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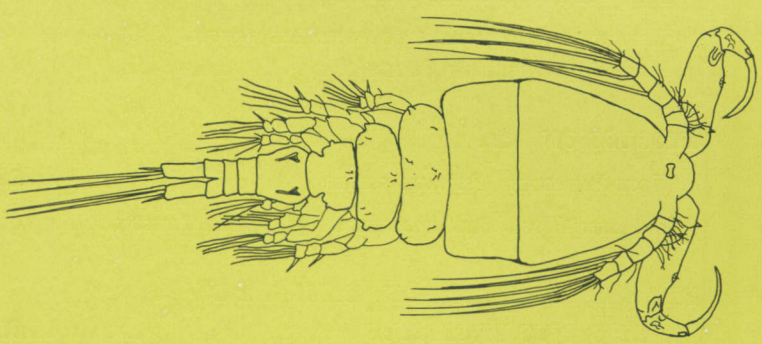
Distribution of the Genus *Ergasilus* in Several Gulf of Mexico Drainage Basins



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Distribution of the Genus *Ergasilus* in Several Gulf of Mexico Drainage Basins

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INTRODUCTION

THE GENUS *Ergasilus* comprises a group of parasitic crustaceans (copepods) that may be considered a threat to fish health. These parasites typically attach to the gill filaments of the fish host where they feed on body tissues. Irritation and tissue damage are apparent symptoms.

Several epizootics caused by *Ergasilus* are noted in the literature. *Ergasilus* species may be considered a threat to a fish population when the sequence of natural events promotes the development of large numbers of the parasites. The effect is that of overburdening the hosts. The presence of few *Ergasilus* parasites typically has little harmful effect on the fish.

The fundamental concepts of identity, host relationships, and distribution are necessary for the proper understanding of a group of parasites. The distribution of the genus *Ergasilus* in several Gulf of Mexico drainage basins is examined herein with emphasis on host relationships and distributional patterns. Combining the resulting data with the more reliable reports of the literature helps to establish more clearly the status of distribution of the *Ergasilus* species along with their preferred hosts.

For this study gill material was examined from 6,965 fishes representing over 3,000 host localities. Fish specimens were obtained primarily from ichthyological museums.

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Background

Wilson *(99,100)* made the most important contribution in establishing a taxonomy for the genus *Ergasilus* in North America. Several new species were described and comments were made on host preferences. Wilson's conclusions on host preferences, however, were frequently supported by little data. Following this work were several descriptions of new taxa but most of them were descriptions of previously described forms.

In the 1960's, L. S. Roberts began revisory work that culminated in a general review of the genus *(80)*. Most of Roberts' work was on material from the U.S. National Museum collection and material that R. V. Bangham had collected in his (1933-1955) survey work. Part of the latter material that Roberts had the opportunity to rework had by that time lost its locality data. Nevertheless, Roberts had provided valuable information for distributional work by revising that material on which he did have locality data.

The Study Area and Fish Fauna

The area selected for study includes several river drainages that flow southward into the Gulf of Mexico and that lie between 30-35 degrees N. latitude. The primary adjacent waters include the large Mississippi River drainage to the west and Atlantic Ocean drainages to the east. The drainage area studied lies within Alabama, Mississippi, northwestern Florida, and western Georgia.

If the size of the drainage area is considered it would be safe to say that the waters support a relatively diverse fish fauna *(66)*. Nearly all of the North American freshwater fish families, with the exception of salmonids, umbrids, and percopsids, have representatives in the area. Smith-Vaniz *(84)* considered the zoogeography of the fish fauna of most of the area included in the present study and noted the Mobile Bay and Apalachicola Bay drainages to be centers of fish species differentiation.

Taxonomic Considerations of the Genus Ergasilus

There are 23 described *Ergasilus* species in North America that are regarded as valid species. Roberts' *(80)* review included 21 species but suggested that two of these, *E. funduli* Kroyer, 1863 and *E. manicatus* Wilson, 1911 may be the same. It appears that

the names represent indeed the same species with the name *E. funduli* having priority. Another species, included by Roberts *(80)* as *E. mugilus* Vogt, 1877 *sensu* Wilderman, 1968, unpublished, has been considered a synonym of *E. versicolor (51).*

Since Roberts' *(80)* review, another taxonomic work *(27)* described a new species and transferred one North American *Ergasilus* species to a new genus. The new species, *E. spathula* Cressey, 1970, is herein considered a synonym of *E. arthrosis* Roberts, 1969.

The described North American species of *Ergasilus* that are considered acceptable in this work are: *E. arthrosis* Roberts, 1969 (Syn. *E. spathula* Cressey, 1970); *E. auritus* Markevich, 1940; *E. caeruleus* Wilson, 1911; *E. celestis* Mueller, 1936 (Syn. *E. osborni* Tidd and Bangham, 1945); *E. centrarchidarum* Wright, 1882 (Syn. *E. nigritus* Wilson, 1916); *E. cerastes* Roberts, 1969; *E. chatauquaensis* Fellows, 1887; *E. clupeidarum* Johnson and Rogers, 1972; *E. cotti* Kellicott, 1892; *E. cyprinaceus* Rogers, 1969; *E. elongatus* Wilson, 1916; *E. felichthys* (Pearse, 1947); *E. funduli* Kroyer, 1863 (Syn. *E. manicatus* Wilson, 1911); *E. labracis* Kroyer, 1863; *E. lanceolatus* Wilson, 1916; *E. lizae* Kroyer, 1863; *E. luciopercarum* Henderson, 1926 (Syn. *E. confusus* Bere, 1931; *E. skrjabini* Mueller, 1936); *E. megaceros* Wilson, 1916 (Syn. *E. fragilis* Mueller, 1936); *E. nerkae* Roberts, 1963; *E. tenax* Roberts, 1965; *E. turgisus* Fraser, 1920; *E. versicolor* Wilson, 1911 (Syn. *E. elegans* Wilson, 1916; and *E. cyanopictus* Carvalho, 1962); *E. wareaglei* Johnson, 1973.

There is a group of names in the North American literature that has been given to *Ergasilus* species that parasitize coastal *Mugil* spp. The original descriptions of these species lacked the explicitness required for proper differentiation. Included in this group are *E. nanus* van Beneden, 1870, *E. mugilus* Vogt, 1877, and *E. lizae* Kroyer, 1863. The results of the present study will show there are probably three forms that will fit the descriptions of these vaguely defined species. One of the forms treated herein is reported as *E. lizae* following Roberts' *(80)* definition, and all three forms are depicted in Figure 1.

Another point that had not been brought out in the literature was the close morphological similarity of *E. arthrosis* Roberts, 1969 to *E. sieboldi* Nordmann, 1832. *E. sieboldi* is considered to have an Eurasian distribution. The senior author had the opportunity to examine Asian and European material of this species

and found it to vary considerably in morphology for an *Ergasilus* species. Roberts *(78)* did not compare *E. arthrosis* to *E. sieboldi*

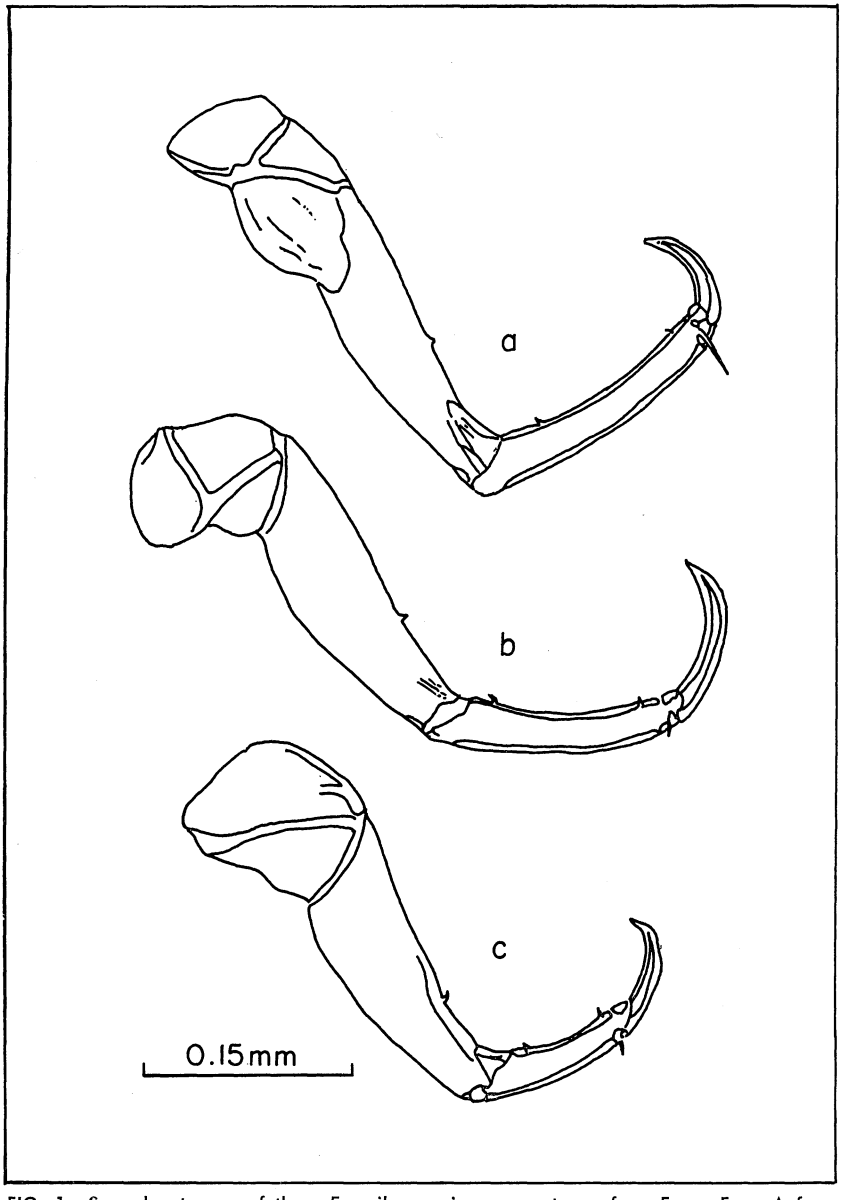

FIG. 1. Second antennae of three *Ergasilus* species: a—antenna from *E.* sp. Form A from gill rakers of *Mugil cephalus* from shore waters, Mobile Co., Ala.; b—antenna from *E. lizae* Kroyer from gill filament of *M. cephalus,* same location; c—antenna of *E.* sp. Form B from gill arch of *M. cephalus* from Intracoastal Waterway, Baldwin, Co., Ala.

in his description. It is suspected that *E. arthrosis* will eventually be shown to be part of a polytypic species of *E. sieboldi* or perhaps a member of a closely related species complex. As for now, *E. arthrosis* will be considered as a legitimate species.

Roberts *(78)* described *E. arthrosis* from paratype material of *E. versicolor* Wilson, 1911. Roberts was able to show that Wilson had inadvertently based his description of *E. versicolor* on both holotype and paratype material and as a result characters of both animals were given in the description. Apparently misled by his own error, Wilson described a second species, *E. elegans,* that was actually the same as the *E. versicolor* holotype. Roberts *(78)* recognized the mistake, erected a new species, *E. arthrosis,* for the *E. versicolor* paratype material, and synonymized *E. elegans* with *E. versicolor.* It is of primary importance here to point out that after Wilson *(99)* and prior to Roberts *(78)* there was confusion regarding the taxonomy of these species and as a result species reported as *E. versicolor* and *E. elegans* must be regarded as questionable.

A similar period of possible misinterpretation may be attributed to *E. caeruleus* Wilson, 1911. Mueller *(68)* synonymized *E. skrjabini* Mueller, 1936 and *E. confusus* Bere, 1931 with *E. caeruleus.* It was later shown by Roberts *(76)* that *E. skrjabini* and *E. confusus* were actually synonyms of *E. luciopercarum* Henderson, 1926. As above, species reported under these taxa must be considered with caution.

Roberts *(80)* reported a species of *Ergasilus* as *E. lizae* (?) from *Lepomis auritus, L. gibbosus, Perca flavescens, Esox niger,* and *Salmo salar.* The report of this species is not well defined and it is assumed that this record will be given further attention by Roberts. Since there is uncertainty about the taxonomic status of the species that are close to *E. lizae,* this record will not be given further attention in the present work to prevent confusion.

Thomsen *(88)* described a species of *Ergasilus* from South America as *E. elongatus.* This was shown to be a homonym by Yamaguti *(106)* and was given the new name of *E. thomseni.* Johnson and Rogers *(51)* later considered *E. thomseni* a junior synonym of *E. felichthys* (Pearse).

METHODS AND MATERIALS

Drainage basins selected for study are shown in Figure 2. Some of the larger basins were divided and the parts studied as

separate drainage units. An attempt was made to study samples of all representative fish species of each drainage unit. Gill material samples were obtained primarily from fish specimens stored in ichthyological museums supplemented with material from personal fish collections. Gill samples were removed from the right side of the fish specimens by removal of all right gill arches. The gill material was placed in 3 × 4 inch zip lip plastic bags partially filled with 5 per cent formalin. Collection data for the fish were recorded, the bag was numbered, and the gill material saved for future examination.

Upon examination, each gill arch was thoroughly searched front and back and between the gill filaments with the aid of a dissecting microscope. When ergasilids were found, observations on location and pathology were noted and the specimens were removed and placed in glass vials filled with 5 per cent formalin. The 6,965 fish that were treated in this fashion are summarized on pages 9-28. Additional materials from outside of the primary study area were accumulated during the investigation and are also presented as part of these data.

For counting and identification, the copepod specimens were studied as wet mounts in lactic acid or as permanent preparations mounted in Hoyer's medium or in glycerin gel by the method of Johnson *(49)*. Phase microscopy proved particularly helpful and was used throughout the study.

Host names and other taxa were reconciled with currently accepted nomenclature by following American Fisheries Society, Committee on Names of Fishes *(1)*. The sequence of family presentation follows Greenwood, Rosen, Weitzman, and Myers *(37)*, and with the exceptions of retaining Elassomidae and Eleotridae, the taxa are followed as well. Genera and species are arranged alphabetically.

Most of the ergasilid material has been retained by the author but representative samples of representative species have been deposited in the following museums: British Museum, London; U.S.S.R. Zoological Institute, Leningrad; and U.S. National Museum Helminthological Collection, Beltsville.

Localities and Numbers of Fish Materials

Following the species name in this listing, numerical representations of data are presented as follows: number of specimens

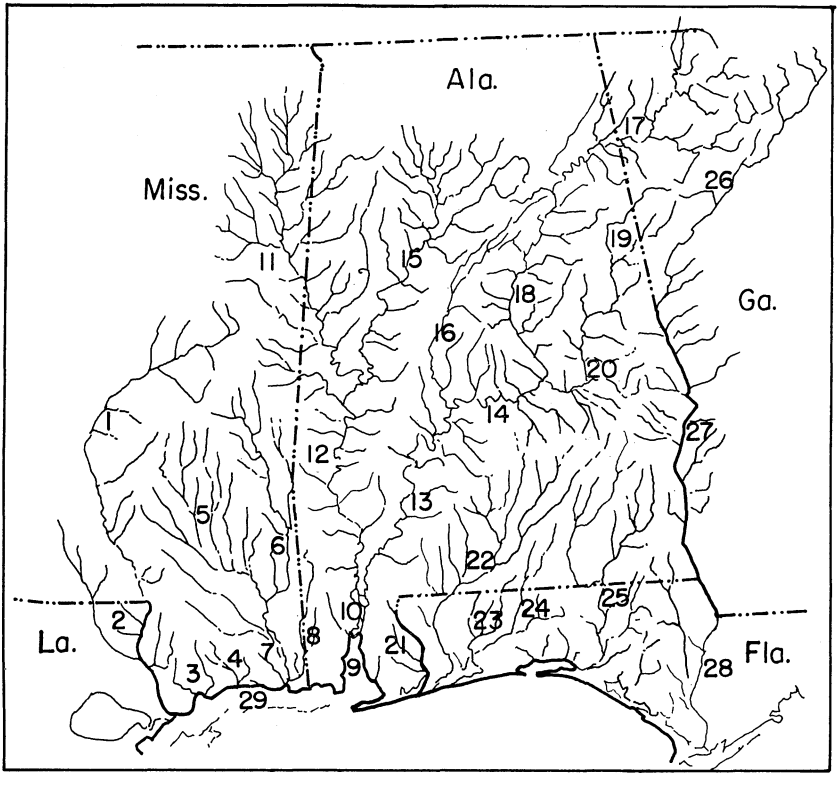

FIG. 2. Drainages sampled: 1—Upper Pearl R.; 2—Lower Pearl R.; 3—Bay St. Louis; 4—Biloxi Bay; 5—Leaf R.; 6—Chickasawhay R.; 7—Pascagoula R.; 8—Escatawpa R.; 9—Mobile Bay; 10—Mobile-Tensaw R.; 11—Upper Tombigbee R.; 12—Lower Tombigbee R.; 13—Lower Alabama R.; 14—Upper Alabama R.; 15—Black Warrior R.; 16—Cahaba R.; 17—Upper Coosa R.; 18—Lower Coosa R.; 19—Upper Tallapoosa R.; 20—Lower Tallapoosa R.; 21—Perdido R.; 22—Escambia R.; 23—Blackwater R.; 24—Yellow R.; 25—Choctawhatchee R.; 26—Upper Chattahoochee R.; 27—Lower Chattahoochee R.; 28—Appalachicola R.; 29—Mississippi Sound.

examined within a drainage, dash, number of localities examined within that drainage, and within parentheses, the number of the drainage as that shown on Figure 2. Lettering: TN – total number of specimens examined; TL – total number of localities examined; NP – number of specimens positive; LP – number of localities positive.

ACIPENSERIDAE

Scaphirhynchus platorynchus. 1–1(13), TN–1, TL–1, NP–0, LP–0.

Acipenser oxyrhynchus. 1–1(1), 2–2(2), 1–1(10), 1–1(11), 1–1(13), TN–6, TL–6, NP–0, LP–0.

POLYODONTIDAE

Polyodon spathula. 1–1(1), 1–1(2), 1–1(12), 1–1(20), TN–4, TL–4, NP–1, LP–1.

LEPISOSTEIDAE

Lepisosteus oculatus. 2–2(1), 1–1(4), 1–1(5), 1–1(6), 1–1(7), 2–1(11), 1–1(15), 2–1(18), 1–1(20), 1–1(23), 1–1(25), TN–14, TL–12, NP–0, LP–0.

L. osseus. 1–1(8), 1–1(9), 1–1(11), 3–2(15), 2–1(18), TN–8, TL–6, NP–1, LP–1.

AMIIDAE

Amia calva. 2–2(1), 1–1(3), 1–1(5), 1–1(8), 1–1(11), 3–2(15), 1–1(22), 1–1(25), 2–1(27), TN–13, TL–11, NP–0, LP–0.

ELOPIDAE

Elops saurus. 3–2(9), TN–3, TL–2, NP–0, LP–0.

ANGUILLIDAE

Anguilla rostrata. 1–1(1), 1–1(2), 2–2(3), 5–4(5), 3–3(6), 3–3(7), 1–1(8), 1–1(9), 1–1(10), 2–1(15), 1–1(16), 1–1(18), 1–1(20), 4–3(25), 1–1(27), TN–28, TL–25, NP–10, LP–8.

CLUPEIDAE

Alosa alabamae. 2–1(10), 2–1(16), TN–4, TL–2, NP–0, LP–0.

A. chrysochloris. 1–1(1), 2–2(2), 2–2(5), 5–3(6), 2–2(9), 4–1(10), 4–2(11), 6–2(12), 1–1(15) 2–1(16), 2–1(18), 3–1(24), 3–1(25), 1–1(27), TN–38, TL–21, NP–4, LP–1.

Brevoortia patronus. 1–1(10), 3–1(23), 1–1(25), TN–5, TL–3, NP–0, LP–0.

Dorosoma cepedianum. 7–4(1), 3–2(2), 1–1(3), 2–2(5), 1–1(6), 1–1(10), 4–2(11), 2–1(12), 4–2(15), 3–1(16), 13–4(20), 3–3(22), 2–1(25), 2–1(26), 6–2(27), TN–54, TL–28, NP–1, LP–1.

D. petenense. 4–3(1), 2–2(3), 2–1(8), 7–3(9), 1–1(10), 6–2(12), 3–1(15), 4–2(18), 5–2(20), 2–1(23), 3–1(25), 3–1(26), 6–2(27), TN–48, TL–22, NP–1, LP–1.

ENGRAULIDAE

Anchoa mitchilli. 2–1(2), 5–3(3), 6–2(9), 4–1(10), 3–1(12), 2–1(28), TN–22, TL–9, NP–0, LP–0.

A. hepsetus. 4–2(9), 7–2(29), TN–11, TL–4, NP–0, LP–0.

HIODONTIDAE

Hiodon tergisus. 5–1(1), 2–1(3), 2–1(6), 3–2(11), 3–1(12), 2–1(15), 3–2(16), TN–20, TL–9, NP–1, LP–1.

ESOCIDAE

Esox americanus. 1–1(1), 2–2(2), 7–4(3), 1–1(4), 5–5(5), 1–1(6), 6–4(7), 1–1(8), 1–1(9), 2–1(10), 4–3(11), 3–2(12), 1–1(13), 1–1(14), 3–2(15), 3–2(16), 3–2(18), 3–2(20), 2–1(21), 4–2(22), 1–1(23), 2–1(24), 5–3(25), 4–2(26), 4–3(27), 1–1(28), TN–71, TL–50, NP–3, LP–3.

E. niger. 2–2(1), 1–1(3), 3–2(5), 1–1(6), 2–2(7), 1–1(8), 1–1(10), 3–2(11), 1–1(12), 1–1(13), 1–1(14), 2–1(15), 1–1(17), 1–1(18), 1–1(20), 1–1(21), 1–1(22), 1–1(23), 1–1(25), 1–1(26), 2–2(27), TN–29, TL–26, NP–2, LP–2.

CYPRINIDAE

Cyprinus carpio. 4–2(27), TN–4, TL–2, NP–0, LP–0.

Campostoma anomalum. 10–4(11), 7–3(12), 3–1(13), 3–1(14), 6–2(15), 3–1(16), 2–1(17), 4–2(18), 3–1(19), 3–1(20), 2–1(22), 1–1(27), TN–47, TL–19, NP–1, LP–1.

Ericymba buccata. 3–1(1), 12–5(2), 3–1(4), 1–1(5), 6–4(6), 21–8(7), 5–2(11), 3–1(12), 3–1(13), 3–1(14), 5–2(16), 3–1(18), 7–2(20), 9–3(22), 3–1(24), 9–3(25), 3–1(26), 6–2(27), TN–105, TL–40, NP–0, LP–0.

Hemitremia flammea. 3–1(17), TN–3, TL–1, NP–0, LP–0.

Hybognathus hayi. 5–2(1), 4–2(11), 4–2(15), 2–1(20), TN–15, TL–7, NP–0, LP–0.

H. nuchalis. 2–1(1), 1–1(5), 4–1(6), 4–1(10), 6–2(11), 12–4(12), 3–1(13), 1–1(14), 1–1(15), 3–1(16), 2–1(20), TN–39, TL–15, NP–2, LP–2.

Hybopsis aestivalis. 8–2(5), 3–1(6), 9–3(11), 3–1(12), 4–2(16), 1–1(19), 2–1(20), 9–3(22), TN–39, TL–14, NP–0, LP–0.

H. amplops. 3–2(1), 2–1(3), 3–1(4), 8–2(5), 3–1(6), 4–2(7), 3–1(11), 3–1(12), 3–1(14), 3–2(15), 1–1(16), TN–36, TL–15, NP–2, LP–1.

H. harperi. 3–2(2), 4–2(5), TN–7, TL–4, NP–0, LP–0.

H. storeriana. 1–1(2), 6–3(5), 10–3(6), 6–3(10), 6–3(11), 8–3(12), 5–2(15), 3–1(16), 3–1(21), TN–48, TL–20, NP–4, LP–3.

H. lineapunctata. 5–2(18), TN–5, TL–2, NP–0, LP–0.

Hybopsis sp. cf. *winchelli* 4–2(21), 4–2(22), 2–1(24), 9–3(25), 3–1(26), 2–1(27), TN–24, TL–10, NP–0, LP–0.

Nocomis leptocephalus. 6–3(1), 2–2(2), 3–1(5), 2–1(6), 11–5(11), 4–2(12), 3–1(13), 4–2(14), 3–1(15), 5–2(16), 2–1(19), 2–1(22), 5–2(26), TN–52, TL–24, NP–3, LP–1.

Notemigonus crysoleucas. 2–1(1), 5–3(3), 6–4(5), 1–1(6), 1–1(7), 2–1(10), 9–3(11), 2–2(12), 3–1(13), 2–1(14), 7–3(15), 3–1(16), 2–2(17), 1–1(18), 3–1(19), 5–3(20), 5–2(22), 1–1(23), 9–4(25), 2–1(26), 2–2(27), TN–73, TL–39, NP–1, LP–1.

Notropis asperifrons. 3–1(15), 2–1(16), 3–1(18), 1–1(19), TN–9, TL–4, NP–0, LP–0.

N. atherinoides. 6–3(1), 11–4(5), 8–2(6), 4–2(7), 3–1(12), 3–1(15), 1–1(16), 1–1(18), 2–1(19), TN–39, TL–16, NP–0, LP–0.

N. baileyi. 5–1(5), 12–4(11), 3–2(12), 4–1(13), 3–1(14), 3–1(15), 7–3(16), 3–1(18), 15–2(20), 3–1(22), 6–2(27), TN–64, TL–19, NP–5, LP–4.

N. bellus. 9–3(11), 4–2(12), 3–1(13), 3–1(14), 6–2(16), 2–1(18), 3–1(19), 15–2(20), TN–45, TL–13, NP–3, LP–1.

N. caeruleus. 2–1(17), 1–1(18), TN–3, TL–2, NP–0, LP–0.

N. callistius. 4–1(14), 8–3(15), 3–1(16), 3–1(17), 2–1(18), 3–1(19), TN–23, TL–8, NP–0, LP–0.

N. callitaenia. 2–1(26), 4–1(27), TN–6, TL–2, NP–0, LP–0.

N. chalybaeus. 3–1(3), 4–2(4), 3–1(10), 2–1(12), 4–1(22), 5–2(26), TN–21, TL–8, NP–0, LP–0.

N. chrosomus. 4–1(15), 6–2(16), 3–1(17), 3–1(18), TN–16, TL–5, NP–0, LP–0.

N. chrysocephalus. 1–1(1), 27–11(2), 2–2(6), 6–3(7), 12–4(11), 7–3(12), 4–1(13), 4–1(14), 6–3(15), 6–2(16), 1–1(17), 3–1(18), 4–1(19), TN–83, TL–34, NP–4, LP–3.

N. cummingsae. 4–1(27), TN–4, TL–1, NP–0, LP–0.

N. emilae. 1–1(1), 1–1(3), 2–2(6), 3–1(7), 5–2(10), 5–2(11), 8–3(12), 3–1(13), 3–1(14), 7–3(15), 3–1(16), 7–3(20), 2–1(22), 3–1(23), 3–1(27), TN–56, TL–24, NP–4, LP–3.

N. euryzonus. 7–2(27), TN–7, TL–2, NP–0, LP–0.

N. gibbsi. 3–1(20), TN–3, TL–1, NP–0, LP–0.

N. hypselopterus. 6–2(9), 6–2(10), 2–1(12), 3–1(13), 9–3(21), 8–4(22), 5–2(23), 6–2(24), 10–3(25), 7–1(27), TN–62, TL–21, NP–0, LP–0.

N. hypsilepis. 7–2(26), 4–1(27), TN–11, TL–3, NP–1, LP–1.

N. lirus. 2–1(14), 2–1(18), TN–4, TL–2, NP–0, LP–0.

N. longirostris. 3–1(1), 4–2(2), 4–2(3), 2–1(4), 13–5(5), 18–7(6), 49–14(7), 2–1(8), 6–2(21), 10–3(22), 6–2(23), 6–2(24), 9–3(25), 3–1(26), 6–2(27), TN–141, TL–48, NP–3, LP–1.

N. edwardraneyi. 6–2(11), 6–2(12), 3–1(14), 7–2(15), 4–1(16), 6–2(20), TN–32, TL–10, NP–1, LP–1.

N. manculatus. 3–1(2), 3–2(10), 2–1(15), 1–1(23), 5–2(25), 1–1(27), TN–15, TL–8, NP–0, LP–0.

N. petersoni. 3–1(10), 6–2(23), 2–2(24), 3–1(25), 3–1(28), TN–17, TL–7, NP–0, LP–0.

N. roseipinnis. 6–2(1), 14–6(2), 3–1(3), 7–2(4), 39–14(5), 30–10(6), 37–12(7), 6–2(8), 2–1(9), 2–1(10), TN–146, TL–51, NP–5, LP–2.

N. shumardi. 6–2(10), 6–2(11), 3–1(15), TN–15, TL–5, NP–0, LP–0.

N. signipinnis. 3–1(2), 3–1(3), 8–3(4), 7–3(5), 12–4(7), 9–3(8), 3–1(9), 3–1(10), 4–2(11), 1–1(13), 6–2(21), 6–2(22), 6–2(23), 6–2(24), 6–2(25), TN–83, TL–30, NP–0, LP–0.

N. stilbius. 7–3(11), 5–2(12), 9–3(15), 3–1(16), 3–1(17), 2–1(18), 3–1(19), 1–1(20), TN–33, TL–13, NP–0, LP–0.

N. texanus. 2–2(1), 11–4(2), 5–2(3), 5–2(4), 33–14(5), 14–6(6), 24–8(7), 5–3(8), 3–1(10), 9–3(11), 10–4(12), 3–1(13), 3–1(14), 3–1(15), 3–1(16), 5–2(20), 6–2(21), 7–2(22), 6–2(23), 3–1(24), 11–4(25), 3–1(26), 7–2(27), TN–181, TL–69, NP–15, LP–9.

N. trichroistius. 3–1(14), 3–1(16), 2–1(17), 7–3(18), TN–15, TL–6, NP–0, LP–0.

N. uranoscopus. 2–1(16), 3–1(20), TN–5, TL–2, NP–0, LP–0.

N. venustus. 3–1(1), 27–9(2), 8–3(3), 6–2(4), 13–5(5), 27–11(6), 24–11(7), 2–1(8), 3–1(10), 9–3(11), 6–2(12), 3–1(13), 3–1(14), 9–3(15), 3–1(16), 2–1(17), 3–1(18), 3–1(19), 5–3(20), 3–1(21), 9–3(22), 4–2(23), 5–2(24),

11–4(25), 3–1(26), 3–1(27), TN–197, TL–75, NP–7, LP–3.

N. volucellus. 3–1(2), 6–2(11), 4–2(12), 3–1(13), 3–1(14), 2–1(15), 3–1(16), 3–1(17), 3–1(20), TN–30, TL–11, NP–0, LP–0.

N. welaka. 3–1(2), 7–4(7), TN–10, TL–5, NP–0, LP–0.

N. xaenocephalus. 3–1(16), 3–1(17), 3–1(18), 3–1(20), TN–12, TL–4, NP–0, LP–0.

N. zonistius. 5–2(26), 4–2(27), TN–9, TL–4, NP–1, LP–1.

Notropis sp. cf. *bellus.* 3–1(15), 2–1(26), 2–1(27), TN–7, TL–3, NP–0, LP–0.

Notropis sp. cf. *longirostris.* 11–4(11), 6–3(12), 3–1(13), 3–1(14), 4–2(15), 4–2(16), 2–1(19), 6–2(20), 2–1(22), TN–41, TL–17, NP–0, LP–0.

Phenacobius catostomus. 3–1(16), 3–1(18), 1–1(19), TN–7, TL–3, NP–0, LP–0.

Pimephales notatus. 2–2(1), 1–1(5), 1–1(6), 9–3(11), 4–2(12), 3–1(13), 3–1(14), 5–2(15), 1–1(16), 3–1(21), TN–32, TL–15, NP–0, LP–0.

P. promelas. 3–1(21), TN–3, TL–1, NP–0, LP–0.

P. vigilax. 3–2(1), 15–6(5), 8–2(6), 3–1(7), 9–3(11), 3–1(12), 2–1(13), 3–1(14), 3–1(15), 3–1(16), 2–1(18), 6–2(19), 3–1(20), TN–63, TL–23, NP–4, LP–2.

Rhinichthys atratulus. 5–2(17), 3–1(18), TN–8, TL–3, NP–0, LP–0.

Semotilus atromaculatus. 4–2(1), 1–1(6), 12–5(11), 1–1(12), 3–1(13), 3–1(14), 9–3(15), 3–1(16), 6–2(17), 6–3(18), 1–1(19), 6–2(20), 6–2(22), TN–61, TL–25, NP–8, LP–4.

CATOSTOMIDAE

Carpiodes sp. 2–1(5), 6–2(6), 2–1(16), 1–1(22), 6–2(25), TN–17, TL–7, NP–0, LP–0.

C. cyprinus. 2–1(10), 2–2(11), TN–4, TL–3, NP–0, LP–0.

C. velifer. 2–1(1), 2–1(6), 12–4(11), 1–1(14), 2–2(15), 6–3(16), 1–1(20), 3–1(22), TN–29, TL–14, NP–0, LP–0.

C. elongatus. 3–1(1), 1–1(11), 1–1(16), TN–5, TL–3, NP–0, LP–0.

Erimyzon oblongus. 2–1(1), 1–1(6), 1–1(8), 5–3(11), 5–3(15), 2–1(18), 2–1(20), 1–1(26), TN–19, TL–12, NP–2, LP–2.

E. sucetta. 3–2(1), 5–5(2), 6–3(3), 1–1(4), 1–1(5), 3–3(6), 4–3(7), 2–1(10), 6–5(11), 4–3(12), 1–1(15), 1–1(16), 3–2(20), 1–1(22), 11–5(25), 2–1(27), 1–1(28),

TN–55, TL–39, NP–5, LP–4.

E. tenuis. 4–1(2), 5–3(3), 1–1(4), 9–6(5), 1–1(6), 15–8(7), 9–4(8), 7–3(9), 5–2(10), 3–2(11), 7–3(12), 3–1(13), 2–1(14), 4–2(16), 8–3(21), 3–1(23), 6–2(24), 4–2(25), TN–96, TL–46, NP–4, LP–4.

Hypentelium etowanum. 9–6(11), 4–2(12), 3–1(13), 10–4(15), 5–2(16), 4–2(17), 3–1(18), 3–2(19), 1–1(20), TN–42, TL–21, NP–1, LP–1.

H. nigricans. 11–6(2), 4–2(3), 1–1(4), 6–5(5), 8–7(6), 26–15(7), TN–56, TL–36, NP–3, LP–3.

Ictiobus bubalus. 1–1(2), 3–1(6), 5–3(11), 1–1(16), 2–2(18), TN–12, TL–8, NP–1, LP–1.

Minytema melanops. 1–1(1), 1–1(2), 1–1(3), 1–1(4), 9–7(5), 1–1(6), 1–1(8), 7–3(11), 1–1(14), 2–2(15), 1–1(16), 1–1(17), 2–2(18), 2–1(19), 2–2(20), 1–1(21), 2–1(22), 4–2(23), 3–1(24), 4–2(25), 2–1(26), 9–2(27), TN–58, TL–36, NP–10, LP–6.

Moxostoma carinatum. 1–1(2), 1–1(6), 1–1(15), 2–1(16), TN–5, TL–4, NP–0, LP–0.

M. duquesnei. 3–2(15), 1–1(16), 2–2(17), 3–2(18), 1–1(19), TN–10, TL–8, NP–0, LP–0.

M. erythrurum. 2–1(11), 1–1(13), 2–1(14), 3–2(15), 1–1(16), 1–1(17), 1–1(19), 1–1(20), TN–12, TL–9, NP–0, LP–0.

M. lachneri. 1–1(26), 1–1(27), TN–2, TL–2, NP–0, LP–0.

M. poecilurum. 2–2(1), 2–1(2), 4–3(3), 2–1(4), 12–9(5), 3–3(7), 4–2(8), 2–2(11), 2–1(12), 1–1(13), 2–1(14), 5–4(15), 5–3(16), 2–2(18), 2–2(19), 1–1(20), 3–2(21), 2–2(22), 1–1(23), 5–2(24), 6–4(25), TN–68, TL–49, NP–4, LP–3.

Moxostoma sp. cf. *poecilurum.* 1–1(26), 7–3(27), TN–8, TL–4, NP–7, LP–3.

ICTALURIDAE

Ictalurus brunneus. 3–1(26), 3–1(27), TN–6, TL–2, NP–2, LP–1.

I. catus. 1–1(27), TN–1, TL–1, NP–0, LP–0.

I. furcatus. 1–1(3), 3–1(9), 2–1(10), 2–1(11), 1–1(15), 6–2(18), TN–15, TL–7, NP–4, LP–3.

I. melas. 2–1(1), 1–1(2), 1–1(3), 2–1(5), 1–1(6), 3–3(11), 1–1(12), 2–1(13), 3–1(15), 3–1(16), 1–1(17), 1–1(19), 1–1(20), 3–2(25), TN–25, TL–17, NP–1, LP–1.

I. natalis. 1–1(1), 1–1(2), 3–2(3), 1–1(4), 8–3(5), 2–2(7), 3–2(11), 1–1(12), 1–1(13), 2–2(15), 3–1(16), 1–1(17), 1–1(18), 3–2(19), 1–1(20), 3–1(21), 1–2(23), 2–2(24), 8–5(25), 1–1(26), 1–1(27), 1–1(28), TN–49, TL–35, NP–3, LP–3.

I. nebulosus. 1–1(2), 1–1(4), 3–2(19), 5–3(25), 2–1(26), 4–2(27), TN–16, TL–10, NP–7, LP–6.

I. platycephalus. 2–1(26), TN–2, TL–1.

I. punctatus. 1–1(1), 2–1(2), 5–3(3), 1–1(4), 5–3(5), 6–5(6), 2–2(7), 6–3(10), 9–3(11), 5–3(12), 1–1(13), 1–1(14), 8–4(15), 7–3(16), 6–3(18), 1–1(19), 2–2(20), 1–1(22), 1–1(23), 5–2(24), 1–1(25), 3–1(26), 2–2(27), TN–81, TL–48, NP–15, LP–10.

Noturus sp. 8–6(5), TN–8, TL–6, NP–0, LP–0.

N. funebris. 3–2(2), 2–1(3), 1–1(4), 1–1(5), 1–1(6), 10–5(7), 2–2(8), 3–1(9), 1–1(10), 6–3(11), 4–2(12), 3–1(13), 3–1(14), 6–2(15), 4–3(16), 2–2(19), 1–1(21), 2–1(22), 3–1(23), 3–1(25), TN–61, TL–33, NP–0, LP–0.

N. gyrinus. 2–1(3), 1–1(4), 5–3(5), 3–1(6), 2–1(7), 4–2(8), 7–6(11), 1–1(12), 2–1(14), 8–3(15), 3–1(20), 3–2(25), TN–41, TL–23, NP–0, LP–0.

N. leptacanthus. 2–2(2), 9–3(3), 3–2(4), 8–3(6), 9–5(7), 4–2(8), 8–3(11), 2–1(12), 2–1(13), 4–2(15), 5–3(16), 2–1(20), 1–1(21), 3–1(22), 2–1(23), 6–2(24), 4–2(25), 3–1(26), 9–3(27), TN–86, TL–39, NP–0, LP–0.

N. miurus. 7–5(2), 1–1(2), TN–8, TL–6, NP–0, LP–0.

N. munitus. 9–3(11), 3–1(12), 1–1(16), TN–13, TL–5, NP–0, LP–0.

N. nocturnus. 2–1(1), 6–3(4), 10–5(6), 5–3(7), 2–1(13), 2–2(16), TN–27, TL–15, NP–1, LP–1.

Pylodictis olivaris. 1–1(1), 5–2(4), 3–3(5), 2–1(6), 1–1(7), 1–1(8), 1–1(11), 1–1(12), 5–2(15), 1–1(16), 2–1(18), 3–2(19), TN–26, TL–17, NP–4, LP–2.

ARIIDAE

Bagre marinus. 1–1(3), 2–2(9), 2–1(29), TN–5, TL–4, NP–6, LP–5.

Arius felis. 2–1(3), 6–2(9), 3–1(22), 6–2(29), TN–17, TL–6, NP–0, LP–0.

AMBLYOPSIDAE

Typhlichthys subterraneus. see text, NP–0, LP–0.

APHREDODERIDAE

Aphredoderus sayanus. 5–2(1), 6–2(2), 7–5(3), 8–8(5), 8–3(6), 5–5(7), 3–2(8), 3–1(10), 7–3(11), 2–1(13), 2–1(14), 5–2(15), 1–1(16), 2–1(20), 4–2(22), 5–2(23), 2–2(24), 5–3(25), 1–1(27), TN–81, TL–47, NP–5, LP–5.

BELONIDAE

Strongylura marina. 1–1(2), 2–1(3), 1–1(6), 1–1(7), 6–2(9), 1–1(15), 1–1(20), 4–2(22), 2–1(25), 1–1(28), 2–1(29), TN–22, TL–13, NP–0, LP–0.

CYPRINODONTIDAE

Cyprinodon variegatus. 3–1(7), 12–4(9), 4–1(10), 5–1(21), 21–7(22), 1–1(28), TN–46, TL–15, NP–8, LP–4.

Fundulus chrysotus. 4–2(3), 2–1(10), 2–1(21), 4–2(23), 7–2(25), 3–1(28), TN–22, TL–9, NP–0, LP–0.

F. cingulatus. 3–1(9), 2–1(10), 3–1(23), 2–1(24), 11–4(25), TN–21, TL–8, NP–0, LP–0.

F. confluentus. 3–1(9), 5–2(10), 6–2(21), TN–14, TL–5, NP–0, LP–0.

F. grandis. 3–2(3), 9–3(7), 4–2(9), 1–1(10), 3–1(21), 3–1(22), 2–1(28), 2–1(29), TN–27, TL–12, NP–7, LP–6.

F. notatus. 6–3(11), TN–6, TL–3, NP–0, LP–0.

F. notti. 1–1(2), 2–1(3), 5–2(4), 3–1(5), 3–2(6), 20–8(7), 2–1(8), 3–1(9), 3–1(10), 6–2(11), 6–2(12), 3–1(13), 1–1(14), 3–1(15), 1–1(16), 3–1(21), 3–1(22), 6–2(23), 3–2(24), 3–1(25), 1–1(27), TN–81, TL–34, NP–0, LP–0.

F. olivaceus. 6–5(2), 15–6(3), 6–2(4), 44–19(5), 13–6(6), 59–21(7), 3–1(8), 3–1(10), 11–5(11), 10–4(12), 3–1(13), 3–1(14), 7–3(15), 9–3(16), 2–1(17), 3–1(18), 1–1(20), 1–1(21), 6–2(22), 3–1(23), 6–2(24), 3–1(25), 7–2(27), TN–224, TL–90, NP–2, LP–2.

F. pulvereus. 6–1(3), 2–1(7), TN–8, TL–2, NP–1, LP–1.

F. similis. 1–1(3), 2–1(7), 7–2(9), 9–3(23), 4–1(28), 5–2(29), TN–28, TL–10, NP–8, LP–5.

F. stellifer. 2–1(13), 4–1(14), 2–1(16), 3–1(17), 3–1(18), 3–2(19), 2–1(20), 3–1(26), TN–22, TL–9, NP–0, LP–0.

Leptolucania ommata. 1–1(22), 8–3(23), 2–1(25), TN–11, TL–5, NP–0, LP–0.

Lucania parva. 3–2(4), 5–1(9), 6–2(10), 3–1(22), 6–2(23), 1–1(25), 6–2(28), TN–30, TL–11, NP–4, LP–3.

Adinia xenica. 2–1(9), 3–2(22), 2–1(29), TN–7, TL–4.

POECILIDAE

Gambusia affinis. 2–1(1), 2–1(2), 13–5(3), 15–6(5), 3–2(6), 18–9(7), 3–1(8), 5–2(9), 6–3(10), 9–3(11), 6–2(12), 3–1(13), 3–1(14), 12–4(15), 6–2(16), 5–2(17), 3–1(18), 4–2(20), 1–1(21), 8–3(22), 3–1(23), 3–1(24), 7–3(25), 3–1(26), 3–1(27), 2–2(28), TN–148, TL–61, NP–1, LP–1.

Heterandria formosa. 9–3(3), 3–1(4), 5–2(25), 3–1(28), TN–20, TL–7, NP–0, LP–0.

Poecilia latipinna. 1–1(3), 3–1(4), 6–2(7), 8–3(9), 3–1(10), 6–2(22), 4–1(28), 3–1(29), TN–34, TL–12, NP–6, LP–5.

ATHERINIDAE

Labidesthes sicculus. 3–1(1), 5–2(2), 5–3(3), 5–2(4), 5–2(5), 3–1(6), 16–7(7), 3–2(8), 3–2(10), 6–2(11), 3–1(12), 3–1(13), 7–3(15), 2–1(16), 2–1(20), 5–2(21), 4–1(22), 4–1(23), 3–1(24), 10–4(25), 6–2(27), TN–103, TL–42, NP–1, LP–1.

Menidia audens. 2–1(2), 4–2(3), 1–1(9), TN–7, TL–4, NP–0, LP–0.

M. beryllina. 3–1(3), 3–1(7), 6–2(9), 6–2(10), 4–1(22), 6–2(23), 3–1(25), 4–1(28), TN–35, TL–11, NP–8, LP–3.

COTTIDAE

Cottus carolinae. 2–1(12), 3–1(13), 3–1(14), 3–1(15), 3–1(16), 6–2(17), 3–1(18), 4–2(19), 1–1(20), TN–28, TL–11, NP–0, LP–0.

C. pygmaeus. 3–1(17), TN–3, TL–1, NP–0, LP–0.

SYNGNATHIDAE

Syngnathus louisianae. 4–2(4), TN–4, TL–2, NP–0, LP–0.

Syngnathus sp. 1–1(7), 1–1(28), 2–1(29), TN–4, TL–3, NP–0, LP–0.

PERCICHTHYIDAE

Morone chrysops. 1–1(15), 3–2(18), 2–1(19), 2–1(27), TN–8, TL–5, NP–1 ,LP–1.

M. mississippiensis. 1–1(3), 1–1(7), 1–1(10), TN–3, TL–3, NP–2, LP–2.

M. saxatilis. 3–2(10), TN–3, TL–2, NP–1, LP–1.

ELASSOMIDAE

Elassoma evergladei. 3–1(9), 2–1(13), 1–1(21), 1–1(24), 2–1(25), TN–9, TL–5, NP–0, LP–0.

E. okefenokee. 6–2(25), TN–6, TL–2, NP–0, LP–0.

E. zonatum. 3–1(1), 2–1(2), 6–4(3), 4–2(4), 6–4(5), 1–1(6), 10–5(7), 8–4(8), 2–1(10), 6–2(11), 6–2(12), 2–1(13), 1–1(14), 5–2(15), 3–1(16), 3–1(20), 5–2(21), 3–1(22), 2–1(23), 1–1(24), 5–2(25), 3–1(27), TN–87, TL–41, NP–0, LP–0.

CENTRARCHIDAE

Ambloplitis rupestris. 3–1(1), 2–2(2), 3–3(3), 2–2(4), 1–1(5), 5–4(6), 2–2(7), 4–2(8), 5–3(11), 2–1(13), 1–1(14), 3–2(15), 5–2(16), 1–1(19), 1–1(20), 1–1(21), 3–2(22), 1–1(23), 3–1(24), 5–2(25), TN–53, TL–35, NP–0, LP–0.

Centrarchus macropterus. 2–1(1), 1–1(2), 5–4(5), 1–1(6), 2–1(7), 2–2(11), 1–1(13), 3–1(15), 1–1(20), 3–1(22), 7–4(25), 3–1(27), TN–31, TL–19, NP–4, LP–4.

Enneacanthus gloriosus. 3–1(10), 1–1(21), 3–1(23), 3–1(25), TN–10, TL–4, NP–0, LP–0.

Lepomis auritus. 1–1(1), 3–3(5), 7–6(7), 4–2(19), 1–1(20), 3–1(26), 7–2(27), 2–1(28), TN–28, TL–17, NP–5, LP–2.

L. cyanellus. 5–5(1), 3–3(2), 3–2(3), 1–1(4), 19–9(5), 1–1(6), 6–3(7), 4–3(11), 1–1(12), 2–1(13), 3–1(14), 10–4(15), 2–1(16), 6–3(17), 3–2(18), 1–1(19), 1–1(22), 3–1(25), 3–1(26), 2–1(27), TN–79, TL–45, NP–6, LP–4.

L. gulosus. 1–1(1), 2–2(2), 11–6(3), 1–1(4), 12–10(5), 4–3(6), 2–7(7), 2–1(8), 2–1(9), 2–1(10), 5–4(11), 2–1(13), 2–1(14), 6–3(15), 1–1(17), 1–1(18), 3–2(19), 2–2(20), 1–1(21), 2–1(22), 2–1(23), 2–2(24), 13–4(25), 2–1(26), 1–1(27), 1–1(28), TN–85, TL–60, NP–9, LP–8.

L. humilis. 3–1(11), 1–1(14), 1–1(15), TN–5, TL–3, NP–0, LP–0.

L. macrochirus. 4–3(1), 12–7(2), 14–8(3), 6–2(4), 21–12(5), 8–5(6), 16–12(7), 4–2(8), 11–3(9), 3–1(10), 12–6(11), 3–1(12), 3–1(13), 3–1(14), 11–4(15), 4–2(16), 6–2(17), 3–1(19), 2–1(20), 5–2(21), 4–1(22), 4–2(23), 5–2(24), 15–3(25), 2–1(26), 4–2(27), 1–1(28), TN–186, TL–88, NP–34, LP–17.

L. marginatus. 1–1(3), 1–1(4), 6–2(5), 2–2(7), 1–1(8), 2–1(9), 2–1(12), 3–1(13), 2–1(15), 3–1(21), 1–1(22),

4–2(23), 1–1(24), 3–1(25), 2–1(27), TN–34, TL–18, NP–7, LP–3.

L. megalotis. 3–2(1), 4–3(2), 14–7(3), 6–2(4), 33–16(5), 7–4(6), 23–13(7), 4–3(8), 9–3(11), 3–2(12), 3–1(13), 2–1(14), 2–1(15), 6–3(16), 2–1(17), 4–2(18), 2–1(19), 2–2(20), 3–2(21), 5–2(22), 3–2(23), 4–3(24), 6–3(25), 1–1(26), 2–1(27), 2–1(28), TN–155, TL–82, NP–15, LP–10.

L. microlophus. 2–1(1), 2–2(3), 5–3(5), 1–1(7), 5–1(9), 4–2(10), 3–3(11), 1–1(12), 2–2(14), 5–4(15), 2–1(16), 1–1(17), 1–1(18), 2–1(20), 2–2(22), 5–2(23), 11–2(25), 1–1(26), 7–3(27), TN–62, TL–34, NP–13, LP–10.

L. punctatus. 2–2(2), 3–2(3), 4–3(4), 7–6(5), 2–1(6), 5–3(7), 5–2(8), 4–1(10), 4–2(11), 4–3(12), 2–1(13), 3–1(14), 3–2(15), 1–1(16), 3–2(20), 2–1(21), 5–2(23), 3–2(24), 9–3(25), 3–1(26), 3–1(27), 7–2(28), TN–84, TL–44, NP–22, LP–17.

Micropterus coosae. 6–4(15), 2–1(16), 2–2(17), 1–1(18), 2–2(19), 1–1(20), 1–1(26), TN–15, TL–12, NP–0, LP–0.

M. punctulatus. 3–1(1), 6–5(2), 7–4(3), 3–1(4), 15–11(5), 15–8(6), 16–11(7), 1–1(8), 3–1(11), 8–4(12), 2–1(13), 5–3(15), 6–2(16), 2–1(17), 1–1(18), 4–2(19), 4–2(20), 2–1(21), 4–2(23), 4–3(24), 6–3(25), TN–117, TL–68, NP–10, LP–8.

M. salmoides. 1–1(1), 2–2(2), 5–4(3), 1–1(4), 8–8(5), 3–2(6), 3–2(7), 5–3(8), 6–1(9), 5–2(10), 7–5(11), 3–2(12), 2–1(13), 4–2(14), 5–3(15), 3–1(16), 2–1(17), 9–3(18), 1–1(19), 3–3(20), 5–2(21), 7–5(22), 6–2(23), 1–1(24), 6–2(25), 1–1(26), 5–2(27), TN–109, TL–63, NP–28, LP–16.

Pomoxis annularis. 4–3(1), 1–1(2), 3–3(5), 4–1(9), 5–2(11), 1–1(13), 2–1(14) 3–1(15), 1–1(17), 1–1(19), 2–2(20), 4–1(25), TN–31, TL–18, NP–8, LP–6.

P. nigromaculatus. 2–1(1), 2–2(5), 1–1(6), 4–2(10), 4–2(11), 2–1(14), 4–2(15), 2–1(16), 1–1(17), 2–1(19), 4–3(20), 3–1(22), 1–1(25), 5–2(26), 1–1(27), TN–38, TL–22, NP–6, LP–6.

PERCIDAE

Ammocrypta asprella. 6–2(11), 3–1(16), TN–9, TL–3, NP–0, LP–0.

A. beani. 1–1(1), 4–2(2), 3–2(3), 3–1(4), 1–1(5), 12–6(6), 17–9(7), 5–3(11), 6–2(12), 1–1(14), 2–1(15), 2–1(16), 2–1(20), 6–2(21), 9–3(22), 6–2(23), 6–2(24), 7–3(25),

TN–93, TL–43, NP–0, LP–0.

A. vivax. 2–1(1), 1–1(2), 1–1(4), 2–2(5), 4–2(6), 8–3(11), 6–2(12), 3–1(13), 3–1(14), 1–1(15), 1–1(16), 3–1(20), TN–35, TL–17, NP–0, LP–0.

Etheostoma chlorosomum. 2–1(1), 4–3(5), TN–6, TL–4, NP–0, LP–0.

E. coosae. 6–2(17), 5–2(18), TN–11, TL–4, NP–0, LP–0.

E. davisoni. 2–1(22), 1–1(23), 5–2(26), TN–8, TL–4, NP–0, LP–0.

E. ditrema. 2–1(17), TN–2, TL–1, NP–0, LP–0.

E. edwini. 1–1(21), 1–1(22), 3–1(23), 5–2(24), 5–2(25), 6–2(27), TN–21, TL–9, NP–0, LP–0.

E. fusiforme. 2–1(3), 1–1(4), 1–1(8), 2–1(10), 7–3(12), 1–1(22), 1–1(23), 3–1(25), 3–1(26), TN–21, TL–11, NP–0, LP–0.

E. histrio. 7–3(11), TN–7, TL–3, NP–0, LP–0.

E. jordani. 1–1(14), 8–3(15), 3–1(16), 3–1(17), 2–1(19), TN–17, TL–7, NP–0, LP–0.

E. nigrum. 9–3(11), 2–1(12), 3–1(13), 2–1(14), 1–1(15), 3–1(20), TN–20, TL–8, NP–0, LP–0.

E. nuchale. 2–1(15), TN–2, TL–1, NP–0, LP–0.

E. okaloosae. 6–2(27), TN–6, TL–2, NP–0, LP–0.

E. parvipinne. 1–1(6), 8–3(11), 5–2(12), 1–1(13), 3–2(14), 6–2(15), 3–1(20), 2–1(22), 2–1(25), 1–1(27), TN–32, TL–15, NP–0, LP–0.

E. proeliare. 2–1(1), 1–1(10), 11–4(11), 6–2(12), 2–1(13), 2–1(14), 2–1(15), 1–1(16), TN–27, TL–12, NP–0, LP–0.

E. rupestre. 9–3(11), 3–1(12), 3–1(13), 3–1(14), 6–2(15), 6–2(16), 3–1(20), TN–33, TL–11, NP–0, LP–0.

E. stigmaeum. 1–1(1), 4–1(2), 3–1(3), 6–3(5), 2–1(6), 24–14(7), 1–1(8), 9–4(11), 6–2(12), 3–1(13), 6–2(15), 2–1(16), 3–1(17), 2–1(18), 2–1(20), 1–1(21), 1–1(23), TN–76, TL–37, NP–0, LP–0.

E. swaini. 3–2(2), 5–2(3), 6–2(4), 15–10(5), 1–1(6), 16–8(7), 5–2(8), 1–1(10), 7–4(11), 4–2(12), 1–1(13), 2–1(14), 6–2(15), 6–2(16), 1–1(20), 6–2(22), 2–1(23), 2–2(24), 6–2(25), 2–1(27), TN–97, TL–49, NP–0, LP–0.

E. whipplei. 1–1(1), 1–1(2), 1–1(6), 9–3(11), 8–3(12), 2–1(13), 3–1(14), 6–2(15), 3–1(16), 3–1(18), 2–1(20), TN–39, TL–16, NP–0, LP–0.

E. zonale. 1–1(1), 3–1(2), 5–2(3), 1–1(5), 2–1(6), 5–2(7),

TN–17, TL–8, NP–0, LP–0.

E. zoniferum. 1–1(12), 3–1(14), TN–4, TL–2, NP–0, LP–0.

E. (Ulocentra) sp. 12–4(11), 5–2(12), 3–1(15), 6–2(16), 4–2(22), 6–2(23), 6–2(24), 6–2(25), TN–48, TL–17, NP–0, LP–0.

E. (Ulocentra) sp. 15–2(15), TN–15, TL–2, NP–0, LP–0.

E. (Ulocentra) sp. 6–2(19), TN–6, TL–2, NP–0, LP–0.

Perca flavescens. 3–1(26), 2–1(27), TN–5, TL–2, NP–0, LP–0.

Percina caprodes. 5–2(1), 2–1(3), 1–1(4), 4–2(5), 6–4(6), 3–2(7), 3–1(8), 1–1(11), 11–4(15), 2–1(16), 2–1(17), 3–1(18), 3–1(19), 1–1(20), 1–1(22), 1–1(25), TN–49, TL–25, NP–1, LP–1.

P. copelandi. 3–1(15), 1–1(16), TN–4, TL–2, NP–0, LP–0.

P. lenticula. 3–1(1), 1–1(6), 2–2(16), TN–6, TL–4, NP–0, LP–0.

P. maculata. 1–1(11), 1–1(12), 2–1(15), 1–1(16), TN–5, TL–4, NP–0, LP–0.

P. nigrofasciata. 11–7(2), 5–2(3), 6–2(4), 14–8(5), 15–6(6), 26–13(7), 6–2(8), 2–1(9), 2–1(10), 12–4(11), 3–2(12), 3–1(13), 11–4(15), 3–1(16), 4–2(17), 4–3(18), 12–4(25), 2–1(26), 3–1(27), TN–144, TL–65, NP–4, LP–3.

P. palmaris. 3–1(17), 8–3(19), TN–11, TL–4, NP–0, LP–0.

P. sciera. 3–3(7), 9–3(11), TN–12, TL–6, NP–0, LP–0.

P. shumardi. 5–2(11), 1–1(13), 3–1(15), 1–1(16), TN–10, TL–5, NP–0, LP–0.

P. uranidea. 1–1(1), 2–1(5), 1–1(6), 7–3(11), 1–1(12), 2–1(13), 2–1(22), TN–16, TL–9, NP–0, LP–0.

P. (Alvordius) sp. 3–1(19), TN–3, TL–1, NP–0, LP–0.

Stizostedion vitreum. 1–1(1), 1–1(2), 2–1(15), 1–1(18), TN–5, TL–4, NP–0, LP–0.

CARANGIDAE

Caranx hippos. 1–1(7), 2–1(9), TN–3, TL–2, NP–1, LP–1.

Oligoplites saurus. 3–1(4), 3–2(9), TN–6, TL–3, NP–0, LP–0.

SPARIDAE

Archosargus probatocephalus. 1–1(3), 3–2(4), 1–1(9), 1–1(23), 1–1(29), TN–7, TL–6, NP–0, LP–0.

Lagodon rhomboides. 1–1(3), 1–1(7), 2–1(9), 1–1(21), 4–2(22), 2–1(25), 4–1(28), TN–15, TL–8, NP–1, LP–1.

SCIAENIDAE

Aplodinotus grunniens. 1–1(1), 1–1(2), 4–3(11), 2–2(12), 4–2(16), 1–1(18), 2–2(20), TN–15, TL–12, NP–0, LP–0.

Bairdiella chrysura. 2–1(9), 1–1(29), TN–3, TL–2, NP–0, LP–0.

Cynoscion arenarius. 2–1(9), 1–1(22), TN–3, TL–2, NP–0, LP–0.

C. nebulosus. 1–1(3), 1–1(21), 3–1(29), TN–5, TL–3, NP–0, LP–0.

Leiostomus xanthurus. 2–1(2), 3–1(3), 3–1(7), 5–1(10), 1–1(21), 1–1(23), 1–1(25), 4–1(28), TN–20, TL–8, NP–7, LP–4.

Micropogon undulatus. 4–2(3), 4–1(10), 2–1(22), 1–1(28), TN–11, TL–5, NP–0, LP–0.

Pogonias cromis. 2–1(3), 2–2(9), TN–4, TL–3, NP–1, LP–1.

Sciaenops ocellata. 1–1(3), 1–1(9), TN–2, TL–2, NP–0, LP–0.

MUGILIDAE

Mugil cephalus. 1–1(2), 12–5(3), 1–1(6), 2–2(7), 6–2(9), 4–2(10), 7–2(21), 5–1(22), 1–1(25), 4–1(28), TN–43, TL–18, NP–23, LP–13.

M. curema. 3–1(4), 5–3(9), 2–1(29), TN–10, TL–5, NP–4, LP–4.

ELEOTRIDAE

Dormitator maculatus. 2–1(3), 1–1(10), 1–1(23), TN–4, TL–3, NP–0, LP–0.

Eleotris pisonis. 1–1(4), 1–1(23), 1–1(25), TN–3, TL–3, NP–0, LP–0.

GOBIIDAE

Gobionellus boleosoma. 3–1(9), 3–1(28), TN–6, TL–2, NP–0, LP–0.

G. hastatus. 2–1(21), TN–2, TL–1, NP–0, LP–0.

G. shufeldti. 1–1(9), 4–3(10), TN–5, TL–4, NP–0, LP–0.

G. stigmaticus. 2–1(7), 3–1(28), TN–5, TL–2, NP–0, LP–0.

Gobiosoma bosci. 2–1(9), 2–1(23), 2–2(28), 8–2(29), TN–14, TL–6, NP–3, LP–1.

Microgobius gulosus. 1–1(9), 1–1(28), 3–1(29), TN–5, TL–3, NP–0, LP–0.

BOTHIDAE

Paralichthys lethostigma. 2–2(3), TN–2, TL–2, NP–0, LP–0.

SOLEIDAE

Archirus lineatus. 3–2(2), 1–1(4), 2–1(5), 2–2(6), 1–1(29), TN–9, TL–7, NP–3, LP–2.

Trinectes maculatus. 1–1(3), 1–1(4), 2–1(9), 1–1(25), TN–5, TL–4, NP–0, LP–0.

RESULTS

Parasite Material and Respective Host Information

The following listings give the parasite and the hosts from which the parasite species were recovered. The parentheses following the hosts include an initial number, which represents the number of parasite specimens recovered from a locality, and a following number, which represents the drainage basin of the collection. This latter number corresponds to the number given for the drainage basin in Figure 2.

Ergasilus arthrosis

Ictalurus furcatus (4–9), (5–18); *I. punctatus* (12–16), (1–12), (1–12), (3–12), (2–7), (1–1), (2–20), (26–18), (2–18); *Pylodictis olivaris* (19-18), (16–20); *Aphredoderus sayanus* (1–3); *Labidesthes sicculus* (1–10); *Morone mississippiensis* (15–3), (12–7); *M. saxatilis* (4–10); *Lepomis gulosus* (1–23), (4–10); *L. macrochirus* (16–23), (1–15), (34–9), (2–9), (4–22); *L. marginatus* (28–23), (7–21); *L. megalotis* (5–12); *L. microlophus* (2–12), (5–23), (9–23), (1–10), (7–7), (1–3); *L. punctatus* (8–23), (15–7), (8–7); *Micropterus punctulatus* (5–12), (2–12), (2–11), (1–15); *M. salmoides* (31–23), (9–23), (5–11), (8–12), (1–10), (7–9); *Pomoxis nigromaculatus* (1–10), (2–10); *Percina caprodes* (1–7); *Caranx hippos* (1–7); *Achirus lineatus* (2–10), (5–3).

Ergasilus caeruleus

Aphredoderus sayanus (12–5), (11–7), (2–1), (11–1); *Lepomis auritus* (4–27), (10–27); *L. cyanellus* (3–12), (2–5), (2–6); *L. gulosus* (6–5), (1–5), (8–2), (3–2); *L. macrochirus* (1–14), (5–12), (1–11), (2–22), (8–6), (7–5), (6–5), (1–5), (3–5), (2–27), (2–27); *L. marginatus* (3–14); *L. megalotis*

(1–5), (1–5), (6–5), (3–5), (16–7), (1–6), (6–20); *L. microlophus* (1–5), (1–5); *L. punctatus* (4–20), (2–11), (1–12), (19–16), (4–26), (3–5), (2–5), (3–5), (8–8), (5–7), (7–3), (2–4), (61–27); *Pomoxis annularis* (15–11), (8–11), (1–14), (23–20), (7–20), (4–5); *P. nigromaculatus* (8–20), (4–15), (1–11); *Percina nigrofasciata* (1–5), (6–5), (3–5).

Ergasilus celestis

Anguilla rostrata (4–3), (29–5), (3–5), (24–1), (1–8), (7–20), (1–18), (1–25).

Ergasilus centrarchidarum

Morone chrysops (1–19); *Centrarchus macropterus* (1–27), (4–5), (1–1), (1–27); *Lepomis cyanellus* (2–5); *L. gulosus* (1–15); *L. macrochirus* (6–25), (2–27); *L. punctatus* (2–25); *Micropterus punctulatus* (1–19), (5–19), (2–5), (1–5); *M. salmoides* (7–25), (15–25), (1–11), (5–11), (1–11), (3–5), (22–5), (1–5), (1–27), (4–20), (6–20); *Pomoxis annularis* (1–20); *P. nigromaculatus* (2–20), (1–26).

Ergasilus cerastes

Ictalurus furcatus (1–3); *I. punctatus* (50–10).

Ergasilus clupeidarum

Alosa chrysochloris (16–9); *Dorosoma cepedianum* (4–20); *D. petenense* (1–27).

Ergasilus cyprinaceus

Campostoma anomalum (1–11); *Hybopsis storeriana* (1–5); *H. winchelli* (2–5); *Nocomis leptocephalus* (2–20), (21–5); *Notemigonus crysoleucas* (1–5); *Notropis baileyi* (2–11), (2–12), (1–20), (3–20); *N. chrysocephalus* (5–5), (1–5), (7–5); *N. longirostris* (8–5); *N. hypsilepis* (1–27); *N. roseipinnis* (2–6), (1–5); *N. texanus* (1–5), (1–6), (1–20); *N. venustus* (1–5); *N. zonistius* (2–26); *Pimephales vigilax* (7–5); *Semotilus atromaculatus* (11–20), (6–20), (1–1), (1–6); *Ictalurus natalis* (5–1), (3–2); *I. nebulosus* (1–25), (1–22); *Noturus nocturnus* (1–1); *Fundulus olivaceus* (1–15), (1–6).

Ergasilus elongatus

Polyodon spathula (14–20).

Ergasilus felichthys

Bagre marinus (1–9), (1–9), (2–29), (1–29), (4–3).

Ergasilus funduli

Adinia xenica (2–9), (5–9); *Cyprinodon variegatus* (2–7), (12–21); *Fundulus grandis* (1–9), (1–22), (1–7), (1–7), (2–28); *F. pulvereus* (1–3); *F. similis* (1–22), (4–22), (2–29), (1–9), (1–9), (2–28); *Lucania parva* (1–23), (2–25), (2–22); *Gambusia affinis* (1–22); *Poecilia latipinna* (4–9), (1–9), (1–7), (1–7), (4–22); *Menidia beryllina* (6–9), (35–7), (4–3); *Gobiosoma bosci* (12–29).

Ergasilus lanceolatus

Hiodon tergisus (1–1).

Ergasilus lizae

Cyprinodon variegatus (2–22), (1–22); *Fundulus grandis* (1–10); *Lepomis macrochirus* (3–9); *Leiostomus xanthurus* (5–7), (1–21), (15–3), (11–10); *Lagodon rhomboides* (1–7); *Mugil cephalus* (1–3), (5–9), (1–25), (1–22), (1–7), (3–3); *Mugil curema* (1–29), (1–4), (5–9).

Ergasilus megaceros

Dorosoma cepedianum (1–20); *Esox americanus* (11–5), (7–12), (7–14); *E. niger* (1–5); *Hybognathus nuchalis* (1–6), (1–12); *Hybopsis storeriana* (1–12), (4–5); *Pimephales notatus* (4–20); *P. vigilax* (4–13); *Notropis bellus* (6–20); *N. edwardraneyi* (2–12); *N. emilae* (2–12), (9–11), (3–7); *N. roseipinnis* (2–5); *N. shumardi* (8–11); *N. texanus* (5–5), (7–5), (3–4), (2–1), (5–22), (2–20), (2–14); *N. venustus* (2–15), (2–4), (3–5); *Erimyzon oblongus* (50–1), (9–26); *E. sucetta* (200+–7), (1–5); *Moxostoma* sp. cf. *poecilurum* (2–27); *Ictalurus melas* (25–20).

Ergasilus tenax

Esox niger (1–20); *Lepomis gulosus* (2–5), (1–5); *L. macrochirus* (9–5), (2–5), (5–5); *L. megalotis* (4–5), (62–5), (6–5), (3–6); *L. microlophus* (1–5), (13–5); *L. punctatus* (8–5), (1–6); *Pomoxis annularis* (4–11), (3–14); *P. nigromaculatus* (6–10), (2–20).

Ergasilus versicolor

Lepisosteus osseus (1–18); *Erimyzon oblongus* (1–27); *E. sucetta* (1–7), (5–25); *E. tenuis* (18–5), (5–25); *Ictiobus bubalus* (1–11); *Minytream melanops* (2–26), (4–22), (2–5), (28–26), (100's–27), (25–27); *Moxostoma* sp. cf. *poecilurum* (30–26), (30–27); *Moxostoma poecilurum* (2–8), (3–4), (4–22); *Ictalurus natalis* (7–25); *I. nebulosus* (21–25), (37–26), (10–25), (7–27); *Mugil cephalus* (6–22), (14–3), (1–9), (8–7), (7–7), (11–3), (6–3), (5–3), (8–3), (1–2); *Pogonias cromis* (1–9).

Ergasilus wareaglei

Hypentelium etowanum (5–16); *H. nigricans* (14–5), (8–5), (2–6).

Ergasilus sp. cf. *lizae* (Form A)

Mugil cephalus (8–3), (4–9), (1–25), (3–7); *Mugil curema* (2–9), (1–9).

Ergasilus sp. cf. *lizae* (Form B)

Mugil cephalus (1–9).

Ergasilus Material Accumulated during Study from Outside of Study Area

After the host names below, information is abbreviated as: (Number of parasite specimens – drainage state – county.)

Ergasilus arthrosis

Morone chrysops (6–Mississippi, Miss.–Warren).

Ergasilus caeruleus

Lepomis cyanellus (1–Big Black, Miss.–Hinds); *L. macro-*

chirus (1—Tennessee, Miss.—Alcorn); *L. punctatus* (4—Atlantic, Fla.—Palm Beach).

Ergasilus centrarchidarum

Lepomis auritus (1—U. Chattahoochee, Ala.—Lee); *Micropterus salmoides* (4—Apalachicola, Fla.—Jackson).

Ergasilus cerastes

Ictalurus catus (25—Ashley, S.C.—Charleston).

Ergasilus clupeidarum

I. nebulosus (20—Potomac, Unk.).

Ergasilus cyprinaceus

Notropis atherinoides (1—Mississippi, Miss.—Cahoma).

Ergasilus funduli

Fundulus heteroclitis (4—Sapelo Is., Ga.—McIntosh); *Mugil cephalus* (4—Sapelo Is., Ga.—McIntosh).

Ergasilus labracis

Morone saxatilis (Many—Cooper, S.C.—Berkeley).

Ergasilus lizae

Mugil cephalus (6—Sapelo Is., Ga.—McIntosh).

Ergasilus megaceros

Cycleptus elongatus (2—Mississippi, Miss.—Warren); *Erimyzon sucetta* (6—Big Black, Miss.—Hinds).

Ergasilus versicolor

Erimyzon sucetta (3—Ochlockonee, Fla.—Leon); *Minytrema melanops* (1—Flint, Ga.—Crisp); *Mugil cephalus* (3—Sapelo Is., Ga.—McIntosh).

Ergasilus sp. cf. *lizae* Form B

Mugil cephalus (6—Sapelo Is., Ga.—McIntosh).

DISCUSSION

Host-Parasite Relationships

Acipenseridae: specimens examined—7; infested—0; localities—7.

No *Ergasilus* species have been recorded from this family in North America and none were recorded from the specimens examined in this work.

Polyodontidae: specimens examined—4; infested—1; localities —4.

Specimens of *Ergasilus elongatus* were taken from the gill rakers of a specimen of *Polyodon spathula* which had been collected on the Tallapoosa River. This species of *Ergasilus* was recovered from *P. spathula* only in this study and is the only species that has been reported in the literature from this host, Table 1.

Lepisosteidae: specimens examined—22; infested—1; localities —18.

Of the 22 gars examined, only 1 was found positive for *Ergasilus*. A single longnose gar from the lower Coosa Drainage was infested with a single *E. versicolor*. Previous works have recorded what represents two species of *Ergasilus* from gars, Table 1. *E. versicolor* was one of these. The other, *E. caeruleus,* was reported from this family on the basis of a single specimen from a longnose gar and a questionable inclusion in a host list in the same work *(100). E. versicolor* may be considered the only ergasilid that has been firmly established as a gar parasite.

Amiidae: specimens examined—13; infested—0; localities—11.

No records of *Ergasilus* have been reported in the literature and none were recovered from the material examined in this work. The lack of records of *Ergasilus* species from *Amia calva* does not reflect limited published examinations of this fish for parasites but rather a true absence of parasitism by *Ergasilus*. Future findings of *Ergasilus* on *A. calva* will probably be the result of infestations by the *Ergasilus* species that are not very selective in their choice of hosts.

Elopidae: specimens examined—3; infested—0; localities—2.

Three specimens of *Elops saurus* were negative. The only report of *Ergasilus* on a North American elopid was made by Causey *(22)*. He reported one specimen of *Ergasilus* under the name *E. mugilus* from *E. saurus*.

Anguillidae: specimens examined—28; infested—10; localities—25.

More than one-third of the localities examined produced specimens of *E. celestis* from *Anguilla rostrata.* Previous records were also of this species with the exceptions of an unidentified species record and one *E. caeruleus* record, Table 1. From this information it can be assumed that *E. celestis* will be the species of *Ergasilus* to be expected as a parasite of *Anguilla rostrata.*

Clupeidae: specimens examined—149; infested—6; localities—76.

Previously reported *Ergasilus* species from North American clupeids are represented by two lots of material. Both of these were initially reported on by Wilson *(100).* One lot, represented by one specimen, was identified as *E. versicolor,* but Roberts *(78)* reexamined this material and designated it as *E. arthrosis* Roberts. The other material reported by Wilson *(100)* was described as a new species, *E. lanceolatus* Wilson. Neither *E. lanceolatus* nor *E. arthrosis* were recovered from the clupeid material reported on herein. However, a new species, *E. clupeidarum* Johnson and Rogers, has been recovered and described *(51).* The new species was collected from all the clupeid species included in this study and also from *Alosa aestivalis* from the Atlantic coastal drainage. *E. clupeidarum* was not found on fishes other than clupeids, and the frequency with which it was recovered suggests that it is the species most likely to be encountered on clupeids.

A single specimen of *E. megaceros* was found loose in the opercular cavity of a specimen of *Dorosoma cepedianum.* Eight host specimens were collected simultaneously but seven were negative.

Engraulidae: specimens examined—33; infested—0; localities—13.

No ergasilids were obtained from the anchovies examined in this study and no reports in the literature record ergasilids from engraulids.

Hiodontidae: specimens examined—20; infested—1; localities—9.

One specimen of *E. lanceolatus* was taken from one of several specimens of *Hiodon tergisus* that had been collected in the upper Pearl River. This is the first report of *E. lanceolatus* since the

original description by Wilson in 1916. Wilson's material for the original description was taken from the gizzard shad (*Dorosoma cepedianum*).

Esocidae: specimens examined—100; infested—5; localities—76.

Ergasilus megaceros was found from four localities as parasites on specimens of *Esox americanus* and *E. niger*. One specimen of *Ergasilus tenax* was found on a specimen of *E. niger*.

Voth and Larson (97) reported an ergasilid from *Esox* spp. from the Goose River, North Dakota, as *Ergasilus* sp., but Dr. O. R. Larson in a personal communication related that the material from the study was not retained.

Cyprinidae: specimens examined—2,116; infested—73; localities —815.

E. cyprinaceus and *E. megaceros* were the only species that were found on cyprinids in this study. Pages 25-26 show that the two parasites are generally distributed in the various cyprinid genera. Previous reports are somewhat diverse in regard to recorded species of *Ergasilus* infesting cyprinids. From the literature summary in Table 1 it was noted that much of the material reported by R. V. Bangham was recognized as *E. nerkae* by Roberts (76). It is possible that other specimens listed by Bangham and Adams (12) were also *E. nerkae*. Mueller (68) expressed doubt to his own identification of *E. versicolor*. Voth and Larson (97) suggested that Hoffman (45) may have misidentified the *E. caeruleus* therein. Furthermore, there is a doubt of the Voth and Larson (97) identification of *E. confusus* Bere that was reported from *Pimephales promelas*. The identification is considered doubtful because other specimens reported as *E. confusus* in the same study were actually representative of a new species, *E. wareaglei* Johnson, 1972.

By combining host record data that have a high degree of certainty as to correct identification with those accumulated in this study, the *Ergasilus* species that infest cyprinids may be narrowed to three. These are *E. cyprinaceus, E. megaceros,* and *E. nerkae*. *E. nerkae* appears to be limited to more northern temperate regions in North America because it was not taken in this study.

Catostomidae: specimens examined—498; infested—37; localities —301.

In this study, *E. megaceros, E. versicolor,* and *E. wareaglei*

were the only species collected from catostomids. These three parasites were found on numerous samples of fishes. In the literature the records of catostomid infestation by *Ergasilus* species are dominated by reports of *E. caeruleus,* Table 1. However, most of the reports were by Bangham *(6-9,11,12)* and are all to some degree questionable in regard to correct identification. Roberts *(76,80)* reexamined some of Bangham's material and found it to be of different species than that reported as *E. caeruleus. E. caeruleus* was collected 49 times in the present study and was never found on catostomids. If it be true that *E. caeruleus* records are erroneous, then it appears that *E. megaceros, E. nerkae, E. versicolor,* and *E. wareaglei* are the primary ergasilid parasites of North American Catostomidae.

Ictaluridae: specimens examined—465; infested—37; localities —265.

E. arthrosis, E. versicolor, E. cerastes, E. cyprinaceus, and *E. megaceros* were encountered, in order of decreasing frequency, from ictalurid hosts. The literature summary shows *E. versicolor* predominating in past records, Table 1. However, the knowledge of this species has undergone a period of taxonomic confusion and, as explained above, a portion of these literature records probably represent *E. arthrosis.*

The data from this study reported only one collection of *E. megaceros* from an ictalurid, but the copepods were plentiful on this sample. Add the fact that the specimens from which Wilson originally described *E. megaceros* came from a channel catfish and it must be assumed that the parasite can be expected on other ictalurids.

Prior to this work, *E. cyprinaceus* was recorded only once from ictalurids, in this case the yellow bullhead (*Ictalurus natalis*). In the study area bullheads and one madtom were found burdened by this parasite. This information substantiates the association between *E. cyprinaceus* and ictalurids and suggests a subfamilial preference for the smaller ictalurids by the parasite.

In estuarine areas the ictalurids were found infested with *E. cerastes.* The three *Ictalurus* spp. that provided *E. cerastes* specimens were all captured in river mouths.

Ariidae: specimens examined—22; infested—6; localities—10.

Pearse *(72)* reported a copepod from the gills of the gafftopsail catfish (*Bagre marinus*) and the sea catfish (*Arius felis*) from

Beaufort, North Carolina. Pearse gave the new name *Macrobrachinus felichthys* to the animal. This copepod is actually an Ergasilus species and Johnson and Rogers *(51)* have placed it in the genus *Ergasilus* as *E. felichthys* (Pearse, 1945). The species is exceptionally close to *E. cerastes* Roberts, 1969, but has not been combined with the latter since there are differences in morphological detail between the two forms.

E. felichthys was found on several samples of *Bagre marinus* gills in the course of the study. The parasite appeared to be quite common on this host. Although Pearse had obtained one specimen of *E. felichthys* from *A. felis* none were obtained from that host in this study.

Amblyopsidae: specimens examined—7; infested—0; localities—4.

Typhlichthys subterraneus specimens were examined from material from four localities. All specimens proved negative. The collections of the fishes were considered part of the Tennessee River system, but as Smith-Vaniz *(84)* pointed out, the underground habitat of *Typhlichthys* allows it to not be dependent on surface drainage systems for distribution. The host specimens recorded in this report were captured near the Coosa system.

Aphredoderidae: specimens examined—81; infested—5; localities—47.

The pirate perch (*Aphredoderus sayanus*) has only once been noted as a host for *Ergasilus*. The species was *E. caeruleus* and was recorded by Bangham and Venard *(14)* from Reelfoot Lake, Tennessee. Herein, *E. caeruleus* and *E. arthrosis* are reported from this host from four and one localities, respectively. The fact that the *E. arthrosis* record was based on one individual parasite as opposed to numerous parasites per host for *E. caeruleus* leads one to conclude that *E. caeruleus* is the *Ergasilus* species usually expected to be encountered on *A. sayanus*.

Belonidae: specimens examined—22; infested—0; localities—13.

Specimens of *Strongylura marina* represented this family in the study. No *Ergasilus* specimens were found on the fishes examined as part of the study, but Cressey and Collette *(27)* did report three *Ergasilus* species from North America. The first was reported as *E. spathula* n. sp., but it is actually a synonym of *E. arthrosis* Roberts. The second species was considered unde-

scribed, reported as *Ergasilus* sp. A, and was suggested to be the same as *E. lizae* Kroyer sensu Thomsen *(88)*. This latter name has been synonymized with *E. versicolor* Wilson by Johnson and Rogers *(51)*. The third species was considered to be the same as *E. tenax* Roberts but the description of the animal by Cressey and Collette made it obvious to the authors that it was actually a new species.

Summarizing, *E. arthrosis* and an unnamed species close to *E. tenax* may be expected to occur on North American belonids. Another species, possibly *E. versicolor,* has been reported from North American belonids but the collection was based on only one specimen.

Cyprinodontidae: specimens examined—547; infested—30; localities—217.

The results of this study as well as that of the literature show this group to be dominated by *E. funduli* and *E. lizae* as prospective parasites, Table 1. Both of these species are found on cyprinodontids in brackish water areas, especially tide pools. Inland-ranging cyprinodontids were found free of ergasilids with the exception of *Fundulus olivaceus,* specimens of which harbored single *E. cyprinaceus* specimens at two localities.

Poeciliidae: specimens examined—202; infested—7; localities—80.

Ergasilids have been recorded from poecilids three times in the North American literature, twice as *E.* sp. from *Gambusia affinis* and *Poecilia latipinna* and once as *E. manicatus* from *G. holbrooki.* All of these collections were made in the vicinity of Englewood, Florida by Bere *(18)* and Bangham *(8)*. *Ergasilus funduli* has been recorded from five localities herein, once from *G. affinis* and five times from *P. latipinna.* Since *E. manicatus* is a synonym of *E. funduli,* the latter is the only species of *Ergasilus* that has been found on poecilids.

Atherinidae: specimens examined—145; infested—9; localities—57.

E. funduli has been reported from *Menidia menidia* from Massachusetts *(99,102,80)* and New Brunswick *(16)*. Within the study area, this species was obtained from three localities on *Menidia beryllina.* This information should justify the supposition that *E. funduli* is the common *Ergasilus* species of coastal atherinids.

The inland atherinid, *Labidesthes sicculus,* was found to host

a single specimen of *E. arthrosis* from one locality, Table 1. The importance of this recovery is probably minor.

Cottidae: specimens examined—31; infested—0; localities—12.

The only species of *Ergasilus* that has been found to infest cottids is *E. cotti* Kellicott, 1892. The parasite has been recovered only once since the original description and this was from a percid, *Etheostoma caeruleum (91).* No cottids or percids were found infested with *E. cotti* in the present study. Unless the parasite is particularly rare in the Southeast, it is likely that it is absent from this region.

Syngnathidae: specimens examined—8; infested—0; localities—5.

The specimens of pipefishes that were examined in the study area proved free of ergasilids. This negative result is likewise found in the literature.

Percichthyidae: specimens examined—14; infested 4; localities—10.

E. arthrosis was found on three samples within the study area and *E. centrarchidarum* on one from the Atlantic coast. *E. labracis* has been noted as common on the striped bass. Reports of *E. labracis* dominate the literature records of ergasilids found on percichthyids, but all of these records were from Atlantic coastal localities, Table 1. It seems quite possible that the mainland distribution of *E. labracis* is localized on the Atlantic coast with other species parasitizing sea basses in Gulf drainages. *E. arthrosis, E. centrarchidarum, E. caeruleus,* and *E. versicolor* have been taken from gills of fishes from Gulf of Mexico drainage basins. Due to the confusion in the literature concerning *E. versicolor,* it is strongly suspected that the reports of *E. versicolor (24)* were based on material that was actually *E. arthrosis.* Specimens of *E. centrarchidarum* and *E. caeruleus* collected from sea basses number three each including material from this study. In contrast, *E. arthrosis* was found in relative abundance on the gills.

Elassomidae: specimens examined—102; infested—0; localities—48.

No ergasilids were reported from this family herein, and none have been recorded in previous works.

Centrarchidae: specimens examined—1,122; infested—167; localities—632.

The results of this study demonstrate four species of *Ergasilus* from centrarchids. These are *E. arthrosis, E. caeruleus, E. centrarchidarum,* and *E. tenax.* The literature with slight exception contains records of the same species but is dominated by reports of *E. caeruleus* and *E. centrarchidarum,* Table 1. Some of the reports of *E. versicolor* from centrarchids were corrected to *E. arthrosis* by Roberts *(78).* The other reports of *E. versicolor* from centrarchids, notably those of Causey *(24),* may also have been *E. arthrosis* for reasons previously mentioned. *E. tenax* has been reported only from *Pomoxis* spp. but was found more frequently on *Lepomis* spp. than *Pomoxis* spp. in this study.

Specimens of *Ambloplites rupestris* provided no *Ergasilus* spp. in this study even though specimens from 35 localities were examined. Previous works have reported numerous cases of *E. centrarchidarum* and *E. caeruleus* from *A. rupestris.*

Centrarchus macropterus specimens were found to host only *E. centrarchidarum* in this study. Previously, one specimen of *C. macropterus* was reported as being parasitized by *E. caeruleus (14).*

Species of the genus *Lepomis* were found to host *E. arthrosis, E. caeruleus, E. centrarchidarum,* and *E. tenax* from 20, 43, 5, and 13 localities, respectively. Infestations by *E. arthrosis* were prevalent in the lower parts of the drainages. *E. caeruleus* was generally distributed and *E. centrarchidarum* and *E. tenax* were prevalent in the upper reaches of the drainages. *E. tenax* were present in the upper portions as well.

Species of the genus *Micropterus* hosted *E. centrarchidarum* from 15 localities and *E. arthrosis* from 10. The apparent absence of *E. caeruleus* from *Micropterus* spp. in the study area overwhelms the senior author's confidence in the literature concerning the Centrarchidae. An objective attempt to discredit the portion of literature that reports *E. caeruleus* from centrarchids was met with some success: Smith's *(83)* spine-seta count on the species he reported as *E. caeruleus* fits *E. arthrosis* much better than *E. caeruleus.* Becker, et al. *(15)* reported that copepod identifications were made under a dissecting microscope, a questionable procedure in the senior author's estimation. The material reported as *E. caeruleus* in Bangham's *(4-11)* works have been considered unreliable earlier.

Ergasilid reports from *Pomoxis* in the literature include reliable records of *E. caeruleus, E. centrarchidarum,* and *E. tenax,* Table

1. The same copepods were collected in this study from nine, three, and four localities, respectively. In addition, specimens of *E. arthrosis* were collected from two localities. Larger numbers of *E. caeruleus* and *E. tenax* rather than *E. arthrosis* and *E. centrarchidarum* were obtained per fish. This result was compatible with the literature.

Percidae: specimens examined—921; infested—5; localities—419.

Although a large number of localities were examined for *Ergasilus* species on percids, only four localities provided parasites. Three localities provided specimens of *E. caeruleus* from *Percina nigrofasciata* and one locality supplied a single specimen of *E. arthrosis* from *P. caprodes.* Most of the specimens of *Ergasilus* that have been taken from percids and reported on in previous work came from the larger perches – *Stizostedion canadense, S. vitreum,* and *Perca flavescens.* Although specimens of *S. vitreum* and *P. flavescens* were examined in the present work, the number of localities checked was small. *E. luciopercarum* has been established by Roberts *(80)* as the prevalent species on the larger perches. Roberts *(80)* noted that a synonym of this species (*E. confusus* Bere, 1931) was reported from other hosts besides percids by Bere *(17)* and considered the records as probable misidentifications.

That *E. luciopercarum* was not found on fishes examined in this study suggests that the parasite may not occur here. Also, that no specimens of this parasite have been taken below 41° N. latitude adds substance to the assumption.

E. cotti has been reported twice in the literature and one of these was from *Etheostoma caeruleum (92).* The latter record is unique for the genus *Etheostoma.*

It is apparent from the data presented herein that ergasilids are not common on the small percids. Those ergasilids that do occur occasionally as parasites are likely to be the ones that show a similar affinity to the larger percids.

Carangidae: specimens examined—9; infested—1; localities—5.

One specimen of *Caranx hippos* was found to host a single specimen of *E. arthrosis.* This is the first record of an *Ergasilus* from a carangid from North American waters.

Sparidae: specimens examined—22; infested—1; localities—14.

Specimens of the sheepshead (*Archosargus probatocephalus*)

and the pinfish (*Lagodon rhomboides*) were examined. One specimen of *E. lizae* was taken from a pinfish at the mouth of the Pascagoula River. This represents the first report of an *Ergasilus* from a North American sparid.

Sciaenidae: specimens examined—63; infested—8; localities—37.

Two species of *Ergasilus* were taken from two sciaenid species in the present study. One was *E. lizae* from the spot (*Leiostomus xanthurus*) from several localities. Causey *(23)* reported *E. lizae* and *E. mugilus* from the spot and says of *E. mugilus*: "This appears to be the most common ergasilid on the Gulf Coast." It is possible that the species of ergasilid that Causey referred to as *E. mugilus* (see section on "Taxonomic Considerations") is the same as that reported as *E. lizae* herein. Causey *(21)* also reported *E. nanus* and *E. mugilus* from the croaker, *Micropogon undulatus*. In the present work, one specimen of *E. versicolor* was taken from a black drum (*Pogonias cromis*) but the relative importance of this find is questionable. The only other sciaenid infestation that the authors are aware of is a freshwater drum (*Aplodinotus grunniens*) that was collected from the Tennessee River drainage by the junior author and was seen to be heavily infested with an undetermined *Ergasilus*.

Mugilidae: specimens examined—53; infested—27; localities—23.

Three nominal species of *Ergasilus* have been reported from this family in the North American literature, *E. lizae*, *E. mugilus*, and *E. nanus*, Table 1. As discussed earlier these three species are poorly defined. One of the species of *Ergasilus* that was found on *Mugil* spp. in this work has been called *E. lizae* following Roberts' *(80)* designation. Two of the other forms that were obtained from mugilids have been partially figured along with *E. lizae*, Figure 1, but given no names. No species were given the identification of *E. nanus* or *E. mugilus*. Because of the ambiguity involved in previous reports of this species group, the literature records are not considered at this time.

The species of *Ergasilus* that were recovered within the study area were *E. versicolor*, *E. lizae*, *E.* sp. Form A, and *E.* sp. Form B. The latter two species were collected only from *Mugil* spp. and are now considered to be restricted as parasites to the family. Within the marine or brackish water environment, *E. versicolor*

and *E. lizae* were found on other hosts, but primarily on *Mugil* spp.

Collections of *E. funduli* were examined from *Mugil cephalus* from Atlantic coastal waters but the infestations were considered light. The association probably was the result of close association of the young mugilids with a dense cyprinodontid population.

Gobiidae and Eleotridae: specimens examined—37; infested—1; localities—18: specimens examined—7; infested—0; localities—6.

The literature reports only one *Ergasilus* species from a gobiid in North America. The parasite-host relationship between *E. auritus* and *Gillichthys mirablis* was reported by Roberts *(80)* from specimens collected in southern California waters. Both animals may be considered species that range only in Pacific coastal drainages.

In this study *E. funduli* was the only species obtained from gobiids. Numerous specimens of *E. funduli* were taken from *Gobiosoma bosci* from one locality. Negative findings of other *Ergasilus* species and numerous copepods per fish suggests *E. funduli* is the important ergasilid parasite of gobiids on the Gulf Coast.

Eleotrids all proved negative for ergasilid parasites.

Bothidae and Soleidae: specimens examined—2; infested—0; localities—2: specimens examined—14; infested—5; localities—11.

No *Ergasilus* species have been reported from these two families in the North American literature. In this study, specimens of *E. arthrosis* were recovered from specimens of *Achirus lineatus* from two of seven localities. This establishes *A. lineatus* as an acceptable host for *E. arthrosis*. No *Ergasilus* specimens were obtained from the other flatfishes examined.

Parasite-Host Relationships and Distribution

Ergasilus arthrosis Roberts, 1969. The literature reports *E. arthrosis* from ictalurids, a clupeid, and centrarchids. The results of this study record this parasite from ictalurids, an aphredoderid, an atherinid, percichthyids, centrarchids, percids, a carangid, and a soleid. Roberts *(80)* considers *E. arthrosis* the common species on ictalurids with occurrences on other families occasional events. The copepod was found commonly on ictalurids in this

study and this supports Roberts' assumption that the parasite is common on catfishes. However, centrarchids and percichthyids appear to be just as susceptible to infestation by *E. arthrosis*. Adequate numbers of *Achirus lineatus* were not examined but the frequency with which the parasite was encountered on this host (2 of 7 localities) and the intensity of infestation suggest that *E. arthrosis* may be found commonly on this host too. The miscellaneous collections from the other host families serves to demonstrate the wide range of suitable hosts for this parasite species.

Although *E. arthrosis* appears widely distributed on Figure 3, most collections were taken from the lower portions of the drainages. Those collections from the upper drainage areas were primarily from ictalurids and from rivers and reservoirs. Outside of the study area *E. arthrosis* has been documented in several

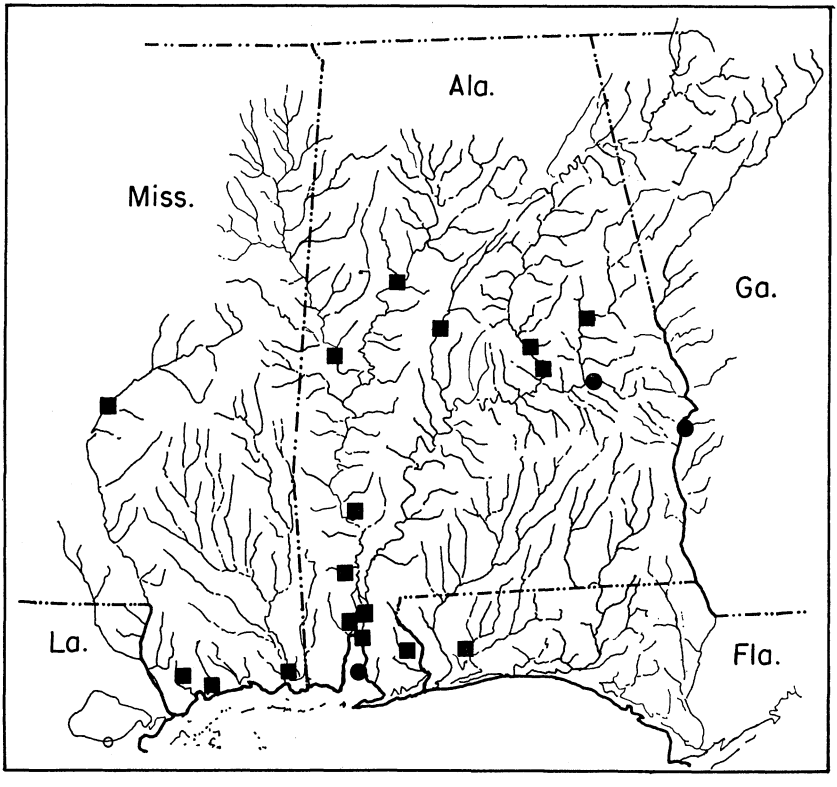

FIG. 3. Distribution of *E. arthrosis* (squares) and *E. clupeidarum* (dots).

localities in the Mississippi River drainage basin and in two collections from coastal areas of Louisiana and Costa Rica.

Ergasilus caeruleus Wilson, 1911. This species name is particularly abundant in survey records. One *(103)* reports the parasite from a lamprey. The species was reported most frequently by Bangham, but since Roberts *(76,80)* has found so many discrepancies in Bangham's works, it is suspected that the majority of them are erroneous. The same must be said for other reports, with the exceptions of Wilson *(99,100)*, Tedla and Fernando *(85)*, and Roberts *(76)*, since there had been taxonomic confusion regarding *E. caeruleus* prior to Roberts *(76)*.

E. caeruleus was found on *Aphredoderus sayanus*, *Lepomis* spp., *Pomoxis* spp., and *Percina nigrofasciata* in this study. The frequency of occurrence and intensity of infestation show that these species are suitable and common hosts for *E. caeruleus*. Furthermore, *E. caeruleus* was recovered from each of these host groups from more localities than any other *Ergasilus* sp.

The distribution presented itself as a random pattern within the study area, Figure 4. No specimens, however, were taken in brackish or salt waters. Comments on continental distributions could be biased because of numerous ambiguous literature records, but there are enough reliable reports available to allow for generalization. It can be said with certainty that *E. caeruleus* may be expected to be a common ergasilid within the Mississippi River drainage, east of it in the United States, and in eastern Canada. Further, well documented reports will probably extend the range westward, complementing that of the natural range of the Centrarchidae.

Ergasilus celestis Mueller, 1936. *Lota lota* and *Anguilla rostrata* have been reported as hosts for this species, from three and two localities respectively. The results presented herein firmly establish *A. rostrata* as a preferred host for this species. It is possible that *E. celestis* is restricted to these two hosts.

As can be seen from Figure 5, *E. celestis* is more or less randomly distributed on *A. rostrata* in the study area. Outside the study area, *E. celestis* has been collected from single localities in New York, Massachusetts, and Ontario.

Ergasilus centrarchidarum Wright, 1882. Previous reports record *E. centrarchidarum* from catostomids, centrarchids, percichthyids, and percids. Centrarchids and a percichthyid are re-

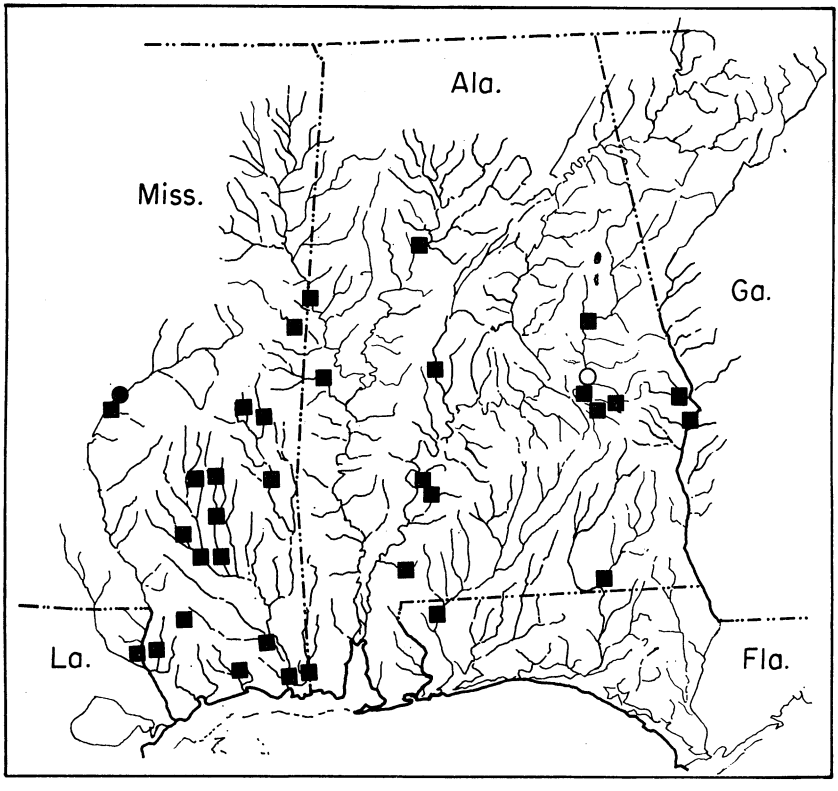

FIG. 4. Distribution of *E. caeruleus* (squares), *E. lanceolatus* (dot), and *E. elongatus* (ring).

ported as hosts herein. It was suspected that the catostomid parasites were actually *E. wareaglei* since the two have very similar morphology and the percid records were erroneous. Tedla and Fernando *(85)* checked fishes of four species from one Ontario locality and found three of them, *Lepomis microlophus, Ambloplites rupestris,* and *Micropterus salmoides,* infested with *E. centrarchidarum.* The heavier infestations were on the latter two species. Since the parasites were larger on *A. rupestris* than *M. salmoides, A. rupestris* was considered the preferred host for *E. centrarchidarum.* Roberts *(80)* studied Wilson's *(99,100)* material, part of Bangham's collections, and material sent to him as gifts, and proposed that *Micropterus* and *Ambloplites* are the preferred hosts of *E. centrarchidarum.* From the results presented here it will be noted that no *A. rupestris* were found posi-

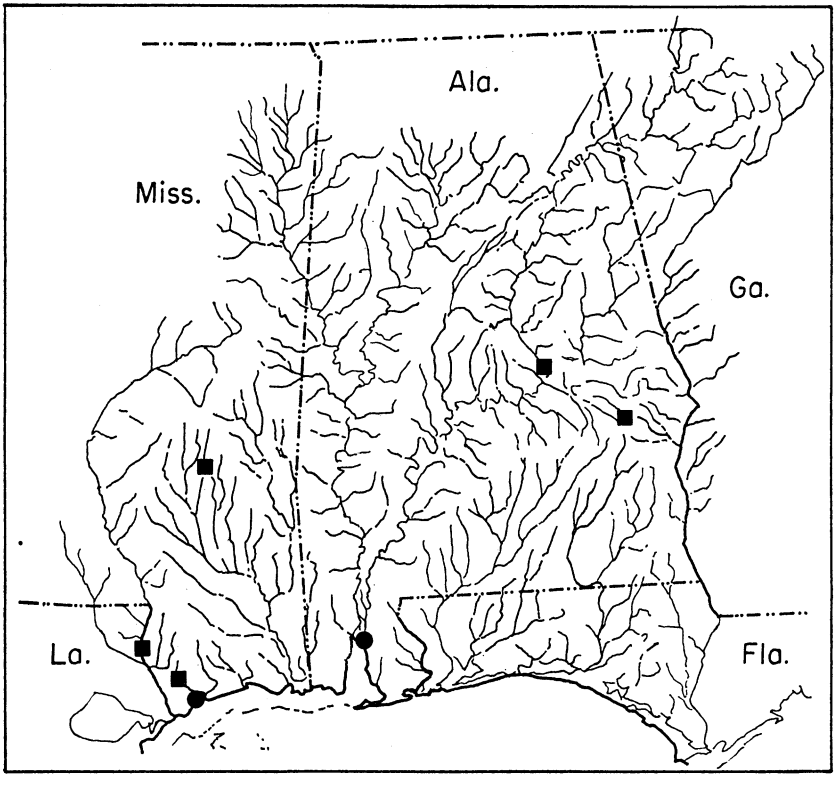

FIG. 5. Distribution of *E. celestis* (squares) and *E. cerastes* (dots).

tive for this parasite and *Centrarchus macropterus, Micropterus* spp., and *Lepomis* spp. were suitable hosts for *E. centrarchidarum.* The one specimen taken from *Morone chrysops* serves to substantiate this fish as an occasional host, for *Wilson (100)* had reported a similar symbiosis.

The distribution of *E. centrarchidarum* in the study area reveals that the species is distributed primarily in the upper portions of the drainages. No collections were taken in areas of tidal influence. In North America *E. centrarchidarum* has been recorded from throughout the Eastern United States and Eastern Canada.

Ergasilus cerastes Roberts, 1969. Roberts *(79)* described this species from an *Ictalurus* species from a Washington, D.C. fishmarket. Roberts correctly postulated that the species of *Ergasilus*

that Mueller (68) had reported as *E. elegans* (= *E. versicolor*) was also *E. cerastes.*

E. cerastes is reported from four localities in this paper, all on *Ictalurus* spp. Apparently this species is restricted to *Ictalurus* in its host selection.

The distribution of the parasite is peculiar in that it has only been taken near or in estuaries, Figure 5.

Ergasilus clupeidarum Johnson and Rogers, 1972. This species has been taken only from clupeids and it would be expected that future collections of this parasite be collected from these hosts. The distribution may be expected to be generalized since specimens were taken from far inland localities as well as Mobile Bay, Figure 3.

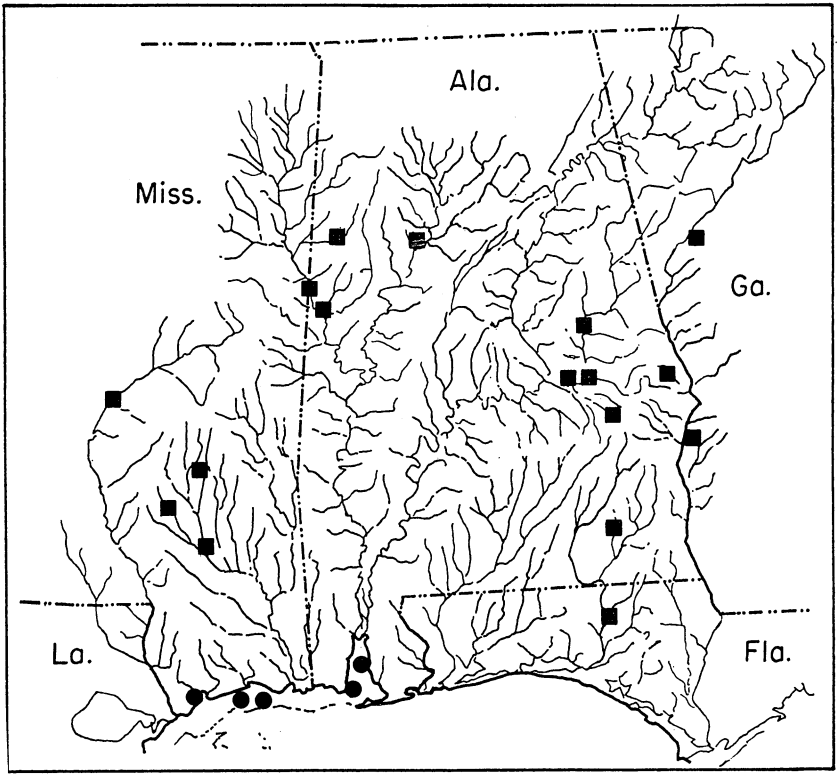

FIG. 6. Distribution of *E. centrarchidarum* (squares) and *E. felichthys* (dots).

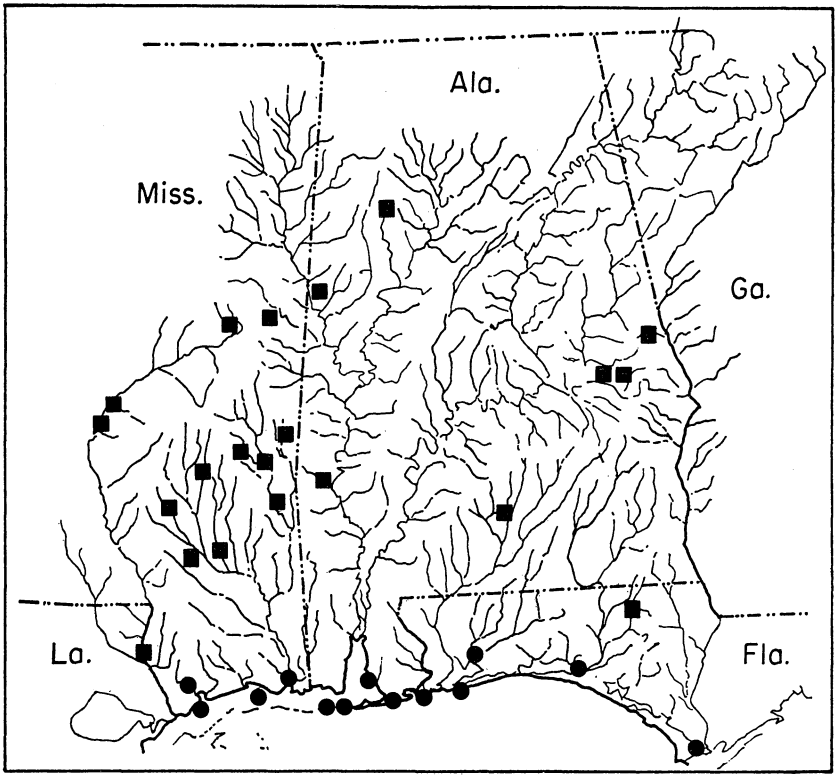

FIG. 7. Distribution of *E. cyprinaceus* (squares) and *E. funduli* (dots).

Ergasilus cyprinaceus Rogers, 1969. Rogers *(81)* reported this species from four genera of cyprinids and Roberts *(80)* added another cyprinid genus to the list. Also, Roberts *(80)* reported one specimen from a stickleback (*Culaea inconstans*) and three specimens from *Ictalurus natalis* that were collected by Bangham *(9)* and reported as *E. versicolor*. Herein, the parasite was collected from seven cyprinid genera, ictalurids, and one species of Cyprinodontidae. The cyprinodontid *Fundulus olivaceus* has a peculiar distribution for a member of a secondary division *(70)* fish group, being found in strictly fresh-water habitats. This ecological peculiarity may account in part for its selection as a host. The ictalurid records add importance to the collection by Bangham *(9)* from *I. natalis*. The occurrence of the parasites on the bullheads was considered frequent enough to establish these fish as pre-

ferred hosts. The one specimen from the *Noturus nocturnus* specimen was not considered as important because more madtoms were examined than bullheads.

The distribution of *E. cyprinaceus,* Figure 7, may be considered as scattered within the study area with no collections recorded near or within the estuaries. Continental records from outside the study area have been reported from single localities in Mississippi (this work), North Dakota *(80),* and Florida *(80).*

Ergasilus elongatus Wilson, 1916. This species has been found only as a parasite of the paddlefish, *Polyodon spathula,* Table 1. As mentioned in the section on host-parasite relationships, this parasite is probably restricted as a parasite to this host species. *E. elongatus* has now been recorded from the Mississippi River and Tallapoosa River-Mobile Bay drainage systems.

Ergasilus felichthys (Pearse, 1947). As mentioned under Ariidae above, this species appears to be restricted in host preference to ariid catfishes and especially to *Bagre marinus* in North America. The distribution of this parasite reflects that of the host family by being confined to brackish or coastal areas, Figure 6.

Ergasilus funduli Kroyer, 1863. Individual data on locality of host capture was not as complete as one would prefer. Nevertheless, it is adequate enough to indicate that *E. funduli* has tide pools and brackish lagoons as its habitat. The host species on which *E. funduli* were found were cyprinodontids, poecilids, an atherinid, a mugilid, and a gobid, and all were collected from or in the proximity of the same habitat type, Figure 7. It is likely that cyprinodontids and poecilids are the preferred hosts and the other species become infested when sharing a closed habitat with these fishes.

The literature reports this species from cyprinodontids, an atherinid, gasterosteids, a poecilid, and an osmerid. These collections were made on the coasts of Louisiana, Florida, North Carolina, Massachusetts, and New Brunswick *(55,18,72,99,102,80).*

Ergasilus lanceolatus Wilson, 1916. This species was found on the mooneye (*Hiodon tergisus*) from the Pearl River, Figure 4, in this study. Previously, *E. lanceolatus* was known only from the original description *(100)* which reported only *Dorosoma cepedianum* as the host. Little can be said about distribution and host affinities with such limited data as the basis of discussion.

Ergasilus lizae Kroyer, 1863. Samples of this species were collected from numerous localities along the cost from cyprinodontids, mugilids, a sparid, and a sciaenid, Figure 9. Previous works report this parasite several times from *Mugil* spp. and once from a sciaenid. The sciaenid, *Leiostomus xanthurus,* was also the species that is reported as a host herein.

Roberts *(80)* suggests correctly that *E. lizae* is probably a cosmopolitan parasite of *Mugil* spp. Future taxonomic work will probably reveal that *E. lizae* has been described under several names. Two names, *E. nanus* van Beneden, 1870 and *E. mugilus* Vogt, 1877, are two fine prospects. Reports of ergasilids under these taxa have been reported by Wilson *(99),* Causey *(21,22)* and Pearse *(75).* Wilson deposited material of *E. mugilus,* but those catalogued at the U.S. National Museum contain free living copepods (Dr. R. Cressey, USNM, personal communication). The materials collected by Causey and Pearse were not available for examination, but it is suspected that the identifications were erroneous.

The cyprinodontids from which *E. lizae* have been reported are probably the victims of confined habitat and close association with young *Mugil* spp. in coastal situations. The converse was noted in the earlier discussion of *E. funduli.*

Kelley and Allison *(53)* reported *E. lizae* from centrarchids from Lake Shelby, Baldwin County, Alabama. Roberts *(78)* reported that this material was actually *E. arthrosis.* He based this assertion on the examination of some of the Kelley and Allison material. Recently, the senior author had the opportunity to examine a larger portion of the material and found that *E. lizae* was indeed present in the material. However, the species was present in very small numbers as compared to *E. arthrosis,* the true causative agent of the fish mortality that was reported by Kelley and Allison *(53).*

Ergasilus megaceros Wilson, 1916. *E. megaceros* was found to be rather evenly distributed in the study area, Figure 8. The parasite was found on several species of cyprinids and catostomids, two esocids, one ictalurid, and one clupeid. The importance of the latter collection appears minor since only one specimen was found unattached in the opercular cavity of one of eight fish from the locality. The data from the other collections indicate that the parasite is adapted to the families Cyprinidae, Cato-

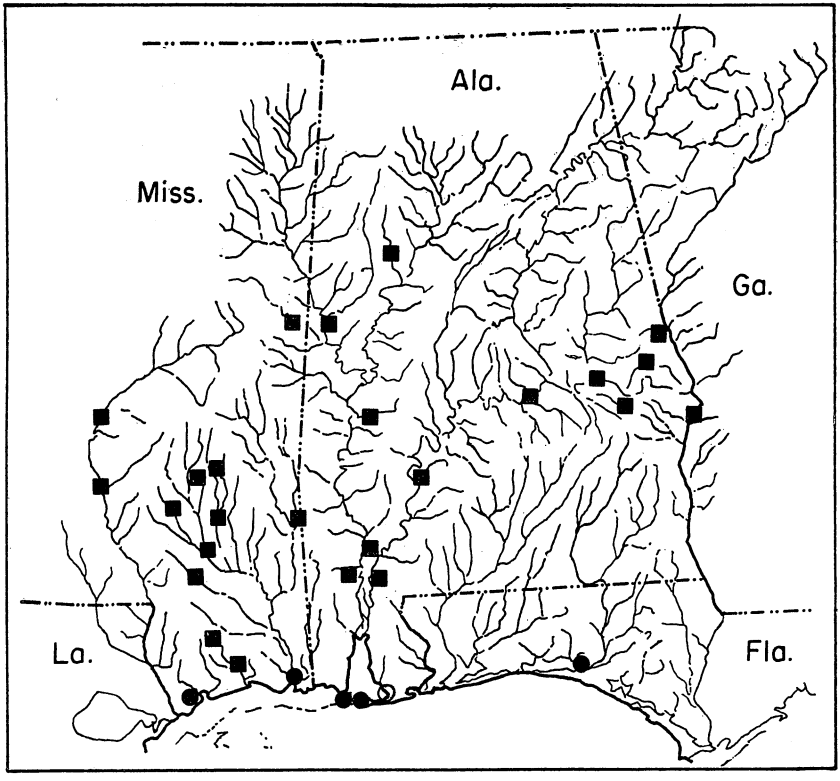

FIG. 8. Distribution of *E. megaceros* (squares), *E.* sp. Form A (dots), and *E.* sp. Form B (ring).

stomidae, Esocidae, and Ictaluridae. The reports of *E. megaceros* in the literature, Table 1 do not alter this hypothesis.

The distribution of *E. megaceros* has been established in the Mississippi River basin *(100)*, the study area, south Florida *(8)*, the Atlantic coastal drainages *(80)*, and the Great Lakes drainages *(67)*. Future collection will probably extend the range throughout most of North America.

Ergasilus tenax Roberts, 1965. This species was found in two drainage basins, Figure 9. The fish hosts included representatives from two centrarchid genera, *Lepomis* and *Pomoxis*, and a single collection from an esocid, *Esox niger*. Importance cannot be attributed to the latter collection since only one parasite specimen was obtained.

The literature, Table 1, includes reports only from *Pomoxis*

annularis for this species. It is assumed, therefore, that this species is selective for *Lepomis* and *Pomoxis* species as fish hosts.

As mentioned previously, this species was placed in a new genus by Cressey and Collette *(27)*, but the species probably should be retained in *Ergasilus*. The genus was established on the basis that the first antenna possessed only five segments as opposed to six for *Ergasilus*. However, at least one *Ergasilus*, *E. kandti* van Douwe, 1921, has been seen (British Museum No. 1950.7.29.17) to possess only five first antennal segments. The two species that were assigned to this new genus also had two segmented first endopods. This character is peculiar to a group of *Ergasilus* species of this hemisphere and, especially, North America.

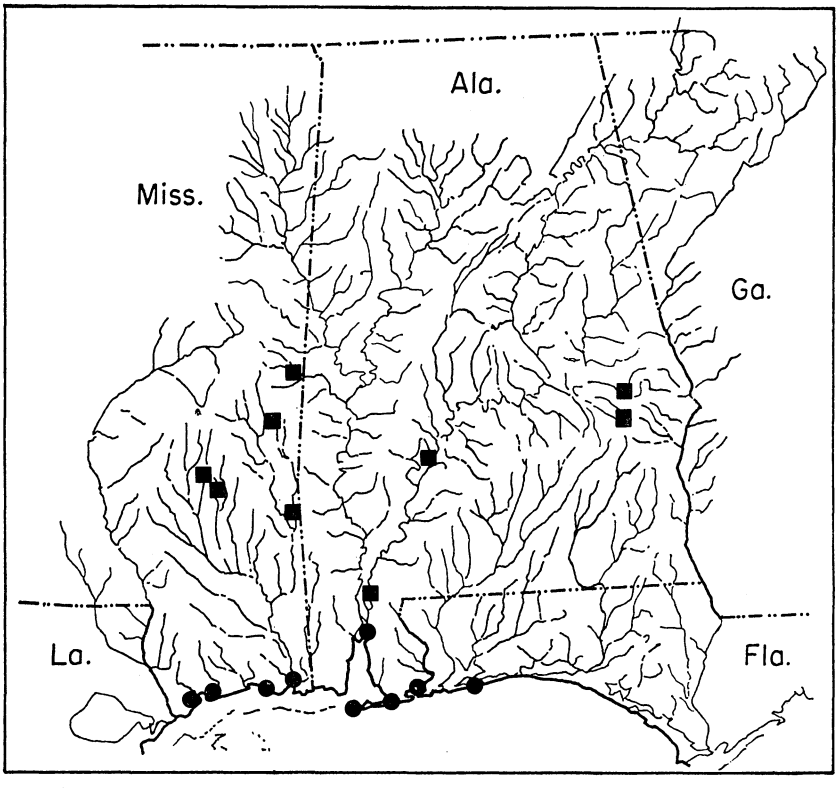

FIG. 9. Distribution of *E. tenax* (squares) and *E. lizae* (dots).

Ergasilus versicolor Wilson, 1911. In this study, *E. versicolor* has been taken from catostomids, ictalurids, a lepisosteid, a mugilid, and a sciaenid. The one collection of *E. versicolor* from the lepisosteid is considered of importance since the relationship between the parasite and lepisosteid has been reported many times in the literature. The importance of the percichthyid record is uncertain.

The distribution of *E. versicolor*, Figure 10, is peculiar for the genus. It has an inland to coastal range in the study area and those that were found in saline waters were, with the exception of the percichthyid, on *Mugil cephalus*. Nevertheless, all material was considered *E. versicolor* by Johnson and Rogers *(51)* and herein for the reasons of morphological conformity. There is a slight difference in the morphology of some of the *Mugil* infesting copepods, but there is so much overlap between characters that a detailed allomeric study will have to be undertaken to separate the groups. Even then, this will not justify separate species status.

Although the literature has reported *E. versicolor* from occasional centrarchids, cyprinids, and percichthyids, Table 1, the centrarchid and percichthyid material may have been *E. arthrosis*, and the cyprinid report was erroneous. *E. versicolor*, then, appears to be selective for species of the families Lepisosteidae, Catostomidae, Ictaluridae, and Mugilidae.

The continental distribution of *E. versicolor* must be derived with scrutiny since the literature of this species is characterized by nomenclatural weaknesses. Reliable records and the data present can establish the distribution in coastal waters on the Atlantic side of North America at least up to Georgia and in inland waters in the Mississippi River basin and eastward.

Ergasilus wareaglei Johnson, 1973. Collections of this species were made from four localities, Figure 10. *E. wareaglei* was found on *Hypentelium nigricans* from three localities and on *H. etowanum* from one locality. As mentioned above, this species was reported from *Catostomus commersoni* from the Mississippi River drainage by Voth and Larson *(97)* as *E. confusus*. Apparently this species is specific for fishes of the family Catostomidae.

Ergasilus spp. Forms A and B. These species were taken from the gill rakers and arches of *Mugil cephalus* and *Mugil curema* from several coastal localities, Figure 8. The species were noted to

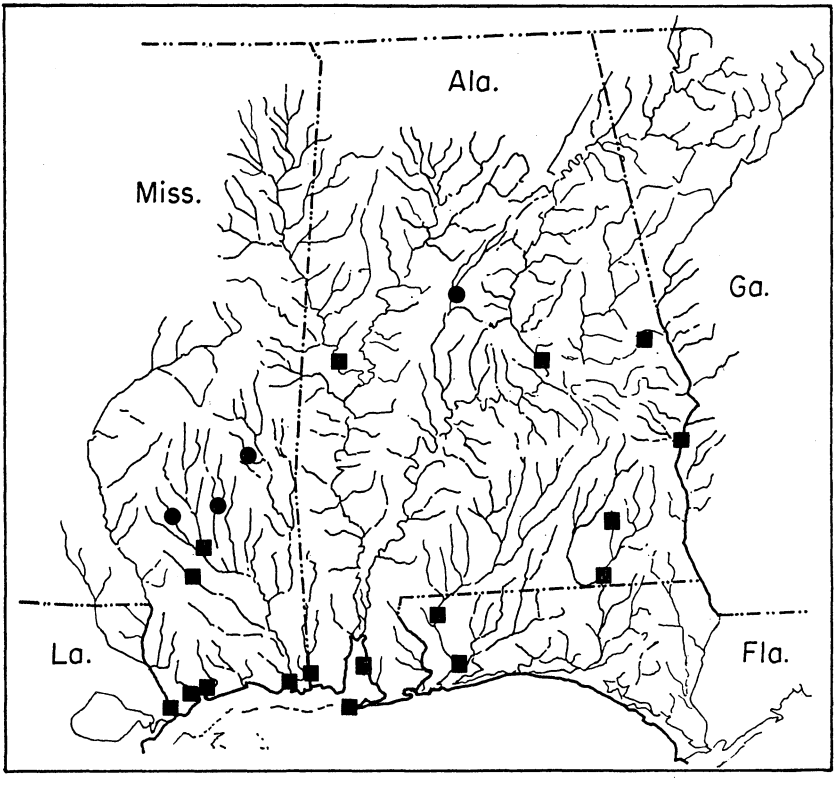

FIG. 10. Distribution of *E. versicolor* (squares) and *E. wareaglei* (dots).

be morphologically very close to *E. lizae* with the exception of the second antennae. In one species, *E.* sp. Form A, the length of the third antennal segment was relatively longer than the same of *E. lizae,* and the terminal (fourth) segment was observed to be relatively shorter, Figure 1. The ratio (fourth segment 0.45-0.5 × the length of third) is comparable to the specimens that Roberts *(78,80)* reported for specimens of *E. lizae* from Chile and Israel. Roberts *(78,80)* reported other *E. lizae* from Puerto Rico and Georgia with antennal characteristic comparable to those of the specimens of *E. lizae* that have been listed as such herein, Figure 1. Both *E. lizae* and *E.* sp. Form A have been taken simultaneously from one fish. The usual habitat (gill rakers) and distinct morphology of the antenna provide the basis for separation of this form from *E. lizae* in this work.

The other species, *E.* sp. Form B, similarly may be separated from *E. lizae.* This species frequents the gill arches rather than the rakers or gill filaments and has segmental features of the antenna that appear stouter than *E. lizae* or Form A, Figure 1.

Form A and Form B have only been found on gill rakers and arches of *Mugil* spp. in coastal waters. The senior author has seen only Form B outside of Gulf waters, but it is likely that Form A is more widespread as well.

Ergasilus auritus Markevich, 1940; ***Ergasilus chatauquaensis*** Fellows, 1877; ***Ergasilus cotti*** Kellicott, 1892; ***Ergasilus luciopercarum*** Henderson, 1926; ***Ergasilus nerkae*** Roberts, 1963; ***Ergasilus turgisus*** Fraser, 1920. These species were not found in the present study area; and with the exception of *E. chatauquaensis,* it is probable that they do not occur in the Southeastern United States.

E. auritus has been reported *(59,76,41)* from British Columbia, Newfoundland, and Labrador from a stickleback (*Gasterosteus aculeatus*) and a salmon (*Oncorhynchus nerka*). Another collections from southern California was reported by Roberts *(80)* from a goby (*Gillichthys mirabilis*). It is probable that this species' distribution in North America is confined to Pacific Ocean drainages. Hanek and Trelfall *(39)* recorded in figures this species from Newfoundland, but the figures most likely depicted something other than *E. auritus.*

E. chatauquaensis has been reported only as part of plankton tow *(29,99,104).*

E. cotti has been reported from a sculpin and a darter from the vicinity of Westerville, Ohio *(52,92).*

E. luciopercarum, with the exception of one specimen collected from *Ambloplites rupestris,* has only been reported from *Perca* and *Stizostedion,* Table 1. The species has not been taken below 41° N. latitude and west of 91° W. longitude in North America. This species has been recovered in plankton tow in a collection from Newfoundland *(28).*

E. nerkae has been found to infest salmonids, catostomids, and cyprinids in drainages that empty into the Pacific Ocean in Washington and British Columbia *(76,80).* One report *(80)* from a "cisco?" from Woodruff, Wisconsin is the only record of *E. nerkae* in waters of the eastern North American drainage. Could this have been an error or an introduction?

E. turgisus has been reported from a salmon, a stickleback, and a surfperch from Pacific drainages *(35,25,20,76,80)*.

Ergasilus labracis Kroyer, 1863. This species occurs in the Southeastern United States but is considered to have a localized distribution. *E. labracis* has only been noted as a parasite of the striped bass (*Morone saxatilis*) on the Atlantic coast, Table 1. It is apparent that this ergasilid is economically important since the striped bass is a prized sport fish, and the infestations by *E. labracis* were always noted in high numbers per fish. That this parasite was not recorded from the study area indicates that the species perhaps has not established here, and it would be wise for fishery biologists to take every precaution that this species is not inadvertently introduced into the Gulf of Mexico.

TABLE 1. SUMMARY OF LITERATURE REPORTING *Ergasilus* spp.

Host and Parasite	Locality	Reference
Polyodontidae		
Polydon spathula		
E. elongatus	Ill.	Wilson, 1916
E. elongatus	Iowa	Wilson, 1916
E. elongatus	La.	Causey, 1957
Lepisosteidae		
Lepisosteus osseus		
E. versicolor[1]	Iowa	Wilson, 1916
E. caeruleus	Iowa	Wilson, 1916
L. platostomus		
E. versicolor[1]	Iowa	Wilson, 1916
L. spatula		
E. caeruleus	Iowa	Wilson, 1916
E. versicolor	La.	Causey, 1957
Anguillidae		
Anguilla rostrata		
E. caeruleus	Tenn.	Bangham and Venard, 1942
E. celestis	Mass.	Roberts, 1969a
	N.Y.	Mueller, 1936a
E. sp.	Newfoundland	Hanek and Threlfall, 1970
	Labr.	Hanek and Threlfall, 1970
Cyprinidae		
Acrocheilus alutaceus		
E. caeruleus	B.C.	Bangham and Adams, 1954
Campostoma anomalum		
E. cyprinaceus	Ala.	Rogers, 1969
Gila atraria		
E. nerkae[2]	Wy.	Bangham, 1951

(Cont.)

TABLE 1. *(Cont.)*

Hybopsis plumbea		
E. nerkae[2]	B.C.	Bangham and Adams, 1954
Mylocheilus caurinus		
E. nerkae[2]	B.C.	Bangham and Adams, 1954
Nocomis leptocephalus		
E. cyprinaceus	Ala.	Rogers, 1969
Notemigonus crysoleucas		
E. megaceros	Fla.	Bangham, 1941a
E. sp.	Me.	Meyer, 1954
	Wis.	Fischthal, 1952
Notropis baileyi		
E. cyprinaceus	Ala.	Rogers, 1969
Notropis crysocephalus		
E. versicolor	N.Y.	Mueller, 1940
Notropis venustus		
E. cyprinaceus	Ala.	Rogers, 1969
Pimephales promelas		
E. confusus	N.D.	Voth and Larson, 1968
E. caeruleus	N.D.	Hoffman, 1953
E. sp.	N.D.	Voth and Larson, 1968
Pimephales sp.		
E. cyprinaceus	N.D.	Roberts, 1970
Ptychocheilus oregonensis		
E. nerkae[2]	B.C.	Bangham and Adams, 1954
Rhinichthys osculus		
E. caeruleus	Wy.	Bangham, 1951
Richardsonius balteatus		
E. nerkae[2]	B.C.	Bangham and Adams, 1954
Semotilus atromaculatus		
E. caeruleus	N.D.	Hoffman, 1953
E. cyprinaceus	Ala.	Rogers, 1969
E. sp.	N.D.	Voth and Larson, 1968
Semotilus corporalis		
E. megaceros	N.Y.	Mueller, 1936a, 1936b
E. sp.	N.Y.	Mueller, 1940
Catostomidae		
Catostomus catostomus		
E. centrarchidarum[3]	Ont.	Bangham, 1941a, 1955
E. caeruleus	Lab.	Threlfall and Hanek, 1970a
E. nerkae[2]	B.C.	Bangham and Adams, 1954
E. versicolor	Ohio	Bangham, 1941b
Catostomus commersoni		
E. caeruleus	Mich.	Wilson, 1924
E. caeruleus	Ont.	Bangham, 1941a, 1955
E. caeruleus	N.D.	Hoffman, 1953
E. caeruleus	Wis.	Bangham, 1946
	Labr.	Threlfall and Hamek, 1970a

(Cont.)

TABLE 1. *(Cont.)*

E. wareaglei[4]	N.D.	Voth and Larson, 1968
E. megaceros	Mass.	Roberts, 1970
E. sp.	Conn.	Hunter, 1942
E. sp.	N.D.	Voth and Larson, 1968
E. sp.	Wis.	Bangham, 1946
E. sp.	Wis.	Fischthal, 1950
E. versicolor	Mass.	Sinderman, 1953
Catostomus fecundus		
E. nerkae[5]	Wy.	Bangham, 1951
Catostomus macrocheilus		
E. nerkae[2]	B.C.	Bangham and Adams, 1954
Erimyzon sucetta		
E. caeruleus	Fla.	Bangham, 1941c
E. caeruleus	Ohio	Bangham, 1941b
E. centrarchidarum	Ohio	Bangham, 1941b
E. megaceros	Fla.	Bangham, 1941c
Ictiobus cyprinellus		
E. versicolor	Iowa	Wilson, 1924
Moxostoma valenciennesi		
E. caeruleus	Wis.	Bangham, 1946
Moxostoma macrolepidotum		
E. nerkae	Unk.	Roberts, 1970
Ictaluridae		
Ictalurus furcatus		
E. versicolor	La.	Causey, 1957
Ictalurus natalis		
E. arthrosis	Unk.	Roberts, 1969a
E. elegans	Tenn.	Bangham and Venard, 1942
E. versicolor	Ill.	Wilson, 1911
E. versicolor	Ind.	Wilson, 1911
E. versicolor	Kan.	Harms, 1959, 1960
E. versicolor	Ohio	Bangham, 1941b
E. cyprinaceus[6]	Fla.	Bangham, 1941c
Ictalurus melas		
E. arthrosis	Wis.	Roberts, 1969a
E. versicolor[8]	Iowa	Wilson, 1916
E. versicolor	N.D.	Voth and Larson, 1968
E. versicolor	Unk.	Roberts, 1969a
E. versicolor	Tenn.	Bangham and Venard, 1942
E. versicolor	Kan.	Harms, 1959, 1960
	Ohio	Bangham, 1941b
E. sp.	N.D.	Voth and Larson, 1968
Ictalurus nebulosus		
E. arthrosis	Iowa	Roberts, 1969a
E. arthrosis	B.C.?	Roberts, 1969a
E. arthrosis[7]	Iowa	Wilson, 1916
E. versicolor	Ind.	Wilson, 1911
E. versicolor	Wis.	Bangham, 1946
E. versicolor	Ont.	Bangham, 1955
E. versicolor	Ohio	Bangham, 1941b
E. versicolor	Fla.	Mueller, 1936b
E. versicolor	Mass.	Sinderman, 1953

(Cont.)

TABLE 1. *(Cont.)*

Ictalurus punctatus		
E. arthrosis	L. Erie	Roberts, 1969a
E. arthrosis	Ohio	Roberts, 1969a
E. caeruleus	Tenn.	Bangham and Venard, 1942
E. elegans	Fla.	Bangham, 1941c
E. megaceros	Iowa	Wilson, 1916
E. arthrosis[7]	Iowa	Wilson, 1911
E. arthrosis[7]	Iowa	Wilson, 1916
E. versicolor	Ohio	Tidd, 1931
E. versicolor	Ohio	Bangham, 1941b
E. versicolor	Tenn.	Bangham and Venard, 1942
E. versicolor	Kan.	Harms, 1959, 1960
E. versicolor	L. Erie	Bangham and Hunter, 1939
E. sp.	Tex.	Lawrence and Murphy, 1967
Ictalurus sp.		
E. cerastes	Unknown	Roberts, 1969b
E. elegans	Fla.	Mueller, 1936b
Noturus gyrinus		
E. caeruleus	Ohio	Bangham, 1941b
E. versicolor	L. Erie	Bangham and Hunter, 1939
Noturus flavus		
E. versicolor	L. Erie	Bangham and Hunter, 1939
Pylodictus olivaris		
E. versicolor	La.	Causey, 1957
Cyprinodontidae		
Cyprinodon variegatus		
E. funduli[9]	N.C.	Pearse, 1947
Floridichthys carpio		
E. lizae	Fla.	Bere, 1936
E. sp.	Fla.	Bangham, 1941c
Fundulus chrysotus		
E. caeruleus	Fla.	Bangham, 1941c
Fundulus confluentus		
E. funduli	La.	Krøyer, 1863
Fundulus grandis		
E. lizae	Fla.	Bere, 1936
Fundulus heteroclitus		
E. funduli	Mass.	Wilson, 1932
E. manicatus	Mass.	Roberts, 1970
Fundulus majalis		
E. funduli[9]	N.C.	Pearse, 1947
Fundulus similis		
E. lizae	Fla.	Bere, 1936
Jordanella floridae		
E. manicatus	Fla.	Bere, 1936
E. sp.	Fla.	Bangham, 1941c
Lucania parva		
E. funduli[9]	N.C.	Pearse, 1947

(Cont.)

TABLE 1. *(Cont.)*

Percichthyidae

Morone saxatilis

E. labracis	Md.	Krøyer, 1863
E. labracis	Pa.	Leidy, 1887
E. labracis	Mass.	Wilson, 1911
E. labracis	Wash., D.C.	Wilson, 1911
E. labracis	Va.	Wilson, 1911
E. labracis	Mass.	Wilson, 1932

M. americanus

E. confusus	N.Y.	Tedla and Fernando, 1969b
E. sp.	Me.	Meyer, 1954

M. chrysops

E. caeruleus	Iowa	Wilson, 1916
E. centrarchidarum	Iowa	Wilson, 1916
E. versicolor	La.	Causey, 1957

M. mississippiensis

E. versicolor	La.	Causey, 1957

Centrarchidae

Ambloplites rupestris

E. caeruleus	Mich.	Pearse, 1924
E. caeruleus	Wis.	Bangham, 1946
E. caeruleus	Wis.	Fischthal, 1950, 1952, 1947
E. caeruleus	Ont.	Bangham, 1955
E. caeruleus	N.Y.	Mueller, 1940
E. centrarchidarum	Ind.	Wilson, 1911
E. centrarchidarum	Ohio	Tidd, 1931
E. centrarchidarum	Mich.	Wilson, 1924
E. centrarchidarum	Mich.	Pearce, 1924
E. centrarchidarum	Que.	Roberts, 1970
E. centrarchidarum	Ont.	Tedla and Fernando, 1969a
E. centrarchidarum	L. Erie	Bangham and Hunter, 1939
E. centrarchidarum	Ont.?	Wright, 1882
E. confusus	Wis.	Bere, 1931
E. elegans	Wis.	Bangham, 1946
E. luciopercarum	Unk.	Roberts, 1970
E. sp.	N.Y.	Hunnien, 1936

Centrarchus macropterus

E. caeruleus	Tenn.	Bangham and Venard, 1942

Lepomis auritus

E. centrarchidarum	Ont.?	Wright, 1882
E. sp.	Me.	Meyer, 1954

Lepomis cyanellus

E. caeruleus	Iowa	Wilson, 1916
E. caeruleus	Ohio	Bangham, 1941b
E. caeruleus	Okla.	McDaniel and Bailey, 1966
E. centrarchidarum	Iowa	Wilson, 1916
E. arthrosis[10]	Okla.	McDaniel, 1963

Lepomis gibbosus

E. caeruleus	Iowa	Wilson, 1916
E. caeruleus	Wis.	Bangham, 1946
E. caeruleus	Wis.	Fischthal, 1950, 1947
E. caeruleus	Ohio	Bangham, 1941b

(Cont.)

TABLE 1. *(Cont.)*

E. caeruleus	Ont.	Bangham, 1955
E. caeruleus	Ont.	Tedla and Fernando, 1969a
E. centrarchidarum	Ont.	Tedla and Fernando, 1969
E. centrarchidarum	Ont.?	Wright, 1882
E. sp.	Me.	Meyer, 1954
Lepomis gulosus		
E. caeruleus	Iowa	Wilson, 1916
E. caeruleus	Fla.	Bangham, 1941c
E. caeruleus	Tenn.	Venard, 1941
E. caeruleus	Tenn.	Bangham and Venard, 1942
E. centrarchidarum	Ind.	Wilson, 1911
E. centrarchidarum	Iowa	Wilson, 1916
E. lizae	Ala.	Kelly and Allison, 1962
E. versicolor	La.	Causey, 1957
E. sp.	Tex.	Lawrence and Murphy, 1967
Lepomis macrochirus		
E. arthrosis	Ala.	Roberts, 1969a
E. caeruleus	N.J.	Smith, 1949
E. caeruleus	Ind.	Wilson, 1911
E. caeruleus	Ohio	Tidd, 1931
E. caeruleus	Ohio	Bangham, 1941b
E. caeruleus	Fla.	Bangham, 1941c
E. caeruleus	Wis.	Bangham, 1946
E. caeruleus	Wis.	Anthony, 1963
E. caeruleus	Wis.	Fischthal, 1950, 1952, 1947
E. caeruleus	Wis.	Roberts, 1970
E. centrarchidarum	Iowa	Wilson, 1916
E. centrarchidarum	Ohio	Bangham, 1941b
E. centrarchidarum	Ga.	Roberts, 1970
E. centrarchidarum	Tenn.	Bangham and Venard, 1942
E. centrarchidarum	Ind.	Wilson, 1911
E. centrarchidarum	Ohio	Bangham and Hunter, 1937
E. lizae	Ala.	Kelly and Allison, 1962
E. versicolor	Okla.	McDaniel, 1963
E. versicolor	La.	Causey, 1957
E. sp.	Calif.	Haderlie, 1953
E. sp.	Tex.	Lawrence and Murphy, 1967
Lepomis megalotis		
E. versicolor	Okla.	McDaniel, 1963
Lepomis microlophus		
E. caeruleus	Fla.	Bangham, 1941c
E. lizae	Ala.	Kelly and Allison, 1962
Lepomis punctatus		
E. caeruleus	Fla.	Bangham, 1941c
Micropterus dolomieui		
E. caeruleus	La.	Causey, 1957
E. caeruleus	Ohio	Bangham, 1933
E. caeruleus	Wis.	Bangham, 1946
E. caeruleus	B.C.	Bangham and Adams, 1954
E. caeruleus	Ont.	Bangham, 1955
E. caeruleus	Ohio	Bangham, 1941b, 1947, 1952
E. caeruleus	Tenn.	Venard, 1940
	Tenn.	Bangham and Venard, 1942
E. centrarchidarum[8]	Wis.	Bangham, 1946
E. centrarchidarum	Iowa	Wilson, 1916

(Cont.)

TABLE 1. *(Cont.)*

E. centrarchidarum	Ohio	Tidd, 1931
E. centrarchidarum	Ga.	Roberts, 1970
E. centrarchidarum	Fla.	Bangham, 1941c, 1938
E. centrarchidarum	Fla.	Mueller, 1936b
E. centrarchidarum	Mass.	Sinderman, 1953
E. centrarchidarum	Ohio	Bangham, 1933, 1941b
E. centrarchidarum	Conn.	Hunter, 1940
E. centrarchidarum	L. Erie	Bangham and Hunter, 1939
E. centrarchidarum	Iowa	Roberts, 1970
E. centrarchidarum[11]	Iowa	Wilson, 1916
E. sp.	Calif.	Haderlie, 1953
E. sp.	Tex.	Lawrence and Murphy, 1967
E. sp.	N.Y.	Hunnien, 1936
E. sp.	Wis.	Marshall and Gilbert, 1905

Pomoxis annularis

E. caeruleus	Iowa	Wilson, 1916
E. caeruleus	Ohio	Bangham, 1941b
E. centrarchidarum	Iowa	Wilson, 1916
E. sp.	Tex.	Lawrence and Murphy, 1967
E. caeruleus	Wis.	Fischthal, 1947, 1952
E. caeruleus	Ark.	Becker, *et al*, 1966
E. centrarchidarum	Ind.	Wilson, 1911
E. centrarchidarum	N.J.	Smith, 1949
E. centrarchidarum	Ohio	Bangham, 1933
E. centrarchidarum	Ohio	Bangham, 1941b
E. centrarchidarum	Mass.	Roberts, 1970
E. centrarchidarum	Ont.	Tedla and Fernando, 1969a
E. centrarchidarum	L. Erie	Bangham and Hunter, 1939
E. confusus	Wis.	Bere, 1931
E. sp.	Me.	Meyer, 1954
E. sp.	Ohio	Bangham, 1926
E. sp.	N.Y.	Hunnien, 1936

Micropterus punctulatus

E. caeruleus	Ohio	Bangham, 1933
E. caeruleus	Ark.	Becker, *et al*, 1966
E. centrarchidarum	Ohio	Bangham, 1933
E. versicolor	La.	Causey, 1957

Micropterus salmoides

E. caeruleus	Fla.	Bangham, 1941
E. caeruleus	N.J.	Smith, 1949
E. caeruleus	N.Y.	Mueller, 1936b
E. caeruleus	Ohio	Bangham, 1933, 1941b
E. caeruleus	Ark.	Becker, *et al*, 1966
E. caeruleus	Wis.	Anthony, 1963
E. caeruleus	Wis.	Fischthal, 1950, 1952, 1947
E. lizae	Ala.	Kelly and Allison, 1962
E. tenax	Tex.	Roberts, 1965
E. tenax	Tex.	Roberts, 1970

Pomoxis nigromaculatus

E. caeruleus	Iowa	Wilson, 1916
E. caeruleus	La.	Causey, 1957
E. caeruleus	N.J.	Smith, 1949
E. caeruleus	Wis.	Bangham, 1946
E. caeruleus	Wis.	Fischthal, 1950, 1952, 1947
E. sp.	N.D.	Voth and Larson, 1968

(Cont.)

TABLE 1. *(Cont.)*

Percidae		
Etheostoma caeruleum		
E. cotti	Ohio	Tidd, 1931
Etheostoma nigrum		
E. sp.	N.D.	Voth and Larson, 1968
E. sp.	N.D.	Hoffman, 1953
Perca flavescens		
E. caeruleus	Ohio	Tidd, 1931
E. caeruleus	Wis.	Pearse, 1924
E. luciopercarum[12]	Wis.	Bangham, 1946
E. caeruleus	Ont.	Bangham, 1955
E. centrarchidarum	Ont.?	Wright, 1882
E. luciopercarum[4]	Wis.	Bere, 1931
E. luciopercarum[4]	Ont.	Tedla and Fernando, 1969
E. luciopercarum[4]	Ont.	Telda and Fernando, 1970
E. sp.	Wis.	Marshall and Gilbert, 1905
E. sp.	N.D.	Voth and Larson, 1968
Stizostedion canadense		
E. caeruleus	Iowa	Wilson, 1916
E. caeruleus	Ohio	Tidd, 1931
E. caeruleus	L. Erie	Bangham and Hunter, 1939
E. caeruleus[4]	Iowa	Wilson, 1916
E. centrarchidarum	L. Erie	Bangham and Hunter, 1939
Stizostedion vitreum		
E. caeruleus	Wis.	Tidd, 1931
E. luciopercarum[12]	Wis.	Bangham, 1946
E. caeruleus	Ont.	Bangham, 1955
E. luciopercarum[12]	N.Y.	Mueller, 1940
E. luciopercarum[12]	L. Erie	Bangham and Hunter, 1939
E. centrarchidarum	L. Erie	Bangham and Hunter, 1939
E. centrarchidarum	Ind.	Wilson, 1911
E. luciopercarum[4]	Wis.	Bere, 1931
E. luciopercarum	Wis.	Roberts, 1970
E. luciopercarum	Penn.	Roberts, 1970
Pikeperches		
E. luciopercarum	Que.	Henderson, 1926
Mugilidae		
Mugil cephalus		
E. lizae	Tex.	Causey, 1953b
E. lizae	Tex.	Pearse, 1952a
E. lizae	N.C.	Pearse, 1947, 1948
E. lizae	Fla.	Pearse, 1952b
E. lizae	Fla.	Bere, 1936
E. lizae	Ga.	Roberts, 1970
E. mugilus	N.C.	Wilson, 1911
E. mugilus	Tex.	Causey, 1953b
E. mugilus	Fla.	Pearse, 1952b
E. mugilus	Mis.	Causey, 1955
E. mugilus	Mexico	Causey, 1955
Mugil curema		
E. lizae	La.	Krøyer, 1863[14]
E. lizae	Fla.	Pearse, 1952b

(Cont.)

TABLE 1. *(Cont.)*

E. lizae	Fla.	Bere, 1936
E. mugilus	La.	Causey, 1953a
E. mugilus	La.	Causey, 1957
E. nanus	La.	Causey, 1953a

[1] Reexamined, name corrected to *E. versicolor* from *E. elegans* by Roberts, (1970).
[2] Reexamined (at least in part), name corrected to *E. nerkae* from *E. caeruleus* by Roberts (1963, 1970).
[3] Reexamined (at least in part), name corrected to *E. centrarchidarum* from *E. caeruleus* by Roberts (1970).
[4] Originally reported as *E. confusus.*
[5] Reexamined (at least in part), name corrected to *E. nerkae* from *E. sp.* by Roberts (1963, 1970).
[6] Reexamined, name corrected to *E. cyprinaceus* from *E. versicolor* by Roberts (1970).
[7] Reexamined, name corrected to *E. arthrosis* from *E. versicolor* by Roberts (1969a).
[8] Reexamined, name corrected to *E. versicolor* from *E. elegans* by Roberts (1969a).
[9] Reexamined (at least in part), name changed to *E. manicatus* from *E. funduli* by Roberts (1970).
[10] Reexamined (in part), name changed to *E. arthrosis* from *E. versicolor* by Roberts (1969a).
[11] Reexamined, name corrected to *E. centrarchidarum* from *E. nigratus* by Roberts, (1970).
[12] Reexamined (at least in part), name changed to *E. luciopercarum* from *E. caeruleus* by Roberts (1970).
[13] Reexamined, name changed to *E. caeruleus* from *E. centrarchidarum* by Roberts (1970).
[14] Host reported as *Mugil liza.*

REVISED PARASITE-HOST CHECKLIST FOR THE GENUS ERGASILUS

Host parasite relationships that were reported from material of this study are noted with a single asterisk (*) following the host name. Relationships that were reported from material of this study and represent new records are noted with a double asterisk (**). Host names followed by (1) represent associations where only a single parasite has been recovered from the respective host, either in this study or the literature. Host names followed by (?) are host-parasite relationships that have been recorded in the literature but are considered questionable for reasons of doubt on correct parasite identification.

Ergasilus arthrosis Roberts
Alosa chrysochloris (1)
*Ictalurus furcatus**
I. melas
I. natalis
I. nebulosus
*I. punctatus**
*Pylodictis olivaris***
*Aphredoderus sayanus***(1)
Strongylura marina
*Labidesthes sicculus***(1)
*Morone mississippiensis***
*M. saxitalis***
*Lepomis gulosus**

*L. macrochirus**
*L. marginatus***
*L. megalotis**
*L. microlophus**
*L. punctatus***
*Micropterus punctulatus***
*M. salmoides**
*Pomoxis nigromaculatus***
*Percina caprodes*** (1)
*Caranx hippos*** (1)
*Achirus lineatus***

Ergasilus auritus Markevich
Onchorhynchus nerka
Gasterosteus aculeatus
Gillichthys mirabilis

Ergasilus caeruleus Wilson
Petromyzon marinus
Lepisosteus osseus (1)
L. spathula (?)
Anguilla rostrata (?)
Coregonus artedi (?)
Coregonus clupeaformis (?)
Acrochelis alutaceus (?)
Catostomus catostomus (?)
Catostomus commersoni (?)
Moxostoma valenciennesi (?)
Erimyzon sucetta (?)
Noturus gyrinus
N. flavus
*Aphredoderus sayanus**
Percopsis omiscomaycus (?)
Lota lota (?)
Fundulus chrysotus (?)
Morone chrysops
Ambloplites rupestris
Centrarchus macropterus
*Lepomis auritus***
*L. cyanellus**
L. gibbosus
*L. gulosus**
L. humilus
*L. macrochirus**
*L. marginatus***
*L. megalotis***
*L. microlophus**
*L. punctatus**
Micropterus dolomieui
M. punctulatus
M. salmoides
*Pomoxis annularis**
*P. nigromaculatus**
Perca flavescens
*Percina nigrofasciata***
Stizostedion canadense
S. vitreum
S. glaucum

Ergasilus celestis Mueller
*Anguilla rostrata**
Lota lota

Ergasilus centrarchidarum Wright
Osmerus mordax
Catostomus catostomus (?)
Erimyzon sucetta (?)
Microgadus tomcod (?)
*Morone chrysops**
Amloplites rupestris
*Centrarchus macropterus***
Lepomis auritus
*L. cyanellus**
L. gibbosus
*L. gulosus**
*L. macrochirus**
*L. punctatus***
Micropterus dolomieui
*M. punctulatus**
*M. salmoides**
*Pomoxis annularis**
*P. nigromaculatus**
Stizostedion canadense
S. vitreum

Ergasilus cerastes Roberts
*Ictalurus catus***
*I. furcatus***
*I. nebulosus**
*I. punctatus***

Ergasilus chatauquaensis Fellows
No hosts

Ergasilus clupeidarum Johnson and Rogers
*Alosa aestivalis***
*A. chrysochloris***
*Dorosoma cepedianum***
*D. petenense***

Ergasilus cotti Kellicott
Etheostoma caeruleus
Cottus bairdi

Ergasilus cyprinaceus Rogers
*Campostoma anomalum**
*Hybopsis storeriana***
*H. winchelli***
*Nocomis leptocephalus**
*Notemigonus crysoleucas***
*Notropis baileyi**
*N. chrysocephalus**
*N. longirostris***
*N. hypsilepis***
*N. roseipinnis***
*N. texanus***
*N. venustus***
*N. zonistius***
*Semotilus atromaculatus**
*Ictalurus natalis**
*I. nebulosus***
*Noturus nocturnus***
*Fundulus olivaceus***
Culaea inconstans (1)

Ergasilus elongatus Wilson
*Polyodon spathula**

Ergasilus felichthys (Pearse)
Arius felis (1)
*Bagre marinus**

Ergasilus funduli Krøyer
Osmerus mordax
*Adinia xenica***
*Cyprinodon variegatus**
*Fundulus grandis**
*F. heteroclitus**
F. majalis
*F. pulvereus**
*F. similis**
Jordanella floridae
*Lucania parva**
*Gambusia affinis**
*Poecilia latipinna***
*Menidia beryllina***
Gasterosteus aculeatus (1)
G. wheatlandi (1)

Ergasilus labracis Krøyer
*Morone saxatilis**

Ergasilus lanceolatus Wilson
Dorosoma cepedianum
*Hiodon tergisus***(1)

Ergasilus lizae Krøyer
*Cyprinodon variegatus**
Floridicthys carpio
*Fundulus grandis**
*F. similis**
Lepomis macrochirus
*Lagodon rhomboides***
*Leiostomus xanthurus**
Chaetodipterus faber
*Mugil cephalus**
*M. curema**

Ergasilus luciopercarum Henderson
Ambloplites rupestris (1)
Perca flavescens
Stizostedion vitreum

Ergasilus megaceros Wilson
*Dorosoma cepedianum***(1)
*Esox americanus***
Esox niger
*Hybognathus nuchalis***
*Hybopsis storeriana***
Notemigonus crysoleucas
*Notropis bellus***
*N. edwardraneyi***
*N. emilae***
*N. roseipinnis***
*N. shumardi***
*N. texanus***
*N. venustus***
*Pimephales promelas***
*P. vigilax***
Semotilus corporalis
Catostomus commersoni
*Erimyzon oblongus***
*E. sucetta**
Moxostoma sp. cf. *poecilurum***
*Ictalurus melas***
I. punctatus

Ergasilus nerkae Roberts
Gila atraria
Hybopsis plumbea
Mylocheilus caurinus
Ptychocheilus oregonensis
Richardsonius balteatus
Catostomus catostomus
C. fecundus
C. macrocheilus
Oncorhynchus nerka
Prosopium williamsoni
Salmo gairdneri

Ergasilus tenax Roberts
*Esox niger***(1)
*Lepomis gulosus***
*L. macrochirus***
*L. megalotis**
*L. microlophus***
*L. punctatus***
*Pomoxis annularis**
*P. nigromaculatus**

Ergasilus turgidus Fraser
Oncorhynchus nerka
Gasterosteus aculeatus
Cymatogaster aggregatus

Ergasilus versicolor Wilson
*Lepisosteus osseus**
L. platostomus
L. spatula

Notropis chrysocephalus
Catostomus commersoni
*Erimyzon oblongus***
*E. sucetta***
*E. tenuis***
*Ictiobus bubalus***
I. cyprinellus
*Minytrema melanops***
*Moxostoma poecilurum***
Ictalurus furcatus
I. melas
*I. natalis**
*I. nebulosus**
I. punctatus
Pylodictis olivaris
Morone chrysops (?)
M. interrupta (?)
Lepomis gulosus (?)
Micropterus punctulatus (?)
M. salmoides (?)
*Mugil cephalus***
*Pogonias cromis***(1)

Ergasilus wareaglei Johnson
*Catostomus commersoni***

*Hypentelium etowanum***
*H. nigricans***

Ergasilus Form A
*Mugil cephalus***

*M. curema***

Ergasilus Form B
*Mugil cephalus***

Host-parasite associations from the literature that are not applicable to acknowledged species:

Ergasilus confusus Bere
Coregonus clupeaformis
Coregonus sp.
Salvelinus namaycush
Pimephales promelas
Morone americana
Ambloplites rupestris
Micropterus dolomieui
Perca flavescens
Sitzostedion vitreum

Ergasilus elegans Wilson
Ictalurus melas
I. natalis
Ambloplites repestris

Ergasilus mugilus Vogt
Elops saurus (1)
Micropogon undalatus
Leiostomus xanthurus
Mugil cephalus

Ergasilus nanus Van Beneden
Trachinotus carolinus
Micropogon undulatus
Mugil curema

Ergasilus skrjabini Mueller
Morone chrysops
Percopsis omiscomaycus

SUMMARY AND CONCLUSIONS

This study provides a basis for opinions that hitherto had little backing. It had been the consensus of most workers that ergasilids exhibited "loose" specificity. Although the specificities of some *Ergasilus* species have broad ranges, some of the species have narrower preferentialism than most workers had previously surmised. Other species, such as *E. arthrosis,* have had their ranges of preferred hosts extended by the present study. Perhaps as important as determining the positive host affinities was demonstrating absence of various *Ergasilus* species on certain host groups.

Some of the *Ergasilus* species were shown to have very narrow specificity. *E. elongatus* is strictly specific to the paddlefish (*Polyodon spathula*), and *E. celestis* is strictly specific to *Anguilla rostrata* in the Southeast but has been shown in other work to accept the burbot (*Lota lota*) as a host within its range. That *E. celestis* infests these two unrelated fishes and not others is indeed a curiosity. Those species that were shown to infest hosts within one main genus are *E. cerastes, E. felichthys,* E. sp. Form A, and E. sp. Form B.

Other species apparently restrict their parasite activity to families of hosts. *E. clupeidarum* and *E. wareaglei* were noted as examples of infesting fishes within a family. *E. centrarchidarum* was shown to infest one family and at least occasional members

of others. Although there is little information to draw on, *E. lanceolatus* might have similar distribution.

The species that were recorded frequently from two or more families represent the remainder of the species in this study. Those species were *E. lizae, E. caeruleus, E. cyprinaceus, E. megaceros, E. versicolor,* and *E. arthrosis.* Even though they each had a relatively broad spectrum of host affinities, a limited number of fish were acceptable.

It was hoped that the study of specificity would contribute information of a practical nature. Smith's *(83)* report of a fish epizootic in a reservoir at New Brunswick, New Jersey showed *E. caeruleus* causing mortality of its preferred hosts but not other species. Kelly and Allison *(53)* concluded that a centrarchid epizootic that occurred in a brackish water lake in Alabama could be attributed to *E. lizae,* an ergasilid of mullets. It has been shown herein that *E. lizae* was actually a common parasite of centrarchids in coastal areas (*E. arthrosis*). It is our conviction that ergasilids will only cause epizootics of their preferred hosts when conditions favor rapid expansion of the parasite population. The possible exceptions to this assertion are cases where the unusual host is introduced into the population and must undergo a period of acclimatization.

There is much unknown about the ecological requirements of the species of *Ergasilus.* Post-hatching phases in the genus *Ergasilus* spend a large part of their lives free-living, and no doubt each has adapted to a preferred habitat. Where the hosts and species were obtained in this study provides limited reliable information on the specific habitat requirements since the hosts are not stationary. Some generalizations, however, may be made based on the distribution patterns. The species may be grouped as follows:

Coastal – *E. felichthys, E. funduli, E. lizae,* E. spp. cf. *lizae.*

Estuarine – *E. cerastes.*

Coastal and inland – *E. clupeidarum, E. versicolor.*

Estuarine and inland – *E. arthrosis.*

General inland – *E. celestis, E. caeruleus, E. megaceros, E. tenax.*

Inland – *E. centrarchidarum, E. cyprinaceus, E. wareaglei.*

It is likely that salinity affects the distribution of a number of these species but temperature should not be excluded as a possibility. The distributions of preferred hosts certainly influence the parasites' distributions.

The interdrainage distributions of the recorded species were shown to be generalized within the study area. Further study will be required to establish objectively the continental distributions for each species. It is apparent, however, that some species range on the Pacific Northwest isolated from the other species of the genus. The literature indicates that there is a zonal pattern of distribution for *E. luciopercarum* for even though preferred hosts range further southward the species has not been collected below a certain latitude. One species, *E. labracis,* is apparently restricted in continental distribution to the east coast of North America. Strong endemism has been demonstrated by only one species, *E. cotti,* but future investigation will probably extend its range.

Dispersal of *Ergasilus* has likely been facilitated by migrations of hosts. No resting stage is known for *Ergasilus,* and although movement by wind and in association with piscivorous birds or other animals are possibilities, an acceptable host must be sought shortly following displacement. Whatever the case, the parasites appear to be generally distributed where their preferred hosts are successfully established.

Incidence, intensity, and other numerical factors were not considered statistically since a certain amount of bias was introduced with incomplete and otherwise inadequate sampling. Generalized statements may be made from listed data from some fish groups. Ergasilids were very common on *Bagre marinus, Anguilla rostrata,* and the mugilids; they commonly occurred on centrarchids, brackish cyprinodontids and atherinids, catostomids, ictalurids, and percichthyids. The frequency of parasitism by *Ergasilus* was considered to be low for percids, cottids, and inland cyprinodontids.

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ADDENDUM

Since this was written, another *Ergasilus* species, *E. rhinos*, has been described* from the nasal fossae of centrarchid fishes of the Black River, North Carolina. The hosts were *Centrarchus macropterus*, flier; *Lepomis gibbosus*, pumpkinseed; and *Lepomis auritus*, redbreast. In the same paper, the authors recorded host relationships for *E. megaceros*. *E. megaceros* was noted to be found on the gills of *Notemigonus crysoleucas*, golden shiner, and *Ictalurus natalis*, yellow catfish.

* BURRIS, K. W. AND G. C. MILLER. 1972. *Ergasilus rhinos* sp. n. (Copepoda: Cyclopoida) from the nasal fossae of three centrarchid fishes of North Carolina. J. Parasit. 58:600-604.

LITERATURE CITED

(1) AMERICAN FISHERIES SOCIETY, Committee on Names of Fishes. 1970. A List of Common and Scientific Names of Fishes from the United States and Canada.

(2) ANTHONY, J. D. 1963. Parasites of Eastern Wisconsin Fishes. Trans. Wis. Acad. Sci., Arts, Letters, 52:83-95.

(3) BANGHAM, R. V. 1926. Parasites Other Than Cestodes in Black Bass of Ohio. Ohio J. Sci., 26:117-127.

(4) ———. 1933. Parasites of the Spotted Bass, *Micropterus pseudaplites* Hubbs, and Summary of Parasites of Smallmouth and Largemouth Black Bass from Ohio Streams. Trans. Amer. Fish. Soc., 63:220-227.

(5) ———. 1938. Parasites of Centrarchidae from Southern Florida. Trans. Amer. Fish. Soc., 68:263-268.

(6) ———. 1941a. Parasites of Fish of Algonquin Park Lakes. Trans. Amer. Fish. Soc., 70:161-171.

(7) ———. 1941b. Parasites from Fish of Buckeye Lake, Ohio. Ohio J. Sci., 41:441-448.

(8) ———. 1941c. Parasites of Freshwater Fish of Southern Florida. Proc. Fla. Acad. Sci., 5:289-307.

(9) ———. 1946. Parasites of Northern Wisconsin Fish. Trans. Wis. Acad. Sci., Arts, Letters, 36:291-325.

(10) ———. 1951. Parasites of Fish in the Upper Snake River Drainage and in Yellowstone Lake, Wyoming. Zoologica, 36:213-219.

(11) ———. 1955. Studies on Fish Parasites of Lake Huron and Manitoulin Island. Amer. Midl. Nat. 53:184-194.

(12) ——— AND J. R. ADAMS. 1954. A Survey of the Parasites of Freshwater Fishes from the Mainland of British Columbia. J. Fish. Res. Bd. Canada, 11:673-708.

(13) ——— AND G. W. HUNTER, III. 1939. Studies on Fish Parasites of Lake Erie. Distribution Studies. Zoologica, 24:385-448.

(14) ——— AND C. E. VENARD. 1942. Studies on Parasites of Reelfoot Lake Fish. IV. Distribution Studies and Checklist. J. Tenn. Acad. Sci., 17:22-38.

(15) BECKER, D. A., R. G. HEARD, AND P. D. HOLMES. 1966. A Pre-Impoundment Survey of Helminth and Copepod Parasites of *Micropterus* spp. of Beaver Reservoir in Northwest Arkansas. Trans. Amer. Fish. Soc., 95:23-34.

(16) BERE, R. 1930. The Parasite Copepods of the Fish of the Passamaquoddy Region. Contrib. Canadian Biol. N.S., 5:423-430.

(17) ———. 1931. Copepods Parasitic on Fish of the Trout Lake Region, with Descriptions of Two New Species. Trans. Wisc. Acad. Sci., Arts, Letters, 26:427-436.

(18) ———. 1936. Parasitic Copepods from Gulf of Mexico Fish. Amer. Midl. Nat., 17:577-625.

(19) CALDWELL, RICHARD D. 1965. A Study of the Fishes from Limestone Springs in the Valley and Ridge Province of the Mobile Basin. Unpublished Master's Thesis. Univ. of Ala.

(20) CARL, G. C. 1937. Flora and Fauna of Brackish Water. Ecology, 18:446-453.

(21) CAUSEY, D. 1953a. Parasitic Copepoda from Grand Isle, Louisiana. Occ. Pap. Mar. Lab. La. State Univ. No. 7, 18 p.

(22) ———. 1953b. Parasitic Copepoda of Texas Coastal Fishes. Inst. Mar. Sci., 3:7-16.

(23) ———. 1955. Parasitic Copepoda from Gulf of Mexico Fish. Occ. Pap. Mar. Lab. La. State Univ. No. 9, 19 p.

(24) ———. 1957. Parasitic Copepoda from Louisiana Freshwater Fish. Amer. Midl. Nat., 58:378-382.

(25) COPE, O. B. 1959. New Parasite Records from Stickleback and Salmon in an Alaskan Stream. Trans. Amer. Microsc. Soc., 78:157-162.

(26) COOK, FANNYE A. 1959. Freshwater Fishes of Mississippi. Miss. Game and Fish Comm., Jackson, Miss., 239 p.

(27) CRESSEY, R. F. AND B. B. COLLETTE. 1970. Copepods and Needlefishes: A Study in Host Parasite Relationships. Fishery Bulletin, 68:347-432.

(28) DAVIS, C. E. 1969. *Ergasilus luciopercarum* Males in an Unusual Collection from Newfoundland. Canadian J. Zool., 47:1,249-1,252.

(29) FELLOWS, C. S. 1887. A Description of *Ergasilus chautauquaensis*, a New Species of Copepoda, and a List of Other Entomostraca Found at Lake Chautauqua, in August, 1886. Proc. Amer. Soc. Microscopists, 9:246-249.

(30) FISCHTHAL, J. H. 1947. Parasites of Northwest Wisconsin Fishes. I. The 1944 survey. Trans. Wis. Acad. Sci., Arts, Letters, 37:157-220.

(31) ———. 1950. Parasites of Northwest Wisconsin Fishes. II. The 1945 survey. Trans. Wis. Acad. Sci., Arts, Letters, 49:87-113.

(32) ———. 1952. Parasites of Northwest Wisconsin Fishes. III. The 1946 survey. Trans. Wis. Acad. Sci., Arts, Letters, 41:17-58.

(33) ———. 1953. Parasites of Northwest Wisconsin Fishes. IV. Summary and Limnological Relationships. Trans. Wis. Acad. Sci., Arts, Letters, 42:83-108.

(34) ———. 1956. Observations on the Occurrence of Parasites in the Fishes of Certain South-central New York Streams. N.Y. Fish and Game J., 3:225-233.

(35) FRASER, C. M. 1920. Copepods Parasitic on Fish from the Vancouver Island Region. Trans. Roy. Soc. Canad. Sec. V, Ser. 3, 13: 45-67.

(36) GILBERT, R. J. 1969. The Distribution of Fishes in the Central Chattahoochee River Drainage. Unpublished Master's Thesis. Auburn Univ.

(37) GREENWOOD, P. H., D. E. ROSEN, S. H. WEITZMAN, AND G. S. MYERS. 1966. Phyletic Studies of Teleostean Fishes with a Provisional Classification of Living Forms. Bull. Amer. Mus. Nat. Hist., 131:341-445.

(38) HADERLIE, E. C. 1953. Parasites of the Fresh-water Fishes of Northern California. Univ. Calif. Pub. Zool., 57:303-440.

(39) HANEK, G. AND W. THRELFALL. 1970a. *Ergasilus auritus* Markewitsch, 1940 (Copepoda:Ergasilidae) from *Gasterosteus aculeatus* Linnaeus, 1758 in Newfoundland. Canad. J. Zool., 48:185-187.

(40) ———. 1970b. Metazoan Parasites of the American Eel (*Anguilla rostrata* (LeSueur)) in Newfoundland and Labrador. Canad. J. Zool., 48:597-600.

(41) ———. 1970c. Parasites of the Threespine Stickleback (*Gasterosteus aculeatus*) in Newfoundland and Labrador. J. Fish. Res. Bd. Canad., 27:901-907.

(42) HARMS, C. E. 1959. Checklist of Parasites from Catfishes of Northeastern Kansas. Trans. Kans. Acad. Sci., 62:262.

(43) ———. 1960. Some Parasites of Catfishes from Kansas. J. Parasitol., 46:695-701.

(44) HENDERSON, J. T. 1926. Description of a Copepod Gill-parasite of Pike-perches in Lakes of Northern Quebec, Including an Account of the Free-swimming Male and Some Developmental Stages. Contr. Canad. Biol., Fish., N.S., 7:237-245.

(45) HOFFMAN, G. L. 1953. Parasites of Fish of Turtle River, North Dakota. N. Dak. Acad. Sci., 7:12-19.

(46) ———. 1967. Parasites of North American Freshwater Fishes. Univ. Calif. Press, Berkeley, 486 p.

(47) HUNNINEN, A. V. 1936. Studies of Fish Parasites in the Delaware and Susquehanna Watersheds. N.Y. (State) Cons. Dept. Biol. Survey (1935):237-245.

(48) HUNTER, G. W., III. 1942. Studies on the Parasites of Freshwater Fishes of Connecticut. Conn. Geol. and Nat. Hist. Survey, Bull. No. 63, pp. 228-288.

(49) JOHNSON, S. K. 1969. Sodium Hypochlorite: Use on Parasitic Copepods for Identification. Trans. Amer. Microsc. Soc., 88:591-592.

(50) ———. 1973. *Ergasilus wareaglei* sp. n. (Copepoda:Cyclopoida) from North American Catostomid Fishes. Ala. Acad. Sci. (In Press).

(51) ———, AND W. A. ROGERS. 1972. *Ergasilus clupeidarum* sp. n. (Copepoda:Cyclopoida) from Clupeid Fishes of the Southeastern U.S. with a Synopsis of the North American *Ergasilus* Species with a Two-jointed First Endopod. J. Parasitol. 58:385-392.

(52) KELLICOTT, D. S. 1892. A Crustaceous Parasite of the "Miller's Thumb" (Cottus). Proc. Amer. Micr. Soc. 14:76-79.

(53) KELLY, H. D., AND R. ALLISON. 1962. Observations on the Infestation of a Fresh Water Fish Population by a Marine Copepod (*Ergasilus lizae* Krøyer 1863). Proc. 16th Ann. Conf. S.E. Game and Fish Comm. 16:236-239.

(54) KING, TOMMY. 1968. The Fishes of Chickasawhay River and its Drainage System. Unpublished Master's Thesis. Univ. of Sou. Miss.

(55) KRØYER, H. 1863. Bidrag til Kundskab om Snyltekrebsene. Naturhist. Tidssk. Serv. 3, 2:275-426.

(56) LAWRENCE, J. L. AND C. E. MURPHY. 1967. Parasites of Five Species of Fish from Benbrook Lake, Tarrant County, Texas. Tex. J. Sci., 19:164-174.

(57) LEIDY, J. 1889. Parasites of the Striped Bass. Proc. Acad. Nat. Sci. Philadelphia, 1888:125, 166-167.

(58) MARCOLIS, L. 1965. Parasites of an Auxiliary Source of Information about the Biology of Pacific Salmons (genus *Oncorhynchus*). J. Fish. Res. Bd. Canad., 22:1,387-1,395.

(59) MARKEVICH, A. P. 1940. New Freshwater Copepoda Parasitica of the Family Ergasilidae. Pratsi Naukovo-doslidnii Inst. Biol. KDU, 4:107-121 (In Ukrainian, summaries in Russian and English).

(60) MARSHALL, W. S. AND N. C. GILBERT. 1905. Rep. U.S. Bur. Fish., 1904:513-522.

(61) MARTIN, BILLY J. 1963. The Fishes of the Tallahala Creek Drainage System (Jasper, Jones, and Perry counties, Miss.). Unpublished Master's Thesis. Univ. of Sou. Miss.

(62) MCDANIEL, J. S. 1963. Parasites from the Genus *Lepomis* (Centrarchidae) in Lake Texoma, Oklahoma. Trans. Amer. Microsc. Soc., 82:423-425.

(63) ——— AND H. H. BAILEY. 1966. Parasites of Centrarchidae from Little River, Oklahoma. Trans. Kan. Acad. Sci., 69:45-47.

(64) METTEE, M. F. 1970. A Survey of Fishes of the Choctawhatchee Bay Drainage in Alabama and Florida. Unpublished Master's thesis, Univ. of Ala.

(65) MEYER, M. C. 1954. The Larger Animal Parasites of the Freshwater Fishes of Maine. Maine Dept. Inland Fisheries and Game, Augusta. 88 p.

(66) MILLER, R. R. 1958. Origin and Affinities of the Freshwater Fish Fauna of Western North America, p. 187-222 *In* Zoogeography. AAAS Publication 51. Horn-Shafer, Baltimore, 509 p.

(67) MUELLER, J. F. 1936a. Parasitic Copepods of the Syracuse Region. Jubilee Collection of Papers in Honor of Professor Skrjabin, Moscow: 412-425.

(68) ———. 1936b. Notes on some Parasitic Copepods and a Mite, Chiefly from Florida Freshwater Fishes. Amer. Midl. Nat., 17:807-815.

(69) ———. 1940. Parasitism and Disease in Fishes of the Lake Ontario Watershed. New York (State) Cons. Dept. Biol. Survey (1939):211-225.

(70) MYERS, G. S. 1949. Salt Tolerance of Freshwater Fish Groups in Relation to Zoogeographical Problems. Bijdragen tot de Dierkunde. 28:315-322.

(71) PEARSE, A. S. 1924. The Parasites of Lake Fishes. Trans. Wisc. Acad. Sci., Arts, Letters, 21:161-194.

(72) ———. 1947. Parasitic Copepods from Beaufort, North Carolina. J. Elisha Mitchel Sc. Soc. 63:1-16.

(73) ———. 1948. A Second Report on Parasitic Copepods Collected at Beaufort, North Carolina. Ibid. 64:127-131.

(74) ———. 1952a. Parasitic Crustacea from the Texas Coast. Inst. Mar. Sci., Port Aransas, Texas. 2:5-42.

(75) ———. 1952b. Parasitic Crustaceans from Alligator Harbor, Florida. Quart. J. Fla. Acad. Sci., 15:187-243.

(76) ROBERTS, L. S. 1963. *Ergasilus nerkae* n. sp. (Copepoda:Cyclopoida) from British Columbia with a Discussion of the Copepods of the *E. caeruleus* Group. Canad. J. Zool., 41:115-124.

(77) ———. 1965. *Ergasilus tenax* sp. n. (Copepoda:Cyclopoida) from the White Crappie, *Pomoxis annularis* Rafinesque. J. Parasitol., 51:987-989.

(78) ———. 1969a. *Ergasilus arthrosis* n. sp. (Copepoda:Cyclopoida) and the Taxonomic Status of *Ergasilus versicolor* Wilson, 1911, *Ergasilus elegans* Wilson, 1916, and *Ergasilus celestis* Mueller, 1936, from North American Fishes. J. Fish. Res. Bd. Canad., 26: 997-1,011.

(79) ———. 1969b. *Ergasilus cerastes* sp. n. (Copepoda:Cyclopoida) from North American Catfishes. J. Parasitol., 55:1,266-1,270.

(80) ———. 1970. *Ergasilus* (Copepoda:Cyclopoida) Revision and Key to Species in North America. Trans. Amer. Microsc. Soc., 89:134-161.

(81) ROGERS, W. A. 1969. Ergasilus cyprinaceus sp. n. (Copepoda: Cyclopoida) from Cyprinid Fishes of Alabama, with Notes on its Biology and Pathology. J. Parasitol., 55:443-446.

(82) SINDERMAN, C. J. 1953. Parasites of Fishes of North Central Massachusetts. Reprinted from Fisheries Report, 1950, Mass. Div. Fish., Game, Boston, 28 p.

(83) SMITH, R. F. 1949. Notes on *Ergasilus* Parasites from the New Brunswick, New Jersey Area with a Check List of all Species and Hosts East of the Mississippi River. Zoologica, 34:127-132.

(84) SMITH-VANIZ, W. F. 1968. Freshwater Fishes of Alabama. Auburn Univ. (Ala.) Agr. Exp. Sta., Auburn, Ala., 211 p.

(85) TEDLA, S. AND C. H. FERNANDO. 1969a. Observations on the Biology of *Ergasilus* spp. (Cyclopoida:Copepoda) Infesting North American Freshwater Fishes. Canad. J. Zool., 47:405-408.

(86) ———. 1969b. Changes in the Parasite Fauna of the White Perch *Roccus americanus* (Gmelin), Colonizing New Habitats. J. Parasitol., 55:1,063-1,066.

(87) ———. 1970. Some Aspects of the Ecology of the Parasite Fauna of the Gills of Yellow Perch, *Perca flavescens*. J. Fish. Res. Bd. Canad., 27:1,045-1,950.

(88) THOMSEN, R. 1949. Copepodos Parasitos de los Peces Marinos del Uruguay. Comun. Zool. Mus. Hist. Nat. Montevido, 3:1-41, plates 1-14.

(89) THORNE, W. AND H. B. PETERSON. 1967. Salinity in United States Waters, p. 221-240. *In* Agriculture and the Quality of our Environment. AAAS Publication 85, 460 p.

(90) THRELFALL, W. AND G. HANEK. 1970a. Metazoan Parasites, Excluding Monogenea from Longnose and White Suckers. J. Fish. Rec. Bd. Canad., 27:1,317-1,319.

(91) ———. 1970b. Metazoan Parasites of Salmonids and Coregonids from Avalon Peninsula, Newfoundland. J. Fish. Res. Bd. Canad., 27:1,894-1,897.

(92) TIDD, W. M. 1931. A List of Parasitic Copepods and Their Fish Hosts from Lake Erie. Ohio J. Sci., 31:453-454.

(93) ——— AND R. V. BANGHAM. 1945. A New Species of Parasitic Copepod, *Ergasilus osburni*, from the Burbot. Trans. Amer. Microsc. Soc., 64:225-227.

(94) VENARD, C. E. 1940. Studies on Parasites of Reelfoot Lake Fish. I. Parasites of the Largemouthed Black Bass, *Huro salmoides* (Lacepede). J. Tenn. Acad. Sci., 15:43-63.

(95) ———. 1941. Studies of Parasites of Reelfoot Lake Fish. II. Parasites of the Warmouth Bass, *Chaenobryttus gulosus* (Cuvier and Valenciennes). J. Tenn. Acad. Sci., 16:14-16.

(96) VOGT, C. 1877. Recherches Cotieres; Seconde Memoire, Seconde Section, de la Famille des Chondracanthides. Mem. Inst. Nat. Genevois, 13:75-100.

(97) VOTH, D. R. AND O. R. LARSON. 1968. Metazoan Parasites of some Fishes from the Goose River, North Dakota. Amer. Midl. Nat., 79:216-224.

(98) WILLIAMS, *J. D.* 1965. Studies on the Fishes of the Tallapoosa River System in Alabama and Georgia. Unpublished Master's Thesis, Univ. of Ala.

(99) WILSON, C. B. 1911. North American Parasitic Copepods Belonging to the Family Ergasilidae. Proc. U.S. Natl. Mus., 39:263-400.

(100) ———. 1916. Copepod Parasites of Freshwater Fishes and their Economic Relations to Mussel Glochidia. Bull. U.S. Bur. Fish., 34:331-374.

(101) ———. 1924. New North American Parasitic Copepods, New Hosts, and Notes on Copepod Nomenclature. Proc. U.S. Nat. Mus. Vol. 64, Art. 17, p. 1-22.

(102) ———. 1932. The Copepods of the Woods Hole Region, Massachusetts. Bull. U.S. Nat. Mus., 158:1-635.

(103) WILSON, K. A. AND K. RONALD. 1967. Parasite Fauna of the Sea Lamprey (*Petromyzon marinus* von Linne) in the Great Lakes Region. Canad. J. Zool., 45:1,083-1,092.

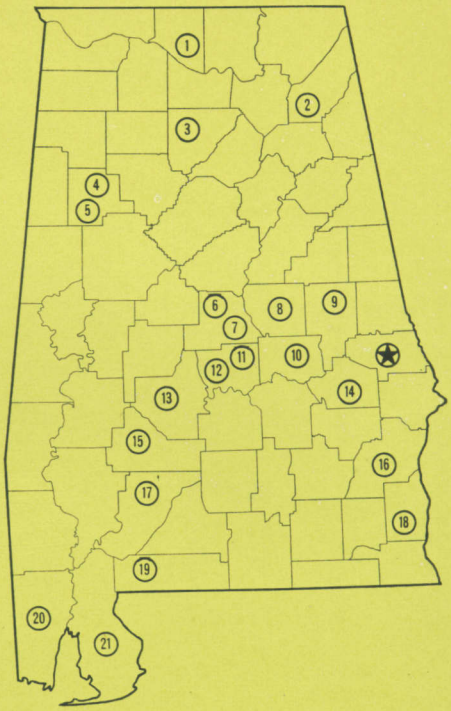
(104) WILSON, M. S. 1959. Branchiura and Parasitic Copepoda, p. 862-868. *In* W. T. Edmondson [ed.], Freshwater Biology, Wiley, New York.

(105) WRIGHT, R. R. 1882. Notes on American Parasitic Copepoda No. 1. Proc. Canad. Inst., N.S., 1:243-254.

(106) YAMAGUTI, S. 1963. Parasitic Copepoda and Branchiura of Fishes. Interscience, New York. 1,104 p.

AGRICULTURAL EXPERIMENT STATION SYSTEM OF ALABAMA'S LAND-GRANT UNIVERSITY

With an agricultural research unit in every major soil area, Auburn University serves the needs of field crop, livestock, forestry, and horticultural producers in each region in Alabama. Every citizen of the State has a stake in this research program, since any advantage from new and more economical ways of producing and handling farm products directly benefits the consuming public.



Research Unit Identification

★ Main Agricultural Experiment Station, Auburn

1. Tennessee Valley Substation, Belle Mina.
2. Sand Mountain Substation, Crossville.
3. North Alabama Horticulture Substation, Cullman.
4. Upper Coastal Plain Substation, Winfield.
5. Forestry Unit, Fayette County.
6. Thorsby Foundation Seed Stocks Farm, Thorsby.
7. Chilton Area Horticulture Substation, Clanton.
8. Forestry Unit, Coosa County.
9. Piedmont Substation, Camp Hill.
10. Plant Breeding Unit, Tallassee.
11. Forestry Unit, Autauga County.
12. Prattville Experiment Field, Prattville.
13. Black Belt Substation, Marion Junction.
14. Tuskegee Experiment Field, Tuskegee.
15. Lower Coastal Plain Substation, Camden.
16. Forestry Unit, Barbour County.
17. Monroeville Experiment Field, Monroeville.
18. Wiregrass Substation, Headland.
19. Brewton Experiment Field, Brewton.
20. Ornamental Horticulture Field Station, Spring Hill.
21. Gulf Coast Substation, Fairhope.