Ödsmål, Kville sn, Bohuslän

Hällristning
Fiskare från
bronsåldern

Rock carving
Bronze age
fishermen

MEDDELANDE från
HAVSFISKELABORATORIET · LYSEKIL nr 138
Hydrografiska avdelningen, Göteborg

Measurements of Yellow Substance in the Baltic and Neighbouring Seas During 1970-1972.

by

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Fishery Board of Sweden
Hydrographic Dpt

Introduction.

Yellow substance will here be expressed as the absorbance coefficient (m^{-1}, base e) at 380 nm of a filtered sample of sea water (Jerlov 1968).

Yellow substance is a complex mixture of dissolved organic compounds, which seem to be very stable. An important part in landlocked waters consists of humus substances. Large quantities of humus compounds are brought to the sea by rivers, especially in northern areas. This abundance is reduced in some degree through coagulation and precipitation mainly of the fine particulate or colloidal portion. Another important source of yellow substance may be the pulp mills which discharge large quatities of lignin sulfonates.

Yellow substance in the seas here concerned has been studied by Kalle (1937), who also compared with the fluorescence of the same sample, by Jerlov (1955), who also used an in situ beam transmittance meter. Such a meter was used exclusively by Malmberg (1964) studying the yellow substance in the Skagerrak, while Fukuda (1960) again used the in vitro technique.

Measuring Technique.

Approximately 100 ml of sea water is (drawn) taken from the ordinary sample of the hydrographic cast. It is vacuum filtered through a membrane filter with a pore size of 0.6 mikron. Thereafter the absorbance is measured at 380 nm with a spectrophotometer (Hitachi 101) in a 5 cm cell. As reference filtered distilled water is used.

Results.

The research vessels of the Fishery Board regularly visit some hundred fixed stations approximately 4 times a year. The data of the more ordinary physical and chemical parameters determined at these cruises, are published in Meddelanden från Havsfiskelaboratoriet.

From the beginning of 1971 the present author has determined the yellow substance at some of the routine stations. The positions are shown in Fig. 1

Fig 2 shows a longitudinal section during January 1971 through the Baltic proper as indicated in Fig. 1. The highest values are met with at BY 39, in contrast to rather low values in the vicinity at BY 5 (the Bornholm deep). Quite similar conditions are met with one year later (see Fig. 3), in March 1972.

In August 1971 (Fig. 4) there is a maximum value at the entrance of the Gulf of Finland.

Fig:s 5 and 6 shows the transversal and longitudinal distribution respectively in the Bothnian Bay in June 1972. Here we find the highest open sea values of yellow substance; the extraordinary high values at station F 10 are due to the vicinity of a river mouth, however.

Fig. 7 is a longitudinal section through the Bothnian Sea at the same occasion, June 1972.

Now to the Kattegatt and Skagerrak areas. Fig. 8 is a transversal section between Gothenburg and Fredrikshavn. The high values off Gothenburg are due to the vicinity of the big Göta River.

Fig. 9 shows a section perpendicular to the Swedish coast in the Skagerrak. The high values of yellow substance (and low salinities) at stations 12 and 13 display water which has been mixed with water of Baltic origin.

Discussion.

As Jerlov (1955) has shown the yellow substance usually decreases with increasing salinity. In sea water the amount of yellow substance is usually low, while the high values in the Baltic are due to a small exchange with the sea. Fig. 10 shows yellow substance versus salinity (to a depth of 70 m) during May-June 1972. The figure has the same shape as in Jerlov (1955) but the values are about 20 % higher.

We have so far discussed the yellow substance in terms of absorbance coefficients. We might very roughly get an idea of concentrations from Almgren and Josefsson (1972), who present a curve of humus (extracted from river water) versus absorbance. For 10 ppm (approx. $10^4 mg/m^3$) they get an absorption coefficient of $\frac{0.3 \times 100}{10 \log e} = 69\ m^{-1}$. Then we have to multiply the original yellow substance figures (in m^{-1}) by 145 (where 145 is $10^4 : 69$) to get concentrations in mg/m^3 (= ton/km^3). This has been used in an attempt to compute the yearly supply of yellow substance to the Bothnian Bay assuming steady state and also that yellow substance is a completely conservative substance. As can seen in Fig. 11 the result would be 45 000 tons/year ($264 \cdot 285 - 187 \cdot 164 \approx 45\ 000$). It is interesting to note that this is about the same order of magnitude as the discharges of lignin sulphonates, (Anon. 1970) while the total amount of organic matter from Swedish rivers to the Bothnian Bay is one order of magnitude higher (Ahl and Odén 1971). It would be interesting to make the same calculation for remaining parts of the sea system. But with missing measurement from the Gulf of Finland and with surprisingly high values in the Kattegatt, it seems wise to postpone such a processing until more data have been collected.

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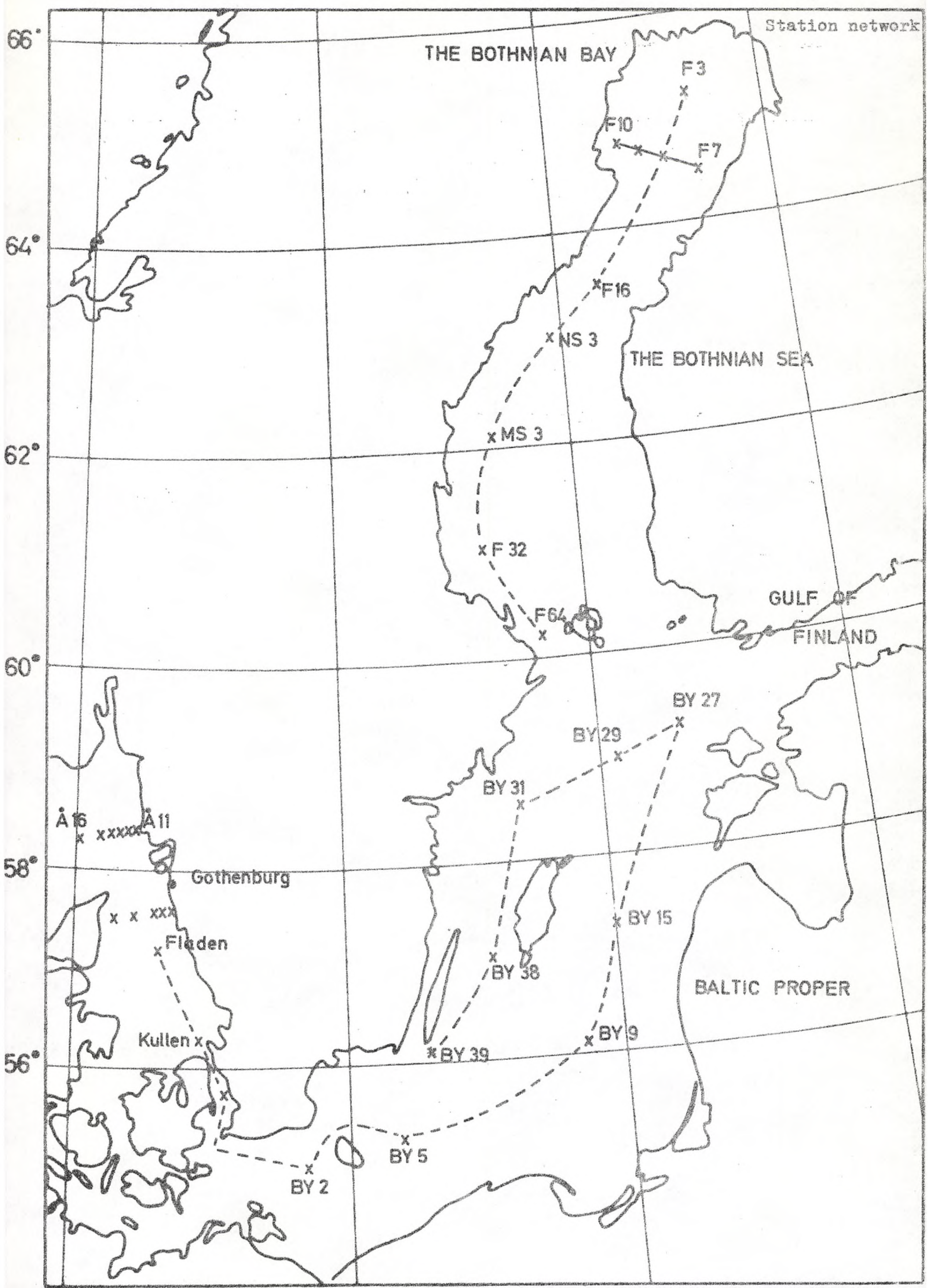
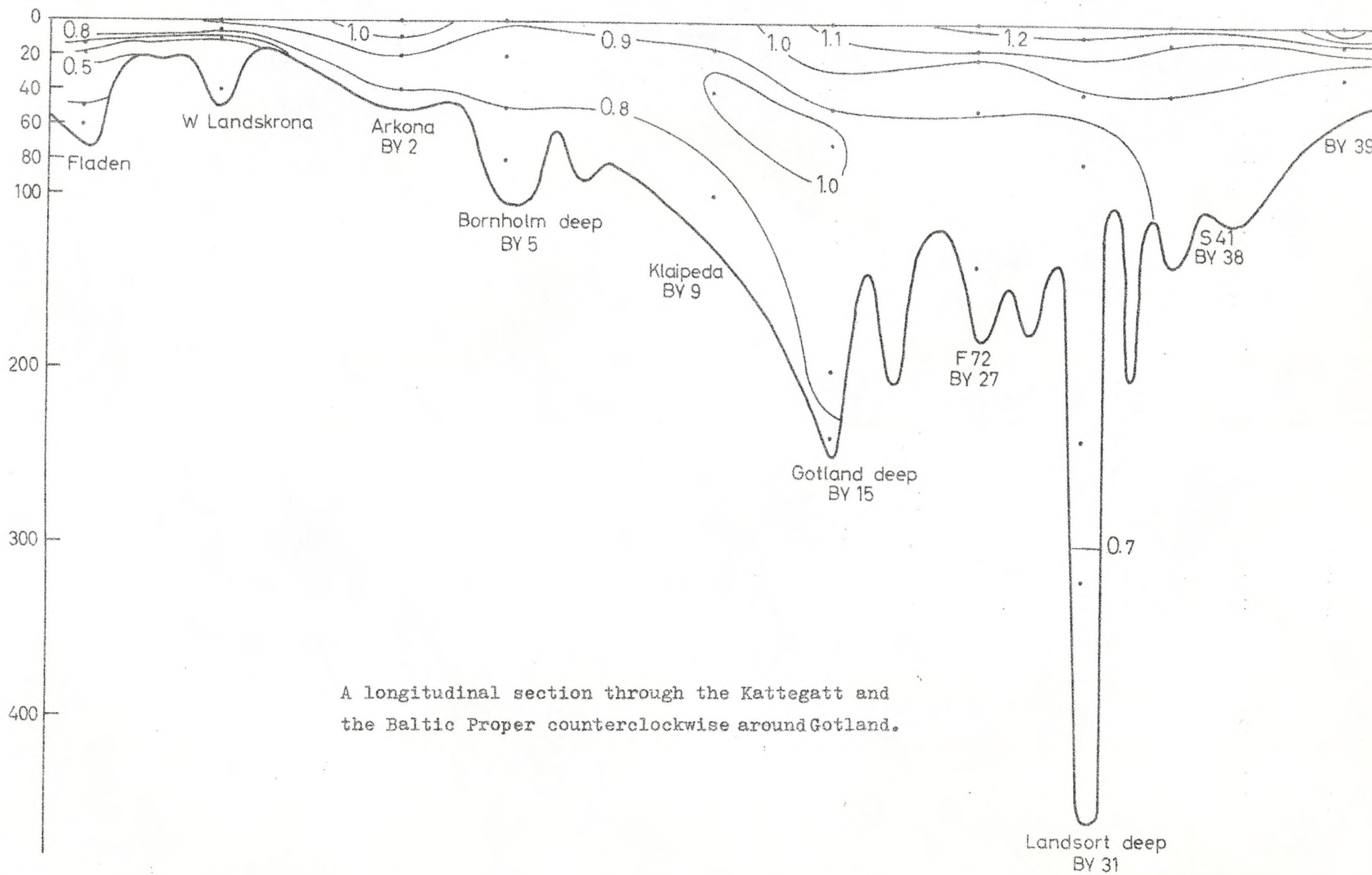

10°
15°
20°
25°
66°
64°
62°
60°
58°
56°
Station network
THE BOTHNIAN BAY
F3
F10
F7
F16
NS 3
THE BOTHNIAN SEA
MS 3
F 32
F64
GULF OF
FINLAND
BY 27
BY 29
BY 31
Å 16
Å 11
Gothenburg
Fladen
BY 15
BY 38
BALTIC PROPER
Kullen
BY 9
BY 39
BY 5
BY 2

Fig. 1

Fig. 2

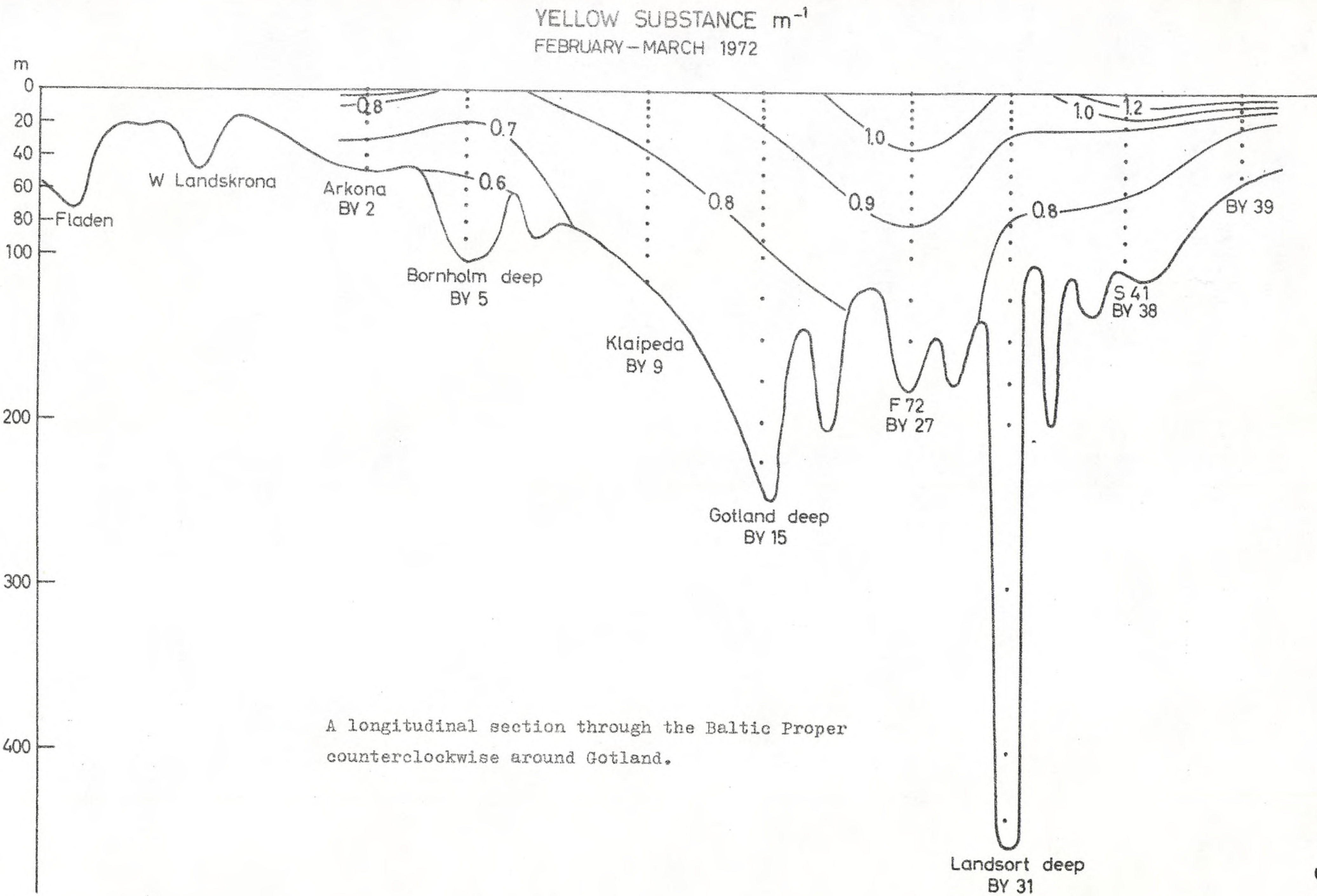
YELLOW SUBSTANCE m^{-1}

JANUARY 1971



A longitudinal section through the Kattegatt and the Baltic Proper counterclockwise around Gotland.

Fig. 3

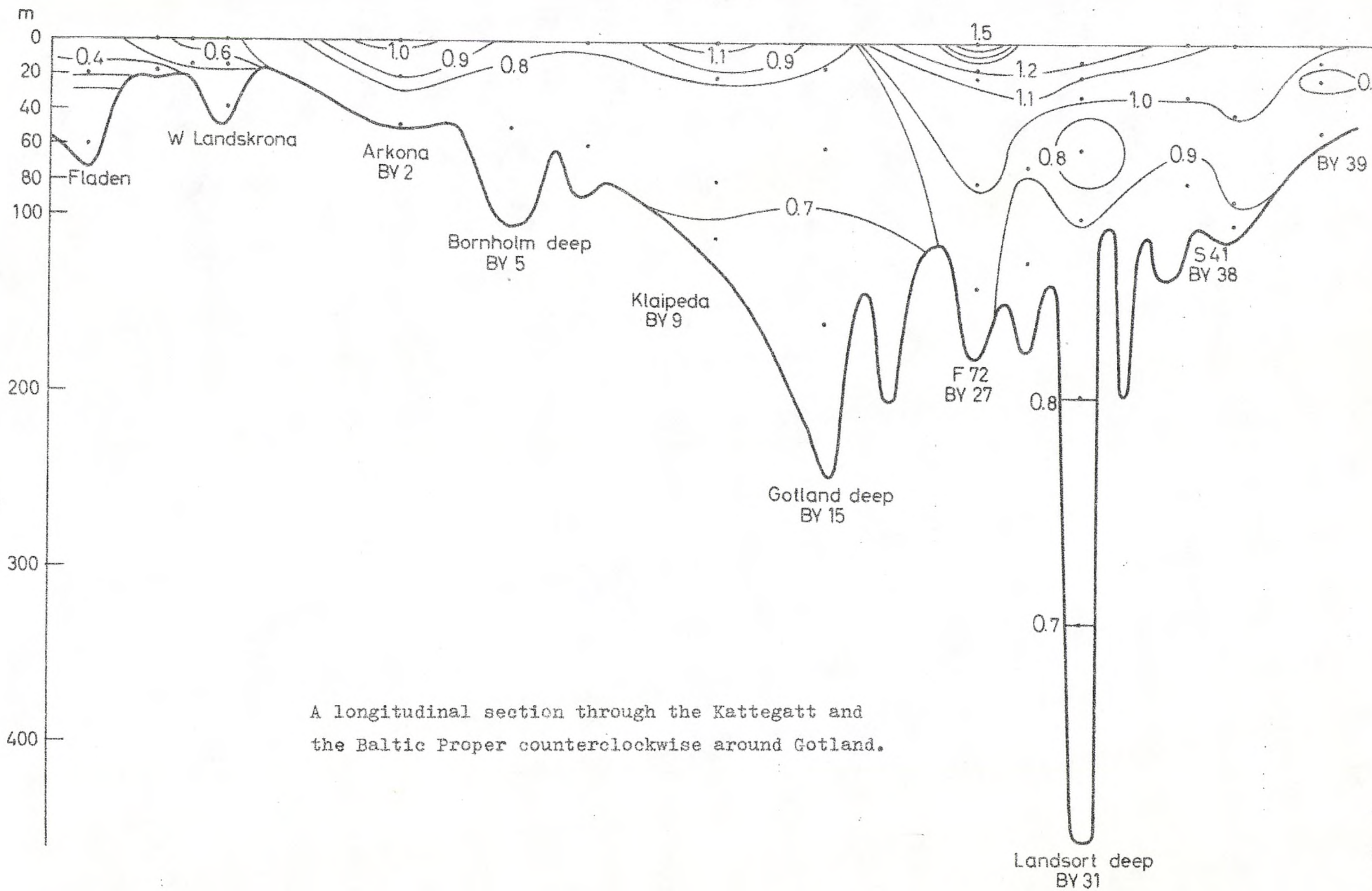


A longitudinal section through the Baltic Proper counterclockwise around Gotland.

Fig. 4

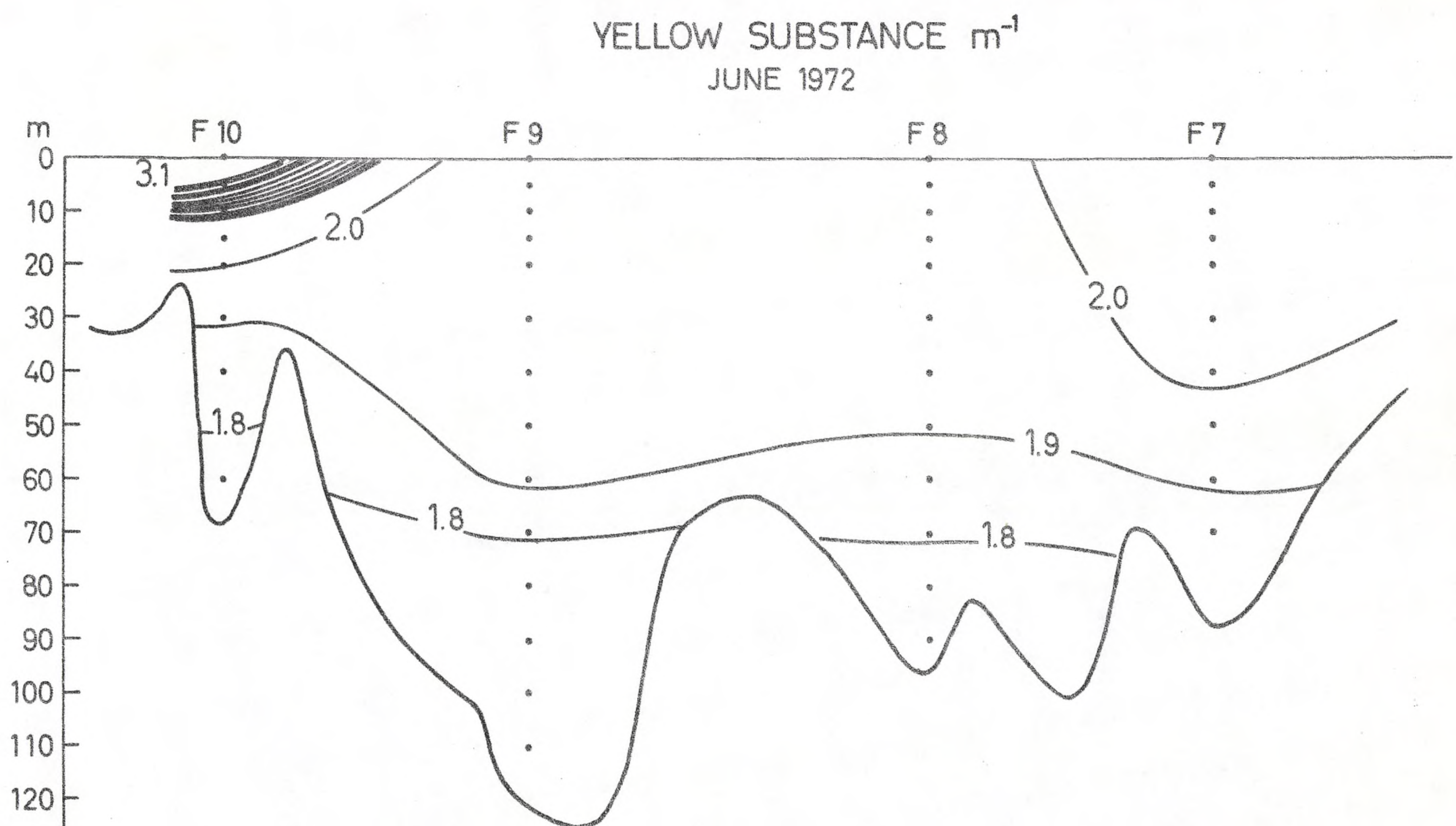
YELLOW SUBSTANCE m^{-1}

AUGUST 1971

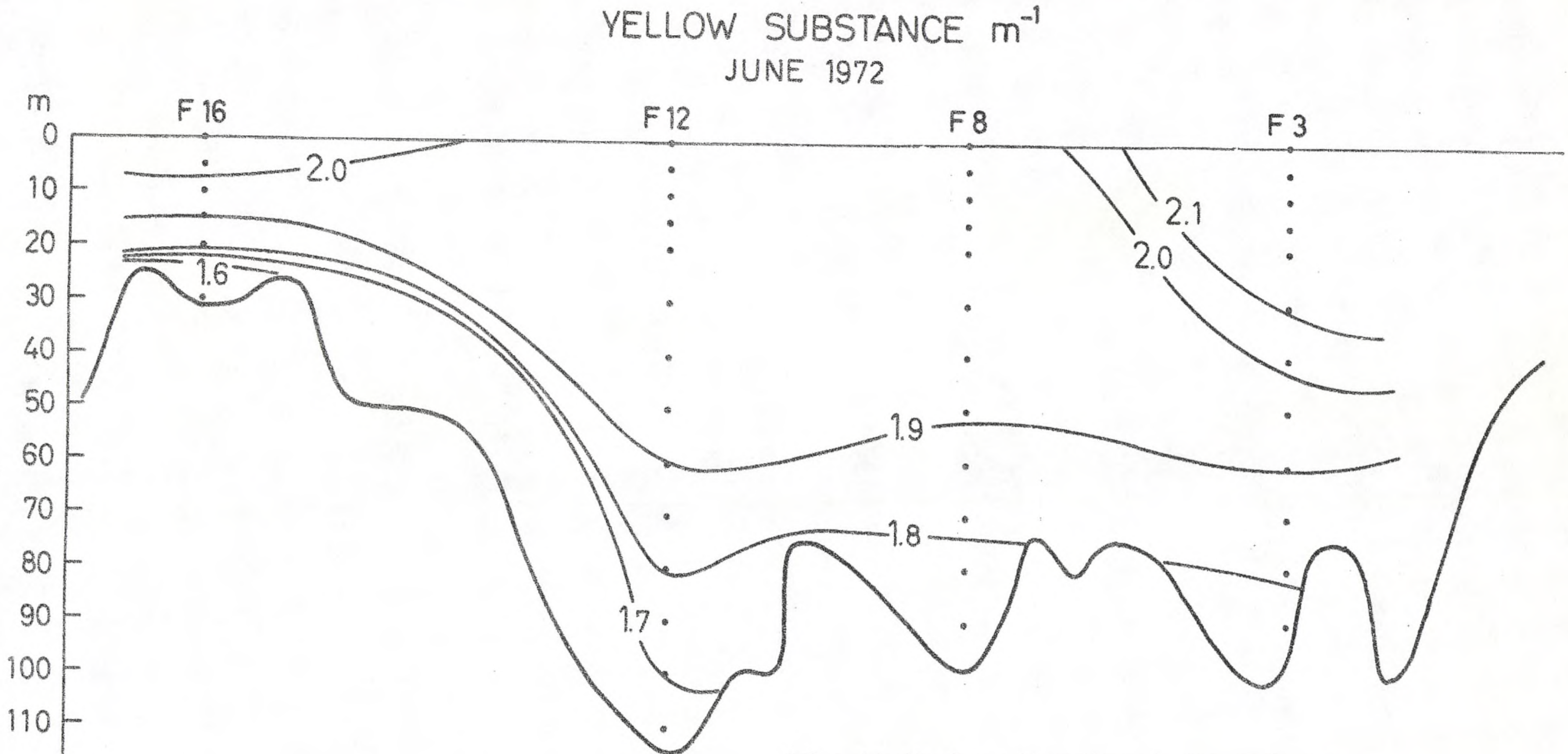


A longitudinal section through the Kattegatt and the Baltic Proper counterclockwise around Gotland.

Fig. 5



A transversal section through the Bothnian Bay.



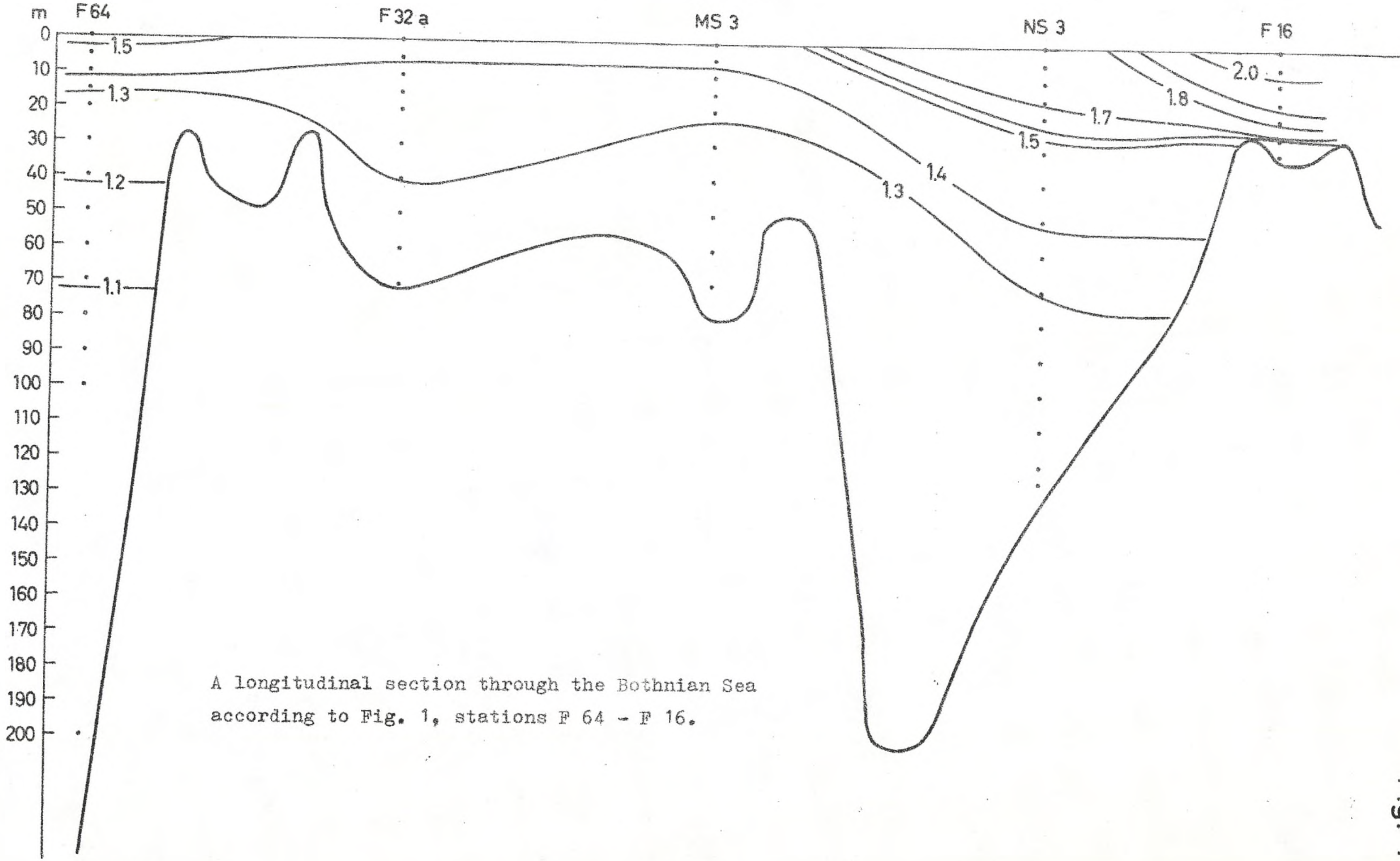
A longitudinal section through the Bothnian Bay according to Fig. 1, stations F 16 - F 3.

Fig. 6

Fig. 7

YELLOW SUBSTANCE m^{-1}

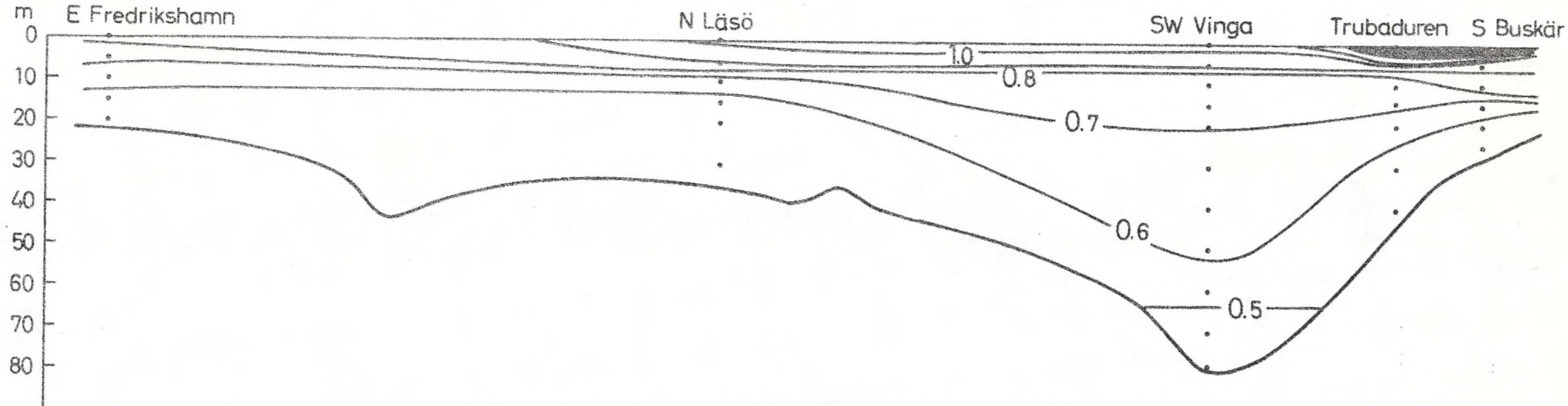
JUNE 1972



A longitudinal section through the Bothnian Sea according to Fig. 1, stations F 64 - F 16.

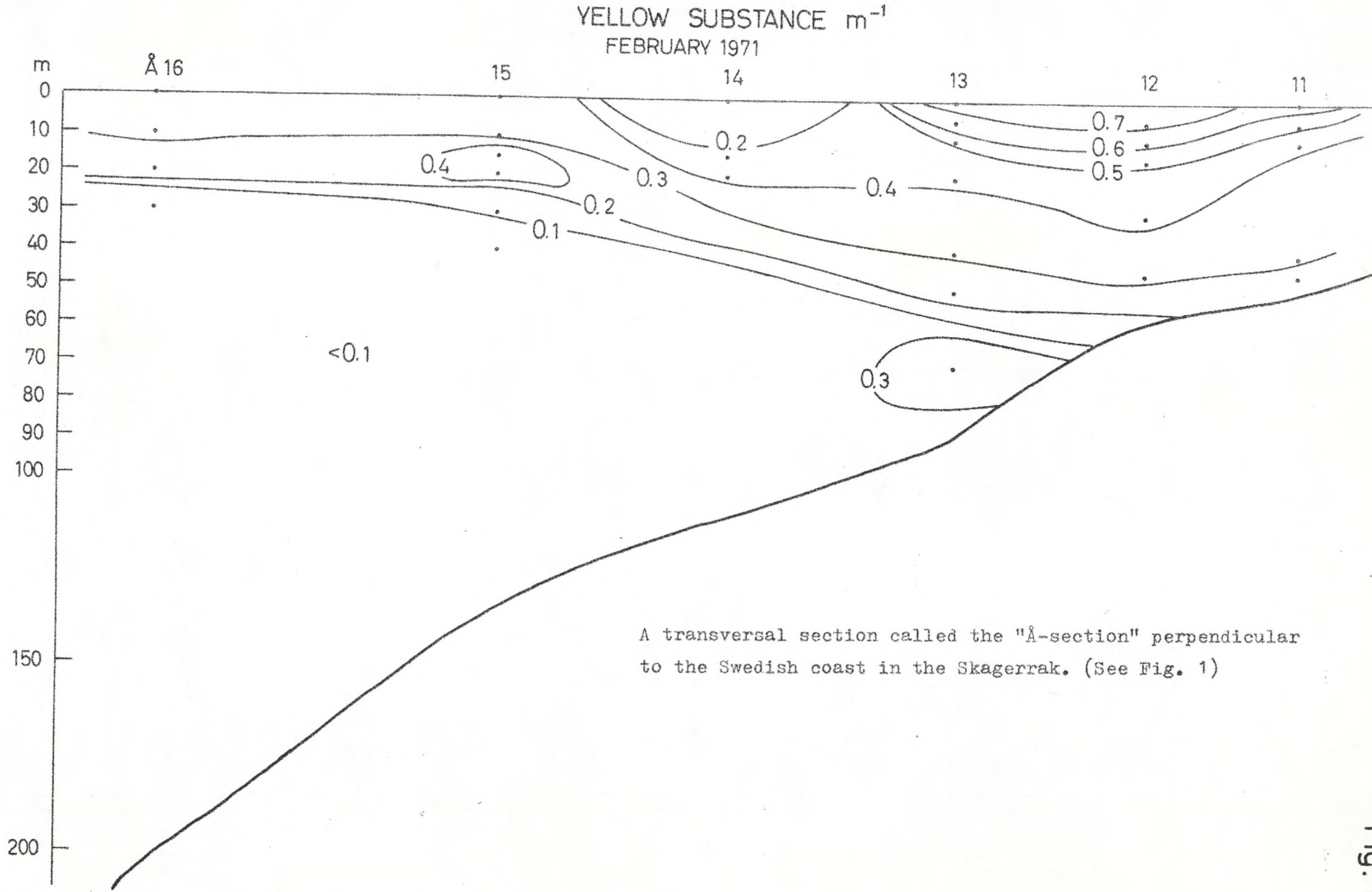
Fig. 8

YELLOW SUBSTANCE m^{-1}
APRIL 1972



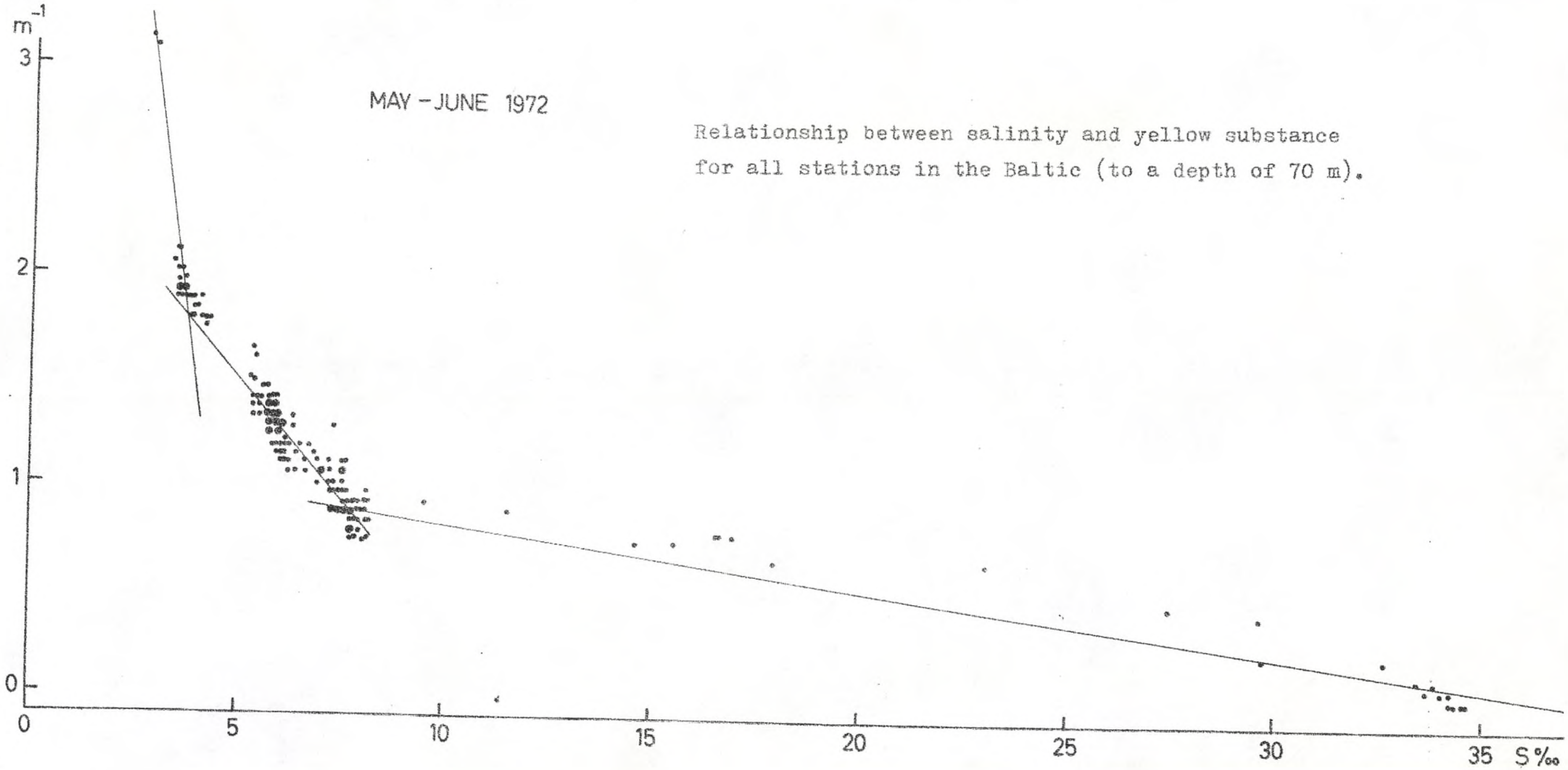
A transversal section through the Kattegatt between Gothenburg and Fredrikshavn. (See Fig. 1)

Fig. 9



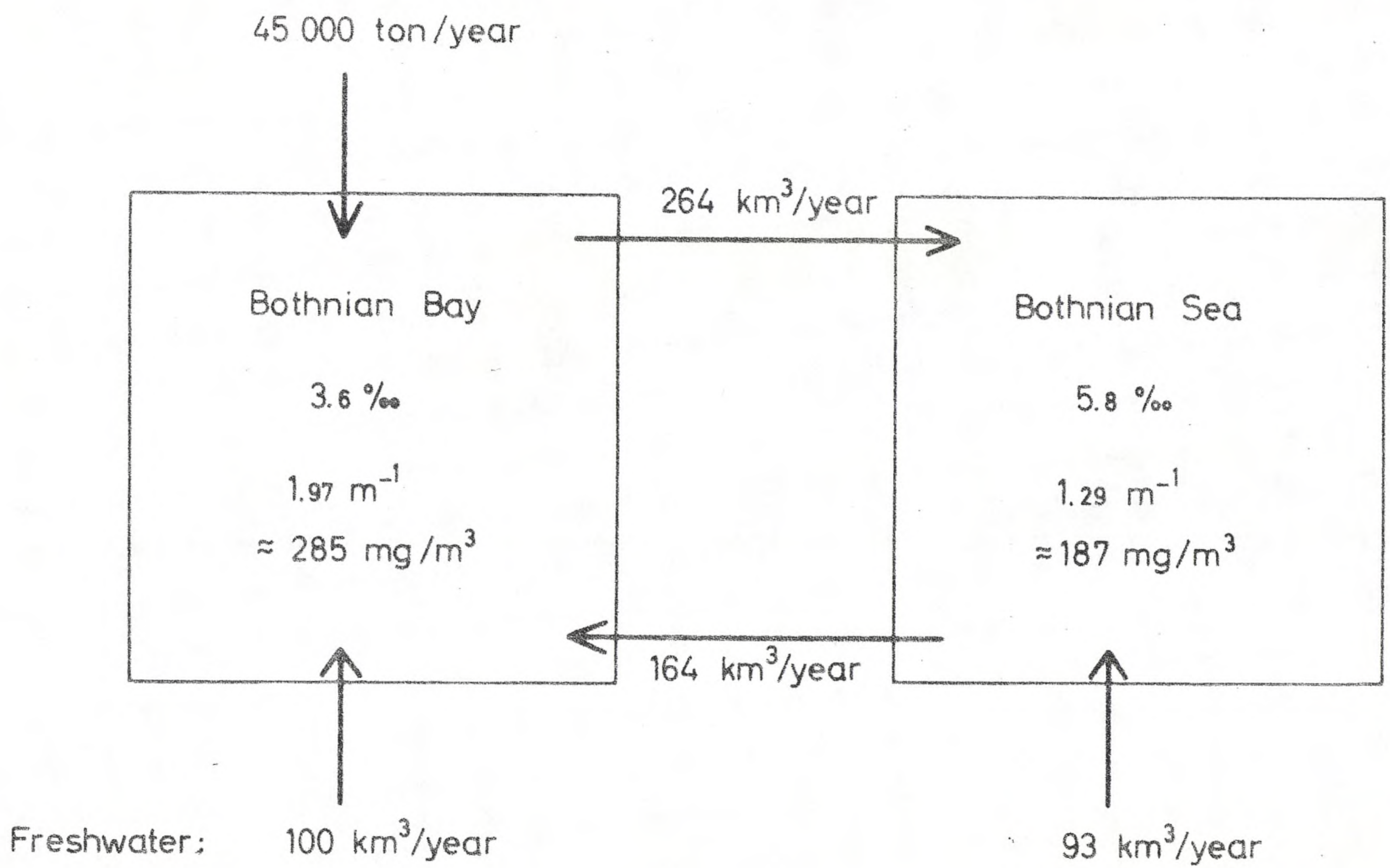
A transversal section called the "Å-section" perpendicular to the Swedish coast in the Skagerrak. (See Fig. 1)

Fig. 10



Relationship between salinity and yellow substance for all stations in the Baltic (to a depth of 70 m).

Fig. 11.



A box model to compute the yearly supply of yellow substance to the Bothnian Bay from known concentrations.