Lernaea cyprinacea (Crustacea: Copepoda: Lernaeidae) Anchorworms from Two Larval Aquatic Insects (Ephemeroptera: Baetidae, Trichoptera: Hydropsychidae) in Northeastern Oklahoma

Chris T. McAllister
Science and Mathematics Division, Eastern Oklahoma State College, 2805 NE Lincoln Road, Idabel, Oklahoma 74745

Charles R. Bursey
Department of Biology, Pennsylvania State University–Shenango Campus, 147 Shenango Avenue, Sharon, Pennsylvania 16146-1537

Samuel D. Martin
Department of Biological Sciences, University of Tulsa, 800 South Tucker Drive, Tulsa, Oklahoma 74104

Anchorworms (Copepoda) are deleterious parasites in both fish culture and in natural populations nearly worldwide (Lester and Hayward 2006). One species, *Lernaea cyprinacea* Linnaeus, exhibits little host specificity and has been reported previously from a variety of freshwater fishes, frogs, frog tadpoles and adult and larval salamanders (Stunkard and Cable 1931; Yashouv 1959; Shields and Tidd 1963; Tidd and Shields 1963; Welborn and Lindsey 1970; Whitaker and Schlueter 1975; Aliff et al. 1977; Hoffman 1999; Green et al. 2002; Kupferberg et al. 2009). However, we are unaware of any infestation in larval aquatic insects. Herein, we report the first infestation of *L. cyprinacea* in two orders of larval aquatic insects from Oklahoma.

Between September and October 2009, and again between March and September 2010, 256 larval aquatic insects, including 198 ephemeropterans belonging to four families (148 Amelitidae and Baetidae [*Baetis* sp.], and 50 Heptageniidae and Leptophlebiidae) and 58 trichopterans (Hydropsychidae [*Hydropsyche* sp.]) were collected by hand or dipnet from 14 sites in seven counties (Adair, Cherokee, Delaware, Mayes, Muskogee, Ottawa, and Sequoyah) of northeastern Oklahoma for geographic distribution studies; specimens were subsequently examined for copepods. These sites could be best described as small, clear upland streams with rocky or gravelly bottoms. Specimens were placed in vials containing 70% ethanol, returned to the laboratory, and examined in a Petri dish with a stereomicroscope. The specimens were processed according to methods provided by Williamson (1991) for copepods. Photomicrographs of attached parasites were taken using a DSLR camera fitted with a macro lens on extension tubes and a teleconverter. Individual photos are a focus stack of nine images using Zerene Stacker 1.02 (Zerene Stacker 2009-2010). Voucher specimens of attached parasites and their hosts were deposited in the invertebrate collection of Henderson State University, Arkadelphia, Arkansas, USA.

Five specimens of *L. cyprinacea* (without egg sacs) were recovered from the integument of four aquatic insects. Hosts included two *Baetis* sp. with one anchorworm and another with two anchorworms collected on 18 June 2010 and 2 September 2010 from 3.2 km W Colcord, Delaware County (36.1576°N, 94.4337°W, 324 m elevation), one *Baetis* sp. with one anchorworm from Council Hollow,

Ottawa County (36.4380°N, 94.4374°W, 169 m elevation) and a single *Hydropsyche* sp. with one anchorworm collected on 10 June 2010 from a tributary of Rock Creek, Adair County (35.5778°N, 94.4716°W, 231 m elevation). Prevalence was three of 41 (7.3%) *Baetis* sp. and one of 12 (8.3%) *Hydropsyche* sp., and overall prevalence between all larval ephemeropterans and trichopterans was four of 256 (1.6%). Interestingly, these hosts did not appear to be injured, either at or near the parasite attachment site.

The type host and locality of *L. cyprinacea* is the common or European carp, *Cyprinus carpio* from Europe (Linnaeus 1758). This anchorworm has been previously reported from Oklahoma by Hoffman (1999). Other reported North American hosts include at least 53 species of fishes (see complete list in Hoffman 1999) and amphibians (Recuero et al. 2010), including salamanders, adult bullfrogs (*Lithobates catesbianus*), green frogs (*Lithobates clamitans*), foothill yellow-legged frogs (*Rana boylii*) and various tadpoles (see Stunkard and Cable 1931; Baldauf 1961; Yashouv 1959; Tidd 1962, 1970; Shields and Tidd 1963; Aliff and Shoemaker 1966; Wellborn and Lindsey 1970; Aliff et al. 1977; Hoffman 1999; Green et al. 2002; Alcalde and Battistoni 2005; Kupferberg et al. 2009). The geographic range of *L. cyprinacea* in the USA includes 29 of 50 (58%) states: Alabama, Arkansas, Arizona, California, Colorado, Georgia, Indiana, Kansas, Kentucky, Maryland, Minnesota, Missouri, Montana, North Carolina, North Dakota, Nebraska, Nevada, New York, Ohio, Oklahoma, Pennsylvania, South Dakota, Tennessee, Texas, Utah, Washington, Wisconsin, West Virginia, and Wyoming (Hoffman 1999).

Lernaea cyprinacea has become widely distributed throughout the world presumably through the introduction of various cyprinid fish into new localities. Kupferberg et al. (2009) considered *L. cyprinacea* to be particularly sensitive to temperature and postulated that the outbreak in *R. boylii* was associated with unseasonally warm and dry conditions in northern California; they predicted increased prevalence of *L. cyprinacea* as a consequence of climate change. Because *L. cyprinacea* exhibits little host specificity, it behooves researchers to carefully examine all aquatic species for anchorworms and examine the nature of parasite attachment. To our knowledge, we report herein the first finding of a species of *Lernaea* on a larval invertebrate. Unfortunately, we were not able to determine if the copepods were embedded in tissue and actually deriving nourishment from the larvae. However, in fish and amphibians, the parasite embeds in tissue and its enzymatic input produces a strong host inflammatory reaction and subsequent tissue thickening around the attachment site. Additional study to include

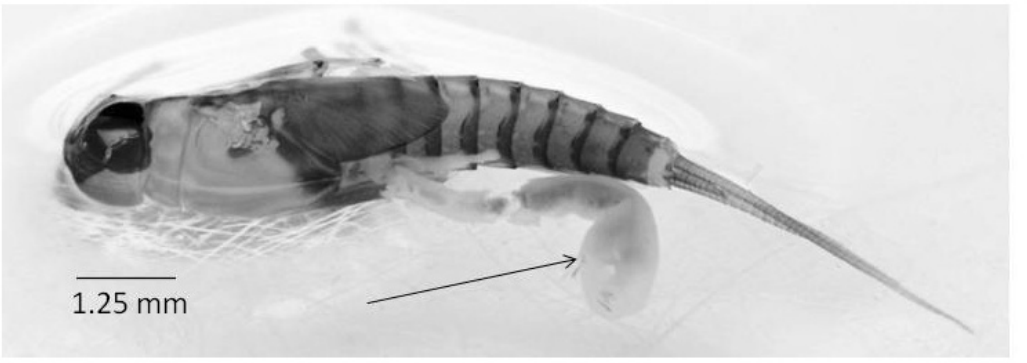

Figure 1. ***Baetis*** **sp. (Ephemeroptera) with attached copepod,** ***Lernaea cyprinacea*** **(arrow).**

histological sections is certainly warranted to investigate more fully the infection in additional invertebrate hosts.

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