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GÖTEBORGS UNIVERSITET

Ödsmål, Kville sn, Bohuslän

Hällristning Fiskare från bronsåldern

Rock carving Bronze age fishermen

MEDDELANDE från HAVSFISKELABORATORIET • LYSEKIL

nr 62

Hydrografiska avdelningen, Göteborg.

On the Oxygen and Phosphate Conditions in the Kattegat and Öresund 1900-1968.

by Ch. Corin, S.H. Fonselius and A. Svansson

February 1969

On the Oxygen and Phosphate Conditions in the Kattegat and Öresund 1900-1968.

by

Ch. Corin, S.H. Fonselius and C.A. Svansson

An investigation of the oxygen and phosphate conditions in the Baltic (Fonselius 1968) shows a strong decrease of the oxygen concentration and a great increase of the phosphate concentration in the deep water from 1900 to 1968. This paper investigates the same problem in the Kattegat and Öresund. The deep water which has its origin in the North Sea lies below the outgoing stream of brackish water from the Baltic. Considering that the two water masses hardly mix because of the great density difference between them, oxygen-rich water only has limited possibilities to reach the bottom layers and the phosphates which exist in the bottom water has small possibilities to reach the surface layers and be carried out from the Kattegat.

The oxygen conditions are represented in Figs 2-6 as oxygen saturation values (Fox 1907). Because these values show a minimum in the summer and autumn probably due to the fact that the oxidation of organic matter is highest during and after the maxima in primary production (Steemann-Nielsen 1958), the values for the months July-September have been specially marked in the figures. The rise of oxygen concentrations during the autumn (during many years this does not seem to occur before December) probably does not only depend on the decreased production but also on the fact that the intensity of the currents both in the upper and lower layers increases considerably (Jacobsen 1925). These values show a decrease in the Kattegat (see Figs 2 and 3) during the present century while the values for other months only show a weak tendency in that direction. Low oxygen values were measured in large parts of the northern Kattegat and also at some stations in the south-eastern Skagerack during the International Skagerrak Expedition in June-July 1966 (Svansson 1968). No decrease can, however, be found in Öresund.

The phosphate conditions are represented in Figures 7-9. There are no measurements from the beginning of the century; the only measurements to which the latest period (1956-1964) can be compared, are single values from 1931. Such a comparison shows that an increase of the PO_4-P values has occured in the Landskrona Deep (No 5). This increase is also clear inside the last period (see Table 1). A similar secular increase may be distinguished for L:a Middelgrund in the Kattegat, but not, however, inside the last period.

This work was initiated by Dr. Sten Vallin, Drottningholm.

The conditions hitherto accounted usually regard the greatest depth on the station considered. In order to get an idea of the distribution of the changes at other depths, Table 2 has been made. One can see that the changes begin to be visible at 15-30 m depth, i.e. probably in or below the halocline.

As a conlusion the following may be stated: In the Kattegat the oxygen conditions have impaired simultanously with a possible phosphate increase; the latter is somewhat difficult to prove.

The phosphate increase is clearly detectable in Öresund but is not accompanied by an oxygen decrease. There are obviously better exchange conditions for oxygen in Öresund (the neighborhood to the mixing area in the southern Öresund) than in the Kattegat.

The fact that the phosphate concentration increases in Öresund's surface water is probably because of the increased amount of phosphate which is discharged with the sewage water from the metropoles and the increased phosphate concentration of the Baltic surface water (Fonselius 1968). There must be other reasons for the fact that an increase of the phosphate concentration also is detectable in the deep water of the Landskrona Deep. Possibly discharge of inorganic phosphorus may be responsible for that, but a considerably more detailed investigation is needed in order to establish that. The oxidation of organic matter seems, however, not to be responisble for this increase because no simultaneous decrease of the oxygen concentration can be detected.

Table 1.

Fladen, 50 m

Year	Day	Oxygen %	Oxygen ml/l
1905	1/8	83.5	5.85
	1/11	81.5	5.28
1906	1/2	94.3	6.96
	1/5	86.8	6.20
	1/8	83.5	5.71
	3/11	88.0	5.55
1907	1/5	92.0	6.58
1930		79.5	
1965	2/9	79.6	5.03
	6/12	93.6	6.58
1966	6/5	90.6	6.55
	22/8	62.0	4.08
	27/9	68.7	4.19
1967	10/2	93.2	6.58
	29/5	92.2	6.41
	6/12	88.5	5.75
1968	5/2	95.0	6.89
	4/6	87.3	6.18
	2/9	67.4	4.40
	4/11	65.3	4.09

L:a Middelgrund

Year	Day	Oxygen % 30m	Oxygen % 80m	PO_4-P µg/l 30m	PO_4-P µg/l 80m
1905	1/8	94.2			
	1/11	73.2			
1906	1/2	89.8			
	1/5	92.0			
	1/8	90.8			
	3/11	88.0			
1907	1/5	87.3			
1931					10.2
1932			76		22
1956					29
1965	2/9	89.7	67.5	5.0	28.5
	6/12	85.8	89.0	24.5	29.5
1966	6/5	84.0	84.5	18.9	27.4
	23/8	75.2	56.2		
	27/9	82.2	55.0	5.3	16.9
	25/11	82.4	76.3	15.8	22.0
1967	10/2	94.0	68.2	18.6	31.3
	29/5	99.9	84.2	5.9	25.4
	6/12	83.9	70.0	24.2	26.6
1968	5/2	92.9	96.0	22.9	22.9
	4/6	91.4	88.0	19.2	22.9
	2/9	75.4	60.7	13.9	26.9
	4/11	69.3	60.2	13.9	22.0

Haken, 25 m

Year	Day	Oxygen ml/l
1931	3/4	5.0
	12/4	5.5
	1/5	3.85
	14/5	4.35
	24/5	5.16
	30/5	4.65
	12/6	5.35
	1/7	3.98
	16/7	1.09
	1/8	2.2
	12/9	1.75
	7/10	2.85
	28/11	3.45
	19/12	4.45
1950	26/9	2.8
1952	12/5	5.7
1963	10/7	6.2

Table 1.

Landskronadjupet

Year	Day	PO_4-P µg/l	Oxygen %
1950	10/5		74.5
1931	10/4		75
	17/6		73
	18/7		54
	15/8	5.5	67
	19/9	14	27
	24/10	18	53
1950	22/9		52
1951	19/11		18.5
1952	12/5		82
1953	10/7		81.3
1954	4/5		82.5
1956	16/10	21.8	44
1957	15/3	21.8	84
	25/4		60
	3/5	34.3	67
1960	16/3	24.8	72
	16/7		79
	24/8		55
1961	22/4	21.4	60
	7/8	44.8	69
1962	10/4	28.5	79
1963	3/4	36.2	75
	2/8	39	
1964	20/3	44.6	73
	27/4	51.5	71
	5/8		69
	18/8		57

Pinhättan

Year	Day	PO_4-P µg/l	Oxygen %
1931	2/4		78
	1/7		68
	1/8	4.0	62
	16/8	2.5	
	13/9	19	
	17/10	20	
	6/11	21	
	1/12	44	
	31/12	9.6	
1932	14/5		100
	15/6		80
	4/10		75
1950	29/9		38
1951	20/11		75
1952	10/5		87
1953	10/7		81
1954	3/5		86
1956	16/10	9.5	86
1957	15/3	37	67
	25/4		62
	3/5	26	81
1960	16/3	18	70
	28/8	15.5	55
1962	10/4	11	80
1963	2/4	36	73
1964	2/8	4	69
	18/8	37	
	28/4	31	
	15/4		70
	5/8		57

Hittarps rev

Year	Day	Oxygen %
1950	28/9	50
1951	19/11	77
1952	13/5	86
1953	9/7	72
1954	4/5	80
1956	16/10	51
1957	18/3	86
	25/4	63
	3/5	77
1960	16/3	73
	23/8	58
1961	8/8	57
1962	10/4	74
1963	3/4	76
	2/8	80
1964	20/3	80.4
	28/4	78
	15/4	26
	5/8	66
	18/8	59

Table 2.

Fladen — O_2 % for the whole year

Depth	1905-1907	1966-1968
0	96.4	99.2
10	94.8	96.7
20	95.1	91.5
30	94.0	88.1
40	91.6	85.0
50	87.1	81.0
60-75	84.9	74.2

Landskronadjupet

O_2 % July-Sept. — PO_4-P µg/l for the whole year

	1931		1960-1963	
Depth	O_2 %	PO_4-P	O_2 %	PO_4-P
0	98.5	0.9	98	4.5
10	97	3	97	10
20	62	7	75	24
30	56	7	62	27
40-45	52	12.5	62	34

Pinhättan

O_2 % July-Sept. — PO_4-P µg/l for the whole year

	1931		1960-1963	
Depth	O_2 %	PO_4-P	O_2 %	PO_4-P
0	98	2	99	5
5	95	3.2	98	6
10	98	6	96	14
15	82	20	72	20
20	62	22.4	62	21.7

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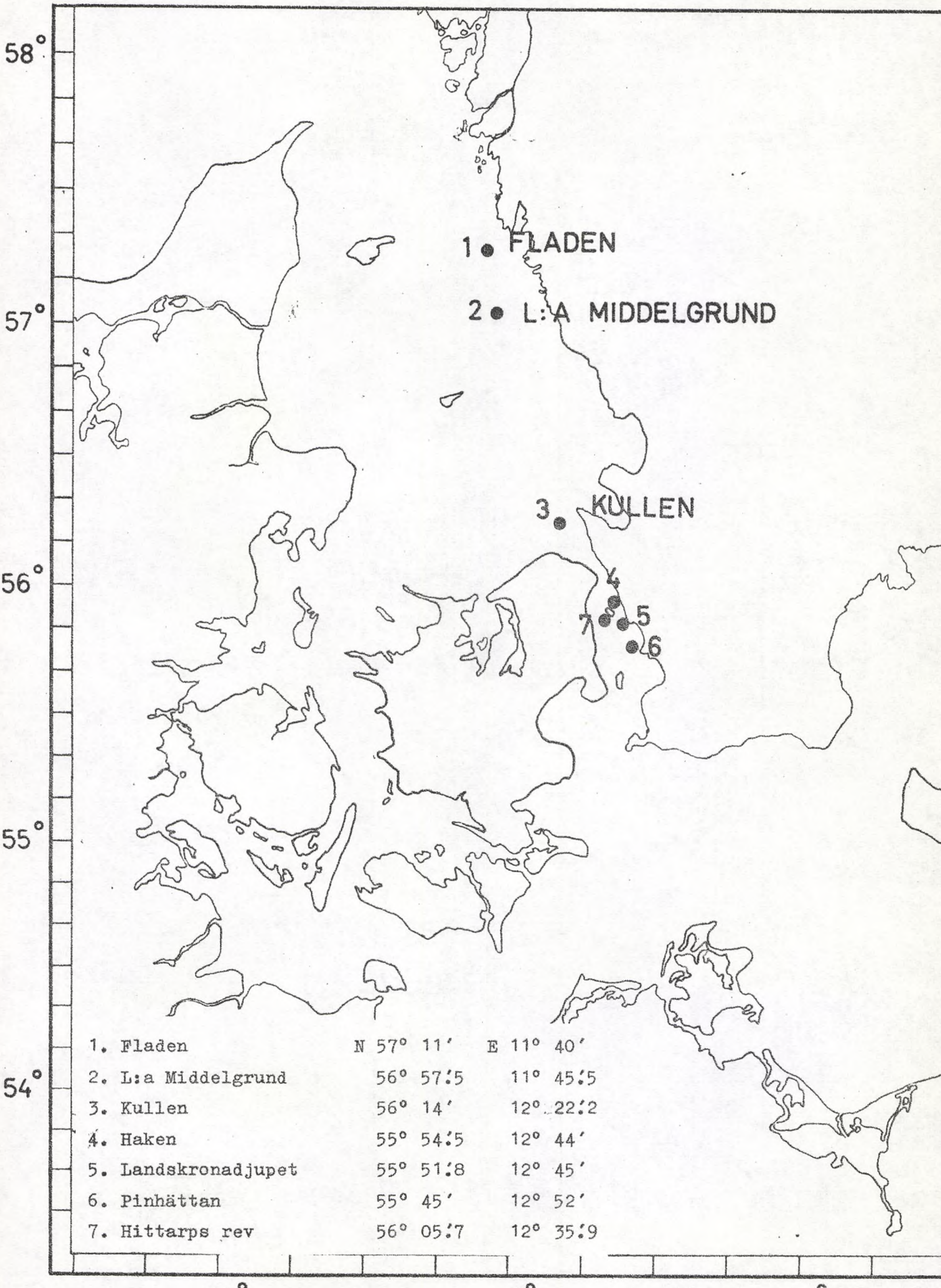


58°
57°
56°
55°
54°
10°
12°
14°
1 FLADEN
2 L:A MIDDELGRUND
3 KULLEN
4
5
6
7
1. Fladen N 57° 11′ E 11° 40′
2. L:a Middelgrund 56° 57:5 11° 45:5
3. Kullen 56° 14′ 12° 22:2
4. Haken 55° 54:5 12° 44′
5. Landskronadjupet 55° 51:8 12° 45′
6. Pinhättan 55° 45′ 12° 52′
7. Hittarps rev 56° 05:7 12° 35:9

FIG. 1

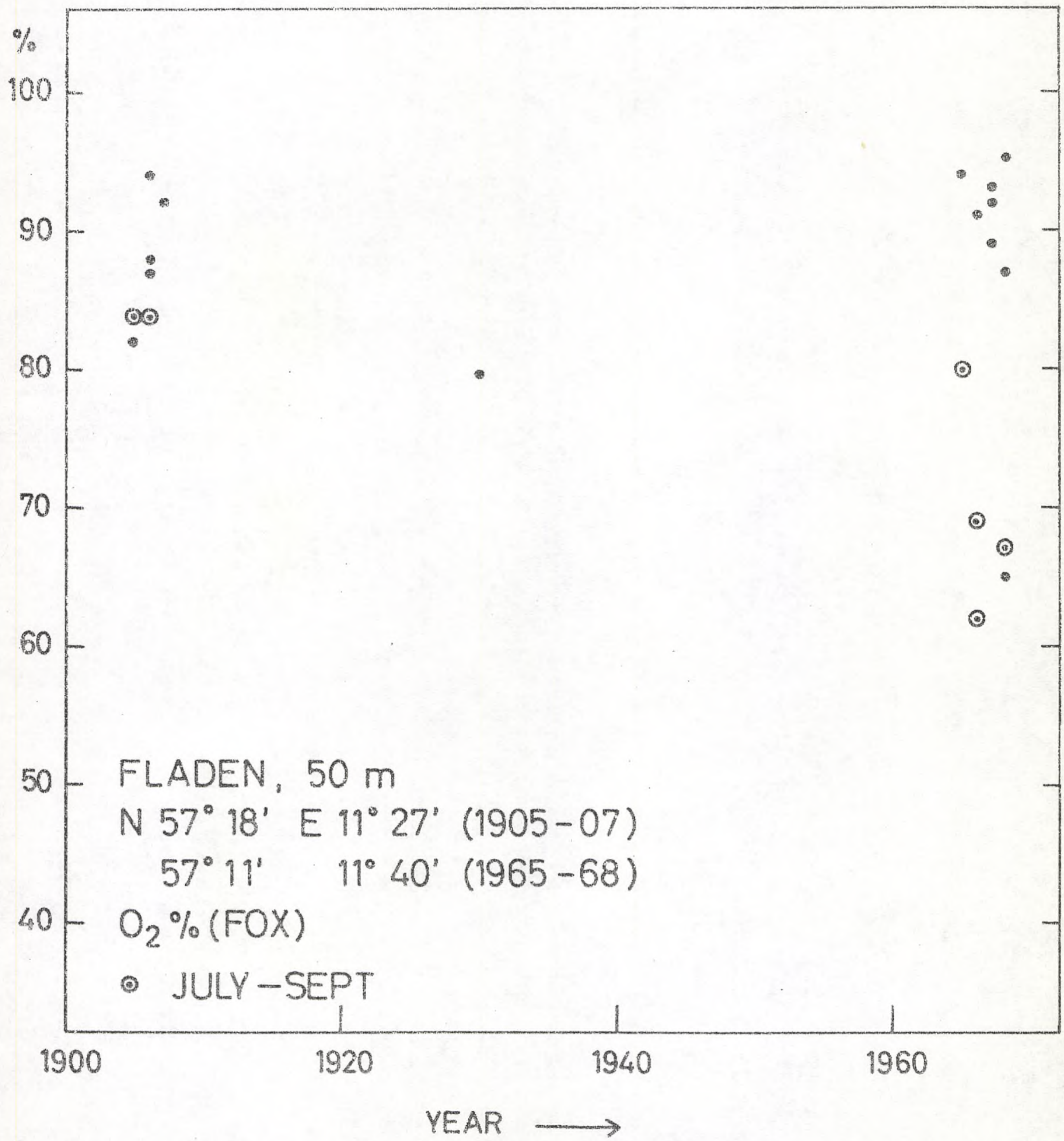
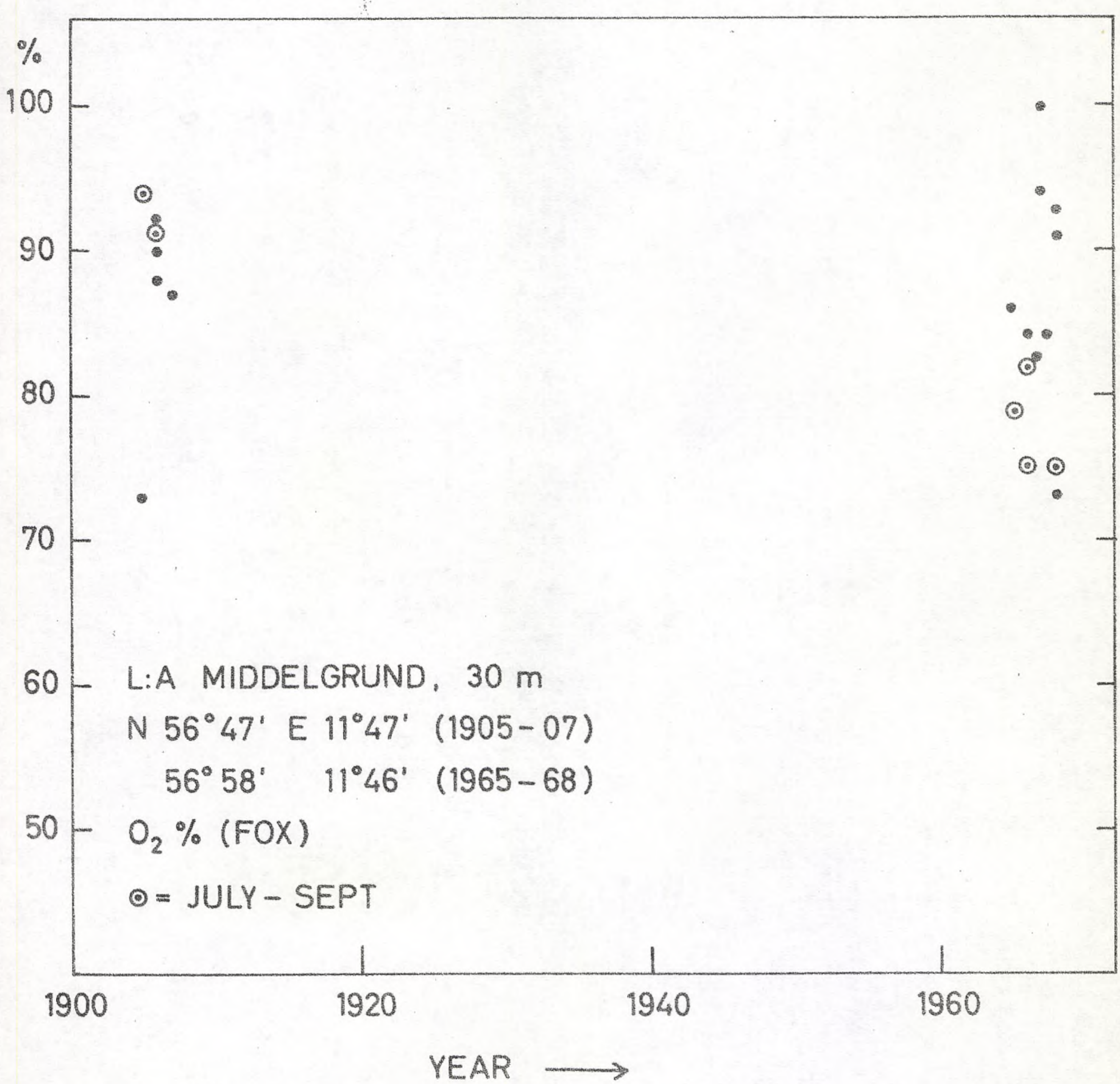

%
100
90
80
70
60
50
40
FLADEN, 50 m
N 57° 18' E 11° 27' (1905-07)
57° 11' 11° 40' (1965-68)
O2 % (FOX)
⊙ JULY-SEPT
1900
1920
1940
1960
YEAR →

FIG. 2



%
100
90
80
70
60
50
L:A MIDDELGRUND, 30 m
N 56°47' E 11°47' (1905-07)
56°58' 11°46' (1965-68)
O2 % (FOX)
⊙ = JULY - SEPT
1900
1920
1940
1960
YEAR

FIG. 3

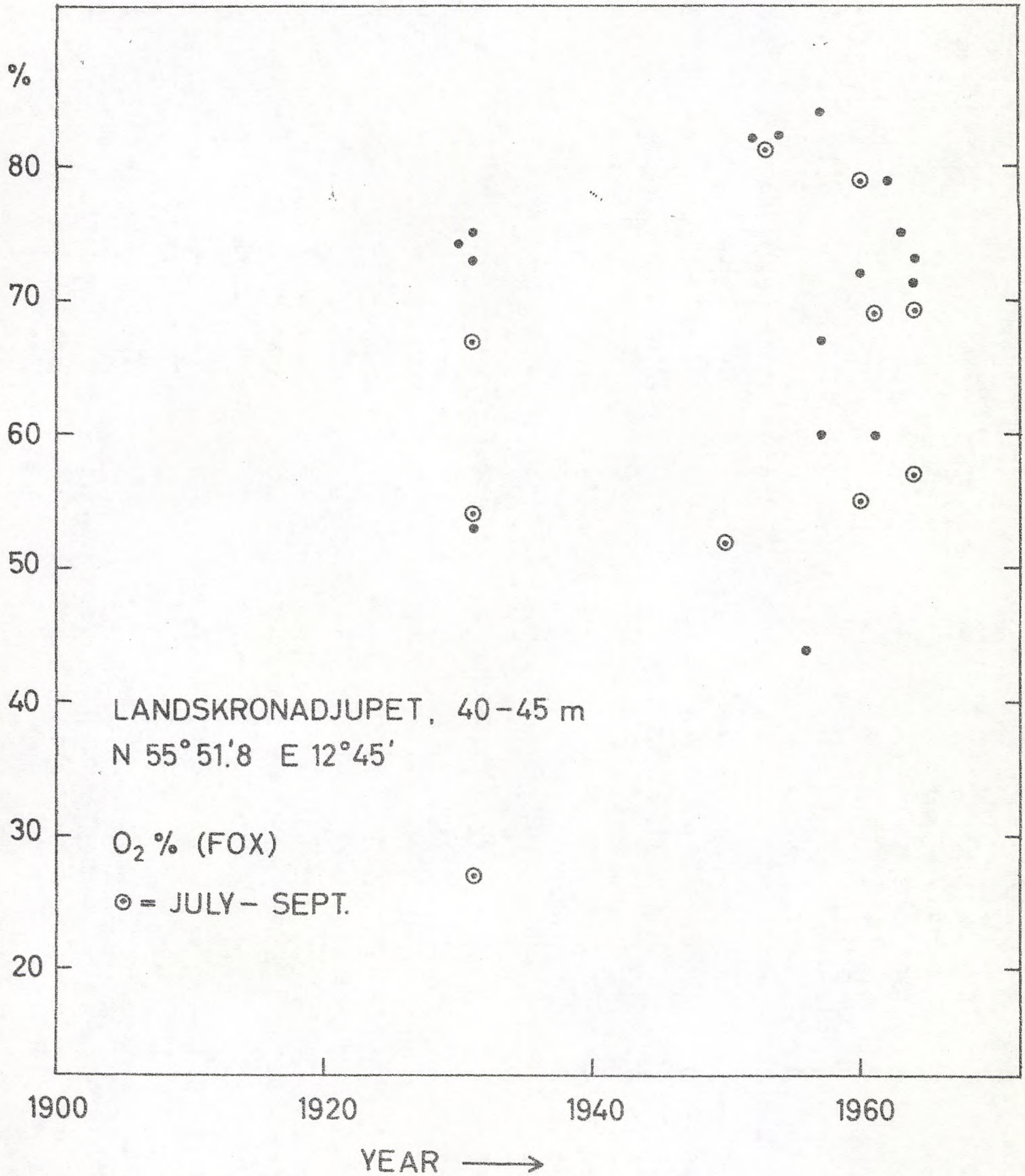

%
80
70
60
50
40
30
20
LANDSKRONADJUPET, 40-45 m
N 55°51.'8 E 12°45'
O2 % (FOX)
⊙ = JULY- SEPT.
1900
1920
1940
1960
YEAR →

FIG. 4

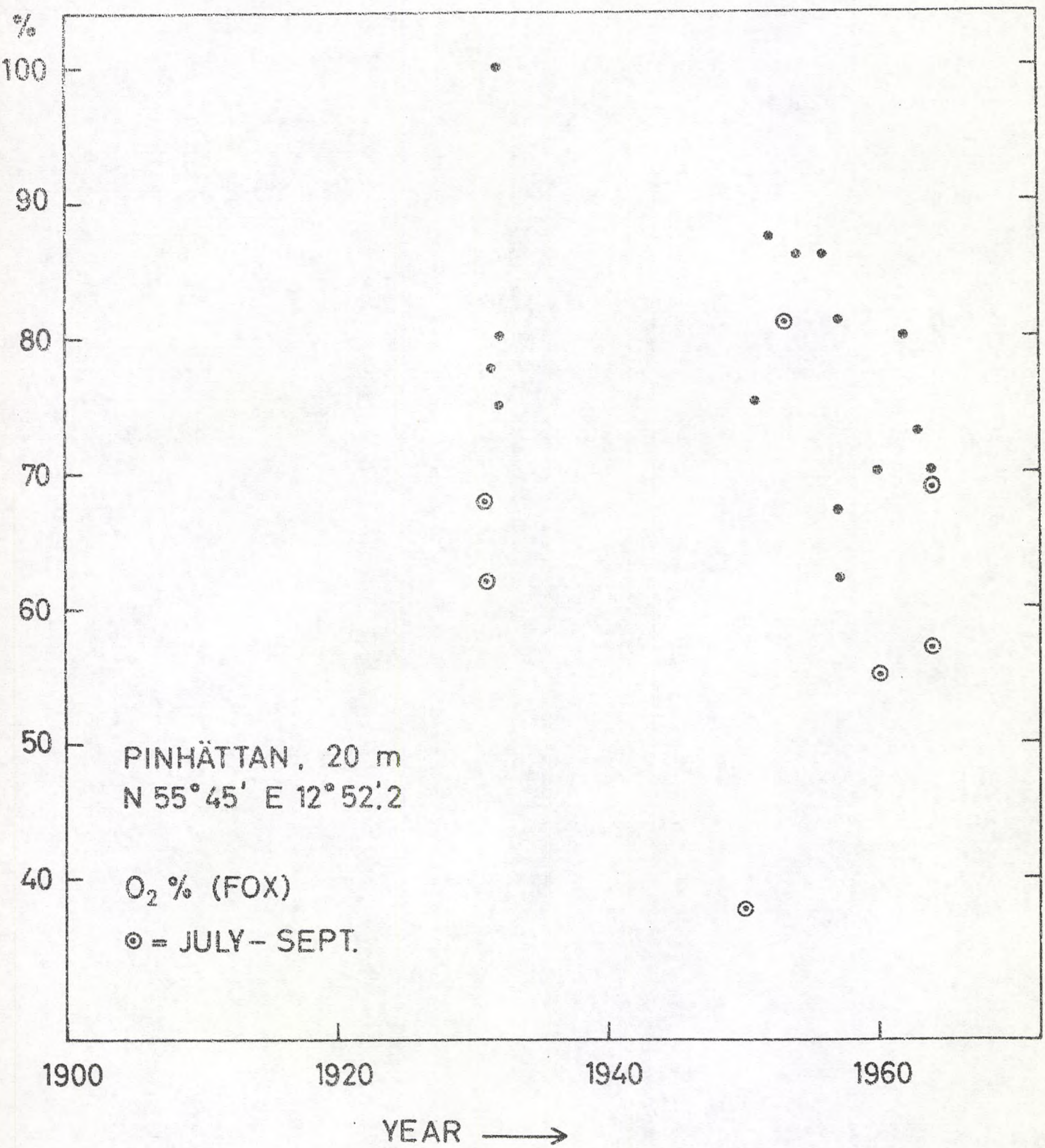

%
100
90
80
70
60
50
40
PINHÄTTAN, 20 m
N 55°45' E 12°52,2
O2 % (FOX)
⊙ = JULY– SEPT.
1900
1920
1940
1960
YEAR ⟶

FIG. 5

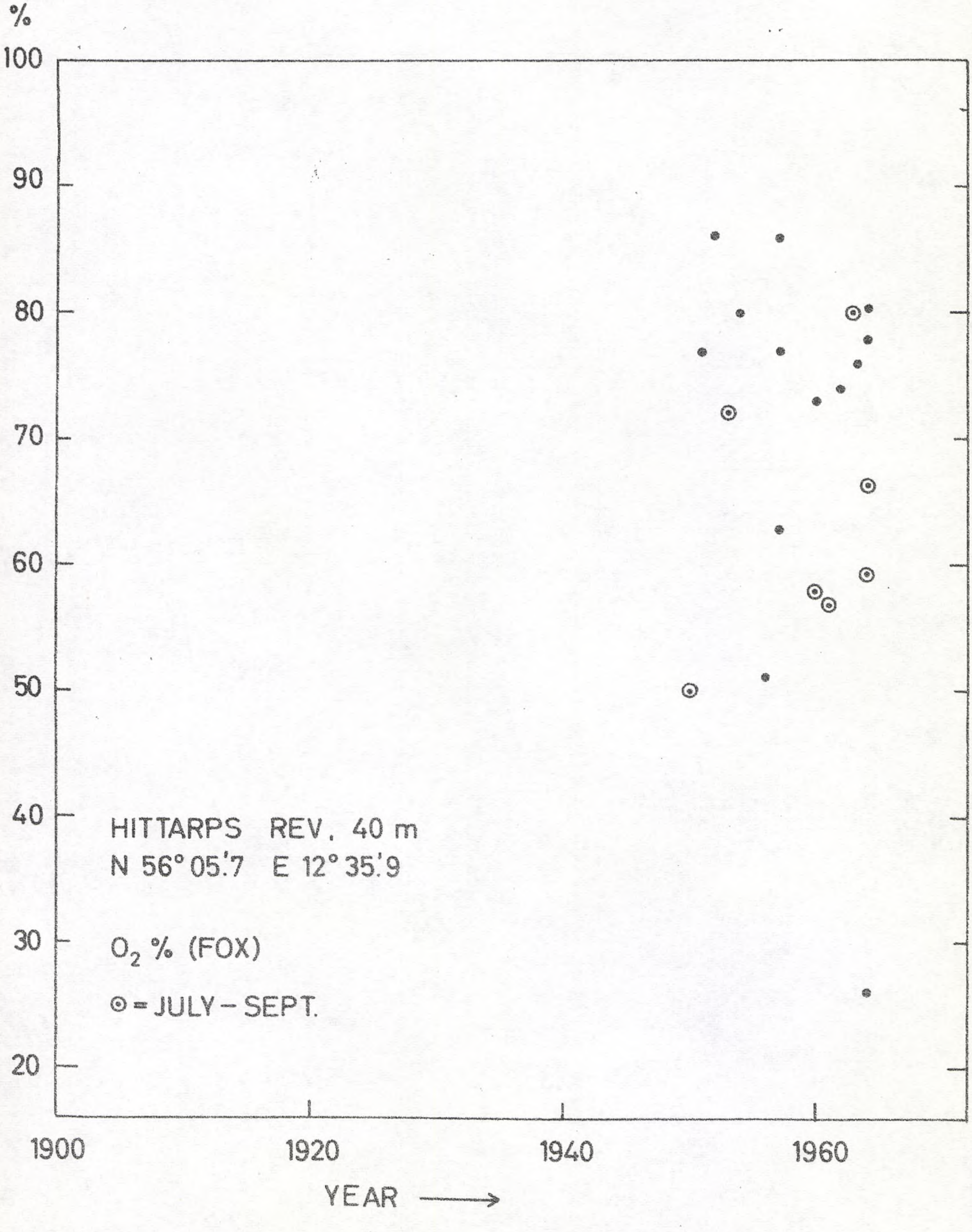
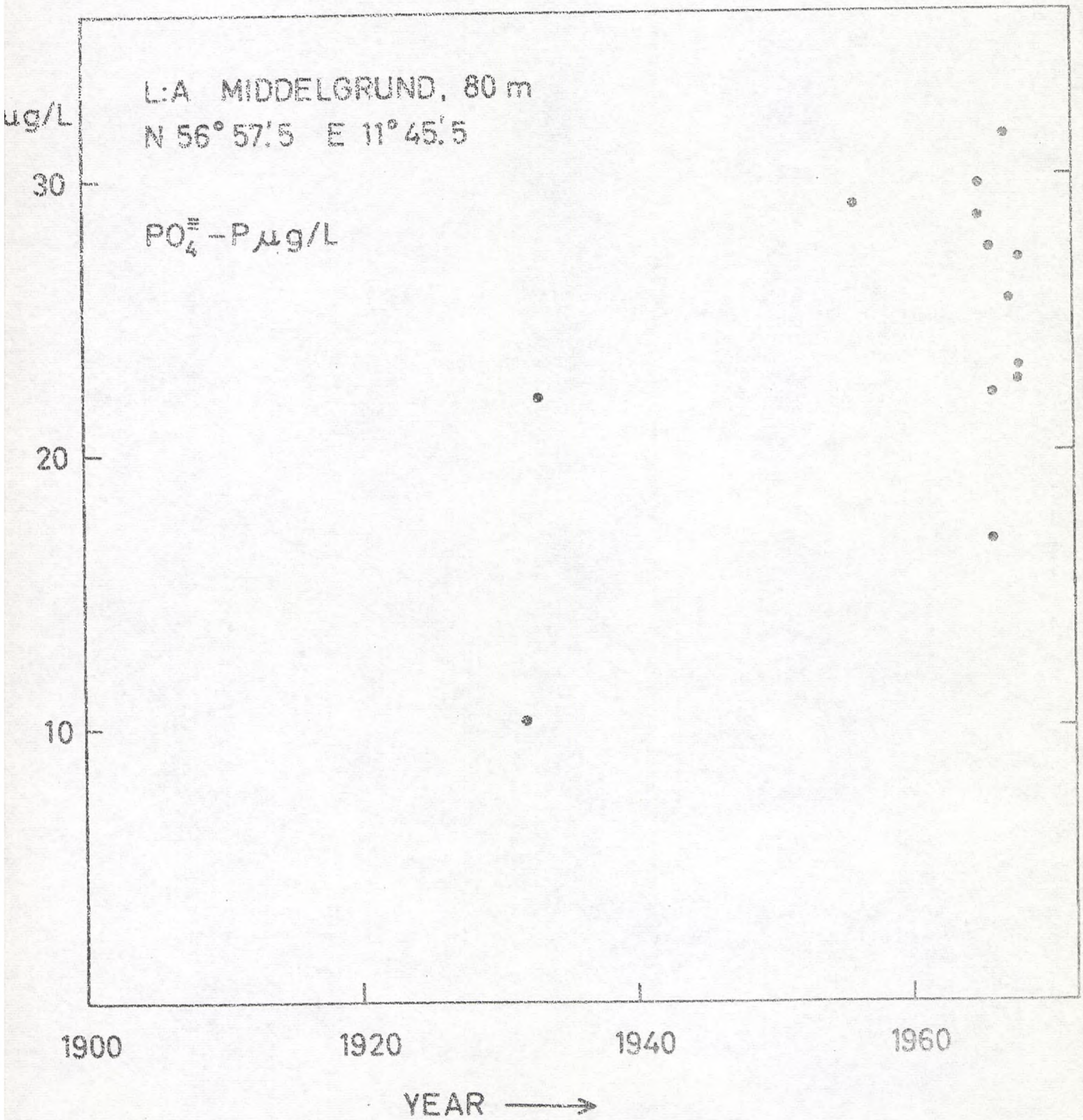
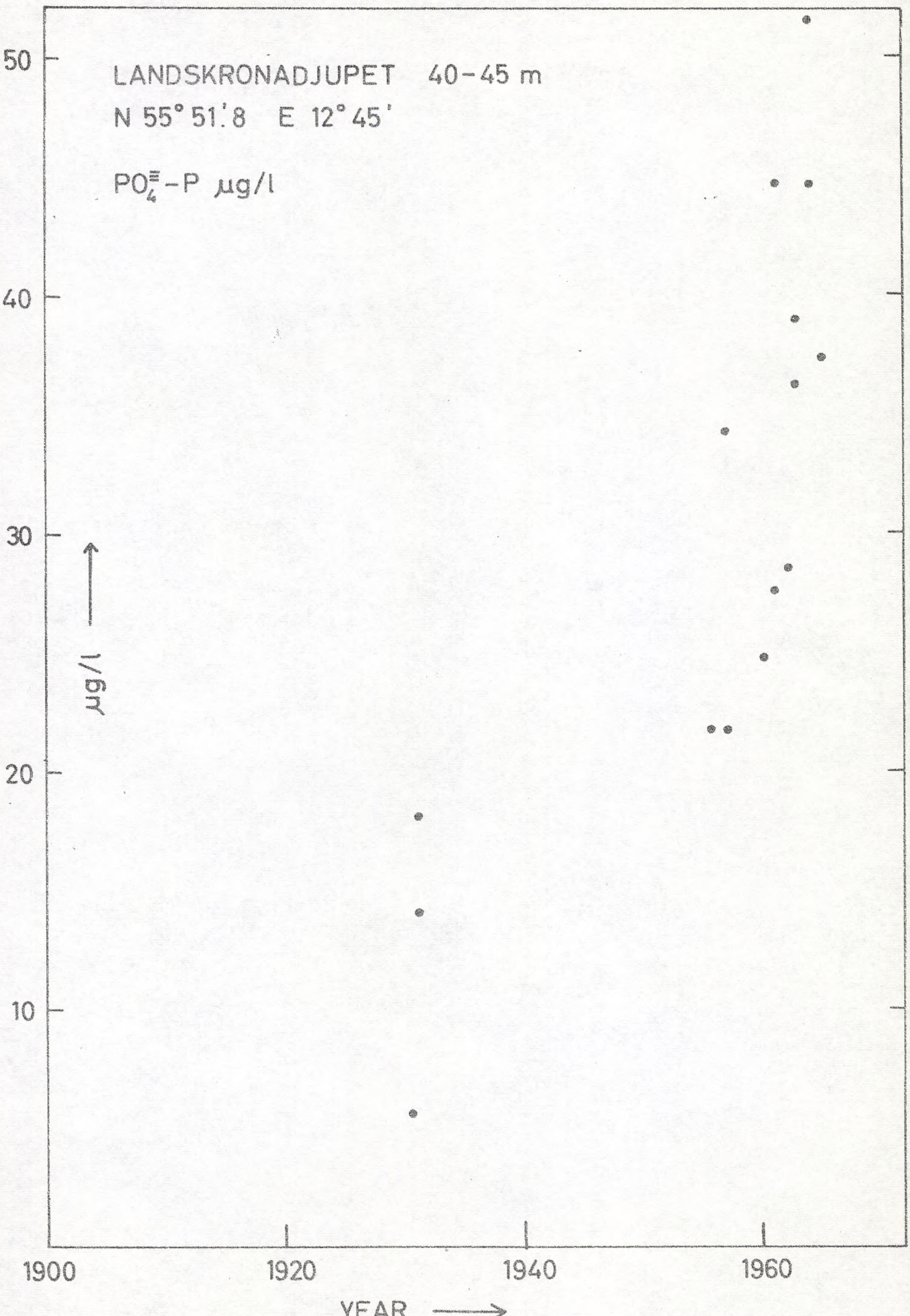

%
100
90
80
70
60
50
40
30
20
HITTARPS REV. 40 m
N 56° 05.'7 E 12° 35.'9
O2 % (FOX)
⊙ = JULY – SEPT.
1900
1920
1940
1960
YEAR

FIG. 6



L:A MIDDELGRUND, 80 m
N 56° 57.'5 E 11° 45.'5
PO$_4^{\equiv}$-P µg/L
µg/L
30
20
10
1900
1920
1940
1960
YEAR ⟶

FIG. 7



LANDSKRONADJUPET 40-45 m
N 55° 51.'8 E 12° 45'
PO₄≡-P µg/l
µg/l
50
40
30
20
10
1900
1920
1940
1960
YEAR

FIG. 8

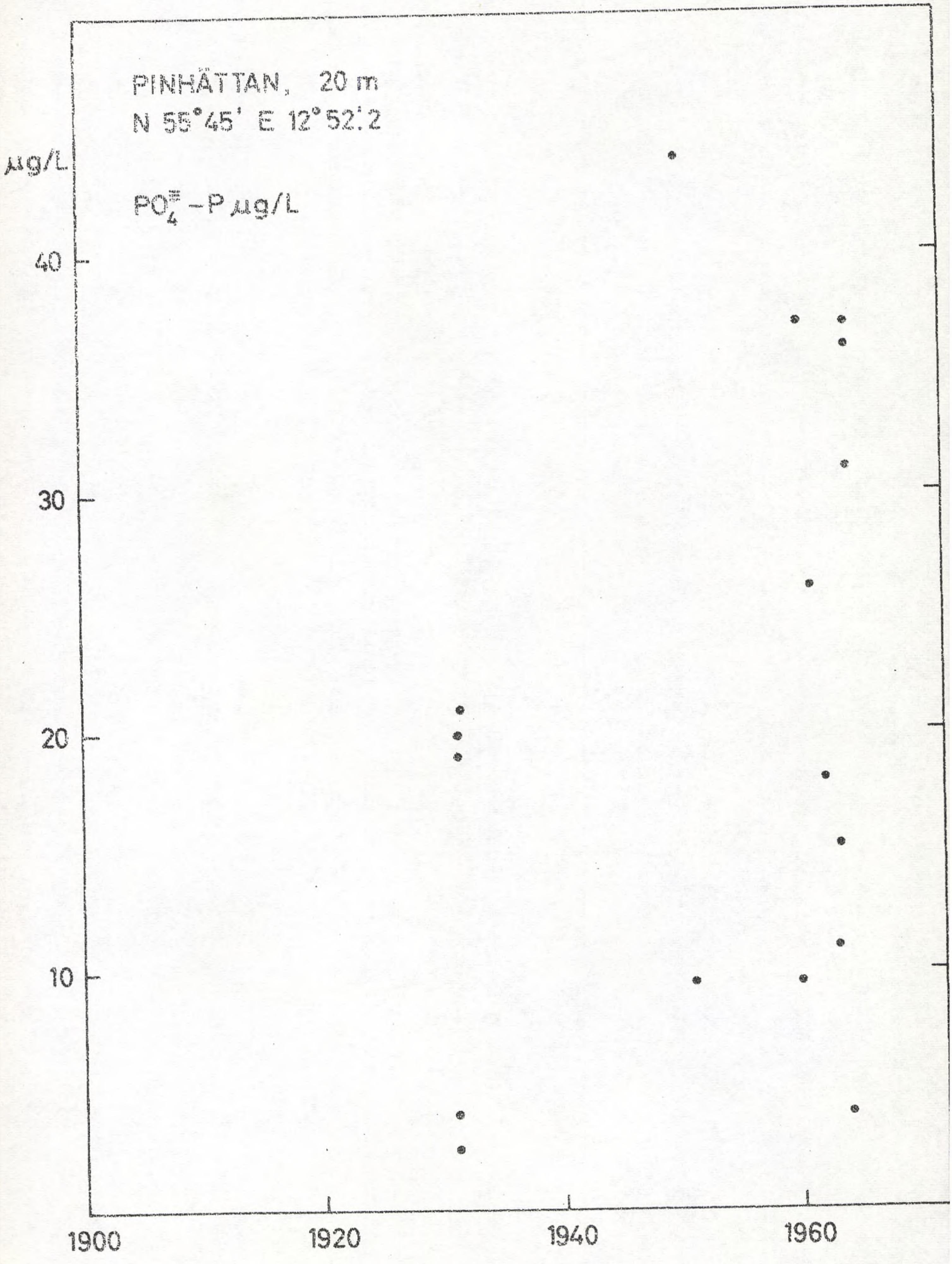

PINHÄTTAN, 20 m
N 55°45' E 12°52!2
µg/L
$PO_4^{\equiv}$ - P µg/L
40
30
20
10
1900
1920
1940
1960
YEAR ⟶

FIG. 9