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A Survey of Parasites of Northwest Atlantic Herring *Clupea harengus* L.: A Preliminary Account

by

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Introduction: The primary aim of this study is to identify and record those parasites found in Clupea harengus from the Northwestern Atlantic. In particular helminth (including Monogenea, Digenea, Cestoda, Nematoda and Acanthocephala) and crustacean parasites are being collected, although routine checks are also being made for any obvious fungal and protozoan infections. In addition blood smears are being made from each fish and will be examined for the presence of blood parasites.

A detailed survey has been carried out in the Pacific (Arthur & Arai, 1980) but, to date, no similar survey has been made of herring parasites in the Atlantic. In the Northeast Atlantic some important investigations of specific parasites have been carried out (Banning & Becker, 1978; Beverley-Burton & Pippy, 1977; Davey, 1972; Kabata, 1963; Khalil, 1969; Molloy, 1970 and Roskam, 1966, 1967) as is true also for the Baltic (Gaevskaya, 1977; Kulachkova, 1974; Lubieniecki, 1972; Petrushevski & Shulman, 1970; and Rokicki, 1973). A few studies have been made of certain parasites in herring in the Northwestern Atlantic (Bere, 1930; Ellis, 1930; Forster, 1941; Lubieniecki, 1974; Parsons & Hodder, 1971; Sindermann, 1957; Sindermann & Rosenfield, 1954; Sindermann & Scattergood, 1954) but little is known of the total parisitofauna present.

In view of the possible future use of this information, particular attention is being paid to the accurate identification of the parasites found in order to establish exactly what species are present in each fish. This taxonomic scrutiny is especially important in reference to the nematode larvae found which are commonly reported as Anisakis sp. or Contracaecum sp.

This detail is necessary as a source of reference to fill the gap in our knowledge of the fish parasites of this region. It is also needed due to the possibility that one or more parasites found may be of use in stock identification; that is, they could act as 'biological tags'. This is especially important for the herring fishery where effective management relies on an accurate knowledge of stock structure and on an understanding of the complex interrelationships of different populations.

Some other factors have been used for stock identification such as meristics (Parsons, 1973), morphometrics (Hodder & Parsons, 1971a,b; Parsons & Hodder, 1974), electrophoresis of certain body constituents (Odense & Annand, 1980), and extensive field-tagging experiments (McKenzie & Skud, 1958; McKenzie & Tibbo, 1961; Stobo, 1976; Stobo, Scott & Hunt, 1975). However, there is still a need for more data, especially where it could be used to complement or confirm other stock identification approaches, and may even provide an independent means of stocks separation and identification.

Biological tags have been used successfully on a number of other fish groups eg., Atlantic salmon (Pippy, 1969), Pacific sockeye salmon (Margolis, 1963 & 1965), and a number of flatfish (Gibson, 1972; Olson & Pratt, 1973 and Scott, 1975). All parasites used in this way fulfill a number of prerequisite criteria: (1) Ideally, the parasite should only be picked up in areas visited by one population of the host species; (2) It should be a long-term resident within the host, which means that totally pathogenic parasites are of no use; and (3) The parasite should also be easily located

and identified on or within the host. A comprehensive survey, concentrating on taxonomic accuracy in identifying any herring parasites found, is therefore essential.

Materials and Methods: Primary sampling sites are located at the following areas (Fig. 1). Within the Gulf of St. Lawrence samples are being collected around the Baie de Chaleur in the north and around Shediac and Prince Edward Island in the south. In the Bay of Fundy, sampling areas are located around Grand Manan and Campobello islands and in Passamaquoddy Bay. Southwest Nova Scotia is being sampled from Scots Bay to Trinity Lodge. Samples are also being collected from Bras d'Or Lakes, Cape Breton, Chedabucto Bay, southeast Nova Scotia and southwest Newfoundland. In addition, a single sample was obtained by a Fisheries Research Cruise off Sable Island.

All sampling sites fall within known spawning areas and two fall within nursery areas. Spawning areas were preferred due to the relatively discrete nature of spawning stocks compared to nursery or feeding aggregations. These sites were also chosen as those which might provide as regular a seasonal sample as possible over the survey period. They were also chosen as those which might provide samples of more than one size-class of fish. Three size-classes of herring are being sampled wherever possible; adults or mature fish, juveniles, in maturity stages I & II and sardines with no gonadal development up to stage I. As with any wild population however, these sites are subject to fluctuations in herring availability and therefore this theoretical sampling programme may not always be practicable.

Each sample consists of 20 herring which are examined fresh, being collected within 12-24 hours after death. Storage is on ice and this effectively keeps the fish fresh over the 3-4 days necessary to complete a thorough examination of each sample. This time span varies with the size of the

fish, with oil and fat content and with stomach contents. Where extra fish are taken, to supplement the sample size from some less accessible sites, they are frozen. However, parasite specimens recovered from frozen fish are not used in the taxonomic study and are useful only for quantitative data.

Each fish is weighed, measured, sexed and checked for maturity (using the scale recommended by the Herring Committee to I.C.E.S.) as accurately as possible. Otoliths and scales (where present) are removed for ageing. The skin, fins and gills are examined for external parasites. All internal organs, including the eyes and musculature are examined for internal parasites. Blood smears are taken as soon as possible after collection of a sample. These are stained for blood Protozoa or Fungi.

Nematodes and acanthocephalans are preserved in hot 70% alcohol which is replaced by fresh 70% alcohol approximately 24 hours after fixing. Platyhelminths are preserved in hot 10% formaldehyde for 24 hours and then transferred to 70% alcohol for longer storage. Crustaceans are stored in 85% alcohol and protozoan cysts and tissue samples are preserved in 10% formaldehyde or Bouins (if the specimen is for sectioning).

Results: To date, this study has involved extensive examination of fish and the parasites found are only now beginning to be identified. Three hundred and thirty fish have been examined since the start of the study and so far the following parasites have been identified:

Anisakis sp. (Fig. 2) commonly known as the "herring-worm" has been recovered from sites throughout the mesenteries. These are commonly found in the herring but have only been retrieved in small numbers so far. All are third stage larvae, this being the stage infective to the seals or porpoises which are presumed to be the definitive hosts of this worm.

Another nematode identified as Phocanema decipiens (synonymous with Porrocaecum decipiens and Terranova decipiens) commonly known as the "cod-worm". This is another ascarid nematode closely related to Anisakis and is found in the same body cavity locations. However, it does not have the opaque ventriculus characteristic of Anisakis and has a more prominent tail papilla. Each of its three lips carries a single papilla and no denticles, whilst the three lips of Anisakis differ with numerous rows of denticles, the dorsal lip being noticeably larger with two papillae. Also, the boring tooth of Phocanema decipiens is short and blunt whilst that of Anisakis is slightly longer and curved. Thus, these two nematodes are easily distinguished.

Only one acanthocephalan has been identified so far, Echinorhynchus gadi (Fig. 3) located in the posterior intestine. It was a pre-adult female worm and, when alive, had an opaque white body and pink protrusable proboscis.

A number of digeneans have been found, primarily in the stomach, but also in the pyloric caecae and intestine. Five species, all belonging to the family Hemiuridae, Luhe 1902, have been identified so far. Three species, Hemiurus levinseni (Fig. 4); H. appendiculatus (Fig. 5) and Brachyphallus crenatus (Fig. 6) have a retractable caudal appendage, the ecsoma, and are finely annulated which gives their margins a serrated appearance. H. appendiculatus is characterised by having a long ecsoma which, when fully extended, is about half the length of the body. The oral and ventral suckers are close together and the diameter of the ventral sucker is about two times that of the oral. There is no oesophagus and the diameter of the pharynx is about half that of the oral sucker. Two slightly lobed vitellaria lie at the posterior margin of the ovary. The folds of the uterus appear to enter the ecsoma for a short distance. H. levinseni closely resembles H. appendiculatus in many of its characters, but is distinctly different in the relative size of the suckers. In this species both suckers are more or less equal in dia-

meter, with the oral sucker often being slightly larger than the ventral. A main characteristic of this species is that the seminal vesicle is in two sections. The oral and ventral suckers of Brachyphallus crenatus are also more or less equal in diameter. However, the vitellaria of this species show distinct but variable lobation, generally with the pattern of three lobes on the right and two on the left. This species is also separated from H. levinseni by having a distinct acetabular pit just anterior to the ventral sucker. The folds of the uterus do not appear to enter the ecsoma.

The two other hemiurids identified, which do not have the ecsoma or annulations characteristic of the other three species, are Lecithaster confusus (Fig. 7) and Derogenes varicus (Fig. 8). L. confusus is a fusiform species with a blunt anterior end and a tapering posterior end. The ventral sucker is much larger than the oral. There is no pre-pharynx and the oesophagus, where present, is very short. The ovary has four blunt lobes lying behind the testes. The vitellaria have seven lobes which are pyriform. The folds of the uterus fill the body from the level of the anterior border of the ventral sucker to the posterior end. D. varicus is also fusiform, however, its anterior end is defined by the presence of a pre-oral lobe. The ventral sucker is larger than the oral and is situated half way down the length of the body. The genital pore is situated mid-ventrally just posterior to the level of the pharynx. The two testes are situated slightly obliquely or symmetrically on each side of the body immediately behind the ventral sucker. The globular ovary is situated just off-centre behind the left testes. The uterus is very convoluted and often fills the available space between the organs from the posterior end of the body to the level of the genital pore. There are two oval vitelline bodies which are situated symmetrically or slightly obliquely on each side of the body behind the ovary.

A number of larval tapeworms have been found primarily within the pyloric caecae and posterior intestine, however, a few have been found encysted on the outside of the pyloric caecae and stomach. Only one name has been used, so far, to identify the ones found in the pyloric caecae and posterior intestine, Scolex pleuronectis (Fig. 9). These are characterised by their scolex which carries four bilocular and motile suckers. In older specimens, found in the intestine, a pink ring is clearly visible at the base of the scolex. These worms are plerocercoid larvae of the Tetraphyllidean cestodes and probably represent more than one species.

Several other parasites have also been found, but have yet to be identified.

Conclusions: From the work done to date nine species of helminths have been identified as parasites of herring in the areas sampled and, from the material not yet examined, it is clear that many more parasitic species are present.

Since herring populations are highly dynamic in nature and samples have to be examined fresh, data analysis at this stage has not been attempted. In general, however, herring as individuals do not appear to carry a great parasite burden relative to other fish species, as fish are commonly found with no nematodes and only one or two digenean worms.

No gill or skin parasites have yet been found. This is not necessarily indicative of their absence, however, since both purse-seine and gill-netting catch methods exact a lot of external damage to the fish, as do the pumps at the weirs. Digenea are often found on the gills of gill-netted fish, where they have been coughed up from the alimentary tract. This indicates that the capture process may cause some internal parasite loss as well as external parasite loss. However, as parasites of the same species are still found internally in these fish this may not be a significant problem.

It should be noted that there are apparent differences in the incidence of certain parasites. If these differences persist throughout the rest of the sampling programme, or are repeated seasonally, they could prove of great interest to fisheries biologists and parasitologists alike.

Summary: This study, which will continue up to May 1984, will provide the first extensive herring parasite survey for the Northwestern Atlantic. The resulting catalogue of these parasites will take the form of a seasonal record of parasites found in herring from various areas around New Brunswick, Nova Scotia and Newfoundland shores. It will also record those parasites found in different age-groups and size-classes of herring.

These data should provide an interesting comparison for herring from different areas at different times and it is hoped that it will be of significant use in the future management of this very valuable fishery resource.

This study is being carried out under the supervision of Dr. M.D.B. Burt and Dr. J. MacKenzie, Biology Department, U.N.B., Fredericton, N.B, Dr. T.D. Iles and Dr. J.S. Scott, Department of Fisheries and Oceans, St. Andrews, N.B., and Dr. G.M. Hare, Department of Fisheries and Oceans, Moncton, N.B.

September 1981

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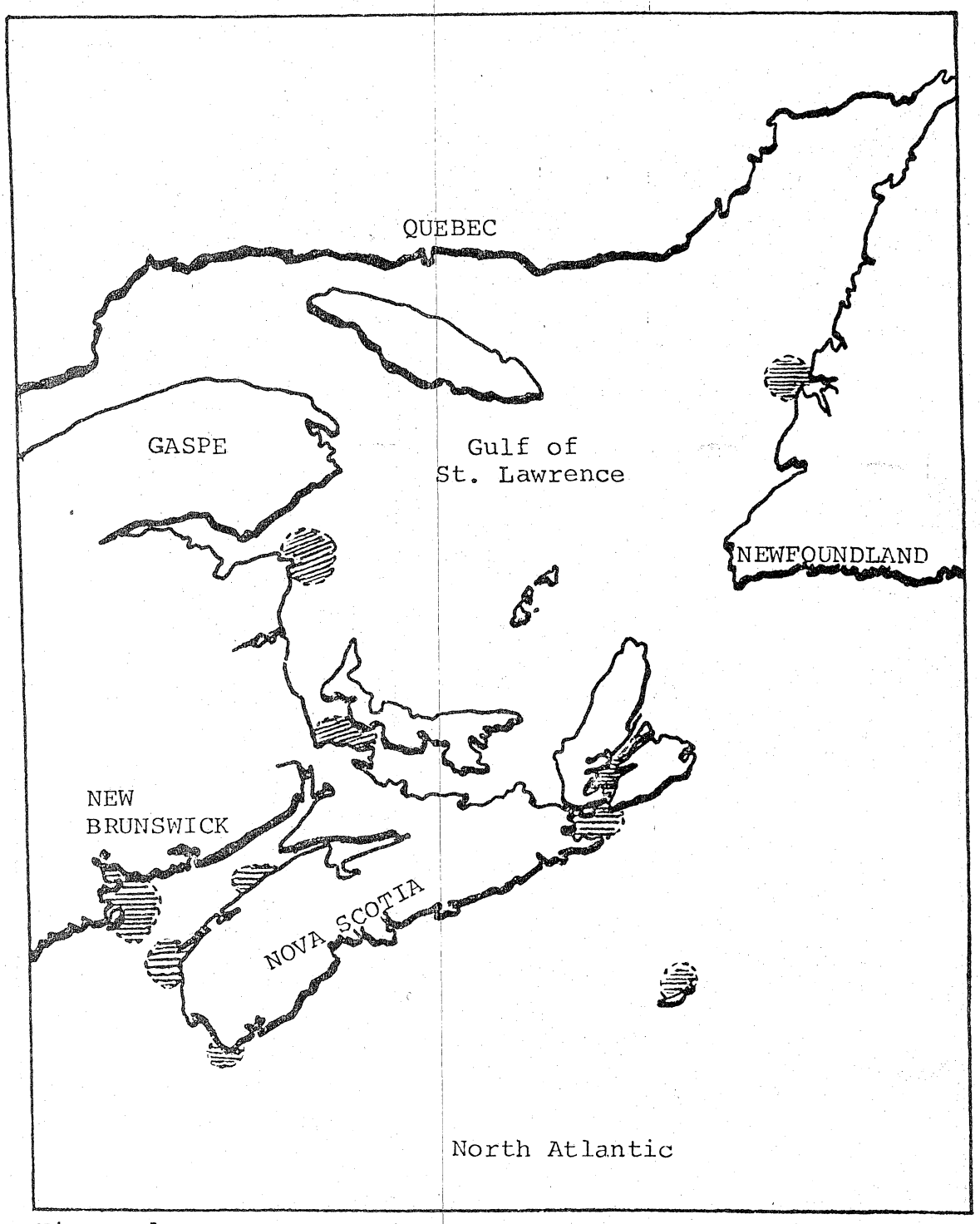

Figure 1:

Northwestern Atlantic herring parasite survey - Sampling areas.

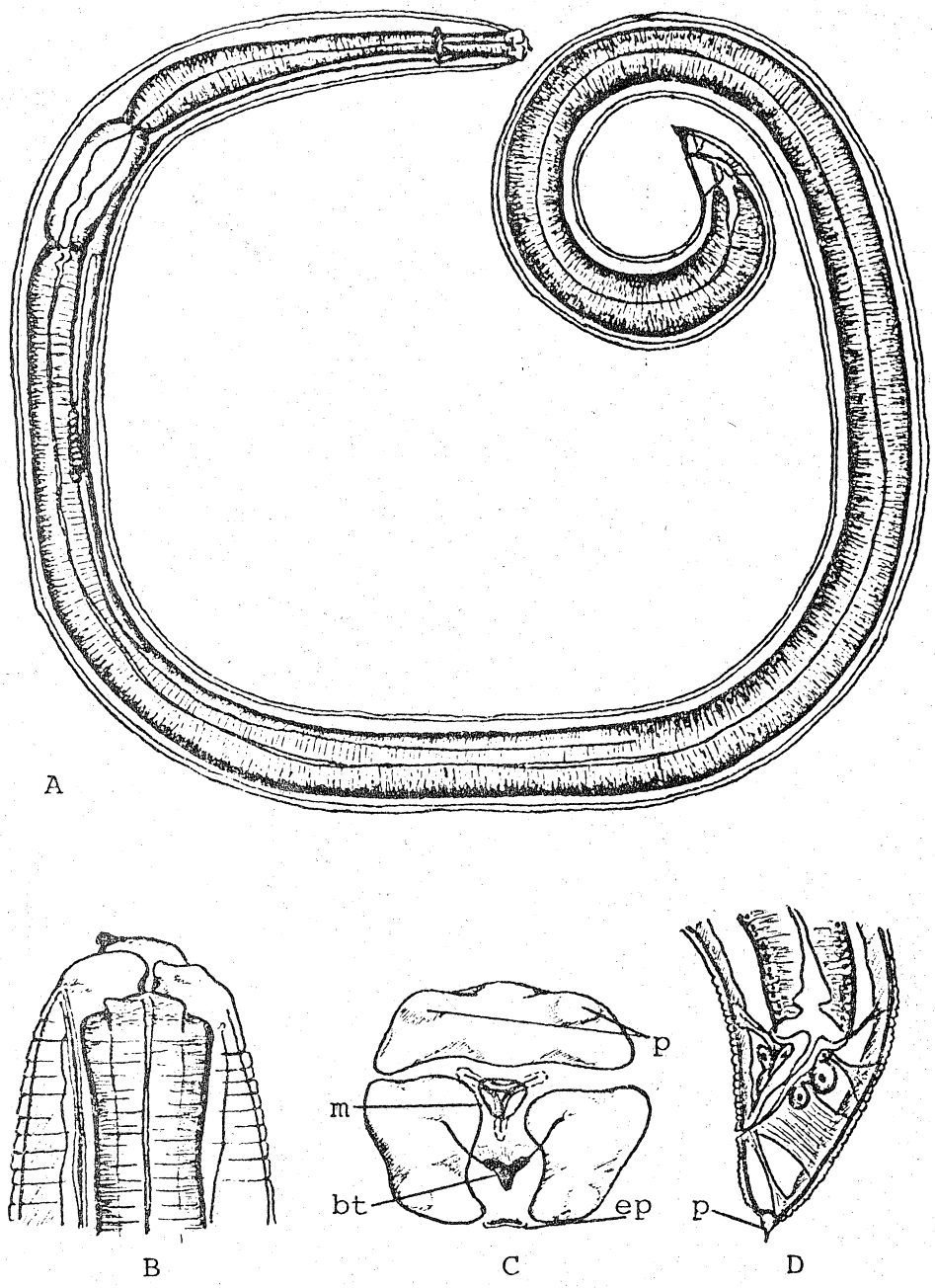

Figure 2:

Anisakis sp.

A. Lateral view of entire larva.
B. Anterior end, lateral view
C. Anterior view of lip structure, showing papillae, boring tooth (bt), mouth (m), and excretory pore (ep).
D. Posterior end, lateral view, showing reduced papilla (p).

(from Beverley-Burton et al, 1977.)

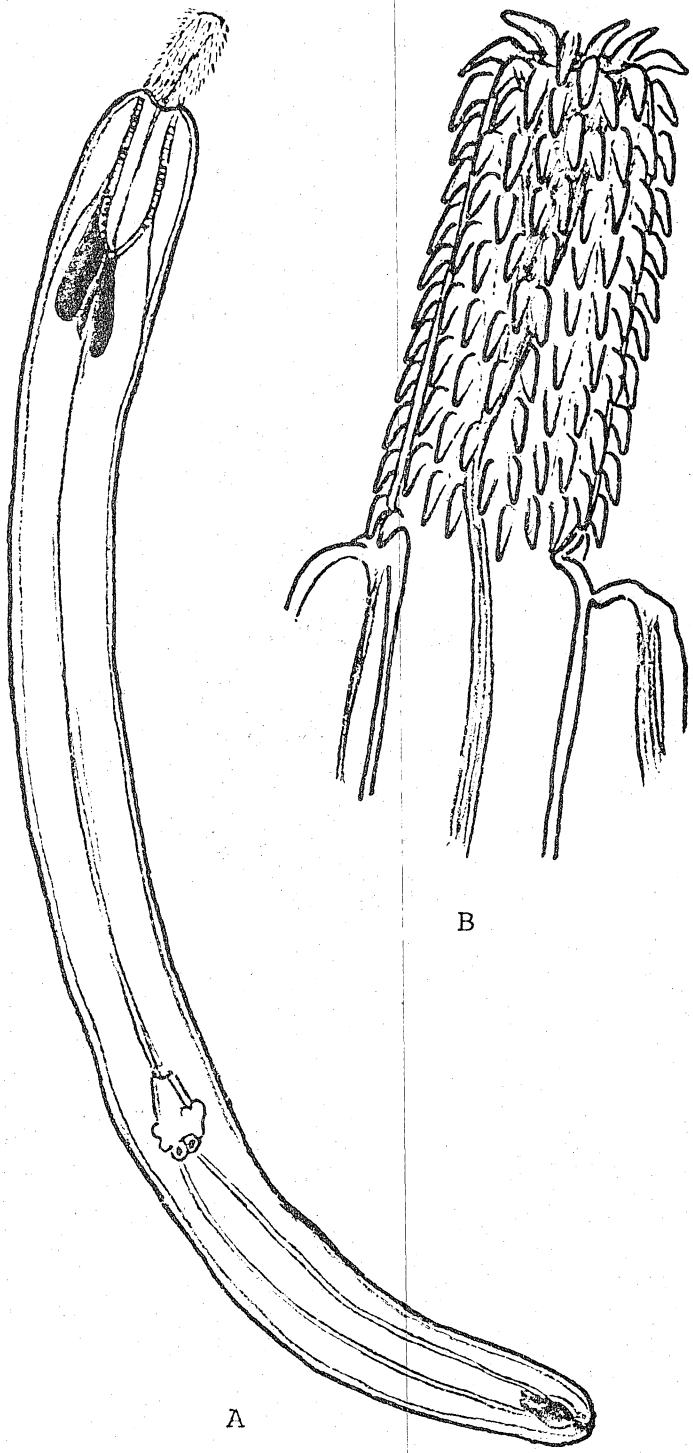

Figure 3:

A. Echinorhynchus gadi - pre-adult female, 11mm in length.
B. Anterior end of worm showing the hooks of the proboscis and muscles resposible for the retraction of the proboscis.

(drawn from mounted specimen)

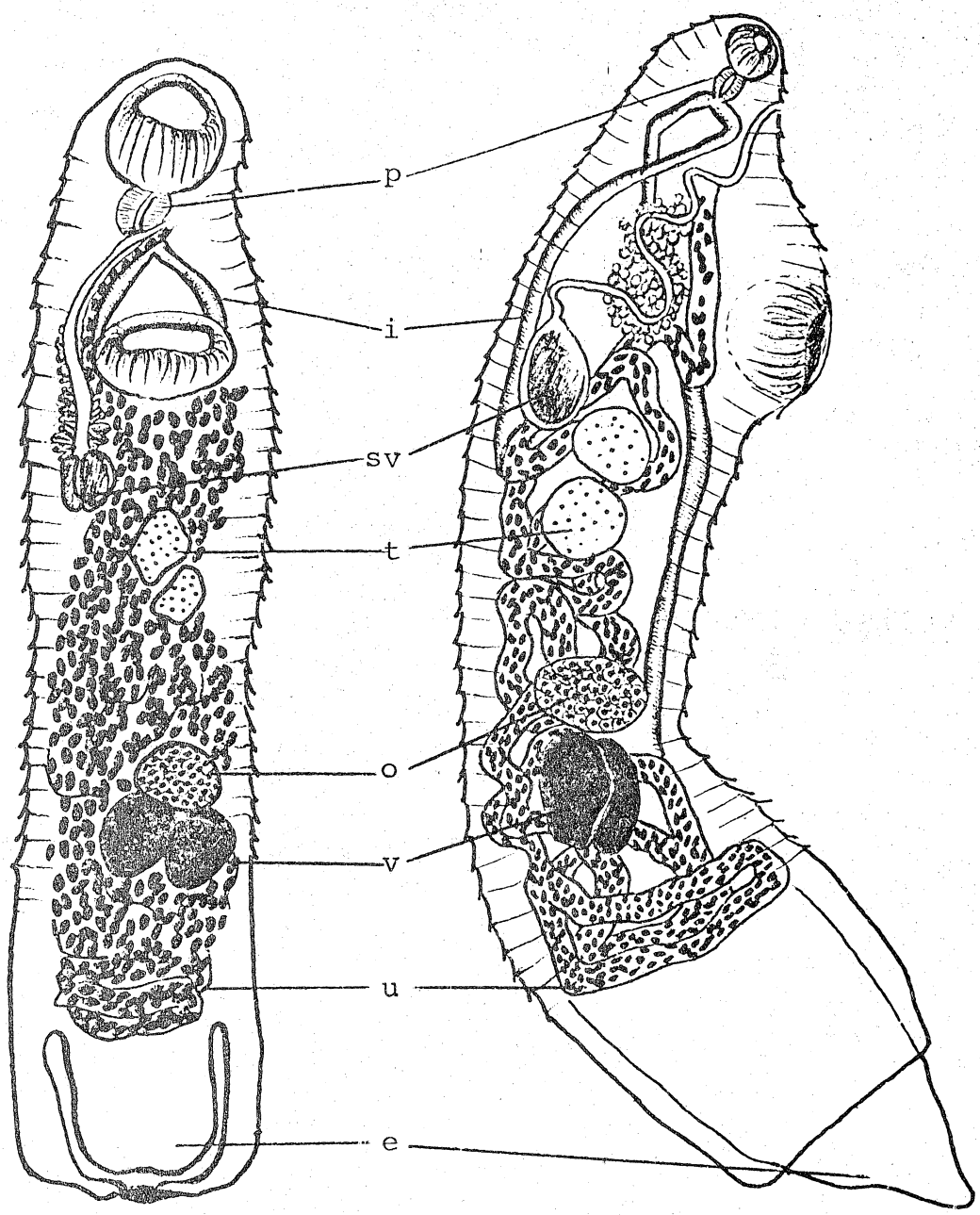

Figure 4: Hemiurus levinseni

Figure 5: Hemiurus appendiculatus

key: p- pharynx
i- intestine
sv- seminal vesicle
t- testes
o- ovary
v- vitellaria
u- uterus
e- ecsoma

(from Linton, E.,1940)

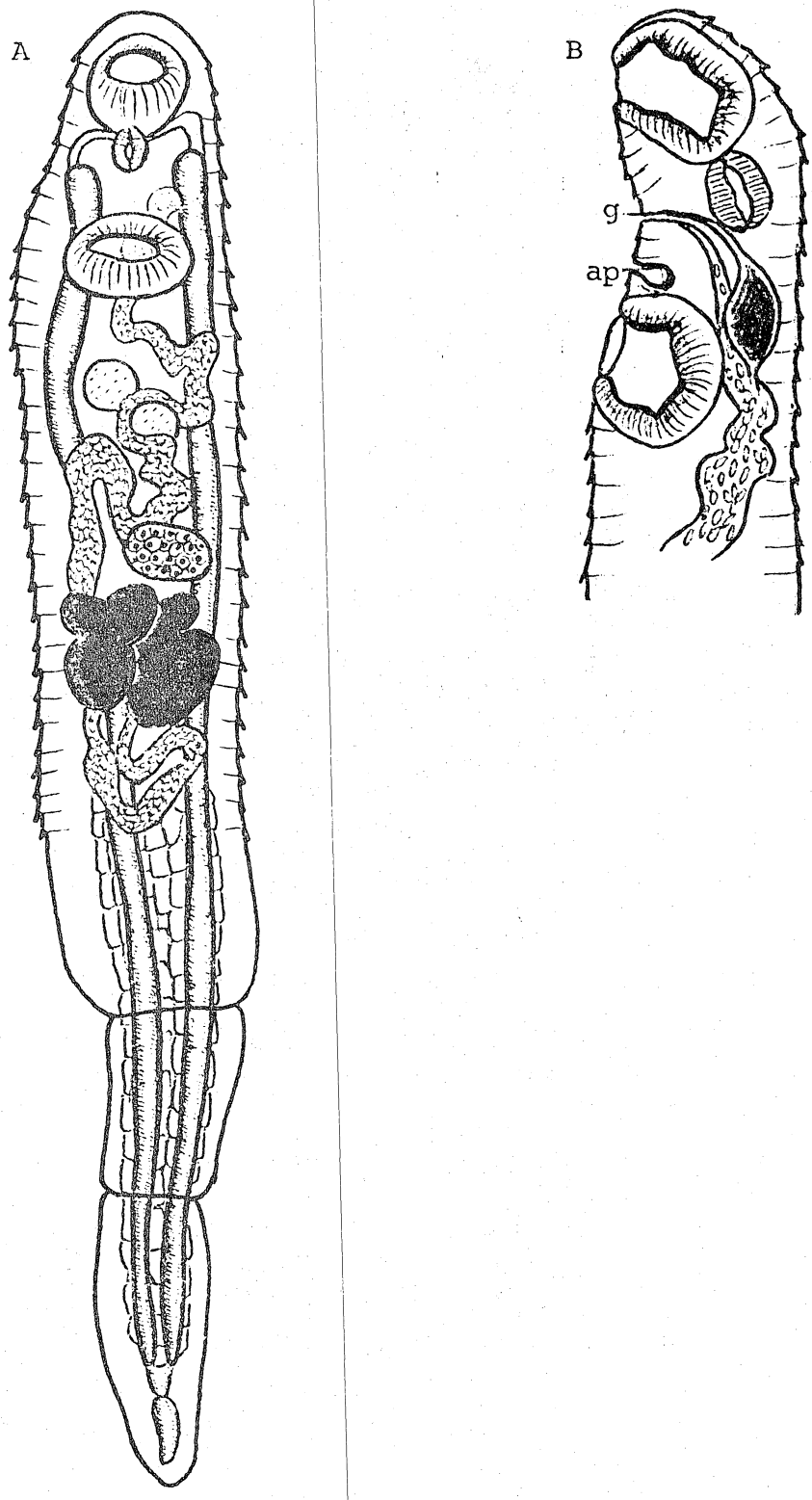

Figure 6: Brachyphallus crenatus
A. Entire worm, ventral view.
B. Anterior end, lateral view, showing the gonopore (g) and characteristic acetabular pit (ap).

(from Skrajabin et al., 1964)

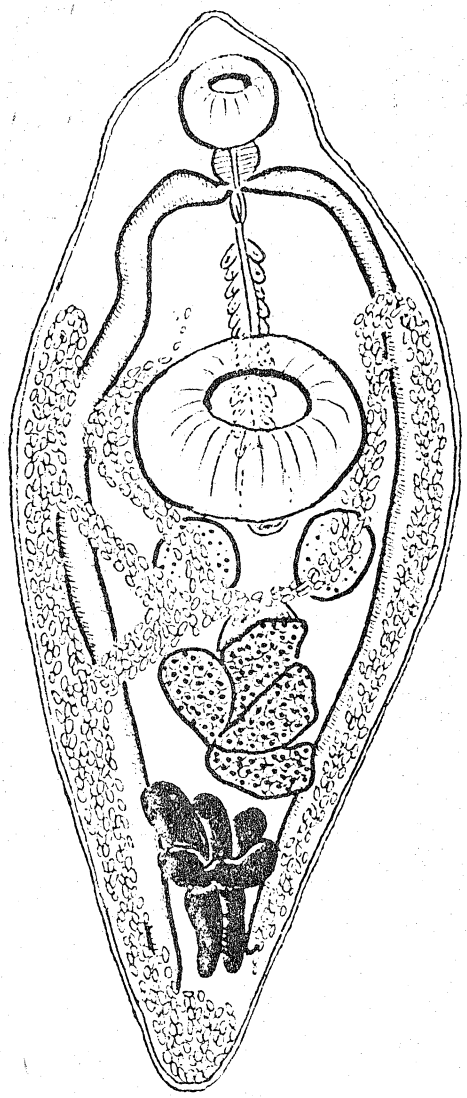

Figure 7: Lecithaster confusus

(from Hunninen & Cable, 1943)

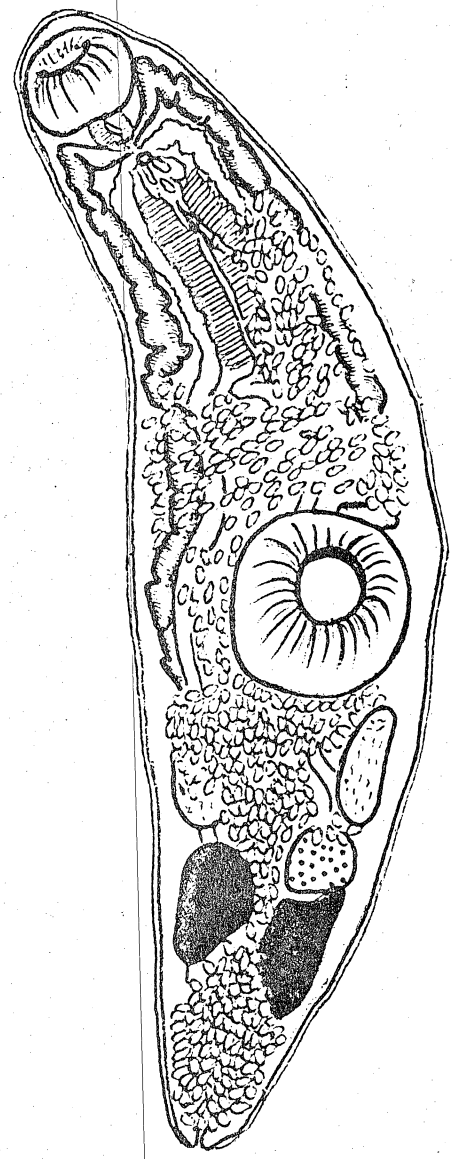

Figure 8: Derogenes varicus

(from Gibson, D.I., 1976)

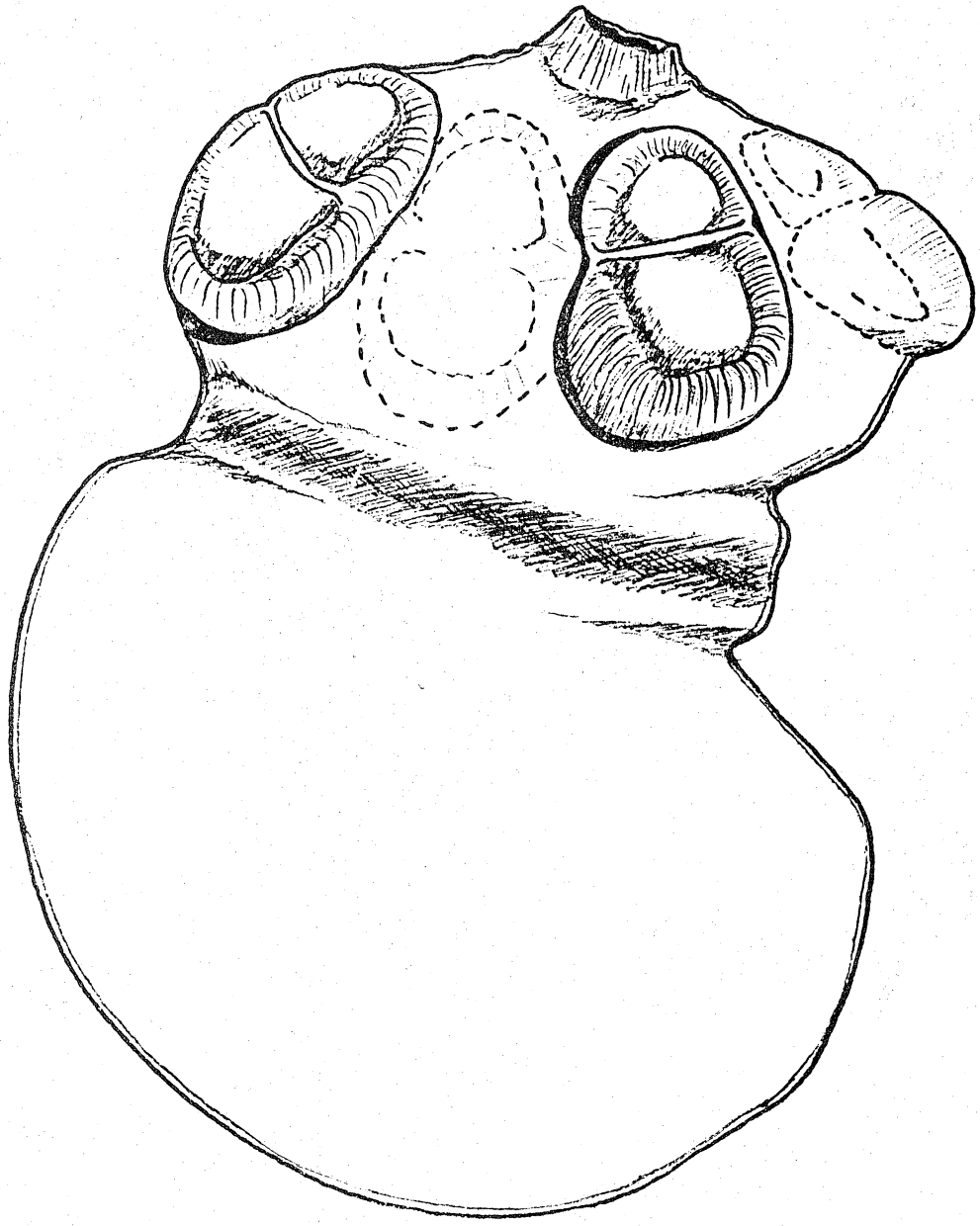

Figure 9: Scolex pleuronectis

(drawn from mounted specimen)