COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

DIVISION of FISHERIES and OCEANOGRAPHY

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HYDROLOGICAL INVESTIGATIONS OF R.V. SPRIGHTLY

April 1974 - April 1975

By R. J. Edwards

Marine Laboratory
Cronulla, Sydney
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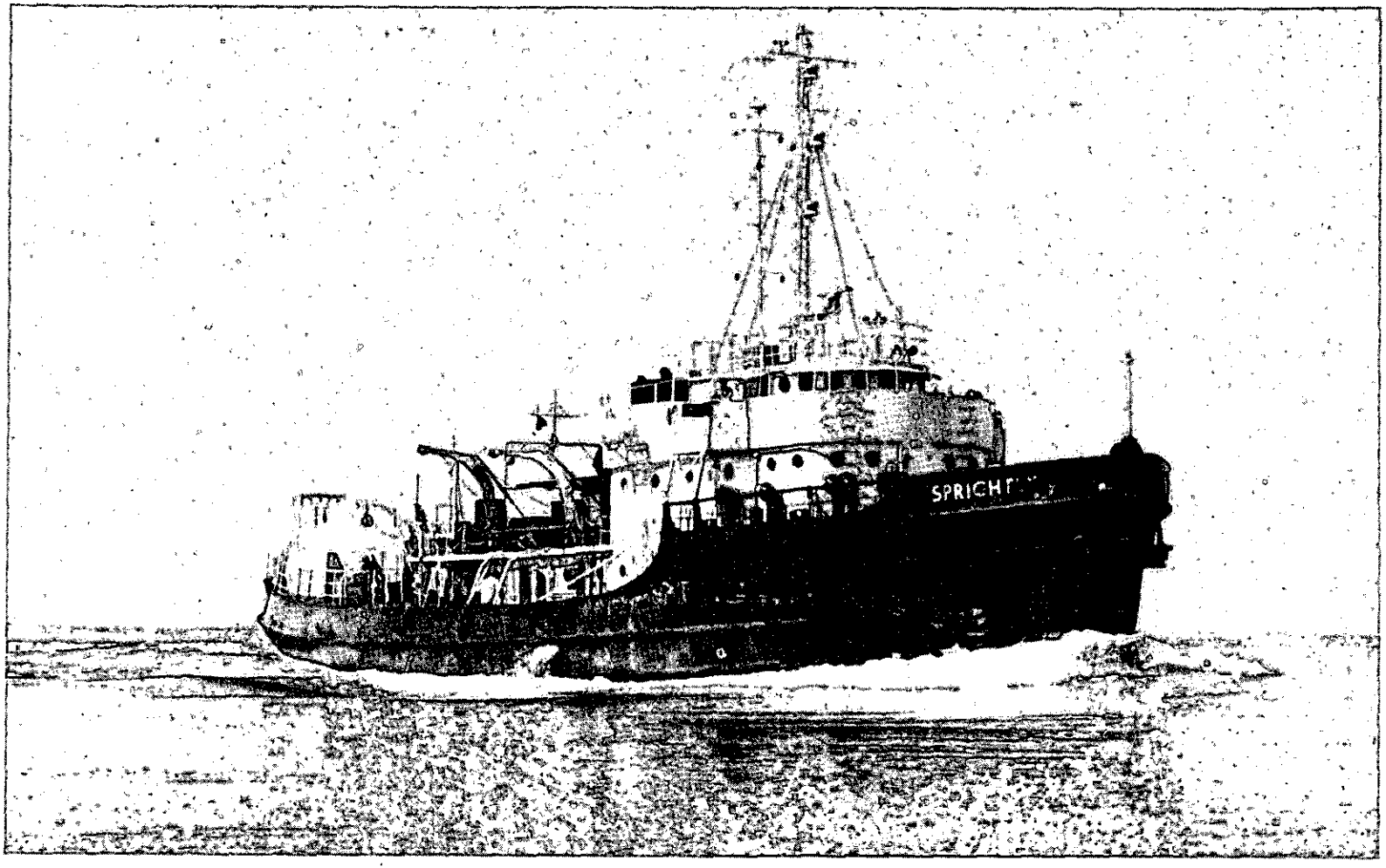

Plate 1. R.V. *Sprightly*

HYDROLOGICAL INVESTIGATIONS FOR R.V. *SPRIGHTLY*

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INTRODUCTION

Reports of Divisional investigations in various areas of the southern Indian Ocean have appeared consistently over the years since 1961. (See bibliography.). The objective of this programme has been to obtain knowledge of the types of waters around the coast of Western Australia, their origins, their circulation paths, the extent of their seasonal and other scales of variation as well as the dynamic features of upwelling and the formation of eddies and fronts as these influence productivity and biological aggregations, in particular the western rock lobster.

This report presents in an atlas format hydrological data gathered aboard R.V. *Sprightly* from April 1974 to April 1975. (Plate 1.).

PROCEDURES

The area in which the investigation took place is shown in Figure 1.

The normal sequence of stations followed a track west from Fremantle along 32°00'S to 114°00'E, thence NNW to 29°00'S, 112°30'E, then east along 29°00'S to the Abrolhos Islands. Current meters moored at the Islands were serviced and a track near to the shelf covered on the return. Nansen stations were occupied each half degree and a thermograph (latterly a thermosalinograph) was in operation throughout the cruise. Depending on station requirements and personnel available, either temperature and salinity, or, temperature, salinity, oxygen, phosphate, nitrate and silicate were measured. The analytical methods given in Major *et al.* (1972) were used; nitrate was determined by the strychnidine method and silicate by the method of Mullins and Riley.

All data are available by listing from this Division or through World Oceanographic Data Centre.

RESULTS

Surface Data

Surface temperatures were taken on all cruises continuously and salinity samples were taken frequently. Figure 2 gives the variation of temperature and salinity with latitude, and Figure 3, the time series for temperature and salinity for 1° □'s, 29.00°S, 113°00'E and 32.00°S, 115°00'E.

The results generally agree with those of Rochford (1969) though he did not find as great a salinity range at 29°S. The temperature and salinity charts for those months when there were sufficient data are given in Figures 5-10. Temperature charts have been contoured at 1°C intervals and salinity at 0.2‰.

These charts show the seasonal trend of the surface water masses involved with the southward-moving, higher temperature and lower salinity features dominating in mid-summer to autumn and the northward-moving, lower temperature and higher salinity features appearing in the winter and early summer. From the thermosalinograph record, which gives a continuous record of the surface layer (the inlet is at about 3 m below the sea surface), there are alternate areas of the two water types and the trace shows remarkable consistency with small changes in temperature reflected by proportionally small inverse changes in salinity. An example of the trace is given in Figure 4.

Hydrological Data - Positions

Due to the poor distribution of hydrology stations in space and time, the data are presented as a time series at the following positions:

29°00'S	112°40'E
29°00'S	113°20'E
32°00'S	114°00'E
32°00'S	114°42'E

Only stations quite close to the above positions have been used.

The data are presented in three forms:

A. Time series of temperature, salinity, σ_t, oxygen and nitrate-nitrogen from 0-1500 m. (Certain shallow intermediate values have been excluded to avoid crowding and the data are contoured in the following interval or ways.).

(i) Temperature - contoured at 1°C intervals.
(ii) Salinity - contoured at 0.1‰ intervals.
(iii) σ_t - contoured at 0.5 σ_t.
(iv) Oxygen - values in ml/l, and the approximate positions of th maximum and minimum shown.
(v) NO_3^- -N/litre - contoured at the following intervals: 5, 10, 20, 30 and 40 µg-atoms.

B. Expanded scale with all values for temperature and salinity have been entered for the depth 0-300 m. Contouring is the same as in section A.

C. Extractions and plot of various parameters for each station are as follows:

(i) Depth of surface layer, interpolated from the data by "feel", taking into account temperature, salinity, and σ_t.
(ii) Depth of salinity maximum.
(iii) Depth of oxygen maximum.
(iv) Depth of salinity minimum.
(v) Depth of oxygen minimum.

These results give the previously determined structure of the water column in this area and there appears to be no large difference between positions. At the bottom of the sampled water column the salinity and σ_t values are increasing to those of the Deep Salinity Maximum. Above this there is a pronounced salinity minimum corresponding to the Antarctic Intermediate Water with, on occasions, incursions of North West Intermediate Water below this to give a double minimum.

From the minimum associated with the Antarctic Intermediate Water the salinity increases to an upper salinity maximum associated with the South Indian Central Water mass which shows quite some variation in its depth and intensity. Values then decrease to the surface waters associated with the southward moving low salinity water.

Rottnest Island

This Division has occupied a station at this site (32°00'S, 115°22'E) for over eleven years (1951-57, 1970-present). Figures 39 and 40 give the long-term means and standard deviation for temperature and salinity at 10 m and 50 m. Superimposed are the values recorded for the period of this report.

The figures show that for the period of the survey, the high temperature, low salinity water from the north has tended to dominate. This, in particular, is evident from the salinity values.

DISCUSSION.

As a result of the Division's previous investigations in the southern Indian Ocean the basic water masses, their movement and their extent are relatively well known. Basically, no new information has emerged from the data collected in this survey, and the interaction of the deep sea and the shelf waters is still little understood.

Normally, six days per month of ship time were allotted to the hydrology programme. However, this time frequently proved to be inadequate due to the need to service current meters at the Island and to the weather. Aanderaa current meters should ideally be serviced once a month and as a result, each cruise tended to revolve around this servicing. Difficulty was sometimes experienced in their recovery and, consequently, the cruise track was, on occasions, directly to and from the mooring site with a minimum of hydrology accomplished. The weather was also a large factor in the success of a cruise.

Certain considerations emerge which emphasize the restrictions placed on working on a special programme where specific results are required.

A. There must be enough ship-time allotted to hydrology. Although under normal circumstances physics and hydrology combine quite well, in this investigation there was need to service the current meters which lead to the poor hydrology cover.

B. On a number of occasions events, which have passed through the area being sampled were not recognized, since Nansen bottle technology is used and results are not known until analyses have been made and results computed. Using a slip-ring winch and an S.T.D. profiling system, results are known immediately and if it is determined that an event is occurring, the cruis plans can be arranged to permit monitoring.

C. An investigation such as this where the object is to determine the interaction of the deep ocean on the shallow shelf, there must be a number of regularly occupied shallow stations on the shelf. Far more information could have been obtained if there had been at least three other coastal stations in addition to the one off Rottnest Island.

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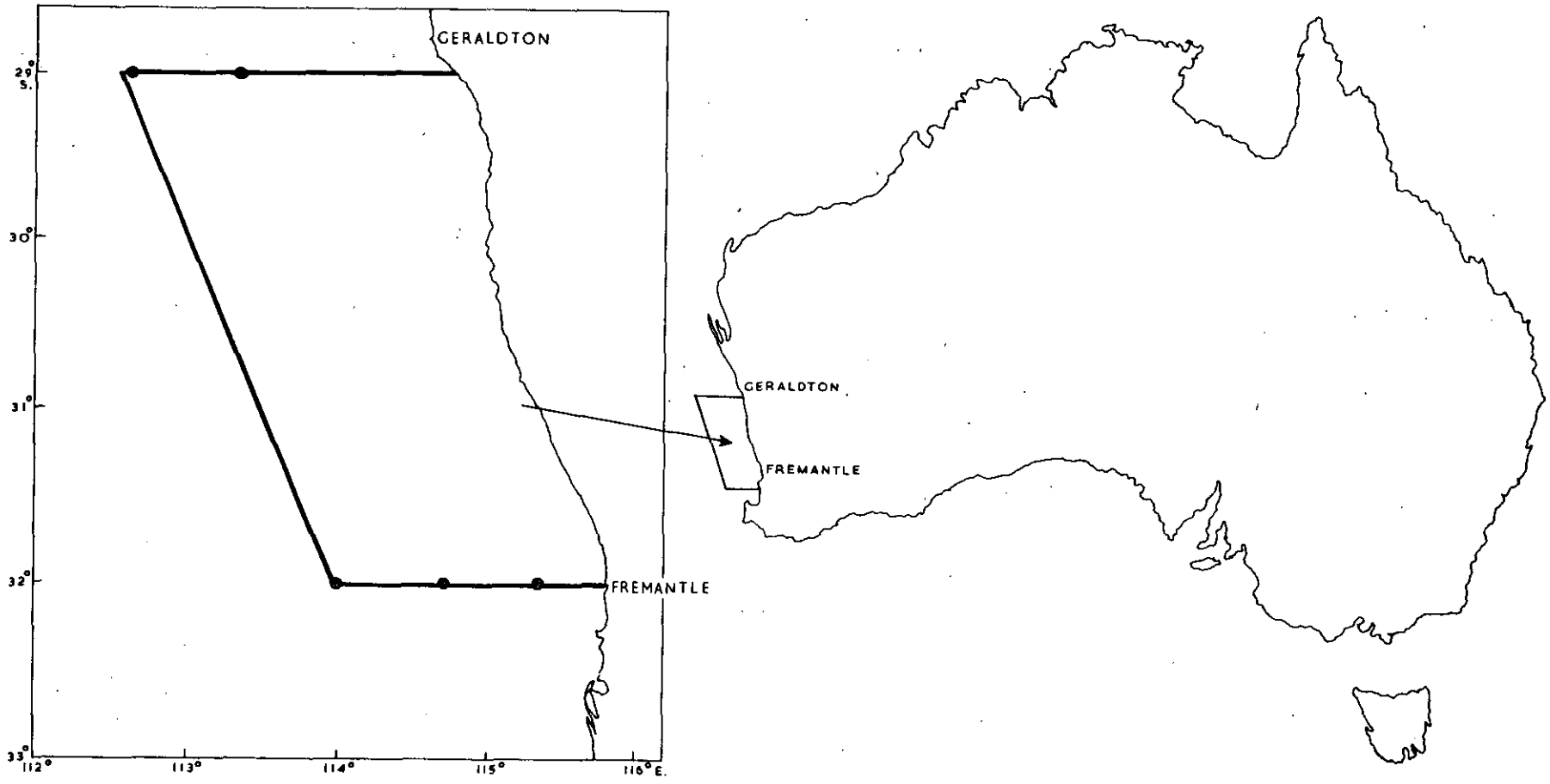

Fig. 1. - Map showing area of interest and positions of time series stations.

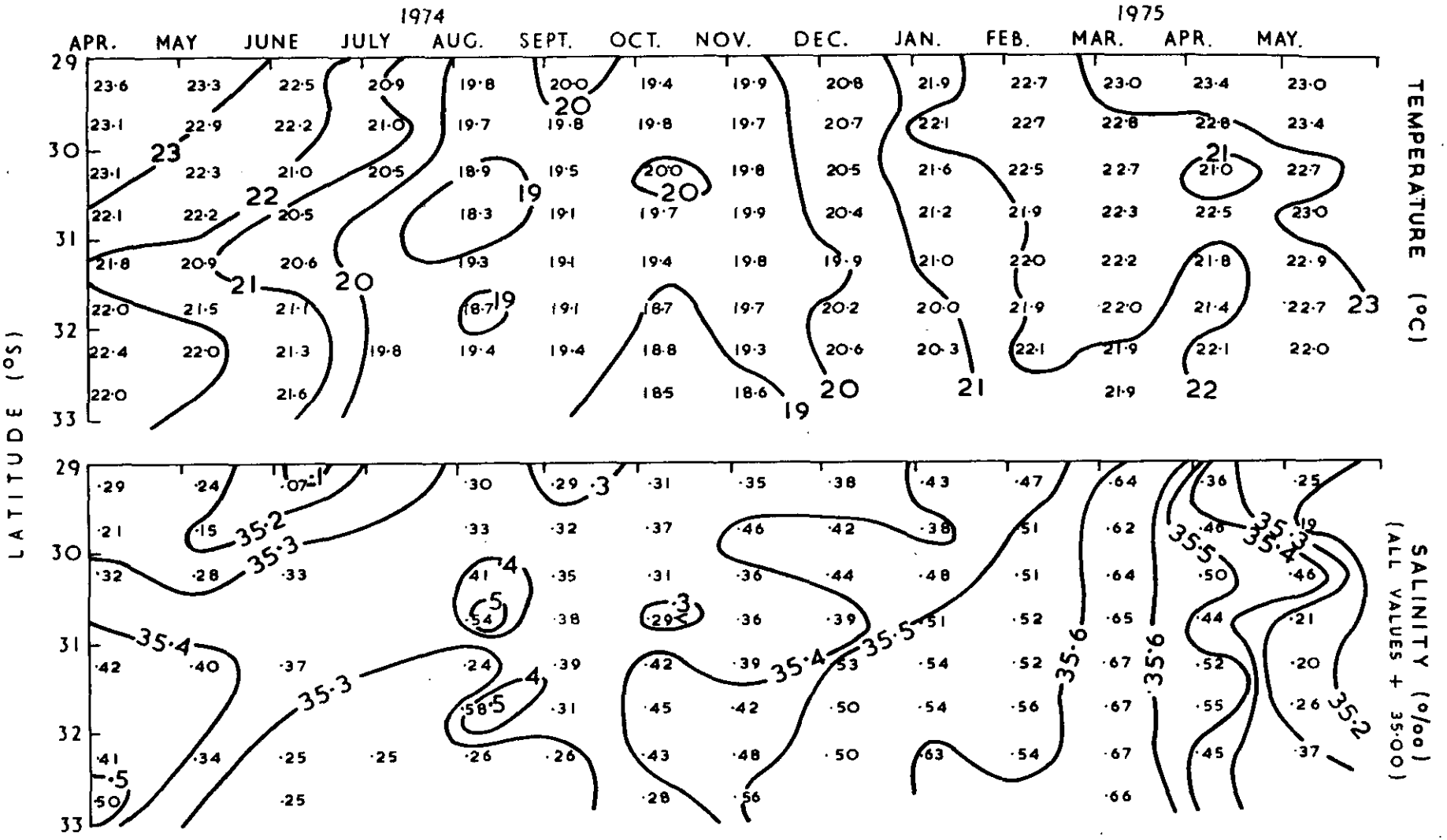

Fig. 2. - Surface temperature and salinity time series.

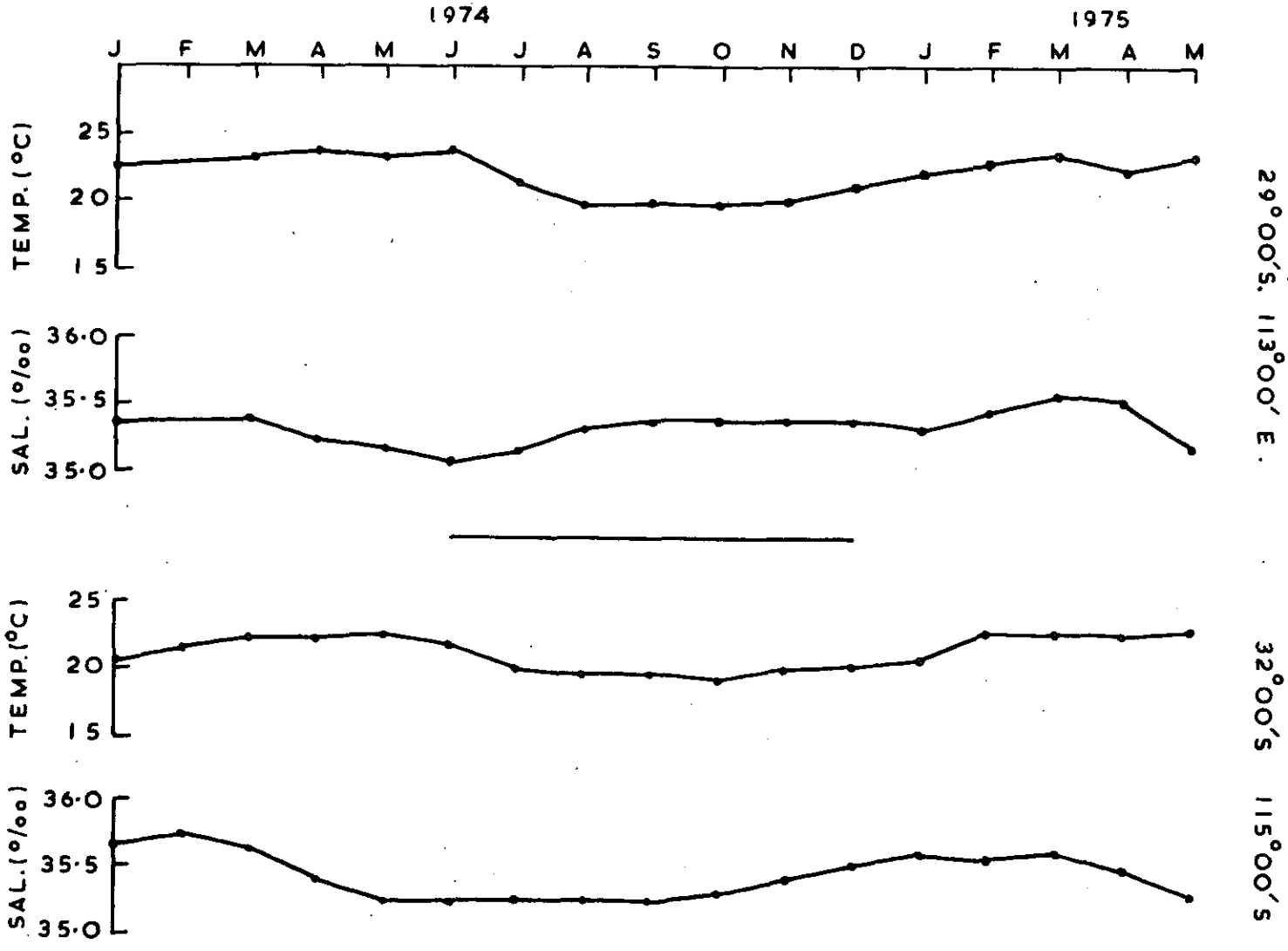

Fig. 3. - Variation of surface temperature and salinity at 29°00'S, 113°00'E and 32°00'S, 115°00'E.

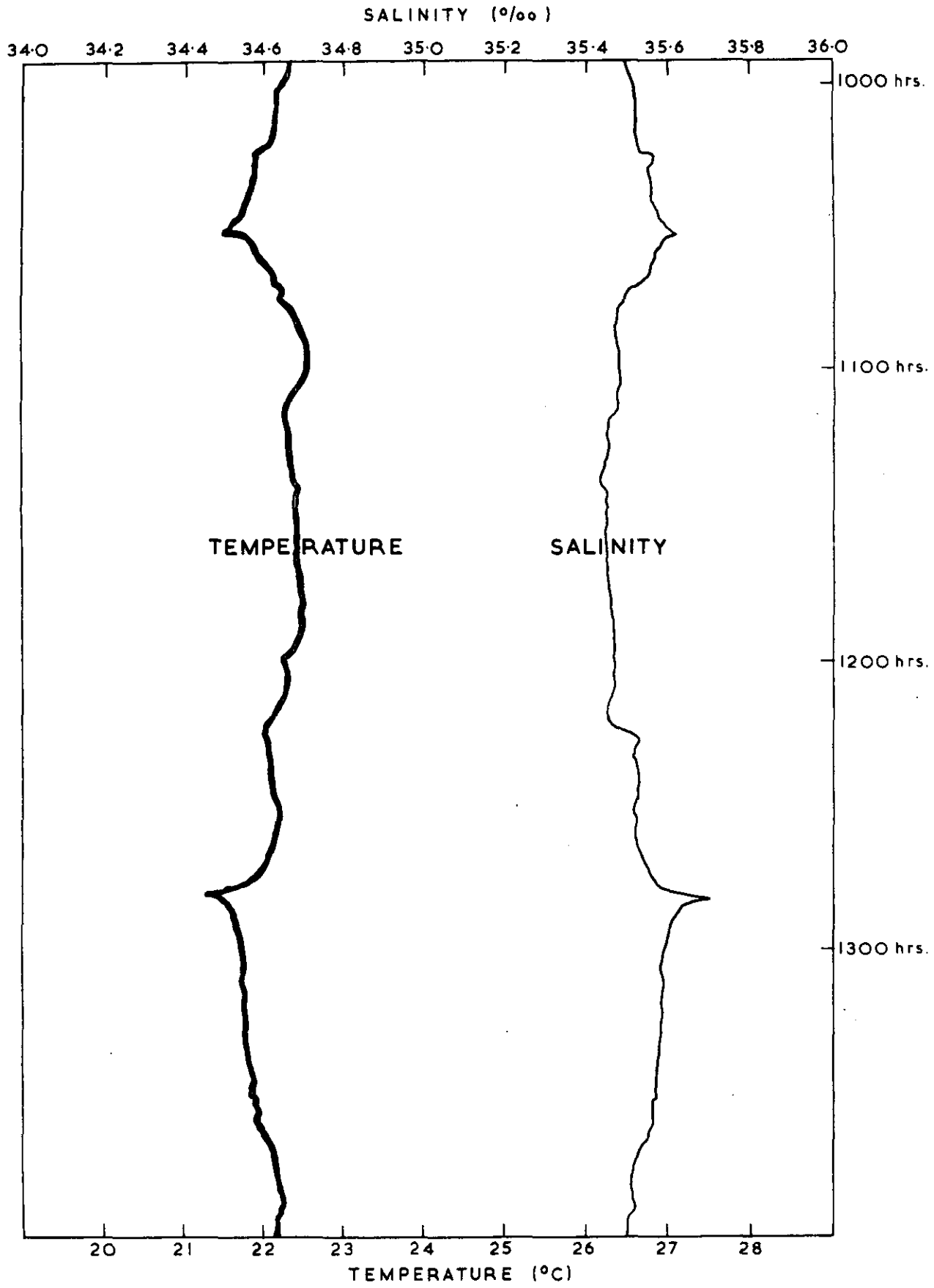

Fig. 4. - Reproduction of thermosalinograph trace showing inverse temperature-salinity relationship

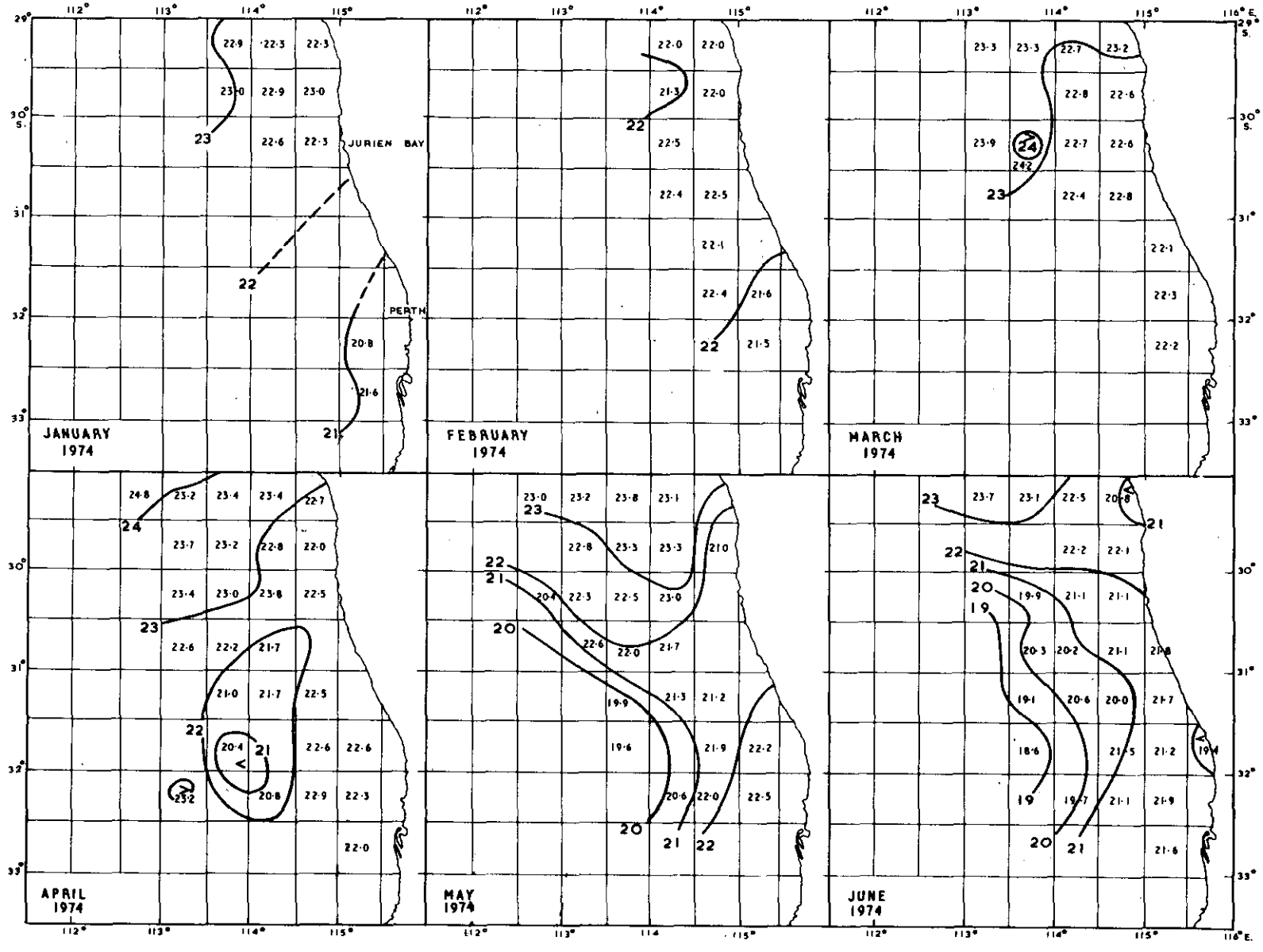

Fig. 5. - Surface temperature distribution - January 1974 - June 1974.

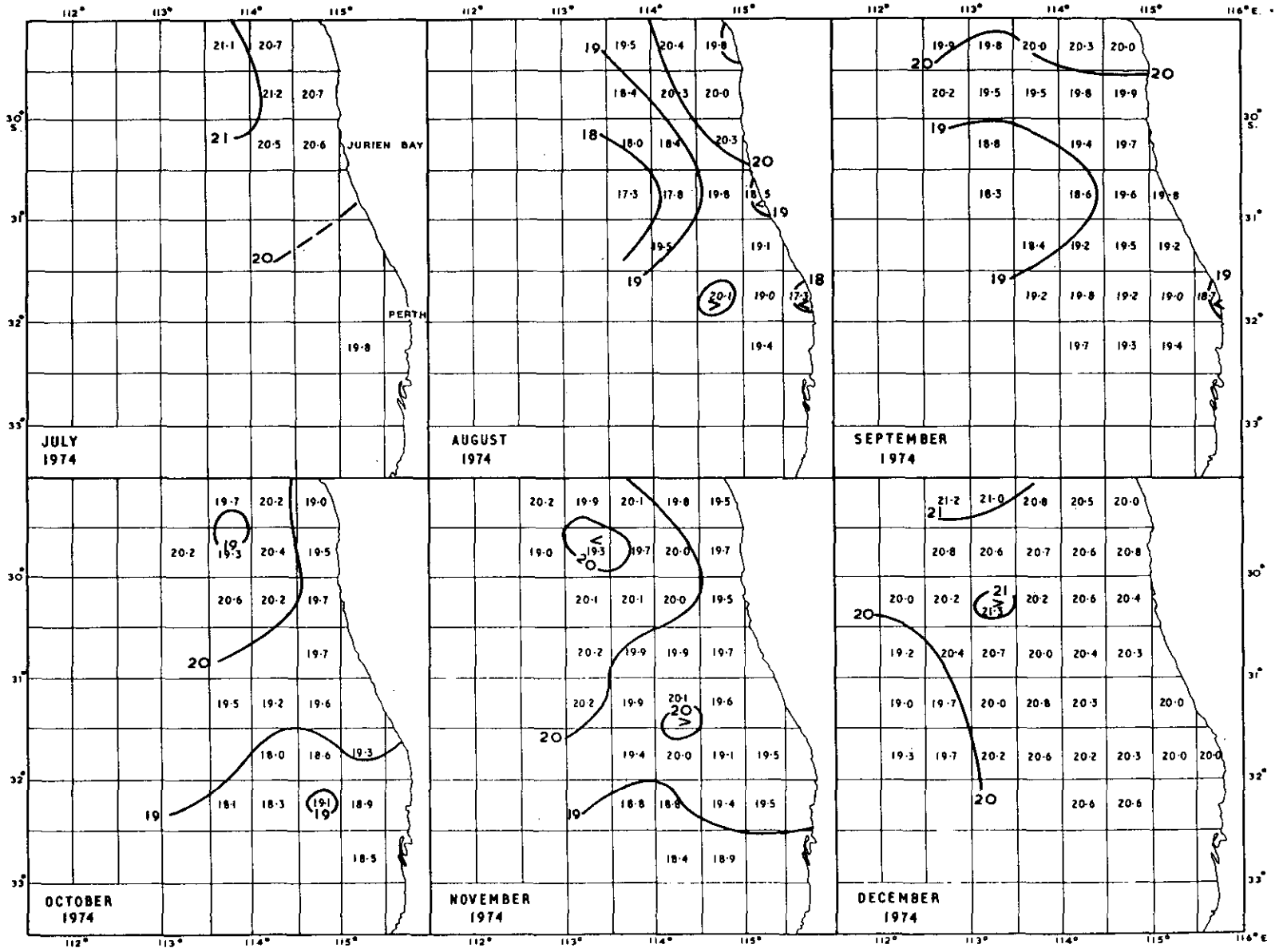

Fig. 6. - Surface temperature distribution - July 1974 - December 1974.

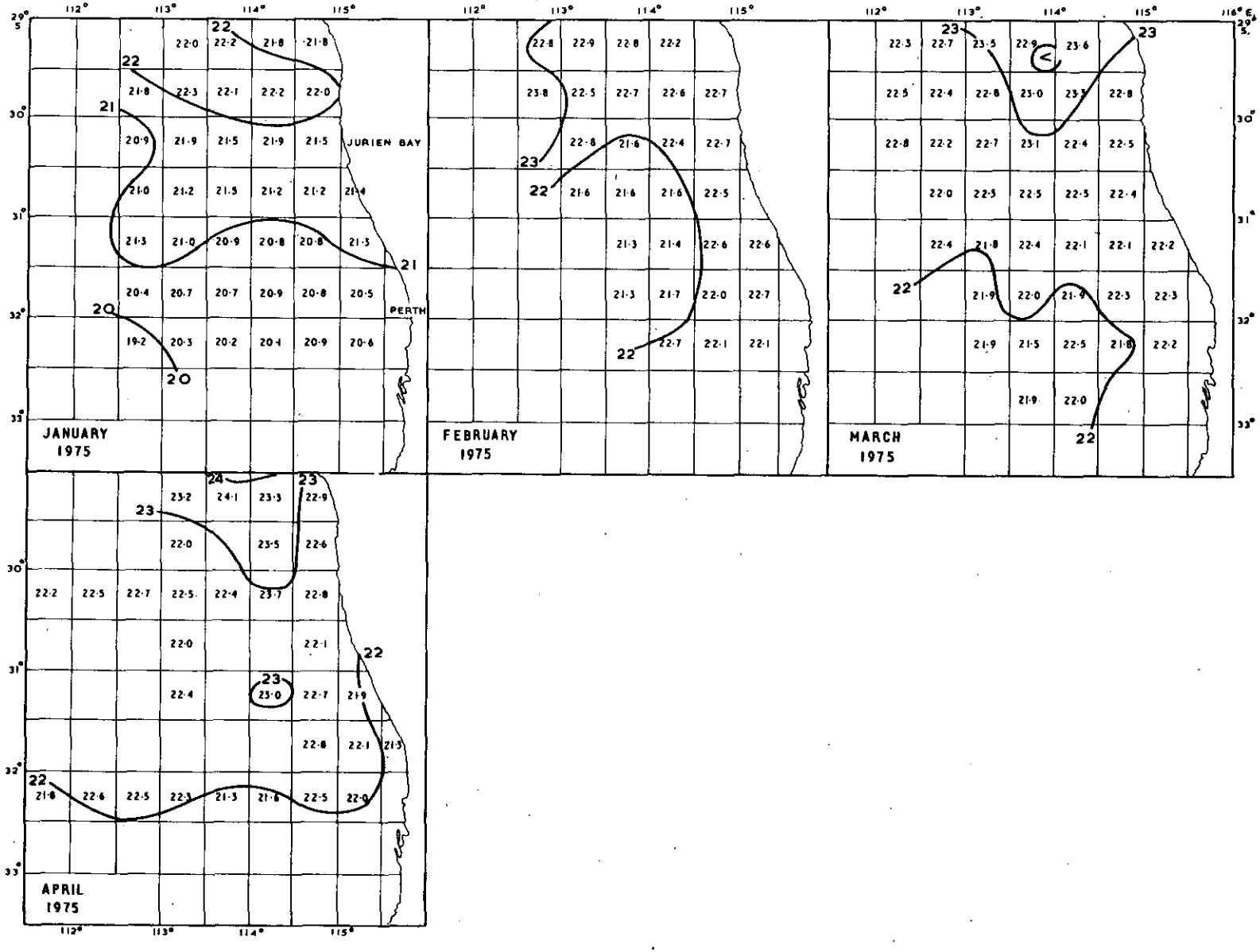

Fig. 7 - Surface Temperature distribution - January 1975 - April 1975.

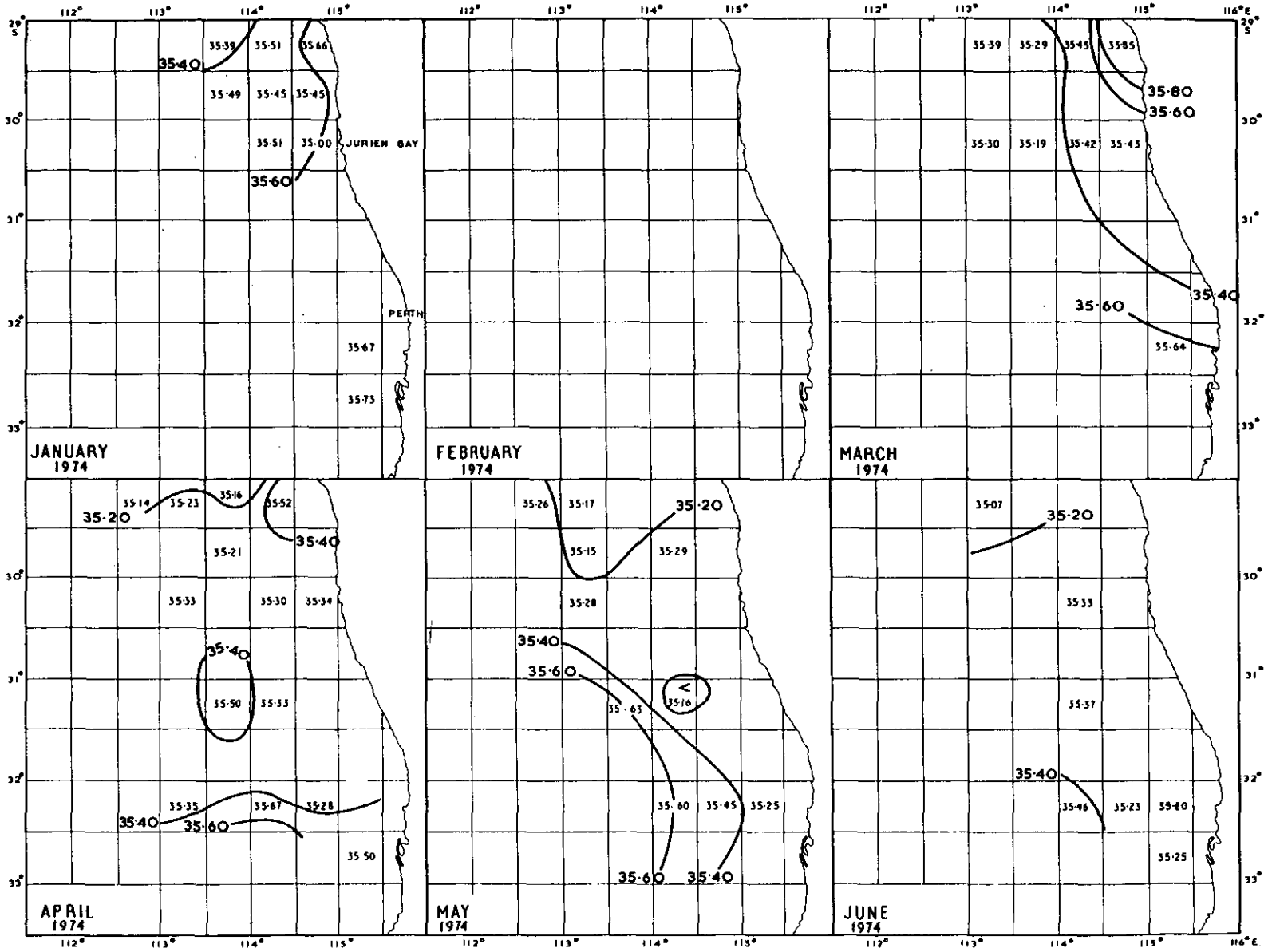

Fig. 8. - Surface salinity distribution - January 1974 - June 1974.

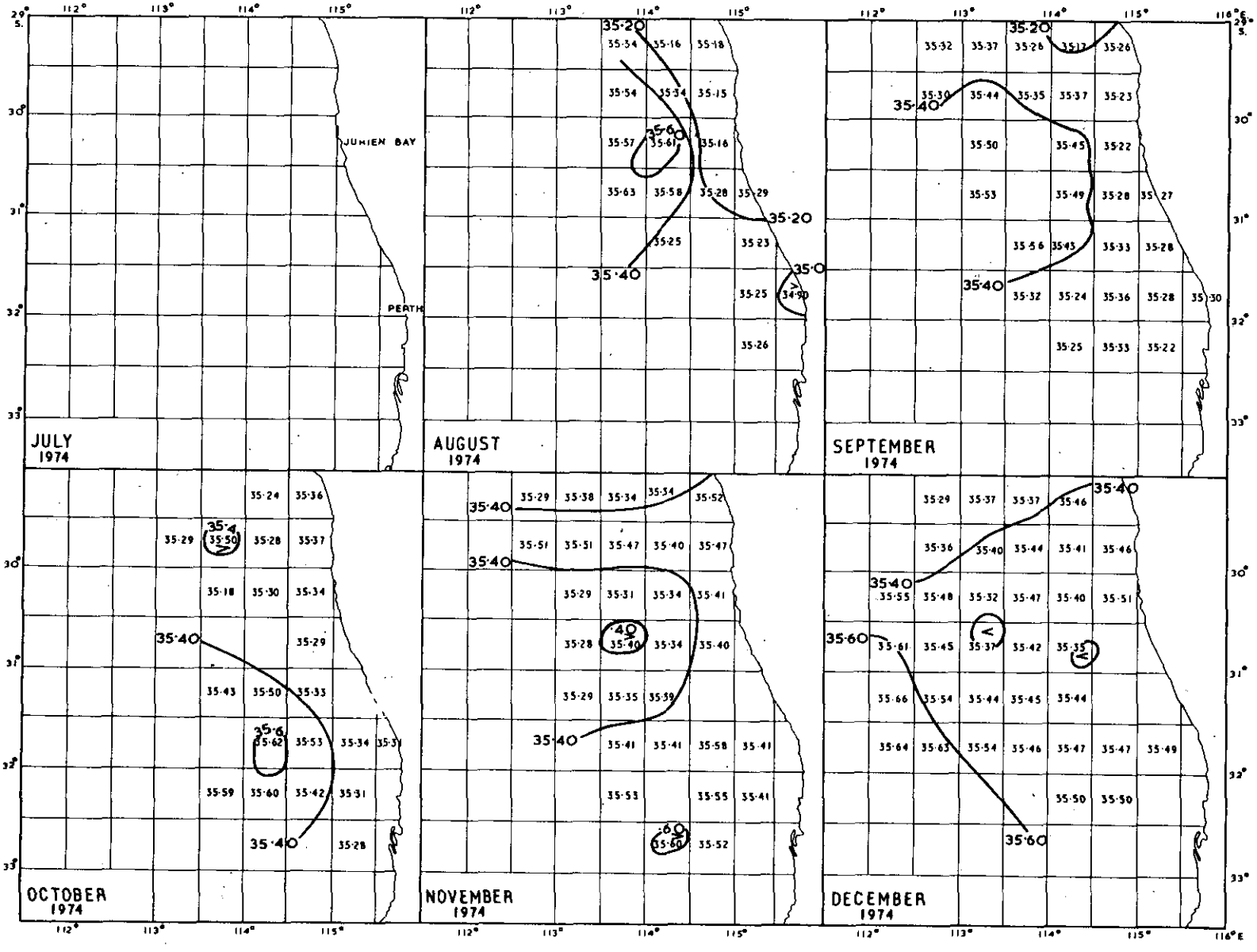

Fig. 9. - Surface salinity distribution - July 1974 - December 1974.

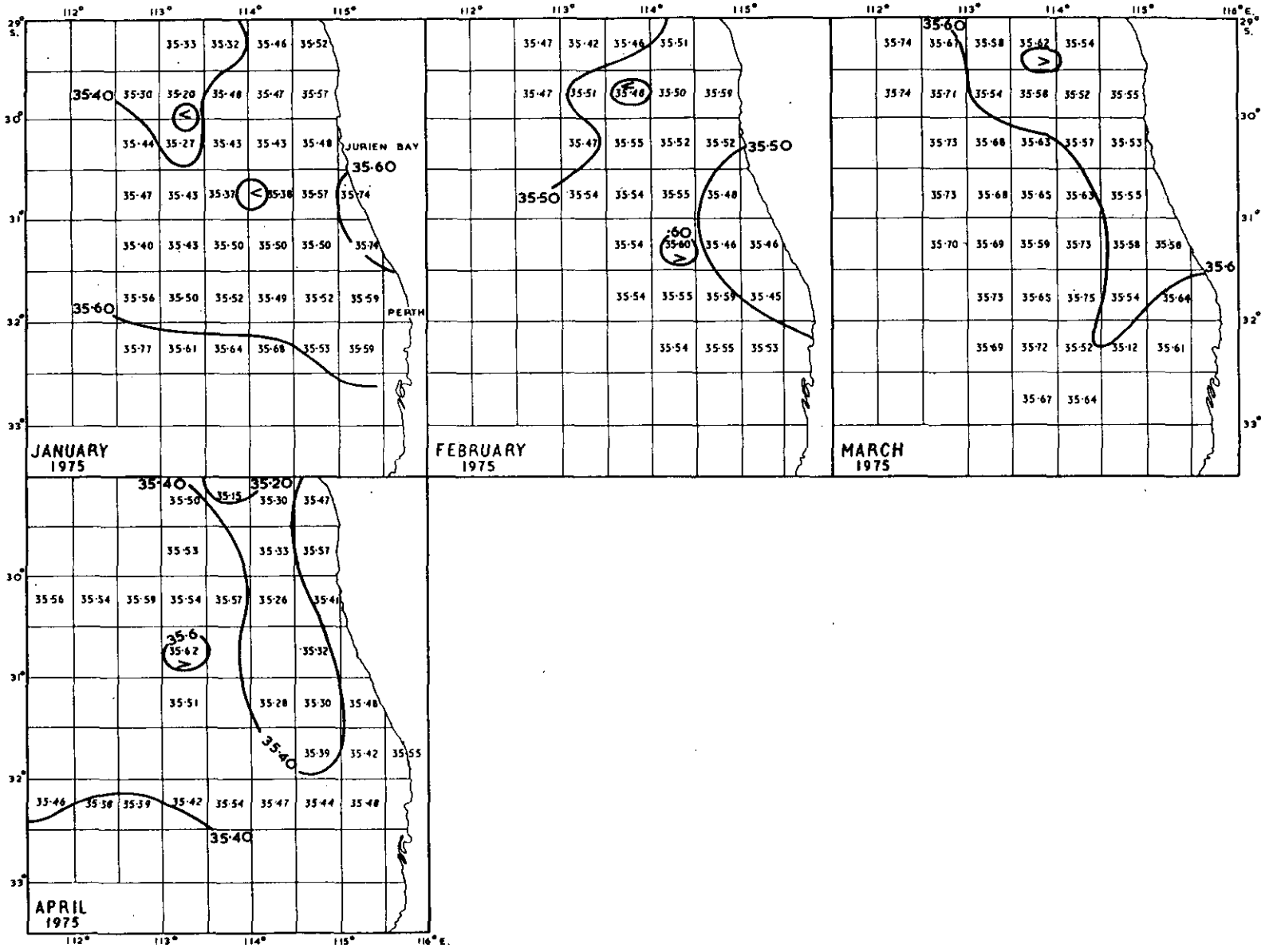

Fig. 10. - Surface salinity distribution - January 1975 - April 1975.

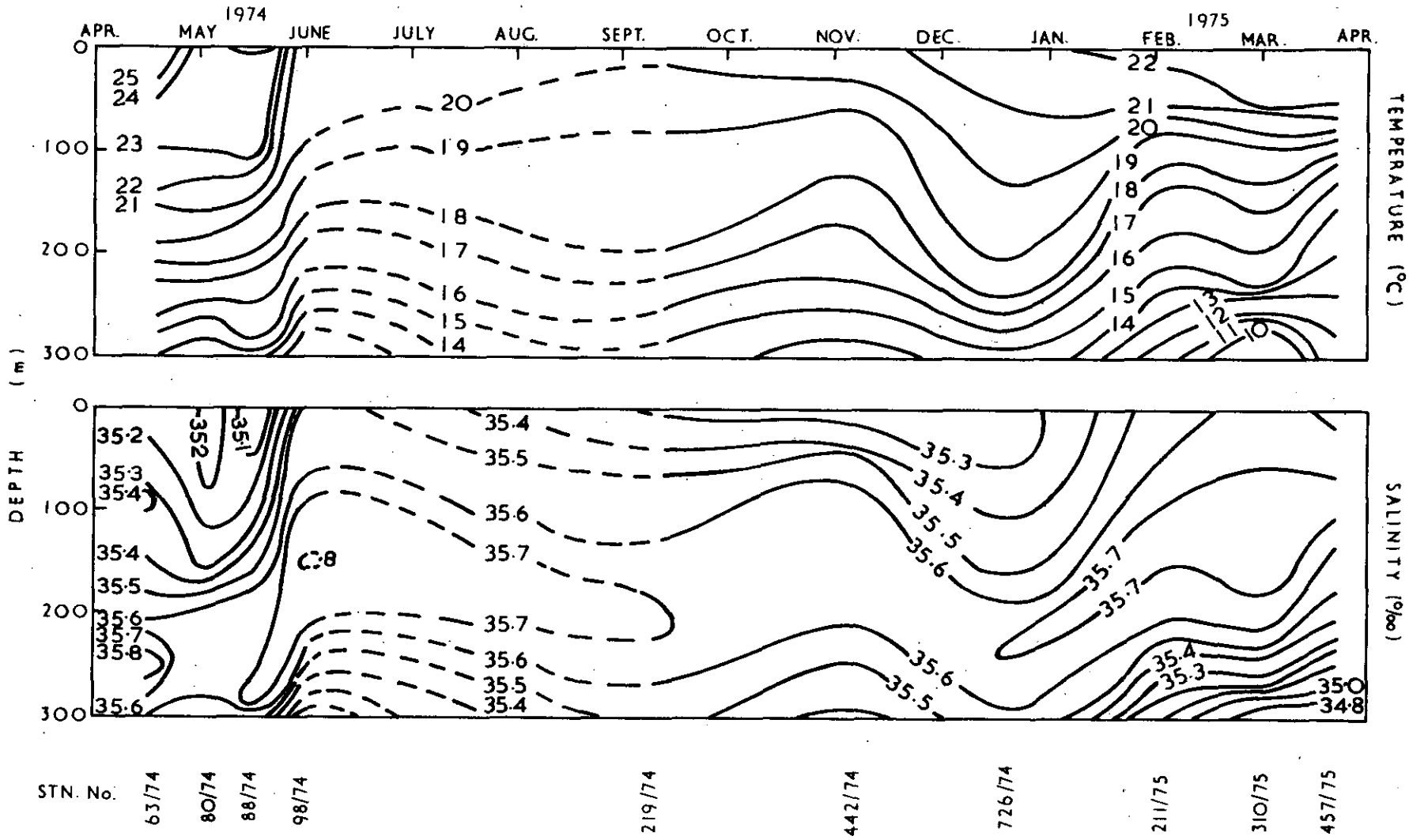

Fig. 11. - Position 29°00'S. 112°40'E. Temperature and salinity distribution from 0 to 300 m.

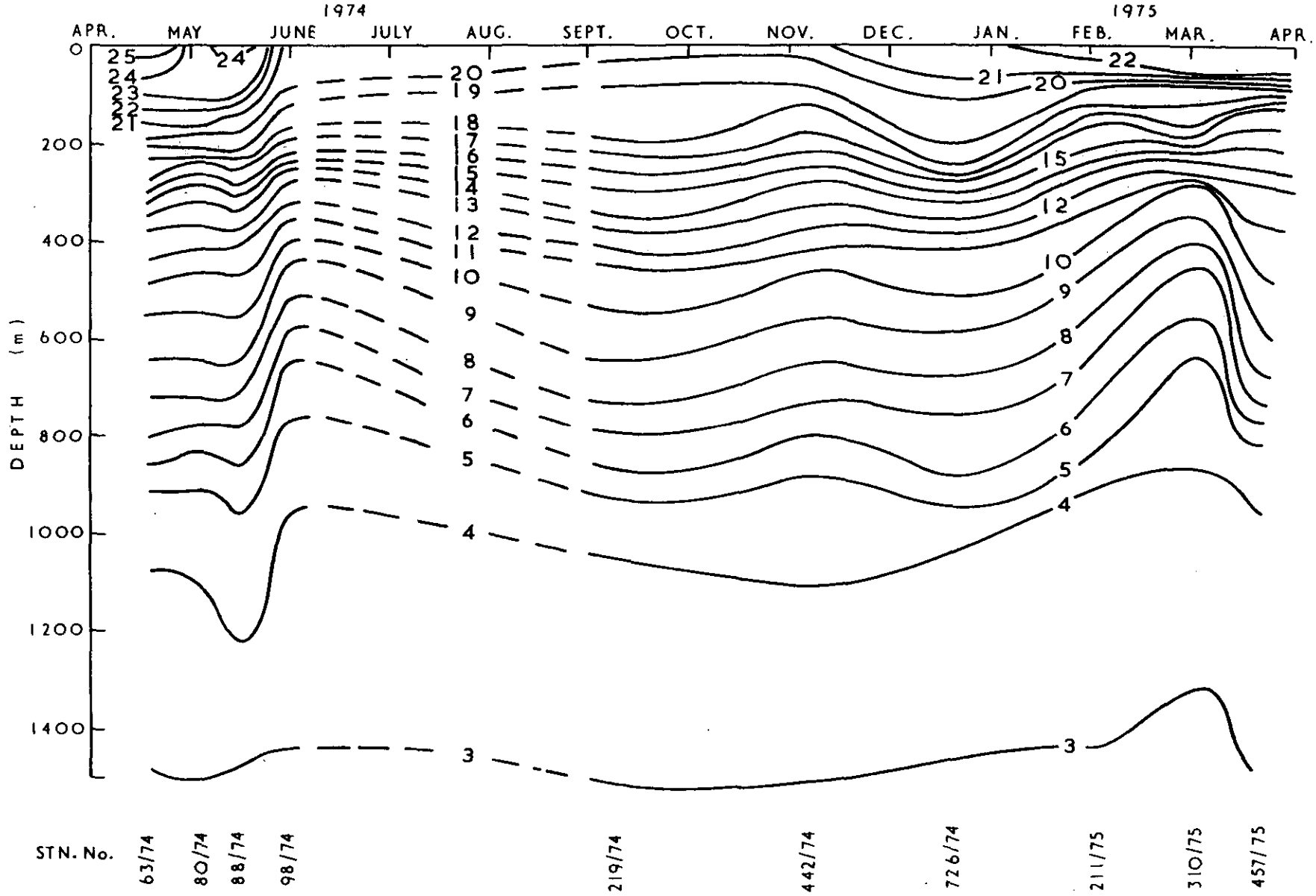

Fig. 12. - Position 29°00'S, 112°40'E. Temperature distribution from 0 to 1500 m.

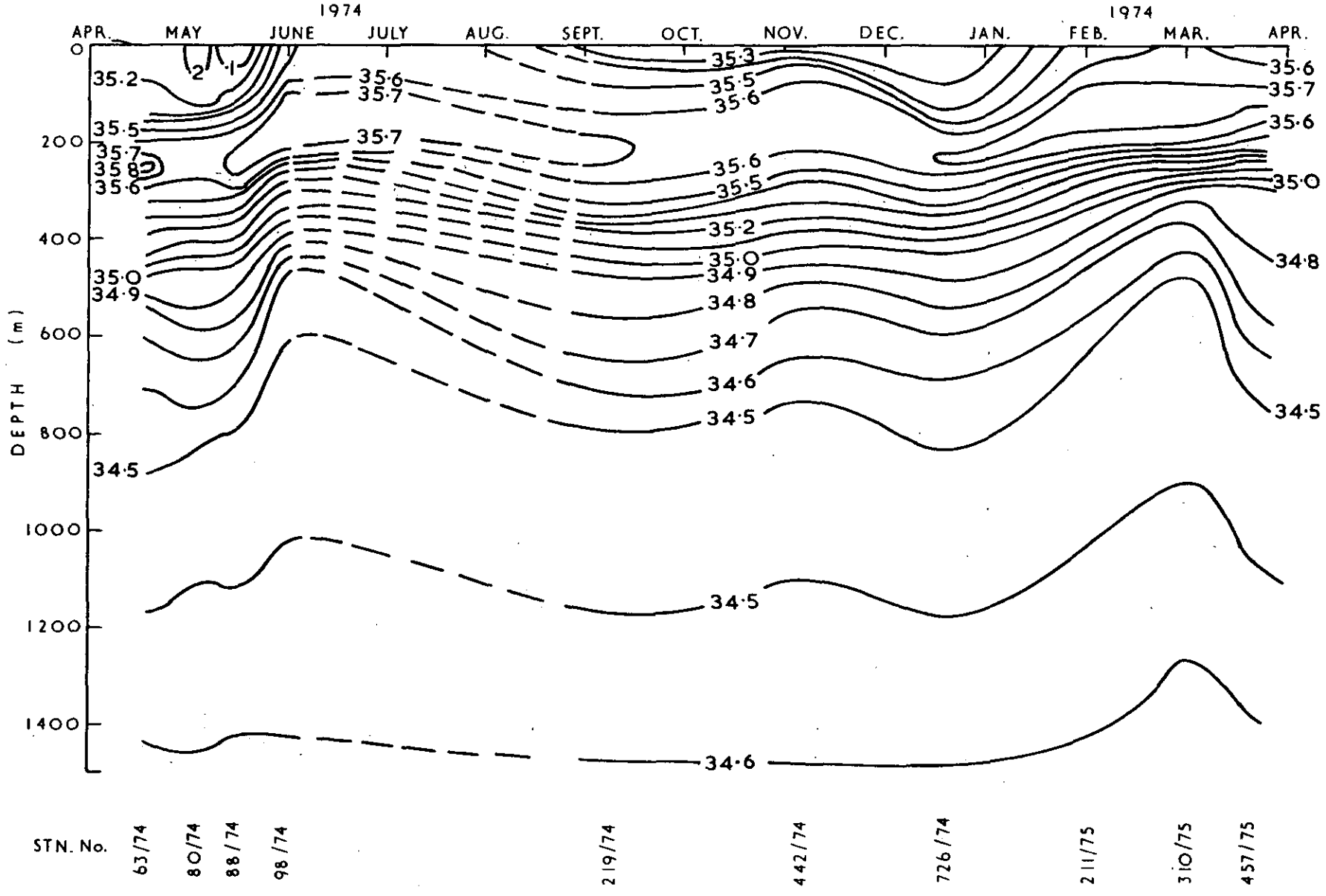

Fig. 13. - Position 29°00'S, 112°40'E. Salinity distribution from 0 to 1500 m.

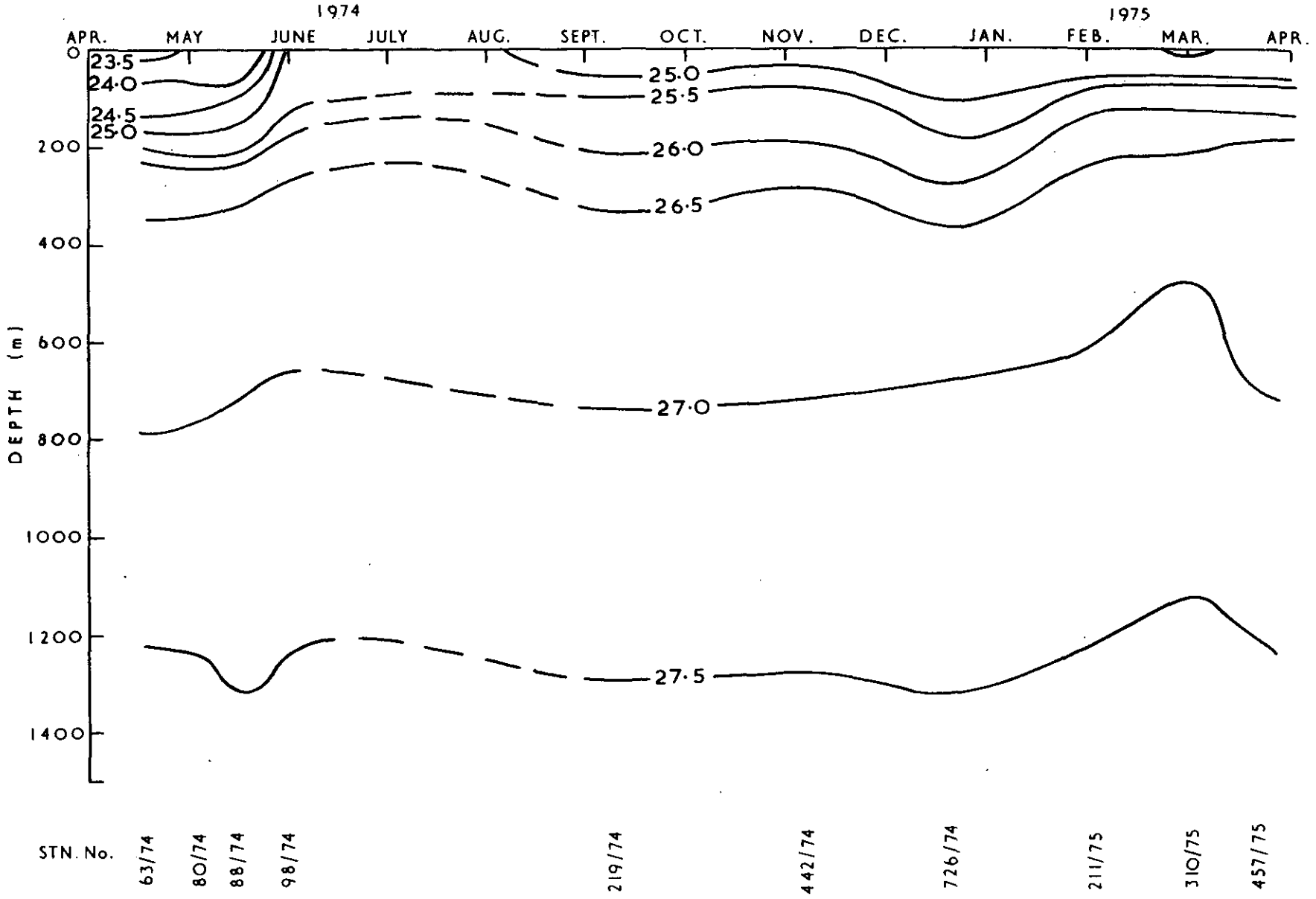

Fig. 14. - Position 29°00'S, 112°40'E. Sigma-t distribution from o to 1500 m.

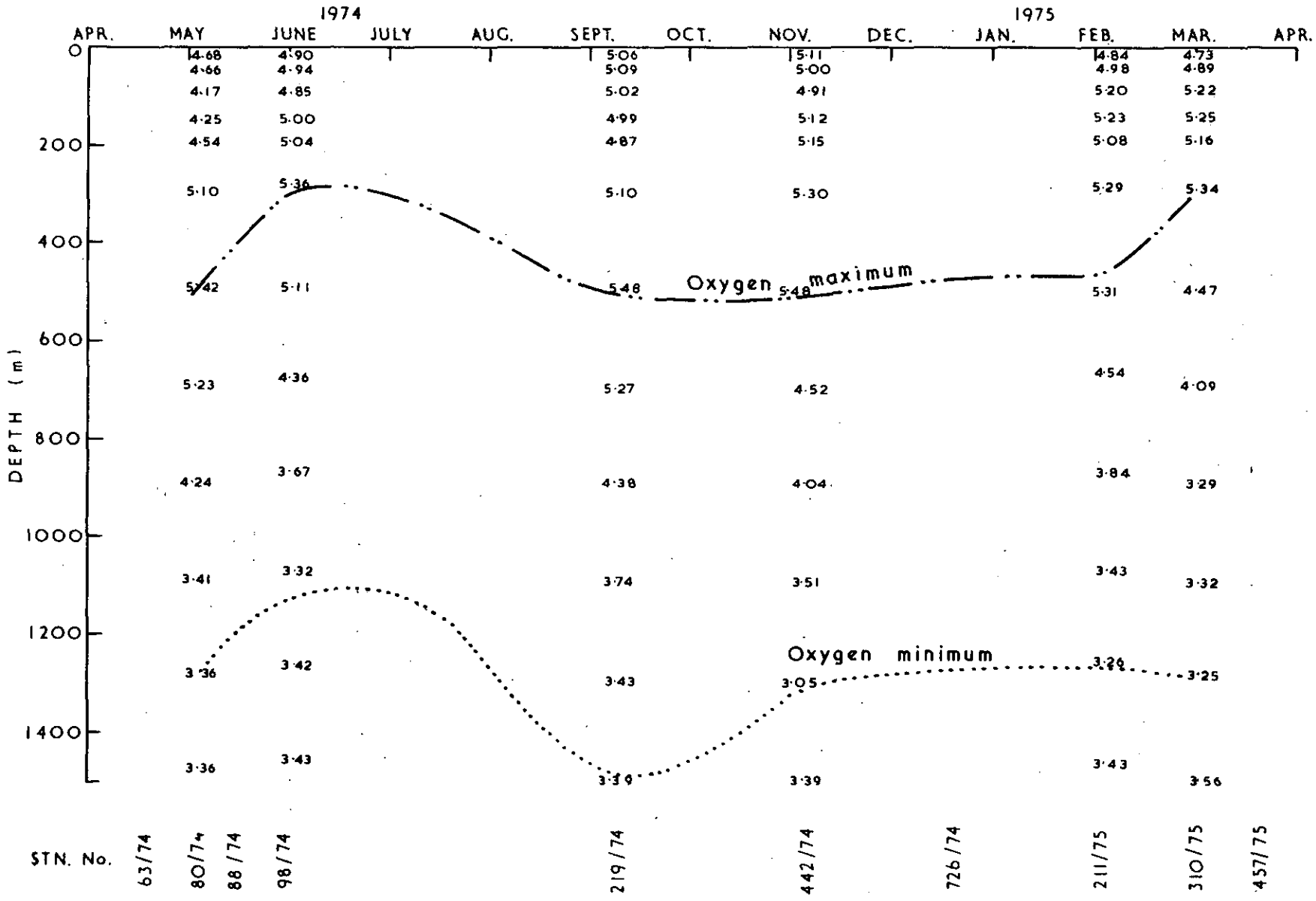

Fig. 15. - Position 29°00'S, 112°40'E. Oxygen distribution from 0 to 1500 m.

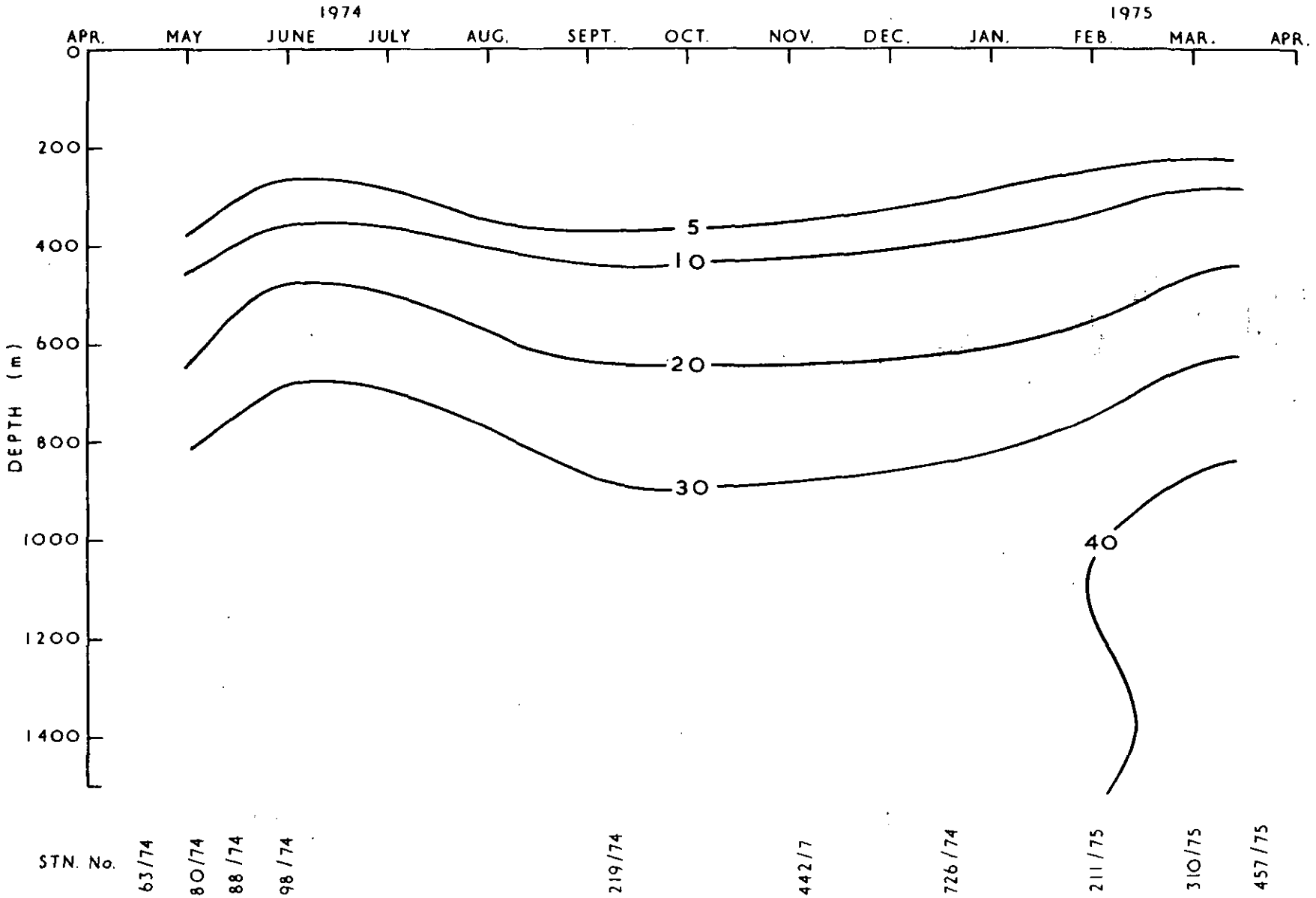

Fig. 16. - Position 29°00'S, 112°40'E. Nitrate-nitrogen distribution from 0 to 1500 m.

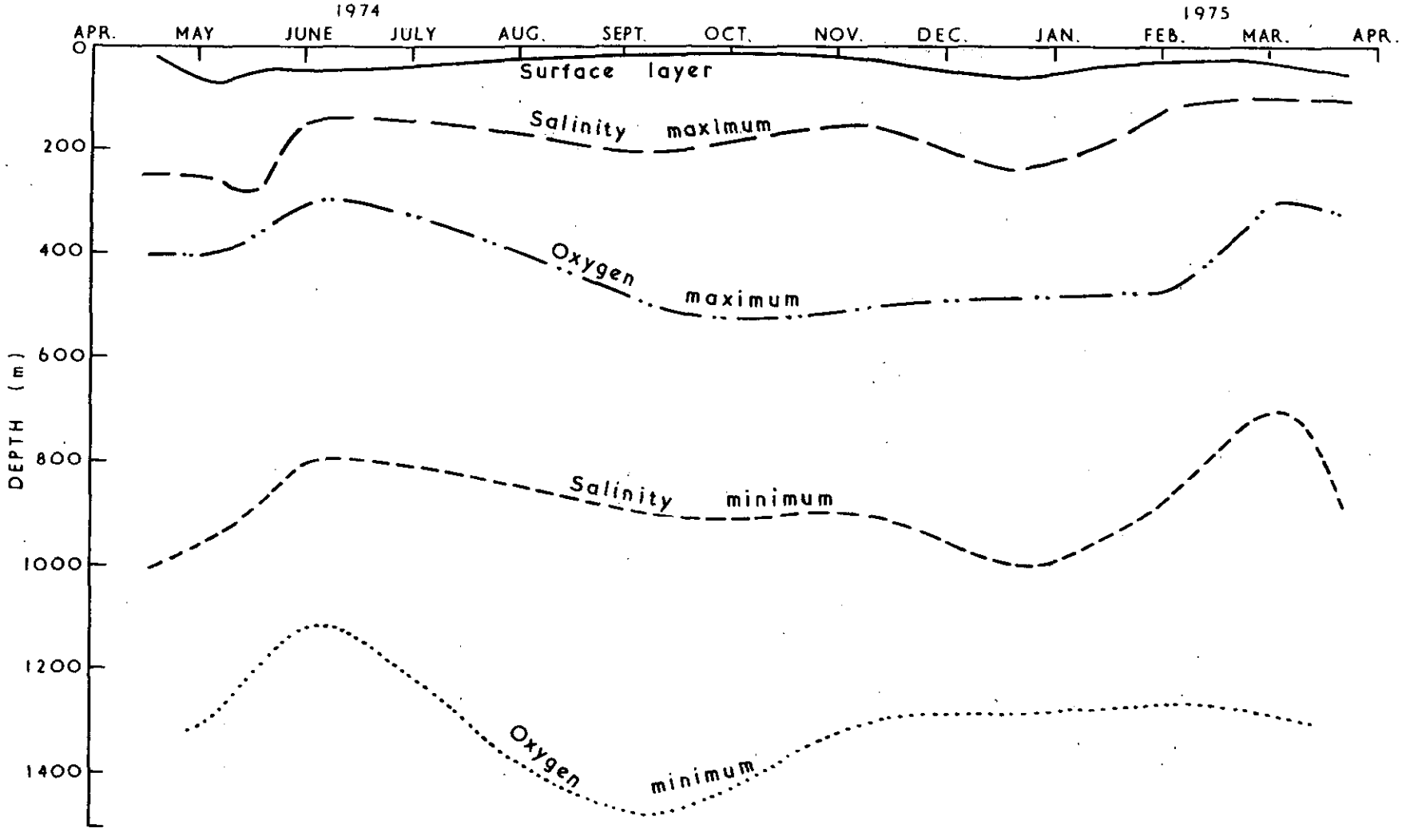

Fig. 17. – Position 29°00'S, 112°40'E. Time series of mixed layer depth, salinity maximum and minimum, and of oxygen maximum and minimum.

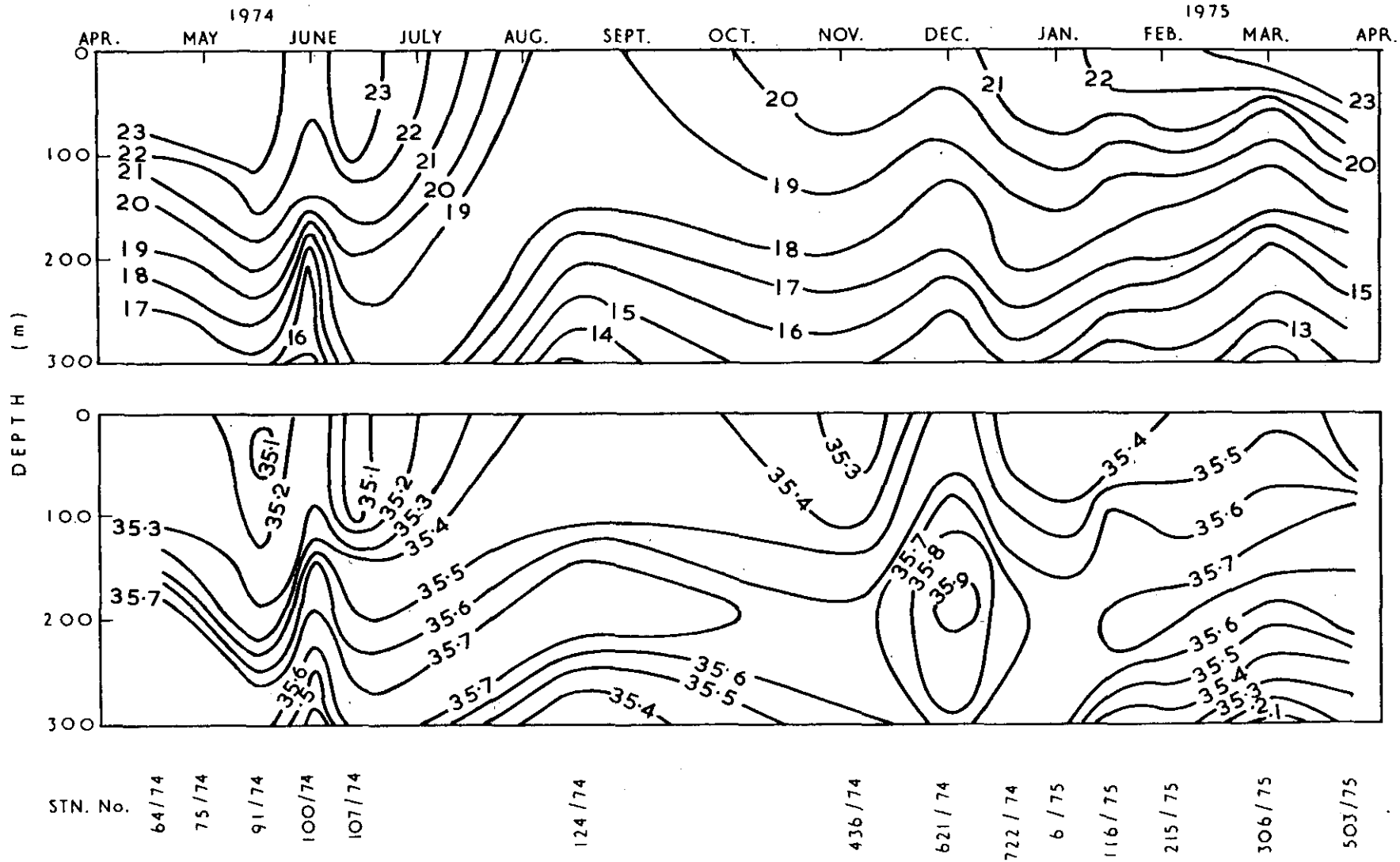

Fig. 18. – Position 29°00'S, 113°20'E. Temperature and salinity distribution from 0 to 300 m.

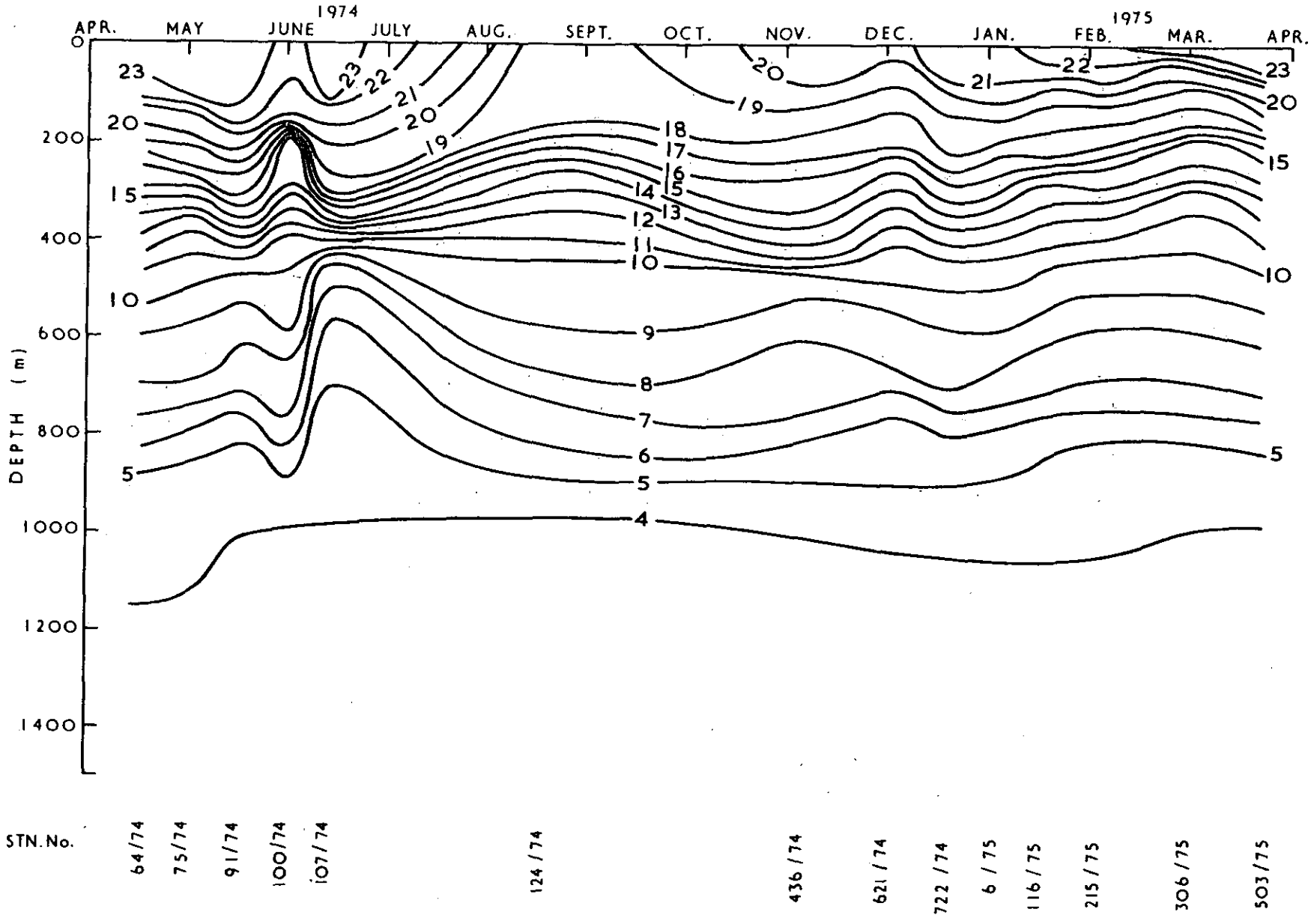

Fig. 19. - Position 29°00'S, 113°20'E. Temperature distribution from 0 to 1500 m.

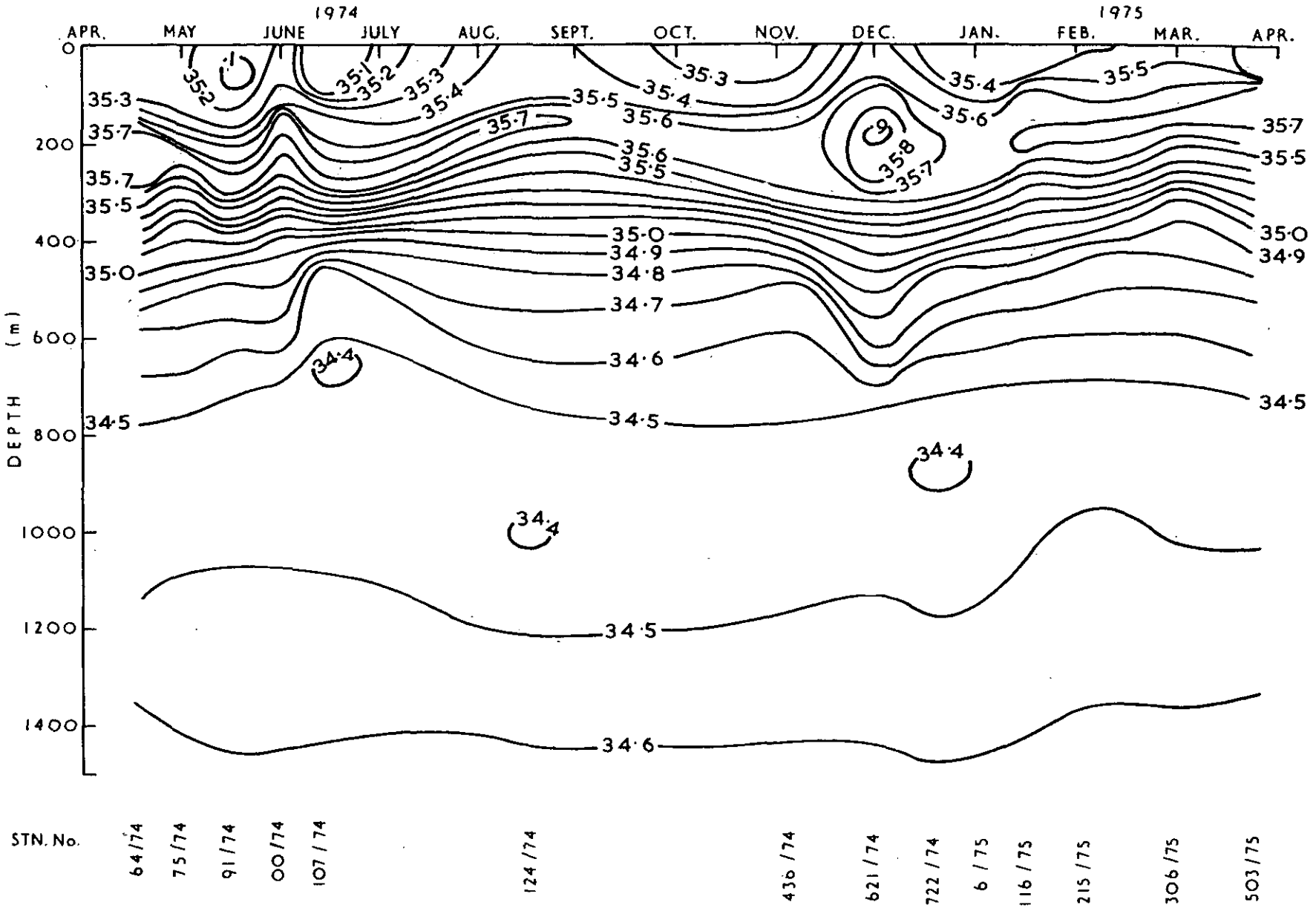

Fig. 20. - Position 29°00'S, 113°20'E. Salinity distribution from 0 to 1500 m.

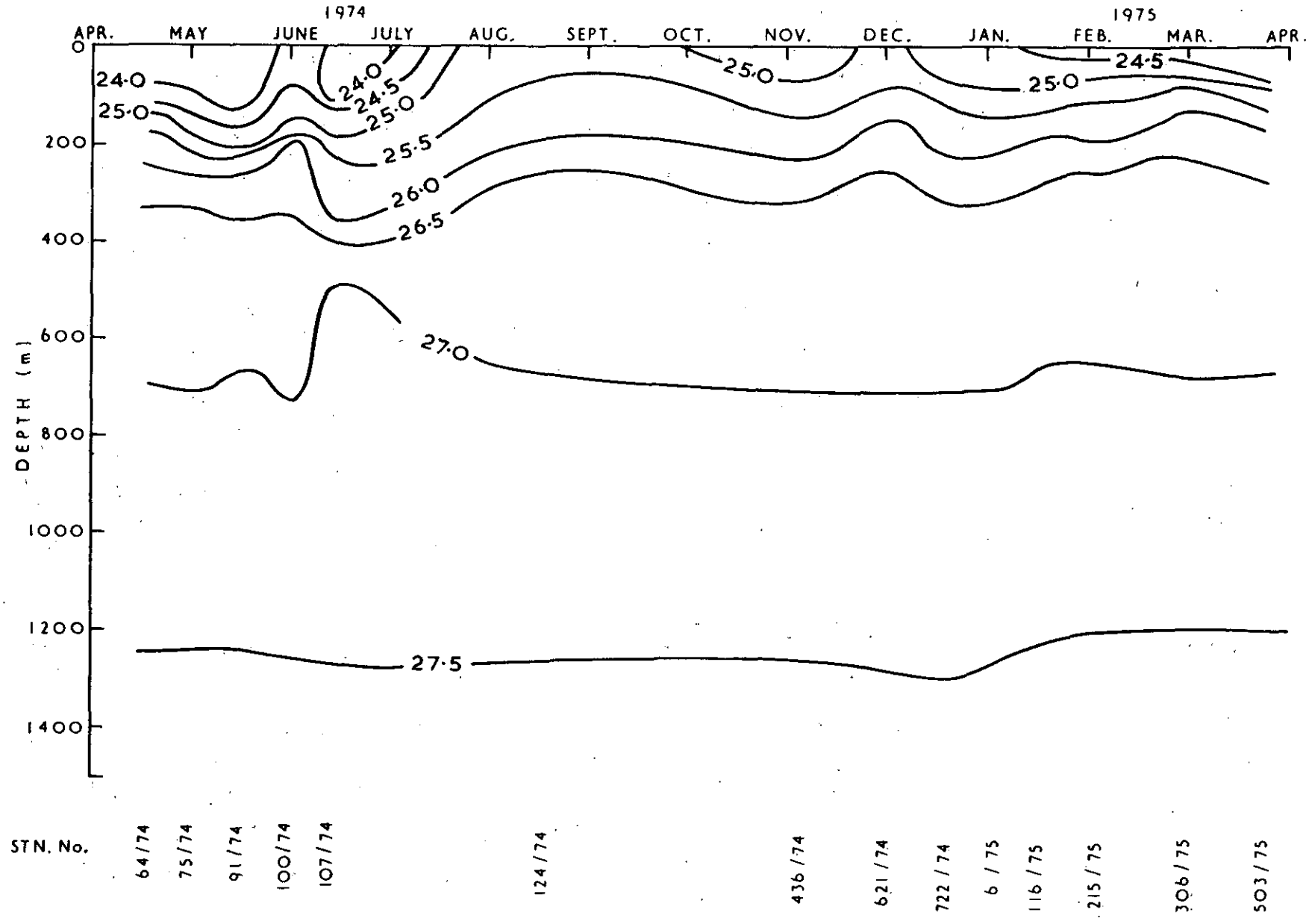

Fig. 21. - Position 29°00'S, 113°20'E. Sigma-t distribution from 0 to 1500 m.

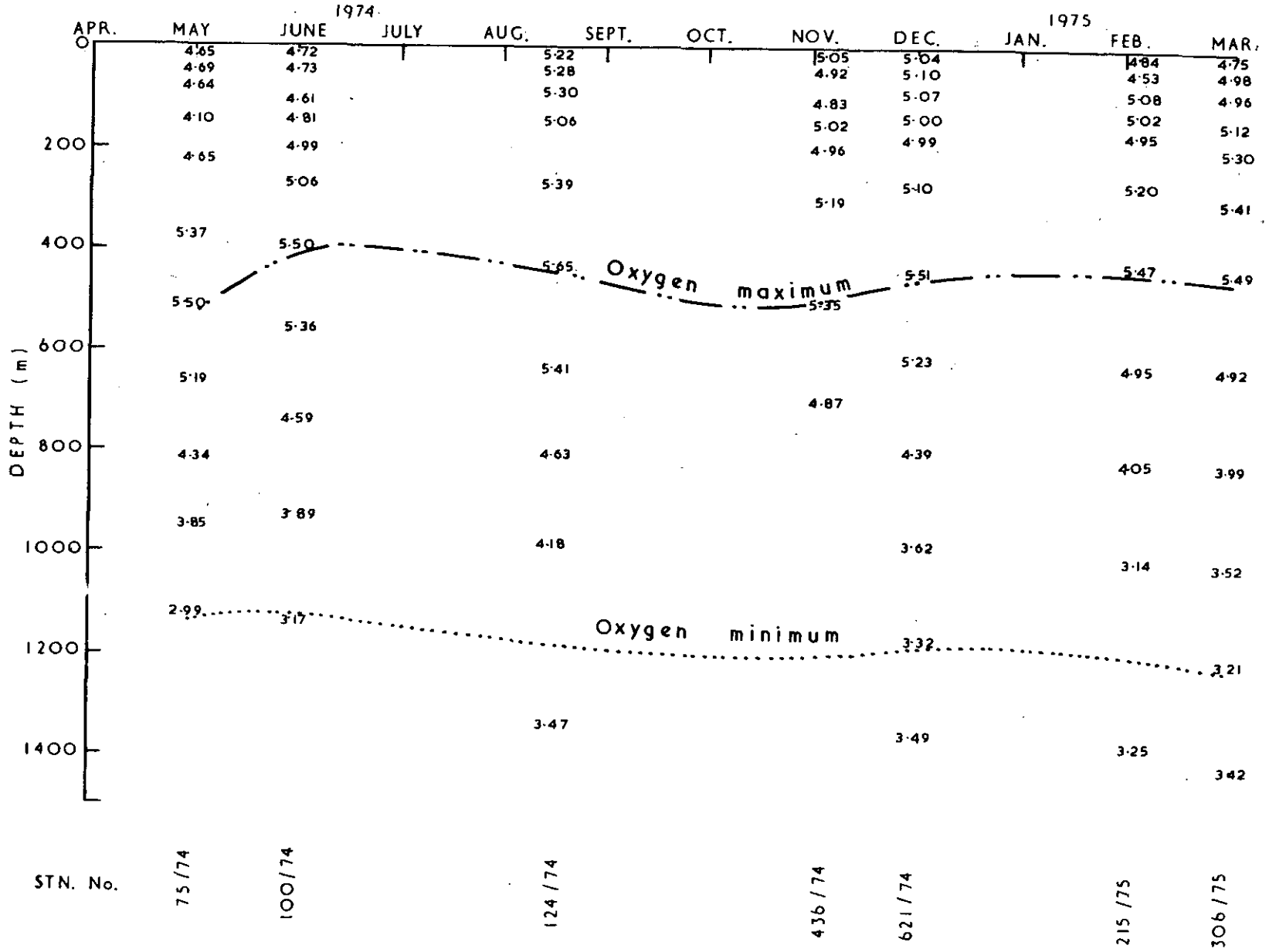

Fig. 22. - Position 29°00'S, 113°20'E. Oxygen distribution from 0 to 1500 m.

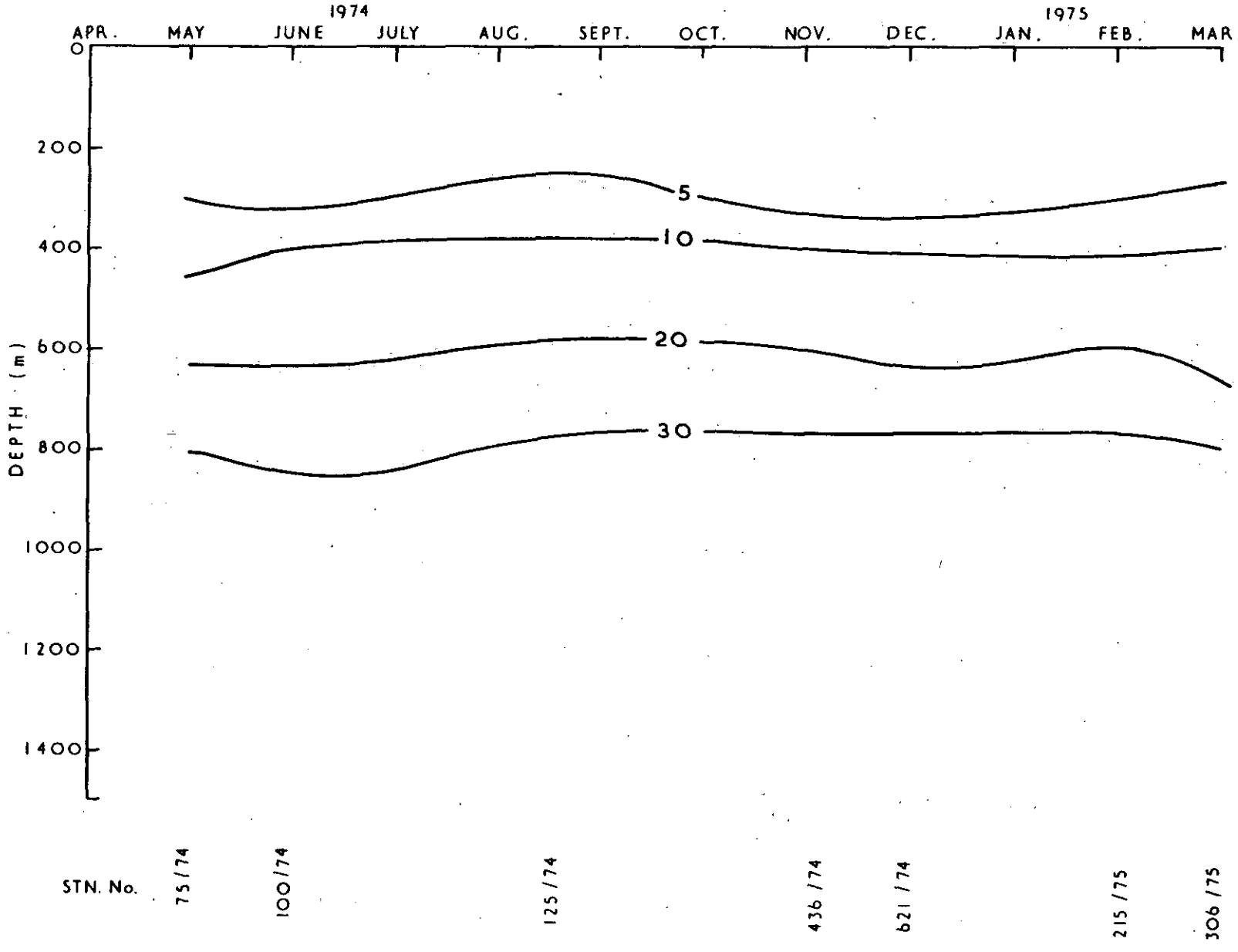

Fig. 23. - Position 29°00'S, 113°20'E. Nitrate-nitrogen distribution from 0 to 1500 m.

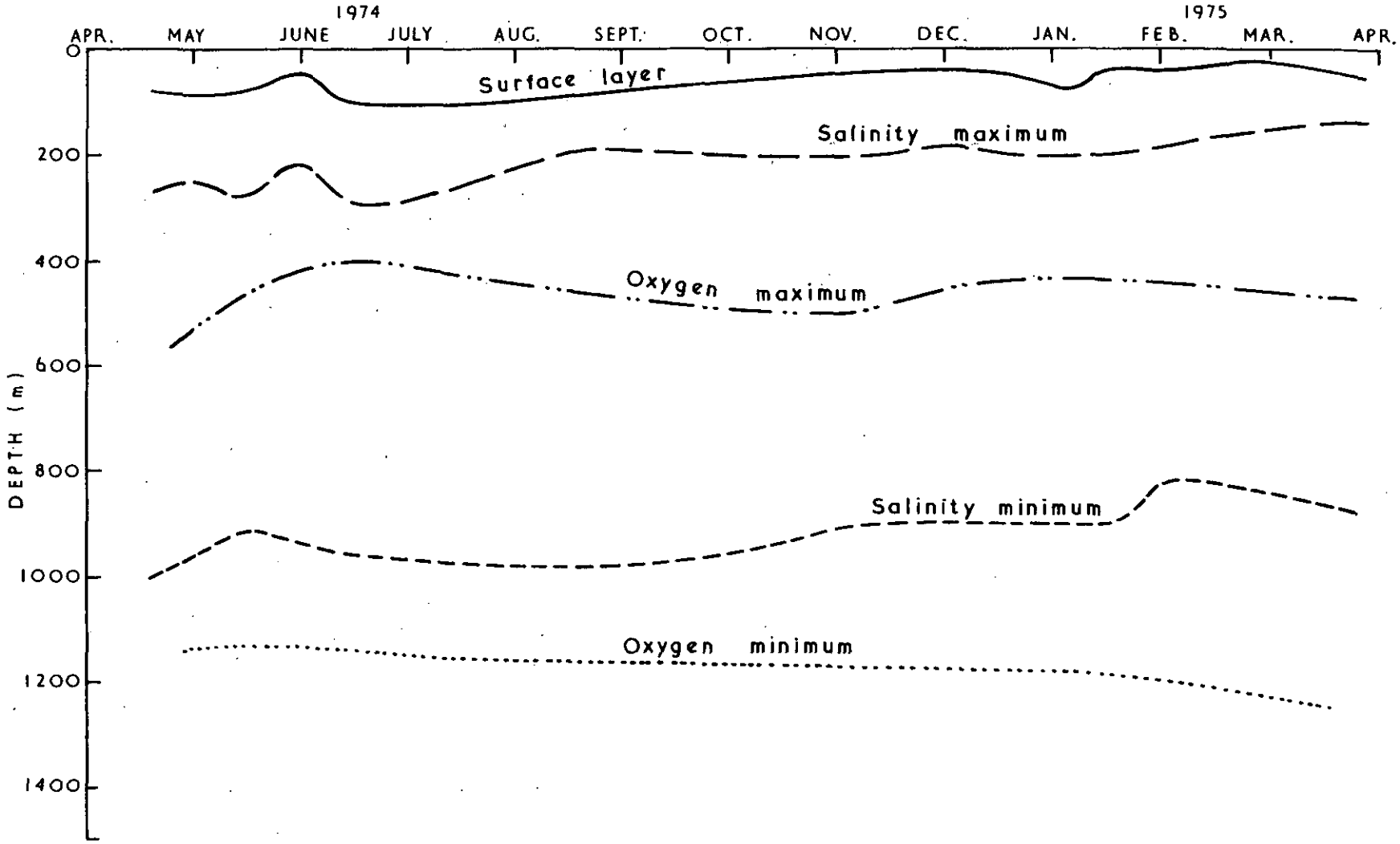

Fig. 24. - Position 29°00'S, 113°20'E. Time series of mixed layer depth, salinity maximum and minimum, and of oxygen maximum and minimum.

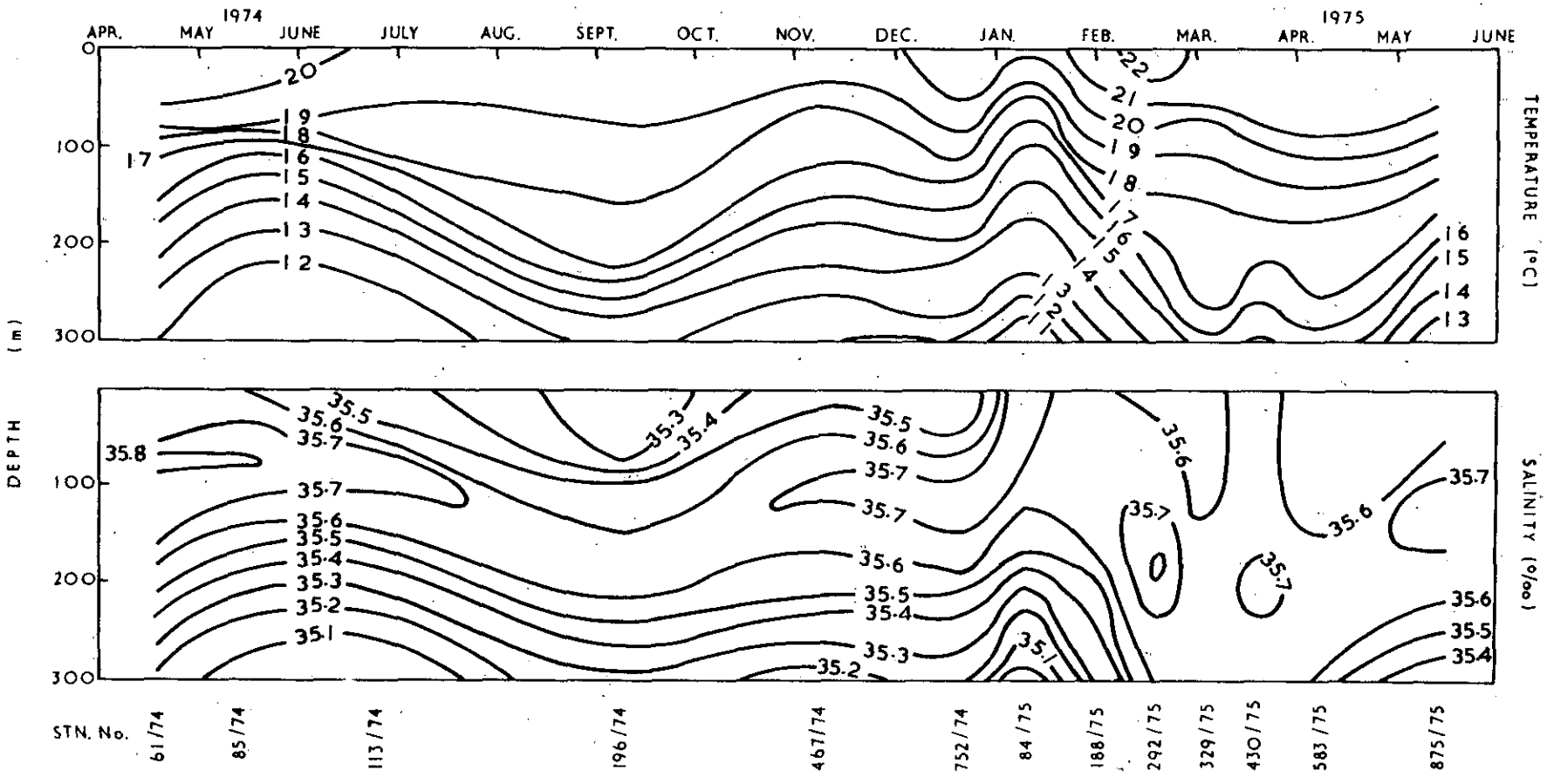

Fig. 25. - Position 29°00'S, 114°00'E. Temperature and salinity distribution from 0 to 300 m.

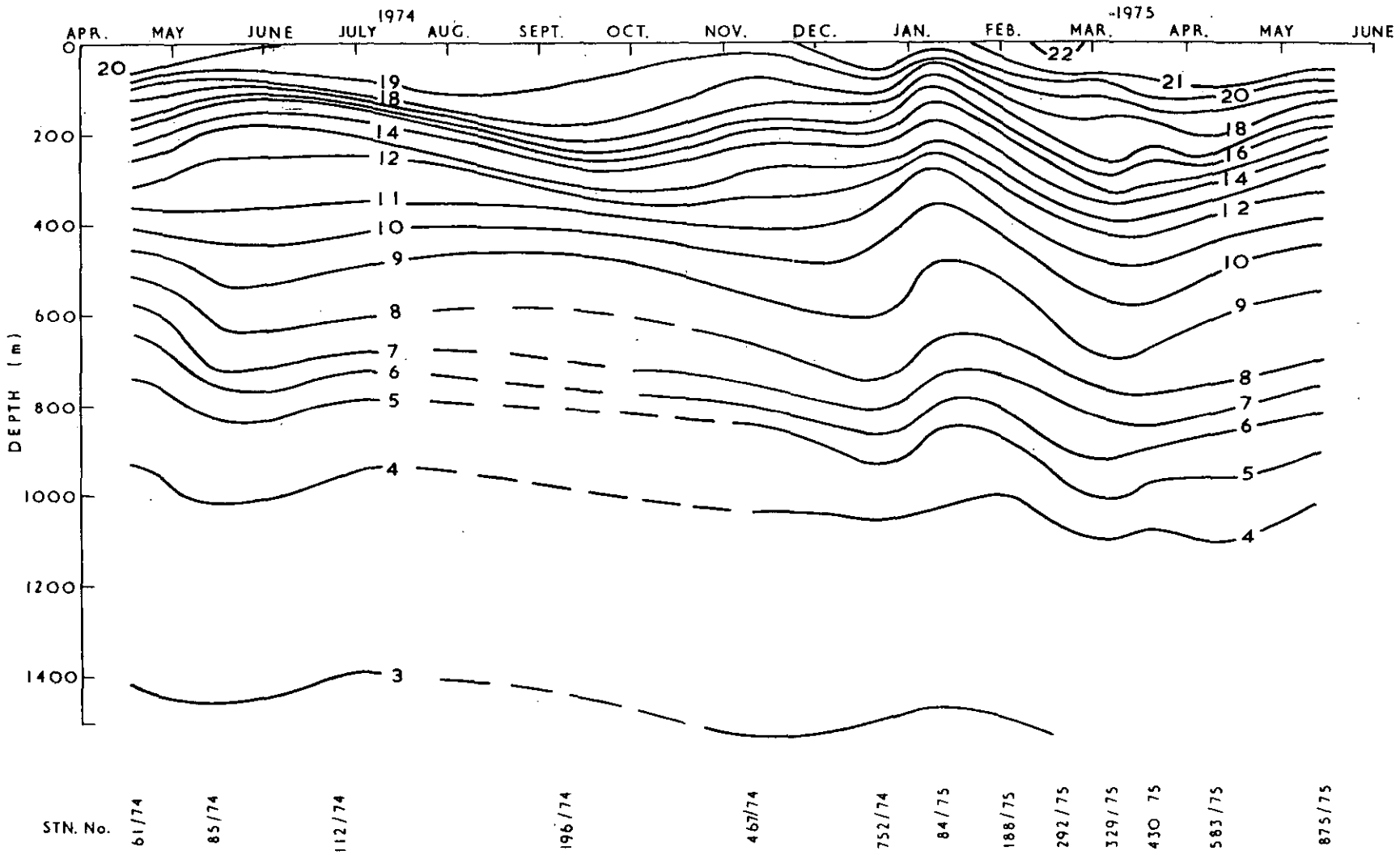

Fig. 26. - Position 29°00'S, 114°00'E. Temperature distribution from 0 to 1500 m.

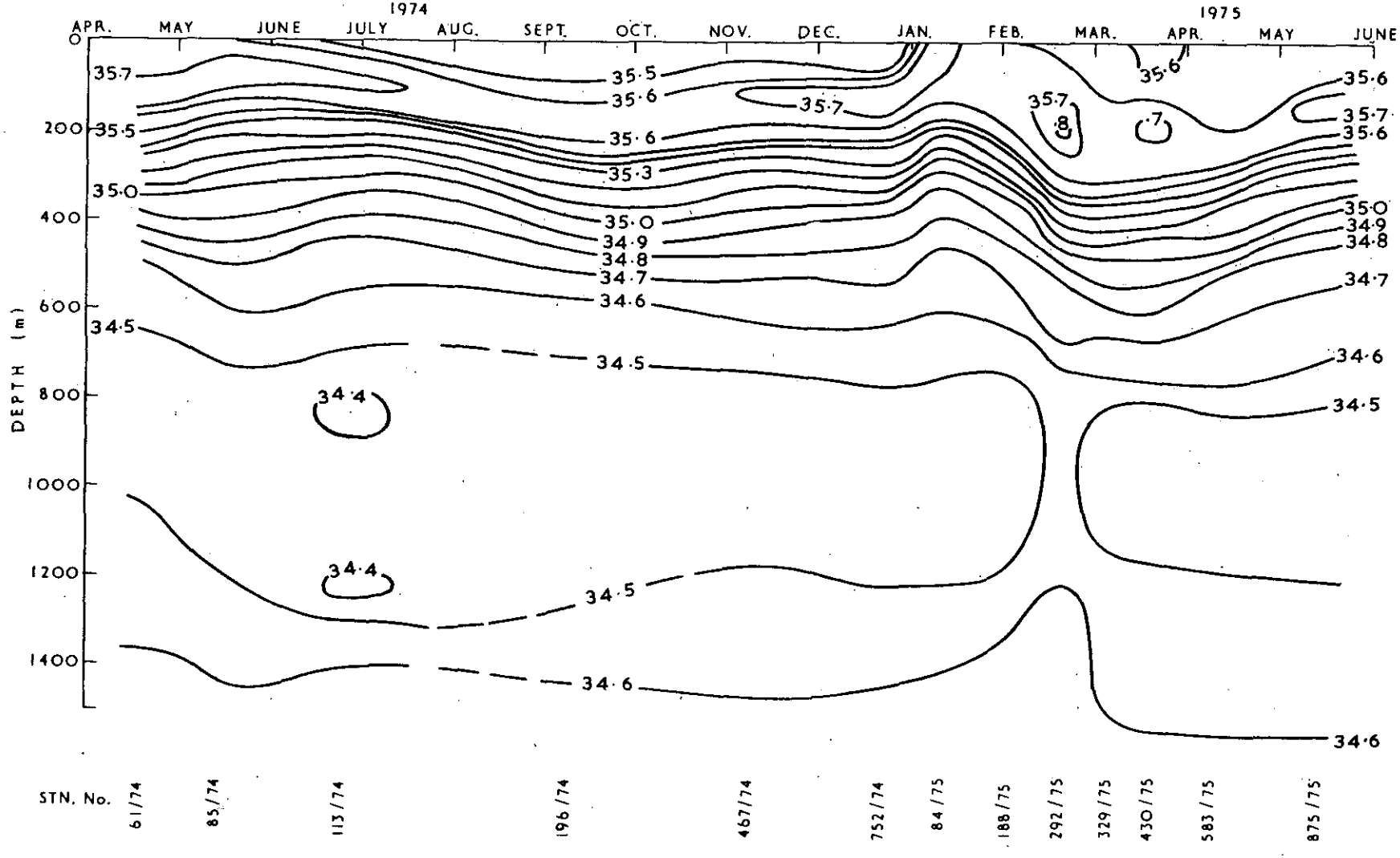

Fig. 27. - Position 32°00'S, 114°00'E. Salinity distribution from 0 to 1500 m.

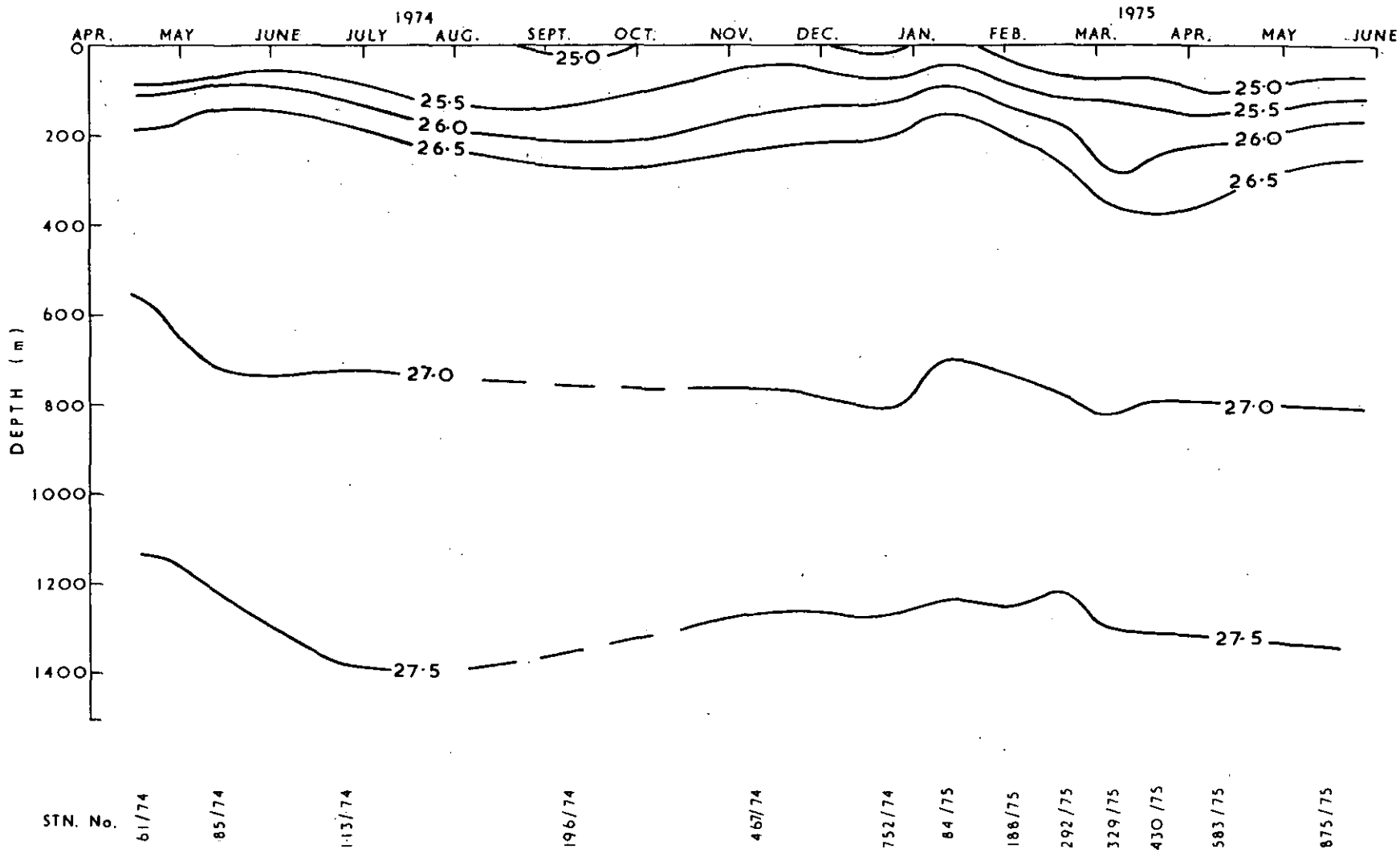

Fig. 28. - Position 32°00'S, 114°00'E. Sigma-t distribution from 0 to 1500 m.

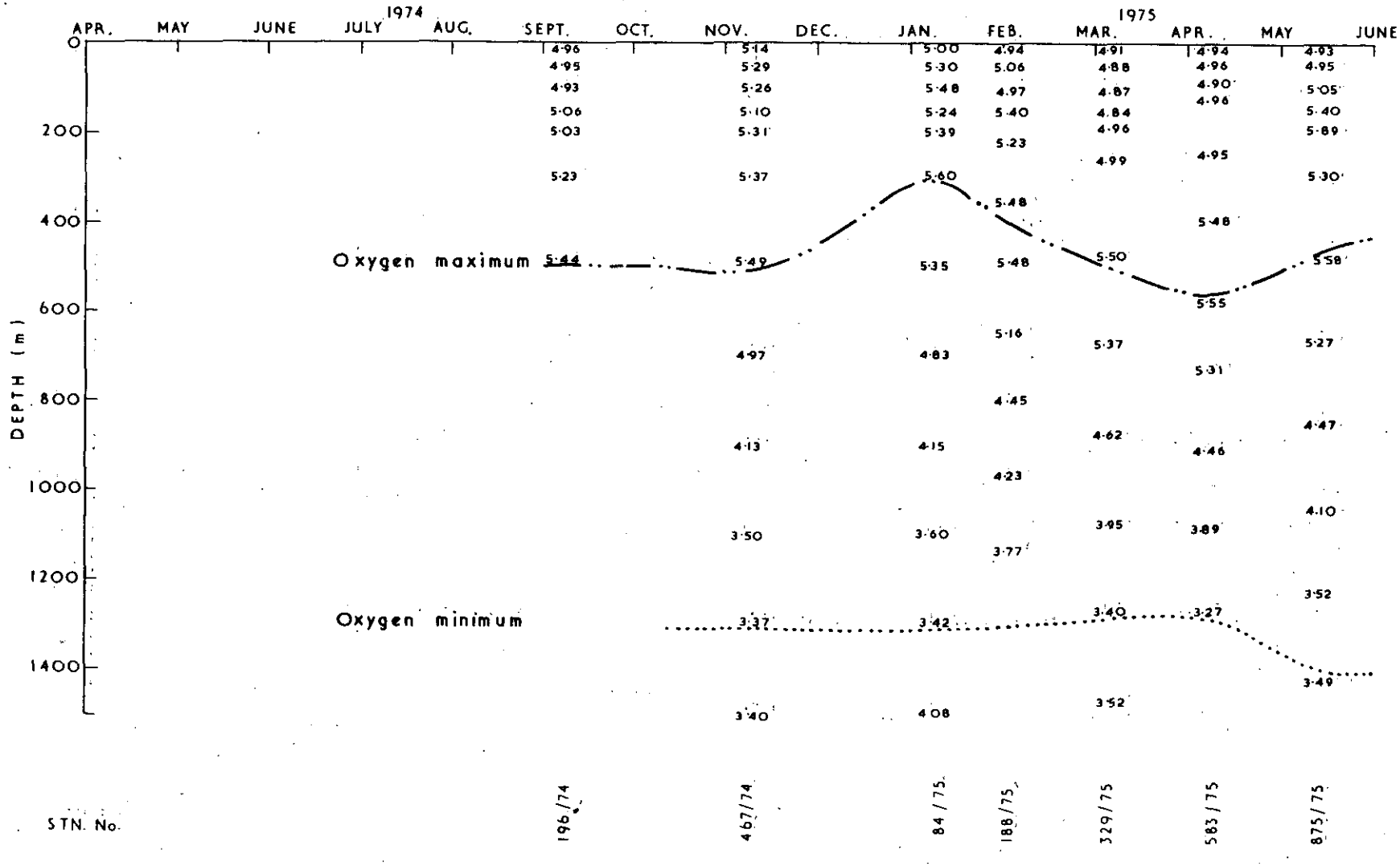

Fig. 29. - Position 32°00'S, 114°00'E. Oxygen distribution from 0 to 1500 m.

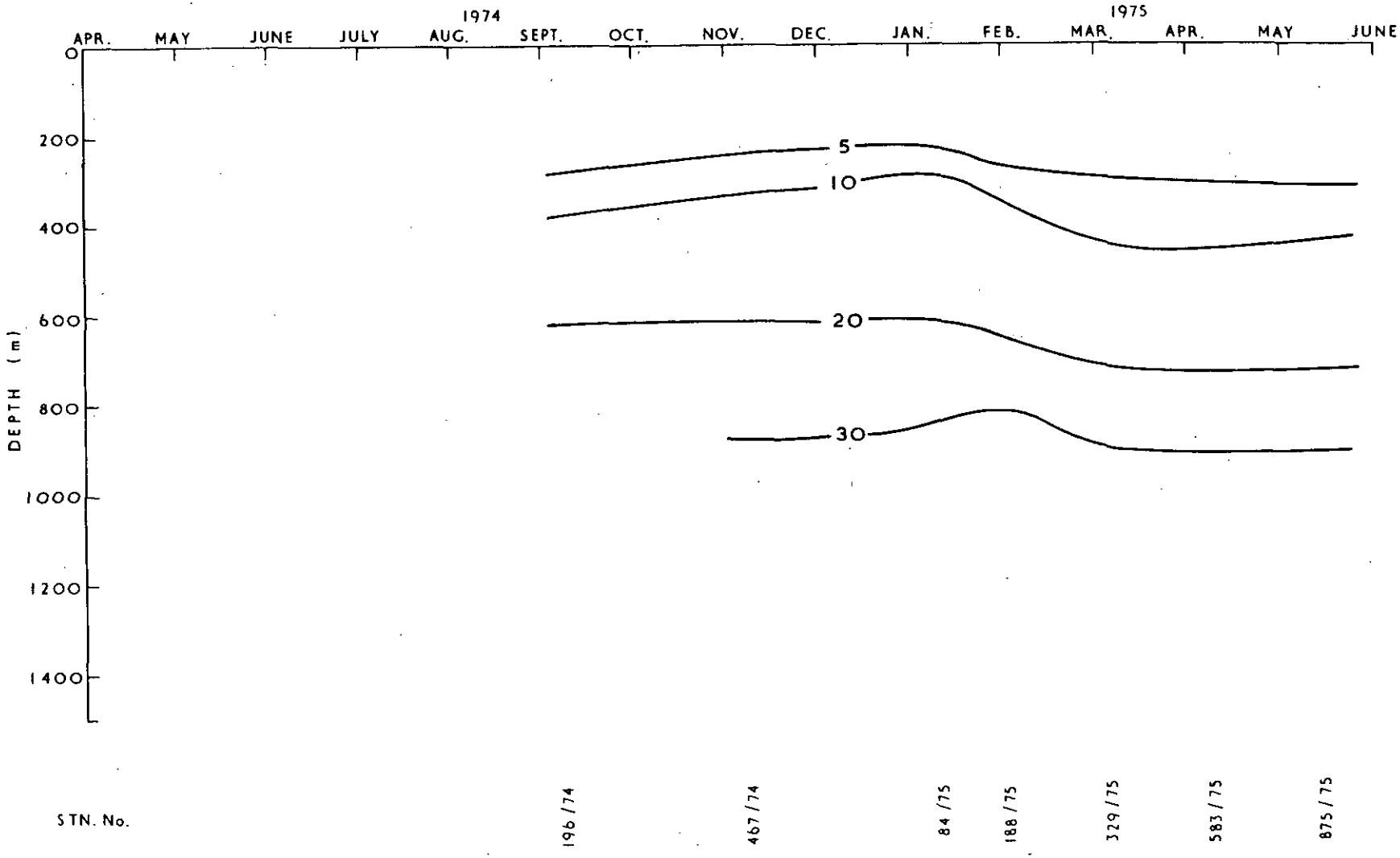

Fig. 30. - Position 32°00'S, 114°00'E. Nitrate-nitrogen distribution from 0 to 1500 m.

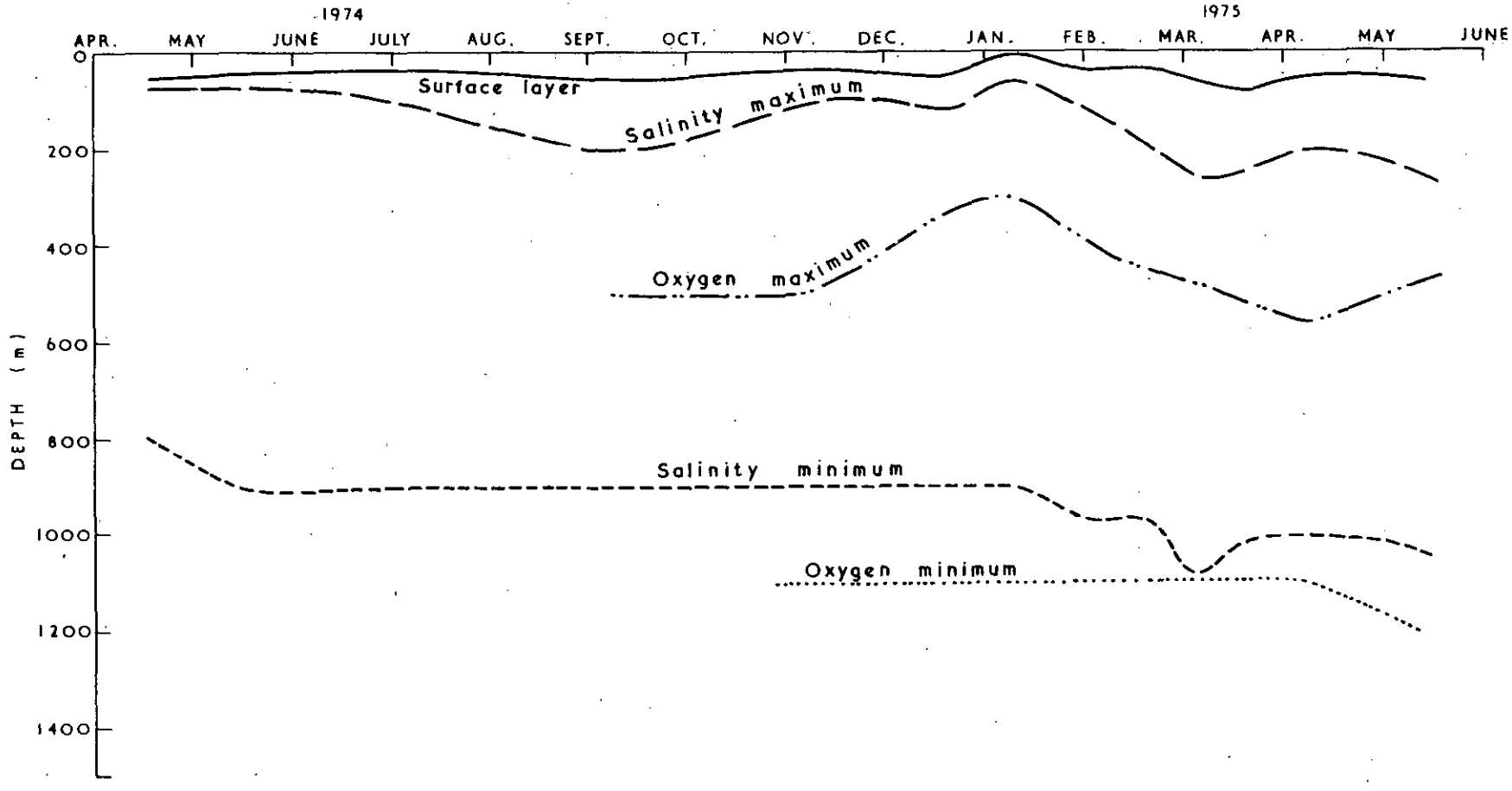

Fig. 31. - Position 32°00'S, 114°00'E. Time series of mixed layer depth, salinity maximum and minimum, and of oxygen maximum and minimum.

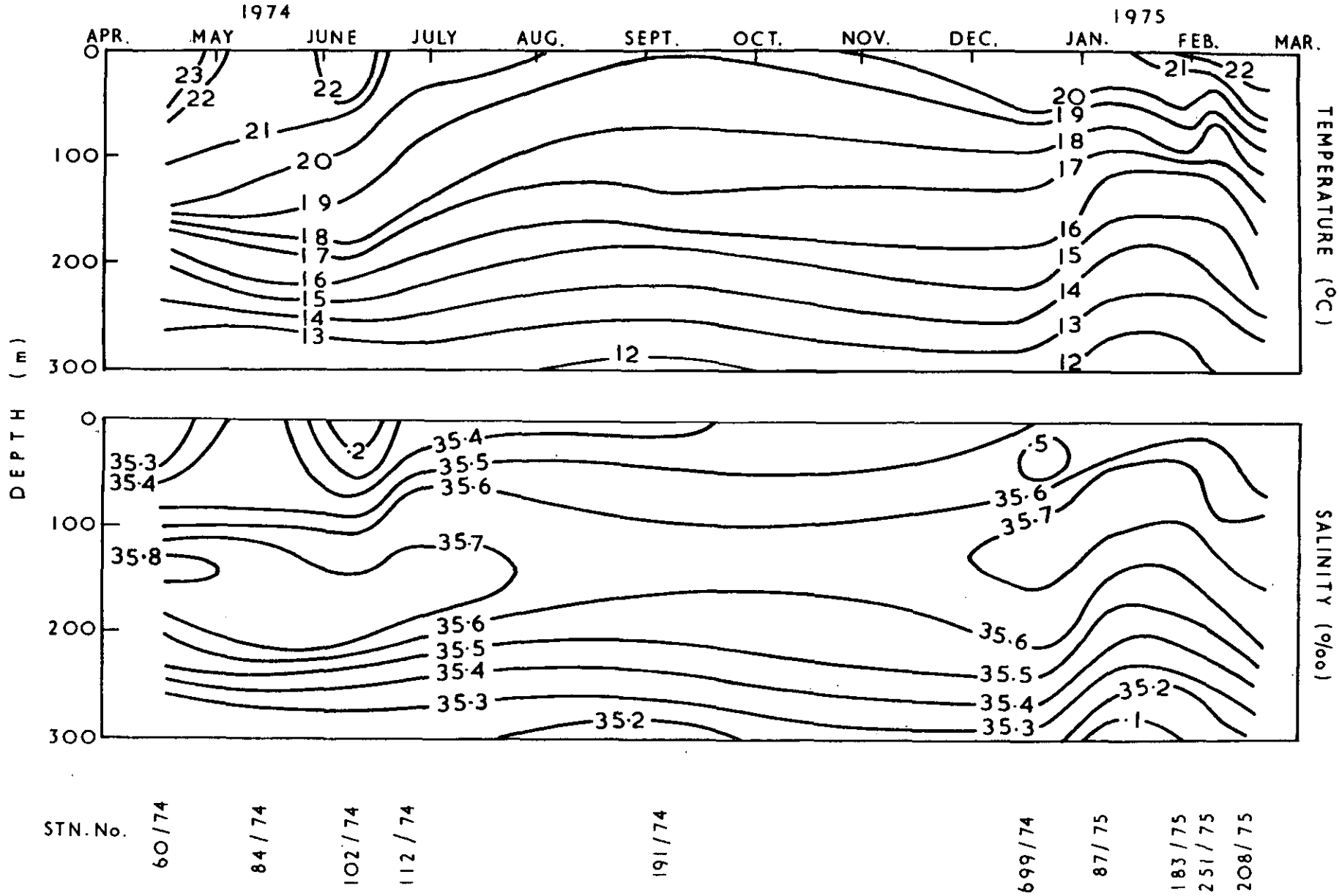

Fig. 32. - Position 32°00'S, 114°42'E. Temperature and salinity distribution from 0 to 300 m.

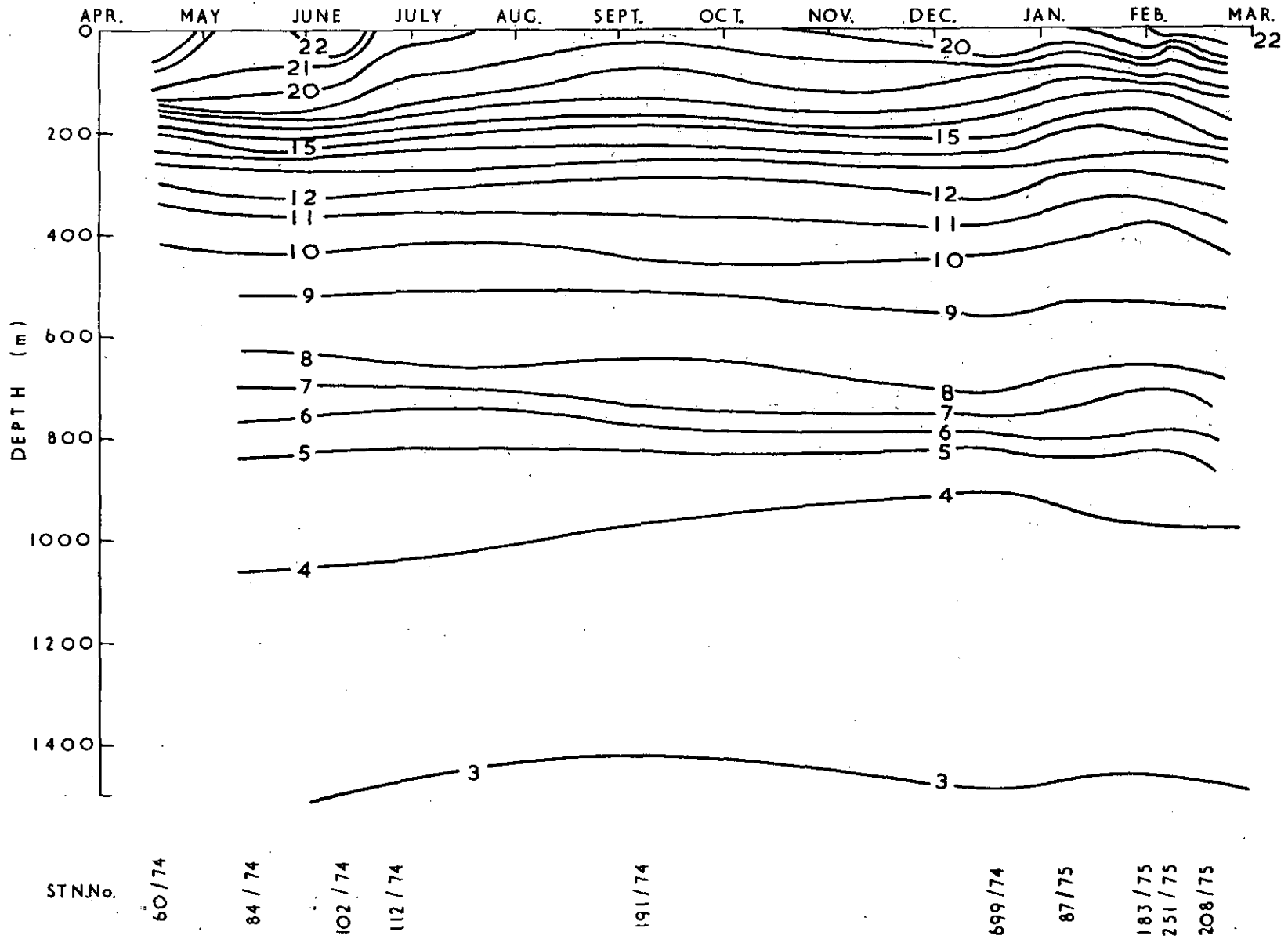

Fig. 33. - Position 32°00'S, 114°42'E. Temperature distribution from 0 to 1500 m.

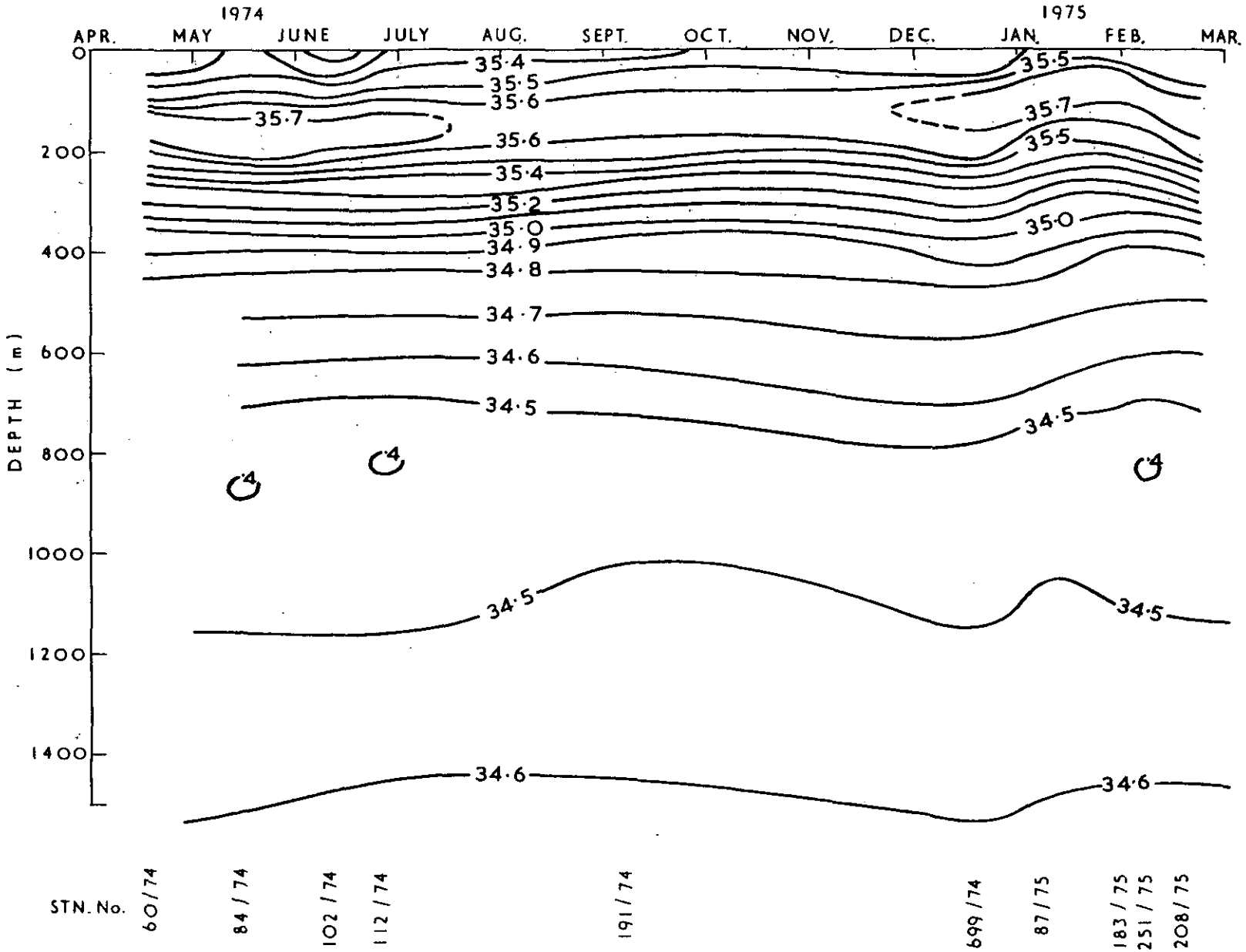

Fig. 34. - Position 32°00'S, 114°42'E. Salinity distribution from 0 to 1500 m.

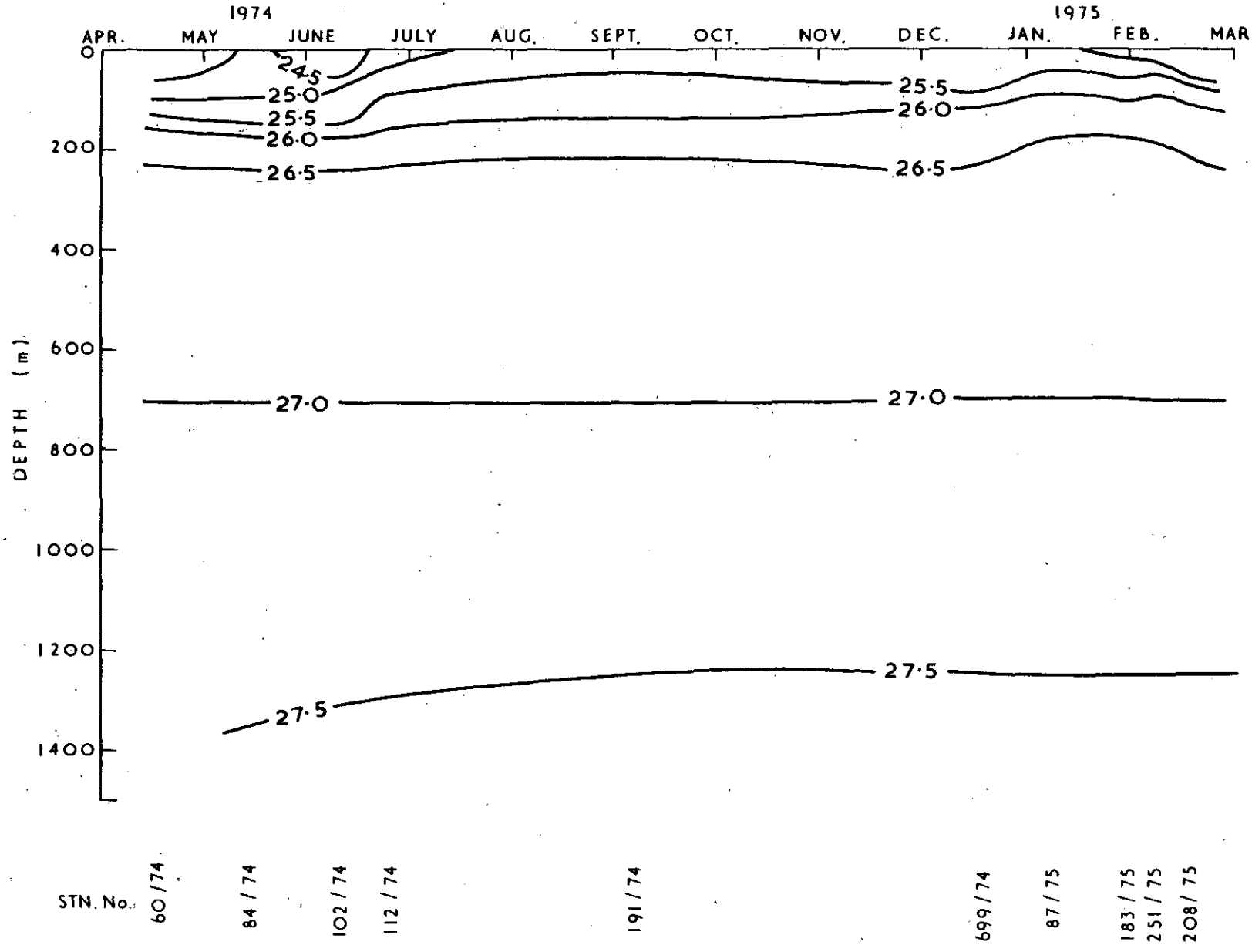

Fig. 35. - Position 32°00'S, 114°42'E. Sigma-t distribution from 0 to 1500 m.

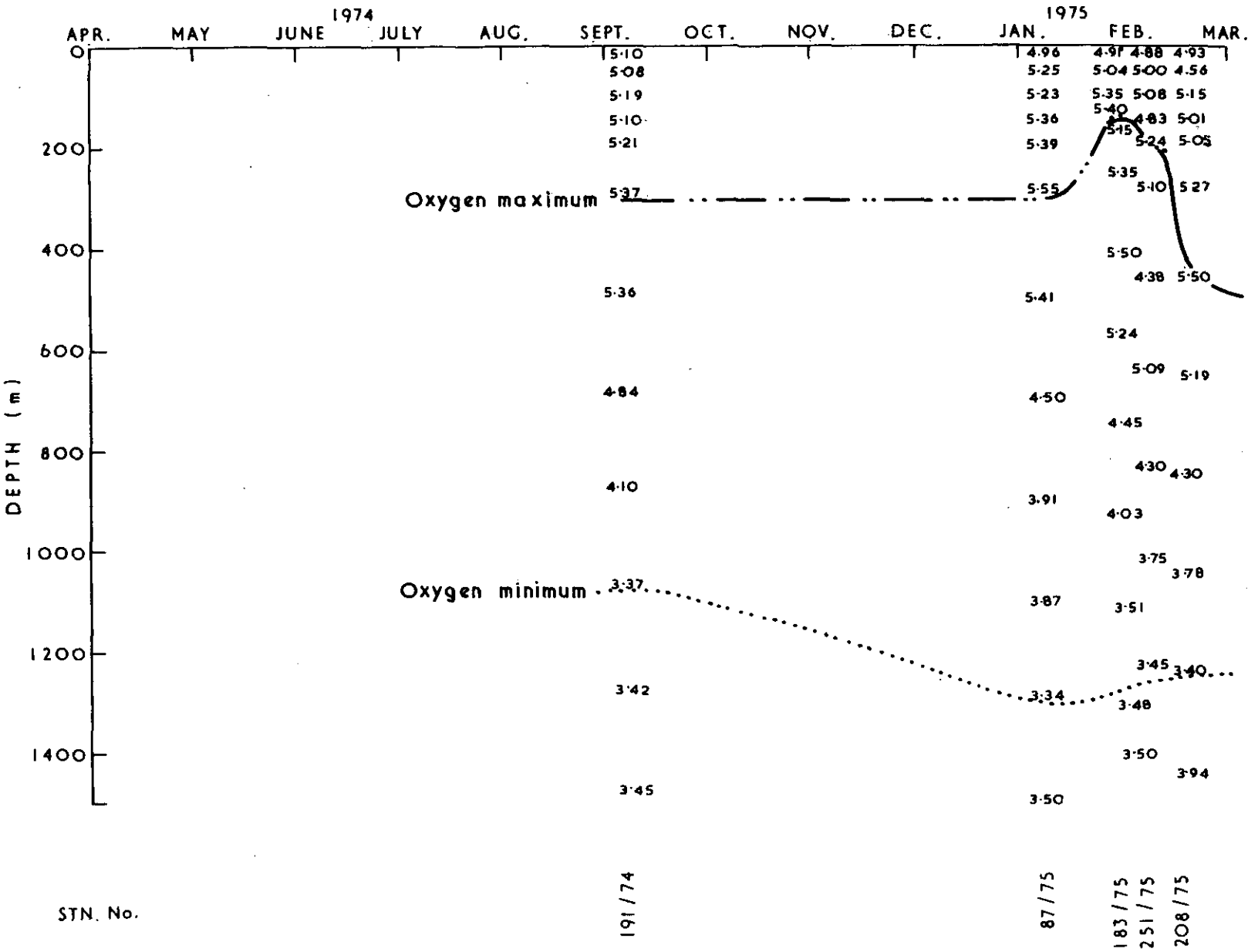

Fig. 36. – Position 32°00'S, 114°42'E. Oxygen distribution from 0 to 1500 m.

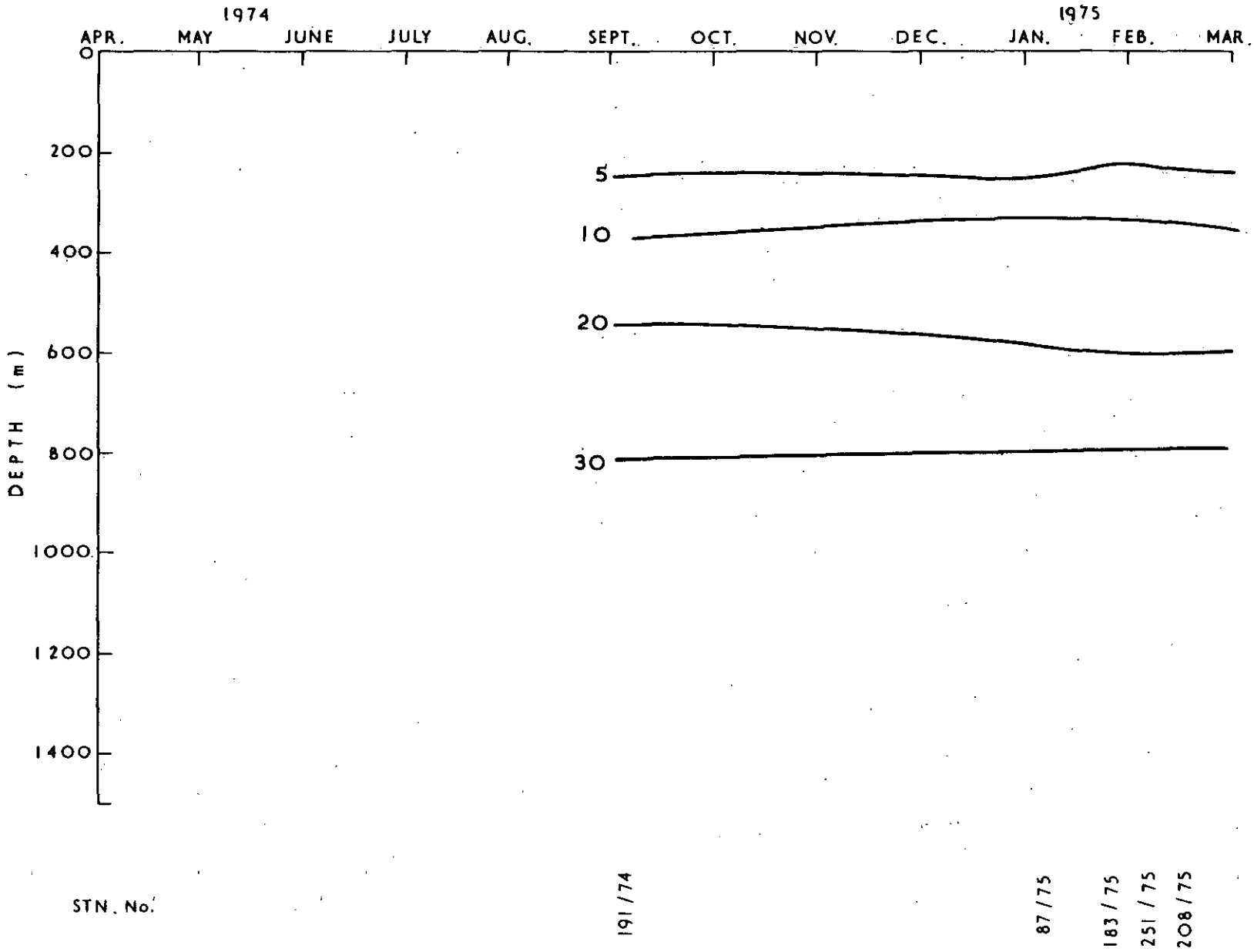

Fig. 37. – Position 32°00'S, 114°42'E. Nitrate-nitrogen distribution from 0 to 1500 m.

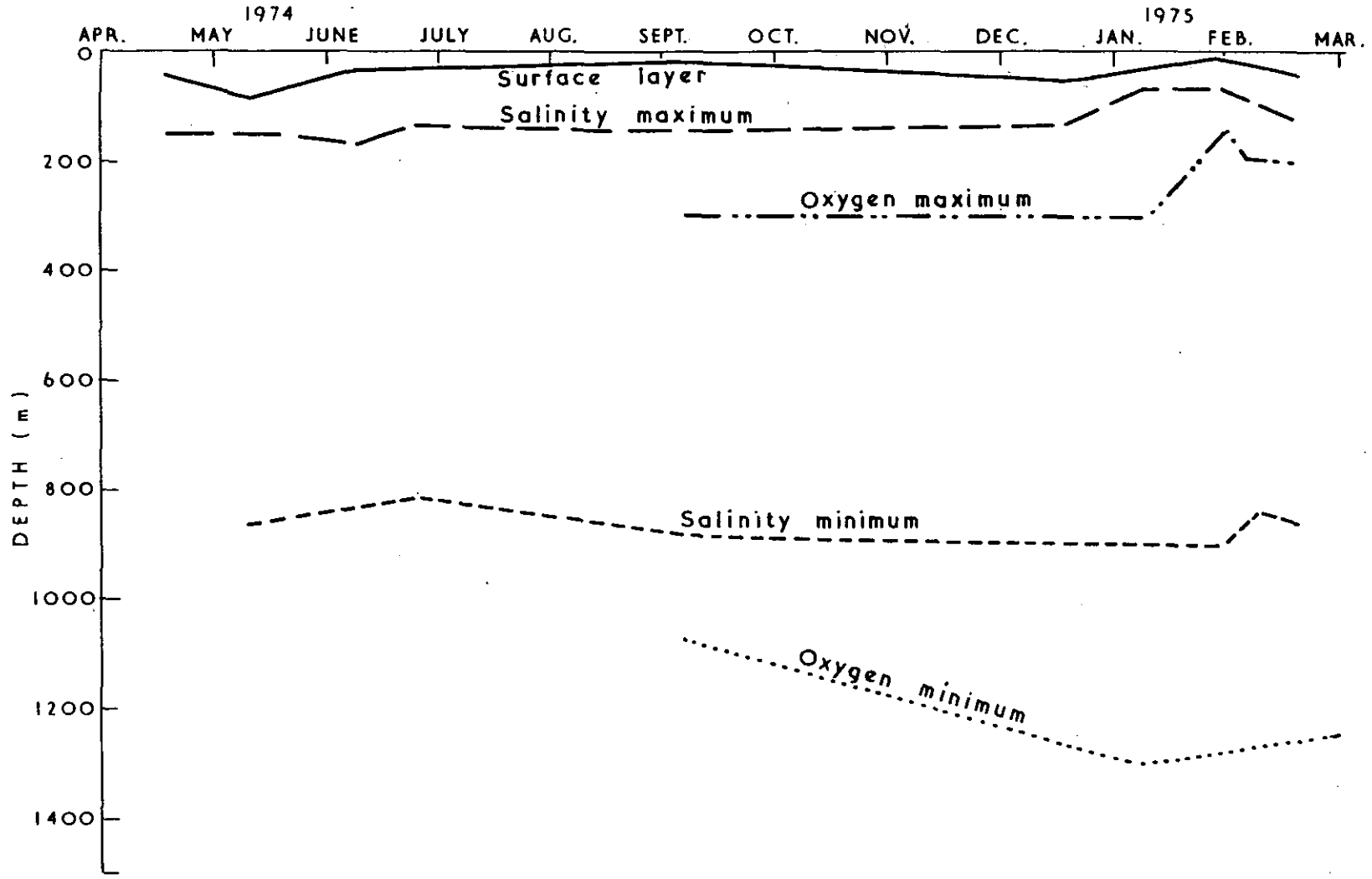

Fig. 38. - Position 32°00'S, 114°42'E. Time series of mixed layer depth, salinity maximum and minimum, and of oxygen maximum and minimum.

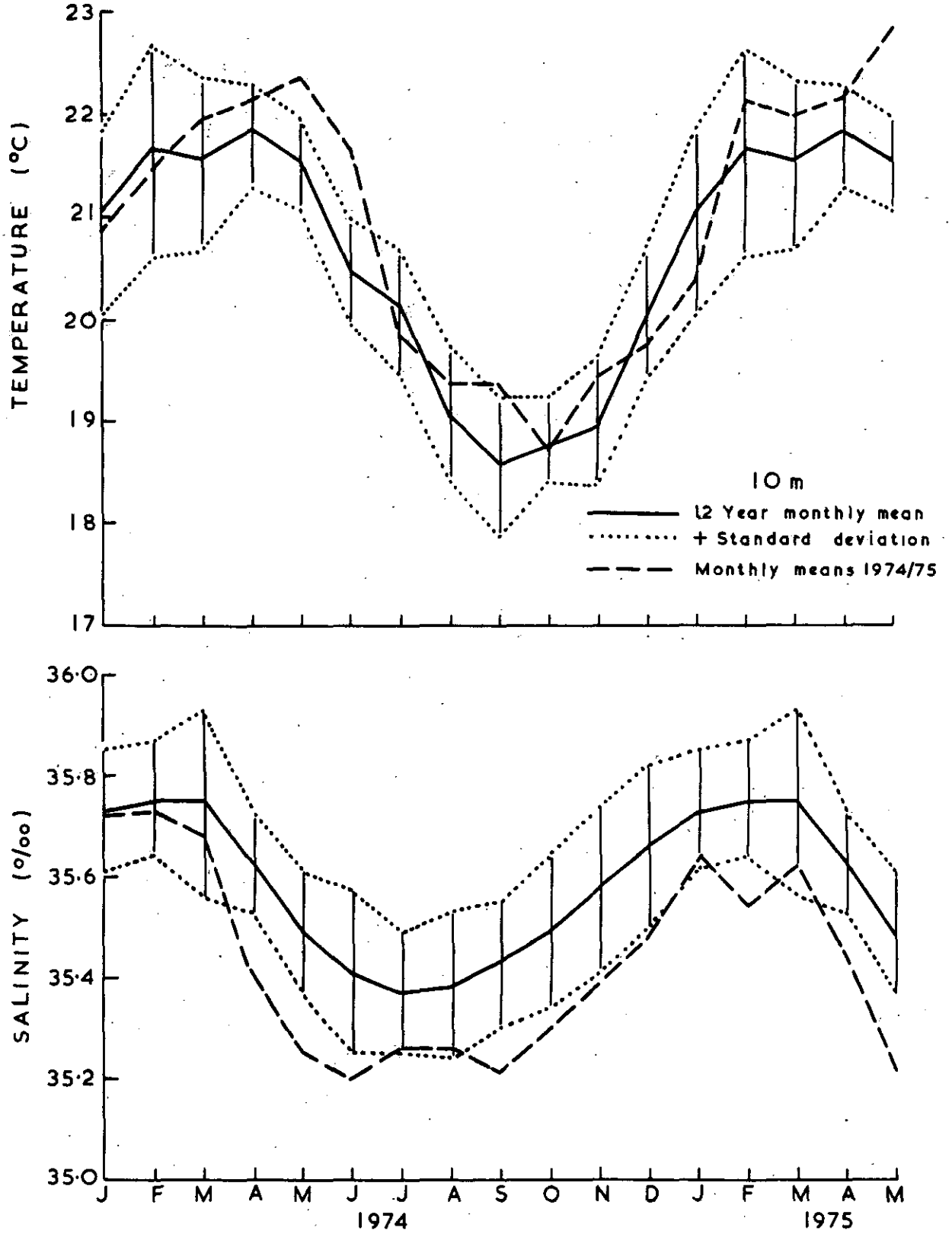

Fig. 39. - Rottnest Island 32°00'S, 115°22'E. 10 m depth. Temperature and salinity long term means and standard deviations with monthly means for 1974/75 superimposed.

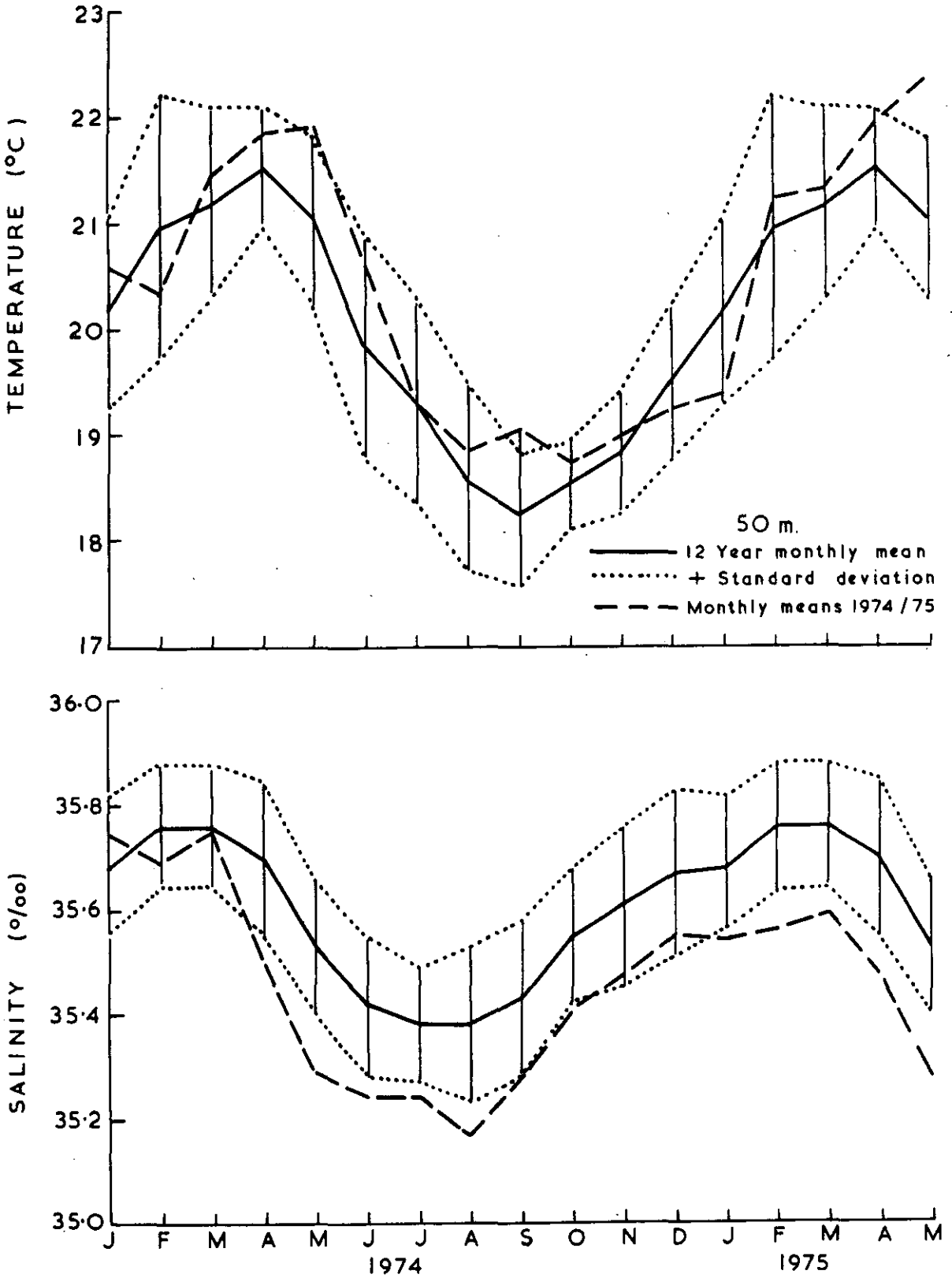

Fig. 40. - Rottnest Island 32°00'S, 115°22'E. 50 m depth. Temperature and salinity long term means and standard deviations with monthly means for 1974/75 superimposed.