A redescription of the common harpacticoid *Pseudobradya arctica* (Olofsson, 1917) comb. nov. (Crustacea, Copepoda) from the Baltic Sea with ecological notes

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SARSIA

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A previously unidentified species of the family Ectinosomatidae (Harpacticoida) dominates soft sediments below 10 m in large areas of the Baltic Sea. It is identical to the species described by Olofsson (1917) as *Ectinosoma arcticum*, which was subsequently classified as *species incertae* by Lang (1948). Close examination of the mouthparts revealed that it belongs to the genus *Pseudobradya*. A description of *P. arctica* is provided in order to facilitate its identification and its ecology in the Baltic Sea is discussed.

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INTRODUCTION

Species of the family Ectinosomatidae are often important components of the harpacticoid community of marine sediments. However, species of this family are considered very difficult to identify, and many records are probably incorrect (Clément & Moore 1995, 2000). In soft sediments, below 10 m of the Baltic Sea, a small ectinosomatid species is commonly found in high numbers and in some areas it is the only representative of the harpacticoid copepod fauna. This species is identical to the species described by Olofsson (1917) from a brackish lagoon in Spitsbergen as *Ectinosoma arcticum* Olofsson, 1917, which was subsequently classified as *species incertae* by Lang (1948). The only record from the Baltic Sea is from Schäfer (1936) who found this species in the southern Baltic (Hiddensee), however expressed doubts as to its identity. We have discovered that the morphology of the maxilla and maxilliped is typical of the genus *Pseudobradya* Sars, 1904 (see Huys & al. 1996). *P. arctica* comb. nov. has often been misidentified as *Halectinosoma abrau* (Kričagin, 1877) (e.g. Sarvala 1971; Ankar & Elmgren 1976) and in recent ecological studies, this species has been referred to as *Pseudobradya* sp. (Ólafsson & Elmgren 1991; Ólafsson 1992; Ólafsson & Elmgren 1997; Modig & Ólafsson 1998; Pallo & al. 1998; Ólafsson & al. 1999). Here, we provide a description of *P. arctica* in order to settle its taxonomic status and facilitate its identification in future studies.

MATERIAL AND METHODS

Specimens were dissected in lactic acid and mounted on slides in polyvinyl lactophenol. All figures were prepared with the aid of a drawing tube. Habitus length was measured from the base of the rostrum to the posterior edge of the anal somite. The sum of all somites was also used as a more reliable measure owing to the telescoping action of the body somites (Clément & Moore, 1995: fig. 1A). It is calculated by placing the specimen on its side and measuring each individual somite on its dorsal edge from its anterior margin to the posterior edge, which includes the hyaline frill when present and the pseudoperculum of the penultimate somite, and excludes the rostrum and caudal rami. Nomenclature follows that of Lang (1965) except for the use of the endopod, exopod and baseoendopod. The only abbreviations used in the text are P1 to P6 for legs 1 to 6. For practical consideration we have retained the terms lacinia and pars incisiva for the coxal gnathobase of the mandible. The material on which the description and illustrations are based has been deposited at the Natural History Museum, Stockholm.

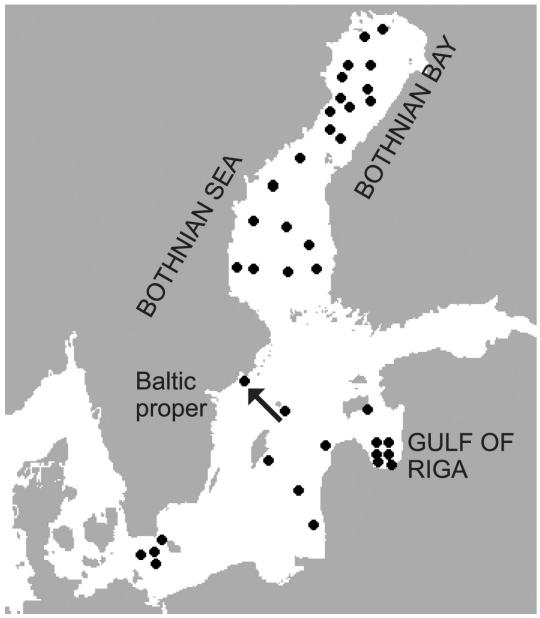

Fig. 1. A map of sampling sites where *P. arctica* has been positively identified. The arrow indicates the type locality.

SYSTEMATICS

Pseudobradya arctica (Olofsson, 1917) comb. nov.

Synonym: *Ectinosoma arcticum* Olofsson, 1917

Material examined

Baltic Sea: 1 female designated as the neotype dissected on slides #1-2 (ref. no.:SMNH-5221), 5 females dissected on slides #3-12, 4 males dissected on slides 13-17 (ref. no.: SMNH-5222), 23 females preserved in tube no.1, 9 males preserved in tube no.2 (ref. no.:SMNH-5223), all from the type locality: a 30 m deep station near the Askö Laboratory, in the northwestern Baltic proper (58º49'N,17º38'E, Fig.1). Hundreds of individuals from over 40 stations in the Baltic proper, Gulf of Riga, Bothnian Sea and Bothnian Bay (see Fig. 1).

Description of female

Length: habitus 420-550 µm (n = 10); sum of all somites 510-575 µm; cephalothorax 200-210 µm; genital double-somite 60-70 µm. Habitus fusiform (Fig. 2A). Colour of preserved specimens brown. Cephalothorax gradually attenuating anteriorly. Rostrum broadly rounded and partially fused at base with cephalothorax. Genital double-somite ventrally with a short transverse chitinous stripe (Fig. 2B). Penultimate somite with rounded pseudoperculum (Fig. 2C).

Caudal ramus (Fig. 2B,C): Slightly broader than long and furnished with seven setae: two adjacent slender setae issuing near distal outer corner, one of which is diminutive; a stouter lateral seta proximal to the slender setae; two well-developed terminal setae, the outer seta being shorter than inner one; one seta issuing from inner distal corner, spinulose along inner margin; one slender dorsal inner seta with biarticulate base. Posterior edge of rami dorsally and ventrally terminating as an acuminate lappet.

Somitic ornamentation (Fig. 2B,C): Body somites, apart from penultimate, sparsely furnished with sensilla and pores. Posterior margin of cephalothorax, free thoracic somites, and first urosomite unadorned. Surface of first and third free thoracic somites and first urosomite with three rows of fine spinules. Surface of second free thoracic somite with four rows of fine spinules. Genital double-somite and fourth urosomite with a complex arrangement of rows of fine spinules and with a semi-incised subulate hyaline frill which is interrupted dorsally by an unadorned, slightly crenulated, distal margin. Penultimate somite a semi-incised subulate hyaline frill which is interrupted dorsally by the unadorned pseudoperculum. Anal somite with a row of spinules on ventral surface that reaches to the dorsal side and a row of spinules along distal margin.

Antennule (Fig. 3A): Short, 6-segmented and without pigmented spot. First segment with one spinulose seta issuing from anterior distal corner. Second segment armed with 9 well-developed setae and a dwarfed seta near anterior distal corner. Third segment with eight setae, one of which is sharing a common base with an aesthetasc at anterior distal corner. Fourth segment short and furnished with one bare seta. Penultimate segment armed with four setae. Distal segment protruding beyond penultimate one and furnished with three apical setae, two of which are sharing a common base and along posterior margin, a set of six diminutive setae.

Antenna (Fig. 3B): Basis with a set of setules at inner distal corner. Endopodite two-segmented; first segment with spinules along inner margin, second segment furnished with two adjacent setae mid-way along inner margin and seven terminal setae of which three are spinulose geniculate, three are spinulose and one dwarfed. Exopodite three-segmented; proximal segment unadorned, middle segment short and furnished with a spinulose seta, distal segment much longer than preceding two segments, with a lateral spinule row and armed with two apical spinulose setae, the outer seta being nearly twice as long as the inner seta.

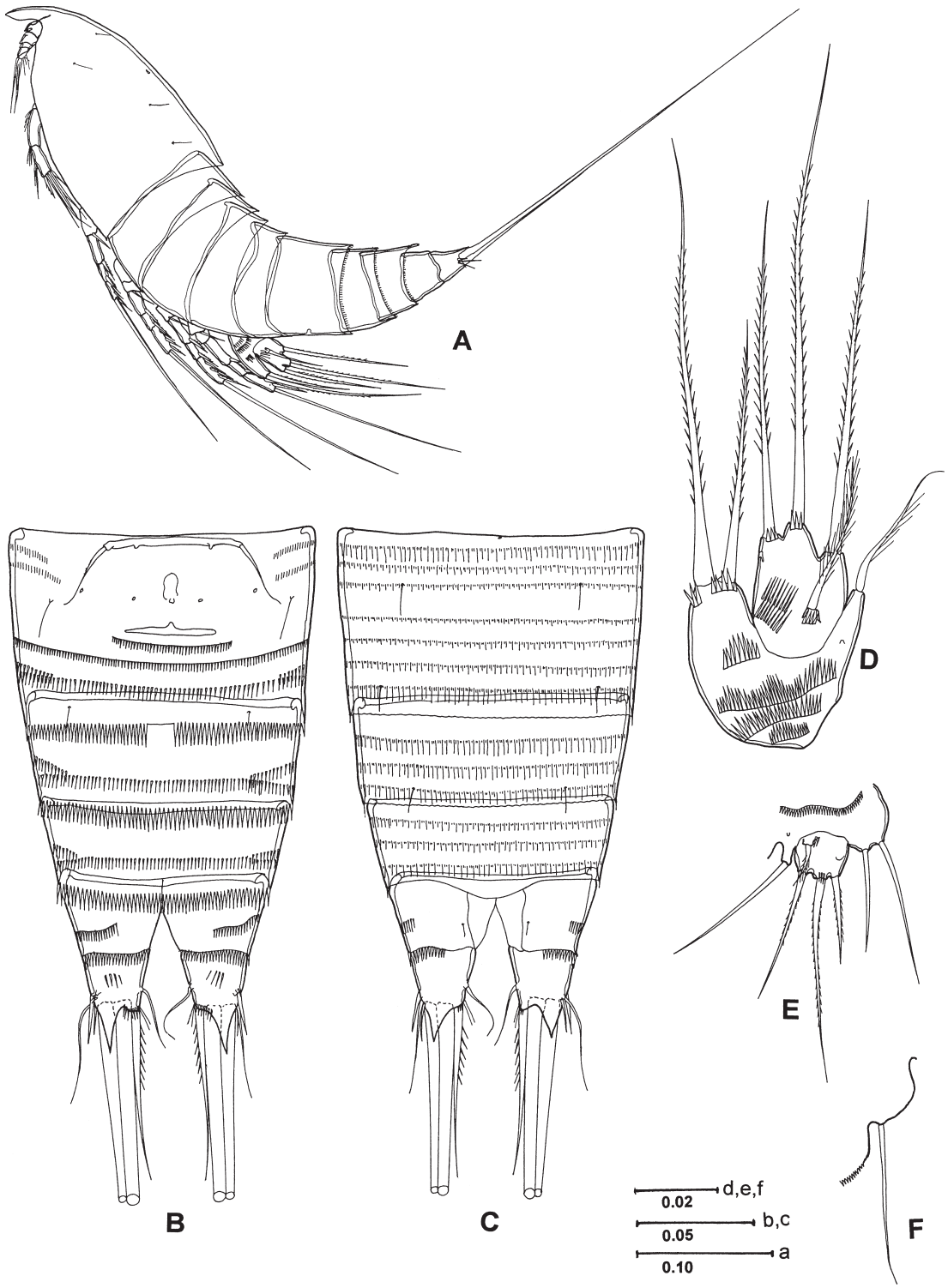

Fig. 2. *Pseudobradya arctica* (Olofsson, 1917) comb. nov. Female: A, Habitus, lateral; B, Urosomites, 2-6, ventral; C, Urosomites 2-6, dorsal; D, P5. Male: E, P5; F, P6.

Mandible (Fig. 3C): Coxal gnathobase well developed and furnished with a short spiniform seta at ventral base of tridentate pars incisiva and a lacinia furnished with three sharp teeth. Basis with three setae issuing from distal inner corner. Endopodite one-segmented and furnished with three juxtaposed setae mid-way along inner margin and eight terminal setae, two of which are fused at base. Exopodite one-segmented and armed with three setae; two spinulose distal setae and a diminutive confluent inner seta.

Maxillule (Fig. 3D): Praecoxal arthrite broad and armed along distal edge with three unguiform spines and, proximal to these, two slender adjacent setae. Coxa short and armed with a spinulose seta. Basis furnished with six setae. Exopodite small, one-segmented, and armed with two plumose setae. Endopodite one-segmented and with three pairs of setae.

Maxilla (Fig. 3E): Geniculate. Syncoxa with three endites along inner margin: proximal endite with four setae, middle and distal endites with 2 and 3 setae respectively. Allobasis furnished with three slender setae near distal inner margin. Endopodite three-segmented, the first two segments each armed with a thick and very long geniculate seta accompanied by a slender seta and the distal segment represented by a broad base from which one lateral and three distal confluent setae arise.

Maxilliped (Fig. 3F): Syncoxa short, furnished with one spinulose seta and with a row of fine spinules. Basis short and robust, and furnished with slender hairs along outer margin and a spinular row on the surface. Endopodite of one short segment, armed with two spinulose setae and two basally fused setae apically.

P1-P4 (Fig. 4A-D): Coxa with a transverse row of spinules on anterior surface (except for P1 which has two) and two rows along distal edge (but only one on P1). Exopod and endopod three-segmented with setal formula as follows:

	Exopod	Endopod
P1	0 : 1 : 123	1 : 1 : 221
P2	1 : 1 : 223	1 : 1 : 221
P3	1 : 1 : 323	1 : 1 : 221
P4	1 : 1 : 323	1 : 1 : 221

Exopod-3 of P4 with middle inner seta distinctively broad and long.

P5 (Fig. 2D): Endopodal lobe reaching to middle of exopod and furnished distally with two with two rows of spinules and two setae, the inner seta being much longer than outer seta. Outer expansion of baseoendopod furnished with a long slender seta and with a small pore on anterior surface. Exopod almost twice as long as broad and separated from baseoendopod by a suture. Surface of baseoendopod with four rows of spinules. Exopod with two rows of fine spinules near inner margin, a small pore near the distal inner margin, and with three lobes at distal edge, each accompanied by a few spinules and armed with a spinulose seta: innermost seta reaching beyond outer seta of endopodal lobe; middle seta longer than innermost seta; outer seta about as long as inner seta. Surface-seta reaching beyond exopod, articulating on a small lobe accompanied by a few spinules and issuing from the exopod.

Description of male

Length: habitus 290-300 µm (n = 10); sum of all somites 360-385 µm; cephalothorax 155-160 µm. Second and third urosomites distinct. Otherwise as in female apart from the following features.

Antennule (Fig. 3G): 7-segmented. First segment with a seta at anterior distal corner. Segment 2 short and bearing one seta at anterior distal corner. Segment 3 furnished with eight setae. Segment 4 with only two setae. Segment 5 moderately swollen and furnished with a complex arrangement of setae: anterior edge with an aesthetasc and two slender setae, ventral surface with two slender setae and a set of three adjacent setae, one of which is short and spinulose. Penultimate segment slightly swollen and without seta. Distal segment small, with a slender seta on the posterior margin and three terminal setae, two of these with a common base.

P5 (Fig. 2E): Baseoendopod confluent with first urosomite: endopodal lobe armed with two setae, innermost slightly longer than outermost seta; outer expansion armed with a seta about as long as outermost seta of exopod. Exopod clearly demarcated from baseoendopod and armed with three spinulose setae: the middle seta twice as long as innermost seta; the outermost seta reaching beyond innermost seta. Surface-seta issuing from a lobule on the exopod and reaching just beyond distal margin.

P6 (Fig. 2F): A plate with one seta at outer distal corner.

DISCUSSION

Taxonomic remarks

The original description of *E. arcticum* is incomplete and this species was later placed by Lang (1948) in the genus *Halectinosoma* as *species incertae* because of numerous discrepancies between the text and illustrations. As far as we know, the type material of *E. arcticum*

Fig. 3. *Pseudobradya arctica* (Olofsson, 1917) comb. nov. Female: A, Antennule; B, Antenna; C, Mandible; D, Maxillule; E, Maxilla; F, Maxilliped. Male: G, Antennule.

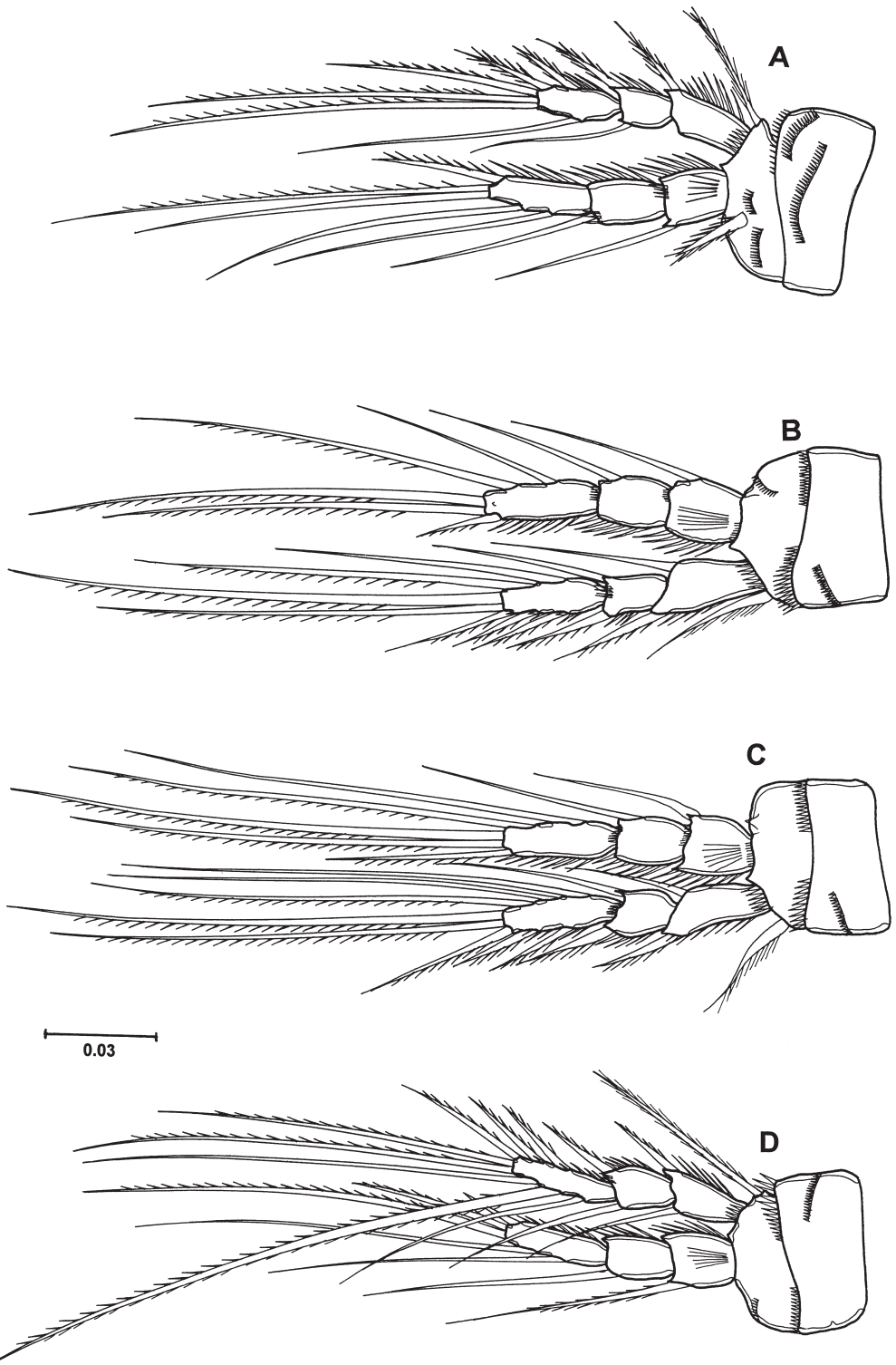

Fig. 4. *Pseudobradya arctica* (Olofsson, 1917) comb. nov. Female: A, P1; B, P2; C, P3; D, P4.

does not exist. We have nonetheless found few differences between the original description given by Olofsson (1917) and the material found in the Baltic. As it was remarked by Olofsson, the setae of the periopods P1 to P4 are long and often reaching to the caudal ramus. The morphology of the cephalic appendages and the female P5, body size and the shape of the caudal rami as given by Olofsson agree with the material examined in the Baltic. The discrepancies appear in the number of setae on the endopodite of the antenna and of the mandible. Setae on these appendages have often been omitted in the past because they are very difficult to discern in Ectinosomatidae. A characteristic feature is also found on the third segment of the P4 exopod of both male and female: the middle inner seta is distinctly thick and much longer than the two adjacent inner setae (Fig. 4D). We have also discovered that the morphology of the maxilla and maxilliped, as illustrated by Olofsson and found in the material examined, is typical of the genus *Pseudobradya* (defined in Huys & al. 1996). The maxilla is geniculate and the maxilliped is short and robust. Owing to the difficulty in differentiating species of *Pseudobradya* and *Halectinosoma*, and the fact that this species is commonly found in the Baltic, we believe that *P. arctica* has often been misidentified as *Halectinosoma abrau* (Kričagin, 1877) (e.g. Sarvala 1971, Ankar & Elmgren 1976). Both species occur in the Baltic and have a somewhat similar morphology. However, the female of *H. abrau* possesses a characteristic spine on the third segment of the antennule (Lang, 1948), a feature that is easily overlooked.

Ecological notes

P. arctica occurs from the low salinity waters (3 psu) of the northern Bothnian Bay down to the southern more saline waters (18 psu) of the Baltic proper (map). It has a wide depth distribution and has been recorded from 10 to 200 m. It is mainly found in muddy sediments although it occurs also in sandy substrata. In the northern Baltic Sea it is typically found at densities of 100-200 inds/10cm^2 but may reach 500-1000 inds/10cm^2 in some localities, while in the southern part it is represented in much lower numbers (around 10 inds/10cm^2). *P. arctica* is the only harpacticoid copepod found below 10 m in the Bothnian Sea and Bothnian Bay while it co-occurs with *Microarthridion littorale* (Poppe, 1881) in the northern Baltic proper, and with *Leimia* sp. in the Gulf of Riga. In the southern Baltic it is found with other representatives of the Ectinosomatidae e.g. *Pseudobradya minor* (T. & A. Scott, 1894), *Halectinosoma curticorne* (Boeck, 1872) and *H. gothiceps* (Giesbrecht, 1881). We did not find *P. arctica* in samples from the marine waters of the Kattegat on the west coast of Sweden. It is likely that it also occurs in the Gulf of Finland, but we did not have samples at our disposal to verify this.

In the northern Baltic proper, highest densities coincide with the coldest water temperatures and so does the number of ovigerous females in the Bothnian Sea, Bothnian Bay and the Gulf of Riga (Ólafsson & Elmgren 1997, pers. observ., Widbom pers. commn). In the laboratory, *P. arctica* has been kept in microcosms for a month at three different temperatures 2, 10 and 20 °C. No mortality was recorded at 2 °C while 50 % and 100 % died at 10 °C and 20 °C respectively. In two different experiments *P. arctica* showed high survival in microcosms where the salinity was 10 and 20, while survival was poor in fresh and fully marine waters.

It is clear that *P. arctica* is a very successful species in the Baltic Sea, both in terms of distribution and abundance. Both laboratory studies and seasonal field observations indicate that it is a cold water species possibly originating from the Arctic and remaining in the Baltic as a glacial relict.

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