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FIRST RECORDS OF *Alona werestschagini* SINEV IN FINLAND – SUBFOSSIL REMAINS FROM SUBARCTIC LAKES[1]

Kaarina Sarmaja-Korjonen[1], Artem Yu. Sinev[2]

[1] *Department of Geology, P.O. Box 64, FIN-00014 University of Helsinki, Finland, e-mail: kaarina.sarmaja-korjonen@helsinki.fi*

[2] *Department of Invertebrate Zoology, Biological Faculty, Lomonosov Moscow State University, Leninskie Gory, Moscow 119991, Russia, e-mail: artem_sinev@mail.ru*

Abstract

Subfossil remains of a new species of Cladocera (water fleas) of the family Chydoridae in Finland, *Alona werestschagini* Sinev, were found in the sediments of four lakes above the treeline in northernmost Finnish Lapland. The remains were found in surface sediments of three lakes and in early Holocene sediments of one lake where the species was a pioneer which soon disappeared. The remains of *A. werestschagini*, except the male postabdomen, closely resemble *Alona guttata*. In Eurasia *A. werestschagini* has a wide but patchy distribution in cold climates, suggesting that it is a postglacial relict adapted to cold climate and oligotrophic lakes. Recently it has been found also in Norway and Kola Peninsula. The early Holocene finds indicate that the species spread to northernmost Finland after the retreat of the Scandinavian Ice Sheet. Since the species has been found in lakes in very severe conditions it may be used as a palaeolimnological indicator in sediment studies.

Key words: Chydorid Cladocera, *Alona werestschagini* Sinev, palaeolimnology, northern Finnish Lapland

INTRODUCTION

Cladocera (water fleas) are microscopic crustaceans (class Branchiopoda) that inhabit all kinds of freshwater environments. Research upon Cladocera began in Europe and most of the European chydorid (family Chydoridae) fauna was described by the early 20th century and the Scandinavian cladoceran fauna was especially well known because of the outstanding studies of G. O. Sars in Norway and W. Lilljeborg in Sweden. However, even in this well-studied region some new species were found during the 20th century, such as *Eurycercus pompholygodes* Frey 1975 and *Unapertura latens* Sarmaja-Korjonen *et al.* 2000, the latter described so far only as subfossil remains from lake sediments.

Cladoceran research has been lively in Russia and several new species have been described recently from Eurasia (e.g. Kotov *et al.* 2006, Sinev 1999, Smirnov 1998). Since the Nordic countries are located on the western edge of this huge land mass extending from the Pacific Ocean in the east to the coast of the Atlantic Ocean in western Norway, it could be expected that some of the Eurasian species have had an opportunity to extend their distribution to the Nordic countries also.

We describe here the first record of a chydorid species from Finland, *Alona werestschagini* Sinev 1999. The record comprises finds of subfossil remains in lakes in northernmost Finnish Lapland.

SITES AND LABORATORY METHODS

The remains were found in four lakes (Table 1) which are situated in Utsjoki, northernmost Finnish Lapland, a few kilometers south of the Norwegian border (Fig. 1). They lie in an upland area above the pine treeline, their elevation ranging between 269 m and 404 m. The surroundings of the three lowermost lakes have sparse mountain birch vegetation. Presently, vegetation around the uppermost lake, Várddoaijávri, consists of Krumholz-type dwarf birch and subarctic heath plants, lichens and mosses. Climate is very harsh, in the elevation of Várddoaijávri the annual mean temperature is only –2.6 °C and the open-water season lasts from late June to early October.

The 0–1 cm surface sediments of Vuolimuš Tsieskuljavri, Rávdojávri and Pâjimuš Tsieskuljavri were collected with a Limnos corer in April 2005. At the same time, a 3 m long sediment core was taken from Várddoaijávri with a Russian peat corer and the uppermost 0–1 cm of sediment was analysed for cladoceran remains, as well as the lowermost section (294–265 cm) with 4–5 cm intervals. The analyses between 265 cm and 1 cm of the core are in course of preparation. Subsamples of 2–3 cm^3 sediment were heated in 10% KOH (potassium hydroxide) for 20 min and sieved through a 44 μm mesh. The samples were mounted in glycerine jelly stained with safranine and analysed under a light microscope at ×200 magnification. 200 chydorid shells were counted

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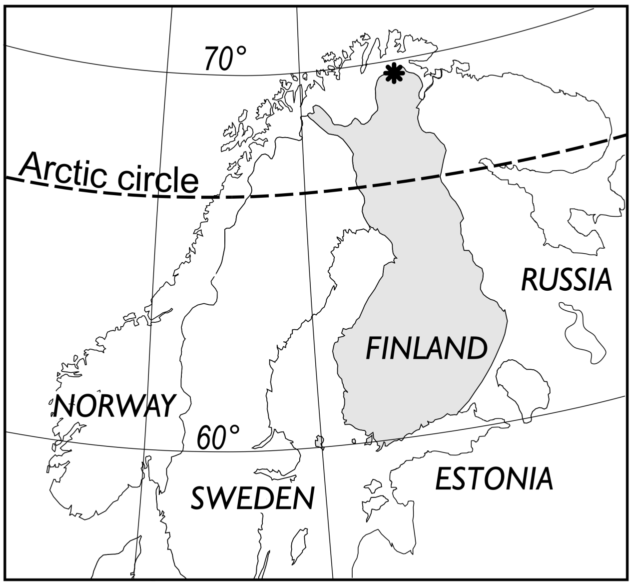

Fig. 1. Location of the study sites (marked with asterisk) in northern Finnish Lapland.

plus all the other cladoceran remains encountered during the count.

RESULTS AND DISCUSSION

Subfossil remains of *Alona werestschagini* were found in the surface sediments of three lakes and the early Holocene sediments of Várddoaijávri (Fig. 1, 2, Table 1). 2 headshields and 3 female postabdomens were found in Vuolimuš Tsieskuljavri, 6 female postabdomens were encountered in Rávdojávri and 6 female postabdomens, 1 male postabdomen, 1 headshield and 1 ephippium in Pâjimuš Tsieskuljavri. The surface sample from Várddoaijávri contained no remains of the species but during the analyses of the long core (Sarmaja-Korjonen, unpublished data) it was found that the species was very abundant in the lowermost sample (294 cm) dating to the early Holocene. 45 female and 9 male postabdomens, 60 headshields and 33 ephippia were found. The species comprised 22.5% of the chydorid fauna. A list of other cladoceran species in the sample is given in Table 2. Only a few *A. werestschagini* remains were found in the two subsequent samples (290 and 285 cm) and none in the samples above these (280–265 cm). At this stage it is impossible to distinguish between the subfossil shell of the species and that of

Table 1

Geographic coordinates, elevation (above sea level) and present pH of the lakes

Lake	Geographic coordinates	m a.s.l.	pH
Vuolimuš Tsieskuljavri	69°43'58" N 27°5'42" E	269	6.5
Rávdojávri	69°40'49" N 27°12'21" E	275	6.1
Pâjimuš Tsieskuljavri	69°43'37" N 27°8'33" E	286	–
Várddoaijávri	69°53'25" N 26°31'42" E	404	6.3

Table 2

Cladocera species whose subfossil remains were present in the sediment samples of the lakes where *Alona werestschagini* Sinev were found

Vuolimuš Tsieskuljavri 0-1 cm	Rávdojávri 0-1 cm	Pâjimuš Tsieskuljavri 0-1 cm	Várddoaijávri 294 cm
Bosmina (Eubosmina) sp.	*Bosmina (Eubosmina)* sp.	*Bosmina (Eubosmina)* sp.	*Bosmina (Eubosmina)* sp.
Eurycercus sp.	*Daphnia* sp.	*Ceriodaphnia* sp.	*Daphnia* sp.
Acroperus harpae	*Ceriodaphnia* sp.	*Eurycercus* sp.	*Eurycercus* sp.
Alonopsis elongata	*Eurycercus* sp.	*Acroperus harpae*	*Acroperus harpae*
Alona affinis	*Camptocercus rectirostris*	*Alonopsis elongata*	*Alonopsis elongata*
Alona quadrangularis	*Acroperus harpae*	*Alona affinis*	*Alona werestschagini*
Alona werestschagini	*Alonopsis elongata*	*Alona guttata*	*Alona intermedia*
Alona rustica	*Alona affinis*	*Alona werestschagini*	*Alonella excisa*
Alona intermedia	*Alona guttata*	*Alona rustica*	*Alonella nana*
Alonella excisa	*Alona werestschagini*	*Alona intermedia*	*Chydorus sphaericus* s.l.
Alonella nana	*Alona rustica*	*Alonella excisa*	*Paralona pigra (Chydorus piger)*
Chydorus sphaericus s.l.	*Alona intermedia*	*Alonella nana*	
Paralona pigra (Chydorus piger)	*Alonella excisa*	*Chydorus sphaericus* s.l.	
Rhynchotalona falcata	*Alonella nana*	*Paralona pigra (Chydorus piger)*	
Ophryoxus gracilis	*Chydorus sphaericus* s.l.	*Rhynchotalona falcata*	
	Paralona pigra (Chydorus piger)	*Ophryoxus gracilis*	
	Rhynchotalona falcata	*Polyphemus pediculus*	
	Anchistropus emarginatus		
	Ophryoxus gracilis		
	Polyphemus pediculus		

Eurycercus species was not determined because, in addition to headshields with a median pore characteristic of adult female of *E. lamellatus* (O.F. Müller 1785), there were also headshields with a relatively circular median pore, possibly belonging to *E. pompholygodes* Frey 1975.

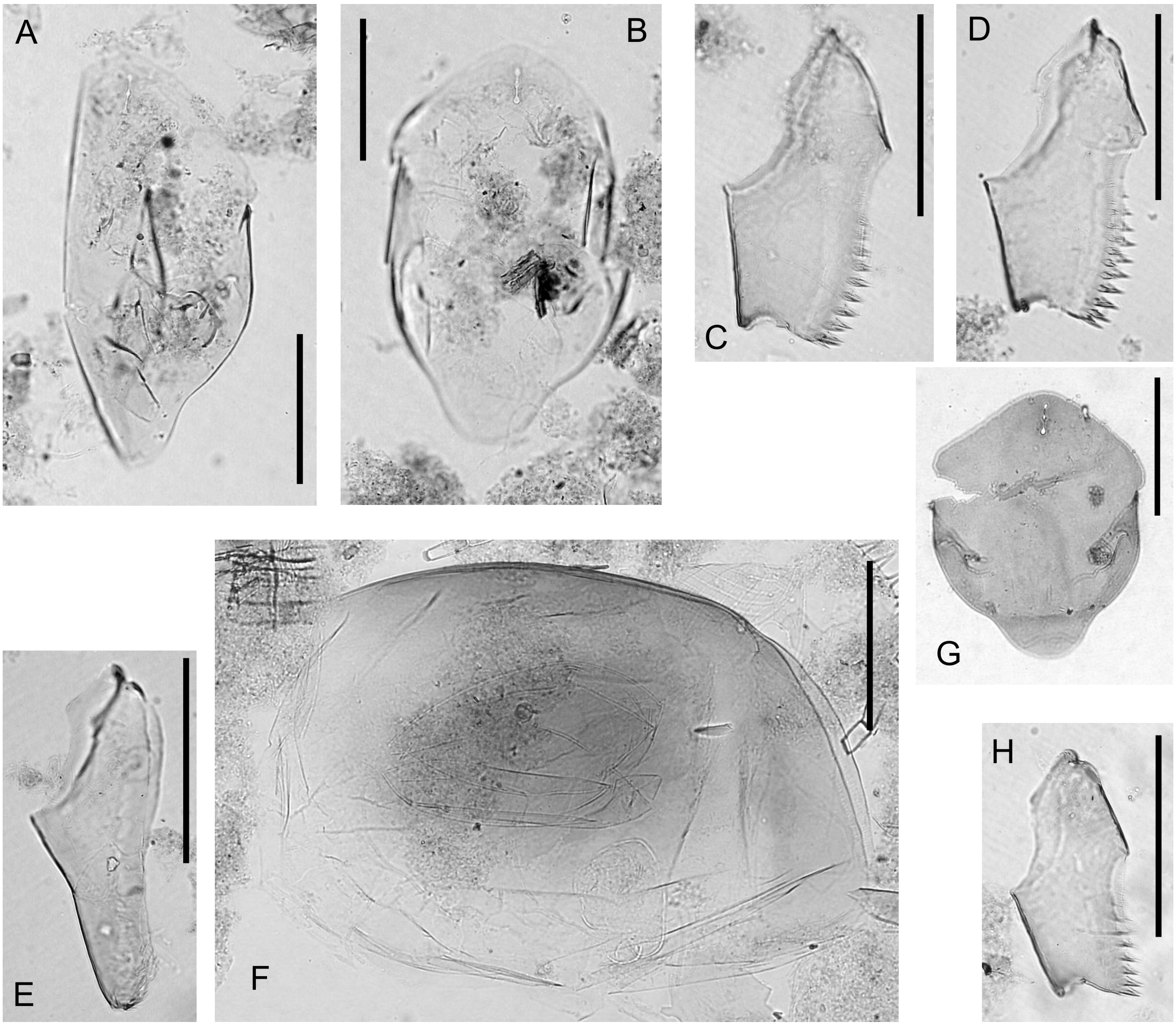

Fig. 2. Subfossil remains of *Alona werestschagini* Sinev from surface sediments of lakes in northernmost Finnish Lapland (see text) and remains of the closely related *A. guttata*. **A**, **B** – Headshields of *A. werestschagini*; **C**, **D** – Postabdomens of female *A. werestschagini*; **E** – Postabdomen of male *A. werestschagini*; **F** – Ephippium of *A. werestschagini*; **G** – Headshield of *A. guttata* (Lake Ylimmäinen Vähälampi, Finland); **H** – Postabdomen of female *A. guttata* (Lake Ruohojärvi, Finland). Scale bar = 100 µm.

Alona intermedia (Szeroczyńska & Sarmaja-Korjonen 2007) and therefore, the shell was excluded in the present descriptions.

The headshield (Fig. 2A, B) resembles that of the closely related *Alona guttata* Sars 1862 (Fig. 2G), both having a rounded posterior margin but lacking any special morphological characteristics. However, *A. werestschagini* headshield is bigger than that of *A. guttata* and has a greater postpore/interpore ratio (Sinev 1999).

Also the female postabdomen (Fig. 2C,D) is larger than that of *A. guttata* (Fig. 2H). It is broader and the number of marginal denticles is greater, having 8–10 instead of ca. 7–8 in *A. guttata*. The *A. guttata* postabdomen is characterized by straight dorsal and ventral margins. In *A. werestschagini* the dorsal margin is somewhat convex and the ventral margin is straight but inclined so that the postabdomen increases in width proximally. The long and narrow male postabdomen (Fig. 2E) has a characteristic form that is unique for the genus (Sinev 1999). It tapers towards the distal end and the preanal and postanal angles are not defined. It has several groups of setae near the claw artculations.

The ephippium (Fig. 2F) has few clear morphological characteristics. Most of the posterior and ventral margins are detached and there is a darker area in the central and dorsal regions. There are faint, irregular lines and dot-like markings visible in the darker region.

The subfossil cladoceran assemblages in the surface samples of Vuolimuš Tsieskuljavri, Rávdojávri and Pâjimuš Tsieskuljavri (Table 2) consist of species such as *Acroperus harpae* (Baird 1835), *Alonopsis elongata* (Sars 1861), *Alona affinis* (Leydig 1860), *A. rustica* Scott 1895, *A. intermedia* Sars 1862, *Alonella excisa* (Fischer 1854) *and A. nana* (Baird 1843), characteristic of lakes in northern Finnish Lapland. Also remains of *A. guttata* were encountered in all three lakes

lakes, indicating that the two species co-occur. The lakes are slightly acidic (April 2005; pH 6.1–6.5) and oligotrophic.

A. werestschagini was the second most abundant chydorid species in the early Holocene fauna in Várddoaijávri (Table 2) but apart to that the species composition was very similar to the other two lakes presently. *A. intermedia* was the dominant and *Eurycercus* sp., *A. harpae*, *A. elongata*, *A. nana* and *Chydorus sphaericus* s.l. were relatively abundant. These species are commonly found in oligotrophic lakes but the early Holocene trophic state and pH remain unknown until more data are available (e.g. the diatom record).

Presently *A. werestschagini* is distributed in a disjunct area. It inhabits mountains of Middle Asia – Pamir, Tien Shan and Altai (Sinev 1999, Belyaeva 2003) and Western Mongolia (Prof. Miguel Alonso, personal comments) as well as northernmost European Russia (Komi Republic and Kola Peninsula) (Sinev 1999, 2002). It was also found in 10 lakes in northern Norway (Walseng *et al.* 2006, web appendix). Such a patchy distribution in cold climates suggests that this species is a postglacial relict, adapted to cold climate (Sinev 2002). Since large areas of Russia were unglaciated during the latest glaciation, the distribution of *A. werestschagini* may have been extensive. The species could spread to northern Finland and Norway immediately after the Scandinavian Ice Sheet retreated, indicated by its presence in the sediments of the newly formed lake Várddoaijávri.

According to Belyaeva (2003), *A. werestschagini* is one of the most common cladoceran species in the Altai mountains. She encountered it in a high-altitude oligotrophic lake containing only two other cladoceran species, *Chydorus* cf. *sphaericus* (O. F. Müller 1776) and *Macrothrix groenlandica* Lilljeborg 1900, as well as in lakes with richer cladoceran assemblages, sometimes coexisting with *A. guttata*. In the Kola Peninsula *A. werestschagini* was found in several very oligotrophic lakes in the Khibiny Mountains above the altitude of 800 m a.s.l.

The conditions where it is presently found are well in accordance with the present results of its distribution also in northern Finland, close to the Kola Peninsula and northern Norway in cold climate and lakes with low nutrient status. In Várddoaijávri it was a clear pioneer species but until more data are available of the early Holocene aquatic ecosystem of the lake it is impossible to infer which ecological or competitive causes hindered it from thriving in the lake after the pioneer phase. However, although the data about the ecology of the species are far from complete, it seems to be a good indicator of oligotrophic conditions and low temperatures in palaeolimnological studies.

CONCLUSIONS

Research of contemporary cladoceran fauna in Finland has mainly been concentrated on planktonic species sampled together with other zooplankton. Chydorids which inhabit the littoral area have not been studied extensively. *A. werestschagini* has been only recently described from Russia and may have remained unnoticed before in Finland because hardly any studies have been performed in subarctic localities. Furthermore, it closely resembles the common species *Alona guttata* and therefore may have remained unnoticed. The presence of the species in northern Fennoscandia suggests that the chydorid fauna in the region is not completely known and plenty of further research is needed. However, it appears as a new indicator of severe climate conditions in palaeolimnological studies.

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