Entomostraceans from a Late-Glacial Lacustrine Deposit at Næstved, Denmark.

By

Erik M. Poulsen.

Frode Søgaard Andersen has recently published a paper on late-glacial Chironomids from Denmark[1]). In some of the samples (from the collections of "Danmarks Geologiske Undersøgelse") he found a number of remains of Entomostraceans, which he has been kind enough to forward to me for further examination.

The samples in question were taken from a deposit found in the neighbourhood of Næstved (Sjælland); in the above-cited paper Frode Søgaard Andersen published the following description of the deposit (translated from German): "Dr. H. Ødum describes the section from which the samples were taken as follows: "During the work on a new harbour at Næstved in 1936 a cutting was made which exposed a bog. Below the peat of the bog a series of late-glacial deposits was found. The size of the basin is only 70 × 150 m, and it is situated in a very slightly undulating boulder-clay region. In the deepest part of the basin, where the samples in question were taken the series of deposits was as follows:

0—70	cm	peat	
70—132	-	grey, clayey gyttja,	upper Dryas deposit
132—134	-	dark gyttja	Allerød gyttja
134—136	-	grey gyttja	Allerød gyttja
136—157	-	dark brown gyttja	Allerød gyttja
157—163	-	grey, clayey gyttja	lower Dryas deposit
163—187	-	grey clay	lower Dryas deposit
187—	-	boulder clay".	lower Dryas deposit

[1]) Frode Søgaard Andersen: Spätglaciale Chironomiden. Medd. fra Dansk Geologisk Forening. Bd. 9. H. 3. København, 1938.

Dr. I. IVERSEN, who has carried out a botanical investigation of the samples, has been kind enough to give me the following summary of his results: "A pollen-analytical investigation of the sediment shows the following development of the vegetation in the nearest surroundings of the late-glacial lake. 1) 187—167 cm: woodless tundra vegetation with *Cyperaceae*, *Gramineae* and *Salix*; 2) 167—157 cm: *Betula* appears, forming small open vegetations; 3) 157—132 cm: Allerød deposit: Open woods of *Betula* with a little *Pinus*; 4) 132—70 cm: the forest is again partly replaced by *Salix*-shrub and *Betula nana* heath; 5) 70 cm: post glacial *Betula-Pinus* forest. A rich vegetation of various water plants (e. g. species of *Potamogeton*) was growing in the lake; in the Allerød age a rich Cyanophyce-plankton was found dominating the whole sediment from this period".

The Material of Entomostraceans.

The remains of entomostraceans found consisted chiefly of parts of the shells and rarely only were appendages or other parts of the body found. Owing to this general absence of the appendages the determination of the species has not always been possible. The structure of the shells of allied species (of *Cladocera* and *Ostracoda*) is often so uniform that it cannot—at any rate with our present knowledge—be used for the determination of the species.

Synopsis of the Species found in the Material.

A. Cladocera.

Daphnia pulex DE GEER.

An ephippium was found in a sample from the upper Dryas deposit (70—132 cm deep, grey clayey gyttja) (Fig. 1). The ephippium is 1.2 mm long and 0.8 mm high; it has two vertically placed hollows for eggs, along its upper margin is a row of small hairs. The form and size of the ephippium and the two hollows for eggs show that it is the ephippium of a species of the genus *Daphnia*. The form of the ephippium shows further that only the two species *D. pulex* and *D. longispina* (with *D. culcullata*) can come into consideration. Concerning the ephippia of these two species W.

LILLJEBORG[1]), 1901, writes that the ephippium of *D. longispina* is longer than that of *D. pulex*. Generally speaking this holds true; however, in calculating the proportion height to length in LILLJEBORG'S figures the following percentages of height are found, *D. pulex* 59—60—72, *D. longispina* 67; thus the height of the *D. pulex* ephippium is not always greater than that of the *D. longispina* ephippium. In 8 ephippia from Denmark I have found the following percentages of height to length: *D. pulex* 65. 69. 71. 72 and *D. longispina* 62. 63. 64. 67. Thus in this case too the *D. pulex* ephippium is not always higher than that of *D. longispina*. However, in the form of the ventral (the curved) margin of the ephippia there is a difference between the two species (see Fig. 2). In *D. pulex* this margin is rather evenly rounded posteriorly as well as anteriorly, whereas in *D. longispina* the posterior part is considerably flattened. Roughly speaking the ventral margin of the *D. pulex* ephippium is like a semi-circle, whereas that of *D. longispina* corresponds to half of the circumference of an egg.

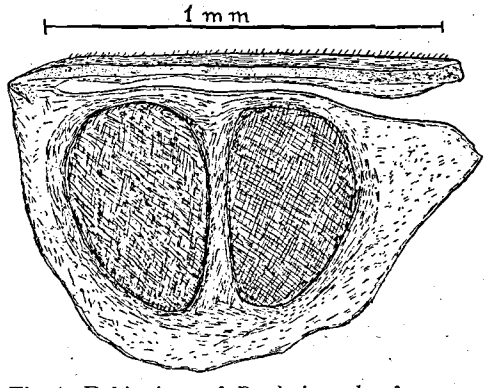

Fig. 1. Ephippium of *Daphnia pulex* from a sample of the Upper Dryas deposit (70—132 cm depth).

The ephippium found in the upper Dryas deposit has a ventral margin in form closely approaching a semi-circle, and thus there can be no doubt that it is the ephippium of *D. pulex*. This species is very widely spread, and found both in warmer regions and in the true Arctic.

Subfossil ephippia of the genus *Daphnia* are found fairly often. In the literature they are as a rule described as ephippia of "*Daphnia*" only. However, as some of the species of the genus *Daphnia* are distributed within rather well-defined climatic regions, it should be of some interest to have the subfossil ephippia of this genus determined as to species, and this can be done somewhat easily. On

[1]) W. LILLJEBORG: *Cladocera sueciae*. Nova acta reg. soc. sc. Upsaliensis. Ser. 3. vol. 19. 1901.

Fig. 2. I have given some contour-drawings of recent ephippia of four of the five species of *Daphnia* occurring in northern Europe and in Greenland, viz. *D. pulex*, *D. longispina*, *D. magna* and *D. atkinsoni*; the fifth species, *D. cucullata*, has about the same distribution as *D. longispina* and is by many authors regarded merely as a variety of this species. From the figure it is seen that the ephippia of the four species fall within two groups: 1) the *pulex-longispina*

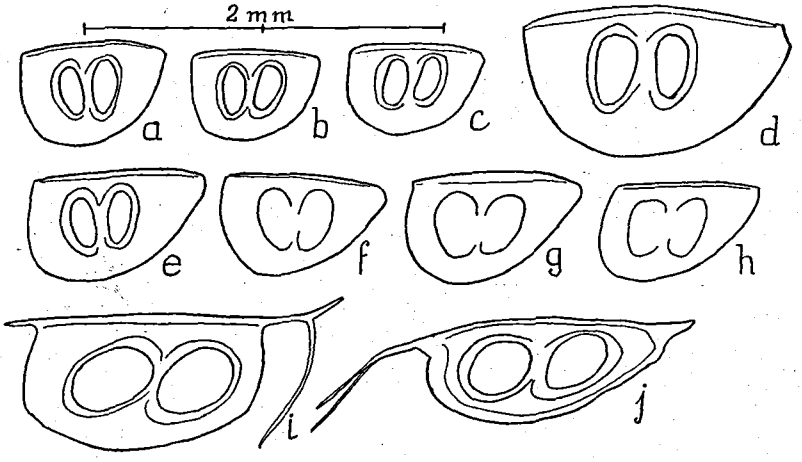

Fig. 2. Contour-drawings of (recent) ephippia of various species of Daphnia; a, b, c *D. pulex* (pond near Vordingborg); d *D. pulex* (marl-pit near Vordingborg); e, f, g and h *D. longispina* (bog near Vordingborg); i *D. magna* (pond in Hellerup); j *D. atkinsoni* (pond on Æðey, Iceland).

group (to which also *D. cucullata* belongs) with short ephippia with nearly vertically placed eggs or egg-hollows, and 2) the *magna-atkinsoni* group with longer ephippia with obliquely placed eggs or egg-hollows. The difference between the *pulex* and *longispina* ephippia has already been mentioned. The ephippia of *D. magna* and *D. atkinsoni* can be separated in much the same way; in *D. magna* the anterior and posterior parts of the ventral margin have nearly the same evenly rounded shape, whereas in *D. atkinsoni* the posterior part is much flattened. Of the species in question *D. magna* and *D. atkinsoni* have been found only in the temperate regions. *D. longispina* (and *D. cullata*) occurs almost exclusively in the temperate regions, though it has been recorded once or twice from the Arctic; the reliability of these records has, however, been doubted. *D. pulex* is found in the temperate regions as well as in the Arctic.

In the lower Dryas deposit (157—163 cm) an only badly conserved ephippium was found; the two vertically placed egg-hollows show that it belongs either to *D. pulex* or to *D. longispina*. The size of the ephippium and its general appearance make it probable that it belongs to the former species.

Simocephalus vetulus (O. F. M.) (species?)

An ephippium (Fig. 3) of a species of *Simocephalus* was found in the upper Dryas deposit (70—132 cm). The length of the ephippium is 0.75 mm. Its form, and the fact that it has one egg-hollow only and that this is placed longitudinally in the ephippium, shows without doubt that it belongs to the genus *Simocephalus*. Of this genus three species, *S. vetulus*, *S. exspinosus* and *S. serrulatus*, occur in Denmark. The ephippium from the upper Dryas deposit coincides completely in size, form and shell-structure with recent ephippia of *S. vetulus*. Therefore I hold that there can be but little doubt that it belongs to this species. However, as I have not been able to find any conclusive difference between the ephippia of the three species, I have registered this one with a "?". *S. vetulus* is by far the most common of the three species and the only one which has been found in the true Arctic.

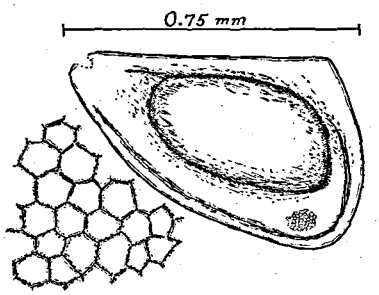

Fig. 3. Ephippium of *Simocephalus vetulus* (?), with the structure of the shell drawn to a larger scale, from a sample of the Upper Dryas deposit (70—132 cm depth).

Bosmina Baird, species indeterm.

In the lowest layer of the Allerød Gyttja (136—157 cm) were found two empty head shells of a *Bosmina* species with the first antennae (Fig. 4). The remains found do not show any of the characters by which the two species of Bosmina (*B. longirostris* (O. F. M.) and *B. coregoni* Baird) can be separated from one another. Both these species are widely spread and found in the arctic regions as well as in the warmer ones.

The head shells found are strongly striated and their ventral-posterior parts reticulated. The height of the head is ca. 0.35 mm; the first antennae are 0.20 mm long and have 12—14 joints.

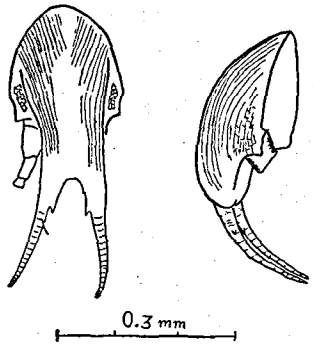

Fig. 4. Two empty shells of the head of *Bosmina* (species indet.) from the lowest layer of the Allerød Gyttja (136—157 cm deep).

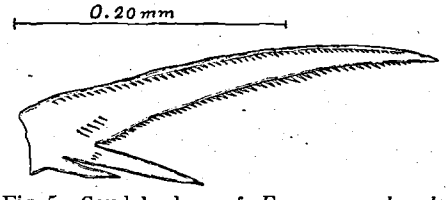

Fig. 5. Caudal claw of *Eurycercus lamellatus* from a sample of the Upper Dryas deposit (70—132 cm depth).

Eurycercus lamellatus (O. F. M.).

A caudal claw was found (Fig. 5) in a sample from the upper Dryas layer (70—132 cm). The claw is fairly straight, with a small and a larger spine at the base. The edges of the claw are furnished with combs of pointed teeth; near the base and laterally is a series of five small spines. The total length of the claw is 0.28 mm. The shape of the claw, its large size and the two rather large basal spines show that it is the caudal claw of an *Eurycercus* species.

Of *Eurycercus* two species, viz. *E. lamellatus* and *E. glacialis*, are known from our region; the former is common both in the temperate region and in the Arctic; the latter is somewhat common in the Arctic and in the northern part of the temperate region (Iceland); on the European continent it is found very rarely only. The claw found in the Dryas layer resembles in every respect that of a full-grown *E. lamellatus*. It is only two-thirds of the length of the claw of an adult *E. glacialis*. Therefore, if the claw belongs to this species it must be that of a young specimen. This, however, is hardly possible, as the claws of the young *E. glacialis* I have examined do not possess the series of about five spines laterally at the base, these being found in larger specimens of *E. glacialis* only, as well as in

E. lamellatus. Also the number of teeth in the comb along the dorsal margin of the claw coincides better with *E. lamellatus* than with *E. glacialis*, as the following figures show:

Claw from upper Dryas layer		ca. 51—53 teeth	
- - *E. lamellatus* (Iceland)	-	50	-
- - *E. glacialis* ad. (Iceland)	-	90	-
- - *E. glacialis* juv. -	-	65	-

Obviously there is thus no reason to doubt that the claw in question belongs to *E. lamellatus*.

Camptocercus rectirostris (SCHOEDLER).

In the lowest layer of the Allerød Gyttja (136—157 cm deep) was found a shell including the cauda (Fig. 6). The shell and the cauda, both being well preserved, do not differ from the figure of *Camptocercus rectirostris* which *Lilljeborg* has given in the above-cited paper, and it is beyond question that they belong to this species. The number of teeth along the dorsal margin of the cauda is 15, the same as stated for *C. rectirostris*, viz. 15—17, whereas the two other species occurring in our region (*C. macrurus* and *C. lilljeborgi*) have more than 20 teeth.

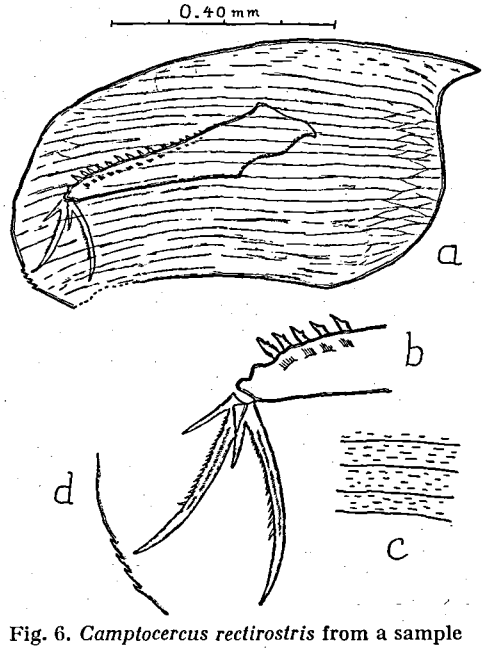

Fig. 6. *Camptocercus rectirostris* from a sample of the lowest deposit of the Allerød Gyttja. a. shell with cauda and caudal claws; b. end of cauda with caudal claws; c. the shell-structure; d. posterior margin of shell.

The length of the shell is 0.83 mm and its height 0.40 mm; the total length must have been about 1.00 mm. The shell is longitudinally striated (Fig. 6c); in the anterior and posterior parts the striation is somewhat irregular (with anastomo-

ses); along the back the striation is less pronounced. Besides the striation the shell is furnished with short streaks arranged in longitudinal rows. On the inferior-posterior angle of the shell (Fig. 6d) are four short teeth; LILLJEBORG (l. c.) and KEILHACK[1]) give for Sweden and Germany the figure 3—5, whereas in Iceland the number of teeth as a rule is 9—11 (ERIK M. POULSEN[2])). The cauda is slender and on the dorsal margin carries 15 teeth and inside these a series of small clusters of hairs. The caudal claws (Fig. 6b) are long, slightly curved, with a basal spine; the proximal two-thirds of the dorsal margin is furnished with a series of spines.

C. rectirostris is not found in the true Arctic; the region nearest the Arctic where it occurs is Iceland, where, however, it is found in the lowland only, i. e. in the warmest parts of the country; in northern Sweden too it occurs in the lowland only (Ekman, 1904[3])). Therefore it is quite natural that it was found in a deposit from the warmer Allerød period.

Alona affinis LEYDIG.

A shell with the cauda of an *Alona* species was found in the lowest layer of the Allerød Gyttja (136—157 cm) (Fig. 7). The shell, which is only badly conserved, measures 0.8 mm; the total length of the individual must have been about 1.0 mm. The anterior-inferior angle of the shell is shown in Fig. 7b. It is of interest to note that not only the setae on the margin but also the minute hairs of these setae have been preserved.

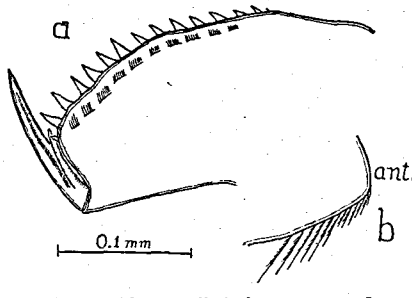

Fig. 7. *Alona affinis* from a sample of the lowest deposit of the Allerød Gyttja (136-157 cm depth). a. cauda; b. anterior-inferior corner of shell.

The shape of the cauda (Fig. 7a) and especially the small hairs on the dorsal margin of the basal spine of the claw show without doubt that the remains belong to the species

[1]) L. KEILHACK: Phyllopoda. Die Süsswasserfauna Deutschlands H. 10. 1909.

[2]) ERIK M. POULSEN: Freshwater Crustacea. The Zoology of Iceland. Vol. III, Part. 35. 1939.

[3]) SV. EKMAN: Die Phyllopoden, Cladoceren und freilebenden Copepoden der nordschwedischen Hochgebirge. Zool. Jahrb. Art. Syst. Bd. 21. 1904.

Alona affinis. The number of teeth on the dorsal margin of the end-claw is 14—15, whereas the nearly related species *A. quadrangularis* has 16—18 teeth.

A cauda without the end-claw has been found in the upper Dryas deposit (70—132 cm deep). The shape of the cauda and the number of dorsal teeth (15) make it very probable that this too belongs to *Alona affinis*.

Chydorus sphaericus O. F. M.

In some samples from the upper as well as the lower Dryas deposit were found a number of remains of the small Cladocera *Chydorus sphaericus* (Fig. 8). The small size of the shells (ca. 0.5 mm), their

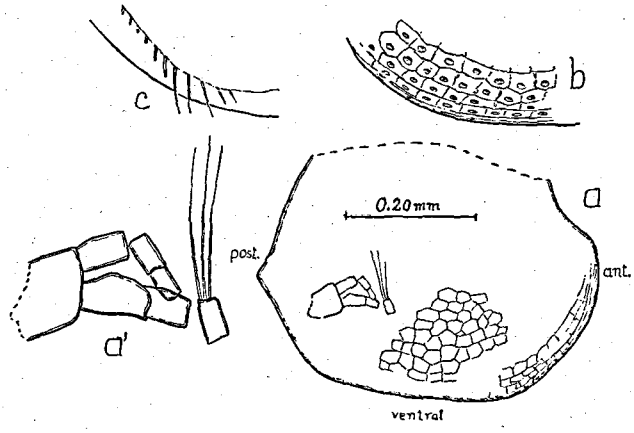

Fig. 8. *Chydorus sphaericus* from a sample of the Upper Dryas deposit (70—132 cm depth). a. shell (without the dorsal margin, a' parts of the first and second antennae of the same specimen; b. part of a shell of another specimen (var. *coelatus*) from the same sample; c. lower margin of the shell of another specimen from the same sample.

rounded, almost circular form, and their sculpture—uneven polygons in the centre of the shell and concentrically arranged rectangles along the margin— leave no doubt that these shells belong to the species *Chydorus sphaericus*. In one of the shells a part of the second antennae is preserved, both the rami are 3-jointed as is the case in all the species of the family *Chydoridae*, but not in the other families of the Cladocera.

In one of the samples from the upper Dryas deposit two shells

were found differing from others in the same sample by having within each polygon a small hollow (Fig. 8b). These shells must be referred to the variety *Chydorus sphaericus* var. *coelatus* SCHOEDLER.

Chydorus sphaericus is a true ubiquist, found both in the Arctic and in the temperate and tropical regions.

B. Ostracoda.

Remains of Ostracoda were scarce and found in two samples only.

Cypria ophthalmica (JURINE).

An Ostracod-shell with the natatory setae of the second antennae and the caudal claws was found in a sample from the upper Dryas deposit (70—132 cm deep) (see Fig. 9). The shell is short (0.6 mm) and high (0.5 mm) and furnished with hairs along the margin (only a small part of the hairs remained). The surface of the shell is smooth, without hairs. Judging from the long natatory setae fringed with minute hairs the second antennae must be regarded as well adapted for swimming. The caudal claws are strong and towards the end curved. On account of these characters there can be no doubt that the specimen must be referred to the species *Cypria ophthalmica*. This species is widely distributed and found both in colder and in warmer regions.

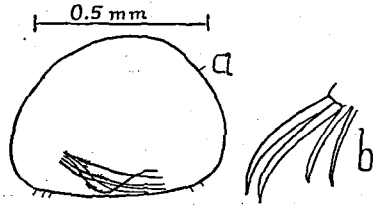

Fig. 9. *Cypria ophthalmica* from a sample of the Upper Dryas deposit (70—132 cm depth). a. shell with natatory setae of second antennae; b. caudal claws.

Potamocypris villosa (JURINE)?

An Ostracod-shell about 0.6 mm long was found in a sample from the upper Dryas deposit. It is rather badly conserved, and neither the shape of the appendages nor the cauda can be observed. The shell is rather oblong and somewhat reniform. The surface of the shell is finely dotted and rather densely haired. On account of these facts I hold that it is probable that the shell belongs to the species *Potamocypris villosa*. However, as it is impossible to ascertain the

specific characters found in the shape of the appendages and the cauda I have put a "?" to the name of the species. *P. villosa* is widely spread through various climatic regions, but not recorded from the true Arctic.

Remarks.

The material on which the present investigation is based dates from three climatic ages succeeding the glacial age, viz: Lower Dryas, Allerød and Upper Dryas.

From these three ages the following species of Entomostraceans were found:

Lower Dryas	Upper Dryas
1. *Chydorus sphaericus*	1. *Daphnia pulex*
2. *Daphnia pulex* (?)	2. *Simocephalus vetulus* (?)
	3. *Eurycercus lamellatus*
Allerød	4. *Alona affinis*
1. *Bosmina sp.*	5. *Chydorus sphaericus*
2. *Camptocercus rectirostris*	6. *Cypria ophthalmica*
3. *Alona affinis*	7. *Potamocypris villosa* (?)

In the Lower Dryas—the age nearest to the glacial age—only the two *Cladocera*: *Chydorus sphaericus* and *Daphnia pulex* (?) were found. It is of interest to note that it is the same two species which now are most commonly recorded from the true Arctic. On Svalbard O. Olofsson[1]) thus found these two species most abundantly and quite dominating, and in North-East Greenland the present author[2]) found the same two species to be absolutely dominating, with frequency-percentages of 67 and 44 respectively. It is therefore only natural that these two species are the first to be recorded from the Arctic Lower Dryas age.

In the next age, the warmer Allerød-age, it is of interest to note the presence of *Camptocercus rectirostris*. This species, which has not been found nearer to the Arctic than in the Icelandic lowland, is a true sign of a warmer climate.

From the Upper Dryas, where the climate again was colder, seven species were recorded. The larger number of species need not at all

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[1]) O. Olofsson: Studien über die Süsswasserfauna Spitzbergens. Zool. Bidrag fr. Uppsala, VI. 1918.

[2]) Erik M. Poulsen: Freshwater Entomostraca. The Zoology of East Greenland. Medd. om Grønland Bd. 121 Nr. 4, København 1940.

indicate that the fauna then was richer than in the preceding ages; it may have been due merely to the fact that the material investigated was larger. The five species of Cladocera found in the Upper Dryas material occur both in the Arctic and in the temperate regions. The two Ostracods found are also known from colder regions, although they have not hitherto been recorded from the true Arctic.

Færdig fra Trykkeriet 15. Januar 1945.