

OCCURRENCE OF *LERNAEA CYPRINACEA* ON ARKANSAS RIVER SHINERS AND PEPPERED CHUBS IN THE CANADIAN RIVER, NEW MEXICO AND TEXAS

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Parasitic cyclopoid copepods of the genus *Lernaea* commonly parasitize freshwater fishes. Infestations have been reported from Africa, Asia, Europe, and North America (Hoffman, 1999), and most reports have involved the cosmopolitan species *Lernaea cyprinacea* (Marcogliese, 1991). All naupliar and the first 4 copepodid stages follow the general developmental pattern for cyclopoid copepods (Grabda, 1963). Mating between males and females takes place during the fifth copepodid stage, and then females attach to the skin and gills of fish where they continue to develop. At maturity, female *Lernaea* have an unsegmented body, are several millimeters in length, and attach to the host fish by a basal cephalic anchor, from which their common name, anchor worm, is derived.

Although substantial mortality of fishes due to *Lernaea* parasitism is most closely associated with fish culture and aquaria-propagated populations (Dempster et al., 1988), a number of studies have reported the prevalence and effects of *Lernaea* parasitism in stream fish populations (Amin et al., 1973; Whitaker and Schlueter, 1975; Bulow et al., 1979; Adams, 1984; Medeiros and Maltchik, 1999). Prevalence of *Lernaea* parasitism on stream fish populations typically is less than 20% during the summer (Wilson et al., 1966; Bulow et al., 1979; Robinson et al., 1998); however, during periods of extreme environmental conditions, prevalence can exceed 60% (Medeiros and Maltchik, 1999). Members of the family Cyprinidae are among those fishes most susceptible to *Lernaea* infestation (Shariff et al., 1986; Goodwin, 1999).

In the Arkansas River drainage, 2 cyprinids, the Arkansas River shiner, *Notropis girardi*, and peppered chub, *Macrhybopsis tetranema*, have been extirpated from 85% and 90%, respectively, of their historic ranges (Larson, 1991; Luttrell et al., 1999); however, both species re-

main common in the Canadian River upstream from Lake Meredith, Texas (Bonner and Wilde, 2000). The purpose of this study was to determine the prevalence and potential effects of *L. cyprinacea* parasitism on Arkansas River shiners and peppered chubs in the Canadian River, New Mexico and Texas.

Arkansas River shiners and peppered chubs were collected during September 1996 through August 1998 at 3 locations on the Canadian River, New Mexico and Texas, between Ute Reservoir (Quay Co., New Mexico) and Lake Meredith (Potter, Moore, and Hutchinson counties, Texas). Fish were sampled monthly except during May through August, when sampling was conducted twice per month. Fish were collected with a 1.8 × 3.4-m seine (5-mm mesh) and preserved in 10% buffered formalin. In the laboratory, total length (TL, mm) and weight (WT, g) were measured for each fish, and the number and attachment location of *L. cyprinacea* were recorded.

For each species, linear regression was used to model the weight-length relationships for fish parasitized by *L. cyprinacea* and for those that were not parasitized. Homogeneity of slopes ($\alpha = 0.05$) between parasitized and unparasitized fish was assessed with analysis of covariance (Neter et al., 1996). Both weight and length were \log_{10} transformed to improve linearity and homogeneity of variances. Only individuals collected during May through September in both years were used in regression analyses. To prevent possible length effects, unparasitized fish were included in regression analyses only if their length was within the range of lengths of parasitized fish of that species.

Of a total of 2,398 Arkansas River shiners and 2,316 peppered chubs collected, 1.3% and 0.8% were parasitized by *L. cyprinacea*. For Arkansas River shiners, prevalence of *L. cyprinacea* did not vary among sites (0.7 to 1.7%; $\chi^2 =$

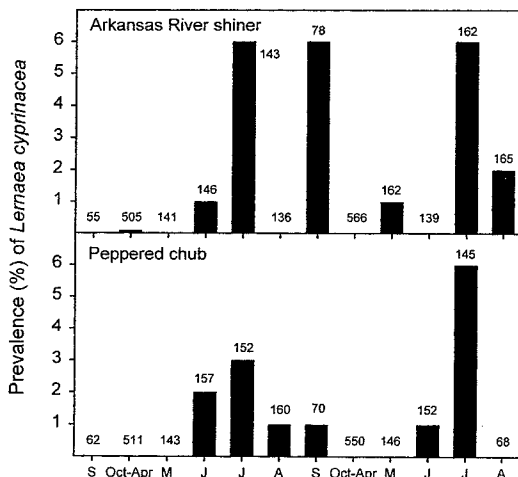


FIG. 1.—Prevalence of *Lernaea cyprinacea* on Arkansas River shiners and peppered chubs from the Canadian River, New Mexico and Texas, during September 1996 through August 1998. Numbers indicate total numbers of fish (parasitized and unparasitized) in each sample.

3.28; $df = 2$; $P = 0.19$). For peppered chubs prevalence also did not vary among sites (0.4 to 1.3%; $\chi^2 = 4.07$; $df = 2$; $P = 0.13$). Mean parasite intensity (number of parasites per fish) was 1.07 for Arkansas River shiners and 1.0 for peppered chubs. Arkansas River shiners were parasitized only during May through September, with the exception of 1 individual captured in November 1996. Peppered chubs were parasitized by *L. cyprinacea* from June through September. During these periods, monthly prevalence ranged from 0% to 6% in both species (Fig. 1). In both years of our study, the prevalence of parasitism was greatest during July in both species. Prevalence of *Lernaea* on fish typically increases during the summer when water temperatures exceed 25°C (Marcogliese, 1991; Medeiros and Maltchik, 1999), although parasitized fish can be found during the fall and winter (Bulow et al., 1979).

On Arkansas River shiners, *L. cyprinacea* typically were found attached to the base of the pelvic (26% of all attachments) and pectoral fins (26%). Other points of insertion included the gills (15%) and the base of the dorsal (15%), caudal (11%), and anal fins (7%). On peppered chubs, *L. cyprinacea* attached to the base of the pelvic (41%), pectoral (35%), and dorsal fins (18%) and the gills (6%). Attach-

ment of *L. cyprinacea* at the base of fins in stream fish is common because fins provide the parasite protection from current and abrasion (McNeil, 1961; Bulow et al., 1979). Furthermore, tissues at the base of fins might be penetrated more easily than those at other locations along the body (Bulow et al., 1979).

Weight-length relationships of Arkansas River shiners parasitized by *L. cyprinacea* and those that were not were $WT = 3.14 \log_{10} TL - 5.32$ ($n = 1,163$, $r^2 = 0.94$, $P < 0.0001$, range = 29 to 60 mm TL) and $WT = 2.73 \log_{10} TL - 4.71$ ($n = 29$, $r^2 = 0.88$, $P < 0.0001$, range = 29 to 60 mm TL), respectively. The weight-length relationship for peppered chubs parasitized by *L. cyprinacea* was $WT = 3.30 \log_{10} TL - 5.72$ ($n = 964$, $r^2 = 0.90$, $P < 0.0001$, range = 39 to 70 mm TL), and the relationship for those that were not parasitized was $WT = 3.52 \log_{10} TL - 6.62$ ($n = 19$, $r^2 = 0.85$, $P < 0.0001$, range = 39 to 70 mm TL). Weight-length relationships differed significantly among parasitized and unparasitized Arkansas River shiners ($F_{2,1192} = 9.54$, $P = 0.0021$), but there was no difference among peppered chubs ($F_{2,983} = 0.81$, $P = 0.4167$). The difference in the slopes of weight-length relationships among parasitized and unparasitized Arkansas River shiners implies that infested fish were thinner and potentially less fit than those without *L. cyprinacea*.

Although *L. cyprinacea* appears to have negatively affected the condition of Arkansas River shiners, the absence of any effect on peppered chubs, and the low observed prevalence of parasitism ($\leq 6\%$) in both species leads us to believe that *L. cyprinacea* parasitism had little adverse effect on populations of Arkansas River shiner and peppered chub in the Canadian River. A similarly low prevalence of *L. cyprinacea* parasitism (3%) was observed by Bulow et al. (1979) in a fish assemblage from the Cumberland River (Tennessee) drainage. In contrast, prevalence of *L. cyprinacea* averaged between 15% and 17%, throughout the year, in 2 streams located in semi-arid regions (Robinson et al., 1998; Medeiros and Maltchik, 1999), which have environmental conditions similar to those in the Canadian River.

Reduced stream flows, such as occur during drought, can increase the prevalence of *Lernaea* in stream fishes (Wilson et al., 1966; Medeiros and Maltchik, 1999); however, we found no evidence of increased parasitism in Arkan-

sas River shiners and peppered chubs between the 2 years of our study, even though the volume of the Canadian River was reduced 90% in 1998 because of severe drought (United States Geological Survey Gauging Station #07227500). Failure to observe any increase is surprising given the relatively protracted (60 days) period of reduced flows; however, longer periods (90+ days) might be necessary to allow *Lernaea cyprinacea* populations to reach large enough sizes to cause massive infestations (e.g., Medeiros and Maltchik, 1999).

Resumen—Se colectaron dos especies ciprínidas (*Notropis girardi* y *Macrhybopsis tetranema*) en el Río Canadian en Nuevo México y Texas de septiembre de 1996 a agosto de 1998. Un total de 2,398 *N. girardi* y 2,316 *M. tetranema*, 1.3% y 0.8%, respectivamente, se encontraron parasitados por *Lernaea cyprinacea*. La mayoría (99%) de las infestaciones ocurrieron de mayo a agosto en *N. girardi* y de junio a agosto en *M. tetranema*. La incidencia del parasitismo varió de 0–6% durante estos períodos para ambas especies en cada año. La relación peso-longitud en *N. girardi* parasitados fue significativamente ($P = 0.0021$) más baja que la de los no parasitados. La relación peso-longitud para *M. tetranema* no presentó diferencias significativas ($P = 0.4167$) entre los infestados y no infestados.

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