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Particulate Size Distribution on Georges Bank During Spring 1981 and 1982

By

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ABSTRACT

A HIAC particle counter was used to analyze the concentrations of nannoplankton (<20μm) and microplankton (20-181μm)-sized particulates from areas on the southern flank of Georges Bank and from nearby shelf/slope stations. It was found that the vertically well-mixed water column on the bank (<60 meters) provided a higher and more evenly distributed density of particulates in both size categories than did the vertical profiles sampled off the bank. It is possible that the evenly-distributed densities of microplankton-sized particles on the bank provide a more uniformly available regime of potential prey items for newly-hatched fish larvae than did the stations sampled off the bank where sparse microplankton-sized particulate densities were found.

INTRODUCTION

Plankton patchiness and related spatial heterogeneity has been investigated by a number of researchers using a variety of methods. Haury, et al. (In Steele, 1978) refers to patchiness as "an aggregated (non-random) distribution of biomass or number of individuals per unit volume of habitat." The above work defines a variety of time-space scales capable of encompassing a variety of oceanographic phenomena from mega- (>3000 km) to micro-scale (1cm - 1m) observations.

The space scale defined by Haury et al. as "fine-scale" is of the order of meters to hundreds of meters. Riley (1976) notes observations of plankton communities made on a "micro-scale" range of "meters or tens of meters." Either of the above descriptions will closely approximate the size-scale range of observations made in this work. Both authors also state that observations made within the above size-scale ranges necessitate consideration of a temporal component. Patchiness on this scale can be affected not only by physical processes but also by population interactions related to vertical migration/diel cycles, grazing, generation times and the availability of nutrients. Richerson et al. (in Steele, 1978), in describing the spatial heterogeneity of plankton communities states that time series analysis confirms that the largest variability occurs on the largest scales. Venrick (1972) found that the detection of nonrandomness depends upon the size and distribution of the

samples within the population distribution. If the scale of sampling is systematically altered, the observed population variance may change and those sampling scales which produce maximum variances may indicate scales of heterogeneity in the population distribution. The above work by Venrick (1972) adds to the hypothesis that due to the prevalence of non-aggregated distributions, the oceanic environment is less complex than the nearshore regions and that the processes which generate local variations in phytoplankton abundance appear to proceed more slowly relative to the randomizing turbulent processes.

Platt (1972), Platt et al. (1970) and Harris and Smith (1977) discuss variations in observations of small-scale phytoplankton patchiness attributable to differing space-scale measurements made in areas of vertical mixing subject to turbulence. McAlice (1970), in a micro-scale study of phytoplankton patchiness, also states that turbulence influences the distribution of plankters over all distance scales.

The study area in this work, Georges Bank, finds the most productive (470 $gr \cdot C \cdot m^{2} \cdot yr^{-1}$) region is the well-mixed area above the 60 m bottom depth (O'Reilly et al., 1980). Areas of high phytoplankton biomass (chlorophyll) generally coincide with areas of high vertical mixing.

The particle counter used in this study also necessitates the consideration of the distribution of particulate/detrital matter in that this equipment does not distinguish the biotic from the abiotic component of the sample. Hobbie et al. (1972) mentions the difficulty involved in evaluating the abundance of

micro-organisms in the ocean due to a low concentration of organisms relative to the amount of detrital material of the same size and density. In this same study, particle size distribution analysis by Sheldon et al. (1972) found that certain areas of the oceans could be identified by characteristic particle size-distribution spectra. Using a Coulter Counter, Sheldon et al. were able to discern North and South Atlantic Ocean water from Sargasso Sea water based on the size-frequency distribution of suspended particulates. However, the shape of the particle-size spectra would be variable at the same location with seasonal changes in productivity. Also, the ratio of detrital particulate matter to living micro-organisms is variable from place to place at the surface (Menzel and Ryther, 1964) and with time (Hobson, 1967) and variable with depth (Steele and Yentsch, 1960; Sheldon et al., 1967). Menzel and Goering (1966) conclude, however, that the distribution of particulate organic carbon is "remarkably constant in space, time and depth" for samples taken below 200 meters.

Other studies using a Coulter Counter to analyze the seasonal, temporal or spatial distribution of particulates include work by Hobson (1967) which showed a seasonal variation in the northeast Pacific Ocean that may also be relative to advective processes. Sheldon et al. (1967) used a Coulter Counter to show that in situ particulate formation itself may influence the distribution of suspended matter.

Related work in the use of electronic particle counters is seen in Sheldon and Parsons, (1966), Sutcliffe et al. (1970) and Cushing et al. (1968).

Microscopic analyses of the distribution of particulates/phytoplankton has been reported in the work of Riley, et al. (1965), Kane (1967) and Gordon (1970).

The use of a HIAC particle counter in the determination of small-scale particle/plankton distributions is discussed in Pugh (1978).

Pugh (1978) stresses the importance of using a combination of fluorescence measurements and particle counting equipment to account for the presence of, for instance, colorless heterotrophs, which may reach such localized concentrations as to have an effect on trophic relationships

Tilseth and Ellertsen (1981) used a HIAC particle counter and a pulse height analyzer adapted to examine the fine-scale distribution of particles within the size range of prey items most frequently captured by first feeding cod larvae. Patchiness patterns were found to correspond with the diel vertical migration patterns of copepods and the patches containing the particle size fractions corresponding to prey items (nauplii) were identified.

The objectives of this work were part of several multidisciplinary process-oriented research cruises to study the ecology and distribution of the larvae of cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*) on Georges Bank (Lough and Laurence, 1982). Integral to this study is the determination of time-space variability of not only the larvae but also the prey (copepods) items for the ichthyoplankton. The areas of study in both the ALBATROSS IV 81-05 (18-30 May 1981) and ALBATROSS IV 82-

05 (10-21 May 1981) cruises were selected to provide a basis for comparison of the distribution of the phyto- zoo- ichtyoplankton in well-mixed Georges Bank waters with the more stratified waters off the southern flank of Georges Bank (Lough and Laurence, 1982). The HIAC particle counter has been included as experimental equipment in the work outlined above. The data acquired in the area of fine-scale particulate distribution and the heterogeneity of phyto-zooplankton populations will be useful to the study of trophic dynamics in this economically important area.

MATERIALS AND METHODS

The work described below uses samples obtained from a STD/Niskin bottle-rosette for the analysis of particle distribution at discrete depths rather than using an on-line flow-through system or in-situ sensors as in Pugh (1977) and Tilseth and Ellertsen (1981). This method resulted in data from specific point samples rather than a set of continuous values. Variations in the fine-scale distribution of particulates/phyto-plankton in relation to physical parameters is shown.

The HIAC PC-320 unit sensor operates on a light-blockage principle in which a collimated light beam, oriented at a right angle to the direction of sample flow, shines through the fluid and is projected onto a photodiode. Particles passing the sensor window cause partial blockage of the light beam. The amount of

reduction in light received by the photodiode produces a change in the amplitude of the pulse in relation to the size of the particle. The voltage corresponding to the appropriate particle size can be pre-set in 12 separate channels. Analog comparators sort out the pulses from the sensors according to size while a steady reference signal (-10v) is applied to each comparator.

Threshold settings for the CMH-600 sensor (range 5μm to 600μm) were organized on subdivisions of an octave or $\log_2$ scale as suggested by Sheldon and Parsons (1967) from Pugh (1977) such that the minimum equivalent spherical diameter at each channel setting is twice that of the previous channel. All particle counts were done with the PC-320 in delta mode, where each channel counts particles between two adjacent thresholds. Channel settings cooresponded with equivalent spherical diameters of 11.3μm, 16.0μm, 22.6μm, 32.0μm etc., up to 512μm in channel 12.

Peak noise level determinations were made at regular intervals in accordance with factory recommendations in order to compensate for differences in shipboard line voltage. Instrument calibration was performed using Divynl Benzene (DVB) spheres according to manufacturer's suggestions.

The flow rate through the automatic bottle sampler was adjusted to 250 ml/min by using vacuum pump controls. This rate was found to be appropriate for use with the CMH-600 sensor, providing the most precision during replicate samplings and minimizing the possibility of coincidence in particles passing the sensor window. Any deviation from this flow rate greater

than 20 ml/min would necessitate a thorough rinse-down and backflushing of the automatic bottle sampling system with 0.2μm filtered water.

In order to reduce the possibility of particulates being introduced by the shipboard water system, an in-line filtration apparatus was installed using a combination of Symbron-Barnstead, Elmar and Gelman filters. The water used to rinse and backflush the bottle sampling system need not be distilled or deionized but should be relatively particle-free. After the samples from each STD vertical profile were analyzed, the particle counter was cleared by running 0.2μm filtered water through the system until only a few particles registered in the lowest channel. This water was then allowed to remain in the system and only flushed immediately prior to analyzing the next sample.

In the 1982 study, a Canberra MCA Series 40 Pulse Height Analyzer (PHA) was adapted to the HIAC partice counter in order to further refine the resolution of the HIAC sensor from 12 channels to 1024. Particle/pulses from the CMH-600 sensor were signal-conditioned to accommodate the -10v bias from the sensor and then applied to the PHA AD converter. The PHA converted the analog pulse signals to the appropriate digital channel, thus, in the CRT presentation, the greater pulse heights are registered in higher channel numbers.

Particle frequency is displayed vertically versus channel number (size). The duration of the PHA collection time was determined by the count gate output from the PC-320 in order that both instruments are counting for the same time period. The data

displayed on the CRT of the PHA is accessible by the operator to determine the size-specific particle counts. Calibration was affected by the use of DVB spheres in comparison with a precision millivolt pulse generator (HIAC CA-920). On the CRT display, an X-axis channel range of 1024 results in each channel being approximately a 0.5μm increment.

The CRT display data were recorded on cassette tape for storage and reference. The PHA is directly compatible with small computers such as the Hewlett-Packard 85 (HP-85) used in this study. The HP-85 has the capability of controlling all function and control settings of the PHA with a pre-programmed cassette that insures that all sampling parameters will be consistent from operator to operator. The use of the HP-85 facilitates the production of a wide variety of camera-ready hard copy. See Figures 1 and 2.

In referring to Figures 1 and 2, the comparison between microplankton-sized particulate distribution in two STD profiles is shown. It is seen that the on-bank (35 m bottom depth) STD 11-53 profile (left column) has an increasing number of particulates in this size range with depth. In the off-bank STD 25-67 profile (right column) the number of microplankton-sized particulates remains low.

The nannoplankton-sized particulates (22.6 μm) are excluded from these figures due to the level of shipboard electronic "noise" being high enough to cause the PHA to register this noise as particles in the smallest, most eletronically sensitive channels. While valid particle counts in this low millivolt

FIG. 1

COMPARISON OF MICROPLANKTON-SIZED PARTICULATE DISTRIBUTIONS FROM CANBERRA PHA

ALB. IV 82-05 ON-BANK STD 11-53 AND OFF-BANK STD 25-67

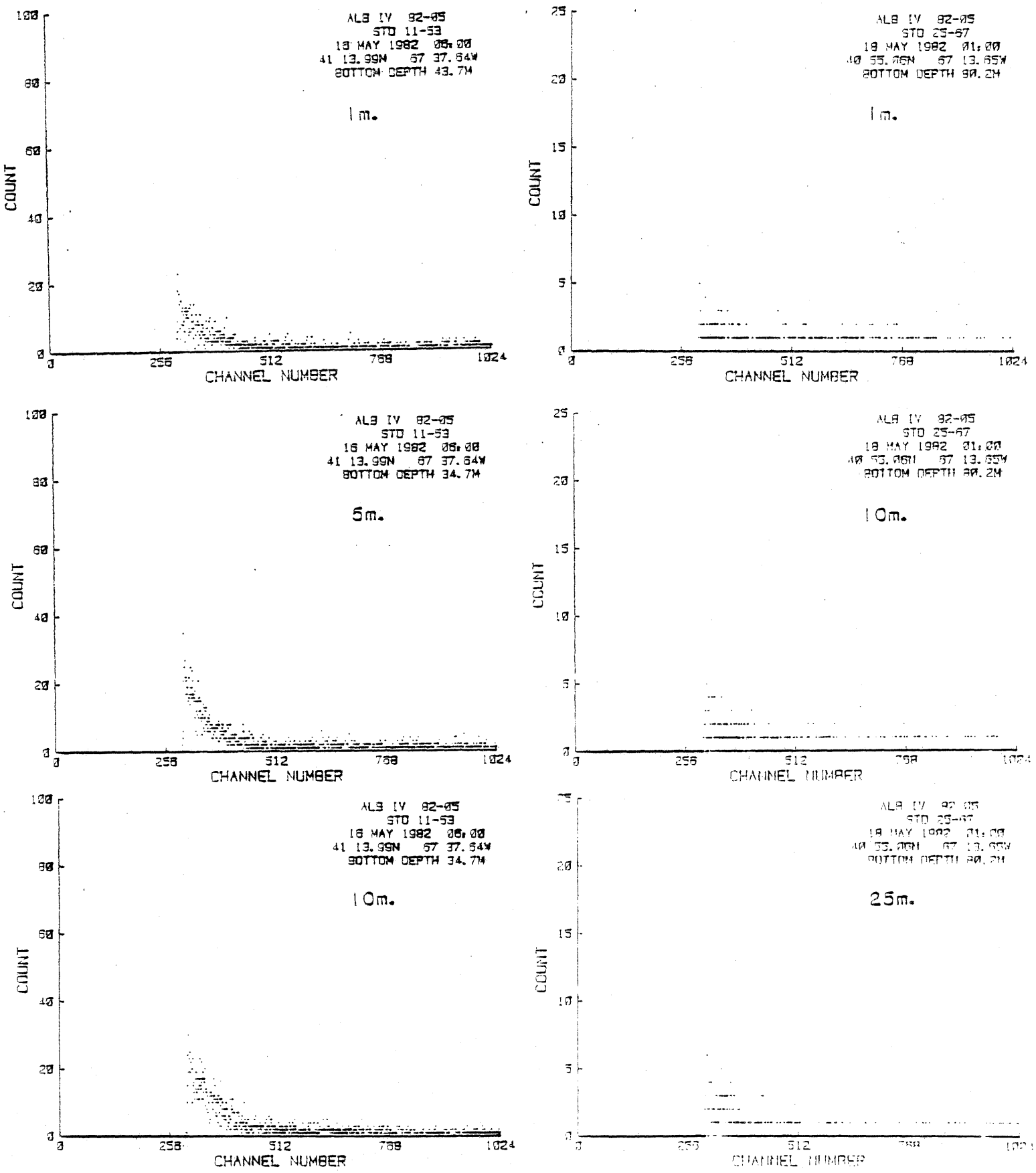
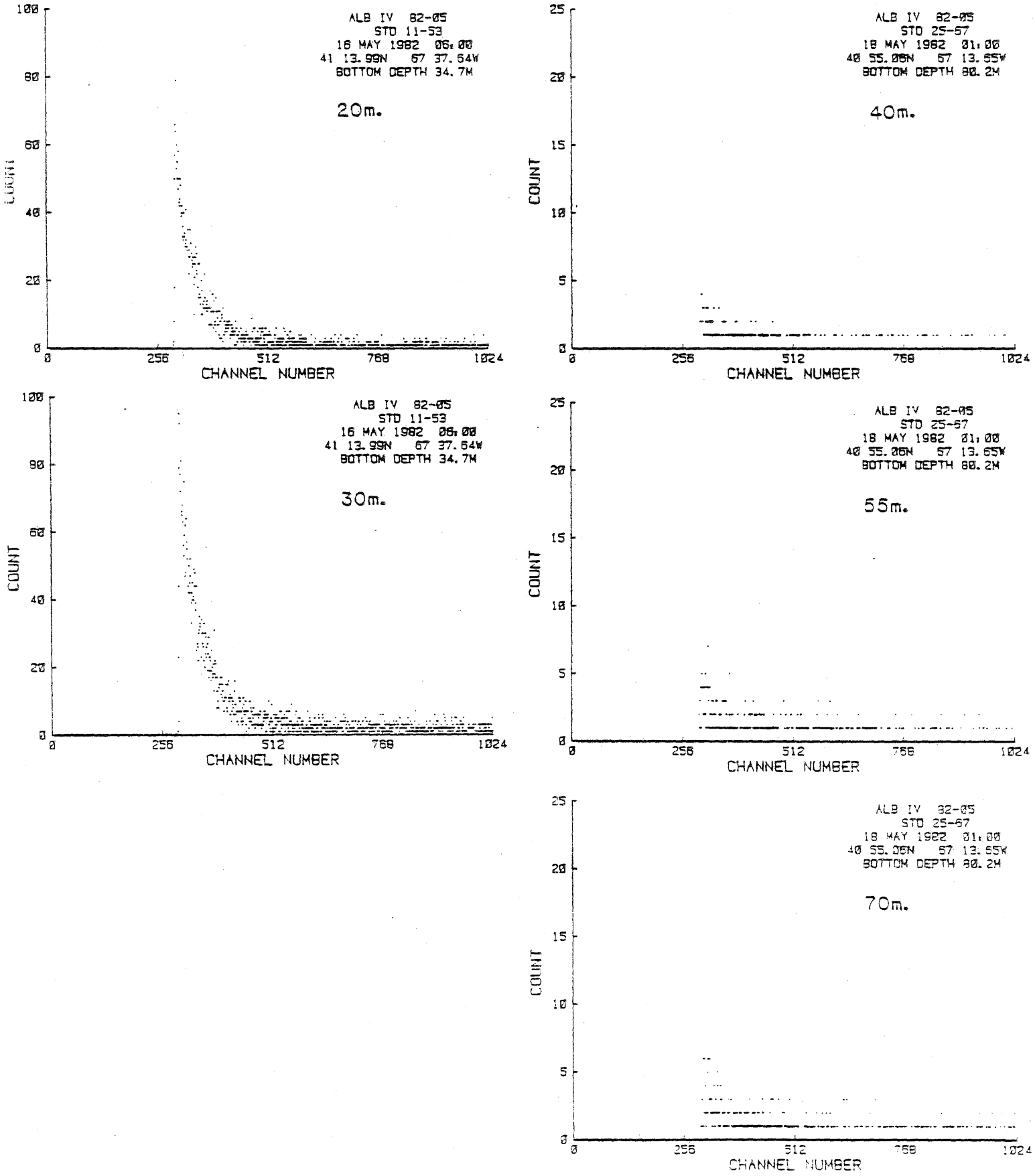


FIG. 2

COMPARISON OF MICROPLANKTON-SIZED PARTICULATE DISTRIBUTIONS FROM CANBERRA PHA ALB.IV. 82-05 ON-BANK STD 11-53 AND OFF-BANK STD 25-67



range are accurately registered by the PC-320, the lower-level discriminators in the PHA were raised to where they eliminated the electronic noise which also effectively "tuned out" the pulses generated by nannoplankton-sized particles. However, it is felt that despite the developmental status of this equipment, an accurate profile of the particulate distribution is shown and that it is possible to make the modifications necessary to compensate for ambient electronic noise.

In conjunction with Figures 1 and 2, the reader is referred to Figure 3, "Sensor Calibration", which shows the PC-320 threshold gate sensitivity settings (calibration number) and the required pulse size in millivolts necessary to register a count and the corresponding particle diameter in micrometers.

SAMPLING PROCEDURES

A rosette of 1.7ℓ Niskin bottles was used to obtain seawater samples in conjunction with STD profiles. Gordon (1970) found that Niskin samplers do not alter in-situ particle conditions "to any measureable degree." However, in the above study, it was found that particle concentrations, not size frequencies, were altered due to particle settling occurring in the Niskin bottles. It was suggested that samples be drawn as soon as possible but that storage for a few hours will not appreciably alter the particle counts. Samples in this study were drawn and processed within an hour of the return of the STD/rosette.

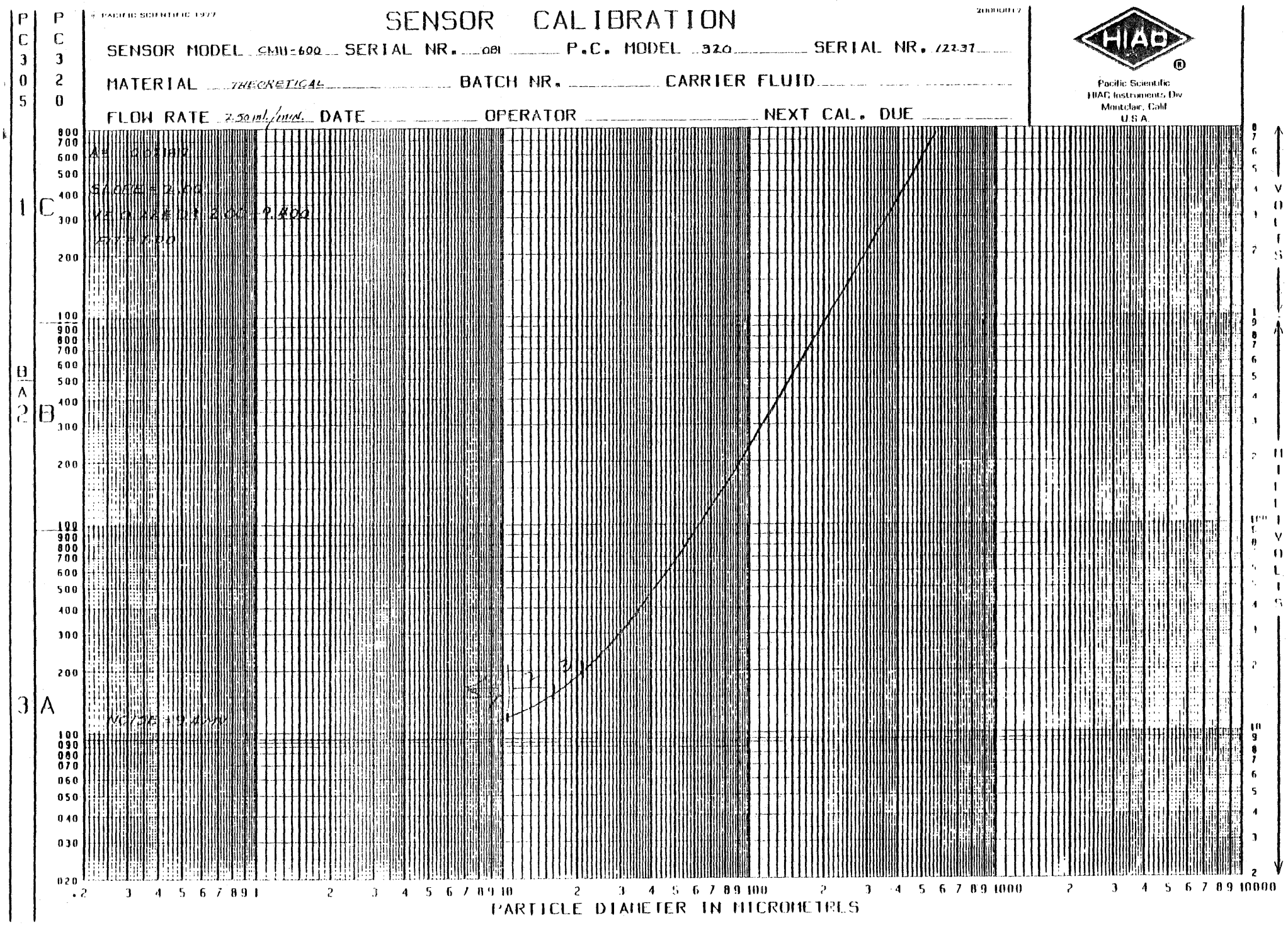

SENSOR CALIBRATION
SENSOR MODEL CMU-600 SERIAL NR. 081 P.C. MODEL 320 SERIAL NR. 12237
MATERIAL THEORETICAL BATCH NR. CARRIER FLUID
FLOW RATE 2.50 ml./min. DATE OPERATOR NEXT CAL. DUE
Pacific Scientific
HIAC Instruments Div
Montclair, Calif
U.S.A.
PC305
PC320
1 C
2 B
3 A
VOLTS
PARTICLE DIAMETER IN MICROMETRES

FIG.3

Gordon (1970) also mentions that surface sampling with Niskin bottles was done first in order to minimize the possibility of particles being introduced by contamination from the ship. This possibility was not considered previously, as surface samples were taken last-after the vessel had been "on station" for at least one-half hour.

At predetermined stations a Niskin bottle rosette/STD was used to provide the seawater samples from which a 200 mℓ subsample was drawn into factory-sterilized glass HIAC sample bottles, sealed with vinyl film and capped.

As stated above, until a sampling run was made, the automatic bottle sampler was kept filled with particle-free water. The graduate was set to sample 20.0 mℓ per run, the first 20.0 mℓ of which was discarded to prevent contamination from the previous sample. Usually three successive 20.0 mℓ replicates from each bottle were made, with the outflow from each sampling being returned to a sterile, sealed sample bottle in order that a microscopic analysis could be done at a later date.

A magnetic stirrer was added to each bottle prior to sampling and the stirrer speed was adjusted to gently homogenize the sample but not to cause a centrifugal vortex. Sampling of the bottom 50 mℓ of each bottle was avoided as the ships rolling would cause the remaining sample to slide from side to side within the sample bottle.

PRESENTATION OF DATA

The data was reduced by using the average number of particles counted for each size channel based upon either three or four 20 mℓ replicates being analyzed from each bottle. This number was entered as the number of particles in that particular size category for that sample. The number of particles in the first three channels having a size gate sensitivity of <11.3 to 22.6μm were then added together and designated "nannoplankton." The averaged numbers of particles from following seven channels- 22.6 to 181.0μm were added together and designated "microplankton." The numbers from each size class were adjusted to give the number of particles/mℓ of sample.

A computer program was developed to graphically illustrate the distribution of particles of both the above size categories versus depth for individual STD profiles. The depths corresponding to each set of size category values represent the actual depth at which the Niskin bottle was tripped. Ancillary data, such as time, date, bottom depth, STD/CTD and station numbers are included in figure headings.

TABLE 1

STUDY SERIES LEGEND

Study/Year	Series	Location	Series Type	Bottom Depth	Time(DST)/Date
81.05/1981	STD 1-52 to STD 10-57-2	Off Bank	Fixed-Station	≅80 m	*1930/21 May-1617/25 May
81.05/1981	STD 11-58-1 to STD 18-61-2	Off Bank	Drogue-Follower	≅80 m	1847/25 May-1540/26 May
81.05/1981	STD 19-62-1 to STD 26-65-2	On Bank	Drogue-Follower	<60 m	0006/27 May-2138/27 May
81.05/1981	STD 27-66 to STD 30-69	Off Bank/ON	Transect	>100 to <50 m	0530/28 May-0633/29 May
82.05/1982	STD 1-43 to STD 15-57	On Bank	Fixed Station	<35 m	0208/15 May-1807/16 May
82.05/1982	STD 16-58 to STD 24-66	On Bank	Drogue-Follower	<47 m	2059/16 May-2059/17 May
82.05/1982	STD 25-67 to STD 34-76	Off Bank	Drogue-Follower	≅80 m	0100/18 May-0305/19 May
82.05/1982	STD 35-78 to STD 36-79	Off Bank	Transect	>100 m	1739/19 May-0257/20 May

*Series interrupted temporarily due to severe weather.

RESULTS

ALBATROSS IV 81.05

The concentration of particulates observed in this study is variable over distance, time and depth for all size categories analyzed. The surface data in this study are similar to those of Sheldon et al. (1972) for North Atlantic surface waters in that the vast majority of particles were to be found in the smallest size channel and seen to diminish progressively with increasing spherical diameter while using logarithmically decreasing size categories. These data also correspond with Hobson's 1967 finding that 90% of the mass of particulate matter had diameters ranging from 8μm to 44μm.

81.05 - off-bank fixed-station series STD 1-52 to STD 10-57-2

Comparing data from 81.05 STD 1-52 and STD 2-53 taken during off-bank, fixed-station sampling, it is seen that the majority of particles from both the nano- and microplankton size categories are concentrated at the surface, above what the corresponding temperature/salinity trace shows to be a feature in which the temperature decreases from 9.73°C to 6.47°C (STD 1-52) in the upper 10 meters. There is no corresponding change in salinity. However, a sigma T plot of profile 1-52 shows a density diference of 0.7 (1025.1-1025.8) that could hold the smallest of the nannoplankton-sized particles at the surface.

Unfortunately, due to Niskin bottle malfunctions, no sample was provided in STD 2-53 for 13 and 23 meter depths. However, there are similarities between the 30 m and 50 m depth particle concentrations for STD 1-52 and the 32 m and 50 m depths of STD 2-53.

Due to severe weather, operations were suspended on May 22, and when resumed on May 24 (STD 3-54-1 and STD 4-54-2), it can be seen that the temperature feature that was present on May 21 has disappeared.

The five hours that had elapsed on station between STD 3-54-1 and STD 4-54-2 does not appear to have affected the vertical distribution of particulates in either the nano- or microplankton size classes and by the time of STD 4-54-2 at 2240h, the water column appears to be homogeneous with respect to temperature and salinity.

STD 9-57-1 and STD 10-57-2 are taken from the same fixed-station time series as STD's 1-4. STD 9-57-1 is representative of the other casts in this series with relation to the negligible changes in temperature and salinity throughout the water column and in that the concentration and distribution of particles in both size categories is very similar. STD 10-57-2 is interesting, however, in that while the temperature and salinity remain relatively stable with depth, the concentration of particles of both size categories increases with depth. This may be indicative of patchiness in that the highest concentration of particles is located at 61 m in a 79.9 m water column. This cannot be concluded without samples between these two depths.

Had the highest concentration of particles occurred directly at the bottom, it may be inferred that these values were attributable to a turbulent resuspension of fine-grained sediments.

81.05 - off-bank drogue-follower series STD 11-58-1 to STD 18-61-2

The following 81.05 24 hour off-bank, drogue-follower series included STD numbers 11-58-1 to 18-61-2. The temperature and salinity traces taken during this series indicated that the drogue and the vessel were indeed following the same water mass durng the 24 hour period.

Subtle trends in the distribution of particulates in both size categories were noticed for this series. While the vertical distribution of particles of both sizes remained nearly constant (a variation of less than 2 particles per ml) from 14 m to 59 m in STD 11-58-1, samples from STD 12-58-2 to STD 15-60-1 show a progressive increase in the number of particles with depth. In the above profiles, the 50 m to 60 m depth appeared to have the greatest number of total particles. STD 13-59-1 showed an average of 6.6 particles per ml in the nannoplankton size class at the surface and an average of 18.5 particles per ml at 52 m. Also, in this series, the ratio of nannoplankton to microplankton-sized particles averaged over all depths remained higher than 4:1. In the latter three profiles of this series (STD 16-60-1, STD 17-61-1, STD 18-61-2), the same general trends were observed in particulate distribution with a higher overall

nannoplankton to microplankton ratio (6:1) in STD 17-61-1. During the above series, in the absence of any significant thermal/density discontinuities, there was no observable temporal change in the vertical distribution of particles in either the 22.6μm-181.0μm size. It seems that had there been any vertical migration of the smaller zooplankton occurring at nightfall, it would be observable on the scales used in this study. The change in the distribution of microplankton-sized particles between the surface and 15 m shown in STD 17-61-1 and STD 18-61-2 is most likely due to the spatial rather than the temporal component due to the hour of the day that the sampling was done.

81.05 - on-bank drogue-follower series STD 19-62-1 to STD 26-65-2

STD 19-62-1 to STD 26-65-2 was a 24 hour on-bank drogue-follower series. Again, the temperature/salinity traces for these profiles showed a well-mixed water column with no major discontinuities. This is reflected in the resulting distribution of particulates. As in the last series, there is a general trend toward increasing particulate concentration with depth and an overall density ratio of nannoplankton to microplankton-sized particles that ranges from 4:1 in STD 19-62-1 to 5:1 in STD 26-65-2.

In a comparison between STD series 11-18 off-bank (drogue-follower) and STD 19-26 on-bank (drogue-follower) it is seen that from the surface to a depth of 60 m, and from station to station, the salinity is nearly uniform, ranging less than 0.20°/oo in each series. The temperature, however, shifts whereby the mean

surface temperature in series STD 11-18 is 7.60°C, and in series STD 19-26, the mean surface temperature is 8.34°C.

It is also seen that the average number of nannoplankton-size particles at the surface (<7 m) in series STD 11-18 was 10.06/mℓ with a corresponding increase in microplankton-sized particles from 2.5/mℓ (STD 11-18) to 5.5/mℓ in (STD 19-26). Considering the average number of particles at all stations and at all depths for both STD series, series 11-18 shows 12.32 and 2.58 particles/mℓ in the nanno- and microplankton size categories, respectively. The STD series 19-26 shows an increase to an average of 26.89 and 6.22 particles/mℓ in corresponding size classes.

It cannot be implied that a shift of less than 1.0°C from one series to the other would cause the change in particle concentration. The time period as related to the duration of the sampling roughly covers the 24 hour cycle in both series. The difference in the depth of the water column between the two series does not appear to be influencial at this time.

81.05 - off- to on-bank transect series STD 27-66 to STD 30-69

In the following off- to on-bank transect series (STD 27-66 to STD 30-69), a feature was encountered which sharply changed the T/S traces from those seen in the STD 19-26 series.

A layer of warm (20.30°C) surface (<16 m) water at STD 27-66 accompanied by surface salinities as high as 35.74°/oo appeared to diminish as the sampling transect proceeded in a northwesterly direction toward STD 28-67. See Chart of Sampling Area (page

38). It appears that the warm water in STD 27-66 is part of Eddy 81-C (Lough, 1982) and its excursion onto the bank appears to be limited only to this station as the water at STD 28-67 (approximately 7 nm to the northwest) is Shelf Water (Lough, pers. comm.). Continuing on the northwesterly transect, upon reaching STD 30-69, the water mass and subsequent particulate distribution once again most closely resembles STD 23-64-1 from the previous on-bank drogue-follower series as STD 30-69 and STD 23-64-1 are geographically close together (2 nm).

It is interesting to note the change in particulate distribution through this transect series. While the concentration of nannoplankton-sized particles at the surface (6 m) of STD 27-66 is one of the highest encountered in the entire 81.05 study, the remaining values over depth to 71 meters show some of the lowest nannoplankton-size range values from the series. In addition, the microplankton-sized particles for this cast are also very low (<2.0 particles/mℓ).

STD 28-67 shows 10°C SHelf Water at the surface. While this station is not influenced by the water from Eddy 81-C, it is still quite different in thermal structure from the other profiles in this series but is more similar to the structure of STD 1-52. However, profile STD 28-67 shows a very low concentration of particles in both size categories at the surface, whereas STD 1-52 shows very high concentrations. It is likely that following an event such as a storm, the water column, especially at the surface, may undergo a thermal restructuring prior to any biological reorganization, given the density of particulates in an under 20μm size class.

STD 29-68 shows an anomalous distribution of microplankton-sized particles over depth that cannot be easily explained. It appears contrary to what would normally be expected for Shelf/Slope Water at this particular time of the year (Lough, pers. comm). STD 30-69 ends this transect with a profile that is again up on the bank and showing a more familiar temperature/salinity profile and particulate distribution. This station closely resembles STD 23-64-1 as stated above.

ALBATROSS IV 82.05

82-05 - on-bank fixed-station series STD 1-43 to STD 15-57

Considering the 82.05 on-bank fixed station series, STD 1-43 to STD 5-47, it can be seen that the shallow (<35 m) bank water is well-mixed with extremely stable T/S profiles. The concentrations of nanno- and microplankton-sized particulates are generally higher than those seen in off-bank 80 m stations in the 81.05 study over all depths sampled.

Patchiness appeared to be demonstrated by the nannoplankton-sized particulate density values in the 30-35 m range in STD 1-43 to STD 5-47, where STD 2-44 shows an average density of 359.39 particles/mℓ. The nannoplankton-sized particle density decreases over the following three profiles while the microplankton-sized particle density is within the range of other on-bank stations.

If the high density located at of 35.1 m in STD 2-44 was caused by the re-suspension of bottom sediments, it would be

expected that a corresponding increase in microplankton-sized particles would also have been seen. It seems plausible that during the time elapsed (0200h to the following noon) between stations STD 1-43 and 5-47, currents could have transported the "patch" away from the fixed station. A gradient in particulate concentration would result if the borders of such a patch were present when the fixed-station sampling began.

While the temperature and salinity traces remained nearly constant from the surface to 30 m indicating that the same water mass was moving past the fixed station, a certain amount of fluctuation in the surface particulate distribution was found that did not appear to be a function of any day/night vertical migration pattern. See corresponding time-series figures showing time-scale fluctuations in particulates located after each STD profile series.

The remaining profiles in the fixed-station series (STD 6-48 to STD 15-57) show an even distribution of particulates from profiles to profile with a relatively constant distribution with depth through the 35 m water column.

82.05 - on-bank drogue-follower series STD 16-58 to STD 25-67

Considering on-bank drogue-follower stations 82.05 STD 16-58 to STD 25-67, it appears that the water mass associated with this series again showed that it was well-mixed from the surface to the less than 40-m bottom. The density and concentration of particulates of both size categories is less than that encountered in the previous series but the distribution pattern

with depth is very similar. Remarkable is that the concentration of particulates of both size categories is so uniformly consistent with depth.

The ecological consideration here is that in the predator/prey interaction among phyto-, zoo-, and ichthyoplankton, there appears to be no part of this shallow, well-mixed water column that is lacking in potential prey items. Without confirmation by microscopic analysis of the actual samples it is difficult to speculate that the microplankton-sized particulates are indeed food items for ichthyoplankton. However, the densities of potential prey items in on-bank stations are greater and more evently distributed with depth than in off-bank stations.

82.05 - off-bank drogue-follower series STD 25-67 to STD 34-76

When considering profiles taken from the following drogue-follower series STD 25-67 to STD 34-76 taken from off the bank in 80 m of water, a very low density of 20-181 μm particulates is found. As can be seen from the corresponding figures, the salinity remains relatively constant with depth and the temperature increases slightly (<1.0 °C) in the upper 25 m. Again, as in the other off-bank profiles, this series shows a very low density of microplankton-sized particles.

82.05 - off-bank transect series STD 35-78 and STD 36-79

The remaining profiles of the 82.05 study (STD 35-78 and STD 36-79) were done well off the bank to the southeast of the

previously described bank and off-bank stations. As in the 81.05 study, warm water was encountered that altered not only the T/S profiles, but also the concentrations and distributions of particulates of both size categories with depth. In STD 35-78 and STD 36-79 the concentration and density of microplankton-sized particulates was very low as compared with nannoplankton-sized particle densities from the same profiles.

SUMMARY AND CONCLUSIONS

In a generalized summary, combining the data from both the 81.05 and 82.05 studies, it can be seen that during each year, the density and distribution of particulates in both size categories showed similar trends. Samples of these STD profiles taken in the shallow (<60 m) bank water found a well-mixed water column with evenly distributed particulate densities throughout. Those STD series taken off the shallow bank in about 80 m of water displayed a variable distribution of particulates and an especially low density of particulates in the microplankton-sized category. In both the 81.05 and 82.05 studies, a warm eddy was found that further disrupted the hydrographic features as well as the corresponding particulate distribution (use STD 81.05: 27-66 and 82.05: 35-78 for comparison).

To capsulize similarities in the series from both years, refer to 82.05 fixed stations STD 1-15, 82.05 drogue-follower stations STD 16-25, and 81.05 drogue-follower stations STD 19-26

which were done on the bank where the T/S profiles were constant with depth and the particulate distribution was relatively even in both size categories. When these are compared with 81.05 fixed stations 1-10, 81.05 drogue-follower stations 11-18 and 82.05 drogue-follower stations 26-34, it is seen that while the hydrographic features are not strikingly dissimilar from the shallow bank stations, the discrepancy between the density of nanno- and microplankton-sized particles is readily seen.

The implication here is that at any given depth in the April-May season the shallow, well-mixed bank, there is an even distribution and density of particulates in the nanno-microplankton sized categories. Immediately off the bank to the southeast, there is a change in the particulate distribution such that the microplankton concentration is generally much less, thus providing a decreased density of potential prey items in this size range that is available to the ichthyoplankton.

Objectives for further study would be to compare the particulate distributions on the bank with those on the flank at different areas along the shelf/slope break from those in this work.

The particulate distribution could be analyzed on a finer vertical scale by using STD/CTD "downcast" data to present a T/S profile of the water column prior to deciding at which depths to trip the bottles. Thus, if an interesting feature is presented, the samples could be obtained on a more refined scale.

The use of the Canberra PHA is instrumental in providing a very specified size category reference frame to be used in

conjunction with the microscopic analysis of subsamples retained from shipboard particle analysis.

It is felt that a supplemental microscopic examination would also be useful in determining more conclusively which particles are actually phyto- and zooplankton of the nanno- and microplankton-sized categories used in this study.

ACKNOWLEDGEMENTS

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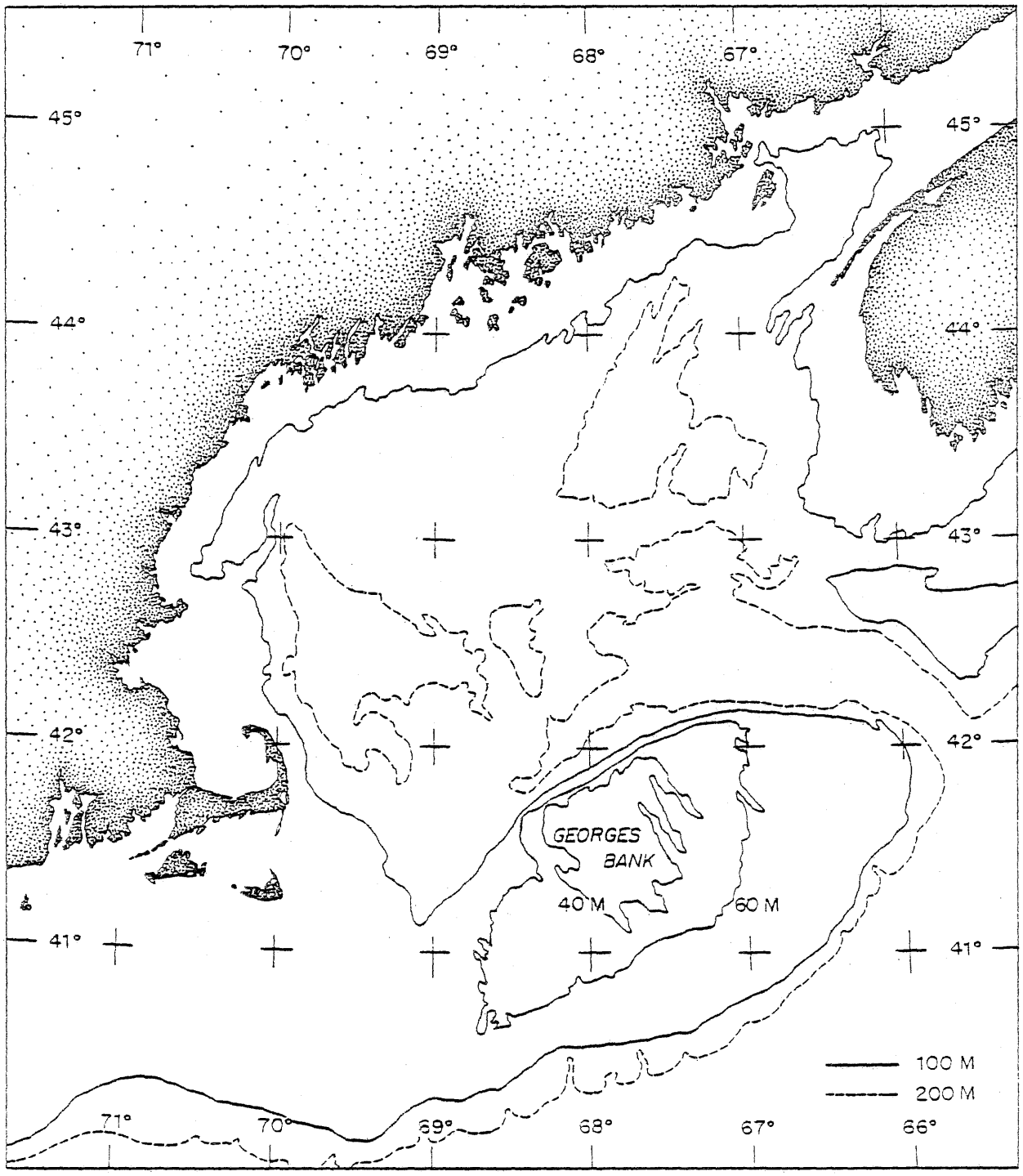
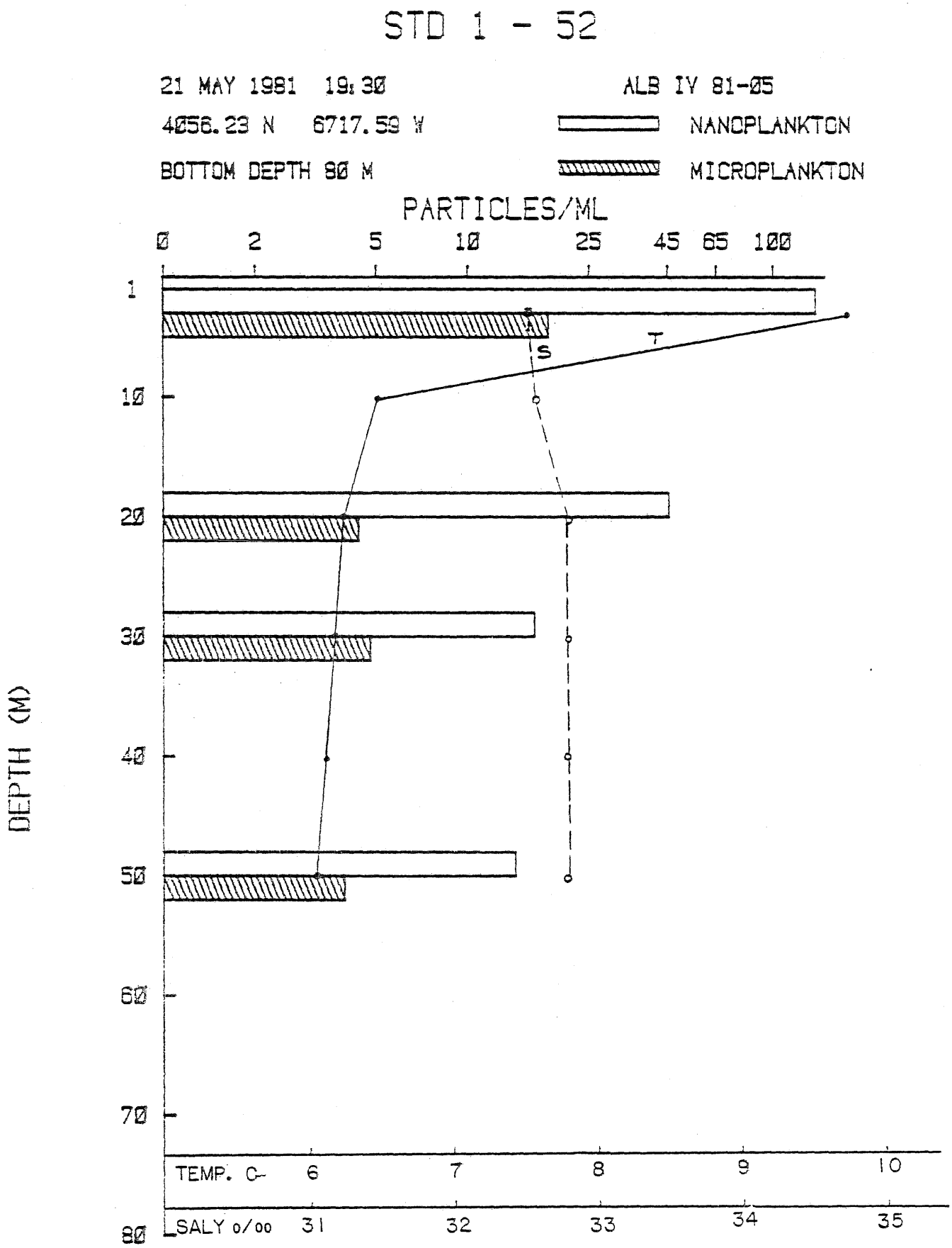
CHART 1
ALB. 81-05 AND 82-05 STUDY AREA

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MICROPLANKTON
PARTICLES/ML
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DEPTH (M)
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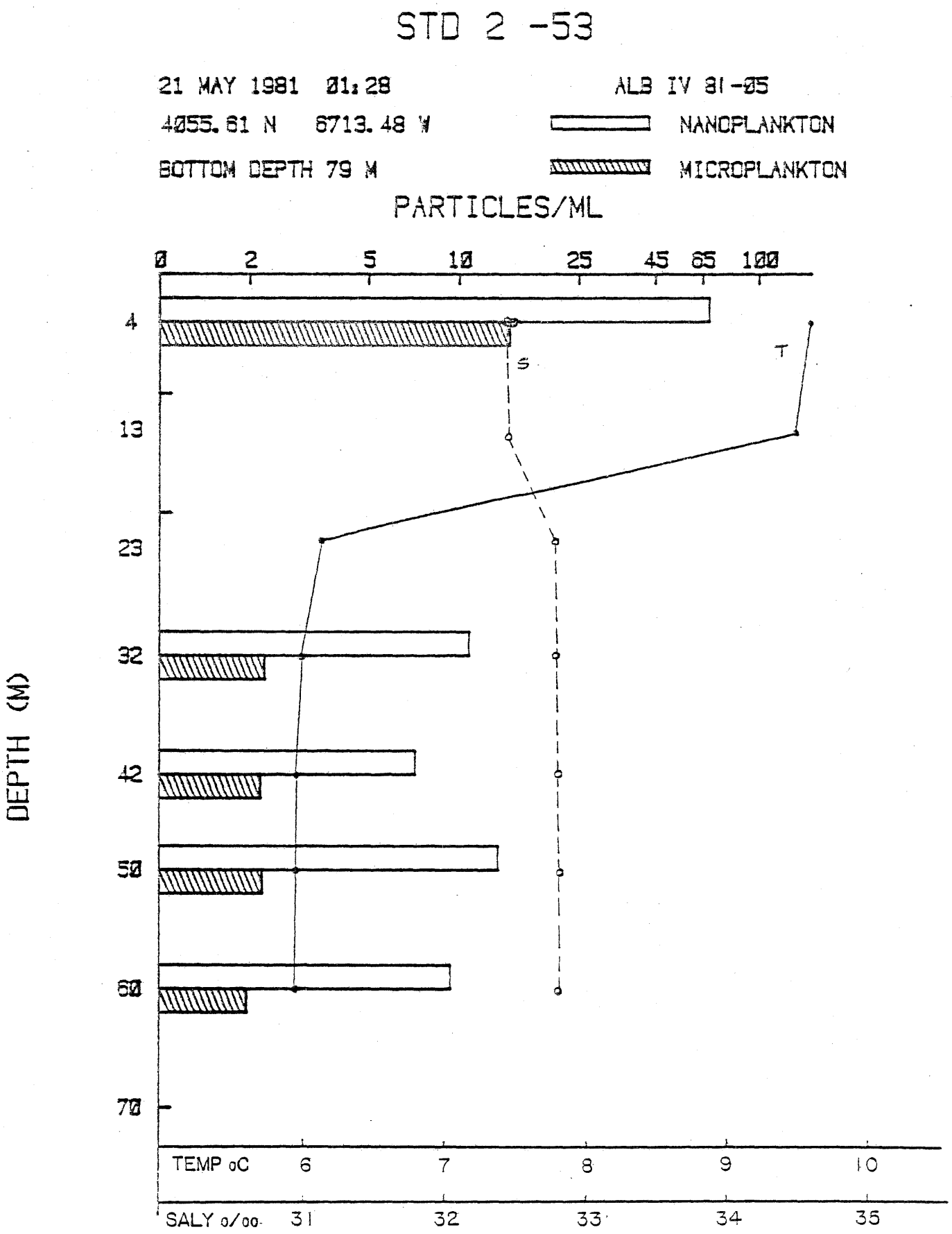
S
T
TEMP. C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 4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PARTICLES/ML
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DEPTH (M)
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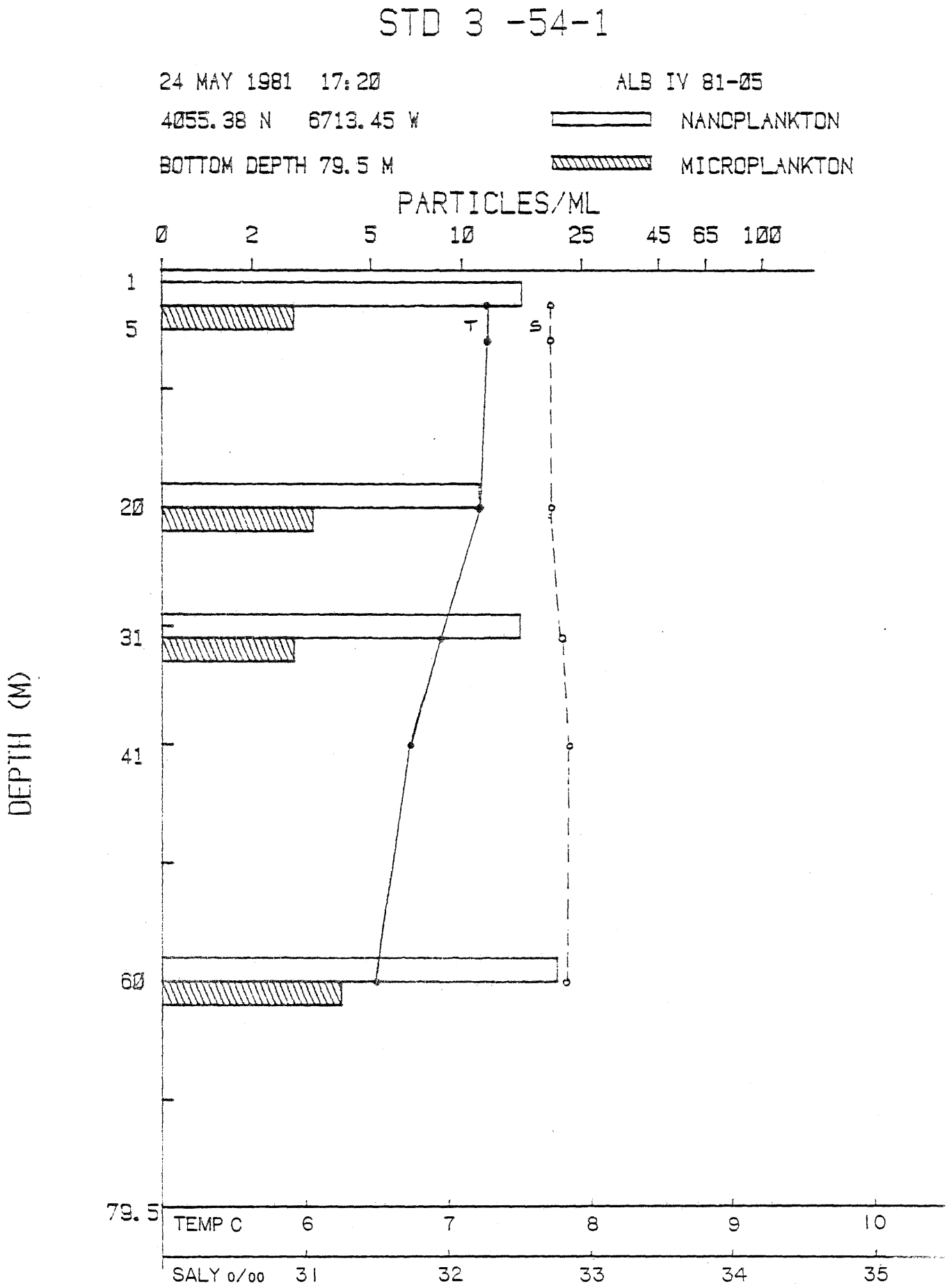
32
42
50
60
70
S
T
TEMP oC 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 5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MICROPLANKTON
PARTICLES/ML
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DEPTH (M)
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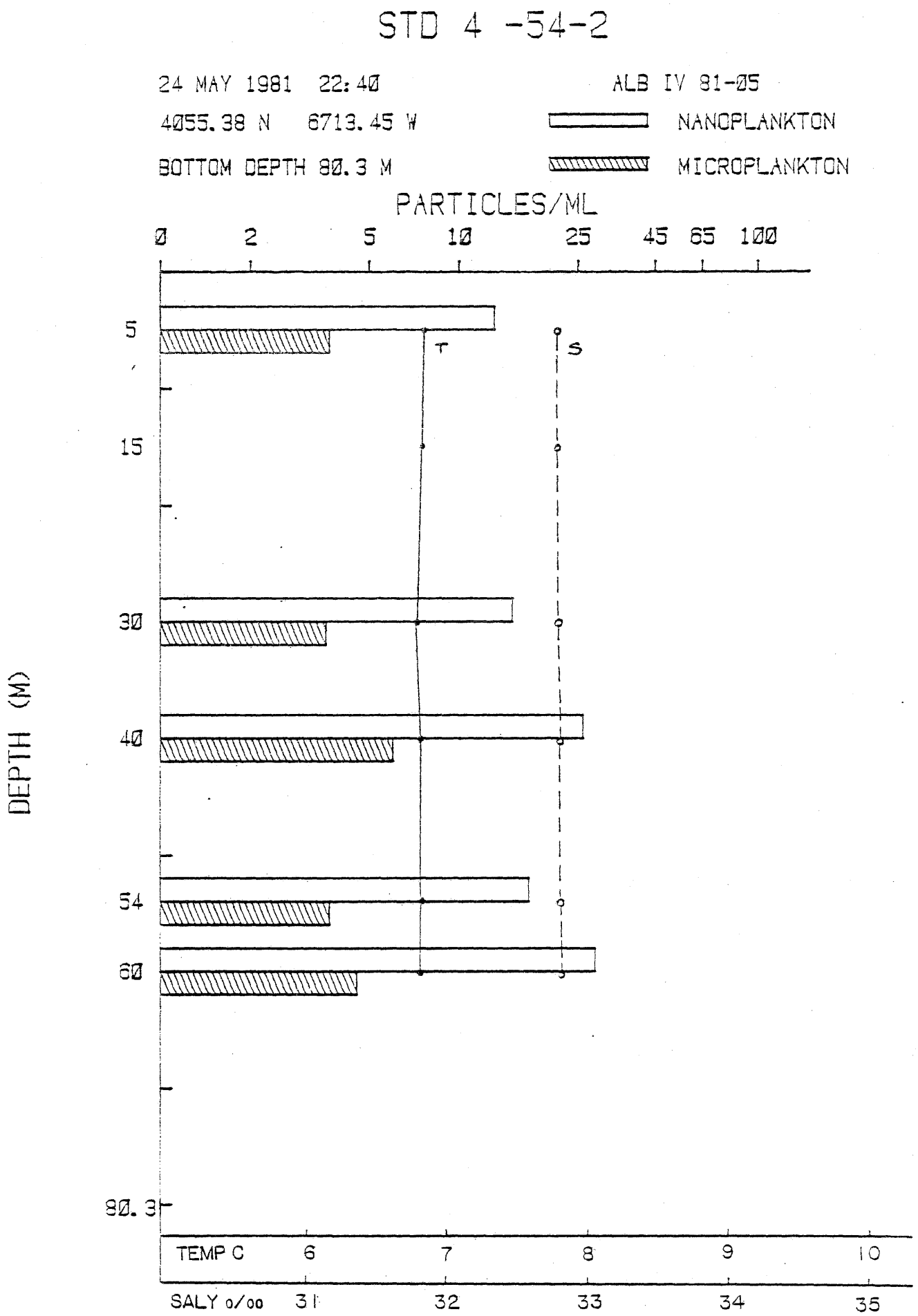
5
20
31
41
60
79.5
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 6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BOTTOM DEPTH 80.3 M
MICROPLANKTON
PARTICLES/ML
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DEPTH (M)
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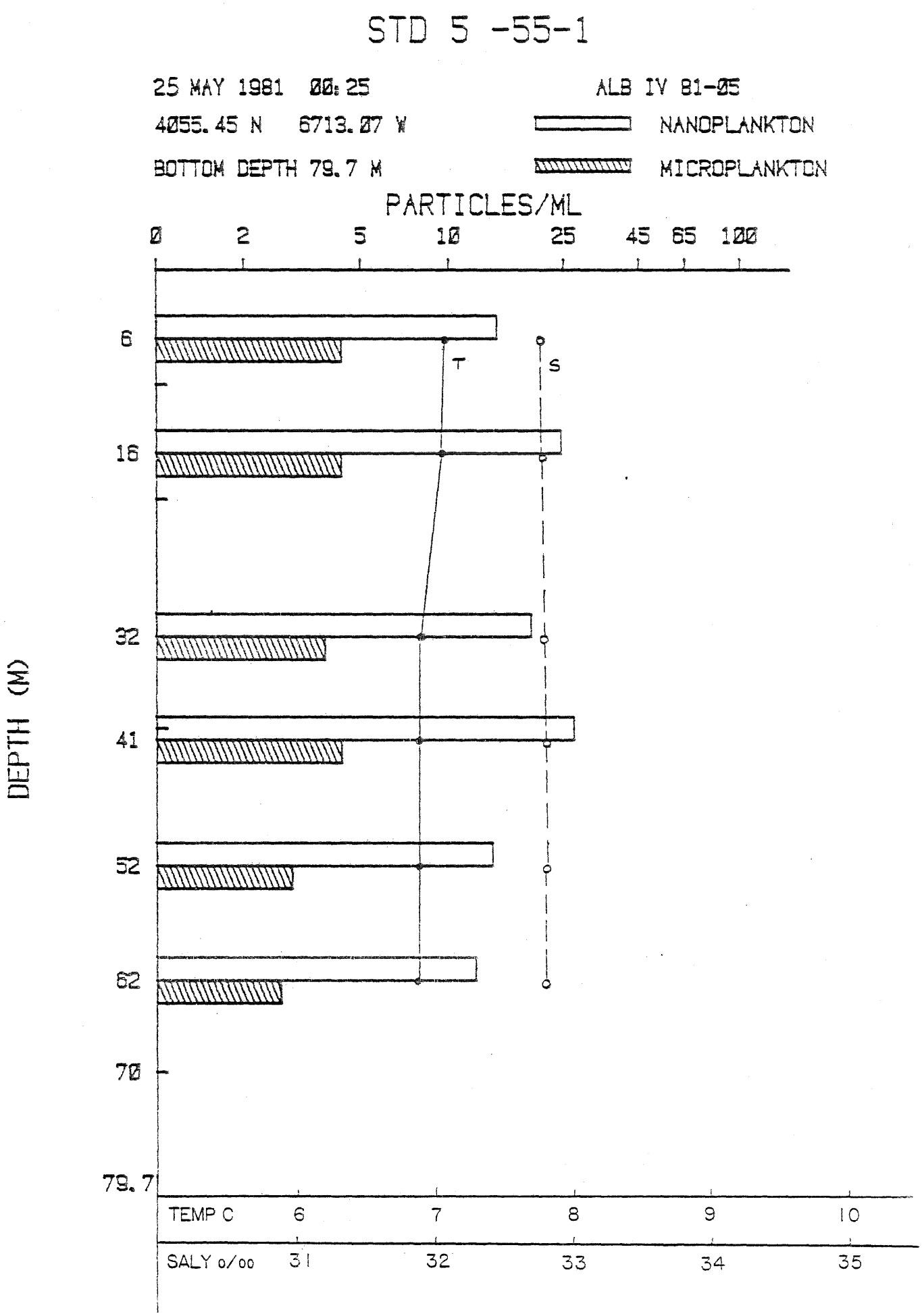
30
40
54
60
80.3
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 7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MICROPLANKTON
PARTICLES/ML
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DEPTH (M)
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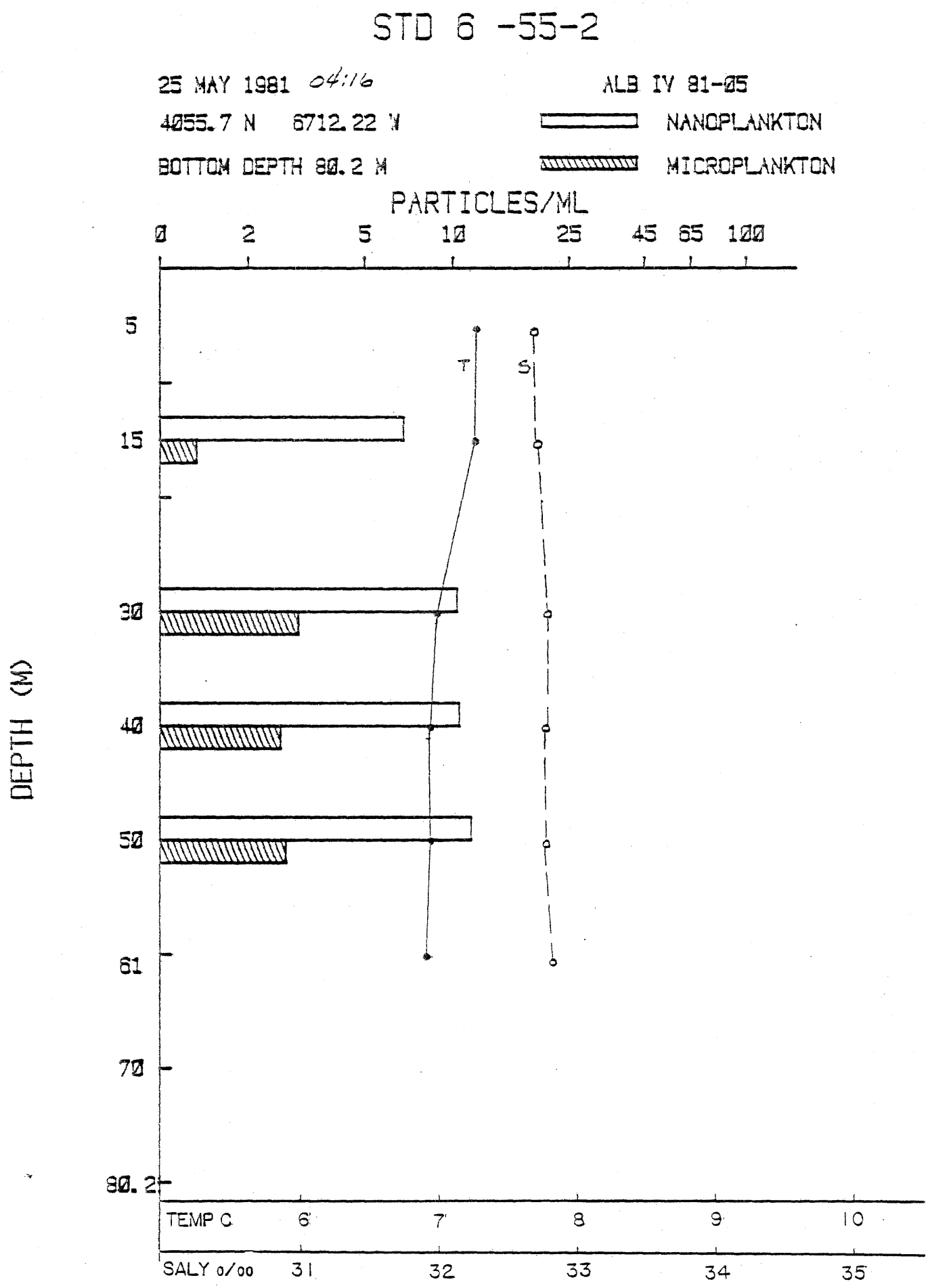
16
32
41
52
62
70
79.7
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 8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DEPTH (M)
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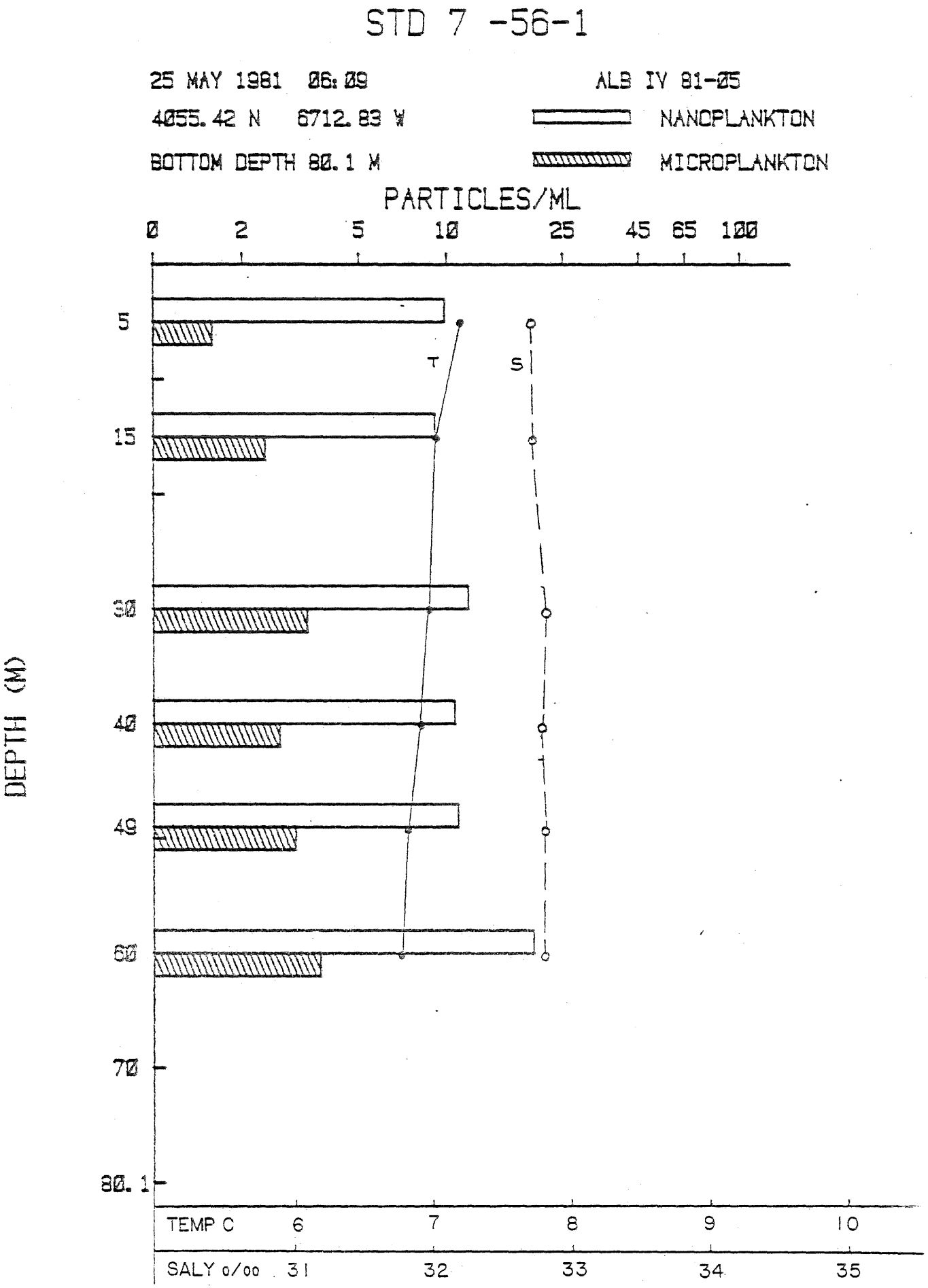
15
30
40
50
61
70
80.2
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 9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MICROPLANKTON
PARTICLES/ML
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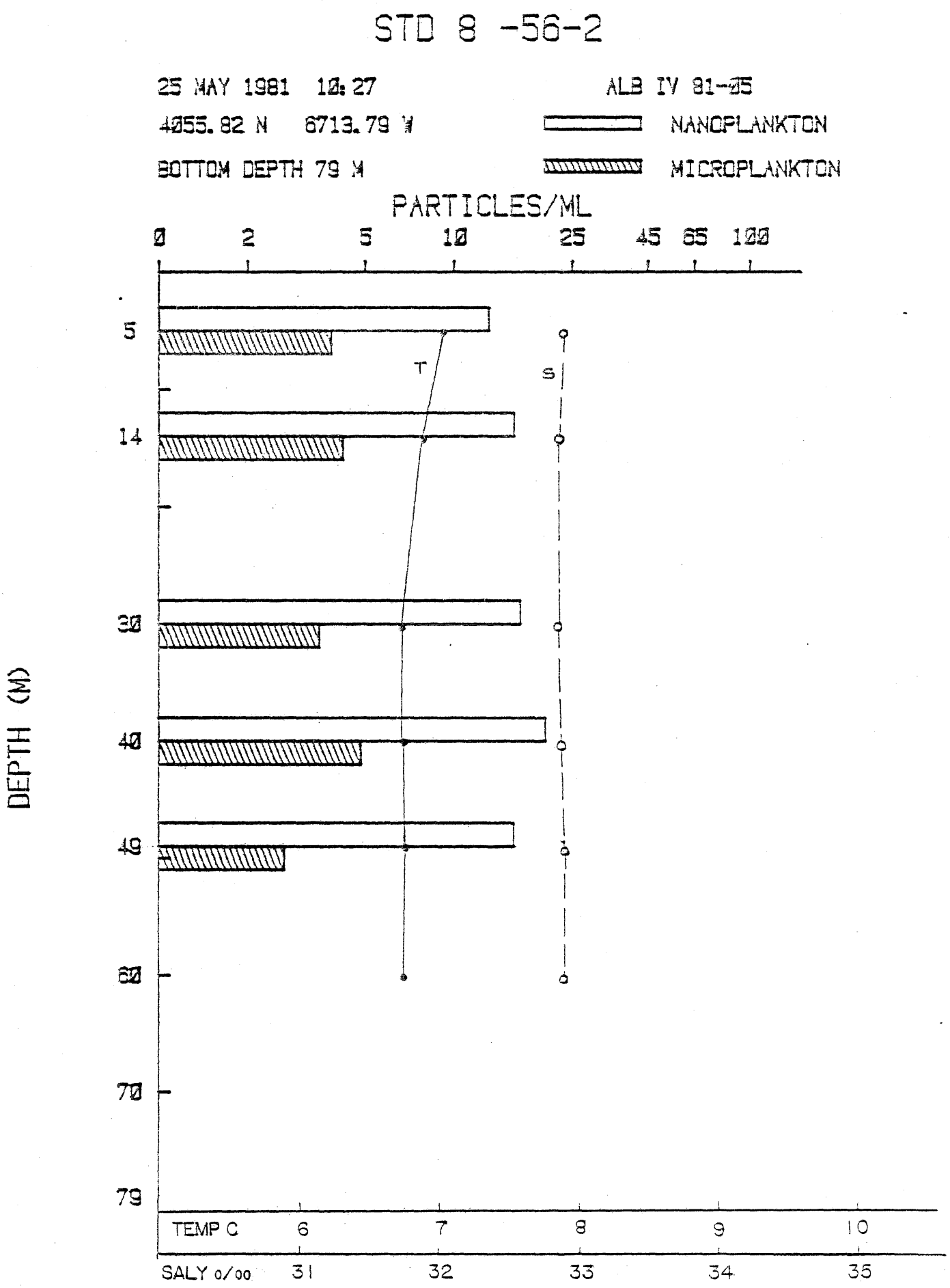
DEPTH (M)
5
15
30
40
49
60
70
80.1
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 10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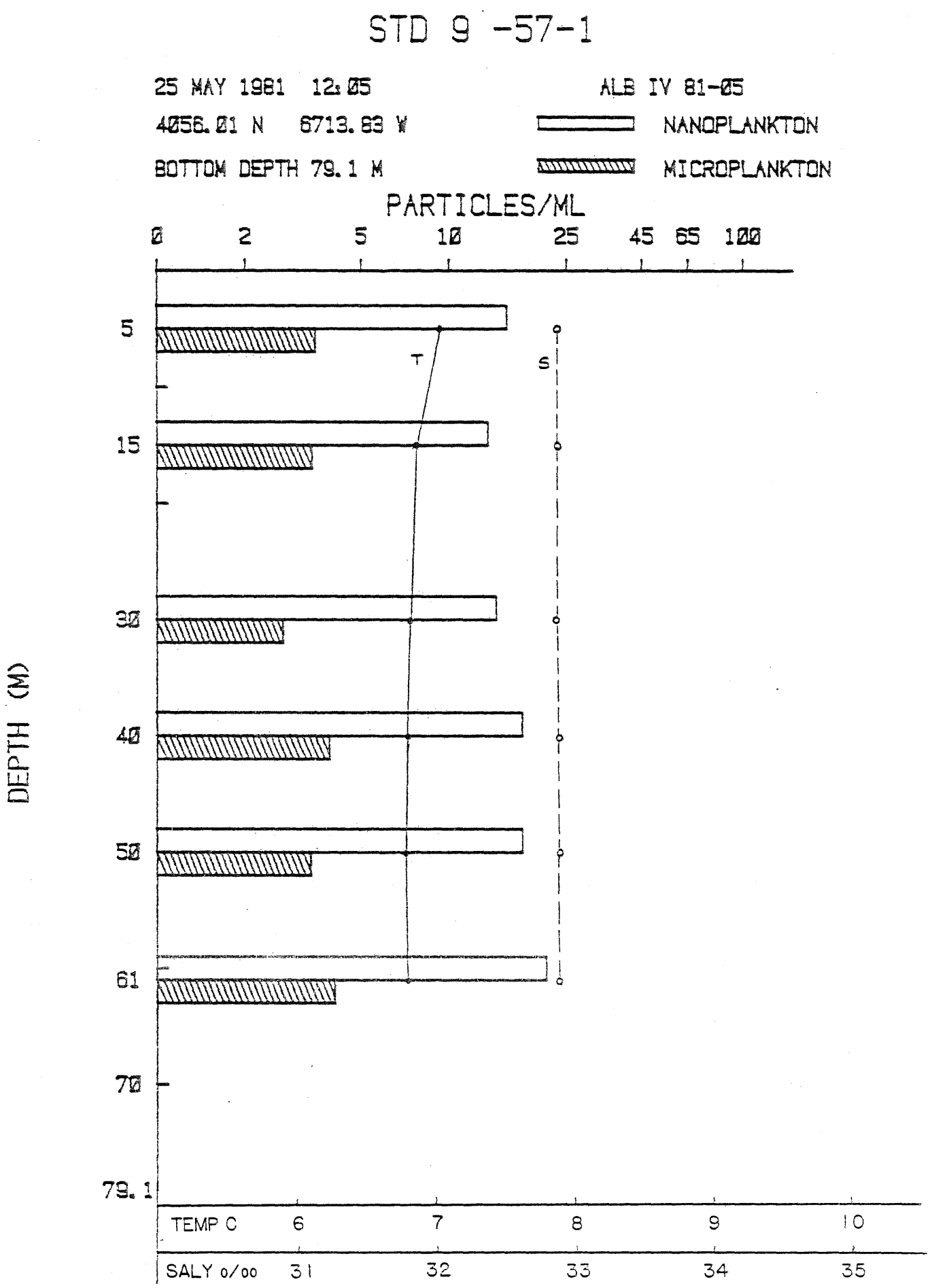
BOTTOM DEPTH 79 M
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
5
14
30
40
49
60
70
79
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 11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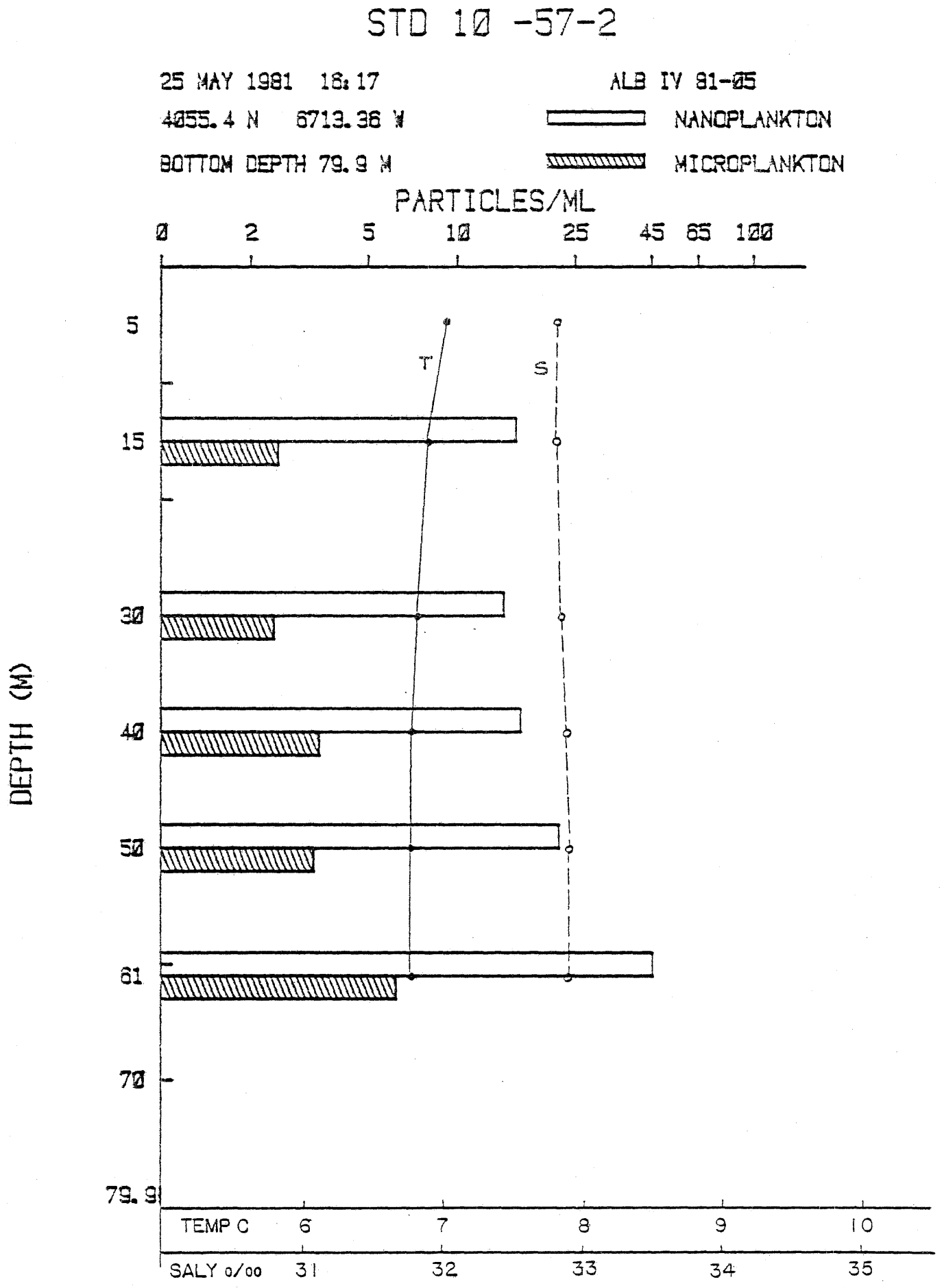
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
5
15
30
40
50
61
70
79.1
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 12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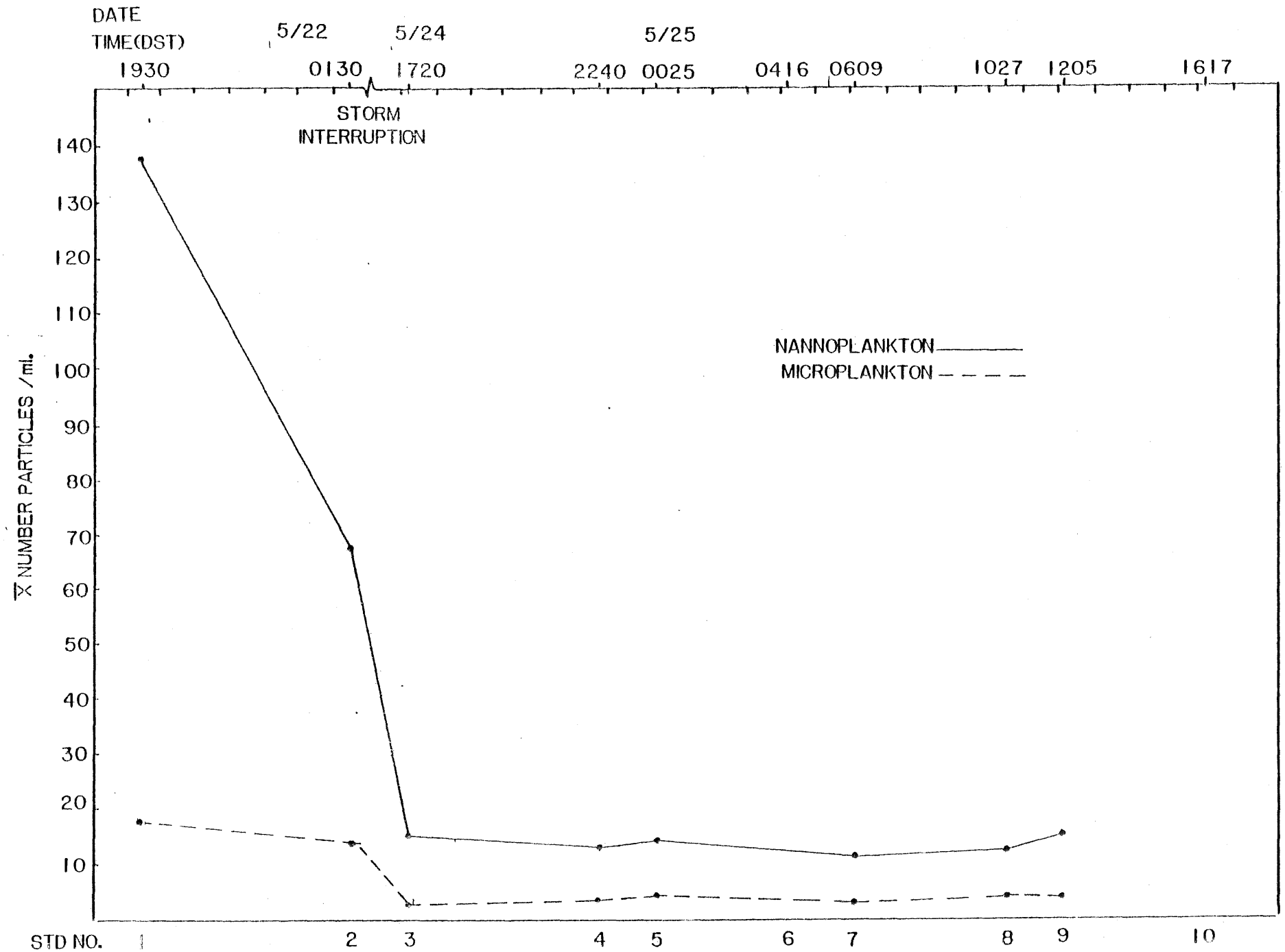
BOTTOM DEPTH 79.9 M
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
5
15
30
40
50
61
70
79.9
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 13

ALB. IV 81-05 OFF-BANK FIXED-STATION SERIES STD 1-52 TO 10-57-2

NANNOPLANKTON AND MICROPLANKTON-SIZED PARTICULATE DENSITY AT 5 m.



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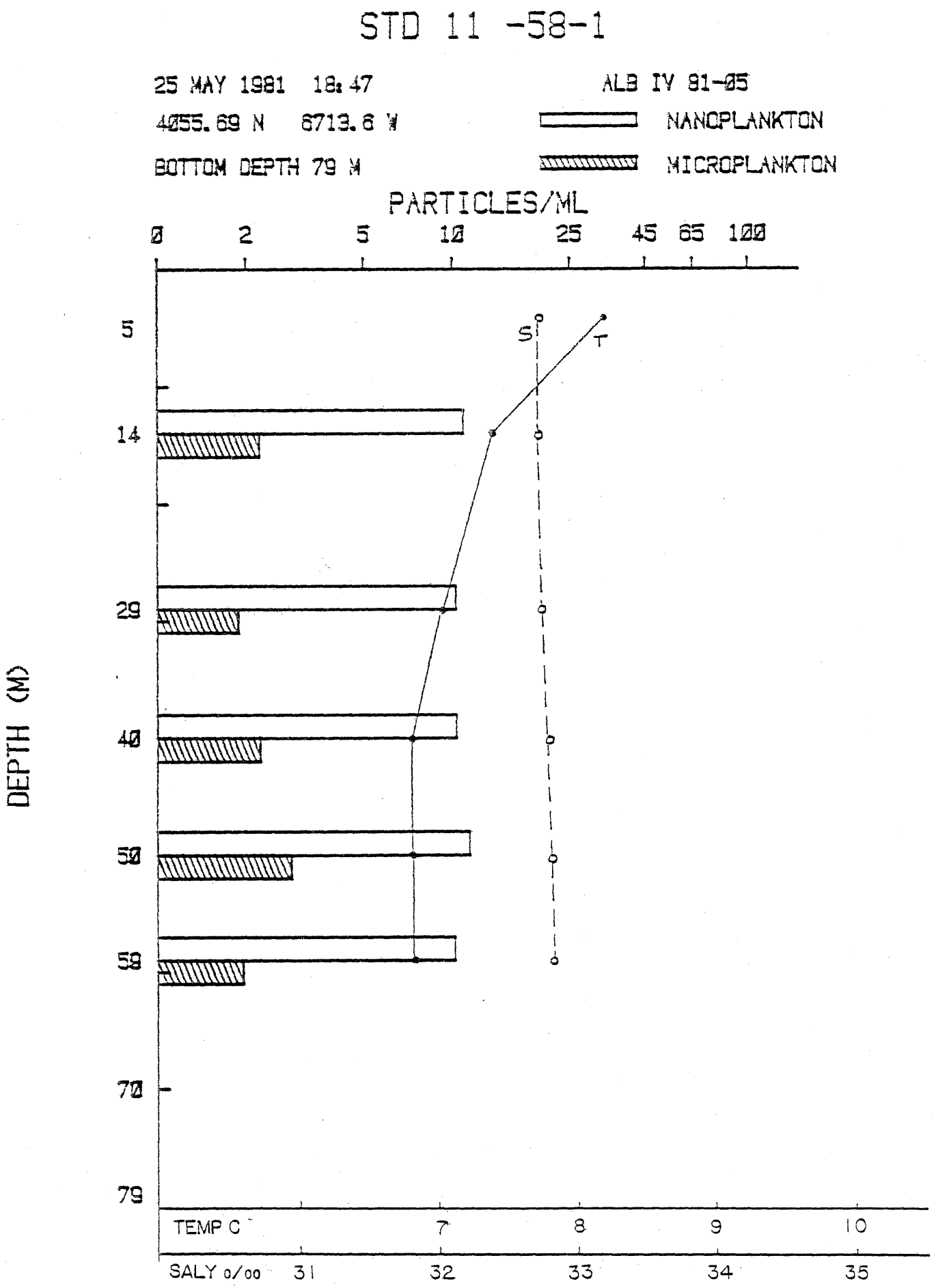
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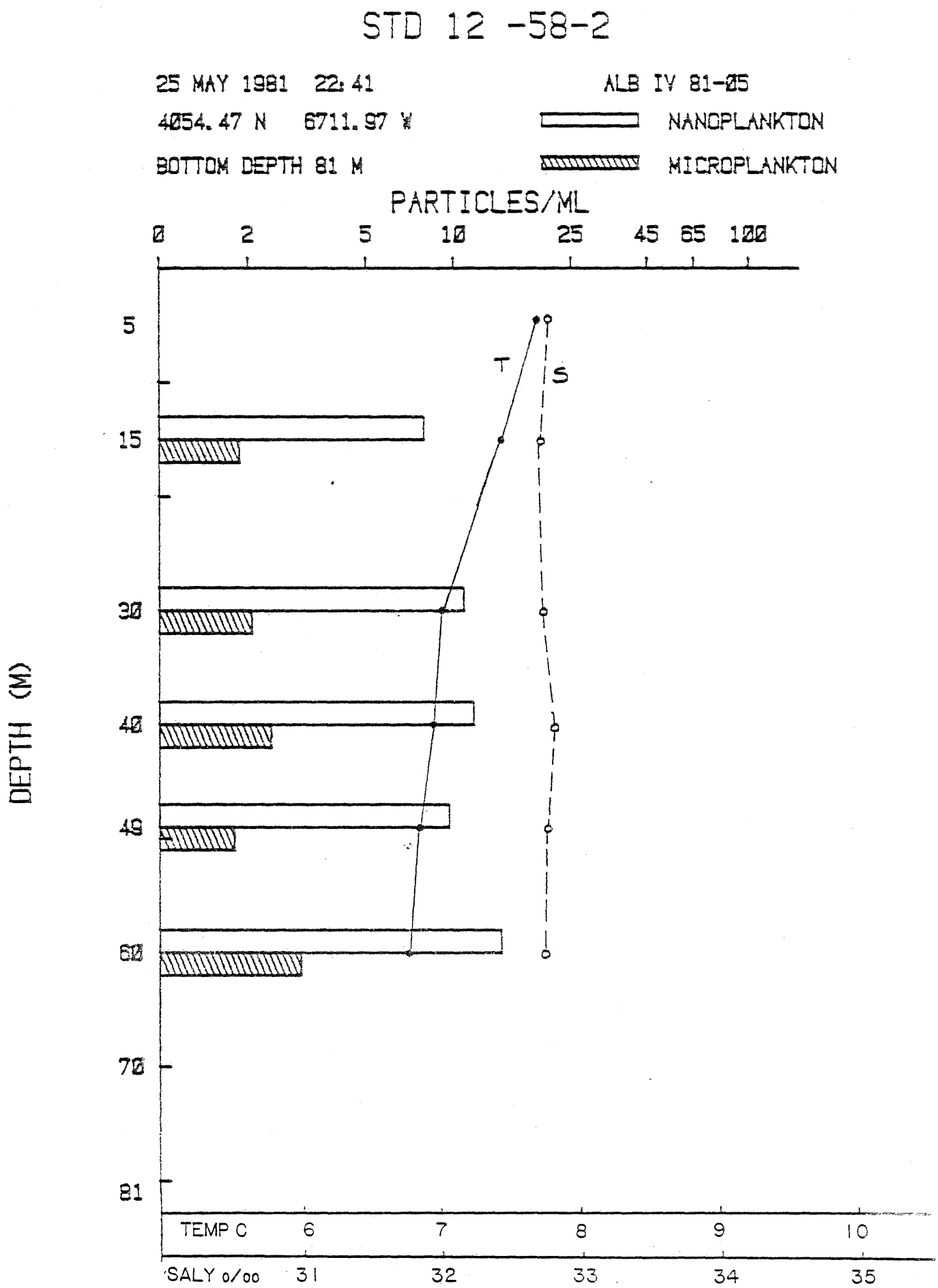
BOTTOM DEPTH 79 M
ALB IV 81-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
5
14
29
40
50
59
70
79
S
T
TEMP C 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 15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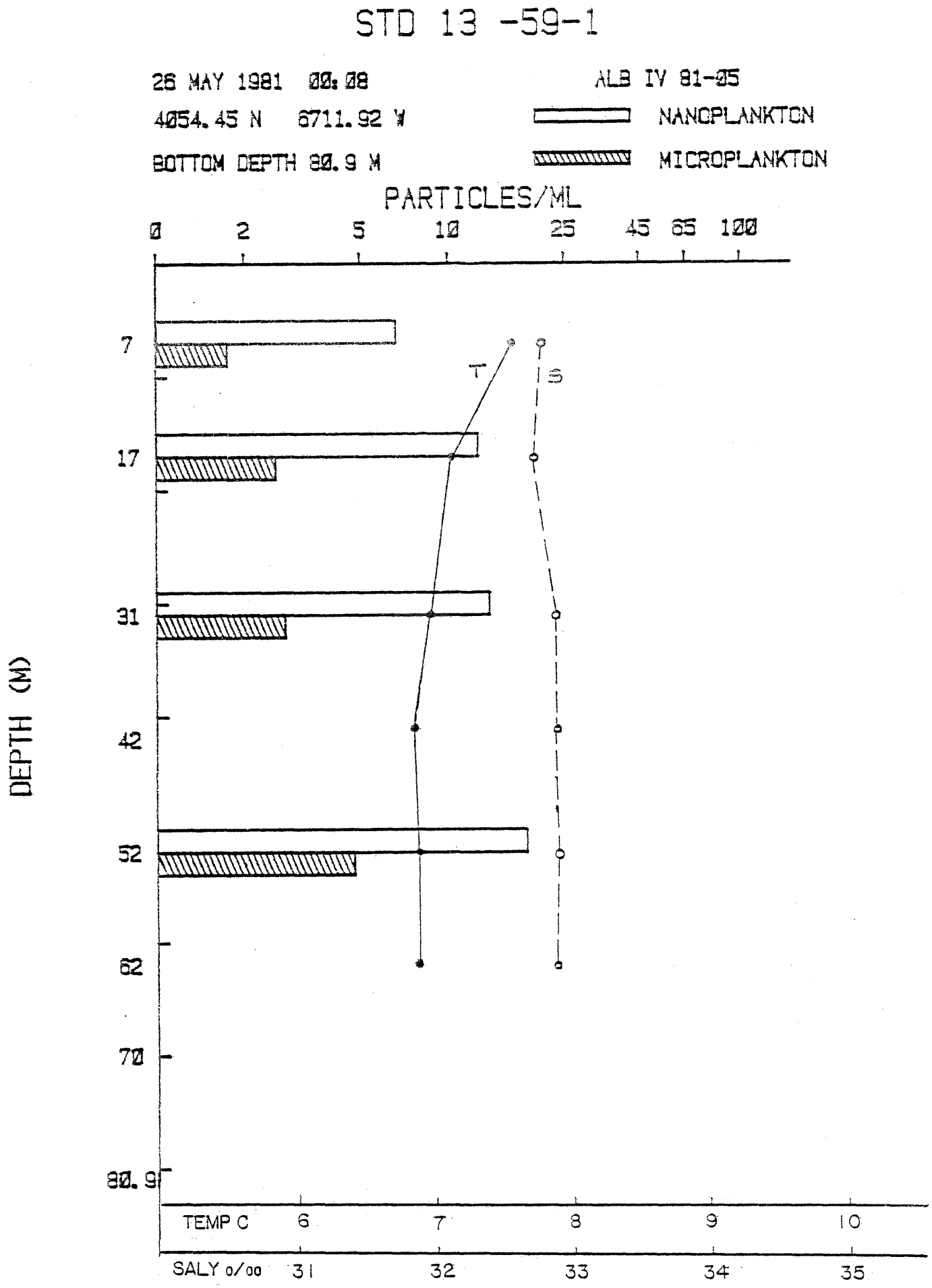
ALB IV 81-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
5
15
30
40
49
60
70
81
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 16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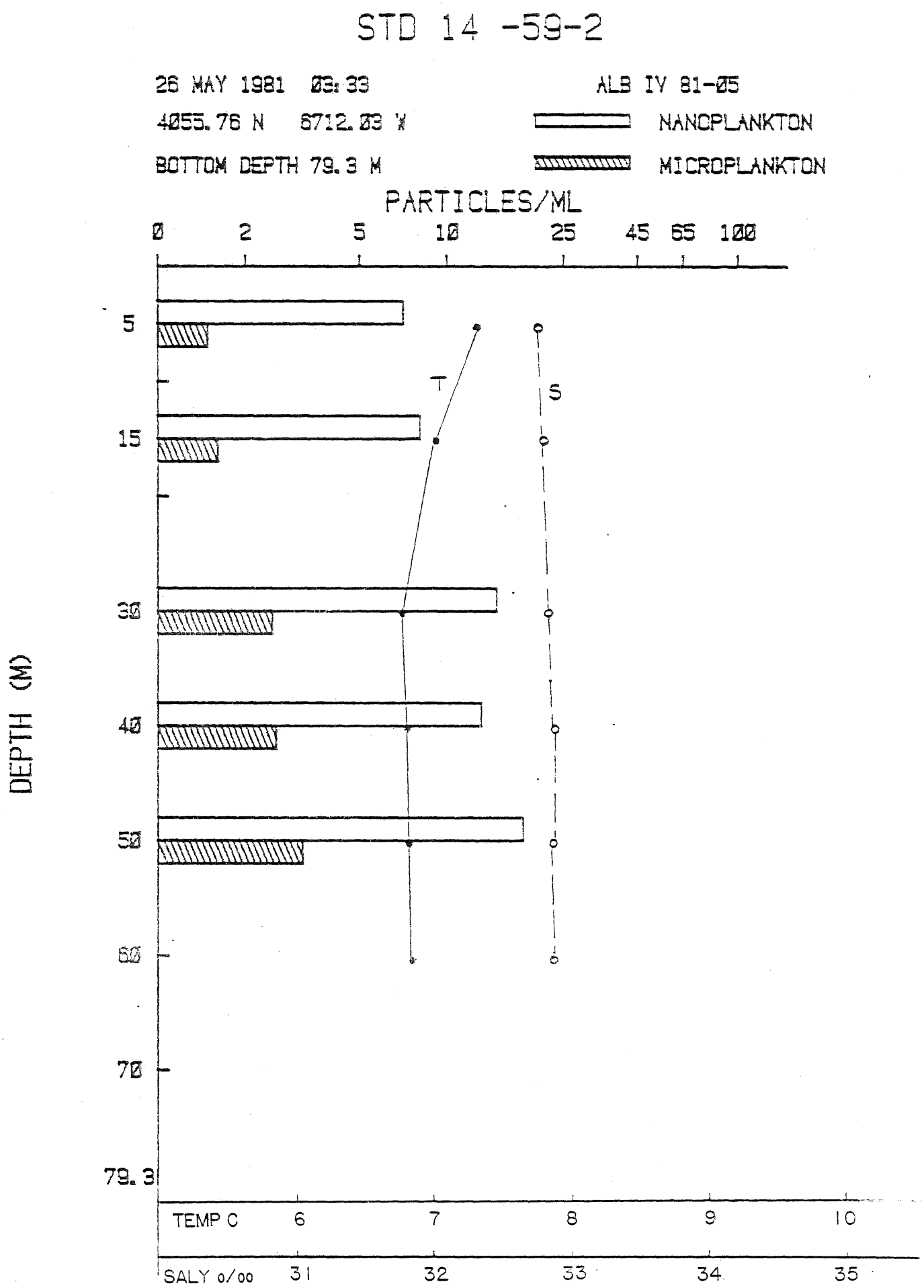
ALB IV 81-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
7
17
31
42
52
62
70
80.9
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 17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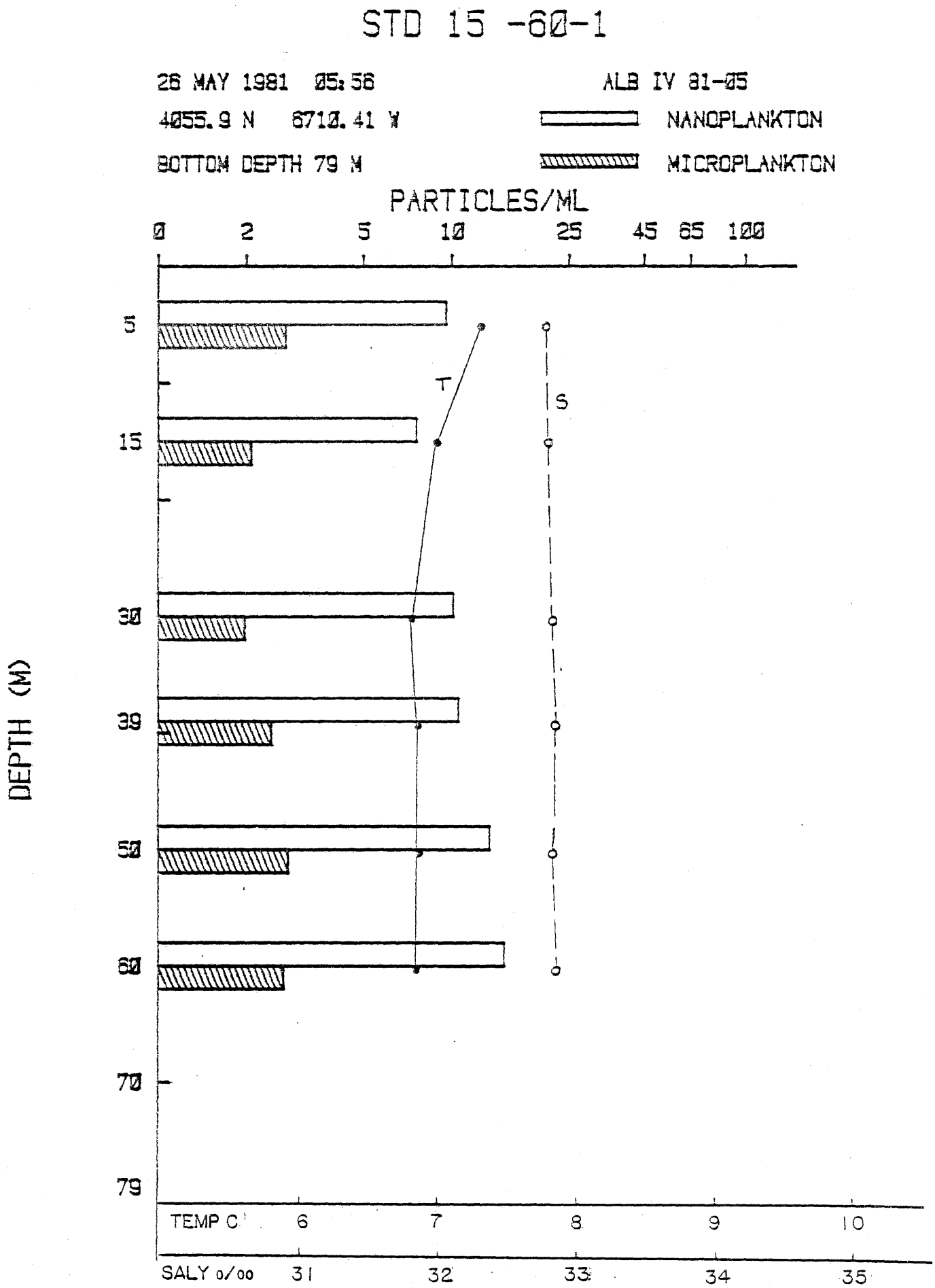
ALB IV 81-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
5
15
30
40
50
60
70
79.3
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 18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BOTTOM DEPTH 79 M
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
5
15
30
39
50
60
70
79
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 19

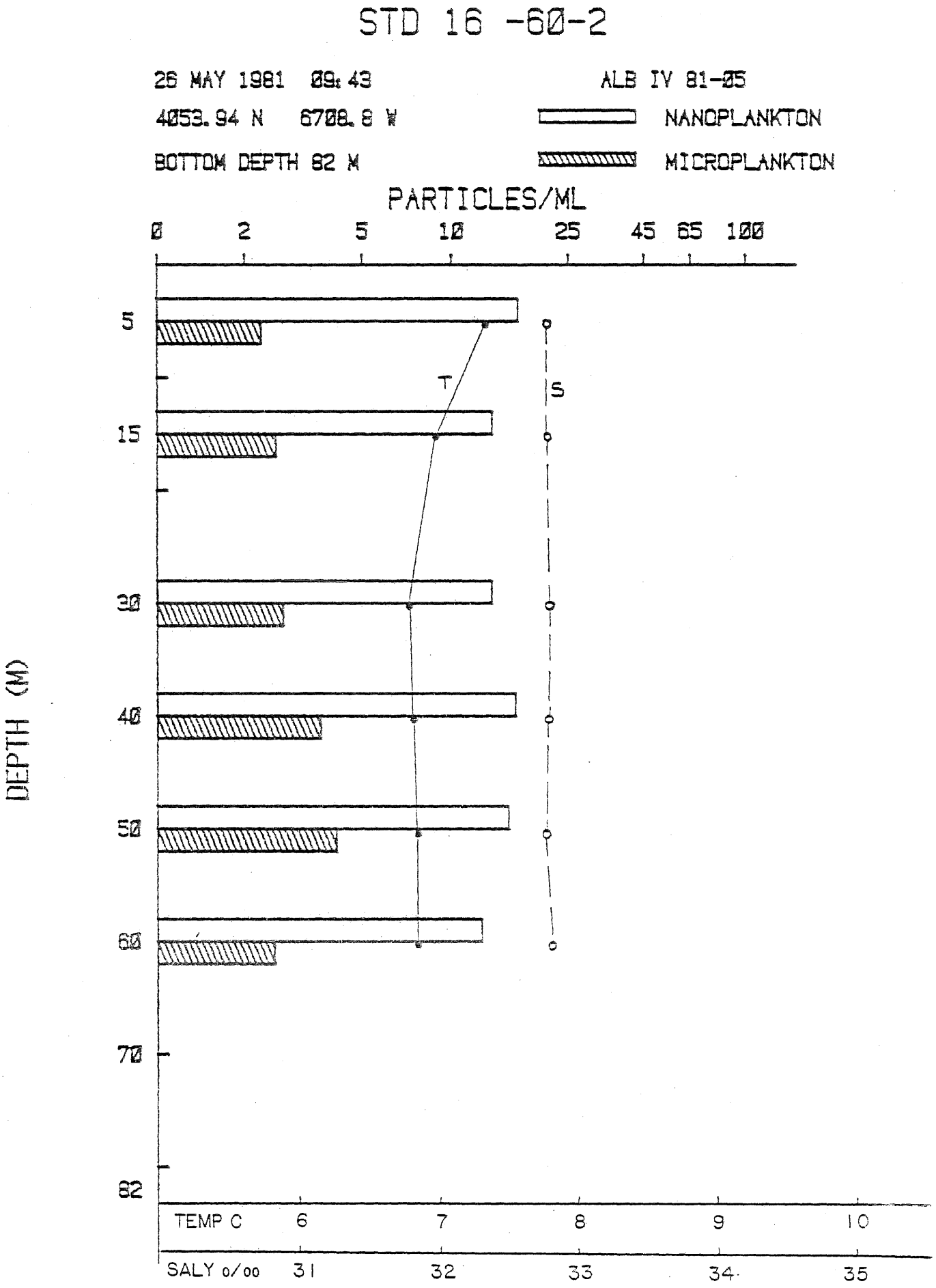

STD 16 -60-2
26 MAY 1981 09:43
4053.94 N 6708.8 W
BOTTOM DEPTH 82 M
ALB IV 81-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
5
15
30
40
50
60
70
82
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 20

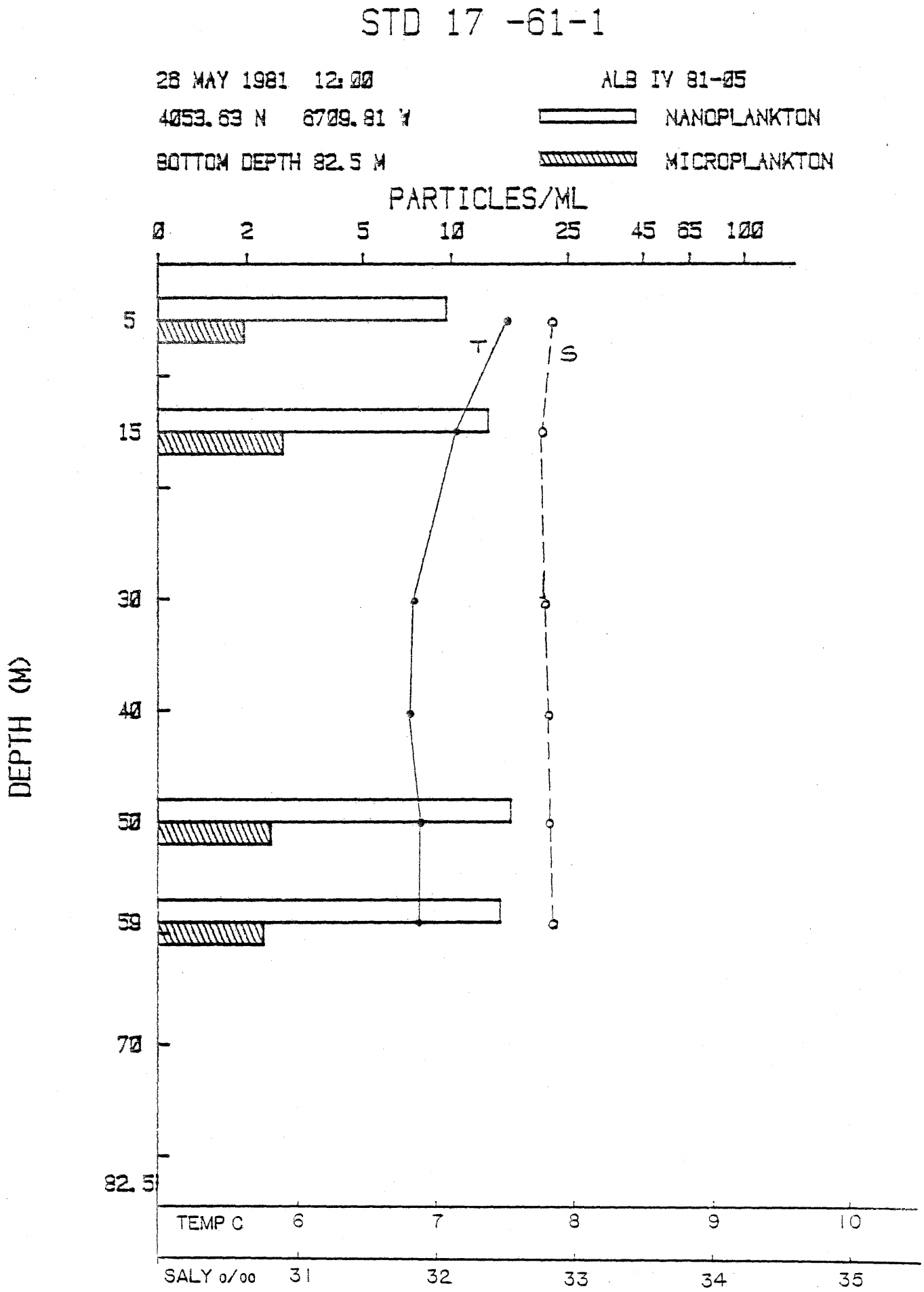

STD 17 -61-1
28 MAY 1981 12:00
4053.63 N 6709.81 W
BOTTOM DEPTH 82.5 M
ALB IV 81-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
5
15
30
40
50
59
70
82.5
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 21

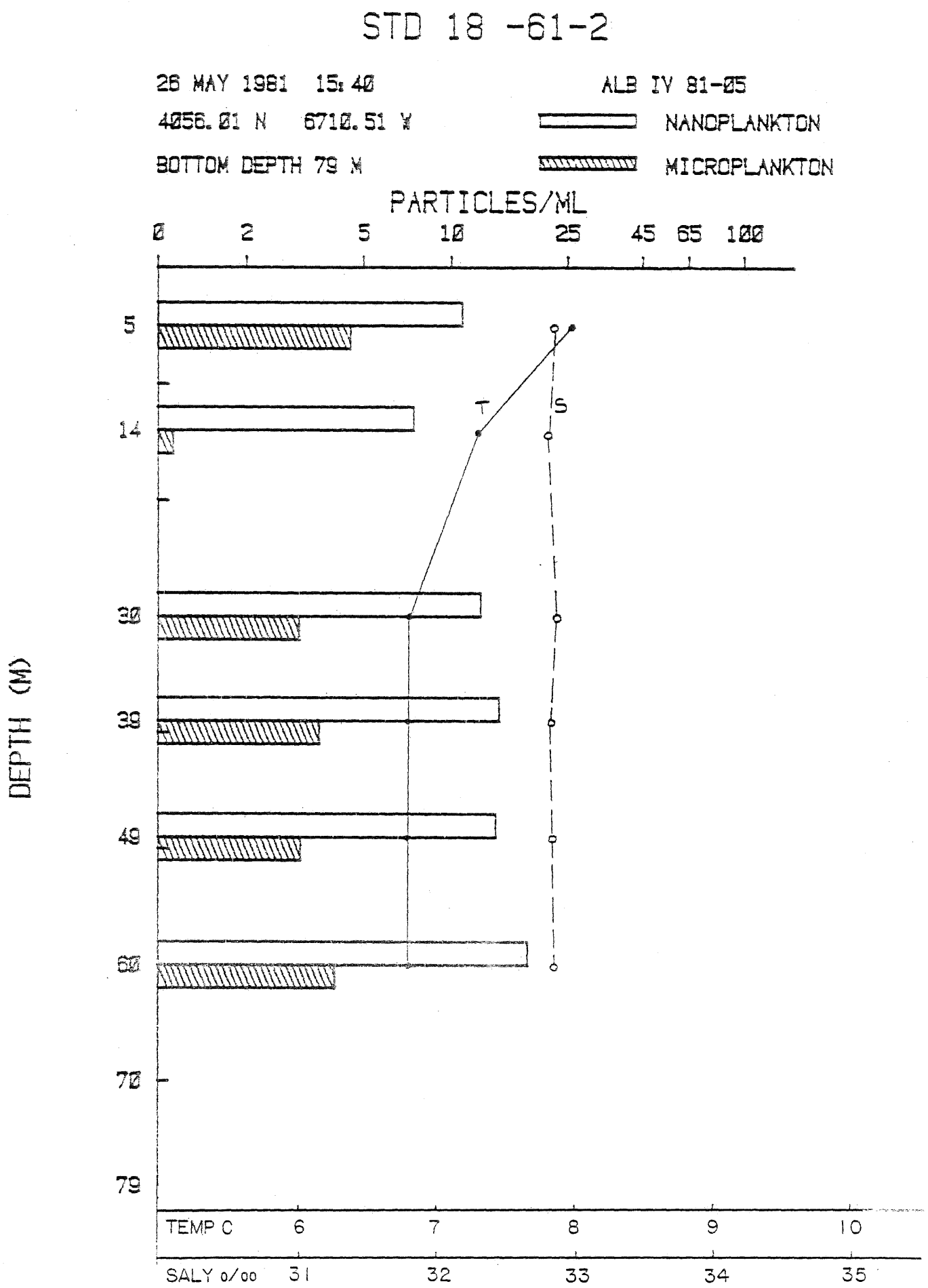

STD 18 -61-2
26 MAY 1981 15:40
4056.01 N 6710.51 W
BOTTOM DEPTH 79 M
ALB IV 81-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
5
14
30
39
49
60
70
79
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 22

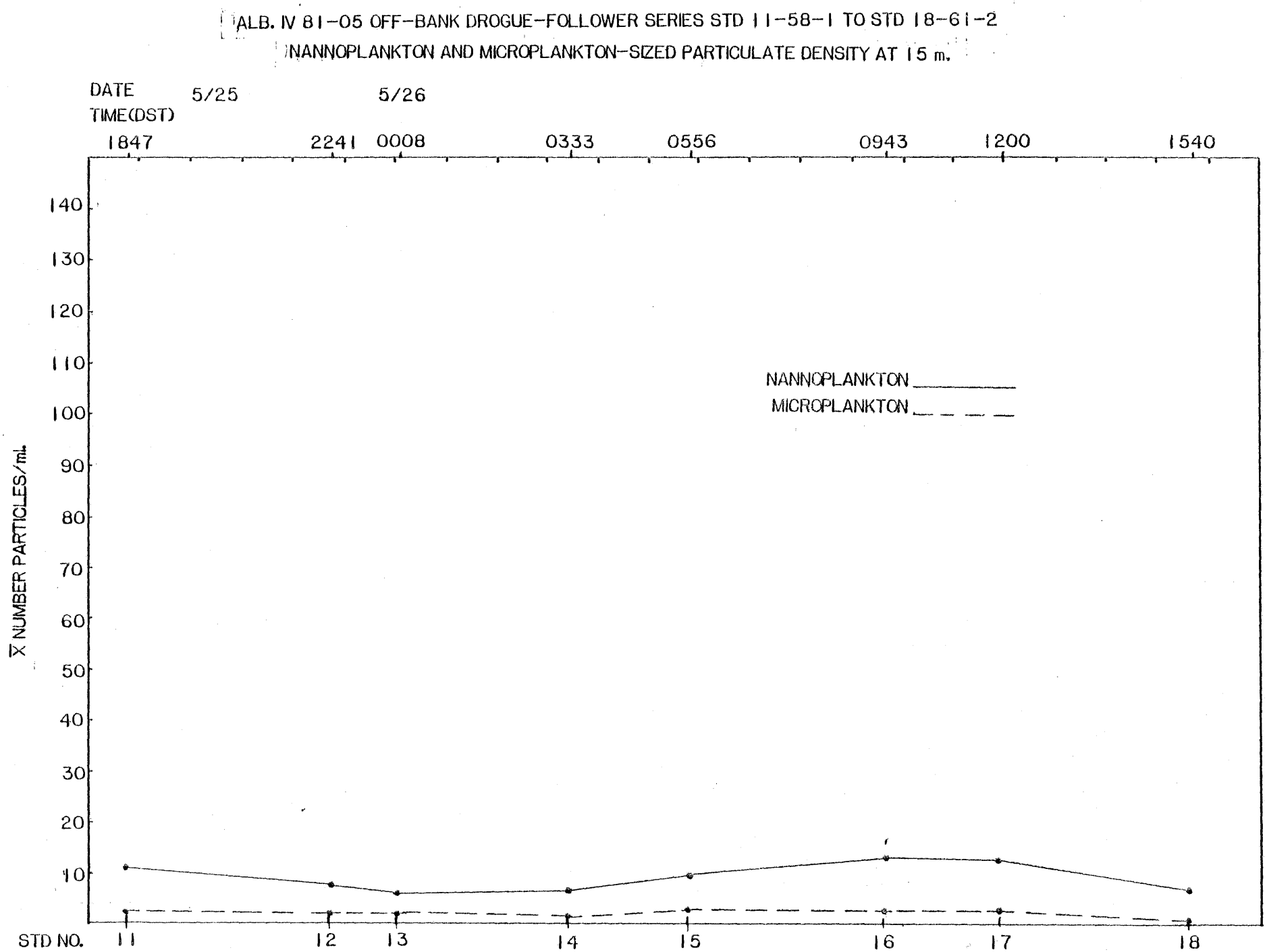

ALB. IV 81-05 OFF-BANK DROGUE-FOLLOWER SERIES STD 11-58-1 TO STD 18-61-2
NANNOPLANKTON AND MICROPLANKTON-SIZED PARTICULATE DENSITY AT 15 m.
DATE
TIME(DST)
5/25
5/26
1847
2241
0008
0333
0556
0943
1200
1540
140
130
120
110
100
90
80
70
60
50
40
30
20
10
X̄ NUMBER PARTICLES/mL
NANNOPLANKTON
MICROPLANKTON
STD NO.
11
12
13
14
15
16
17
18

Figure 23

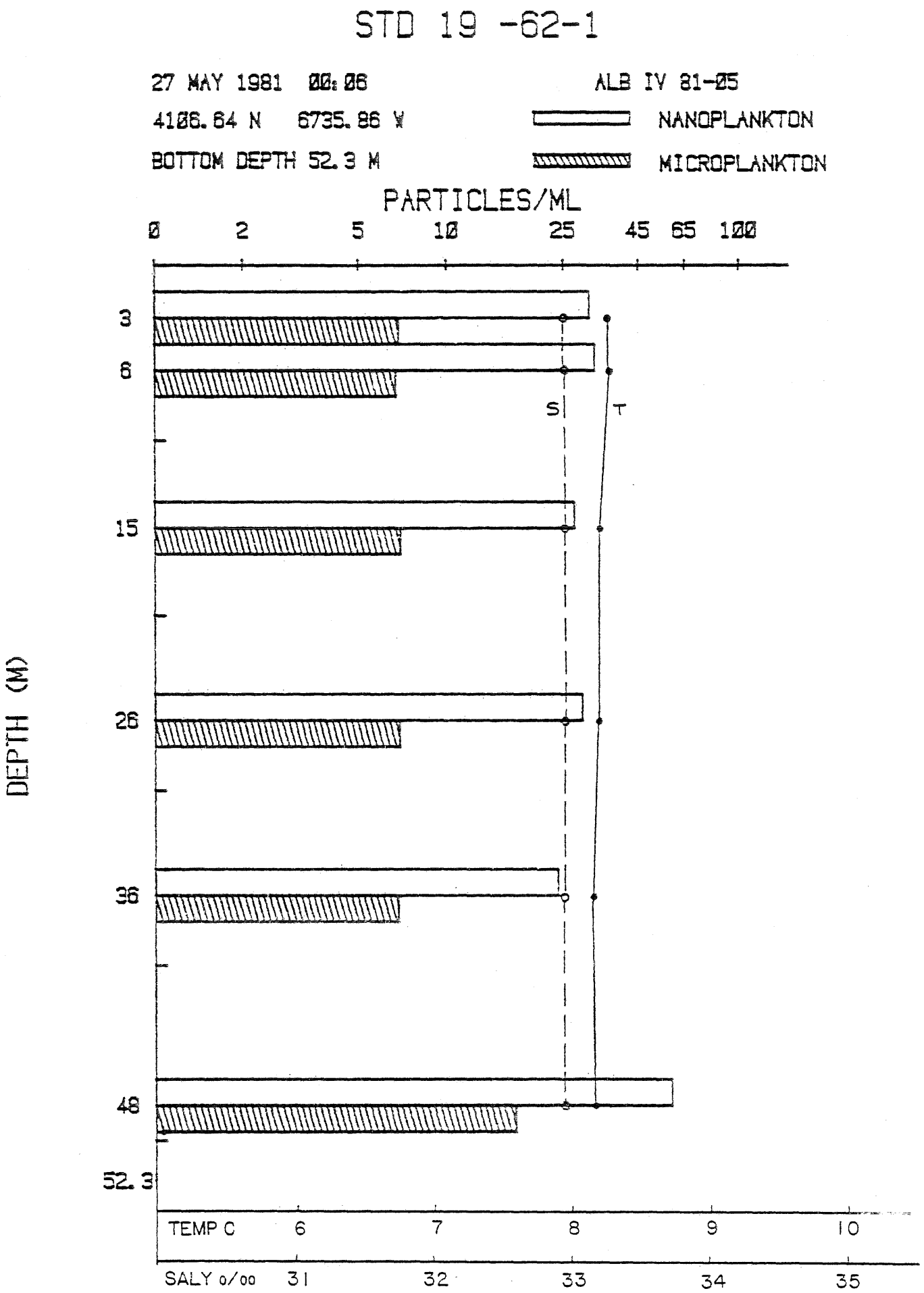

STD 19 -62-1
27 MAY 1981 00:06
4106.64 N 6735.86 W
BOTTOM DEPTH 52.3 M
ALB IV 81-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
3
6
15
26
36
48
52.3
S
T
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 24

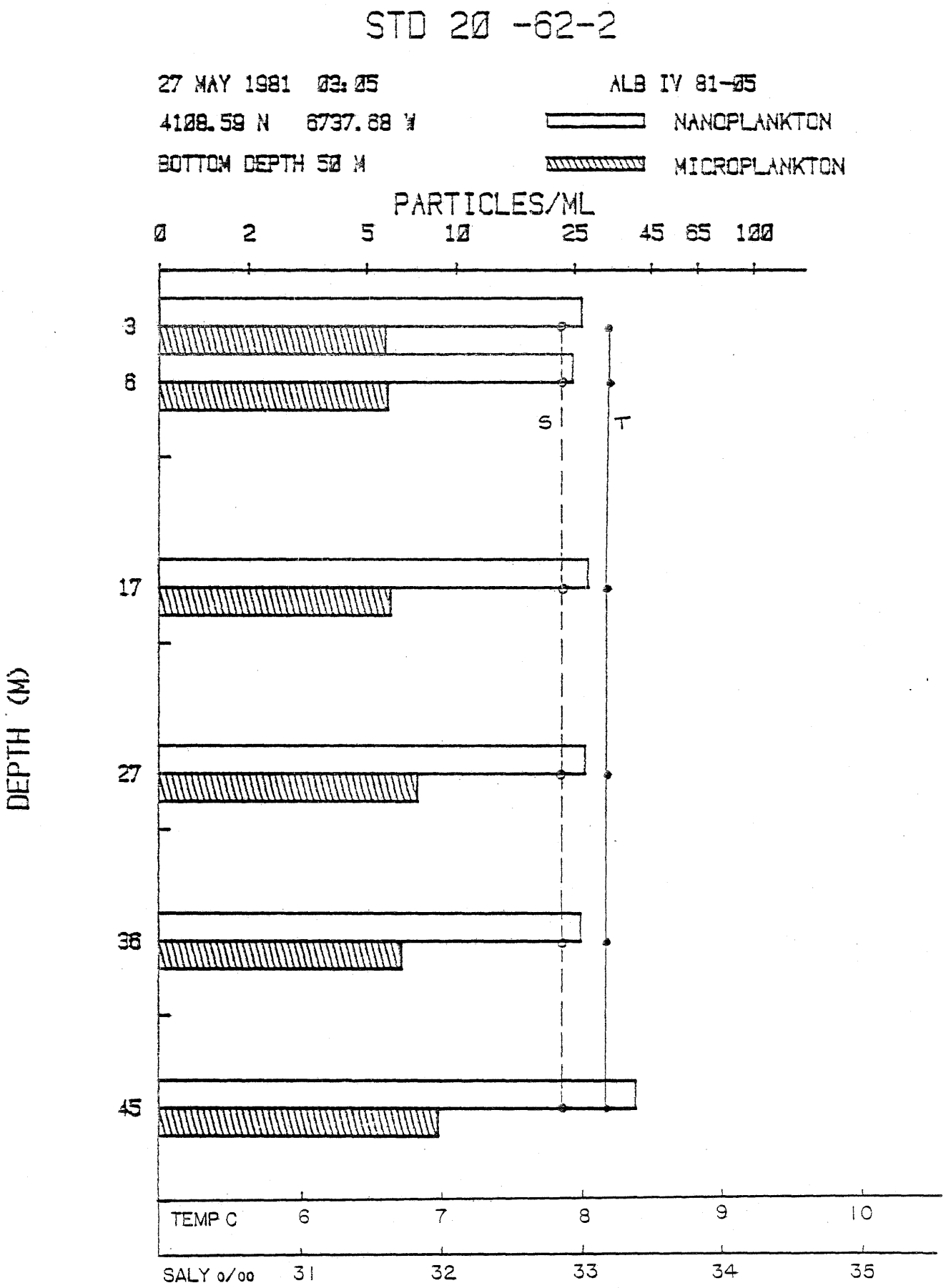

STD 20 -62-2
27 MAY 1981 03:05
ALB IV 81-05
4108.59 N 6737.88 W
NANOPLANKTON
BOTTOM DEPTH 50 M
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
3
6
17
27
36
45
S
T
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 25

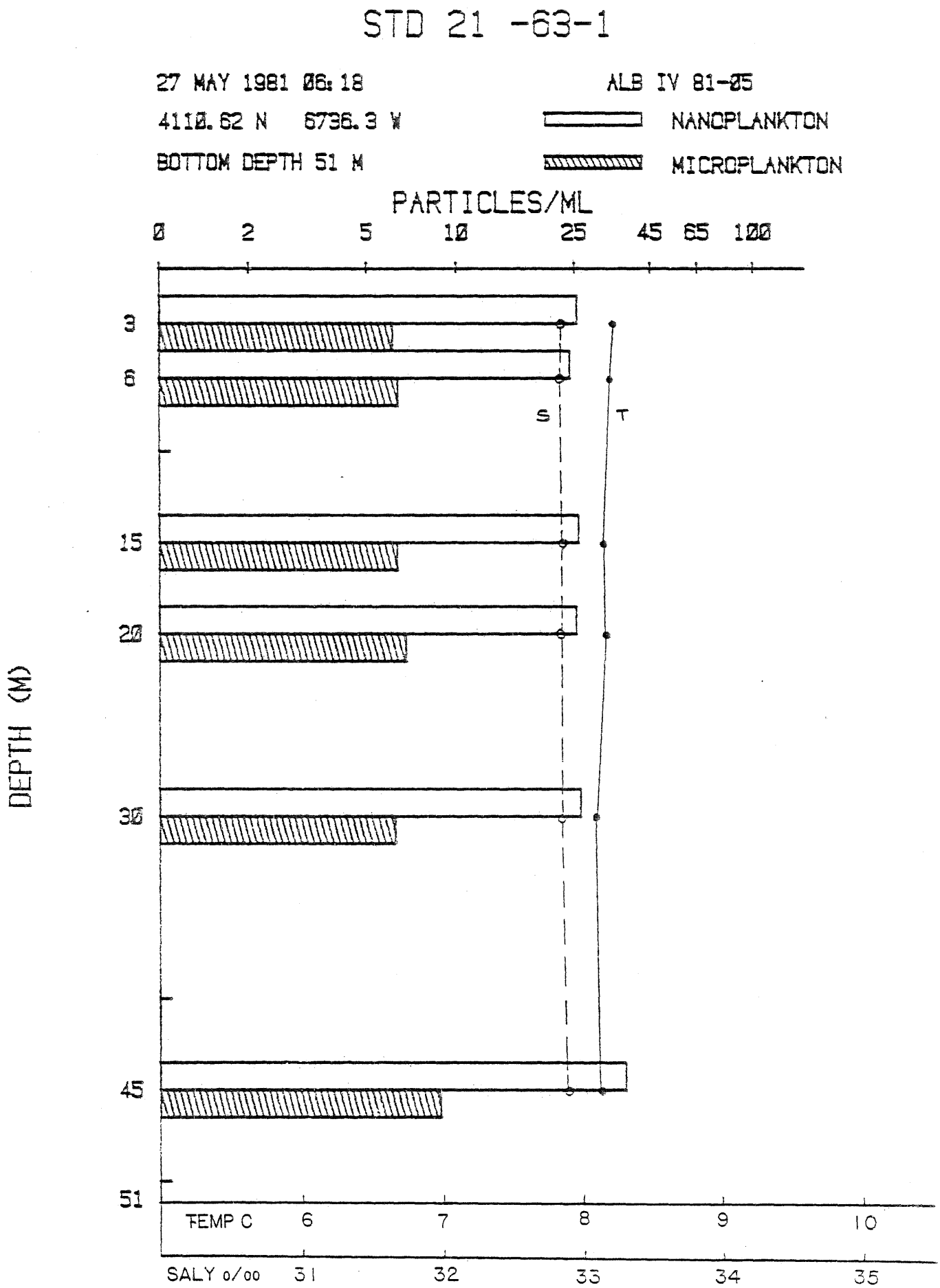

STD 21 -63-1
27 MAY 1981 06:18
4110.62 N 6736.3 W
BOTTOM DEPTH 51 M
ALB IV 81-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
3
6
15
20
30
45
51
S
T
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 26

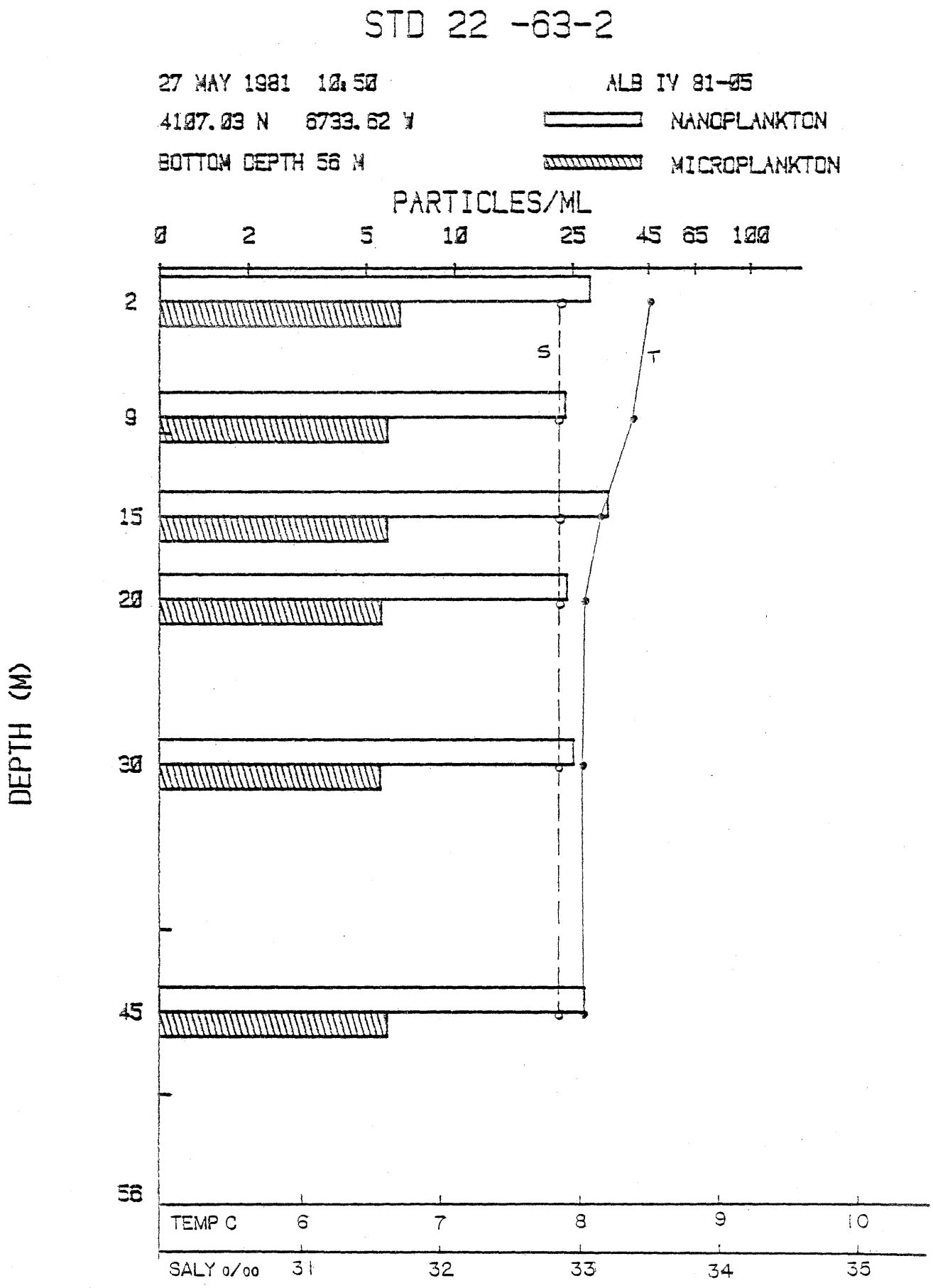

STD 22 -63-2
27 MAY 1981 10:50
4107.03 N 6733.62 W
BOTTOM DEPTH 56 M
ALB IV 81-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
2
9
15
20
30
45
56
S
T
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 27

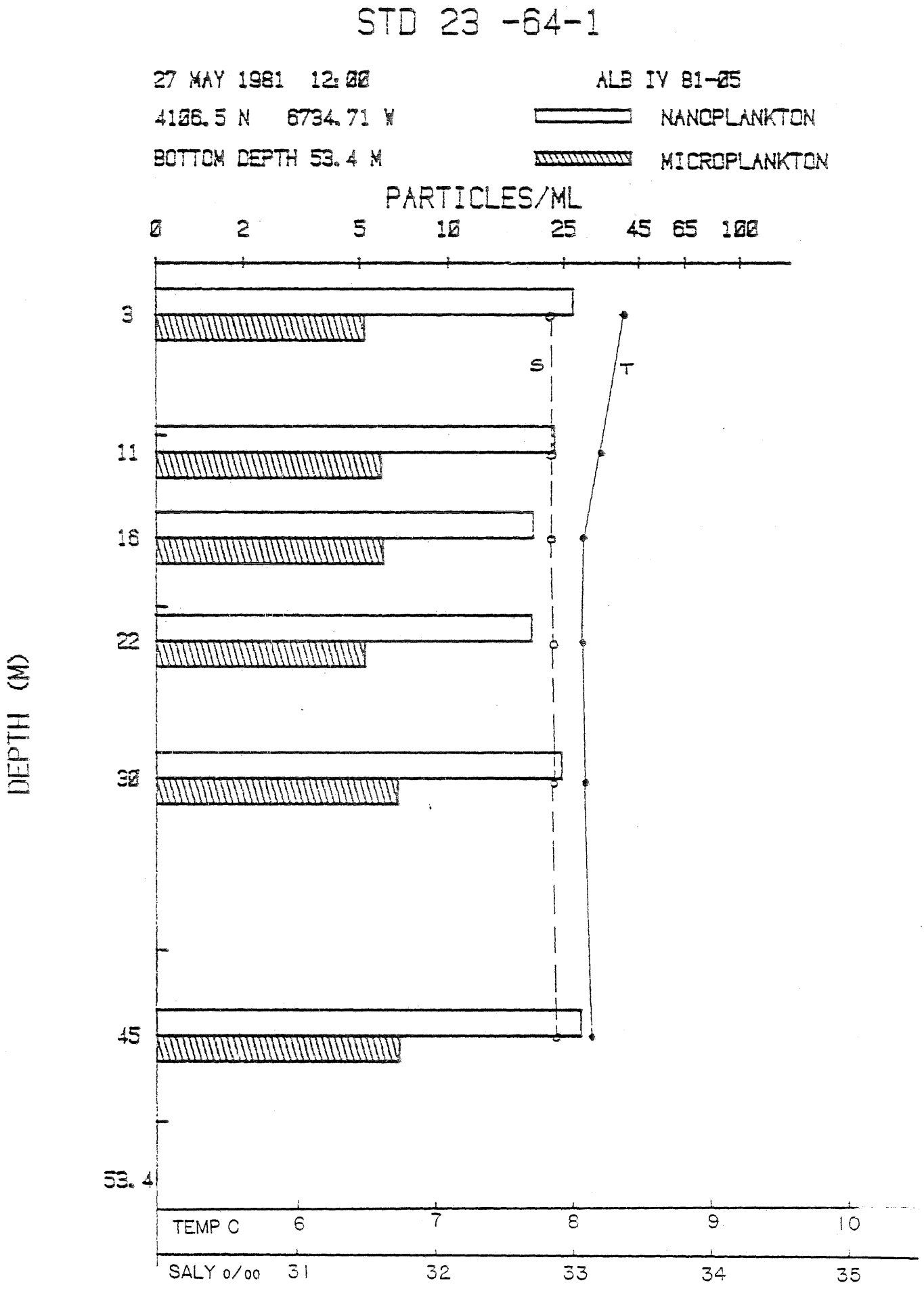

STD 23 -64-1
27 MAY 1981 12:00
4106.5 N 6734.71 W
BOTTOM DEPTH 53.4 M
ALB IV 81-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
3
11
16
22
30
45
53.4
S
T
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 28

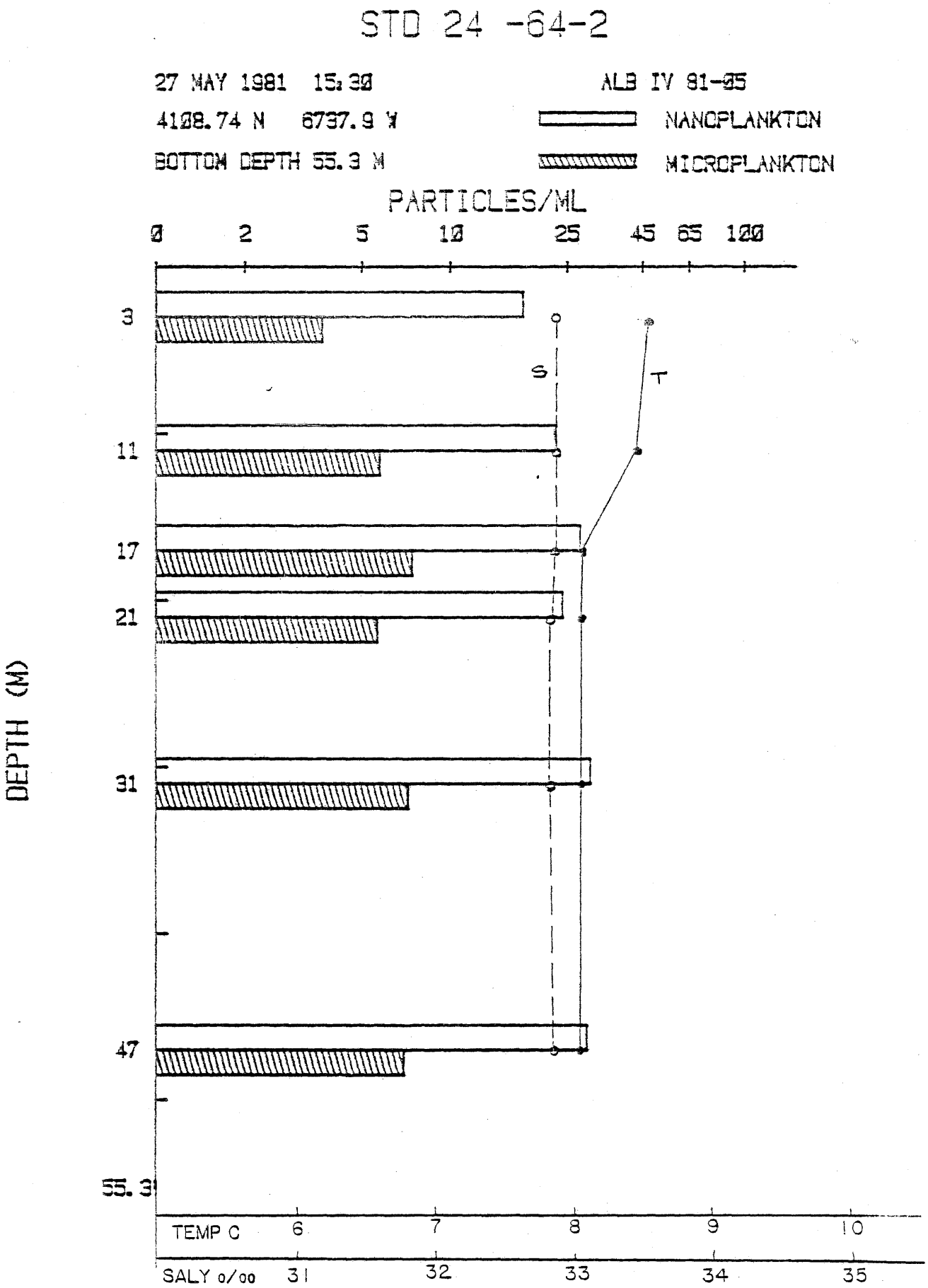

STD 24 -64-2
27 MAY 1981 15:30
4108.74 N 6737.9 W
BOTTOM DEPTH 55.3 M
ALB IV 81-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
3
11
17
21
31
47
55.3
S
T
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 29

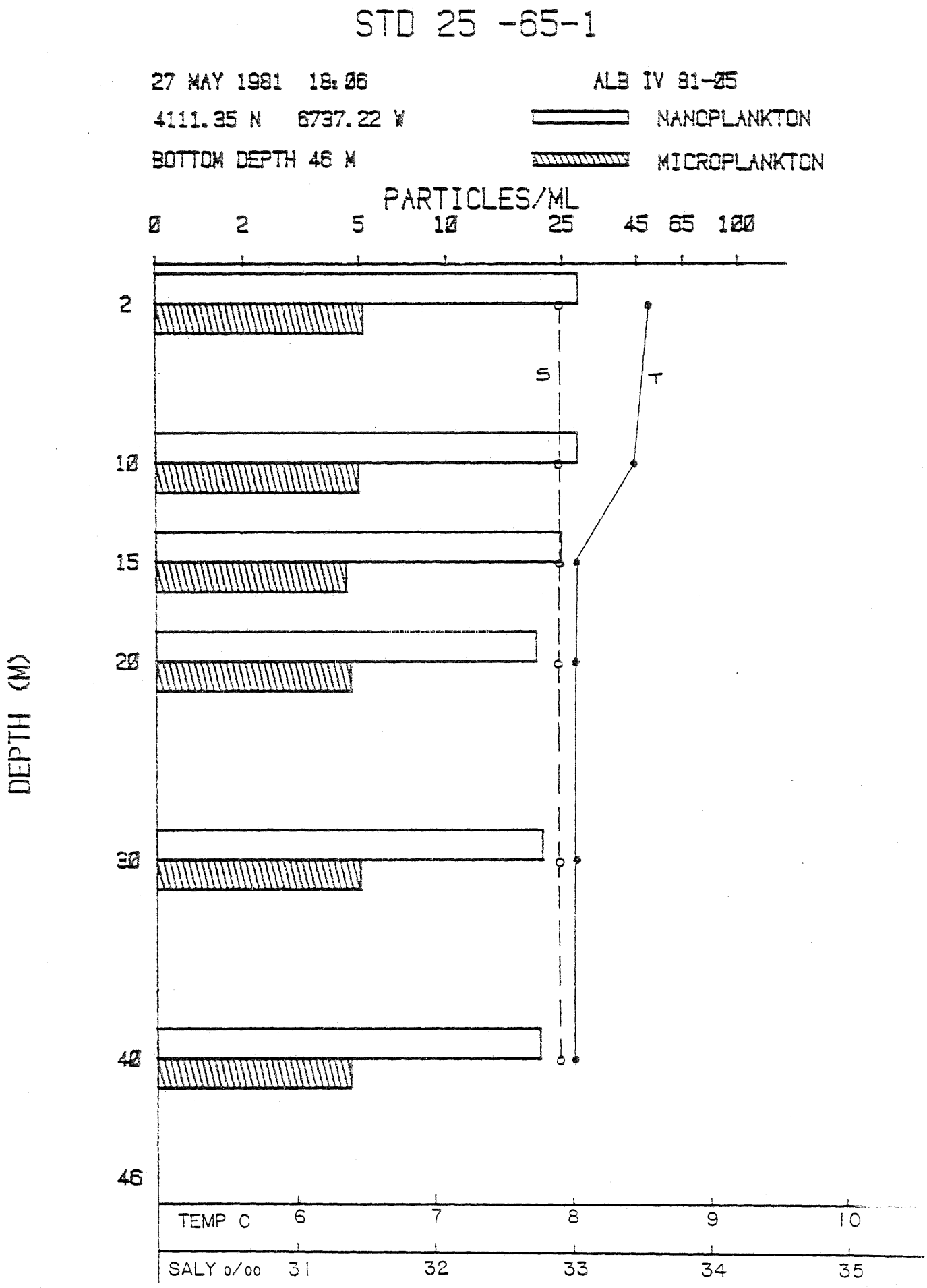

STD 25 -65-1
27 MAY 1981 18:06
4111.35 N 6737.22 W
BOTTOM DEPTH 46 M
ALB IV 81-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
2
10
15
20
30
40
46
S
T
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 30

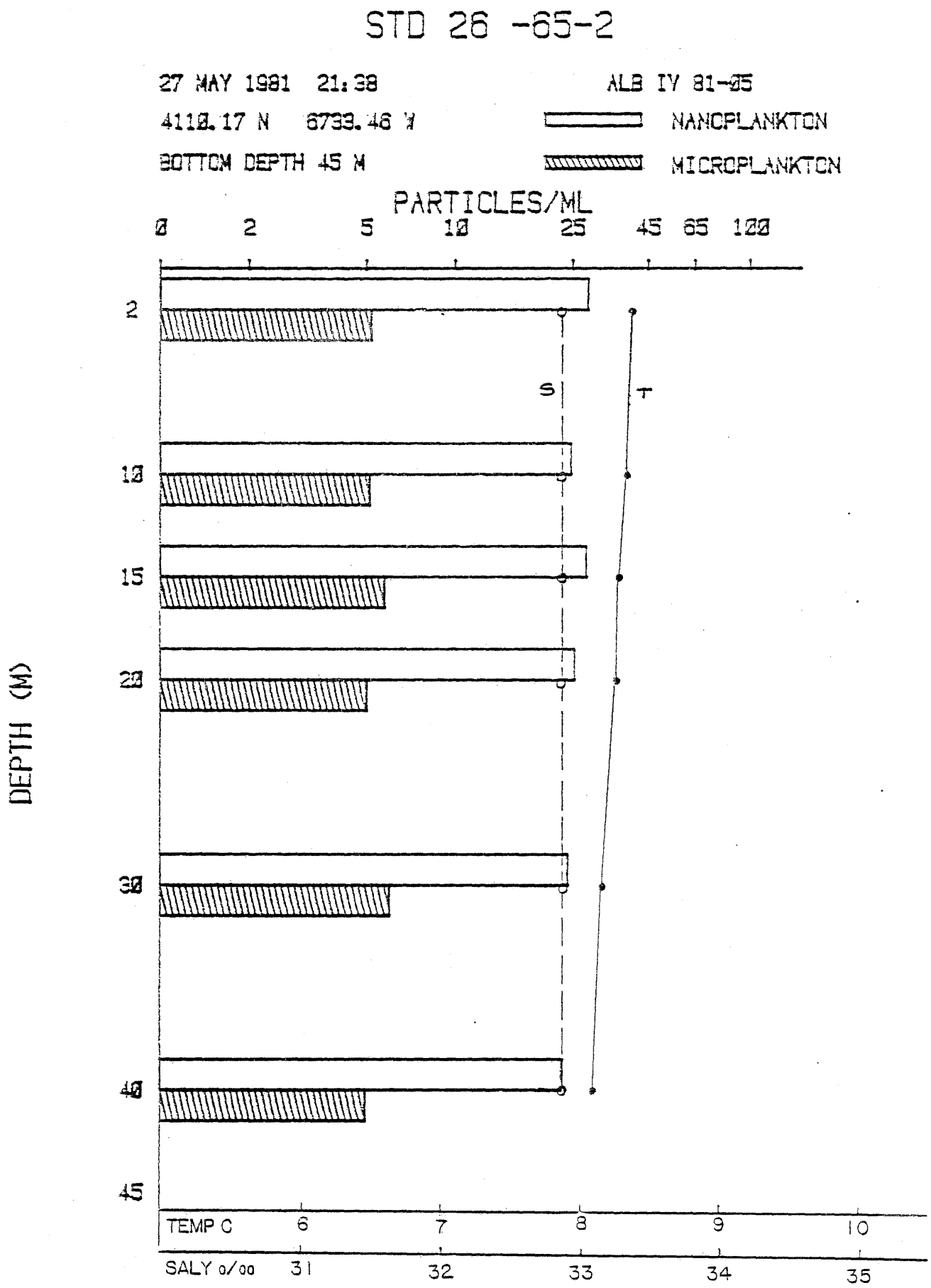

STD 26 -65-2
27 MAY 1981 21:38
4110.17 N 6733.46 W
BOTTOM DEPTH 45 M
ALB IV 81-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
2
10
15
20
30
40
45
S
T
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 31

ALB. IV 81-05 ON-BANK DROGUE-FOLLOWER SERIES STD 19-62-1 TO STD 26-65-2

NANNOPLANKTON AND MICROPLANKTON-SIZED PARTICULATE DENSITY AT 3 m.

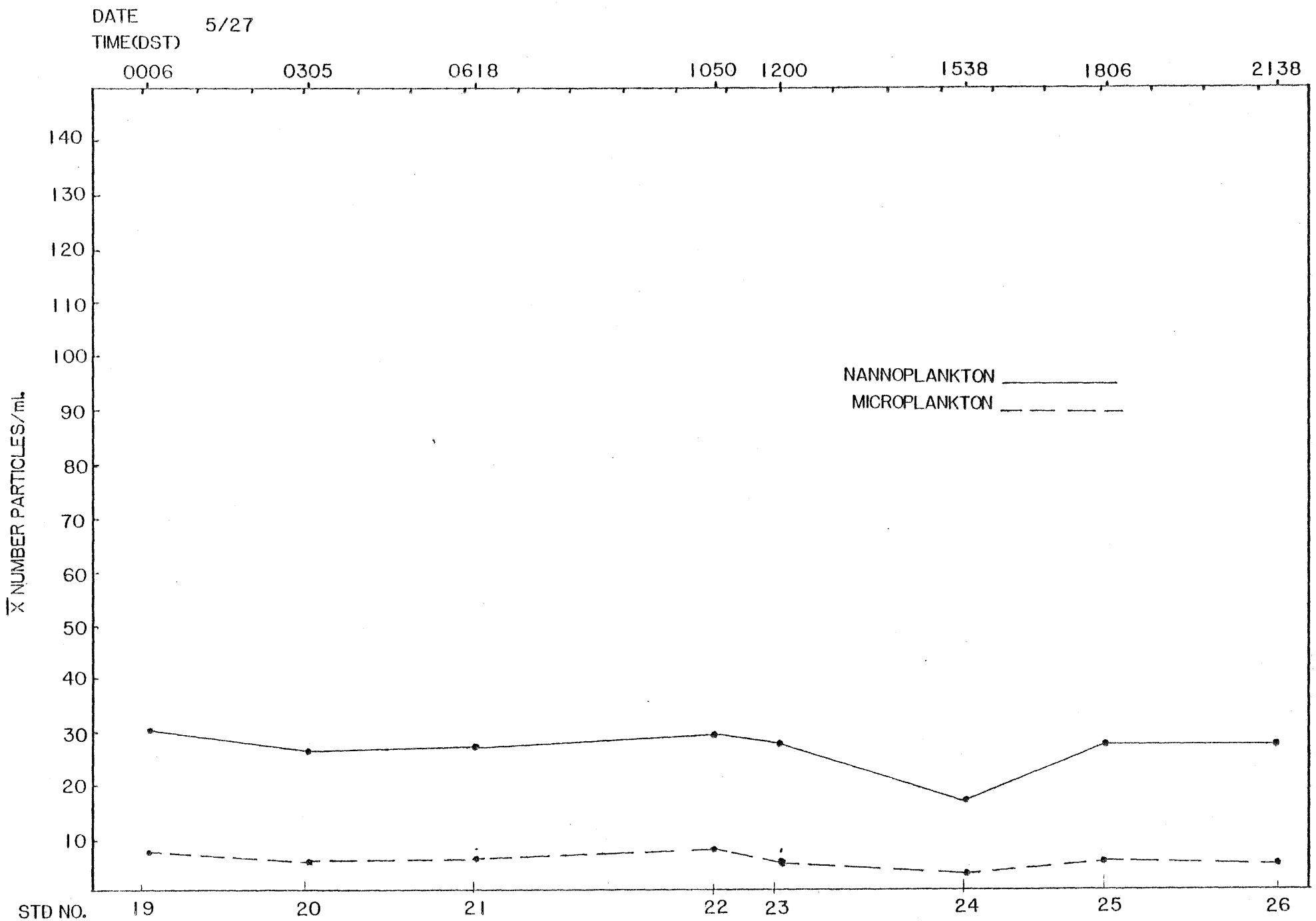


Figure 32

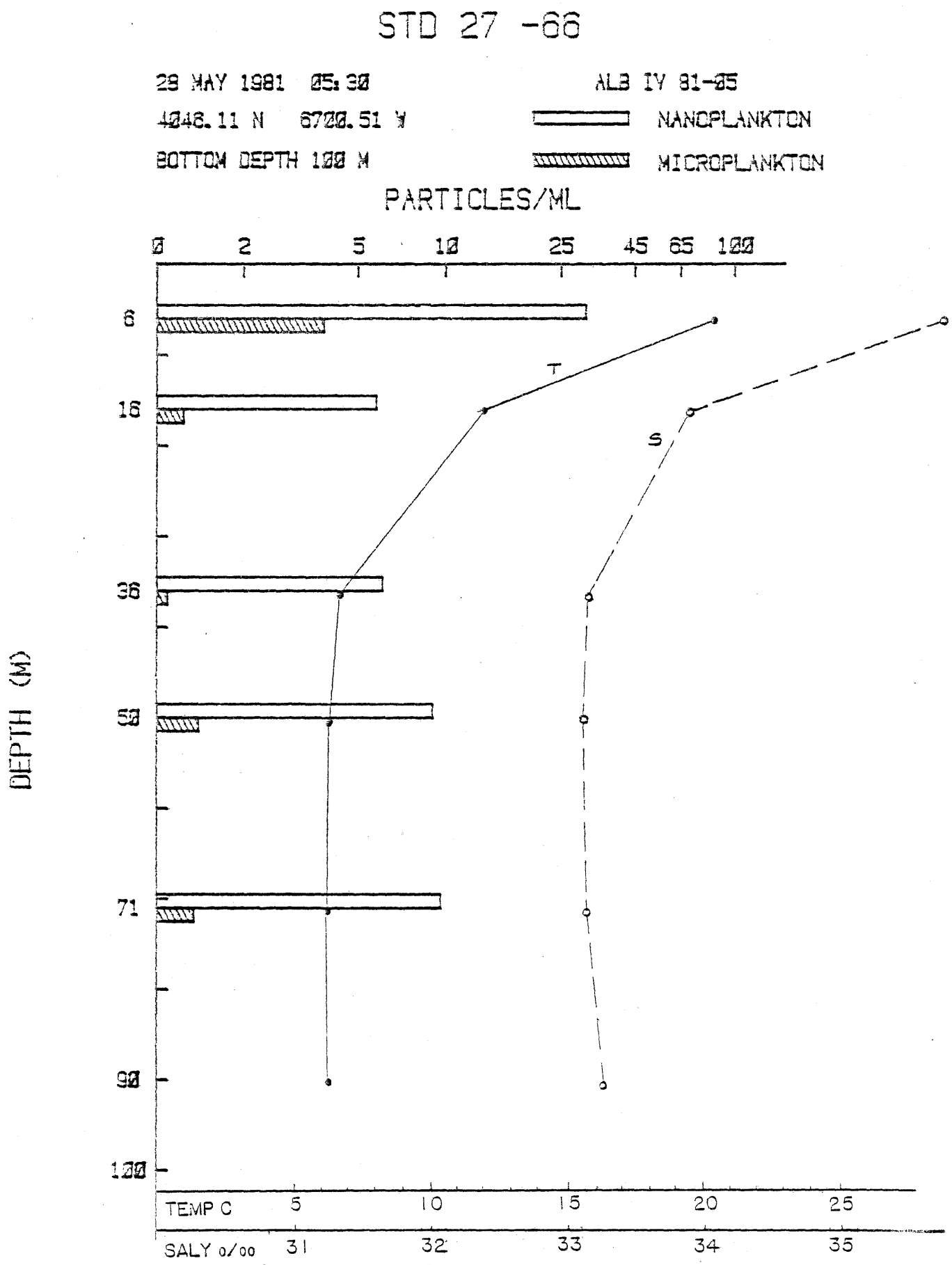

STD 27 -66
28 MAY 1981 05:30
4048.11 N 6700.51 W
BOTTOM DEPTH 100 M
ALB IV 81-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
6
16
36
50
71
90
100
T
S
TEMP C 5 10 15 20 25
SALY o/oo 31 32 33 34 35

Figure 33

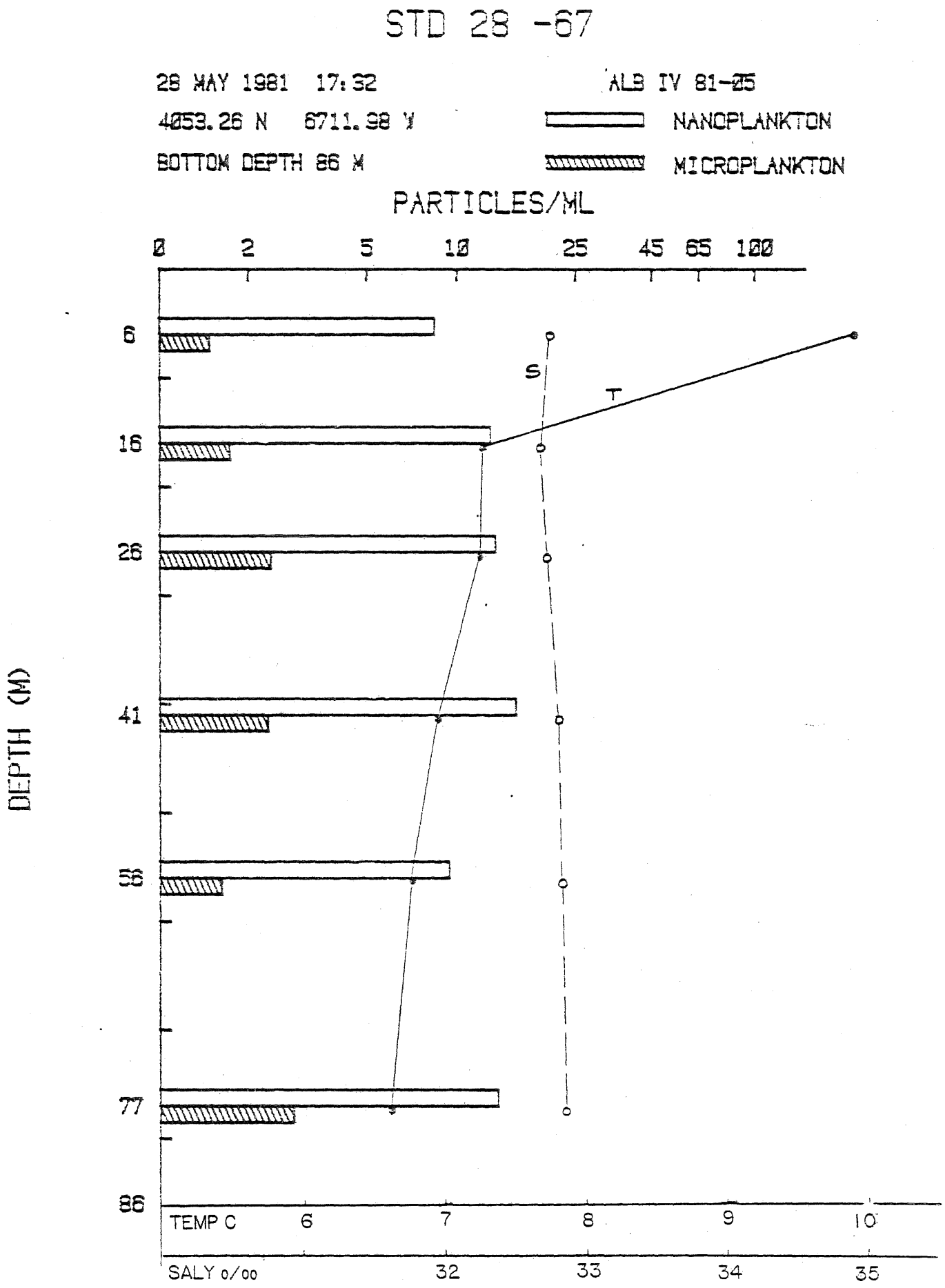

STD 28 -67
28 MAY 1981 17:32
4053.26 N 6711.98 W
BOTTOM DEPTH 86 M
ALB IV 81-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
6
16
26
41
56
77
86
S
T
TEMP C 6 7 8 9 10
SALY o/oo 32 33 34 35

Figure 34

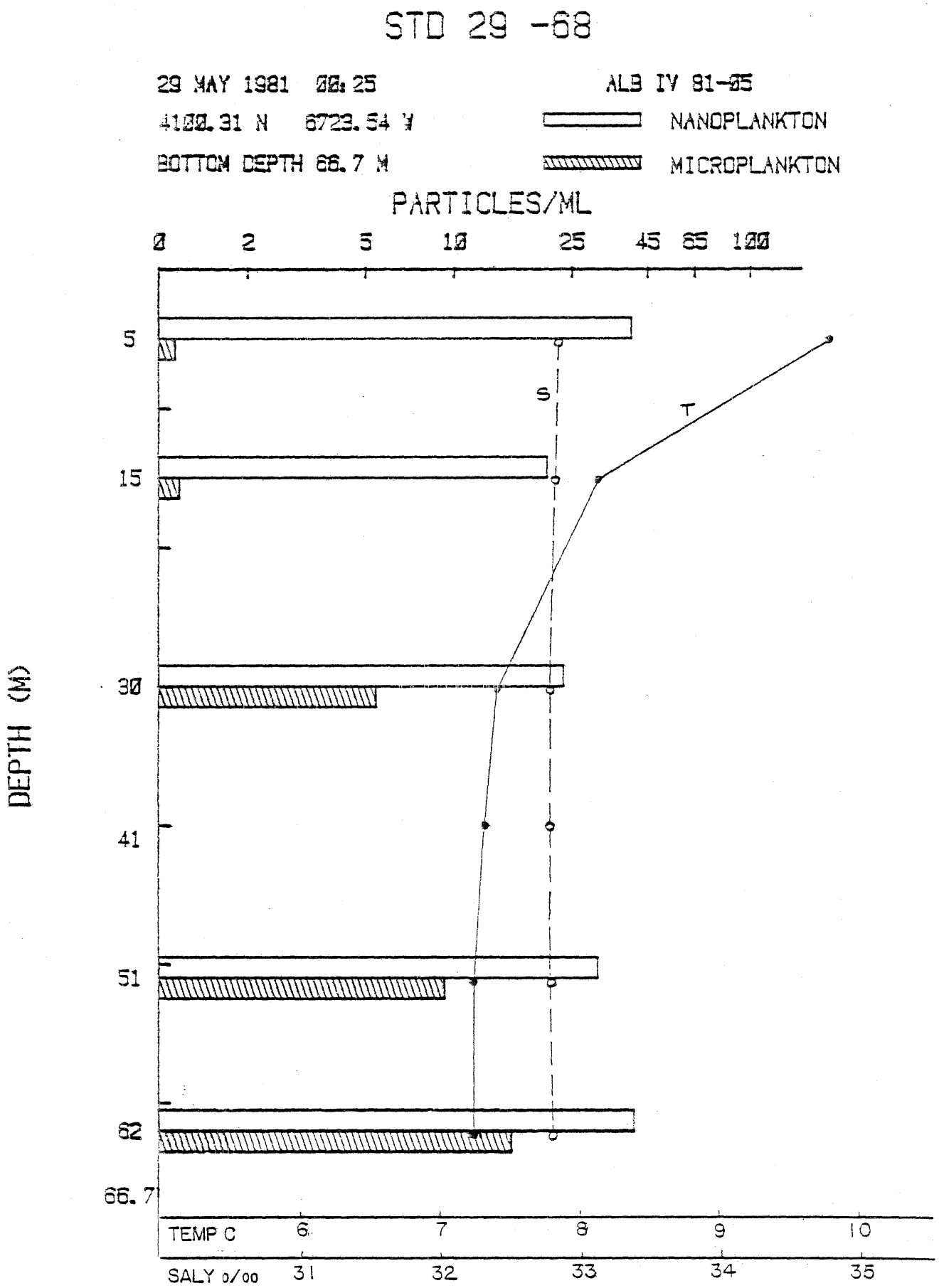

STD 29 -68
29 MAY 1981 00:25
4100.31 N 6723.54 W
BOTTOM DEPTH 66.7 M
ALB IV 81-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
5
15
30
41
51
62
66.7
S
T
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 35

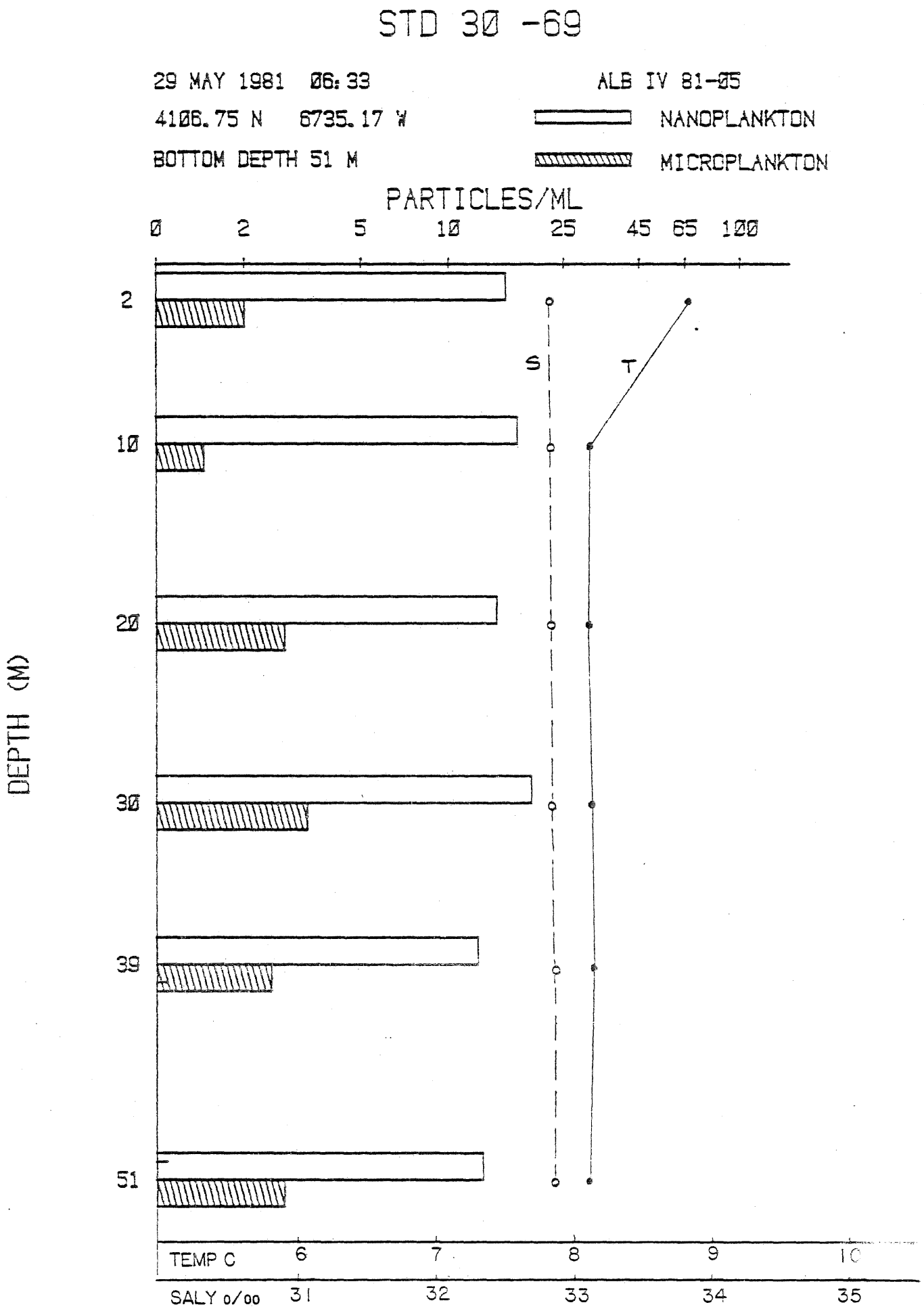

STD 30 -69
29 MAY 1981 06:33
4106.75 N 6735.17 W
BOTTOM DEPTH 51 M
ALB IV 81-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
2
10
20
30
39
51
S
T
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 36

ALB. IV 81-05 TRANSECT SERIES STD 27-66 TO STD 30-69
NANNOPLANKTON AND MICROPLANKTON-SIZED PARTICULATE DENSITY AT 2-6 m.

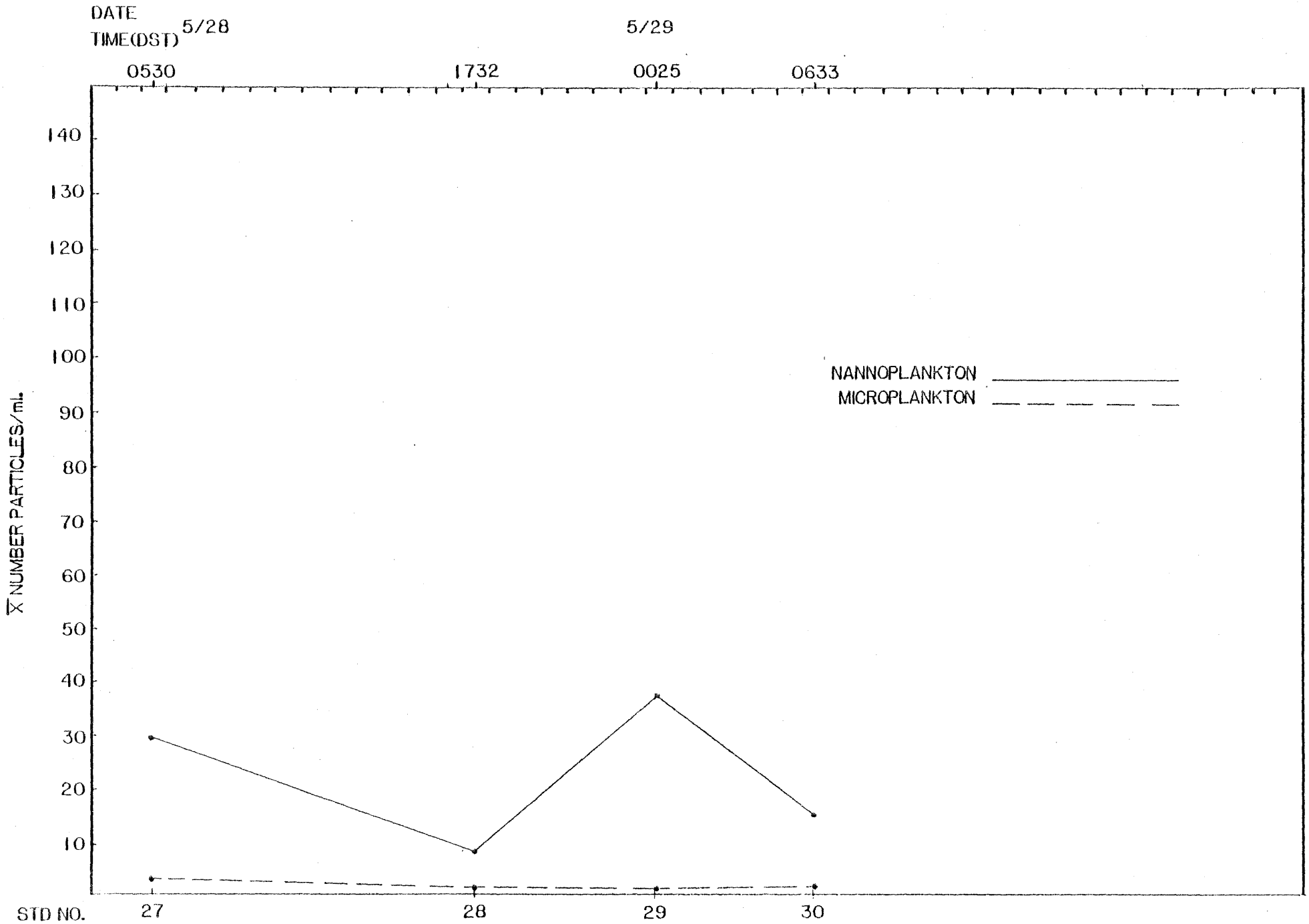


Figure 37

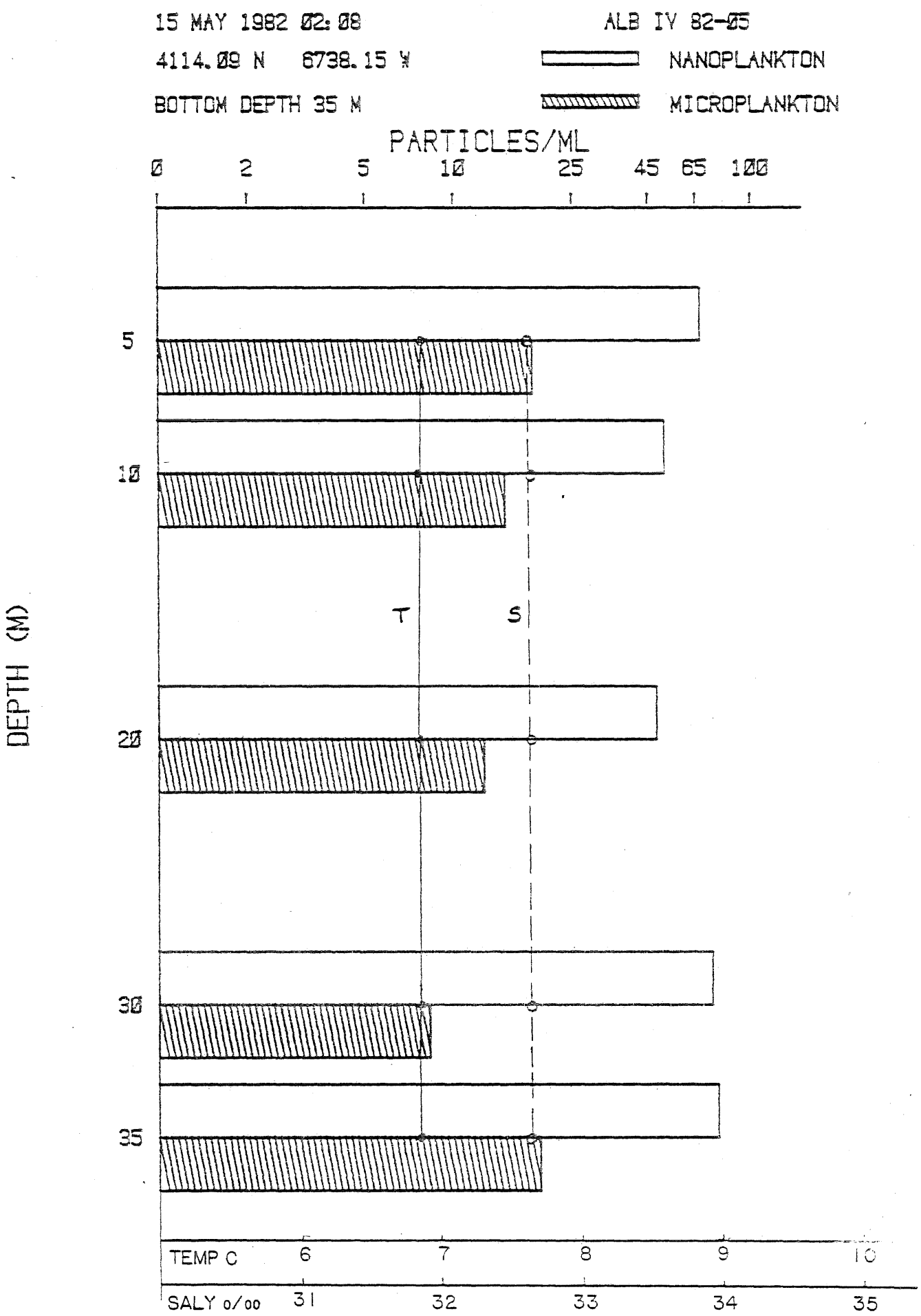

STD 1 -43
15 MAY 1982 02:08
4114.09 N 6738.15 W
BOTTOM DEPTH 35 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
5
10
20
30
35
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 38

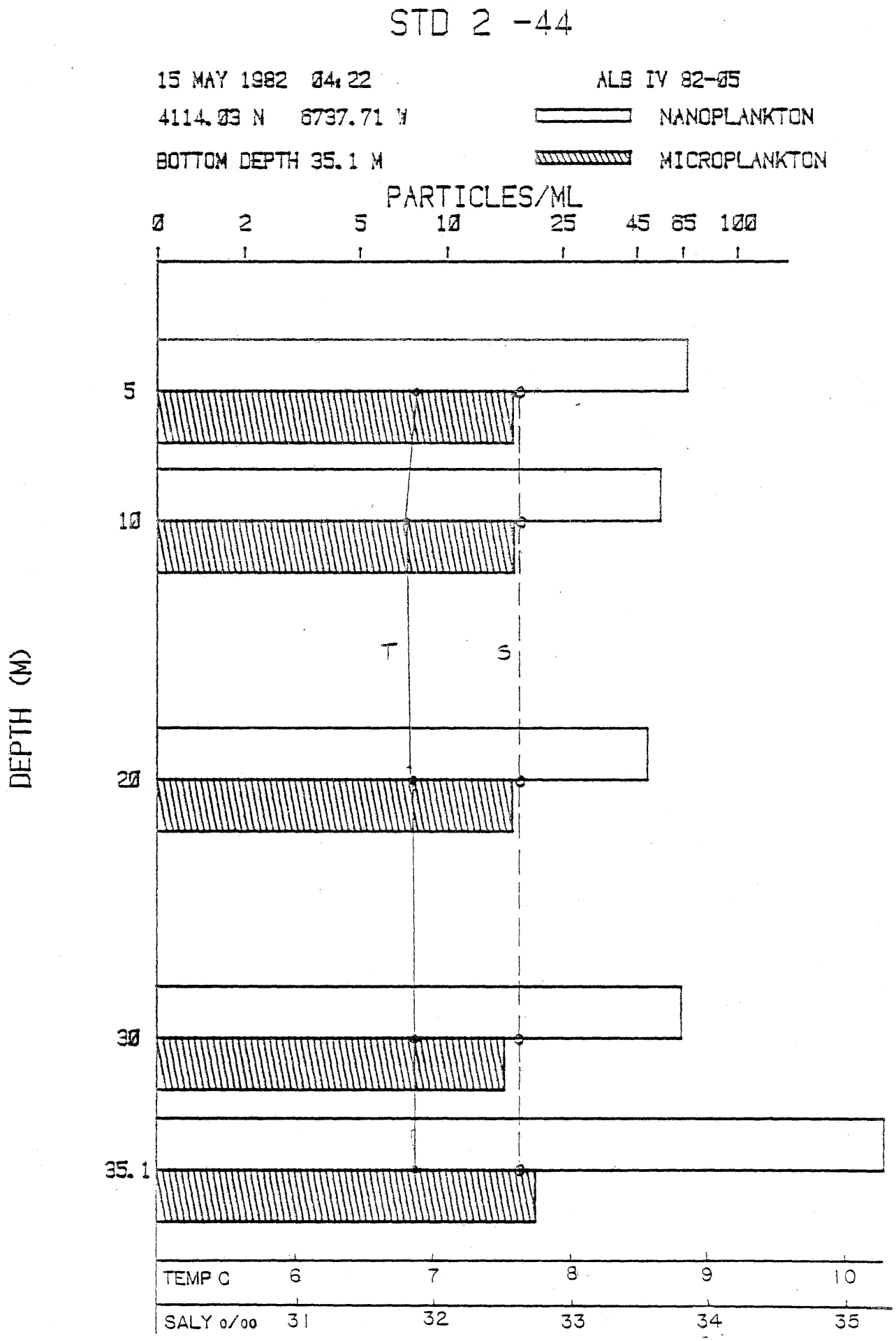

STD 2 -44
15 MAY 1982 04:22
4114.03 N 6737.71 W
BOTTOM DEPTH 35.1 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
5
10
20
30
35.1
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 39

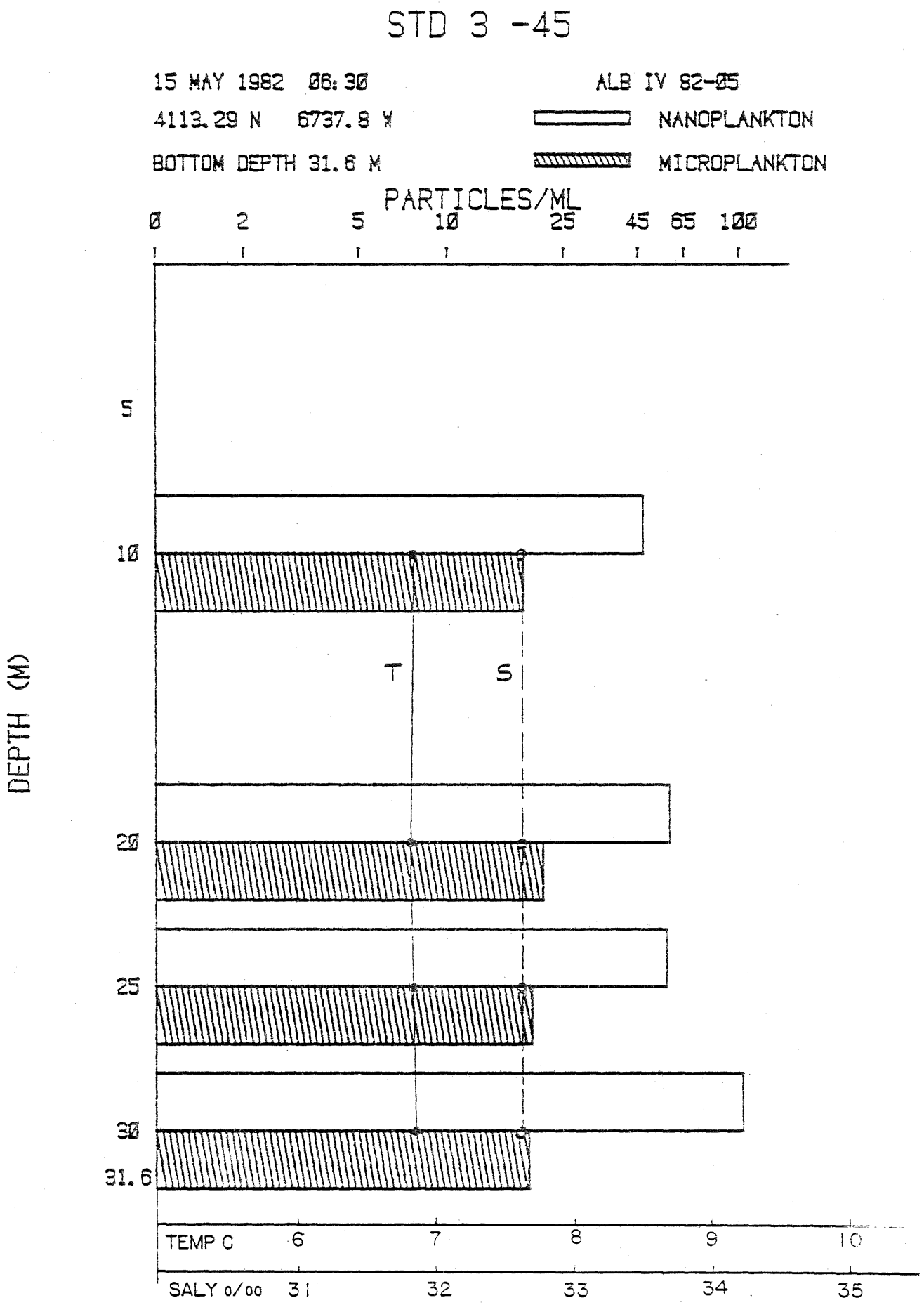

STD 3 -45
15 MAY 1982 06:30
4113.29 N 6737.8 W
BOTTOM DEPTH 31.6 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
5
10
20
25
30
31.6
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 40

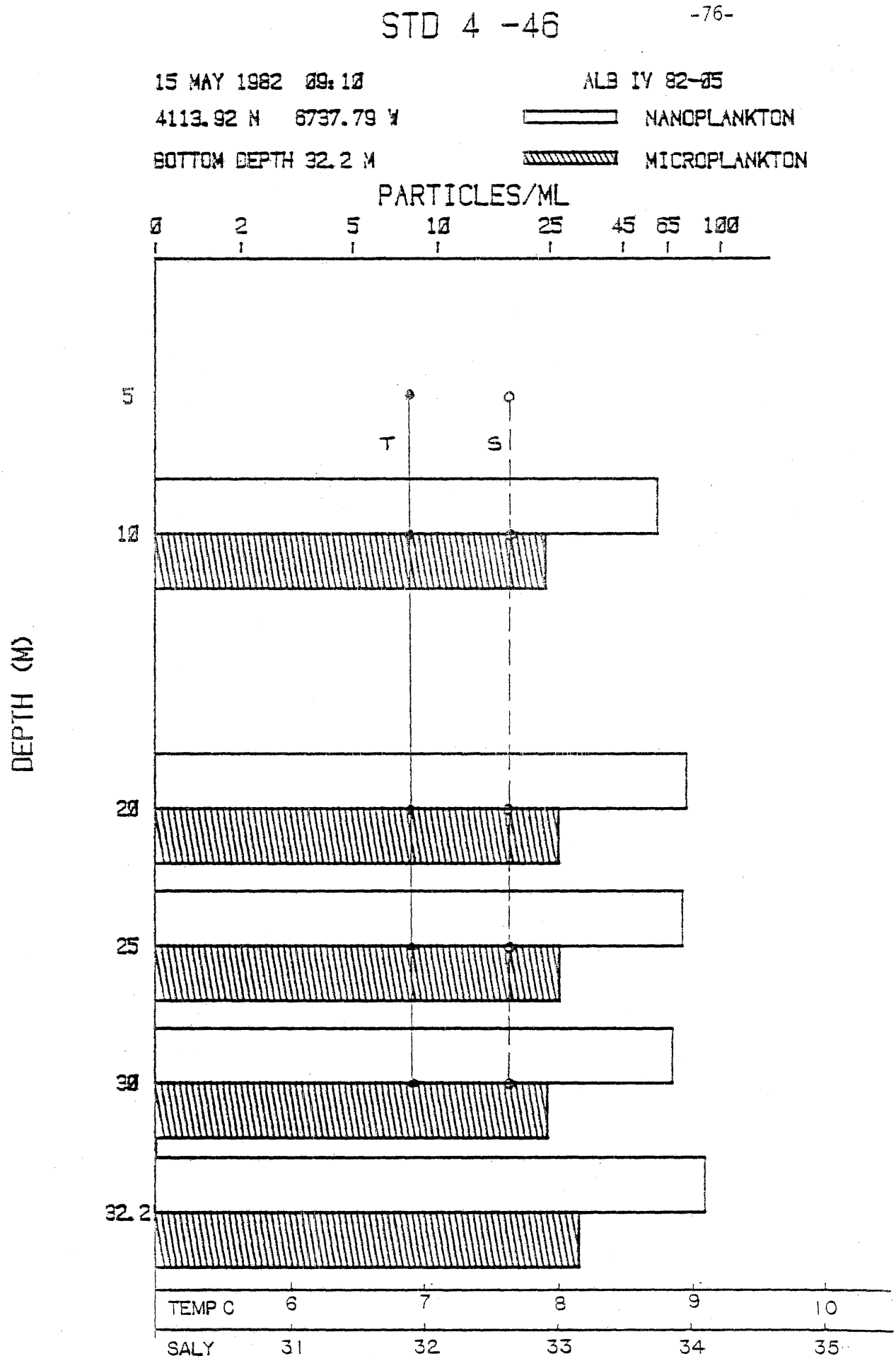

STD 4 -46
15 MAY 1982 09:10
4113.92 N 6737.79 W
BOTTOM DEPTH 32.2 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
5
10
20
25
30
32.2
T
S
TEMP C 6 7 8 9 10
SALY 31 32 33 34 35

Figure 41

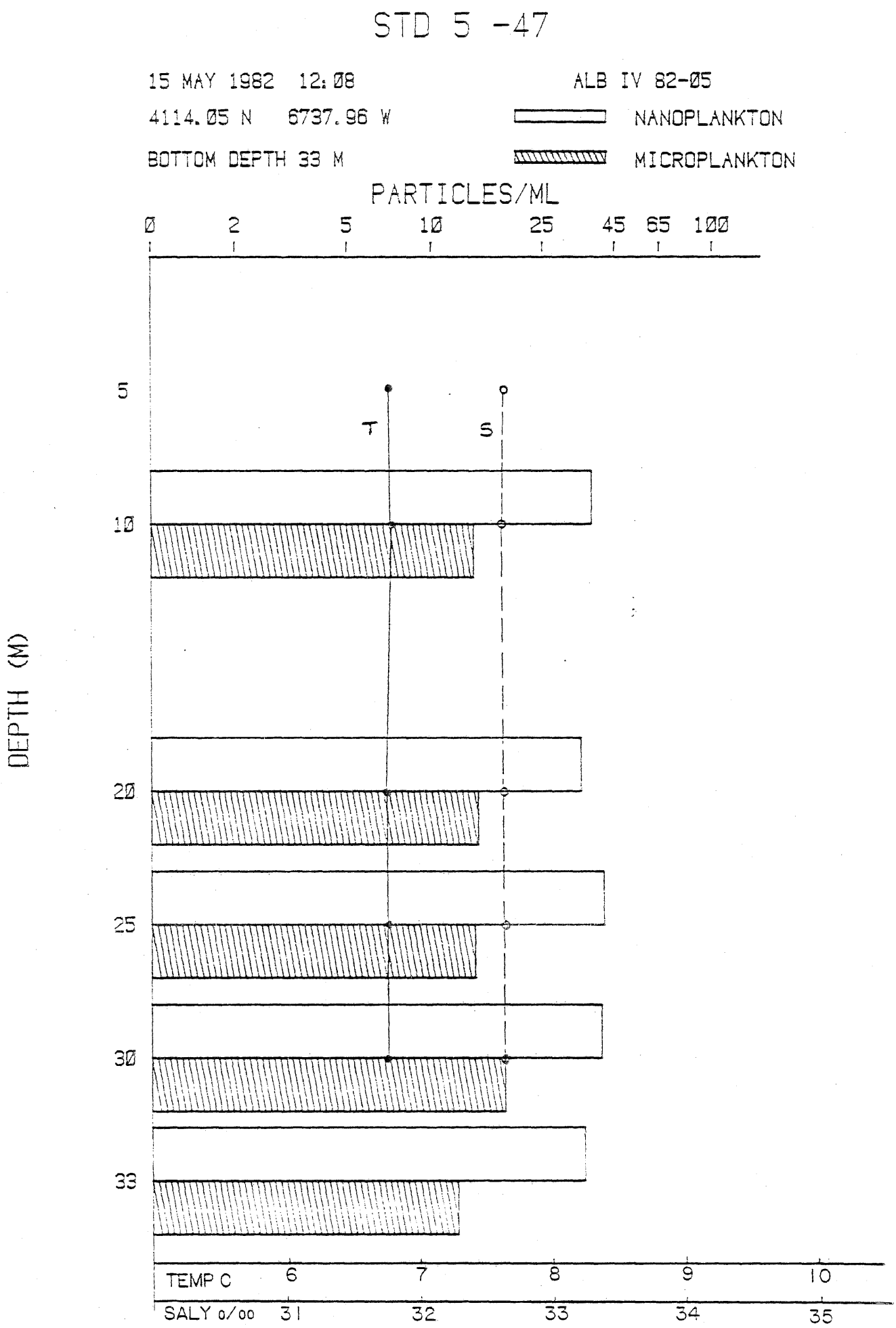

STD 5 -47
15 MAY 1982 12:08
ALB IV 82-05
4114.05 N 6737.96 W
NANOPLANKTON
BOTTOM DEPTH 33 M
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
5
10
20
25
30
33
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 42

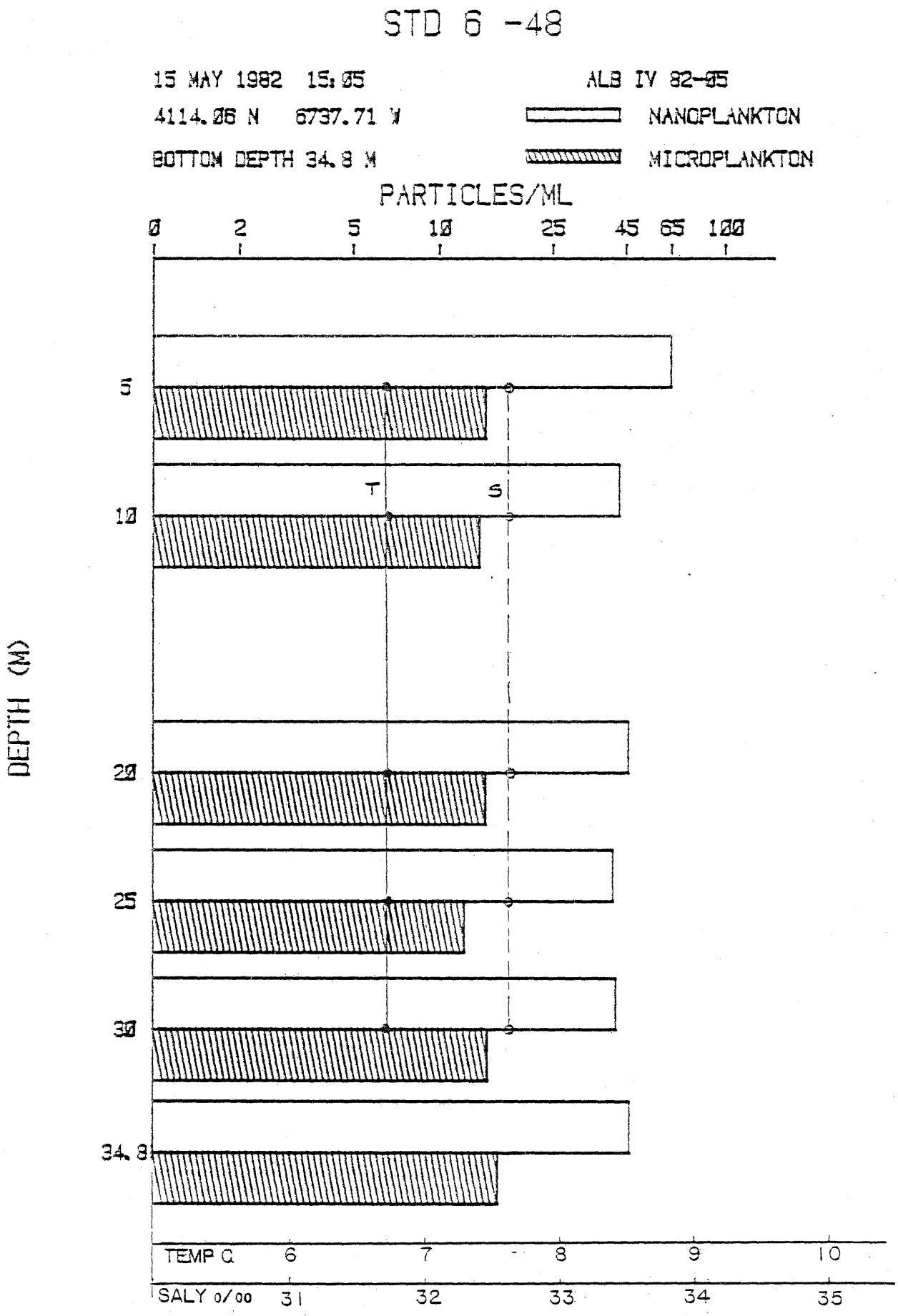

STD 6 -48
15 MAY 1982 15:05
4114.06 N 6737.71 W
BOTTOM DEPTH 34.8 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
5
10
20
25
30
34.8
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 43

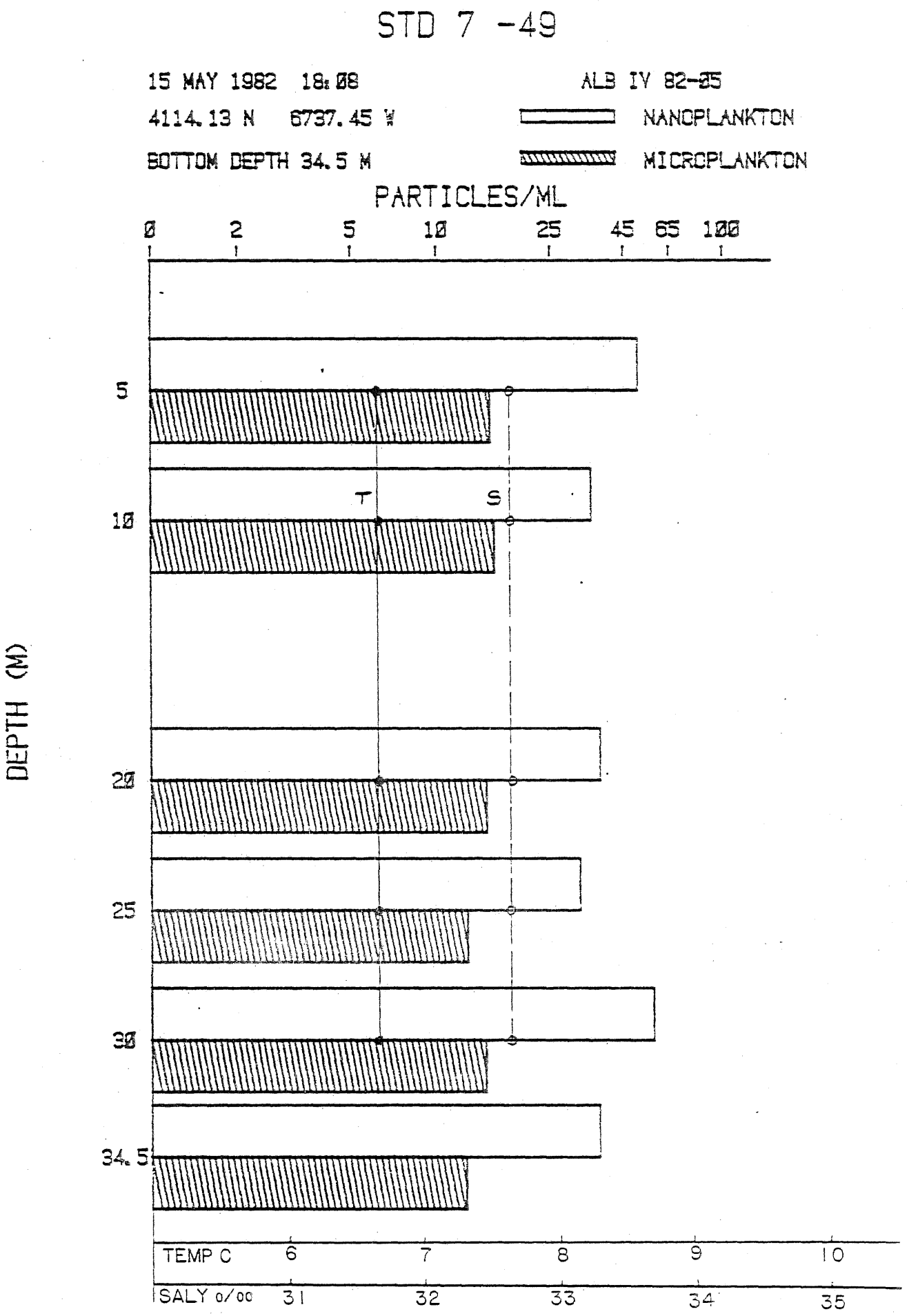

STD 7 -49
15 MAY 1982 18:08
4114.13 N 6737.45 W
BOTTOM DEPTH 34.5 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
5
10
20
25
30
34.5
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 44

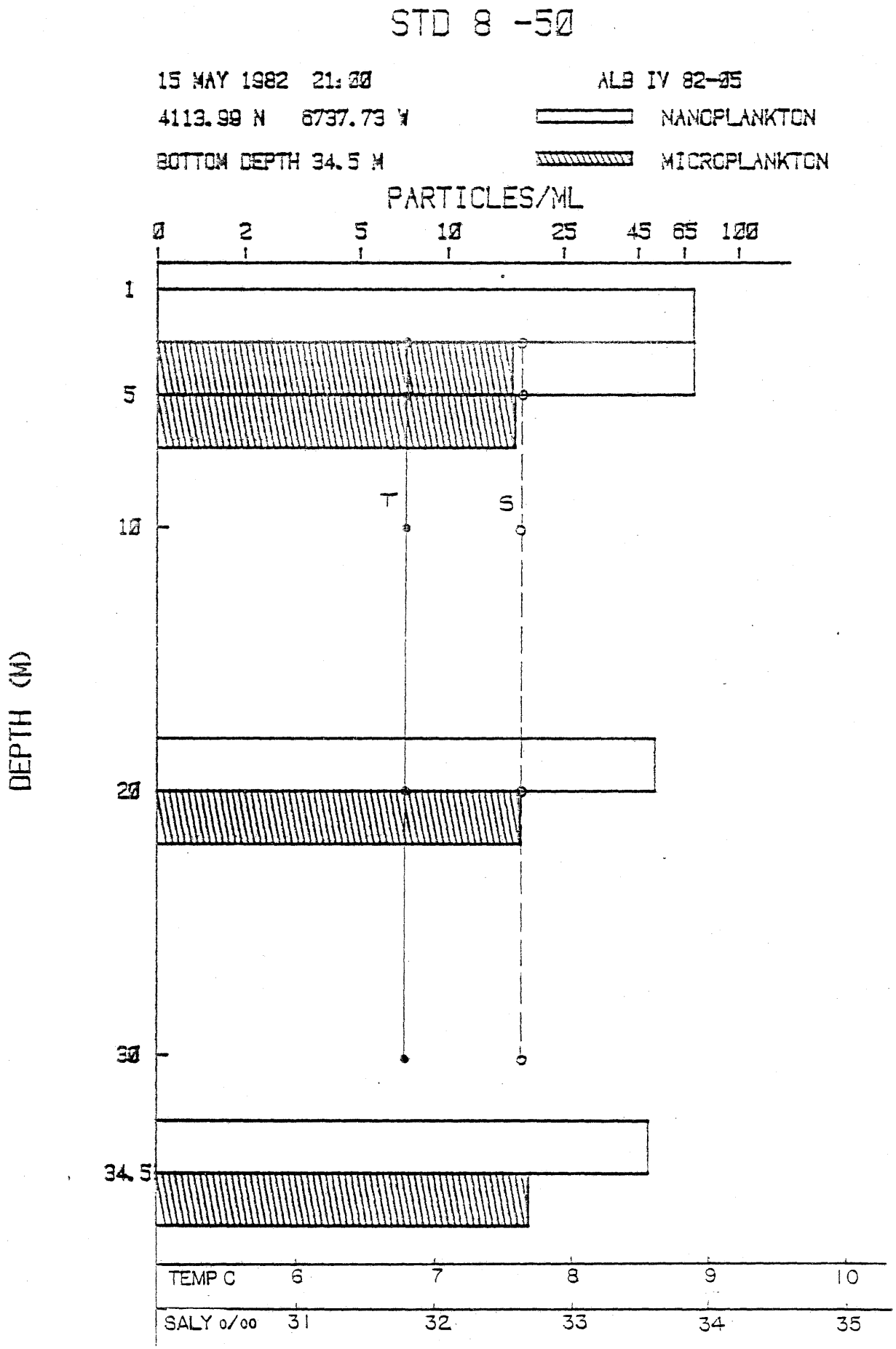

STD 8 -50
15 MAY 1982 21:00
4113.98 N 6737.73 W
BOTTOM DEPTH 34.5 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
1
5
10
20
30
34.5
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 45

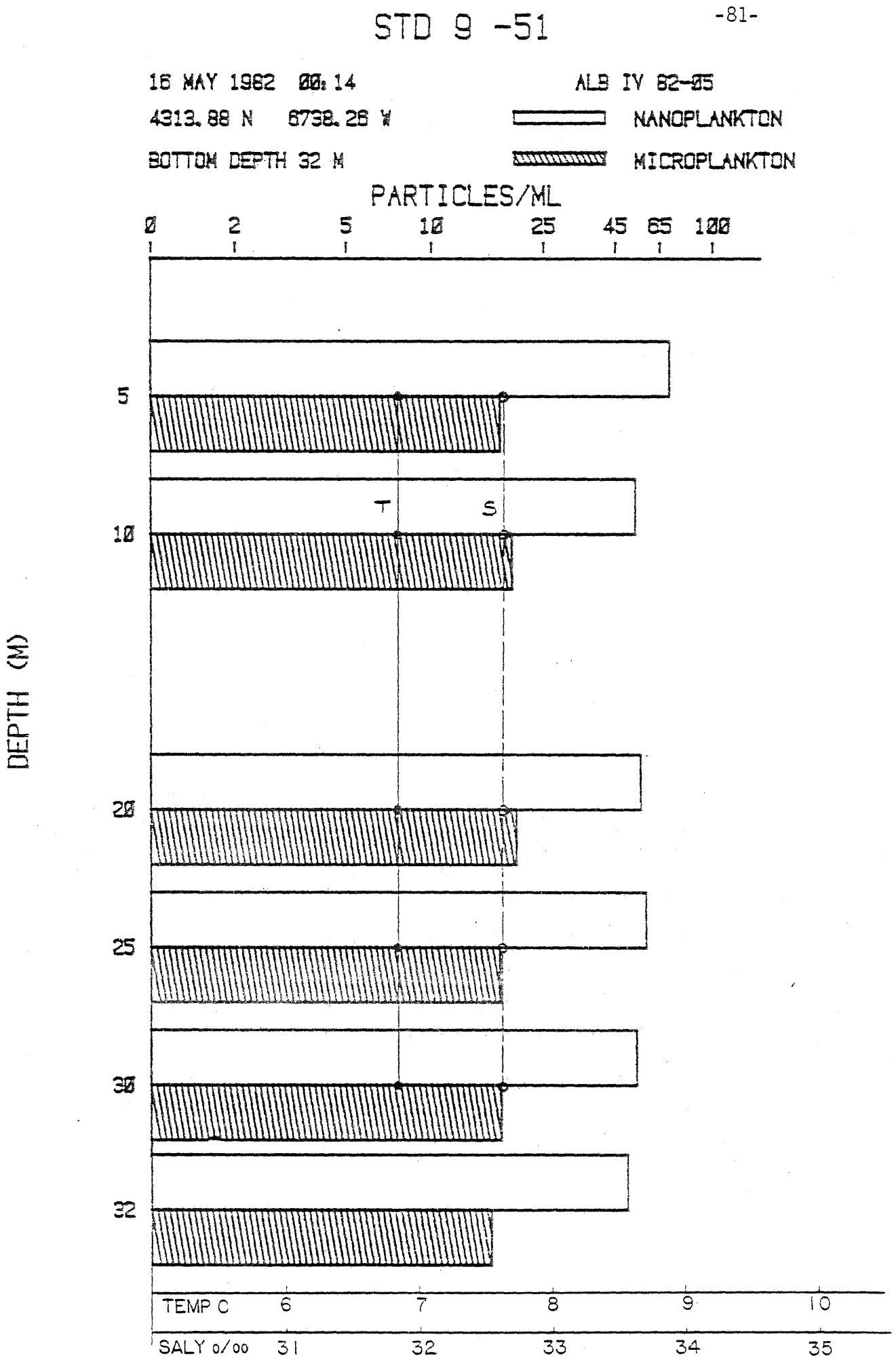

STD 9 -51
16 MAY 1982 00:14
4313.88 N 6738.26 W
BOTTOM DEPTH 32 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
5
10
20
25
30
32
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 46

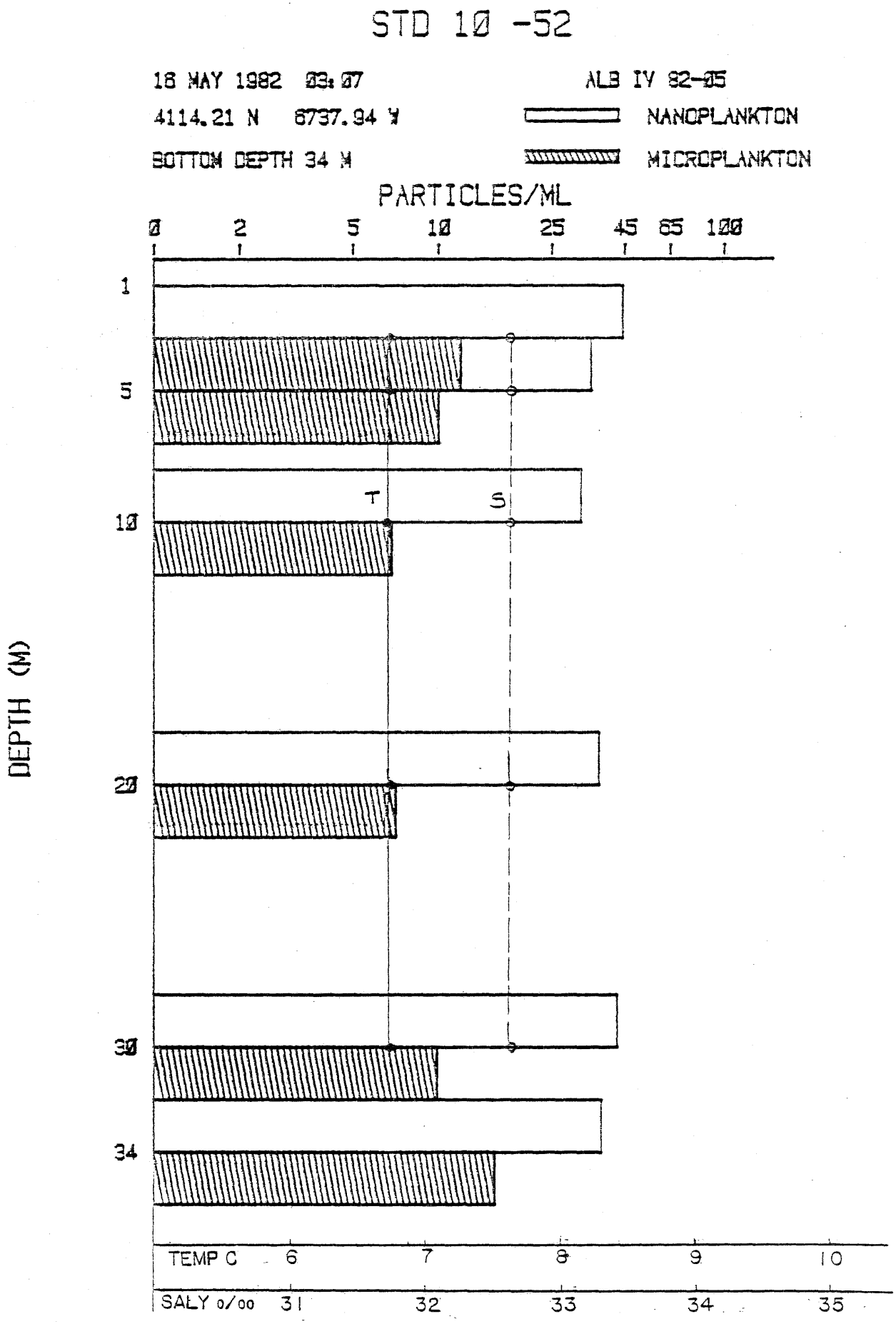
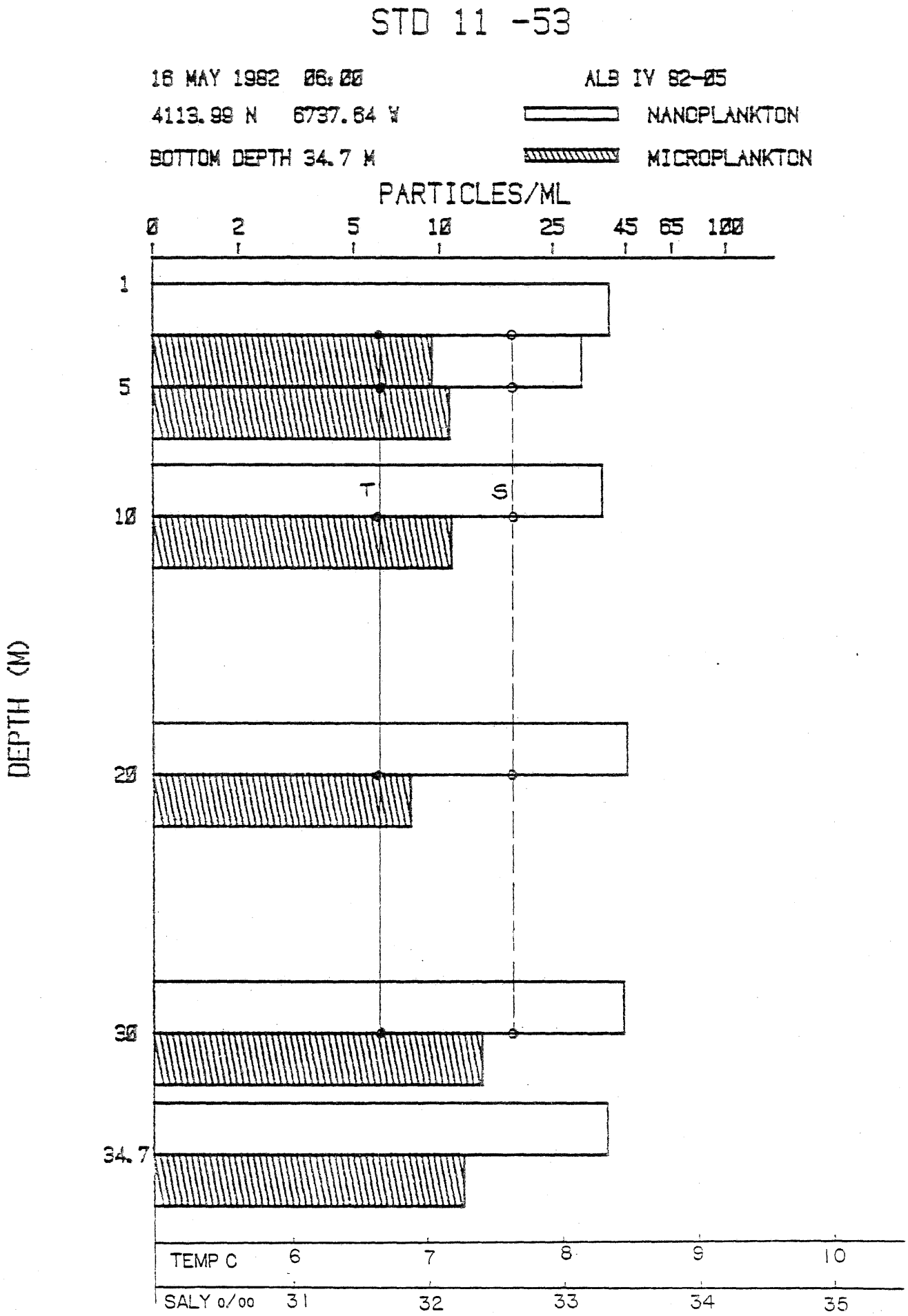

STD 10 -52
18 MAY 1982 03:07
4114.21 N 6737.94 W
BOTTOM DEPTH 34 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
1
5
10
20
30
34
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 47


STD 11 -53
16 MAY 1982 06:00
4113.99 N 6737.64 W
BOTTOM DEPTH 34.7 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
1
5
10
20
30
34.7
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

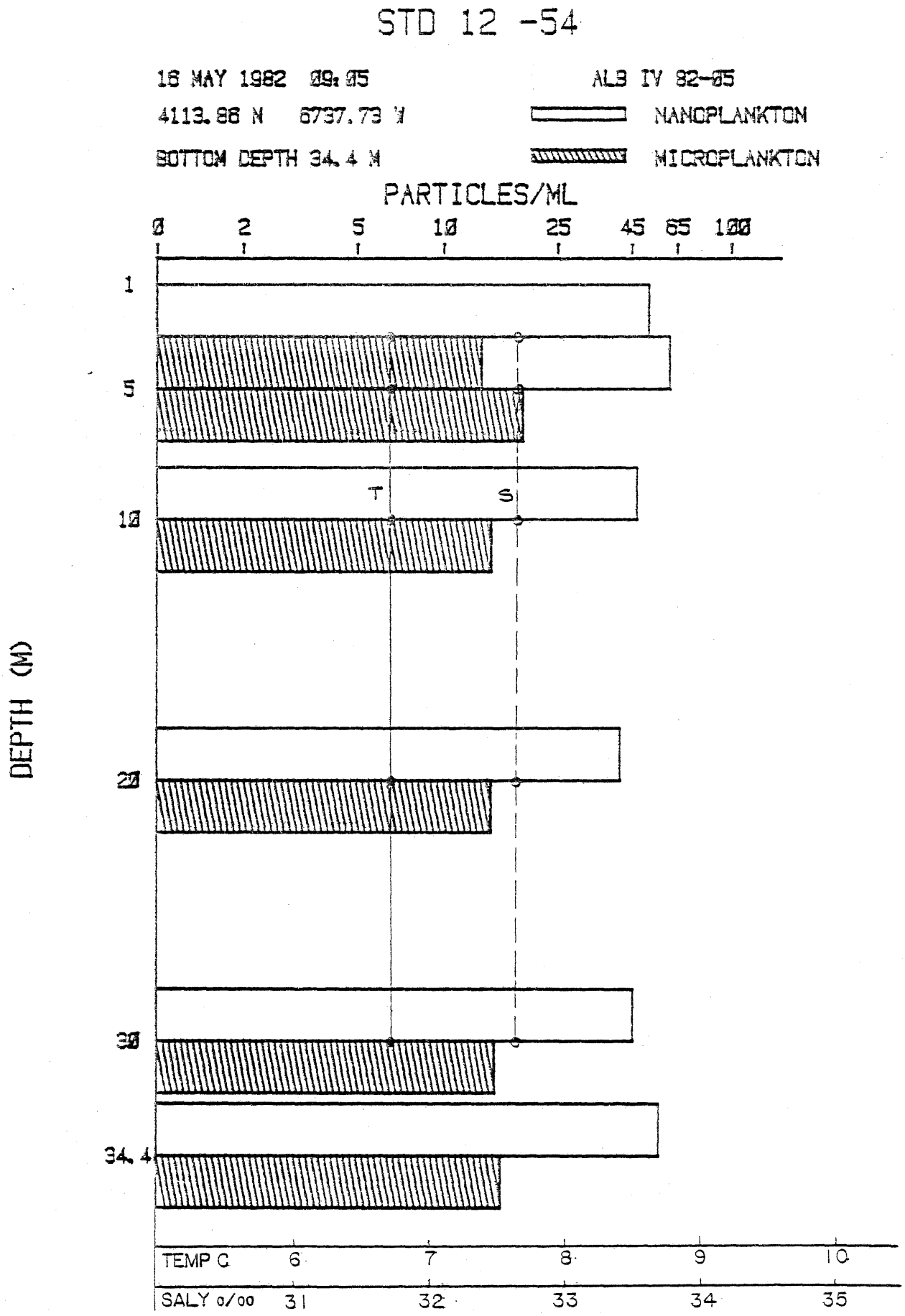

STD 12 -54
16 MAY 1982 09:05
4113.86 N 6737.73 W
BOTTOM DEPTH 34.4 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
1
5
10
20
30
34.4
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 49

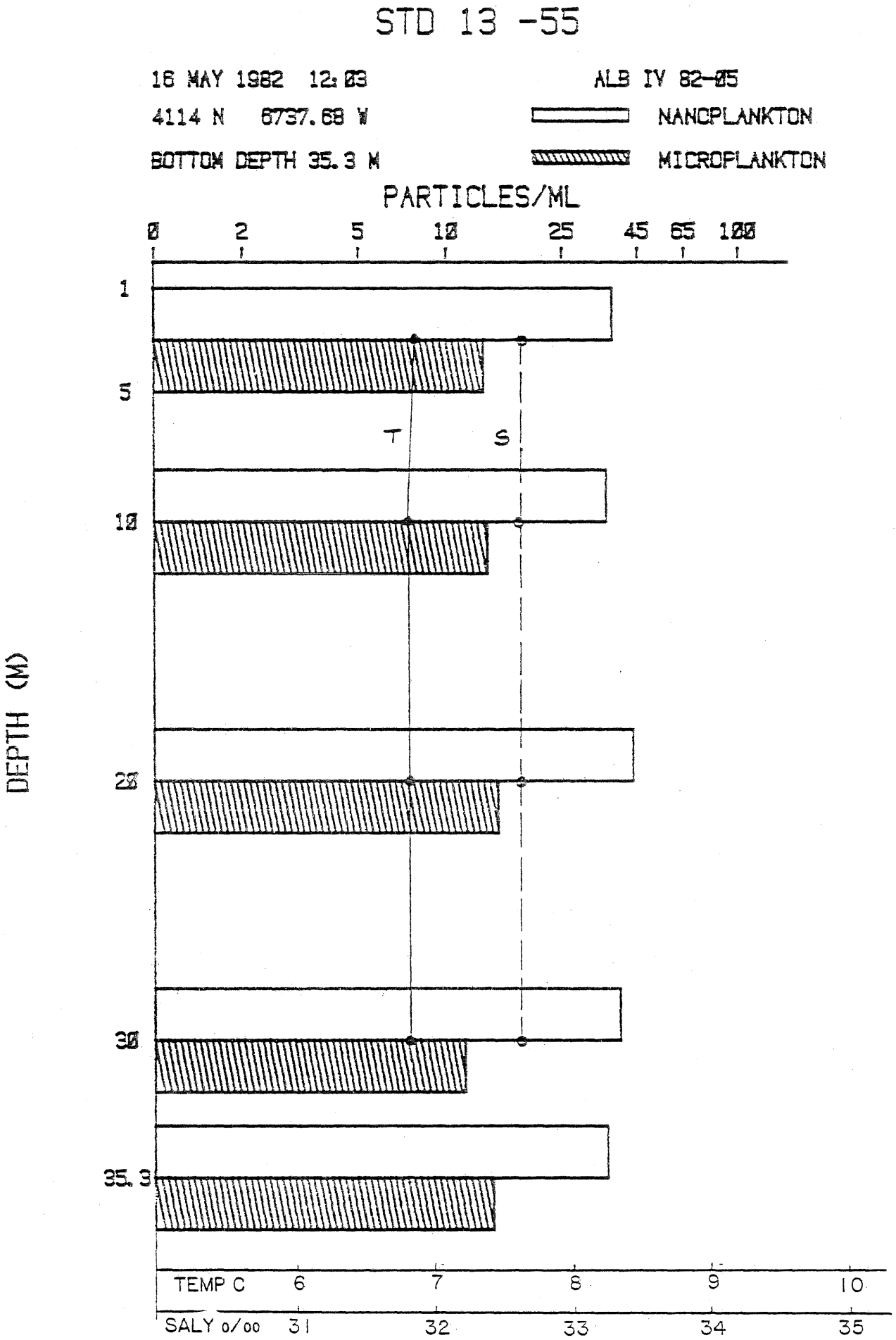

STD 13 -55
16 MAY 1982 12:03
4114 N 6737.68 W
BOTTOM DEPTH 35.3 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
1
5
10
20
30
35.3
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 50

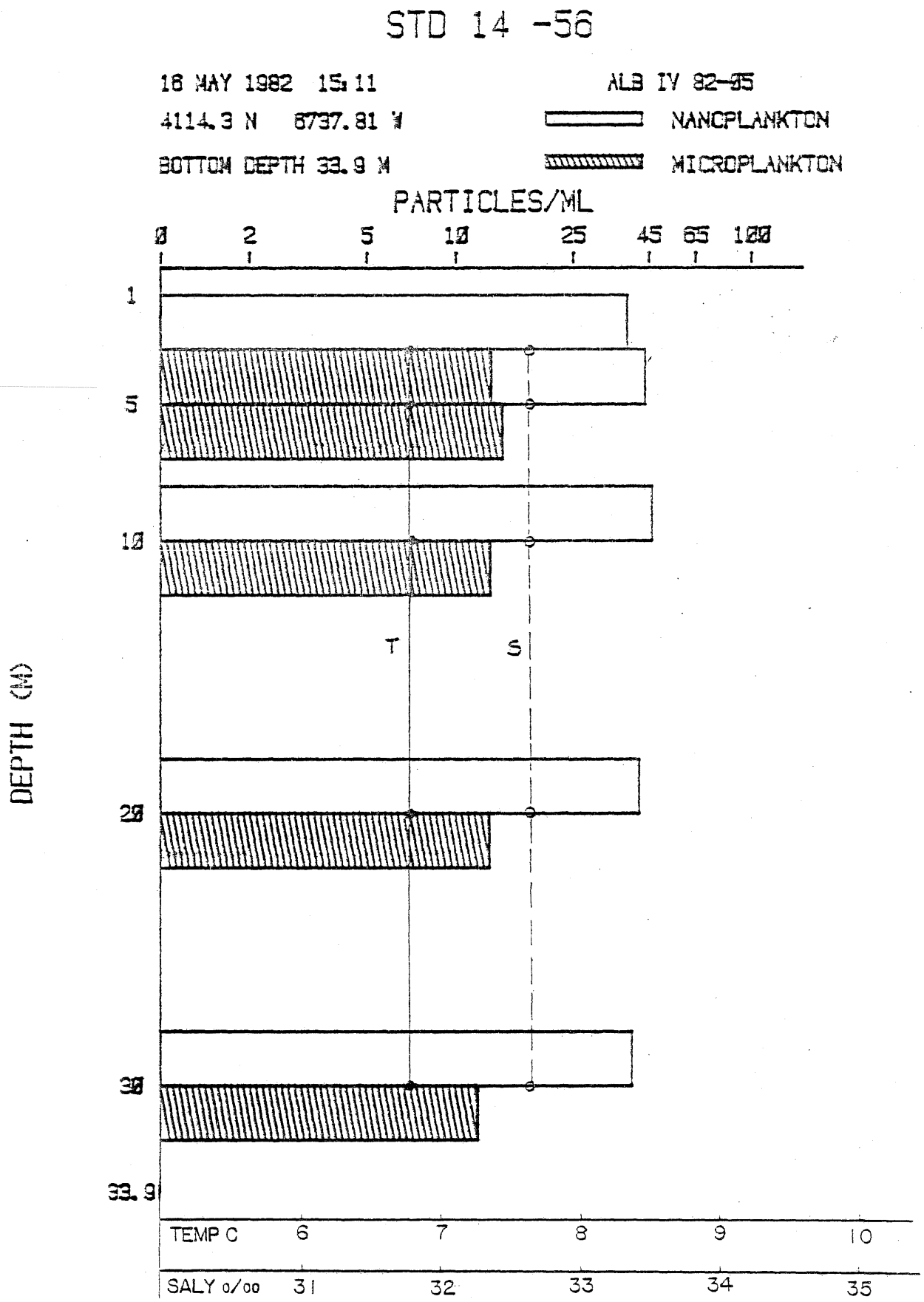

STD 14 -56
18 MAY 1982 15:11
4114.3 N 6737.81 W
BOTTOM DEPTH 33.9 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
1
5
10
20
30
33.9
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 51

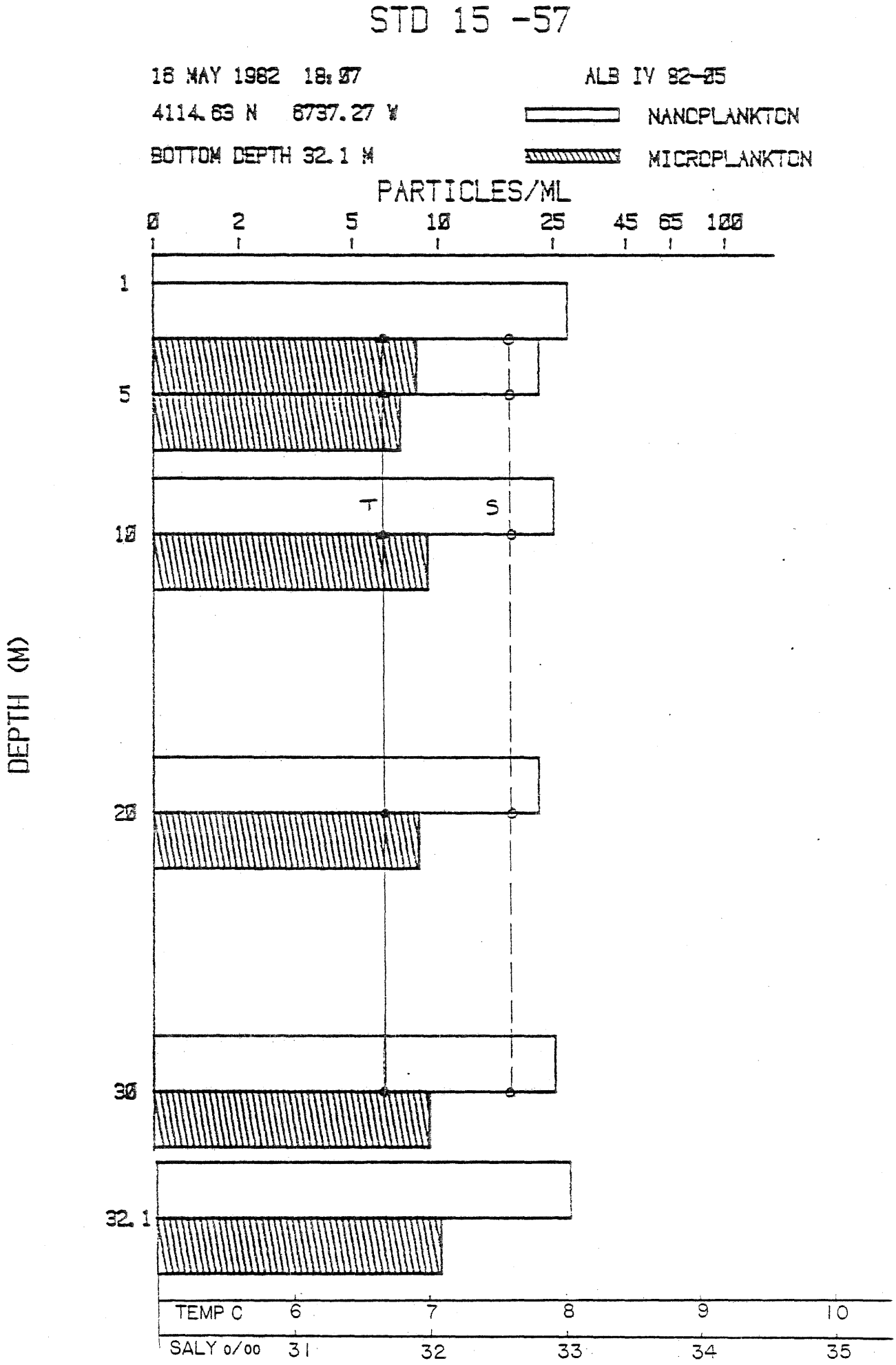

STD 15 -57
18 MAY 1982 18:07
4114.63 N 6737.27 W
BOTTOM DEPTH 32.1 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
1
5
10
20
30
32.1
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 52

ALB. IV 82-05 ON-BANK FIXED-STATION SERIES STD 1-43 TO STD 15-57
NANNOPLANKTON AND MICROPLANKTON-SIZED PARTICULATE DENSITY AT 5 m.

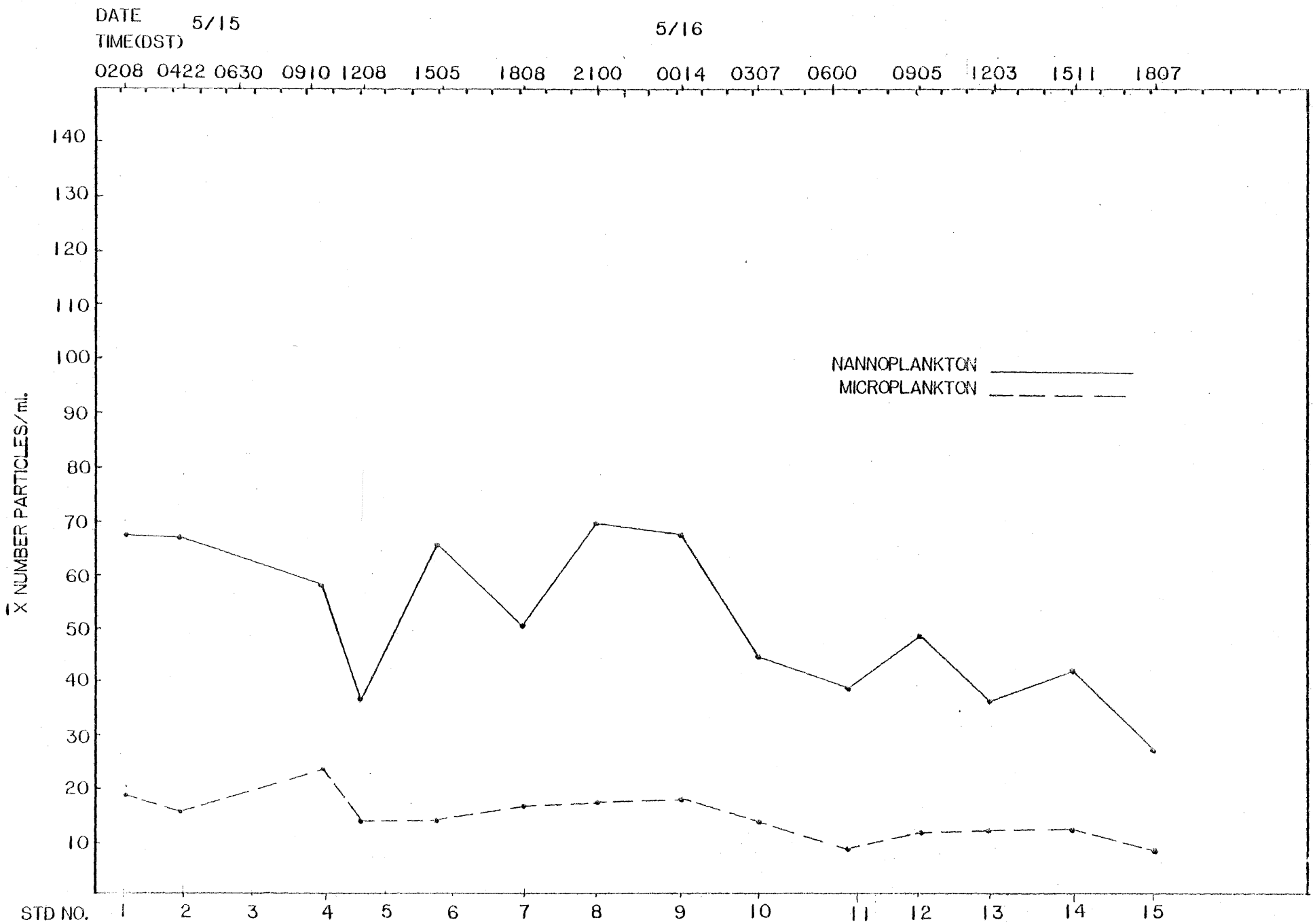


Figure 53

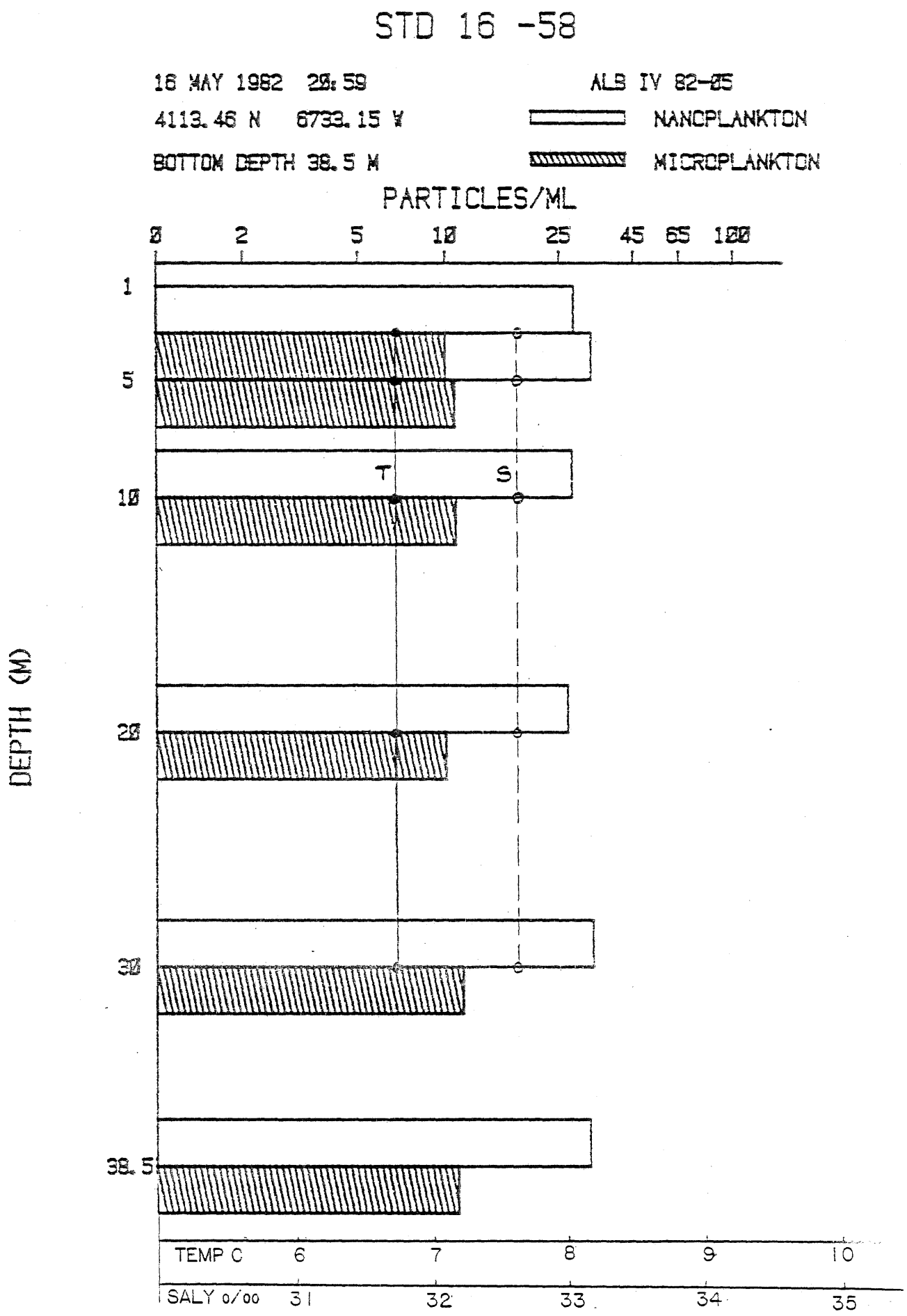

STD 16 -58
16 MAY 1982 20:59
4113.46 N 6733.15 W
BOTTOM DEPTH 38.5 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
1
5
10
20
30
38.5
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 54

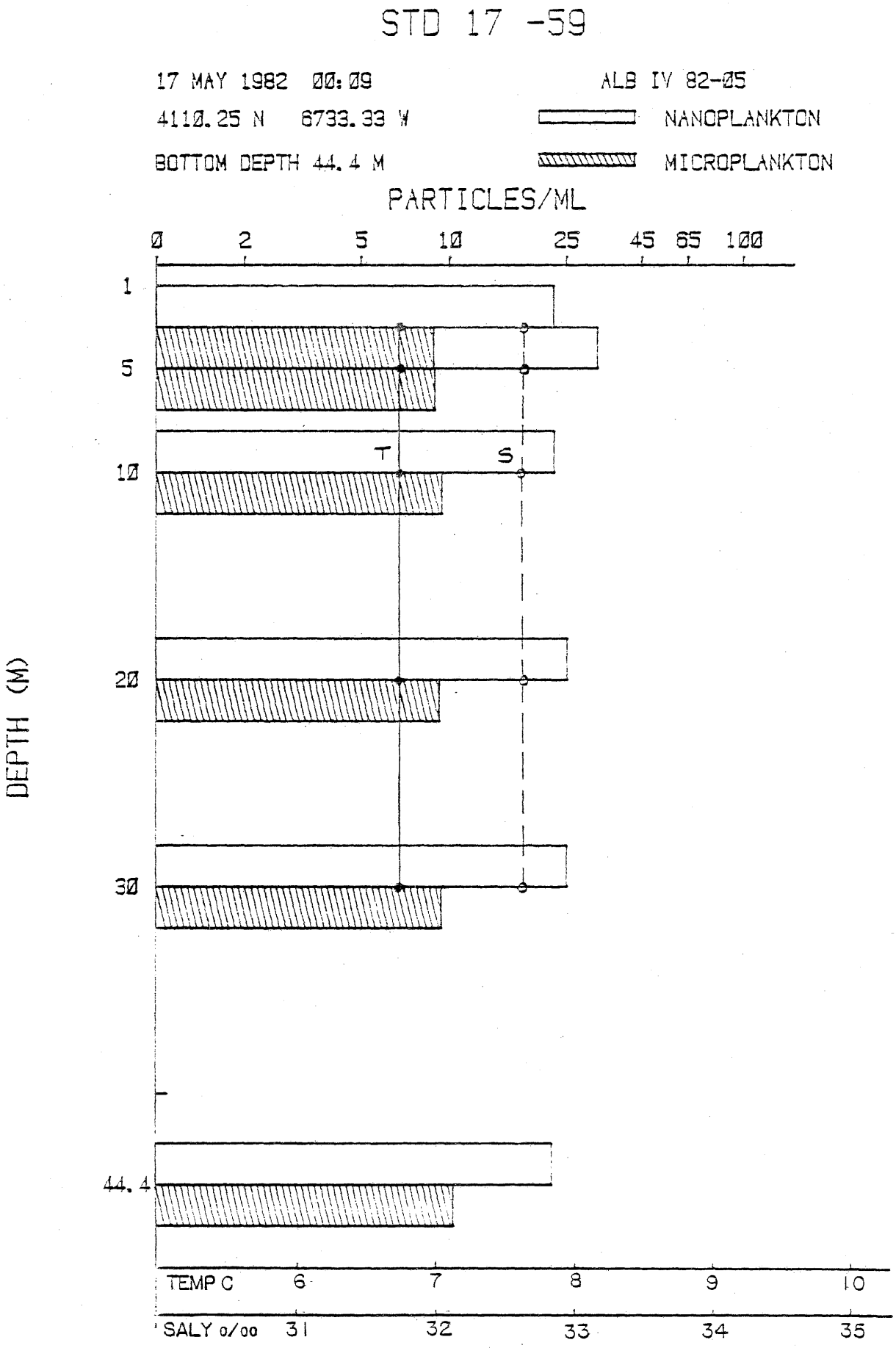

STD 17 -59
17 MAY 1982 00:09
4110.25 N 6733.33 W
BOTTOM DEPTH 44.4 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
1
5
10
20
30
44.4
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 55

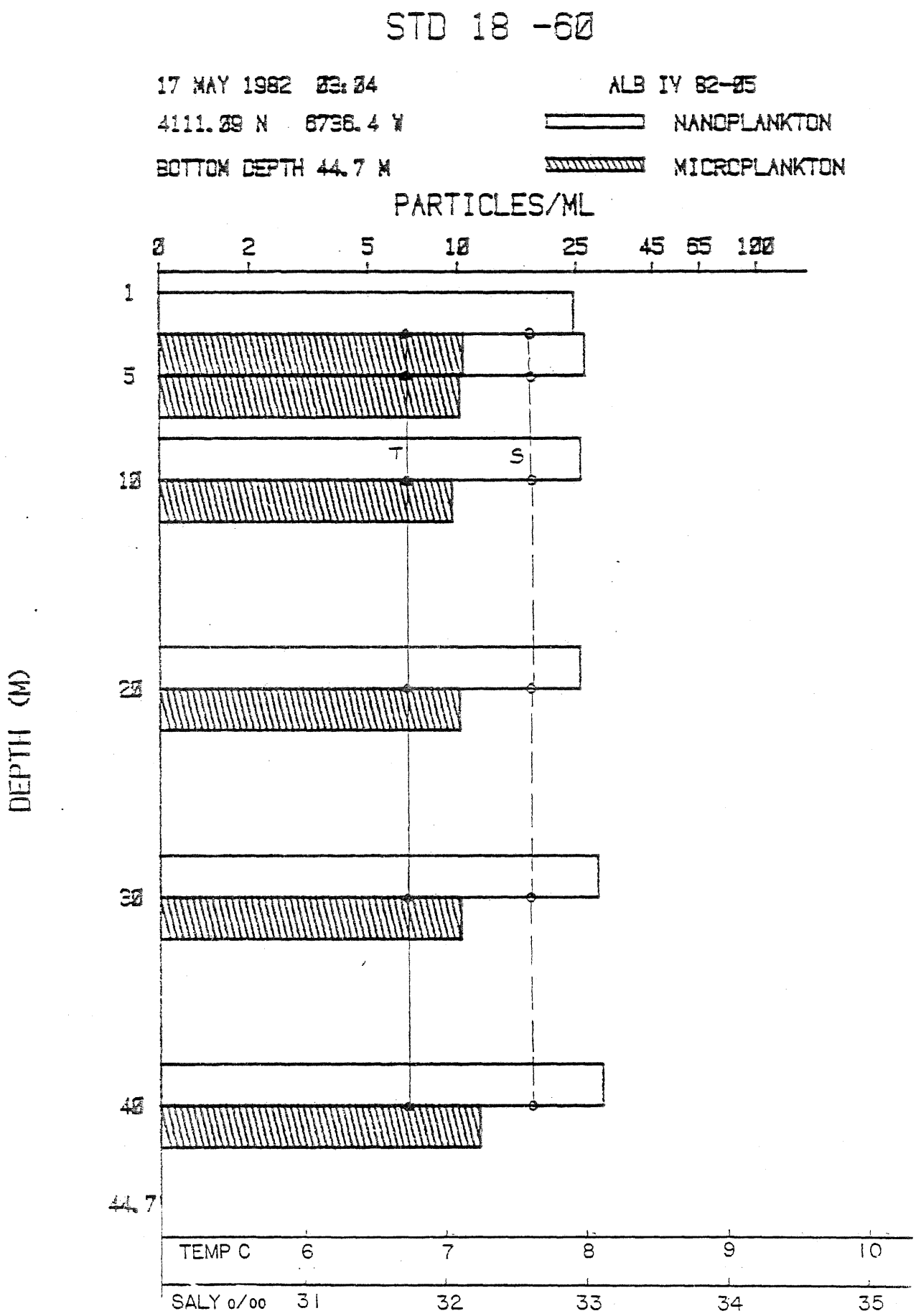

STD 18 -60
17 MAY 1982 03:04
4111.09 N 6736.4 W
BOTTOM DEPTH 44.7 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
1
5
10
20
30
40
44.7
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 56

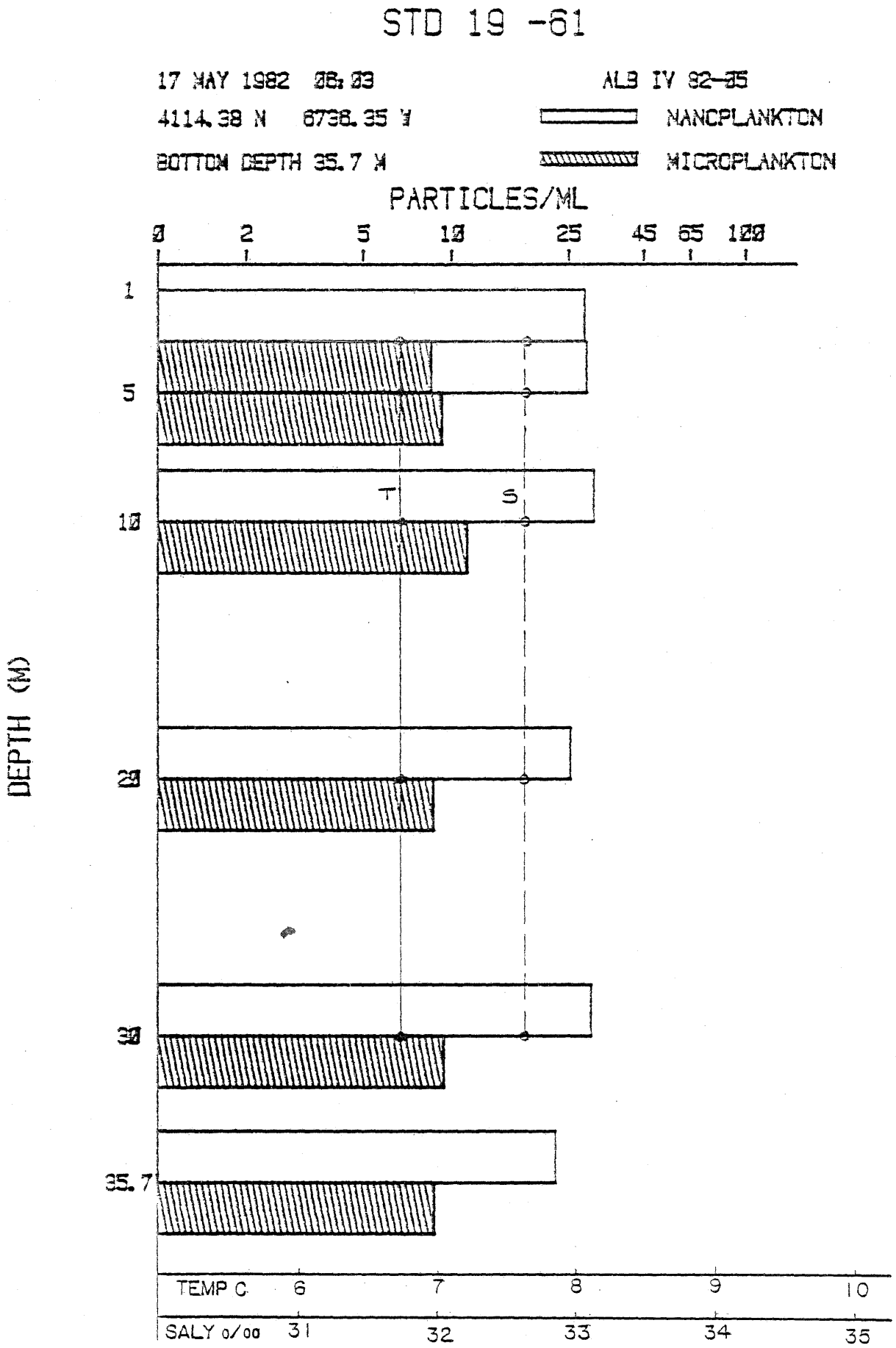

STD 19 -61
17 MAY 1982 08:03
4114.38 N 6738.35 W
BOTTOM DEPTH 35.7 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
1
5
10
20
30
35.7
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 57

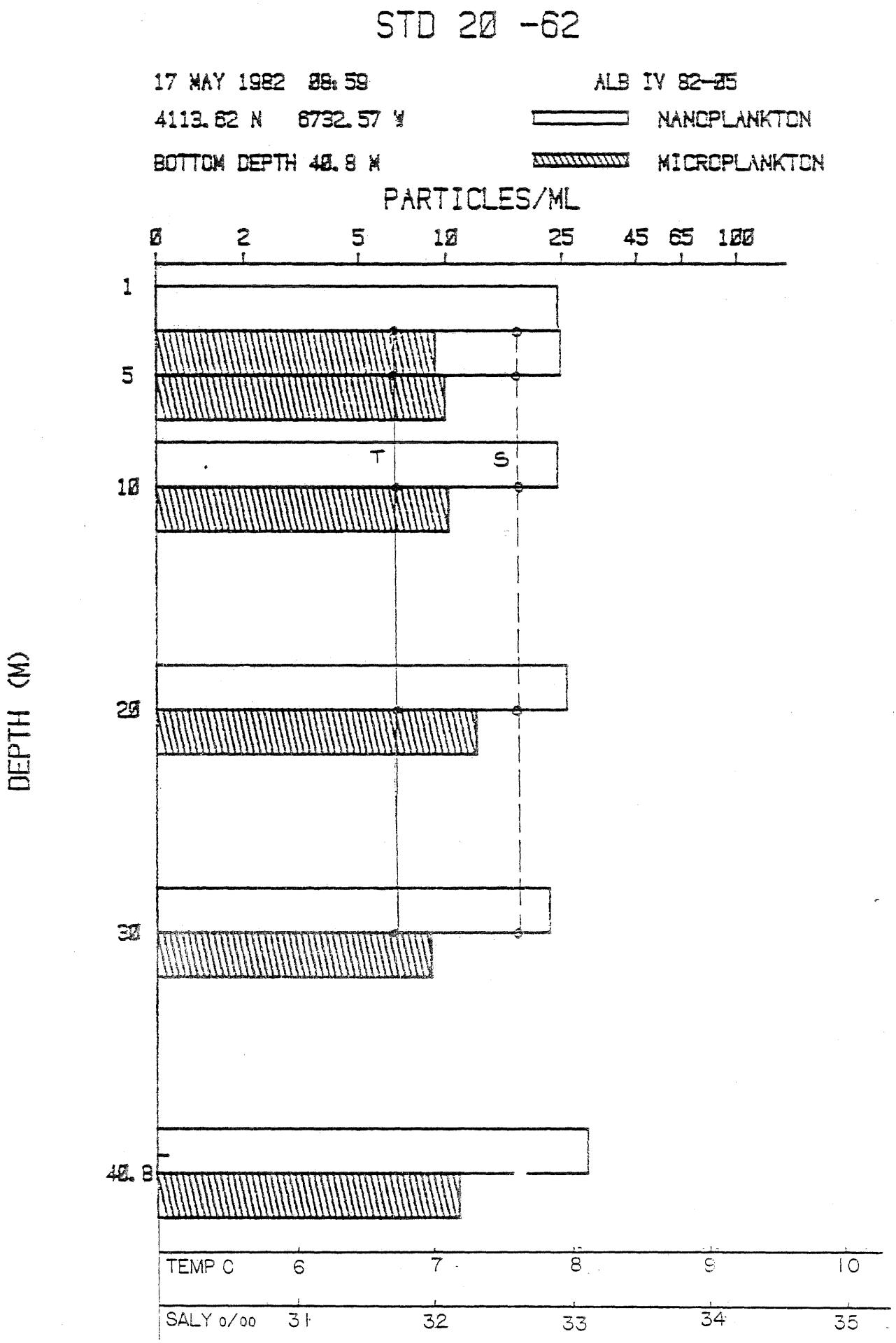

STD 20 -62
17 MAY 1982 08:59
4113.62 N 6732.57 W
BOTTOM DEPTH 40.8 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
1
5
10
20
30
40.8
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 58

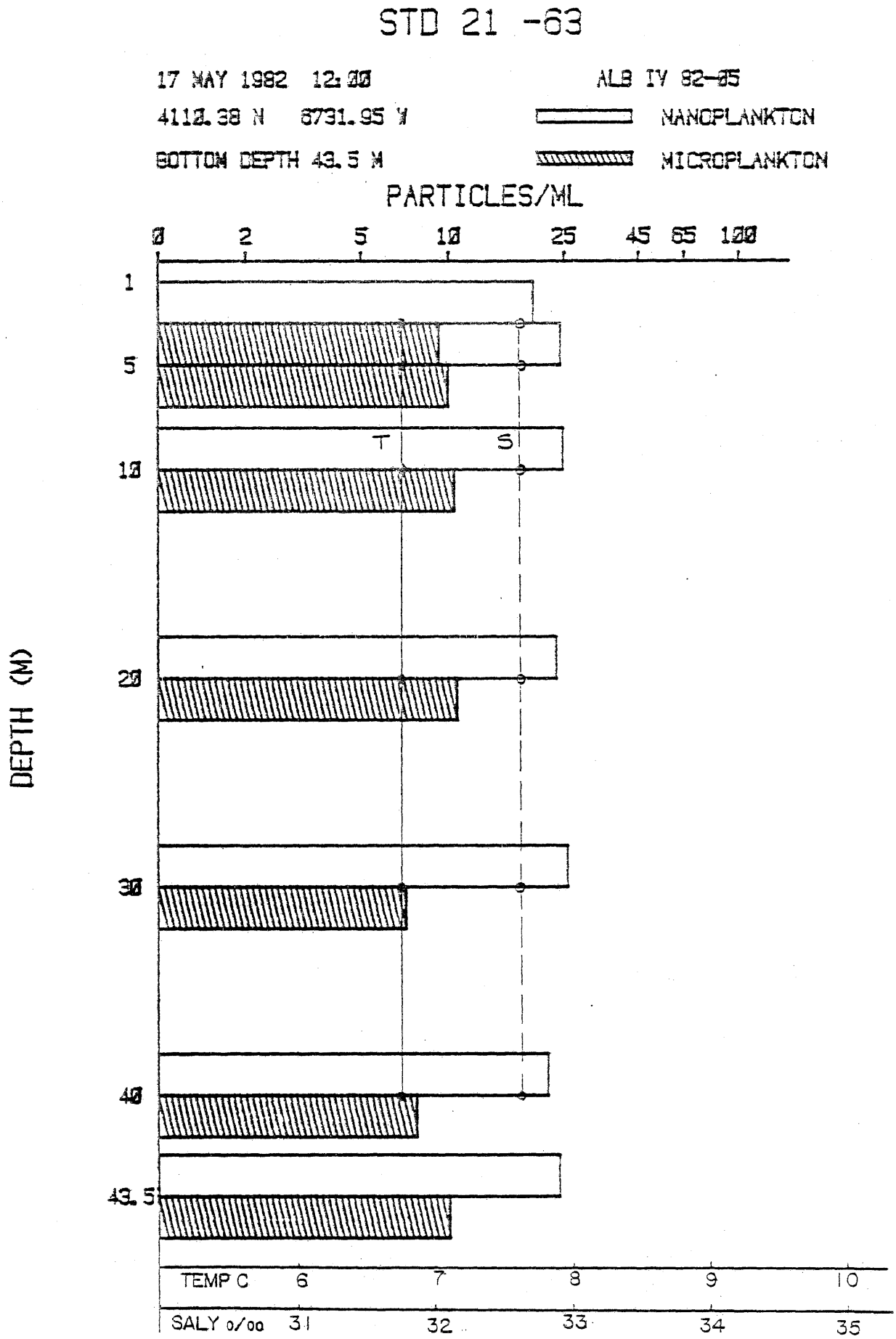

STD 21 -63
17 MAY 1982 12:00
4110.38 N 8731.95 W
BOTTOM DEPTH 43.5 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
1
5
10
20
30
40
43.5
T
S
TEMP C 6 7 8 9 10
SALY o/oo 31 32 33 34 35

Figure 59

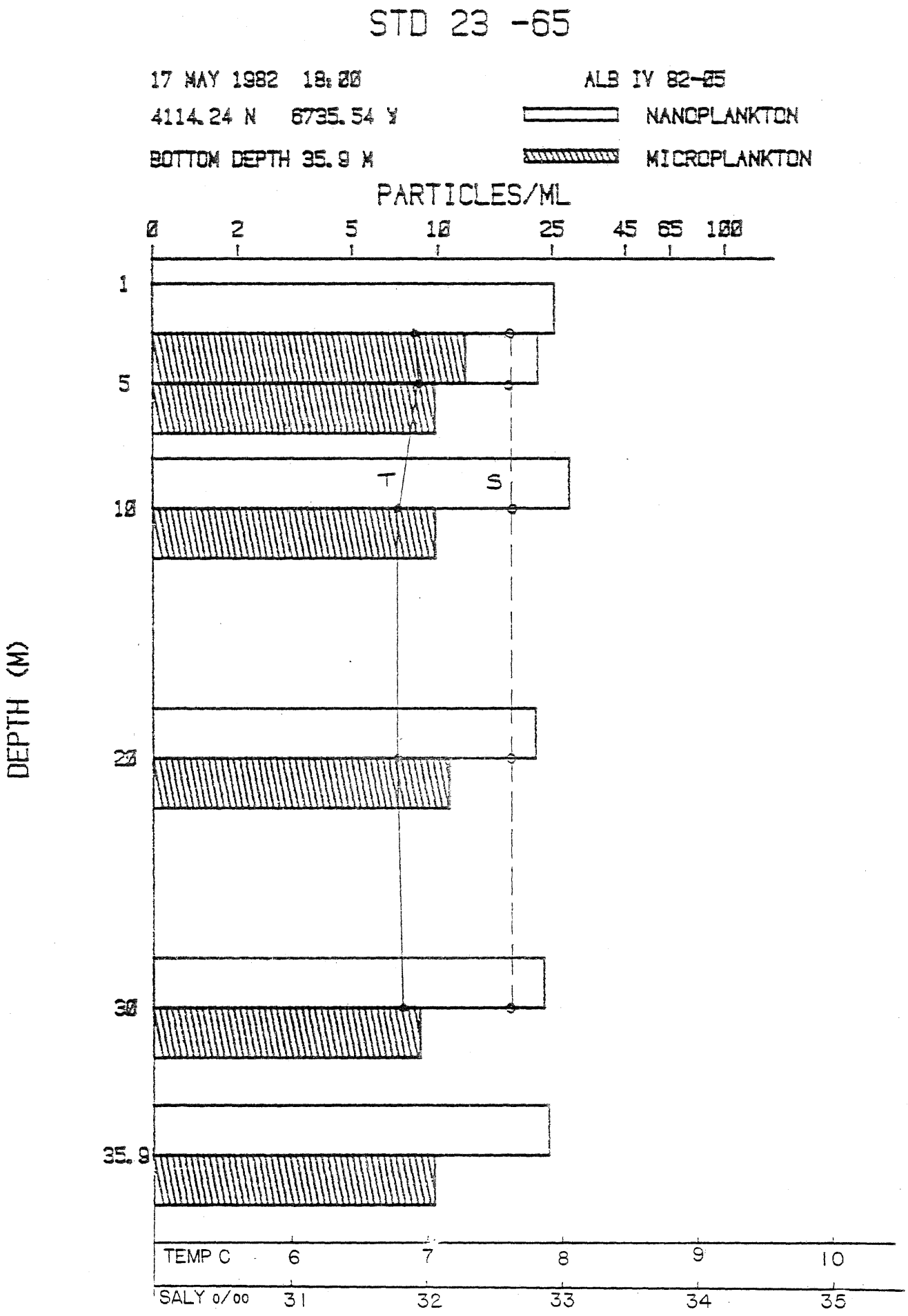

STD 23 -65
17 MAY 1982 18:00
4114.24 N 6735.54 W
BOTTOM DEPTH 35.9 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
1
5
10
20
30
35.9
T
S
TEMP C 6 7 8 9 10
SALY 0/00 31 32 33 34 35

Figure 60

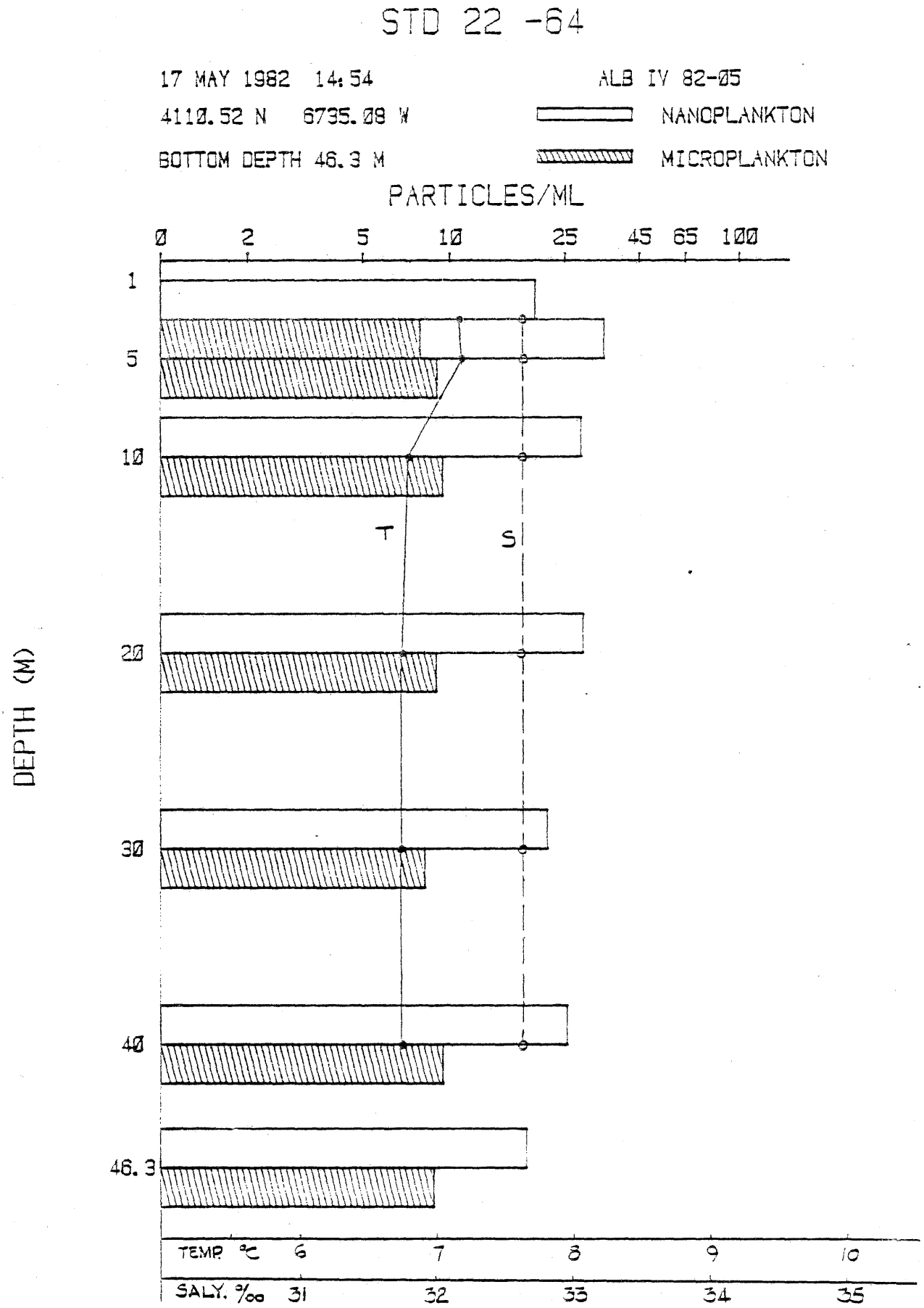

STD 22 -64
17 MAY 1982 14:54
4110.52 N 6735.08 W
BOTTOM DEPTH 46.3 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
1
5
10
20
30
40
46.3
T
S
TEMP °C 6 7 8 9 10
SALY. ‰ 31 32 33 34 35

Figure 61

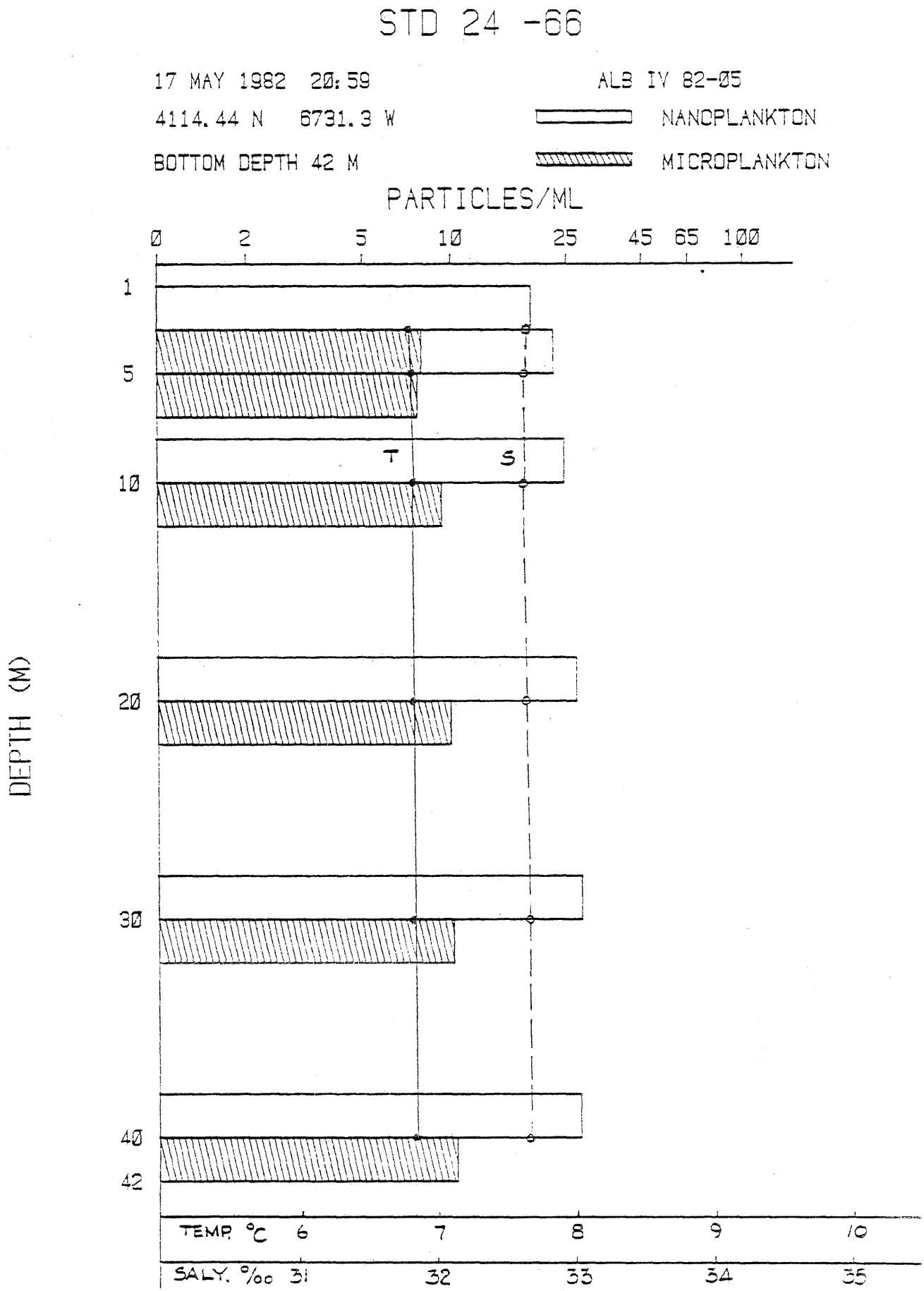

STD 24 -66
17 MAY 1982 20:59
4114.44 N 6731.3 W
BOTTOM DEPTH 42 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
1
5
10
20
30
40
42
T
S
TEMP. °C 6 7 8 9 10
SALY. ‰ 31 32 33 34 35

Figure 62

ALB. IV 82-05 ON-BANK DROGUE-FOLLOWER SERIES STD 16-58 TO STD 24-66
NANNOPLANKTON AND MICROPLANKTON-SIZED PARTICULATE DENSITY AT 5 m.

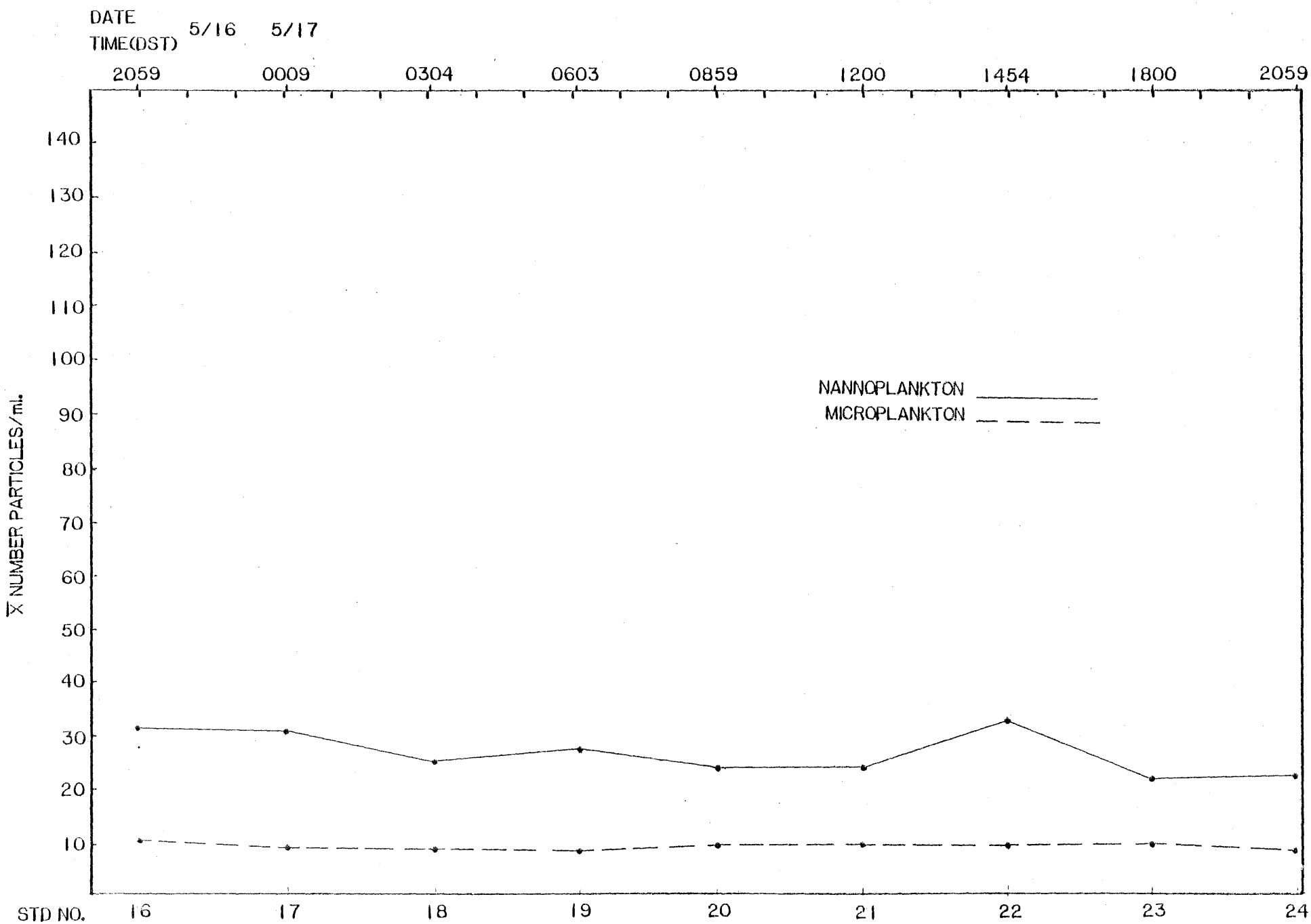


Figure 63

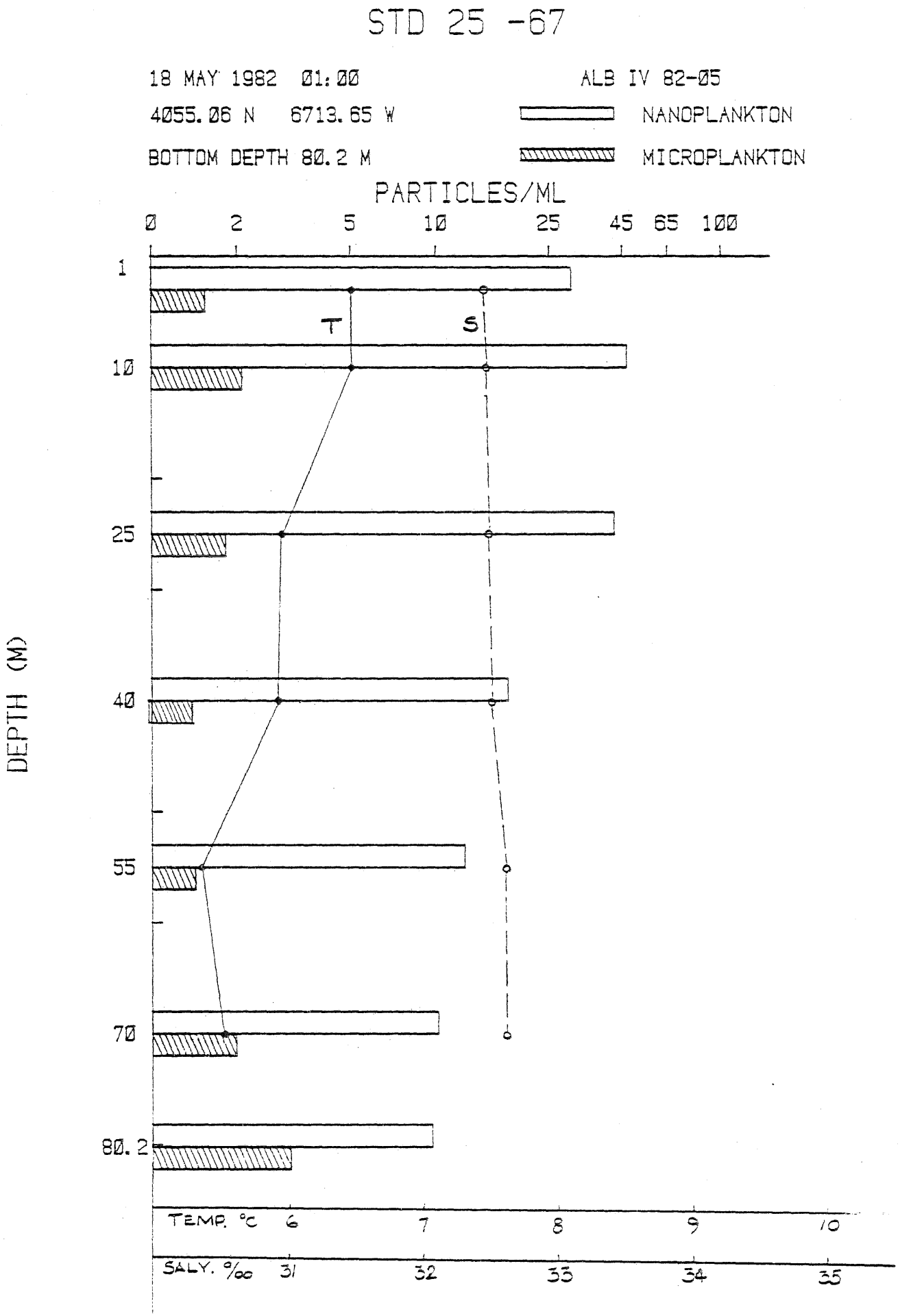

STD 25 -67
18 MAY 1982 01:00
4055.06 N 6713.65 W
BOTTOM DEPTH 80.2 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
1
10
25
40
55
70
80.2
T
S
TEMP. °C 6 7 8 9 10
SALY. ‰ 31 32 33 34 35

Figure 64

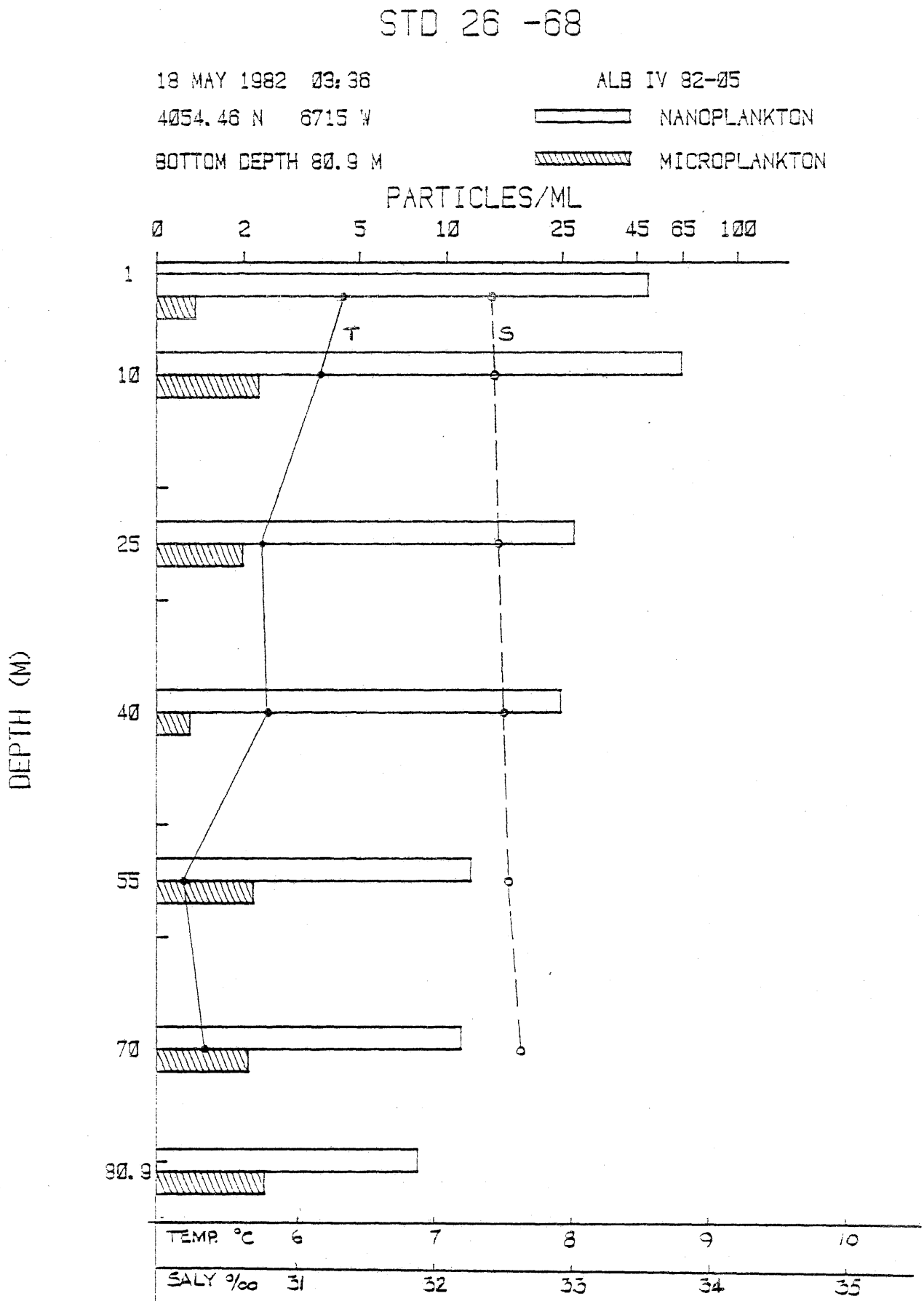

STD 26 -68
18 MAY 1982 03:36
4054.46 N 6715 W
BOTTOM DEPTH 80.9 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
1
10
25
40
55
70
80.9
T
S
TEMP. °C 6 7 8 9 10
SALY ‰ 31 32 33 34 35

Figure 65

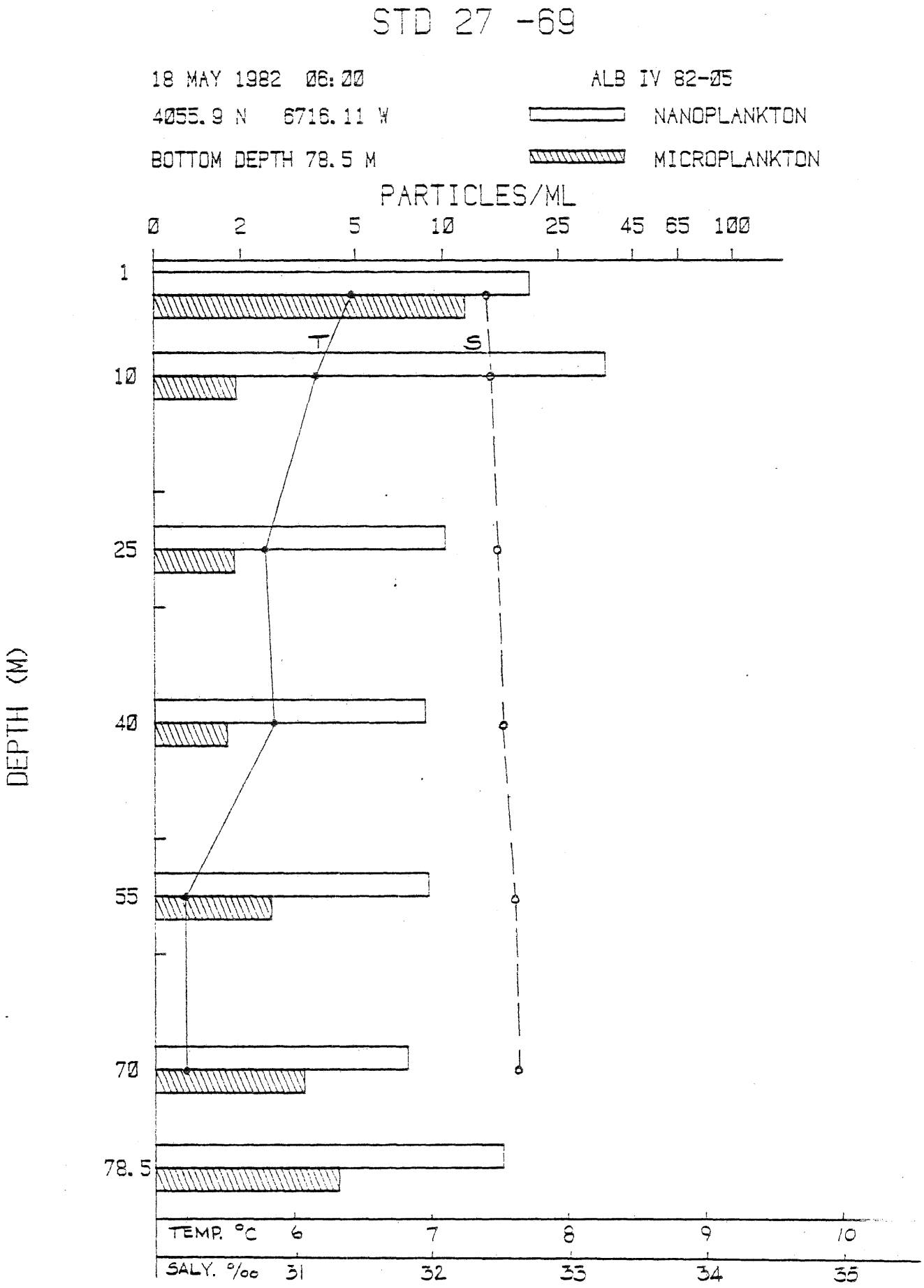

STD 27 -69
18 MAY 1982 06:00
ALB IV 82-05
4055.9 N 6716.11 W
NANOPLANKTON
BOTTOM DEPTH 78.5 M
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
1
10
25
40
55
70
78.5
T
S
TEMP. °C 6 7 8 9 10
SALY. ‰ 31 32 33 34 35

Figure 66

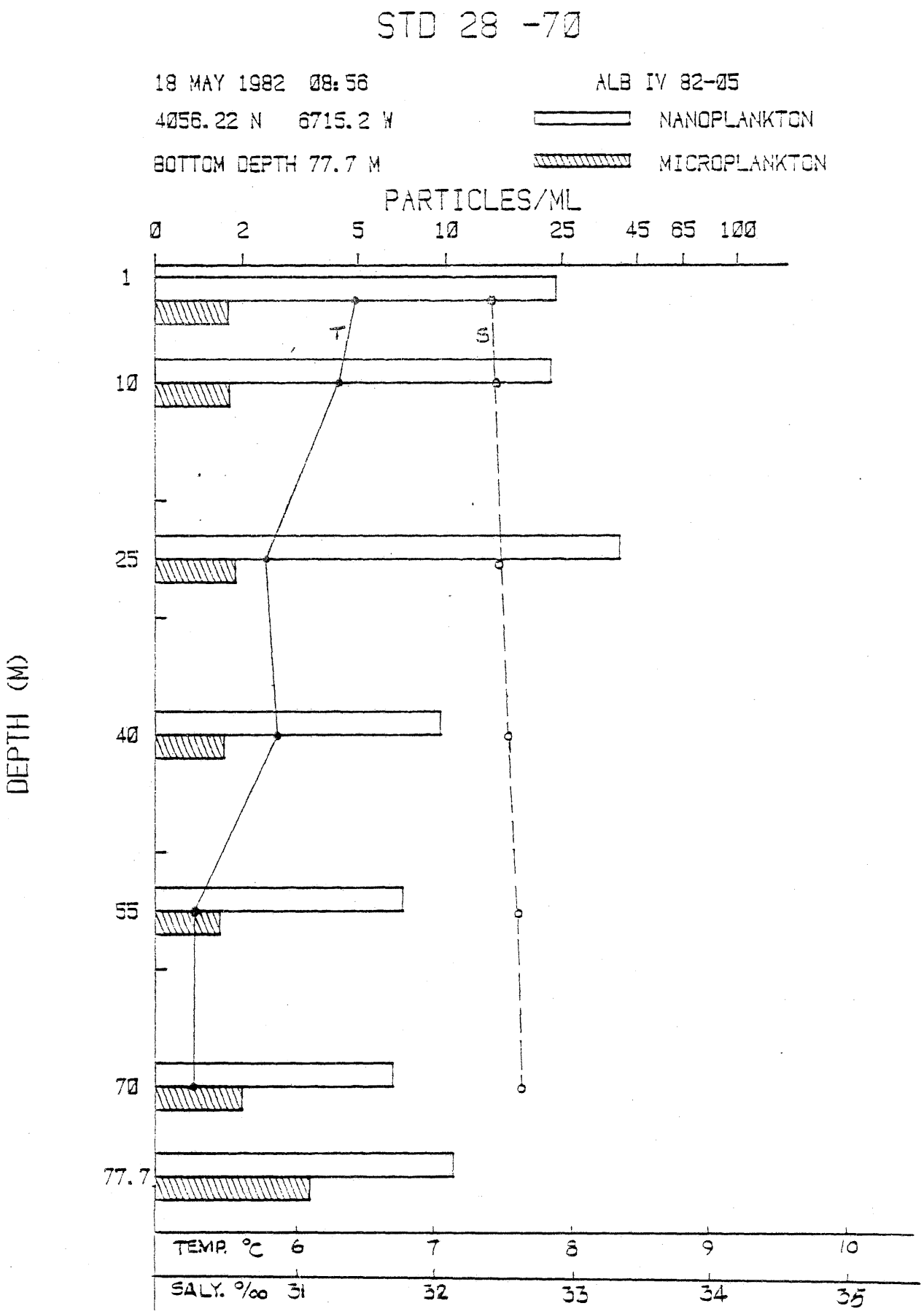

STD 28 -70
18 MAY 1982 08:56
4056.22 N 6715.2 W
BOTTOM DEPTH 77.7 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
1
10
25
40
55
70
77.7
T
S
TEMP. °C 6 7 8 9 10
SALY. ‰ 31 32 33 34 35

Figure 67

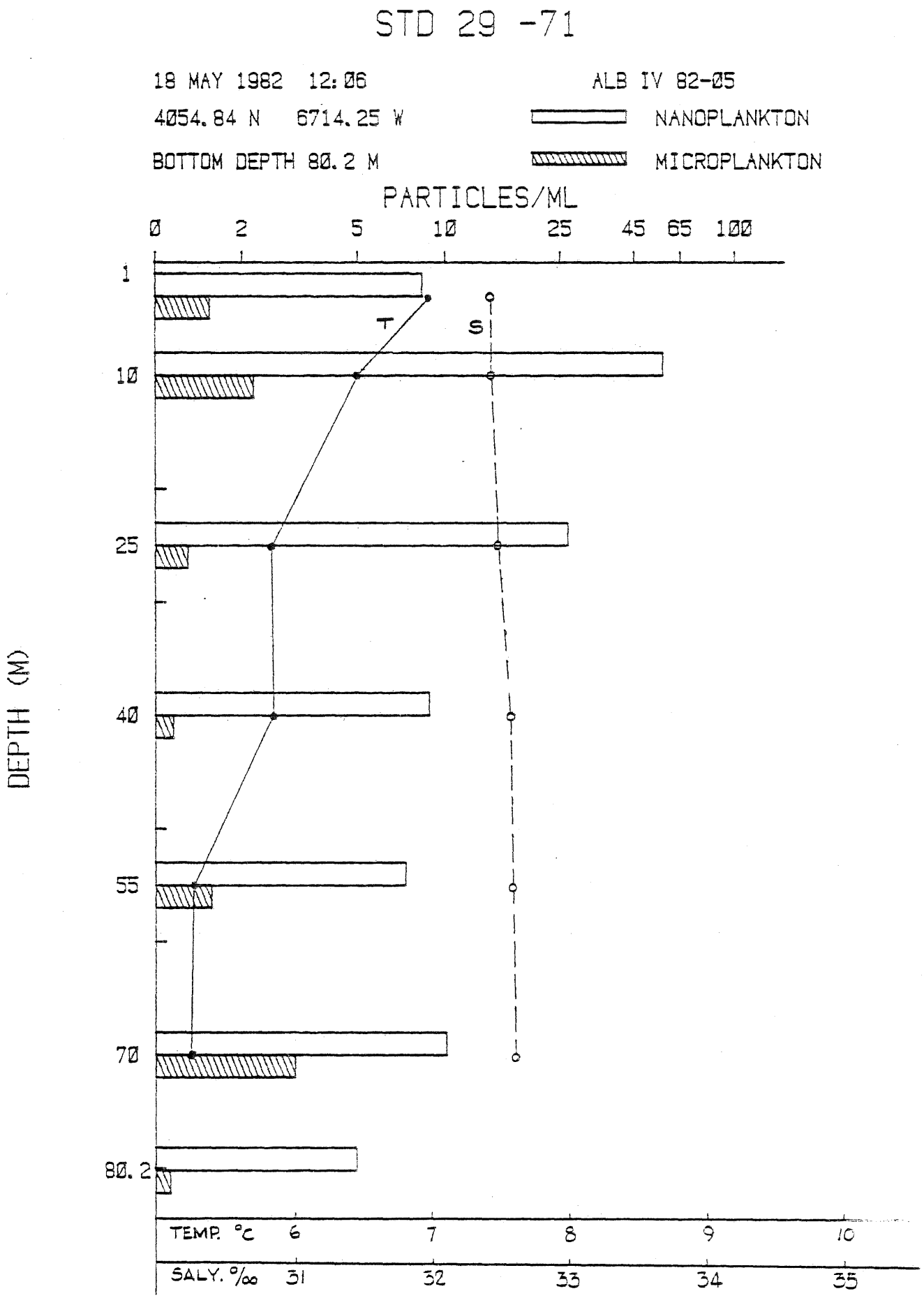

STD 29 -71
18 MAY 1982 12:06
4054.84 N 6714.25 W
BOTTOM DEPTH 80.2 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
1
10
25
40
55
70
80.2
T
S
TEMP. °C 6 7 8 9 10
SALY. ‰ 31 32 33 34 35

Figure 68

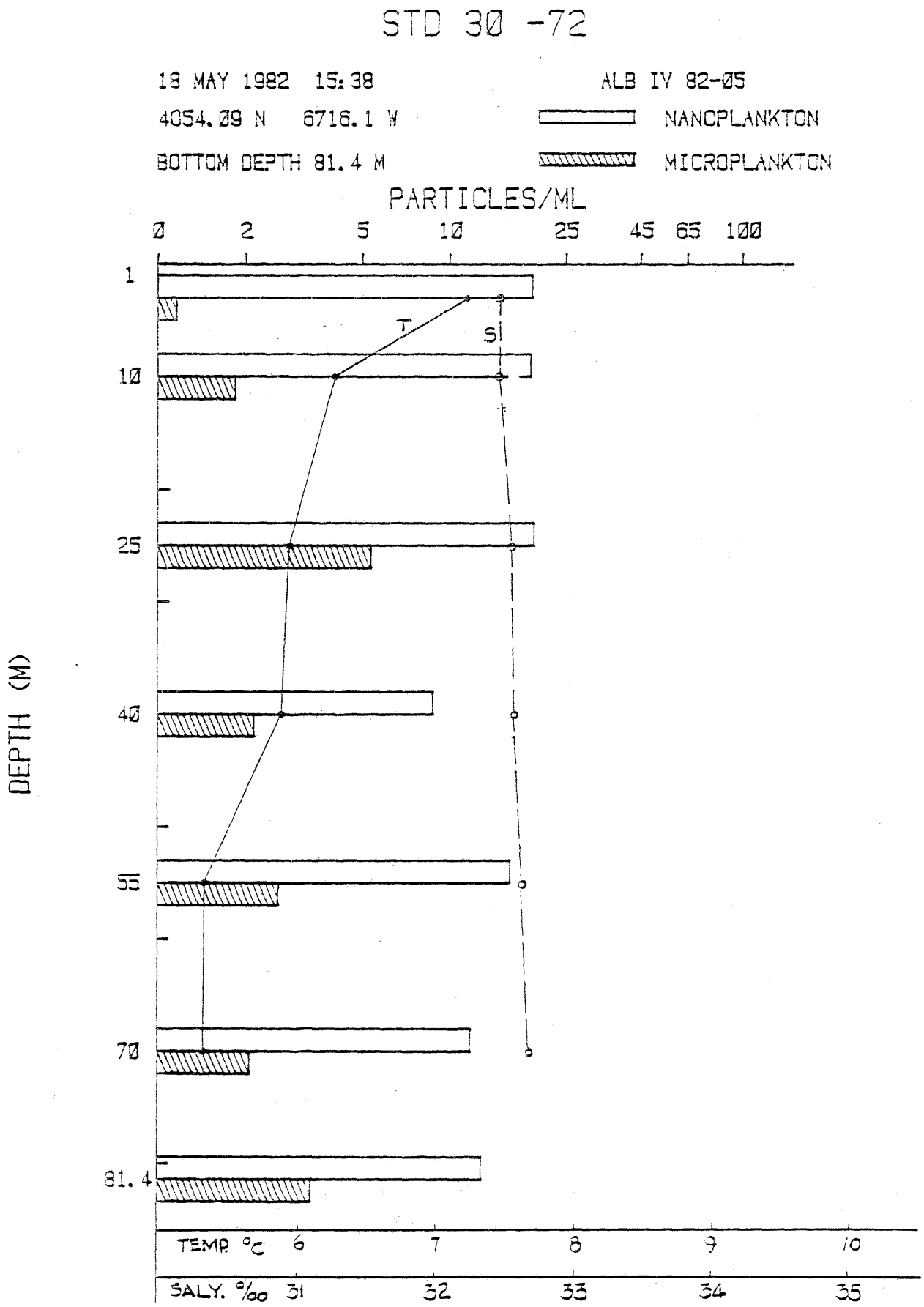

STD 30 -72
18 MAY 1982 15:38
4054.09 N 6716.1 W
BOTTOM DEPTH 81.4 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
1
10
25
40
55
70
81.4
T
S
TEMP °C 6 7 8 9 10
SALY. ‰ 31 32 33 34 35

Figure 69

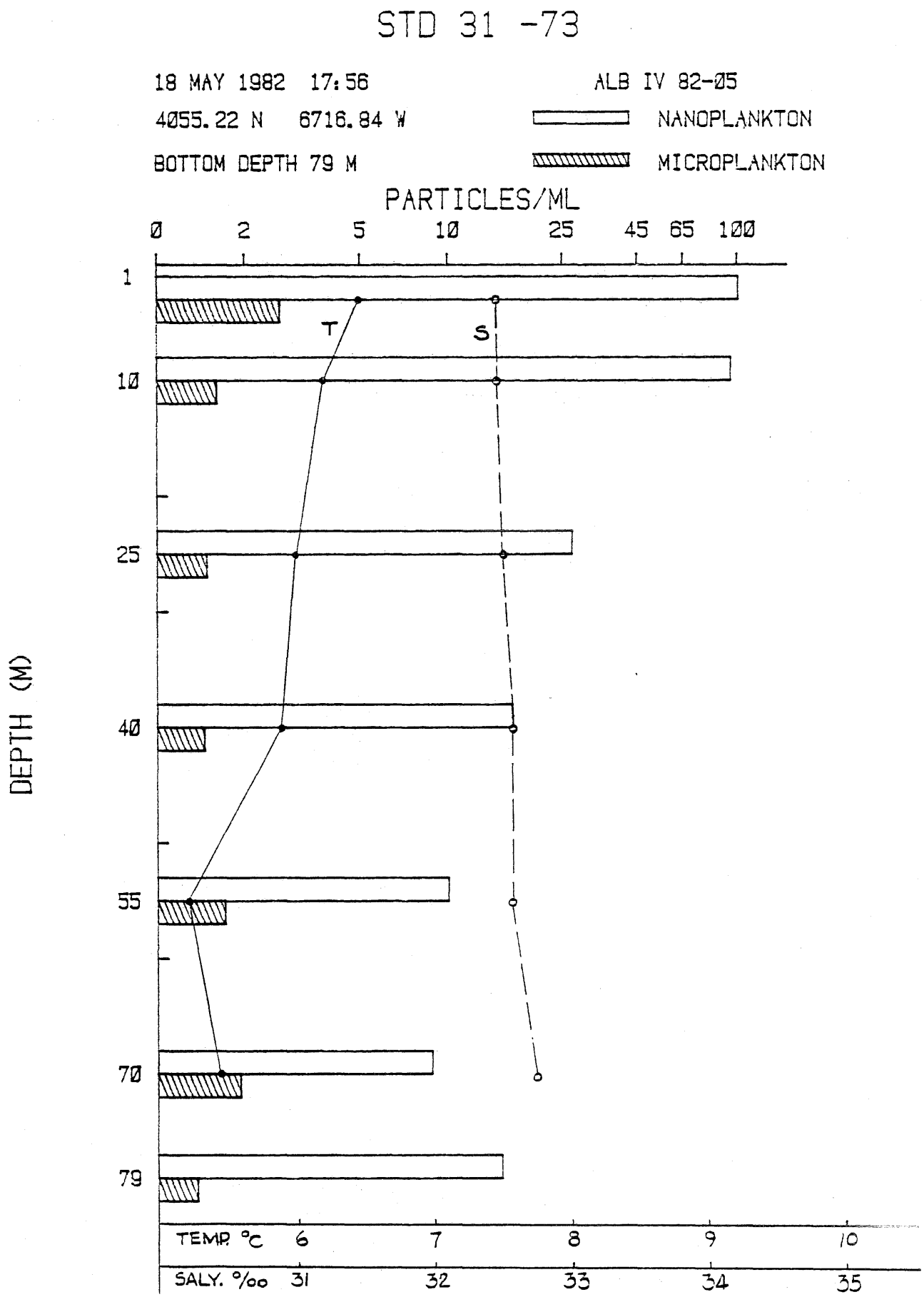

STD 31 -73
18 MAY 1982 17:56
4055.22 N 6716.84 W
BOTTOM DEPTH 79 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
1
10
25
40
55
70
79
T
S
TEMP. °C 6 7 8 9 10
SALY. ‰ 31 32 33 34 35

Figure 70

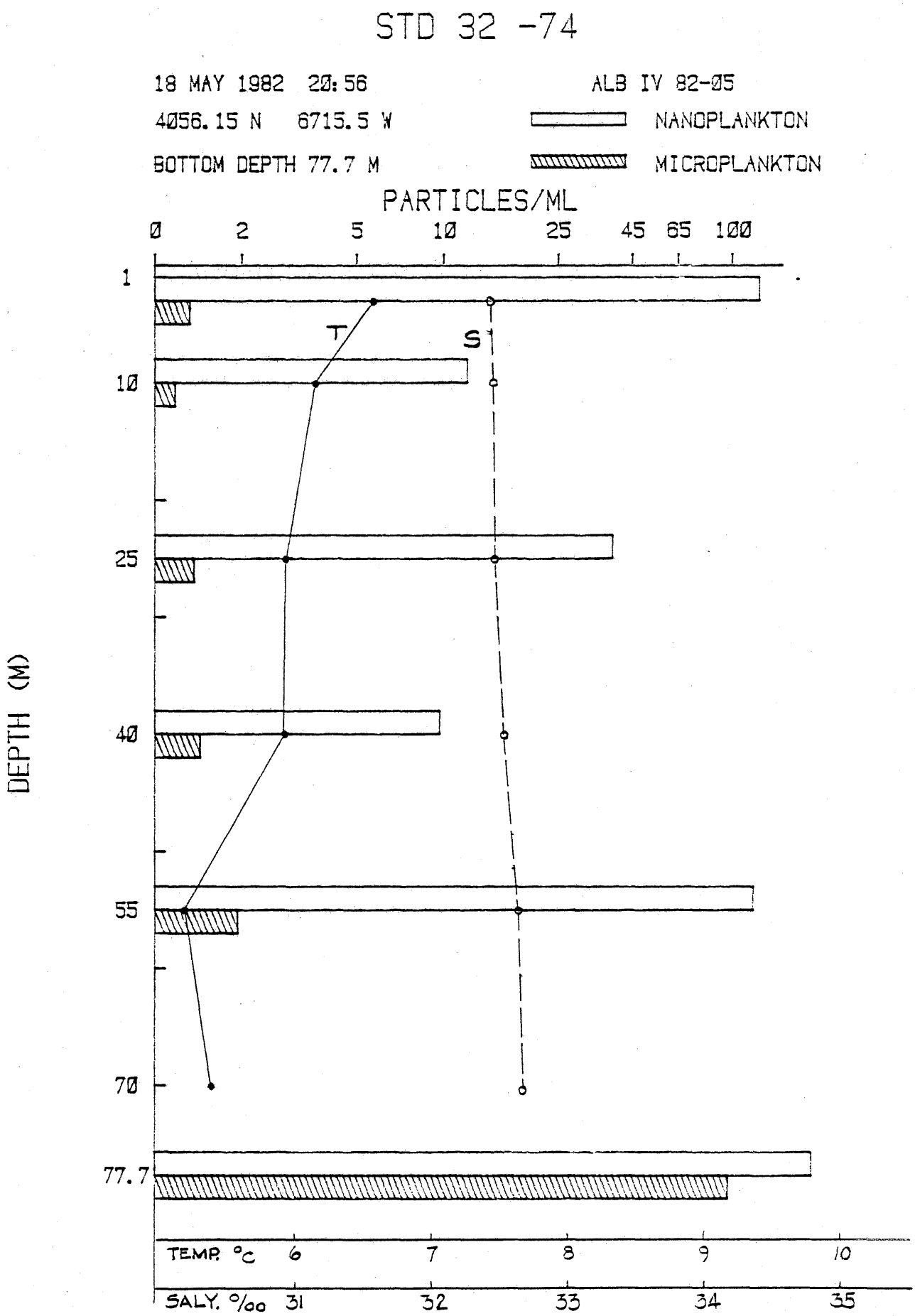

STD 32 -74
18 MAY 1982 20:56
4056.15 N 6715.5 W
BOTTOM DEPTH 77.7 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
1
10
25
40
55
70
77.7
T
S
TEMP. °C 6 7 8 9 10
SALY. °/oo 31 32 33 34 35

Figure 71

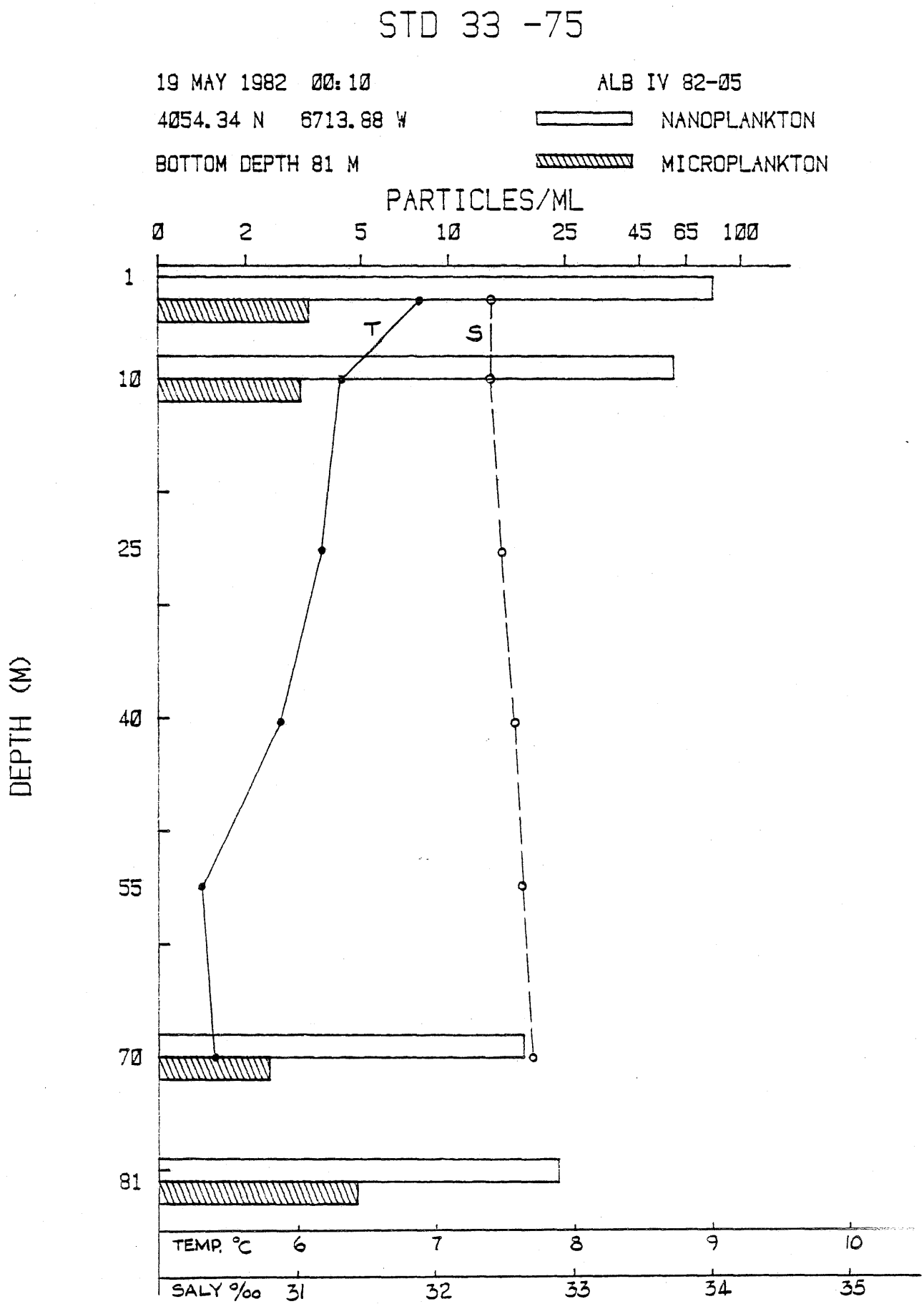

STD 33 -75
19 MAY 1982 00:10
4054.34 N 6713.88 W
BOTTOM DEPTH 81 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
1
10
25
40
55
70
81
T
S
TEMP. °C 6 7 8 9 10
SALY ‰ 31 32 33 34 35

Figure 72

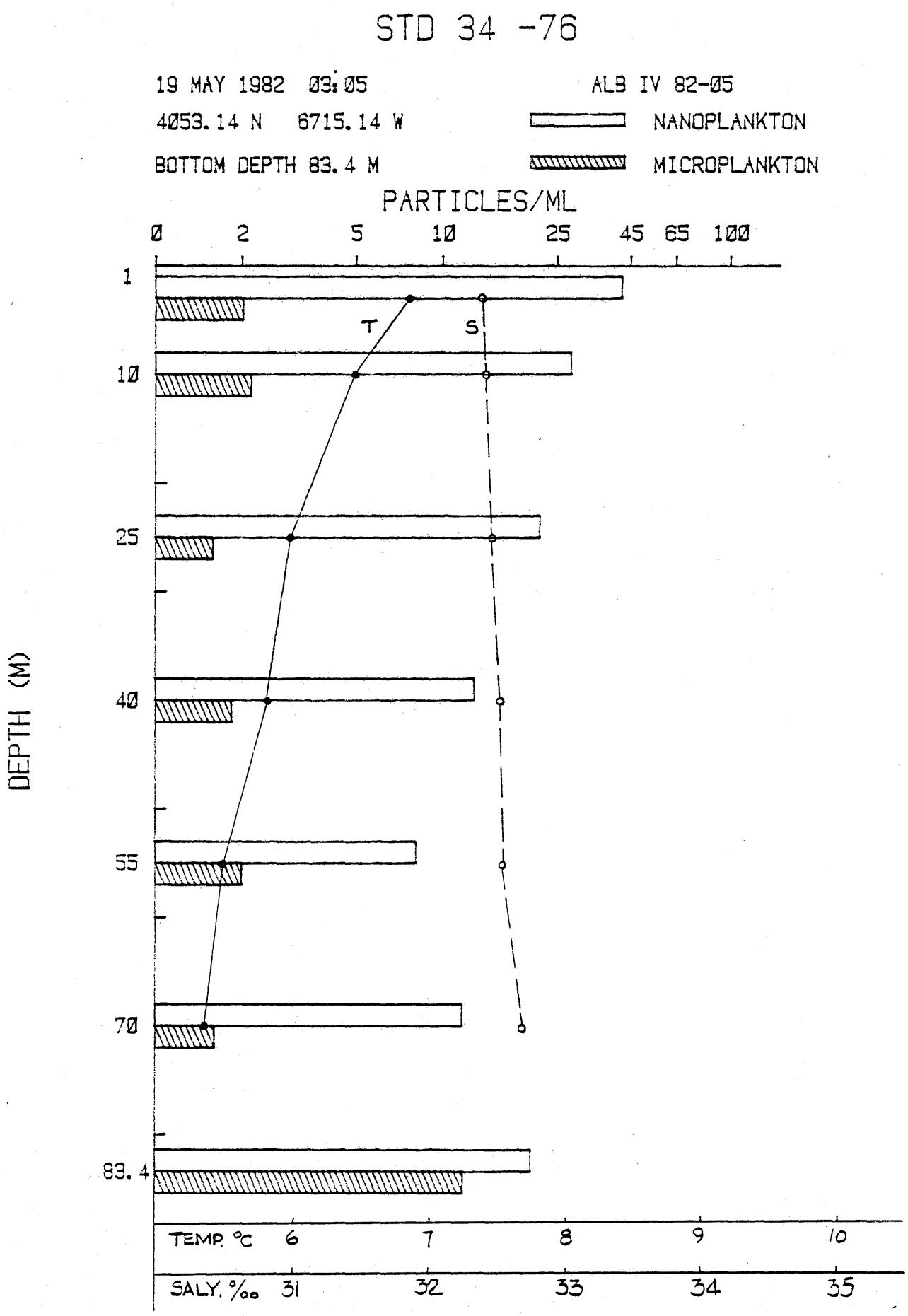

STD 34 -76
19 MAY 1982 03:05
ALB IV 82-05
4053.14 N 6715.14 W
NANOPLANKTON
BOTTOM DEPTH 83.4 M
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
1
10
25
40
55
70
83.4
DEPTH (M)
T
S
TEMP. °C 6 7 8 9 10
SALY. ‰ 31 32 33 34 35

Figure 73

ALB. IV 82-05 OFF-BANK DROGUE-FOLLOWER SERIES STD 25-67 TO STD 34-76
NANNOPLANKTON AND MICROPLANKTON-SIZED PARTICULATE DENSITY AT 10 m.

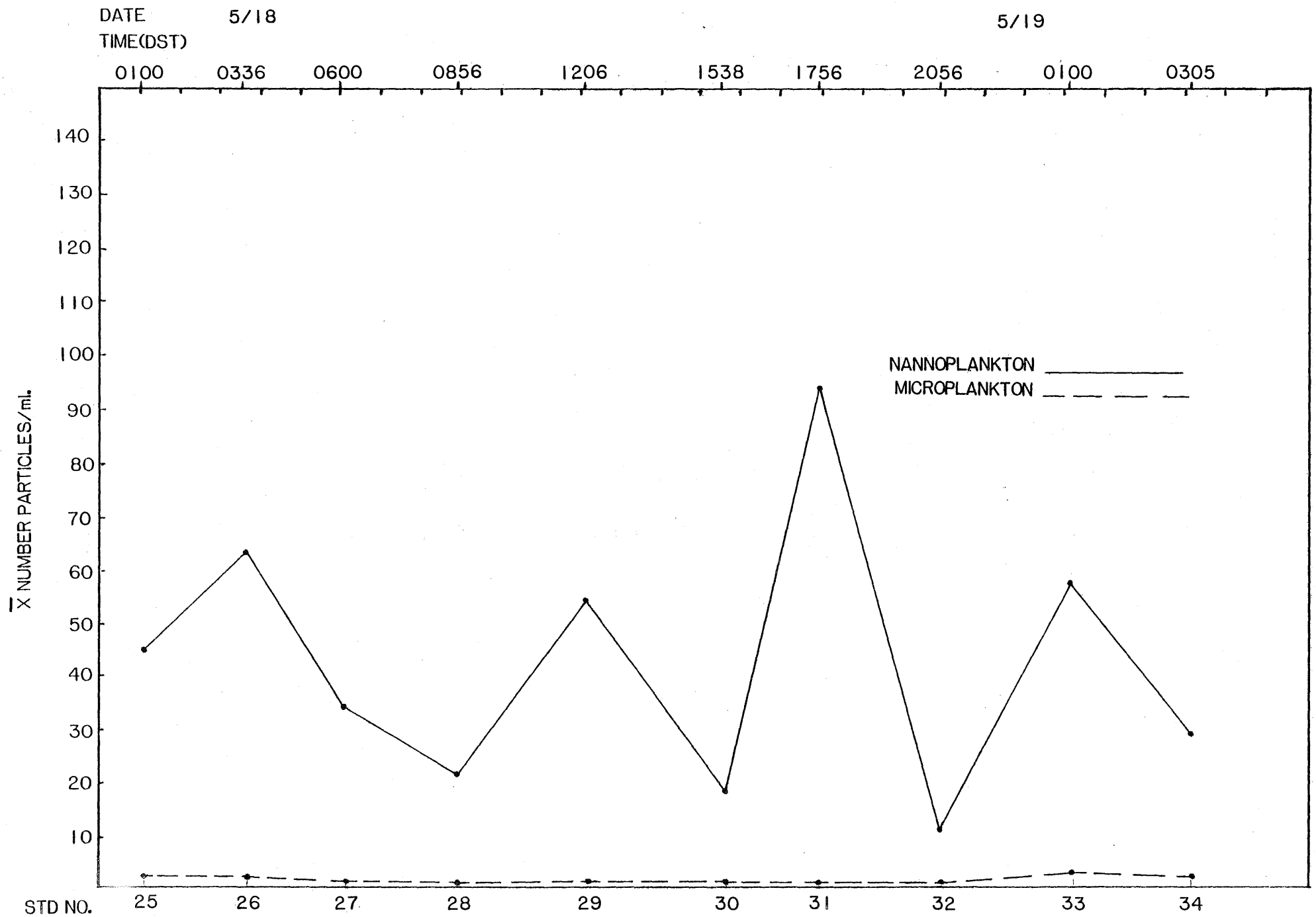


Figure 74

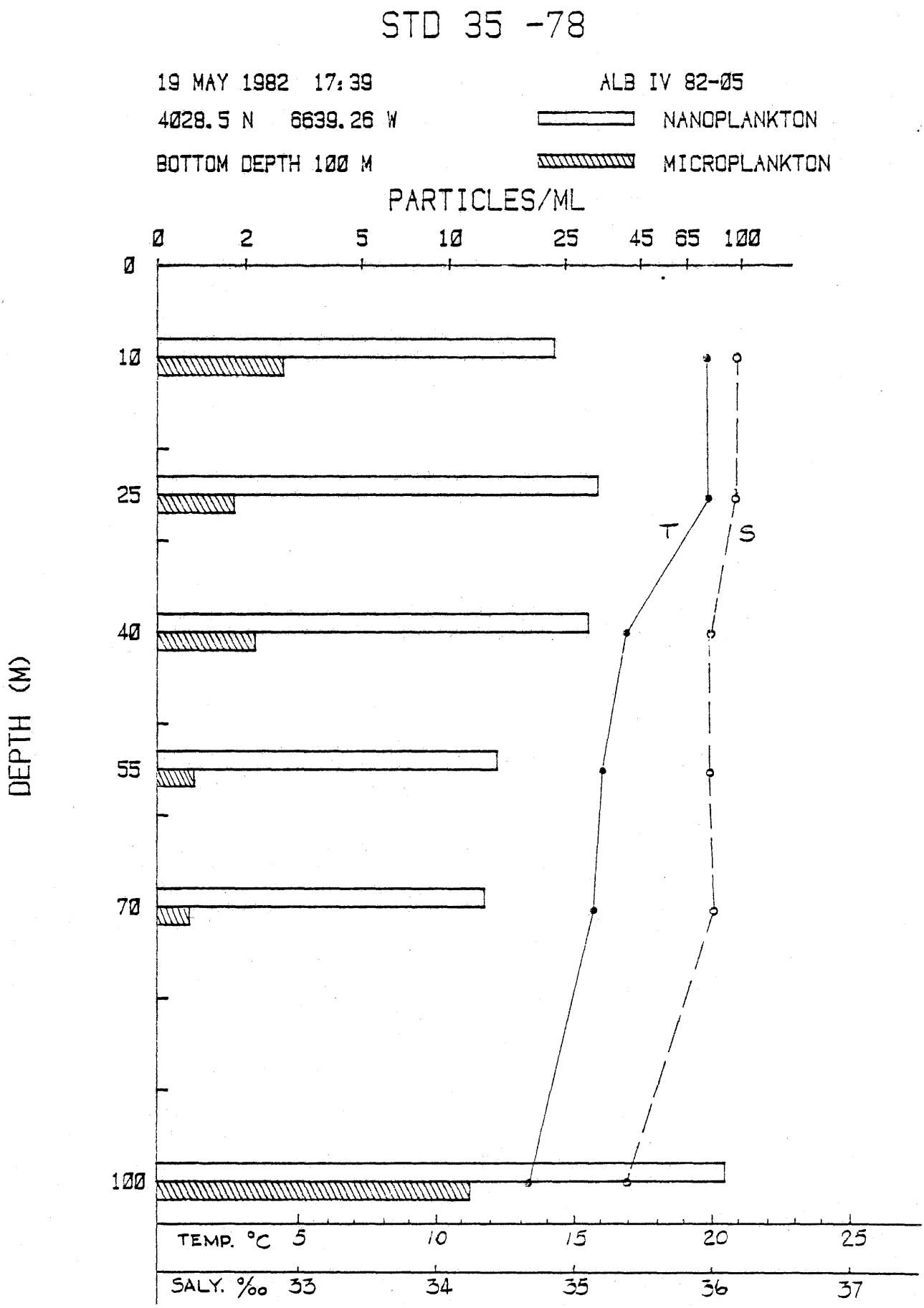

STD 35 -78
19 MAY 1982 17:39
4028.5 N 6639.26 W
BOTTOM DEPTH 100 M
ALB IV 82-05
NANOPLANKTON
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
0
10
25
40
55
70
100
T
S
TEMP. °C 5 10 15 20 25
SALY. ‰ 33 34 35 36 37

Figure 75

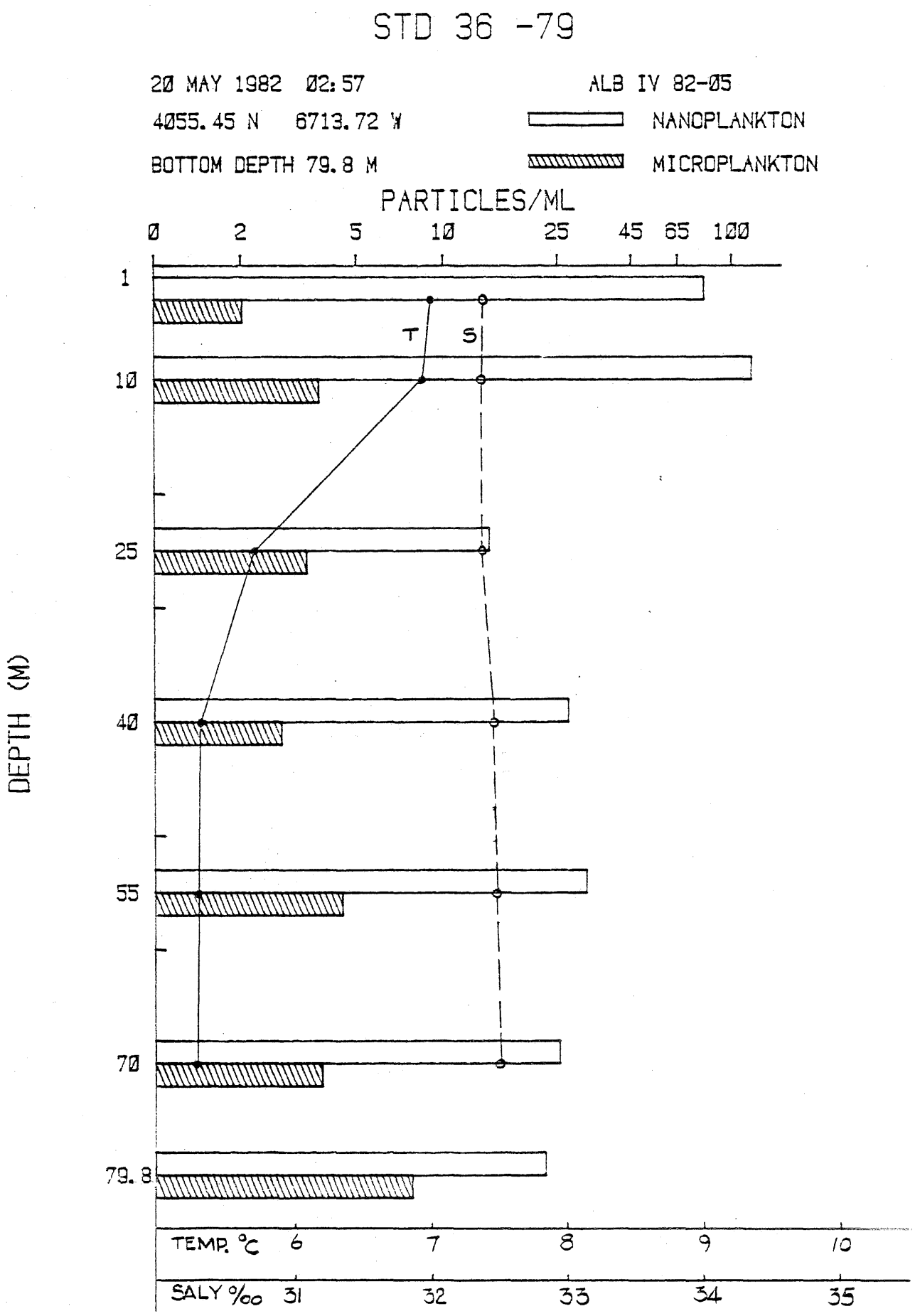

STD 36 -79
20 MAY 1982 02:57
ALB IV 82-05
4055.45 N 6713.72 W
NANOPLANKTON
BOTTOM DEPTH 79.8 M
MICROPLANKTON
PARTICLES/ML
0 2 5 10 25 45 65 100
DEPTH (M)
1
10
25
40
55
70
79.8
T
S
TEMP. °C 6 7 8 9 10
SALY ‰ 31 32 33 34 35

Figure 76

ALB. IV 82-05 OFF-BANK TRANSECT SERIES STD 35-78 AND STD 36-79
NANNOPLANKTON AND MICROPLANKTON-SIZED PARTICULATE DENSITY AT 10 m.

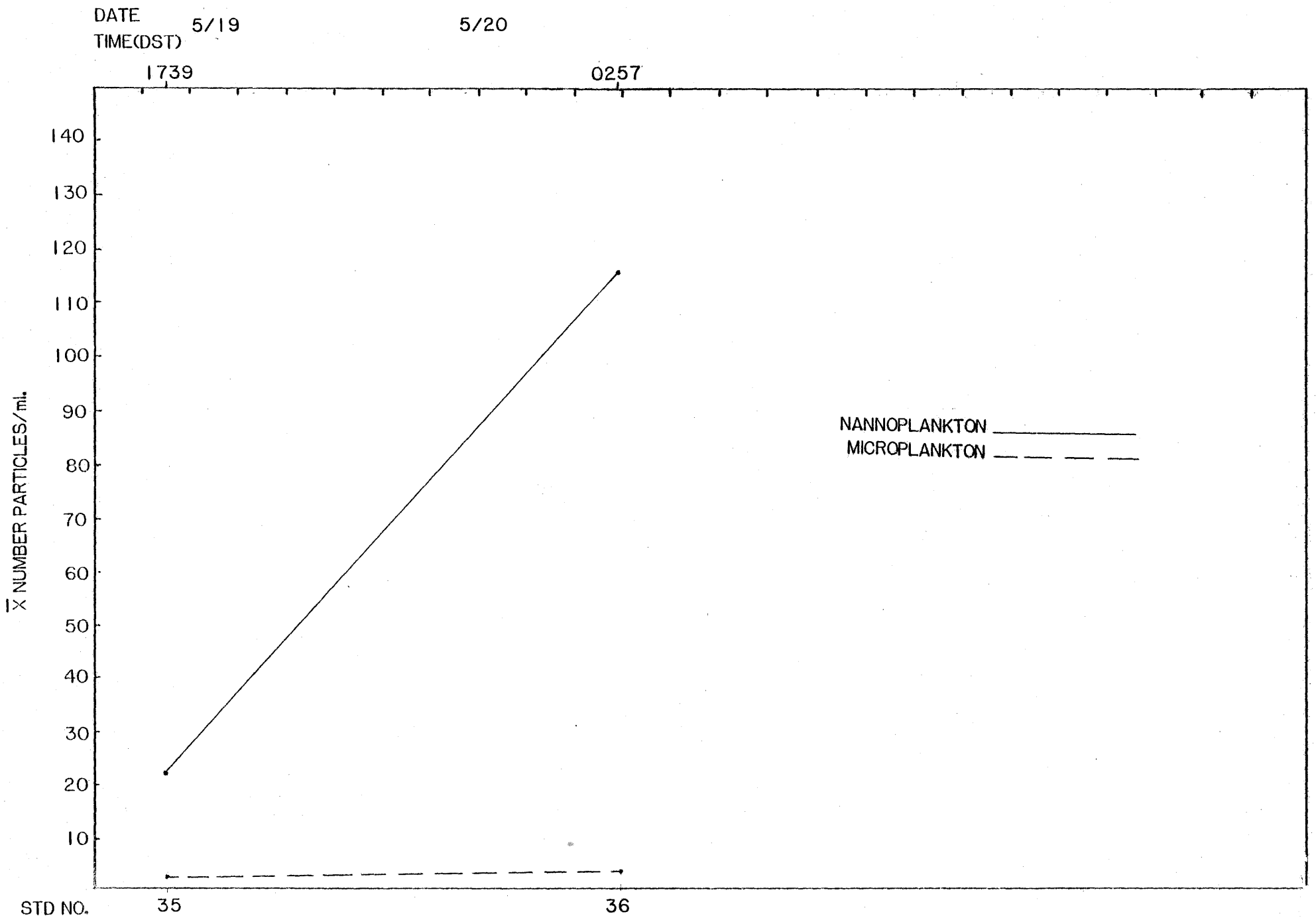


Figure 77