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NOTE

A NEW BIOLOGICAL MARKER LAYER IN THE SEDIMENTS OF THE GREAT LAKES: *BYTHOTREPHES CEDERSTROEMI* (SCHÖDLER) SPINES

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ABSTRACT. The European cladoceran, Bythotrephes cederstroemi *(Schödler), recently invaded the Laurentian Great Lakes. Based on recent zooplankton records, it most likely appeared first in 1984 in Lakes Ontario, Erie, and Huron, and in 1985 in Lake Michigan. It has yet to be reported from Lake Superior. This species is a relatively large-bodied predatory form that possesses a long, caudal, latterally barbed spine.* B. cederstroemi *spines and spine fragments were found in the upper fractions (predominantly 0–4 cm) of 35 sediment cores collected from seven areas of deposition in the eastern basin of Lake Erie. All remains were well preserved and easy to identify. Very few to 0 spines were found in core depths greater than 4 cm suggesting that the invasion of this species has resulted in a new, readily distinguishable time horizon marker.*
ADDITIONAL INDEX WORDS: Benthos, cores, Lake Erie, paleolimnology.

INTRODUCTION

The presence of *B. cederstroemi* was first reported in Lake Ontario from power plant water intake samples in September, 1985 (Lange and Cap 1986); however, it was observed as early as December, 1984, in southern Lake Huron and recorded as occurring in all of Lake Erie throughout the fall of 1985 (Bur *et al.* 1986). Although unpublished at this time, it was a prolific component of the Lake Michigan zooplankton community (and currently is) as early as August, 1986. Although it is premature to predict the fate of the organism in the Great Lakes, it does appear that it will establish itself as a persistent zooplankter. To date, the occurrence of its remains in the sediments of the Great Lakes has not been reported.

METHODS

During the first week of June, 1987, sediments at seven stations in the depositional areas of the eastern basin of Lake Erie (Table 1) were cored using a 30 cm × 30 cm × 100 cm General Oceanics box corer (1 box per station). From each box core, five subcores (Benthos, 6.7 cm ID) were collected and hydraulically extruded on board in 2-cm intervals to a depth of 12 cm, followed by 12–15, and 15–20 cm intervals. Each fraction was preserved with 4% $CaCO_3$ buffered formalin. Samples were washed through a 0.250 mm mesh sieve and observed under a dissecting microscope.

RESULTS AND DISCUSSION

Numerous, well preserved, large *B. cederstroemi* caudal spines (Fig. 1) were found in, and restricted to, the upper sediment fractions of all 35 cores examined. Intact, as well as all identifiable spine fragments were counted in each fraction of each core (Table 1). Although the relative densities of remains among stations vary, the distinct and abrupt absence of spines and spine fragments at a discrete depth in each core is consistent. Two plausable interpretations of these data exist: 1) spines may be dissolving at lower depths in the cores, or 2) spines form a recent time horizon because of their recent introduction to the sediments. Based on the observed high degree of preservation of all remains over all core depth intervals, the latter is presumed.

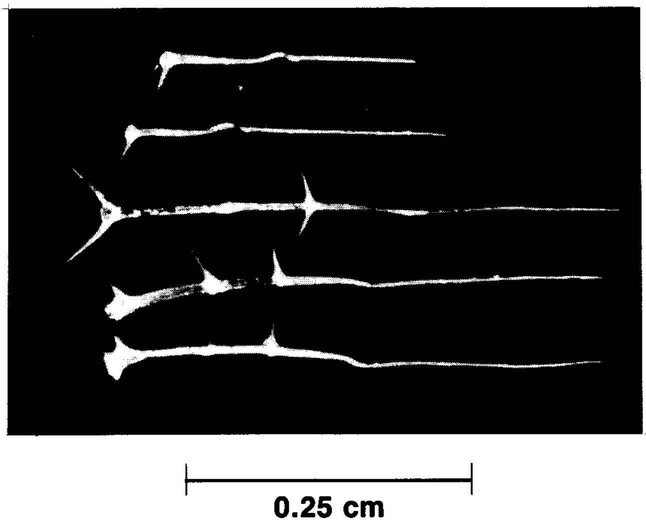

FIG. 1. Typical **Bythotrephes cederstroemi** *caudal spine remains from sediment cores collected in the eastern basin of Lake Erie.*

These data strongly suggest that in the future as sediments accumulate, this layer will be a valuable time-stratigraphic marker with a well documented time reference. I would suggest using 1984 as a reference date for Lakes Ontario, Erie, and Huron, and perhaps 1985 for Lake Michigan. Because it was seen in southern Lake Huron in late 1984, it is very likely that the species was in Lakes Erie and Ontario also, yet still in low enough densities to be missed. However, caution should be advised with regard to the certainty of these dates until more detailed sedimentary and pelagic records from all of the Great Lakes become available. Additionally, since the spines are often the size of many oligochaetes, and most remains retain the lateral spines, effects of bioturbation from oligochaete feeding should be minimal. The lateral spines should also have an anchoring effect, reducing interstitial movement.

Other possible uses of spine data could include the calculation of flux rates to compare *B. cederstroemi* remains with herbivorous cladoceran remains. Over time, comparisons of this type may be helpful in assessing the impact of this predatory species on the current zooplankton community.

To demonstrate the potential usefulness of the spine horizon, previously determined ^{137}cesium-derived sedimentation rates from the same stations are provided (Table 1; J. Robbins, 1987 Great Lakes Environmental Research Laboratory, National Oceanic and Atmospheric Administration, Ann Arbor, Michigan, personal communication) to compare with what one might expect from the *B. cederstroemi* remains data. Although the 2-

TABLE 1. Location, water depth (m), sedimentation rates (cm/yr) as determined by ^{137}cesium analyses (courtesy of J. Robbins, see text), and mean number (n = 5) and standard deviation of **Bythotrephes cederstroemi** *remains at discrete depth intervals in sediment cores obtained from seven stations in the eastern basin of Lake Erie.*

	Station													
	38		42		43		47		52		53		55	
Physical Data														
Latitude	42°29.06		42°30.54		42°24.47		42°32.49		42°35.17		42°28.59		42°37.48	
Longitude	80°02.06		79°58.05		79°41.13		79°44.53		79°34.05		79°31.41		79°31.41	
Water Depth (m)	60		65		45		60		53		41		28	
Sed. Rate (cm/yr)	2.20		0.95		0.14		0.65		0.50		0.85		0.46	
Spine Data														
Depth Interval (cm)	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
0–2	14.6	4.0	16.4	11.2	44.4	15.9	24.2	5.0	11.8	6.1	88.6	19.8	7.8	3.7
2–4	26.0	13.8	110.6	70.8	12.6	11.2	19.2	5.8	31.0	2.1	40.4	15.9	0.0	
4–6	4.6	4.9	2.2	1.9	1.6	3.1	0.6	0.6	1.2	0.8	1.2	1.3	0.0	
6–8	0.6	0.9	0.4	0.6	0.2	0.5	0.0	0.0	0.0		0.0		0.0	
8–10	0.2	0.5	0.0		0.0		0.0		0.0		0.0		0.0	
10–12	0.0		0.0		0.0		0.0		0.0		0.0		0.0	
12–15	0.0		0.0		0.0		0.0		0.0		0.0		0.0	
15–20	0.0		0.0		0.0		0.0		0.0		0.0		0.0	
Total	45.8	10.9	129.6	79.9	57.6	28.9	44.0	18.2	44.0	5.4	130.2	33.4	7.8	3.7

cm core fraction intervals are too crude to actually assign a rate for each station, one can predict approximately where the majority of remains should occur using the ^{137}cesium rate data. Using 1984 as the reference date (approximately 3 years of accumulation) and the sedimentation rates provided in Table 1, the occurrence of spines/spine fragments should decline sharply after the 4-6 cm fraction for Station 38, the 2-4 cm fractions for Stations 42 and 53, and the 0-2 cm fractions for Stations 43, 47, 52, and 55. Spine data from Station 38 would suggest a slower rate, and data from Station 52 a faster rate. Although the relatively very low numbers of spines in the deeper core strata may suggest some mixing, it is also quite plausible that these remains reflect the early colonizing populations of the species, when water column densities were very low. Cores collected in the future, employing 1 cm or smaller core fraction sizes, should provide a simple time-stratigraphic marker, permitting accurate dating of sediments. Spine stratigraphy may also add to our knowledge of bioturbation by careful comparisons of sedimentation rates determined on the same sediments by using the "spine method" and radiometric methods.

The ultimate usefulness of this new technique will be determined by many future stratigraphic core analyses. The preliminary data presented here for the eastern basin of Lake Erie suggest, however, that a new, permanent biological marker layer exists with very attractive attributes—it is readily distinguishable with an apparent high degree of preservation, it is potentially resistant to feeding bioturbation, and it has a well documented date of introduction.

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