

## THE CLADOCERA AND COPEPODA OF TENNESSEE I. LIMNETIC CLADOCERA OF EAST TENNESSEE AND THE TVA RESERVOIRS

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### ABSTRACT

A six-year survey was conducted in East Tennessee and the TVA reservoirs to determine the species composition of the limnetic cladocera. Fifteen species in six genera; *Daphnia*, *Diaphanosoma*, *Bosmina*, *Holopedium*, *Leptodora*, and *Ceriodaphnia*; were represented in the collections. All species appeared in the plankton of at least one reservoir. However, *Daphnia pulex*, *Daphnia ambigua* and *Ceriodaphnia quadrangula* were more typical of the small lakes and ponds of East Tennessee; and *Daphnia retrocurva*, *Daphnia galeata mendotae*, *Holopedium gibberum* and *Holopedium amazonicum* were restricted to the reservoirs. Most species appearing in the reservoir plankton were uniformly distributed in the TVA system. Exceptions noted were *D. galeata mendotae* restricted to Norris Reservoir, *H. gibberum* restricted to Kentucky Reservoir, and *Daphnia laevis* and *H. amazonicum* restricted to the reservoirs on the Little Tennessee River.

### INTRODUCTION

A systematic resume of the cladocerans and copepods of Tennessee has never been published. This is regrettable for a variety of reasons. Studies prior to the construction of the large reservoir system by the Tennessee Valley Authority, along with proper post-impoundment studies, could have yielded a wealth of information dealing with dispersal and changes in species composition and diversity, and also could have provided some much needed basic information on the effect of changes in water quality on species distribution. The pre- and post-impoundment studies by Yeatman (1954) on Woods Reservoir near Tullahoma have presented one of the few examples of local changes in the species composition of zooplankton brought about by impoundment. Secondly, taxonomic and distributional studies being presently undertaken at the University of Tennessee have shown a rather large number of species of fish and crayfish in the state. Several new species have been collected as a result of a prodigious sampling program, and it is not inconceivable that the same will hold true for some groups of cladocerans and copepods. Finally, distributional records for cladocerans and copepods in North America, particularly in the Southeast, are spotty and incomplete, with data from Tennessee being especially scarce. The works of Eddy (1930) and Hoff (1943, 1944) on the plankton of Reelfoot Lake remain the only detailed studies of a given area in the state. Gerking (1963), reviewing the Reelfoot Lake data, remarked that the plankton had evidently changed greatly during the thirteen years between studies. This is probably true, but differences in sampling technique may have determined the presence or absence of certain species.

Green (1934) has studied the seasonal changes in

species composition and abundance of the zooplankton in Andrew Jackson Lake in Knox County. His study also provides information on the distribution of species in sinks and ponds in the vicinity of the lake. Recent visits by the author have indicated a complete change in the organisms present in the lake and ponds. Yeatman (1954) studied changes in species composition brought about by the impoundment of Woods Reservoir. Smith (1966) conducted a limited survey of the abundance and depth distribution of limnetic cladocera in the Taylor Creek embayment of Center Hill Reservoir. Isom (1963) listed the cladoceran *Leptodora kindtii* (Focke) in the tailwaters of Pickwick Dam. These references appear to be the only published accounts available pertaining to the distribution of limnetic species of cladocerans in the eastern half of Tennessee. It is probable that some unpublished data exists in the form of notes, reports, and theses. The author would greatly appreciate receiving any information of this type.

### METHODS

This report is the result of six years of sampling in East Tennessee and the TVA Reservoirs. A total of 356 collections from eleven counties and 19 reservoirs have been examined. Most of the TVA reservoirs, with the exception of those in Alabama, Georgia, and extreme northeastern Tennessee, have been sampled. Other reservoirs such as Dale Hollow, Center Hill, and numerous small impoundments have also come under scrutiny. All other collections have come from permanent and semi-permanent lakes and ponds. Most samples were taken with a no. 20 plankton tow-net. During the past year a no. 3 net has been employed in addition to the no. 20 net to provide greater numbers of the larger species. Collections were made during most months of the year and many localities were visited on a number of occasions to provide some seasonal information on species composition. Specimens of known littoral species were occasionally collected but are not included in this report.

### ANNOTATED LIST OF SPECIES

#### Genus *Daphnia* O. F. Müller

The systematics of North American *Daphnia* were revised by Brooks (1957). On the basis of major changes proposed for the taxonomy of the genus, all prior records must be reevaluated. For example, Brooks (*loc. cit.*) has shown that *Daphnia longispina* does not exist in North America; and that all existing records

pertaining to this species belong to one of several other species. In the absence of the original collections, records for *D. longispina* must be discarded in all cases where the synonymy is not clear. The study of *Daphnia* in Tennessee is particularly important since Brooks did not examine material from the state. Consequently, morphological variation in taxonomically important structures must be carefully examined, especially in species which appear to be at the extent of their range in Tennessee. Except where noted, all species were determined in the author's laboratory using Brooks (1957, 1959) as the authority for the genus.

*Daphnia pulex* Leydig *emend.* Richard. This species occurs over most of North America where it is primarily a pond form though it may become important in the plankton of some lakes. The author has taken specimens in many small, permanent and temporary ponds in Blount County, and in the plankton of the steam-plant impoundment of Cherokee Reservoir. Intensive sampling should reveal general distribution over the entire state, especially in small ponds during the spring and fall months.

*Daphnia laevis* Birge. This species is normally found in shallow, permanent or semi-permanent waters over most of its range in the southern United States. Brooks' (1957) distribution does not include Tennessee though most other southeastern states are listed. My records are unique in that they show the species to be a major limnetic form in Fontana, Calderwood, and Chilhowee Reservoirs. The only shallow-water collections of the species were from two small semi-permanent ponds in Blount County. Hoff (1943) listed *D. longispina elongata* from Reelfoot Lake which is probably this species. Green (1934) may also have collected it in Knox County though the synonymy is not clear.

*Daphnia catawba* Coker. Brooks (1957) examined collections containing this species from western North Carolina and concluded that its range extended into Tennessee. Though the author has failed to record the species from East Tennessee, it was listed by Smith (1966) for Center Hill Reservoir and by Green (1934) for Andrew Jackson Lake and all stations surrounding it. Collections examined by the author from Center Hill and Andrew Jackson Lake have revealed only *D. parvula*.

*Daphnia ambigua* Scourfield. This species is listed by Brooks (1957) as a small pond form and an important limnetic species in lakes of the glaciated portion of North America. Though Tennessee is listed in Brooks' (1957) distribution, this paper presents the first record of its collection in the state. In East Tennessee I collected it in five counties in small ponds. I also identified it in samples taken by the Tennessee Game and Fish Commission from the plankton of Kentucky Reservoir in May, 1966.

*Daphnia retrocurva* Forbes. According to Brooks (1957), *D. retrocurva* is "... confined to lakes of the glaciated portion of the continent which lies east of the

Rocky Mountains." Thus, its presence in Tennessee where it is widely distributed in the TVA reservoirs, is of major importance. The species has been collected in the plankton of Norris, Ft. Loudoun, Melton Hill, Watts Bar, Kentucky, and Dale Hollow Reservoirs. Green (1934) listed the species from Andrew Jackson Lake, but he may have been dealing with another species. In the material examined by the author, it was restricted to the reservoir and never found in small lakes and ponds.

*Daphnia parvula* Fordyce. This species is probably the most common daphnid in East Tennessee. It has been collected in more than 30 localities in habitats varying from small ponds to large impoundments. Its greatest abundance as a plankton species appears to be in the TVA system of the Little Tennessee River drainage where it occurs with *D. laevis*. It is also found in other reservoirs in East and West Tennessee though not as abundantly. It is quite abundant during the summer and fall months in small ponds in East Tennessee. The general distribution given by Brooks (1957) includes Tennessee though this report represents the first collection in the state.

*Daphnia galeata* Sars *mendotae* Birge. *Daphnia galeata mendotae* is the only subspecies of *D. galeata* found in North America, since *D. galeata galeata* is restricted to Eurasia (Brooks 1957). The distribution given by Brooks (*loc. cit.*) is disjunct, the subspecies being very common in the glaciated portions of the United States and present along the western part of the continent from Alaska to Central America. So far the author has encountered it only in Norris Reservoir. The specimens from Norris are somewhat variable when compared to Brooks' (*loc. cit.*) diagnosis, having helmets that are smoothly rounded. Dr. G. A. Cole (personal communication) has indicated that the same problem exists for Arizona specimens. Yeatman (1954) referred to the presence of *D. longispina galeata* in Woods Reservoir, and Hoff (1943) mentions *D. longispina apicata* form *galeata* from Reelfoot Lake. It is possible that both authors were dealing with *D. galeata mendotae*, but the original collections would have to be examined to confirm the possibility.

#### Genus *Holopedium* Zaddach

*Holopedium gibberum* Zaddach. This species occurs in the plankton of lakes with low mineral concentrations, particularly those with basins in igneous rock (Coker 1938). It is a typical northern species in the United States, and in Europe its distribution is limited to lakes with a pH range of 4.5-6.0 (Tauson 1932). These observations do not preclude the occurrence of *H. gibberum* in cold soft-water reservoirs in the Southeast. The author has seen the species in samples from Kentucky Reservoir taken by the Tennessee Game and Fish Commission in 1966. This is considered a new record for the state. Further sampling, including adequate physical and chemical measurements in Kentucky Reservoir, should be undertaken to determine seasonal abundance and environmental requirements, as

the species has evidently not established itself in the other reservoirs of the system.

In January, 1969, specimens of *Holopedium* were collected in Fontana and Santeetlah Reservoirs which appear to be intermediate between *H. gibberum* and *H. amazonicum*. The latter species was first described from the mouth of the Amazon River and since has been collected at Lake Charles, Louisiana. Brooks (1959) indicates that it will probably be collected in other areas of the Southeast. Typical specimens of *H. amazonicum* have no basal spine on the claw, no spinules on the ventral margins of the valves, a short and blunt postabdomen, and seven to eight anal spines. Some of our specimens have faint clusters of spinules on the valve margins while others lack them. The number of anal spines is 12, intermediate between the 7 to 8 for *H. amazonicum* and nearly 20 for *H. gibberum*. Coker (1938) examined a collection from Crystal Lake, Moore County, North Carolina, which contained a *Holopedium* species which he considered as intermediate between the two previously described species. His specimens all lacked spinules on the ventral margins of the valves and were intermediate in number of anal spines. McKee and Coker (1940) listed *H. amazonicum* from another locality in North Carolina, without indication of variability. The author has examined *H. gibberum* from Olaf's Pond, Itasca Park, Minnesota, in which the valve spinulation was variable. A small percentage of the adults lacked spinules while others were inconsistent in the degree of spinulation. A detailed morphological study of *Holopedium* in the United States will be necessary to differentiate the species.

#### Genus *Bosmina* Baird

*Bosmina longirostris* (O. F. Müller). This species is very common in North America in lakes and ponds, and has appeared in virtually every collection from Tennessee examined by the author. In the eastern part of the state it appears to reach maximum abundance during the colder months when competition may be low. Some populations become so large that specimens caught in the surface tension almost cover the lake.

*Bosmina coregoni* Baird. G. A. Cole (1959) identified this species from a collection made by the author in Dale Hollow Reservoir in July, 1958. The only other record of the species in Tennessee is that of Smith (1966) for Center Hill Reservoir. The species is difficult to separate morphologically from *B. longirostris* with which it may occur. Jones (1958) has expressed some doubt as to the specific distinction between the two species.

#### Genus *Leptodora* Lilljeborg

*Leptodora kindtii* (Focke). This species is generally considered to be confined to lakes in the northern United States and Canada. Coker (1938) recorded the species from Phelps Lake, Washington County, North Carolina, and considered his find the most southern record to that date. Isom (1963) collected the species

in the tailwaters of Pickwick Dam, the first record for Tennessee. The author collected *L. kindtii* in Dale Hollow Reservoir in 1958, and since that time has found it in six of the TVA impoundments. Though Coker's (*loc. cit.*) specimens were small and rare in the sample, the author's collections contain some very large individuals (19mm.), and in Melton Hill Reservoir they are sometimes so abundant that they clog a no. 10 plankton net in a very short time.

#### Genus *Diaphanosoma* Fischer

*Diaphanosoma leuchtenbergianum* Fischer. This species is characteristic of the summer plankton of East Tennessee reservoirs and small lakes. Kentucky Reservoir represents the author's only record of the species in the western part of the TVA system to date. Green (1934) was the first to record the species in Tennessee.

#### Genus *Ceriodaphnia* Dana

*Ceriodaphnia lacustris* Birge. Brooks (1959) lists the species as limnetic in lakes over most of the United States. The author collected specimens in Dale Hollow Reservoir, the only record he obtained in East Tennessee. Hoff (1943) was the first to list the species in the state.

*Ceriodaphnia quadrangula* (O. F. Müller). This species is widespread, found in the plankton of lakes and in the littoral zone among the weeds (Brooks 1959). The author has collected specimens in Ft. Loudoun Reservoir and a small lake in Knox County. The only other Tennessee records are those of Green (1934) and Yeatman (1954).

#### SUMMARY AND CONCLUSIONS

The distribution of most limnetic cladoceran species in the reservoirs of the Tennessee River appears to be quite uniform in spite of differences in water quality between the reservoirs. However, the restricted locations of *Holopedium gibberum* and *Daphnia galeata mendotae* may be partially related to water quality. *Holopedium gibberum* may be limited to lakes with a low mineral content and low pH (Coker 1938, Tauson 1932), though the author's knowledge of the species fails to substantiate this. Until more is known about the ecological requirements and tolerances of these species, the question of their unique distribution in the TVA system will remain unanswered. Other faunal differences in the reservoirs come to light when the drainage patterns are investigated. The limnetic fauna of the reservoirs on the Little Tennessee River is slightly different from that found in the reservoirs on the Tennessee River. The dominant species are *Daphnia pcrvula*, *Daphnia laevis*, *Bosmina longirostris*, *Diaphanosoma leuchtenbergianum*, and a species that is probably *Holopedium amazonicum*. *Daphnia laevis* and *H. amazonicum* appear in no other reservoirs in the system. This is also true for a copepod, *Diaptomus mississippiensis*, which is quite abundant in Fontana Reservoir.

All of the 15 species of limnetic cladocerans collected in the course of the study appeared in the plankton

of at least one reservoir. However, *Daphnia pulex*, *Daphnia ambigua*, and *Ceriodaphnia quadrangula* are more typical of the fauna of small lakes and ponds in East Tennessee, while *Daphnia retrocurva*, *Holopedium gibberum*, *Holopedium amazonicum*, and *Daphnia galeata mendotae* were restricted to the reservoirs.

The large number of collections precludes the listing of locality, date, and composition of all the samples. This information may be obtained from the author on request.

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