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CYCLIC SEASONAL FLUCTUATIONS OF THE PHYTOPLANKTON BIOMASS AND COMPOSITION IN THE GDAŃSK BASIN IN 1987 – 1988.

by

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Abstract.

Phytoplankton biomass and composition were determined on the basis of samples, which were collected in the period from 21.01.1987 to 19.08.1988 (every two weeks in 1987 and monthly in 1988) at three different stations situated in the Gdańsk Basin.

The phytoplankton shows characteristic seasonal succession. Five phases may be distinguished in the annual cycle at the inshore, shallow station protected from the open sea as well as at the deep station situated offshore. The first phase is the spring diatom culmination in the middle of April, composed of: *Thalassiosira levanderi, Thalassiosira spp., Chaetoceros spp., Achnanthes taeniata* in 1987 and *Skeletonema costatum, Chaetoceros spp., Thalassiosira levanderi* in 1988. The late spring dinoflagellate maximum - the second stage - was dominated by *Peridinella catenata (Gonyaulax catenata)* and *Scripsiella sp.*.The third, summer phase of the phytoplankton succession consisted mainly of blue-green algae and also of dinoflagellates *Prorocentrum balticum* and *Heterocapsa triquetra.* The autumn peak of the phytoplankton biomass was composed of big (80-200 um diameter) diatom *Coscinodiscus granii* and autotrophic ciliate *Mesodinium rubrum,* whereas the fifth phase of the winter dormancy consisted of different resting stages.

The maximum biomass values in the whole annual cycle were reached at the station situated inside the Gulf of Gdańsk in the middle of July 1987 (715 ugC/l) and in the beginning of June in 1988 (950 ugC/l).

Introduction.

The cyclic seasonal fluctuations of the phytoplankton biomass and composition is a well known phenomenon, characteristic for the sea waters of the temperate zone. It is in general connected with seasonal changes of sun irradiance affecting water temperature, thermocline forming and - as a consequence of this - nutrients concentration (Thurman 1982). The Gdańsk Basin as a part of the Baltic Sea, which belongs to the temperate zone is directed by the same rules. Also, former investigations of the phytoplankton in the Gdańsk Basin (Rumek 1950, Malewicz et al. 1974, Ringer 1976, Borysiak 1977, Pliński et al. 1982, 1985, 1986, Witek 1986) and in the other parts of the Baltic Sea (Niemi 1975, Edler 1977, Smetacek et al. 1984, Smetacek 1985, Elmgren 1984, Larson et al. 1986, Kahru 1991) as well as in the other temperate areas (Gieskes & Kraay 1975) point to this. However, a comparison of the data recorded in different seasons from 1947 (Rumek 1950) till now in the Gdańsk Basin allows to observe some changes in composition and quantity of the phytoplankton. It may suggest that some other environmental factors, as local hydrography, increase of pollutants inflow, interactions between phytoplankton and other organisms in the ecosystem, play important role in the population development.

Therefore, the aim of this paper was to obtain some data about the seasonal changes in biomass and species composition of the phytoplankton in relation to major factors influencing this succession.

Materials and Methods.

Research for this study took place in the period from 21 January 1987 to 19 August 1988 at three stations situated in the Gdańsk Basin (Fig.1). The samples were taken approximately every two weeks during 1987 and monthly during 1988 with a van Dorn water sampler from the integrated layers: 0-5-10-15m, 15-20-25-30m, 30-40-50-60m, 60-70-80-90m, 90-100m-above the bottom, and preserved with Lugol's solution (Edler 1979). 50 ml subsamples were analysed in an inverted microscope (Utermohl 1958).

Phytoplankton analysis consisted in the identification of the organisms to the higher taxonomic units and their volume classification. Whole phytoplankton spectrum contained organisms of a size range 32 to $1*10^6 um^3$ (i.e. 4-125 um as an equivalent of the sphere diameter), divided into 15 volume classes formed in a logarithmic scale. A width of a volume class was equal to 0.3 $\log_{10}$, which almost corresponded to a width of 1 $\log_2$ and meant a volume two times greater in class n+1 than in class n (Witek et al in press). The formulae for the volume of single geometric figures were used for the determination of the specimens volume. Counting procedure was continued until recording 500 objects and at least 10 objects in each volume class.

The form in which a given object occurred in nature was assumed as one specimen (e.g. whole colonies of diatoms, blue-green algae or green algae).

This study is concentrated on the phytoplankton understood as a group of the autotrophic organisms, so some dinoflagellates (all *Protoperidinium, Amphidinium, Oxytoxum* species and most of *Gymnodinium* and *Gyrodinium*) and *Ebria tripartita* are excluded because of their heterotrophic nutriation. On the other hand, an obligatory autotrophic ciliate - *Mesodinium rubrum* is included.

Results.

1. Hydrological conditions.

Each of the sampled stations (Fig.1) represents different environmental circumstances (Witek et al in press). Stations R6 and 92A are about 35 m deep, situated at the coastal area. However, station 92A is situated in the area protected from the open sea (Gulf of Gdańsk), where seasonal summer stratification and good mixing due to the wind activity during the rest of the year is observed. On the other hand, station R6 represents highly unstable environment, where intensive mixing in the whole water column takes place. The third 105 m deep station (G2) is situated in the Gdańsk Deep and characterized by permanent picocline at about 60 m., mixing of the surface layer and stagnation of the bottom water, where there is an oxygen deficit. Figure 2 shows temperature changes during 1987 at all stations under discussion. Changes in the inorganic phosphorus, nitrogen and silicium concentrations in the water column at respective stations, are shown in figures 3 - 5.

2. Qualitative analysis.

All identified taxons are recorded in Table 1. In some cases the identification to a species level was impossible with regard for preserved and long stored material, as well as for a taxonomic uncertainty. For that reason some organisms were combined into bigger groups (as *Microcystis / Aphanothece* group, *Dinophysis* group, naked dinoflagellates, *Thalassiosira* looking like, etc.) to insure accuracy and certainty of the identification.

3. Seasonal changes of the most important phytoplankton groups.

Diatoms, dinoflagellates and *Mesodinium rubrum* had the biggest contribution to the phytoplankton biomass (Fig.6). Diatoms formed the first peak of biomass during the vegetation season in the middle of April 1987 at all stations, although, at the coastal area the biomass value was greater than at station G2. Besides that phase of the phytoplankton growth lasted longer at the station protected from the open sea (92A) than in the open area (R6). It is difficult to compare the spring seasons in 1987 and 1988 due to the lack of the samples from March and beginning of April 1988, but the considerable values of diatoms at the end of April indicated the final stage of the spring diatoms development.

When the diatoms were decaying, a sensible amount of dinoflagellates appeared in the water column and in the end of May 1987 built up the second peak of the phytoplankton biomass. In 1988 development of this maximum was shifted towards beginning of May. At the stations situated in the open sea there was only one dinoflagellate peak during vegetation season, whereas in the Gulf area another outburst of dinoflagellates took place in the middle of July 1987, and in the beginning of June 1988.

In the summer the phytoplankton biomass remained at a very low level (60-70 ugC/l, maximum value of 130 ugC/l was recorded at the Gulf of Gdańsk) especially at the Gdańsk Deep. Summer phytoplankton consisted of blue-green and green algae and also of small flagellates

The last peak of the phytoplankton biomass was observed in the middle of October (1987; inshore station) and November (1987; offshore station). It was formed by diatoms and, particularly in the coastal area, by *Mesodinium rubrum*.

Development of the latter proceeded in the course of the vegetation season with two clear maxima: late spring -

accompanying dinoflagellates, and autumn - accompanying diatoms, at the inshore stations, while in the open area fairly clear was only the spring peak.

4. Changes in the diatom composition during the period under discussion.

Each of the two diatom culminations was characterized by different species composition (Fig.7). *Thalassiosira levanderi* was the most important component in the early spring, especially in 1987. Besides, *Achnanthes taeniata* and *Chaetoceros* group (consisted chiefly of small-cell species as: *Ch. siplex, Ch. sociale, Ch. holsaticum, Ch. wighamii*) reached maximum values of their biomass in this period, but about two weeks later than *T. levanderi*. Considerable contribution of *T. levanderi* in the spring of 1988 took place only in the Gdańsk Deep, whereas at the inshore stations higher concentrations of *Skeletonema costatum* and *Chaetoceros spp.* were reached. Autumn maximum was built of big diatoms *Coscinodiscus granii* and *Actinocyclus octonarius*. Moreover, appreciable amount of *Skeletonema costatum* appeared in the middle of June and July 1987 at the Gulf station. In the summer, unconsiderable number of *Chaetoceros spp.* (consist mainly of bigger-cell species as: *Ch. densum, Ch. boreale* - in opposite to spring *Chaetoceros* group), *Cyclotella spp.* and other non def. Centrales was also noticed at the region under discussion (Table 1).

5. Changes in the dinoflagellate composition during the period under discussion.

Seasonal biomass changes of the main taxa belonging to dinoflagellates are shown in Figure 8. *Peridinella catenata* was absolutely dominant during late spring maximum in both vegetation seasons, although at station R6 (1987) it was replaced by *Scripsiella sp.* Two additional peaks of dinoflagellate biomass in the protected area were caused by *Prorocentrum balticum* in 1987 and *Heterocapsa triquetra* in 1988. Moreover, small concentrations of *Dinophysis spp.* were observed during summer.

6. Changes in the composition of other phytoplankton groups.

Blue-green algae appeared in the summer (Table 1) and consisted above all of *Microcystis reinboldii, Aphanothece clathrata* and *Gomphosphaeria spp.* However, they started to develop their biomass two months earlier (June/July) in 1988 than in 1987 (August - October). The contribution of Nostocales (*Aphanizomenon flos-aquae, Nodularia spumigena, Anabaena sp.*) was greater in 1988. The phenomenon of double season vegetation was observed in the case of *Aphanizomenon flos-aquae*, which appeared in the spring and summer. It was also observed by Borysiak (1977). The difference between two populations consisted in the heterocystas producing. First one did not produce any heterocysts, while the second did.
Green algae, represented by many species, actually did not

create a big crop. They built their biomass in summer and particularly in the Gulf area, where the inflow of river waters becomes pronounced.
Just before and during diatoms culminations, Euglenophyceae appeared developing higher concentrations in the protected area than in the open sea (Table 1).

7. Size structure analysis.

Results of the size structure analysis are shown in Figure 9, where it becomes noticeable that at the beginning of the vegetation season there was a mixture of small (i.e.: *Thalassiosira levanderi* - 125-2000 um^3 = 6.3-16 um ESD, *Chaetoceros spp.* - 32-500 um^3 = 4-10 um ESD) and big organisms (i.e.: *Thalassiosira baltica* - $16*10^3$-$250*10^3$ um^3 = 32-80 um ESD, *Achnanthes taeniata* chain forming - 10^3- $500*10^3$ um^3 = 13-125 um ESD) which was replaced in the summer by the community consisted of small cells. The autumn phase was dominated by big organisms (80-200 um ESD).

8. Vertical distribution.

Changes in the vertical distribution of the phytoplankton biomass are presented in Figure 10. The decrease of phytoplankton biomass with depth was noticeable. At the station protected from the open sea the early spring and autumn peaks appeared with some delay in the bottom layer, indicating sedimentation of the diatoms. During the rest of the year fluctuations of the biomass in the bottom layer did not reflect the changes in the surface. At the station situated inshore, but characterised by unstable hydrological conditions (R6), (permanent mixing) the respective peaks of biomass were present at the same time in the both layers. At the deep water station situated in the Gdańsk Deep, where the transparency was the highest, the phytoplankton biomass in the lower layer (15-30 m.) exceeded this in the surface at the beginning of late spring and during autumn phases.

Discussion.

The phytoplankton community in the Southern Baltic undergoes some noticeable changes in the species composition, although the number of the taxa remains more or less at the same level (265 - Rumek 1948, 210 - Pliński et al. 1982, 206 - Pliński et al. 1985, 156 in the present study). In the present study there have not ascertained any specimens belonging to waters of full salinity as *Rhizosolenia, Dityl um, Ceratium* genera, which were recorded by all previous authors. This may be an effect of the lack of the North Sea water inflow since 1983 (Wojewódzki 1991). On the other hand, both Ringer (1976) and Pliński et al. (1985, 1986) underlined the importance of freshwater green algae in the phytoplankton of the Gulf of Gdańsk in the summer season. Whereas, in the light of the present results, it appeared, that the contribution of green algae in the phytoplankton biomass was inconsiderable. In spite of relatively big variety of species

and high number of *Oocystis* and *Monoraphidium* cells in the period July - December 1987, their biomass never exceeded 70 ugC/l (mean range: 0.2-2.5ugC/l).
The blue-green algae mass occurances in the summer are familiar phenomena in the Central Baltic (Niemi 1975) and are caused chiefly by *Aphanizomenon flos-aquae, Nodularia spumigena* and *Anabaena flos-aquae*. Similar events were recorded by Pliński et al. (1985. 1986) Borysiak (1977) and Ringer (1973, 1976) in the Southern Baltic and the Gulf of Gdańsk. However, in 1987, the contribution of Nostocales among blue-green algae was surprisingly low in comparison to Chroococcales: *Aphanothece clathrata, Microcystis reinboldii* and *Gomphosphaeria spp.* Relatively low temperatures in 1987 might have caused such a small amount of Nostocales in summer community. (According to Edler (1977), 17-18^{o}C had to be reached befor heavy blooms of blue-green algae can occur, while the maximum temperature of the surface water in 1987 merely reached 15-16^{o}C (Fig.2).) In the warmer 1988 summer, the proportion between Nostocales and Chroococcales was turned out to Nostocales advantage. In general, however, the Southern Baltic blue-green algae community seems to consist mainly of Chroococcales, which are continuously present, from year to year, while Nostocales builds up high biomass only occasionally. (After 1988, more considerable appearance of Nostocales took place in 1991, when surface water temperature reached 20^{o}C and *Aphanizomenon flos-aquae* biomass grew up to $12*10^6$ ugC/l, whereas *Nodularia spumigena* - $10*10^6$ ugC/l (unpublished data)).
Pliński et al. (1985) noticed the decrease in the number of dinoflagellate species in the Gulf of Gdańsk during last 40 years. The present study can not confirm this tendency. Such species as *Katodinium rotundatum, Scripsiella sp., Gyrodinium aureolum, Gymnodinium simplex* and other autotrophic naked dinoflagellates were not reported before from this area. Moreover, the first mass occurence of *Heterocapsa triquetra* in the coastal area of the Gulf of Gdańsk was recorded in 1977 (Pliński et al. 1985). According to the author's unpublished observations *Heterocapsa triquetra* forms rapid (lasting only a few days) blooms every year, somewhen between June and July (at least in the period 1988-1992) in the coastal region. When occuring, it changes the water colour to red and causes enormous mortality of *Salmo gairdneri* in the field cultures (J.Wiktor personal information). Because of such a rapid outburst of the population and its immediate decline, it might have been missed in 1987. On the other hand, *Prorocentrum balticum* appeared at the Gulf station during the time when *H. triquetra* had used to grow. The bloom of *H. triquetra* was observed in the beginning of June 1988. Its biomass value reached 642 ugC/l (Fig.8) at the Gulf station.
It may be well worth adding, that the succeeding change in the Southern Baltic phytoplankton composition concerns the

Euglenophyceae group. The number of species increased in comparison with previous data (Rumek 1948, 1950, Ringer 1976, Borysiak 1977, Pliński 1985). *Eutreptiella gymnastica, Eutreptia spp.* and *Trachelomonas spp.* appeared last time.

Apart from the long-term changes in the presence of some phytoplankton components in the ecosystem of the Gdańsk Basin, cyclic seasonal fluctuations of the algae biomass and species composition were observed.

Rumek (1950) in 1947 had already took first steps in order to differentiate certain groups of the phytoplankton taxa, which occured one by one in following seasons in the course of the year in the area under discussion. Next, that pattern was confirmed and studied in more detail by other investigators of this region (Ringer 1976, Borysiak 1977, Pliński et al. 1982, 1985,1986, Witek 1986). Ringer (1973, 1976) and Borysiak (1977) were concerned with characterising of the 4 climatic seasons in their phytoplankton observations, while Pliński (1982) and Witek (1986) paied attention to respective algae group succession in the course of the year.

Results obtained during this study led to distinguishing following phases of the phytoplankton species succession in the annual cycle (Fig.10):

1- the early spring diatom culmination,
2- the late spring peak of the dinoflagellate biomass,
3- the summer stratification connected with blue-green algae and small flagellate growth,
4- the autumn maximum of big diatoms and *Mesodinium rubrum*,
5- the winter dormancy.

The first phase began at the end of March and lasted until the middle of May with culmination in the middle of April. It was characterized by a massive outburst of small diatoms, which was probably possible thanks to favourable conditions leading to a rapid build-up of the biomass, i.e.: maximum values of the nutrients concentrations (Fig.3,4,5), sufficient temperature, calm weather conditions, stable water column. The decline of the spring bloom was brought about by nutrient depletion, increasing of the temperature and rapid sedimentation. According to Smetacek (1985), in the Kiel Bight more than half of the total production sediments out of the water column after the spring maximum, while Elmgren (1984) and Larsson et al. (1986) estimated sedimentation of the organic carbon in the Baltic Sea at 30-40%. Changes in the inorganic silicium concentrations (Fig.5) in the water column may indicate occurence of the diatom sedimentation process in the Gdańsk Basin. When the diatom biomass was developing, the amount of silicium was rapidly depleted in the surface layer, whereas very high concentrations of silicium appeared at the bottom about one and a half months later. This crop of silicium at the bottom might come from sedimented spring diatoms. When the diatom culmination had passed, there was no nitrate left in the euphotic layer, while phosphate and silicium remained continuosly, although in lower concentration (Fig.3, 4, 5). This might suggest that the lack of nitrate limited the duration of the diatom existence in the water column. Similar observations made Niemi (1975).

The second stage began in the middle of May and extended to the middle of June 1987, while in 1988 it started about two weeks earlier. Higher temperature in 1988 might have affected this slight shift. Thanks to their locomotive ability, *Peridinella catenata* and *Scripsiella sp.* - basic components of the late spring community - could utilize the nutrients which occurred in the deeper layer in higher concentrations than at the surface, where the diatoms had used them up. Besides, *Peridinella catenata* and *Scripsiella sp. as dinoflagellates,* require higher light intensity and temperature than diatoms. It is another reason for their success in competing with diatoms and creating such a big biomass. High activity of the protozooplankton (Witek et al. in press) may - at least partly - influence the disapperance of this phytoplankton group.

In the some parts of the Baltic Sea two stages of the phytoplankton succession mentioned above, are combined in one phase (Northern Baltic Proper - Larsson et al.(1986), Tvarminne area - Niemi (1975)), whereas in Kiel Bight (Smetacek 1985), Sound (Edler 1977) and Gdańsk Basin (Witek 1986, present study) they may be clearly separate.

The summer phase of the phytoplankton succession in the Gdańsk Basin began in the middle of June and lasted to the end of September 1987. Also in this case a shift in the time of about two weeks appeared in 1988. This part of the vegetation season looked different in the protected area in comparison with the open sea. The former region was characterised by massive growth of dinoflagellate *Heterocapsa triquetra* in 1983 (Witek 1986), *Prorocentrum balticum* in 1987, *H. triquetra* in 1988 at the beginning, whereafter multispecies community of a very low biomass. In the open sea the summer dinoflagellate peak did not occur. Summer phytoplankton community developed when the phosphate and nitrate concentrations were at the lowest, and water thermal stratification made the inflow of nutrient supply impossible. A probable explanation of this was, presumably, the ability of blue-green algae - main component of the phytoplankton at that time - to accumulate phosphorus and nitrate in their cells (Edler 1977). In comparison to relatively low phytoplankton biomass quite high values of primary production were noticed at that time (Witek et al. in press) indicating the high assimilation coefficient (Niemi 1975). Phytoplankton summer population vanished probably as a result of sedimentation on the one hand (Niemi 1975, Smetacek 1985) and grazing by vigorously developed metazooplankton (Witek et al. in press) on the other hand.

The autumn stage of phytoplankton succession was initiated at the end of September and ended at the beginning of December. Just before the autumn peak of big diatom biomass had been reached, nutrient concentrations in the surface layer increased. This was connected with the break-down of the summer stratification resulting in upward mixing of nutrients from stagnating bottom layers. The fate of this culmination was partially similar to that of the spring one, which means, a part of the autumn diatoms sedimented. However, nutrient depletion was not the factor trigging sedimentation but rather worse weather conditions at the end of this period. Considerable amount of *Coscinodiscus granii* cells remained in the water column during winter.

The phase of the winter dormancy started at the beginning of December. The phytoplankton population was probably sparse over winter and consisted of different resting stages, algae which remained in the state of restricted vegetation and small flagellate (chiefly *Cryptophyceae*).

Seasonal succession becomes pronounced in the phytoplankton size structure. Observations made by Witek (1986) and Kahru (1991) are in agreement with results presented above (Fig.10) and indicate that phytoplankton population consists at the beginning of vegetation season of the different sizes mixture replaced in the summer by small cell fraction and finally in the autumn - by bigg organisms. This tendency together with changes in nutrient concentrations may affect the different ability of carbon assimilation by respective phytoplankton communities in the course of the year.

The comparison of available data concerning phytoplankton succession in the Baltic Sea explains that differences are only connected with species composition and duration of the respective culminations. This is dependent on the geographical situation and the weather conditions. Figure 11, for exampler, shows the time of spring maxima in the different parts of the Baltic Sea in different years. Following from west to east and farther north to the Gulf of Finland, it is easy to find that maximum values of the spring diatoms biomass shifted from March to May.

It is evident from all above considerations that the phytoplankton community undergoes continuous changes in species composition and biomass in the course of a year and that environmental factors play an important role in the development of these populations. The phases of the succession distinguished here correspond to fundamental changes in the functioning of the ecosystem (Witek et al. in press) and thus also of the food web of which the phytoplankton is only a part

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TABLE 1. Maximal concentrations of the respective taxons recorded at the investigated stations and separate layers (number of units*/l)

TAXON	Station 92A			Station R6			Station G2					
	0-15m 1987	15-30m 1987	0-15m 1988	0-15m 1987	15-30m 1987	0-15m 1988	0-15m 1987	15-30m 1987	30-60m 1987	60-90m 1967	90m-bot. 1987	0-15m 1988
CYANOPHYCEAE												
CHROOCOCCALES												
Microcystis / Aphanothece group consist of:												
Aphanothece clathrata W. et G.S.West 1906	1.8E+06 Jl	8.3E+05 Au	1.1E+03 Ap	4.7E+05 Au	2.9E+05 Au	1.3E+06 Jl	3.9E+05 Au	1.9E+05 Au	1.9E+04 Au	2.6E+04 D	1.6E+04 D	1.7E+05 Jl
A. saxicola / A. castagnei												
Nageli 1849 / (Kutzing 1846) Rabenhorst 1865								8.7E+03 Au				
Microcystis aeruginosa (Kutzing 1833b)												
Kutzing 1845-49		1.2E+02 Jl										
M. grevillei (Hassal) Elenkin		3.4E+02 D										
M. reinboldii (Richter in Reinb. 1889b)												
Forti in De Toni 1907	3.0E+02 Jl	9.6E+04 S		2.9E+04 Jl	3.3E+04 Au		4.7E+04 Jn	3.5E+04 S	4.5E+03 Au	1.3E+03 S	1.6E+03 D	8.3E+03 Jl
M. viridis (A.Braun in Rbh. 1862) Lemmermann 1903b	2.0E+01 F	6.8E+03 S	1.9E+05 Jl			8.3E+04 Jl	3.0E+04 Jl	1.5E+04 Jl	2.3E+03 Au	9.8E+02 D	2.9E+02 O	3.0E+03 Jl
Microcystis reinboldii / Aphanothece clathrata			2.7E+06 Jl	2.8E+03 J		5.5E+04 Jn	4.5E+03 D	1.3E+05 Au	1.4E+04 N	9.8E+01 M	7.2E+03 O	6.1E+03 Ap
Microcystis sp. Kutzing 1833												
ex Lemmermann 1907	7.6E+02 Jl	2.6E+03 Ap	8.6E+03 Jn			2.5E+02 Jn		6.3E+03 N	1.9E+03 Au	2.3E+03 O	2.6E+03 O	
Gomphosphaeria group consist of:												
Gomphosphaeria compacta (Lemmermann 1900b)												
Strom 1923		4.9E+03 D		7.3E+02 M								
G. lacustris Chodat 1989	5.1E+04 Au	6.9E+04 Au		1.4E+02 Mr	1.8E+02 Mr		2.9E+04 Au	5.1E+04 S	1.3E+04 S	2.1E+03 J	6.3E+02 S	
G. pusilla (van Goor 1924) Komarek 1958	4.5E+05 Au	4.2E+05 S		2.5E+05 Au	1.8E+05 S		3.8E+04 Au	3.0E+04 S	4.8E+03 F	6.9E+03 M	3.3E+03 F	
G. pusilla/lacustris				6.4E+04 S	8.0E+03 D			2.0E+04 S	1.2E+04 O	7.3E+03 O		
Gomphosphaeria sp. Kutzing 1836		1.8E+04 Au	3.4E+05 Jl	8.1E+04 S	3.0E+04 S	9.5E+04 Jl	1.7E+05 S	1.1E+04 D	3.4E+03 Au	4.5E+03 D	1.9E+04 O	6.7E+04 Jl
Chroococcus limneticus Lemmermann 1898a												
(syn.:Gleocapsa limnetica (Lemm.1898a)												
Hollerbach)		5.1E+03 Au		1.3E+03 F								
Ch. turgidus (Kutzing 1845-49) Nageli 1849												
(syn.:Gleocapsa turgida (Kutzing) Hollerbach)		5.1E+03 Jl						1.4E+03 F				
Gleocapsa crepidium (Thuret 1854)												
Bornet et Thuret 1876		1.3E+03 Mr		9.2E+02 F			7.4E+03 S		1.3E+02 Jl			
G. minima (Keissler) Hollerbach ?	4.0E+05 Au	1.7E+05 S		1.2E+05 Au	2.3E+04 Au		9.6E+04 S		2.7E+03 S	1.8E+03 Au	2.5E+02 Au	
G. minuta (Kutzing) Hollerbach		4.0E+01 S					2.2E+04 O		3.9E+02 Au			
Gleocapsa sp. (Kutzing) Hollerbach 1938							1.3E+02 F	6.4E+03 O				
Merismopedia glauca (Ehrenb. 1838)												
Nageli 1849								1.6E+03 N				
M. punctata Meyen 1839	1.0E+04 Au	1.2E+04 S			2.6E+03 Au		5.5E+03 S	1.3E+03 Au			4.0E+03 O	
M. warmingiana Lagerh. 1883b												
(syn.:Merismopedia tenuissima Lemmermann 1898a)	6.2E+04 Au	2.7E+04 S	2.9E+04 Jl	2.8E+04 O	1.3E+04 O	2.5E+03 Jn	3.4E+03 O	1.4E+04 S	3.8E+03 S	5.1E+03 O	4.5E+03 O	5.2E+02 Jl
Synechocystis salina Wislouch ?							2.8E+05 Au	7.2E+03 F				
Synechococcus sp. Nageli 1849 ?									4.5E+02 Au			
Chroococcales non def.	2.2E+05 Jl		2.5E+05 Jl	2.1E+04 Au		5.1E+05 Jl	9.3E+04 S	2.3E+05 Au	3.0E+04 S	9.0E+03 O	1.3E+05 D	1.3E+05 Au
NOSTOCALES												
Anabaena flos-aquae (Lyngb.1819) Breb.in Breb.												
et Goday 1835 ex Bornet et Flahoult 1888	2.3E+03 Jl	3.8E+02 Ap	1.4E+03 Jl				9.2E+01 Jl					
Anabaena sp. Bory 1823 ex Bornet et Flahoult 1888	2.6E+03 O	1.0E+03 D		3.6E+02 Au	2.4E+02 Au	1.4E+04 Jl	4.4E+02 Au	8.2E+02 Au		2.0E+01 Au	2.7E+02 Jl	6.0E+02 Jl
Aphanizomenon flos-aquae (L. 1753)												
Ralfs ex Bornet et Flahoult 1888	8.8E+04 Jl	1.1E+04 Au	7.3E+04 Jn	1.0E+04 Jl	1.4E+04 Au	5.2E+04 Jl	4.3E+04 Au	9.5E+03 N	2.7E+03 Ap	4.8E+03 F	3.5E+03 O	3.8E+03 Au
Lyngbia contorta Lemmermann 1989c										2.1E+02 S		
L. limnetica Lemmermann 1898a	5.1E+03 Au			5.8E+04 Au			4.8E+03 S	3.2E+02 Mr				
Nodularia spumigena Mertens in Jurgens 1822												
ex Bornet et Flahoult 1886	4.0E+01 Au	4.0E+01 Au	1.8E+03 Jl	3.2E+02 Jl	8.0E+01 Jl	1.9E+03 Jl	4.4E+02 Au	3.0E+02 S	4.0E+01 Au		1.4E+02 N	1.2E+02 Jl
Oscillatoria limnetica Lemmermann 1900b ?		4.6E+04 Jl						7.9E+02 N	3.7E+02 Au	4.0E+03 O	2.9E+03 S	
O.chlorina (Kutzing 1843b) Gomont 1892							4.0E+01 Ap					
O. splendida Grev. 1824 ex Gomont 1892								2.0E+01 F				
O. subtilissima Kutzing 1845-49												
ex Gomont 1892	2.2E+05 Jl							6.4E+02 Jl				
Oscillatoria sp. Vaucher 1803 ex Gomont 1892	1.0E+03 D		2.1E+05 Jl			2.1E+04 Jn	6.1E+02 D	7.9E+02 N	1.7E+02 Mr	6.2E+02 M	2.6E+03 O	5.2E+02 Jl
Spirulina sp. Turpin ex Gomont 1892												
emend. Gardner 1817	1.7E+03 O											

TABLE 1. continuation

TAXON	Station 92A 0-15m 1987	Station 92A 15-30m 1987	Station 92A 0-15m 1988	Station R6 0-15m 1987	Station R6 15-30m 1987	Station R6 0-15m 1988	Station G2 0-15m 1987	Station G2 15-30m 1987	Station G2 30-60m 1987	Station G2 60-90m 1987	Station G2 90m-bot. 1987	Station G2 0-15m 1988
BACILLARIOPHYCEAE												
CENTRALES												
Chaetoceros group consist (probably) of:												
Chaetoceros boreale Bailey 1854								4.5E+02 S				
C. curvisetum Cleve 1889								1.6E+02 Ap				
C. danicum Cleve 1889 ?	8.0E+01 F	1.6E+02 Jl		2.1E+03 O	3.6E+03 Ap							
C. densum Cleve 1901				3.8E+02 O			1.0E+04 Au	3.2E+03 Au	7.2E+02 Au	3.9E+01 Mr		
C. densum / boreale		1.8E+02 Mr	9.4E+02 Jl			3.6E+03 Au	3.1E+03 S	3.0E+02 Au	9.0E+02 S	4.0E+01 N	2.9E+02 S	6.4E+02 Au
C. gracile Schutt 1895b	1.7E+04 Jl	5.6E+04 Ap		1.9E+05 M	5.8E+05 M							
C. holsaticum Schutt 1895		2.1E+04 Ap					4.8E+05 Ap	4.5E+05 M	9.0E+04 Ap	1.5E+05 Ap	1.0E+05 Ap	
C. pseudocrinitum Ostenfeld 1901a	5.3E+05 M	8.5E+05 M		1.0E+04 M	1.8E+05 M			1.5E+04 Ap				
C. septentrionale / ceratosporum												
Oestrup 1895 / Ostenfeld 1910	2.6E+06 Ap	4.2E+05 Ap		1.5E+05 Ap	1.4E+06 M		2.7E+05 Ap	2.3E+05 Ap	4.4E+04 Ap	3.9E+04 M	1.8E+04 Ap	
C. simplex Ostenfeld 1901a							2.7E+04 M	3.7E+04 M				
C. sociale Lauder 1864		4.1E+04 Ap			2.9E+03 Mr		9.7E+04 Ap	7.1E+04 Ap	3.3E+04 Ap	5.9E+04 M	5.8E+04 Ap	
C. subtile Cleve 1896	9.0E+02 F	2.6E+04 M	1.0E+03 J	1.5E+05 M	9.2E+04 M	1.1E+05 Ap	3.2E+04 Ap	1.4E+03 M	6.5E+03 Ap	1.5E+03 Ap	1.6E+03 Ap	
C. wighamii Brightw. 1856	1.1E+05 M	2.4E+05 M			2.0E+05 M		1.4E+05 Ap	5.2E+04 M	2.2E+03 M	9.9E+03 Ap	2.6E+03 Ap	
C. wighamii / holsaticum	1.6E+05 Mr								2.0E+05 M			
Chaetoceros sp. Ehrenberg 1844	4.2E+06 Ap	2.5E+05 Ap	3.0E+06 Ap	5.9E+05 M	3.5E+05 Ap	1.2E+06 Ap	1.3E+03 F	3.7E+03 N	1.1E+03 M	4.5E+03 Mr	4.0E+04 M	2.0E+06 Ap
Group of big diatoms consist of:												
Actinocyclus octonarius Ehrenberg 1838	3.8E+03 Ap	4.0E+03 O	8.0E+01 M	1.6E+03 D	1.6E+03 O	1.8E+03 Au	3.3E+03 O	3.8E+03 N	3.2E+03 O	6.9E+02 O	2.4E+03 O	3.2E+02 Au
Coscinodiscus granii Gough 1905	5.0E+03 O	4.1E+03 O		1.5E+03 N	1.9E+03 N	4.0E+01 Au	1.5E+02 S	1.5E+04 N	2.9E+03 O	7.4E+02 N	3.0E+03 O	
Coscinodiscus sp. Ehrenberg 1844	1.5E+03 S	3.0E+03 S		7.9E+02 Ap	3.8E+02 Ap	8.0E+01 Au	3.7E+03 O	6.8E+02 O	1.0E+02 D	6.0E+01 S		4.0E+01 FJl
Coscinodiscus / Actinocyclus								1.5E+03 Au				
Cyclotella melosiroides (Kirchner)												
Lemmermann 1900	1.2E+03 O	2.6E+03 Au		4.0E+04 Ap								
C. meneghiniana Kutzing 1844	4.4E+04 O	2.5E+04 O		2.4E+04 M	1.5E+04 M		2.0E+04 Au					
C. stelligera Cleve et Grunow 1881	2.2E+05 S	1.4E+05 S		1.0E+05 S	4.7E+05 Au		1.9E+05 S	4.6E+04 S				
C. glomerata Bachmann 1911							1.1E+05 Au	8.7E+03 N				
C. striata (Kutzing 1844) Grunow												
in Cleve et Grunow 1880							1.2E+03 Mr	2.0E+01 Mr	3.8E+02 Ap	6.7E+01 M		
Cyclotella sp. Kutzing 1833a	5.1E+05 Ap	4.7E+03 Ap	1.4E+03 Jl	2.0E+01 F			3.6E+02 S	2.0E+03 Ap	5.1E+03 N	1.5E+03 J	4.2E+02 N	
Melosira arctica (Ehrenberg 1854)												
Dickie in Pritchard 1861	1.3E+04 Ap	1.3E+04 Ap		1.6E+02 Ap	7.5E+01 Ap			8.8E+02 M	1.4E+02 Ap			
M. granulata (Ehrenberg 1843)												
Ralfs in Pritchard 1861	3.0E+03 Jl	2.6E+02 J88										
M. italica (Ehrenberg 1838) Kutzing 1844	1.0E+03 D											
M. moniliformis (O.F.Muller 1783)												
C.A.Agardh 1824											2.0E+01 Au	
Melosira sp. C.A.Agardh 1824	1.2E+05 Ap	2.6E+04 Ap	4.0E+01 F		1.2E+04 M	1.2E+02 Ap		2.7E+02 N		2.0E+03 M		1.1E+03 Ap
Skeletonema costatum (Grev. 1866) Cleve 1878	3.6E+06 Jn	3.3E+05 Jn	2.4E+06 M	1.8E+04 S	1.6E+05 M	8.4E+05 M	8.0E+04 Ap	1.0E+04 Ap	5.9E+03 M	3.1E+03 M	2.7E+02 M	3.7E+04 Ap
Thalassiosira looking like group:												
Thalassiosira baltica (Grunow in												
Cleve et Grunow 1880) Ostenfeld 1901a	1.1E+03 Ap	1.1E+04 Ap	6.1E+03 Ap	6.1E+03 M	2.9E+03 M	2.6E+03 M	3.5E+03 Ap	6.6E+03 M	1.4E+03 M	8.3E+02 M	1.4E+02 M	1.0E+04 Ap
T. decipiens (Grunow in v.H. 1880-85)												
Joergensen 1905	8.4E+04 Ap	4.1E+04 M	5.3E+04 Ap	4.8E+05 Ap	3.0E+04 M	1.7E+04 M	5.4E+04 Ap	3.0E+04 M	5.8E+04 Ap	9.5E+03 Ap	1.6E+04 Ap	1.2E+05 Ap
T. levanderi v.Goor 1924	5.5E+06 Ap	1.6E+06 Ap	6.3E+04 Ap	8.6E+06 Ap	5.0E+05 Ap	1.6E+05 Ap	2.0E+06 Ap	2.3E+06 Ap	1.5E+06 Ap	9.9E+05 Ap	1.8E+06 Ap	1.0E+05 Ap
Thalassiosira nana / Cyclotella striata												
Lohmann 1908 / (Kutzing 1844) Grunow 1880								1.0E+05 Au	1.9E+04 S	2.5E+03 S	5.0E+03 S	
Centrales non def.	1.7E+05 Au	1.4E+05 Au	1.8E+05 Jl	7.3E+03 F	1.4E+04 F	2.6E+05 Jl	5.9E+03 F	1.6E+03 J	5.6E+02 O	6.0E+03 N	1.1E+04 O	4.0E+04 Jl
diatom cysta	6.0E+02 J8	1.0E+03 M	3.3E+04 Ap	5.0E+04 M	1.4E+05 M	1.4E+04 M	2.7E+03 Ap	7.9E+02 N	1.7E+02 Ap	4.1E+03 M	1.9E+04 N	2.1E+04 Ap
PENNALES												
Achnanthes taeniata Grunow in Cleve												
et Grunow 1880	4.0E+04 Ap	5.5E+04 Ap	3.8E+04 Ap	9.2E+04 M	2.9E+04 M	1.0E+04 M	1.8E+04 Ap	3.2E+04 M		4.9E+04 M	2.2E+04 M	6.7E+04 Ap
Achnanthes sp. Bory 1822		5.0E+02 F					6.3E+02 J	5.6E+02 O				
Amphiprora sp. Ehrenberg 1843			4.0E+01 J	4.0E+01 S								
Amphora ovalis (Kutzing 1833) Kutzing 1844					4.0E+01 Ap							
Asterionella formosa Hass. 1850	9.1E+03 Jl	1.4E+03 D										
Asterionella sp. Hass. 1850			2.8E+05 Ap			5.6E+02 M			2.0E+04 M		2.1E+02 N	

TABLE 1. continuation

TAXON	Station 92A			Station R6			Station G2					
	0-15m 1987	15-30m 1987	0-15m 1988	0-15m 1987	15-30m 1987	0-15m 1988	0-15m 1987	15-30m 1987	30-60m 1987	60-90m 1987	90m-bot. 1987	0-15m 1988
Diatoma elongatum (Lyngb. 1819) C.A.Agardh 1824	1.0E+03 D											
Diploneis interrupta (Kutzing 1844) Cleve 1894	5.1E+02 D	8.0E+01 Au							2.3E+01 Au		4.0E+01 J	
Fragilaria tabulata (C.A.Agardh 1830-32) Lange-Bertalot 1980b (syn.:Synedra tabulata (C.A.Ag. 1830-32) Kutz.1844)	5.1E+03 M											
F. ulna (Nitzsch 1817) Lange-Bertalot 1980b (syn.:Synedra ulna Kutzing 1844)	1.0E+03 D											
Fragilaria sp. Lyngb. 1819												
Navicula sp. Bory de St.Vincent 1824	1.5E+04 Ap	5.1E+02 F		1.8E+02 F	1.0E+04 M			7.9E+02 N	2.5E+02 J	3.8E+02 Ap		
Nitzschia closterium (Ehrenberg 1840) W.Smith 1853	1.5E+04 Jn	5.1E+03 JnJl			5.1E+03 M				5.5E+01 Ap	1.5E+02 N		
N. longissima (Breb. ex Kutzing 1849) Ralfs in Pritchard 1861			6.2E+03 Jn									
Nitzschia sp. Hass. 1845		1.0E+04 Jl	7.4E+02 F						1.9E+03 M		6.3E+02 N	
non def. Pennales	3.5E+04 Jl	1.7E+03 Jn	3.0E+03 M	3.1E+02 J	1.7E+03 J	3.7E+03 Jn	1.3E+04 Au	6.3E+03 N	1.9E+03 D	2.4E+02 M	4.6E+02 S	1.1E+04 Ap
DINOPHYCEAE (autotrophic only)												
Dinophysis group consist of:												
Dinophysis acuminata (group) Claparede et Lachmann 1858/59			2.4E+02 M	1.3E+02 M		7.7E+02 Jn	3.8E+02 Jn	1.4E+02 Jn		5.4E+02 N	4.2E+02 O	2.2E+02 Ap
D. acuta Ehrenberg 1839					1.2E+02 Jl		4.0E+01 ON					
D. arctica Mereschkowsky 1879	3.1E+03 Jn											
D. baltica (Paulsen 1908) Kofoid												
D. norvegica (group) Claparede et Lachmmann 1858/59	6.8E+03 Jl	9.6E+02 Jl	1.2E+02 Jl	3.0E+03 Jl	1.0E+03 Jl	1.0E+03 Jn	1.4E+03 Jl	2.0E+02 Jl	5.5E+01 O	1.6E+02 S		4.0E+01 JuJlAu
Dinophysis sp. Ehrenberg 1839	7.6E+02 Jl	7.5E+02 M	5.4E+03 Jn	2.0E+01 JM	1.5E+02 Jl	1.2E+02 Ap	9.6E+02 M		1.5E+02 M	5.5E+02 O	3.4E+02 Au	4.0E+01 F
Dissodinium pseudolunula Swift ex Elbrachter et Drebes 1978		4.0E+01 S		4.9E+02 S			8.8E+01 O					
Gonyaulax triacantha Jorgensen 1900	2.0E+04 Jn	1.5E+03 Jn	3.9E+03 Jn	1.1E+03 M	7.6E+01 N	1.5E+03 Jn	1.4E+03 M	7.9E+02 N				1.2E+02 Ap
Gymnodinium simplex (Lohmann 1908) Kofoid et Swezy 1921	3.1E+05 Jl	3.8E+05 M		7.2E+04 Au	3.0E+04 M	1.3E+04 Ap	6.7E+04 Au	4.0E+04 M	5.2E+04 M	2.6E+04 M	1.6E+04 Mr	
Gymnodinium sp. Stein 1878	2.3E+05 Ap	2.4E+02 Jn		5.0E+02 F	5.1E+03 Ap		1.1E+04 Ap	9.9E+03 S		6.0E+03 Jl	8.8E+02 S	
Gyrodinium aureolum Hulburt 1957						4.0E+01 M			8.8E+01 F		8.9E+01 F	9.4E+01 Ap
Heterocapsa triquetra Stein 1883	4.1E+04 Jn	6.8E+03 Jn	7.1E+05 Jn			4.9E+04 JN	3.0E+04 Ap	1.6E+04 Ap	7.7E+03 M	1.5E+02 N	8.0E+01 Mr	2.4E+02 Au
Katodinium rotundatum (Lohmann 1908) Loeblich III 1965	2.3E+05 M	5.1E+04 Jn	2.4E+04 Ap	2.4E+05 M	1.0E+05 M	4.9E+04 M	3.9E+05 M	3.9E+04 N	2.4E+03 M	2.2E+03 Mr	1.3E+04 Ap	3.5E+04 Ap
Naked Dinophyceae (Gymnodinium / / Gyrodinium mainly)			3.4E+04 Jl			2.4E+04 M						
Peridinella catenata (Levander 1894) Balech 1977 (syn.:Gonyaulax catenata (Levander 1894) Kofoid 1911b)	4.9E+05 M	2.2E+04 M	6.0E+04 Ap	7.4E+04 M	1.9E+03 M	2.6E+05 M	6.3E+05 M	2.5E+05 M	2.4E+04 M	2.0E+04 M		6.3E+04 Ap
Prorocentrum balticum (Lohmann 1908) Loeblich III 1970	1.4E+06 Jl	2.3E+05 Jl	2.8E+03 Jl	3.3E+04 Jl	1.5E+04 S	1.2E+04 Jl	3.8E+02 Jn		4.0E+03 M	5.0E+02 J		3.7E+03 Jl
P. micans Ehrenberg 1835										1.5E+02 Au		
P. minimum (Pavillard 1916) Schiller 1933			2.7E+04 Jn			6.0E+03 Jn						3.0E+03 Ap
Prorocentrum sp. Ehrenberg 1835	4.7E+04 Ap	7.2E+03 O	2.1E+04 Jl	4.1E+03 O	3.1E+04 Jl	2.4E+03 Au	3.5E+04 Jl	4.1E+04 Jl	8.4E+03 Ap	3.1E+03 M	2.1E+04 Ap	
Scripsiella sp. Balech 1959 ex ex Loeblich III 1965 ?	1.4E+05 Jl	3.3E+04 Ap	4.4E+03 Jn	4.2E+05 M	2.2E+05 M	5.6E+02 Ap	4.7E+03 Ap	3.3E+04 M	2.5E+02 J	5.9E+03 M		
Dinophyceae non def	3.1E+04 Jn	1.2E+05 M		6.7E+03 M	3.6E+03 M		5.2E+04 O	2.7E+03 J	1.9E+02 Au	3.4E+02 Mr	5.0E+03 Jl	
dinoflagellate cysta	1.0E+03 D	2.2E+03 Jn	1.9E+03 M	3.0E+03 M	2.1E+03 S	4.0E+02 Ap	2.1E+02 Mr	3.6E+03 M	2.2E+02 N	6.3E+02 Mr	2.2E+03 Ap	7.5E+02 Jn
CHLOROPHYCEAE												
VOLVOCALES												
Chlamydomonas Ehrenberg 1837								1.6E+03 Mr				
Volvox aureus Ehrenberg 1830	4.0E+01 S	4.0E+01 S			4.0E+01 S							

TABLE 1. continuation

TAXON	Station 92A 0-15m 1987	Station 92A 15-30m 1987	Station 92A 0-15m 1988	Station R6 0-15m 1987	Station R6 15-30m 1987	Station R6 0-15m 1988	Station G2 0-15m 1987	Station G2 15-30m 1987	Station G2 30-60m 1987	Station G2 60-90m 1987	Station G2 90m-bot. 1987	Station G2 0-15m 1988
CHLOROCOCCALES												
Actinastrum hantzschii Lagerheim 1883a	1.1E+04 Jl	5.1E+02 O										
Ankistrodesmus falcatus (Corda 1835) Ralfs 1848				2.6E+03 Au					7.2E+01 F			
Ankistrodesmus sp. Corda 1838	1.7E+04 Jl		1.1E+05 Jn			7.3E+04 Jn	8.4E+02 Au	7.1E+03 N	1.4E+03 Au		7.4E+02 Au	
Botryococcus braunii Kutzing 1849 ?							2.7E+02 J					
Chlorella sp. Beijerinck 1890 ?	1.0E+03 D		2.1E+03 J	8.7E+03 Au			1.6E+03 S	1.9E+03 Au		3.8E+02 Ap		
Coelastrum microporum Nageli in Kutzing 1849	1.5E+03 Jl	3.1E+03 O	4.9E+03 Jn			2.8E+03 Jn	1.2E+03 Mr	6.3E+03 N				4.8E+02 Au
C. reticulatum (Dangeard 1889) Senn 1899	8.6E+02 O	6.3E+02 Mr		2.4E+03 N	1.2E+03 N							
Crucigenia quadrata Morren 1830	1.0E+05 Jl	5.1E+03 S				3.0E+02 Jl	4.7E+03 S	3.2E+03 N			5.4E+02 D	3.0E+02 Jl
C. tetrapedia (Kirchner 1880) W. et G.S.West 1902	7.0E+04 Jl	2.1E+03 O	9.4E+02 Jl									
Crucigenia sp. Morren 1830								3.2E+02 Mr				
Crucigeniella rectangularis (Nageli in litt. 1849) Komarek 1974	7.0E+04 Jl	3.8E+03 S			1.0E+03 O							
Dictyosphaerium ehrenbergianum Nageli 1849	1.7E+03 M	2.1E+04 Jl										
D. pulchellum Wood 1874									1.4E+02 Ap			
Dictyosphaerium sp. Nageli 1849 ?	1.7E+04 Jl		1.9E+03 Jl		5.1E+03 Au		7.4E+04 Au	3.8E+04 Au		3.1E+02 S		
Kirchneriella lunaris (Kirchner 1878) Moebius 1894	5.2E+04 Jl	5.1E+03 Au										
K. obesa (W.West 1892) Schmidle 1893	1.5E+04 S	1.5E+04 AuS										
Kirchneriella sp. Schmidle 1893				3.1E+04 O	2.1E+04 S	6.1E+03 Jn	1.1E+03 S		2.7E+03 S	1.7E+03 O		
Monoraphidium convolutum / contortum (Corda 1838) Kom.-Legn. 1969 / / (Thuret in Breb.1856) Kom.-Legn. 1969	2.3E+05 Jl	1.5E+04 Au	1.1E+05 Jl	2.2E+03 M		8.6E+03 Jn	2.9E+03 M	3.9E+03 O		1.3E+03 S	1.9E+03 N	1.1E+03 Ap
Nephrochlamys subsolitaria (G.S.West 1908) Kors.1953 (syn.:Kirchneriella subsolitaria G.S.West 1908)	5.2E+04 Jl											
Oocystis borgei Snow 1903	2.6E+03 O	1.0E+03 O			4.9E+05 D		2.2E+03 S	9.7E+03 Au	1.9E+03 Au	2.0E+02 D		
O. lacustris Chodat 1897							6.5E+03 S	1.2E+04 S				
O. Novae-Semliae Wille	5.1E+03 Au	1.2E+02 S					2.2E+03 S	7.0E+03 O		4.0E+01 S		
O. pelagica Lemmermann 1901b		4.0E+01 S		1.0E+03 N								
O. solitaria Wittrock in Wittrock et Nordstedt 1879		1.7E+03 Au						1.1E+03 O				
O. submarina Lagerheim 1886a	8.7E+04 Jl	1.0E+04 JD	1.7E+04 Jn	3.6E+04 Au	3.9E+04 S	1.3E+04 Au	3.8E+04 Au	2.4E+04 S	5.2E+02 O	7.6E+03 D	8.3E+03 O	4.5E+03 Au
O. submarina / lacustris								1.5E+03 S				
Oocystis sp. Nageli in A.Br. 1855	3.8E+04 S	2.1E+04 M	5.2E+04 Jl	2.8E+04 O	3.8E+02 J	3.1E+04 Jn	3.0E+04 S	1.1E+04 O		4.5E+03 N	1.3E+04 O	1.3E+04 Jl
Pediastrum boryanum (Turpin 1828) Meneghini 1840	8.6E+02 O	2.6E+03 Jn	4.0E+01 Jl	2.0E+01 F		4.8E+02 F	2.4E+01 Jn	8.4E+01 Mr	2.0E+01 Ap	2.0E+01 Jl	1.4E+02 M	4.0E+01 JlAu
P. duplex Meyen 1829	1.7E+04 Jl	7.5E+02 M										
P. kawraiskyi Schmidle 1897b		4.0E+01 Jn			1.3E+02 M							
P. tetras (Ehrenberg 1838) Ralfs 1844			8.0E+01 Jl									
Pediastrum sp. Meyen 1829			1.9E+02 F		2.0E+01 J							
Scenedesmus acuminatus (Legerheim 1883a) Chodat 1902	8.7E+04 Jl	5.1E+03 O	2.6E+04 Jl	1.3E+02 F		4.5E+03 Jn	2.4E+03 Mr	1.6E+03 N		3.1E+02 N	6.3E+02 N	5.1E+03 Jl
S. arcuatus (Lemmermann 1898a) Lemmermann 1899	2.3E+03 Jl	3.1E+03 D										
S. bicaudatus (Hansg. 1890) Chodat 1929	1.7E+04 Jl	1.0E+03 D										
S. denticulatus Lagerheim 1883a		7.7E+03 Jn		1.3E+02 F								
S. ecornis (Ehrenberg 1835) Chodat 1926	1.0E+03 F			1.0E+03 Au		5.7E+02 M	4.2E+03 Ap	3.2E+03 N		9.0E+02 Mr	4.2E+02 N	7.3E+02 Jl
S. opoliensis P.Richter 1896	4.5E+03 Jl	2.8E+02 Jl					3.2E+03 S	3.0E+03 S			3.7E+02 Ap	
S. quadricauda (Turpin 1820) Brebisson et Goday 1835	3.5E+04 Jl	9.7E+03 D	3.5E+04 Jl	2.6E+03 Jl	2.8E+03 F	1.7E+04 Jn	4.4E+03 Au	1.6E+03 N	2.5E+03 F	6.2E+02 N	8.8E+02 S	4.7E+03 Jl
Scenedesmus sp. Meyen 1829	6.3E+02 F	3.6E+04 Jl	3.4E+04 Jn	9.4E+02 J	6.3E+02 F	1.7E+04 F	1.1E+03 O	5.6E+02 O	1.1E+03 N	1.1E+03 Au	2.6E+03 O	1.5E+02 F
Schroederia setigera (Schroder 1897a) Lemm.1898b (syn.:Ankistrodesmus setigerus (Schroder 1897a) G.S.West 1907)	1.7E+03 N						1.6E+02 N					
Tetraedron caudatum (Corda 1839) Hansgirg 1888a											2.1E+02 N	
T. minimum (A.Braun 1855) Hansgirg 1888a									1.7E+02 Mr			
T. trigonum (Nageli 1849) Hansgirg 1888a			9.4E+02 Jl									

TABLE 1. continuation

TAXON	Station 92A			Station R6			Station G2					
	0-15m	15-30m	0-15m	0-15m	15-30m	0-15m	0-15m	15-30m	30-60m	60-90m	90m-bot.	0-15m
	1987	1987	1988	1987	1987	1988	1987	1987	1987	1987	1987	1988
ULOTRICHALES												
Binuclearia lauterbornii (Schmidle 1903) Proschkina-Lavrenko 1966			1.4E+04 Jl	5.1E+02 F		1.2E+03 Jl	6.8E+03 S	1.1E+04 O	1.0E+04 S	3.1E+03 O	4.9E+03 O	5.9E+02 Jl
Ulothrix sp. Kutzing 1833a	7.6E+02 Jl				6.8E+03 S							
DESMIDIALES												
Cosmarium laeve Rbh. 1868					5.1E+03 Ap							
Staurastrum gracile Ralfs 1845 ex Ralfs 1848									2.0E+01 Mr			
Chlorophyceae non def.	1.3E+05 Jl	1.0E+03 O	1.9E+05 Jl	2.6E+03 S	3.1E+04 Ap	3.5E+04 Jl	7.0E+03 O	7.7E+03 Jl	1.1E+04 N	6.2E+03 Ap	9.1E+03 N	2.1E+04 Jl
EUGLENOPHYCEAE												
Euglena acus Ehrenberg 1830	1.4E+05 Ap	2.8E+03 Ap		9.5E+03 Ap	7.3E+02 Mr							
Euglena sp. Ehrenberg 1830	2.2E+03 S		4.0E+02 F	1.3E+04 Ap	1.4E+03 Ap		2.3E+04 Ap	1.9E+04 Ap		6.2E+02 M		
Eutreptia viridis Perty 1852	3.2E+04 Ap	6.8E+03 Ap		4.8E+03 Ap			3.2E+03 Ap	9.6E+02 Ap	3.9E+02 Ap	7.0E+02 Ap	5.0E+02 Ap	
E. lanowii Steuer 1904	2.6E+05 Au	5.6E+04 Au		1.4E+04 O	5.6E+04 S		2.0E+04 S				1.5E+02 Ap	
Eutreptia sp. Perty 1852	6.8E+03 Ap	8.7E+03 F		3.3E+04 S	6.1E+03 Ap		6.2E+03 Mr	2.9E+04 S	1.3E+03 O		8.8E+02 S	
Eutreptiella gymnastica Throndsen 1969			2.6E+04 Jn			3.9E+04 Ap		2.2E+04 S	4.2E+02 Mr			1.2E+04 Ap
Trachelomonas cf. schewiakoffii Skvortzov 1925				2.5E+02 Ap	1.2E+03 Ap		3.9E+02 Ap	3.2E+03 Ap	2.9E+03 Ap	2.3E+03 Ap	4.0E+03 Ap	
T. volvocina Ehrenberg 1833			1.2E+02 Jl									
Trachelomonas sp. Ehrenberg 1833 emend. Deflandre 1926			4.0E+01 Ap									
Euglenophyceae non def.	1.7E+04 Jl			1.5E+04 S	1.9E+03 F			6.3E+03 N	2.5E+03 F	5.0E+02 F	2.6E+03 O	
OTHER PHYTOPLANKTON ORGANISMS												
CHRYSOPHYCEAE	5.1E+03 Jn	1.0E+03 Jn	2.0E+04 Jl			5.2E+03 Au	1.5E+04 Jl	1.2E+04 M	2.7E+03 M	3.0E+03 Jn	6.4E+03 Jn	8.5E+03 Ap
Pedinellaceae Pascher 1916			4.1E+05 Jn			1.3E+05 Jn						
Uroglena sp. Ehrenberg 1838	2.0E+02 F	5.1E+03 S		2.6E+03 S								
Dinobryon balticum (Schutt 1896) Lemmermann 1900							8.8E+03 M	7.8E+03 M	2.8E+03 M	2.2E+03 D	1.1E+04 O	
Dinobryon sp. Ehrenberg 1832a						2.4E+03 Jn						9.4E+02 F
CRYPTOPHYCEAE	7.1E+05 Au	3.6E+05 S	3.3E+06 Jl	3.7E+05 S	6.1E+05 Au	3.7E+05 Au	3.2E+05 S	2.3E+05 S	4.9E+04 S	1.0E+04 Ap	1.6E+04 O	1.2E+06 Au
PRASINOPHYCEAE												
Pyramimonas sp. Schmarda 1850	4.8E+05 Au	1.4E+05 Au	6.1E+05 Jl	1.5E+05 S	1.1E+05 S	2.0E+05 Jl	1.5E+05 S	6.5E+04 Au	4.9E+03 F	4.3E+03 Ap	2.5E+03 Au	1.9E+05 Au
Flagellata non def.	5.0E+06 Jn	1.0E+06 Jn	1.2E+06 Jl	3.9E+06 Jl	2.0E+06 Au	7.1E+05 Jl	2.0E+05 Ap	1.0E+05 J	1.3E+05 Ap	4.6E+04 Ap	2.5E+04 N	9.3E+04 Au
Others non def.		1.0E+04 M	1.5E+06 Jl	8.0E+02 Au		7.4E+05 Jl	1.7E+04 S			7.5E+02 N	1.8E+04 M	2.1E+05 Au
cysts	5.1E+02 D	2.6E+03 M	8.3E+04 Jn	1.0E+04 M	3.9E+03 J	8.3E+03 Jl	6.0E+03 M	9.7E+03 Au	3.5E+03 Au	9.0E+04 M	6.5E+03 J	1.9E+03 Jl
AUTOTROPHIC BUT NOT PHYTOPLANKTON ORGANISMS												
Mesodinium rubrum (Lohmann 1908) Hamburger et Buddenbrock 1911	8.5E+04 O	5.0E+04 O	2.7E+05 Jn	5.2E+04 Jl	6.4E+04 M	7.2E+04 Jn	7.7E+04 M	7.3E+04 N	9.2E+03 N	8.4E+03 Jn	1.9E+04 Jn	2.2E+04 Au

J - January, F - February, Mr - March, Ap - April, M - May, Jn - June, Jl - July, Au - August, S - September, O - October, N - November, D - December

? determination of the taxon is uncertain

* unit = cell or colony/cenobium in the case of some Cyanophyceae, Bacillariophyceae and Chlorophyceae

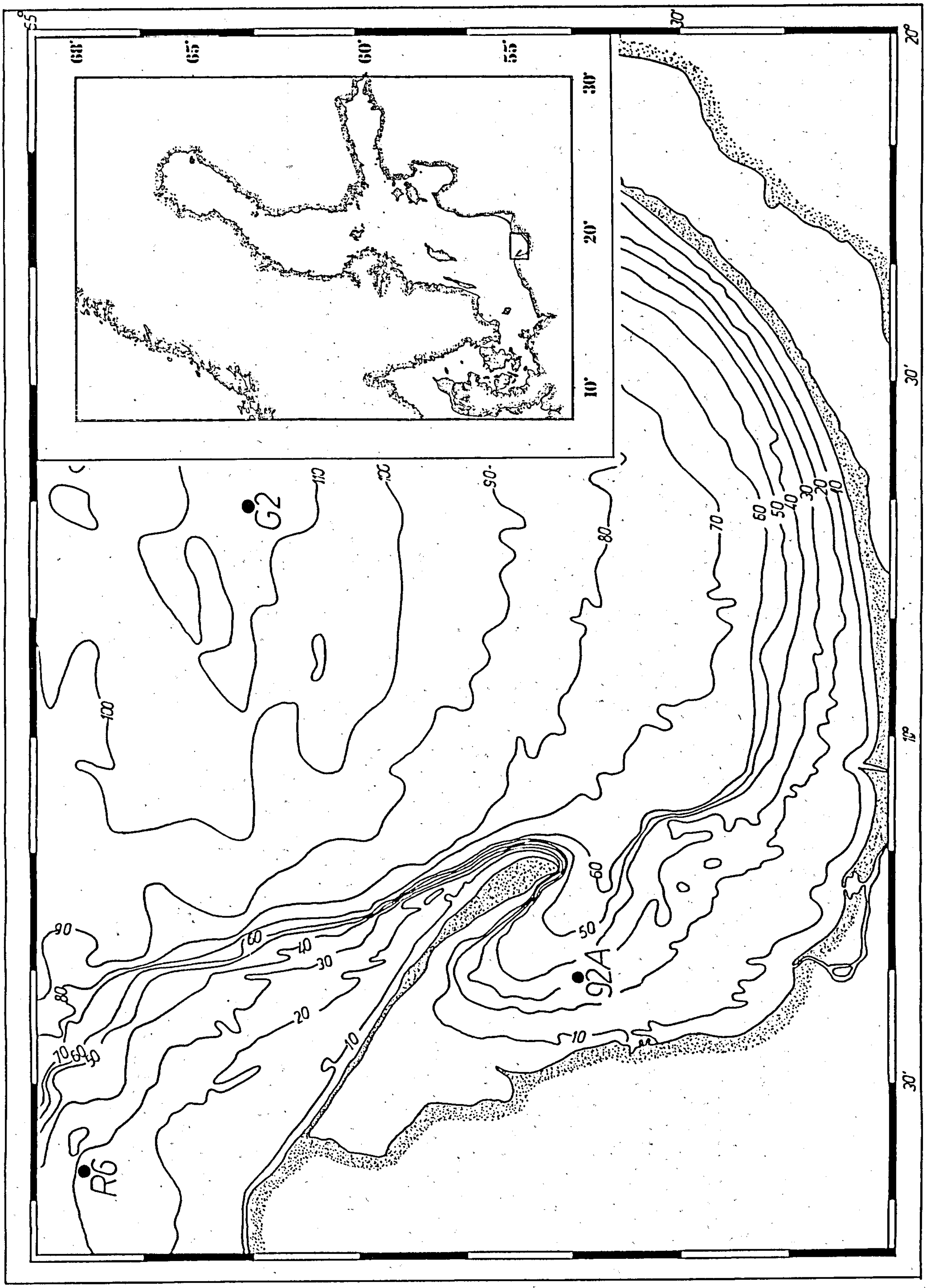


FIG.1 - CHART WITH THE STATIONS DISTRIBUTION.

FIG.2a - TEMPERATURE CHANGES DURING 1987 AT THE STATION 92A.

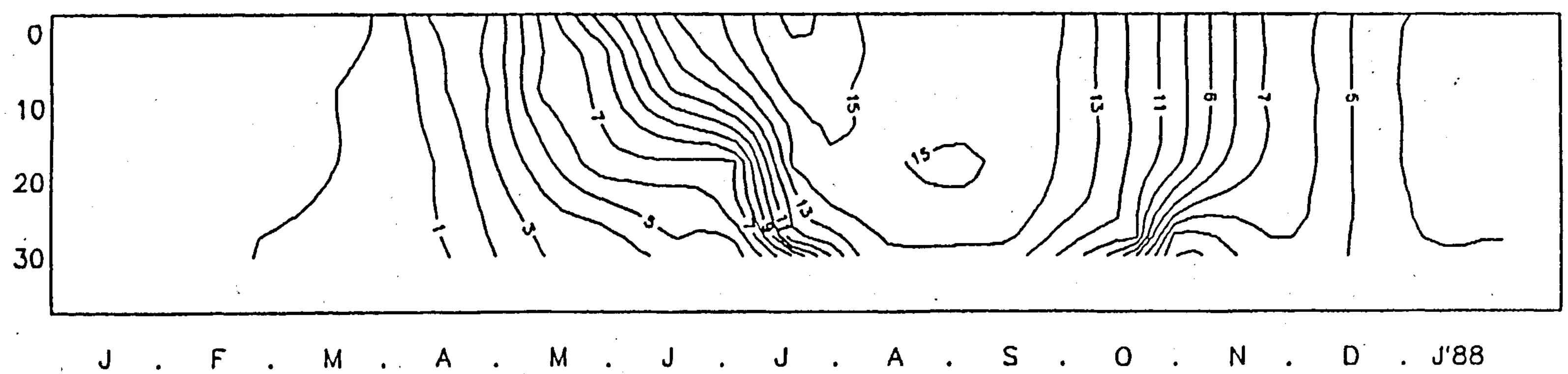
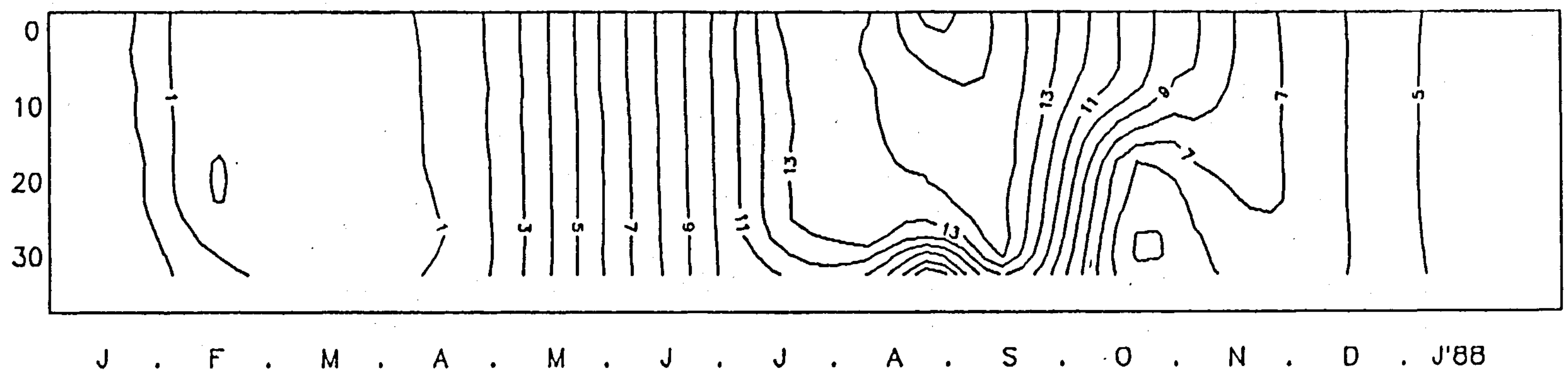


FIG. 2b - TEMPERATURE CHANGES DURING 1987 AT THE STATION R6.



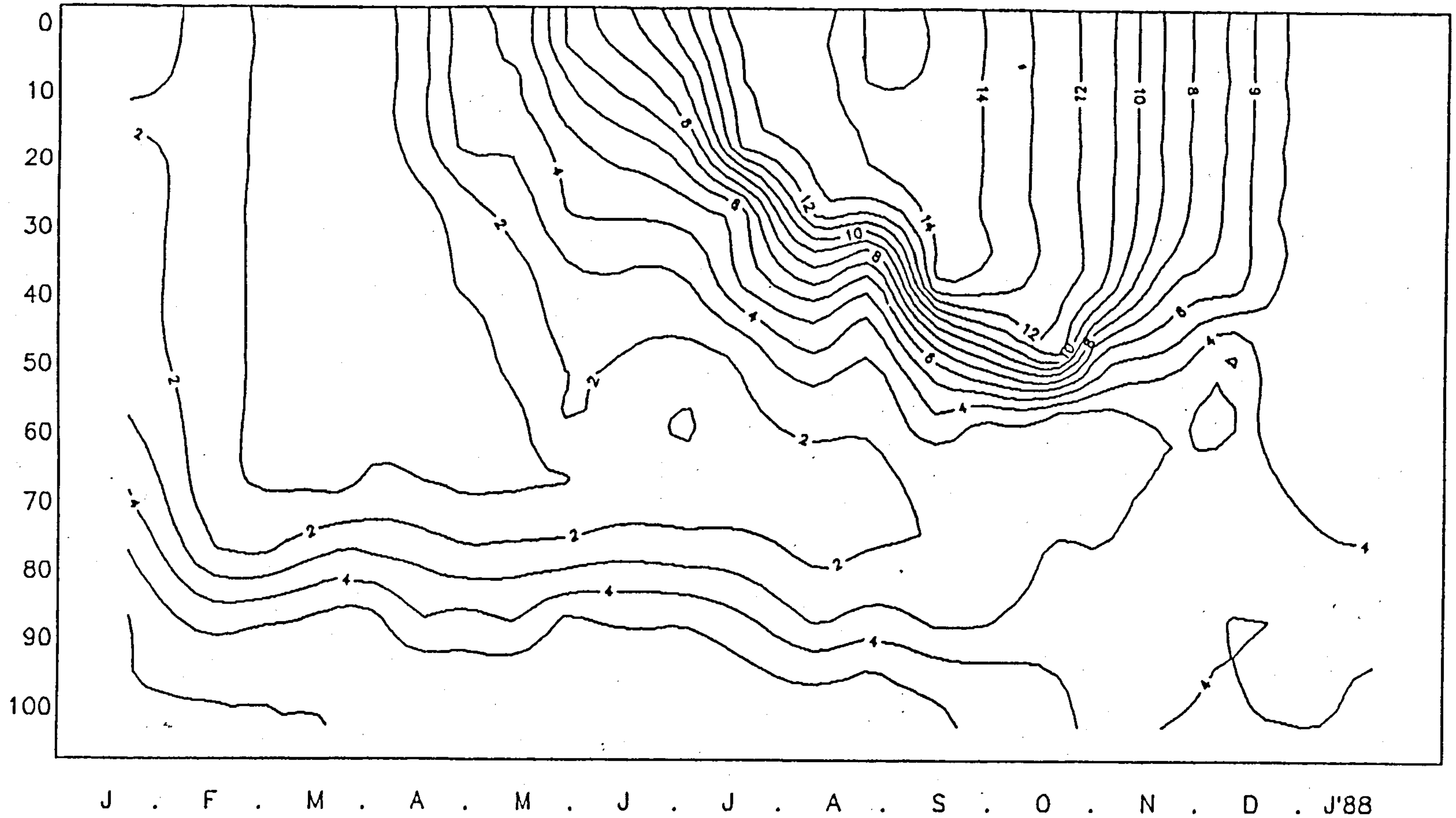
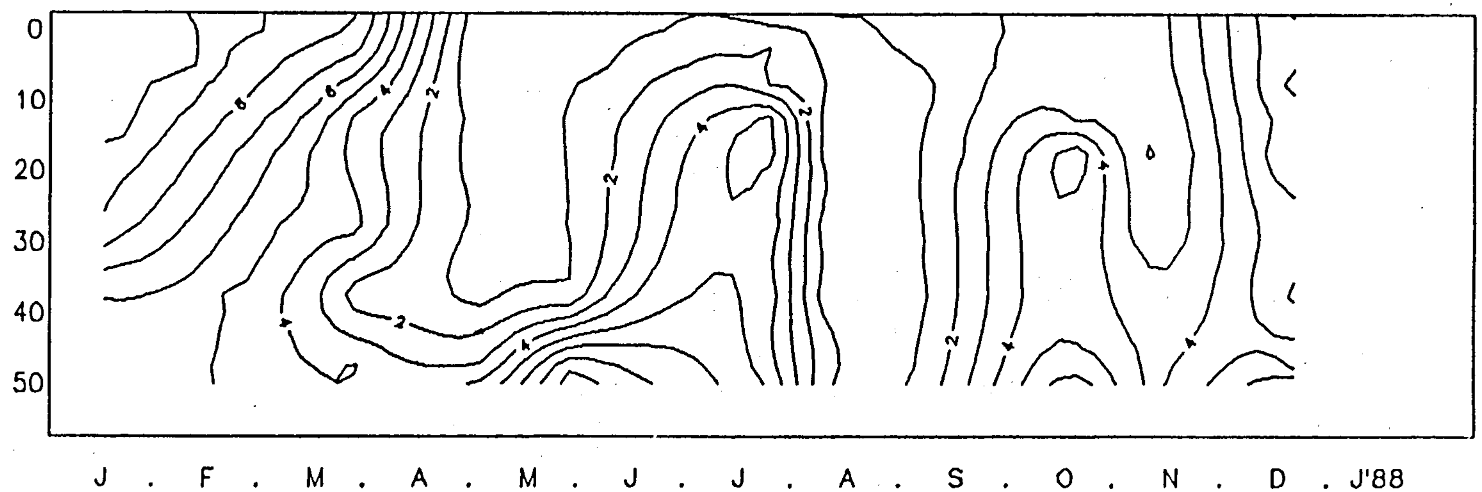


FIG. 2c - TEMPERATURE CHANGES DURING 1987 AT THE STATION G2.

FIG.3a - CHANGES IN THE CONCENTRATION OF THE INORGANIC NITROGEN IN THE WATER COLUMN. STATION P104 (SITUATED NEAR 92A). (DATA ACCORDING TO INSTITUTE OF METEOROLOGY AND WATER MANAGEMENT).



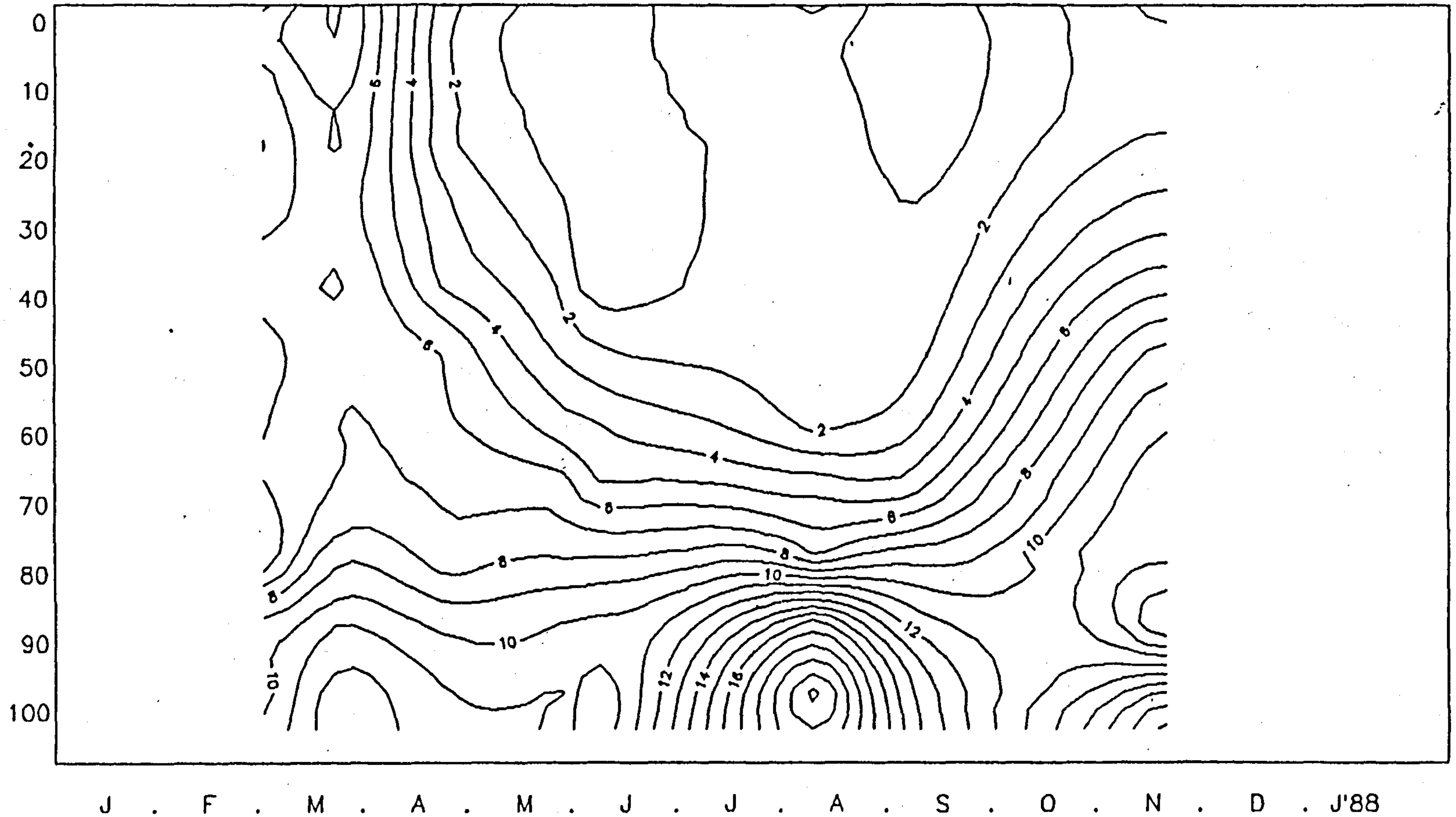


FIG.3b - CHANGES IN THE CONCENTRATION OF THE INORGANIC NITROGEN IN THE WATER COLUMN. STATION G2 (DATA ACCORDING TO INSTITUTE OF METEOROLOGY AND WATER MANAGEMENT).

FIG.4a - CHANGES IN THE CONCENTRATION OF PHOSPHATE (PO_4) IN THE WATER COLUMN IN 1987. STATION 92A.

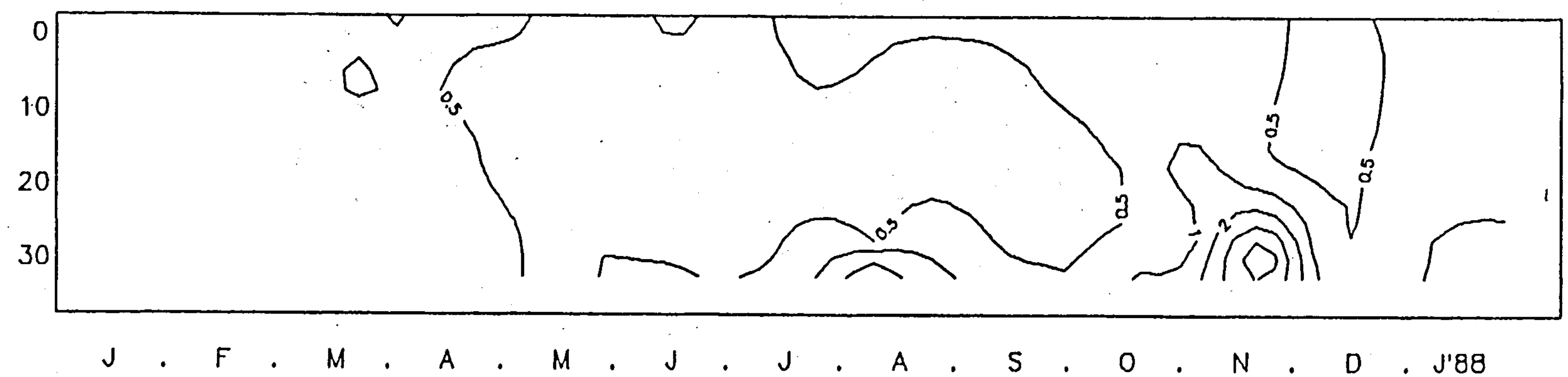
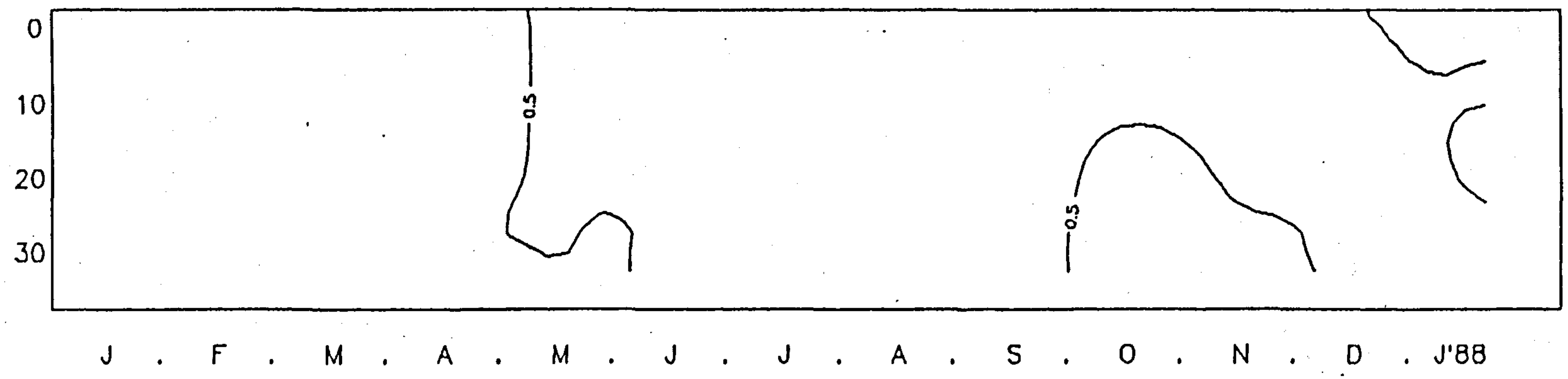


FIG. 4b - CHANGES IN THE CONCENTRATION OF PHOSPHATE (PO_4) IN THE WATER COLUMN IN 1987. STATION R6.



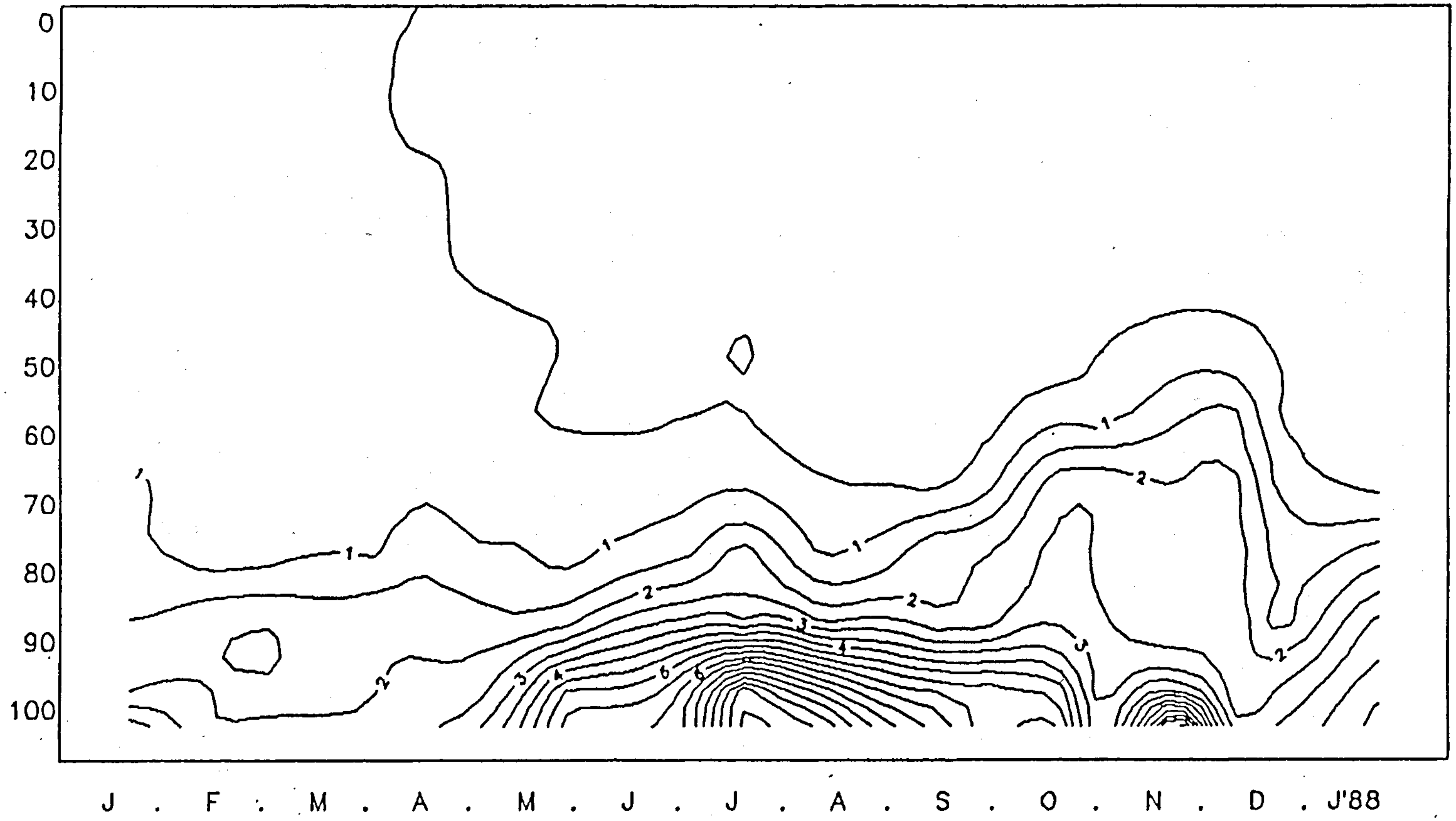
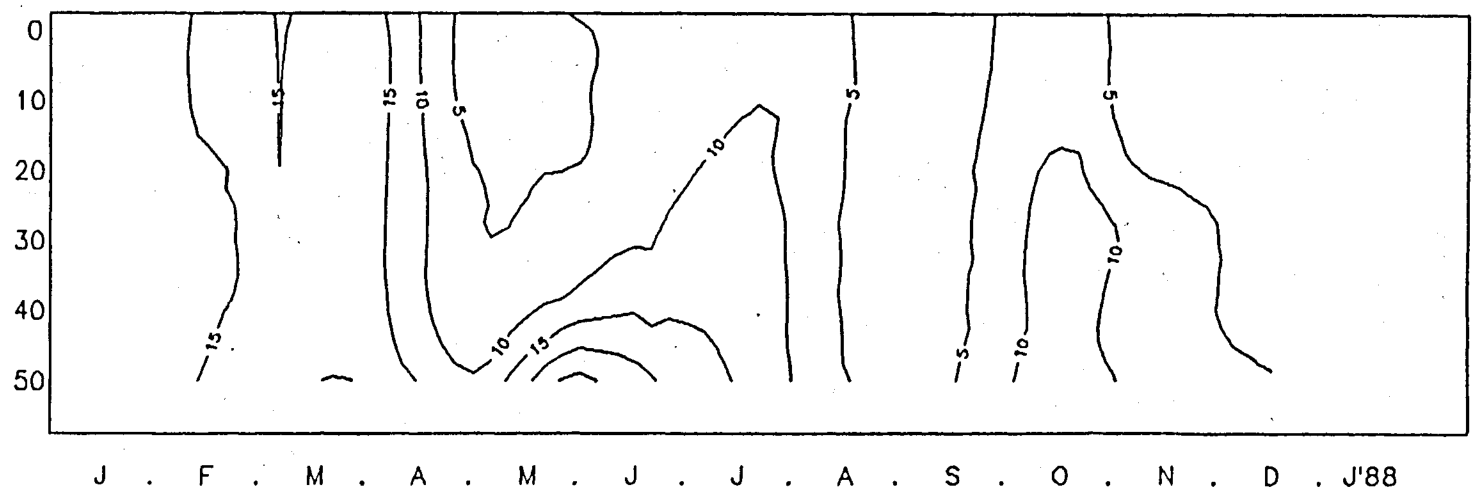


FIG. 4c - CHANGES IN THE CONCENTRATION OF PHOSPHATE (PO_4) IN THE WATER COLUMN IN 1987. STATION G2.

FIG. 5a - CHANGES IN THE CONCENTRATION OF INORGANIC SILICIUM IN THE WATER COLUMN IN 1987. STATION P104 (SITUATED NEAR 92A). (DATA ACCORDING TO INSTITUTE OF METEOROLOGY AND WATER MANAGEMENT).



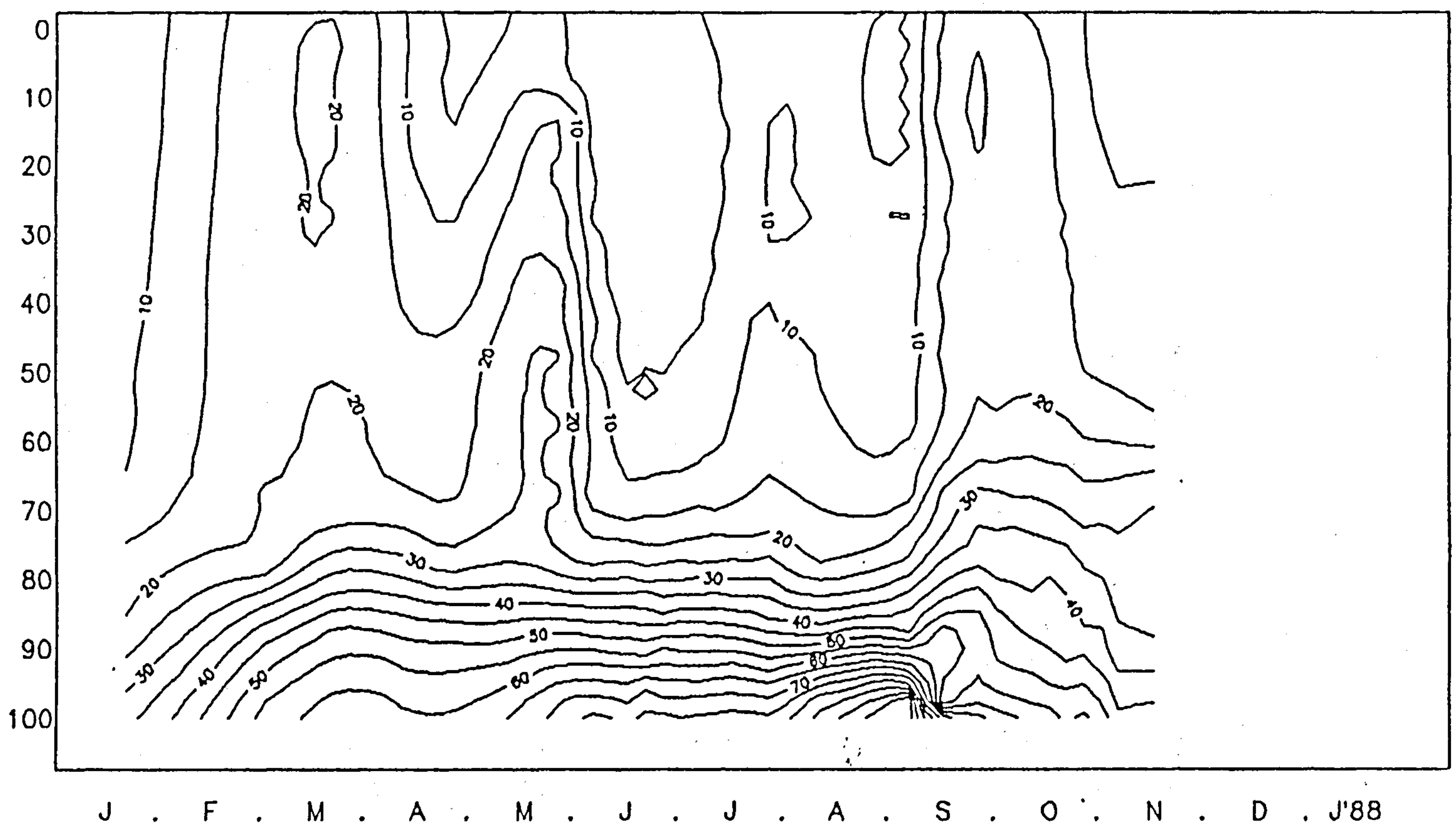


FIG.5b - CHANGES IN THE CONCENTRATION OF INORGANIC SILICIUM IN THE WATER COLUMN IN 1987. STATION G2. (DATA ACCORDING TO INSTITUTE OF METEOROLOGY AND WATER MANAGEMENT).

FIG. 6a - CHANGES OF THE PHYTOPLANKTON BIOMASS IN THE UPPER LAYER (0-15M) TAKING INTO CONSIDERATION THE CONTRIBUTION OF THE MOST IMPORTANT GROUPS OF ORGANISMS. STATION 92A.

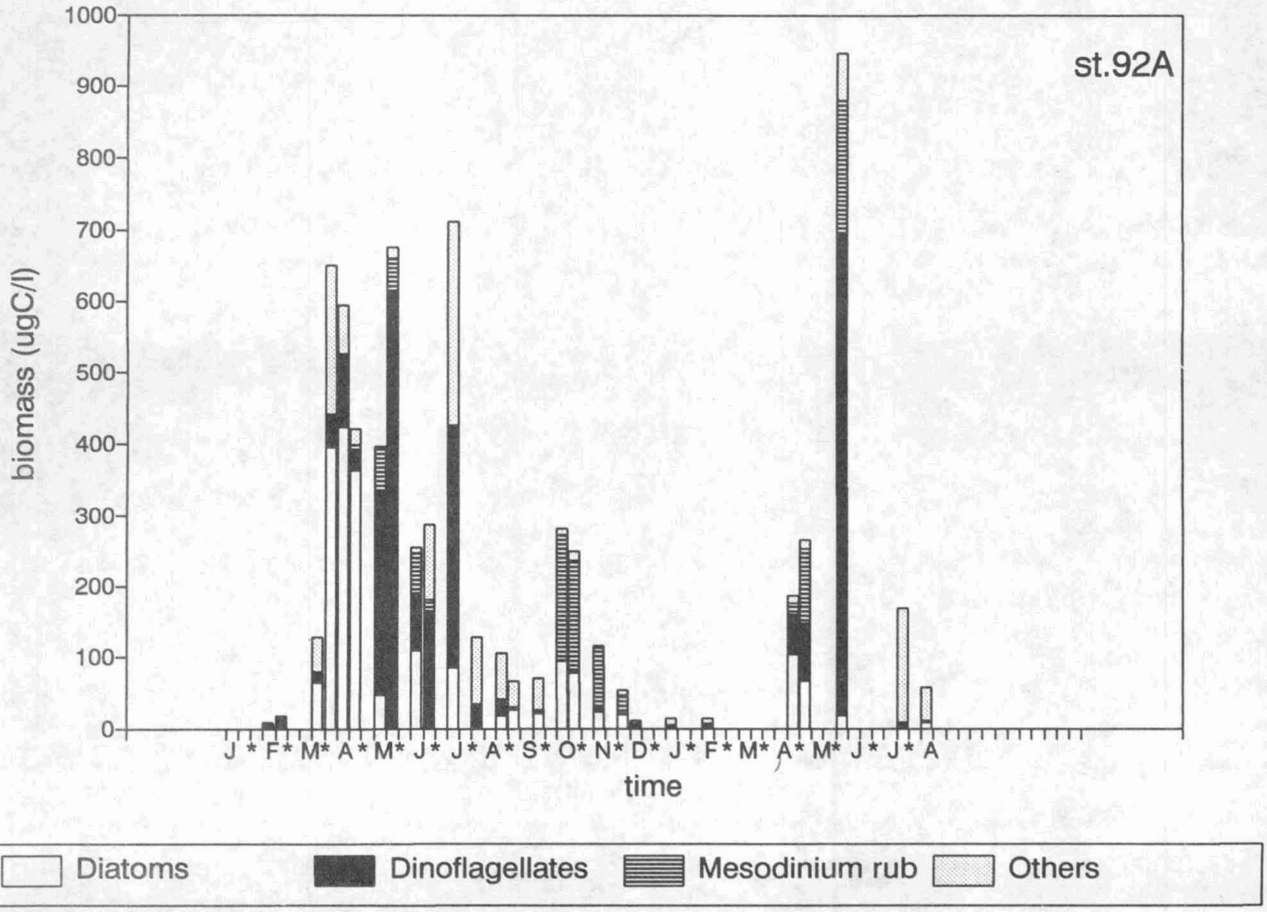


FIG. 6b - CHANGES OF THE PHYTOPLANKTON BIOMASS IN THE UPPER LAYER (0-15M) TAKING INTO CONSIDERATION THE CONTRIBUTION OF THE MOST IMPORTANT GROUPS OF ORGANISMS. STATION R6.

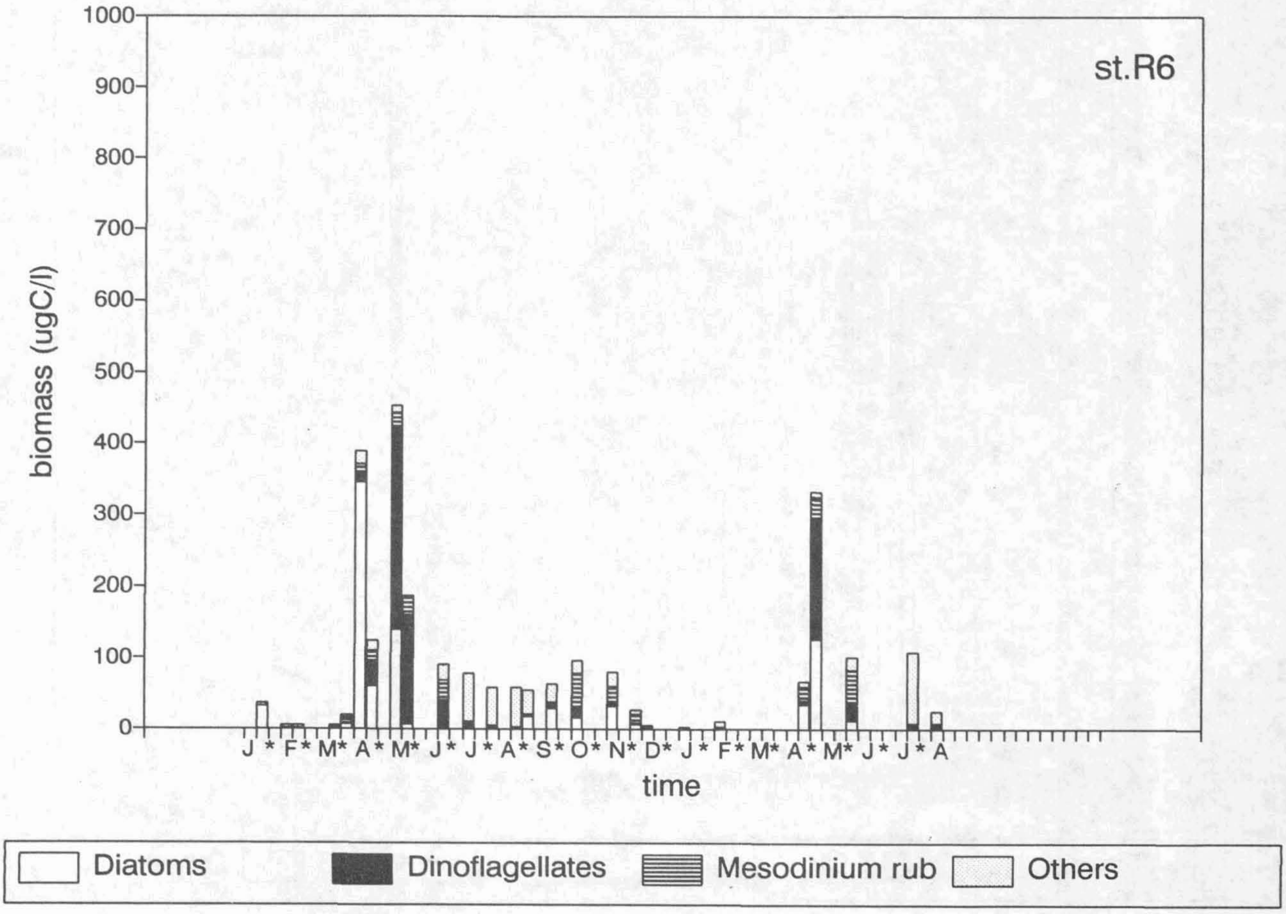


FIG. 6c - CHANGES OF THE PHYTOPLANKTON BIOMASS IN THE UPPER LAYER (0-15M) TAKING INTO CONSIDERATION THE CONTRIBUTION OF THE MOST IMPORTANT GROUPS OF ORGANISMS. STATION G2.

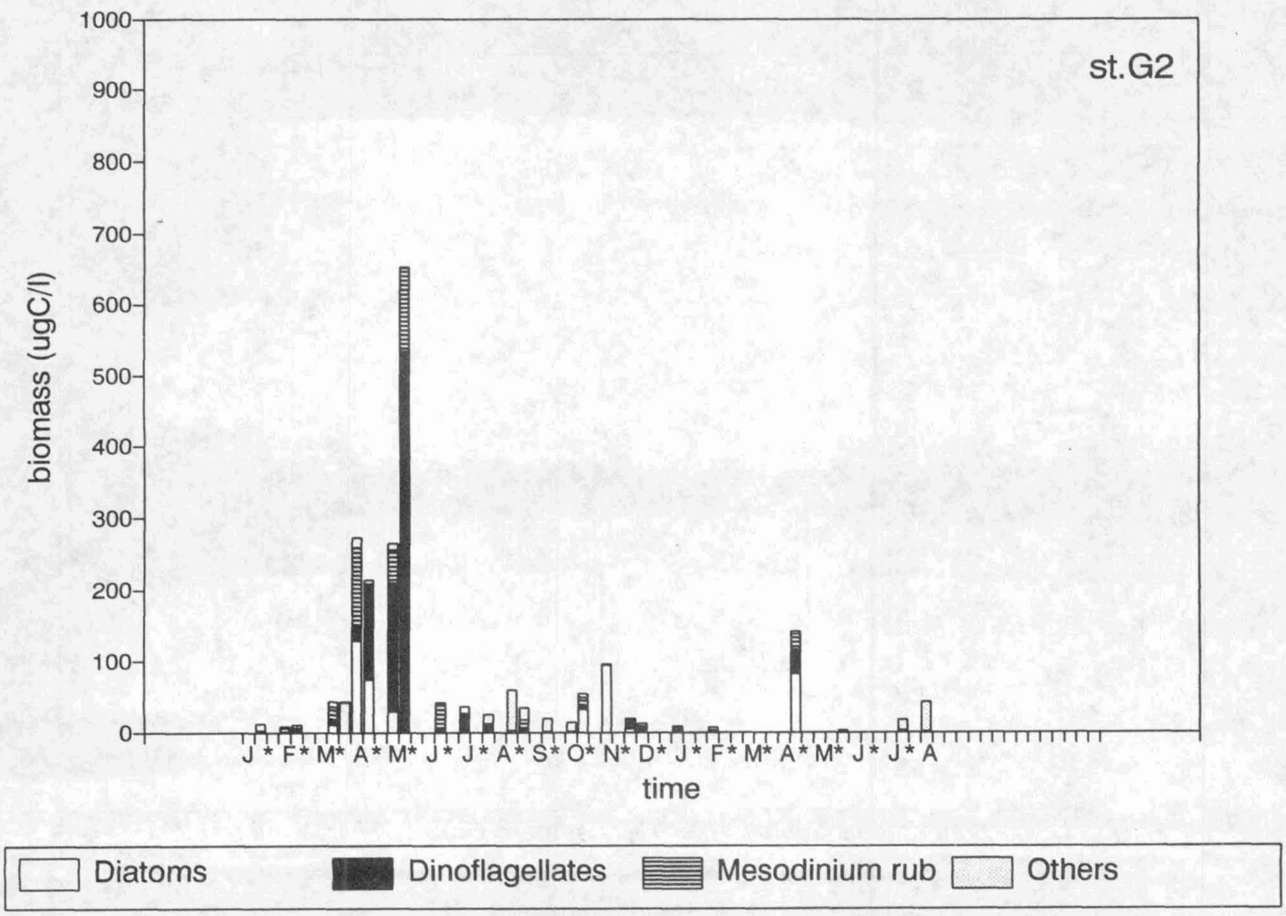


FIG.7a - CHANGES OF THE DIATOM BIOMASS IN THE UPPER LAYER (0-15M) TAKING INTO CONSIDERATION THE CONTRIBUTION OF THE MOST IMPORTANT TAXA. STATION 92A.

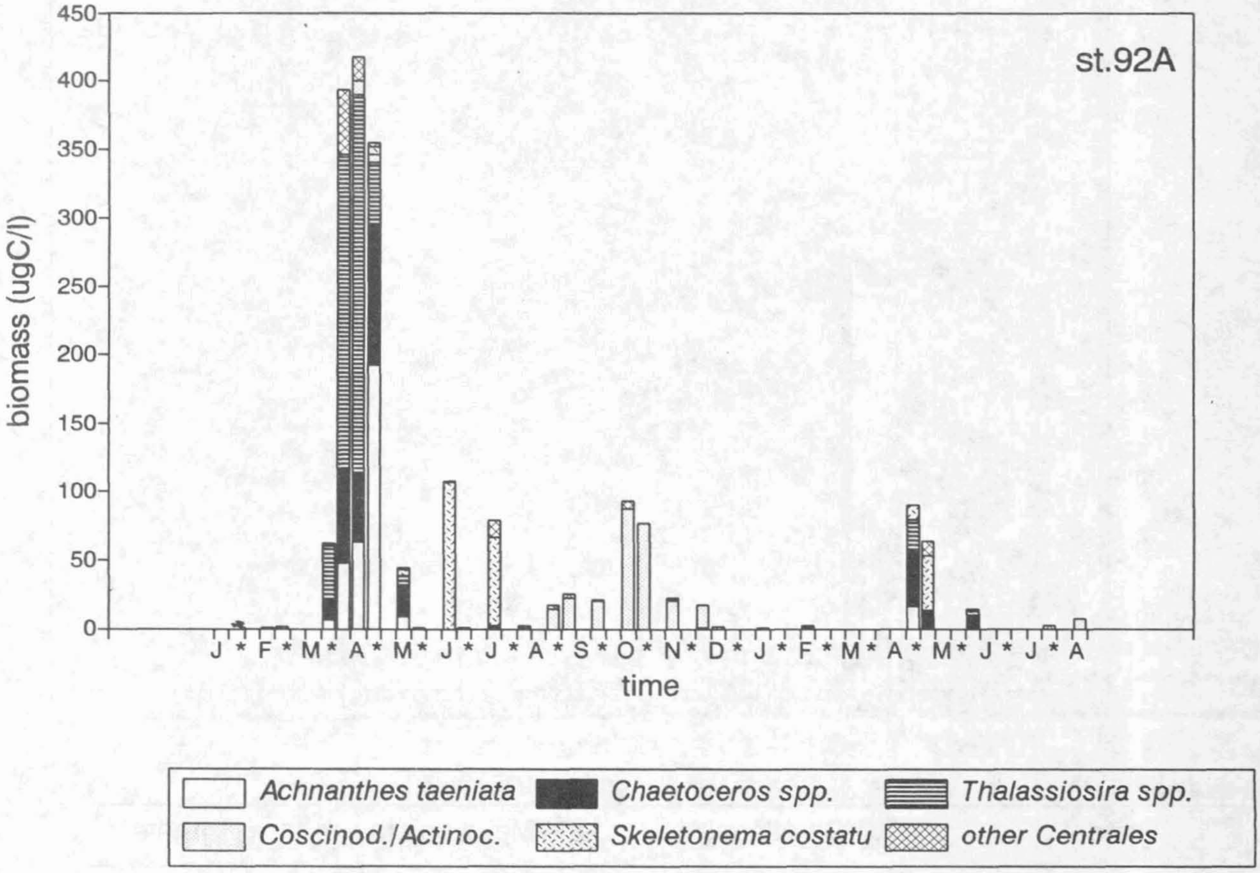


FIG. 7b - CHANGES OF THE DIATOM BIOMASS IN THE UPPER LAYER (0-15M) TAKING INTO CONSIDERATION THE CONTRIBUTION OF THE MOST IMPORTANT TAXA. STATION R6.

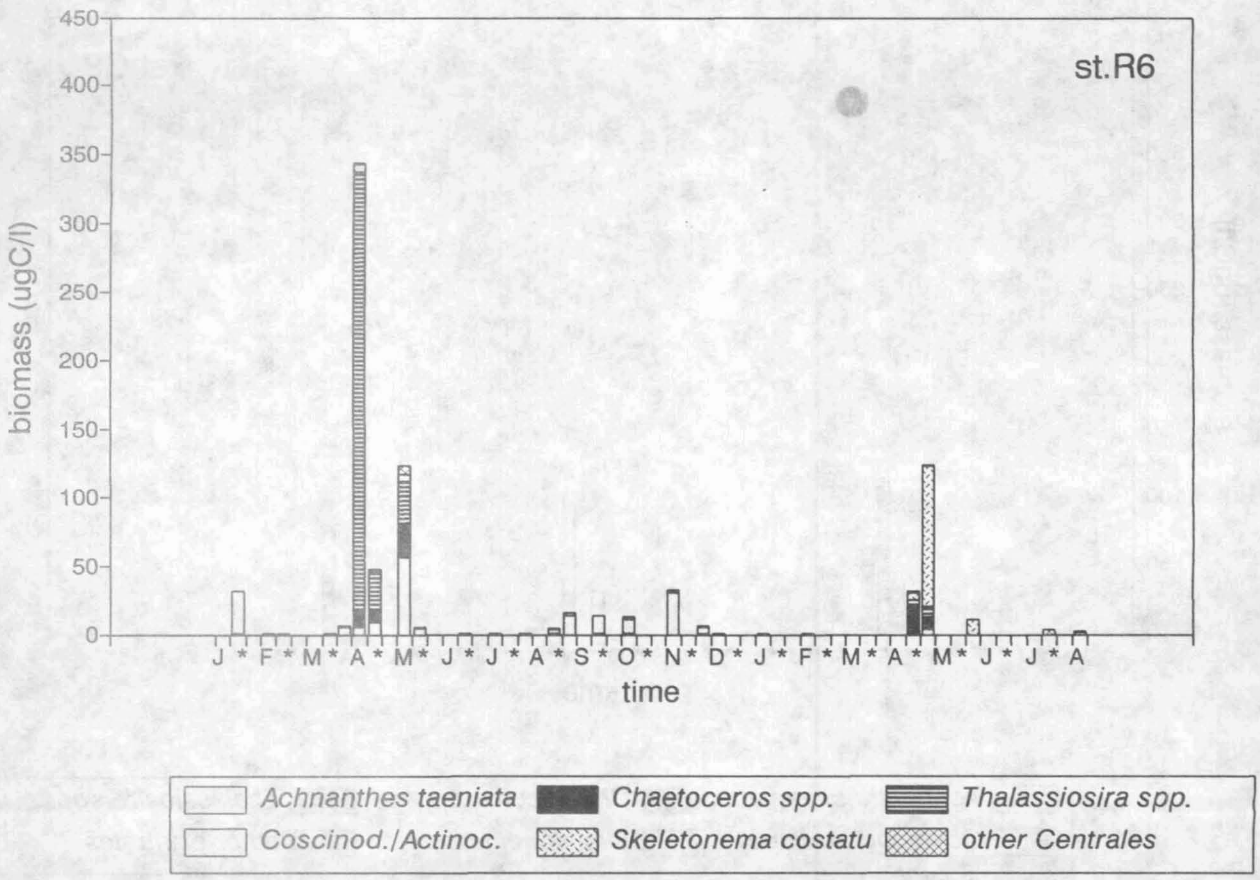


FIG. 7c - CHANGES OF THE DIATOM BIOMASS IN THE UPPER LAYER (0-15M) TAKING INTO CONSIDERATION THE CONTRIBUTION OF THE MOST IMPORTANT TAXA. STATION G2.

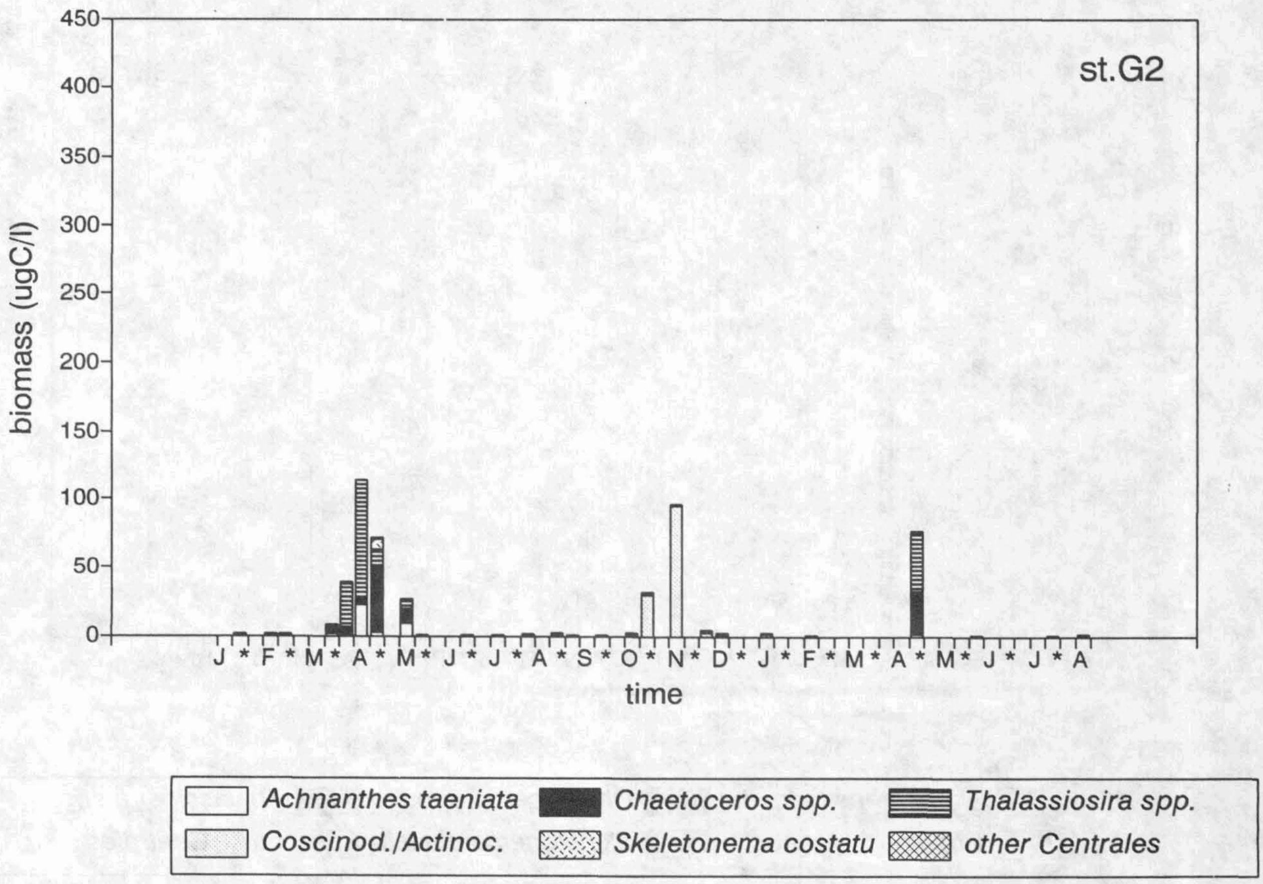


FIG. 8a - CHANGES OF THE DINOFLAGELLATE BIOMASS IN THE UPPER LAYER (0-15M) TAKING INTO CONSIDERATION THE CONTRIBUTION OF THE MOST IMPORTANT TAXA. STATION 92A.

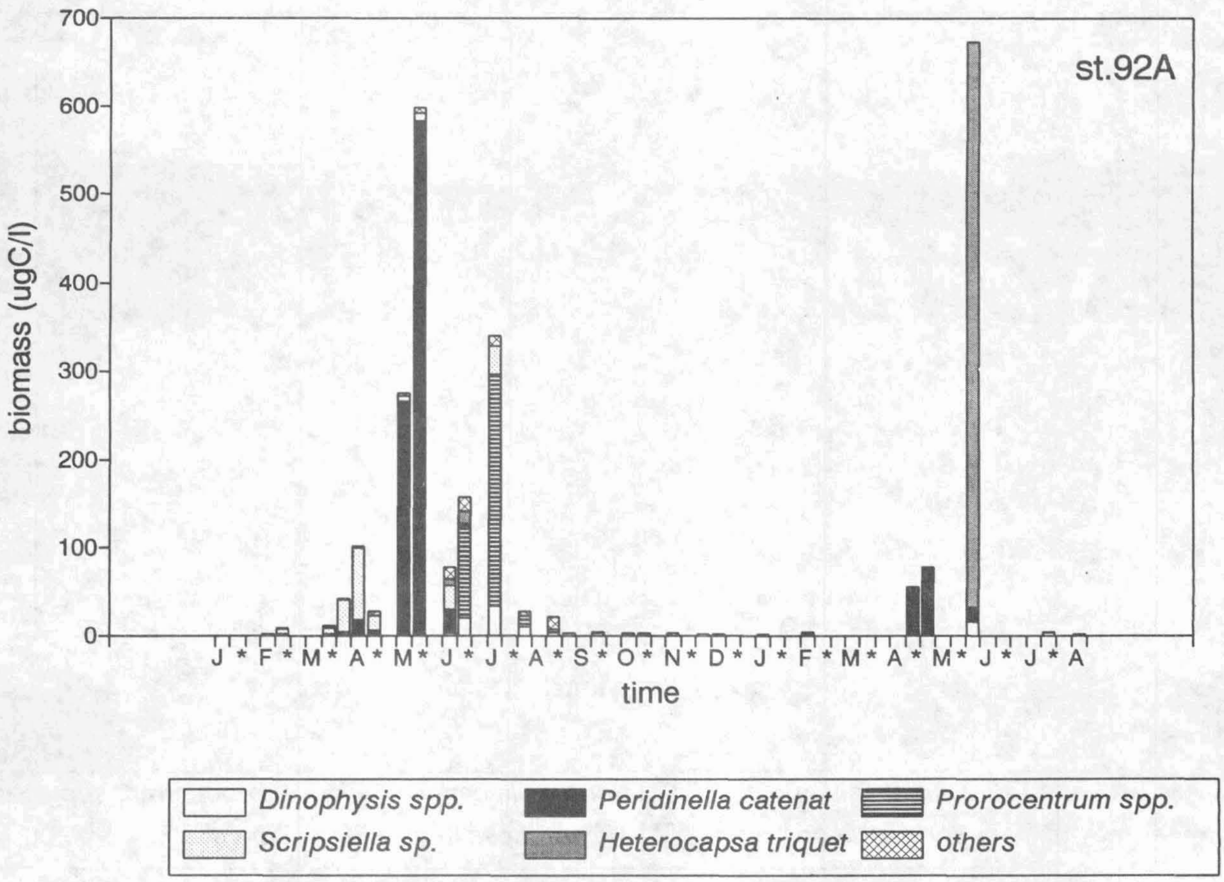


FIG. 8b - CHANGES OF THE DINOFLAGELLATE BIOMASS IN THE UPPER LAYER (0-15M) TAKING INTO CONSIDERATION THE CONTRIBUTION OF THE MOST IMPORTANT TAXA. STATION R6.

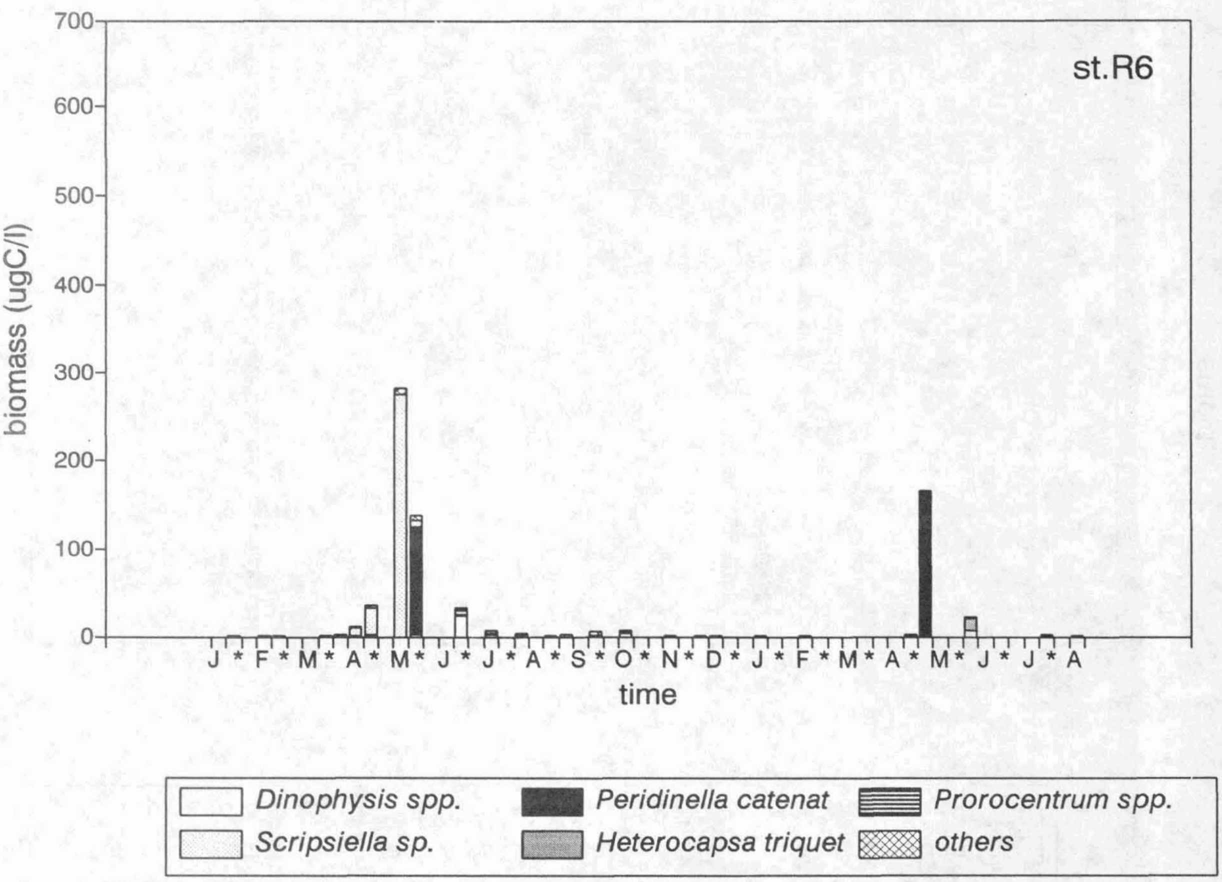
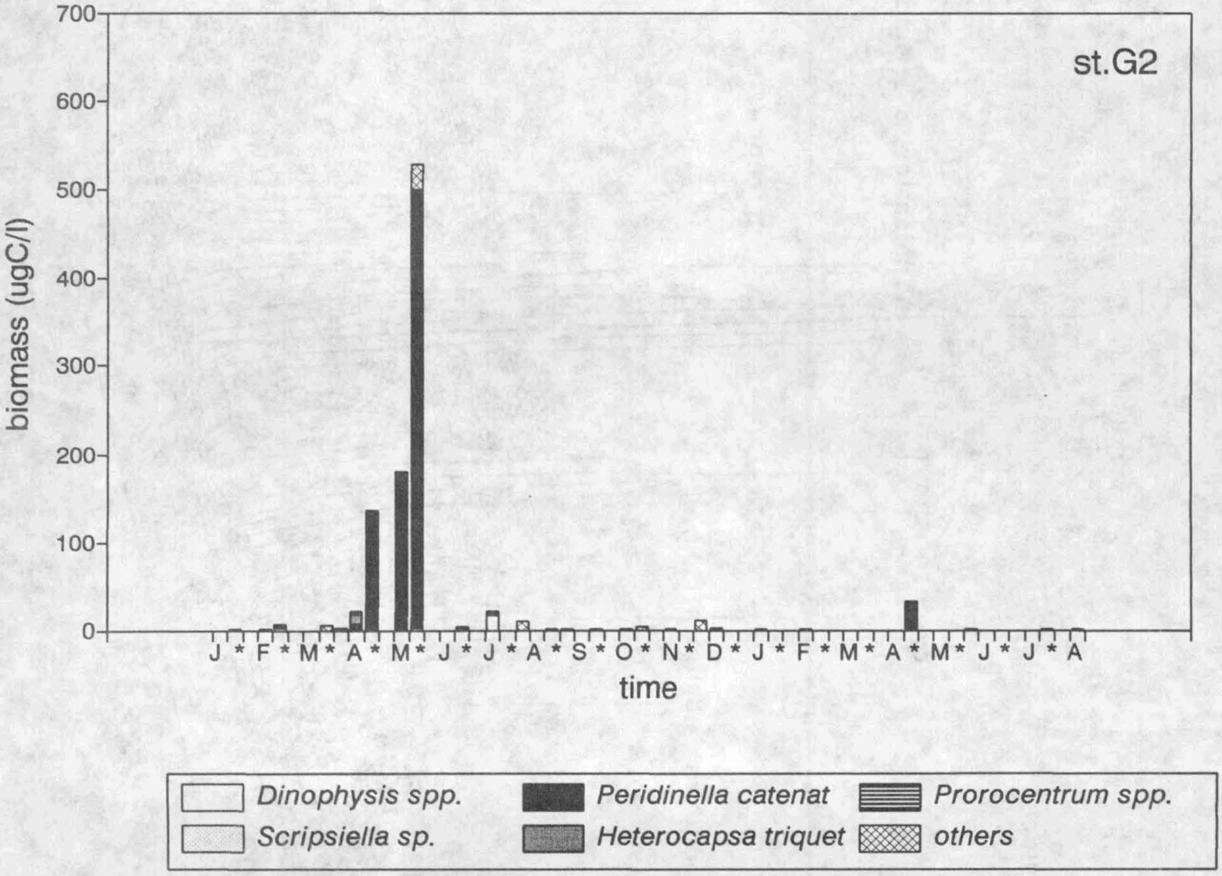


FIG. 8c - CHANGES OF THE DINOFLAGELLATE BIOMASS IN THE UPPER LAYER (0-15M) TAKING INTO CONSIDERATION THE CONTRIBUTION OF THE MOST IMPORTANT TAXA. STATION G2.



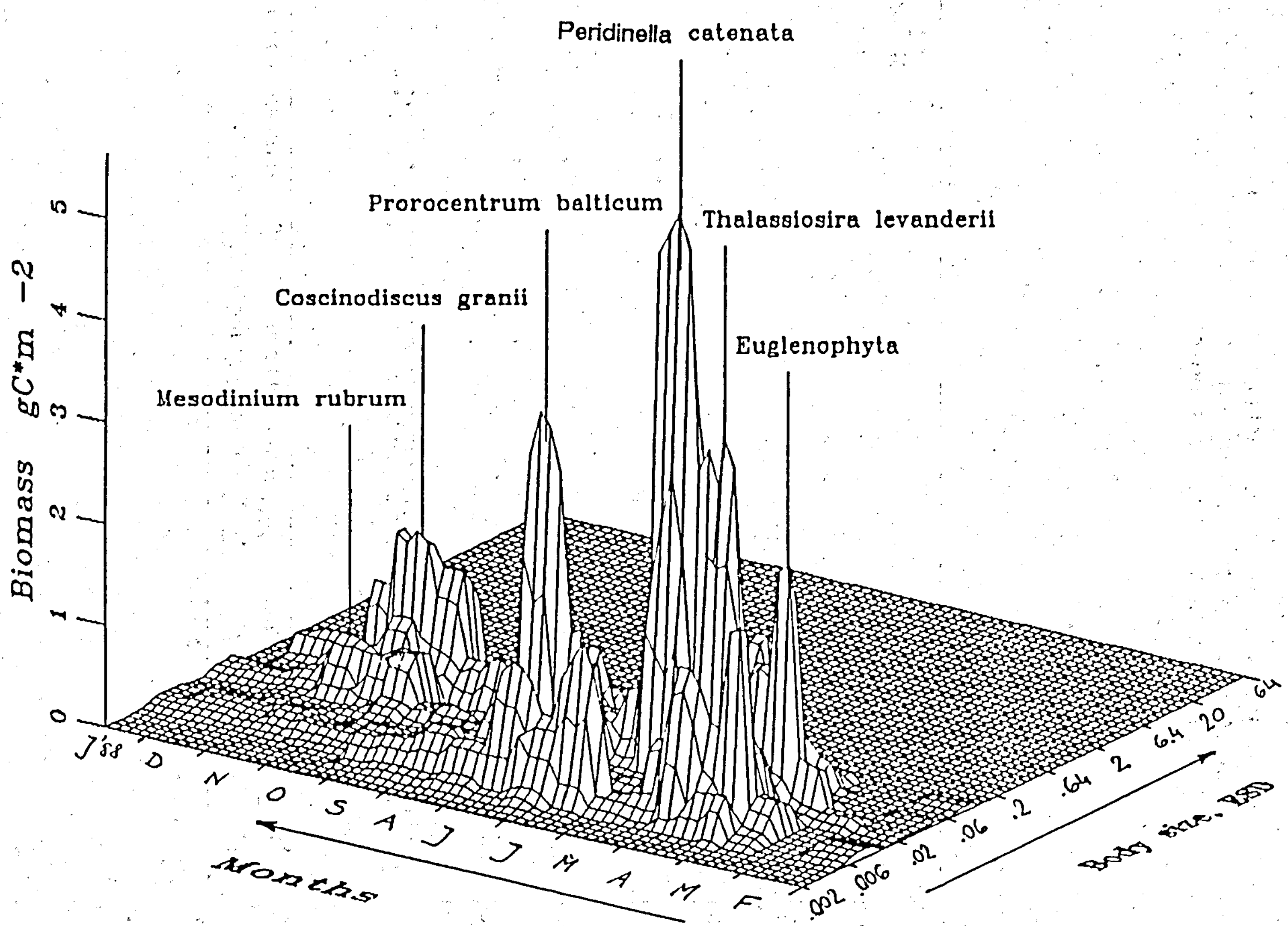
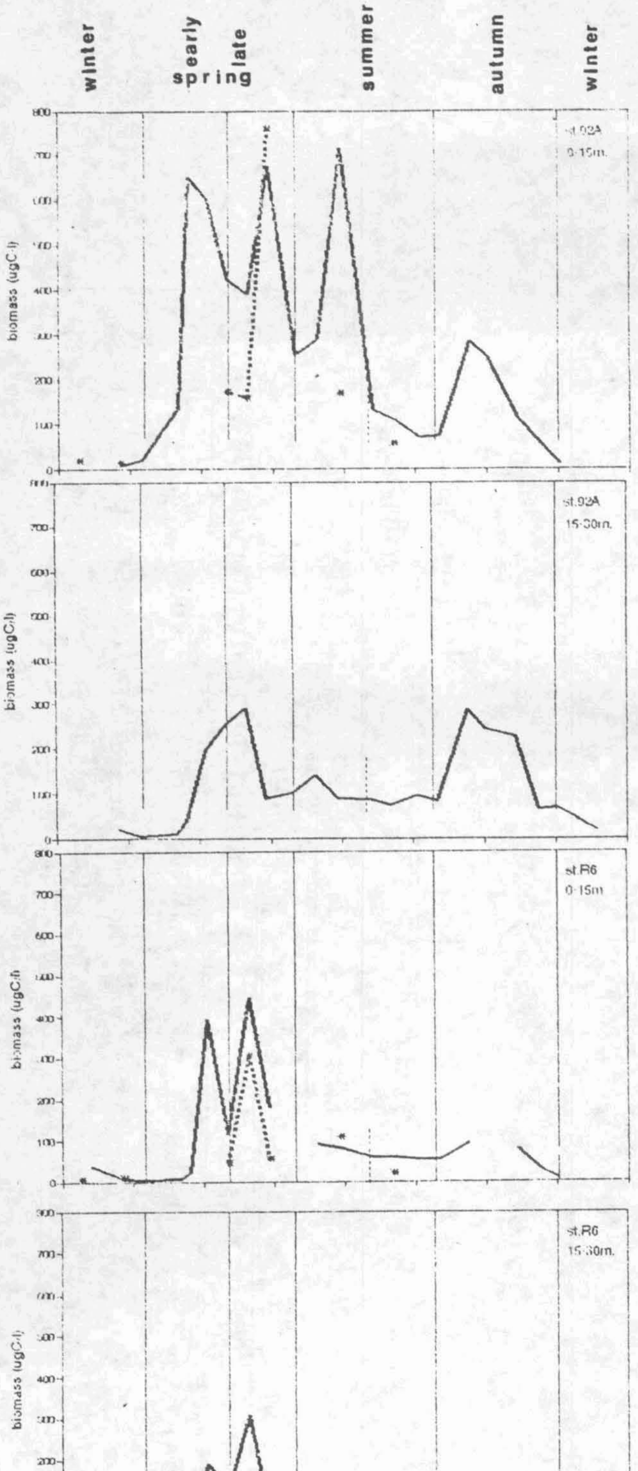


FIG.9 - PHYTOPLANKTON SIZE STRUCTURE AT THE GULF OF GDANSK STATION IN 1987.



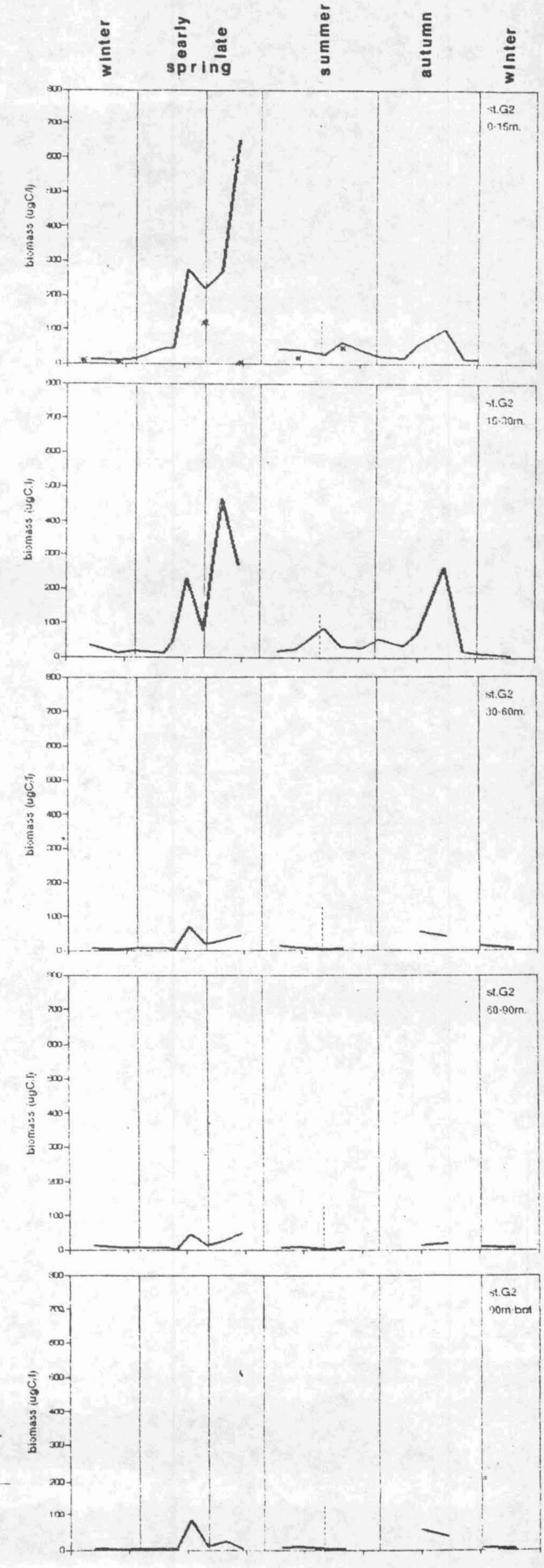


FIG. 10 – SEASONAL CHANGES OF THE PHTOPLANKTON BIOMASS AT DIFFERENT DEPTHS AND STATIONS. (SOLID LINE – 1987; DOTTED LINE WITH ASTERIX – 1988).

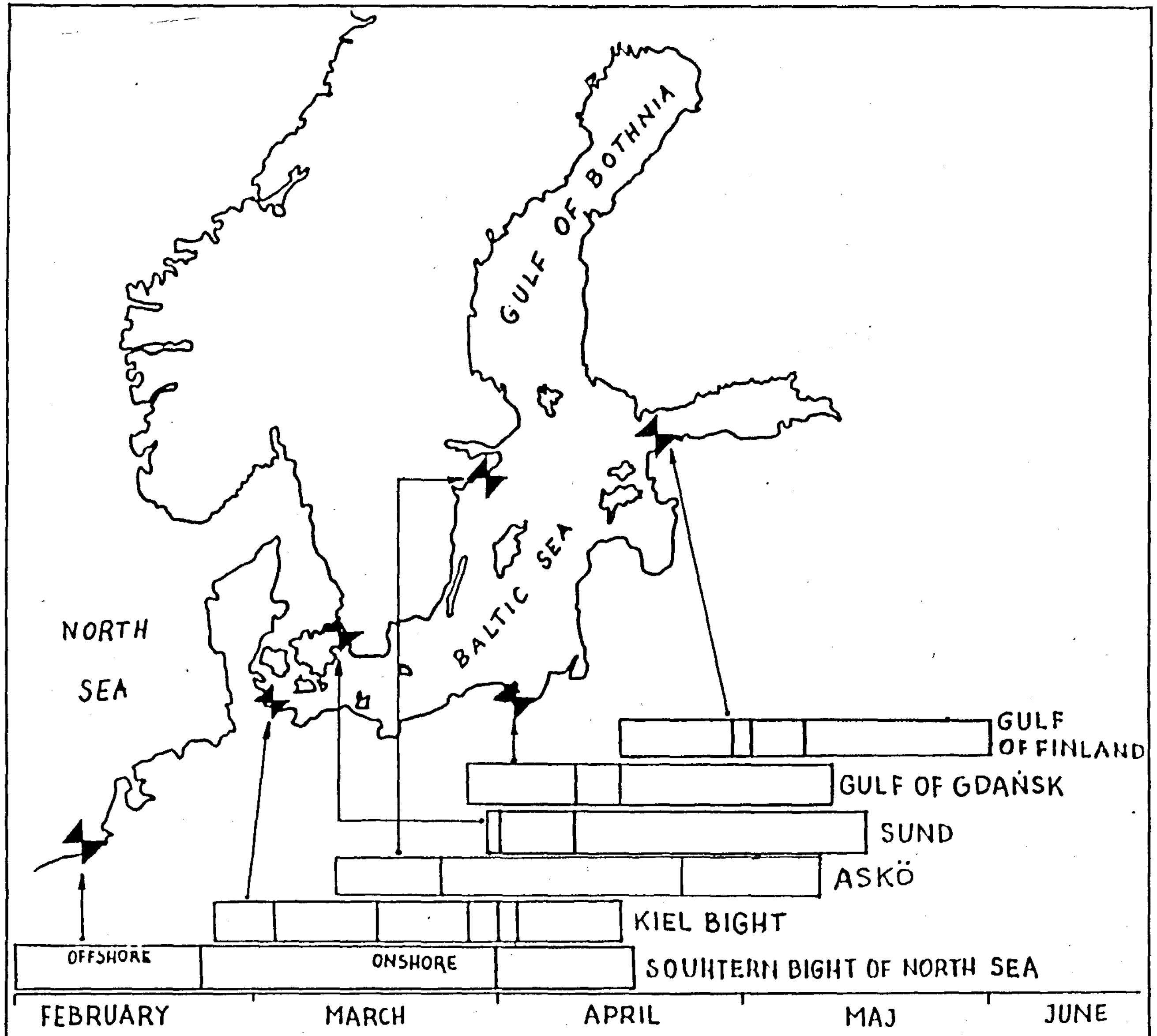


FIG. 11 - CHANGES IN THE INITIATING OF THE VEGETATION SEASON IN DIFFERENT PARTS OF THE BALTIC SEA.