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ACANTHOCEPHALA FROM FISHES OF DOUGLAS
LAKE, MICHIGAN¹

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The writer has recently described two new species of Acanthocephala, *Neoechinorhynchus crassus* and *Octospinifer macilentus*², from the common sucker of Douglas Lake, Michigan. Of these the latter represents a new genus. The specimens forming the basis for these descriptions were from the extensive collections taken by Dr. George R. La Rue during the summer of 1912 in connection with investigation at the University of Michigan Biological Station. In the course of his investigation more than 375 specimens representing sixteen different species of fish were examined for parasites. The Acanthocephala obtained in this extensive piece of work together with exceptionally complete data were sent to the writer for identification and study. Since no intensive study has been

¹ Contributions from the Zoological Laboratory of the University of Illinois, No. 137.

² Illinois State Natural History Survey, Volume 13, Article 8. In addition to the descriptions of the two new species mentioned above the same work contains the description of *Pomphorhynchus bulbocollis* Linkins which is cited subsequently in this paper.

made upon the Acanthocephala of a habitat in North America similar to the one under consideration it seems desirable to present the results of this investigation. A number of new hosts have been discovered. These with biological data concerning a number of species, including a number of important negative findings, will add to the available data concerning this important group of fish parasites. In connection with the presentation of negative records it must be remembered that the period over which the examinations extended was restricted to the months of July and August. Thus there is a possibility that fishes not parasitized with Acanthocephala during these two months might harbor them at other seasons of the year. Such periodicity has been shown by the writer (1916) to occur in varying degrees in certain freshwater species of Acanthocephala.

Reighard (1915) in his reconnaissance of the fishes of Douglas Lake has recorded twenty-two species of fish from this region. La Rue's examinations for parasites include data for sixteen of these species. Of the six species not represented in his records of examinations five are of rare occurrence in Douglas Lake, or at least have been infrequently taken in collections. These rare species of which no examinations are available are: *Notropis cayuga* Meek, *Etheostoma iozuae* Jordan and Meek, *Cottus ictalops* (Rafinesque), *Lota maculosa* (LeSueur), and *Umbra limi* (Kirtland). The last of these according to Reighard has never been taken in Douglas Lake itself. Consequently it is apparent that records containing data for sixteen of the species make possible an unusually comprehensive survey of the Acanthocephala infesting the fishes of the vicinity.

Eight of the sixteen species of fish included in this investigation were found to harbor Acanthocephala. The percentages

of infestation and the number of species of parasites found varied broadly in the different hosts. In the following section an analysis of the acanthocephalan infestation is given for each host species.

LIST OF SPECIES INFESTED WITH ACANTHOCEPHALA

Catostomus commersonii (Lacépède). Common Sucker.

Specimens examined: 15. Infested with Acanthocephala: 10.

Analysis of Infestation

Species represented in individual host	No. of instances
<i>Pomphorhynchus bulbocolli</i> Linkins, only.....	4
<i>Octospinifer macilentus</i> VanCleave, only	1
<i>Neoechinorhynchus crassus</i> VanCleave }	2
<i>Pomphorhynchus bulbocolli</i> Linkins }	
<i>Pomphorhynchus bulbocolli</i> Linkins }	1
<i>Echinorhynchus thecatus</i> Linton }	
<i>Pomphorhynchus bulbocolli</i> Linkins }	2
<i>Neoechinorhynchus crassus</i> VanCleave }	
<i>Octospinifer macilentus</i> VanCleave }	

Though four species of Acanthocephala were found in this host they were so distributed among individuals that no host specimen harbored representatives of more than three species. A few instances of simple infestation were recorded. Four individuals bore *Pomphorhynchus bulbocolli* only, while one carried a simple infestation of *Octospinifer macilentus*. *P. bulbocolli* was present in nine of the ten infested individuals. One specimen examined Aug. 5, 1912, harbored nearly three hundred fully matured parasites of this species, while other individuals collected at approximately the same time revealed but a very slight infestation. No satisfactory explanation has been found for this great variability in degree of infestation within the same host species from the same locality. It may be due to individual differences in food habits of the hosts or

to a strict localization of centers of infestation. If fishes bearing parasites which are discharging embryos frequent a restricted locality where suitable primary hosts occur in abundance, such an area might easily become a localized center of infestation. The individual fishes by chance or by choice habitually using such a center of infestation as a feeding ground would acquire heavy infestations of Acanthocephala. Other individuals feeding where infested primary hosts were less abundant would acquire relatively few parasites. It might be even possible for individuals to entirely avoid infestation because of individual peculiarities in selection of food.

Catostomus commersonii from the region under consideration is the type host for *Neoechinorhynchus crassus* and for *Octospinifer macilentus*. The former of these parasites was present in about 27% of the suckers examined and always occurred in association with one or two other species of Acanthocephala. *O. macilentus* appeared in 20% of the hosts. In one instance it constituted the sole infestation while in the remaining records it appeared along with both *N. crassus* and *P. bulbocollis*.

One specimen yielded two representatives of *Echinorhynchus thecatus*. While these were both fully mature individuals it seems probable that they represent an accidental infestation. The fact that members of this species may find lodging in the sucker and there reach sexual maturity indicates that there is no physiological barrier to the establishing of this species as a normal parasite of the sucker. The only apparent explanation of its general absence in the sucker must lie in the fact that neither primary nor intermediate hosts of *E. thecatus* enter into the food supply of this fish.

The sucker is by far the richest in acanthocephalan fauna of any of the fishes found in this region. One of its parasites,

N. crassus, is yet unknown for any other host as well as from any other locality. The diversity of its acanthocephalan infestation offers a number of interesting biological problems for consideration. Conditions for existence for the sucker are apparently not very favorable in Douglas Lake. This is probably one of the reasons for the great diversity in infestation. Professor Reighard (1915:225) has called attention to the large numbers of dead suckers that are thrown upon the beach during the summer. According to his observations they present strong evidence of starvation for they do not seem to be diseased "and are not usually parasitized heavily enough to account for their emaciation." If lack of proper quantities of suitable food may cause the death of numbers of individuals of this species it is not an unwarranted assumption that many individuals are led to take as food, organisms which under normal conditions are not included in the diet of members of this species. In this manner parasites not normally found in the digestive tract of this species find entrance with the unusual food substances taken by the starving fish. It is apparent that the primary or intermediate host of *Echinorhynchus thecatus* cannot normally serve as any conspicuous portion of the food supply of the sucker, for at the season when other species of fishes in the same locality are carrying heavy infestations of this parasite but one individual of *C. commersonii* carried a light infestation of this species. Its entrance into the intestine must have been due to some unusual circumstance such as that mentioned above.

La Rue's field notes show that of the fifteen specimens examined only seven were adult. Of these adult specimens only one was free from infestation and the epithelium lining the intestine of this one showed thickened patches surrounding pits which were evidently the scars left by the removal of pro-

boscides from an earlier acanthocephalan infestation. All of the purely negative records for this species are thus based upon examinations of immature fish.

Micropterus dolomieu Lacépède. Small-mouthed Black Bass.

Specimens examined: 10. Infested with Acanthocephala: 10.

Analysis of Infestation

Species represented in individual host	No. of instances
<i>E. thecatus</i> Linton, only.....	8
<i>P. bulbocolli</i> Linkins }	2
<i>E. thecatus</i> }	

M. dolomieu is preeminently the definitive host of *E. thecatus* in the region under consideration. Every fish examined contained this parasite in the digestive tract in numbers ranging from a single specimen to more than a hundred. In one host two individuals were removed from cysts, one from the ovary and one from the liver. In both these instances the parasites were small and immature. This would indicate that their presence outside of the digestive tract resulted from adaptability of the bass to the role of intermediate host for this species. This same species was frequently taken from the stomach of the host though the intestine and pyloric caeca seem to be the normal and more usual habitat.

A single specimen of *P. bulbocolii* was taken from the intestine of each of two hosts. Both of them were normal mature individuals.

Micropterus salmoides (Lacépède). Large-mouthed Black Bass.

Specimens examined: 4. Infested with Acanthocephala: 4.

Echinorhynchus thecatus is the only species of Acanthocephala discovered in the large-mouthed black bass of this locality. It occurred in each of the four individuals examined, though in much smaller numbers than encountered in *M.*

dolomieu. The number in a single host individual varied from one to five as a maximum.

The minute size of the representatives of *E. thecatus* found in this species is noteworthy in that it gives a probable clue to a periodicity in the life cycle of this species. All of the specimens of *M. salmoides* in this collection were examined about three weeks earlier than any of those of *M. dolomieu*. Since individuals of *E. thecatus* from the last named host were much the larger, many of them fully mature, and much more numerous than in *M. salmoides*, it seems that evidence is here presented of a periodicity in life cycle of the parasite. Since hosts taken the second week in July carried but few immature parasites while those taken the first week in August were heavily infested with sexually mature parasites there is probably a season of the year when *E. thecatus* is absent from the digestive tract of its normal definitive host. This is borne out by the evidence of an infestation period beginning in June or early July for the locality under consideration.

Ambloplites rupestris (Rafinesque). Rock Bass.

Specimens examined: 10. Infested with Acanthocephala: 7.

Analysis of Infestation

Species represented in individual host	No. of instances
<i>E. thecatus</i> Linton, only.....	5
<i>P. bulbocolli</i> Linkins, only	1
<i>E. thecatus</i> }	1
<i>P. bulbocolli</i> }	

E. thecatus is the most characteristic acanthocephalan of this host. Infestations were extremely light, single specimens being encountered frequently. The maximum infestation for an individual of this species comprised eighteen individuals of *E. thecatus* and a single one of *P. bulbocolli*. One host car-

ried a single gravid female of *P. bulbocolli* attached to the wall of the intestine.

A cyst in the stomach wall of one host individual yielded a single specimen of what is apparently *E. thecatus*.

Percina caprodes (Rafinesque). Log-perch.

Specimens examined: 13. Infested with Acanthocephala: 10.

Analysis of Infestation

Species represented in individual host	No. of instances
<i>E. thecatus</i> Linton, only	6
<i>P. bulbocolli</i> Linkins, only	1
<i>E. thecatus</i> }	3
<i>P. bulbocolli</i> }	

This species apparently serves *E. thecatus* both as intermediate and as definite host. Numerous cysts bearing *E. thecatus* were encountered, especially in the mesentery. All of the intestinal forms encountered were immature. However, the examinations were all made early in July. It has been pointed out previously that *E. thecatus* is apparently entering the infesting stage at about this time. It is consequently impossible to determine whether this host serves normally as a definitive host or whether the parasites were taken into the digestive tract and had not yet found time to encyst as would be the case if this species served only as intermediate host.

Pomphorhynchus bulbocolli is a normal intestinal parasite of this host, though it also is found in cysts. One specimen bore five normal adults attached to the intestine wall.

Reighard (1915) has referred to the association of the log-perch and suckers at the breeding season. It is possible that the encysted larvae in the bodies of the log-perch may be responsible to some extent for the infestations of *Pomphorhynchus* and of *Echinorhynchus* found in the sucker. The rare occurrence of *E. thecatus* in the sucker would indicate

that it finds entrance with some uncommon food substance. Thus two possibilities present themselves, either that the suckers occasionally feed upon the log-perch or the eggs of the log-perch may carry larval Acanthocephala with them at the time of their discharge from the body, thereby bringing an infestation into the suckers which are known to feed upon the eggs of the log-perch.

Perca flavescens (Mitchill). Yellow Perch.

Specimens examined: 168. Infested with Acanthocephala: 2.

A single specimen of *E. thecatus* was removed from the stomach of *P. flavescens*, and but one other individual was found in the washings from the intestines of forty fish of the same species. Of the 168 specimens of this fish examined, only 25 were searched minutely. The remaining 143 were not so thoroughly studied. In these the digestive tracts were removed and slit open. Shaking the opened intestine in salt solution usually secures representative samples of the worm parasites when the liquid is decanted. Even granting the probable escape of small, securely fixed specimens by this method, the carefully studied 25 individuals give ample evidence of the practically complete freedom of the perch in this region from attack by Acanthocephala.

Esox lucius Linnaeus. Common Pike.

Specimens examined: 10. Infested with Acanthocephala: 2.

Echinorhynchus thecatus was the only species of Acanthocephala discovered in this host. Of the two infested specimens one bore five parasites and the other a single one. All of these were small individuals, apparently not sexually mature, though collected in August when this species of parasite is mature in other hosts.

Ameiurus nebulosus (LeSueur). Common Bullhead.

Specimens examined: 2. Infested with *Acanthocephala*: 2.

Two dead specimens belonging to this species were picked up from the beach. A single specimen of *P. bulbocolli* was attached in the intestine of one of these, while the other bore two intestinal cysts each containing a young form of this same species of parasite.

LIST OF SPECIES NOT INFESTED WITH ACANTHOCEPHALA

Representatives of the following species were examined without revealing any evidence of acanthocephalan infestation. The number preceding each species name indicates the number of individuals examined.

6 *Leucichthys* sp.? Herring.

2 *Eupomotis gibbosus* (Linnaeus). Pumpkin Seed.

9 *Lepomis pallidus* (Mitchell). Blue-gill.

117 *Notropis hudsonius* (DeWitt Clinton) Spot-tailed Minnow.

1 *Notropis cornutus* (Mitchell). Common Shiner.

5 *Percopsis guttatus* Agassiz. Trout-perch.

2 *Pimephales notatus* (Rafinesque). Blunt-nosed Minnow.

2 *Semotilus atromaculatus* (Mitchill). Horned Dace.

NEW HOST RECORDS

As a result of this investigation a few new host records have been added to those previously recorded for *E. thecatus* and for *P. bulbocolli*.

New hosts for *E. thecatus*: *Catostomus commersonii*, *Esox lucius*, *Percina caprodes*.

New hosts for *P. bulbocilli*: *Catostomus commersonii*, *Percina caprodes*, *Micropterus dolomieu*, *Ambloplites rupestris*.

HOSTS OF SPECIES OF ACANTHOCEPHALA KNOWN FROM
DOUGLAS LAKE

The following table lists the host of each of the species of Acanthocephala considered in this study and in each instance indicates the relative abundance of the species of parasites in individuals of the host species.

Species of Acanthocephala	Host species	Relative infestation
<i>Echinorhynchus thecatus</i> Linton	<i>Micropterus dolomieu</i>	Abundant*
	<i>Percina caprodes</i>	Moderate
	<i>Ambloplites rupestris</i>	Slight**
	<i>Micropterus salmoides</i>	Slight
	<i>Catostomus commersonii</i>	Rare
	<i>Perca flavescens</i>	Rare
<i>Pomphorhynchus bulbocollis</i> Linkins	<i>Esox lucius</i>	Rare
	<i>Catostomus commersonii</i>	Slight
	<i>Percina caprodes</i>	Slight
	<i>Micropterus dolomieu</i>	Rare
	<i>Ambloplites rupestris</i>	Rare
<i>Octospinifer macilentus</i> VanCleave	<i>Ameiurus nebulosus</i>	Rare
	<i>Catostomus commersonii</i>	Moderate
<i>Neoechinorhynchus crassus</i> VanCleave	<i>Catostomus commersonii</i>	Moderate

* Words indicating relative degree of infestation have been assigned arbitrary value as follows:

Abundant—more than 50 parasites of the species under consideration found in at least some individuals of the host.

Moderate—of frequent occurrence but never more than 50 in a host individual.

Slight—never more than 10 parasites of this species in an infested host individual.

Rare—not more than 1 or 2 parasites of this species in an infested host individual.

**One individual had a "Moderate" infestation.

LITERATURE CITED

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