Akademisk avhandling för filosofie doktorsexamen

Thesis for the Degree of Doctor of Philosophy

Paleolimnological Reconstructions of Fish Population Changes in Acidified Lakes

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The oral defense of this thesis will take place at 10:00 am on Friday March 25th 2011 at the Department of Zoology, Medicinaregatan 18, Göteborg, Sweden. The opponent is Professor John P. Smol from Queen's University, Department of Biology, Kingston, Ontario, Canada.

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ABSTRACT

This thesis deals with the potential of using subfossil *Chaoborus* spp. and *Daphnia* spp. remains preserved in lake sediments to reveal past fish community alterations related to progressive acidification. Sediment cores were collected from acidified lakes with known present fish population status and well-documented fish community developments in southwest Sweden. Sediment analyses were conducted on comparatively large sediment samples from sediment cores that were sectioned for a high temporal resolution (5-mm intervals).

Subfossil *Chaoborus* assemblages were related to fish population developments in the study lakes. Mandibles of *Chaoborus flavicans* were common in most sediment samples, and this species is known to co-exist with fish. However, *C. obscuripes* mandibles were exclusively recovered and identified in more recent sediments from fish-free lake periods, as judged from known historical fish population changes in the study lakes. These findings suggest that past fish extirpations can be revealed by the appearance and successive presence of *C. obscuripes* mandibles in sediment records. Progressive acidification was additionally confirmed by the loss of acid-sensitive daphnid zooplankton, as indicated by developments in sedimentary assemblages of *Daphnia* ephippia (resting eggs).

In this thesis I describe and test the first ever paleo-method for revealing periods of cyprinid presence in lake histories, without including fish fossils in the analyses. Cyprinid fish species are characterized by pharyngeal teeth that are used to crush and fragment food items. Cyprinid fish, in this thesis represented by roach (*Rutilus rutilus* L.), were shown to evacuate significantly higher proportions of fragmented *Chaoborus* mandibles than non-cyprinid perch individuals (*Perca fluviatilis* L.), when fed live *Chaoborus* larvae in the laboratory. Similar and significant differences in proportions of fragmented subfossil *Chaoborus* mandibles were also shown for three independent paleolimnological approaches; (1) a comparative study of surface sediments from lakes with and without cyprinid fish, (2) a stratigraphical analysis of a dated sediment core from a lake with a known period of roach presence, and (3) a comparison between two dated sediment cores from lakes that differed in historical presence of roach.

These findings have important implications for future freshwater management by providing tools for assessing past fish population changes in acidified lakes with uncertain developmental histories.

Keywords: Acidification, *Chaoborus*, *C. flavicans*, *C. obscuripes*, cyprinids, *Daphnia*, fish loss, fish community composition, ephippia, fragmentation, mandibles, perch, roach, sediments, ^{210}Pb-chronology

ISBN 978-91-628-8238-9. ELECTRONIC VERSION: http://hdl.handle.net/2077/24148