1959

Monogenetic Trematodes from Some Chesapeake Bay Fishes

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May 1959

A THESIS SUBMITTED IN PARTIAL FULFILLMENT
OF REQUIREMENTS FOR THE DEGREE OF MASTER
OF ARTS FROM THE COLLEGE OF WILLIAM AND MARY

ACKNOWLEDGEMENTS

The author wishes to express his appreciative thanks to Dr. W. J. Hargis, Jr., Virginia Fisheries Laboratory, for aid and encouragement throughout this study.

Special thanks are due to Dr. J. L. McHugh, former Director, Virginia Fisheries Laboratory, for his assistance, to Mr. Frank Wojcik for aid in statistical analysis of data, to Mr. Robert Bailey for aid with photography, to other staff members of the Laboratory for their invaluable aid in helping to collect and identify host material and to Ruth W. McMahon for her moral support and assistance in preparation of the plates.

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INTRODUCTION

Very little work has been done on the monogenetic trematodes of the Atlantic coast of North America. Previous records are confined mainly to areas such as Woods Hole (Mass.), New York Aquarium, Beaufort, (N. C.), and the Tortugas. Only fragmentary records are listed for the Western Atlantic from Labrador to Havana, Cuba. Because past studies have been of a limited localized nature, almost the entire continental shelf area and open water are completely unexplored. Works on monogeneids of the Gulf of Mexico, not within the strictly Atlantic region but closely allied to it in character of fish fauna, add useful supplementary records.

The following summary refers to known Atlantic locality records and the respective workers: Labrador, Price (1939); Nova Scotia, Stafford (1904), Linton (1940); Maine, Manter (1926); Woods Hole (Mass.), MacCallum (1931), Linton (1940); Cape Cod, Goto (1899), Linton (1940); Rhode Island, Goto (1899); New York Aquarium and Fish Market, MacCallum (1913-18, 1921); Virginia, Frayne (1943); Beaufort, North Carolina, Linton (1905), Manter (1938), Pearse (1949); Bermuda, Monticelli (1909), Hanson (1950); Tortugas, Pratt (1910), Linton (1910), MacCallum (1917-18), Brooks (1934), Manter (1930-42), Fujii (1944); Cuba, Vigueras (1935-1940). In a single paper, Frayne (1943) treated a few monogeneid flukes from the region under study. Thus the Chesapeake Bay is a relatively unexplored region for monogeneids.

Most of the above papers are systematic studies with very few data on distribution of parasites, number of hosts infected and intensity of infectinns. Some workers, e.g. MacCallum (1913-18, 1921), obtained specimens from mixed fish samples from aquaria and fish markets which resulted in erroneous host records. To avoid spurious host records, careful collecting techniques and consideration of host and parasite numbers were incorporated into the present work.

This paper deals with the Monogenea recovered from 116 individual host specimens representing 12 genera and 11 families. In all 149 host specimens of 30 species were collected and examined during the period from June 1957 to October 1958. Of these, 77 hosts of 13 species bore the parasites reported below. Collections were made at Cape Henry, Lynhaven Inlet, Ocean View, York River and several trawling stations in Chesapeake Bay.

Eighteen monogeneid species belonging to 15 genera were taken from the skin (one) or gills (17) of their hosts. Seven species are partially or completely redescribed, and they and the remaining eleven are reported from the Chesapeake Bay area for the first time. Data on occurrence, indidence, and host-specificity are included along with other pertinent biological notes.

MATERIALS AND METHODS

Fishes used in this investigation were collected from commercial pound nets and haul seines and exploratory otter trawls. Some specimens of Rhinoptera quadriloba, LeSueur, cow-nosed ray, were captured by hand spear in shallow water areas of the York River. Tylosurus marinus, Walbaum, needlefish, specimens were taken with a dip net off the Laboratory dock at night. Fish gills were immediately excised on board the fishing vessel if time and other conditions permitted, but most host material was collected from fresh catches of incoming fishing boats.

Methods of Host Identification

Hosts were identified using keys and systematics of Hildebrand and Schroeder (1927), Breder (1929) and Bigelow and Schroeder (1953a, 1953b). Skates, rays, and other host species not properly identified in the field were brought to the Laboratory for verification. Species identification was verified by Dr. W. J. Hargis, Jr., and W. H. Massmann of the Virginia Fisheries Laboratory.

Gills were excised from fish as quickly as possible and lamella were separated to facilitate manipulation. Gills from each host were placed immediately into marked bottles containing the relaxing agent [saturated solution of Chloretone (Parke-Davis) and filtered sea water]. Shaking of jars containing gills hastened relaxation of the worms, which after an hour or more dropped off the gills.

Worms were then preserved by adding a mixture of A. F. A. [glacial acetic acid, 95 per cent alcohol, formaldehyde, distilled water 1: 20: 6: 40]. Proportion of water was later reduced because excessive dilution tended to render some of the worms soft and easily damaged. Parasites were recovered by examining gill material and sediment under a dissecting microscope.

Skates and rays were also examined for ventral and nasal specimens of Monogenea. Skin specimens occurred entirely on the ventral surface of the host. Careful examination under bright oblique light was necessary to locate these transparent Monogenea which revealed their presence by slight movements. A spatula or thin-edged instrument facilitated removal of these forms.

Delafield's haematoxylin and alum cochineal were used to bring out the complex structures of these animals. Of the two the latter was most satisfactory and widely used. The technique involved over-staining, and then destaining, under close observation, with a weak solution of HCl in 30 per cent alcohol. After dehydrating specimens were cleared in beechwood creosote and mounted permanently in Piccolyte. Clear mounts in Euparal were used in some cases to observe structures such as excretory pores and ducts which might otherwise have been obscured by the stain. Whole mounts were used exclusively, and where possible a large number of individuals was studied for comparison.

Methods of Parasite Identification

Parasites were identified using the keys and the descriptions of Sproston (1946), Hargis (1955-1957b) and Price (1936-1943b). The taxonomic scheme of Sproston is employed in this paper. Her "Synopsis" drew extensively from the work of Price (1936-1943b). Hargis (1955a-1959) and Yamaguti (1942 and 1953) have made some taxonomic emendations and additions since Sproston's synopsis was published.

Morphological Terminology

The terminology employed is that presented by Hargis (1954, 1958). Earlier workers tended to borrow inapplicable terms, from other groups or utilize long descriptive phrases. Prior to Hargis' list of terms, Sproston and Price contributed much towards standardization of terminology.

Measurements

All measurements were made using an ocular or filar micrometer and are cited in millimeters. Adult specimens were used for all measurements, the presence of egg capsules denoting maturity. Measurements of curved structures were made of lines subtending the greatest arcs. In the descriptions the mean is followed by the minimum and the maximum in parentheses, and then the standard deviation. The number of measurements used to find the mean is usually the same as the

number of worms measured, otherwise the number, in parentheses, precedes the measurements. Standard deviation measures variation of size of body parts. Statistical comparisons between similar morphological structures involved the use of a simple analysis of variance and the standard error of the mean. Probability values for these computations are stated in the discussions. All drawings were made with the camera lucida.

The ecological classification of marine habitats by Hedgpeth (1957) is the scheme employed herein.

RESULTS AND DISCUSSIONS

Host and Parasite List

Hosts and parasites and the systematic arrangements employed therefor are given in table 3.

SUPERFAMILY CAPSALOIDEA PRICE 1936

The writer accepts the superfamily as characterized by Price (1936) and Sproston (1946) with the emendations of Hargis (1955a).

Subfamily Monocotylinae, Gamble 1896

Genus Monocotyle, Taschenberg, 1878, sensu Hargis, 1955

According to Hargis (1955a) the genus includes the type species, Monocotyle myliobatis Taschenberg, 1878, and two others, Monocotyle pricei Pearse, 1949 and Monocotyle diademalis Hargis, 1955. The last two are represented in the present collection. These monocotylids from Chesapeake Bay have pseudosuckers and ridge sclerites similar to

species, Monocotyle myliobatis

those from specimens collected in Florida by Hargis (1955a), and are similar in all other respects. More careful work of a statistical and morphological nature will probably show that the two species from Chesapeake Bay are identical to the respective Florida species.

Monocotyle pricei Pearse, 1949

Host: Dasyatis say (LeSueur), Say's sting ray, a sublittoral marine dasyatid

Location: Gills

Previously reported hosts and localities: Archosargus probatocephalus ("unnatural host"? see immediately below) from Beaufort, N. C. and Dasyatis americana and D. say from Alligator Harbor, Florida.

Number studied: 15

Discussion: Pearse (1949) described Monocotyle pricei from a single curled, distorted, specimen. A complete redescription was given by Hargis (1955a) from a series of 132 specimens collected in Florida. Examination of these slides and existing literature indicates the conspecificity of Pearse's and Hargis' specimens with those in the present collection.

The original host, Archosargus probatocephalus, the sheepshead, is considered by Hargis to be an "unnatural host", or the result of an erroneous record. This conclusion was based on material collected in Florida where 106 specimens of M. pricei were taken from

eight Dasyatis americana, 26 from five Dasyatis say, and none from four Archosargus probatocephalus. The present collection yields further evidence that dasyatids are the natural hosts. Fifteen specimens of Monocotyle pricei were recovered from three of five Dasyatis say specimens. No. M. pricei were recovered from two Dasyatis americana. All known monocotylids parasitize elasmobranchs, none occur on teleostomids.

A study of the opisthaptor on Monocotyle pricei suggests that ridge sclerites on the septa may serve as minute projecting devices for increasing surface friction with the host's gills, thereby aiding the disk, central anchors and marginal hooks in adhesion.

Monocotyle diademalis Hargis, 1955

Host: Dasyatis americana (Hildebrand and Schroeder), southern sting ray and D. say (LeSueur), Say's sting ray, sublittoral marine dasyatids.

Location: Gills

Previously reported hosts and locality: Dasyatis sabina (LeSueur) and Dasyatis sp. (Probably either D. say or D. americana) from Alligator Harbor, Franklin Co., Florida.

Number studied: 13

Discussion: Thirteen specimens of Monocotyle diademalis Hargis, 1955, were recovered from one host species, Dasyatis americana. Examination

of Hargis' specimens and the literature indicate the conspecificity of Monocotyle diademalis with forms in the present collection.

M. diademalis appears closely related to M. pricei Pearse, 1949, from which it differs in all characters mentioned by Hargis (1955b). In addition, the pharynx is cylindrical and large: 0.168 (0.112 - 0.223) long by 0.117 (0.082 - 0.153) wide while that of M. pricei is ovoid: 0.089 (0.067 - 0.106) long by 0.065 (0.052 - 0.073) wide.

Hargis (1955b) suggested that Dasyatis sabina be considered the primary host of M. diademalis. He also reported that D. sp. (not precisely identified, probably D. say or D. americana), harbored a different species of Monocotylidae. Present collections show that two D. americana harbored eleven specimens of M. diademalis while only two M. diademalis were recovered from one Dasyatis say.

Table 1 tends to suggest that on the basis of present collections it would be possible to distinguish host species of the family Dasyatidae by examination of monogeneids on the branchial material. Host species could be determined from each other both within separate geographical ranges and between the two areas as shown in the table.

Table 1. Host-parasite relationship between Dasyatidae species.

Host	Locality					
	Florida			Chesapeake Bay		
	No. of Hosts	Parasites	No. of Parasites	No. of Hosts	Parasites	No. of Parasites
Dasyatis americana	8	AC	150	2	D	11
Dasyatis say	2	C	26	1	CD	17
Dasyatis sabina	2	D	30			
Dasyatis sp.	1	BD	7			

A = Heterocotyle americana; B = H. pseudominima; C = Monocotyle pricei and D = M. diademalis

Close relationship of the three hosts is suggested by the occurrence of related Monocotyle spp. on Dasyatis spp. and not on other fishes.

Subfamily Loimoinae Price 1936, sensu Hargis 1955

Diagnosis: This group was emended by Hargis (1955b) to include his new genus Loimopapillosum. The type species, Loimopapillosum dasyatis, differs from Loimos and Loimosina Manter, 1944 in (1) possessing head organs and cephalic glands in the prohaptor, (2) lacking cuticular ridges on the dorsal surface of the opisthaptor, (3) having pedunculated marginated hooks.

Loimopapillosum dasyatis Hargis, 1955

Host: Dasyatis say (LeSueur), Say's sting ray, a sublittoral marine dasyatid.

Location: Gills

Previously reported hosts and locality: Dasyatis americana, D. say, and D. species (either D. say or D. americana) from Alligator Harbor, Franklin Co., Florida.

Number studied: 17

Discussion: Seventeen members of the genus Loimopapillosum Hargis 1955, were recovered from two specimens of Dasyatis say. A study of L. dasyatis confirms Hargis' description of the following characters: opisthaptor an undivided, concavo-convex oval disk, armed with two anchors and fourteen marginal hooks on long, digitiform peduncles; testes single or double; cirrus cuticularized; ovary looped over right intestinal crus; vaginal pore ventral; gut bifurcated, crura unramified, not confluent.

Hargis suggested that Loimopapillosum dasyatis from Dasyatis say was smaller than the same species from Dasyatis americana. On available specimens there is no significant difference in body length ($F = 0.67$, d.f. 12 and 1, $F_{0.05} = 244.0$) and width ($F = 0.86$, d.f. 12 and 1, $F_{0.05} = 244.0$) between specimens from the two hosts.

The occurrence of the same gill parasite on these two species of the family Dasyatidae is probably a further indication of the close relationship of the host fishes.

Subfamily Merizocotylinae Johnston and Tiegs, 1922

Palombi (1949) refused to recognize this subfamily and included Merizocotyle Cerfontaine, 1894, the type genus, and Thaumatocotyle in the subfamily Monocotylinae. The writer prefers to follow

Price, 1938, Sproston, 1946, and Hargis, 1955, and retain Merizocotylinae as a subfamily for members of the genus Empruthotrema which were found in Chesapeake Bay waters.

Genus Empruthotrema Johnston and Tiegs, 1922

Empruthotrema raiae (MacCallum, 1916)

Johnston and Tiegs, 1922

Synonyms: Acanthocotyle raiae, MacCallum, 1916

Host: Raja eglanteria Bosc, 1802, Brier skate, a sublittoral marine rajid

Location: Gills

Previously reported hosts and localities: from nasal fossae of Raja erinacea Mitchell and Raja diaphanes Mitchell from Woods Hole, Mass. and gills of Raja eglanteria Lacépède from Alligator Harbor, Florida.

Number studied: 2

Discussion: Comparison of specimens in this collection with MacCallum's (1916) slides, U.S.N.M. Helm. Coll., Nos. 35160, 35172, 35666-7 and 8 showed the present forms to be conspecific with Empruthotrema raiae.

The two specimens in this collection are smaller than the type specimens and those in Hargis' collections, however, more specimens should be collected before the significance of this difference can be judged.

The occurrence of E. raiae on the gills or in the nasal fossae of three different skates suggests a close relationship between the hosts.

Family Capsalidae Baird, 1853

Subfamily Benedeniinae Johnston, 1931

Genus Benedenia Diesing, 1858

The genus Benedenia is accepted as defined by Price (1939) and Sproston (1946). The attempts by Johnston (1929) and Yamaguti (1934, 1937, and 1938) to subdivide this group into subgenera have not met with wide acceptance. Hargis (1955) suggested that the characters used, e.g. position of vaginal pore, etc., are not of subgeneric value. However, Hargis implied that Price's suggested erection of separate genera for the two groups of Benedenia may be legitimate after further study of the groups.

Benedenia posterocolpa Hargis, 1955

Host: Rhinoptera quadriloba (LeSueur), cow-nosed ray, a sublittoral marine rhinopterid.

Location: Skin, ventral surface

Previously reported host and locality: Rhinoptera quadriloba from Tampa Bay, Pinellas Co., Florida.

Number studied: 9

Discussion: Comparison of specimens in this collection with Benedenia posterocolpa Hargis, 1955, indicates the conspecificity of the two forms. posterocolpa

Specimens from Florida and Chesapeake Bay appear similar in structure but slightly different in body size, however, this size difference is not significant ($F = 1.59$, d.f. 4 and 5, $F_{0.05} = 5.19$).

A pair of conical papillae, resembling horns, not mentioned by the original author, were observed on the anteroventral suckers of the prohaptor. These projections, one on each sucker, were also found on specimens of Benedenia posterocolpa from Flroida. The function of these papillae is not clear but they may be sensory.

Benedenia posterocopla Hargis, 1955, is closely related to B. macrocolpa (Luhe 1906) Johnston, 1929, but differs in the following: (1) ovary with oviduct internal and dendritic; (2) length of vaginal duct; (3) position of the vaginal pore etc.

The host of the latter fluke is Rhinoptera javanica Muller and Henle, and that of the former R. quadriloba. Both worms are closely related as are the hosts.

Superfamily Diclidophoroidea Price, 1936

Thirteen members of four families, Mazocraeidae Price 1936, Discocotylidae Price, 1936, Microcotylidae Taschenberg, 1879, and Gastrocotylidae, Price, 1943, of this superfamily were recovered from hosts in Chesapeake Bay. Although Palombi (1949) combined the families Microcotylidae Taschenberg, 1879, and Discocotylidae Price, 1936, in the family Arreptocotylidae Palombi, 1949, the writer prefers to follow the arrangement of Price (1943) and Sproston (1946). Taxonomic structures such as arrangement and number of clamp sclerites and anchors and general features of body shape are very important in the systematics of this superfamily (Hargis 1955c).

Family Discocotylidae Price, 1936

Subfamily Anthocotylinae Price, 1936

The genera Tagia and Bicotylophora, are reported in this paper as occurring on fish hosts in Chesapeake Bay. In his emendation of the family Discocotylidae, Hargis (1956a) suggested that the members of the subfamily Anthocotylinae, Price, 1936, be divided into two separate groups. On the basis of anchor and body shapes it is possible to separate the genera Winkenthughesia Price, 1943, and Anthocotyle van Beneden and Hesse, 1863, from the complex of genera Tagia Sproston, 1946, Hemitagia Sproston, 1946, and Bicotylophora Price, 1936. Hargis (1956a) suggested that Winkenthughesia and Anthocotyle may not even belong in the family Discocotylidae. A more detailed account of the superfamily Diclidophoroidea Price, 1936, and the subfamily Anthocotylinae Price, 1936, is given in Hargis (1956). The systematic scheme of Bychowsky (1957) elevates Anthocotylinae Price, 1936, to family rank. (Not clarified) As Hargis (1959) indicated, this Russian worker did not use superfamilial and superordinal groupings in his systematic scheme. Evaluation of this new scheme will have to await translation and study of the Russian text.

Genus Tagia (Sproston, 1946) sensu Hargis, 1956a

Hargis (1956) emended Tagia to accommodate T. micropogoni Pearse, 1949, T. bairdiella Hargis, 1956, and T. cupida Hargis, 1956. However, Caballero et al, 1953, implied that T. micropogoni

was not congeneric with T. equadori. Hargis (1959) pointed out that T. equadori and T. micropogoni differ considerably and Caballero et al 1953, were probably justified in their generic separation of the two species. Hargis shows that Caballero et al failed to determine the generic affinity of this group even though it appears to fit their own grouping Macrovalvitrema Caballero and Hollis, 1955. Hargis further stated that T. bairdiella, T. micropogoni, and T. cupida and Caballero's and Hollis' (1955) species are closely related to each other, possibly belonging to Hemitagia Sproston, 1946, or to another generic aggregation in the subfamily Anthocotylinae. Pending further studies of this group the author agrees with Hargis' (1959) decision to retain the genus Tagia for the above forms.

Tagia bairdiella Hargis, 1956

Host: Bairdiella chrysura (Lacépède) silver perch, a bentho-sublittoral, euryhaline, marine sciaenid.

Location: Gills

Previously reported host and locality: B. chrysura from Alligator Harbor, Franklin Co., Florida.

Number studied: 1

Discussion: This specimen, from the gills of Bairdiella chrysura is conspecific with Tagia bairdiella Hargis, 1956. Present research confirms presence of the following characteristics of T. bairdiella which separates it from all other known members of the genus: (1) details of

clamp sclerites, (2) clamps of two different shapes, a highly modified fire-tong shape and a rounded shape, (3) testes apparently saccate, not follicular, (4) vaginal placodes present, and (5) host.

Genus Bicotylophora Price, 1936

Bicotylophora trachinoti (MacCallum, 1921) Price, 1936

(Figs. 9 - 17)

Synonyms: Dactylocotyle trachinoti, also D. trachynoti (MacCallum, 1921).

Host: Trachinotus carolinus (Linnaeus), common pompano, a neritic marine carangid.

Location: Gills

Previously reported host and locality: Trachinotus carolinensis [(sic), type host] and Roccus saxatilis (= R. lineatus, probably an accidental host) from the N. Y. Aquarium and T. carolinus from Alligator Harbor.

Number studied: 150

Number measured: 33

Redescription: Body symmetrical, 2.3(1.8 - 2.9), S.D. = 0.28 long by 0.3 (0.2 - 0.4), S.D. = 0.06 wide. Cuticle uniform, relatively thick and smooth. Prohaptor narrows abruptly near pharynx. Oral suckers, 0.1 by 0.03, situated ventrolaterally to terminal mouth (0.1 by 0.03). Opisthaptor two narrow lobes, 0.3 long by 0.2 wide, each bearing a row of four sessile clamps, (60); 0.143 (0.106 - 0.178), S.D. = 0.02 long by

0.104 (0.086 - 0.135), S.D. = 0.01 wide. Pharynx round, 0.04 in diameter. A pair of anchors present between posterior lobes, 0.01 long. Esophagus short, 0.16 long by 0.01 wide, laterally ramified antero-dorsal to corona. Gut bifurcated, slightly ramified, extends length of body and enters posterior lobes. Testes posterior to ovary between intestinal crura, 0.36 long by 0.15 wide, follicles numerous, ovoid, (12) 19 (17 - 21) in number; seminal vesicle, 0.63 long by 0.04 wide, winding anteroventrally to genital corona. Atrium spherical, muscular, 0.04 in diameter, armed with hooks and spines. Posterolateral pair, (39) 0.05 (0.04 - 0.06), S.D. = 0.02, mediolateral pair, (41) 0.05 (0.04 - 0.06), S. D. = 0.03, spines numerous, 0.02 long, lateral to genital pore. Ovary saccate, curved, anterior to testes in mid-region, 0.16 long by 0.03 wide. Oviduct, entering base of vitelline reservoir from right end of ovary. Vitelline reservoir, 0.05 long by 0.03 wide, dividing into two anteroventral ducts. Uterus dorsal to vitelline reservoir and seminal vesicle extending anteriorly to genital atrium, 0.81 long by 0.25 wide. Usually greatly extended with numerous eggs. Genito-intestinal canal running from posterior to vitelline reservoir to right gut. Vaginal pore muscular, situated dorsally, mid-way between atrium and testes, unarmed, (2) 0.05 long by 0.03 wide. Duct, 0.18 long by 0.03 wide extends dorsal to seminal vesicle to posterior of vitelline reservoir. Eggs, 0.10 long by 0.03 wide, filamentous at posterior pole. Eyespots, brain and excretory vesicles are not observed. No Mehlis glands observed.

Discussion: Several workers have reported this worm from Trachinotus carolinus although no one has redescribed MacCallum's species until now. Although this species has been placed in the family Discocotylidae Price, 1936, the clamp structure is distinctly microcotylid. It is highly probable that this form is intermediate in nature to these groups.

The redescription given differs with that of MacCallum (1921) in the following: (1) vagina and cirrus unarmed, MacCallum's forms armed with spines, hooks and spicules; (2) presence of a pair of small anchors between haptoral lobes, not noted by MacCallum; (3) body measurements greater, 4.0 long by 0.52 wide in MacCallum's specimens compared to 2.3 long by 0.3 wide in Chesapeake Bay forms.

The intensity of infection by B. trachinoti on the gills of Trachinotus carolinus suggests that the genus Trachinotus is the natural host. It is probable that Roccus lineatus from the New York Aquarium is an accidental host since B. trachinoti has been reported only once from this host.

Family Mazocraeidae Price, 1936

Sproston (1946) and others regard this group as possessing primitive clamps in which the dorsal loop elements (posterior loop elements) fuse medially, and the dorsal (posterior) and ventral (anterior) loops form a complete circle. The genus Kuhnia Sproston, 1945, is said to have such an arrangement of these loops. Hargis (1956a) employed the term dorsal loop element in place of the more inaccurate term

dorsal loop. In contrast to Sproston's (1945) description of dorsal and ventral loops Hargis showed that none of his specimens of mazocraeids, which included a new species of Kuhnia had the dorsal loop element fused medially. A detailed study of clamp elements (Llewellyn 1956, 57) definitely showed that the posterior loop (dorsal loop) was not complete in the K. scombri he examined.

Llewellyn (1956 and 1957) pointed out that in life clamps project ventrally or away from the opisthaptor with the open end, or gape, distal and the closed portion, the cup or base proximal. Hargis (1959) showed that direction and position of clamp elements are altered considerably under cover slip pressure so that the gape is directed posteriorly. This results in an artificial picture of the natural direction and position of the dorsal (posterior) and ventral (anterior) loop elements.

Though several reputable workers have made use of clamp structure as a taxonomic character, Llewellyn (1956) intimated that it might be over-rated. Hargis (1959) reaffirmed the systematic importance of the details of clamp sclerite morphology but stated that clamp structure data should always be accompanied by data of other external structures and all internal organs when making decisions. In reporting the conclusions of his 30 years study of monogenetic trematodes Bychowsky (1957) strongly supported the use of these organs as systematic tools.

The fish families Scombridae and Clupeidae are the only known hosts of members of the Mazocraeidae, the majority of known mazocraeids occurring on the latter. Hargis suggests this pattern of ectoparasite infestation may reflect either an obscure taxonomic relationship or an ecological relationship of the host family.

Clupeocotyle brevoortia Hargis, 1955

(Figs. 1 - 4)

Probably synonyms: Dactylocotyle sp. Linton, 1905, Clupeocotyle lintoni (Koratha, 1955) Hargis, 1959, [= Diclidophora lintoni Koratha 1955] and Diclodophora sp. (sic) Westman and Nigrelli, 1955.

Host: Brevoortia tyrannus Latrobe, menhaden, a nerito-pelagic marine clupeid.

Location: Gills

Previously reported hosts and localities: Brevoortia tyrannus from Beaufort, North Carolina, B. patronus from Alligator Harbor, Florida, B. gunteri near Port Aransas, Texas, and B. tyrannus from Long Island and New Jersey.

Number studied: 23

Number measured: 17

Description: Body elongate, (15) 8.2 (5.9 - 10.0), S.D. = 1.35 long by (15) 1.3 (0.8 - 2.0), S.D. = 0.28 wide, narrow anteriorly, broadened posteriorly to the posthaptor which is clearly demarcated. Cuticle thin.

Prohaptor a pair of small muscular buccal suckers, (4) 0.1 in diameter, in dorsolateral walls of buccal funnel. Opisthaptor a rectangular cotylophore, with four pairs of similar clamps and two posterior, conical papillae armed with a pair of anchors and a pair of small sclerites on immature forms. Clamps sub-equal, (68) 0.089 (0.063 - 0.102), S.D. = 0.01 long by (68) 0.067 (0.049 - 0.086), S.D. = 0.01 wide, ventral loop continuous, dorsal loop elements interrupted, middle loop complete, center piece modified and often fenestrated.

Anchors (one pair) located on terminal lappets, (30) 0.058 (0.046 - 0.069), S.D. = 0.01 long with deep roots, sickle-shaped ends. A pair of bottle-shaped sclerites observed near anchor shafts. Mouth subterminal. Pharynx ovoid, 0.07 long by 0.05 wide; esophagus ramified laterally, extending one-third length of body. Gut bifurcated, crura ramified medially and laterally, rami forked, crura confluent posteriorly in haptor, testes elongate, deeply lobed, (2) 1.72 long by 0.35 wide, post-equatorial, between intestinal crura, vas deferens loosely coiled in midline dorsal to uterus. Genital pore midventral anterior to vagina, opening into an armed gential atrium. Genital corona in two parts, (5) 0.052 (0.042 - 0.060) long by 0.039 (0.034 - 0.043) wide, central part a ring-shaped muscular piece armed medially with 4-5 pairs of curved spines, (33) 0.007 (0.006 - 0.008), S.D. = 0.001; anterolateral part of a U-shaped muscular piece armed medially with one pair of longer, ventrally curved spines, (16), 0.015 (0.014 -

0.15), S.D. = 0.001. Ovary elongate, tubular, folded, with free ends anterior, 1.49 long by 0.11 wide, situated to right of testes; oviduct extending from left anterior end of ovary, Ootype fusiform, dorsal to vitelline reservoir, uterus, 3.05 long, proceeding anteriorly in mid-ventral line to genital atrium. Genito-intestinal canal short, entering into right crus. Crater-like depression posteroventral to genital corona, (3) 0.337 (0.322 - 0.366) long by 0.149 (0.125 - 0.168) wide interpreted as vaginal opening. Mehlis' gland at base of ootype. Vitellaria follicular, near intestinal crura, fairly dense in mid-region of body, sparse anteriorly and on opisthaptor; transverse vitelloducts, 0.19 long by 0.03 wide fuse medially to form the Y-shaped vitelline reservoir, 0.64 long. Egg in utero fusiform, 0.31 long by 0.08 wide, with short, subequal filaments at both ends. Cephalic glands anterior to vagina, 0.24 long by 0.04 wide extending to prohaptor suckers. Excretory pores dorsolateral at level of vagina, ducts extending posteriorly the length of the vagina.

Discussion: This species was first reported by Hargis (1955c). Clupeocotyle brevoortia of this collection is larger than Florida forms in body length ($F = 52.1$, d.f. 1 and 18, $F_{0.01} = 8.28$) and width ($F = 12.7$, d.f. 1 and 19, $F_{0.01} = 8.18$).

A study of the description and drawing of Dactylocotyle sp. Linton, 1905, indicates that this form is possibly conspecific to Clupeocotyle brevoortia Hargis, 1955. The writer agrees with Hargis'

(1959) suggestion that Diclidophora lintoni Koratha, 1955 from B. gunteri is conspecific to C. brevoortia. Judging from the brief description it is probable that Diclodophora sp. (sic) [= Diclidophora sp.] mentioned by Westman and Nigrelli (1955) is also conspecific to Hargis' species. Specimens from Port Aransas, Beaufort and New Jersey should be collected and redescribed before this problem of conspecificity can be settled because the specimens of Diclidophora lintoni, Dactylocotyle sp. and Diclodophora sp. (sic) are not available for study.

The occurrence of this fluke on Brevoortia tyrannus, Chesapeake Bay (new host record), Beaufort, North Carolina, and New Jersey, B. patronus, Gulf of Mexico and B. gunteri, Port Aransas, Texas, is possibly a reflection of the close relationship of hosts. This possibility is strengthened by the occurrence of Mazocraeoides georgei Price, 1936, on Brevoortia species from Gulf of Mexico and Chesapeake Bay.

Mazocraeoides georgei Price, 1936

(Figs. 5 - 8)

Host: Brevoortia tyrannus (Latrobe), Atlantic Coast menhaden, a nerito-pelagic marine clupeid.

Location: Gills

Previously reported hosts and localities: Pomolobus pseudoharengus and P. mediocris from Woods Hole, Mass; Brevoortia patronus from Alligator Harbor, Florida.

Number studied: 50

Number measured: 31

Redescription: Body clavate, (22) 2.7 (2.2 - 2.9), S.D. = 0.29 long by 0.8 (0.6 - 1.1), S.D. = 0.03 wide. Anterior portion narrow, broadened posteriorly to a clearly defined posthaptor, not separated from body. Cuticle thin, transparent. Prohaptor a pair of round, muscular, buccal suckers, 0.03 in diameter, placed ventrolaterally in the buccal funnel. Cephalic glands lateral to genital atrium, opening via ducts, 1.4 long by 0.01 wide to buccal funnel. Opisthaptor consisting of four pairs of clamps ventrolateral in posterior half of body and slight posterior extension of body bearing three pairs of anchors. Anterior and posterior clamps same size, (61) 0.048 (0.043 - 0.053), S.D. = 0.003 long by 0.043 (0.040 - 0.050), S.D. = 0.002 wide; ventral loop continuous, dorsal loop elements apparently incomplete though prominent, middle loop complete. Anchors posteromedial to posterior clamps; largest anchors lateral, (28) 0.081 (0.063 - 0.086) S.D. = 0.01 long, with deep roots and sickle-shaped ends; intermediate anchors smallest, (21) 0.011 (0.010 - 0.017), S.D. = 0.002 long, appear to be S-shaped; medial anchors, (27) 0.029 (0.023 - 0.033), S.D. = 0.01 long. Mouth subterminal, pharynx ovoid, 0.07 long by 0.04 wide; esophagus broad, ramified posterior to genital atrium, extending to about one-fourth level of body. Gut bifurcate, crura ramified, rami mostly lateral, confluent posterior to testes. Testes saccate, post equatorial, to left of midline between intestinal crura, 0.7 long by 0.1 wide, vas deferens wide,

slightly sinuous, 1.5 long by 0.1 wide in midline proceeding anteriorly to midventral genital pore, about the middle of the esophagus, opening into an armed genital atrium. Genital corona, 0.04 in diameter, in three pieces, central, ring-like muscular piece armed medially by five pairs of small dorsally curved spines, (43) 0.012 (0.008 - 0.015), S.D. = 0.002; two laterally placed curved muscular pieces armed by a pair of ventrally curved spines, (24) 0.013 (0.008 - 0.018), S.D. = 0.002 long with irregular bases. Ovary tubular, folded to right of midline, 0.8 long by 0.1 wide; oviduct extending medially from anterolateral end of ovary lobe. Ootype dorsal to vitelline reservoir, uterus proceeding anteriorly in midline, 1.5 long by 0.1 wide. Genito-intestinal canal, 0.1 long by 0.03 wide curving ventromedially from the right crus. Vaginal pore anterior to genital atrium. Vitellaria follicular, near intestinal crura, mostly between rami, from a level just posterior to genital pore to near posterior portion of body; transverse vitelloducts, ventral, 0.1 long by 0.05 wide, fusing in midline to form Y-shaped vitelline reservoir, 0.5 long by 0.1 wide. Egg ovate, 0.1 long by 0.02 wide, no filaments observed. Mehlis gland present.

Discussion: Mazocraeoides georgei Price, 1936, was initially published in a brief account, later redescribed and figured by Linton (1940) from the gills of two species of the clupeid genus Pomolobus from Woods Hole, Mass. Hargis (1956) described as this parasite a population from the gills of Brevoortia patronus, also a clupeid. He also redescribed

Linton's material (Specimens on U.S.N.M. Helm. Coll. slide No. 35623). Separate redescriptions were made because Hargis contended that Gulf of Mexico forms differed noticeably from Woods Hole specimens. However, since these differences could not be considered specific at that time the two groups were not mixed because specific separation might later be necessary.

M. georgei, in this work is described as a parasite from the gills of still another clupeid, Brevoortia tyrannus. M. georgei from Chesapeake Bay is significantly larger in body length ($F = 144.9$, d.f. 1 and 25, $F_{0.05} = 4.24$) than M. georgei from Gulf of Mexico. Hargis stated that anterior clamps were slightly larger than posterior clamps on M. georgei, Gulf of Mexico. Analysis of clamp length and width (single variance technique) on Hargis' specimens and those in the present collection shows this difference between the anterior and posterior clamps of both groups is not significant. However, analysis of clamp length between Chesapeake Bay and Gulf of Mexico forms shows a significant difference, the former being larger ($F = 33.3$, d.f. 1 and 25, $F_{0.05} = 4.24$).

Mazocraeoides olentangiensis Sroufe (1958) was described from the gills of the clupeid Dorosoma cepedianum. This new species is very similar to M. georgei, already described from four other clupeids. Sroufe states that M. olentangiensis differs from M. georgei in: (1) measurement of hard parts; (2) extent of ovary; (3) morphology of

genital corona; (4) number of polar filaments of egg; (5) difference of hosts.

A comparative study of measurements of hard parts indicates that these differences may not be statistically significant. ex. Anchor length (largest pr.), 0.063 (0.058 - 0.067) for M. olentangiensis lies within the range M. georgei (Gulf of Mexico), 0.055 (0.047 - 0.061) and M. georgei (Chesapeake Bay), 0.081 (0.063 - 0.086). Similarity of other measurements and morphological characters support this observation, however, statistical analysis and comparison of Sroufe's data with present material will be necessary before definite conclusions can be made.

Further statistical treatment of body parts of M. georgei from its four known clupeid hosts may aid in the determination of existing similarities or differences between these parasitic populations.

Family Microcotylidae Taschenberg, 1879

The original family Microcotylidae Taschenberg, 1879, was redefined by Sproston (1946). Hargis (1957a) emended this family by removing the subfamily Gastrocotylinae from Microcotylidae and placing it in the reinstated family Gastrocotylidae Price, 1943. The subfamily Axininae Monticelli, 1903, was also reinstated. The writer adopts the emendation made by Hargis.

The present confusion existing in the taxonomy of this group stems from: (1) a lack of detailed descriptions of many microcotylids by earlier workers, (2) possible unwarranted creation of new genera by recent workers, e.g. Metamicrocotyla Yamaguti, 1943, and Gonioplasius Sandars, 1944, etc. and (3) the poor systematic condition of the type genus Microcotyle resulting in lack of clarity of the subfamily Microcotylinae.

Two subfamilies; Microcotylinae Monticelli, 1892, and Axininae (Monticelli, 1903), sensu Hargis, 1957, are discussed herein. The redescriptions of three species from the genus Microcotyle van Beneden and Hesse, 1863, are based on fresh material collected from fish from Chesapeake Bay.

Microtyle poronoti MacCallum, 1915

(Figs. 21 - 24)

Host: Poronotus triacanthus, ~~harvestfish~~ BUTTERFISH, pelagic marine stromateidae.

Location: Gills

Previously reported host and locality: Poronotus triacanthus from Woods Hole, Massachusetts (MacCallum, 1915), (Linton 1940); Canada (Cooper 1915). duecomplete

Number studied: 14

Number measured: 13

Redescription: Body elongate, fusiform, flattened dorsoventrally, (10) 3.0 (2.4 - 3.6), S.D. = 0.46 long by (9) 0.8 (0.7 - 1.0), S.D. = 0.01 wide.

Posterior third of body a tapering opisthaptor bearing two rows of profuse typically microcotylid clamps. Cuticle thin and smooth. Prohaptor a pair of biloculate buccal suckers, (2) 0.07 by 0.06 placed ventrolaterally in the buccal funnel. Opisthaptor a long, narrowing cotylophore armed with (five) 45 to 59 pairs of clamps. Clamps similar in shape, dissimilar in width, anterior clamps significantly wider than posterior, $F = 10.00$, d.f. 12 and 13, $F_{0.01} = 3.96$. Anterior clamps, (13) 0.082 (0.069 - 0.089), S.D. = 0.01 long by 0.049 (0.043 - 0.056), S.D. = 0.01 wide. Posterior clamps, (13) 0.067 (0.053 - 0.079), S.D. = 0.02 long by 0.044 (0.040 - 0.046), S.D. = 0.003 wide. No anchors present. Peduncle narrow, (11), 0.4 (0.2 - 0.6). Mouth subterminal. Pharynx spherical, (2) 0.05; esophagus broad, 0.31 long by 0.02 wide, extending just posterior to genital atrium. Gut bifurcated, crura ramified laterally, rami bifurcated, unramified posterior ends of crura fusing at peduncle. Testes long, 0.63 by 0.24, follicular, (9) 23 (17 - 30) in number, usually ovoid, between intestinal crura post equatorially; vas deferens fairly broad, sinuous, 1.40 long by 0.03 wide twisting dorsally in midline anteriorly. Genital pore mid-ventral, near anterior end, opening into the genital atrium, (2) 0.10 long by 0.09 wide, armed with numerous conical spines, (4) 0.01 long. Two rows of spines, (24) $\tilde{x} = 10$, (6 -14) on each side extend posteromedially from genital atrium. Small, muscular, disc-shaped structure resembling a vaginal pore observed on ventral surface immediately posterior to genital atrium, armed with

seven or eight small curved sclerites. Ovary pretesticular, dorsal to vitelline reservoir, relatively long, folded 0.91 long by 0.03 wide, oviduct running posteriorly from right hand side. Ootype dorsal to vitelline reservoir; uterus, 1.25 long by 0.01 wide, ventral along midline, running anteriorly to genital atrium. Genito-intestinal canal, 0.28 long by 0.03 wide, proceeding from right crus, fusing with oviduct medially. Vitellaria follicular near intestinal crura, extending from just posterior to genital atrium to one third length of cotylophore; transverse vitelloducts, (2) 0.17 long by 0.02 wide, fusing medially to form the equatorial Y-shaped vitelline reservoir, 0.35 long by 0.02 wide, lying anteroventral to testes. Egg "in utero" elongate, (2) 0.20 long by 0.06 wide, short filament at both poles. No Mehlis glands observed.

Discussion: Careful study of the original description makes it clear that the present specimens are conspecific with M. poronoti MacCallum, 1915. The above redescription is given because the original figures and description were incomplete.

M. poronoti MacCallum, 1915, which was discussed superficially by Linton (1940) is much like the present species but differs in the following characters: present specimens smaller in body length and width than the type species; average number of clamps, (53 pairs); significant difference in width between anterior and posterior clamps, ($F = 10$, d.f. 12 and 13, $F_{0.05} = 3.96$). Biloculate suckers,

noted by Linton (1940) confirmed herein. Testes follicular, between intestinal crura, postequatorial, 23 in number, compared to 32 as given by MacCallum. Genital pore midventral, near anterior end. Posteromedial atrium spines 10 in number. Original description stated 15 in number. An armed ventral pore, posterior to the genital atrium was clearly defined in only one specimen (see figure), less so in three other specimens. This pore may function as a vaginal opening, however, lack of observable detail has caused the author to refrain from further description. More specimens are necessary to adequately study this structure. Thus, the structures not mentioned in previous descriptions are the ootype, genito intestinal canal and (armed vaginal pore?).

Sproston (1946) considered egg measurement as given by MacCallum (1915) to be erroneous. However, comparison of MacCallum's measurements with those herein suggests that egg length measurements (0.31 Wodds Hole, 0.20 Chesapeake Bay). are in proportion to their respective parasite body lengths (6.0 Woods Hole, 3.0 Chesapeake Bay). Thus, MacCallum's egg measurements may be considered reasonably accurate.

Comparison of samples of the three Microcotyle species

Similar appearance of the three microcotylids, M. poronoti, M. peprili, and M. pomatomi, prompted a comparative study to determine if specimens in the present collection could have been

drawn from a homogeneous population. Two methods of analysis were used: (1) Comparison of morphological structures; (2) statistical comparison of various body measurements by analysis of variance.

M. pomatomi differed from M. poronoti and M. peprili in shape and arrangement of the armed genital atrium, presence and position of an "unarmed" (vaginal pore?), possession of larger body parts, smaller clamp lengths and significantly greater numbers of posterolateral atrium spines ($F = 47.5$, d.f. 1 and 31, $F_{0.01} = 7.53$). Body length (minus the haptor) of the largest form, M. pomatomi, differs from length of M. peprili ($F = 12.97$, d.f. 1 and 11, $F_{0.05} = 4.84$) and M. poronoti ($F = 16.81$, d.f. 1 and 15, $F_{0.05} = 4.54$). The difference in body length between M. poronoti and M. peprili was not significant at the 5 per cent level. These differences are considered sufficient criteria to distinguish M. pomatomi as a separate species from M. peprili and M. poronoti.

Conclusions based on statistical analyses about relationships between the species M. poronoti and M. peprili have not been drawn because of reasons mentioned below.

Reliability of statistical analyses is influenced by two main factors when working with soft-bodied forms such as monogeneids. One is differential shrinkage due to variability in methods of host collecting, and variability in relaxation or flattening and preserving and staining techniques. The other is variability within and between species in growth (and quantitative dimensions) of various body parts.

Differential shrinkage and growth rate factors which may give misleading statistical results do not appear to effect stable morphological structures such as the sclerotized genital and haptoral armature. Differences in these "hard parts" are considered sound evidence to imply a distinct difference between the two forms being compared.

Body length and width, clamp and egg size, and numbers of clamps, testes lobes and posterolateral atrium spines of both species were examined. These differences, collectively, may be specific in stature but this is highly subjective and more adequate samples should be examined. For the present M. peprili and M. poronoti are considered separate.

The close similarity of the two worms probably reflects the close relationships of the hosts within the family Stromateidae.

Microcotyle peprili Pearse, 1949

(Figs. 25 - 27)

Host: Peprilus alepidotus - ~~butterfish~~ HARVESTFISH, pelagic marine stromateidae.

Location: Gills

Previously reported host and locality: Peprilus alepidotus from Beaufort, North Carolina.

Number studied: 10

Number measured: 9

Description: Body elongate, fusiform, flattened dorsoventrally, (8) 2.72 (2.03 - 3.63), S.D. = 0.57 long by 0.61 (0.31 - 0.85), S.D. = 0.22

wide. Posterior third of body forms a tapering opisthaptor bearing two rows of numerous clamps. Cuticle thin and smooth. Prohaptor a pair of biloculate buccal suckers, (5) 0.06 (0.04 - 0.07) placed ventrolaterally in the buccal funnel. Opisthaptor a long, narrowing cotylophore armed with, (7) 19 to 40 pairs of clamps. Clamps similar in shape, no significant difference insize, anterior clamps, (9) 0.09 (0.076 - 0.099), S.D. = 0.03 long by 0.052 (0.040 - 0.060), S.D. = 0.01 wide, posterior clamps, (9) 0.084 (0.069 - 0.096), S.D. = 0.01 long by 0.052 (0.043 - 0.066), S.D. = 0.01 wide. Dorsal and ventral loop elements incomplete, separated at their extremities. Center loop forked and ornate. Base composed of muscular pieces joining dorsal and ventral elements. No anchors present. Peduncle narrow, (9) 0.253 (0.155 - 0.396). Mouth subterminal. Pharynx spherical, 0.05; esophagus narrow, 0.26 long by 0.01 wide extending just posterior to genital atrium. Gut bifurcated, crura ramified laterally, rami bifurcated, unramified posterior ends of crura fusing at peduncle and extending as a blind sac into anterior third of opisthaptor. Testes long, 0.59 by 0.25 wide, follicular, (8) 19 (13 - 24) lobes in number, usually ovoid, between intestinal crura postequatorially; vas deferens broad, sinuous, 1.12 long by 0.03 wide, twisting dorsally in midline anteriorly. Genital pore midventral, near anterior end, opening into a ventral genital atrium, (4) 0.09 (0.06 - 0.11) long by 0.07 (0.06 - 0.08) wide; divided into 2 parts, an outer muscular rim and an inner section armed with numerous conical spines arranged in

concentric circles. Two rows of spines, (16) 11 (7 - 17) in number, extending posteromedially from genital atrium. A structure, similar to the "armed pore" noted in Microcotyle poronoti was also observed in M. peprili. It is located posteroventrally to genital atrium, armed with 7 or 8 small, curved sclerites. Ovary pretesticular, dorsal to vitelline reservoir, relatively long, folded, 0.94 long by 0.07 wide, oviduct running posteriorly from right hand side. Ootype dorsal to vitelline reservoir; uterus, 1.09 long by 0.01 wide, ventral in midline, running anteriorly to genital atrium. Genito-intestinal canal proceeding from right crus, fusing with oviduct medially. Vitellaria follicular near intestinal crura, extending from just posterior to genital atrium to one third length of cotylophore; transverse vitelloducts, (4) 0.11 long by 0.02 wide, fusing medially to form the equatorial Y-shaped vitelline reservoir, 0.23 long by 0.03 wide, lying anteroventral to testes. Mehlis gland present. Egg in utero elongate, 0.30 long by 0.08 wide, with a short filament at both poles.

Discussion: Comparison of specimens in this collection with Pearse's type specimen (U.S.N.M. Helm. Coll. No. 36936) indicated that the two forms are conspecific. The lack of detail in the original description of Microcotyle peprili prompted this complete redescription and refiguring.

The parasites exhibit the following anatomical features not noted in the distorted type specimen; biloculate suckers; two rows of clamps on posthaptor instead of four mentioned by Pearse (1949);

conical spines lying posteromedially to armed genital atrium (obscured in type species); follicular testes; pretesticular ovary; uterus; seminal vesicle; genito-intestinal canal; ootype; vitelline reservoir, and ducts; Mehlis gland and eggs. There is a poorly defined small, armed, ventral opening posterior to the genital atrium in the present specimens. This structure similar to the one found in M. poronoti may represent a vaginal opening, however, more specimens will have to be studied before its identity can be determined.

Pearse (1949) stated that Microcotyle peprili differed from other members of the genus Microcotyle in the number and character of the haptors (referring to posthaptor clamps) and in the spinose genital pore. A comparative study of this worm with two close microcotylid species (see page 32) suggests that Pearse's statement is unfounded. In fact, M. poronoti MacCallum, 1915, from Poronotus triacanthus is very similar to M. peprili in the characters mentioned by Pearse. Both appear strikingly similar in structure and numbers of body parts, but as mentioned previously, more extensive collections of both species are necessary to clarify this problem.

Microcotyle pomatomi Goto, 1900, given elsewhere as 1899

(Figs. 18 - 20)

Synonym: Microcotyle sp. of Linton, 1905

Host: Pomatomus saltatrix (Linn) bluefish, a nerito-pelagic marine pomatomid.

Location: Gills

Previously reported host and localities: Pomatomus saltatrix from Newport, Rhode Island, Woods Hole, Mass. (Goto, 1900); Beaufort, N. C. (Linton, 1905), (Pearse, 1949); "off Port Aransas, Texas" (Koratha, 1955); and Alligator Harbor, Florida (Hargis, 1957a).

Number studied: 13

Number measured: 11

Redescription: Body elongate, fusiform, flattened dorsoventrally, (9) 4.2 (2.4 - 5.8), S.D. = 1.07 long by (11) 0.7 (0.4 - 1.1), S.D. = 0.24 wide. Posterior third of body a tapering opisthaptor bearing about 55 pairs of clamps in two rows. Cuticle thin and smooth. Prohaptor a pair of biloculate, ovoid, buccal suckers, (3) 0.06 by 0.05 placed ventrolaterally in the buccal funnel. Cephalic glands, 0.03 by 0.02, anterior end of prohaptor. Opisthaptor a long, narrowing cotylophore armed with numerous clamps in two equal rows, (4) (31 to 77 pairs). Clamps similar in shape, slightly dissimilar in size. All clamps, (20) 0.05 (0.04 - 0.06), S.D. = 0.01 long by 0.05 (0.03 - 0.06), S.D. = 0.01 wide. Clamps typically microcotylid in framework. No anchors present in adult. Mouth subterminal. Pharynx ovate, 0.07 long by 0.04 wide, esophagus broad, 0.31 long by 0.03 wide, extending just posterior to genital atrium. Gut bifurcated, crura ramified slightly medially and laterally, rami bifurcated, long, unramified posterior

ends of crura fusing at peduncle and continuing as a blind caecum almost to end of cotylophore. Testes follicular, (6) 37 (24 - 47) in number, usually ovoid, between intestinal crura postequatorially; vas deferens wide, sinuous, 2.66 long by 0.07 wide running dorsal in midline to anterior end. Cirrus not observed. Genital pore midventral, near anterior end, opening into the genital atrium, 0.17 long by 0.04 wide, which is armed with numerous slightly curved conical spines. Two rows of spines, (17) $\tilde{x}$ = 16 (12 - 21) in number extend posteromedially from lateral expansions of the atrium. Ovary pretesticular, dorsal to vitelline reservoir, long, folded, 1.46 long by 0.07 wide, oviduct running posteriorly from right hand side. Ootype weakly fusiform, dorsal and posterior to vitelline reservoir; uterus, 2.65 long by 0.01 wide, ventral in midline, running anteriorly to genital atrium. Genito-intestinal canal, 0.24 long by 0.02 wide, proceeding from right crus, fusing with oviduct medially. Vaginal pore round, diameter 0.02, opening mid-dorsally a distance of 0.2 mm from posterior of genital atrium. Vaginal ducts not observed. Mehlis gland present. Vitellaria follicular, near intestinal crura, extending from just posterior to genital atrium to region level with posterior of testes, few follicles on cotylophore; transverse vitelloducts, (4) 0.23 long by 0.02 wide, fusing medially to form equatorial Y-shaped vitelline reservoir, (2) 0.15 long by 0.04 wide, lying anteroventral to testes. Egg "in utero" ovoid, 0.14 by 0.05, filaments at both ends. No sclerites noticed on

rims of buccal suckers.

Discussion: Detailed study of specimens in this collection and a review of existing literature affirmed the identity of these monogeneids as Microcotyle pomatomi. This redescription was made because the original description of Goto (1900) was incomplete.

Hargis (1957a) noted that: (1) cotylophore of relaxed specimens more elongate and rectangular than described by Goto (1900); (2) buccal suckers armed with small conical sclerites on the rims; (3) genital spines with constant shapes and (4) clamps arranged in two parallel rows on cotylophore. The present material generally confirms Hargis' description but differs in lacking conical sclerites on the buccal suckers. This difference is probably not specifically significant.

The following structures were not mentioned by earlier workers: biloculate suckers; Mehlis' glands; cephalic glands and ducts; intestine bilaterally symmetrical in terminal portion (Goto stated that one side of intestine was longer); genital atrium spines slightly recurved but with constant shapes. The division of the vaginal canal as described by Goto was not observed in this study. Linton's description (1905) involved much larger specimens; body length, 7.5 by 2.0 wide. This overall greater size may possibly account for the large number of clamps (90 - 100 pairs) and testes lobes (50). However, a study of Linton's specimens and fresh specimens from his collection area and statistical comparison with those from Chesapeake Bay and other

localities is necessary before these differences can be evaluated.

Microcotyle pomatomi appears very similar to M. poronoti and M. peprili. Statistical analysis of body parts was employed to explore possible relationships between the three flukes (see discussion page 32). This new locality is intermediate to the previous ones--Woods Hole, (Mass.), Beaufort, North Carolina, and the Gulf of Mexico.

Microcotyle stenotomi Goto, 1899

Host: Stenotomus chrysops (Linnaeus) northern porgy, a bentho-littoral marine sparid.

Location: Gills

Previously reported host and localities: Stenotomus chrysops from Woods Hole, Mass. (Linton, 1940); and Newport, Rhode Island (Goto, 1899).

Number studied: 3

Discussion: This species is in need of a complete redescription. Goto (1900) published a superficial account of the parasite, neglecting all measurements except body length and an approximation of the numbers of atrium spines and haptoral clamps (refered to as "minute suckers"). Goto's drawing of the specimen lacks detail and clarity. Linton (1940) added a few anatomical measurements but made no improvements over the original drawings.

This parasite is very similar in appearance to M. poronoti and M. peprili in the following characters: body length and width; biloculate suckers; spines in two rows, posteromedially to genital atrium. It appears more closely related to M. poronoti in pharynx length, egg size, and number of clamps. The testicular lobes may be larger and reduced in number in comparison to the above mentioned microcotylids. Statistical tests coupled with a redescription of this worm may verify the suggested close relationship between these three monogeneids.

This new locality record extends the known range of this species from Woods Hole, Mass., to lower Chesapeake Bay.

Subfamily Axininae Monticelli 1903, sensu Hargis 1956c

Hargis (1956c) reinstated the subfamily Axininae Monticelli, 1903, on the basis of the following characteristics: (1) cotylophore laterally asymmetrical, (2) embryonically posterior end lateral in mature specimens, (3) anchors retained by adults and (4) general triangular body shape. Though this emendation is warranted there are many characteristics which affirm the close relationship between Microcotylinae and Axininae. These general similarities are: (1) the arrangement of internal organs (2) anchor shape and (3) structure of the basic clamp sclerites.

Though extensively studied and discussed by Hargis (1956c) this subfamily requires additional study. Many species should be redescribed.

Genus Axinoides Yamaguti 1938, sensu Hargis 1956c

Type species: Axinoides tylosuri Yamaguti, 1938. Hargis (1956c) emended the genus Axinoides and separated it from the similar genus Axine Abildgaard, 1794. The writer adopts the emendations made by Hargis.

Axinoides gracilis (Linton, 1940), Sproston, 1946

Host: Tylosurus marinus (Walbaum), needlefish, a nerito-pelagic marine belonid.

Location: Gills

Previously reported host and localities: Tylosurus marina [= Strongylura marina] from Woods Hole, Mass. and Alligator Harbor, Florida.

Number studied: 2

Discussion: Review of existing literature and a study of specimens of Axinoides gracilis, Alligator Harbor, Florida, indicates that the two specimens in this collection are conspecific with Linton's (1940) species.

The presence of two pairs of anchors at the embryonic region of opisthaptor and the muscular, unarmed cirrus observed by Hargis (1956c) was confirmed. The poor condition of the two flukes found in Chesapeake Bay limits further discussion. This species needs redescription from adequate material.

Because Axinoides gracilis has been reported in three separate localities from the same host species and no other it seems

safe to consider it as species-specific according to the terminology of Hargis (1957c).

Suborder Polyopisthocotylea Odhner, 1912

Superfamily Diclidophoridea Price, 1936

Family Gastrocotylidae (Price, 1943) sensu Hargis, 1956b

Hargis, 1956b, revived and emended the family Gastrocotylidae Price, 1943. The writer accepts Gastrocotylidae, Price, 1943, as a separate family.

Subfamily Gastrocotylinae (Sproston, 1946), sensu Hargis, 1956

The gastrocotylinid genera found thus far in Chesapeake Bay are: Scomberocotyle Hargis, 1956; Pseudaxine Perona and Perugia, 1890; Lithidocotyle (Sproston, 1946) Hargis, 1956; and Thoracocotyle (MacCallum, 1913) Hargis, 1956.

Genus Scomberocotyle, Hargis 1956

Scomberocotyle was erected by Hargis (1956b) to accommodate the type species S. scomberomori (Koratha, 1955) Hargis, 1956. Because this species differs in several taxonomically important structures from the microcotylinid genus Heteraxine wherein Koratha originally placed it the writer agrees with Hargis' recombination. Scomberocotyle, Hargis appears to be most closely related to the genus Pseudaxine Parona and Perugia, 1890. However, it differs in the following characters: (1) opisthaptor more angular (2) clamps arranged

in two unequal, lateral rows, (3) details of clamp center place (4) cirrus armed with numerous long spines and (5) genital atrium not armed with genital corona.

Scomberocotyle scomberomori (Koratha, 1955) Hargis, 1956

Host: Scomberomorus maculatus (Mitchill), Spanish mackerel, a neritopelagic marine ecombrid.

Location: Gills

Locality: Lower Chesapeake Bay

Number studied: 1

Previously reported hosts and localities: Scomberomorus maculatus and S. cavalla from Alligator Harbor, Florida; Tampa Bay, Pinellas Co. Florida (Hargis, 1956) and S. maculatus "off Port Aransas" Texas (Koratha, 1955).

Discussion: A study of Hargis' specimens (1956b), the individual in the present collection and the literature involved indicates the conspecificity of this species with Scomberocotyle scomberomori (Koratha, 1955).

The chief difference between the specimens in the two collections is the posttion of the larval end. Scomberocotyle scomberomori of the present collection possesses an opisthaptor directed to the left, the anchors and flask-shaped cuticular pieces located on the extreme left tip. Specimens from Alligator Harbor, Florida, (Hargis, 1956b) exhibit the opposite condition, the opisthaptor or larval end lying to the right of the body. This is not unusual however, because in many

asymmetrical monogeneids the direction of haptor asymmetry may be either right or left but the relative positions of the internal organs remain constant. The present specimen is essentially similar morphologically to those of Hargis (1956) but the "giant nucleus" between the crura on the haptor of Florida forms was not seen. Chesapeake Bay is the most northern geographic range recorded to date.

Pseudaxine mexicana Meserve, 1938

(Fig. 32)

Host: Scomberomorus maculatus (Mitchill), Spanish mackerel, a neritopelagic marine scombrid.

Location: Gills

Previously reported hosts and localities: Scomberomorus maculatus, Tangola-Tangola, Mexico (Pacific) S. maculatus and S. cavalla from Alligator Harbor, Florida and Grande Isle, Louisiana (Hargis, 1956), and S. maculatus "off Port Aransas", Texas.

Number studied: 3

Discussion: A comparison of Hargis' (1956b) specimens with the specimens in this collection and a review of existing literature show these forms to be conspecific with Pseudaxine mexicana Meserve, 1938. This species is in need of complete redescription. Although this redescription is not possible because of the poor quality of the present material, some additional notations are possible. The clamps possess five or six

accessory wall sclerites (not mentioned by Hargis). The testes are irregular in shape but not longer than broad as suggested by Meserve (1938). A pair of bottle-shaped sclerites is present on opisthaptor medially to anchors. The buccal suckers are uniloculate, not bilocuate as shown by Meserve though as seen above in Scomberocotyle scombero-cotyle, this may vary between collections. P. mexicana also exhibits asymmetrical development of the opisthaptor, however, position of internal organs remains constant.

Hargis (1959) studied Koratha's specimen, holotype U.S.N.M. Helm. Coll. No. 54758 and questioned the validity of Pseudaxine texana Koratha, 1955, stating that this form is probably a synonym of P. mexicana Meserve, 1938.

Two fish hosts: Scomberomorus maculatus and S. cavalla are parasitized by P. mexicana. This probably reflects the close relationship between scombrid hosts.

Lithidocotyle acanthophallus (MacCallum and MacCallum, 1913) Sproston, 1946

Synonyms: Lithidocotyle acanthophallus on gills of Roccus lineatus MacCallum and MacCallum, 1913, Sproston, 1946, Microcotyle acanthophallus of Meserve 1938, L. acanthophallus, Hargis, 1956b.

Host: Scomberomorus maculatus (Mitchill), Spanish mackerel, a nerito-pelagic marine scombrid.

Location: Gills

Previously reported hosts and localities: Roccus saxatilis (Walbaum) [=R. lineatus] from N. Y. fish market or Atlantic Ocean (MacCallum and MacCallum); Scomberomorus cavalla (Cuvier and Valenciennes) and S. maculatus (Mitchell) from Alligator Harbor and Tampa Bay, Florida and Grande Isle, La. (Hargis, 1956b).

Number studied: 5

Discussion: A study of Hargis' specimens from Florida and a review of the literature verified the specific determination of these forms.

The present study confirms Hargis' (1956) report on the following characters: (1) clamp skeleton gastrocotylid with asymmetrical clamp sclerites; middorsal, muscular vaginal pore; terminal anchors present in adult, but no small larval anchors were found on the anterior portion of the opisthaptors of specimens from Chesapeake Bay.

A single specimen of the type species L. acanthophallus MacCallum and MacCallum (1913) was reported as occurring on Roccus saxatilis (= R. lineatus). Because there is strong evidence that the host came from a New York fish market or the N. Y. Aquarium where parasites could easily transfer from one species to another, Hargis (1956b) concluded that R. lineatus was an unnatural host. This conclusion seems justified because no specimens have been reported from R. lineatus since 1913 even though many have been recovered from

Scomberomorus maculatus from Gulf of Mexico and Chesapeake Bay and S. cavalla of Gulf of Mexico.

Koratha (1955) erected a new species, Microcotyle scomberomori, which appears very similar to Lithidocotyle acanthophallus. Further studies of Koratha's holotype and a redescription of L. acanthophallus will be necessary before any definite statements can be made concerning conspecificity of these forms.

Locality records for this monogeneid now include N. Y. fish market (Atlantic ocean); Alligator Harbor, Florida; Tampa Bay, Florida; Grande Isle, La.; and Chesapeake Bay.

Lithidocotyle acanthophallus (MacCallum and MacCallum 1913) Sproston 1946

Synonyms: (see immediately above)

Host: Pomatomus saltatrix (Linnaeus), bluefish, a nerito-pelagic marine pomatomid.

Previously reported hosts and localities: S. maculatus (Mitchell) from Alligator Harbor and Tampa Bay, Florida; and Grande Isle, La., Hargis (1956b).

Location: Gills

Number studied: 7

Discussion: Until now the only reliable host records for L. acanthophallus were the Spanish and King mackerels. This record from Pomatomus saltatrix, a fish of an entirely different family (Pomatomidae), is so

unusual that it should be discussed separately. Hargis and Koratha reported 27 specimens from S. maculatus and 70 from S. cavalla. The present collection includes five specimens from S. maculatus. Though Hargis and Koratha also took bluefish they found no specimens of L. acanthophallus. It seems therefore, that scombrids are the primary hosts. However, a few more (7) were taken from bluefish than from mackerel gills in the present study and it seems unlikely that they were accidental transfers in the fishing gear or sampling containers. Bluefish are voracious predators and it is possible that they can acquire an infestation from their prey--scombrids in this case.

Although a detailed study of this monogeneid was not carried out in the present study it appears certain that Lithidocotyle acanthophallus from both Scomberomorus maculatus and Pomatomus saltatrix are conspecific.

Genus Thoracocotyle MacCallum, 1913, diag. emend.

Diagnosis: Gastrocotylinae. Diagnosis the same as Hargis' (1956) except for the following change: testes situated in the "foot" mediodorsal to the clamp rows. Ovaries and other genitalia situated in the posterior region of the "neck" and not in the "foot" as described earlier.

Thoracocotyle crocea MacCallum 1913

(Figs. 28 - 31)

Synonyms: Thoracocotyle croceus MacCallum, 1913, a spelling synonym

of Sproston (1946), T. paradoxica Meserve, 1938, Hargis (1954) and probably T. paradoxica Pearse (1949).

Host: Scomberomorus maculatus (Mitchell) Spanish mackerel, a nerito-pelagic marine scombrid.

Location: Gills

Previously reported hosts and localities: Scomberomorus maculatus from the New York Aquarium, (MacCallum, 1913); Tangola-Tangola, Mexico (Meserve, 1938); S. cavalla (probably) from Beaufort, N. C. (Pearse, 1949); and S. cavalla from Alligator Harbor, Florida (Hargis, 1956).

Number studied: 90

Number measured: 30

Redescription: Body elongate, 3.5 (2.2 - 4.4), S.D. = 0.49, by 0.4 (0.2 - 0.6), S.D. = 0.09 wide, cuticle fairly thick, transparent. Anterior end slightly flattened dorsoventrally; posterior end dorsoventrally asymmetrical forming two distinct body regions. Opisthaptor, 2.8 (1.8 - 3.0), S.D. = 0.08 long by 0.4 (0.3 - 0.6), S.D. = 0.08 wide, a cotylophore bearing two rows (15 pairs) of sessile clamps; gastrocotylid in structure, but modified, permanently open and appear to function as suckers instead of clamps. Rib-like accessory sclerites with a sculptured center piece. Ventral loop incomplete medially. Clamps dissimilar in size, middle clamps large, (31) 0.173 (0.099 - 0.224), S.D. = 0.03 long by (31) 0.145 (0.086 - 0.198), S.D. = 0.03 wide.

Anterior and posterior clamps smaller than middle, (62) 0.118 (0.060 - 0.198), S.D. = 0.03 long by (62) 0.102 (0.036 - 0.152), S.D. = 0.03 wide. Two pairs of anchors on the terminal lappet, outer, anterior pair longer, relatively straight with short recurved points, (37) 0.049 (0.043 - 0.053), S.D. = 0.003 long, middle, posterior pair, sickle-shaped, (37) 0.019 (0.017 - 0.019), S.D. = 0.01 long. Mouth ventral, approximately subterminal, (3) 0.09 by 0.07. Buccal suckers anterolateral, without septa, (2) 0.08 by 0.05. Pharynx ovate, (2) 0.05 by 0.04. Esophagus 0.7 long by 0.01 wide, bifrucates posterior to genital pore. Gut extends length of body, ramifying into posthaptor. Cephalic glands just posterior to genital atrium, vesicle, 0,05, duct, 0.89 long by 0.01 wide. Excretory pores, one pair, anterior to junction of intestine, opening laterally, ducts, 0.06 long. Genital pore anteroventral, unarmed. Seminal vesicle, 1.4 long by 0.2 wide, median, twisting length of body, joining testes dorsal and posterior to vitelline reservoir, and entering genital pore near anterior end. Testes smooth, follicular, 11 - 13 in number, (3) 0.84 long by 0.15 wide, a single row situated in dorsoanterior section of posthaptor. Cirrus, 0.08 by 0.02, muscular, unarmed and protrusible. Ovary U-shaped, 0.82 long by 0.04 wide, inverted, twisting in posterodorsal part of body; oviduct running ventrally from right lobe, 0.7 long by 0.003 wide, to common anteroventral genital pore. Muscular vaginal pore 0.01 in diameter, posteroventral to cirrus. Vaginal duct not observed. Vitellaria follicular, near intestinal crura, extending

from level posterior to vaginal pore through entire length of posthaptor; transverse vitelloducts, (2) 0.15 long by 0.01 wide fusing ventrally to form Y-shaped vitelline reservoir, 0.7 long by 0.04 wide. Genito-intestinal canal, 0.3 by 0.01, parallel to vitelloduct, ventral, crossing over ovary to right intestinal crus. Egg in utero fusiform, 0.2 by 0.1, terminal filaments present.

Discussion: A study of Hargis' (1956a) specimens from Florida, the forms in the present collection and the literature involved, indicates the conspecificity of present specimens with Thoracocotyle crocea MacCallum (1913), U.S.N.M. Helm. Coll. slide No. 35588. This redescription was prompted by the lack of detail and apparent confusion regarding its internal anatomy.

Previous workers studied extremely few specimens: Meserve, one and a half worms; and MacCallum, a "few specimens." In contrast, the large number of individuals from several areas available for the present study enabled the author to cover a wider range of measurements and counts and evaluate averages and respective ranges.

Slight variation is noted in linear measurements of body parts reported by past workers. Body length and width of MacCallum's specimens are larger than those of Chesapeake Bay forms. MacCallum reported eighteen to twenty pairs of posthaptor suckers and Meserve (1938) listed fourteen pairs while the flukes in the present collection

average fifteen pairs. Suckers from Meserve's (1938) forms are slightly smaller than those described herein and the posthaptor anchors also show some variation in size. Meserve stated that the testes were lobulate (giving seven as the number of lobes) while MacCallum considered them as merely indented. The author considers the testes as follicular with the number of follicles varying between eleven and thirteen in number in present material. The ovaries and other genitalia described herein are not located in the "foot" or posthaptor as suggested by previous workers but are situated in the posterior region of the "neck" (posterior section of the body proper). This change in internal displacement might be due to geographic variation or variability in fixation (ours were relaxed). Study of specimens from varying localities should clarify this matter.

OCCURRENCE OF MONOGENEIDS ON THEIR HOSTS

Table 2 deals with the occurrence of monogeneids on Chesapeake Bay fishes. Two phases of the problem are discussed: (1) Incidence of infection or the percentage of parasites per total number of hosts observed and (2) Intensity of infection or the average number of parasites obtained from infected hosts.

In the family Monocotylidae *M. diademalis* was encountered on 20 per cent of the *Dasyatis say* and on 50 per cent *D. americana*. Hargis (1957c) found that *M. diademalis* (Gulf of Mexico) occurred on *D.* spp. (*D. say* or *americana*) (100 per cent) and on *D.*

sabina (55 per cent). The small numbers of hosts in both collections make it impossible to draw conclusions concerning this incidence of infection.

In Chesapeake Bay, M. pricei occurred on 60 per cent of the D. say. In the Gulf of Mexico it occurred on D. say (40 per cent) and D. americana (75 per cent). Because so few hosts were observed and M. pricei was not found on D. americana during the study, additional collections are necessary to evaluate the incidence of infection in dasyatids.

In the family Mazocraeidae both Mazocraeoides georgei and Clupeocotyle brevoortia occurred on 52 per cent of the Brevoortia tyrannus examined. In contrast M. georgei from the Gulf of Mexico infected only 33 per cent of B. patronus and C. brevoortia only 30 per cent. Thus incidence of infection appears higher for Chesapeake Bay hosts than for those from the Gulf of Mexico.

The incidence of infection of stromateid fishes by the microcotylids, M. poronoti and M. peprili, is slightly different. Four of seventeen Poronotus triacanthus (24 per cent) were parasitized by the former while four of eleven Peprilus alepidotus (36 per cent) bore the latter. As mentioned earlier stromateid fishes appear similar to each other in ecological habits. The two microcotylids in question also appear similar in general appearance and in average degrees of intensity of parasitism. These close similarities of the two parasites spp. possibly reflect the close relationship between hosts.

The incidence of infection in Scomberomorus maculatus varies significantly between the three gastrocotylid species Scomberocotyle scomberomori (8 per cent), Pseudaxine mexicana (17 per cent) Lithidocotyle acanthophallus (25 per cent) and Thoracocotyle crocea (50 per cent). Intensity of infection also increases from S. scomberomori to T. crocea on the one host S. maculatus.

Lithidocotyle acanthophallus occurred on 25 per cent of the Pomatomus saltatrix studied. Twenty-five per cent of the S. maculatus were parasitized by the same fluke. Hargis (1957c) showed that L. acanthophallus occurred on 50 per cent of the S. maculatus and 100 per cent of S. cavalla from Gulf of Mexico and none on P. saltatrix. Little can be said about the significance of the incidence of infection of L. acanthophallus on its hosts pending results of more extensive future collections of all hosts.

As was stated above the intensity of infection is concerned with the average number of parasites occurring on infected hosts (table 2 , column 5). Bychowsky (1957) suggested that parasites occurring on a number of hosts are more numerous on a particular host. He employed the terms "basic" and "secondary" hosts in reference to the varying intensities of parasitism, with the host harboring the greater numbers of a species of fluke regarded as the original and basic host.

There is some confusion in the literature concerning the meanings of the terms "basic host" and "secondary host."

Possibly "basic" could apply to that host which harbors the greatest numbers of a particular species of parasite or parhaps it could be restricted to that host which is the oldest phylogenetically. However, the two are not necessarily the same and it is conceivable that a parasite occuring initially on one host species may, given an opportunity, infect a new host in greater numbers. The new host may even offer a more suitable environment than the older host. However, because of the small number of hosts involved if is not feasible to designate "basic" hosts in this study. Some cases may be cited as examples.

The monocotylids studied herein occur solely on the family Dasyatidae. M. diademalis was encountered on D. say (2.0 per host) and on D. americana (11.0 per host). In the Gulf of Mexico (Hargis 1957c) M. diademalis occurred on D. sabina (2.7 per host) and on D. sp. (D. say or americana) (3.0 per host). Within the family Dasyatidae it appears as though D. americana, Chesapeake Bay and D. sp. (D. say or americana) Gulf of Mexico were the "basic" hosts, however, such an inference should be substantiated by additional collections of the fishes involved.

In Chesapeake Bay M. pricei occurred on D. say in the number of 5.0 per host and in the Gulf of Mexico on D. say (13.0 per host) and D. americana (17.7 per host). Though the intensity of infection was greater on D. americana in the Gulf of Mexico it did not occur on this host species in Chesapeake Bay. Since only two specimens of D. americana were examined in this collection no conclusion can be

drawn regarding the intensity of parasitism by this monocotylid.

The clupeid Brevoortia tyrannus harbored two parasites, Mazocraeoides georgei (8.9 per host) and Clupeocotyle brevoortia (2.2 per host). Closely related B. patronus of the Gulf of Mexico bore M. georgei (1.8 per host) and C. brevoortia (2.2 per host). Thus the intensity of infection of the two parasites was greater on B. tyrannus than on B. patronus. The former may be the "basic" host for both parasites, however, more material must be collected to affirm this.

Intensity of parasitism by Lithidocotyle acanthophallus on different host families is an example of a possible "basic" host. In Chesapeake Bay L. acanthophallus occurred on Scomberomorus maculatus (1.7 per host) and on Pomatomus saltatrix (3.5 per host). On the basic of this pattern of intensity of infection it might be inferred that P. saltatrix is the "basic" host, however, Meserve (1938) and Hargis (1957c) reported this form only from scombrid fishes. In the Gulf of Mexico intensity of infection on S. maculatus was 2.5 per host and on S. cavalla 35.0 per host. Thus Gulf of Mexico mackerels are more heavily infected than those from Chesapeake Bay. No specimens of L. acanthophallus occurred on P. saltatrix in the Gulf of Mexico. As suggested elsewhere, infestation of the bluefish may be due to its predatory habits and therefore it cannot be regarded as a "basic" host. New and careful collections should be made of all fishes in both areas. MacCallum and MacCallum's (1913) reported occurrence of Lithidocotyle

acanthophallus (one specimen) on Roccus saxatilis is disregarded since the source of material (N. Y. fish market) and recovery of only one fluke raises serious doubts concerning the validity of considering this fish as a "natural" host.

Of the gastrocotylids occurring on Scomberomorus maculatus, Thoracocotyle crocea occurred in greater numbers (15 per host) than any of the other three species studied. Thoracocotyle crocea may be better adapted to its host than any of the other three gastroocotylid spp. reported above.

Incidence of infection was discussed for Monogenea on their respective hosts from Chesapeake Bay in table 2. The small numbers of hosts observed limit possible conclusions concerning the percentage of the parasites on their hosts. Generally speaking related Monogenea were found on fishes which are phylogenetically related with each other.

The intensity of infection was considered in the discussion of average numbers of parasites occurring on individual host species wherein the terms "basic" and "secondary" host were employed. The small numbers of hosts used limit conclusions regarding "basic" hosts; however, infection of the family Dasyatidae by the monocotylids and the scombrid S. maculatus by L. acanthophallus are cited as possible examples of "basic" hosts. Detailed studies of occurrence of monogeneids on all their known hosts will provide better understanding of incidence and intensity of infection of these forms.

The discussion of occurrence of monogeneids on their hosts supports the findings reported in Bychowsky (1957).

HOST SPECIFICITY

Monogenea from Chesapeake Bay are found to be strongly specific to their particular hosts (table 3). Bychowsky (1933), MacCallum (1913 and 1915), and Baer (1951) have discussed many features of this host-parasite relationship. Workers such as Hargis (1953 - 1957), Koratha (1955a), Llewellyn (1956), Malmberg (1956), and Bychowsky (1957) have recently attempted to evaluate reports on distribution of parasites among their specific fish hosts. Prior to the present work no attempt had been made to study this phenomenon in Chesapeake Bay fishes.

Parasites listed in the table of host-specificity (table 3) were gathered from fishes taken during this study. Six hundred and seven flukes belonging to eighteen monogeneid species were recovered from 116 host specimens belonging to thirteen fish species. In only two cases individual worms appeared on "unnatural" hosts. In both instances further checking of the data showed that the two "natural" and "unnatural" hosts had been confined for some time in the same fishing gear prior to sampling. Because the parasites could have transferred to the "unnatural" hosts these records are not included in the table.

Host collections and examination of gill material were carefully handled to avoid unreliable host records. Only fresh host material was used and the gills were excised within a relatively short

time after capture of the host. Specimen bottles were labelled and parasites processed separately to enable checking in the case of suspected "unnatural" host occurrence and to help determine numbers of individuals per host.

Results of the present work suggests that hosts from Chesapeake Bay could be identified to species by observing the Monogenea from the branchial material, ventral surface or nasal fossae collected from several individuals of each host species.

The terms infraspecificity and supraspecificity, redefined by Hargis (1957) to clarify earlier definitions by the same author (1954, 1955a) are employed in this discussion.

Infraspecificity is defined as the phenomenon of the occurrence of a single monogeneid species on members of a single fish taxon. The auxiliary terms species-specificity, genus-specificity, etc., as discussed by Hargis, may be applied where a single monogeneid species is restricted to one host species, to several congeneric hosts, etc.

Supraspecificity, the counterpart of infraspecificity is the restriction of a natural group of monogeneid species to a natural grouping of fish species. This connotes the presence of monogeneids of any supraspecific taxon, subgenus, genus, subfamily, etc., on the members of any supraspecific category of fishes. Hargis noted that the limits and significant value of supraspecificity were vague, however, it was sufficiently noticeable to justify analysis of

material collected from Alligator Harbor, Florida. Material collected in Chesapeake Bay verify Hargis' findings and, therefore, may be treated in similar fashion.

Infraspecificity

Sixteen (16) species or 88.9 per cent of the present collection of Monogenea are species-specific. Only two species, 11.1 per cent parasitized two host species. One of these monogeneids Lithidocotyle acanthophallus infests host species belonging to two separate families, Scombridae and Pomatomidae but of the same order Percomorphi. This deviates from past observations (Hargis, 1957) where this form was confined to a single fish family. A check of the data shows that there was scant possibility of transfer between the parasites of the two hosts in the fishing gear prior to removal of the gills. On two occasions the "unusual host" Pomatomus saltatrix was captured while Scomberomorus maculatus, the common host, was not present in the catch. Members of the Scombridae and Pomatomidae exhibit similar ecological habits. These plagic fishes are migratory and congregate in schools. Their ranges extend along the east coast of the Americas from Maine to Brazil. Their movements in Chesapeake Bay are strikingly similar--P. saltatrix arrives in March or April while S. maculatus enters the Bay in May or June. September is the departure time for both forms. S. maculatus is believed to spawn in lower Chesapeake Bay during late spring or summer. Little is known about

spawning habits of the pomatomids but it is believed that they spawn offshore in the summer, interrupting their inshore visit for this purpose. Therefore, it is unlikely that this common infection can occur on the spawning grounds as is often the case with other monogeneids. However, P. saltatrix is a voracious predator and is known to attack schools of mackerel, menhaden, alewives and other species of fish. Probably the bluefish obtained the parasites from their prey, the mackerels. Thus P. saltatrix may be considered a natural but not the "common or usual" host for Lithidocotyle acanthophallus. This should be verified by additional collections.

Superfamily Capsaloidea

Family Monocotylidae: The monocotylids reported in this study occurred on members of the order Batoidea (subclass Elasmobranchii). Three monogeneids in the table are shown to be species-specific, the fourth, M. diademalis is genus-specific. Hargis (1957c) showed that similar species from the Gulf of Mexico are genus-specific and infest two or more members of the Batoidea. Future collections of this host group from the Bay area may reveal a similar genus-specific pattern among these monocotylids.

Family Capsalidae: The single capsalid species was collected from a member of the order Batoidea. Capsalids also parasitize some selachians and large teleosts. It has been suggested by several authors (Jahn and Kuhn 1932, Sproston 1946, Hargis 1957) that worms parasitizing

the skin and fins may be less specific than more internal ones.

Supraspecificity

The following section deals with supraspecificity patterns observed at the family level in table 3. Relationships exhibited by many Gulf of Mexico monogeneids (Hargis 1955b and Koratha 1955) are very similar to those shown by Chesapeake Bay forms.

Suborder Polyopisthocotylea

Superfamily Diclidophoroidea

All diclidophoroidids reported herein occur on fishes of the subclass Teleostomi. This is the same pattern as observed by Hargis (1957c) and indicates a supraspecific type of infestation.

Family Mazocraeidae: Two mazocraeids discussed in this work were recovered from members of the family Clupeidae, order Isospondyli. Other workers have reported flukes of this family from other clupeids and from scombrid fishes of the family Scombridae, order Percomorphi. Both host families are in the subclass Teleostomi. Hargis (1957) suggested that this pattern of infestation could probably have developed as a result of the use of small pelagic clupeids as food fishes by scombrids. Thus, the predators may have historically obtained the original mazocraeid parasites from their prey. This mechanism has been suggested by Bychowsky (1957) to explain certain monogeneids which are found mainly on fresh-water cyprinids (food fishes) but also on pike (predator). However, no species presently parasitic on clupeids has

ever been reported from scombrids and it is suggested that speciation may have taken place among mazocraeids which parasitize scombrids since their acquisition from the prey species--the clupeids.

Family Discocotylidae: Members of this family are confined to hosts of the order Percomorphi. Here supraspecificity involves two host families, Carangidae and Sciaenidae which are closely related phylogenetically.

Family Microcotylidae: The five microcotylids studied occur solely on members of the orders Synentognathi and Percomorphi. A review of the literature shows that numerous members of the subfamily Microcotylinae infest percomorph fishes.

Family Gastrocotylidae: The four gastrocotylids listed herein were found on the two host families Scombridae and Pomatomidae of the order Percomorphi. Jordan (1923) suggested that the mackerels and bluefishes were closely related phylogenetically. Also, as mentioned above, pomatomids may acquire their parasites through preying on other fishes. Since both families are pelagic fishes this supraspecificity may be due to ecological relationships.

Supraspecificity as defined by Hargis (1957c) is divided into two phases: rigid and non-rigid. Rigid supraspecificity is defined as the occurrence of most of the members of two or more related parasite groups on the members of two or more related fish groups, with a separate monogeneid group on each fish group and intermediate connections between the parasite groups. An example in this study is

the restriction of the superfamily Diclidophoroidea to members of the host subclass Teleostomi. Hargis suggested that rigid supraspecificity is largely phylogenetic in nature and can be used as an aid in determination of the hosts' phylogenetic relationships.

Non-rigid supraspecificity is the occurrence of scattered, isolated members e.g. species, genera, of a larger monogeneid taxon on members of two or more host groups which are not phylogenetically closely related. These patterns are possible indications of ecological relationships and cannot be regarded as phylogenetic in origin. The occurrence of mazocraeids on members of the families Clupeidae and Scombridae is an example of non-rigid supraspecificity. The predator-prey relationship between the scombrids and clupeids probably accounts for the occurrence of Mazocraeids on their branchial structures.

Parasite transfers between ecologically related hosts limits the application of host-specificity patterns in the understanding of host phylogeny. Previous studies by Bychowsky (1933) Hargis (1953b, 1954, 1955a, and 1958) and work reported herein suggests that much evaluation remains before limitations of this phenomenon can be clearly understood.

CONCLUSION

The discussion and table 3 of the present paper demonstrates that a high degree of host-specificity exists among the monogenetic trematodes studied and supports conclusions concerning the

specificity of marine monogeneids reached by earlier workers.

The deviation from infraspecificity exhibited by L. acanthophallus on both Scomberomorus maculatus and Pomatomus saltatrix in Chesapeake Bay is an exception to the several patterns observed by Hargis. However, as was suggested, this sharing of a single species by two distant hosts is probably based on ecological factors. More extensive studies of life histories, physiology, zoogeography and ecology of both parasites and hosts are needed in order to clarify specificity patterns.

SUMMARY

Eighteen species of Monogenea from the genera Monocotyle Taschenberg, 1878; Empruthotrema Johnston and Tiegs, 1922; Loimopapillosum Hargis, 1956b; Benedenia Diesing, 1858; Tagia Sproston, 1946; Bicotylophora Price, 1936; Clupeocotyle Hargis, 1955; Mazocraeoides Price, 1936; Microcotyle van Beneden and Hesse, 1863; Axinoides Yamaguti, 1938; Gastrocotyle van Beneden and Hesse, 1863; Scomberocotyle Hargis, 1956; Lithidocotyle Sproston, 1946; Thoracocotyle MacCallum, 1913; were recovered from Chesapeake Bay hosts and are reported and discussed in this paper.

Seven species of Monogenea have been re-described and four species are reported as occurring on new hosts.

Statistical methods were applied in comparative studies and the standard deviation was included with the usual measurements of

mean and range. A new locality record is established for all the forms mentioned herein.

In the discussion of specificity it was concluded that monogeneids studied herein are very host specific; the species Lithidocotyle acanthophallus being the only form which parasitized hosts in two different fish families.

An analysis of occurrence of monogeneids on their hosts suggests that evaluation of "incidence" and "intensity" of infection might aid in determining basic host-specificity relationships and provide further clues to the phylogeny of the Monogenea and their fish hosts.

LITERATURE CITED

BIGELOW, HENRY B. and WILLIAM C. SCHROEDER. 1953. Fishes of the western North Atlantic. Sawfishes, guitarfishes, skates, rays, and chimaeroids. Mem. 1, Part 11. Sears Found. Mar. Res. xv + 588 pp.

_____ _____ 1953. Fishes of the Gulf of Maine. U. S. Fish and Wildlife Service Fish. Bull. 74. viii + 577 pp. (Contr. 592, Woods Hole Oceanogr. Inst.)

BREDER, CHARLES M. JR. 1948. Field book of marine fishes of the Atlantic Coast from Laborador to Texas. Putnam, New York. xxxvii + 332 pp.

BYCHOWSKY, B. E. 1957. Monogeneticheskie sosalshchiki ikh sistema i filogeniia. [Monogenetic trematodes their systematics and phylogeny.] Akad. Nauk SSSR Zool. Inst. Moscow-Laningrad. 509 pp.

COOPER, A. R. 1915. Trematodes from marine and freshwater fishes, including one species of ectoparasitic tubellarian. Trans. Roy. Soc. Canada, Sec. IV, 9: 181-205.

GOTO, SEITARO 1900. Notes on some exotic species of ectoparasitic trematodes. Jour. Coll. Sci. Tokyo 12: 263-295.

HARGIS, WILLIAM J. JR. 1953. Chloretone as a trematode relaxer, and its use in mass-collecting techniques. Jour. Parasitol. 39: 224-225.

_____ 1954. An annotated list of terms useful for studies of monogenetic trematodes. Mimeographed and distributed by the author. 6 pp.

_____ 1955a. Monogenetic trematodes of Gulf of Mexico fishes. Part IV. The superfamily Capsaloidea Price, 1936. Rev. Iberica Parasitol. Vol. Extr. 1955: 1-16.

_____ 1955b. Monogenetic trematodes of Gulf of Mexico fishes. Part V. The superfamily Capsaloidea. Trans. Amer. Micr. Soc. 74: 203 - 225.

_____ 1955c. Monogenetic trematodes of Gulf of Mexico fishes. Part VI. The superfamilies Polystomatoidea Price, 1936, and Diclidophoroidea, Price, 1936. Trans. Amer. Micr. Soc. 74: 361-377.

_____ 1955d. Monogenetic trematodes of Gulf of Mexico fishes. Part VII. The superfamily Diclidophoroidea, Price, 1936. Quart. Jour. Florida Acad. Sci. 18: 113-119.

_____ 1955e. Monogenetic trematodes of Gulf of Mexico fishes. Part IX. The family Diclidophoroidae Fuhrmann, 1928. Trans. Amer. Micr. Soc. 74: 377-388.

_____ 1956a. Monogenetic trematodes of Gulf of Mexico Fishes. Part VIII. The superfamily Diclidophoroidea, Price, 1936 (continued). Proc. Helm. Soc. Washington 23: 5-13.

_____ 1956b. Monogenetic trematodes of Gulf of Mexico Fishes.

Part XII. The family Gastrocotylidae Price, 1943. Bull. Mar. Sci. Gulf and Caribbean 6: 28-43.

_____ 1956c. Monogenetic trematodes of Gulf of Mexico fishes. Part XI. The family Microcotylidae Taschenberg, 1879 (continued). Proc. Helm. Soc. Washington 23: 153-162.

_____ 1957a. Monogenetic trematodes of Gulf of Mexico fishes. Part X. The family Microcotylidae Taschenberg, 1879. Trans. Amer. Micr. Soc. 74: 436-453.

_____ 1957b. Monogenetic trematodes of Gulf of Mexico fishes. Part XIII. The family Gastrocotylidae Price, 1943 (continued). Trans. Amer. Micr. Soc. 76: 1-12.

_____ 1957c. The host-specificity of monogenetic trematodes. Exper. Parasitol. 6: 610-625.

_____ 1959. Systematic notes on the monogenetic trematodes. Proc. Helm. Soc. Washington 26: 14-31.

HEDGPETH, JOEL W. 1957. Classification of marine environments. Geol. Soc. Amer. Mem. 67, Vol. 1. Ecology, pp. 17-28.

HILDEBRAND, SAMUEL F. AND WILLIAM C. SCHROEDER. 1928. Fishes of Chesapeake Bay. Bull. U. S. Bur. Fish. 43, Pt. 1. 366 pp.

KORATHA, KUNNENKERI J. 1955a. Studies on the monogenetic trematodes of the texas coast. 1. Results of a survey of marine fishes at Port Aransas, with a review of

Monogenea reported from the Gulf of Mexico and notes on euryhalinity, host-specificity, and relationship of the remora and cobia. Publ. Inst. Mar. Sci. Univ. Texas 4: 233-250.

_____ 1955. Studies on the monogenetic trematodes of the Texas coast. II. Descriptions of species from marine fishes from Port Aransas. Publ. Inst. Mar. Sci. Univ. Texas 4: 253-278.

LINTON, EDWIN 1905. Parasites of fishes of Beaufort, North Carolina. Bull. U. S. Bur. Fish. 24: 321-428.

_____ 1940. Trematodes from fishes mainly from the Woods Hole region, Mass. Proc. U. S. Natl. Mus. 88: 1-172.

LLEWELLYN, J. 1956. The adhesive mechanisms of monogenetic trematodes: The attachment of Plectonocotyle gurnardi (v. Ben. and Hesse) to the gills of Trigla. J. Mar. Biol. Ass. U. K. 35: 507-514.

_____ 1957. The mechanism of the attachment of Kuhnia scombri (Kuhn 1829) (Trematoda: Monogenea) to the gills of its host Scomber scombrus L., including a note on the taxonomy of the parasite. Jour. Parasitol. 47: 30-39.

MacCALLUM, G. A. 1913. Further notes on the genus Microcotyle. Zool. Jahrb. Jena Abt. Syst. 35: 389-402.

_____ 1913. Thorocotyle croceus nov. gen., nov. sp. Zentralbl. Bakt. Abt. 68: 335-337.

_____ 1915. Notes on the genus Microcotyle. Zool. Jahrb. Jena. Abt. Syst. 38: 71-78.

_____ 1916. Some new species of parasitic trematodes from marine fishes. Zoopathologica 1: 3-38.

_____ and W. G. MacCallum. 1913. Four species of Microcotyle, M. pyragraphorus, M. marcroura, M. eueides and M. acanthophallus. Zool. Jahrb. Jena Abt. Syst. 34: 223-244.

MESERVE, F. G. 1938. Some monogenetic trematodes from the Galapagos Islands and the neighboring Pacific. Rept. Allan Hancock Pacific Exped. 2: 31 - 89.

PEARSE, A. S. 1949. Observations on flatworms and nemerteans collected at Beaufort, N. S. Proc. U. S. Natl. Mus. 100: 25-38.

PRICE, E. W. 1936. North American monogenetic trematodes. George Washington Univ. Bull. (Summ. Doctoral Theses 1934-36): 10-13.

SNEDECOR, GEORGE W. 1957. Statistical methods. 5th ed. Iowa State College Press, Ames, Iowa. xiii + 534 pp.

SPROSTON, NORA G. 1946. A synopsis of the monogenetic trematodes. Trans. Zool. Soc. London 25: 185-600.

SROUFE, STANLEY A. JR. 1958. Mazocraeoides olentangiensis, n. sp., a monogenetic trematode parasitic on the gills of the gizzard shad, Dorosoma cepedianum (LeSueur). Jour. Parasitol. 44: 643-646.

WESTMAN, J. R. and R. F. NIGRELLI. 1955. Preliminary studies of menhaden and their mass mortalities in Long Island and New Jersey waters. New York Fish and Game Jour. 2: 142-153.

Table 2

Infection of Chesapeake Bay Fishes by Monogeneids

Parasite on Host	Number of fishes examined	Number infected	Incidence of infection	Number of parasites	Average Intensity of parasitism per host
Monocotyle diademalis on Dasyatis say	5	1	20	2	2.0
Monocotyle diademalis on Dasyatis americana	2	1	50	11	11.0
Monocotyle pricei on Dasyatis say	5	3	60	15	5.0
Empruthotrema raiae on Raja eglanteria	2	2	100	2	1.0
Loimopapillosum dasyatis on Dasyatis say	5	3	60	17	5.7
Benedenia posterocolpa on Rhinoptera quadriloba	7	2	29	9	4.5
Clupeocotyle brevoortia on Brevoortia tyrannus	27	14	52	31	2.2
Mazocraeoides georgei on Brevoortia tyrannus	27	14	52	125	8.9
Tagia bairdiella on Bairdiella chrysura	8	1	10	1	1.0
Bicotylophora trachinoti on Trachinotus carolinus	7	5	71	256	51.2
Microcotyle poronoti on Poronotus triacanthus	17	4	24	14	3.5
Microcotyle peprili on Peprilus alepidotus	11	4	36	10	2.5
Microcotyle pomatomi on Pomatomus saltatrix	8	5	63	13	2.6
Microcotyle stenotomi on Stenotomus chrysops	9	3	33	3	1.0
Axinoides gracilis on Tylosurus marinus	1	1	100	2	2.0
Scomberocotyle scomberomori on Scomberomorus maculatus	12	1	8	1	1.0
Pseudaxine mexicana on Scomberomorus maculatus	12	2	17	3	1.5
Lithidocotyle acanthophallus on Scomberomorus maculatus	12	3	25	5	1.7
Lithidocotyle acanthophallus on Pomatomus saltatrix	8	2	25	7	3.5
Thoracocotyle crocea on Scomberomorus maculatus	12	6	50	90	15.0

Table 3

TABLE OF HOST-SPECIFICITY

Class	Subclass	Order	Hosts (rows) / Parasites (columns)	Number of Individuals	MONOPISTHOCOTYLEA CAPSALOIDEA MONOCOTYLIDAE MONOCOTYLINAE Monocotyle diadematis	Monocotyle pricei	MERIZOCOTYLINAE Empruthotrema raiae	LOIMOINAE Loimopapillosum dasyatis	CAPSALIDAE BENEDENIINAE Benedenia posterocolpa	POLYOPISTHOCOTYLEA DICLIDOPHOROIDEA MAZOCRAEIDAE Clupeocotyle brevoortia	Mazocraeoides georgei	DISCOCOTYLIDAE ANTHOCOTYLINAE Tagia bairdiella	Bicotylophora trachinoti	MICROCOTYLIDAE MICROCOTYLINAE Microcotyle poronoti	Microcotyle peprili	Microcotyle pomatomi	Microcotyle stenotomi	AXININAE Axinoides gracilis	GASTROCOTYLIDAE GASTROCOTYLINAE Scomberocotyle scomberomori	Pseudaxine mexicana	Lithidocotyle acanthophallus	Thoracocotyle crocea
			Number of Individuals		13	15	2	17	9	31	125	1	256	14	10	13	3	2	1	3	12	90
CHONDRICHTHYES	ELASMOBRANCHII	BATOIDEA	RAJIDAE																			
			Raja eglanteria	2			x															
			DASYATIDAE																			
			Dasyatis say	5	2	x																
			Dasyatis americana	2	11			x														
			RHINOPTERIDAE																			
			Rhinoptera quadriloba	7					x													
OSTEICHTHYES	TELEOSTOMI	ISOSPONDYLI	CLUPEIDAE																			
			Brevoortia tyrannus	27						x	x											
		SYNENTOGNATHI	BELONIDAE																			
			Tylosurus marinus	1														x				
		PERCOMORPHI	SCOMBRIDAE																			
			Scomberomorus maculatus	12															x	x	5	x
			STROMATEIDAE																			
			Poronotus triacanthus	17										x								
			Peprilus alepidotus	11											x							
			CARANGIDAE																			
			Trachinotus carolinus	7									x									
			POMATOMIDAE																			
			Pomatomus saltatrix	8												x					7	
			SPARIDAE																			
			Stenotomus chrysops	9													x					
			SCIAENIDAE																			
			Bairdiella chrysura	8								x										
TOTALS			Individuals	116																		
			Species	13																		

TOTALS (Parasites): Individuals 617; Species 18

Graphic symbols used in legends of plates

Structure	Symbol
eggs in utero	egg oval shaped
genito-intestinal canal	clear duct leading from vitelline reservoir to right crus
intestine	clear area, outlined by vitelline bodies
ovary	ova ⊙
testes	posterior region of body S-shaped ∫∫
uterus	straight, clear duct, mid-ventral region, extending from vitelline reservoir anterior to genital pore
vas deferens	wide, clear duct convoluing dorso-anteriorly to genital atrium
vitelline bodies	stippled, scattered cells
vitelline reservoir and ducts	Y-shaped, heavily stippled

Plate 1

Clupeocotyle brevoortia Hargis 1955

Figs.

1 Whole mount, ventral view

2 Terminal lappet showing anchors

3 Clamp, ventral view

4 Genital corona

Mazocraeoides georgei Price 1936

Figs.

5 Whole mount, ventral view

6 Genital corona

7 Enlargement of anchors on posterior end

8 Clamp, ventral view, open

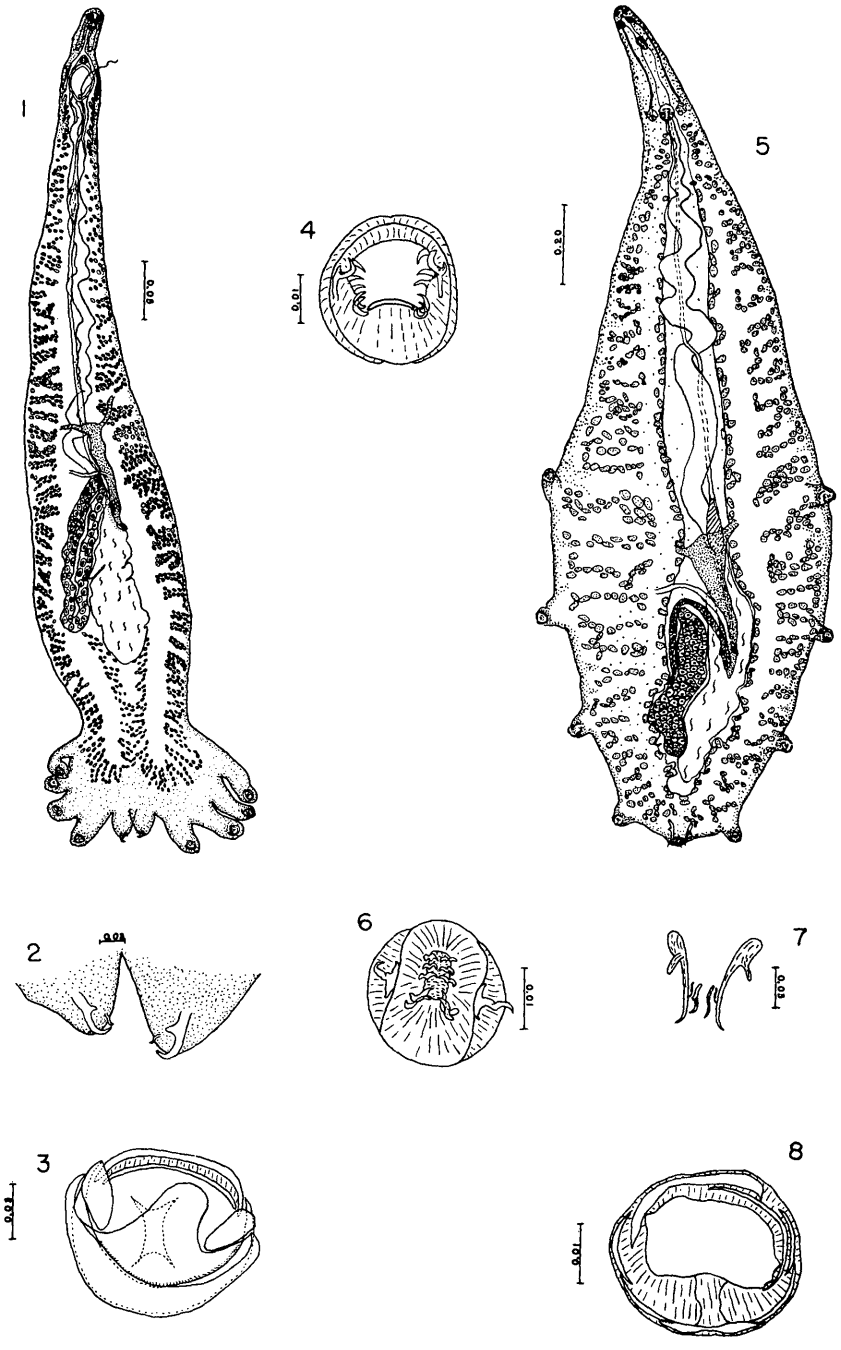
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Plate 2

Bicotylophora trachinoti (MacCallum 1921) Price, 1936

Figs.

9 Whole mount, ventral view

10 Genital corona

11 Lateral view of dorsal vaginal pore

12 Dorsal view of enlarged vaginal pore

13 Clamp, ventral view

14 Anterolateral genital spine

15 Mediolateral genital spine

16 Posterolateral genital spine

17 Anteromedial genital spine.

Microcotyle pomatomi Goto, 1900

Figs.

18 Whole mount, ventral view

19 Genital corona

20 Clamp, ventral view

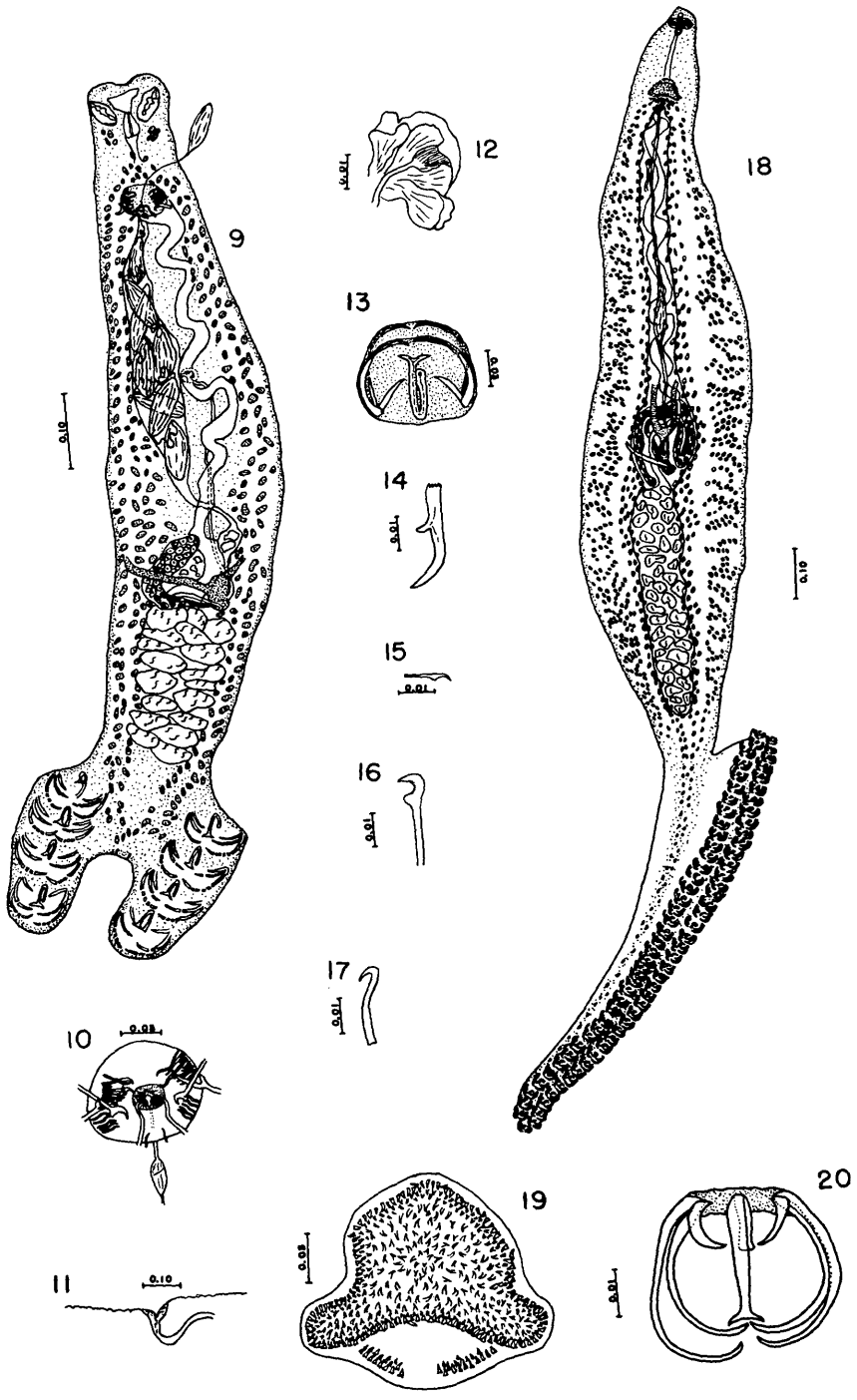
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Plate 3

Microcotyle poronoti MacCallum 1915

Figs.

21 Whole mount, ventral view

22 Clamp, ventral view

23 Genital corona

24 Armed opening posteroventral to genital corona (see also fig. 27--*M. peprili*)

Microcotyle peprili Pearse, 1949

Figs.

25 Whole mount, ventral view

26 Clamp, ventral view

27 Genital corona

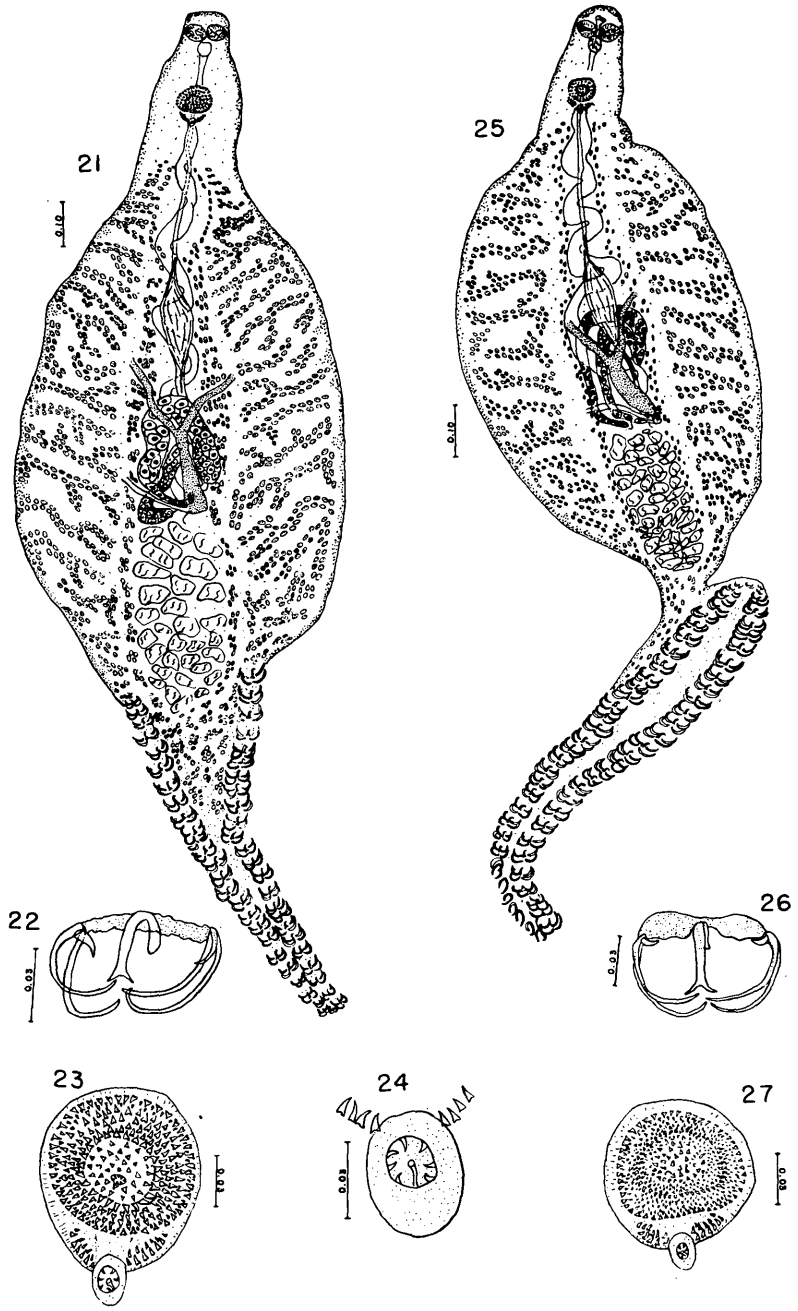
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Plate 4

Thoracocotyle crocea MacCallum, 1913

Figs.

28 Whole mount, ventral view

29 Clamp, ventral view

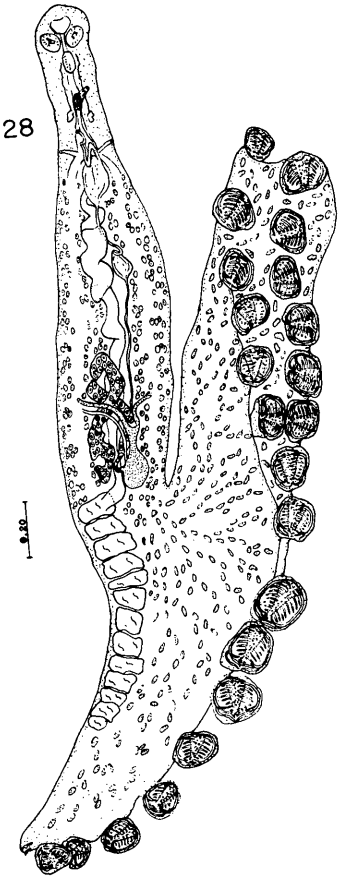
30 Enlargement of posteroventral anchors

31 Enlargement of posterodorsal anchors

Pseudaxine mexicana Meserve 1938

Fig.

32 Clamp, ventral view, showing accessory sclerites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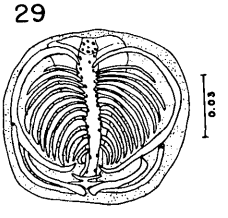
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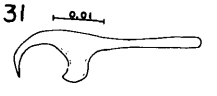
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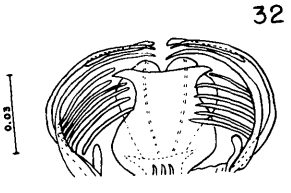
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