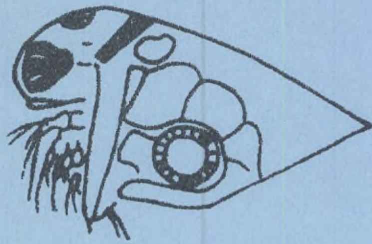
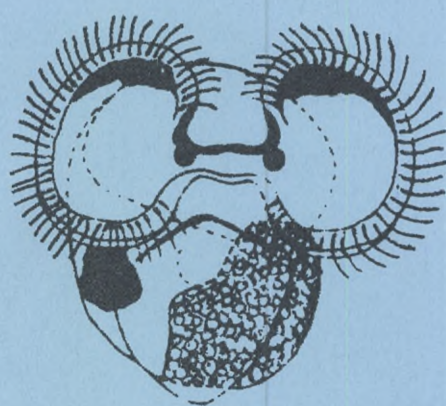
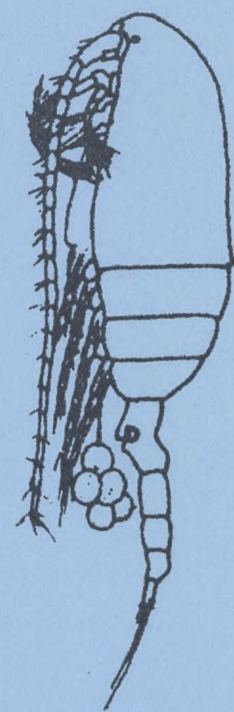






MEDDELANDE från
HAVSFISKELABORATORIET · LYSEKIL

nr 182

Results from the Swedish participants in the "Joint zooplankton biomass investigation" in the Baltic proper in 1974

by

Lars Hernroth and Ulf Persson

April, 1975

ERRATA

Due to misunderstanding it was written in Meddelande nr 179 that chlorophyll measurements in the Åland Sea were performed by G Brattberg. In reality they were carried out by G Engström, University of Uppsala.

CONTENTS

INTRODUCTION

At the Second Baltic Symposium on Marine Biology in Stockholm in 1971, it was agreed to form six working-groups representing meiofauna, sediments, phytal, primary production, bottom fauna and zooplankton resp.

One of the aims of the working-groups was to try to standardize both methods and equipments used in the Baltic marine research. In the autumn of 1973, the working-group of zooplankton had reached agreement on most methodological questions and a manual on zooplankton and ichthyoplankton methods was prepared. This manual was published in October 1974 (Ackefors et. al. 1974).

At the meeting of the working-group in Gdynia, Poland in October 1973, a proposal was made by the Polish participants to join our efforts in order to obtain a better geographical and seasonal covering of our research in the Baltic. As a first task, a study on the zooplankton biomass was proposed. The reason for chosing the biomass was simply that agreement had been reached on both gears and methods for this particular task.

The Polish proposal was discussed and later on adopted and it was decided to work on a "Joint zooplankton biomass investigation" during 1974.

ACKNOWLEDGEMENTS

The authors wish to thank the crew onboard R/V Eystrasalt for their kind co-operation during the three cruises. We also want to thank miss Marianne Martinsson for helping us with the drawings and Dr. Hans Ackefors for his critical examination of the manuscript.

MATERIAL AND METHODS

The aim of the "Joint zooplankton biomass investigation" was to get as many countries as possible to concentrate during one year on zooplankton sampling for biomass estimation. If possible, the sampling should be carried out during the months of March, May, August and November. The Baltic proper was to be divided into several sub-areas and each participating country should be responsible for one such sub-area (fig. 1). All participants were to use oblique hauls with the Bongo-net (300 µ and 500 µ) at a ship-speed of 3.5 knots. The net should be lowered at the speed of 50 meter wire/minute and brought back at 20 m/min. Each net should have a flow-meter (General Oceanics). All samples should be stored for one month and then analysed according to the displacement volume technique. A rough analysis of the species composition of each sample was recommended in order to establish the dominating species. To check the occurrence of smaller organisms like rotifers, copepodites and nauplii, a vertical haul with a UNESCO WP II-net of 100 µ should be made in addition to the Bongo-haul. All fish-larvae or a subsample of at least 100 specimens and 300 eggs per species and season were to be measured. In case of polymodal length frequencies the number of larvae measured should be at least n = 100 x number of modes. In addition to the biological investigations ordinary hydrographical parameters should be measured.

The Swedish participation in this program consisted of three expeditions: May 6th - 17th, July 31st - August 5th and September 30th - October 15th. The area visited is illustrated in fig. 1. The hauls were made as close to the center of each square as possible.

The original intensions of the joint investigation were fulfilled with the following exceptions: since the depth-recorder could only be checked after each haul and due to lack of experience with the Bongo-net a large amount of cautiousness was taken during the hauls. This sometimes resulted in rather shallow hauls in order to avoid loosing the gear by hitting the bottom. Despite this, the bottom was hit twice and on the second occasion the flow-meters were lost. From that date (31/7) and on, the value given for the amount of water strained is equal to the theoretical. The fish-larvae have not been identified to species, only to clupeid-larvae and "others". The fish-eggs have merely been counted.

RESULTS

Hydrography:

The surface temperature in May showed for the investigated area a mean of 4.9°C. The south-eastern section of the area was somewhat colder (4.0 - 4.8°C) than the western (5.0 - 5.6°C). The vertical profiles showed slightly decreasing temperatures down to the secondary halocline (60 - 80 m.). In August the mean surface temperature was 14.5°C but great variations occurred. The two most northern stations (P 17 and O 18) were considerably colder, 10.1 and 13.6°C resp. At most stations the thermocline was located between 15 - 30 meters depth. In October the south-eastern section of the area was relatively warm (9.8 - 10.3°C) compared to the mean surface temperature of 8.7°C, the central section showed values close to the mean, while the stations L 15 and P 17 close to the Swedish coast were considerably colder than the mean. No pronounced thermocline was found in October. The surface salinity showed rather small variations throughout the investigation. The mean value for May was 7.4 °/oo, for August 7.2 °/oo and for October 7.6 °/oo. A secondary halocline with a salinity of 10 - 11 °/oo was generally found between 60 - 80 meters depth.

Zooplankton:

As is evident from fig. 2 and table 4, the biomass of zooplankton varied considerably during the cruise in May. The range was 0.5 - 4.3 ml · 100 m^{-3} with the lowest values found at stations M 15 and N 18 and the highest at station L 16. The mean value for all 10 stations was 1.9 ml · 100 m^{-3}. The dominating species were at all stations Acartia sp. and Evadne nordmanni. Other important species were: Fritillaria borealis at stations N 18, L 18, M 17, L 17 and L 16, Temora longicornis at stations O 18, N 18, L 18, M 17 and L 17, Centropages hamatus at stations N 18, M 17 and L 17, Pseudocalanus m. elongatus at stations O 18, L 18 and L 16. Eurytemora sp. was present at the coastal stations P 17, L 15 and M 15.
During the cruise in July-August, fig. 3 and table 5, the increase in biomass was obvious. The mean value for 11 stations was 9.1 ml · 100 m^{-3} with a range of 4.6 - 20.7 ml · 100 m^{-3}. The difference between the stations was however not as great as it was in May.
The qualitative analysis of the samples showed that Acartia sp. remained the most important species but at most stations, Temora longicornis, Centropages hamatus and Pseudocalanus m. elongatus were about as numerous as Acartia sp. At station O 18 the sample was completely dominated by Pseudocalanus m. elongatus. The abundance of Evadne nordmanni and Fritillaria borealis was sharply decreased in August. Instead, two other species began to appear, namely Bosmina cor. maritima and Podon intermedius.
In September-October, fig. 4 and table 6, the mean biomass value was 4.9 ml · 100 m^{-3}. This was only about 50 % of the mean value in August. A great variation between the different stations occurred and the range was as wide as 0.4 - 10.8 ml · 100 m^{-3}. The maximum value was found at station O 18 and the minimum at station L 18. At most stations, Evadne nordmanni and Acartia sp. were the dominating species, closely followed by Temora longicornis. At stations O 18, M 18 and M 17 however, the largest contribution to the biomass value was made by Pseudocalanus m. elongatus. It is interesting to note, that the high abundance of P. m. elongatus coincides with the highest biomass values of October. The abundance of Aurelia aurita was very high in October. Except for station P 17, A. aurita

was found at all stations in numbers from 1 - 22 per haul. The size-range of the medusae was 5 - 20 cm in diameter with a mean of 10.8 cm. It must be pointed out that all medusae were removed from the samples before the biomass analysis was made.

According to the original intensions of the "Joint Program", vertical hauls from bottom to surface with a UNESCO WP-II 90 µ-net were carried out. In May, the mean biomass value from 7 vertical hauls was 0.230 ml · m^{-3} with a range of 0.100 - 0.444 ml · m^{-3}. The dominating groups were nauplii and young copepodite stages of Pseudocalanus m. elongatus and Acartia sp. and rotifers of Synchaeta sp. In July-August, the mean biomass value from 7 vertical hauls was 0.497 ml · m^{-3} with a range of 0.160 - 1.000 ml · m^{-3}. The samples were dominated by copepodites of Pseudocalanus m. elongatus and Temora longicornis but also of Acartia sp. and Eurytemora sp. The mean biomass value from 6 hauls in September-October was 0.235 ml · m^{-3} with a range of 0.104 - 0.333 ml m^{-3}. Young copepodites of particularly Pseudocalanus m. elongatus dominated the samples but Temora longicornis and Centropages hamatus were also present.

Ichthyoplankton:

Prior to the analysis of the zooplankton biomass, all fish-eggs and larvae were removed from the samples. The number of eggs was merely counted while the larvae were counted and determined into two groups, clupeid-larvae and "others". The distribution of eggs and larvae is evident in figs, 5 - 10 and in tables 1 - 3. The 300 and the 500 µ-nets have been analysed separately in order to discover any disparity.

In May, the mean number of larvae per 100 m^3 in the 300 and 500 µ-nets was 0.9 and 0.5 resp. (figs. 5 - 6). Most larvae were found in the southern part of the investigated area. Clupeid-larvae only appeared at station L 18. Fish-eggs were only found at stations M 16 and O 18. In August, the number of eggs and larvae had sharply increased and the mean number of larvae and eggs was now 12.7 and 3.5 in the 300 µ-net and 13.6 and 2.4 in the 500 µ-net (figs. 7 - 8). Both clupeid and "cther" larvae were found at all stations but a slight concentration of clupeid-larvae to the south-western area was noticed. The fish-eggs were mainly found at stations M 18, N 18 and O 18.

In October, no eggs were found and only one single larvae occurred at station L 15 (figs. 9 - 10).

DISCUSSION

Hydrography:

Looking at the hydrography during the three cruises, one can reach the conclusion that the investigated area is rather uniform and that the observed differences are merely assigned to seasonal changes. This homogeneity is further illustrated by the species composition at the different stations (tables 4 - 6). On most occassions, Acartia sp., Temora longicornis and Pseudocalanus m. elongatus have been the dominating copepods. Among the cladocerans Evadne nordmanni have dominated in May and October while Podon intermedius was rather abundant in August.

Composition of species:

The composition of species in the different samples is in good accordance with the authors' earlier experience (Ackefors & Hernroth, 1970 a, b, 1971, 1973). One important group is missing however, viz. the rotifers. Due to the large meshes in the net (300 µ), this group of organisms, which at times can make a rather important contribution to the biomass, will pass through the net.

Relative importance of occurring species:

Looking at the relative importance of the occurring species, it is rather surprising to find the great dominance of Acartia sp. and Evadne nordmanni in comparison to Pseudocalanus m. elongatus and Temora longicornis. Earlier investigations in off-shore waters (Ackefors & Hernroth, 1970 a, b, 1971, 1973) have namely shown that the largest contributions to the biomass values are most of the times made by P. m. elongatus and T. longicornis. However, these investigations were carried out as vertical hauls. The vertical hauls made in connection with the Bongo-hauls during this investigation showed a relative importance of the occurring species that to a large extent coincides with the results from previous years but differs quite a lot from the results from the Bongo-net. In May for instance, the dominating groups were nauplii and young copepodite stages of Pseudocalanus m. elongatus and Acartia sp., and rotifers of Synchaeta sp. These size-fractions were totaly absent in the 300 µ Bongo-net. In August, the most important species and their relative importance were rather similar in the oblique and the vertical hauls. As could be expected however, the number of younger copepodites (C. II-IV) caught was much greater in the 90 µ than in the 300 µ-net. Nauplii were only found in the 90 µ vertical haul.

The oblique hauls made in October showed a high abundance of Evadne nordmanni, Acartia sp., Temora longicornis and Pseudocalanus m. elongatus. The vertical hauls with the 90 µ-net dit not show this dominance of Evadne nordmanni and Acartia sp. but instead a high abundance of young copepodites of Pseudocalanus m. elongatus and Temora longicornis. Rotifers and nauplii were found in rather low numbers and only in the 90 µ-net.

Factors influencing qualitatively:

Looking at the results from the qualitative analysis, the differences in both species and size composition is obvious. The reason for these differences is probably due to the following factors:
The vertical hauls were made from the bottom to the surface, viz, the whole water-column was sampled and hopefully all of the species present were sampled. The oblique hauls on the other hand, did not always perform an ideal oblique curve from surface to bottom and back to the surface. Due to our cautiousness the hauls were sometimes rather shallow which in turn may have caused a certain disprcportion of the sampling in favour of the upper water layers. This is probably one of the reasons why such surface-loving species as Evadne nordmanni and Acartia sp. dominated the oblique hauls.
The other factor that may have influenced the results is the difference in mesh-size. The Bongo-net with it´s 300 µ meshes did only sample older copepodites such as C. V-VI and large cladocerans like Evadne nordmanni while the 90 µ-net was able to catch the smaller copepodites, the nauplii and the rotifers as well. This fact is without any doubt of the utmost importance when discussing the relative important of the zooplankton species. According to the authors´ earlier experience of the zooplankton fauna in the Baltic proper, the younger copepodite stages are far more abundant than the older ones. A 300 µ-net will therefore reflect only a certain fraction of the fauna excluding important groups like the above mentioned young copepodite stages, the nauplii, the rotifers and certain cladocerans.

Factors influencing quantitatively:

A discussion of the biomass values obtained, must naturally consider the same sources of influence as were discussed in connection with the qualitative analysis. The fact that the oblique hauls did not always cover the whole water column from bottom to surface may have influenced the biomass values in the following way: Hauls that do not reach the depths close to or below the halocline, will problably miss the larger part of the Pseudocalanus population which has a preference for the deeper layers. This is particularly true for the older copepodite stages of Pseudocalanus m. elongatus

(Ackefors & Hernroth,1972). The biomass values will in case of a shallow haul be particularly biased since P. m. elongatus is the biggest copepod occurring regularly in the Baltic proper and thus of great importance to the biomass. A good illustration of this is the fact that high biomass values in this investigation often coincided with high Psedocalanus abundance. The influence of the 300 µ-meshes in relation to those of 90 µ is a wider problem than that of the oblique vs. vertical hauls. Factors like clogging, size-fractions caught and relative abundance of the different size-fractions may influence the results both separately and jointly.

The clogging-effect is supposedly of negliable importance in the 300 µ-net. This is also verified in the flow-meter recordings. A 90 µ-net on the other hand, is much more sensible in this way, both to a high abundance of phytoplankton and zooplankton. Depending on the season, the efficiency of the 90 µ-net will therefore differ to a much larger extent than the 300 µ-net.

The influence on the biomass values caused by the lack of smaller organisms in the 300 µ samples is probably of great importance. As was pointed out earlier, the Bongo-samples contained mostly older copepodites and larger cladocerans while the 90 µ-net contained a wider range including all the stages from young nauplii to adult copepods. In view of the relative importance of the different size-fractions, both from previous investigations in the area and from vertical hauls during this program, the 300 µ-net must be considered much too coarse to sample the zooplankton of the Baltic proper. Since the main part of the zooplankton-biomass consists of copepodite stages I-V, seasonally also rotifers (Synchaeta sp.) and smaller cladocerans (Bosmina cor. maritima), the 300 µ-net is bound to give an incorrect picture of the actual biomass. The results of the vertical hauls with the WP-II 90 µ-net made in connection with the oblique hauls and the results from previous years, indicate that the Bongo 300 µ-net have only caught about 20 % of the zooplankton biomass caught in vertical hauls with a net of 90 µ.

Comparison with the results from other investigations:

A comparison between the results from this investigation and those obtained by other authors is hard to make since very few investigations were carried out in the same way as this was. Two investigations however, have in recent years been made with the same gear and method. One was carried out every four weeks during 1970-1971 in the Kiel Bay (Müller, 1973). The monthly mean values in this investigation were in general higher, but just as was found in our investigation, great differences occurred between

the stations within the investigated area. The dominating groups in the Kiel Bay were copepods of the same species as were found in the mid-western Baltic, but in addition to the copepods Müller also found Isopods, Amphipods, Cumacees, Mysidacees and Chaetognaths. Due to their large individual volume, the presence of specimens from these groups may explain some of the differences in biomass-value between the two investigations.
The other authors having used the same methods were the Polish participants in this "Joint Zooplankton Biomass Investigation" (Grimm & Siudzinski, 1974). Their preliminary results cover a cruise in the south-eastern Baltic proper during February 20 - March 4, 1974. The mean biomass-value from this cruise was 4.1 ml • 100 m^{-3} (1.3 - 7.2). This value is twice as high as that obtained by the Swedish participant in May 1974. The main species were Pseudocalanus m. elongatus, Temora longicornis and Acartia longiremis with P. m. elongatus constituting about 90 % of the biomass in the deep waters.

Several other investigations on the zooplankton biomass of the Baltic proper have been made but most of these were made with vertical hauls. The differences between the results from the various investigations are rather large, partly due to the great variation in gears and mesh-sizes used.

A Polish investigation in the southern and central-southern Baltic proper in 1969 (Mankowski, 1970) reported the following mean-values for the biomass: February 8.5 $g \cdot m^{-2}$, March 7.6 $g \cdot m^{-2}$, May-June 18.0 $g \cdot m^{-2}$, July 21.1 $g \cdot m^{-2}$, August 27.6 $g \cdot m^{-2}$, September 21.7 $g \cdot m^{-2}$ and November 13.2 $g \cdot m^{-2}$.

Another investigation during the same year was carried out by the Institut für Meereskunde in Warnemünde (Arndt & Stein, 1973). Their biomass values from the Arkona- and Bornholm Sea were: March-April 10-20 $g \cdot m^{-2}$, October 30-40 $g \cdot m^{-2}$ and December 25-30 $g \cdot m^{-2}$. The values from the mid-western Gotland Sea were considerably less.

The same Institute has also presented values from 1971 and 1972 in the eastern Gotland Sea (Schulz & Kaiser, 1974). Presented as $ml \cdot m^{-3}$ the mean biomass in 1971 was: March 0.168, May 0.198 and October 0.275. The corresponding values during 1972 were: April 0.100, May 0.139 and August 0.97 $ml \cdot m^{-3}$. Assuming a mean depth of 100 meters the biomass in $g \cdot m^{-2}$ would approximately be: March-April 10-17 $g \cdot m^{-2}$, May 14-20 $g \cdot m^{-2}$, August 97 $g \cdot m^{-2}$ and October 28 $g \cdot m^{-2}$.

A long-term mean of the zooplankton biomass (1949-1960) from the central Baltic proper have been presented by Nikolaev & Krievs (1961). Their mean values for the layer 0-100 m. were: February 54 $mg \cdot m^{-3}$, May 53 $mg \cdot m^{-3}$, August 182 $mg \cdot m^{-3}$ and October 123 $mg \cdot m^{-3}$. This corresponds to the following values in $g \cdot m^{-2}$: February 5.4, May 5.3, August 18.2 and October 12.3 $g \cdot m^{-2}$.

Finally, the results of our own vertical hauls made in connection with the Bongohauls shall be presented. The mean zooplankton biomass obtained in the vertical hauls with the UNESCO WP-II 90 µ-net was: May 18.8 $g \cdot m^{-2}$, July-August 37.8 $g \cdot m^{-2}$ and September-October 18.2 $g \cdot m^{-2}$.

SUMMARY:

Within the program "Joint Zooplankton Biomass Investigation" outlined by W.G. 6 of the Baltic Marine Biologists, the Institute of Marine Research in Lysekil has carried out three expeditions (May, July-August and September-October) in the area between Gotland and the Swedish mainland. The samples were collected by oblique hauls with a Bongo-net of 300 µ and 500 µ. In addition, vertical hauls with a UNESCO WP-II 90 µ-net were made at most stations. The mean biomass value in May was 1.9 ml · 100 m^{-3}, in July-August 9.1 ml · 100 m^{-3} and in September-October 4.9 ml · 100 m^{-3}. The dominating species were Acartia sp., Temora longicornis, Pseudocalanus m. elongatus and Evadne nordmanni. The biomass values obtained in the vertical hauls with the WP-II 90 µ-net were more than 500 % higher than those from the Bongo 300 µ-net. The samples from the Bongo-net contained mostly larger specimens like copepods of C. V-VI and cladocerans like Evadne nordmanni while the samples from the 90 µ-net were dominated by smaller specimens like copepods of C. I-III, nauplii and rotifers.

REFERENCES

ACKEFORS, H., & HERNROTH, L., 1970 a: Seasonal and vertical distribution of zooplankton off the coast in the Baltic proper in 1968. - Medd. Havsfiskelab., Lysekil, nr 76, 13 pp., 125 figs., 6 tables (mimeo.).

ACKEFORS, H., & HERNROTH, L., 1970 b: Ecological zooplankton studies in the Baltic proper in connection with oceanographic studies in 1969 during the Baltic Year. - Medd. Havsfiskelab., Lysekil, nr 89, 9 pp., 61 figs., 4 tables (mimeo.).

ACKEFORS, H., & HERNROTH, L., 1971: Seasonal and vertical distribution of zooplankton off the coast in the Baltic proper in 1970. - Medd. Havsfiskelab., Lysekil, nr 113, 11 pp., 113 figs., 6 tables (mimeo.).

ACKEFORS, H., & HERNROTH, L., 1972: The Zooplankton Fauna of the Baltic proper. - Zool. Revy, 34 (1972), 6-31 (in Swedish).

ACKEFORS, H., & HERNROTH, L., 1973: Changes in the productivity and distribution of zooplankton off the coast in the Baltic proper in 1971. - Medd. Havsfiskelab., Lysekil, nr 147, 17 pp., 65 figs., 5 tables (mimeo.).

ACKEFORS, H., et. al., 1974: Manual for zooplankton - ichthyoplankton investigations in the Baltic area. - Medd. Havsfiskelab., Lysekil, nr 171, 8 pp., 8 figs. (mimeo.).

ARNDT, E.A., & STEIN, H., 1973: Biologische Untersuchungen während des Internationalen Ostseejahres 1969-70, III. Beiträge zur Meereskunde, H. 32 (1973), 33-55.

GRIMM, S.K., & SIUDZINSKI, K.W., 1974: Preliminary results of survey on plankton biomass distribution in southeastern Baltic February 20 - March 4, 1974. - Meeting of Committee of Baltic Marine Biologists, Kiel, 1974 (mimeo.).

MANKOWSKI, W., 1970: Polish Investigations on Zooplankton in the Southern and Central Baltic in 1969. - ICES, C.M. 1970/L:12, Plankton Committee (mimeo.).

MÜLLER, A., 1973: Der Jahresgang des Zooplanktons in der Kieler Bucht I. Das Verdrängungsvolumen. - Kieler Meeresforsch. 29, 23-33.

NIKOLAEV, J.J., & KRIEVS, H.K., 1961: Quantitative characteristics of the zooplankton in The Central Baltic and The Gulf of Riga. - Ann. Biol., 17 (1961), 92-93.

SCHULZ, S., & KAISER, W., 1974: Produktionsbiologische Untersuchungen in der Ostsee 1972. - Fischereiforsch., Rostock 12 (1974), 1.

Joint zooplankton biomass investigation 1974
Stations visited by the swedish participants

Fig. 1

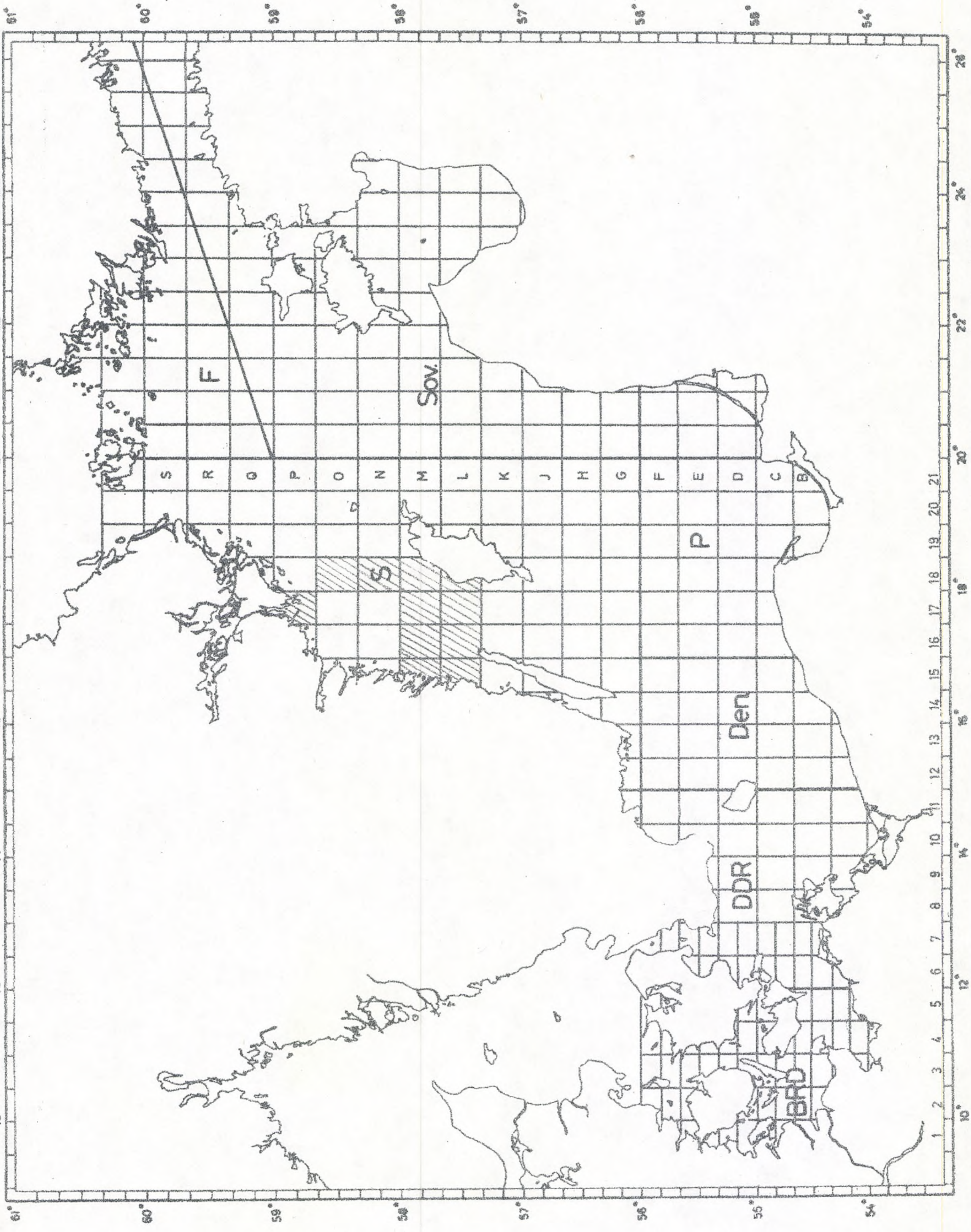


Fig. 2

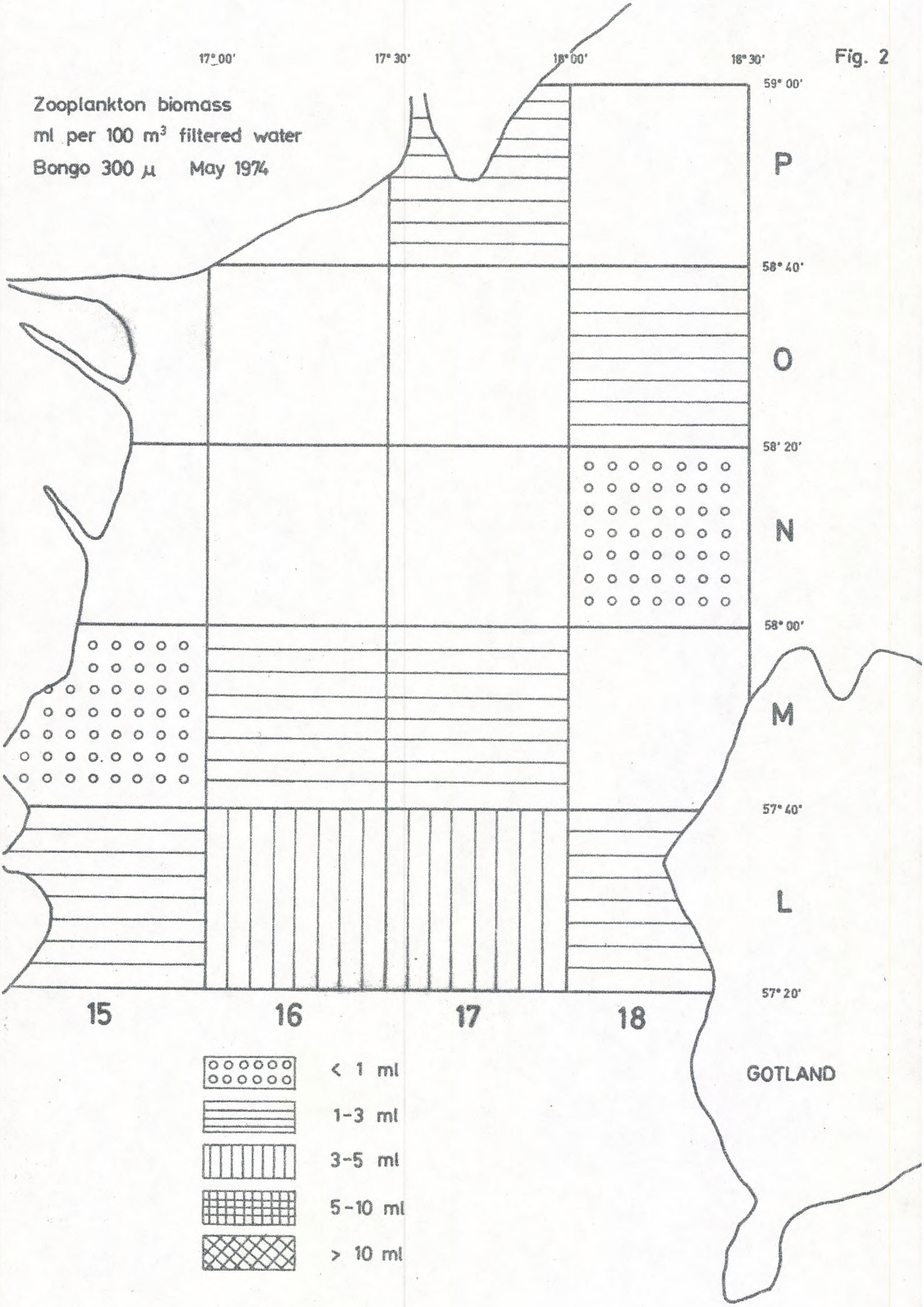

Zooplankton biomass
ml per 100 m³ filtered water
Bongo 300 µ May 1974
17° 00'
17° 30'
18° 00'
18° 30'
59° 00'
58° 40'
58° 20'
58° 00'
57° 40'
57° 20'
P
O
N
M
L
15
16
17
18
GOTLAND
< 1 ml
1-3 ml
3-5 ml
5-10 ml
> 10 ml

Fig. 3

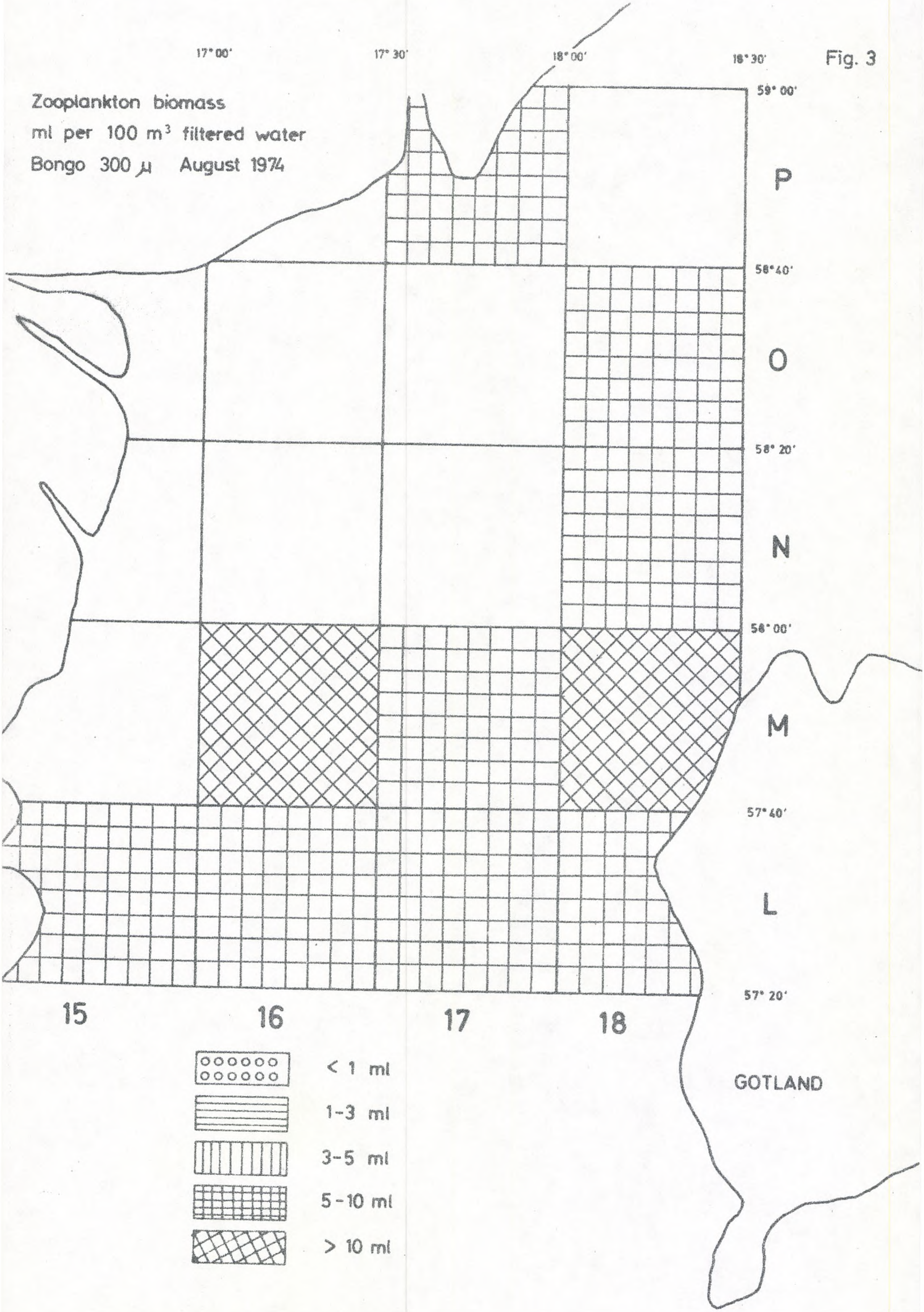
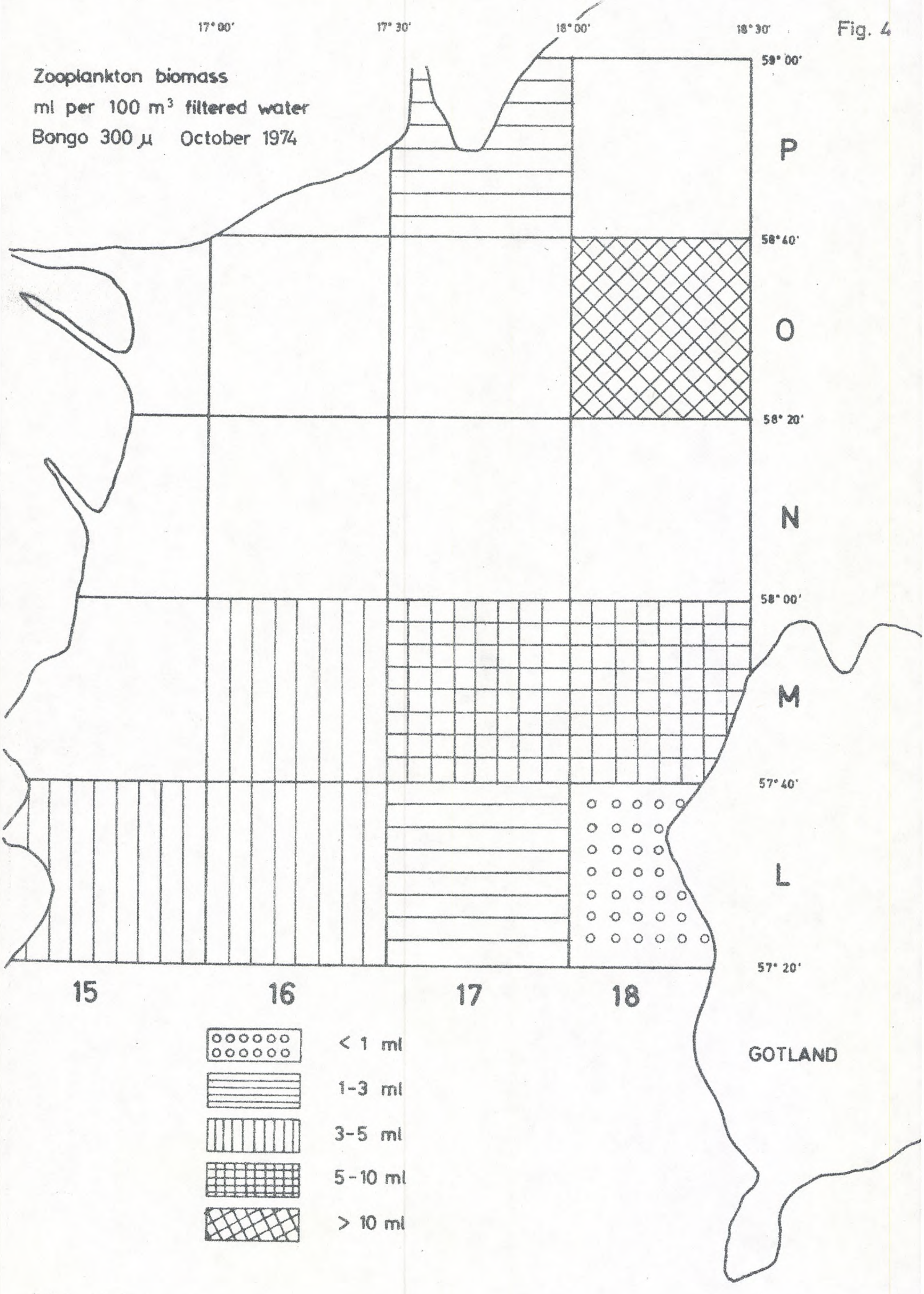

Zooplankton biomass
ml per 100 m³ filtered water
Bongo 300 µ August 1974
17° 00'
17° 30'
18° 00'
18° 30'
59° 00'
58° 40'
58° 20'
58° 00'
57° 40'
57° 20'
P
O
N
M
L
15
16
17
18
GOTLAND
< 1 ml
1-3 ml
3-5 ml
5-10 ml
> 10 ml

Fig. 4


Zooplankton biomass
ml per 100 m³ filtered water
Bongo 300 µ October 1974
17° 00'
17° 30'
18° 00'
18° 30'
59° 00'
58° 40'
58° 20'
58° 00'
57° 40'
57° 20'
P
O
N
M
L
15
16
17
18
< 1 ml
1-3 ml
3-5 ml
5-10 ml
> 10 ml
GOTLAND

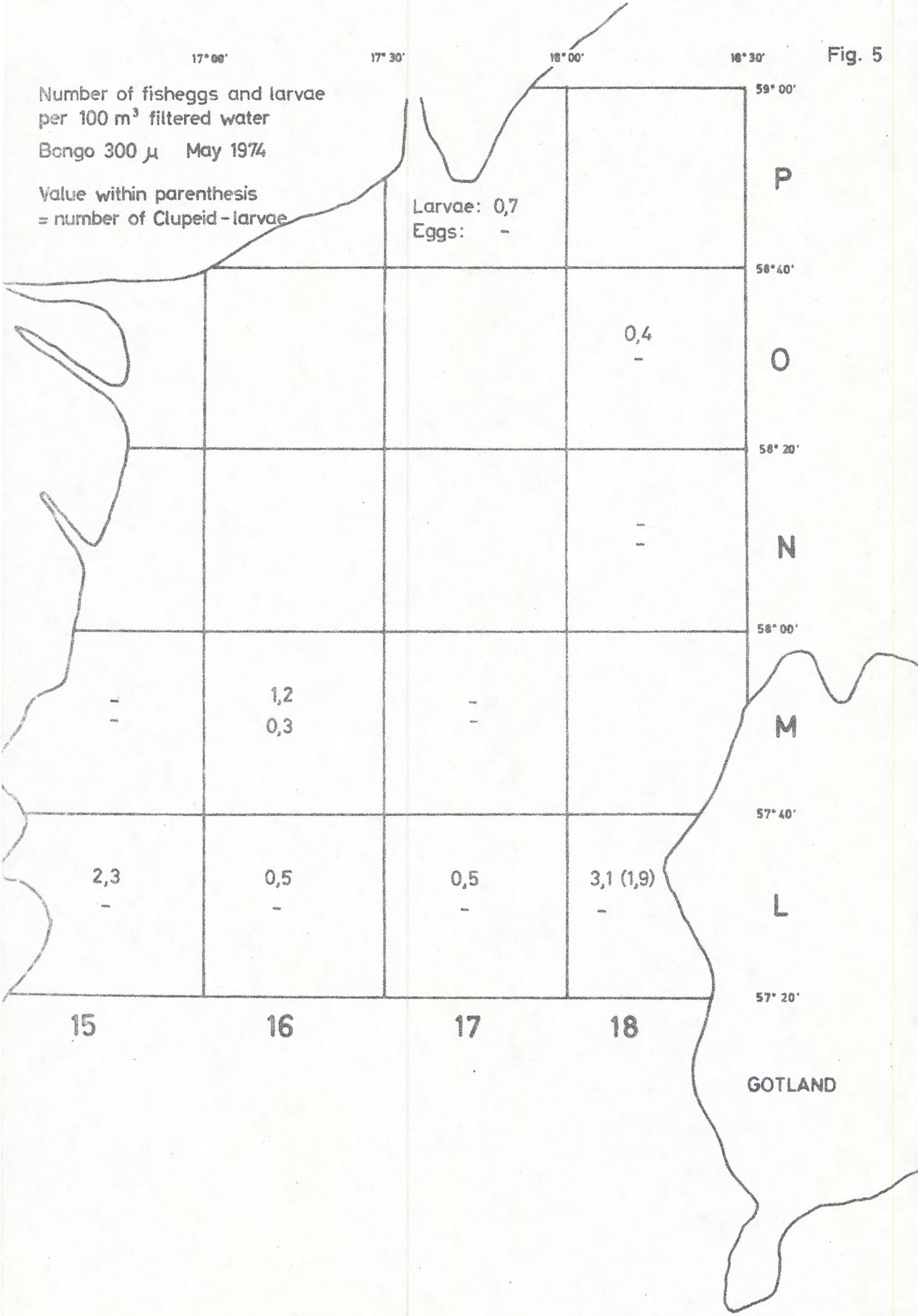
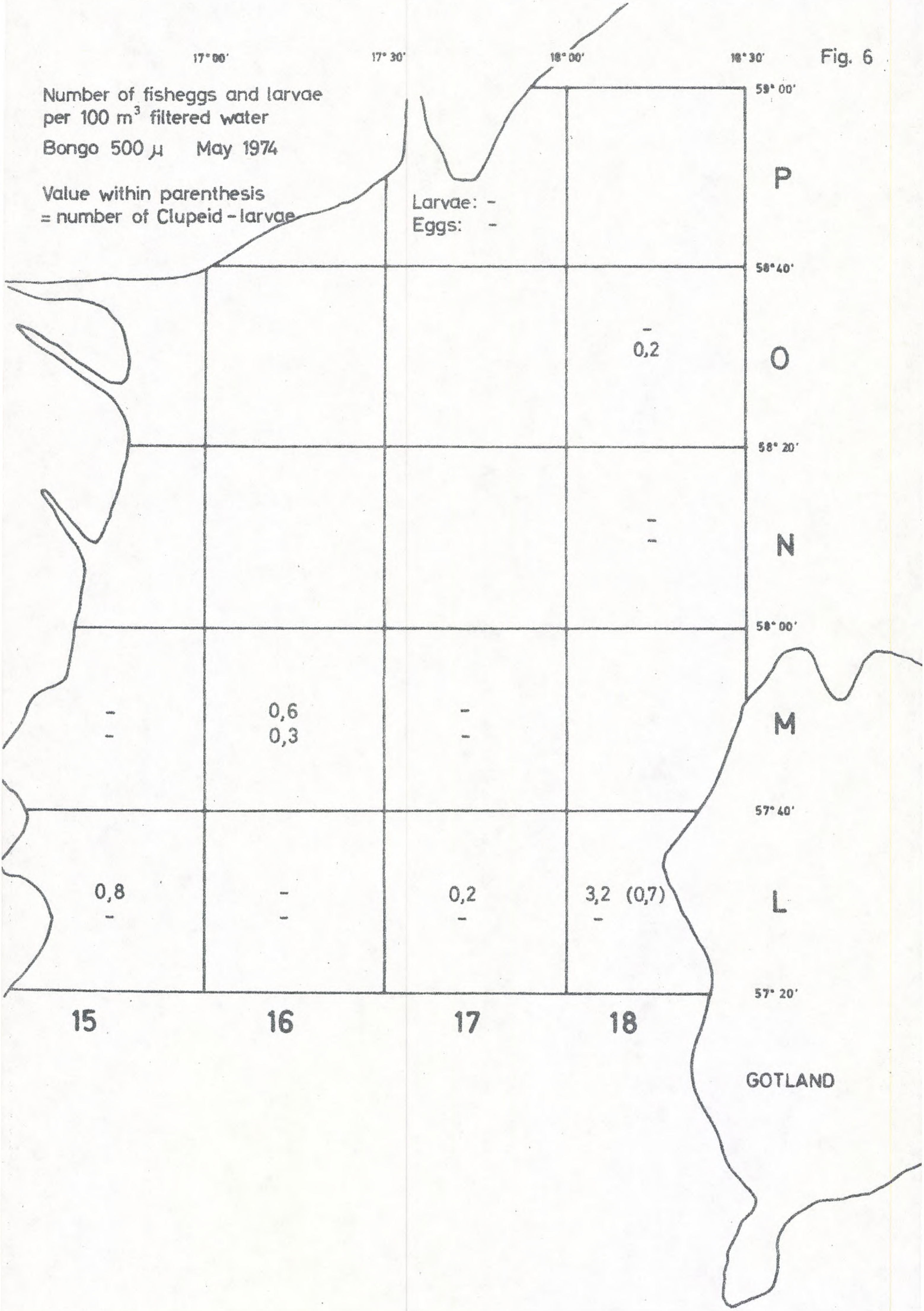


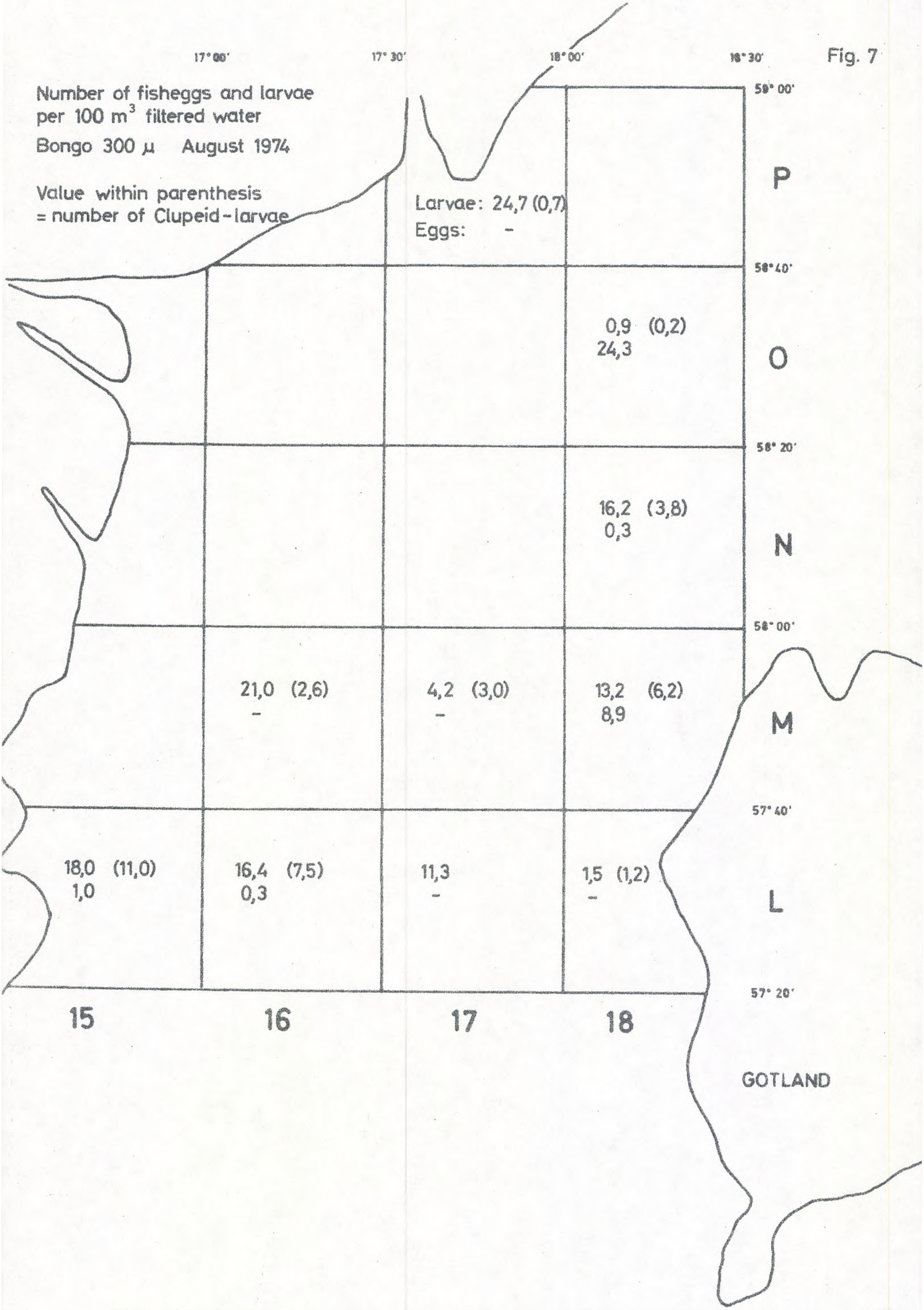
Fig. 5
Number of fisheggs and larvae per 100 m³ filtered water
Bongo 300 µ May 1974
Value within parenthesis = number of Clupeid-larvae
17° 00'
17° 30'
18° 00'
18° 30'
59° 00'
58° 40'
58° 20'
58° 00'
57° 40'
57° 20'
P
O
N
M
L
Larvae: 0,7
Eggs: –
0,4
–
–
–
–
–
1,2
0,3
–
–
2,3
–
0,5
–
0,5
–
3,1 (1,9)
–
15
16
17
18
GOTLAND

Fig. 6



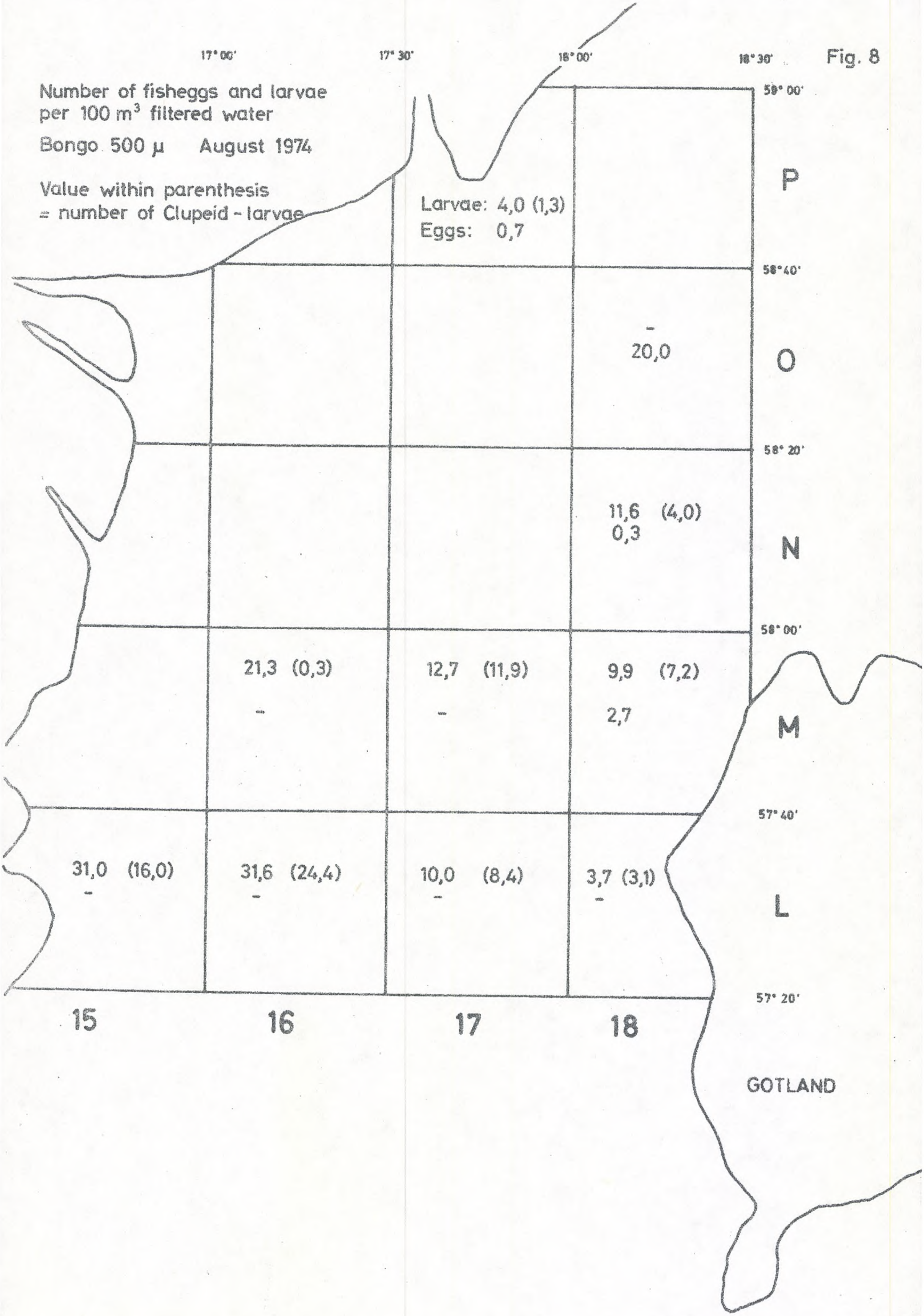
Number of fisheggs and larvae
per 100 m³ filtered water
Bongo 500 µ May 1974
Value within parenthesis
= number of Clupeid - larvae
17° 00'
17° 30'
18° 00'
18° 30'
59° 00'
58° 40'
58° 20'
58° 00'
57° 40'
57° 20'
Larvae: -
Eggs: -
P
O
N
M
L
-
0,2
-
-
-
-
0,6
0,3
-
-
0,8
-
-
-
0,2
-
3,2 (0,7)
-
15
16
17
18
GOTLAND

Fig. 7



17° 00'
17° 30'
18° 00'
18° 30'
Number of fisheggs and larvae
per 100 m³ filtered water
Bongo 300 µ August 1974
Value within parenthesis
= number of Clupeid-larvae
Larvae: 24,7 (0,7)
Eggs: -
59° 00'
P
58° 40'
0,9 (0,2)
24,3
O
58° 20'
16,2 (3,8)
0,3
N
58° 00'
21,0 (2,6)
-
4,2 (3,0)
-
13,2 (6,2)
8,9
M
57° 40'
18,0 (11,0)
1,0
16,4 (7,5)
0,3
11,3
-
1,5 (1,2)
-
L
57° 20'
15
16
17
18
GOTLAND

Fig. 8



Number of fisheggs and larvae per 100 m³ filtered water
Bongo 500 µ August 1974
Value within parenthesis = number of Clupeid - larvae
17° 00'
17° 30'
18° 00'
18° 30'
59° 00'
58° 40'
58° 20'
58° 00'
57° 40'
57° 20'
P
O
N
M
L
15
16
17
18
Larvae: 4,0 (1,3)
Eggs: 0,7
-
20,0
11,6 (4,0)
0,3
21,3 (0,3)
-
12,7 (11,9)
-
9,9 (7,2)
2,7
31,0 (16,0)
-
31,6 (24,4)
-
10,0 (8,4)
-
3,7 (3,1)
-
GOTLAND

Fig. 9

Number of fisheggs and larvae per 100 m^3 filtered water

Bongo 300 µ October 1974

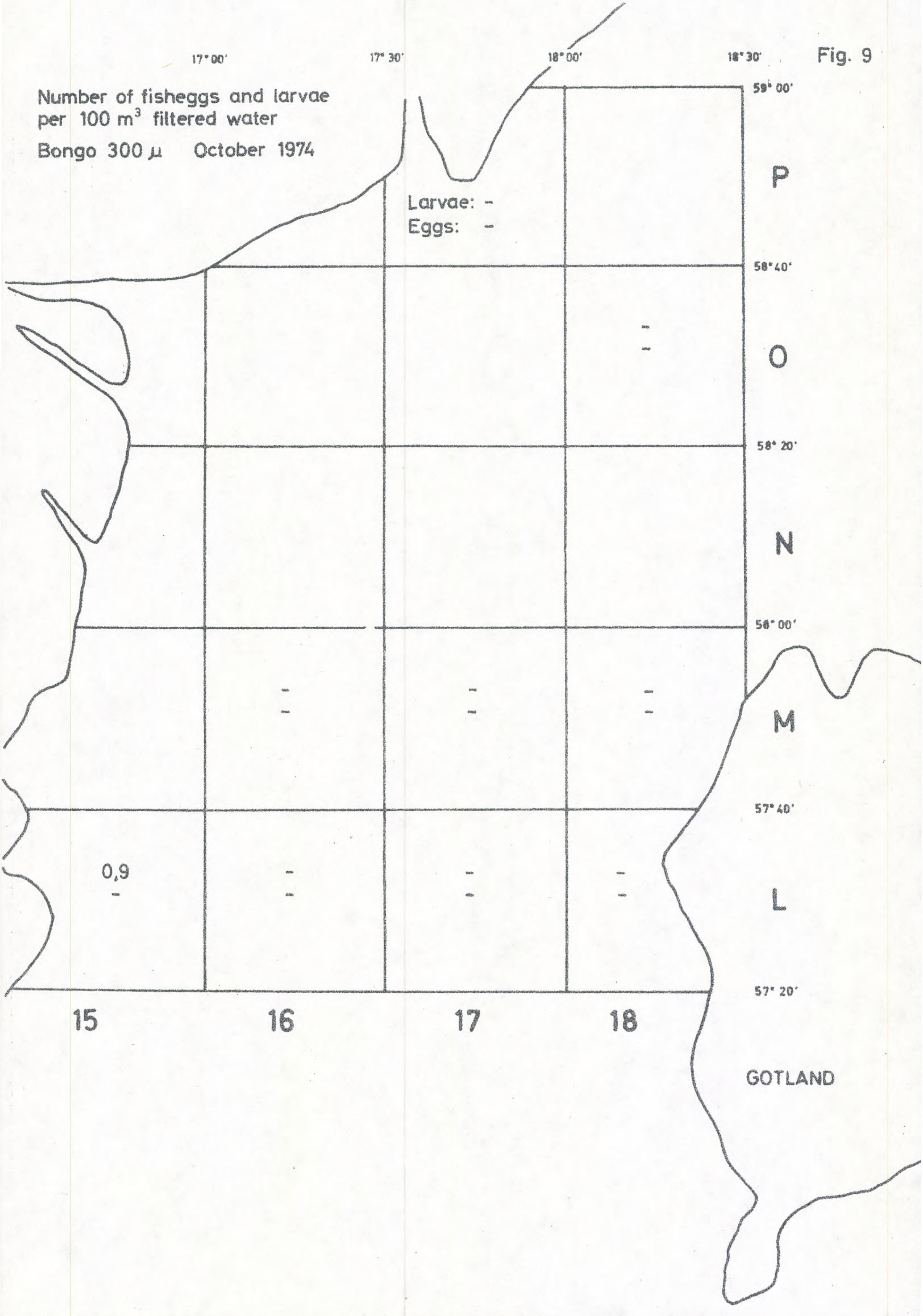


Fig. 10

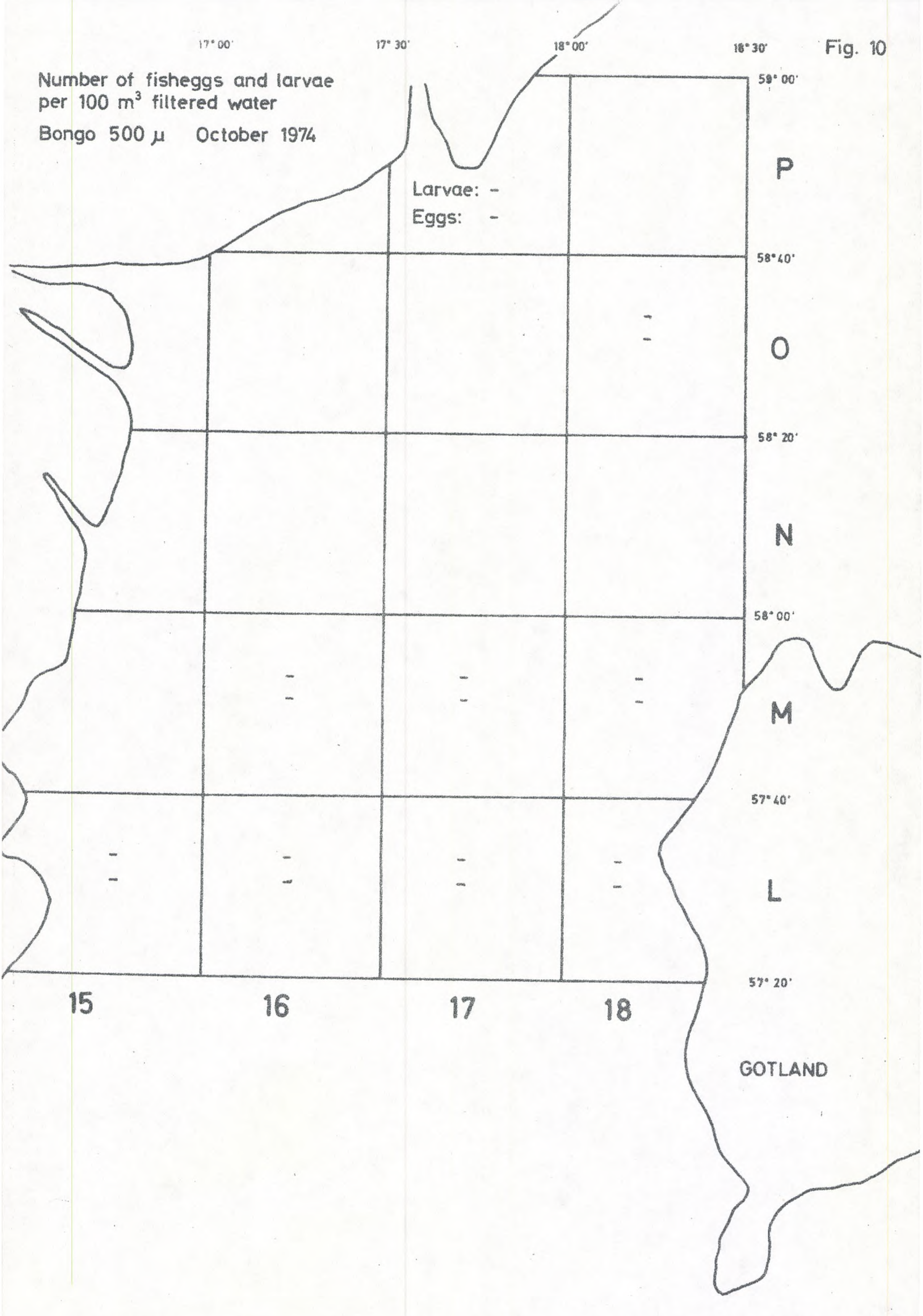

Number of fisheggs and larvae per 100 m³ filtered water
Bongo 500 µ October 1974
17° 00'
17° 30'
18° 00'
18° 30'
59° 00'
58° 40'
58° 20'
58° 00'
57° 40'
57° 20'
Larvae: -
Eggs: -
P
O
N
M
L
15
16
17
18
GOTLAND

Table 1

Program: Joint zooplankton biomass investigation

Vessel: R/V Eystrasalt   **Country:** Sweden   **Cruise Period:** 6/5 - 17/5 1974   **Gear:** Bongo-net

Mesh size: 300 and 500 µ

SAMPLE No	STATION No	STATION POSITION (see map)	STATION DEPTH (m)	STATION DATE	TOW Start Time (GMT)	TOW Duration (min)	TOW Speed (knots)	TOW Water Strnd (m^3)	TOW Depth (m)	WIND Knots	WIND DRCTN	WAVE HGT (m)	CLOUDE Cover (8 ths)	Secchi depth (m)	REMARKS
2	P17		60	13/5	1630	6:30	3	147 148		5,8	-		1	-	1 larvae
4	O18		440	14/5	1030	26:00	3	550 555		9,7	NE		0	-	2 larvae 1 egg
6	N18		130	14/5	1415	14:00	3	365 363		9,7	NE		0	-	
-	M18		100	14/5	1645	-	3	-		9,7	NE		0	-	gear filled with mud
8	L18		100	15/5	0800	12:45	3	320 298		13,6	N		0	-	16 larvae 11 larvae
10	M17		95	15/5	1130	11:25	3	299 296		11,7	N		0	-	
12	L17		140	15/5	1230	14:20	3	408 407		11,7	N		0	-	2 larvae 1 larvae
14	L16		130	15/5	1400	14:20	3	373 368		11,7	N		0	-	2 larvae
16	L15		65	15/5	1530	4:15	3	128 125		11,7	N		0	-	2 larvae 1 larvae
18	M16		150	16/5	0830	12:00	3	343 -		11,7	NE		8	-	4 larvae, 1 egg 2 larvae, 1 egg
20	M15		48	16/5	0940	4:30	3	120 118		11,7	NE		8	-	

Table 2

Program: Joint zooplankton biomass investigation

Vessel: R/V Eystrasalt **Country:** Sweden **Cruise Period:** 31/7 - 5/8 1974 **Gear:** Bongo-net

Mesh size: 300 and 500 µ

SAMPLE No	STATION No	POSITION (see map)	DEPTH (m)	DATE	TOW Start Time (GMT)	Duration (min)	Speed (knots)	Water Strnd (m^3)	Depth (m)	WIND Knots	DRCTN	WAVE HGT (m)	CLOUDE Cover (8 ths)	Secchi depth (m)	REMARKS
1	P17		60	31/7	0900	5:30	3	152 151		9,7	W		1	8	36 larvae, 1 egg 6 larvae, 1 egg
3	O18		300	31/7	1205	19:00	3	444 442		15,6	SW		1	6	4 larvae. 107 eggs 88 eggs
5	N18		130	31/7	1520	14:30	3	376 376		15,6	SW		1	-	60 larvae, 1 egg 43 larvae, 1 egg
7	M18		100	31/7	1830	14:30	3	376 376		15,6	SW		1	-	49 larvae, 33 eggs 38 larvae, 10 eggs
9	L18		90	1/8	0640	12:30	3	324 324		9,7	WSW		1	5	5 larvae 12 larvae
11	M17		90	1/8	1045	10:00	3	259 259		9,7	SW		1	4,5	11 larvae 33 larvae
13	L17		110	1/8	1330	12:00	3	311 311		9,7	SW		1	-	35 larvae 31 larvae
15	L16		114	1/8	1430	14:00	3	363 363		9,7	SW		1	-	59 larvae, 1 egg 114 larvae
17	M16		140	2/8	1430	15:00	3	389 389		1,9	W		7	5	82 larvae 88 larvae
19	L15		74	5/8	1130	4:00	3	104 104		3,9	E		8	-	18 larvae, 1 egg 31 larvae
21	M16		60	5/8	1235	5:00	3	130 130		3,9	E		8	4,5	10 larvae 31 larvae

Table 3

Program: Joint zooplankton biomass investigation

Vessel: R/V Eystrasalt   Country: Sweden   Cruise Period: 30/9 - 15/10 1974   Gear: Bongo-net

Mesh size: 300 and 500 μ

SAMPLE	STATION				TOW					WIND					REMARKS
No	No	POSITION (see map)	DEPTH (m)	DATE	Start Time (GMT)	Dura-tion (min)	Speed (knots)	Water Strnd (m^3)	Depth (m)	Knots	DRCTN	WAVE HGT (m)	CLOUDE Cover (8 ths)	Secchi depth (m)	
2	D18		300	1/10	1040	17:15	3	445 445		1,9	-		1	15	
4	P17		60	1/10	1420	5.00	3	129 129		0	-		4	11	
6	M16		60	8/10	0940	5:40	3	146 146		11,7	E		7	11	
8	L15		74	8/10	1145	4:30	3	116 116		13,6	E		8	-	1 larvae
10	L16		114	12/10	1115	14:40	3	378 378		7,8	SW		-	-	
12	L17		110	12/10	1225	16:50	3	434 434		7,8	SW		-	-	
14	M18		100	12/10	1515	18:15	3	471 471		7,8	SW		-	-	
16	L18		90	14/10	0655	12:30	3	322 322		9,7	NE		8	9	
18	M17		90	15/10	1530	15:50	3	408 408		11,7	NNW		1	8	

Table 4

The biomass and relative abundance of zooplankton in samples taken by a Bongo-net 300 µ in the area between Gotland and the Swedish east-coast.

The samples were taken in May, 6-17, 1974.

Sample	No	FRCTN analysed	Biomass ml/tow	Biomass ml/m^3	Biomass ml/m^2	MAIN GROUPS OF ORGANISMS (rel. abundance)
P17	1	1/1	2	0.014		Acartia sp (+++), Evadne nordmanni (+++), Eurytemora sp (++)
O18	3	1/1	7	0.013		Pseudocalanus m. elongatus (+++), Evadne nordmanni (+++), Acartia sp (++), Temora longicornis (++)
N18	5	1/1	1.5	0.005		Acartia sp (+++), Evadne nordmanni (+++), Fritillaria borealis (+++), Centropages hamatus (++), Temora longicornis (++)
L18	7	1/1	6	0.019		Acartia sp (+++), Evadne nordmanni (+++), Fritillaria borealis (+++), Pseudocalanus m. elongatus (++), Temora longicornis (++)
M17	9	1/1	8	0.027		Acartia sp (+++), Evadne nordmanni (+++), Fritillaria borealis (+++), Centropages hamatus (++), Temora longicornis (++)
L17	11	1/1	12	0.030		Acartia sp (+++), Temora longicornis (+++), Evadne nordmanni (+++), Fritillaria borealis (+++), Centropages hamatus (++)
L16	13	1/1	16	0.043		Acartia sp (+++), Evadne nordmanni (+++), Fritillaria borealis (++), Pseudocalanus m. elongatus (++)
L15	15	1/1	1.5	0.012		Acartia sp (+++), Evadne nordmanni (+++), Eurytemora sp (++)
M16	17	1/1	8	0.024		Acartia sp (+++), Evadne nordmanni (+++)
M15	19	1/1	0.5	0.005		Acartia sp (+++), Evadne nordmanni (+++), Eurytemora sp (++)
Mean value:				0.019		
Range:			0.005 - 0.043			

Table 5

The biomass and relative abundance of zooplankton in samples taken by a Bongo-net 300 µ in the area between Gotland and the Swedish east-coast.

The samples were taken during the period July 31–August 5, 1974.

Sample	No	FRCTN analysed	Biomass ml/tow	Biomass ml/m^3	Biomass ml/m^2	MAIN GROUPS OF ORGANISMS (rel. abundance)
P17	1	1/1	10	0.065		Acartia sp (+++), Centropages hamatus (++)
O18	3	1/1	38	0.085		Pseudocalanus m. elongatus (+++)
N18	5	1/1	21	0.055		Pseudocalanus m. elongatus (+++), Acartia sp. (+++), Temora longicornis (+++), Centropages hamatus (++)
M18	7	1/1	78	0.207		Pseudocalanus m. elongatus (+++), Acartia spp (+++), Temora longicornis (+++), Centropages hamatus (+++)
L18	9	1/1	28	0.086		Acartia sp (+++), Centropages hamatus (+++), Temora longicornis (++), Pseudocalanus m. elongatus (++)
M17	11	1/1	18	0.069		Acartia sp (+++), Centropages hamatus (+++), Temora longicornis (++)
L17	13	1/1	26	0.083		Acartia sp (+++), Temora longicornis (+++), Centropages hamatus (++)
L16	15	1/1	33	0.090		Acartia sp (+++), Centropages hamatus (+++), Temora longicornis (++)
M16	17	1/1	54	0.138		Acartia sp (+++), Centropages hamatus (+++), Pseudocalanus m. elongatus (+++), Temora longicornis (++)
L15	19	1/1	8	0.077		Acartia sp (+++), Centropages hamatus (+++), Podon intermedius (+++), Bosmina cor. maritima (++)
M16	21	1/1	6	0.046		Acartia sp (+++), Centropages hamatus (+++), Podon intermedius (++), Bosmina cor. maritima (++)
Mean value:				0.091		
Range:			0.046 – 0.207			

Table 6

The biomass and relative abundance of zooplankton in samples taken by a Bongo-net 300 µ in the area between Gotland and the Swedish east-coast.

The samples were taken during the period September 30 - October 15, 1974.

Sample No		FRCTN analysed	Biomass ml/tow	Biomass ml/m^3	Biomass ml/m^2	MAIN GROUPS OF ORGANISMS (rel. abundance)
O18	1	1/1	48	0.108		Pseudocalanus m. elongatus (+++)
P17	3	1/1	1.5	0.011		Acartia sp (+++), Temora longicornis (+++), Centropages hamatus (++)
M16	5	1/1	6.7	0.045		Evadne nordmanni (+++), Acartia sp (++), Temora longicornis, Bosmina cor. maritima (++)
L15	7	1/1	5.5	0.047		Evadne nordmanni (+++), Acartia sp (++)
L16	9	1/1	16.0	0.042		Evadne nordmanni (+++), Acartia sp (+++), Temora longicornis (++)
L17	11	1/1	8.5	0.019		Evadne nordmanni (+++), Acartia sp (+++), Temora longicornis (++), Centropages hamatus (++)
M18	13	1/1	45.0	0.095		Evadne nordmanni (+++), Temora longicornis (+++), Pseudocalanus m. elongatus (+++) Acartia sp (++)
L18	15	1/1	1.2	0.004		Temora longicornis (+++), Evadne nordmanni (++)
M17	17	1/1	28.5	0.070		Pseudocalanus m. elongatus (+++), Acartia sp (++), Evadne nordmanni (++)
Mean value:				0.049		
Range:			0.004 - 0.108			

Table 7. Temperature and salinity at 11 stations visited during May 1974.

Station P 17; 74-05-13

Depth m	t°C	S‰
0	5.6	6.6
5	5.6	6.6
10	5.3	6.6
15	5.3	6.6
20	5.2	6.6
30	4.6	6.6
40	4.2	7.5
50	3.4	8.0
60	3.2	8.3

Station O 18; 74-05-14

Depth m	t°C	S‰
0	5.0	7.5
5	5.0	7.5
10	4.8	7.7
15	4.8	7.7
20	4.8	7.7
30	3.6	7.7
40	3.7	7.8
50	3.7	7.8
60	3.7	7.8
70	3.6	7.8
80	4.0	9.8
90	4.3	10.8

Station N 18; 74-05-14

Depth m	t°C	S‰
0	4.0	7.7
5	4.0	7.7
10	4.0	7.7
15	4.0	7.7
20	4.0	7.7
30	3.4	7.7
40	3.4	7.8
50	2.6	7.8
60	3.0	8.1
70	3.7	8.8
80	4.1	9.7
90	4.2	10.2

Station M 18; 74-05-14

Depth m	t°C	S‰
0	4.7	7.8
5	4.7	7.8
10	4.7	7.8
15	4.7	7.8
20	4.6	7.8
30	4.1	7.9
40	4.0	7.9
50	3.8	7.9
60	3.6	8.0
70	3.4	8.1
80	3.3	8.4
90	3.9	9.5

Station L 18; 74-05-15

Depth m	t°C	S‰
0	4.2	7.8
5	4.2	7.8
10	4.2	7.8
15	4.5	7.8
20	4.5	7.8
30	4.8	7.8
40	4.8	7.8
50	4.4	8.0
60	4.4	8.0
70	4.3	8.0
80	4.1	8.0
90	3.7	9.0

Station M 17; 74-05-15

Depth m	t°C	S‰
0	4.7	7.7
5	4.7	7.7
10	4.6	7.7
15	4.5	7.7
20	4.0	7.8
30	3.8	7.8
40	3.7	7.8
50	3.6	7.9
60	3.4	8.0
70	3.8	9.0
80	4.2	10.1
90	4.3	10.3

Table 7 continued

Station L 17; 74-05-15

Depth m	t°C	S‰
0	4.8	7.8
5	4.8	7.8
10	4.6	7.8
15	4.6	7.8
20	4.4	7.8
30	4.2	7.8
40	3.6	7.8
50	4.0	7.8
60	3.0	8.0
70	4.0	9.1
80	4.2	10.2
90	4.3	10.5

Station L 16; 74-05-15

Depth m	t°C	S‰
0	5.0	7.7
5	5.0	7.7
10	4.7	7.7
15	4.7	7.7
20	4.5	7.7
30	4.4	7.7
40	4.3	7.7
50	3.9	7.7
60	3.7	7.8
70	3.5	7.8
80	4.1	9.9
90	4.3	10.5

Station L 15; 74-05-15

Depth m	t°C	S‰
0	5.6	7.2
5	5.3	7.2
10	5.2	7.2
15	4.9	7.2
20	4.8	7.2
30	4.8	7.2
40	4.8	7.3
50	4.2	7.4
60	4.0	7.7
65	4.0	7.7

Station M 16; 74-05-16

Depth m	t°C	S‰
0	5.3	7.2
5	5.3	7.2
10	5.3	7.2
15	4.9	7.4
20	4.5	7.5
30	4.6	7.5
40	4.3	7.6
50	4.1	7.7
60	4.0	7.8
70	4.0	9.3
80	4.3	10.5
90	4.3	10.6

Station M 15; 74-05-16

Depth m	t°C	S‰
0	5.2	7.0
5	5.2	7.0
10	5.2	7.0
15	5.2	7.0
20	5.2	7.0
30	5.0	7.0
40	4.4	7.3
46	4.1	7.7

Table 8. Temperature and salinity at 11 stations visited during July-August 1974.

Station P 17; 74-07-31

Depth m	t°C	S‰
0	10.1	7.3
5	10.0	7.3
10	9.0	7.4
15	6.9	7.8
20	6.2	7.8
30	5.0	8.0
40	4.6	8.0
50	4.2	8.2
60	3.8	8.8

Station O 18; 74-07-31

Depth m	t°C	S‰
0	13.6	6.8
5	13.6	6.8
10	12.7	7.0
15	11.8	7.1
20	8.0	7.6
30	5.0	7.9
40	4.0	8.0
50	4.0	8.1
60	3.3	8.7
70	4.0	10.0
80	4.2	10.5
90	4.4	10.7

Station N 18; 74-07-31

Depth m	t°C	S‰
0	15.0	7.2
5	14.8	7.3
10	14.8	7.0
15	7.2	7.9
20	5.5	7.9
30	3.9	7.9
40	3.7	8.0
50	4.0	8.0
60	3.8	8.2
70	3.0	8.2
80	3.6	8.8
90	4.4	10.7

Station M 18; 74-07-31

Depth m	t°C	S‰
0	15.9	7.1
5	15.7	7.8
10	14.3	6.9
15	15.0	7.0
20	14.0	7.1
30	8.6	7.3
40	5.6	7.6
50	3.6	7.8
60	3.6	8.5
70	3.8	10.0
80	4.0	10.6
90	5.8	11.5

Station L 18; 74-08-01

Depth m	t°C	S‰
0	15.2	7.1
5	15.0	7.1
10	15.0	7.1
15	14.8	7.3
20	14.7	7.7
30	6.4	8.1
40	3.7	8.5
50	3.6	9.8
60	3.8	10.5
70	4.1	10.8
80	4.2	11.2
90	4.6	

Station M 17; 74-08-01

Depth m	t°C	S‰
0	15.1	7.5
5	14.8	7.5
10	14.9	7.5
15	14.5	7.5
20	11.6	7.7
30	4.5	8.0
40	4.3	8.1
50	4.1	8.1
60	3.2	8.5
70	3.6	9.4
80	4.2	10.5
90	4.4	10.8

Table 8 continued

Station L 17; 74-08-01

Depth m	t°C	S‰
0	14.4	7.5
5	14.4	7.5
10	14.3	7.2
15	14.4	7.4
20	14.5	7.2
30	5.2	7.9
40	4.0	8.0
50	3.6	8.1
60	3.6	8.1
70	3.2	9.0
80	4.2	10.0
90	4.2	10.6

Station L 16; 74-08-01

Depth m	t°C	S‰
0	15.4	7.0
5	14.6	7.3
10	14.7	7.5
15	14.5	7.5
20	13.9	7.5
30	5.2	7.8
40	3.6	7.8
50	3.4	7.8
60	3.2	7.7
70	4.8	8.4
80	3.9	10.6
90	4.7	10.8

Station M 16; 74-08-02

Depth m	t°C	S‰
0	15.2	7.3
5	15.1	7.4
10	15.1	7.4
15	14.9	7.5
20	8.3	7.8
30	4.2	8.0
40	4.0	8.0
50	4.1	8.1
60	3.8	8.1
70	4.0	9.6
80	4.5	10.6
90	4.7	10.7

Station L 15; 74-08-05

Depth m	t°C	S‰
0	15.0	7.5
5	14.9	7.5
10	14.8	7.5
15	10.0	7.7
20	7.1	7.8
30	4.4	8.0
40	3.9	8.0
50	3.8	8.2
60	3.8	8.9

Station M 16; 74-08-05

Depth m	t°C	S‰
0	15.0	7.4
5	14.9	7.4
10	14.8	7.5
15	14.2	7.4
20	9.4	7.6
30	4.4	7.9
40	4.0	8.0
50	3.9	8.2
60	3.9	8.9

Table 9. Temperature and salinity at 9 stations visited during October 1974.

Station O 18; 74-10-01

Depth m	t°C	S‰
0	7.9	7.7
5	7.0	7.7
10	6.4	7.7
15	6.1	7.8
20	5.1	7.8
30	4.4	7.9
40	3.6	8.0
50	3.4	8.2
60	3.2	8.7
70	3.3	9.3
80	3.6	10.1
90	4.0	10.7

Station P 17; 74-10-01

Depth m	t°C	S‰
0	6.4	7.8
5	5.7	7.8
10	5.6	7.8
15	5.5	7.8
20	5.0	7.9
30	4.0	8.0
40	3.6	8.1
50	3.6	8.2

Station M 16; 74-10-08

Depth m	t°C	S‰
0	7.2	7.8
5	7.2	7.8
10	7.1	7.8
15	7.1	7.8
20	7.0	7.8
30	5.8	7.9
40	4.5	8.1
50	3.8	8.2
60	3.8	8.3

Station L 15; 74-10-08

Depth m	t°C	S‰
0	6.9	7.8
5	6.8	7.8
10	6.6	7.9
15	6.2	7.2
20	6.1	7.9
30	5.7	7.9
40	4.9	8.0
50	4.7	8.0
60	4.1	8.3

Station L 16; 74-10-12

Depth m	t°C	S‰
0	10.3	7.5
5	10.3	7.5
10	10.3	7.5
15	10.2	7.5
20	9.8	7.6
30	9.8	7.6
40	9.5	7.6
50	5.0	7.8
60	4.3	8.0
70	3.5	8.2
80	3.5	8.4
90	3.5	8.9

Station L 17; 74-10-12

Depth m	t°C	S‰
0	9.8	7.5
5	9.8	7.5
10	9.7	7.6
15	9.5	7.6
20	9.1	7.6
30	8.3	7.7
40	6.8	7.8
50	4.1	8.0
60	3.6	8.5
70	3.4	8.5
80	3.4	8.8
90	3.4	8.9

Table 9 continued

Station M 18; 74-10-12			Station L 18; 74-10-14			Station M 17; 74-10-14		
Depth m	t°C	S‰	Depth m	t°C	S‰	Depth m	t°C	S‰
0	10.2	7.5	0	10.3	7.5	0	8.9	7.6
5	10.2	7.5	5	10.3	7.5	5	8.9	7.6
10	10.2	7.5	10	10.3	7.5	10	8.9	7.6
15	9.9	7.5	15	10.3	7.5	15	8.9	7.6
20	9.7	7.5	20	10.0	7.5	20	8.9	7.6
30	8.7	7.6	30	5.8	7.8	30	8.7	7.6
40	4.2	7.9	40	4.0	8.2	40	7.7	7.7
50	3.8	8.2	50	3.5	9.1	50	4.0	7.9
60	3.8	8.4	60	3.6	9.7	60	3.6	8.2
70	3.6	9.0	70	3.8	10.2	70	3.5	8.6
80	3.9	10.3	80	3.9	10.6	80	3.7	10.0
90	4.8	10.6	90	3.9	10.7	90	4.2	10.8