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On the Stock Identity of Short-finned squid (Illex illecebrosus) in the Northwest Atlantic

by

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INTRODUCTION

Illex illecebrosus ranges in distribution from northern Newfoundland and Labrador in the north to Cape Kennedy, Florida in the south (Roper et al. 1969, Lu 1973). Little information is available regarding its distribution at the southern extreme of its range, but it is only seldom captured south of Cape Hatteras (Lu 1973). Although the stock identity of this species remains uncertain, it appears that a single stock complex exists, which spawns over a broad area and period of time (Mercer 1969a).

There is little direct evidence to confirm the existance of a single stock. Most insight regarding stock identity and life cycle is derived from consideration of size and maturity data (Mercer 1969a, Mesnil 1977, Lange and Sissenwine MS 1981). Recently further indirect evidence has resulted from descriptions of the distribution of larvae and small juveniles (Roper and Lu MS 1978, Vecchione MS 1978, Fedulov and Froerman MS 1980, Dawe and Beck MS 1982, Hatanaka et al. MS 1982), as well as mechanisms which may be responsible for their transport (Trites MS 1982).

More critical examination of stock composition is rendered difficult due to deficiencies in our understanding of the life history of the species. Paramount in that respect is uncertainty as to the time and location of spawning since the spawning population has not yet been found. Determination of time of spawning as well as growth rates and age at maturity are further complicated by the lack of a method of ageing this species. For this reason the longevity and basic life-cycle remain unresolved with estimates of life span varying between one year (Squires 1967, Hurley and Beck 1979) and 18 months (Mesnil 1977, Dupouy MS 1982).

This paper provides a review of the indirect evidence for stock composition based on size and maturity as well as distribution. The usefulness of other methods often used to help discriminate among fish stocks is also considered, including incidence of parasitism, tag and recapture studies and mechanisms of dispersal of young stages.

MATERIALS AND METHODS

Size and maturity, as well as incidence of parasitism by cestode plerocercoids are described from samples collected between the Grand Bank (NAFO Subarea 3) and Delaware Bay (NAFO Statistical Area 6) (Fig. 1) aboard the Canadian research vessel, A.T. CAMERON. Samples were collected on the Continental Shelf at various localities and seasons during the years 1966-1968 (Fig. 2-4). Between 1970 and 1972 samples were collected during spring or summer (May to July) on the Grand Bank and Scotian Shelf (Fig. 2 and 3).

Sampling was conducted using a Yankee 41.5 otter trawl with a small mesh liner in tows of 30-minute duration. Further details of methodology and sampling gear have been described by Mercer (1969b, 1969c). The November 1966 sample from Holyrood was collected using Japanese mechanical jiggers.

Detailed examination of samples included measurement of dorsal mantle length to the nearest 0.5 cm, sex determination and, in males, classification of maturity stages according to Mercer (1973). Presence or absence of the cestode plerocercoids Dinobothrium and Phyllobothrium was also noted.

Anisakis larvae from squid as well as several fish hosts were cultured in vitro at Memorial University of Newfoundland in order to determine species identity based on the adult stage. Salmon, herring, mackerel, and squid were obtained from a variety of locations around the coast of insular Newfoundland during the period May-November 1979 and examined for anisakine larvae using conventional parasitological techniques. From early June to mid-August 2300 squid were necropsied and yielded 12 Anisakis larvae (only three in the first 1000 squid). During the period mid-September to mid-October 230 squid were examined and 100 larvae found.

The nematodes that were recovered were treated in one of three ways: (1) cultured in vitro; (2) fixed in glacial acetic acid and then stored in glycerine alcohol; and, (3) deep frozen at -20°C for further analysis.

The method used in this project was a slight modification of the van Banning (1971) method. Fresh hog liver was liquefied in a 0.9% NaCl solution in a blender (100 g liver/500 ml NaCl soln.). Better results were obtained with liver that had been chilled for 24 hours than with liver that was only 2-3 hours old. After blending all large pieces of material (eg. blood vessels) were strained from the solution. Pepsin (0.5-1.5 g) was then added to the above solution, the pH lowered to 1.0-1.5 using concentrated hydrochloric acid, and the resultant mixture left to digest, at 38°C, overnight (periods of longer than 16 hours made no difference to the final medium).

After digestion the solution was once again strained and any undigested particles removed. The pH was raised to 2.0 using concentrated sodium hydroxide, and the whole mixture centrifuged at 5000 rmp for 30 minutes. The resultant clear yellow supernatant was removed and 0.015 g of Nystatin/100 ml was added.

The medium was placed in 10, 20, or 40 ml vials, with one to three worms (almost invariably one). The yellow supernatant is the activating medium for the larvae, but it is necessary to add fresh whole blood daily if maturation is to occur. Fresh hog's blood was obtained (sodium-citrated) every three days, and 1-2 drops added per vial per day after the first moult occurred. The optimal temperature for culture was 36-37°C, with development ceasing and mortality increasing at temperatures of 38°C or higher.

Samples of worms of varying age, from day culturing started, were preserved for meristic and morphological study. Specimens of larvae and adults from each host were examined using a scanning electron microscope.

RESULTS AND DISCUSSION

Size and Maturity

Based in part on similarity in distribution of sizes, it appears that short-finned squid between Newfoundland and Cape Hatteras comprise a single stock complex. Examination of modal lengths reveals that between May and November squid on the Grand Bank and inshore at Newfoundland (Subarea 3) are similar to those captured on the Scotian Shelf (Subarea 4) and were likely spawned at the same time. May to July modal lengths for males ranged 13-18 cm on the Grand Bank and 10-19 cm on the Scotian Shelf (Fig. 2a). Thoughout this period modal lengths of females from the Grand Bank ranged 13-21 cm whereas those from the Scotian Shelf ranged 10-20 cm (Fig. 3a).

November samples from Holyrood and the Scotian Shelf show a further increase in modal length with modes for females at 22 and 24 cm, respectively (Fig. 3b). Males from the Scotian Shelf (with modal length 22 cm) were in advanced stages of maturity and would appear to spawn in winter (December-February). Apparently less advanced maturity of males at Holyrood may be due to low sample size or emigration of larger more mature males as seen by the low proportion of males in the sample (35%, Fig. 2b). Males captured inshore at Newfoundland in November are usually in much more advanced stages of maturity (Beck et al. MS 1980), than those described here (Fig. 2b).

These large squid which support the July-November fishery in Subareas 3 and 4 are of the same size as the best represented mode observed in autumn samples between Georges Bank and Virginia. Lange and Sissenwine (MS 1981) showed that in that area during October to December 1973-1979 modal lengths for sexes combined were usually within the range 20-23 cm for the largest group. This agrees with Mesnil (MS 1977) and Mesnil et al. (MS 1976) who found that within that same area in November-December modes for the largest males and females were at 23 cm and 26 cm respectively in 1975 and at 22 cm and 27 cm respectively in 1976. This same group of squid was dominant in August 1968 samples between Atlantis Canyon and Delaware Bay (Fig. 3a). Modes for large males (21 and 22 cm) were comparable to those observed inshore at Newfoundland, where during 1980 and 1981 modes were at 20-21 cm for most localities. The same was true for the large females, with modes of 21 and 24 cm at the southern areas (Fig. 3a) compared to 20-22 cm at Newfoundland localities during 1980-1981 (Beck et al. MS 1981, MS 1982). Lange and Sissenwine (MS 1981) found that between Georges Bank and Virginia modes during late July and August 1973-1979 were usually within the range 18-21 cm for sexes combined. During August males from the more southern localities (Fig. 3a) were in much more advanced stages of maturity than are those from the northern extreme of their range of distribution (Beck et al. MS 1980, MS 1981, MS 1982). Maturation of males at smaller sizes to the south has been previously noted by Lu (1973); this is likely due to an accelerating effect of temperature on sexual maturation.

The close similarity of sizes of the largest and best represented group of squid between Newfoundland and Virginia suggest that they were likely spawned at the same time of year. Mesnil (1977) suggested that the life span of this species involves a life span of 18 months with alternating generations, such that these large squid were hatched the previous summer (August) and would spawn in winter (January). This is unlikely however since large catches of juveniles ranging in mantle length 0.6-11.5 cm were experienced in January-February 1982 off the Continental Shelf as far east as 58°W (Hatanaka et al. MS 1982). Also Lange and Sissenwine MS 1981) noted that although summer spawning may be more prominent in some years, winter spawning is much more consistent. Thus it is believed that the growth rates of young stages is faster than had been assumed by Mesnil (1977) and the greatest and most consistent peak of spawning occurs during winter, as originally proposed by Squires (1967). Some squid from the winter brood may live for 18 months and spawn during their second spring or summer (Dupouy MS 1982). However, the majority likely spawn during winter at an age of one year.

The existance of larval <u>Illex illecebrosus</u> throughout most of the year indicates that spawning occurs to some degree throughout the year (Roper and Lu MS 1978, Vecchione MS 1978, Lu and Roper 1979, Dawe and Beck MS 1982, Hatanaka et al. MS 1982). Smaller modes in length frequency distributions probably reflect less prominent peak periods of spawning (Lange and Sissenwine MS 1981). The secondary modes in Fig. 4a at 10 cm for males and females probably resulted from a peak of spring-spawning, probably to the south of Chesapeake Bay. This is supported by length frequency distributions presented by Lange and Sissenwine (MS 1981) which showed a secondary mode for sexes combined at 9 and 10 cm during August 1977 and 1979, but only for the southern extreme of the survey area (New Jersey to Virginia). This may be comparable to the group of squid found on the Scotian Shelf in late August and September 1981 with modal length of approximately 8 cm for both sexes (Dupouy and Minet MS 1982, Dupouy MS 1982). In later autumn (October to November) of some years this group has appeared in length frequency distributions from the areas Georges Bank to New Jersey with modal lengths varying between 9 and 12 cm (Mesnil MS 1977, Lange and Sissenwine MS 1981).

It has also been shown that in more southern areas spawning occurs in summer (Lange and Sissenwine MS 1981). These authors noted that a group of small squid of less than 10 cm which may be quite prominent during autumn of some years likely resulted from summer spawning. They also noted that summer spawning is more prevalent to the south. The specimens collected off Delaware and Virginia in April 1967 (Fig. 4b) were likely hatched in spring or summer and will likely spawn in spring or summer based on the advanced stages of maturation in males. The existance of a group of unusually small squid (approximately 14-25 cm) during late autumn of some years at southern localities of Newfoundland (Squires 1957) indicates that not all squid at the northern extreme of their range are from the winter-spawned group.

Thus it appears that spawning occurs throughout most of the year, with a prominent peak during winter. Less pronounced peaks occur during other seasons and squid from all broods, especially the winter brood become distributed throughout most of the area of northeastern United States to Newfoundland. Differences in distribution patterns of the different broods may be due to seasonal variation in the flow of the Gulf Stream System which is probably responsible for the dispersal of young stages (Trites MS 1982, Hatanaka et al. MS 1982).

Parasites

Parasites have been used successfully in stock discrimination of herring (Sindermann 1961a, Parsons and Hodder 1971, Davey 1972), salmon (Nyman and Pippy 1972), redfish (Templeman 1950, Sindermann 1961b), and other fish species. Kabata (1963) has outlined some conditions which should be met for a parasite to be used successfully as a biological tag.

Cestodes

The most common parasites infecting Illex illecebrosus are plerocercoids of the tetraphyllidean cestodes Phyllobothrium sp. and Dinobothrium sp. (Squires 1957, Mercer MS 1965, Brown and Threlfall 1968a, 1968b). Both parasites most frequently infest the caecum of the live host (Brown and Threlfall 1968a). From preserved specimens however Dinobothrium is usually found encysted on the spiral part of the caecum, whereas Phyllobothrium may be found on other organs as well (Squires 1957). For both genera crustaceans probably serve as the first intermediate host (Squires 1957), whereas elasmobranchs are likely definitive hosts (Brown and Threlfall 1968a). Dinobothrium from inshore Newfoundland squid has been indeitified as D. plicitum. Percent infection of squid with Dinobothrium, in relation to host mantle length, is shown in Fig. 5 for sexes combined from various seasons and regions of the northwest Atlantic. Squid usually do not become infected with this parasite until they have reached approximately 14 cm in mantle length. Brown and Threlfall (1968b) found that squid sampled inshore at Newfoundland in 1966 and 1967 were not infected with this parasite at sizes of less than 16 and 18 cm, respectively. The infection rate was lowest in May and June but increased with mantle length, as found by other investigators (Squires 1957, Mercer MS 1965, Brown and Threlfall 1968b).

There appears to be little variation in degree of infection related to geographical area (Fig. 5). This however does not provide support for the existance of a single stock due to the unsuitability of this parasite as a biological tag. Dinobothrium is distributed throughout the range of short-finned squid and is common to a wide variety of intermediate hosts including many species of bony fish (Gaevskaya and Nigmatullin 1975). These authors noted that helminths found in ommastrephids have a wide host specificity and consist of typical 'fish' forms. Dinobothbrium shows an ecological rather than host specificity (Mercer MS 1965) and is a member of the coastal coenosis described by Gaevskaya and Nigmatullin (1975). They are not acquired by Illex illecebrosus early in the hosts' life cycle but are probably consumed as procercoids with their crustacean intermediate hosts on the Continental Shelf (Squires 1957, Mercer MS 1965). Such a parasite is of little use as an indicator of the geographic origin or migration of its host (Kabata 1963).

Percent infection by Phyllobothrium in relation to squid mantle length is shown in Fig. 6. This parasite is acquired at smaller host size than is Dinobothrium with squid as small as 7 cm being infected. The percent infection by this parasite is generally much higher than for Dinobothrium especially during May-July on the Grand Bank and Scotian Shelf (Fig. 5 and 6). These differences probably relate to the fact that Phyllobothrium is not only found in the coastal environment but is also a member of the oceanic coenosis described by Gaevskaya and Nigmatullin (1975). Thus this parasite is probably initially acquired by its host at a younger age during the oceanic phase of its life cycle. An increase in percent infection with size is evident for May to July samples from the Grand Bank and Scotian Shelf, as previously described by Mercer (MS 1965). Squires (1957) and Brown and Threlfall (1968b) reported the reverse however with higher percent infection in smaller squid from inshore Newfoundland localities. The increase with size during May-July may reflect increased consumption of procercoids with crustaceans by larger squid on the continental shelf.

The percent infection by Phyllobothrium during May to July is quite similar between the Grand Bank and Scotian Shelf (Fig. 6). The higher percent infection of small squid during August 1968 between Cape May and Chesapeake Bay may be due to the later time of sampling or seasonal differences in availability of the parasite, since this group of small squid probably resulted from a different period of spawning (Fig. 4a). The exceptionally high percentage of infected squid during April 1967 off Delaware and Virginia (Fig. 6) may reflect the greater age of this group which may have hatched in spring or summer, as also seen by the advanced stages of maturation in males (Fig. 4b). Further insight regarding stock discrimination using Phyllobothrium may not be attainable due to the broad distribution of this parasite throughout the range of distribution of Illex illecebrosus, as well as its wide host specificity (Gaevskaya and Nigmatullin 1975).

Anisakis sp.

Anisakis sp. larvae are found in Illex illecebrosus as well as in a variety of fish species from the northwest Atlantic. Although larval Anisakis from the northwest Atlantic have not been cultured in vitro to the adult stage it was felt that Anisakis simplex is the species found in herring and salmon (Beverly-Burton et al. 1977, Beverly-Burton and Pippy 1977). A second species, Anisakis typica, is reportedly found in its adult form in cetacean hosts between 40°N and 36°S (Davey 1971). Thus, if the species of Anisakis in squid from the Newfoundland area were found to be Anisakis typica then it could be concluded that squid from that region spend part of their life cycle in waters to the south of 40°N.

Anisakis larvae from herring, Atlantic salmon, mackerel and short-finned squid were cultured in 1979 in an effort to determine the specific identity of the adult form. Although maturation of larvae did not occur, pre-adults cultured from specimens taken from salmon, herring, and mackerel were designated Anisakis simplex, based on spicule size in males and lip conformation in both sexes (Davey 1971). From morphometric measurements (Tables 1-4) it was found that larvae from squid were recognizably different from those of other species, being much smaller in size (Table 1). Mean length achieved by Anisakis from squid after 37 days (22.5 mm, Table 1) was much smaller than for those from other hosts (31-36 mm, Table 2-4). Some larger larvae appeared in squid later in the season but even these attained a mean width of only 0.6 mm (Table 1) which was less than that for pre-adults cultured from larvae from salmon (1.5 mm, Table 3) or herring (1.3 mm, Table 4).

Larvae from squid cultured for 0-2 days (Table 1) ranged 6.8-19.1 mm in total length and 0.3-0.6 mm in width. These compare with lengths 16-22 mm and widths 0.5-0.6 mm for larval Anisakis in the ommastrephids Ommastrephes pteropus and O. bartrami from the tropical Atlantic as reported by Gaevskaya (1974).

A Scanning Electron Microcope study of various larvae, pre-adults and adults was also performed. Anisakis from squid (Fig. 7) appeared to have a larger number of teeth per lip than did an adult A. simplex from a Beluga (Delphinapterus leucas) (Fig. 8).

Thus, it seems likely that Anisakis sp. larvae from squid are a different species from those found in other hosts. However, culture of these larvae to the adult stage will be necessary to establish species identity.

Other Evidence

Tag and recapture data are too limited to serve as the basis of conclusions regarding stock identity. However inshore tagging at Newfoundland (Hurley and Dawe MS 1980) has shown that short-finned squid move at least occasionally from NAFO Subarea 3 to Subarea 4. Further, a single tag recapture involved a squid tagged at Newfoundland being recaptured in December off Delaware (Dawe et al. 1981). This is consistent with spawning of squid from the northern extreme of their range of distribution in areas far to the south.

The distribution and size composition of larval and juvenile short-finned squid also suggest that squid from more northern areas spawn to the south as part of the same stock complex found off the mid-Atlantic states. The similarity of minimum-sized juveniles along the northern boundary of the Gulf Stream during January to March as well as the dynamics of water transport by the Gulf Stream System suggest that young stages are transported from a southern locality by this water mass (Fedulov and Froerman MS 1980, Hatanaka et al. MS 1982, Trites MS 1982). Further, catches of larvae immediately south of the Grand Bank during 1980 and 1981 did not contain newly hatched larvae (Dawe and Beck MS 1982). If spawning occurs at least as far south as the mid-Atlantic states within the relatively homogenous environment of the Gulf Stream System, then all spawners during any season are likely members of the same stock spawning over an extensive area. Fairly continuous spawning throughout the year could provide sufficient genetic exchange such that seasonal peaks of spawning are not sufficiently distinct so as to suggest the existence of separate stocks.

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Table 1 : Measurements (mm) of _Anisakis_ sp. larvae cultured from Short-finned Squid (_Illex illecebrosus_)

	Days after culture 0				1-2				11				25-27				37			
	a	b	c	d*	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d
Total length	3	16.9	2.3	15.0 -19.1	33	12.6	2.4	6.8 -18.3	2	15.3	2.6	13.4-17.1	5	20.1	6.2	13.7 -28.5	3	22.5	1.7	21.3-24.5
Maximum width	3	0.4	0.1	0.4 - 0.6	33	0.4	0.05	0.3 - 0.5	2	0.3	0.2	0.1- 0.4	5	0.6	0.2	0.4 - 0.9	-	-	-	-
Oesophagus length	3	1.6	0.2	1.4 - 1.8	31	1.2	1.3	0.6 - 1.3	1	1.1	-	-	1	2.3	-	-	-	-	-	-
Ventricle length	3	0.7	0.1	0.6 - 0.8	31	0.6	0.2	0.4 - 0.7	1	0.6	-	-	1	0.7	-	-	-	-	-	-
Anus to tip of tail (excluding mucron)	2	0.1	0.04	0.08- 0.1	23	0.1	0.03	0.08- 0.15	-	-	-	-	4	0.1	0.02	0.11- 0.15	1	0.2	-	-

* a - number of larvae measured, b - mean size, c - standard deviation, d - range of size.

Table 2 : Measurements (mm) of _Anisakis_ sp. larvae cultured from Mackerel (_Scomber scombrus_)

	Days after culture 0				35				45			
	a	b	c	d*	a	b	c	d	a	b	c	d
Total length	10	25.6	3.8	18.7 - 31.3	1	41.6	-	-	1	29.0	-	-
Maximum width	10	0.5	0.1	0.4 - 0.7	1	1.0	-	-	1	0.8	-	-
Oesophagus length	10	1.8	0.2	1.3 - 2.0	-	-	-	-	-	2.8	-	-
Ventricle length	10	0.9	0.2	0.6 - 1.2	-	-	-	-	-	0.9	-	-
Anus to tip of tail (excluding mucron)	10	0.1	0.02	0.06 - 0.1	-	-	-	-	-	-	-	-

* a - number of larvae measured, b - mean size, c - standard deviation, d - range of size.

Table 3: Measurements (mm) of _Anisakis_ sp. larvae cultured from Salmon (_Salmo salar_)

Days after culture

	1				21-30				31-40				41-50			
	a	b	c	d*	a	b	c	d	a	b	c	d	a	b	c	d
Total length	5	21.4	2.1	17.7 - 23.3	5	28.5	8.1	20.9 - 41.9	4	36.0	9.5	21.9 - 41.8	9	46.7	14.9	26.7 - 67.9
Maximum width	5	0.6	0.04	0.5 - 0.7	5	0.9	0.3	0.8 - 1.4	4	1.1	0.2	0.8 - 1.2	9	1.5	0.3	1.0 - 1.9
Oesophagus length	4	2.2	0.3	1.8 - 2.4	4	2.5	0.7	1.6 - 3.2	1	3.5	-	-	-	-	-	-
Ventricle length	3	0.9	0.1	0.8 - 1.0	4	0.7	0.02	0.70- 0.75	1	1.2	-	-	-	-	-	-
Anus to tip of tail (excluding mucron)	5	0.1	0.03	0.05- 0.11	3	0.2	0.02	0.16- 0.20	4	0.2	0.04	0.15- 0.25	1	0.35	-	-

* a - number of larvae measured, b - mean size, c - standard deviation, d - range of size.

Table 4: Measurements (mm) of _Anisakis_ sp. larvae cultured from Herring (_Clupea harengus_)

Days after culture

	0				1-10				11-20				21-30				31-40			
	a	b	c	d*	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d
Total length	24	26.2	2.2	21.9-29.7	4	18.9	4.6	13.9-25.0	6	23.8	9.1	15.6-35.3	17	24.2	7.9	14.0-42.3	4	31.0	5.9	24.3-37.3
Maximum width	24	0.4	0.08	0.3-0.6	4	0.4	0.02	0.3-0.4	6	0.6	0.1	0.3-0.7	15	0.7	0.2	0.4-1.0	4	1.0	0.2	0.8-1.3
Oesophagus length	24	2.1	0.1	1.9-2.9	1	2.1	-	-	3	2.4	0.4	1.9-2.8	3	1.9	0.3	1.8-2.3	-	-	-	-
Ventricle length	24	1.1	0.1	0.8-1.3	1	0.9	-	-	1	0.7	-	-	3	0.6	0.1	0.5-0.7	-	-	-	-
Anus to tip of tail (excluding mucron)	23	0.1	0.03	0.08-.16	2	0.1	0.01	0.1	2	0.2	0.02	0.2	4	0.2	0.02	0.02	-	-	-	-

*a - number of larvae measured, b- mean size, c -standard deviation, d - range of size.

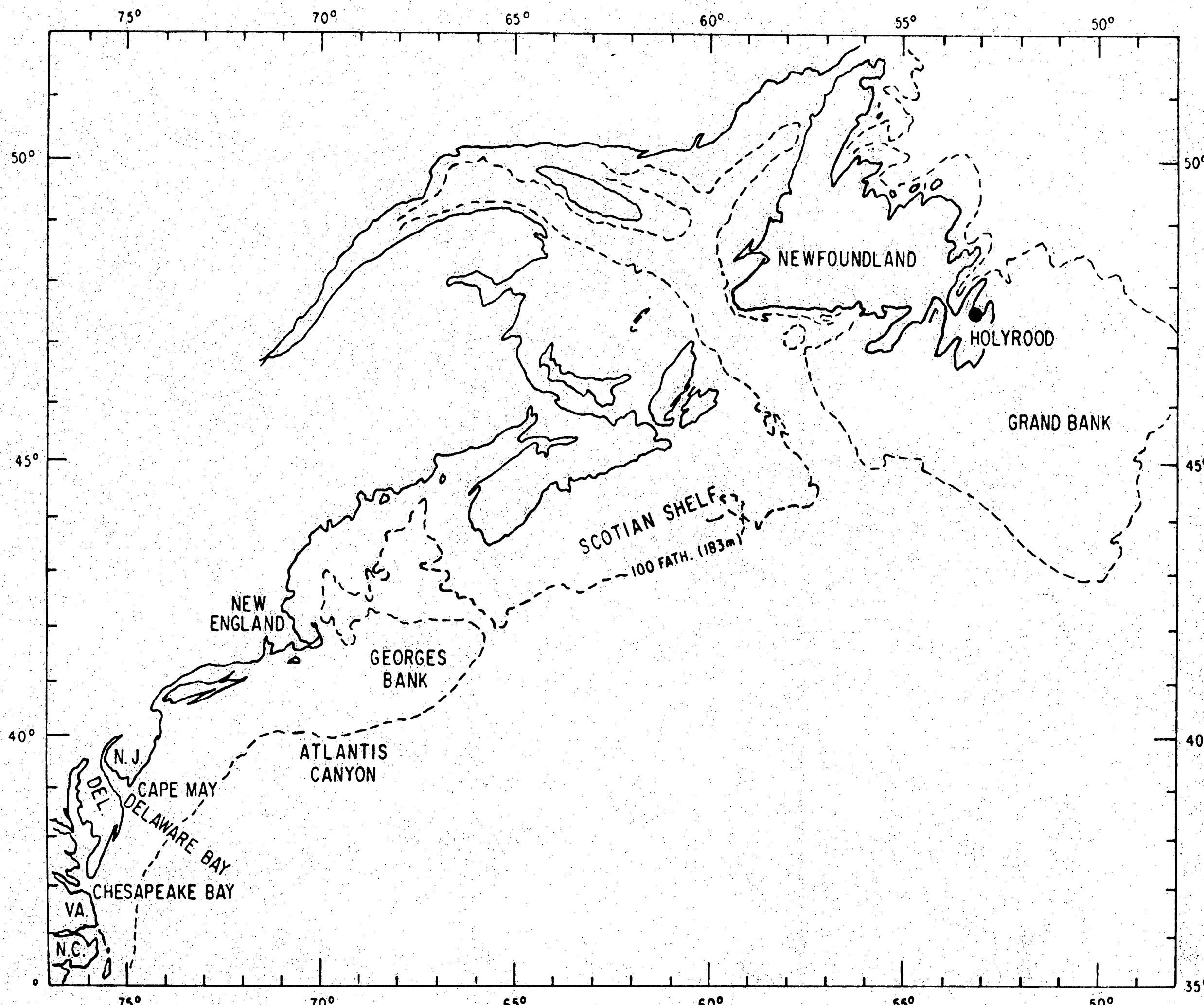

Fig. 1. Map of the Northwest Atlantic showing localities referred to in the text.

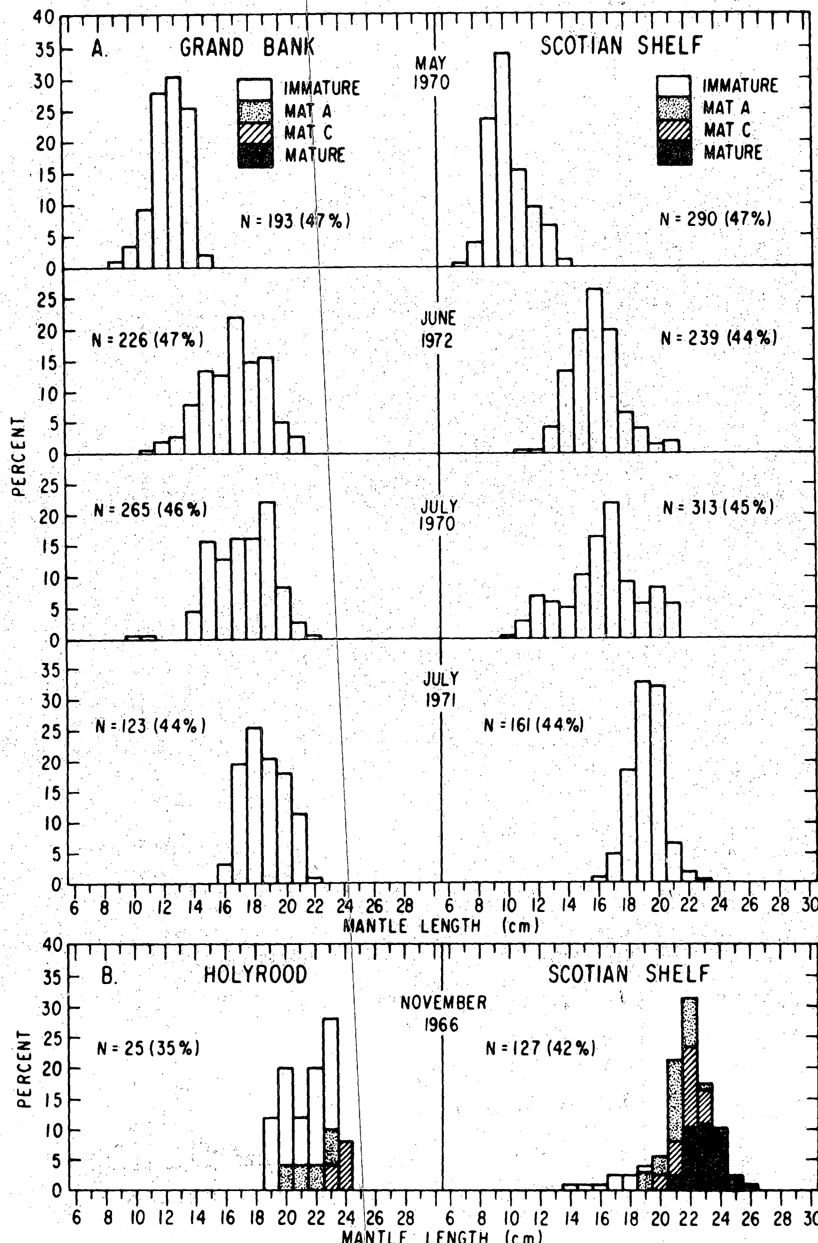

Fig. 2. Distribution of length and maturity stages for male short-finned squid on the Grand Bank and Scotian Shelf during spring or summer (a) and at Holyrood and on the Scotian Shelf during November (b). Figures in parenthesis represent percentage of males in the sample.

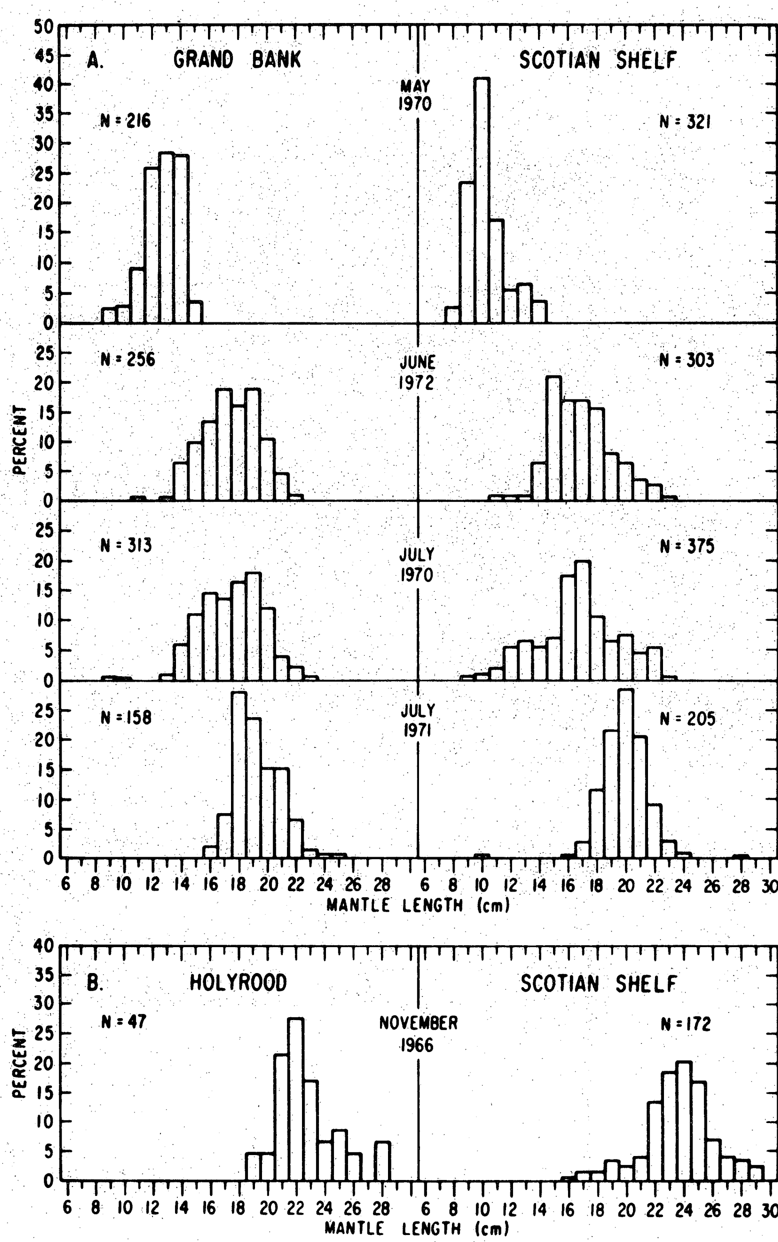

Fig. 3. Length frequency distributions for female short-finned squid on the Grand Bank and Scotian Shelf during spring or summer (a) and at Holyrood and on the Scotian Shelf during November (b).

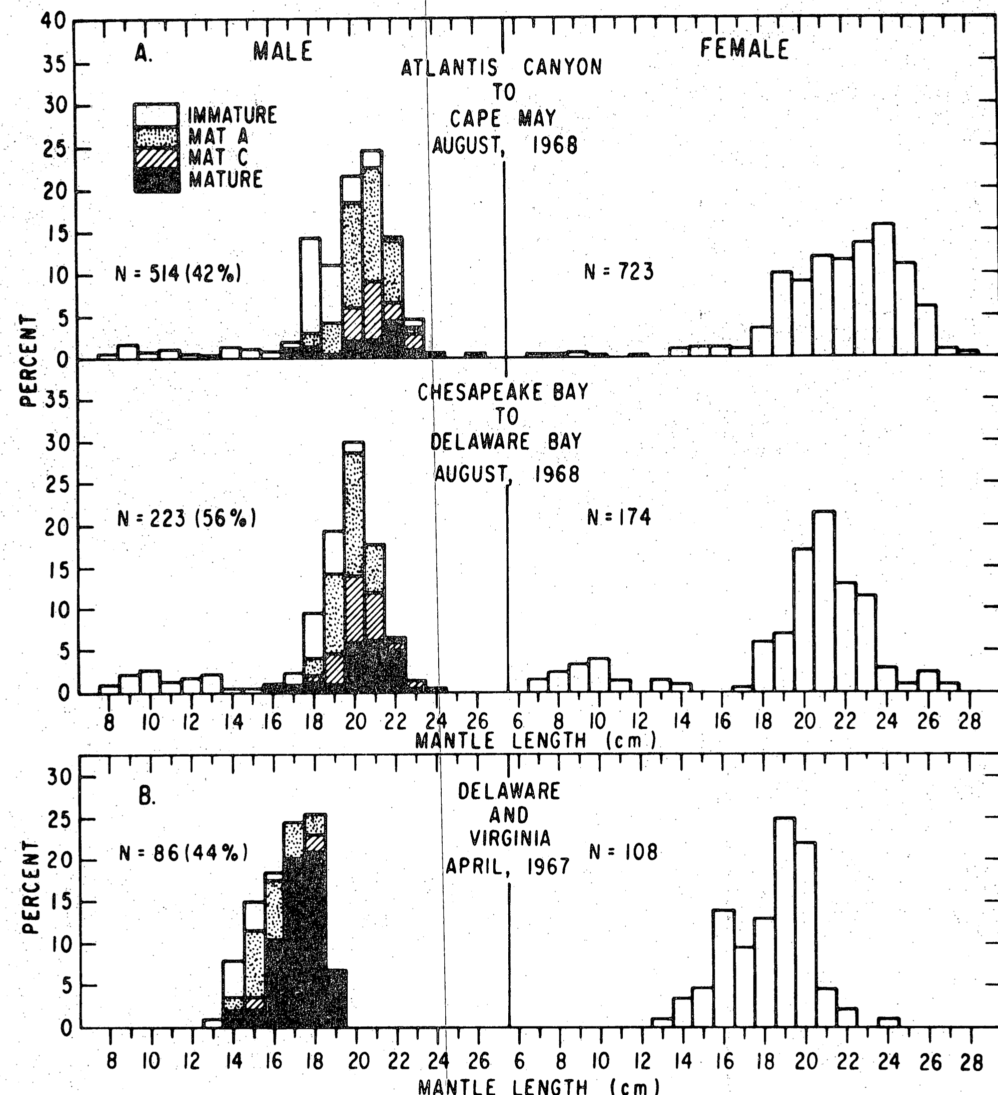

Fig. 4. Length frequency distribution by sex and, for males, maturity stages for three regions between Atlantis Canyon and Virginia: (a) August 1968, (b) April 1967.

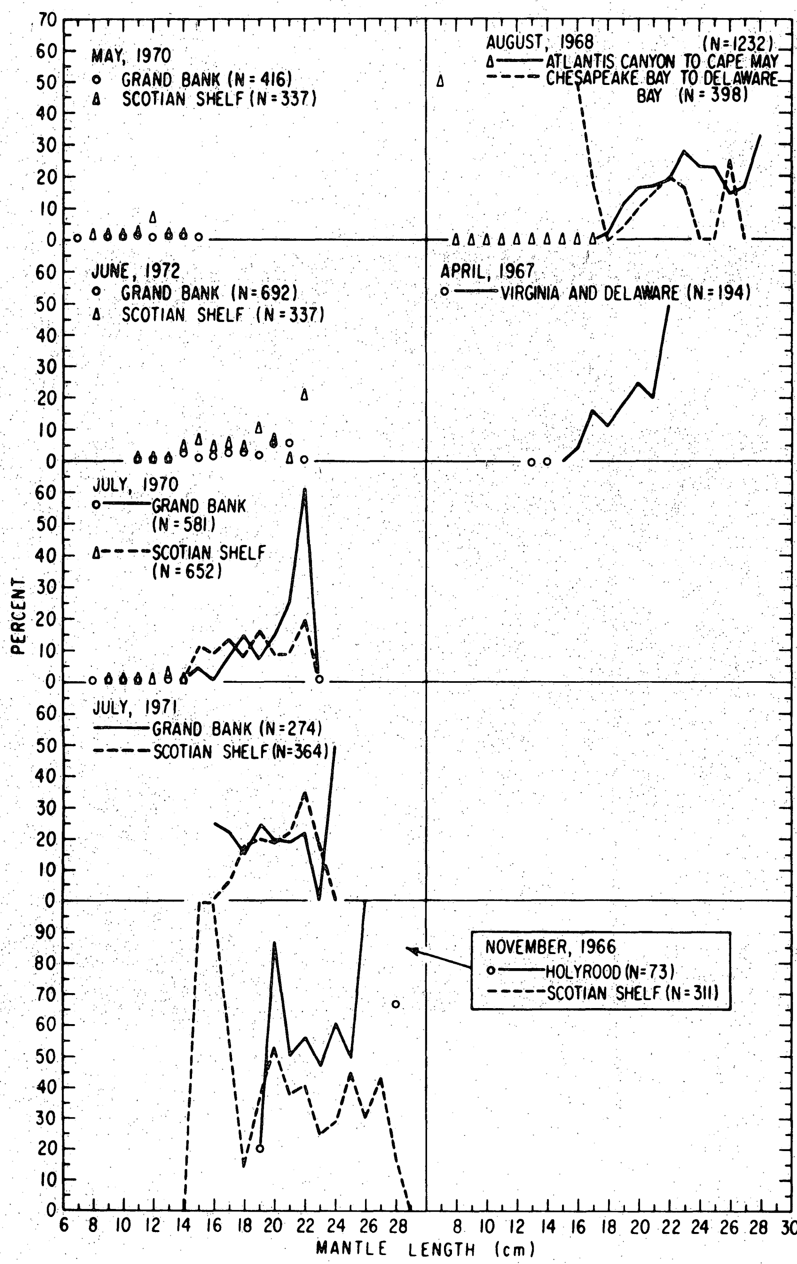

Fig. 5. Percent infection of short-finned squid by <u>Dinobothrium</u> sp. vs host mantle length for various years, seasons and regions of the Northwest Atlantic.

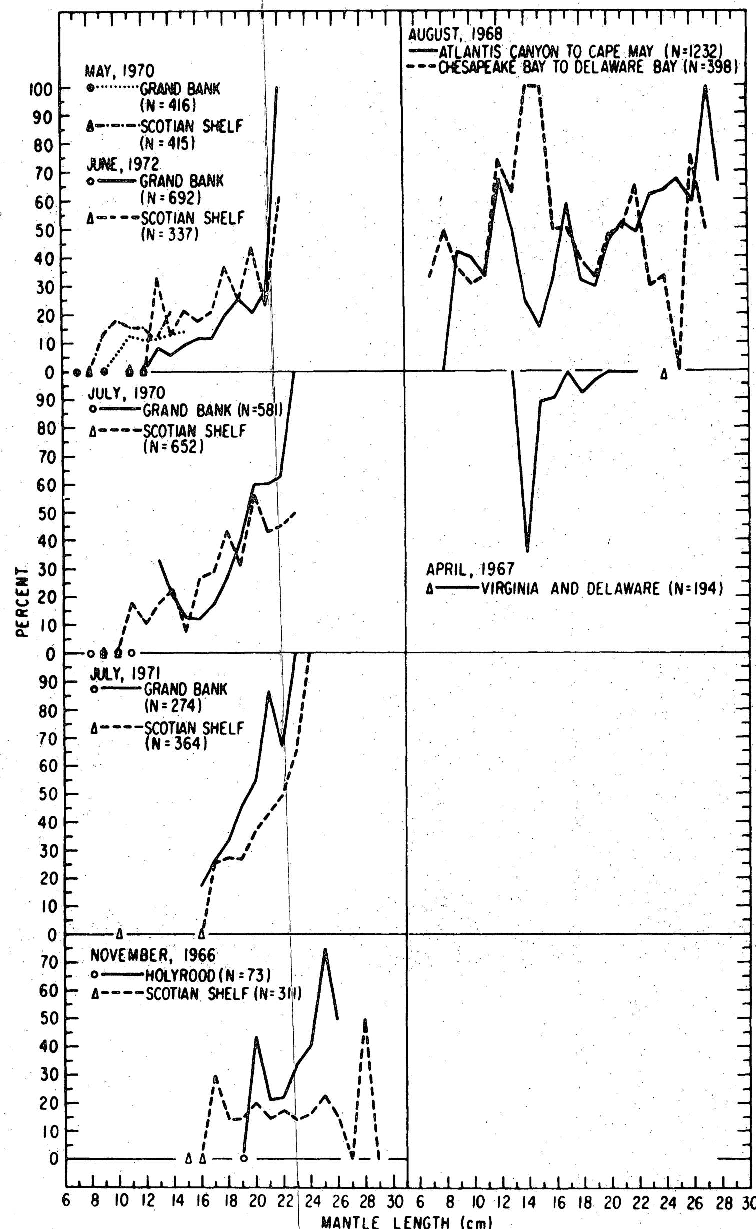

Fig. 6. Percent infection of short-finned squid by Phyllobothrium sp. vs Host mantle length for various years, seasons, and regions of the Northwest Atlantic.

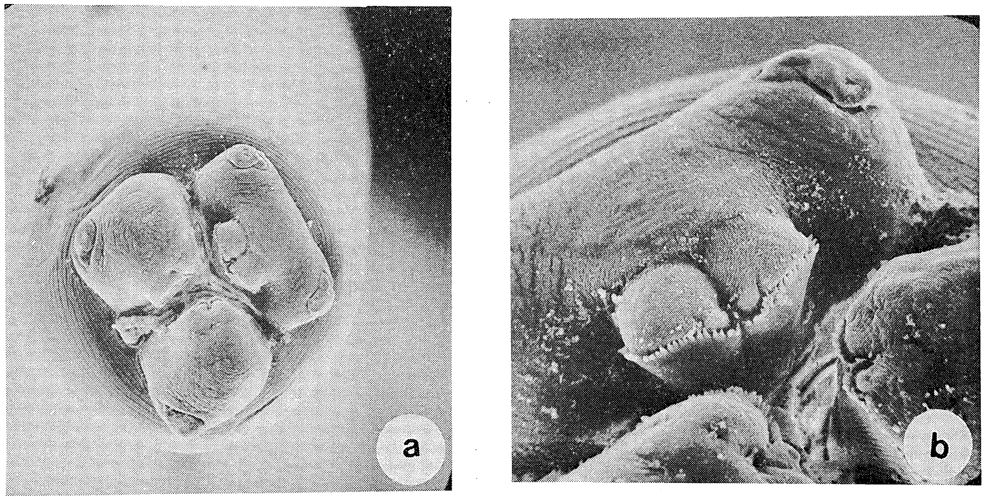

Fig. 7. (a) En face view of a cultured "large variety" Anisakis sp. larva from a squid. (b) Dentigerous ridge on lip of Anisakis sp. larva from squid.

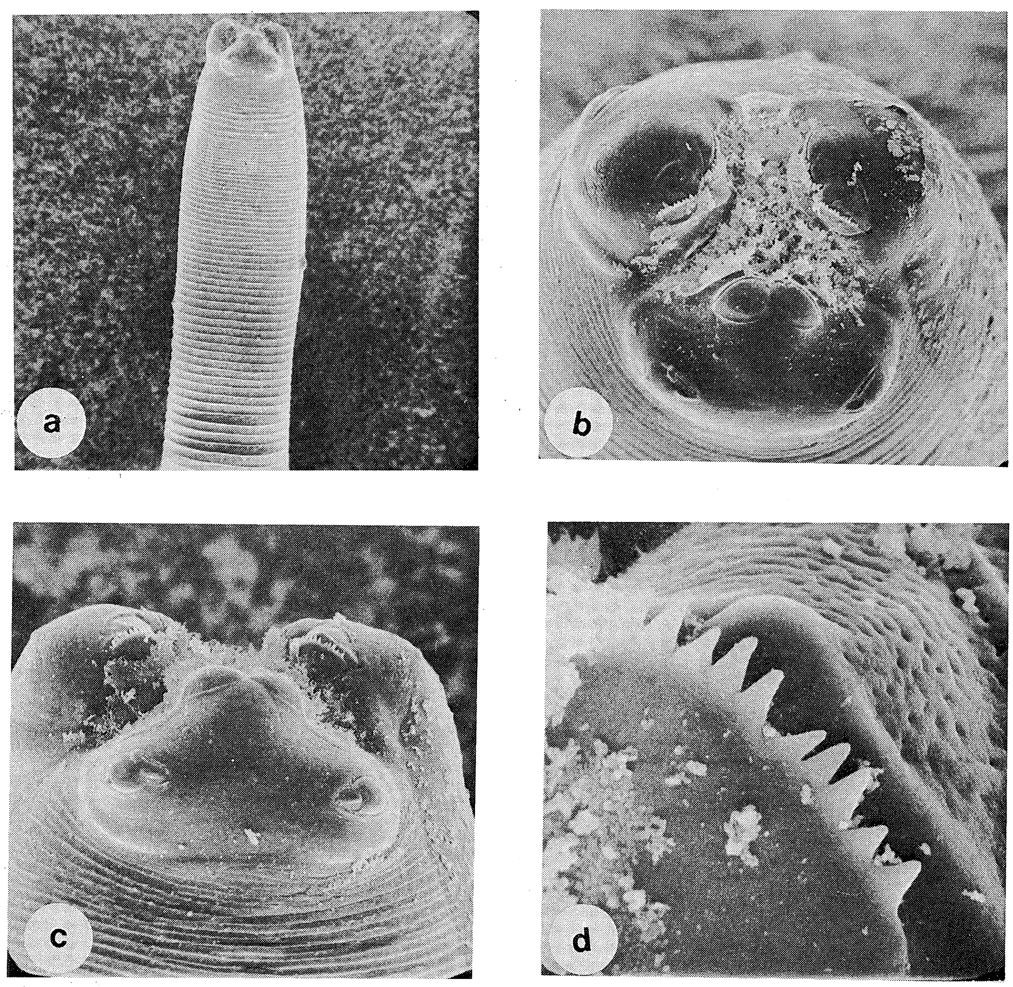

Fig. 8. Adult Anisakis simplex from a Beluga (Delphinapterus leucas) showing: (a) anterior end of worm, (b) En face view to show lips, (c) lateral view of lips, and (d) part of a dentigerous ridge.