (ep) is a paired bone forming posterior portion of the cranium. It is separated from the pterotic anterolaterally, from the supraoccipital anteromedially and from the exoccipital posteroventrally. Anteriorly it is overlapped by the parietal or separated from the bone, when the bone is present. The medial portion of the posttemporal attaches to the posterolateral surface of the epiotic.

The intercalar (i) is a small paired bone located between the pterotic and the exoccipital. This bone varies in size and shape. It is absent in *Paraliparis garmani*, *P. rosaceus*, *P. ulochir*, *P. bathybius*, *P. barbulifer*, *P. attenuatus*, *P. opercularis*, *P. regina*, *Osteodiscus* and *Nectoliparis* (Figs. 4, 6A). In *Careproctus reinhardti* and *Crystallichthys matsushima* (HUMZ 42472), it is present on left side, but absent on right side (Fig. 3B). In the remaining specimen (HUMZ 75947) of *Crystallichthys matsushima*, they are present on both sides.

The supraoccipital (so) forms the dorsomedial portion of the posterior end of the cranium. The supraoccipital crest is weakly developed. Anteriorly it is overlapped by the frontal or separated from the bone. Laterally it is overlapped by the parietal or separated from the bone when the bone is present. It is separated from the epiotic posterolaterally and from the exoccipital posteroventrally.

The exoccipital (eo) is a paired bone forming the dorsolateral wall of the foramen magnum and connecting the cranium to the first vertebra dorsally. The exoccipitals are separated from each other by the cartilaginous interposition. It is

separated from the epiotic and supraoccipital anterodorsally. Dorsolaterally it is usually overlapped by the intercalar, when the bone is present. It contacts the basioccipital medially. Posteroventrally it has a developed condyle to articulate with the lateral articular head of the first centrum. The small glossopharyngeal foramen opens on this bone or on the cartilaginous interposition between the prootic and this bone. The position of this foramen considerably varies within species. The large vagal foramen opens on this bone.

The basioccipital (bo) is the most posteroventrally located bone of the cranium. It is separated from the prootic anteriorly and overlapped by the parasphenoid medially. It contacts the exoccipital laterally. Posteriorly it articulates with the first centrum.

The parashenoid (ps) is a long bone forming the ventral axis of the cranium. It is overlapped by the prevomer anteriorly. Laterally it overlaps or is separated from the lateral ethmoid and prootic. Posteriorly it tapers into two rami which overlap the ventral portion of the basioccipital.

DISCUSSION. The liparidid cranium has been studied by Garman (1892, 1899), Ueno (1970) and Yabe (1985). Garman (1892) mainly described the frontal ridge and the supraoccipital crest in several species of *Liparis*. Garman (1899) figured the cranium of *Paraliparis grandiceps* (= *Paraliparis rosaceus*). Ueno figured the cranium of *Liparis florate*. Yabe examined the cranium of *Liparis tessellatus* and compared it to those of the cottoid fishes. However, the interspecific variations of the liparidid crania are little known.

Among the liparidid crania examined, the following interspecific variations are recognized: (1) length of the nasal; (2) reduction of the ethmoid cartilage; (3) reduction of the posterior portion of the frontal; (4) presence or absence of the parietal; (5) presence or absence of the pterosphenoid; (6) presence or absence of a bone on the pterotic; and (7) presence or absence of the intercalar.

(1) Length of the nasal: The length of the nasal in *Crystallichthys* is more than one-third of the cranium (Fig. 3B). While, in the other liparidids and all cyclopterids examined, it is less than one-third, mostly about one-fifth, of the cranium (Figs. 3A, 4, 6). The long nasal bone is a derived state within liparidids.

(2) Reduction of the ethmoid cartilage: In *Nectoliparis*, there is lost the ethmoid cartilage supporting posterodorsal portion of the ethmoid (Fig. 5). In the other liparidids and all cyclopterids examined, the ethmoid cartilage is present in this region (Figs. 3, 4B, 6). The state found in *Nectoliparis* is derived within liparidids.

(3) Reduction of the posterior portion of the frontal: In *Liparis fabricii*, *Careproctus reinhardti*, *Paraliparis bathybius*, *P. regina* and *Nectoliparis*, the posterior portion of the frontal is reduced (Fig. 4). It is not reduced in the other liparidids and all cyclopterids examined (Figs. 3, 6). The reductive frontal is a derived state within liparidids.

(4) Presence or absence of the parietal: In *P. rosaceus*, *P. garmani*, *P. ulochir*, *P. bathybius*, *P. barbulifer*, *P. attenuatus*, *P. opercularis*, *P. regina*, *P. nanus* and *Osteodiscus*, the parietal is absent (Figs. 4B, 6A). In the remaining liparidids and all cyclopterids examined, it is present (Figs. 3, 4A, 6B). The lack of the parietal represents a derived state within liparidids.

(5) Presence or absence of the pterosphenoid: The pterosphenoid is present in *Liparis*, *Nectoliparis* and all cyclopterids examined (Figs. 3A, 4A, 6B). This bone is absent in the other liparidids examined (Figs. 3B, 4B, 6A). The lack of the pterosphenoid is a derived state within liparidids.

(6) Presence or absence of a bone on the pterotic: This character are not adopted because the intraspecific variation is observed in *Liparis fabricii*.

(7) Presence or absence of the intercalar: This character is not adopted because the intraspecific variations are observed in *Careproctus reinhardti* and *Crystallichthys matsushima* (Fig. 3B).

2. INFRAORBITAL BONES

DESCRIPTION. Infraorbital bones (io) are slender and four in number (Fig. 7). They are deeply canalized for the infraorbital sensory canal.

The first infraorbital is attached anteromedially to the anterior process of the palatine. It bears an articular facet at the dorsomedial margin for articulation with the lateral wing of the lateral ethmoid.

The second and third infraorbitals form the ventral border of the orbit with the first. The second infraorbital is attached anterodorsally to the first infraorbital.

The third infraorbital is the longest bone of the four, and its posterior half is needle-like in shape. Anterodorsally it is attached to the second infraorbital. Posteriorly it is firmly attached to the preopercle to form the suborbital stay. It extends posteriorly to almost posterior margin of the preopercle in *Liparis*, *Crystallichthys* and several species of *Careproctus* (Fig. 8A). In the other liparidids examined, the third infraorbital extends posteriorly to almost middle of preopercle or somewhat behind it. In *Nectoliparis*, however, it extends posteriorly to the anterior margin of the preopercle (Fig. 8B).

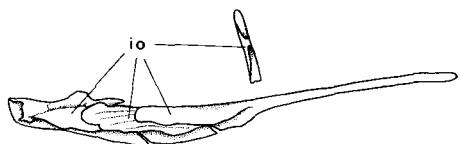


Fig. 7. Infraorbital bones of *Liparis agassizii* in lateral view. io, infraorbital bone. Bar is 5 mm.

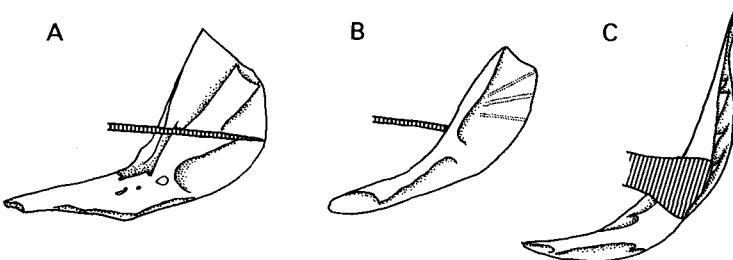


Fig. 8. Position of posterior end of third infraorbital in liparidid (A, B) and cyclopterid (C) fishes. A, *Liparis miostomus*; B, *Nectoliparis pelagicus*; C, *Eumicrotremus orbis*.

The fourth infraorbital is generally tubular, and the smallest bone of the four, forming the posterior margin of the orbit. It is located above almost the middle of the third infraorbital, and connected dorsally with the sphenotic.

DISCUSSION. The liparidid infraorbital bones have been examined by Gill (1891), Garman (1892), Regan (1913), Burke (1930), Matsubara (1943, 1955), Ueno (1970) and Yabe (1985), and they have noted the slender suborbital stay. Ueno showed a figure of the infraorbital bones in *Liparis florae* (fig. 77B), but the fourth infraorbital bone is inaccurate in position.

Among the liparidid infraorbital bones examined, an interspecific variation is found in the position of the posterior end of the third infraorbital. In almost all liparidids examined, the third infraorbital reaches posteriorly from the middle to the posterior margin of the preopercle (Fig. 8A), while its posterior end is located on the anterior margin of the preopercle in *Nectoliparis* (Fig. 8B). In all cyclopterids examined, its posterior end is located on almost the middle of preopercle or behind it (Fig. 8C). The state found in *Nectoliparis* is thus derived within liparidids.

3. JAWS

DESCRIPTION. The upper jaw is composed of the premaxillary and the maxillary (Fig. 9). The lower jaw is composed of the dentary, angular, retroarticular, coronomeckelian and meckelian cartilage (Fig. 9).

The premaxillary (pm) forms the upper margin of the gape. It is always provided with the ascending, articular, alveolar and postmaxillary processes. The ascending and alveolar processes (acp and alp) meet at approximately right angle to one another. The ascending process projects dorsally, and is firmly bounded to its fellow in the midline. The rostral cartilage (rc) projects back from the ascending process, and is articulated with the rostral region of the cranium. The ascending

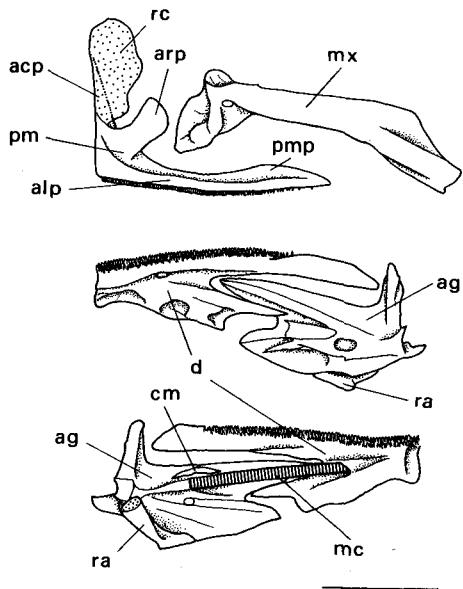


Fig. 9. Jaws of *Liparis tessellatus*. Top, upper jaw in lateral view; middle, lower jaw in lateral view; bottom, lower jaw in medial view. acp, ascending process; alp, alveolar process; ag, angular; arp, articular process; cm, coronomeckelian; d, dentary; mc, meckelian cartilage; mx, maxillary; pm, premaxillary; pmp, postmaxillary process; ra, retroarticular; rc, rostral cartilage. Large dots represent cartilage. Bar is 5 mm.

process is ligamentously connected with the maxillary head and the palatine. The articular process (arp) projects posteriorly from the angle between the ascending and alveolar processes, and is articulated with the maxillary head. The alveolar process is always toothed, and runs parallel to the the maxillary. The postmaxillary process (pmp) is on the posterodorsal edge of the alveolar process.

The maxillary (mx) is slender and rodlike. It is composed of the head and shaft. The maxillary head bears two facets for anterior articulation with the articular process of the premaxillary and posterior articulation with the anterior process of the palatine. It is ligamentously connected with the ascending process of the premaxillary and the ethmoid.

The dentary (d) forms the lower margin of the gape. It is always toothed and possesses a deep notch posteriorly where the angular and the meckelian cartilage insert. The operculomandibular sensory canal passes anteriorly through its ventral portion.

The angular (ag) forms a half of the lower jaw posteroventrally. Posterodorsally it possesses a facet for reception of the quadrate condyle. It bears a distinct process projecting dorsally in front of the facet. It is connected with a small process behind the maxillary head by a ligament. Ventrally the operculomandibular sensory canal passes anteriorly through it.

The retroarticular (ra) is a small bone which forms the posteroventral corner of the lower jaw. It is attached to the posteroventral corner of the angular. Posteriorly it is connected with the epihyal by a well developed ligament.

The coronomeckelian (cm) is a tiny bone located on the medial surface of the angular. It is present in almost liparidids examined (Fig. 9), but absent in *P. regina*, *P. bathybius*, *P. ulochir* and *Osteodiscus*. In *P. opercularis*, it is present in one specimen, but absent in another specimen. In *Nectoliparis* (HUMZ 92708), it is present on left side, but absent on right side. In *P. attenuatus* (HUMZ 81865), it is present on right side, but absent on left side.

The meckelian cartilage (mc) is rodlike, and located on the medial surface of the angular. It interconnects the angular and the dentary.

DISCUSSION. Gill (1891) gave a description of the jaws of liparidids. The jaws of *Paraliparis grandiceps* (= *P. rosaceus*) are figured by Garman (1892).

The jaws of liparidids examined here are almost uniform. They are very similar to those of cyclopterids and cottoids. Presence or absence of the coronomeckelian is not adopted as a character because of the intraspecific variation in *P. opercularis*, *P. attenuatus* and *Nectoliparis*.

4. SUSPENSORIUM AND OPERCULAR APPARATUS

DESCRIPTION. The suspensorium is composed of the hyomandibular, metapterygoid, symplectic, quadrate, ento+ectopterygoid and palatine. The opercular apparatus is composed of the opercle, subopercle, interopercle and preopercle.

The hyomandibular (h) is an inverted L-shaped bone which connects the mandibular suspensorium and opercular apparatus to the cranium. There are three prominent condyles on the dorsal end of the hyomandibular. The anterior condyle articulates with the cartilaginous fossa surrounded with the sphenotic, pterotic and prootic. The middle condyle articulates with the ventrolateral fossa of the pterotic.

The posterior condyle with the long shank articulates posteroventrally with a anterodorsal socket of the opercle. Anteroventrally this bone is more or less overlain by the metapterygoid in almost liparidids. In several liparidids, it just touches the metapterygoid or is somewhat separated from the bone. Posteroventrally it is firmly attached to the preopercle. Ventrally it is separated from the symplectic by the cartilaginous region.

The metapterygoid (m) is a thin bone, and roughly oval, rectangular or triangular in shape. Ventrally it is attached to the symplectic or separated from the bone by the narrow cartilaginous region. Anteriorly it just touches the ento+ectopterygoid or is separated from the bone.

The symplectic (s) is a rodlike bone which fits into a groove on the medial surface of the quadrate. There is a large gap between the symplectic and the preopercle.

The quadrate (q) is a roughly triangular bone forming the ventral margin of the suspensorium. It is separated from the metapterygoid by the cartilaginous region. On the posteromedial surface it bears a deep groove which accepts the symplectic. Its posterior process is attached along the lower anterior arm of the preopercle. Ventrally it bears a large condyle for articulation with the angular. Anterodorsally it just touches the ento+ectopterygoid or is separated from the bone.

The ento+ectopterygoid (e) consists of fusion of the entopterygoid and the ectopterygoid in liparidids. It is a thin bone, and roughly elongate roctangular or triangular in shape. It is located among the palatine, quadrate and metapterygoid. It is medially attached to the anterior expansion from the cartilaginous region between the metapterygoid and the quadrate. In almost all liparidids it is relatively large (Fig. 10A, C-E), whereas in *Careproctus reinhardti* it is moderate in size (Fig. 10B). In *Nectoliparis*, it is reduced to a tiny bone completely overlain by the anterior cartilaginous extention (Fig. 10F).

The palatine (p) is a triangular bone with the process anteriorly or reduced rodlike bone. It articulates anteriorly with the facet of the premaxillary, and is attached anterolaterally to the first infraorbital. It bears a facet dorsomedially for articulation with the ventrolateral articular head of the lateral ethmoid. It is ligamentously connected anterodorsally with the ethmoid, with the ascending process of the maxillary in the middle of the dorsal margin, medially with the lateral tip of the prevomer and posterodorsally with posterior base of the lateral wing of the lateral ethmoid. Posteriorly it is attached to the ento+ectopterygoid and the anterior cartilaginous extension or only to the anterior cartilaginous extension. This bone is toothless.

The opercle (o) bears anterodorsally a socket which articulates with the posterior condyle of the hyomandibular. Behind the socket there is a small process. The opercle generally bears anteroventrally a short spine directed ventrally and posteroventrally a long spine directed posteriorly. These two spines are thin and weak (Fig. 10A-C, E). In *P. opercularis*, they are distinctly long and strong, and directed posterolaterally (Fig. 10D).

The subopercle (so) is an thin and inverted V shaped bone which is loosely attached to the medial surface of the anteroventral spine of the opercle. In *Careproctus dentatus* sp. nov., the anterior spine is much reduced to a tiny process,

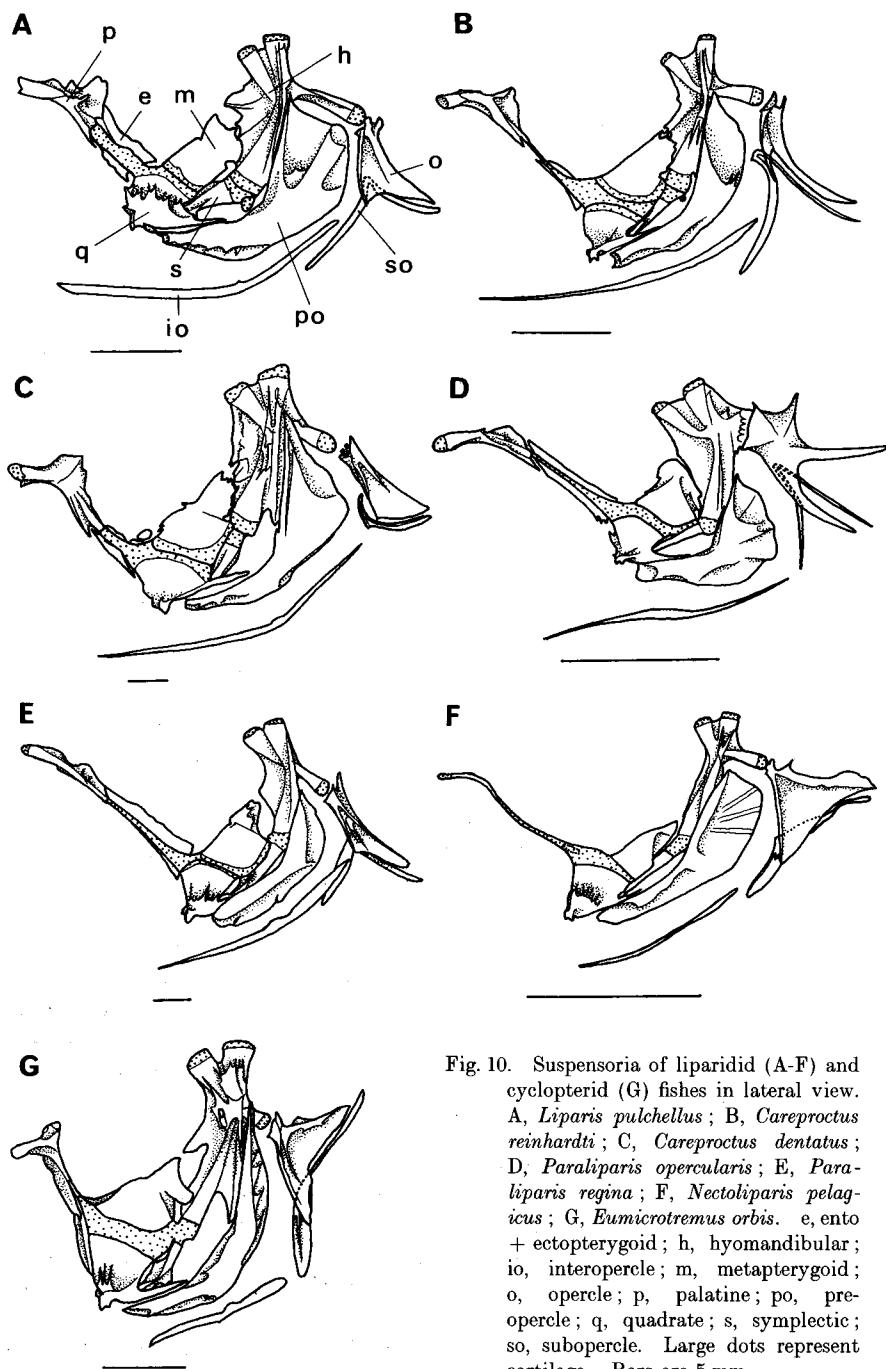


Fig. 10. Suspensoria of liparidid (A-F) and cyclopterid (G) fishes in lateral view.
 A, *Liparis pulchellus*; B, *Careproctus reinhardti*; C, *Careproctus dentatus*; D, *Paraliparis opercularis*; E, *Paraliparis regina*; F, *Nectoliparis pelagicus*; G, *Eumicrotremus orbis*. e, ento + ectopterygoid; h, hyomandibular; io, interopercle; m, metapterygoid; o, opercle; p, palatine; po, preopercle; q, quadrate; s, symplectic; so, subopercle. Large dots represent cartilage. Bars are 5 mm.

and the subopercle is L in shape (Fig. 10C). In almost all liparidids, both spines of the subopercle form a sharp angle at least less than right angle (Fig. 10A-E). In *Nectoliparis*, they form a larger angle of about 160° (Fig. 10F).

The interopercle (io) is a very long and slender bone lying under the preopercle. It is separated from the subopercle in almost all liparidids (Fig. 10A-D, F), whereas in *P. regina* it is attached to the lateral surface of the anterior spine of the subopercle (Fig. 10E).

The preopercle (po) is the largest bone in the opercular apparatus. Anteriorly it is firmly attached along the posterior margin of the hyomandibular and the posterior process of the quadrate. Ventrally the operculomandibular sensory canal passes anteriorly through it.

DISCUSSION. The liparidid opercular apparatus has been examined in several species by Gill (1891), Garman (1892, 1899), Johnsen (1921) and Ueno (1970). They have noted the shape of the opercular bones. Ueno (1970) and Yabe (1985) have examined the liparidid suspensorium in a few species. Yabe described the fusion of the entoptygoid and ectoptygoid in cyclopterids and liparidids.

Among the liparidid suspensoria and opercular apparatus examined, the following interspecific variations are recognized: (1) reductive degree of the ento+ectoptygoid; (2) state of the opercular spines; (3) state of the anterior spine of the subopercle; (4) angle formed by two spines of the subopercle; and (5) relation between the subopercle and the interopercle.

(1) Reductive degree of the ento+ectoptygoid: In *Careproctus reinhardti*, the ento+ectoptygoid is distinctly reduced (Fig. 10B). This bone in *Nectoliparis* is further reduced to a tiny bone (Fig. 10F). In all the other liparidids and cyclopterids examined, it is not reduced (Fig. 10A, C-E, G). The state in *Nectoliparis* is the most derived within liparidids.

(2) State of the opercular spines: In *P. opercularis*, the opercular spines are long and strong, and directed posterolaterally (Fig. 10D). In all the other liparidids and cyclopterids examined, they are thin and weak, and not directed laterally (Fig. 10A-C, E-G). The state in *P. opercularis* is derived within liparidids.

(3) State of the anterior spine of the subopercle: In almost all liparidids examined, the subopercle consists of two spines (Fig. 10A-B, D-F). In *Careproctus dentatus* sp. nov., its anterior spine is reduced to a tiny process (Fig. 10C). In cyclopterids examined, the anterior spine is not reduced (Fig. 10G). The state in *C. dentatus* is thus derived within liparidids.

(4) Angle formed by two spines of the subopercle: In almost all liparidids examined, an angle formed by two spines of the subopercle is less than right angle (Fig. 10A-E), while it is about 160° in *Nectoliparis* (Fig. 10F). These two states are also recognized in cyclopterids examined. In cottoids, only the same state as in *Nectoliparis* is recognized (see Yabe, 1985, fig. 16). The state found in liparidids except for *Nectoliparis* is thus derived within liparidids.

(5) Relation between the subopercle and the interopercle: In *P. regina* the interopercle is attached to the lateral surface of the subopercle (Fig. 10E), while it is separated from the bone in all the other liparidids and all cyclopterids examined (Fig. 10A-D, F-G). The state in *P. regina* is derived within liparidids.

5. HYOID ARCH

DESCRIPTION. The hyoid arch is composed of the basihyal, dorsal and ventral hypohyals, ceratohyal, epihyal, interhyal, branchiostegal rays and urohyal.

The basihyal is present in *Careproctus bowersianus* and *C. ostentum*, while it is absent in the other liparidids. In *C. bowersianus*, it is a cartilaginous bone lying on the connection of both ventral hypohyals. In *C. ostentum*, it is a tiny bone located between both ventral hypohyals and in front of the first basibranchial.

The dorsal hypohyal (hh) occupies a position anterior and dorsomedial to the ceratohyal. Both dorsal hypohyals are dorsally connected to each other by a strong ligament. The ventral hypohyal (hh) is caplike in shape, and occupies a position at the anterior end of the ceratohyal. The dorsal and ventral hypohyals are bound dorsally to the first basibranchial by ligamentous connective tissue.

The ceratohyal (ch) is narrow in anterior portion, and abruptly widens in posterior one-third. It is usually perforated by a foramen through which the hyoid artery passes (Fig. 11A). In *Crystallichthys*, *C. roseofuscus* and *C. marginatus* sp. nov. (Fig. 11B), the hyoid artery passes through a deep notch. It passes through a groove in *Paraliparis regina*, *P. nanus*, *Osteodiscus* and *Nectoliparis* (Fig. 11C-D).

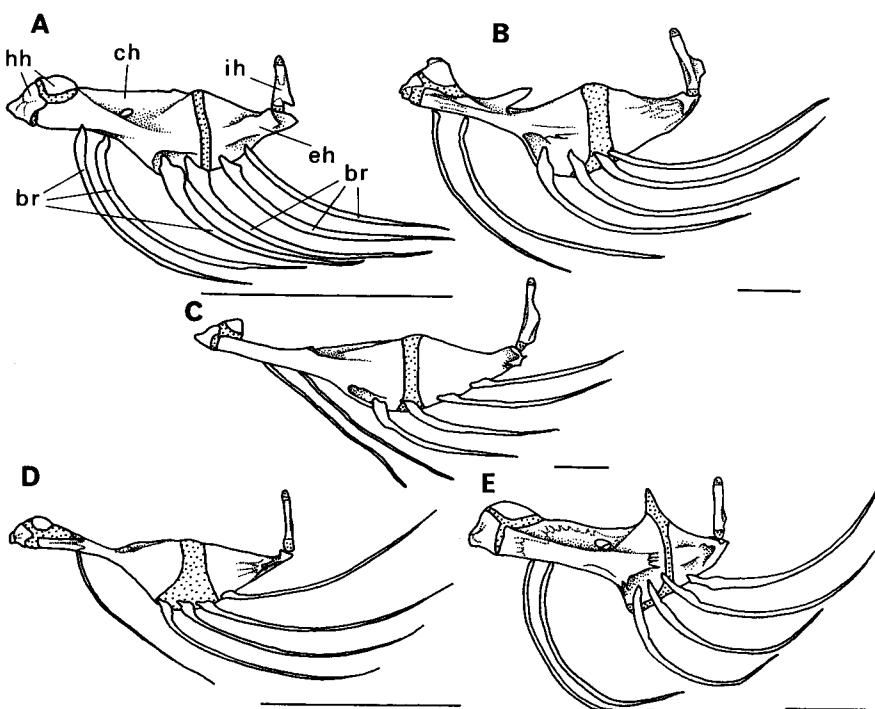


Fig. 11. Hyoid arches of liparidid (A-D) and cyclopterus (E) fishes in lateral view. A, *Liparis mucosus*; B, *Crystallichthys matsushima*; C, *Paraliparis regina*; D, *Nectoliparis pelagicus*; E, *Eumicrotremus pacificus*. br, branchiostegal ray; ch, ceratohyal; eh, epihyal; hh, hypohyal; ih, interhyal. Large dots represent cartilage. Bars are 5 mm.

In *Careproctus* sp. B, it passes through a foramen (HUMZ 84416) or groove (HUMZ 81952).

The epihyal (eh) is a triangular bone connected with the ceratohyal anteriorly and articulates with the interhyal posteriorly. On posterior portion it bears a process, from which a well developed ligament originates.

The interhyal (ih) is a small and rodlike bone. It interconnects the postero-dorsal corner of the epihyal and the cartilaginous region of the hyomandibular and symplectic.

The branchiostegal rays (br) are six in number in almost all liparidids (Fig. 11A-C). The anterior two rays is attached to the anteroventral edge of the ceratohyal, and are more slender than the posterior four rays which are attached ventrolaterally to the posterior ceratohyal, epihyal and cartilaginous region between them (Fig. 11A-C). In *P. nanus* and *Nectoliparis*, the branchiostegal rays are five in number, and only one ray is attached to the anteroventral edge of the ceratohyal (Fig. 11D).

The urohyal is considerably variable in shape and size. It is located below the first basibranchial, and tightly attached to the first basibranchial by a facet at the posterodorsal margin.

DISCUSSION. The liparidid hyoid arch has been examined in several species by Johnsen (1921), Burke (1930) and McAllister (1968). Johnsen and Burke mainly noted the number of the branchiostegal rays, i.e., five or six. McAllister figured the hyoid arch of *Liparis atlanticus*.

Among the liparidid hyoid arches examined, the following interspecific variations are recognized: (1) presence or absence of the basihyal; (2) relation between the ceratohyal and the hyoid artery; and (3) number of the branchiostegal rays.

(1) Presence or absence of the basihyal: This character is not adopted because of the intraspecific variation observed in a cyclopterid, *Eumicrotremus pacificus*.

(2) Relation between the ceratohyal and the hyoid artery: In liparidids examined, the hyoid artery passes through a foramen, a notch, or a groove of the ceratohyal. Of these three states, the second and third states are not distinguishable from each other because of intraspecific variation in *Careproctus* sp. B as described above. Furthermore, the first and second states are found in cottoids (Yabe, 1985) and cyclopterids. The polarity of this character can not be decided.

(3) Number of the branchiostegal rays: It is usually six in liparidids (Fig. 11A-C), but five in *Paraliparis nanus* and *Nectoliparis* (Fig. 11D). In all cyclopterids examined, it is six (Fig. 11E). Five branchiostegal rays is derived state within liparidids.

6. BRANCHIAL APPARATUS

DESCRIPTION. The branchial apparatus is composed of the basibranchial, hypobranchial, ceratobranchial, epibranchial and pharyngobranchial.

The basibranchials (bb) are two to four (usually three) in number, and lies in the ventral midline of the oral cavity. The first basibranchial is a rodlike ossified or cartilaginous bone firmly attached to a dorsal facet of the urohyal. It is usually an ossified bone in liparidids (Fig. 12A), while it is cartilaginous in *Careproctus*

dentatus sp. nov., *Paraliparis bathybius*, *P. rosaceus*, *P. garmani*, *P. ulochir*, *P. regina* and *P. nanus* (Fig. 12B-D). The second and third basibranchials are flattened cartilaginous bones, and usually present as a single elongate bone (Fig. 12A, C). These two bones are separated from each other in *Liparis inquilineus*, *L. greeni*, *C. candidus*, *Careproctus marginatus* sp. nov., *Crystallichthys cyclospilus*, *Paraliparis bathybius*, *P. rosaceus*, *P. garmani* and *P. regina* (Fig. 12B, D). As

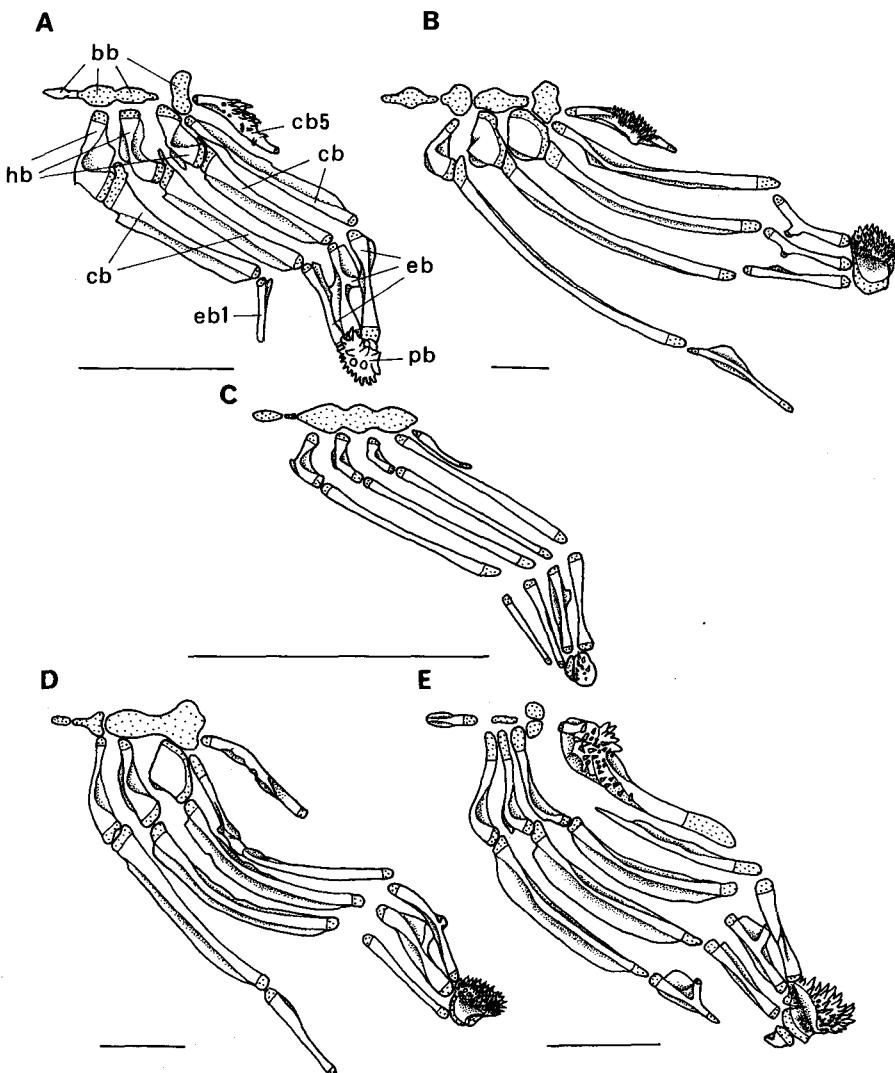


Fig. 12. Branchial apparatus of liparidid (A-D) and cyclopterid (E) fishes in dorsal view.
A, *Liparis ritteri*; B, *Paraliparis regina*; C, *Paraliparis nanus*; D, *Paraliparis bathybius*; E, *Eumicrotremus derjugini ochotensis*. bb, basibranchial; cb, ceratobranchial; eb, epibranchial; hb, hypobranchial; pb, pharyngobranchial. Large dots represent cartilage. Bars are 5 mm.

intraspecific variations, the fusion and separation of these bones are observed in *Liparis liparis*, *L. fabricii*, *Careproctus dentatus* sp. nov. and *Crystallichthys mirabilis*. The fourth basibranchial is a wide cartilaginous bone which articulates posteriorly with the fourth and fifth ceratobranchials. In *Paraliparis bathybius*, *P. rosaceus*, *P. garmani* and *P. nanus*, this bone fuses anteriorly to the third basibranchial (Fig. 12C, D).

The hypobranchials (hb) are three in number, and fan-shaped in dorsal view. The first hypobranchial articulates medially with the anterior portion of the second + third basibranchial or the second basibranchial. The second hypobranchial is about the same size as the first, and articulates medially with the middle portion of the second + third basibranchial or the third basibranchial. The third hypobranchial is smallest and articulates medially with the posterior portion of second + third or the third basibranchial and posteriorly with the fourth basibranchial. Posteriorly the hypobranchials articulate with the ceratobranchials.

The ceratobranchials (cb) are the longest bones in the branchial arches, and five in number. They support most of the gill filaments and gill rakers. The first three are similar in shape, and articulate with the posterior ends of their respective hypobranchials. The fourth is more irregular in shape, and articulates with the fourth basibranchial. The fifth is the shortest of the five, and has a tooth plate fused to its dorsal surface in most liparidids (Fig. 12A, B). In *Paraliparis bathybius*, *P. rosaceus*, *P. garmani* and *P. nanus*, this bone lacks the tooth plate (Fig. 12C, D). This bone also articulates with the fourth basibranchial.

The epibranchials (eb) are rodlike bone forming the upper limbs of the branchial arches, and four in number. The posterolateral end of each epibranchial articulates with the ends of the first four ceratobranchials. The third and fourth articulates with each other by dorsal process on the middle of each bone.

There is only the third pharyngobranchial (pb) in liparidids (Fig. 12A-D). It articulates posteriorly with the second to fourth epibranchials, and is attached dorsally to the ventral surface of the parasphenoid and prootic. It always bears a ventral tooth plate.

DISCUSSION. The liparidid branchial apparatus was examined by Yabe (1985) in *Liparis tessellatus*. He referred to the number of the pharyngobranchial and its tooth plate and the absence of the tooth plate on the third epibranchial.

Among the liparidid branchial apparatus examined, the following interspecific variations are recognized: (1) presence or absence of the ossification of the first basibranchial; (2) presence or absence of the fusion of the second and third basibranchials; (3) presence or absence of the fusion of the third and fourth basibranchials; and (4) presence or absence of the tooth plate on the fifth ceratobranchial.

(1) Presence or absence of ossification of the first basibranchial: The first basibranchial is ossified in most liparidids examined (Fig. 12A), while it is a cartilaginous bone in *Careproctus dentatus* sp. nov., *Paraliparis bathybius*, *P. rosaceus*, *P. garmani*, *P. ulochir*, *P. regina* and *P. nanus* (Fig. 12B-D). In all cyclopterids examined, the bone is ossified (Fig. 12E). The cartilaginous first basibranchial thus represents a derived state within liparidids.

(2) Presence or absence of fusion of the second and third basibranchials: This character are not adopted because intraspecific variations are observed in *Liparis*

liparis, *L. fabricii*, *Careproctus dentatus* sp. nov. and *Crystallichthys mirabilis* as described above.

(3) Presence or absence of fusion of the third and fourth basibranchials: In most liparidids, the fourth basibranchial is separated from the third basibranchial (Fig. 12A, B), while it fuses to that bone in *Paraliparis bathybius*, *P. rosaceus*, *P. garmani* and *P. nanus* (Fig. 12C, D). In all cyclopterids examined, it is separated from the third basibranchial (Fig. 12E). The fusion of the third and fourth basibranchials represents a derived state within liparidids.

(4) Presence or absence of the teeth plate on the fifth ceratobranchial: The fifth ceratobranchial bears a tooth plate in most liparidids and all cyclopterids examined (Fig. 12A, B, E), while it lacks a tooth plate in *Paraliparis bathybius*, *P. rosaceus*, *P. garmani* and *P. nanus* (Fig. 12C, D). The fifth ceratobranchial without a tooth plate represents a derived state within liparidids.

7. PECTORAL GIRDLE

DESCRIPTION. The pectoral girdle is composed of the supratemporal, posttemporal, supracleithrum, cleithrum, postcleithrum, scapula, coracoid and actinosts.

The supratemporal (st) is a thin membranous bone lying on the posterodorsal surface of the pterotic. There is usually one supratemporal, while in *P. nanus* and *Nectoliparis* this bone is absent (Fig. 13C, D). The postorbital sensory canal coming from the posttemporal passes anteriorly through it.

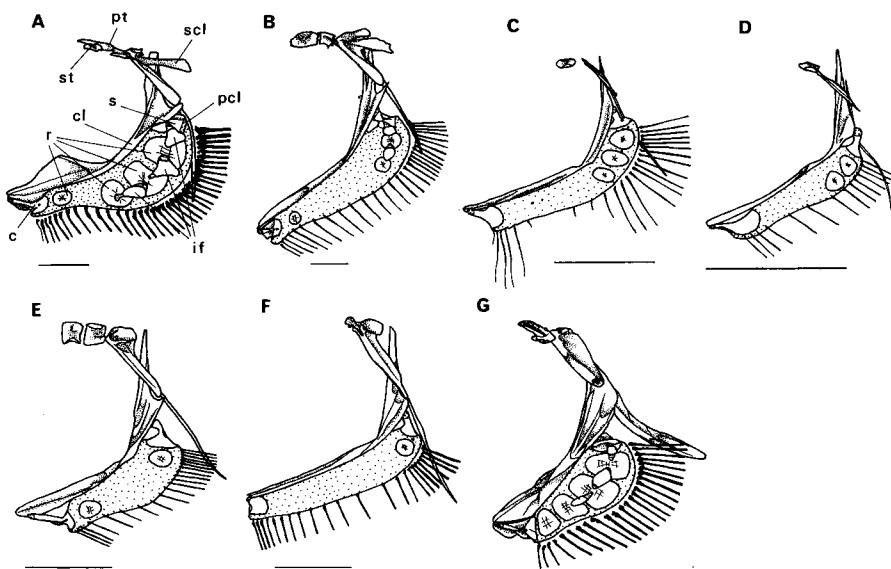


Fig. 13. Pectoral girdles of liparidid (A-F) and cyclopterid (G) fishes in lateral view. A, *Liparis pulchellus*; B, *Careproctus reinhardtii*; C, *Nectoliparis pelagicus*; D, *Paraliparis nanus*; E, *Osteodiscus cascadiæ*; F, *Paraliparis ulochir*; G, *Eumicrotremus orbis*. c, coracoid; cl, cleithrum; if, interradial foramen; pcl, postcleithrum; pt, posttemporal; s, scapula; scl, supracleithrum; st, supratemporal; r, radial. Large dots represent cartilage. Bars are 5 mm.

The posttemporal (pt) consists of the medial and lateral portions. The medial portion is bladelike, and is attached anterodorsally to the posterodorsal surface of the epiotic and accepts posteroventrally the cartilaginous surface of the cranium between the epiotic and the intercalar. The lateral portion is membranous. It forms a groove through which the sensory canal coming from the supracleithrum passes anteriorly.

The supracleithrum (scl) generally bears two processes extending posteriorly. The upper process forms a groove for reception of the sensory canal. The lower process is laminar, which considerably varies in shape. The supracleithrum is articulated anteriorly with posttemporal, and attached posteromedially to the cleithrum.

The cleithrum (cl) is a long and gently curved bone which is broadened dorsally, anteromedially, anterodorsally and anteroventrally. It generally bears a notch dorsally. It is attached dorsolaterally to the medial surface of the supracleithrum, and posteromedially to the scapula, cartilaginous plate and coracoid. Ventrally both cleithra are bound tightly together by the connective tissue, and inserted by the dorsal portion of the pelvis.

There is always a single postcleithrum (pcl). It is a very slender bone attached anterolaterally to the medial surface of the supracleithrum or the cleithrum and supracleithrum.

The scapula (s) is a crescent-shaped bone located posterodorsally to the cartilaginous plate. It does not support the radials, and is widely separated from the coracoid by the cartilaginous plate. It is attached anterodorsally to the cleithrum. The scapular foramen is surrounded by the scapula, cleithrum and cartilaginous plate.

The coracoid (c) is a roughly L-shaped bone occupying a position anteroventral to the cartilaginous plate. It does not support the radials. It is attached anteroventrally to the cleithrum by its anterior arm.

The cartilaginous plate is a large and flat plate attached along the posteroventral surface of the cleithrum. Each radial (r) is present as the ossifications within the plate. There are four in most liparidids (Fig. 13A). The fourth (ventralmost) radial, when present, is sometimes widely separated from upper three radials. In *Careproctus reinhardti*, *Paraliparis bathybius* and *P. rosaceus*, there are three radials without the third radial (Fig. 13B). *Nectoliparis* has three radials without the fourth (Fig. 13C). *P. regina* has three radials without the third (HUMZ 99460) or four radials (HUMZ 99459). In *Careproctus roseofuscus*, there are three radials on left side without the fourth and four radials on right side. In *Paraliparis garmani*, there are three radials on left side, but five on right side. *P. nanus* has two radials without the third and fourth (Fig. 13D). *Osteodiscus* also has two radials, but it lacks the second and third (Fig. 13E). In *Paraliparis ulochir*, only the first radial remains (Fig. 13F).

In *Liparis* and several *Careproctus* species, there are three interradial foramina (if) between the scapula and the first radial (dorsalmost), between the first and the second and between the second radial and the third (Fig. 13A). These foramina considerably vary in number and size among and within species, and their presence or absence is not always discernible owing to their reduction. They are completely

absent in *Paraliparis tremebundus*, *P. bathybius*, *P. opercularis*, *P. regina*, *P. nanus*, *Osteodiscus* and three *Careproctus* species (*bowersianus*, *cyclocephalus* and *macrodiscus*) (Fig. 13D-E). There are intraspecific variations, however, on presence or absence of the first interradial foramen (dorsalmost) in *Careproctus furcellus* and *C. dentatus* and of the second in *Nectoliparis*. In *Careproctus trachysoma* the third interradial foramen is present on left side, but absent on right side.

The pectoral fin rays are always unbranched. In *Paraliparis garmani*, *P. regina* and *Nectoliparis*, rays of the notched region of the pectoral fin are rudimentary (Fig. 13C). In the other liparidids, these rudimentary rays are absent (Fig. 13A-B, D-F).

DISCUSSION. The liparidid shoulder girdle has been examined by Garman (1892, 1899), Regan (1913), Johnsen (1921), Taranetz (1941), Ueno (1970), Andriashev (1975, 1978, 1979, 1980, 1982a, b, c, 1986), Andriashev and Neyelov (1976, 1979), Andriashev et al. (1977) and Yabe (1985). They mainly noted the numbers of the radials and fin rays, the presence of the interradial foramina, the wide separation of the scapula from the coracoid and the shape of the pectoral fin. Andriashev has studied the primary shoulder girdle of the deepwater liparidids (genera *Genioliparis*, *Nectoliparis* and *Paraliparis*) from the Antarctic and its neighboring waters in detail, and discussed the polarities of several characters.

Among the liparidid pectoral girdle examined, the following interspecific variations are recognized: (1) presence or absence of the supratemporal; (2) number of the radials; (3) number of the interradial foramina; and (4) presence or absence of the rudimentary pectoral fin rays.

(1) Presence or absence of the supratemporal: This character is not adopted because of the intraspecific variation observed in *Paraliparis ulochir* and *Eumicrotremus derjugini ochotensis*.

(2) Number of the radials: Concerning this character, four states are recognized within liparidids; three to five (Fig. 13A-C), two (first and second) (Fig. 13D), two (first and fourth) (Fig. 13E) and one (Fig. 13F). In all cyclopterids examined, there are always four radials (Fig. 13G). Thus, three to five radials is the most primitive state, and one radial is the most derived state. Two radials in *P. nanus* and *Osteodiscus* are the derived states different from each other.

(3) Number of the interradial foramina: This character is not adopted because the intraspecific variations are observed concerning presence or absence of each interradial foramen as described above.

(4) Presence or absence of the rudimentary pectoral fin rays: The rudimentary pectoral fin rays are present in *Paraliparis garmani*, *P. regina* and *Nectoliparis* (Fig. 13C). These rays are absent in the other liparidids examined (Fig. 13A, B, D-F). They are also absent in cyclopterids examined (Fig. 13G). Presence of these rays is a derived state within liparidids.

8. PELVIC GIRDLE

DESCRIPTION. The pelvic girdle consists of the paired basipterygia.

The basipterygia (b) are united anterodorsally to each other, and is attached to a cartilaginous block lying on the ventral midline. The anterior halves of the bones directed anterodorsally are inserted between the lower portions of the both cleithra.

There is the well developed subpelvic process (sp) which is extending anteromedially below the anterior half of the basipterygium (Fig. 14A, B). It bears a spine (s) posteroventrally. The posterior half of the basipterygium bears five soft rays (r) ventrally. These spines and rays on both sides support directly the sucking disk. In *Liparis* and most *Careproctus* species, the size of the disk varies considerably among species according to the size of each element. In *Osteodiscus*, the first soft ray is shifted forward to lie close to a spine, and is widely separated from the remaining four rays (Fig. 14B). In *Careproctus mederi*, *C. ostentum*, *C. sp. B* and *Paraliparis tremebundus*, which have the reduced or rudimentary disk, the pelvic girdle is very small (Fig. 14C). In these species, the posterior portions of the basipterygia are much reduced, and the spine and rays are rudimentary or absent (Fig. 14C). In the species lost the disk, the pelvic girdle is a very tiny bone. In *Paraliparis pectoralis*, *P. dactylosus*, *P. rosaceus* and *P. grandis*, the subpelvic process is still prominent (Fig. 14D). The other species without the disk, however, lack this process (Fig. 14E, F). In *P. nanus*, the pelvic girdle is a inverted L-shaped bone in lateral view (Fig. 14F). In *Paraliparis bathybius* and *Nectoliparis*, it is reduced to a extremely small cartilaginous bone completely concealed between the lower portions of the

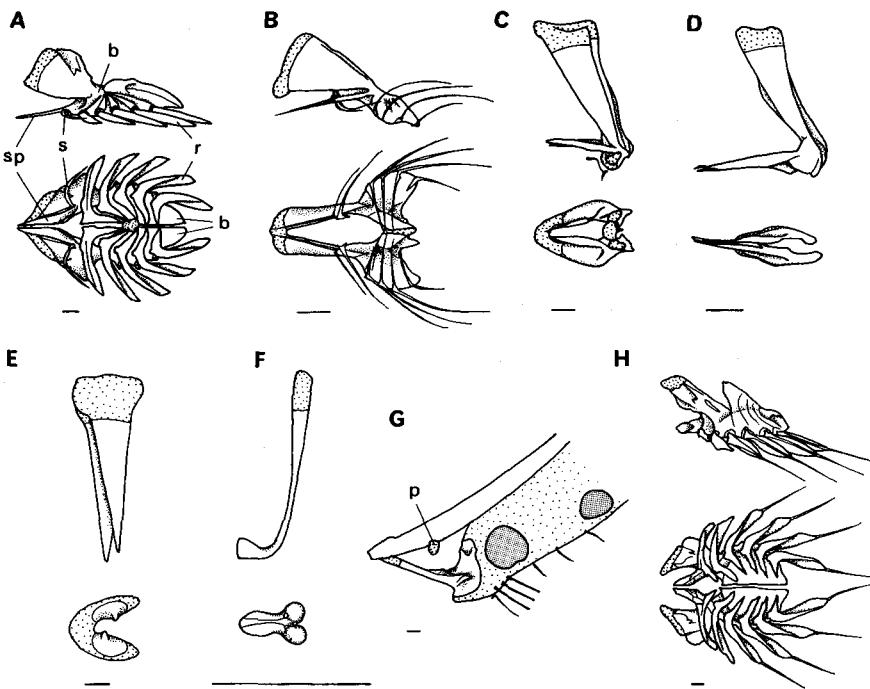


Fig. 14. Pelvic girdles of liparidid (A-G) and cyclopterid (H) fishes in lateral (top) and ventral (bottom) views. A, *Liparis callyodon*; B, *Osteodiscus cascadiae*; C, *Careproctus mederi*; D, *Paraliparis pectoralis*; E, *Paraliparis regina*; F, *Paraliparis nanus*; G, *Paraliparis bathybius*; H, *Eumicrotremus pacificus*. b, basipterygium; s, spine; sp, subpelvic process; r, soft ray. Large dots represent cartilage. Bars are 1 mm.

cleithra (Fig. 14G).

DISCUSSION. The liparidid pelvic girdle has been examined by Gill (1891), Garman (1892, 1899), Johnsen (1921), Matsubara and Iwai (1954), Ueno (1970) and Stein (1978a). Garman (1892) referred to the shape of the pelvic rays in a few species of *Liparis*. Garman (1899) and Johnsen noted the rudimentary pelvic girdles in *Paraliparis* and *P. regina*. Matsubara and Iwai described the differences in shape of the pelvic girdles of three species (*Liparis tessellatus*, *Careproctus rastrinus* and *Crystallichthys matsushima*e). Ueno figured the pelvic girdle of *Liparis florate*. Stein described the unique structure of the disk in *Osteodiscus*.

In *Liparis* and most species of *Careproctus*, the pelvic girdle is perfect with one spine and five soft rays on each side (Fig. 14A), though it varies in size among species. In the other liparidids examined except in *Osteodiscus*, the pelvic girdle is rudimentary with or without the rudimentary spines and rays on both sides (Fig. 14C, D). In all cyclopterids examined, it is perfect with one spine and five soft rays on each side (Fig. 14H). The rudimentary pelvic girdle thus represents a derived state. In *Osteodiscus*, it is unique in having the first soft ray shifted forward (Fig. 14B). This is also a derived state different from the former.

9. VERTEBRAE AND THEIR ACCESSORY BONES

DESCRIPTION. The vertebrae, pleural rib and epipleural rib are treated in this section.

The vertebrae consist of the abdominal and caudal vertebrae. The abdominal vertebrae (av) are defined as the elements anterior to the vertebrae bearing a definite haemal spine (hs) without the pleural rib. The number of the abdominal vertebrae ranges from eight to 13 (usually 10 or 11). The remainings are the caudal vertebrae (cv). The first abdominal vertebra usually forms the neural arch with a small neural spine (ns). It does not form the neural arch in several *Careproctus*, *P. opercularis*, *P. barbulifer* and *Nectoliparis*. But these two states are found in *Liparis callyodon* as an intraspecific variation. Each abdominal vertebra except a few anterior ones possesses a pair of parapophyses ventrally. Several posterior parapophyses form haemapophyses by two elements. The neural prezygapophyses

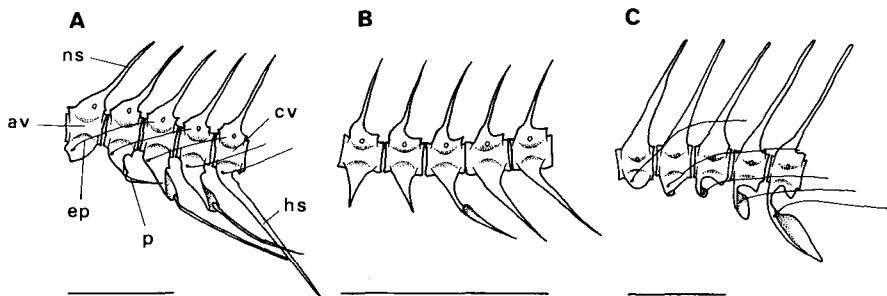


Fig. 15. Anterior vertebrae (7th to 11th) and their accessory bones of liparidid (A, B) and cyclopterid (C) fishes in lateral view. A, *Liparis liparis*; B, *Osteodiscus cascadiae*; C, *Eumicrotremus orbis*. av, abdominal vertebra; cv, caudal vertebra; ep, epipleural rib; hs, haemal spine; ns, neural spine; p, pleural rib. Bars are 5 mm.

and postzygapophyses are absent. The haemal prezygapophyses and postzygapophyses are not developed in the abdominal and anterior caudal vertebrae.

The pleural rib (p) is attached near the tip of the parapophysis or the haemapophysis. It is frequently rudimentary. It is present on posterior one to five (usually three) abdominal vertebrae in *Liparis*, *Careproctus*, *Crystallichthys* and *P. grandis*. The number of the pleural ribs varies among and within species. It begins with seventh to 11th vertebrae (usually eighth or ninth) and ends on 10th to 13th vertebrae (usually 10th or 11th) (Fig. 15A). It is absent in the remaining species examined (Fig. 15B).

The epipleural rib (ep) is attached to the lateral surface of the centrum except in the posterior abdominal and anterior caudal vertebrae where it is attached to the upper portion of the parapophysis or the haemapophysis. The number of the epipleural ribs ranges from five to 42. It considerably varies among and within species. It begins with second to eighth vertebrae (usually second or third) and ends on eighth to 44th vertebrae. It is found in almost all liparidids (Fig. 15A), but it is absent in *Osteodiscus* (Fig. 15B). The epipleural ribs are minute posteriorly, so that it is frequently difficult to find them.

DISCUSSION. The vertebrae and their accessory bones of liparidids have not been examined.

Among the vertebrae and their accessory bones of liparidids examined, the following interspecific variations are recognized : (1) presence or absence of the pleural ribs and (2) presence or absence of the epipleural ribs.

(1) Presence or absence of the pleural ribs : It is present in *Liparis*, *Careproctus*, *Crystallichthys* and *P. grandis* (Fig. 15A). It is absent in the other liparidids and all cyclopterids examined (Fig. 15B, C). The presence of the pleural rib is derived within liparidids.

(2) Presence or absence of the epipleural ribs : In *Osteodiscus*, it is absent (Fig. 15B). It is present in the other liparidids and all cyclopterids examined (Fig. 15A, C). The absence of the epipleural rib represents a derived state within liparidids.

The numbers of the vertebrae (abdominal and caudal), pleural and epipleural ribs are not available, because they considerably vary within species.

10. DORSAL AND ANAL FINS

DESCRIPTION. The dorsal and anal fins consists of the fin rays and distal and proximal pterygiophores (Fig. 16). The stay is absent behind the last dorsal and anal proximal pterygiophores.

The dorsal fin is continuous and long. It mostly consists of soft rays (r), which are composed of two slender segmented or unsegmented elements. They are always unbranched. A pair of elements holds the distal pterygiophore between them. A few or several anterior elements are spiny rays. The posterior spines usually hold the distal pterygiophore. But it is difficult to tell if a few elements between spines and soft rays are spiny or soft rays. All are thus included as the dorsal fin rays. The first dorsal fin ray is frequently reduced to a tiny bone.

The distal pterygiophore (dp) of the dorsal fin is a small bone located between each proximal pterygiophore and fin ray. It originates on the second to 10th proximal pterygiophores. All or almost distal pterygiophores are paired.

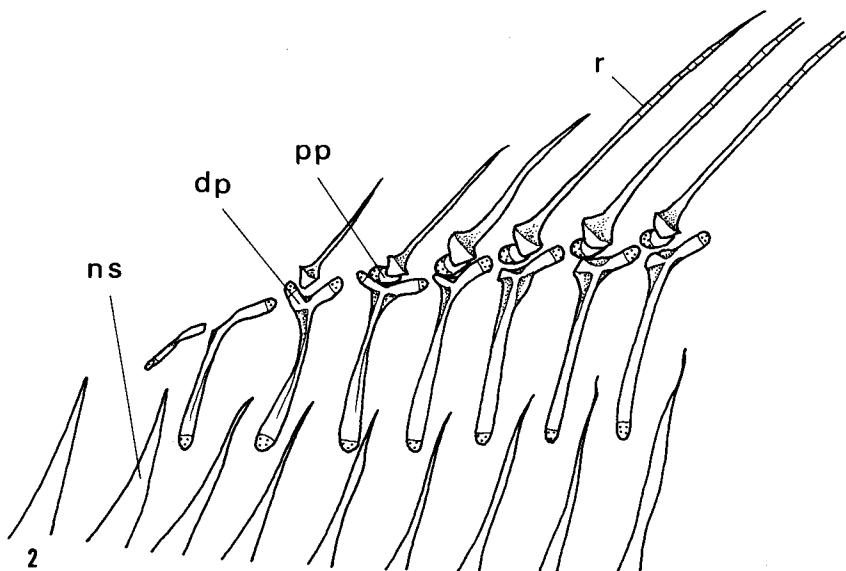


Fig. 16. Anterior dorsal fin rays and their pterygiophores of *Careproctus bowersianus* in lateral view. dp, distal pterygiophore; ns, neural spine (second to 10th); pp, proximal pterygiophore; r, soft ray. Large dots represent cartilage. Bar is 5 mm.

The proximal pterygiophore (pp) of the dorsal fin is a slender rodlike bone and inserts between the neural spines (ns) of the adjacent vertebrae. The first proximal pterygiophore inserts from between the second and the third neural spines to between the seventh and the eighth neural spines (Fig. 16). The position of insertion considerably vary among and within species. The first proximal pterygiophore is frequently reduced and first and second pterygiophores are frequently lost their rays (Fig. 16).

The anal fin is continuous and long, and consists of the segmented and unbranched soft rays. The structure of the distal and proximal pterygiophores is similar to that of the soft rays of the dorsal fin.

DISCUSSION. Burke (1930) intensively discussed as to presence of the spiny rays. Yabe (1985) examined the median fin supports of *Liparis tessellatus*. Andriashov (1986) noted the posterior shift of the first proximal pterygiophore within liparidids.

In the present study, the available interspecific variations were not found in the dorsal and anal fins of liparidids.

11. CAUDAL COMPLEX

DESCRIPTION. The caudal complex is composed of the preural centrum 2, preural centrum 1, upper hypural plate, parhypural-hypural plate and epurals.

The haemal spine (hs) of the preural centrum 2 (pc 2) is autogenous in *Liparis* except in *L. pulchellus*, *L. montagui* and *L. tessellatus*, in which it is fused with the

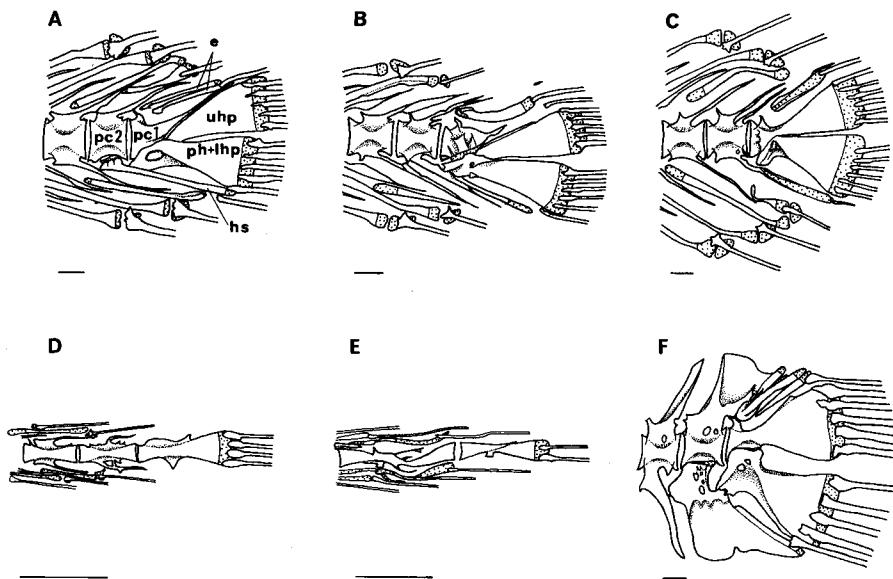


Fig. 17. Caudal complex of liparidid (A-E) and cyclopterid (F) fishes in lateral view. A, *Liparis tanakai*; B, *Crystallichthys matsushima*; C, *Careproctus dentatus*; D, *Paraliparis ulochir*; E, *Paraliparis attenuatus*; F, *Eumicrotremus birulai*. e, epural; hs, haemal spine; lhp, lower hypural plate; pc 1, preural centrum 1; pc 2, preural centrum 2; ph, parhypural; uhp, upper hypural plate. Large dots represent cartilage. Bars are 1 mm.

centrum (Fig. 17A). In all the other liparidids examined, it is fused with the centrum (Fig. 17B-E).

The upper hypural plate (uhp) is triangular in shape. The preural centrum 1 is a triangular bone with a more or less developed neural prezygapophysis. The upper hypural plate is autogenous with the preural centrum 1 (pc 1) in *Liparis*, *Crystallichthys cyclospilus* and *C. matsushima* (Fig. 17A, B), whereas in all the other liparidids, it is fused with the preural centrum 1 (Fig. 17C-E).

The parhypural-hypural plate (ph+lhp) is a fan-like in shape. It is autogenous with the preural centrum 1 in *Liparis* and *Crystallichthys* except in *L. pulchellus*, whereas it is fused with the preural centrum 1 in all the other liparidids examined.

The number of the hypural plates is two in *Liparis* and *Crystallichthys* (Fig. 17A, B). It is only one in all the other liparidids examined because of fusion of the preural centrum 1 with two hypural plates (Fig. 17C-E).

The epurals (e) are slender bones lying between the last neural spine and the upper hypural plate. The number of the epurals varies among liparidids examined: two in *Liparis* (Fig. 17A); one is *Careproctus*, *Crystallichthys*, *Paraliparis opercularis*, *P. regina*, *P. pectoralis*, *P. grandis* and *P. rosaceus* (Fig. 17B, C); absent in *Osteodiscus*, *Nectoliparis*, *Paraliparis nanus*, *P. attenuatus*, *P. barbulifer*, *P. dactylosus*, *P. garmani*, *P. ulochir* and *P. bathybius* (Fig. 17D, E).

The caudal fin rays in liparidids are unbranched, and composed of the principal

rays and the procurrent rays. The dorsal procurrent rays, when present, are mainly supported by the epurals. The ventral procurrent rays, when present, are supported by the haemal spine of the preural centrum 2. The principal rays are supported by two hypural plates or the fused hypural plate. They vary in number: four in *Paraliparis nanus* and *P. ulochir* (Fig. 17D); three in *P. barbulifer*; and two in *P. attenuatus* (Fig. 17E). Their number, which are continuous by intraspecific variations, ranges from six to 13 in all other liparidids examined (Fig. 17A-C).

DISCUSSION. The liparidid caudal complex has been examined by Stein (1978a), Able et al. (1984), Yabe (1985) and Andriashev (1986). Stein noted the lack of epurals in *Careproctus longifilis*. Able et al. described the caudal development of *Liparis fabricii*. Yabe referred to the haemal spine fused to the preural centrum 2 in *Liparis tessellatus*. Andriashev noted the reduction of the caudal complex and the decrease of the fin rays.

Among the liparidid caudal complexes examined, the following interspecific variations are recognized: (1) relation between the preural centrum 1 and its haemal spine; (2) relation between the preural centrum 1 and the upper hypural plate; (3) relation between the preural centrum 1 and the parhypural-hypural plate; (4) number of the hypural plates; (5) number of the epurals; and (6) number of the principal caudal rays.

(1) Relation between the preural centrum 1 and its haemal spine: The haemal spine of the preural centrum 1 is autogenous or fused with the centrum in liparidids examined (Fig. 17A-E). These two states are also found in cyclopterids examined. In cottoids, only the fused state occurs (Yabe, 1985). The autogenous haemal spine with the preural centrum 1 represents a derived state within liparidids.

(2) Relation between the preural centrum 1 and the upper hypural plate: The preural centrum 1 is autogenous or fused with the upper hypural plate in liparidids examined (Fig. 17A-E). In all cyclopterids examined, it is fused with the upper hypural plate (Fig. 17F). The autogenous preural centrum 1 with the upper hypural plate represents a derived state within liparidids.

(3) Relation between the preural centrum 1 and the parhypural-hypural plate: The preural centrum 1 is autogenous or fused with the parhypural-hypural plate in liparidids examined (Fig. 17A-E). The fusion of the preural centrum 1 with the parhypural-hypural plate represents a derived state, because the preural centrum 1 is autogenous with the parhypural-hypural plate in all cyclopterids examined (Fig. 17F).

(4) Number of the hypural plates: In liparidid fishes, the number of the hypural plates is one or two (Fig. 17A-E). It is always two in cyclopterids examined (Fig. 17F). One hypural plate thus represents a derived state within liparidids.

(5) Number of the epurals: Most liparidids examined have one or two epurals, and several liparidids lack the epurals (Fig. 17A-E). In cyclopterids examined, one or two epurals are recognized (Fig. 17E). A cyclopterid, *Eumicrotremus pacificus*, has one or two epurals as intraspecific variation. The presence of the epurals is regarded as a primitive state, and their absence as a derived state.

(6) Number of the principal caudal rays: Concerning this character, four states are recognized within liparidids: six to 13, four, three and two (Fig. 17A-E).

In cyclopterids examined, it varies nine to 12 with interspecific and intraspecific variations. Thus, six to 13 principal caudal rays is the most primitive state, and two principal caudal rays the most derived state.

12. OTHERS

DESCRIPTION AND DISCUSSION. In this section, several external and internal characters are treated. These characters have been used mainly for the taxonomy of liparidids (see Burke, 1930).

(1) Barbels on the snout: In most liparidids examined, the barbels on the snout are absent, whereas there are two long barbels in *Paraliparis barbulifer* (Fig. 55) and seven barbels in *P. attenuatus*. In all cyclopterids examined, the barbels on the snout are absent. Thus, the absence of the barbels is the most primitive state, and seven barbels are the most derived state.

(2) Papillae around the mouth: In almost all liparidids and all cyclopterids examined, the papillae around the mouth are absent. They are present only in *Crystallichthys matsushima* (Fig. 33). The presence of the papillae is a derived state within liparidids.

(3) Cleft on the snout: The cleft (c) on the lower surface of the snout is absent in most liparidids and all cyclopterids examined. It is present in *Crystallichthys mirabilis* and *C. matsushima* (Fig. 18A). The presence of the cleft is a derived state within liparidids.

(4) Pseudobranchia: The pseudobranchia is present in *Liparis* and all cyclopterids examined. It is absent in the other liparidids. The absence of the pseudobranchia is a derived state within liparidids.

(5) Origin of the gill opening: In almost all liparidids and all cyclopterids examined, the origin of the gill opening is present above the uppermost pectoral fin ray, while it is located in front of the uppermost pectoral fin ray in *Nectoliparis* (Fig. 66). The state found in *Nectoliparis* is derived within liparidids.

(6) End of the gill opening: In *Paraliparis regina*, the ventral end of the gill opening (ego) is located in front of the lowermost pectoral fin ray (Fig. 18b). In the other liparidids and all cyclopterids examined, it does not reach the lowermost

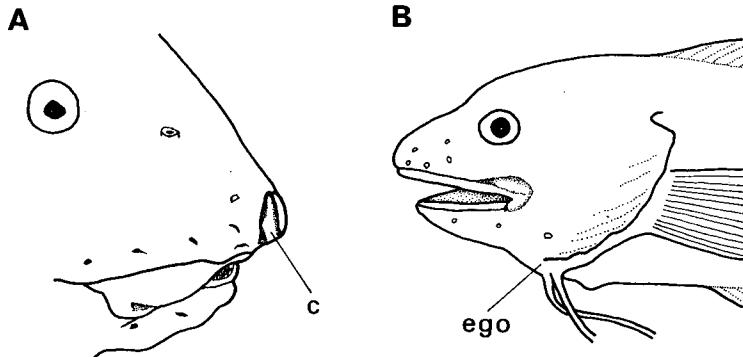


Fig. 18. Two external characters. A, cleft on snout in *Crystallichthys mirabilis*; B, gill opening in *Paraliparis regina*. c, cleft; ego, end of gill opening.

pectoral fin ray. The state found in *P. regina* is derived within liparidids.

(7) Disk: In *Paraliparis* and *Nectoliparis*, the disk is absent. It is present in the other liparidids (Fig. 34) and all cyclopterids examined. The absence of the disk thus represents a derived state within liparidids.

(8) Pyloric caeca: In *Paraliparis opercularis* and *Osteodiscus*, the pyloric caeca is absent. In *Liparis greeni*, the number of the pyloric caeca is more than 300. In the other species examined, it ranges from four to 130. It ranges from four to 47 in cyclopterids (Ueno, 1970). The absence and the numerousness of the pyloric caeca are the derived states different from each other.

VI. Phylogeny of the Liparidae

1. MONOPHYLY OF THE LIPARIDAE

As shown in the chapter IV, the liparidid fishes form a monophyletic group defined by the following five unique unreversed character states (i.e., autapomorphies): 1) the ethmoid cartilage forms a keel projecting anteriorly on the dorsal midline; 2) the ethmoid cartilage does not form a posterior expansion in the anterior portion of the orbit; 3) a narrow cartilage extends along the ventral ridge of the frontal in the dorsal orbital region of each side; 4) the third infraorbital is needle-like in shape; 5) the retroarticular is connected with the epihyal by a well developed ligament, which is free from the interopercle.

2. RELATIONSHIPS WITHIN THE LIPARIDAE

The derived character states are listed in Table 1, and the character states in 60 species are summarized in Fig. 19. The cladogram of the Liparidae (Fig. 20) was constructed on the basis of 34 characters in 60 species. In this section, numerals in parentheses after the derived character states refer to those of Table 1.

At branch point 1, all liparidids examined are divided into two groups, *Nectoliparis* (monotypic) and other liparidids. The former possesses three autapomorphies: reduction of ethmoid cartilage (2); third infraorbital not attached to lateral side of preopercle (6) and dorsal origin of gill opening located in front of uppermost pectoral fin ray (31), and 10 apomorphies: reduction of posterior portion of frontal (3); reduction of ento+ectopterygoid (7); five branchiostegal rays (12); presence of rudimentary pectoral fin rays (17); rudimentary pelvic girdle (18); fusion of preural centrum 1 with parhypural-hypural plate (23); one hypural plate (24); absence of epurals (25); presence of pseudobranchia (30) and absence of disk (33). The latter form a monophyletic group defined by one synapomorphy (autapomorphy): angle formed by two subopercle spines less than right angle (10).

At branch point 2, the common stem are divided into two sister groups, *Liparis* and other liparidids. The former forms a monophyletic group characterized by two synapomorphies: presence of pleural ribs (19) and autogenous preural centrum 1 with upper hypural plate (22). At branch point 2a, *Liparis* are divided into three groups, *L. montagui* group (with *L. tessellatus*), *L. pulchellus* and other *Liparis* species. *L. montagui* group possesses no apomorphies. *L. pulchellus* possesses a single apomorphy: fusion of preural centrum 1 with parhypural-hypural plate (23). The remaining species of *Liparis* form a monophyletic group defined by one

Table 1. List of derived character states.

-
1. Cranium
 1. Length of nasal more than one-third of cranium
 2. Reduction of ethmod cartilage
 3. Reduction of posterior portion of frontal
 4. Absence of parietal
 5. Absence of pterosphenoid
 2. Infraorbital bones
 6. Third infraorbital not attached to lateral side of preopercle
 3. Suspensorium and opercular apparatus
 7. Reduction of ento+ectopterygoid
 8. Long and strong opercular spines directed posterolaterally
 9. Reduction of anterior subopercular spine
 10. Angle formed by two subopercular spines less than right angle
 11. Interopercle attached to lateral surface of subopercle
 4. Hyoid arch
 12. Five branchiostegal rays
 5. Branchial apparatus
 13. Cartilaginous first basibranchial
 14. Fusion of third and fourth basibranchials
 15. Absence of tooth plate on fifth ceratobranchial
 6. Pectoral girdle
 16. Loss of radials
 17. Presence of rudimentary pectoral fin rays
 7. Pelvic girdle
 18. Rudimentary pelvic girdle and pelvic girdle of *Osteodiscus* type
 8. Vertebrae and their accessory bones
 19. Presence of pleural ribs
 20. Absence of epipleural ribs
 9. Caudal complex
 21. Autogenous haemal spine on preural centrum 1
 22. Autogenous preural centrum 1 with upper hypural plate
 23. Fusion of preural centrum 1 with parhypural-hypural plate
 24. One hypural plate
 25. Absence of epurals
 26. Loss of principal caudal fin rays
 10. Others
 27. Two and seven barbels on snout
 28. Presence of papillae around mouth
 29. Presence of cleft on snout
 30. Presence of pseudobranchia
 31. Dorsal origin of gill opening located in front of uppermost pectoral fin ray
 32. Ventral end of gill opening located in front of lowermost pectoral fin ray
 33. Absence of disk
 34. Numerous pyloric caeca and absence of them
-

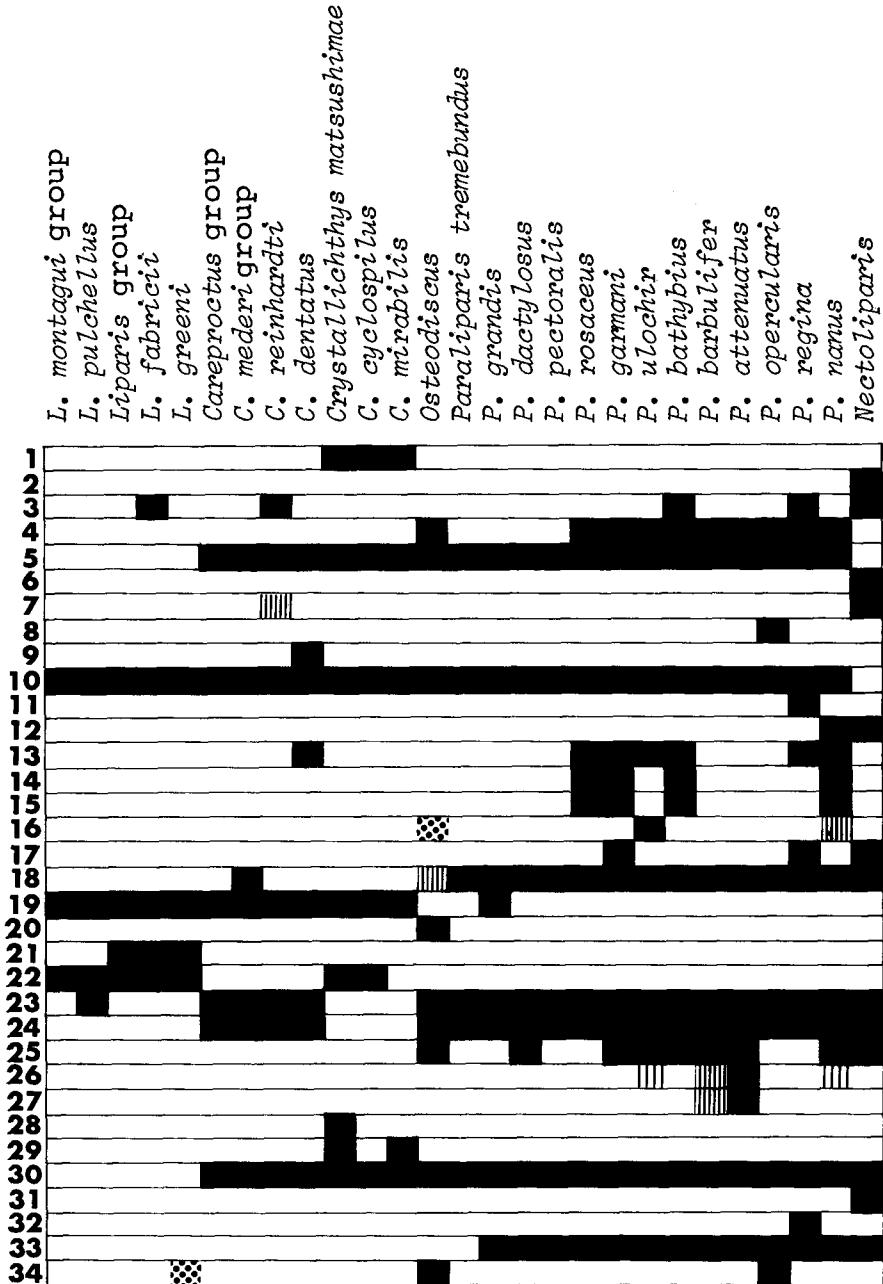


Fig. 19. Summary of character states in 60 species of the family Liparidae. White, most primitive states; vertical stripes, intermediate derived states; solid black, most derived states; dots, another derived states. Numerals correspond to those of Table 1.

synapomorphy (autapomorphy): autogenous haemal spine on preural centrum 1 (21). At branch point 2b, the remaining species of *Liparis* are divided into three groups, *Liparis* group including 18 species, *L. fabricii* and *L. greeni*. *Liparis* group possesses no apomorphies. *L. fabricii* possesses one apomorphy: reduction of posterior portion of frontal (3). *L. greeni* possesses one apomorphy: numerous pyloric caeca (34).

At branch point 3, the common stem is divided into two sister groups, *Crystallichthys* and other liparidids. The former forms a monophyletic group defined by two synapomorphies: length of nasal more than one-third of cranium (autapomorphy) (1) and presence of pleural ribs (19). *Crystallichthys* is divided into three species at branch point 3a. *C. cyclospilus* possesses a single apomorphy: autogenous preural centrum 1 with upper hypural plate (22). *C. mirabilis* possesses a single apomorphy: presence of cleft on snout (29). *C. matsushimae* possesses two apomorphies (22 and 29) and one autapomorphy: presence of papillae around mouth (28). Other liparidids form a monophyletic group characterized by two synapomorphies: fusion of preural centrum 1 with parhypural-hypural plate (23)

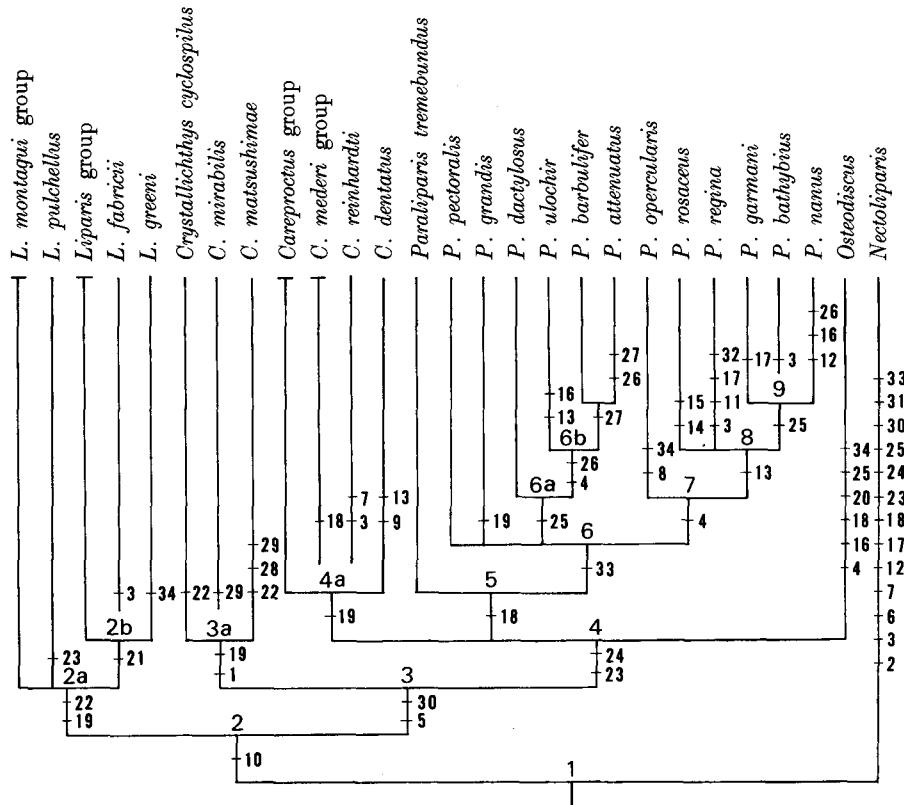


Fig. 20. Cladogram of 60 liparidid fishes from the Northern Hemisphere. Numerals correspond to those of Fig. 19 and Table 1.

and one hypural plate (24).

At branch point 4, the common stem is divided into three groups, *Careproctus*, *Paraliparis* and *Osteodiscus*. *Careproctus* forms monophyletic group defined by a single synapomorphy: presence of pleural ribs (19). At branch point 4a, *Careproctus* is divided into four groups, *Careproctus* group including 14 species, *C. mederi* group including 3 species, *C. reinhardti* and *C. dentatus* sp. nov. *Careproctus* group possesses no apomorphies. *C. mederi* group possesses one synapomorphy: rudimentary pelvic girdle (18). *C. reinhardti* possesses two apomorphies: absence of pterosphenoid (3) and reduction of ento+ectopterygoid (7). *C. dentatus* possesses two apomorphies: reduction of anterior opercular spine (autapomorphy) (9) and cartilaginous first basibranchial (13). *Paraliparis* forms a monophyletic group defined by one synapomorphy: rudimentary pelvic girdle (18). *Osteodiscus* (monotypic) possesses three autapomorphies: two radials (16); pelvic girdle of *Osteodiscus* type (18) and absence of epipleural ribs (20), and three apomorphies: absence of parietal (4); absence of epurals (25) and absence of pyloric caeca (34).

At branch point 5, *Paraliparis* is divided into two groups, *P. tremebundus* and other species of *Paraliparis*. The former possesses no apomorphies. The latter forms a monophyletic group defined by a single synapomorphy: absence of disk (33).

At branch point 6, *Paraliparis* is divided into four groups, *P. pectoralis*, *P. grandis*, *P. dactylosus* group including four species and *P. opercularis* group including six species. *P. pectoralis* possesses no apomorphies. *P. grandis* possesses one apomorphy: presence of pleural ribs (19). *P. dactylosus* group forms a monophyletic assemblage having a single synapomorphy: absence of epurals (25). At branch point 6a, this group is divided into two groups, *P. dactylosus* and other species. The former possesses no apomorphies. The latter forms a monophyletic group having two synapomorphies: absence of parietal (4) and two or three principal caudal fin rays (26). At branch point 6b, this group is divided into two sister groups, *P. ulochir* and *P. barbulifer* group. The former possesses two apomorphies: cartilaginous first basibranchial (13) and one radial (16). The latter forms a monophyletic assemblage having one synapomorphy: presence of barbels on snout (27). This group consists of *P. barbulifer* and *P. attenuatus*. The former possesses no apomorphies. The latter possesses two apomorphies: two principal caudal fin rays (26) and seven barbels on snout (27). *P. opercularis* group forms a monophyletic assemblage having one synapomorphy: absence of parietal (4).

At branch point 7, *P. opercularis* group is divided into two sister groups, *P. opercularis* and *P. rosaceus* group. The former possesses two apomorphies: long and strong opercular spines directed posterolaterally (autapomorphy) (8) and absence of pyloric caeca (34). The latter forms a monophyletic assemblage having one synapomorphy: cartilaginous first basibranchial (13).

At branch point 8, *P. rosaceus* group is divided into three groups, *P. rosaceus*, *P. regina* and *P. garmani* group. *P. rosaceus* possesses two apomorphies: fusion of third and fourth basibranchials (14) and absence of tooth plate on fifth ceratobranchial (15). *P. regina* possesses two autapomorphies: interopercle attached to lateral surface of subopercle (11) and ventral end of gill opening located in front of lowermost pectoral fin (32), and two apomorphies: reduction of posterior portion of

frontal (3) and presence of rudimentary pectoral fin rays (17). *P. garmani* group forms a monophyletic assemblage having one synapomorphy : absence of epurals (25).

At branch point 9, *P. garmani* group is divided into three species. *P. garmani* possesses one apomorphy : presence of rudimentary pectoral fin rays (17). *P. bathybius* possesses one apomorphy : reduction of posterior portion of frontal (3). *P. nanus* possesses three apomorphies : five branchiostegal rays (12); two radials (16) and four principal caudal fin rays (26).

A major trend is apparent in the evolution of the liparidid fishes from the Northern Hemisphere shown in the cladogram. The reduction and loss of the disk modified from the pelvic fins is correlated with the tendency towards elongation of the body following the increase in numbers of vertebrae, dorsal and anal fin rays and the decrease in numbers of pectoral and caudal fin rays. This trend is correlated osteologically with the reduction and loss of each bone and the replacement by the cartilaginous bone. These evidences show that the liparidid fishes of the Northern Hemisphere penetrated from the inshore bottom into the great depths or midwater as pointed out repeatedly by many authors (Burke, 1930; Schmidt, 1950; Andriashev, 1953, 1954, 1986; Matsubara, 1955; Stein, 1978a; Able and McAllister, 1980; etc.).

3. CLASSIFICATION

The liparidid fishes have been included in the family Cyclopteridae (e.g., Gill, 1865, 1907; Boulenger, 1904; Regan, 1913; Berg, 1940; Schmidt, 1950; Greenwood et al., 1966; Nelson, 1976, 1984; Lauder and Liem, 1983; Able et al., 1984) or recognized in their own family (e.g., Gill, 1889, 1891; Garman, 1892; Jordan and Evermann, 1898; Burke, 1930; Taranetz, 1941; Matsubara, 1943, 1955; Ueno, 1970; Stein, 1978a; Able and McAllister, 1980; Andriashev, 1986). As shown in the chapter IV, the liparidid fishes form their own family Liparidae.

Within the Liparidae, two major groups, i.e., *Nectoliparis* (monotypic) and other liparidids, are recognized from the cladogram (see branch point 1). *Nectoliparis* is well defined by three autapomorphies and 10 apomorphies, though other liparidids are defined only by one autapomorphy. These two groups are placed at subfamilial level and named as *Nectoliparidinae* and *Liparidinae*.

The ranking of the generic level is very difficult at the present cladogram, because many unresolved trichotomous or polychotomous interrelationships are included in the cladogram and they are poorly defined by synapomorphies. Rather than erecting new genera poorly defined, large genera including many species are retained at present (see branch points 1-4). As a result, the following six genera are ranked : *Nectoliparis* (monotypic), *Liparis*, *Crystallichthys*, *Careproctus*, *Osteodiscus* (monotypic) and *Paraliparis*. According to the generic ranking, *Polypera* Burke is synonymized with *Liparis*, *Crystallias* Jordan et Snyder (monotypic) with *Crystallichthys*, and *Temnocora* Burke (monotypic) with *Careproctus*. Similarly, *Elassodiscus* Gilbert et Burke, *Rhinoliparis* Gilbert, *Acantholiparis* Gilbert et Burke, *Rhodichthys* Collett (monotypic) and *Lipariscus* Gilbert (monotypic) are synonymized with *Paraliparis*.

Nelson (1976) established the subfamily Rhodichtinae on the basis of *Rhodich-*

thys regina (= *Paraliparis regina*) without evidence. In 1984, he reduced this subfamily to the tribe Rhodichthyini. The present cladogram, however, does not support these taxa.

A new classification of the Liparididae is shown below, using the sequence convention to reflect the cladogram.

Family Liparididae

Subfamily Nectoliparidinae

Genus *Nectoliparis*

Subfamily Liparidinae

Genus *Liparis*

Crystallichthys

Careproctus, *sedis mutabilis*

Osteodiscus, *sedis mutabilis*

Paraliparis, *sedis mutabilis*

Species of the genera *Gyrinichthys* Gilbert, *Menziesichthys* Nalbant et Mayer, *Notoliparis* Andriashev, *Genioliparis* Andriashev et Neyelov and *Odontoliparis* Stein were not examined in this study. These genera are monotypic and represented by a single specimen except for *Notoliparis*. They are retained due to lack of most available osteological information.

VII. Taxonomy of the liparidid fishes found around Japan

FAMILY LIPARIDIDAE

Body gelatinous, tadpole-like in shape; caudal region elongate. Third infraorbital needle-like, reaching or overlapping preopercle to form suborbital stay. Dorsal and anal fins single, elongate, reaching or overlapping caudal fin. Pelvic fins forming a sucking disk or absent. Vertebrae more than 35.

As a result of the present study, 5 genera and 41 species were recognized in waters around Japan.

1. KEY TO SUBFAMILIES

- 1a. Gill opening at least partly above pectoral fin Liparidinae
- 1b. Gill opening restricted to front of pectoral fin Nectoliparidinae

2. SUBFAMILY LIPARIDINAE

Diagnosis. Gill opening at least partly above pectoral fin. Ethmoid cartilage and pterosphenoid bridged by a narrow cartilage under frontal. An angle formed by two spines of subopercle less than right angle. Third infraorbital at least extending to middle of preopercle.

This subfamily includes all genera and species examined in the present study except for *Nectoliparis*.

3. KEY TO GENERA OF LIPARIDINAE

- 1a. Disk present 2
- 1b. Disk absent *Paraliparis* Collett

- 2a. Nostrils usually with double opening, rarely with a single opening. Pseudobranchiae present. Pectoral fin typically with more rays than anal fin *Liparis* Scopoli
.....
2b. Nostrils always with a single opening. Pseudobranchiae absent. Pectoral fin typically with less rays than anal fin 3
3a. Body with dark bars and spots *Crystallichthys* Jordan et Gilbert
3b. Body without dark bars and spots *Careproctus* Krøyer

4. GENUS *Liparis* Scopoli (Japanese name: Kusauo-zoku)

(*Cyclogaster* Gronovius, 1760 : 581 (non-binomial, *auctorum*)).

Liparis Scopoli, 1777 : 453 (type-species *Cyclopterus liparis* Linnaeus, 1776, by original designation of Jordan, 1917); Günther, 1861 : 158; Gill, 1865 : 190; Garman, 1892 : 45; Goode and Bean, 1896 : 274; Jordan and Evermann, 1898 : 2114; Jordan and Snyder, 1902 : 348; Burke, 1930 : 43; Soldatov and Lindberg, 1930 : 342; Able and McAllister, 1980 : 10.

Actinochir Gill, 1865 : 190 (type-species *Liparis tunicata* Krøyer (not of Reinhardt), 1837, by original designation).

Neoliparis Steindachner, 1875 : 54 (type-species *Liparis mucosus* Ayres, 1855); Jordan and Evermann, 1898 : 2106; Soldatov and Lindberg, 1930 : 333.

Careliparis (subgenus) Garman, 1892 : 62 (type-species *Liparis agassizii* Putnam, 1874).

Lyoliparis (subgenus) Jordan and Evermann, 1896 : 451 (type-species *Liparis pulchellus* Ayres, 1855, by original designation).

Polypera Burke, 1912 : 567 (type-species *Neoliparis greeni*, 1895, by original designation); Burke, 1930 : 91.

Diagnosis. Disk present. Nostrils double, sometimes single. Pseudobranchiae present. Pectoral fin rays typically with more than anal fin rays. Body color usually variegated.

5. KEY TO SPECIES OF *LIPARIS*

- 1a. Anal fin overlapping less than 40% of caudal fin. Dorsal fin rays 31-37, anal fin rays 25-31, pectoral fin rays 27-35, vertebrae 36-43 2
1b. Anal fin overlapping more than 40% of caudal fin. Dorsal fin rays 40-48, anal fin rays 32-40, pectoral fin rays 35-45, vertebrae 45-52 7
2a. Posterior nostril absent or rudimentary; if present, rudimentary opening smaller than head pores 3
2b. Posterior nostril always present with raised rim; its opening about equal to or larger than head pores 5
3a. Anal fin rays 28-31, vertebrae 40-42 *L. burkei* (Jordan et Thompson)
3b. Anal fin rays 25-28, vertebrae 36-39 4
4a. Gill opening usually above pectoral fin, rarely extending ventrally in front of 1-2 pectoral fin rays *L. punctulatus* (Tanaka)
4b. Gill opening extending ventrally in front of 3-6 pectoral fin rays
..... *L. bikunin* Matsubara et Iwai
5a. Gill opening usually above pectoral fin, rarely extending ventrally in front of 1-2 pectoral fin rays. Dorsal fin notched. Disk 1.5-1.8 in head length. Dorsal fin rays 32-33, anal fin rays 25-27, pectoral fin rays 27-32, vertebrae

- 37-39 *L. miostomus* Matsubara et Iwai
- 5b. Gill opening extending ventrally in front of 3-9 pectoral fin rays. Dorsal fin unnotched. Disk 1.9-2.7 in head length. Dorsal fin rays 34-37, anal fin rays 28-31, pectoral fin rays 32-35, vertebrae 39-43
..... *L. frenatus* (Gilbert et Burke)
- 6a. Pyloric caeca 16-38 7
- 6b. Pyloric caeca 50-130 9
- 7a. Dorsal fin overlapping more than two-thirds of caudal fin
..... *L. tessellatus* (Gilbert et Burke)
- 7b. Dorsal fin overlapping less than one-half of caudal fin 8
- 8a. Gill opening extending ventrally in front of 11-18 pectoral fin rays. Dorsal and anal fins with a dark border along their margins. Pectoral fin rays 39-45 *L. ochotensis* Schmidt
- 8b. Gill opening extending ventrally in front of 6-12 pectoral fin rays. Dorsal and anal fins with a interrupted dark border along their margins. Pectoral fin rays 35-41 *L. latifrons* Schmidt
- 9a. Pectoral fin notchless in adults. Pectoral fin rays 39-45 10
- 9b. Pectoral fin notched. Pectoral fin rays 35-40 *L. agassizii* Putnam
- 10a. Head flat in nasal region. Snout low, projecting
..... *L. tanakai* (Gilbert et Burke)
- 10b. Head convex in nasal region. Snout deep, not projecting
..... *L. owstoni* (Jordan et Snyder)

***Liparis burkei* (Jordan et Thompson)**
 (Japanese name : Nise-sokoshiro)
 (Fig. 21)

Cyclogaster frenatum Gilbert : Jordan and Thompson, 1914, 281 (misspelled).

Careproctus burkei Jordan and Thompson, 1914 : 281, pl. 34 (original description ; Yokohama Market) ; Burke, 1930 : 192 ; Okada and Matsubara, 1938 : 348 ; Matsubara, 1955 : 1195 ; Kido, 1984 : 339, pl. 365.

Material examined. Holotype : FMNH 57515, female, 75 mm SL, Yokohama Market, 1911.

Paratype : CAS-SU 22604, female, 70 mm SL, collected with holotype.

Other material : 11 specimens : FAKU 50043, male, 46 mm SL, Shijiki Bay, Hirado I., Nagasaki Pref., depth 30 m, 15 Feb. 1976 ; FMNH 57155, female, 76 mm SL, Misaki, Sagami Bay ; HUMZ 94347, female, 49 mm SL, Hamada Bay, Shimane Pref. ; ZUMT 18393, male, 80 mm SL, date lacking ; ZUMT 27956, male, 83 mm SL, Tokyo Market ; ZUMT 29880, male, 40 mm SL, Yokkaichi, Mie Pref. ; ZUMT uncatalogued, 3 females and 2 males, 61-73 mm SL, Atsumi Peninsula, Aichi Pref.

Comparative material : *Liparis choanus* Wu et Wang : 2 specimens : CAS-SU 53271, 53272, 1 female and 1 male, 82-86 mm SL, approximately 38°30'N, 124°15'E, off Chodo I., Yellow Sea, May 1953.

Diagnosis. A *Liparis* without posterior nostril or with rudimentary posterior nostril ; length of anal overlap of caudal 29.7-34.1% of caudal fin length ; dorsal fin rays 35-37 ; anal fin rays 28-31 ; pectoral fin rays 32-35 ; vertebrae 40-42.

Description. Counts : Dorsal 35-37, anal 28-31, pectoral 32-35, caudal 11-12, vertebrae 10+30-32=40-42, pyloric caeca 10-13, cephalic pores 2-6-7-2.

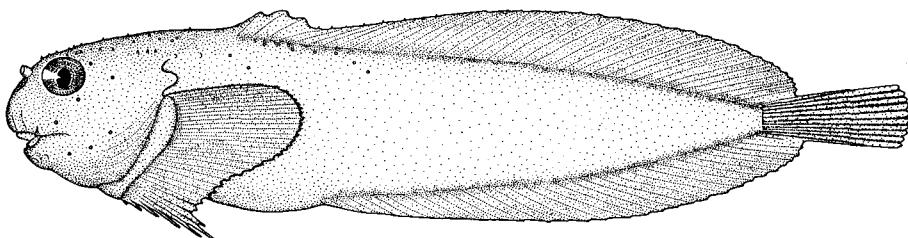


Fig. 21. *Liparis burkei* (Jordan et Thompson), FAKU 50043, 46 mm SL, from Shijiki Bay, Hirado Island, Nagasaki Prefecture.

Morphometry : Head length 22.5–26.3% SL, body depth 16.5–26.5, head width 15.0–20.8, predorsal length 25.3–31.4, mandible to anal origin length 40.5–50.5; snout length 28.9–34.4% HL, eye diameter 17.2–23.0, interorbital width 31.9–42.6, upper jaw length 36.0–44.7, lower jaw length 34.9–41.7, length of upper lobe of pectoral fin 65.6–77.2, length of lower lobe of pectoral fin 47.1–58.2, gill opening length 20.5–33.5, snout to disk length 52.1–77.0, snout to anus length 127.0–163.0, mandible to disk length 47.1–54.9, mandible to anus length 123.0–154.4, disk to anus length 27.0–68.3, anus to anal length 35.0–64.6, disk length 36.4–51.3; length of dorsal overlap of caudal 17.6–28.0% caudal fin length, length of anal overlap of caudal 29.7–34.1.

Body tadpole-like, compressed behind origin of anal fin. Skin firm. Thumback prickles present on head and body in mature males. Rudimentary pores forming three rows on nape and each side of body.

Head relatively compressed; its upper profile descending slowly to snout. Anterior nostril in tube. Posterior nostril absent or rudimentary when present. Snout high, projecting. Eye small. Mouth small; mouth cleft reaching a vertical between anterior nostril and anterior margin of eye; maxillary reaching below middle of eye. Lower lip included within upper lip. Teeth distinctly trilobed with well developed lateral lobes, arranged in 7–11 oblique rows in wide bands on both jaws. Gill opening small, wholly above pectoral fin or extending ventrally in front of 1–3 pectoral fin rays.

Pectoral fin shallowly notched; its uppermost fin ray on a level with lower margin of eye. Upper lobe of pectoral fin short, not reaching origin of anal fin. Lower lobe of pectoral fin short with 5–7 rays, reaching behind posterior margin of disk. Dorsal fin shallowly notched at 4th ray in males. Origin of dorsal fin slightly posterior to a vertical through posterior tip of opercular flap. Origin of anal fin below 8th–10th dorsal fin ray. Caudal fin broad; its posterior margin rounded. Dorsal and ventral notches on caudal fin not distinct.

Disk large, located between verticals through posterior margin of orbit and gill opening. Anus well separated from disk, located almost midway between posterior margin of disk and origin of anal fin.

Stomach large. Pyloric caeca short, bluntly pointed, located on right side of body cavity.

Body color in alcohol uniformly light brown; fins dark brown; branchial

cavity sparsely pigmented ; oral cavity, peritoneum, stomach and pyloric caeca pale. Eye silvery when fresh.

Reaching 83 mm SL.

Distribution. Distributed from Chiba (Jordan and Thompson, 1914) to Mie Prefectures and from Shimane to Nagasaki Prefectures.

Remarks. This species has been described as a species of *Careproctus* because the holotype lacks posterior nostrils on both sides. This character, however, varies within this species as described above. This species is placed into *Liparis* here for the first time because other characters of this species show the condition of typical *Liparis*.

In the same page as the original description of *L. burkei*, Jordan and Thompson (1914) recorded *L. frenatus* from Misaki, Kanagawa Prefecture, based on a specimen (FMNH 57155). Re-examination of this specimen reveals that it apparently belongs to *L. burkei*.

This species is similar to *L. bikunin*, *L. punctulatus*, *L. choanus* Wu et Wang and *L. chefuensis* Wu et Wang in having the reduced posterior nostril. It, however, differs from *L. bikunin* in having more reduced or no posterior nostril (opening always clear in *L. bikunin*), more dorsal and anal fin rays and vertebrae (32–35, 25–28 and 36–39), fewer pyloric caeca (15–20), broader dorsal overlap of caudal (7.9–14.0% of caudal fin length) and smaller disk (51.3–58.9% of head length) ; and from *L. punctulatus* in having more dorsal and anal fin rays and vertebrae (31–33, 25–28 and 36–38 in *L. punctulatus*) and broader dorsal overlap of caudal (3.9–15.9% of caudal fin length). In this study two specimens of *L. choanus* previously described by Cohen (1960) were available. These specimens differ from this species in having more pectoral fin rays (37) and narrower dorsal and anal overlap of caudal (5.3–14.4%, 13.0–18.8% of caudal fin length). This species is most similar to *L. chefuensis* known from Chefoo. No significant differences were not found between this species and the original description of *L. chefuensis* (Wu and Wang, 1933). Close comparison is needed to resolve the relationship between the two.

Liparis punctulatus (Tanaka)
(Japanese name : Suna-bikunin)
(Fig. 22)

Liparis liparis (Linnaeus) : Franz, 1910 : 77, pl. 9 (Fukuura, Sagami Bay ; Misaki, Miura Peninsula, Kanagawa Pref.).

?*Careproctus sarasa* Tanaka, 1916 : 174 (original description ; Toba, Mie Pref.) ; Okada and Matsubara, 1938 : 346 ; Matsubara, 1955 : 1194.

Careproctus punctulatus Tanaka, 1916 : 174 (original description ; near Misaki) ; Okada and Matsubara, 1938 : 346 ; Matsubara, 1955 : 1194.

Careproctus okadae Tanaka, 1916 : 174 (original description ; near Misaki) ; Okada and Matsubara, 1938 : 346.

Liparis franzi Abe, 1950 : 135 (original description ; Tokyo Bay and Misaki) ; Matsubara, 1955 : 1190.

Liparis punctulatus punctulatus : Abe, 1955 : 320, fig. 1 ; Kido, 1984 : 337, pl. 364.

Liparis punctulatus okadae : Abe, 1955 : 321, fig. 2, (Hayama, Kanagawa Pref.).

Liparis punctulatus rutilus Abe, 1955 : 323, fig. 4 ; (original description ; Hayama, Kanagawa Pref.) ; Honma, 1957 : 112 (Sado I., Japan Sea) ; Kido, 1984 : 337, pl. 304.

Liparis okadai : Matsubara, 1955 : 1194.

Liparis sp. : Honma, 1956 : 112 (Sado I., Japan Sea).

Liparis frenatus (Gilbert et Burke) : Kuroda, 1957 : 4, figs. 1, 2 (Chiba Pref.).

Liparis punctulatus franzi : Honma, 1957 : 112 (Sado I., Japan Sea) ; Kido, 1984 : 337, pl. 304.

Liparis ingens (Gilbert et Burke) : Chyung, 1961 : 621, pl. 209 (east coast of Korean Peninsula).

Liparis punctulatus : Shiogaki, 1982 : 31 (Fukaura and Ajigasawa, Aomori Pref.).

Liparis punctulatus okadai : Honma, 1959 : 144 ; Kido, 1984 : 337, pl. 304.

Material examined. *Careproctus punctulatus* Tanaka : holotype, ZUMT 7079, female, 64 mm SL, near Misaki, Kanagawa Pref., 28 Mar. 1916, radiograph only.

Careproctus okadae Tanaka : holotype, ZUMT 7080, female, 62 mm SL, near Misaki, 5 Apr. 1916, radiograph only.

Liparis franzi Abe : paratype, ZUMT 30206, female, 58 mm SL, Misaki, date unknown, radiograph only.

Liparis punctulatus rutilus Abe : paratype, ZUMT 5547, female, 67 mm SL, date lacking, radiograph only.

Other material : 17 specimens : FAKU 50544, sex unknown, 23 mm SL, Shijiki Bay, Hirado I., Nagasaki Pref., depth 20 m, 1 July 1981 ; HUMZ 79036, female, 48 mm SL, Mano Bay, Sado I., Japan Sea, 3-15 m, 16 Feb. 1978 ; HUMZ 79050, female, 42 mm SL, Mano Bay, depth 2-20 m, 23 Dec. 1977 ; HUMZ 86641, female, 45 mm SL, Jogashima I., Miura Peninsula, Kanagawa Pref., 1 m, 19 Dec. 1979 ; HUMZ 87443, female, 83 mm SL, Hikari, Yamaguchi Pref., Setonaikai Sea, 20 Mar. 1973 ; HUMZ 94012-94018, 1 male and 5 specimens of unknown sex, 21-29 mm SL, Aoya, Tottori Pref., 4 June 1981 ; NSMT-P 21726, female, 65 mm SL, Ago, Mie Pref., 12 Mar. 1982 ; NSMT-P uncatalogued, male, 58 mm SL, Hayama, Kanagawa Pref., tide pool, 2 Apr. 1979 ; ZUMT 9862, female, 71 mm SL, south coast of Awaji-shima I. ; ZUMT 23707, female, 83 mm SL, Wakayama Pref., date unknown ; ZUMT 43118, female, 52 mm SL, Mito, Ibaragi Pref., date unknown.

Diagnosis. A *Liparis* without posterior nostril or with rudimentary posterior nostril ; gill opening usually above pectoral fin, rarely extending ventrally in front of 1-2 pectoral fin rays ; length of anal overlap of caudal 10.1-21.2% of caudal fin length ; dorsal fin rays 31-33 ; anal fin rays 25-28 ; pectoral fin rays 29-33 ; vertebrae 36-38.

Description. Counts : Dorsal 31-33, anal 25-28, pectoral 29-33, caudal 11-13, vertebrae $10+26-28=36-38$, pyloric caeca 11-16, cephalic pores 2-6-7-2.

Morphometry (in specimens more than 41.7 mm SL) : Head length 24.9-30.2% SL, body depth 20.4-30.1, head width 19.4-26.1, predorsal length 25.7-34.6, man-

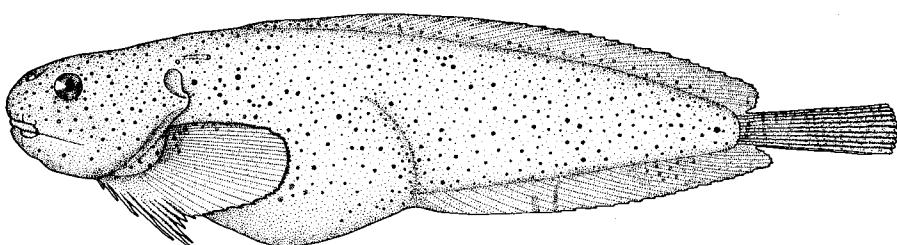


Fig. 22. *Liparis punctulatus* (Tanaka), NSMT-P 21726, 65 mm SL, from Ago, Mie Prefecture.

dible to anal origin length 34.9–54.9; snout length 33.2–39.4% HL, eye diameter 12.9–18.0, interorbital width 36.9–44.1, upper jaw length 34.8–46.6, lower jaw length 32.6–45.9, length of upper lobe of pectoral fin 47.9–68.0, length of lower lobe of pectoral fin 37.4–64.9, gill opening length 18.8–34.6, snout to disk length 47.6–71.0, snout to anus length 121.1–142.9, mandible to disk length 40.8–64.5, mandible to anus length 116.3–136.1, disk to anus length 12.3–42.8, anus to anal length 32.3–68.5, disk length 44.2–60.7; length of dorsal overlap of caudal 3.9–15.9% caudal fin length, length of anal overlap of caudal 10.1–21.2.

Body tadpole-like, compressed behind origin of anal fin. Skin firm. Thumtack prickles present on head and body in mature males. Rudimentary pores forming two rows on each side of body.

Head relatively broad; its upper profile descending slowly to snout. Anterior nostril in tube. Posterior nostril absent or rudimentary when present. Snout low, slightly projecting. Eye small. Mouth small; mouth cleft reaching almost below anterior nostril; maxillary reaching below middle of eye. Lower lip included within upper lip. Teeth distinctly trilobed with well developed lateral lobes, arranged in 7–12 oblique rows in wide bands on both jaws. Gill opening small, wholly above pectoral fin or extending ventrally in front of 1–2 pectoral fin rays.

Pectoral fin shallowly notched; its uppermost fin ray on a level between lower margin of orbit and posterior corner of maxillary. Upper lobe of pectoral fin short, reaching slightly behind anus. Lower lobe of pectoral fin short with 5–7 rays, reaching behind posterior margin of disk. Dorsal fin unnotched. Origin of dorsal fin almost middle of upper lobe of pectoral fin. Origin of anal fin below 7th–10th dorsal fin ray. Caudal fin broad; its posterior margin rounded. Dorsal and ventral notches on caudal fin present.

Disk large, its posterior margin located almost below posterior tip of opercular flap. Anus well separated from disk, located almost midway between posterior margin of disk and origin of anal fin or nearer disk than origin of anal fin.

Stomach large. Pyloric caeca short, bluntly pointed, located on right side of body cavity.

Body color extremely variable; four basic patterns present. Ground color of white spotted pattern brown to dark brown; white spots larger than pupil. That of dark brown spotted pattern light brown; dark brown spots smaller than pupil. That of striped pattern reddish brown to dark brown. That of plain pattern light brown to blackish brown. Eye silvery when fresh. Ventral surface of body paler. Dorsal and anal fins slightly dusky. Caudal fin barred. Oral cavity, stomach and pyloric caeca pale; branchial cavity and peritoneum sparsely pigmented.

Reaching 83 mm SL.

Distribution. Distributed from Nagasaki Prefecture and the Setonaikai Sea to Aomori Prefecture, and in the east coast of the Korean Peninsula.

Remarks. This species has been divided into 4 subspecies based on color patterns (Abe, 1955; Kido, 1984), but species of *Liparis* showing a wide range of color variation are known (Burke, 1930; Hubbs and Schultz, 1934; Matsubara and Iwai, 1954; Wheeler, 1969; Hart, 1973; Able, 1973, 1976; Able and McAllister, 1980; Eschmeyer et al., 1983). Live specimens from Tottori Prefecture caught with *Undaria pinnatifida* at the same time showed three basic patterns and four different

ground colorations. These four subspecies cannot be therefore recognized.

This species is most similar to *L. bikunin*, but differs from the latter in having more reduced or no posterior nostril (opening always clear in the latter) and smaller gill opening (gill opening extending ventrally in front of 3-6 pectoral fin rays).

***Liparis bikunin* Matsubara et Iwai**
 (Japanese name: Ama-kusauo)
 (Fig. 23)

Liparis bikunin Matsubara and Iwai, 1954: 434, figs. 7, 8 (original description; Kushiro);
 Matsubara, 1955: 1191; Ueno, 1971: 96; Kido, 1984: 337, pl. 364.

Material examined. Holotype: FAKU 13318, female, 53 mm SL, Kushiro, Hokkaido, collected from shallow water by beach seine, Mar. 1938.

Paratypes: FAKU 13305-13307, 13309-13317, 13319, 13320, 9 females and 5 males, 40-70 mm SL, collected with holotype.

Diagnosis. A *Liparis* with minute posterior nostril smaller than head pores; gill opening extending ventrally in front of 3-6 pectoral fin rays; length of anal overlap of caudal 15.0-21.5% of caudal fin length; dorsal fin rays 32-35; anal fin rays 25-28; pectoral fin rays 31-35; vertebrae 36-39.

Description. Counts: Dorsal 32-35, anal 25-28, pectoral 31-35, caudal 11-13, vertebrae $10+26-29=36-39$, pyloric caeca 15-20, cephalic pores 2-6-7-2.

Morphometry: Head length 25.3-29.2% SL; eye diameter 13.8-17.1% HL, disk length 51.3-58.9; length of dorsal overlap of caudal 7.9-14.0% caudal fin length, length of anal overlap of caudal 15.0-21.5.

Body tadpole-like, compressed behind origin of anal fin. Skin firm. Prickles absent. Rudimentary pores were not found because of poor skin condition.

Head relatively compressed; its upper profile descending slowly to snout. Anterior nostril in tube. Posterior nostril minute pore, distinctly smaller than head pores. Snout low, slightly projecting. Eye small. Mouth small; mouth cleft reaching almost below anterior nostril; maxillary reaching below anterior margin of eye. Lower lip included within upper lip. Teeth distinctly trilobed with well developed lateral lobes, arranged in 7-9 oblique rows in wide bands on both jaws. Gill opening moderately large, extending ventrally in front of 3-6 pectoral fin rays.

Pectoral fin shallowly notched; its uppermost fin ray almost on a level with lower margin of eye. Upper lobe of pectoral fin short with 5-7 rays, reaching

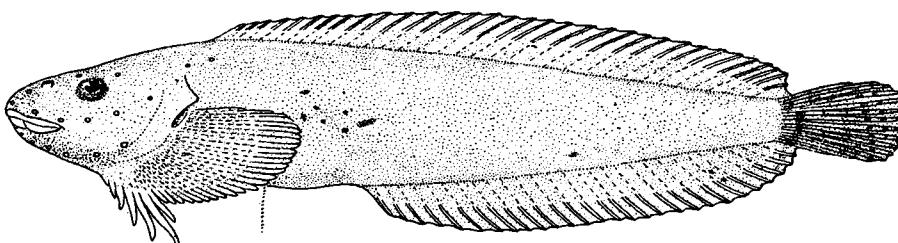


Fig. 23. *Liparis bikunin* Matsubara et Iwai, holotype, FAKU 13318, 53 mm SL, from Kushiro, Pacific coast of Hokkaido, from Matsubara and Iwai (1954).

posterior margin of disk. Dorsal fin unnotched. Origin of dorsal fin posterior to a vertical through posterior tip of opercular flap. Origin of anal fin below 8th-9th dorsal fin ray. Caudal fin broad; its posterior margin rounded. Dorsal and ventral notches on caudal fin present.

Disk large; its anterior margin located below posterior margin of orbit. Anus well separated from disk, nearer origin of anal fin than posterior margin of disk.

Stomach large. Pyloric caeca short, pointed, located on right side of body cavity.

In formalin body uniformly light brown; caudal fin with several irregular crossbars; oral and branchial cavities, stomach, peritoneum and pyloric caeca pale.

Reaching 70 mm SL.

Distribution. Known only from shallow water of Kushiro.

Remarks. This species has minute posterior nostril, which can not be found without using microscope (Metsubara and Iwai, 1954). It, however, always has an opening. In this respect, this species differs from other species having the rudimentary posterior nostril such as *L. burkei*, *L. punctulatus*, *L. choanus* and *L. chefuensis*.

***Liparis miostomus* Matsubara et Iwai**

(Japanese name: Kokuchi-kusauo)

(Fig. 24)

Liparis miostomus Matsubara and Iwai, 1954 : 429, figs. 4, 5 (original description; Kushiro);
Matsubara, 1955 : 1190; Ueno, 1971 : 96; Kido, 1984 : 337, pl. 304.

Material examined. Holotype: FAKU 13291, male, 73 mm SL, Kushiro, Hokkaido, collected from shallow water by beach seine, Mar. 1938.

Paratypes: FAKU 13286-13290, 13292, 13293, 13304, 4 females, 3 males and 1 specimen of unknown sex, 62-83 mm SL, collected with holotype.

Other material: HUMZ 75802, female, 54 mm SL, Cape Notoromisaki, Okhotsk coast of Hokkaido, tide pool, 27 Apr. 1978; HUMZ 95313, female, 69 mm SL, Minamikayabe, Pacific coast of southern Hokkaido, tide pool, 25 May 1982; HUMZ 104891, 104892, 2 males, 78-93 mm SL, Muroran, Pacific coast of southern Hokkaido, 5 Apr. 1985; HUMZ 107666, female, 63 mm SL, Ishikari Bay, Hokkaido, Japan Sea, 19 Mar. 1986; HUMZ 109753, female, 72 mm SL, Minamikayabe, collected by beach seine, 21 July 1986.

Diagnosis. A *Liparis* with notched dorsal fin; posterior nostril not reduced; gill opening usually above pectoral fin, rarely extending ventrally in front of 1-2

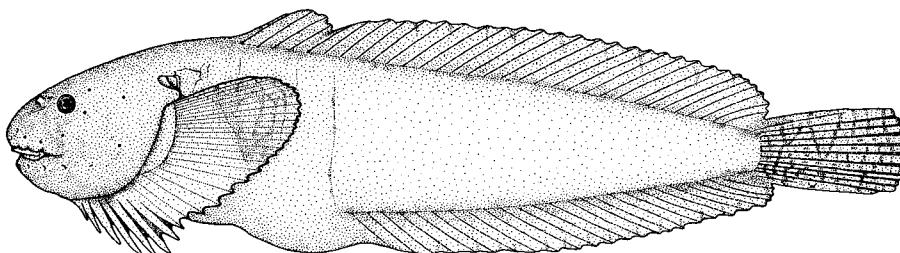


Fig. 24. *Liparis miostomus* Matsubara et Iwai, HUMZ 104891, 93 mm SL, from Muroran, Pacific coast of Hokkaido.

pectoral fin rays ; length of anal overlap of caudal 0-15.8% of caudal fin length ; disk length 56.9-66.1% of head length ; dorsal fin rays 32-33 ; anal fin rays 25-27 ; pectoral fin rays 27-32 ; vertebrae 37-39.

Description. Counts : Dorsal 32-33, anal 25-27, pectoral 27-32, caudal 10-11, vertebrae $10+27-29=37-39$, pyloric caeca 23-41, cephalic pores 2-6-7-2.

Morphometry : Head length 23.1-28.6% SL, body depth 18.8-29.8, head width 20.1-25.8, predorsal length 29.5-39.0, mandible to anal origin length 40.6-52.6 ; snout length 33.9-37.3% HL, eye diameter 10.7-16.3, interorbital width 32.7-41.2, upper jaw length 30.9-38.8, lower jaw length 29.4-35.7, length of upper lobe of pectoral fin 60.7-72.5, length of lower lobe of pectoral fin 45.1-54.6, gill opening length 18.9-26.2, snout to disk length 48.4-60.6, snout to anus length 127.9-148.6, mandible to disk length 36.6-55.2, mandible to anus length 117.6-144.3, disk to anus length 17.9-41.3, anus to anal length 38.3-65.6, disk length 56.9-66.1 ; length of dorsal overlap of caudal 0-9.0% caudal fin length, length of anal overlap of caudal 0-15.8.

Body tadpole-like, compressed behind origin of anal fin. Skin firm. Thumb-tack prickles present on head and body in mature males. Rudimentary pores forming three rows on nape and each side of body.

Head large ; its upper profile descending slowly to snout. Anterior nostril in tube. Posterior nostril prominent, raised pore without a flap on anterior portion. Snout low, slightly projecting. Eye small. Mouth small ; mouth cleft reaching below anterior nostril ; maxillary reaching below middle of eye. Lips fleshy ; lower lip included within upper lip. Teeth distinctly trilobed with well developed lateral lobes, arranged in 6-10 oblique rows in wide bands on both jaws. Gill opening small, wholly above pectoral fin or extending ventrally in front of the 1-2 pectoral fin rays.

Pectoral fin shallowly notched ; its uppermost fin ray on a level with lower margin of orbit. Upper lobe of pectoral fin short, not reaching origin of anal fin. Lower lobe of pectoral fin short with 5-7 rays, reaching posterior margin of disk. Dorsal fin deeply notched at 4th ray. Origin of dorsal fin above middle of upper lobe of pectoral fin. Origin of anal fin below 8th-9th dorsal fin ray. Caudal fin broad ; its posterior margin rounded. Dorsal and ventral notches on caudal fin present.

Disk large, its anterior margin located almost below posterior margin of orbit. Anus well separated from disk, but nearer posterior margin of disk than origin of anal fin.

Stomach large. Pyloric caeca short, pointed, located on right side of body cavity.

In alcohol body uniformly dark brown on dorsal and lateral surfaces, paler on ventral surface ; pectoral fin paler on ventral portion ; rudimentary pores often margined with black ; oral cavity, stomach and pyloric caeca pale ; branchial cavity and peritoneum pigmented. Eye silvery when fresh.

Reaching 93 mm SL.

Distribution. Known only from shallow waters around Hokkaido.

Remarks. This species is similar to *L. curilensis* Gilbert et Burke (Matsubara and Iwai, 1954) known from Simushir Island, the Kuril Islands, in most characters.

It differs from the latter, however, in having fewer pyloric caeca (65 in the latter (Burke, 1930)) and no flap on anterior portion of posterior nostril (present in the latter (Gilbert et Burke, 1912b)). It is also very similar to *L. kuznetzovi* Tarantet known from the Tatar Strait. No significant differences were found between it and the original description of *L. kuznetzovi* (Tarantet, 1937). It may be conspecific with the latter.

***Liparis frenatus* (Gilbert et Burke)**
 (Japanese name : Kanten-bikunin)
 (Fig. 25)

Cyclogaster frenatus Gilbert and Burke, 1912b : 356, pl. 42 (original description ; Japan Sea off Aomori Pref., Albatross station 4809, in 379 m) ; Jordan et al., 1913 : 306.

Liparis frenatus : Burke, 1930 : 70, fig. 7 ; Soldatov and Lindberg, 1930 : 350 ; Tarantet, 1937 : 132 ; Okada and Matsubara, 1938 : 344 ; Lindberg, 1947 : 193 ; Matsubara and Iwai, 1954 : 432, fig. 6 (Kushiro) ; Matsubara, 1955 : 1190 ; Lindberg, 1959 : 255 ; Ueno, 1971 : 96 ; Maruyama, 1971 : 65 ; Kido, 1984 : 338, pl. 364.

Material examined. 9 specimens : HUMZ 52890, female, 43 mm SL, near Hakodate, Hokkaido, 14 May 1976 ; HUMZ 79037, 79051, 79061, 79063, 3 females and 1 male, 31-35 mm SL, Mano Bay, Sado I., Japan Sea, depth 3-20 m, 9 July 1977 and 16 Feb. 1978 ; HUMZ 92972, male, 50 mm SL, off Omu River, Okhotsk coast of Hokkaido, 10 m, 3 May 1979 ; HUMZ 97511, male, 42 mm SL, near Hakodate, Hokkaido, 13 Nov. 1958 ; HUMZ 102384, sex unknown, 40 mm SL, Sarufutsu, Okhotsk coast of Hokkaido, 1983 ; HUMZ 104890, male, 63 mm SL, Muroran, Pacific coast of Hokkaido, 5 Apr. 1985.

Diagnosis. A *Liparis* with unnotched dorsal fin ; posterior nostril not reduced ; gill opening extending ventrally in front of 3-9 pectoral fin rays ; length of anal overlap of caudal 18.4-29.4% of caudal fin length ; disk length 39.6-52.5% of head length ; dorsal fin rays 34-37 ; anal fin rays 28-31 ; pectoral fin rays 32-35 ; vertebrae 39-43.

Description. Counts : Dorsal 34-37, anal 28-31, pectoral 32-35, caudal 10-11, vertebrae 10-11+29-32=39-43, pyloric caeca 14-23, cephalic pores 2-6-7-2.

Morphometry : Head length 26.1-32.6% SL, body depth 20.3-26.8, head width 18.5-25.2, predorsal length 28.2-37.7, mandible to anal origin length 39.1-49.6 ; snout length 29.7-39.8% HL, eye diameter 17.5-24.8, interorbital width 39.3-41.6,

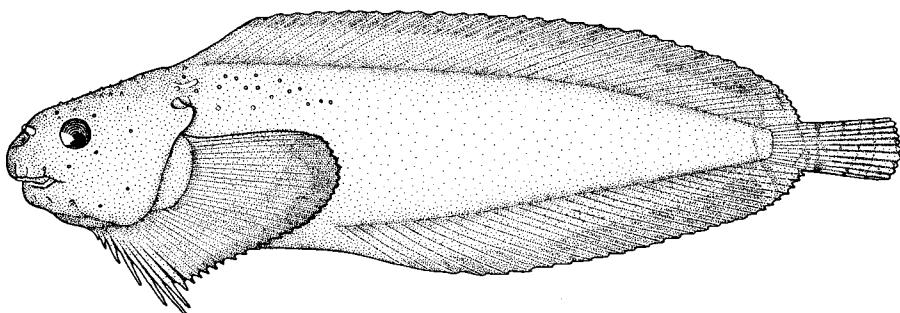


Fig. 25. *Liparis frenatus* (Gilbert et Burke), HUMZ 104890, 63 mm SL, from Muroran, Pacific coast of Hokkaido.

upper jaw length 36.2-44.0, lower jaw length 35.5-40.6, length of upper lobe of pectoral fin 52.5-84.8, length of lower lobe of pectoral fin 51.7-71.3, gill opening length 21.6-30.0, snout to disk length 52.5-67.0, snout to anus length 122.5-140.8, mandible to disk length 42.8-57.3, mandible to anus length 110.8-136.4, disk to anus length 23.5-39.3, anus to anal length 21.5-37.9, disk length 39.6-52.5; length of dorsal overlap of caudal 13.9-22.1% caudal fin length, length of anal overlap of caudal 18.4-29.4.

Body tadpole-like, compressed behind origin of anal fin. Skin firm. Thumback prickles present on head and body in mature males. Rudimentary pores forming three rows on nape and each side of body.

Head large; its upper profile descending slowly to snout. Anterior nostril in tube. Posterior nostril prominent, raised pore with a flap on anterior portion. Snout low, slightly projecting. Eye small. Mouth small; mouth cleft reaching a vertical between anterior nostril and anterior margin of eye; maxillary reaching below middle of eye. Lower lip included within upper lip. Teeth distinctly trilobed with well developed lateral lobes, arranged in 8-11 oblique rows in wide bands on both jaws. Gill opening moderately large, extending ventrally in front of 3-7 pectoral fin rays.

Pectoral fin shallowly notched; its uppermost fin ray on a level with lower margin of orbit. Upper lobe of pectoral fin not reaching origin of anal fin or reaching it. Lower lobe of pectoral fin short with 5-7 rays, reaching midway between posterior margin of disk and anus. Dorsal fin unnotched. Origin of dorsal fin somewhat posterior to a vertical through tip of opercular flap or almost above middle of upper lobe of pectoral fin. Origin of anal fin below 8th-10th dorsal fin ray. Caudal fin broad; its posterior margin rounded. Dorsal and ventral notches on caudal fin present.

Disk large, its anterior margin located almost below posterior margin of orbit. Anus well separated from disk, located almost midway between posterior margin of disk and origin of anal fin.

Stomach large. Pyloric caeca short, pointed, located on right side of body cavity.

In alcohol body grayish brown or brown, paler on ventral surface; pectoral fin with several irregular bars on upper portion or entirely blackish; dorsal and anal fins with small spots or several irregular crossbars or entirely blackish; caudal fin with several irregular crossbars; rudimentary pores often margined with black; oral cavity, stomach, peritoneum and pyloric caeca pale; branchial cavity slightly pigmented. Eye silvery when fresh.

Reaching 78 mm SL (Gilbert and Burke, 1912b).

Distribution. Known from the Japan Sea and waters around Hokkaido at depths of 3 to 379 m (mainly from shallow waters).

Remarks. This species is similar to *L. tartaricus* Soldatov known from Peter the Great Bay. It differs from the latter by having fewer dorsal fin rays and more pectoral fin rays (38 and 28 in the latter (Soldatov and Lindberg, 1930)). It is also very similar to *L. brashnikovi* Soldatov known from Peter the Great Bay and the Tatar Strait. The original description of the latter (in Soldatov and Lindberg, 1930) shows that this species does not differ significantly from the latter. Close

comparison is needed to resolve the relationship between the two.

Liparis tessellatus (Gilbert et Burke)
 (Japanese name : Bikunin)
 (Fig. 26)

Liparis pulchellus Ayres : Schmidt, 1904a : 160 (Peter the Great Bay and Aniwa Bay); Pavlenko, 1910 : 44 (Peter the Great Bay and Aleksandrozk-Sakhalinskiy); Soldatov and Lindberg, 1930 : 346 (Peter the Great Bay).

Cyclogaster tessellatus Gilbert and Burke, 1912b : 355, fig. 2, pl. 41 (original description; Pacific off Hokkaido and Japan Sea off Korea, Albatross stations 4867, 5041 and 5042, in 112-275 m); Jordan et al., 1913 : 306; Yanai, 1950 : 21.

Liparis tessellatus : Burke, 1930 : 89, fig. 18; Soldatov and Lindberg, 1930 : 347; Tarantet, 1937 : 132; Okada and Matsubara, 1938 : 345; pl. 84; Lindberg, 1947 : 193; Hikita, 1951 : 310 (Funka Bay); Honma, 1952 : 224; Katayama, 1953 : 3, figs. 3, 4 (off Hyogo Pref.); Matsubara and Iwai, 1954 : 439, fig. 11 (off Hyogo, Toyama and Kyoto Prefs. and off Kushiro); Matsubara, 1955 : 1192, pl. 130; Mori, 1956b : 30 (off Hyogo and Shimane Prefs.); Lindberg, 1959 : 255; Chyung, 1961 : 621, pl. 209 (off east coast of Korean Peninsula); Ueno, 1971 : 97; Maruyama, 1971 : 65; Hikita, 1981 : 74 (off east coast of Shiretoko Peninsula); Shiogaki, 1982 : 31 (Japan Sea and Pacific off Aomori Pref.); Kido, 1984 : 338, pl. 304.

Liparis brevicaudus Mori, 1956c : 31, fig. 3 (original description; Yamato Bank, Japan Sea).
Liparis merdionalis Schmidt : Ueno, 1971 : 97 (misspelled).

Liparis alboventer Schmidt, in Lindberg, 1959 : 255 (nomen nudum); Ueno, 1971 : 97.

Careproctus alboventer : Krasyukova, 1984 : 14, fig. 7 (original description; South-Kuril Strait).

Material examined. 28 specimens: HUMZ 18957, male, 211 mm SL, 42°25'N, 143°38'E, off Hiroo, Pacific off Hokkaido, depth 70-90 m, 13 Oct. 1962; HUMZ 40922, male, 150 mm SL, Minamikayabe, Pacific coast of southern Hokkaido, depth unknown, 3 May 1975; HUMZ 41485, 41491-41493, 41501, 1 female and 4 males, 195-272 mm SL, 42°20'N, 141°10'E, off Muroran, Pacific off Hokkaido, 116 m, 7 July 1973; HUMZ 52404, male, 142 mm SL, off Murakami, Japan Sea off Niigata Pref., depth unknown, 24 Mar. 1976; HUMZ 58634, male, 167 mm SL, off Kushiro, Pacific off Hokkaido, 20 m, 28 Aug. 1976; HUMZ 62258, female, 106 mm SL, 44°45'N, 141°25'E, off Teshio, Japan Sea off Hokkaido, depth unknown, 18 June 1974; HUMZ 63684, female, 106 mm SL, off Iwafune, Japan Sea off Niigata Pref., 105-106 m, 14 Apr. 1977; HUMZ 65984, male, 130 mm SL, 37°48'N, 137°08'E, Japan Sea off Noto Peninsula, 131-141 m, 4 June 1977; HUMZ 66090, male, 154 mm SL, 37°14.5'N, 136°31'E, Japan Sea off Noto Peninsula, 147-158 m, 7 June 1977; HUMZ 71443, female, 113 mm SL, off Hitachi, Pacific off Ibaragi Pref., 255-346 m, 13 Nov. 1977; HUMZ 77531, female, 187 mm SL, off Shiranuka, Pacific off Aomori Pref., 240 m, 26 Sep. 1978; HUMZ 80584, 80585, 81286-81288, 3 females and 2 males, 81-98 mm SL, 44°52'N-45°00'N, 141°30'E-141°40'E, off Teshio, 10 June 1978; HUMZ 80586, 80588, 80589, 2 females and 1 male, 79-109 mm SL, 43°20'N-43°21'N, 141°22'E, Ishikari Bay, depth unknown, 9 June 1978; HUMZ 80590, female, 94 mm SL, 43°41'N, 141°18'E, off Ofuyu, Japan Sea off Hokkaido, 78 m, 6 June 1978; HUMZ 80799, male, 90 mm SL, off Akkeshi, Pacific off Hokkaido, depth unknown, 29 June 1979; HUMZ 80918, female, 82 mm SL, off Kushiro, depth unknown, 1 July 1979; HUMZ 91968, female, 113 mm SL, 44°40'06"N, 142°50'50"E, off Omu, 50 m, 10 July 1981; HUMZ 106319, female, 189 mm SL, off Kamaishi, Pacific off Iwate Pref., 160 m, 20 Dec. 1984.

Diagnosis. A *Liparis* with dorsal fin overlapping 67.2-81.0% of caudal fin length; anal fin overlapping 76.3-85.0% of caudal fin length; pectoral fin notched; gill opening extending ventrally in front of 15-23 pectoral fin rays; pyloric caeca 17-36.

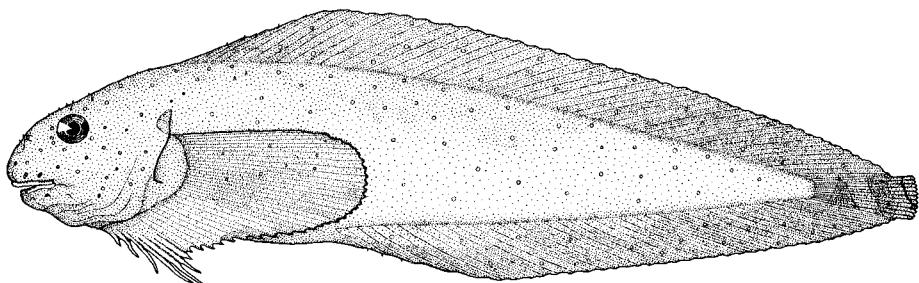


Fig. 26. *Liparis tessellatus* (Gilbert et Burke), HUMZ 40922, 150 mm SL, from Minami-kayabe, Pacific coast of southern Hokkaido.

Description. Counts: Dorsal 45-48, anal 37-40, pectoral 35-40, caudal 10, vertebrae 11-12+37-39=49-51, pyloric caeca 17-36, cephalic pores 2-6-7-2.

Morphometry: Head length 21.7-26.6% SL, body depth 16.8-26.5, head width 14.2-17.7, predorsal length 25.1-31.9, mandible to anal origin length 33.9-44.8; snout length 33.5-41.1% HL, eye diameter 14.6-25.6, interorbital width 44.5-52.5, upper jaw length 35.5-45.9, lower jaw length 45.9-60.8, length of upper lobe of pectoral fin 88.8-125.7, length of lower lobe of pectoral fin 54.3-75.2, gill opening length 31.6-52.4, snout to disk length 53.1-68.0, snout to anus length 130.2-174.2, mandible to disk length 40.7-55.3, mandible to anus length 119.1-167.0, disk to anus length 39.1-85.7, anus to anal length 14.4-35.4, disk length 25.2-38.8; length of dorsal overlap of caudal 67.2-81.0% caudal fin length, length of anal overlap of caudal 76.3-85.0.

Body elongate, slender. Skin firm. Thumtack prickles present on head and body in mature males and females. Rudimentary pores forming three rows on nape and each side of body.

Head compressed; its upper profile descending slowly to snout. Anterior nostril in tube. Posterior nostril reduced, almost equal to head pores in size. Snout low, projecting. Eye small. Mouth large, inferior; mouth cleft reaching below midway between anterior nostril and anterior margin of eye; maxillary reaching below middle of eye. Lower lip included within upper lip. Teeth trilobed with central lobe larger than lateral lobes, arranged in about 14-21 oblique rows in wide bands on both jaws. Gill opening large, extending ventrally in front of 15-23 pectoral fin rays.

Pectoral fin shallowly notched; its uppermost fin ray on a horizontal with middle of eye. Upper lobe of pectoral fin reaching behind origin of anal fin. Lower lobe of pectoral fin short with 5-7 thickened rays, reaching almost midway between posterior margin of disk and anus. Dorsal fin unnotched. Origin of dorsal fin almost above tip of opercular flap. Origin of anal fin below 10th-12th dorsal fin ray. Caudal fin broad; its posterior margin rounded. Dorsal and ventral notches on caudal fin present.

Disk relatively small; its posterior margin almost below posterior tip of opercular flap. Anus well separated from disk, nearer origin of anal fin than disk.

Stomach large. Pyloric caeca long, pointed, located on right side of body

cavity.

Body color pale brown. Four basic patterns present: marbled, striped, speckled and plain patterns. Dorsal and anal fins with dark bars or entirely blackish; pectoral fin with dark bars on upper portion or entirely blackish; caudal fin with three dark bars. Body musculature, eye and peritoneum silvery when fresh. In alcohol oral cavity, stomach and pyloric caeca pale; dorsal surface of peritoneum and branchial cavity pigmented.

Reaching 272 mm SL.

Distribution. Distributed from Shimane and Ibaragi Prefectures to Hokkaido, in the east coast of the Korean Peninsula, Peter the Great Bay, the western coast of Sakhalin, Aniwa Bay and the South-Kuril Strait, at depths of 0 to 272 m. Abundant in the Japan Sea (Matsubara, 1955).

Remarks. Mori (1956c) described *L. brevicaudus* based on a single specimen (260 mm SL) taken from the Yamato Bank, the Japan Sea. The specimen is apparently lost (M. Katayama, pers. comm.). Mori stated that *L. brevicaudus* differs from *L. tessellatus* in having more pectoral fin rays, fewer and shorter caudal fin rays, longer lower lobe of pectoral fin and larger disk. *L. brevicaudus*, however, apparently has the abnormal caudal fin and the other differences are included in intraspecific variations of *L. tessellatus*. *L. brevicaudus* is a junior synonym of *L. tessellatus*.

Careproctus alboventer was originally described by Krasyukova (1984). The species, however, is the same species as *L. tessellatus* because it agrees well with *L. tessellatus*. Krasyukova apparently failed to find posterior nostrils due to their smallness.

This species has been misidentified by several authors (Schmidt, 1904a; Pavlenko, 1910; Soldatov and Lindberg, 1930; and others). It is easily identified, however, by having broad connection between dorsal, anal, and caudal fins, wider gill opening and slender body.

***Liparis ochotensis* Schmidt**
(Japanese name: Isago-bikunin)
(Figs. 27, 28)

Liparis ochotensis Schmidt, 1904a: 163, fig. 11 (original description; Aniwa and Terpenie Bays); Pavlenko, 1910: 45 (Peter the Great Bay); Burke, 1930: 80, fig. 11; Soldatov and Lindberg, 1930: 349 (Peter the Great Bay); Tarantzev, 1937: 132; Okada and Matsubara, 1938: 345; Schmidt, 1950: 193; pl. 16 (off eastern coast of Sakhalin, near Shantar Is., and Iona I.; in part); Matsubara, 1955: 1192; Mori, 1956c: 31 (Yamato Bank, Japan Sea); Lindberg, 1959: 255; Ueno, 1971: 97; Fedorov, 1973: 65; Hikita, 1981: 74 (off east coast of Shiretoko Peninsula); Kido, 1983b: 293, pl. 174 (off Okhotsk coast of Hokkaido); Kido, 1984: 323, pl. 304.

Cyclogaster ochotensis: Gilbert and Burke, 1912b: 359, pl. 42 (Aniwa Bay and off eastern coast of Sakhalin); Jordan et al., 1913: 304.

Cyclogaster ingens Gilbert and Burke, 1912b: 360, pl. 43 (original description; off eastern coast of Korea, Albatross station 4863, in 458 m); Jordan et al., 1913: 306.

Liparis ingens: Burke, 1930: 81, fig. 12; Soldatov and Lindberg, 1930: 351 (Peter the Great Bay and Tatar Strait); Tarantzev, 1937: 132; Okada and Matsubara, 1955: 1192; Mori, 1956b: 30; Mori, 1956c: 31, fig. 3 (Yamato Bank, Japan Sea); Lindberg, 1959: 255;

Kido, 1984 : 323, pl. 364.

Liparis rhodosoma Burke, 1930 : 81, fig. 13 (original description ; off southwestern coast of Sakhalin, Albatross stations 5016, 5017, 5020, 5021 and 5023, in 117-137 m) ; Tarantzev, 1937 : 132 ; Okada and Matsubara, 1938 : 345 ; Hikita and Misu, 1952 : 41, pl. 8 (Japan Sea off Hokkaido) ; Katayama, 1953 : 3, fig. 2 (off Hyogo Pref.) ; Matsubara, 1955 : 1192 ; Mori, 1956b : 30 (off Kyoto and Hyogo Prefs.) ; Lindberg, 1959 : 254 ; Ueno, 1971 : 97 ; Quast and Hall, 1972 : 31.

Liparis niger Soldatov and Lindberg, 1930 : 352, fig. 56 (original description : Peter the Great Bay) ; Tarantzev, 1937 : 132 ; Lindberg, 1947 : 193 ; Matsubara, 1955 : 1191 ; Ueno, 1971 : 96.

Liparis dubius Soldatov, in Soldatov and Lindberg, 1930 : 356, fig. 58 (original description ; Peter the Great Bay) ; Tarantzev, 1937 : 132 ; Lindberg, 1947 : 193 ; Matsubara, 1955 : 1192 ; Ueno, 1971 : 96.

Liparis latifrons meridionalis Schmidt, 1950 : 197 (original description ; Peter the Great Bay and southern Tatar Strait).

Liparis multiradiatus Matsubara and Iwai, 1954 : 437, fig. 9 (original description ; Kushiro) ; Matsubara, 1955 : 1192 ; Ueno, 1971 : 97 ; Kido, 1984 : 323, pl. 364.

Liparis inger (Gilbert et Burke) : Ueno, 1971 : 97 (misspelled).

Material examined. 46 specimens : HUMZ 33984, male, 539 mm SL, 42°12.5'N, 143°06.5'E, off Okhotsk coast of Hokkaido, depth 128 m, 27 Oct. 1974 ; HUMZ 34021, 34223, 2 males, 146-464 mm SL, off Kushiro, 88-450 m, 16-17 July 1974 ; HUMZ 44886, 44887, 2 males, 481-507 mm SL, 44°48'N, 139°50'E, Musashi Bank, northern Japan Sea, 375-390 m, 15 July 1975 ; HUMZ 46393, male, 334 mm SL, 54°05'N, 154°40'E, off western coast of Kamchatka, depth 163-172 m, 8 May 1975 ; HUMZ 46429, male, 357 mm SL, 49°07'N, 155°08'E, off Harumukotan I., Kuril Is., 295-350 m, 24 June 1975 ; HUMZ 53713-53716, 53887, 53889, 6 males, 215-271 mm SL, 38°23.4'N-38°24.2'N, 137°20.0'E-137°23.1'E, off Noto Peninsula, Japan Sea, 263-560 m, 4 June 1976-19 June 1976 ; HUMZ 55392, 55394, 2 males, 311-338 mm SL, 61°00'N, 158°41'E, Penzhinskiy Bay, 88-90 m, 7 June 1976 ; HUMZ 55043, male, 342 mm SL, 51°25'N, 158°04'E, off southeastern Kamchatka, 135-140 m, 21 May 1976 ; HUMZ 55470, 55471, 2 males, 331-354 mm SL, 58°11'N, 151°57'E, off Koni Peninsula, northern Okhotsk Sea, 155-156 m, 9 June 1976 ; HUMZ 71001, male, 597 mm SL, 45°07'N, 142°59'E, off Okhotsk coast of Hokkaido, 125 m, 26 Oct. 1977 ; HUMZ 75763, male, 432 mm SL, 45°18'N, 142°52'E, off Okhotsk coast of Hokkaido, 120-122 m, 4 Oct. 1977 ; HUMZ 75893, 75951, 75952, 75957-75961, 75963, 75964, 75988, 8 females, 2 males and 1 specimen of unknown sex, 82-361 mm SL, 42°43'N-42°52.4'N, 144°19.1'E-144°23'E, off Kushiro, Pacific coast of Hokkaido, 180-230 m, 11 July 1978-14 July 1978 ; HUMZ 77583, 77627, 77628, 77636, 77669, 77671, 77672, 77692, 77796, 9 males, 161-267 mm SL, 44°20'N-44°49'N, 144°20'E-145°02'E, off Okhotsk coast of Hokkaido, depth unknown, 20 Sep. 1978-5 Oct. 1978 ; HUMZ 92676, male, 185 mm SL, 45°15.5'N, 142°53.0'E, off Okhotsk coast of Hokkaido, 125 m, 7 Oct. 1981 ; HUMZ 92707, female, 396 mm SL, 45°09'N, 143°23'E, off Okhotsk coast of Hokkaido, 147-153 m, 7 Oct. 1981 ; HUMZ 94102, male, 598 mm SL, off Yoichi, Japan Sea off Hokkaido, 300-350 m, 21 Jan. 1982 ; HUMZ 107083, 107084, 2 females, 130, 145 mm SL, 48°02'N, 145°15'E, off Cape Terpenie, Sakhalin, 145 m, 24 Oct. 1984.

Diagnosis. A *Liparis* with notched pectoral fin ; gill opening extending ventrally in front of 11-18 pectoral fin rays ; dorsal fin overlapping 25.9-45.9% of caudal fin length ; anal fin overlapping 45.6-65.4% of caudal fin length ; dorsal fin rays 43-48 ; anal fin rays 35-39 ; pectoral fin rays 39-45 ; vertebrae 48-52 ; pyloric caeca 16-38 (Schmidt, 1904a and present study) ; dorsal and anal fins with a dark border along their margins.

Description. Counts : Dorsal 43-48, anal 35-39, pectoral 39-45, caudal 10-11, vertebrae 12+36-40=48-52, pyloric caeca 21-38, cephalic pores 2-6-7-2.

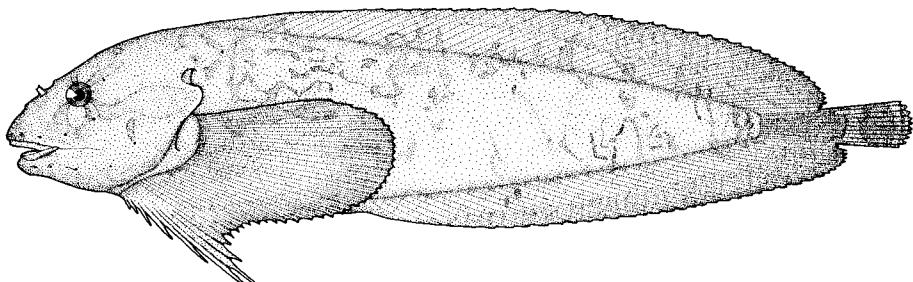


Fig. 27. *Liparis ochotensis* Schmidt, HUMZ 92676, 185 mm SL, from off Okhotsk coast of Hokkaido.

Morphometry : Head length 25.3-31.5% SL, body depth 22.6-34.9, head width 17.4-26.6, predorsal length 27.8-34.8, mandible to anal origin length 40.0-49.6; snout length 33.4-44.7% HL, eye diameter 8.2-23.8, interorbital width 33.5-46.3, upper jaw length 43.5-58.5, lower jaw length 35.7-49.9, length of upper lobe of pectoral fin 73.2-100.3, length of lower lobe of pectoral fin 50.0-75.0, gill opening length 33.0-55.0, snout to disk length 50.0-64.4, snout to anus length 122.9-151.8, mandible to disk length 42.1-56.2, mandible to anus length 109.6-142.8, disk to anus length 26.8-53.2, anus to anal length 17.0-43.7, disk length 28.8-44.1; length of dorsal overlap of caudal 25.9-45.9% caudal fin length, length of anal overlap of caudal 45.6-65.4.

Body relatively compressed. Skin relatively fragile. Thumbtack prickles present on head and body in mature males and females. Rudimentary pores forming three rows on nape and each side of body.

Head large, relatively compressed ; its upper profile descending slowly to snout. Anterior nostril in tube. Posterior nostril prominent, raised pore without a flap on anterior portion. Snout low, projecting. Eye small ; its diameter decreasing with body size (Fig. 28). Mouth large, inferior ; mouth cleft reaching below middle between anterior nostril and anterior margin of eye ; maxillary reaching below posterior margin of eye. Lips freshy ; lower lip included within upper lip. Teeth small, numerous, arranged in about 11-37 oblique rows in wide bands on both jaws. Teeth strongly trilobed with lobes of similar size in smaller specimens, weakly trilobed with a longer central lobe in larger specimens. Gill opening large, extending ventrally in front of 11-18 pectoral fin rays.

Pectoral fin shallowly notched ; notch more prominent in smaller specimens than larger ones. Uppermost pectoral fin ray on a horizontal between lower margin of orbit and posterior corner of maxillary. Upper lobe of pectoral fin reaching behind origin of anal fin. Lower lobe of pectoral fin short with 6-8 thickened rays, reaching halfway between posterior margin of disk and anus. Dorsal fin unnotched. Origin of dorsal fin almost above tip of opercular flap. Origin of anal fin below 10th-13th dorsal fin ray. Caudal fin broad ; its posterior margin rounded. Dorsal and ventral notches on caudal fin usually present.

Disk large, located almost between verticals through posterior margin of eye and gill opening. Anus far back, nearer origin of anal fin than posterior margin of disk

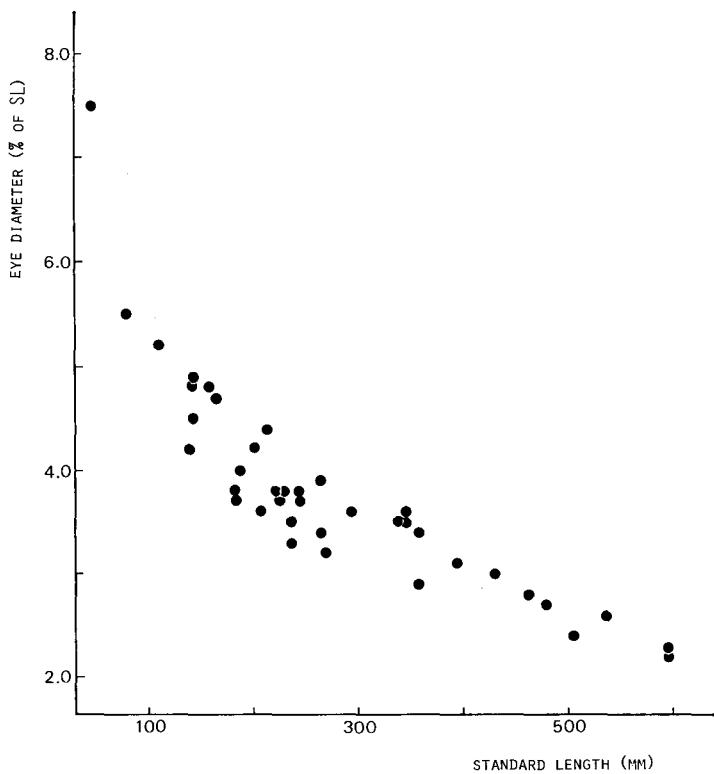


Fig. 28. Morphometric change of eye diameter as a percent of SL versus SL in *Liparis ochotensis*.

or located almost midway between the two. Stomach large. Pyloric caeca long, pointed, located on right side of body cavity.

Body color extremely variable: gray, light brown, brown, blackish brown, or blackish. Eight basic patterns present: white spotted, black spotted, speckled, dusted, striped, mottled, reticulated and plain patterns. Dorsal and anal fins with the same color pattern as body, with dark bars, or entirely blackish; pectoral fin with the same color pattern as body or blackish; caudal fin with two or three broad dark bands, with several irregular dark bars, or entirely blackish. Eye silvery when fresh. In alcohol, oral and branchial cavities, peritoneum, stomach and pyloric caeca pale.

Reaching 598 mm SL.

Distribution. Widely distributed in the Okhotsk and Japan Seas, the Tatar Strait, and the Pacific off Hokkaido, Kuril Islands and the southeastern Kamchatka, at depths of 0 to 560 m (mainly about 50 to 200 m).

Remarks. Gilbert and Burke (1912b) and Burke (1930) described that the jaws of *L. ochotensis* are nearly equal in length, and used this character as one of the diagnostic characters. Several authors followed them (Taranetz, 1937; Okada and Matsubara, 1938; Matsubara and Iwai, 1954; and Matsubara, 1955). In *L. ochot-*

ensis, however, the lower jaw is included in the upper as originally described by Schmidt (1904a) (Okada and Kobayashi, 1968).

Gilbert and Burke (1912b) originally described *L. ingens* based on a large specimen (490 mm TL) from off Korea. It was distinguished from *L. ochotensis* in having slenderer body (30% of SL), shorter jaw (52.4% of head length), different number of teeth rows (30 rows in upper jaw and 20 rows in the lower) and different shape of teeth (slender and weakly trilobed) (Gilbert and Burke, 1912b; Burke, 1930). The shape of teeth in *L. ochotensis*, however, varies with body size as described above and the other differences fall within the range of variation of *L. ochotensis* examined here. *L. ingens* is thus conspecific with *L. ochotensis*.

Burke (1930) described a new species *L. rhodosoma* based on five specimens (105–200 mm TL) from the Okhotsk Sea off Sakhalin. He stated that it differs from *L. ochotensis* in having different shape of head (distinctly pointed) and coloration (striped and white spotted patterns). These differences, however, are included in variation of *L. ochotensis*. *L. rhodosoma* is a synonym of *L. ochotensis*.

L. niger was described as a new species by Soldatov and Lindberg (1930) based on a large specimen (523 mm SL) from Peter the Great Bay. It was distinguished from *L. ingens* in having shorter head (24.6% of SL), smaller eye (2.7%), shorter predorsal length and different coloration (bluish black). Eye diameter in *L. ochotensis*, however, decreases with growth (Fig. 28) and the other differences are almost included in variation of *L. ochotensis* examined here. *L. niger* is thus conspecific with *L. ochotensis*.

L. dubius Soldatov, which was described on the basis of two specimens (70–124 mm SL) from Peter the Great Bay, was distinguished from *L. ochotensis* by having smaller gill opening (35.7–38.2% of head length), no dorsal and ventral notches on caudal fin, more anal fin rays (39–40) and fewer pectoral fin rays (39–40). *L. dubius*, however, is not clearly separable from *L. ochotensis* by these differences.

Matsubara and Iwai (1954) described a new species *L. multiradiatus* based on a small specimen (60.5 mm SL) from shallow water off Kushiro, the Pacific coast of Hokkaido. It was distinguished from *L. ochotensis* in having larger eye (7.0% of SL), larger disk (13.6%) and dorsal fin jointed to basal one-third of caudal fin. Eye diameter in *L. ochotensis*, however, is relatively larger in smaller specimen (Fig. 28) and the other differences fall within the range of variation of *L. ochotensis*. *L. multiradiatus* is thus conspecific with *L. ochotensis*.

This species closely resembles *L. latifrons*. See the remarks of the latter.

***Liparis latifrons* Schmidt**
 (New Japanese name : Bozu-kusaou)
 (Fig. 29)

Liparis latifrons Schmidt, 1950 : 196 (original description ; northwestern Okhotsk Sea, in 65–165 m) ; Quast and Hall, 1972 : 31.

?*Careproctus furcatus* Mori, 1956a : 17, figs. 3, 4 (original description ; near Oki I., Japan Sea).

Liparis quasimodo Schmidt, in Lindberg, 1959 : 255 (nomen nudum) ; Kras'yukova, 1984 : 7, fig. 2 (original description ; Terpenie Bay).

Liparis rotundirostris Schmidt, in Lindberg, 1959 : 255 (nomen nudum) ; Ueno, 1971 : 97 ; Kras'yukova, 1984 : 9, fig. 4 (original description ; Mordvinova and Terpenie Bays).

Liparis eos Schmidt, in Lindberg, 1959 : 255 (nomen nudum) ; Ueno, 1971 : 97 ; Krasyukova, 1984 : 11, fig. 5 (original description ; southeastern coast of Sakhalin, Aniwa and Mordvinova Bays).

Liparis lindbergi Schmidt, in Lindberg, 1959 : 255 (nomen nudum) ; Ueno, 1971 : 97 ; Krasyukova, 1984 : 12, fig. 6 (original description ; northeastern coast of Sakhalin).

Liparis quasimods Schmidt : Ueno, 1971 : 97 (misspelled).

Material examined. 28 specimens : HUMZ 33894, female, 224 mm SL, 45°20'N, 142°59'E, off Okhotsk coast of Hokkaido, depth unknown, 6 Sep. 1968 ; HUMZ 55165, 55167, 56458, 60813, 60931, 5 males, 96-187 mm SL, 59°59'N-61°01'N, 158°17'E-160°00'E, Penzhinskiy Bay, 94-120 m, 6 June 1976-7 June 1976 ; HUMZ 56245, 56251, 56256, 1 female and 2 males, 124-184 mm SL, 58°30'N, 151°57'E, off Koni Peninsula, northern Okhotsk Sea, 119-120 m, 9 June 1976 ; HUMZ 56349, 56350, 2 females, 116-126 mm SL, 58°11'N, 151°57'E, off Koni Peninsula, 155-156 m, 9 June 1976 ; HUMZ 57728, 57732, 57733, 3 females, 193-233 mm SL, 58°22'N, 152°47'E, off Koni Peninsula, 144 m, 12 Sep. 1976 ; HUMZ 57809, 57810, 2 males, 207-223 mm SL, 58°28'N, 151°10'E, off Koni Peninsula, 131 m, 26 Sep. 1976 ; HUMZ 58907, male, 204 mm SL, 58°33'N, 147°25'E, northern Okhotsk Sea, 138 m, 10 Sep. 1976 ; HUMZ 60297, 60298, female and male, 159-184 mm SL, 55°19'N, 142°34'E, north of Sakhalin, 178 m, 23 Oct. 1976 ; HUMZ 60701, female, 136 mm SL, 57°38'N, 141°00'E, northwestern Okhotsk Sea, 121 m, 14 Oct. 1976 ; HUMZ 60801, 60806, 2 males, 104-129 mm SL, 54°54'N, 142°57'E, north of Sakhalin, 110 m, 6 Sep. 1976 ; HUMZ 60843, male, 192 mm SL, 55°30'N, 139°00'E, northwestern Okhotsk Sea, 117 m, 7 Sep. 1976 ; HUMZ 60873, male, 120 mm SL, 54°43'N, 142°42'E, north of Sakhalin, 82 m, 6 Sep. 1976 ; HUMZ 101485, female, 107 mm SL, 44°55'N, 143°30'E, off Okhotsk coast of Hokkaido, 104-360 m, 20 June, 1984 ; HUMZ 103306, male, 105 mm SL, 45°39.6'N, 143°32'E, Aniwa Bay, 145-150 m, 24 Oct. 1984 ; HUMZ 103310, 107085, 2 females, 85-98 mm SL, 48°02'N, 145°15'E, Terpenie Bay, 145 m, 24 Oct. 1984.

Diagnosis. A *Liparis* with notched pectoral fin ; gill opening extending ventrally in front of 6-12 pectoral fin rays ; dorsal fin overlapping 30.2-46.9% of caudal fin length ; anal fin overlapping 44.0-58.7% of caudal fin length ; dorsal fin rays 41-44 ; anal fin rays 35-38 ; pectoral fin rays 35-41 ; pyloric caeca 20-38 ; vertebrae 47-50 ; dorsal and anal fins with a interrupted border along their margins.

Description. Counts : Dorsal 41-44, anal 35-38, pectoral 35-41, caudal 10-11, vertebrae 10-11+36-39=47-50, pyloric caeca 20-38, cephalic pores 2-6-7-2.

Morphometry : Head length 26.5-33.3% SL, body depth 24.5-32.3, head width 19.8-27.3, predorsal length 30.6-35.8, mandible to anal origin length 41.1-50.2 ; snout length 31.2-44.1% HL, eye diameter 13.5-19.3, interorbital width 40.4-50.3, upper jaw length 43.0-51.4, lower jaw length 40.9-50.0, length of upper lobe of

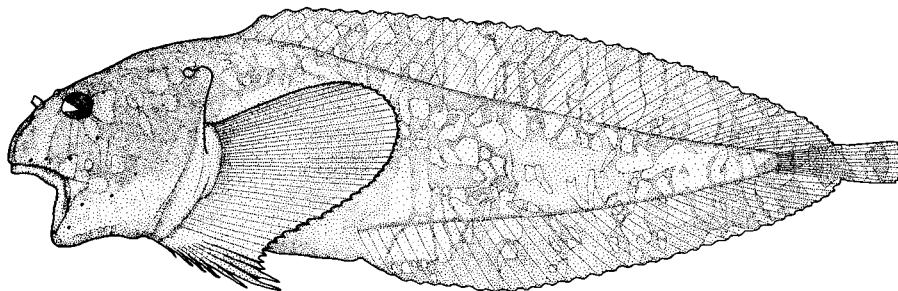


Fig. 29. *Liparis latifrons* Schmidt, HUMZ 101485, 107 mm SL, from off Okhotsk coast of Hokkaido.

pectoral fin 74.4–100.8, length of lower lobe of pectoral fin 48.5–67.5, gill opening length 34.1–47.9, snout to disk length 45.2–56.9, snout to anus length 111.2–133.2, mandible to disk length 39.9–50.1, mandible to anus length 106.8–127.2, disk to anus length 17.5–45.5, anus to anal length 20.5–51.8, disk length 35.1–50.0; length of dorsal overlap of caudal 30.2–46.9% caudal fin length, length of anal overlap of caudal 44.0–58.7.

Body tadpole-like, laterally compressed behind origin of anal fin. Skin firm. Thumbtack prickles present in a large female specimen (HUMZ 33894). Rudimentary pores forming three rows on nape and each side of body.

Head large; its upper profile descending slowly to snout. Anterior nostril in tube. Posterior nostril prominent, raised pore without a flap on anterior portion. Snout relatively high, projecting. Eye small. Mouth large, inferior; mouth cleft reaching below middle between anterior nostril and anterior margin of eye; maxillary reaching below posterior margin of eye. Lips freshy; lower lip included within upper lip. Teeth small, numerous, distinctly trilobed with well developed lateral lobes, arranged in about 11–21 oblique rows in wide bands on both jaws. Gill opening large, extending ventrally in front of 6–12 pectoral fin rays.

Pectoral fin shallowly notched. Uppermost pectoral fin ray on a horizontal between lower margin of orbit and posterior corner of maxillary. Upper lobe of pectoral fin reaching behind origin of anal fin. Lower lobe of pectoral fin short with 5–9 thickened rays, reaching midway between posterior margin of disk and anus or anus. Dorsal fin unnotched. Origin of dorsal fin almost above tip of opercular flap. Origin of anal fin below 8th–11th dorsal fin ray. Caudal fin broad; its posterior margin rounded. Dorsal and ventral notches on caudal fin usually absent.

Disk large, located almost between verticals through posterior margin of eye and gill opening. Anus far back, located midway between posterior margin of disk and origin of anal fin. Stomach large. Pyloric caeca long, pointed, located on right side of body cavity.

Body color light brown. At least two basic patterns present: marbled and mottled. Dorsal and anal fins with the same color patterns as body; posterior part of pectoral fin blackish; caudal fin with two broad dark bands. Eye silvery when fresh. In alcohol, oral cavity, peritoneum, stomach and pyloric caeca pale; branchial cavity sparsely pigmented.

Distribution. Distributed in the northern and western Okhotsk Sea and the Tatar Strait at depths of 65 to 360 m (mainly 65 to 178 m).

Remarks. Krasyukova (1984) described four new *Liparis* species, i.e., *L. quasimodo*, *L. rotundirostris*, *L. eos* and *L. lindbergi*, based on the Schmidt's manuscript. She, however, did not sufficiently compare them with *L. latifrons*. The original descriptions of these four species show that they agree well with *L. latifrons* and there are not significant differences between these four species and *L. latifrons*. They are junior synonyms of *L. latifrons*.

This species is most similar to *L. ochotensis* and both species overlap in most characters. They are distinguishable, however, by the combination of the following characters: notches of caudal fin usually absent in *L. latifrons* (usually present in *L. ochotensis*); gill opening extending ventrally in front of 6–12 pectoral fin rays (in front of 11–18 pectoral fin rays); pectoral fin rays 35–41 (39–45); and dorsal and

anal fins with an interrupted border along their margin (with a dark uninterrupted border along their margin).

Liparis agassizii Putnam
(Japanese name : Ezo-kusauo)
(Fig. 30)

Liparis agassizii Putnam, 1874 : 399 (original description ; Tatar Strait) ; Garman, 1892 : 62, pls. 1-3 (in part) ; Jordan and Snyder, 1900 : 369 (Hakodate) ; 1901 : 107 ; 1902 : 348 (Otaru and Aomori) ; Burke, 1930 : 76 ; Soldatov and Lindberg, 1930 : 348 (Primorskiy and Peter the Great Bay) ; Taranetz, 1937 : 132 ; Okada and Matsubara, 1938 : 344 ; Lindberg, 1947 : 193 ; Hikita, 1951 : 310 (Funka Bay) ; Matsubara, 1955 : 1191 ; Lindberg, 1959 : 254 ; Ueno, 1971 : 65 ; Maruyama, 1971 : 65 ; Kido, 1984 : 338, pl. 304.

Liparis herschelinus Scofield : Schmidt, 1904a : 161 (near Cape Senyavina, southeastern Sakhalin ; in part) ; Soldatov and Lindberg, 1930 : 345 (in part).

Liparis agassizii : Tanaka, 1908b : 251 (Aniwa Bay).

Liparis dennysi Jordan and Starks : Pavlenko, 1910 : 45 (Peter the Great Bay).

Cyclogaster agassizii Gilbert et Burke, 1912b : 356 (Tsugaru Strait) ; Jordan et al., 1913 : 304.

Liparis takashimensis Nojima, 1936 : 179 (original description ; Otaru) ; Taranetz, 1937 : 131 ; Lindberg, 1947 : 193 ; Yamamoto, 1948 : 46 (southwestern coast of Sakhalin) ; Matsubara, 1955 : 1191 ; Ueno, 1971 : 96.

Liparis tunicatiformes Schmidt, in Lindberg, 1959 : 255 (nomen nudum) ; Ueno, 1971 : 97 ; Krasyukova, 1984 : 8, fig. 3. (original description ; western coast of Sakhalin and southern Kuril Is.).

Material examined. Syntype : MCZ 32262, ca. 25 cm TL, Tatar Strait, radiograph only. Other material : 28 specimens : HUMZ 5630-5632, 3 males, 92-135 mm SL, Korsakov, Aniwa Bay, date unknown ; HUMZ 54007, male, 105 mm SL, near Hakodate, southern Hokkaido, 21 June 1976 ; HUMZ 66389, 68891, 68893, 69966, 1 female, 2 males and 1 specimen of unknown sex, 99-241 mm SL, Minamikayabe, Pacific coast of southern Hokkaido, 9 July 1977-21 Aug. 1977 ; HUMZ 70755-70758, 4 males, 96-171 mm SL, near Hakodate, 1 Oct. 1977 ; HUMZ 76151, male, 172 mm SL, Minamikayabe, 25 Aug. 1978 ; HUMZ 77847, female, 77 mm SL, off Omu River, Okhotsk coast of Hokkaido, depth 40 m, 26 Aug. 1978 ; HUMZ 78562-78566, 2 males and 3 females, 240-287 mm SL, off Yoichi, Japan Sea off Hokkaido, 14 Dec. 1978 ; HUMZ 79109, male, 82 mm SL, Minamikayabe, 10 July 1977 ; HUMZ 79112, male, 97 mm SL, Kawajiri, Okhotsk coast of Hokkaido, 50 m, 26 Aug. 1978 ; HUMZ 80742, 80743, 2 males, 248-332 mm SL, off Akkeshi, Pacific coast of Hokkaido, 27 Nov. 1978 ; HUMZ 81301, male, 161 mm SL, Shikkari, Pacific off Aomori Pref., 31 July 1979 ; HUMZ 87869, male, 197 mm SL, Minamikayabe, 25 Aug. 1980 ; HUMZ 88100, male, 288 mm SL, off Suisho I., Habomai Is., 20 m, 29 Aug. 1980 ; HUMZ 89888, male, 363 mm SL, Funka Bay, 5-7 m, 17 Dec. 1980 ; HUMZ 92417, male, 147 mm SL, 45°26'N, 142°40'E, off Okhotsk coast of Hokkaido, 75-85 m, 6 Oct. 1981.

Diagnosis. A *Liparis* with notched pectoral fin ; gill opening extending ventrally in front of 4-11 pectoral fin rays ; length of dorsal overlap of caudal 36.5-53.9% of caudal fin length ; anal overlap of caudal 41.2-61.8% of caudal fin length ; dorsal fin rays 40-44 ; anal fin rays 32-35 ; pectoral fin rays 35-40 : pyloric caeca 66-130.

Description. Counts : Dorsal 40-44, anal 32-35, pectoral 35-40, caudal 10-11, vertebrae 11-12+33-36=45-48, pyloric caeca 66-130, cephalic pores 2-6-7-2.

Morphometry : Head length 26.4-34.8% SL, body depth 19.5-31.4, head width 20.4-26.6, predorsal length 28.8-34.4, mandible to anal origin length 37.0-48.3 ; snout length 30.7-42.7% HL, eye diameter 8.5-16.7, interorbital width 37.3-45.7,

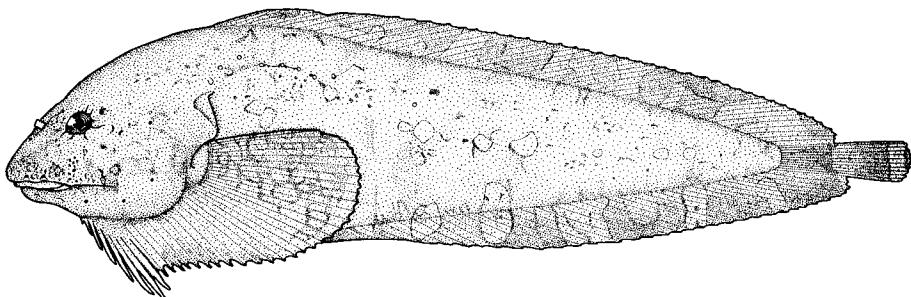


Fig. 30. *Liparis agassizii* Putnam, HUMZ 92417, 147 mm SL, from off Okhotsk coast of Hokkaido.

upper jaw length 35.0-53.9, lower jaw length 31.4-50.8, length of upper lobe of pectoral fin 74.4-100.8, length of lower lobe of pectoral fin 60.1-83.5, gill opening length 28.2-42.1, snout to disk length 41.0-59.9, snout to anus length 118.9-156.1, mandible to disk length 31.8-43.0, mandible to anus length 109.6-143.3, disk to anus length 28.7-57.7, anus to anal length 12.4-43.2, disk length 37.1-56.1; length of dorsal overlap of caudal 36.5-53.9% caudal fin length, length of anal overlap of caudal 41.2-61.8.

Body tadpole-like, laterally compressed behind origin of anal fin. Skin firm. Thumbtack prickles present on head and body in mature males. Rudimentary pores forming three rows on nape and each side of body.

Head large; its upper profile descending slowly to snout. Anterior nostril in tube. Posterior nostril prominent, raised pore without a flap on anterior portion. Snout low, projecting. Eye small. Mouth large, inferior; mouth cleft reaching below anterior margin of eye; maxillary reaching below posterior margin of eye. Lips freshy; lower lip included within upper lip. Teeth small, numerous, distinctly trilobed with well developed lateral lobes, arranged in about 13-33 oblique rows in wide bands on both jaws. Gill opening large, extending ventrally in front of 4-11 pectoral fin rays.

Pectoral fin shallowly notched; notch more prominent in smaller specimen than larger ones; pectoral fin unnotched in the largest specimen (HUMZ 89888). Uppermost pectoral fin ray on a horizontal between lower margin of orbit and posterior corner of maxillary. Upper lobe of pectoral fin reaching or reaching behind origin of anal fin. Lower lobe of pectoral fin short with 6-9 thickened rays, reaching behind posterior margin of disk. Dorsal fin deeply notched in mature males, and unnotched or shallowly notched in mature females. Origin of dorsal fin almost above tip of opercular flap. Origin of anal fin below 9th-12th dorsal fin ray. Caudal fin broad; its posterior margin rounded. Dorsal and ventral notches on caudal fin usually present.

Disk large, located almost between verticals through posterior margin of eye and gill opening. Anus far back, nearer posterior margin of disk than origin of anal fin.

Stomach large. Pyloric caeca long, pointed, located on right side of body cavity.

Body color brown, gray or blackish. Four basic patterns present: striped, speckled, mottled and plain patterns. Dorsal and anal fins with the same color pattern as body, with dark bars or entirely blackish; pectoral fin with the same color pattern as body or blackish; caudal fin with two dark bars. Eye silvery when fresh. In alcohol, oral cavity, stomach and pyloric caeca pale; branchial cavity and peritoneum pale or sparsely pigmented.

Reaching 363 mm SL.

Distribution. Distributed from Iwate Pref. to Hokkaido, in Peter the Great Bay, the coast of Primorskiy, the western and southeastern coast of Sakhalin and southern Kuril Islands, at depths of 0 to 86 m. Common around Hokkaido.

Remarks. *L. takashimensis* Nojima and *L. tunicatiformis* Schmidt are junior synonyms of *L. agassizii*, because I found no differences among these three nominal species.

This species is similar to *L. tunicatus* Reinhardt (Burke, 1930; Krasyukova, 1984). It differs from *L. tunicatus* by its numerous pyloric caeca (10-49 in *L. tunicatus* (Able and McAllister, 1989).

It has been misidentified by several authors (Schmidt, 1904a; Pavlenko, 1910; Nojima, 1936; and others). As shown by these and others, it is common in shallow waters of the northern Japan Sea and the southern Okhotsk Sea.

Liparis tanakai (Gilbert et Burke)

(Japanese name : Kusaou)

(Fig. 31)

Liparis owstoni (Jordan et Snyder) : Schmidt, 1904b : 189, figs. 1, 2 (Nagasaki Fish Market);

Tanaka, 1908a : 45, pl. 3 (Tokyo Fish Market, off Noto Peninsula and Sagami Bay);

Franz, 1910 : 77 (Kashima-nada Sea and off Yokohama : in part).

Cyclogaster owstoni : Yanai, 1950 : 21; Kamohara, 1950 : 228, fig. 172 (off Wakayama Pref.).

Liparis agassizii (Putnam) : Smith and Pope, 1906 : 488 (Matsushima Bay).

Cyclogaster tanakae Gilbert and Burke, 1912b : 357, pl. 42 (original description; Sagami Bay); Jordan et al., 1913 : 305; Jordan and Thompson, 1914 : 281 (Aomori, off Misaki and near Izuoshima I.); Mori and Uchida, 1934 : 19; Tanaka, 1951 : 287, pl. 79.

Liparis tanakae : Burke, 1930 : 85, fig. 15 (off Shiogama and Pusan); Soldatov and Lindberg, 1930 : 350; Wu and Wang, 1933 : 85, fig. 7 (off Chefoo); Tarantetz, 1937 : 132; Okada and Matsubara, 1938 : 345, pl. 84; Lindberg, 1947 : 193; Honma, 1952 : 223; Katayama, 1953 : 4; Chyung, 1961 : 620, pls. 59, 60 (off Pusan and near Saishu I.); Shiozaki, 1982 : 31 (Mutsu Bay, Japan Sea and Pacific off Aomori Pref.).

Liparis tanaka : Maruyama, 1971 : 65 (off Kamaishi; misspelled).

Liparis tanakius : Wang and Wang, 1935 : 237 (misspelled).

Liparis tanakai : Matsubara, 1955 : 1192; Mori, 1956b : 30; Kosaka, 1967 : 153 (Sendai Bay); Ueno, 1971 : 97; Kido, 1984 : 338, pl. 304; Yamada, 1986 : 360, col. pl. and figs. (Yellow Sea and East China Sea).

Material examined. 26 specimens: HUMZ 33172, male, 474 mm, East China Sea, depth unknown, 5-10 Apr. 1968; HUMZ 48986, 48987, 2 males, 263, 263 mm SL, off Sanriku-cho, Pacific off Iwate Pref., depth unknown, 31 Oct. 1975; HUMZ 60266, male, 308 mm SL, off Shiruchi, Tsugaru Strait, depth unknown, Oct. 1976; HUMZ 65925, 65926, 2 specimens of unknown sex, 99-112 mm SL, 37°32.5'N, 136°43.5'E, Japan Sea off Ishikawa Pref., depth 106-108 m, 4 June 1977, 106-108 m; HUMZ 65956, 1 specimen of unknown sex, 118 mm SL, 37°22.5'N, 136°38.5'E, Japan Sea off Ishikawa Pref., depth 118-121 m, June 1977, 118-121 m; HUMZ 71280, 71281, 1 female and 1 male, 171-235 mm SL, off Iwaki City, Pacific off

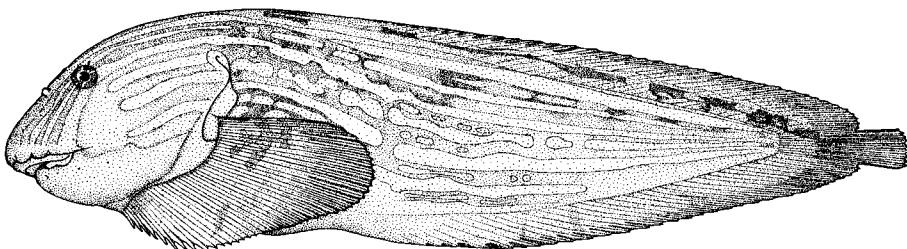


Fig. 31. *Liparis tanakai* (Gilbert et Burke), HUMZ 48987, 263 mm SL, from off Sanriku-cho, Pacific off Iwate Prefecture.

Fukushima Pref., 50-80 m, 10 Nov. 1977; HUMZ 90254-90263, 90265-90267, 3 females and 10 males, 250-349 mm SL, off Iwaki City, depth unknown, 7 Nov. 1980; HUMZ 106258, female, 268 mm SL, 34°32.07'N, 122°23.05'E, Yellow Sea, 53 m, 29 Nov. 1985; HUMZ 106260, female, 268 mm SL, 34°43.27'N, 122°28.75'E, Yellow Sea, 61 m, 30 Nov. 1985; W 762, male, 203 mm SL, Wakasa Bay, Japan Sea, depth unknown, 29 Sep. 1977; FAKU 36801, male, 294 mm SL, off Choshi, Pacific off Chiba Pref., depth unknown, 12-13 Oct. 1964.

Diagnosis. A *Liparis* with unnotched pectoral fin; head flat in nasal region; snout low, projecting; dorsal fin overlapping 52.3-67.9% of caudal fin length; anal fin overlapping 61.9-76.1% of caudal fin length; pectoral fin rays 39-45; pyloric caeca 50-110.

Description. Counts: Dorsal 42-44, anal 34-35, pectoral 39-45, caudal 10, vertebrae 12+34-36=46-48, pyloric caeca 50-110, cephalic pores 2-6-7-2.

Morphometry: Head length 23.8-29.8% SL, body depth 21.6-27.8, head width 18.0-25.4, predorsal length 24.5-33.5, mandible to anal origin length 31.7-44.8; snout length 38.3-47.5% HL, eye diameter 9.7-15.5, interorbital width 43.4-54.1, upper jaw length 43.6-57.3, lower jaw length 38.5-50.4, pectoral fin length 65.0-82.4, gill opening length 28.1-46.0, snout to disk length 40.8-62.0, snout to anus length 120.3-135.8, mandible to disk length 34.1-41.2, mandible to anus length 106.2-135.8, disk to anus length 31.9-55.2, anus to anal length 14.6-30.0, disk length 35.6-44.2; length of dorsal overlap of caudal 52.3-67.9% caudal fin length, length of anal overlap of caudal 61.9-76.1.

Body tadpole-like, laterally compressed behind origin of anal fin. Skin firm. Thumbtack prickles present on head and body in mature males and females. Rudimentary pores forming three rows on nape and each side of body.

Head large; its upper profile descending slowly to snout. Anterior nostril in tube. Posterior nostril prominent, raised pore without a flap on anterior portion. Snout low, projecting. Eye small. Mouth large, inferior; mouth cleft reaching below anterior margin of eye; maxillary reaching below posterior margin of eye. Lips freshy; lower lip included within upper lip. Teeth small, numerous, distinctly trilobed with well developed lateral lobes, arranged in about 13-30 oblique rows in wide bands on both jaws. Gill opening large, extending ventrally in front of 5-12 pectoral fin rays.

Pectoral fin notchless in adults, slightly notched in smaller specimens (99-118 mm SL); its uppermost fin ray on a horizontal between lower margin of orbit and

posterior corner of maxillary. Pectoral fin reaching behind origin of anal fin. Anterior pectoral rays thickened at posterior portion. Dorsal fin unnotched. Origin of dorsal fin above tip of opercular flap. Origin of anal fin below 9th-11th dorsal fin ray. Caudal fin broad; its posterior margin rounded. Dorsal and ventral notches on caudal fin usually present.

Disk large, located between verticals through posterior margin of orbit and gill opening. Anus far back, nearer origin of anal fin than posterior margin of disk.

Stomach large. Pyloric caeca long, pointed, located on right side of body cavity.

Body pale gray with dusky mottles and/or stripes along base of dorsal fin and top of head; margin of dorsal, anal, pectoral and caudal fins blackish; posterior half of pectoral fin blackish; free tips of all rays and base of caudal fin white; rudimentary pores margined with black; oral and branchial cavities, peritoneum, stomach and pyloric caeca pale. Eye silvery when fresh.

Attaining 474 mm SL.

Distribution. Distributed from Wakayama and Nagasaki Prefectures to the southern extremity of Hokkaido, in the Korean Peninsula, the Gulf of Po-Hai, the Yellow Sea and the East China Sea, at depths of 50 to 121 m. Common in southern Japan.

Remarks. This species is very similar to *L. owstoni*. It differs from the latter by the shape of head and short connection of caudal fin with dorsal and anal fins.

Kuronuma (1943) recorded this species from the Paramushir Island, the northern Kuril Islands. The northern limit of its distribution, however, is apparently in southern Hokkaido. His specimen (470 mm SL) belongs to other species of large size, e.g., *L. ochotensis*.

***Liparis owstoni* (Jordan et Snyder)**
(Japanese name: Osuton-kusauo)
(Fig. 32)

Trimegistus owstoni Jordan and Snyder, 1904: 238, fig. 29, pl. 58 (original description; Sagami Bay).

Cyclogaster owstoni: Gilbert and Burke, 1912b: 358; Jordan et al., 1913: 305, fig. 259.

Liparis owstoni: Burke, 1930: 87, fig. 16; Soldatov and Lindberg, 1930: 343; Taranetz, 1937: 131; Okada and Matsubara, 1938: 345; Lindberg, 1947: 193; Matsubara, 1955: 1192; Ueno, 1971: 97; Kido, 1984: 338, pl. 365.

This species has been represented only by the holotype (429 mm TL). The specimens described by Schmidt (1904b) and Tanaka (1908a) probably belong to *L. tanakai*.

Diagnosis. A *Liparis* with unnotched pectoral fin; head convex in nasal region; snout deep, not projecting; dorsal fin rays 43; anal fin rays 35; pectoral fin rays 40, pyloric caeca 50.

Distribution. Known only from Sagami Bay.

Remarks. This species is peculiar in having very short snout and caudal fin. Since it has been known only from the holotype, the holotype may be an abnormal specimen of *L. tanakai*.

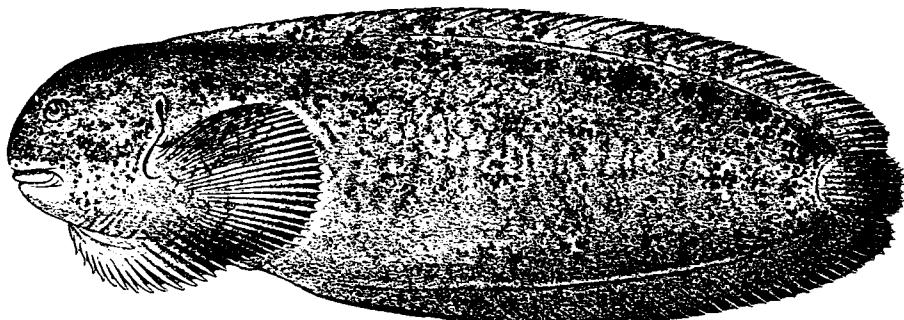


Fig. 32. *Liparis owstoni* (Jordan et Snyder), holotype, CAS-SU 8385, 429 mm TL, from Sagami Bay, from Jordan and Snyder (1904).

**GENUS *Crystallichthys* Jordan et Gilbert
(Japanese name : Suishouo-zoku)**

Crystallichthys Jordan and Gilbert, 1898, in Jordan and Evermann, 1898, 2866 (type-species *Crystallichthys mirabilis* Jordan et Gilbert, 1898, in Jordan and Evermann, 1898, by original designation); Jordan and Gilbert, 1899 : 476; Burke, 1930 : 147; Soldatov and Lindberg, 1930 : 332.

Crystallias Jordan and Snyder, 1902 : 349 (type-species *Crystallias matsushimae* Jordan and Snyder, 1912, by original designation); Burke, 1930 : 150; Soldatov and Lindberg, 1930 : 331.

Diagnosis. Disk present. Nostril single. Branchiostegal rays six. Snout and both jaws with or without barbels. Body with dark bars and spots.

***Crystallichthys matsushimae* (Jordan et Snyder)
(Japanese name : Abachan)
(Fig. 33)**

Crystallias matsushimae Jordan and Snyder, 1902 : 350, fig. 2 (original description; Matsushima Bay, northeastern Honshu, Albatross station 3773, in 143 m); Schmidt, 1904a : 167, pl. 6 (Peter the Great Bay); Gilbert and Burke, 1912b : 376 (near Sado I., off Korea, off northwest end of Hokkaido and off Cape Terpenie, Sakhalin); Jordan et al., 1913 : 309, fig. 260; Jordan and Hubbs, 1925 : 293 (Kushiro and Japan Sea); Burke, 1930 : 150, figs. 77-78; Soldatov and Lindberg, 1930 : 331 (Peter the Great Bay); Mori and Uchida, 1934 : 19; Taranetz, 1937 : 138; Okada and Matsubara, 1938 : 345, pl. 85; Lindberg, 1947 : 194; Yanai, 1950 : 21; Schmidt, 1950 : 217; Honma, 1952 : 224; Hikita and Misu, 1952 : 43, pl. 8 (northern Japan Sea); Katayama, 1953 : 4 (off Hyogo Pref., Japan Sea); Matsubara, 1955 : 1195, pl. 130; Mori, 1956b : 30; Oshima, 1957 : 5; Lindberg, 1959 : 255; Chyung, 1961 : 621, pl. 210 (off Korea); Ueno, 1971 : 98; Maruyama, 1971 : 65 (Pacific off Iwate Pref.); Hikita, 1981 : 75, fig.; Shiogaki, 1982 : 31 (Japan Sea and Pacific off Aomori Pref.); Kido, 1983b : 301, pl. 181 (southern Okhotsk Sea); Kido, 1984 : 340, pl. 305.

Crystallias kamoae Oshima, 1957 : 5, fig. 3 (original description; off Kamo, Yamagata Pref., Japan Sea).

Material examined. 30 specimens: HUMZ 33963, female, 243 mm SL, 45°02.5'N, 144°05.0'E, off Okhotsk coast of Hokkaido, depth 235 m, 3 Oct. 1974; HUMZ 41282, female, 378 mm SL, 49°11'N, 141°15'E, Tatar Strait, 230-280 m, 24 Mar. 1975; HUMZ 42476-42478, 1 female

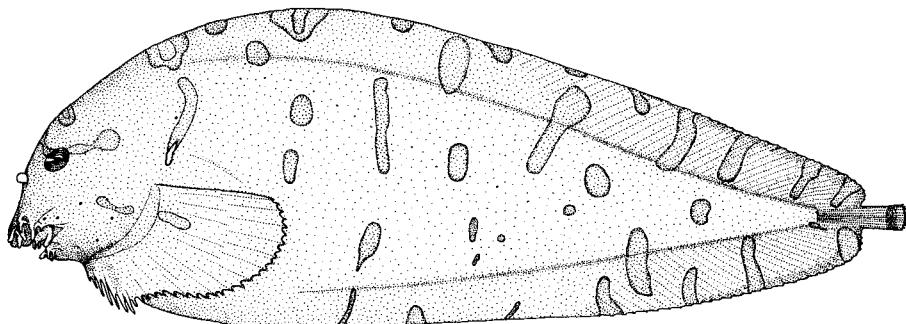


Fig. 33. *Crystallichthys matsushima* (Jordan et Snyder), HUMZ 93163, 215 mm SL, from off Okhotsk coast of Hokkaido.

and 2 males, 248–285 mm SL, 42°01.0'N, 139°37.0'E, near Okushiri I., northern Japan Sea, depth unknown, 6 June 1975; HUMZ 51647, female, 220 mm SL, 42°03'N, 143°43'E, off Hiroo, Pacific off Hokkaido, 327 m, 23 Mar. 1976; HUMZ 53059, female, 279 mm SL, 46°43'N, 141°33'E, Tatar Strait, 375 m, 26 May 1976; HUMZ 57691, 57692, 58965, 2 females and 1 male, 236–302 mm SL, 47°43'N–47°57'N, 144°10'E–144°31'E, 113–120 m, 29 Sep. 1976–30 Sep. 1976; HUMZ 68147, male, 345 mm SL, 44°31'N, 140°17'E, northern Japan Sea, 315–330 m, 16 May 1977; HUMZ 69372, 75894–75896, 75948, 75950, 75985, 75992, 75993, 5 females and 4 males, 209–323 mm SL, 42°43'N–42°52.4'N, 144°19.1'E–144°23'E, off Kushiro, Pacific off Hokkaido, 60–230 m, 12 Aug. 1977–14 July 1978; HUMZ 77526, 77528, 1 female and 1 male, 156–196 mm SL, Pacific off Aomori Pref., 240 m, 26 Sep. 1978; HUMZ 77790, 78620, 1 female and 1 male, 269–284 mm SL, 44°15.5'N–45°25'N, 144°38.5'E–145°20'E, off Okhotsk coast of Hokkaido, depth unknown, 27 Sep. 1978–28 Sep. 1978; HUMZ 86835, male, 320 mm SL, off Yoichi, northern Japan Sea, 3 May 1979; HUMZ 92389, 92444, 93163, 93164, 1 female and 3 males, 172–277 mm SL, 42°23.0'N–45°30'N, 142°41'E–143°47.2'E, off Okhotsk coast of Hokkaido, 100–196 m, 6 Sep. 1981–11 Oct. 1981; HUMZ 99389, female, 125 mm SL, Pacific off Iwate Pref., depth unknown, 26 May 1982.

Diagnosis. A *Crystallichthys* with barbels on snout and both jaws.

Description. Counts: Dorsal 54–61, anal 45–52, pectoral 31–37, caudal 10–11, vertebrae 11–12+47–54=57–65, pyloric caeca 38–80, cephalic pores 2–5–6–1.

Morphometry: Head length 20.1–26.9% SL, body depth 21.2–34.0, head width 8.6–13.4; snout length 32.8–45.4% HL, eye diameter 12.2–19.2, interorbital width 40.7–49.4, upper jaw length 31.8–39.5, lower jaw length 28.9–35.3, length of upper lobe of pectoral fin 66.3–100.7, length of lower lobe of pectoral fin 30.2–48.4, gill opening length 14.7–24.1, snout to disk length 38.1–71.6, snout to anus length 83.7–122.2, mandible to disk length 26.5–48.1, mandible to anus length 63.6–96.6, disk to anus length 0–18.8, disk length 32.1–43.9.

Body compressed, deep. Gelatinous tissue thick beneath skin. Skin smooth, generally lacking prickles, but thumbtack prickles in only two specimens (HUMZ 86835, 93163). Rudimentary pores preset, forming lateral line behind suprabranchial pores to caudal fin.

Head compressed, deep. Barbels 20–30 in number, present on snout, upper lip and lower jaw. Snout conical, projecting anteriorly to premaxillary by about equal to eye diameter with 12–14 barbels. A longitudinal cleft present in snout, but

relatively inconspicuous due to a stiff vertical fold of skin projecting from base of cleft. Nostril in moderately long tube, on a level with lower margin of eye. Eye small with round or elliptical pupil. Mouth inferior; upper lip with 3 and sometimes 5 small barbels. Lower jaw with 5 barbels in one row or 7-11 barbels in two rows. Teeth trilobed, forming broad bands of 9-14 oblique rows on both jaws. Cephalic pores small. Supraocular, postocular and upper pore of suprabranchial pores absent. Anteriormost pair of mandibular pores separated from each other.

Pectoral fin very shallowly notched; its uppermost fin ray on a level with lower margin of orbit. Upper lobe of pectoral fin almost reaching origin of anal fin. Lower lobe of pectoral fin short with 4-7 thickened rays, reaching anus or halfway between posterior margin of disk and anus. Pectoral symphysis located below eye or behind it. Origin of dorsal fin above gill opening. Origin of anal fin below 8th-10th dorsal fin ray. Caudal fin broad, round, continuous with vertical fins for one-half of its length. Ends of dorsal and anal fins forming notches on caudal fin.

Disk round, large and flat; its margin thin, broad. Anus located almost below gill opening, nearer to disk than to origin of anal fin.

Stomach and pyloric caeca located on left side of body cavity. Stomach moderately large. Pyloric caeca long, slender and pointed.

Body translucent; color in life pinkish with reddish bars and spots bearing marginal pigmentation; bars extending onto dorsal and anal fins; several small spots on head and body; eye and peritoneum silvery. In alcohol pinkish and reddish color faded; oral and branchial cavities, peritoneum, stomach and pyloric caeca pale.

Distribution. The Japan Sea, the Tatar Strait, the southern Okhotsk Sea and the Pacific off Hokkaido and northern Honshu, at depths of 60 to 375 m.

Remarks. Oshima (1957) described *Crystallias kamoae* based on a single specimen taken from off Kamo, the Japan Sea. The specimen is apparently lost. He stated that *C. kamoae* differs from *C. matsushima* in having neither bars nor markings on body, pectoral fin with fringed posterior part and narrow wedge-like body of nearly straight profile. These differences, however, are apparently due to poor condition in the specimen. He reported that the specimen has 25 pectoral fin rays. This counts, however, seems to be his error because he did not use this character as the diagnosis of the species. *C. kamoae* is concluded to be a junior synonym of *C. matsushima*.

7. GENUS *Careproctus* Krøyer

(Japanese name: Konnyakuuo-zoku)

Careproctus Krøyer, 1861 (type-species *Careproctus reinhardti* Krøyer, 1861, by monotypy);

Gill, 1865: 194; Garman, 1892: 71; Goode and Bean, 1896: 275; Jordan and Evermann, 1898: 2129; Burke, 1930: 95; Soldatov and Lindberg, 1930: 370; Stein, 1978a: 10.

Enantioliparis Vaillant, 1888b: 22 (type-species *Enantioliparis pallidus* Vaillant, 1888, by monotypy).

Bathyphasma Gilbert, 1895: 447 (type-species *Bathyphasma ovigerum* Gilbert, 1895, by monotypy); Jordan and Evermann, 1898: 2128.

Caremira (subgenus) Jordan and Evermann, 1896: 452 (type-species *Cereproctus simus* Gilbert, 1895, by original designation).

Allochir (subgenus) Jordan and Evermann, 1896: 452 (type-species *Careproctus melanurus* Gilbert, 1892, by original designation).

Allurus (subgenus) Jordan and Evermann, 1896: 452 (type-species *Careproctus ectenes* Gilbert, 1895, by original designation).

Allinectis (subgenus) Jordan and Evermann, 1898: 2866 (replaced *Allurus*, preoccupied by *Allurus* Forester, 1862, Hymenoptera: Insecta).

Prognurus Jordan and Gilbert, 1898, in Jordan and Evermann, 1898: 2866 (type-species *Prognurus cypselurus* Jordan et Gilbert, 1898, in Jordan and Evermann, 1898, by original designation); Jordan and Gilbert, 1899: 478.

Temnocora Burke, 1930: 146 (type-species *Careproctus candidus* Gilbert et Burke, 1912, by original designation).

Diagnosis. Disk present. Nostril single. Pseudobranchiae absent. Pectoral fin typically with less rays than anal fin. Body color not variegated.

8. KEY TO SPECIES OF *CAREPROCTUS*

- 1a. Teeth on jaws uniserial. Disk length 1.7 or less in head length *C. dentatus* sp. nov.
- 1b. Teeth on jaws in bands. Disk length more than 1.7 in head length 2
- 2a. Teeth trilobed or at least some teeth with obvious lobes 3
- 2b. All teeth simple 8
- 3a. Tips of anterior dorsal fin rays projecting above fin membrane. Dorsal fin rays 44, anal fin rays 38, pectoral fin rays 38 *C. jordani* Burke
- 3b. Tips of anterior dorsal fin rays buried in gelatinous tissue. Dorsal fin rays more than 46, anal fin rays more than 39, pectoral fin rays less than 35 4
- 4a. Lower lobe of pectoral fin 0.9–1.0 in head length *C. rhodomelas* Gilbert et Burke
- 4b. Lower lobe of pectoral fin 1.7 or more in head length 5
- 5a. Pectoral fin rays less than 30 6
- 5b. Pectoral fin rays more than 30 7
- 6a. Dorsal fin rays 47–50, anal fin rays 40–43, caudal fin rays 10 *C. marginatus* sp. nov.
- 6b. Dorsal fin rays 61, anal fin rays 53, caudal fin rays 6 *C. segaliensis* Gilbert et Burke
- 7a. Stomach pale *C. sinensis* Gilbert et Burke
- 7b. Stomach black *C. homopterus* Gilbert et Burke
- 8a. Gill opening extending ventrally in front of 15–20 pectoral fin rays. Disk rudimentary, 4.0 or more in eye diameter *C. mederi* Schmidt
- 8b. Gill opening wholly above pectoral fin or extending ventrally in front of 1–6 pectoral fin rays. Disk not rudimentary, less than 2.3 in eye diameter .. 9
- 9a. Disk length 1.8–2.4 in head length. Upper lobe of pectoral fin elongate with free tips of its rays *C. macrodiscus* Schmidt
- 9b. Disk length more than 2.5 in head length. Upper lobe of pectoral fin not elongate 10
- 10a. Pectoral fin rays 22, caudal fin rays 7 *C. bathycoetus* Gilbert et Burke
- 10b. Pectoral fin rays more than 24, caudal fin rays more than 7 11

- 11a. Pectoral fin without notch or slightly notched 12
 11b. Pectoral fin with notch 13
 12a. Pectoral fin without notch. Snout projecting. Caudal fin emarginate, nearly truncate when spread *C. furcellus* Gilbert et Burke
 12b. Pectoral fin slightly notched. Snout not projecting. Caudal fin distinctly forked *C. cypselurus* (Jordan et Gilbert)
 13a. Peritoneum silvery or pale. Stomach pale to black 14
 13b. Peritoneum black or dusky. Stomach pale 16
 14a. Gill opening widely separated from pectoral fin. Pectoral fin rays 26-31. Pyloric caeca 33-50 *C. cyclocephalus* Kido
 14b. Gill opening usually extending ventrally in front of 1-6 pectoral fin rays, rarely above pectoral fin. Pectoral fin rays 31-38. Pyloric caeca 16-35 15
 15a. Body entirely pinkish when fresh. Peritoneum not pigmented
 *C. rastrinus* Gilbert et Burke
 15b. Body dusky with bluish black fins when fresh. Peritoneum pigmented
 *C. trachysoma* Gilbert et Burke
 16a. Teeth long, slender, lanceolate; outer teeth almost similar in length to inner teeth. Disk round or oval; its length 2.6-6.7 in head length 17
 16b. Teeth not lanceolate; outer teeth distinctly shorter than inner teeth. Disk triangular; its length 6.9 or more in head length *C. nigriceps* Schmidt
 17a. Lower lobe of pectoral fin 0.6-0.9 in head length (in specimens more than 128 mm SL). Body depth 3.3-5.3 in SL. Pectoral fin rays 25-31. Pyloric caeca 10-18 *C. colletti* Gilbert
 17b. Lower lobe of pectoral fin 1.6-2.2 in head length. Body depth 2.3-3.6 in SL. Pectoral fin rays 30-35. Pyloric caeca 17-31
 *C. roseofuscus* Gilbert et Burke

Careproctus dentatus sp. nov.

(New Japanese name: Ooban-konnyakuuo)

(Figs. 34, 35)

Holotype. HUMZ 77723, male, 250 mm SL, 45°18'N, 142°52'E, off Okhotsk coast of Hokkaido, depth 120-122 m, 4 Oct. 1977.

Paratypes. 9 specimens: HUMZ 45047, male, 354 mm SL, 51°55'N, 154°55'E, off western coast of Kamchatka, 300-305 m, 11 May 1975; HUMZ 70914, male, 295 mm SL, 44°12'N, 144°54'E, off Okhotsk coast of Hokkaido, 750 m, 23 Oct. 1977; HUMZ 77668, female, 234 mm SL, 44°41'N, 144°24'E, off Okhotsk coast of Hokkaido, depth unknown, 22 Sep. 1978; HUMZ 77724, male, 254 mm SL, collected with holotype; HUMZ 77760, 77791, 77793, 77988, 78758, 3 females and 2 males, 163-306 mm SL, 44°13'N-44°55'N, 144°20'E-145°01'E, off Okhotsk coast of Hokkaido, depth unknown, 25 Sep. 1978-2 Nov. 1978.

Diagnosis. A *Careproctus* with unique teeth strongly recurved backward in middle lobe; teeth on jaws uniserial, but two rows only at posterior corner of upper jaw; disk extremely large, its diameter 58.8-64.5% of head length.

Description. Data for the holotype are followed by those for the paratypes.

Counts: Dorsal 48 (46-50), anal 41 (39-42), pectoral 27 (27-29), caudal 11 (10-12), vertebrae 13+42=55 (12-13+39-44=52-57), pyloric caeca 30 (22-29), cephalic pores 2-6-7-2.

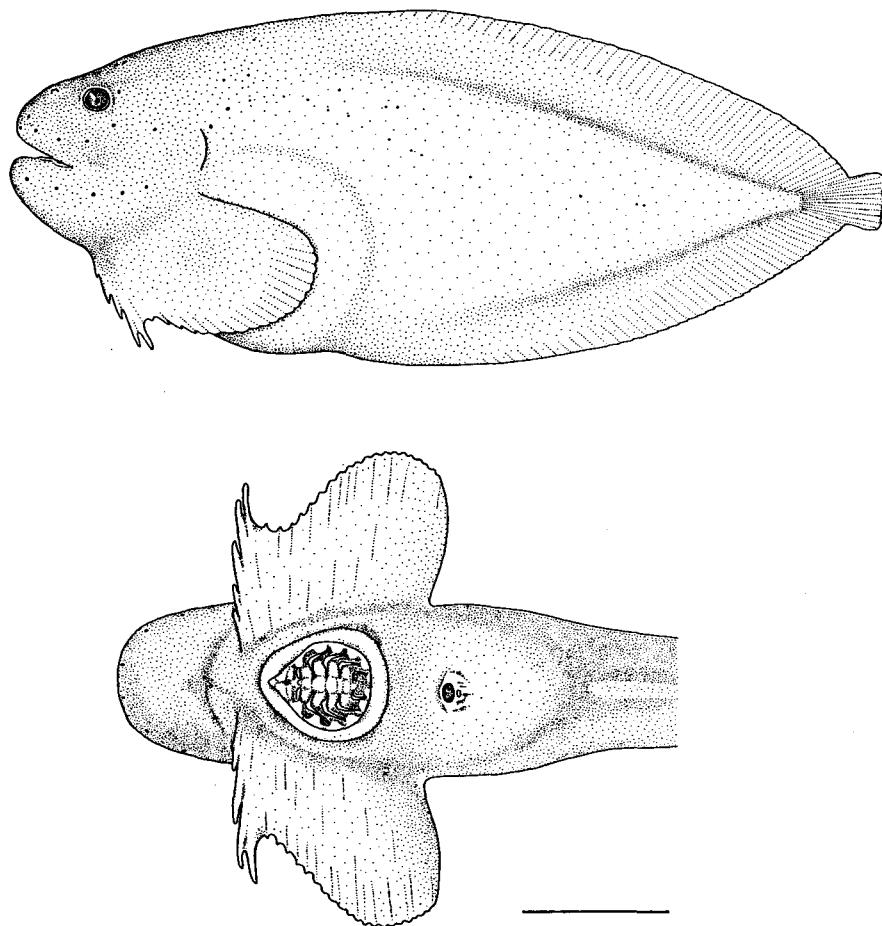


Fig. 34. Lateral (top) and ventral (bottom) views of *Careproctus dentatus* sp. nov., holotype, HUMZ 77723, 250 mm SL, from off Okhotsk coast of Hokkaido. Bar is 30 mm.

Morphometry : Head length 26.4 (22.4-30.1)% SL, body depth 36.1 (29.8-38.9), head width 15.6 (14.0-19.8); snout length 38.3 (35.0-38.4)% HL, eye diameter 14.4 (12.6-15.3), interorbital width 49.2 (42.0-49.6), upper jaw length 45.2 (38.7-48.4), lower jaw length 45.2 (37.0-48.0), length of upper lobe of pectoral fin 67.8 (56.2-78.8), length of lower lobe of pectoral fin 57.2 (40.7-70.8), gill opening length 20.0 (16.0-20.9), snout to disk length 66.4 (55.5-66.4), snout to anus length 136.9 (113.2-137.5), mandible to disk length 53.7 (45.9-54.8), mandible to anus length 126.3 (104.5-131.0), disk to anus length 8.3 (3.2-16.3), disk length 59.5 (58.8-64.5).

Body stout, short and deep. Skin thick, lacking prickles. Galatinous tissue thick all over beneath skin. Rudimentary pores forming two rows on each side of body : upper row only above anterior curve of lateral line ; lower row forming lateral line from behind suprabranchial pores to caudal fin. The other rudimentary



Fig. 35. Premaxillary teeth of *Careproctus dentatus* sp. nov., paratype, HUMZ 77791. Bar is 1.0 mm.

pores present on nape, temporal and cheek regions.

Head massive; its upper profile descending slowly to snout. Snout blunt, not projecting. Nostril single, in a short tube, on a level with upper margin of eye. Eye small. Mouth large, broad; maxillary reaching below posterior margin of pupil. Teeth short with broad base, modified trilobed (Fig. 35); anterior lobe absent; middle lobe large, strongly recurved backward; posterior lobe present. Teeth arranged in a single row on both jaws, and two rows only at posterior corner only on upper jaw. Teeth faintly overlapped one another, forming continuous cutting edges on both jaws. Symphysial gap absent on both jaws. All cephalic pores minute. Coronal pore present. Anteriormost pair of mandibular pores separated from each other. Gill opening short, wholly above pectoral fin. Opercular flap round.

Pectoral fin shallowly notched; its uppermost fin ray on a level with posterior corner of maxillary. Upper lobe of pectoral fin round, short, reaching middle between anus and origin of anal fin. Lower lobe of pectoral fin with thickened 5 (5-6) rays, reaching anus when depressed. Pectoral symphysis below eye. Origin of dorsal fin posterior to a vertical through gill opening. Origin of anal fin below 9th (9th-10th) dorsal fin ray. Anterior rays of dorsal and anal fins buried in thick gelatinous layer. Caudal fin truncate, broad, continuous with vertical fins for about three-fifths of its length. Ends of dorsal and anal fins not forming notches on caudal fin.

Disk deeply cupped with very thick margin, extremely large (Fig. 34); its diameter 1.7 (1.6-1.7) in head length. Anus located almost below gill opening, separated from posterior margin of disk by a distance about equal to eye diameter when disk unfolded.

Stomach large. Pyloric caeca long, pointed and located on left side of body cavity.

Body color when fresh pinkish gray; eye silvery. In alcohol body gray; eye black; oral and branchial cavities, peritoneum, stomach and pyloric caeca pale.

Attaining 354 mm SL.

Distribution. Known from off the Okhotsk coast of Hokkaido and off western coast of Kamchatka at depths of 120 to 750 m.

Remarks. This species has several unique characters. None of other liparidid fishes has such unique teeth in shape as this species does. Teeth of this species were arranged in a single row, while in all other *Careproctus* teeth form bands. Its disk is the largest of all species of *Careproctus* (58.8-64.5% of head length against less than 56.2% in all other species of *Careproctus*). In this species the coronal pore is present, while it has not been reported in other species of *Careproctus*. These characters appear to show that this species is not closely related to any known

species of *Careproctus*.

Etymology. From the Latin *dentatus* (toothed) in reference to unusual arrangement of the unique teeth.

***Careproctus jordani* Burke**
 (Japanese name: Misaki-bikunin)
 (Fig. 36)

Careproctus gilberti Jordan and Thompson, 1914: 282, pl. 34, fig. 1, 1a (preoccupied by *C. gilberti* Burke, 1912).

Careproctus jordani Burke: 1930, 192 (original description; renamed; off Misaki, Sagami Bay); Okada and Matsubara, 1938: 347; Matsubara, 1955: 1194; Kido, 1984: 339, pl. 365.

Material examined. Holotype: FMNH 57514, male, 139 mm SL, off Misaki, Sagami Bay, depth unknown, date unknown.

Comparative material: *Careproctus pycnosoma* Gilbert et Burke: holotype, USNM 73340, sex unknown, 39 mm SL, 46°42'N, 151°47'E, off Simushir I., Kuril Is., Albatross station 4803, depth 419 m, 24 June 1906: HUMZ 88509, female, 79 mm SL, 53°15.3'N, 169°03.4'W, northwest of Umnak I., Aleutian Is., 596–610 m, 19 July 1980. *Careproctus curilanus* Gilbert et Burke: holotype, USNM 73341, male, 64 mm SL, same locality with holotype of *C. pycnosoma*. *Careproctus ectenus* Gilbert: holotype, USNM 48618, female, 64 mm SL, 54°01'40"N, 166°48'50"W, north of Unalaska I., Bering Sea, Albatross station 3331, 641 m, 21 Aug. 1890. *Careproctus attenuatus* Gilbert et Burke: holotype, USNM 74386, sex unknown, 35 mm SL, 52°14'30"N, 174°13'E, between Petral Bank and Agattu I., Allbatross station 4781, 882 m, 7 June 1906.

Diagnosis. A *Careproctus* with simple and trilobed teeth; tips of anterior dorsal fin rays projecting above fin membrane; dorsal fin rays 44, anal fin rays 38, pectoral fin rays 38.

Description. Counts: Dorsal 44, anal 38, pectoral 38, caudal 12, vertebrae 10+38=48, cephalic pores 2–6–7–2.

Morphometry: Head length 25.0% SL; eye diameter 23.1% HL, upper jaw length 45.8, length of upper lobe of pectoral fin 65.4, length of lower lobe of pectoral fin 51.3, mandible to disk length 51.0, disk to anus length 20.5, disk length 39.2.

Body relatively short, robust; posterior part of body deep and thick.

Nostril in a well developed tube, on a level with upper half of eye. Eye large. Maxillary reaching below middle of eye. A small flap present on anterior interorbital region and on posterior interorbital region on each side. Some large inner teeth

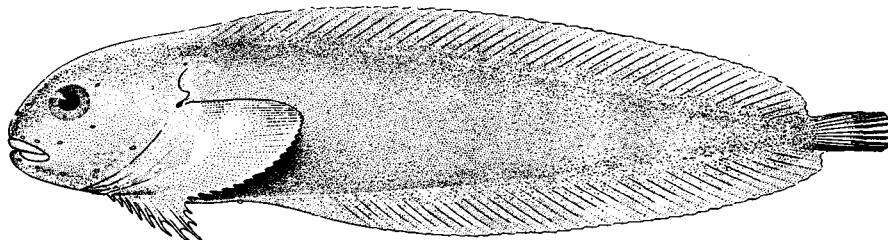


Fig. 36. *Careproctus Jordani* Burke, holotype, FMNH 57514, 139 mm SL, from Sagami Bay, from Jordan and Thompson (1914).

simple, sharp and recurved. Other teeth more or less trilobed with central lobe larger than lateral lobes or bluntly pointed without lateral lobes. Outer teeth smaller than inner teeth. Teeth forming wide bands arranged in 11 rows on both jaws. Cephalic pores small. Upper nasal pore, 4th to 6th maxillary pore, 6th and 7th mandibular pores and both suprabranchial pores provided with a small flap. Anteriormost pair of mandibular pores widely separated from each other. Gill opening short, extending down in front of about two pectoral fin rays.

Pectoral fin shallowly notched; its uppermost fin ray on a level with lower margin of orbit. Upper lobe of pectoral fin short, not reaching a vertical through origin of anal fin. Lower lobe of pectoral fin short with 7 (left) and 8 (right) rays, almost reaching posterior margin of disk. Pectoral symphysis almost below middle of eye. Origin of dorsal fin above tip of opercular flap. Origin of anal fin below 9th dorsal fin ray. Anterior dorsal and anal fin rays stiff; their tips projecting above fin membrane. Caudal fin round, stout and broad; its connection to dorsal fin about one-fifth of its length. Ends of dorsal and anal fins forming notches on caudal fin.

Disk relatively large, round and flat, located between verticals through posterior end of orbit and gill opening. Anus not immediately behind disk, nearer to disk than origin of anal fin.

In alcohol body color faded; peritoneum black; stomach pale.

Distribution. Known only from Sagami Bay on the Pacific side of Honshu.

Remarks. The holotype of this species has a small flap on rim of the head pores and on the interorbital region. Those on rim of head pores are reported in the second specimen of *C. pycnosoma* (Kido, 1985b) and those on interorbital region are reported in the holotype of *Odontoliparis ferox* (Stein, 1978a) as minute and simple papillae. More materials are needed to determine the taxonomic value of this character.

This species belongs to a group of species including *C. pycnosoma* Gilbert et Burke, *C. curilanu*s Gilbert et Burke, *C. ectenes* Gilbert and probably *C. attenuatus* Gilbert et Burke, which is characterized by trilobed teeth, relatively large disk and anterior dorsal fin rays whose tips are projecting above fin membrane. It differs from *C. pycnosoma* in having black peritoneum (pale in *C. pycnosoma*); from *C. curilanu*s, *C. ectenes* and *C. attenuatus* in having fewer dorsal and anal fin rays and vertebrae (ca. 46 or more, ca. 40 or more and 50 or more in these three species), and more pectoral fin rays (34 or fewer). These species, however, are represented by a small number of specimens. More materials are needed to determine whether these meristic differences are significant.

This species has been represented only by the holotype.

Careproctus rhodomelas Gilbert et Burke

(Japanese name: Bara-bikunin)

(Fig. 37)

Careproctus rhodomelas Gilbert and Burke, 1912b: 365, pl. 44 (original description; Bungo-suido Channel, south of Suruga Bay, Albatross stations 4958, 4980, in 741-928 m); Jordan et al., 1913: 307; Burke, 1930: 118, fig. 36; Soldatov and Lindberg, 1930: 371; Taranetz, 1937: 134; Okada and Matsubara, 1938: 347; Matsubara, 1955: 1194;

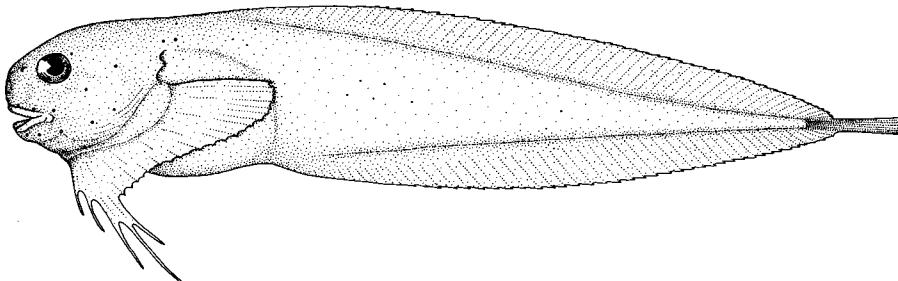


Fig. 37. *Careproctus rhodomelas* Gilbert et Burke, BSKU 29497, 115 mm SL, from Tosa Bay.

Okamura, 1982 : 293, pl. 209 (Tosa Bay); Kido, 1984 : 338, pl. 304.

Material examined. BSKU 22787, female, 119 mm SL, 32°57.3'N, 133°33.5'E, depth 707-750 m, Tosa Bay, 24 July 1974 : BSKU 29497, male, 115 mm SL, 32°58'N, 133°32'E, Tosa Bay, 605 m, 21 Dec. 1979.

Diagnosis. A *Careproctus* with trilobed teeth; length of lower lobe of pectoral fin almost equal to or longer than head length; peritoneum and stomach black.

Description. Counts: Dorsal 56, anal 50, pectoral 29-31, caudal 9, vertebrae 9-10+51-52=61, pyloric caeca 10-13, cephalic pores 2-6-7-2.

Morphometry: Head length 19.9% SL, body depth 18.3-19.8, head width 12.3-16.2; snout length 26.3-36.4% HL, eye diameter 21.1-23.2, interorbital width 48.2-52.7, upper jaw length 39.9-51.5, lower jaw length 38.6-50.2, length of upper lobe of pectoral fin 65.8-72.2, length of lower lobe of pectoral fin 100.9-116.0, gill opening length 20.6-20.7, snout to disk length 51.8-54.9, snout to anus length 77.2-84.0, mandible to disk length 39.2-40.8, mandible to anus length 68.0-71.3, disk to anus length 17.5-18.1, disk length 11.0-12.7.

Body compressed, slender, deepest at origin of dorsal fin, then tapering slowly to caudal fin. Gelatinous tissue thin. Skin smooth, lacking prickles. Rudimentary pores present, forming at least two rows on each side of body: upper row only above anterior curve of lateral line; lower row forming lateral line from suprabranchial pore to caudal fin.

Head short, broad; its width nearly equal to its depth. Snout short and deep, not projecting. Nostril in a short tube, just in front of eye on a level with upper margin of pupil. Mouth small; maxillary reaching a vertical through middle of eye. Teeth coarse, short, distinctly trilobed with three lobes well developed, forming wide bands arranged in 8-9 oblique rows in premaxillary and 7-9 rows in dentary. Outer teeth distinctly trilobed, slightly smaller than the inner. Cephalic pores small. Anteriormost pair of mandibular pores widely separated from each other. Gill opening small, wholly above pectoral fin. Opercular flap triangular, supported by two spines slightly recurved dorsally: upper opercular spine much broader than lower spine; its tip on a level with middle of eye.

Pectoral fin deeply notched; its uppermost fin ray on a level with lower margin of orbit. Upper lobe of pectoral fin reaching a vertical through origin of anal fin. Rays of notch not distinguishable from those of upper lobe of pectoral fin. Lower

lobe of pectoral fin long with 4–5 rays, much longer than upper lobe, nearly reaching origin of anal fin. Pectoral symphysis located below posterior margin of orbit. Origin of dorsal fin posterior to posterior tip of opercular spine. Origin of anal fin below 8th-9th dorsal fin ray. Anterior rays of dorsal and anal fins buried in gelatinous tissue. Caudal fin slender, confluent with anal fin for about one-third of its length.

Disk small, triangular with narrow margin. Anterior margin of disk located slightly posteriorly to a vertical through posterior margin of orbit. Anus separated from disk by a distance longer than disk length, located slightly anterior to gill opening.

Stomach and pyloric caeca located on left side of body cavity. Stomach small. Pyloric caeca short, fat and bluntly pointed.

Body color when fresh reddish; anterior part of body jet black. In alcohol body pale; anterior part of body including head, abdomen and pectoral fins densely pigmented; oral and gill cavities, peritoneum, stomach, intestine and pyloric caeca black.

Reaching 119 mm SL.

Distribution. Bungo-suido Channel to off Suruga Bay at depths of 605 to 928 m.

Remarks. This species is easily distinguishable from the other species of the genus by having well developed trilobed teeth and longer lower lobe of pectoral fin.

This species has been known from the holotype and a single paratype. The present specimens are the third and fourth specimens of this species.

***Careproctus marginatus* sp. nov.**
 (New Japanese name: HIREGURU-BIKUNIN)
 (Fig. 38)

Careproctus segaliensis Gilbert et Burke: Schmidt, 1950: 201.

Holotype. HUMZ 72755, female, 180 mm SL, 41°58.3'N, 143°46.1'E, off Pacific coast of Hokkaido, depth 420–430 m, 2 Apr. 1978.

Paratypes. 15 specimens: HUMZ 46096, female, 235 mm SL, 44°25'N, 144°17.5'E, off Okhotsk coast of Hokkaido, depth 385–400 m, 3 July 1975; HUMZ 46252, male, 183 mm SL,

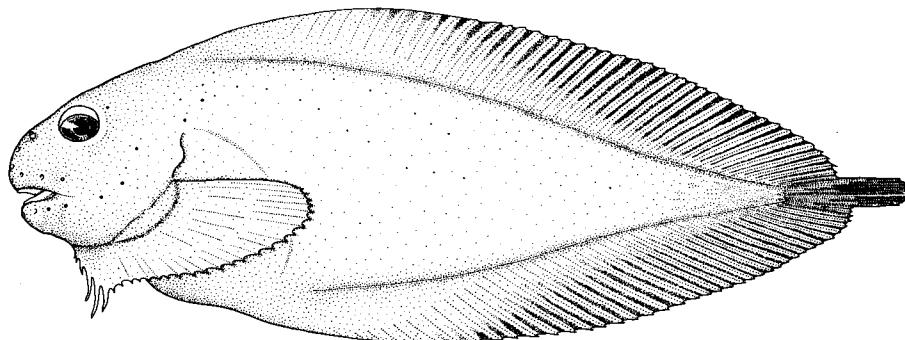


Fig. 38. *Careproctus marginatus* sp. nov., holotype, HUMZ 72755, 180 mm SL, from off Pacific coast of Hokkaido.

55°24'N, 154°25'E, off western coast of Kamchatka, 370-410 m, 9 May 1975; HUMZ 52678, female, 200 mm SL, 42°01.9'N, 143°44.4'E, off Pacific coast of Hokkaido, 360 m, 24 Mar. 1976; HUMZ 72756-72758, 1 female and 2 males, 85-136 mm SL, collected with holotype; HUMZ 78705, 78708-78712, 185-236 mm SL, 5 females and 1 male, 44°31'N, 144°20'E, off Okhotsk coast of Hokkaido, 650-950 m, 2 Nov. 1978; HUMZ 97653-97655, 168-217 mm SL, 1 female and 2 males, 42°42.5'N, 144°52.5'E, off Pacific coast of Hokkaido, 410 m, 29 Mar. 1983.

Comparative material. *Careproctus segaliensis* Gilbert et Burke : radiograph of holotype, USNM 73336, 48°36'10"N, 147°17'30"E, off Cape Terpenie, Sakhalin, Okhotsk Sea, Albatross station 5026, 218 m, 28 Sep. 1906.

Diagnosis. A *Careproctus* with trilobed teeth; dorsal fin rays 47-50; anal fin rays 40-43; pectoral fin rays 25-29; peritoneum dusky or black; stomach pale.

Description. Data for the holotype are followed by those for the paratypes.

Counts : Dorsal 48 (47-50), anal 43 (40-43), pectoral 29 (25-29), caudal 10 (10), vertebrae 10+44=54 (9-10+42-45=52-55), pyloric caeca 30 (24-35), cephalic pores 2-6-7-2.

Morphometry : Head length 22.8 (21.2-25.8)% SL, body depth 30.2 (25.4-32.2), head width 11.9 (11.4-12.5); snout length 47.0 (35.7-42.3)% HL, eye diameter 22.9 (21.4-25.9), interorbital width 41.4 (33.6-43.4), upper jaw length 37.5 (33.2-38.4), lower jaw length 33.1 (30.3-38.0), length of upper lobe of pectoral fin 72.3 (70.9-83.3), length of lower lobe of pectoral fin 47.4 (35.8-58.2), gill opening length 21.9 (15.9-26.2), snout to disk length 63.5 (49.2-63.2), snout to anus length 101.0 (99.2-115.8), mandible to disk length 42.8 (40.5-53.7), mandible to anus length 83.7 (88.9-105.9), disk to anus length 18.2 (17.4-29.5), disk length 26.8 (26.6-28.6).

Body deep, compressed. Skin smooth, lacking prickles. Gelatinous tissue thick beneath skin. Rudimentary pores forming two rows on each side of body : upper row only above anterior curve of lateral line ; lower row forming lateral line from behind suprabranchial pores to caudal fin.

Head compressed ; its upper profile descending slowly to snout. Snout deep, slightly projecting anteriorly to lower jaw. Nostril single, in a short tube, almost on a level with lower margin of pupil. Eye large. Mouth horizontal, small ; maxillary reaching below anterior margin of pupil. Teeth stout, strongly trilobed with central lobe larger than lateral lobe, forming wide bands arranged in 10 (9-11) rows on both jaws. Outer teeth simple with rounded tips (simple with rounded tips or trilobed), smaller than the inner. Cephalic pores small. Anteriormost pair of mandibular pores separated from each other. Gill opening short, wholly above pectoral fin. Opercular flap round, supported by two spines ; tip of upper opercular spine on a level with lower margin of orbit.

Pectoral fin shallowly notched ; its uppermost fin ray almost on a level with posterior corner of maxillary. Upper lobe of pectoral fin reaching a vertical through origin of anal fin. Lower lobe of pectoral fin composed of 5 (4-6) thickened rays, reaching almost anus when depressed. Pectoral symphysis below middle of eye. Origin of dorsal fin above gill opening. Origin of anal fin below 7th (7th-9th) dorsal fin ray. Anterior rays of dorsal and anal fins buried in thick gelatinous layer. Caudal fin round, continuous with dorsal fin for two-fifths of its length. Ends of dorsal and anal fins forming small notches on caudal fin.

Disk round, flat (flat or cupped) with broad margin. Anus separated from posterior end of disk by a distance about equal to eye diameter, located almost below

gill opening; a small conical genital papilla present in males.

Stomach large. Pyloric caeca long, pointed, located on left side of body cavity.

Body color when fresh pink; posterior dorsal and anal fins and caudal fin black. In alcohol pinkish color faded; oral cavity pale; branchial cavity dusky; peritoneum dusky or black; stomach and pyloric caeca pale.

Reaching 236 mm SL.

Distribution. The Okhotsk Sea and the Pacific off Hokkaido at depths of 338 to 950 m.

Remarks. Schmidt (1950) described this species as *C. segaliensis* Gilbert et Burke based on a specimen from the Okhotsk Sea despite of significant differences in dorsal and anal fin ray counts between both species. This species apparently differs from *C. segaliensis*, which is known only from the holotype, in having fewer dorsal and anal fin rays and vertebrae (61, 53 and 66 in the latter), more caudal fin rays, pyloric caeca and suprabranchial pores (10, 17 and 1) and dusky peritoneum (pale).

Etymology. From the Latin *marginatus* (edged) in reference to the black vertical fins.

***Careproctus segaliensis* Gilbert et Burke**

(Japanese name: Karafuto-bikunin)

(Fig. 39)

Careproctus segaliensis Gilbert and Burke, 1912b: 367, fig. 9 (original description; off Cape Terpenie, Sakhalin, southern Okhotsk Sea, Albatross station 5026, in 218 m); Jordan et al., 1913: 307; Burke, 1930: 115, fig. 32; Soldatov and Lindberg, 1930: 374; Tarantetz, 1937: 137; Okada and Matsubara, 1938: 347; Matsubara, 1955: 1194; Lindberg, 1959: 255; Ueno, 1971: 97; Quast and Hall, 1972: 29; Kido, 1984: 338; pl. 365.

Material examined. Holotype: USNM 73336, 69 mm SL, 48°36'10"N, 145°17'30"E, off Cape Terpenie, Sakhalin, southern Okhotsk Sea, Albatross station 5026, depth 218 m, 28 Sep. 1906, radiograph only.

Diagnosis. A *Careproctus* with trilobed teeth; dorsal fin rays 61; anal fin rays 53; pectoral fin rays 25; caudal fin rays 6.

This species has been known only from the holotype. The following description is based on Gilbert and Burke (1912b), and Burke (1930) and a radiograph of the holotype.

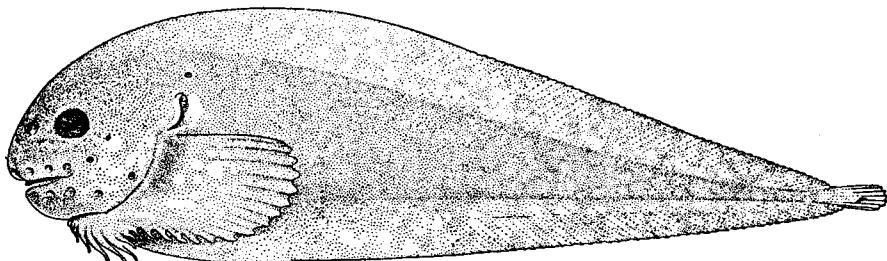


Fig. 39. *Careproctus segaliensis* Gilbert et Burke, holotype, USNM 73336, 69 mm SL, from off Cape Terpenie, Sakhalin, from Gilbert and Burke (1912b).

Description. Counts : Dorsal 61, anal 53, pectoral 25, caudal 6, vertebrae 10+56=66, pyloric caeca 17, cephalic pores 2-5-6-1.

Morphometry : Head length 22.5% SL, body depth 24, head width 14, snout length 10, eye diameter 5, interorbital width 12, length of upper lobe of pectoral fin 18, length of lower lobe of pectoral fin 9.5, gill opening length 3.8, snout to disk length 12.5, sonut to anus length 18.5, disk length 4.3.

Body deep and compressed.

Head compressed. Snout projecting beyond upper lip for two-thirds of eye diameter. Eye small. Maxillary reaching below pupil. Teeth trilobed, forming broad bands on both jaws. Outer teeth smaller than inner teeth, bluntly pointed without lateral lobes. Gill opening short, wholly located above pectoral fin.

Pectoral fin shallowly notched. Lower lobe of pectoral fin reaching behind anus.

Disk small. Anus close behind anus.

When fresh body transparent with a reddish tinge, dusky posteriorly.

Distribution. Known only from the southern Okhotsk Sea at depth of 218 m.

Remarks. This species resembles *C. marginatus* in having a deep and compressed body, trilobed teeth, gill opening wholly located above pectoral fin and shallowly notched pectoral fin. It is easily distinguishable from *C. marginatus*, however, by more dorsal and anal fin rays and vertebrae (47-50, 40-43 and 52-55 in *C. marginatus*), fewer caudal fin rays and pyloric caeca (10 and 24-35) and a different number of cephalic pores (2-6-7-2).

***Careproctus sinensis* Gilbert et Burke**

(Japanese name : Sekichiku-bikunin)

(Fig. 40)

Careproctus sinensis Gilbert and Burke, 1912b : 371, fig. 13, pl. 46 (original description ; off Sado I., Japan Sea, Albatross station 4813, in 366 m) ; Jordan et al., 1913 : 308 ; Burke, 1930 : 114, fig. 31 ; Soldatov and Lindberg, 1930 : 372 ; Tarantzev, 1937 : 137 ; Okada and Matsubara, 1938 : 347 ; Lindberg, 1947 : 193 ; Honma, 1952 : 224 ; Matsubara, 1955 : 1194 ; Oshima, 1957 : 5 ; Lindberg, 1959 : 255 ; Ueno, 1971 : 98 ; Kido, 1984 : 338, pl. 365.

Material examined. Holotype : USNM 73339, female, 59 mm SL, 38°35'N, 138°41'E, off

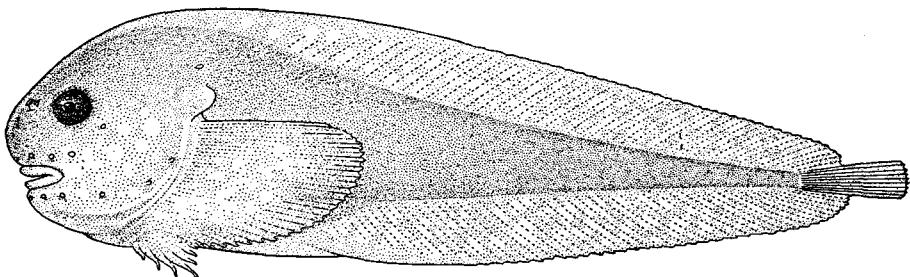


Fig. 40. *Careproctus sinensis* Gilbert et Burke, holotype, USNM 73339, 59 mm SL, from off Sado Island, Japan Sea, from Gilbert and Burke (1912b).

Sado I., Japan Sea, Albatross station 4813, depth 366 m, 18 July 1906.

Comparative material : *Careproctus seraphimae* Schmidt: holotype, ZIL 24483, 123 mm SL, 55°31'N, 149°10'E, central Okhotsk Sea, 13 Sep. 1932, radiograph only.

Diagnosis. A *Careproctus* with trilobed teeth; pectoral fin rays 33; peritoneum and stomach pale.

Description. Counts 53, anal 47, pectoral 33, caudal 10, vertebrae $11+47=58$, pyloric caeca ca. 20, cephalic pores 2-6-7-1.

Morphometry: Head length 26.7% SL, body depth 28.1, head width 13.2; snout length 30.4% HL, eye diameter 19.6, interorbital width 44.3, upper jaw length 46.8, lower jaw length 42.4, gill opening length 17.1, snout to disk length 76.7, snout to anus length 98.7, mandible to disk length 58.2, mandible to anus length 84.8, disk length 24.7.

Body deep, compressed, deepest at nape, then tapering rapidly to caudal fin.

Head deep, compressed, strongly swollen at nape; its profile descending rapidly to snout, then retracting to mouth. Snout short, deep and slightly projecting. Nostril in a short and broad tube, in front of eye on a level with upper margin of pupil. Eye moderately large. Mouth terminal; maxillary reaching below posterior margin of pupil. Teeth weakly trilobed with lateral lobes forming a shoulder, forming wide bands. Outer teeth simple, smaller than the inner. Anterior cephalic pores relatively large, sinking in pits. Anterior pair of mandibular pores having a common opening. Suprabranchial pore single, large. Gill opening short, wholly located above pectoral fin. Opercular flap round, supported by two spines recurved dorsally: upper opercular spine stronger than lower spine; its tip on a horizontal with upper margin of pupil.

Pectoral fin shallowly notched; its uppermost fin ray almost on a level with lower margin of eye. Lower pectoral fin lobe reaching slightly behind anus with 4 rays. Pectoral symphysis located posteriorly to a vertical through posterior margin of orbit. Origin of anal fin below 9th dorsal fin ray. Anterior rays of dorsal and anal fins buried in gelatinous layer.

Disk moderately large, round and flat with broad margin; its diameter larger than eye diameter. Anus immediately behind anus, located below lower end of gill opening. Ovipositor just behind anus.

Stomach large. Pyloric caeca fat, short and pointed.

Body color in alcohol pale; oral and branchial cavities, peritoneum, stomach and pyloric caeca pale.

Distribution. Known only from off Sado I., Japan Sea, at depth of 366 m.

Remarks. This species resembles *C. marginatus* in having a deep and compressed body, trilobed teeth, gill opening wholly located above pectoral fin and shallowly notched pectoral fin. It differs from *C. marginatus*, however, by more dorsal, anal, and pectoral fin rays and vertebrae (47-50, 40-43, 25-29 and 52-55 in *C. marginatus*), fewer suprabranchial pores (2) and different coloration of peritoneum and vertical fins (dusky or black, and black). This species also closely resembles *C. seraphimae* Schmidt from the Okhotsk Sea in almost all characters, but differs from the latter in having one suprabranchial pore (2 in the latter).

This species has been represented only by the holotype.

***Careproctus homopterus* Gilbert et Burke**
 (Japanese name : Kuro-konnyakuuo)
 (Fig. 41)

Careproctus homopterus Gilbert and Burke, 1912b : 374, fig. 16, pl. 47 (original description ; off Cape Terpenie, Sakhalin, southern Okhotsk Sea, in 805 m) ; Jordan et al., 1913 : 308 ; Burke, 1930 : 117, fig. 36 ; Tarantetz, 1937 : 137 ; Okada and Matsubara, 1938 : 348 ; Schmidt, 1950 : 195 ; Matsubara, 1955 : 1195 ; Lindberg, 1959 : 255 ; Ueno, 1971 : 98 ; Kido, 1984 : 339, pl. 365.

Careproctus hamopterus : Soldatov and Lindberg, 1930 : 377 (misspelled).

This species has been represented only by the holotype (43 mm SL). The following description is based on Gilbert and Burke (1912b) and Burke (1930).

Diagnosis. A *Careproctus* with trilobed teeth ; pectoral fin rays 32 or 34 ; peritoneum pale ; stomach black.

Description. Counts : Dorsal 55, anal 49, pectoral 32 (Burke, 1930) or 34 (Gilbert and Burke, 1912b), caudal 10, cephalic pores 2-?-?-2.

Morphometry : Head length 24.0% SL, body depth 18.0, head width 14.0, snout length 8.0, eye diameter 6.3, interorbital width 10.0, length of upper lobe of pectoral fin 18.0, length of lower lobe of pectoral fin 6.0, gill opening length 3.2, snout to disk length 14.0, snout to anus length 26.5, disk length 8.0.

Body moderately deep and compressed.

Nostril in a broad tube, on a level with upper margin of eye. Teeth strongly trilobed. Outer teeth simple, smaller than inner teeth. Gill opening extending down to first pectoral fin ray.

Pectoral fin very shallowly notched. Lower lobe of pectoral fin not reaching posterior margin of disk.

Anus separated from disk by a distance less than disk length.

In alcohol head pale to dusky ; body nearly uniformly dusky ; peritoneum pale ; stomach black.

Distribution. Known only from the southern Okhotsk Sea at depth of 805 m.

Remarks. This species resembles *C. cyclocephalus* in having similar counts of vertical fin rays and black stomach. There is the gap of body length between the two because this species is represented only by the small holotype. Several morphometric characters of this species may change with growth. It differs from *C. cyclocephalus*, however, in having trilobed teeth (simple teeth in *C. cyclocephalus*),

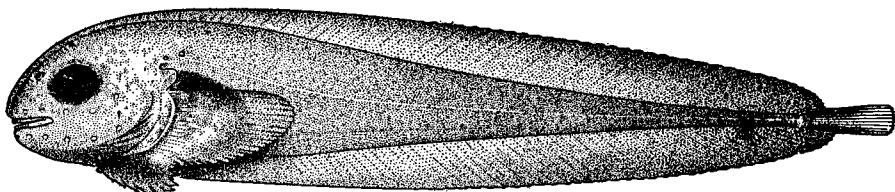


Fig. 41. *Careproctus homopterus* Gilbert et Burke, holotype, USNM 73342, 43 mm SL, from off Cape Terpenie, Sakhalin, from Gilbert and Burke (1912b).

gill opening extending down to first pectoral fin ray (gill opening widely separated from pectoral fin), uppermost pectoral fin ray located above lower margin of eye (Gilbert and Burke, 1912b : pl. 47) (uppermost pectoral fin ray located below posterior corner of maxillary) and more pectoral fin rays (26-31).

***Careproctus mederi* Schmidt**
 (Japanese name : Hige-bikunin)
 (Fig. 42)

Careproctus mederi Schmidt, 1915 : 628, figs. 7, 8 (original description ; near St. Jones I., northern Okhotsk Sea, in 320 m) ; Burke, 1930 : 192 ; Soldatov and Lindberg, 1930 : 380, figs. 59, 60 ; Taranetz, 1937 : 137 ; Schmidt, 1950 : 215 (northern Okhotsk Sea) ; Matsubara, 1955 : 1193 ; Quast and Hall, 1972 : 28.

Material examined. Syntypes : ZIL 18958, 114-151 mm SL, 56°18'N, 145°04'E, northern Okhotsk Sea, depth 320 m, 20 Aug. 1914, radiograph only.

Other material : 15 specimens : ZIL 24485, ca. 107 mm SL, 55°40'N, 143°04'E, Okhotsk Sea, 19 Aug. 1932, radiograph only ; HUMZ 76010, 77598, 77600, 77612, 77646, 77647-77649, 77689, 77690, 78894-78897, 8 females, 4 males and 2 specimens of unknown sex, 103-239 mm SL, 44°11.6'N-44°54.3'N, 144°20'E-145°03'E, off Okhotsk coast of Hokkaido, 400-950 m, 29 June 1978-2 Nov. 1978.

Comparative material : *Careproctus ostentum* Gilbert : 21 specimens : HUMZ 82565-82567, 2 females and 1 male, 49-68 mm SL, 59°20'N, 178°04'W, Bering Sea, 610 m, 28 June 1979 ; HUMZ 88465-88470, 6 females, 93-110 mm SL, 52°40'N, 172°26'W, near Amukta I., Aleutian Is., 520-590 m, 16 July 1980 ; HUMZ 88678, 88680-88689, 88699, 12 females, 81-96 mm SL, 51°41'N, 177°49'W, near Kiska I., Aleutian Is., 552-560 m, 10 Aug. 1981. *Careproctus gilberti* Burke : 4 specimens : HUMZ 82577, female, 74 mm SL, 54°34'N, 166°27'W, Bering Sea, 427-440 m, 4 Aug. 1979 ; HUMZ 88475, female, 64 mm SL, 52°40'N, 172°26'W, near Amukta I., Aleutian Is., 520-590 m, 16 July 1980 ; HUMZ 88722, female, 78 mm SL, 52°01'N, 175°09'W, near Buldir I., Aleutian Is., 515-529 m, 14 Aug. 1980 ; HUMZ 88795, male, 65 mm SL, 52°48'N, 172°10'W, near Attu I., Aleutian Is., 560-600 m, 21 Aug. 1980.

Diagnosis. A *Careproctus* with reduced disk, its length 2.7-4.9% of head length ; pyloric caeca 18-25 ; peritoneum dusky or black.

Description. Counts : Dorsal 52-59, anal 48-54, pectoral 30-37, caudal 8-9, vertebrae 10+52-54=62-64, pyloric caeca 18-25, cephalic pores 2-6-7-2.

Morphometry : Head length 24.8-29.6% SL, body depth 22.9-26.7, head width 14.5-17.7 ; snout length 34.5-42.7% HL, eye diameter 14.5-19.6, interorbital width

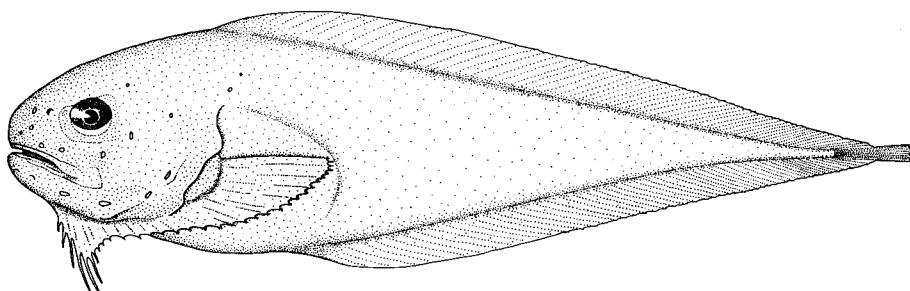


Fig. 42. *Careproctus mederi* Schmidt, HUMZ 77646, 233 mm SL, from off Okhotsk coast of Hokkaido.

47.1-57.2, upper jaw length 48.3-57.0, lower jaw length 46.5-53.6, length of upper lobe of pectoral fin 48.4-62.8, length of lower lobe of pectoral fin 41.4-62.4, gill opening length 48.0-63.7, snout to disk length 39.0-56.6, snout to anus length 51.2-62.4, mandible to disk length 33.5-46.6, mandible to anus length 45.7-57.0, disk to anus length 4.9-9.2, disk length 2.7-4.9.

Body relatively slender, deepest at middle between anus and origin of anal fin. Skin covered with cactus-like prickles. Gelatinous tissue thin beneath skin. Rudimentary pores absent. Head heavy; its profile descending slowly to snout. Snout not projecting. Nostril in a short tube, almost on a level with upper margin of pupil. Eye moderately large. Mouth slightly oblique, large; maxillary extending below posterior margin of pupil. Teeth small, sharp, distinctly recurved, arranged in moderately wide bands consisting of irregularly oblique rows on both jaws. Outer teeth minute. Cephalic pores moderately large. Anteriormost pair of mandibular pores separated from each other. Gill opening large, starting above pectoral fin, extending down in front of 15-20 pectoral fin rays. Upper portion of opercular flap round, supported by two spines; tip of upper spine on a level with lower margin of orbit. Tips of four branchiostegal rays entering lower outline of opercular flap.

Pectoral fin shallowly notched; its uppermost fin ray on a horizontal between lower margin of orbit and posterior corner of maxillary. Upper lobe of pectoral fin reaching a vertical through origin of anal fin. Rays of notch about 15 in number, widely spaced. Lower lobe of pectoral fin reaching a vertical through lower end of gill opening with weak 4-6 rays. Base of pectoral fin extending anteriorly; pectoral symphysis almost below nostril. Origin of dorsal fin above tip of opercular flap. Origin of anal fin below 6th-8th dorsal fin ray. Anterior dorsal and anal rays buried in gelatinous layer. Caudal fin round, narrow, continuous with vertical fins for about half its length. Ends of dorsal and anal fins not forming notches on caudal fin.

Disk reduced, deeply cupped, hidden between both lower lobes of pectoral fin. Disk and anus located below eye. Anus located immediately behind disk with a small conical genital papilla in males.

Stomach large. Pyloric caeca long, pointed and located on left side of body cavity.

Body color when fresh uniformly pink; eye and peritoneum silvery. In alcohol pinkish color faded; oral and branchial cavities pale; peritoneum dusky or black; stomach black.

Reaching 239 mm SL.

Distribution. The Okhotsk Sea at depths of 202 to 950 m.

Remarks. The present HUMZ specimens differ from the syntypes and the original description of *C. mederi* in having more dorsal and anal fin rays and vertebrae (56-59, 51-54 and 62-64 in HUMZ specimens against 51-54, 48-49 and 57-59), and longer lower lobe of pectoral fin ("extends not far behind the anus" in syntypes (Schmidt, 1915)). General physiognomy, a greatly reduced disk and a large gill opening suggest, however, that HUMZ specimens belong to *C. mederi*.

This species resembles *C. ostentum* Gilbert from the Bering Sea and *C. gilberti* Burke from the Bering Sea and off the Pacific coast of Canada and U.S.A. in having

a reduced disk, large gill opening, silvery peritoneum when fresh and black stomach. It differs from the latter two species, however, by dusky peritoneum (sparsely pigmented peritoneum in the latter two species), slender pyloric caeca with pointed tips (stout pyloric caeca with rounded tips) and more pyloric caeca (7-14). In addition to the above characters, it differs from *C. ostentum* by longer lower lobe of pectoral fin (22.5-42.4% of HL in *C. ostentum*), and from *C. gilberti* by smaller disk (6.4-11.2% of HL in *C. gilberti*) and shorter lower lobe of pectoral fin (72.4-78.5%).

This species reaches 239 mm SL, while the known largest specimens is 110 mm SL in *C. ostentum* and 117 mm SL in *C. gilberti*. *C. mederi* is probably the species of large size among these three species.

Until now this species has been known only from the northern Okhotsk Sea. The present HUMZ specimens provide the first record of this species from Japan and extend the known range to the south.

***Careproctus macrodiscus* Schmidt**
 (Japanese name : Ohotsuku-konnyakuuo)
 (Fig. 43)

Careproctus macrodiscus Schmidt, in Taranetz, 1937 : 137 (nomen nudum); Schmidt, 1950 : 208, fig. 18, pl. 19 (original description; northern Okhotsk Sea, in 355 m); Kido, 1983a : 377, figs. 5, 10 (northern and southern Okhotsk Sea); Kido, 1983b : 299, pl. 179; Kido, 1984 : 339, pl. 304.

Material examined. 34 specimens: HUMZ 46461-46463, 46465, 46467, 46469, 67539-67541, 77588, 77614, 77643, 77645, 77688, 77691, 77753, 78759-78761, 78887, 92711, 92712, 13 females, 7 males and 2 specimens of unknown sex, 204-416 mm SL, 44°25'N-44°53'N, 144°17.5'E-144°28'E, southern Okhotsk Sea, depth 152-400 m, 3 July 1975-8 Oct. 1981; HUMZ 54848, 55292, 55293, 55296, 55298, 1 female and 4 males, 289-443 mm SL, 57°59'N-58°21'N, 152°00'E, off Koni Peninsula, northern Okhotsk Sea, 130-215 m, 9 June 1976; HUMZ 55495, 55504, 55506, 1 female, 1 male and 1 specimen of unknown sex, 178-291 mm SL, 55°02'N, 154°18'E, eastern Okhotsk Sea, 445-465 m, 1 June 1976; HUMZ 57845, 57846, 2 females, 355-381 mm SL, 56°44'N, 143°30'E, near Iona I., northwestern Okhotsk Sea, 305 m, 16 Sep. 1976; HUMZ 60358, male, 439 mm SL, 58°12'N, 154°10'E, off Pyagina Peninsula, northern Okhotsk Sea, HUMZ 60415, female, 328 mm SL, 56°37'N, 143°35'E, western Okhotsk Sea, 240 m, 22 Sep.

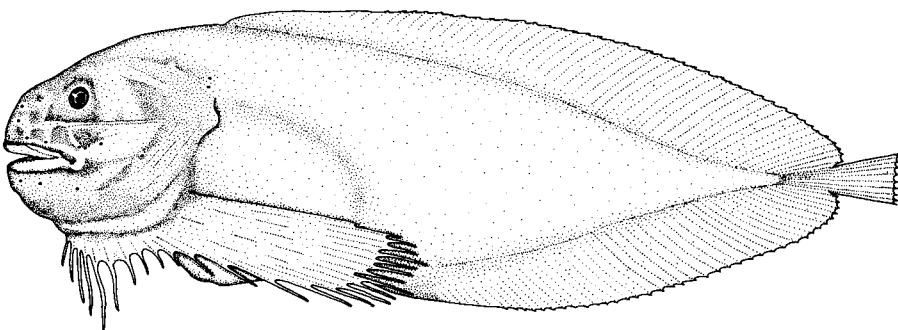


Fig. 43. *Careproctus macrodiscus* Schmidt, HUMZ 77643, 416 mm SL, from off Okhotsk coast of Hokkaido, from Kido (1983a).

1976.

Diagnosis. A *Careproctus* with large disk, its diameter 41.1-56.2% of head length; teeth in bands; gill opening wholly above pectoral fin; cephalic pores 2-5-6-2, supraocular and postocular pores absent.

Description. Counts: Dorsal 50-55, anal 44-48, pectoral 23-28, caudal 8-10, vertebrae 11+46-50=57-61, pyloric caeca 43-60, cephalic pores 2-5-6-2.

Morphometry: Head length 26.2-33.2% SL, body depth 28.3-37.0, head width 16.6-22.0; snout length 26.6-40.6% HL, eye diameter 9.2-14.7, interorbital width 39.6-44.4, upper jaw length 43.7-52.5, lower jaw length 40.7-50.7, length of upper lobe of pectoral fin 93.4-136.7, length of lower lobe of pectoral fin 41.0-73.0, gill opening length 19.3-37.1, snout to disk length 30.0-52.4, snout to anus length 81.6-115.9, mandible to disk length 29.3-45.1, mandible to anus length 84.4-113.8, disk to anus length 7.3-22.4, disk length 41.1-56.2.

Body massive, deep, tapering rapidly to caudal fin. Skin smooth, lacking prickles. Rudimentary pores absent.

Head large, massive; its upper profile descending slowly to snout. Snout deep, not projecting. Nostril tubular, short, on a horizontal through pupil. Eye small. Mouth large, horizontal; maxillary extending to below posterior margin of eye. Teeth small, recurved canines in 11-22 oblique rows forming broad bands on both jaws. Outer teeth much smaller than inner teeth. Cephalic pores small; supraocular and postocular pores absent. Anteriormost pair of mandibular pores widely separated from each other. Gill opening wholly above pectoral fin; its lower end separated from uppermost pectoral fin ray by twice horizontal eye diameter. Opercular flap supported by two spines: tip of upper spine on a level with lower rim of orbit.

Pectoral fin notch moderately deep; its uppermost fin ray below a horizontal through posterior corner of maxillary. Upper pectoral fin lobe with 13-17 long rays extending behind origin of anal fin. Notch bridged by 4-5 widely spaced short rays reaching posterior margin of disk or anus. Tips of all pectoral fin rays except for uppermost ray free. Pectoral symphysis located below anterior portion of orbit. Origin of dorsal fin above gill opening. Origin of anal fin below 7th-13th dorsal fin ray. Anterior dorsal and anal fins buried in gelatinous layer; tips of remaining rays free. Dorsal and anal fin rays relatively long. Caudal fin broad, continuous with dorsal and anal fins for about half its length. Ends of dorsal and anal fins forming notches on caudal fin.

Disk large, flat, round with wide and thin margin. Disk located between verticals through anterior margin of eye and lower end of gill opening. Anus located below posterior tip of opercular flap, separated from posterior margin of disk by a distance about equal to horizontal eye diameter. In male a small genital papilla just behind anus.

Stomach very large. Pyloric caeca long, slender, pointed and located on left side of body cavity.

Body color when fresh entirely pinkish; eye except for pupil silvery. In alcohol pinkish or pale; eye black; oral and branchial cavities, peritoneum, stomach and pyloric caeca pale.

Reaching 443 mm SL.

Distribution. The northern and southern Okhotsk Sea at depths of 130 to 465 m.

Remarks. This species is readily distinguishable from any other species of the genus by its large disk and elongate upper lobe of pectoral fin. Schmidt (1950) in the original description of this species recognized the resemblance of this species to *C. ovigerum* from great depths off British Columbia in the general appearance of body, tooth shape and size of disk. According to the redescription of *C. ovigerum* by Stein (1978a), however, this species is clearly different from it (see Kido, 1983a).

Careproctus bathycoetus Gilbert et Burke
(Japanese name : Soko-bikunin)
(Fig. 44)

Careproctus bathycoetus Gilbert et Burke, 1912b : 368, fig. 10, pl. 45 (original description ; southern Okhotsk Sea, Albatross station 5030, in 3294 m) ; Jordan et al., 1913 : 307 ; Burke, 1930 : 129, fig. 50 ; Soldatov and Lindberg, 1930 : 372 ; Tarantzev, 1937 : 137 ; Okada and Matsubara, 1938 : 347 ; Schmidt, 1950 : 200 ; Matsubara, 1955 : 1195 ; Grey, 1956 : 225 ; Lindberg, 1959 : 255 ; Ueno, 1971 : 97 ; Kido, 1984 : 339, pl. 365.

Diagnosis. A *Careproctus* with recurved canine teeth ; pectoral fin rays 22 ; caudal fin rays 7 ; pyloric caeca 9 ; body uniformly black.

This species has been known only from the holotype (160 mm SL). The following description is based on Gilbert and Burke (1912b), Burke (1930) and Stein (1978a).

Description. Counts : Dorsal 61, anal 55, pectoral 22, caudal 7, vertebrae 67, pyloric caeca 9.

Morphometry : Head length 20.6% SL, body depth 18.2 ; eye diameter 17.0% HL, upper jaw length 40.1, length of upper lobe of pectoral fin 82.4, length of lower lobe of pectoral fin 77.2, mandible to disk length 39.2, snout to anus length 101.5, mandible to anus length 81.8, disk to anus length 23.4, disk length 15.5.

Snout slightly projecting. Nostril in front of eye on a level with middle of eye. Maxillary reaching below posterior margin of pupil. Teeth recurved, sharp, arranged in about 12 oblique rows on both jaws. Gill opening wholly above pectoral fin. Pectoral fin notched. Lower lobe of pectoral fin reaching halfway between anus and origin of anal fin. Disk small, deeply cupped, located posteriorly to a vertical through posterior margin of eye.

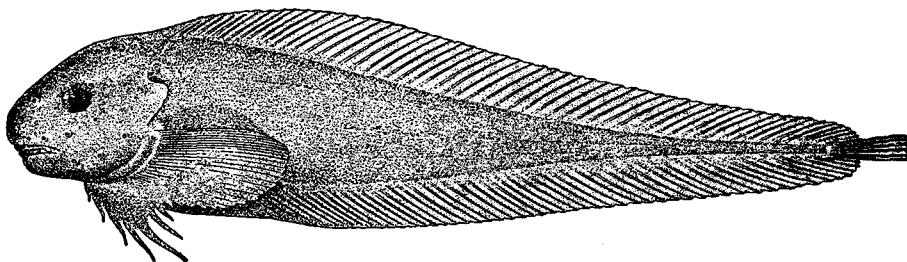


Fig. 44. *Careproctus bathycoetus* Gilbert et Burke, holotype, USNM 73337, 160 mm SL, from southern Okhotsk Sea, from Gilbert and Burke (1912b).

Body color uniformly jet black; gill cavities and peritoneum black; stomach pale.

Distribution. The southern Okhotsk Sea at depth of 3294 m.

Remarks. This species resembles *C. nigricans*. See the remarks of the latter.

***Careproctus furcellus* Gilbert et Burke**
 (Japanese name : Oguro-konnyakuuo)
 (Fig. 45)

Careproctus furcellus Gilbert and Burke, 1912a : 80, fig. 25 (original description; between Petral Bank and Agattu I., eastern Bering Sea, Albatross station 4748, in 882 m); Burke, 1930 : 126, fig. 46; Soldatov and Lindberg, 1930 : 380; Tarantsov, 1937 : 137; Schmidt, 1950 : 205 (northern and central Okhotsk Sea); Wilimovsky, 1954 : 287; Quast and Hall, 1972 : 28; Fedorov, 1973 : 66; Shiogaki, 1982 : 31 (Pacific off Aomori Pref.); Kido, 1983a : 378, figs. 6, 10 (off Pacific and Okhotsk coasts of Hokkaido, off Kuril Is., off eastern and western coasts of Kamchatka, off Aleutian Is. and Bering Sea); Kido, 1983b : 295, pl. 176; Kido, 1984 : 339, pl. 305.

Material examined. 31 specimens: HUMZ 34026, 34207, 2 males, 425-449 mm SL, off Kushiro, Pacific coast of Hokkaido, depth 450 m, 16 July 1974; HUMZ 34172, 41730, 1 male and 1 specimen of unknown sex, 443-448 mm SL, east of Matsuwa I., Kuril Is., 320 m, 9 July 1976; HUMZ 44877, 44879, 2 females, 331-347 mm SL, 50°15'N, 156°40'E, east of Paramushir I., Kuril Is., 205-235 m, 13 May 1975; HUMZ 44881, 46211, 46212, 2 females and 1 male, 291-461 mm SL, 55°51'N, 162°17'E, Gulf of Kamchatskii, eastern coast of Kamchatka, 287-300 m, 16 May 1975; HUMZ 44890, 46254, 46255, 55489, 3 females and 1 specimen of unknown sex, 187-439 mm SL, 55°02'N-55°24'N, 154°18'E-154°50'E, eastern Okhotsk Sea, 98-465 m, 9 May 1975-1 June 1976; HUMZ 46472, male, 358 mm SL, 51°55'N, 154°55'E, eastern Okhotsk Sea, 300-305 m, 11 May 1975; HUMZ 46480, 46482, 55199, 55425, 55427, 55989, 55996, 6 females and 1 male, 275-389 mm SL, 53°36'N-54°16'N, 160°23'E-160°57'E, Gulf of Kronotskii, eastern coast of Kamchatka, 125-520 m, 15 May 1975-20 May 1976; HUMZ 46495, female, 363 mm SL, 57°01'N, 163°13'E, Gulf of Ozernoi, eastern coast of Kamchatka, 150-170 m, 17 May 1975; HUMZ 46510, female, 391 mm SL, 54°05'N, 154°40'E, eastern Okhotsk Sea, 163-172 m, 8 May 1975; HUMZ 67533, 67537, 77615, 78645, 92716, 2 females, 2 males and 1 specimen of unknown sex, 221-394 mm SL, 44°11.6'N-44°53'N, 144°19'E-145°03'E, southern Okhotsk Sea, 152-790 m, 2 July 1977-8 Oct. 1981; HUMZ 68121, male, 306 mm SL, 51°44'N, 175°33'W, southeast of Atka I., Aleutian Is., 320-340 m, 8 July 1977; HUMZ 81826, female, 291 mm SL, 54°20.09'N, 167°20.90'W, north of Unalaska I., Bering Sea, 805 m, 22 June 1979; HUMZ

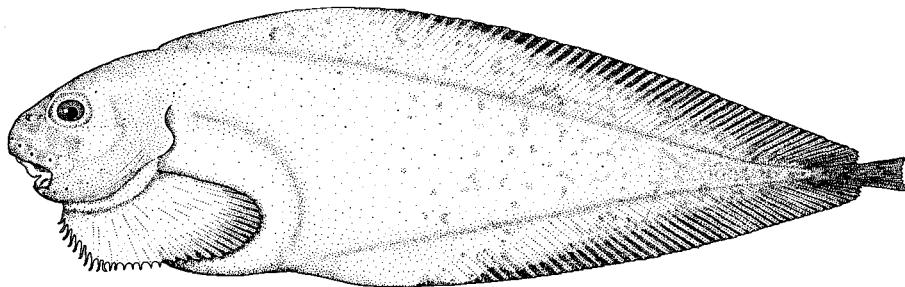


Fig. 45. *Careproctus furcellus* Gilbert et Burke, HUMZ 92716, 394 mm SL, from Okhotsk coast of Hokkaido, from Kido (1983a).

81897, female, 110 mm SL, 57°50.92'N, 173°57.72'W, Bering Sea, 725-750 m, 21 June 1979.

Diagnosis. A *Careproctus* with notchless pectoral fin; disk triangular; snout projecting; pectoral fin rays 32-37; pyloric caeca 33-49.

Description. Counts: Dorsal 61-65, anal 54-59, pectoral 32-37, caudal 10, vertebrae 10-11+57-61=67-71, pyloric caeca 33-49, cephalic pores 2-6-7-2.

Morphometry: Head length 17.1-27.0% SL, body depth 20.5-30.1, head width 10.3-15.9; snout length 33.4-44.6% HL, eye diameter 13.7-25.0, interorbital width 45.5-51.9, upper jaw length 37.2-46.8, lower jaw length 34.1-42.5, pectoral fin length 67.9-86.0, gill opening length 23.0-39.9, snout to disk length 37.2-52.4, snout to anus length 52.5-73.8, mandible to disk length 22.3-38.0, mandible to anus length 36.9-56.6, disk to anus length 1.7-7.1, disk length 11.7-19.6.

Body stout, relatively deep, tapering rapidly to caudal fin. Skin tough, smooth and lacking prickles. Rudimentary pores present, forming three rows on each side of body: upper row extending from nape to base of second or third dorsal fin ray; middle row only above anterior curve of lateral line; lower row forming lateral line from behind suprabranchial pores to caudal fin.

Head stout, almost rectangular in dorsal view; dorsal profile evenly descending to upper jaw. Snout deep, projecting over mouth. Nostril with a moderately long tube on a horizontal with lower margin of eye. Eye moderately large. Mouth inferior, broad; maxillary extending to below pupil. Teeth small, slender, arranged in about 18-37 oblique rows in moderately wide bands on both jaws. Large inner teeth faintly lobed or simple. Outer teeth simple, smaller than inner teeth. Cephalic pores small. Pores at mandibular symphysis widely separated from each other. Gill opening entirely above pectoral fin; its lower end separated from uppermost pectoral fin ray by a distance about equal to diameter of pupil. Opercular flap supported by two spines sharply angled ventrally: upper opercular spine stronger than lower spine; its tip slightly below a level of lower margin of orbit.

Pectoral fin unnotched, not divided into lobes; uppermost fin ray below a level of posterior corner of maxillary. Longest ray of pectoral fin almost reaching origin of anal fin. Anterior most 7-10 rays evenly increasing in length dorsally, thickened and exserted. Pectoral symphysis below anterior portion of eye. Origin of dorsal fin above tip of opercular flap. Origin of anal fin below 6th-9th dorsal fin ray. Caudal fin slightly emarginate, continuous with vertical fins for about half its length. Posterior margins of dorsal and anal fins forming notches on caudal fin.

Disk below eye, triangular; its width equal to or wider than its length. Margin thin, edge curled towards center. Anus immediately behind disk. In mature males a short and conical genital papilla just behind anus.

Stomach large. Pyloric caeca long, slender and located on left side of body cavity.

Body color when fresh pinkish; eye black; posterior part of body, dorsal, anal and pectoral fins black. In alcohol body pinkish or pale, dusted with black; eye and fins black; oral and branchial cavities dusky; peritoneum black; stomach and pyloric caeca pale.

Reaching 461 mm SL.

Distribution. The Bering Sea, off the Aleutian Islands, off eastern coast of

Kamchatka, the Pacific off Kuril Islands, the Okhotsk Sea and the Pacific off Hokkaido and northern Honshu, at depths of 98 to 882 m.

Remarks. This species is very similar to *C. cypselurus* in having a heavy head, notchless pectoral fin, gill opening completely above pectoral fin, opercular spines sharply angled ventrally and a triangular disk (Gilbert and Burke, 1912a; Burke, 1930). Meristic characters also overlap. They differ, however, by the combination of the following characters: pectoral fin notch absent in *C. furcellus* (slightly notched in *C. cypselurus*) ; snout projecting (not projecting) ; caudal fin emarginate, nearly truncate when spread (distinctly forked) ; body color when fresh pinkish (purplish indigo) (Kido, 1983a).

***Careproctus cypselurus* (Jordan et Gilbert)**
 (Japanese name : Ai-bikunin)
 (Fig. 46)

Prognurus cypselurus Jordan and Gilbert, in Jordan and Evermann, 1898 : 2866 (original description ; western Bering Sea and off Washington, Albatross stations 3074, 3634, in 1215-1604 m) ; Jordan and Gilbert, 1899 : 478, pl. 77 ; Evermann and Goldsborough, 1907 : 333, pl. 20 ; Jordan et al., 1930 : 403.

Careproctus cypselurus (Jordan et Gilbert) : Gilbert and Burke, 1912a : 80 (off southern coast of Kamchatka) ; Gilbert and Burke, 1912b : 362 (southern Okhotsk Sea) ; Jordan et al., 1913 : 306 ; Burke, 1930 : 127, figs. 47, 48 ; Soldatov and Lindberg, 1930 : 379 ; Rendahl, 1931 : 16 ; Schultz, 1936 : 188 ; Schultz and Delacy, 1936 : 136 ; Taranetz, 1937 : 137 ; Okada and Matsubara, 1938 : 346 ; Schmidt, 1950 : 206 ; Wilimovsky, 1954 : 287 ; Matsubara, 1955 : 1193 ; Lindberg, 1959 : 255 ; Grinols, 1965 : 147 ; Ueno, 1971 : 97 ; Quast and Hall, 1972 : 28 (Gulf of Alaska) ; Fedorov, 1973 : 66 ; Stein, 1978a : 16 ; Kido, 1983b : 161, 295, pl. 106, 175 (Pacific off Aomori Pref. and southern Okhotsk Sea) ; Kido, 1984 : 339, pl. 305.

Material examined. 29 specimens : HUMZ 74626, female, 374 mm SL, off Kashima, Pacific coast of Honshu, depth 900 m, Jan. 1978 ; HUMZ 77618, male, 273 mm SL, 44°46'N, 144°28'E, off Okhotsk coast of Hokkaido, 700-790 m, 21 Sep. 1978 ; HUMZ 72628, male, 289 mm SL, 37°30'N, 142°19.5'E, off Fukushima Pref., Pacific coast of Honshu, 815-860 m, 24 Jan. 1978 ; HUMZ 77677, 77680, 77681, 77686, 77771, 77772, 77809, 77811, 77950, 5 females and 4 males, 132-302 mm SL, 44°18.7'N-44°37'N, 144°20'E-145°01'E, 915-1340 m, 23 Sep. 1978-11 Oct. 1978 ; HUMZ 78239, female, 349 mm SL, 40°35.5'N, 142°31.3'E, 1190-1195 m, 13 Sep. 1978 ; HUMZ 78870, male, 266 mm SL, 44°20'N, 145°03.5'E, off Okhotsk coast of Hokkaido,

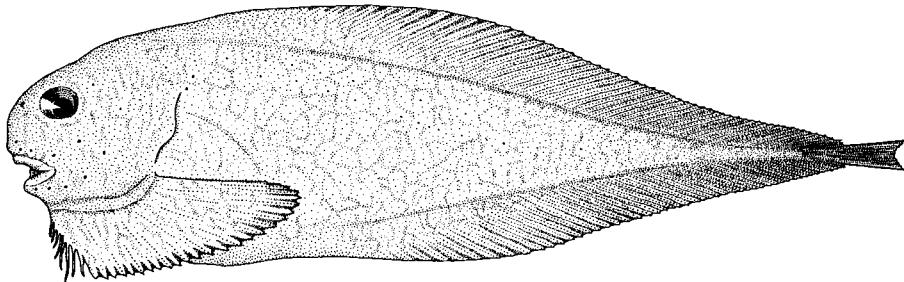


Fig. 46. *Careproctus cypselurus* (Jordan et Gilbert), HUMZ 77811, 271 mm SL, from off Okhotsk coast of Hokkaido.

940-970 m, 12 Sep. 1978; HUMZ 79729-79732, 79734, 79736, 79737, 79741, 79743, 79744, 79747-79750, 6 females and 8 males, 176-299 mm SL, 44°26.3'N, 144°25'E, off Okhotsk coast of Hokkaido, 1080-1310 m, 2 Nov. 1978; HUMZ 81920, female, 147 mm SL, 58°34'N, 175°05'W, Bering Sea, 895-910 m, 22 June 1979.

Diagnosis. A *Careproctus* with slightly notched pectoral fin; disk triangular; snout not projecting; caudal fin deeply forked; pectoral fin rays 33-40; pyloric caeca 29-49.

Description. Counts: Dorsal 59-64, anal 53-58, pectoral 33-40, caudal 10, vertebrae 10-11+55-60=65-70, pyloric caeca 29-49, cephalic pores 2-6-7-2.

Morphometry: Head length 18.3-23.5% SL, body depth 17.9-26.7, head width 11.5-16.8; snout length 29.5-38.8% HL, eye diameter 17.0-22.7, interorbital width 40.3-52.9, upper jaw length 41.5-52.9, lower jaw length 41.1-51.2, length of upper lobe of pectoral fin 82.1-107.5, length of lower lobe of pectoral fin 43.1-58.8, gill opening length 23.0-39.9, snout to disk length 39.3-52.7, snout to anus length 52.5-72.5, mandible to disk length 23.0-38.1, mandible to anus length 40.9-62.1, disk to anus length 1.9-9.7, disk length 13.1-17.5.

Body stout anteriorly, gradually tapering to caudal fin and attenuate posteriorly. Skin thin, lacking prickles. Gelatinous tissue thin. Rudimentary pores present, forming three rows on each side of body: upper row extending from nape to anterior dorsal fin rays; middle row only above anterior curve of lateral line; lower row forming lateral line from behind suprabranchial pores to caudal fin.

Head heavy, broad, rectangle in cross section. Snout blunt, broadly rounded laterally. Interorbital region broad, flat. Eye moderately large. Nostril in a short tube, on a level with middle of eye. Mouth broad, horizontal; maxillary extending below posterior margin of orbit. Teeth small, conical, arranged in about 17-33 oblique rows in moderately wide bands on both jaws. Outer teeth simple, smaller than inner teeth. Cephalic pores small. Pores at mandibular symphysis widely separated from each other. Gill opening broad, wholly above pectoral fin; its ventral end on a level with posterior corner of maxillary, separated from uppermost pectoral fin ray by a distance about equal to diameter of pupil. Opercular flap supported by two spines sharply angled ventrally; tip of upper opercular spine on a level with or slightly below lower margin of orbit.

Pectoral fin slightly notched; its uppermost fin ray below a horizontal through posterior corner of maxillary. Upper lobe of pectoral fin extending slightly behind origin of anal fin. Lower lobe of pectoral fin short with 6-8 thickened rays, about half length of head, reaching below gill opening. Base of pectoral fin extending anteriorly; pectoral symphysis below anterior margin of orbit. Origin of dorsal fin above gill opening. Origin of anal fin below 6th-8th dorsal fin ray. Anterior dorsal and anal rays buried in gelatinous layer. Caudal fin distinctly forked, confluent with vertical fins for about two-fifths of its length.

Disk triangular, smaller than eye diameter; its margin thin, curled to center. Disk and anus located below eye. Anus immediately behind disk with a small conical genital papilla in males.

Stomach and pyloric caeca located on left side of body cavity. Stomach moderately large. Pyloric caeca long, pointed.

Body color when fresh purplish indigo with red color in anterior portion;

posterior pectoral, dorsal, anal and caudal fins black. In alcohol red color faded; body with scattered dark pigments; oral and branchial cavities dusky; peritoneum black; stomach and pyloric caeca pale.

Reaching 374 mm SL.

Distribution. The Okhotsk and Bering Seas, the Gulf of Alaska and the Pacific off Washington State and northern Honshu, at depths of 700 to 1608 m.

Remarks. This species is very similar to *C. furcellus*. See the remarks of the latter.

***Careproctus cyclocephalus* Kido**
 (Japanese name: Daruma-konnyakuuo)
 (Fig. 47)

Careproctus cyclocephalus Kido, 1983a: 375, figs. 2-4 (original description; off Abashiri, southern Okhotsk Sea, in 380-950 m); Kido, 1983b: 299, pl. 180; Kido, 1984: 339, pl. 304.

Material examined. Holotype: HUMZ 77754, female, 282 mm SL, 44°27'N, 144°26.5'E, off Abashiri, Okhotsk coast of Hokkaido, depth 930-950 m, 25 Sep. 1978.

Paratypes: 31 specimens: HUMZ 70923, 71077, 75926, 77586, 77590-77592, 77609, 77644, 77687, 77805, 77936-77939, 77941-77946, 77948, 77949, 78647, 78754-78757, 92713, NSMT-P 21484, 21485, 20 females, 9 males and 2 specimens of unknown sex, 140-288 mm SL, 44°11.6'N-45°02'N, 144°20'E-145°03'E, off Abashiri, 380-950 m, 23 Oct. 1977-8 Oct. 1981.

Diagnosis. A *Careproctus* with simple, recurved canine teeth in bands; gill opening widely separated from pectoral fin; uppermost pectoral fin ray below a horizontal through posterior corner of maxillary; pectoral fin rays 26-31; pyloric caeca 33-50; peritoneum pale; stomach black.

Description. Counts: Dorsal 54-57, anal 47-51, pectoral 26-31, caudal 8-10, vertebrae 11-12+48-52=59-63, pyloric caeca 33-50, cephalic pores 2-6-7-2.

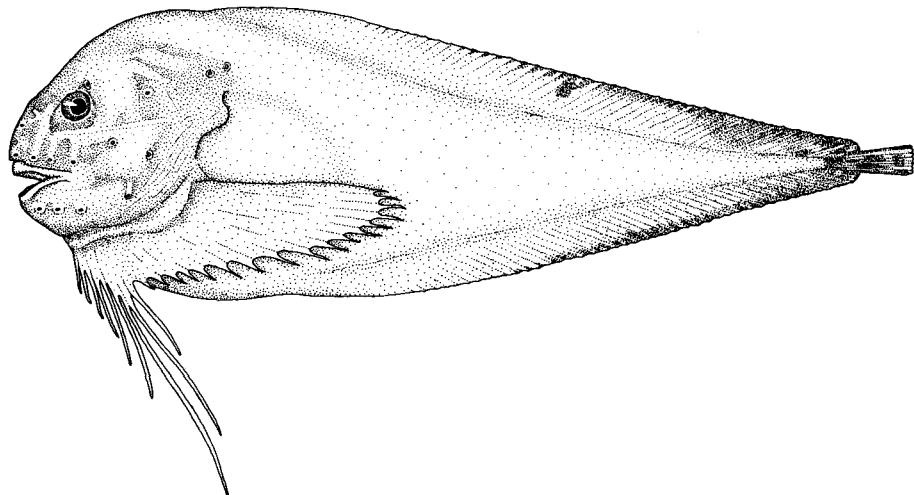


Fig. 47. *Careproctus cyclocephalus* Kido, holotype, HUMZ 77754, 282 mm SL, from off Okhotsk coast of Hokkaido, from Kido (1983a).

Morphometry : Head length 25.7-29.9% SL, body depth 26.8-34.8, head width 17.5-22.9 ; snout length 27.2-36.7% HL, eye diameter 13.9-18.3, interorbital width 38.3-44.8, upper jaw length 45.3-51.9, lower jaw length 38.3-52.1, length of upper lobe of pectoral fin 80.9-111.6, length of lower lobe of pectoral fin 84.5-126.6, gill opening length 29.9-42.5, snout to disk length 35.5-51.2, snout to anus length 59.2-79.8, mandible to disk length 29.1-41.8, mandible to anus length 53.9-71.1, disk to anus length 7.8-16.2, disk length 13.4-18.0.

Body deep anteriorly, deepest at origin of dorsal fin, then tapering rapidly to caudal fin. Skin tough, smooth and lacking prickles. Gelatinous tissue thick on anterior part of body including fins. Lateral line and other rudimentary pores absent.

Head large, massive and globular. Profile of head descending steeply to snout. Nostril with a prominent tube on a horizontal through pupil. Eye moderately large. Mouth large, horizontal ; maxillary extending posteriorly to below posterior margin of eye. Teeth small, simple, recurved canines with broad bases. Tooth bands broad, composed of 12-18 oblique rows on premaxillary and 14-19 rows on dentary. Outer teeth much smaller, increasing rapidly in size towards inside of mouth. Caphalic pores small. Anteriormost pair of mandibular pores widely separated from each other. Gill opening wholly above pectoral fin ; its lower end on a level with posterior corner of maxillary, separated from uppermost pectoral fin ray by a distance about equal to eye diameter. Opercular flap supported by two spines : upper opercular spine stronger than lower spine ; its tip on a horizontal with lower margin of eye.

Pectoral fin distinctly notched ; its uppermost fin ray below a horizontal through posterior corner of maxillary. Upper lobe of pectoral fin with 11-16 rays, reaching behind origin of anal fin. Notch with 6-8 rays. Lower lobe of pectoral fin with 6-9 long and exserted rays, almost reaching origin of anal fin or behind it. Symphysis of lower lobe of pectoral fin below anterior margin of eye. Tips of all pectoral fin rays except for uppermost ray free. Origin of dorsal fin above gill opening. Origin of anal fin below 6th-10th dorsal fin ray. Anterior dorsal and anal fin rays buried in thick gelatinous layer. Caudal fin narrow, continuous with dorsal and anal fins for about half its length. Dorsal and ventral notches on caudal fin absent.

Disk small, flat, round with wide and thin margin ; its diameter about equal to or somewhat smaller than eye diameter. Posterior margin of disk below posterior margin of orbit. Anus below a point about halfway between posterior margin of orbit and lower end of gill opening, separated from posterior margin of disk by a distance equal to two-thirds of disk length.

Stomach large. Pyloric caeca long, slender, located on left side of body cavity.

Body color when fresh reddish ; posterior dorsal and anal fins and caudal fin black ; eye black. In alcohol reddish color faded ; eye black ; oral and branchial cavities faintly dusky ; peritoneum and pyloric caeca pale ; stomach black.

Attaining 288 mm SL.

Distribution. Known from off Abashiri, the southern Okhotsk Sea, at depths of 380 to 950 m.

Remarks. This species resembles *C. homopterus*. See the remarks of the latter.

***Careproctus rastrinus* Gilbert et Burke**
 (Japanese name: Sake-bikunin)
 (Figs. 48, 49)

Careproctus rastrinus Gilbert and Burke, 1912b: 362, fig. 3, pl. 43 (original description; southern Okhotsk Sea, Albatross stations 5021, 5026, in 134–218 m); Jordan et al., 1913: 306; Burke, 1930: 136, figs. 57–59; Soldatov and Lindberg, 1930: 371; Tarantet, 1937: 137; Okada and Matsubara, 1938: 346, pl. 85; Schmidt, 1950: 212 (Okhotsk Sea); Matsubara, 1955: 1193; Mori, 1956b: 30 (near Oki I., Japan Sea); Lindberg, 1959: 255; Ueno, 1971: 97; Quast and Hall, 1972: 29; Kido, 1984: 339, pl. 305.

Careproctus acanthodes Gilbert and Burke, 1912b: 363, fig. 4, pl. 43 (original description; Tatar Strait, Albatross station 4997, in 582 m); Jordan et al., 1913: 306; Burke, 1930: 135, figs. 55, 56; Soldatov and Lindberg, 1930: 373; Tarantet, 1937: 137; Okada and Matsubara, 1938: 346; Lindberg, 1947: 193; Matsubara, 1955: 1193; Ueno, 1971: 97; Quast and Hall, 1972: 28; Kido, 1984: 339, pl. 365.

Careproctus pellucidus Gilbert and Burke, 1912b: 366, fig. 8, pl. 44 (original description; off Oshika Peninsula, Pacific off Miyagi Pref., Albatross stations 5048, 5049, in 206–333 m); Jordan et al., 1913: 307; Burke, 1930: 134, fig. 54; Soldatov and Lindberg, 1930: 371; Tarantet, 1937: 137; Okada and Matsubara, 1938: 347; Hikita and Misu, 1952: 43, pl. 8 (off Yoichi, Japan Sea off Hokkaido); Katayama, 1953: 4, fig. 5 (off Hyogo Pref., Japan Sea); Matsubara, 1955: 1194; Mori, 1956b: 29 (Japan Sea); Oshima, 1957: 4; Ueno, 1971: 97; Maruyama, 1971: 65 (off Kamaishi, Pacific off Iwate Pref.); Hikita, 1981: 74; Shiogaki, 1982: 31 (off Hachinohe, Pacific off Aomori Pref.); Kido, 1984: 339, pl. 365.

Material examined. Holotype: USNM 73331, female, 251 mm SL, 48°36'10"N, 145°17'30"E, southern Okhotsk Sea, Albatross station 5026, depth 218 m, 28 Sep. 1906.

Other material: 49 specimens: USNM 73332 (holotype, *C. acanthodes* Gilbert et Burke), female, 78 mm SL, 47°38'40"N, 141°24'30"E, Tatar Strait, Albatross station 4997, 582 m, 23 Sep. 1906; USNM 73335 (holotype, *C. pellucidus* Gilbert et Burke), female, 110 mm SL, 38°09'24"N, 141°52'30"E, off Oshika Peninsula, northeast coast of Honshu, Albatross station 5048, 236 m, 10 Oct. 1906; HUMZ 33848, male, 230 mm SL, off Monbetsu, Okhotsk coast of

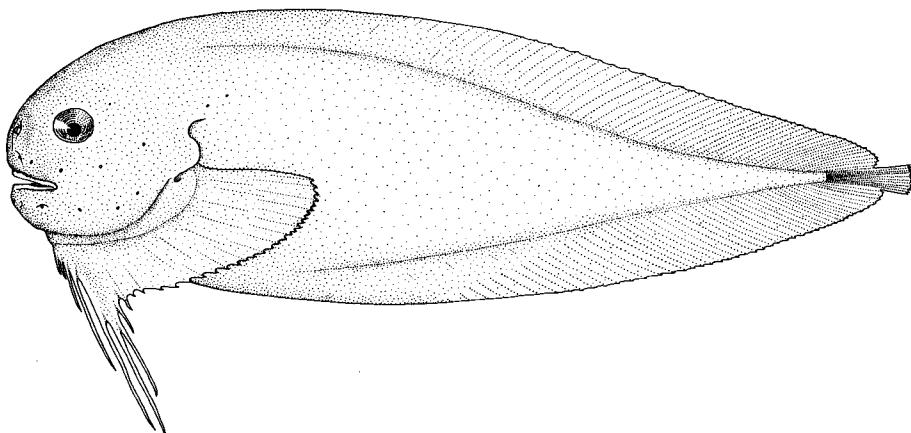


Fig. 48. *Careproctus rastrinus* Gilbert et Burke, HUMZ 92882, 303 mm SL, from off Okhotsk coast of Hokkaido.

Hokkaido, depth unknown, 6 Sep. 1968 ; HUMZ 33953, female, 333 mm SL, 44°45'N, 144°04'.3'E, off Okhotsk coast of Hokkaido, 200 m, 31 Oct. 1974 ; HUMZ 41604, female, 321 mm SL, 45°08'N, 143°10'E, off Okhotsk coast of Hokkaido, 6 Sep. 1968 ; HUMZ 46506, male, 308 mm SL, 54°05'N, 154°40'E, off western coast of Kamchatka, 163-172 m, 8 May 1975 ; HUMZ 51633, 51634, 2 females, 131-206 mm SL, 42°02'.7'N, 143°43.6'E, off Hiroo, Pacific coast of Hokkaido, 325 m, 24 Mar. 1976 ; HUMZ 51885, male, 93 mm SL, off Suizu, Sado I., Japan Sea, depth unknown, 4 Feb. 1976 ; HUMZ 53244, male, 309 mm SL, 45°14.5'N, 143°39'E, off Okhotsk coast of Hokkaido, 175 m, 1 June 1976 ; HUMZ 60766, male, 217 mm SL, 48°42'N, 145°17'E, southern Okhotsk Sea, 163 m, 4 Sep. 1976 ; HUMZ 67948, male, 225 mm SL, 45°10'N, 143°42'E, off Okhotsk coast of Hokkaido, 188-190 m, 19 Mar. 1977 ; HUMZ 68069, male, 294 mm SL, 44°31'N, 140°17'E, northern Japan Sea, 315-330 m, 16 Mar. 1977 ; HUMZ 71444, female, 118 mm SL, off Hitachi, Ibaragi Pref., Pacific coast of Honshu, 256-348 m, 13 Nov. 1977 ; HUMZ 72123, 72124, 1 female and 1 male, 124-132 mm SL, off Iwaki, Fukushima Pref., Pacific coast of Honshu, about 200-300 m, 13 Nov. 1977 ; HUMZ 72491, 72492, 2 males, 98-153 mm SL, 37°17.5'N, 142°03.4'E, off Fukushima Pref., Pacific coast of Honshu, depth unknown, 24 Jan. 1978 ; HUMZ 75897-75900, 75903-75906, 75934, 75937, 75939-75941, 75970, 75990, 75991, 77420, 77422, 77423, 77425, 77427, 11 females and 10 males, 68-299 mm SL, 42°31'N-42°52.4'E, 143°57'E-144°23'E, off Kushiro, Pacific coast of Hokkaido, 180-290 m, 11 July 1978-8 Sep. 1978 ; HUMZ 77530, female, 139 mm SL, off Shiranuka, Aomori Pref., Pacific coast of Honshu, 240 m, 26 Sep. 1978 ; HUMZ 90219, 90220, 1 female and 1 male, 81-88 mm SL, off Iwaki, 100-360 m, 6 Nov. 1980 ; HUMZ 92717, 92719, 92720, 92882, 93165, 3 females and 2 males, 195-321 mm SL, 44°50.5'N-44°51'N, 144°12'E-144°25'E, off Okhotsk coast of Hokkaido, 210-400 m, 8 Oct. 1981 ; HUMZ 97870, female, 208 mm SL, 45°02.2'N, 144°06'E, off Okhotsk coast of Hokkaido, 230 m, 9 June 1983 ; HUMZ 99388, female, 92 mm SL, 39°20'N, 142°07'E, off Iwate Pref., Pacific coast of Honshu, 192 m, 28 Apr. 1982.

Diagnosis. A *Careproctus* with simple, conical teeth; gill opening extending ventrally in front of 1-6 pectoral fin rays, or rarely above pectoral fin; pectoral fin deeply notched with 31-38 rays; disk length 11.1-19.8% of head length; when fresh body entirely pinkish and peritoneum silvery without dark pigmentation; stomach pigmented or not.

Description. Counts: Dorsal 53-62, anal 48-54, pectoral 31-38, caudal 9, vertebrae 9-11+48-56=58-67, pyloric caeca 16-35, cephalic pores 2-6-7-2.

Morphometry: Head length 22.1-27.5% SL, body depth 24.0-36.6, head width 13.4-19.9; snout length 31.9-48.3% HL, eye diameter 17.4-36.5, interorbital width 51.7-64.8, upper jaw length 41.7-53.6, lower jaw length 39.4-52.4, length of upper lobe of pectoral fin 49.6-78.4, length of lower lobe of pectoral fin 48.4-126.9, gill opening length 24.9-42.3, snout to disk length 41.0-70.6, snout to anus length 60.8-83.6, mandible to disk length 32.7-48.9, mandible to anus length 49.3-77.2, disk to anus length 0.5-12.7, disk length 11.1-19.8.

Body stout, deep. Skin thick, covered with cactus-like prickles in most specimens more than about 130 mm SL. Gelatinous tissue thick beneath skin. Rudimentary pores absent.

Head heavy; its upper profile descending steeply to snout. Snout short, deep. Eye moderately large in adult specimens, very large in specimens less than about 100 mm SL. Nostril in a short tube, on a level with lower margin of pupil. Mouth horizontal; maxillary extending below posterior margin of pupil. Teeth small, conical, arranged in 12-27 oblique rows in moderately wide bands on both jaws. Outer teeth simple, smaller than inner teeth. Cephalic pores small. Anteriormost mandibular pores separated from each other. Gill opening moderately large, extend-

ing ventrally in front of 1-6 pectoral fin rays or rarely wholly above pectoral fin. Opercular flap round, supported by two spines extending horizontally; tip of upper spine on a level with lower margin of orbit or slightly below it.

Pectoral fin deeply notched; uppermost fin ray on a level between lower margin of orbit and posterior corner of maxillary. Upper lobe of pectoral fin reaching a vertical through origin of anal fin. Lower lobe of pectoral fin long with 5-7 rays, reaching origin of anal fin or not; its rays largely free from fin membrane. Base of pectoral fin extending anteriorly; pectoral symphysis located anteriorly to a vertical through anterior margin of eye. Origin of dorsal fin above tip of opercular flap. Origin of anal fin below 6th-9th dorsal fin ray. Anterior dorsal and anal fin rays buried in thick gelatinous layer. Caudal fin broad, round, continuous with dorsal fin for three-fifths and with anal fin for two-thirds of its length. Ends of dorsal and anal fins forming notches on caudal fin.

Disk small, triangular, cupped with narrow margin. Disk and anus located below eye. Anus immediately behind anus with a small conical papilla in males.

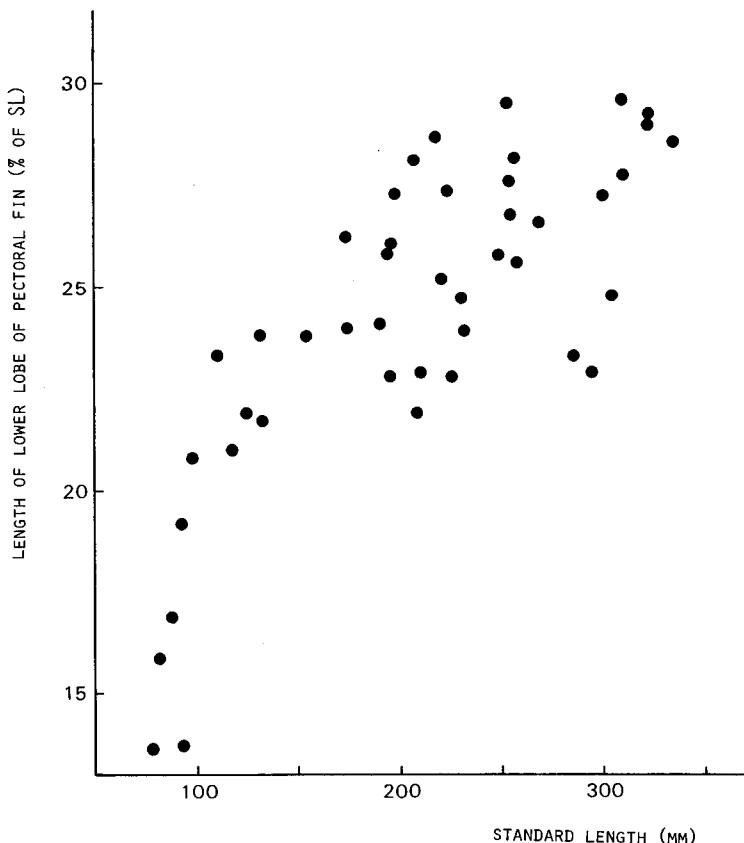


Fig. 49. Morphometric change of lower lobe of pectoral fin as a percent of SL versus SL in *Careproctus rastrinus*.

Stomach large. Pyloric caeca long, pointed, located on left side of body cavity.

Body color when fresh entirely pink; eye and peritoneum silvery; posterior vertical fins sparsely pigmented. In alcohol pinkish color faded; eye black; oral and branchial cavities and peritoneum pale; stomach pigmented or not; pyloric caeca dusky at base.

Reaching 333 mm SL.

Distribution. The Okhotsk and Japan Seas, the Tatar Strait, and the Pacific off Hokkaido and northern Honshu, at depths of 100 to 582 m.

Remarks. This species shows a large variation in length of lower lobe of pectoral fin. This variation is due to allometric growth (Fig. 49).

Gilbert and Burke (1912b) described *Careproctus acanthodes* based on specimens taken in the Tatar Strait. Comparison of the holotype of *C. acanthodes* (78 mm SL) with *C. rastrinus* shows that the former has slightly lower values in length of lower lobe pectoral fin (13.5% of SL against 13.7–29.6%) and gill opening length (6.9% against 7.0–9.9%) and slightly higher value in disk length (5.5% against 2.7–5.4%). These slight differences do not seem to be meaningful in delimiting species. *C. acanthodes* and *C. rastrinus* are conspecific, and the former is a junior synonym of the latter.

Gilbert and Burke (1912b) also described *Careproctus pellucidus* from specimens taken off the Oshika Peninsula, northeast coast of Honshu. My examination of the holotype of *C. pellucidus* (110 mm SL) shows that all its morphometric and meristic characters fall within the range of variation of *C. rastrinus* examined here, except for no prickles in *C. pellucidus* (Gilbert and Burke, 1912b; Burke, 1930; and my observation). This character, however, is useless in delimiting species by following reasons: prickles are easily detached from skin and are secondarily lost if specimens are not handled carefully (Burke, 1930; Able and McAllister, 1980); prickles are a sexual dimorphic character in species of *Liparis* (see Burke, 1930; Cohen, 1960; Able, 1973; Able and McAllister, 1980). *C. rastrinus* and *C. pellucidus* are thus conspecific, and the latter is a junior synonym of the former.

This species closely resembles *C. trachysoma*, but the former are distinguished from the latter by coloration: pinkish body (dark body in the latter), pinkish fins (bluish black fins), pale peritoneum (pigmented peritoneum) and dark stomach (blackish stomach).

Careproctus trachysoma Gilbert et Burke

(Japanese name: Zara-bikunin)

(Fig. 50)

Careproctus trachysoma Gilbert and Burke, 1912b: 364, fig. 5, pl. 44 (original description; off Sado I., northern Japan Sea, and Tatar Strait, Albatross stations 4814, 4981–4983, 4992, 4997, in 582–785 m); Jordan et al., 1913: 307; Burke, 1930: 137, fig. 60; Soldatov and Lindberg, 1930: 374; Tarantsov, 1937: 137; Okada and Matsubara, 1938: 346; Lindberg 1947: 193; Schmidt, 1950: 212 (northern Okhotsk Sea); Honma, 1952: 224; Matsubara, 1955: 193; Ueno, 1971: 97; Quast and Hall, 1972: 29; Kido, 1984: 339, pl. 305.

Careproctus acanthodes Gilbert et Burke: Schmidt, 1950: 210 (off western coast of Kamchatka).

Material examined. 31 specimens: HUMZ 42509, 42510, 1 female and 1 male, 284–313

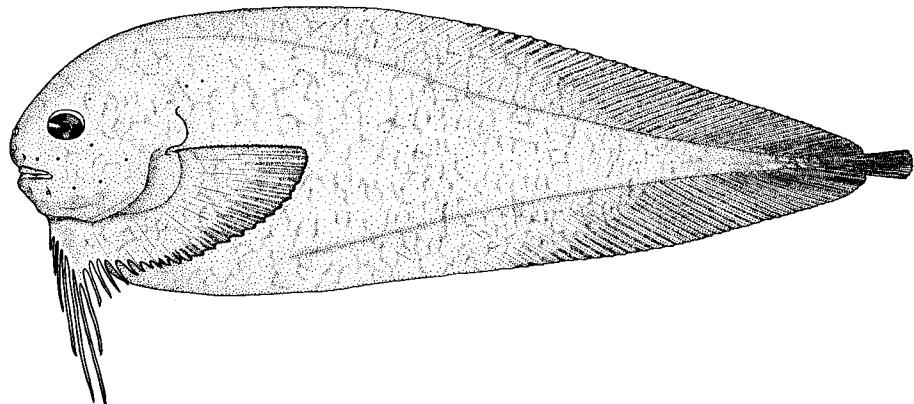


Fig. 50. *Careproctus trachysoma* Gilbert et Burke, HUMZ 53874, 257 mm SL, from Yamato Bank, Japan Sea.

mm SL, 42°06.2'N, 139°35.1'E, near Okushiri I., northern Japan Sea, depth 540-610 m, 5 June 1975; HUMZ 42743, 42745, 42749, 42760, 42762, 42767, 42773, 42774, 42803, 42808, 6 females and 4 males, 217-309 mm SL, 42°05.4'N, 139°39.6'E, near Okushiri I., 603-700 m, 5 June 1975; HUMZ 46602, 46607, 46627, 46634, 46681, 46683, 46685, 46686, 46692, 46694, 46696, 46703, 6 females and 6 males, 147-299 mm SL, 41°49'N, 139°34.9'E, near Okushiri, 700-705 m, 7 June 1975; HUMZ 53056, female, 261 mm SL, 46°48'N, 141°33'E, Tatar Strait, 370 m, 26 Mar. 1976; HUMZ 53021, male, 282 mm SL, 46°43'N, 141°33'E, Tatar Strait, 375 m, 26 Mar. 1975; HUMZ 53614, male, 186 mm SL, 39°17.0'N, 135°03.5'E, Yamato Bank, Japan Sea, 375 m, 30 Mar. 1976; HUMZ 53701, female, 259 mm SL, 38°00'N, 136°42.8'E, near Hegurajima I., Japan Sea, depth unknown, 2 June 1976; HUMZ 53873, 53874, 1 female and 1 male, 246-257 mm SL, 39°53.0'N, 133°47.0'E, Yamato Bank, 519 m, 11 June 1976; HUMZ 53914, female, 251 mm SL, 38°07.5'N, 136°52.2'E, near Hegurajima I., depth unknown, 18 June 1975.

Diagnosis. A *Careproctus* with simple, conical teeth; gill opening extending ventrally in front of 1-4 pectoral fin rays; disk length 11.3-16.3% of head length; when fresh body dusky with bluish black fins and peritoneum silvery with dark pigmentation; stomach blackish.

Description. Counts: Dorsal 58-62, anal 52-57, pectoral 31-37, caudal 8-9, vertebrae 10-11+54-58=64-68, pyloric caeca 23-35, cephalic pores 2-6-7-2.

Morphometry: Head length 20.0-24.9% SL, body depth 19.5-27.5, head width 51.0-66.0; snout length 30.8-38.5% HL, eye diameter 16.4-22.4, interorbital width 49.1-64.0, upper jaw length 38.5-50.0, lower jaw length 38.5-51.4, length of upper lobe of pectoral fin 63.1-87.5, length of lower lobe of pectoral fin 87.7-128.1, gill opening length 29.6-40.0, snout to disk length 43.1-64.0, snout to anus length 61.0-84.9, mandible to disk length 32.3-50.0, mandible to anus length 60.0-80.4, disk to anus length 4.8-22.0, disk length 11.3-16.3.

Body long, slender. Skin thick, covered with cactus-like prickles. Gelatinous tissue thick beneath skin. Rudimentary pores forming two rows on each side of body: upper row only above anterior curve of lateral line; lower row forming lateral line from behind suprabranchial pores to caudal fin.

Head small; its upper profile descending steeply to snout. Snout short, deep. Eye moderately large. Nostril in a short tube, almost on a level with lower margin of pupil. Mouth horizontal; maxillary reaching below posterior margin of eye. Teeth small, conical, arranged in 16-23 oblique rows in moderately wide bands on both jaws. Outer teeth simple, smaller than inner teeth. Cephalic pores small. Anterior mandibular pores separated from each other. Gill opening moderately large, extending ventrally in front of 1-4 pectoral fin rays. Opercular flap round, supported by two spines extending horizontally; tip of upper spine almost on a level with middle of eye.

Pectoral fin deeply notched; its uppermost fin ray on a horizontal between lower margin of orbit and posterior corner of maxillary. Upper lobe of pectoral fin reaching behind a vertical through origin of anal fin. Lower lobe of pectoral fin long, reaching almost origin of anal fin; its rays 5-7 in number, largely free from fin membrane. Pectoral symphysis located almost below anterior margin of eye. Origin of dorsal fin above tip of opercular flap. Origin of anal fin below 7th-9th dorsal fin ray. Anterior dorsal and anal fins buried in thick gelatinous layer. Caudal fin round, continuous with vertical fins for two-fifths to one-half of its length. Ends of dorsal and anal fins not forming notches on caudal fin.

Disk small, round, deeply cupped; its margin thin. Disk almost located below eye. Anus immediately behind anus with a small conical anal papilla in males.

Stomach large. Pyloric caeca long, pointed, located on left side of body cavity.

Body color when fresh dusky, faintly pinkish, darker on top of head; posterior parts of dorsal, anal and pectoral fins and caudal fin bluish black; eye and peritoneum silvery. In alcohol pinkish color faded; eye black; oral and branchial cavities, peritoneum and pyloric caeca pigmented; stomach blackish.

Distribution. The Japan Sea, the Tatar Strait and the Okhotsk Sea at depths of 185 to 785 m.

Remarks. This species closely resembles *C. rastrinus*. See the remarks of the latter.

***Careproctus nigricans* Schmidt**
 (New Japanese name : Yogore-konnyakuuo)
 (Fig. 51)

Careproctus nigricans Schmidt, in Tarantet, 1937 : 137 (nomen nudum); Schmidt, 1950 : 213, fig. 20, pl. 19 (original description; between Iona I. and Cape Elizaveta and northeast of Cape Elizaveta, northwestern Okhotsk Sea, in 500-525 m); Quast and Hall, 1972 : 28.

Material examined. Syntypes: ZIL 24478, ca. 95 mm, 102 mm SL, 55°40'N, 143°04'E, northwestern Okhotsk Sea, depth 500 m, 19 Aug. 1932, radiograph only.

Other material: 4 specimens: HUMZ 71090, 71092, 71139, 3 females, 183-209 mm SL, 45°09'N, 144°31'E, southern Okhotsk Sea, 1000 m, 29 Oct. 1977; HUMZ 77742, female, 228 mm SL, 44°27.5'N, 144°30'E, off Okhotsk coast of Hokkaido, 1300-1340 m, 24 Sep. 1978.

Diagnosis. A *Careproctus* with small disk, its diameter 12.4-14.4% of head length; length of lower lobe of pectoral fin 43.8-59.7% of head length; dorsal fin rays 57-61; anal fin rays 51-55; pectoral fin rays 29-32; pyloric caeca 18-25; peritoneum black; stomach pale.

Description. Counts: Dorsal 57-61, anal 51-55, pectoral 29-32, caudal 8-10,

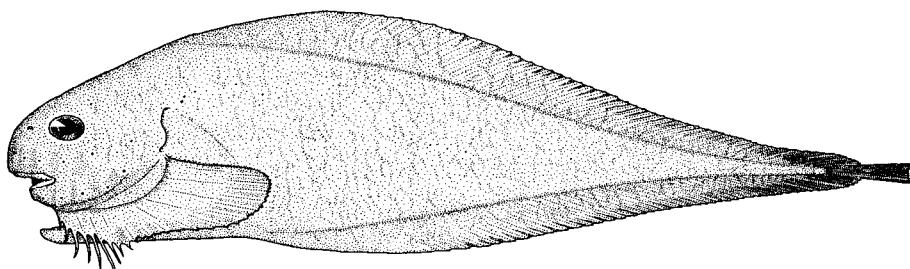


Fig. 51. *Careproctus nigricans* Schmidt, HUMZ 77742, 228 mm SL, from off Okhotsk coast of Hokkaido.

vertebrae $9-10+52-58=62-67$, pyloric caeca 18-25, cephalic pores 2-6-7-2.

Morphometry : Head length 18.0-19.9% SL, body depth 15.3-23.6, head width 9.3-9.6; snout length 8.8-33.0% HL, eye diameter 20.4-24.0, interorbital width 23.9-35.2, upper jaw length 36.5-39.7, lower jaw length 33.0-38.5, length of upper lobe of pectoral fin 62.6-80.0, length of lower lobe of pectoral fin 43.8-59.7, gill opening length 20.0-31.4, snout to disk length 43.1-50.9, snout to anus length 61.7-71.8, mandible to disk length 27.0-33.1, mandible to anus length 43.8-60.0, disk to anus length 8.0-11.5, disk length 12.4-14.4.

Body greatly compressed, slender, descending slowly to caudal fin. Skin smooth, lacking prickles. Gelatinous tissue thin beneath skin. Rudimentary pores forming three rows on each side of body : upper row extending from nape to anterior dorsal fin rays ; middle row only above anterior curve of lateral line ; lower row forming lateral line from behind suprabranchial pores to caudal fin.

Head small, compressed ; upper profile of head descending slowly to snout, then retracting to mouth. Snout projecting anteriorly to lower jaw by a distance about equal to one-half to two-thirds of eye diameter. Interorbital region narrow. Eye moderately large. Nostril in a short tube, on a level with middle of eye. Mouth inferior ; maxillary extending below posterior margin of pupil. Teeth simple, arranged in 12-14 oblique rows in moderately wide bands on both jaws. Some large inner teeth with faint lobes. Outer teeth simple, smaller than inner teeth. Anteriormost pair of mandibular series separated from each other. Gill opening moderately large, wholly above pectoral fin. Opercular flap round, supported by two spines extending horizontally ; tip of upper spine on a level with lower margin of eye.

Pectoral fin shallowly notched ; its uppermost fin ray placed between lower margin of orbit and posterior corner of maxillary. Upper lobe of pectoral fin extending slightly behind origin of anal fin. Lower lobe of pectoral fin short with 5-6 rays, about half length of head, reaching below gill opening. Pectoral symphysis below anterior margin of orbit. Origin of dorsal fin above gill opening. Origin of anal fin below 7th-8th dorsal fin ray. Anterior dorsal and anal rays buried in gelatinous layer. Caudal fin slightly emarginate, confluent with vertical fins for about two-fifths of its length.

Disk small, triangular, deeply cupped, smaller than eye diameter ; its margin

thick, elevated. Disk located below eye. Anus immediately behind disk with a prominent genital papilla in males.

Stomach and pyloric caeca located on left side of body cavity. Stomach small. Pyloric caeca long, pointed.

Body color when fresh purplish indigo with red color in anterior portion; posterior pectoral, dorsal, anal and caudal fins black. In alcohol red color faded; body with scattered dark pigments; oral and branchial cavities and peritoneum black; stomach and pyloric caeca pale.

Reaching 209 mm SL.

Distribution. The Okhotsk Sea at depths of 500 to 1340 m.

Remarks. This species closely resembles *C. bathycoetus* from the Okhotsk Sea in having a greatly compressed and slender body, projecting snout, small disk, and similar counts of dorsal and anal fin rays and vertebrae, but differs from the latter in having more pectoral and caudal fin rays and pyloric caeca (22, 7 and 9 in the latter (Stein, 1978a)).

This species has been known from the northwestern Okhotsk Sea. The present HUMZ specimens provide the second record of this species and the first record from Japan, and extend the known range to the south.

Careproctus colletti Gilbert
(Japanese name: Arasuka-bikunin)
(Figs. 52, 53)

Careproctus colletti Gilbert, 1895: 442 (original description; south of Alaska Peninsula, Albatross station 3338, in 1144 m); Jordan and Evermann, 1896: 425; Jordan and Evermann, 1898: 2131; Jordan and Gilbert, 1899: 478; Gilbert and Burke, 1912b: 370, fig. 12, pl. 46 (northern Japan Sea and southern Okhotsk Sea); Jordan et al., 1913: 308; Burke, 1930: 142, figs. 66, 67 (eastern Bering Sea); Jordan et al., 1930: 402; Soldatov and Lindberg, 1930: 375; Tarantet, 1937: 137; Okada and Matsubara, 1938: 347; Lindberg, 1947: 194; Schmidt, 1950: 216; Honma, 1952: 224; Wilimovsky, 1954: 287; Matsubara, 1955: 1195; Mori, 1956b: 30 (near Oki I., Japan Sea); Ueno, 1971: 98; Quast and Hall, 1972: 28; Fedorov, 1973: 67; Kido, 1983b: 297, pl. 177 (southern Okhotsk Sea); Kido, 1984: 340, pl. 305.

Careproctus entomelas Gilbert and Burke, 1912b: 374, fig. 17, pl. 47 (original description; off Cape Benkei and west of Tsuruga, Japan Sea, Albatross stations 4838, 4983, in 264-783 m); Burke, 1930: 145, fig. 68; Soldatov and Lindberg, 1930: 373; Tarantet, 1937: 137; Okada and Matsubara, 1938: 348; Lindberg, 1947: 194; Matsubara, 1955: 1195; Lindberg, 1959: 255; Ueno, 1971: 98; Kido, 1984: 340, pl. 35.

Careproctus entargyreus Gilbert and Burke, 1912b: 375, fig. 18, pl. 47 (original description; Tatar Strait, Albatross stations 4998, 5003, in 64-121 m); Burke, 1930: 146, fig. 69; Soldatov and Lindberg, 1930: 377; Tarantet, 1937: 137; Okada and Matsubara, 1938: 348; Lindberg, 1947: 194; Matsubara, 1955: 1195; Ueno, 1971: 98; Kido, 1984: 340, pl. 365.

Careproctus puniceus Mori, 1955: 2, figs. 2, 3 (original description; off Kyogasaki, Japan Sea, in 300-500 m).

Careproctus cryptacanthoides Schmidt, in Lindberg, 1959: 255 (nomen nudum); Ueno, 1971: 98; Krasyukova, 1984: 15, fig. 8 (original description; Aniwa Bay).

Material examined. 32 specimens: HUMZ 42770, female, 355 mm SL, 42°01.0'N, 139°37.0'N, near Okushiri I., Japan Sea, depth 655 m, 6 June 1975; HUMZ 46215, 46216, 2 males, 306-324 mm SL, 55°51'N, 162°17'E, off eastern coast of Kamchatka, 287-300 m, 16 May 1975;

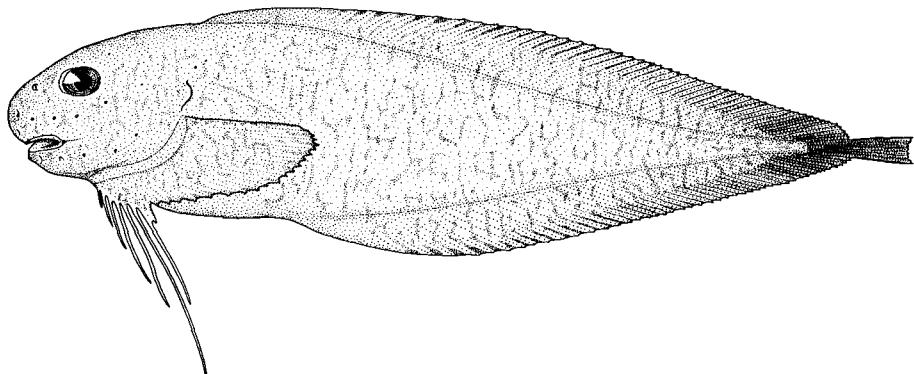


Fig. 52. *Careproctus colletti* Gilbert, HUMZ 49065, 194 mm SL, from southern Okhotsk Sea.

HUMZ 49065, female, 194 mm SL, 45°32.5'N, 143°50'E, southern Okhotsk Sea, 345-395 m, 9 Oct. 1975; HUMZ 52974, female, 346 mm SL, 47°38'N, 141°31'E, northern Japan Sea, 145 m, 25 May 1976; HUMZ 53058, female, 338 mm SL, 46°43'N, 141°33'E, northern Japan Sea, 375 m, 26 May 1976; HUMZ 68148, female, 371 mm SL, 44°31'N, 140°17'E, northern Japan Sea, 315-330 m, 16 May 1975; HUMZ 71091, male, 313 mm SL, 45°09'N, 144°31'E, off Okhotsk coast of Hokkaido, 1000 m, 29 Oct. 1977; HUMZ 77575, 77576, 77587, 77744, 77810, 77961, 78862, 78871, 78872, 79722-79728, 7 females and 9 males, 138-258 mm SL, 44°18.7'N-44°49'N, 144°24'E-145°03.5'E, off Okhotsk coast of Hokkaido, 915-1350 m, 12 Sep. 1978-2 Nov. 1978; HUMZ 80788, female, 397 mm SL, off Kaga, Ishikawa Pref., Japan Sea, ca. 500 m, Sep.-Oct. 1978; HUMZ 81257, male, 288 mm SL, 45°20'N, 140°23'E, off Okhotsk coast of Hokkaido, 404 m, 13 June 1979; HUMZ 81980, female, 282 mm SL, 55°10'N, 167°00'W, Bering Sea, 830 m, 16 June 1979; HUMZ 82001, 82912, 83037, 86100, 86112, 4 females and 1 specimen of unknown sex, 128-289 mm SL, 58°32.04'N-60°48.3'N, 176°06.35'W-179°10.8'W, 261-609 m, 26 June 1979-27 July 1979.

Diagnosis. A *Careproctus* with long, slender and lanceolate teeth in broad bands; outer teeth almost similar in length to inner teeth; snout projecting; length of lower lobe of pectoral fin 108.9-175.0% of head length (in specimens more than 128 mm SL); pectoral fin rays 25-31; pyloric caeca 10-18; peritoneum black or dusky.

Description. Counts: Dorsal 51-58, anal 47-52, pectoral 25-31, caudal 8-9, vertebrae 10-11+49-55=59-65, pyloric caeca 10-18, cephalic pores 2-6-7-2.

Morphometry: Head length 16.0-23.8% SL, body depth 18.9-30.7, head width 9.3-15.0; snout length 32.2-43.2% HL, eye diameter 16.5-25.0, interorbital width 42.2-56.0, upper jaw length 38.1-48.4, lower jaw length 35.4-47.6, length of upper lobe of pectoral fin 59.2-88.7, length of lower lobe of pectoral fin 108.9-175.0, gill opening length 15.0-23.7, snout to disk length 47.4-68.3, snout to anus length 71.7-104.5, mandible to disk length 38.0-56.0, mandible to anus length 61.7-92.7, disk to anus length 4.3-21.2, disk length 15.0-30.5.

Body elongate, deepest at origin of dorsal fin, then gradually tapering to caudal fin. Skin smooth, lacking prickles. Gelatinous tissue thick beneath skin. Rudimentary pores present in no discernible pattern.

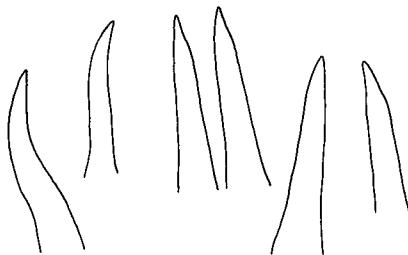


Fig. 53. Premaxillary teeth of *Careproctus colletti*, HUMZ 78862. Bar is 0.5 mm.

Head stout; its upper profile descending slowly to snout, then retracting to mouth. Snout blunt, deep, projecting anteriorly to lower jaw. Eye moderately large. Nostril in a short tube, on a level with middle of eye. Mouth horizontal; maxillary reaching below middle of eye. Teeth long, slender, lanceolate (Fig. 53), forming wide bands arranged in 16-30 oblique rows on both jaws. Outer teeth almost similar in length to inner teeth. Cephalic pores small. Anteriormost pair of mandibular pores separated from each other. Gill opening short, wholly above pectoral fin. Opercular flap round, supported by two spines; tip of upper opercular spine on a level with lower margin of orbit.

Pectoral fin deeply notched; its uppermost fin ray on a horizontal between lower margin of orbit and posterior corner of maxillary. Upper lobe of pectoral fin reaching or not reaching a vertical through origin of anal fin. Lower lobe of pectoral fin long with 5-8 rays, reaching or reaching behind origin of anal fin when depressed; its rays largely free from fin membrane. Pectoral symphysis below middle of eye. Origin of dorsal fin almost above gill opening. Origin of anal fin below 6th-8th dorsal fin ray. Anterior dorsal and anal rays buried in thick gelatinous layer. Caudal fin emarginate, continuous with vertical fins for two-fifths of its length. Ends of dorsal and anal fins not forming notches on caudal fin.

Disk round or oval, cupped with narrow margin; its diameter almost equal to eye diameter. Anus separated from posterior margin of disk by a distance less than disk length, located below or anteriorly to a vertical through gill opening; a prominent long genital papilla present in males.

Stomach moderately large. Pyloric caeca long, pointed, located on left side of body cavity.

Body color when fresh pink with scattered dark pigments; lips dusky; posterior pectoral, dorsal, anal and caudal fins black. In alcohol pinkish color faded in most specimens; oral and branchial cavities and peritoneum black or dusky; stomach and pyloric caeca pale.

Attaining 397 mm SL.

Distribution. The Japan, Okhotsk and Bering Seas and the Gulf of Alaska at depths of 64 to 1350 m.

Remarks. *C. entomelas* was originally described by Gilbert and Burke (1912b) based on two small specimens (larger specimen: holotype, 70 mm SL) from the Japan Sea. They and Burke (1930) suggested that *C. entomelas* is closely related to

C. colletti, but it differs from the latter in having deeper body, longer projecting snout, lighter coloration, shorter lower lobe of pectoral fin and thumbtack prickles. The former three differences are easily recognizable as intraspecific variations of *C. colletti*. Burke (1930) reported that lower lobe of pectoral fin does not reach beyond anus in a small specimen of *C. colletti*. This shows that the lower lobe of pectoral fin varies with growth in *C. colletti*. The lower lobe of pectoral fin in *C. entomelas* reaches little beyond anus (Burke, 1930). Thus, in this character *C. entomelas* does not significantly differ from *C. colletti*. The presence of thumbtack prickles is useless to distinguish species. Prickles are a sexual dimorphic character found in *Careproctus roseofuscus* and *Crystallichthys matsushima*. *C. colletti* and *C. entomelas* are thus conspecific.

C. entargyreus was also described by Gilbert and Burke (1912b) based on two small specimens (smaller specimen : holotype, 57 mm SL). They and Burke (1930) suggested that *C. entargyreus* is closely related to *C. entomelas* and differs from it in having less black pigments in peritoneum and smaller pupil. Melanophores in the peritoneum, however, increase with growth in *Liparis fabricii* Krøyer (Able and McAllister, 1980), and intraspecific variation in the peritoneum color are recognized in *C. colletti*, *C. roseofuscus* and *C. mederi*. The size of pupil varies due to constriction and expansion of iris in *C. rastrinus* (Y. Sakurai, pers. comm.) and preserved several species (pers. ob.). *C. entargyreus* and *C. entomelas* are thus conspecific, and *C. entargyreus* is a junior synonym of *C. colletti*.

Mori (1955) described *Careproctus puniceus* based on a single specimen (328 mm SL) taken from the southern Japan Sea. The specimen is apparently lost (M. Katayama, pers. comm.). Mori stated that *C. puniceus* is related to *C. colletti* and differs from it in having fewer number of fin rays, compressed head, deeper body, shorter lower lobe of pectoral fin and different coloration. These differences, however, are almost included in intraspecific variation of *C. colletti*. The only prominent difference is in body depth (39% of SL in *C. puniceus* against 18.9–30.7% in *C. colletti*). This difference may reflect development of gonad in the holotype of *C. puniceus* because prominent expansion of belly in the specimen is shown in the original description (Mori, 1955 : fig. 3), or may result from incorrect measurement due to thick gelatinous layer. *C. puniceus* seems to be a junior synonym of *C. colletti*.

Careproctus cryptacanthoides was originally described by Krasyukova (1984) based on the Schmidt's manuscript. The species, however, is the same species as *C. colletti* because no significant differences are found between the two.

Careproctus roseofuscus Gilbert et Burke
(Japanese name : Tobi-bikunin)
(Fig. 54)

Careproctus roseofuscus Gilbert and Burke, 1912b : 369, fig. 11, pl. 45 (original description ; southern Okhotsk Sea, Albatross stations 5018, 5026, in 183–218 m) ; Jordan et al., 1913 : 307 ; Burke, 1930 : 141, fig. 65 ; Soldatov and Lindberg, 1930 : 375 ; Tarantsov, 1937 : 137 ; Okada and Matsubara, 1938 : 347 ; Schmidt, 1950 : 215 (southern Okhotsk Sea) ; Matsubara, 1955 : 1195 ; Ueno, 1971 : 98 ; Quast and Hall, 1972 : 29 ; Kido, 1983b : 297, pl. 178 (southern Okhotsk Sea) ; Kido, 1984 : 340, pl. 305.

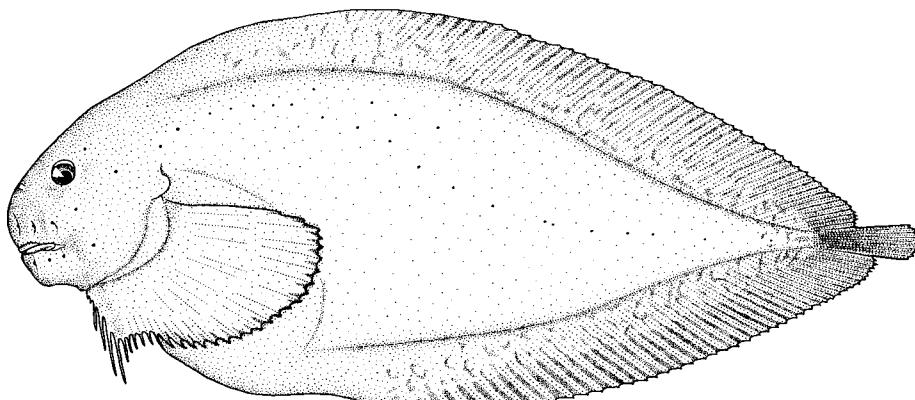


Fig. 54. *Careproctus roseofuscus* Gilbert et Burke, HUMZ 49063, 282 mm SL, from off Okhotsk coast of Hokkaido.

Careproctus rostrinus Gilbert et Burke : Hikita, 1981 : 74, fig. (misspelled).

Material examined. 26 specimens: HUMZ 33959, 33962, 33988, 2 females and 1 male, 304-346 mm SL, 44°45'N-45°02.5'N, 144°04.3'E-144°05.0'E, off Okhotsk coast of Hokkaido, depth 220-235 m, 31 Oct. 1974; HUMZ 46249, female, 273 mm SL, 55°24'N, 154°25'E, off western coast of Kamchatka, 370-410 m, 9 May 1975; HUMZ 46262, 46351, 1 female and 1 male, 275-333 mm SL, 44°25'N-44°26.5'E, 144°07'E-144°17.5'E, off Okhotsk coast of Hokkaido, 210-400 m, 3 July 1975; HUMZ 46355, 46356, 2 males, 326-329 mm SL, 54°05'N, 154°40'E, off western coast of Kamchatka, 162-172 m, 8 May 1975; HUMZ 49063, male, 282 mm SL, 45°19'N, 143°51'E, off Okhotsk coast of Hokkaido, 285-365 m, 7 Oct. 1975; HUMZ 57693, 57696, 57698, 2 females and 1 specimen of unknown sex, 253-283 mm SL, 57°26'N, 149°16'E, northern Okhotsk Sea, 220 m, 11 Sep. 1976; HUMZ 57717, male, 296 mm SL, 57°06'N, 154°42'E, off western coast of Kamchatka, 296 m, 14 Sep. 1976; HUMZ 57748, 57749, 258-275 mm SL, 1 female and 1 male, 58°35'N, 148°56'E, northern Okhotsk Sea, 127 m, 25 Sep. 1976; HUMZ 58964, 58967, 2 females, 306-312 mm SL, 55°32'N, 138°08'E, northern Okhotsk Sea, 85 m, 7 Sep. 1976; HUMZ 60365, female, 328 mm SL, 56°37'N, 143°35'E, northern Okhotsk Sea, 240 m, 22 Sep. 1976; HUMZ 68071, female, 202 mm SL, 44°31'N, 140°17'E, northern Japan Sea off Hokkaido, 315-330 m, 16 May 1977; HUMZ 68422, 332 mm SL, 44°53'N, 144°19'E, off Okhotsk coast of Hokkaido, 152-153 m, 2 July 1977; HUMZ 75924, male, 306 mm SL, 44°57.2'N, 144°24.0'E, off Okhotsk coast of Hokkaido, 440-450 m, 28 June 1978; HUMZ 77594, 77597, 77610, 78699, 78702, 2 females and 3 males, 232-346 mm SL, 44°31'N-44°49'N, 144°20'E-144°28'E, off Okhotsk coast of Hokkaido, depth unknown, 20 Sep. 1978-2 Nov. 1978.

Diagnosis. A *Careproctus* with long, slender and lanceolate teeth in broad bands; outer teeth almost similar in length to inner teeth; length of lower lobe of pectoral fin 45.8-62.5% of head length; disk length 26.5-38.5% of head length; pectoral fin rays 30-35; peritoneum black or dusky.

Description. Counts: Dorsal 51-59, anal 44-50, pectoral 30-35, caudal 8-10, vertebrae 11-13+45-53=57-65, pyloric caeca 17-31, cephalic pores 2-6-7-2.

Morphometry: Head length 18.2-25.3% SL, body depth 27.7-44.1 (mean 34.1), head width 8.7-14.1; snout length 31.5-47.6% HL, eye diameter 13.5-19.3, interorbital width 39.1-48.4, upper jaw length 36.1-43.8, lower jaw length 32.8-40.4, length

of upper lobe of pectoral fin 73.5-90.9, length of lower lobe of pectoral fin 45.8-62.5, gill opening length 17.6-26.6, snout to disk length 53.1-72.1, snout to anus length 95.3-134.4, mandible to disk length 42.4-57.7, mandible to anus length 87.5-119.3, disk to anus length 7.8-32.9, disk length 26.5-38.5.

Body deep, compressed. Skin smooth, lacking prickles; but a specimen (HUMZ 49063) having thumbtack prickles. Gelatinous tissue thick beneath skin. Rudimentary pores forming three rows on each side of body; upper row extending from nape to anterior dorsal fin rays; middle row only above anterior curve of lateral line; lower row forming lateral line from behind suprabranchial pores to caudal fin.

Head compressed; its upper profile descending steeply to snout. Snout deep, slightly projecting anteriorly to lower jaw. Nostril in a moderately long tube, on a level with lower margin of orbit. Eye small. Mouth horizontal, small; maxillary reaching below middle of eye. Teeth long, slender, lanceolate, forming wide bands arranged in 12-18 oblique rows on both jaws. Outer teeth almost similar in length to inner teeth. Cephalic pores small. Anteriormost pair of mandibular pores separated from each other. Gill opening short, wholly above pectoral fin. Opercular flap round, supported by two spines; tip of upper opercular spine on a level with lower margin of orbit.

Pectoral fin shallowly notched; its uppermost fin ray on a horizontal between lower margin of orbit and posterior corner of maxillary. Upper lobe of pectoral fin round, reaching a vertical through origin of anal fin. Lower lobe of pectoral fin composed of 5-7 rays, short, reaching behind anus when depressed. Pectoral symphysis below posterior margin of orbit. Origin of dorsal fin above gill opening. Origin of anal fin below 7th-10th dorsal fin ray. Anterior dorsal and anal rays buried in thick gelatinous layer. Caudal fin broad, round, continuous with dorsal fin for two-fifths and with anal fin for three-fifths of its length. Ends of dorsal and anal fins forming small notches on caudal fin.

Disk relatively large, round, flat or cupped with broad margin. Anus separated from posterior end of disk by a distance about equal to eye diameter, located almost below gill opening; a small conical genital papilla present in males.

Stomach large. Pyloric caeca long, pointed, located on left side of body cavity.

Body color when fresh pink; lips reddish; posterior parts of pectoral, dorsal, anal and caudal fins black. In alcohol pinkish color faded in most specimens; oral and branchial cavities, stomach and pyloric caeca pale; peritoneum black or dusky.

Reaching 346 mm SL.

Distribution. The Okhotsk Sea at depths of 85 to 450 m.

Remarks. This species is similar to *C. colletti* in dentition. It is easily distinguishable from the latter, however, by its deeper body (18.9-30.7 (mean 23.7)% of SL in the latter) and shorter lower lobe of pectoral fin (110.0-175.0% of head length).

9. GENUS *Paraliparis* Collett (Japanese name: Inkiuo-zoku)

Paraliparis Collett, 1874 : 32 (Type-species *Paraliparis bathybia* Collett, 1879, by monotypy); Günther, 1887 : 68; Garman, 1892 : 80; Goode and Bean, 1896 : 279; Jordan and

- Evermann, 1898 : 2139 ; Burke, 1930 : 154 ; Soldatov and Lindberg, 1930 : 382 ; Stein, 1978a : 37.
- Rhodichthys* Collett, 1879 : 99 (type-species *Rhodichthys regina* Collett, 1879, by monotypy) ; Collett, 1880 : 153 ; Andriashev, 1954 : 466 ; Stein and Able, 1986 : 1282.
- Amitra* Goode, 1881 : 478 (type-species *Amitra liparina* Goode, 1881, by monotypy) ; Goode and Bean, 1896 : 277 ; Jordan and Evermann, 1898 : 2138.
- Monomitra* Goode, 1884 : 109 (replaced *Amitra*, preoccupied by *Amitrus* Schoenherr, 1840, Coleoptera : Insecta).
- Gymnolycodes* Vaillant, 1888a : 40 (type-species *Gymnolycodes edwardsi* Vaillant, 1888, by monotypy) ; Goode and Bean, 1896 : 281.
- Rhinoliparis* Gilbert, 1895 : 445 (type-species *Rhinoliparis barbulifer* Gilbert, 1895, by original designation) ; Jordan and Evermann, 1898 : 2145 ; Burke, 1930 : 185 ; Stein, 1978a : 32.
- Hilgendorfia* Goode and Bean, 1896 : 280 (type-species *Paraliparis membranaceus* Günther, 1887, by monotypy).
- Amitrichthys* (subgenus) Jordan and Evermann, 1896 : 453 (type-species *Paraliparis cephalus* Gilbert, 1892, by original designation).
- Elassodiscus* Gilbert and Burke, 1912a : 81 (type-species *Elassodiscus tremebundus* Gilbert et Burke, 1912, by original designation) ; Burke, 1930 : 154 ; Soldatov and Lindberg, 1930 : 381 ; Stein, 1978a : 26.
- Acantholiparis* Gilbert and Burke, 1912a : 83 (type-species *Acantholiparis opercularis* Gilbert et Burke, 1912, by original designation) ; Burke, 1930 : 188 ; Soldatov and Lindberg, 1930 : 383 ; Grinols, 1969 : 1237 ; Stein, 1978a : 35.
- Lipariscus* Gilbert, 1915 : 358 (type-species *Lipariscus nanus* Gilbert, 1915, by original designation) ; Burke, 1930 : 194 ; Stein, 1978a : 29.
- Eutelichthys* Tortonese, 1959 : 226 (type-species *Paraliparis leptochirus* Tortonese, 1959, by designation).

Diagnosis. Disk absent. Nostril single. Branchiostegals rays six, five in one species. Gill opening not restricted to front of pectoral fin, starting above pectoral fin. Barbels, if present, only on snout.

10. KEY TO SPECIES OF *PARALIPARIS*

- 1a. Snout with two barbels *P. barbulifer* (Gilbert)
- 1b. Snout without barbels 2
- 2a. Branchiostegal rays five *P. nanus* (Gilbert)
- 2b. Branchiostegal rays six 3
- 3a. Mouth oblique. Origin of uppermost pectoral fin ray located below lower tip of lower jaw *P. mandibularis* Kido
- 3b. Mouth horizontal. Origin of uppermost pectoral fin ray located above or on a level with posterior corner of maxillary 4
- 4a. Teeth on jaws uniserial, in bands only at symphysis *P. rosaceus* Gilbert
- 4b. Teeth on jaws in bands only 5
- 5a. Teeth large, blunt, rounded at ends. Dorsal fin rays more than 70 or fewer than 54, anal fin rays more than 63 or fewer than 47, vertebrae more than 74 or fewer than 59 6
- 5b. Teeth small, conical or canine. Dorsal fin rays 58-64, anal fin rays 54-58, vertebrae 64-69 7
- 6a. Dorsal fin rays 52-53, anal fin rays 46, pectoral fin rays ca. 22-26, vertebrae 57-58 *P. atramentatus* Gilbert et Burke

- 6b. Dorsal fin rays 71-82, anal fin rays 64-76, pectoral fin rays 31-39, vertebrae 75-86 *P. grandis* Schmidt
- 7a. Stomach pale. Caudal fin rays 8 *P. meridionalis* Kido
- 7b. Stomach black. Caudal fin rays fewer than 7 8
- 8a. Pectoral fin rays 12 *P. dipterus* sp. nov.
- 8b. Pectoral fin rays 17-21 9
- 9a. Dorsal fin rays 63-64, anal fin rays 56-58, pectoral fin rays 20-21, caudal fin rays 6, vertebral 69 *P. entochloris* Gilbert et Burke
- 9b. Dorsal fin rays 58, anal fin rays 54, pectoral fin rays 17, caudal fin rays 4, vertebral 64 *P. melanobranchus* Gilbert et Burke

***Paraliparis barbulifer* (Gilbert)**

(Japanese name : Shirohige-konnyakuuo)
(Fig. 55)

Rhinoliparis barbulifer Gilbert, 1895 : 445 (original description ; north of Unalaska I., Bering Sea, Albatross stations 3227, 3325, 3326 and 3329-3332, in 412-1054 m) ; Jordan and Evermann, 1896 : 453 ; Jordan and Evermann, 1898 : 2145 ; Evermann and Goldsborough, 1907 : 334 ; Gilbert and Burke, 1912b : 379 (off east coast of Sakhalin, Pacific off Hokkaido and off Oshika Peninsula (northeast coast of Honshu)) ; Jordan et al., 1913 : 310 ; Burke, 1930 : 185, fig. 102 (off California) ; Jordan et al., 1930 : 405 ; Schultz, 1936 : 189 ; Schultz and Delacy, 1936 : 136, 215 ; Tarantza, 1937 : 139 ; Okada and Matsubara, 1938 : 348 ; Schmidt, 1950 : 215 (Okhotsk Sea) ; Wilimovsky, 1954 : 287 ; Matsubara, 1955 : 1196 ; Willimovsky, 1958 : 80 ; Lindberg, 1959 : 255 ; Grinols, 1965 : 155 ; Ueno, 1971 : 98 ; Maruyama, 1971 : 66 ; Quast and Hall, 1972 : 32 ; Stein, 1978a : 33.

Material examined. 3 specimens from off Iwate Pref., Pacific off northeastern Honshu : HUMZ 103286, 103287, 1 female and 1 male, 45-55 mm SL, 39°23.4'N, 142°17.2'E, depth 500 m, 19 Jan. 1984 ; HUMZ 193288, 53 mm SL, female, 39°22.7'N, 142°18.4'E, 600 m, 17 Apr. 1984.

Diagnosis. A *Paraliparis* with two snout barbels ; teeth trilobed ; pectoral fin rays 18-20 ; caudal fin rays 3.

Description. Counts : Dorsal 63-65, anal 58, pectoral 18-20, caudal 3, vertebrae 9+59=68, pyloric caeca 8-9, cephalic pores 2-6-7-1.

Morphometry : Head length 24.0-24.4% SL, body depth 15.4-16.5, head width 13.1 (1 specimen) ; snout length 28.1-34.9% HL, eye diameter 29.4-30.5, upper jaw length 38.5-42.2, lower jaw length 31.2-33.6, length of upper lobe of pectoral fin 58.6 (1 specimen), length of lower lobe of pectoral fin 47.7-49.5, gill opening length 16.5-

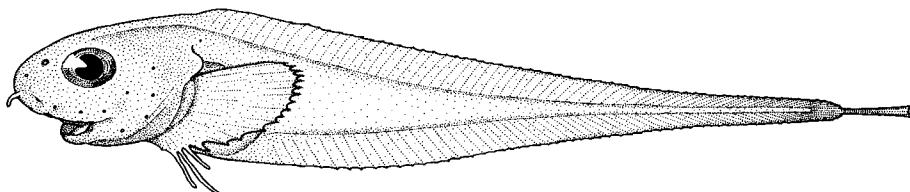


Fig. 55. *Paraliparis barbulifer* (Gilbert), HUMZ 103288, 53 mm SL, from Pacific off Iwate Prefecture, from Kido and Kitagawa (1986).

21.9, snout to anus length 88.1–93.0, mandible to anus length 57.8–60.6.

Body very slender, tapering very gradually to caudal fin. Skin lacking prickles. Rudimentary pores absent.

Head flattend, wider than deep. Snout projecting beyond upper lip for two-thirds of eye diameter with a pair of barbels. Nostril in a very short tube, located on a level with middle of pupil. Eye large. Mouth inferior; maxillary reaching below posterior margin of pupil. Teeth arranged in narrow bands consisting of about 10 rows on upper jaw and about 9 rows on the lower. Outer teeth simple, smaller than inner teeth. Inner teeth trilobed. Anteriormost pair of mandibular pores widely separated from each other. Gill opening extending down in front of 2 pectoral fin rays. Opercular flap round.

Pectoral fin deeply notched; its uppermost fin ray on a level with pupil. Upper lobe of pectoral fin with 13–15 rays, extending behind origin of anal fin. Notch bridged by 2–3 widely spaced rays. Lower lobe of pectoral fin with 3 rays, not reaching origin of anal fin. Origin of dorsal fin above posterior tip of opercular flap. Origin of anal fin below 7th or 8th dorsal fin ray. Caudal fin very slender.

Anus located below gill opening.

Stomach and pyloric caeca located on left side of body cavity. Stomach small. Pyloric caeca fat, short and bluntly pointed.

Body color in alcohol pale; posterior dorsal and anal fins and caudal fin sparsely pigmented; body musculature sparsely pigmented; oral and branchial cavities, peritoneum and stomach black; pyloric caeca pale.

Distribution. The Pacific off northern Honshu and Hokkaido, the Okhotsk and Bering Seas, Alaska and California at depths of 252 to 1054 m.

Remarks. This species is easily distinguishable from its congener, *P. attenuatus* (Burke), in having two barbels on snout, trilobed teeth (Burke, 1912, 1930; Stein, 1978a) and different counts of each fin rays and vertebrae (Kido and Kitagawa, 1986).

***Paraliparis nanus* (Gilbert)**
(Japanese name : Kobito-kusauo)
(Fig. 56)

Lipariscus nanus Gilbert, 1915 : 358, pl. 19 (original description; Monterey Bay, Albatross stations 4461, 4468, in 57–653 m); Burke, 1930 : 194, fig. 110; Jordan et al., 1930 : 401; Lindberg, 1959 : 255 (southern Okhotsk Sea); Quast, 1968 : 486 (southeastern Alaska); Ueno, 1971 : 98; Quast and Hall, 1972 : 31; Stein, 1978a : 29, fig. 19(a) (off British Columbia and Monterey Bay); Kido, 1984 : 341, pl. 366 (Bering Sea).

Material examined. 9 specimens from Bering Sea: HUMZ 77419, female, 56 mm SL, 54°33.5'N, 165°43.1'E, depth 390–398 m, 4 May 1978; HUMZ 82511, male, 42 mm SL, 58°32.44'N, 176°09.83'W, 497–539 m, 24 June 1979; HUMZ 82530, female, 58 mm SL, 55°46.61'N, 168°56.57'W, 830–890 m, 25 July 1979; HUMZ 82532–82534, 3 females, 52–62 mm SL, 56°28.87'N, 171°59.04'W, 533–560 m, 6 July 1979; HUMZ 83657, male, 56 mm SL, 54°50.74'N, 167°02.57'W, 280–315 m, 12 June 1979; HUMZ 83694, male, 59 mm SL, 58°33.91'N, 175°04.94'W, 895–910 m, 22 June 1979; HUMZ 93189, female, 52 mm SL, 58°21.9'N, 174°23.5'W, 470–695 m, 22 July 1981.

Diagnosis. A *Paraliparis* with five branchiostegal rays; gill opening wholly above pectoral fin; pectoral fin rays 12–14.

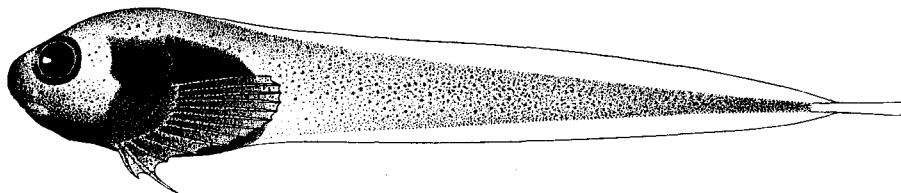


Fig. 56. *Paraliparis nanus* (Gilbert), holotype, USNM 75817, ca. 43 mm SL, from Monterey Bay, California, from Gilbert (1915).

Description. Counts: Dorsal 51-56, anal 48-52, pectoral 12-14, caudal 4, vertebrae 8-9+51-53=60-62, pyloric caeca 4-8, cephalic pores 2-6-7-1.

Morphometry: Head length 16.4-19.0% SL, body depth 9.2-20.8, head width 7.2-10.9; snout length 21.7-27.2% HL, eye diameter 23.3-35.0, interorbital width 23.9-39.8, upper jaw length 32.1-38.7, lower jaw length 28.4-37.4, length of upper lobe of pectoral fin 69.9-81.3, length of lower lobe of pectoral fin 44.1-68.9 (in females), 73.3-109.9 (in males), gill opening length 9.7-14.7, snout to anus length 69.2-89.2, mandible to anus length 57.1-71.7.

Body deepest at occipital region, then tapering slowly to caudal fin. Skin thin, fragile, lacking prickles.

Head small, compressed. Snout short, deep. Nostril not tubular, located just in front of eye. Eye large. Mouth small, inferior; maxillary reaching below center or posterior margin of pupil. Teeth small, conical, arranged in two rows anteriorly and one row posteriorly. Cephalic pores slightly enlarged. Anterior-most pair of mandibular pores separated from each other only by a septum. Gill opening short, wholly located above pectoral fin.

Pectoral fin moderately notched. Upper lobe of pectoral fin with 7-8 rays, reaching a vertical through origin of anal fin. Notch bridged by 2-3 widely spaced rays. Lower lobe of pectoral fin with 2-4 rays, not reaching origin of anal fin. Origin of dorsal fin posterior to a vertical through tip of opercular flap. Origin of anal fin below 5th-6th dorsal fin ray. Caudal fin narrow.

Anus located anteriorly to a vertical through gill opening.

Stomach and pyloric caeca located on left side of body cavity. Pyloric caeca short, bluntly pointed.

Body in alcohol transparent with scattered melanophores; body musculature with evenly distributed melanophores; oral and branchial cavities, peritoneum, stomach and pyloric caeca black.

Reaching 62 mm SL.

Distribution. The southern Okhotsk Sea, the Bering Sea, the southeastern Alaska, off British Columbia and Monterey Bay, at depths of 0 to 910 m.

Remarks. The present specimens from the Bering Sea have higher counts of dorsal and anal fin rays than those ever reported (40-52 and 37-49 (Stein, 1978a; Peden, 1981)).

Lindberg (1959) listed this species from the southern Okhotsk Sea without supplying information for specimens. Ueno (1971) cited this record. According to

these papers, Kido (1984) reported this species in the southern Okhotsk Sea. At present, the record from the southern Okhotsk Sea is of doubtful validity.

***Paraliparis mandibularis* Kido**
 (Japanese name : Ago-inkiuo)
 (Fig. 57)

Paraliparis mandibularis Kido, 1985a : 363, figs. 2-4 (original description ; Tosa Bay, in 605 m).

Material examined. Holotype : BSKU 30513, male, 107 mm SL, 32°58'N, 133°32'E, near Tosa Bay, depth 605 m, 21 Dec. 1979.

Other material : BSKU 22786, female, ca. 122 mm SL, 32°57.3'N, 133°33.6'E, near Tosa Bay, 707-750 m, 24 July 1974.

Diagnosis. A *Paraliparis* with oblique mouth ; origin of uppermost pectoral fin ray below a horizontal through lower (retroarticular) tip of lower jaw ; pectoral fin rays 27-30.

Description. Counts : Dorsal 60-61, anal 53-54, pectoral 27-30, caudal 6, vertebrae 9-10+56=65-66, pyloric caeca 6, cephalic pores 2-6-7-1.

Morphometry (from the holotype) : Head length 20.8% SL, body depth 16.3, head width 9.0 ; snout length 29.7% HL, eye diameter 27.5, upper jaw length 47.3, lower jaw length 47.3, gill opening length 45.9, snout to anus length 64.9, mandible to anus length 64.0.

Body long, greatly compressed, deepest just behind anus, then tapering slowly to caudal fin. Skin, fragile, lacking prickles. Rudimentary pores were not observed because of poor skin condition.

Head small, compressed ; its upper profile descending slowly to snout. Nostril in a short tube, located just anteriorly to orbit on a level with upper margin of eye. Eye large. Mouth large, oblique ; maxillary extending posteriorly to below nearly middle of eye. Teeth small, conical, arranged in irregular oblique rows forming narrow bands less than four teeth wide. Symphysis of mandible fitting in wide and toothless gap at juncture of both premaxillaries ; toothless gap at symphysis of mandible narrow. Cephalic pores small. Pores at mandible symphysis widely separated from each other. Gill opening very large, extending from a horizontal through lower margin of pupil to lower (retroarticular) tip of lower jaw, wholly located above pectoral fin. Opercular flap supported dorsally by two spines extending posteroventrally and ventrally by four branchiostegal rays reaching outline of

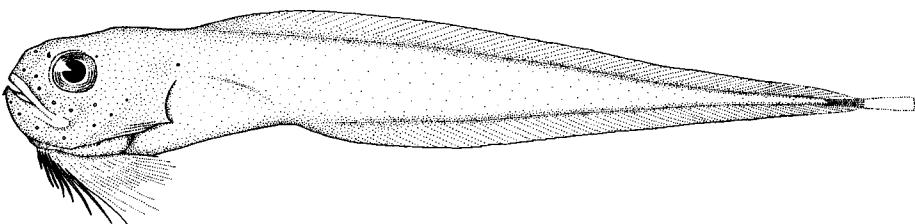


Fig. 57. *Paraliparis mandibularis* Kido, holotype, BSKU 30513, 107 mm SL, from near Tosa Bay, from Kido (1985a).

opercular flap. Upper opercular spine slightly broader than the lower ; tips of both spines on a level with posterior corner of maxillary.

Base of pectoral fin extending anteriorly ; its uppermost fin ray below a horizontal through ventral tip of lower jaw. All rays of pectoral fin closely spaced. Anteriormost three rays entirely free from fin membrane. Pectoral symphysis below middle of snout. Origin of dorsal fin slightly behind a vertical through tip of opercular flap. Origin of anal fin below almost 10th dorsal fin ray. Caudal fin narrow.

Anus located below posterior margin of orbit with a short and conical genital papilla.

Stomach relatively large. Pyloric caeca short, bluntly pointed and located on left side of body cavity.

Body color in alcohol pale ; posterior part of dorsal and anal fins dusky ; body musculature and oral and branchial cavities sparsely pigmented ; peritoneum black ; stomach and pyloric caeca pale.

Reaching ca. 122 mm SL.

Distribution. Known only from near Tosa Bay at depth of 605 to 750 m.

Remarks. This species is similar to *P. cephalus* Gilbert, *P. mento* Gilbert and *P. angustifrons* Garman from the North Pacific, *P. micrurus* (Barnard) from the Indian Ocean and *P. garmani* Burke from the North Atlantic in having the oblique mouth, but it is easily distinguishable from them (see Kido, 1985a).

***Paraliparis rosaceus* Gilbert**
 (Japanese name : Ao-inkiuo)
 (Fig. 58)

Paraliparis rosaceus Gilbert, 1890 : 93 (original description ; off southern California, Albatross station 2919, in 1801 m) ; Garman, 1892 : 80 ; Jordan and Evermann, 1898 : 2142 ; Burke, 1930 : 182, fig. 100 ; Jordan et al., 1930 : 404 ; Stein, 1978a : 41, fig. 11(c) (off Oregon, off central California and Gulf of California) ; Peden and Ostermann, 1980 : 215, fig. 3 (off British Columbia) ; Kido, 1983a : 382, figs. 9, 10 (southern Okhotsk Sea) ; Kido, 1983b : 301, pl. 182 ; Kido, 1984 : 340, pl. 305.

Paraliparis grandiceps Garman, 1899 : 117, pl. 29 (original description ; Gulf of California, Albatross station 3434, in 2906 m) ; Jordan et al., 1930 : 404 ; Burke, 1930 : 183, fig. 101.

Material examined. HUMZ 77743, 77802, 78816, 3 males, 287-309 mm SL, 44°25'N-44°56'N, 144°24'E-145°04'E, off Abashiri, Okhotsk coast of Hokkaido, depth 1050-1350 m, 8 Sep. 1978-11 Oct. 1978.

Diagnosis. A *Paraliparis* with small canine teeth in a single series and in bands only at symphysis on jaws ; head length 18.2-19.7% of SL ; pectoral fin rays 18-22.

Description. Counts : Dorsal 63-69, anal 57-60, pectoral 20-22, caudal 6, vertebrae 12-13+58-61=70-74, pyloric caeca 6-8, cephalic pores 2-6-7-1.

Morphometry : Head length 18.2-19.7% SL, body depth 21.4-23.5, head width 13.4-13.6 ; snout length 28.7-36.7% HL, eye diameter 17.0-20.9, interorbital width 40.5, upper jaw length 39.9-42.6, lower jaw length 38.2-40.5, length of upper lobe of pectoral fin 54.0-65.7, length of lower lobe of pectoral fin 58.8-76.2, gill opening length 15.2-16.9, snout to anus length 73.0-81.4, mandible to anus length 62.6-71.1.

Body stout, tapering slowly to caudal fin. Skin thin, fragile, lacking prickles. Gelatinous tissue thick except for caudal fin. Rudimentary pores forming lateral

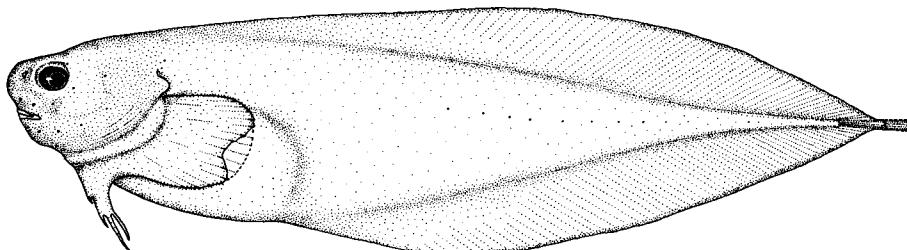


Fig. 58. *Paraliparis rosaceus* Gilbert, HUMZ 77743, 309 mm SL, from off Okhotsk coast of Hokkaido, from Kido (1983a).

line to caudal fin.

Head small, low, almost flat in interorbital region; its upper profile descending very slowly to snout, then abruptly to upper jaw. Snout low, slightly projecting. Nostril represented by raised rim on a level with pupil. Eye moderately large. Mouth slightly inferior, wide, horizontal; maxillary extending posteriorly to below middle of eye. Teeth short, small, relatively blunt, forming narrow bands composed of 2-5 oblique rows at symphysis, completely uniserial on posterior part of premaxillary and dentary. Cutting surface of premaxillary and dentary vary narrow. Pores at mandibular symphysis close to each other, but not in a common pit. Gill opening small, wholly above pectoral fin. Opercular flap supported by two spines recurved dorsally: upper opercular spine stronger than lower spine; its tip on a horizontal through pupil.

Pectoral fin deeply notched; its uppermost fin ray on a horizontal through lower margin of orbit. Upper lobe of pectoral fin with 13-15 rays, round, short, not reaching origin of anal fin. Notch bridged by 4 widely spaced rays. Lower lobe of pectoral fin with 3 rays somewhat longer than upper lobe; its rays abruptly increasing in length dorsally. Lower lobes of pectoral fin widely separated from each other. Origin of dorsal fin posterior to a vertical through opercular flap. Origin of anal fin below 9th-11th dorsal fin ray. Anterior dorsal and anal fin rays buried deeply in gelatinous tissue. Caudal fin narrow, continuous with dorsal and anal fins for about two-thirds of its length. Ends of dorsal and anal fins not forming notches on caudal fin.

Anus located between both lower lobes of pectoral fin with a small genital papilla in males.

Stomach very large. Pyloric caeca long, slender, located on left side of body cavity.

Body color when fresh bluish with faint pink; eye black; head, pectoral fin and posterior part of vertical fins black. In alcohol pinkish color faded; eye black; oral cavity dusky; branchial cavity and peritoneum black; stomach and pyloric caeca pale.

Reaching 400 mm SL (Peden and Ostermann, 1980).

Distribution. The Pacific off California and Oregon, British Columbia and off the Okhotsk coast of Hokkaido, at depths of 1050 to 3358 m.

Paraliparis atramentatus Gilbert et Burke
 (Japanese name : Inki-uo)
 (Figs. 59, 60)

Paraliparis atramentatus Gilbert and Burke, 1912b : 377, pl. 48 (original description ; off Cape Shionomisaki, east coast of Honshu, in 1188 m) ; Jordan et al., 1913 : 309 ; Burke, 1930 : 180, figs. 97, 98 ; Tarantet, 1937 : 138 ; Okada and Matsubara, 1938 : 348, pl. 85 ; Matsubara, 1955 : 1196 ; Maruyama, 1971 : 65 ; Kido, 1984 : 340, pl. 366 ; Kido, 1985a : 366, figs. 4, 7, 8 (Okinawa Trough, East China Sea) ; Yatou, 1985 : 603, pl. 376.

Material examined. Holotype : USNM 73345, male, 69 mm SL, 33°23'30"N, 135°34'E, off Cape Shionomisaki, east coast of Honshu, Albatross station 4971, depth 1188 m, 30 Aug. 1906, radiograph only.

Other material : BSKU 26438, female, 71 mm SL, 26°20.1'N, 124°50.7'E, Okinawa Trough, East China Sea, depth 1000-1140 m, 22 Jan. 1978.

Diagnosis. A *Paraliparis* with stout teeth with rounded tips on both jaws ; dorsal fin rays 52-53 ; anal fin rays 46, pectoral fin rays ca. 22-26 ; vertebrae 57-58.

Description. Counts : Dorsal 52-53, anal 46, pectoral ca. 22-26, caudal 8, vertebrae $10+47-48=57-58$, pyloric caeca 5-7, cephalic pores 2-6-?-?.

Morphometry : Head length 18.7% SL, head width 10.3 ; snout length 28.8% HL, eye diameter 28.0, upper jaw length 43.9, lower jaw length 41.7, length of lower lobe of pectoral fin 56.7, gill opening length 16.7.

Body long, greatly compressed, tapering slowly to caudal fin. Skin thin,

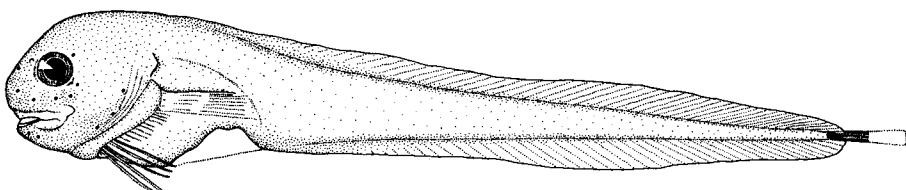


Fig. 59. *Paraliparis atramentatus* Gilbert et Burke, BSKU 26438, 71 mm SL, from Okinawa Trough, East China Sea, from Kido (1985a).

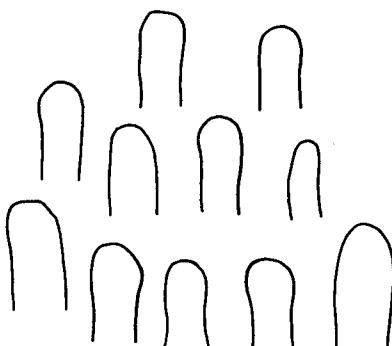


Fig. 60. Premaxillary teeth of *Paraliparis atramentatus*, BSKU 26438, from Kido (1985a). Bar is 0.5 mm.

fragile, lacking prickles. Rudimentary pores were not observed because of poor skin condition.

Head compressed; its upper profile descending steeply to snout. Snout short and deep, slightly projecting. Nostril with short tube, located in front of eye on a level with upper margin of pupil. Mouth slightly inferior, horizontal; maxillary extending posteriorly to below posterior margin of orbit. Teeth large, stout, rounded at tips (Fig. 60), forming moderately wide bands composed of 7 oblique rows on premaxillary and 8 rows on dentary. Cephalic pores small. Anteriormost pair of mandibular pores widely separated from each other. Gill opening small, wholly located above pectoral fin. Opercular flap round, supported by two spines extending posteroventrally; upper opercular spine nearly as broad as the lower; tips of both spines on a level with upper margin of pupil.

Pectoral symphysis below posterior margin of eye. Uppermost pectoral fin ray nearly on a level with lower margin of orbit. Upper lobe of pectoral fin almost reaching a vertical through origin of anal fin; rays of notch not distinguishable from those of upper and lower lobes; lower lobe of pectoral fin composed of 4 rays, shorter than upper lobe, reaching behind a vertical through tip of opercular flap. Origin of dorsal fin slightly behind a vertical through tip of opercular flap. Origin of anal fin below 9th dorsal fin ray. Caudal fin narrow.

Stomach and pyloric caeca located on left side of body cavity. Stomach small. Pyloric caeca short, bluntly pointed.

Body color in alcohol pale; snout and lips dusky; body musculature sparsely pigmented; oral cavity dusky; branchial cavity black; peritoneum black; stomach and pyloric caeca pale.

Reaching 71 mm SL.

Distribution. Known from off Cape Shionomisaki on the Pacific coast of Honshu and the Okinawa Trough in the East China Sea at depths of 1000 and 1188 m.

Remarks. Burke (1930: 37) reported that stomach of the holotype of *P. atramentatus* is black. Its stomach, however, is creamy white (Jeffrey T. Williams, pers. comm.) (Kido, 1985a).

Gilbert and Burke (1912b) described that the holotype has 20 pectoral fin rays. Though pectoral fin rays of the holotype are badly damaged, it may have about 22 pectoral fin rays (Jeffrey T. Williams, pers. comm.). I believe that pectoral fin rays in *P. atramentatus* vary from about 22 to 26, because other characters of the new specimen agree well with the original description (Kido, 1985a).

***Paraliparis grandis* Schmidt**
(Japanese name: Hira-inkiuo)
(Fig. 61)

Paraliparis grandis Schmidt, in Tarantet : 138 (nomen nudum); Schmidt, 1950 : 218, fig. 21, pl. 20 (original description; northern Okhotsk Sea, in 592 m); Quast and Hall, 1972 : 31; Kido, 1983a : 380, figs. 7, 8, 10 (southern Okhotsk Sea and off eastern coast of Kamchatka); Kido, 1983b : 303, pl. 183; Kido, 1984 : 340, pl. 305.

Material examined. 28 specimens: HUMZ 55196, 55198, 55200, 55201, 2 females and 2 males, 310–355 mm SL, 53°43'N, 160°33'E, Gulf of Kronotskii, eastern coast of Kamchatka,

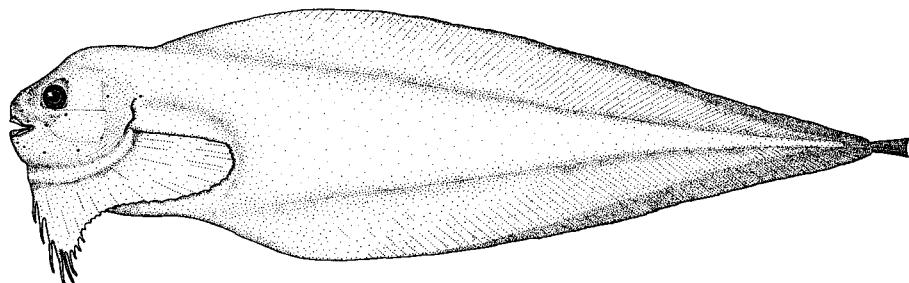


Fig. 61. *Paraliparis grandis* Schmidt, HUMZ 77658, 343 mm SL, from off Okhotsk coast of Hokkaido, from Kido (1983a).

depth 515-520 m, 20 May 1976; HUMZ 70924, 71131, 77585, 77593, 77642, 77657, 77658, 77679, 77812, 77813, 77953, 77955, 77957-77960, 78747, 78788, 78855-78858, 78860, 80126, 140-381 mm SL, 7 females and 16 males and 1 specimen of unknown sex, 44°11'N-45°09'N, 144°20.5'E-145°03.5'E, off Abashiri, Okhotsk coast of Hokkaido, 400-1000 m, 23 Oct. 1977-11 Oct. 1978.

Diagnosis. A *Paraliparis* with heavy teeth with rounded tips in 8-12 rows on both jaws; dorsal fin rays 71-82, anal fin rays 64-76; pectoral fin rays 31-39.

Description. Counts: Dorsal 71-82, anal 64-76, pectoral 32-39, caudal 7-8, vertebrae 10-11+65-74=75-86, pyloric caeca 25-41, cephalic pores 2-6-7-1.

Morphometry: Head length 14.5-19.3% SL, body depth 17.0-26.3, head width 8.6-12.2; snout length 26.4-34.4% HL, eye diameter 16.2-23.9, interorbital width 34.7-42.2, upper jaw length 36.5-43.1, lower jaw length 34.4-42.0, length of upper lobe of pectoral fin 69.4-88.9, length of lower lobe of pectoral fin 57.2-101.1, gill opening length 25.8-37.1, snout to anus length 38.1-66.4, mandible to anus length 37.9-59.0.

Body long, greatly compressed, deepest at occiput, then tapering slowly to caudal fin. Skin thin, fragile, smooth and lacking prickles. Rudimentary pores absent.

Head small; its upper profile descending steeply to snout. Snout projecting. Nostril with a short tube just anterior to eye on a level with mid-pupil. Eye moderately large. Mouth small, horizontal; maxillary extending posteriorly to below middle of eye. Teeth short, stout, rounded at tips, forming moderately wide bands of 8-12 oblique rows on both jaws. Outer teeth slightly smaller than inner teeth. Cephalic pores small. Anteriormost pair of mandibular pores closely spaced, located in the same pit. Gill opening small, extending ventrally in front of 1-4 pectoral fin rays. Opercular flap supported by two spines angled ventrally: upper opercular spine short, much broader than lower spine; its tip straight on a level with lower margin of orbit.

Pectoral fin notch moderately deep; its uppermost fin ray on a level with posterior corner of maxillary. Upper lobe of pectoral fin almost reaching origin of anal fin. Rays of notch about 10, not easily distinguishable from those of upper lobe. Lower lobe of pectoral fin with 4-6 rays extending to below gill opening or behind it when depressed. Symphysis of lower lobe of pectoral fin below anterior

margin of orbit, but in larger specimens more than about 300 mm SL position of symphysis shifted forward to below nostril with development of gonad; anterior-most pectoral rays of both sides connected by a fold of skin. Origin of dorsal fin slightly behind a vertical through gill opening. Origin of anal fin below 7th-10th dorsal fin ray. Caudal fin narrow, continuous with dorsal and anal fins for about two-fifths of its length. Ends of dorsal and anal fins not forming notches on caudal fin.

Anus located almost below eye with a long genital papilla in males.

Stomach and pyloric caeca located on left side of body cavity. Stomach small. Pyloric caeca long and slender.

Body color when fresh dusky pink; eye and fins black. In alcohol body pinkish or pale with melanophores densely scattered over body; eye and fins black; oral cavity dusky; branchial cavity and peritoneum black; stomach and pyloric caeca pale.

Attaining 381 mm SL.

Distribution. The northern and southern Okhotsk Sea and off the eastern coast of Kamchatka at depths of 400 to 1000 m.

Remarks. The counts of dorsal and anal fin rays of this species are the highest of all known *Paraliparis* species (Schmidt, 1950; Kido, 1983a), and vary widely (Kido, 1983a).

This species has similar teeth in shape to those of *P. atramentatus*, but differs distinctly from the latter in having more fin rays, vertebrae and pyloric caeca (Kido, 1983a).

***Paraliparis meridionalis* Kido**
(Japanese name : Ryukyu-inkiuo)
(Fig. 62)

Paraliparis meridionalis Kido, 1985a : 364, figs. 4-6 (original description; Okinawa Trough, East China Sea, in 600-932 m); Yatou, 1985 : 605, pl. 377.

Material examined. Holotype: BSKU 28687, female, 149 mm SL, 29°46.0'N, 127°59.0'E, Okinawa Trough, East China Sea, depth 610-713 m, 20 Mar. 1978.

Paratypes: BSKU 27875, male, 127 mm SL, 28°35.0'N, 127°10.0'E, Okinawa Trough, 600 m, 16 Mar. 1978; BSKU 28505, female, 146 mm SL, 29°44.0'N, 128°03.3'E, Okinawa Trough, 815 m, 20 Mar. 1978.

Other material. BSKU 28556, female, 143 mm SL, 29°49.0'N, 128°06.0'E, Okinawa Trough, 915-932 m, 20 Mar. 1978.

Diagnosis. A *Paraliparis* with conical teeth forming wide bands on both jaws; gill opening wholly above pectoral fin; dorsal fin rays 60-62; anal fin rays 54-56; pectoral fin rays 22-23; caudal fin rays 8.

Description. Counts: Dorsal 60-62, anal 54-56, pectoral 22-23, caudal 8, vertebrae $11+55-57=66-68$, pyloric caeca 5-7, cephalic pores 2-6-7-1.

Morphometry: Head length 17.4-18.8% SL, body depth 15.4-18.8, head width 9.3-9.9; snout length 25.6-29.6% HL, eye diameter 26.1-30.6, upper jaw length 46.2-48.2, lower jaw length 44.7-47.6, length of upper lobe of pectoral fin 68.7-73.9, length of lower lobe of pectoral fin 58.4-67.7, gill opening length 15.8-21.0, snout to anus length 84.7-96.9, mandible to anus length 82.1-90.1.

Body long, compressed, deepest at middle between anus and origin of anal fin.

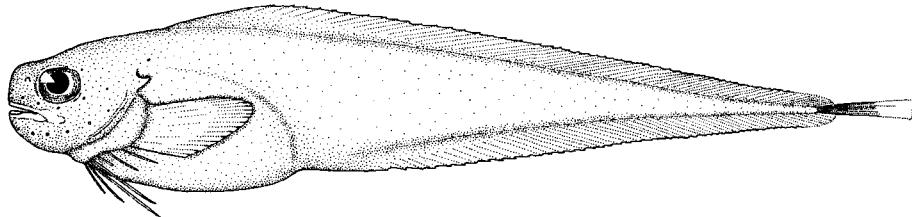


Fig. 62. *Paraliparis meridionalis* Kido, holotype, BSKU 28687, 149 mm SL, from Okinawa Trough, East China Sea, from Kido (1985a).

Almost all skin torn off.

Head small, compressed; its upper profile descending slowly to snout, then abruptly to upper jaw. Nostril with a short tube, located in front of eye on a level with middle of eye. Eye large. Mouth terminal and horizontal; maxillary extending posteriorly to below posterior margin of pupil. Teeth simple, small, conical. Tooth bands wide, composed of 16–18 oblique rows on premaxillary and 14–16 rows on dentary. Symphysial gap very narrow on both jaws. Cephalic pores small. Anteriormost pair of mandibular pores close to each other, but in the same pit. Gill opening small, wholly located above pectoral fin. Opercular flap triangular, supported by two spines recurved dorsally; upper opercular spine much broader than the lower; those tips nearly on a level with middle of eye.

Pectoral fin notch moderately deep; its uppermost fin ray nearly on a level with lower margin of orbit. Upper lobe of pectoral fin short with 14–16 rays, not reaching origin of anal fin; notch bridged by 4 widely spaced rays; lower lobe with 3 short rays, somewhat shorter than upper lobe, extending behind a vertical through tip of opercular flap. Pectoral symphysis below posterior margin of pupil. Origin of dorsal fin slightly behind a vertical through tip of opercular flap. Origin of anal fin below 10th–11th dorsal fin ray. Caudal fin narrow.

Anus located below gill opening.

Stomach large. Pyloric caeca short, bluntly pointed and located on left side of body cavity.

Body color when fresh dusky, semitransparent; eye and lower half of head jet black; peritoneum jet black through abdominal wall. Color of head in alcohol dusky; lips dusky; body musculature not pigmented; oral and branchial cavities dusky; peritoneum black; stomach and pyloric caeca pale.

Reaching 149 mm SL.

Distribution. Known only from the Okinawa Trough, the East China Sea, at depths of 600 to 932 m.

Remarks. This species is very similar to *P. rosaceus* Gilbert in most characters, but its pattern of dentition differs distinctly from that of the latter (see Kido, 1985a). Furthermore, it occurs in shallower depths than the latter (Kido, 1985a).

***Paraliparis dipterus* sp. nov.**
 (New Japanese name : Suruga-inkiuo)
 (Fig. 63)

Holotype. HUMZ 106666, female, 49 mm SL, off Ida, Suruga Bay, Pacific side of Honshu, depth 250 m, 15 Nov. 1985.

Diagnosis. A *Paraliparis* with 12 pectoral fin rays; rays of lower lobe of pectoral fin 2; gill opening extending ventrally in front of 3 rays; pyloric caeca absent.

Description. Counts: Dorsal 58, anal 54, pectoral 12, caudal 6, vertebrae 8+56=64, pyloric caeca 0, cephalic pores 2-6-7-1.

Morphometry: Head length 19.8% SL, body depth 21.2, head width 11.6; snout length 21.6% HL, eye diameter 29.9, upper jaw length 39.2, lower jaw length 38.1, length of upper lobe of pectoral fin 88.7, length of lower lobe of pectoral fin 101.0, gill opening length 30.9, snout to anus length 79.4, mandible to anus length 64.9.

Body long, greatly compressed, tapering slowly to caudal fin. Skin thin, fragile, lacking prickles. Rudimentary pores were not observed because of poor skin condition.

Head compressed; its upper profile descending steeply to snout. Snout short and deep. Nostril with raised rim, located on a level with upper margin of pupil. Mouth horizontal; maxillary extending below posterior margin of pupil. Teeth simple, small, conical. Tooth bands wide, composed of about 9 rows on both jaws. Cephalic pores small. Anterior pair of mandibular pores separated from each other. Gill opening moderately large, starting above pectoral fin, extending ventrally in front of 3 rays. Opercular flap triangular, supported by two spines recurved dorsally; upper opercular spine much broader than the lower; those tips nearly on a level with middle of eye.

Pectoral fin deeply notched; its uppermost fin ray nearly on a level with posterior corner of maxillary. Upper lobe of pectoral fin with 8 rays, reaching origin of anal fin. Rays of notch 2, not rudimentary, widely spaced. Lower lobe of pectoral fin with 2 rays; its upper ray long, reaching almost a vertical through origin of anal fin when depressed; both rays almost completely free from fin membrane except for their bases. Pectoral symphysis below middle of eye. Origin of dorsal fin well behind a vertical through tip of opercular flap. Origin of anal fin below 6th

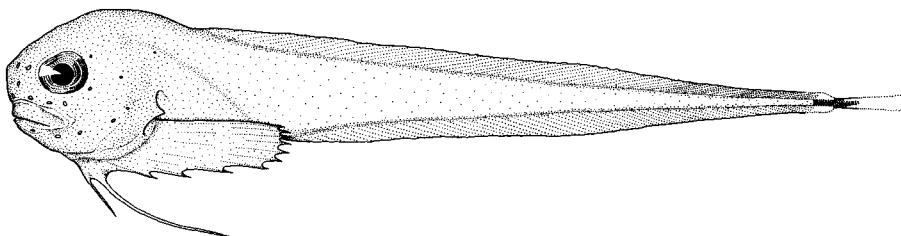


Fig. 63. *Paraliparis dipterus* sp. nov., holotype, HUMZ 106666, 49 mm SL, from Suruga Bay.

dorsal fin ray. Caudal fin extremely narrow.

Anus located below middle between posterior margin of eye and posterior tip of opercular flap.

Body color in alcohol pale, sparsely pigmented; body musculature scattered with pigments; snout, lips, chin and throat black; all fins dusky; oral and branchial cavities, peritoneum and stomach black.

Distribution. Known only from Suruga Bay on the Pacific side of Honshu at depth of 250 m.

Remarks. This species is similar to *P. melanobranchus* Gilbert et Burke from the southern Okhotsk Sea, which is known only from the holotype, in having the same number of dorsal and anal fin rays and vertebrae. It differs from the latter, however, in having fewer pectoral fin rays (17 in the latter), more caudal fin rays (4), gill opening extending down in front of 3 rays (gill opening wholly located above pectoral fin), longer lower lobe of pectoral fin (20% of SL against 11%) and lacking pyloric caeca (7).

Etymology. From the Greek di (two) and pteros (fin) in reference to the deeply notched pectoral fin.

***Paraliparis entochloris* Gilbert et Burke**

(Japanese name : Momoiro-inkiyo)

(Fig. 64)

Paraliparis entochloris Gibert and Burke, 1912b : 378, pl. 48 (original description; southern Okhotsk Sea, Albatross station 5018, in 183 m); Jordan et al., 1913 : 310; Burke, 1930 : 169, fig. 87; Taranetz, 1937 : 138; Okada and Matsubara, 1938 : 348; Schmidt, 1950 : 223; Matsubara, 1955 : 1196; Lindberg, 1959 : 255; Ueno, 1971 : 98; Quast and Hall, 1972 : 31; Kido, 1984 : 340, pl. 366.

Material examined. Holotype : USNM 73347, male, 85 mm SL, 46°41'30"N, 143°57'40"E, southern Okhotsk Sea, Albatross station 5018, depth 183 m, 26 Sep. 1906.

Paratype : CAS-SU 22381, sex unknown, 96 mm SL, collected with the holotype.

Diagnosis. A *Paraliparis* with simple and sharp teeth forming bands on both jaws; gill opening wholly located above pectoral fin; uppermost pectoral fin ray on a level with upper margin of pupil; dorsal fin rays 63-64; anal fin rays 56-58; pectoral fin rays 20-21; caudal fin rays 6; peritoneum and stomach black.

Description. Counts : Dorsal 63-64, anal 56-58, pectoral 20-21, caudal 6,

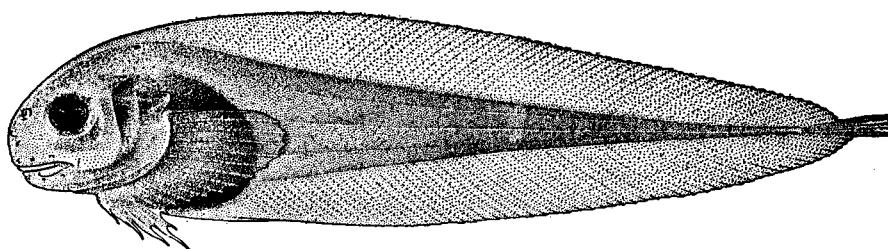


Fig. 64. *Paraliparis entochloris* Gilbert et Burke, holotype, USNM 73347, 85 mm SL, from southern Okhotsk Sea, from Gilbert et Burke (1912b).

vertebrae $9 + 58 - 60 = 67 - 69$, pyloric caeca 8, cephalic pores ?-?-?-1.

Morphometry (calculated from those shown by Gilbert and Burke (1912b)) : Head length 22.5% SL, body depth 20.0 ; snout length 26.7% HL, eye diameter 28.9, upper jaw length 44.4, length of upper lobe of pectoral fin 84.4, length of lower lobe of pectoral fin 62.2, gill opening length 13.3, snout to anus length 77.8.

Body long, compressed, deepest at origin of dorsal fin, then tapering slowly to caudal fin. Almost all skin torn off.

Head compressed ; its upper profile descending slowly to snout. Snout short, deep, not projecting. Nostril with short tube, located just in front of eye on a level with middle of eye. Mouth horizontal ; maxillary reaching below posterior margin of pupil. Teeth irregularly arranged in moderately wide bands on both jaws. Inner teeth enlarge, canine. Outer teeth small, conical. Cephalic pores small. Anteriormost pair of mandibular pores widely separated from each other. Gill opening small, wholly located above pectoral fin. Opercular flap supported by two spines recurved dorsally : upper opercular spine stronger than lower spine.

Uppermost pectoral fin ray on a level with lower margin of orbit. Upper lobe of pectoral fin reaching nearly a vertical through 6th anal fin ray. Pectoral symphysis located below posterior margin of orbit. Origin of dorsal fin above tip of opercular spine. Origin of anal fin below 6th-7th dorsal fin ray. Caudal fin narrow.

Stomach large. Pyloric caeca short, pointed, and located on left side of body cavity.

Body musculature sparsely pigmented ; oral cavity pale ; gill cavity, peritoneum, stomach and pyloric caeca black.

Distribution. Known only from the southern Okhotsk Sea at depth of 183 m.

Remarks. This species is most similar to *P. melanobranchus* Gilbert et Burke, which is known only from the holotype and also occurs in the southern Okhotsk Sea. New materials are needed to clarify the relationships between these two species, though at present they are easily separable from each other by the number of each fin ray and vertebrae.

***Paraliparis melanobranchus* Gilbert et Burke**
 (Japanese name : Tobi-inkiuo)
 (Fig. 65)

Paraliparis melanobranchus Gilbert and Burke, 1912b : 378, pl. 48 (original description ; southern Okhotsk Sea, Albatross station 5029, in 805 m) ; Jordan, 1913 : 309 ; Burke,

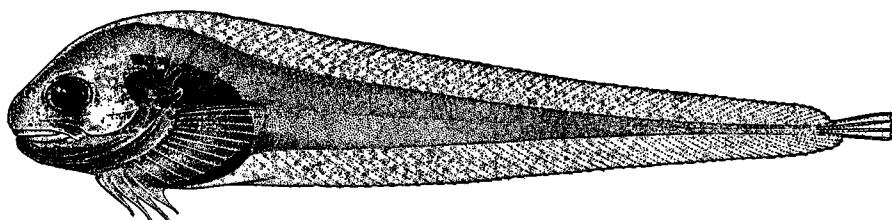


Fig. 65. *Paraliparis melanobranchus* Gilbert et Burke, holotype, USNM 73346, 76 mm SL, from southern Okhotsk Sea, from Gilbert et Burke (1912b).

1930 : 174, fig. 90 ; Taranetz, 1937 : 138 ; Okada and Matsubara, 1938 : 348 ; Schmidt, 1950 : 222 ; Matsubara, 1955 : 1196 ; Lindberg, 1959 : 255 ; Ueno, 1971 : 98 ; Quast and Hall, 1972 : 32 ; Kido, 1984 : 340, pl. 366.

Material examined. Holotype : USNM 73346, female, 76 mm SL, 48°22'30"N, 145°43'30"E, southern Okhotsk Sea, Albatross station 5029, depth 805 m, 28 Sep. 1906, radiograph only.

Diagnosis. A *Papaliparis* with simple teeth forming bands on both jaws ; gill opening wholly located above pectoral fin ; uppermost pectoral fin ray on a level with pupil ; dorsal fin rays 58 ; anal fin rays 54 ; pectoral fin rays 17 ; caudal fin rays 4 ; peritoneum and stomach black.

This species has been known only from the holotype. The following description is based on Gilbert and Burke (1912b), Burke (1930), Stein (1978a) and a radiograph of the holotype.

Description. Counts : Dorsal 58, anal 54, pectoral 17, caudal 4, vertebrae 9 + 55 = 64, pyloric caeca 7, cephalic pores 2-?-1.

Morphometry : Head length 22% SL, body depth 21, snout length 6, interorbital width 8, eye diameter 6, upper jaw length 9.5, length of upper lobe of pectoral fin 13, length of lower lobe of pectoral fin 11, gill opening length 3, snout to anus length 16.

Nostril in front of eye on a level with middle of eye. Maxillary reaching below posterior margin of eye. Teeth rather stout in broad bands of about 12 oblique rows ; inner teeth not enlarged or caninelike. Gill opening wholly above pectoral fin. Pectoral fin notched ; its fin ray on a level with pupil ; intervals between rays increasing downward. Upper lobe of pectoral fin reaching slightly behind origin of anal fin.

Skin transparent, sparsely pigmented ; body musculature dusted with pigments ; chin dusky ; oral and branchial cavities, peritoneum and stomach black.

Distribution. The southern Okhotsk Sea at depth of 805 m.

Remarks. This species closely resembles *P. entochloris*. See the remarks of the latter.

11. SUBFAMILY NECTOLIPARIDINAE

Diagnosis. Gill opening restricted to front of pectoral fin. Ethmoid cartilage and pterosphenoid not bridged by a narrow cartilage under frontal. An angle formed by two spines of subopercle about 160°. Third infraorbital extending to anterior margin of preopercle.

This subfamily includes only the monotypic genus *Nectoliparis* Gilbert et Burke.

12. GENUS *Nectoliparis* Gilbert et Burke (Japanese name : Kantenuo-zoku)

Nectoliparis Gilbert and Burke, 1912a : 82 (type-species *Nectoliparis pelagicus* Gilbert et Burke, 1912, by original designation) ; Burke, 1930 : 189 ; Soldatov and Lindberg, 1930 : 384 ; Stein, 1978a : 31.

Diagnosis. Disk absent. Nostril single. Branchiostegal rays five. Gill opening restricted to front of pectoral fin. Rudimentary pectoral fin rays present. Anus anterior to bases of lower lobe of pectoral fin (in specimens larger than 25 mm SL).

Nectoliparis pelagicus Gilbert et Burke

(Japanese name : Kanten-uo)

(Fig. 66)

Nectoliparis pelagicus Gilbert and Burke, 1912a : 82, fig. 27 (original description ; Bering Sea and central Okhotsk Sea, Albatross stations 4765, 4767, 4781, 4785 and 4800, in 549 m) ; Gilbert and Burke, 1912b : 380 (southern Okhotsk Sea and Pacific off Hokkaido) ; Gilbert, 1915 : 358 (off San Diego, off San Nicolas I. and Monterey Bay) ; Jordan et al., 1913 : 310 ; Burke, 1930 : 189, figs. 106-108 (southeastern Alaska) ; Jordan et al., 1930 : 402 ; Soldatov and Lindberg, 1930 : 384 ; Barnhart, 1936 : 71, fig. 225 ; Schultz, 1936 : 189 ; Schultz and Delacy, 1936 : 135, 215 ; Tarantza, 1937 : 139 ; Okada and Matsubara, 1938 : 348 ; Clemens and Wilby, 1949 : 306, fig. 228 (Sechelt inlet and English Bay) ; Schmidt, 1950 : 216 ; Follett, 1952 : 421 (off central California) ; Wilimovsky, 1954 : 287 ; Matsubara, 1955 : 1197 ; Lindberg, 1959 : 255 ; Pearcey, 1964 : 87 (off Oregon) ; Grinols, 1965 : 151 ; Bailey et al., 1970 : 60 ; Ueno, 1971 : 98 ; Quast and Hall, 1972 : 31 (southeastern Alaska) ; Hart, 1973 : 591 ; Stein, 1978a : 31, fig. 11(c) (off British Columbia, Puget Sound, off Oregon and Monterey Bay) ; Kido, 1984 : 340, pl. 366.

Material examined. 5 specimens : HUMZ 82507, 82509, 2 females, 42-51 mm SL, 58°32' 16"N, 176°09.83'E, eastern Bering Sea, depth 497-539 m, 24 June 1979 ; HUMZ 86533, 86534, 1 female and 1 male, 42-65 mm SL, 3 males off Iwaobetsu, Shiretoko Peninsula, Okhotsk coast of Hokkaido, 400-500 m, 20 July 1978 ; HUMZ 92708, female, 61 mm SL, 44°51'N, 144°25'E, off Okhotsk coast of Hokkaido, 380-440 m, 8 Oct. 1981.

Diagnosis. See diagnosis of the genus.

Description. Counts : Dorsal 54-58, anal 49-53, pectoral 20-24, caudal 4-6, vertebrae 11-12+51-55=63-66, pyloric caeca 6-9, cephalic pores 2-6-6-1.

Morphometry : Head length 19.1-22.1% SL, body depth 12.6-18.3, head width 9.3-11.7 ; snout length 21.7-26.2% HL, eye diameter 27.8-37.6, interorbital width 30.0-33.6, upper jaw length 35.7-40.0, lower jaw length 33.9-38.3, length of upper lobe of pectoral fin 48.9-80.0, length of lower lobe of pectoral fin 46.9-70.1, gill opening length 16.0-19.5, mandible to anus length 45.4-52.9.

Body relatively robust, tapering very gradually to caudal fin.

Head compressed ; its upper profile descending steeply to snout. Snout short, deep. Eye large. Nostril with a raised rim, on a level with middle of eye. Mouth slightly oblique ; maxillary reaching below pupil. Teeth small, conical in very narrow bands, forming oblique rows of up to 3 teeth and single row posteriorly on both jaws. Cephalic pores prominent. Anteriormost pair of mandibular pores closed together. Gill opening narrow, restricted front of pectoral fin.

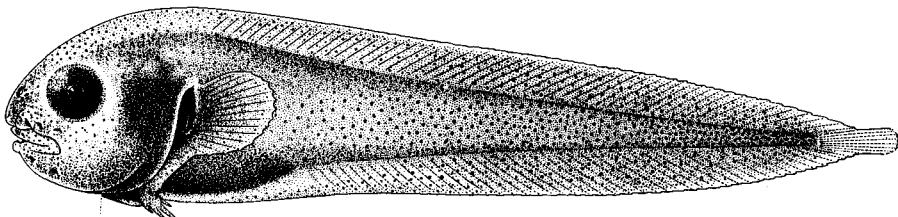


Fig. 66. *Nectoliparis pelagicus* Gilbert et Burke, holotype, USNM 74389, 28 mm SL, from between Attu and Medni Islands, Bering Sea, from Gilbert and Burke (1912a).

Pectoral fin divided into two distinct lobes. Gap between two lobes bridged by 3-5 widely spaced rudimentary rays. Upper lobe of pectoral fin consisting of 14-17 rays. Lower lobe consisting of 2-3 rays, shorter than or about equal to upper lobe. Origin of dorsal fin nearly above middle of upper lobe of pectoral fin. Origin of anal fin below 6th-8th dorsal fin ray.

Anus anterior to pectoral symphysis, located at throat.

Stomach large, located on left side of body cavity. Pyloric caeca stout, blunt.

Body color in alcohol pale, transparent, sparsely pigmented; body musculature scattered with pigments; oral and branchial cavities, peritoneum and stomach black; pyloric caeca pale.

Reaching 65 mm SL.

Distribution. The Pacific off Hokkaido, the Okhotsk Sea, the Bering Sea, the Gulf of Alaska, and the Pacific off Canada and the United States, at depths of 0 to 3383 m.

Remarks. Peden (1981) showed the broad ranges of dorsal and anal fin rays (44-56 and 40-51) in this species based on many specimens of the Bering Sea to California. The specimen (HUMZ 82507) from the Bering Sea has 58 dorsal and 53 anal fin rays. These counts extend their known ranges (44-58 and 40-53).

This species is one of midwater liparidid fishes (Gilbert and Burke, 1912a, b; Burke, 1930; Schmidt, 1950; Stein, 1978a; Peden, 1981). Two specimens (HUMZ 86533, 86534) were also captured at midwater by a plankton net.

13. DOUBTFUL SPECIES

Liparis sarasa (Tanaka)

(Japanese name : Sarasa-bikunin)

Careproctus sarasa Tanaka, 1916 : 174 (original description; Toba, Mie Pref.); Okada and Matsubara, 1938 : 346; Matsubara, 1955 : 1194.

Though this species has been reported as a species of *Careproctus*, it apparently belongs to *Liparis* because of the variegated coloration.

It was described on the basis of a single specimen which has not been found in the Department of Zoology, University Museum, University of Tokyo. Tanaka (1916) stated in the original description of *Careproctus punctulatus* (= *Liparis punctulatus*) that "this species is similar to *Careproctus sarasa* in general appearance, but differs from the latter only in having pectoral fin with notch." If the holotype of *L. sarasa* is abnormal in the pectoral fin, *L. sarasa* may be conspecific with *L. punctulatus*.

Liparis furcatus (Mori)

Careproctus furcatus Mori, 1956a : 17, figs. 3, 4 (original description; near Oki I., Japan Sea).

In the original description this species was placed in *Careproctus*, but it belongs to *Liparis* because of the variegated coloration.

This species was originally described based on a single specimen (248 mm TL) from near Oki Island, the Japan Sea. The specimen is apparently lost (M. Katayama, pers. comm.). Mori described the forked caudal fin as one of the diagnostic characters, but the caudal fin is apparently abnormal.

It is most similar to *L. latifrons*, but has the gill opening extending down in

front of 3 or 4 pectoral fin rays (6-12 in the latter). This minor difference may be meaningless in differentiating the two.

VIII. Summary

1. PHYLOGENY

Specimens of 60 species of the liparidid fishes from the Northern Hemisphere were used for the comparative anatomy. The following 11 skeletal parts of each specimen were examined: cranium, infraorbital bones, jaws, suspensorium and opercular apparatus, hyoid arch, branchial apparatus, pectoral girdle, vertebrae and their accessory bones, dorsal and anal fins, and caudal complex. In addition to skeletons, some external and internal characters were examined. Thirtyfour characters were selected and adopted to construct the cladogram. Character polarity was established by outgroup comparison following the method of Sawada (1982).

The monophyly of the family Liparidae is supported by five autapomorphies: the ethmoid cartilage forms a keel projecting anteriorly on dorsal midline; the ethmoid cartilage does not form a posterior expansion in the anterior portion of the orbit; there is a narrow cartilage which extends along the ventral ridge of the frontal in the dorsal orbital region of each side; the third infraorbital is needle-like in shape; and the retroarticular is connected with the epihyal by a well developed ligament, which is free from the interopercle.

Two subfamilies were established in the family Liparidae: Nectoliparidinae and Liparidinae. Nectoliparidinae includes only one genus, *Nectoliparis* (monotypic), and is defined by three autapomorphies and ten apomorphies. Liparidinae includes five genera: *Liparis*, *Crystallichthys*, *Careproctus*, *Osteodiscus* and *Paraliparis*, and is defined by only one apomorphy. The following genera previously established were synonymized: *Polypera* (with *Liparis*); *Crystallias* (with *Crystallichthys*); *Temnocora* (with *Careproctus*); and *Elassodiscus*, *Rhinoliparis*, *Acantholiparis*, *Rhodichthys* and *Lipariscus* (with *Paraliparis*).

The cladogram shows a major trend in the evolution of the liparidid fishes from the Northern Hemisphere: the reduction and loss of the disk related with the tendency towards elongation of the body, the reduction and loss of each bone, and replacement by the cartilaginous bone. The evolutional trend is closely related to the penetration from the inshore bottom into the great depths or midwater.

2. TAXONOMY

The liparidid fishes of 41 species in five genera were reviewed and described from waters around Japan. Three new species were described: *Careproctus dentatus*, *C. marginatus* and *Paraliparis dipterus*. *Careproctus mederi* and *C. nigricans* were described as the first records from Japan. The latter is also the second record of the species. Keys to subfamilies, genera and species were presented.

IX. Acknowledgments

I wish to express the deepest appreciation to Dr. Kunio Amaoka, my major professor of the Laboratory of Marine Zoology, Hokkaido University (HUMZ), for

his valuable advice and critical reading of the manuscript. Also, I wish to thank Drs. Takashi Minoda and Kenji Shimazaki, professors of the same university, for their critical readings of the manuscript. I wish to express my sincere gratitude to the late Dr. Takao Igarashi, my former professor, for his guidance in the course of this study.

I would like to express my sincere gratitude to Dr. Kazuhiro Nakaya, associate professor (HUMZ), and many fellow graduate students of our laboratory who helped me in various ways.

Special thanks are due to Dr. Mamoru Yabe (HUMZ), for invaluable discussions and giving his knowledge of the cottoid fishes, and Dr. David L. Stein of the College of Oceanography, Oregon State University (OSUO), for giving his valuable advice and information of the liparidid fishes, throughout the course of this study.

The following persons have generously given their help with this study by providing gifts, loans or information of specimens or accomodating me during visits : Messrs. Koji Abe, Mikio Koike, Shuka Maruyama, Jun Nakata, Shuichi Nishiuchi, Mitsuhiro Sano and Toshikatsu Sakamoto of the Hokkaido Fisheries Experimental Stations ; Dr. Anatole P. Andriashev and Mrs. V.P. Prirodina (ZIL) ; Drs. Ryoichi Arai and Keiichi Matsuura (NSMT-P) ; Dr. Marie L. Bauchot (MNHN) ; late Dr. Robert H. Gibbs, Jr., Drs. Stanley H. Weitzman, Jeffrey T. Williams, Janet Gomon and Susan L. Jewett (USNM) ; Drs. Tamotsu Iwai, Izumi Nakamura, Takashi Minami (presently Japan Sea Regional Fisheries Research Laboratory), Tetsuji Nakabo, Messrs. Minoru Tomiyama and Kiyotaka Hatooka (FAKU and FRSKU) ; Drs. Hiroshi Hatanaka, Kiyoshi Wakabayashi (presently Hokkaido Reg. Fish. Res. Lab.) and Mr. Hirotsume Yamaguchi (presently Hachinohe Branch, Tohoku Reg. Fish. Res. Lab.) (FSFL) ; Dr. Tomio Iwamoto (CAS) ; Dr. Robert K. Johnson (formerly FMNH, presently GMBL) ; Messrs. Shin-ichi Kanamaru and Takahiko Irie (presently Nansei Reg. Fish. Res. Lab.) of the Hokkaido Reg. Fish. Res. Lab. ; Dr. Masao Katayama, the former professor of Yamaguchi University ; Dr. Daiji Kitagawa of the Iwate Fisheries Experimental Station (presently Hachinohe Branch, Tohoku Reg. Fish. Res. Lab.) ; Dr. Karel F. Liem and Mr. Karsten E. Hartel (MCZ) ; Dr. Don E. McAllister (NMC) ; Dr. Jørgen Nielsen (ZMC) ; Dr. Han Nijssen (ZMA) ; Dr. M.J.P. van Oijen (RMNH) ; Drs. Osamu Okamura and Yoshihiko Machida (BSKU) ; Dr. Alex E. Peden and Mr. Grant W. Hughes (BCPM) ; Dr. Yasunori Sakurai of the Research Institute of North Pacific Fisheries of the same university ; Mr. Zen-ichi Sonoda of the Onahama Fisherman's Cooperative Association ; Dr. David L. Stein (OSUO) ; Mr. Alwyne Wheeler (BMNH) ; Dr. Norman J. Wilimovsky and Mr. Robert G. Carveth (BC) ; Dr. Richard Winterbottom (ROM) ; Drs. Yoshiaki Tominaga, Kenji Mochizuki and Mr. Masahiro Aizawa (ZUMT) ; Messrs. Osamu Otsuka, Fumito Tsuchiya, Ken Tsumura (presently Tokai University) and Shokichi Yoshida of the Niigata Fisheries Experimental Station.

This study was supported in part by grants from the Ito Foundation for the Advancement of Ichthyology.

X. Literature cited

- Abe, T. 1950. New, rare or uncommon fishes from Japanese waters. I. *Liparis franzi*, new name.

- Japan. J. Ichthyol.*, **1**(2) : 135-139.
- Abe, T. 1955. New, rare or uncommon fishes from Japanese waters. III. Description, redescription and records of rare fishes of the genus *Liparis*. *Bull. Biogeogr. Soc. Japan*, **16-19** : 319-325.
- Able, K.W. 1973. A new cyclopterid fish, *Liparis inquilinus*, associated with the sea scallop, *Placopecten magellanicus*, in the western North Atlantic, with notes on the *Liparis liparis* complex. *Copeia*, **1973**(4) : 787-794.
- Able, K.W. 1976. A new cyclopterid fish, *Liparis coheni*, from the western North Atlantic with notes on life history. *Ibid.*, **1976**(3) : 515-521.
- Able, K.W., D.F. Markle and M.P. Fahay. 1984. Cyclopteridae: development. Pages 428-437 in H.G. Moser, W.J. Richards, D.M. Cohen, M.P. Fahay, A.W. Kendall, Jr. and S.L. Richardson, eds. *Ontogeny and systematics of fishes based on an international symposium dedicated to the memory of Elbert Halvor Ahlstrom*. Amer. Soc. Ichthyol. Herpetol. Spec. Publ., (1).
- Able, K.W. and D.E. McAllister. 1980. Revision of the snailfish genus *Liparis* from Arctic Canada. *Can. Bull. Fish. Aquat. Sci.*, **208** : i-viii+1-52.
- Andriashev, A.P. 1953. Ancient deep-water and secondary deep-water fishes and their importance in a zoogeographical analysis. Pages 1-6 in *Notes on special problems in ichthyology*. Akad. Nauk SSSR, Ikhioi. Kom., Moscow, Leningrad. (In Russian, English translation in Bur. Comm. Fish., U.S. Fish Wildl. Ser.).
- Andriashev, A.P. 1954. *Fishes of the northern seas of the U. S.S.R.* 566 p. Zool. Inst. Akad. Nauk SSSR, Moskva-Leningrad. (Translated by Israel Program for Sci. Transl., Jerusalem, No. 836, 1964).
- Andriashev, A.P. 1955. A new fish of the lumpfish family (Pisces, Liparidae) from at a depth of more than 7 kilometers. *Trudy Inst. Okeanol.*, **12** : 340-344. (In Russian).
- Andriashev, A.P. 1975. A new ultra-abyssal fish *Nectoliparis kurchatovi* gen. et sp. n. (Liparidae) from the South Orkney Trench (Antarctic). *Ibid.*, **103** : 313-319. (In Russian with English summary).
- Andriashev, A.P. 1978. On the third species of the ultra-abyssal genus *Notoliparis* Andr. (Pisces, Liparidae) trawled from depths of the Macquarie Trench, and some notes on the zoogeographic and evolutionary significance of this fact. *Ibid.*, **112** : 152-161. (In Russian with English summary).
- Andriashev, A.P. 1979. On the occurrence of fishes belonging to the families Zoarcidae (*Apodolycus hureaui* gen. et sp. n.) and Liparidae (*Paraliparis operculosus* sp. n.) off Kerguelen Island. *Mar. Biol., Vladivostok* (6) : 28-34 (In Russian with English summary).
- Andriashev, A.P. 1980. A new liparid fish in McMurdo Sound. *Antarctic J., U.S.*, **15**(5) : 150.
- Andriashev, A.P. 1982a. New species of the genus *Paraliparis* (Liparidae) from the Western Antarctic. Report 2. *J. Ichthyol., U.S.S.R.*, **22**(2) : 179-186. (In Russian).
- Andriashev, A.P. 1982b. A review of fishes of the genus *Paraliparis* Collett (Liparidae) from the Kerguelen area, Subantarctic. *Zool. Zhurn.*, **61**(5) : 716-725. (In Russian with English summary).
- Andriashev, A.P. 1982c. Review of the genus *Paraliparis* (Liparidae) from the East Antarctic. *J. Ichthyol., U.S.S.R.*, **22**(4) : 531-542. (In Russian).
- Andriashev, A.P. 1986. *Revision of the snailfish genus Paraliparis (Scorpaeniformes: Liparidae) of the Southern Ocean.* iv+204 p. Theses Zoologicae, 7, Koeltz Scientific Books, Koenigstein, Federal Republic of Germany.
- Andriashev, A.P. and A.V. Neyelov. 1976. *Genioliparis lindbergi*, gen. et sp. n. -a new snailfish (Liparidae) from the bathyal depths of the Antarctic. Pages 68-77 in V.M. Korovina, eds. *Zoogeography and systematics of fishes*. Zool. Inst. Acad. Sci., U.S.S.R., Leningrad. (In Russian).
- Andriashev, A.P. and A.V. Neyelov. 1979. New species of the genus *Paraliparis* (Liparidae) from the Western Antarctic. *J. Ichthyol., U.S.S.R.*, **19**(1) : 10-19. (In Russian).
- Andriashev, A.P., A.V. Neyelov and V.P. Prirodina. 1977. On the method of studying the morphology and systematics of snailfishes (Liparidae). *Zool. Zhurn.*, **56**(1) : 141-147. (In Russian with English summary).
- Bailey, R.M., J.E. Fitch, E.S. Herald, E.A. Lachner, C.C. Lindsey, C.R. Robins and W.B. Scott. 1970. *A list of common and scientific names of fishes from the United States and Canada.* Third ed. 150 p. Amer. Fish. Soc. Spec. Publ., Bethesda.

- Barnhardt, P.S. 1936. *Marine fishes of southern California.* iv+209 p. Univ. Calif. Press, Berkeley.
- Berg, L.S. 1940. Classification of fishes, both recent and fossil. *Trav. Inst. Zool. Acad. Sci. URSS*, **5**(2) : 87-345. (In Russian).
- Boulenger, G.A. 1904. *Fishes (systematic account of the Teleostei).* Pages 541-727 in S.F. Harmer and A.E. Shipley, eds. *The Cambridge Natural History.* Vol. 7. MacMillan and Co. Ltd, London.
- Burke, C.V. 1912. A new genus and six new species of fishes of the family Cyclogasteridae. *Proc. U.S. Natn. Mus.*, **43**(1941) : 567-574.
- Burke, C.V. 1930. Revision of the fishes of the family Liparidae. *Bull. U.S. Natn. Mus.*, **150** : 1-204.
- Chyung, M.-K. 1961. *Illustrated encyclopedia. The fauna of Korea (2). Fishes.* 861 p., 309 pls. Ministry of Education of Korea, Seoul. (In Korean).
- Clemens, W.A. and G.V. Wilby. 1949. Fishes of the Pacific coast of Canada. Rev. ed. *Bull. Fish. Res. Bd. Can.*, **68** : 1-368.
- Cohen, D.M. 1960. Notes on a small collection of liparid fishes from the Yellow Sea. *Proc. Biol. Soc. Wash.*, **73** : 15-20.
- Collett, R. 1879. Fiske fra Nordhavs-Expeditionens sidste Togt, Sommeren 1878. *Forh. Vidensk.-Selsk. Christ.*, **1878**(14) : 1-106.
- Collett, R. 1880. *Fiske, Zoologi, Norske Nordhavs-Expedition 1876-1878.* 165 p., 5pls. Christiania, Norway.
- Collette, B.B. and J.L. Russo. 1984. Morphology, systematics, and biology of the Spanish mackerels (*Scomberomorus*, *Scombridae*). *Fish. Bull., U.S.*, **82**(4) : 545-692.
- Dingerkus, G. and L.D. Uhler. 1977. Enzyme clearing of alcian blue stained whole small vertebrates for demonstration of cartilage. *Stein Technol.*, **52**(4) : 229-232.
- Eschmeyer, W.N., E.S. Herald, H. Hamman and K.P. Smith. 1983. *A field guide to Pacific coast fishes of North America from the Gulf of Alaska to Baja California.* xii+336 p., 48pls. Houghton Mifflin Co., Boston.
- Evermann, B.W. and E.L. Goldsborough. 1907. The fishes of Alaska. *Bull. U.S. Bur. Fish.*, **26** : 219-360, pls. 14-42.
- Fedorov, V.V. 1973. A list of the Bering Sea fishes. *Izv. Tikhookean. Nauchno-Issled. Inst. Rybn. Khoz. Okeanogr.*, **87** : 42-71. (In Russian).
- Follett, W.I. 1952. Annotated list of fishes obtained by the California Academy of Sciences during six cruises of the U.S.S. Mulberry conducted by the United States Navy off central California in 1949 and 1950. *Proc. Calif. Acad. Sci., Ser. 4*, **27**(16) : 399-432, pls. 21-26.
- Franz, V. 1910. Die japanischen Knochenfische der Sammlungen Haberer und Doflein. In Beiträge zur Naturgeschichte Ostasiens. *Abhand. math. phys. Klasse K. Bayer. Akad. Wiss.*, **4**, Suppl. -Bd., **1** : 1-135, pls. 1-11.
- Garman, S. 1892. The Discoboli. *Mem. Mus. Comp. Zool. Harvard Coll.*, **14**(2) : 1-96, pls. 1-13.
- Garman, S. 1899. Reports on an exploration off the west coasts of Mexico, Central and South America, and off the Galapagos Islands, in charge of Alexander Agassiz, by the U.S. Fish Commission steamer "Albatross," during 1891, Lieut. Commander Z.L. Tanner U.S.N., commanding. XXVI. The fishes. *Ibid.*, **24** : 1-431, pls. 1-97.
- Gilbert, C.H. 1890. A preliminary report on the fishes collected by the steamer Albatross on the Pacific coast of North America during the year 1889, with descriptions of twelve new genera and ninety-two new species. *Proc. U.S. Natn Mus.*, **13**(797) : 49-126.
- Gilbert, C.H. 1895. Ichthyological collections of the United States Fish Commission steamer Albatross during the years 1890 and 1891. *Rep. U.S. Comm. Fish.*, **19** : 393-476, pls. 20-35.
- Gilbert, C.H. 1915. Fishes collected by the United States fisheries steamer "Albatross" in southern California in 1904. *Proc. U.S. Natn. Mus.*, **48**(2075) : 305-380, pls. 14-22.
- Gilbert, C.H. and C.V. Burke. 1912a. Fishes from Bering Sea and Kamchatka. *Bull. U.S. Bur. Fish.*, **30** : 31-96.
- Gilbert, C.H. and C.V. Burke. 1912b. New cyclogasterid fishes from Japan. *Proc. U.S. Natn. Mus.*, **42**(1907) : 351-380, pls. 41-48.
- Gill, T. 1865. Synopsis of the cyclopteroids of eastern North America. *Proc. Acad. Nat. Sci. Philad.*, **16** : 189-194.

- Gill, T. 1889. On the classification of the mail-cheeked fish. *Proc. U.S. Natn. Mus.*, **11**: 567-592.
- Gill, T. 1891. On the relations of the Cyclopteridae. *Ibid.*, **13**(834): 361-376, pls. 28-30.
- Gill, T. 1907. The lump sucker: its relationships and habits. *Smithson. Misc. Coll.*, **50**: 175-194.
- Goode, G.B. 1881. Fishes from the deep-water on the south coast of New England, obtained by the United States Fish Commission in the summer of 1880. *Proc. U.S. Natn. Mus.*, **3**: 467-486.
- Goode, G.B. 1884. The generic names *Amitra* and *Thyris* replaced. *Ibid.*, **6**: 109.
- Goode, G.B. and T.H. Bean. 1896. *Oceanic ichthyology*. xxxv+533 p., 123 pls. Smithson. Inst., U.S. Natn. Mus., Washington.
- Greenwood, P.H., D.E. Rosen, S.H. Weitzman and G.S. Myers. 1966. Phylogenetic studies of teleostean fishes, with a provisional classification of living forms. *Bull. Amer. Mus. Nat. Hist.*, **131**(4): 339-456, pl. 21-23.
- Grey, M. 1956. The distribution of fishes found below a depth of 2000 meters. *Fieldiana Zool.*, **36**(2): 75-337.
- Grinols, R.B. 1965. Check-list of the offshore marine fishes occurring in the northeastern Pacific Ocean, principally off the coasts of British Columbia, Washington, and Oregon. 217 p. M. S. Thesis, Univ. Washington.
- Grinols, R.B. 1969. A new species of *Acantholiparis* (Pisces: Liparidae) from the eastern subarctic Pacific region, with distribution notes for the genus. *J. Fish. Res. Bd. Can.*, **26**(5): 1237-1242.
- Gronovius, L.T. 1760. Animalium in Belgio Habitantium. *Acta Helvetica*, **4**: 243-270.
- Günther, A. 1861. *Catalogue of the fishes in the British Museum*. Vol. 3. xxv+586 p. Taylor and Francis, London.
- Günther, A. 1887. Report on the deep-sea fishes collected by H.M.S. Challenger during the years 1873-1876. *Rep. Sci. Res. Exp. Voy. H.M.S. Challenger, Zool.*, **22**: i-lxv+1-335, pls. 1-73.
- Hart, J.L. 1973. Pacific fishes of Canada. *Bull. Fish. Res. Bd. Can.*, **180**: i-ix+1-740, pls. 1-8.
- Hikita, T. 1951. Fishes of Volcano Bay in Hokkaido. *Japan J. Ichthyol.*, **1**(5): 306-313. (In Japanese).
- Hikita, T. 1981. The fishes from eastern waters and rivers of the Shiretoko Peninsula in Hokkaido, Japan. *Sci. Rep. Hokkaido Salmon Hatchery*, (35): 57-88, pls. 1-5. (In Japanese).
- Hikita, T. and H. Misu. 1952. The bottom fishes of the northern Japan Sea. *Rep. North Japan Sea Fish. Res. Comm.*, (3): 5-70, pls. 1-15. (In Japanese).
- Honma, Y. 1952. A list of the fishes collected in the Province of Echigo including Sado Island. *Japan. J. Ichthyol.*, **2**(4-5): 220-229. (In Japanese).
- Honma, Y. 1956. A list of the fishes in the vicinity of Sado Marine Biological Station. II. *J. Fac. Sci., Niigata Univ., Ser. II*, **2**(3): 79-87. (In Japanese).
- Honma, Y. 1957. Further additions to "A list of the fishes collected in the Province of Echigo, including Sado Island". (V). *Japan. J. Ichthyol.*, **6**(4-6): 109-112. (In Japanese).
- Honma, Y. 1959. Further additions to "A list of the fishes collected in the Province of Echigo, including Sado Island". (VI). *Ibid.*, **7**(5-6): 139-144. (In Japanese).
- Hubbs, C.L. and L.P. Schultz. 1934. The reef liparid fishes inhabiting the west coast of the United States. *J. Pan-Pac. Res. Inst.*, **9**(4): 2-7.
- Johnsen, S. 1921. Ichthyological notiser I. *Bergens Mus. Aarb.*, **1918-19**, *Naturvidenskabelig raække*, (6): 1-94, pl. 1.
- Jordan, D.S. and B.W. Evermann. 1896. A checklist of the fishes and fish-like invertebrates of North and Middle America. *Rep. U.S. Comm. Fish.*, **21**: 257-584.
- Jordan, D.S. and B.W. Evermann. 1898. The fishes of North and Middle America. Part 2, 3. *Bull. U.S. Natn. Mus.*, (47): 1241-3136.
- Jordan, D.S., B.W. Evermann and H.W. Clark. 1930. Check-list of the fishes and fish-like vertebrates of North and Middle America north of northern boundary of Venezuela and Columbia. *Rep. U.S. Comm. Fish.*, **1928**(2): 1-670.
- Jordan, D.S. and C.H. Gilbert. 1899. The fishes of the Bering Sea. Pages 433-492, plates 42-85 in D.S. Jordan, ed. *The fur seals and fur-seal islands of the North Pacific Ocean. Part 3*. Gov. Print. Off., Washington, D.C.
- Jordan, D.S. and C.L. Hubbs. 1925. Record of fishes obtained by David Starr Jordan in Japan,

1922. *Mem. Carnegie Mus.*, **10**(2) : 93-346, pls. 5-12.
- Jordan, D.S. and J.O. Snyder. 1900. A list of fishes collected in Japan by Keinosuke Otaki, and by the United States steamer Albatross, with description of fourteen new species. *Proc. U.S. Natn. Mus.*, **23**(1213) : 335-380, pls. 9-20.
- Jordan, D.S. and J.O. Snyder. 1901. A preliminary check list of the fishes of Japan. *Ann. Zool., Japon.*, **3**(2-3) : 31-159.
- Jordan, D.S. and J.O. Snyder. 1902. A review of the discobolous fishes of Japan. *Proc. U.S. Natn. Mus.*, **24**(1259) : 343-351.
- Jordan, D.S. and J.O. Snyder. 1904. On a collection of fishes made by Mr. Alan Owston in the deep waters of Japan. *Smithson. Misc. Coll.*, **45** : 230-240, pls. 58-63.
- Jordan, D.S., S. Tanaka and J.O. Snyder. 1913. A catalogue of the fishes of Japan. *J. Coll. Sci., Tokyo Imp. Univ.*, **33**(1) : 1-497.
- Jordan, D.S. and W.F. Thompson. 1914. Record of the fishes obtained in Japan in 1911. *Mem. Carnegie Mus.*, **6**(4) : 205-313, pls. 24-42.
- Kamohara, T. 1950. *Description of the fishes from the Provinces of Tosa and Kishu, Japan*. 323 p. Kochi Pref. Bunkyo Assoc., Kochi. (In Japanese).
- Katayama, M. 1953. Record of the fishes of northern Japan obtained off Tajima. *Bull. Fac. Edu. Yamaguchi Univ.*, **2**(1) : 1-7. (In Japanese).
- Kido, K. 1983a. New and rare liparidid species from the Okhotsk and Bering seas and their adjacent waters. *Japan. J. Ichthyol.*, **29**(4) : 374-384.
- Kido, K. 1983b. Family Liparidae. Pages 106-107, 292-303, plates 106, 174-183 in K. Amaoka, K. Nakaya, H. Araya and T. Yasui, eds. *Fishes from the northeastern sea of Japan and the Okhotsk Sea off Hokkaido. The intensive research of unexploited fishery resources of continental slopes*. Japan Fish. Resour. Conserv. Assoc., Tokyo. (In Japanese and English).
- Kido, K. 1984. Family Liparidae. Pages 337-341, plates 304-305, 364-366 in H. Masuda, K. Amaoka, C. Araga, T. Uyeno and T. Yoshino, eds. *The fishes of the Japanese Archipelago*. English text and plates. Tokai Univ. Press, Tokyo.
- Kido, K. 1985a. New and rare species of the genus *Paraliparis* (family Liparidae) from southern Japan. *Japan. J. Ichthyol.*, **31**(4) : 362-368.
- Kido, K. 1985b. New and rare species of the genus *Careproctus* (Liparidae) from the Bering Sea. *Ibid.*, **32**(1) : 6-17.
- Kido, K. and D. Kitagawa. 1986. Development of larvae and juveniles of *Rhinoliparis barbulifer* (Liparidae). Pages 697-702 in T. Uyeno, R. Arai, S. Taniuchi and K. Matsuura, eds. *Indo-Pacific Fish Biology*. Ichthyol. Soc. Japan, Tokyo.
- Kosaka, M. 1967. Zoogeographical studies on the demarsal fishes of Sendai Bay. *J. Coll. Mar. Sci. Tech., Tokai Univ.*, (2) : 147-159. (In Japanese).
- Krasuyukova, Z.V. 1984. Eight new species of the sea-snailfishes (Scorpaeniformes, fam. Liparidae), described by Prof. P. Yu. Schmidt on the materials of the Kurilo-Sakhalin expeditions of the Zoological Institute of the Academy of Sciences of the USSR, 1947-1949. *Proc. Inst. USSR Acad. Sci.*, **127** : 5-16. (In Russian).
- Krøyer, H.N. 1861. Nogle bitrag til Nordisk ichthiologi. *Naturhist. Tidss.*, **3**(1) : 233-310.
- Kuroda, N. 1957. A list of the fishes of Nabuto, Boshu, Japan. *Zool. Mag., Japan*, **66**(1) : 3-5. (In Japanese).
- Kuronuma, K. 1943. Fishes from the Paramushir Island in North Kuril Islands. *Bull. Biogeogr. Soc. Japan*, **13**(16) : 101-124. (In Japanese).
- Lauder, G.V. and K.F. Liem. 1983. The evolution and interrelationships of actinopterygian fishes. *Bull. Mus. Comp. Zool.*, **150**(3) : 95-197.
- Lindberg, G.U. 1947. A preliminary list of fishes of the Japan Sea. *Bull. Pac. Sci. Fish. Inst.*, **25** : 125-206. (In Russian).
- Lindberg, G.U. 1959. A list of the fauna of the sea waters of the South Sakhalin and South Kuril Islands composed by some authors under G.U. Lindberg's leadership: Chordata. Invest. Far-eastern Seas USSR., 6. *Rep. Kurile-Sakhalin Exped.*, **2** : 235-256. (In Russian).
- Linnaeus, C. 1758. *Systema Nature*. *Pegnum animale*. 10th ed. 824 p. Holmiae.
- Maruyama, K. 1971. A catalogue of fishes of Iwate Prefecture, Japan. *Bull. Iwate Pref. Fish. Exp. Stn.*, (1) : 1-70. (In Japanese).
- Matsubara, K. 1943. Studies of the scorpaenoid fishes of Japan. Anatomy, phylogeny and taxon-

- omy (I). *Trans. Shigenkagaku Kenkyusho*, (1) : 1-170.
- Matsubara, K. 1955. *Fish morphology and hierarchy. Part 2.* p. 791-1605. Ishizaki Shoten, Tokyo. (In Japanese).
- Matsubara, K. and T. Iwai. 1954. Some remarks on the family Liparidae, with descriptions of three new species and two interesting ones of the genus *Liparis*. *Rep. Fac. Fish. Prefect. Univ. Mie*, **1**(3) : 425-441.
- McAllister, D.E. 1968. Evolution of branchiostegals and associated opercular, gular, and hyoid bones and the classification of teleostome fishes, living and fossil. *Mus. Canada Bull.*, (221), *Biol. Ser.*, (77) : i-xiv + 1-239, pls. 1-21.
- Mori, T. 1955. On the two new deep-sea fishes found off Kyogasaki, Kyoto Prefecture, the southern Japan Sea. *Sci. Rep. Hyogo Univ. Agri.*, **2**(1) : 1-4.
- Mori, T. 1956a. Descriptions of three new species of fishes from Oki Island in the southern Japan Sea. *Japan. J. Ichthyol.*, **5**(1-2) : 15-18.
- Mori, T. 1956b. Fishes of San-in District including Oki Islands and its adjacent waters (southern Japan Sea). *Mem. Hyogo Univ. Agri.*, **2**(3) : 1-62. (In Japanese).
- Mori, T. 1956c. On the bottom fishes of the Yamato-Bank in the central Japan Sea, with descriptions of two new species. *Sci. Rep. Hyogo Univ. Agri.*, **2**(2) : 29-32.
- Mori, T. and K. Uchida. 1934. A revised catalogue of the fishes of Korea. *J. Chosen Nat. Hist. Soc.*, (19) : 1-23. (In Japanese).
- Nelson, J.S. 1976. *Fishes of the world*. xiii + 416 p. Wiley-Interscience, New York.
- Nelson, J.S. 1984. *Fishes of the world*. Second ed. xv + 523 p. Wiley-Interscience, New York.
- Nojima, S. 1936. On a new species of *Liparis*. *Trans. Sapporo Nat. Hist. Soc.*, **14**(3) : 179-180.
- Okada, S. and K. Kobayashi. 1968. *Colored illustrations of pelagic and bottom fishes in the Bering Sea*. x + 179 p., 24 pls. North Pac. Salmon Resour. Res. Soc. and Japan Fish. Resour. Conserv. Assoc., Tokyo. (In Japanese).
- Okada, Y. and K. Matsubara. 1938. *Keys to the fishes and fish like animals of Japan*. xl + 584 p., 113 pls. Sanseido, Tokyo. (In Japanese).
- Okamura, O. 1982. Family Liparidae. Pages 292-293, plate 209 in O. Okamura, K. Amaoka and F. Mitani, eds. *Fishes of the Kyushu-Palau Ridge and Tosa Bay. The intensive research of unexploited fishery resources on continental slopes*. Japan Fish. Resour. Conserv. Assoc., Tokyo. (In Japanese and English).
- Oshima, M. 1957. Notes on the bottom-fishes obtained at off-shore of Niigata and Yamagata Prefectures, with descriptions of five new species. *Japan. J. Ichthyol.*, **6**(4-6) : 1-8.
- Pavlenko, M.N. 1910. Fishes of Peter the Great Bay. *Trudy Obs. Est. Kaganskogo Univ.*, **42**(2) : 1-72. (In Russian).
- Pearcy, W.G. 1964. Some distributional features of mesopelagic fishes off Oregon. *J. Mar. Res.*, **22**(1) : 83-102.
- Peden, A.E. 1981. Meristic variation of four fish species exhibiting lowest median counts in Georgia Strait, British Columbia. *Can. J. Zool.*, **59**(4) : 679-683.
- Peden, A.E. and W. Ostermann. 1980. Three fish species previously unknown from marine waters off British Columbia. *Syesis*, **13** : 215-217.
- Putnam, F.W. 1874. Notes on *Liparis* and *Cyclopterus* and their allies. *Proc. Amer. Ass. Adv. Sci.*, **22** : 335-340.
- Quast, J.C. 1968. New record of thirteen cottid and blennioid fishes for southern Alaska. *Pac. Sci.*, **22** : 482-487.
- Quast, J.C. and E.L. Hall. 1972. List of fishes of Alaska and adjacent waters with a guide to some their literature. *NOAA Tech. Rep., NMFS SSRF Circ.*, (658) : i-iv + 1-47.
- Rass, T.S. 1958. Fishes from the greatest depths. *Priroda*, (7) : 107-108. (In Russian, English translation in Bur. Comm. Fish., U.S. Fish Wildl. Ser.).
- Regan, C.T. 1913. The osteology and classification of the teleostean fishes of the order Scleroparei. *Ann. Mag. Nat. Hist., Ser. 8*, **11**(62) : 169-184.
- Rendahl, H. 1931. Ichthyologische Ergebnisse der Schwedischen Kamtchatka-Expedition 1920-1922. *Ark. Zool.*, **22A**(18) : 1-75.
- Sawada, Y. 1982. Phylogeny and zoogeography of the superfamily Cobitoidea (Cyprinoidei, Cypriniformes). *Mem. Fac. Fish., Hokkaido Univ.*, **28**(2) : 65-223.
- Schmidt, P. Yu. 1904a. *Pisces marium orientalium*. xi + 466 p., 6 pls. Imperii Rossi, Petersbourg.

(In Russian).

- Schmidt, P. Yu. 1904b. On the *Liparis (Trismegistus) ovstoni* Jordan and Snyder. *Proc. U.S. Natn. Mus.*, **28**(1390) : 189-191.
- Schmidt, P. Yu. 1915. Ichthyological notes. II. On a new cyclogasterid fish with a rudimentary disk. *Ann. Mus. Zool. Russ.*, **20** : 627-630.
- Schmidt, P. Yu. 1950. *Fishes of the Sea of Okhotsk*. 370 p., 20 pls. Izdatel'stov Akad. Nauk SSSR, Moskva. (In Russian).
- Schultz, L.P. 1936. Key to the fishes of Washington, Oregon, and closely adjoining regions. *Univ. Wash. Publ. Biol.*, **2**(4) : 103-228.
- Schultz, L.P. and A.C. Delacy. 1936. Fishes of the American Northwest. A catalogue of the fishes of Washington and Oregon, with distributional records and a bibliography. *J. Pan-Pac. Res. Inst.*, **11**(2) : 127-142 ; **11**(3) : 211-226.
- Scopoli, G.A. 1777. *Introduction ad historiam naturatum... subinae as leges naturae*. 506 p. Prague.
- Shiogaki, S. 1982. A catalogue of the fishes collected from the waters of Aomori Prefecture, Japan. *Bull. Fish. Exp. Stn. Aomori Pref.*, 1-36. (In Japanese).
- Smith, H.M. and T.E.B. Pope. 1906. List of fishes collected in Japan in 1903, with descriptions of new genera and species. *Proc. U.S. Natn. Mus.*, **31**(1489) : 459-499.
- Soldatov, V.K. and G.U. Lindberg. 1930. A review of the fishes of the sea of Far East. *Bull. Pac. Sci. Fish. Inst.*, **5** : 1-576, pls. 1-15. (In Russian).
- Stein, D.L. 1978a. A review of the deepwater Liparidae (Pisces) from the coast of Oregon and adjacent waters. *Occ. Pap. Calif. Acad. Sci.*, (127) : 1-55.
- Stein, D.L. 1978b. The genus *Psednos* a junior synonym of *Paraliparis*, with a redescription of *Paraliparis micrurus* (Barnard) (Scorpaeniformes : Liparidae). *Matsuya*, **4** : 5-10.
- Stein, D.L. and K.W. Able. 1986. Family Liparidae. Pages 1275-1283 in P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese, eds. *Fishes of the North-eastern Atlantic and the Mediterranean. Volume 3*. Unesco, Paris.
- Steindachner, F. 1985. Ichthyologische Beiträge. III. *Sitz. Akad. Wiss., Wein*, **72**(1) : 29-96, pls. 1-8.
- Tanaka, S. 1908a. Notes on some Japanese fishes, with descriptions of fourteen new species. *J. Coll. Sci., Imp. Univ. Tokyo*, **23**(7) : 1-54, pls. 1-4.
- Tanaka, S. 1908b. Notes on a collection of fishes made by Professor Iijima in the southern part of Saghalin. *Ann. Zool., Japon.*, **6**(4) : 235-254, pl. 9.
- Tanaka, S. 1916. Four new species of Japanese fishes. *Zool. Mag., Japan*, **28** : 173-174. (In Japanese).
- Tanaka, S. 1951. *Figures and descriptions of fishes of Japan, 1-30*. Rev. ed. xii+557 p., 141 pls. Kazama Shobo, Tokyo. (In Japanese and English).
- Taranetz, A.Y. 1937. Handbook for identification of fishes of Soviet Far East and adjacent waters. *Bull. Pac. Sci. Fish. Inst.*, **11** : 1-200. (In Russian).
- Taranetz, A.Y. 1941. On the classification and origin of the family Cottidae. *Bull. Acad. Sci. USSR, Biol. Ser.*, **1941**(3) : 427-447. (In Russian, English translation in Inst. Fish., Univ. British Columbia, Vancouver).
- Tortonese, E. 1959. Un nuove pesce Mediterraneo di profondità : *Eutelichthys leptochirus* n. gen. e n. sp. (fam. Eutelichthyidae, nov.). *Ann. Mus. Civ. Stor. Nat. 'Giacomo Doria'*, **71** : 226-232. (In Italian).
- Ueno, T. 1970. *Fauna Japonica. Cyclopteridae (Pisces)*. 233 p., 13 pls. Academic Press of Japan, Tokyo.
- Ueno, T. 1971. List of the marine fishes from the waters of Hokkaido and its adjacent regions. *Sci. Rep. Hokkaido Fish. Exp. Stn.*, (13) : 61-102. (In Japanese).
- Vaillant, L. 1888a. *Poissons in Expéditions scientifiques du Travailleur et du Talisman, pendant les années 1880, 1881, 1882, 1883*. 406 p., 28 pls. Masson, Paris.
- Vaillant, L. 1888b. *Poissons in Mission scientifique du Cap Horn, 1882-83*. 35 p., 4 pls. 6, Zoologie, Paris.
- Wang, K. -F. and S. -C. Wang. 1935. Study of the teleost fishes of coastal region of Shantung III. *Contrib. Biol. Lab. Sci. Soc. China, Zool. Ser.*, **11**(16) : 236-237.
- Wheeler, A.C. 1969. *The fishes of the British Isles and northwest Europe*. xvii+613 p. McMillan, London.

- Wilimovsky, N.J. 1954. List of fishes of Alaska. *Stanford Ichthyol. Bull.*, **4**(5) : 279-294.
- Wilimovsky, N.J. 1958. *Provisional keys to the fishes of Alaska*. 113 p. U.S. Fish. Wildl. Serv., Fish. Res. Lab., Juneau.
- Wilson, E.O. 1965. A consistency test for phylogenies based on contemporaneous species. *Syst. Zool.*, **14**(3) : 214-220.
- Wu, H.-W. and K.-F. Wang. 1933. A review of the discobolous fishes on the Chinese coast. *Sci. Soc. China*, **9**(2) : 77-86.
- Yabe, M. 1985. Comparative osteology and myology of the superfamily Cottoidea (Pisces: Scorpaeniformes), and its phylogenetic classification. *Mem. Fac. Fish., Hokkaido Univ.*, **32**(1) : 1-130.
- Yamada, U. 1986. Family Liparidae. Pages 360-361 in O. Okamura, ed. *Fishes of the East China Sea and the Yellow Sea*. Seikai Reg. Fish. Res. Lab., Nagasaki.
- Yamamoto, K. 1948. Ecological research of the northern fishes I. Fishes of the shallow waters in Rakuma and its vicinity, Sakhalin, with ecological discussion of the seasonal changes of their fishes. 2. *Suisan-Fukajo-Shiken-Hokoku*, **3**(2) : 35-55. (In Japanese).
- Yanai, R. 1950. Fishes of San-in District, Japan. *Zool. Mag., Japan*, **59**(1) : 17-22. (In Japanese).
- Yatou, T. 1985. Family Liparidae. Pages 602-605, plates 376-377 in O. Okamura, ed. *Fishes of the Okinawa Trough and adjacent waters. II. The intensive research of unexploited fisheries resources on continental slopes*. Japan Fish. Resour. Conserv. Assoc., Tokyo. (In Japanese and English).