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On the temperature variation in the bottom water of the northern North Sea.

by

R. Ljøen.
Institute of Marine Research,
Bergen, Norway.

INTRODUCTION

It is well known that the water masses on the greater part of the North Sea plateau are entirely mixed from the sea surface to the bottom during late winter. It is also well known that on the central and northern part of the plateau the tidal currents are not able to break down the thermocline, which during the summer is developed between the top and bottom layers. The stratification appearing is strengthened by the lateral movement of coastal waters. It is evident therefore that in these areas the cooling of the sea surface water in the winter will influence the heat budget of the bottom water most of the year. Prahm (1958) indicates a relationship between extreme cold winters and relatively low temperature in the bottom water the following summer.

During the last five years the Institute of Marine Research, Bergen has carried out hydrographic surveys in the North Sea, including Skagerrak, between the latitudes 57° and 61° north in June-July.

This paper gives a short report on the variation of the temperature in the deep water, recorded on these surveyes. Included is also a simple analysis of the observed temperature and salinity on the "Famita" station.

OBSERVATIONS

Fig. 1 shows the mean air temperature and the temperature anomaly in February of the years 1967-1971. Nearly the same conditions

are found in January and March. The February condition thus roughly represents the situation during most of the winter. In all these cases the temperature of the sea surface was higher than that of the air above. One of the requirements for heat transport from sea to air is thus present. There has, however, been significant differences in air temperature from year to year. In the winters 1967 and 1971 the temperature was relatively high with positive anomalies between +1° and +3°C. Especially the winters 1969 and 1970 were relatively cold with negative anomalies between -2° and -4°C.

Fig. 2 shows the minimum water temperature in June-July of the years 1967-1971. On the North Sea plateau the minimum is observed in the bottom layers. In the Norwegian Channel the minimum occurs at 50-100 meters, the depth to which the cooling of the preceding winter has penetrated.

Evidently the core of cold water on the shallow sea is split into two parts. This probably reflects the transverse movement of warmer water along the southern slope of the Fladen Ground (Dietrich, 1959).

The heat content in both the northern and the southern core was in 1967 and 1971 of the same magnitude. However, the bottom temperature these years was 1,5° to 2°C higher than in 1969 and approximately 1°C higher than in 1970. In its broad feature there seems to be a positive correlation between the air and sea temperature. However, in 1970 the water temperature should be expected somewhat lower, seen in relation to the air temperature that winter.

On the "Famita" station near the Great Fisher Bank, in the southern core of cold water, the salinity and temperature between sea surface and bottom have been recorded on an average every third or second day during the months November-March for some years. the water masses on the station have proved to be homogeneous in the last part of the winter but with great year to year variations, both in salinity and in temperature. A ten years mean shows that usually the temperature decreases from November to March (Ljøen 1970), probably reaching minimum in March-April.

Fig. 3A shows the temperature versus salinity of the February and March observations from the years 1963-1971. Obviously there is a positive correlation between the two parameters. Winters with extreme low temperature and salinity are those of the years 1963, 1966 and 1969, whereas the observations in the winters 1964,1965, 1971 and partly 1967 show higher temperature combined with higher salinity. The observation in February and March 1968 fell out of the correlation.

In some years, e.g. 1963,1967 and first of all 1966, the mean temperature increased from February to March. However, these rises in temperature were closely combined with significant increases in the salinity. This feature of the hydrography on the station clearly shows that variations in the winter temperature to a great extent are subjected to variations in the intrusion of Atlantic water to this locality.

The squares in Fig. 3B represent limits of temperature-salinity relation in the northern and southern (central) core of cold water, designated N and C respectively. Evidently there is a positive correlation between the parameters in both localities, indicating that the heat content very much depends on admixture of Atlantic water and not on the winter cooling only. A comparison between the summer observations on the shallow sea and the observations on the "Famita" station may indicate that this lateral mixing is strong during the winter.

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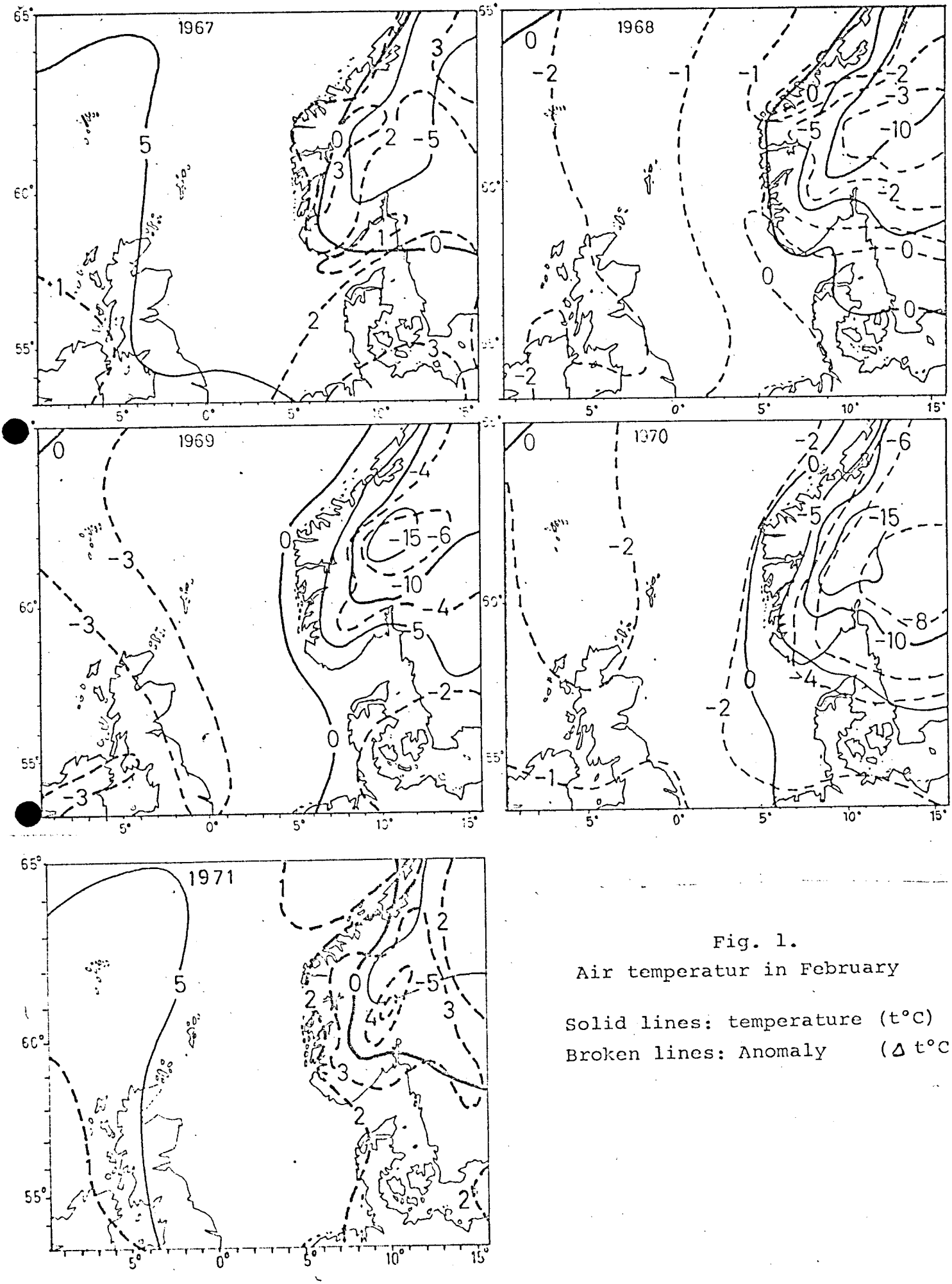

Fig. 1.
Air temperatur in February

Solid lines: temperature (t°C)
Broken lines: Anomaly (Δ t°C)

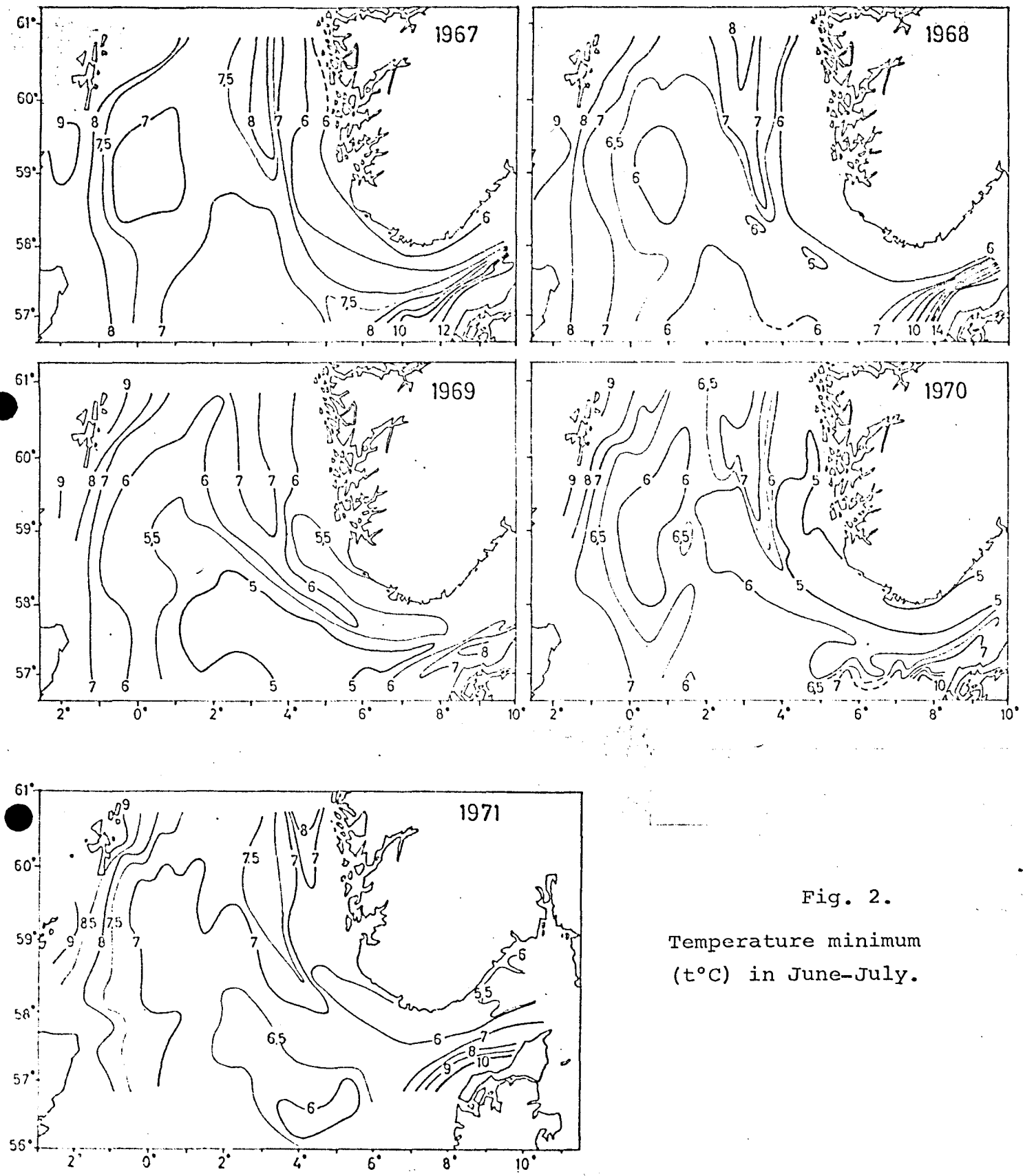

Fig. 2.

Temperature minimum (t°C) in June-July.

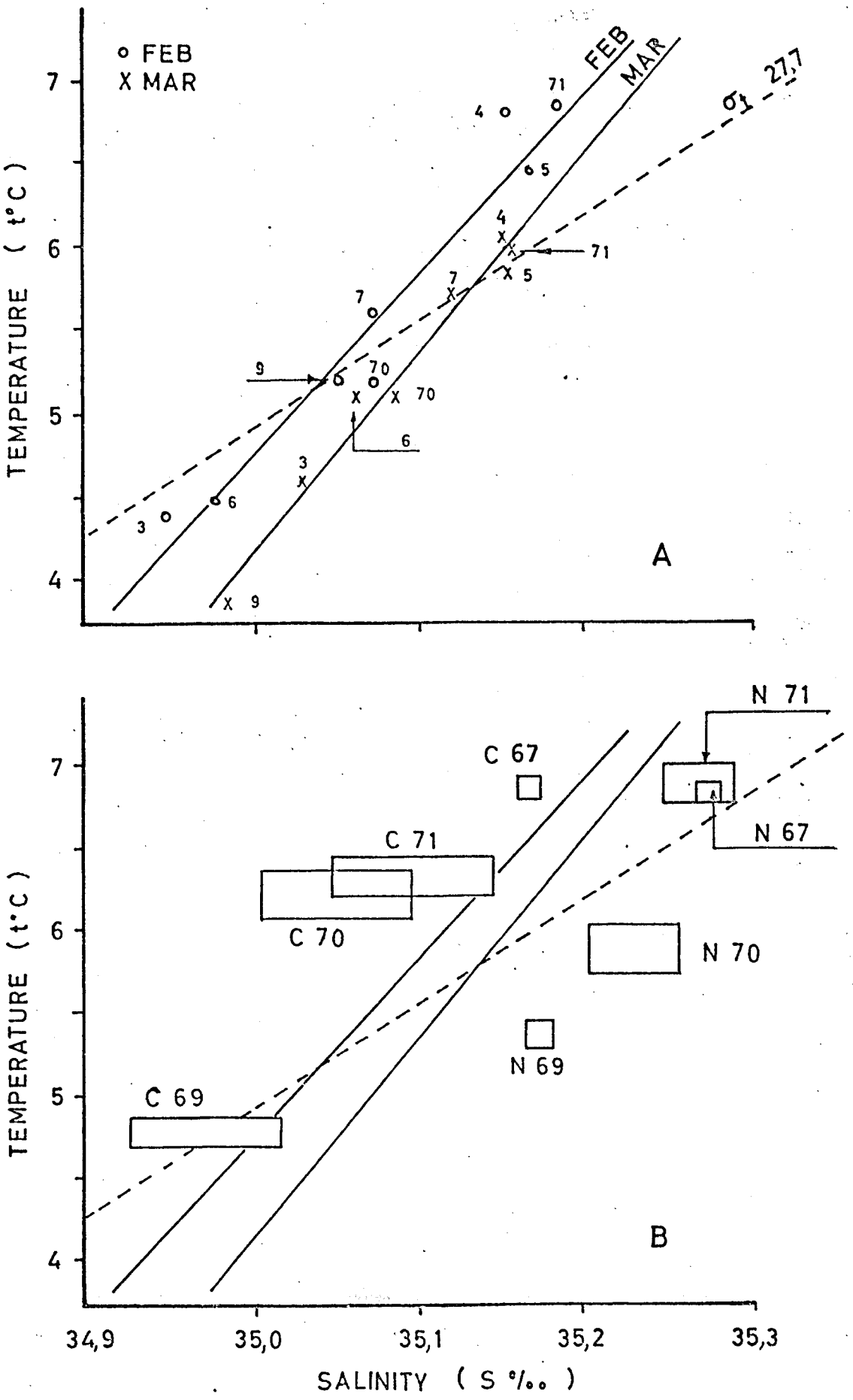
o FEB
X MAR
FEB
MAR
σt 27,7
TEMPERATURE (t°C)
A
B
C 67
C 71
C 70
C 69
N 71
N 67
N 70
N 69
34,9
35,0
35,1
35,2
35,3
SALINITY (S °/oo)

Fig. 3