Ödsmål, Kville sn, Bohuslän

Hällristning
Fiskare från
bronsåldern

Rock carving
Bronze age
fishermen

MEDDELANDE från
HAVSFISKELABORATORIET LYSEKIL Nr 259
INSTITUTE OF HYDROGRAPHIC RESEARCH
GÖTEBORG SERIES No 4

THE BALTIC ENTRANCE PROJECT:
Optical Investigations in Northern Kattegat.

by
Peter Möller

Mars 1980

1 Utförande institution/Rapportutgivare

Fiskeristyrelsen
Hydrografiska laboratoriet
Box 2566, 403 17 Göteborg

☐ PROJEKTBESKRIVNING
☐ TITELBLAD-RAPPORTER

2 RGF

PR

3 Datum
1980-01-24

4 Ärendebeteckning (Diarienr)

8 Projekt

☐ 1 Uppläggning ☐ 2 Komplettering ☐ 3 Avslutat

10	11 Kontraktnr	12 Startar	13 Slutar	14 Id projektnr (i förek fall)
	SNV 7-182/74-78	1974	1978	1258

15 Finansierande organ

SNV Forskningsnämnd

16 Projektbeskrivning/Rapportens titel och undertitel

THE BALTIC ENTRANCE PROJECT:

Optical Investigations in Northern Kattegat

17 Projektledare/Författare

Möller, Peter (författare)

Svansson, Artur (projektledare)

18 Sammandrag (ange gärna målsättning, metod, teknik, resultat m m)

Secchi disc depths and hydro-chemical parameters were measured during hydrographic cruises in northern Kattegat 1975-1977. The results from 19 cruises during 1977 show the deepest light penetration in September/October, just before the low surface concentrations of nutrients start to increase. Two feasible causes to this fact are discussed.

Two series from 1977 and 1978 of beam transmission measurements are shown and discussed. The series from 1978 indicates a particle maximum in the lower part of the pycnocline, possibly due to slowing up of sinking particles.

Siktdjup, kemiska och fysikaliska parametrar har mätts under hydrografiska expeditioner i norra Kattegatt under åren 1974-77. Resultaten från 19 expeditioner 1977 diskuteras. Resultaten visar de största siktdjupen under september/oktober, precis innan de låga närsaltskoncentrationerna i ytskiktet börjar öka. Vidare diskuteras två serier med genomskinlighetsmätningar. Den ena serien visar en ansamling av partiklar i nedre delen av täthetsskiktningen, möjligen beroende på att partiklarnas sjunkhastighet bromas upp.

19 Sammandraget skrivet av

Peter Möller

20 Förslag till nyckelord

Y, Kattegatt, siktdjup, Secchidjup, genomskinlighet

21 Klassifikationssystem och klass

22 Indexterm (ange källa)

23 Övriga bibliografiska uppgifter

Meddelande från Havsfiskelaboratoriet nr 259

IHR Göteborg Series No. 4

24 ISRN

25 ISSN

26 Hemligt		§ paragraf	27 Språk	28 Antal sidor	29 Pris
X Nej	☐ Ja jämlikt	§ sekretesslagen	engelska		

30 Projektbeskrivning/Rapporten beställs hos

Se ovan

Blanketten beställs hos	Postadress	Telefon
MILJÖDATANÄMNDEN	Jordbruksdepartementet Fack 103 20 STOCKHOLM	08-763 10 00

THE BALTIC ENTRANCE PROJECT:
Optical Investigations in Northern Kattegat.

by

Peter Möller

Institute of Hydrographic Research
National Board of Fisheries
Box 2566
S-403 17 Göteborg, Sweden

Abstract.

Secchi disc depths and hydro-chemical parameters were measured during hydrographic cruises in northern Kattegat 1974-1977. The results from 19 cruises during 1977 show the deepest light penetration in September/October, just before the low surface concentrations of nutrients start to increase. Two feasible causes to this fact are discussed.

Two series from 1977 and 1978 of beam transmission measurements are also shown and discussed. The series from 1978 indicates a particle maximum in the lower part of the pycnocline, possibly due to slowing up of sinking particles.

Introduction.

From August 1974 until December 1977, 75 hydrographic cruises were made between Göteborg and Frederikshavn in northern Kattegat (figure 1). The project which was granted by the National Swedish Environmental Protection Board, had as objective to determine transports of water and nutrients in northern Kattegat. It was coordinated with a larger Danish investigation in the Belt Sea area, in the 'Baltic Entrance Project'.

Though the stress was laid upon measurements of currents, temperature, salinity and chemical parameters, some optical investigations were also made.

Secchi Disc Depth Measurements.

The only optical parameter which has been measured during the standard cruises was Secchi disc depth. The Secchi disc used had a diameter of 300 mm and was white-painted. The result from these measurements during 1977 at station No. 4 (figure 1) is shown in figure 2. Though very variable, the deepest light penetration is clearly found around September and October. The same pattern is also evident in 1976 (not shown here).

During the summer months the concentrations of NH_4-N, NO_3-N, NO_2-N and PO_4-P are very low in the euphotic zone and these values are not increasing until around September-October. In figure 2 also the surface values of density, nitrate and ammonia are plotted together with Secchi disc depths. These curves might indicate either, or both, of two things: Firstly, a deficit of nutrients, especially nitrogen (Gargas et.al., 1978), in early autumn starts a decrease in production. Secondly, and this year it may be a more dominant factor, the stability is decreasing in the upper layers towards the end of September. The vertical mixing process caused by the decreasing stability, shortens the exposition time in the euphotic zone for each plankton, thus decreasing the rate of primary production. The diluting effect causes the increase in Secchi disc depth, but it also brings up nutrients from below and when the stratification is manifest, the conditions for primary production again are favourable. Unfortunately there are no measurements of primary production from this area and year, but the measurements at Anholt Nord lightvessel 1954 - 1960 (Steemann Nielsen, 1960 and Steemann Nielsen et.al., 1976), might justify a supposition of a high production rate in October and November (the lowest Secchi disc depth 1977 was determined in November).

The average Secchi disc depth during 1977 at station 4 was 8.5 meters. According to Höjerslev (1978), as a rough estimation the Secchi disc depth equals the depth were 10 % of the surface quanta irradiance is found (= z(q,10 %)). Usually the euphotic zone is defined as z(q, 1 %). Jerlov (1977) has established the ratio between z(q, 1 %) and z(q, 10 %) to be, on average, 2.3. If this ratio is applied to our values from 1977, the mean depth of the euphotic zone at station 4 is 18 meters with variations from 13 to 26 meters.

Particle Measurements.

Principles.

The contents of particles in the water is of great importance to the penetration of daylight and therefore to the possibilities of photosynthesis in the deeper layers.

An accurate method to determine the particle contents, is to filter the water and then weighing and microscoping the filter contents. A less time consuming way is to use an optical method to determine at least a relative value. There are two theoretically different optical principles. The best principle is to measure the scattered light from the lit up particles in a water mass, the Tyndall effect (Jerlov, 1968). This should be done with an in-situ instrument, which is an expensive device that could not be obtained within the budget of the project. During the first expeditions of the project, experiments were made with a laboratory turbidity meter (Hach Corp 2100). The particle contents in this area, was, however, much too small to get sufficiently accurate result, and the method was therefore abandoned.

The other optical principle is to determine the attenuation of a beam of light. This is done in a beam transmission meter (BMT). A BMT is, in this case, a submersible light source, which through optics casts a horizontal, well collimated, 1 meter long light beam on a photo voltaic cell. The disadvantage when measuring particles with such an instrument is that the attenuation is not only dependent of the light scattering, but also of the light absorption in dissolved organic matter, the so called yellow substance. This yellow substance absorbs blue and ultra-violet light to a large extent and red light to a much smaller extent. It is therefore possible to use a red filter and thus to get a relative estimation of the particle concentration versus the depth. The instrument used in this project was equipped with a 2 mm thick glass filter RG 1 (Schott and Genossen).

To get a value that is proportional to the particle concentration, it is necessary to measure the current from the photo voltaic cell when it is working as a current source. That means that the detector should have no or little load (maximum 100 ohms). The negative logarithm of the current, detected in this way, is proportional to the changes in particle concentration, as long as the optical characteristics of the instrument are not changed (Jerlov, 1968).

During two expeditions beam attenuation measurements were made. During the first one, in August 1977, the research vessel Thetis was anchored at station 4 (figure 1) and four measurements of beam attenuation were made during about 25 hours. Simultaneously, hydrography and current measurements were made at the depths 0, 10, 15, 20, 30, 50, 60, 70 and 75 meters.

The particle concentration in the four measurements shows a similar pattern and the result of only one of them is therefore shown here (figure 3). This measurement was made just before sunset (18^{40} hours GMT). It can be seen that there is a significant decrease of both total phosphorus and particle concentration within the pycnocline, but there is also a change of current direction in this layer. The current picture was at this time the 'classical' (e.g. Svansson, 1975), with an outgoing 'Baltic' surface current and an incoming bottom current of Skagerrak origin. This 'typical' picture is however usually hidden by the strong movements caused by the weather conditions and the tide. Figure 3 indicates that there is no conglomeration of particles (e.g. plankton) in the halocline, as is indicated for instance by Lundgren (1970). The lack of a particle maxium might be caused by a temporary decrease in the production or by a good horizontal mixing with less productive areas. However, the small particle maximum within the minimum might indicate the reverse situation, although it is not detectable with the discrete water samples.

In May 1978, measurements of beam transmission were made at six stations (no:s 3, 4, 6, 8, 9 and 10) along the Göteborg - Frederikshavn section. At this time a rather different result was obtained, as can be seen in figure 4. In addition to the natural increase of particle density near bottom, a very distinct particle maximum could be seen in the lower part of the pycnocline.

Figure 5 showing station GF4 results can be regarded to be a typical example from this cruise. Here we can see how the particle maximum coincides with a minimum of totalphosphorus. This might be taken as an indication of particles of mineral origin. This is however not in correspondence with the investigations published by Steemann Nielsen and Hansen (1961), where they found not only a similar particle maximum in the pycnocline, but also a maximum of production at these depths.

In more recent investigations made within the Danish part of the project by Bo Lundgren (1976), the particles have been measured by means of their light scattering effect.

This method has been shown to be a more accurate way to determine particle contents (Jerlov, 1968). In measurements from May and July 1975, Lundgren shows a pattern similar to the anchor station (figure 3) with a little particle maximum followed by a minimum in the lower part of the pycnocline which, he indicates, could be caused by the pycnocline slowing up the sinking particles from the upper layers.

Conclusions.

The somewhat diverting results from the optical parameters claim for a more thorough investigation, especially in the halocline, with synoptic measurements of chemical, physical, biological and optical parameters. A good way to get synoptic measurements, is to equip an optical in-situ instrument with an electrically controlled water sampler in order to get a sample from exactly the water mass that is detected with the optical method. If the optical instrument is the combined attenuation and scattering meter, the bc-meter, which Lundgren (1976) describes it could be a very useful device to detect the often thin layers of pollutants in suspended form, but it could of course also be used in planktological studies.

Acknowledgements.

I wish to express my gratitude to the project leader, Artur Svansson and my coworkers at the project: Staffan Lööf, Jan Szaron and Bodil Thorstensson, but also, of course to Birgit Stahm for typing and to Anita Taglind for making the drawings.

References.

Gargas, E., G. AErtebjerg Nielsen and S. Mortensen, 1978: Phytoplankton production, chlorophyll-a and nutrients in the open Danish waters 1975-77. - National Agency of Environmental Protection. The Belt Project.

Höjerslev, N.K., 1978: Daylight measurements appropriate for photosynthetic studies in natural sea waters. - Journal du Conseil International pour l'Exploration de la Mer. 38:2, 131-146.

Jerlov, N.G., 1968: Optical Oceanography. Elsevier Publishing Company. Amsterdam.

Jerlov, N.G., 1977: Classification of sea waters in terms of quanta irradiance. -Journal du Conseil International pour l'Exploration de la Mer. 37, 281-7.

Lundgren, B., 1976: Undersögelser af fordeling og transport af partikulärt stof i danske farvande. Miljöstyrelsen. Bältprojektet, Fysiske undersögelser. Juli 1976, 71-76.

Steemann Nielsen, E. and Vagn Kr. Hansen, 1961: Undersögelser over planteplanktonets stofproduktion i de danske farvande. Skrifter fra Danmarks Fiskeri- og Havundersögelser. 21, 27-38.

Steemann Nielsen, E., E. Gargas and S. Mortensen, 1976: Primärproduktion i åbne danske farvande 1975. Miljöstyrelsen, Bältprojektet, Kemiske og biologiske undersögelser. November 1976, 33-42.

Svansson, A., 1975: Physical and chemical oceanography of the Skagerrak and the Kattegat. I. Open sea conditions. - Fishery Board of Sweden, Institute of Marine Research. Report no. 1.

Other works within the project.

Bieler, H., Lööf, S., Möller, P., Szaron, J. and B. Thorstensson, 1976: Preliminary results of investigatigations in the Kattegat. - 10th Conference of the Baltic Oceanographers (Göteborg), Paper no. 28.

Bieler, H. and A. Svansson, 1977: Tidal and spectral analysis of Kattegat time series of currents and salinity. - Meddelande från Havsfiskelab. nr. 209.

Lööf, S., 1979: The influence of sampling frequency of the study of time variations of hydrographic parameters.- Meddelande från Havsfiskelab. nr. 244.

Lööf, S., Möller, P., Szaron, J. och B. Thorstensson, 1976: Vatten- och materialtransporten i norra Kattegatt. - Vannet i Norden, 1976:1.

Lööf, S. and A. Svansson, 1979: Baltic Entrance Project: Analysis of currents measured at Läsö Nord/Trindel lightvessel 1974-77. - Meddelande från Havsfiskelab. nr 252.

Lööf, S. and B. Thorstensson, 1980: Baltic Entrance Project: Methods and equipment. Quality of measurements.- Meddelande från Havsfiskelab. nr. 257.

Möller, P., 1980: Baltic Entrance Project: Current measurements in the northern Kattegat 1975-1977. To be published.

Möller, P. and A. Svansson, 1978: Investigations in the northern Kattegat during the international JONSDAP-76 period INOUT, March - April 1976.-Meddelande från Havsfiskelab. nr 243 (Jonsdap-76 contribution no.15).

Svansson, A., 1980: Exchange of water and salt in the Baltic and adjacent seas. - Manuscript.

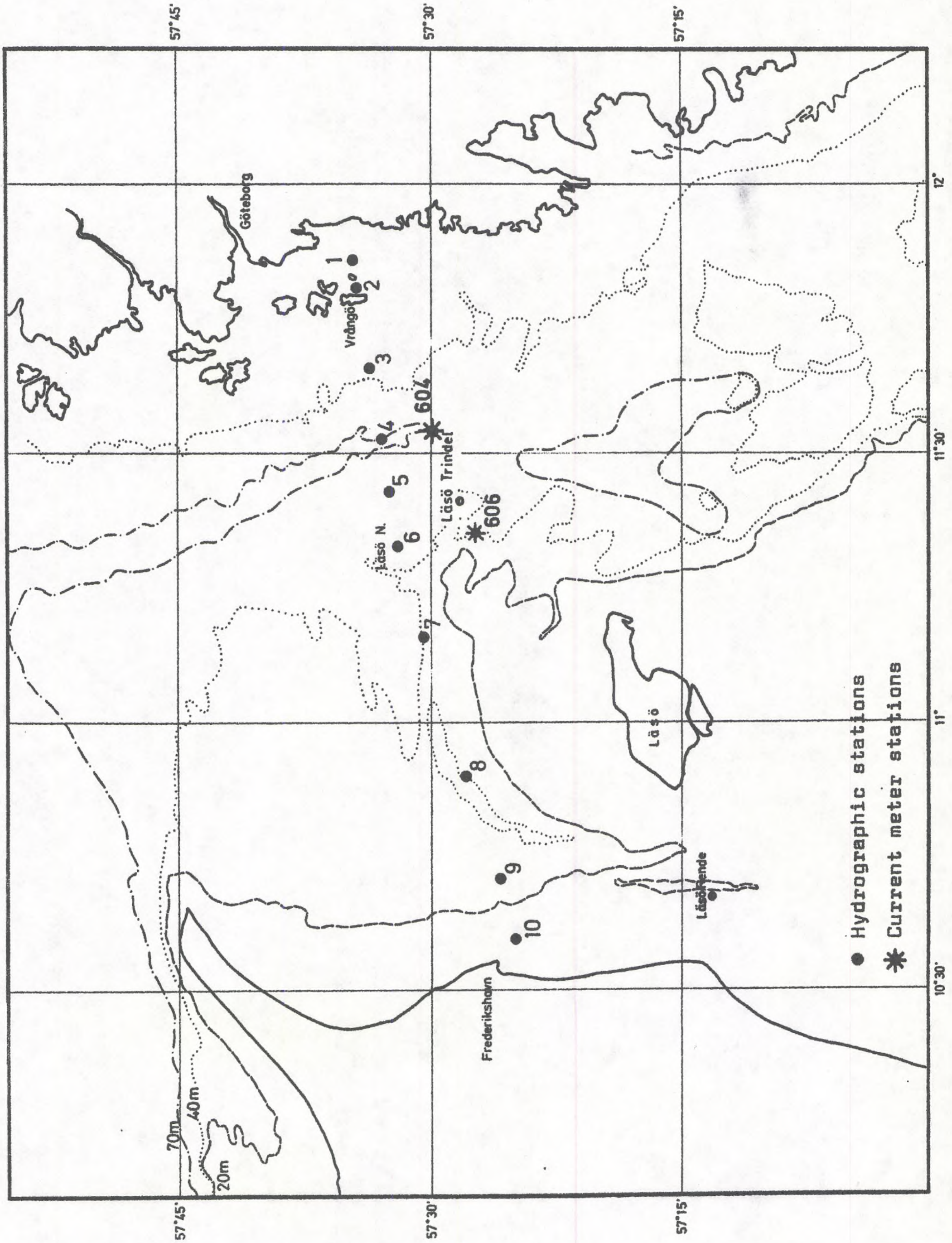
Svansson, A. and J. Szaron, 1974: Computations of current-profiles in a barotropic canal-model with application to northern Kattegat. - ICES special meeting on Models of water circulation in the Baltic, Paper no. 5.

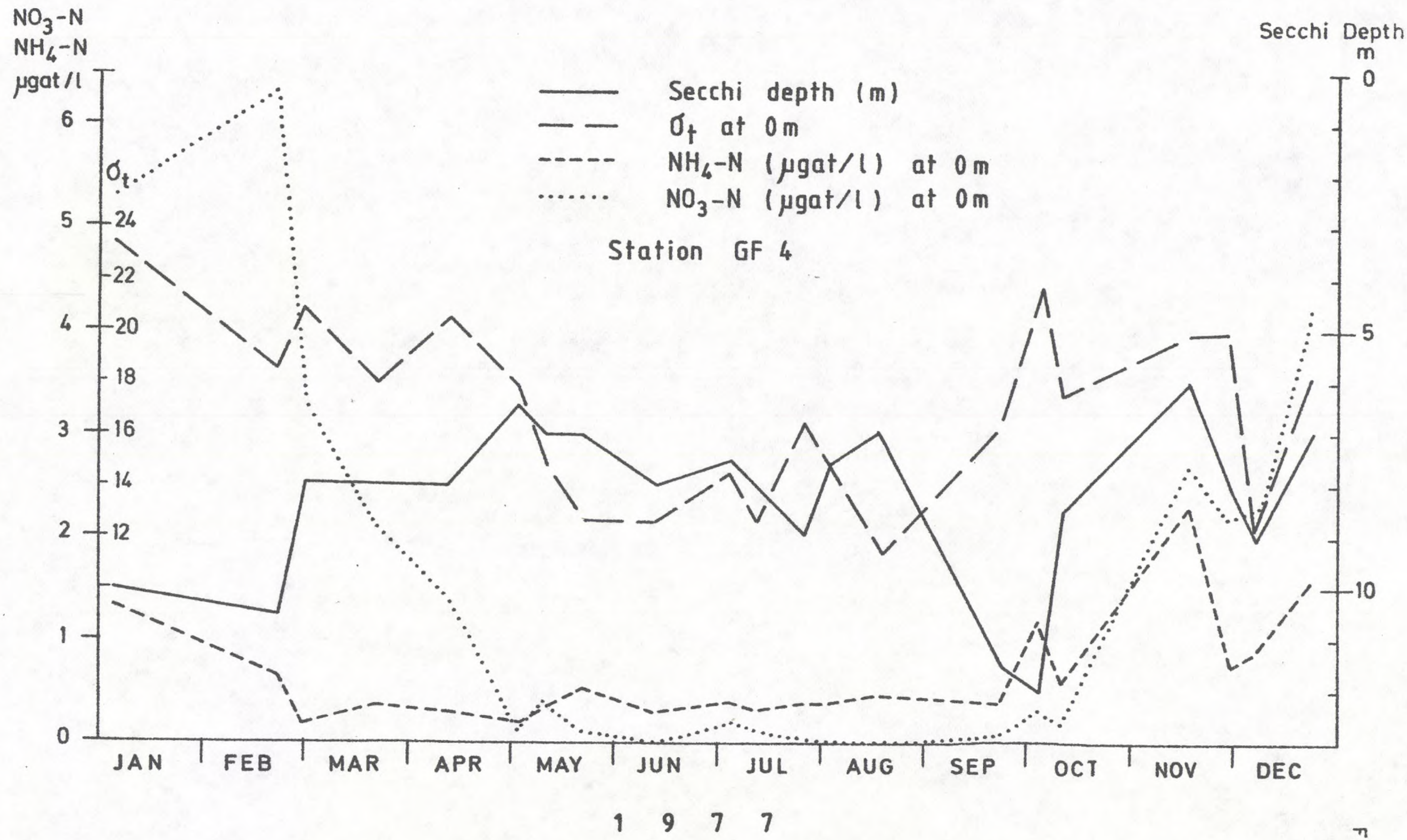
Szaron, J., 1979: Baltic Entrance Project: Preliminary transport computations of water, salt and nutrients through the Göteborg - Frederikshavn (GF) section in the northern Kattegat, based on measurements 1975-1977. - Meddelande från Havsfiskelab. nr. 255 (ICES CM 1979/C42).

Szaron, J., 1980: Baltic Entrance Project: Data inventory. To be published.

Thorstensson, B., 1980: Baltic Entrance Project: Mean values of parameters measured at the GF-section in the northern Kattegat 1975-1977. To be published.

Fig. 1.


57°45'
57°30'
57°15'
12°
11°30'
11°
10°30'
Göteborg
Vrångö
1
2
3
604
4
5
6
7
8
9
10
Läsö N.
Läsö Trindel
606
Läsö
Läsö Rende
Frederikshavn
70m
40m
20m
● Hydrographic stations
✱ Current meter stations

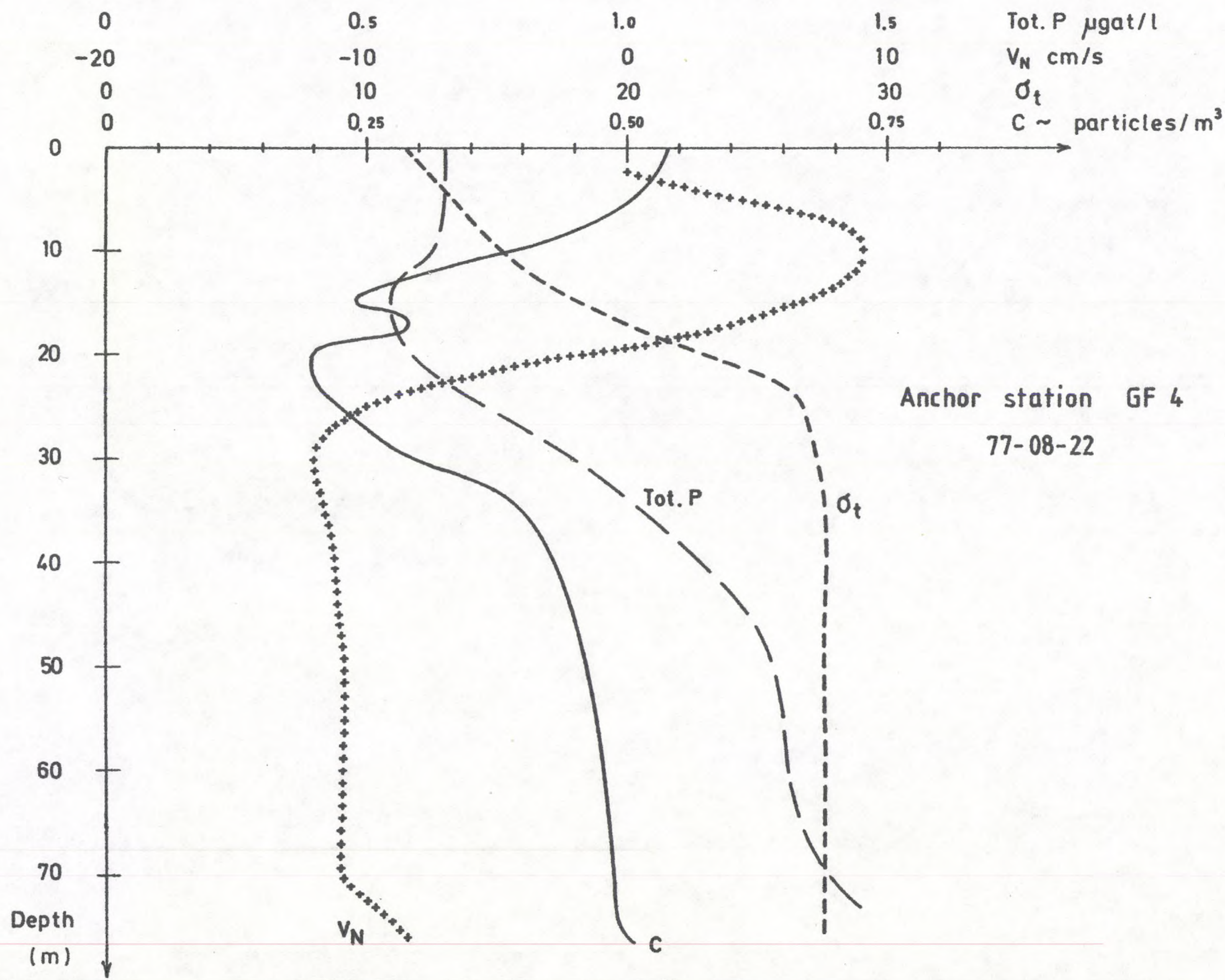


NO3-N
NH4-N
µgat/l
Secchi Depth
m
0
5
10
6
5
4
3
2
1
0
σt
24
22
20
18
16
14
12
Secchi depth (m)
σt at 0m
NH4-N (µgat/l) at 0m
NO3-N (µgat/l) at 0m
Station GF 4
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1 9 7 7

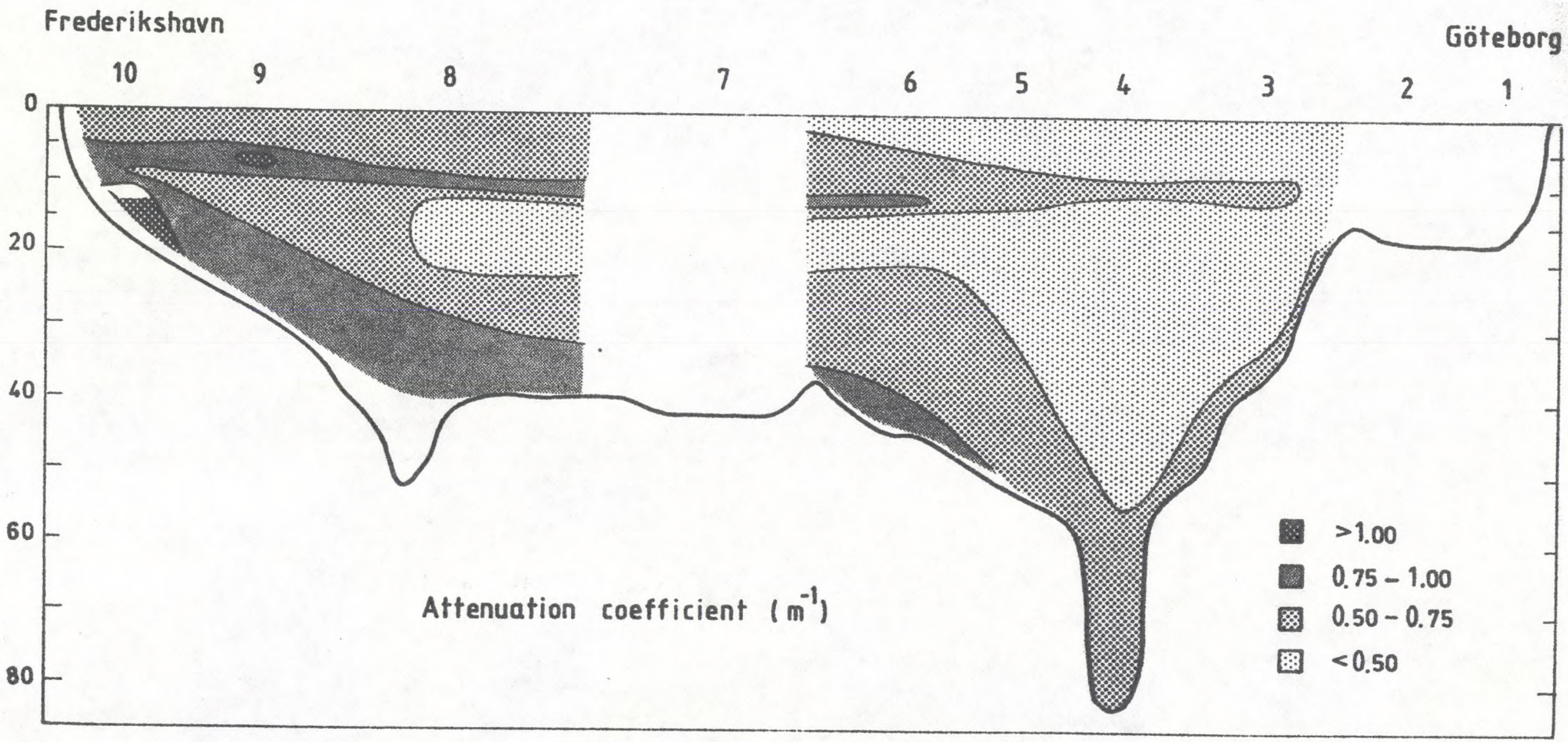
HyA / 78 / 5

Fig. 2.

Fig. 3.



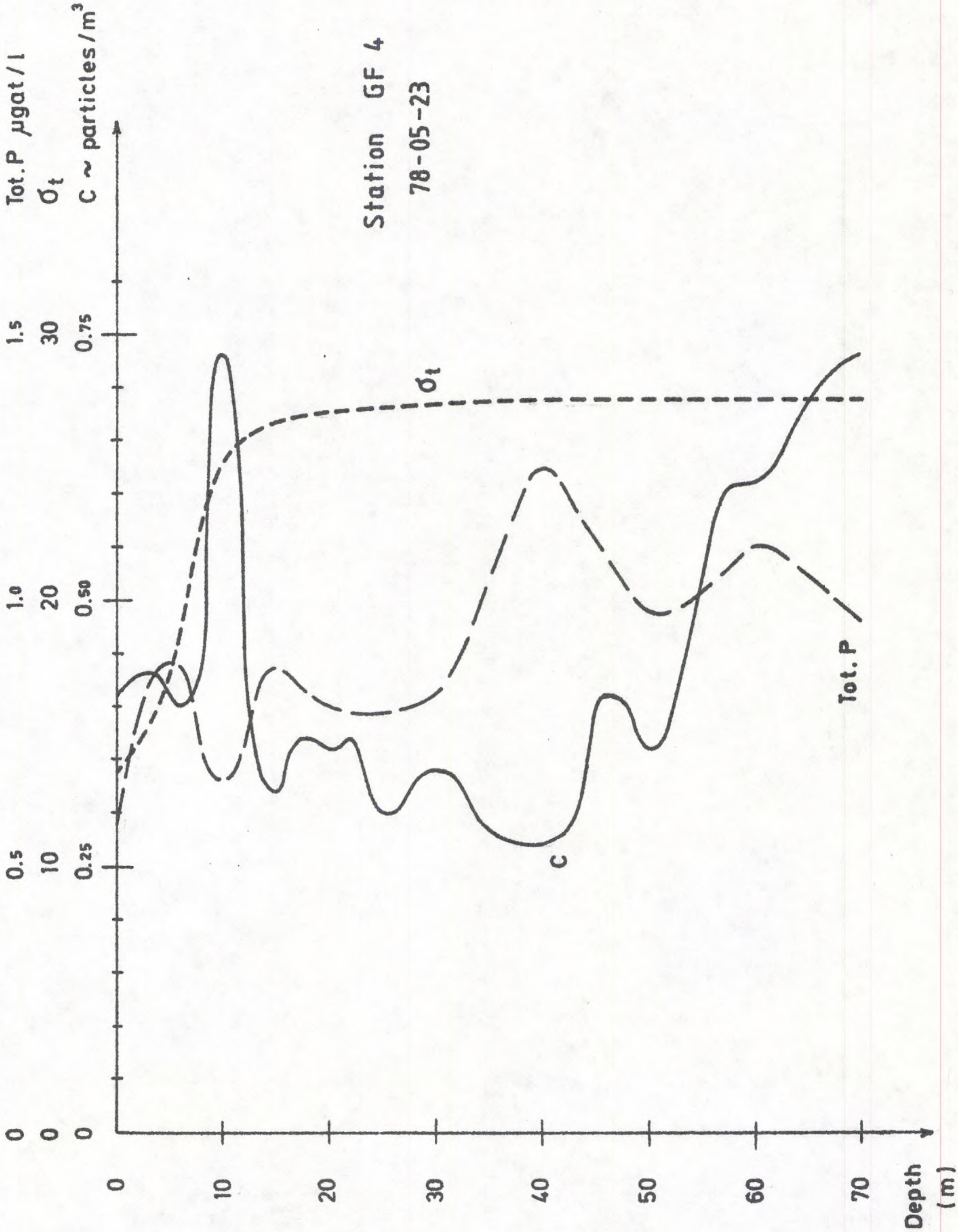
HyA/78/π



1978 05 23

Fig. 4.

Fig. 5.



Tot.P µgat/l
σ_t
C ~ particles/m³
Station GF 4
78-05-23
1.5
30
0.75
1.0
20
0.50
0.5
10
0.25
0
0
0
σ_t
Tot. P
C
0
10
20
30
40
50
60
70
Depth (m)

HyA/78/x