International Council for the Exploration of the Sea

C.M. 1968/ C:37
Hydrography Committee

The International Skagerrak Expedition 1966. Conditions in the Northern Part of the Kattegat and along the Swedish Coast of the Skagerrak.

by
Artur Svansson
Fishery Board of Sweden

This paper intends only to indicate a few characteristic features of the hydrographic conditions at the border between the Kattegat and the Skagerrak and its nearest surroundings during the International Skagerrak expedition in 1966. This area where the Baltic water of medium salinity enters the Skagerrak meeting its strong currents is very complicated. Fortunately, however, we have here valuable additional information from the Danish (and one Swedish) light-ships. There is possibilities that the combination of this information and the data from the international cooperation might spread some light on the complicated problems studied during many years.

Fig. 1 is a map showing the isobaths and the positions of lightships and the sections discussed in this paper. Fig. 2 shows a distribution of salinity during a Swedish expedition in May 1963; such maps are under preparation for the expedition 1966. Usually there is a strong horisontal salinity gradient in this ares. As we shall see it is oscillating a lot.

In Fig. 3 the salinities measured once a day at Bornö Station in the Gullmarfjord and at the lightship Läsö Nord (LN) are presented for the months of June and July 1966. Otto Pettersson (1909) assumed the variations which he found in the Bornömaterial to have tidal origin. Hans Pettersson (1916, 1920) found that the correlation with the wind was rather high, further that the phenomenon could be studied also at other places in the ares. Fig. 4 shows the isohalines at four places; only the isohalines of the higher salinities have been included. The most interesting feature is the increment of salinity at the end of June and the beginning

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of July. Water of higher salinity comes up towards the surface first at Bornö and Skagens Rev (SR) later at Läsö Nord and Fladen (F). Probably the rather strong west winds are responsible for the effects (Fig. 5). Possibly in this way Baltic water is retarded giving the paradoxical effect at the Swedish coast of the Skagerrak of "upwelling" together with coastward wind (see Fig. 7).

During periods when ice covers the Gullmarfjord and the waters off the coast very good correlation has been found between the variations of isohaline depth and atmospheric pressure (Johnsson 1943). Lybeck (1968) is of the opinion that the phenomenon must be connected with internal continental shelf waves (Mysak 1967).

The surface currents measured many times a day are shown in Figs 5 and 6 (daily means). Fig. 8 presents three maps of the mean currents during the three periods of section measurements. The situation seems to be similar to May-June 1963 (Svansson 1965). Fig. 9 , taken from this paper, presents a possible pattern of currents in the Kattegat particularly valid at times of weak winds or winds which press Baltic water back. The inflow particularly prominent during the second and third run in 1966 takes place in the eastern part of the Kattegat, while in the western and probably also very near the Swedish coast outflow takes place. (See Fig. 12, S‰). Also from experiments with surface drifters (Engström 1967) it is clear that the beginning of July is a period of remarkable inflow of surface water to the Kattegat.

Another interesting question which will be taken up here concerns the oxygen conditions. As already known (O. Pettersson and G. Ekman, 1891) there are low oxygen values in the deeper layers of the Kattegat. Table 1 shows recent measurements from three stations along the Swedish coast. From our measurements during the international cooperation 1966 we now find such low values even in the southeastern part of the Skagerrak (Figs 10 and 11). Probably the "bubble" of low oxygen emanates from the Kattegat; some days later it has disappeared in the Skagerrak, has on the other hand increased in the Kattegat (Fig. 12).

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Table 1

Percentage oxygen saturation,

at N 57°11,5′ E 11°40′, vicinity of Fladen lightship

	May 6 1966	Aug 22 1966	Sep 27 1966	Nov 25 1966	Feb 10 1967	May 29 1967	Dec 6 1967
30 m	90	84	90	90	94	100	95
50 m	91	63	68	77	93	93	89
60 m	90	52	58			92	80

Fig. 1

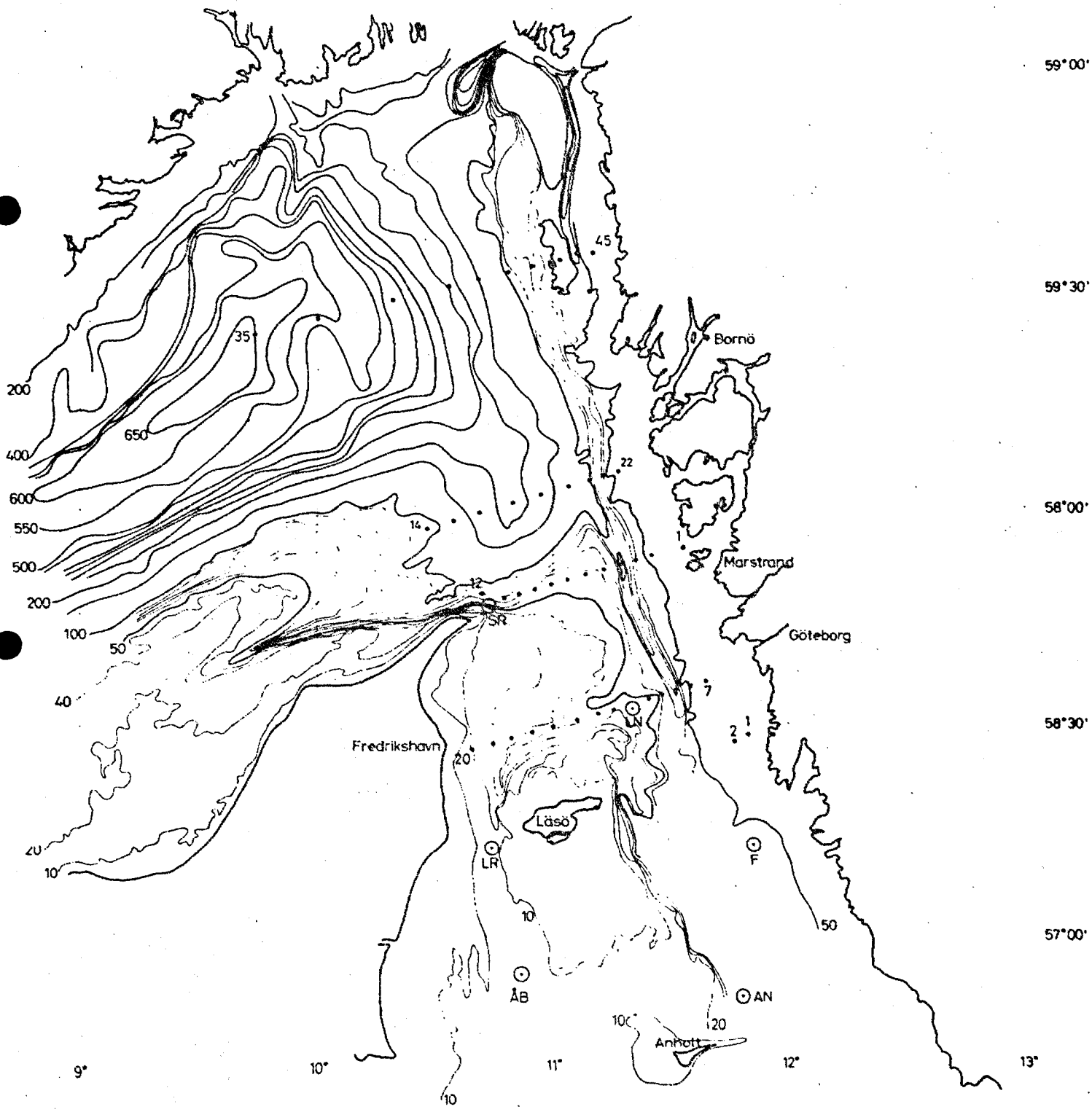
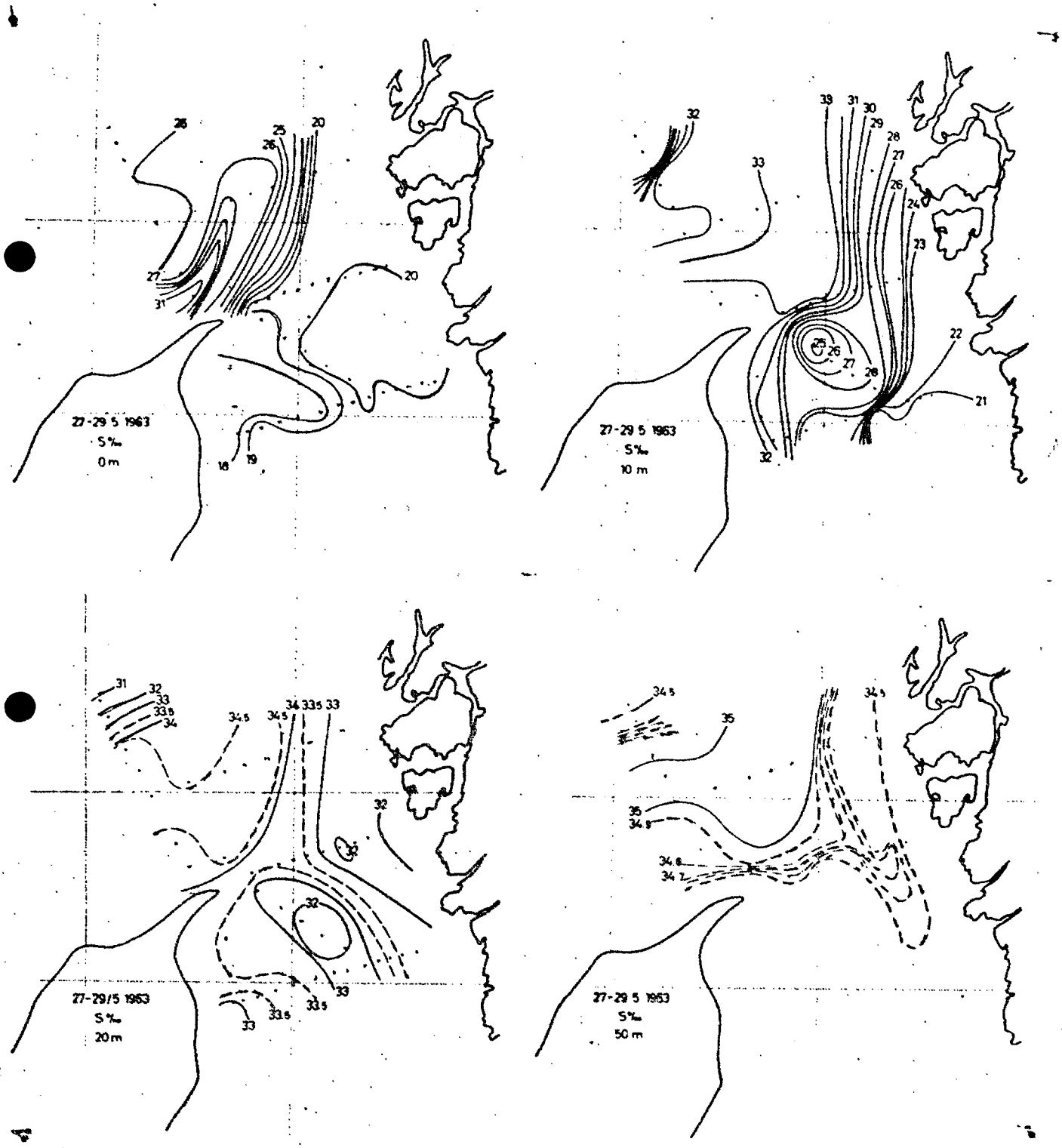
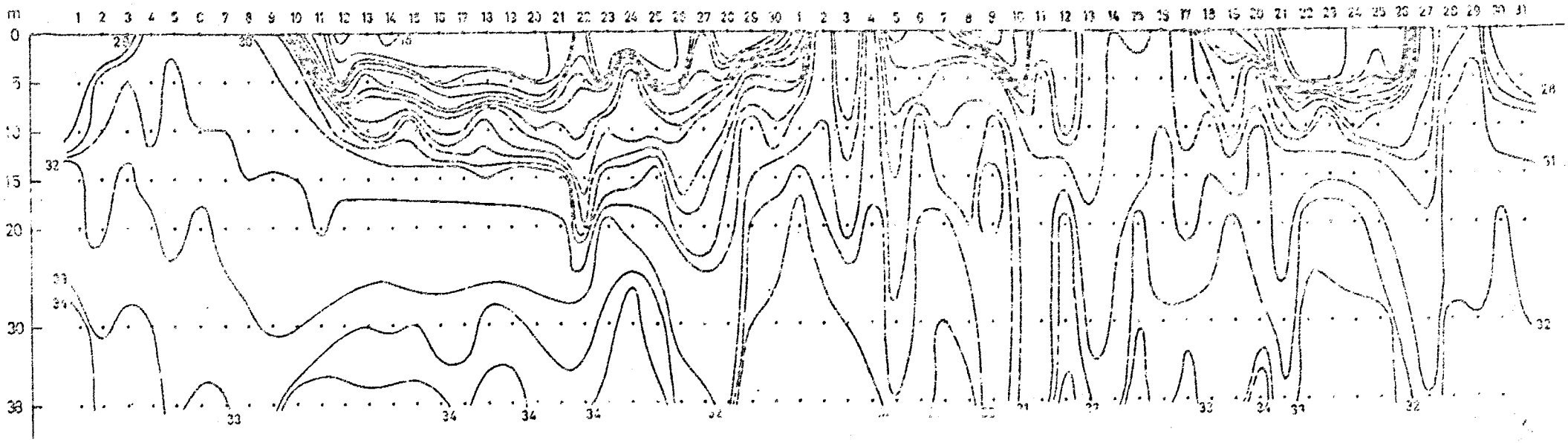

59°00'
59°30'
58°00'
58°30'
57°00'
9°
10°
11°
12°
13°
Bornö
Marstrand
Göteborg
Fredrikshavn
Läsö
LN
LR
F
ÅB
AN
Anholt
45
35
22
14
12
7
20
10
50
100
200
400
600
550
500
650
40

Fig. 2


27-29 5 1963
S‰
0 m
27-29 5 1963
S‰
10 m
27-29/5 1963
S‰
20 m
27-29 5 1963
S‰
50 m


Læsø Nord 1966
S‰
June
July
m
0
5
10
15
20
30
38

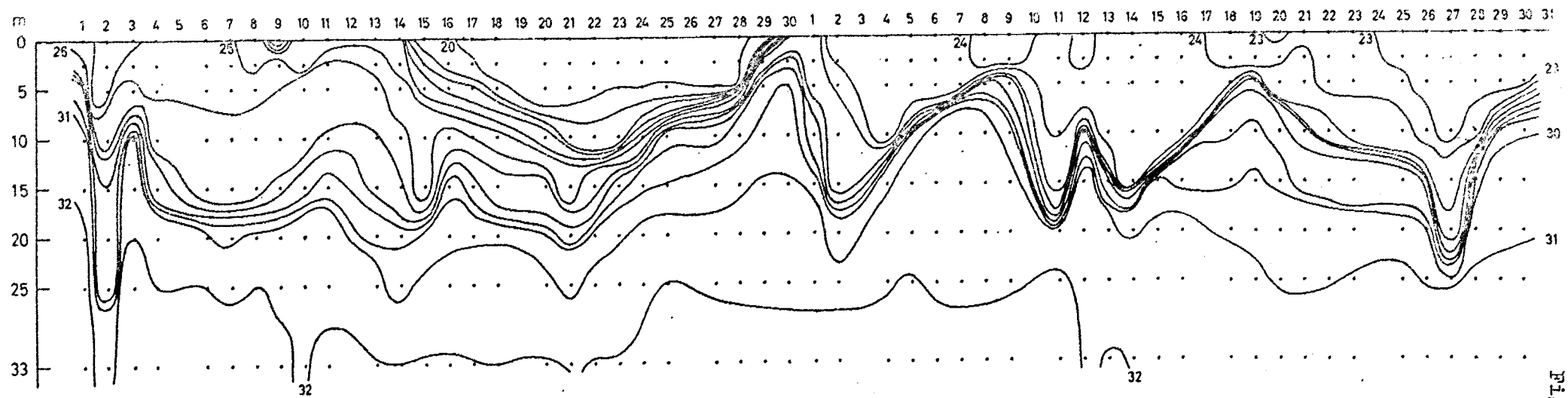

Bornö June 1966
S‰
Bornö July 1966
S‰
m
0
5
10
15
20
25
33

Fig.3

Fig. 4

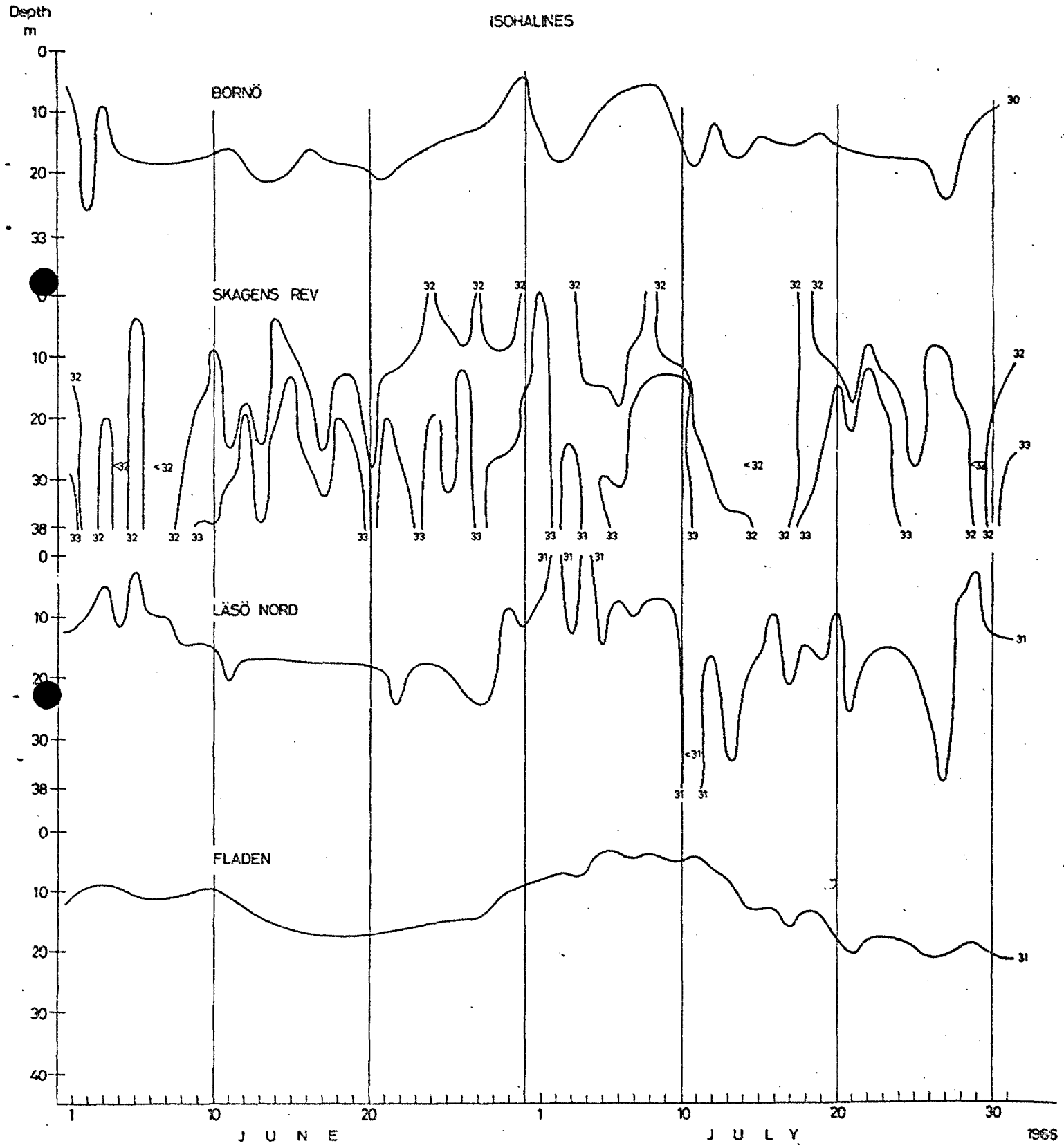
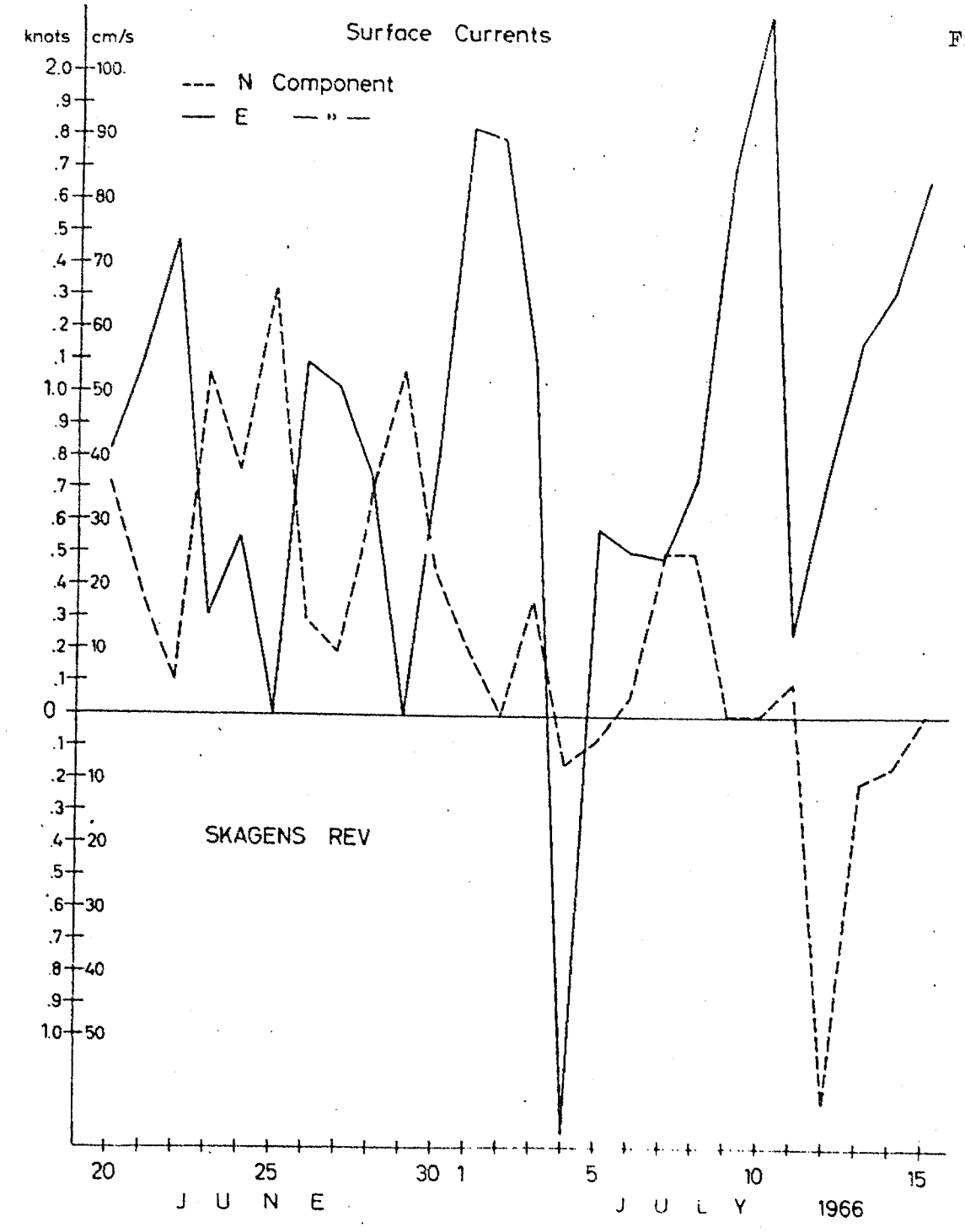
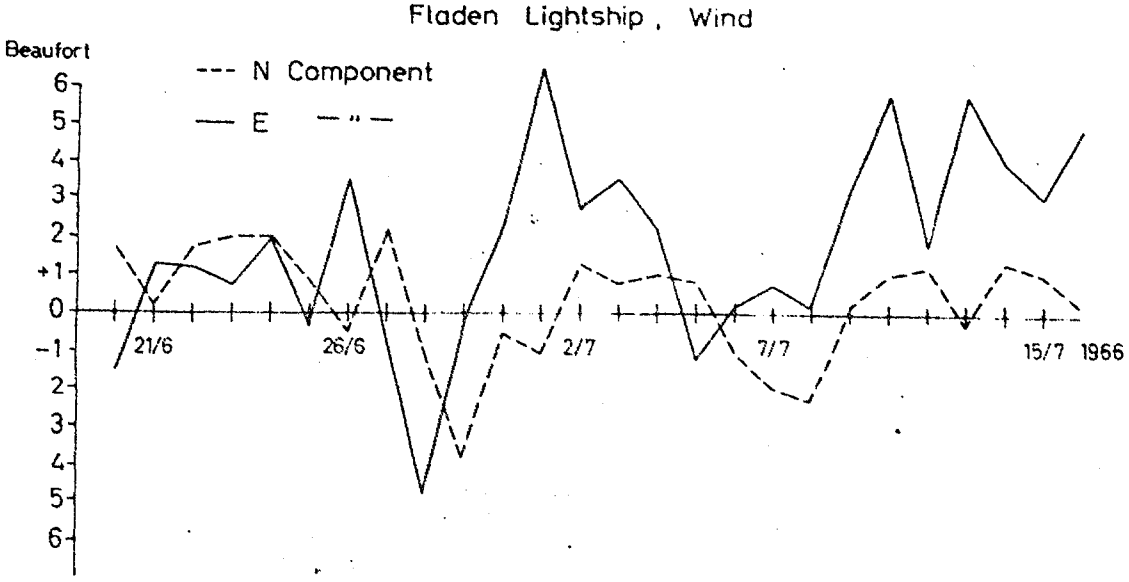

Depth
m
ISOHALINES
BORNÖ
SKAGENS REV
LÄSÖ NORD
FLADEN
0
10
20
30
38
40
1
10
20
1
10
20
30
JUNE
JULY
1965

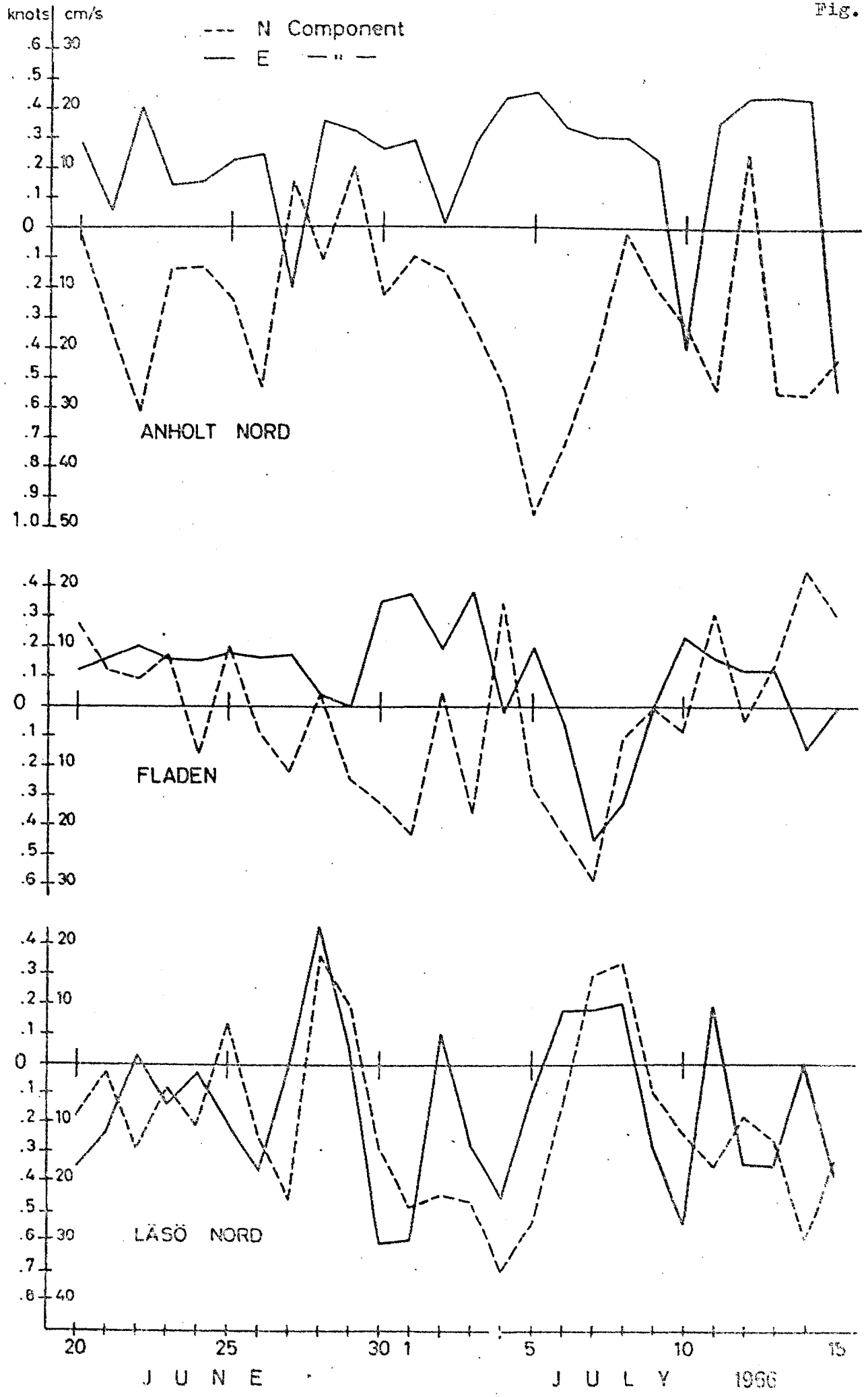
Fig. 5


Surface Currents
knots
cm/s
--- N Component
— E —"—
SKAGENS REV
20
25
30
1
5
10
15
J U N E
J U L Y
1966


Fladen Lightship, Wind
Beaufort
--- N Component
— E —"—
21/6
26/6
2/7
7/7
15/7
1966

Surface Currents

Fig. 6



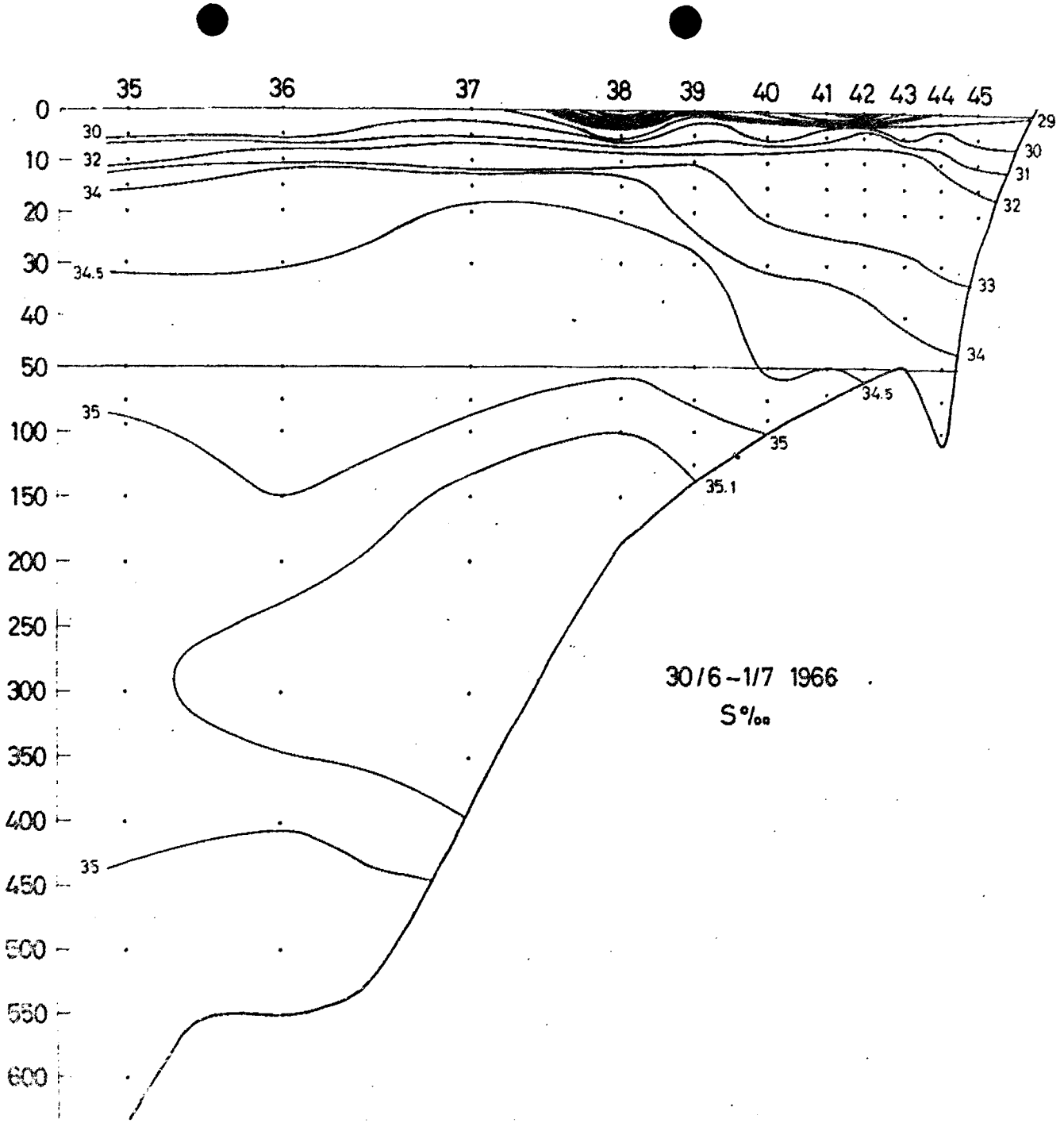
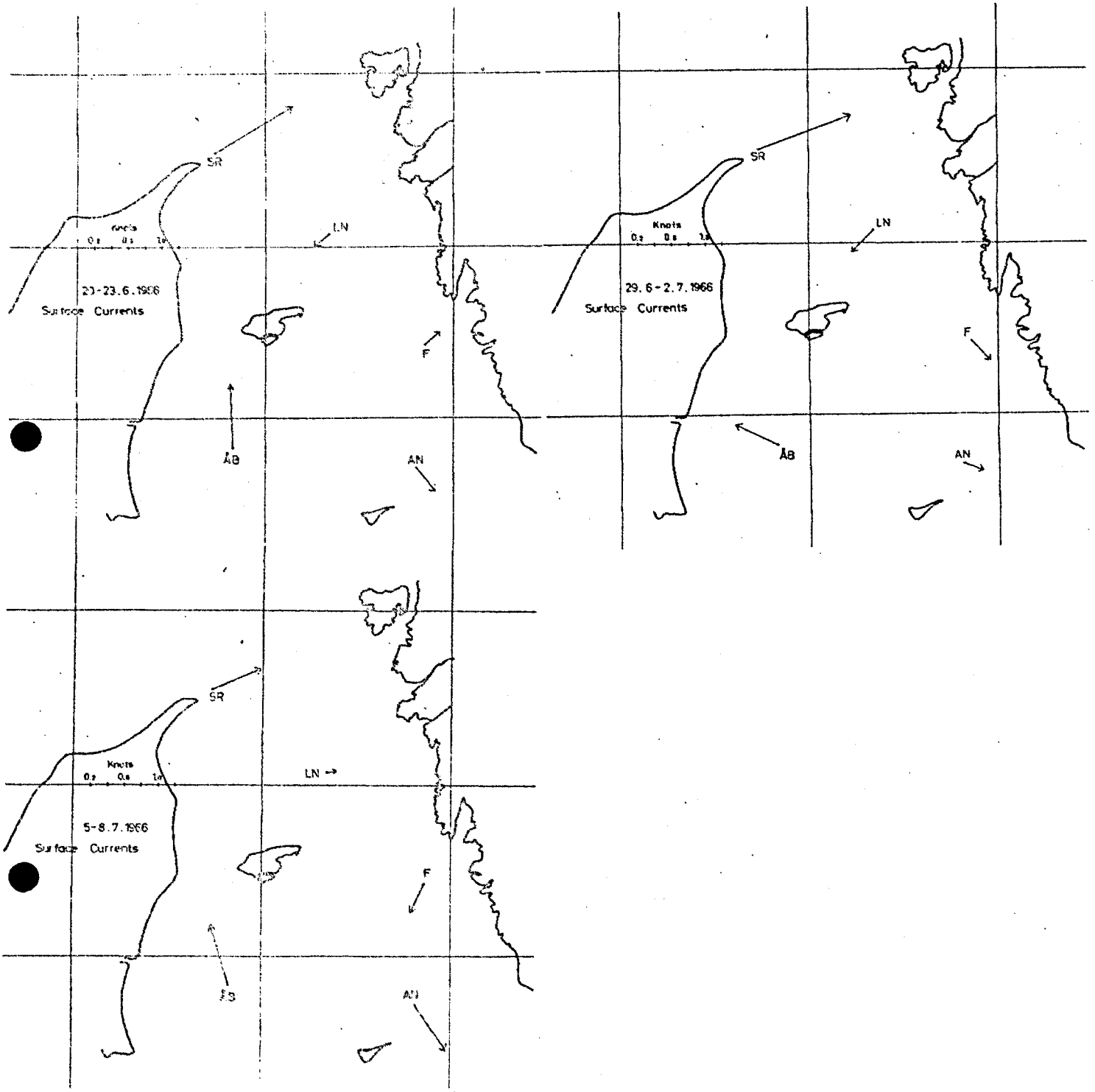
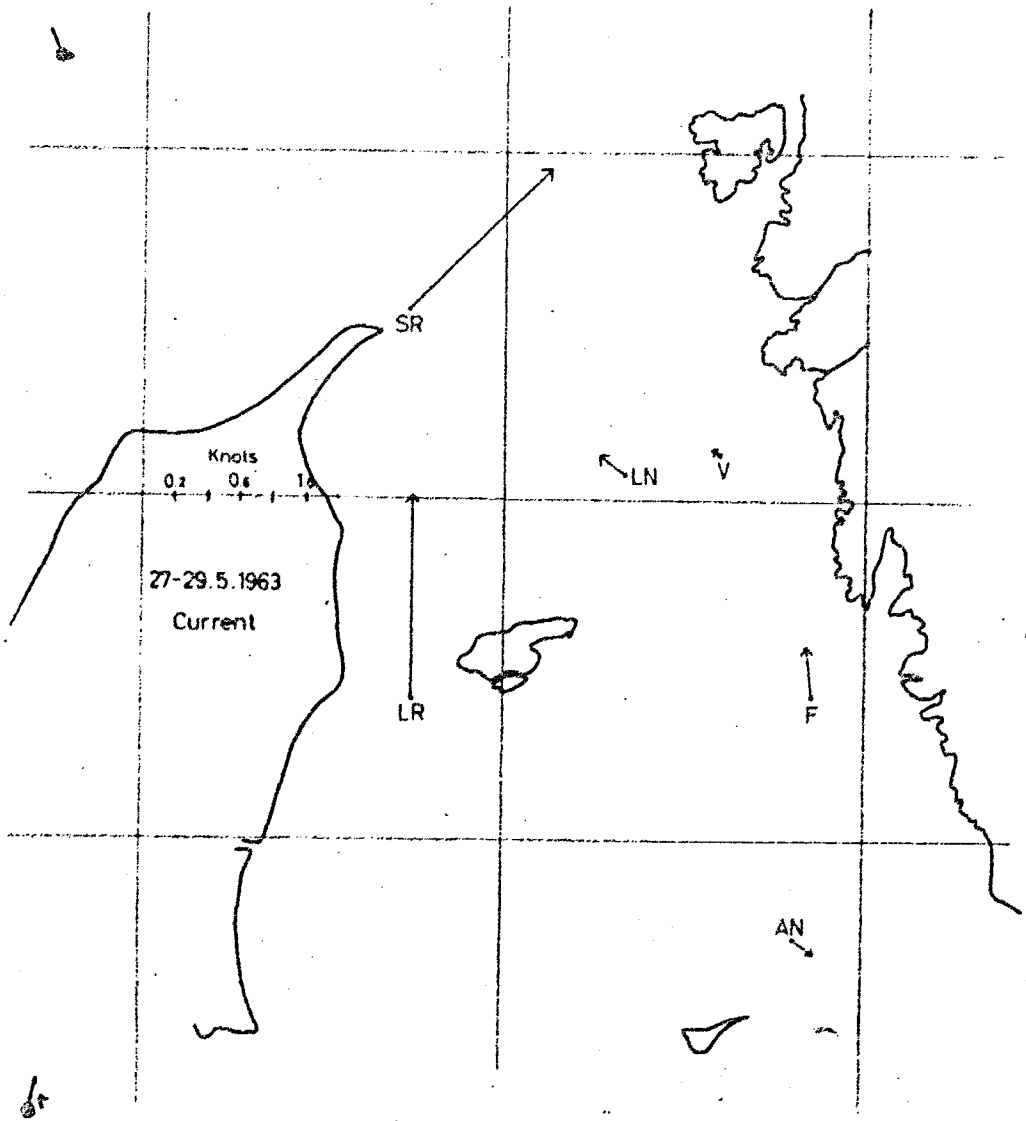
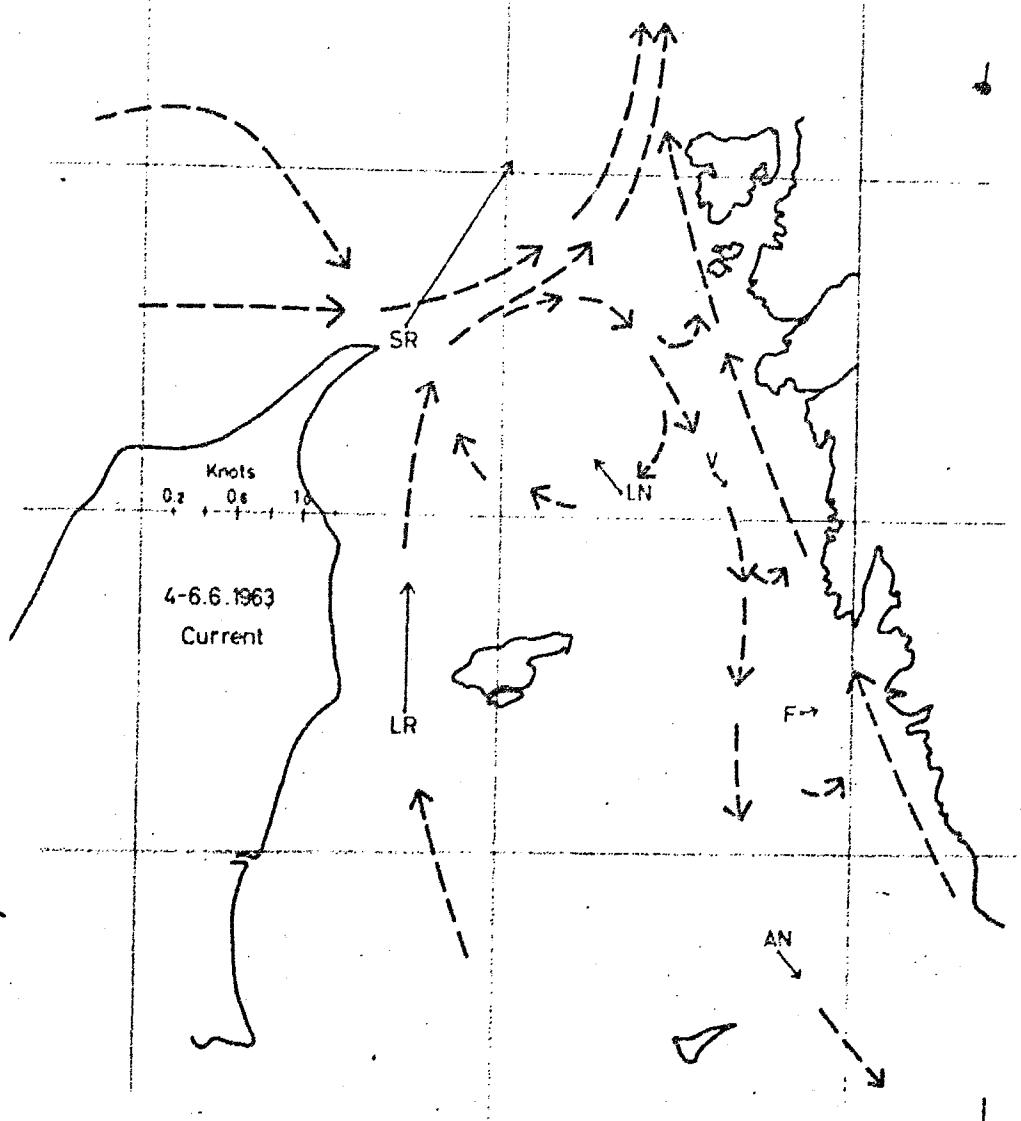

35
36
37
38
39
40
41
42
43
44
45
0
10
20
30
40
50
100
150
200
250
300
350
400
450
500
550
600
30
32
34
34.5
35
35
35
29
30
31
32
33
34
34.5
35.1
30/6-1/7 1966
S‰

Fig. 7

Fig. 8


SR
LN
F
ÅB
AN
Knots
0.2 0.6 1.0
23-23.6.1966
Surface Currents
29.6-2.7.1966
Surface Currents
5-8.7.1966
Surface Currents
LN →
ÅS





Mean Surface Currents at the Lightships

Fig. 9

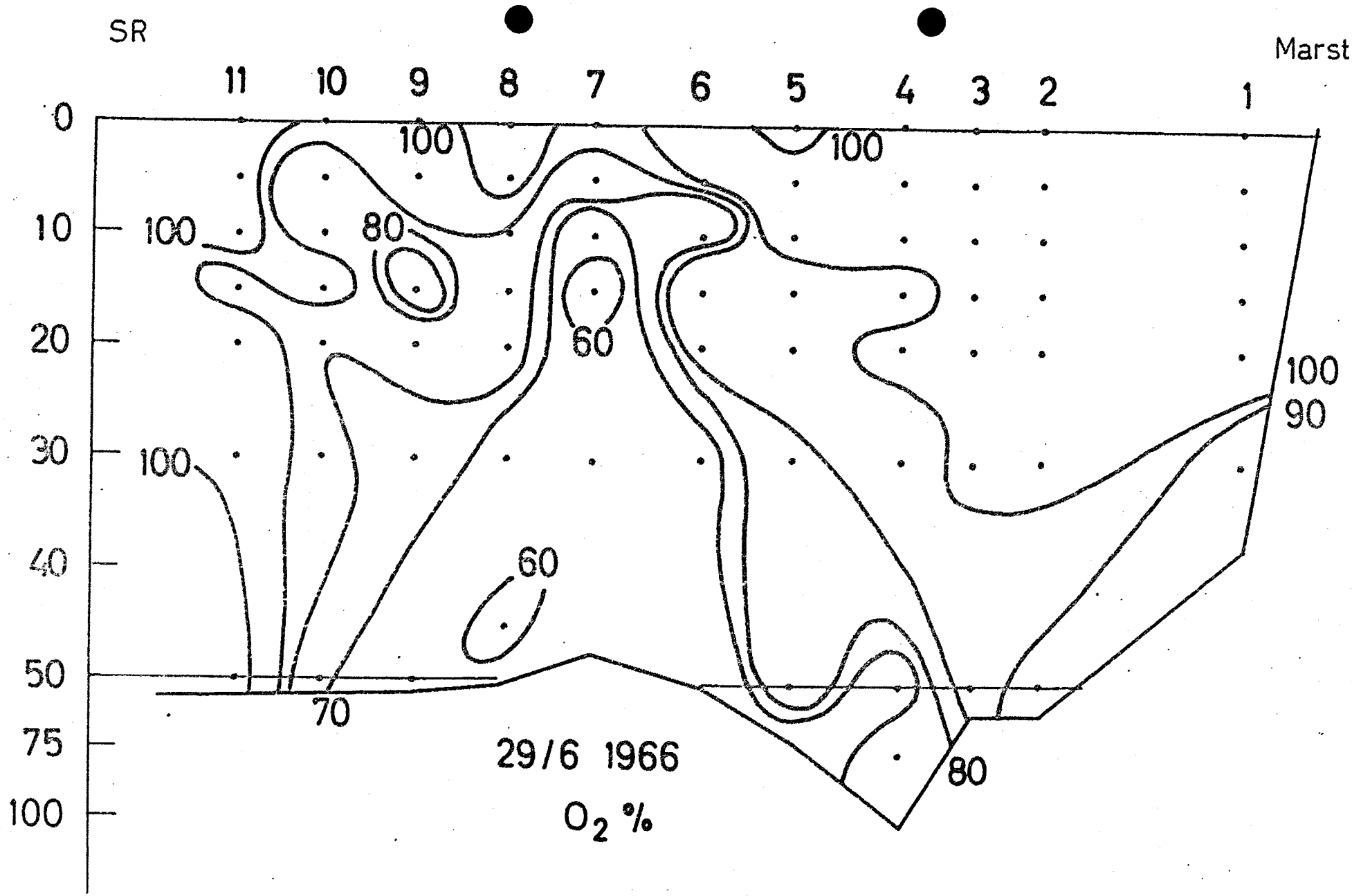

SR
Marstrand
11
10
9
8
7
6
5
4
3
2
1
0
10
20
30
40
50
75
100
100
100
80
60
100
100
90
60
70
80
29/6 1966
O2 %

Fig. 10

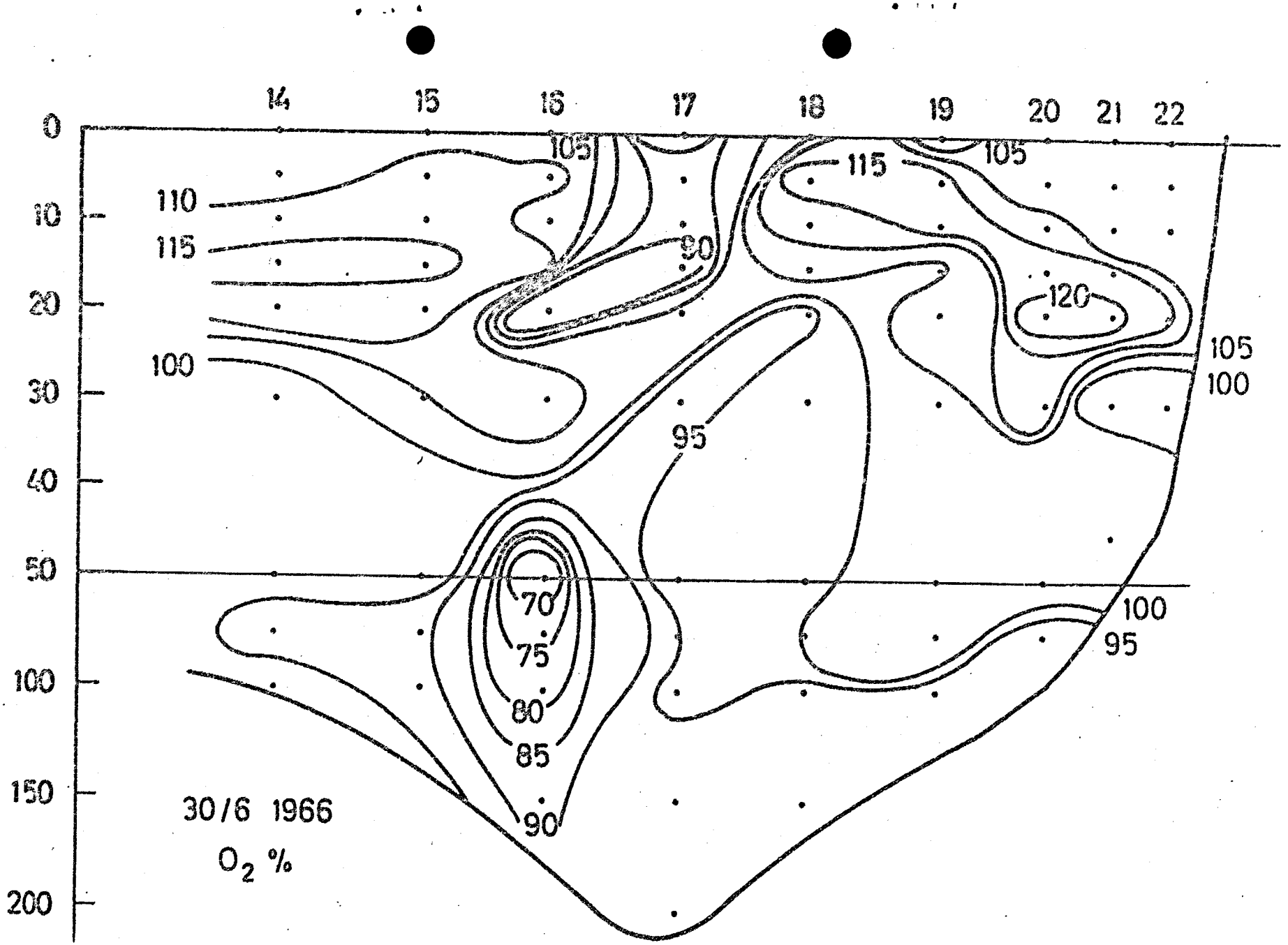
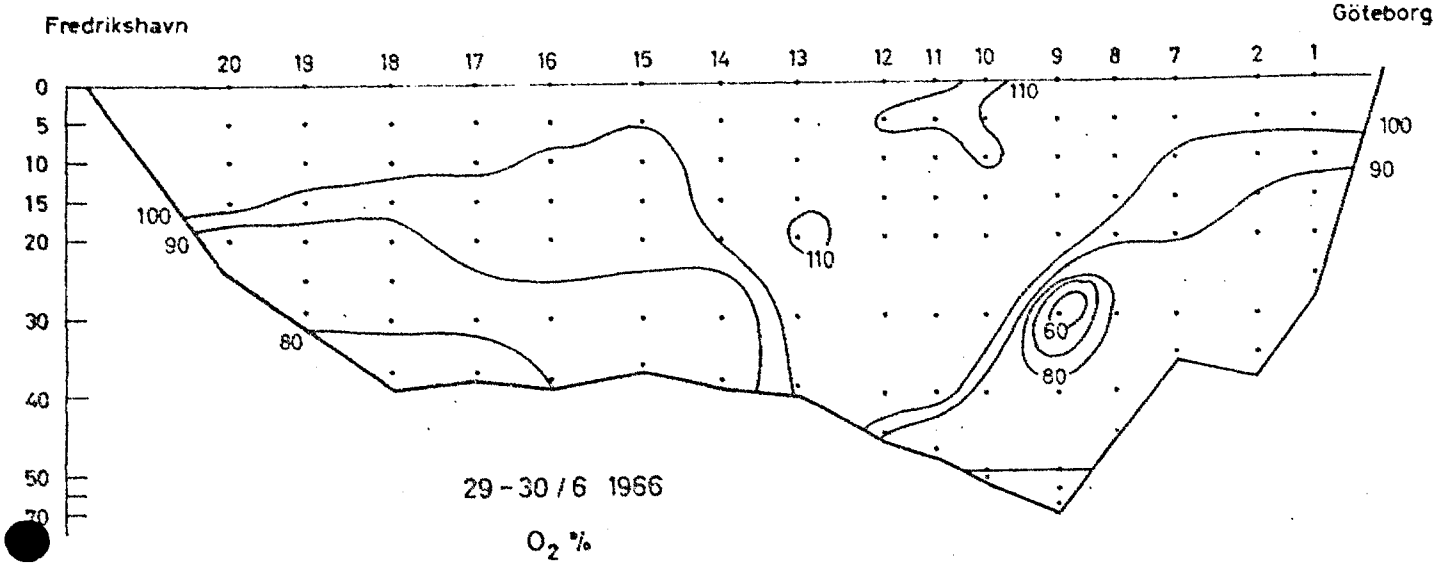
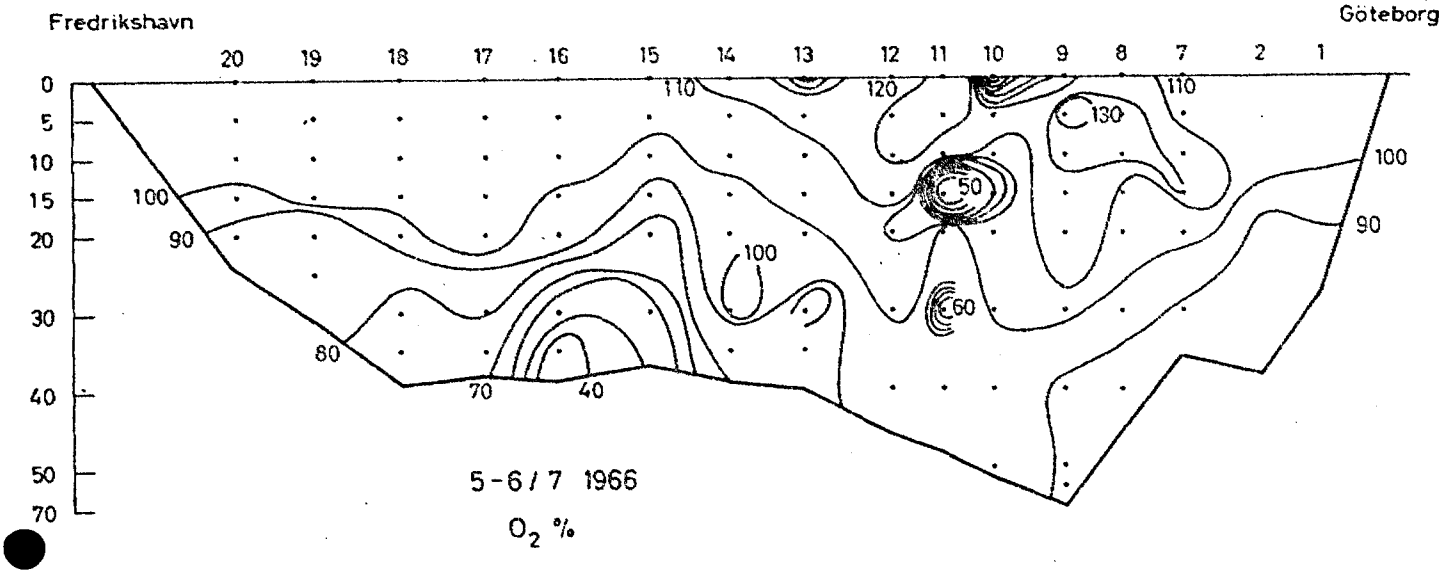
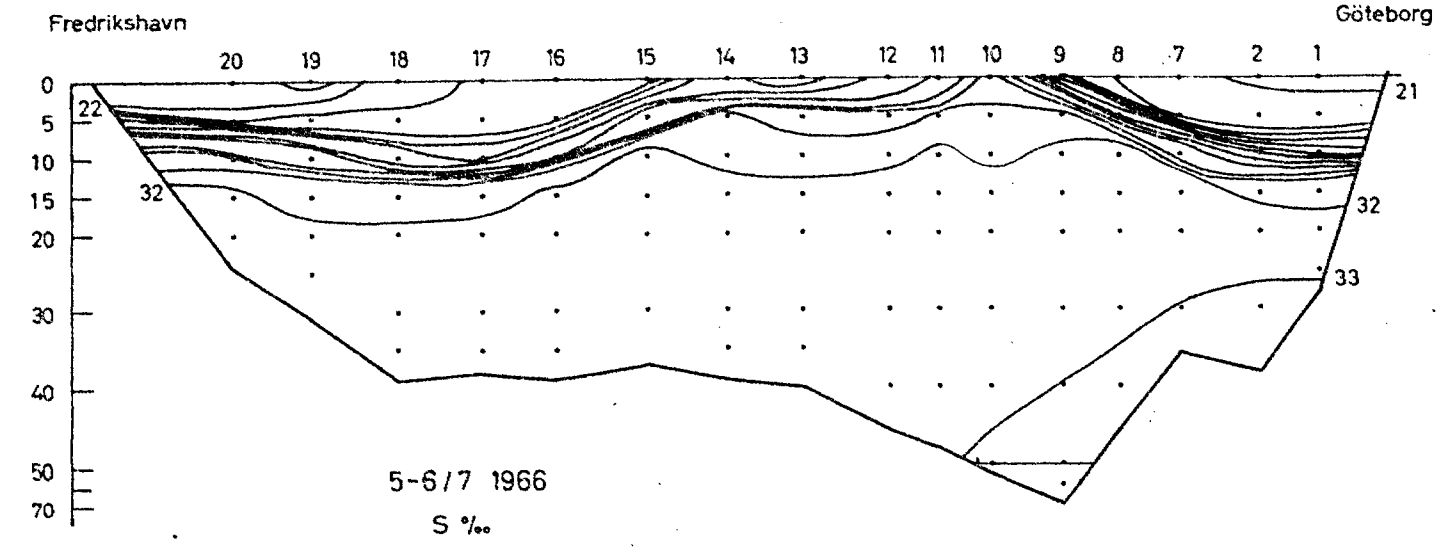

14
15
16
17
18
19
20
21
22
0
10
20
30
40
50
100
150
200
105
115
105
110
115
90
120
100
105
100
95
70
75
80
85
90
100
95
30/6 1966
O2 %

Fig. 11

Fig. 12


Fredrikshavn
Göteborg
20 19 18 17 16 15 14 13 12 11 10 9 8 7 2 1
0 5 10 15 20 30 40 50 70
100
90
80
110
110
100
90
60
80
29-30/6 1966
O_2 %


Fredrikshavn
Göteborg
20 19 18 17 16 15 14 13 12 11 10 9 8 7 2 1
0 5 10 15 20 30 40 50 70
100
90
80
110
120
110
130
50
100
60
70
40
100
90
5-6/7 1966
O_2 %


Fredrikshavn
Göteborg
20 19 18 17 16 15 14 13 12 11 10 9 8 7 2 1
0 5 10 15 20 30 40 50 70
22
32
21
32
33
5-6/7 1966
S ‰