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The Catenula of the Eastern United States

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With the exception of *Stenostomum* and *Dalyellia*, *Catenula* is probably the most common genus of rhabdocoel encountered in the eastern United States. Collection records indicate the genus *Catenula* to be equally prevalent over the entire eastern part of the country. At present there is no single piece of literature available which would make identification easy or even possible.

The following treatment of the genus *Catenula* is an attempt to evaluate the species known to the United States and to so describe and figure them as to make accurate identification possible. Included are descriptions of two new species and notes on distribution, collection, general biology, culture methods, and a key to the American species so far known.

The genus *Catenula* was established in 1832 by Dugés for a fresh-water worm which he collected in autumn, 1830. He proposed the name *Catenula* because of the resemblance of a specimen of several zooids to a small chain; the specific name *lemnæ* was used because he had discovered the animal in a lens of water. Dugés' description is somewhat incoherent and is confused by the fact that throughout the paper he becomes involved in comparisons with tape-worms, other flatworms, and annelids. However, his figures are good and, with the description given, he established beyond doubt the fact that he was dealing with the same species we have cultured for seven years.

Leidy (1851) described *Anortha gracilis* from Philadelphia which so early as 1854 was recognized by Leuckart as a *Catenula* and carried by him as *Catenula gracilis*. *Catenula gracilis* was carried as a species by practically every author who mentioned the genus until Graff (1913) relegated it to synonymy with *Catenula lemnae*. From Leidy's description it is difficult to see how it was specifically identified at all.

Schmarda (1959) added *C. bina* and *C. quarterna* to the genus. *C. bina* lacked a statocyst and *C. quarterna* had a protonephridial tube down each side of the body. However, the description of *C. quarterna* leaves no doubt that Schmarda was dealing with an organism of the same general structure as a *Catenula*. It was suggested by Beauchamp (1919) that such a protonephridial condition would justify removal to another group. Luther (1907) suspected that Schmarda had committed an observational error with reference to the two protonephridial tubes, and Marcus (1945a) considers the inclusion of *C. quarterna* as a valid species open to question but, nevertheless, includes it in his key for the genus. In view of the fact that this species conforms so completely in other respects to the generic criteria, it seems logical that these criteria be revised to allow the inclusion of this species.

Graff (1882) moved *C. lemnae*, *C. gracilis*, *C. bina*, and *C. quarterna* into the genus *Stenostomum* in the family Microstomidae, but in 1913 he re-established the genus *Catenula* in the family Catenulidae with two species — *C. lemnae* and *C. quarterna*. Since 1913 six species have been described. From Europe Beauchamp (1919) described *C. sekerai* and Reisinger (1924), *C.*

pygmaea. From Virginia, Kepner and Carter (1930) described *C. virginia*. From Brazil, Marcus (1945a) described *C. alitha*, *C. leuca* and *C. macrura*.

Beauchamp (1919) undertook to separate *C. sekarai* from *C. lemnae* on the basis of anatomical features, but particularly on the difference in the histology of the parenchyma. The species with which he was comparing his new species appears not to have been *C. lemnae* but an undescribed species very widely found in the eastern United States. This species is described in this paper as *C. confusa*.

All the species which have been encountered can be easily identified from study of living specimens. Beauchamp (1919) was justified in questioning size as a major factor in specific identification in *Catenula* but it is entirely unnecessary to resort to fixed material for identification. Marked structural differences in the living animal parallel differences in rate of reproduction, response to culture media, and pattern of regeneration.

Considered in this paper are five species of the genus, four of which we have been able to collect and study in large numbers.

PRESENT TAXONOMIC POSITION OF THE GENUS CATENULA

Graff (1905) established the family Catenulidae and named it for the first genus in the group, *Catenula*. The family also included the genus *Stenostomum*. In 1907 Luther reorganized the family so as to include the following genera: *Catenula*, *Lophorhynchus*, *Stenostomum*, and *Rhynchoscolex*. Reisinger (1924) is responsible for the sharp definition of the sub-order Notandropora and for an adequate discussion of the history and the systematic position of the Catenulidae. Meixner (1938) proposed that the suborder Notandropora be removed from the order Rhabdocoela and be given ordinal rank with the name Catenulida. Marcus (1945a) has followed the taxonomic scheme of Meixner in his work with the group. Although Meixner's arrangement has much to commend it the older system is followed in this paper.

The Catenulidae are Notandropora (Catenulida) in which there are usually four to eight nerve stems running posteriorly from the cephalic ganglion or ganglia. The male gonads are follicular. The female reproductive structures consist only of an ovary; there is neither an oviduct nor a female genital pore. Except in *Rhynchoscolex*, sexual reproduction is periodic, and the usual method of propagation is asexual.

For the genus *Catenula* Graff in 1913 laid down the following criteria: cephalic region delimited posteriorly by ciliated pre-oral groove; anterior region of digestive tract differentiated as a simple pharynx; eye-spots absent; statocyst present in the anterior end of each zooid; protonephridial tube mesio-dorsally placed; paired ciliated pits absent. Figure 1 shows diagrammatically the basic features of the genus.

Ruebush (1941) separates the genus *Catenula* on the basis of being composed of a chain of zooids each of which contains a statocyst in its anterior end. Only one platyhelminth, the larval form of *Rhynchoscolex*, could possibly be confused with a *Catenula*. This larva possesses a statocyst but lacks a pre-oral groove. With the changes suggested the position of the genus seems sound.

Marcus (1945a), in his reorganization of the genus *Catenula*, considered

the fact that the intestine occupies only the middle of the zooid (not continuous from one zooid to the next) to be critical diagnostic feature for the genus. Because *C. pygmaea* has an intestine continuous between the zooids he removed it to the genus *Dasyhormus*. One of his species, *C. alitha*, lacks a statocyst.

It appears to this author that Graff's criteria, with slight modification, would serve quite as well as those of Marcus for a valid, sharply defined genus. The species described in this paper conform to the criteria of both Graff and Marcus.

Numerous collections for this study were made over a period of several years from Georgia, Virginia, North and South Carolina, Tennessee, Florida, Pennsylvania, New York and New Jersey. *Catenula* inhabit permanent ponds, lakes, and ditches that range from almost crystal clearness to stagnancy. Seasonal variations have no marked effect on the prevalence of species.

Satisfactory collections can be made by removing with a large spoon the upper one-half inch of sediment to a jar filled with water from the site of collection. Sediment washed into a jar from submerged vegetation is also a satisfactory source. After the jars have settled, specimens can be obtained from its sides or from the sediment by means of pipette. In such a jar the population tends to increase until extreme stagnation or other factors interfere.

In nature the food of *Catenula* is composed largely of microorganisms and under ideal conditions reproduction is rapid. *C. lemnae* and *C. leptcephala* are readily cultured in wheat grain infusions prepared according to directions given in Needham's *Culture Methods for Invertebrates*, pp.135-136 (1937). *C. confusa* and *C. sekeræ* do not culture satisfactorily.

The morphology of all species except *C. virginia* was studied from living and fixed material. Living specimens can be easily studied in water under a cover glass, even at magnifications of 1500. Satisfactory fixation of *Catenula* was very difficult to obtain. Gilson's, Bouin's (65° C), and Helly's fixing fluids were used. Helly's fluid, 15 to 20 minutes, proved the best fixing agent. Specimens were embedded in tissuemat, sectioned at 7 micra, stained for 20 minutes in Harris' haematoxylin, destained in acid dioxane, and mounted in clarite.

Best fixation was obtained with *C. lemnae*. Attempts to prepare satisfactory whole mounts were not successful.

The general body form is thread-like, roughly cylindrical and somewhat dorso-ventrally flattened. The anterior extremity may be rounded or pointed; the posterior end typically narrows gradually to form a blunt point.

The epidermis is ciliated and differs from that of many rhabdocoels in that its cells carry no visible rhabdites. The ciliary length is usually two to four times the epidermal thickness. In sections the epidermis appears to be composed of squamous or cuboidal cells, whereas in the living animal the epidermal cells appear to be cuboidal. The fact that satisfactory fixation is difficult, probably accounts for the differences in the appearance of the fixed epidermis. The cytoplasm of the epithelial cells stains fairly darkly, and the cells contain large vesicular nuclei.

Immediately beneath the epithelium is the longitudinal musculature. This

tissue is fibroid and the spindle-shaped nuclei resemble those of ordinary visceral muscle. These nuclei show no visible karyosomes.

Separating the cephalic region from the remainder of the zooid is a ciliated, pre-oral groove. The cilia in and about this groove are stouter and longer than those of the general ciliary coat and assist in the feeding process. The lateral aspects of the groove set off the cephalic region sharply.

The V-shaped mouth is located mesio-ventrally just behind the pre-oral groove and is bounded by heavily ciliated lips. It opens directly into a ciliated, muscular, elongate pharynx simplex. In section there may be observed on the antero-ventral walls of the pharynx groups of columnar cells containing small, compact nuclei. These appear to be a part of the pharyngeal musculature. Posteriorly the pharynx opens through a weak sphincter into the sac-like enteron. Gland cells are associated with the pharynx and enteron in various arrangements.

The enteric cells observed were mostly columnar with large, basally placed nuclei containing scattered chromatin granules. Occasional goblet-like cells occur among those of the general enteric epithelium. The cytoplasm of these cells is mottled but without obvious vacuoles or granules.

The enteric epithelium is finely ciliated as indicated by the movement of the food content in the intestinal lumen. No distinct musculature has been observed like that immediately beneath the general epidermis.

The pseudocoel, which varies in width in the different regions of the organism, is filled with cells of various sizes and shapes. Some appear stellate, spindle-like and reticular. Radial muscle tissue may transverse the pseudocoel throughout the entire length of the animal. In the pharyngeal and post-pharyngeal regions of the pseudocoel can be observed unusually large cells containing extremely large nuclei having karyosomes and several groups of chromatin material located just under the nuclear membrane. These cells are unquestionably glandular.

Located in the anterior end of each well-developed zooid is a cephalic ganglion from which arises on each side a pair of posteriorly directed nerves. Marcus (1945b) was able to identify additional nerve tracts to the pharyngeal wall and the lateral, ventral and anterior regions of the epidermis. Sections reveal the interior of the ganglia to be fibrous in appearance and the exterior to be composed of nerve cell bodies.

Associated with each ganglion is a refractive, ovoid statocyst which contains a statolith. The statocyst may or may not be embedded in the ganglionic tissue. Marcus (1945a, 1945b) describes and figures the statocyst in *Catenula* on the posterior face of the cerebral ganglion and states (1945a) that Kepner and Carter (1930) were in error in thinking this feature peculiar to *C. virginia*. Marcus has interpreted the central mass to be the cerebral ganglion proper and the cellular peripheral cells as ganglionic. In living specimens the statocyst appears, in many cases, to be embedded in this ganglionic exterior and consequently does not appear to lie on the posterior face of the "brain mass." Kepner and Carter (1930) described the statolith of *C. virginia* as made up of an almost cytoplasm-free cell with a nucleus and a definite nucleolus. Careful studies of all species, except *C. virginia*, fail to show statoliths conforming to the structure described by Kepner and Carter. These studies show the statocyst to be composed of a vesicle filled with a clear, homogeneous mass contain-

ing a structure of permanent shape. In fixed material the statocyst appears to be surrounded by a flat epithelium.

In a disintegrating worm the vesicular membrane ruptures and the clear semi-fluid content escapes. After the rupture of the vesicle, the statolith remains for hours without change in size or shape. Neither observations on its structure nor behavior suggest that the statolith is a nucleus. In fig. 2 are shown statocysts as seen in fixed material of *C. lemnae*, and in fig. 3 are statocysts from living specimens of *C. leptcephala*.

In living specimens the diameter of the statocysts of any given species is fairly constant for zooids in the same stage of development. Statocysts in different zooids of the same chain differ in size. Measurements of the anterior statocysts in the several species range in diameter from .008 to .02 mm. The statoliths range from .004 to .016 mm in diameter.

The excretory system has been described in detail by Sekara (1924) and by Marcus (1945b). It is similar to that of *Stenostomum* in which there are two mesio-dorsally located tubes.

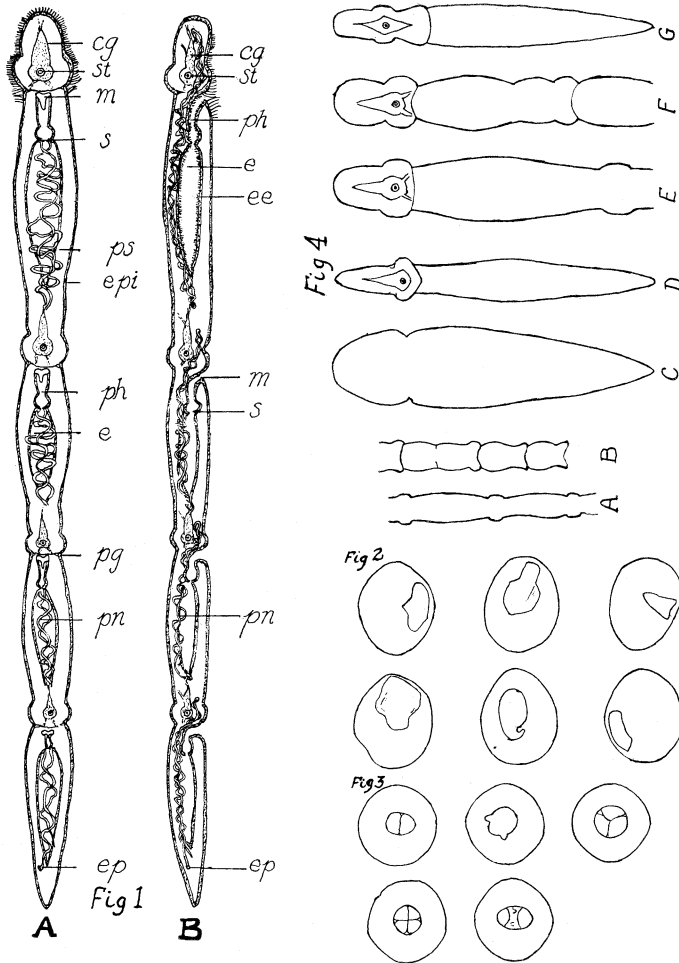
Originating in the posterior end of the worm is a capillary tube, equipped with flame cells, which runs anteriorly, dorsal to the enteron. In the cephalic region it dips ventral to the ganglion and turns abruptly to proceed posteriorly as a collecting duct differing from the capillary tube in size and in the absence of flame cells. It terminates at or near the posterior tip of the body. The tubes twist about each other throughout almost the entire length of the animal.

Reproduction is for the most part accomplished asexually by transverse fission. When a fission plane becomes sufficiently advanced, separation occurs and the two zooids, or chains of zooids, assume separate existences.

Sekara (1924) described sexually mature individuals. According to him, both the male and female gonads lie in the pseudocoel and are without extensive ducts or accessory apparatus. Marcus (1945a) describes both male and female gonads but differs with Sekara as to the position of the male gonad and its opening. According to Marcus the gonad is dorsal rather than ventral. The single ovum is located centrally in the post-intestinal region. This writer has never observed sexuality in any species, either in recently collected material or in cultures under constant observation for over fifteen years.

KEY TO THE AMERICAN SPECIES OF CATENULA

1. (a) Length of the cephalic region less than twice its width (fig. 4, F) 2
 (b) Length of the cephalic region more than twice its width (fig. 4, D and G) 4
2. (a) Cephalic region approximately $\frac{1}{2}$ the length of the first zooid (fig. 4, F); chain 4-8 or more zooids; form balustrade (fig. 4, B) (Plate I) *lemnae*
 (b) Cephalic region less than $\frac{1}{2}$ the length of the first zooid (fig. 4, C and E); chain usually of 1-8 zooids; form not balustrade (fig. 4, A) 3
3. (a) With a dorsal, ciliated groove on pre-oral zone (Plate III, D) *virginia*
 (b) Without dorsal, ciliated groove on pre-oral zone (fig. 4, E) (Plate II, A and B) *confusa*
4. (a) Cephalic region elongated anteriorly into a point, cephalic lobes located immediately anterior to the pre-oral groove (fig. 4 D) (Plate II, C and D) *leptocephala*
 (b) Cephalic region rounded anteriorly, lobes located midway in the cephalic region (fig. 4, G) (Plate III, A and B) *sekerai*



Figs. 1-4.—A. Diagrammatic, dorsal, optical view of a *Catenula*. B. Lateral view of same. cg, cephalic ganglion; e, enteric cavity; ee, enteric epithelium; ep, excretory pore; pn, protonephridium; ps, pseudocoel; s, sphincter; st, statocyst; epi, epidermis; m, mouth; ph, pharynx; pg, pre-oral groove. 2. Statocysts from fixed material of *C. lemnae*. 3. Statocysts from living specimens of *C. leptocephala*. 4. A. Non-balustrade form. B. Balustrade form. C. Outline of *C. virginia*. D. *C. leptocephala*. E. *C. confusa*. F. *C. lemnae*. G. *C. sekerai*.

CATENULA LEMNAE Dugés
Plate I

The review of a large number of papers, many of them referred to later, has convinced the author that the name *C. lemnae* has been used in an almost generic sense for any *Catenula*, and, in most cases since 1832 has it been applied to other species than that described by Dugés. The species which has

been most commonly confused with *C. lemnae* is sharply defined and is widely distributed in the eastern United States and appears also to occur in Europe. This species is described in this paper under the name *C. confusa*.

C. lemnae has been collected several times from ponds in the vicinity of Augusta, Georgia, and once from Valdosta, Georgia.

The specimens vary greatly in length, depending upon the number of zooids in the chain and the state of nutrition of the worm. Chains of four to eight zooids are usual, and in one case forty-nine zooids were observed in a chain. Long chains of zooids are extremely threadlike in appearance. Length ranges from 1.5 to 16 mm. Contracted specimens have almost twice the width of extended ones.

The cephalic region of the anterior zooid is marked off posteriorly by a sharply defined pre-oral groove. Behind the first zooid, the cephalic region in each succeeding well-developed zooid of the chain is delimited both anteriorly and posteriorly by a sharply pronounced constriction. Each cephalic zone is somewhat less than twice as long as wide. These deep constrictions give the animal a rugose appearance when the worm is contracted (Plate I, D.).

In reflected light the organism is milky white in color. In transmitted light the body wall, pseudocoel, and cephalic end are light gray to brown. The enteric tract is generally slightly darker and in well fed specimens the dilated portion of the enteron in each zooid appears almost black.

The general ciliary coat is fine (cilia, approximately .012 mm long), except for the cilia around and in front of the pre-oral groove, which appears longer, denser and heavier. The cilia at the posterior end of the last zooid are extremely prominent. They are about four times as long as the epidermis is thick, and are generally kept at rest, whereas the cilia elsewhere are always in motion. The epidermis measures about .003 mm in thickness.

The cephalic ganglion appears as an elongate mass in the anterior end of each zooid. The mass seems to be constricted transversely near the middle. From this constriction it narrows anteriorly. The posterior part broadens, giving rise to at least one posteriorly directed cord on each side. The spherical statocyst lies partly embedded on the postero-dorsal region of the ganglionic mass.

There is considerable variation in the diameters of both the vesicle and the statolith—.01 to .02 mm for the vesicle and .008 to .016 mm for the statolith.

When the animal is at rest, the anterior lip of the narrow, V-shaped mouth is covered by the posterior fold of the cephalic region. The lips are heavily muscled and their margins are elaborately ciliated. The mouth opens into a muscular, short, tubular pharynx the inner lining of which is heavily ciliated. Posteriorly the pharynx opens through a sphincter into the wide enteron, which narrows sharply before it reaches the posterior end of each zooid. The enteric epithelium is finely ciliated.

The pseudocoel is traversed by numerous radial muscle fibers. It is tightly filled with cells of various sizes and shapes, except for a cell-free vesicular region in the end of the last zooid.

The protonephridial system is similar to that described for the genus as a whole.

C. lemnae has been successfully cultured for several years in wheat grain infusions.

Special diagnosis.—Rugose and balustrade in appearance, width of cephalic region approximately one-half the length; cephalic region approximately one-half the length of the first zooid; protonephridium not readily obvious; large in size; chains of from 1 to 49 zooids have been observed.

***Catenula confusa* n. sp.**

Plate II, A and B

This species has been collected from ponds and roadside ditches throughout the eastern United States. It is the most common of all species of *Catenula* collected.

Single zooid specimens range from .354 to .5 mm in length; eight zooid specimens, 3.2 mm; extended worms measure from .083 to .091 mm in width. Chains of two to four zooids are of most frequent occurrence.

The general form is thread-like; the anterior end is rounded and the posterior end tapers into a blunt point. A deep pre-oral groove separates the cephalic region from the rest of the zooid. Developing fission planes of the more mature zooids form prominent constrictions at intervals in a chain. The ratio of the length of the cephalic region to the total length of the zooid in a single zooid specimen is about 1:5; in a two zooid specimen the ratio of the anterior zooid's cephalic region to the chain becomes approximately 1:8. Anteriorly the cephalic region is rounded; posteriorly it is symmetrically expanded into lateral lobes.

In reflected light the worm is milky white in appearance. Greenish granules are scattered throughout the parenchyma.

The cilia of the general ciliary coat measure about .01 mm in length. In the region of the pre-oral groove the cilia are thicker and longer.

The cephalic ganglion conforms to the general shape of the head. It is prolonged anteriorly into a point, but widens considerably between the lateral cephalic lobes. Embedded dorsally in the tissue of the posterior part of the ganglion is the statocyst which measures from .016 to .018 mm in diameter in mature zooids. The statoliths vary in diameter from .004 to .006 mm.

The V-shaped mouth is situated ventro-posteriorly to the pre-oral groove. It is bounded by muscular, heavily ciliated lips and opens into a short, muscular, ciliated pharynx. The pharynx opens through a sphincter into the ciliated enteron. In the mid-region of each zooid the enteron is distinctly widened, and as it approaches the posterior end of the zooid it narrows gradually.

Irregularly shaped cells fill the pseudocoel. Muscle strands traverse the pseudocoel in all regions of the body, and are particularly prominent at the anterior and posterior ends of the body. In contracted specimens the parenchymatous cells appear to be organized into irregular rolls.

The protonephridial system follows the generic pattern. The nephridiopore opens at the posterior end of the body.

This species does not culture under laboratory conditions.

Specific diagnosis.—Anterior cephalic region bluntly rounded; cephalic auricles at posterior end of cephalic region; cephalic region distinctly less than one-half the length of the body of a mature zooid; 1-8 zooids; statocyst embedded in postero-dorsal aspect of ganglion.

CATENULA VIRGINIA Kepner and Carter
Plate III, D and E

It has been impossible to obtain living specimens of *C. virginia* for study. The following is from the original description of Kepner and Carter (1930) and from a subsequent paper on this species by Heinlein and Wachowski (1944). *C. virginia* was collected by these authors from a stream near Scottsville, Virginia, and from Washington, D. C. The quotations used in the description are from Kepner and Carter (1930).

The spindle-shaped body of a single-zooid specimen measures about 0.5 mm; that of two zooid specimens, 1.0 mm. A chain of more than two zooids was not observed. The cephalic region is separated sharply from the body proper by a distinct pre-oral groove.

The epidermis is composed of low epithelium uniformly ciliated except for that of the oral region where the cilia are longer than those of the general body surface. The mesoderm is differentiated into an axial, coarsely granular region and a region presenting larger radiating vacuoles.

The T-shaped mouth lying on the ventral side immediately posterior to the transverse groove opens into a highly ciliated pharynx. "The pharynx opens into a sac-shaped, straw-colored enteron which may be seen projecting as ridges through the axial, granular mesenchyme."

The most conspicuous feature of the cephalic lobe is a statocyst which lies within the radial mesenchyme dorsal to the mass of axial, granular mesenchyme. On the dorsal surface of the cephalic lobe a pit extends posteriorly along the mid-dorsal line from the tip of the lobe to a little beyond its middle. The statocyst and the dorsal pit both have intimate connection with the dorsal ganglion.

"The statocyst does not lie dorsal to the cephalic ganglion as is given for its position in other species, but lies against the posterior vertical wall of the cephalic ganglion." As pointed out previously in this paper, Marcus states that this is the only position in which the statocyst is found in *Catenula*. "The wall of the statocyst is composed of an endothelium the cells of which are quite small. The statolith in life appears as an highly refractive homogeneous body; but in fixed material it appears to be a minute cell with a small amount of cytoplasm surrounding a nucleus. Within the nucleus of the statolith cell a nucleolus lies.

The median dorsal pit is lined with a modified region of the general epidermal epithelium. The cilia of this region are not much larger than those found over the general surface of the cephalic lobe or 'head.' The epithelium of the dorsal pit occupies about one-third of the dorsal width of the cephalic lobe at the region in which it lies. The general epithelium of the dorsal pit is a simple, low columnar one, except at the point where it stands in connection with the anterior nerve of the cephalic ganglion. At this point it tends to become stratified and lacks a well-defined basement membrane. Into this area, in which several layers of nuclei are found, an anterior median nerve is sent from the brain."

The protonephridium is similar to that described for the genus as a whole.

Specific diagnosis.—Not more than 2 zooids; dorsal cephalic pit present; body about .5 mm long.

Catenula leptocephala n. sp.

Plate II, C and D

This species was collected only from a small, permanent pond in the vicinity of Athens, Georgia. The total length and general size of specimens of this species vary greatly and is dependent upon nutritional state, age of zooids, and number of zooids in a chain. The usual number of zooids is two; but chains of three are not uncommon and of four are occasional. Single zooids measure .4 to .5 mm in length and .03 to 0.5 mm in width, two-zooid specimens, .5 to .7 mm in length and .03 to .06 mm in width. In extended three-zooid chains the ratio of width to length is about 1:30.

The body tapers both anteriorly and posteriorly. The cephalic region, which is about one-sixth the total zooid length, is prolonged anteriorly into a tapering snout which is about two-thirds the entire cephalic region in length. The posterior one-third of the cephalic region is expanded laterally into distinct lobes or auricles.

In reflected light the animal is milky white; in transmitted light the enteron is yellowish to brown and the parenchyma, greenish or yellowish.

Cilia of the general ciliary coat measure from .008 to .01 mm and are about four times the thickness of the epidermis. In the pharyngeal region the cilia are thicker, stouter, and longer than those in other regions of the body. With the exception of the cilia at the end of the last zooid, the cilia appear to be in almost constant motion.

Conforming to the general shape of the head, the cephalic ganglion is roughly triangular with its greatest width in the region of the posterior lateral expansions. Anteriorly it is prolonged into a tapering point extending about three-fourths the length of the cephalic region.

Embedded dorsally in the tissue of the ganglion at the point of greatest width is the refractive statocyst measuring from .008 to .01 mm in diameter. This structure carries a statolith measuring approximately .004 mm.

The V-shaped mouth lies just posterior to the ciliated pre-oral groove. The lips are well muscled and heavily ciliated with the anterior lip somewhat concealed by the posterior head margin. The mouth opens into a muscular, ciliated, tubular pharynx. At its posterior end the pharynx opens by a sphincter into the wide sac-like enteron which almost completely fills the space within the body wall. The enteron extends almost to the end of the zooid and conforms to the tapering shape of the body.

The cells of the pseudocoel are of various sizes and shapes and their cytoplasm appears fairly granular. Transverse muscular bands are not apparent.

The prominent protonephridial system conforms to the general pattern for the genus (fig. I). The protonephridial pore is located at the posterior end of the last zooid.

Special diagnosis.—Rarely more than 1 mm in length; cephalic region elongated anteriorly into a point; cephalic auricles located just anterior to the pre-oral groove; cephalic region approximately one-fourth to one-eighth the length of the anterior zooid; pseudocoel in region of enteron fairly narrow; protonephridium easily observed; chains of more than four zooids unknown.

CATENULA SEKERAI Beauchamp
Plate III, A, B, C

This species was collected in large numbers on several occasions over a period of two years from a clear, cool pond located seven miles south of Valdosta, Georgia.

There can be little doubt that the species described here is identical with *C. sekerai* Beauchamp. It has two unique features exhibited by *C. sekerai*, namely, lateral lobes in the middle of the cephalic region and a statocyst located far anterior to its usual position in the genus. Although Beauchamp's description is none too extensive, comparison of other features also support this diagnosis of specific identity.

Measurements show the specimens to average .55 mm in length. Maximum observed length of a two zooid specimen was approximately .95 mm. In diameter the range is from .04 to .055 mm. Chains of more than two zooids have not been observed.

In general the body is cylindrical and somewhat flattened ventrally. Viewed dorsally the worm shows slight tapering from the pharyngeal region forward to the bluntly rounded anterior end. The posterior one-third of the body tapers sharply to terminate as a rounded point.

The cephalic region is distinctly marked off from the rest of the body by a deep pre-oral groove. The anterior two-fifths of this region is dorso-ventrally compressed and is somewhat spatulate in appearance. The middle one-fifth is distinctly dilated laterally and ventrally. The posterior two-fifths is narrowed anteriorly but gradually increases in diameter as it proceeds posteriorly.

About midway in the pharyngeal region there are pronounced constrictions in the lateral body wall.

In reflected light the animals are milky white, but in transmitted light the epidermis, pharyngeal, and cephalic regions are translucent and brownish in color. The depth of color of the enteric region is largely dependent on the food content and is generally of a darker brown color.

The general ciliary coat is uniform, prominent, and the ciliary length is about two and one-half times the epidermal thickness. The cilia on the anterior and posterior borders of the pre-oral groove are stout and long. The epidermis is rather thin, measuring .0033 mm in thickness.

The cephalic ganglion is roughly diamond shaped with the greatest width occurring about midway of the cephalic region between the median cephalic dilations. The anterior apex extends well forward; the posterior apex terminates near the pre-oral groove.

The statocyst lies embedded in the dorsal side of the ganglion along the midline in the region of the greatest ganglionic width. The statocyst's vesicle averages about .01 mm in diameter; the centrally located statolith, approximately .004 to .005 mm.

There appear to be two pairs of small latero-dorsal ciliated depressions: an anterior pair just in front of the median cephalic dilation and the posterior pair immediately behind this dilation. This species fixed so poorly that details of the cephalic region could not be satisfactorily studied.

The anterior margin of the V-shaped mouth is located on the midventral line just posterior to the pre-oral groove. The lips are well muscled and bear

on their exposed surfaces extremely long and stout cilia. Similar cilia are also apparent on the ventral and lateral margins of the pre-oral groove. The mouth opens into a ciliated, tubular pharynx which is deeply constricted in the mid-region. The original description calls for glands throughout the length of the pharynx and cells which may well be glandular were observed in this region.

Posteriorly the pharynx opens through a sphincter into the enteric tube. This tube conforms to the general shape of the posterior end of the body and extends almost to the end and in a single-zooid specimen. The enteric epithelium is composed of large cells, but the enteric lumen is relatively wide and is continuous throughout most of the length of the enteron.

Even though there is little pseudocoelic space, in both the pharyngeal and cephalic regions the pseudocoel contains many large, finely granular cells. Traversing the pseudocoel at various points may be seen evidence of the radial musculature.

The protonephridial system conforms to the common pattern for the genus.

Specific diagnosis.—Pseudocoel in region of enteron distinctly narrow; lobes or dilations located midway in the cephalic region; cephalic ganglion roughly diamond-shaped; two pairs of cephalic, latero-dorsal depressions which resemble ciliated pits, statocyst located near center of cephalic region.

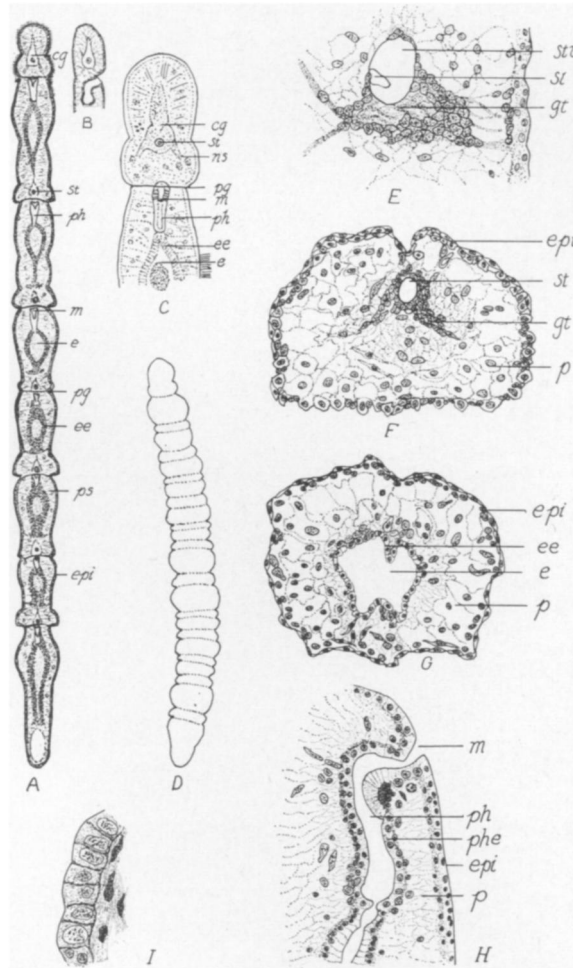
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ABBREVIATIONS FOR PLATES

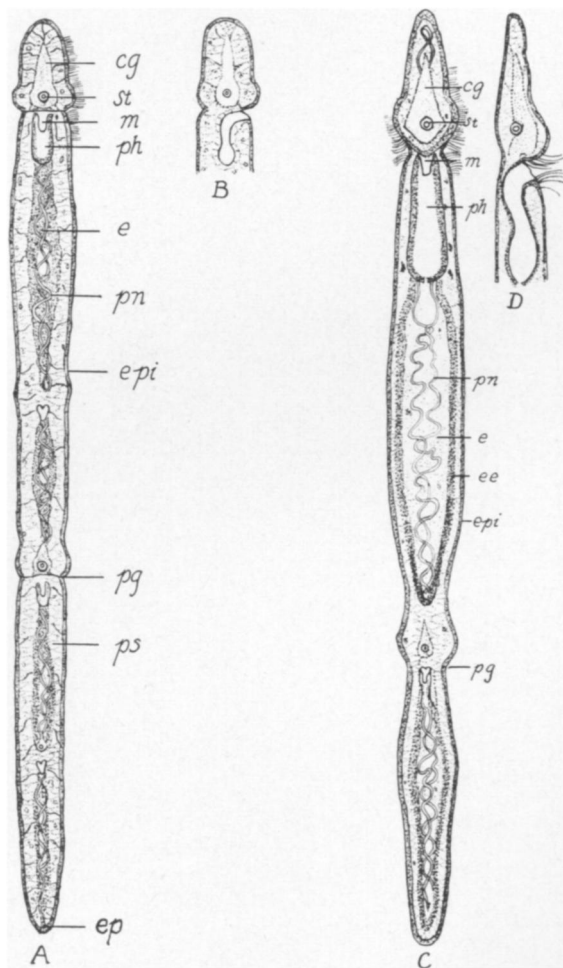
c, region in epithelium of floor of dorsal pit; cg, cephalic ganglion; cp, ciliated pit; dp, dorsal pit; e, enteric cavity; ee, enteric epithelium; en, enteron; ep, excretory pore; epi, epidermis; gm, granular, axial mesenchyme; gt, ganglionic tissue; m, mouth; ns, nerve stem; p, parenchyma; pg, pre-oral groove; ph, pharynx; phe, pharyngeal epithelium; pn, protonephridium; ps, pseudocoel; rm, radial mesenchyme; s, sphincter; sl, statolith; st, statocyst; stv, statocyst vesicle; tg, transverse, pre-oral groove.

PLATE I



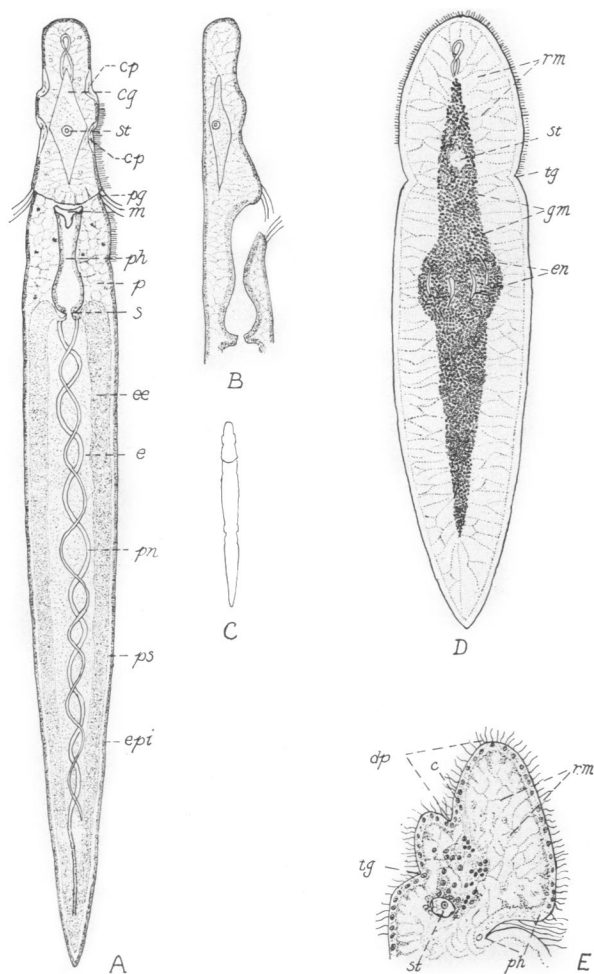
A. Dorsal view of *C. lemnae*. B. Lateral aspect of cephalic and pharyngeal regions. C. Enlarged cephalic region. D. Outline of a contracted specimen. E. Longitudinal section through cephalic ganglion. F. Cross section through enteron. G. Cross section through the pharynx. H. Longitudinal section through the pharynx. I. Portion of the epidermis showing the longitudinal musculature.

PLATE II



A. Dorsal view of *C. confusa*. B. Lateral aspect of cephalic and pharyngeal regions.
C. Dorsal view of *C. leptcephala*. D. Lateral aspect of cephalic and pharyngeal regions.

PLATE III



A. Dorsal view of *C. sekerai*. B. Lateral aspect of cephalic and pharyngeal regions. C. Outline of two zooid specimen. D. Dorsal view of *C. virginia* (redrawn from Kepner and Carter, 1930). E. Sagittal section through axis of cephalic lobe (redrawn from Kepner and Carter, 1930).