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Plankton Committee

Observations on the plankton in the sea area of the City of Helsinki

Terttu Melvasalo

Helsinki City Engineer's Office
Street Construction Department
Water Conservation Laboratory
Rajasaari, 00250 Helsinki 25
Finland

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The City of Helsinki is located on the cape surrounded by shallow bays and islands. Many sewage treatment plants of the city are located so that the sea area around the city proper has been the recipient of biologically or only mechanically purified sewage. The result of this has been eutrophication of shore areas which is seen most clearly as turbidwater due to abundant plankton. The eutrophication and its effects on water organisms has been intensively studied in the Water Conservation Laboratory of the City of Helsinki since the year 1965. The study area has also partly covered water areas of neighbouring parishes. The length of the study area was about a 50 kilometer shoreline and it stretched about 10 kilometers outwards from the coast. Chemical, physical and biological analyses have been made in the laboratory. Especially mentioned the investigations of currents and mixing of the waters, the chemistry and physics of the sea bottom, hygienic condition of the sea and in 1969 started fishery investigations with qualitative and quantitative zooplankton studies. Phytoplankton investigation has included from the beginning qualitative and quantitative studies with primary production analyses. Since zooplankton observations have been studied only during two years, I have concentrated in this paper mostly on the phytoplankton studies based on the 2000 quantitative phytoplankton analyses from the years 1966-1970 most of them taken simultaneously with primary production samples. Planktonsamples were taken at intervals of 2-4 weeks from the beginning of the open water period to November. (Fig. 1)

The sampling stations were located on the most eutrophied and slightly eutrophied areas and on the outer sea areas which are considered to be in their natural state. The greater number of samples have been mixed profile samples from the surface to the 4 meters depth and they were conserved in the Keefe-solution and counted with Utermöhl-technique with 600 or 625 fold magnification. From the western sea area some vertical samples series have been counted. (Keefe 1926, Utermöhl 1958)

According to phytoplankton observations the water area around the city can be divided in four zones characterized by primary production 1. highly eutrophied 2. eutrophied 3. slightly eutrophied 4. not eutrophied. On the figure 2 it is shown, that of the zones surrounding the city, the most eutrophied areas are both the large inner bays, Vanhankaupunginselkä (station 4) in the eastern and Laajalahti (87) with Lehtisaarenselkä (140) in the western part of the sea area. The other zones are outwards from these areas. The mean depth of this very eutrophic zone is about 3-5 m. Both of these bays are recipients of the biggest treatment plants of the city. In addition there is the only river of Helsinki the Vantaa river, which flows into Vanhankaupunginselkä (4). The mean flow of the river is about 16 m^3/s and the water is rather polluted. The primary production values 'in situ' in this zone are 1200 kg C/hectares/year (Pesonen 1971). The phytoplankton biomass mean value in Laajalahti (87) from May to October is about 100 mg/l and in Vanhankaupunginselkä bay 30-70 mg/l resp. (Melvasalo) 1971).

The areas, where primary production 'in situ' is 1200-800 kg/hectares/year are classified as eutrophied (Pesonen 1971). This zone in the western part is a very small area between very eutrophic and slightly eutrophic zones. On the eastern part of the study area the rather large Kruunuvuorenselkä (18) belongs to this zone. Mean value of the phytoplanktonbiomass in these areas is more than 25 mg/l. (Fig. 3)

The third or slightly eutrophied zone can be considered an area ranging from polluted coastal waters to pure brackish water. In these areas the phytoplankton biomass mean value of the growth period is mostly less than 5 mg/l. The eutrophication is seen in increased primary production values in spring, and the annual mean value is 800-400 kg C/hectars/year. The biomass of spring bloom of diatoms is also higher than that of the undisturbed area.

The biomass of the stations in the western part of the city are shown in the figure (Melvasalo 1971). The curves are drawn on the basis of 1 m samples from the years 1966-1970. In the foreground there is the year 1970 and in the background the year 1966. (Fig. 4)

The sampling stations are from the left to the right so that the first on the left is the curve of the most eutrophied area, Laajalahti (87) and the last in the right is the curve of the unpolluted area (125). The figure shows the differences in the biomass between these four areas and the annual rhythm of each curve, which for example in the stations 87 and 140 are with two maxima. In these curves the first maximum is short and sharp and due to diatoms in the beginning of the growth period. The second maximum is a broad one caused by blue-green algae, and it begins soon after the biomass minimum in June and lasts for 3-4 months. The highest values in the maximum of the blue-green algae exceeds every year the highest values of the diatom maximum. During the *Cyanophyta*-period, for example, the phytoplanktonbiomass in Laajalahti (87) can be over 200 mg/l or 6000 kg/hectare.

Due to the scale the differences between the curves of the sampling stations 68 and 125 are not very clear. Both in the slightly eutrophied area (68) and the not eutrophied area (125) there is a clear maximum in spring. Though the biomass values increase in late summer they remain smaller than the highest values of the diatom maximum in spring. The sampling station 125 is located in the area, where the planned sewage pipe of Helsinki will discharge its contents into the sea. The area is about 7 kilometers from the coast where the mean depth is about 30 meters and mixing of the water is rather good.

The centrales-diatom *Stephanodiscus hantzschii* var. *pusilla* makes almost entirely alone the spring bloom of diatoms. Though the mean volume of the individuals of this species is only 400 μ^3, it can make even 100 mg/l phytoplanktonbiomass in Laajalahti (87). Just before the diatom maximum in the spring the green colour of the water in the polluted areas is caused by a flagellated alga *Chlamydomonas* sp. which is the only dominating green alga in the whole study area.

The phytoplankton species which dominate from April to October can be roughly divided into two groups: spring and summer species. The spring species in April and May are mainly diatoms. In the polluted areas there are typical eutrophic species, but in outer sea area the diatom species are those of cold, arctic brackish water and, in addition, an arctic, dinoflagellate *Gonyaulax catenata*.

These marine spring species are among other *Achnanthes taeniata, Melosira arctica, Nitzschia frigida, Navicula vanhöffenii* and *Thalassiosira baltica*. In summer there is a clear difference between the populations of the polluted and unpolluted areas. In summer in polluted areas the predominating group is *Cyanophyta* (fig. 5). In the outer sea area there are no predominating groups, though the most species are flagellates. In the most eutrofied areas, Laajalahti (87), Vanhankaupunginselkä (4) and Lehtisaarenselkä (140) the chief species of the *Cyanophyta* maximum is *Oscillatoria agardhii*, which can be more than 90 percent of the whole phytoplankton biomass in Laajalahti (87).

Due to the fresh water discharged into Vanhankaupunginselkä the amount of cyanophyta-algae is not as large as in the western part and phytoplankton species include also diatoms. The phytoplankton species of the third inner bay, Vartiokylänlahti (25) to the east of the city, differ from those of the other two inner bays. The bay is only slightly eutrofic (Pesonen 1971) and the percentage values of the group *Chyanophyta* are the lowest of the whole study area. It is observed that in this bay there are the highest values of copepod and cladocerans (Viljamaa 1971), which are important food for many fishes.

The autumn maximum of *Aphanizomenon* is characteristic to the Gulf of Finland. It is rather interesting that the species is absent in the highly eutrophied zone around the city though in literature the species is mentioned to be found also in the shore areas when those waters have been poor in plankton.

The zooplankton studies have been going on only for two years. The zooplankton biomass in the highly eutrophied areas is only about 1/10, and in eutrophied areas about a half of phytoplankton biomass (fig. 6). However in slightly eutrophied areas (68 and 25) in summer both phyto- and zooplanktonbiomass of the uppermost water layers are about equal, 10 mg/l. Due to the scarcity of observations it is impossible to show any kind of zonation, but qualitatively there is clear difference between eutrophied and pure areas. In Laajalahti (87) the most part of biomass include cyclops (black area), of which *Cyclops vernalis* consisted about 1.7 mg/l in 1970. This is 70 % of the whole biomass (Viljamaa 1971). The amount of this species is not so big in Vanhankaupunginselkä (4). Other species favouring polluted areas in spring are *Brachionus angularis* and *Brachionus calyciflorus*. In summer ciliates are abundant. In outer areas the most important species are *Synchaeta baltica, S. monopus, Podon polyphemoides, Acartia bifilosa, Bosmina coregoni maritima* and *Eurytemora hirundoides*.

In the phyto- and zooplanktonbiomass and species and primary productivity it is observed that there is a clear difference between the polluted and unpolluted areas. It is obvious that the bad condition of the shore water is due to the discharge of the domestic sewage of the city to the low inner bays. The situation does not improve before the flow of nutrients discharged into the sea water is stopped. It is possible only by means of chemical purification and piping the sewage out to the sea where they mix with sea water. This would be espesially good when considering the sea areas close to the settlement, which because of their location would excellently suit to recreational purposes.

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Figures:

1. Sampling stations for primary production and phytoplankton

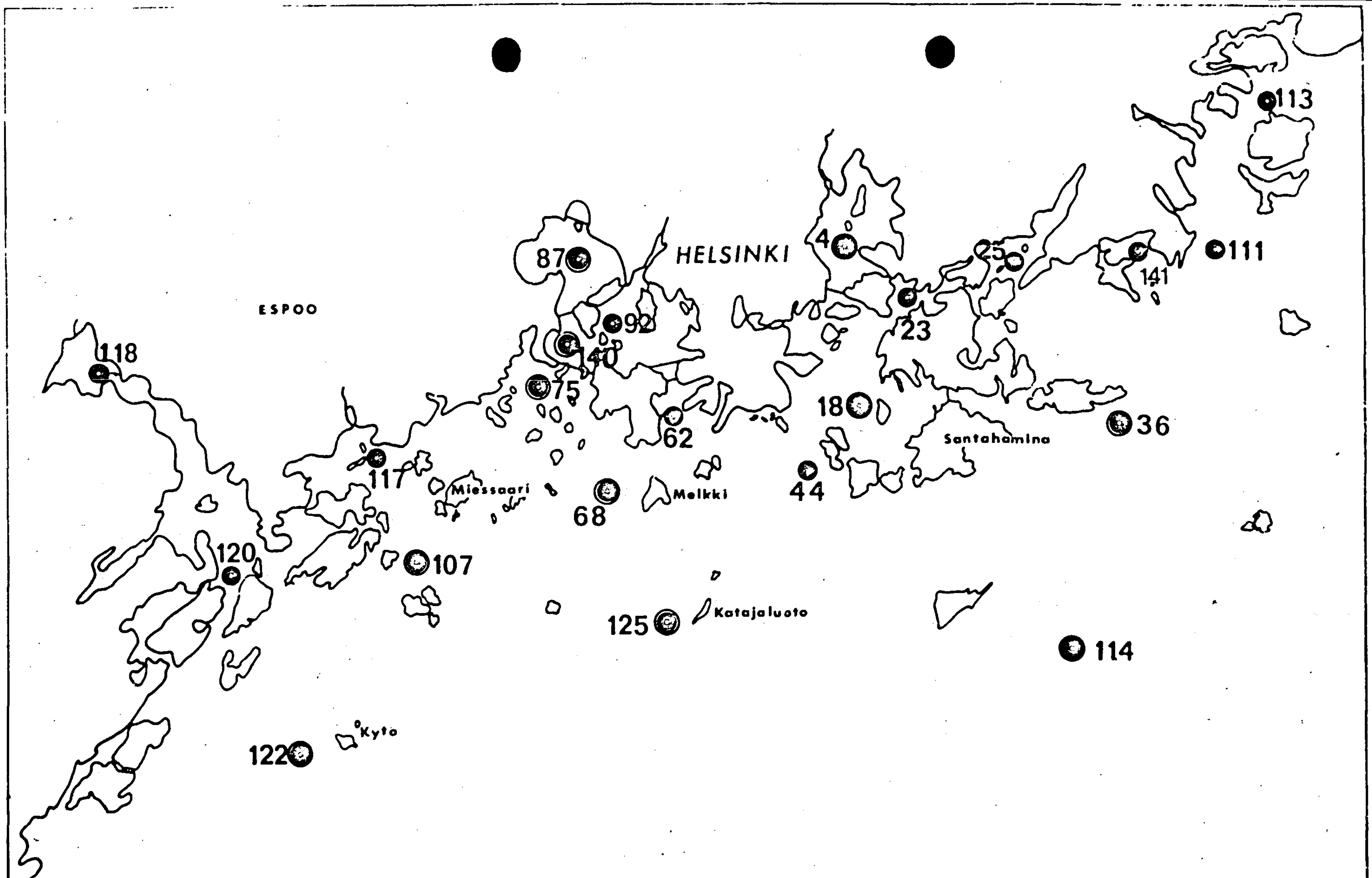
2. Eutrophication in Helsinki and Espoo sea areas 'in situ' samples 1970

3. Phytoplankton biomasses in 1968-1970 mean values mg/l during growth period May-October

4. Phytoplankton biomasses in 1966-1970 mg/l in 1 m samples, stations 87, 140, 68 and 125

5. Percentages of chief phytoplankton groups in 0-4 m samples May-October

6. Mean values of zooplankton biomasses in whole water column May-October, 1970



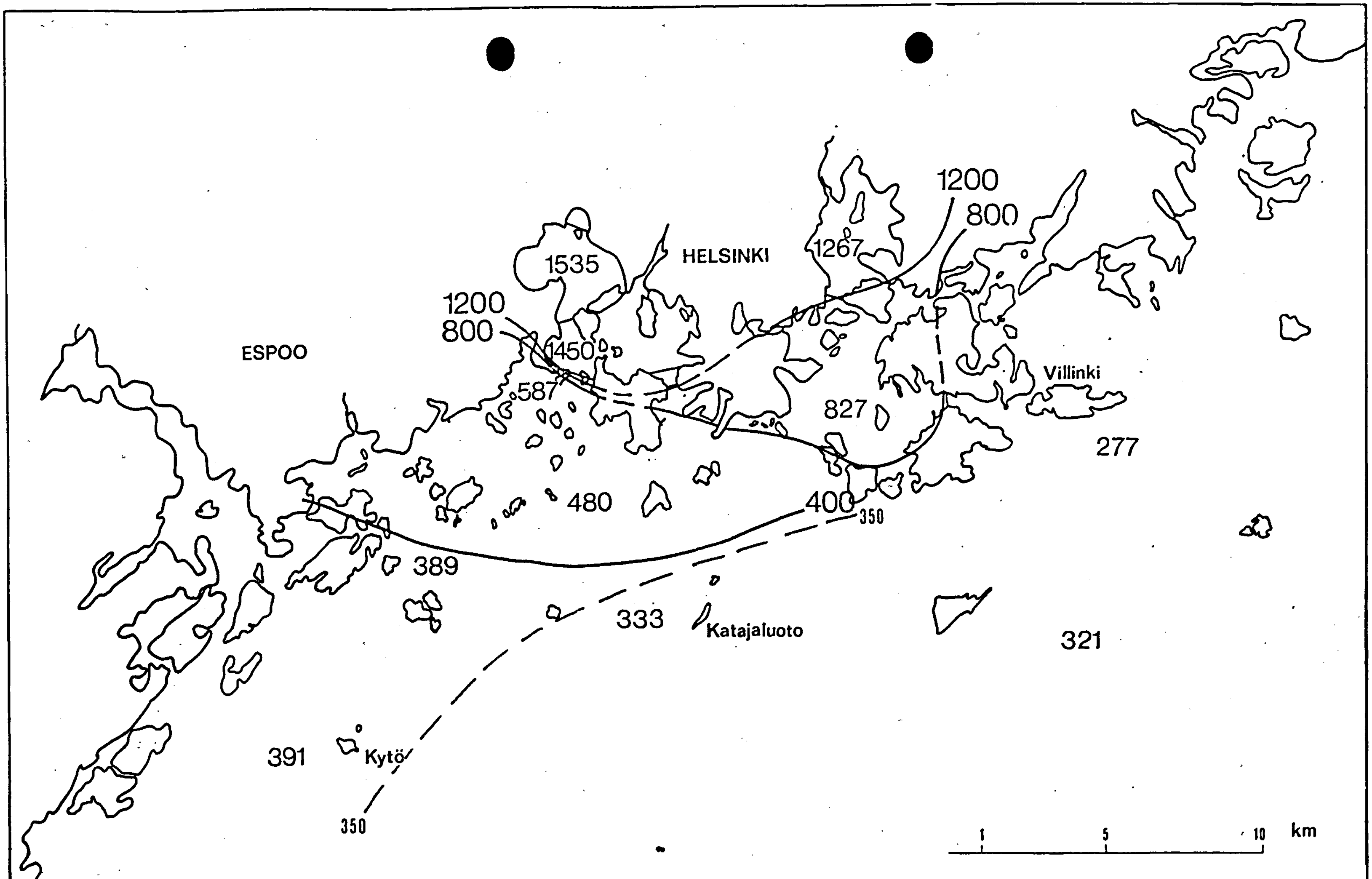
PERUSTUOTANTOHAVAINTOPAIKAT 1970

SAMPLING STATIONS FOR PRIMARY PRODUCTION 1970

● PATSASHAVAINNOT
Profile samples

○ VERTIKAALIHAVAINNOT
Vertical samples

1 5 10 KM

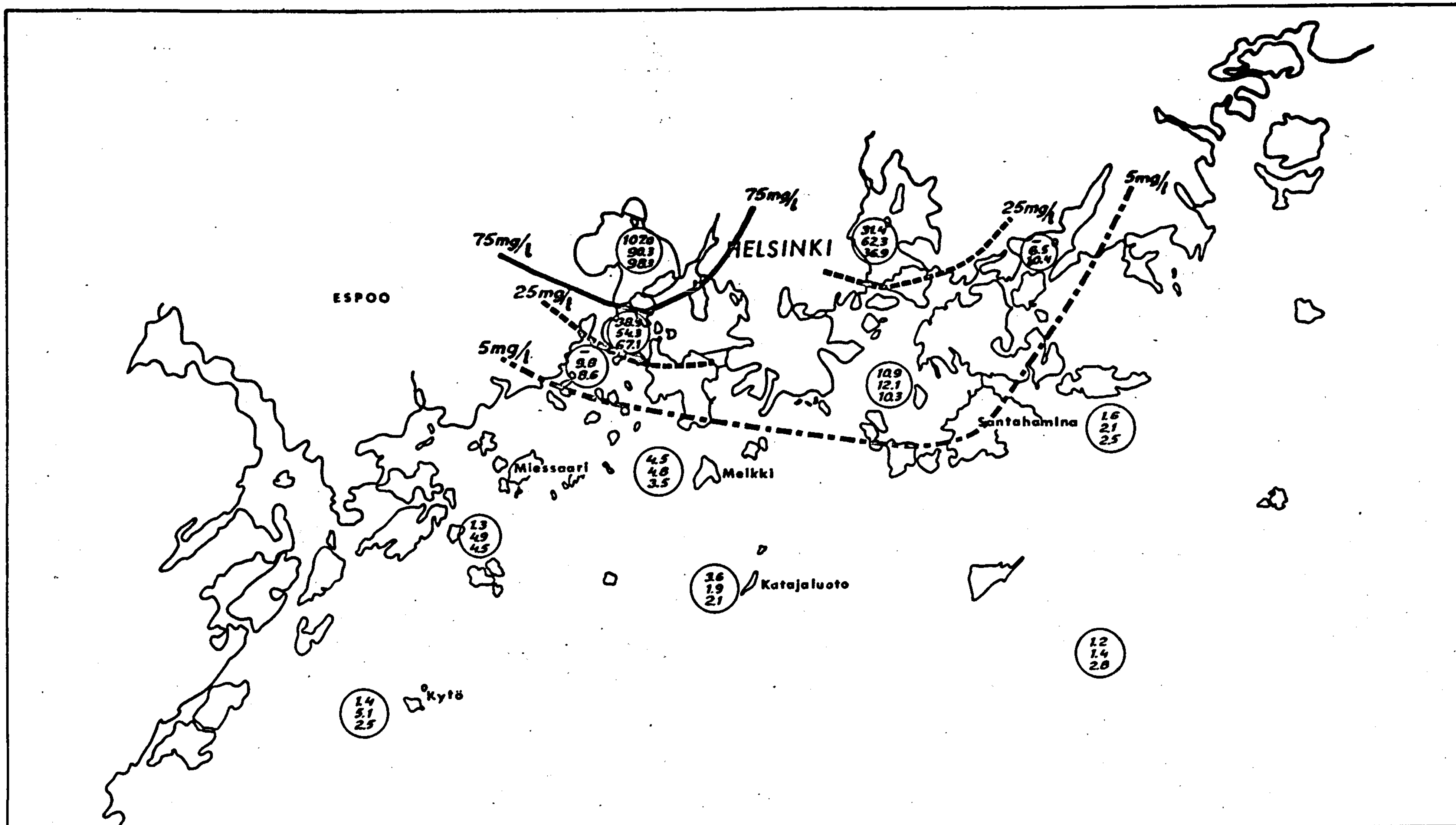


REHEVYYSASTE HELSINGIN JA ESPOON EDUSTALLA 1970
'in situ' -havaintojen mukaan

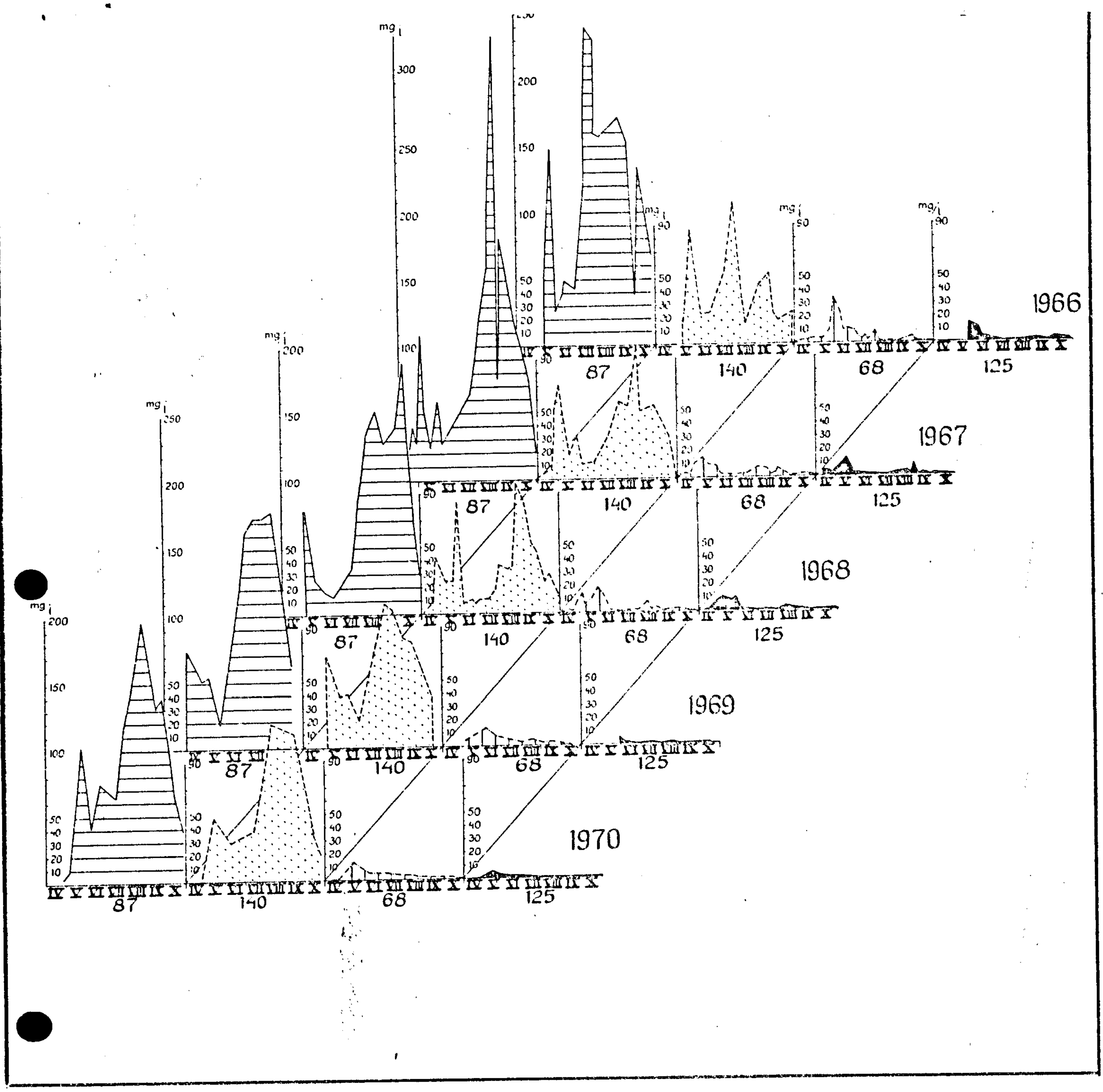
EUTROPHICATION IN HELSINKI AND ESPOO SEA AREAS. 1970
'in situ' samples

	kg C/ha/vuosi year	
erittäin rehevä	›1200	very eutrophic
rehevä	1200 - 800	eutrophic
lievästi rehevä	800 - 400	slightly eutrophic
rehevöitymätön	400 ›	not eutrophic

1/3

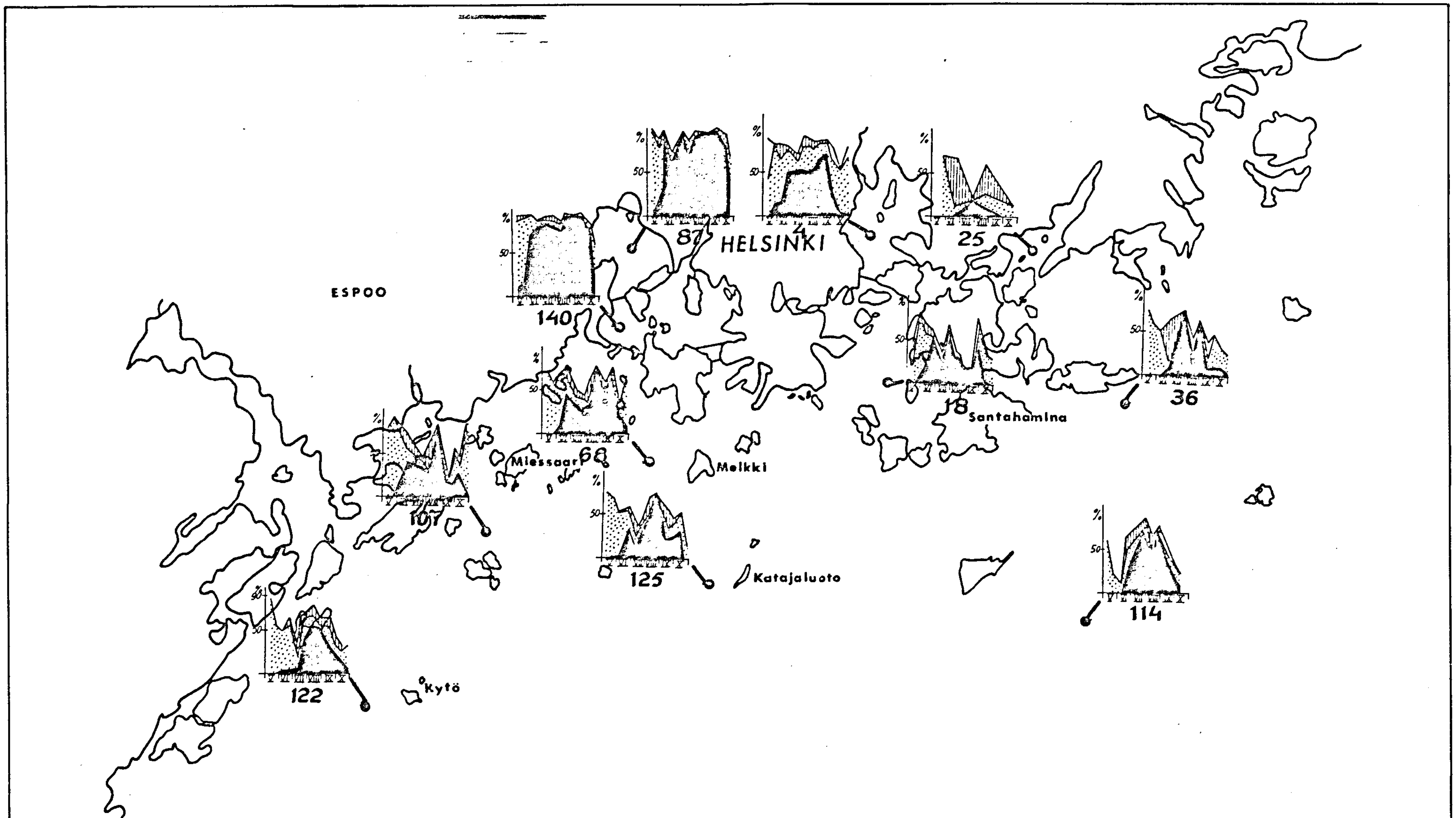


Kasviplanktonbiomassat V–X mg/l keskiarvo
Phytoplanktonbiomasses 1968 mean value
1969
1970



Kasviplanktonbiomassat mg/l vuosina 1966-1970 havaintopaikoilla 87, 140, 68, 125 1 m:n näytteissä

Phytoplanktonbiomass in 1966-1970 mg/l in 1 m samples, stations 87, 140, 68, 125

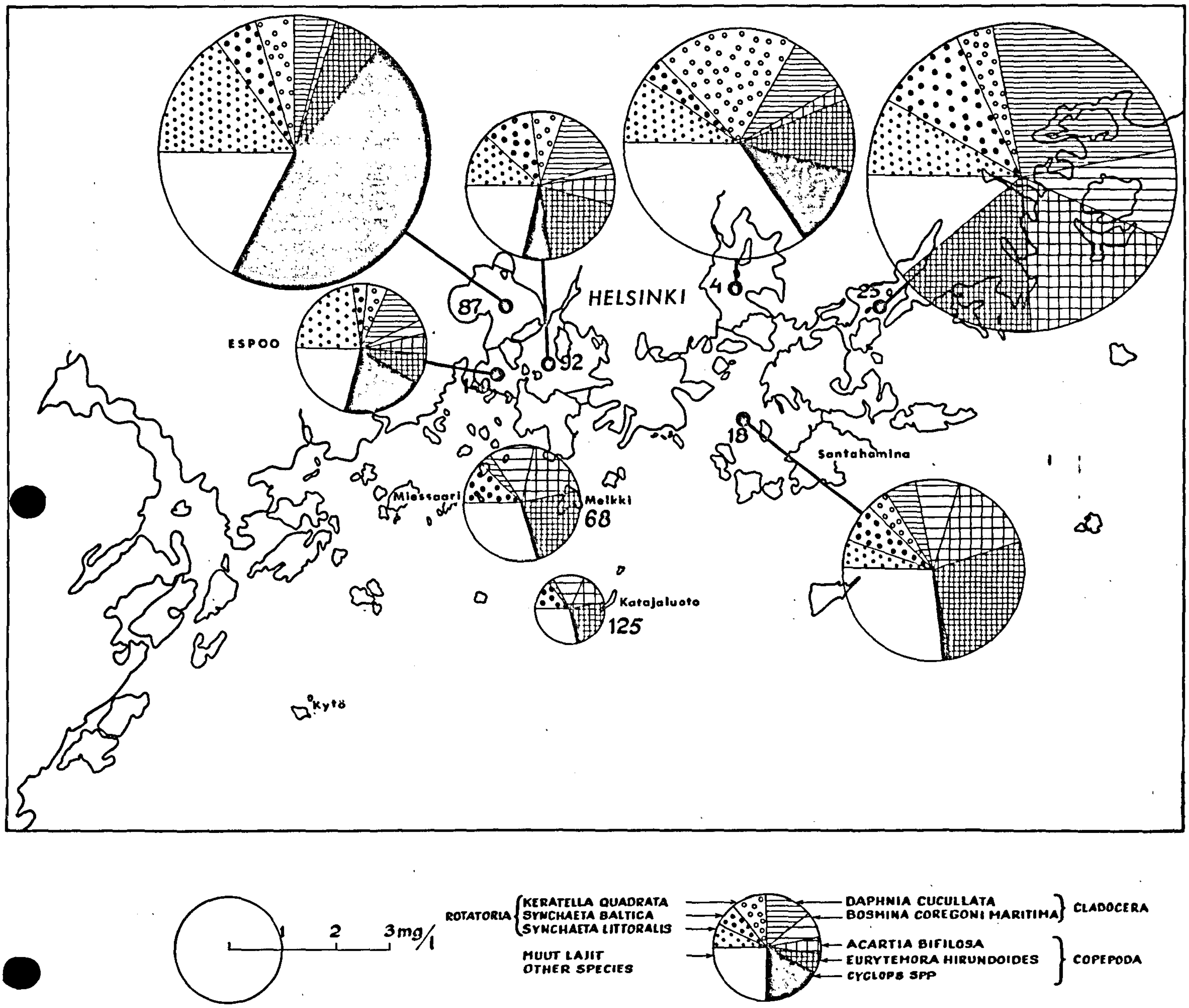


= CYANOPHYTA sinilevät blue-green algae

= DIATOMAE piilevät diatoms

= CHLOROPHYTA viherlevät green algae

= MUUT RYHMÄT other groups



HELSINKI
ESPOO
87
92
40
25
140
18
Santahamina
Miessaari
Melkki
68
Katajaluoto
125
Kytö
1 2 3mg/l
ROTATORIA
KERATELLA QUADRATA
SYNCHAETA BALTICA
SYNCHAETA LITTORALIS
MUUT LAJIT
OTHER SPECIES
DAPHNIA CUCULLATA
BOSMINA COREGONI MARITIMA
CLADOCERA
ACARTIA BIFILOSA
EURYTEMORA HIRUNDOIDES
CYCLOPS SPP
COPEPODA