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NEW RECORDS FOR *EUHRYCHIOPSIS LECONTEI* (COLEOPTERA: CURCULIONIDAE) AND THEIR DENSITIES IN WISCONSIN LAKES

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ABSTRACT

The native aquatic weevil, *Euhrychiopsis lecontei* is currently being researched as a potential biological control for the exotic aquatic macrophyte Eurasian watermilfoil (*Myriophyllum spicatum*), yet little is known about its specific distribution in North America. In this study, *E. lecontei* was collected in 25 of 27 lakes surveyed for the weevil in Wisconsin, greatly increasing the known distribution of the species in this state. *E. lecontei* densities evaluated in 14 Wisconsin lakes ranged from <0.01 to 1.91 weevils per apical stem of milfoil. These new records indicate that *E. lecontei* is widespread throughout Wisconsin and is associated with natural declines of *M. spicatum* in some lakes. Additional sampling for *E. lecontei* and research on its ecology and life history are needed to understand the role of this organism in aquatic ecosystems.

Recent interest in using the aquatic weevil, *Euhrychiopsis lecontei* Dietz (= *Eubrychiopsis lecontei*) as a potential biological control for the exotic aquatic macrophyte Eurasian watermilfoil (*Myriophyllum spicatum* L.) has increased the need for a better understanding of the weevil's geographical distribution and abundance, life history requirements, and ecological niche. This herbivorous weevil, known to feed and reproduce on various species in the genus *Myriophyllum*, has been shown to significantly reduce the standing biomass of *M. spicatum* by removing vascular tissue, causing a loss of stem buoyancy, and by destroying apical growing tips (Creed et al. 1992, Creed and Sheldon 1993, 1995, Sheldon and Creed 1995, Newman et al. 1996). *E. lecontei* has been associated with episodic declines of *M. spicatum* in some lakes in Wisconsin, Illinois and Vermont (Creed and Sheldon 1991, Kirschner 1995, Lillie and Helsel 1997).

E. lecontei is native to North America and is thought to be widespread across the northern United States and Canada, with its general distribution documented in Wisconsin, Illinois, Iowa, Minnesota, Washington, Michigan, Connecticut, Massachusetts, New York, Vermont, Alberta, British Columbia,

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and Saskatchewan (Newman and Maher 1995, Sheldon 1996). However, there has been little work specific to its detailed distribution. In Wisconsin, it has previously been reported in four lakes: Bierbrauer Pond in St. Croix County, Lake Wingra and Fish Lake in Dane County, and Devil's Lake in Sauk County (Lillie 1991, Newman and Maher 1995, Lillie and Helsel 1997).

Further research on *E. lecontei* is being conducted in Wisconsin in order to better document the geographic distribution of *E. lecontei* in the state, assess limnological and geographical characteristics associated with its abundance, and evaluate the effectiveness of stocking *E. lecontei* as a practical management tool for *M. spicatum* control. In this paper we report new records of *E. lecontei* in Wisconsin and identify densities of *E. lecontei* from a subset of those lakes.

METHODS

The presence of *E. lecontei* was assessed using three methods in 25 Wisconsin lakes containing *M. spicatum* during the summer of 1996. First, we surveyed 12 lakes to assess presence of *E. lecontei* by snorkeling and visually searching for *E. lecontei* adults. During these surveys, evidence of *E. lecontei* herbivory aided in the search for actual specimens by helping to identify areas to search more intensively. Second, in three additional lakes, *E. lecontei* was collected during macrophyte sampling used to assess density of *E. lecontei* (described later). Third, *E. lecontei* was collected in 10 other lakes by Wisconsin Department of Natural Resources personnel inspecting *M. spicatum* from boats or while snorkeling. Adult *E. lecontei* specimens were preserved and maintained as voucher specimens for each lake except Little Falls Lake, Mason Lake, and Parker Lake where adult specimens were not collected; only larvae from these lakes were collected and kept as voucher specimens. All specimens are housed in the Museum of Natural History at the University of Wisconsin - Stevens Point.

The density of *E. lecontei* was evaluated in 14 Wisconsin lakes between mid-July and mid-August 1996. In each lake, four *M. spicatum* beds that had not been harvested or treated with herbicides were chosen for density sampling. Areas with harvesting or herbicide use may not represent background levels of *E. lecontei* because these treatments directly affect the upper portions of the stems where the weevils are known to reside (Sheldon 1997). The distance between the four macrophyte beds was maximized to provide an estimate of weevil density for the entire lake. A total of 120 apical stems of *M. spicatum* was collected from each lake (4 beds x 3 transects/bed x 5 sampling points/transect x 2 stems/sampling point). Within each *M. spicatum* bed, three equidistant transects (relative to the macrophyte bed width) were sampled. Transects were placed perpendicular from the deep edge of the bed in toward shore (i.e. toward the shallow edge of the bed). If *M. spicatum* dominated the entire lake, then transects were placed from the center of the lake to shore. Along each transect, two stems from five, equidistant points were sampled. At each sampling point, the top ~50 cm of the first two stems of *M. spicatum* touching the snorkeler's hand beneath the surface were collected. Because only the top 50 cm of stem was collected, these are referred to as apical stems herein. Each sample was placed in a labeled bag and kept on ice until the stems could be processed. Any samples that could not be processed within seven days of collection were preserved in 70% ethyl alcohol. To minimize seasonal influences on abundance, southern lakes were sampled first followed by central lakes and finally northern lakes.

In the laboratory, the stems were inspected for occurrence of *E. lecontei* eggs, larvae, pupae, and adults and for damage by the weevils. All apical tips and portions of stems with damage were inspected with a dissecting microscope between 10x and 20x power. Stems damaged by herbivory were sliced open length-wise with a razor blade and larvae and pupae were extracted (Creed and Sheldon 1995). The number of weevils of each life stage (egg, larva, pupa, adult) on each stem was recorded and all were preserved. Abundance was recorded as the number of *E. lecontei* (all life stages combined) per apical stem of *M. spicatum*.

Differences in weevil density were tested with a One-Way Analysis of Variance and Tukey multiple-comparison test at $P \leq 0.05$. Two lakes (Lower Spring and Eagle) were plotted but not tested because weevil densities were evaluated as weevils per two stems resulting in different variance estimates.

RESULTS

E. lecontei was widely distributed across Wisconsin in lakes containing Eurasian watermilfoil (Fig. 1,Table 1). *E. lecontei* was found in 25 lakes where it had not previously been recorded, and it was found in nearly every lake sampled. In lakes surveyed for weevil densities, *E. lecontei* larvae and eggs were found to be more abundant than adults or pupae. However, in eight of the 14 lakes all life stages were collected during density sampling. *E. lecontei* was not collected from only two lakes that were sampled, Silver Lake in Waupaca County, and Kangaroo Lake in Door County. In addition to its absence in these lakes, there was also no evidence of damage to *M. spicatum* that is typical of *E. lecontei* herbivory.

E. lecontei density varied among lakes throughout the state ranging from a mean of <0.01 to 1.91 weevils per apical stem (Fig. 2). Based on the data, there appears to be two distinct levels of weevil density in these lakes. One set of lakes had densities that were not significantly different from each other, ranging from <0.01 to 0.33 weevils per apical stem, while the other set of lakes had densities ranging from 1.01 to 1.91 weevils per apical stem.

DISCUSSION

Although *E. lecontei* is native to North America, its detailed distribution has not been well studied. Previous to this study it was known only in four Wisconsin lakes: Bierbrauer Pond in St. Croix County, Lake Wingra and Fish Lake in Dane County, and Devil's Lake in Sauk County (Lillie 1991, Newman and Maher 1995, Lillie and Helsel 1997). Our surveys, the most comprehensive to date in Wisconsin, and those of others show *E. lecontei* is geographically widespread throughout Wisconsin as twenty-nine lakes from southern, central, and northern parts of the state harbor the weevil. More importantly, most lakes that were surveyed in this study actually contained the weevil and therefore we suspect that *E. lecontei* is widespread across most Wisconsin lakes containing *M. spicatum*. In lakes where it was not found, we suspect that it might still occur but at low abundances, making it difficult to detect in our sampling.

The natural break that we found in *E. lecontei* densities between 0.33 and 1.01 weevils per apical stem is interesting and may have ecological significance. Perhaps certain environmental conditions, such as lake characteristics or milfoil abundance or architecture, must exist before weevil populations can increase to densities high enough to cause a significant decline in *M. spicatum*. Alternatively, perhaps the numbers relate to population dy-

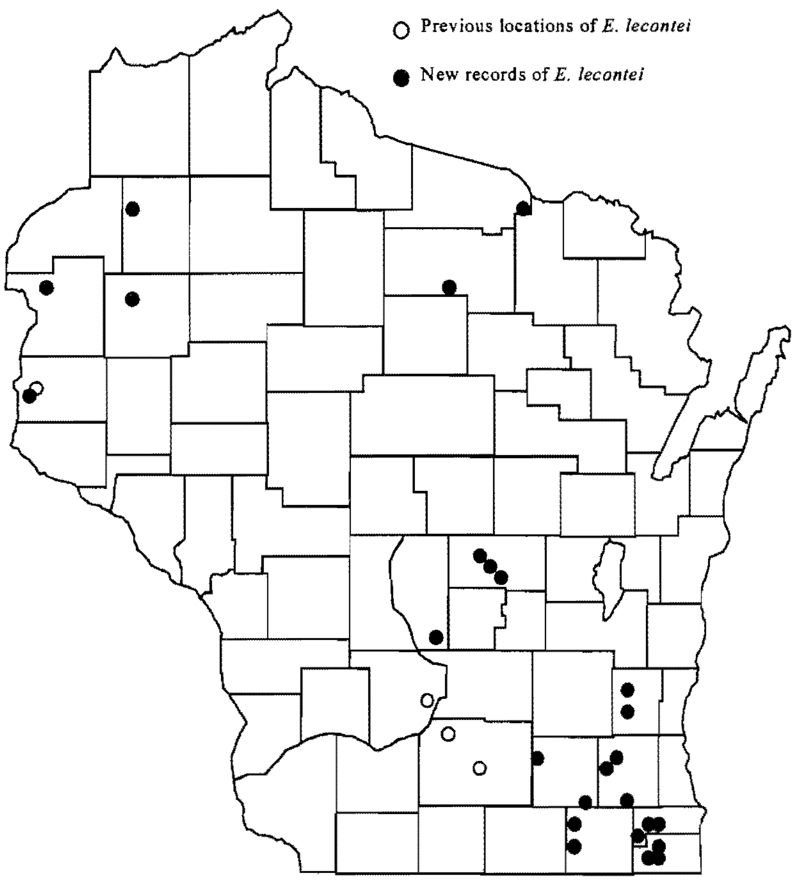

Figure 1. Known distribution of *E. lecontei* in Wisconsin. Previous locations referenced in Lillie (1991), Newman and Maher (1995), Lillie and Helsel (1997).

namics of the organism. Additional analysis of *E. lecontei* densities and their associations with environmental conditions may reveal factors that limit weevil population growth and help explain this discontinuity in densities.

Sheldon and O'Bryan (1996) report that adult *E. lecontei* reside outside the stems, moving among plants as they eat and reproduce. They are usually found in the top meter of milfoil stems and lay eggs on the leaves of the apcial tips of the plant. The hatching larvae burrow into the apical meristems and subsequent instars burrow further down inside the milfoil stems, consuming vascular tissues. Larvae sometimes burrow to the outside of a stem and crawl along it until burrowing back into the stem on the same plant, or they may crawl onto the stems of adjacent plants (Sheldon and O'Bryan 1996). The consumption of the vascular tissues by the larvae damages the

Table 1. New records of *Euhrychiopsis lecontei* in Wisconsin.

LAKE NAME	COUNTY	LOCATION	AREA (acres)	DATE OF COLLECTION
Beaver Dam Lake	Barron	T35N R13W Secs. 5, 6, 7, 8; T35N R14W Sec. 1	1,112	12 June 1996
Big Cedar Lake	Washington	T10N R19E Sec. 5; T11N R19E Secs. 20,20,30,31,32	932	25 June 1996
Big Sand Lake	Vilas	T41N R12E Secs. 2,3,4,9; T42 R12E Secs. 34,35	1,408	25 June 1996
Camp Lake	Kenosha	T1N R20E Secs. 20,21,28,29	461	02 August 1996
Crooked Lake	Waukesha	T7N R17E Sec. 23	58	17 September 1996
Eagle Lake	Racine	T3N R20E Secs. 21,22,27,28	520	06 June 1996
George Lake	Kenosha	T1N R21E Secs. 20,29	59	02 August 1996
Gilbert Lake	Waushara	T20N R11E Secs. 10,11,14,15	141	10 June 1996
Kusel Lake	Waushara	T20N R11E Secs. 26,27,34,35	79	10 June 1996
Little Falls Lake	St. Croix	T29N R19W Secs. 4,8,9	172	14 August 1996
Long Trade Lake	Polk	T36N R18W Sec. 49	153	06 August 1996
Lorraine Lake	Walworth	T3N R15E Sec. 29	133	06 June 1996
Lower Spring Lake	Jefferson	T5N R16E Secs. 22,23	104	06 June 1996
Manson Lake	Oneida	T36N R7E Secs. 32,33	236	25 June 1996
Mason Lake	Adams	T13N R7E Secs. 25, 26, 35, 36; T13N R8E Secs. 30, 31	855	13 August 1996
Mukwonago Pond	Waukesha	T5N R18E Sec. 29	16	18 June 1996
Nancy Lake	Washburn	T42N R13W Secs. 27,28,33	500	12 June 1996
North Lake	Waukesha	T8N R18E Secs. 16,17,20,21	437	14 August 1996
Paddock Lake	Kenosha	T1N R20E Sec. 2	112	02 August 1996
Pearl Lake	Waushara	T19N R12E Sec. 30	92	10 June 1996
Pike Lake	Washington	T10N R18E Secs. 22,23,26,27	522	12 August 1996
Rock Lake	Jefferson	T7N R13E Secs. 2,10,11,14,15	1,371	13 August 1996
Whitewater Lake	Walworth	T3N R15E Sec. 3; T4N R15E Secs. 25, 26, 27, 34, 35	640	06 June 1996
Wind Lake	Racine	T4N R20E Secs. 3,4,8,9,10,16,17	936	29 July 1996
Wolf Lake	Racine	T2N R20E Secs. 15, 22	115	8 August 1996

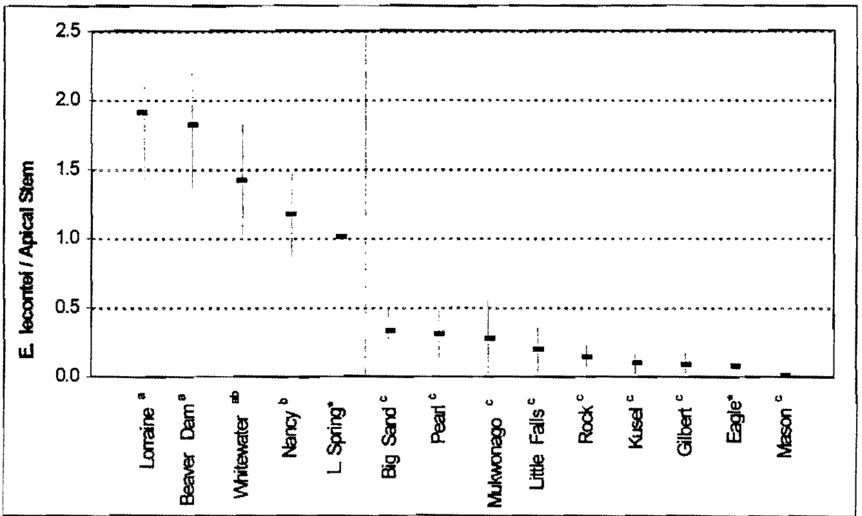

Figure 2. Density of *E. lecontei* in Wisconsin lakes, all weevil life stages combined. Values indicate the mean density of *E. lecontei* per apical stem ± 95% confidence intervals. Lakes with the same letter are not significantly different from each other based on a One Way ANOVA and Tukey Multiple Comparisons Test ($P \leq .05$).
*Lower Spring and Eagle Lakes are not included in the analyses due to different sampling method.

milfoil plants. Stem buoyancy is compromised, nutrients and carbohydrates can no longer move between the roots and shoots, and the overall standing biomass of the milfoil is significantly decreased by weevil infestation (Creed et al. 1992, Creed and Sheldon 1993, 1995, Sheldon and Creed 1995, Newman et al. 1996). Pupation also occurs in the stem, usually at or greater than 50 cm from the top of the plant (Sheldon and O'Bryan 1996). The data collected through our density surveys agree with this previous research. Eggs were always observed in the apical tips of the plant and larvae and pupae were found in the stems. Larvae were occasionally found heading into the meristem after hatching or into larger stems from the outside. Our surveys also indicate that eggs and larvae are more abundant than adults and pupae. The observation of fewer adults is intuitive due to the population dynamics of insects. The lower number of pupae recorded may be related to the collection of only 50 cm of the milfoil stem, as they may be found lower in the plant. Three generations per summer have been documented in Vermont (Sheldon and O'Bryan 1996) and because Wisconsin is at a similar latitude, it is expected that three generations per summer may occur here.

This species of weevil is of particular interest because the effects of its herbivory on *Myriophyllum spicatum* make it a plausible candidate for biological control of this exotic. Localized declines of *M. spicatum* were apparent in some of the surveyed lakes, particularly in lakes where *E. lecontei* densities were greater than 1.0 weevil per apical stem. Some whole and partial declines of *M. spicatum* in lakes have been associated with high *E. lecontei* abundance (Browington Pond in Vermont, Fish Lake in Wisconsin and McCollum Lake in Illinois) (Creed and Sheldon 1991, Kirschner 1995, Lillie and Helsel 1997). As a management tool, it is possible that augmenting *E. lecontei* populations would speed up processes that would occur naturally in a normal predator-prey relationship and thus more quickly cause a decline in *M. spicatum*. More research in this area needs to be evaluated.

Currently, *M. spicatum* is controlled mostly by chemical herbicides and mechanical harvesters. However, these methods provide only short-term reductions in biomass (Aiken et al. 1979, Smith and Barko 1990, Bode et al. 1993) and can harm non-target plants and animals (Engel 1990). Research conducted on *E. lecontei* shows that it has a high specifity for *M. spicatum* (Solarz and Newman 1996) and that impacts to native aquatic plants are not significant (Sheldon and Creed 1995, Creed and Sheldon 1993). The widespread distribution of *E. lecontei* encourages further research into assessing the potential of using this species as a biological control. The use of a native insect to control an exotic plant is a novel approach. Understanding how these organisms interact with *M. spicatum*, why they have an affinity with *M. spicatum*, and how they affect aquatic systems where they are found will elucidate the potential for this organism to serve as a biological control agent. It is unlikely that elimination of *M. spicatum* will occur in these systems. However, even a partial decline in *M. spicatum* through more environmentally-sound methods than current control techniques would allow re-establishment of native macrophyte communities and help achieve greater biodiversity. Clearly, more information is needed to better understand the role of this organism in aquatic ecosystems. Key to that understanding is more detailed information on its distribution, abundance, life history requirements and influence on *M. spicatum* and native plant communities.

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