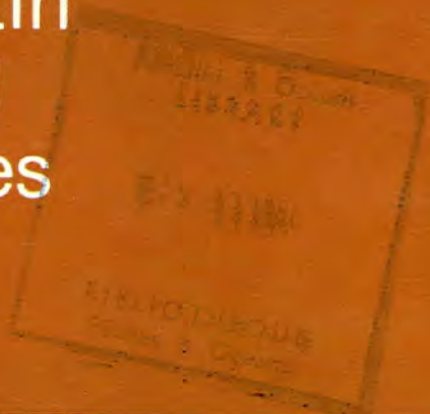


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Canadian Bulletin of Fisheries and Aquatic Sciences



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Revision of the Snailfish genus *Liparis* from Arctic Canada



K.W. Able
D.E. McAllister

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from Arctic Canada**

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BULLETIN 208

Revision of the Snailfish genus *Liparis* from Arctic Canada

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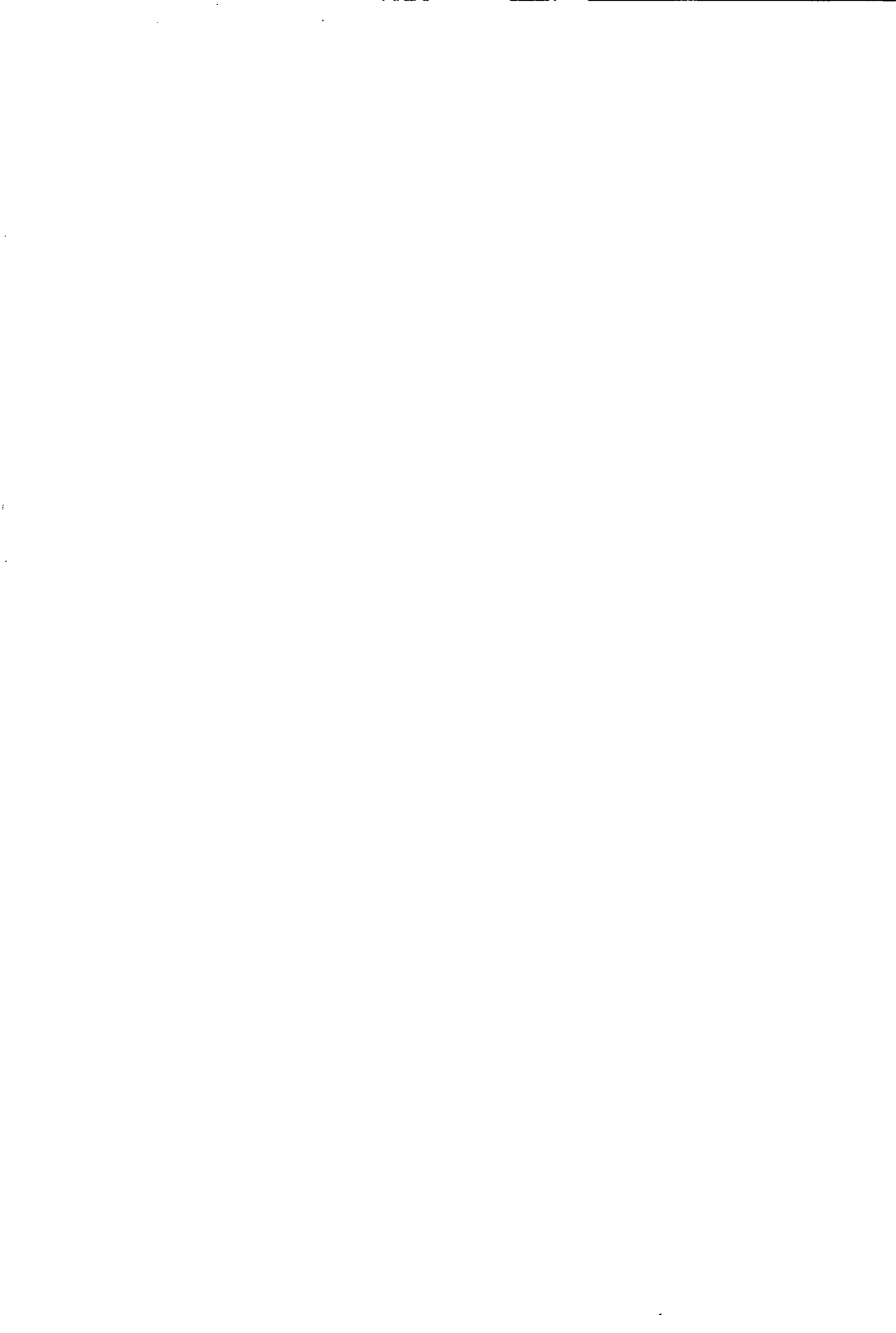
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*Dedicated to the past,
present, and future staff of
the Arctic Biological Station,
Ste-Anne-de-Bellevue, Quebec,
and to the
editorial staff
who,
like alchemists of old,
endeavor to transmute
lead to GOLD!*



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Abstract

ABLE, K. W., AND D. E. MCALLISTER. 1980. Revision of the snailfish genus *Liparis* from Arctic Canada. Can. Bull. Fish. Aquat. Sci. 208: 52 p.

Four species of *Liparis*, *L. fabricii*, *L. tunicatus*, *L. gibbus*, and *L. atlanticus*, are recognized from Arctic Canada, and synonymies, descriptions, illustrations, distribution maps, habitat, and life history data are given. In addition, analyses of systematics, zoogeography, and sexual dimorphism are presented, based on about 550 specimens mainly from Arctic Canada, but also from Alaska, the Atlantic coast of Canada, Greenland, and Spitsbergen. A key to the nine possible species of Liparididae occurring in Canadian Arctic waters is included.

The differences between *Liparis herschelinius* Scofield, 1898 and *L. tunicatus* Reinhardt, 1837 are shown to be clinal and it is hypothesized that the differences arose during isolation in western and eastern Nearctic refugia during the Wisconsin glaciation. *Liparis herschelinius* is synonymized with *L. tunicatus*. A new vernacular, kelp snailfish, is proposed for *L. tunicatus*, which uses its sucking disk to occupy the habitat offered by the slippery surface of large algae such as *Laminaria*.

Liparis fabricii Krøyer, 1847, previously considered a synonym of *L. liparis* Linnaeus, is shown to be a senior subjective synonym of *L. koefoedi* Parr, 1932. *L. koefoedi* should, therefore, be replaced by the older name, *L. fabricii*.

Liparis cyclostigma Gilbert, 1895 is synonymized with *L. gibbus* Bean, 1881.

Key words: taxonomy, distribution, life history, *Liparis*, Canadian Arctic, Liparididae, Cyclopteridae

Résumé

ABLE, K. W., AND D. E. MCALLISTER. 1980. Revision of the snailfish genus *Liparis* from Arctic Canada. Can. Bull. Fish. Aquat. Sci. 208 : 52 p.

Cette étude présente les quatre espèces reconnues de *Liparis* de l'Arctique canadien, *L. fabricii*, *L. tunicatus*, *L. gibbus*, *L. atlanticus*, ainsi que des descriptions, des synonymies, des illustrations, des cartes de répartition, des données sur l'habitat et le cycle évolutif. On y trouve en plus des études sur les modes de classification, la zoogéographie et le dimorphisme sexuel, fondées sur environ 550 spécimens en provenance surtout de l'Arctique canadien mais aussi de l'Alaska, de la côte atlantique, du Groenland et du Spitzberg. Une élé des neuf espèces possible de Liparididae se retrouvant dans les eaux de l'Arctique canadien.

On démontre que les différences entre *Liparis herschelinius* Scofield, 1898 et *L. tunicatus* Reinhardt, 1837 se présentent par clines et l'on suppose qu'elles sont apparues alors que les espèces étaient isolées dans un refuge nearctique de l'est et de l'ouest pendant la glaciation du Wisconsin. *Liparis herschelinius* est un synonyme de *L. tunicatus*. Puisque *L. tunicatus* semble tirer avantage de son disque-ventouse afin d'occuper l'habitat offert par les surfaces glissantes des grandes algues telles que les *Laminaria*, on lui propose un nouveau nom vernaculaire, la limace de laminaire.

On montre que *Liparis fabricii* Krøyer, 1847 considéré précédemment comme synonyme de *L. liparis* (Linnaeus, 1766) est, en réalité, un synonyme plus ancien de *L. koefoedi* Parr, 1932, désignation que l'on devrait par conséquent remplacer par son antécédente.

Liparis cyclostigma Gilbert, 1895, est synonymisé avec *L. gibbus* Bean, 1881.

Introduction

The snailfish family Liparididae (Cyclopteridae of some authors), is one of the more diverse families with over 150 species in cool marine waters. The genus *Liparis* is one of the most important genera in the family. This Bulletin provides a taxonomic revision of the species of *Liparis* found in Arctic Canada (Fig. 1), presents identification keys, and summarizes information on distribution and biology.

The taxonomy of liparid fishes of the genus in Arctic waters is largely unresolved (Andriashev 1954; Dunbar and Hildebrand 1952; Walters 1955) despite the major revisions by Burke (1930)

and Parr (1932). Most authors readily agree that *L. koefoedi* Parr, 1932 (which we synonymize with *L. fabricii*) is a distinct species, but there has been confusion in identification of the remaining Arctic *Liparis*. Many authors (Jensen 1910; Parr 1932; Walters 1955; Andriashev 1954) have relegated most forms to *L. liparis* (Linnaeus 1766), primarily because of the wide morphological variation recorded for this species (Andriashev 1954; Dunbar and Hildebrand 1952; Walters 1955). The spelling of the family name Liparididae, instead of Liparidae, follows Steyskal (1980).

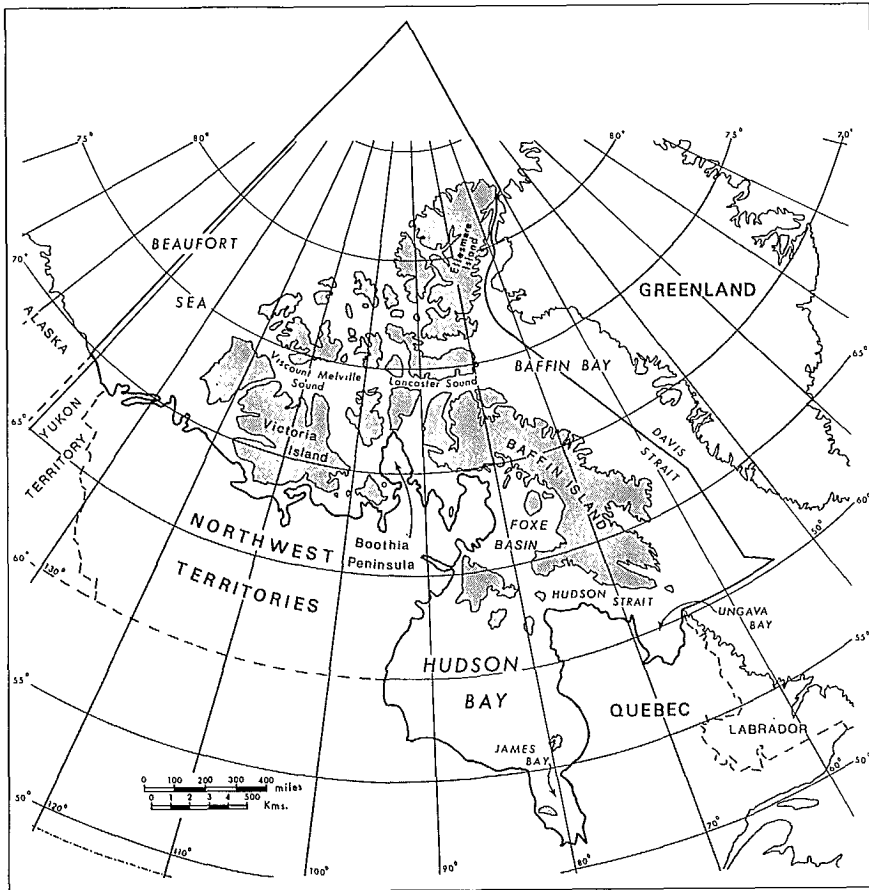


FIG. 1. Arctic Canada study area with major geographic localities mentioned in text.

In contrast, most authors working in the Canadian Arctic (Vladykov 1933; Dunbar and Hildebrand 1952; McAllister 1962) have usually recorded other *Liparis* (*L. cyclostigma*, *L. atlanticus*, *L. tunicatus*, *L. herschelini*, and *L. fabricii* (as *L. koefoedi*). Burke (1930) and Andriashev (1954) expressed doubts as to the distinctness of *L. gibbus* and *L. cyclostigma*. Recently, Able (1973, 1976) suggested that *L. liparis* may not occur in the western North Atlantic or Canadian Arctic, and Legendre et al. (1975) questioned its occurrence in Arctic Canada. This Bulletin presents our current resolution of the problems in the taxonomy of Canadian Arctic *Liparis* and represents a first step to an eventual revision of all the North Atlantic and Arctic forms. Literature on marine fishes of the Canadian Arctic is summarized in McAllister (1966) and K. Robinson and D. E. McAllister (unpublished manuscript).

Methods

Counts of fin rays (except pectorals) and vertebrae were made from radiographs or preserved material according to the methods of Hubbs and Lagler (1958) except for the following: the last two rays of the dorsal and anal fin, being on separate basals, are counted separately; caudal rays are counted as primary (upper and lower — above and below midline) when attached to the hypurals, and secondary (rudimentary or procurrent of Stein, 1978) when above or below hypurals; total caudal fin ray count is the sum of the primary and secondary rays; caudal and total vertebral counts include the urostyle. The number of teeth in a row refers to the first oblique, complete row at the symphysis of the premaxillae and dentary bones (Fig. 2). Cephalic pore nomenclature follows Burke (1930). Measurements were taken with dial calipers or dividers as depicted in Fig. 3. Measurements were taken to the nearest 0.1 mm, but we would claim reproducibility at most to the nearest millimetre. Head width is measured at the point midway between the eye and gill slit. Characterization of teeth shape is based primarily on the posterior teeth in the rows near the center of the jaws.

Meristic values in the species accounts are for Canadian Arctic specimens only, except for *Liparis atlanticus* where the values also include specimens for the Canadian Atlantic. The same is true for the text description, except extralimital material was included to increase sample size for the study of sexual dimorphism. Meristic values found in 5% or fewer of the specimens are enclosed in

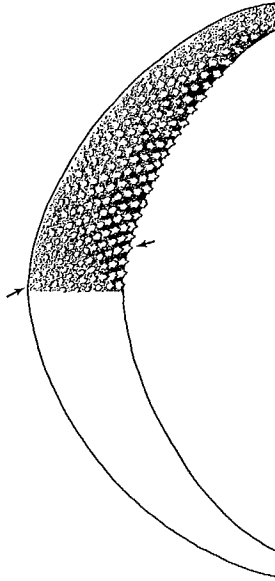


FIG. 2. Premaxillary teeth of *L. tunicatus* (NMC 64-70) showing first complete row at symphysis of premaxillary bones as indicated by arrows.

parentheses for the ranges; the ranges are followed by the mean, then by the sample size on which the mean was based, in parentheses.

The following abbreviations are used in the description of characters: dorsal (D), anal (A), pectoral (P), caudal (C), fin rays; abdominal (Abd.), caudal (Caud.), and total (Tot.), vertebrae (Vert.); gill rakers (GR), pyloric caeca (PC), standard length (SL), and total length (TL).

Data were analyzed on a Hewlett-Packard 9845 minicomputer system. Principal components (PCA) and discriminant function analyses (DFA) were run using programs in BASIC translated from FORTRAN in Davies (1971). Both methods permit combining the utility of several characters. PCA permits inspection of homogeneity of samples suspected to be heterogeneous without having to assign specimens to groups a priori. Thus, it may be used to test a hypothesis that there is more than one taxon present, or that variation is clinal rather than bimodal, or to inspect effects of size, shape, or sex. Discriminant function analysis on the other hand can be more powerful in distinguishing two or more groups. But it requires that the specimens be assigned to the groups before the analysis and that the character(s) used in the assignment not be employed in the analysis. For theory of these analyses refer to Blackith and Reyment (1971) and Jolicoeur and Mosimann (1960). For theory and practice of trend surface analysis see Gabriel and Sokal (1969) and Gross (1977).

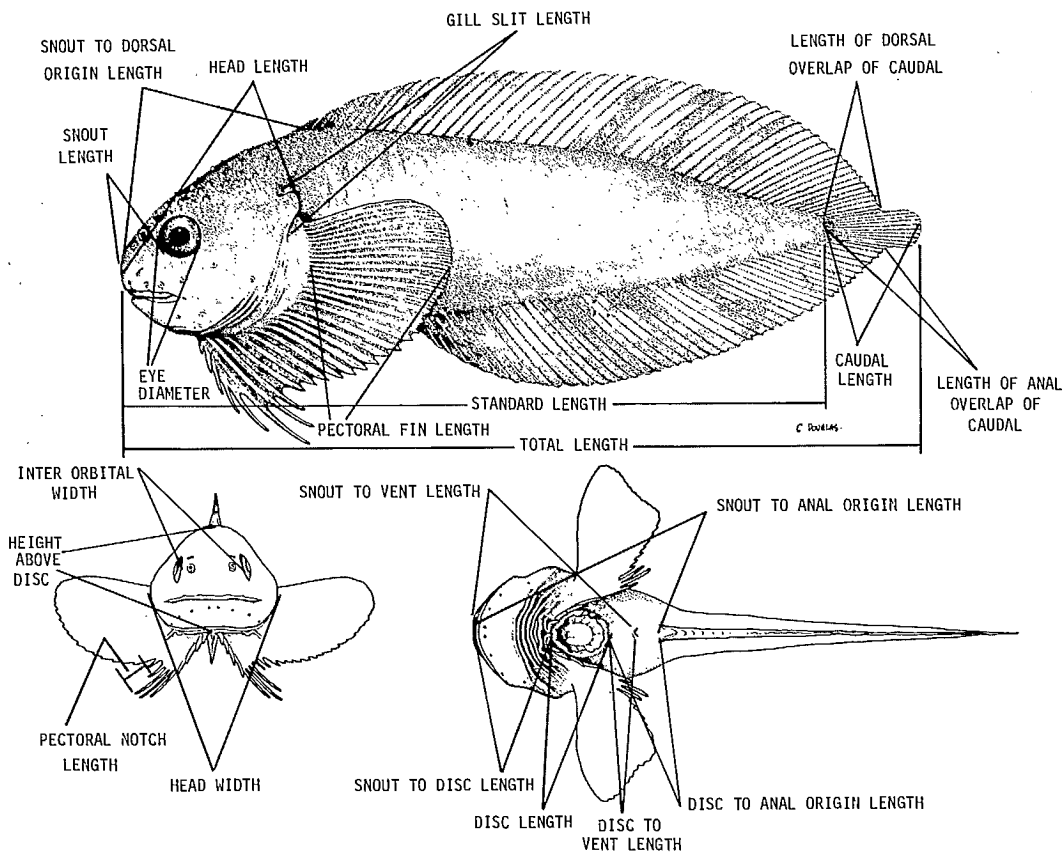


FIG. 3. Methods of taking measurements.

Scanning electron micrographs of tooth shape were taken with a Phillips Electronic Equipment model AMR 1000 microscope.

To facilitate analysis of geographic variation, specimens were grouped into regional samples (Fig. 1): western Canadian Arctic (from the Alaskan border east to and including Victoria Island and south of Viscount Melville Sound); northern Canadian Arctic (from Viscount Melville and Lancaster sounds northward); eastern Canadian Arctic (south of the above sounds and east of Boothia Peninsula to the northern tip of Labrador); Atlantic Canada (from Labrador southward).

The frequency distributions for dorsal, anal, and left pectoral rays, teeth in first row of upper jaw, pyloric caeca, and total vertebrae are presented in Tables 2 to 7 (p. 41-46). Note that frequencies for western, northern, and eastern Canadian Arctic are subtalled as Arctic Canada.

Materials

Counts and measurements were taken from more than 550 specimens, although not all counts and measurements were made on every specimen; more than 440 specimens were x-rayed. Distribution maps are based on these plus additional material for a total of some 250 species-lots and selected literature.

The majority of specimens in the National Museum of Natural Sciences, National Museums of Canada (NMC) Ottawa, came from trawl collections made by the Arctic Biological Station, Department of Fisheries and Oceans, Ste-Anne-de-Bellevue, Que. Occasional collections were obtained by midwater trawl, scuba diving, rotenone, plankton net tows, and seines. Most collections were made in July and August, some in June and September, and a few at other times of the year.

Table 1 shows the depth distribution of species in the collections. Most gear used was nonclosing and shallower midwater occurrence of some species cannot be excluded. Nevertheless, we feel it indicates the species' relative depth preferences. The collection data, including environmental and geographical data, were stored in the museum's IKTHOS minicomputer system (McAllister et al. 1978). Maps were plotted and habitat data were retrieved by this system.

Other specimens examined were from Auke Bay Biological Laboratory, Alaska (ABBL); American Museum of Natural History, New York, N.Y. (AMNH); Academy of Natural Sciences, Philadelphia, PA (ANSP); University of Alaska, Fairbanks (UA); British Museum (Natural History) (BMNH); Groupe interuniversitaire de recherches océanographique du Québec (GIROQ); Ministère de l'Industrie et du Commerce, Québec (MIC); United States National Museum, Washington, D.C. (USNM); Royal Ontario Museum, Toronto, Ont. (ROM); Smithsonian Oceanographic Sorting Center, Washington, D.C. (SOSC); Department of Fisheries and Oceans, St. John's, Nfld. (FRB, St. John's); University of British Columbia, Vancouver (BC); Zoological Museum, University of Oslo, Norway (UZMO); Zoological Museum, University of Copenhagen, Denmark (UZMC); Zoological Museum, University of Bergen, Norway (UZMB).

Taxonomic Characters

Specimens of *Liparis*, like many other liparids, have few taxonomically useful morphological characters because of their naked, flaccid bodies. Inadequate preservation often compounds problems of measurement and description of form. A problem particular to North Atlantic *Liparis* has been the tendency of authors to use dissimilar diagnostic characters, thus making comparisons

between authors difficult (Parr 1932). Andriashev et al. (1977) discussed some taxonomic methods and characters for the family.

In our studies, we have found that dorsal, anal, and pectoral fin ray and pyloric caeca counts are often the minimum information necessary for correct identification. Pyloric caeca have proved especially useful and analysis of a large number of specimens of *L. gibbus* (44 specimens), *L. fabricii* (72 specimens), and *L. inquilinus* (40 specimens, K. W. Able personal observation) indicate they do not increase in number with increase in size. Unfortunately, several authors have omitted this count. Vertebral counts are often useful as well, but have been used infrequently in the past.

Tooth number in the first complete row (Fig. 2) and tooth shape (Fig. 4A, B) are of some assistance and occasionally diagnostic. However, numbers of teeth increase with body size. Tooth shape may vary with location in the jaw and size of the individual. Usually the anterior teeth in the jaw are small and trilobed with lobes of similar size. The teeth in the posterior portion of the row are usually longer, especially in rows near the middle of the jaw, and these teeth are used to characterize tooth shape. They may be strongly trilobed as in *L. atlanticus*, trilobed with lobes subequal as in *L. tunicatus*, weakly trilobed with a longer central lobe as in *L. gibbus* (Fig. 4A), or simple as in *L. fabricii* (Fig. 4B). The above characteristic shapes are most pronounced in adults.

Prickle distribution appears to differ on males of different species. In *L. fabricii* (see Fig. 6A) they are found on the top and upper side of the head and sometimes on the anterior dorsal fin; in *L. gibbus* on the top and sides of the head, under the eye, on the nape, and over the dorsal fin and the upper third of the body to the caudal fin; and in *L. atlanticus*, according to Van Vliet (1970), over the skin except for the inner pectoral fin, underside of the head, and abdomen. Prickles

TABLE 1. Depth distribution and disk size in *Liparis* of Arctic North America.

Species	Frequency of occurrence at depths (m)						Mean depth (m)	Mean disk length (% SL)
	0-50	51-100	101-150	151-200	201-250	251-300		
<i>L. atlanticus</i>	1(7) ^a	(1) ^a	-	-	-	-	1	15.7
<i>L. tunicatus</i>	52	3	-	-	-	-	17	13.3
<i>L. gibbus</i>	7	2	2	3	-	-	82	12.8
<i>L. fabricii</i>	16	8	2	8	2	1	90	12.2

^a Atlantic coast



FIG. 4. Scanning electron micrographs of: (A) Dusky seasnail, *Liparis gibbus* (NMC 77-1496). Close-up of teeth showing trilobed shape with central lobe larger than lateral lobes. (B) Gelatinous seasnail, *Liparis fabricii*, showing simple teeth with lateral lobes much reduced. C. Thumbtack prickle of male *Liparis gibbus*.

were found on top of the head down to the level of the eye and forward to in front of the nostrils and on the anterior dorsal fin of one *L. tunicatus*.

The relatively short intestine length in Canadian Arctic species suggests a diet composed predominantly of animal matter. Johansen (MS) reported fragments of algae among invertebrates in stomach contents, but contents in most of our species consisted of crustaceans.

The dark color of the peritoneum is useful in distinguishing *L. fabricii* from other Canadian Arctic *Liparis* although the degree of pigmentation changes somewhat with size, and occasional specimens lack dark peritoneal pigmentation. Small juveniles of this species have numerous individual stellate melanophores on the peritoneum. In larger juveniles and adults, the melanophores are so numerous that the peritoneum is completely black. In all species with melanophores, they are most abundant on the dorsal surface of the peritoneum. Most species we have examined have a pale peritoneum with very few, small melanophores. *L. fabricii* is also the only species examined with melanophores in the lining of the mouth and the opercular cavity.

External color patterns appear to be quite variable. Able (1973) previously noted that the pronounced differences in the color pattern of *L. inquilinus* were not correlated with sex, season, or geographical location. Mottled and spotted patterns were occasionally present in the material we examined, but most specimens were uniformly brown, possibly due to fading. One Canadian Arctic *Liparis gibbus* specimen had a striped color pattern; the significance of this striking pattern, whether behavioral or cryptic, is unknown. Dunbar and Hildebrand (1952) observed a nearly black specimen collected over black mud, which changed to brown when kept alive in a jar of water on deck.

Some morphometric characters are of limited value due to the soft, pliable bodies of these fishes. We have found that measurements of head, pectoral, and disk length, however, are often useful. Larger portions of the body are often so variable they are often useless as diagnostic characters, although Able (1973) was able to detect significant sexually dimorphic differences in the distance from snout to origin of anal fin and snout to vent length for a small species, *L. inquilinus* (see Sexual Dimorphism section).

One specimen of about the same length was measured for standard length, and length of intestine was expressed as % of SL: *L. atlanticus* 109 mm, 73%; *L. gibbus* 114 mm, 76%; *L. fabricii* 117 mm, 81%; and *L. tunicatus* 109 mm, 73%. Among these species, differences did not appear taxonomically promising.

SUCKING DISK

The sucking disk is an important adaptive feature that enables snailfishes to exploit shallow water exposed to wave surge, rocky bottoms, bottoms scoured by tidal currents, and the fonds of marine kelps. The size of the sucking disk has

been a useful taxonomic character (Burke 1930) for distinguishing species, but variation within species reduces its taxonomic utility in the Canadian Arctic. Authors have noticed a tendency for species in shallower depths to have larger disks than species in deep water. Table 1 shows reduction in disk size with decreasing mean depth, which supports this generalization. The trend has been attributed to greater wave action (Burke 1930). While agreeing with this argument, we would like to suggest the possibility of a second contributory factor.

Suction power is affected by atmospheric pressure plus pressure of the water column. At the water surface, the absolute pressure is about 1 kg/cm², at about 10 m depth the pressure is doubled, at 20 m tripled, etc. To obtain the same suction power, a tide pool snailfish (ignoring differences in wave action and currents) would need a sucking disk with twice the area of a species dwelling at 10 m depth. Gibson (1969) pointed out that a sucking disk can resist greater forces in deeper water. *Liparis atlanticus*, common in tide pools, has a longer disk, 15.7% of TL, than the sublittoral species, *L. tunicatus*, with disk averaging 13.5% of TL. The area of the disk of the former would be one-third greater than that of the latter.

Additionally, wave surges and currents are generally less at greater depths; thus, the size of sucking disk necessary to resist an equivalent stress is considerably smaller at greater depths. One other factor deserving consideration is the degree of mid-water as opposed to benthic existence. Species spending a higher proportion of time in mid-water, like *L. fabricii*, might be expected to and do have smaller disks than benthic species like *L. tunicatus*. Also body form, because of drag, will influence suction capacity requirements (Arita 1967). Deeper-bodied cyclopterids might be expected to have more drag and, hence, proportionately require more sucking capacity than slender-bodied liparidids. This is borne out by a comparison of forms with dissimilar body shapes. Arita measured the sucking capacity of the cyclopterid, *Eumicrotremus orbis* (deep-bodied form) at 14 cm depth and found it to be 84.3 g/cm² (about 74% efficiency). Gibson (1969) found about 50–60% efficiency in *Liparis montagui* (slender-bodied form) in shallow dishes of water.

This hypothesis of absolute pressure in regard to suction power should apply equally to other fishes with sucking disks such as the clingfishes of the family Gobiesocidae and the remoras, Echeneidae, or to ectoparasites such as the aquatic leeches, and the parasitic lampreys,

Petromyzonidae. It may even have been significant in the decimation of the lake trout, *Salvelinus namaycush*, in the Great Lakes by the sea lamprey, *Petromyzon marinus*. The preferred depth of lake trout in Lake Superior, 20–60 m (Scott and Crossman 1973), would make it three to seven times harder to dislodge a lamprey with the same size sucking disk than if it had been at the surface.

CHARACTER POLARITY

Although we deal with too few species to construct a phylogenetic tree, we would like to make a few suggestions on the direction characters have evolved, in order to contribute toward an eventual phylogeny. Burke (1930) discussed polarity of a number of characters.

Trilobed teeth with lobes equal or subequal in size appear to be common in several species groups, but simple teeth are found in species like *L. fabricii* that have adapted to the less common midwater habitat. We postulate the three equal-sized lobes are primitive, three lobes with the central one larger are intermediate, and simple teeth without lobes are the advanced state.

Pale peritoneum is common in sea snails from the inshore habitat, and secondary deepwater and midwater liparidids have a black peritoneum (Rass 1964). Stein (1978) reported that most deepwater (468–3585 m) liparidids from Oregon have a dark peritoneum. More liparidids found between 468 and 2000 m had dark or blacker stomachs than those living in still deeper waters. McAllister (1961) suggested that a black peritoneum in oceanic and deepwater fishes is an adaptation to consumption of bioluminescent prey and Stein (1978) supported this hypothesis in reference to stomach color. The black peritoneum conceals the bioluminescent stomach and gut contents, which might reveal the fish to other predators. Dr Maxwell Dunbar (in lit., June 5, 1979) observed bioluminescence when preserving copepods in West Greenland and Frobisher Bay and Dr E. H. Grainger observed bioluminescence in late summer and early fall in the calanoid copepod *Metridia longa* in Ungava and Frobisher bays. A similar function, the masking of luminous prey or resident luminous bacteria, has been attributed to the opacity of digestive organs in the transparent midwater shrimp, *Sergestes similis*, by B. Robinson (in Warner et al. 1978). We postulate that for *Liparis* pale peritoneum is the primitive, and dark the advanced state.

The dorsal fin is notched and little overlaps the caudal, the disk is large and the eyes are small in inshore species such as *Liparis atlanticus*. Notched dorsals are found as well in *Careproctus*,

Polypera, and *Temnocora* (Burke (1930). Species of *Liparis* in deeper or midwater habitats usually have unnotched dorsal fins, smaller sucking disks, longer dorsal and anal overlap of the caudal, and larger eyes. We concur with Burke (1930) that notched dorsals, large disks, vertical fins little overlapping the caudal, and small eyes are primitive. Similarly, dorsal rays are generally few in shallow species (primitive) and numerous in deep-water species (advanced). The same may be said for the number of anal and pectoral fin rays and total vertebrae.

Liparis fabricii is unusual in having 37 or more anal rays and *L. gibbus* in having a wide gill opening. We suggest that these two character states are secondarily derived from anal fins with fewer than 32 rays and narrow gill openings, respectively.

Confidence in our interpretation of the direction of evolution of character states is increased because what we consider primitive is frequently found in an outgroup, the closely related family Cyclopteridae.

SEXUAL DIMORPHISM

Statistically significant differences in meristic characters between sexes in individual species were found only in pyloric caeca in *Liparis fabricii* (males with fewer caeca) and in right pectoral rays and upper jaw teeth in first row (males with more teeth). This low number of significant differences probably results from limited sample sizes, and the following information provides some support for this view.

Of the 16 meristic characters examined for the 4 species, males averaged more parts than females in 43 out of 64 (67%) cases. In all species except *L. fabricii*, males had the majority of character means with higher values than females (9 to 14 out of 16). In *L. fabricii*, eight characters had higher means in females, the other eight in males. Clearly the general trend is for males to have more parts. A chi-square test shows that the chance of males having 43 means higher than females instead of the expected 32 is less than 0.01 (chi-square 7.56). Therefore, the difference can be judged significant.

Three or four out of four species have means higher in males than in females in dorsal, anal, upper and lower primary caudal rays, teeth in first row of dentary, gill rakers, and caudal and total vertebrae. Other characters, except for abdominal vertebrae, have approximately equal numbers for both sexes. Females have higher counts for abdominal vertebrae in three out of four species. In all four species, males averaged

larger in size; *L. atlanticus* 23.3, *L. gibbus* 74.1, *L. fabricii* 11.4, and *L. tunicatus* 14.4 mm more in standard length than females.

A possible explanation for the sexual dimorphism in some meristic characters may be found in Lindsey's pleomeristic rule (Lindsey 1975) assuming that males are, on the average, larger in size. According to the rule, among related taxa the number of segments is correlated with characteristic body size (for related taxa read sexes of the same species). Spouge and Larkin (1979) propose a hydrodynamic explanation for the rule. The larger number of abdominal vertebrae in females may be related to increased abdominal capacity to accommodate eggs, as Lindsey suggested for the capelin, *Mallotus villosus*. Able (1973) found significantly greater snout-to-anal lengths in females than males of the same size for *L. inquilinus*. In all species, either the snout-to-anal or snout-to-disk length or both was proportionately longer in females than in males.

Prickles in *Liparis* are thumbtacklike dermal structures consisting of a circular plate and an erect central spine. Wiley and Collette (1970) did not mention liparidid prickles in their review of breeding tubercles and contact organs in fishes. Prickles have been previously reported to occur only in males of *L. atlanticus* (Burke 1930; Detwyler 1963), *L. choanus* (Cohen 1960), *L. mucosus*, *L. microspidophorus*, *L. ingens*, *L. rhodosoma*, *L. tanakae*, and *L. owstoni* (Burke 1930) and on only a few females of *L. inquilinus* (Able 1973). Prickles occur on both sexes in *L. megacephalus*, *L. bristolense*, *L. ochotensis*, and possibly *L. fabricii* (Backus 1957). We report them also for males of *L. gibbus*, *L. tunicatus*, and confirm their presence in *L. fabricii*. They are easily detached from the skin and may be secondarily lost if the specimens are not handled carefully. Our samples are not adequate to indicate seasonal variation in the occurrence of prickles.

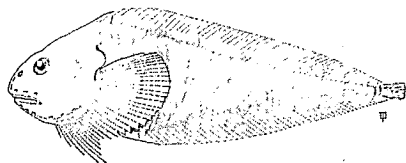
The base, which is embedded in the skin, is usually circular and flat with a slender spine that is somewhat shorter than the diameter of the base. In a specimen of *L. fabricii* exposed to long-wave light from an ultraviolet lamp (Blak-ray model B100-A), both prickles and teeth fluoresced in the dark, suggesting the possibility of similar composition. Exposure of prickles of a male *L. gibbus* to alizarin stain in potassium hydroxide resulted in weak staining of the base and stronger staining of the spine. The unossified basal portion of the spine may give the shaft flexibility.

In mature male *Liparis atlanticus* the rays of the anterior dorsal are elongated and deeply incised, while normal in females and young.

Key to LIPARIDAE of Arctic Canada

- 1 Disk present 2
 Disk absent 7
- 2 Disk several times larger than eye diameter; anal rays 25–42; total vertebrae 38–54; pseudobranch present; nostrils with double opening¹ seasnails/limaces/*Liparis* Scopoli, 1777 3

Disk about diameter of eye; anal rays 45–52; total vertebrae 57–64; pseudo-branch absent; nostrils with single opening (don't confuse



sensory pore with second nostril) sea tadpoles/limaces/*Careproctus* Krøyer, 1862²

- 3 Anterior part of dorsal fin with a notch; anal rays 25–29; pectoral rays 27–31; total vertebrae 38–42 Atlantic snailfish/limace atlantique/*Liparis atlanticus* (Jordan and Evermann, 1898 (p. 13)



No notch in dorsal fin; anal rays 30–42; pectoral rays 32–42; total vertebrae 42–53 (42 only in *L. coheni*) 4

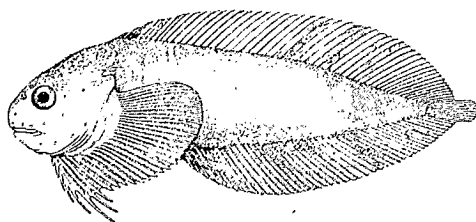
- 4 Anal rays 30–36 (37); peritoneum pale; posterior jaw teeth trilobed in adults 5



Anal rays (36) 37–42; peritoneum dark; posterior jaw teeth simple in adults

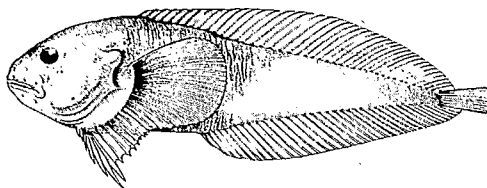


..... gelatinous snailfish/limace gélatineuse/*Liparis fabricii* Krøyer, 1847, (p. 18)



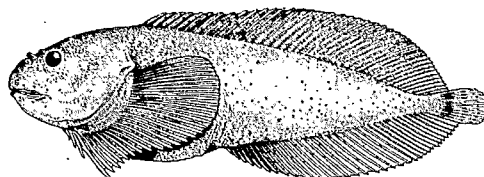
¹ Some extralimital species have a single nostril: *L. choanus*, *L. franzi*, *L. punctulatus*, and probably *L. chefuensis* (Abe 1955; Cohen 1960) and adult *L. montagui* (Andriashev 1954).

² Edwards (1961) recorded *Careproctus reinhardi* Krøyer, 1862 sea tadpole/petite limace from Richmond Gulf, Hudson Bay, Quebec. The second author has a record of *Careproctus* from Franklin Bay, N.W.T.



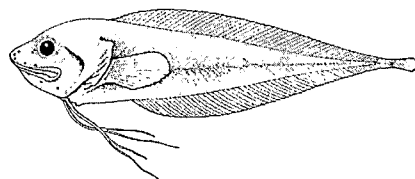
- 5 Usually 8–16 pectoral rays opposite gill opening in adults; posterior teeth in jaws with larger central lobe; pectoral rays (37) 38–42 dusky snailfish/limace marbrée/*Liparis gibbus* Bean, 1881 (p. 25)

Usually 0–7 pectoral rays opposite gill opening; posterior teeth in jaws with lobes equal in size; often with prominent bar on caudal fin; pectoral rays 32–40 6



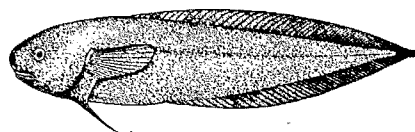
- 6 Dorsal rays (39, 40) 41–43 (44); anal rays (33) 34–36 (37); pyloric caeca in eastern Arctic Canada 25–47 kelp snailfish/limace de laminaire/*Liparis tunicatus* Reinhardt, 1837 (p. 32)

Dorsal rays 36–40 (41); anal rays 30–35; pyloric caeca 14–29 Cohen's snailfish/limace de Cohen/*Liparis coheni* Able, 1976³



- 7 Gill openings large, reaching lower base of pectoral fin; nostrils with double opening; lower pectoral rays long and threadlike, completely separated from rest of fin rays threadfin seasnail/limace à filaments/*Rhodichthys regina* Collett, 1879

Gill openings small, above or reaching just below upper pectoral base; nostrils with single opening; several short rays between upper and lower lobes of pectoral fin *Paraliparis* Collett, 1879⁴ 8

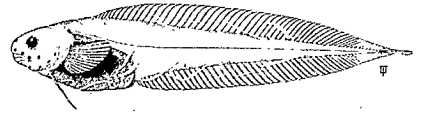


- 8 Body black; anal rays 50–55 black seasnail/limace noire/*Paraliparis bathybius* Collett, 1879
- Body pale; anal rays 51–60 9

³ No Arctic Canadian record known yet.

⁴ For more information on *Paraliparis* see Cohen (1968), Jensen (1950), Karrer (1973), and Wenner (1979).

- 9 Jaw teeth in single row; dorsal rays 60–68; anal rays 55–60; rays in upper pectoral lobe 17 blacksnout seasnail/limace à museau noir/*Paraliparis copei* Goode and Bean, 1896⁵
- Jaw teeth in several rows; dorsal rays 56–59; anal rays 51–53; rays in upper pectoral lobe 13–14 *Paraliparis garmani* Burke, 1912



Genus *Liparis* Scopoli, 1777 snailfishes/
limaces de mer

(*Cyclogaster* Gronovius 1760, 581, fig. 1, 2 (non-binomial, *auctorum*)

Liparis Scopoli, 1777: 453 (type: *Cyclopterus liparis* Linnaeus 1776 (ex Artedi, 1738: 117), by designation of Jordan 1917: 41; gender masculine)

Actinochir Gill, 1865: 190 (type: *Liparis tunicata* Krøyer (nec Reinhardt), by original designation of Gill 1865).

Neoliparis Steindachner 1875: 54 (type: *Liparis mucosus* Ayres)

Careliparis Garman, 1892: 62 (type of subgenus: *Liparis agassizii* Putnam, by designation of Jordan and Evermann 1895)

Lyoliparis Jordan and Evermann 1895: 451 (type of subgenus: *Liparis pulchellus* Ayres, by original designation)

Diagnosis

Disk present; nostrils 2 (sometimes 1); teeth trilobed or simple; suprbranchial pores 2; anterior dorsal rays spinous; pyloric caeca present, less than 150 (usually less than 100); pseudobranchiae present; branchiostegals 6 (Burke 1930).

In addition to the above, all Canadian Arctic *Liparis* show the following characteristics: pectorals bilobed, rays in lower lobe fleshy, especially on distal portions; disk with 13 pads on ventral surface; nostrils 2; genital papillae present in both sexes; cephalic pores 2-6-7-2; pharyngeal teeth simple, in 2 distinct patches on floor and roof of mouth; gill rakers short, knoblike, located on each side of first 3 arches and anterior side of fourth, rakers on adjoining arches intermesh, each raker with small projecting spines.

About 50 or 60 species are described from boreal and Arctic seas of the northern hemisphere; 2 species in the Antarctic.

⁵ No Canadian Arctic record reported yet, but known from just over dividing line in Davis Strait between Greenland and Canada.

SPECIES ACCOUNTS



Liparis atlanticus
(Jordan and Evermann, 1898)

Atlantic snailfish
limace atlantique

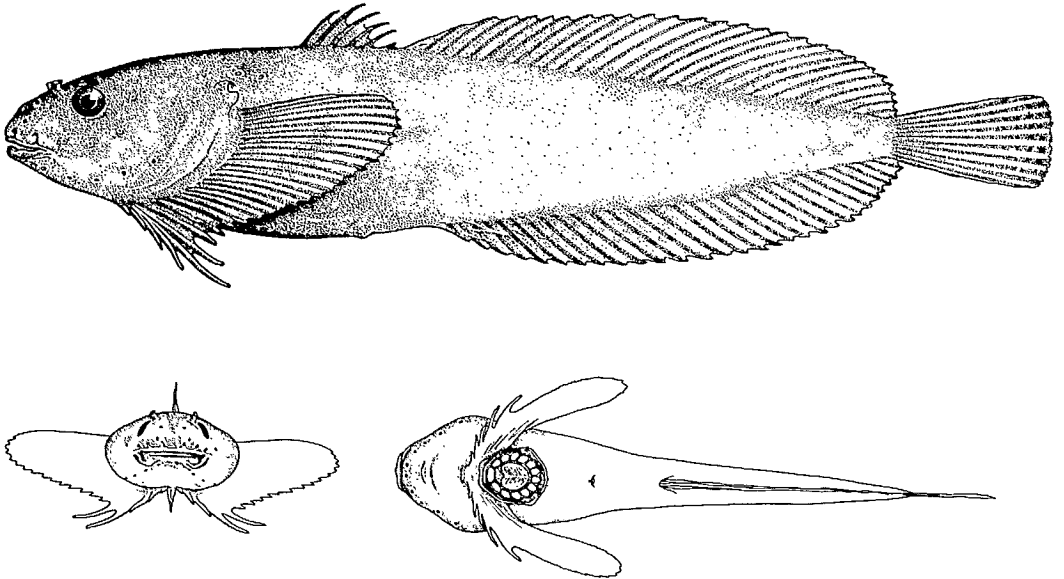


FIG. 5A. 57 mm SL, tide pool, Squid Cove, St. John Bay, Nfld. (NMC 66-181).

Synonymy

ORIGINAL DESCRIPTION

Neoliparis atlanticus Jordan and Evermann, 1898: 2107 (synon., descr., taxon., holotype USNM 47215, 109 mm long, male, from Godbout, Que., 1885; paratypes Salem, Mass., USNM 20367, and Woods Hole, Mass., USNM 40118, and from Newfoundland to Cape Cod).

CANADIAN ARCTIC RECORDS

Liparis atlanticus, Hildebrand 1948: 101 (range, distr., tide pool in Keglo Bay, eastern Ungava Bay, Que.); Dunbar and Hildebrand 1952: 120 (descr., distr. Pitsulasitik, between George and Whale rivers, Ungava Bay, Que.); McAllister 1960a: 47 (taxon., lit.); McAllister 1960b: 19 (key); Leim and Scott 1966: 374, 375 unnumbered fig. (descr., diagnosis, size, range, Canadian distr., biology, key p. 368); nec Emery 1973: 19 (Resolute Bay, N.W.T.); nec Bell 1973: 28 (collected and photographed, but specimen destroyed); nec Turnbull 1974: 1 (2 specimens labeled *L. atlanticus* in ROM collected by Turnbull are actually *L. tunicatus*); Legendre et al. 1975: 10 (listed for Canadian Arctic).

SUPPLEMENTARY REFERENCES

Liparis atlanticus, Burke 1930: 59 (type specimen USNM 47215, distr., relationships, descr. of type specimen, color, diagnosis, thumbtack prickles); Gordon and Backus 1957: 18 (distr., habitat, Hebron Harbour, Lab.); Detwyler 1963: 1 (descr., distr., habitat, food, reprod., devel., parasites N.H.); Van Vliet, 1970: 15 (distr., descr., habitat, Nfld.); Hauser 1973: 50 (spawning season, larval distr., abundance in Sheepscot R. estuary, Me.); Able 1978: 1519 (spawning season, larval distr., depth, abundance in St. Lawrence estuary, Que.).

Etymology—*atlanticus*, in allusion to its occurrence in the Atlantic Ocean.

DIAGNOSIS

The only Canadian Arctic *Liparis* with dorsal fin notched. Fin rays fewer than other species, 25–29 in anal (as opposed to 32–42) and 27–31 in pectoral (as opposed to 32–42). Total vertebrae 38–42 (as opposed to 45–53). Furthermore, dorsal and anal fins overlap caudal fin up to one quarter of length.

DESCRIPTION

MERISTICS

Range, mean, and sample size for Canadian Arctic and Atlantic specimens.

D (31) 32–35; 33.36 (52)
C upper secondary (2) 3–4; 3.72 (50)
C upper primary 5(6); 5.02 (50)
C lower primary 5–6; 5.52 (50)
C lower secondary 1–3; 1.86 (50)
Tot. C 14–18; 16.12 (50)
A 25–29; 26.83 (52)
P left 27–31; 28.72 (51)
P over gill slit 0–1(2); 0.56 (50)
P.C. (23) 24–35 (36–45); 32.06 (51)
G.R. (3) 4–6(7); 4.70 (50)
Abd. vert. 10–11; 10.36 (50)
Caud. vert. (27) 28–30 (31); 29.16 (50)
Tot. vert. 38–41 (42); 39.62 (50)
Teeth in 1st row, upper jaw 4–7; 5.76 (34)
Teeth in 1st row, lower jaw 4–7; 5.79 (33)

Head — Dorsal profile relatively flat with gradual slope to snout, head short, length 22.1–39.5% (mean 25.9) SL. Head relatively narrow, width 18.1–30.7% (mean 22.3) SL. Snout length 6.3–11.0% (mean 8.0) SL. Anterior and posterior nostrils in tubes, anterior much longer. Orbit small, 3.3–8.6% (mean 8.0) SL. Interorbital distance 7.0–13.2% (mean 8.9) SL. Mouth small, does not reach to below front of eyes. Lips fleshy, scalloped due to recessed cephalic pores on upper and lower jaws, lower lip included within upper. Jaw teeth trilobed, anterior teeth in rows with weakly defined lobes, posterior teeth strongly trilobed, each lobe of similar size. Teeth arranged in regular oblique rows. Numerous papillae present on entire surface of floor and roof of mouth. Gill slit opening 1.2–8.3% (mean 6.0) SL.

Body — Broad anteriorly, laterally compressed behind origin of anal fin, height at level of disk 14.4–25.9% (mean 18.8) SL. Skin firm, not as easily detached as in deepwater *Liparis*. Dorsal fin originates behind suprabranchial pores, snout to dorsal origin 25.1–50.4% (mean 33.5) SL; with well-developed notch in mature males. Dorsal fin overlaps caudal 1.1–5.0% (mean 2.7) SL. Snout to anal origin 23.8–66.2% (mean 49.2) SL, anal overlap of caudal 2.2–7.3% (mean 4.4) SL. Caudal fin length 15.2–28.9% (mean 19.9) SL, posterior margin slightly rounded. Longest ray in upper lobe of pectoral fin not quite reaching origin of anal fin, 16.1–28.9% (mean 19.7) SL.

Disk large, 12.3–26.3% (mean 15.7) of SL, originates below posterior margin of eye, snout to disk 11.7–21.7% (mean 15.8) SL, disk to anal origin 7.5–26.9% (mean 18.8) SL. Vent surrounded anteriorly with a fold of skin, approximately midway between posterior margin of disk and origin of anal fin, disk to vent 6.5–20.6% (mean 18.9) SL, snout to vent 33.8–54.8% (mean 39.5) SL. Pyloric caeca fingerlike, on right side of body cavity, shorter caeca under larger ones, longest pyloric caeca 8.1–20.1% (mean 13.8) SL. (Proportions based on 27–63 specimens.)

COLOR

In preserved specimens, dorsal surface is uniformly dark brown, becomes somewhat lighter on the lateral surface, lighter still on the ventral surface and lightest on the disk. Pectoral fins are lightest on ventral portion as well. Rudimentary pores often appear as small black spots. Caudal fins often have 1–3 nearly vertical bars on the anterior portion. Peritoneum is light with a few scattered melanophores, most numerous on dorsal surface of body cavity. Buccopharyngeal cavity is pale. Detwyler (1963) collected live fish that were black, gray, or dark brown. Fins were frequently barred with white, blue, or pink.

SEXUAL DIMORPHISM

The dorsal fin is deeply notched at the 5th or 6th ray and the length of the anterior portion of the fin is one half to more than the head length in mature males. The dorsal fin is barely notched and the anterior portion of the fin is less than half the head length in females. Burke (1930) found prickles in males only during the breeding season, and Van Vliet (1970) reported scattered prickles over the skin of males except on the inner side of the pectoral, the underside of the head, and abdomen. Twelve males averaged 103.7 mm and 33 females 80.4 mm SL.

SIZE

Bigelow and Schroeder (1953) and Leim and Scott (1966) reported a maximum length of 127 mm TL (5 in.). Van Vliet (1970) reported 67 specimens from Newfoundland ranging from 8.7 to 95.5 mm. The largest specimen we examined, a male (NMC 71-660 from the St. Lawrence estuary, Que.), was 144 mm TL and 128 mm SL and weighed 28.4 g. The largest Canadian Arctic specimen was 81.2 mm TL and 76.4 mm SL. The largest specimen from extensive collections in a portion of the Gulf of Maine was 97 mm TL (Detwyler 1963).

Material Examined

Eighty specimens from Arctic Quebec, Newfoundland, Atlantic Quebec, and Nova Scotia ranged from 22.3 to 128.0 mm SL.

From Eastern Canadian Arctic

NMC 59-374 (1), Ungava Bay; NMC 59-457 (1), Adorik, Ungava Bay (specimen dried up).

From Newfoundland

NMC 66-166 (3), St. Margaret's Bay; NMC 66-168 (8), St. John Bay; NMC 66-172 (18), western Newfoundland; NMC 66-178 (16), northern Newfoundland; NMC 66-193 (1), Bonavista Bay; NMC 73-386 (1), Bonne Bay.

From Quebec

NMC 60-194 (1), Kamouraska; NMC 60-211 (2), same; NMC 60-215 (1), Ouelle; NMC 64-627 (1), Ste-Flavie; NMC 71-660 (10), St. Lawrence estuary; NMC 71-656 (6), Gulf of St. Lawrence.

From Nova Scotia

NMC 67-54 (1), Halifax Harbour; NMC 72-99 (3), Kingsport; NMC 72-100 (1), Minas Basin; NMC 72-103 (1), same; NMC 72-246 (2), Black Rock; NMC 77-617 (2), Minas Basin.

Systematics

According to Andriashev (1954) this species is closely related to the European *Liparis montagui* (Donovan, 1804). Andriashev notes that adult *L. montagui* have the posterior nostril covered with skin, fewer total vertebrae, and dorsal and anal rays (35-37, 26-32, and 22-25, respectively). Like *L. atlanticus*, it has low numbers of fin rays and the dorsal fin does not overlap or little overlaps the caudal fin. Burke (1930) found that *L. atlanticus* bore a close resemblance to *L. rutteri* (Gilbert and Snyder, 1898), which ranges from California to the Bering Sea; the latter tends to have fewer dorsal rays (30-33 instead of (31) 32-35) and more pectoral rays (30-32 as opposed to 27-31), and never has prickles, but the spinous dorsal is usually distinct and sometimes elevated as in *L. atlanticus*.

Northern populations (Ungava Bay and Newfoundland) averaged more dorsal and anal rays, pyloric caeca, and caudal and total vertebrae, but fewer pectoral rays and abdominal vertebrae than southern populations (Quebec and Nova Scotia) (Tables 2, 3, 4, 6, 7). Similar trends were found in northern populations of *L. fabricii*.

Distribution

This species is recorded from two collections in Ungava Bay in the Canadian Arctic (Fig. 5B), where it reaches the northern limit of its range.

Distribution extends to southern New England (Bigelow and Schroeder 1953). It has been rarely collected from Rhode Island (Gordon 1974), Connecticut (Pearcy and Richards 1962), and New York (Cooley 1968). A single specimen reported off New Jersey (Bigelow and Schroeder 1953) proved to be *L. inquilinus* (Able 1973). Specimens reported from Resolute, N.W.T. by Emery (1973), MacInnis and Curtsinger (1973), and Bell (1973) are probably misidentified *L. tunicatus* (we identify two Resolute specimens in ROM collected by Turnbull (1974) and labeled *L. atlanticus* as *L. tunicatus*). The northern limit coincides with the 2°C August surface temperature isotherm, the southern limit with 20°C (see map in Steele 1975). For world distribution see Fig. 5C.

Habitat

One collection was made in a tide pool and one in a fjord in Ungava Bay. On the Atlantic coast, this species occurs along rocky shores in tide pools, into the subtidal zone, and according to Burke (1930) down to 91 m. It is often found coiled up under stones, clinging to the undersides or attached by the sucking disk to kelp stalks or other seaweed (Bigelow and Schroeder 1953; Detwyler 1963). However, two of the three specimens collected from Labrador (Gordon and Backus 1957) were in 8-16 m on a hard, sandy-mud bottom. The third was taken along the shore over a sand bottom. Several authors have reported them from sea scallops, *Placopecten magellanicus*, and bay scallops, *Aequipecten irradians*, but these have proved to be misidentified *L. inquilinus* (Able 1973; Able and Musick 1976). Van Vliet (1970) reported *Liparis atlanticus* in exposed tide pools 6-75 cm deep from 9.0-12.5°C (with one at 6°C) and 29.5-30.0‰ salinity. Detwyler (1963) found *L. atlanticus* to be rare inshore at temperatures above 12°C. Most of our collections from the Atlantic coast were from shallow water 1 m deep or less, usually in bedrock tide pools with macroalgae, temperatures 7.0-14.5°C, and salinities 29.5-31.0‰. Only one collection was from more than 20 km offshore. Larvae were planktonic in the St. Lawrence estuary but may have been more abundant near the bottom (Able 1978).

Reproduction

Detwyler (1963) found that, in New Hampshire, this species probably reaches sexual maturity at a length of 60-70 mm as it is entering its

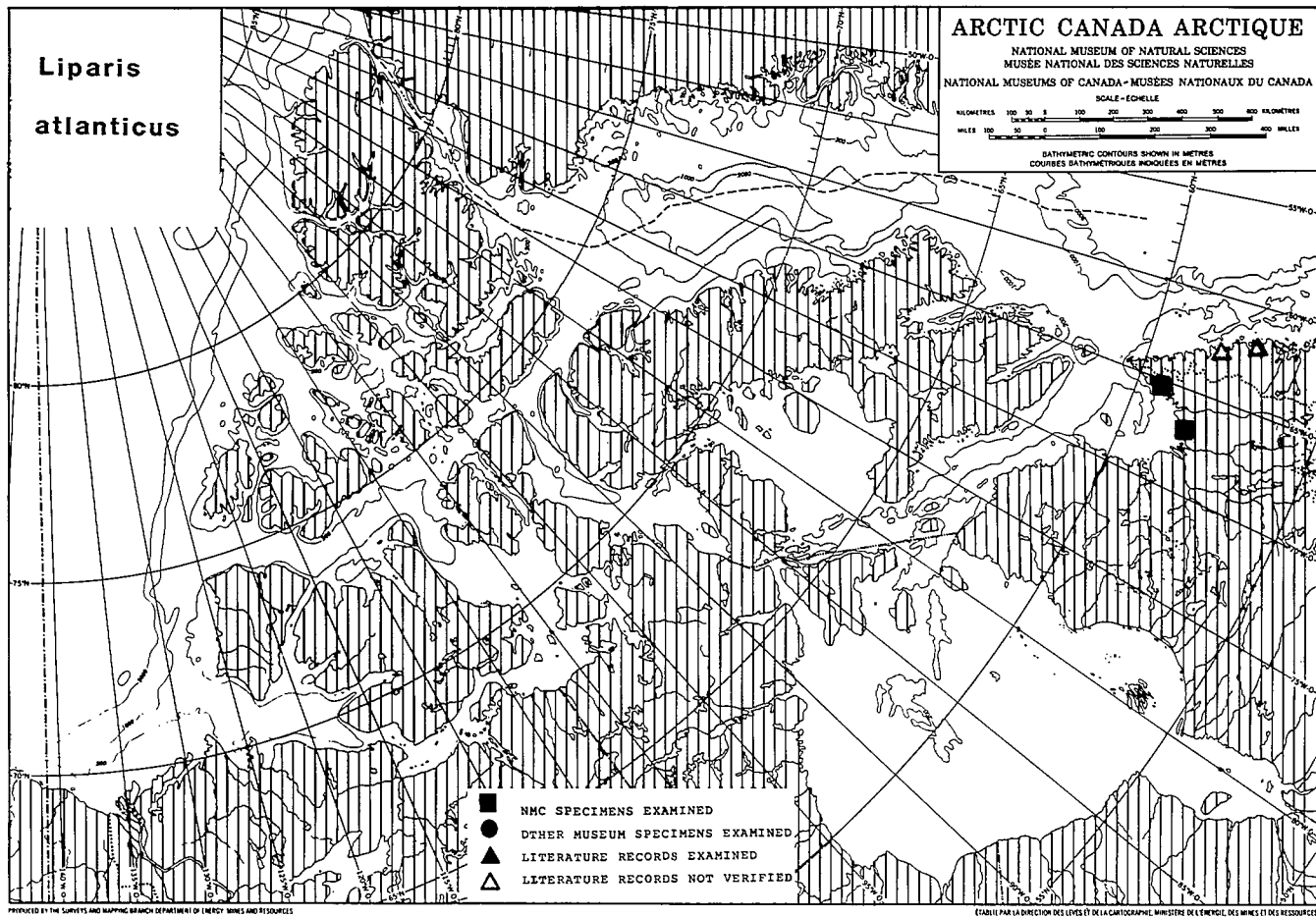


FIG. 5B. Distribution of *Liparis atlanticus* in Arctic Canada.

second year. Mature adults began migrating into the intertidal zone in October prior to spawning in March, and left after spawning ended in June. Females induced the male to select and prepare a spawning site. Larger females spawned several times, depositing small egg masses which the male fertilized and gathered into a single, attached egg mass. In the laboratory, the eggs were hidden among stones and algae. Fertilized eggs were 0.8–1.4 mm in diameter (mean 1.1 mm). Van Vliet (1970) reported females in Newfoundland tide pools in June with ovarian eggs 0.7–1.1 mm in diameter after preservation. Detwyler (1963) also described development up to yolk sac absorption. Burke (1930) reported 12-mm specimens taken July 31. Able (1978) collected recently hatched larvae from June through September in the St. Lawrence estuary. Gordon and Backus

(1957) trawled 35- to 36-mm specimens in Hebron Harbour, Labrador, July 18, 1952.

Food

Stomachs of 48 fish from New Hampshire contained primarily crustaceans and polychaetes (Detwyler 1963).

Predators

None known.

Parasites

A tapeworm, *Spathebothrium simplex*, was common in fish from New Hampshire. Other parasites included trematodes, acanthocephalans, nematodes, and protozoans (Detwyler 1963). Margolis and Arthur (1979) record the protozoan *Haemogregarina* sp. from Quebec specimens.



FIG. 5C. World distribution of *Liparis atlanticus*.

*Liparis fabricii*⁶
Krøyer, 1847

gelatinous snailfish
limace g latineuse

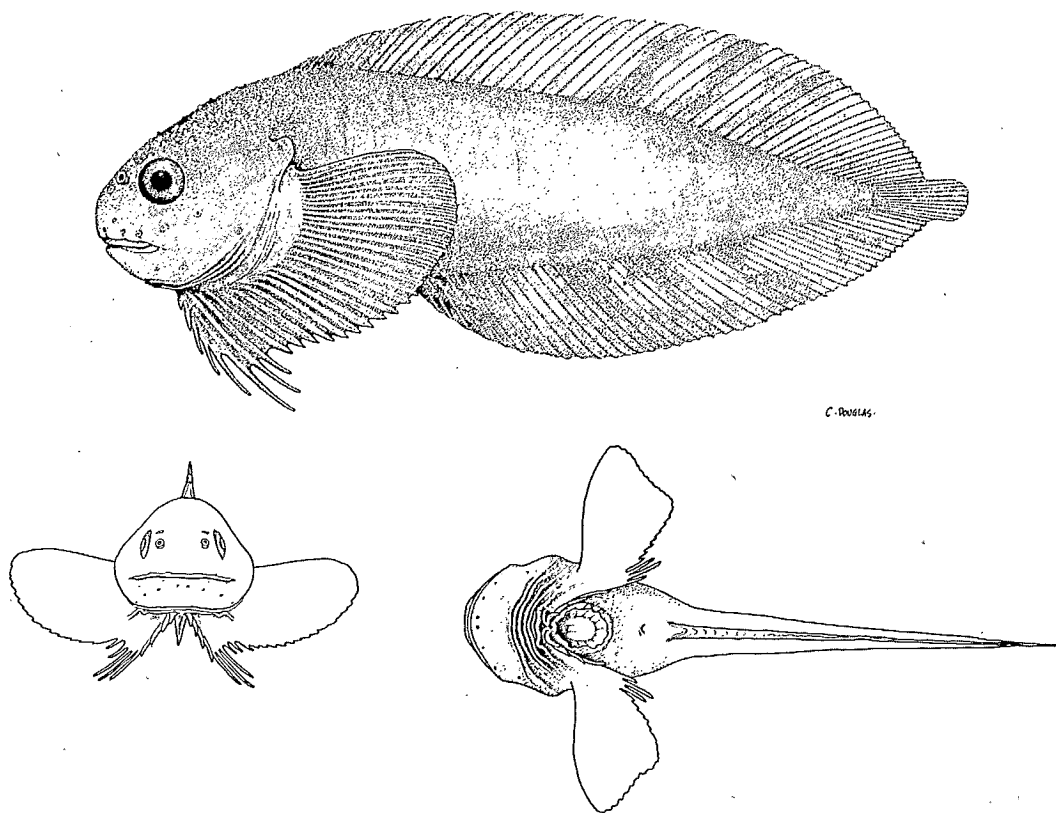


FIG. 6A. 118 mm SL, 162–189 m, Evans Strait, northern Hudson Bay, N.W.T. (NMC 60-70). (Note thumbtack prickles on head and nape.)

Synonymy

ORIGINAL DESCRIPTIONS

Ophidium parrii Ross, 1826: 109 (original descr., habits, distr., Baffin Bay and Prince Regent Inlet, swimming about pieces of ice; whereabouts of holotype unknown, not in BMNH; original description also reproduced in Andriashev and McAllister (1978); proposal before Int. Comm. Zool. Nomencl. for suppression of this name as *nomen oblitum*).

Liparis fabricii Kr yer, 1847a: 274 (syntypes, numbers 116–123, 141, all from Belsund, Spitsbergen, with

117–123 almost dissolved according to Nielsen (1974); Kr yer, 1847b: 18, fig. 2).

Liparis koefoedi Parr, 1932: 12, 39, fig. 6 (synon., diagnosis, descr., taxon., distr., Icefjord, Green Harbor, and Waygats Island all in Spitsbergen; Kara Sea; Barents Sea at 75°5–6'N, 35°54'E; Greenland at 77°31'N, 18°24'W; and at Proven).

CANADIAN ARCTIC RECORDS

Ophidium parrii Ross, 1826: 109 (opp. cit.); Richardson 1836: 274 (distr., descr., ex Ross, 1826); nec Ross, 1835; xlvii (synon., distr., one 10 cm long, ejected from a *Glaucus* gull stomach, shot near Felix Harbour; according to Johansen (MS) and Gunther (1862), this specimen is *Gymnelis viridis*).

Liparis fabricii, Gunther 1877a: 294 (distr.; Discovery Bay, now Harbour; 81°42'N, 65°20'W; Franklin

⁶ The second *i* termination is not optional in this case because the first *i* is part of the root.

Pierce Bay (at 79°25'N, 74°55'W, BMNH 77.2.23); Günther 1877b: 476 (distr.; Franklin Pierce Bay, BMNH 77.2.23-99); Bean 1879: 116 (ex Günther 1877b); Jensen 1910: 12 (distr., descr.; north of the Gaasefjord Peninsula, south Ellsmere Island in 8-27 m, D 48, A 40; also doubtfully referred are 3 small specimens from Gaasefjord); Dunbar 1947: 7 (distr. and descr. of young; Lake Harbour, south Baffin Island).

Uronectes parrii, Gunther 1862: 325 (synon., descr., distr., ex Ross, 1826, proposal of genus *Uronectes* for *Ophidium parrii*); Bean 1879: 115 (lit.); Ehrenbaum 1901: 118, in part (synon., distr.).

Lycocara parrii, Jordan and Evermann 1898: 2478 (descr., distr., synon., compiled); Halkett 1913: 115 (distr., ex Ross, 1926); Jordan et al. 1930: 478 (synon.); McAllister 1960a: 33 (listed, lit.); McAllister 1960b: 14 (key).

Liparis laptevi, Turnbull 1974: 1 (reference not seen, Resolute Bay, probably this species).

Liparis koefoedi, Dunbar and Hildebrand 1952: 122 (distr., descr., taxon.; Port Burwell in cod (*Gadus morhua*) stomachs; off Burwell at stations 103 and 106); Walters 1953a: 253 (descr., distr.: Alert, Ellsmere Island, 7 specimens including one from a tern stomach); Walters 1955: 322 (range, Alaskan records); McAllister 1960a: 48 (lit.); McAllister 1960b: 18 (key); McAllister 1962: 33 (distr., descr., taxon.; 13 km northeast Collinson Head, Herschel Island, Y.T.; 5 km southeast of Herschel (settlement); 3 km south of Simpson Point, Herschel Island); Leim and Scott 1966: 377 (descr., diagnosis, size, range, lit.); Hunter 1968: 361 (listed as new to Hudson Bay); Vogt 1973: 24 (comparison with new species *L. catharus*); Legendre et al. 1975: 10 (listed for Canadian Arctic); Andriashev 1975: 771 (taxon., suggested synonymy of *Ophidium parrii* with *L. tunicatus* or *L. koefoedi*); McAllister and Andriashev 1978: 58 (application for suppression of *Ophidium parrii* considered senior synonym of *L. koefoedi*); Andriashev and McAllister 1978: 710 (taxon., nomencl., reproduction of original description of *Ophidium parrii*).

SUPPLEMENTARY REFERENCES

Liparis fabricii, Koefoed, 1909: 12, fig. 10, 11 (descr., fig. larvae 7.5-12.0 mm long, 40 anal rays in one, Spitsbergen, East Greenland).

Liparis major, Burke 1930: 90, fig. 19 (teeth synon., relationships, descr., diagnosis, taxon., key); Briskina 1939: 351 (food in Barents Sea); Hildebrand 1948: 102 (range, taxon.); Huntsman et al. 1954: 249 (planktonic young from Strait of Belle Isle, Gulf of St. Lawrence).

Liparis koefoedi, Backus 1951: 292 (distr., depth, size, Labrador); Andriashev 1954: 459, fig. 267-269 (synon., descr., taxon., distr., biol., spawn September-October, 485-735 eggs, food); Backus 1957: 322 (distr., size, meristic counts, taxon., geogr. variation, morphometry, prickles); Nizortsev et al. 1963: 1417 (fig., food, morph.); Lucio 1966: 32 (Grand Bank at 48°15'N, 51°10'W, Aug. 2, 1957); Quast and Hall 1972: 31 (lit., distr.); Lindberg 1973: 609 (synon., habi-

at 40-600 m, White Sea, Barents Sea, Spitsbergen, Norwegian Sea, Greenland, Labrador, generally Arctic Ocean); Green and Steele 1977: 11-83 (diving observations under ice on habits and feeding at Resolute, N.W.T.).

Etymology — *fabricii*, after Othonis Fabricii, naturalist and author of *Fauna Groenlandica*.

Diagnosis

The only Canadian Arctic *Liparis* with black peritoneum and (36) 37-42 anal rays (others have 26-36 (37) anal rays and pale peritoneum). Additionally, adults have relatively large eyes and simple unlobed teeth in the inner portion of the jaws, whereas other species have small eyes and trilobed teeth.

Description

MERISTICS

Range, mean, and sample size for Canadian Arctic specimens.

D (43) 44-48; 45.82 (95)

C upper secondary 1-3; 2.01 (81)

C upper primary 4-5; 4.14 (86)

C lower primary 4-5 (6); 4.86 (86)

C lower secondary 1-2; 1.29 (83)

Tot. C 11-14; 12.30 (78)

A (36) 37-40 (41, 42); 38.72 (95)

P left (32) 33-37; 34.93 (87)

P over gill slit (3, 4) 5-11 (12); 7.31 (75)

P.C. (19) 20-30 (31, 34); 25.34 (80)

G.R. (5) 6-9; 7.05 (78)

Abd. vert. (8, 9) 10-12; 10.73 (88)

Caud. vert. 38-42; 39.91 (87)

Tot. vert. (48) 49-51 (53); 50.64 (87)

Teeth in 1st row, upper jaw 4-7 (8); 5.29 (75)

Teeth in 1st row, lower jaw 4-6 (7); 5.07 (76)

Head — Short, 21.9-32.9% (mean 26.8) SL, laterally compressed, head width 14.7-27.3% (mean 19.6) SL. Dorsal profile sloping steeply from origin of dorsal fin to snout. Snout length 4.5-10.1% (mean 7.3) SL. Anterior nostrils in short tubes, posterior nostrils a slit. Orbit large, 5.3-10.3% (mean 7.6) SL. Interorbital distance 7.1-13.8% (mean 9.5) SL. Mouth reaches to level of middle of eye, lower lip included within upper. Jaw teeth arranged in short oblique rows; anterior teeth in rows smaller, trilobed, with larger central lobe; posterior teeth larger with prominent central lobe, often lateral lobes almost or completely lacking; teeth appear simple in large adults. Papillae

present on floor and roof of mouth, variable in abundance and size. Gill slit opening overlaps upper portion of pectoral fin, length of gill slit 5.5-15.0% (mean 9.7) SL.

Body—Deep, height at level of disk 18.5-27.7% (mean 22.9) SL; laterally compressed, especially behind level of origin of anal fin. Skin thin, loose. Rudimentary pores present but often difficult to detect if skin damaged. Dorsal fin originates at level of suprabranchial pores, snout to dorsal origin 20.2-36.5% (mean 26.8) SL; longest rays approximately two-thirds distance from origin of fin, these about 15% SL. Dorsal fin overlap of caudal 3.8-13.9% (mean 7.6) SL. Snout to anal origin 30.9-53.7% (mean 43.7) SL and anal fin overlap of caudal 6.0-19.3% (mean 9.3) SL. Caudal fin length 6.7-22.5% (mean 16.6) SL, posterior margin rounded. Pectoral fin bilobed, with shallow notch at 8th or 9th rays from ventralmost ray; rays in lower lobe separate and fleshy at posterior portion, especially longest rays in lower lobe; longest ray in upper lobe reaching beyond origin of anal fin, 13.8-27.3% (mean 21.0) SL. Disk small, 7.8-24.6% (mean 12.2) SL, originates below posterior margin of eye; snout to anterior margin of disk 10.4-27.9% (mean 15.8) SL; posterior margin of disk to anal origin 8.0-24.9% (mean 17.1) SL. Vent located midway between posterior margin of disk and origin of anal fin; disk to vent 3.6-17.0% (mean 9.2) SL; snout to vent 25.9-42.7% (mean 34.8) SL. Longest pyloric caecum 7.4-20.2% (mean 11.8) SL. (Proportions based on samples from 65-113 specimens.)

COLOR

Based on preserved specimens, coloration varies with length. Smaller specimens have a uniform brown background and some have distinct patches of darker color, smaller than the eye, on the tail. Posterior portions of the dorsal and anal fin have three or four posteriorly directed oblique bars. This color pattern is retained longest on preserved material and is often also visible on large adults. In adults, the dorsal surface is darker, somewhat lighter on ventral surface of the head and disk. Posterior margin of the pectoral fin is light also. Dorsal, anal, and pectoral fins are dark brown or black. Interior of the mouth, opercular cavity, gill arches, peritoneum, and stomach have numerous melanophores. Melanophores lining the peritoneum are fewest in small specimens and uniformly scattered, increase in number with increasing size, and eventually completely cover the peritoneum. The lining of the peritoneum may be more visible externally in smaller specimens due to lack of skin

pigmentation. The dark peritoneum is less visible externally in larger specimens except in the immediate area of the vent.

SEXUAL DIMORPHISM

Apparently males develop prickles during the breeding season or at sexual maturity. Prickles are distributed over the dorsal and lateral surface of the head and body (Fig. 6A). On the head they occur anteriorly to the nostrils and laterally to the level of the eye. On the body they are on the anterior portion of the dorsal fin and laterally to above the pectoral fin. Similar observations have been made by Backus (1957). The prickles have a striated cone-shaped base and a short spine. Prickles were observed on a specimen collected Aug. 10, 1875 (BMNH 77.2.23-99); Aug. 11, 1954 (NMC 60-70); Aug. 6, 1960 (NMC 60-476); a 152-mm SL male Aug. 31, 1952 (FRB St. John's 4263); and in 6 specimens 65-79 mm SL Aug. 4-12, 1966. In the last 6 specimens the prickles were found only on the top and upper sides of the head and nape.

Of the 16 meristic characters examined, only 1 showed a significant difference at the chosen level of probability of 0.01. For 32 males the mean pyloric caeca count was 24.2 and for 34 females 25.7, which gave a *t*-value of 3.83 and a level of probability of less than 0.001. The number of teeth in the lower jaw, 5.7 for 29 males and 4.1 for 31 females, approached significance at a probability of 0.05-0.02 but did not pass the selected level. The samples used included specimens from Alaska and Canada. Twenty-eight males averaged 76.4 mm and 34 females 65.0 mm SL.

SIZE

The largest Canadian Arctic specimens were a 174.0-mm TL (152-mm SL) male from Frobisher Bay, N.W.T. (FRB St. John's 4267) and a 127.0-mm TL female. A 149-mm TL (137-mm SL) male (NMC 77-976) weighed 38.9 g. Andriashev (1954) reported the species to reach 172 mm in the Kara Sea and 182 mm (presumably total length), but usually less in the White Sea, USSR.

Material Examined

One hundred and thirty-two specimens from Alaska, Yukon, Northwest Territories, Arctic Quebec, Greenland, and Spitsbergen, 40-152 mm SL.

From Alaska

NMC 74-284 (4), Beaufort Sea 44 km north of Maguire Islands.

From Yukon and Northwest Territories, western Canadian Arctic

NMC 60-476 (8), Herschel Island; NMC 62-415 (1), Creswell Bay; NMC 65-366A (1), Franklin Bay; NMC 65-373 (1), Parry Peninsula; NMC 75-149 (4), Starvation Cove; NMC 75-1929 (1), Beaufort Sea; NMC 77-976 (1), Franklin Bay; NMC 77-1361 (10), Victoria Island; NMC 77-1363 (7), same; NMC 77-1367 (4), same; NMC 77-1379 (5), same; NMC 77-1397 (8) same.

From Northwest Territories, northern Canadian Arctic

NMC 58-266 (4), Ellesmere Island; NMC 60-445 (1), Hole in Fog Bay; NMC 62-402 (2), Ellesmere Island; NMC 62-379 (2), Barrow Strait; NMC 65-362 (1), Somerset Island; NMC 77-008 (1), Prince Leopold Island; UZMO J 6657 (1), Gaasefjord, Ellesmere Island; BMNH 77.2.23.23 (1), Discovery Bay; BMNH 77.2.23-99 (1), Franklin Piercc Bay.

From eastern Canadian Arctic

NMC 59-362 (1), Ungava Bay; NMC 59-408 (3), same; NMC 59-409 (1), same; NMC 59-472 (1), Frobisher Bay; NMC 60-45 (2), same; NMC 60-63 (1), off Term Point, Hudson Bay; NMC 60-69 (1), Evans Strait; NMC 60-70 (2), same; NMC 60-105 (1), Cape Jensen; NMC 62-504 (1), Roes Welcome Sound; NMC 75-1953 (7), Strathcona Sound; FRB St. John's 4263 (7), Davis Strait east of Frobisher Bay; FRB St. John's 4437 (3), Hudson Strait; FRB St. John's 4347 (4), Ungava Bay; FRB St. John's 4363 (3), Hudson Strait; FRB St. John's 4449 (4), same.

From Greenland

FRB St. John's 6704 (5), west of Disco Bay; FRB St. John's 6609 (1), same; AMNH 4965 (1), Faulke Fjord.

From Spitsbergen

UZMB 6509 *L. koefoedi* type series (8), Green Harbor, Tavik Strait; UZMB 2132 (3), same; UZMC 141, *L. fabricii*, syntype (1), Belsund.

From Atlantic Canada

FRB, St. John's 2371 (2), Lake Melville, Labrador.

Systematics

Andriashev and McAllister (1978) and McAllister and Andriashev (1978) showed that *Ophidium parrii*, described from Baffin Bay and Prince Regent Inlet, is a senior synonym of *L. koefoedi* and proposed to the International Commission of Zoological Nomenclature that *Ophidium parrii* be suppressed, as it had not been correctly applied for over 50 yr, and was previously considered a zoarcid. Since 1978 we have examined specimens of *L. fabricii* collected offshore in Baffin Bay, the only *Liparis* known there to date, and provided confirmatory evidence that this species does occur in the type locality and habitat.

Examination of one of the syntypes of *Liparis fabricii* Krøyer shows that, contrary to Parr (1932) and Lindberg (1973) and in agreement with some earlier authors, this species is conspecific with *L. koefoedi*. This is indicated by the 37 or more anal rays and 52 vertebrae (counted from an x-ray) and black peritoneum of the syntype. Most remaining syntypes are in poor condition (Nielsen 1974) and could not be examined. *L. fabricii* has priority over *L. koefoedi* and, therefore, replaces the latter name, if the Commission favors suppression of *Ophidium parrii*.

McAllister (1962; see Andriashev 1954: 459) judging by ray counts and disk size, suggested that *Liparis laptevi*, described from Tamir, Arctic USSR, was based on a specimen of *L. fabricii*, which lacked the usual dark peritoneum.

Nizortsev et al. (1963) reported eight specimens from the Barents Sea that resembled *L. koefoedi*, but had forked caudal fins. Andriashev (1954) suggested that *Cyclogaster liparis* forma *megalops* Smitt, 1893 and *Liparis fabricii* var. *leprosa* Lutken, 1887 may be synonyms of *L. koefoedi* (our *L. fabricii*), and Lindberg (1973) included them in the synonymy of *L. koefoedi*. However, *L. fabricii* Krøyer, 1847, has priority over both these names. *L. fabricii*, var. *leprosa*, according to Lutken (1887), has 36-40 anal rays and large eyes that would, without examining the types, confirm identity with *L. fabricii*.

The name *Liparis major* has been applied to this species. The original definition of the variety by Fabricius (1780) is identifiable with *L. gibbus* (see discussion under that species), but later authors, Gill (1865), Burke (1930), etc., have applied *L. major*, we believe erroneously, to what we call *L. fabricii* in this Bulletin.

Northern Canadian Arctic populations had more dorsal and anal fin rays, pyloric caeca, caudal and total vertebrae, and fewer pectoral fin rays than more southern Canadian Arctic populations (Tables 2, 3, 4, 6, 7). Similar trends were noted for northern populations of *L. atlanticus*.

Backus (1957) reported considerable variation in several morphometric characters for various populations. His data suggested that material from Ellesmere Island differed in pigmentation and head size from Labrador populations, but that these two were more similar to each other than material from Spitsbergen.

Distribution

Liparis fabricii is circumpolar and occurs in northern seas of USSR, Arctic Alaska and Canada, Atlantic coast of Canada, Greenland,

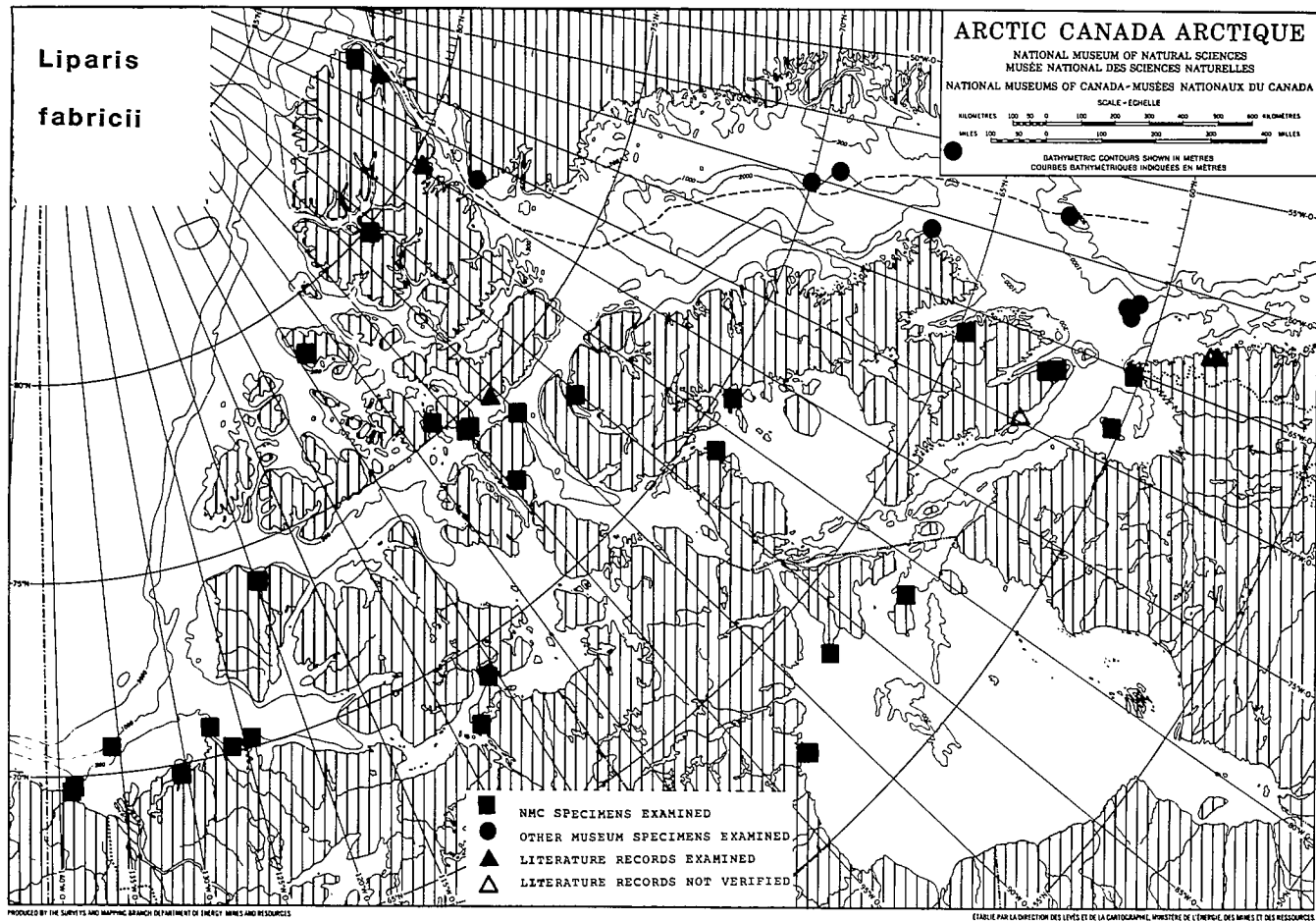


FIG. 6B. Distribution of *Liparis fabricii* in Arctic Canada.

near Iceland, Norwegian Sea, and Spitsbergen. In the Canadian Arctic it ranges from northern Ellesmere Island to 48°15'N, 51°10'W on the Grand Banks (Lucio 1966) (Fig. 6B). It and *L. tunicatus* are the most northerly of the species of *Liparis*. For world distribution of *L. fabricii* see Fig. 6C.

Habitat

This species is probably both benthic, as suggested by its developed sucking disk, and pelagic. Andriashev and McAllister (1978) presented evidence for occurrence in mid-water — Hyperiidæ in stomachs and collection of a 3.8-cm specimen in a stramin net towed at 65 m over much deeper water near Hershel Island, Y.T. Another collec-

tion was made with a midwater trawl between 250 and 300 m. *Ophidium parrii* (synonym of *L. fabricii*) was collected swimming among ice floes.

Our collections (Table 1) show a probable preference for depths over 50 m when one allows for more collections at shallower depths. But some catches may have been made in mid-water as the trawls descended or ascended. At least 15 catches were made 20 km or more offshore. These offshore catches represent a much greater proportion than for any other Arctic *Liparis*. Andriashev (1954) reported the species from 40 to 600 m, mostly 100–300 m, and predominantly below 0°C in USSR waters. Our catches were taken at salinities 30.3–34.4‰ and temperatures -1.5° to 0.56°C (with one at 6.5°C). Most collections (20



FIG. 6C. World distribution of *Liparis fabricii*.

out of 22) were in trawl hauls over mud and mixed mud and sand, or shell or detritus substrates; one was from pebbles and sand and one from stones and shell.

Reproduction

Andriashev (1954) reported eggs of three sizes, the largest from 2.1 to 2.7 mm in diameter (medium and large eggs numbered 485-735), and suggested spawning extends from September to October. Dunbar (1947) recorded young 12-31 mm taken July 30-Aug. 23 near Labrador and Baffin Island, and gave a description of their color pattern. Hunter et al. (1980) recorded larvae 15-25 mm TL taken at Brevoort Island, southeast Baffin Island, Aug. 8.

Food

Nizortsev et al. (1963) found the following food items in stomachs of specimens taken by trawl in the Barents Sea: Mysidacea, Euphausiacea, Polychaeta, Gammaridae, *Pandulus borealis*, *Pseudomma roseum*, *Phascolosoma*, *Hali-rages fulvocinctus*, and *Stegocephaloides*

christianiensis. Johansen (MS) reported fragments of algae and three *Mysis oculata*, half a dozen littoral amphipods, and one nereid chaetopod from stomachs of Günther's (1877a) specimens (11 and 12 cm long, 27 m, Discovery Bay, August). Green and Steele (1977) reported the dominant food of this species to consist of amphipods in December and June at Resolute, N.W.T.

Predators

Dunbar and Hildebrand (1952) reported about 20 specimens taken from cod (*Gadus morhua*) stomachs at Port Burwell. Walters (1953b) recorded a specimen collected by S. D. MacDonald from the stomach of a tern, and Jensen (1909) noted a specimen (as *L. fabricii*) from a seal stomach in East Greenland. The National Museum of Natural Sciences has a young specimen collected on a ledge beside a murre chick on Prince Leopold Island, N.W.T.; presumably it was captured by an adult murre.

Parasites

None known.

Liparis gibbus
Bean, 1881

dusky snailfish
 limace marbrée

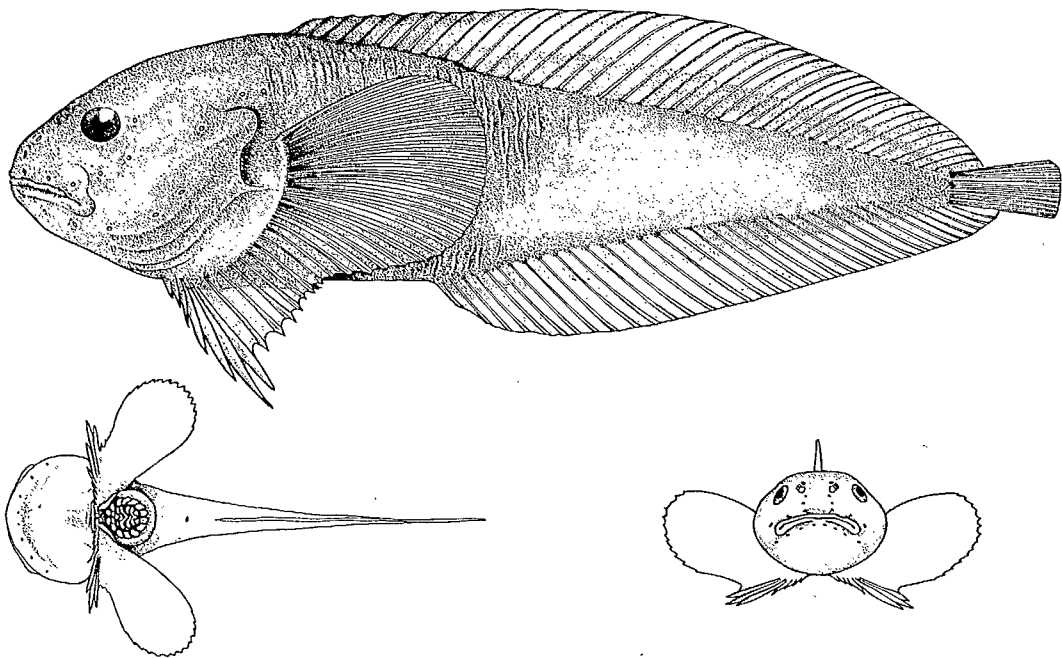


FIG. 7A. 185 mm SL, 120 m, Hudson Bay near Richmond Gulf, Que., 56°11'N, 76°42'W (NMC 62-554).

Synonymy

ORIGINAL DESCRIPTIONS

[*Cyclopterus liparis altera major* Fabricius, 1780: 136 (Greenland; nonbinomial, type no longer extant).]

Liparis gibbus Bean, 1881: 148 (USNM 24010 (1) Unalaska, Bering Sea, W. H. Dall; USNM 24047 (1) Saint Paul Island, Bering Sea, 1872, H. W. Elliot; USNM 26625 (1) off Cape Tchaplín, Siberia, 1880, Dall and Bean; USNM 27535 (1) Plover Bay, Siberia, 1880, Dall and Bean; USNM 27545 (2) Plover Bay, Siberia, 1880, Dall and Bean; original description, live color of specimen USNM 26625 dredged off Indian Point (Cape Tchaplín, E. Siberia, Bering Strait)).

Liparis cyclostigma Gilbert, 1895: 446 (original descr., one specimen, 360 mm long, from Bristol Bay, Bering Sea, Alaska, at *Albatross* station 3252, 57°22'20"N, 164°24'40"W in 53 m (depth of 295 fath. by Burke 1930 is in error) at 44.8°F, on black mud bottom, June 14, 1890; holotype USNM 48621; color description in error, properly applies to *Crystallichthys cyclopilus* as noted by Gilbert and Burke 1912).

CANADIAN ARCTIC RECORDS

Liparis cyclostigma, Vladykov 1933: 35 (distr., descr., *Loubyrne* station 40, 58°39'N, 85°18'W, 58 m, stone; *Loubyrne* station 42, 57°49'N, 82°14'W, 142 m, stone; fragments of 7 young specimens, probably this species, from stomach of *Gadus callarias* (synonym of *G. morhua*), Hudson Bay; Hildebrand 1948: 103 (range); McAllister 1960a: 48 (lit.); McAllister 1960b: 18 (key); Leim and Scott 1966: 376, unnumbered fig. (descr., diagnosis, size, range, Canadian distr.); Emery 1973: 19 (in part, (ROM 27668) habits, Resolute Bay, N.W.T.); Legendre et al. 1975: 10 (listed for Canadian Arctic; new English vernacular).

Liparis tunicatus, Dunbar and Hildebrand 1952: 121 (*partim*, perhaps station 126, off Payne Bay, Ungava Bay, Que.).

SUPPLEMENTARY REFERENCES

Liparis cyclostigma, Burke 1930: 79 (synon., type specimen, distr. *Albatross* stations 3252, 4777, 4779, 4789, 4795, 4796, relationships, closely resembles *L.*

gibbus, diagnosis); *Liparis* sp., Backus 1957: 326 (distr. Labrador, taxon., descr., habits, -1.85 to -0.8°C , 24–227 m in bottom trawls on mud, rocky, and sand bottoms); Gordon and Backus 1957: 19 (taxon., meristics, morph., habitat, Hebron Fjord); Drainville 1970: 642, 648 (habitat, distr., Sagucnay Fiord, Qué.); Able 1976: table 1 (meristics in western North Atlantic); Able 1978: 1519 (larvae, distr., depth, spawning).

Liparis gibbus, Andriashev 1954: 456 (synon., distr., taxon.; *L. cyclostigma* is questionably placed in the synonymy of *L. gibbus*).

Liparis tunicatus, Vladykov and Tremblay, 1935: in part, 80 (Trois Pistoles, (Que.); Leim and Scott 1966: in part, 378, fig. (Trois Pistoles, Que. in St. Lawrence estuary); Drainville 1970: 640 (distr., Saguenay Fiord, Que.); Quast and Hall 1972: 30 (distr., lit., Aleutian Islands, southeastern Alaska).

Etymology — *gibbus*, a hump or hunch in reference to the somewhat elevated vertex and nape.

Diagnosis

Differs from most other specimens of Canadian Arctic *Liparis* in usually having 38–42 pectoral rays (instead of 32–37) and 8–16 pectoral rays (instead of 0–7) opposite gill opening in adults. Teeth in posterior part of jaws have the central cusp larger than the lateral cusps in adults.

Description

MERISTICS

Range, mean, and sample size for Canadian Arctic specimens.

D 40–45; 42.03 (38)

C upper secondary 2–4; 2.52 (33)

C upper primary (4) 5; 4.97 (34)

C lower primary 5–6; 5.12 (34)

C lower secondary 1–2 (3); 1.47 (34)

Tot. C 13–17; 14.09 (33)

A 34–37; 35.05 (37)

P left (37) 38–42; 39.66 (32)

P over gill slit (4, 5, 6) 8–14 (15, 16); 10.19 (31)

P.C. 23–36 (39, 42); 30.69 (35)

G.R. 6–10; 7.55 (31)

Abd. vert (10) 11–12; 11.11 (35)

Caud. vert. (34) 35–38; 36.31 (35)

Tot. vert (45) 46–49; 47.43 (35)

Teeth in 1st row, upper jaw 6–10 (11, 12); 8.39 (28)

Teeth in 1st row, lower jaw 5–10 (11); 7.75 (28)

Head — Large, 22.8–34.8% (mean 28.6) SL, width 14.8–32.8% (mean 23.5) SL; dorsal profile rounded gently from level of gill slit to tip of snout. Snout length 6.6–12.6% (mean 9.4) SL. Anterior nostril in tube, posterior nostril raised

pore without projection on anterior portion. Orbit small, 2.5–7.9% (mean 4.9) SL. Interorbital distance 7.0–16.2% (mean 10.8) SL. Mouth large, terminal, reaches below front of eye. Lips with scalloped appearance due to cephalic pores on upper and lower jaw. Jaw teeth numerous, in regular oblique rows, shape trilobed, anterior teeth in rows, small with lobes of similar size; posterior teeth larger, recurved with much larger central lobe (Fig. 4A), latter most pronounced in adults. Papillae present in mouth, largest and most abundant anterior to esophagus and on medial surface of roof of mouth. Gill slit opening overlapping upper portion of pectoral, length 6.2–15.1% (mean 11.1) SL.

Body — Broad anteriorly, laterally compressed behind origin of anal fin, height at level of disk 18.0–26.9% (mean 22.7) SL. Rudimentary pores in line behind suprabranchial pores, present but not often numerous. Dorsal fin originates behind level of suprabranchial pores, snout to dorsal origin 23.7–41.1% (mean 30.9) SL, anterior rays not notched. Dorsal fin overlap of caudal 2.4–15.9% (mean 8.6) SL. Anal fin originates where body becomes laterally compressed; snout to anal origin 41.7–59.1% (mean 48.0) SL, anal overlap of caudal 5.7–17.4% (mean 10.9) SL. Caudal fin length 4.7–26.1% (mean 18.7) SL. Pectoral fin large, bilobed, notched at 8th or 9th rays from ventralmost ray, rays in lower lobe separate and fleshy at posterior portion, especially longest rays in lower lobe. Upper lobe fan-shaped, longest ray extending beyond origin of anal fin, length 12.9–35.6% (mean 26.3) SL.

Disk length 9.5–16.3% (mean 12.8) SL, originates below posterior edge of eye, snout to anterior margin of disk 12.3–25.5% (mean 16.8) SL, posterior margin of disk to anal origin 10.9–29.7% (mean 19.0) SL. Vent located approximately midway between posterior margin of disk and origin of anal fin, disk to vent 4.8–15.2% (mean 10.2) SL, snout to vent 33.0–47.6% (mean 39.6) SL. Longest pyloric caecum 7.9–23.3% (mean 15.5) SL. (Proportions based on 66–108 specimens.)

COLOR

Preserved specimens are dark brown over most of the body and lighter brown on disk, vent, and ventral surface of head. Some specimens have dark, faded blotches on head and body. Many specimens are darkest on posterior portion of dorsal, anal, and pectoral fins. Caudal fin often has two or three broad dark bands. Recently collected specimens from the Gulf of St. Lawrence show the above pattern and some specimens

have pronounced dark horizontal stripes extending continuously from the dorsal surface of the head to the caudal fin. One male specimen, from Arctic Canada (NMC 64-670 from Roes Welcome Sound, northwest Hudson Bay) exhibited a striped color pattern (Fig. 7B). Eye is black. Peritoneum has a few scattered melanophores, primarily in dorsal portion of body cavity.

The following color notes on large fresh specimens are by Gordon and Backus (1957). Background is pale reddish pink with brassy yellow overtones; chin and disk white; upper head and sides vermiculated with greenish brown, melanophores are fairly dense on upper head. Edges of pectorals are dark with green tone; vertical fins banded alternately with light and blackish areas.

A live specimen photographed in an aquarium (148.5 mm SL, male, 248–236 m trawl haul, Franklin Bay, Beaufort Sea, N.W.T. (NMC 77-957)) had the following coloration. Head and body dark reddish brown becoming less intense posteriorly where yellowish tints were evident. Iris yellowish brown, much lighter than rest of head. Underside of head whitish. Dorsal, anal, and caudal fins with charcoal patches and bands. Wide bar slanting backwards at base of caudal fin. Basal half of anal fin much lighter and sharply demarcated from rest of fin. Pectoral fin even dusky gray except tips of rays of lower lobe were lighter.

SEXUAL DIMORPHISM

Thumbtack prickles are present on males, none on females. Largest prickles are on the head, extending onto snout and below the level of the

eye; others are distributed over the dorsal fin and upper third of the lateral surface of body to caudal base. T-tests for sexual dimorphism in the 16 meristic characters revealed significant differences in only pectoral fin rays and number of teeth in first row of upper jaw (probability of 0.01–0.001). Right pectoral rays averaged 40.4 in males and 39.0 in females, with standard deviations of 1.6 and 1.5 (left pectoral rays were lower but not significantly so in females); upper teeth averaged 10.6 in males and 9.3 in females with standard deviations of 2.3 and 1.8. Significance was approached at a probability of 0.05–0.02 in teeth in first row of lower jaw, gill rakers, pyloric caeca, and abdominal vertebrae where the female had fewer parts. Thirty-four males averaged 185 mm and 24 females 111 mm SL.

SIZE

This is the largest species of *Liparis* known from the Canadian Arctic. The largest Canadian Arctic specimens were 236 mm TL (203 mm SL) male (NMC 65-369) from Darnley Bay, N.W.T. that weighed 187.6 g, and a 206-mm TL female (NMC 62-554) from Richmond Gulf, Que. A 282-mm TL male and a 240-mm TL female have been collected from the Gulf of St. Lawrence. A 524-mm TL (433 mm SL) female from 58°N, 154°W, in Alaska (BC 62-712) weighed 1027 g. Barsukov (1958) reported a male *L. gibbus* from Bering Sea 384 mm long weighing 650 g and another male 350 mm and 475 g. In general, the largest specimens were from Alaska, with mean 210 mm SL for 52 specimens; 40 specimens from

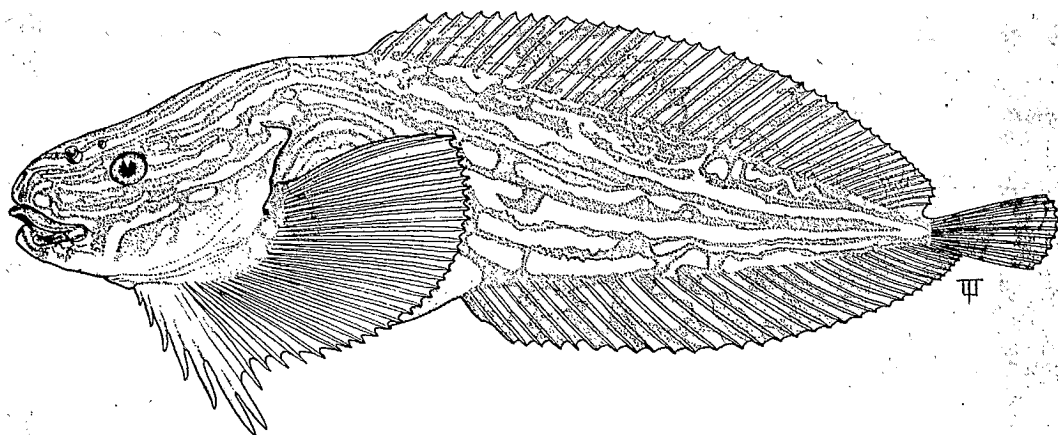


FIG. 7B. Striped color pattern of *Liparis gibbus*, 132 mm SL, 5 m, Roes Welcome Sound, Hudson Bay, N.W.T. (NMC 64-670).

Arctic Canada averaged 98 mm SL and 37 specimens from Atlantic Canada averaged 114 mm SL.

Material Examined

One hundred and sixty-four specimens from Alaska, Northwest Territories, Newfoundland, Quebec, and Nova Scotia 34.9–433 mm SL.

From Alaska

BC 61-544 (1), Frederick Sound; BC 62-438 (1), Kashivik Bay; BC 62-452 (2), Shelikof Strait; BC 62-494 (1), same; BC 62-514 (1), same; BC 62-517 (1), Raspberry Strait; BC 62-650 (1), Shelikof Strait; BC 62-673 (1), Gulf of Alaska; BC 62-698 (1), Savak Island; BC 62-704 (1), Gulf of Alaska; BC 62-710 (1), Shelikof Strait; BC 62-712 (1) same; BC 62-741 (4), same; BC 62-746 (1), same; BC 62-994 (2), Alaska; BC 62-997 (1), Kachemak Bay; BC 62-999 (1), same; BC 63-109 (1), same; BC 63-120 (1), Alaska; BC 63-352 (1), Alaska; BC 63-354 (1), Bristol Bay; BC 65-362 (1), same; BC 65-491 (2), Glacier Bay; BC 65-708 (2), Bering Sea; ABBL 62-276 (1), Auke Bay; ABBL 66-941 (1), Gulf of Alaska; BC 65-714 (4), Bering Sea; BC 73-21 (1), Kalsin Bay; BC 73-23 (1), same; BC 73-25 (3), same; NMC 74-284 (1), Beaufort Sea ca. 4 km N Maguire Islands; NMC 77-1 (1), Gulf of Alaska; NMC 77-2 (1), same; SOSC BS 22002 (1), Bering Sea; SOSC BS 22204 (1), same, July 23, 1977; SOSC BS 22204 (1), same, July 19, 1977; SOSC BS 22202-09 (1), same, June 1977; SOSC BS 22202 (1), same, June 5, 1977; SOSC BS 22202 (1), same, June 6, 1977; UA 7574 (1), Wrangel Island; UA 1890 (3), St. Lawrence Island; NMC 79-507 (1), St. Matthew Island; NMC 79-528 (1) Bering Strait; NMC 79-529 (4), same; NMC 79-530 (3), same; USNM 24047 (1), St. Paul Island, Bering Sea, syntype *L. gibbus*; USNM 48621 (1), Bristol Bay, Bering Sea, type of *L. cyclostigma*; USNM 27535 (1), Plover Bay, Siberia, syntype *L. gibbus*; USNM 24047, St. Paul Island, Bering Sea, syntype of *L. gibbus*.

From Northwest Territories, western Canadian Arctic

NMC 62-417 (1), Liverpool Bay; NMC 62-427 (1), Franklin Bay; NMC 65-366 (3), Booth Island; NMC 65-367-C (2), Franklin Bay; NMC 65-367-D (1), same; NMC 65-368 (1), Darnley Bay; NMC 65-369 (7), same; NMC 65-372 (2), Franklin Bay; NMC 65-374 (2), same; NMC 75-151 (1), Melville Sound; NMC 77-975 (1), Franklin Bay.

From Northwest Territories, northern Canadian Arctic

NMC 76-124 (1), Netsiksiuvik Inlet; UZMO J6663 (1), Vestre Sound; ROM 27668 (1), Resolute Bay, Cornwallis Island.

From Northwest Territories, eastern Canadian Arctic

BC 61-223 (1), Frobisher Bay; NMC 59-392 (1), same; NMC 59-407 (1), Ungava Bay; NMC 59-452 (1), Hudson Strait; NMC 60-70 (1), Evans Strait; NMC

62-278 (1), Belcher Islands, Hudson Bay; NMC 62-554 (2) near Richmond Gulf; NMC 72-272 (1), Frobisher Bay; FRB St. John's 4375 (1), Ungava Bay; ROM 14153 (1), Hudson Bay; FRB St. John's 4437 (1), Ungava Bay.

From Greenland

UZMO J6667 (1), Reindeer Point, Foulke Fjord.

From Canadian Atlantic

NMC 60-146 (1), Nova Scotia; NMC 63-154 (1), Newfoundland; FRB St. John's 6039 (2), Hawke Channel, Nfld.; FRB St. John's 2806 (1), Conception Bay, Nfld.; FRB St. John's 2803 (2), same; NMC 60-192 (1), Trois-Pistoles Que.; NMC 69-123 (1), Saguenay Fiord; NMC 69-213 (1), St. Lawrence estuary; NMC 70-13 (1), Saguenay Fiord; NMC 71-655 (3), St. Lawrence estuary; MIC Q74-74 (1), Gulf of St. Lawrence; MIC 1, 2, 3, 5, 7, 12, 13, 22, 27, 51 (20), same; GIROQ (1), same; GIROQ 98 (1), southeast of Grand Rivière, Que.; GIROQ Cr. 74051 (2), St. Lawrence estuary; ROM 1465 (1), Atlantic Ocean off Nova Scotia; ROM 17622 (1), same; ROM 17623 (4), same; ROM 17624 (3), same; ROM 23185 (1), same.

Systematics

Bean (1881) described *L. gibbus* from the Bering Sea. Gilbert (1895) named a similar form, *L. cyclostigma*, from the same area and Gilbert and Burke (1912) noted the similarity between the two forms but provisionally maintained them as distinct. Later Burke (1930) indicated they could not be readily separated. The most recent reviewer (Andriashev 1954) questionably placed *L. cyclostigma* in the synonymy of *L. gibbus*.

Bean (1881) did not designate a type specimen but Burke (1930) considered USNM 24047 to be the lectotype. This specimen is in poor condition but it was possible to determine that it has 42 or 43 pectoral rays, 33–35 pyloric caeca, and 10 teeth in the first row of the upper jaw. These are all characters shared only by other *L. gibbus* from Alaska (Table 4, 5, 6). Also, the jaw teeth of the lectotype are tricuspid with the central cusp larger as noted for other *L. gibbus* from Alaska. Thus, the teeth are not similar to *L. fabricii* as indicated by Bean (1881). Unfortunately, the remaining specimens of the type series are so damaged they are of no use.

A principal components analysis based on five meristic characters (dorsal, anal, left pectoral rays, pyloric caeca, and total vertebral counts) on 45 specimens from the Bering Sea and Gulf of Alaska (including the type of *L. cyclostigma*) also indicates there was only a single species represented. Thus, we feel justified in synonymizing *L. cyclostigma* with *L. gibbus*. However, we have not examined other apparently closely related species

(*L. dennyi*, *L. ochotensis*, *L. rhodosoma*, and *L. ingens* (Burke 1930)) so caution should be used in following our interpretation.

Fabricius (1780) described a variety of *Liparis* as *Cyclopterus liparis altera major*. Parr (1932) construed this as a subspecies, *Liparis liparis major*, of the type species, although attributing its authorship to Gill (1865) rather than Fabricius. He apparently followed Jordan and Evermann (1898) in considering the quadrinomial to be non-binomial. Jordan et al. (1930) indicated *major* was simply used as an adjective. Fabricius' description included a count of 40 pectoral, 44 dorsal, and 35 anal rays, and a length of 10 old Danish inches (261.5 mm). (Dr Einar Bertelsen, in lit., writes that Fabricius' types disappeared long ago.) Burke (1930) treated this form as a distinct species, *L. major*, but it was evident from his description (anal rays 40, peritoneum black) that he was referring material of *L. fabricii* to *L. major*. Fabricius' pectoral count of 40 and large size exclude identification of *L. major* with *L. fabricii*. The only Arctic-Atlantic species with this many pectoral rays (Table 4) and this length is *Liparis gibbus*. Therefore, we consider that *Cyclopterus liparis altera major* Fabricius is conspecific with *L. gibbus*. If the name is non-binomial as indicated by Jordan and Evermann (1898), then it would not replace *L. gibbus* under the Law of Priority. Should authors consider Fabricius' name available, however, it would supplant the latter names unless application was made to suppress it. It may be noted that Gill (1865) also did not consider Fabricius to have properly named the variety *major*, and Gill attributed the authorship of *Liparis major* to himself (but Gill's *L. major* is *L. fabricii*).

To examine geographic variation, samples were divided into 3 groups: Alaskan, Canadian Arctic (Alaskan border to Ungava Bay), and Atlantic Canada (Labrador and southward). In 11 of the 17 meristic characters, Alaskan specimens had higher mean values than Canadian Arctic, and the latter higher than Atlantic Canada (dorsal, anal, lower primary caudal, lower secondary caudal, right and left pectoral rays, pectoral rays opposite gill opening, pyloric caeca, abdominal, caudal, and total vertebrae). In four other characters the Alaskan value exceeds the combined mean for Canadian Arctic and Atlantic Canada specimens. Clearly, the dominant trend is for meristic parts to decrease clinally from west to east (Table 2-7).

To explain this clinal variation, three interpretations will be considered; temperature, size, and isolation in different refugia. If the causal factor

was temperature, then we would expect the two southern populations to be more similar in fin ray and vertebral counts, rather than a decrease from west to east. Also, lower pyloric caeca counts are usually found in warmer waters (McAllister 1977 and see *L. tunicatus*), but this is not so in the present case (Table 2-7). Temperature, at least as the main factor, may be rejected.

Alaskan specimens averaged 210 mm SL (52 specimens), Canadian Arctic 98 mm SL (40), and Atlantic Canada 114 mm SL (37). Assuming the samples are representative, the size trend does not match the meristic trend, although it matches it better than temperature.

The last hypothesis and the one we accept is that the clinal differences owe their origin to separation in two different refugia during glaciation, and the intermediacy of Canadian Arctic populations is due to interbreeding of the two forms when they met following deglaciation.

Liparis gibbus seems to be a more southerly species than *L. fabricii* and *L. tunicatus*, reaching further south and less common in the north. Therefore, a western refugium south of, rather than north of, Beringia would seem indicated. For the east, at least two refugia are possible. An Ellesmere refugium has been suggested by England and Bradley (1978), but can be rejected on the same basis as a north Beringian refugium. Ives (1978) and Vilks and Mudie (1978) described a Labrador shelf refugium involving the southern corner of Labrador and significant areas below present sea level. This or a more southerly refugium, Grand Banks or the banks off Nova Scotia and New England, would seem probable.

Distribution

Ranges from southeastern Alaska and Kodiak Island (Quast and Hall 1972), Gulf of Alaska, Kamchatka near Avatcha Bay (Gilbert and Burke 1912), Aleutian Islands, Bering, Chukchi, and Beaufort seas north to southern Ellesmere Island (but most records are south of 75°N), east to Foulke Fjord, Greenland, and south to Belcher Islands in Hudson Bay (Fig. 7C) and to off Nova Scotia at 44°N, 62°30'W (NMC 60-146) on the Atlantic coast of Canada. Curiously, it has not been previously reported for Greenland. Whether it is really uncommon (we have seen one Greenland specimen and there is a Fabricius specimen already discussed) or has not yet been correctly identified is unknown. Greenland *Liparis* collections should be searched for this species. It is a more southerly species than *L. fabricii* and *L. tunicatus*. For world distribution of *L. gibbus* see Fig. 7D.

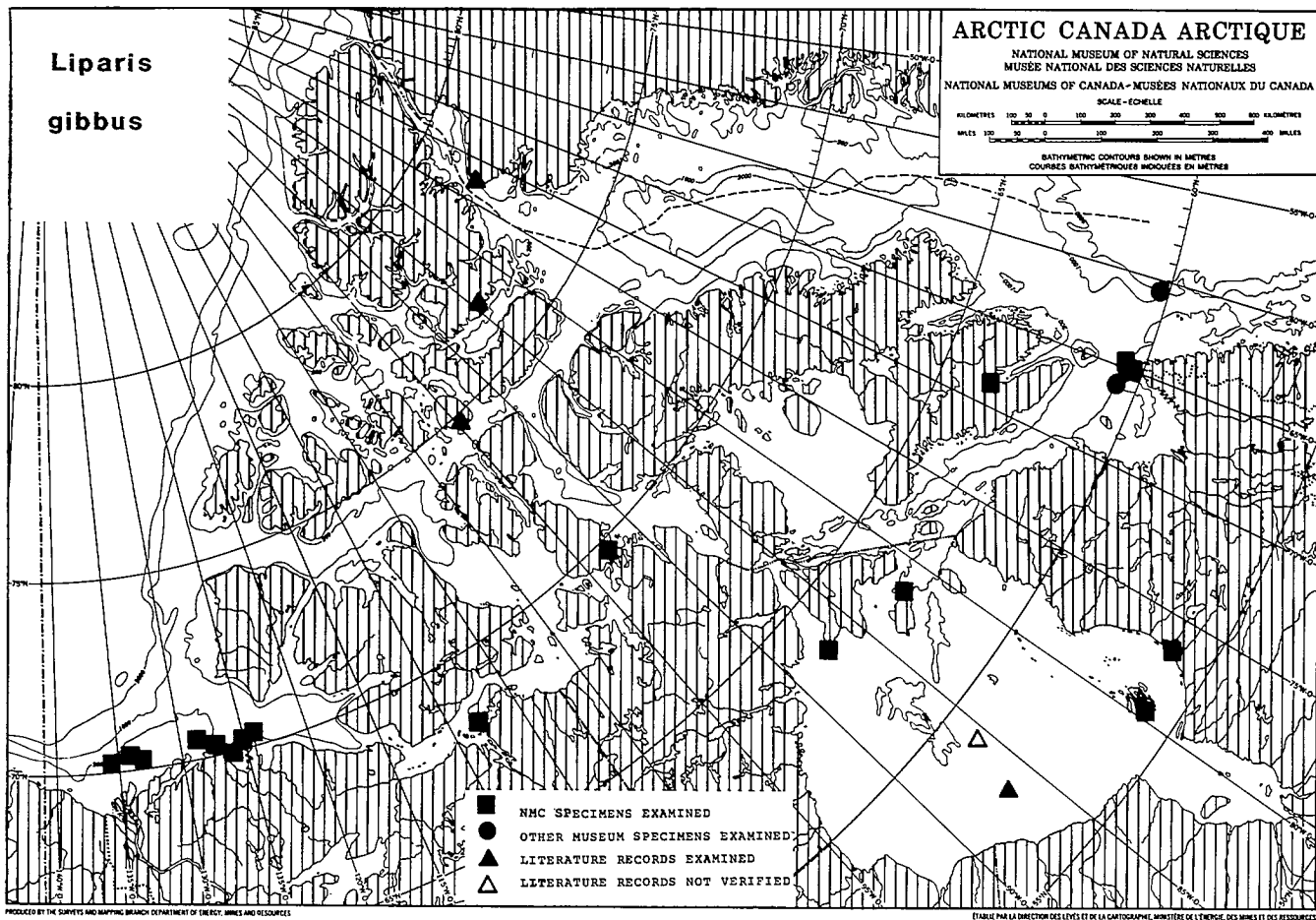


FIG. 7C. Distribution of *Liparis gibbus* in Arctic Canada.

Habitat

Juveniles and adults of this species have been collected in Hudson Bay, Ungava Bay, and off Labrador over rock, sand, and mud bottoms in depths of 82-364 m (Vladykov 1933; Gordon and Backus 1957; Backus 1957). But all our five collections with benthic data were taken in trawl or dredge hauls on mud bottom. Our collections were taken between 0-50 and 151-200 m (Table 1). However, given the greater proportion of trawls in shallower depths, it seems probable they are most common between 100 and 200 m. Like *L. fabricii*, this species is common in offshore waters. At least six collections were made 20 km or more offshore and four catches were made with midwater trawls (nonclosing) suggesting their

possible occurrence in mid-water. The larvae in the St. Lawrence estuary were planktonic but may have been more abundant near the bottom (Able 1978).

Reproduction

In the St. Lawrence estuary the pelagic larvae (3.3-15.2 mm SL) have been collected June through September with some of the smallest larvae in samples from September, indicating that spawning may occur throughout the summer (Able 1978). The timing of reproduction may not be similar in the Canadian Arctic. None of the six large females (159-206 mm TL) in collections from April 13-Aug. 7 have mature ovaries.



FIG. 7D. World distribution of *Liparis gibbus*.

Food

Andriashev (1954) reported food consists of benthic and pelagic crustaceans, mainly Hyperiidæ (*Themisto libelula* and *T. abyssorum*). Barsukov (1958) recorded remains of a crab from a *Liparis gibbus* from the Bering Sea.

Predators

Young specimens, probably of this species, have been collected from *Gadus morhua* stomachs in Hudson Bay (Vladykov 1933).

Parasites

Margolis and Arthur (1979) recorded the protozoan *Trypanosoma murmanensis* from Atlantic coast species.

Liparis tunicatus
Reinhardt, 1837

kelp snailfish
limace de laminaire

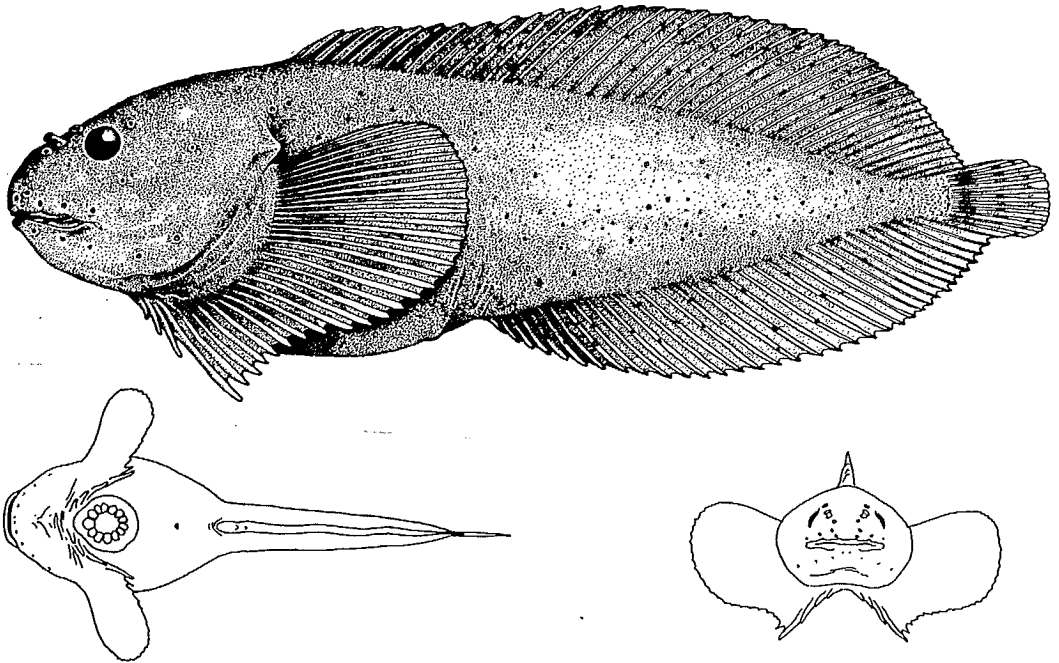


FIG. 8A. Male, 119 mm SL, 4 m, Assistance Bay, Cornwallis Island, N.W.T. (NMC 62-406).

Synonymy

ORIGINAL DESCRIPTIONS

Liparis tunicata Reinhardt 1837, CX1, after Fabricius 1780: 136 *Cyclopterus liparis altera minor* (Greenland); publication date 1837 not 1836 fide Nielsen 1974.

Liparis herschelinus Scofield 1898, 2123 in Jordan and Evermann, 1898 (original descr., distr., synon., syntypes according to Burke 1930 were in Stanford University Museum as cat. no. 5601, with 17 small specimens, 37–64 mm, now in California Academy of Science); Scofield 1899: 504, LXXIV (descr., distr. Herschel Island (Yukon Territory) indicated as n.sp., but Scofield 1898 is the original description).

CANADIAN ARCTIC RECORDS

Liparis vulgaris, Bean 1879: 115 (synon., descr., 9–16 m, fastened to kelp, head of Cumberland Gulf; Annanactook, Cumberland Gulf, Baffin Island, D 40–42, A 34–35, P 34–35, C 10–11).

Cyclogaster herschelinus, Ehrenbaum 1901: 101 (listed, partim Herschel Island, nec north coast of British Columbia).

Liparis liparis, Jensen 1910: 10 (32 specimens in 19 collections from southern and southeastern Ellesmere Island, Devon Island, and Greenland from 3–5 m; Ellis 1962: 188 (Frobisher Bay in tide pools at low or midwater level in June and July).

Liparis herschelinus, Halkett 1913: 108 (listed, Herschel Island, Arctic Ocean); Hildebrand 1948: 103 (range, distr., taxon., possible synonym of *L. tunicatus*; doubtfully refers small specimen from Dolphin and Union Strait collected by F. Johansen to this species); McAllister 1960b: 18 (key); McAllister 1962: 32 (distr., descr., taxon., between Collinson Head and Herschel (settlement), Herschel Island, Y.T.; 48 km east of Y.T.–Alaska boundary); Kobayashi 1968: 109, col. photo 64 (descr., Bering Strait at 66°09'N, 168°25'W in 54 m at 4.1°C, pyloric caeca 20; D 45–46; A 36, P 38); Legendre et al. 1975: 10 (listed for Canadian Arctic; new French vernacular); Green and Steele 1977: 1–83, 11–85 (diving observation on habits and feeding).

Careliparis herschelinus, Jordan et al. 1930: 400, in part (synon. but excluding *L. fabricii*).

Liparis tunicatus, Pfaff 1937: 2, 17 (distr., descr., A ca. 34, P ca. 36, P.C. 30, crag at Vansittart Island; Hildebrand 1939: 11 (1 specimen from Lyons Inlet, Foxe Basin); Hildebrand 1948: 101 (range, distr., taxon., in 15 m at Leaf Bay; tide pools in Keglo Bay, eastern Ungava Bay, Que.); Dunbar and Hildebrand 1952: 121 (taxon., descr., distr. *Calanus* stat. 126 off mouth of Payne Bay; Port Burwell; Keglo Bay; Tunulik (between Whale and George rivers; Leaf Bay; off George River estuary; one of commonest fishes in Ungava Bay); McAllister 1960a; 48 (listed, taxon., lit.); McAllister 1960b: 18 (key); Hunter 1968: 361, 362 (listed as new to Hudson Bay); Legendre et al. 1975: 10 (listed for Canadian Arctic); McAllister 1977: 11, 61 (occurrence on *Laminaria* fronds).

Liparis ? liparis, Walters 1953a: 253 (descr., Alert, N.W.T.); Walters 1953b: 12 (Alert, Ellesmere Island); Walters 1955: 322, in part (listed, lit.).

Liparis atlanticus, Emery 1973: 16 (Resolute, N.W.T.); MacInnis and Curtsinger 1973: 267, col. photo (clinging to kelp, Resolute, N.W.T.); Bell 1973: 24 (Resolute, N.W.T.); Turnbull 1974: 1 (2 specimens from ROM reidentified as *L. tunicatus*).

Liparis cyclostigma, Emery 1973: 19 (habits, Resolute Bay, N.W.T. ROM 27668).

SUPPLEMENTARY REFERENCES

Liparis tunicatus, Nichols 1918: 680 (morph., meristics, habitat, Etah and Umanak, Greenland); Burke 1930: 73, fig. 10 (of teeth), in part (synon., distr., relationships, descr., diagnosis, closely related to *L. herschelinus*, not specimen from Nauset Beacon, Mass.); *L. herschelinus*, ibid: 75 (synon., type specimen, distr., relationships, descr. of types, diagnosis); Andriashev 1954: 456 (synon., descr., taxon.); Backus 1957: 326 (distr., Kaipokok Fjord at 54°52'N, 59°50'W in 27 m over mud bottom, 69 mm specimen); Gordon and Backus 1957: 19 (distr., habitat, 11–18 m rocky bottom, Saglek Bay and 7–10 m mud bottom, Indian Harbour, Hamilton Inlet, Lab.; latter apparently the southernmost valid record).

Etymology—*tunicatus*, bearing a cloak, in allusion to the peculiar loose adherence of the skin.

Diagnosis

Distinguished from *L. gibbus* by having 32–37 instead of (37) 38–42 pectoral rays and 0–7 instead of usually 8 or more pectoral rays opposite the gill slit in adults, and tooth lobes equal in size instead of central lobe larger; from *L. fabricii* by 33–36 (37) instead of (36) 37–42 anal fin rays and pale instead of dark peritoneum; from *L. atlanticus* by an unnotched dorsal fin and 33–36 (37) instead of 27–31 anal fin rays.

Description

MERISTICS

Range, mean, and sample size for Canadian Arctic specimens.

D (39) 40–44; 41.85 (141)
C secondary upper (1) 2–4; 2.84 (134)
C primary upper 4–5 (6); 4.98 (135)
C primary lower (4) 5 (6); 5.02 (135)
C secondary lower 1–2 (3); 1.45 (130)
Tot. C 12–15 (16, 17); 14.28 (130)
P left 33–37; 35.46 (82)
P over gill slit (0) 1–6 (7–12); 4.04 (75)
P.C. (10, 16–19), 21–35 (36, 38, 39, 41, 42, 46, 47, 49); 28.96 (84)
G.R. 5–9 (10, 11); 7.54 (76)
Abd. vert. (10) 11–12; 11.24 (139)
Caud. vert. (34) 35–38; 35.99 (139)
Tot. vert. 45–49 (50); 47.23 (139)

Teeth in 1st row, upper jaw 6–11; 8.39 (33)
Teeth in 1st row, lower jaw 5–10 (11); 7.97 (31)

Head — Blunt, length 23.7–32.8% (mean 27.6) SL; width 19.5–31.4% (mean 25.1) SL; dorsal profile relatively flat, slight concavity over eyes. Snout blunt, length 4.9–10.9% (mean 7.9) SL. Anterior and posterior nostrils in tubes, anterior much longer. Orbit 4.0–10.7% (mean 5.7) SL. Interorbital distance 7.6–12.3% (mean 9.6) SL. Mouth small, does not reach to level of front of eye. Lips fleshy, lower included within upper. Jaw teeth numerous; arranged in regular oblique rows; teeth trilobed with lobes of similar size or central lobe slightly longer; posterior teeth larger than anterior teeth in rows. Papillae present on entire surfaces of floor and roof of mouth. Gill slit overlaps pectoral fin slightly; gill slit length 6.1–13.9% (mean 7.9) SL.

Body — Broad anteriorly then laterally compressed behind origin of anal fin; height at level of disk 18.4–26.5% (mean 22.5) SL. Rudimentary pores or superficial neuromasts on lateral surface of body behind suprabranchial pores, then gradually lower on posterior portion of body; pores also usually present on dorsal surface of head in two patches of 2 or 3 pores slightly posterior and medial to each eye and in line of 3 to 4 pores parallel to and overlapping origin of dorsal fin. Dorsal fin originates behind level of suprabranchial pores; snout to dorsal origin 25.3–41.0% (mean 32.3) SL; dorsal overlap of caudal 2.3–13.7% (mean 5.3) SL. Anal fin originates where body becomes laterally compressed; snout to anal origin 42.5–57.0% (mean 49.3) SL; anal overlap of caudal fin 4.2–10.3% (mean 7.0) SL. Caudal fin length 12.3–19.6% (mean 16.7) SL. Pectoral fin notched at 7th to 9th ray from ventralmost ray; rays in lower lobe separate and fleshy on posterior portion; longest ray in upper lobe extends to or slightly beyond level of origin of anal fin; length 16.1–28.0% (mean 22.0) SL. Disk length 11.2–15.9% (mean 13.5) SL, originates below posterior margin of eye; snout to anterior edge of disk 13.6–28.4% (mean 18.7) SL; posterior edge of disk to anal fin origin 4.9–25.3% (mean 17.6) SL. Vent approximately midway between posterior margin of disk and origin of anal fin; disk to vent 5.8–18.6% (mean 9.4) SL; snout to vent 32.8–51.1% (mean 41.7) SL. Longest pyloric caecum 6.9–32.1% (mean 13.9) SL. (Proportions based on 60–95 specimens.)

COLOR

Specimens preserved for long periods are uniformly brown, except for a somewhat lighter

shade on ventral surface of the head and disk. On this background, numerous small dark spots are commonly distributed evenly over every surface except for the lateral and ventral portions of abdomen and ventral surface of the head. Caudal fin has a single bar, or occasionally two or three bars. The latter are often most prominent on small specimens and may become somewhat obscured on larger individuals. The eye is black; peritoneum is generally pale and occasionally has numerous small melanophores especially on the dorsal surface. Burke (1930) described a Labrador specimen with two pale stripes, one from the nostril to the dorsal origin, the second from the snout below the eye and across the gill slit down to the anal base, thence to the caudal fin base. Dunbar and Hildebrand (1952) described a nearly black specimen collected over black mud that changed to brown when kept alive in a jar of water on deck. Johansen (MS) noted specimens from Bernard Harbour, N.W.T. to be dominantly *Laminaria* brown, with paler underside, brass-colored belly, and orange-reddish fins with 6–8 cross-bars on dorsal and anal and two (medial one broadest) on caudal.

McAllister (1962) noted a specimen caught in a trawl with *Laminaria* near the Yukon Territory–Alaska border was kelp-brown with a golden iris when alive, other specimens were grey-brown in life. A specimen trawled in Cy Peck Bay, Cape Bathurst, Beaufort Sea, N.W.T., July 21, 1977, and photographed live in an aquarium had the following coloration: head and body reddish-brown though speckled and mottled skin with small dark brown spots; rosy midlateral band; light-colored chin; yellowish reflections over body cavity and some yellowish tones on posterior third of body; dorsal and anal fins with larger irregular mottlings, darker than body, especially posteriorly; light vertical band crosses the ends of the dorsal, caudal, and anal fins; two dark and two other light vertical bands cross the caudal fin; the pectoral fin with dark mottlings dorsally; lower lobe is whitish.

SEXUAL DIMORPHISM

Light colored prickles were found in three mature males collected Oct. 17, 1970 from Bering Sea (ABBL 70-244, originally labelled *L. bristolense*). Prickles were found on top of the head down to the level of the eye, forward to in front of the nostrils and back to the anterior dorsal fin. In a sample of 18-40 males and 16-30 females, all body parts differed less than 1% SL between sexes except for snout to dorsal origin 31.7 in males and 33.5 in females, snout to anal origin 48.6 and 50.1, snout to disk 17.7 and 19.1, head width 25.9

and 24.9, pectoral notch 23.1 and 22.0, and disk to anus 17.1 to 18.2. Most of these involve a longer abdominal region in the females and may be related to increased accommodation for eggs. Thirty-one males averaged 88.3 mm and 26 females 73.9 mm SL.

SIZE

The largest specimen examined was a male 161 mm TL (141 mm SL) from Ungava Bay, Que. (NMC 59-382) that weighed 33.4 g.

Material examined

Two hundred specimens from Alaska, Canadian Arctic, and Greenland, from 48.6 to 118.3 mm SL.

From Alaska

ABBL 63-193 (1), 15 km north and 65 km east at Nunuk Point, near Point Barrow; ABBL 70-244 (3), Chukchi Sea at 68°55'N, 166°47'W; ABBL 70-167 (2), Chukchi Sea at 69°45'N, 163°34'W; NMC 74-284 (2), Beaufort Sea about 46 km north of Maquire Islands; NMC 79-530 (3), Bering Strait at 65°24'N, 168°43'W.

From western Canadian Arctic

NMC 60-472 (12), Herschel Island, Y.T.; NMC 60-478 (1), 27 km west of Herschel Island; NMC 60-486 (5), west of Pauline Cover, Herschel Island; NMC 60-491 (1), Herschel Island; NMC 62-401 (1), Prince of Wales Strait, Banks Island, N.W.T.; NMC 62-417 (9), Wood Bay, Liverpool Bay, N.W.T.; NMC 62-427 (2), Franklin Bay, N.W.T.; NMC 65-366C (1), Langton Bay, N.W.T.; NMC 65-368 (1), Darnley Bay, N.W.T., off Cape Parry; NMC 65-372 (6), Franklin Bay, N.W.T.; NMC 72-340 (1), Prince of Wales Strait, Banks Island; NMC 75-149 (1), Starvation Cove, N.W.T.; NMC 77-1103 (1), Johnson Bay northern Liverpool Bay, N.W.T.

From northern Canadian Arctic, N.W.T.

NMC 62-379 (3), Barrow Strait, Cornwallis Island; NMC 62-399 (2), Assistance Bay, Cornwallis Island; NMC 65-349 (1), Creswell Bay, Somerset Island; NMC 76-130 (1), Emery Bay, Devon Island; NMC 76-132 (3), mouth of Viks and West fiords, Devon Island; NMC 77-1098 (3), Queens Channel, Devon Island; NMC 77-1099 (1), Barrow Strait, Somerset Island; AMNH 33492 (2), Resolute Bay; ROM 28866 (1), same; ROM 28868 (1), same; ROM 28869 (1), same; NMC 58-266 (2), Parr Inlet, Alert, Ellesmere Island at 82°29'N, 62°15'W; NMC 62-380 (11), West Devon Island; NMC 62-381 (9), same; NMC 62-382 (14), Hungry Bay, West Devon Island; NMC 62-383 (2), Barrow Strait, Cornwallis Island; NMC 62-385 (1), Cornwallis Island; NMC 62-393 (6), southern Cornwallis Island, Barrow Strait; NMC 62-400 (3), Assistance Bay, Resolute, Cornwallis Island; NMC 62-406 (8), Barrow Strait, Cornwallis Island; NMC 62-408 (3),

same; NMC 72-339 (1), Slidre Fiord, Ellesmere Island; NMC 74-261 (2), Bellot Strait, Brands Island; NMC 76-129 (1), south of Templeton Bay, Little Cornwallis Island; NMC 76-133 (1), Bear Bay, Cape Skogn; NMC 76-135 (1), McDougall Sound, Bathurst Island; UZMO J5554 (4), St. Helena Island, Ellesmere Island; UZMO J6655 (2), Renbukten, Ellesmere Island; UZMO J6656 (4), Fosheim Peak and west side of Havnefj, Ellesmere Island; UZMO J6658 (2), Vinterham, Havnefj, Ellesmere Island; UZMO J6660 (1): Hvalrosfj, Ellesmere Island; UZMO J6661 (1), Landsend, Ellesmere Island; UZMO J1498 (3), Bugtan, Ellesmere Island; UZMO J6786 (1), Storoealen, Havne Fiord, Ellesmere Island.

From eastern Canadian Arctic

NMC 59-361A (4), Leaf and Keglo bays, Ungava Bay; NMC 59-382 (2), Ungava Bay; NMC 59-385 (2), Port Burwell, Que.; NMC 59-432 (1), north of Payne Bay, Ungava Bay, Que.; NMC 60-86 (1), Foxe Basin near Melville Peninsula; NMC 62-271 (4), Frobisher Bay, Sharat River; NMC 62-272 (7), Frobisher Bay; NMC 62-286 (2), James Bay, 139 km north of Moose Factory; NMC 74-255A (1), Stanley Harbour, Southampton Island, N.W.T.; NMC 75-1953 (1), Strathcona Sound, Baffin Island; BC 61-223 (1), Frobisher Bay, Baffin Island.

From Greenland

AMNH 17019 (15), Umanak; AMNH 18647 (1), Etah; AMNH 19572 (3), Umanak; ANSP 39944 (1), Robertson Bay, North Greenland.

From Labrador

USNM 87662 (1); USNM 177638 (1), Saglek Bay.

Systematics

Burke (1930) was uncertain whether *Liparis herschelini* was distinct from *L. tunicatus*. McAllister (1962), when examining topotypic material of *L. herschelini*, found 17–24 pyloric caeca compared with 30–35 in *L. tunicatus* from the eastern Canadian Arctic and, therefore, proposed the two should be regarded as distinct species. The collection and study of specimens from intervening regions leads us to reject that proposal and suggest instead that the two are conspecific.

The pattern of geographic variation in pyloric caeca is clinal (Fig. 8B, C). We found a mean value of 23.0 for the Beaufort Sea in Alaska, Y.T., and N.W.T., 28.7 in the central Canadian Arctic near Cornwallis and Devon Islands, 33.9 in the north for Ellesmere Island (31.3 for central and northern combined), and 36.0 in the eastern Canadian Arctic for Frobisher and Ungava bays, and 36.0 for Greenland. Unfortunately, Backus (1957) did not report caeca counts for Labrador specimens, but one specimen from Labrador (USNM 87662) had 37 pyloric caeca. Thus, there

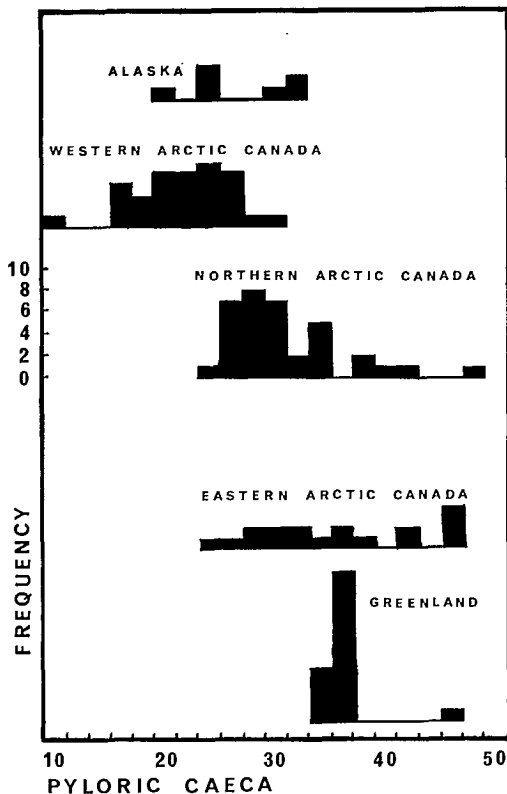


FIG. 8B. Histogram of pyloric caeca frequencies in different populations of *Liparis tunicatus*.

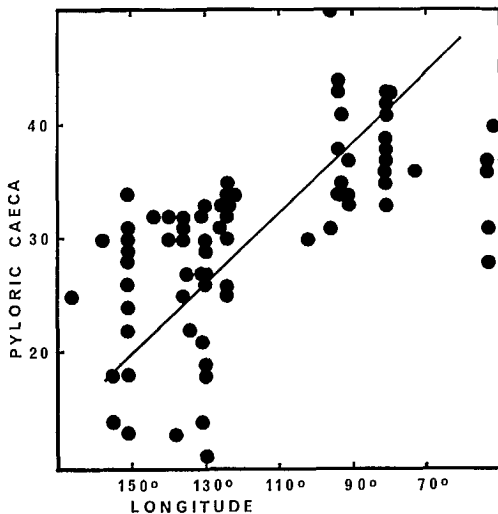


FIG. 8C. Variation in pyloric caeca with longitude in *Liparis tunicatus* with Barlett's line of best fit. Regression equation gives number of pyloric caeca equalling -0.157° longitude plus 45.691.

is a regular trend for increase in pyloric caeca counts from west to east with perhaps a tendency to increase toward the north. Association between pyloric caeca and longitude, latitude, and August surface temperatures (latter from Daniel 1958; Steele 1975) were measured with correlation coefficients. Figure 8C shows the relationship between pyloric caeca and longitude. The coefficient between pyloric caeca and longitude was -0.61 , significant at a probability of less than 0.001 (98 specimens), between pyloric caeca and temperature -0.38 , significant at less than 0.001, and was not significant between pyloric caeca and latitude. The mean count for the central (northern) Canadian Arctic is intermediate between counts from the eastern and western Canadian Arctic. It would be possible that the intermediacy of this mean was due to a mixture of two forms. But examination of coefficients of variation for the central Canadian Arctic shows counts to be lower, not higher than those from the western Canadian Arctic (Table 6). Thus, the intermediacy of the mean for the central Canadian Arctic is due to intermediate counts and not a mixture of low and high counts. A west-east clinal increase is thus demonstrated.

The hypothesis that there is a single species was subjected to two tests using principal components analysis, one on six meristic characters (dorsal, anal, left pectoral rays, rays opposite gill opening, pyloric caeca, and total vertebrae) with 73 specimens, and one on seven morphometric characters with 58 specimens. Neither test revealed distinct east and west clusters. Plots of the first and second components tended to sort out in an east-west gradient with western specimens at one end, eastern at the other, and central Canadian Arctic specimens scattered in between. Principal components analysis of the six meristic characters with latitude and longitude of the collection locality resulted in three clusters largely composed of western, central, and eastern Canadian Arctic collections, respectively. But, as samples for the three areas are each separated by about 600 km, trends suggest that geographically intermediate specimens would be morphologically intermediate. Clines were not evident in the results of principal component analysis of morphometric data. A trend surface analysis of meristic data did not reveal discontinuities suggestive of the presence of two species. A discriminant function analysis using six meristic characters of Alaskan and western Canadian Arctic specimens against the remainder permitted correct identification of only about 85% of the specimens. Misclassified specimens were mainly from the intermediate central Canadian Arctic. Of 20 morphometric characters,

only 6 showed mean differences expressed as percent standard length of 1% or more and none exceeded 2.3%.

For the moment, on the basis of the characters and specimens examined, we conclude that *Liparis herschelini* is a junior subjective synonym of *L. tunicatus*. The possibility must be admitted that study of other characters or a larger series from intervening localities might reveal distinct differences.

Either of two hypotheses could explain the origin of the cline in pyloric caeca. First, that the species had a single refugium during the Wisconsin glaciation and that the cline reflects postglacial adaptation of local populations to temperature subsequent to dispersal. McAllister (1977) suggested that colder water forms frequently have more pyloric caeca that generate more digestive enzymes to counteract lower enzymatic activity at lower temperatures. The second hypothesis is that the pyloric caeca pattern reflects isolation and differentiation in a western and an eastern refugium during the Wisconsin glaciation. The lower counts of the western population might reflect warmer conditions south of or just north of Beringia where they were isolated (see Walters 1955 for discussion of western refugia). A cooler eastern refugium near Ellesmere Island and from Labrador (or further south) is possible. Ice-free areas between Ellesmere Island and Greenland back to at least 28,000–30,000 B.P. have been proposed by England and Bradley (1978). Contrary to previous proposals, Ives (1978) and Vilks and Mudie (1978) presented evidence for seasonally open water off Labrador during the last 22,000 yr, including an ice-free southern corner of Labrador and significant ice-free areas of land presently below sea level. Following this hypothesis, the intermediacy of central Canadian Arctic populations would be due to hybridization of the eastern and western forms when they met following deglaciation. McPhail and Lindsey (1970) found similar patterns of variation in pyloric caeca counts of round whitefish, *Prosopium cylindraceum*, and burbot, *Lota lota*, that survived in northern and southern refugia.

Whether the cline is more the result of isolation and subsequent differentiation, perhaps under selective effects of different temperatures, or to postglacial adaptation in pyloric caeca number in response to temperature selection is difficult to resolve. The correlation is stronger between longitude and pyloric caeca (coefficient of -0.61), than between August temperature and pyloric caeca (coefficient of -0.38), although it is possible that the weaker correlation might be due to the crude temperature data. When a partial correlation

coefficient between pyloric caeca and longitude with the effects of temperature are removed, the correlation is much higher (-0.53) than between pyloric caeca and temperature with the effects of longitude removed (-0.15). This, and the fact that the opposite geographic trend in pyloric caeca is found in *Liparis gibbus*, argues more strongly in favor of the primacy of the influence of differentiation during isolation in two refugia.

Jordan and Evermann (1898: 2128) and Burke (1930) considered Fabricius' (1780) proposal of *Cyclopterus liparis altera major* as nonbinomial. Fabricius proposed *Cyclopterus liparis altera minor* in the same fashion for what is now called *L. tunicatus*. Reinhardt (1837) and Burke (1930) did not consider Fabricius' name a valid proposal and Reinhardt erected the name *Liparis tunicatus* (see discussion under *L. gibbus*).

Vernacular

The vernacular, Greenland snailfish, applied to *Liparis tunicatus* is now geographically inappropriate as most of its known range is now outside of Greenland. To reflect this and the changed taxonomic status we coin a new vernacular, kelp snailfish, chosen because of this species association with laminarians. Inukituk vernaculars (nee-fit shak, nipi-shah, and nipi-sak) are documented by McAllister et al. (unpublished manuscript).

Distribution

Known from Bering Strait at $65^{\circ}24'N$, $168^{\circ}43'N$ (NMC 79–530) and $66^{\circ}09'N$, $168^{\circ}25'W$ (Kobayashi 1968), Chukchi Sea, Beaufort Sea, Victoria Island (Starvation Cove), north to Alert, northern Ellesmere Island at $82^{\circ}29'N$, $62^{\circ}15'W$, south to Frobisher and Baffin bays and to Indian Harbour, Palliser Island ($54^{\circ}27'N$, $57^{\circ}12'W$) in Labrador (Gordon and Backus 1957), and to James Bay 139 km north of Moose Factory at $52^{\circ}00'N$, $80^{\circ}00'W$, and east to Greenland (Fig. 8E). McAllister (1962) suggested that the Laptev Sea specimen of *Liparis liparis* figured in Andriashev (1954, ex Popov) resembled *Liparis herschelini*. If this were so, it would extend the known range of *L. tunicatus* westward about 2500 km and raise the question of whether it may range even further. Comparison of specimens is needed to settle this question. *L. tunicatus* and *L. fabricii* are the most northerly species of the genus in the Canadian Arctic. The southern limit in Labrador coincides with the $6^{\circ}C$ August surface isotherm (see map in Steele 1975). For world distribution of *L. tunicatus* see Fig. 8E.

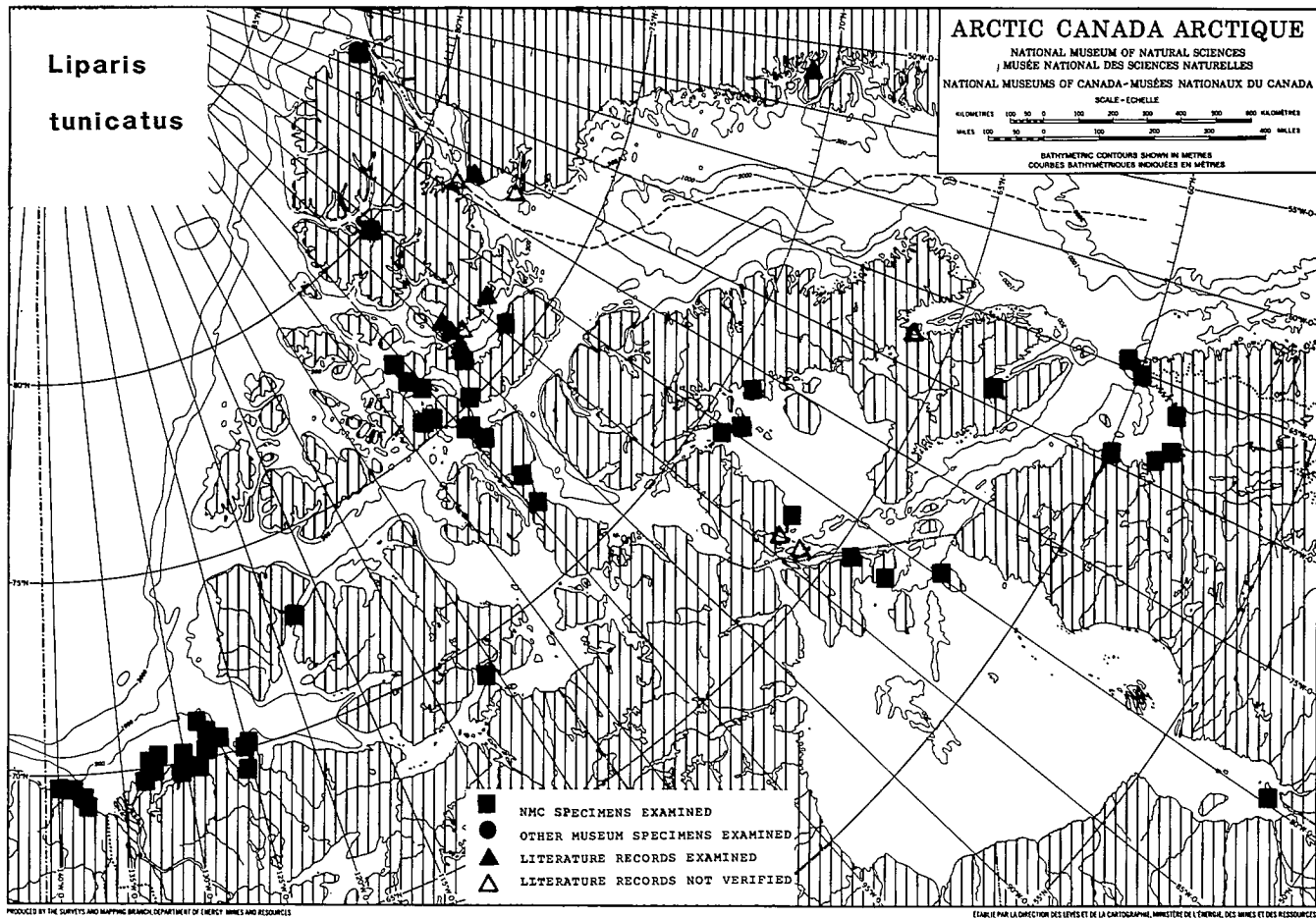
FIG. 8D. Distribution of *Liparis tunicatus* in Arctic Canada.



FIG. 8E. World distribution of *Liparis tunicatus*.

Habitat

Dunbar and Hildebrand (1952) found *L. tunicatus* in tide pools and deeper water in Ungava Bay. They also reported postlarvae and adults swimming up to the surface layer at night. Ellis (1962) reported specimens (as *L. liparis*) in tide pools at low- to mid-tide levels in Frobisher Bay at the end of June and beginning of July. Green and Steele (1977) observed this species swimming and feeding up to 1 m above the bottom, although most were rarely seen more than 1 m from attached algae and most specimens were collected from *Laminaria* fronds at Resolute, N.W.T., in June and December beneath sea ice.

Bean (1879) reported this species fastened to kelp taken in 9–16 m in Cumberland Sound. MacInnis and Curtsinger (1973) presented a photo of a 38-mm specimen (misidentified as

Liparis atlanticus) curled in a circle clinging to a kelp frond, and the junior author found them in the same position on kelp fronds trawled in the Beaufort Sea. McAllister (1977) using scuba observed them on *Laminaria* fronds at 5 m in Bellot Strait, N.W.T. (reported as *L. herschelinus*). These observations, their frequent occurrence with *Laminaria* or *Agarum* in trawls, and their kelp-colored pigmentation suggest, at least for small- and moderate-sized specimens, that the surface of laminarian fronds is their normal habitat.

This species occurs at shallower depths than *L. gibbus* and *L. fabricii*; 52 of 55 collections were at 50 m or less (Table 1). Eight diving collections confirmed their presence on the bottom, not in mid-water at 3–30 m. Only one collection was made more than 20 km offshore; most were within 5 km. The bottom included stones, pebbles, or

boulders in 13 of 23 trawl or dredge hauls, mud in 9, and sand in 1. Only two salinities were recorded, 31.9 and 35.6 ‰. Temperatures at collection localities ranged from -1.5°C in December to 2.1°C in August.

Reproduction

Gonads appeared immature in most specimens taken in summer.

Food

Green and Steele (1977) found about 80% of stomachs contained pelagic (up to 1 m above bottom) organisms, mainly amphipods, in June and December. Collett in Bean (1879) reported the alimentary canal of a specimen filled with small amphipods, one *Caprella septentrionalis*, and many *Protomedea fasciata*. A specimen from Dease Strait (NMC 77-1360) contained seven amphipods in the stomach.

Predators

Kumlien (1879) found remains of *Liparis vulgaris* (misidentification of *L. tunicatus*) in seal stomachs from either Cumberland Sound or Greenland, and noted that, during winter especially, seals subsist to a considerable extent on fish.

Parasites

Johansen (MS) reported a parasitic copepod, *Haemobaphes cyclopterina*, in both the gill chambers of a 10-cm kelp snailfish from Jammerbugten, southern Ellesmere Island, N.W.T., and repeated Lutken's (1887) records of an *Ascaris* from a Greenland *L. tunicatus*.

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The National Museum of Natural Sciences, Ottawa, Ont., supplied the majority of specimens, use of computer systems, soft x-ray machines, scanning electron microscope, and support for field work, including helicopter and boat rental, and publication.

Much of the material was obtained through the collecting efforts over many years of Dr J. G. Hunter and Dr M. J. Dunbar with the Arctic Unit of the Fisheries Research Board of Canada. Efforts of Ingram Gidney, Shirley Leach, and Margaret Jones, working for the Board, made these available. Valuable specimens from several localities in the high Arctic that would otherwise be unrepresented were collected by S. D. MacDonald of the National Museum of Natural Sciences. Dr Robert Lee, also of the museum, and John Boom provided several specimens collected from arctic seaweed by scuba diving.

Roberta Boyle assisted in x-raying specimens and making counts, and Jadwiga Aniskowicz, Jennifer Lewis, and Michèle Steigerwald assisted in cataloging specimens, mapping, and computerizing data. J. Aniskowicz also took additional x-rays and, with Anne Marchand, assisted with maps and graphs. Drawings were prepared by C. H. Douglas. C. G. Gruchy effectively wielded his pen in clarifying the manuscript. Dr D. M. Cohen provided x-rays of the type of *Liparis gibbus*. Dr Frederick Schueler performed a trend surface analysis on data from specimens of *Liparis tunicatus*. Dr M. J. Dunbar, McGill University, Montreal, and Dr E. H. Grainger, Arctic Biological Station, Ste-Anne-de-Bellevue, Que., shared their observations on bioluminescence of Arctic copepods.

The following generously loaned specimens in their care: J. C. Quast, ABBL; C. L. Smith, AMNH; J. E. Bohlke, ANSP; A. Wheeler, BMNH; G. J. Mueller, UA; J. Bergeron, MIC; E. J. Crossman, ROM; L. Knapp, SOSC; A. M. Fleming, FRB, St. John's; N. J. Wilimovsky, BC; Per Pethon, UZMO; J. G. Nielsen, UZMC; and O. Froiland, UZMB. J. G. Nielsen, UZMC, also provided a radiograph of one of the syntypes of *L. fabricii*.

The authors are deeply grateful for the assistance of all these persons.

TABLE 2. Dorsal fin ray counts for *Liparis* of Arctic North America.

Species and area	Sample	Mean	SD	CV ^a	Frequency																						
					30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50		
<i>Liparis atlanticus</i>																											
Ungava Bay & Newfoundland	37	33.4	.76	2.26	-	-	3	16	15	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Quebec & Nova Scotia	15	33.0	1.03	3.12	-	1	3	6	4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Total	52	33.3	.86	2.58	-	1	6	22	19	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
<i>Liparis gibbus</i>																											
Alaska	55	43.2	1.61	3.72	-	-	-	-	-	-	-	-	-	1	4	3	7	12	15	12	1	-	-	-	-	-	
Arctic Canada	38	42.0	.91	2.17	-	-	-	-	-	-	-	-	-	-	2	7	19	8	2	-	-	-	-	-	-	-	
Atlantic Canada	51	41.4	1.34	3.24	-	-	-	-	-	-	-	-	1	2	7	19	12	5	5	-	-	-	-	-	-	-	
Total	144	42.2	1.56	3.69	-	-	-	-	-	-	-	-	1	3	13	29	38	25	22	12	1	-	-	-	-	-	
<i>Liparis fabricii</i>																											
Western Canadian Arctic	50	45.5	.95	2.09	-	-	-	-	-	-	-	-	-	-	-	-	-	1	6	16	22	4	1	-	-	-	
Northern Canadian Arctic	12	46.8	1.19	2.54	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0	3	4	4	-	-	-	
Eastern Canadian Arctic	33	45.9	1.24	2.71	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	8	9	9	3	-	-	-	
Arctic Canada (W, N, & E)	95	45.8	1.15	2.52	-	-	-	-	-	-	-	-	-	-	-	-	-	2	10	24	34	17	8	-	-	-	
Greenland-Spitsbergen	10	45.5	1.58	3.47	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	3	4	0	0	1	-	-	
Total (incl. Atl. Canada)	109	45.7	1.19	2.60	-	-	-	-	-	-	-	-	-	-	-	-	-	3	11	29	39	18	8	1	-	-	
<i>Liparis tunicatus</i>																											
Alaska	7	41.4	1.13	2.73	-	-	-	-	-	-	-	-	-	-	2	1	3	1	-	-	-	-	-	-	-	-	-
Western Canadian Arctic	37	42.0	.96	2.74	-	-	-	-	-	-	-	-	-	-	-	13	12	10	2	-	-	-	-	-	-	-	-
Northern Canadian Arctic	79	41.7	1.08	2.60	-	-	-	-	-	-	-	-	-	1	10	22	25	19	2	-	-	-	-	-	-	-	-
Eastern Canadian Arctic	25	42.0	.91	2.17	-	-	-	-	-	-	-	-	-	-	2	4	11	8	-	-	-	-	-	-	-	-	-
Arctic Canada	141	41.8	1.02	2.43	-	-	-	-	-	-	-	-	-	1	13	39	47	37	4	-	-	-	-	-	-	-	-
Greenland	18	41.8	.78	1.87	-	-	-	-	-	-	-	-	-	-	7	7	4	-	-	-	-	-	-	-	-	-	-
Total	166	41.8	1.00	2.39	-	-	-	-	-	-	-	-	-	1	14	47	58	42	4	-	-	-	-	-	-	-	-

^aCoefficient of variation.

TABLE 3. Anal fin ray counts for *Liparis* of Arctic North America.

Species and area	Sample	Mean	SD	CV ^a	Frequency																		
					25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
<i>Liparis atlanticus</i>																							
Ungava Bay & Newfoundland	37	26.9	.86	3.20	1	9	19	6	2	-	-	-	-	-	-	-	-	-	-	-			
Quebec & Nova Scotia	15	26.4	1.18	4.48	3	6	3	2	1	-	-	-	-	-	-	-	-	-	-	-			
Total	52	26.8	.98	3.67	4	15	22	8	3	-	-	-	-	-	-	-	-	-	-	-			
<i>Liparis gibbus</i>																							
Alaska	58	35.1	1.13	3.21	-	-	-	-	-	-	1	3	12	19	17	6	-	-	-	-			
Arctic Canada	37	35.0	.94	2.68	-	-	-	-	-	-	-	-	13	11	11	2	-	-	-	-			
Atlantic Canada	51	34.4	1.10	3.19	-	-	-	-	-	-	-	11	16	15	7	2	-	-	-	-			
Total	146	34.8	1.11	3.18	-	-	-	-	-	-	1	14	41	45	35	10	-	-	-	-			
<i>Liparis fabricii</i>																							
Western Canadian Arctic	50	38.6	.79	2.05	-	-	-	-	-	-	-	-	-	1	3	11	31	4	-	-			
Northern Canadian Arctic	12	39.4	1.31	3.32	-	-	-	-	-	-	-	-	-	-	1	2	2	6	-	1			
Eastern Canadian Arctic	33	38.5	1.14	2.98	-	-	-	-	-	-	-	-	-	-	7	11	7	7	1	-			
Arctic Canada (W, N, & E)	94	38.7	1.03	2.66	-	-	-	-	-	-	-	-	-	1	11	24	40	17	1	1			
Greenland-Spitsbergen	11	38.6	.67	1.74	-	-	-	-	-	-	-	-	-	-	-	5	5	1	-	-			
Total (incl. Atl. Canada)	110	38.7	1.02	2.65	-	-	-	-	-	-	-	-	-	1	12	29	45	20	2	1			
<i>Liparis tunicatus</i>																							
Alaska	8	34.1	.83	2.44	-	-	-	-	-	-	-	2	3	3	8	-	-	-	-	-			
Western Canadian Arctic	37	35.1	.96	2.74	-	-	-	-	-	-	-	2	4	20	7	4	-	-	-	-			
Northern Canadian Arctic	81	34.8	.96	2.77	-	-	-	-	-	-	-	6	22	32	18	3	-	-	-	-			
Eastern Canadian Arctic	25	35.1	.89	2.55	-	-	-	-	-	-	-	1	5	8	11	-	-	-	-	-			
Arctic Canada	143	35.0	.96	2.74	-	-	-	-	-	-	-	9	31	60	36	7	-	-	-	-			
Greenland	20	35.2	.78	2.23	-	-	-	-	-	-	-	-	4	7	9	-	-	-	-	-			
Total	171	34.9	.95	2.72	-	-	-	-	-	-	-	11	38	70	45	7	-	-	-	-			

^aCoefficient of variation.

TABLE 4. Pectoral fin ray counts (left) for *Liparis* of Arctic North America.

Species and area	Sample	Mean	SD	CV ^a	Frequency																		
					27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
<i>Liparis atlanticus</i>																							
Ungava Bay & Newfoundland	36	28.3	1.45	4.93	5	14	15	2	-	-	-	-	-	-	-	-	-	-	-	-			
Quebec & Nova Scotia	15	29.5	.80	2.80	2	2	2	4	5	-	-	-	-	-	-	-	-	-	-	-			
Total	51	28.7	1.15	4.00	7	16	17	6	5	-	-	-	-	-	-	-	-	-	-	-			
<i>Liparis gibbus</i>																							
Alaska	45	40.2	1.89	4.69	-	-	-	-	-	-	-	-	-	-	3	3	11	10	7	5	3	2	1
Arctic Canada	32	39.6	1.38	3.48	-	-	-	-	-	-	-	-	-	-	1	6	9	7	5	4	-	-	-
Atlantic Canada	41	39.1	.98	2.50	-	-	-	-	-	-	-	-	-	-	-	14	11	13	3	-	-	-	-
Total	118	39.7	1.55	3.92	-	-	-	-	-	-	-	-	-	-	1	23	31	30	15	9	3	2	1
<i>Liparis fabricii</i>																							
Western Canadian Arctic	50	35.2	1.12	3.18	-	-	-	-	-	-	3	9	18	12	8	-	-	-	-	-	-	-	-
Northern Canadian Arctic	12	33.9	1.08	3.19	-	-	-	-	-	1	3	5	2	1	-	-	-	-	-	-	-	-	-
Eastern Canadian Arctic	25	34.7	1.16	3.35	-	-	-	-	-	1	3	4	11	5	1	-	-	-	-	-	-	-	-
Arctic Canada (W, N, & E)	87	34.9	1.21	3.48	-	-	-	-	-	2	-	18	31	18	9	-	-	-	-	-	-	-	-
Greenland-Spitsbergen	5	34.4	1.51	4.40	-	-	-	-	-	1	-	1	2	1	-	-	-	-	-	-	-	-	-
Total (incl. Atl. Canada)	95	34.8	1.22	3.50	-	-	-	-	-	3	10	19	34	20	9	-	-	-	-	-	-	-	-
<i>Liparis tunicatus</i>																							
Alaska	9	35.5	1.81	5.09	-	-	-	-	-	1	-	1	2	2	2	1	-	-	-	-	-	-	-
Western Canadian Arctic	27	35.8	.96	2.68	-	-	-	-	-	-	-	2	9	8	8	-	-	-	-	-	-	-	-
Northern Canadian Arctic	36	35.1	1.19	3.38	-	-	-	-	-	-	3	9	10	9	5	-	-	-	-	-	-	-	-
Eastern Canadian Arctic	19	35.6	1.16	3.26	-	-	-	-	-	-	1	2	5	6	5	-	-	-	-	-	-	-	-
Arctic Canada	82	35.4	1.14	3.23	-	-	-	-	-	-	4	13	24	23	18	-	-	-	-	-	-	-	-
Greenland	2	36.0	0.0	0.0	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
Total	93	35.4	1.20	3.39	-	-	-	-	-	1	4	14	26	27	20	1	-	-	-	-	-	-	-

^aCoefficient of variation.

TABLE 5. Teeth in first row of upper jaw in *Liparis* of Arctic North America.

Species and area	Sample	Mean	SD	CV ^a	Frequency														
					3	4	5	6	7	8	9	10	11	12	13	14	15		
<i>Liparis atlanticus</i>																			
Ungava Bay & Newfoundland	20	5.6	.94	16.79	—	3	5	9	3	—	—	—	—	—	—	—	—		
Quebec & Nova Scotia	14	6.0	.78	13.07	—	—	4	6	4	—	—	—	—	—	—	—	—		
Total	34	5.7	.89	15.43	—	3	9	15	7	—	—	—	—	—	—	—	—		
<i>Liparis gibbus</i>																			
Alaska	46	11.8	1.97	16.68	—	—	—	1	0	2	3	4	8	7	12	7	2		
Arctic Canada	28	8.3	1.52	18.15	—	—	—	4	3	8	7	4	1	1	—	—	—		
Atlantic Canada	7	9.5	1.71	17.95	—	—	—	—	—	3	1	—	2	1	—	—	—		
Total	81	10.4	2.42	23.18	—	—	—	5	3	13	11	8	11	9	12	7	2		
<i>Liparis fabricii</i>																			
Western Canadian Arctic	45	5.5	.91	16.53	—	5	17	17	5	1	—	—	—	—	—	—	—		
Northern Canadian Arctic	11	4.6	.67	14.54	—	5	5	1	—	—	—	—	—	—	—	—	—		
Eastern Canadian Arctic	19	5.0	.78	15.43	—	4	11	3	1	—	—	—	—	—	—	—	—		
Arctic Canada (W, N, & E)	75	5.2	.91	17.22	—	14	33	21	6	1	—	—	—	—	—	—	—		
Greenland-Spitsbergen	11	4.5	1.29	28.45	1	6	3	—	—	1	—	—	—	—	—	—	—		
Total (incl. Atl. Canada)	89	5.1	.98	19.01	1	21	37	22	6	2	—	—	—	—	—	—	—		
<i>Liparis tunicatus</i>																			
Alaska	5	7.0	.70	10.10	—	—	—	1	3	1	—	—	—	—	—	—	—		
Western Canadian Arctic	13	9.0	1.22	13.60	—	—	—	—	2	1	7	1	2	—	—	—	—		
Northern Canadian Arctic	15	8.0	1.51	18.89	—	—	—	2	4	5	2	0	2	—	—	—	—		
Eastern Canadian Arctic	5	8.0	1.58	19.76	—	—	—	1	1	1	1	1	—	—	—	—	—		
Arctic Canada	33	8.3	1.45	17.35	—	—	—	3	7	7	10	2	4	—	—	—	—		
Greenland	1	8.0	0.0	0.0	—	—	—	—	—	1	—	—	—	—	—	—	—		
Total	39	8.2	1.43	17.50	—	—	—	4	10	9	10	2	4	—	—	—	—		

^aCoefficient of variation.

TABLE 6. Pyloric caeca counts in *Liparis* of Arctic North America.

Species and area	Sample	Mean	SD	CV ^a	Frequency																																						
					10	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50			
<i>Liparis atlanticus</i>																																											
Ungava Bay & Newfoundland	36	32.3	4.78	14.79	-	-	-	-	-	-	-	-	1	1	1	2	1	1	0	3	5	5	4	2	4	1	1	1	0	1	-	-	1	-	1	-	-	-	-	-	-		
Quebec & Nova Scotia	15	31.4	4.38	13.94	-	-	-	-	-	-	-	-	1	-	-	2	0	2	2	2	1	1	0	2	0	0	0	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	
Total	51	32.0	4.64	14.47	-	-	-	-	-	-	-	1	2	1	2	3	1	2	5	7	6	5	2	6	1	1	1	1	2	-	-	1	-	1	-	-	-	-	-	-	-	-	
<i>Liparis gibbus</i>																																											
Alaska	35	33.4	4.02	12.01	-	-	-	-	-	-	-	-	1	1	1	1	3	1	3	3	3	2	5	2	1	4	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Arctic Canada	35	30.6	4.84	15.78	-	-	-	-	-	-	-	2	1	3	-	3	5	1	4	1	2	3	5	-	2	-	-	1	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
Atlantic Canada	23	28.3	3.48	12.28	-	-	-	-	-	1	1	-	3	3	2	-	2	4	2	3	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	92	31.1	4.65	14.91	-	-	-	-	-	1	1	2	1	7	4	6	6	6	9	6	8	7	8	5	4	1	4	4	1	-	2	-	-	-	-	-	-	-	-	-	-	-	
<i>Liparis fabricii</i>																																											
Western Canadian Arctic	50	25.0	3.46	13.83	-	-	-	1	4	2	5	4	11	3	5	3	4	2	4	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Northern Canadian Arctic	11	27.2	4.60	16.89	-	-	-	1	-	1	-	-	3	2	-	2	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Eastern Canadian Arctic	19	25.0	3.17	12.65	-	-	-	-	2	1	1	1	5	1	2	-	3	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Arctic Canada (W, N, & E)	80	25.3	3.60	14.23	-	-	-	-	2	6	3	7	5	16	4	10	5	7	6	4	1	-	-	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Greenland-Spitsbergen	4	24.0	2.44	10.20	-	-	-	-	1	-	-	-	0	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Total (incl. Atl. Canada)	87	25.4	3.62	14.25	-	-	-	-	2	6	4	7	6	16	4	13	5	7	6	4	2	1	-	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Liparis tunicatus</i>																																											
Alaska	7	26.2	4.71	17.94	-	-	-	-	1	-	-	1	2	-	-	-	1	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Western Canadian Arctic	31	22.2	4.27	19.25	1	1	3	1	2	-	5	3	2	2	4	3	2	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Northern Canadian Arctic	35	31.3	5.34	17.07	-	-	-	-	-	-	-	-	-	1	3	4	6	2	6	1	-	2	2	3	-	1	1	-	1	1	-	-	-	-	-	-	-	-	-	-	-	1	-
Eastern Canadian Arctic	18	36.0	7.44	20.67	-	-	-	-	-	-	-	-	1	1	-	1	1	1	1	1	1	1	1	-	2	-	1	-	-	0	2	-	-	-	-	-	-	-	-	2	2	-	-
Arctic Canada	84	28.9	7.72	26.67	1	1	3	1	2	-	5	3	2	2	6	7	6	7	4	8	2	1	3	3	3	2	-	2	1	-	1	3	-	-	-	-	-	-	-	2	2	-	1
Greenland	2	36.0	1.41	3.92	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Total	93	28.9	7.54	26.10	1	1	3	1	2	1	5	3	3	4	6	7	6	7	5	8	2	3	3	3	4	2	1	2	1	-	1	3	-	-	-	-	-	2	2	-	1		

^aCoefficient of variation.

TABLE 7. Total vertebrae (including urostyle) in *Liparis* of Arctic North America.

Species and area	Sample	Mean	SD	CV ^a	Frequency												
					38	39	40	41	42	43	44	45	46	47	48	49	50
<i>Liparis atlanticus</i>																	
Ungava Bay & Newfoundland	35	39.6	.81	2.05	1	17	13	3	1	-	-	-	-	-	-	-	-
Quebec & Nova Scotia	15	39.3	.90	2.28	3	5	6	1	-	-	-	-	-	-	-	-	-
Total	50	39.5	.83	2.12	4	22	19	4	1	-	-	-	-	-	-	-	-
<i>Liparis gibbus</i>																	
Alaska	57	48.0	1.46	3.05	-	-	-	-	-	2	3	4	3	20	19	6	-
Arctic Canada	35	47.4	.91	1.93	-	-	-	-	-	-	1	3	15	12	4	-	-
Atlantic Canada	35	46.2	1.09	2.36	-	-	-	-	-	2	5	14	12	-	2	-	-
Total	127	47.3	1.43	3.03	-	-	-	-	-	4	9	21	30	32	25	6	-
<i>Liparis fabricii</i>																	
Western Canadian Arctic	50	50.6	.71	1.41	-	-	-	-	-	-	-	-	-	-	2	18	25
Northern Canadian Arctic	12	51.4	1.44	2.80	-	-	-	-	-	-	-	-	-	1	-	2	1
Eastern Canadian Arctic	25	50.2	1.33	3.34	-	-	-	-	-	-	-	-	-	2	5	9	5
Arctic Canada (W, N, & E)	87	50.6	1.08	2.15	-	-	-	-	-	-	-	-	-	3	7	29	31
Greenland-Spitsbergen	9	50.6	.70	1.39	-	-	-	-	-	-	-	-	-	-	-	4	4
Total (incl. Atl. Canada)	100	50.6	1.04	2.06	-	-	-	-	-	-	-	-	-	3	7	33	38
<i>Liparis tunicatus</i>																	
Alaska	7	46.2	1.38	2.98	-	-	-	-	-	-	3	1	1	2	-	-	-
Western Canadian Arctic	39	47.5	.91	1.92	-	-	-	-	-	-	-	5	14	14	6	-	-
Northern Canadian Arctic	75	47.0	.94	2.00	-	-	-	-	-	-	2	21	29	20	2	1	-
Eastern Canadian Arctic	25	47.3	.90	1.91	-	-	-	-	-	-	1	3	8	12	1	-	-
Arctic Canada	139	47.2	.95	2.01	-	-	-	-	-	-	3	29	51	46	9	1	-
Greenland	20	47.0	.88	1.88	-	-	-	-	-	-	1	4	8	7	-	-	-
Total	166	47.1	.97	2.07	-	-	-	-	-	-	7	34	60	55	9	1	-

^aCoefficient of variation.

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