Bottom fauna of the Finnish southwestern archipelago

III. The Lohm area[1]

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Data on the bottom fauna of the Finnish southwestern Archipelago Sea have been published earlier by Tulkki (1960 and 1964). He deals with the bottom animals in parts of the inner and middle sections of the archipelago southwest of the city of Turku. The present paper represents a continuation of these studies. The study area is centred round the Marine Biological Station of the University of Turku on the island of Lohm, which lies at the inner limit of the outer section of the Finnish southwestern archipelago. Here the environmental conditions become gradually more marine towards the Central Baltic. The present data relate to material collected in May and June, 1959 – 1964, during the ecological hydrobiology classes at the biological station.

Remarks on the bottom fauna of this area were published as long ago as 1890 by Nordquist and, more recently, by Sjöblom (1955). For other short notes on the Archipelago Sea, the reference list given by Tulkki (1960) should be consulted.

I. Description of the area studied

Our samples have been taken mainly from the Storströmmen Sound about 40 – 50 km S.W. of Turku, in the vicinity of the Marine Biological Station of the University of Turku (Fig. 1, Lohm).

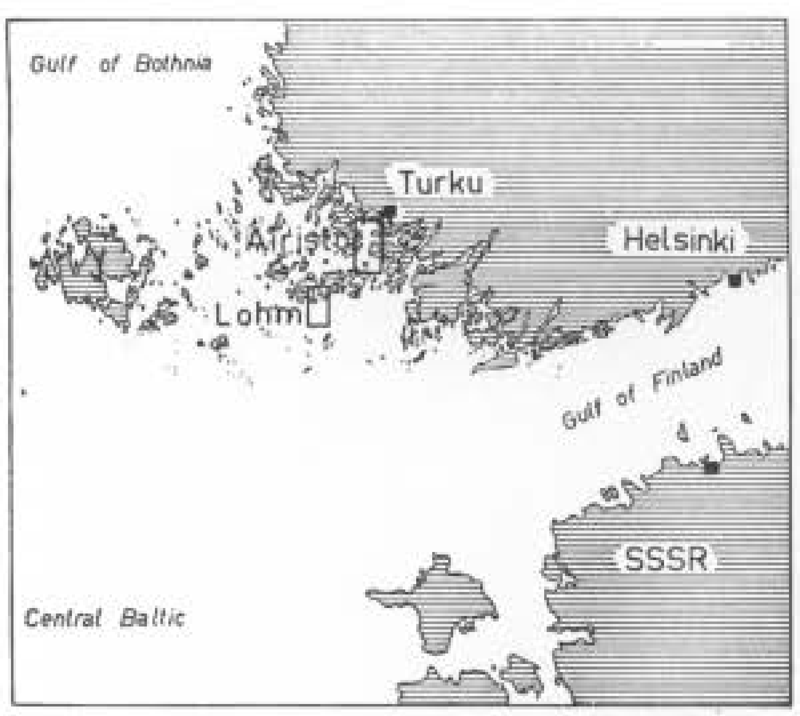

Fig. 1. Location of the study area.

The Storströmmen Sound is deep compared with the neighbouring waters, the maximum depth being 74 m. In the southern part of the study area there is an even deeper trench (Fig. 2). For the bathymetric conditions, see Palosuo (1964, p. 15).

The mean Baltic current is the dominating current in the area (Palmén, 1930). It flows from the south and southeast towards the Gulf of Bothnia northwest of the Lohm area. It is sometimes very strong in the Storströmmen Sound, which runs from north to south. Because just south of the sound there is a large sea area with only a few small islands, the current, when moving northwards, is forced into the Storströmmen Sound, which is one of the larger straits through the archipelago to the north (see the map in Palosuo, 1964).

The current is an important biological factor

[1] The first two papers of this series have been published by Tulkki (1960 and 1964).

in the study area. More saline water may be carried by it from the Central Baltic. Marine organisms thus tend to spread northwards through the archipelago.

In the Storströmmen Sound even the bottom is affected by the current, which must sometimes be strong, because there is a clear erosion bottom with sand, gravel, and stones, and often even with limonite. The clay observed in the deepest localities is not soft muddy clay, but stiff blue clay stratified soon after the glacial period. The softer layers, if ever formed, have been eroded by the current. Fig. 3 shows an echogram south, southeast and east of Lohm. We can observe the soft bottom surface south of Lohm and the mixed character (glacial clay, sand, and gravel) of the bottom east of Lohm, where the southern end of the Storströmmen Sound is situated. Soft deep bottoms have been observed, but mainly outside the Storströmmen Sound proper.

The bottom at depths of 0 – 10 m along the coast of the Storströmmen Sound is sandy, stony or rocky, as are also the littorals of the southernmost small island. This kind of stony littoral is shallower in sheltered localities between the larger islands of the inner part of the study area and, in fact, in all sheltered bays. Sandy bottoms are relatively rare and situated off beaches.

Limonite in the form of plates and around stones has been observed at some stations, mostly in the trench of the Storströmmen Sound. An interesting observation is the existence of shell gravel from the Littorina period of the Baltic at one of the stations (St. *XVII – 4*, N. of Lohm, 11 m). Hitherto it has not been found in the sea, but numerous finds of the *Littorina* shell gravel exist within or near our area (Segerstråle, 1927).

A comparison between the bottoms of the present study area and the Airisto Sound (Tulkki, 1960) shows that erosion bottoms (mixed bottoms) are situated much deeper in the exposed Storströmmen Sound than in the more sheltered Airisto Sound (Fig. 10).

Notes on the chemistry and temperature of the waters near Lohm have been published by Granqvist (1938, 1952, 1955 a, and 1955 b), Lisitzin (1939), and Buch (1954).

Our temperature measurements were made with an ordinary laboratory thermometer in a Ruttner water sampler. pH determinations were made electronically with a Beckman pH-meter from water samples immediately on return to the station. Salinity was determined titrimetrically according to the Mohr – Knudsen method (Barnes 1959) and oxygen according to Winkler's standard method (Barnes *op. cit.*).

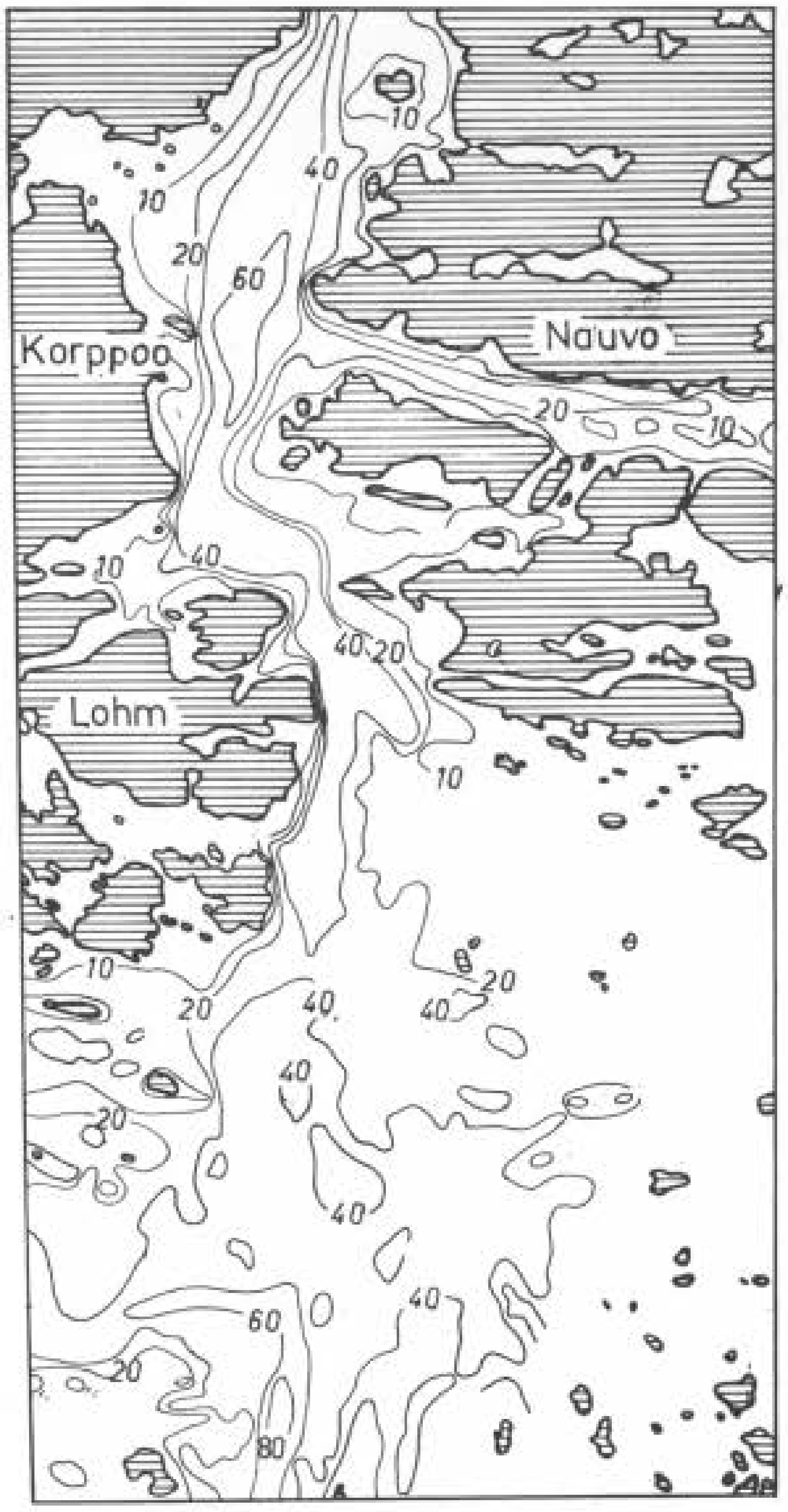

Fig. 2. The depths in the area studied.

Temperature. – The seasonal temperature fluctuations are shown in Fig. 4, which has been compiled according to the harmonic values published by Granqvist (1952). In Fig. 5 the temperature conditions of the Storströmmen Sound as measured by us on 15. VI. 1963 are shown. At that time the temperature of the surface water was 8.0 – 17.8° C and that of the deep water 1.4 – 4.5° C.

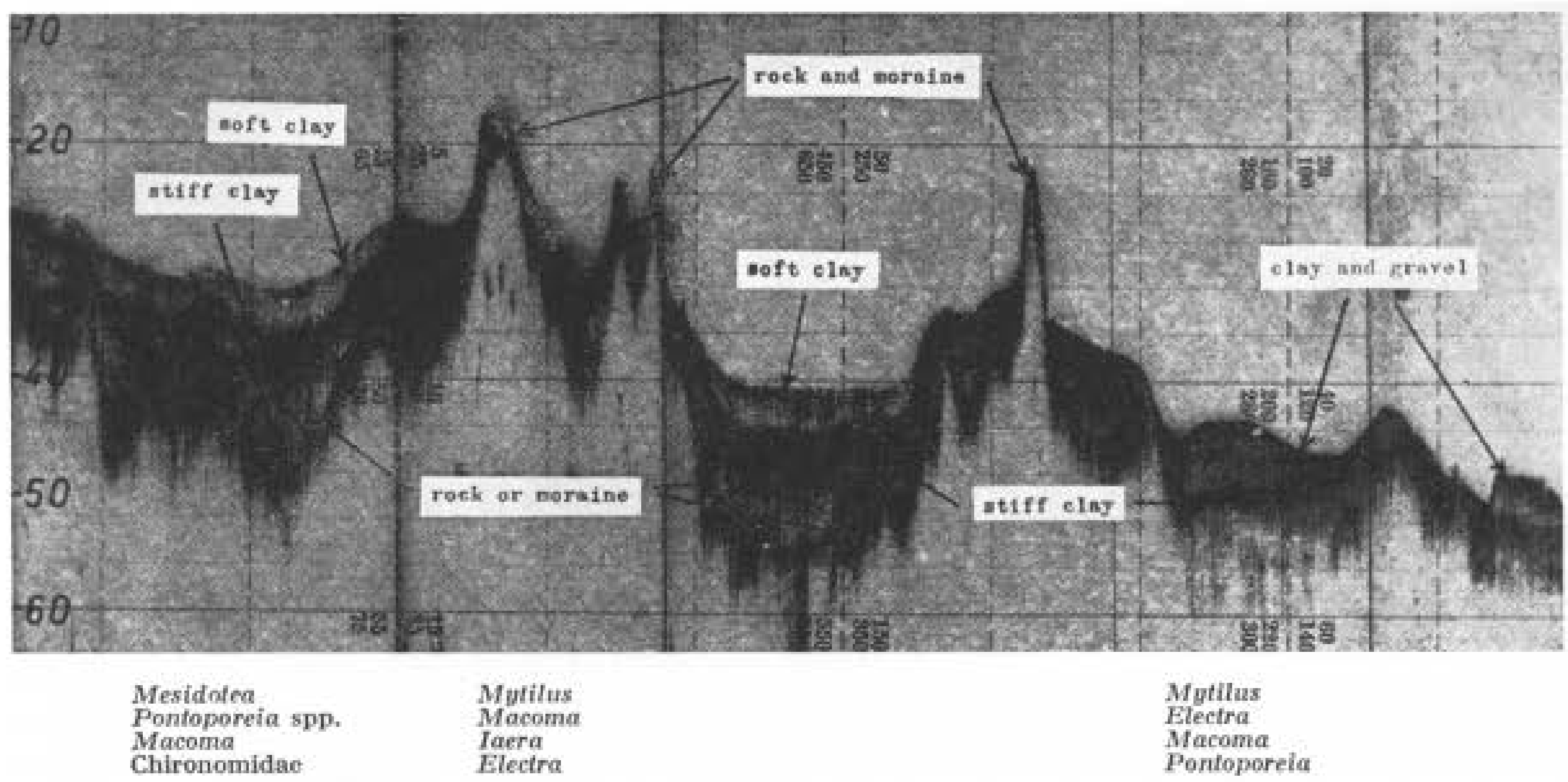

Fig. 3. An echogram south and east of Lohm taken with the Atlas echo sounder (frequence 15 KC) on board R/V Aranda. Below the base-line lists of species at the corresponding localities.

In the deepest localities the temperature conditions are suitable for the survival of some glacial relicts, typical of the Baltic. Some littoral species are also met with, but they probably do not reproduce here because of the continuously low temperature.

Salinity. – During the investigation the average salinity of the surface water was about 6 ‰. Its seasonal variation is small and the vertical stratification is not clear (cf. Fig. 6). The minimum salinity of the surface water (5.5 ‰) is reached in spring at the time when the ice and snow are melting. This decrease has been widely observed in the whole archipelago (Granqvist, 1938). It must be a limiting factor, at least in some years, for some marine littoral species, especially for those that reproduce in spring. The difference in the salinity of surface and deep water is 0.3 – 0.4 ‰ (cf. Fig. 7). Having a mean salinity of 6 ‰, the water of the area studied must be classed as β-mesohaline brackish water according to the Venice system (Symposium on the classification of brackish waters, 1959).

Oxygen. – Owing to the current in the Storströmmen Sound the oxygen content of the water is almost homogeneous throughout the whole water mass all the year round. According

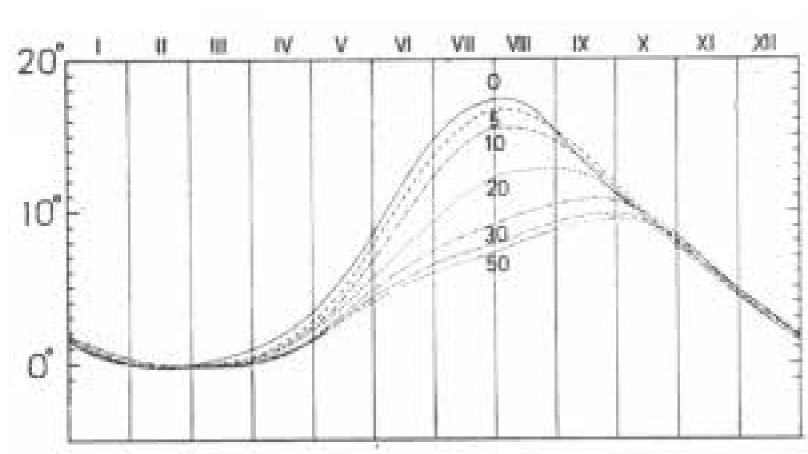

Fig. 4. The annual temperature cycle in the study area as based on the harmonic values for the 20-year period 1921 – 1940 published by Granqvist (1952).

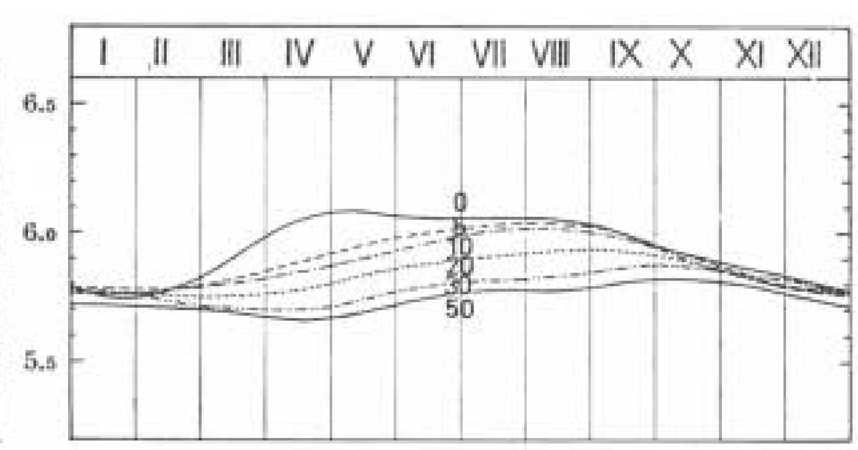

Fig. 6. The annual salinity variation according to the harmonic values given by Granqvist (1952).

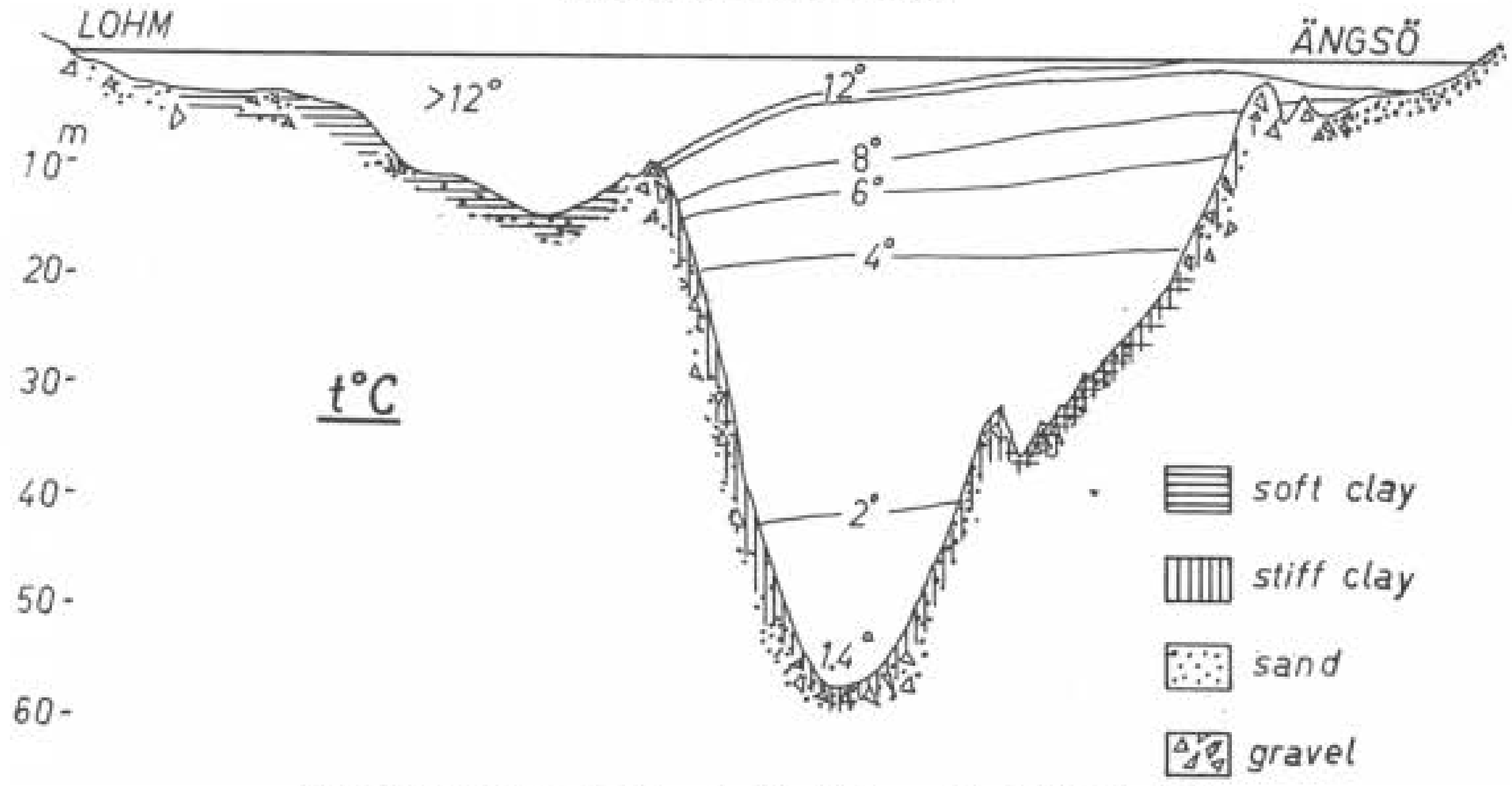

Fig. 5. Temperature conditions in Storströmmen Sound (15. VI. 1963).

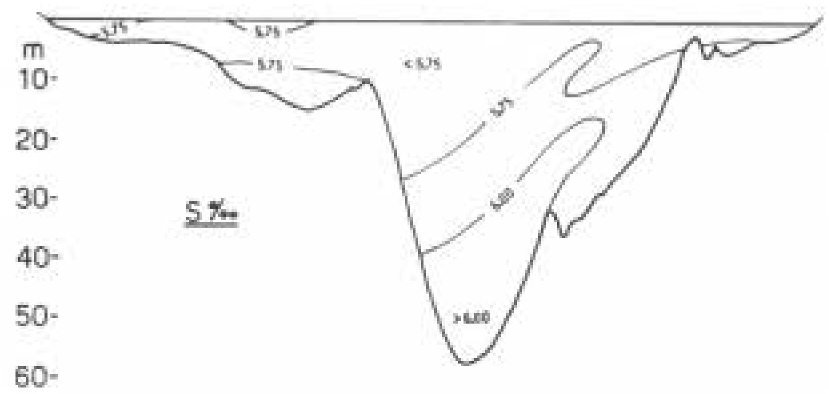

Fig. 7. Salinity distribution in Storströmmen Sound (15. VI. 1963).

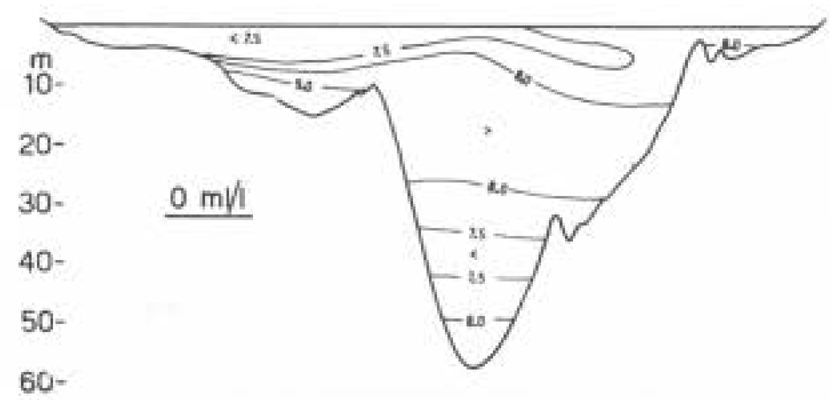

Fig. 8. Oxygen conditions in Storströmmen Sound (15. VI. 1963).

to our measurements the oxygen content of the deep water is $7._3 - 9._8$ ml/l in June. An example of the situation on June 15, 1963, is shown in Fig. 8.

The pH values measured by us vary from $7._4$ to $8._2$ in the surface water and $7._1$ to $7._6$ in the deep waters.

The transparency of the water is about 10 m, a figure which is greater than that given by TULKKI (1960) for the Airisto Sound.

II. Material and methods of collecting

In the period 1959 – 1962 most samples were taken with a bottom sampler of the Ekman-Birge type with an aperture area of 400 cm². Since 1961 we have operated with two modified van Veen samplers, which are more suitable for sandy and mixed bottoms. The larger of these samplers covers an area of 833 cm², the smaller 323 cm².

Various number of samples per station have been taken. It has not been possible on every occasion to take sufficient samples to provide a statistically reliable picture. Therefore the figures of depth distribution (Fig. 12) have been made by combining data for all stations at the same depth.

The location of the sampling lines and the stations are seen in Fig. 9. The vertical distribution of the various kinds of bottoms is seen in Fig. 10.

Numbers of stations and samples, as well as the total areas sampled, are listed below.

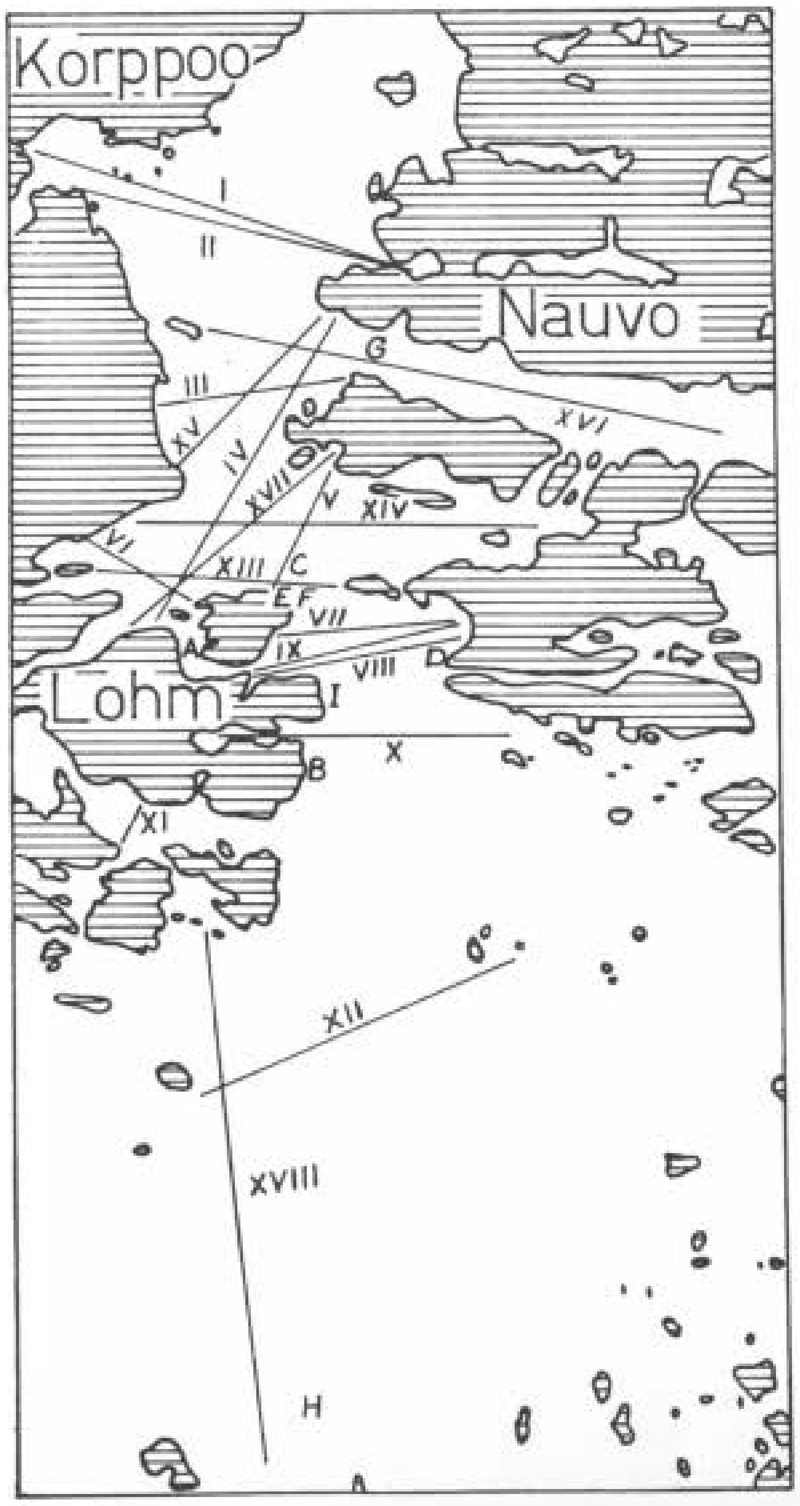

Fig. 9. Location of the sampling lines and the separate stations.

Depth, m	No. of stations	No. of samples	Area, cm²
0 – 2.5	3	9	3 140
2.5 – 5	14	42	18 350
5 – 7.5	11	27	14 700
7.5 – 10	4	9	5 970
10 – 15	13	31	19 950
15 – 20	12	32	18 430
20 – 25	8	16	10 730
25 – 30	3	8	4 070
30 – 35	2	5	4 170
35 – 40	4	9	6 200
40 – 45	3	9	3 600
45 – 50	6	12	8 700
50 – 55	7	16	10 730
55 – 60	1	1	830
60 – 65	–	–	–
65 – 70	–	–	–
70 – 75	–	–	–
75 – 80	1	3	1 200
80 – 85	1	1	830
Total	93	230	131 560

The samples were washed immediately through a sieve with 1 mm mesh. Thus many of the smaller animals and young individuals were lost (cf. TULKKI, 1960, p. 6). The animals were collected in water and weighed alive immediately after counting, after all surplus water had been removed.

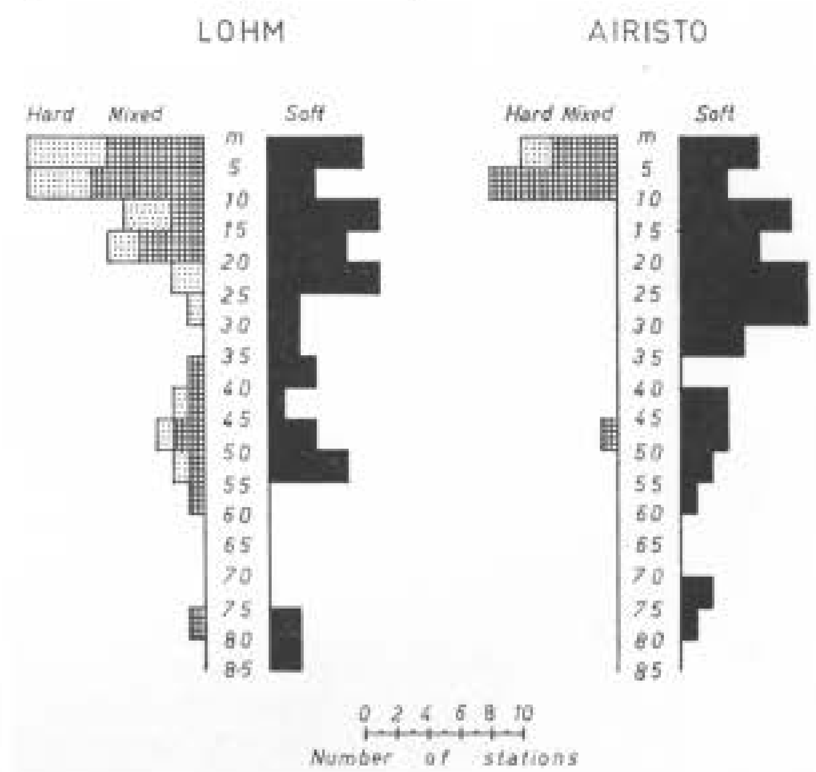

Fig. 10. The vertical distribution of various kinds of bottoms.

III. Vertical distribution and abundance

A detailed review of the occurrence of the species found in the quantitative samples is given below. The material collected is listed in Tables 1. – 10. For notes on the general distribution of various species in Finnish coastal waters, see e.g. SEGERSTRÅLE (1957).

Nematoda

Nematods are too small to be collected by the method used. Only two individuals of an unidentified species was recorded at 38 m.

Polychaeta

Harmothoe sarsi Kinb. At 7 stations from 4 to 80 m (Fig. 12). The bathymetric range of the species seems to be large. The maximum density was 31 ind./m² and biomass 3.1 g/m².

Nereis diversicolor Müll. is the commonest polychaete in the area. On various kinds of bottoms down to 15 m (Fig. 12). Maximum observed density and biomass 60 ind./m² and 9.6 g/m², respectively.

Pygospio elegans Clap. At three stations (9, 10, and 20 m) on silty or sandy bottoms. Empty tubes rather common in the upper littoral.

Oligochaeta

The limnic Tubificidae are fairly evenly dispersed in the littoral area (Fig. 12). SJÖBLOM (1955) observed oligochaetes at a depth of 64 m near Lohm island. Usually they occur on clay or ooze bottoms. In our material the maximum depth recorded for this group was 24 m. The maximum density and biomass are 372 ind./m² and 6.2, g/m² respectively.

Probably the dominant species in the area is *Tubifex tubifex*. We also caught one *Limnodrilus* species at St. *XVII – 1* at a depth of 3 m.

Priapulida

Halicryptus spinulosus Sieb. At 12 stations, only from soft bottoms. According to our data, it seems to be rarer in the Lohm area than in the Airisto Sound, where it occurs at medium depths (TULKKI, 1960).

Mysidacea

Mysis relicta Lovén. One specimen taken with a bottom sampler from the 80-m locality in the southern part of our area.

Isopoda

Idotea baltica Pall., *I. chelipes* (Pall.) (= *I. viridis* Slabber) and *I. granulosa* Rathke are all species living mainly on seaweed and are not often caught with bottom samplers. *I. baltica* is the commonest (8 records), *I. chelipes* has been noticed twice and *I. granulosa* once.

Mesidotea entomon (L.) As in the Airisto Sound, *M. entomon* has not been found in great numbers, but it is evenly distributed on all kinds of bottoms at depths from 2 to 55 m. Recorded from 38 localities. Maximum density 30 ind./m² and biomass 16.7 g/m².

Asellus aquaticus L. A fresh-water species. In sheltered localities its density and biomass may reach relatively high values (361 ind./m² and 12.3 g/m²).

Table 1. The bottom samples.

The samplers used: A = Ekman-Birge sampler, 400 cm², B = modified van Veen sampler, 323 cm², C = modified van Veen sampler, 833 cm².

Stations: The stations marked with arabic numbers are situated on lines numbered *I – XVIII* (see Fig. 10). Stations outside of these lines are marked with letters *A – I*. The stations are arranged according to depth.

Bottom: C = clay, G = gravel, Glac. C. = stiff bluish glacial clay, D = plant detritus, L = limonite, M = mud, O = ooze, S = sand, Si = silt, Sulph. C = sulphide clay. The asterisk at Station *XVII – 4* means shell gravel from the Littorina period of the Baltic.

Vegetation: *C* = *Ceramium*, *F* = *Fucus*, *Furc.* = *Furcellaria*, *P* = *Potamogeton*, Rhodoph. = unidentified red algae.

Animals: *As.* = *Asellus aquaticus*, *A.v.* = *Agrypnia varia*, *B.t.* = *Bithynia tentaculata*, *C.l.* = *Calliopius laeviusculus*, *Cor.* = *Corophium volutator*, *C.pl.* = larvae of the *Chironomus plumosus* type *C.s.* = larvae of the *Chironomus salinarius* type, *E.c.* = *Electra crustulenta*, *G.* = *Gammarus* (unidentified), *G.l.* = *Gammarus locusta*, *G.m.* = *Gobius minutus*, *G.o.* = *Gammarus oceanicus*, *G.s.* = *Gammarus salinus*, *Hal.* = *Halicryptus spinulosus*. *H.s.* = *Harmothoe sarsi*, *Hy.* = *Hydrobia* spp., *I.* = *Iaera*, *I.b.* = *Idotea baltica*, *I.e.* = *Ischnura elegans*, *I.g.* = *Idotea granulosa*, *L.* = *Limnodrilus*, *L.a.* = *Leander adspersus*. *L.p.* = *Limnophilus politus*, *Ly.p.* = *Lymnaea peregra*, *M.e.* = *Mesidotea entomon*, *Myt.* = *Mytilus*, *N.* = *Nereis diversicolor*, Nem. = Nematoda, O. = Oligochaeta, *P.a.* = *Pontoporeia affinis*, *P.e.* = *Pygospio elegans*, *P.f.* = *Pontoporeia femorata*, *P.fl.* = *Polycentropus flavomaculatus*, *P.g.* = *Phryganea grandis*, *P.j.* = *Potamopyrgus jenkinsi*, *Pr.* = *Procladius* type larvae, *P.s.* = *Phryganea striata*, *T.* = *Tubifex*, *Tan.* = *Tanytarsus gregarius* type larvae, *T.fl.* = *Theodoxus fluviatilis*, Tr. = Trichoptera.

Numbers in brackets indicate empty shells. Two asterisks at Stat. *VIII – 8* mean that the data are not quite reliable.

Sampler, no. of samples	B, 3	B, 3	A, 3	C, 3	C, 2	C, 2	A, 9	B, 3	B, 3	B, 2
Station Depth, m Bottom Vegetation	*X – 2* 0.7 S, C –	*VIII – 7* 1 C, G –	*IX – 18* 2 C, G P.	*IV – 7* 2.5 C, O *F*	*VII – 12* 2.5 S *F*	*VI – 1* 2.5 C –	*A* 2.5 C –	*X – 1* 2.6 O, D –	*I – 6* 3 G –	*XVII – 1* 3 S –
Date	28. V. 1963	15. VI. 1963	17. VI. 1960	7. VI. 1963	18. VI. 1962	31. V. 1962	8. VI. 1959	28. V. 1963	7. VI. 1963	28. V. 1964
Nereis diversicolor	–	1	7	4	–	–	9	–	–	4
Idotea baltica	–	–	–	1	6	3	–	–	1	–
I. chelipes	–	–	–	–	–	2	–	–	–	1
Asellus aquaticus	35	–	–	15	–	–	7	3	–	–
Gammarus oceanicus	–	3	–	–	3	–	2	–	–	–
Corophium volutator	–	12	15	14	–	–	1	–	–	–
Chironomidae	17	–	6	–	–	–	60	–	–	44
Theodoxus fluviatilis	2	13	–	6	28	13	2	–	1	3
Hydrobia sp.	–	12	–	1	5	19	–	–	–	81
Lymnaea peregra	34	–	–	–	–	–	1	–	–	–
Cardium lamarcki	2	–	5	3	–	14	14	–	1	1
Macoma baltica	7	32	49	11	20	40	130	–	–	15
Mytilus edulis	–	36	17	12	9	70	135	–	2	13
Other species	*I.e.* 1 *P.s.* 1 *A.v.* 1 *P.fl.* 1	*L.p.* 2 *P.f.* 1	*M.e.* 1 *P.a.* 1	*G* 10 *L.a.* 2 *G.m.* 1		*M.e.* 1 *P.a.* 1 *P.f.* 1 *G.s.* 3 *C.l.* 1	*M.e.* 1 *H.m.* 1 *E.c.* +	*H.m.* 1 *Tr* 7 *C.pl.* 3 *Tan.* 8 *B.t.* 1 *E.c.* +	*C.pl.* 5 *C.s.* 2	*P.e.* 3 *T.* 5 *L.* 2
Animals per m²	1020	1143	838	382	433	1002	1019	237	124	2550
Total biomass, g/m²	85	82	176	57	27	196	–	1	5	141

Table 2. The bottom samples (cont.). For explanations, see Table 1.

Sampler, no. of samples	A, 3	A,3	A, 3	A, 3	B, 1	B, 1	B, 3	C, 2	A, 3	A, 3
Station	*B*	*I*	*XIV – 6*	*IX – 10*	*VIII – 8*	*XVI – 7*	*VIII – 6*	*VII – 6*	*F*	*IX – 14*
Depth, m.	3	3.5	4	4	4	4	4	5	5.5	5.5
Bottom	G, C	S, M	C	C. G	C	O	C, G	C, G	S, C	C, G
Vegetation	–	F	–	–	F	–	C	–	–	–
Date	15. VI. 1959	31. V. 1960	28. V. 1960	5. VI. 1960	13. VI. 1964	5. VI. 1964	15. VI. 1963	18. VI. 1962	15. VI. 1959	8. VI. 1960
Nereis diversicolor	1	5	–	3	–	1	–	1	1	–
Tubifex sp.	3	–	–	–	–	12	–	–	2	1
Corophium volutator	10	–	–	8	8	21	37	10	2	10
Chironomidae	–	7	56	–	4	–	–	–	5	–
Theodoxus fluviatilis	6	4	–	–	9	1	4	4	–	–
Hydrobia sp.	–	25	–	–	60	16	–	–	–	–
Lymnaea peregra	–	7	–	–	3	–	–	–	–	3
Cardium lamarcki	5	74	–	4	23	3	8	–	3	–
Macoma baltica	6	59	63	12	9	33	33	31	47	26
Mytilus edulis	20	12	–	18	87	1	44	4	3	7
Other species	*As.* 1, *G.* O. 5	*I* 1			*I.b.* 2, *I.2*, *G.s.* 2 *Pr.* 1, *C. pl.*95, *C.s.* 8, *Tan.* 2	*H.s.* 1, *C.s.* 1, *Tan.* 2	*M.e.* 2, *G.o.* 7	*I.b.* 2, *G.s.* 7, *C. pl.* 3	*G.l.* 3	*I.b.* 2, *B.t.* 1
Animals per m^2	475	1591	988	370	**	2852	1400	363	550	398
Total biomass, g/m^2	–	146	135	112	**	482	364	367	–	72

Table 3. The bottom samples (cont.). For explanations, see Table 1.

Sampler, no. of samples	A, 3	A, 3	C, 2	A, 3	A, 3	C 3,	C, 2	B, 3	C, 2	C, 2
Station	*XIV – 1*	*III – 5*	*VIII – 1*	*D*	*G*	*XV – 13*	*I – 1*	*XVIII-7*	*X – 6*	*VII – 16*
Depth, m	5.5	6.3	6.5	7	7	7	7	7.5	8	8.5
Bottom	M, C	C, S	S, G	S	Si	C, O	C, O	Si, G	C, G	O, G
Vegetation	–	–	–	–	–	–	–	–	–	*Furc.*
Date	28. V. 1960	29. V. 1961	15. VI. 1963	16. VI. 1959	20. VI. 1959	16. VI. 1961	7. VI. 1963	13. VI. 1964	28. V. 1963	18. VI. 1962
Halicryptus spinulosus	–	–	–	–	–	2	3	–	–	–
Mesidotea entomon	–	–	–	1	–	3	1	–	–	3
Pontoporeia affinis	4	–	–	–	29	96	50	–	1	–
Corophium volutator	–	12	2	–	–	–	–	2	4	23
Chironomidae	12	–	–	–	–	–	–	–	–	–
Theodoxus fluviatilis	1	–	–	14	–	–	–	1	–	2
Hydrobia sp.	2	–	–	30	–	9	–	4	–	*
Cardium lamarcki	4	–	–	8	–	3	–	2	–	–
Macoma baltica	33	16	17	22	15	81	53	8	18	4
Mya arenaria	–	–	–	–	–	1	–	–	–	–
Mytilus edulis	–	2	6	23	–	–	–	7	47	383
Other species	*H.s.* 1, *P.* 3, *I* 1, *E.c.* +	*P.e.* (11) O. 1, *G.s.* 1	*N.* 1, *G.o.* 1	*G.l.* 1, *E.c.* +	*C.pl.* 42	*T.* 8	*P.j.* 3	O 1, *Tan.* 5	*I* 1, *P.f.* 2	*G.s.* 5
Animals per m^2	490	348	162	830	714	814	660	309	438	2520
Total biomass, g/m^2	–	57	29	–	56	100	90	71	165	691

Table. 4. The bottom samples (cont.). For explanations, see Table 1.

Sampler, no. of samples	C, 2	A, 3	A, 3	A,4	B, 3	C, 1	C, 2	C, 3	C, 2	C, 2
Station	*XII – 11*	*XIII -23*	*IX – 15*	*C*	*VIII– 5*	*XVIII-6*	*XVII–4*	*XV – 17*	*XVI – 6*	*I – 2*
Depth, m	9	10	10	10	10	11	11	11	12	12
Bottom	C, G	M	G	O	S, O	Si, G	Si, *	C, O	C, O	C, O
Vegetation	*F*	–	–	–	–	–	–	–	–	–
Date	11. VI. 1962	17. VI. 1960	17. VI. 1960	15. VI. 1959	15. VI. 1963	13. VI. 1964	28. V. 1964	16. VI. 1961	5. VI. 1964	7. VI. 1963
Tubifex sp.	–	–	–	5	9	–	1	3	4	2
Pontoporeia affinis	–	64	8	42	1	–	44	22	42	78
Corophium volutator	10	–	–	3	2	–	–	–	–	–
Chironomidae	3	–	–	–	3	–	–	–	–	1
Hydrobia sp.	15	–	–	9	15	–	–	1	–	–
Cardium lamarcki	1	–	–	–	–	2	–	–	–	–
Macoma baltica	40	17	12	6	9	39	17	27	9	14
Mytilus edulis	122	–	4	12	10	111	–	–	–	1
Other species	*N.* 1, *G.s.* 3, *G.o.* 1, *T.fl.* 1	*Hal.* 1, *M.e.* 2, *E.c.* +	*E.c.* +	*G.* 2	*N.* 1, *P.e.* 1, *M.e.* 1	*P.g.* 1, *E.c.* +	*H.s.* 1	*C. pl* .1	*H.s.* 2, *I.g.* 1, *Pr.* 2	*N.* 1, *P.f.* 1, *C.pl.* 4
Animals per m²	1182	700	199	494	516	1836	378	216	360	606
Total biomass, g/m²	410	73	69	–	42	646	46	36	36	45

Table 5. The bottom samples (cont.). For explanations, see Table 1.

Sampler, no. of samples	C, 2	C, 2	C, 2	C, 2	C, 2	A, 3	A, 3	A, 3	C, 2	C, 2
Station	*VI – 5*	*VIII – 4*	*X – 3*	*XVI – 5*	*VII – 4*	*III – 4*	*XIV – 5*	*IX – 11*	*XVII – 4*	*XVI – 4*
Depth, m	12	13	14	14	15	15	15	15	16	17
Bottom	C, O	O, G	O	O	O, G	O	O	C, G	C, O	S
Vegetation	–	–	–	–	–	–	–	–	–	–
Date	31. V. 1962	15. VI. 1963	28. V. 1963	5. VI. 1964	18. VI. 1962	29. V. 1961	28. V. 1960	8. VI. 1960	29. V. 1964	5. VI. 1964
Mesidotea entomon	5	–	1	1	3	–	–	–	1	–
Pontoporeia affinis	–	9	5	20	18	10	–	–	7	–
Chironomus plumosus	–	14	18	–	9	–	–	4	–	–
Chironomidae	–	–	4	–	–	–	–	–	1	–
Cardium lamarcki	–	–	–	–	1	–	–	–	1	–
Macoma baltica	42	26	22	4	52	–	5	11	50	1
Mytilus edulis	83	1	1	–	24	–	–	–	230	–
Other species	*N.* 1, *Cor.* 5, *E.c.* +	*T.* 1, *I.b.* 1	*P.f.* 1	O. 4, *Hal.* 3	*N.* 1, *Cor.* 1	–	*T.* 4	–	*Hal.* 1, *Hg.* 1, *E.c.* +	*P.f.* 4
Animals per m²	816	314	312	192	654	83	75	125	1752	30
Total biomass g/m²	339	88	54	10	270	1	–	32	780	1

Table 6. The bottom samples (cont.). For explanations, see Table 1.

Sampler, no. of samples	A, 3	A, 4	A, 3	C, 2	C, 3	C, 2	C, 1	C, 1	A, 3	C, 2
Station	*IV – 10*	*E*	*XIV – 2*	*XVII – 2*	*XV – 14*	*I – 3*	*VI – 17*	*XII – 10*	*IX – 13*	*VI – 2*
Depth, m	17.5	17.5	18	18	18	20	20	20	20	20
Bottom,	O, G	C, O	M, S	Si	C, O	C	S	C	S, G	C
Vegetation	Rhodoph.	–	–	–	–	–	–	–	–	–
Date	7. VI. 1962	15. VI. 1959	28. V. 1960	29. V. 1964	16. VI. 1961	7. VI. 1963	18. VI. 1962	11. VI. 1962	8. VI. 1960	31. V. 1962
Tubifex sp.	–	2	2	4	–	–	–	–	–	–
Pontoporeia affinis	–	18	18	48	38	38	–	10	–	72
P. femorata	–	–	1	5	–	–	–	1	–	–
Chironomidae	–	1	–	–	–	1	–	–	–	–
Hydrobia sp.	–	2	(1)	–	–	–	–	–	–	–
Macoma baltica	4	14	5	7	5	5	8	2	10	8
Mytilus edulis	8	57	–	–	–	–	–	–	–	–
Other species	–	*M.e.* 1, *G.l.* 1, *Cor.* 4	*I.* 1	*Hal.* 1	*M.e.* 1, *C. pl.* 5	*C.pl.* 8	*P.e.* 2	*C.pl.* 2	–	–
Animals per m²	100	625	228	390	48	312	120	160	83	480
Total biomass g/m²	14	–	–	20	13	18	43	16	39	17

Table 7. The bottom samples (cont.). For explanations, see Table 1.

Sampler, no. of samples	A, 3	C, 3	C, 1	C, 2	A, 3	A, 3	C, 2	C, 3	C, 2	C, 2
Station	*IX – 16*	*XVI – 3*	*XVIII-5*	*VI – 3*	*III – 1*	*IV – 11*	*XVI – 1*	*XV – 15*	*VIII – 2*	*I – 5*
Depth, m	21	21	23	24	25	25	26	32.5	33	35
Bottom	Sulf. C	O	C, O, L	Sulph. C	O	Si	C, O	C, O	C, L	Sulph. C
Vegetation	–	–	–	–	–	Rhodoph.	–	–	–	–
Date	8. VI. 1960	5. VI. 1964	14. VI. 1964	31. V. 1962	29. V. 1961	7. VI. 1962	5. VI. 1964	16. VI. 1961	15. VI. 1963	7. VI. 1963
Mesidotea entomon	1	–	2	–	1	–	–	–	1	1
Pontoporeia affinis	10	74	43	10	–	1	2	4	3	1
P. femorata	–	1	3	1	–	–	1	–	1	–
Chironomidae	–	–	–	–	–	6	–	–	3	–
Macoma baltica	5	1	9	2	3	5	10	4	10	(1)
Mytilus edulis	–	–	–	–	–	–	15	–	2	–
Other species	–	*O.* 1, *Ly.p.* 1	*Hal.* 1	*T.* 1, *C. pl.* 2	*Cor.* 2	–	*E.c.* +	*T.* 1, *Hal.* 1	*Hy.* (1)	*C.pl.* 2
Animals per m²	143	312	696	96	50	99	168	40	126	24
Total biomass g/m²	5	8	39	9	17	15	50	6	48	3

Table 8. The bottom samples (cont.). For explanations, see Table 1.

Sampler, no. of samples	C, 2	C, 2	A, 3	A, 3	A, 3	A, 3	C, 2	C, 2	A, 3	C, 1
Station	*X – 5*	*XII – 9*	*XIV – 3*	*IV – 9*	*XIII –21*	*XIII –22*	*XII – 6*	*X – 4*	*III – 2*	*XVIII-1*
Depth, m	35	36	38	42	43	44	45	46	47	48
Bottom	C, L	C, O	C, G	Glac. C	C	C, G	Sulph. C	C, G	C	Si, G
Vegetation	–	–	–	–	–	–	–	–	–	–
Date	28. V. 1963	11. VI. 1962	28. V. 1960	7. VI. 1962	17. VI. 1961	17. VI. 1961	11. VI. 1962	28. V. 1963	29. V. 1961	13. VI. 1964
Mesidotea entomon	1	1	–	–	1	–	1	3	2	2
Pontoporeia affinis	–	14	6	–	3	2	10	–	–	76
P. femorata	–	10	–	–	8	1	9	–	–	15
Chironomidae	–	1	–	–	–	–	–	–	–	–
Macoma baltica	12	1	8	1	2	2	–	9	2	3
Mytilus edulis	14	–	1	5	–	–	–	–	–	–
Other species	–	–	*Nem.* 2, *Hal.* 2, *I.* 4, *G* 3, *Hy.* (1), *E.c.* +	*M.e.* +	*Hal.* 2	–	–	–	–	*Hal.* 2
Animals per m²	162	162	224	66	109	42	120	45	33	1164
Total biomass, g/m²	63	29	–	7	11	5	10	23	14	40

Table 9. The bottom samples (cont.). For explanations, see Table 1.

Sampler, no. of samples	C, 2	C, 2	A, 3	C, 2	C, 1	C, 3	C, 2	C, 2	A, 3	C, 1
Station	*XVI – 2*	*I – 4*	*IX – 19*	*XVII –3*	*XVIII-3*	*XV – 16*	*VII – 15*	*VIII – 3*	*III – 3*	*VI – 4*
Depth, m	48	49	50	50	51	52	52	52	53	56
Bottom	C, O	C, S	Sulph. C	Glac. C	Sulph. C	C, L	C	S, C	Sulph. C	C, G
Vegetation	–	–	–	–	–	–	–	–	–	–
Date	5. VI. 1964	7. VI. 1963	10. VI. 1960	28. V. 1964	13. VI. 1964	16. VI. 1961	18. VI. 1962	15. VI. 1963	29. V. 1961	31. V. 1962
Mesidotea entomon	2	1	–	2	1	4	1	–	1	–
Pontoreia affinis	–	–	2	2	13	–	–	–	1	–
Chironomidae	–	–	–	–	–	–	–	–	–	1
Macoma baltica	2	6	–	3	–	(1)	7	23	–	5
Other species	*P.f.* 6, *C.s.* 1	–	*P.f.* 9	–	–	–	*H.s.* 1, *Hal.* 1, *E. c.* +	–	*P.f.* 1, *Myt.* 1	–
Animals per m²	66	42	94	42	168	16	78	264	25	72
Total biomass, g/m²	11	21	–	15	3	6	36	110	6	28

Table 10. The bottom samples (cont.). For explanations, see Table 1.

Sampler, no. of samples	A, 3	C, 1
Station Depth, m Bottom Vegetation	*H* 77.5 C, S –	*XVIII – 4* 80 O, L –
Date	1. VI. 1960	13. VI. 1964
Harmothoë sarsi	–	1
Mysis relicta	–	1
Pontoporeia affinis	2	1
P. femorata	6	3
Electra crustulenta	–	+
Animals per m²	66	72
Total biomass, g/m²	0.5	4

Iaera marina L.[1], a species of the littoral zone, was recorded from six localities only. It is remarkable that one find is from 38 m. In the Airisto Sound *Iaera* has been recorded at a maximum depth of 7 m. FORSMAN (1956) mentions it even at a depth of over 30 m on the Swedish coast of the Baltic.

Amphipoda

Pontoporeia affinis Lindstr. is the commonest species of deep clay and muddy bottoms. Its biomass reaches 4.7 g/m² and density 912 ind./m². A comparison of the records from the Airisto Sound (3 720 ind./m²; TULKKI 1960), shows that the present study area is less suitable for *P. affinis* because soft bottoms preferred by this species are not as common and large here as in the Airisto Sound (cf. Fig. 10). The depth range of *P. affinis* is 2.5 to 80 m, the maximum density being at 10 – 20 m. In the Airisto Sound the species reaches a maximum density at ca. 10 m deeper. The reason for this difference is, again, the structure of the bottom. In the Lohm area, soft bottoms are rare at depths of 25 – 50 m, but somewhat more common down to 20 m, as can be seen from Fig. 10. One-third of the finds of *P. affinis* are from mixed bottoms (clay with stones, gravel or sand) in the Lohm waters and only one-sixth from similar bottom in the Airisto Sound.

Pontoporeia femorata Kröyer was recorded from depths of 8 to 80 m. The maximum densities are at 40 – 80 m. The Lohm area lies near the northern limit of the range of this species in the Baltic. Therefore *P. femorata* usually lives at the greatest depths, where it finds the most saline water. It is the only species with maximum density at the greatest depths studied (Fig. 12). Its biomass and density are smaller than those of *P. affinis* (maximum 1.1 g/m² and 180 ind./m², respectively). *P. femorata* has not been found in the Airisto Sound. SJÖBLOM (1955) recorded it in the present study area.

The *Gammarus* species live mainly in the *Fucus* vegetation or under littoral stones, but they are also occasionally caught with bottom samplers. *G. salinus* Spooner, *G. oceanicus* Segerstr. and *G. zaddachi* (Sexton) Spooner are the more common and *G. locusta* L. the least common species. The densities reach 70 ind./m² and the biomass 3 g/m². (*G. duebeni*, common in rock pools, has not been recorded from the sea in the area.)

[1] The *Iaera* living in Finnish coastal waters has so far been regarded as *I. marina*, but its taxonomic status is at present being checked.

Corophium volutator Pall. Relatively scarce compared with the neighbouring areas. In the harbour area of Turku a maximum density of 8 550 ind./m² was reported (TULKKI, 1964) and from the Airisto Sound 1 240 ind./m² (TULKKI, 1960), but only 651 ind./m² from our present area. The more sheltered waters of the inner archipelago of Southwestern Finland are thus clearly more suitable for this species than our study area. The lower limit of the vertical distribution is about 25 m and the maximum density occurs at 2 – 10 m depth, in both the Airisto and Storströmmen Sounds.

Calliopius laeviusculus (Kröyer). Found only once, although it is not rare among the *Fucus* vegetation in the southernmost parts of the area.

Decapoda

Leander adspersus Rathke. Only one specimen caught. Not rare in the *Fucus* vegetation in the Lohm area.

Odonata

One larva of *Ischnura elegans* Lind. at St. *X – 2*. Rather common in the Lohm area in the upper littoral. Larvae of *Libellula quadrimaculata* (L.), *Aeschna juncea* (L.), *A. coerulea* (Ström), *Agrion armatum* (Fabr.), and *A. hastulatum* (Charp.) are also common in the littoral zone. According to LINDBERG (1948), all these species occur in water of a salinity of about 6 ‰ in the Baltic. He mentions *Aeschna juncea* and *A. coerulea* even from salinities of 9 – 10 ‰.

Coleoptera

Larvae of *Haemonia mutica* F. were caught at St. A and X – 1 on a clay bottom (depth 2.5 m). Some pupae were collected in the *Fucus* zone. The species is known from various places along the coasts of the Baltic (LINDBERG, 1948), but not from the innermost parts of the Gulf of Bothnia. *H. mutica* has also been recorded from some lakes in Finnish Lapland and Åland (LINDBERG, *op. cit.*).

Trichoptera

The maximum occurrence of caddis-fly larvae seems to be in the uppermost littoral zone. Only *Phryganea grandis* L. was found below the *Fucus* zone at a depth of 11 meters. Altogether 5 species of Trichoptera were observed in the quantitative samples. Of them *Polycentropus flavomaculatus*, Pict., *Phryganea grandis*, and *P. striata* L. occur throughout the country, whilst *Agrypnia varia* Fabr., and *Limnophilus politus* McLach. are relatively southern species in Finland (NYBOM 1960). In the net samples taken in the littoral zone *Phryganea obsoleta* (Hag.), *Limnophilus decipiens* (Kol.) and *Athripsodes aterrimus* Steph. were common. All these species except *Polycentropus*, *Athripsodes* and *Limnophilus politus* are included in LINDBERG's (1948) material of the Baltic Sea.

Chironomids

The chironomid larvae were only identified to main larval type. Fig. 12 shows the vertical distribution of the larvae. The maximum density (1806 ind./m²) was observed at one station in the *Fucus* zone. Because a large number of small larvae pass through the sieve, the figures obtained

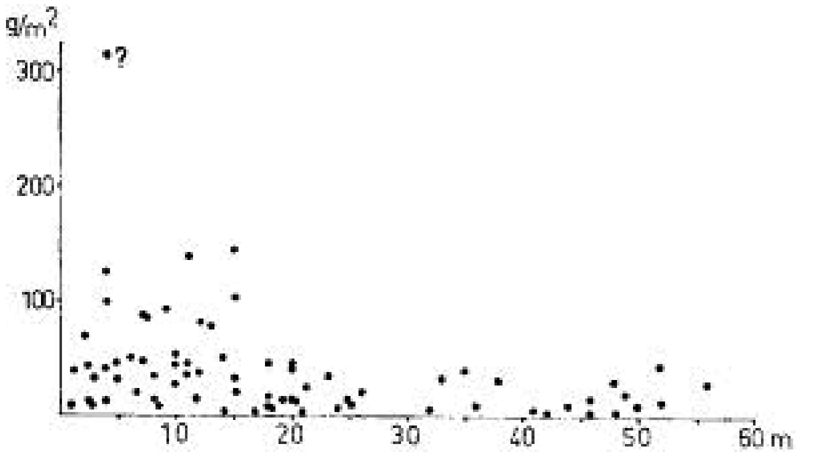

Fig. 11. The biomass of *Macoma baltica* at different depths. The station with greatest biomass is not truly quantitative.

may be misleading. It seems, however, that the density decreases steadily with depth, the deepest record being at 56 m. Sjöblom (1955) even found chironomids at 64 m in our study area.

Gastropoda

Theodoxus fluviatilis L. Very common everywhere on shallow stony bottoms and among the *Fucus* vegetation, vertical range from 0.7 to 9 m. There are only two records from a clay bottom. The greatest density was 168 ind./m², and 24.6 g/m². This species was also found in some lakes that are occasionally in connexion with the sea and where the salinity is 1 – 3 o/oo.

Bithynia tentaculata (L.) is common among vegetation in the upmost littoral, but it was caught only twice with the bottom sampler from 2.4 and 5 metres.

Hydrobia spp. were recorded from 1 to 18 metres. Both Finnish species (*H. ulvae* and *H. ventrosa*) occur in the study area, but because not all the specimens were identified the material will be considered collectively. The maximum abundance was 1 215 ind./m² and 12.4 g/m². The *Hydrobia* species penetrate to greater depths in the Lohm area than is known in other parts of the south coast of Finland, viz. 18 m. In the Airisto Sound the greatest depth is 9.5 m (Tulkki, 1960), at Tvärminne 9 m (H. *ventrosa*) and 15 m (*H. ulvae*) (Koli, 1961). The reason for this basal submergence is discussed below.

Potamorpyrgus jenkinsi Smith. Only in one bottom sample (7 m, ooze bottom), but in netting samples taken from the shores *Potamopyrgus* is not rare in sheltered places. Like *Theodoxus*, it also occurs in small brackish-water lakes temporarily connected with the sea.

Lymnaea peregra (Müll.), and *L. stagnalis* (L.) are the commonest pulmonates in the area, the latter living in the uppermost littoral. *L. peregra* was found at 6 stations ranging from 0.7 to 21 m. The maximum density was 350 ind./m². The deepest find is probably fortuitous, but it clearly shows the wide vertical range of this species in the well oxygenated waters of the study area. At Tvärminne *L. peregra* has been found at a depth of 19 – 20 metres (Segerstråle, 1933).

Pelecypoda

Cardium lamarcki Reeve occurs everywhere in the littoral from 0.7 to 15 metres. It is a characteristic species of the mineral bottom community, but sometimes occurs in sulphide clay, clay, and ooze bottoms. The maximum abundance observed was 93 ind./m² and 96.8 g/m². As long ago as 1890, Nordqvist (*op.cit.*) recorded this species near Lohm at a depth of 52 m.

Macoma baltica (L.) was found in almost every sample. A density of over 200 ind./m² was recorded. The depth range is 0.7 to 56 metres. The biomass values of *Macoma* can be seen in Fig. 11. The maximum biomass observed was 316.8 g/m², but this value may be misleading, because only one bottom sample with a small sampler was taken in this case. The mean individual weights of *Macoma* increase with depth and small specimens have not been observed below 20 m (cf. Segerstråle, 1962).

Mya arenaria L. is a characteristic species of shallow sandy bottoms. We found only one living specimen however.

Mytilus edulis L. is quantitatively the most important Pelecypod species of the Archipelago Sea. We recorded it at 43 stations. The maximum density was 2 298 ind./m² and the greatest biomass 669 g/m². It has been recorded six times at depths of more than 30 m, the deepest find being from 53 m, and here the density was 8 ind/m². In the Airisto Sound the maximum depth, according to Tulkki, (1960), is 20 m and in the Tvärminne area 33 – 35 m (Segerstråle, 1933). Forsman (1956) mentions this pelecypod from 37 and 48 metres near the N.W. corner of Bornholm, where the hydrographical conditions and the character of the bottom greatly resemble those in the Storströmmen Sound. This so-called basal submergence will be discussed below.

Bryozoa

Electra crustulenta Pall. was observed down to 80 meters, and thus has the widest vertical distribution of the species considered here. The occurrence of this mainly littoral species at great depths is connected with the development of limonite on the soft bottoms, which provides a suitable substrate, essential for this sessile species.

IV. Discussion

Sixteen truly marine species were recorded from the study area, whose fauna is thus more marine than that of the Airisto Sound in the inner archipelago, where only 11 or 12 marine species were found in the bottom samples (Tulkki, 1960). The northern limit of some marine species in the Baltic lies approximately in the present study area. These species (*Idotea granulosa*, *Pontoporeia femorata*, *Gammarus locusta*, and *Calliopius laeviusculus*) seem to be absent from the Airisto area (cf. Segerstråle 1944, 1957, and 1959).

The following species in our material are suggested to be of brackish-water origin (see

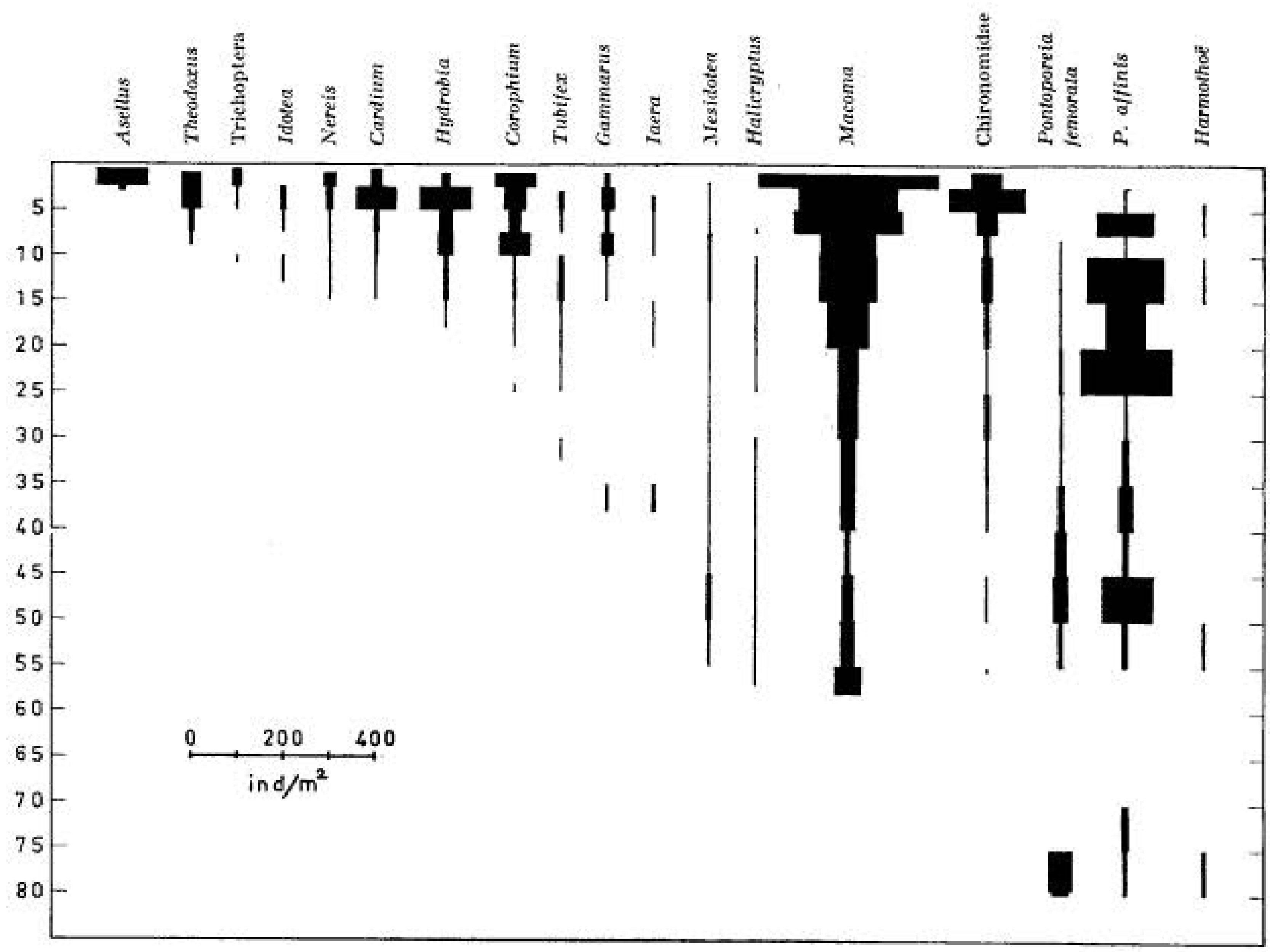

Fig. 12. The bathygraphic distribution of some bottom animals.

e.g. Segerstråle, 1957): *Electra crustulenta*, *Hydrobia ventrosa*, *Idotea viridis*, *Mesidotea entomon*, *Pontoporeia affinis*, *Gammarus salinus*, *G. zaddachi*, *G. duebeni*, and *Mysis relicta*. Most other species are limnic.

We have often found the following additional species, which were not obtained with the aid of quantitative methods: *Laomedea loveni* Allm., *Prostoma obscurum* Schultze, *Balanus improvisus* Darwin, *Bathyporeia pilosa* Lindst. and *Crangon crangon* (L.).

As seen from Figs. 12 and 13, the density of different species and their total abundance are greatest in the uppermost littoral. The figures do not give a true idea of the shallow hard bottom fauna owing to the sampling method. The quantitatively most important components are *Mytilus*, *Macoma*, and *Pontoporeia affinis*. In the deeper waters the latter species especially increases. If the density values are compared with those of the Airisto Sound, it will be observed that they are strikingly greater in the latter area. They are greater at every depth and especially between 20 and 40 metres (see Tulkki 1960, Fig. 16). One possible cause of this phenomenon is the fact that, owing to the currents, mineral bottoms poor in foodstuffs are commoner in the Lohm area than in the Airisto Sound.

If we compare the densities of different species in the areas of Lohm, Airisto, and the harbour of Turku, we observe an increasing gradient in the density of *Corophium*, probably caused by pollution:

Lohm	Airisto	Turku harbour
651 ind./m² 9.3 g/m	1 240 ind./m²	8 550 ind./m² 26 g/m²

Corophium is a species of sheltered localities, shallow bottoms and some detritus. Such

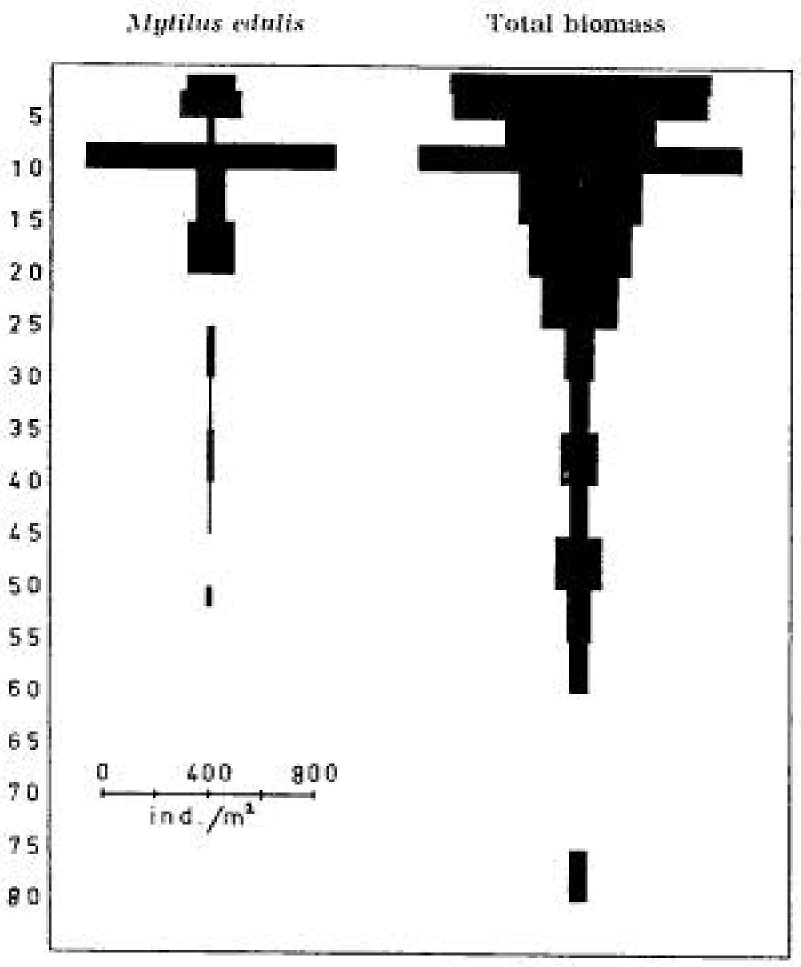

Fig. 13. The bathygraphic distribution of *Mytilus edulis* and all bottom animals collected. Observe that the scale is different from that of Fig. 12.

bottoms increase from the Lohm area towards the inner archipelago. *Macoma* also shows increasing densities from Lohm to Turku.

Examples of species more numerous in the Lohm area than in the Airisto area are the following: *Harmothoë*, *Mytilus*, and *Asellus*. Reverse conditions prevail in the abundance of the following species: *Nereis*, *Halicryptus*, *Mesidotea*, *Pontoporeia affinis*, *Cardium*, *Theodoxus*, and *Hydrobia* spp.

Comparisons of the biomasses and densities of the different areas in the archipelago give similar results (cf. Tulkki 1960 and 1964).

As criticisms of our quantitative results the following points should be noted: 1) The season of the investigations is different (late spring in Lohm, autumn in Airisto and Turku harbour), which accounts for great fluctuations in the abundance of many species owing to the reproduction periods. 2) The collecting methods have not been fully standardized. 3) The collecting methods are not reliable where hard bottoms are concerned.

Many species commonly living in the uppermost littoral penetrate relatively deep in the Storströmmen Sound, much deeper than in the neighbouring archipelago. Such species are *Mytilus*, *Electra*, and *Iaera*. The two first-mentioned are sessile species with a pelagic larval stage. In spite of the perpetual coldness and darkness they may settle on hard surfaces at depths of 40 – 50 m in the trench. The more stable salinity in deeper waters is advantageous for marine species, because they are not sub-

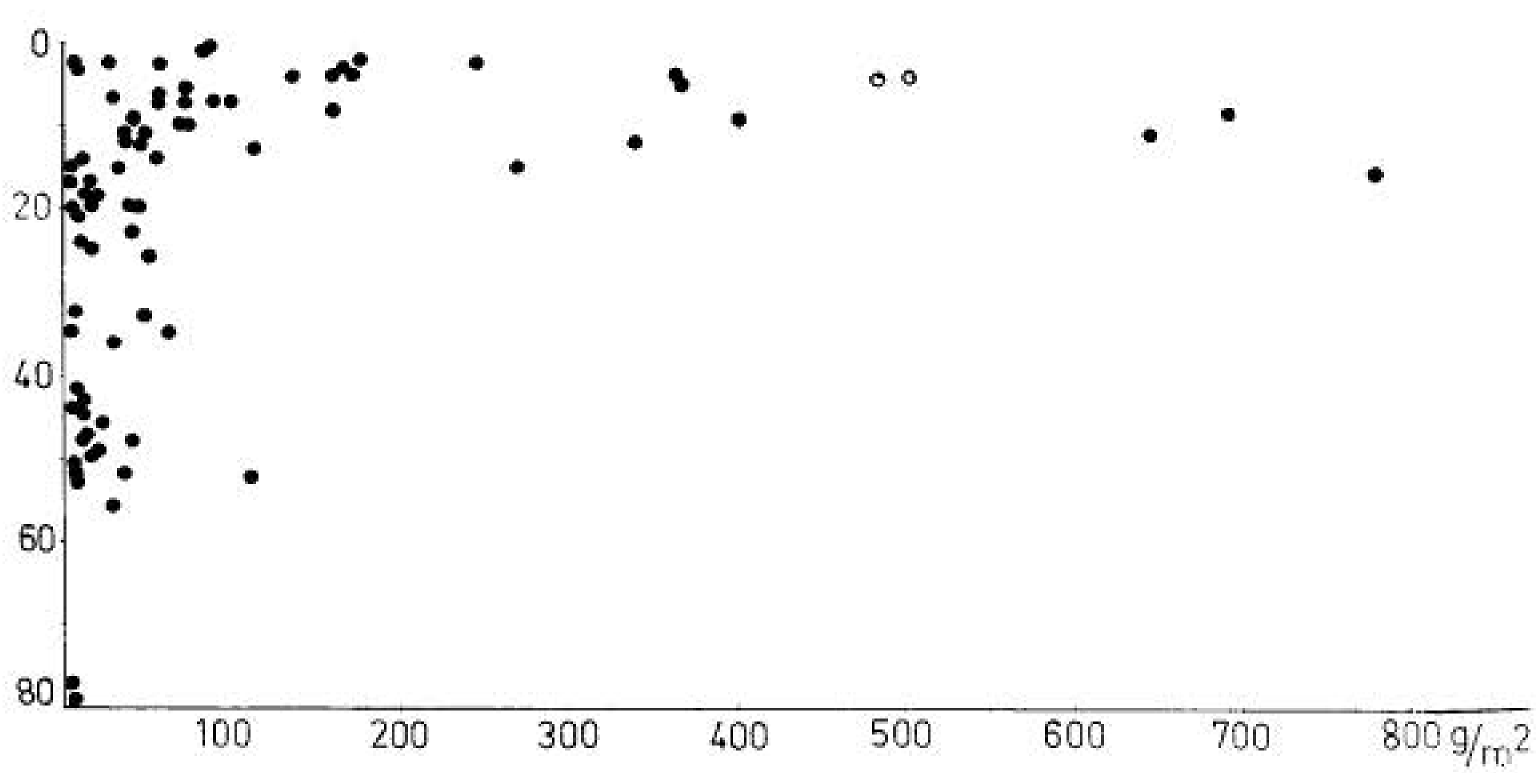

Fig. 14. The total biomass according to the depth. The stations at which only one sample was taken with the small van Veen dredge are marked with open rings.

jected to the lowered salinity during the reproduction time in spring. Their reproduction is probably hampered, however, by the permanent coldness in deeper waters.

In the Storströmmen Sound the littoral animals thus occur mainly at two levels, viz. at 0 – 15 m and 30 – 60 m. Between these depths, on the shelves, there are mainly soft bottoms with typical species. In the places where the bottom falls steeply from the water line to 60 m however, it has the littoral character at every level.

Because of the varying environmental conditions it is not possible to delineate well-defined animal communities in the study area. Only a rough division can be made.

1) On soft bottoms from 5 m (or 10 m at more exposed localities) to 80 m the following species are usually recorded:

Mesidotea	*Pontoporeia affinis*
Macoma	*P. femorata*
Halicryptus	*Harmothoë*

2) On hard and mixed bottoms from the water-line to varying depths the typical species are:

Mytilus	*Theodoxus*
Macoma	*Hydrobia* spp.
Cardium	Chironomidae
Iaera	

3) In sheltered bays from 0 to 20 m, where the bottom consists of mud, sand, gravel, and often of rich plant detritus, the following animals often occur:

Asellus	*Lymnaea* spp.
Corophium	Chironomidae
Cardium	*Theodoxus*
Macoma	Trichoptera
Tubificidae	*Nereis*
Gammarus spp.	

The littoral community at depths of 0 – 10 m of the Airisto (Tulkki, 1960) resembles the hard and mixed bottom community of the present study area, and the soft bottom community in the Airisto Sound at depths below 20 metres is somewhat similar to that of the Lohm area. The depth range of these two communities is wider in the Lohm area than in the Airisto Sound, owing to the differences in the hydrographical conditions and the character of the bottom, as mentioned above.

So far, no polluted waters occur in our study area, nor do less saline brackish waters except for the slightly saline young lakes on the islands. These lakes will be the subject of later studies.

Summary

The study is a survey of the bottom fauna in the Lohm area, south of the harbour of Turku and the Airisto Sound studied earlier by Tulkki (1960 and 1964). The salinity in the present study area in the outer part of the archipelago has been somewhat over 6 ‰ during the period of the investigation (from 6 to slightly over 7 ‰ in the Airisto Sound in 1956). The temperature of the water varies between – 0.2 and 9° C in the deepest localities and – 0.2 to near 20° C at the surface. Much attention has been paid to currents in the Storströmmen Sound near Lohm. The mean current flows from south to north. It erodes the bottom and even in the deepest localities produces an environment which resembles littoral habitats. The littoral animals partly replace the deep bottom species. The numbers of individuals and species are small, however, owing to the permanent coldness. Typical soft bottoms with characteristic species have also been found outside the Storströmmen Sound.

The composition of the fauna is somewhat more marine in character than in the Airisto Sound, although the limnic species are the most important element of the fauna.

No clear animal communities have been observed. The following uncertain communities may be mentioned: 1. The soft bottom community from 5 to 80 m (characteristic species are listed above). 2. The hard and mixed bottom community. 3. The community of sheltered bays.

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