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A Taxonomic and Distributional Study of the Family Bucephalidae (Trematoda) in the Northern Gulf of Mexico.

Kenneth C. Corkum

Louisiana State University and Agricultural & Mechanical College

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A TAXONOMIC AND DISTRIBUTIONAL STUDY OF THE FAMILY
BUCEPHALIDAE (TREMATODA) IN THE NORTHERN
GULF OF MEXICO

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, Entomology and Physiology

by
Kenneth C. Corkum
B.S., Aurora College, 1958
M.S., Louisiana State University, 1960
August, 1963
PLEASE NOTE:
Plates tend to "curl". Filmed in the best possible way.

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ABSTRACT

A total of twenty seven species of gasterostomatous trematodes are reported from various estuarine and marine fishes from the northern Gulf of Mexico. A new genus and several new species are described in conjunction with a re-evaluation of the classification of subfamilies in the trematode family Bucephalidae. New hosts and localities are reported and comparisons are made between the bucephalid fauna of the northern Gulf and adjacent areas. A complete host-parasite list is also presented.
INTRODUCTION

Studies of the trematode fauna thus far undertaken in the Gulf of Mexico have, for the most part, only touched upon the family Bucephalidae. With the exception of a few works, most reports of bucephalids have been confined to sporadic accounts of new species.

Linton (1910) conducted a survey of fish trematodes in the area of Dry Tortugas, Florida, and found a number of gasterostome species. Although much of his work has since had to be revised, it was a noteworthy beginning.

Manter (1934) reported four new species from deep water fishes taken off Dry Tortugas and in 1935, Chandler described a new form collected on the Texas Coast. Manter (1940c) published a work on the bucephalids in which he reported and described fifteen species from fishes of tropical Florida.

Melugin (1940) named, but did not describe, a new species from the shallow waters of the Louisiana Coast and in 1941, Chandler gave an account of a second new species from Texas waters. By 1947, Manter was able to list sixteen species of gasterostomes found in the fishes of the Gulf, the majority of which were known only from Florida.

Hopkins (1950) began a series of studies on the gasterostomes in the northern and western Gulf and in 1954, Manter listed the names of eighteen gulf species. The same year, Hopkins (1954) described three new bucephalids from the northern Gulf. He also contributed a very thorough analysis of some of the taxonomic problems that had developed since the beginning of gasterostome taxonomy.
Sogandares (1955) named a new gasterostome from Lake Ponchatrain, Louisiana, and in the following year, Hopkins (1956) described two additional species from Grand Isle, Louisiana.

Sparks (1957) made a general survey of the northern Gulf and recorded the incidence of eight described species of gasterostomes in fishes of the Louisiana Coast. Sogandares and Hutton (1959 and 1960) reported five known species from the Tampa Bay area of Florida. Sparks (1960) made several interesting comparisons between the fauna of different parts of the Gulf of Mexico and in 1961, Corkum named a new species from the coast of Louisiana as did Riggin and Sparks (1962).

It is quite evident from the above resume' that only a limited amount of information has been accumulated concerning the gasterostomes of the Gulf of Mexico. This is especially true in areas other than the tropical waters of South Florida. Because the Louisiana Coast is in a subtropical region and, since it has a coastal estuary unlike any other in the world, it is of considerable interest to investigate the various faunas common to its unique environment. A study was, therefore, begun in 1960 with the purpose of determining both taxonomic and distributional character of the gasterostome fauna in the northern Gulf of Mexico and primarily of the Louisiana Coast.
MATERIALS AND METHODS

Most of the field work involved in this study was accomplished at the Louisiana Wild Life and Fisheries Commission Marine Laboratory, Grand Terre Island, adjacent to Grand Isle, Louisiana.

The host material was collected in a number of ways, but most of the fishes taken in shallow water were obtained by trawling or hook and line fishing. Fishes were also obtained from local shrimpers working in water of up to twenty fathoms in depth. A third source of fishes was the catfood processing plants in Pascagoula, Mississippi. The majority of hosts recorded from east of the Mississippi River were acquired in this manner.

Predatory fishes were of particular interest and, since they comprise the sport fishing along the coast, charter boat landings were a major source of the larger pelagic fishes as well as the smaller game fishes. Many of the larger animals were caught in the vicinity of the numerous offshore drilling platforms which stand in water of from ten to twenty-five fathoms. These platforms were also an attraction to skindivers who were always willing to contribute specimens to the survey.

A short cruise was taken aboard the United States Fish and Wild Life Service research vessel M/V Oregon operating out of the gear research station at Pascagoula, Mississippi. All of the fishes examined on this voyage were dredged up from depths greater than one hundred ninety fathoms at a series of stations located approximately one hundred fifty miles due south of Mobile, Alabama.
Whatever method was used to obtain the host, it was followed by a standard procedure of examination. The alimentary canal of the fish was removed, and in the case of large animals, it was divided into stomach, gastric caeca, small intestine, and large intestine. Each area was kept separate and usually placed in a jar of dilute sea water until ready for closer study. Because of the weak organs of attachment common to the gasterostomes, vigorous agitation of the host organs in sea water usually freed all of the worms present. They then settled to the bottom of the jar along with the detritus. It was also found that cooling of the jars containing the viscera to be studied was also helpful in causing the worms to release their hold on the host tissue. Subsequently, both the host organ and detritus were examined under a dissecting microscope and any trematodes found were removed to fresh sea water for further washing. This method was very satisfactory in a land based laboratory. It did, however, present certain problems when at sea because of the constant pitch and roll of the vessel. Even though close examination was a bit more difficult under these circumstances, it was felt that the collections were complete with very few specimens being overlooked.

When trematodes were found, they were subjected to gentle warming and the pressure of a cover glass prior to being killed and fixed in a solution of alcohol, formalin, and acetic acid. When feasible, live specimens were examined under high power magnification to determine the character of the excretory system, a feature not easily seen in mounted material.

Specimens prepared for whole mounts were treated with various gradations of ethanol, stained in Mayer's acid carimine, cleared in
methyl salicilate and mounted in Canada balsam. Material to be sectioned was embedded in paraffine, sectioned, and stained with Harris' hematoxylin and eosine.

Measurements of the trematodes in this study are given in millimeters with the average being presented first and followed by the range in parentheses. Drawings were made with the aid of a camera lucida and drawing tube.

The identification of the fishes examined was largely accomplished through the efforts of Dr. Herbert Boschung of the University of Alabama. Whenever feasible, representative specimens were retained and preserved for identification. In some instances, however, it was necessary to identify the material in the field. For this reason the author assumes full responsibility for the names which appear in the text. The scientific and common names that are employed in the text and the host list are those indicated as being preferred in the checklist of the American Fisheries Society.
GENERAL ACCOUNT OF THE FAMILY BUCEPHALIDAE

Morphology

Members of the family Bucephalidae are unique among the digenetic trematodes in possessing a mid-ventral oral opening concomitant to an imperforate anterior end. The mouth is not surrounded by a muscular sucker, as in most digenea, but is merely a crescentic slit in the ventral body wall. Internal to the oral aperture, a muscular pharynx encircles the alimentary passage and this, in turn, is followed by a thin-walled esophagus and a sacculate intestine.

The body shape of gasterostomes ranges from ovoid to elongate with body lengths that are of less than a millimeter to more than eight millimeters. Most often, the size is in the one to three millimeter range.

The cuticle is spinous and usually relatively thin. Posteriorly, the spines diminish in size and may be lacking at the posterior extremity.

The cephalic end of the bucephalids is modified to form an adhesive organ that may appear as a cup-like sucker or a wedge-shaped rhynchus. Coincidental to the basic structure of the sucker, there may be additional adhesive devices in the form of tentacular processes, spines, or flap-like hoods.

The male reproductive organs are much like those in other trematode groups. A single pair of testes is present and usually found along the dextral side of the hind-body. The testes are either in tandem, diagonal, or lateral to each other. Each testis gives off a single vas efferens which unites with its counterpart at the mid-line...
prior to entering the seminal vesicle. The latter structure is contained in the proximal portion of the cirrus pouch and may assume an ovoid shape or may be long and somewhat sinuous.

Another unique feature of bucephalid anatomy is the posterior disposition of the cirrus pouch. It usually lies against the left side of the body and contains the aforementioned seminal vesicle and the muscular cirrus. Coursing down the middle of the cirrus is the ejaculatory duct which is surrounded over most of its length by well developed prostatic cells. The cirrus terminates in a varying number of lobes, which are retained in the spacious genital atrium, near the posterior end of the body.

The female reproductive system consists of the same fundamental structures found in most digenea. The ovary is usually smooth, subspherical and most often lies dextrally in the mid-body. A short oviduct leads from the ovary to the ootype and uterus. Mehlis' gland surrounds the ootype. Laurer's canal proceeds from the vicinity of the ootype to the dorsal body wall, posterior to its origin at the ovarian complex. A seminal receptacle is rarely present. The uterus is highly variable in its disposition, but it always empties into the genital atrium. There is often a distinct uterine duct at the terminus of the uterus through which the ova pass into the genital atrium. In some forms there is also a short genital duct leading from the genital atrium to the genital pore while in others the pore opens directly from the atrium. The vitellaria consist of follicular glands arranged in clusters at the anterior end of the body, in linear groups along the sides of the body or in an archiform band across the fore-body. In most instances the vitelline glands of the left side extend more posteriorly than those on the right. The left vitelline duct is always
considerably longer than that of the right side. The two ducts unite to form a common vitelline duct prior to emptying into the ovarian complex. The ova are usually ovoid and always operculate, with polar filaments rarely being present.

The excretory system is made up of a bladder that is tubular or sacculate and with two primary excretory ducts arising at various points along the bladder. The excretory bladder is usually thin-walled, extending variously into the fore-body and opening posteriorly by means of a terminal excretory pore.

Although the nervous system is not usually observed, it can be detected in sectioned material. It consists of a loosely formed, fibrous "ganglion" which lies just posterior to the anterior sucker and stretches across most of the fore-body. Longitudinal connectives can be seen passing both anteriorly and posteriorly.

General Distribution

The gasterostomes are almost exclusively fish parasites. Only one species is known to occur as an adult in amphibians. Both fresh water and marine fishes are host to the adult forms as well as to the metacercariae in many instances. As in other digenea, the early larval stages are confined to molluscan hosts. Although Hopkins (1958), reported a metacercaria from a marine clam, most of the larvae in this stage of development are found in small fishes, either encysted in the vicinity of large nerves or even lying free in the body cavity (Dawes, 1956)

Adult bucephalids are found almost without exception in the gastric caeca and small intestine of predatory fishes. So well adapted have the bucephalids become to this restricted environment, that when they
are found in the stomach or large intestine of the host it is considered an accidental occurrence.

Of the thirteen genera recognized by Yamaguti (1958), only one is restricted to fresh water definitive hosts whereas four are found in both fresh water and marine environments and eight are strictly marine. Such generic distribution suggests the possibility that many more marine genera are to be found since only a comparatively small number of host animals have been studied in a very limited number of marine or brackish water habitats. In contrast, the fresh water species are quite well known.
SYSTEMATICS OF THE FAMILY BUCEPHALIDAE

Historical Review

The bucephalids, like any other group, have been subjected to a number of taxonomic revisions. This is certainly expected and no doubt will continue.

Historically, the first description of a bucephalid dates back to 1819 at which time Rudolphi described three new species, Monostomum crucibulum, M. galeatum and Distomum gracilescens as based on adults from marine fishes. Kniskern (1952) has pointed out that Rudolphi was apparently aware of the imperforate cephalic end of these forms, but it was not until subsequent workers realized the nature of the gut and oral opening that his species were referred to as gasterostomatous trematodes.

Von Baer (1827) described a cercaria from a European fresh water clam and proposed the name Bucephalus polymorphus for the highly motile, ox-head larva. It is an interesting, and perhaps unfortunate coincidence, that the generic name von Baer selected to characterize the larval form should eventually be found to have an equally important application to an anatomically different feature among some of the adult bucephalids.

Von Siebold (1848), in describing the adult of Gasterostomum fimbriatum from the fresh water fishes Perca and Lucioperca, noted the similarity between his new species and Bucephalus polymorphus. He found both Bucephalus polymorphus and Gasterostomum fimbriatum to have a sac-like gut with a mid-ventral mouth and on this basis, suggested the former species was, in all probability, the larval stage of
Gasterostomum fimbriatum and it should therefore be transferred to his newly erected genus, Gasterostomum. With the establishment of the genus Gasterostomum, von Siebold gave the first indication that the significance of the unique morphology of the bucephalids had been realized.

Wagener (1852) named a new species, Gasterostomum minimum, and also removed Distomum gracilescens from the genus to which it had been assigned by Rudolphi (1819), and placed it in the genus Gasterostomum. In the same paper, and again in 1857, Wagener redescribed Gasterostomum fimbriatum and in the following year (Wagener, 1858) he, like von Siebold, postulated that the life cycle of the cercaria Bucephalus polymorphus terminated in the adult form known as Gasterostomum fimbriatum.

As indicated by Hopkins (1950), Diesing (1858) recognized the lack of continuity in the genus Gasterostomum as perceived by Wagener and, therefore, erected a new genus, Rhipidocotyle, to accommodate Gasterostomum gracilescens and Gasterostomum minimum. These two species, unlike Gasterostomum fimbriatum, possess neither tentacles nor projections on the anterior end of their body.

Lacaze-Duthier (1854) described a cercaria, Bucephalus haimeanus, from the oyster and cockle of the Mediterranean Coast. It was noted in the description that the mouth occurred at the anterior end. Diesing (1855) recognized this as being distinctly inconsistent with the characteristics of the only other known bucephalid cercaria and, consequently, established the subgenus Bucephalopsis for the species of Lacaze-Duthier.

Ziegler (1883), in agreement with the suggestions of von Siebold and Wagener, considered Bucephalus polymorphus to be the larval stage.
of *Gasterostomum fimbriatum*. In view of this, the name *Gasterostomum*, von Siebold 1848, was reduced to synonymy, *Bucephalus* von Baer 1827, having just priority. On the grounds of Ziegler's action, Poche (1907) replaced the family name *Gasterostomidae* Braun, 1893, with the preferential name *Bucephalidae* and designated *Bucephalus* von Baer, 1827, as the type genus.

Odhner (1905), followed what has generally been attributed to Van Beneden (1858) and divided the Class *Trematoda* Rudolphi, 1818, into the orders *Monogenea* and *Digenea*. He further subdivided the latter into the suborders *Prosostomata* and *Gasterostomata*. Odhner also erected the genus *Prosorhynchus* to accommodate two new species in addition to *Monostomum crucibulum* Rudolphi, 1819.

Nicoll (1914) raised the subgenus *Bucephalopsis* Diesing, 1855, to generic rank and grouped the known genera into the subfamilies *Bucephalinae* and *Prosorhynchinae*. In the latter, he placed only the genus *Prosorhynchus* because of its plug-like rhynchus. He listed under the second subfamily, the genus *Bucephalus*, *Bucephalopsis* and *Rhipidocotyle* on the basis of the similarities in the anterior sucker possessed by these forms.

MacCallum (1917) erected the genus *Alcicornis* for a group of trematodes purported to have cephalic tentacles and an anteriorly located mouth. MacCallum's misinterpretation of the morphology of this form, led Eckmann (1932) to consider it a synonym of *Bucephalus* von Baer, 1827. Nagaty (1937) re-established the genus when he collected a similar gasterostomatous species in the Red Sea. He found the species did possess tentacular projections, but they encircled a rhynchus rather than a sucker as is typical of *Bucephalus*.
Ozaki (1924) proposed the name *Dolichoenterum* for *D. longissimum*, a species with a funnel-shaped hood, an intertesticular ovary and a long intestine. This genus is still held to be valid, but such is not the case for a second genus introduced by Ozaki, *Gotonius* Ozaki, 1924. The latter genus was characterized as possessing an anterior adhesive organ in the form of a rhynchus and in having the ovary located medianly rather than laterally. Nagaty's (1937) relegation of this genus to synonymy with *Prosorhynchus* has been generally accepted.

Ozaki (1924) also introduced the generic name *Nannenterum* but both Eckmann (1932) and Nagaty (1937) considered this to be synonymous with *Rhipidocotyle* by virtue of the fact that both have a cephalic hood.

Issaitschikov (1928) introduced the generic name *Skrjabiniella* for a species said to have the testes arranged laterally rather than in tandem, as well as having a rhyncoid adhesive organ. Nagaty (1937) pointed out the variability in the location of such structures as the testes and, therefore, relegated the genus to synonymy with *Prosorhynchus* on the basis of its adhesive device.

Pigulewsky (1931) erected the genus *Mordvilkovia* to accommodate species with the uterus extending beyond the vitellaria and with a rhynchus bearing cuticular folds but this too was reduced to synonymy with *Prosorhynchus* by Nagaty (1937).

Dollfus (1929) proposed the genus *Prosorhynchoides* for *Monostomum orbiculare* Rudolphi of Linton, 1898, and *Gasterostomum ovatum* of Linton, 1900. Both Nagaty (1932) and Manter (1940a) consider this to be a synonym of the genus *Bucephalopsis*.

Eckmann (1932) made a very thorough study of the family Bucephalidae...
and proposed a new genus, *Dollfustrema* Eckmann, 1934 to accommodate species with an anterior rhynchus bearing spines. Nagaty (1937) did not consider this of generic value. Manter (1940c), however, resurrected the genus when he found gasterostomes at Tortugas, Florida, that had a collar of cephalic spines. Previously, Manter (1940a) had been inclined to consider *Dollfustrema* as a synonym of *Mordvilkovia* on the assumption that the "cuticular folds" characteristic of the latter group might actually represent spines and in that case *Mordvilkovia* would have priority. As Manter (1940a) points out such synonymy is based only on an assumption and, therefore, the nature of the "cuticular folds" in *Mordvilkovia* will have to be re-examined before any conclusive decision can be made.

Nagaty (1937) erected the genus *Neidhartia* on the basis of the sinistral location of the ovary and the rhyncoid adhesive organ in species from the Red Sea. In 1938, Yamaguti introduced the name *Pseudoprosorhynchus* for species that have a discoid rhynchus which is not as powerful as found in *Neidhartia*. There is some question as to the validity of the latter genus because of its obvious relationship to *Neidhartia*. At the present time, there is only one species known for the genus *Pseudoprosorhynchus* and until additional species of both genera are found, both should be retained to avoid possible taxonomic confusion at a later date.

By 1940, the family was thought to consist of the following genera in the subfamilies established by Nicoll (1914): Bucephaline - *Bucephalus, Bucephalopsis, Rhipidocotyle, Dolichoenterum*; Pro sorhynchinae - *Proisorhynchus, Alcicornis Neidhartia, Dollfustrema*,
Manter (1940a and 1940b). This was in general accord with Nagaty (1937) with the exception of the genus Dollfustrema.

Jones (1943) accepted the validity of the genus Skrjabiniella in contrast to Crowcroft (1946) who did, however, recognize the genus Gotonius and Mordvilkovia. He also erected the genus Telorhynchus Crowcroft, 1947, and characterized it as possessing a spined, conical rhynchus and vitellaria that form an arch in the anterior part of the body.

Dayal (1948) put forth the generic name Neobucephalopsis for species resembling those of the genus Bucephalopsis but which possess a seminal receptacle, a very unique feature among the bucephalids.

Kniskern (1952) made a systematic review of the family but apparently was primarily interested in fresh water forms for little consideration was given to the status of various marine genera. His recognition of valid genera was essentially that of Nagaty (1937).

Yamaguti (1953) recognized the following genera but did not indicate their subfamily relationships; Bucephalus, Bucephalopsis, Proso rhynchoides, Alcicornis, Rhipidocotyle, Dolichoenterum, Dollfustrema, Telorhynchus, Pseudoprosorhynchus, Neidhartia and Prosorhynchus. Chauhan (1954) would have the genus Neobucephalopsis included. He also suggested that the genus Dollfustrema and Pseudoprosorhynchus should be reduced to synonymy with the genus Prosorhynchus and Neidhartia respectively.

Hopkins (1954, p. 368) proposed the generic name Bucephaloides for those forms which, "as adults, have a muscular sucker at the anterior end and do not have accessory structures such as a hood or papillae." The name Bucephaloides would, therefore, replace Bucephalopsis Nicoll, 1914, nec Diesing, 1855, which, according to
Hopkins, should be reserved solely for the cercaria, *Bucephalus haimeanus* Lacaze-Duthiers, 1854. Hopkins' revision has not been well received outside of this country and yet, as he points out, there is no evidence to suggest a relationship between the cercaria for which the genus *Bucephalopsis* was originally erected, and the adult forms other than their common membership in the family Bucephalidae. Until the life cycle of *Bucephalopsis haimeanus* is worked out and proven experimentally, there is no reason to assume its definitive stages will fit into the genus as it is now perceived. The proposal of Hopkins (1954) is considered well justified and is therefore followed in this study.

Dickerman (1954) erected the genus *Paurorhynchus* for a fresh water species with a weakly developed rhynchus and placed it in a new subfamily, Paurorhynchinae.

Dawes (1956) held a very conservative view with regard to the validity of many of the genera that had been proposed. It was his contention that only the genera *Bucephalus*, *Bucephalopsis* and *Rhipidocotyle* should be held valid in the subfamily Buciphalinae and *Prosorhynchus*, *Neidhartia* and *Alcicornis* in the subfamily Prosorhynchinae.

Yamaguti (1958) proposed a number of additional subfamilies and grouped the known genera accordingly: Bucephalinae; *Bucephalus*, *Alcicornis*, *Telorhynchus*, *Dollfustrema*, *Rhipidocotyle*, *Dolichoenterinae*; *Dolichoenterum*, *Paurorhynchus*, *Neidhartiinae*; *Neidhartia*, *Pseudoprosorhynchus*, *Neoprocorhynchinae*; *Neoprocorhynchus*, *Prosorhynchinae*; *Prosorhynchus*, *Neobucephalopsis*, *Bucephalopsis*.

It has been pointed out by Skrjabin (1962) that Yamaguti (1958) was in error in placing the genus *Paurorhynchus* Dickerman, 1954 in the
subfamily, Dolichoenterinae Yamaguti, 1958, since Dickerman (1954) had already established the subfamily Paurorhynchinae for his new genus.

The Russian school of helminthologists recently published another part of their monumental series on the class Trematoda in which they review the prior schemes of classification of the bucephalids (Skrjabin and Guschanskaja 1962). Essentially they are in agreement with the subfamily designations of Yamaguti (1958). They have, however, questioned the status of the higher categories of classification.

Odhner in 1905 erected the suborders Gasterostomata and Prosostomata in the order Digenea van Beneden, 1858, and in 1907, Poche established the family Bucephalidae. This system has long been accepted and, even though LaRue (1926) created the suborder Bucephalata and superfamily Bucephaloidea, most students of the gasterostomes have not followed LaRue's scheme. In 1957, LaRue did away with his suborder Bucephalata and superfamily Bucephaloidea in favor of a system in which he grouped the bucephalids with the brachylamids and fellodistomids primarily on the basis of larval similarities. LaRue's (1957) proposal has been referred to by various investigators but has not had generally wide acceptance because of the questions that must be answered before its validity can be verified.

Skrjabin and Guschanskaja (1962) would reinstate the suborder Bucephalata LaRue, 1926, and would also raise the bucephalids to the rank of order Bucephalidida (Odening, 1960) in the subclass Bucephalididea. Skrjabin and Guschanskaja (1962), contend the gasterostomatous trematodes are distinctive enough to warrant a higher category of classification. They do, however, retain the family name Bucephalidae Poche, 1907, along with the following subfamilies;
Bucephalinae, Dolichoenterinae, Neidhartiinae, Neoprosorhynchinae, Paurorhynchinae and Prosorhynchinae.

There is a certain appeal to the Russian proposal of Skrjabin and Guschanskaja (1962) since it does not group the bucephalids with distomate trematodes as is suggested by LaRue (1957) on what are considered rather tenuous grounds. On the other hand, there is some question as to the wisdom of giving the group the rank of order. For these reasons, the generally recognized scheme of classification is as follows:

<table>
<thead>
<tr>
<th>Class</th>
<th>Trematoda</th>
<th>Rudolfi, 1818</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order</td>
<td>Digenea</td>
<td>van Beneden, 1858</td>
</tr>
<tr>
<td>Suborder</td>
<td>Gasterostomata</td>
<td>Odhner, 1905</td>
</tr>
<tr>
<td>Family</td>
<td>Bucephalidae</td>
<td>Poche, 1907</td>
</tr>
</tbody>
</table>
Proposed Classification Within Family BUCEPHALIDAE

Observations made in the course of the present study have directed attention to the necessity of re-evaluating the classificatory system employed in the family Bucephalidae. Problems at the species level are numerous, but this is expected when dealing with a little known group. What these problems entail will be discussed in the section devoted to species found in the Gulf of Mexico. First, however, it is essential to consider the perplexities that have developed among the generic and subfamilial groups.

It was shown in the historical review that at the time Nicoll (1914) proposed the subfamilies Prosorhynchinae and Bucephalinae, there were four recognized genera of gasterostomes. It was also indicated these assemblages were based on the nature of the organ of attachment in the respective genera. Nicoll (1914, p. 490) remarked, "The definitions of these subfamilies are identical with the definitions given...for the genera..." Thus it was clear those species bearing a rhynchus should be ascribed to the genus Prosorhynchus and subfamily Prosorhynchinae. By contrast, those forms which possess a simple sucker, or one adorned with tentacles or a flap-like hood, should be assigned to the genus Bucephaloïdes, Bucephalus and Rhipidocotyle respectively, and all to be included in the subfamily Bucephalinae. The important thing to note here is that Nicoll (1914) considered the fundamental structure of the adhesive organ to be the significant feature and not secondary modifications such as tentacles or flap-like hoods. This is evidenced by his placing the genera Bucephalus, Bucephaloïdes and Rhipidocotyle in the same subfamily. Two of these
genera possess cephalic projections of one sort or another but yet all three have the same basic type of sucker.

The taxonomic value assigned to the cephalic adhesive organ should be emphasized, for until 1954, it was generally believed this was the only character upon which both genera and subfamilies could be founded. Nicoll (1914, p. 489) stated, with regard to a comparison of the nomenclatural importance of gonadal structures in the prosostomates, "In the gasterostomata...it is evident that one cannot regard this feature as a satisfactory basis of classification, and recourse must be had to others of a more constant nature."

It should be noted that members of the above genera all have a short intestine and a pretesticular ovary. There is, of course, a great degree of variation in the relative position of these and other internal organs, but among the above four genera this is taxonomically of specific or infraspecific value. These morphological features, however, assumed a greater significance as more genera and species were found and described.

Between the years of 1914 and 1954, eight new genera were added to the family and assigned to the subfamilies Bucephalinae and Prosorhynchinae. The characteristics of the two subfamilies were simultaneously expanded to include the wide ranges of variation in the internal anatomy of the newly described genera. It was recognized during this period that only in the nature of the anterior end was there any means by which the family could be subdivided. Nagaty (1937) and Manter (1940a), among others, adhered to this view and hence followed the systematic outline introduced by Nicoll (1914).

Dickerman (1954) described the new genus, \textit{Paurorhynchus}. It was his contention that it could not be assigned to one or the other of the
subfamilies erected by Nicoll (1914) because of its unique internal anatomy regardless of the fact that it also possessed a rhynchoid anterior end. It is believed the establishment of the subfamily Paurorhynchinae Dickerman, 1954, was unwarranted since it reduced the value of what is held to be the one subfamilial taxonomic character, namely the basic character of the cephalic organ of attachment. Dickerman's proposal at the same time increased the significance attached to internal structures, a feature considered to be of only generic value.

In 1958, Yamaguti introduced a taxonomic scheme that warrants considerable attention. To facilitate a close examination of the system, it is relevant to list the various subfamilies and genera along with the essential parts of the subfamily diagnoses presented by Yamaguti (1958).
Family BUCEPHALIDAE Poche, 1907

Subfamily Bucephalinae Nicoll, 1914

Rhynchus sucker-like or wedge shaped. Tentacles, pentagonal hood or spines present. Pharynx postequatorial, intestine short. Ovary pretesticular.

Genus Bucephalus von Baer, 1828
  Rhipidocotyle Diesing, 1858
  Alcicornis MacCallum, 1917
  Dollfustrema Eckmann, 1934
  Teolorhynchus Crowcroft, 1947

Subfamily Dolichoenterinae Yamaguti, 1958

Rhynchus funnel-shaped with horn-like projections or weakly developed. Pharynx in anterior one-third of body, intestine very long. Ovary opposite or intertesticular.

Genus Dolichoenterum Ozakii, 1924
  Paurorhynchus Dickerman, 1954

Subfamily Neidhartiinae Yamaguti, 1958

Rhynchus discoid or plug-shaped. Pharynx equatorial or postequatorial, intestine short. Ovary opposite or intertesticular.

Genus Neidhartia Nagaty, 1937
  Pseudoprosorhynchus Yamaguti, 1938

Subfamily Neoprosorhynchinae Yamaguti, 1958


Genus Neoprosorhynchus Dayal, 1948

Subfamily Prosorhynchinae Nicoll, 1914

Rhynchus plug-like or sucker-like. Location of pharynx variable. Ovary pretesticular.

Genus Prosorhynchus Odhner, 1905
  Neobucephalopsis Dayal, 1948
  Bucephaloides Hopkins, 1954
It has been previously noted that Yamaguti (1958) erroneously placed the genus *Paurorhynchus* in the subfamily Dolichoenterinae. According to Dickerman (1954), members of the subfamily Paurorhynchinae possess the following features:

**Subfamily Paurorhynchinae** Dickerman, 1954


**Genus Paurorhynchus** Dickerman, 1954

Skrjabin and Guschanskaja (1962) consider the rhynchus of prime importance in the subfamilies Bucephalinae and Prosorhynchinae as opposed to Yamaguti (1958) who placed greater emphasis on the similarity of cephalic projections. Skrjabin and Guschanskaja (1962) classified the bucephalids in the following manner:

**Family BUCEPHALIDAE**

**Subfamily Bucephalinae** Nicoll, 1914

- **Genus Bucephalus** von Baer, 1827
  - *Neobucephalopsis* Dayal, 1948
  - *Bucephalooides* Hopkins, 1954

**Subfamily Dolichoenterinae**

- **Genus Dolichoenterum** Ozakii, 1924

**Subfamily Neidhartiinae** Yamaguti, 1958

- **Genus Neidhartia** Nagaty, 1937
  - *Pseudoprosorhynchus* Yamaguti, 1938

**Subfamily Neoprosorhynchinae** Yamaguti, 1958

- **Genus Neoprosorhynchus** Dayal, 1948

**Subfamily Paurorhynchinae** Dickerman, 1954

- **Genus Paurorhynchus** Dickerman, 1954

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Subfamily Prosorhynchinae Nicoll, 1914

Genus Prosorhynchus Odhner, 1905
   Alcicornis MacCallum, 1917
   Dollfustrema Eckmann, 1934
   Rhipidocotyle Diesing, 1858
   Telorhynchus Crowcroft, 1947
There are several features of Yamaguti's 1958 proposal that are difficult to accept from the standpoint of using the subfamily to indicate generic relationships. It will be noted that both the subfamilies Bucephalinae and Prosorhynchinae contain genera that can be characterized by their possession of a rhynchus. It is evident that the basis upon which Yamaguti separates the two subfamilies is that of whether or not the genera have cephalic projections. Thus, the tentaculate forms, and those bearing a cephalic hood, are placed in one subfamily without regard for the fact that some of them have a sucker while others have a rhynchus. Conversely, in the Prosorhynchinae Yamaguti (1958) placed not only the genus Prosorhynchus but also Bucephaloides on the grounds that one has an unadorned rhynchus and the other a simple sucker. Yamaguti (1958) has thereby attached a greater significance to the secondary modifications than he has to the fundamental structure of the anterior end. Such a proposal is completely incongruous with that originally set forth by Nicoll (1914). Skrjabin and Guschanskaja (1962) have rectified the situation somewhat by regrouping the genera in the subfamilies Bucephalinae and Prosorhynchinae according to the intrinsic nature of the organ of attachment. These authors do, however, retain the subfamilies Paurorhynchinae, Neidhartiinae, Dolichoenteninae and Neoprosorhynchinae. It is here that a second difficulty arises in the systematics of the bucephalids.

Yamaguti (1958) followed much the same procedure as Dickerman in his establishment of the subfamilies Dolichoenterninae, Neidhartiinae, and Neoprosorhynchinae, in that he consigned greater meaning to the characteristics of the internal anatomy than to that of the anterior end. Because the bucephalids have a narrow range of
significant internal modifications, such a proposal necessitates a very restricted definition of the subfamily in order to have any semblance of a distinct group. This is especially true, if in addition, the significance of the anterior end has been reduced.

The result of all this has been the establishment of subfamilies on the grounds of what are believed to be generic characteristics. This in turn means that it is extremely difficult to place new genera in established subfamilies.

A case in point is the genus *Pararhipidocotyle* described elsewhere in this paper. On the basis of its anterior end, it demonstrates very strong affinities to the genus *Rhipidocotyle*, but at the same time its internal anatomy is distinctly different. Assuming *Pararhipidocotyle* is closely related to *Rhipidocotyle* on the basis of its anterior sucker, it should be assigned to the subfamily Prosorhynchinae according to Yamaguti's scheme and to Bucephalinae if the system of Skrjabin and Guschanskaja (1962) is followed. If, however, the characteristics of its internal anatomy are to be considered, and given the weight proposed by Yamaguti (1958), it demonstrates a similarity to the genus *Dolichoenterum*, and should consequently be placed in the subfamily Dolichoenterinae. An alternative measure would be to erect a new subfamily, a motion not totally unacceptable in light of recent taxonomic procedures. The latter is not considered to be any real solution, but rather another instance of weakening the stature of the subfamily in the family Bucephalidae.

The genera in the family Bucephalidae can be divided into two distinct groups strictly on the grounds of fundamental similarities.
in the organs of attachment. Not taking into account the various cephalic embellishments, or modifications, all the genera display an interrelationship in the possession of either a rhynchus or an anterior sucker. (See Table I). It seems ambiguous, therefore, to interject internal characteristics or secondary anterior modifications at the subfamily level. To do so, is to obscure the only grounds upon which there appears to be a natural point of division in the family. Furthermore, this is the only means by which the interrelationship of many of the genera can be demonstrated. If each genus that differs internally is placed in a new subfamily there is no way to indicate the affinities that may be evident in the nature of the anterior end. Thus, if *Pararhipidocotyle* and *Rhipidocotyle* are to be placed in separate subfamilies, there is nothing to indicate their relationship short of being contained in the same family. The same may be said for the genus *Paurorhynchus*, *Dolichoenterum*, *Neoprosorhynchus*, *Neidhartia*, *Neobucephalopsis* and *Pseudoprosorhynchus*.

It is submitted, therefore, that only the subfamilies *Bucephalinae* and *Prosorhynchinae* should be retained and that they be redefined to permit the inclusion of all the known genera. In view of this proposal these subfamilies can be defined as follows:

**Subfamily Bucephalinae** - Anterior organ of attachment in the form of a muscular sucker. Accessory tentacles present or absent. Ovary either pre- or intertesticular. Intestine saccular and either short or elongate. Seminal receptacle present or absent.

**Subfamily Prosorhynchinae** - Anterior organ of attachment in the form of a rhynchus. Accessory tentacles or spines
<table>
<thead>
<tr>
<th>Genus</th>
<th>Organ of Attachment</th>
<th>Cephalic Processes</th>
<th>Ovary Location</th>
<th>Seminal Receptacle</th>
<th>Testes</th>
<th>Excretory Bladder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bucephalus</td>
<td>Sucker-like</td>
<td>Tentacles present</td>
<td>Pretesticular</td>
<td>Absent</td>
<td>Smooth</td>
<td>Thin-walled</td>
</tr>
<tr>
<td>Bucephaloides</td>
<td>Simple sucker</td>
<td>Absent</td>
<td>Pretesticular</td>
<td>Absent</td>
<td>Smooth</td>
<td>Thin-walled</td>
</tr>
<tr>
<td>Neobucephalopsis</td>
<td>Sucker-like</td>
<td>Absent</td>
<td>Pretesticular</td>
<td>Present</td>
<td>Smooth</td>
<td>Thin-walled</td>
</tr>
<tr>
<td>Rhipidocotyle</td>
<td>Sucker-like</td>
<td>Hood present</td>
<td>Pretesticular</td>
<td>Absent</td>
<td>Smooth</td>
<td>Thin-walled</td>
</tr>
<tr>
<td>Pararhipidocotyle</td>
<td>Sucker-like</td>
<td>Hood present</td>
<td>Intertesticular</td>
<td>Absent</td>
<td>Smooth</td>
<td>Thick-walled</td>
</tr>
<tr>
<td>Dolichoenterum</td>
<td>Funnel-like</td>
<td>Processes horn-like</td>
<td>Intertesticular</td>
<td>Absent</td>
<td>Smooth</td>
<td>Thin-walled</td>
</tr>
<tr>
<td>Prosorhynchus</td>
<td>Rhynchus plug-like</td>
<td>Absent</td>
<td>Pretesticular</td>
<td>Absent</td>
<td>Smooth</td>
<td>Thin-walled</td>
</tr>
<tr>
<td>Pseudoprosorhynchus</td>
<td>Rhynchus discoid</td>
<td>Absent</td>
<td>Intertesticular</td>
<td>Absent</td>
<td>Smooth</td>
<td>Thin-walled</td>
</tr>
<tr>
<td>Genus</td>
<td>Plug Type</td>
<td>Rhynchus</td>
<td>Intertesticular</td>
<td>Testes</td>
<td>Surface</td>
<td>Walling</td>
</tr>
<tr>
<td>------------------</td>
<td>---------------</td>
<td>----------</td>
<td>----------------</td>
<td>--------</td>
<td>---------</td>
<td>----------</td>
</tr>
<tr>
<td>Neidhartia</td>
<td>plug-like</td>
<td>Absent</td>
<td>Absent</td>
<td></td>
<td>Smooth</td>
<td>Thin-walled</td>
</tr>
<tr>
<td>Neoprosorhynchus</td>
<td>plug-like</td>
<td>Absent</td>
<td>Absent</td>
<td>Postesticular</td>
<td>Smooth</td>
<td>Thin-walled &quot;y&quot; shaped (?)</td>
</tr>
<tr>
<td>Paurorhynchus</td>
<td>weak</td>
<td>Absent</td>
<td>Opposite</td>
<td>Absent</td>
<td>Lobed</td>
<td>Thin-walled</td>
</tr>
<tr>
<td>Dollfustrema</td>
<td>plug-like</td>
<td>Three rows of spines</td>
<td>Pre-or inter testicular</td>
<td>Absent</td>
<td>Smooth</td>
<td>Thin-walled</td>
</tr>
<tr>
<td>Telorhynchus</td>
<td>plug-like</td>
<td>One row of spines</td>
<td>Pretesticular</td>
<td>Absent</td>
<td>Smooth</td>
<td>Thin-walled</td>
</tr>
<tr>
<td>Alcicornis</td>
<td>plug-like</td>
<td>Tentacles present</td>
<td>Pretesticular</td>
<td>Absent</td>
<td>Smooth</td>
<td>Thin-walled</td>
</tr>
</tbody>
</table>
present or absent. Ovary pre-, inter-, or postesticular.

Intestine simple and either short or elongate. Seminal receptacle absent.

Family Bucephalidae Poche, 1907

Subfamily Bucephalinae Nicoll, 1914

Genus Bucephalus
   Bucephaloides
   Neobucephalopsis
   Rhipidocotyle
   Pararhipidocotyle
   Dolichoenterum
von Baer, 1827
Hopkins, 1954
Dayal, 1948
Diesing, 1858
Ozaki, 1924

Subfamily Prosorhynchinae Nicoll, 1914

Genus Prosorhynchus
   Pseudoprosorhynchus
   Neidhartia
   Neoprosorhynchus
   Paurorhynchus
   Dollfustrema
   Telorhynchus
   Alcicornis
Odhner, 1905
Yamaguti, 1938
Nagaty, 1937
Dayal, 1948
Dickerman, 1954
Eckmann, 1934
Crowcroft, 1947
MacCallum, 1917
Subfamily BUCEPHALINAE Nicoll, 1914.

**Bucephalus brevitentaculatus** sp. n.

Host: *Trichiurus lepturus* Linnaeus

Incidence: In 12 of 28.

Location: Gastric caeca.

Locality: Barataria Bay - Chandeleur Islands - Mississippi Sound - Wine Island

Plate I

Diagnosis: *Bucephalus brevitentaculatus* has a somewhat elongated body with nearly parallel sides, bluntly rounded posterior end and tapered anterior. It is 1.03 (0.66 - 1.33) mm long and 0.326 (0.264 - 0.374) mm wide. Small, thin spines cover the cuticle with the exception of that at the posterior end of the body. The muscular, anterior sucker measures 0.108 (0.075 - 0.125) mm in length and 0.072 (0.065 - 0.101) mm in width. Seven short tentacles encircle the anterior end of the body and have an average length of 0.013 mm and a width of 0.007 mm. Frequently, all but two of the tentacles are retracted, in which case, the remaining five projections are very difficult to detect. There are no tentacular or basal papillae.

The pharynx is located postequatorially and is usually shorter than it is wide; 0.066 (0.057 - 0.078) mm by 0.081 (0.080 - 0.093) mm. It is usually situated in the median concavity formed between the tandemly arranged testes. The esophagus is directed anteriorly and leads into a thick-walled gut that is anterior to the mid-body and measures 0.097 (0.091 - 0.104) mm by 0.079 (0.073 - 0.088) mm.

The testes are dextrally tandem and may be contiguous or over-
lapping, depending upon the amount of body contraction. The anterior testis, measuring 0.115 (0.101 - 0.132) mm by 0.098 (0.080 - 0.127) mm, is slightly anterior to the mid-level of the pharynx, whereas the posterior testis, 0.108 (0.101 - 0.114) mm by 0.106 (0.091 - 0.130) mm, is postpharyngeal. A long cirrus pouch extends from near the equatorial plane to the subterminal genital atrium and measures 0.386 (0.310 - 0.1440) mm long by 0.078 (0.065 - 0.088) mm wide. In contracted forms, the cirrus may exceed the pharyngeal level anteriorly. The seminal vesicle, that may be ovoid or cylindrical, has a length of 0.090 (0.086 - 0.104) mm and a width of 0.042 (0.026 - 0.065) mm. Lobes from the cirrus project into the genital atrium, which is located on the average of 0.068 mm from the subterminal, genital pore.

The subspherical ovary is located at the level of the gut and lies in close proximity to the anterior testis. It measures 0.075 (0.060 - 0.094) mm in length and 0.073 (0.065 - 0.080) mm in width. The ootype and Mehlis' gland are situated lateral and posterior to the ovary. Laurer's canal is long and extends to a level equal to the dorsal, posterior border of the anterior testis. In highly gravid forms, the uterus fills much of the body space, extending anteriorly into the vitelline field and into the dextral portion of the hind-body, adjacent to the cirrus. The vitelline follicles are formed into two groups in the anterior one-quarter of the body. Each group arches toward the mid-line and in so doing the follicles nearly reach the median, posterior border of the anterior sucker. Because of the large quantity of eggs usually present, the exact number of vitelline follicles is very difficult to determine. One cannot be certain if some of the bodies are merely bilobed or whether they represent two distinct follicles. There appears to be a total of between twenty-five
and thirty follicles or about fifteen per side. The left vitelline duct courses diagonally to the level of the pharynx before turning anteriorly to unite with the right duct at the mid-dorsal level of the anterior testis. The thick-shelled ova measure 0.020 - 0.023 mm in length and 0.013 mm in width.

A thin-walled excretory bladder extends from the posterior pore to a point slightly anterior to the pharynx.

Comparisons: *Bucephalus brevitentaculatus*, like most members of the genus, possesses a series of seven anterior tentacles or projections. It differs from the majority of species, however, in that the tentacles are very short and blunt and are not adorned with secondary papillae. Of the other two species that clearly fall into this category, *Bucephalus brevitentaculatus*, more nearly resembles *B. retractilis*, Yamaguti, 1952. In comparison, *Bucephalus brevitentaculatus* differs in having a much shorter but proportionately wider body, in possessing smaller internal organs in having tentacles that are much more blunt and finally in producing larger ova. Compared to *B. leognathi*, Velasquez, 1958, *Bucephalus brevitentaculatus* has a longer and slightly wider body, a pharynx that is more posteriorly situated, a cirrus that is relatively longer and ova that are significantly larger. In view of these dissimilarities, it is believed that *Bucephalus brevitentaculatus* represents a new species and it is here named according to the nature of its cephalic projections.

Distribution: *Bucephalus brevitentaculatus* very possibly is the species referred to by Sparks (1958) as "*Bucephalus sp." from the cutlassfish of Grand Isle, Louisiana. If this is the same species, the present study is the second record of its occurrence along the
Louisiana Coast and the first report of its incidence east of the Mississippi River. Further study of the host might expand the known range of the parasite but, judging from the information at hand, it appears to be endemic in the central, northern Gulf of Mexico.

The host, *Trichiurus lepturus*, is quite widespread in its distribution and yet specimens examined by Linton (1940) at Woods Hole, Chandler (1935) from Galveston Bay, Sogandares (1959) from the Gulf of Panama, and by Siddiqi and Cable (1960) from Puerto Rico were not found to harbor this species of gasterostome. Linton (1940) examined seven host fishes and reported a gasterostome that is now believed to be *Bucephaloidea trichiuri*, Sogandares, 1955. It is significant to note that this species occurs concomitantly with *Bucephalus brevitentaculatus* in the caeca of fishes from the northern Gulf. It would seem, that had the latter species been present in the fishes examined by Linton, it probably would not have been overlooked. Therefore, it may be reasonable to assume that *Bucephalus brevitentaculatus* does not occur in fishes of the northern Atlantic Coast. In the survey made by Chandler, Sogandares, and by Siddiqi and Cable, the numbers of fishes examined were so small that there is no conclusive evidence that *Bucephalus brevitentaculatus* does or does not infect fishes in coastal areas lateral to Louisiana and Mississippi. It would be of interest to determine its extent since it might serve to indicate the nature of bucephalid distribution in marginal waters. The possibility also exists that *Bucephalus brevitentaculatus* is truely an endemic species and that its range is a direct reflection of the distribution of one of the intermediate hosts. This postulation is strengthened by the fact that the outflow of the Mississippi River
may foster the development of the intermediate forms whereas coastal areas further east or west might provide a less suitable environment. There are, of course, a great many unknown factors involved and it is for this reason that additional information will be necessary before any definite conclusions can be drawn.

Within the host, *Bucephalus brevitentaculatus* was almost exclusively confined to the gastric caeca. Only on one occasion was a specimen collected from the intestine. The latter incident did not appear to be the result of over crowding since very few worms were present in that particular fish's gut. Of the thirteen fishes harboring *Bucephalus brevitentaculatus*, only four were found to have a single gasterostome infection. That is, in nine of the fishes, *Bucephalus brevitentaculatus* was found side by side with *Bucephaloides trichiuri*. The combination of the two infections was often of such intensity that the caeca were discolored because of the great number of egg-bearing worms present. As many as thirty-two specimens of *Bucephalus brevitentaculatus* were collected from a single host but more frequently, only four or five specimens were encountered.
Bucephalus cynoscion Hopkins, 1956.

Host: Cynoscion nebulosus (Cuvier)

Cynoscion arenarius Ginsburg

Incidence: In 8 of 29 Cynoscion nebulosus.
In 4 of 9 Cynoscion arenarius.

Location: Gastric caeca

Locality: Cynoscion nebulosus - Barataria Bay - Mississippi Sound

Cynoscion arenarius - Barataria Bay

Plate II

Diagnosis: Bucephalus cynoscion has a spinous body that is usually elongated although it may be ovoid in contracted specimens. In relaxed forms, the body measures 0.88 (0.60 - 1.12) mm in length by 0.189 (0.132 - 0.231) mm in width. The muscular anterior sucker is 0.102 (0.073 - 0.132) mm long and 0.827 (0.057 - 0.101) mm wide and is beset with seven tentacular processes that average 0.054 mm in length. On the posterior surface of each of the tentacles are two papillae that may be in varying degrees of contraction in fixed material. The basal papilla is located about 0.015 mm from the origin of the tentacle and ranges from 0.010 to 0.078 mm in length. The distal papilla frequently appears as nothing more than a slight elevation but in well prepared specimens it has an average length of 0.005 mm and is located about 0.04 mm from the base of the tentacle.

The subspherical pharynx, measuring 0.032 (0.028 - 0.041) mm by 0.049 (0.039 - 0.065) mm, is situated postequatorially and opens into the anteriorly directed esophagus. The saccular gut may lie anterior to the pharynx or it may curve posteriorly and thus come to lie
dorsal to the pharynx.

The paired testes are in tandem and are contiguous although they may overlap in contracted specimens. The anterior testis, measuring 0.110 (0.070 - 0.159) mm by 0.0826 (0.065 - 0.096) mm, is most often anterior to the pharynx. In some specimens, however, the pharynx may be shifted anteriorly and is thus pretesticular. The posterior testis is 0.079 (0.060 - 0.096) mm by 0.0745 (0.055 - 0.096) mm.

The cirrus pouch usually extends as far anterior as the testes and in some forms it may reach the level of the pharynx. It measures 0.285 (0.210 - 0.330) mm by 0.046 (0.034 - 0.054) mm and contains a seminal vesicle that is 0.0516 (0.049 - 0.054) mm by 0.025 (0.025 - 0.028) mm. The terminal portion of the cirrus bears a club-shaped lobe that projects into the subterminal, genital atrium.

The subspherical ovary may lie dextrally adjacent to the gut or, in specimens that have an anteriorly shifted pharynx, it may be found at the level of the pharynx. It measures 0.0684 (0.054 - 0.078) mm by 0.068 (0.054 - 0.078) mm and is separated from the anterior testis by the ootype and Mehlis' gland. Laurer's canal runs along the median surface of the anterior testis to very nearly its dorsal, posterior border.

The uterus courses anteriorly from the ootype to fill much of the space between the laterally disposed vitellaria. In some specimens, it almost reaches the anterior sucker and in all, it extends at least anteriorly to the vitelline field. Posteriorly the uterus displays two coils that are adjacent to the cirrus pouch but which do not extend posteriorly to the genital atrium. The vitellaria consist of two widely separated groups that consist of from thirteen to seventeen
follicles each. The left vitelline duct passes posteriorly to the level of the pharynx before crossing the body to meet the shorter dextral duct at the level of the anterior testis.

The ova are thick-shelled and measure 0.020 mm by 0.013 mm. The thin-walled excretory bladder extends from the terminal pore to very near the posterior margin of the anterior sucker.

Comparisons: Hopkins (1956) remarked about his uncertainty as to the number of tentacles borne on the anterior end of *Bucephalus cynoscion*. He further stated that he noted two "small knob-like" structures on the ventral surface of the sucker "which may have represented retracted papillae." Many of the specimens observed in this study did have some of the tentacles retracted but in a good many, it was very clear that seven projections were present. A study of the two ventral tentacles showed that they are of the same fundamental structure as the remaining five. That is, they too possess two secondary papillae.

In contrast to Hopkins description, it was noted that not a single specimen had a uterus that extended posteriorly beyond the genital atrium. In his description, and figure of *Bucephalus cynoscion*, Hopkins (1956, p. 130) points out the uterus "fills all of the hindbody not occupied by the cirrus and the excretory bladder." Many of the specimens that were examined were heavily gravid so it would not seem that this variation was due to the lack of ova. Although uterine extent is often used or referred to as a species character, it is believed to represent mere variation in this case since the forms in question agree very well with the species in every other respect.

It was also noted that in a single specimen that the pharynx was
not at the level of the intertesticular concavity but rather located anterior to the testes. This particular specimen was in excellent condition and did not indicate any other displacement of organs that might have been the result of fixation procedures. In this same form, the cirrus reached the level of the pharynx rather than merely the level of the testes. This is pointed out because it demonstrates quite clearly the amount of individual variation that may be observed when a large series of worms is studied.

Distribution: *Bucephalus cynoscion* has been recorded from *Bairdiella chrysura* of Clear Lake, Texas, and from *Cynoscion arenarius* of Galveston Bay, Texas (Sparks, 1960). Along the Louisiana Coast, it has been collected from *Bairdiella chrysura*, *Cynoscion arenarius* (Sparks, 1958) and, of course, from the type host *Cynoscion nebulosus* (Hopkins, 1956) and (Sparks, 1958).

In this survey, its occurrence was noted in eight of the twenty-nine specimens of *Cynoscion nebulosus* and in four of the nine specimens of *Cynoscion arenarius* from Barataria Bay. Six specimens of *Bairdiella chrysura* from the same location were examined but all proved to be negative as did an equal number of specimens of *Cynoscion nebulosus* from the Mississippi Sound.

The fact that *Bucephalus cynoscion* has never been obtained east of the Mississippi River should be emphasized for such information is apparently a general reflection of gasterostome distribution in marginal waters. Of course, it must also be stated that further studies of fishes from the northern Gulf may extend the currently known range of *Bucephalus cynoscion*, but even in our present state of knowledge, there
strong indications that additional data will show essentially the same pattern of distribution.

The absence of *Bucephalus cynoscion* from areas other than the western Gulf of Mexico cannot be considered as an indication of the lack of either definitive hosts or systematic surveys. The scianids are known as one of the more common groups of fishes along the Atlantic and Gulf Coast (Gunter, 1945) and (Guest and Gunter, 1958). As a result, they have been fairly well studied as possible hosts of marine trematodes in both the eastern and western Gulf as well as at various points along the Atlantic Coast. Manter (1931) reported distomes from *Cynoscion nebulosus* of Beaufort, North Carolina, but made no mention of their being infected with gasterostomes. Linton (1940), in working with the related fish *Cynoscion regalis* of Woods Hole, Massachusetts, also encountered various distomes but did not record any gasterostomes from the scianids. Hutton and Sogandares (1960) listed a large number of host animals from the Florida Coast and among them were *Bairdiella chrysura* and *Cynoscion nebulosus*. But like the earlier reports, there was no incidence of *Bucephalus cynoscion*.

From the above data, it is apparent that *Bucephalus cynoscion* is confined to the western Gulf of Mexico. Just how far south it occurs is difficult to establish since the coastal fishes beyond Galveston Bay have been very much neglected. Sogandares (1959) did examine several species of *Cynoscion* from the Gulf of Panama and it is not surprising to note that neither *Bucephalus cynoscion*, nor a related species, was collected from these host animals. It would seem therefore, that the range of *Bucephalus cynoscion* extends from the Mississippi River Delta to a point somewhere along the south and western edge of the Gulf of Mexico. In all likelihood, it begins to disappear where
the fauna assumes a more tropical nature.

An explanation of the distributional limitation imposed upon this bucephalid is, at this time, difficult to determine conclusively and not until the life cycle is known will there be any definite answer. But, it is apparent nonetheless, that its range is in direct relationship to that of the intermediate hosts. Hedgpeth (1953) has clearly shown that various invertebrates have very definite population boundaries along the Gulf Coast and it is an obvious corollary that a parasite fauna dependent upon such invertebrates would likewise demonstrate distributional limitations. Furthermore, if the definitive host itself has local populations, then there is every reason to believe that the endemicity of the parasite would be reinforced. Guest and Gunter (1958), in their discussion of the genus Cynoscion of the Gulf of Mexico state "...the speckled trout Cynoscion nebulosus population in bay areas is fairly static..." although, as they further remark, there are seasonal migrations to deeper water. From all this it is evident that the possibility of localized populations of parasites is quite high.

One final aspect of the distribution of Bucephalus cynoscion will be considered in the discussion under the species Bucephaloides caecorum Hopkins, 1956.
**Bucephalus gorgon** (Linton, 1905) Eckmann, 1932.

Synonym: **Gastrostomum gorgon** Linton, 1905

**Nannenterum gorgon** Linton, 1940

Host: **Seriola dumerili** (Risso)

**Seriola zonata** (Mitchill)

Incidence: In 7 of 8 **Seriola dumerili**.

In 1 of 3 **Seriola zonata**.

Location: Upper small intestine

Locality: **Seriola dumerili** off Grand Isle (New locality record)

**Seriola zonata** off Grand Isle - Port Eads (New locality record)

Plate III

Diagnosis: **Bucephalus gorgon** has an elongate body that is 2.31 (1.89 - 3.00) mm in length and 0.308 (0.209 - 0.473) mm in width. Long, thin spines cover the entire body but become less dense near the posterior extremity. A well formed anterior sucker is present and measures 0.190 (0.154 - 0.264) mm long by 0.159 (0.110 - 0.220) mm wide. Distally, the anterior sucker is encircled by a series of twenty-two projections. These may be divided into three categories on the basis of their length and position. Two primary tentacles, with an average length of 0.104 mm, are situated at the ventro-lateral border of the sucker. Lateral to each of the primaries, is a secondary tentacle which has an average length of 0.073 mm. Three additional secondaries are positioned mid-dorsally along the anterior rim of the sucker. Fifteen basal papillae, having an average length of 0.042 mm, are distributed in the following manner: two at the base of each of
the primary tentacles, three associated with each of the two lateral secondaries, one at the base of each of the dorso-lateral secondaries and finally three at the base of the median dorsal secondary.

The pharynx, located in the posterior portion of the middle one-third of the body, has a length of 0.061 (0.04 - 0.07) mm and a width of 0.073 (0.05 - 0.08) mm. Proceeding from the pharynx is a thin-walled esophagus that empties into the anteriorly directed gut.

The testes lie in tandem in the dextral posterior one-third of the body between the level of the pharynx and the anterior extent of the cirrus pouch. The anterior testis is the larger of the two and has an average diameter of 0.174 mm as compared to that of 0.155 mm for the posterior testis. The vasa efferentia unite at the mid-line and the resulting vas deferens enters an ovoid seminal vesicle. The cirrus pouch lies sinistrally in the hind-body and is 0.548 (0.451 - 0.649) mm long by 0.096 (0.077 - 0.110) mm wide. Three terminal lobes project from the cirrus into the genital atrium.

The ovary is dextral with an average diameter of 0.133 mm. It is situated anterior, or adjacent, to the pharynx and is separated from the anterior testis by the ootype and Mehlis' gland. Laurer's canal extends from the ootype to a point near the dorsal, posterior margin of the anterior testis. Upon leaving the ootype, the uterus crosses the body and continues up the left side in a series of short transverse coils. Before proceeding posteriorly, the uterus forms a single longitudinal coil which extends anteriorly for a distance that is about equal to one-fifth of the body length from the anterior sucker. Posteriorly, two uterine coils lie dextrally adjacent to the cirrus pouch and thus fill much of the hind-body. The genital pore is sub-terminal and is preceded by a spacious genital atrium.
Twenty-eight to thirty-one vitelline follicles are formed into two linear groupings that lie anterior to the ovary in the second one-quarter of the body. The left vitelline duct loops diagonally across the body and passes dorsal to the anterior testis before uniting with the duct from the right side to form the common vitelline passage. The ova are relatively thick-shelled and measure 0.019 by 0.013 mm.

The thin-walled excretory bladder very nearly reaches the posterior margin of the anterior sucker and opens posteriorly through a terminal pore.

Discussion: The perfunctory nature of Linton's original description has left the real character of the species *Bucephalus gorgon* (Linton, 1905) in a state of uncertainty especially in view of the fact that type specimens are apparently no longer available. What is now known of the species is largely based on a second collection and description made by Linton in 1940. In his later publication, Linton ascribed the species to the genus *Nannenterum* Ozaki, 1924. Prior to this, Eckmann (1932) had transferred *Gasterostomum gorgon* Linton, 1905, to the genus *Bucephalus* von Baer, 1827, on the grounds of the tentacular projections associated with the anterior end of the body. Although Eckmann was admittedly unfamiliar with the detailed anatomy of the anterior sucker of Linton's species, she was justified in replacing the generic name since the designation, *Gasterostomum*, had been submerged in synonymy in 1883 by Ziegler.

It is surprising that Linton selected the genus *Nannenterum* for his species for Ozaki (1924) had clearly characterized the group as consisting of species that had the cephalic end of the body modified to form a fan-shaped hood with no mention being made of tentacular processes. Because of this rather obvious mistake, Linton's proposed
name was generally considered to be synonymous with *Bucephalus gorgon* (Linton, 1905) Eckmann, 1932.

MacCallum (1917) had erected the genus *Alcicornis* to accommodate those forms which have a rhynchus rather than an anterior sucker adorned with tentacles. His interpretation of other anatomical features proved to be erroneous with the result that Eckmann (1932) did not consider the genus valid.

Until 1937, when Nagaty re-established the genus *Alcicornis* on the basis of new material and descriptions, *Bucephalus* was the only recognized group of tentaculate gasterostomes. Kniskern (1952) stated that Linton's species should be restudied in view of the fact that MacCallum's *Alcicornis* had been clearly re-defined. And, furthermore, since the nature of the cephalic end of *Bucephalus gorgon* had never been determined, it was not possible to place the species in *Bucephalus* unequivocally. Velasquez (1959) re-examined specimens of Linton's "*Nannenterum gorgon*" and came to the conclusion that an anterior sucker was present and that Eckmann had, therefore, properly assigned species to the genus *Bucephalus*.

It is of interest to note that tentacular papillae are a common feature among the bucephalids and when the entire genus is considered, these structures fall into two fundamental types. In the first, the papillae are merely protuberances on the tentacles themselves and are distal to the base of the primary projection. In the second group, these accessory structures are more basaly situated and in some instances, they appear to arise from the cuticle of the body and not from that of the tentacle. On the basis of these two tentacular types, the genus can be divided into two species groupings. Nicoll (1914) made the comment, at the time when *Bucephalus gorgon* was the only species
known to possess more than seven tentacles, that this species probably represents a new sgenus of which *Bucephalus gorgon* should be the type. There is some credibility in this proposal when not only the morphology of the two groups is considered but also the ecology. All of the species known to have more than seven cephalic projections have been collected from marine hosts whereas the remaining members of the genus have come from fresh water as well as marine environments. It is difficult at this level of our understanding of the Trematoda to attach any definite significance to this fact, but as the group becomes better known, it is very likely that such observations will have a new meaning and it is conceivable that the genus *Bucephalus* will be divided either at the generic or subgeneric level. Such a division does not at this time seem justified or necessary.

Comparisons: A large series of bucephalids was collected from the carangids, *Seriola dumerili* and *Seriola zonata* of the Louisiana Coast and when these were compared with several specimens of *Nannenterum gorgon* from Linton's 1940 collection (USNM #8185), it was concluded that the two forms were conspecific. Linton (1905) stated that the species characteristically possesses about eighteen tentacles but in his 1940 report, he mentioned that there were approximately twenty appendages surrounding the anterior sucker. A close study of these forms shows that there are actually twenty-two processes associated with the anterior end of the body. Velazquez (1952) reported that twenty-four appendages could be found around the sucker of *Bucephalus gorgon*. The same author, however, was apparently somewhat confused in his interpretation of the tentacular complex. In the original description of a new species from the Philippines, he referred to the
basic number of seven tentacles, or multiples thereof, as being characteristic of the genus and yet he attributes *B. gorgon* with having twenty-four and in the figure of his new species he shows twenty-four processes after stating that there are only twenty-one present. It is readily understood how such uncertainty could prevail since it is rather difficult to determine the number of tentacles unless a series of well prepared specimens is closely examined.

A comparison of *Bucephalus gorgon* with other members of the genus can readily be confined to only those forms having more than seven cephalic processes. There have been three other species found to have this character: *B. aoria* Verma, 1936; *B. heterotentaculatur* Bravo and Sogandares, 1956; and *B. paraheterotentaculatus* Velasquez, 1959. *Bucephalus aoria*, from the Indian fish *Aoria aoria*, was described as having fourteen to twenty-two tentacles. It is not possible to confirm this from the figure provided by Verma (1936) or by Chauhan (1954). On the basis of what can be determined from the description, it is a distinct species even though it was named only provisionally by Verma. As for *B. paraheterotentaculatus*, it differs from *B. gorgon* in possessing a much larger anterior sucker but smaller pharynx and in having a uterus that does not extend as far anteriorly and posteriorly. It may differ further if it can be established that *B. paraheterotentaculatus* has twenty-four rather than twenty-one tentacles.

Morphologically, the most closely related species is *B. heterotentaculatus*. Through the courtesy of Dr. Franklin Sogandares, two paratypes of this species were studied and it was observed that there are minor differences between it and *B. gorgon*. It was noted that the anterior sucker and the pharynx are larger in *B. heterotentaculatus*.
as is the cirrus pouch. With the exception of these variations, there is a striking similarity between the two forms. The tentacular apparatus is very nearly the same in character as is the disposition of the uterus and the anatomy of the terminal portion of the cirrus. Unfortunately, a large series of \textit{B. heterotentaculatus} was not available for examination. When such a study does become possible, there is a strong probability that the two species will be found morphologically indistinguishable, at least within an acceptable range of variation. If this is found to be the case, then they will have to be synonymized, with \textit{Bucephalus gorgon} (Linton, 1905) Eckmann, 1932, having priority.

Distribution: The ecology of both \textit{B. gorgon} and \textit{B. heterotentaculatus} cannot be overlooked in determining their relationship for it is this aspect of their biology that may provide the answer to their affinities. \textit{Bucephalus heterotentaculatus} was collected from the scomberid, \textit{Scomberomorous sierra} of the Gulf of Panama whereas \textit{B. gorgon} has been reported from carangids of the Atlantic Coast and the Gulf of Mexico. Since it is unusual for individual species of bucephalids to infect more than one host family, the distinctiveness of the two forms might be assumed on this basis alone. Host specificity has not, however, been found a strong enough character to support the taxonomic union or separation of trematode species. An alternative explanation of the relationship between these two species may be based on the concept of geminate speciation as promulgated by Jordan (1908, p. 73). In discussing this phenomenon, Jordon stated, "One of the most interesting features of 'Jordan's Law' is the existence of what I amy term \textit{geminate} species-twin species - each one representing the other on opposite side of some form of barrier." He further commented that "One of the most
remarkable cases of geminate species is that of the fishes on the two sides of the Isthmus of Panama. Living under essentially the same conditions since the end of the Miocene Period by the rise of the Isthmus, we find species after species which have been thus split into two." In view of this, it would not be surprising if the fauna harbored by radiating hosts also would also undergo modification. Manter (1940b, p. 545) has pointed out quite clearly that "The digenetic trematode fauna of marine fishes of the tropical American Pacific shows a very marked similarity to that of the tropical American Atlantic especially as compared with such trematodes in other regions." Although Manter's statement has direct reference to the observations he made at Tortugas, Florida, and at the Galapagos Islands it still has come relevance here especially in the light of the problem at hand.
**Bucephalus scorpaenae** Manter, 1940

**Host:** *Scorpaena plumieri* (Bloch)

**Incidence:** In 1 of 2 hosts.

**Location:** Upper intestine

**Locality:** Off Grand Isle, (New locality record)

**Plate IV**

**Diagnosis:** *Bucephalus scorpaenae* has a long, cylindrical body that is truncate anteriorly and bluntly rounded posteriorly. It measures 2.48 (2.08 - 2.88) mm long and 0.299 (0.253 - 0.308) mm wide at the level of the pharynx. The anterior sucker is strongly developed and is beset with seven tentacular processes; two latero-ventral, two lateral, and three dorsal. Each of the tentacles bears a single basal papilla. The sucker is 0.226 (0.208 - 0.242) mm long by 0.180 (0.171 - 0.190) mm wide. The pharynx, measuring 0.073 (0.068 - 0.078) mm long by 0.091 (0.088 - 0.096) mm wide, is situated slightly posterior to the mid-body and lies directly ventral to the sacculate gut.

The testes are in tandem in the posterior one-third of the body and are separated from each other by a single uterine coil. In contracted specimens, the uterus may be displaced and the testes may be overlapping. The anterior testis is 0.210 (0.190 - 0.232) mm long by 0.164 (0.140 - 0.182) mm wide whereas the posterior testis is 0.186 (0.150 - 0.208) mm by 0.154 (0.143 - 0.172) mm. The cirrus reaches the level of the posterior testis and is 0.599 (0.517 - 0.605) mm long and 0.112 (0.101 - 0.130) mm wide. Terminally, the cirrus bears two genital lobes. The ovoid seminal vesicle is 0.110 (0.104 - 0.116) mm.
in length and 0.061 (0.057 - 0.065) mm in width.

The ovary is situated at the junction of the posterior and middle one-third of the body and is separated from the anterior testis by the ootype and Mehlis' gland. The ovary is 0.142 (0.140 - 0.177) mm long and 0.136 (0.104 - 0.163) mm wide. Laurer's canal appears to extend to the dorsal, posterior level of the anterior testis. The uterus ascends the forebody in a series of short, transversal loops and comes within one-ninth the body length of the anterior sucker before coursing posteriorly. Several short coils of the uterus lie dextral to the cirrus pouch but none exceeds the posterior limit of the subterminal, genital atrium. The vitellaria are arranged into two linear groups of thirteen to fifteen follicles each and extend from the level of the pharynx to within one-third the body length from the anterior sucker. The ova are thin-shelled and 0.018 mm in length and 0.013 mm in width. The extent of the excretory bladder was obscured by the uterus and, therefore, could not be clearly determined.

Comparisons: Bucephalus scorpaenae from the northern gulf agrees completely with the characters of the species described by Manter (1940).

Distribution: Manter (1940c) first described Bucephalus scorpaenae from Tortugas, Florida. Since that time, it has only been reported from one other location, Orange County, California (Winter, 1950). There is reason to believe the latter account may actually represent a closely related species of Bucephalus scorpaenae. Winter (1950) collected the parasite from Scorpaena guttata Girard of the Pacific Coast which in itself suggests a difference in species. Manter (1940c) pointed out the apparent host specificity of Bucephalus.
scorpaenae has, so far as known, limited it to Scorpaena plumieri. He examined four other species of Scorpaena at Tortugas but failed to find the gasterostome in anything other than the type host.

It is of additional interest to note, Sparks (1957) in the Bahamas, Sogandares (1959) at Bimini, British West Indies and Siddiqi and Cable (1960) at Puerto Rico all posted specimens of Scorpaena plumieri but none was found infected with Bucephalus scorpaenae.

There is obvious difficulty in trying to appraise the distribution of Bucephalus scorpaenae especially if it actually does occur in the Pacific. If it does not occur in the west, then there is indication that it is confined to the Gulf of Mexico. It is surprising, however, that it has not been collected in the Caribbean area for as Manter (1955) and Sparks (1957) have indicated there are strong affinities in the fauna of the Dry Tortugas and the aforementioned islands.
**Bucephalus varicus** Manter, 1940

**Synonym:** *Bucephalus polymorphus* of Nagaty, 1937

**Host:**
- *Caranx hippos* (Linnaeus)
- *Caranx latus* Agassiz
- *Caranx ruber* (Bloch)
- *Caranx crysos* (Mitchill)

**Incidence:**
- In 6 of 20 *Caranx hippos*.
- In 1 of 1 *Caranx latus*.
- In 1 of 1 *Caranx ruber*.
- In 2 of 6 *Caranx crysos*.

**Location:** Gastric caeca and upper intestine

**Locality:** Chandeleur Island. (New locality record)
- Off Grand Isle. (New locality record)

**Plate V**

**Diagnosis:** *Bucephalus varicus* has a long, thin body that becomes wider posteriorly. It measures 1.33 (0.913 - 1.77) mm in length and 0.232 (0.187 - 0.341) mm in width at the level of the pharynx. The cuticle is covered with very small, finely pointed spines. The anterior sucker is 0.097 (0.080 - 0.106) mm long and 0.091 (0.077 - 0.112) mm wide at its distal end. It is encircled by seven horn-like tentacles each of which bears two papillae. The proximal papillae are about twice the length of those more distal. The pharynx is in the posterior one-third of the body with a length of 0.057 (0.049 - 0.070) mm and a width of 0.059 (0.054 - 0.070) mm. The saccular gut is directed anteriorly and lies in the intervitelline space.

The testes are in tandem dextrally and may be contiguous or overlapping. The anterior testis has an average diameter of 0.075 mm and the posterior testis 0.071 mm. The cirrus extends anteriorly to the level of the anterior testis and has a length of 0.240 (0.221 - 0.268) mm and a width of 0.057 (0.052 - 0.067) mm. It terminates.
distally in the genital atrium.

The ovary is at the level of the pharynx and has a length of 0.055 (0.044 - 0.062) mm and a width of 0.063 (0.060 - 0.068) mm. The ootype and Mehlis' gland are in tandem with the ovary. The uterus is extremely variable and may or may not exceed the level of the vitellaria anteriorly and the genital atrium posteriorly. The vitellaria are usually confined to the third quarter of the body and have fourteen to sixteen dextral follicles and ten to fifteen sinistral. The ova are thick-shelled and measure 0.020 - 0.023 mm in length and 0.013 - 0.015 mm in width. The excretory bladder extends anteriorly to a point about mid-way between the vitellaria and the anterior sucker. A distinct muscular sphincter surrounds the terminal excretory pore.

Comparisons: Manter (1940a) declared *Bucephalus varicus* to be a synonym of *Bucephalus polymorphus* of Nagaty, 1937, on the basis of their morphological similarities and, perhaps more significantly, on the grounds that *Bucephalus polymorphus* was originally described from fresh water fishes. Nagaty's specimens were collected from a marine host. Chauhan (1954) believed the converse to be true but gave no reason for his decision. There is little question in the justification of separating forms that occur in two such diverse environments especially when intermediate hosts must be taken into account.

Manter (1940a) was duly impressed with the variability found in this species and named it accordingly. In a large series, any number of variations in the internal anatomy can be observed. In general, it was found that the specimens from *Caranx crysos* were slightly smaller than those from the other jackfishes. Whether this was due to the age of the parasites or was host induced is not known.
Distribution: *Bucephalus varicus* is quite remarkable in that it has a world wide distribution. As indicated by Sogandares and Hutton (1959), it has been reported from eleven different species of carangids from Okinawa, the Red Sea, the Panamanian and Mexican Pacific and Tortugas and Tampa, Florida. This report represents the northernmost known part of its range.
Bucephaloides arcuatus (Linton, 1900) Hopkins, 1954

Synonym: Gasterostomum arcuatum Linton, 1900

Bucephalopsis arcuatus (Linton 1900) Eckmann, 1932

A review of the works dealing with Bucephaloides arcuatus (Linton, 1900) raises a considerable degree of doubt relative to the conspecificity of all the forms placed under this species designation. Much of the problem stems from Linton's works in which it is clear that the name was applied to several distinctly different gasterostomes. Linton himself expressed some doubt concerning the application of the name but, as he stated in (1900, p. 267), "This report should, perhaps, be understood as a contribution to economic rather than systematic zoology. It is hoped that it may be followed by more detailed and more precise determination than are here essayed." With subsequent compounding of Linton's nomenclatural confusion, the problem can now only be resolved by a complete re-evaluation of the species in the light of present information. To attempt this solely on the basis of Linton's figures and descriptions would require considerable reservation.

Combining this information, however, with a study of some of the type specimens and a large series of gasterostomes acquired in the present study, it is possible, in most instances, to interpret what parasites Linton was working with and thereby reconstruct the taxonomic history of the species.

Linton (1900) described and figured a gasterostome from the bonito, Sarda sarda (Bloch), of Woods Hole, Massachusetts, and proposed the name Gasterostomum arcuatum. He characterized the new species in the following manner: body slender and cylindrical,
tapering gracefully at the anterior end, body arcuate, posterior end bluntly rounded, (length of living specimen 1.28 mm, median diameter 0.21 mm, posterior diameter 0.14 mm, mounted specimen length 2.7 mm); anterior sucker terminal (live diameter 0.09 mm, mounted 0.1 mm) ventral sucker a little advance of mid-body and smaller than anterior sucker (mounted diameter 0.09 mm), 1.3 mm from anterior end; gut short; posterior testis about midway between ventral sucker and end of body, anterior testis midway between posterior testis and mouth; ovary pretesticular; cirrus extending anteriorly to posterior testis (mounted length 0.7 mm); vitellaria 32 in number and mostly anterior to the ventral sucker; uterus hiding other organs and filling hind-body; excretory bladder up to nearly anterior sucker; ova (0.021 x 0.014 mm). With this description and the accompanying figure the species was taxonomically established. Although this is a simple matter of priority, it must be emphasized here since it is evident that neither Linton nor all later taxonomists recognized the type with the result that there has been extensive and invalid use of the name Bucephaloides arcuatus (Linton, 1900).

It was considered necessary to obtain a more complete characterization of Bucephaloides arcuatus, and for this reason, specimens from Linton's collection were borrowed from the United States National Museum. One slide (USNM #6524), labeled "Gasterostomum arcuatum" was from the 1900 collection. It is doubtful that Linton based his description on this particular specimen even though it is indicated as being the type for it consists of only the posterior part of the animal. A second slide (USNM #8170) was a representative of the 1940 collection and is very likely the specimen upon which fig. 234 of...
Plate 18, Linton (1940) is based. According to Linton's report, this specimen came from the type host and it is upon this individual that the subsequent description is based.

Linton provided very little descriptive information in his account. It is, therefore, considered relevant to describe briefly Bucephaloides arcuatus on the basis of measurements and observations made on "Gasterostomum arcuatum" (USNM #8170). The body is 2.36 mm long by 0.248 mm wide. Cuticular spination dense at anterior end of body and diminishing posteriorly. Anterior sucker 0.076 mm long by 0.080 mm wide. Pharynx located anterior to mid-body and 0.059 mm in length and 0.075 mm width. Gut dorsal to pharynx and in the middle portion of the vitelline field. Testes in tandem in posterior one-half of the body. Anterior testis 0.209 mm long by 0.131 mm wide. Posterior testis 0.165 mm long by 0.110 mm wide. Cirrus pouch 0.572 mm in length and 0.110 mm in width. Uterus medial to ovary, between anterior and posterior testis and posterior testis and cirrus pouch. Vitellaria lateral, follicles irregular and extending from ovarian level to one-fifth body length from anterior sucker. Fifteen dextral and sixteen sinistral follicles. Ova 0.018 mm by 0.013 mm. Excretory bladder not visible.

Linton, (1901) again reported Gasterostomum arcuatum from Woods Hole and listed both the bonito and the dusky shark, Carharinus obscurus (LeSueur), as hosts. Little comment was made about the second collection from the bonito so it must be assumed that Linton was dealing with the same species of gasterostome. Concerning the specimens from the shark, he made the remark that they agreed in all essential characters with those from the bonito. It would seem likely,
however, that the incidence of gasterostomes in an elasmobranch represents an accidental or pseudoinfection since these trematodes are not known to infect this group of fishes normally.

In 1905, at Beaufort, North Carolina, Linton recorded the occurrence of *Gasterostomum arcuatum* in the crevalle jack, *Caranx hippos* (Linnaeus) and the cero, *Scomberomorus regalis* (Bloch). Linton expressed some doubt concerning the disposition of the forms from the crevalle jack but since he neither figured nor adequately described them, it is not possible to be certain of the species he had before him. The material from the cero was, however, briefly described as being 4.2 mm in length, 0.26 mm in diameter, as having a pharynx 0.05 mm in diameter and a cirrus pouch 0.63 mm long, and finally as producing ova that were 0.020 mm x 0.014 mm. The figure of a specimen from the cero (Plate 32, fig. 235) gives the impression of being a different species than that described from the bonito.

Linton (1910) discovered several gasterostomes in the barracuda, *Sphyraena barracuda* (Walbaum), of Tortugas, Florida, but being uncertain of their relationship, he merely referred to them as "*Gasterostomum* sp." and gave a very short description (p. 80-81) with accompanying figures (Plate 26, figs. 223, 224, 225). At that time, Linton (1910, p. 80) made the statement, "It does not seem credible that such diverse forms as those shown in figs. 223, 224, and 225, can belong to the same species." The truth of Linton's remark was borne out by subsequent workers.

Eckmann (1932) recognized the invalidity of the generic name employed by Linton and, therefore, relegated *Gasterostomum arcuatum* to the genus *Bucephalopsis* (Diesing, 1855). It henceforth was referred
to as *Bucephalopsis arcuatus* (Linton, 1900). Apparently unaware of Eckmann's generic revision, Linton (1940) retained the original name and reported *Gasterostomum arcuatum* from the bonito, the Atlantic mackerel, *Scomber scombrus* Linnaeus, the Atlantic cutlassfish, *Trichiurus lepturus* Linnaeus, and the Atlantic cod, *Gadus morhua* Linnaeus, all of Woods Hole.

Manter (1940), in working with the digenea of the Tortugas area, found the barracuda to be infected with three species of gasterostomes, two of which agreed with Linton's "*Gasterostomum sp.*" (Plate 26, figs. 223 and 224) of 1910. Manter re-described these forms and named one *Bucephaloides longoviferus* (Manter, 1940c) and the other (fig. 223) he considered to be *Bucephaloides arcuatus* (Linton, 1900) as originally described by Linton. Manter (1954) declared *Bucephaloides arcuatus* from the barracuda of American waters to be synonymous with *Bucephaloides longicirrus* (Nagaty, 1937) from the same host genus but of the Red Sea.

Subsequent to 1940, almost all of the identifications that have been listed for *Bucephaloides arcuatus* are obviously based on Manter's re-description. Too, for some unknown reason, the numbers of scomberid hosts that have been examined since Linton's survey have been very small with the apparent result that studies have not been made of forms that would cast any doubt on Manter's interpretation of the species. Hence, the species as originally conceived has become obscured by the weight of modern works.

The present survey has shown that the scomberids of the Gulf of Mexico harbor bucephalids and that when these are compared with Linton's type specimens and with his written descriptions, there is no question but some of them are similar to those reported by Linton. Furthermore,
when these gasterostomes are compared with Manter's types of "Bucephaloides arcuatus" (U.S.N.M. 39306) from the barracuda and with material from the same host of the Louisiana Coast, it becomes evident that there are at least two species involved. Concurrent with this study, Manter (personal communication) has come to the same conclusion and has asserted that only those forms from Sarda sarda should be considered as Bucephaloides arcuatus and those from other hosts need further study. He also states that the species from the barracuda is not the same as Bucephaloides arcuatus (Linton, 1900) and should, therefore, be referred to another species. (Manter, 1963 in press).

A single specimen of Sarda sarda was accessible in this survey but, unfortunately, it was in a rather poor condition at the time of examination. There was only one bucephalid in the gut and it was far too macerated to be of much use as far as specific identification is concerned. Chandler (1935) is apparently the only other person who has posted Sarda sarda from the Gulf of Mexico and in his account of trematodes from this host, he makes no mention of Bucephaloides arcuatus although he did describe a new species of gasterostome but of another genus. Whether Bucephaloides arcuatus occurs in the Gulf of Mexico is still open to question but it seems quite probable that it does since the definitive host is an oceanic animal and thus ranges over wide areas of the open sea.
Bucephaloides bennetti  Hopkins and Sparks, 1958

This species was collected from seven of 108 specimens of Paralichthys lethostigma in an earlier survey of fish parasites in Barataria Bay. A very limited number of the host species was examined in the present survey and none was found to be infected with B. bennetti.

To date this species has been reported from Louisiana (Hopkins and Sparks, 1958) and from the west coast of Florida (Hutton and Sogandares, 1960). Through the kindness of Dr. Franklin Sogandares, it was possible to compare specimens from Florida with those collected in Louisiana waters. Although this comparison did not involve a large series of animals, there were no significant differences detected between the two groups.

Corkum (1961) compared this species with that described by Melugin (1940) and discussed the incidence of B. bennetti and B. paralichthydis in Paralichthys lethostigma of Barataria Bay, Louisiana.
**Bucephaloides caecorum** Hopkins, 1956

**Host:** *Cynoscion nebulosus* (Cuvier)

**Incidence:** In 15 of the 29 hosts from Barataria Bay and In 6 of the 6 hosts from the Mississippi Sound.

**Location:** Gastric caeca and upper small intestine

**Locality:** Barataria Bay and Mississippi Sound (New locality record)

**Plate VI**

**Diagnosis:** *Bucephaloides caecorum* has an ovoid body that is covered with broad, thin spines to very near the posterior end of the body. It measures 0.946 (0.635 - 1.04) mm in length and 0.516 (0.396 - 0.583) mm wide at the mid-body. The anterior sucker is most often slightly longer than wide and possesses strong circular muscle fibers that when contracted, cause the formation of characteristic lip-like protuberances which extend medially. It is 0.209 (0.161 - 0.251) mm long and 0.194 (0.161 - 0.251) mm wide. A small muscular pharynx, having a length of 0.057 (0.495 - 0.066) mm and a width of 0.068 (0.052 - 0.078) mm, lies in the mid-body and is followed by a narrow esophagus which extends anteriorly. The saccular gut bends caudally and comes to lie dorsal and posterior to the pharynx.

The testes lie in tandem or slightly oblique in the dextral portion of the hind-body. The anterior testis is at the level of the pharynx and in close proximity to the posterior testis. It has a length of 0.125 (0.109 - 0.145) mm and a width of 0.127 (0.112 - 0.145) mm whereas the posterior testis has a length of 0.106 (0.99 - 0.112) mm and a width of 0.129 (0.099 - 0.162) mm. The cirrus pouch is located in the sinistral hind-body and usually extends just past the anterior margin of the posterior testis. In contracted forms, it
may reach the level of the pharynx. The cirrus pouch is 0.305 (0.220 - 0.405) mm long and 0.051 (0.039 - 0.060) mm wide. An ovoid seminal vesicle is contained in the proximal part of the cirrus pouch. Distally, the cirrus bears a large lobe that is recurved in the genital atrium.

The pretesticular ovary is about equal to the testes in size, having a length of 0.138 (0.112 - 0.135) mm and a width of 0.116 (0.094 - 0.135) mm. It is situated slightly anterior to the level of the pharynx. The ootype and Mehlis' gland are located medial to the ovary. Laurer's canal extends to a mid-dorsal point, posterior to the pharynx. The vitelline follicles are in two lateral clumps in the anterior one-half of the body, just posterior to the anterior sucker. There are from twelve to fourteen follicles in each cluster. Upon leaving the ootype, the uterus courses posteriorly for a short distance and then proceeds anteriorly to fill much of the fore-body. It then extends posteriorly to fill the space dextrally adjacent to the cirrus pouch. The genital pore is subterminal and ventral. A tubular excretory bladder runs anteriorly from the terminal pore to the level of the anterior sucker. The ova are thin-shelled and measure 0.023 mm in length and 0.013 mm in width.

Distribution: *Bucephaloides caecorum* was found quite frequently in the spotted seatrout, *Cynoscion nebulosus*. Fifteen of the 29 fishes from Barataria Bay were infected and all six specimens from the Mississippi Sound contained *Bucephaloides caecorum*. It was also noted in four of the nine specimens of *Cynoscion arenarius* from Barataria Bay. In this latter instance, however, the worms were all in an immature condition.
Sparks (1957) reported *Bucephaloides caecorum* from *Micropogon undulatus* and *Bairdiella chrysura* as well as from the trouts of the Grand Isle area. A number of the former two species were examined but none was found host to *Bucephaloides caecorum*.

As many as nineteen worms were encountered in the caeca and intestine of a single host but most often only four or five were present. It was noted that in the light infections, the worms were confined to the caeca but as the number increased, a few could be located in the small intestine, just below the caeca.

The known geographic range of *Bucephaloides caecorum* presents an interesting example of gasterostome distribution for it is apparently limited to the north and eastern coast of the Gulf of Mexico. To this date, it has been reported from four hosts in the northern Gulf (Sparks, 1957) and in two from the west coast of Florida, *Cynoscion nebulosus* and *Bairdiella chrysura* (Sogandares and Hutton, 1960). Its absence from the western Gulf cannot be attributed to a paucity of definitive hosts for all the above fishes are known to be very common along the Texas Coast (Hoese, 1958). Furthermore, all of these species of fishes have been examined for parasites. Sparks (1960) reported *Bucephalus cynoscion* from both *Cynoscion arenarius* and *Bairdiella chrysura* of Galveston Bay and Clear Lake, Texas. Interestingly, both *Bucephaloides caecorum* and *Bucephalus cynoscion* occur concurrently in *Cynoscion nebulosus* and *Cynoscion arenarius* of Barataria Bay. It is possible that further study will reveal that *Bucephaloides caecorum* occurs in the western Gulf. On the other hand, its distribution, as well as that of *Bucephalus cynoscion*, is conceivably a substantiation of the theory promulgated by Baugham (1950) and Ginsburg (1952).
Though not agreeing in detail, it is their general contention that the eastern and western extremities of the Gulf of Mexico represent faunal entities as based on the distribution of various closely related fish species. Thus, Baugham (1950) contends that the tremendous outflow of the Mississippi River has acted as an ecological barrier to forms to the east and west of the delta. Ginsburg (1952) would place the line of demarcation further to the east but in any case, that such a barrier exists is of considerable importance to a study of parasites in hosts from marginal waters. It is not improbable that the northern gulf in turn represents an area of melding or faunal overlap. In terms of *Bucephaloides caecorum* and *Bucephalus cynoscion*, it may mean that the intermediate hosts for both gasterostomes occur in the northern area but are mutually exclusive at the extremities of the Gulf. This possibility is given further credence in view of the fact that neither *Bucephalus cynoscion* nor *Bucephaloides caecorum* have been recorded from Beaufort, North Carolina, or Woods Hole, Massachusetts. Linton (1904 and 1940) and Manter (1931) examined specimens of what are now known to be the hosts of *Bucephaloides caecorum* and *Bucephalus cynoscion* but reported nothing that could possibly represent either one of these forms.

Unfortunately, the life cycles of *Bucephaloides caecorum* and *Bucephalus cynoscion* are unknown so that at this point it is mere speculation to suggest that such discreet faunal boundaries exist, but it does not seem beyond the realm of possibility.
**Bucephaloides longicirrus** (Nagaty, 1937) Hopkins, 1954

Synonym: *Gasterostomum* sp. Linton, 1910 (pp. 80-81, plate 26, fig. 223, 223a)

**Bucephalopsis longicirrus** Nagaty, 1937

**Bucephalopsis arcuatus** of Manter (1940b), Siddiqi and Cable (1960), Ward (1954)

**Bucephaloides arcuatus** of Sogandares (1959), Sogandares and Sogandares (1961).

Host: *Sphyraena barracuda* (Walbaum)

Incidence: In 6 of 11 hosts.

Location: Gastric caeca and upper intestine

Locality: Off Grand Isle, Louisiana (New locality record)

Plate VII

**Diagnosis:** *Bucephaloides longicirrus* has an elongate body that is tapered anteriorly and rounded posteriorly. It measures 1.84 (1.80 - 1.91) mm in length and 0.391 (0.330 - 0.473) mm in width at the level of the testes. The cuticle is spinous except for that of the posterior extremity. The well developed anterior sucker is 0.076 (0.065 - 0.091) mm long and 0.078 (0.072 - 0.085) mm wide.

The pharynx is located in the posterior one-third of the body and may be either pre- or posttesticular with a length of 0.060 (0.052 - 0.073) mm and a width of 0.070 (0.052 - 0.080) mm. The esophagus may be long or short, depending upon the relative position of the pharynx. The gut is prepharyngeal and slightly posterior to the mid-body.

The testes are diagonal with the anterior testis being situated at the mid-line and the posterior testis near the right side of the body. The anterior testis is postovarian and has a length of 0.128 (0.117 - 0.140) mm and a width of 0.120 (0.104 - 0.140) mm. The
The posterior testis is in a direct line with the ovary but is separated from it by the ootype and Mehlis' gland. It is also separated from the anterior testis by the uterus. It has a length of 0.119 (0.116 - 0.125) mm and a width of 0.115 (0.109 - 0.122) mm. The cirrus pouch is sinistral with a length of 0.455 (0.418 - 0.495) mm and a width of 0.084 (0.094 - 0.078) mm. It reaches the level of the posterior testis but not that of the anterior testis or pharynx. The ovoid seminal vesicle is 0.115 (0.114 - 0.115) mm long and 0.045 (0.039 - 0.054) mm wide. The cirrus is terminally bilobed.

The ovary is at the level of the posterior portion of the gut and is 0.118 (0.113 - 0.122) mm long and 0.116 (0.104 - 0.135) mm wide. The ootype and Mehlis' gland are in tandem with the ovary on the right side of the body. Laurer's canal extends to about the dorsal, posterior border of the posterior testis. The uterus fills much of the hind-body dextrally adjacent to the cirrus pouch and may or may not extend posterior to the genital atrium. Anteriorly, the uterus courses into the intervitelline space and may extend anterior to the vitellaria for a short distance. The vitellaria are composed of two linear groups of follicles located in the mid-body. There are from thirteen to fourteen dextral follicles and fifteen to eighteen sinistral. The left vitelline duct passes posterior to the anterior testis before uniting with the right duct near the ovary. The ova are thin-shelled and measure 0.023 mm in length and 0.013 mm in width. The excretory bladder was not clearly visible in the specimens studied.

Comparisons: Manter (1940c) ascribed one species of gasterostome from Sphyraena barracuda of Tortugas, Florida, to Linton's species, Bucephaloides arcuatus (Linton, 1900). In this paper, Manter commented about the dissimilarity of some of the forms placed in this
species by Linton, but at the same time he believed conspecificity existed between the forms from *Sarda sarda* and *Sphyraena barracuda*. As indicated above, all subsequent recordings of *Bucephaloides arcuatus* from American waters were based on Manter's (1940c) re-description.

Manter (1954), without any explanation, declared *Bucephaloides arcuatus* from *Sphyraena barracuda* to be a synonym of *Bucephaloides longicirrus* (Nagaty, 1937) collected from *Sphyraena agam* of the Red Sea. There is a very decided similarity in *Bucephaloides longicirrus* and the forms from the Gulf of Mexico. As pointed out by Manter (personal communication), the general morphology of the two forms suggests conspecificity.

Specimens of *Bucephaloides longicirrus* from the Red Sea have not been examined in this study, but on the basis of the very complete description by Nagaty (1937), there are several points of deviation that should not be ignored. The specimens from *Sphyraena barracuda* collected in the northern Gulf are larger, in both length and width, than the range given for *Bucephaloides longicirrus* from the Red Sea. Secondly, both the pharynx and anterior sucker have a greater diameter as do the testes and the ovary. The dimensions of the cirrus in the Gulf specimens fall into the middle of the range given by Nagaty but the cirrus is not "one half or even more than half the length of the whole trematode." Finally, the ova in the Gulf specimens are slightly longer though they are of the same width.

Some of the discrepancies may be explained on the basis of body contraction or relaxation at the time the animals were preserved. This, however, does not account for the difference in the cirrus-body.
length ratio. The specimens collected in the present study, exceed the maximum body length given by Nagaty but yet they have a shorter cirrus.

These variations are of interest since a comparison of the material from the present survey with the type specimens (U.S.N.M. #39306) and with the description given by Manter (1940c) reveals that the forms from Tortugas, Florida, bear a closer resemblance to those of the Red Sea than they do to those of the northern Gulf of Mexico. Manter (1940c) stated that the cirrus always reaches the posterior testis and may even extend to the pharynx. A large number of specimens were examined for this character but none was found to have a cirrus that reached beyond the posterior testis. Furthermore, Manter remarked that the uterus rarely exceeds the anterior limit of the vitellaria and usually only reaches the anterior edge of the ovary. This character was found to be quite variable in the northern forms.

Sogandares and Sogandares (1961) discovered that "The Panama specimens of Bucephaloides longicirrus differ from Manter's (1940c) re-description mainly in egg size, in the more anterior extent of the uterus, and by possessing more vitelline follicles." Thus, the material collected from Sphyraena barracuda of the Atlantic Coast of Panama demonstrated another series of constant dissimilarities.

Most of the specimens from the northern Gulf had a uterus that extended into the vitelline field but never exceeded it as found by Sogandares and Sogandares (1961). Moreover, the majority of northern Gulf forms have a coil of the uterus posterior to the genital atrium, a feature not found by Sogandares but noted as occasionally happening by Manter (1940c).
It has been suggested by Sogandares and Sogandares (1961) that there may be more than one species of gasterostome involved in the Bucephaloides longicirrus complex, but more probably, the variations are of a population nature. The latter explanation seems more plausible since there is an intergradation of characters among the forms from American waters that would be extremely difficult to delimit at the species level. It would be of considerable interest to know the geographic ranges of these group variations as an added insight into gasterostome speciation.

As for the species from the Red Sea, they should be considered to be of the same species as those from the Gulf of Mexico until both groups can be studied first hand. There is a possibility that there are actually two species involved but this, of course, needs confirmation from more extensive surveys.

Distribution: Bucephaloides longicirrus has a wide range of distribution especially if the forms from American waters and the Red Sea are of the same species. Up to this time, the species has been reported not only from Tortugas, Florida, (Linton, 1910) and (Manter, 1940c), but also from Puerto Rico by Siddiqi and Cable (1960) as well as from Panama by Sogandares and Sogandares (1961) and Bimini, British West Indies (Sogandares, 1959). Ward (1954) reported Bucephaloides longicirrus from the Miami, Florida, region. This report, is therefore, the northern most record for the species.

Eleven specimens of Sphyraena barracuda were taken from the waters around various offshore drilling platforms along the Louisiana Coast. Most of these sites were within forty miles of Grand Isle, Louisiana. Six of eleven barracudas examined were infected with Bucephaloides longicirrus and of these, five also harbored B. longoviferus.
Bucephaloides longoviferus (Manter, 1940) Hopkins, 1954

Synonym: Gasterostomum sp. of Linton, 1910, (pp. 80-81, plate 26, fig. 224, 224a)

Bucephalopsis longoviferus Manter, 1940

Host: Sphyraena barracuda (Walbaum)

Incidence: In 5 of 11 hosts.

Location: Gastric caeca and upper small intestine

Locality: Off Grand Isle, Louisiana
(New locality record)

Plate VIII

Diagnosis: Bucephaloides longoviferus has an elongate body that is 1.34 (1.11 - 0.52) mm in length and 0.277 (0.231 - 0.330) mm in width at the level of the pharynx. The anterior end is tapered and the posterior end bluntly rounded. Very small cuticular spines cover most of the body surface. The anterior sucker is terminal with a length of 0.064 (0.057 - 0.070) mm and a width of 0.055 (0.052 - 0.070) mm. The pharynx is located about three-fifths of the body length from the anterior end and is 0.048 (0.044 - 0.052) mm long by 0.045 (0.042 - 0.048) mm wide. In some specimens, the pharynx is posttesticular with the esophagus passing anteriorly between the two testes. The gut is prepharyngeal and is preceded by a long or short esophagus, depending upon the relative position of the pharynx.

The testes are diagonal with the anterior testis sinistrally postpharyngeal and measuring 0.110 (0.104 - 0.117) mm by 0.103 (0.096 - 0.110) mm. The posterior testis is dextral to the mid-line but is separated from the right side of the body by the uterus. It lies behind, but not in contact with, the ovary and has a length of 0.096 (0.088 - 0.105) mm and a width of 0.094 (0.081 - 0.101) mm.

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The cirrus pouch extends from the subterminal genital atrium to about the level of the posterior testis and is 0.305 (0.297 - 0.330) mm long and 0.052 (0.041 - 0.065) mm wide. Proximally, it contains an ovoid seminal vesicle that is 0.077 (0.067 - 0.086) mm long and 0.043 (0.028 - 0.052) mm wide. The cirrus appears to be distally bilobed.

The ovary is located at the level of the esophagus and has a length of 0.078 (0.073 - 0.091) mm and a width of 0.080 (0.077 - 0.088) mm. The ootype and Mehlis' gland are directly posterior to the ovary along the right side of the body. Laurer's canal is extremely long, reaching a point on the mid-dorsal surface that is equal to the level of the middle of the cirrus. The uterus extends anteriorly past the vitelline glands to within three tenths of the body length of the anterior sucker. Posteriorly, the uterus is largely confined to the body space dextral to the cirrus pouch but usually does not extend posterior to the genital atrium. The vitellaria are formed into two linear groups and are restricted to the middle one-fifth of the body. There are from twelve to fourteen dextral follicles and eleven to fourteen sinistral. The left vitelline duct passes around the posterior border of the anterior testis and then courses anteriorly between the two testes before uniting with the duct from the right side of the body. The ova are thin-shelled and much longer than they are wide: 0.027 - 0.028 mm long by 0.013 mm wide. The excretory bladder was visible in only one specimen and was noted to extend from the terminal pore to the level of the pharynx.

Comparisons: *Bucephaloides longoviferus*, from the northern Gulf of Mexico, is in general agreement with the description and type specimen (U.S.N.M. #36710) designated by Manter (1940c). With the

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exception of the egg size, the northern specimens were found to be consistently larger in every part of their morphology. It was also noted that the anterior coil of the uterus did not extend as far forward and that the cirrus never reached the level of the anterior testis. Exclusive of these variations, there is no question of the conspecificity of the two forms. This perhaps is another instance of population variability as discussed under the host related species, Bucephaloides longicirrus.

Manter (1940c) made note of the similarity of B. longoviferus and Linton's "Gasterostomum sp. " (1910, pp. 80-81, plate 26, fig. 224, 224a). As he remarked, there is no doubt but they represent the same species for B. longoviferus is very distinctive in the type of ova it produces.

Distribution: The reports of Linton (1910) and Manter (1940c) are the only records of this species prior to this study. It is somewhat surprising that it has not been collected at the various sampling stations in the Caribbean since its relative, B. longicirrus, is well known from the barracuda of that area. It does not seem probable that it has been overlooked or confused with B. longicirrus since it is quite different. Perhaps further studies will reveal the presence of B. longoviferus in regions other than Tortugas, Florida, and the northern Gulf of Mexico.
Bucephaloides megacirrus  Riggin and Sparks, 1962

Host:  Scianops ocellatus  (Linnaeus)

Incidence: In 19 of 28 hosts.

Location: Gastric caeca and upper intestine

Locality:  Barataria Bay
Mississippi Sound

Plate IX

Diagnosis:  Bucephaloides megacirrus has an elipsoid body which is 0.99 mm (0.86 - 1.00) mm long and 0.35 (0.31 - 0.37) mm wide at the level of the gut. The cuticle is covered with spines which diminish in the size and density near the posterior end of the body. The anterior sucker is nearly spherical and has a length of 0.142 (0.124 - 0.166) mm and a width of 0.141 (0.124 - 0.163) mm. The pharynx is slightly wider than it is long and measures 0.071 (0.067 - 0.10) mm in length and 0.088 (0.074 - 0.10) mm in width. It is located near the posterior limits of the middle one-third of the body and opens into a fairly long esophagus that runs anteriorly to the sacculate gut. The intestine extends as far anteriorly as the posterior extent of the vitellaria.

The testes are dextrally tandem in the middle one-third of the body. The anterior testis has an average diameter of 0.104 mm and the posterior 0.085 mm. The very long cirrus pouch extends to very near the equatorial plane and has a length of 0.59 (0.45 - 0.56) mm and a width of 0.102 (0.07 - 0.140) mm. An ovoid seminal vesicle, measuring 0.071 (0.069 - 0.080) mm by 0.040 (0.025 - 0.056) mm, is contained in the proximal portion of the pouch. The terminal part of the cirrus consists of two clavate lobes that protrude into the

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genital atrium.

The spherical ovary measures 0.077 (0.062 - 0.087) mm in diameter and is situated anterior to the testis in the posterior portion of the anterior one-third of the body. The ootype and Mehlis' gland are medial to the ovary and Laurer's canal reaches to near the dorsal, posterior margin of the anterior testis. The uterus extends into the intervitelline space with coils that lie in close proximity to the anterior sucker. Most of the uterus is confined to the anterior one-half of the body with only a single coil passing posteriorly to enter the genital atrium. No part of the uterus extends posterior to the genital pore. The vitellaria are arranged into lateral groups of follicles that extend from the level of the posterior margin of the ovary to within about one-sixth of the body length from the anterior sucker. The dextral group of follicles has from eleven to sixteen follicles and the sinistral fifteen to twenty. The ova are relatively very large and thin-shelled. They have a length of 0.0348 mm and a width of 0.0184 mm. The saccular excretory bladder extends from the terminal pore to about the mid-body.

Distribution: Twenty-eight specimens of Scianops ocellatus from Barataria Bay were examined and nineteen of these were infected with Bucephaloides megacirrus. A single fish from the Mississippi Sound was also studied and found to be positive. As many as thirty-three trematodes were collected from the gastric caeca and intestine of a single host. Collections were made in seven different months of the year, including the winter and summer seasons, but there was no indication of seasonal variation. Fishes studied in May or August had, on the average, the same degree of infection as those of November or January.
The known distribution of *Bucephaloides megacirrus* is restricted to the northern and eastern Gulf of Mexico. In their original account of the species, Riggin and Sparks (1962) state they had collected this gasterostome from Grand Isle, Louisiana, and from Alligator Harbor, Florida. Sogandares (personal communication) remarked that he found the same species in the Boca Giega Bay region of Florida. This is the first report of *Bucephalus megacirrus* from the Mississippi Coast although one would expect to find it in this area as well as all along the northeastern shores of the Gulf.

The curious feature of this gasterostome's distribution is that it has been unreported in other areas. The host animal was studied at Woods Hole, Massachusetts, by Linton (1901), at Beaufort, North Carolina, by both Linton (1905) and Manter (1931) and finally at Galveston Bay by Chandler (1935). Since the worm occurs in great numbers within the host, it would seem probable that had it been present, it could not have been overlooked. *Bucephaloides megacirrus* apparently has a distributional pattern much like that of *Bucephaloides caecorum*, which also seems to be restricted to the eastern Gulf.
**Bucephaloides paralichthydis** Corkum, 1961

**Host:** *Paralichthys lethostigma*

**Incidence:** In 2 of 3 hosts.

**Location:** Gastric caeca and upper small intestine

**Locality:** Barataria Bay

**Plate X**

**Diagnosis:** *Bucephaloides paralichthydis* was described as having an ovoid body that measures 0.689 (0.5 - 0.9) mm long and 0.25 (0.16 - 0.37) mm wide. The anterior sucker is terminal and 0.15 (0.10 - 0.17) mm long by 0.16 (0.12 - 0.20) mm wide. The pharynx has a lip-like oral lobe and is posterior to the mid-body with a diameter of 0.045 (0.041 - 0.050) mm. The intestine lies dorsal and anterior to the pharynx.

The testes are in tandem and have an average diameter of 0.073 mm. The cirrus pouch is 0.16 (0.12 - 0.24) mm long by 0.044 (0.035 - 0.055) mm wide. The ovary is dextral and opposite or anterior to the pharynx. It measures 0.062 (0.041 - 0.085) mm in diameter. The ootype and Mehlis' gland lie in tandem with the ovary. The uterus nearly reaches the level of the anterior sucker but does not extend posterior to the genital pore. The vitellaria are arranged into two clusters that lie in the anterior portion of the middle one-third of the body. The ova are 0.029 (0.027 - 0.032) mm long and 0.014 (0.013 - 0.016) mm wide.

**Comparisons:** *Bucephaloides paralichthydis* was compared with *B. bennetti* named but undescribed by Melugin (1940) and as re-described by Hopkins and Sparks (1958). Corkum (1961) also reported its coincidence
with B. bennetti in the host animal. It was noted at that time that it had been collected from 44 of 108 host fishes.

Distribution: Bucephaloides paralichthydis has been found only in the north central part of the Gulf of Mexico. Hutton and Sogandares (1960) examined a related host in Tampa Bay, Florida, and collected B. bennetti but did not report the incidence of B. paralichthydis. From the information at hand, this species appears to have a distributional pattern much like that of Bucephalus brevitentaculatus and Rhipidocotyle lepisostei. Further study may show that all three species have a wider range than is now known.
Bucephaloides pomatomus sp. n.

Host: Pomatomus saltatrix (Linnaeus)

Incidence: In 2 of 16 hosts.

Location: Upper small intestine

Locality: Off Grand Isle, Louisiana

Plate XI

Diagnosis: Bucephaloides pomatomus has a narrow elongate body that is rounded posteriorly and measures 3.98 (2.94 - 5.82) mm in length and 0.458 (0.372 - 0.589) mm in width at the level of the pharynx. The cuticle is densely covered with long, thin spines that have an average length of 0.006 mm. The muscular, anterior sucker is terminally situated and has a length of 0.160 (0.122 - 0.187) mm and a width of 0.173 (0.143 - 0.198) mm. The pharynx is at about the mid-body and in the anterior one-half of the vitelline field. It measures 0.109 (0.085 - 0.132) mm long and 0.125 (0.099 - 0.154) mm wide. A short esophagus empties into the sacculate gut, which lies posterior to the pharynx and often overlaps the anterior portion of the ovary.

The testes are in tandem in the posterior one-half of the body and are separated from each other by several transverse, uterine coils. The anterior testis averages 0.217 mm in diameter compared to a diameter of 0.194 mm for the posterior testis. The cirrus pouch is short and has a length of 0.795 (0.715 - 0.957) mm and a width of 0.115 (0.099 - 0.143) mm. The cirrus is trilobed distally and is preceded by an ovoid seminal vesicle.

The ovary is subspherical and has a length of 0.172 (0.164 - 0.209) mm and a width of 0.169 (0.154 - 0.187) mm. Lateral and posterior to the ovary is the ootype and Mehlis' gland. All three structures are
separated from the anterior testis by two or three coils of the uterus. Most of the uterine coils are transversly interposed between the two testes, and between the posterior testis and the cirrus pouch.

The vitellaria consist of two laterally arranged groups that extend from the level of the ovary to within about two-fifths of the body length from the anterior sucker. There are between fourteen and fifteen follicles dextrally and sixteen to nineteen sinistrally. The left vitelline duct crosses the body, passing between the ovary and the anterior testis to unite with the right yolk duct before entering the ootype. The ova are small and thick-shelled with a measurement of 0.018 mm by 0.013 mm. The sacculate excretory bladder extends from the terminal pore to near the anterior sucker.

Comparisons: Bucephaloides pomatomus bears a resemblance to the following species mainly on the basis of its long, slender body; Bucephaloides arcuatus (Linton, 1900), B. exilis (Nicoll, 1915), B. microcirrus (Chanhan, 1943), B. philippinorum (Velasquez, 1959), B. tenuis (Yamaguti, 1952), Bucephaloides truncatus and Bucephaloides scomberomorus. (See Table II).

Bucephaloides pomatomus differs from B. tenuis, and B. philippinorum in having the uterus restricted to the postovarian level of the body. Compared to B. exilis, the pharynx and reproductive organs are more anterior in Bucephaloides pomatomus.

One of the more closely related species is B. microcirrus from a scianid of Indian marine waters. Bucephaloides pomatomus is at variance with this species, however, in the possession of a much longer and wider body, concomitantly larger internal organs, and in the production of smaller ova.
**TABLE II**

Comparisons of morphologically similar species in the genus *Bucephaloides*

<table>
<thead>
<tr>
<th>Species</th>
<th>Location of Pharynx</th>
<th>Anterior Extent of Uterus</th>
<th>Size of Ova</th>
<th>Size of Anterior Sucker &amp; Pharynx</th>
<th>Body Length</th>
<th>Cirrus Length</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Bucephaloides arcuatus</em></td>
<td>anterior to mid-body</td>
<td>post-ovarian</td>
<td>0.018 x 0.013 mm</td>
<td>0.076 x 0.080 mm 0.059 x 0.075 mm</td>
<td>2.36 mm</td>
<td>0.572 mm</td>
</tr>
<tr>
<td><em>B. exilis</em></td>
<td>in posterior one-third of body</td>
<td>preovarian</td>
<td>0.021 x 0.013 mm</td>
<td>0.05 mm 0.04 mm</td>
<td>1.9 mm</td>
<td>0.500 mm</td>
</tr>
<tr>
<td><em>B. microcirrus</em></td>
<td>in posterior one-third of body</td>
<td>post-ovarian</td>
<td>0.035 x 0.023 mm</td>
<td>0.016 x 0.040 mm 0.222 x 0.030 mm</td>
<td>1.71 mm</td>
<td>0.360 mm</td>
</tr>
<tr>
<td><em>B. philippinorum</em></td>
<td>anterior one-third of body</td>
<td>preovarian</td>
<td>0.016 x 0.012 mm</td>
<td>0.09 x 0.09 mm 0.06 x 0.06 mm</td>
<td>2.44 mm</td>
<td>0.60 mm</td>
</tr>
<tr>
<td><em>B. tenuis</em></td>
<td>middle one-third of body</td>
<td>preovarian</td>
<td>0.021 x 0.013 mm</td>
<td>0.050 x 0.090 mm 0.060 x 0.110 mm</td>
<td>2.1-3.7 mm</td>
<td>0.5-.6 mm</td>
</tr>
<tr>
<td><em>B. pomatomus</em></td>
<td>posterior of middle one-third of body</td>
<td>postovarian</td>
<td>0.018 x 0.013 mm</td>
<td>0.160 x 0.173 mm 0.109 x 0.125 mm</td>
<td>3.98 mm</td>
<td>0.795 mm</td>
</tr>
<tr>
<td></td>
<td>Location</td>
<td>Size</td>
<td>Length</td>
<td>Width</td>
<td></td>
<td></td>
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<tr>
<td>----------------</td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>B. truncatus</strong></td>
<td>posterior of middle one-third of body</td>
<td>0.020 x 0.125 x 0.140 mm</td>
<td>4.15 mm</td>
<td>0.752 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>postovarian</td>
<td>0.013 mm 0.075 x 0.076 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B. scomberomorus</strong></td>
<td>posterior of middle one-third of body</td>
<td>0.015 x 0.132 x 0.132 mm</td>
<td>3.08 mm</td>
<td>0.608 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>postovarian</td>
<td>0.010 mm 0.083 x 0.064 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Bucephaloides pomatomus is quite similar to B. arcuatus but, by comparison, is a larger worm in every respect. Thus, its body is about one-third longer and nearly twice as wide as B. arcuatus. Furthermore, the sucker-pharynx ratio of Bucephaloides pomatomus is greater as is the length-width ratio of the cirrus and average diameter of the ovary and testes. Both species, however, produce ova of the same size.

Bucephaloides pomatomus can be distinguished from Bucephaloides truncatus on the basis of its rounded posterior and by the fact that it has a much heavier body spination. Bucephaloides pomatomus also has a smaller sucker-pharynx ratio and does not have any vitelline follicles posterior to the ovary. It differs further in having the pharynx at a more anterior level in the vitelline field and finally in producing ova that are consistently smaller.

Compared to Bucephaloides scomberomorus, B. pomatomus has a heavier cuticular spination, a larger anterior sucker and a more anterior pharynx. There is also a greater length-width ratio in the cirrus and larger ova are produced.

It is noteworthy that Bucephaloides pomatomus was collected from a family of fishes of which there is only one species in the Gulf of Mexico. Although host specificity cannot in itself be considered as a taxonomic character, it must still be given consideration in the total analysis for there is a great degree of specificity displayed by the gasterostomes. While an individual species may infect different species or even genera, it is very unusual for transfamilial infections to occur.

On the grounds of the above differences, Bucephaloides pomatomus is considered to be a new species and is named after the host from which it was collected.
Distribution: Two specimens of *Pomatomus saltatrix*, collected on different occasions from waters off Grand Isle, were infected with *Bucephaloides pomatomus*. In both instances, the gravid worms were alive and active when removed from the intestine of the host. This is the first known incidence of a member of the genus *Bucephaloides* in *Pomatomus saltatrix* although Manter (1931) found a specimen of *Prosorhynchus crucibulum* in the gill of one fish at Beaufort, North Carolina, and Linton (1904) reported "*Gasterostomum gracilescens*" from the same host and locality. The former case very probably represents an accidental infection and one in which the worm migrated out to the pharyngeal cavity of the fish. Linton (1904) did not describe or figure the specimen of *Prosorhynchus gracilescens* so there is no way of being certain what gasterostome he was dealing with.

*Pomatomus saltatrix* has not been widely studied along the Atlantic and Gulf Coasts though Linton (1901 and 1940) did post a small number of specimens at Woods Hole, Massachusetts. Sparks (1958) examined a very few specimens at Grand Isle, Louisiana, but did not find them infected with gasterostomes. Perhaps more extensive surveys will show *Pomatomus saltatrix* to have a higher rate of infection than is inferred by existing information.
**Bucephaloides scomberomorus** sp. n.

**Host:** *Scomberomorus cavalla* (Cuvier)

*Scomberomorus maculatus* (Mitchill)

**Incidence:** In 3 of 11 *Scomberomorus cavalla*.

In 11 of 33 *Scomberomorus maculatus*.

**Location:** Gastric caeca and upper small intestine

**Locality:** Off Grand Isle, Louisiana

**Plate XII**

**Diagnosis:** *Bucephaloides scomberomorus* has a long, slender body that is tapered gradually at the anterior end and rounded posteriorly. It is 3.08 (2.73 - 3.10) mm long and 0.242 (0.187 - 0.308) mm wide at the level of the pharynx. Cuticular spines, measuring 0.0039 mm in length, cover the anterior half of the body. The anterior sucker is well formed and measures 0.132 (0.099 - 0.154) mm long and 0.134 (0.119 - 0.143) mm wide. The pharynx is located near the mid-body, in the posterior portion of the vitelline field, and is 0.083 (0.054 - 0.154) mm long and 0.064 (0.054 - 0.070) mm wide. A short esophagus extends between the pharynx and the sacculate postpharyngeal gut.

The testes are in tandem in the posterior one-half of the body and are separated by several coils of the uterus. The anterior testis is 0.137 (0.099 - 0.164) mm long and 0.102 (0.078 - 0.119) mm wide whereas the posterior testis is 0.115 (0.099 - 0.148) mm by 0.102 (0.078 - 0.130) mm. The relatively short cirrus pouch has a length of 0.608 (0.539 - 0.682) mm and a width of 0.066 (0.052 - 0.096) mm but does not reach the level of the posterior testis. Three lobes are present on the terminal portion of the cirrus.

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The ovary, measuring 0.918 (0.086 - 0.104) mm long by 0.082 (0.054 - 0.104) mm wide, is situated posterior to the equatorial plane and is separated from the anterior testis by the median ootype and Mehlis' gland and by two or three coils of the uterus. The main portion of the uterus consists of short transverse coils coursing between the two testes and that part of the hind-body not occupied by the cirrus pouch. There is no part of the uterus that extends anterior to the ovary or posterior to the genital pore.

The vitellaria consist of two linear groups beginning at the level of the ovary and extending to within one-third the body length of the anterior sucker. There are fourteen or fifteen follicles dextrally and fifteen to eighteen sinistrally. The ova are small and thick-shelled with a length of 0.015 mm and a width of 0.010 mm. The excretory bladder extends from the terminal pore to a point near the anterior sucker.

Comparisons: Bucephaloides scomberomorus is morphologically similar to B. arcuatus, B. exilis, B. microcirrus, B. philippinorum, B. tenuis, B. pomatomus and B. truncatus. (See Table II).

The digestive and reproductive organs of Bucephaloides scomberomorus differ from that of B. exilis in being located very near the mid-body. Unlike B. tenuis, and B. philippinorum, the uterus of Bucephaloides scomberomorus does not exceed the level of the ovary and, in comparison to B. microcirrus, Bucephaloides scomberomorus is a larger worm throughout, but at the same time, it gives rise to much smaller ova.

Bucephaloides scomberomorus is much like B. arcuatus but is significantly larger, with a greater ratio between the size of the anterior sucker and pharynx and between the length and width of the
cirrus pouch. It also produces ova that are consistently smaller. Compared to *B. pomatomus*, the cuticular spines are smaller in *Bucephaloides scomberomorus* as are the anterior sucker and pharynx. Also, the pharynx is located more posteriorly in respect to the vitellaria, the length-width ratio of the cirrus is less, and the ova are smaller.

The main difference between *Bucephaloides scomberomorus* and *B. truncatus* is the shape of the posterior end of the body, the density of cuticular spination, the lack of vitellaria posterior to the ovary, and in the production of smaller ova.

*Bucephaloides scomberomorus* is considered to represent a new species and is named after the host from which it was collected.

Distribution: It is impossible to discuss the distribution of *Bucephaloides scomberomorus* and *B. truncatus* without becoming involved in trying to distinguish what species previous authors were referring to when speaking of bucephalids from the scomberids. Since some of Linton's species actually consisted of several distinct forms, and since the synonymy that developed is only now being unraveled, it would be of no value to make reference to synonyms and their distribution. As indicated previously, there have been surprisingly few scomberids studied in this country with the result that Linton's records are about the only reports of trematodes from this group of fishes. It does seem reasonable to assume that *Bucephaloides scomberomorus* occurs along both the Atlantic and Gulf Coasts but just how extensive this distribution is, cannot be concluded until additional surveys are made.
Bucephaloides trichiuri Sogandares, 1955

Synonym: Gasterostomum arcuatum of Linton, 1940 (pp. 26)

Host: Trichiurus lepturus Linnaeus

Incidence: In 14 of 18 from Barataria Bay.

In 4 of 9 hosts from the Chandeleur Islands.

In 1 of 1 host from the Mississippi Sound.

In 1 of 1 host from Wine Island, Louisiana.

Location: Gastric caeca

Locality: Listed above (All new locality records)

Plate XIII

Diagnosis: Bucephaloides trichiuri has an elongated, cylindrical body that is 1.79 (1.33 - 2.40) mm long and 0.283 (0.242 - 0.31) mm wide at the level of the ovary. Small, scale-like spines cover most of the body surface. The anterior sucker is terminal with a length of 0.112 (0.099 - 0.121) mm and a width of 0.118 (0.110 - 0.132) mm. The pharynx is located in the anterior portion of the middle one-third of the body and has a diameter of 0.093 (0.088 - 0.099) mm. The saccular gut lies posterior and dorsal to the pharynx.

The testes lie in tandem in the posterior one-half of the body and are separated from each other by several coils of the uterus. They have a diameter of 0.093 (0.088 - 0.099) mm. The cirrus pouch is 0.346 (0.330 - 0.363) mm long and 0.062 (0.055 - 0.069) mm wide but does not reach the level of the posterior testis.

The ovary is located adjacent to the posterior end of the gut and has a diameter of 0.846 (0.068 - 0.099) mm. The ootype and Mehlis' gland are medial to the ovary. Laurer's canal extends to a level equal to the posterior margin of the anterior testis. The uterus is
restricted to the postovarian part of the body, mainly in the space between the cirrus pouch and the posterior testis. It does not exceed the genital atrium posteriorly. The vitellaria are formed in two linear groups beginning at the level of the ovary and reaching to within about one-eighth of the body length from the anterior sucker. There are thirteen to twenty follicles in each vitelline group. The ova are thick-shelled and measure 0.016 mm in length and 0.013 mm in width. The excretory bladder extends to near the level of the anterior sucker.

Comparisons: Linton (1940) listed Trichiurus lepturus as a host of Bucephaloides arcuatus. Judging from the great difference in the host animals and from the brief description provided by Linton, it can be assumed that he had specimens of B. trichiuri at hand. Linton (1940, p. 26) commented on the fact "The neck is relatively shorter and thicker than it is in specimens from the bonito." There is a similarity in the two species in that they both possess elongate bodies with the same general arrangement of internal organs and could, therefore, have been easily mistaken if the detailed anatomy were taken for granted.

Distribution: Assuming Linton (1940) was dealing with Bucephaloides trichiuri at Woods Hole, Massachusetts, the distribution of this species extends from the Atlantic Coast to the Texas Coast (Sparks, 1960). It is, however, clearly absent from tropical waters for as pointed out in the discussion of Bucephalus brevitentaculatus, the host species has been studied in the Gulf of Panama by Sogandares (1959) and Puerto Rico by Siddiqi and Cable (1960) and yet neither gasterostome has been reported from these areas.
Bucephaloides truncatus sp. n.

Synonym: *Gasterostomum* sp. of Linton, 1905. (pp. 336, fig. 235)

Host: *Scomberomorus cavalla* (Cuvier)

*Scomberomorus maculatus* (Mitchill)

Incidence: In 4 of 11 *Scomberomorus cavalla*.

In 6 of 33 *Scomberomorus maculatus*.

Location: Gastric caeca and upper small intestine

Locality: Off Grand Isle, Louisiana

Plate XIV

Diagnosis: *Bucephaloides truncatus* has a very elongate body that is 4.15 (3.10 - 5.26) mm long and 0.264 (0.210 - 0.286) mm wide at the level of the ovary. The body is tapered anteriorly and broadly truncate posteriorly. The very small and delicate cuticular spines display a great amount of evanesence and are found only infrequently. The anterior sucker is terminal and may appear to be directed anteriorly. Its distal margin often appears to be notched. This is apparently the result of muscular contraction at the time of fixation. The sucker measures 0.125 (0.099 - 0.143) mm long by 0.140 (0.099 - 0.176) mm wide. The pharynx is located equatorially, or slightly anterior, and is 0.075 (0.066 - 0.088) mm long and 0.076 (0.073 - 0.088) mm wide. The gut lies posterior to the pharynx and may overlap the anterior border of the ovary.

The testes are in tandem in the posterior one-half of the body and are separated from each other by several coils of the uterus. The anterior testis is 0.149 (0.113 - 0.165) mm long by 0.121 (0.110 - 0.143) mm wide whereas the posterior testis is 0.150 (0.145 - 0.154) mm by
0.115 (0.099 - 0.132) mm. The relatively short cirrus pouch has a length of 0.752 (0.60 - 0.88) mm and a width of 0.077 (0.055 - 0.088) mm but does not reach the level of the posterior testis. An ovoid seminal vesicle is contained in the proximal portion of the cirrus pouch. Distally, the cirrus terminates in three lobes.

The ovary is in the posterior one-half of the body and is separated from the anterior testis by a number of uterine coils as well as by the ootype and Mehlis' gland. It measures 0.114 (0.099 - 0.132) mm long and 0.103 (0.088 - 0.110) mm wide. The highly convoluted uterus fills much of the hind-body with several short, transverse coils located between the ovary and anterior testis, the two testes and between the posterior testis and the cirrus pouch. There are no uterine coils anterior to the ovary or posterior to the genital pore.

The two laterally disposed groups of vitelline glands consist of fourteen dextral and sixteen to twenty sinistral follicles. There may be as many as ten vitelline follicles posterior to the ovary and never fewer than three. Anteriorly, the vitellaria extend to within one-third the body length of the anterior sucker. The ova measure 0.020 mm long and 0.013 mm wide. The excretory bladder extends from the terminal pore to very near the anterior sucker.

Comparisons: Bucephaloides truncatus differs from all other members of the genus in possessing a broadly truncate, posterior end. It most nearly resembles Bucephaloides pomatomus, Bucephaloides scomberomorus and Bucephaloides microcirrus but can be distinguished from the first two on the basis of having smaller vitelline follicles, from three to ten vitelline follicles posterior to the ovary, in producing larger ova and in having much more delicate cuticular spines. Compared to Bucephaloides microcirrus, it is a much larger worm, with
a relatively longer cirrus and smaller ova.

**Bucephaloides truncatus** is believed to represent a new species and is named for its characteristically blunt posterior extremity.

**Distribution:** It is probable that *Bucephaloides truncatus* is conspecific with the form briefly described and figured by Linton (1905), (pp. 336, fig. 235), from *Scomberomorus regalis*, Woods Hole. He said of the species "These specimens resemble this species, *Gasterostomum arcuatum*, although no spines were seen" (Linton, 1905, p. 363).

Ward (1954) reported collecting *Bucephaloides arcuatus* from *Sphyraena barracuda* and *Scomberomorus cavalla* of the Miami, Florida, region and judging from her discussion, there is no doubt she was dealing with two species, one from each of the hosts. Although it is not possible to be certain of the species from *Scomberomorus cavalla*, the figure provided by Ward suggests that she probably had *Bucephaloides truncatus* before her. If this assumption is correct, and if the form Linton collected from *Scomberomorus regalis* is the same species, then we know that *Bucephaloides truncatus* occurs along both the Atlantic and Gulf Coasts.
Rhipidocotyle adbaculum Manter, 1940

Host: Scomberomorus maculatus (Mitchill)
(New host record)

Incidence: In 1 of 33 hosts.

Location: Upper small intestine

Locality: Off Grand Isle, Louisiana
(New locality record)

Plate XV

Diagnosis: Rhipidocotyle adbaculum has an elongate body that is 2.02 mm long and 0.33 mm wide at the level of the ovary. Cuticular spines are present over much of the body surface. The anterior sucker is 0.154 mm long and 0.187 mm wide at its distal end. A broad hood with a shallow, ventral cleft lies over the extremity of the anterior sucker. The pharynx, measuring 0.059 mm in diameter, is located slightly anterior to the mid-body. The esophagus arches anteriorly before entering the gut, which is located postpharyngeal and in close proximity to the ovary.

The testes are in tandem in the dextral posterior one-third of the body and are separated from each other by two coils of the uterus. The anterior testis is contiguous with the ovary and has a diameter of 0.135 mm. The posterior testis is 0.120 mm in diameter. The cirrus pouch reaches the mid-level of the posterior testes and has a length of 0.704 mm and a width of 0.086 mm. The ovoid seminal vesicle is 0.140 mm long by 0.068 mm wide.

The ovary is located at the junction of the middle and posterior one-third of the body and has a length of 0.112 mm and a width of 0.094 mm. The ootype and Mehlis' gland are posterior and lateral to the ovary. Laurer's canal was not discernible. The uterus has four
sinistral, longitudinal coils which extend from the posterior testis to slightly in front of the pharynx. Several uterine coils lie dextrally adjacent to the cirrus pouch and extend posterior to the genital atrium. The vitellaria are arranged into two linear groups that begin at the level of the pharynx and reach a point one-third of the body from the anterior sucker. There are fourteen dextral and seventeen sinistral follicles. The left vitelline duct passes dorsal to the anterior testis before uniting with the right duct at the level of ootype.

The ova are small and thin-shelled with a length of 0.018 mm and a width of 0.013 mm. The excretory bladder was not visible beyond the level of the anterior testis.

Comparisons: A single specimen of *Rhipidocotyle adbaculum* was collected from *Scomberomorus maculatus*. It differs from the original description of the species in being a slightly larger worm with a uterus that exceeds the level of the pharynx and with ova of greater dimensions. The nature of the cephalic hood and the general disposition of the reproductive and digestive organs both serve as strong indications of its similarity to *Rhipidocotyle adbaculum*.

Manter (1940) described this species from *Scomberomorus regalis* of Tortugas, Florida, and in his description he noted its similarity to *R. baculum* (Linton, 1905) from *Scomberomorus maculatus* of Beaufort, North Carolina. There is a strong possibility these are synonymous species. Linton (1905, 1910), however, listed so many obviously different species under a single name that it is almost impossible to be certain of which one he had reference to in his descriptions. For this reason, both species are considered valid until further collections demonstrate the existence of just one or both forms.
Distribution: Prior to this study, *Rhipidocotyle adbaculum* was known only from Tortugas, Florida. Should this species prove to be a synonym of *R. baculum* then, of course, its known distributional range would be extended to include the Atlantic as well as the Gulf Coast.
Rhipidocotyle angusticolle Chandler, 1941

Host: Euthynnus alleteratus (Rafinesque)
Scomberomorus cavalla (Cuvier)

Incidence: In 6 of 6 Euthynnus alleteratus.
In 2 of 11 Scomberomorus cavalla (New host record).

Location: Upper small intestine

Locality: Off Grand Isle, Louisiana
(New locality record)

Plate XVI

Diagnosis: Rhipidocotyle angusticolle has an elongate body that is truncate and somewhat flattened anteriorly and cylindrical posteriorly. Long, thin cuticular spines cover the anterior three quarters of the body. The anterior sucker is muscular and bears five blunt lappets distally. There are two such structures ventro-lateral, two lateral and one dorsal. The sucker is 0.240 (0.180 - 0.275) mm long and 0.0249 (0.200 - 0.319) mm wide. The pharynx is in the anterior portion of the posterior one-half of the body and has a diameter of 0.114 mm. The sacculate gut lies dorsal and posterior to the pharynx.

The testes are in the posterior one-third of the body and are contiguously diagonal. The anterior testis is 0.142 (0.120 - 0.165) mm long by 0.136 (0.096 - 0.200) mm wide. The posterior testis is diagonally dextral to the anterior testis with a length of 0.127 (0.109 - 0.143) mm and a width of 0.102 (0.112 - 0.143) mm. The cirrus pouch reaches the level of the anterior testis and has a length of 0.639 (0.450 - 0.820) mm and a width of 0.132 (0.090 - 0.154) mm. The cirrus terminates in a single genital lobe which rests in the sub-terminal, genital atrium.

The ovary is located at the junction of the middle and posterior...
one-third of the body at the dextral, posterior margin of the gut. It measures 0.117 (0.091 - 0.174) mm long and 0.097 (0.083 - 0.125) mm wide. The ootype and Mehlis' gland lie posterior and slightly median to the ovary. The uterus is confined to the postovarian part of the body with the majority of its coils in the body space dextrally adjacent to the cirrus pouch. It terminates in a short, narrow uterine duct which opens into the genital atrium. The vitellaria are arranged in two lateral groups that commence at the level of the pharynx and extend to within one-half of the body from the anterior sucker. The ova are thick-shelled and 0.023 mm long by 0.015 mm wide. The extent of the excretory bladder could not be determined with certainty but it appears to reach anterior limits of the vitelline field.

Comparisons: Chandler (1941, p. 183) described the anterior end of Rhipidocotyle anguisticolle as possessing "two horn-like projections on each side dorsally, a pair of lobes overhanging the sucker ventrally ...." A close examination of the specimens collected from Euthynnus alletteratus revealed that there are actually five lappet-like folds of tissue associated with the anterior sucker. There are two ventral, two lateral and one dorsal. Since these structures are easily distorted during the process of being placed on a slide, it seems quite likely that the dorsal lappet was overlooked. Once it had been established that five lappets were present, the type specimen (USNM #36786) was examined and found to confirm this. In that specimen, the dorsal fold is flattened against the sucker and difficult to find unless the observer is aware of its existence. The relationship of these protuberances is best seen prior to mounting.

A large series of Rhipidocotyle anguisticolle was collected from Euthynnus alletteratus and it was found that most of the specimens
exceeded the size ranges given by Chandler (1941). The characteristic measurements for the species should, therefore, be expanded to include these larger forms. Sparks (1960) reported the species from both *Sarda sarda* and *Euthynnus alletteratus* of the Texas Coast but since he did not provide any descriptive information, there is no way of judging whether this is a host related variation or one of population differences. In this study, notice was made of the fact that a series from a given host was usually at slight variance with a similar series from a second fish even though all the worms appeared to be at the same degree of maturity.

**Distribution:** *Rhipidocotyle anguisticolle* has previously only been reported from the Texas Coast, (Chandler, 1941) and (Sparks, 1960). Manter (1947) listed the host related species *R. nagatyi* from Florida as did Siddiqi and Cable (1960) at Puerto Rico. Linton (1900 and 1940) studied both hosts at Woods Hole and found *R. capitatum* but not *R. anguisticolle*. Sparks (1957) had similar results in the Bahama Islands. Ward (1950) listed the host *Euthynnus* sp. from off Miami but did not indicate the incidence of any gasterostomes.

The possibility that *R. anguisticolle* is limited to the northern and western gulf exists, but since *Euthynnus alletteratus* inhabits the open sea it does not seem as probable as in the instances of the parasites of fishes from shallow bay areas. It is worthy of mention, however, that the related species *R. capitatum* and *R. nagatyi*, both also occurring in *Euthynnus alletteratus*, have not been reported from areas west of the Louisiana Coast. By comparison, all three species have been collected off of Grand Isle, Louisiana. Such discontinuity in distribution may be a reflection of the small number of hosts that
have been studied in the western Gulf, but it cannot explain the lack of *R. angusticolle* in eastern waters where more extensive surveys have been made. Whether the information at hand represents a true picture of the distribution of *R. angusticolle* can only be determined by further sampling.
Rhipidocotyle lepisostei  Hopkins, 1954

Host:  Lepisosteus spatula  Lacépède

Incidence:  In 6 of 8 hosts.

Location:  Upper small intestine

Locality:  Barataria Bay

Plate XVII

Diagnosis:  Rhipidocotyle lepisostei has a broad, elongate body that is 1.7 mm long and 0.484 mm wide. Cuticular spines are present over most of the body surface. The anterior sucker is rather weakly developed and is surmounted by a hood-like flap. The sucker measures 0.264 mm in length and 0.198 mm in width. The pharynx is located at the junction of the anterior and middle one-third of the body and has a diameter of 0.198 mm. The saccular gut lies dorsal to the pharynx and is surrounded by a large number of clustered gland cells.

The testes are diagonal in the posterior portion of the middle one-third of the body. Both testes are 0.204 mm in diameter. The cirrus pouch extends anteriorly to the level of the anterior testis and is 0.462 mm long and 0.099 mm wide. The cirrus appears to terminate in a single lobe contained within the genital atrium.

The ovary is pretesticular and has a diameter of 0.176 mm. The ootype and Mehlis' gland are medial to the ovary. The uterus extends into the vitelline field anteriorly and into the space adjacent to the cirrus posteriorly. It does not run posterior to genital atrium. The vitellaria are formed into an arch in the middle one-third of the body and consist of about twenty-eight follicles. The ova are small and thin-shelled with a length of 0.020 mm and a width of 0.013 mm. The
excretory bladder is thin-walled and extends almost to the anterior sucker.

Comparisons: Surprisingly few mature specimens of *R. lepisostei* were collected although immature forms were very common in the host fish. It is not possible to make adequate comparisons for this reason.

Distribution: *Rhipidocotyle lepisostei* has been recorded only from the Louisiana Coast. Hopkins (1954) found *Mugil cephalus* to be one of the intermediate hosts in the Grand Isle region. Since both the definitive and intermediate host are common in the estuarine waters of the northern Gulf, *R. lepisostei* would be expected to have an equally wide range of distribution.
Rhipidocotyle lintoni Hopkins, 1954

Host: Strongylura marina (Walbaum)

Incidence: In 2 of 3 hosts.

Location: Upper small intestine

Locality: Barataria Bay

Plate XVIII

Diagnosis: Rhipidocotyle lintoni has an ovoid to fusiform body that is 0.852 (0.795 - 0.925) mm long and 0.427 (0.410 - 0.455) mm wide. Cuticular spines are visible over four-fifths of the body surface. The anterior sucker characteristically bears a distal button-like hood that is limited to the median portion of the sucker. The length of the anterior sucker is 0.217 (0.194 - 0.256) mm and the width 0.227 (0.198 - 0.270) mm. The very small pharynx is located equatorially and is 0.069 (0.064 - 0.073) mm long and 0.083 (0.072 - 0.088) mm wide. The thick-walled, saccular gut lies anterior and dorsal to the pharynx.

The testes are diagonal to each other. The anterior testis is slightly anterior and dextral to the pharynx and the posterior testis is nearer the mid-line. The anterior testis measures 0.124 (0.118 - 0.138) mm long and 0.124 (0.118 - 0.138) mm wide whereas the posterior testis is 0.127 (0.107 - 0.152) mm long and 0.112 (0.104 - 0.120) mm wide. In some specimens, the testes may be somewhat displaced and thus appear lateral to each other rather than diagonal. The cirrus pouch extends sinistrally to the level of the pharynx and has a length of 0.352 (0.280 - 0.384) mm and a width of 0.100 (0.083 - 0.118) mm. A long genital lobe is present and appears to be covered

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with cuticular plications. The genital atrium is spacious and sub-terminal.

The ovary is at the level of the pharynx and medial to the anterior testis. It measures 0.141 (0.115 - 0.152) mm long and 0.115 (0.104 - 0.125) mm wide. The ootype and Mehlis' gland are medial to the ovary. Laurer's canal extends to the level of the dorsal, posterior border of the posterior testis. The uterus fills much of the fore-body anterior to the pharynx, and all available space in the dextral portion of the hind-body. The vitellaria are formed into two groups just posterior to the anterior sucker. The follicles are arranged transversely but do not intermingle at the mid-line. Hence, there is not a complete band of vitellaria across the fore-body. There are approximately twenty-eight or thirty follicles. The exact number remains uncertain because of the disjunct nature of the follicles along with their being obscured by the uterus. The left vitelline duct courses posterior to the pharynx before uniting with the right duct at the level of the ootype. The ova are very thin-shelled and have a length of 0.030 - 0.035 mm and a width of 0.014 - 0.016 mm. The saccular excretory bladder reaches the level of the pharynx.

Comparisons: Specimens of Rhipidocotyle lintoni collected in this study fit well within the range of characters described by Hopkins (1954). Linton (1940) at Woods Hole, Massachusetts, described and figured a gasterostome (plate 18, fig. 245 and 248) from Menticirrhus sp. and Strongylura marina which he believed to be conspecific with Prosorhynchus gracilescens. As Hopkins (1954) pointed out, Linton was unquestionably dealing with two species of Rhipidocotyle, one of which was certainly R. lintoni. Linton even remarked about the distinctive button-like process over the anterior sucker.
Hopkins (1954) also drew the conclusion that the adult form *Gasterostomum gracilescens* figured by Tennent (1906) from *Strongylura marina* taken in the York River of Virginia, was in reality what is now referred to as *R. lintoni* and not a prosorhynchid. There is reason to believe it also was this species referred to by Eckmann (1932) as *Bucephalopsis haemeana* in which case, the characteristics she described for the latter species, are invalid. A great deal of confusion has grown up around some of the early established species. This happened mainly because a name was applied originally to larval stages with subsequent attempts being made to associate it with adult forms presumed to be the definitive state. Unfortunately, there have been too few life cycle studies which would confirm or nullify the efforts of some of the early taxonomists.

**Distribution:** *Rhipidocotyle lintoni* has rather an extensive range in shallow coastal waters. It has been reported from Woods Hole, Massachusetts, (Linton, 1940), Virginia, (Tennent, 1906), Grand Isle, Louisiana, (Hopkins, 1954) and (Sparks, 1958 and 1960) and from the coast of Texas (Sparks, 1960). Hutton and Sogandares (1960) examined *Strongylura timucu* (Walbaum) from Tampa Bay, Florida, and found the related rhipidocotylid, *R. transversale* but not *R. lintoni*. Further studies will probably reveal that its distribution is continuous along the brackish waters of the Atlantic and Gulf Coasts. There is, however, a gap in the distributional range corresponding to the southern, tropical coast of Florida. Manter (1947) examined a large number of related species of *Strongylura* at Tortugas but reported neither *R. lintoni* nor *R. transversale*. Siddiqi and Cable (1960) also studied specimens of *Strongylura* in Puerto Rico but did not find either of
the rhipidocotylids. Both of these reports substantiate the
conclusion that *R. lintoni* is restricted in its distribution to
temperate and subtropical waters.
Rhipidocotyle longleyi  Manter, 1934

Host: Synagrops bella  (Goode and Bean)

Incidence: In 5 of 7 hosts.

Location: Small intestine

Locality: Oregon Stations 3715, 3724, 3744

Depth: 220-225 fathoms

Plate XIX

Diagnosis: Rhipidocotyle longleyi has a long, cylindrical body that is densely covered with long, thin spines. It has a length of 3.69 (2.60 - 4.45) mm and a width of 0.566 (0.396 - 0.770) mm. The anterior sucker is surmounted with a hood which in turn bears seven blunt papillae. The sucker is 0.261 (0.242 - 0.286) mm long by 0.214 (0.187 - 0.242) mm wide. The pharynx is located in the middle one-third of the body and is 0.92 (0.079 - 0.110) mm in diameter. The saccular gut lies dorsal and posterior to the pharynx.

The testes are in the dextral, posterior one-third of the body and are separated from each other by a single coil of the uterus. The anterior testis is 0.326 (0.275 - 0.407) mm long and 0.291 (0.220 - 0.396) mm wide whereas the posterior testis is 0.290 (0.198 - 0.342) mm by 0.282 (0.198 - 0.385) mm. The cirrus has a length of 1.16 (0.836 - 1.60) mm and a width of 0.220 (0.176 - 0.253) mm and reaches the level of the posterior testis. Terminally, the cirrus bears two genital lobes and proximally it is preceded by a seminal vesicle that is 0.131 (0.143 - 0.253) mm long and 0.106 (0.044 - 0.132) mm wide.

The ovary is located dextrally at the level of the gut and is 0.203 (0.165 - 0.253) mm long and 0.239 (0.154 - 0.319) mm wide.
Posterior to the ovary is the ootype and Mehlis' gland. Laurer's canal was not observed. The uterus proceeds up the left side of the body in a series of short transverse coils to very near the anterior sucker before coursing posteriorly. There are several uterine coils adjacent to the cirrus pouch but no part of the uterus exceeds the posterior limit of the subterminal, genital atrium. The vitellaria consist of two lateral groups of follicles that extend from the level of the ovary to within one-fifth the body length of the anterior sucker. There are approximately fourteen to seventeen follicles in each linear group. The ova measures $0.023 - 0.026$ mm in length and $0.063 - 0.015$ mm in width. The excretory bladder was not observed.

Comparisons: The specimens of *Rhipidocotyle longleyi* collected in the northern gulf are in agreement with Manter (1934) except the larger forms exceed the size ranges given in the original description.

Distribution: Manter (1934) first reported *Rhipidocotyle longleyi* from the deep waters off Tortugas, Florida, and in 1938, Yamaguti collected it from the related host, *Synagrops japonica*, taken off the coast of Japan. Ward (1950) tentatively identified this species from *Slyraena barracuda* but more than likely, she was dealing with another species. It is rather doubtful that *Rhipidocotyle longleyi* could make its way into a fish such as the barracuda simply from standpoint of the great separation between the environments of the two hosts.

There is very little known about the distribution of deep water trematodes and it is with a great deal of interest that reports such as Yamaguti (1938) are received. As remarked by Manter (1955), there is good reason to believe there is a faunal continuity in the benthic fauna as well as in some of the pelagic forms. Just how extensive or complete this is remains to be determined.
**Rhipidocotyle nagayi** Manter, 1940

**Host:** *Euthynnus allletteratus* (Rafinesque)

**Incidence:** In 1 of 6 hosts.

**Location:** Upper small intestine

**Locality:** Off Grand Isle, Louisiana

(New locality record)

**Plate XX**

**Diagnosis:** *Rhipidocotyle nagayi* has an elongate body that is narrow and truncate anteriorly and broadly rounded posteriorly. It measures 1.59 - 1.70 mm in length and 0.495 - 0.616 mm in width at the widest point in the posterior one-half of the body. The anterior sucker is well developed and beset with a flap-like hood that has a narrow, ventral cleft. The sucker is 0.220 mm in length and 0.319 mm in width. The spherical pharynx, having a length of 0.121 - 0.132 mm and width of 0.110 - 0.143 mm, is located equatorially and is followed by a short esophagus. The sacculate gut lies posterior to the mid-body.

The testes are in the posterior part of the body and are slightly diagonal to each other as well as being contiguous. The anterior testis is located near the mid-line and in close proximity to the posterior margin of the gut. It has a length of 0.132 - 0.159 mm and a width of 0.165 mm. The posterior testis lies near the right side of the body and has a length of 0.110 - 0.132 mm and a width of 0.154 - 0.165 mm. The cirrus pouch extends from the subterminal, genital pore to the level of the anterior testis and has a length of 0.506 - 0.583 mm and a width of 0.110 mm. It terminates in a single, large genital lobe.

The ovary is situated dextrally at the mid-level of the gut and has a length of 0.121 mm and a width of 0.099 mm. The uterus is con-
fined to the hind-body, posterior to the level of the ovary. The ootype and Mehlis' gland lie lateral and posterior to the ovary.

There are two longitudinal coils of the uterus between the cirrus and the left side of the body and a series of shorter coils to the right of the cirrus. There are no coils posterior to the genital atrium. The vitellaria consist of two groups that are somewhat linear and extend from the level of the pharynx to within one-fourth the body length of the anterior sucker. There are fifteen to seventeen follicles in each of the two groups. The left vitelline duct courses posteriorly to pass between the two testes before uniting with the right duct at the level of the ootype. The ova are thick-shelled and with a length of 0.023 mm and a width of 0.013 mm. The excretory bladder was not visible in the available specimens.

Comparisons: Sparks (1957) suggested *Rhipidocotyle nagatyi* may be a synonym of *R. capitatum* (Linton, 1940). A study of both Manter's and Linton's type specimens (USNM #36707) and (USNM #8172) respectively was made and the conclusion drawn that both represent good species. *Rhipidocotyle capitatum* was noted to have more anterior uterine coils, a longer cirrus and much smaller ova. Furthermore, the anterior hood of the two species is quite different. Both species were compared with *R. angusticolle* and there is no question but all three are distinctive. This is pointed out since it is possible that *R. nagatyi* may have been confused with *R. capitatum* in some of the earlier reports but it is very unlikely that either could have been mistaken for *R. angusticolle*.

Distribution: *Rhipidocotyle nagatyi* has been reported from Tortugas, Florida, (Manter, 1940c) and Puerto Rico, (Siddiqi and Cable, 1960). This survey represents the first record of the species in the
northern Gulf although, as pointed out previously, *R. capitatum* was conceivably mistaken for *R. nagatyi* in earlier publications, in which the former species was reported from Grand Isle, Louisiana. That this may have happened is further suggested by the fact that *R. capitatum* is otherwise known only from Woods Hole, Massachusetts.
Rhipidocotyle transversale Chandler, 1935

Synonym: Gasterostomum sp. of Linton, 1900
pp. 442, plate 34, fig. 367, 368)

Gasterostomum gracilescens of Linton, 1905
(pp. 410, plate 33, fig. 238)

Prosorhynchus gracilescens of Linton, 1940
(pp. 30-32, plate 18, fig. 246)

Host: Strongylura marina (Walbaum)

Incidence: In 1 of 3 hosts.

Location: Upper small intestine

Locality: Barataria Bay

Diagnosis: Rhipidocotyle transversale has an ovoid body that is truncate anteriorly and rounded posteriorly with cuticular spines covering the body except at the posterior extremity. It measures 0.814 - 0.913 mm in length and 0.264 - 0.286 mm in width at the level of the ovary. The anterior sucker is surmounted by a broad muscular flap-like hood, and has a length of 0.153 - 0.179 mm and a width of 0.138 - 0.169 mm. A large number of cephalic glands are located on either side of the anterior sucker. The pharynx is situated at the junction of the middle and anterior one-third of the body and has a length of 0.070 - 0.078 mm and a width of 0.172 - 0.188 mm. The large saccular gut lies directly dorsal to the pharynx.

The testes are diagonal and contiguous in the middle one-third of the body. Both testes have a length of 0.101 - 0.104 and a width of 0.101 - 0.104 mm. The cirrus reaches the level of the posterior testis and has a length of 0.264 - 0.319 mm and a width of 0.065 - 0.066 mm. There is a single genital lobe on the distal end of the cirrus.
The ovary is located at the level of the anterior testis and has a length of 0.057 - 0.078 mm and a width of 0.052 - 0.057 mm. The ootype and Mehlis' gland are posterior and medial to the ovary. Laurer's canal reaches the posterior, dorsal limit of the posterior testis. The uterus reaches but does not exceed the level of the pharynx. In the posterior half of the body, the uterus fills the body space dextrally adjacent to the cirrus. The vitellaria are formed into a loose band of follicles that extend transversely across the anterior end of the body just posterior to the anterior sucker. There is a total of approximately thirty follicles or fifteen in the dextral and sinistral group. The ova are small and thin-shelled with a length of 0.015 mm and a width of 0.010 mm. The genital atrium is subterminal and is connected to the genital pore by a short genital duct. The excretory bladder is saccular and reaches the level of the posterior testis.

Comparisons: Chandler (1935) originally described *Rhipidocotyle transversale* on the basis of metacercariae from *Menidia beryllina* (Cope) of Galveston Bay, Texas. Hopkins (1954) re-described the species from adults collected from *Strongylura marina* of Barataria Bay, Louisiana. Both investigators indicated the probable conspecificity of this species with some of the forms described by Linton (1900, 1905, 1940). In his early paper Linton (1900) reported "Gasterostomum sp." (pp. 442, plate 34, figs. 367 - 368) from *Tylosurus marinus* of Woods Hole, Massachusetts. Although his description is very brief and inadequate, Linton's figure 367 is clearly drawn from a specimen of *R. transversale* and is not of the genus *Bucephaloides* as deduced by Eckmann (1932). For one thing, the transverse arrangement of the
vitellaria is plainly indicated and there is no known species of the genus *Bucephaloïdes* that has such a vitelline system.

Linton (1905) listed no less than eight hosts for *Gasterostomum gracilescens* of Beaufort, North Carolina. He did not figure the specimens from all of the different hosts, but it can be determined from those he did draw that some undoubtedly represent what is now known as *R. transversale*. His figure 238 is in all probability *R. transversale*.

Linton (1940, plate 18, fig. 246) without a doubt based his description and figure of *Prosorhynchus gracilescens* from *Strongylura marina* on a specimen of *R. transversale*. The transverse vitellaria and characteristic cephalic end are clearly indicated.

Hopkins (1954) was of the opinion that Tennet (1906) was also dealing with *R. transversale* as well as *R. lintoni*.

Distribution: *Rhipidocotyle transversale* has a distributional pattern much like that of *R. lintoni*, which is harbored by the same host. One exception is the reported occurrence of *R. transversale* from the coast of Florida in the region of Tampa Bay, by Hutton and Sogandares (1960). As in the case of *R. lintoni*, it does not extend into the tropical waters of Florida, or the Caribbean, but is found on either side of the peninsular land barrier and extends all the way into the western Gulf of Mexico. Ginsburg (1952) contends the same sort of distribution can be detected in certain fish species. And, as suggested elsewhere, it seems quite probable that the gasterostome distribution is a direct reflection of the intermediate host dispersal and not that of the definitive host.
Pararhipidocotyle megagaster gen. n. et sp. n.

Host: Lophius americanus Valenciennes

Incidence: In 10 of 13 hosts.

Location: Gastric caeca

Locality: Oregon Stations 3714, 3716-17, 3724, 3739, 3745, 3749

Depth: 190 to 270 fathoms

Plate XXII


Species diagnosis: Pararhipidocotyle megagaster has an elongate body that is covered with finely pointed spines and which measures 6.27 (4.34 - 8.52) mm in length and 0.84 (0.63 - 0.96) mm wide at the level of the pharynx. The anterior sucker is nearly spherical and is capped with a well defined hood which bears a mid-ventral cleft. The sucker is 0.306 (0.385 - 0.420) mm long and 0.323 (0.275 - 0.370) mm wide. The large pharynx is located in the anterior one-fifth of the body and measures 0.297 (0.275 - 0.330) mm in length and 0.310 (0.286 - 0.360) mm in width. A large number of gland cells lies along its posterior margin and empty into the pharynx and distal part of the esophagus. The esophagus is short and slightly muscular. It passes posteriorly to the very large gut which extends to within one-fifth
the body length of the posterior extremity. The wall of the gut is dense and very cellular.

The subspherical testes are located at the mid-body or slightly posterior and are in tandem or diagonal. They are separated from each other by the ovary and several coils of uterus. The anterior testis is 0.312 (0.253 - 0.400) mm long and 0.312 (0.286 - 0.400) mm wide, whereas, the posterior testis is 0.296 (0.231 - 0.400) mm long and 0.326 (0.279 - 0.400) mm wide. The short blunt cirrus pouch is confined to the posterior one-sixth of the body and is 1.04 (0.847 - 1.23) mm long and 0.295 (0.275 - 0.430) mm wide. The seminal vesicle is ovoid with a length of 0.149 (0.099 - 0.198) mm and a width of 0.119 (0.099 - 0.171) mm. The seminal vesicle is followed by a sinuous pars prostatica. Distally, the lobes of the cirrus project into the genital atrium which has a subterminal genital pore.

The spherical ovary is intertesticular with the ootype and Mehlis' gland directed posteriorly. It measures 0.271 (0.165 - 0.400) mm long and 0.284 (0.253 - 0.370) mm wide. Laurer's canal is very sinuous and appears to terminate a short distance posterior to the ovary. The uterus has rather uncomplicated coiling. It proceeds anteriorly to about the level of the esophagus before coursing posteriorly. Posteriorly, it passes beyond the genital atrium before recurving to enter that structure. The vitellaria consist of widely separated follicles beginning slightly posterior to the pharynx and extending in two linear groups to a level equal to that of the posterior border of the anterior testis. The left vitelline duct courses posteriorly to the mid-dorsal level of the posterior testis before turning anteriorly to unite with the right duct at a point medial and just posterior to
the ovary. The ova are very small and thin-shelled with a length of 0.018 mm and a width of 0.010 mm.

The tubular excretory bladder has a thick, cellular wall and extends anteriorly to the posterior limit of the gut. A pair of primary ducts leave the bladder a short distance from its anterior end and course up the sides of the body, medial to the vitellaria. They reach the level of the pharynx before dividing to form secondary ducts.

Comparisons: The anterior sucker of Pararhipidocotyle megagaster is much like that of the rhipidocctylids in that it surmounted by a well-developed hood. The similarity to the genus Rhipidocotyle ends at this point because of the anterior location of the pharynx, the long intestine, the intertesticular ovary and the epithelially lined excretory bladder.

Pararhipidocotyle resembles the genus Dolichoenterum in possessing a long intestine and intertesticular ovary. The fact that the former has a rhipidoctylid sucker and unique excretory bladder prevents the two from being considered as congeneric forms.

Pararhipidocotyle megagaster cannot be ascribed to any of the known genera without distorting the range of characters by which they are identified. It is believed the only alternative is to erect a new genus for the species from Lophius americanus.

The generic name, Pararhipidocotyle, is to indicate the apparent relationship of the new form to the genus Rhipidocotyle. The type species is designated Pararhipidocotyle megagaster to denote the unique characteristic of the intestine.

Discussion: There are several anatomical features found in Pararhipidocotyle megagaster that are worthy of further discussion. Of greatest significance is the nature of the excretory bladder. In
totomounts, it appears as a thick-walled structure extending from the terminal pore to near the posterior tip of the gut. More detailed study shows the wall of the bladder actually is made up of a series of horizontally oriented cells lying in the longitudinal plane of the bladder. In cross section, these cells are pyramidal in shape. It was also learned from sectioned material that these cellular components are not confined solely to the excretory bladder but can also be found throughout the length of the primary ducts although they become very reduced at the anterior end of these ducts.

The point of interest here is the fact that there is no other known species of gasterostome that has an excretory bladder with a thick, cellular wall.

The formation of an epithelial or thick-walled bladder has been observed by several investigators, Wallace (1941), Lundahl (1941), Hussey (1941 and 1943) and Kuntz (1950 and 1951). There is a fundamental pattern of development of the excretory bladder in all trematodes, at least, this seems to be the case in the early cercarial stages.

Essentially, the process involves the fusion of the two primary collecting tubules near the posterior end of the cercaria to form a so called primary excretory bladder. In those forms which possess an epithelial or thick-walled bladder, a cluster of mesodermal cells group around the fusing tubules and eventually come to form the wall of the secondary bladder by replacing the cells of the primary structure. By comparison, cercariae which have a non-epithelial excretory bladder go through the same developmental steps with the exception that no mesodermal layer is formed around the primary bladder. Consequently, cercariae in the latter group retain the primary bladder through subsequent developmental stages and terminating in the adult.
The gasterostomatous trematodes have been described as having a non-epithelial or primitive type of excretory bladder. *Pararhipidocotyle megagaster* is an obvious exception. It is not possible to understand the full significance of this, for the method by which the epithelial bladder of *Pararhipidocotyle megagaster* is formed is, of course, unknown. Kuntz (1951) has suggested that the thickening of the bladder wall in some species is not the result of mesodermal accretion but rather of the proliferation of cells from the wall of the primary excretory ducts. Such a process has never been described for the forked tailed cercaria of which the bucephalids are representatives. The way the cellular wall of the excretory bladder of *Pararhipidocotyle megagaster* is formed may never be known, but the fact remains that such a bladder is present in the adult and therefore, must be recognized as an exception to what appeared to be a constant characteristic of the family Bucephalidae.

LaRue (1957) has attached a great deal of significance to the type of excretory bladder found in various families of digenea. As a matter of fact, the thin-walled nature of the excretory bladder of most bucephalids has been considered by LaRue (1957), and others, to be of great phylogenetic significance since it appeared to be a constant and fundamental character of the group. In his proposed scheme of classification, he divides all of the digenetic trematodes into two groups on the basis of whether or not the primitive or primary excretory bladder is retained or is replaced by an epithelial lining of mesodermal origin. Thus, the gasterostomes would be placed in his super order Anepitheliocystidia.

Such a scheme seems to be untenable in view of the nature of the excretory system in *Pararhipidocotyle megagaster*. It is readily
admitted that this species may represent a single exception to the general rule of a nonepithelial bladder in the bucephalids but it does, nonetheless, point out the possibility that similar species may also exist. Secondly, there is a practical problem that must be considered. It is doubtful that the life cycles of all the groups of digenea will ever be known and, therefore, adult anatomy must still be employed in any system of classification. If such were not the case, then variations as found in *Pararhipidocotyle megagaster* would have to be ignored.

**Distribution:** *Pararhipidocotyle megagaster* is known only from deep waters of the northern Gulf of Mexico. Manter (1934 and 1947) examined several specimens of *Lophius piscatoris* Linnaeus from Dry Tortugas, Florida, but did not report the incidence of gasterostomes. This is rather surprising since one would expect these parasites to occur in such a closely related area.

Linton (1905 and 1940) also studied a number of specimens of *Lophius piscatoris* but in the Woods Hole area and like Manter, he made no mention of finding bucephalids. The same host in European waters harbors the species *Bucephaloides gracilesens* but as Hopkins (1954) remarks this gasterostome has never been reported from the western North Atlantic. A remarkable feature about this species is its unusually large size. Its range of body measurements is a great deal like that of *Pararhipidocotyle megagaster*, both of which are extremely large compared to most bucephalids.
Subfamily PROSORHYNCHINAE Nicoll, 1914

Prosorhynchus gonoderus Manter, 1940

Host: *Mycteroperca bonaci* (Poey)  
(New host record)

Incidence: In 1 of 16 hosts.

Location: Upper small intestine

Locality: Off Grand Isle (New locality record)

Plate XXIII

Diagnosis: *Prosorhynchus gonoderus* has an elongated, spinous body that tapers posteriorly, beginning at about the level of the pharynx. It has a length of 2.90 mm and a width of 0.68 mm at the widest point of the body. The wedge-shaped rhynchus is 0.40 mm long and 0.47 mm wide at the anterior extremity. The spherical pharynx measures 0.104 mm in diameter and is situated at the posterior limit of the anterior one-third of the body. It opens into a sacculate gut that is prepharyngeal and which extends anteriorly into the intervitelline space, nearly reaching the rhynchus.

The diagonal testes are anterior to the mid-body and have the following measurements: anterior testis 0.253 mm by 0.220 mm, posterior testis 0.143 mm by 0.187 mm. The anterior testis is very near the right side of the body and lies in close proximity to the ovary and dextral vitelline gland. The posterior testis is located near the mid-line and is separated from its counterpart by the ootype, Mehlis' gland and a uterine coil. The cirrus pouch, measuring 0.550 mm by 0.220 mm, is confined to the posterior one-third of the body and contains a recurved seminal vesicle that is 0.220 mm by 0.088 mm.

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The prepharyngeal ovary has a diameter of 0.187 mm. A long oviduct passes dorsal to the anterior testis to the intertesticular ootype. Laurer's canal extends to the dorsal posterior margin of the posterior testis. The convoluted uterus does not extend anterior to the ovary but does have several coils posterior to the genital atrium. The vitelline follicles are clumped into two, well separated groups that lie near either side of the anterior one-quarter of the body. Anteriorly, the vitellaria reach the level of the rhynchus. The thick-shelled ova measure 0.031 mm by 0.018 mm. The excretory bladder was not visible in the specimen at hand.

Comparisons: The specimen from the Louisiana Coast is slightly larger than the dimensional range given by Manter (1940a). There is no question of conspecificity, however, because of the agreement in the general morphology and in the distinctive location of the reproductive organs in the fore-body.

Distribution: A single specimen of Proserhynchus gonoderus was collected from Mycteroperca bonaci. The host was taken from water of about twenty fathoms near one of the offshore drilling platforms south of Grand Isle, Louisiana. Both the host and the location are new for the species. As a matter of fact, Proserhynchus gonoderus has previously only been reported from James Island, Galapagos, in a yellow-spotted grouper Manter (1940a), and from Epinephelus analogus Gill of Taboga Island in the Panama Pacific (Sogandares, 1959). That it should be found in the Gulf of Mexico is not too surprising since Manter (1940b and 1955) has given considerable evidence of the species continuity between the Gulf of Mexico and the American Pacific. It is, however, of considerable interest that it should be collected from the northern Gulf. Like the incidence of Proserhynchus ozakii, this...
is very probably the northern limit of the parasite's occurrence not only because it has reached the limits of the Gulf itself, but because it has penetrated a subtropical region.

Manter (1940b, p. 543) stated, "Other kinds of evidence indicate that Galapagos affinities are strongly Atlantic in nature. A submarine plateau of relatively shallow water (less than 1,500 fathoms) extends from the Galapagos Islands past Cocos Island almost to Panama, while deeper water lies between the Galapagos Islands and South America. Thus, a possible former shallow-water connection with the present Gulf of Mexico is suggested." If one were to draw a line between the Galapagos Islands and Louisiana, that line would nearly pass through the Gulf of Panama. Thus, all reported areas of incidence, with the exception of the Tortugas, of Prosorhynchus ozakii and Prosorhynchus gonoderus would be connected. This is not to say by any means, that the species does not extend laterally from such a line. What it does suggest, is the plausability of Manter's statement.

Siddiqi and Cable (1960, p. 368) made the following observation: "Factors controlling the distribution of marine organisms are not well understood, but an important one is water depth....Deep water, therefore, would serve to isolate populations of such fishes and of the parasites they obtain in feeding." Following both lines of thought, it is not difficult to picture a faunal band extending diagonally across the amphi-American region that would thereby connect the Galapagos Island area to the Gulf of Mexico and its environs. The existence of such faunal continuity is not restricted to fishes and their parasites for as Manter (1940b) points out, various other groups of vertebrates and invertebrates tend to corroborate this belief. There-
fore, the incidence of *Prosorhynchus ozakii* and *Prosorhynchus gonoderus* in the northern Gulf exemplify a very interesting zoogeographic phenomenon.
Prosorhynchus ozakii Manter, 1940

Host: Epinephelus sp.

Epinephelus itajara (Lichtenstein) (New host record)

Incidence: In 1 of each host.

Location: Upper small intestine

Locality: Off Grand Isle (New locality record)

Plate XXIV

Diagnosis: Prosorhynchus ozakii has a fusiform body that is 1.89 mm in length and 0.62 mm at the widest point. Spines cover the body surface but become very small posteriorly. The rhynchus is a weakly formed structure that is cap-like with a length of 0.19 mm and a width of 0.19 mm at the distal end. The pharynx, measuring 0.052 mm by 0.054 mm, is located slightly postequatorial. The sacculate gut lies anterior to the pharynx and extends into the space between the laterally disposed vitelline glands, but does not exceed the anterior limits of these latter structures. It measures 0.275 mm by 0.220 mm.

The testes are almost lateral though the left testis is slightly anterior to that of the right side. Both testes are located postequatorially and have an average diameter of 0.132 mm. The cirrus pouch reaches the level of the pharynx and is 0.715 mm in length and 0.142 mm in width. It contains a recurved seminal vesicle that has a length of 0.33 mm and a width of 0.055 mm.

The ovary is prepharyngeal with a length of 0.088 mm and a width of 0.154 mm. The ootype and Mehlis' gland are located medial and posterior to the ovary. Uterine coils extend into the intervitelline space but do not extend anterior to the vitellaria. Several coils of
the uterus are found in the hind-body, adjacent to the cirrus, but none extend posterior to the genital atrium.

The vitellaria are arranged into two linear groups of 13 to 16 follicles each. They range from just anterior to the equatorial plane to very near the level of the rhynchus and are well separated over their entire extent. The ova measure 0.026 mm by 0.016 mm. The excretory bladder was not visible in the specimens available for study.

Comparisons: *Prosorhynchus ozakii* is unique in that it is one of the only two species within the genus that has the testes positioned laterally rather than in tandem as is characteristic of most prosorhynchids. The other species, *Prosorhynchus aculeatus* Odhner, 1905, differs from the standpoint that it does not have the vitellaria divided into two distinct and separate groups. Too, the uterus is not interposed between the vitelline glands as it is in *Prosorhynchus ozakii*.

Issaitschikow (1928) erected the genus *Skrjabiniella* to accomodate those prosorhynchids that have the testes arranged laterally. Manter (1934) questioned the value of such a morphological character and, contending that it was not of generic weight, reduced the genus to synonymy with *Prosorhynchus*.

Yamaguti (1953 and 1958) suggested the genus *Skrjabiniella* should not be abandoned but retained in the status of a subgenus. There is a certain desirability to this since it provides a convenient and functional division of the genus. Whether it is sound from the standpoint of a natural system, is open to question. It seems a bit premature to introduce subgenera into trematode taxonomy for not many of the genera are well enough understood to warrant such manipulation.

Pigulewsky (1931) considered the subfamily *Prosorhynchinae* Nicoll,
1914, divisible into two tribes. Under the tribe Prosorhynchia, he placed those forms which have ovoid bodies and vitellaria arranged in an arch while in the tribe Goto尼亚 he included the species with elongated bodies and with vitellaria separated into two linear groups. This proposal has never been accepted because of the obvious weakness of the criteria upon which it is based. Whether a species has an ovoid or elongated body cannot be considered as tribal or even of generic significance. At the most, it would be applied at the species level and even then other factors would have to be taken into account.

Besides Pigulewsky's work, there have been several attempts to form the genus *Prosorhynchus* into various groupings. Jones (1943) believed the genus *Skrjabinia* to be valid and in so doing he divided the prosorhynchids according to whether the vitellaria were formed into an arc, on the disposition of the testes, the body shapes and the nature of the rhynchus. This scheme is untenable because species such as *Prosorhynchus ozakii* cannot be placed in either genus without nullifying the criteria of one or the other genera.

Crowcroft (1947) has proposed the most attractive scheme but even that is not totally acceptable and has not been generally recognized. He would divide the genus *Prosorhynchus* on the grounds of only two criteria, namely, the nature of the rhynchus, whether it is conical or cap-like and whether the vitellaria are linear or aeriform. From this viewpoint, *Prosorhynchus gonoderus*, *Prosorhynchus ozakii* and *Prosorhynchus pacificus* would have to be transferred to what he considers the more acceptable genus, *Gotonius* Ozaki, 1924. This system is not completely satisfactory for in his characterization of the genus, *Gotonius*, Ozaki (1924) considered the mid-body location of the
reproductive organs to be of generic value and therefore, *Prosorhynchus gonoderus* would be an exception although it does comply with the other features of the genus. It does not seem advisable to separate the genus until such time that a better understanding is had of the range of variations within the group.

Distribution: Two specimens of *Prosorhynchus ozakii* were collected from a single grouper of the genus *Epinephelus*. Unfortunately, it was not possible to retain the host for more positive identification because of its large size but at the time of the collection, the similarity between it and *Epinephelus nigratus* was noted. This may represent a new host record for *Prosorhynchus ozakii* but additional observations will have to be made for confirmation.

The host fish was obtained near one of the numerous drilling platforms located along the Louisiana Coast. This particular platform stands in about twenty-two fathoms of water and is about forty miles due south of Grand Isle, Louisiana. A third specimen of *Prosorhynchus ozakii* was collected from a new host *Epinephelus itajara* taken off Wine Island, Louisiana. These details are given since this is the northern most known occurrence of *Prosorhynchus ozakii*. Prior to this, Manter (1934) had described the species from *Epinephelus niveatus* (Cuvier and Valenciennes) from ninety fathoms of water off the Florida Coast. The same author, (Manter, 1940a), gave an account of this prosorhynchid from a grouper-like fish taken off Isabel Island, Mexico, and from *Mycteroperca olfax* (Jenyns) and *Mycteroperca xenarcha* from Albemarle Island, Galapagos. Sogandares (1959) also collected *Prosorhynchus ozakii* from the Pacific but from *Epinephelus analyogus* Gill of Taboga Island, Panama Pacific.
The incidence of *Prosorhynchus ozakii* in northern Gulf waters is of particular interest for it undoubtedly represents the outermost limit of the amphi-American fish trematode fauna. There is a strong likelihood that the infections of the prosorhynchids originate in more tropical waters and, though the definitive host moves freely into subtropical areas, it does not necessarily mean that subtropical mollusks and small fishes become involved in the life cycle of the parasite. Thus, the incidence of this species off Louisiana is perhaps more indicative of the host's vagility than it is of the parasite's distribution.
**Prosorhynchus pacificus** (Manter, 1940) Hanson, 1950

**Synonym:** *Gasterostomum sp.* of Linton, 1919  
(pp. 79-80, plate 26, fig. 217, 217a, 218, 222, 222a)

**Prosorhynchus atlanticus** Manter, 1940.

**Host:** *Mycteroperca bonaci* (Poey)

*Epinephelus nigratus* (Holbrook) (New host record)

**Incidence:** In 5 of 16 *Mycteroperca bonaci.*

In 1 of 1 *Epinephelus nigratus.*

**Location:** Gastric caeca and upper small intestine.

**Locality:** Off Grand Isle (New locality record)

**Plate XXV**

**Diagnosis:** *Prosorhynchus pacificus* has a spinous body that is elongated and tapered posteriorly with a length of 1.77 (1.65 - 1.99) mm and a width of 0.452 (0.41 - 0.62) mm. The muscular, wedge-shaped rynchus is 0.38 (0.22 - 0.429) mm long and 0.355 (0.0280 - 0.385) mm wide at the anterior extremity. The pharynx, measuring 0.068 - 0.075 mm in length and 0.081 - 0.088 mm in width, is located at or near the equatorial plane of the body. The gut is prepharyngeal and is interposed between the vitelline glands. Its anterior limit is at a level equal to about one-third of the body length from the anterior end of the body.

The anterior testis is prepharyngeal and near the mid-line. It has a measurement of 0.150 (0.137 - 0.204) mm by 0.201 (0.132 - 0.220) mm. The posterior testis is located to the right of the mid-line and is separated from its counterpart by uterine coils. It is 0.138 (0.120 - 0.180) mm long and 0.147 (0.108 - 0.220) mm wide. The cirrus pouch
is confined to the posterior one-third of the body and is 0.585 (0.495 - 0.627) mm long and 0.140 (0.120 - 0.144) mm wide. A recurved seminal vesicle is located in the distal portion of the cirrus pouch and is 0.330 to 0.360 mm long and 0.060 - 0.077 mm wide.

The prepharyngeal ovary is situated to the right of the mid-line and is 0.0127 (0.093 - 0.176) mm long and 0.110 (0.084 - 0.154) mm wide. The ootype and Mehlis' gland are in tandem with the ovary on the dextral side of the body. Laurer's canal extends to a point equal to the mid-dorsal portion of the posterior testis. Uterine coils do not extend anterior to the ovary but do reach past the genital atrium posteriorly. The vitellaria are arranged into two linear groups of usually thirteen dextral and sixteen sinistral follicles. The vitelline glands are well separated and extend from about the equatorial plane to very near the level of the rhynchus. The ova are thick-shelled and have a length of 0.031 - 0.033 mm and a width of 0.019 - 0.020 mm. The excretory bladder reaches the level of the pharynx and has a terminal excretory pore.

Comparisons: When Manter (1940a) described Prosorhynchus pacificus from the Galapagos Islands, he remarked that it bore a great similarity to a then undescribed species from the Tortugas of Florida. In the same year, Manter (1940c) described and named the latter form Prosorhynchus atlanticus. Manter commented on the fact that the two species differed only in the size of their ova and that this might be subspecifically important rather than having specific merit. Hanson (1950), in working with a collection from Bermuda, found specimens that contained ova that were of intermediate dimensions and therefore, relegated Prosorhynchus atlanticus to synonymy. Since the ova were apparently the only distinguishing feature, Hanson's proposal has been generally...

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accepted and it would appear to be justified for the ova of bucephalids are well known for their variation within the species or even within a series of specimens. The material collected in this survey, on the basis of the egg size, is more like the Bermuda group since the ova are smaller than what Manter described for *Prosorhynchus atlanticus* and larger than that of *Prosorhynchus pacificus*.

Manter (1940c) referred to Linton's (1910) description of prosorhynchids from *Mycteroperca bonaci* and *Mycteroperca venenosa* (pp. 79 and 80, plate 26, figs. 217, 217a, 218, 222, 222a) of Tortugas and considered them to be conspecific with *Prosorhynchus pacificus*. On the basis of Linton's data and figures, there seems to be no doubt but Manter's interpretation is correct.

**Distribution:** *Prosorhynchus pacificus* was collected from five of the sixteen specimens of *Mycteroperca bonaci* examined. The worms were found in the caeca in every infection and usually only five or six trematodes were present. The three hosts that were positive all came from water of about twenty fathoms at approximately forty miles south of Grand Isle, Louisiana. Of the remaining eleven fishes that proved to be uninfected, all but three came from the same general locality. The three other specimens were taken from Barataria Bay.

The incidence of *Prosorhynchus pacificus* in *Epinephelus nigritus* is a new host record for the species and in this animal the worms were collected from both the caeca and the upper small intestine. Like the majority of other groupers represented in this study, *Epinephelus nigritus* was caught in water of about twenty fathoms.

The overall distribution of *Prosorhynchus pacificus* is quite consistent with that known for the other prosorhynchids of the amphi-
American zone. This is especially true if it is assumed that the synonymy established by Hanson (1950) is correct. Thus, like the other known species, *Prosorhynchus pacificus* is part of the faunal band connecting the Gulf of Mexico with the Galapagos Islands. It differs, however, in that its ranges appears to be more extensive. Manter (1940a) first described the species from *Mycteroperca olfax*, *Mycteroperca xenarcha* of Albermarle James Island, Galapagos, and from an unidentified grouper of James Island, Galapagos. At Tortugas, Manter (1940c) reported *Mycteroperca bonaci*, *Mycteroperca microlepis* (Goode and Bean) and *Mycteroperca venenosa* (Linnaeus) as host animals. The latter species was also found infected in waters off Bimini, British West Indies, by Sogandares (1959), and Siddiqi and Cable (1960) listed *Mycteroperca* sp. as a host in Puerto Rico. Hanson (1950) added a new host, *Sebastopyr ruberrinus* (Cramer), and Bermuda as a new locality. Winter (1950) also added a new host and locality when he reported *Prosorhynchus pacificus* from *Epinephelus analogus* of Mazatlan, Mexico.

This prosorhynchid is of particular interest zoogeographically because it appears to be much more widespread in both the extent of hosts in which it has been found and in the widely separated waters in which it occurs. Furthermore, the available data would indicate that it is more common at the eastern end of its range than it is in the south and western part. This may be partially explained by the deficiencies in field data for the serranids have not been as widely studied in the western part of the amphi-American zone as they have in the eastern portion. The distributional pattern that has been established certainly suggests that it is one of the most common prosorhynchids and that more extensive surveys would reveal that it ranges over the entire Gulf of Mexico and American Pacific.
SUMMARY AND CONCLUSIONS

General remarks on the distribution of gasterostomes in the Gulf of Mexico

There are several generalizations that can be drawn from the distributional accounts given in the above text. With respect to bucephalid distribution, the Gulf of Mexico can be divided into four geographical and ecological zones. The shallow, inshore waters, extending from central Florida north and westward to the south Texas Coast, unquestionably support a fauna different from that found in similar waters of tropical Florida. Both of these areas do, however, share a certain number of gasterostome species by virtue of the wide distribution in the third zone, namely that of the pelagic hosts. The fourth zone is that of the deep waters beyond the one hundred fathom line which has its own distinctive fauna.

Manter (1934) presented a considerable amount of evidence to show the unique nature of the trematode fauna in the deep waters of Dry Tortugas as compared to species taken in water of a lesser depth but in the same region. He found a greater similarity between the deep water species and those known from colder and more northern seas than he did between local, deep and shallow water species.

Only two species of gasterostomes were collected from fishes of the deep waters in the northern Gulf of Mexico. One of these represents a new genus and species and the other was previously found off Florida by Manter (1934). It is of interest to note that the host of the new species was also examined by Manter (1934) but found to be uninfected.
with bucephalids. Manter (1934) did, however, find the benthic fish *Kathetostoma albigutta* of Dry Tortugas to harbor the gasterostome *Bucephalus kathetostomae* Manter, 1934. A number of specimens of this fish was studied in the northern Gulf but none was found host to this species of trematode. Although it is rather difficult to formulate generalities on the basis of three species, the evidence does suggest that even in deep waters, which are usually considered to have a cosmopolitan trematode fauna, there are enzootic species.

The bucephalids infecting pelagic fishes, in some instances, have a world-wide distribution while in others they appear to be confined to a large, but none the less, delimited faunal zone. *Bucephalus varicus* has been known to occur on opposite sides of the world and yet some of the prosorhynchid species are confined to the amphi-American zone. Without knowing the life cycle of the parasite, it is difficult to account for the different patterns of distribution involving pelagic hosts. Undoubtedly, they reflect the zoogeography of the intermediate hosts as well as that of the definitive animal.

It is less difficult to interpret the dispersal to bucephalids in shallow waters than it is in offshore habitats. There is reason to believe the shallow water zone not only has its own characteristic trematode fauna but also that it is subdivided into discontinuous populations. The distribution of *Bucephalus cynoscion* and *Bucephaloides caecorum* is illustrative of this fact. As stated above, these two species appear singly at the eastern and western extremities of the Gulf but in the delta region they occur simultaneously in the same host. The apparent limited occurrence of *Bucephalus brevitentaculatus* and *Bucephaloides paralichthidis* point to even smaller distributional boundaries. Since the life cycle of these species are yet unknown,
it is not possible to understand the exact limiting factor, but in all likelihood, it is a reflection of the intermediate host range. Hedgepeth (1953) refers to a "delta fauna" among the polychaetes and it seems quite possible there are molluscs that display a similar "delta fauna" that might in turn figure in the life cycle of the bucephalid.

Eckmann (1953, p. 54) stated "The northern part of the Gulf of Mexico...occupies a special position in that both the fauna and hydrographical conditions differ from the neighboring regions in possessing features which are more akin to warm-temperate regions, for instance, of Beaufort, North Carolina." He continues, "...temperate species which are missing from southern Florida, are found along the northern coast of the Gulf." Eckmann's statement is a precise account of the distribution of *Rhipidocotyle lintoni* and *R. transversale*. Both species are found in the northern Gulf and at Beaufort, but are absent in South Florida. This is clearly a reflection of either the absence of the intermediate host or the inability of the larval stages to survive in a tropical environment for close relatives of the definitive host are well known in the waters around Dry Tortugas.

The topical waters off South Florida quite certainly act as a barrier to many forms and thus prevent migrations around the tip of the peninsula. The question of how and why there is a similarity in the parasites on either side of the barrier can be explained by the fairly recent submergence of North Florida. Both Rivas (1954) and Ginsburg (1952) have referred to the close relationship of fishes on either side of Florida and state there is no question of the faunal
continuity that once existed. Hedgpeth (1954) has demonstrated the same thing in various molluscs. The distribution of certain bucephalid species quite obviously substantiates this observation.
Comparisons of the bucephalid fauna of the northern gulf to that of other areas

There have been forty eight species of gasterostomes reported from the western North Atlantic, the Gulf of Mexico, the Caribbean and the amphi-American zone. Twenty seven of these species have been collected in the northern Gulf of Mexico in a survey made of 103 fish species composed of 614 individuals. A comparison of the northern Gulf fauna with that of other areas may be seen in Table III.
### TABLE III

The distribution of northern Gulf Bucephalids in the western Atlantic, Caribbean, American Pacific and tropical Gulf of Mexico

Symbols used to denote geographic areas are as follows: B.B.- Barataria Bay, Louisiana; G.I.-Off Grand Isle, Louisiana; M.S.- Mississippi Sound, Mississippi; Tam.-Tampa Bay, Florida; Tex.- Coast of Texas; Tor.-Dry Tortugas, Florida; B.N.C.-Beaufort, North Carolina; W.H.-Woods Hole, Massachusetts; Pan.-Gulf of Panama; Bim.- Bimini British West Indies; P.R.-Puerto Rico; Ber.-Bermuda; Gal.- Galapagos Islands; C.I.-Chandeleur Islands; W.I.-Wine Island, Louisiana.

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SELECTED BIBLIOGRAPHY


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Jones, D.O. 1943. The anatomy of three digenetic trematodes, Skrjabiniella aculeatus (Odhner), Lecithochirium rufovirdie (Rud.) and Sterrhurus fusiformes (Luhe) from Conger conger. Parasitol. 35(1-2): 40-57.


Park, J.T. 1939. Trematodes of fishes of Tyosen. IV. A new digenetic trematode parasite Bucephalopsis cybii sp. nov. (Bucephalidae) Poche, 1907.


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EXPLANATION OF PLATES

All drawings were made with the aid of a camera lucida or drawing tube and the scale used is indicated on each plate.

Plate I. Bucephalus brevitentaculatus sp. n.
Plate II. Bucephalus cynoscion Hopkins, 1956
Plate III. Bucephalus gorgon (Linton, 1905) Eckmann, 1932
Plate IV. Bucephalus scorpaenae Manter, 1940
Plate V. Bucephalus varicus Manter, 1940
Plate VI. Bucephaloides caecorum Hopkins, 1956
Plate VII. Bucephaloides longicirrus (Nagaty, 1937) Hopkins, 1954
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Plate IX. Bucephaloides megacirrus Riggin and Sparks, 1962
Plate X. Bucephaloides paralichthydis Corkum, 1961
Plate XI. Bucephaloides pomatomus sp. n.
Plate XII. Bucephaloides scomberomorus sp. n.
Plate XIII. Bucephaloides trichiuri Sogandares, 1955
Plate XIV. Bucephaloides truncatus sp. n.
Plate XV. Rhipidocotyle adbaculum Manter, 1940
Plate XVI. Rhipidocotyle angusticolle Chandler, 1941
Plate XVII. Rhipidocotyle lepisostel Hopkins, 1954
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Plate XIX. Rhipidocotyle longleyi Manter, 1934
Plate XX. Rhipidocotyle nagatyi Manter, 1940
Plate XXI. Rhipidocotyle transversale Chandler, 1935
Plate XXII.  Pararhipidocotyle megagaster gen. n., sp. n.
Plate XXIII.  Prosorhynchus gonoderus Manter, 1940
Plate XXIV.  Prosorhynchus ozakii Manter, 1940
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*Bucephalus brevitentaculatus* from *Trichiurus lepturus*
Plate II

*Bucephalus cynoscion* from *Cynoscion nebulosus*
Plate III

Bucephalus gorgon from Seriola dumerili
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Plate V

Bucephalus varicus from Caranx hippos
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*Bucephaloides caecorum* from *Cynoscion nebulosus*
Plate VII

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Plate XII

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Plate XIII

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Plate XIV

Bucephaloides truncatus from Scomberomorus cavalla
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Plate XVI

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Plate XVII

*Rhipidocotyle lepisostei* from *Lepisosteus spatula*
Plate XVIII

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Plate XIX

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Plate XXIII

Prosorhynchus gonoderus from Mycteroperca bonaci
Plate XXIV

Prosorhynchus ozakii from Epinephelus sp.
Plate XXV

*Prosrhynchus pacificus* from *Mycteroperca bonaci*
BIOGRAPHY

Kenneth C. Corkum, born August 9, 1930, was graduated from West Aurora High School, Aurora, Illinois. He received a B.S. degree from Aurora College in June of 1958 and an M.S. degree from Louisiana State University in 1960. He is now a candidate for a Doctor of Philosophy degree in the Department of Zoology, Entomology and Physiology, Louisiana State University.
Candidate: KENNETH C. CORKUM

Major Field: General Zoology

Title of Thesis: A taxonomic and distributional study of the family Bucephalidae (Trematoda) in the northern Gulf of Mexico.

Approved:

[Signatures of faculty members]

Date of Examination: July 22, 1963