1966

The Freshwater Tricladida of the Florida Parishes of Louisiana.

William Douglas Longest
Louisiana State University and Agricultural & Mechanical College

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LONGEST, William Douglas, 1929—
THE FRESHWATER TRICLADIDA OF THE
FLORIDA PARISHES OF LOUISIANA.

Louisiana State University, Ph.D., 1966
Zoology

University Microfilms, Inc., Ann Arbor, Michigan
THE FRESHWATER TRICLADIDA OF THE
FLORIDA PARISHES OF
LOUISIANA

A Dissertation

Submitted to the Graduate Faculty of
the Louisiana State University
and Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Zoology and Physiology

by
William Douglas Longest
B. S., Baylor University, 1954
M. S., Baylor University, 1956
I wish to express my appreciation to Dr. Walter J. Harman for suggesting this problem and for his counsel and encouragement throughout its accomplishment.

Dr. Henry J. Werner is due a large amount of credit because of his advice and counsel on stains and sectioning. He was never too busy to help or advise me about procedures.

I want to give credit to Mr. Harry Henson, Woodlawn High School, Mr. A. W. Romano, Mr. R. E. Tandy, my colleagues in graduate school, and Dr. Walter J. Harman for bringing me collections of worms.

I cannot avoid giving a large amount of credit for the success of the study to my wife, Catherine, who has typed, criticised, encouraged, and gone along on field trips to help collect worms.

I wish to express my gratitude to Dr. Roman Kenk, Division of Invertebrates, Smithsonian Institution, United States National Museum, for checking my identifications.
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ABSTRACT

Fifty-three collections of triclad were obtained from the streams, rivers, ponds, and lakes of the Florida Parishes from November 1963 to March 1966. In these, two families were represented by six genera. The area included East Feliciana, West Feliciana, Saint Helena, Tangipahoa, Washington, Saint Tammany, Livingston, East Baton Rouge, Ascension, and a corner of Iberville parishes.

The Family Planariidae was represented by Dugesia tigrina, Cura foremanii, Hymanella retenouva, Planaria dactyligera, and Phagocata gracilis gracilis. The Family Dendrocoelidae was represented by Procotyla fluviatilis. Dugesia tigrina is well distributed in the study area, existing as sexual and asexual races. Cura foremanii, Phagocata gracilis gracilis, and Procotyla fluviatilis were collected from clear, flowing streams and are rheophilic. D. tigrina is limnadalophilic because it exists as large populations in standing waters or sluggish streams. Hymanella retenouva and Planaria dactyligera were collected from standing water in two sites in
Livingston and Saint Tammany parishes, respectively. The collection of these species as sexually mature specimens in the spring season indicates they reproduce sexually in Louisiana. Besides Dugesia tigrina, reported in 1939, the study establishes and extends the range of five other species.
INTRODUCTION

The triclad fauna of Louisiana has not been thoroughly investigated. A search of literature revealed only one report on triclads in the state. Hyman (1939a) reported that Dr. Ira George sent her specimens from Baton Rouge and that only asexual worms were found in Louisiana. My study gives additional information about these animals. I have attempted to investigate the distribution, and the conditions under which the animals live in the study area. In two cases the life cycle was studied. The lotic and lentic environments of the area compare favorably with those described by Kenk (1935) in his study of Virginia triclads and in 1944 on those of Michigan.

The area of study includes the 10 parishes, known as the Florida Parishes, between the Pearl River on the east, the Mississippi River on the west, the Mississippi state line on the north, and the brackish water of Lake Maurepas and Lake Pontchartrain on the south. The Amite, the Comite, and the two rivers named as boundaries serve as drainage tributaries. These streams drain into a swampy area north of Lake Maurepas and Lake Pontchartrain or
into the Gulf of Mexico. Many of the minor streams are probably spring fed because they are small and flow even during the dry season.

The topography of the Florida Parishes ranges from low swampy areas in the southern parishes to rolling hills in the northern parishes. The highest elevation above mean sea level is along the northern parts of the parishes that border on the Mississippi state line with a gradual slope toward the lakes to the south and to the rivers and streams that traverse the area. The greatest height above sea level on the geological survey map is 360 feet in Washington Parish. The lowest point is 5 feet above sea level along the shores of Lake Pontchartrain and Lake Maurepas. The swamps and marshes are only 5 to 10 feet above sea level. As much as 200 feet of difference exists in the northern parishes indicating the slope and the hills present in these areas. It also indicates the flow of water toward the gulf and lakes.

The dominant vegetation in the wooded area is pine or hardwood, which is composed of oak, gum, maple, magnolia, and hickory. The pine areas are found as isolated stands in the eastern parishes. The trees influence the animals that live in the streams and even determine their presence. The debris consisted of limbs, dead leaves, grass, and
stems of water plants. The contribution to the habitat by plants is difficult to assess, even though the presence of debris from them is necessary for many animals.

This study was undertaken to determine the species present in the numerous aquatic habitats of Southeast Louisiana and to record the temperature and type of water they were found inhabiting. The conditions investigated by others making surveys in the triclad faunas were water temperature, whether the water was flowing or standing, and the conditions of the stream such as type bottom and debris present. The collecting and field observations were made from November 1963 to March 1966.
MATERIALS AND METHODS

The equipment used to make collections consisted of: fine mesh dip nets, plastic buckets with tight fitting tops for bringing back water and debris, white plastic pans, a centigrade thermometer, and several different kinds and sizes of medicine droppers.

Leaves and other debris were scooped from the place of collection, and rooted vegetation was swept with the dip net. This material was examined for worms at the site in the white plastic pans. If any worms were found, they were placed in a plastic refrigerator box containing some of the water from the collection site. The debris and water were then put into a bucket with a fitted top and taken to the laboratory for further observation. When the water and debris remain undisturbed in the buckets overnight, the worms come to the surface and congregate along the edge of the water. The specimens are easily detected and can be picked out with a medicine dropper. Occasionally, worms were collected at the site in large numbers by dipping them from the edge of the stream, slough, or seep hole.
The immature worms were kept in a refrigerator at a constant temperature and fed on a regular schedule. These animals seemed to thrive best at temperatures ranging from 13° to 20° C. Jenkins and Brown (1964) in a study on *Dugesia dorotocephala* used a temperature of 18° C. My animals were fed beef liver, earthworm bits, or mealworm twice a week. Jenkins and Brown (1964) fed their animals once a week; however Hyman (1959) recommended feeding three times a week. Initially the feeding schedule recommended by Hyman was tried along with a group fed once a week. Those fed once a week grew slowly while the worms fed three times per week grew rapidly with an increased fission rate. A schedule of twice a week was instituted and found to give sufficient growth without as much bacterial growth and fouling of the water as occurred in the three times a week schedule. At first the water was changed after every other feeding to keep down bacterial growth and to prevent it becoming foul. Eventually, it became necessary to change after every feeding since this is the safest method to prevent loss of cultures. Aged tapwater was used in the early phase of the study to replace the culture medium. The worms responded to it by writhing on the bottom of the dish for as long as 15 minutes. The next day the cultures often showed
many indications of rapid fission. There were numerous tail pieces and many worms were without half their body. Because of this response to the aged tapwater, I began looking for another source of culture medium. A balanced salt solution was tried but the worms responded so violently to even a very weak solution that it was abandoned. In the salt solution the worms decreased in size and some even died. Then water from the fish pool was tried as a culture medium. The pond water was filtered twice to remove algae and dirt, then its temperature was equalized with that of the water already in the culture dishes by placing it in the refrigerator. In winter the pond water temperature was almost the same as that in the dishes. The worms did not show adverse signs of response to the conditioned habitat water from the pool.

In the early part of the study the worms were kept in glass finger bowls, but these were replaced by plastic freezer boxes with tight fitting tops. The plastic is translucent; thus, the worms were not subjected to strong light upon removal from the refrigerator for feeding. The tight top also prevents excessive evaporation of water.

Attempts to induce sexual maturity were made using a temperature of 10° C for a week then elevation to 15° C. In both plastic and glass containers, culture of the
worms to sexual maturity was successful in a number of cases. By culture is meant the maturing of the worms, their depositing cocoons, and these cocoons breaking to release young worms after a period of development. Some species of worms could be maintained at 12° C to 15° C and develop into mature worms. *Cura foremanii* was kept at a constant temperature and produced cocoons that hatched. This species produced a second generation within nine months from the date of collection in three cases. *Dugesia tigrina* must have the lowered temperature then elevation to become mature. The Wards Creek collection produced cocoons in November following a temperature depression in October of 1964.

The examination of mature specimens for species identification must be made on the reproductive structures in flattened, extended worms according to Hyman. Kenk (personal communication, 1966) reported, however, that he had found these structures better preserved in a worm killed quickly, even though they curl in the killing and fixing agent. Several methods of killing and fixing were used to select the one that gave the best details of reproductive structures. The method suggested by Hyman (1959) for killing with 2-per cent nitric acid, followed by fixation in a saturated solution of corrosive sublimate
in 0.9 per cent sodium chloride solution for from 30 minutes to six hours gave the best extended and flattened specimens. The worms were placed on a sheet of glass plate, excess water removed, then the nitric acid was dropped on them. They were flooded with fixative after two minutes. Helly's fluid used as the fixative after killing with the nitric acid, caused the worms to be hard. Gilson's fluid, tried as both killing and fixing agent, proved to be acceptable, even though it caused swelling and separation of tissues in the anterior region of the specimens. In his letter Kenk suggested the use of a saturated solution of corrosive sublimate heated to a temperature of 40° to 60° C and De Beauchamp's method. Both methods gave worms that were curled excessively. However, the copulatory complex was in good condition.

Routinely, Hyman's method gave the best results, but the excess mercuric chloride must be removed since it gives crystalline artifacts in tissue according to Humason (1961). I did not observe any of these crystals in sections. Because of the time involved, the methods of Kenk could not be tried enough to come to a conclusive decision.

After fixing, the worms were washed in water if corrosive sublimate (mercuric chloride) was in the fixative. The specimens were then passed up the alcohol series
for dehydration to 70 per cent alcohol. Iodine in 70 per cent alcohol was used for 12 hours to remove the excessive amounts of mercuric chloride, then the iodine was washed out with several changes of alcohol.

In collections having more than five specimens, some were made into whole mounts. These were passed down the alcohol series to water, then to Mayer's carmalum stain for 24 to 48 hours. While in the stain the specimens were checked regularly to see how much stain had been taken up. When they appeared to have enough stain they were dehydrated and cleared. An ethyl alcohol series of 10, 35, 70, 90, and two changes of absolute, then to either methyl salicylate of 50-50 xylene-alcohol followed by two changes of xylene. In each solution the worms remained a minimum of 45 minutes but no longer than an hour. A prolonged stay in the alcohols above 95 per cent produced excessive hardness and brittleness. The worms were then mounted in Hareco resin on thin slides.

The sectioned worms were imbedded in tissue mat, paraffin melting between 54° and 55° C, after clearing with the alcohol and xylene series. The specimens remained in each solution of the clearing series for one hour. The worms were infiltrated with two changes of melted paraffin for one hour maximum in each change. They were
then imbedded in fresh melted paraffin. Two problems encountered in the imbedding procedure were excessive hardness and bubbles in the paraffin that condensed about the specimen. The hardness of the specimen was overcome by reducing the time in the oven one hour for each change of melted paraffin. To avoid the air bubbles a heated scalpel was thrust into the melted paraffin after it was poured in the paper boat but before the specimens were added. The air bubbles rose to the surface and broke. The paraffin was then solidified about the specimen by lowering the boat gently into ice water.

The examination of reproductive structures was made on sectioned material cut on the rotary microtome at a thickness of 15 microns at first, but at the suggestion of Dr. Roman Kenk the thickness was reduced to 10 microns. The reduction in thickness was made so that the smaller ducts would be revealed more clearly. Both sagittal and cross sections were cut for examination when collections contained more than one worm, but when just a single specimen was available, only sagittal sections were cut. Sagittal sections reveal more about the reproductive structures than cross sections.

The sections were attached to the slides with Mayer's albumin. This was accomplished by smearing the slide with
albumin, then putting on distilled water. Next, the sections were lifted onto the water surface with a camel's hair brush. These slides with floating sections were placed on a warming plate set at 41° C, which caused the sections to expand upon the water before adhering to the slides as the moisture evaporated. The slides were numbered serially and identified with the number of the collection. The number of slides required to mount a serial section varied from three to 40, depending upon the size of the worm and thickness of section.

The sectioned specimens were stained with Harris's hematoxylin and counterstained with eosin. The same Harleco synthetic resin was used to mount the stained sections. Both whole mounts and mounted sections were dried on the warming plate for two or more days.

After identification the specimens were labeled with the name, location of site, and date of collection.
DESCRIPTION OF COLLECTION LOCALITIES


4. Livingston Parish. Stream 0.1 mile north of La. Hwy 42, 1 mile east of Springfield, La. 25 April 1964. Collected from flowing water on dead grass along the edges of the stream, some leaf litter in the water. 1 *Dugesia tigrina*.

clear, rapidly flowing water. Water temperature 20° C. 1 *Cura foremanii*.


44. Tangipahoa Parish. Slough north side of highway east of Baptist, La. on U. S. Hwy 190. 2.4 miles from Livingston Parish line. 24 October 1964. Clear water with large amount of duckweed. Water temperature 19° C. 60 *Dugesia tigrina*.


47. Saint Tammany Parish. Abita River on U. S. Hwy 190 14.8 miles east of Tangipahoa Parish line. 24 October


63. East Baton Rouge Parish. Creek, 2.9 miles south of


94. Ascension Parish. Grand Goudine Bayou, 5.8 miles east of Iberville Parish line on La. Hwy 74. 6 February 1965. Dark water obscured objects in 3 inches, mud bottom, a large amount of debris from plants. 20 Dugesia tigrina.


2 Cura foremanii.


132. Washington Parish. Foster Creek, 2.2 miles east of Angie, La. on La. Hwy 1071. 31 May 1965. Clear,
flowing stream with some debris. Water temperature 22° C. 1 Cura foremanii and 1 Phagocata.


137a. Tangipahoa Parish. Slough, Baptist, La., 2.3 miles east of Livingston Parish line of U. S. Hwy 190. 6 June 1965. Standing water with large amount of duckweed on surface. 35 Dugesia tigrina.


140. East Baton Rouge Parish. University Lake at spillway on Stanford Avenue, Baton Rouge, La. 5 October 1965. Clear, flowing water. Water temperature 20° C. 8 **Dugesia tigrina**.


151. Livingston Parish. Seep hole, 0.1 miles north of La. Hwy 42, 1.2 miles west of Springfield, La. 5 March 1966. Water clear with brownish precipitate, large amount of leaves in water. Water temperature 14.5° C. 41 Hymanella retenuova.

153. East Baton Rouge Parish. University Lake spillway on Stanford Avenue, Baton Rouge, La. 8 March 1966. Water clear and flowing. Water temperature 11° C. 75 Dugesia tigrina, many of which were approaching
maturity.

156. East Baton Rouge Parish. University Lake spillway on Stanford Avenue, Baton Rouge, La. 26 March 1966. Water clear and flowing. Water temperature 15° C. Many mature worms present with many cocoons. 50 *Dugesia tigrina.* Specimens in collections 38, 39, 52, 57, 59, 60, 63, 64, and 69 died before they could be identified. Nineteen of the localities were beyond the range of this study, either in Louisiana or Mississippi.
TAXONOMIC LIST

Family Planariidae

This family comprises all the freshwater triclads having the inner muscular zone of the pharynx composed of distinct inner circular and outer longitudinal layers. There is no adhesive organ on the anterior margin.

*Cura foremanii* (Girard, 1852)

Plates II and V.

*Dugesia foremanii*, Girard, 1852, p. 211.

*Planaria simplissima*, Curtis, 1900, p. 447.

*Planaria simplissima*, Stevens, 1907, p. 350.


*Cura foremanii*, Strand, 1942, p. 388.

The living animal is dark gray, sometimes with a tinge of brown dorsally; the bluntly triangular head has very blunt and inconspicuous auricles with a unpigmented spot on the posterior of each; two eyes are present; pharynx is single and unpigmented. The mature worms are 8 to 15 mm long and 2 to 5 mm wide. The largest of my specimens
was one that had been kept in the laboratory for six months. Kenk (1944) gave a maximum width of 4 mm. Drawings and a picture of the species are shown by Kenk (1935).

The spherical cocoon is attached by a stalk to the container, rocks, or other objects in water. The cocoon is light brown when first deposited but turns black with age.

The copulatory complex consists of a cylindrical penis having a distinct bulb. The seminal vesicle is a round enlargement within the bulb and connects with the vasa deferentia, each coming from the testes along each side of the body beginning anteriorly just behind the ovary. The ejaculatory duct is the continuation of the seminal vesicle of the bulb into the penis. The vesicle gradually narrows to the end of the penis papilla. The gonopore, located on the ventral surface less than half the distance between the mouth at the end of the pharynx and the posterior end, opens into the common antrum that branches into the male antrum anteriorly about the penis and the female antrum dorsally. The copulatory duct, passing from the female antrum, first dorsally, then anteriorly, usually ends blindly near a gut diverticulum, but does not join with the lumen of the gut. The common oviduct, formed by the union of the oviducts, joins the female antrum posteriorly. The tissue about the antra is strongly
eosinophilic. Plate V shows the copulatory complex of this species from Louisiana.

_Cura foremanii_ was collected at one site each in Saint Helena, West Feliciana, East Baton Rouge, East Feliciana parishes and from three sites in Washington Parish.

_Cura foremanii_ has been reported by Kenk (1935, 1944) from Virginia and Michigan. Hyman (1951) gave additional distribution in Canada, New England, North Carolina, and Tennessee in cool creeks and rivers. The collection of this species in Louisiana extends the range and suggests that it may be more common in the United States than has been thought previously. Plate II shows the distribution in the study area.
Dugesia tigrina (Girard, 1850)

Plates I and VI

Planaria maculata, Leidy, 1847, p. 252.
Planaria tigrina, Girard, 1850, p. 264.
Dugesia maculata, Girard, 1851, p. 1.
Euplanaria novangliae, Hyman, 1931a, p. 326.
Dugesia tigrina, Hyman, 1939b, p. 266.

Dugesia tigrina from Louisiana has a definite triangular head: oval auricles, two eyes, single pharynx, dorsal surface spotted brown to brown with black on white, and in some cases an unpigmented streak is down the mid-dorsal surface. The ventral surface is white and the pharynx is pigmented. Both sexual and asexual races occur in Louisiana. The length varies from 7 to 20 mm and width from 1 to 3 mm. The sexual specimens are stouter and wider but not longer than those of the asexual race, which attain a length of 20 mm but are less wide than sexual specimens under laboratory conditions. Kenk (1944) reported a length of 25 mm for asexual races. Sexual specimens are
usually 11 to 15 mm long and 2.5 mm wide. The asexual specimens, as well as the sexual specimens, were fed twice a week and kept at a temperature of 13°C. The temperature was lowered to 10°C on four different occasions, then raised to 15°C in an attempt to stimulate sexual maturity in the immature specimens. The only ones to reach maturity were from localities where sexual races were found in nature. The immature specimens were smaller when collected; and if they belonged to an asexual race, they remained thin and narrow, but grew longer in the laboratory.

The copulatory complex of D. tigrina in Louisiana consists of the copulatory bursa, antrum of three areas, ovaries, testes, penis, and ducts connecting these. The ovaries are behind the brain medial to the nerve cords. Testes are along each side of the body beginning just behind the ovaries and extending to the posterior end. The ovovitelline ducts are adjacent to the ovary and extend posteriorly. These ducts conduct the fertilized ova to the antrum and receive yolk cells from the yolk glands as they pass posteriorly. The gonopore is posterior to the mouth on the mid-ventral surface and opens into the common antrum which branches into the male antrum anteriorly and the female antrum dorsally. The male antrum surrounds the penis papilla. The penis has a large
muscular bulb with concentric layers of muscle. These muscle layers pass outward into the papilla. The vasa deferentia enter the bulb separately, enlarge, and unite to form the seminal vesicle that narrows into the papilla as the ejaculatory duct. The ovovitelline ducts join posterior to the female antrum, becoming the common oviduct which enters the copulatory bursa as it passes dorsally. The bursal canal or duct, after junctioning with the oviduct, turns anteriorly above the penis papilla and bulb to enlarge anterior to the latter complex as the copulatory bursa. Plate VI gives drawings of the variants found in Louisiana. In some of the Louisiana specimens, intestinal diverticula were between the buccal cavity and the complex as shown in figure B of Plate VI.

*D. tigrina* deposits a round, stalked cocoon that it attaches to the underside of rocks, to other objects below water level, and to the sides of the culture dishes. In University Lake on the L. S. U. Campus the species is sexually mature in March, at which time many cocoons are found under rocks. Kenk (1937) observed a similar situation in studies of worms brought into the laboratory of a sexual race from Massachusetts. In 1941 he presented further data in support of an annual cycle. Hyman (1951a) prefers to think of this being a cyclic rhythm and implies
that it can be brought about in the laboratory at any
time by manipulation of temperature. Apparently, in
Louisiana the temperature stimulus is sufficient in winter
to induce the animals to become sexual. Several attempts
in the laboratory failed to induce sexual maturity after
March. Hyman thinks they need a period of time between
each period of sexual activity.

The color patterns vary in University Lake on the
L. S. U. Campus from a spotted brown to gray with black.
Some have a mid-dorsal light streak. The color pattern
of the asexual race from Baptist, La., showed only the
spotted pattern of brown with a few black spots on white.
Hyman (1939b) said two principal color patterns are spot-
ted and striped with several minor color patterns. A
uniform brown coloration, consisting under magnification
of fine granulation, is not uncommon, while some with
shades of mauve, red, and yellow have been reported. One
had finely granulated dots more or less reticulated on
reddish brown ground according to Hyman. None of the
unusual minor color patterns was found in Louisiana.

This species was collected from all the parishes
studied giving a total of 36 localities (distribution map
Plate I).

Hyman (1951b) reported that *Dugesia tigrina* is
distributed throughout the United States and Canada in ponds and rivers. Dahm (1958) reported that asexual races of the species had been found in Europe and Britain. My study confirms Hyman (1939b) about the asexual race in Louisiana and also adds the sexual race.

Kenk (1935, 1944) shows pictures and drawings of the copulatory complex. Hyman (1931a, 1939b) gives illustrations of the color patterns and copulatory complex. These agree with the material collected in my study.
Phagocata gracilis gracilis (Haldeman, 1840)

Plates II and VII

Planaria gracilis, Haldeman, 1840, p. 3.
Phagocata gracilis, Leidy, 1847a, p. 248.
Phagocata gracilis gracilis, Hyman, 1951b, p. 161.

The living animal is blackish brown above and lighter ventrally, has a truncate head with slight auricles, has two eyes in the normal position, is polypharyngeal, and has a rounded posterior end. The living worms are 7 to 20 mm long and 1 to 2.5 mm wide. The largest sexually mature worms were from a collection that had been maintained in the laboratory for nine months. Woodworth (1891) reported the largest specimens to be 30 mm long and 4 1/2 mm wide. Hyman (1937) said the adults are large, 20 mm or more in length and stout owing to presence of numerous pharynges. These worms matured in the early months of 1966, at which time they deposited several spherical, un-stalked cocoons that lay free on the bottom of the culture.
vessel.

The worms were collected from clear, flowing water in Saint Tammany and Washington parishes. The temperature of the water varied from 20° C to 26° C. In three streams the worms were collected by sweeping vegetation in the streams with the dip net, while in the other streams the worms were removed from beneath a rock.

The Louisiana specimens are like those described by Hyman (1937) and Kenk (1935) with the exception that the penis papilla is not as elongated as that shown by Kenk and Hyman. This is assumed to be due to contraction of the specimens. The bursal canal, opening above the gonopore, is located dorsal to the penis and extends anteriorly to the large copulatory bursa behind the pharyngeal area. The common oviduct descends to open into the roof of the male antrum anterior to the union of the male antrum and common antrum. The terminal portions of ovovitelline ducts and common oviducts are in an area of numerous eosinophilous glands cells.

The testes, lying between intestinal diverticula on each side of the body, extend to the posterior end. The vasa deferentia pass on each side of the pharyngeal cavity, each enlarging into a bulbar region, called the false spermiducal vesicle. The location of this enlargement is
the area beside the buccal cavity surrounding the pharynges. Each vas deferens twists about posterior and ventral to the bulb, and then turns anteriorly to enter the bulb separately from below. The vasa deferentia unite, then open into the enlarged cavity of the bulb, the seminal vesicle, which opens into the ejaculation duct.

Plate VII shows a sketch of the copulatory complex of a Louisiana specimen.

Hyman (1951) reported the species in Pennsylvania and Virginia westward to Missouri, mostly in springs. Hyman (1937) said polypharyngeal specimens, which she received some years ago from Chattanooga, Tennessee, were presumably Phagocata gracilis. I collected this species in a spring in east Tennessee in 1963 and can therefore confirm Hyman's determination. The extension of the range into Louisiana is not surprising, and the species probably has a wide distribution.

The other two subspecies are Phagocata gracilis woodworthi Hyman and Phagocata gracilis monopharyngea Hyman. They are both indistinguishable from P. gracilis gracilis by means of external characters (Hyman, 1951). Phagocata gracilis woodworthi is polypharyngeal and has a short truncate penis papilla. Phagocata gracilis monopharyngea possesses a single pharynx and probably a
tubular spermiducal vesicle, and the penis papilla is conical and pointed but less elongated than in *gracilis*, according to Hyman (1951). *Phagocata gracilis woodworthi* is distributed in New England westward to the Delaware River. *Phagocata gracilis monopharyngea* is found in Iowa.
Hymanella retenuova Castle, 1941

Plates II and VIII

Hymanella retenuova Castle, 1941, p. 85.

Planaria simplississima, Chidester, 1908, p. 226.

This species in Louisiana is light gray dorsally with little pigment ventrally. The head is truncate, bearing two eyes; if auricles are present, they are slight. The specimens are monopharyngeal and have a pointed posterior end. The length is from 5 to 10 mm and the width is 1 to 1.5 mm.

When collected, many of the specimens were carrying cocoons in the antrum, which they continued to do for a time. The cocoon is oval and unstalked. Under proper conditions the specimens continued to deposit cocoons, but the culture gradually wanes even under the best of care in the laboratory. The worms disintegrate after a period of time, possibly due to age.

The antrum is large and elongated, with the poorly developed penis on the anterior end. The male antrum is lined by a columnar epithelium both dorsally and ventrally. The gonopore opens into the posterior ventral end, where
the bursal canal originates and goes dorsally; then the canal of the antrum turns anteriorly to the copulatory sac anterior to the penis. The oviduct opens into the dorsal posterior side of the antrum just anterior to the junction of the bursal canal or duct into the antrum.

In all respects, this species conforms to Castle's 1941 description except it has the truncate head described for it by Hyman (1955).

Hyman (1955) reported collections of this species from vernal pools in North Carolina and Delaware.

Castle (1941) collected specimens upon which his description was based from a spring-fed swampy stream in Seeknok, Massachusetts. He also collected these in 1937 at Brown University.
Planaria dactyligera Kenk, 1935

Plates II and IX


The living animal has a truncate head and two eyes, is gray dorsally and lighter ventrally. They are from 8 to 11 mm long and 2 mm wide at maturity. Examination of serial sections shows an adenodactyl running slightly to the right caudad and dorsoventrally from the gonopore. The adenodactyl is not solid in any of the Louisiana specimens, as reported by Kenk (1935). Strands of mucous from the cells line the central region indicating it was filling. The adenodactyl, bursal canal, and antrum open into the region near the gonopore. The common oviduct, formed by the union of the two ovovitelline ducts from each side, opens into the roof of the male antrum. The male antrum is anterior to the gonopore and fits the cone-shaped penis papilla. The bulb of the penis consists of concentric layers of muscle extending into the papilla. In the posterior region of the bulb the vasa deferentia enter separately from each side, one entering dorsally, the other ventrally. These enter the seminal vesicle together.
Prior to reaching the area anterior to the bulb, the vasa deferentia enlarge to form false seminal vesicles on each side of the buccal cavity. The spherical seminal vesicle tapers into the ejaculatory duct that passes through the center and to the end of the penis papilla. The copulatory duct or bursal canal arises above the gonopore posterior to the antrum, passes a little to the right side above the antrum cephalad to the large copulatory bursa lined by columnar epithelium.

A sketch of the copulatory complex of a Louisiana specimen is given on Plate IX.

The specimens were collected from a wash hole at the end of a culvert in Abita Springs State Park, Abita Springs, La. The non-flowing water had a temperature of 16° C. The wash hole had a mud bottom with only a few leaves.

The species was described by Kenk in 1935 from springs and spring-fed ponds and swamps in Virginia. The present location was examined for a spring but none was found. The area around the wash hole, above and below, was swampy.

My specimens conform to the description given by Kenk, except that in two worms the testes do not extend to the end of the pharynx on each side, but end a little short of half the pharynx length.

This is the second report of this species in the United
States, and the only species of the genus found in North America. Hyman (1959) listed only *Planaria dactyligera* in her key of the triclads.
Phagocata species

Plate II

These were taken in collections from Saint Helena and Washington parishes. All the specimens had a truncate head, were monopharyngeal, were gray, white with gray spots, or black.

Collection 102 from Saint Helena Parish came from a stream that was clear and flowing with drifts of leaves. The water temperature was 9° C. The worms were 4 to 6 mm long and 1 mm wide. All were immature and began to die shortly after they were brought to the laboratory. A number were killed, but those remaining in three culture dishes died. Those killed were too immature for identification.

Collection 132 consisted of one immature black worm with a truncate head and a single pharynx. It was killed when 10 mm long and 3 mm wide at the widest point.

Collection 82 consisted of two worms with gray spots on creamy white having truncate heads. They were both past maturity and could not be identified as to species.

Collection 90 consisted of four immature worms. They
had truncate heads and were gray dorsally.

Collection 105 contained one immature worm with a truncate head and gray spots over the dorsal surface.
Family Dendrocoelidae

The family consists of those freshwater triclad species having the circular and longitudinal muscle fibers of the inner muscular zone of the pharynx intermingled. An adhesive organ and eyes are usually present.

*Procotyla fluviatilis* (Leidy, 1857)

Plates II and X

*Procotyla fluviatilis* Leidy, 1857, p. 23.


*Procotyla fluviatilis*, Hyman, 1928, p. 222.

The specimen upon which the identification was made was collected in Washington Parish from Lawrence Creek (collection 119).

The specimen had a well developed copulatory apparatus, consisting of a large penis bulb, penis, copulatory bursa, and common gonopore. This complex is situated caudad to the pharyngeal region. The pharynx is much smaller than the bulb of the penis. The penis bulb is made up of a thick outer layer of longitudinal muscle, an outer mucous layer, an inner narrow longitudinal muscle layer, and a
central mucous core. The vasa deferentia enlarge on each side in the region of the pharynx, anterior to the mouth, as the false seminal vesicles. These pass posteriorly, join posteriorly to the penis bulb to form a common vas deferens. The vas deferens is folded upon itself before passing into the anterior, ventral, inner muscular layer of the bulb, becoming the ejaculatory duct leading to the penis. The inner muscular core in the mature specimen shows clavate cells which produce mucous, but is has not become solid as Hyman (1928) described it for a mature animal. However, sperm are present in the vasa deferentia, vas deferens, and ejaculatory duct. The antrum surrounds the penis and receives the common oviduct dorsal and anterior to the gonopore. The bursal canal enters posterior to the antrum and dorsal to the gonopore. The bursal canal is above the penis complex and joins the copulatory bursa anterior to the bulb. The bursal canal and copulatory bursa are lined by columnar cells.

The copulatory complex of the Louisiana specimen is given on Plate X.

This animal is fully described by Hyman (1928) with further reports by Kenk (1944) on Michigan triclads, and by Hyman (1955). Kenk gives the distribution of the species as Connecticut, Illinois, Indiana, Massachusetts, New
Hampshire, Pennsylvania, Rhode Island, Wisconsin, Michigan, and Ontario, Canada. He is doubtful of a report of it from Washington. Hyman (1951) says it is common in the United States as far south as North Carolina. It appears wanting in the gulf states, according to her.

In Louisiana, it was collected once in Saint Tammany Parish and twice in Washington Parish. The species was collected from plants in clear, flowing water.
OBSERVATIONS

Collections of worms were made from 53 localities. These collections were taken from streams, ponds, puddles, and lakes of the parishes included in this survey. All these were freshwater and varied in turbidity from clear to muddy. In the habitats, places existed where the worms could attach and hide. In streams with sandy bottoms or those with little debris, stones were usually present under which the worms could secrete themselves. In cases where rooted plants in the stream or plant remains made up the debris, the animals were on the former, or under and between the debris. The worms were always found near the edge of the stream, lake, or pool. The temperature of the water, turbidity, and substratum were recorded for each locality. The turbidity was estimated by visual means using a white pan. However, very few places examined were muddy or had enough sediments to be called turbid.

The environments under consideration can be divided into two series: the lotic and lentic. Plates III and IV show three localities.

The lotic series, made up of streams, rivers, and
bayous, varied from very shallow, swift flowing to those that were sluggish. The more rapid streams were always shallow and under three feet deep, while the sluggish streams, usually the rivers, were deeper. The rate of current flow also depended upon the amount of rainfall that had occurred prior to the collecting trip. However, attempts were made to avoid periods when streams would be in flooded conditions. In some cases the water was quite muddy after rains. Some collections were from pools left by receding water after spring floods. The temperature of the water varied from a low of 8° C in February to a high of 31° C in July. Very few collections were made in mid-summer when the temperature of the water would be expected to be at the maximum for the year. During the summer fewer worms were present and experience during the summer of 1964 indicated the scarcity of worms. Many streams dry up in summer, thus habitats were reduced. The streams observed in this study varied with season and origin. The streams assumed to be spring-fed were clearer and cooler than the water of streams that were rainfall drainage tributaries. An example of this is shown by a spring, locality 122, having a temperature of 18° C while a very sluggish stream, locality 125, had a water temperature of 27° C on the same date. On the same day the temperature of the water in the
Comite River was 24° C along the bank at a depth of less than a foot. Streams that are assumed to be spring-fed were found in East Feliciana, West Feliciana, Saint Helena, and Washington parishes. These streams flow into parishes to the south of those mentioned; therefore it is possible for planaria from these to be carried by currents into these more southern areas. Most of the drainage streams in the parishes under study had a darker water color or were muddy, while the spring-fed ones were clear with some having a black to brown precipitate.

In all the lotic habitats either leaves, tree branches, small rocks, and emerging plants, primarily arrowhead (Sagittaria) and sedges, or a combination of these were in the water where the worms could conceal themselves.

The lentic series consisting of standing freshwaters had higher water temperatures, were not as clear as the spring-fed streams, and had more debris. Some had plants growing in the littoral zone, while others had floating vegetation. University Lake, a good example of this series, possesses rooted vegetation, large pieces of broken concrete in the water, and floating vegetation along the shore out to a maximum of 2 to 3 meters in late summer. This floating vegetation consisted mostly of water hyacinth. All these provide abundant niches for planaria. Examination
of the petiole of the rooted plants, the underside of water hyacinth, and the pieces of concrete often disclosed *Dugesia tigrina*. In March, the worms deposit large numbers of cocoons attaching them to the concrete pieces. In winter the floating vegetation is killed leaving only the pieces of concrete and a few clumps of dead vegetation around the shore. The water temperature of University Lake varied from a low of 11° C in spring to a high of 31° C in summer. Other lentic habitats varied with some having an abundance of leaves and twigs in the bottoms of streams, while others had mud bottoms and less debris.

The seep hole near Springfield, La., resembled a vernal pool with the exception that it did not dry up in the summer. This led to the assumption that it might be spring-fed. However, investigation of the locality did not indicate that it was spring-fed. Apparently, the water level was maintained by rainfall and seepage from a nearby stream. The hole had a large amount of oak leaves in the water. The lower leaves were in states of decay, but the more recent ones, making up the top layer, covered the entire bottom and bank.

The streams in the wooded areas differed in the presence of flatworms. In areas with oak, elm, maple, magnolia, and hickory, worms were collected in streams from
drifts of leaves. The pine areas, even when some leaves were present in the streams from the few hardwoods along the bank, failed to yield any worms. Streams of the pine area are generally acid, and other investigators have failed to find flatworms under these conditions. Buchanan (1936) reported flatworms distribute themselves in a gradient of neutral to slightly alkaline water.

The collected specimens are from two families of freshwater triclads. The Planariidae was represented by one species each from five genera and several undetermined species of Phagocata, while the family Dendrocoelidae had only one species. The most common of the Planariidae was Dugesia tigrina. This species was collected from 36 localities with each parish having several sites from which it was obtained (locality map Plate I). The other Planariidae collected from the lotic series only were Cura foremanii, Phagocata gracilis gracilis, and several specimens of Phagocata.

Cura foremanii was obtained in one collection from Saint Helena Parish, one from West Feliciana, three from Washington Parish, and one from East Baton Rouge Parish. The habitat of this species was clear, flowing water with a temperature range of 10° to 26°C. Phagocata gracilis gracilis was collected in Saint Tammany and Washington
parishes. This species came from clear, flowing streams. Two streams had rooted vegetation while another stream had rocks under which the worms were found. Water temperature ranged from 20° to 26° C. Collection was made in April and May of 1965. *Planaria dactyligera* was collected from a wash hole in Saint Tammany Parish. Kenk (1935) said the *P. dactyligera* is found in cold water springs and in spring-fed pools. A search of the site of collection in Saint Tammany Parish failed to indicate the presence of a spring near the site. An attempt to collect these the following year at the same place was unsuccessful.

The specimens of *Phagocata* of undetermined species were in two Saint Helena collections and one from Washington Parish. In all cases the water was clear and flowing with a temperature varying from 9° to 22° C. These could not be identified to species because they were either immature or had begun to lose, due to age, structures necessary for identification.

The dendrocoelid, *Procotyla fluviatilis*, was found only in streams from sites in Saint Tammany and Washington parishes. The Saint Tammany collection was from a flowing stream with rooted vegetation and a temperature of 24° C. The two collections from the other parish were from flowing water with a temperature of 21° C. In all cases debris and
plants were present in the water.

Table 1

Numbers of Specimens of Sympatric Species

<table>
<thead>
<tr>
<th>Species</th>
<th>Collection Number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>99</td>
</tr>
<tr>
<td>Cura foremanii</td>
<td>1</td>
</tr>
<tr>
<td>Dugesia tigrina</td>
<td>17</td>
</tr>
<tr>
<td>Phagocata gracilis</td>
<td>6</td>
</tr>
<tr>
<td>Procotyla fluviatilis</td>
<td>3</td>
</tr>
</tbody>
</table>

In a few localities sympatric species were collected. Table 1 is a compilation of these data. Collections 120 and 130 are from the same site but taken at different times during the collection period. Dugesia tigrina is the most abundant species found and exists in habitats with the other species in Louisiana. D. tigrina was not present with Cura foremanii in the springs and streams having rocky and sandy bottoms of West Feliciana, East Baton Rouge, and East Feliciana parishes. Procotyla fluviatilis is similar to D. tigrina in distribution, but was not collected with the same frequency nor in the same quantity. Cura foremanii
is rheophilic in Louisiana, thus conforming to Kenk's (1944) description of it. *Phagocata gracilis gracilis* and *Procotyla fluviatilis* occupy an intermediate position with regard to rheophilia, while *Dugesia tigrina* is a possible limnadophilic form. *D. tigrina* is widely distributed and is more frequent in sluggish streams and standing waters.

An attempt was made to observe the reproductive cycle of *Dugesia tigrina* in two localities. These localities were University Lake because of proximity to the campus and the occurrence of a sexual race of the species; and the slough at Baptist, La., because it had a large population of worms. In the latter the animals represented an asexual race and never attained sexual maturity.

A total of 10 collections were taken from the Baptist site and University Lake. Collections of worms from Baptist were obtained on October 24, 1964, April 5, 1965, June 6, 1965, and March 5, 1966. The lake was examined each month, with more frequent observations during periods of change. These periods of change were the approach of sexual maturity and the annual fish kill. Collections 55, 138, 139, 140, 153, and 156 were from University Lake. The worms in University Lake deposited cocoons in March of 1965 and 1966. Worms collected in November, 1964, became mature under laboratory conditions. If the worms were
already mature they continued to deposit cocoons. Analysis of the data collected on these worms in the lake and those in laboratory cultures seemed to indicate an annual cycle. The laboratory animals had been kept at a temperature of 13° C without any change for 3 months and were mature and depositing cocoons on April 3, 1966. Those in the Lake were approaching maturity on March 8, 1966 and had deposited many cocoons on March 26, 1966. Specimens from the slough at Baptist, La., often showed signs of fission when collected. This was the only method of reproduction observed in the cultures and in field collections. Cocoons were never found at the Baptist site, yet, they were observed in the lake from March to July. The rate of binary fission in immature worms increased when feeding was increased because the worms grew faster and upon reaching a certain size they divided. Besides growth, increase in temperature and their being disturbed seemed to increase the fission rate. Kenk (1937) gives data to support changes in fission rate in response to temperature and nutrition.

This indicates that Dugesia tigrina exists in Louisiana as sexual and asexual races. It also exhibits an annual cycle. Phagocata gracilis gracilis became mature under laboratory conditions. The other species were either
collected mature in Louisiana or approaching maturity. 
This indicates that Hymanella retenuova, Planaria dactyligera, Cura foremanii, and Procotyla fluviatilis reproduce sexually in this area. Reproduction in these occurs in the spring because they were only collected as mature specimens at that time of year.

Cura foremanii was collected immature in all but collection 29. In all the other collections the worm matured in the laboratory and deposited cocoons. The worm from collection 29 deposited one cocoon from which 6 worms hatched.

In three other collections of C. foremanii a total of 8 cocoons yielded an average of 4.8 offspring. The cocoons of Hymanella retenuova failed to hatch in the laboratory. The offspring from cocoons of Phagocata gracilis gracilis hatched but were eaten by larger worms.
DISCUSSION

In the 10 Florida Parishes of Louisiana six species of planarians (triclads) belonging to two families were identified. Those representing the family Planariidae are *Dugesia tigrina*, *Cura foremanii*, *Hymanella retenuova*, *Planaria dactyligera*, and *Phagocata gracilis gracilis*. One species from the family Dendrocoelidae, *Procotyla fluviatilis*, was found. The separation into families is based upon the structure of the pharynx and whether the animals possess an adhesive organ (sucker, according to some authors) on the anterior margin of the head. The members of the family Planariidae have an inner muscular zone in the pharynx made up of separate inner circular and outer longitudinal bands. Those in the family Dendrocoelidae have an inner muscular zone of intermingled circular and longitudinal fibers and usually have an adhesive organ. The only other freshwater family of the Order Tricladida, the Kenkidae, have two layers of muscle in the inner muscular zone of the pharynx, and an adhesive organ is present. They are eyeless cave dwellers. There were no members of the family Kenkidae found in
this study.

Collections of Dugesia tigrina show the animals to be widespread in Louisiana with some attaining sexual maturity, contrary to the assumption of Hyman (1939b). Collections of mature D. tigrina were obtained in East Baton Rouge Parish from University Lake and Wards Creek, in Saint Tammany Parish from the Abita River, and in East Feliciana Parish from the Comite River. The worms from the Comite River produced cocoons after being kept in the laboratory for some time. All other collections of D. tigrina reproduced asexually in cultures kept during the study and many specimens were collected with posterior ends missing, indicating they reproduced by this method in the natural habitat.

The distribution map for this species is shown on Plate I.

Dugesia tigrina can be identified to species, even though immature, by means of external characters and its pigmented pharynx. The external characters are the triangular head, two eyespots with an unpigmented area lateral to each, and oval auricles having usually an unpigmented spot on the posterior margin. The dorsal surface provides a further character, being spotted gray, brown, or a mixture of these with black. In some cases a white stripe is down the center of the dorsal surface. The ventral surface is unpigmented, allowing one to see the pigmented pharynx
from the ventral side. This is accomplished by placing the living worm on a slide with a little water, then after the worm begins to glide on the slide turning it over to see the ventral side under the dissecting microscope. This method of using the pigmented pharynx was suggested by Dr. Kenk in a personal communication in 1966.

Examination of sectioned mature *D. tigrina* from University Lake shows a variation in the position of the copulatory complex. In some specimens, it is immediately posterior to the buccal cavity wall; in others it is situated more posteriorly with diverticula of the gut interposed between the complex and the buccal cavity wall. Hyman (1951) said the species present many variations in shape and color patterns. Attempts to split *D. tigrina* into several species is not surprising, she continued, and asserted that local morphological differences undoubtedly exist. She further says the opinion of those studying the triclads is to consider all the variations as one polytypic species, *Dugesia tigrina*. I consider this variation of internal morphology as another example of these differences which should be expected in this species. It is not surprising that at one time *D. tigrina* was divided into several species.

*Cura foremanii* differs from the other planaria by
having a low triangular head, only slight auricles, monopharyngeal, dark gray to brown pigment, and a lightly pigmented ventral surface. The unpigmented pharynx lies mid-ventrally in the body. Examination of the ventral surface of a living, sexually mature worm, the gonopore can be seen posterior to the mouth but is closer to it than the posterior end. Careful examination also reveals the outline of the ovary just behind the auricles, medially with the oviducts proceeding posteriorly.

Phagocata gracilis gracilis is a polypharyngeal species, dark gray in color with two eyes on the truncate head, a neck region at the level of the eyes, and an oval posterior end. With mature specimens the dark, circular gonopore behind the mouth on the ventral surface can be easily distinguished.

Hymanella retenuova was first described by Castle in 1941 from vernal ponds and a spring-fed swampy stream in Massachusetts. He gave a complete description including the life history. He described the head as being of low triangular form, but Hyman (1955) described it as truncate. The Louisiana specimens have a truncate head and the copulatory complex is as that described by Hyman (Plate VIII). If one uses the copulatory complex as described by Hyman and Castle with the head shape of those described by Hyman,
the planaria collected near Springfield, La. in collections 2 and 151 are of this species. The worm produces an oval cocoon that is carried about for days then is extruded through the dorsal body wall. Castle (1941) gives evidence that supports this characteristic in the Louisiana specimens. After depositing the cocoon, the Louisiana worm may immediately form another or undergo cotolysis. In the process the worm turns white and then disintegrates. Castle (1941) found that his worms produced several cocoons, then died. In those collected from Louisiana only a few produced a second cocoon before disintegrating. The species is not present in the summer months and disappears from culture dishes even though fed on a regular schedule and kept at a favorable temperature of 12° C. This species shows a regular annual reproductive cycle at the site of collection. Mature specimens were collected on January 21, 1964 and again on March 5, 1966. The cocoons failed to hatch in the laboratory even though movement was observed within one of the cocoons from the first collection. Castle (1941) was able to get some cocoons to hatch but no worms attained maturity.

Planaria dactyligera, collected in Saint Tammany Parish, site 106, was thought for a while to be a new species. Careful examination of all specimens indicated it is not
since it conforms to the description given by Kenk (1935), with the exception that the testes in two specimens do not reach the end of the pharynx. This, like some other morphological differences, may be due to the state of development of the specimens. In some cases the testes tend to degenerate after copulation and after the worms have begun to deposit cocoons. After collecting, the mature worms were killed the next day except for a few kept for a culture. These specimens showed no other signs of degeneration, however. Previously, it had only been collected in Virginia from springs and spring-fed swamps. In Louisiana the animals were obtained from standing water at the end of a culvert.

The dendrocoelid, *Procotyla fluviatilis*, was collected by Kenk (1944) in Michigan. The mature worms from Michigan were 12 to 20 mm long and 2 to 5 mm wide. The mature specimen collected in Washington Parish was 12 mm long and 2 mm wide. It was evidently at the height of maturity as indicated by the sperm in the vasa deferentia. It conformed to the description given by Hyman (1928). Several additional specimens with the external characteristics of the genus were collected, but due to their immaturity identity is doubtful but one can hazard an identity by the structures present.
The only other species of the genus is *Procotyla typhlops*, which attains a length of 12 mm, has a feebly developed adhesive organ represented by a glandular area, and is without eyes. Kenk (1935) showed the two differing when mature by *P. fluviatilis* having eyes, having an adhesive organ that is a true sucker provided with glandular and muscular differentiation, and the muscular zones of the penis bulb being two layers of longitudinal muscle. Hyman (1928) shows a round adhesive organ for *P. fluviatilis*. All immature specimens collected had a distinct, round adhesive organ and eyes, thus these could not be *P. typhlops*, but conform to the description of *P. fluviatilis*. The two other genera in the family, *Sorocelis* and *Dendrocoelopsis*, have, according to Hyman (1951), weakly developed adhesive organs. In 1953 Hyman described a new member of the family, *Rectocephala exotica*. It has a well-developed adhesive organ but the species is black in color. In 1956 Hyman added *Macrocotyla glandulosa*, an eyeless worm, that has a well developed adhesive organ deeply indented from the anterior margin of the head. Compared with the other dendrocoelids, the immature white worms are *Procotyla fluviatilis* because they possess a well-developed, round adhesive organ, their being white in color, and having two eyes.
Kenk (1944) places *Dugesia tigrina* and *Procotyla fluviatilis* in an intermediate position with regard to their being in running or standing water. In Louisiana *D. tigrina* is found as large population in standing waters. However, it was present in 36 sites examined, some of which were definitely polluted, for example the University Lake collection 139 was made during a fish kill in August, 1965. The water temperature in the lake had been 31° C on July 1, and was 29° C on the date of collection. The worms were able to survive the period of pollution by moving up near the surface to get the necessary oxygen. This is indicated by their being on the underside of floating boards, limbs, and the parts of plants just barely under the water. *D. tigrina* in University Lake withstands a temperature range of below 11° C to 31° C, thus indicating they are eurythermic as mentioned by Kenk (1935) in his study of Virginia triclads. In the same study Kenk also said that *D. tigrina* was limnadophilic. In Louisiana this is borne out, since the larger populations are found in slow flowing streams and in standing waters. Many of these same waters become stagnant and even foul. In Virginia Kenk found *D. tigrina* frequently occurring in stagnant water.

*Procotyla fluviatilis* was collected only from flowing streams in Louisiana. Kenk (1944) reported it from
standing waters and slow streams in Michigan, while Hyman (1928) reported it from streams, rivers, ditches, ponds, and springs. Kenk recognized the species as living under a wide temperature range. It is probably eurythermic in Louisiana, as Kenk found it to be in Michigan.

The other Planariidae, *Cura foremanii*, *Phagocata gracilis gracilis*, and the unidentifiable *Phagocata* species, were all collected from flowing water. The distribution of these is shown on Plate II. *Cura foremanii* is classified as a rheophilic form by Kenk (1935, 1944). It is found in cool, flowing streams in the Florida Parishes. Kenk (1935) places *Phagocata gracilis gracilis* (= *Fonticola gracilis*) in an intermediate position. In Louisiana *P. gracilis gracilis* was collected from rapidly flowing water in all but one collection. The one site was that of an abandoned swimming pool in Cassidy Park, Bogalousa, La., where it was taken from the edge under pieces of broken concrete. The water flows continually through this pool; however, the current at the place of collection was negligible. It was not collected from standing water, and appears to be a moderately rheophilic form in Louisiana.

*Cura foremanii* and *Phagocata gracilis gracilis* were collected from water having a temperature range of 10° to 26° C. *C. foremanii* appears to be eurythermic. In
culture at a temperature of 10° to 15° C both species became mature and produced cocoons. In the laboratory plenty of food and low temperature result in cocoon production in \textit{C. foremanii}. Collections 130, 132, and 137b of \textit{C. foremanii} produced the $F_2$ generation in April 1966. In culture, two generations were obtained from this species in less than a year; however, the $F_2$ are only newly hatched at the time of this writing. Collections 130 and 132 were collected in May 1965, and 137b in July 1965. The cultures of \textit{Dugesia tigrina} and \textit{P. gracilis gracilis} have become sexually mature only one time during the year.

In collections 130 and 132 only one immature specimen of \textit{C. foremanii} was obtained from each site. These grew to maturity in the culture dish and deposited viable cocoons. Anderson (1952) reported experiments with isolated, newly hatched \textit{C. foremanii} that produced offspring without copulation. The infertility rate of these cocoons from isolated individuals is only 12 per cent. He did not observe copulation in the mass cultures maintained in the laboratory. He demonstrated that cross-copulation is not essential to sexual reproduction in the species and suggested that it may never occur. In observing cultures of \textit{Dugesia tigrina} in this study, copulation between two individuals has been common but I have not observed the
process between two C. foremanii. The question remains as to whether this species is parthenogenetic or has self-fertilization. I prefer the latter, since I have observed sperm in the oviduct of a sectioned specimen reared in isolation.

The other Phagocata represent at most three species, judging by color patterns and size. Collection 102 was a small gray Phagocata collected at a temperature of 9° C. When brought into the laboratory, it was allowed to sit at room temperature for several hours to facilitate collecting the specimens. They were then placed in a container of habitat water at 13° C. A few were killed immediately. Unfortunately, within the next few days all were dead, having cotolyzed without reaching maturity. The death of these animals is, in all probability, a physiological response to the increase in temperature that developed while the container was sitting to allow the worms to move to the surface. The temperature of the room was about 28° C. Theoretically, a temperature change of this magnitude would cause a change in physiological processes that could have an adverse effect. Several other collections were lost in the same manner.

The Planariidae C. foremanii, P. gracilis gracilis, and the Phagocata species were all collected from clear
flowing streams indicating they have a preference for streams without stagnation. Therefore the change to standing water with a possible lower oxygen content, some bacterial contamination, and no current probably led to the loss of the Phagocata species. Repeated efforts to replace these specimens were fruitless. Some Dugesia tigrina collections were lost, however these were definitely due to the water becoming foul as could be determined by the odor of the water. In this last case bacterial contamination was definitely a contributing factor.

In the Florida Parishes of Louisiana three planarians can be identified easily. The external characters of these are distinct enough to distinguish them from each other and from the others. These worms are Cura foremanii, Dugesia tigrina, and Phagocata gracilis gracilis. Dugesia tigrina and C. foremanii both have a triangular head. The head of D. tigrina is a higher triangle than that of C. foremanii. Cura foremanii is dark gray to brown dorsally and has pigment on the ventral side. Dugesia tigrina is a spotted brown, brown and black, or gray spotted on white dorsally. Phagocata gracilis gracilis is distinguished by its possessing numerous pharynges and having a truncate head with an oval posterior end instead of a pointed posterior end. Hymanella retenuova and Planaria dactyligera
can be determined only from serial longitudinal sections of mature worms. The dendrocoelid *Procotyla fluviatilis* has a circular adhesive organ, is white, elongated, and usually has two eyes.

The collecting sites all possessed niches consisting of leaves, limbs, or rocks where the worms could attach or hide during the day. Many ponds and streams were examined in the study which had all the necessary characters but were without planarians. This probably means that the animals have never been in these streams or were there, and man has so disturbed their habitat that they were killed. Mr. Harry Henson has reported that *D. tigrina* is almost non-existent in Wards Creek, now that it has been dredged. Possibly this population will return with time as litter accumulates. In areas of the Florida Parishes where dredging has been recently done, no triclads could be found in the drifts of these large canals. Jones Creek on La. Hwy 426 did yield triclads as did the North Branch of Wards Creek at La. Hwy 426. Both of these have been dredged and now have places where the worms can establish themselves. Kenk (1944) maintained that in order for a population of triclads to be present in large numbers they must have abundant resting places. In Louisiana more specimens are available where there are large amounts of
debris in the form of leaves, sticks, rocks, grass, or water plants.

Several attempts to collect worms in streams of pine woodland failed. Two factors probably account for their scarcity, the absence of adequate cover and the water being acid. These streams in the pine areas were always yellowish and without the large drifts of leaves and broken limbs found in the hardwood woodlands. In the hardwood areas the streams were usually clear and had large drifts of leaves. In addition to those species already described in detail, there is the possibility of additional ones being found. Several specimens of the genus Phagocata did not culture well under laboratory conditions. These were either immature or in a post-reproductive stage that precluded their identification. These cultures died without adapting to laboratory conditions, repeated efforts to collect them again in the field were without results.
KEY TO THE FRESHWATER TRICLADIDA OF
THE FLORIDA PARISHES OF LOUISIANA

1a. Inner muscular zone of the pharynx composed of two distinct layers of circular and longitudinal muscle, no adhesive organ present on anterior end. . . . . . . . . . . Family Planariidae 2.

1b. Inner muscular zone of the pharynx composed of intermingled circular and longitudinal muscle fibers, adhesive organ present. . . . . . . . . . . Family Dendrocoelidae.

2a. Pigmented . . . . . . . . . . . . . . . . . . . . . . . . . . 3.

2b. Unpigmented, penis bulb large and having two layers of longitudinal muscle separated by mucous layers . . . . . . . Procotyla fluviatilis.

3a. Triangular shaped head . . . . . . . . . . . . . . . . . .4.

3b. Truncate shaped head. . . . . . . . . . . . . . . . . . . . 5.

4a. Dorsal surface spotted brown, gray, or mixture of these with black; ventral surface white; high triangular head; vasa deferentia unite in bulb of penis; copulatory bursa large; pharynx pigmented. . . . . . . . . Dugesia tigrina.

4b. Dorsal surface solid gray, may have some brown; ventral lighter gray; low blunt triangular head; vasa deferentia enter each side of seminal vesicle separately; without a copulatory bursa; pharynx unpigmented. . . . . . . Cura foremanii.

5a. Slight auricles, polypharyngeal, dorsal surface dark gray, ventral lighter, large copulatory bursa, oviduct entering male antrum . . . . . . . . . . Phagocata gracilis gracilis.
5b. No auricles, monopharyngeal. .............. 6.

6a. Adenodactyl present, well developed penis and bulb, male antrum fits penis closely. 
.......
Planaria dactyligera.

6b. Adenodactyl absent, penis and bulb degenerate, antrum enlarged. .... Hymanella retenuova.
KEY TO THE FRESHWATER TRICLADIDA OF
THE FLORIDA PARISHES OF LOUISIANA
USING EXTERNAL CHARACTERS

1a. Pigmented. ................................. 2.

1b. Unpigmented, truncate head, circular adhesive organ on anterior margin of head
    ........................................... Procotyla fluviatilis.


3a. High (acute) triangular shaped head
    ........................................... Dugesia tigrina.

3b. Low (blunt) triangular shaped head
    .......................................... Cura foremanii.

4a. Monopharyngeal. 
    Hymanella retenuova, 
    Planaria Dactyligera 
    Phagocata species
    (other than gracilis gracilis)

4b. Polypharyngeal, dark gray dorsally, slightly lighter ventrally, posterior end rounded
    ........................................ Phagocata gracilis gracilis.

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SUMMARY

1. Six species of triclads belonging to six genera and two families were collected in the Florida Parishes. Those belonging to the Family Planariidae were Dugesia tigrina, Phagocata gracilis gracilis, Hymanella retenuova, Cura foremanii, and Planaria dactyligera. The species from the Family Dendrocoelidae was Procotyla fluviatilis.

2. Dugesia tigrina exists as sexual and asexual races in the study area. It reproduces sexually in March of each year in University Lake.

3. Cura foremanii, Hymanella retenuova, Planaria dactyligera, and Procotyla fluviatilis were collected sexually mature. Phagocata gracilis gracilis became sexually mature in the laboratory and deposited cocoons.

4. Cultures of Cura foremanii and Dugesia tigrina have developed from the worms collected. C. foremanii will grow and reproduce if plenty of food is provided and the temperature is kept around 12° to 13° C. Dugesia tigrina specimens responded to low temperature stimulus one time during the study and developed into mature
worms, but only from one site. The cultures of D. tigrina became mature in the refrigerator in April of 1966 without low temperature stimulation.

5. Cura foremanii, Phagocata gracilis gracilis, and Procotyla fluviatilis were collected from flowing water and are rheophilic. Planaria dactyligera and Hymanella retenuova were collected from standing water in Saint Tammany and Livingston parishes, respectively. Dugesia tigrina was collected from both flowing and standing water. Those collected from standing water are considered limnadiophilic forms.

6. No collections of planaria were secured from streams or standing water in the pine woodlands.

7. This study records 5 additional species besides Dugesia tigrina previously reported from Louisiana. This extends the range of the added species and contributes to our knowledge of temperature tolerance.
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SELECTED BIBLIOGRAPHY (CONTINUED)


PLATE I

Map showing the distribution of Dugesia tigrina in the Florida Parishes of Louisiana.
PLATE II

Map showing the distribution of *Cura foremanii*, *Hymanella retenuova*, *Phagocata gracilis gracilis*, *Phagocata* species, *Planaria dactyligera*, and *Procotyla fluviatilis* in the Florida Parishes of Louisiana.
PLATE III

Figure A. Slough, Baptist, La., 2.3 miles east of Livingston Parish line, Tangipahoa Parish.

Figure B. University Lake, spillway on Stanford Avenue, Baton Rouge, La., East Baton Rouge Parish.
PLATE IV

Figure A. North Branch Wards Creek, 0.5 miles west of U. S. Hwy 61 on La. Hwy 426. East Baton Rouge Parish.
PLATE V

Figure A. *Cura foremanii* showing the copulatory complex. Magnification 106X.

In this figure: 2. bursal duct or canal. 3. female antrum, 4. common antrum, 5. male antrum, 6. gonopore, 7. vas deferens, 8. seminal vesicle, 9. ejaculatory duct, 10. penis bulb, 11. penis, 12. common oviduct.
PLATE VI

Figure A. *Dugesia tigrina* showing the copulatory complex. Magnification 125X.

Figure B. *Dugesia tigrina* composite drawing of the copulatory complex of a University Lake specimen to show a variation in the position of the complex. Magnification 125X.

In these figures: 1. copulatory bursa, 2. bursal duct or canal, 3. female antrum, 4. common antrum, 5. male antrum, 6. gonopore, 7. vas deferens, 8. seminal vesicle, 9. ejaculatory duct, 10. penis bulb, 11. penis, 12. common oviduct, 13. intestinal diverticulum.
PLATE VII

Figure A. Drawing of *Phagocata gracilis gracilis* showing the copulatory complex. Magnification 27X.

In this figure: 1. copulatory bursa, 2. bursal duct or canal, 4. common antrum, 5. male antrum, 6. gonopore, 7. vas deferens, 8. seminal vesicle, 9. ejaculatory duct, 10. penis bulb, 11. penis, 12. common oviduct.
PLATE VIII

Figure A. *Hymanella retenuova* showing the copulatory complex.

In this figure: 1. copulatory bursa, 2. bursal canal or duct, 5. male antrum, 6. gonopore, 7. vas deferens, 11. penis, 12. common oviduct.
PLATE IX

Figure A. *Planaria dactylogera* showing the copulatory complex. Magnification 60X.

In this figure: 1. copulatory bursa, 2. bursal duct or canal, 4. common antrum, 5. male antrum, 6. gonopore, 7. vas deferens, 8. seminal vesicle, 9. ejaculatory duct, 10. penis bulb, 11. penis, 12. common oviduct, 18. adenodactyl.
Figure A
PLATE X

Figure A. *Procotyla fluviatilis* showing the copulatory complex.
Magnification 84X.

In this figure: 1. copulatory bursa, 2. bursal duct or canal, 4. common antrum, 5. male antrum, 6. gonopore, 7. vas deferens, 9. ejaculatory duct, 10. penis bulb, 11. penis, 12. common oviduct, 14. inner mucous core, 15. inner longitudinal muscular layer, 16. outer mucous layer, 17. outer longitudinal muscle layer.
VITA

William Douglas Longest was born January 22, 1929 in Pontotoc County, Mississippi. He attended grade school at Beckham School in Pontotoc County until his family moved to Calhoun County in 1937. He graduated from Bruce High School, Bruce, Miss., in 1946. His college education began at Northwest Junior College, Senatobia, Miss., in 1946 and he graduated there in 1948. He served four years in the United States Air Force, from 1946 to 1952. In 1952 he entered Baylor University, completing the Bachelor of Science Degree in 1954. He immediately began graduate studies and completed the Master of Science in 1956.

He taught science at Parma High School, Parma, Mo., in 1955-56. He then joined the faculty of Northwest Junior College as the Instructor of Biology from 1956 to 1959. He was a member of the faculty of Blue Mountain College from 1959 to 1962. He joined the Department of Biology, Memphis State University, as a temporary instructor for the year 1962-63. He came to Louisiana State University in 1963 as a graduate student and was an Instructor in the Department of Zoology and Physiology.
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Major Field: Zoology

Title of Thesis: The freshwater Tricladida of the Florida Parishes of Louisiana

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Date of Examination: May 10, 1966