13.

Studies on the Genus *Hirudinella*, Giant Trematodes of Scombriform Fishes.

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(Plates I-VIII).

Introduction.

Nigrelli and Stunkard (1937) reported giant trematodes from the "wahoo," *Acanthocybium solandri;* they were referred without specific identification to the *Distoma clavatum* group of the Hemiuridae. These trematodes belong to the genus *Hirudinella* which Dollfus (1932) named as type of a new family in the Hemiuroidea. Members of *Hirudinella* infect fishes of the sub-order Scombroidei, in particular those of the family Scombridae, and a large number of species have been described. These parasites have been known for more than 200 years; with *Fasciola hepatica* and *Haplometra cylindracea* (Zeder, 1800), they are among the oldest known trematodes. Yet knowledge of the group is very incomplete and there is no agreement concerning the number of species or their differential diagnoses. This situation may be explained by several obvious facts: (1) the hosts are oceanic fishes which range through all tropical and temperate seas; (2) relatively few individuals have been recovered from any single host; (3) the location of the parasites, which usually occur in the stomach but have been found also in the intestine, on the gills and free in the plankton; (4) the early reports were made before there was any adequate knowledge of trematode morphology and consist merely of accounts of size and shape; and (5) the enormous size of the worms and their powerfully muscular bodies, which on contraction may assume unusual shapes and greatly modify the arrangement of internal structures. Combinations of these several features have made it difficult to measure individual variation or to form a definite concept of specific limitations.

Historical accounts of the genus and lists of species were given by Poirier (1885), Moniez (1886, 1891), Blanchard (1891), Buttel-Reepen (1902) and Mühlschlag (1914). More recent papers include those of Manter (1926, 1940), Dollfus (1932, 1940), Chandler (1937), Guiart (1938) and Yamaguti (1938).

The earlier accounts were so inadequate that it is quite impossible to recognize the species from the descriptions and often the hosts were not designated or were listed by vernacular names which make positive identification difficult and uncertain. Many of the original specimens are no longer available and those that have been studied were in such poor condition that they contributed little to knowledge of the species. Moreover, the usual method of redescribing a species, by collecting new material from type hosts and localities, is quite inapplicable since the life cycles of the parasites are unknown, there is no assurance of host-parasite specificity, and the final hosts (the only ones known) have no type locality. As noted by earlier authors and discussed by Chandler (1937, p. 353), the features which have been used to distinguish species may be influenced very markedly by age, by different states of contraction and by different methods of preparation. As stated by Chandler, satisfactory studies can be made only on serial sections, which impose a difficult and tedious task. There is, accordingly, no adequate basis for recognizing the many species that have been included in the "*Distomum clavatum*" group of trematodes. A list of these species and their hosts is included in Table I.

Material and Methods.

During the past ten years, the writers have examined 56 specimens of *Hirudinella* taken from 9 different species of scombriform fishes from both the Atlantic and Pacific oceans. The specimens were studied by various methods; alive, as whole mounts, in serial sections or by needle dissections. We are indebted to Dr. William Beebe, Dr. Charles Breder, Jr., Dr. G. M. Smith, Dr. N. R. Stoll, John Tee-Van, Francesca LaMonte and W. W. Doxee for material collected on different expeditions. Through the kindness of Dr. William Beebe and Dr. A. C. Chandler, we have had the opportunity to study the slides of *H. beebei* Chandler, 1937, prepared by Professor Chandler. Most of the material came from *Acanthocybium*

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TABLE I.

List of Species of *Hirudinella.*

Species	Host	Locality
1. *Hirudinella marina* Garcin[1], 1730	*Scomber pelamys*	Atlantic
2. *Fasciola ventricosa* Pallas, 1774	Host not given	Amboyna
Distomum ventricosum (Pallas) Monticelli	.....	.....
D. ventricosum of the following		
Braun, 1893	.....	.....
Stossich, 1900	*Pimelepterus* (*Kyphosus*)	.....
H. ventricosa (Pallas) Baird, 1853	.....	.....
3. *Fasciola clavata* Menzies, 1791	*Scomber pelamys*	Pacific
D. clavatum of the following:		
Baird, 1853	.....	.....
Barbagallo and Drago, 1903	*Pelamys sarda*	Catania
Beneden, van, 1870	*Thynnus vulgaris*	Atlantic
Le Billardière, 1801	.....	.....
Blanchard, R., 1891	*Thynnus vulgaris*	Atlantic
	Pelamys sarda	Atlantic
Brandes, 1891	*Pelamys sarda*	.....
Braun, 1892, 1893a, b, c	.....	.....
Buttel-Reepen, 1900, 1902, 1904, 1905	.....	.....
Carus, 1884	.....	.....
Chatin, 1887	.....	.....
Cobbold, 1860	.....	.....
1867	*Xiphias gladius*	Atlantic
1879	.....	.....
Cooper, 1915	*Thunnus thynnus*	Atlantic
Creplin, 1837	.....	.....
Darr, 1902	"Diamantfisch"	.....
Diesing, 1850	*Pelamys sarda*	Atlantic
	Thynnus vulgaris	.....
	Coryphaena hippuris	Brazil
1859	.....	.....
Dujardin, 1845	.....	.....
Goto, 1891	.....	.....
Jackson, 1888	.....	.....
Jaegerskiold, 1900	.....	.....
Jourdan, 1881	*Thynnus*	Atlantic
Juel, 1889	.....	.....
Krøyer, 1838-1840	*Thynnus vulgaris*	Atlantic
Lander, 1904	.....	.....
Linton, 1898	*Thunnus thynnus*	Atlantic
1901	*Xiphias gladius*	Atlantic
Looss, 1894, 1895, 1896, 1899	.....	.....
Moniez, 1892	.....	.....
Monticelli, 1888, 1893	.....	.....
Olfers, 1816	.....	.....
Osbeck, 1765	.....	.....
Owen, 1835, 1837	.....	.....
Parona, 1887	.....	.....
Poirier, 1885	Ocean bonito (*S. pelamis*)	Atlantic & Pacific
Rudolphi, 1808	.....	.....
Shipley, 1910	*Coryphaena hippuris*	Atlantic
Siebold, von, 1835	.....	.....
Stiles, 1901	.....	.....
Stossich, 1886	.....	.....
Wagener, 1860	.....	.....
Ziegler, 1905	.....	.....
H. clavata (Menzies, 1791) Blainville, 1828	.....	.....
H. clavata (Menzies) of Manter, 1940	*Gymnosarda alletterata*	Galapagos (Pacific)

[1] Also spelled Garsin and Garzin in papers of later authors.

	Species	Host	Locality
4.	*Fasciola fusca* Bosc, 1802	"Dorade" (*Coryphaena hippuris*)	Atlantic
	Distoma fuscum (Bosc) Poirier, 1885	.....	.....
	D. fuscum of the following:		
	Braun, 1893	.....	.....
	Buttel-Reepen, 1902	.....	.....
	Mühlschlag, 1914	.....	.....
	H. fusca (Bosc, 1802) Dollfus, 1932	.....	.....
	H. fusca (Poirier, 1885) Manter, 1926	*Xiphias gladius*	Atlantic
	H. fusca of the following:		
	Guiart, 1938	"Germon" (tuna)	Atlantic
	Legendre, 1940	*Thunnus thynnus*	Atlantic
	Linton, 1940	*Thunnus secundodorsalis*	Atlantic
		Trachurops crumenophthalma	Atlantic
		Trichurus lepturus	Atlantic
		Xiphias gladius	Atlantic
5.	*Fasciola coryphaenae* Bosc, 1802	*Coryphaena hippuris*	Atlantic
	F. coryphaenae hippuridis Tilesius (*in litteris*, Rudolphi, 1809)	.....	.....
	Distoma coryphaenae (Bosc) Rudolphi	.....	.....
6.	*Fasciola scombri pelamidis* Tilesius (*in litteris*, Rudolphi, 1809)	*Scomber pelamis*	Atlantic
7.	*Distoma heurteli* Poirier, 1885	*Thynnus vulgaris*	.....
8.	*Distoma dactylipherum* Poirier, 1885	"un Argonaute d'espèce indeterminée."	Indian Ocean
9.	*Distoma verrucosum* Poirier, 1885	*Thunnus* sp.	Atlantic
	D. verrucosum of the following:		
	Braun, 1892	.....	.....
	Jaegerskiold, 1900	.....	.....
	Lander, 1904	.....	.....
10.	*Distoma personatum* Poirier, 1885	.....	Gulf of Mexico
	D. personatum of the following:		
	Buttel-Reepen, 1902	.....	.....
	Darr, 1902	.....	.....
	Loennberg, 1891	.....	.....
11.	*Distoma pallasii* Poirier, 1885 (*D. ventricosum* of Pallas renamed)	*Delphinus phocaena* (Dolphin)	"Indies"
	D. pallasii of the following:		
	Braun, 1892	.....	.....
	Buttel-Reepen, 1902	.....	.....
	Darr, 1902	.....	.....
	Stossich, 1892	*Phocaena communis* (Porpoise)	Indian Ocean
12.	*Distoma ingens* Moniez, 1886	.....	.....
	D. ingens of the following:		
	Blanchard, 1888	.....	.....
	Braun, 1889, 1892, 1893	.....	.....
	Buttel-Reepen, 1900, 1902	.....	.....
	Hoyle, 1890	.....	.....
	Monticelli, 1888	.....	.....
	H. ingens (Moniez) Darr, 1902	.....	.....
	H. ingens of the following:		
	Mühlschlag, 1914	Albicore	South Atlantic
		Fish	Indian Ocean
13.	*Distoma poirieri* Moniez, 1891	.....	.....
	H. poirieri (Moniez) Dollfus, 1935	"Germon" (*Thynnus alalonga*)	Atlantic
14.	*Distoma siemersi* Buttel-Reepen, 1900	*Sphyraena barracuda*	Atlantic
	D. siemersi of the following:		
	Buttel-Reepen, 1902, 1904, 1905	.....	.....
	Darr, 1902	.....	.....

Species	Host	Locality
15. *Distoma ampullaceum* Buttel-Reepen, 1900	*Coryphaena* sp.	Indian Ocean
D. ampullaceum of the following:		
Buttel-Reepen, 1902, 1904, 1905	.....	.....
Darr, 1902	.....	.....
Mühlschlag, 1914	.....	.....
16. *Hirudinella beebei* Chandler, 1937	*Acanthocybium petus*	Atlantic
H. beebei of the following:		
Manter, 1940	*Acanthocybium solandri*	Pacific
17. *Hirudinella spinulosa* Yamaguti, 1938	*Thynnus alalonga*	Pacific
18. *Hirudinella oxysoma* Guiart, 1938	"Germon" (*Thynnus alalonga*)	Atlantic
H. oxysoma of the following:		
Dollfus, 1940		
(Dollfus incorrectly spelled the name *oxystoma*).	*Thunnus thynnus*	Mediterranean
19. *Hirudinella phalloidea* Guiart, 1938	*Coryphaena hippuris*	Atlantic
20. *Hirudinella bonnacouri* Guiart, 1938 (*D. fuscum* Poirier, 1885 renamed)	.....	.....

spp. from both Atlantic and Pacific, although we have made no attempt to distinguish between *A. solandri* (Cuvier and Valenciennes) and *A. petus* (Poey) since there is some doubt whether these names represent two distinct species. Our collection of *Hirudinella,* though limited, is probably the largest yet assembled and has provided the basis for an extended study of the genus, while comparison of our specimens with accounts in the literature permits a consideration of morphological features and specific determinations. Pertinent data on collection, and size of worms are presented in Tables II-V.

In the absence of information concerning the life cycle, host-parasite specificity and/or the possible influence of development in different fish hosts, the limits of specific variation can not be determined with certainty. It is impossible at present to characterize any species of *Hirudinella* completely or even adequately. This fact, however, does not justify the naming of a new species for a specimen which manifests some variation from previously published accounts. The size at which sexual maturity is attained may be a valid specific character, but it it possible that maturity may develop at different sizes in different hosts. It is possible, also, that in different hosts the same species may differ in the ultimate size attained and in the delicacy or coarseness of the various organs, e.g., one may compare gravid specimens of *Fasciola hepatica* from the livers of a guinea pig, a rabbit and a cow. As in many other trematode genera, egg-size in *Hirudinella* is too variable to serve as a reliable specific character. In general, as noted by Moniez (1891), the size of eggs is correlated with the size of the worm.

Our data indicate that the large, thick-bellied worms from *Acanthocybium* (Figs. 1-20, Tables II & III) which become gravid at a length of approximately 17 mm. and may attain a length of 70 mm., belong to one species which we identify as *H. ventricosa* (Pallas, 1774). Study of the morphology has disclosed no feature of difference that can not be explained by differences in degree of development or of muscular contraction. Length of a specimen is not a valid indication of size or degree of maturity as a specimen may extend to more than five times its contracted length. The specimen listed as Cat. No. 7 (Plate I, Fig. 1) was alive when removed from the stomach of a "wahoo" flown to the New York Aquarium. Extended, it measured 170 mm. long by 30 mm. wide and it contracted to a length of only 40 mm. It was purplish in color and the cuticula was so transparent that the internal organs were visible when the worm was compressed between glass plates. When the worm was held up by the anterior end, the cecal contents passed to the posterior end which swelled in balloon-like fashion. When placed in 10% formalin it contracted vigorously and when fixed it measured 98 by 40 mm. with dermal rugae and the shape characteristic of other worms from *Acanthocybium.*

Whether the worms from other fishes represent a different species can not be determined with certainty. With the exception of the two specimens from *Katasuwonus pelamis* taken at Bermuda (Cat. No. 10, Fig. 11) which were immature and may belong to *H. ventricosa,* they are smaller, differ in shape and in the position of the acetabulum, attain sexual maturity at a smaller size, have less powerful suckers and body walls and presumably belong to a dif-

TABLE II.

Hirudinella from *Acanthocybium.*

Cat. No.	Collector	No. of Specimens	Locality	Figure
1	Beebe	2	Long Key, Florida	9-10
2a	Beebe	2	Bermuda	...
2b	Beebe	5	Bermuda	4
2c	Beebe	1	Bermuda	...
2d	Beebe	2	Bermuda	5-6
3	Beebe (*Antares* Exp., 1933)	2	Pearl Island, Panama (Pacific)	...
4	Beebe (Templeton Crocker Exp.)	2	Mexico (Pacific) Clarion Island	7-8
5a	Breder (*Atlantis* Exp.)	4	Yucatan, (Atlantic)	3
5b	Breder	2	La Plata Islands, Equador (Pacific)	...
5c	Breder	3	Equador (Pacific)	...
6	Smith	6	Bermuda	...
7	Erl Roman Formerly of Miami Herald through Miss F. LaMonte	1	Bimini (Atlantic)	1
8	Stoll[2]	1	Marianas Islands (Pacific)	2

[2] The host was listed as a "King Mackerel," possibly *Acanthocybium.*

ferent species. All of them appear to belong to a single species which we identify as *H. marina* Garcin.

Hirudinella marina Garcin[3], 1730.
(Plate VII, Tables IV and V).

Fasciola clavata Menzies, 1791.
Distoma clavatum (Menzies, 1791) Rudolphi, 1808.
Hirudinella clavata (Menzies, 1791) Blainville, 1828.
Fasciola coryphaenae Bosc, 1802.
Distoma coryphaenae (Bosc, 1802) Rudolphi, 1808.
Fasciola fusca Bosc, 1802.
Distoma fuscum (Bosc, 1802) Poirier, 1885.
Hirudinella fusca (Bosc, 1802) Dollfus, 1932.
Hirudinella fusca (Poirier, 1885) Manter, 1926.
Hirundinella bonnacouri Guiart, 1938.
Fasciola coryphaenae hippuridis Tilesius in Rudolphi, 1809.
Fasciola scombri-pelamidis Tilesius in Rudolphi, 1809.
Distomum dactylipherum Poirier, 1885.
Distomum heurteli Poirier, 1885.
Distomum verrucosum Poirier, 1885.
Distoma poirieri Moniez, 1891.
Hirudinella poirieri (Moniez, 1891) Dollfus, 1935.
Distoma siemersi Buttel-Reepen, 1900.

[3] Name spelled Garsin and Garzin by subsequent authors.

Hirudinella spinulosa Yamaguti, 1938.
Hirudinella oxysoma Guiart, 1938.
Hirudinella phalloidea Guiart, 1938.

Hirudinella ventricosa (Pallas, 1774) Baird, 1853.
(Plates I-VI, Tables II and III).

Fasciola ventricosa Pallas, 1774.
Distomum ventricosum (Pallas, 1774) Monticelli, 1893.
Distomum clavatum of Owen, 1834.
Distomum pallasii Poirier, 1885.
Distomum personatum Poirier, 1885.
Distoma ingens Moniez, 1886.
Distomum ingens of Mühlschlag, 1914.
Distomum ampullaceum Buttel-Reepen, 1900.
Hirudinella beebei Chandler, 1937.

Discussion.

The first of the giant trematodes from the stomach of scombriform fishes was found in *Scomber pelamys* of the Atlantic and was described by Garcin (1730), who named the parasite *Hirudinella marina.* His description was accompanied by a figure of the worm and supplemented by a second report, Garcin (1732), with a plate and 3 additional figures. The description is admittedly inadequate but was as good as that of many later specific descriptions that have been universally accepted. Pallas (1774) described a similar but larger and more robust parasite from an unnamed host in the Malay Archipelago and designated

TABLE III.

Some Measurements of *Hirudinella* from *Acanthocybium*.
(In millimeters, except eggs, which are in microns).

Cat. No.	Length	Greatest Width	Width at Acetabulum	Diameter Acetabulum	Diameter Oral Sucker	O.S. to G.P.	Eggs
1	58	22	13	7	3	5	35 × 23
	33	24	14	5.5 × 7.5	2.5	4	34 × 23
							(See Fig. 20)
2a	38	21	10	4.5 × 5.5	..	4.5	31 × 21.5
	31	19	8	5 × 6	..	3.5	38 × 24
2b	57	23	10	4	2.5	2.5	36 × 25
	31	19	7	6	2	4	32 × 21
	44	19	10	6	2	4	32 × 22
	47	19	10	4 × 5	2	3	31 × 20
	31	19	7	6	3	2	35 × 22
2c	31	21	9	4 × 6	..	3.8	33 × 22
2d	32	20	9	6	..	1.3	34 × 21
	31	21	9	6	..	2	35 × 20
3	26	19	9	4	..	3	35 × 22
	28	17	10	3.5 × 4.5	..	2	35 × 22
4	44	23	10	5.5	4	8	34 × 25
	41	22	11	7	3	8.5	37 × 26
5a	52	sectioned, (mature)					
	50						
	19	whole mount					
	12	sectioned, (immature)					
5b	24	15	8				
	25	12	8				35 × 19.5
5c	31	14.5	9				
	32	18	9				
	32	15.5	8				
6	45	17	7	5	..	6	33 × 25
	44	17	7	7	..	6.5	32 × 23
	36	17	8	3	..	..	32 × 24
	15	9	6	3	..	..	immature
	12	3	2.5	..	..	..	immature
	19	10	..	..	..	..	..
7	98	40	(see description later)				
8	48	18	6	..	..	2	..

it *Fasciola ventricosa*. This species was transferred to the genus *Hirudinella* by Baird (1853) and to *Distoma* by Monticelli (1893). It was deliberately renamed *D. pallasi* by Poirier (1885). Menzies (1791) described specimens from *Scomber pelamys* taken in the Pacific Ocean as *Fasciola clavata*. This species was transferred by Rudolphi (1808) to *Distoma* and by Blainville (1828) to *Hirudinella*. Blainville (1828) designated *F. clavata* as type of the genus *Hirudinella*. Bosc (1802) described material from the "dorade," *Coryphaena hippuris*, taken in the Atlantic, as *Fasciola fusca*. Specimens assigned to this species were described by Poirier (1885) as *Distomum fuscum* and Manter (1926) transferred the *Distomum fuscum* of Poirier to the genus *Hirudinella*. Manter studied specimens from the swordfish, *Xiphias gladius*, which he regarded as identical with those described by Poirier. Dollfus (1932) transferred *F. fusca* of Bosc to *Hirudinella*.

The genus *Hirudinella* Garcin was pre-Linnaean and monotypic. According to Opinion 5 of the International Commission on Zoological Nomenclature, which deals with the "Status of Certain Pre-Linnaean Names Reprinted Subsequent to 1757," "A pre-Linnaean name, ineligible because of its publication prior to 1758, does not become eligible simply by being cited or reprinted with its original diagnosis after 1757. To become eligible under the code, such names must be reinforced by adoption or acceptance by the author publishing the reprint." Concerning *Hirudinella* of Garcin, Blainville (1824) stated specifically, "J'admets ce genre pour les fascioles cylindriques qui ont quelque ressemblance avec les sangsues, et entre autres le *Fasc. clavata* Linn." He later (1828, p. 586) designated *H. clavata* as type of the genus. But Art. 30c of the International Rules of Zoological Nomenclature states, "A genus proposed with a single original species takes that species as

TABLE IV.

Hirudinella from Scombriform Fishes Other Than *Acanthocybium.*

Cat. No.	Collector	No. of Specimens	Host	Locality	Figure
9a	Beebe	1	Black Finned Tuna. *Parathunnus atlanticus* (Lesson)	Bermuda	Similar to Figs. 24-25
9b	Beebe	2	*Parathunnus atlanticus* (Lesson)	Bermuda	Similar to Figs. 24-25
9c	Beebe	4	*Parathunnus atlanticus* (Lesson)	Bermuda	Similar to Figs. 24-25
9d	Beebe	1	*Parathunnus atlanticus* (Lesson)	Bermuda	Similar to Figs. 24-25
9e	Beebe	1	*Parathunnus atlanticus* (Lesson)	Tobago	Similar to Figs. 24-25
10	Beebe	2	Ocean Bonito. *Katsuwonus pelamis* (L.)	Bermuda	11
11	Templeton Crocker Exp. (Beebe)	1	Little Tunny. *Euthynnus alletteratus* (Rafinesque)	C. San Lucas, Lower Calif. Pacific	Similar to 24-25
12	Templeton Crocker Exp. (Beebe)	3	California Yellowfin Tuna. *Neothunnus macropterus* (Temminck & Schlegel)	C. San Lucas, Lower Calif. Pacific	Similar to 24-25
13	Templeton Crocker Exp. (Beebe)	1	Pacific Swordfish. *Nakaira mitsukurii* (Jordan & Snyder)	C. San Lucas Lower Calif. Pacific	23
14	Templeton Crocker Exp. (Beebe)	1	Spanish Mackerel. *Scomberomorus maculatus* Mitchill	Port au Prince Bay Haiti	Similar to 11
15	Doxsee	6	Bluefin Tuna. *Thunnus thynnus* (L.)	Point Lookout, L. I.	24-25

type. (Monotypical genera.) (See opinions Nos. 6, 9, 22, 30, 42, 47)." In his paper Blainville (1824) formally validated the generic name *Hirudinella* and by the rules, *H. marina* must be the type species. Opinions 22 and 30, dealing with similar cases, reaffirm the principle that monotypic genera must retain the original species as type, and that the original type takes precedence over any later designated types. Accordingly, the acceptance by Blainville (1824) of *Hirudinella* as a valid generic name also validated *H. marina* as the type species and his later (1828) designation of *H. clavata* as type can not be accepted. A further attempt to designate a new type species was made by Blanchard (1891). Since *H. marina* Garcin is a pre-Linnaean name, Blanchard proposed that *F. ventricosa* (= *D. ventricosum*), the first post-Linnaean name, be accepted as type of the genus. But application of the International Rules renders Blanchard's proposal also untenable. By the Rules of International Nomenclature, the type of *Hirudinella* is *H. marina. Hirudinella* Gray, 1850, mollusk, and *Hirudinella* Muenster of Diesing, 1850, leech, are untenable homonyms.

Comparison of our material with accounts in the literature shows that most if not all of the previously described species can be referred to one or the other of the two species we recognize. We have studied the sections of *H. beebei* (the species was described from this one specimen) and can not agree with Chandler's interpretation of certain structures. He stated, (1937, p. 350) "Near point where conical anterior part of body joins expanded posterior part, ceca begin branching in extremely complicated manner, with veritable maze of pockets and anastomosing, interlacing branches, which in cross-section give appearance of a reticulum. Near middle of hind-body a rather large expanded central lumen on each side, without much branching on medial sides, but with very complicated lateral and outer walls. As ceca proceed posteriorly they throw off laterally a series of backward-directed divisions, each with its complicated pockets and anastomosing branches. Longest divisions of ceca terminate at extreme posterior end of body" (See Plate VI, Figs. 16-19). While examination of single sections indicates branching and anastomosis of the intestinal ceca with the formation of a reticulum, careful reading of successive sections shows that the walls of the ceca are

TABLE V.

Measurements of *Hirudinella* from Scombriform Fishes Other Than *Acanthocybium.*

Cat. No.	Length	Greatest Width	Width at Acetabulum	Diameter Acetabulum	Eggs
9a	15	5		5 × 4	34 × 23
9b	15	8	5	5	34 × 23
	8.5	2.5			immature
9c	28	6.5	5	5	38 × 23
	9.5	2	1.5		immature
	13	3	3		immature
	13.5	3.5	3.5		immature
9d	15	6	4	4 × 3	38 × 21
9e	17	5.5			immature
10	37	6	2.5	3 × 3	immature
	20	2			immature
11	16	3.5			immature
12	26	8	3.5	3 × 3	33 × 20
	17	5	3.5	5 × 4	35 × 22
	11	4	4	4 × 4	31 × 23
13	17.5	5	4.5	4.5 × 4.5	36 × 21 (see Fig. 21)
14	18	5	3	3 × 3	immature
15	21	6		5 × 4	
	21	5		5 × 4	
	22	5		5 × 4	44 × 26
	19	4		4 × 3	(see Fig. 22)
	19	5		5 × 4	

collapsed in innumerable folds and plications, but that actual branching does not occur. The cavities of the supposed branches are parts of a continuous lumen and study of other specimens shows that when the ceca are filled, the plications disappear (Plate V, Fig. 14). In some of our sections small connections were found between the posterior ends of the ceca and the excretory vesicle and we believe that this condition is characteristic for the genus. None of the intestinal content, however, was observed in the excretory vesicle.

Furthermore, in specimens from both Atlantic and Pacific, which we identify as *H. ventricosa,* the vitelline follicles are intracecal as well as extracecal. As described for *D. ampullaceum* by Buttel-Reepen, (1902, p. 212), "In der obern Partie liegen die Acini meist dicht zusammen (Fig. 28 *dodr*), während sie sich auf Querschnitten durch die untere Partie in dem spärlichen Parenchym überall zerstreut zeigen." Mühlschlag (1914) reported that in both *D. fuscum* and *D. ingens,* the vitellaria are extracecal and extend from the level of the testes to the excretory vesicle. His figure shows the vitellaria in a cross-section taken near the middle of the body and at that level the vitellaria are always extracecal. In discussing the differences between the specimens he identified as *D. ingens* and those described as *D. ampullaceum* by Buttel-Reepen, Mühlschlag (1914) pointed out that they might readily be regarded as identical, and the features he cited to distinguish between them were either minor histological or positional ones that do not commend themselves as truly specific. All may be explained by differences in age, degree of development, functional activity or muscular contraction. Accordingly, the two features on which Chandler distinguished *H. beebei* from *H. ampullaceum* and *H. ingens,* viz., the form of the digestive system and distribution of the vitellaria, appear inadequate. We are unable to discover any sound morphological character or set of characters to separate these species and regard them as identical with *H. ventricosa.*

The various features used by previous authors to determine species of *Hirudinella* include host, size and shape of the digestive ceca and of the excretory bladder, relation of parts of the copulatory organs, presence of dermal rugae and papillae, thickness of the cuticula and body wall, size of suckers and their openings, position of the genital pore, details of histological organization and size of eggs. When these features concern true morphological differences, they constitute the basis for specific distinction, but when they are only manifestitations of different physiological states, they cannot be criteria of specificity.

Study of our material shows that in most cases the reported differences are merely variations that have no specific value. As noted earlier, the hosts of *Hirudinella* are wide-ranging oceanic fishes and Manter

(1940, p. 536), in discussing the trematode parasites of marine fishes, included *H. clavata,* remarked on their wide distribution and stated, "their occurrence in both the Atlantic and Pacific may have no particular significance." In the absence of information concerning life histories, there is no ground for the assumption of host-parasite specificity. The only known life cycle of a marine hemiurid is that of *Lecithaster confusus,* traced by Hunninen and Cable (1943). This species has a cystophorous cercaria which develops into an unencysted metacercaria in the haemocoele of copepods, and adults occur in a large number of marine fishes, including *Scomber scomber.*

The report by Jourdan (1881), discussed by Poirier (1885), that specimens of *Hirudinella* were found on the gills of fishes and free in the floating material of the Sargasso Sea, may not be significant. The worms may survive for considerable time in sea water and if they had migrated or been regurgitated from the stomach, it is not surprising that they were found on the gills of the fishes or on adjacent vegetation. They are normal parasites of the stomach, but the observation of Jourdan may possibly explain the fact that they often occur singly and that so few individuals are present in a host.

These trematodes are enormous, powerfully muscular worms, capable of great variation as different sets of muscles contract; the motility of the preacetabular region was portrayed in the sketches by Garcin (1739); and like other hemiurid trematodes, discussed by Stunkard and Nigrelli (1934), they may be greatly distorted in the process of killing and preserving. This distortion may affect both the external form and the relations of internal structures. If the authors who have described preserved museum specimens had recognized this fact, the literature would not be burdened with several new species proposed on the differences in shape, in appearance of dermal plications, and other results of muscular contraction. The failure to distinguish between true morphological differences and physiological variation is commonplace and even modern authors are not exempt, as may be observed in the following quotation from Guiart (1938, p. 29), "Toutefois il n'existe certainement aucune relation entre ce Distome (*D. ventricosa*) à corps ovalaire lisse et à ventouse ventrale lisse et celui (*H. phalloidea*) que nous allons décrire, qui présents un corps globuleux très fortement plissé et une ventouse ventrale à bord mamelonné. Celui-ci constitue certainement une espèce nouvelle; en tous cas ses affinitiés seraient avec l'*Hirudinella bonnacouri* nom. nov., plutôt qu'avec l'*Hirudinella pallasii* Poirier 1885." And in a footnote on the same page the author makes the statement, "En 1885 Poirier a bien décrit sous le nom de *Distomum personatum* un *Hirudinella* à abdomen bilobé, récolté au Mexique par Geoffroy, sans indication d'hôte; mais ici l'abdomen est ovalaire et surtout la ventouse ventrale présente un bord lisse; donc rien de commun avec notre exemplaire." *Hirudinella phalloidea* was described from a single specimen, which in our opinion is specifically identical with *H. bonnacouri* and both names are synonyms of *H. marina* Garcin. These specimens are probably distinct from *H. ventricosa* (= D. *personatum*). It appears that certain investigators harbored the opinion that all members of a single species would be identical in morphological aspects, regardless of the manner in which they had been killed. The bulbous enlargement of the posterior portion of the body, so often figured and discussed, is explained by the text-figure of Darr (1902, p. 692) which shows the bending of the lateral excretory canals in this condition and by his Fig. 26, which shows the powerful longitudinal muscles which are inserted around the caudal tip of the body. Retraction of the posterior end of the body is characteristic of the hemiurid trematodes and finds its culmination in the so-called "appendiculate distomes." When living specimens of *Hirudinella* are suspended by the anterior end, if the digestive ceca are filled with blood, this fluid material flows downward and contributes to the caudal enlargement.

Another feature which has occasioned much confusion and discussion is the structure and relations of the musculature which surrounds and comprises the copulatory organs. In the hemiurid trematodes, where the terminal portions of both the male and female ducts are enclosed in a common muscular sac, the relations may be varied and perplexing. This muscular sac has a complex structure, is connected by muscle bands to the body wall at different places, and may be retracted or protruded, especially as the preacetabular portion of the body is extended and contracted. These relations were represented in Figures 6 and 9 of Buttel-Reepen (1900) and Figures F and H in his 1902 paper. If the musculature is retracted, the male and female ducts open into a long, deep and narrow genital sinus, whereas if the mass is protruded (Plate I, Fig. 2), the two ducts open through separate papillae on a common genital protuberance. These small papillae were figured by Bosc (1802) and discussed by Blanchard (1891). In different positions, the copulatory organs and especially the musculature associated with the male papilla manifest greatly altered relations, but these morphological variations have been observed in different individuals

of the same species and result merely from contractions of different sets of muscles. The specimens from *Xiphias gladius* described by Manter (1926) and identified by him as *H. fusca* (Poirier, 1885) agree in essential respects with those we recognize as *H. marina.* Manter distinguished between *H. fusca* and *H. clavata* on the location of the openings of the male and female genital ducts. Our observations show that the reported differences actually represent only differences in the state of contraction of the genital musculature. This musculature and its relation to the "cirrus sac" was discussed by Mühlschlag (1914) and Manter (1926). Mühlschlag (1914) described as *H. fusca* (Bosc, 1802) specimens presumably identical with those of Manter and all of them we regard as identical with *H. marina.* The specimens described by Buttel-Reepen (1903) as *D. siemersi* we assign to the same species, *H. marina.*

With slight emendations we are in accord with the conclusions of Moniez (1891, p. 116). This eminent helminthologist reviewed the descriptions and synonyms of *Distoma clavatum* and summarized the situation as follows, "Il result donc de tout ceci, ce que nous avons déjà exprimé, à savoir: (1) que le véritable *Dist. clavatum* est celui de Garsin et de Menzies, redécrit ensuite par Dujardin, Jourdan, Poirier, etc.: (2) que c'est par erreur qu'Owen a donné ce nom à une espece tout differente, qui j'ai appelée plus tard *Dist. ingens,* nom qui doit etre maintenu; (3) et comme consequence qu'il n'y a pas identite entre les *Dist. clavatum* et *ingens.*" In this same publication Moniez admitted the identity of *Dist. clavatum* of Owen and *Dist. ingens.* If the name *Hirudinella marina* is substituted for *D. clavatum* and the name *Hirudinella ventricosa* (Pallas, 1774) Baird, 1853, for *D. ingens,* our conclusions agree entirely with those of Moniez. Baird (1853) had predicated the identity of *D. clavatum* of Owen with *Fasciola ventricosa* Pallas, 1774. The two species recognized by Moniez were redescribed by Buttel-Reepen (1900, 1902) as *Dist. siemersi* and *Dist. ampullaceum.* The worms described by Buttel-Reepen (1900) as *D. ampullaceum* and by Mühlschlag (1914) as *D. ingens* are almost certainly conspecific with those we have studied and referred to *H. ventricosa. Dist. personatum* Poirier is probably identical, but his description is too incomplete to permit final identification.

Distomum megnini Poirier, 1885, was regarded by the author as a member of the *D. clavatum* group, but it is so different in internal structure that it cannot be retained in the genus *Hirudinella.* Monticelli (1893) considered it identical with *D. macrocotyle* Diesing, 1858, and included it in the subgenus *Accacoelium,* which was raised by Looss (1899) to generic rank. Stossich (1898) transferred *D. macrocotyle* Diesing, 1858, to the genus *Podocotyle.*

Since both *H. marina* and *H. ventricosa* have been described previously under different names, (q.v., lists of synonymy), further detailed accounts are unnecessary. The data presented in Table II give measurements of our specimens and the morphology agrees essentially with previous descriptions.

We are not in agreement with the opinion of Dollfus (1932, 1940) who erected families to receive the genera *Hirundinella* and *Bathycotyle.* The hemiurid trematodes constitute a well-defined group in the Digenea; they are related to the Azygiidae, but other relationships are yet undetermined and until the life cycles and developmental stages are known, we prefer to regard the units as subfamilies, Hirudinellinae, Bathyycotylinae, etc.

Summary.

Examinations of specimens of *Hirudinella* from 9 different species of scombriform fishes, taken in both the Atlantic and Pacific Oceans, have disclosed the great variation in form and internal arrangements that may be manifested by these large, very muscular trematodes. All of our material is allocated to two species which we identify as *H. marina* Garcin, 1730, and *H. ventricosa* (Pallas, 1774) Baird, 1853. The validity of *H. marina* Garcin, 1730, and its status as type of the genus *Hirudinella,* are established. Comparison of our specimens with accounts in the literature indicates that most, if not all, other described species are merely variants of one or the other of the two species we recognize. The other designated species were described from a single or very few specimens, and are regarded as synonyms. Information is yet too incomplete to permit definitive taxonomic determination and we are not in accord with Dollfus (1932, 1940) in the erection of families for subgroups of the Hemiuriidae.

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EXPLANATION OF THE PLATES.

All photographs by S. C. Dunton, staff photographer of the New York Zoological Society.

Plates I-VI, *Hirudinella ventricosa* (Pallas, 1774) from *Acanthocybium* spp. taken from the Atlantic and Pacific Oceans.

Plate I.

Fig. 1. Living worm pressed between two glass plates. The parasite was taken from the stomach of a fish sent by air to the New York Aquarium from Bimini, W. I. When fully expanded it measured 170 mm. in length and 30 mm. in width. About natural size.

Fig. 2. Parasite from the stomach of a "King Mackerel" (*Acanthocybium*?) taken off the Marianas Islands, Pacific. The specimen was sent by Dr. N. R. Stoll. Note the common genital protuberance with two separate papillae. About 3×.

Fig. 3. Parasites from fish caught off the coast of Yucatan (Atlantic). Worms 1 and 4 were sectioned serially; worm 3 was stained and mounted *in toto*. The smallest form was immature. A little less than twice natural size.

Plate II.

Fig. 4. *Hirudinella ventricosa* from the stomach of *Acanthocybium* captured off Bermuda. A little less than natural size.

Figs. 5-6. These worms were taken from fish caught off Bermuda. Note the numerous minute papullae, especially on specimen 5. These are artifacts formed in the process of fixing. They are rough to the touch and are similar to the structures Poirier (1885) found on the species he described as *D. verrucosum*. About 2×.

Figs. 7-8. From fish taken off Clarion Island, Mexico (Pacific). Beebe-Templeton Crocker Expedition, 1936. Note the extent of contraction at the posterior end, smoothness of the anterior extremity and the terminal position of the oral sucker. About 1½×.

Plate III.

Figs. 9-10. Parasites, similar in appearance to 7 and 8, taken from fish caught off Long Key, Florida. About 1½×.

Fig. 11. One of two specimens from the ocean bonito *Katasuwonus pelamis* (Linnaeus) taken off the coast of Bermuda. About 10×.

Plate IV.

Fig. 12. Gross dissection of a worm taken from *Acanthocybium*. Body wall deflected posterior to the acetabulum, showing musculature of the body wall and the bands which control movements of the acetabulum, with external view of intestinal ceca. 3×.

Fig. 13. Same structures as in Fig. 8, part of body wall removed to expose the testes. 3×.

Plate V.

Fig. 14. Interior of a single cecum with plicated wall, limits of uterus, ovary, Mehlis' gland, testes, copulatory organs and genital pore. 4×.

Fig. 15. Further dissection of anterior portion, showing testes, ovary, and details of male and female genital ducts. 8×.

Plate VI.

Figs. 16-19. Photomicrographs of sections of *Hirudinella beebei* Chandler (1937) taken (16) near the middle region at about the end of the uterine coils, (18) midway between the region shown in 16 and posterior end of the body, and (19) at the posterior end. Figure 17 is an enlargment of the region indicated by arrow in Figure 16. These sections attempt to show the complicated nature of the ceca, which according to Chandler form a . . . "maze of pockets and anastomosing, interlacing branches, which in cross section give appearance of a reticulum." Our studies have shown that the walls of the ceca are collapsed in innumerable folds and plications, but that actually branching does not occur. When the ceca are filled, the plications disappear (see Plate III, Fig. 10). Photomicrographs by Dr. Chandler.

Plate VII.

Figs. 20-22. Photomicrographs of eggs from several specimens of *Hirudinella*. Fig. 20 from parasite found in *Acanthocybium;* Fig. 21, from parasite of the Pacific swordfish (see Fig. 20); Fig. 22 from one of the worms taken from bluefin tuna (see Figs. 24, 25). Each unit represents 7 microns.

Hirudinella marina Garcin, 1730, from other scombriform fishes.

Fig. 23. Parasite from the stomach of the Pacific swordfish, *Makaira mitsukurii* (Jordan and Snyder). Note the nature of the acetabulum. About 3×.

Figs. 24-25. Five of six specimens found in the stomach of a bluefin tuna, *Thunnus thynnus* (Linnaeus), caught off Point Lookout, L. I. About 1½×.

Plate VIII.

Fig. 26. Plate from Buttel-Reepen's (1902) paper in *Zool. Jahr., Syst.*, Bd. 17, Taf. 6 showing drawings of species of *Hirudinella* described by various authors up to that time.

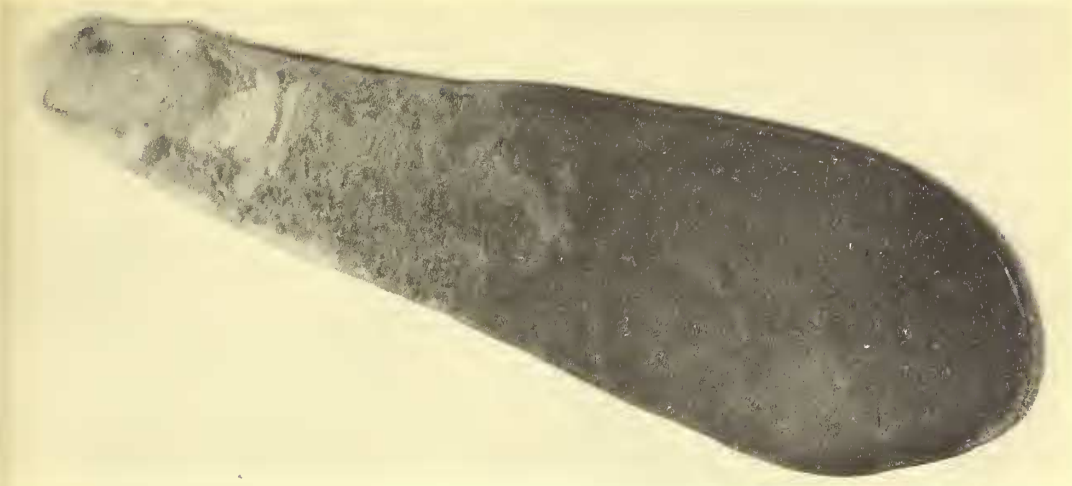


FIG. 1.

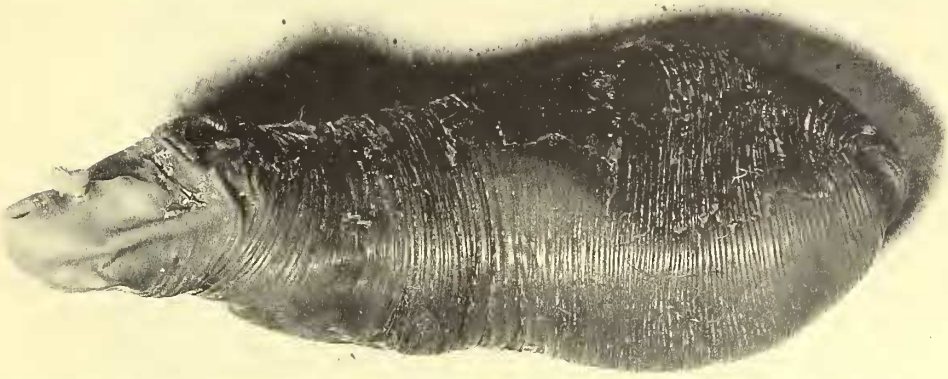


FIG. 2.

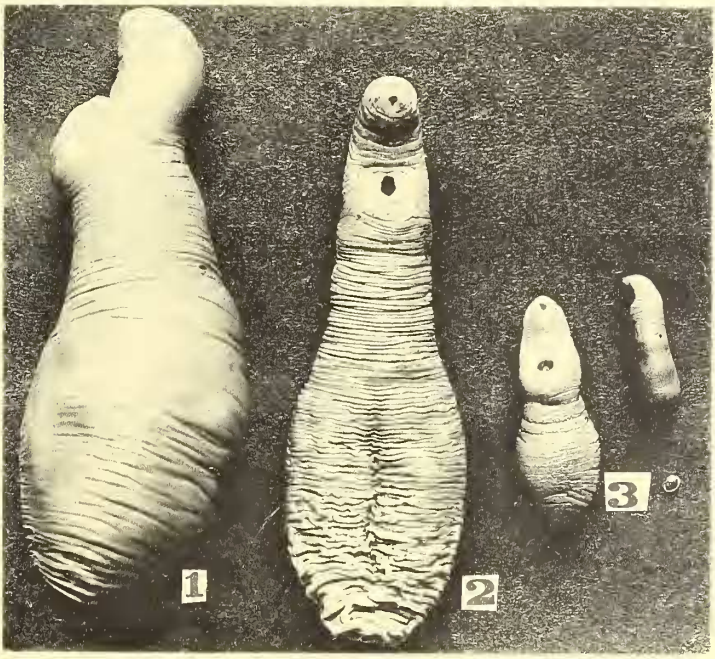


FIG. 3.

STUDIES ON THE GENUS HIRUDINELLA, GIANT TREMATODES OF SCOMBRIFORM FISHES.

FIG. 4.

FIG. 5.

FIG. 6.

FIG. 7.

FIG. 8.

STUDIES ON THE GENUS HIRUDINELLA, GIANT TREMATODES OF SCOMBRIFORM FISHES.

FIG. 9.

FIG. 10.

FIG. 11.

STUDIES ON THE GENUS HIRUDINELLA, GIANT TREMATODES OF SCOMBRIFORM FISHES.

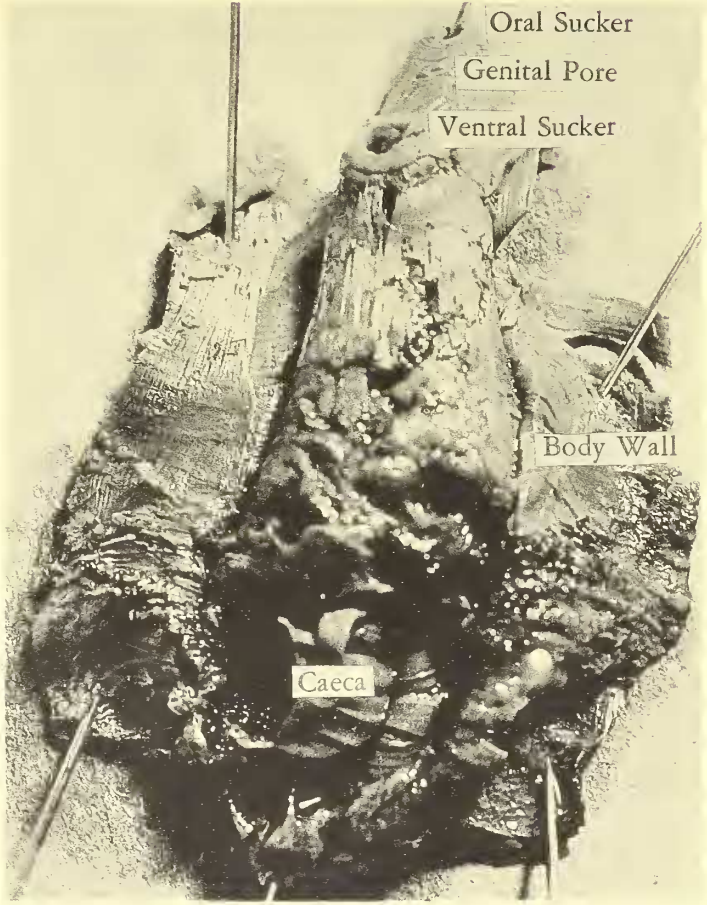


FIG. 12.

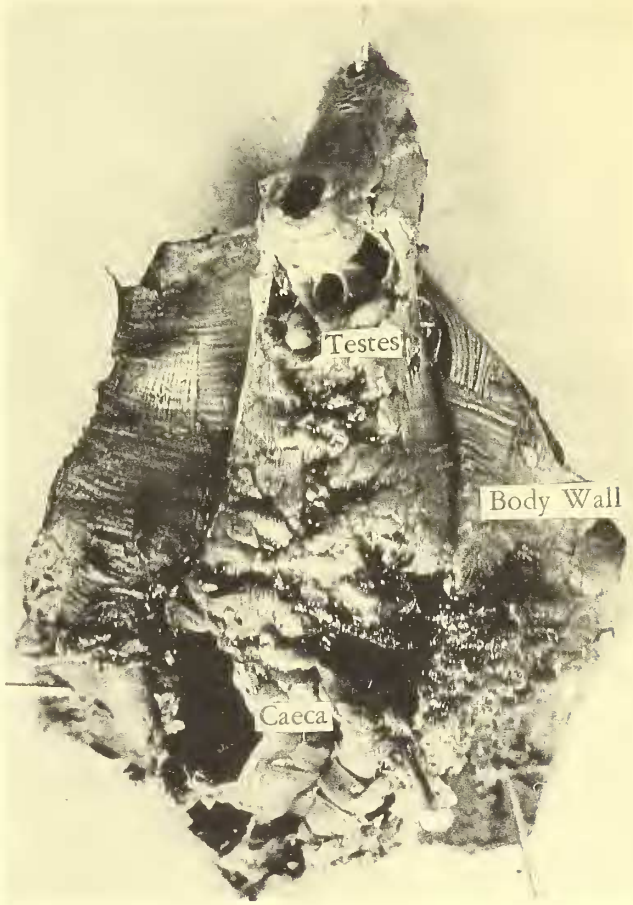


FIG. 13.

STUDIES ON THE GENUS HIRUDINELLA, GIANT TREMATODES OF SCOMBRIFORM FISHES.

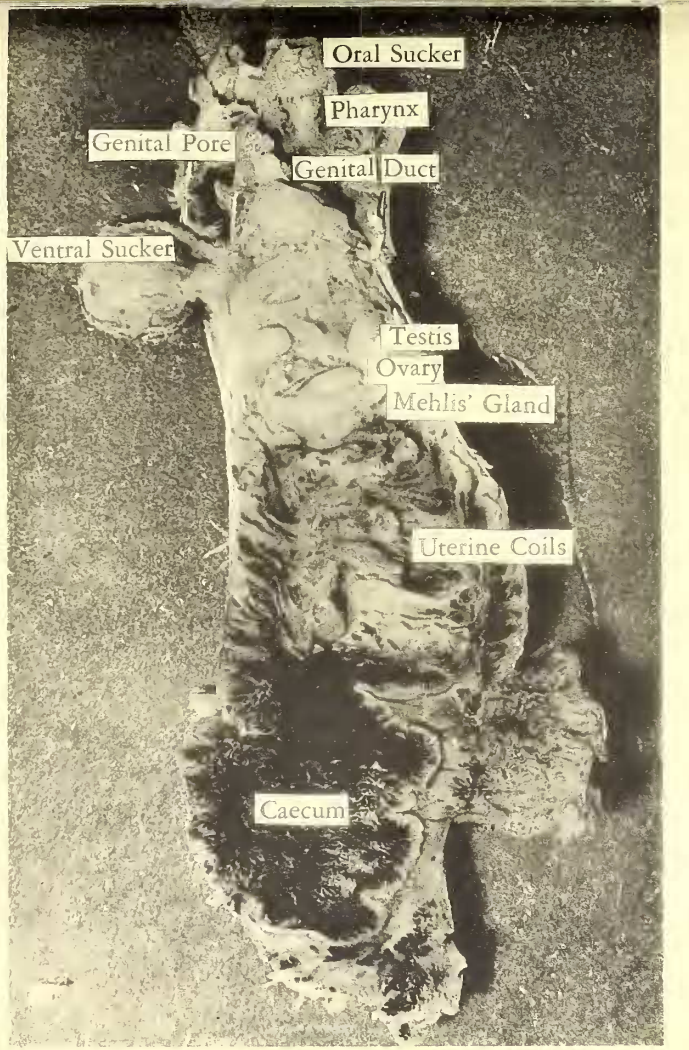


FIG. 14.

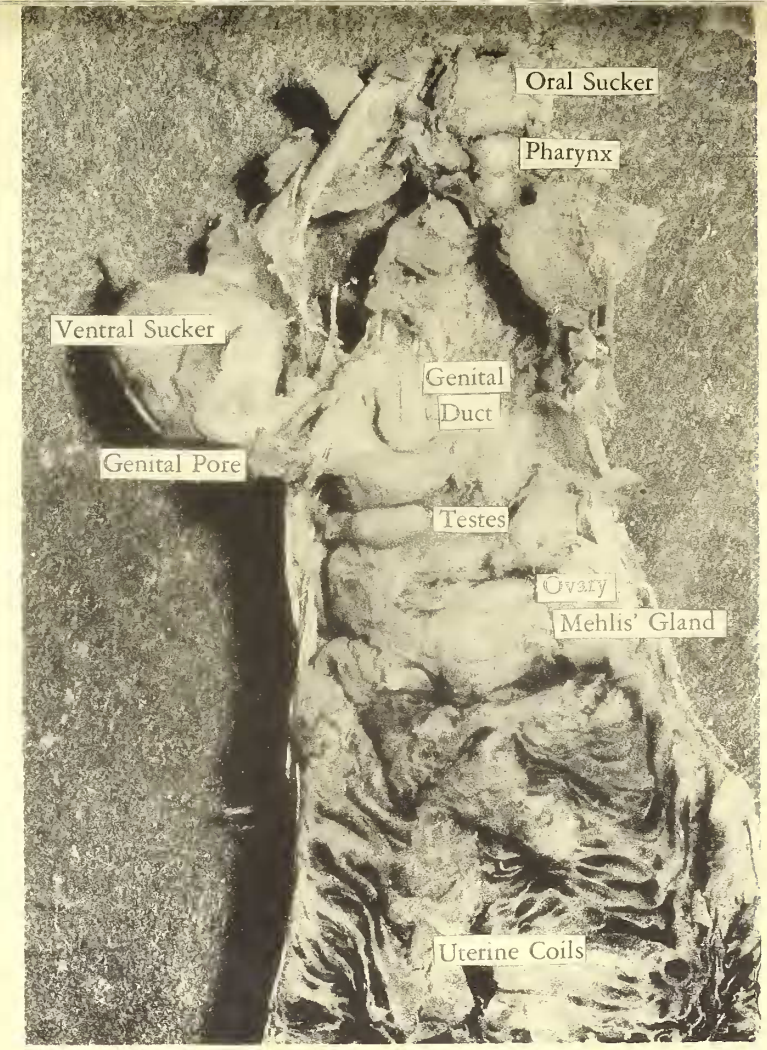


FIG. 15.

STUDIES ON THE GENUS HIRUDINELLA, GIANT TREMATODES OF SCOMBRIFORM FISHES.

FIG. 16.

FIG. 17.

FIG. 18.

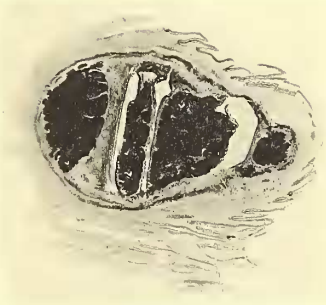


FIG. 19.

STUDIES ON THE GENUS HIRUDINELLA, GIANT TREMATODES OF SCOMBRIFORM FISHES.

FIG. 20.

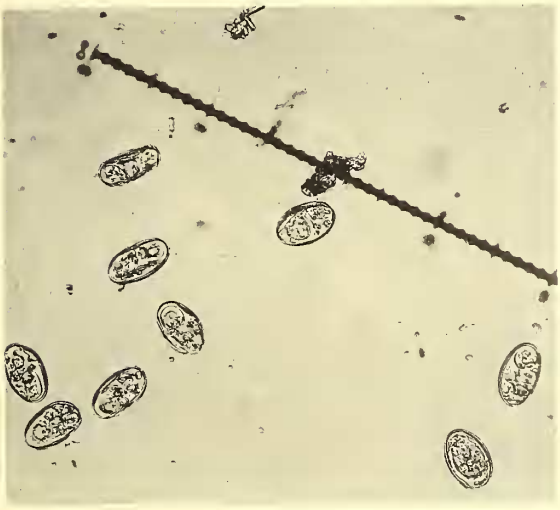


FIG. 21.

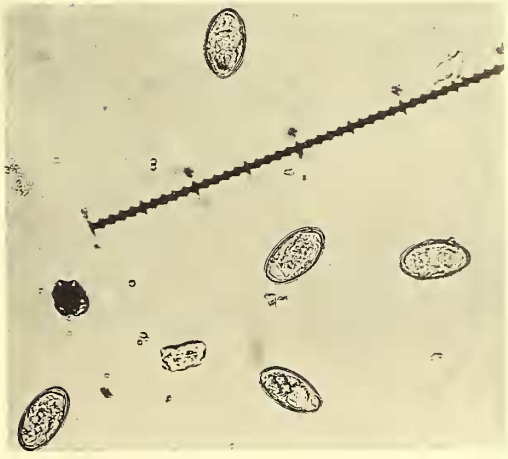


FIG. 22.

FIG. 23.

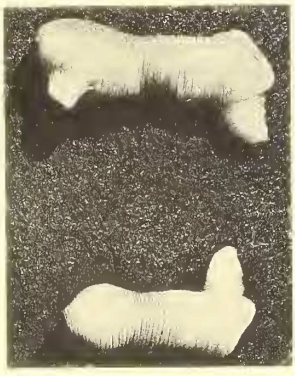


FIG. 24.

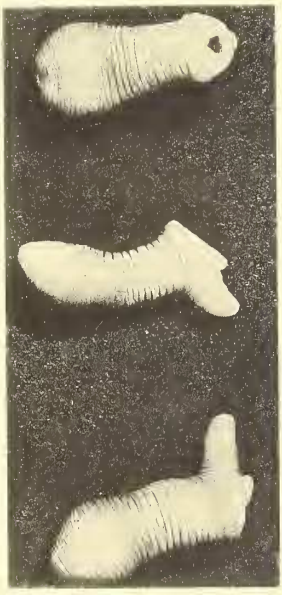
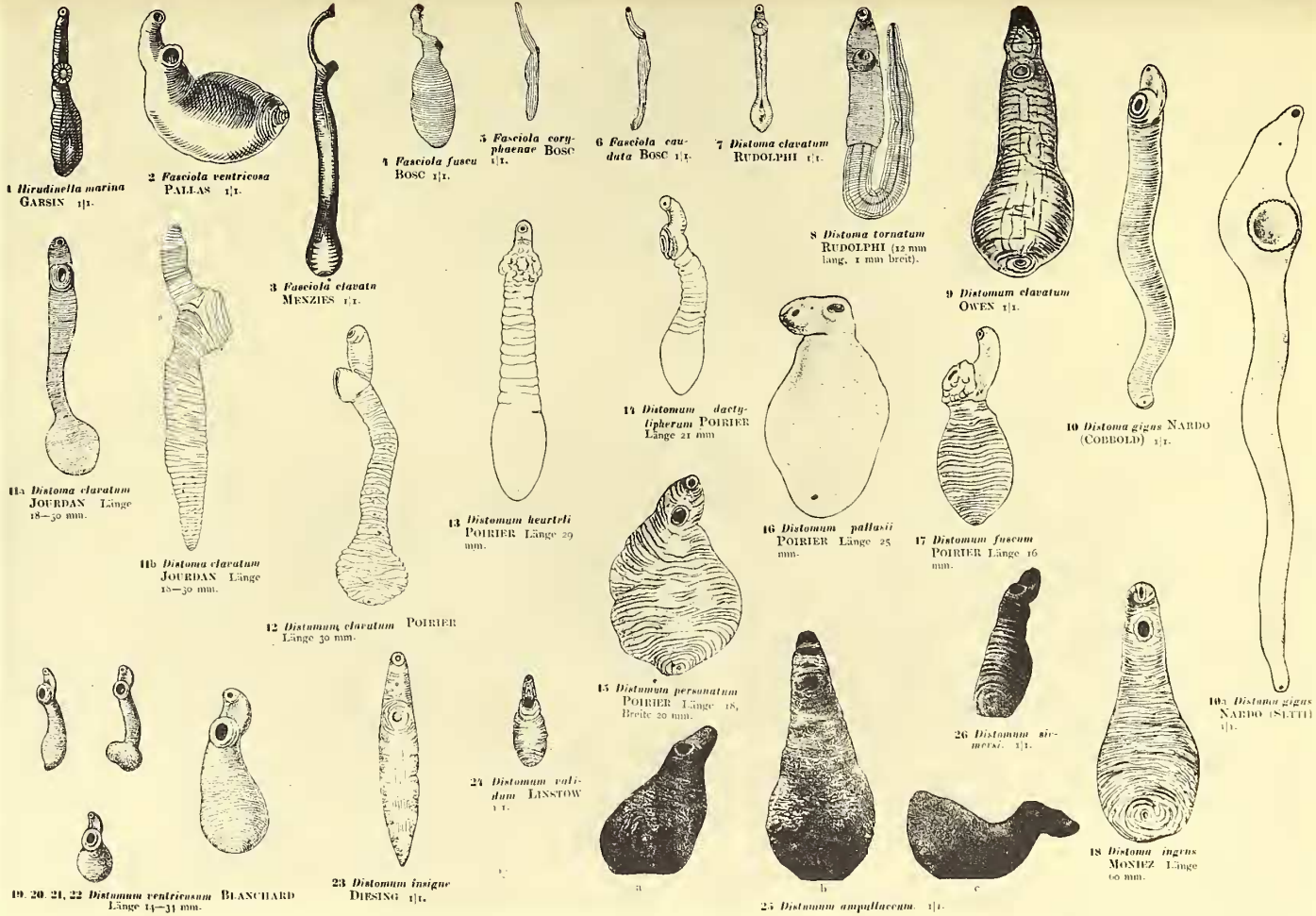


FIG. 25.



1 *Hirudinella marina* GARSIN 1|1.

2 *Fasciola ventricosa* PALLAS 1|1.

3 *Fasciola clavata* MENZIES 1|1.

4 *Fasciola fusca* BOSC 1|1.

5 *Fasciola coryphaenae* BOSC 1|1.

6 *Fasciola caudata* BOSC 1|1.

7 *Distoma clavatum* RUDOLPHI 1|1.

8 *Distoma ternatum* RUDOLPHI (12 mm lang, 1 mm breit).

9 *Distomum clavatum* OWEN 1|1.

10 *Distoma gigas* NARDO (COBBOLD) 1|1.

10a *Distoma gigas* NARDO (SETTI) 1|1.

11a *Distoma clavatum* JOURDAN Länge 18—50 mm.

11b *Distoma clavatum* JOURDAN Länge 18—30 mm.

12 *Distomum clavatum* POIRIER Länge 30 mm.

13 *Distomum heurtrii* POIRIER Länge 29 mm.

14 *Distomum dactylipherum* POIRIER Länge 21 mm

15 *Distomum personatum* POIRIER Länge 18, Breite 20 mm.

16 *Distomum pallasii* POIRIER Länge 25 mm.

17 *Distomum fuscum* POIRIER Länge 16 mm.

18 *Distoma ingens* MONIEZ Länge 60 mm.

19. 20. 21. 22 *Distomum ventricosum* BLANCHARD Länge 14—31 mm.

23 *Distomum insigne* DIESING 1|1.

24 *Distomum validum* LINSTOW 1 1.

25 *Distomum ampullaceum*. 1|1.

26 *Distomum sirmesi*. 1|1.