



**FURTHER DATA ON SUMMER-BREEDING IN BALTIC
POPULATIONS OF THE AMPHIPODS *PONTOPOREIA
AFFINIS* AND *P. FEMORATA*, WITH COMMENTS ON
THE TIMING PROBLEM INVOLVED**

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In a paper of 1967, the author demonstrated that in Baltic populations of the amphipods *P. affinis* Lindström and *P. femorata* Köyer, which normally breed in winter, the former species reproduces even in the warm season at depths below 100 m and that in the latter summer-breeding, which had earlier been observed below 85 m, may occur even at c. 60 m. Examination of new material of the two species collected off the south coast of Finland confirms the conclusions that breeding during the warm season is confined to deep water and that the minimum depth for such reproduction lies higher in *femorata* (at one station breeding found even at 45 m). For *affinis* even the deepest locality from which new material of this species was available (situated at 60 m) showed no indications of summer-breeding. The fact that, in both species, reproduction in this season is restricted to deep water and the differences between them in this respect are suggested to be due to the light factor.

In a recent publication (Segerstråle 1967) I have discussed the incidence of reproduction in *Pontoporeia affinis* Lindström and *P. femorata* Kröyer in Baltic waters, where these amphipods are among the main constituents of the benthic fauna. For the former species, the earlier view that in this area breeding is confined to the cold season (egg-laying in late autumn, release of the young from the brood-pouch of the mother in spring; cf. Segerstråle 1937) was shown not to cover the whole truth: in a number of samples collected below the 100 m level in the Gulf of Bothnia in the first half of June, 1965, not only spent females but also females with swollen ovaries or freshly deposited eggs in the brood-pouch were found. In the case of *P. femorata*, breeding in the Baltic area at other seasons besides the winter — the normal time of reproduction in this species — had already been reported earlier (Segerstråle 1938).

In this this case, too, such observations referred to deep water, *viz.* below the 85 m level. In my 1967 paper, the minimum depth at which summer-breeding was observed could be raised to about 60 m on the basis of samples collected in the Gulf of Finland in May, 1965 (presence of females with freshly deposited eggs).

THE NEW OBSERVATIONS

In order to obtain more information about the occurrence of summer-breeding in Baltic populations of the two amphipods under discussion, I collected additional material in the years 1967—1969 in the area adjacent to the Zoological Station at Tvärminne, situated on the southwest coast of Finland.¹⁾ Besides this material, which comprises 14 samples, I have had the opportunity to examine 8 further collections, kindly placed at my disposal by the following colleagues: Mr. Henrik Backman, Mr. Julius Lassig, Lic.Phil., and Mr. Ilkka Luotamo, Cand.Nat. These collections originate partly from the Tvärminne region, partly from areas further east in the Gulf of Finland, *viz.* open waters off the towns of Helsinki and Lovisa. All the material examined was collected by dredging. The depths sampled ranged from 44 to 73 m. The collecting period covered the time from late April to mid-August.

Pontoporeia affinis. Females with freshly deposited eggs were totally lacking from the new material examined, which included 9 samples from depths of 49—60 m (the collections from below 60 m did not contain the species concerned). Some of these samples were rather large, comprising hundreds of full-grown females. This result is in accordance with the earlier observation that in *P. affinis* summer-breeding is confined to comparatively great depths (Segerstråle 1967). As material is lacking from the zone between 60 m and 100 m, the depth below which breeding at the warm season has been observed, we do not know the exact depth at which such reproduction commences; however, certain facts (*cf.* just-mentioned paper) point to the lower part of the gap in question.

Pontoporeia femorata. Females with freshly deposited eggs were found in collections from all the months sampled. Earlier no such observations had been made in July or August. Whereas in the samples from these months females of the type concerned were few in number, they were more numerous in the material collected during the period from late April to early June. In fact, in some of the samples from this time, the majority of the full-grown females had freshly laid marsupial eggs or swollen ovaries. Such a feature has not been observed before. Another new point observed is the minimum depth of egg-laying during the warm season in Baltic waters, as in one sample, collected in late May at 45 m, a female with freshly deposited eggs was found; as was mentioned above, corresponding records made earlier from the Baltic area refer to *c.* 60 m.

¹⁾ For the kind assistance given by the staff of the Station in that connection my sincere thanks are expressed.

SUMMARY AND DISCUSSION

As has emerged, examination of the new material of *P. affinis* and *P. femorata* from Baltic waters has confirmed the earlier conclusions (1) that in this area egg-laying outside the cold season is confined to deep water and (2) that the level at which such reproduction commences is different in the two species, being clearly higher in *femorata*. The new observations accentuate this difference, as indications of incipient breeding were found in this species already at a depth of 45 m (earlier minimum *c.* 60 m).

These results should be compared with those obtained in other parts of the world. As far as *P. affinis* is concerned, no data on propagation outside the cold season are known from other marine areas. By contrast, the phenomenon has been observed in a number of lakes in North America, where, as in the Baltic area, summer-breeding seems to be restricted to greater depths (Segerstråle 1967, 1971 a). In the case of *P. femorata*, a purely marine species, sampling in the Canadian arctic area also indicates that reproduction in shallow water (above 25 m; Steele, *cf.* Segerstråle 1967) does not occur at the warm season. This result is in good accord with recent observations in the White Sea, as collecting work performed there (in Rugozerskaya Bay) above 20 m did not reveal any signs of incipient reproduction in the species during the period May—August (Margulis 1970).

There is thus clear evidence from various parts of their ranges that in both *P. affinis* and *P. femorata* the restriction of breeding to the cold season becomes less pronounced with depth and that in the minimum depth concerned the two species exhibit a difference.

What, then, about the reasons for these phenomena?

In my paper of 1967, it was already suggested that the light factor is involved. Recent experimental work (Segerstråle 1970, 1971 b) has yielded strong support for this conclusion. In populations of *P. affinis* living in comparatively shallow water, the restriction of reproduction to the cold season seems to be due to the maturation of the gonads being induced by the decrease in illumination in late summer. It should be noted that recent field work and experimental studies on the reproductive cycle of the arctic-subarctic amphipod *Gammarus setosus* Dementieva, which also breeds during the cold season, have led to the same conclusion as that arrived at in my work on *Pontoporeia*: »Timing of breeding is evidently independent of temperature, but photoperiod has been found to affect the cycle (V. J. Steele, unpublished observations)» (Steele & Steele 1970, p. 669).

The view that light is the factor responsible would also explain why the widening of the reproductive period of *P. affinis* to include the warm season is confined to deep water, as there practically dark conditions prevail or, at any rate, the seasonal fluctuations of illumination are largely smoothed out and, in consequence, the regulating effect of light on maturation can be concluded to be comparatively weak.

It also seems logical to seek a link between the light factor and the fact that in *P. femorata* breeding during the warm season is observed at a higher level than in *P. affinis*. Two alternative explanations may be considered: (1) the light perception of the eyes of the two species is different (being weaker in *femorata*), or (2) there is no difference in perception, but the effect of the perceived light on the maturation of the gonads (conceivably through neurosecretory processes) is not the same (*femorata* less sensitive). Since recent comparative studies on the perception of light in the two species of *Pontoporeia* under discussion (Donner 1971) have shown that they exhibit practically no difference in this respect, the first of these alternatives seems to be untenable.

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