Commentationes Biologicae

67 1973

Results of bottom fauna sampling in certain localities in the Tvärminne area (inner Baltic), with special reference to the so-called *Macoma-Pontoporeia* theory

Sven G. Segerstråle

Institute of Marine Research, Biological Division
Helsinki/Helsingfors

Societas Scientiarum Fennica
Helsinki—Helsingfors

Contribution from the
INSTITUTE OF MARINE RESEARCH
Helsinki 14, Finland

Societas Scientiarum Fennica

Commentationes Physico-Mathematicae
Commentationes Biologicae
Commentationes Humanarum Litterarum
Commentationes Scientiarum Socialium
Bidrag till kännedom av Finlands natur och folk
Årsbok — Vuosikirja

Commentationes Biologicae

The series has appeared since 1923, having earlier formed a part of the series ÖFVERSIGT AF FINSKA VETENSKAPS-SOCIETETENS FÖRHANDLINGAR 1839—1923, and appears at irregular intervals.
Contributions (in a congress language) will be communicated by a member of the Society.
Editor: Head curator Göran Bergman, Zool. Museum of the University, N. Järnvägsgatan 13 SF-00100 Helsingfors 10.
Requests for exchange: Societas Scientiarum Fennica, Snellmansgatan 9—11, SF-00170 Helsingfors 17 / Snellmaninkatu 9—11, SF-00170 Helsinki 17.
Subscription & Sale: The Academic Bookstore, P.Box 10 128, SF-00100 Helsingfors 10 / SF-00100 Helsinki 10, Finland.

Die Serie ist seit dem Jahre 1923 erschienen, nachdem sie zuvor ein Teil der Serie ÖFVERSIGT AF FINSKA VETENSKAPS-SOCIETETENS FÖRHANDLINGAR 1839—1923 gewesen ist. Erscheint in zwangloser Folge.
Beiträge (in einer Kongresssprache) werden von einem Mitglied der Gesellschaft zum Druck vorgelegt.
Redaktor: Kustos Göran Bergman, Zool. Museum der Universität, N. Järnvägsgatan 13, SF-00100 Helsingfors 10.
Austausch: Societas Scientiarum Fennica, Snellmansgatan 9—11, SF-00170 Helsingfors 17 / Snellmaninkatu 9—11, SF-00170 Helsinki 17.
Verkauf: Akademische Buchhandlung, Postfach 10 128, SF-00100 Helsingfors 10 / SF-00100 Helsinki 10, Finnland.

Commentationes
Biologicae

67 1973

Results of bottom fauna sampling in certain localities in the Tvärminne area (inner Baltic), with special reference to the so-called *Macoma-Pontoporeia* theory

Sven G. Segerstråle

Institute of Marine Research, Biological Division
Helsinki/Helsingfors

Societas Scientiarum Fennica
Helsinki—Helsingfors

ISBN 951-653-029-X

Abstract

SEGERSTRÅLE, SVEN G: Results of bottom fauna sampling in certain localities in the Tvärminne area (inner Baltic), with special reference to the so-called *Macoma-Pontoporeia* theory. *Commentat. Biol. 66*, 12 pp., 1973. — The paper presents and comments on the results of quantitative sampling of the bottom fauna performed in five localities (depth range 3—35 m) in the neighbourhood of the Zoological Station at Tvärminne (southwest coast of Finland), in the years 1960—1963. This work was a continuation of earlier long-term studies on the interannual fluctuations in the abundance and composition of the populations of the bivalve *Macoma baltica* in the area. The results are found to accord with the theory that an inverse correlation exists between the recruitment of *Macoma* and the abundance of *Pontoporeia* (mainly the species *P. affinis*). It has been suggested that this amphipod ingests the newly-settled spat of *Macoma* together with the bottom substrate.

Author's address: Institute of Marine Research, Biological Division
Bulevarden 9 A, SF-00120,
Helsingfors 12, Finland.

Introduction

Studies on the quantitative occurrence of benthic animals have been in progress since 1926 in the area adjacent to the Zoological Station at Tvärminne, situated on the southwest coast of Finland, near the entrance to the Gulf of Finland. A salient feature revealed by repeated sampling at a number of selected stations was the marked interannual fluctuation in the abundance of all the main members of the bottom fauna, including *Macoma baltica, Pontoporeia affinis, Corophium volutator,* and the larvae of chironomids (cf. *1—4;* surveys in *5, 9*).

Special attention has been paid to the changes in the *Macoma* populations, since certain unexpected anomalies in the composition of the stock of this bivalve were observed at the very start of the sampling work in the Tvärminne waters (corresponding results had already been obtained in 1922—1923 in another area off the south coast of Finland, viz. Pellinge; cf. *4*).

Repeated quantitative sampling carried out in some Tvärminne localities (depth range 3—35 m) for 11—17 years within the period 1926—1959 gave the following results. Below c. 20 m, the populations of *Macoma* usually show total absence, or at least strikingly poor representation, of several year classes, the phenomenon becoming increasingly pronounced with depth. In contrast, populations of the bivalve in shallow

water invariably exhibit a more or less normal composition. At the deepest repeatedly visited station in the study area (35 m), the failure of recruitment proved to comprise periods of up to c. 25 years. In consequence, the abundance of *Macoma* at greater depths is subject to especially marked fluctuations and is, on the whole, low as compared with that in shallow water. Examination of *Macoma* material from other parts of the Baltic, together with data available in the literature, indicates that periodical failure of recruitment is a more or less characteristic feature of the populations of the bivalve living in deeper parts of the Baltic basin (*6*).

Studies carried out at Tvärminne in order to find an explanation of the feature led to the conclusion that physical factors (nature of substrate, salinity, temperature, oxygen supply) are not involved. On the other hand, certain facts suggest that the gaps in the *Macoma* populations are caused by periods of high abundance of *Pontoporeia* and the author has put forward the idea that this amphipod eats newly-settled spat of *Macoma* when ingesting the bottom substrate, which constitutes its food (*6*).

In order to check the assumption that there exists an inverse correlation between the success of *Macoma* spatfall in a given year and the abundance of *Pontoporeia* in the same year, special sampling was performed in the years 1960—1963 at five selected stations in the Tvärminne area. The results gave support to the »*Macoma*-*Pontoporeia* theory». Part of them were published in 1965 (*7*).

The present paper is intented to present the full results relating to *Macoma* and *Pontoporeia* of the sampling carried out in 1960—1963. Apart from their contribution to our knowledge of the annual fluctuations of benthic animals in the Tvärminne waters, a further reason for publishing these results is the inclusion from 1964 onwards of the five sampling stations in the annual programme of bottom fauna studies of the Institute of Marine Research of Finland. Thus by now material from no less than 13 successive years is available for the elucidation of the fluctuations in numbers of the benthic animals inhabiting the localities in question (although not treated in the present paper, other components of the fauna than *Macoma* and *Pontoporeia* were also included in the collecting work in 1960—1963).

Material and methods

The five sampling stations mentioned above are as follows: No. I (3 m), No. XXVI (20 m), No. XLIV (35 m), and two of the »Spar Buoy Stations», viz. Spar Buoy West F (20 m) and Spar Buoy East B (20 m); for their locations, see *4*, Figs. 14 and 16. Collecting was carried out with the Ek-

man-Birge quantitative bottom sampler (area covered 250 cm^2). On each occasion 20 samples, equalling 0.5 m^2, were taken (only exception: 10 samples at St. I, 1961). The bottom material was washed through a sieve of 0.5 mm mesh size. Experience has shown that the minimum length of *Macoma* retained by this mesh size is c. 1 mm. Alcohol was used as preserving fluid.

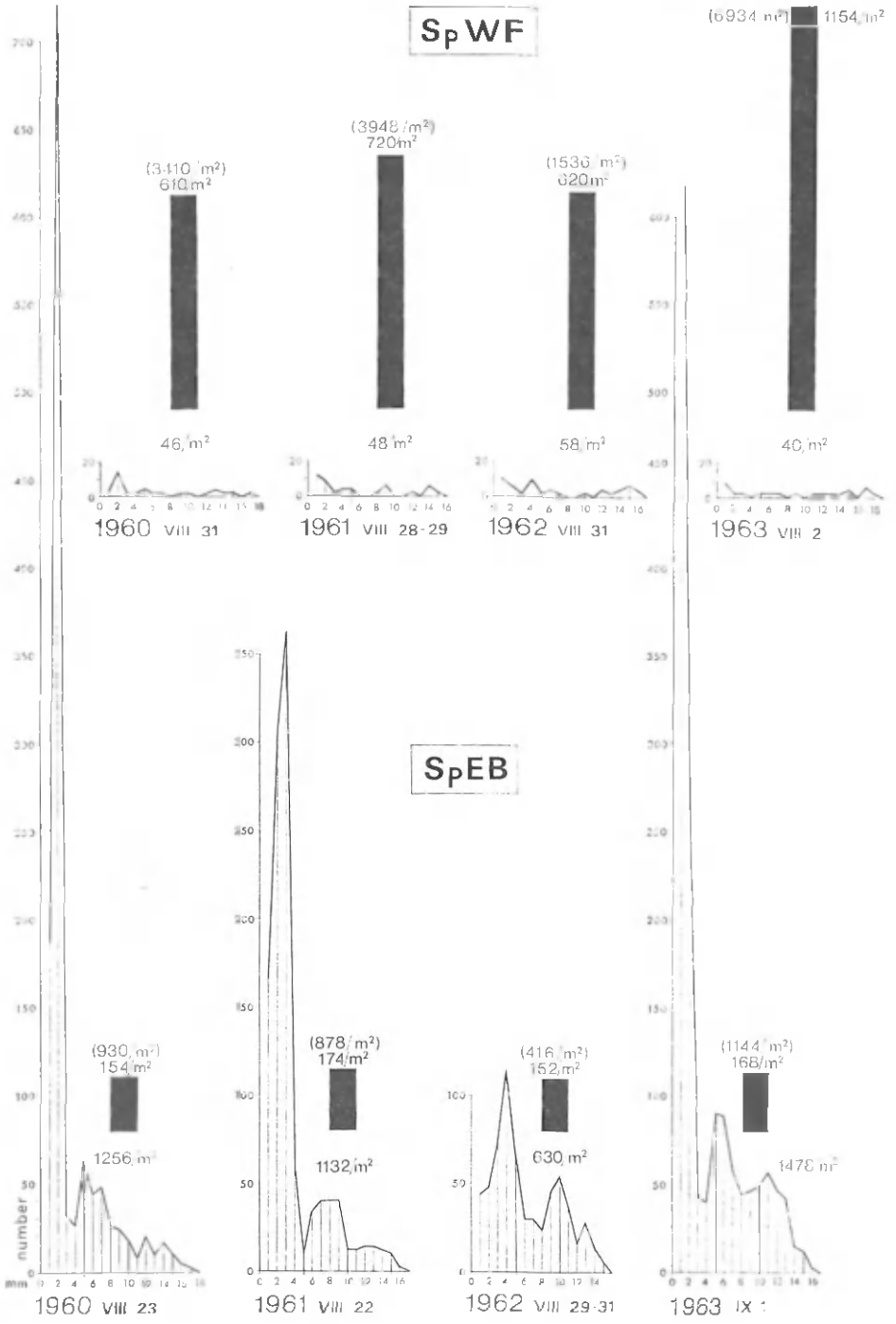
Results and comments

The results of the sampling at the five localities in 1960—1963 are illustrated in Figs. 1—3, which show the density of the *Macoma* and *Pontoporeia* at each sampling time and the distribution by length classes of *Macoma*. As regards *Pontoporeia*, the total number is given in brackets and the number of specimens with a minimum length of 6 mm without brackets (black bars). Attention should primarily be paid to the latter value, as smaller *Pontoporeia* can hardly be assumed to ingest the spat of *Macoma*, which has a length of 0.25—0.30 mm. The size limit drawn is, of course, arbitrary, as details of the feeding of *Pontoporeia* are not known.

Stations Spar Buoy West F (SpWF), Spar Buoy East B (SpEB), and No. XXVI (Figs. 1 and 3). All three stations are situated at the same depth, 20 m, but the bottom at St. SpEB clearly differs from that at the other two, where the substrate is more or less homogenous mud. At St. SpEB clay, sand, and gravel are also found — a consequence of the locality being comparatively strongly exposed to swell from the open sea.

As is shown by a glance at the diagrams, there is also a clear difference between the stations in the relationship between the densities of *Macoma* and *Pontoporeia*. At St. SpEB, with its bottom rich in mineral components, *Macoma* was very abundant in all four years and *Pontoporeia* was relatively scarce, whereas at the two other stations the opposite was the case. This contrast is in accordance with the *Macoma-Pontoporeia* theory discussed in the Introduction. Apart from this general feature, in one special case the diagrams allow direct comparison of the success of *Macoma* recruitment with the abundance of *Pontoporeia* in the year of spatfall concerned. In 1963, the stock of *Macoma* at St. SpEB exhibited a very marked peak of bivalves about 1 mm in length. Age analysis has shown that these young *Macoma* settled in 1960 and, especially, in 1961. In these two years the numbers of *Pontoporeia* (with a minimum length of 6 mm) caught at St. SpEB, expressed as percentages of those caught in the two other localities, were as follows:

	SpWF	XXVI
1960	25 %	16 %
1961	24 %	20 %


SpWF
(3410 /m²)
610 m²
46 /m²
1960 VIII 31
(3948 /m²)
720/m²
48 /m²
1961 VIII 28-29
(1536 /m²)
620/m²
58 /m²
1962 VIII 31
(6934 /m²)
1154 /m²
40 /m²
1963 VIII 2
SpEB
(930 /m²)
154/m²
1256 /m²
number
mm
1960 VIII 23
(878 /m²)
174/m²
1132/m²
1961 VIII 22
(416 /m²)
152/m²
630 /m²
1962 VIII 29-31
(1144 /m²)
168/m²
1478 /m²
1963 IX

The relative scarcity of *Pontoporeia* at St. SpEB in the two years with markedly successful *Macoma* recruitment is thus very pronounced.

However, it is difficult to regard the conspicuous peak of young *Macoma* at St. SpEB in 1963 as being due exclusively to a decrease in predation by *Pontoporeia* on the spat in 1960—1961, since the scarcity of young Macoma at the two other stations was much more marked in 1963 than might be expected from the differences in *Pontoporeia* abundance. Concentration by water movements seems most likely to be an additional factor contributing to the high numbers of young *Macoma* at SpEB in 1963. In fact, the abundant occurrence of mineral components on the bottom and the location of station on a slope exposed to heavy wave action suggest that, under special hydrodynamic circumstances, settling or newly-settled *Macoma* accumulate in the locality. Such »hydrographic concentration» of very young bivalves has earlier been assumed for a number of other localities in the Tvärminne area, as well as for areas outside the Baltic basin (cf. *4*, p. 35).

The following additional comments may be made in respect of the diagrams referring to St. SpEB: (a) they offer an opportunity to observe the gradual decline of a clear-cut peak in a population of *Macoma*, viz. that of 2-mm bivalves in 1960; (b) they contribute to our knowledge of the rate of growth of *Macoma* in the Tvärminne region, the bivalves of the above-mentioned peak having reached 4 mm by 1962 (this growth rate agrees with earlier results obtained for *Macoma* populations living at 20 m; cf. *6*, Fig. 22).

Stations I and XLIV (Fig. 2). These two localities are among those sampled in several earlier years (cf. *4*).

The following results of the collecting work performed during the period 1960—1963 may be mentioned:

Station I. (a) In conformity with earlier observations, the locality, situated at only 3 m depth, was found to harbour a *Macoma* stock of normal composition, i.e. without gaps pointing to years or periods of recruitment failure. Bivalves 1 mm in length were admittedly absent from the samples in 1960, but as, in the following year, there are abundant specimens of this size class, which, on age analysis, settled in 1960, the absence of spat from the material from this year is obviously due to its having been too small, at the time of sampling (21—23 July), to be re-

Fig. 1. Numbers per m² of *Macoma* and distribution of the bivalve by length classes at the Tvärminne sampling stations Spar Buoy West F (depth 20 m) and Spar Buoy East B (same depth) according to quantitative sampling in 1960—1963, and abundance of *Pontoporeia* in the same samples. Figures in brackets: total abundance of *Pontoporeia*; without brackets (referring to black bars): specimens of the amphipod with a minimum length of 6 mm.

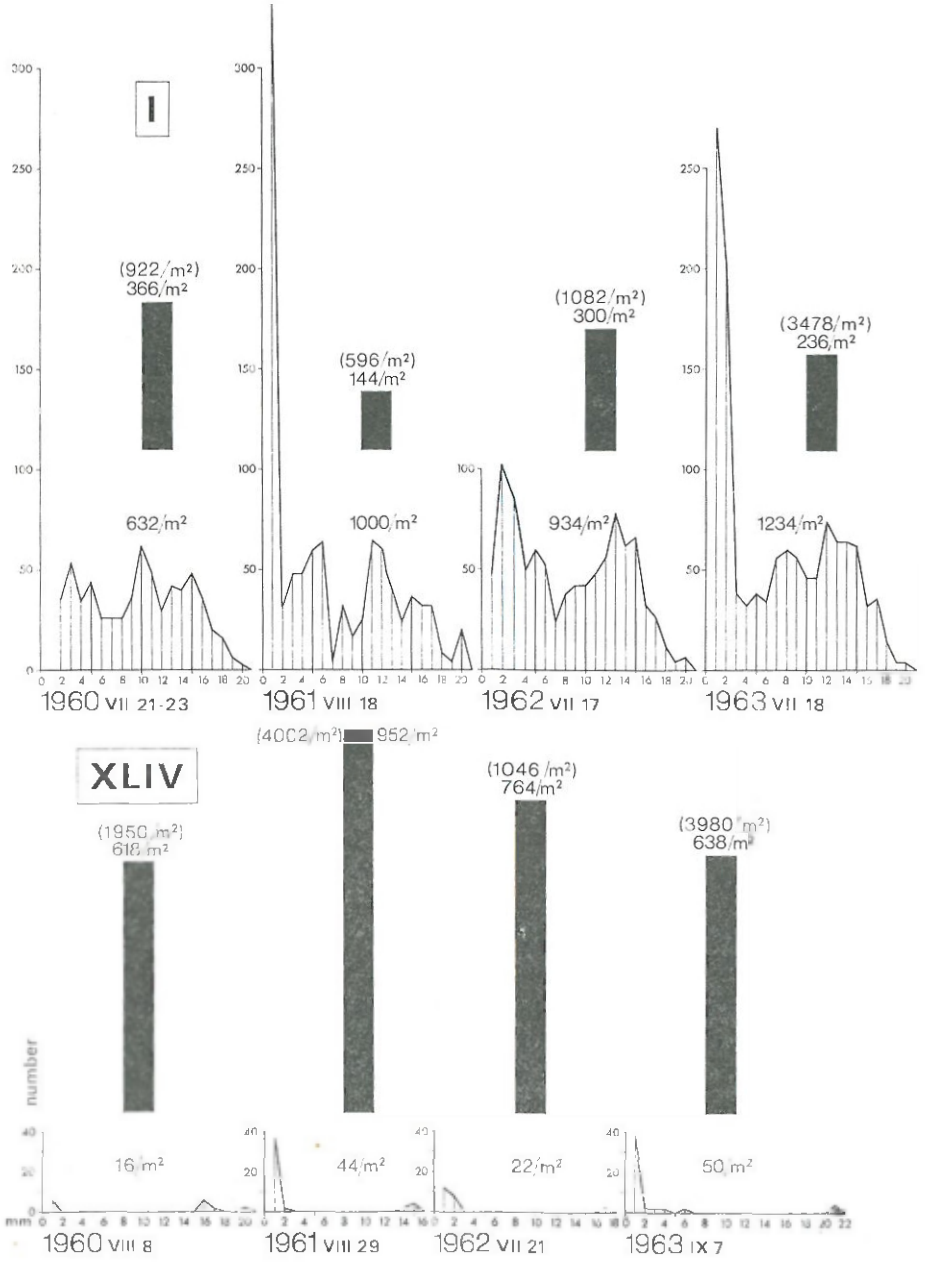


Fig. 2. Macoma and *Pontoporeia* diagrams for the Tvärminne stations I (3 m) and XLIV (35 m). Cf. Fig. 1.

tained by the sieve. (b) In addition to the peak in 1961, another may be observed in the diagram for 1963. In this case, too, the peak proved to be due to abundant spatfall in the preceding year. (c) The diagrams show that in the two years of successful *Macoma* recruitment (1960 and 1962) *Pontoporeia*, the supposed predator of minute *Macoma*, was moderately abundant (density of specimens with a minimum length of 6 mm 366 and 300/m², respectively).

Station XLIV. The diagrams in Fig. 2 prompt the following remarks: (a) In contrast to that at St. I, the *Macoma* stock at St. XLIV has proved to be characterized by recruitment failure during long periods. The markedly low number of large bivalves caught during the four years now under discussion is due to just such an exceptionally prolonged period (cf. *4*, p. 26). (b) The occurrence of minute bivalves in the years of the study period indicates some recruitment at St. XLIV (the group of *Macoma* 3—6 mm in length found in the samples of 1963 is seemingly referable to spatfall in 1959; cf. *4*, Fig. 9). As far as the period 1951—1958 is concerned, when the sampling in the locality showed total absence of *Macoma* recruitment, newly-settled bivalves, even if present, no doubt escaped through the sieve then used (mesh size 1 mm). (c) As far as the *Macoma-Pontoporeia* theory is concerned, comparison between the recruitment of *Macoma* and the abundance of the amphipod in the year of spatfall is possible in one case only, owing to the slow growth of the bivalve in the locality now under discussion (cf. *4*, Fig. 22). Age analysis showed that the individuals constituting the moderate peak of 1 mm *Macoma* in 1963 (38/m²) had settled in 1959—1960, mainly in the latter year. In 1960 (data from 1959 not available) the recorded density of *Pontoporeia* (with a minimum length of 6 mm) was comparatively high, 618/m², a result that supports the *Macoma-Pontoporeia* theory.

Concluding remarks

As was mentioned in the Introduction, the aims of the present paper are both to contribute to our knowledge of the long-term fluctuations of benthic animals in the Tvärminne area and to present additional data pertaining to the *Macoma-Pontoporeia* theory. As far as the former aim is concerned, general interest attaches to the results obtained in the case of *Macoma*, owing to the large material available. At St. XXVI, in particular, where sampling with quantitative gear was started in 1926, the changes in the population of *Macoma* have proved striking and offer an instructive example of the fluctuation in numbers and stock composition of this bivalve within the Baltic area. In Fig. 4 the whole series of sampling re-

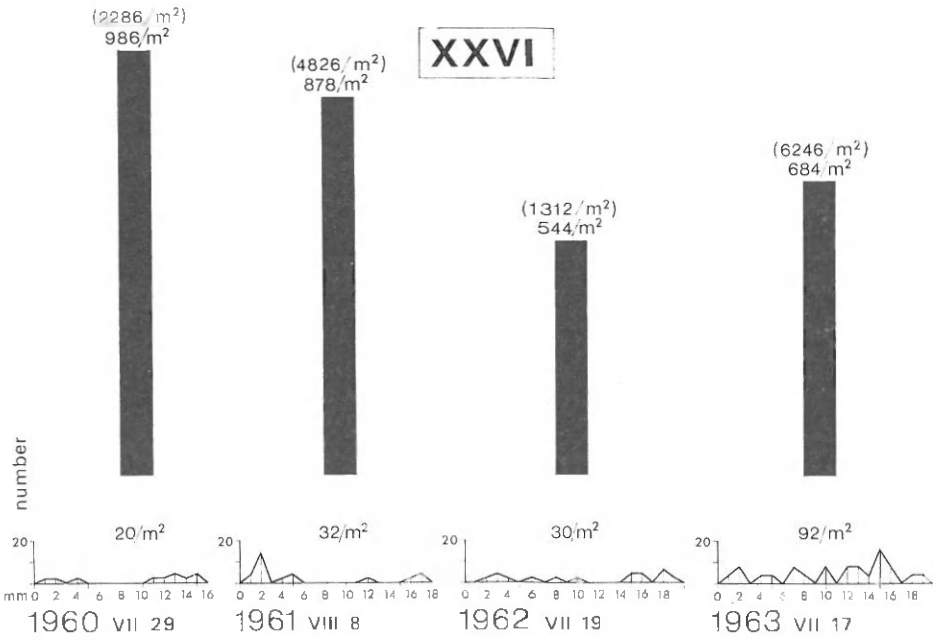
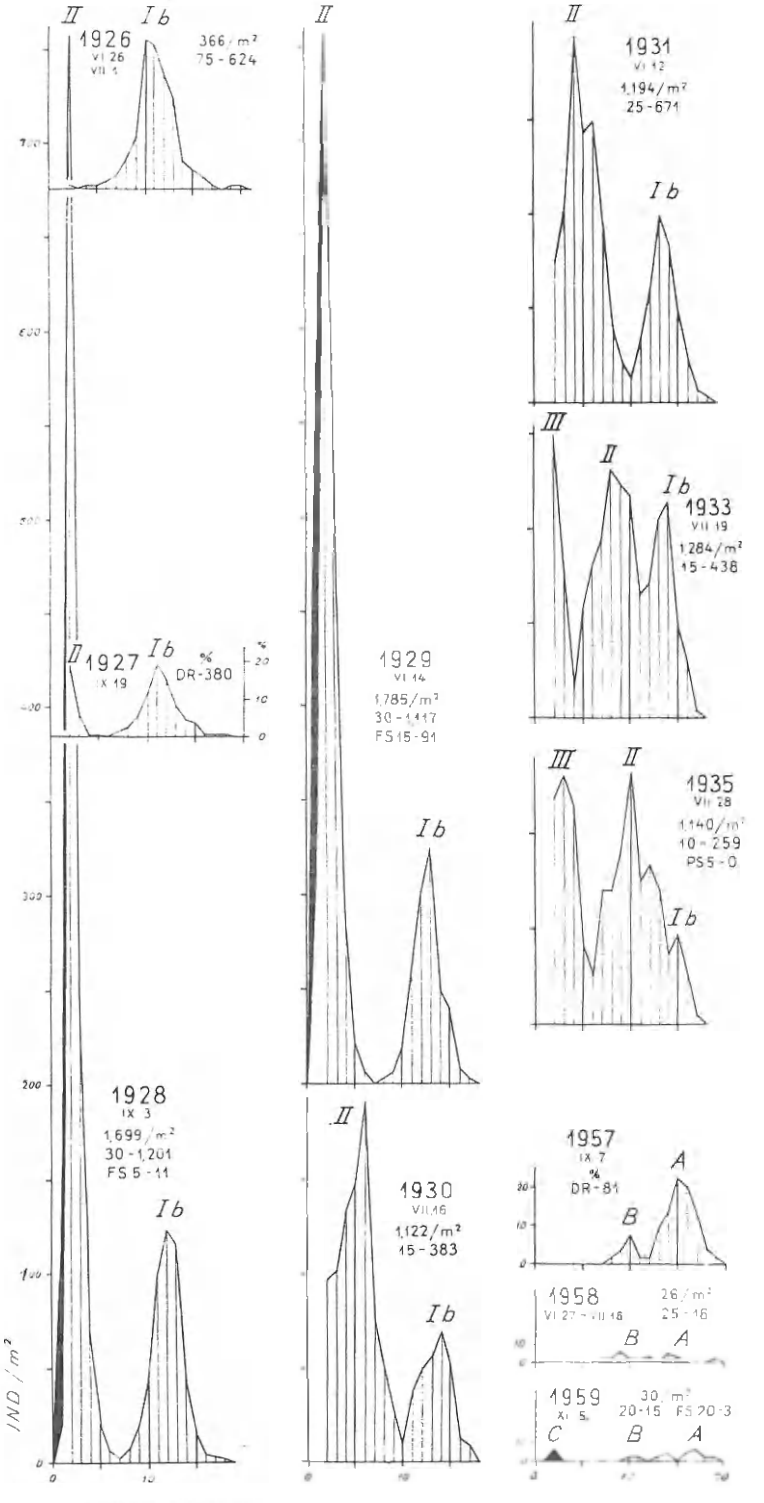


Fig. 3. Macoma and *Pontoporeia* diagrams for the Tvärminne station XXVI (20 m). Cf. Fig. 1.

sults obtained prior to 1960 is reproduced from an earlier paper (*4*, Fig. 8). The total period of observations comprises 15 years between 1926 and 1963. As will be seen, the maximum and minimum densities of *Macoma* are 1785 and 20/m² (in 1929 and 1960, respectively; in both cases the same sieving technique was used).

As far as the *Macoma-Pontoporeia* theory is concerned, evidence supporting it is, as we have found, provided by some of the results obtained in 1960—1963, which allowed direct comparison between the recruitment of *Macoma* and the abundance of its supposed predator in the year of settlement of *Macoma*. The other data obtained at the five sampling stations also accord with the general view that localities with a low abundance of *Macoma* harbour a relatively dense population of *Pontoporeia*.

Fig. 4. Distribution by length classes and density of *Macoma* at the Tvärminne station XXVI in the 11 years of sampling prior to 1960 (1926—1959; in 1927 only dredge, »DR», used). Figures below those indicating number/m² give number of samples (Ekman-Birge) and number of bivalves caught. Black parts of diagrams: bivalves caught with sieve with meshes of 0.5 mm (»FS»), in other cases a 1.0 mm sieve was used. *After Segerstråle 1960 a.*


II
Ib
1926
VI 26
VII 1
366 / m²
75 - 624
1927
IX 19
DR-380
%
1928
IX 3
1,699 / m²
30 - 1,201
FS 5 - 11
1929
VI 14
1,785 / m²
30 - 1,117
FS 15 - 91
1930
VII 16
1,122 / m²
15 - 383
1931
VI 12
1,194 / m²
25 - 671
III
1933
VII 19
1,284 / m²
15 - 438
1935
VII 28
1,140 / m²
10 - 259
PS 5 - 0
1957
IX 7
DR-81
A
B
1958
VI 27 - VII 16
26 / m²
25 - 16
1959
XI 5
30 / m²
20-15
FS 20-3
C
IND. / m²
SHELL LENGTH, mm

Acknowledgements. The author wishes to express his gratitude to Mr. Julius Lassig, Lic. Phil., who, in the capacity of scientific assistant, performed the collecting work in 1960—1963 with the utmost efficiency. Thanks are also due to him and Mr. Ilkka Luotamo, M.A., for having read the manuscript (Mr. Luotamo is at present working on the material sampled at the five stations from 1964 onwards). The study was supported financially by the State Board for Natural Sciences.

References

1. SEGERSTRÅLE, S. G. 1933: Studien über die Bodentierwelt in südfinnländischen Küstengewässern. II. Übersicht über die Bodentierwelt, mit besonderer Berücksichtigung der Produktionsverhältnisse. *Commentat. Biol.* (Soc. Sci. Fenn.), IV (9), 64 pp.
2. —»— 1937 a: Studien über die Bodentierwelt etc. III. Zur Morphologie und Biologie des Amphipoden *Pontoporeia affinis*, nebst einer Revision der *Pontoporeia*-Systematik. *Ibid.*, VII (1), 181 pp.
3. —»— 1937 b: Studien über die Bodentierwelt etc. IV. Bestandesschwankungen beim Amphipoden Corophium volutator. *Acta Soc. F. Fl. Fenn.* 60, 245—255.
4. —»— 1960 a: Investigations on Baltic populations of the bivalve *Macoma baltica* (L.). Part I. Introduction. Studies on recruitment and its relation to depth in Finnish coastal waters during the period 1922—1959. Age and growth. *Commentat. Biol.*, XXIII (2). 72 pp.
5. —»— 1960 b: Fluctuations in the abundance of benthic animals in the Baltic area. *Ibid.*, XXIII (9), 19 pp.
6. —»— 1962: Investigations on Baltic populations of the bivalve *Macoma baltica* (L.). Part II. What are the reasons for the periodic failure of recruitment and the scarcity of *Macoma* in deeper waters of the inner Baltic? *Ibid.*, XXIV (7), 26 pp.
7. —»— 1965: Biotic factors affecting the vertical distribution and abundance of the bivalve *Macoma baltica* (L.) in the Baltic Sea. *Bot. Gothoburg.* III. (Proc. Fifth Mar. Biol. Sympos.), 195—204.
8. —»— 1969: Biological fluctuations in the Baltic Sea. *Progr. Oceanogr.*, Vol. 5, 169—184.

Communicated February 19, 1973
Printed May 1973

Keskuskirjapaino—Centraltryckeriet
Helsinki—Helsingfors

Commentationes Biologicae

Vol. 31 (1967—1970) ..... 20,—

1. Kurtén, Björn: Continental drift and the palaeogeography of reptiles and mammals. 1967. 8 p. ..... 2,—
2. Collander, Runar: Some corrections and additions to »The History of Botany in Finland 1828—1918». 1967. 2 p. ..... 0,—
3. Müller-Wille, Linna L.: Biometrical comparison of four populations of *Phoca hispida* Schreb. in the Baltic and White Seas and Lakes Ladoga and Saimaa. 1969. 12 p. ..... 2,—
4. Kosonen, Martti: Primary Production, Composition and Seasonal Growth Rhythm of Some Dry Meadow Communities on the South Coast of Finland. 1969. 23 p. 2,40
5. Strassen, Richard zur: Neue Angaben zur Thysanopteren-Fauna (*Insecta, Thysanoptera*) der Kanarischen Inseln. 1969. 74 p. ..... 10,—
6. Kurtén, Björn: A radiocarbon date for the cave bear remains (*Ursus spelaeus*) from Odessa. 1969. 3 p. ..... 2,—
7. Lindholm, S.: Influence of starvation and fatty diet on mast cells in the alimentary tract of rat. 1969. 5 p. ..... 2,—
8. Lindholm, S.: Gastro-intestinal mast cells in guinea-pig, mouse and rabbit. 1970. 5 p. 2,—
9. den Hartog, C.: Some aspects of brackish-water biology. 1970. 15 p. ..... 2,—

10. Hüther, Walter: Über einige Collembolen von den Kanarischen Inseln. 1970. 11 p. .. 2,—
11. Forstén, Ann: *Mesobippus* from the Chadron of South Dakota, and a comparison with Brulean *Mesobippus bairdii* Leidy. 1970. 22 p. 2,50

Vol. 32 (1969) von Haartman, Lars: The Nesting Habits of Finnish Birds I. Passeriformes. 1969. 187 p. ..... 19,—

33. (1970) Dhindsa, Kuldip Singh: Malononitrile dimer: its effect on RNA content and thyroid activity in the mouse. 46 p. 4,60
34. (1970) Kock, Boris: The influence of adrenal steroids on the mast cell count in the skin of developing rats. 80 p. ..... 10,—
35. (1970) Alhonen Pentti: On the significance of the planktonic/littoral ratio in the cladoceran stratigraphy of lake sediments. 9 p. ..... 2,—
36. (1971) Kurtén, Björn: Time and hominid brain size. 8 p. ..... 2,—
37. (1971) Israelson, Gunnar: A revision of the genus *Astenus* Steph. in the Canary Islands with an Appendix on *A. indicus* (Kr.) and *A. chimaera* (Woll.) (*Col. Staphylinidae*). 26 p. .. 4,—
38. (1971) Segerstråle, Sven G.: The distribution and morphology of *Pontoporeia affinis* Lindström f. *brevicornis* (Crustacea Amphipoda) inhabiting North American lakes, with a description of a new aberrant male form from the area. 19 p. ..... 3,—
39. (1971) Fyhrquist, Frej: Radioimmunoassay of plasma angiotensin II in patients with hypertension, in renal transplant recipients, and in anephric patients. 52 p. ..... 10,—
40. (1971) Hyvärinen, Hannu: Two Late Weichselian stratigraphical sites from the eastern foreland of the Salpausselkäs in Finland. 12 p. ..... 2,—
41. (1971) Donner, K. O.: On vision in Pontoporeia affinis and P. femorata (Crustacea, Amphipoda). 17 p. ..... 3,—
42. (1971) Bergman, Göran: Grillteisten *Cepphus grylle* in einem Randgebiet: Nahrung, Brutresultat, Tagesrhythmus und Ansiedlung. 26 p. ..... 4,—
43. (1971) Wikström, Mårten K. F.: Mitochondrial Energy Transduction and Oxidative Phosphorylation. 42 p. ..... 6,—
44. (1971) Segerstråle, Sven G.: On summer-breeding in populations of *Pontoporeia affinis* (Crustacea Amphipoda) living in lakes of North America. 18 p. ..... 3,—

45. (1971) Wennström, Johan: Effect of ionizing radiation on the chromosomes in meiotic and mitotic cells. 60 p. ..... 8,—
46. (1971) Stenman, Svante: Chromosome pulverization induced by paramyxoviruses. A study of premature chromosome condensation in human cells. 29 p. ..... 5,—
47. (1972) Loginova, M. M.: On the fauna of Psylloidea (Homoptera) from Morocco. 39 p. 6,—
48. (1972) Wikström, Markku: The incidence of broad fish tapeworm, *Diphyllobothrium latum*, in the human population of Finland. 8 p. ..... 2,—
49. (1972) Ardoin, P.: Liste des espèces de Tenebrionidae (Coleoptera) récoltées au Sudan par les expéditions finlandaises (1962—1964). 20 p. ..... 4,—
50. (1972) Friman, Claes: Glycosaminoglycans in the urine and serum of healthy persons and of patients with disorders afflicting tissues of mesenchymal origin. 91 p. ..... 13,—
51. (1972) Maury, Peter: Studies on the structure, origin and biological significance of urinary neuraminyl-oligosaccharides. 30 p. ..... 5,—
52. (1972) Palmgren, Pontus: Studies on the spider populations of the surroundings of the Tvärminne Zoological Station, Finland. 133 p. ..... 18,—
53. (1972) Donner, J. J.: Pollen frequencies in the flandrian sediments of lake Vakojärvi, South Finland. 19 p. ..... 4,—
54. (1972) Hustich, Ilmari: On the Phytogeography of the Eastern Part of the Central Quebec-Labrador Peninsula III. Notes on Introduced Species. 28 p. ..... 5,—
55. (1972) Niemi, Å.: Effects of toxicants on brackish-water phytoplankton assimilation. 19 p. 4,—
56. (1972) Hovi, Tapani: Ribonucleic acid of rubella virus. 30 p. ..... 5,—
57. (1972) Alhonen, Pentti: Galträsket: the geological development and palaeolimnology of a small polluted lake in Southern Finland. 34 p. ..... 6,—
58. (1972) Bylund, Göran: Pathogenic effects of a diphyllobothriid plerocercoid on its host fishes. 11 p. ..... 3,—
59. (1972) Hyvärinen, Hannu: Flandrian regional pollen assemblage zones in eastern Finland. 25 p. ..... 5,—
60. (1973) Gyllenberg, Göran: Comparison of the Cartesian diver technique and the polarographic method, an open system, for measuring the respiratory rates in three marine copepods. 13 p. ..... 3,—
61. (1973) Palmgren, Pontus: Über die Biotopverteilung waldbodenliebender Pseudoscorpionidea (Arachnoidea) in Finnland und Österreich. 11 p. ..... 3,—
62. (1973) Kurtén, Björn: Pleistocene Jaguars in North America. 23 p. ..... 5,—
63. (1973) Kurtén, Björn: Geographical Variation in the Size in the Puma (*Felis concolor* Linné). 8 p. ..... 3,—
64. (1973) Eriksson, Aldur W.: Human twinning in and around the Åland Islands 159 p. 25,—
65. (1973) Kurtén, Björn: Transberingian Relationships of *Ursus arctos* Linné (Brown and Grizzly Bears). 10 p. ..... 3,—

3,—

ISBN 951-653-029-X