PRNC – 174

PUERTO RICO NUCLEAR CENTER

PUNTA HIGUERO POWER PLANT
ENVIRONMENTAL STUDIES 1973-1974

Prepared for the Puerto Rico Water Resources Authority
By the Staff of Puerto Rico Nuclear Center of the
University of Puerto Rico
May 1974

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PREFACE

This report stems from investigations being carried on by the Puerto Rico Nuclear Center. The studies were designed to provide data upon which to judge the suitability of a site for the construction of power generating facilities and to allow the determination of the impact of such construction and operation upon the environment. This report is the combined effort of the scientists, technicians and support staff of the Site Selection Survey Project:

E.D. Wood, Project Leader	Physical and Chemical Parameters
Marsh J. Youngbluth	Zooplankton
Vance P. Vicente	Benthic Invertebrates
F.D. Martin	Fish
M.J. Canoy	Terrestrial Surveys
Alina Szmant Froelich	Benthic Invertebrates

Report assembled by E.D. Wood

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Physical Parameters

Pta. Higuero commonly referred to as "Rincon" or the "BONUS Site" is the most westerly point on the Island of Puerto Rico (Fig. 1). Some environmental work has been done in the Pta. Higuero region related to the construction and operation of the BONUS-Reactor power plant. Data from independent studies in the Mona Passage are also available. The Puerto Rico Nuclear Center has been collecting and analyzing data from the immediate region of Pta. Higuera for about one year on a regular basis.

The nearshore currents have been measured on several occasions. The factors effecting nearshore currents such as winds, tides, bathymetry, and density structure of the water column have been studied and are being presented here.

a. Tides

The tidal excursion at Pta. Higuero is on the order of 30 cm and its period is semi-diurnal. The tides here were not measured, but can be calculated from the San Juan tidal data. Calculated tidal data (Fig. 2) are presented for the period 6/7/73 to 6/8/73 relating to currents covered in the following subsection. In addition, a plot of the tides for the month of June, 1973 is shown in Fig. 3 to cover a lunar cycle.

b. Currents

In general, the currents are toward the west, both north and south of Puerto Rico. The current, north of the

Fig. 1 - Punta Higuero (Rincon), west coast of Puerto Rico.

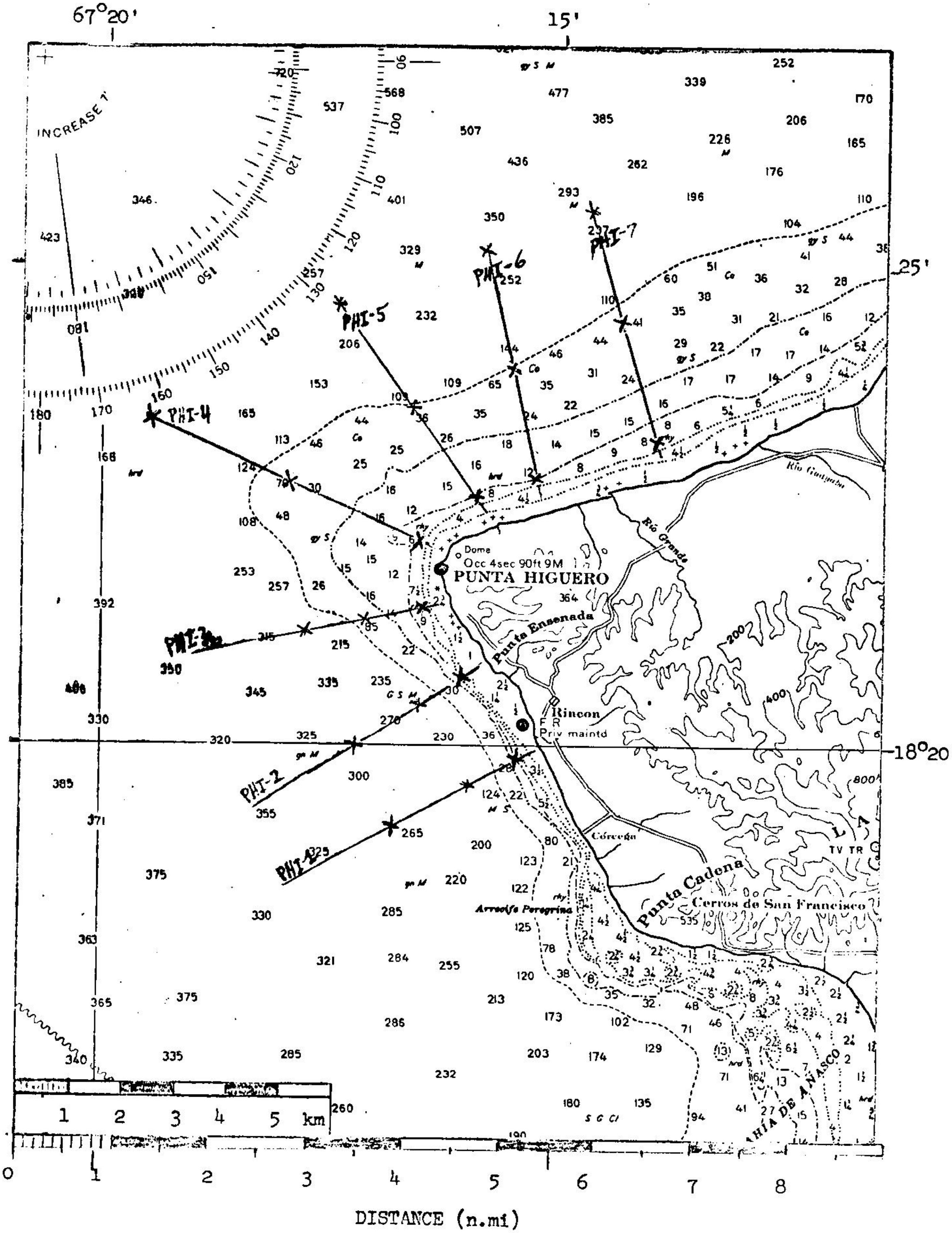


Fig. 2 - Calculated tide levels for the period noon to noon June 7-8, 1973 at Pta. Higuera.

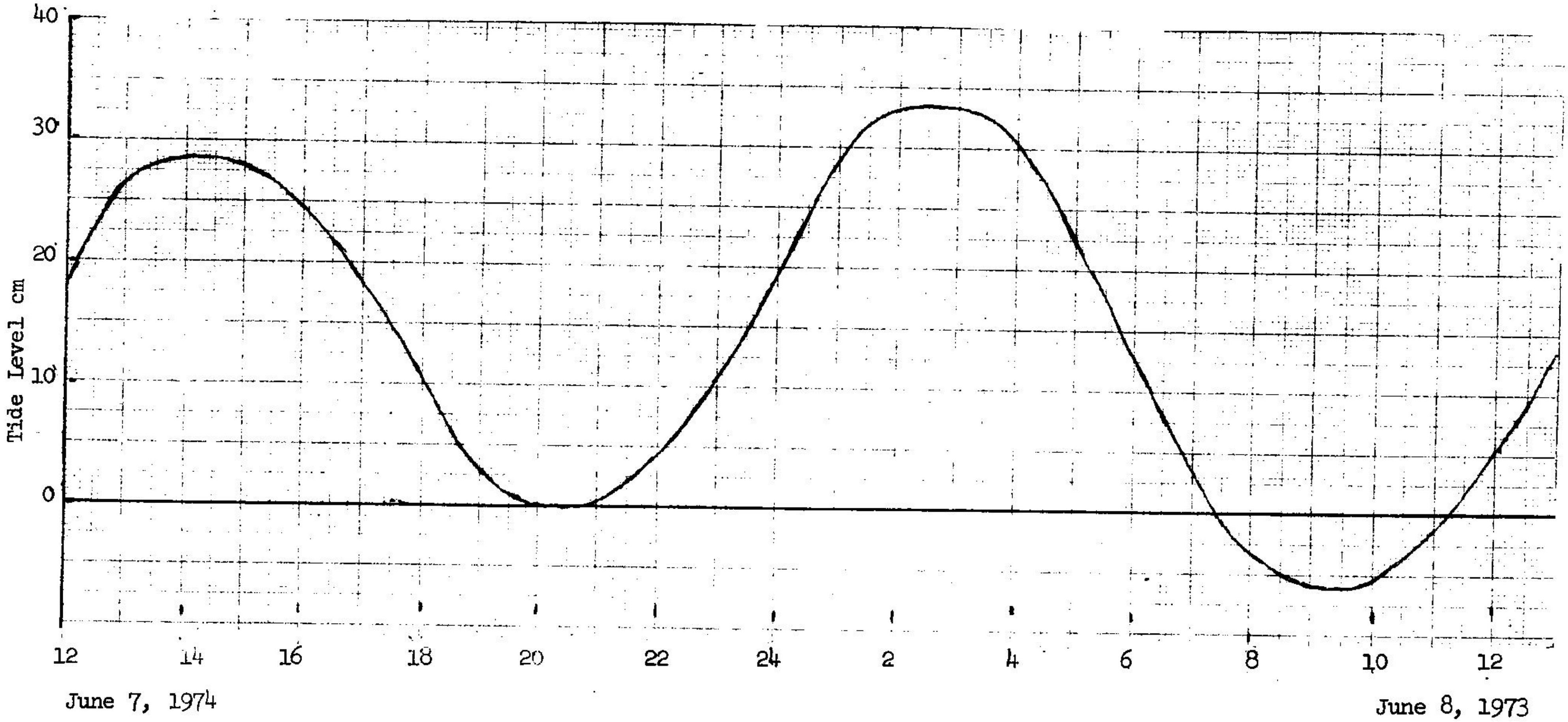
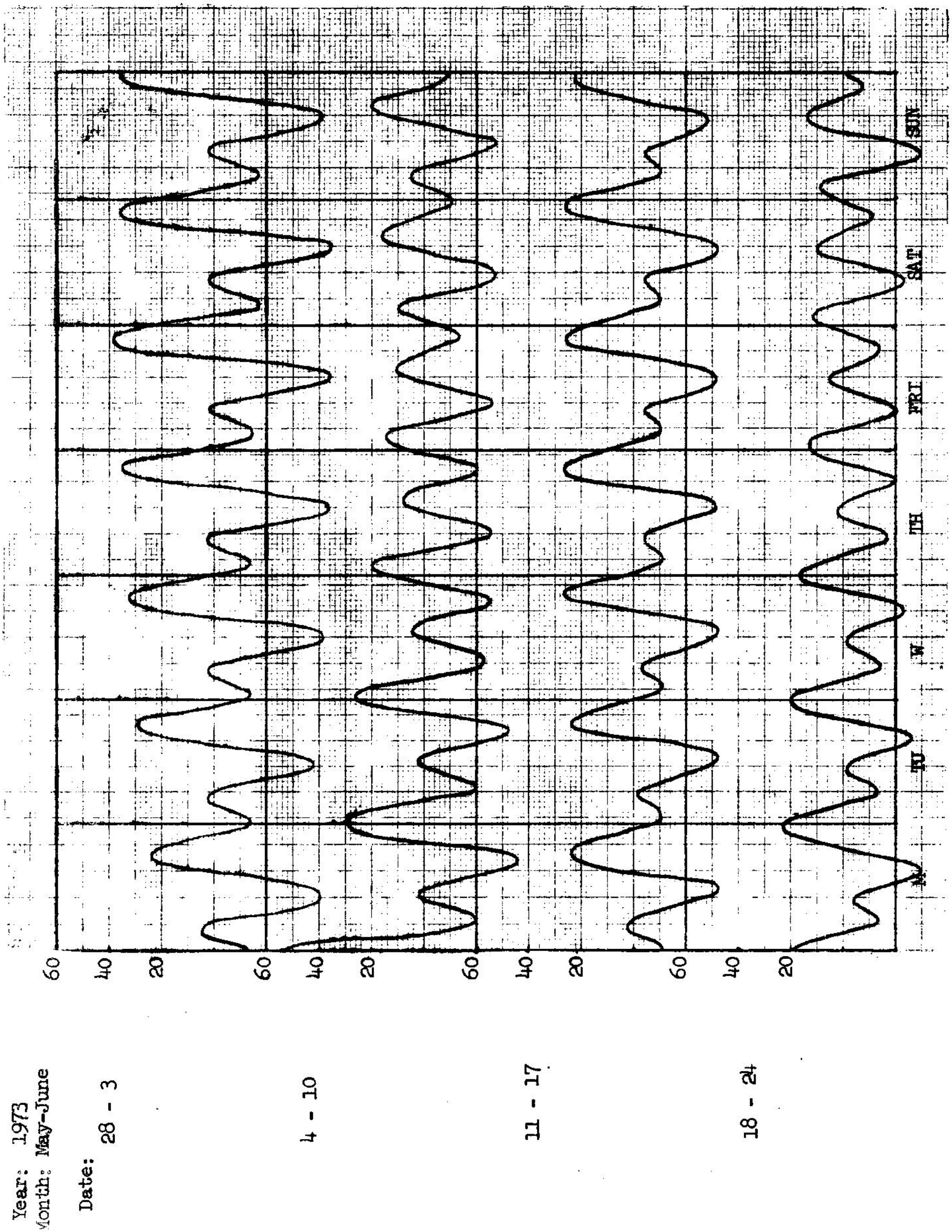


Fig. 3 - Calculated tides for Pta. Higuero for the period May 28 to June 24 to show the variation over a lunar cycle



island, eddies around Pta. Borinquen in Aguadilla Bay and westward north of Pta. Higuero. The current along the south coast turns northward through Mona Passage and is generally to the north along the west coast of Puerto Rico with numerous eddies and reversals in the nearshore waters because of a complex bottom topography, tides, wind fluctuations and surface runoff.

These two currents tend to meet at Pta. Higuero and turn westward, although the convergence has been observed to oscillate from south to north depending upon wind and tide conditions. The currents off Pta. Higuero have been measured on five different occasions.

1), 2) In the fall of 1972, the currents were measured using dye drops and aerial photography. Eight drops were made on the afternoon of Oct. 7, 1972 and photographed periodically for about two hours. The results are tabulated in the Appendix and shown in Fig. 4. There was a 4.5-5 m/sec. wind from the south and the beginning of a flood tide which caused the surface waters to move north at 15-30 cm/sec. The following morning, a similar drop pattern was repeated and followed photographically for about two hours Fig. 5. The same current trend was seen. The wind had been near calm, then picked up to 5-5.5 m/sec. as the drop began. The tide was high slack. The currents north of Pta. Higuero were sluggish, moving north and west converging with the north flowing west coast current. The offshore

Fig. 4 - Dye Study at Pt. Higuero Afternoon of 7-X-72.

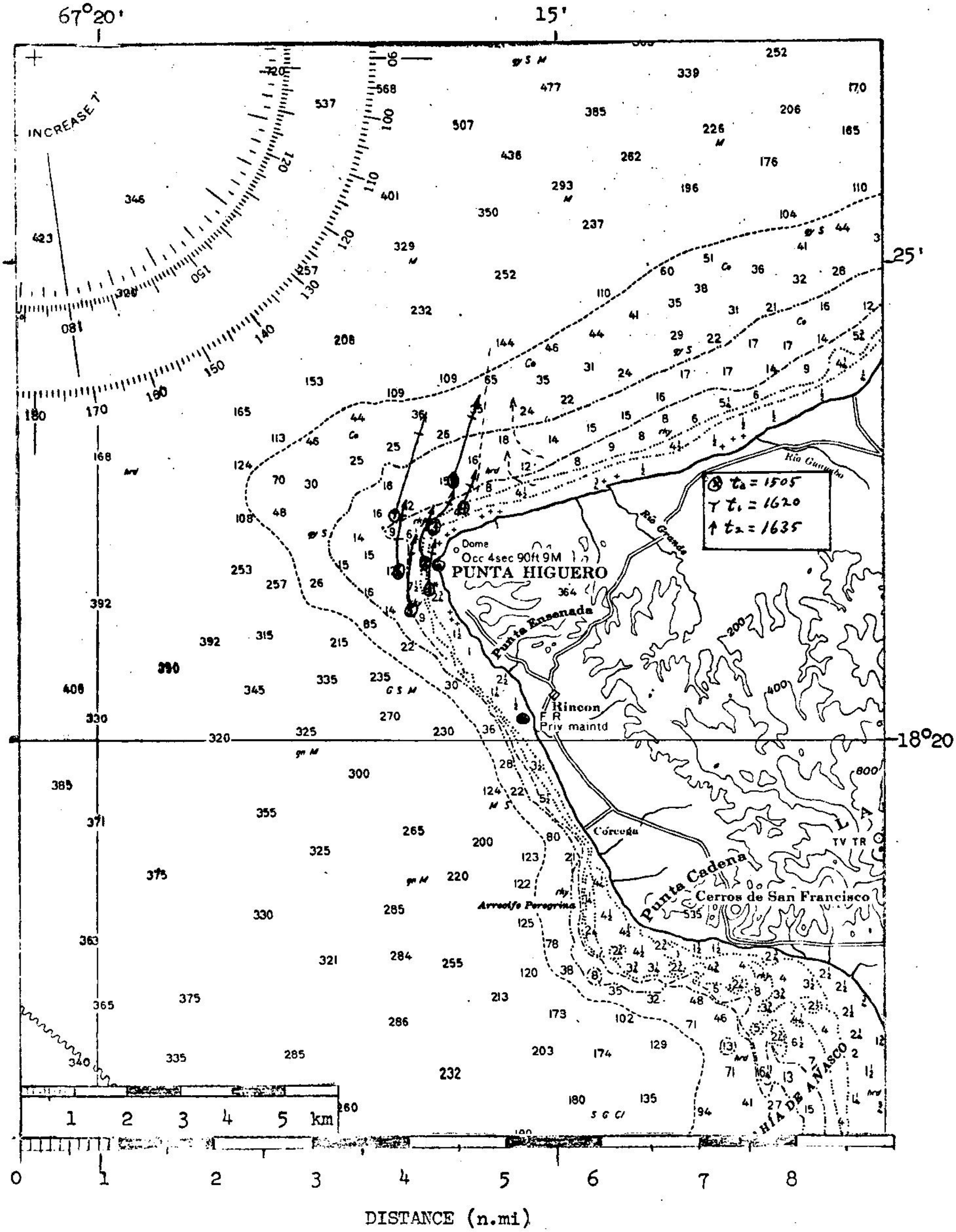
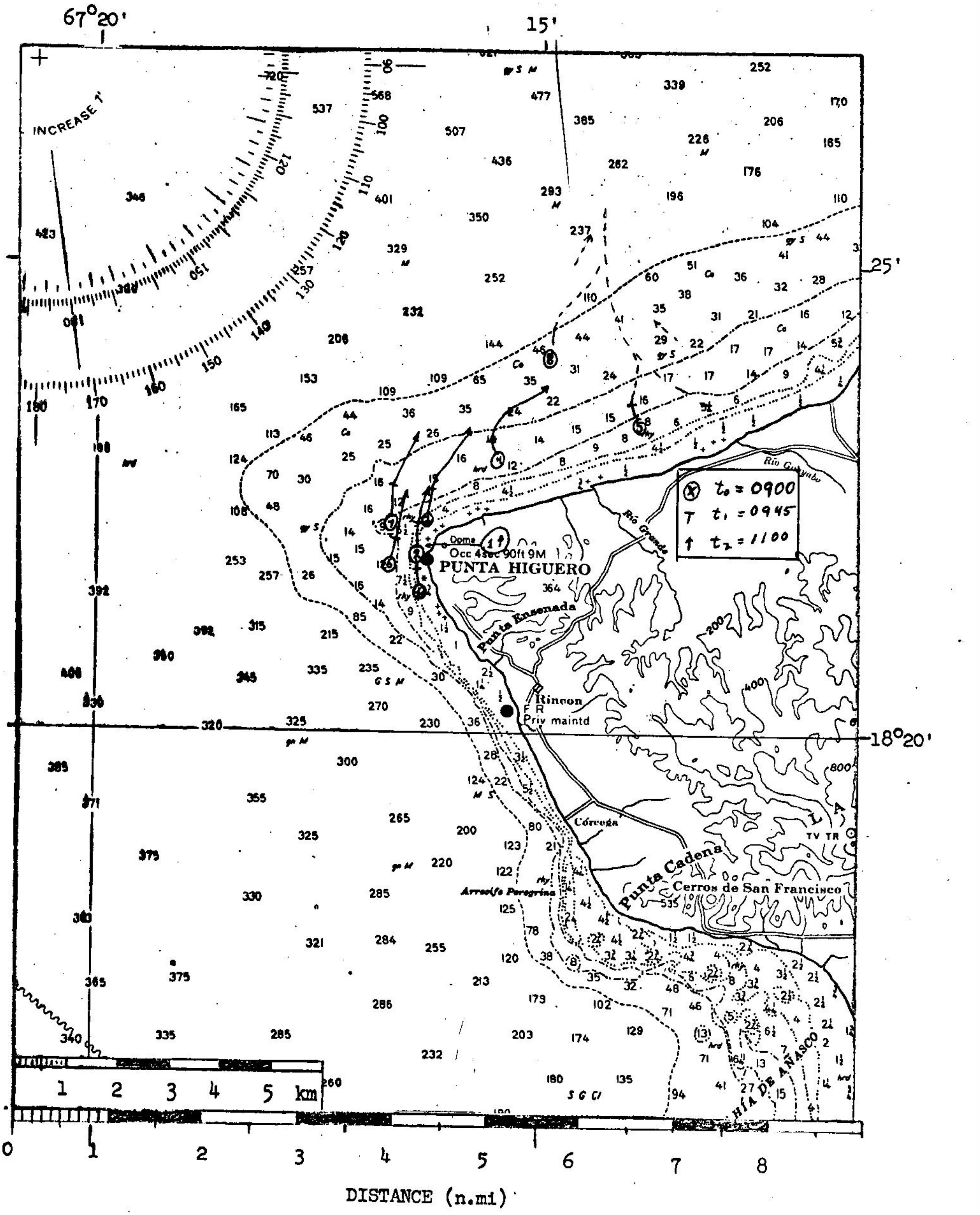


Fig. 5 - Dye Study at Pt. Higuero Morning of 8-X-72.



currents were nearly twice as strong as in the nearshore region.

3) Current Meters October 30 - November 2, 1972.

Two current meters were anchored very near station PHI-4A (Fig. 1) at depths of 3 and 6 m. The tides (plotted from tide book - appendex) were semi-diurnal with highs at 0400-0700 and 1500-1800; lows from 0900-1200 and 2200-2400. The average range of the tide for this period was about 33 cm, and the average water level was about 21 cm. Maximum flood was about 0300 and 1300 with maximum ebb near 0800 and 1900.

It is the convention to describe water currents by the direction they are traveling and wind by the direction they are from. However, in order to correlate wind and currents, both will be described by the direction they are traveling. The station log data in the Appendix retains the "from" convention for winds.

The nearest source of wind data was Ramey AFB. The surface winds are plotted in the Appendix. The direction was to the west northwest at about 3.5 m/sec. The winds were generally strongest from 1000-1600 at about 5.4 m/sec. and about 1.3 m/sec. during the early morning hours.

A combination of winds and tide should give the strongest currents about noon. However, the nearly three days of continuous recordings (Appendix) showed that the strongest currents (46 cm/sec.) were about 0400 to the north at 3 m. The highest velocity at 6 m depth was 26 cm/sec. In general, the strongest currents were to the northeast. The 3 m currents oscillated between NE and S, while the 6 m currents were between E and SW; the average 3 m current was about 23 cm/sec. and the average of 6 m current was 14 cm/sec. The 3 m current was about 80% of the outer surface current measured October 7-8. There was a weak trend for the highest velocities (3 m) to the north to coincide with high slack tide. Lowest velocities (3 m) were to the south at low slack tide. The trend was less pronounced at 6 m. Currents at 3 m and 6 m were directly opposed on several occasions. One of these times was of maximum current when the surface wind at Ramey was calm. This trend was seen at several times. It may be that the winds to the west over Aguadilla Bay retard the north bound currents west of Pta. Higuero so that when the wind calms it allows high flow to the north.

4) Current Meters - January 17-19, 1973.

Current meters were suspended from an anchored buoy at station PHI-4A during the period of cruise PA-021. The tides were more extreme during this period than during the Oct.-Nov., 1972 sampling periods. The maximum range was 76 cm with the average range 43 cm. The average water level was 15.5 cm. The period of maximum flood was 0500 and maximum ebb about 1200. The winds were generally to the west and northwest at velocities from 0 to 7.6 m/sec. Winds recorded on the ship, together with the Ramey AFB surface winds, are plotted along with current data in the Appendix and show only general correlation. There were several brief occasions when the wind was to the east during the sampling period. Average velocity and directions were 2.7 m/sec. to the west. Surface currents were variable from NNE through south around to NW. The average velocity and direction was 27 cm/sec. to the SE, the strongest currents were 46 cm/sec. to the NNE. The weakest surface currents were 15 cm/sec. to the south. No direction was available for the 3 m depth, but the velocity tended to follow the surface currents in pattern at about 15 cm/sec. or about 56% of the surface current value.

Great differences are seen in both the current velocity and direction between the surface and 6 m depths. The average velocity was 18 cm/sec. about 67% of the surface average. The direction was varied between NE and SE with the highest velocities to the NE. Flows in opposing directions were frequent between surface and 6 m. Also, when surface currents were strong, bottom currents were weak and vice versa. There were periods when the surface currents appeared to be onshore coinciding with offshore currents at depth.

5) The currents at Pta. Higuero were measured for a 24 hour period, noon on June 7, to noon on June 8, 1973, at four depths with General Oceanics inclination meters. The data were recorded on film at 2 minute intervals. In computer reducing the data, every nine points were averaged to smooth the data and reduce computer and plotter time. The data are presented in three forms.

i) Currently velocity and direction are plotted separately against time. An independent plot is given for each depth and each day (Appendix).

ii) A progressive vector for each depth, combining velocity and direction, is shown in Fig. 6. The times are indicated. This approach treats the water passing the current meter as a point in motion which may not be exactly correct, but does give the reader a feel for the extent of water movement. The four depths are plotted on one page with a land reference drawn to scale.

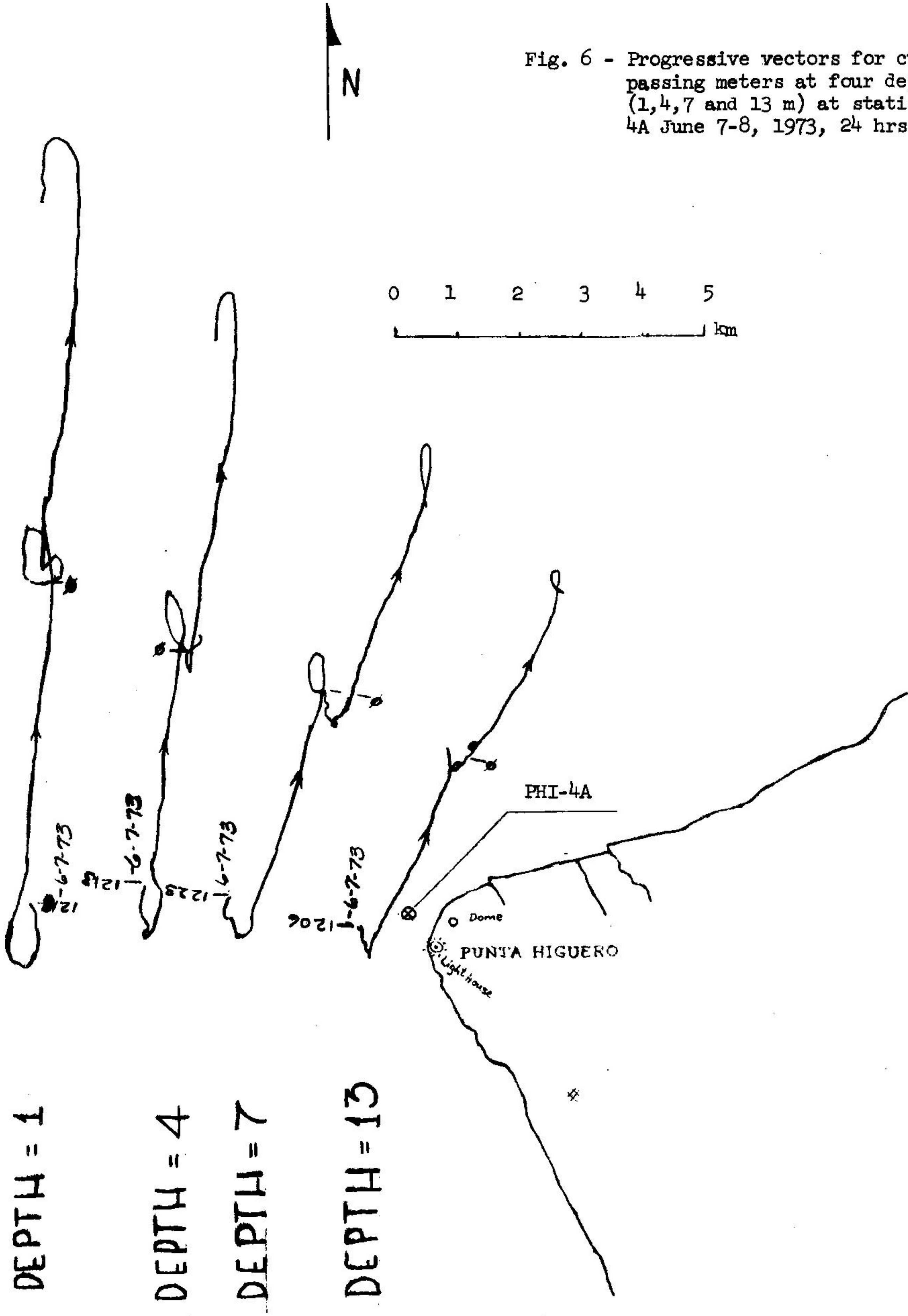


Fig. 6 - Progressive vectors for currents passing meters at four depths (1,4,7 and 13 m) at station PHI-4A June 7-8, 1973, 24 hrs.

iii) The current vectors were summed in 10° increments and plotted on a "compass rose". A separate plot for each day and each depth are given in the Appendix.

The currents during the period measured were strongest to the north. The changes in velocity and direction were periodic and appeared to be related to tide. The afternoon period of northward flow was faster and more erratic than the morning period, probably due to the influence of wind.

Surface velocities reached a high of 60 cm/sec. in the afternoon, but were more commonly 40-50 cm/sec. during the northward flow. During the slack periods between northward flows the currents were weak at about 10 cm/sec. generally southward, but the direction was sporatic.

In the progressive vector plot, a noticeable trend toward a right-hand twist to the current with depth exists. This appears to be a coriolis effect.

The RMV R.F. Palumbo was anchored about 150 m west of the current meters during the period of data collection releasing dye continuously and collecting surface weather data. The direction of flow as indicated by the dye release coincided well with the data from the surface current meter. The dye was not traceable for any great distance as it was dispersed and diffused within about 0.5 km of the point of release. The release was photographed from an aircraft periodically during daylight hours.

Summary of Currents

The currents at Pta. Higuero have been measured on five occasions during three seasons with varying wind and tidal conditions. The currents are generally strongest to the north during flood tide. Weakest currents are during ebb tide to the south. Generally good mixing can be expected in the waters off Pta. Higuero with an ultimate offshore movement of surface water. The highest currents observed were 60 cm/sec. (1.2 kt) to the north. The northward flows were about 25-30 cm/sec. while southward currents were 10-20 cm/sec. At 28 cm/sec. a body of water would flow about 4 km in a 4 hour period typical of flood tide currents at Pta. Higuero. The data also shows that there may be periods of nearly four hours when very little water movement occurs.

With this in mind, a heated water discharge should be far enough offshore so that the build-up of heated water during slack periods would not seriously effect biologically sensitive regions. In addition, the discharge velocity should be sufficient to cause rapid initial mixing (150-300 cm/sec.). An alternative would be a diffuser discharge.

Current Measurements

Current measurements will continue at Pta. Higuero generally on a quarterly basis. The period of sampling will increase up to about one week at a time and the points of current meter locations expanded to better define the currents in the region of convergence off Pta. Higuero. Dye releases and aerial photography coincidental with current meter measurements will be used to determine flow past a point, path of a point in motion and mixing characteristics of the body of water.

c. Bathymetry

The Puerto Rico Nuclear Center has undertaken no detailed bathymetry of the Pta. Higuero region to date beyond that done during benthic sampling. The C&G.S. chart 901 (Fig. 1) has been found to be adequate for most work. The narrowest shelf (400 m) on the island of Puerto Rico is just south of Pta. Higuero in the region of Corcega. The narrow shelf gradually widens to about 5000 m off the point, then turns east and narrows to about 3000 m north of Pta. Higuero. Now that a recording depth sounder is available on the RMV Sultana, detailed bathymetry is planned for the region. The bottom traces will be correlated with photographs taken by swimmers.

d. Temperature and Salinity

Hydrographic cruises have been made to Pta. Higuero quarterly since January, 1973 except for the fall quarter of 1973. Temperature and salinity were measured at 70 depths on each cruise. Three stations on each of the transects 2-6 (Fig. 1) were sampled each time collecting data from the surface to 10, 100 and 300 m for A, B, and C stations respectively. Fifteen surface samples were measured for temperature and salinity. Temperatures are measured using oceanographic reversing thermometers with readings good to ± .03 °C. Salinity samples are returned to the laboratory and determined with an induction salinometer to an accuracy of ± .005 °/oo.

The data for the four cruises (PA-021, PA-027, PA-033, and PA-036) are found in the Appendix along with the plots of temperature, salinity and sigma-t versus depth. Sigma-t, σ_t, is a measure of the water density, ρ_t

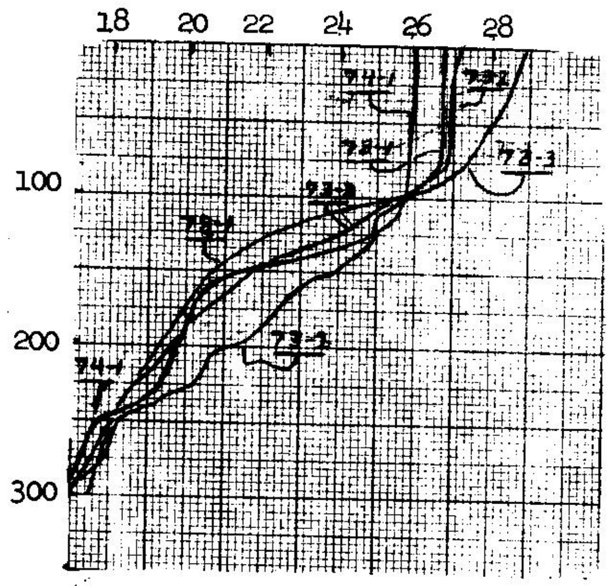
$$\sigma_t = (\rho_t - 1) \times 10^3 \qquad (1)$$

Sigma-t indicates the stability of the water column. A small sigma-t gradient with depth indicates a well mixed or unstable zone; whereas, a high gradient is indicative of a very stable portion of the water column. The near surface mixing zone varies from 50 m in the summer to about 130 m in the winter as shown in Fig. 7 by seasonal bathythermograph, BT, plots. The BT recorded temperature with depth as it was lowered and retrieved at the 300 m stations. The BT data for all cruises are in the Appendix.

1) Temperature

It can be seen from Fig. 7 that there is very little seasonal change in temperature below about 200 m. The mixing zone is the deepest and the surface temperature is the lowest in the winter season with surface warming in the spring. The

Fig. 7 - Corrected bathythermograph traces from PHI-3C for the sampling quarters: 73-1, 73-2, 73-3 and 74-1.



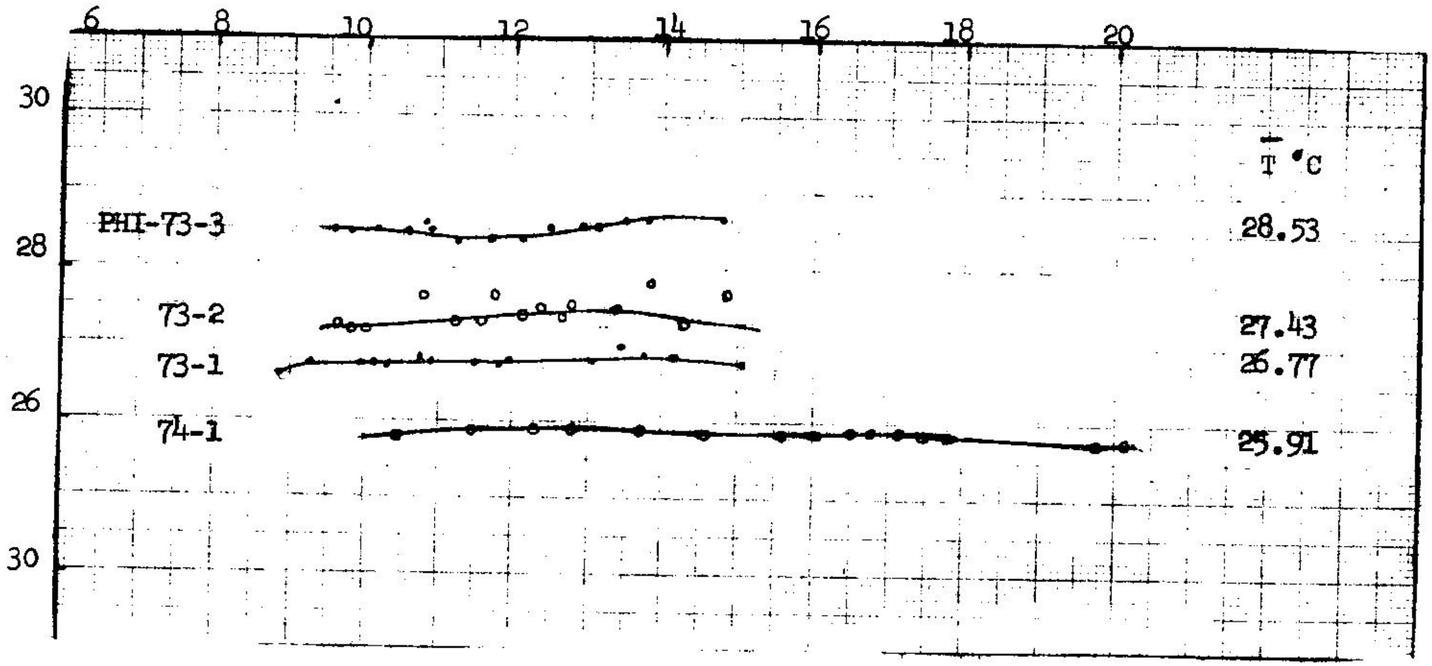
shallowest mixing zone and the highest surface temperatures occur in the summer followed by a return to winter conditions through the fall. The winter-summer surface temperature difference is about 2.5 °C, 25-28.5 °C. Some of the BT traces show a sharp break in the temperature gradient at about 225 m which indicates a shear zone between two layers of water. The shear zone is 30 to 50 m thick.

Surface temperatures vary by less than 0.5 °C in any one quarter sampling and relate as well to time of day as to their lateral distribution (Fig. 8) except for the spring cruise PA-027 when a tongue of warm water appeared north and east of Pta. Higuero to include stations 4B, 5B, 5C and 6C (Fig. 9). At least part of this difference can be explained by the fact that transects PHI-2 and 3 were sampled a day after PHI-4, 5 and 6 when the air temperature was about 3 °C lower than the first day, 27 versus 30.

Table 1 gives an "average" temperature for the depths measured plus the range over the year. The wide range near the surface is due to seasonal changes. A wide range is seen at the 150 m depth also and is due to high gradient, thermocline, at this depth and the fact that the depth of the thermocline (Fig.10) changes from station to station. The range narrows below 200 m and one finds greater differences between stations in any one sampling period than between seasons.

PHI

Fig. 8 - Surface Temperatures from four cruises to Pta. Higuero plotted against time of day.



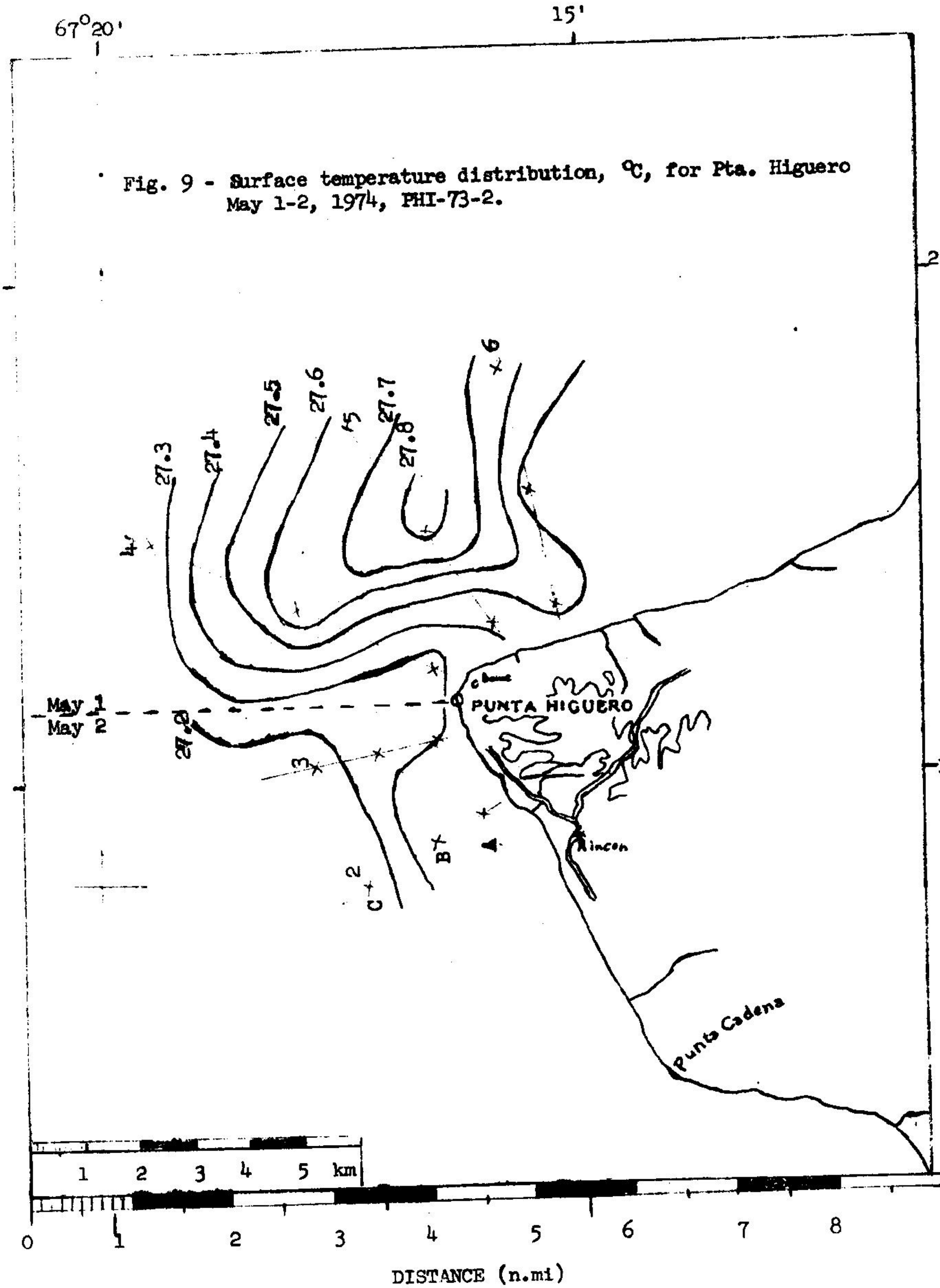


Fig. 9 - Surface temperature distribution, °C, for Pta. Higuero May 1-2, 1974, PHI-73-2.

TABLE 1

Temperatures at Pta. Higuero, averaged with depth and ranges for the year1973-74

Temperature, °C

Depth	Average	Range W		Range S	ΔT
0	27.2(5)	25.8	-	28.7	2.9
25	27.2(0)	25.9	-	28.5	2.6
50	27.2(0)	25.9	-	28.5	2.6
100	25.9(0)	25.0	-	26.8	1.8
150	22.0(5)	20.7	-	23.4	2.7
200	19.8(5)	19.3	-	20.4	1.1
250	17.9(0)	17.6	-	18.2	.6
300	16.9(5)	16.7	-	17.2	.5

Fig. 10 - Temperature, Average, and Range for the year 1973-74 plotted against depth for Pta. Higuero

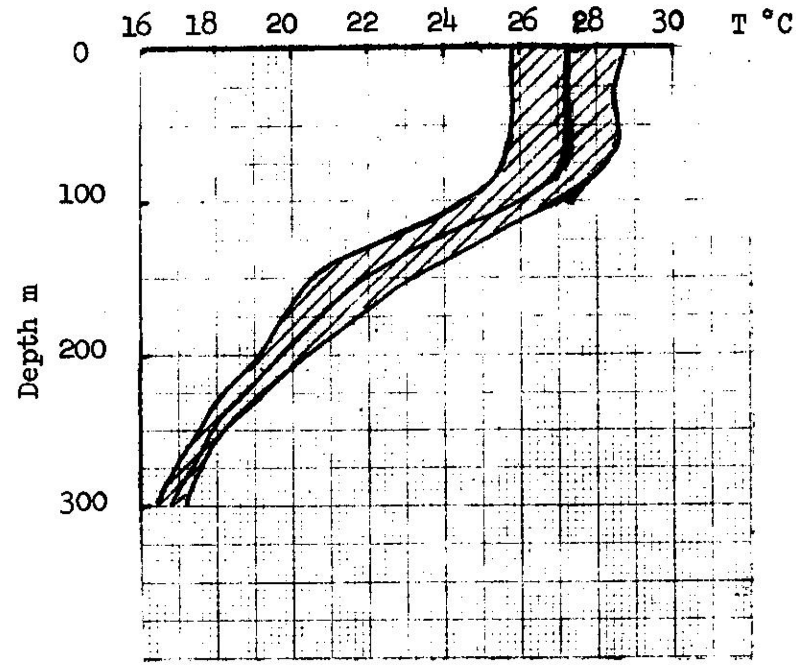
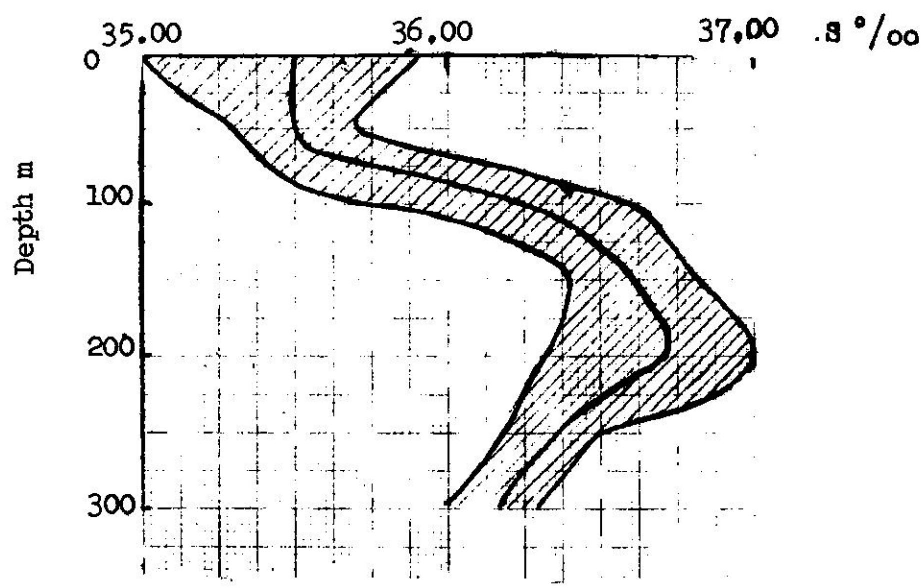


Fig. 11 - Salinity, Average, and Range for the year 1973-74 plotted against depth for Pta. Higuero



2) Salinity

The salinity of the surface waters of Pta. Higuero varied from 35.00 °/oo in summer and winter to 35.90 °/oo in the spring, reflecting the heavy runoff from June to November and the relatively dry season, December through May. The averages and ranges of salinities with depth are listed in Table 2 and plotted in Fig. 11. The average salinity is constant at 35.5 °/oo in the mixing zone (50 m) then increases rapidly to about 36.5 °/oo at 130 m. A further increase to 36.7 °/oo is seen at 200 m with lower salinities to 300 m (36.2 °/oo). Salinities at 200 m have been measured as high as 37.00 °/oo. This is usually at the deep stations north of Pta. Higuero. The high salinity water between 100 and 250 m originates in the tropical Atlantic and flows westward north and south of Puerto Rico. Mixing in the Mona Passage probably accounts for the generally lower salinities at 200 m south of Pta. Higuero.

3. Density

As mentioned above, the stability of the water column is determined by density differences. Density expressed as sigma-t (Equation 1) is a function of temperature, salinity, and to a lesser extent, pressure. A plot of temperature versus salinity is shown in Fig. 12.

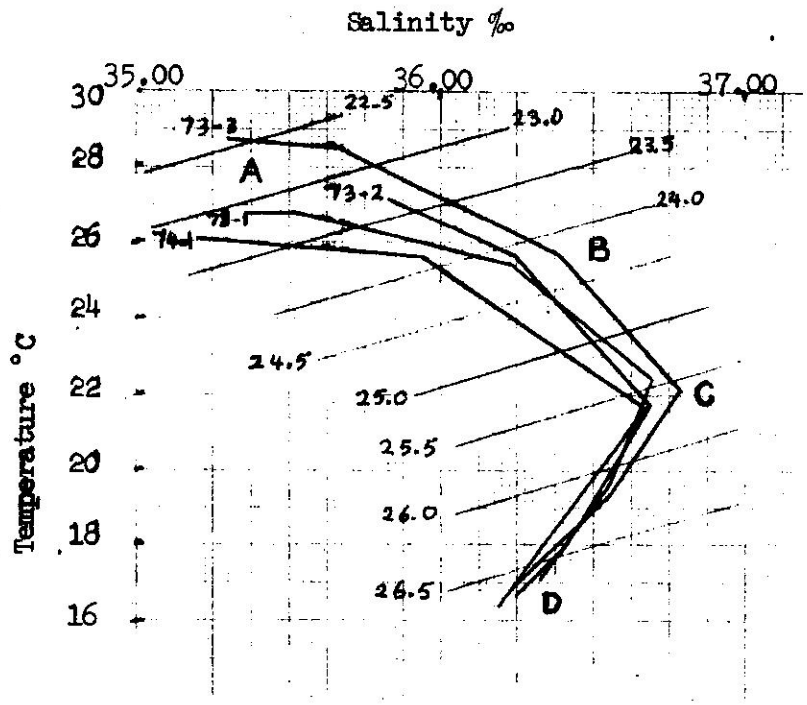
TABLE 2

Salinities for Pta. Higuero, averaged with depth

and ranges for year 1973-74

	$\bar{s}$ °/oo	Range w		Range sp	Δ s°/oo
0	35.5	35.0	-	35.9	.9
25	35.5	35.1	-	35.8	.7
50	35.5	35.3	-	35.7	.4
100	36.2	35.7	-	36.6	.9
150	36.6	36.4	-	36.8	.4
200	36.7	36.3	-	37.0	.7
250	36.4	36.2	-	36.5	.3
300	36.2	36.0	-	36.3	.3

Fig. 12 - T-S diagram showing visually averaged temperatures and salinities for four sampling quarters at Pt. Higuero. Diagonal lines show the density factor. Sigma-t.



Each line is the average of the data collected at the "C" stations for each cruise.

The greatest seasonal density difference is in the surface waters denoted by "A" on Fig. 12. A much lower sigma-t is seen in the summer data, (73-3) where σ_t = 22.4. Even though the temperatures and salinities do differ for the winter and spring data, sigma-t does not change appreciably, 23.1 - 23.3. This dry season-wet season difference in sigma-t probably accounts for most of the difference seen in the monthly mean tide levels. The monthly mean tide levels are generally low in the winter-spring (dry season) and high in the summer-fall (wet season). The difference in sigma-t decreases with depth from "B" to "C" and is nearly uniform throughout the year below "C".

Temperature and salinity measurements will continue on a quarterly basis at Pta. Higuero to determine seasonal variation, and will be expanded to better explain mixing processes which occur in the convergence of the west coast current and the north coast current. More detailed nearshore temperatures will also be taken. The region has been scanned on three occasions with an aerial infrared camera (9/73, 11/73, 3/74). The surface temperature distribution patterns from the scans are being worked up.

e. Marine Geology and Sediment Transport

No PRNC input.

f. Chemical Parameters

Dissolved oxygen O_2, and reactive phosphate, $PO_4^{\equiv}$, were determined at the same time and depths that temperature and salinity were on all cruises to Pta. Higuero as part of the regular hydrographic work. All of the data are listed and plotted in the Appendix. Dissolved oxygen is given in ml/L, mg/L (commonly called ppm even though it is incorrect), and percent saturation. Reactive phosphate is given in ug-at. $PO_4^{\equiv}$/L.

1) Dissolved Oxygen

The amount of dissolved oxygen in sea water was determined by the standard Winkler titration method. In addition, oxygens on the PHI-74-1 cruise were measured with a YSI probe on the same samples that were titrated. A comparison of the two methods is plotted in Fig. 13. The agreement is fairly good, however, the titrated values are consistently higher than the probe values. Since the titrated values are at or near saturation in the surface waters, they appear to be more reliable. The oxygen concentrations were near saturation in the surface waters (6.7-7.0 mg O_2/L). Some super-saturation was noted at 25 to 50 m due to photo-synthesis (103%). A typical plot of oxygen versus depth is shown in Fig. 14. Below about 100 m, the concentration of O_2 decreased to a minimum of 5.75 mg O_2/L, 70% saturation, at 300 m. The lowest surface O_2 was no lower than 95% saturation and may have been due to the BOD of surface runoff.

2) Reactive Phosphate

Reactive phosphate was determined by the Murphy and Riley molybdate complex method using a Beckman DU spectrophotometer. Phosphate can be determined rapidly with good accuracy. There exists a good relationship between phosphate and nitrate in sea water (1:14) so that phosphate can be used as a nutrient indicator.

Phosphate is very low in most surface waters of the Caribbean except near very highly populated regions. Surface values characteristically run $0.05 \pm .05$ ug-at. $PO_4^{\equiv}$/L from surface to 100 m. A slight increase in $PO_4^{\equiv}$ occurs at 150 m, followed by a steady increase to about .50 ug-at. $PO_4^{\equiv}$/L at 300 m. A typical plot is seen in Fig. 14.

Phosphate is withdrawn from the surface waters during photosynthesis, incorporated in biota which sinks and decomposes using up oxygen and releasing nutrients into the water column. The turn-over rate of the near surface nutrients is fairly rapid to allow what little productivity there is to occur, probably a matter of hours or a few days at most. The distribution of phosphate in the surface waters seems to be spotty as in plankton. Probably low phosphate conditions exists where productivity is active.

The chemical parameters of dissolved oxygen and reactive phosphate will continue to be sampled as part of the quarterly hydrographic work with attention given to diurnal changes and possible sources of nutrients or BOD from terrestrial sources.

Fig. 13 - A comparison of the Winkler titration and the YSI oxygen probe for 70 samples at Pta. Higuero, 1/15/74.

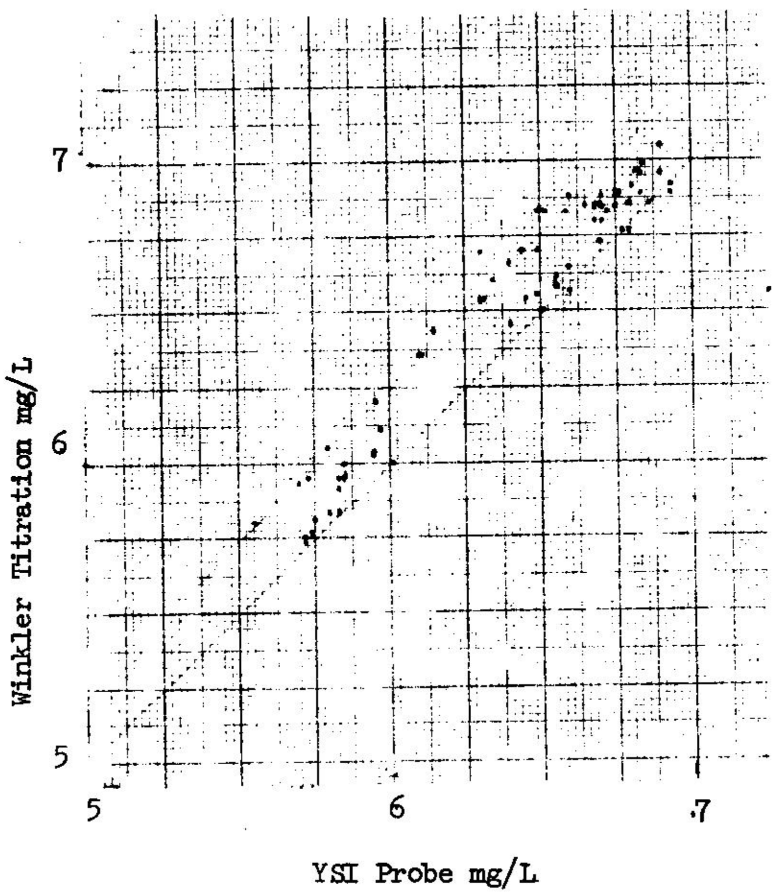
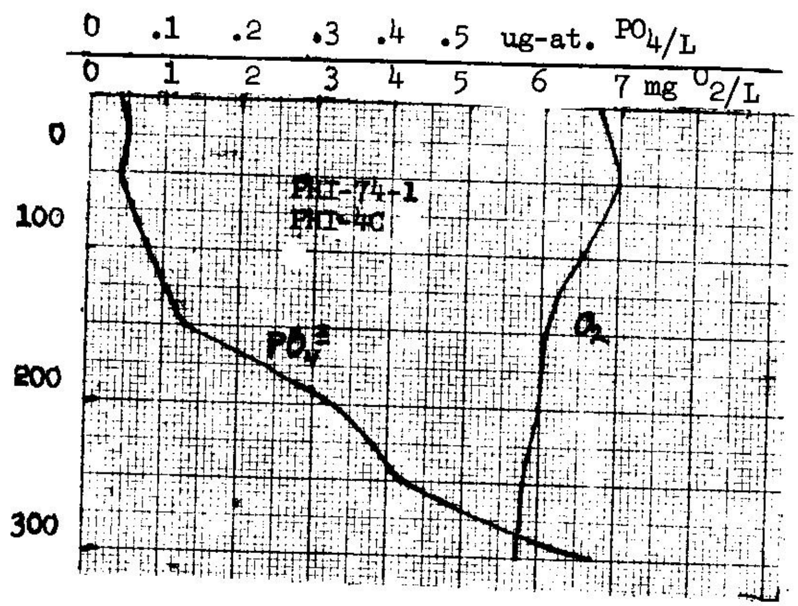


Fig. 14 - Dissolved oxygen and reactive phosphate profiles typical of the Pta. Higuero region, 1/15/74, PHI-4C



b. PLANKTON SURVEY AT THE PUNTA HIGUERO SITE. I. Standing stock estimates of the major taxonomic groups.

By Marsh J. Youngbluth

INTRODUCTION

The following report provides quantitative estimates of the biomass and number of zooplankton collected in the surface waters near the coast. The data represent one part of an environmental survey conducted by the Puerto Rico Nuclear Center in the vicinity of the proposed site for fossil power plants at Punta Higuero. Samples were gathered on 5 days during 1973 - 17 January, 2 May, 14 August, 3 December, and 11 December.

MATERIALS AND METHODS

Field Procedure

Plankton were collected with 1/2-meter diameter, cylinder-cone shaped nylon nets of two mesh sizes (64 and 202 microns). These nets were designed to reduce clogging error (Smith, Counts and Clutter 1968). The larger mesh netting retains most of the macrozooplankton. The smaller mesh captures the larger microzooplankton and phytoplankton. Nets of finer porosity are impractical to use in coastal areas since the mesh clogs very quickly.

All samples were gathered in a standard manner. The nets were towed from a 17 ft. skiff in a circular path through the upper 2 meters. The speed of the vessel was about 3 knots (determined with a Sims yacht speedometer). The smaller mesh net was hauled for 5 minutes, the larger for 10 minutes. After each tow, before the cod end was removed, the nets were thoroughly washed by sea water with the aid of a battery powered pump (12 volt, Jabsco water-puppy). Samples were preserved in 4% sea water-formalin buffered to pH 7.6. All samples were gathered during the daylight hours. The volume of water filtered through a net was estimated with a flowmeter (General Oceanics, Model 2030) suspended off-center in the mouth of the net.

One tow was made with each net at every station except in the area adjacent to the proposed site for the power plant (station 2) where triplicate tows were made with the coarser net. These replicate samples were used to determine the range of variability between successive tows and to provide more reliable estimates of the organisms present. The stations were situated in such a way as to sample within and around the area where thermal alteration is likely to occur (see Fig. 1). Station 1 to the north is upcurrent from the proposed site and should depict a plankton community unaffected by a pollution source. Plankton populations in areas downcurrent, station 3, and offshore, stations 4 and 5, may show pollution related stresses.

Laboratory Procedure

Within 24 hours after samples were collected the pH was checked and adjusted, if necessary, to 7.6. If a sample contained a noticeable conglomerate of phytoplankton or detritus, the zooplankton were separated by gently filtering such material through 202 micron mesh netting. Before estimates of biomass and numbers were made, all organisms larger than 1 centimeter, usually hydrozoan medusae, ctenophores, or scyphozoans, were removed.

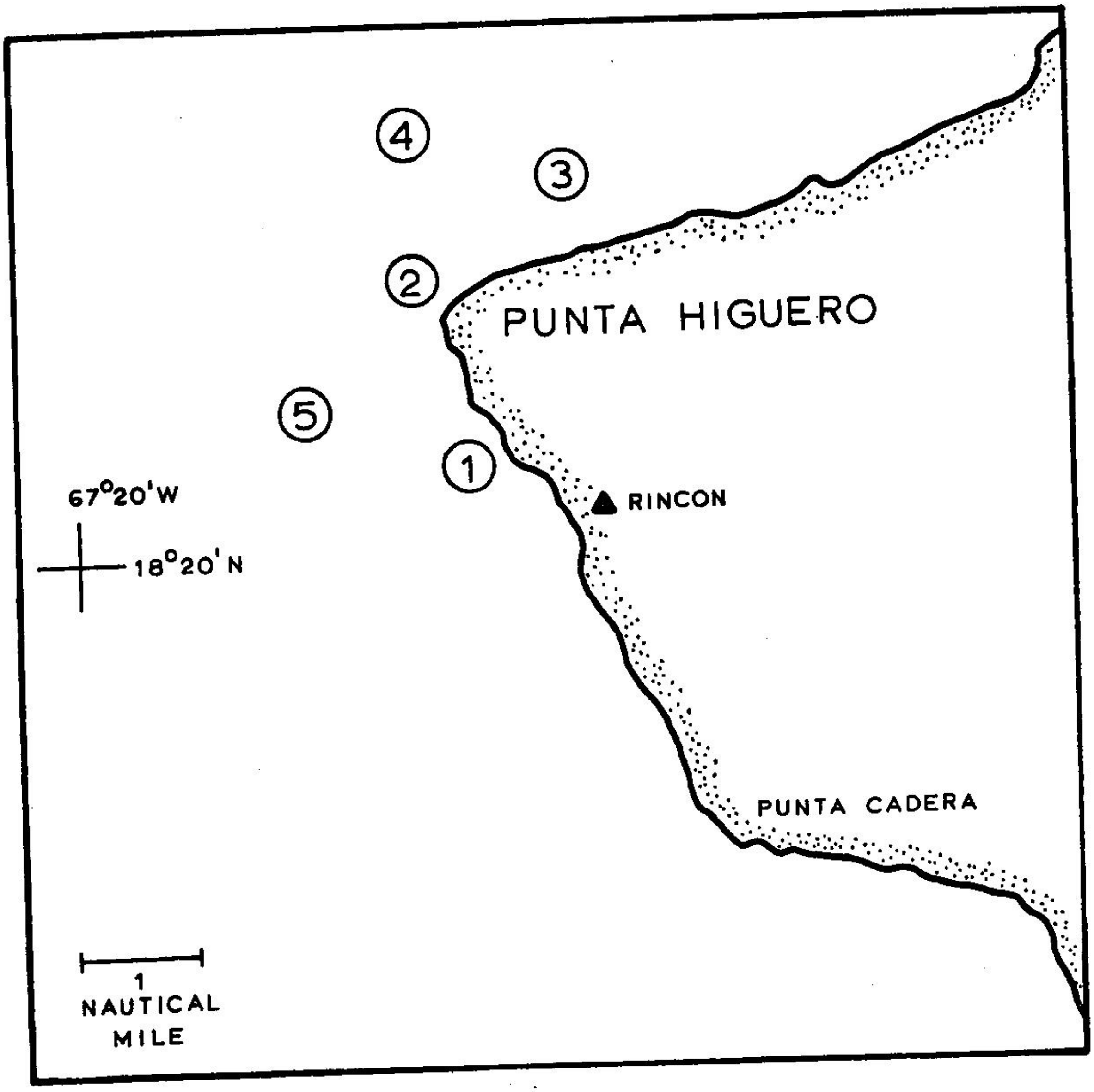


Fig. 1. The locations at Punta Higuero where zooplankton were collected.

Biomass was calculated as wet volume (Ahlstrom and Thraikill 1962). This method was employed to measure biomass because it is quick and does not damage the organisms. Conversion factors for wet volume to wet weight or dry weight have been determined from other studies of zooplankton along the south coast of Puerto Rico (see Youngbluth 1974). These factors are cited in a footnote on Table 1.

The number of organisms in the coarse net catches was estimated by volumetric subsampling with replacement (Brinton 1962). Three aliquots from each sample were counted unless otherwise noted. The choice of which organisms are counted and identified to species needs some clarification. Plankton tows collect many different kinds of organisms. It is extremely difficult and time consuming to identify all organisms to the species level. Fortunately, this is not necessary to detect changes in the abundance of the plankton community. Usually the more abundant of the most numerous organism is given primary attention. In the plankton copepods are usually numerically dominant. In this report the majority of these animals have been identified to species. Quantitative estimates of their relative abundances will be the subject of a later report. The other fauna have been grouped into two categories, being identified by life history and taxonomic position. Dilutions were made so that about 200-400 organisms were categorized into major taxonomic groups.

All biomass and enumeration data were standardized to a per cubic meter basis or multiple thereof. Data were initially reduced

TABLE 1. Total biomass of zooplankton (ml/m^3)*

	Nearshore Replicate Tows Stations			Nearshore Tows Stations			Offshore Tows Stations	
DATE	2C1	2C2	2C3	2C	1C	3C	4C	5C
170173	.135	.279	.241	.219	-	-	-	-
20573	.074	.105	.087	.089	.146	.041	.038	.024
140873	.043	.043	.065	.050	.004	.011	.033	-
31273	-	-	-	-	-	.048	-	-
111273	.313	.249	.183	.248	.156	.061	.055	-

* Conversion factors adjusting wet volume to wet weight and dry weight are 0.54 and 0.059, respectively.

with hand calculators (Hewlett Packard Model 35) and, more recently, with a larger computer (PDP-10). See Appendix A for a listing of the program.

RESULTS

A total of 46 samples were collected from five sites around Punta Higuero. Variations in the biomass and number of zooplankton from 27 coarse net tows are presented in this paper. An earlier report (Youngbluth 1973a) discussed the zooplankton caught in coarse and fine net tows during January 1973. For the sake of completeness all data from coarse mesh tows taken at Punta Higuero in 1973 are included in this report. Because of time and manpower limitations no further attention will be given to microzooplankton from the fine mesh tows for some time.

The range of variation for those subsamples that were counted three times was always within the range expected for subsamples drawn from a Poisson distribution. Thus, counts were made on organisms drawn from randomly dispersed populations. Previous testing and continual checks on the subsampling technique indicate that there is no significant variation between replicate counts or counters. Thus three counts per sample are now made less frequently.

The magnitude of variation among the replicate, inshore, and offshore tows and between inshore and offshore tows during each collection period was summarized by dividing the highest total number of organisms by the lowest within each set. Among the replicate nearshore tows the factors were 2.5, 1.4, 1.9, and 1.2 for January, May, August and December.

These variations are similar to those observed at Quebrada de Toro, Punta Manati, and Tortuguero (see Youngbluth 1973b). Among the nearshore tows the differences were 3.4, 3.1 and 6.0 for May, August and December. The ratio among offshore samples during May was 2.3. Thus it appears that there is usually more variation between tows from different stations than from replicate tows at the same station. Variation in terms of total numbers between tows at different stations must therefore be greater than 2.5 to be significant.

Zooplankton biomass was usually greater near the coast. The largest concentrations were found just off the tip of Punta Higuero at station 2. Volumes in this area were 4 to 5 times higher in January and December (Table 1). In terms of numbers per m^3 6 to 10 times more zooplankton were present in December (Table 2).

Holoplanktonic fauna dominated the catches composing 58 to 97% of the total numbers nearshore and 61 to 84% offshore. Numbers per m^3 are listed in Table 3. During January and December copepods accounted for about 80% of the zooplankton in either area (Table 4). In May and August copepods composed around 60% of the zooplankton. Chaetognaths were abundant in January and May (Table 5). Larvaceans, _Oikopleura_ spp. and _Fritillaria_ spp. were proportionately most numerous in May and December (Table 6). Cladocerans, _Evadne_ spp., were not conspicuous at any time of the year. Pteropods, mostly _Cressis_ spp. and coiled forms, were an order of magnitude more dense in December than in other months (Table 7).

The abundance of meroplanktonic organisms was low and concentrations averaging 30 individuals per m^3 were common in May, August and December (Table 8). About half this amount was recorded in January. Brachyuran

TABLE 2. Total number of zooplankton per m^3

	Nearshore Replicate Tows Stations			Nearshore Tows Stations			Offshore Tows Stations	
DATE	2C1	2C2	2C3	2C	1C	3C	4C	5C
170173	498	1260	976	911	-	-	-	-
20573	1024	918	1305	1082	475	319	176	411
140873	610	339	636	529	49	172	847	-
31273	-	-	-	-	-	2094	-	-
111273	7396	7568	6349	7105	1178	1179	1206	-

TABLE 3. Total number of holoplankton per m^3

	Nearshore Replicate Tows Stations			Nearshore Tows Stations			Offshore Tows Stations	
DATE	2C1	2C2	2C3	2C	1C	3C	4C	5C
170173	478	1245	939	887	-	-	-	-
20573	924	825	1220	990	362	259	108	327
140873	525	292	548	456	28	110	710	-
31273	-	-	-	-	-	1675	-	-
111273	7210	7202	6023	6812	1088	1078	1025	-

TABLE 4. Total number of copepods per m^3

	Nearshore Replicate Tows Stations			Nearshore Tows Stations			Offshore Tows Stations	
DATE	2C1	2C2	2C3	2C	1C	3C	4C	5C
170173	441	1161	883	828	-	-	-	-
20573	716	716	1026	820	280	232	77	271
140873	485	280	505	424	26	88	595	-
31273	-	-	-	-	-	1533	-	-
111273	6782	6869	5532	6395	845	943	936	-

TABLE 5. Total number of chaetognaths per 10 m^3

	Nearshore Replicate Tows Stations			Nearshore Tows Stations			Offshore Tows Stations	
DATE	2C1	2C2	2C3	2C	1C	3C	4C	5C
170173	316	698	227	414	-	-	-	-
20573	699	332	732	588	284	96	55	29
140873	127	68	102	83	5	9	333	-
31273	-	-	-	-	-	101	-	-
111273	409	997	311	572	196	153	123	-

TABLE 6. Total number of larvaceans per 10 m^3

	Nearshore Replicate Tows Stations			Nearshore Tows Stations			Offshore Tows Stations	
DATE	2C1	2C2	2C3	2C	1C	3C	4C	5C
170173	<10	<10	141	47	-	-	-	-
20573	1039	638	906	861	339	40	202	382
140873	<10	<10	120	40	2	9	304	-
31273	-	-	-	-	-	541	-	-
111273	409	832	1712	984	1189	599	495	-

TABLE 7. Total number of pteropods per 10 m^3

	Nearshore Replicate Tows Stations			Nearshore Tows Stations			Offshore Tows Stations	
DATE	2C1	2C2	2C3	2C	1C	3C	4C	5C
170173	27	124	156	102	-	-	-	-
20573	339	115	296	250	187	132	41	118
140873	277	17	204	166	8	194	485	-
31273	-	-	-	-	-	541	-	-
111273	2754	1164	2178	2033	1000	553	234	-

TABLE 8. Total number of meroplankton per m^3

	Nearshore Replicate Tows Stations			Nearshore Tows Stations			Offshore Tows Stations	
DATE	2C1	2C2	2C3	2C	1C	3C	4C	5C
170173	<10	<10	24	12	-	-	-	-
20573	65	38	34	46	33	<10	<10	15
140873	60	19	66	48	<10	28	34	-
31273	-	-	-	-	-	67	-	-
111273	55	<10	38	32	29	21	17	-

crab larvae were abundant in May ($\bar{x}/10^3$= 30, Table 9). Barnacle larvae were preponderant in August ($\bar{x}/10^3$= 123, Table 10). Caridean shrimp larvae were most numerous in May and August, particularly near the coast ($\bar{x}/10^3$= 82, Table 11).

Other holoplankton and meroplankton observed included: tretomphalus stage of a foraminiferan (probably Tretomphalus bulloides), myodocopid ostracods, hyperid amphipods, ctenophores, siphonophores, hydromedusae, salps, and the larvae of polychaetes, echinoderms, lamellibranchs, and isopods. These groups occurred in densities of less than 5 individuals per m^3.

Fish eggs often ranked as the second most abundant planktonic form. Fish larvae were much less numerous. The largest densities of fish eggs and larvae occurred in December ($\bar{x}/m^3$= 64, Tables 12 and 13). Some of the fish eggs are football-shaped, resembling the anchovetta egg. It is not known at this time which fish groups are represented by most of the eggs.

The 38 copepod and 8 chaetognath species identified are listed in Table 14.

DISCUSSION

The zooplankton community in the Punta Higuero area is dominated numerically by copepods. There are at least 38 species. The majority are small (1-3 mm), herbivorous populations common to tropical and coastal oceanic regions (Bjornberg 1971). The chaetognath species identified are conspicuous in the mixed layer of the Atlantic and Caribbean (Suarez-Caabro 1955, Pierce and Wass 1962, Alvariño 1969).

TABLE 9. Total number of brachyuran larvae per 10 m^3

	Nearshore Replicate Tows Stations			Nearshore Tows Stations			Offshore Tows Stations	
DATE	2C1	2C2	2C3	2C	1C	3C	4C	5C
170173	27	<10	28	18	-	-	-	-
20573	63	63	34	54	35	35	<10	20
140873	34	<10	<10	11	<10	11	58	-
31273	-	-	-	-	-	67	-	-
111273	<10	<10	<10	<10	18	46	13	-

TABLE 10. Total number of cirripede nauplii per 10 m^3

DATE	Nearshore Replicate Tows Stations			Nearshore Tows Stations			Offshore Tows Stations	
	2C1	2C2	2C3	2C	1C	3C	4C	5C
170173	0	0	0	0	-	-	-	-
20573	148	25	<10	58	20	<10	<10	<10
140873	254	85	278	206	8	205	72	-
31273	-	-	-	-	-	33	-	-
111273	<10	<10	<10	<10	536	61	82	-

TABLE 11. Total number of caridean larvae per 10 m^3

	Nearshore Replicate Tows Stations			Nearshore Tows Stations			Offshore Tows Stations	
DATE	2C1	2C2	2C3	2C	1C	3C	4C	5C
170173	27	31	156	71	-	-	-	-
20573	190	204	174	189	117	10	19	73
140873	231	51	204	162	7	<10	80	-
31273	-	-	-	-	-	270	-	-
111273	111	<10	<10	37	54	46	13	-

TABLE 12. Total number of fish eggs per m^3.

	Nearshore Replicate Tows Stations			Nearshore Tows Stations			Offshore Tows Stations	
DATE	2C1	2C2	2C3	2C	1C	3C	4C	5C
170173	11	3	9	8	-	-	-	-
20573	25	47	48	40	76	48	59	59
140873	21	27	19	23	15	34	96	-
31273	-	-	-	-	-	345	-	-
111273	126	299	287	238	39	49	159	-

TABLE 13. Total number of fish larvae per 10 m^3

	Nearshore Replicate Tows Stations			Nearshore Tows Stations			Offshore Tows Stations	
DATE	2C1	2C2	2C3	2C	1C	3C	4C	5C
170173	<10	46	<10	2	-	-	-	-
20573	84	76	17	59	41	<10	<10	<10
140873	<10	<10	<10	<10	<10	<10	15	-
31273	-	-	-	-	-	0	-	-
111273	<10	665	<10	222	27	<10	14	-

TABLE 14. A list of the copepod and chaetognath species identified from the Punta Higuero collections.

COPEPOD SPECIES	CHAETOGNATH SPECIES
Acartia spinata	*Sagitta hexaptera*
Acartia lilljeborgii	*Sagitta hispida*
Paracalanus crassirostris	*Sagitta enflata*
Paracalanus parvus	*Sagitta tenuis*
Paracalanus aculeatus	*Sagitta* **serratodentata**
Oithona oculata	*Sagitta bipunctata*
Oithona plumifera	*Krohnitta mutabbii*
Oithona sp. A	*Pterosagitta draco*
Clausocalanus furcatus	
Temora turbinata	
Temora stylifera	
Oncaea venusta	
Oncaea mediterranea	
Corycaeus subulatus	
Corycaeus giesbrechti	
Corycaeus pacificus	
Corycaeus agilis	
Corycaeus speciosus	
Corycaeus anglicus	
Corycaeus clausi	
Corycaeus lautus	
Farranula gracilis	
Farranula sp. A	
Undinula vulgaris	
Nannocalanus minor	
Centropages furcatus	
Calocalanus pavo	
Lucicutia flavicornis	
Calanopia americana	
Macrosetella gracilis	
Microsetella norvegica	
Acrocalanus longicornis	
Candacia pachydactyla	
Euchaeta marina	
Eucalanus cf. *attenuatus*	
Labidocera spp.	
Miracia efferata	
Euterpina acutifrons	

Previous studies of zooplankton in the coastal areas of Puerto Rico are restricted to the bays and shelf regions along the southwestern portion of the island (Duran 1957, Coker and Gonzalez 1960, Bowman and Gonzalez 1961, Gonzalez and Bowman 1965). The species found at Punta Higuero included many of those mentioned in the papers just cited as well as those encountered in several recent surveys around Puerto Rico (Youngbluth 1973a,b; 1974a,b).

The range of variability between replicate tows is similar to previous estimates observed in other plankton investigations (e.g., see the review by Wiebe and Holland 1968).

The seasonal increase in the abundance of most zooplankton populations during December and January and the tendency for most groups to be more numerous nearshore probably reflect greater mixing of the water column and a higher level of primary production.

LIMITATIONS OF THE DATA

The sampling program was designed to provide quantitative estimates of: 1) the standing stock of zooplankton, 2) the variety of major taxonomic groups, and 3) the diversity and abundance of the more numerous copepod species. The manner of field sampling determined the variety and biomass of organisms encountered. The data in this report are based on collections made in the surface waters during the daylight hours. The sampling gear and methods were kept uniform, i.e., net type, net mesh, towing speed, and depth range sampled. A small number of replicate tows were gathered at each site to obtain some measure of the variability between samples. To obtain a better understanding of the zooplankton community more sampling with replication should be done at frequent intervals, at a greater number of stations, at different depths, during the day and night, and during different seasons for several years. The sum of the information gathered in these ways is necessary to interpret fluctations in standing stock and diversity in relation to environmental changes and biotic interactions.

ACKNOWLEDGEMENTS

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c. Benthic

OCCURRENCE AND DISTRIBUTION OF THE MAJOR TYPES OF EPIBENTHIC COMMUNITIES AT PUNTA HIGUERO

By: Vance P. Vicente

INTRODUCTION

An increase of electrical power has become mandatory in Puerto Rico, due to population growth and technical advances. A proposed site for a fossil fuel plant is located at Punta Higuero on the west coast of Puerto Rico. Sea water from the immediate area will be used as a coolant and then discharged at temperatures above ambient. In the past there has been much misuse of coastal waters by power plants, and their detrimental effect upon marine life has been well documented (Zieman 1970; Roessler and Zieman 1969). To prevent continuing misuse and subsequent harm, it has also become mandatory to evaluate the ecological and economic character of existing marine communities before exposing them to industrial processes.

The purpose of this study was to make a preliminary survey of the benthic communities at the Punta Higuero site. In order to study benthic life adequately three important aspects should be taken into consideration.

1) Determination of the types of communities, populations, and species of a particular area at a particular time.
2) Natural changes (i.e. seasonal) occurring within a particular community and within its components.
3) Their tolerance to the forthcoming environmental impacts.

The present field study deals with the first of these.

For additional information consult a previous study of this site (Szmant 1972).

MATERIALS AND METHODS

Sampling was done during two periods - 26-28 June 1973 and 14-16 January 1974. Three stations were designated as sampling areas: Station A, located north of the dome at Punta Higuero; Station B, located perpendicular to the dome and slightly northwest of the Point; and Station C, located south of the Point (Fig. 1). Although basically the same methods were used during both sampling periods, Station B was omitted from the second period due to unfavorable weather conditions.

The field work involved a total effort of three divers and 69 man hours (48 man hours during the first sampling and 21 during the second). The survey was done using SCUBA apparatus, underwater cameras (Nikonos)[1], and collecting bags. Data on the types of benthos, dominant species, types of substrate and other geographical characters of the area was recorded on an underwater plexiglass slate.

Three transects were made. Each transect spanned a distance of approximately 1 nautical mile. The divers swam along the transects, taking pictures, sampling and recording data. Benthic communities in depths from 3-27 m were surveyed in this manner. During the second sampling period four samples were collected with 1/4 m^2 grid by removing all epibenthic forms by hand. A species list, biomass, and the relative abundance of each species were obtained from each of the samples.

In summary, the results of this study are based on three aspects:

1) Field observations and notes.
2) The samples collected.
3) Detailed studies from the photographs taken of the area.

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1. Unless otherwise cited, all photographs included were taken by Vance P. Vicente.

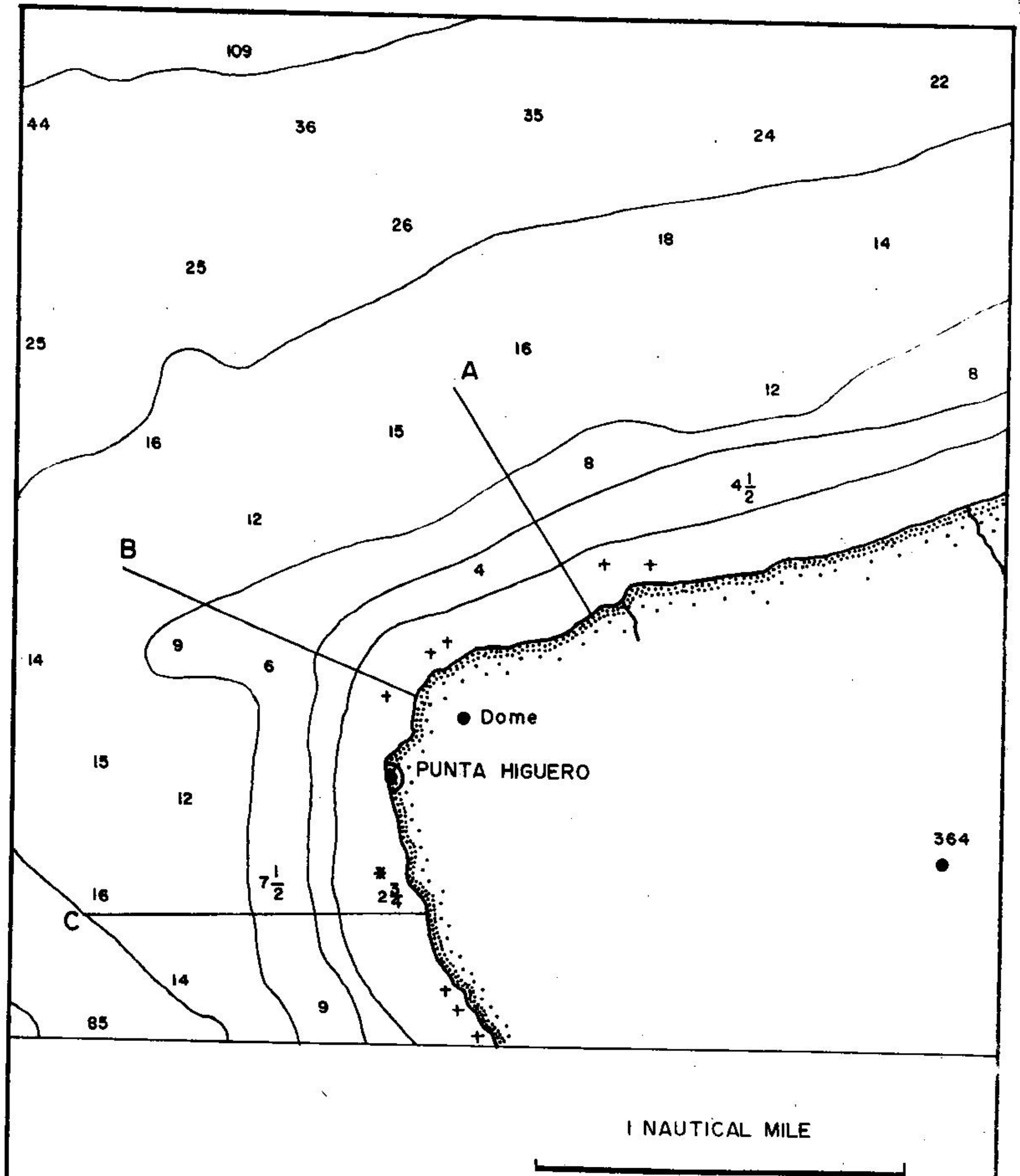


Fig. 1. Location and distance covered by the three transects at Punta Higuero.

RESULTS

STATION A - 26-28 June 1973

24-27 m:

SPONGE AGGREGATIONS

Substrate

The bottom at such depths in Station A consisted of a sandy substrate except where sponge communities occurred. The sand consisted of large particles (approximately 1/2 2 mm) and could be classified as coarse sand, according to the Wentworth scale (Bird 1969). On the bare spots wide ripple marks (wave length of .3 - .6 m and wave weight of a few centimeters) were observed, arranged in a westward direction.

A thin layer of precipitated organic sediments covered the sand. On some sections, this layer had a green tinge probably due to small filamentous algal forms.

Dominant Organisms

1. Sponges

   As mentioned before, sponges (Porifera) were the dominant group, particularly the basket sponge *Xestospongia muta*. However, other forms were quite abundant, including *Sphaeciospongia vesparia*, *Neofibularia massa* (Stinging sponge), *Ircinia* sp. and Verongia sp. (Fig. 2).

2. Algae

   Other groups of organisms were present despite their limited distribution at such depths. The red algae

Fig. 2. The sponges, *X. muta* (basket shaped) and *Verongia* sp. (tubular shape in the lower left corner) at Station A, the dominant forms of benthos at 27 m. Two species of the queen trigger fish *Balistes vetula* can be seen in the upper corners.

Laurencia intricata covered some parts of the bottom and sometimes covered some of the sponges, and to a lesser extent the brown algae *Dictyota dentata* and others.

3. Corals (Octocorallia)

One gorgonian was observed at this depth. This was *Pseudopterogorgia* sp.

12-18 m:

RED ALGAL COVER; SPONGES

Substrate

The bottom at these depths was practically all covered by algae and sponges. The substrate is covered by sand but the inner substrate consisted of hard rock.

Dominant Organisms

1. Algae

Most of the bottom substrate was covered by an aggregation of algae. A sample of this algal cover revealed that it was composed mostly of the red algae *Amphiroa rigida* entangled with other red, brown, and green algae, but the predominant form being Rhodophytes (red algae).

2. Sponges

Sponges were quite abundant throughout the transect. At these depths the basket sponge *X. muta*, *Desmopsamma anchorata*, *Verongia* sp. and others, to a less extent, were quite common.

3. Corals

Very few coral formations were observed. Only scattered small patches of Meandrina sp. were observed.

16-18 m:

CORAL; GORGONIANS

Dominant Organisms

At 18 m a transitional zone (ecotone) occurred between the algal and coral gorgonian communities. This culminated at 16 m where corals and gorgonians formed most of the epibenthos (Figs. 3 and 4). Many fishes live among the coral formations.

1. Corals

Various types of coral formations were present. Gorgonians such as Plexaurella sp., Pterogorgia anceps, Pseudopterogorgia anceps and others occurred. Hard corals included Meandrina sp., Montastrea cavernosa, Diploria sp., and Dendrogyra cylindricus (Fig. 4).

2. Algae

Some algae were attached to the hard substrate free of coral formations; however, the specific dominant algal species were not recorded.

Fig. 3. A gorgonian garden at 16.5 m at Station A. The tallest gorgonian at the center is a specimen of Briareum asbestinum. Other gorgonians such as Pseudopterogorgogia sp. can be seen in the lower right corner. The many small blue fish are a school of Blue Chromis, Chromis cyaneus.

Fig. 4. A patch of the scleractinian coral Dendrogyra cylindricus at 16.5 m at Station A. The yellow and black fish is the rock beauty, Holacanthus tricolor.

FISHES

Many fishes, mostly small ones, aggregated in and around the gorgonian coral formations. These included: A school of over 50 specimens of blue chromis, *Chromis cyaneus* (Pomacentridae); 4 adult forms and a school of 30 juvenile forms of the blue head wrasse, *Thalassoma bifasciatum* (labridae); 1 rock beauty, *Holocanthus tricolor* (Chaetodontidae); a small school of the brown Chromis, *Chromis multilineatus*, 1 black durgon, *Melichthys niger*, (Balistidae); and 2 schools of surgeon fish, *Acanthurus* sp., (Acanthuridae).

Four queen trigger fish, *Balistes vetula* (Balistidae) and a few bicolor damselfish, *Eupomacentrus bipartitus* (Pomacentridae) were observed in the deeper waters.

9-13 m:

CORAL: SPONGES; ALGAE

The coral formations were restricted to a depth of 16-18 m. At 13.5 m coral formations were non-existent except for a few specimens of *Pterogorgia anceps*, *Dichocoenia stokesii*, and *Meandrina* sp. At 12 m, patches of the sponge *Anthosignella varians* were observed.

From 9-12 m the bottom was covered by two main types of growth: 1) algal mats consisting mostly of the red algae *Amphira rigida* and entangled with other less common ones. 2) large patches of the sponge *A. varians* (Fig. 5).

The sediment in this location consisted mostly of skeletons of the dominant algal form (coralline) *Amphiroa* sp.

3-7.5 m

ALGAE

At 7.5 m, the bottom consisted of algal mat formations, a few smaller patches of *A. varians* and a few gorgonians, such as *Muricea* sp.

At 6 m, the bottom was practically covered by an algal mat of a different composition than those found at greater depths. The algal cover at this depth consisted primarily of the red algae *Corallina* sp. and *Jania* sp., entangled with other algae.

A sandy bottom, and heavily silted water was encountered at 4.5 m. From 3-4.5 m the benthos consisted of miscellaneous forms. However, patches of algae, primarily *Corallina* sp., seemed to be dominant.

Fig. 5. The sponge *A. varians* (pale patches on lower right, lower left and upper right corners) and red alga in apparent competition for substrate at 9-12 m at Station A.

Many other forms of life made up the benthos of this shallow region including *Thallasia testudinum*, small patches of the coral *Siderastrea siderea*, and the sponge *Verongia* sp. The observations at this time were limited due to poor visibility.

STATION A - 14-16 January 1974

The relative distribution of the dominant forms are discussed below in relation to their occurrence during the first sampling period.

24-27 m:

SPONGE AGGREGATIONS

Substrate

The substrate was generally unchanged from the first sampling period.

Dominant Organisms

1. Sponges

The macro-epibenthic fauna consisted primarily of sponge aggregations (Porifers:Demospongioe). Specimens of the basket sponge *Xestospongia muta* and *Ircinia* sp. occurred quite commonly. This is similar to the observations made during June 1973.

2. Algae

Brown algae (Phaeophyta) such as *Dictyota* sp. and *Dictyopteris* sp. were observed growing over portions of many sponges. This observation was not made during the previous trip. At that time, the red alga (Rhodophyta) *Laurencia intricata* was observed growing on similar habitats.

3. Corals

The coral fauna observed were considerably sparse. There were no scleractinian corals, and the coral fauna was represented only by scattered gorgonians dwelling among and on the sponges.

6-18 m:

BENTHOS

Substrate

Most of the bottom consisted of a hard substrate, occasionally interrupted by sandy channels and sand holes.

Dominant Communities

1. Algae

A dominant algal community attached to the hard substrate was observed. The dominant alga was the red alga (Rhodophyta), existing in a complex arrangement with other brown (Phaeophyta) and green (Chlorophyta) algae.

The most common Rhodophytes included the articulated coralline red algae *Corallina cubensis*, *Amphiroa fragilissima*, and *Jania adhaerens*. However, at 16.5 m, (Table 1) the calcareous red algae *Lithothamnion occidentalis* and *Coelarthrum albertisii* constituted a large part of the total biomass; while at 7.5 m, the coralline algae were the principal component (Table 2). At both depths mentioned above most of the algae and articulated corallines were entangled with the brown alga *Dictyota linearis* and to a lesser extent

TEXT TABLE 1

14-16 January 1974

The relative abundance of the algae obtained at 16.7 m in a sample at Station A. The numbers represent the dry weight obtained for each species within the 1/4 m^2 sample.

Species	Dry Weight (g)
Rhodophyta	
Corallina cubensis) *Amphiroa fragilissima*) *Jania adhaerens*)	18.9
Lithothamnion occidentalis	17.6
Coelarthrum albertisii	4.2
Phaeophyta	
Dictyota linearis	.7
Dictyopteris plagiograma	-
Chlorophyta	
Caulerpa vickersiae	-
Caulerpa microphysa	-
Miscellaneous	1.0
Total	42.4

TEXT TABLE 2

14-16 January 1974

The relative abundance of the algae obtained at 7.6 m at Station A. The numbers represent the dry weight obtained for each species within the 1/4 m^2 sample.

Species	Dry Weight (g)
Rhodophyta	
Corallina cubensis, *Amphiroa* sp., *Jania rubens*	8.8
Martensia pavonia	-
Dictyurus occidentalis, *Amansia multifida*, *Gelidium pusillum*	.1
Cryptoremia sp.	.3
Phaeophyta	
Dictyopteris sp.	-
Dictyota linearis	.3
Dictyota sp.	.7
Chlorophyta	
Cladophora sp.	.1
Miscellaneous algae	2.5
Total	12.8

by *Dictyopteris* sp. and *Dictyota divaricata*. A possibility is that a brown algal bloom may have been occurring at this site, since this was observed in many locations along the transect.

2. Sponges

The sponges *Ircinia fasciculata*, *Cynochira* sp., *Verongia* sp. occurred rather sparsely. However, the heavily encrusting sponge *Anthosigmella varians* commonly formed patches among the algal mats (Fig. 6).

Several observations were made concerning *A. varians*: 1) they were less abundant than during the summer of 1973; 2) coralline red algae (Rhodophyta) and brown algae (Phaeophyta) were observed growing within the patches which is unusual; 3) some of the patches were surrounded by a layer of mucuous. This could indicate biological interaction within the algae-sponge interface, as many corals and sponges secrete a mucuous slime when they are cut, injured, or under stress.

3. Corals

Coral formations prevailed principally in areas of hard substrate that were unoccupied by algae and sponges. They occurred infrequently, except at 15 m.

The scleractinian corals *Diploria labyrinthiformis*, *Montastrea cavernosa*, *Colpophyllia amaranthus* and

Fig. 6. The encrusting sponge (Porifera: Demospongiae) _Anthosigmella varians_ as in January 1974. The occurrence of algal patches within them is unusual.

Dichocoenia stokesii formed encrustations and coral heads on the hard bottom.

The gorgonians *Eunicea laxispica*, *Eunicea* sp., *Pseudopterogorgia americana* and *Pseudopterogorgia* sp. were observed on the hard substrate.

STATION B - 26-28 June 1973

The weather conditions were favorable and there was little wave action. Water visibility was approximately 16.5 - 18 m.

20-27 m:

BENTHOS

No predominant formations characterized the area, except for possibly the sponges There were primarily two bottom types: a sandy bottom and a hard bottom.

Sandy bottom:

1. Substrate - The nature of the sand was the same as that found near the deep communities in Station A, except for the absence of ripple marks.

Dominant Organisms

1. Algae

Portions of this sandy region were covered by algae. *Amphiroa rigida* and *A. fragilissima* were two common ones. There were patches of the flowering plant *Halophila baillonis* growing over the sand.

2. Sponges

The only sponge growing here was the basket sponge *Xestospongia muta*, which was quite common at these depths.

Hard bottom:

This area consisted mostly of coral-sponge aggregations. Many sponges occurred including *Xestospongia muta*, *Sphaeciospongia vesparia*, *Verongia longissima*, *V. fistularis*, and *Callyspongia vaginalis*. Many of these were covered by hydrozoans.

The predominant coral forms were the gorgonians.

18 m:

RED ALGAL MAT

The sandy bottom was nearly entirely covered by algae. However, there was an underlying hard substrate to which algae and other organisms were attached.

Dominant Organisms

1. Algae

   The algal mat forming most of the epibenthos consisted primarily of an entanglement of the red algae (Rhodophyta) *Corallina cubensis* and *Jania adhaerens*; *Coelarthrum albertesii* was also common.

2. Sponges

   Sponges were common here. Portions of the bottom substrate were covered with large patches of *A. varians*. Some of the other sponges observed were *X. muta* (very abundant on the deep benthos bordering the site), *Sphaeciospongia vesparia*, *Higginsia strigilata* and *Desmapsamma anchorata*.

3. Corals

Corals were not abundant in this region, but a few patches of Diploria sp., Montastrea cavernosa and Siderastrea siderea could be observed encrusting the bottom. A few gorgonians were observed such as Pterogorgia anceps and Plexaurella sp.

12 m:

BOULDERS

Boulders were conspicuous. These were spaced between either a sandy bottom or a hard rocky bottom. There are three bottom types at this depth: the boulder themselves, the sandy bottom, and hard bottom between or among the boulders.

SANDY BOTTOM

Substrate

A thin layer of organic sediments covered the sand. The ripple marks were small and arranged in a capillary fashion. Although there are exceptions this type of substrate is generally unfavorable for benthic life.

HARD BOTTOM

Boulders

Most boulder surfaces were covered by algal aggregations. A large amount of organic sediment, polychaete tubes, bryozoans and hydrozoans was observed. The sponges present were predominantly X. muta and a few other such as Haliclona rubens and Callyspongia vaginalis.

Dominant Organisms

1. Algae

This hard flat bottom among the boulders offered good substrate for algal attachment. A red algal mat composed of entangled *Jania adhaerens* and *Amphiroa rigida* covered most of this substrate. *Coelarthrum albertesii* was common but less so at 18 m.

2. Sponges

A. varians formed wide encrustations among the algal mats. A few basket sponges were also present.

6 m:

RED - BROWN ALGAL MAT

Dominant Organisms

1. Algae

Most of the hard substrate was covered by an algal aggregation composed primarily of two types: the red algae (Rhodophyte) *Bryothamnion triquetum*, and the brown algae (Phaeophyta) *Dictyopteris delicatula*. Less common algae occurring in this area were: *Corallina* sp., *Jania* sp., *Valonia ventricosa*, *Halimeda* sp. and a few thalassia leaves.

2. Sponges

Patches of *A. varians* on the algal mat were observed. *Verongia* sp. and the stinging sponge *Neofibularia massa* were also common at this depth.

3. Corals

Two species of gorgonians, Muricea elongata and Eunicea tournefort, occurred in reduced sizes. Occasional patches of the scleractinian coral Siderastrea siderea were seen. This coral seems to be quite resistant to sedimentation, as it repeatedly occurred in shallow turbid waters.

It has also been observed in tide pools of increased temperatures, with no apparent adverse effects.

1.5 - 3 m:

INSHORE COMMUNITIES

It is known that the inshore benthos are affected throughout the year by wave action and sediments in suspension; however, detailed observations on this shallow region were not made due to poor visibility.

The substrate was sandy, and the portions covered with algal mats were underlined by hard structures.

Dominant Organisms

1. Algae

There were two types of algal cover in this range. At 3 m there was a light algal cover of red filaments over portions of the sand. This algae may belong to the phylum cyanophyta, which has red accessory pigments (Phycoerythrin) used in photosynthesis. At 1.5 m a different algal aggregation occurred, consisting primarily of two kinds of red algae (Rhodophyta): *Corallina cubensis*, and *Jania adhaerens*.

Some green algae (Chlorophyta) were common at these shallow depths. These included *Penicillus capitatus*, *Halimeda discoidea*, *Udotea flabellum* and *Cladophora fuliginosa*.

2. *Corals*

Coral growth are limited in environments heavily affected by siltation; thus only a few greatly reduced encrustations of the coral *Siderastrea siderea* occurred.

3. *Sponges*

Only one sponge, a species of *Verongia*, was near shore. Much of its surface was covered by bud-like structures which are probably used in propagation.

No patches of *A. varians* were observed.

STATION C - 26-28 June 1973

The weather conditions were favorable and permitted good water visibility (18.2 m). There were no bottom disturbances and no wave action.

The biotic aggregations inhabiting this area were characterized by coral growths, unlike the epibenthic communities found at Stations A and B. These observations are in agreement with Szmant (1973).

There was a transitional zone at 3 - 12 m, which culminated in a coral community. The biotic aggregations on the deeper portions of the transect 24-27 m revealed that there was biotic continuity at this depth. Similar to Stations A and B, the deep benthos consisted of sponge and algal formations.

3 m:

ALGAL ZONE (*STYPOPODIUM ZONALE*)

The above description of the benthos present is descriptive rather than real. It does not mean that this alga covered most of the substrate, but rather characterized the area by its abundance (Fig. 7).

Substrate

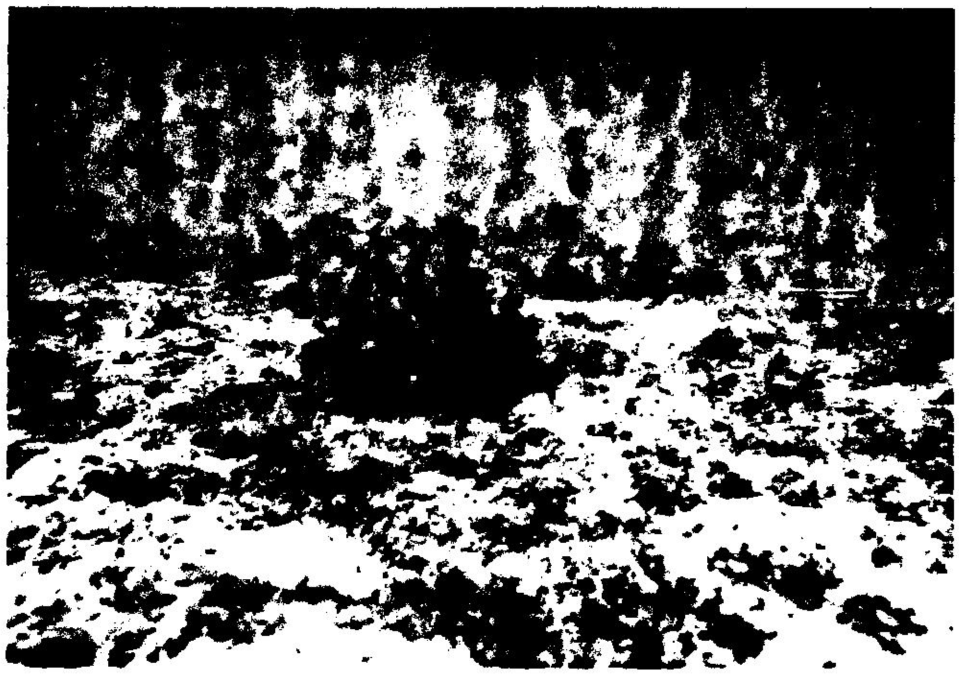
The bottom at this depth consisted of a flat hard structure with few, sandy pockets.

Dominant Organisms

1. Algae

Bushes of the brown alga (Phaeophyta) *Stypopodium zonale* characterized the area. Other algae covered

Fig. 7. The brown bushes are specimens of _Stypopodium zonale_. They were abundant at 3 m at Station C.



portions of the hard substrate. These included Corallina cubensis, Dictyota dentata, Udotea flabellum.

2. Corals

Corals were common despite the reduced size of the species at this depth. The hard corals (Scleractinian) occurred as small patches or encrustations on the hard substrate. Similarly, the gorgonians were consistently reduced in size. This was probably due to heavy siltation or wave action.

The hard corals which formed reduced patches or small heads included Porites asteroides, Siderastrea siderea, Montastrea annularis and cavernosa. The gorgonians included Muricea sp. Eunicea sp. and Plexaurella sp. They were less common than the hard corals at this depth.

3. Sponges

Many specimens of Verongia sp., described in the inshore communities in Station B, occurred. An occasional patch of A. varians was observed.

6 m:

TRANSITIONAL ZONE

No particular name was assigned to this zone since the epibenthos had a miscellaneous composition. An algal mat consisting of tufts of Jania adhaerens entangled with other algae (e.g. Cladophora fuliginosa) covered portions of the substrate. There were hard corals and patches of A. varians. Gorgonians occurred in larger numbers and sizes than those at 3 m (Fig. 8).

Substrate

The substrate was hard, rocky and generally flat, except a few coral outgrowths.

Dominant Organisms

1. Algae

   Algal tufts composed of Jania adhaerens entangled with other algae covered portions of the area. Other algae, including Amphiroa fragilissima and Corallina cubensis, were present.

2. Corals

   The hard corals formed wider patches and bigger formations at this depth than at 3 m. Those corals present included: Siderastrea siderea, Meandrina sp., Diploria sp., Montastrea cavernosa, Millepora sp. (hydrocorallina) and Porities asteroides.

3. Sponges

   A. varians was the most common sponge, covering much of the substrate.

12 m:

CORAL COMMUNITY

The previously discussed transitional zone culminated at 12 m in a coral reef community. The corals attained full size and fomed a

Fig. 8. The pale patches (center) are _A. varians_. Some gorgonians are also present.

complex aggregation of organisms (Fig. 9). Also, many gorgonians and sponges occurred, covering most of the algal aggregations.

Substrate

Most of the substrate had a calcarous composition, probably formed by the many corals present, and in some cases forming boulders (Fig. 9).

Dominant Organisms

A wide variety of corals, gorgonians, sponges, and other organisms occurred; corals were the most abundant. Algae also occurred on certain areas around the coral formations.

1. Corals (Scleractinia)

   There seemed to be no predominant form of coral, yet several types occurred. The corals observed included Montastrea cavernosa, Meandrina sp., Diploria sp., Isophyllia sinuosa, Isophyllia sp., and Millepora sp.

   Corals (Octocorallia)

   Many gorgonians occurred, and they attained a greater size than at previous shallower depths. They included Pterogorgia sp., Muricea elongata, M. flavida, M. sulphurea, Gorgonia ventalina, and Eunicea tourneforti.

2. Sponges

   A great variety of sponges occurred on the coral formations, some of them typical of coral reef communities. There were the following: Gelliodes

Fig. 9. A coral community which occurred at Station C.

areolata, *Callyspongia vaginalis*, *Sphaeciospongia vesparia*, small specimens of *Xestospongia muta*, and *Hircinia* sp. Other less conspicuous forms such as *Microcions* sp. formed thin encrustations on the underside of corals and over the surface of dead corals, and *Cliona caribboea* and *Cliona* sp. harbored the inner calcareous structures.

18-27 m:

DEEP BENTHOS

Sponge aggregations appeared to be the dominant group in this region; however, these deeper regions were difficult to characterize due to the limited bottom diving time.

Despite the limited sampling, three different bottom types were observed: 1) sandy flat bottom; 2) boulder-like structures with many gorgonians and a few coral patches; 3) boulder-like structures with few gorgonian or coral formations.

Deep sandy bottom

This type of bottom was observed at depths of 27 m, 24 m, 21 m, and 18 m. In contrast to the sandy formation at Station A, there were no ripple marks observed and the formation was flat in structure. Similar to Station A at these depths, there was a thin layer of organic sediments covering most of the sand. These areas were nearly devoid of marine life, except for a thin layer of filamentous green algae covering some of the substrate. There were no starfish, sand dollars, or any of the commonly found sandy bottom organisms.

Boulder-like structures with gorgonians. (18 m)

There was a great variety of organisms attached to these structures. Most common of these were the gorgonians, along with a few coral encrustations and sponges (Fig. 10). As found at Station A, the red algae *Laurencia intricata* covered many of the sponges and portions of the boulders. Also, an unidentified species of hydrozoa and a few bryozoans were on these deep boulders.

The gorgonians observed included *Eunicea laxispica*, *Diodogorgia nodulifera*, *Pterogorgia anceps* and *P. citrina*.

Probably the most common sponge at this depth was the basket sponge *Xestospongia muta*.

Boulder-like structures-no gorgonians (27 m)

The boulders at 27 m lacked the gorgonian formations found at 18 m. Instead, much of their surface was covered by algae such as *Laurencia intricata*, *Coelarthrum albertesii*, and *Jania adhaerens* (Fig. 11).

Only one type of hard coral, *Montastrea annularis*, was observed growing on portions of these boulders.

Many specimens of the sponge *Xestospongia muta* were also found.

FISHES

Fish were commonly found in and around the coral formations.

The observed species included: 3 specimens of *Halachoeres bivattatus* (Labridae); 12 specimens of *Dupomacentrus partitus* (Pomacentridae); 5 adult blue head wrasses and 2 juveniles of *Thalassoma bifasciatum* (Labridae); 2 queen triggerfish, *Balistes vetula* (Balistidae); 3 groupers (Serranidae); 5 surgeon fish, *Acanthurus bahianus* (Acanthuridae); and 3 squirrel fish (Holocentridae).

Fig. 10. Boulder-like platforms with several gorgonians at Station C.

Fig. 11. Boulder-like platforms nearly devoid of gorgonians at Station C.

TEXT TABLE 3

14-16 January 1974

The relative abundance of the algae obtained at 6 m at Station C. The numbers represent the dry weight obtained for each species within the 1/4 m^2 sample.

Species	Dry Weight (g)
Rhodophyta	
Amphiroa sp.) *Jania* sp.) *Hildenbrandia prototypus*)	.1
Gelidium pusillum	.1
Martensia pavonia	-
Phaeophyta	
Dictyota sp.	.4
Miscellaneous	2.2
Total	2.8

TEXT TABLE 4

14-16 January 1974

The relative abundance of the algae obtained at 18 m at Station C. The numbers represent the dry weight obtained for each species within the 1/4 m^2 sample.

Species	Dry Weight (g)
Rhodophyta	
Corallina cubensis, Amphiroa sp., Jania rubens	10.1
Dictyurus occidentalis	.3
Coelarthrum albertesii	.2
Gelidium pusillum	.2
Martensia pavonia	-
Phaeophyta	
Dictyota sp.	1.3
Dictyota linearis	.1
Dictyopteris hoytii	-
Padina sp.	.1
Chlorophyta	-
Total	12.3

composed of articulated coralline red algae such as Corallina cubensis, Amphiroa sp., and Jania rubens. Similar to the findings at Station A, the brown algae, Dictyota sp. and Dictyopteris sp. were observed living as macroepiphytes and entangled within the dominant coralline red algae.

Generally sparse coral fauna was observed. Gorgonians and encrusting corals were rarely observed on those boulders with available hard substrate.

DISCUSSION

Ten different epibenthic associations were observed throughout the study (Fig. 12):

1) Sponge communities inhabiting the deep benthos at all three stations. Corals and gorgonians did not occur widely, probably due to the limited light penetration at such depths. Light is essential for the growth of corals since it is required by the symbiotic algae that assist them in calcification and other physiological processes;
2) Red algae communities usually among the patches of *A. varians*. This situation was common at all three stations;
3) Coral communities, encountered at Station A at depths of 13.5 m, and throughout Station C, particularly at 12 m;
4) Boulders at Station B at 12 m;
5) Red and brown algal communities at 6 - 7.5 m at Station B;
6) A *Stypopodium zonale* zone inshore at Station C;
7) Boulder-like structures with gorgonians at 18 m at Station C;
8) Boulder-like structures with no gorgonians at Station C at 24 - 27 m;
9) Sandy bottoms with thin layers of organic sediments;
10) Sandy-silty bottoms inshore at Stations A and B, harboring miscellaneous biotic aggregations.

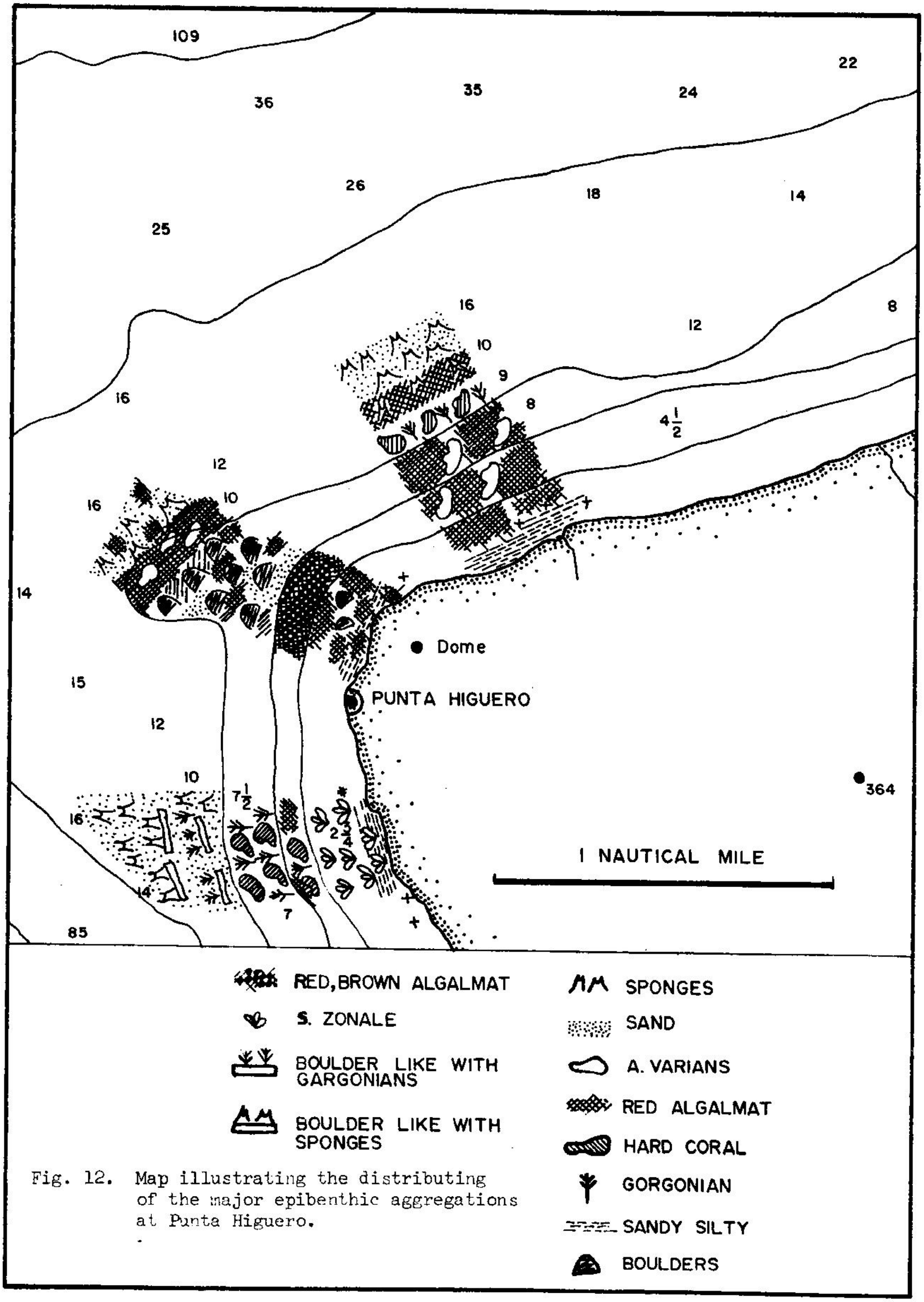


Fig. 12. Map illustrating the distributing of the major epibenthic aggregations at Punta Higuero.

There is a tendency towards dominant algal populations north of the Point, while on the south of the Point there is a tendency towards coral formations. However, there are coral reef formations slightly north of the Point, (Station b, 16.5 m) although not as extensive as those occurring south of the Point. These observations, made during the summer study, agree in some ways with those made by Szmant (1973).

Most of the hard substrata occurring in the deep sublittoral zone north of Punta Higuero harbor benthic fauna composed principally of algae and sponges. A major change seemed to occur in the benthos during the winter expedition. The Sponge Anthosigmella varians formed large patches, sometimes covering several square meters of hard substrate. However, almost all the patches of A. varians observed during the winter sampling were smaller than those observed during the summer sampling. Algal aggregations were observed within the sponge mats which is unusual. A mucuous slime within the sponge-algal interface on some patches was observed, possibly indicating biological interaction.

A transition in which algal communities dominate the sponge formations seemed to be occurring. It is not known if this is a seasonal phenomenon, since no previous data are available.

One cause of successions within the benthic fauna at Punta Higuero may be the influence of the nearby Añasco River (Fig. 13). The silt clay and other terrigenous matter transported to the site would have some affect on the benthic organisms. However, no statement can be made concerning the degree of the river's influence without further research.

Fig. 13. Aerial photograph of Punta Higuero taken during the winter of 1974 illustrating the sediment transported to the south around Punta Higuero.

(E.D. Wood)

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d. Fish

F.D. Martin & J.W. Patus

The fishes of the Punta Higuero site have been sampled by a number of methods. They have been taken using dip nets and rotenone and have been identified by swimming through an area and from photographs taken by the benthic team. Table 1 lists the species identified from this area and the method used to sample them. Table 2 lists only those species taken by rotenone and the numbers taken at each station. For locations of these stations see Fig. 1. No samples taken thus far have turned up species which are unusual for this end of the island and all species thus far can be characterized as reef, rocky shoreline, pelagic or sandy bottom dwelling species. The habitats which these fish prefer are more or less continuous from Cabo Rojo to Aguadilla and all have pelagic larvae except for the blennies. Wide spread damage to these species then seems unlikely. Sampling is proceeding on a quarter year basis and will be continuations of the sampling procedures above.

Species	*Sampling Method	**Normal habitat
Echidna catenata - Chain Moray	R	Rf
Gymnothorax sp. - Moray (juv.)	R	Rf
Harengula clupeola - False pilchard	R	P
Jenkinsia lamprotaenia - Dwarf Herring	S	P
Arcos rubrigenosus - Red Clingfish	R	Rk
Atherinomorus stipes - Hardhead Silverside	R	P
Adioryx vexillarius - Dusky Squirrelfish	R	Rf, Rk
Holocentrus sp. - Squirrelfish	S	Rf, Rk
Serranus sp. - Grouper	S	Rf, Rk
Malacanthus plumieri - Sand Tilefish	P	SB
Caranx fuscus - Bluerunner	S	P
Caranx ruber - Bar Jack	S	P
Lutjanus apodus - Schoolmaster	S,R	Rf, Rk
Haemulon parrai - Sailorschoice	R	Rf
Pseudupeneus maculatus - Spotted Goatfish	S	SB
Pempheris schomburgki - Copper Sweeper	S	Rf
Pomacanthus arcuatus - Gray Angelfish	P	Rf
Abudefduf saxatilis - Sergeantmajor	R,D,S	Rf, Rk
Abudefduf taurus - Night Sergeant	R	Rk
Eupomacentrus leucostictus - Beaugregory	S	Rf
Eupomacentrus variabilis - Cocoa Damsel	S	Rf
Eupomacentrus sp. - Damselfish	P	Rf
Mugil liza - Liza	D	P
Mugil sp. - Mullet (juvenile)	R	P
Thalassoma bifasciatum - Bluehead	D,S	Rf, Rk
Unidentified small wrasses	R,P	Rf
Scarus sp. - Parrotfish	S	Rf
Sparisoma sp. - Parrotfish	S	Rf
Dactyloscopus tridigitatum - Sand Stargazer	R	SB
Blennius cristatus - Molly Miller	D	Rk
Entomacrodus nigricans - Pearl Blenny	R	Rk

Species	*Sampling Method	**Normal habitat
Ophioblennius atlanticus - Redlip Blenny	S	Rf
unidentified juvenile blenny	R	
Acanthemblemaria spinosa - Spinyhead Blenny	D	Rk
Coralliozetus cardonae - Twinhorn Blenny	D	Rk
Labrisomus guppyi - Mimic Blenny	R	Rk
Labrisomus nuchipinnis - Hairy Blenny	R	Rf, Rk
Malacoctenus versicolor - Barfin Blenny	R,D	Rk
Paraclinus fasciatus - Banded Blenny	R	Rk
Unidentified juvenile clinid	R	
Bathgobius soporator - Frillfin Goby	R,D	Rk, Rf
Acanthurus bahianus - Ocean Surgeon	S,P	Rf
Acanthurus coeruleus - Blue Tang	S,P	Rf
Acanthurus sp. larval	R	
Balistes vetula - Queen Triggerfish	P	Rf
Melichthys niger - Black Durgeon	P	Rf

*R = Rotenone stations, 15 & 16 January 1973
S = Swimming mostly around "Steps", July 1972.
P = Photographs, benthic team samples, January 1973
D = Dipnetting 18 February and 6 May 1972.

**Rf = Coral Reef fishes
Rk = Rocky shoreline or Rock Reef area fish
P = Pelagic
SB = Sandy bottom, or sand patch species.

COLLECTING SITES

1. Beach near Toñito's Place.
2. Picnic Rock - a large rock formation on Punta Gorda.
3. Splash Pools N. of Dome.
4. Rock Groin and protected water at the old Bonus outfall.
5. Rocky shore between Dome and Lighthouse.
6. Rocky shore just S. of Lighthouse.
7. Surfer's Beach
8. Small channel in the beach rock N. of Steps.
9. Runnel behind a beach rock outcropping N. of Steps.
10. Steps

TABLE 2 - ROTENONE SAMPLES

	Echidna catenata Chain Moray	Gymnothorax sp. Moray (juv.)	Harengula clepeola False pilchard	Arcos rubrigenosus Red Clingfish	Atherinomorus stipes Hardhead Silverside	Adioryx vexillarius Dusky Squirrelfish	Latjanus apodus Schoolmaster	Haemulon parrai Sailorschoice	Abudefduf saxatilis Sergeantmajor	Abudefduf taurus Night Sergeant	Mugil sp. Mullet (juv.)	Unidentified wrasse	Dactyloscopus tridigitatum Sand Stargazer	Entomacrodus nigricans Pearl Blenny	Unidentified Blenny	Labrisomus guppyi	Labrisomus nuchipinnis Hairy Blenny	Malacoctenus versicolor	Paraclinus fasciatus	Unidentified Clinid	Bathgobius soporator Frillfin Goby	Acanthurus sp. Surgeonfish (juv.)
Beach near Toñito's Place	1						2*		2*	1*						1				1*	1	
Picnic Rock									25*	5*				9							6*	1*
Splash Pools N of Dome												1*		8							7*	
Rock Groin at Dome	7*		6	2	27			2					4			1	1					
Rocky Shore between Dome and Lighthouse		1*				1			1*							2*		1	1			
Rock Shore just S. of Lighthouse														2								
Surfer's Beach									2*	4*	1*			1	1*						5*	
Small Channel in Beach N of Steps																					1	
Runnel just N. of Steps									2*												1	
Steps									1*													

* at least some specimens were juvenile

APPENDIX A

would cut the beach at the dock area so there would be a "north beach" accessible from Aguada and "south beach" accessible from near the gate to the PRWRA site.

With ready access, adequate oil spill guards, and planting to screen the area from the public there should be no loss to recreational or aesthetic values.

Fauna observed in Punta Higuero was restricted. This was partially due to a natural paupacy in local fauna. Also transect observations do not get many of the more shy or rare birds or animals. These require trapping and covert observation. Macrofauna consisted mainly of pelicans, rats, mongoose, cats, and dogs. All, except pelicans, are introduced pest species.

FAUNA LIST

Reptiles and Amphibians

- Leptodactylid frog
- *Bufo marinus*
- *Anolis crystatellus*
- *Anolis* sp.

AVES

- *Crotophaga ani*
- *Tyrannus dominicensis*
- *Mimus polyglottos*
- *Quiscalus niger*

MAMMALS (native)

- Noctilionid bat

PROBABLE UNAVOIDABLE ADVERSE EFFECTS

The most probable adverse effects are those physical effects relating to removal of the vegetation for development and disruption of run-off patterns. Nothing can be done about the former. A partial compensation can be made by planting fringe areas (Possible Remedial Actions). This action, plus care in grading, should help in advoiding the bad effects of disrupting run-off patterns.

POSSIBLE REMEDIAL ACTIONS

Designed Successional Forests:

Many attractive and useful plant species are normal members of the secondary successional forest. These include coconuts, almendras, mangos, royal palms, tamarindo, cocoloba, casuarine, spodilla (manilkara), flamboyan, gumbo limbo, etc. These hardy species can be planted along roads and the perimeters of developed areas. This would serve to (a) promote natural succession, (b) provide a screen against noise, dust, ambient heat, etc., (c) cover the plant from public view.

Beach Front Parks:

The beach areas of Puerto Rico are considered public domain. Therefore, any unsightly, hazardous, or prohibitive developments are undesirable. By and large, the beach front areas (stippled in Fig.3) are not planned for extensive development. Much of the scenic beauty and community value could be preserved by leaving existing natural areas, planting trees along roads, (by the fences) and between the beach and the plant and water front (dock) area. Exclusion fences for the PRWRA facilities would be essential. This

TABLE 3. Species list for the secondary successional forest on the Limestone Hills at Punta Higuero.

TREES IN THE SECONDARY FOREST

Artocarpus altilus
Bucida buceras
Busera simaruba
Casearia guianensis
Cocos nucifera
Ficus stahlii
Guarea trichilioides
Manganifera indica
Piper aduncum
Roystonea borinqueña
Thounia striata
Terminalia catappa
Zanthoxylum martinicense

SHRUBS

Duggena hirsuta
Lantana involucrata
L. camara
Solanum torvum
Urena sp.

VINES

Abrus abrus
Ipomea sp.
Melothria guadalupensis
Passiflora sp.
Stigmaphyllon tomentosum
Urechistes lutea

FERNS

Adiantum cristutum
Polypodium sp.
Camphyloneurum sp.
Tectaria heracleifolia

TABLE 3. (cont.)

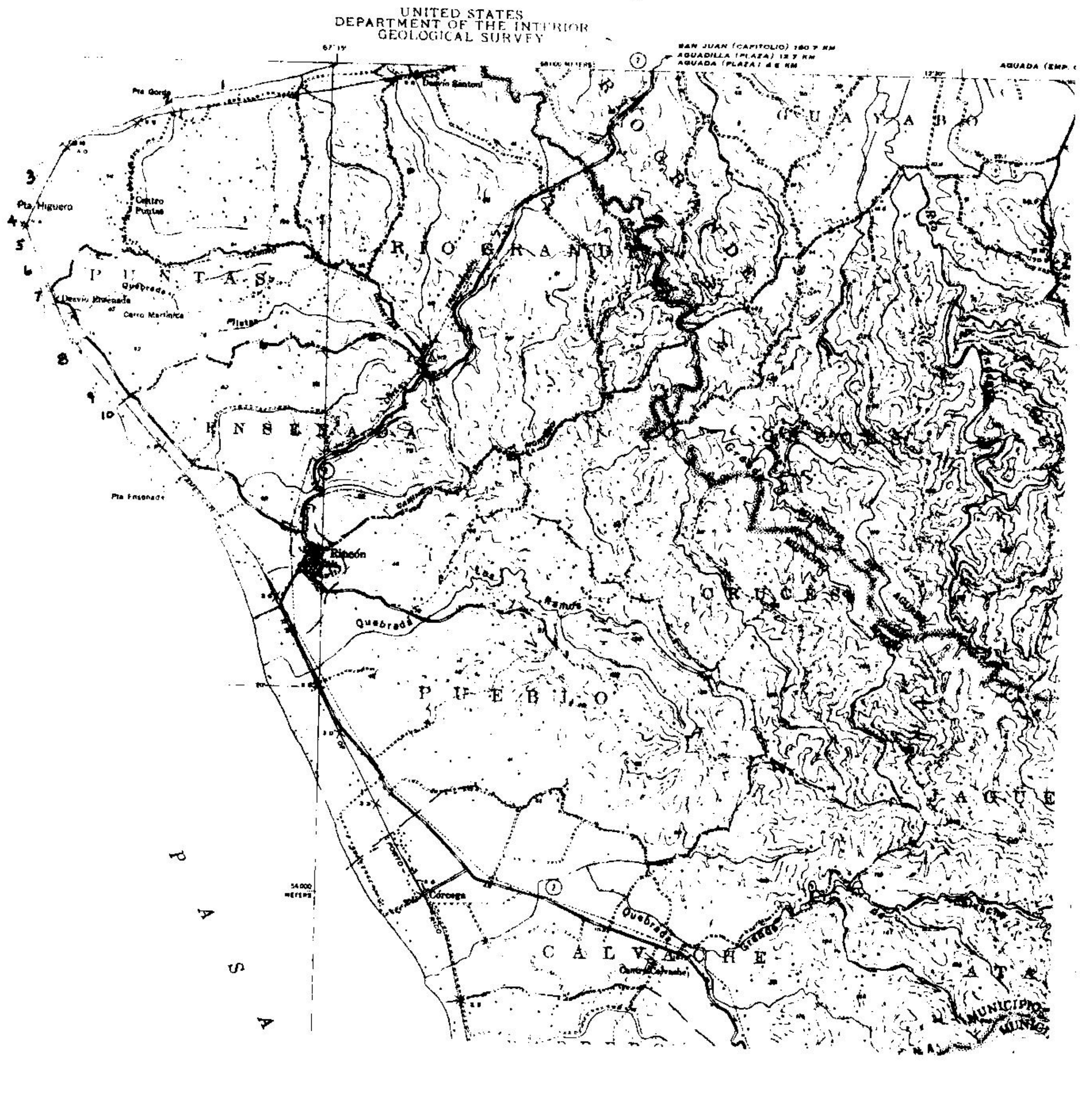
HERBS

Anthurium acaule
Borreria laevis
Cassia tora
Crotalaria incana
Desmodium spp.
Lobelia robusta
Mimosa pudica
Pilea sp.
Stachytarpheta jamaicense
Wedelia sp.

GRASSES

Digitaria sanguinalis
Paspalum spp.
Sporabolus sp.

Figure 1 - Collecting Sites



Additions to the Fish Species Lists for the Punta Higuero Site

by F. D. Martin

On 12 March 1974 two shoreline rotenone stations were done. One was at the station designated as Picnic Rock in the 1973 first quarter report and the other was at a beach rock outcropping between stations 7 and 8 of that report.

Species taken are as follows:

Species	Previously Reported	Picnic Rock	Station 7.5
Echidna catenata-Chain Moray	X		
Gymnothorax sp.-Moray (juv.)	X		
Gymnothorax vicinus-Purplemouth Moray		X	X
Harengula clupeola-False Pilchard	X		
Harengula humeralis-Redear Sardine			X
Jenkinsia lamprotaenia-Dwarf Herring	X	X	
Anchoa lamprotaenia-Bigeye Anchovy			X
Arcos rubrigenosus-Red Clingfish	X		X
Ogilbia sp.			X
Parophidion schmidti-Dusky Cusk-eel			X
Atherinomorus stipes-Hardhead Silverside	X		
Adioryx vexillarius-Dusky Squirrelfish	X		X
Scorpaena plumieri-Spotted Scorpionfish		X	X
Epinephalus adscensionis-Rock Hind		X	X
Serranus sp.-Grouper	X		

Pseudogramma gregoryi-Reef Bass		X	X
Rypticus subbifrenatus-Spotted Soapfish			X
Apogon maculatus-Flamefish			X
Malacanthus plumieri-Sand Tilefish	X		
Caranx fuscus-Bluerunner	X		
Caranx ruber-Bar Jack	X		
Trachynotus goodei-Palometa		X	
Lutjanus apodus-Schoolmaster	X		
Haemulon carbonarium-Caesar Grunt			X
Haemulon parrai-Sailors Choice	X		X
Pseudupeneus maculatus-Spotted Goatfish	X	X	X
Pempheris schomburgki-Copper Sweeper	X		
Chaetodon striatus-Banded Butterflyfish		X	
Pomacanthus arcuatus-Gray Angelfish	X		
Abudefduf saxatilis-Sergeant Major	X	X	X
Abudefduf taurus-Night Sergeant	X		
Eupomacentrus fuscus-Dusky Damselfish			X
Eupomacentrus leucostictus-Beaugregory	X		
Eupomacentrus rariabilis-Cocoa Damselfish	X		
Mugil Liza-Liza	X		
Mugil sp. (juveniles)	X		
Doratonotus megalepis-Dwarf Wrasse			X
Halichoeres bivittatus-Slippery Dick			X
Halichoeres maculipinna-Clown Wrasse			X
Halichoeres poeyi-Blackear Wrasse			X
Thalassoma bifasciatum-Bluehead	X		X
Scarus sp.-Parrotfish	X		

Sparisoma chrysopterum-Redtail Parrotfish			X
Sparisoma radians-Bucktooth Parrotfish			X
Sparisoma rubripinne-Redfin Parrotfish		X	X
Dactyloscopus crossotus-Bigeye Stargazer			X
Dactyloscopus tridigitatus-Sand Stargazer	X	X	X
Gillelus rubrocinctus-Saddle Stargazer			X
Blennius cristatus-Molly Miller	X	X	X
Entomacrodus nigricans-Pearl Blenny	X	X	X
Ophioblennius atlanticus-Redlip Blenny	X		X
Acanthemblemaria spinosa-Spineyhand Blenny	X		
Coralliozetus cardonae-Twinhorn Blenny	X		
Labrisomus bucciferus-Puffcheek Blenny			X
Labrisomus guppyi-Mimic Blenny	X		
Labrisomus nuchipinnis-Hairy Blenny	X	X	X

6.1.4.3 Ecological Parameters

TERRESTRIAL SURVEY

By
M.J. Canoy

INTRODUCTION

The terrestrial ecology of the Punta Higuero proposed power site is divided into three broad community regions: (A) coastal beach and limestone communities, (B) successional plains, and (C) dry limestone. These are sub-provinces of the dry coastal (Little & Wadsworth, 1946) province.

The Punta Higuero site and bordering area was surveyed in February, 1973 and 1974. For this purpose three transects were walked (Fig. 1) from east to west and three north to south. From these samples, species lists and locale of plant communities were established. From color aerial photos of the site, and referring to the surface transect data, a map of plant communities was drawn. Three spot checks were made in anomalous areas (marked, Fig. 1) to verify local conditions.

Faunal lists and region of occurrence were compiled by observation. Avifauna includes the sea birds as well as terrestrial species.

The structure and appearance of any ecological association depends primarily on the species present and the relative numbers of each. In a normal tropical assemblage, the number of species might be very high. Puerto Rico, however, is a densely populated and severely disturbed area. Also, it is an isolated place in terms of zoogeography. Practically all remnants of the original forests are gone. In most cases, the "mature" forests are secondary or tertiary forests.

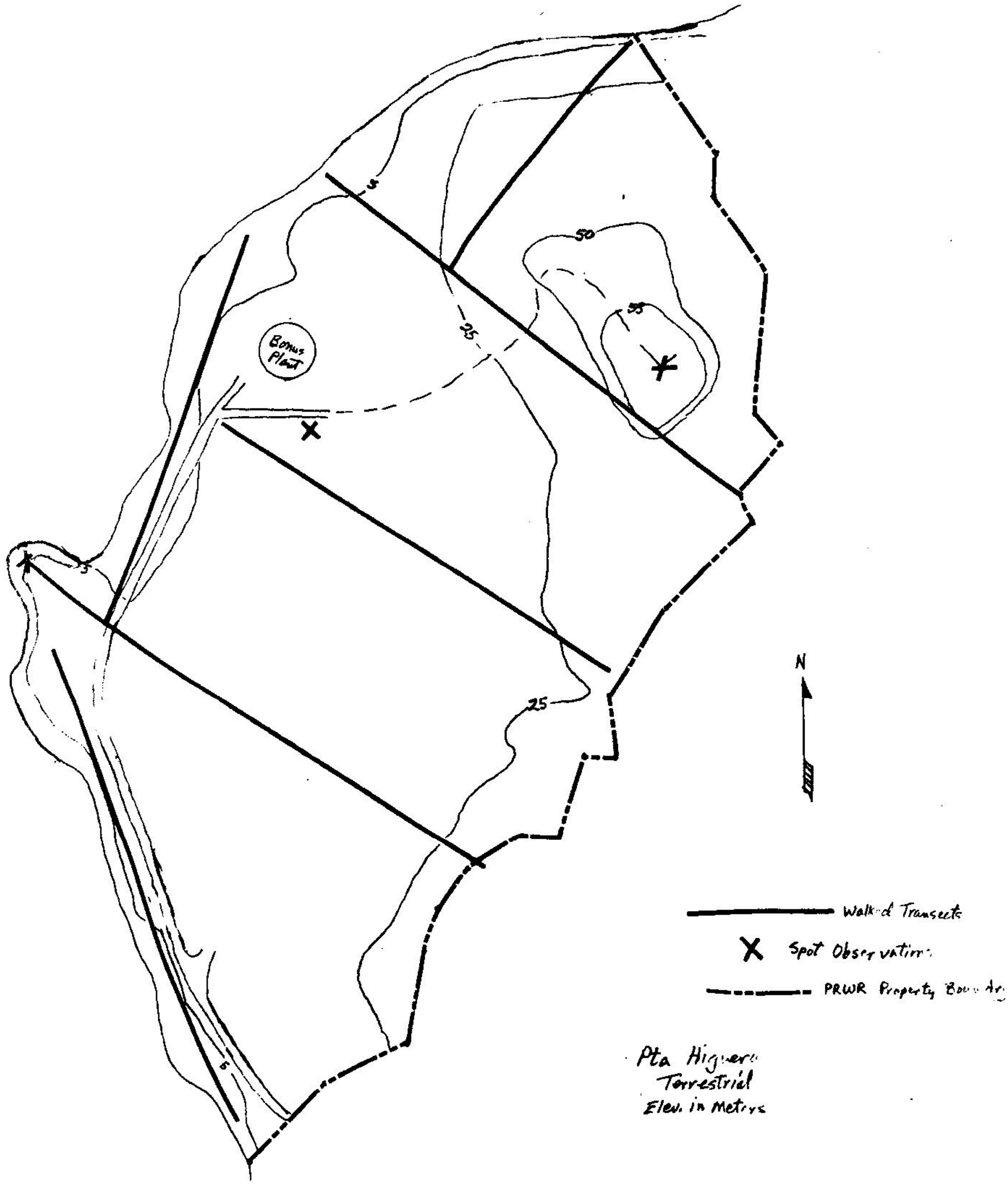


Fig. 1. Map of the Punta Higuero site showing orientation and sample locations.

Much of the island is kept in a permanent state of succession due to constant interference by man. The Punta Higuero site is no exception to this.

To determine the present and possible future trends of succession, we followed well-established ecológical techniques. The accuracy and completeness of the work is more or less dependent on the activities of man, both locally and "up wind".

HISTORY

The general area is a more or less xerophytic coastal regime on sand and limestone with a narrow coastal plain of heavy clay. Some 200 years ago it was forested with dry country hard woods. When these were cut for lumber and fuel a secondary forest began. This was cleared off the plain area for sugar cane and off the hills for fuel.

Sugar cane culture continued until shortly before PRWRA acquired the land for the Bonus Reactor Project (approximately 1958). The area between Rincon and Punta Higuero is still in agricultural use for cane and for pasturage.

When PRWRA built the Bonus Reactor all the site not used in construction returned to a tropical old field succession. A few large breadfruit (Artocarpus altilis), Australian pine (piñero, Casuarina) and Royal Palms (Roystonea borinqueña) remained but the major vegetation was acacias, vines, and herbs. This grew to cover most of the plain and the lower hillsides. However, most of it was bulldozed away in January and February, 1974 (Fig. 2).

Fig. 2. Newly bulldozed area on the plain at Punta Higuero.

PLANT COMMUNITIES

The Beach Association (Map, Fig. 3) at the site is quite typical (Fig.4). The dominant trees are the almond (almendra, *Terminalia catappa*), sea-grape (uva del mar, *Coccoloba uvifera*), and coconuts (cocoa, *Cocos nucifera*). Numerous small shrubs, herbs, and vines form a ground cover under the trees. Common among these are mother-in-law toungues (*Antharium*), *Lantana involucrata*, *Ipomea* spp., and *Solanum* spp. Other species included are *Scaevola plumieri* *Crotalaria retusa*, *Bidens pilosa*, *Erithalaris* sp., and *Eugenia* sp.

The beach community serves to hold the sand against wind and water, to make humus, and provide a basis for successional forests to follow. Also on a densely populated, tourist-oriented island, such as Puerto Rico, it serves to hide less esthetic aspects of farms, barrios, and industry from public view at the beaches. For these reasons it should be preserved.

On a small rocky point south of the Bonus plant there are a few *Aguave* and *Plumieria alba*. This outcrop is sand and clay over a limestone and beach rock conglomerate.

A list of the major species observed in the beach community is seen in Table 1.

Clay plains at the foot of the hills represent the most disturbed sector of the site. This area was cut over for timber many years ago, then cultivated, and finally left undisturbed when PRWRA put in the Bonus plant experiment. It was covered with old sugar can and zancilla (*Leucaena glauca*) (Fig. 5). Well over 90% of the biomass was in these two species. During the winter of 1973-74 this area was burned and bulldozed by PRWRA in preparation for construction (Fig. 2).

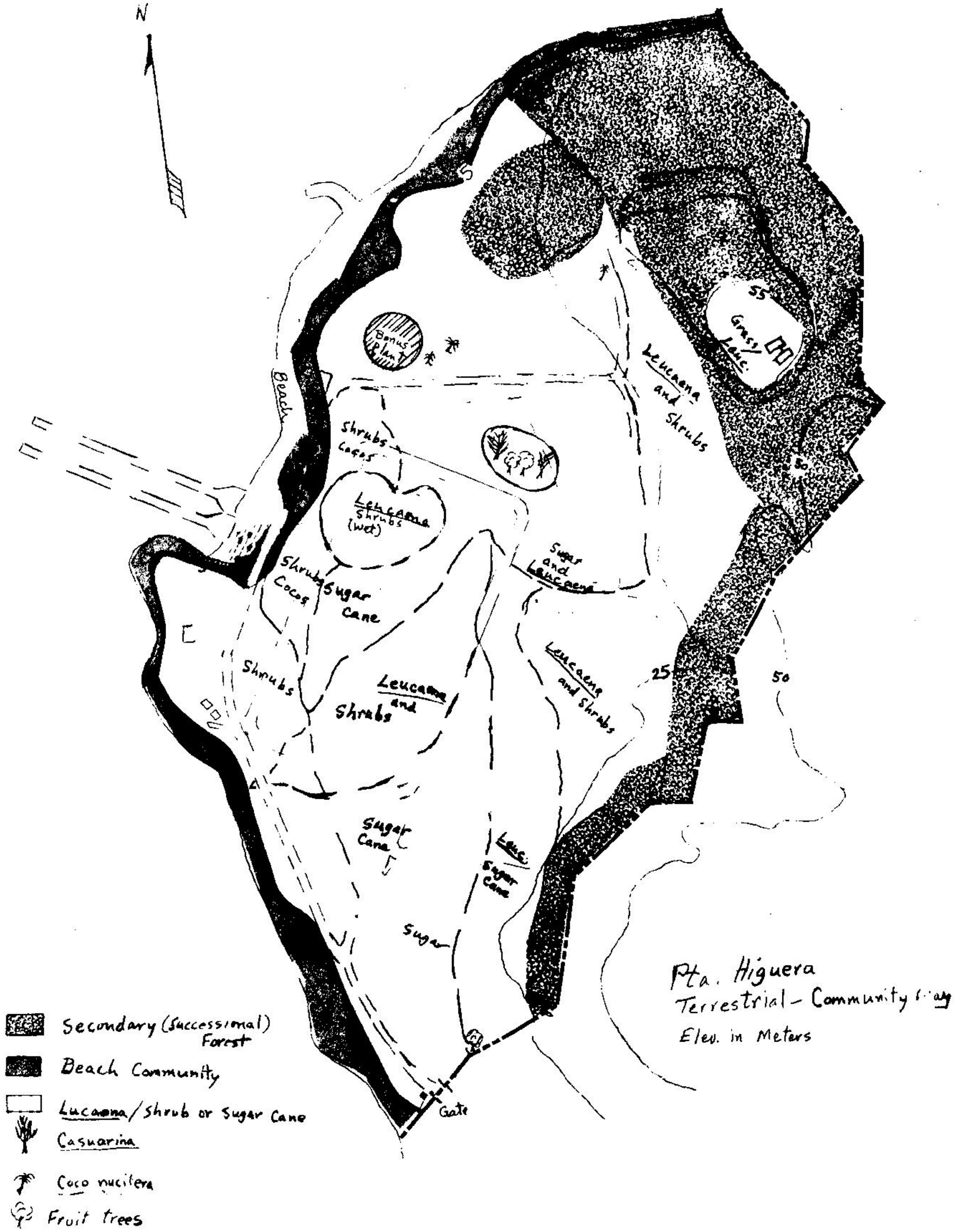


Fig. 3. Community map of Punta Higuero site showing approximate boundries.

Fig. 4. Beach at Punta Higuero showing shrub community.

Fig. 5. _Luecaena glauca_, the major natural component of the plains area plant community.

TABLE 1. Beach community species list.

TREES and SHRUBS

Cocos nucifera
Coccolobis uvifera
Chrysobalanus icaco
Lantana involucrata
Plumieria alba
Terminalia catappa
Erithalis fructicosa
Citharexylum fructicosum
Scaevola plumieri
Lantana camara
Solanum torvum

HERBS and VINES:

Crotalaria retusa
Indigofera suffruticosa
Stylosanthes hamata
Guilandia crista
Smilax coriacea
Ipomea spp.
Stigmaphyllon tomentosum
Anthurium acaule
Cassia tora
Lobelia robusta
Mimosa pudica
Hymenocallis littoralis

The few large trees left on the plain are casuarina (*Casuarina equestrifolia*), panapen (*Artocarpus altilis*), almendra (*Terminalia catalappa*), and palma real (*Roystonea borinqueña*). The species list for plants is found in Table 2.

TABLE 2. Species list for the plant community on the coastal plains at Punta Higuero.

TREES and SHRUBS:

Lantana involucrata
Leucaena glauca
Artocarpus altilis
Casuarina equiestrifolia
Terminalia catappa
Randia aculeata
Solanum torvum

HERBS and VINES:

Ipomea spp.
Rauwolfia tetraphylla
Crotalaria retusa
Indigofera suffruticosa
Bidens pilosa
Anthurium acaule
Cassia tora
Lobelia robusta
Mimosa pudica
Pilea sp.
Strachytarpheta jamaicense
Hymenocallis littoralis

GRASSES:

Andropogon glomeratus
Sporabolus indicus
S. porratii
Digitaria sanguinalis
Setaria geniculata

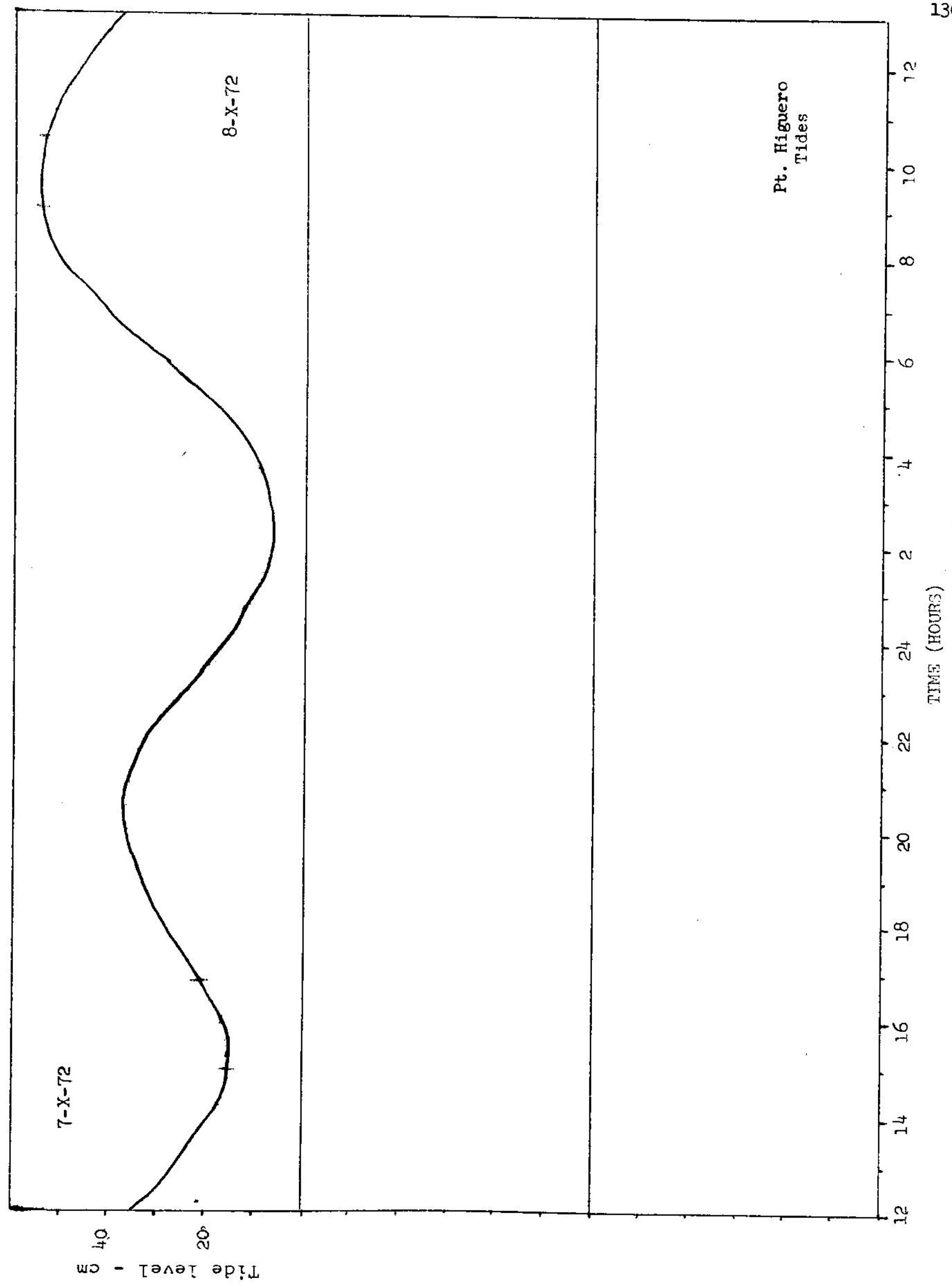
SECONDARY SUCCESSIONAL FOREST

The Limestone Hills plant association ranges from the dry communities on the western slopes of the hills to moist forest stands in low areas of the eastern slopes. This assòciation has not been seriously disturbed for 15-30 years. It may serve as a propagation source for re-population of the undeveloped portions of the plain area.

Near the base of the hills are Leucaena glauca, Bursera simaruba, and Zanthoxylum martenicinse. These are over an under-story of Piper spp., Dieffenbachia, Pothomorphe, Randia, Urena, and Amaranthus. Young mangos (Mangifera indica) and Royal Palms (Roystonea borinqueña) are appearing on the slopes from a few mature individuals up the hills. The grass and sugar cane from the flat area grades into shrubs and scrubby trees. No true demarcation can be made. A return to the mature forest would take a long period of time. A species list appears in Table 3.

The drier areas of forest do not have a large ground flora but they are difficult to walk through due to the numerous tree trunks, interlocking branches, and thorns.

Prominent trees are the gumbo limbo (Bursera simaruba), guebracho (Thounia striata), and guaranguao (Guarea trichilioides). On the east of the properties there are two moist valleys. Here are found mangos (Mangifera indica), panapen (Artocarpus altilus), some of the climbing grasses, Lasiacis and Abrus, also occur here.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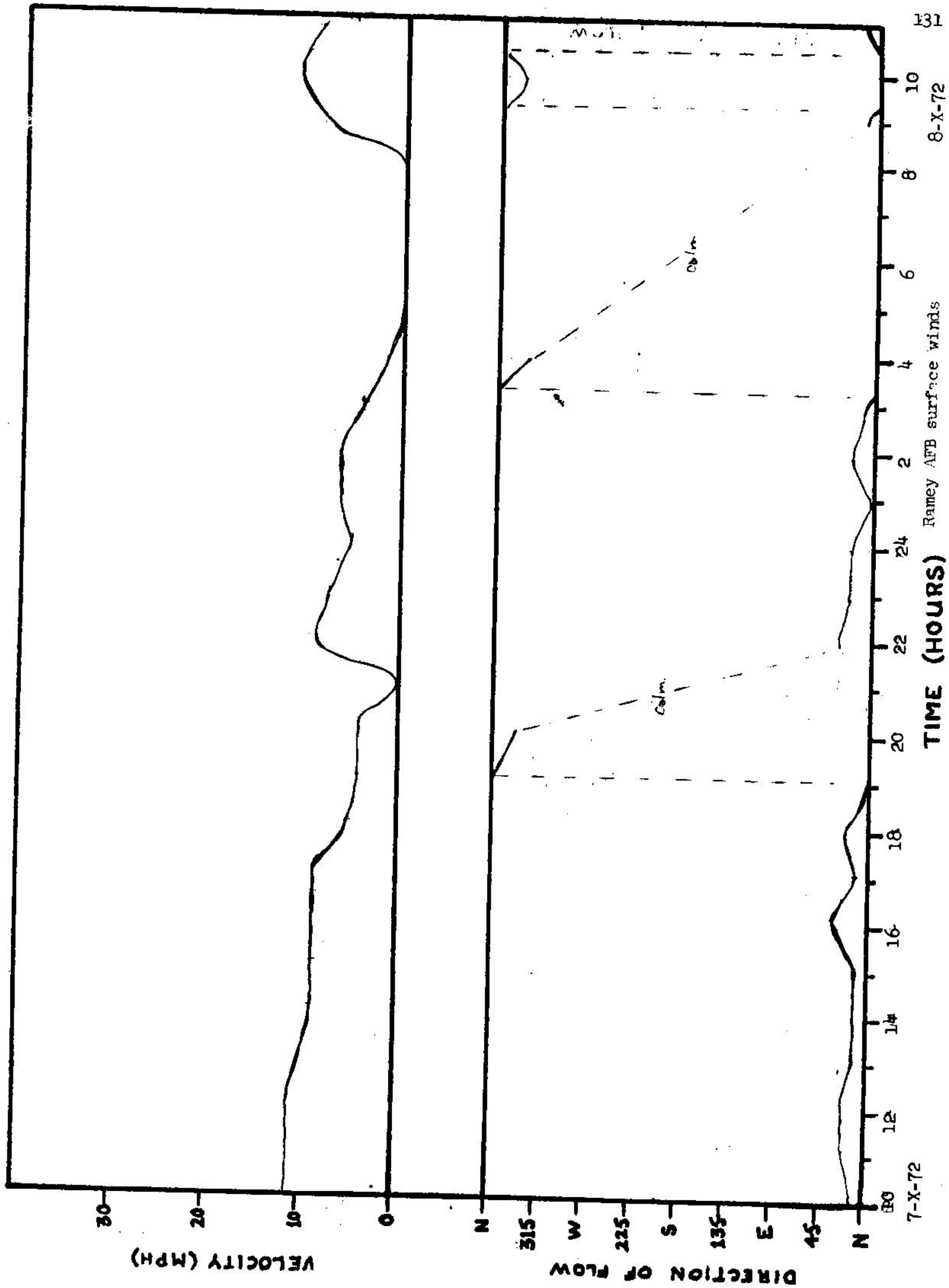
7-X-72
8-X-72
TIME (HOURS)
Tide level - cm
12 14 16 18 20 22 24 2 4 6 8 10 12
20 40



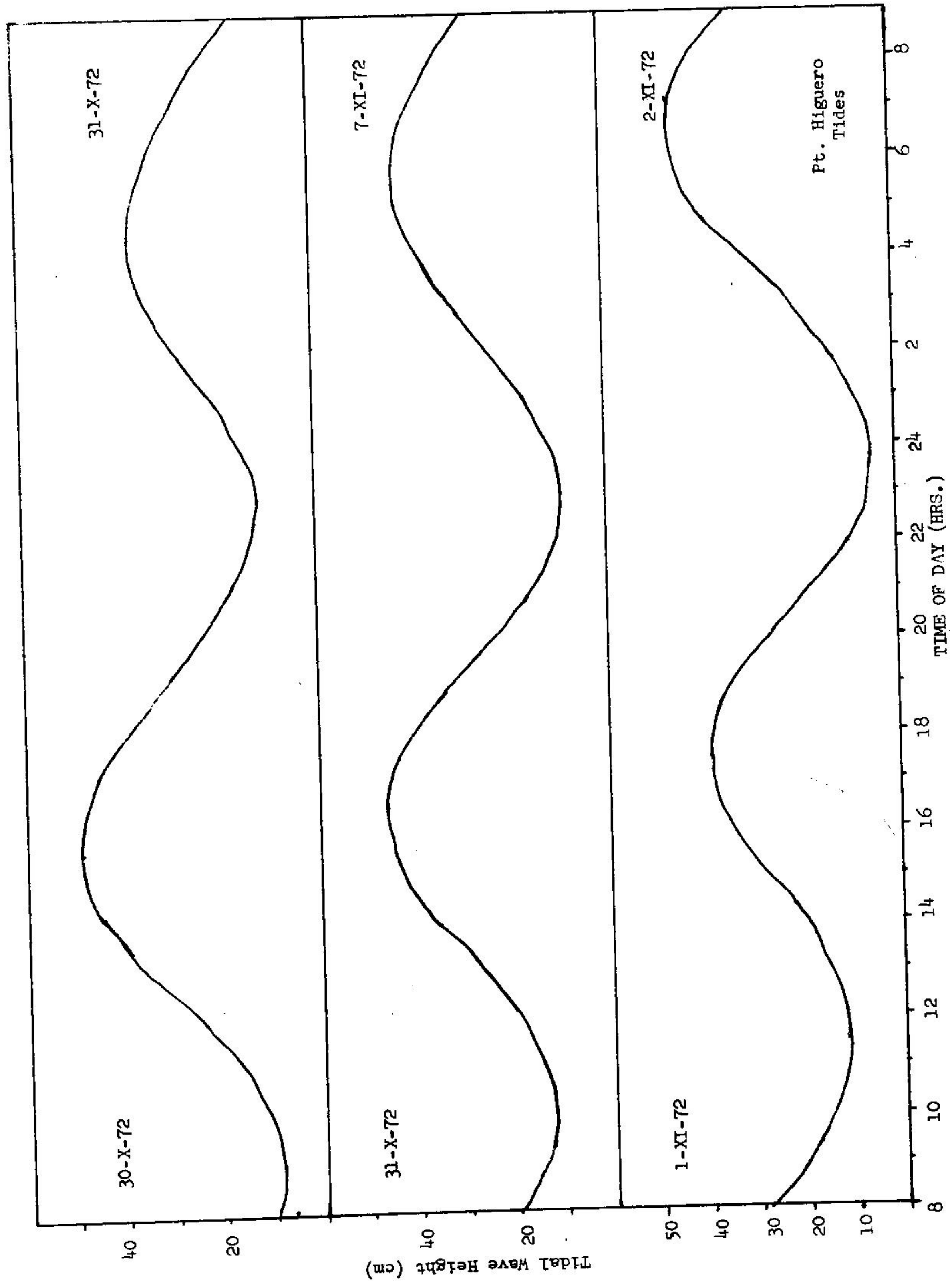
Ramey AFB surface winds

Dye Study | Pt. Higuero | 7-X-72

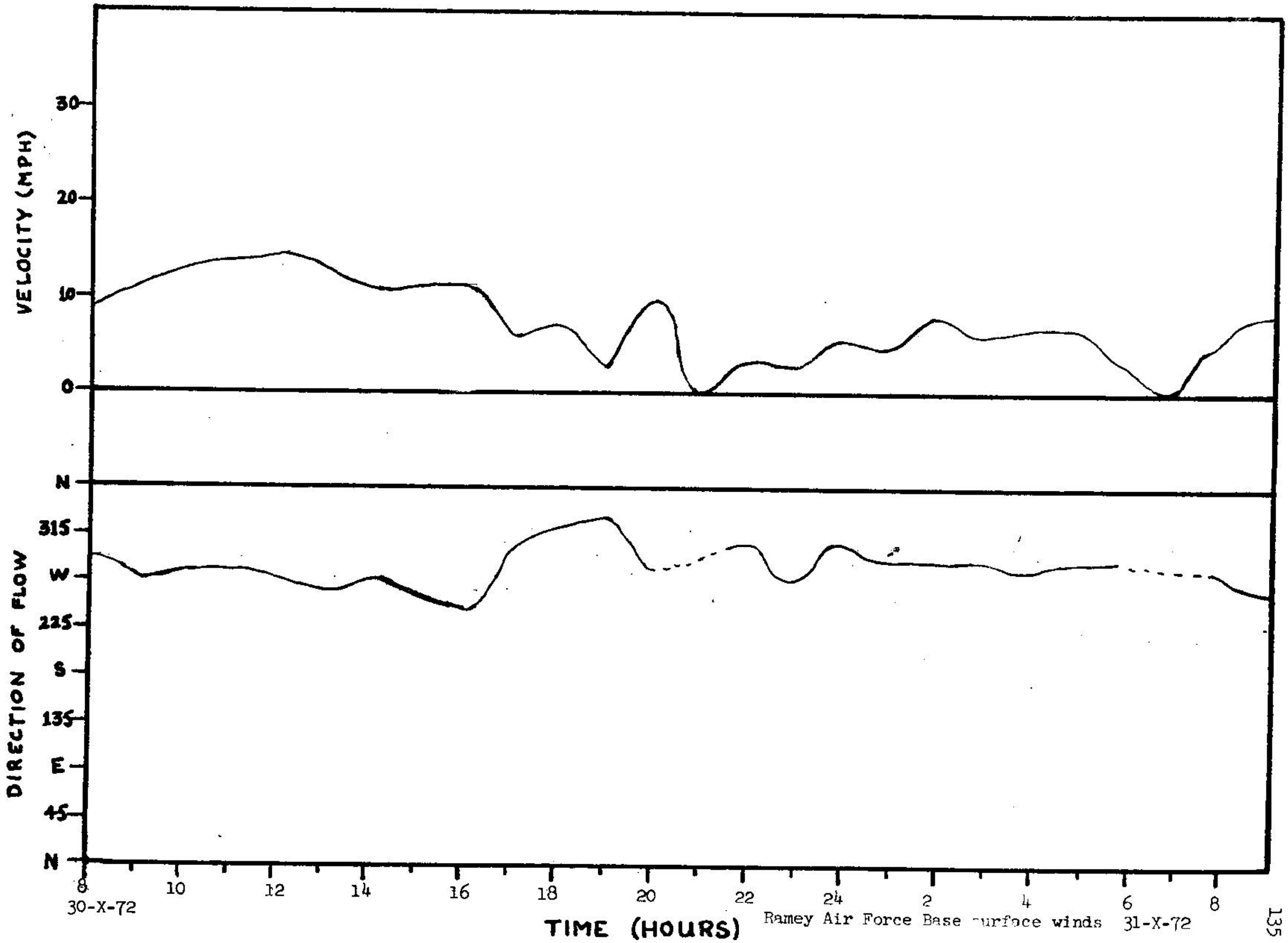
Dye Drop	Distance (n.mi)	Distance (m)	Time (min.)	Velocity (kts.)	Velocity (cm/sec.)	Direction (deg)
1	.5	926	90	.33	17.1	6
2	.53	982	90	.35	18.2	9
3	.39	722	90	.26	13.4	34
4	.39	722	90	.26	13.4	18
			Ave.	.30	15.5	17
5	.73	1352	90	.49	25.0	2
6	.74	1370	90	.49	25.4	7
7	1.1	2037	90	.73	37.7	17
8	.91	1685	90	.61	31.2	18
			Ave.	.58	29.8	11

Dye Study   Pt. Higuero   8-X-72

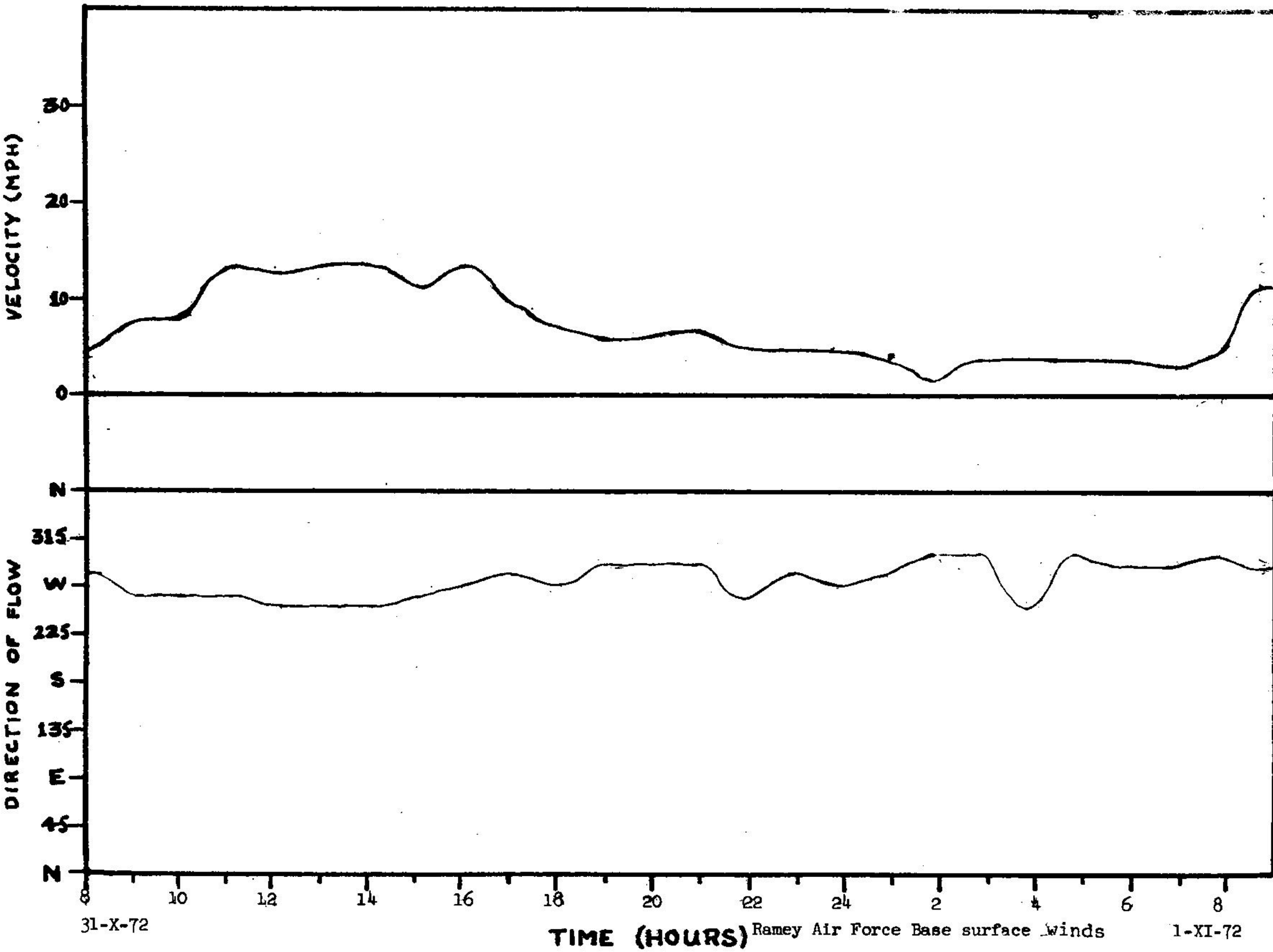
Dye Drop (No.)	Distance (n.mi)	(m)	Time (min.)	Velocity (kts.)	(cm/sec.)	Direction (deg)
1	.48	889	120	.24	12.3	356
2	.80	1482	120	.40	20.6	5
3	1.16	2148	120	.58	29.8	20
4	1.10	2037	120	.55	28.3	36
5	.25	463	120	.33	17.1	2
			Ave.	.32	16.7	1
6	.85	1574	120	.43	21.9	11
7	1.1	2037	120	.55	28.3	16
			Ave.	.53	27.1	21
8	*disappeared into a convergence.					(26)



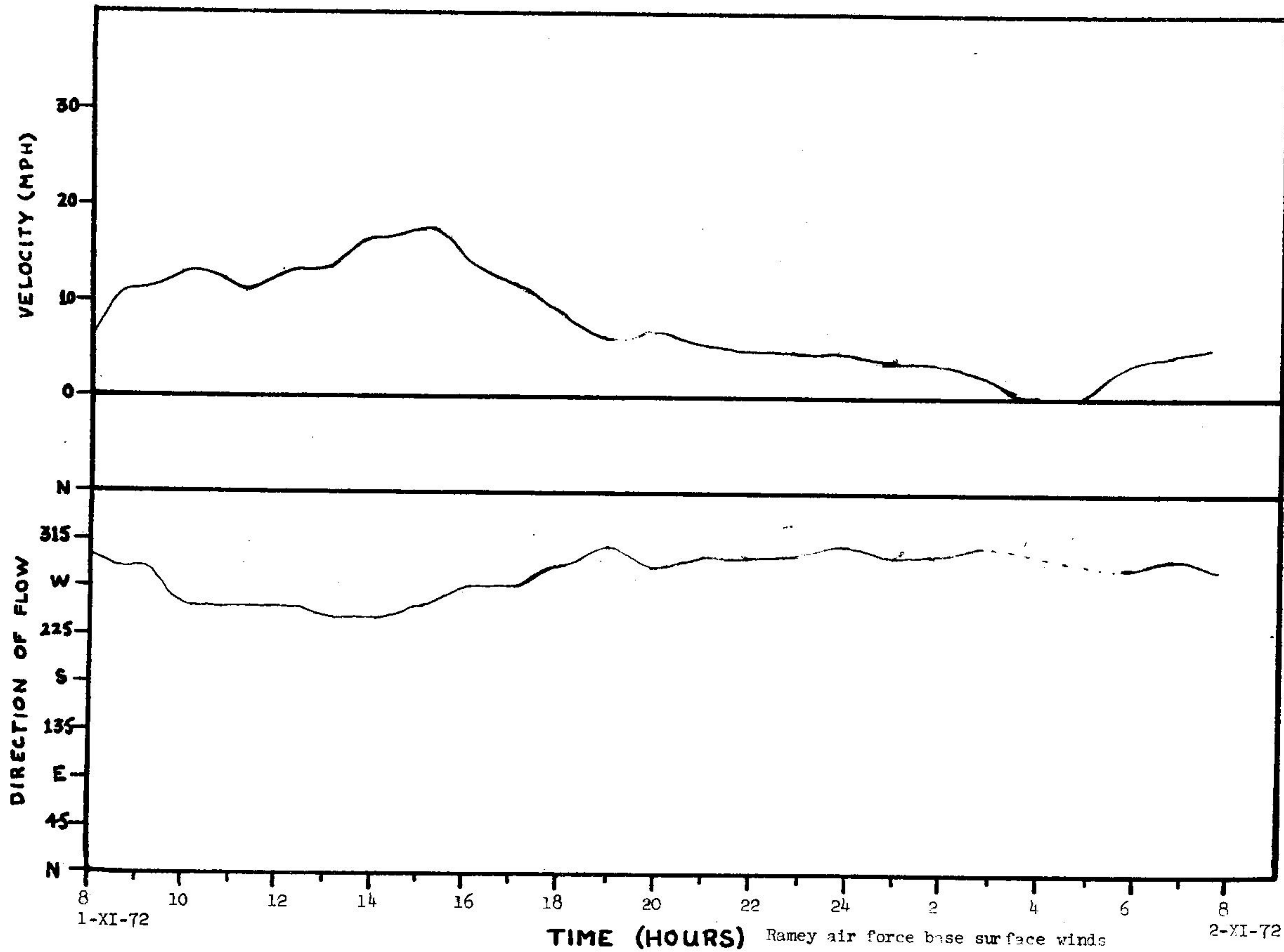
30-X-72
31-X-72
31-X-72
7-XI-72
1-XI-72
2-XI-72
Pt. Higuero
Tides
40
20
40
20
50
40
30
20
10
Tidal Wave Height (cm)
8
10
12
14
16
18
20
22
24
2
4
6
8
TIME OF DAY (HRS.)



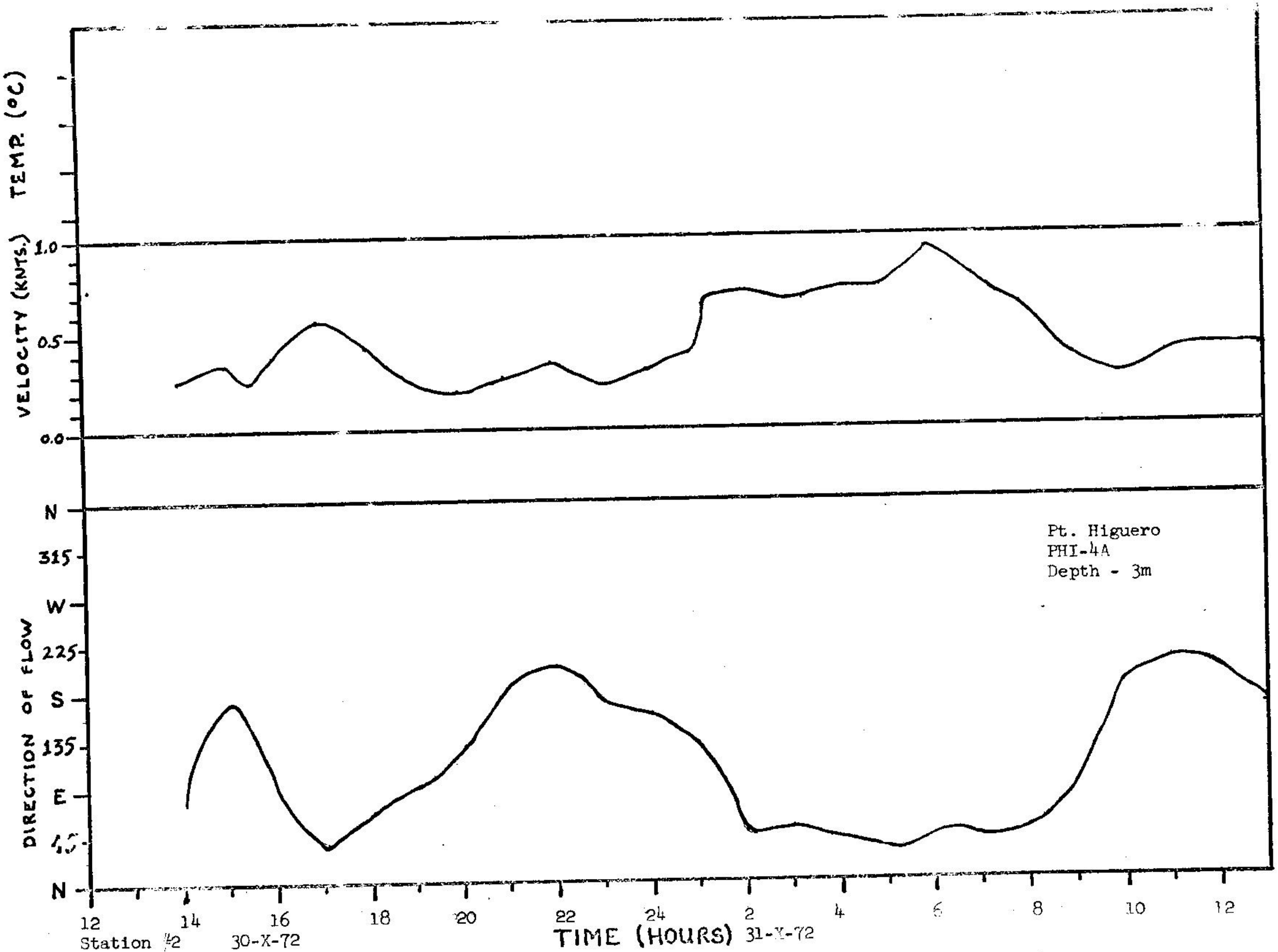
Ramey Air Force Base surface winds



Ramey Air Force Base surface winds



Ramey air force base surface winds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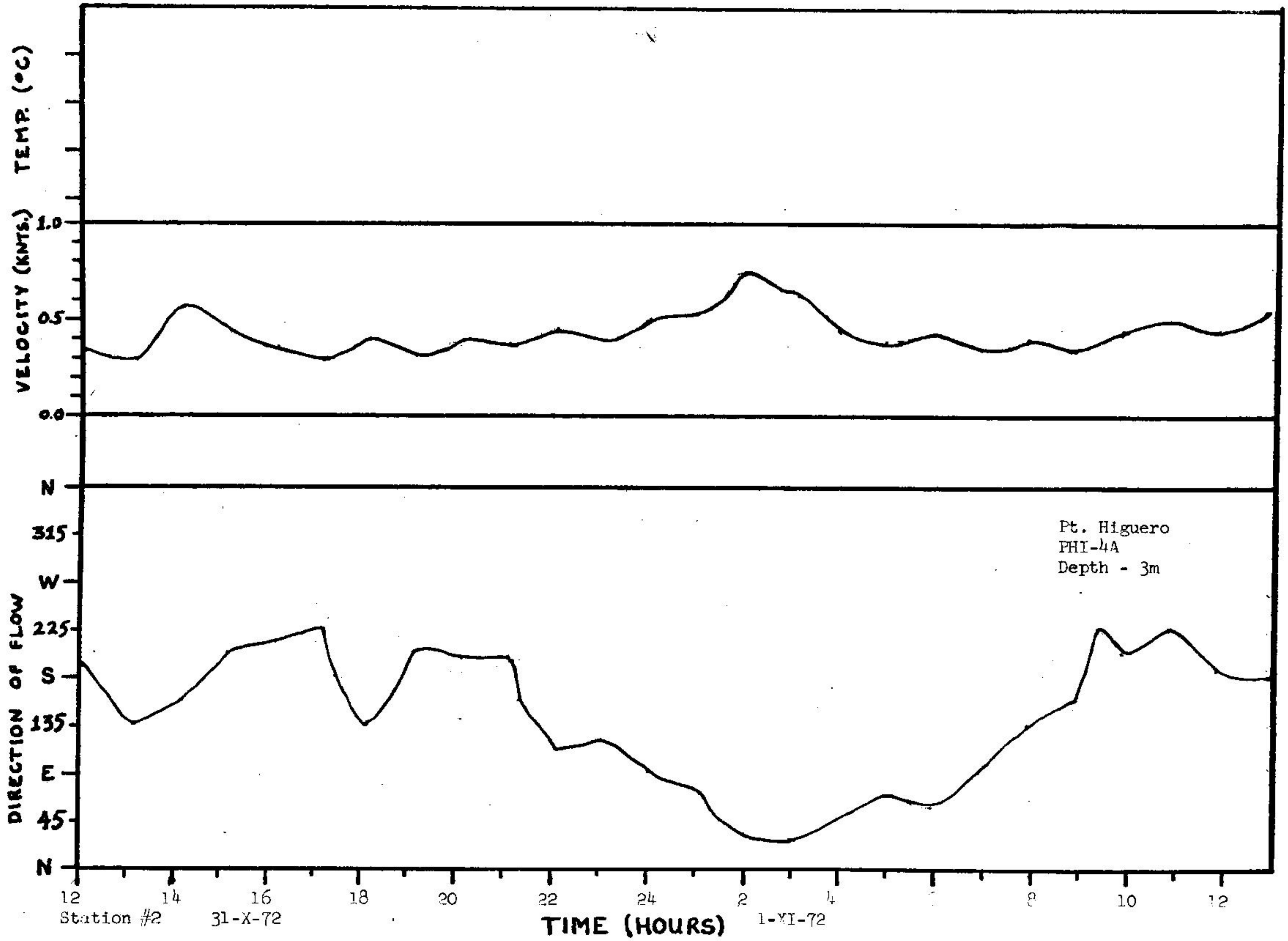
VELOCITY (KNTS.)
1.0
0.5
0.0
N
315
W
225
S
135
E
45
N
DIRECTION OF FLOW
Pt. Higuero
PHI-4A
Depth - 3m
12
14
16
18
20
22
24
2
4
6
8
10
12
Station #2
30-X-72
TIME (HOURS)
31-X-72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VELOCITY (KNTS.)
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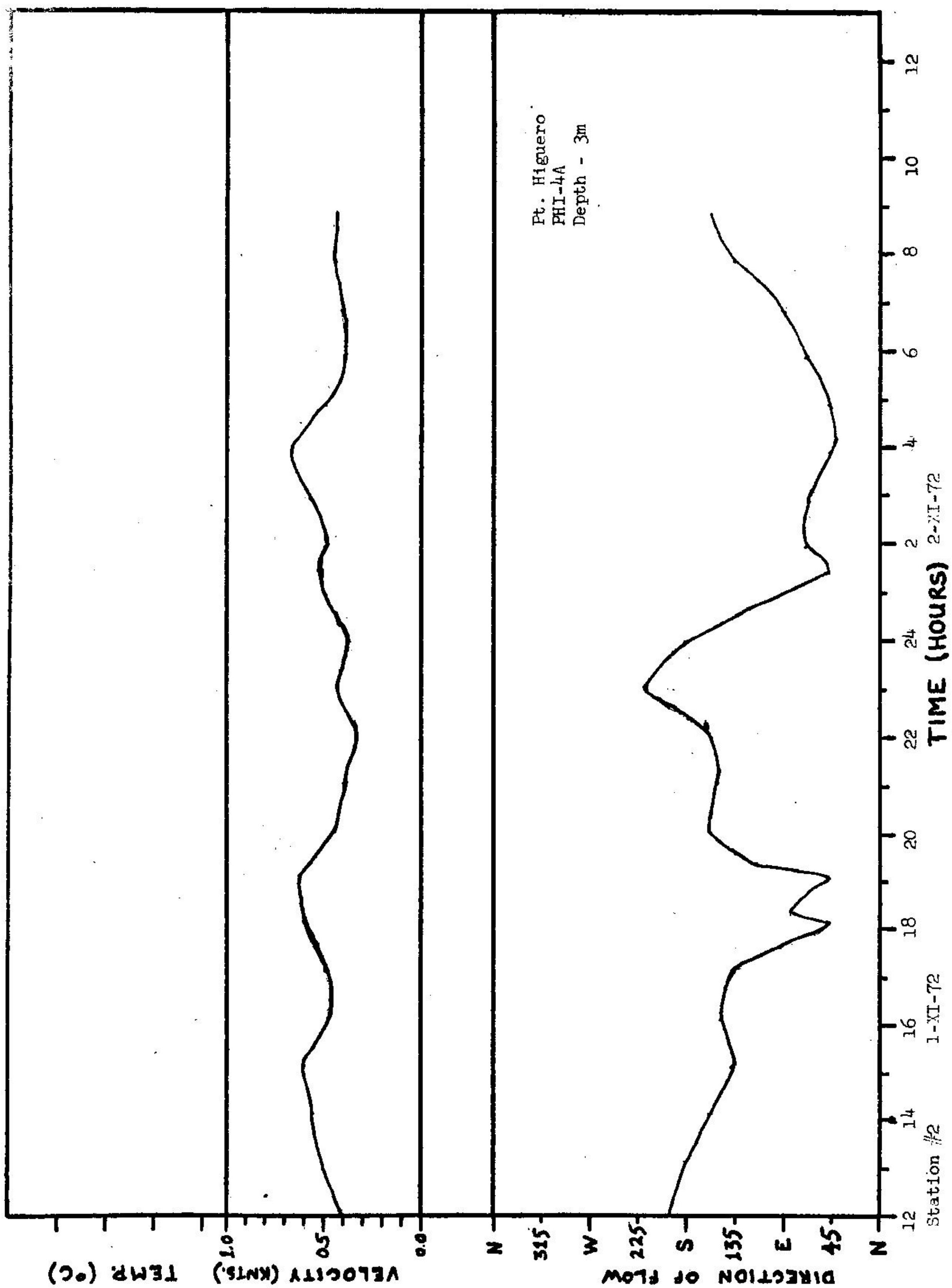
0.5
0.0
DIRECTION OF FLOW
N
315
W
225
S
135
E
45
N
Pt. Higuero
PHI-4A
Depth - 3m
12
14
16
18
20
22
24
2
4
8
10
12
Station #2
31-X-72
TIME (HOURS)
1-XI-72


Pt. Higuero
PHI-4A
Depth - 3m
TEMP. (°C)
VELOCITY (KNTS.)
DIRECTION OF FLOW
1.0
0.5
0.0
N
315
W
225
S
135
E
45
N
TIME (HOURS)
Station #2
1-XI-72
2-XI-72
12
14
16
18
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24
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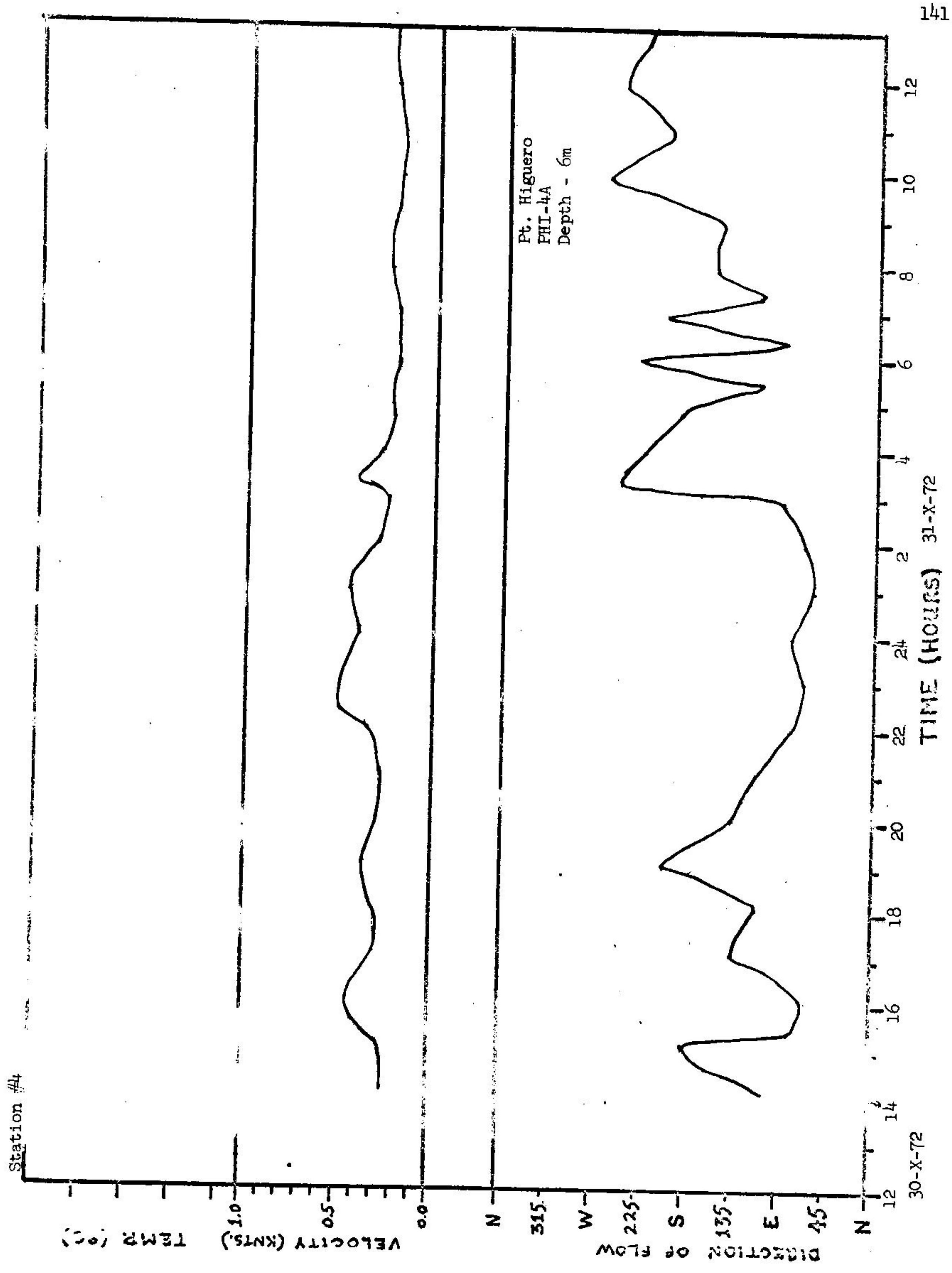
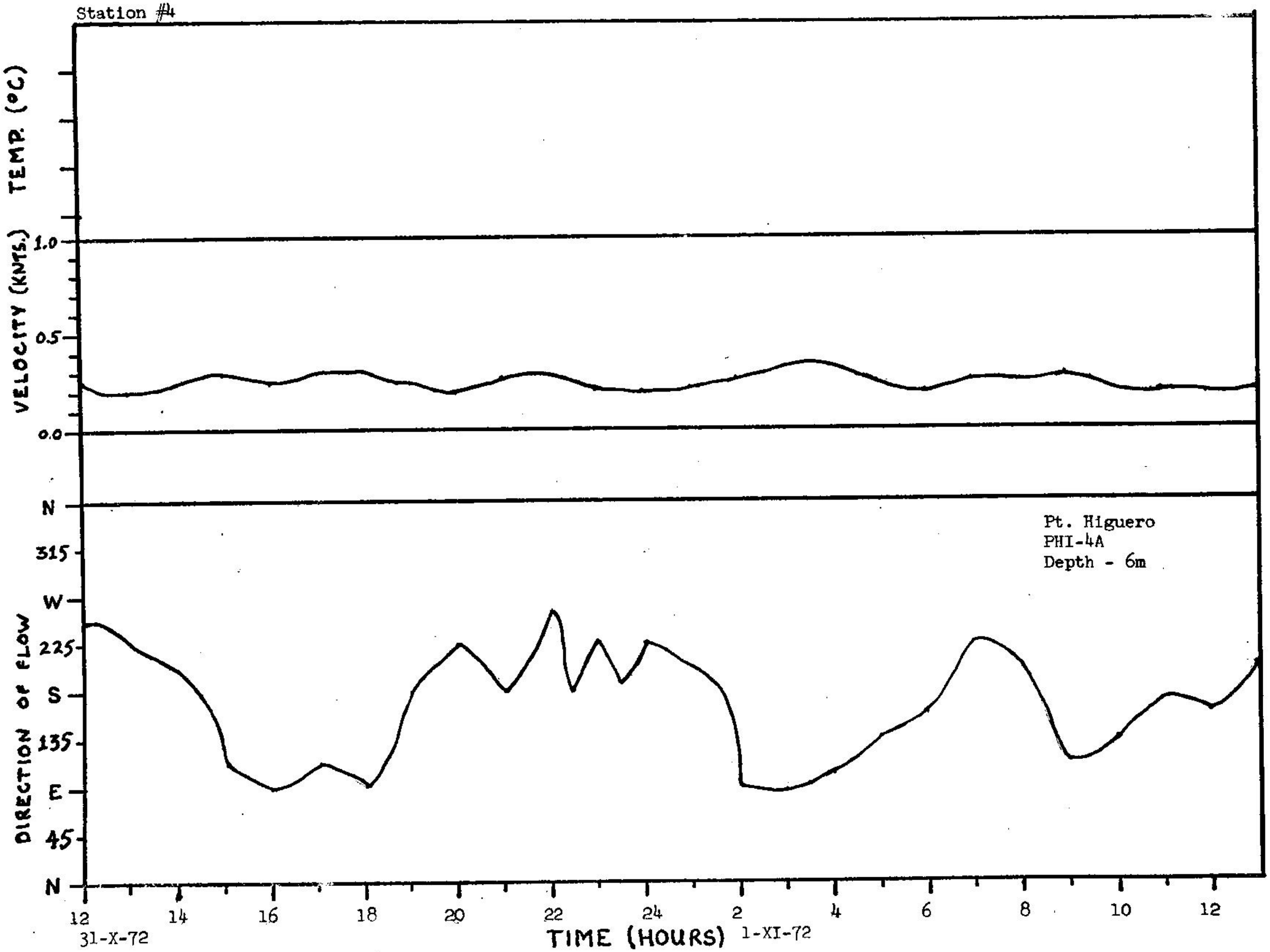
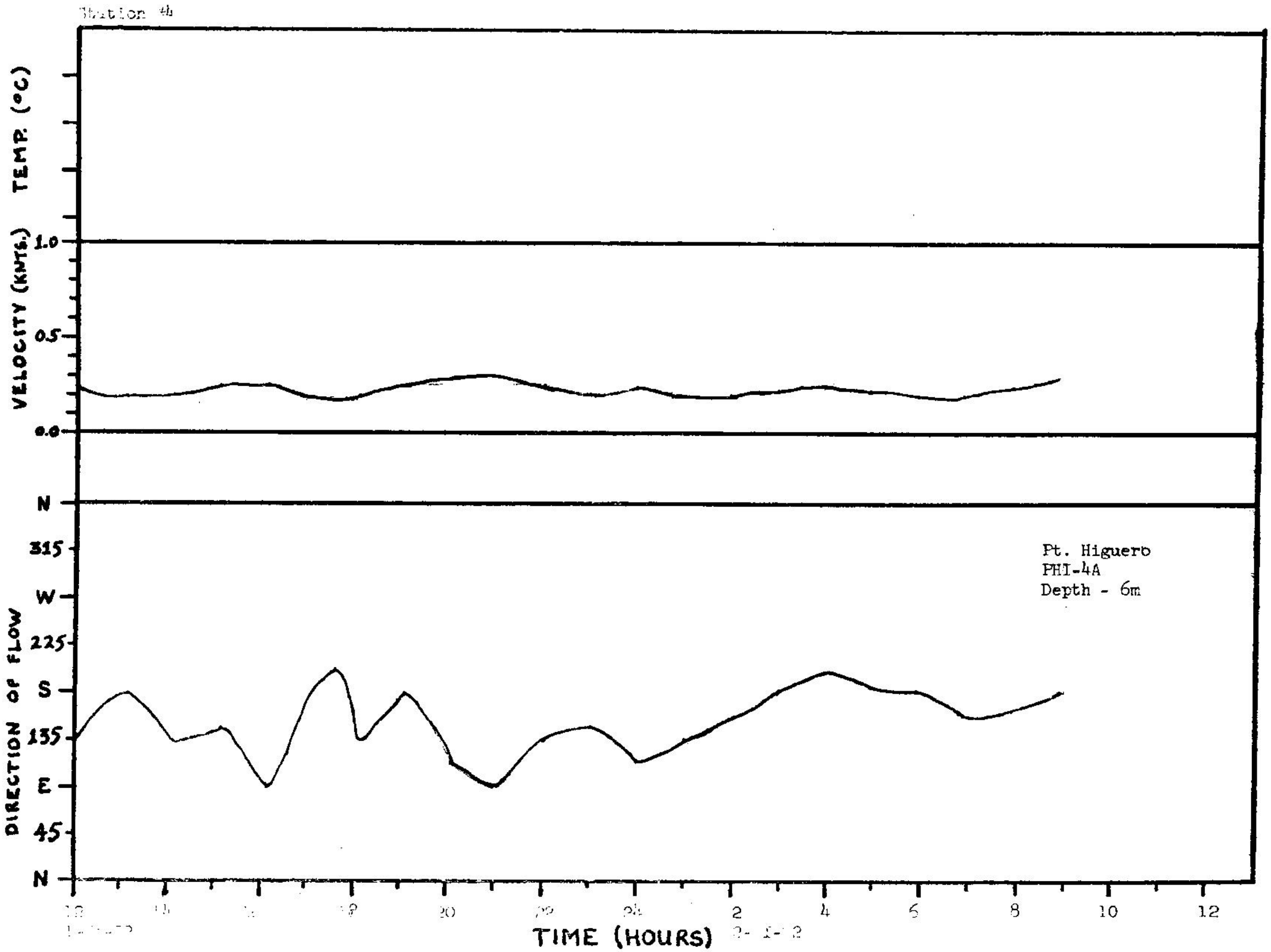
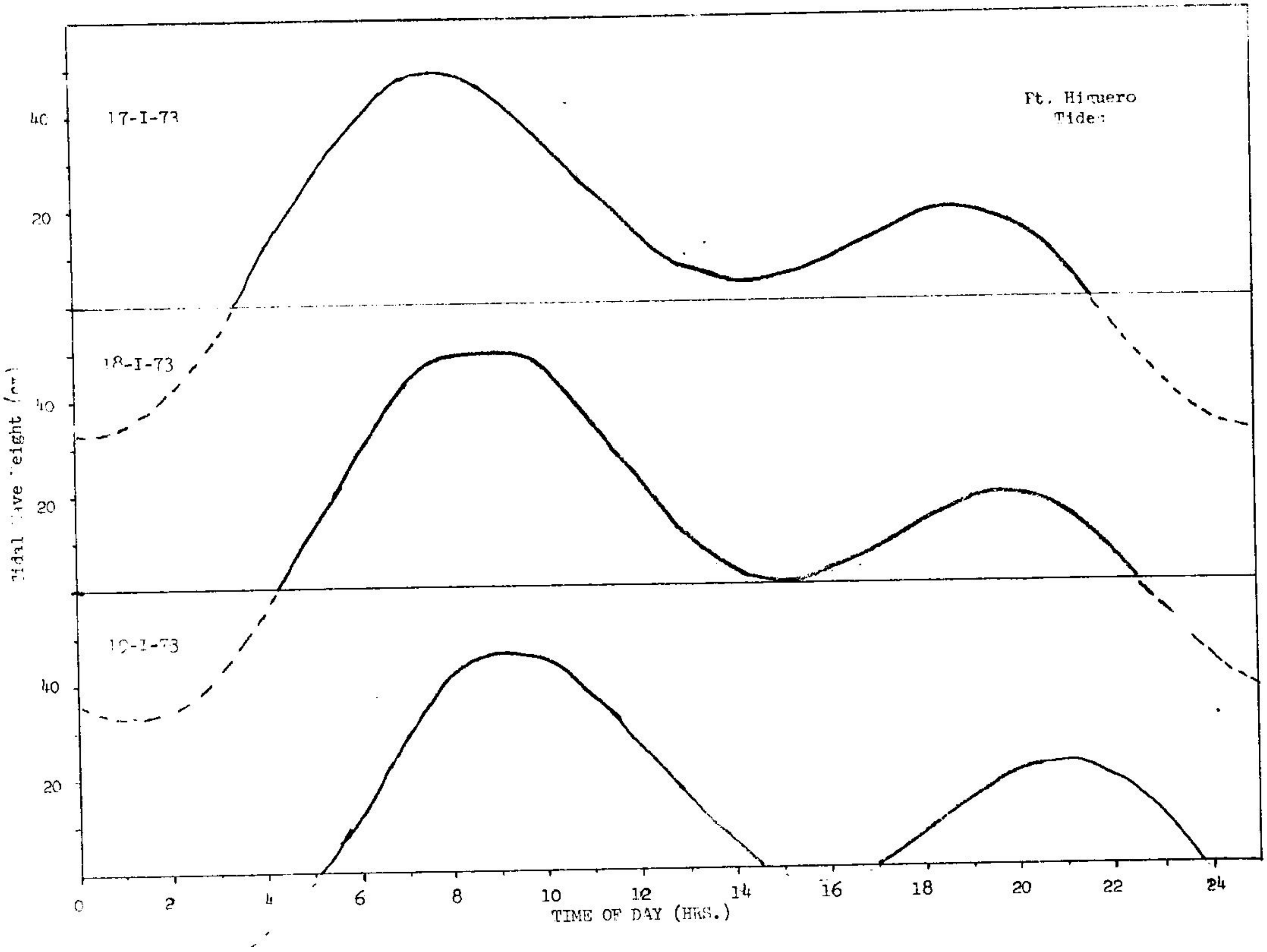
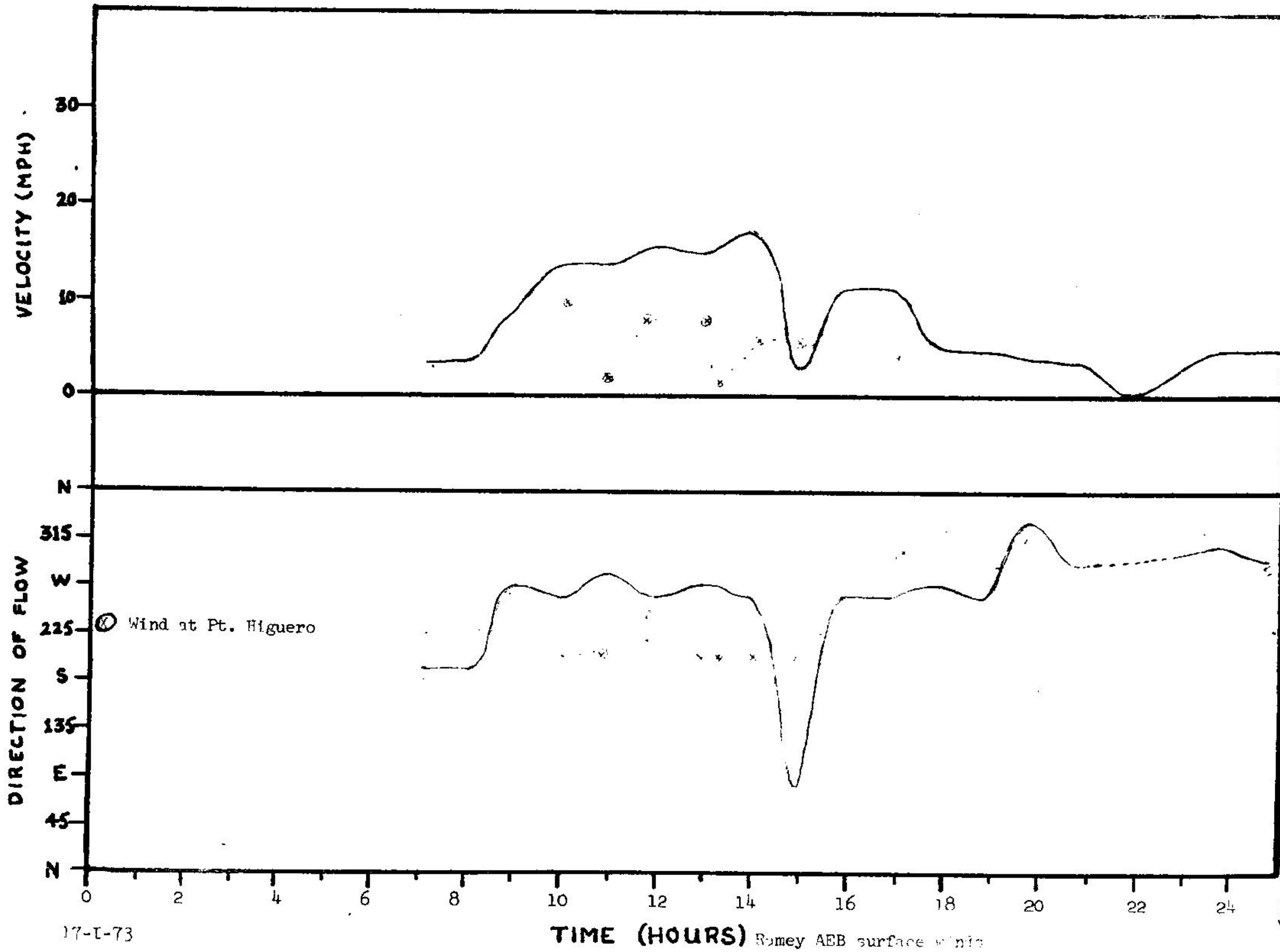
4
6
8
10
12

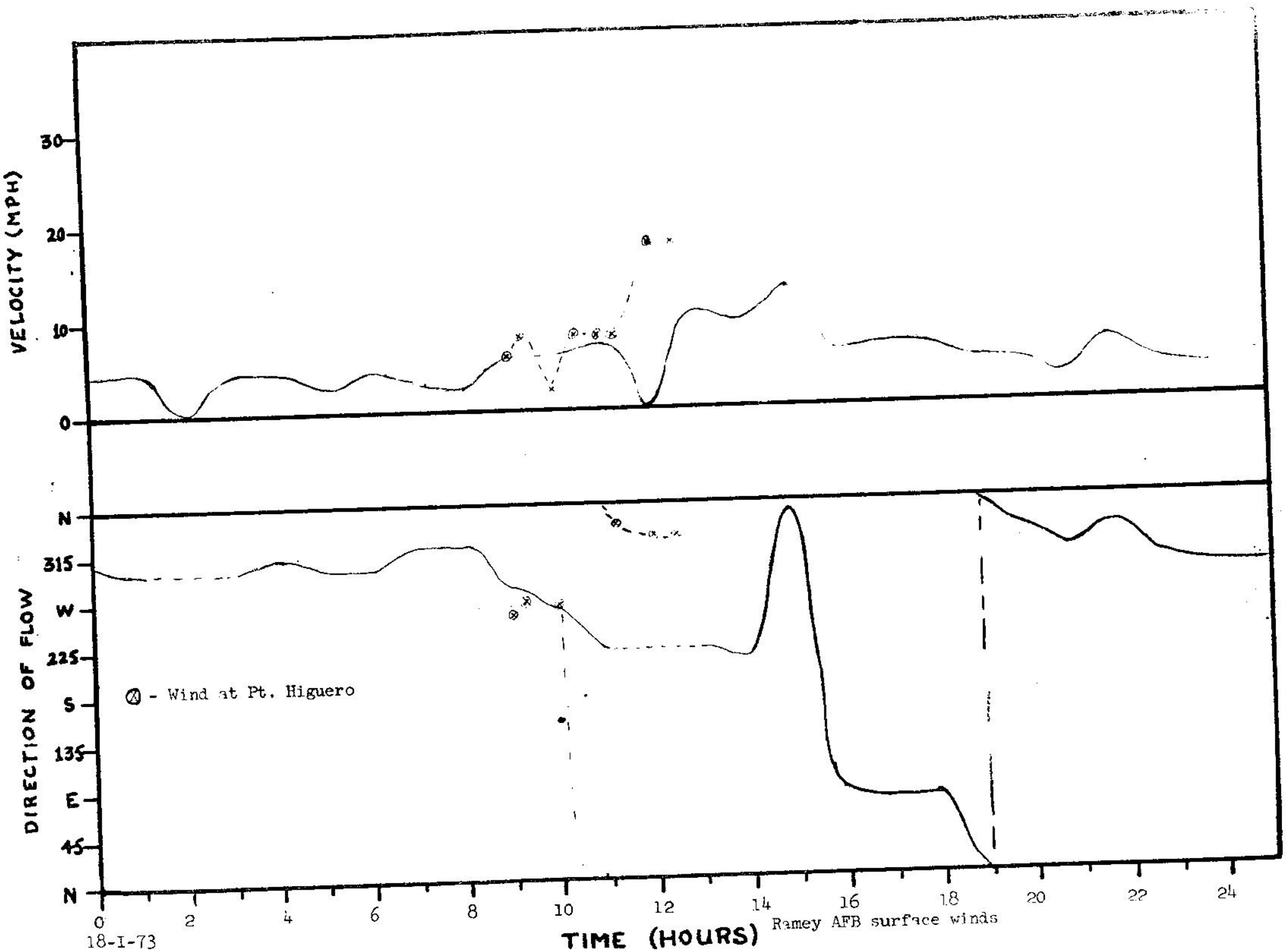

Station #4
Pt. Higuero
PHI-4A
Depth - 6m
TEMP (°C)
VELOCITY (KNTS.)
1.0
0.5
0.0
DIRECTION OF FLOW
N
315
W
225
S
135
E
45
N
TIME (HOURS)
12
14
16
18
20
22
24
2
4
6
8
10
12
30-X-72
31-X-72

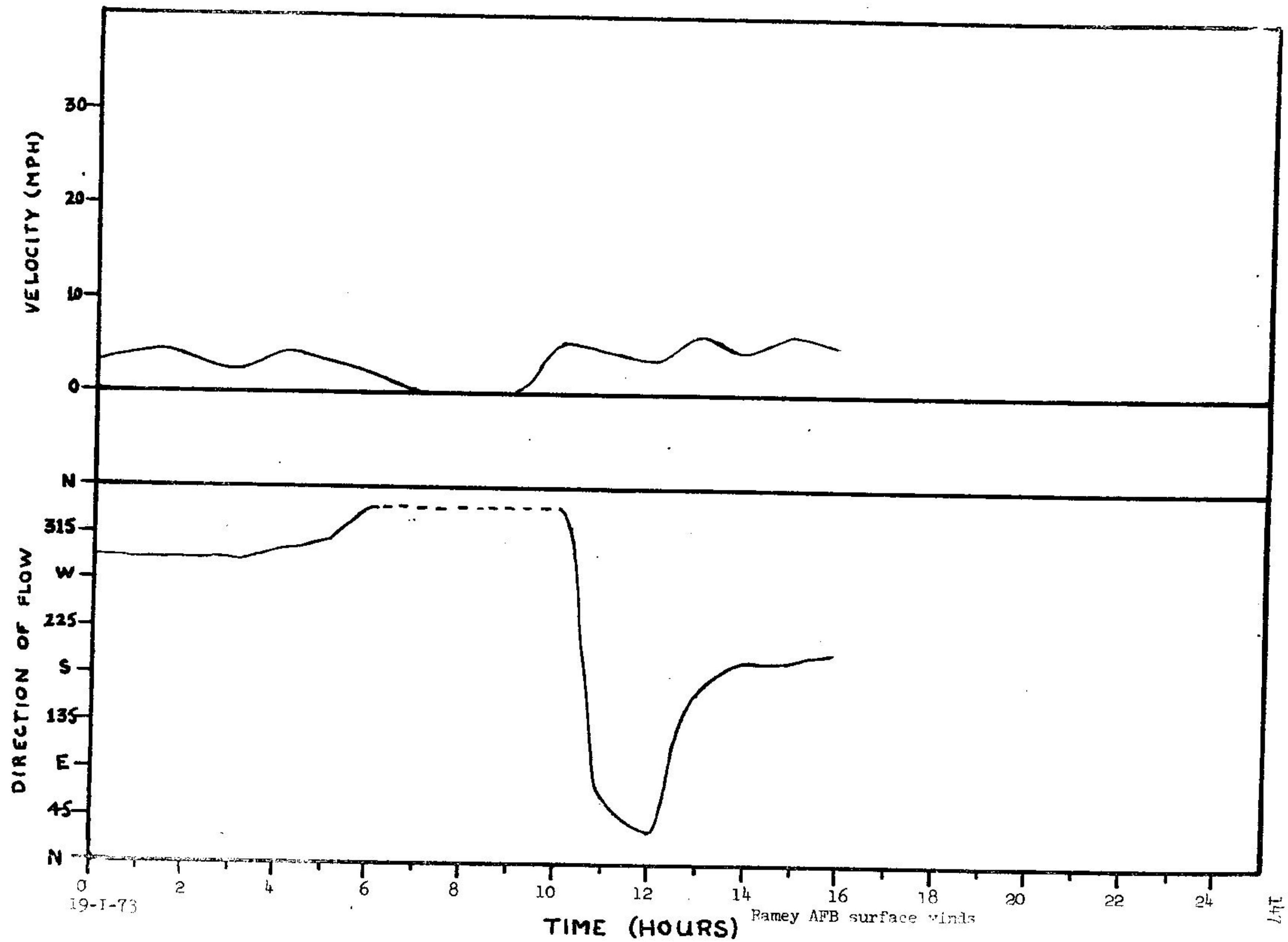

Station #4
TEMP. (°C)
VELOCITY (KNTS.)
1.0
0.5
0.0
DIRECTION OF FLOW
N
315
W
225
S
135
E
45
N
Pt. Higuero
PHI-4A
Depth - 6m
12
14
16
18
20
22
24
2
4
6
8
10
12
31-X-72
TIME (HOURS)
1-XI-72


Station 4
TEMP. (°C)
VELOCITY (KNTS.)
1.0
0.5
0.0
N
315
W
225
S
135
E
45
N
DIRECTION OF FLOW
Pt. Higuero
PHI-4A
Depth - 6m
20
2
4
6
8
10
12
TIME (HOURS)

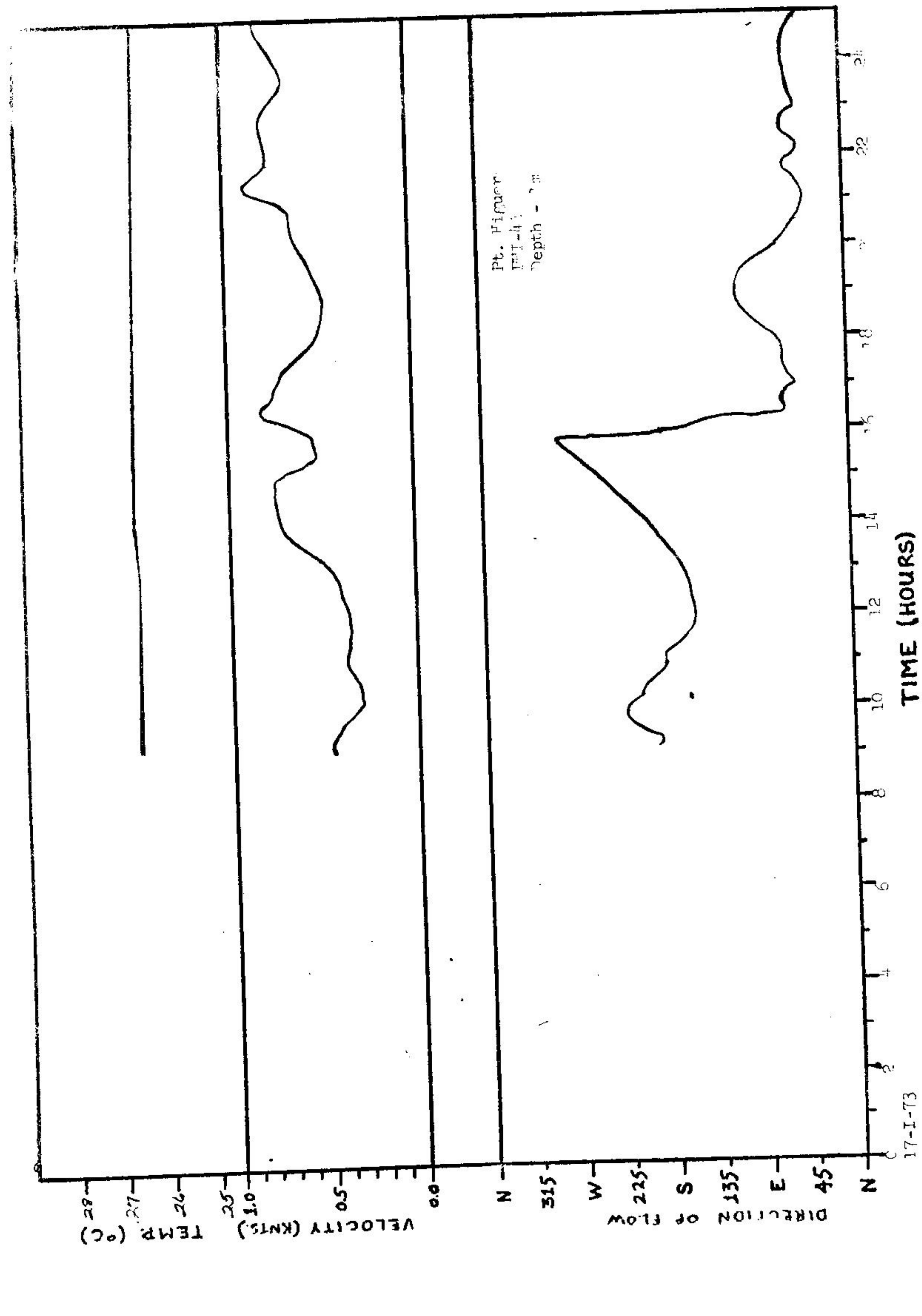

Pt. Higuero
Tides
17-I-73
18-I-73
19-I-73
Tidal Wave Height (cm)
TIME OF DAY (HRS.)

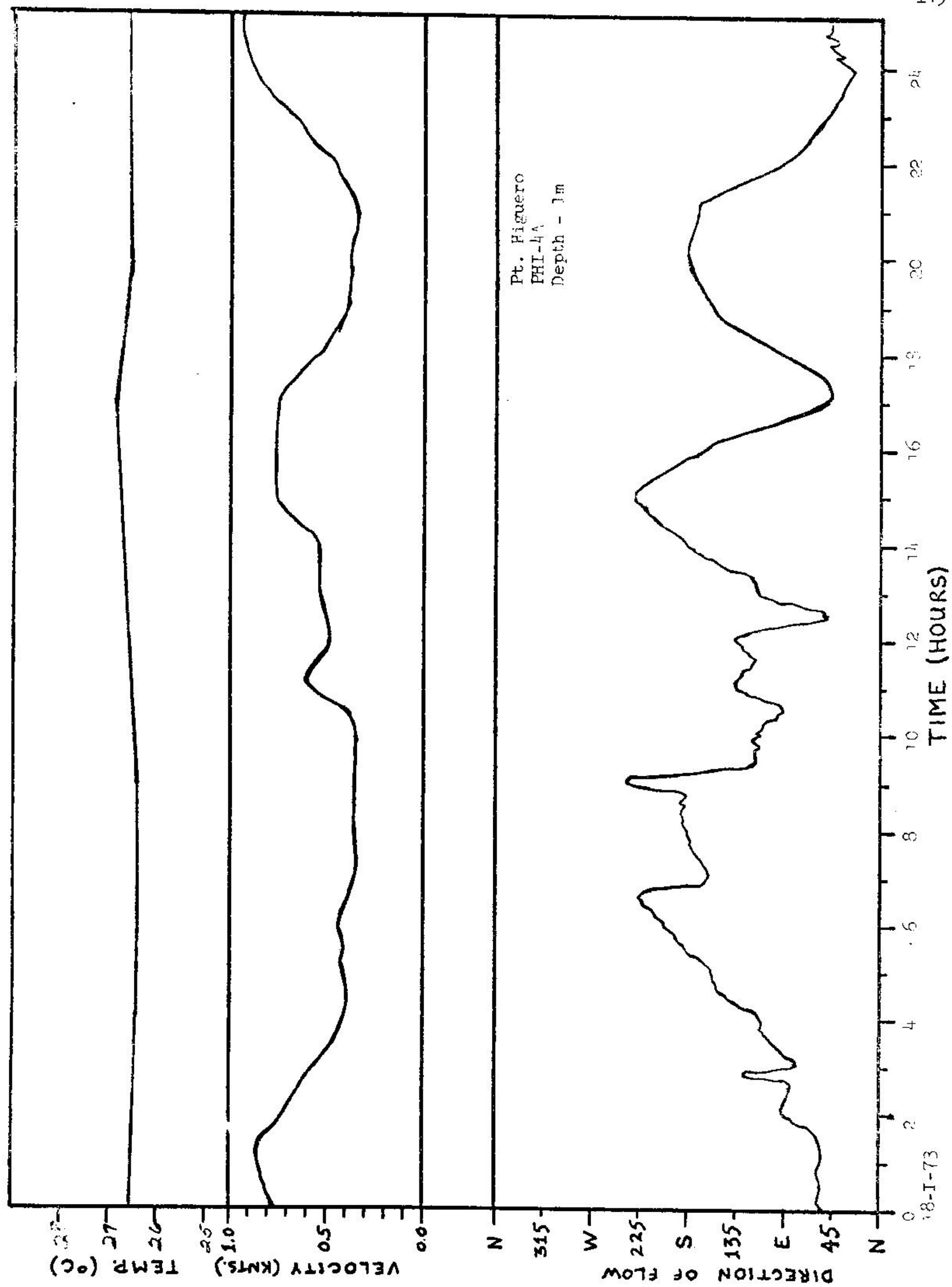

VELOCITY (MPH)
30
20
10
0
N
315
W
225
S
135
E
45
N
DIRECTION OF FLOW
Wind at Pt. Higuero
0
2
4
6
8
10
12
14
16
18
20
22
24
17-I-73
TIME (HOURS)
Romey AEB surface


VELOCITY (MPH)
30
20
10
0
DIRECTION OF FLOW
N
315
W
225
S
135
E
45
N
⊗ - Wind at Pt. Higuero
0
2
4
6
8
10
12
14
16
18
20
22
24
18-I-73
TIME (HOURS)
Ramey AFB surface winds

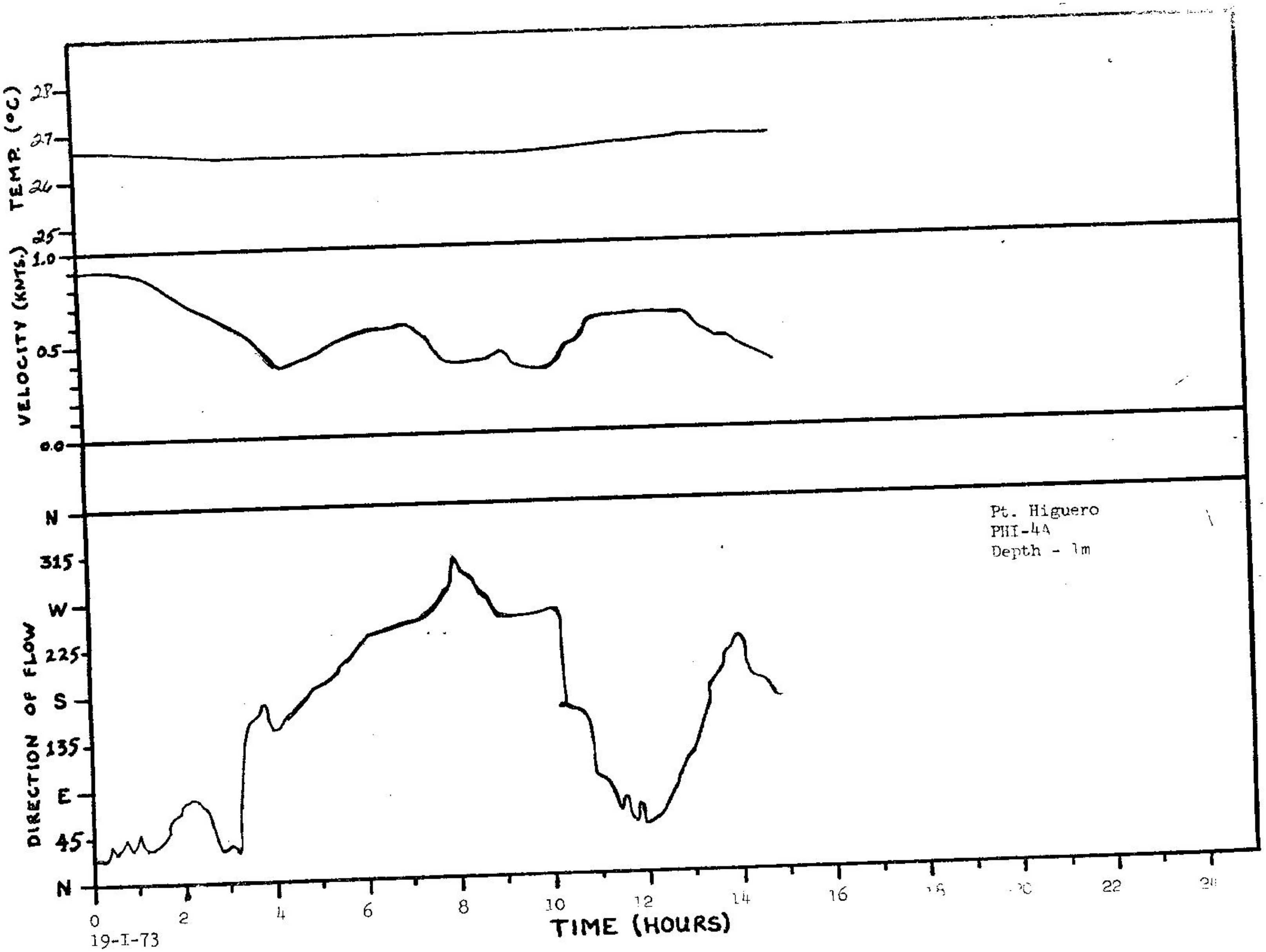


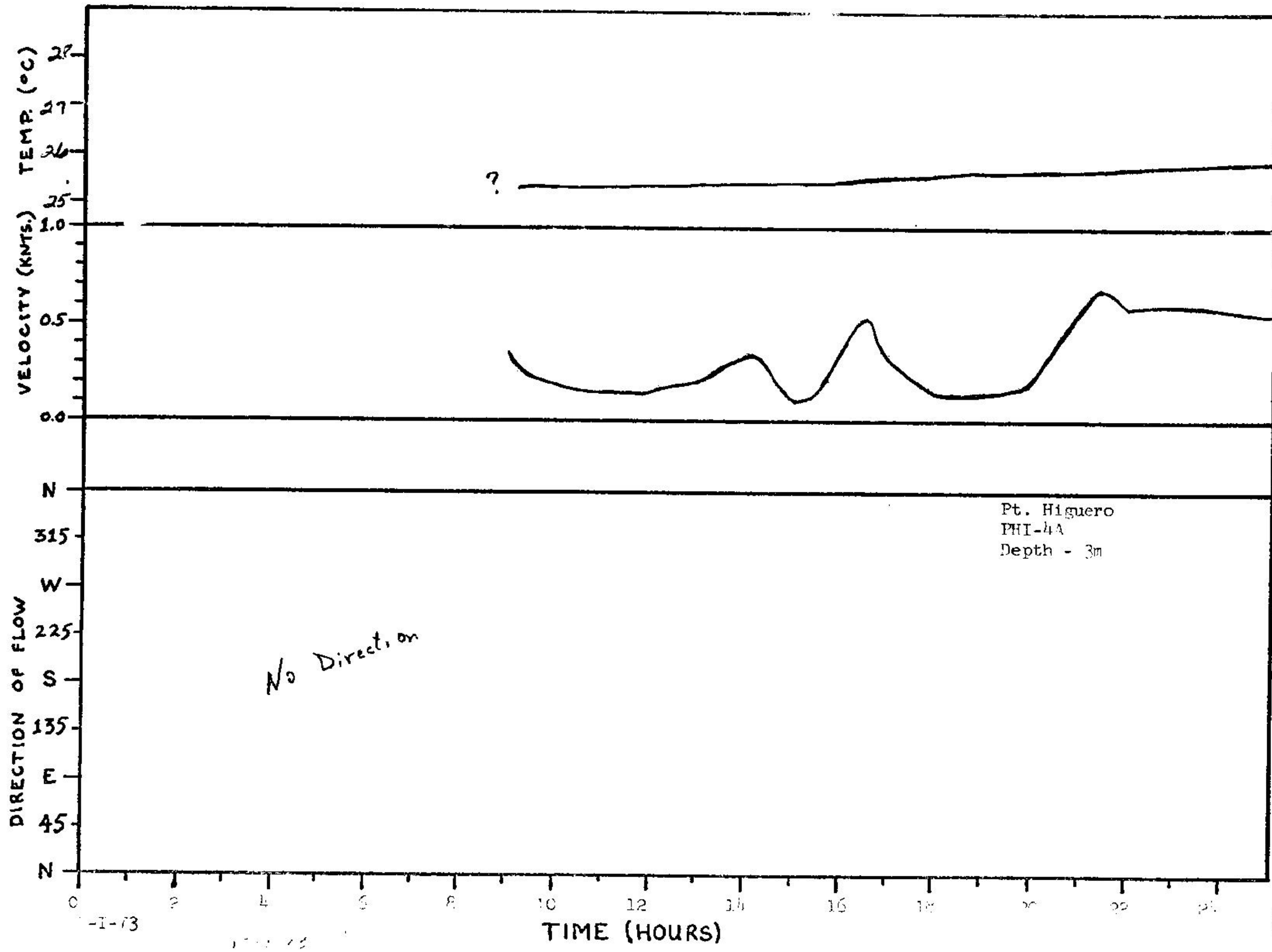
Ramey AFB surface winds

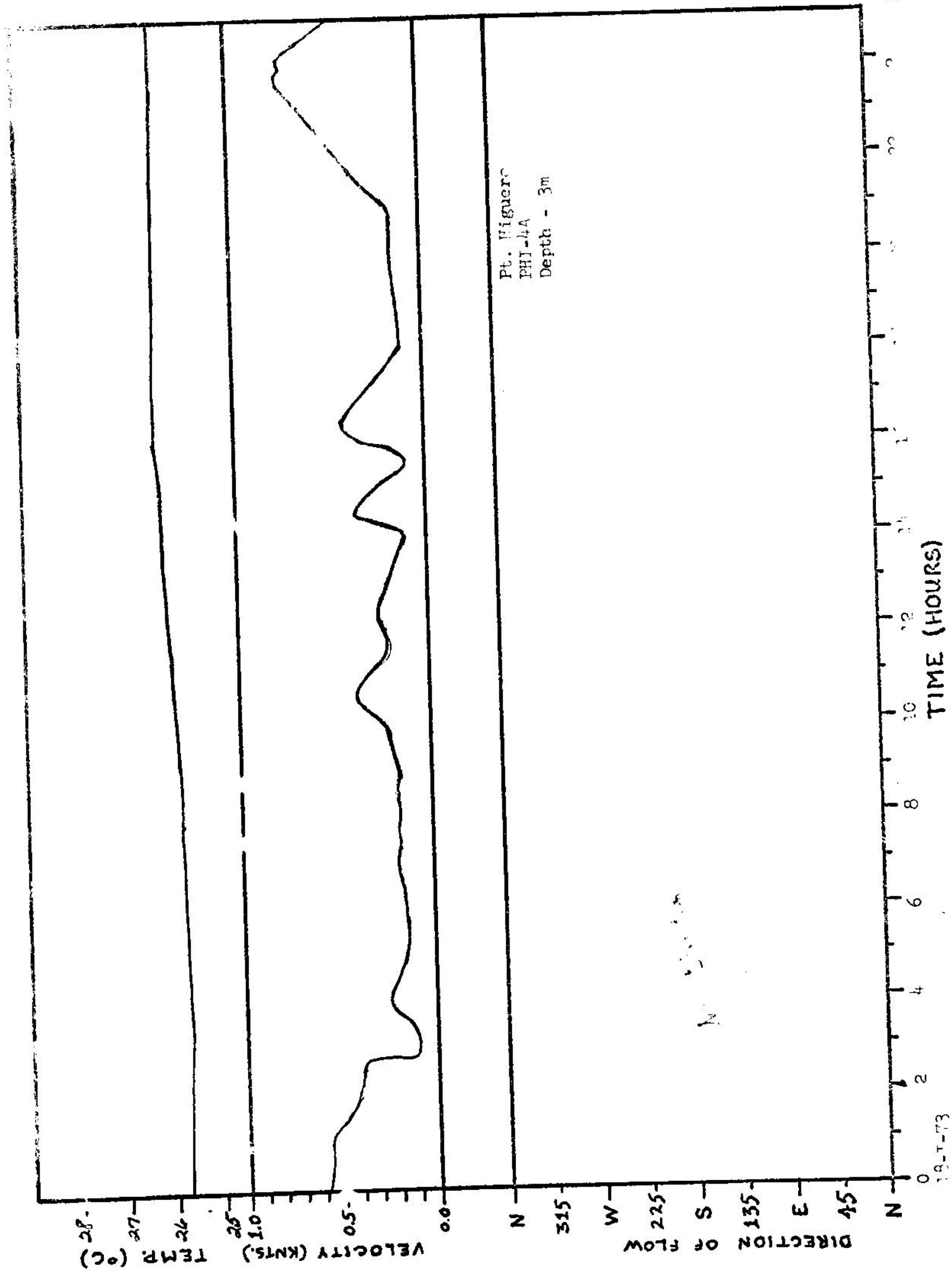

TIME (HOURS)
TEMP. (°C)
VELOCITY (KNTS.)
DIRECTION OF FLOW
17-I-73
Pt. Higuer
0 2 4 6 8 10 12 14 16 18 20 22 24
28 27 26 25
1.0 0.5 0.0
N 315 W 225 S 135 E 45 N



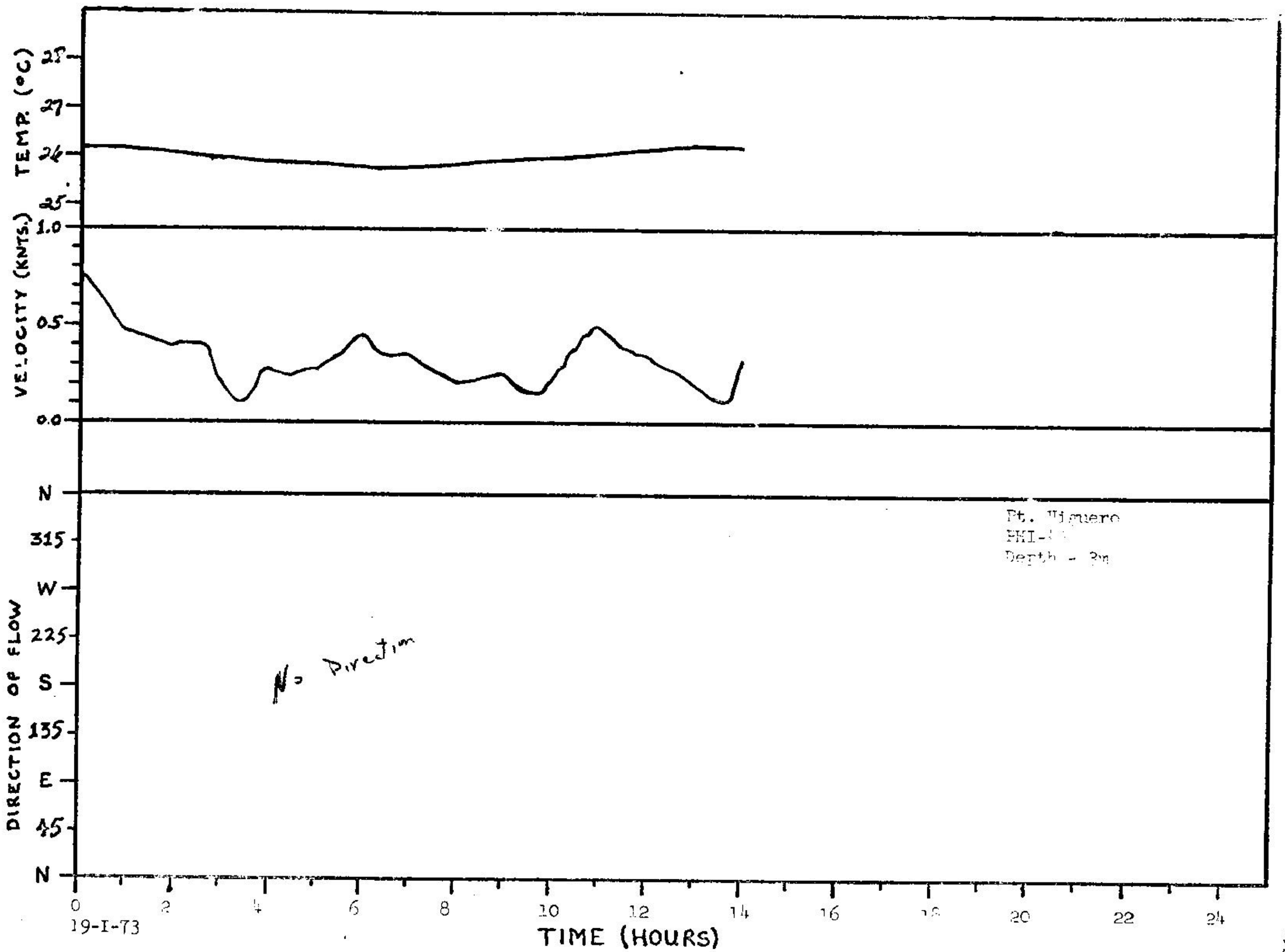
Pt. Figuero
PHI-4A
Depth - 1m
TIME (HOURS)
18-I-73
0
2
4
6
8
10
12
14
16
18
20
22
24
TEMP (°C)
27
26
25
VELOCITY (KNTS.)
1.0
0.5
0.0
DIRECTION OF FLOW
N
315
W
225
S
135
E
45
N

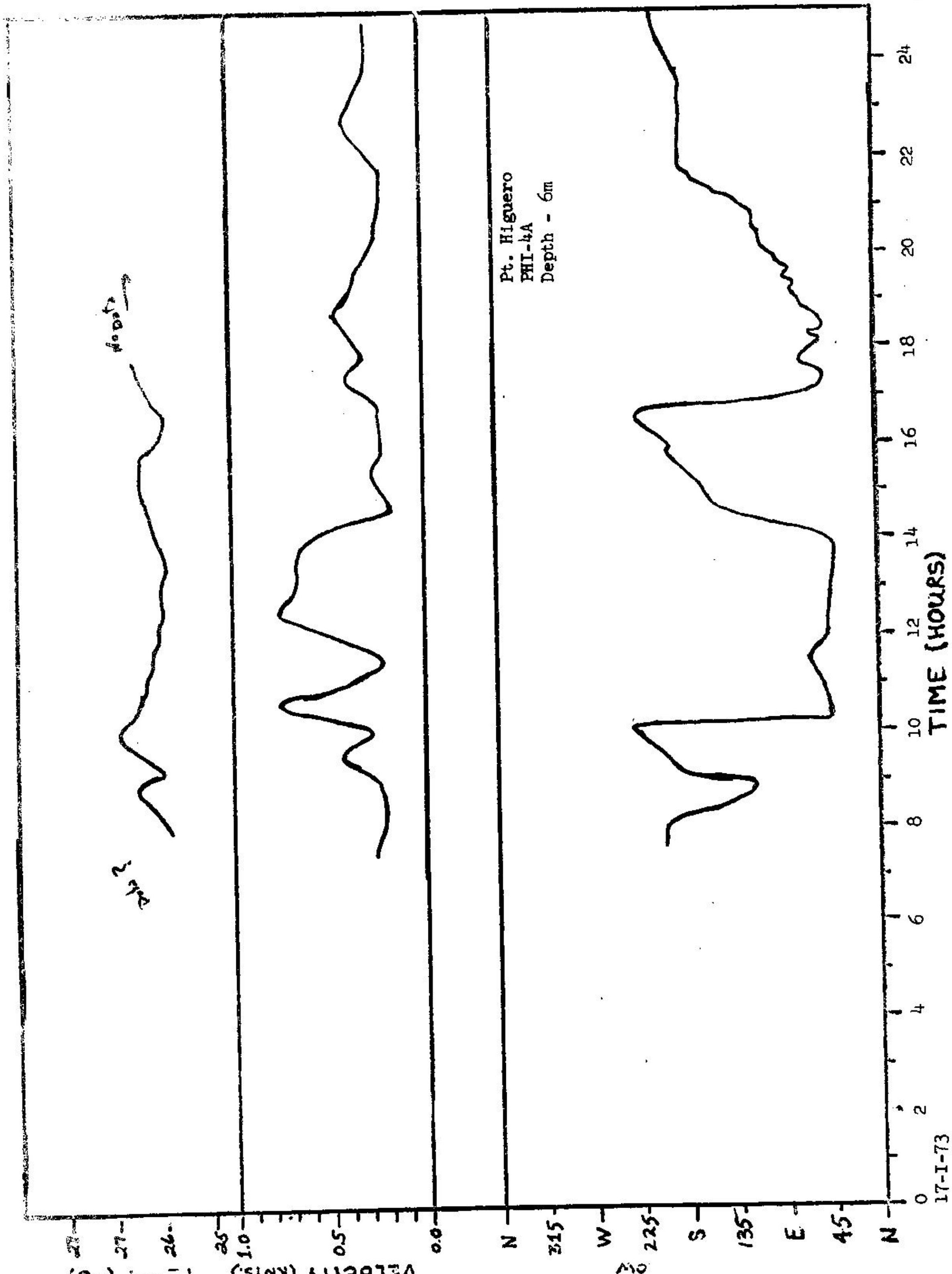

TEMP. (°C)
28
27
26
25
VELOCITY (KNTS.)
1.0
0.5
0.0
DIRECTION OF FLOW
N
315
W
225
S
135
E
45
N
Pt. Higuero
PHI-4A
Depth - 1m
0
19-I-73
2
4
6
8
10
12
14
16
22
TIME (HOURS)

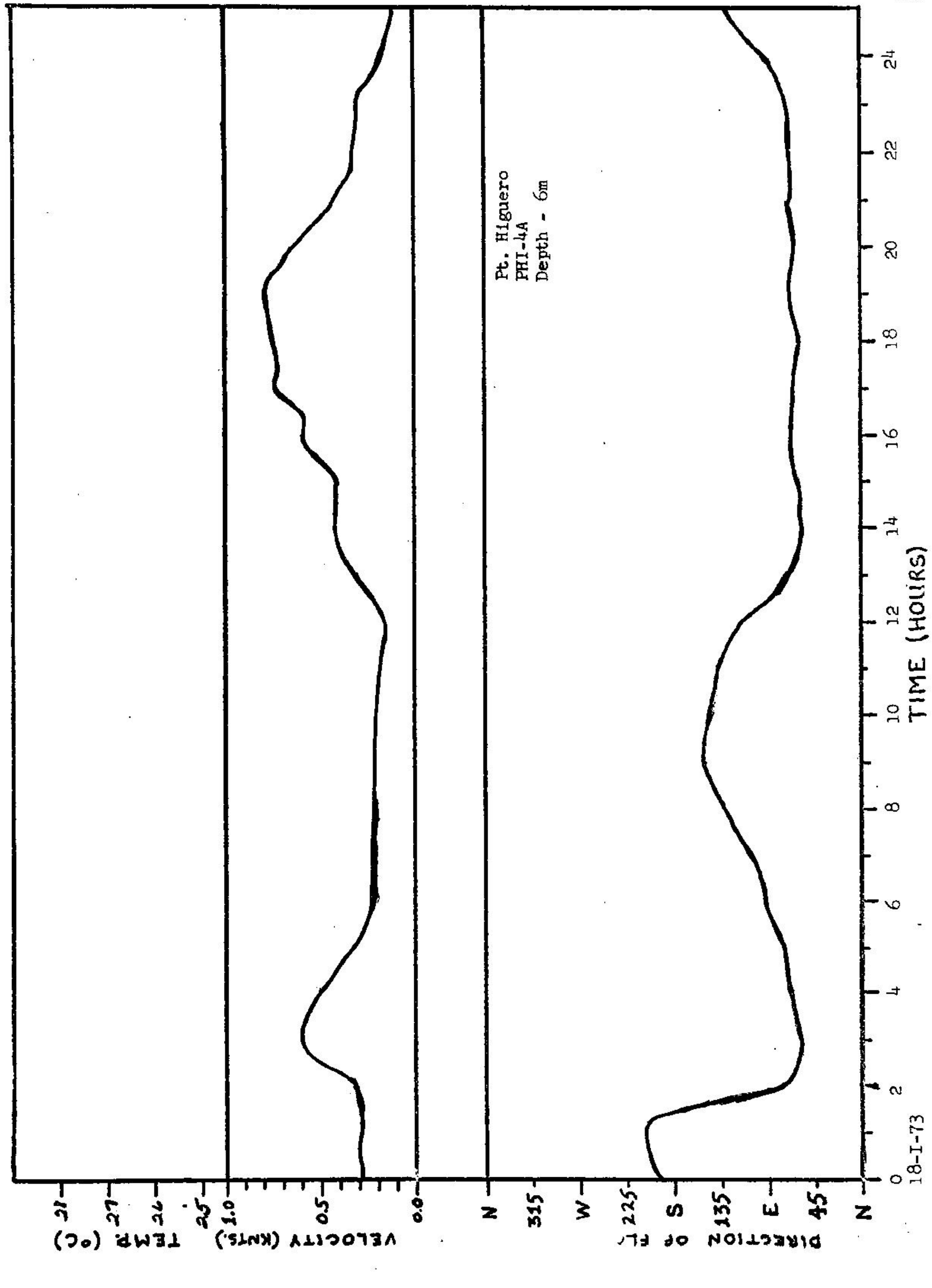

TEMP. (°C)
28
27
26
25
VELOCITY (KNTS.)
1.0
0.5
0.0
DIRECTION OF FLOW
N
315
W
225
S
135
E
45
N
?
Pt. Higuero
PHI-4A
Depth - 3m
No Direction
0
2
4
6
8
10
12
14
16
22
-I-73
TIME (HOURS)

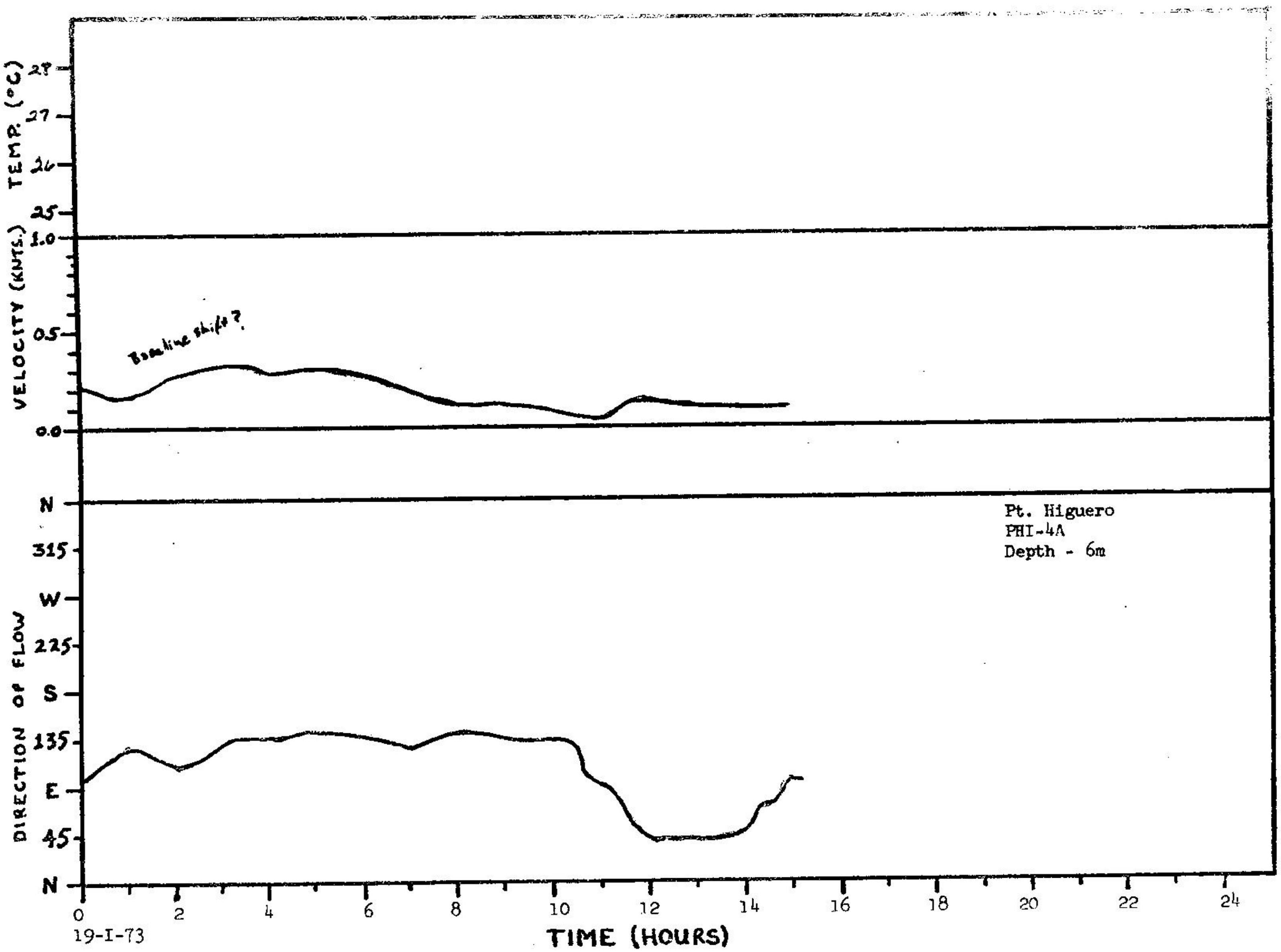


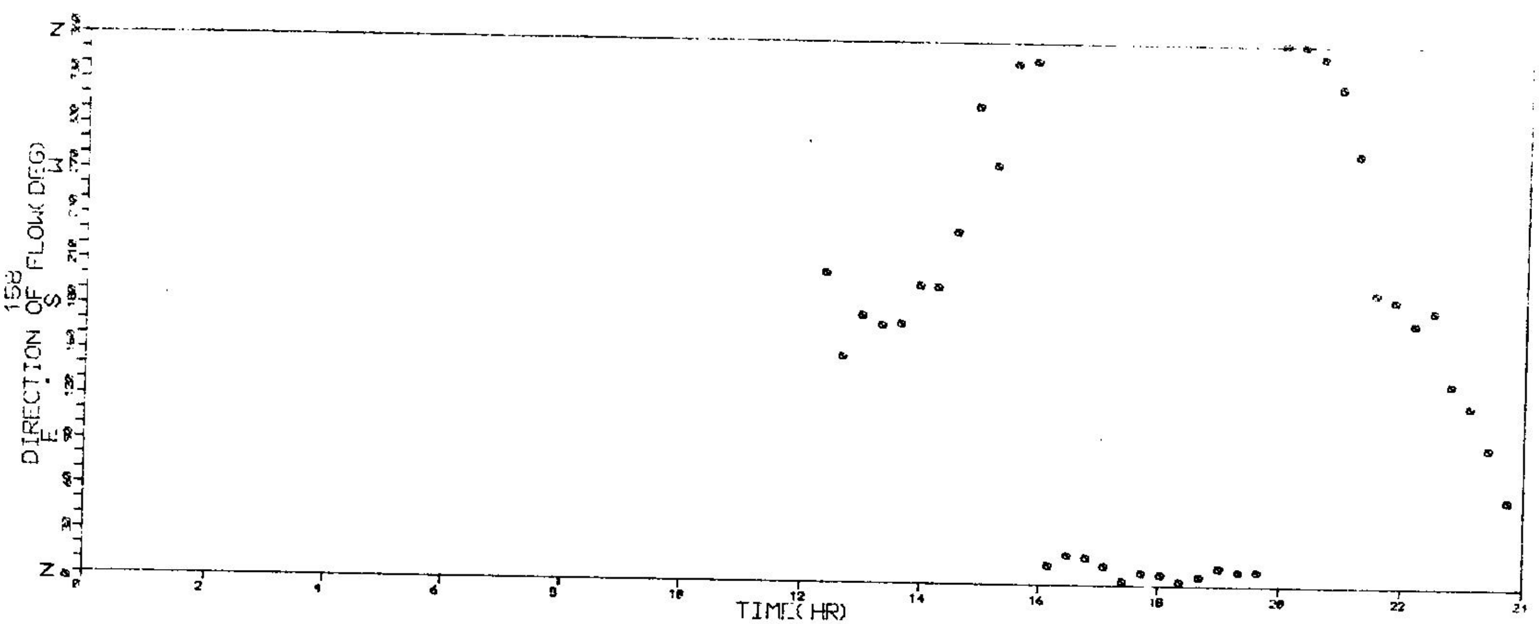
Pt. Higuero
PHI-4A
Depth - 3m
TIME (HOURS)
TEMP. (°C)
VELOCITY (KNTS.)
DIRECTION OF FLOW


TEMP. (°C)
28
27
26
25
VELOCITY (KNTS.)
1.0
0.5
0.0
DIRECTION OF FLOW
N
315
W
225
S
135
E
45
N
0
2
4
6
8
10
12
14
16
20
22
24
19-I-73
TIME (HOURS)
No Direction
Depth - 3m

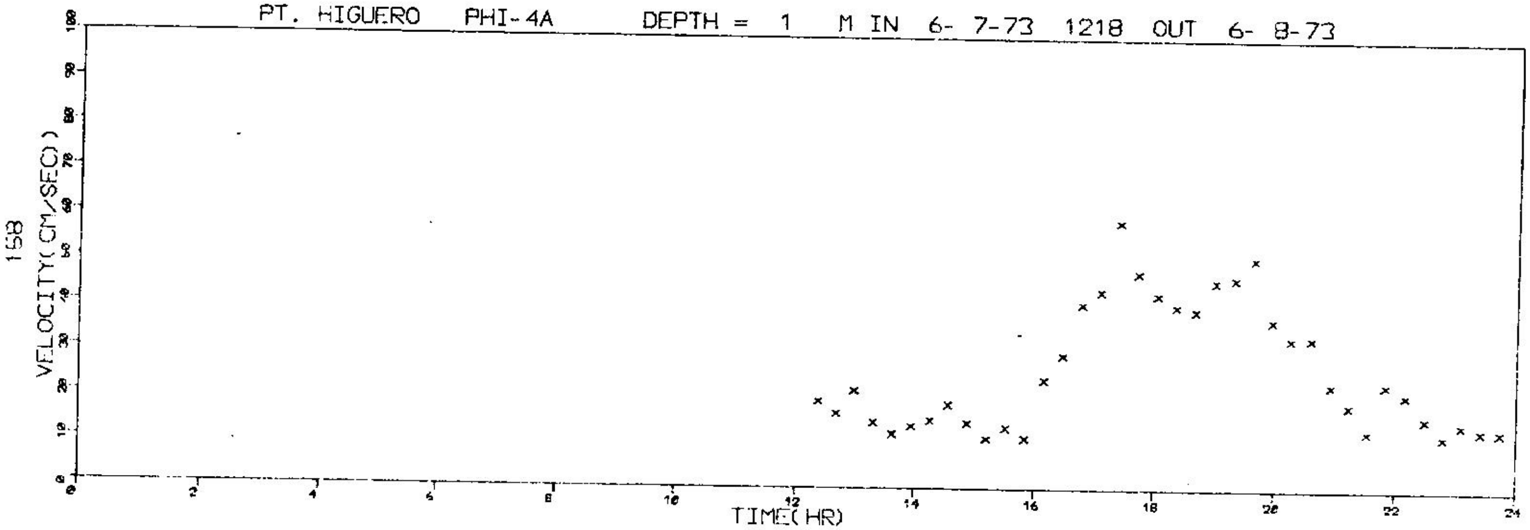

Pt. Higuero
PHI-4A
Depth - 6m
TIME (HOURS)
0 2 4 6 8 10 12 14 16 18 20 22 24
17-I-73
VELOCITY (KNTS.)
0.0 0.5 1.0
N 315 W 225 S 135 E 45 N

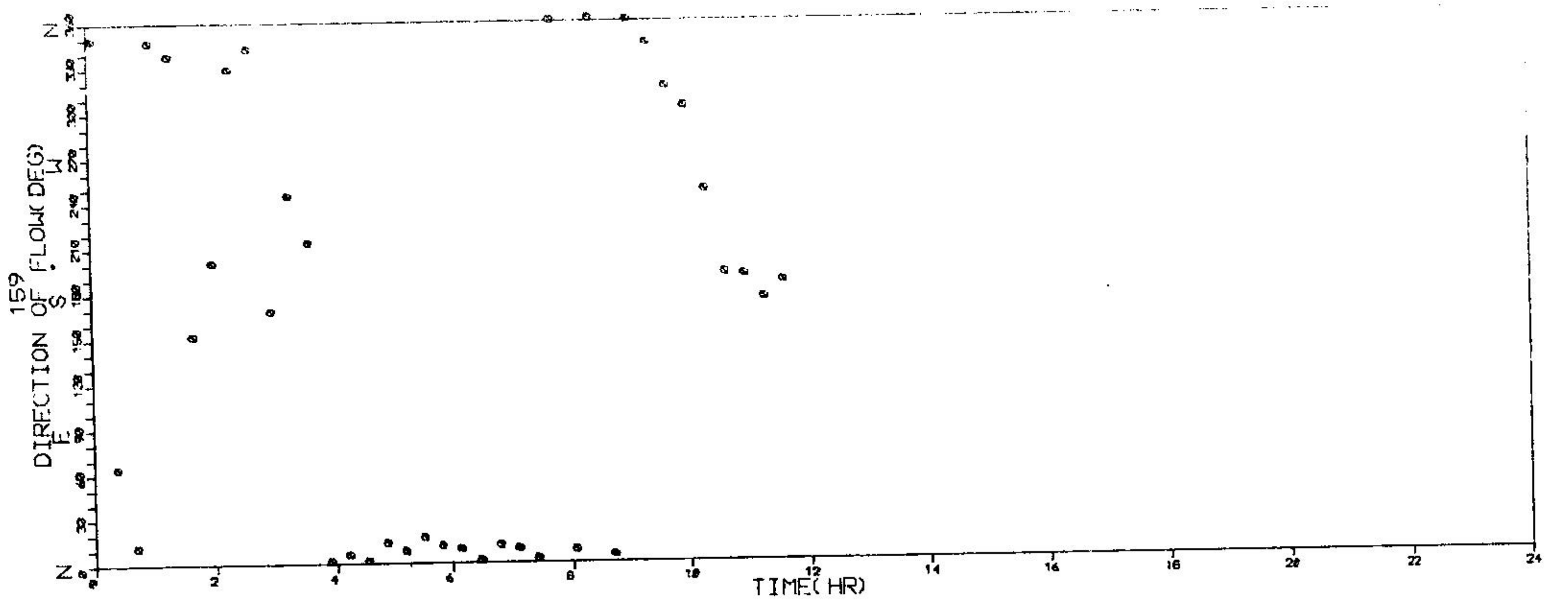

Pt. Higuero
PHI-4A
Depth - 6m
TIME (HOURS)
0 2 4 6 8 10 12 14 16 18 20 22 24
18-I-73
TEMP. (°C)
VELOCITY (KNTS.)
1.0
0.5
0.0
N
315
W
225
S
135
E
45
N


TEMP. (°C)
28
27
26
25
VELOCITY (KNTS.)
1.0
0.5
0.0
Baseline shift?
DIRECTION OF FLOW
N
315
W
225
S
135
E
45
N
0
2
4
6
8
10
12
14
16
18
20
22
24
19-I-73
TIME (HOURS)
Pt. Higuero
PHI-4A
Depth - 6m

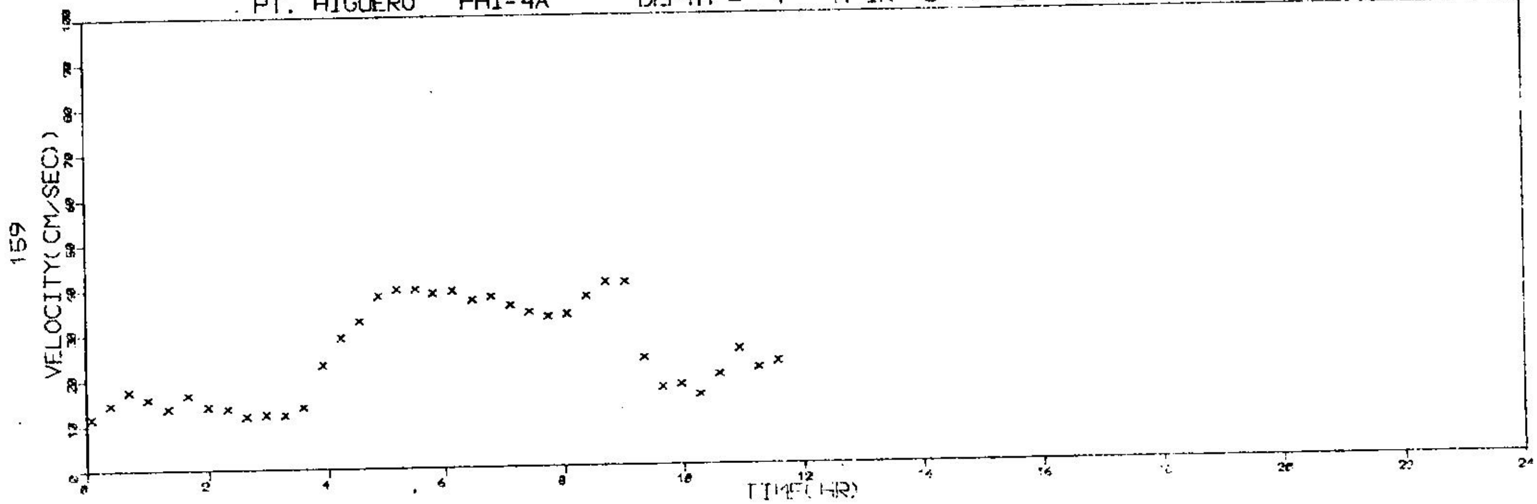


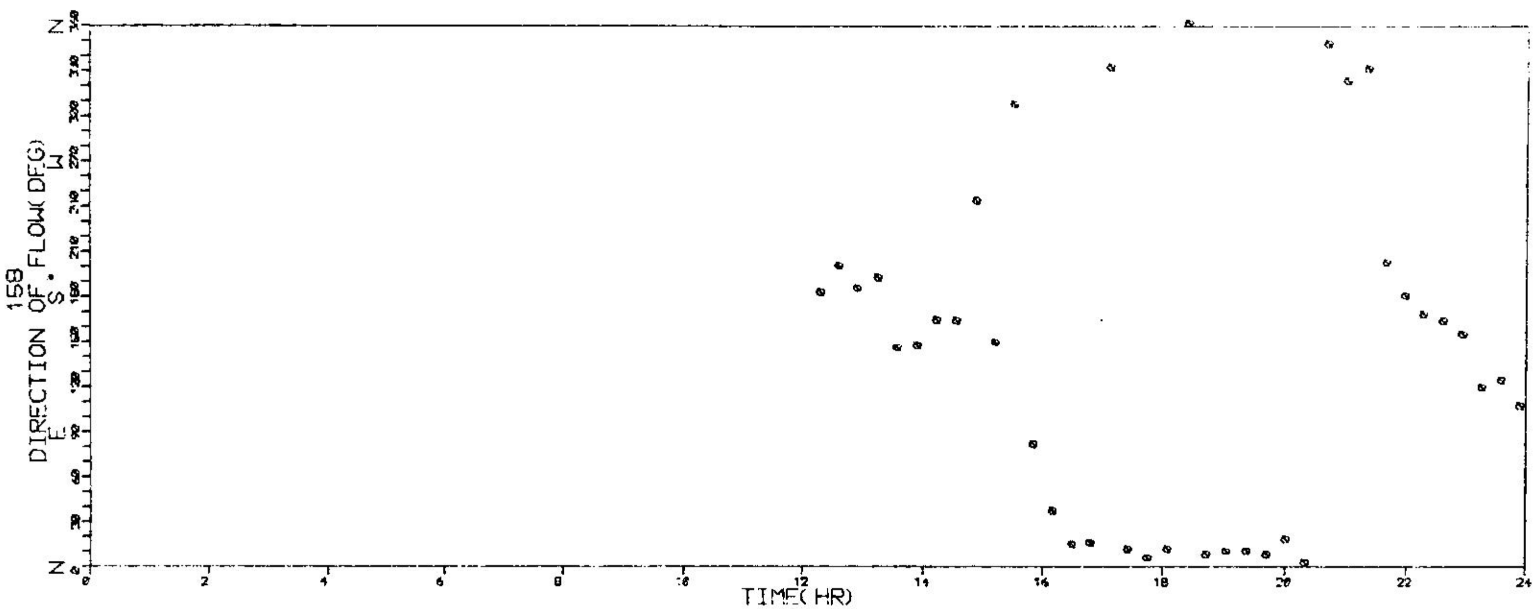
PT. HIGUERO PHI-4A DEPTH = 1 M IN 6- 7-73 1218 OUT 6- 8-73



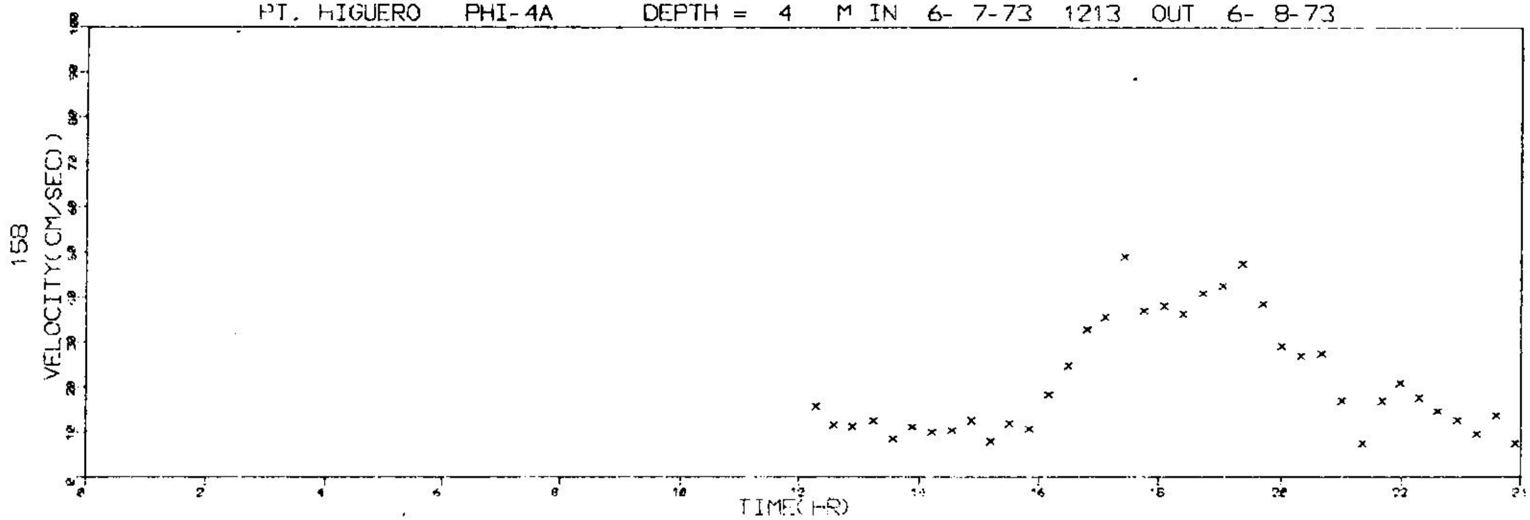


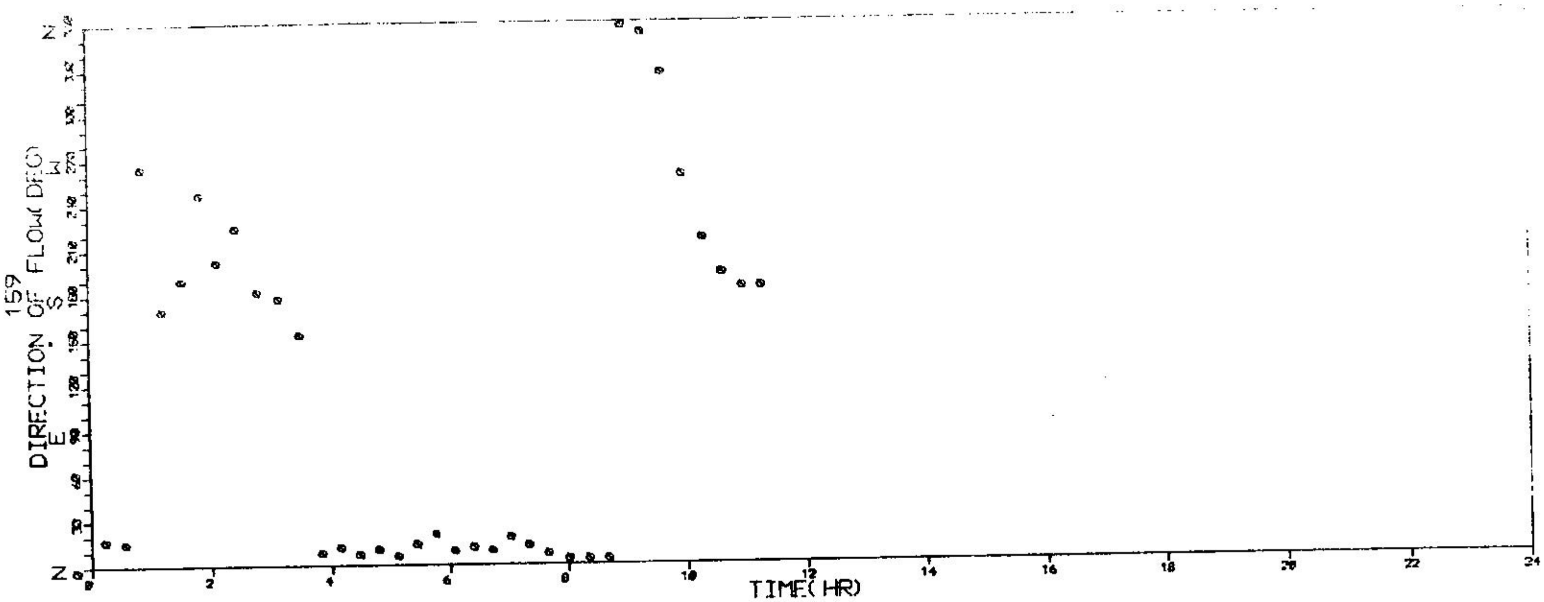
PT. HIGUERO PHI-4A DEPTH = 1 M IN 6- 7-73 1218 OUT 6- 8-73



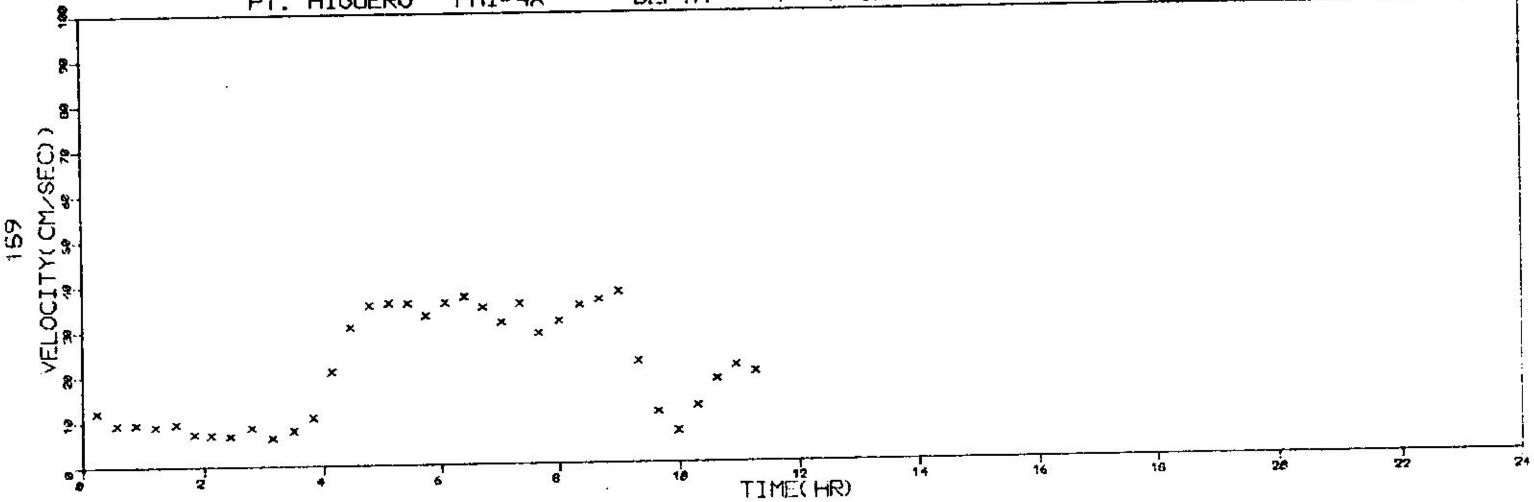


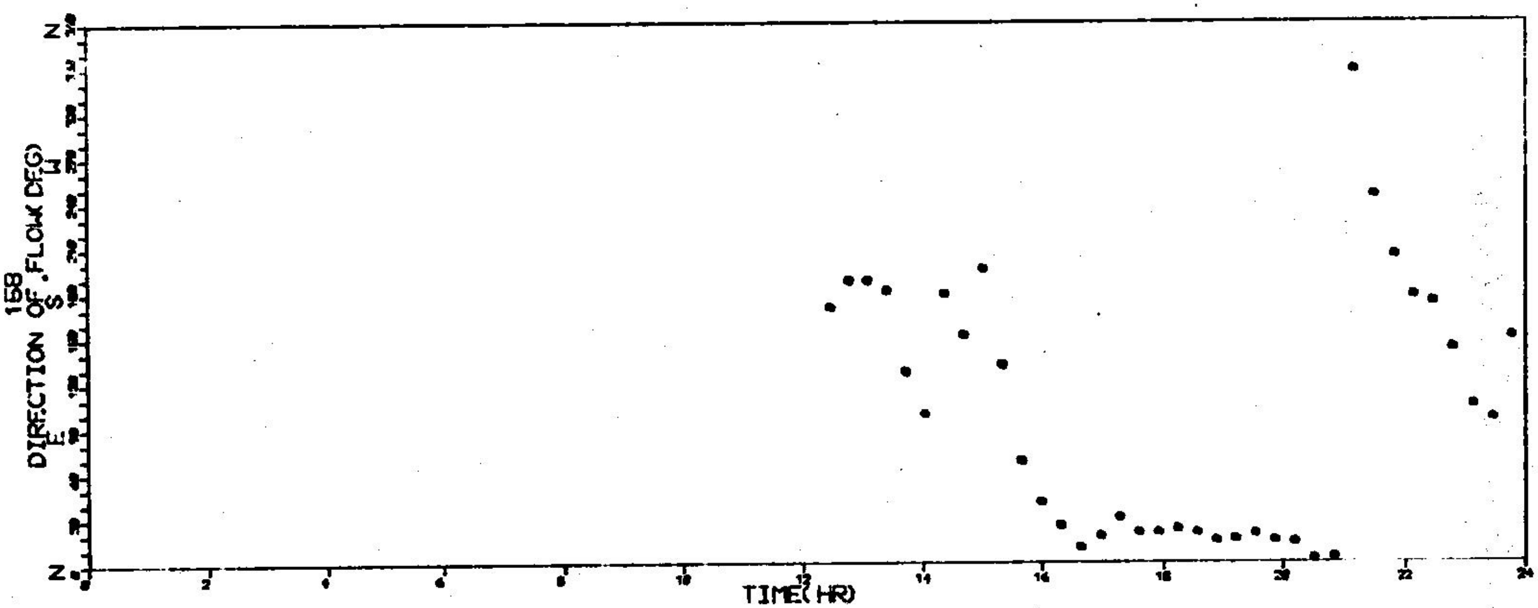
PT. HIGUERO PHI-4A DEPTH = 4 M IN 6- 7-73 1213 OUT 6- 8-73



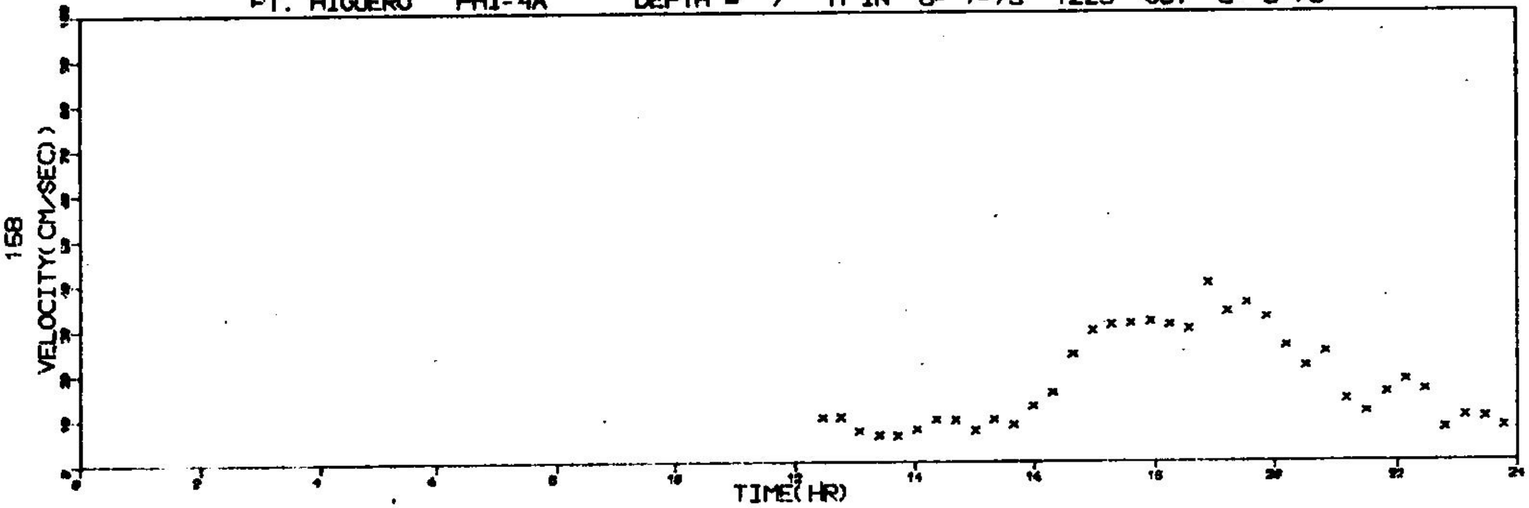


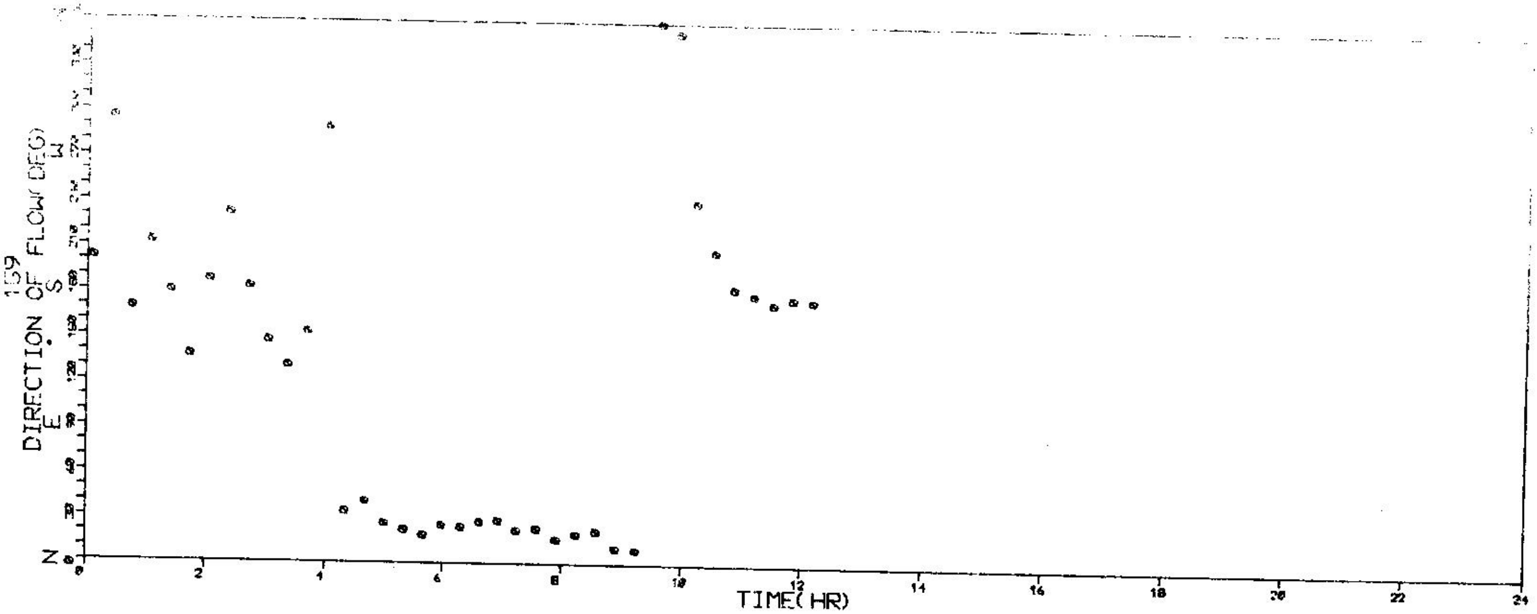
PT. HIGUERO PHI-4A DEPTH = 4 M IN 6- 7-73 1213 OUT 6- 8-73

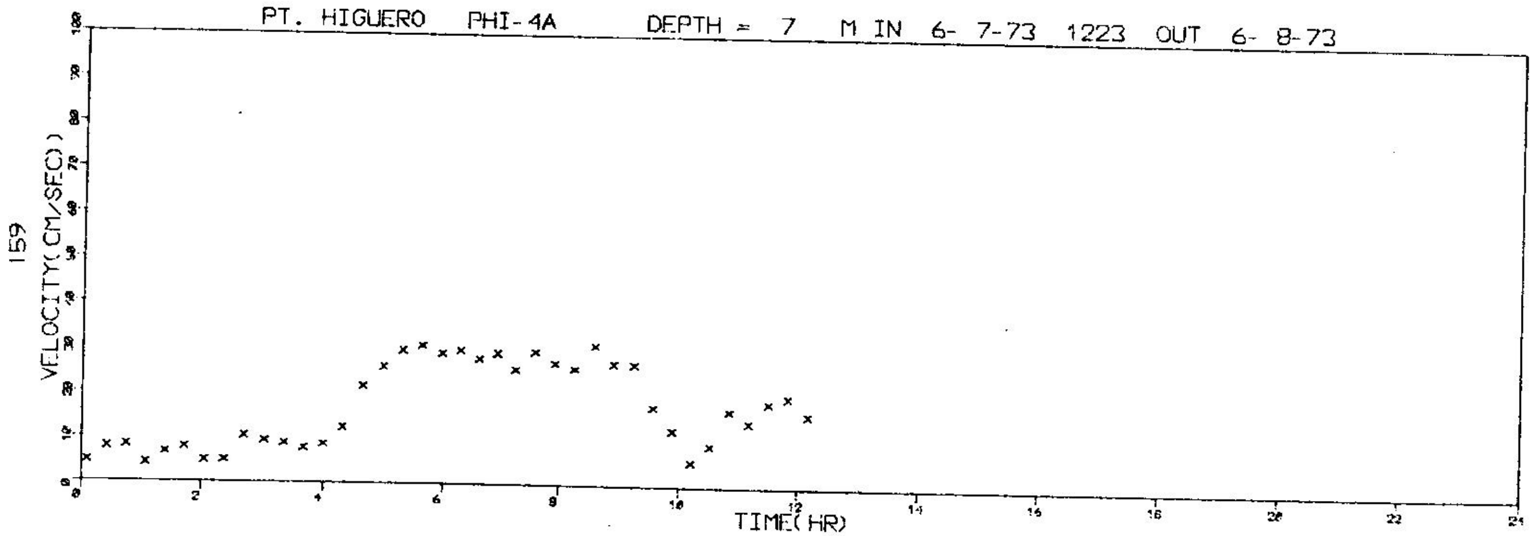


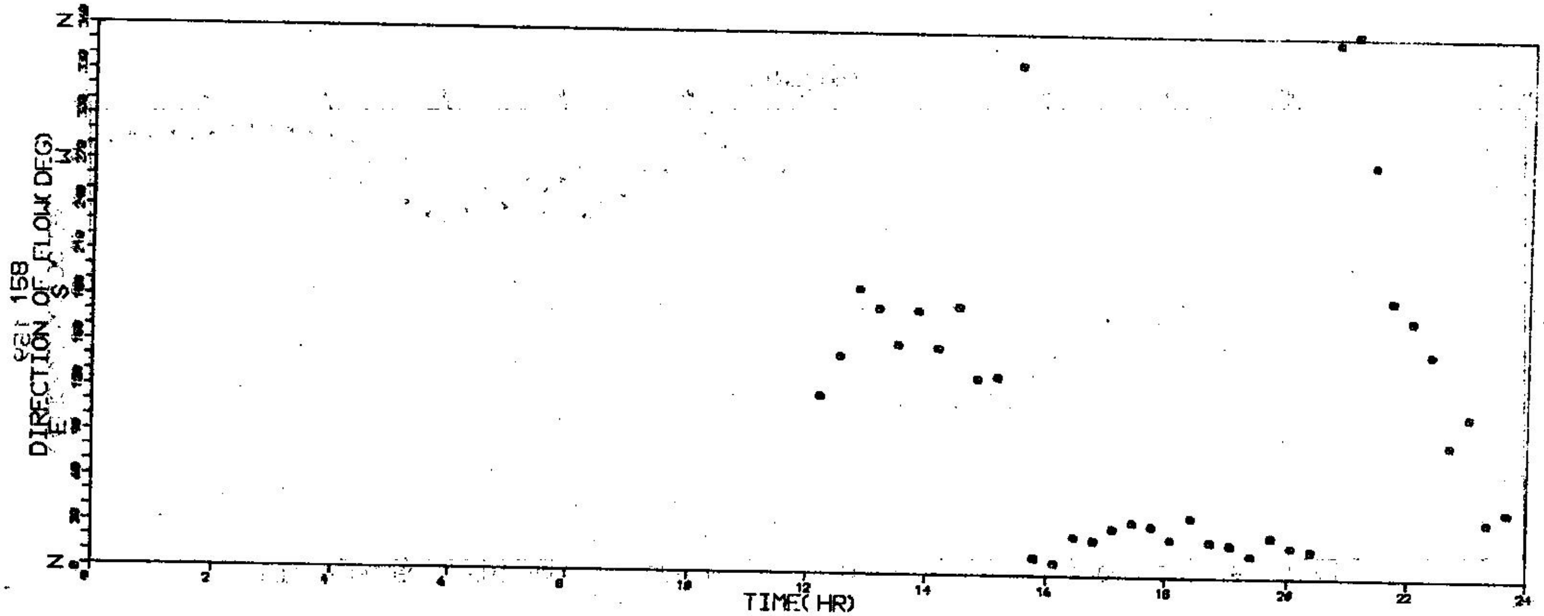


FT. HIGUERO PHI-4A DEPTH = 7 M IN 6- 7-73 1223 OUT 6- 8-73

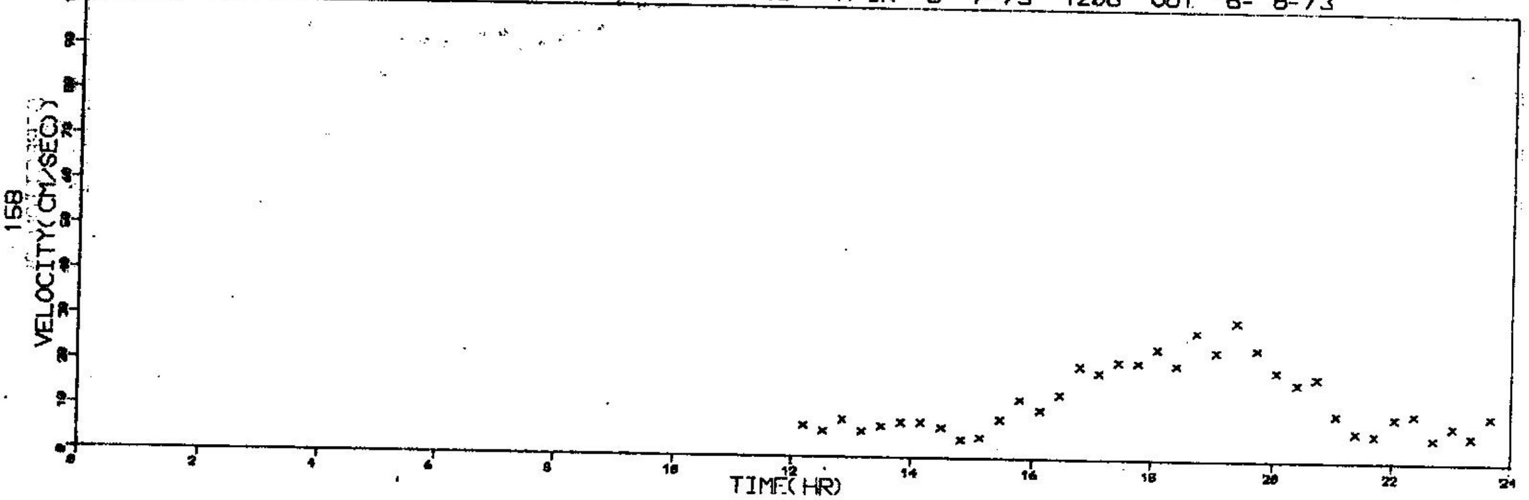


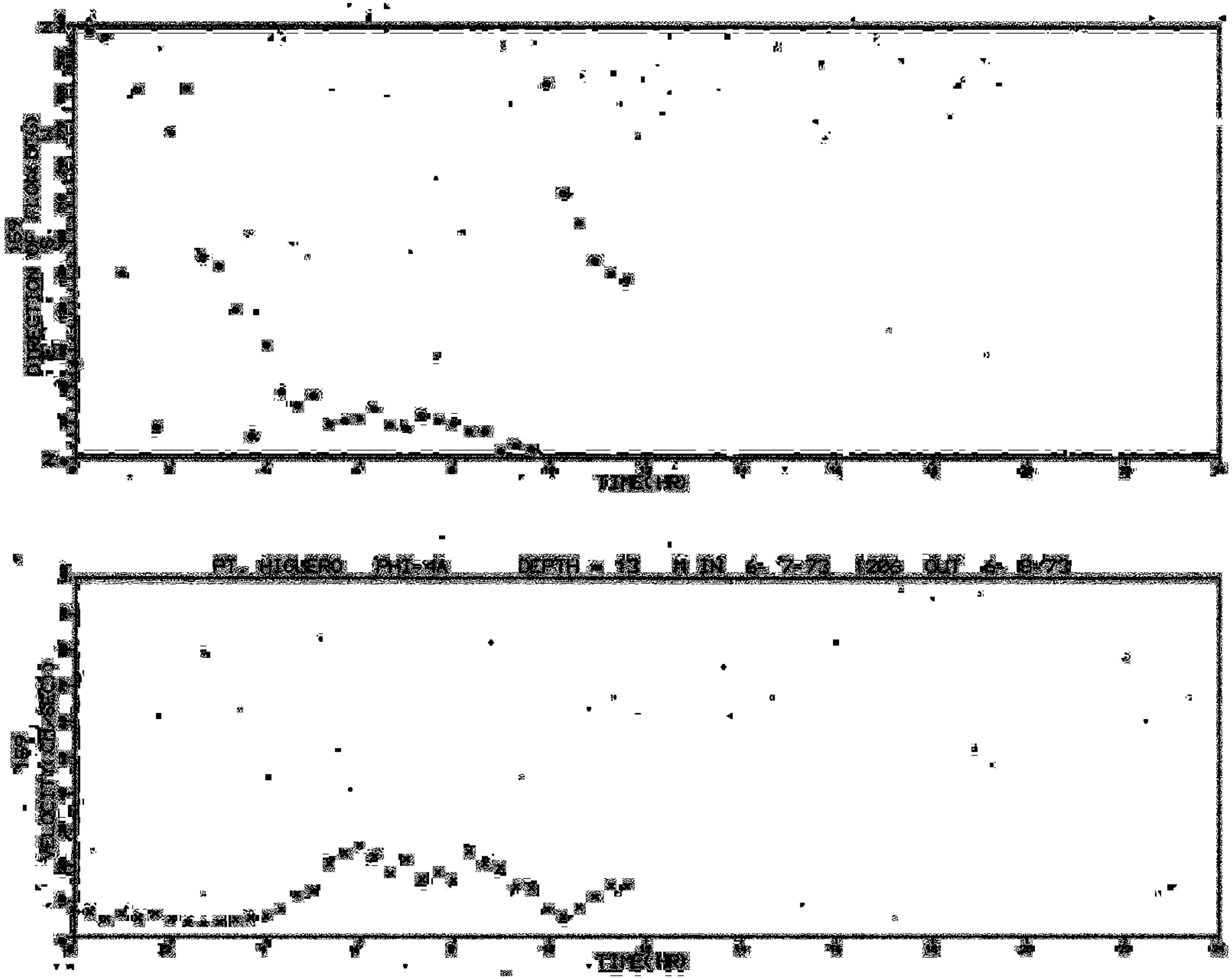

DIRECTION OF FLOW (DEG)
159
N
E
S
W
TIME (HR)


PT. HIGUERO PHI-4A DEPTH = 7 M IN 6- 7-73 1223 OUT 6- 8-73
VELOCITY (CM/SEC)
159
TIME (HR)

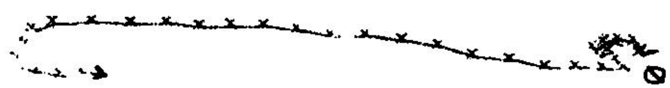


PT. HIGUERO PHI-4A DEPTH = 13 M IN 6- 7-73 1206 OUT 6- 8-73

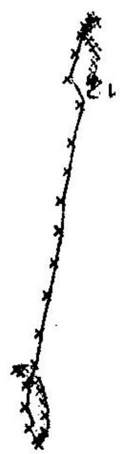



DIRECTION OF FLOW (DEG)
TIME (HR)
PT. HIGUERO PH1-4A DEPTH = 13 IN 6- 7-73 1266 OUT 6- 8-73
VELOCITY (CM/SEC)
TIME (HR)

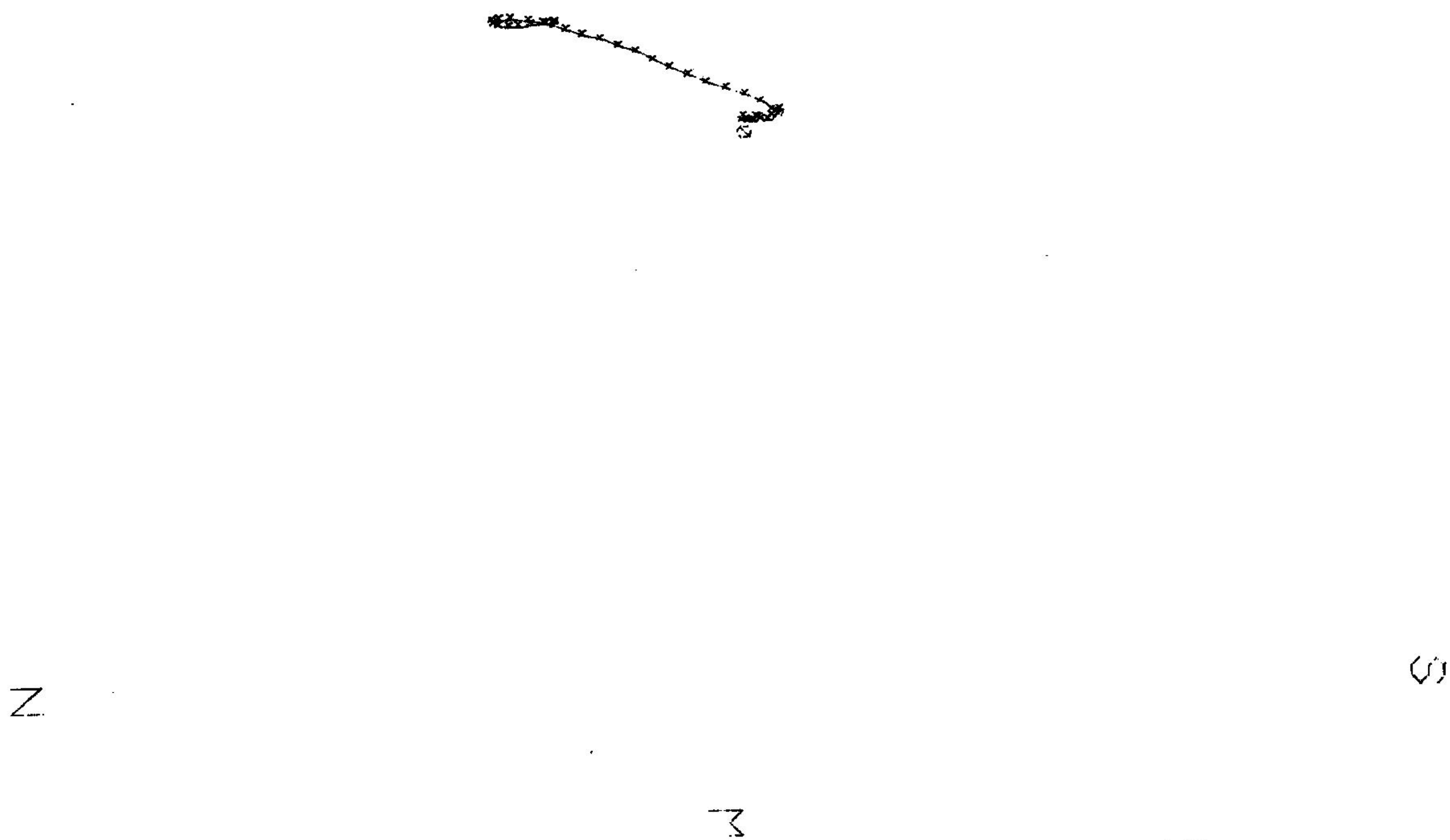
PL HI.U/P2 PHT 4A D PBF - M IN 6- 7-73 12.8 OUT 6- 8-73



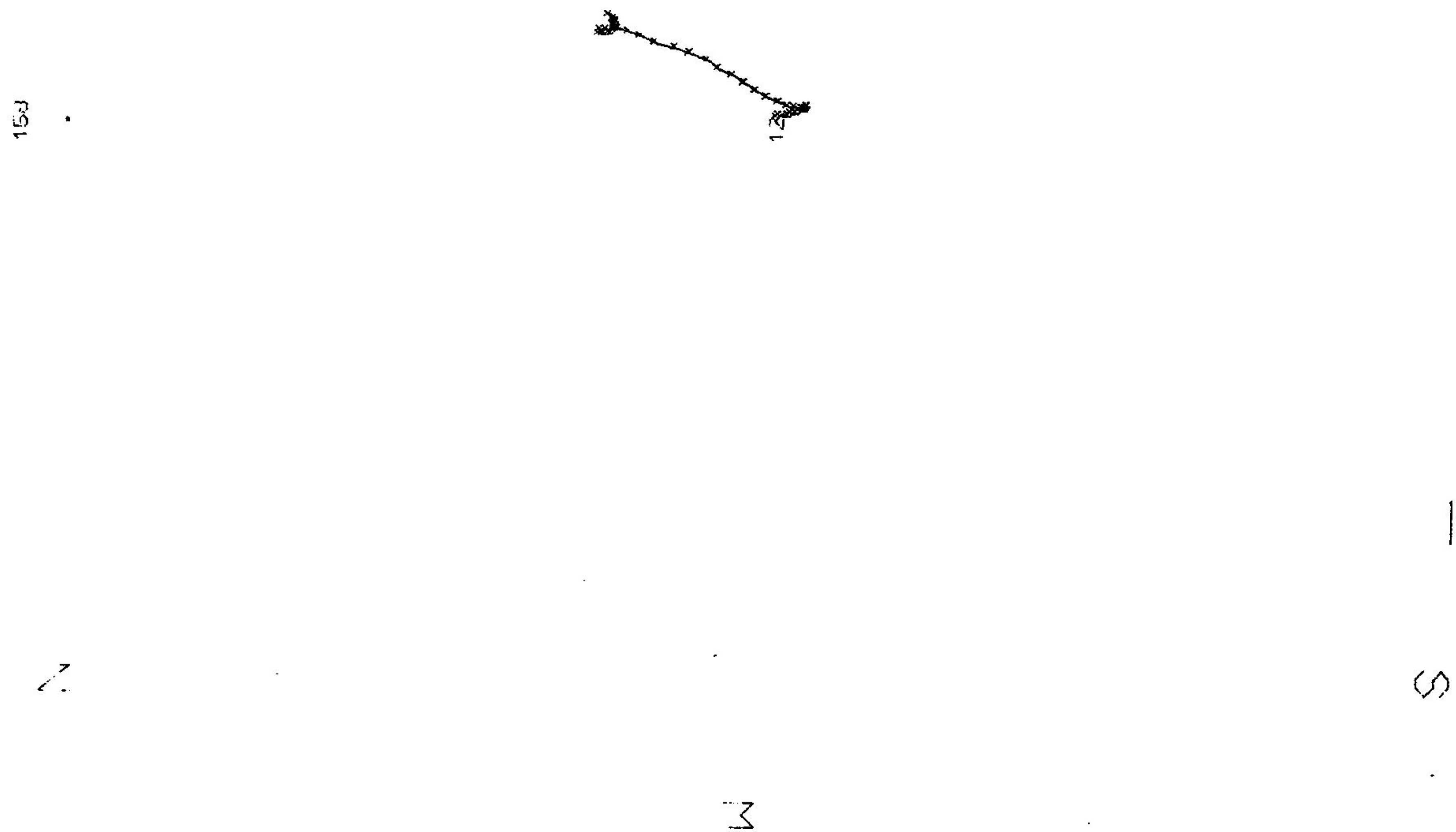
PT HIGUERO PHI 4A DEPTH = 1 M IN 6- 7 73 1218 OUT 6- 8-73



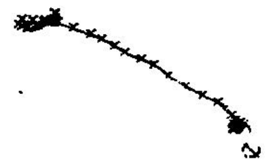
PT. HIGUERO PHI-4A DEPTH = 7 M IN 6- 7-73 1223 OUT 6- 8-73



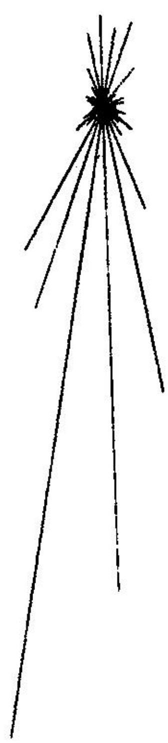
PT. FIGUERO PHI-4A DEPTH = 7 M IN 6- 7-73 1223 OUT 6- 9-73

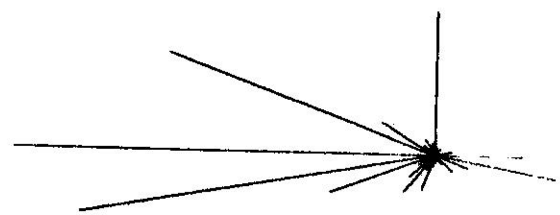


PT. FIGUERO FHI-4A DEPTH - 13 M IN 6- 7-73 1206 OUT 6- 9-73

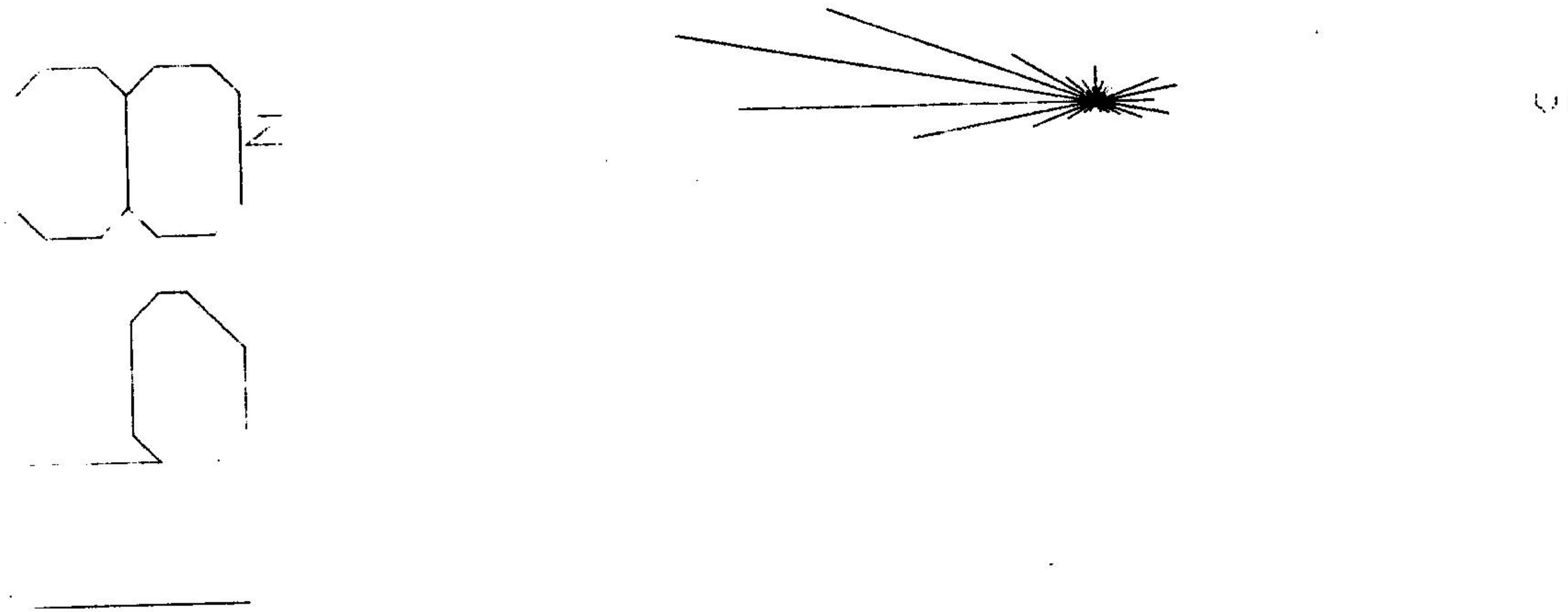


PT. HIGUERO PHI-4A DEPTH - 1? IN 6- 7-72 1206 OUT 6- 8-72

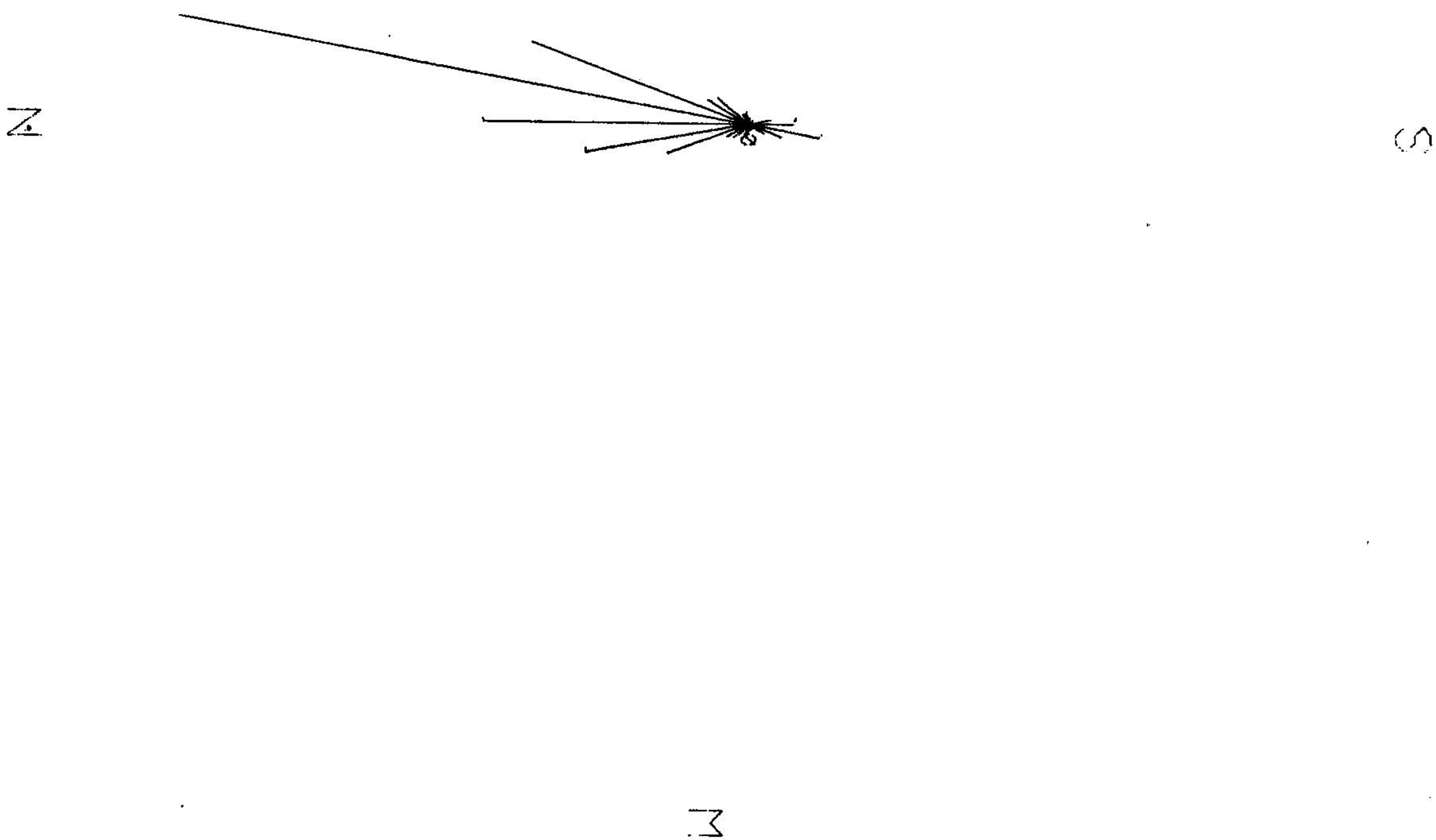




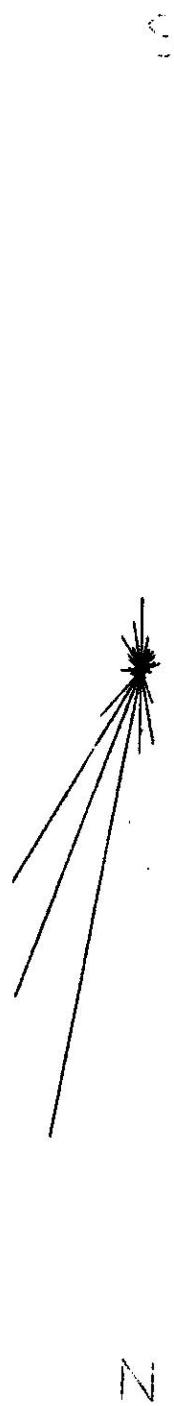
PT. HIGUERA FHI-4A DEPTH - [illegible] IN 6 - 73 12:8 OUT 6 [illegible]-73

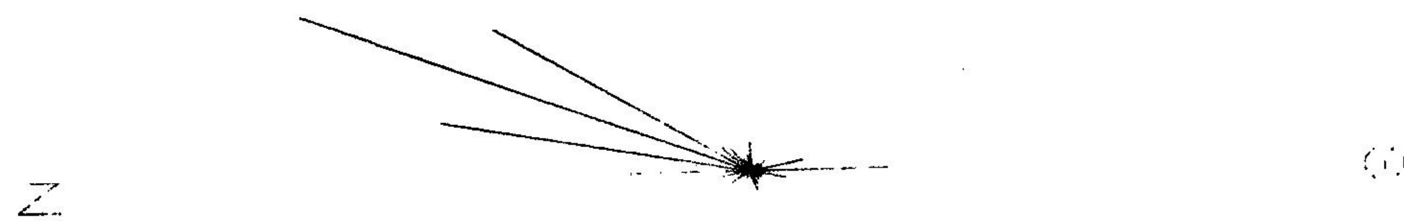


PHI 4A DEPTH . 4 . 7 /3 .213 OUT 5-73



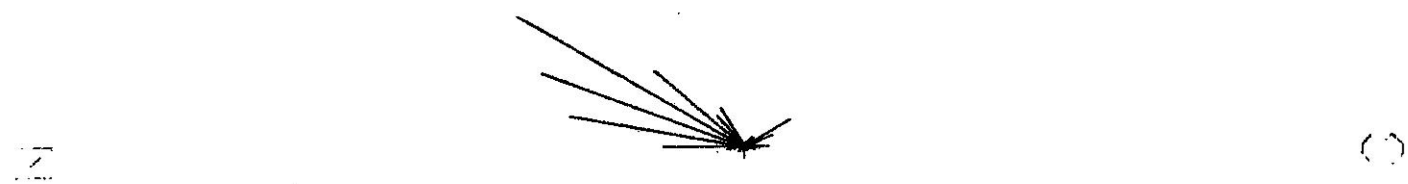
PT. HIGUERO PHI-4A DEPTH = 4 M IN 6- 7-73 1213 OUT 6- 9-73


S
N



... 4A DEPTH = 7 ... IN 6 7 73 ... 6- 8-72

[illegible] FHI 4A DEPTH - 12.5 M IN 6-7-73 1206 OUT 6-8-73



[illegible] FIGURE [illegible]-4A DEPTH = 13 M IN 6-7-73 [illegible] OUT 6-9-73

ALL DEPTHS ARE IN METERS. NUTRIENTS IN UG-AT/L.
MAX.SAMP. DEPTH = MAXIMUM SAMPLING DEPTH = E-2.
WATER COLOR = FOREL WATER COLOR SCALE, H.O. 215.
TRANSPARENCY = SECCHI DISC DEPTH.
WIND AND WAVE DIRECTION COMING FROM = E-1 ROUNDED, TABLE IN H.O.215.
WAVE HEIGHT = H.O.215 WIND WAVE CODE.
WAVE PERIOD = IN SECONDS.
WIND SPEED = IN METERS PER SECOND.
WEATHER,VISIBILITY,CLOUD TYPE AND AMOUNT = H.O. 215 CODE.

Table 15.—FOREL WATER COLOR SCALE CODE

Code	Description
00	Deep blue.
10	Blue.
20	Greenish-blue (or green blue).
30	Bluish-green (or blue green).
40	Green
50	Light green
60	Yellowish-green
70	Yellow green.
80	Green yellow.
90	Greenish-yellow.
99	Yellow.

Table 5.—STATE OF SEA—WIND WAVES (WMO Code 75)

Code	Description	Height Meters
0	Calm—glassy	0
1	Calm—ripples	0–1/10
2	Smooth—wavelets	1/10–½
3	Slight	½–1¼
4	Moderate	1¼–2½
5	Rough	2½–4
6	Very rough	4–6
7	High	6–9
8	Very high	9–14
9	Phenomenal	over 14

Table 1.—WEATHER STATE CODE

00–49. No precipitation at the ship at the time of observation.

00–19. No precipitation, fog, duststorm, sandstorm, or drifting snow at the ship at the time of observation or during the preceding hour, except for 03.

00	Cloud development not observed or not observable.	*No hydrometeors except clouds.*
01	Clouds generally dissolving or becoming less developed.	
02	State of sky on the whole unchanged.	*Characteristic change of the state of sky during past hour.*
03	Clouds generally forming or developing.	

Higher number indicate various rain conditions.

Table 8.—COMPASS DIRECTION CODE

True Direction From Which Surface Wind is Blowing or From Which Wave System is Approaching, in 10° Intervals. (WMO Code 23)

Code		
00	Calm.	
01	5° to 14°.	
02	15° to 24°	NNE.
03	25° to 34°.	
04	35° to 44°.	
05	45° to 54°	NE.
06	55° to 64°.	
07	65° to 74°	ENE.
08	75° to 84°.	
09	85° to 94°	E.
10	95° to 104°.	
11	105° to 114°	ESE.
12	115° to 124°.	
13	125° to 134°.	
14	135° to 144°	SE.
15	145° to 154°.	
16	155° to 164°	SSE.
17	165° to 174°.	
18	175° to 184°	S.
19	185° to 194°.	
20	195° to 204°	SSW.
21	205° to 214°.	
22	215° to 224°.	
23	225° to 234°	SW.
24	235° to 244°.	
25	245° to 254°	WSW.
26	255° to 264°.	
27	265° to 274°	W.
28	275° to 284°.	
29	285° to 294°	WNW.
30	295° to 304°.	
31	305° to 314°.	
32	315° to 324°	NW.
33	325° to 334°.	
34	335° to 344°	NNW.
35	345° to 354°.	
36	355° to 4°	N.
99	Direction variable or unknown.	

Table 4.—VISIBILITY CODE

[Use range-finder readings of known landmarks if possible.]

Code	Objects not visible at—	Description
0	50 yards	Dense fog.
1	200 yards	Thick fog.
2	400 yards	Fog.
3	1,000 yards	Moderate fog.
4	1 nautical mile	Thin fog or mist.
5	2 nautical miles	Visibility poor.
6	5 nautical miles	Visibility moderate.
7	10 nautical miles	Visibility good.
8	30 nautical miles	Visibility very good.
9	Over 30	Visibility excellent.

Table 3.—CLOUD COVER CODE

Code	Amount of sky covered in tenths
0	No clouds.
1	Less than 1 and 1.
2	2 and 3.
3	4.
4	5.
5	6.
6	7 and 8.
7	9 and 9 plus.
8	10.
9	Sky obscured.

Table 2.—CLOUD TYPE CODE

Code	Cloud type
0	Stratus or Fractostratus (St or Fs).
1	Cirrus (Ci).
2	Cirrostratus (Cs).
3	Cirrocumulus (Cc).
4	Altocumulus (Ac).
5	Altostratus (As).
6	Stratocumulus (Sc).
7	Nimbostratus (Ns).
8	Cumulus or Fractocumulus (Cu or Fc)
9	Cumulonimbus (Cb).

R V PALUMBO CRUISE STATION PHI-2A PRNC REFERENCE 21262

DATE	1/18/73	BARO	1014.4	WEATHER	02	WIND VELOC	04	WAVE PERIOD	5
HOUR	15.5	TEMP DRY	31.0	VISIBILITY	8	WIND DIREC	16	TRANSPAR	*
LAT	18-20.8 N	TEMP WET	0.0	CLOUD TYPE	8	WAVE DIREC	33	SONIC DEP	0016
LONG	67-16.7 W	REL HUMID	064	CLOUD AM.	4	WAVE HEIGHT	4	COLOR	10

CAST 1 MESS TIME 15.5 GMT. 1132 LOCAL MAX DEPTH 10 WIRE ANGLE 0
OXYGEN TITER .680 METER WHEEL FACTOR .997

DEPTH (M) WIRE	CZ	TZ	BN	TEMP TL	TM	TAVE	SALIN	SIG T	OXYGEN ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	10	26.75	26.73	26.74	35.364	23.10	4.74	6.77	98.28	.03	*
10	10	0	15	26.66	0.00	26.66	35.364	23.12	4.79	6.85	99.31	.06	*

R V PALUMBO CRUISE STATION PHI-2B PRNC REFERENCE 21263

DATE	1/18/73	BARO	1014.4	WEATHER	02	WIND VELOC	09	WAVE PERIOD	5
HOUR	16.0	TEMP DRY	32.0	VISIBILITY	8	WIND DIREC	15	TRANSPAR	*
LAT	18-20.6 N	TEMP WET	0.0	CLOUD TYPE	8	WAVE DIREC	33	SONIC DEP	0338
LONG	67-16.7 W	REL HUMID	062	CLOUD AMT	4	WAVE HEIGHT	4	COLOR	10

CAST 1 MESS TIME 16.0 GMT. 1158 LOCAL MAX DEPTH 100 WIRE ANGLE 0
OXYGEN TITER .680 METER WHEEL FACTOR .997

DEPTH (M) WIRE	CZ	TZ	BN	TEMP TL	TM	TAVE	SALIN	SIG T	OXYGEN ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	10	26.76	26.77	26.77	35.365	23.09	4.78	6.83	99.15	.05	*
25	25	0	15	26.68	0.00	26.68	35.287	23.06	4.79	6.85	99.18	.04	*
50	50	0	12	26.59	0.00	26.59	35.465	23.22	4.63	6.61	96.05	.04	*
100	99	0	16	23.73	0.00	23.73	36.567	24.93	4.51	6.44	86.89	.11	*

R V PALUMBO CRUISE STATION PHI-2C PRNC REFERENCE 21264

DATE	1/18/73	BARO	1013.8	WEATHER	02	WIND VELOC	09	WAVE PERIOD	6
HOUR	16.6	TEMP DRY	32.0	VISIBILITY	8	WIND DIREC	15	TRANSPAR	•
LAT	18-20.4 N	TEMP WET	0.0	CLOUD TYPE	8	WAVE DIREC	33	SONIC DEP	05R5
LONG	67-17.4 W	REL HUMID	062	CLOUD AMT	2	WAVE HEIGHT	3	COLOR	10

CAST 1 MESS TIME 17.8 GMT, 1345 LOCAL MAX DEPTH 100 WIRE ANGLE 0
OXYGEN TITER .680 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
150	150	0	10	22.34	22.32	22.33	36.693	25.43	4.34	6.20	83.34	.14	.
200	200	0	15	19.68	0.00	19.68	36.541	26.74	4.30	6.15	76.50	.27	.
250	250	0	12	17.94	0.00	17.94	36.404	26.38	4.27	6.10	74.84	.31	.
300	300	0	16	16.74	0.00	16.74	36.284	26.58	4.30	6.14	74.73	.47	.

CAST 2 MESS TIME 16.6 GMT, 1235 LOCAL MAX DEPTH 300 WIRE ANGLE 7
OXYGEN TITER .680 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	10	26.79	26.76	26.78	35.383	23.10	4.82	6.88	100.05	.05	.
25	25	0	15	26.72	0.00	26.72	35.412	23.14	4.81	6.87	99.91	.06	.
50	53	0	12	26.66	0.00	26.66	35.429	23.17	4.79	6.85	99.45	.04	.
100	99	0	16	23.00	0.00	23.00	36.577	25.15	4.40	6.29	84.60	.11	.

R V PALUMBO CRUISE — STATION PHI-3A — PRNC REFERENCE 21261

DATE	1/18/73	BARO	1014.5	WEATHER	02	WIND VELOC	04	WAVE PERIOD	6
HOUR	14.3	TEMP DRY	31.0	VISIBILITY	8	WIND DIREC	19	TRANSPAR	*
LAT	18-20.7 N	TEMP WET	0.0	CLOUD TYPE	8	WAVE DIREC	36	SONIC DEP	
LONG	67-16.5 W	REL HUMID	066	CLOUD AMT	4	WAVE HEIGHT	4	COLOR	10

CAST 1 MESS TIME 14.3 GMT, 1016 LOCAL MAX DEPTH 10 WIRE ANGLE 0
OXYGEN TITER .680 METER WHEEL FACTOR .997

DEPTH (M) WIRE	CZ	TZ	BN	TEMP TL	TM	TAVE	SALIN	SIG T	OXYGEN ML/L	MG/L	XSAT	PHOS	NITRA
0	1	0	10	26.69	26.78	26.78	35.367	23.11	4.70	6.72	97.53	.02	.
10	10	0	15	26.67	0.00	26.67	35.381	23.13	4.68	6.68	96.96	.04	.

R V PALUMBO CRUISE — STATION PHI-3B — PRNC REFERENCE 21260

DATE	1/18/73	BARO	1014.5	WEATHER	02	WIND VELOC	04	WAVE PERIOD	5
HOUR	14.9	TEMP DRY	30.5	VISIBILITY	8	WIND DIREC	18	TRANSPAR	*
LAT	18-20.5 N	TEMP WET	0.0	CLOUD TYPE	8	WAVE DIREC	35	SONIC DEP	0256
LONG	67-17.2 W	REL HUMID	067	CLOUD AMT	5	WAVE HEIGHT	4	COLOR	10

CAST 1 MESS TIME 14.9 GMT, 1056 LOCAL MAX DEPTH 100 WIRE ANGLE 0
OXYGEN TITER .680 METER WHEEL FACTOR .997

DEPTH (M) WIRE	CZ	TZ	BN	TEMP TL	TM	TAVE	SALIN	SIG T	OXYGEN ML/L	MG/L	XSAT	PHOS	NITRA
0	1	0	10	26.74	26.74	26.74	35.370	23.10	4.76	6.80	98.71	.02	.
25	25	0	15	26.68	0.00	26.68	35.349	23.10	4.79	6.84	99.16	.02	.
50	50	0	12	26.65	0.00	26.65	35.402	23.15	4.70	6.72	97.55	.03	.
100	100	0	16	24.66	0.00	24.66	36.444	24.55	4.45	6.36	85.85	.07	.

R V PALUMBO CRUISE STATION PHI-3C PRNC REFERENCE 21259

DATE	1/18/73	BARO	1014.4	WEATHER	02	WIND VELOC	01	WAVE PERIOD	6
HOUR	13.9	TEMP DRY	30.0	VISIBILITY	8	WIND DIREC	08	TRANSPAR	*
LAT	18-21.2 N	TEMP WET	0.0	CLOUD TYPE	8	WAVE DIREC	33	SONIC DEP	0457
LONG	67-17.6 W	REL HUMID	067	CLOUD AMT	5	WAVE HEIGHT	4	COLOR	10

CAST 1 MESS TIME 14.0 GMT, 958 LOCAL MAX DEPTH 300 WIRE ANGLE 0
OXYGEN TITER .680 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	10	26.75	26.75	26.75	35.365	23.09	4.76	6.80	98.71	.03	.
25	25	0	15	26.72	0.00	26.72	35.400	23.13	4.76	6.80	98.75	.02	.
50	50	0	12	26.70	0.00	26.70	35.413	23.15	4.54	6.49	94.24	.04	.
100	100	0	16	25.74	0.00	25.74	36.236	24.07	4.79	6.84	98.16	.09	.

CAST 2 MESS TIME 14.4 GMT, 1025 LOCAL MAX DEPTH 100 WIRE ANGLE 0
OXYGEN TITER .680 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
150	150	0	10	20.73	20.71	20.72	36.642	25.84	4.30	6.14	81.51	.23	.
200	200	0	15	19.25	0.00	19.25	36.531	26.14	4.27	6.11	75.80	.21	.
250	250	0	12	18.09	0.00	18.09	36.419	26.35	4.27	6.10	74.93	.30	.
300	300	0	16	17.48	0.00	17.48	36.347	26.45	4.25	6.08	74.34	.32	.

R V PALUMBO CRUISE STATION PHI-4A PRNC REFERENCE 21257

DATE	1/18/73	BARO	1Ø14.4	WEATHER	Ø2	WIND VELOC	Ø3	WAVE PERIOD	5
HOUR	12.9	TEMP DRY	29.Ø	VISIBILITY	8	WIND DIREC	Ø7	TRANSPAR	*
LAT	18-22.Ø N	TEMP WET	Ø.Ø	CLOUD TYPE	8	WAVE DIREC	2Ø	SONIC DEP	Ø Ø1Ø
LONG	67-16.5 W	REL HUMID	Ø68	CLOUD AMT	5	WAVE HEIGHT	4	COLOR	1Ø

CAST 1 MESS TIME 12.9 GMT, 852 LOCAL MAX DEPTH 1Ø WIRE ANGLE Ø
OXYGEN TITER .68Ø METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
Ø	1	Ø	1Ø	26.65	26.55	26.6Ø	35.381	23.15	4.56	6.52	94.49	.Ø6	.
1Ø	1Ø	Ø	15	26.51	Ø.ØØ	26.51	35.319	23.13	4.66	6.66	96.39	.Ø5	.

R V PALUMBO CRUISE STATION PHI-4P PRNC REFERENCE 21258

DATE	1/18/73	BARO	1Ø14.4	WEATHER	Ø2	WIND VELOC	Ø4	WAVE PERIOD	5
HOUR	13.3	TEMP DRY	31.Ø	VISIBILITY	8	WIND DIREC	Ø8	TRANSPAR	*
LAT	18-22.6 N	TEMP WET	Ø.Ø	CLOUD TYPE	8	WAVE DIREC	21	SONIC DEP	Ø152
LONG	67-18.Ø W	REL HUMID	Ø68	CLOUD AMT	5	WAVE HEIGHT	4	COLOR	1Ø

CAST 1 MESS TIME 13.3 GMT, 915 LOCAL MAX DEPTH 1ØØ WIRE ANGLE Ø
OXYGEN TITER .68Ø METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
Ø	1	Ø	1Ø	26.74	26.73	26.74	35.381	23.11	4.87	6.86	99.58	.Ø4	.
25	25	Ø	15	26.71	Ø.ØØ	26.71	35.414	23.14	4.97	7.1Ø	1Ø3.15	.Ø3	.
5Ø	5Ø	Ø	12	26.69	Ø.ØØ	26.69	35.413	23.15	4.8?	6.86	99.59	.Ø4	.
1ØØ	1ØØ	Ø	16	26.23	Ø.ØØ	26.23	35.797	23.58	4.55	6.51	94.63	.Ø6	.

R V PALUMBO CRUISE   STATION PHI-4C   PRNC REFERENCE 21256

DATE	1/17/73	BARO	1Ø12.4	WEATHER	Ø2	WIND VELOC	Ø3	WAVE PERIOD	3
HOUR	19.Ø	TEMP DRY	3Ø.Ø	VISIBILITY	8	WIND DIREC	Ø3	TRANSPAR	
LAT	18-23.5 N	TEMP WET	Ø.Ø	CLOUD TYPE	8	WAVE DIREC	Ø3	SONIC DEP	Ø374
LONG	67-19.3 W	REL HUMID	Ø71	CLOUD AMT	6	WAVE HEIGHT	2	COLOR	1Ø

CAST 1 MESS TIME 19.Ø GMT, 15 3 LOCAL MAX DEPTH 3ØØ WIRE ANGLE 12
OXYGEN TITER .68Ø METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
Ø	1	Ø	1Ø	26.78	26.75	26.77	35.383	23.1Ø	4.84	6.91	1ØØ.46	.Ø6	.
25	25	Ø	15	26.71	Ø.ØØ	26.71	35.4ØØ	23.13	4.78	6.83	99.17	.Ø8	.
5Ø	49	Ø	12	26.59	26.98	26.79	35.53Ø	23.21	4.66	6.65	96.99	.Ø5	.
1ØØ	98	Ø	16	25.65	Ø.ØØ	25.65	36.3Ø6	24.15	4.62	6.6Ø	94.87	.Ø7	.

CAST 2 MESS TIME 19.8 GMT, 1546 LOCAL MAX DEPTH 1ØØ WIRE ANGLE Ø
OXYGEN TITER .68Ø METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
15Ø	15Ø	Ø	1Ø	22.88	22.88	22.88	36.692	25.27	4.39	6.27	84.56	.16	.
2ØØ	2ØØ	Ø	15	19.79	Ø.ØØ	19.79	36.549	26.Ø2	4.4Ø	6.28	78.27	.27	.
25Ø	25Ø	Ø	12	18.73	Ø.ØØ	18.73	36.474	26.23	4.33	6.18	76.39	.27	.
3ØØ	3ØØ	Ø	16	17.72	Ø.ØØ	17.72	36.422	26.45	4.44	6.34	77.79	.33	.

R V PALUMBO CRUISE — STATION PHI-5A — PRNC REFERENCE 21253

DATE	1/17/73	BARO	1013.4	WEATHER	02	WIND VELOC	04	WAVE PERIOD	4
HOUR	17.0	TEMP DRY	29.0	VISIBILITY	8	WIND DIREC	03	TRANSPAR	
LAT	18-22.5 N	TEMP WET	0.0	CLOUD TYPE	4	WAVE DIREC	03	SONIC DEP	0016
LONG	67-16.9 W	REL HUMID	074	CLOUD AMT	5	WAVE HEIGHT	2	COLOR	10

CAST 1 MESS TIME 17.0 GMT, 13 2 LOCAL MAX DEPTH 10 WIRE ANGLE 0
OXYGEN TITER .680 METER WHEEL FACTOR .997

DEPTH (M) WIRE	CZ	TZ	BN	TEMP TL	TM	TAVE	SALIN	SIG T	OXYGEN ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	10	26.78	26.78	26.78	35.388	23.10	4.76	6.81	98.94	.05	.
10	10	0	16	26.73	0.00	26.73	35.388	23.12	4.78	6.83	99.16	.06	.

R V PALUMBO CRUISE — STATION PHI-5B — PRNC REFERENCE 21254

DATE	1/17/73	BARO	1013.9	WEATHER	02	WIND VELOC	01	WAVE PERIOD	5
HOUR	17.3	TEMP DRY	32.0	VISIBILITY	8	WIND DIREC	03	TRANSPAR	
LAT	18-24.4 N	TEMP WET	0.0	CLOUD TYPE	4	WAVE DIREC	04	SONIC DEP	0109
LONG	67-16.6 W	REL HUMID	069	CLOUD AMT	6	WAVE HEIGHT	2	COLOR	10

CAST 1 MESS TIME 17.3 GMT, 1320 LOCAL MAX DEPTH 100 WIRE ANGLE 8
OXYGEN TITER .680 METER WHEEL FACTOR .997

DEPTH (M) WIRE	CZ	TZ	BN	TEMP TL	TM	TAVE	SALIN	SIG T	OXYGEN ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	10	26.97	26.96	26.97	35.392	23.04	4.80	6.86	99.87	.04	.
25	25	0	15	26.78	0.00	26.78	35.388	23.10	4.74	6.77	98.37	.02	.
50	50	0	12	26.70	0.00	26.70	35.483	23.20	4.79	6.84	99.47	.02	.
100	99	0	16	24.98	0.00	24.98	36.282	24.34	4.52	6.46	86.66	.14	.

R V PALUMBO CRUISE   STATION PHI-5C   PRNC REFERENCE 21255

DATE	1/17/73	BARO	1012.8	WEATHER	02	WIND VELOC	03	WAVE PERIOD	4
HOUR	18.1	TEMP DRY	34.0	VISIBILITY	8	WIND DIREC	03	TRANSPAR	
LAT	18-24.7 N	TEMP WET	0.0	CLOUD TYPE	4	WAVE DIREC	03	SONIC DEP	0369
LONG	67-17.5 W	REL HUMID	065	CLOUD AMT	6	WAVE HEIGHT	2	COLOR	10

CAST 1 MESS TIME 18.1 GMT. 14 8 LOCAL MAX DEPTH 300 WIRE ANGLE 15
OXYGEN TITER .680 METER WHEEL FACTOR .997

DEPTH (M) WIRE	CZ	TZ	BN	TEMP TL	TM	TAVE	SALIN	SIG T	OXYGEN ML/L	MG/L	XSAT	PHOS	NITRA
0	1	0	10	26.84	26.84	26.84	35.384	23.08	4.80	6.86	99.70	.07	.
25	25	0	15	26.77	0.00	26.77	35.387	23.10	4.81	6.86	99.77	.04	.
50	49	0	12	26.53	0.00	26.53	35.732	23.44	4.67	6.67	97.35	.06	.
100	97	0	16	24.95	0.00	24.95	36.411	24.44	4.51	6.45	87.02	.05	.

CAST 2 MESS TIME 18.6 GMT. 1438 LOCAL MAX DEPTH 100 WIRE ANGLE 0
OXYGEN TITER .680 METER WHEEL FACTOR .997

DEPTH (M) WIRE	CZ	TZ	BN	TEMP TL	TM	TAVE	SALIN	SIG T	OXYGEN ML/L	MG/L	XSAT	PHOS	NITRA
150	150	0	10	24.03	24.05	24.04	36.640	24.89	4.54	6.49	87.94	.11	.
200	200	0	15	20.48	0.00	20.48	36.647	25.91	4.41	6.30	83.59	.32	.
250	250	0	12	18.96	0.00	18.96	36.564	26.24	4.31	6.16	76.38	.18	.
300	300	0	16	17.87	0.00	17.87	36.539	26.50	4.32	6.17	75.95	.26	.

R V PALUMBO CRUISE　　STATION PHI-6A　　PRNC REFERENCE 21250

DATE	1/17/73	BARO	1016.4	WEATHER	02	WIND VELOC 05	WAVE PERIOD 5
HOUR	14.1	TEMP DRY	27.0	VISIBILITY	8	WIND DIREC 03	TRANSPAR
LAT	18-22.8 N	TEMP WET	0.0	CLOUD TYPE	9	WAVE DIREC 02	SONIC DEP 0015
LONG	67-15.2 W	REL HUMID	072	CLOUD AMT	1	WAVE HEIGHT 3	COLOR 10

CAST 1　MESS TIME 14.1 GMT, 10 6 LOCAL　MAX DEPTH 10　WIRE ANGLE 0
OXYGEN TITER .680　METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	RN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	10	26.72	26.71	26.72	35.384	23.12	4.74	6.77	98.29	.07	.
10	10	0	12	26.69	0.00	26.69	35.381	23.12	4.77	6.82	98.96	.16	.

R V PALUMBO CRUISE　　STATION PHI-6P　　PRNC REFERENCE 21251

DATE	1/17/73	BARO	1015.0	WEATHER	02	WIND VELOC 01	WAVE PERIOD 5
HOUR	14.8	TEMP DRY	29.0	VISIBILITY	8	WIND DIREC 03	TRANSPAR
LAT	18-23.8 N	TEMP WET	0.0	CLOUD TYPE	9	WAVE DIREC 02	SONIC DEP 0152
LONG	67-15.5 W	REL HUMID	070	CLOUD AMT	1	WAVE HEIGHT 3	COLOR 10

CAST 1　MESS TIME 14.8 GMT, 1049 LOCAL　MAX DEPTH 50　WIRE ANGLE 0
OXYGEN TITER .680　METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	RN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	10	26.86	26.86	26.86	35.391	23.08	4.8[illegible]	6.86	99.74	.06	.
25	25	0	16	26.41	0.00	26.41	35.392	23.22	4.89	6.97	100.91	.06	.
50	50	0	12	26.75	0.00	26.75	35.396	23.12	4.81	6.86	99.77	.04	.
100	100	0	15	26.37	0.00	26.37	35.798	23.54	4.68	6.68	97.38	.05	.

R V PALUMBO CRUISE STATION PHI-6C PRNC REFERENCE 21252

DATE	1/17/73	BARO	1014.4	WEATHER	02	WIND VELOC	04	WAVE PERIOD	5
HOUR	15.6	TEMP DRY	31.0	VISIBILITY	8	WIND DIREC	06	TRANSPAR	
LAT	18-25.2 N	TEMP WET	0.0	CLOUD TYPE	9	WAVE DIREC	03	SONIC DEP	0507
LONG	67-15.9 W	REL HUMID	068	CLOUD AMT	2	WAVE HEIGHT	3	COLOR	10

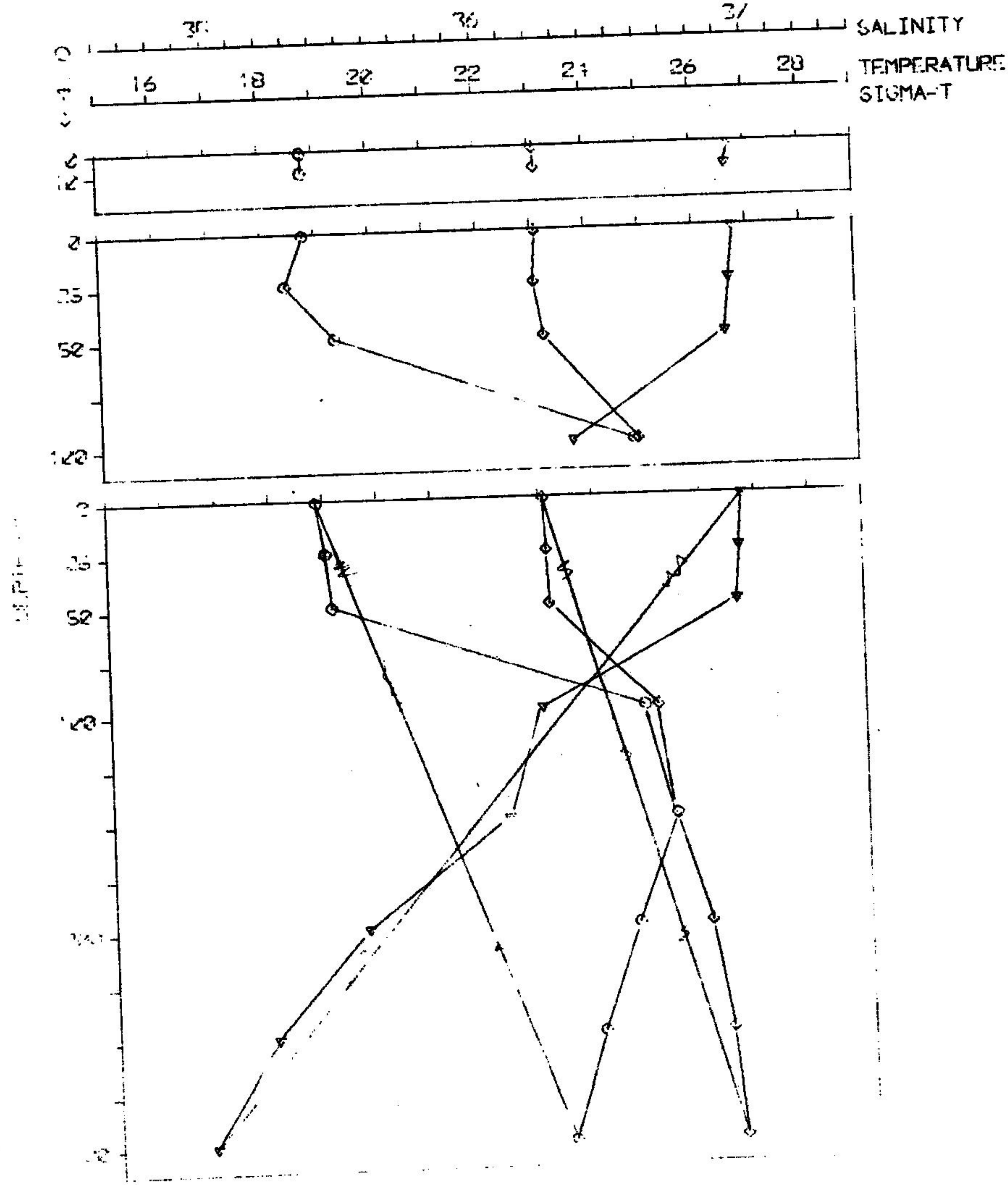
CAST 1 MESS TIME 15.9 GMT. 1155 LOCAL MAX DEPTH 300 WIRE ANGLE 3
OXYGEN TITER .680 METER WHEEL FACTOR .997

DEPTH (M) WIRE	CZ	TZ	BN	TEMP TL	TM	TAVE	SALIN	SIG T	OXYGEN ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	10	26.76	26.75	26.76	35.378	23.10	4.81	6.86	99.73	.08	.
25	25	0	16	26.69	0.00	26.69	35.371	23.12	4.79	6.84	99.22	.03	.
50	50	0	12	26.67	0.00	26.67	35.380	23.13	4.72	6.75	97.95	.07	.
100	100	0	15	26.23	0.00	26.23	35.928	23.68	4.62	6.60	96.26	.07	.

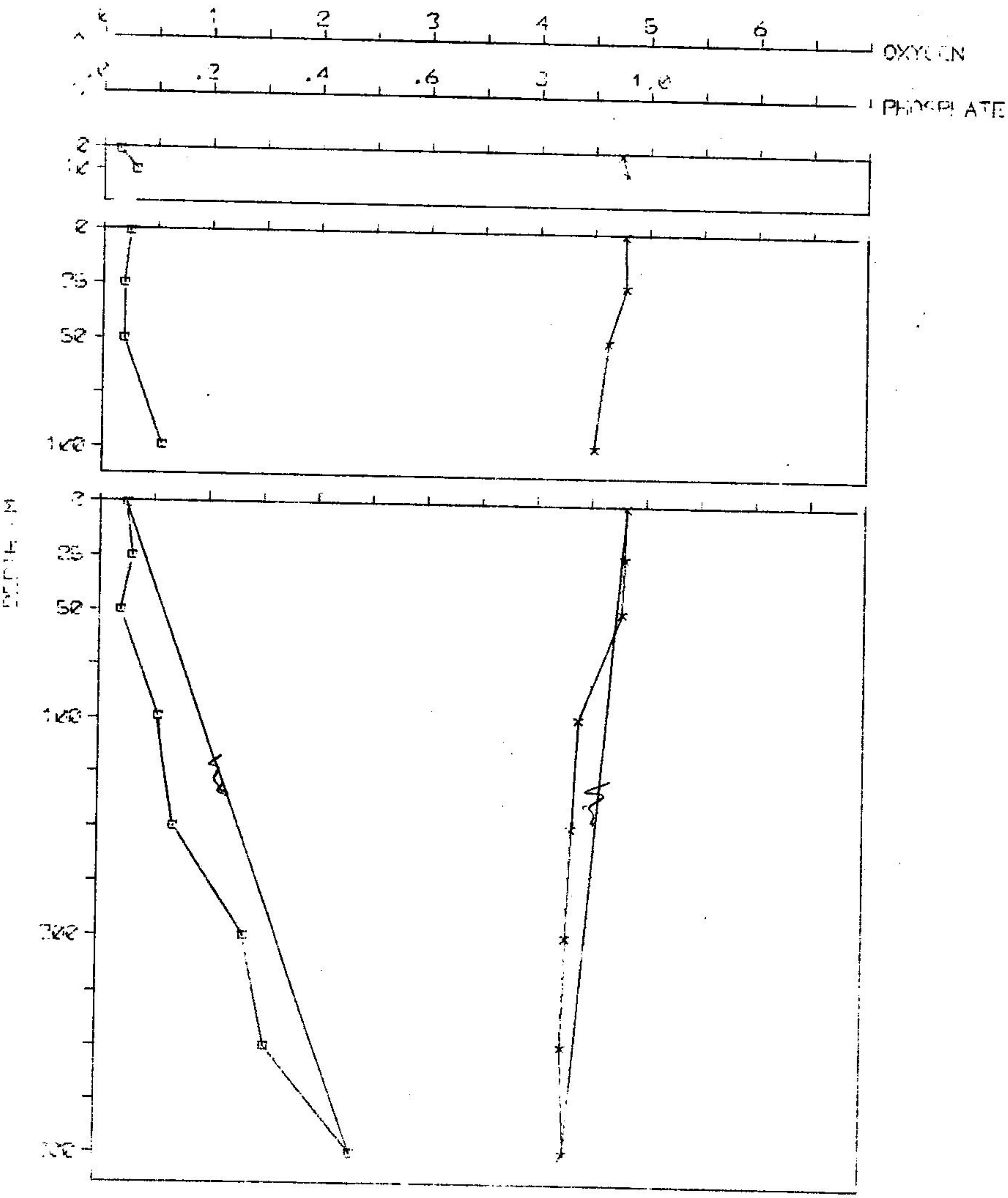
CAST 2 MESS TIME 16.4 GMT. 1222 LOCAL MAX DEPTH 100 WIRE ANGLE 4
OXYGEN TITER .680 METER WHEEL FACTOR .997

DEPTH (M) WIRE	CZ	TZ	BN	TEMP TL	TM	TAVE	SALIN	SIG T	OXYGEN ML/L	MG/L	%SAT	PHOS	NITRA
150	150	0	10	20.85	20.85	20.85	36.652	25.81	4.31	6.16	81.84	.18	.
200	199	0	16	18.89	0.00	18.89	36.562	26.26	4.32	6.17	76.46	.24	.
250	249	0	12	17.69	0.00	17.69	36.565	26.56	4.38	6.25	77.01	.40	.
300	299	0	15	16.97	0.00	16.97	36.325	26.55	4.44	6.34	77.35	.37	.

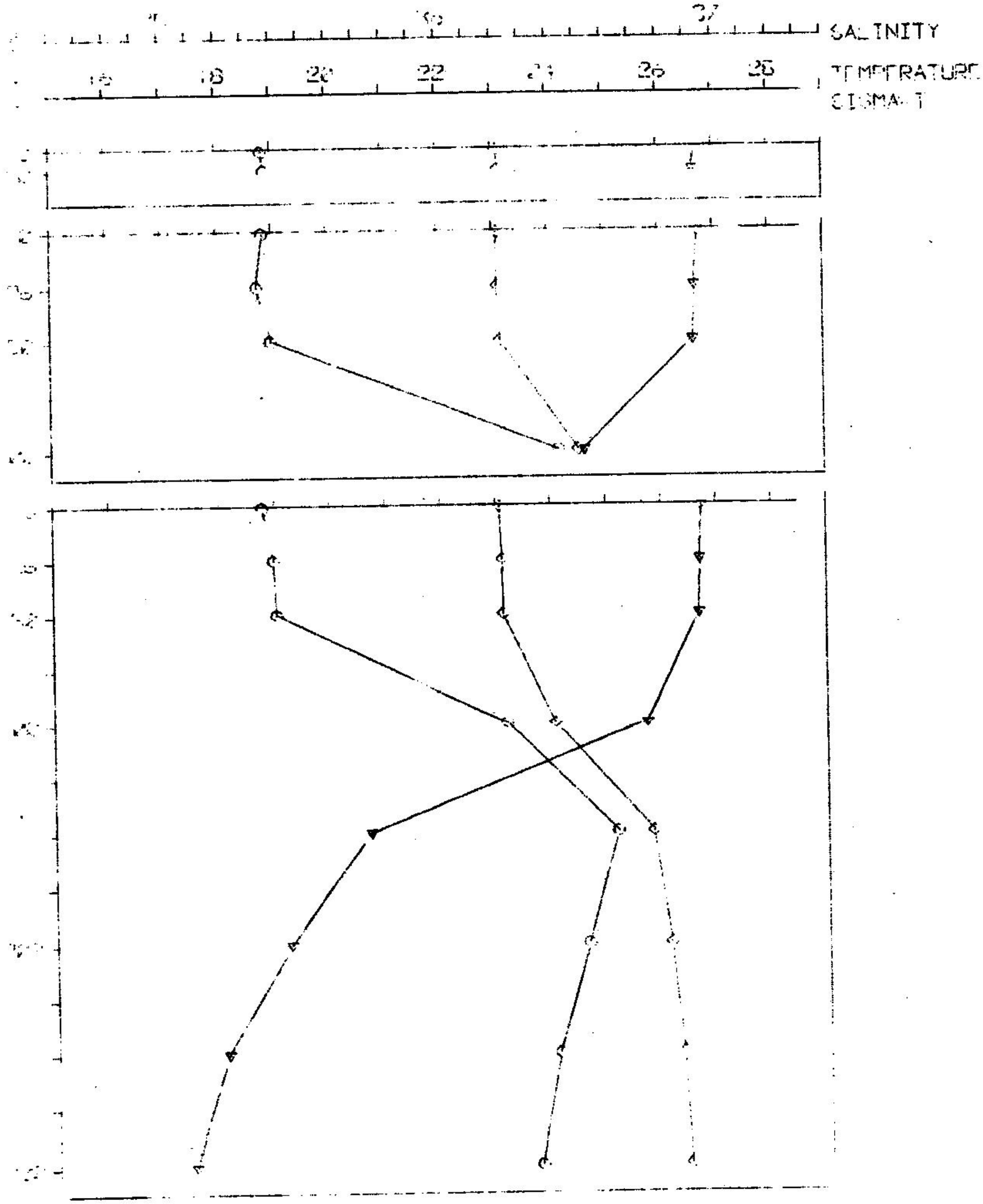
HYDROSTATION VERTICAL PROFILES FOR TEMPERATURE,
SALINITY AND SIGMA-T.
TRANSECT PHI-2. DATE 1/18/73



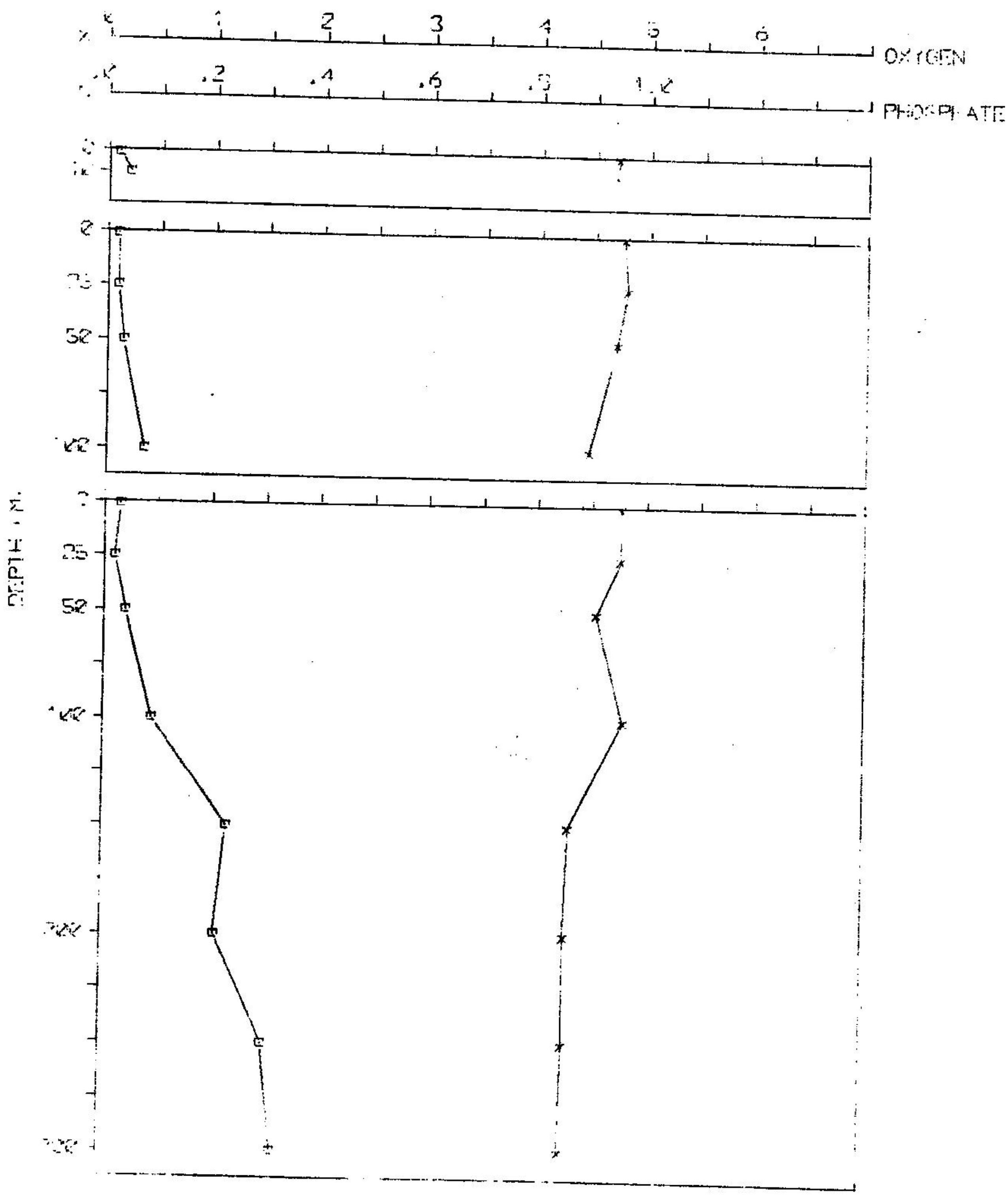
HYDROSTATION VERTICAL PROFILES FOR DISSOLVED OXYGEN AND REACTIVE PHOSPHATE.
TRANSECT PHI-2. DATE 1/18/73



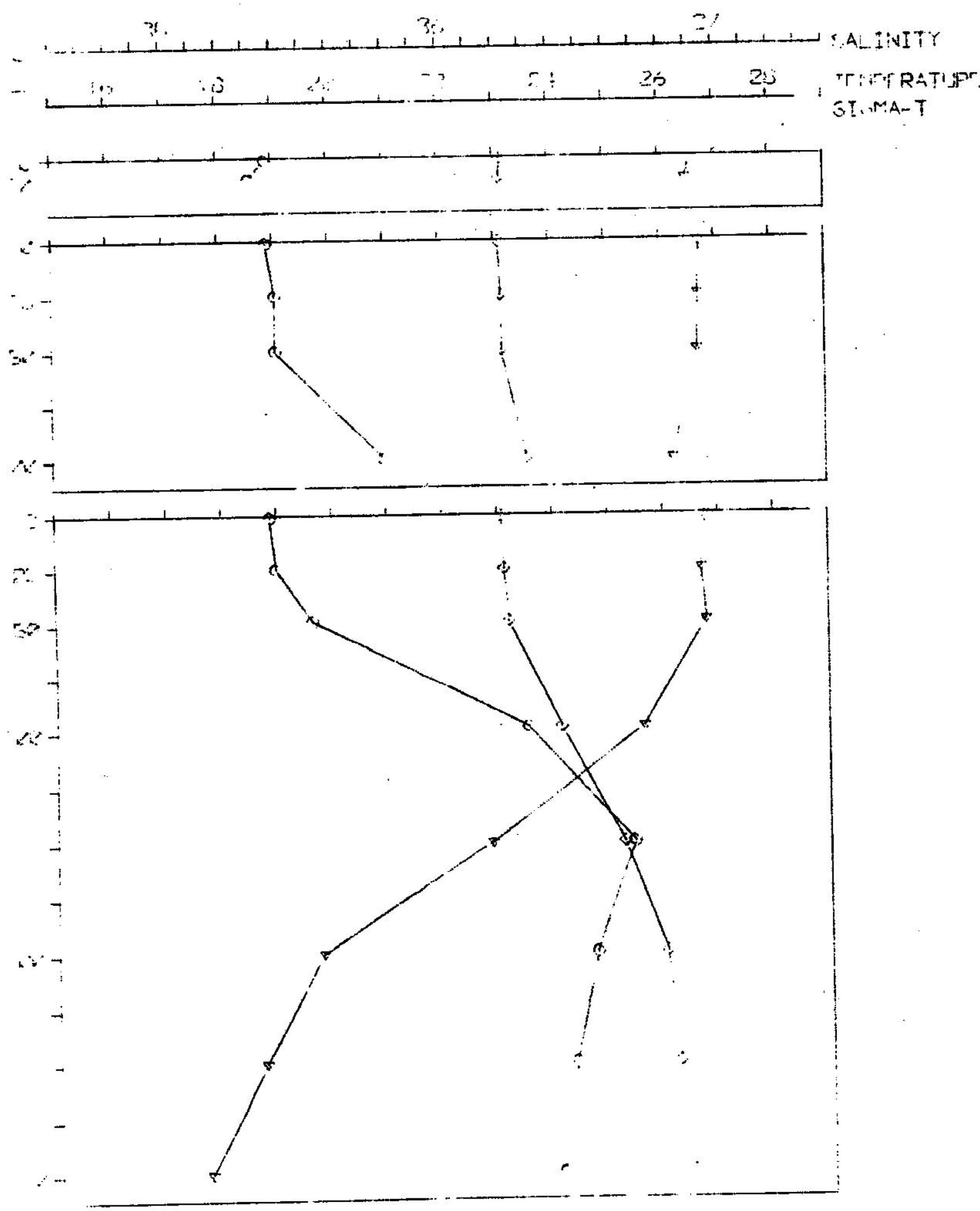
PREDOSTATION VERTICAL PROFILES FOR TEMPERATURE, SALINITY AND SIGMA-T.
TRANSECT PHI-3 DATE 1/18/73



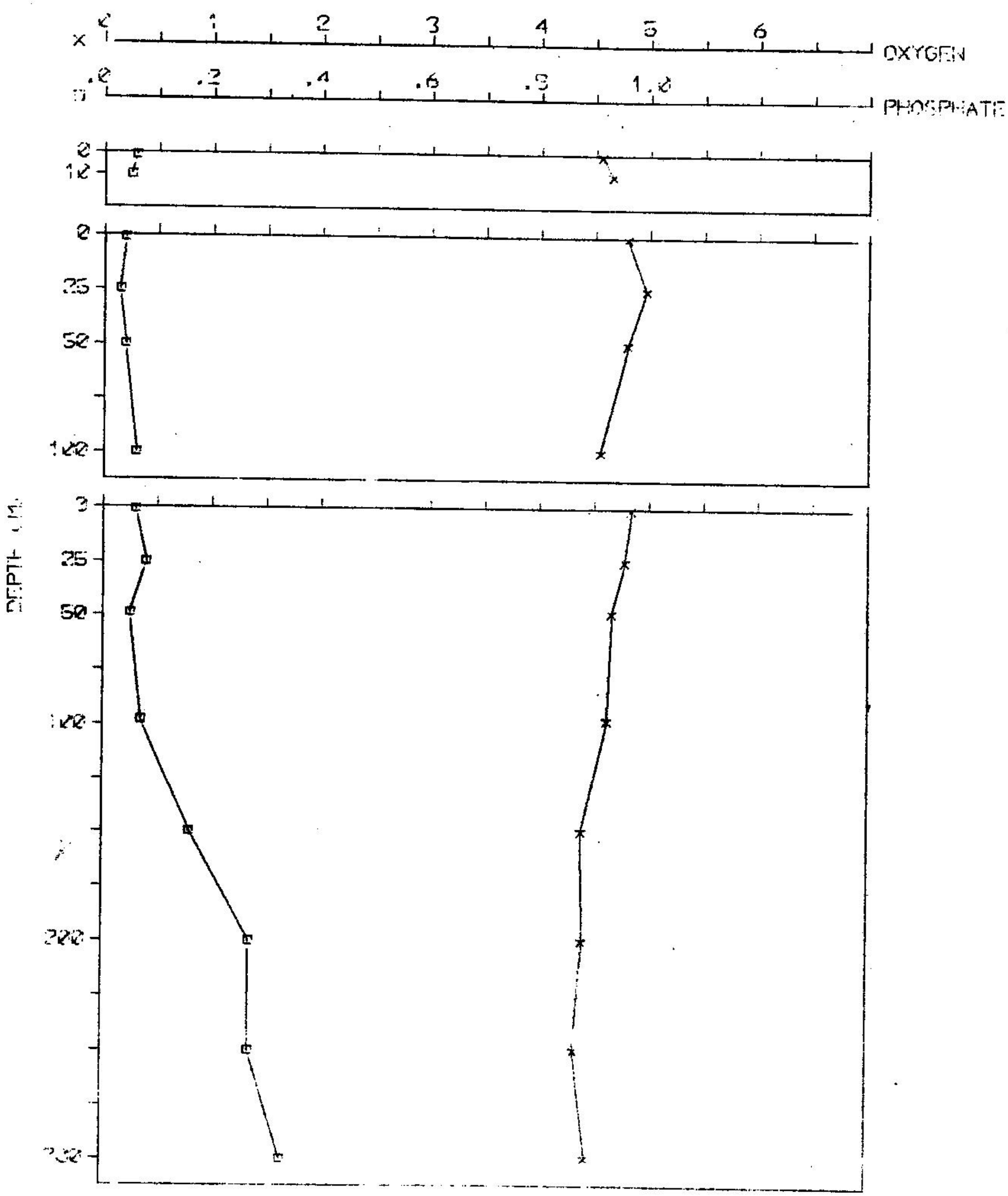
HYDROSTATION VERTICAL PROFILES FOR DISSOLVED OXYGEN AND REACTIVE PHOSPHATE
TRANSECT PHI-3 DATE 1/19/73



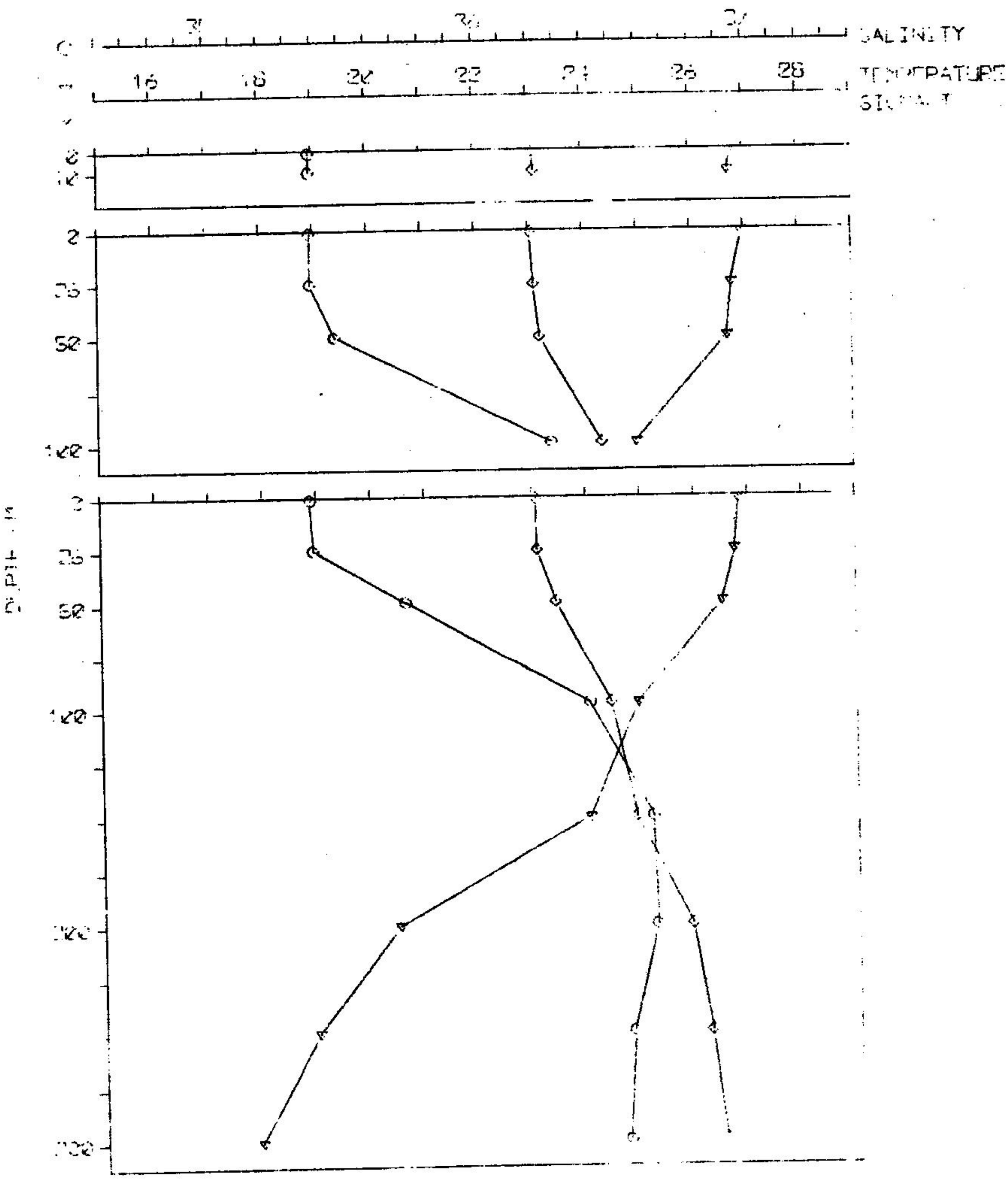
HYDROSTATION VERTICAL PROFILES FOR TEMPERATURE,
SALINITY AND SIGMA-T
TRANSECT [illegible] DATE 1/16/73



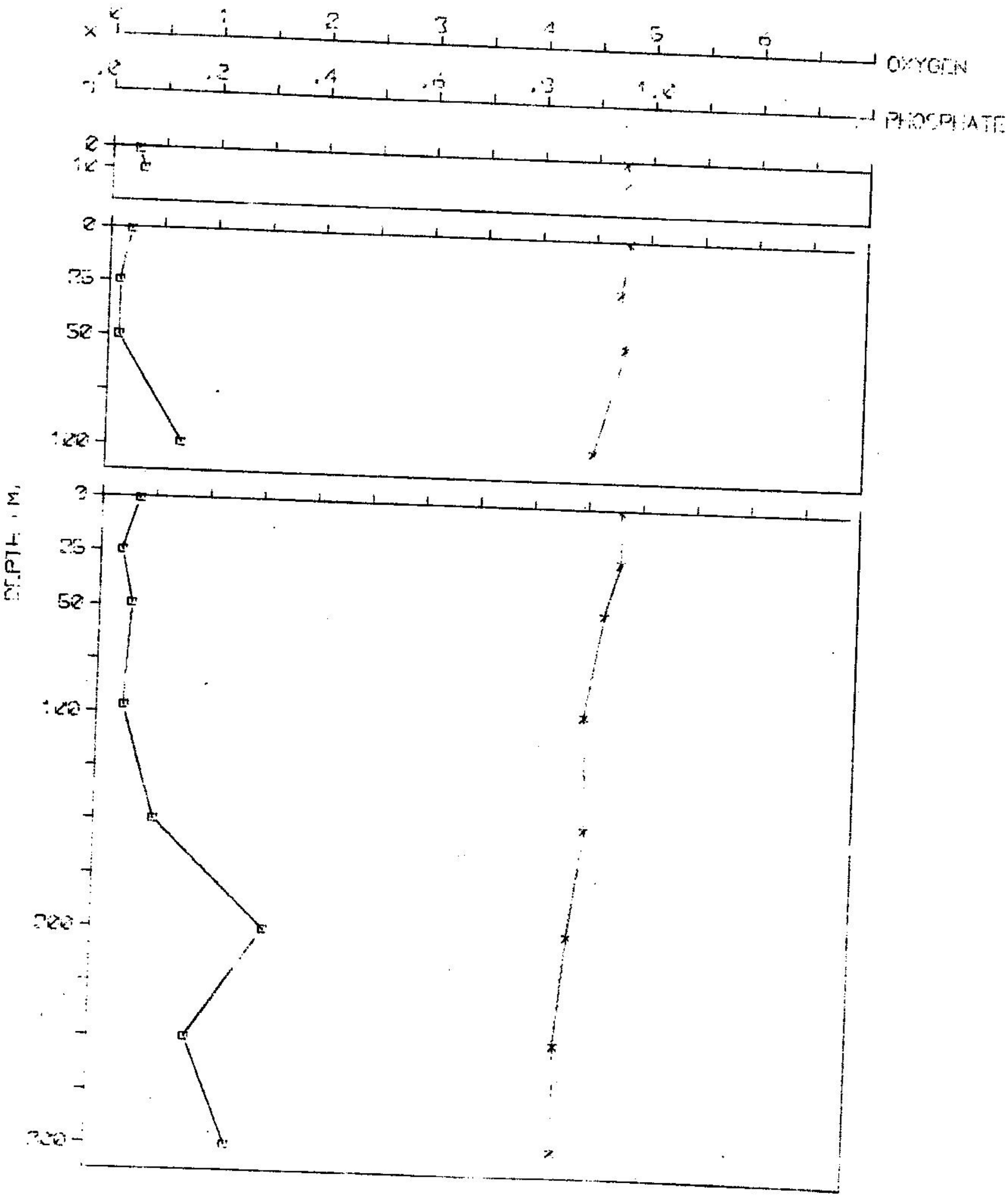
HYDROSTATION VERTICAL PROFILES FOR DISSOLVED
OXYGEN AND REACTIVE PHOSPHATE.
TRANSECT PHI-4. DATE 1/18/73



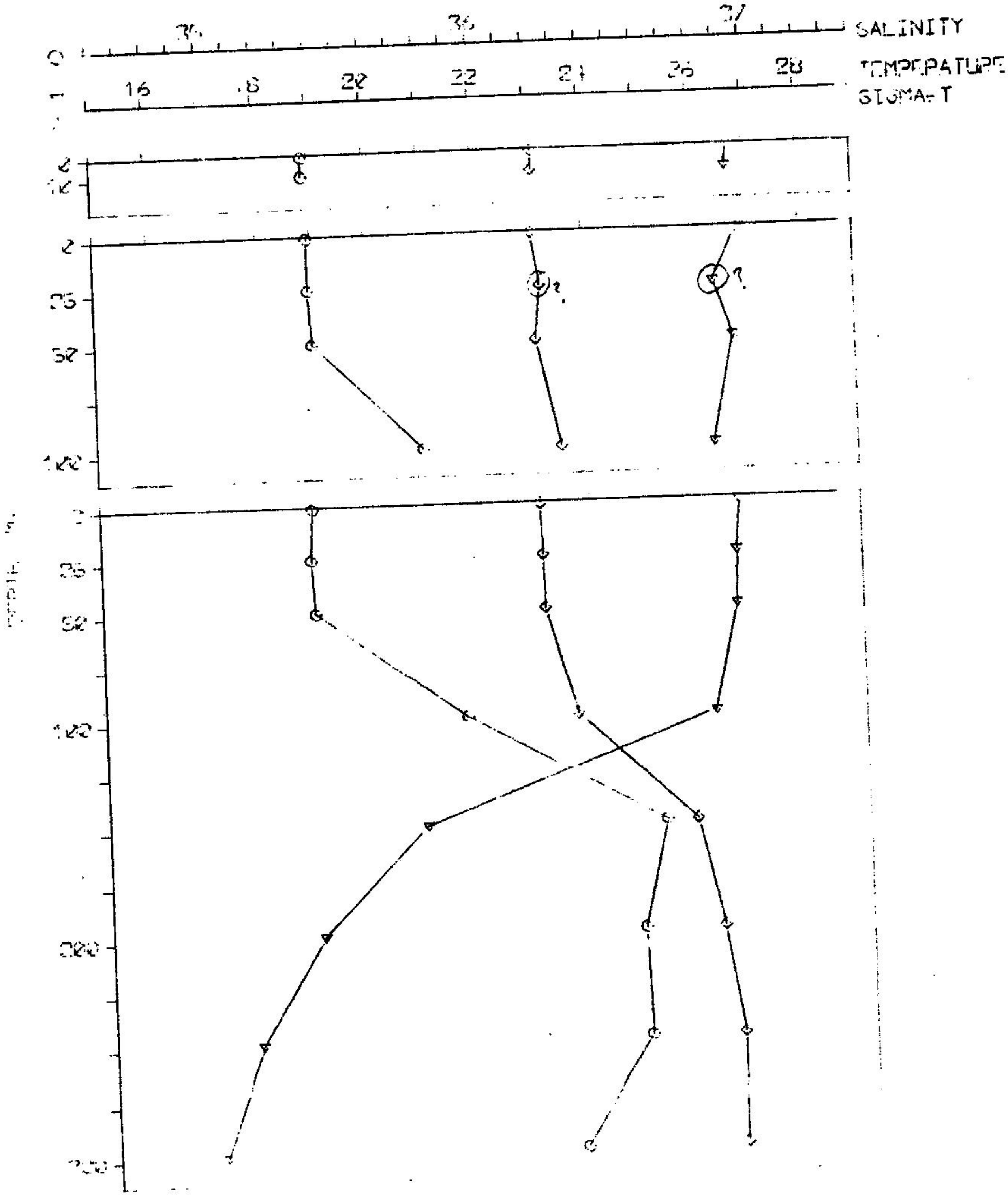
STATION VERTICAL PROFILES FOR TEMPERATURE,
SALINITY AND SIGMA-T.
TRANSECT PHI-5. DATE 1/17/73



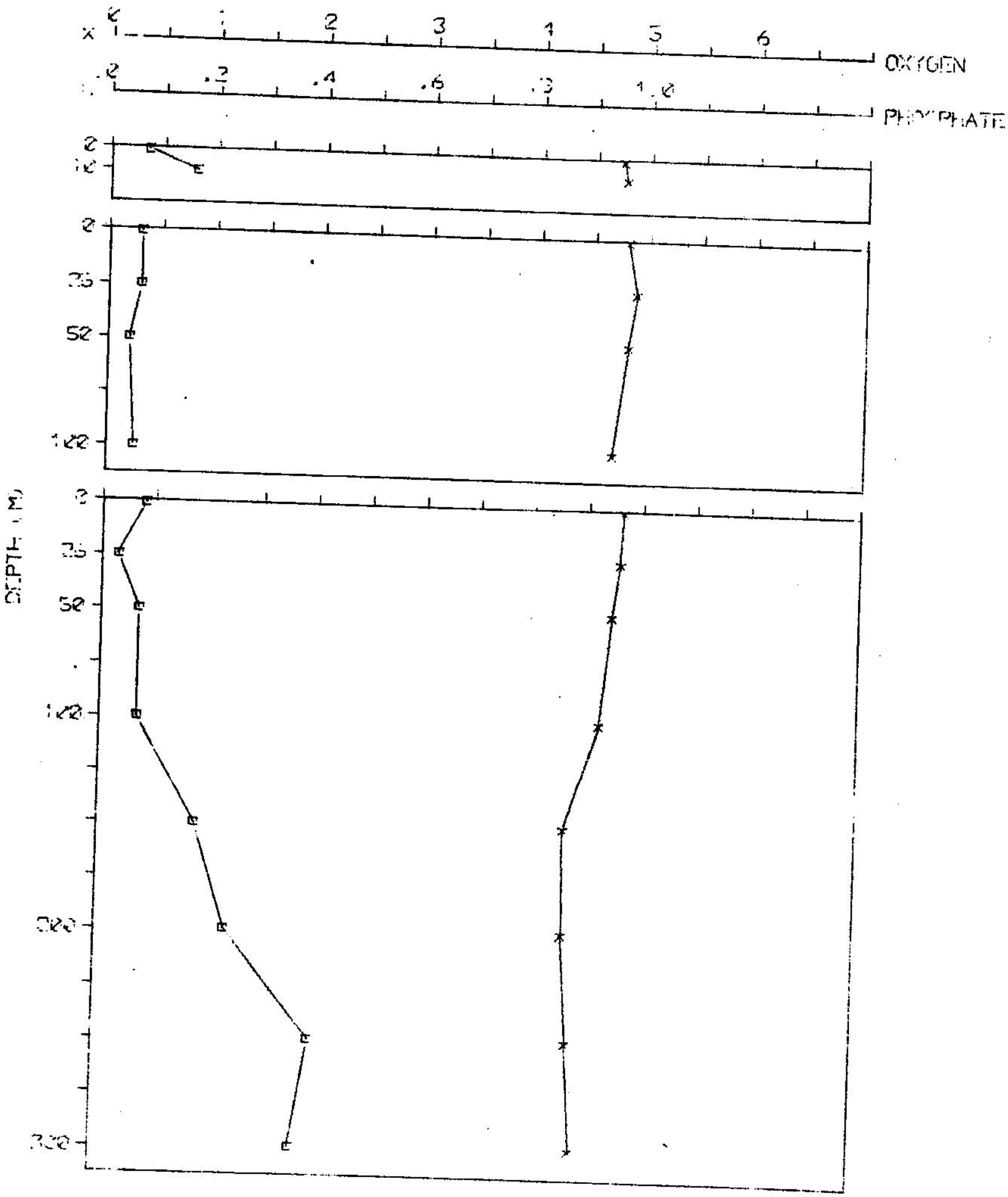
HYDROXTATION VERTICAL PROFILES FOR DISSOLVED
OXYGEN AND REACTIVE PHOSPHATE
TRANSECT PHI-5, DATE 1/17/73



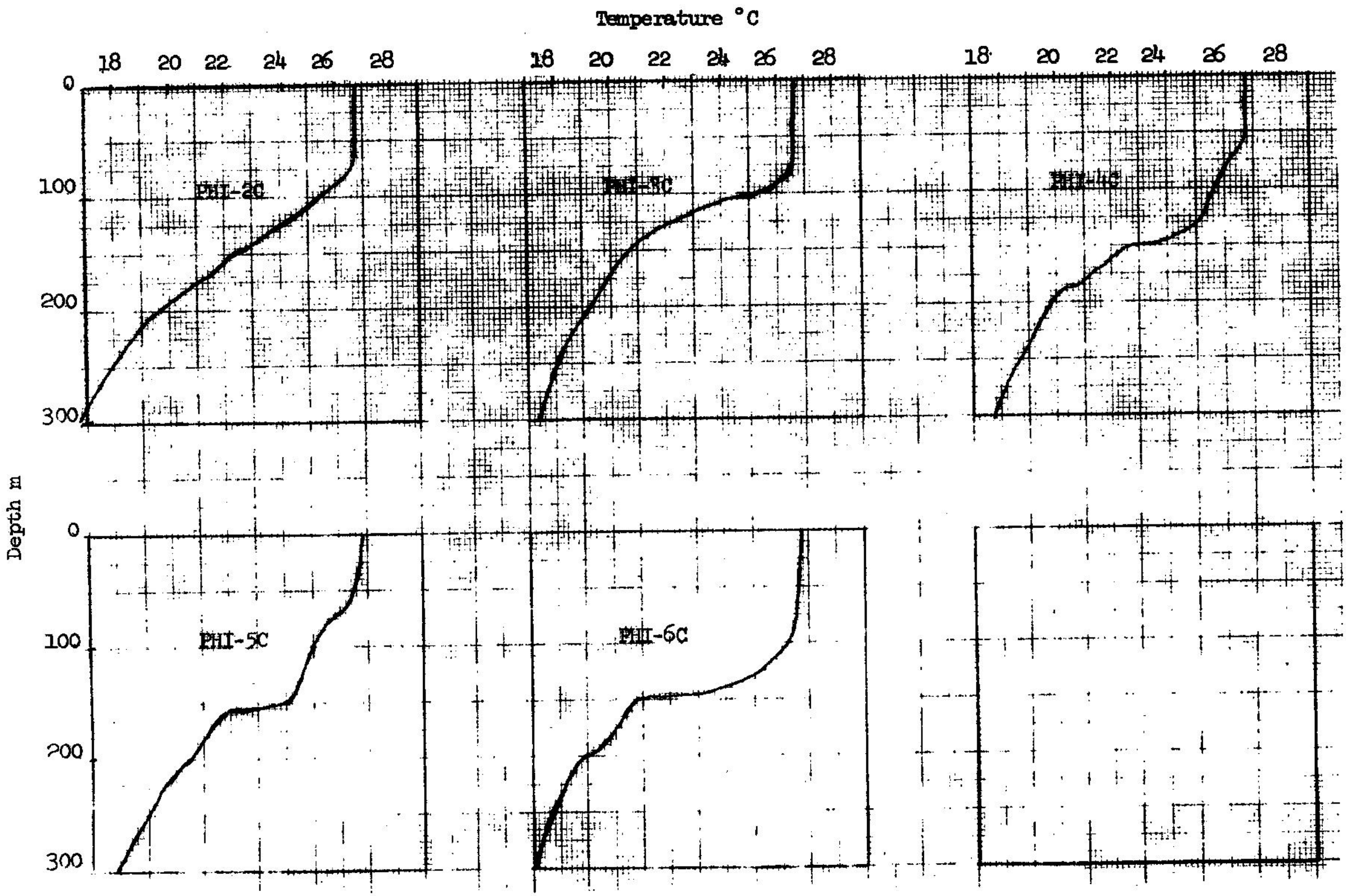
HYDROSTATION VERTICAL PROFILES FOR TEMPERATURE, SALINITY AND SIGMA-T.
TRANSECT PHI-6. DATE 1/17/73



HYDROSTATION VERTICAL PROFILES FOR DISSOLVED OXYGEN AND REACTIVE PHOSPHATE.
TRANSECT PHI-6. DATE 1/17/73



Bathythermograph traces for Pta. Higuero
PHI-73-1, 1-15-73



R V PALUMBO CRUISE   STATION PHI-2A   PRNC REFERENCE 27443

DATE	5/ 2/73	BARO	1019.5	WEATHER	03	WIND VELOC	06	WAVE PERIOD	4
HOUR	16.1	TEMP DRY	27.0	VISIBILITY	8	WIND DIREC	01	TRANSPAR	
LAT	18-20.7 N	TEMP WET	0.0	CLOUD TYPE	8	WAVE DIREC	01	SONIC DEP	0015
LONG	67-16.3 W	REL HUMID	074	CLOUD AMT	2	WAVE HEIGHT	2	COLOR	20

CAST 1 MESS TIME 16.1 GMT, 12 6 LOCAL MAX DEPTH 10 WIRE ANGLE 0
OXYGEN TITER 1.028 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	11	27.39	27.36	27.37	35.889	23.29	4.66	6.65	98.74	.03	.
10	10	0	12	27.15	0.00	27.15	35.875	23.35	4.73	6.76	99.87	.03	.

R V PALUMBO CRUISE   STATION PHI-2B   PRNC REFERENCE 27444

DATE	5/ 2/73	BARO	1018.3	WEATHER	03	WIND VELOC	07	WAVE PERIOD	5
HOUR	16.7	TEMP DRY	27.5	VISIBILITY	8	WIND DIREC	01	TRANSPAR	
LAT	18-20.6 N	TEMP WET	0.0	CLOUD TYPE	8	WAVE DIREC	01	SONIC DEP	0152
LONG	67-16.3 W	REL HUMID	074	CLOUD AMT	2	WAVE HEIGHT	2	COLOR	10

CAST 1 MESS TIME 16.7 GMT, 1240 LOCAL MAX DEPTH 100 WIRE ANGLE 0
OXYGEN TITER 1.028 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	1	27.36	0.00	27.36	35.863	23.27	4.71	6.73	99.74	.03	.
25	25	0	2	27.13	0.00	27.13	35.880	23.36	4.71	6.73	99.42	.03	.
50	50	0	3	0.00	0.00	0.00	35.854	0.00	4.71	6.73	*******	.04	.
100	100	0	4	24.36	0.00	24.36	36.458	24.66	4.48	6.40	86.38	.15	.

R V PALUMBO CRUISE STATION PHI-2C PRNC REFERENCE 27439

DATE	5/ 2/73	BARO	1019.0	WEATHER	03	WIND VELOC	03	WAVE PERIOD	3
HOUR	13.8	TEMP DRY	27.0	VISIBILITY	8	WIND DIREC	01	TRANSPAR	
LAT	18-20.0 N	TEMP WET	0.0	CLOUD TYPE	2	WAVE DIREC	01	SONIC DEP	0539
LONG	67-17.2 W	REL HUMID	073	CLOUD AMT	1	WAVE HEIGHT	4	COLOR	10

CAST 1 MESS TIME 13.8 GMT, 949 LOCAL MAX DEPTH 300 WIRE ANGLE 0
OXYGEN TITER 1.028 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	11	27.17	27.16	27.17	35.831	23.31	4.60	6.57	96.96	.07	.
25	25	0	12	27.06	0.00	27.06	35.883	23.38	4.73	6.76	99.75	.05	.
50	50	0	15	26.91	0.00	26.91	35.868	23.42	4.73	6.76	99.47	.06	.
100	100	0	16	26.16	0.00	26.16	36.041	23.79	4.73	6.76	98.59	.12	.
150	150	0	1	24.82	0.00	24.82	36.482	24.53	4.69	6.70	90.64	.06	.
200	200	0	2	19.89	0.00	19.89	36.545	25.99	4.06	5.80	72.33	.28	.
250	250	0	3	17.00	0.00	17.00	36.256	26.49	3.99	5.70	69.44	.55	.
300	300	0	4	16.45	0.00	16.45	36.165	26.55	3.99	5.70	69.19	.65	.

R V PALUMBO CRUISE STATION PHI-3A PRNC REFERENCE 27442

DATE 5/ 2/73 BARO 1Ø19.3 WEATHER Ø1 WIND VELOC Ø5 WAVE PERIOD 6
HOUR 15.5 TEMP DRY 27.5 VISIBILITY 8 WIND DIREC Ø1 TRANSPAR
LAT 18-21.4 N TEMP WET Ø.Ø CLOUD TYPE 8 WAVE DIREC Ø2 SONIC DEP ØØ15
LONG 67-16.7 W REL HUMID CLOUD AMT 1 WAVE HEIGHT 4 COLOR 2Ø

CAST 1 MESS TIME 15.5 GMT, 1132 LOCAL MAX DEPTH 1Ø WIRE ANGLE Ø
OXYGEN TITER 1.Ø28 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
Ø	1	Ø	11	27.29	27.28	27.29	35.876	23.31	4.7Ø	6.71	99.44	.Ø1	.
1Ø	1Ø	Ø	12	27.11	Ø.ØØ	27.11	35.88Ø	23.37	4.76	6.8Ø	1ØØ.47	.Ø1	.

R V PALUMBO CRUISE STATION PHI-3B PRNC REFERENCE 27441

DATE 5/ 2/73 BARO 1Ø19.1 WEATHER Ø2 WIND VELOC Ø6 WAVE PERIOD 6
HOUR 15.2 TEMP DRY 28.Ø VISIBILITY 8 WIND DIREC Ø2 TRANSPAR
LAT 18-21.3 N TEMP WET Ø.Ø CLOUD TYPE 8 WAVE DIREC ØØ SONIC DEP Ø219
LONG 67-17.2 W REL HUMID Ø72 CLOUD AMT 1 WAVE HEIGHT 4 COLOR 1Ø

CAST 1 MESS TIME 15.2 GMT, 1111 LOCAL MAX DEPTH 1ØØ WIRE ANGLE Ø
OXYGEN TITER 1.Ø28 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
Ø	1	Ø	1	27.27	Ø.ØØ	27.27	35.867	23.3Ø	4.76	6.8Ø	1ØØ.69	.33	.
25	25	Ø	2	27.13	Ø.ØØ	27.13	35.844	23.33	4.74	6.77	99.98	.Ø6	.
5Ø	5Ø	Ø	3	26.91	Ø.ØØ	26.91	35.853	23.41	4.71	6.73	99.Ø1	.Ø4	.
1ØØ	1ØØ	Ø	4	24.58	Ø.ØØ	24.58	36.37Ø	24.52	4.5Ø	6.43	86.56	.Ø6	.

R V PALUMBO CRUISE | STATION PHI-3C | PRNC REFERENCE 27440

DATE	5/ 2/73	BARO	1000.0	WEATHER	02	WIND VELOC	04	WAVE PERIOD	6
HOUR	14.7	TEMP DRY	28.0	VISIBILITY	8	WIND DIREC	01	TRANSPAR	
LAT	18-21.2 N	TEMP WET	0.0	CLOUD TYPE	8	WAVE DIREC	01	SONIC DEP	0533
LONG	67-17.8 W	REL HUMID	072	CLOUD AMT	1	WAVE HEIGHT	4	COLOR	10

CAST 1 MESS TIME 14.7 GMT; 1041 LOCAL MAX DEPTH 300 WIRE ANGLE 2
OXYGEN TITER 1.028 METER WHEEL FACTOR .997

DEPTH (M) WIRE	CZ	TZ	BN	TEMP TL	TM	TAVE	SALIN	SIG T	OXYGEN ML/L	MG/L	XSAT	PHOS	NITRA
0	1	0	11	27.18	27.17	27.18	35.794	23.28	4.69	6.70	98.84	.10	.
25	25	0	12	26.93	0.00	26.93	35.849	23.40	4.75	6.79	99.89	.10	.
50	50	0	15	26.88	0.00	26.88	35.840	23.41	4.71	6.73	98.93	.64	.
100	100	0	16	25.65	0.00	25.65	36.161	24.04	4.64	6.63	95.02	.22	.
150	150	0	1	23.85	0.00	23.85	36.533	24.86	4.38	6.26	84.42	.20	.
200	200	0	2	21.32	0.00	21.32	36.601	25.64	4.09	5.85	77.90	.28	.
250	250	0	3	18.22	0.00	18.22	36.382	26.29	4.06	5.80	71.27	.31	.
300	299	0	4	17.43	0.00	17.43	36.295	26.42	4.04	5.77	70.50	.47	.

R V PALUMBO CRUISE STATION PHI-4A PRNC REFERENCE 27437

DATE	5/ 1/73	BARO	1017.6	WEATHER	Ø2	WIND VELOC	Ø3	WAVE PERIOD	2
HOUR	18.3	TEMP DRY	31.Ø	VISIBILITY	8	WIND DIREC	Ø3	TRANSPAR	
LAT	18-22.Ø N	TEMP WET	Ø.Ø	CLOUD TYPE	8	WAVE DIREC	19	SONIC DEP	ØØ17
LONG	67-16.5 W	REL HUMID	Ø68	CLOUD AMT	9	WAVE HEIGHT	3	COLOR	2Ø

CAST 1 MESS TIME 18.3 GMT, 1421 LOCAL MAX DEPTH 1Ø WIRE ANGLE 2
OXYGEN TITER 1.Ø28 METER WHEEL FACTOR .997

DEPTH (M) WIRE	CZ	TZ	BN	TEMP TL	TM	TAVE	SALIN	SIG T	OXYGEN ML/L	MG/L	%SAT	PHOS	NITRA
Ø	1	Ø	11	27.28	27.28	27.28	35.877	23.31	4.59	6.55	97.Ø4	.Ø7	.
1Ø	1Ø	Ø	12	26.98	Ø.ØØ	26.98	35.881	23.41	4.73	6.76	99.62	.Ø4	.

R V PALUMBO CRUISE STATION PHI-4B PRNC REFERENCE 27438

DATE	5/ 1/73	BARO	1016.5	WEATHER	Ø2	WIND VELOC	Ø2	WAVE PERIOD	4
HOUR	18.8	TEMP DRY	31.Ø	VISIBILITY	8	WIND DIREC	Ø2	TRANSPAR	
LAT	18-22.7 N	TEMP WET	Ø.Ø	CLOUD TYPE	8	WAVE DIREC	19	SONIC DEP	Ø174
LONG	67-18.1 W	REL HUMID	Ø69	CLOUD AMT	9	WAVE HEIGHT	3	COLOR	1Ø

CAST 1 MESS TIME 18.8 GMT, 1448 LOCAL MAX DEPTH 1ØØ WIRE ANGLE 3
OXYGEN TITER 1.Ø28 METER WHEEL FACTOR .997

DEPTH (M) WIRE	CZ	TZ	BN	TEMP TL	TM	TAVE	SALIN	SIG T	OXYGEN ML/L	MG/L	%SAT	PHOS	NITRA
Ø	1	Ø	1	27.67	Ø.ØØ	27.67	35.884	23.19	4.72	6.74	1ØØ.52	.Ø3	.
25	25	Ø	2	26.96	Ø.ØØ	26.96	35.876	23.41	4.75	6.79	1ØØ.Ø1	.Ø2	.
5Ø	5Ø	Ø	3	26.84	Ø.ØØ	26.84	35.853	23.43	4.79	6.85	1ØØ.63	.Ø3	.
1ØØ	1ØØ	Ø	4	25.54	Ø.ØØ	25.54	36.233	24.13	4.83	6.9Ø	99.Ø8	.Ø4	.

R V PALUMBO CRUISE STATION PHI-4C PRNC REFERENCE 27430

DATE	5/ 1/73	BARO	1017.5	WEATHER	02	WIND VELOC		WAVE PERIOD 4
HOUR	13.5	TEMP DRY	26.0	VISIBILITY	7	WIND DIREC		TRANSPAR
LAT	18-23.4 N	TEMP WET	0.0	CLOUD TYPE	8	WAVE DIREC 06		SONIC DEP 0325
LONG	67-19.2 W	REL HUMID	081	CLOUD AMT	9	WAVE HEIGHT 3		COLOR 10

CAST 1 MESS TIME 13.5 GMT. 931 LOCAL MAX DEPTH 300 WIRE ANGLE 2
OXYGEN TITER 1.028 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	XSAT	PHOS	NITRA
0	1	0	11	27.27	27.26	27.27	35.853	23.30	4.83	6.90	102.17	.31	.
25	25	0	12	27.22	0.00	27.22	35.827	23.29	4.90	7.01	103.55	.11	.
50	50	0	15	26.74	0.00	26.74	35.824	23.44	4.79	6.85	100.40	.11	.
100	100	0	16	25.44	0.00	25.44	36.297	24.21	4.81	6.87	98.69	.10	.
150	150	0	1	21.40	0.00	21.40	36.656	25.66	4.20	5.99	79.97	.23	.
200	200	0	2	19.19	0.00	19.19	36.513	26.14	4.09	5.85	72.49	.42	.
250	250	0	3	17.80	0.00	17.80	36.406	26.41	4.10	5.86	71.91	.86	.
300	299	0	4	17.17	0.00	17.17	36.343	26.52	4.13	5.91	72.13	.60	.

R V PALUMBO CRUISE   STATION PHI-5A   PRNC REFERENCE 27435

DATE	5/ 1/73	BARO	1017.8	WEATHER	02	WIND VELOC		WAVE PERIOD	4
HOUR	17.4	TEMP DRY	30.0	VISIBILITY	8	WIND DIREC		TRANSPAR	
LAT	18-22.6 N	TEMP WET	0.0	CLOUD TYPE	8	WAVE DIREC	02	SONIC DEP	0015
LONG	67-16.0 W	REL HUMID	069	CLOUD AMT	9	WAVE HEIGHT	2	COLOR	20

CAST 1 MESS TIME 17.4 GMT, 1322 LOCAL MAX DEPTH 10 WIRE ANGLE 0
OXYGEN TITER 1.028 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	11	27.44	27.43	27.44	35.878	23.26	4.52	6.46	95.97	.05	.
10	10	0	12	27.03	0.00	27.03	35.861	23.38	4.77	6.82	100.51	.05	.

R V PALUMBO CRUISE   STATION PHI-5B   PRNC REFERENCE 27436

DATE	5/ 1/73	BARO	1017.7	WEATHER	02	WIND VELOC		WAVE PERIOD	5
HOUR	17.8	TEMP DRY	30.0	VISIBILITY	8	WIND DIREC		TRANSPAR	
LAT	18-23.5 N	TEMP WET	0.0	CLOUD TYPE	8	WAVE DIREC	02	SONIC DEP	0182
LONG	67-16.6 W	REL HUMID	068	CLOUD AMT	9	WAVE HEIGHT	2	COLOR	10

CAST 1 MESS TIME 17.8 GMT, 1349 LOCAL MAX DEPTH 100 WIRE ANGLE 0
OXYGEN TITER 1.028 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	1	27.87	0.00	27.87	35.881	23.12	4.76	6.80	101.71	.04	.
25	25	0	2	27.03	0.00	27.03	35.870	23.38	4.80	6.86	101.19	.04	.
50	50	0	3	26.92	0.00	26.92	35.855	23.41	4.83	6.90	101.62	.03	.
100	100	0	4	26.34	0.00	26.34	35.967	23.68	4.79	6.85	100.05	.05	.

R V PALUMBO CRUISE STATION PHI-5C PRMC REFERENCE 27431

DATE	5/ 1/73	BARO	1017.8	WEATHER	02	WIND VELOC		WAVE PERIOD	5
HOUR	14.3	TEMP DRY	29.0	VISIBILITY	7	WIND DIREC		TRANSPAR	
LAT	18-24.6 N	TEMP WET	0.0	CLOUD TYPE	8	WAVE DIREC	03	SONIC DEP	0375
LONG	67-17.4 W	REL HUMID	074	CLOUD AMT	9	WAVE HEIGHT	3	COLOR	10

CAST 1 MESS TIME 14.8 GMT, 1047 LOCAL MAX DEPTH 300 WIRE ANGLE 3
OXYGEN TITER 1.028 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	11	27.66	27.64	27.65	35.927	23.23	4.79	6.85	102.15	.10	.
25	25	0	12	27.12	0.00	27.12	35.911	23.39	4.81	6.87	101.65	.08	.
50	53	0	15	26.83	0.00	26.83	35.891	23.46	4.76	6.80	100.05	.05	.
100	102	0	16	25.76	0.00	25.76	36.262	24.08	4.79	6.85	98.34	.02	.
150	150	0	1	21.76	0.00	21.76	36.682	25.58	4.29	5.99	80.19	.18	.
200	200	0	2	19.72	0.00	19.72	36.550	26.03	4.07	5.82	72.46	.55	.
250	249	0	3	18.02	0.00	18.02	36.422	26.37	4.10	5.86	72.01	.44	.
300	299	0	4	16.64	0.00	16.64	36.289	26.61	4.23	6.04	73.51	.60	.

R V PALUMBO CRUISE STATION PHI-6A PRNC REFERENCE 27434

DATE	5/ 1/73	BARO	1017.7	WEATHER	02	WIND VELOC		WAVE PERIOD 4
HOUR	16.7	TEMP DRY	30.0	VISIBILITY	8	WIND DIREC		TRANSPAR
LAT	18-22.9 N	TEMP WET	0.0	CLOUD TYPE	8	WAVE DIREC	02	SONIC DEP 0016
LONG	67-15.0 W	REL HUMID	070	CLOUD AMT	9	WAVE HEIGHT	2	COLOR 20

CAST 1 MESS TIME 16.7 GMT, 1244 LOCAL MAX DEPTH 10 WIRE ANGLE 0
OXYGEN TITER 1.028 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	11	27.52	27.52	27.52	35.881	23.23	4.58	6.54	97.21	.05	.
10	10	0	12	27.04	0.00	27.04	35.854	23.37	4.80	6.86	101.16	.05	.

R V PALUMBO CRUISE STATION PHI-6B PRNC REFERENCE 27433

DATE	5/ 1/73	BARO	1018.0	WEATHER	02	WIND VELOC	02	WAVE PERIOD 5
HOUR	16.3	TEMP DRY	30.0	VISIBILITY	8	WIND DIREC	03	TRANSPAR
LAT	18-24.1 N	TEMP WET	0.0	CLOUD TYPE	8	WAVE DIREC	02	SONIC DEP 0143
LONG	67-15.5 W	REL HUMID		CLOUD AMT	9	WAVE HEIGHT	2	COLOR 10

CAST 1 MESS TIME 16.3 GMT, 1221 LOCAL MAX DEPTH 100 WIRE ANGLE 20
OXYGEN TITER 1.028 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	11	27.48	27.48	27.48	35.889	23.25	4.79	6.85	101.75	.04	.
25	24	0	12	26.90	0.00	26.90	35.854	23.41	4.81	6.87	101.16	.03	.
50	47	0	15	26.78	0.00	26.78	35.852	23.45	4.81	6.87	100.96	.05	.
100	94	0	16	26.40	0.00	26.40	35.963	23.65	4.80	6.86	100.36	.03	.

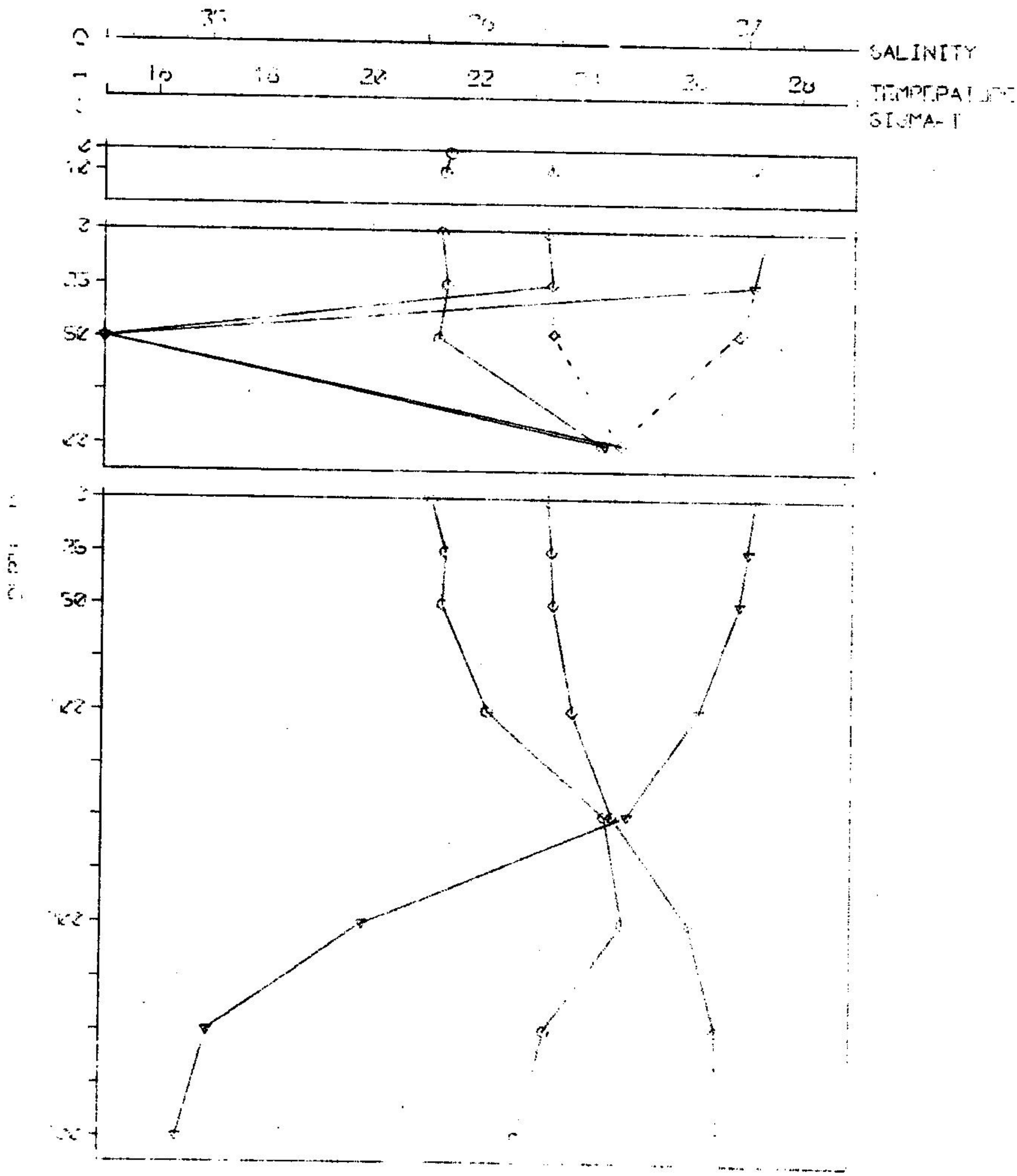
R V PALUMBO CRUISE STATION PHI-6C PRNC REFERENCE 27432

DATE	5/ 1/73	BARO	1017.8	WEATHER	02	WIND VELOC	01	WAVE PERIOD	6
HOUR	15.6	TEMP DRY	29.0	VISIBILITY	8	WIND DIREC	01	TRANSPAR	
LAT	18-25.0 N	TEMP WET	0.0	CLOUD TYPE	8	WAVE DIREC	02	SONIC DEP	0530
LONG	67-15.9 W	REL HUMID	073	CLOUD AMT	9	WAVE HEIGHT	3	COLOR	10

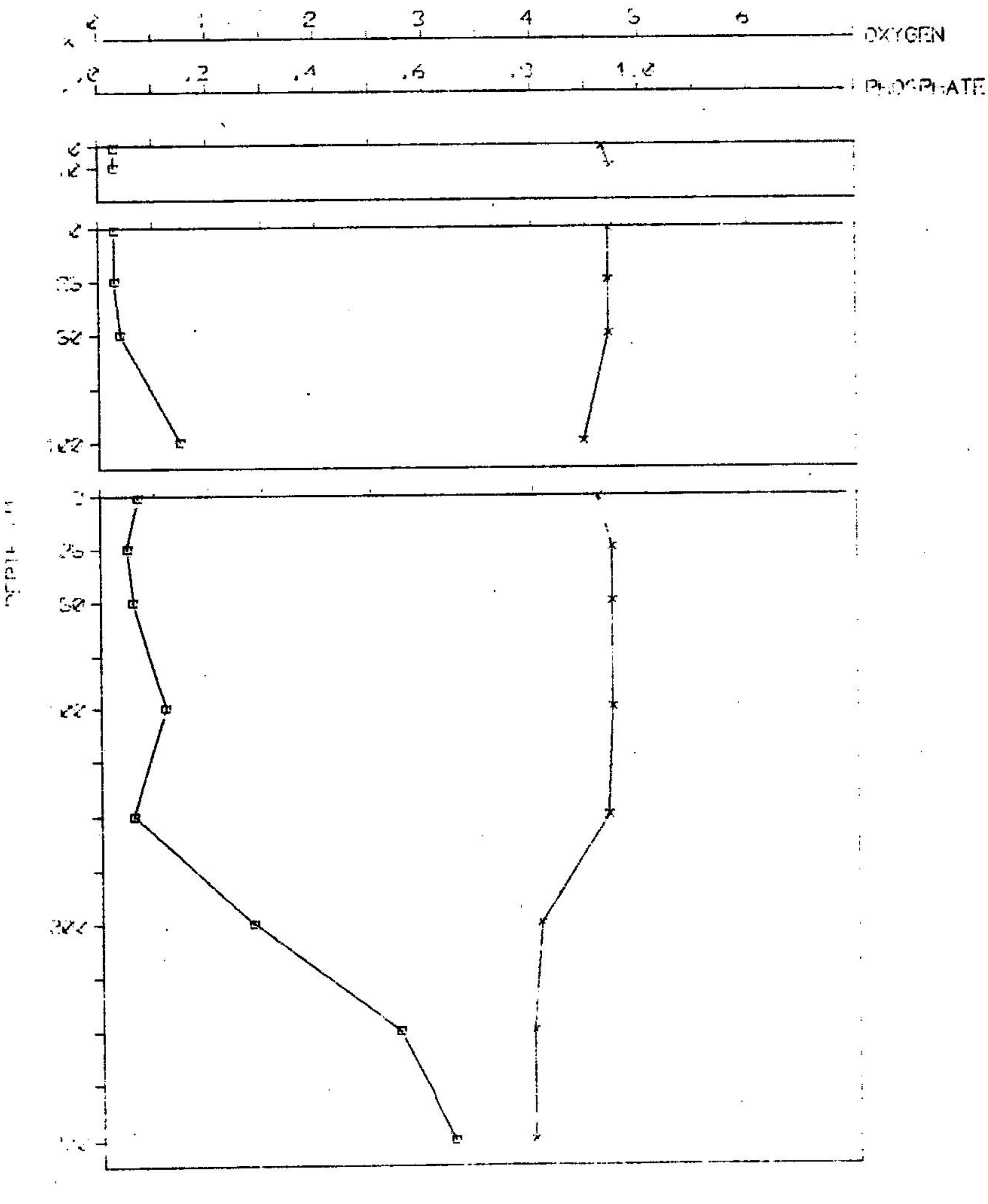
CAST 1 MESS TIME 15.6 GMT, 1138 LOCAL MAX DEPTH 300 WIRE ANGLE 4
OXYGEN TITER 1.028 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	11	27.61	27.62	27.62	35.922	23.23	4.72	6.74	100.54	.10	.
25	25	0	12	27.08	0.00	27.08	35.982	23.39	4.78	6.83	100.91	.06	.
50	50	0	15	26.86	0.00	26.86	36.007	23.54	4.83	6.90	101.88	.11	.
100	100	0	16	26.16	0.00	26.16	36.098	23.83	4.81	6.87	100.41	.10	.
150	150	0	1	22.84	0.00	22.84	36.743	25.32	4.14	5.92	79.90	.13	.
200	199	0	2	19.46	0.00	19.46	36.539	26.09	4.09	5.85	72.68	.35	.
250	249	0	3	17.81	0.00	17.81	36.410	26.41	4.12	5.89	72.28	.38	.
300	299	0	4	17.81	0.00	17.81	36.243	26.29	4.12	5.89	71.93	.50	.

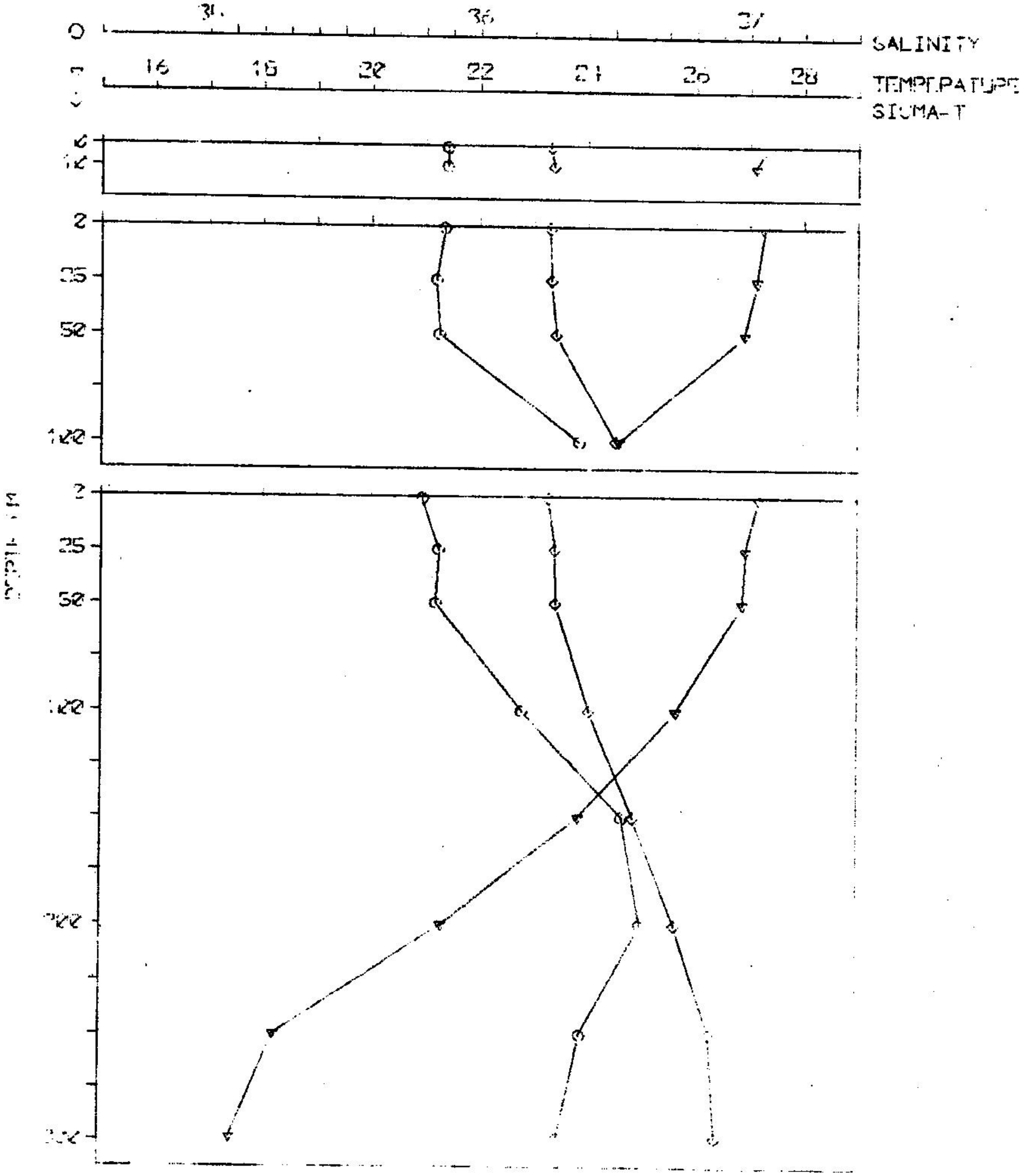
HYDROSTATION VERTICAL PROFILES FOR TEMPERATURE,
SALINITY AND SIGMA-T
TRANSECT P1-2, DATE 5/ 3/73



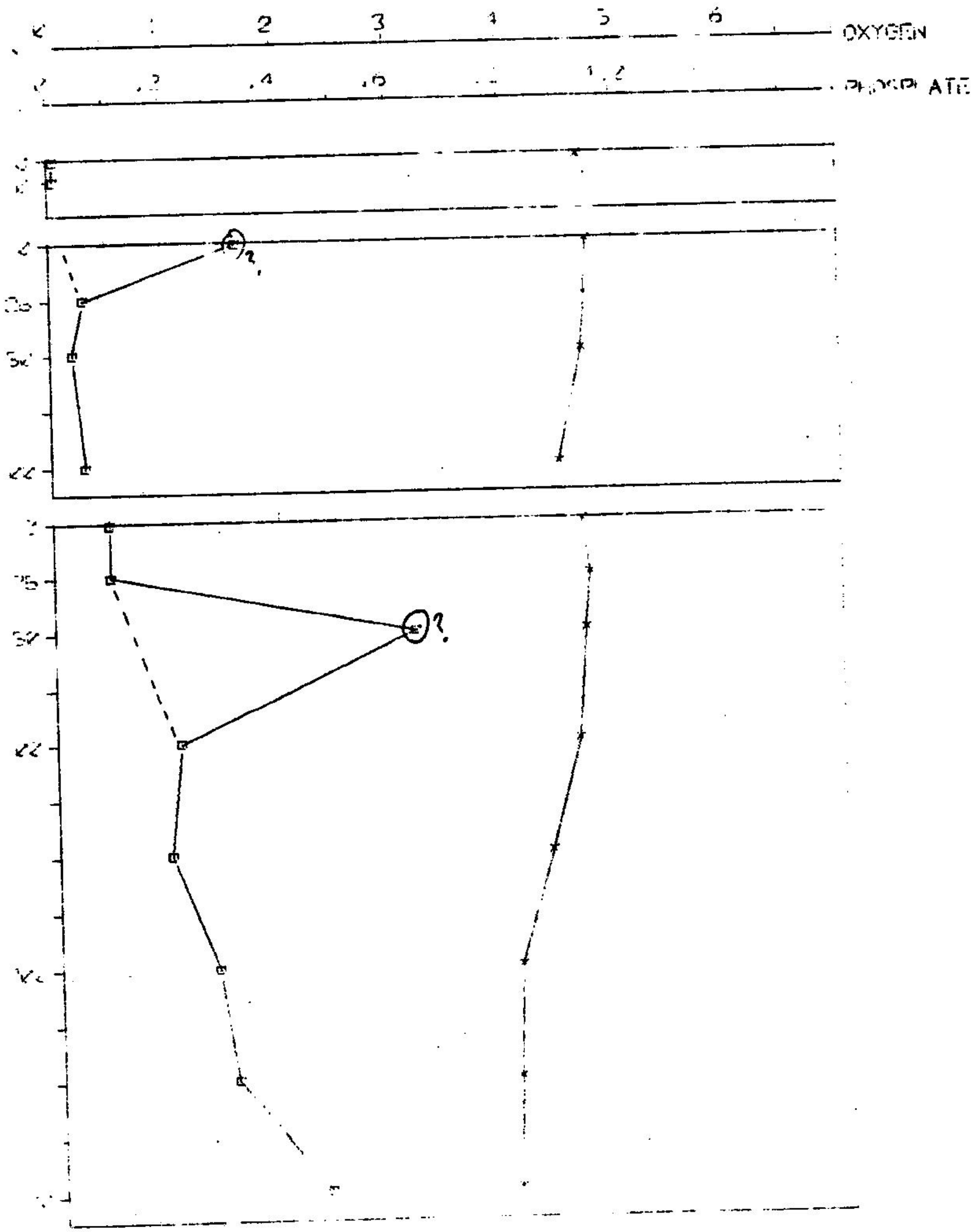
HYDROSTATION VERTICAL PROFILES FOR DISSOLVED OXYGEN AND REACTIVE PHOSPHATE.
TRANSECT PHI-2. DATE 5/ 3/73



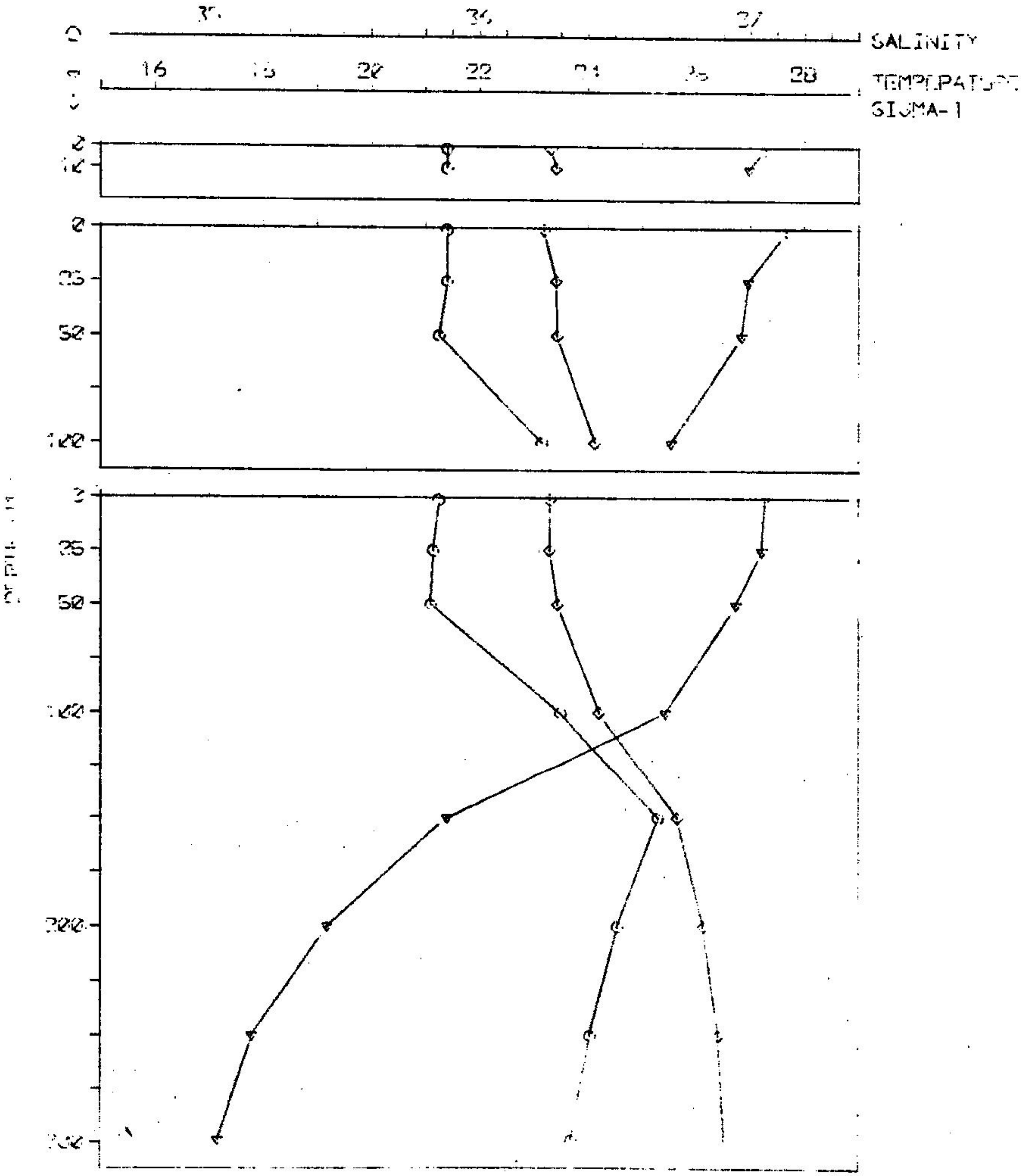
HYDROSTATION VERTICAL PROFILES FOR TEMPERATURE, SALINITY AND SIGMA-T.
TRANSECT PHI-3 DATE 5/ 2/73



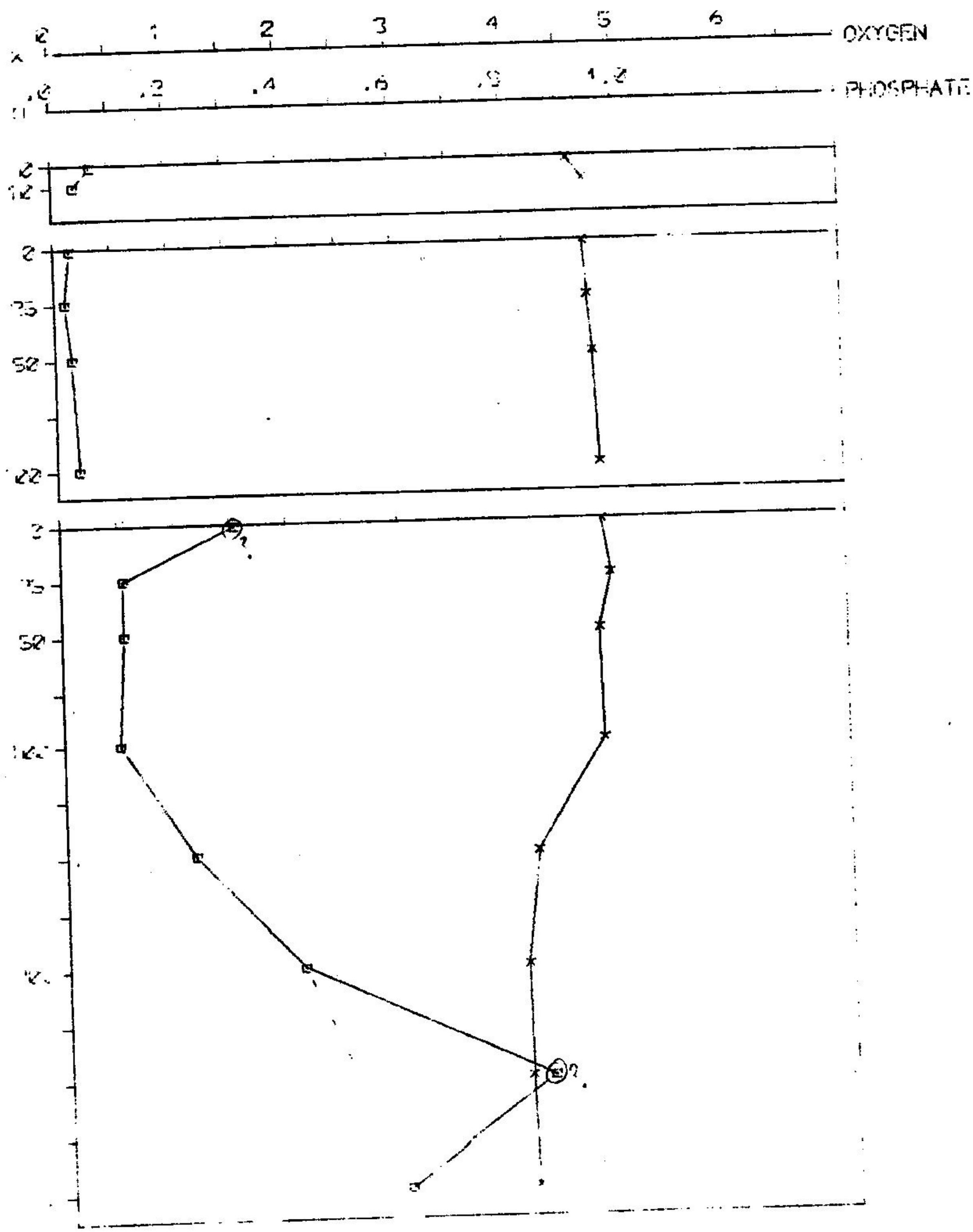
HYDROSTATION VERTICAL PROFILES FOR DISSOLVED
OXYGEN AND REACTIVE PHOSPHATE.
TRANSECT PH1 3 DATE 5/ 2/7



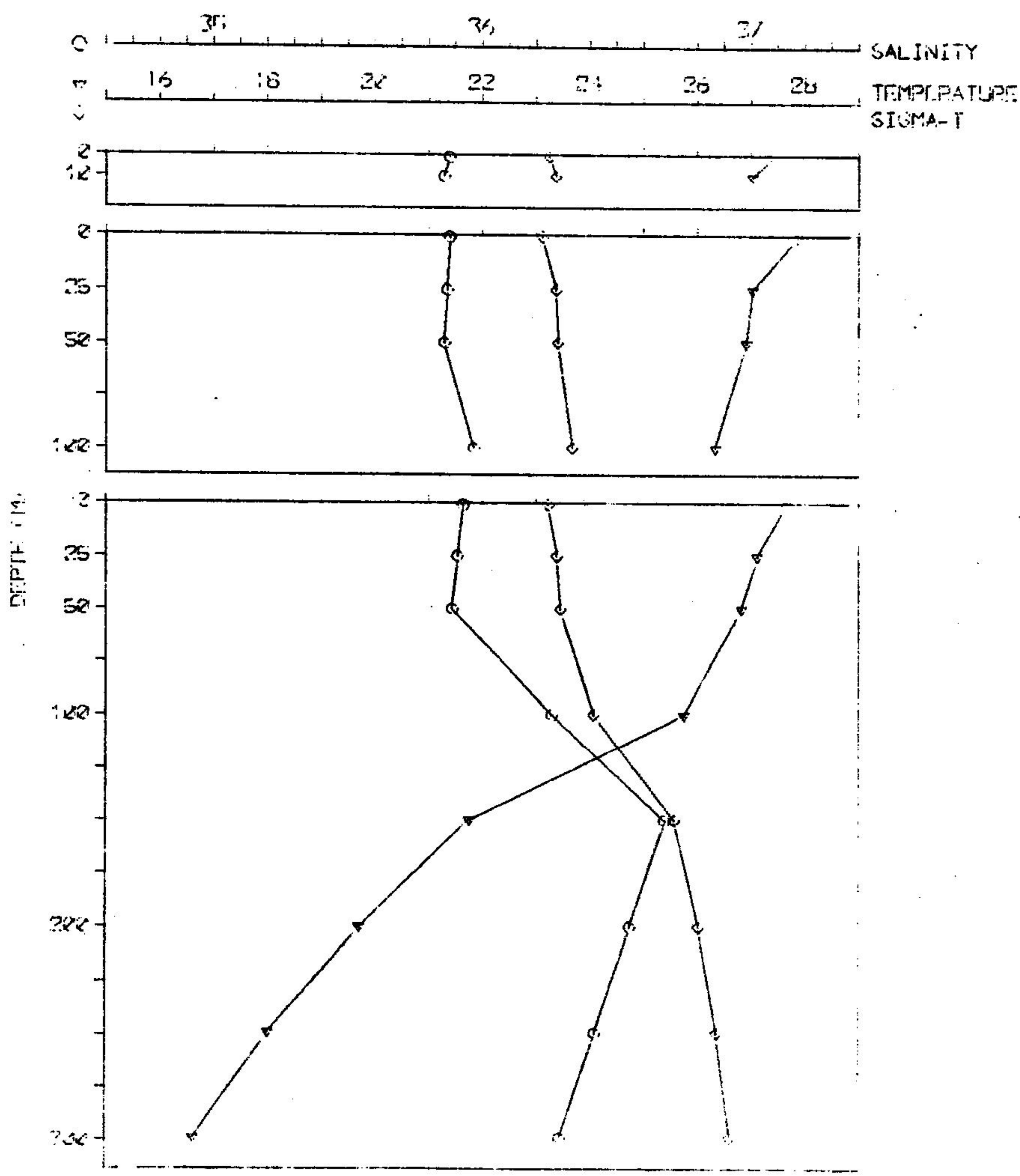
HYDRO STATION VERTICAL PROFILES FOR TEMPERATURE, SALINITY AND SIGMA-T.
TRANSECT PHI-4, DATE 5/ 1/73



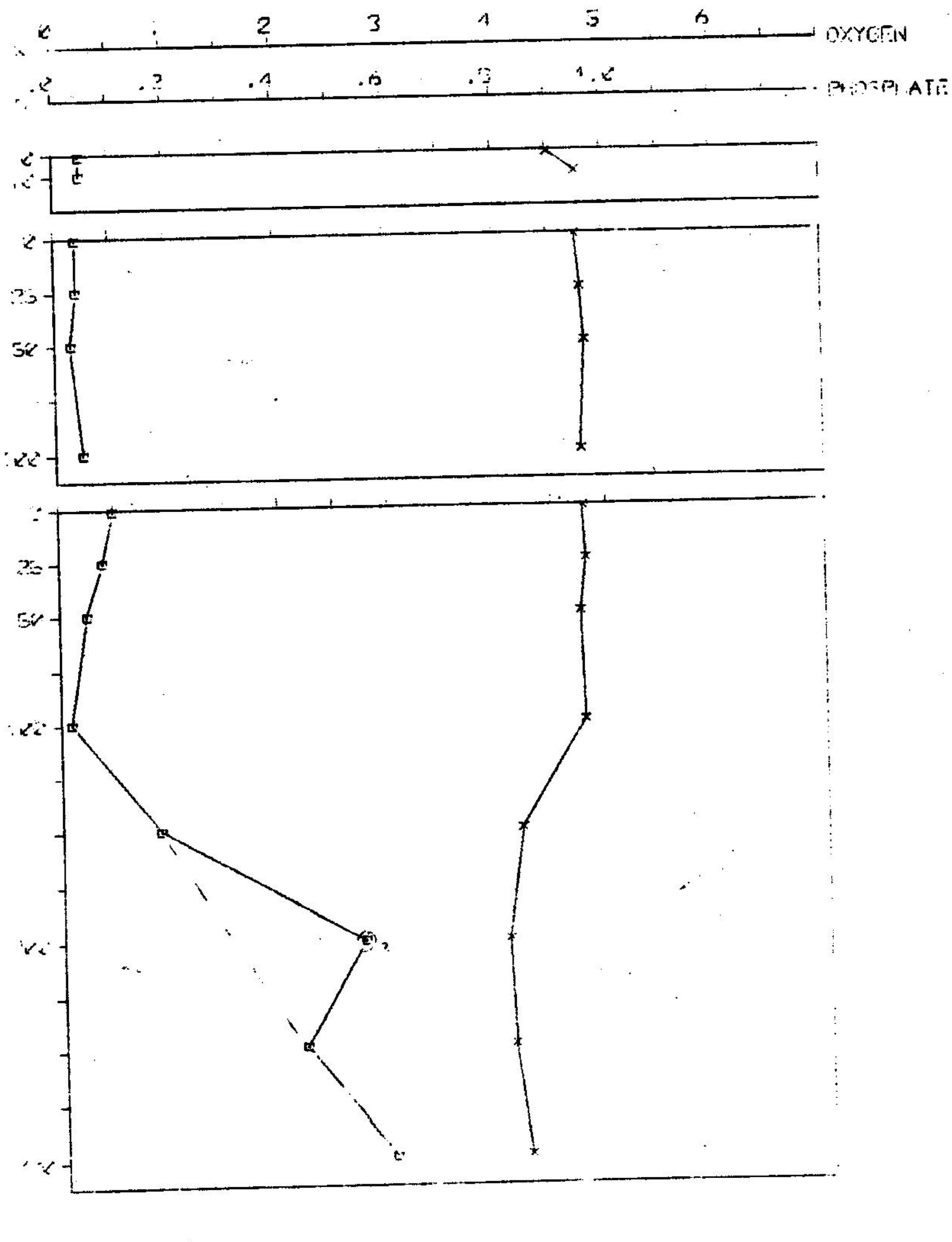
HYDROSTATION VERTICAL PROFILES FOR DISSOLVED
OXYGEN AND REACTIVE PHOSPHATE
TRANSECT PHI-4. DATE 5/ 1/73



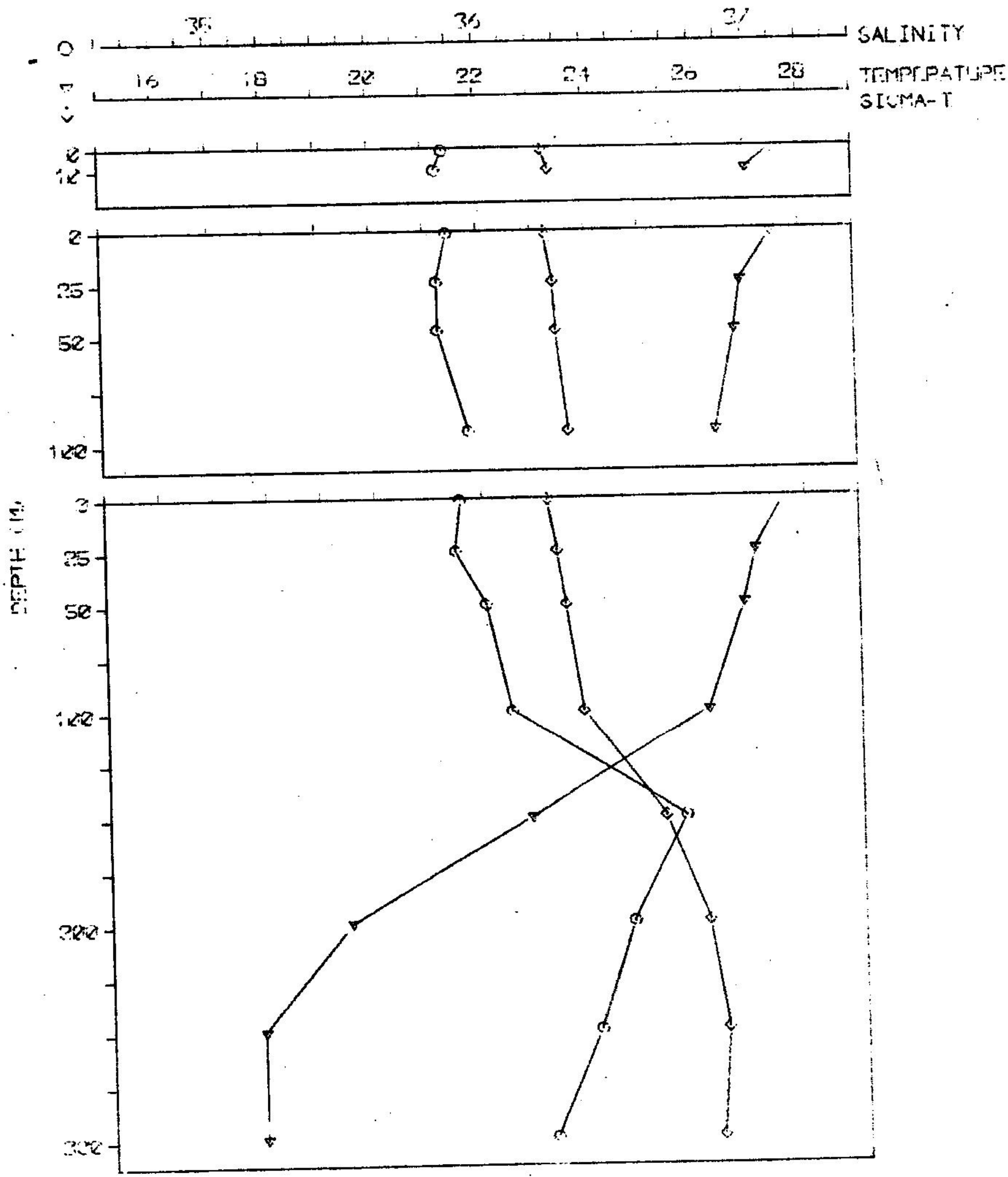
HYDROSTATION VERTICAL PROFILES FOR TEMPERATURE,
SALINITY AND SIGMA-T.
TRANSECT PHI-5, DATE 5/ 1/73



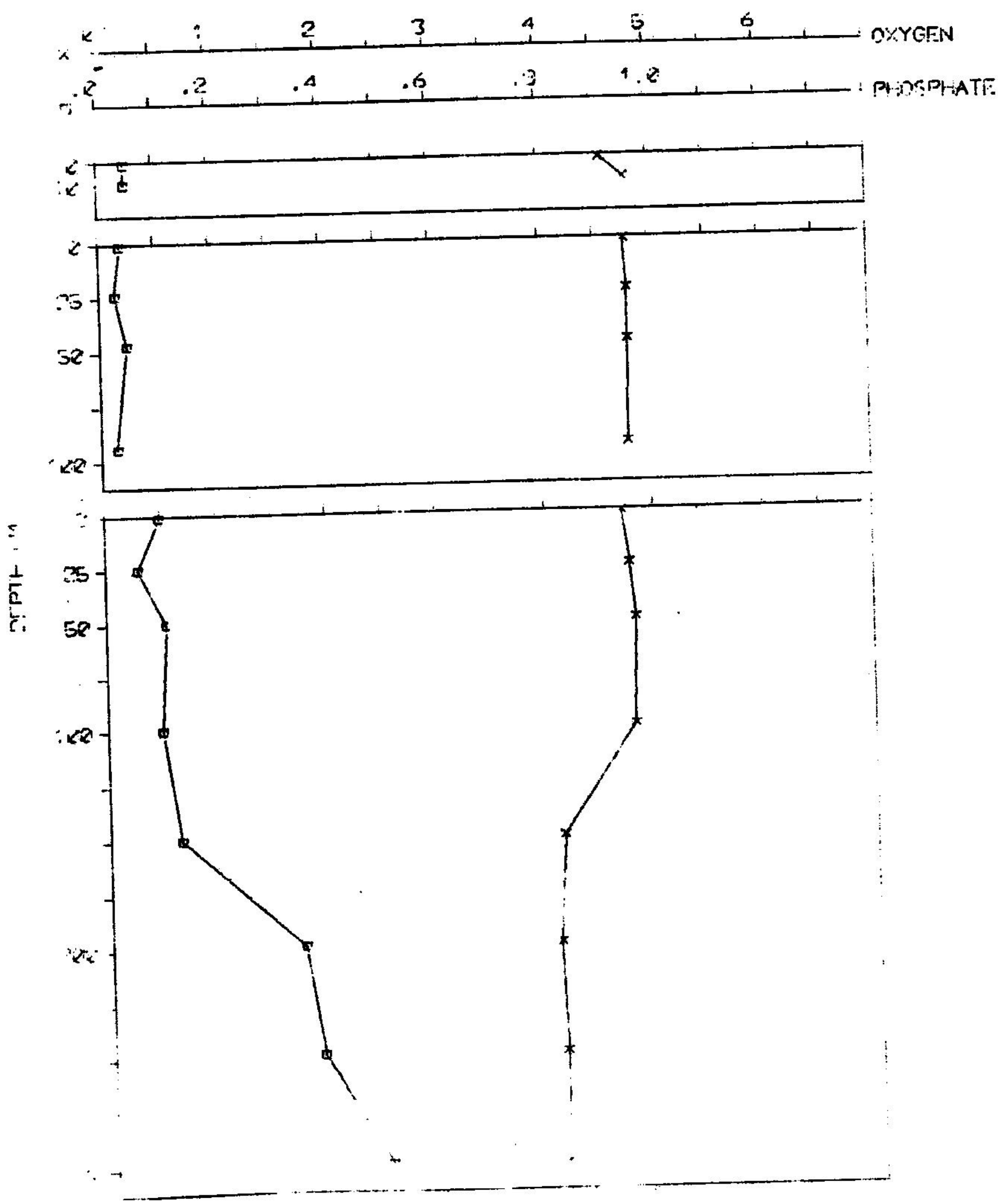
HYDROSTATION VERTICAL PROFILES FOR DISSOLVED
OXYGEN AND REACTIVE PHOSPHATE.
TRANSECT PHI-5. DATE 5/ 1/73



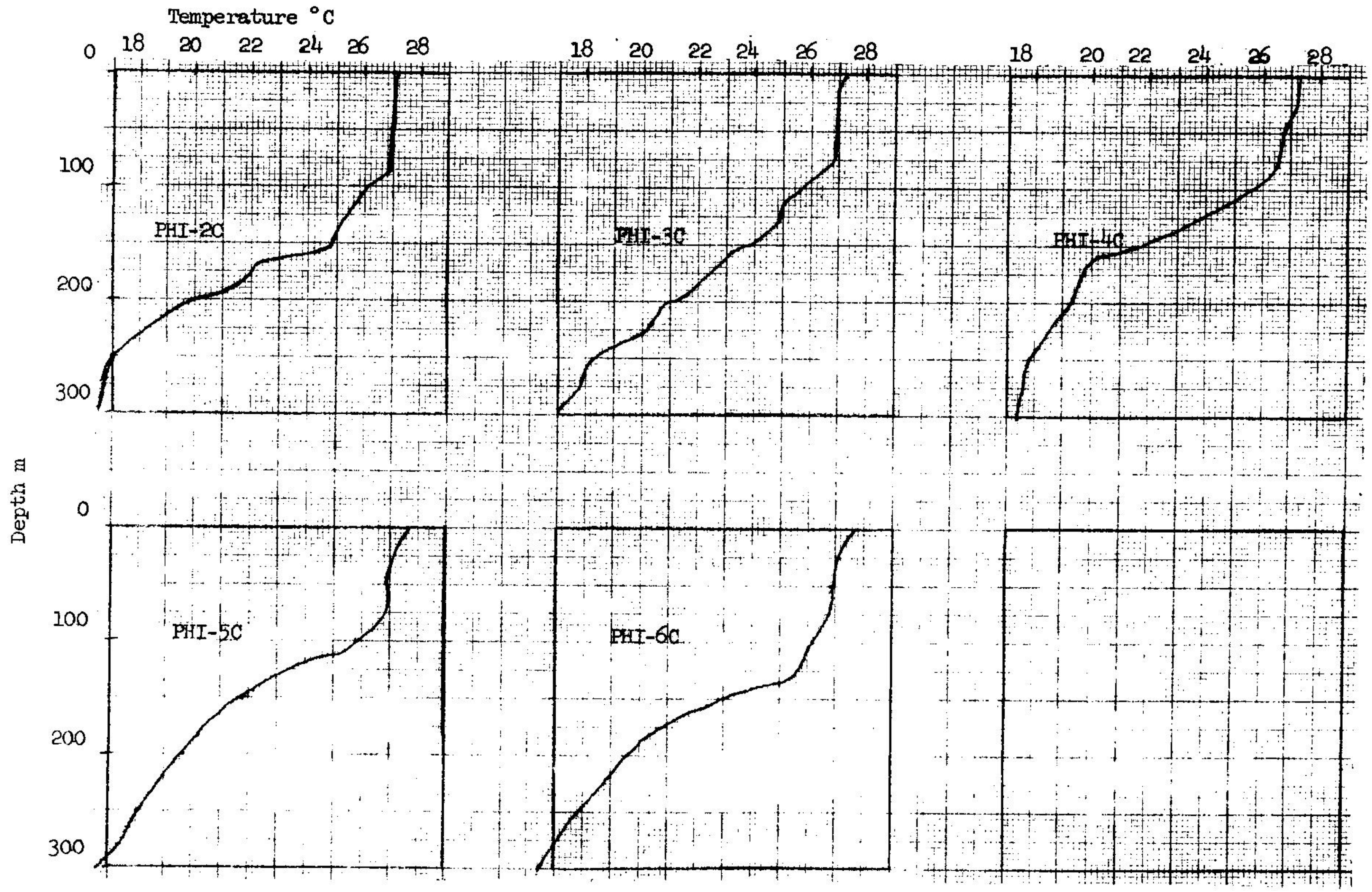
HYDROSTATION VERTICAL PROFILES FOR TEMPERATURE,
SALINITY AND SIGMA-T.
TRANSECT PHI-6, DATE 5/ 1/73



HYDROSTATION VERTICAL PROFILES FOR DISSOLVED
OXYGEN AND REACTIVE PHOSPHATE.
TRANSECT PHI-6. DATE 5/ 1/73



Bathythermograph traces for Pta. Higuero
PHI-73-2, 5-2-73



R V PALUMBO CRUISE STATION PHI-2A PRNC REFERENCE 33553

DATE	8/13/73	BARO	1017.5	WEATHER	05	WIND VELOC	11	WAVE PERIOD	5
HOUR	13.6	TEMP DRY	30.2	VISIBILITY	6	WIND DIREC	05	TRANSPAR	
LAT	18-20.8 N	TEMP WET	0.0	CLOUD TYPE	8	WAVE DIREC	32	SONIC DEP	0018
LONG	67-16.1 W	REL HUMID	072	CLOUD AMT	8	WAVE HEIGHT	1	COLOR	

CAST 1 MESS TIME 13.6 GMT, 934 LOCAL MAX DEPTH 10 WIRE ANGLE 0
OXYGEN TITER .952 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	11	28.49	28.51	28.50	35.332	22.50	4.64	6.62	98.03	.03	.
10	10	0	12	28.47	0.00	28.47	35.392	22.56	4.67	6.68	99.02	.03	.

R V PALUMBO CRUISE STATION PHI-2B PRNC REFERENCE 33562

DATE	8/13/73	BARO	1017.8	WEATHER	05	WIND VELOC	12	WAVE PERIOD	4
HOUR	17.5	TEMP DRY	30.5	VISIBILITY	7	WIND DIREC	09	TRANSPAR	
LAT	18-20.5 N	TEMP WET	0.0	CLOUD TYPE	8	WAVE DIREC	00	SONIC DEP	0367
LONG	67-16.6 W	REL HUMID	070	CLOUD AMT	3	WAVE HEIGHT	2	COLOR	

CAST 1 MESS TIME 17.5 GMT, 1328 LOCAL MAX DEPTH 100 WIRE ANGLE 0
OXYGEN TITER .952 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	11	28.63	28.62	28.62	35.334	22.46	4.80	6.86	101.60	.06	.
25	25	0	12	28.50	0.00	28.50	35.387	22.54	4.70	6.72	99.64	.09	.
50	50	0	15	28.39	0.00	28.39	35.707	22.82	4.51	6.45	96.61	.06	.
100	100	0	16	24.94	0.00	24.94	36.451	24.48	4.51	6.45	87.17	.11	.

R V PALUMBO CRUISE STATION PHI-2C PRNC REFERENCE 33563

DATE	8/14/73	BARO	1017.0	WEATHER	05	WIND VELOC	12	WAVE PERIOD	5
HOUR	14.8	TEMP DRY	28.6	VISIBILITY	6	WIND DIREC	09	TRANSPAR	
LAT	18-20.0 N	TEMP WET	0.0	CLOUD TYPE	8	WAVE DIREC	01	SONIC DEP	0494
LONG	67-17.0 W	REL HUMID	067	CLOUD AMT	6	WAVE HEIGHT	1	COLOR	

CAST 1 MESS TIME 14.8 GMT, 1049 LOCAL MAX DEPTH 300 WIRE ANGLE 10
OXYGEN TITER .952 METER WHEEL FACTOR .997

DEPTH (M) WIRE	CZ	TZ	BN	TEMP TL	TM	TAVE	SALIN	SIG T	OXYGEN ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	11	28.59	28.63	28.61	35.254	22.41	4.70	6.72	99.26	.09	.
25	25	0	12	28.51	0.00	28.51	35.369	22.52	4.57	6.53	96.76	.07	.
50	50	0	15	28.43	0.00	28.43	35.456	22.77	4.63	6.61	98.92	.08	.
100	99	0	16	26.01	0.00	26.01	36.262	24.00	4.40	6.28	90.36	.12	.
150	148	0	1	23.36	0.00	23.36	36.700	25.14	4.28	6.12	82.82	.14	.
200	197	0	2	19.56	0.00	19.56	36.570	26.09	4.04	5.77	71.83	.26	.
250	246	0	3	17.91	0.00	17.91	36.374	26.36	4.02	5.74	70.39	.44	.
300	295	0	4	16.79	0.00	16.79	36.234	26.53	3.96	5.66	68.85	.50	.

R V PALUMBO CRUISE STATION PHI-3A PRNC REFERENCE 33554

DATE 8/13/73	BARO 1017.6	WEATHER	05	WIND VELOC	09	WAVE PERIOD	5
HOUR 13.9	TEMP DRY 30.4	VISIBILITY	6	WIND DIREC	07	TRANSPAR	
LAT 18-21.4 N	TEMP WET 0.0	CLOUD TYPE	8	WAVE DIREC	32	SONIC DEP	0015
LONG 67-16.5 W	REL HUMID 073	CLOUD AMT	8	WAVE HEIGHT	1	COLOR	

CAST 1 MESS TIME 13.9 GMT, 953 LOCAL MAX DEPTH 10 WIRE ANGLE 0
OXYGEN TITER .952 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	11	28.49	28.45	28.47	35.360	22.53	4.70	6.72	99.51	.04	.
10	10	0	12	28.48	0.00	28.48	35.387	22.55	4.55	6.50	96.39	.00	.

R V PALUMBO CRUISE STATION PHI-3B PRNC REFERENCE 33561

DATE 8/13/73	BARO 1017.6	WEATHER	05	WIND VELOC	16	WAVE PERIOD	4
HOUR 17.0	TEMP DRY 30.7	VISIBILITY	7	WIND DIREC	07	TRANSPAR	
LAT 18-21.3 N	TEMP WET 0.0	CLOUD TYPE	8	WAVE DIREC	04	SONIC DEP	0180
LONG 67-17.1 W	REL HUMID 072	CLOUD AMT	3	WAVE HEIGHT	2	COLOR	

CAST 1 MESS TIME 17.0 GMT, 1259 LOCAL MAX DEPTH 100 WIRE ANGLE 4
OXYGEN TITER .952 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	11	28.57	28.56	28.57	35.347	22.49	4.70	6.72	99.57	.10	.
25	25	0	12	28.47	0.00	28.47	35.446	22.60	4.68	6.69	99.42	.06	.
50	50	0	15	28.19	0.00	28.19	35.851	22.99	4.76	6.80	102.12	.04	.
100	100	0	16	25.57	0.00	25.57	36.313	24.18	4.52	6.46	92.81	.10	.

R V PALUMBO CRUISE   STATION PHI-3C   PRNC REFERENCE 33567

DATE	8/14/73	BARO	1015.5	WEATHER	05	WIND VELOC	16	WAVE PERIOD	6
HOUR	18.8	TEMP DRY	30.2	VISIBILITY	7	WIND DIREC	07	TRANSPAR	
LAT	18-21.3 N	TEMP WET	0.0	CLOUD TYPE	8	WAVE DIREC	03	SONIC DEP	0466
LONG	67-17.8 W	REL HUMID	074	CLOUD AMT	3	WAVE HEIGHT	2	COLOR	

CAST 1 MESS TIME 18.8 GMT, 1446 LOCAL MAX DEPTH 300 WIRE ANGLE 5
OXYGEN TITER .952 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVR	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	11	28.68	28.68	28.68	35.245	22.38	4.61	6.58	97.29	.06	.
25	25	0	12	28.46	0.00	28.46	35.458	22.61	4.56	6.52	96.82	.05	.
50	50	0	15	27.82	0.00	27.82	35.979	23.21	4.54	6.49	97.25	.05	.
100	100	0	16	25.42	0.00	25.42	36.428	24.31	4.61	6.58	94.62	.09	.
150	149	0	1	21.79	0.00	21.79	36.626	25.53	4.00	5.71	76.36	.21	.
200	199	0	2	19.22	0.00	19.22	36.493	26.12	3.96	5.66	70.11	.31	.
250	249	0	3	18.02	0.00	18.02	36.353	26.32	3.87	5.52	67.71	.41	.
300	298	0	4	17.09	0.00	17.09	36.243	26.46	3.91	5.59	68.10	.50	.

R V PALUMBO CRUISE STATION PHI-4A PRNC REFERENCE 33555

DATE	8/13/73	BARO	1017.5	WEATHER	05	WIND VELOC	11	WAVE PERIOD 5
HOUR	14.2	TEMP DRY	30.5	VISIBILITY	7	WIND DIREC	07	TRANSPAR
LAT	18-22.1 N	TEMP WET	0.0	CLOUD TYPE	8	WAVE DIREC	03	SONIC DEP 0016
LONG	67-16.5 W	REL HUMID	074	CLOUD AMT	9	WAVE HEIGHT	2	COLOR

CAST 1 MESS TIME 14.2 GMT, 1011 LOCAL MAX DEPTH 10 WIRE ANGLE 0
OXYGEN TITER .952 METER WHEEL FACTOR .997

DEPTH (M) WIRE	CZ	TZ	BN	TEMP TL	TM	TAVE	SALIN	SIG T	OXYGEN ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	11	28.50	28.51	28.51	35.389	22.54	4.48	6.41	95.01	.04	.
10	10	0	12	28.47	0.00	28.47	35.399	22.56	4.63	6.61	98.04	.00	.

R V PALUMBO CRUISE STATION PHI-4B PRNC REFERENCE 33560

DATE	8/13/73	BARO	1017.7	WEATHER	05	WIND VELOC	19	WAVE PERIOD 5
HOUR	16.1	TEMP DRY	31.1	VISIBILITY	7	WIND DIREC	08	TRANSPAR
LAT	18-22.7 N	TEMP WET	0.0	CLOUD TYPE	8	WAVE DIREC	04	SONIC DEP 0174
LONG	67-18.0 W	REL HUMID	071	CLOUD AMT	4	WAVE HEIGHT	3	COLOR

CAST 1 MESS TIME 16.1 GMT, 12 7 LOCAL MAX DEPTH 100 WIRE ANGLE 9
OXYGEN TITER .952 METER WHEEL FACTOR .997

DEPTH (M) WIRE	CZ	TZ	BN	TEMP TL	TM	TAVE	SALIN	SIG T	OXYGEN ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	11	28.48	28.49	28.49	35.288	22.47	4.66	6.65	98.25	.04	.
25	25	0	12	28.47	0.00	28.47	35.480	22.62	4.70	6.72	99.95	.07	.
50	50	0	15	28.23	0.00	28.23	35.695	22.86	4.45	6.35	94.92	.10	.
100	99	0	16	26.29	0.00	26.29	36.271	23.92	4.50	6.43	92.62	.09	.

R V PALUMBO CRUISE STATION PHI-4C PRNC REFERENCE 33566

DATE	8/14/73	BARO	1015.8	WEATHER	05	WIND VELOC	18	WAVE PERIOD	5
HOUR	17.8	TEMP DRY	31.4	VISIBILITY	7	WIND DIREC	07	TRANSPAR	
LAT	18-23.4 N	TEMP WET	0.0	CLOUD TYPE	8	WAVE DIREC	05	SONIC DEP	0375
LONG	67-19.5 W	REL HUMID	072	CLOUD AMT	3	WAVE HEIGHT	3	COLOR	

CAST 1 MESS TIME 17.8 GMT, 1351 LOCAL MAX DEPTH 300 WIRE ANGLE 8
OXYGEN TITER .952 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	11	28.66	28.66	28.66	35.305	22.43	4.70	6.72	99.51	.07	.
25	25	0	12	28.47	0.00	28.47	35.437	22.59	4.61	6.58	97.77	.06	.
50	50	0	15	28.39	0.00	28.39	35.673	22.79	4.57	6.53	97.71	.06	.
100	99	0	16	25.48	0.00	25.48	36.410	24.28	4.51	6.45	92.68	.09	.
150	149	0	1	22.80	0.00	22.80	36.802	25.38	4.25	6.07	81.99	.13	.
200	198	0	2	20.39	0.00	20.39	36.682	25.96	3.99	5.70	75.58	.21	.
250	247	0	3	18.21	0.00	18.21	36.444	26.34	4.08	5.84	71.81	.33	.
300	297	0	4	17.15	0.00	17.15	36.294	26.49	4.04	5.77	70.35	.43	.

R V PALUMBO CRUISE STATION PHI-5A PRNC REFERENCE 33556

DATE	8/13/73	BARO	1017.8	WEATHER	05	WIND VELOC	14	WAVE PERIOD	5
HOUR	14.5	TEMP DRY	30.6	VISIBILITY	7	WIND DIREC	07	TRANSPAR	
LAT	18-22.6 N	TEMP WET	0.0	CLOUD TYPE	8	WAVE DIREC	04	SONIC DEP	0016
LONG	67-15.8 W	REL HUMID	073	CLOUD AMT	8	WAVE HEIGHT	2	COLOR	

CAST 1 MESS TIME 14.5 GMT, 1033 LOCAL MAX DEPTH 10 WIRE ANGLE 0
OXYGEN TITER .952 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	XSAT	PHOS	NITRA
0	1	0	11	28.51	28.50	28.51	35.355	22.52	4.68	6.69	99.12	.04	.
10	10	0	12	28.49	0.00	28.49	35.361	22.53	4.43	6.32	93.69	.00	.

R V PALUMBO CRUISE STATION PHI-5B PRNC REFERENCE 33559

DATE	8/13/73	BARO	1017.8	WEATHER	05	WIND VELOC	16	WAVE PERIOD	5
HOUR	15.7	TEMP DRY	30.0	VISIBILITY	6	WIND DIREC	09	TRANSPAR	
LAT	18-23.5 N	TEMP WET	0.0	CLOUD TYPE	8	WAVE DIREC	05	SONIC DEP	0180
LONG	67-16.6 W	REL HUMID	073	CLOUD AMT	7	WAVE HEIGHT	3	COLOR	

CAST 1 MESS TIME 15.7 GMT, 1141 LOCAL MAX DEPTH 100 WIRE ANGLE 20
OXYGEN TITER .952 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	XSAT	PHOS	NITRA
0	1	0	11	28.47	28.50	28.49	35.278	22.46	4.69	6.71	99.02	.06	.
25	24	0	12	28.46	0.00	28.46	35.334	22.52	4.75	6.79	100.40	.06	.
50	47	0	15	28.48	0.00	28.48	35.401	22.56	4.70	6.72	99.67	.08	.
100	94	0	16	28.17	0.00	28.17	35.907	23.04	4.72	6.75	101.47	.09	.

R V PALUMBO CRUISE STATION PHI-5C PRNC REFERENCE 33565

DATE	8/14/73	BARO	1016.1	WEATHER	05	WIND VELOC	14	WAVE PERIOD	5
HOUR	17.1	TEMP DRY	31.8	VISIBILITY	7	WIND DIREC	08	TRANSPAR	
LAT	18-24.6 N	TEMP WET	0.0	CLOUD TYPE	8	WAVE DIREC	04	SONIC DEP	0438
LONG	67-17.4 W	REL HUMID	071	CLOUD AMT	2	WAVE HEIGHT	3	COLOR	

CAST 1 MESS TIME 17.1 GMT, 13.7 LOCAL MAX DEPTH 300 WIRE ANGLE 10
OXYGEN TITER .952 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	11	28.56	28.53	28.55	35.405	22.54	4.58	6.54	97.14	.11	.
25	25	0	12	28.48	0.00	28.48	35.400	22.56	4.62	6.60	97.85	.07	.
50	50	0	15	28.48	0.00	28.48	35.480	22.62	4.56	6.52	96.96	.07	.
100	99	0	16	26.03	0.00	26.03	36.264	24.00	4.65	6.64	95.45	.07	.
150	148	0	1	21.40	0.00	21.40	36.776	25.75	4.05	5.78	77.29	.14	.
200	197	0	2	19.19	0.00	19.19	36.550	26.17	4.09	5.85	72.62	.29	.
250	246	0	3	17.85	0.00	17.85	36.396	26.39	4.16	5.94	72.91	.34	.
300	295	0	4	17.07	0.00	17.07	36.291	26.50	4.14	5.92	72.15	.43	.

R V PALUMBO CRUISE STATION PHI-6A PRNC REFERENCE 33557

DATE	8/13/73	BARO	1017.8	WEATHER	05	WIND VELOC	16	WAVE PERIOD	4
HOUR	14.8	TEMP DRY	30.9	VISIBILITY	7	WIND DIREC	08	TRANSPAR	
LAT	18-22.8 N	TEMP WET	0.0	CLOUD TYPE	8	WAVE DIREC	04	SONIC DEP	0015
LONG	67-15.2 W	REL HUMID	073	CLOUD AMT	9	WAVE HEIGHT	2	COLOR	

CAST 1 MESS TIME 14.8 GMT, 1050 LOCAL MAX DEPTH 10 WIRE ANGLE 0
OXYGEN TITER .952 METER WHEEL FACTOR .997

DEPTH (M) WIRE	CZ	TZ	BN	TEMP TL	TM	TAVE	SALIN	SIG T	OXYGEN ML/L	MG/L	XSAT	PHOS	NITRA
0	1	0	11	28.46	28.47	28.47	35.282	22.47	4.80	6.86	101.22	.05	.
10	10	0	12	28.47	0.00	28.47	35.302	22.49	4.49	6.42	94.87	.03	.

R V PALUMBO CRUISE STATION PHI-6B PRNC REFERENCE 33558

DATE	8/13/73	BARO	1017.7	WEATHER	05	WIND VELOC	12	WAVE PERIOD	4
HOUR	15.2	TEMP DRY	31.1	VISIBILITY	7	WIND DIREC	07	TRANSPAR	
LAT	18-23.9 N	TEMP WET	0.0	CLOUD TYPE	8	WAVE DIREC	04	SONIC DEP	0200
LONG	67-15.5 W	REL HUMID	074	CLOUD AMT	7	WAVE HEIGHT	2	COLOR	

CAST 1 MESS TIME 15.2 GMT, 1114 LOCAL MAX DEPTH 100 WIRE ANGLE 15
OXYGEN TITER .952 METER WHEEL FACTOR .997

DEPTH (M) WIRE	CZ	TZ	BN	TEMP TL	TM	TAVE	SALIN	SIG T	OXYGEN ML/L	MG/L	XSAT	PHOS	NITRA
0	1	0	11	28.34	28.36	28.35	35.054	22.34	4.69	6.71	98.09	.05	.
25	25	0	12	28.45	0.00	28.45	35.393	22.56	4.68	6.69	99.20	.07	.
50	49	0	15	28.50	0.00	28.50	35.639	22.73	4.61	6.58	98.55	.00	.
100	97	0	16	29.03	0.00	29.03	35.709	22.61	4.78	6.83	103.29	.00	.

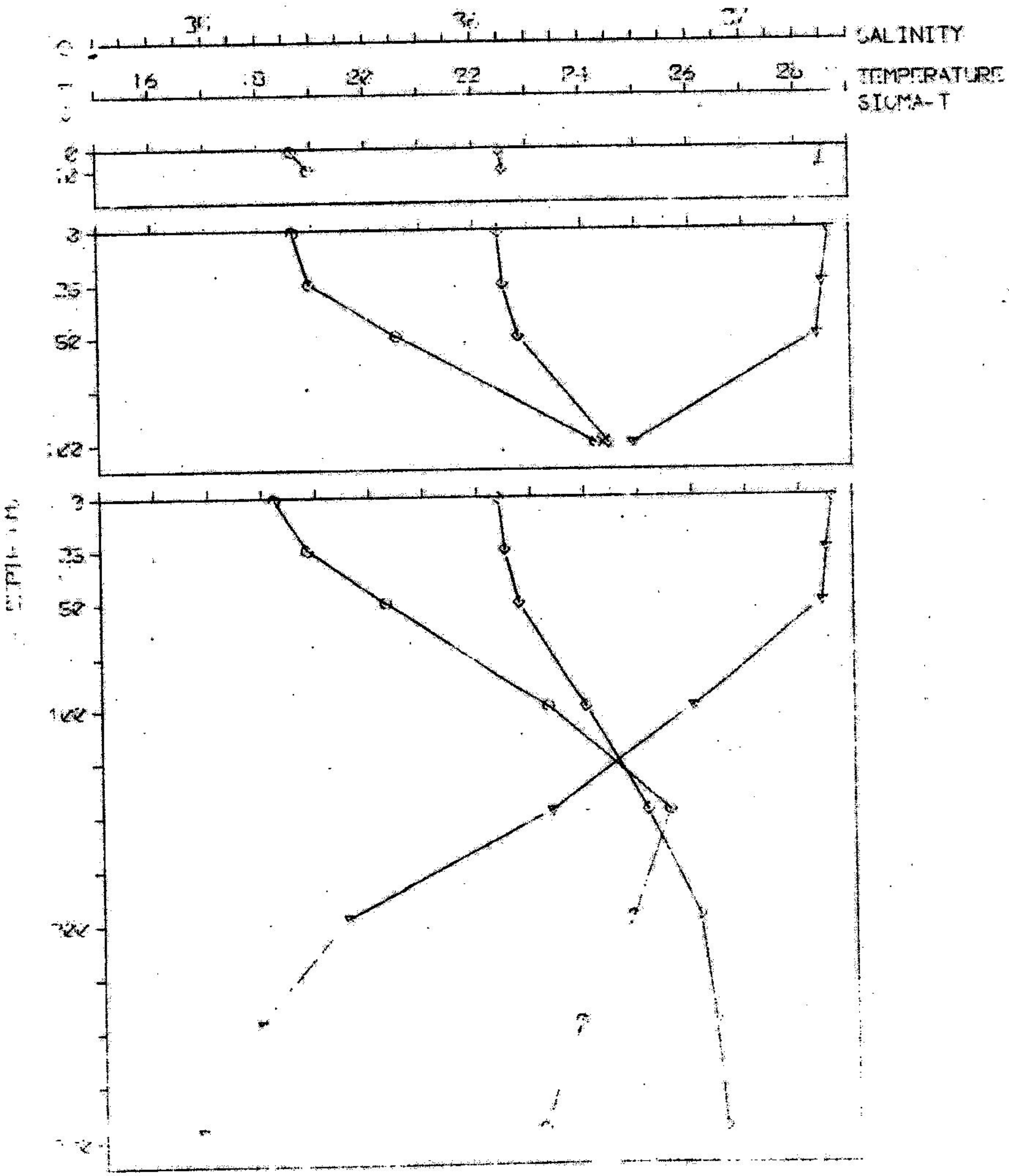
R V PALUMBO CRUISE STATION PHI-6C PRNC REFERENCE 33564

DATE	8/14/73	BARO	1016,2	WEATHER	05	WIND VELOC	14	WAVE PERIOD	5
HOUR	16,5	TEMP DRY	31,9	VISIBILITY	7	WIND DIREC	08	TRANSPAR	
LAT	18-25,1 N	TEMP WET	0,0	CLOUD TYPE	8	WAVE DIREC	05	SONIC DEP	0475
LONG	67-15,8 W	REL HUMID	070	CLOUD AMT	3	WAVE HEIGHT	2	COLOR	

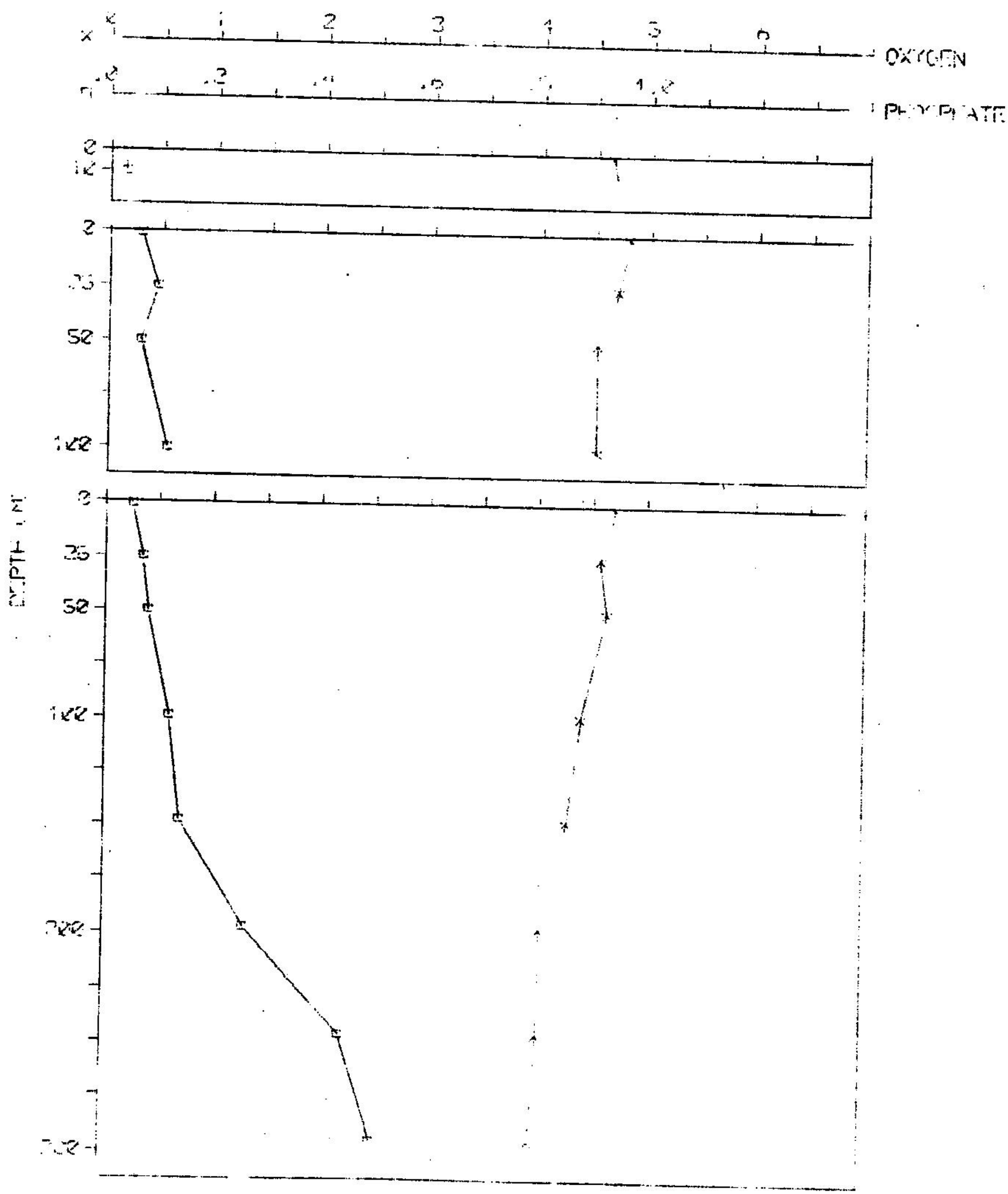
CAST 1 MESS TIME 16,5 GMT, 1228 LOCAL MAX DEPTH 300 WIRE ANGLE 2
OXYGEN TITER ,952 METER WHEEL FACTOR ,997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	XSAT	PHOS	NITRA
0	1	0	11	28,53	28,52	28,53	35,450	22,58	4,61	6,58	97,88	,06	.
25	25	0	12	28,48	0,00	28,48	35,462	22,60	4,47	6,38	94,84	,08	.
50	50	0	15	28,47	0,00	28,47	35,644	22,74	4,54	6,49	97,10	,06	.
100	100	0	16	25,36	0,00	25,36	36,426	24,33	4,47	6,38	91,66	,08	.
150	150	0	1	21,19	0,00	21,19	36,794	25,82	4,04	5,77	77,01	,18	.
200	200	0	2	19,53	0,00	19,53	36,977	26,41	4,05	5,78	73,25	,42	.
250	250	0	3	18,10	0,00	18,10	36,470	26,39	4,04	5,77	70,99	,39	.
300	299	0	4	16,71	0,00	16,71	36,234	26,55	4,08	5,84	70,98	,50	.

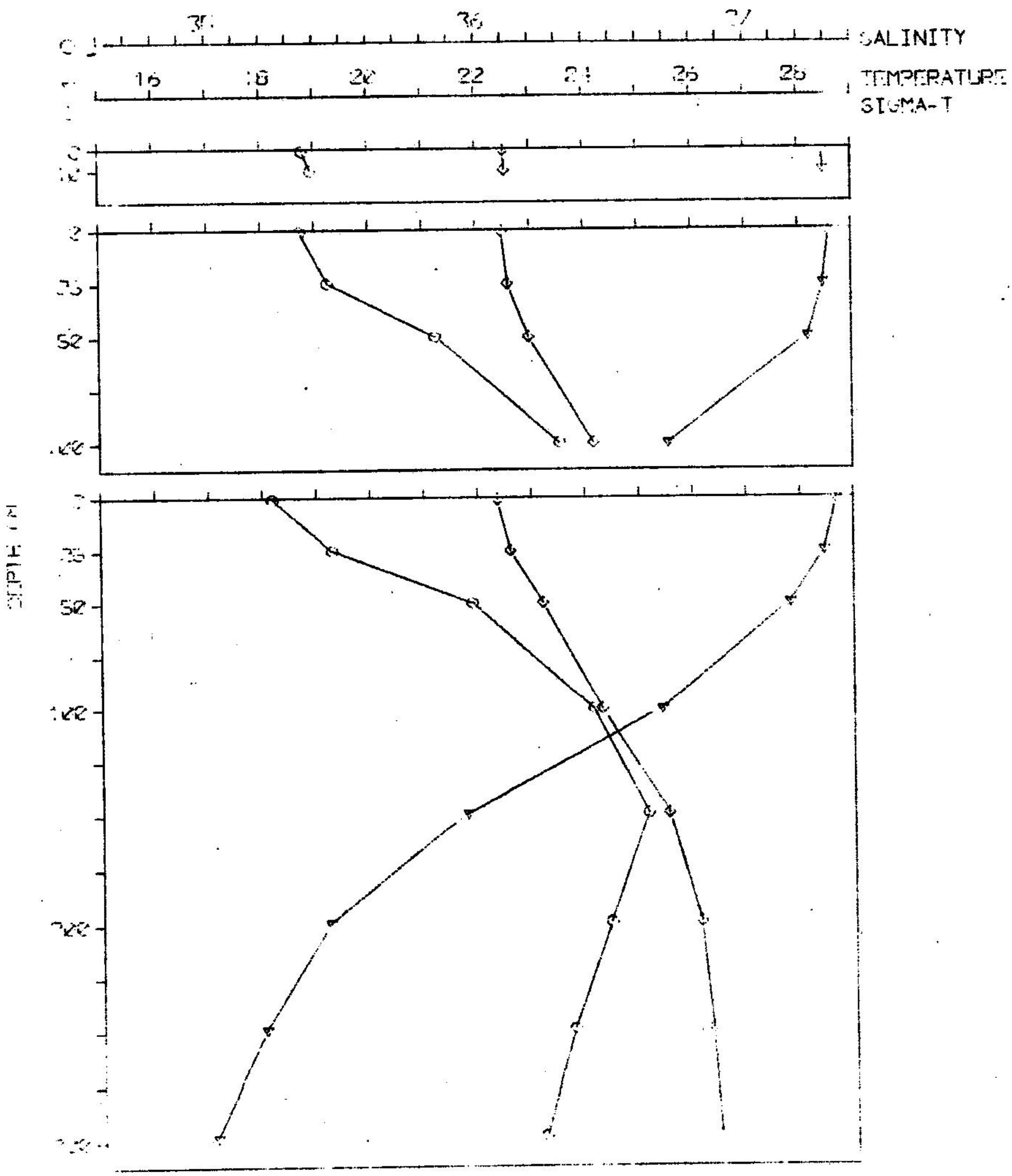
HYDROSTATION VERTICAL PROFILES FOR TEMPERATURE,
SALINITY AND SIGMA-T.
TRANSECT PHI-2. DATE 8/13/73



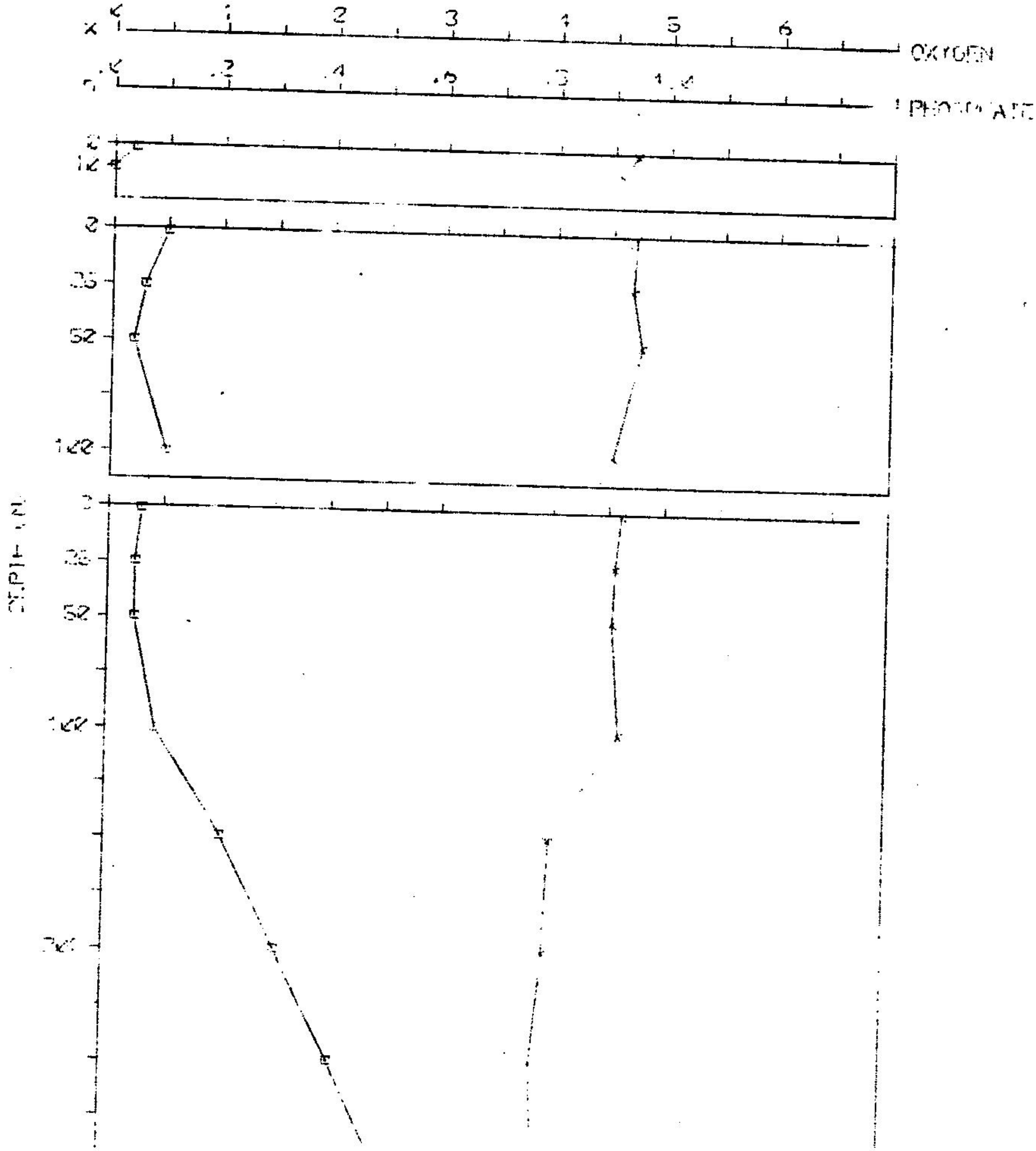
HYDROXYLATION VERTICAL PROFILES FOR DISSOLVED OXYGEN AND REACTIVE PHOSPHATE.
TRANSECT PHI-2. DATE 8/13/78



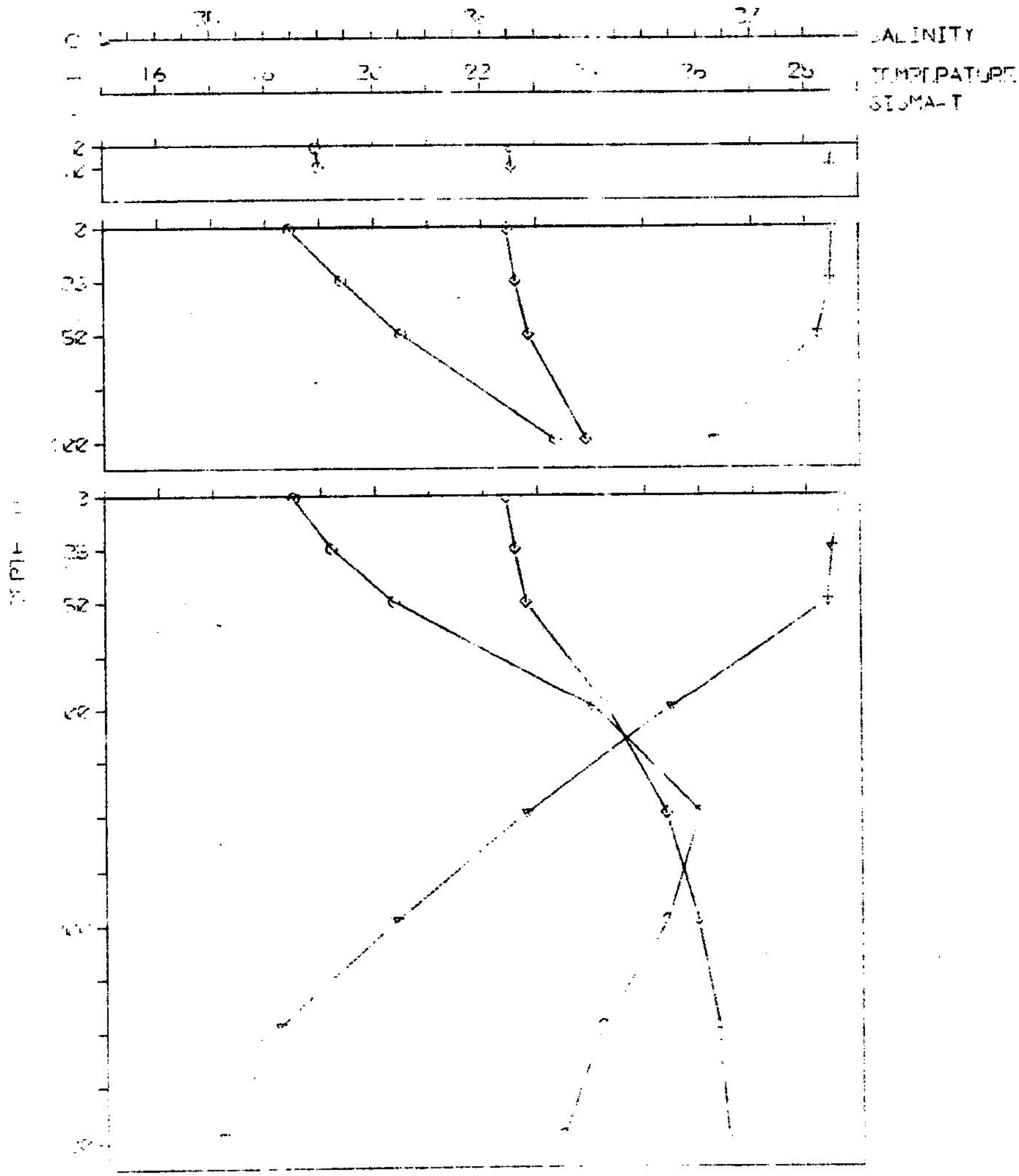
HYDROSTATION VERTICAL PROFILES FOR TEMPERATURE, SALINITY AND SIGMA-T.
TRANSECT PHI-3. DATE 8/13/73



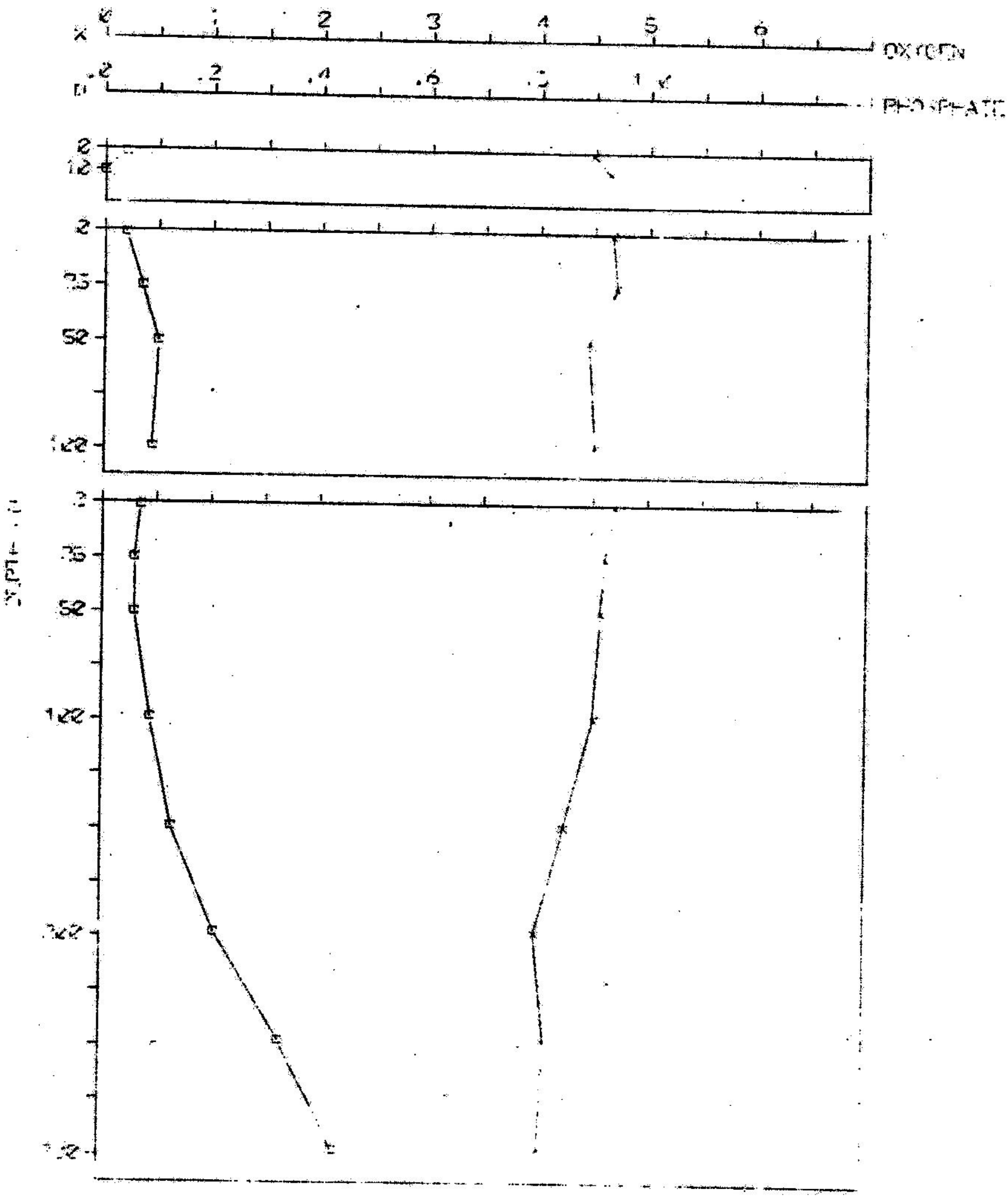
HYPOLIMNETIC [illegible] VERTICAL PROFILES FOR DISSOLVED OXYGEN AND REACTIVE PHOSPHATE.
TRANSECT [illegible] 3 DATE 8/13/73



...STATION VERTICAL PR...S FOR TEMPERATURE,
SALINITY AND SIGMA-T
TRANSECT P..-4 DATE 8/13 7.



HYDROSTATION VERTICAL PROFILES FOR DISSOLVED
OXYGEN AND REACTIVE PHOSPHATE.
TRANSECT PHI-4. DATE 8/13/73



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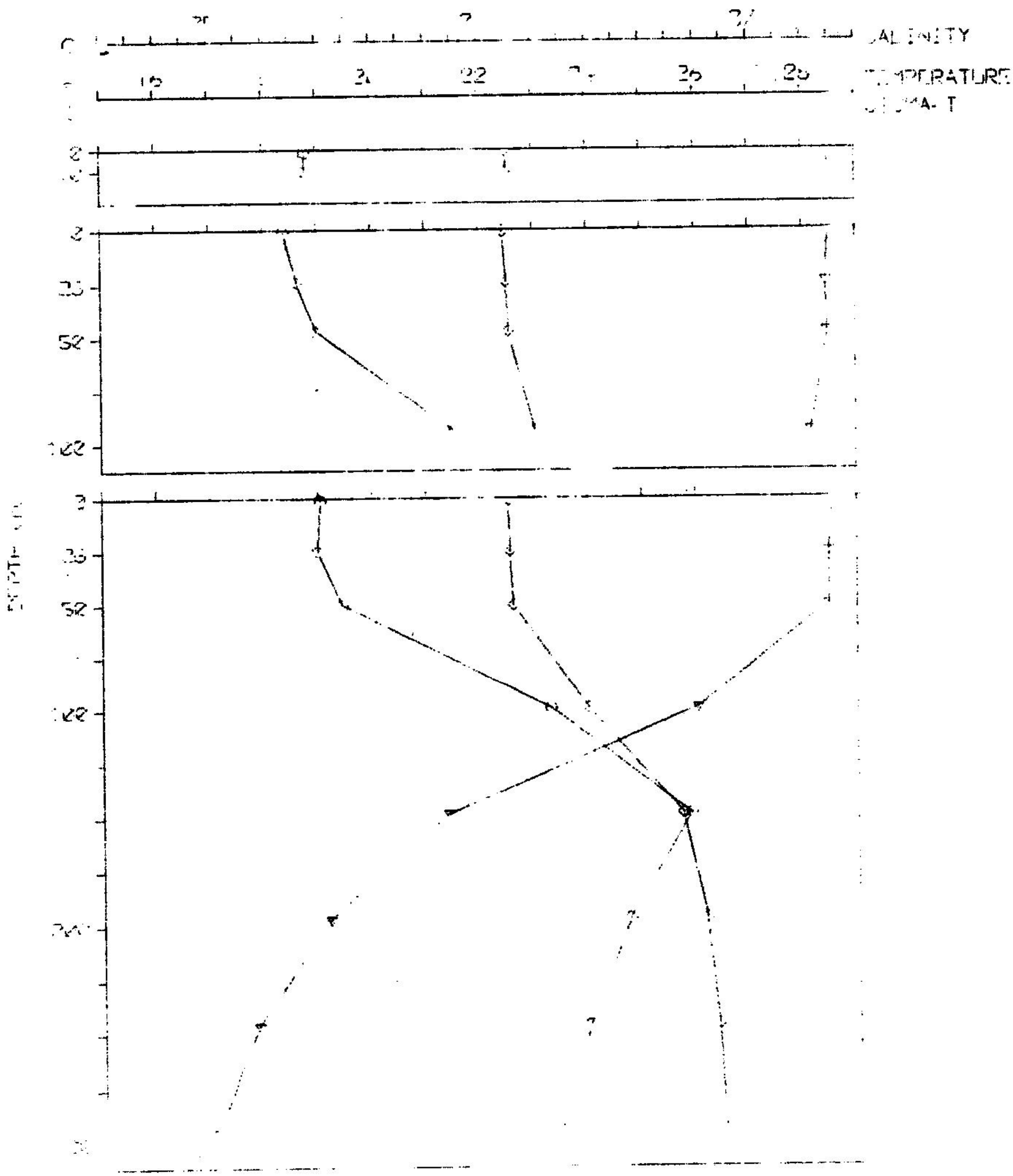
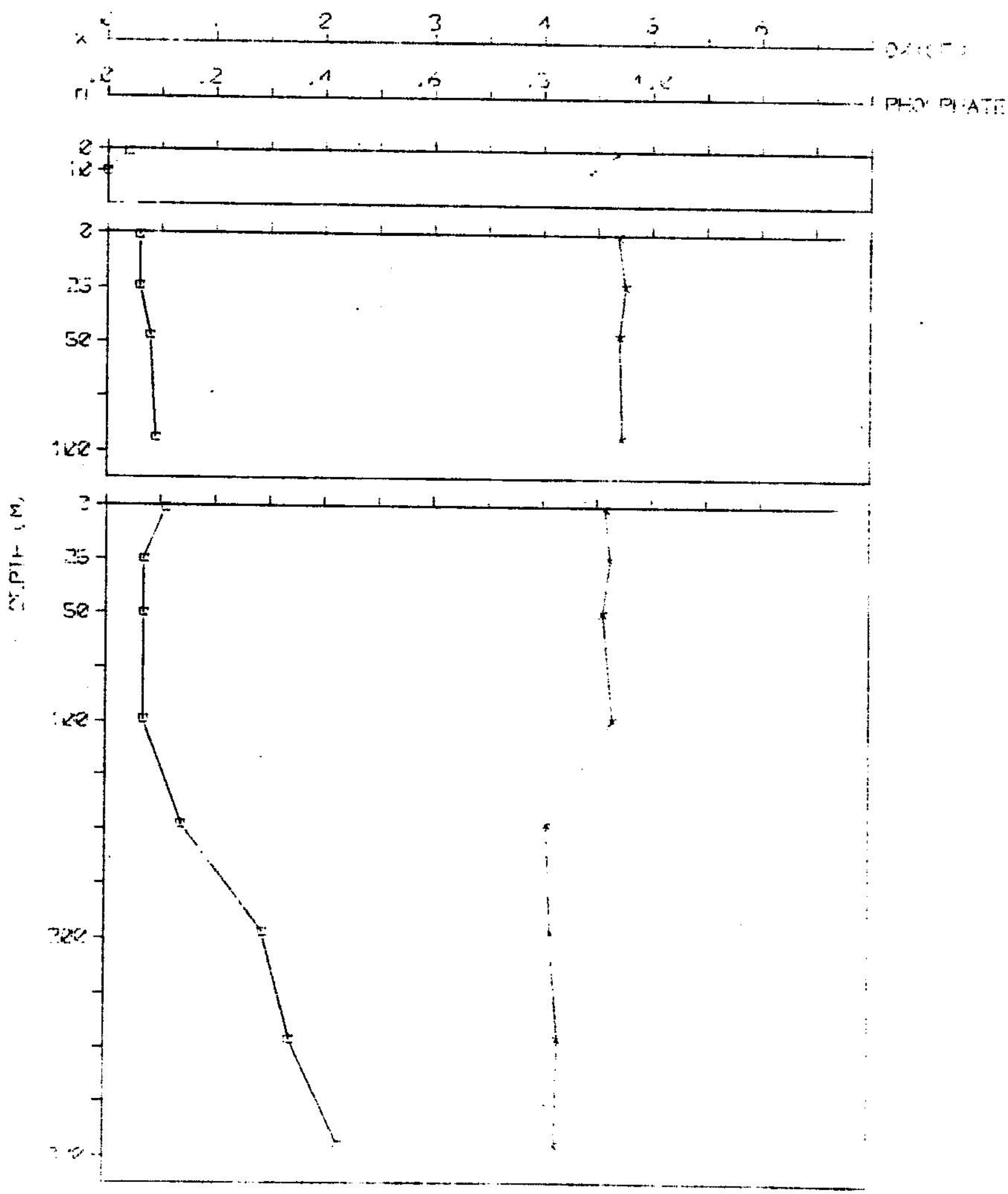
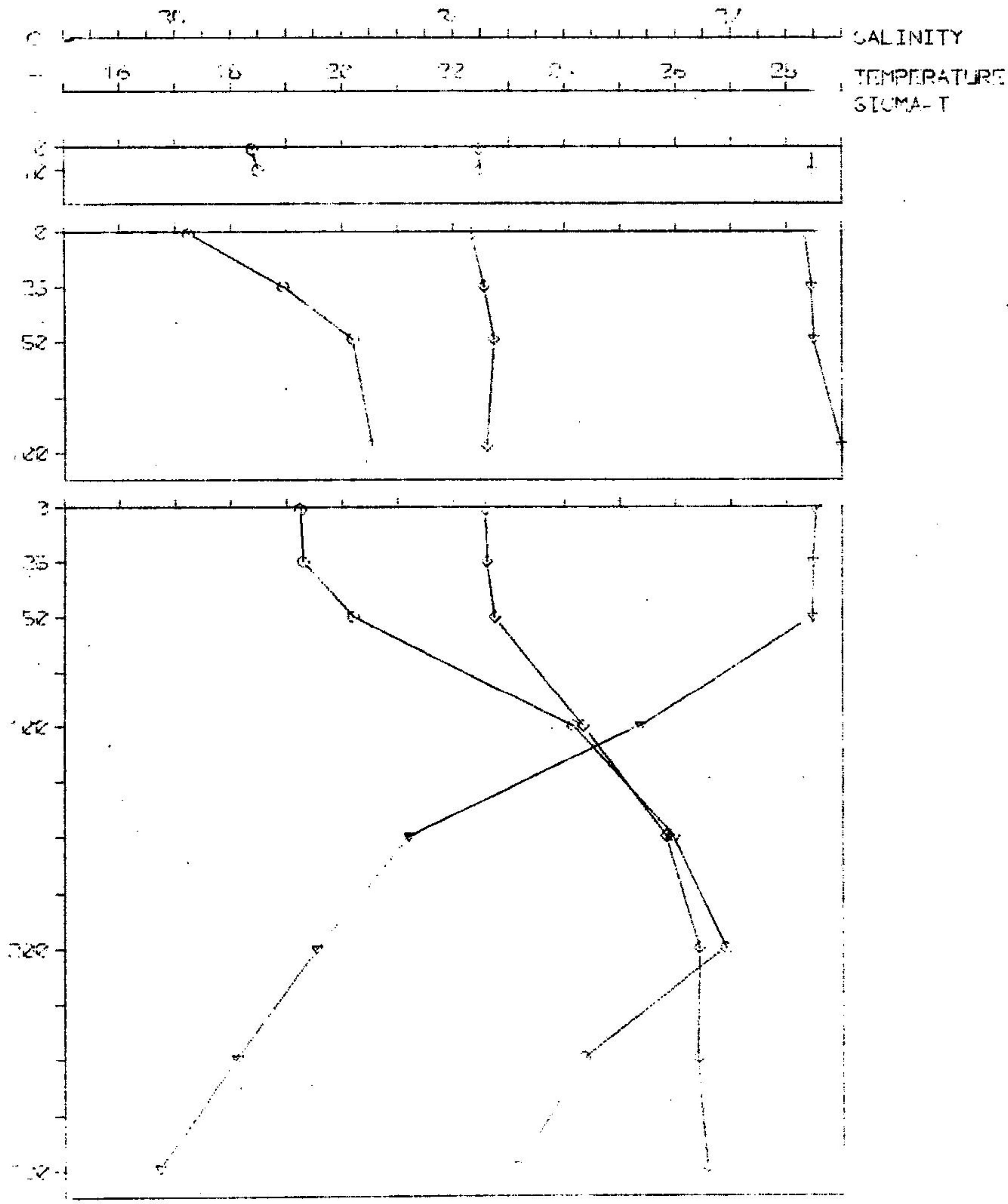
TRANSECT [illegible] DATE 8/[illegible]



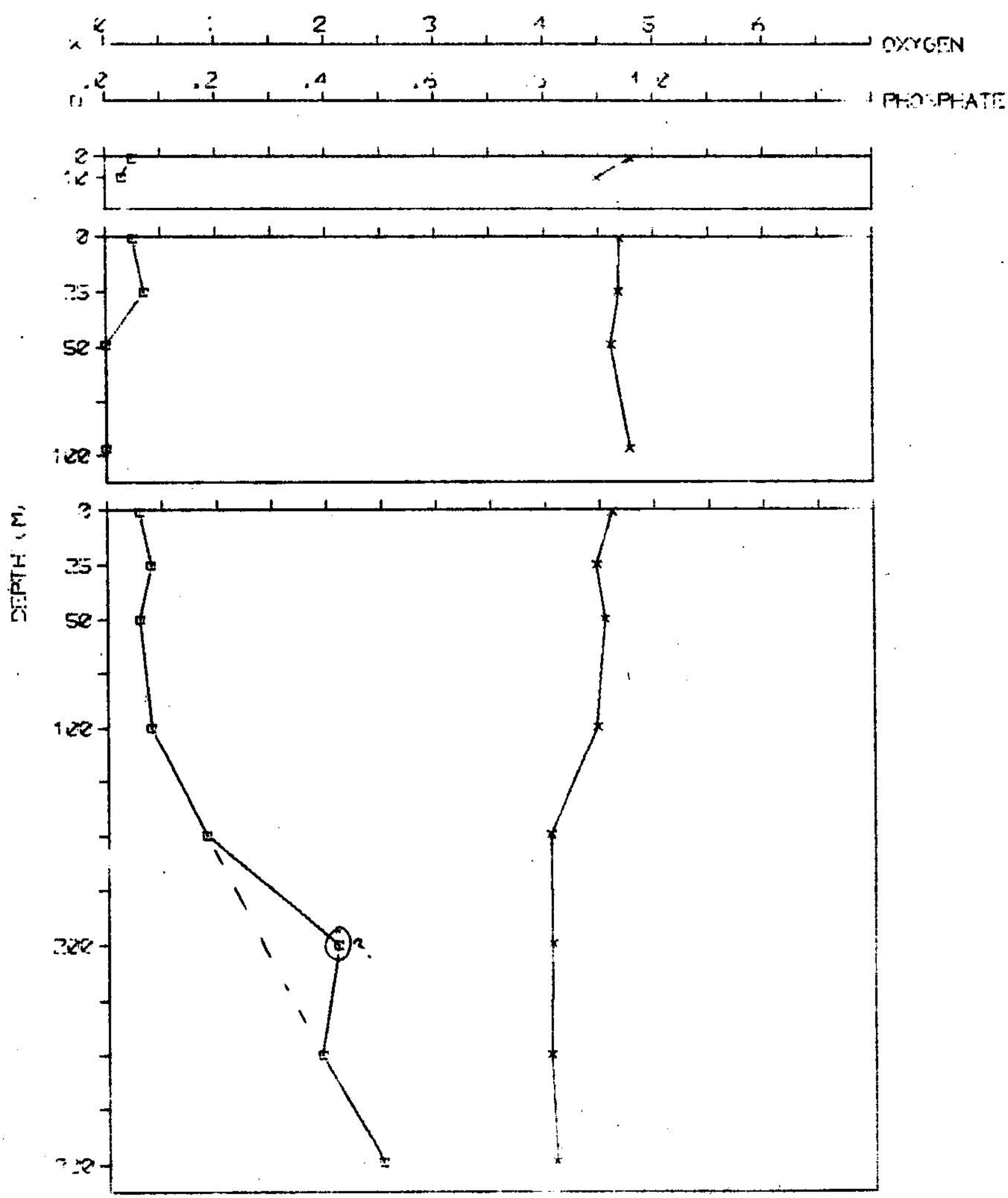
HYPO STATION VERTICAL PROFILES FOR DISSOLVED
OXYGEN AND REACTIVE PHOSPHATE
TRANSECT 24 1-5, DATE 8/13/73



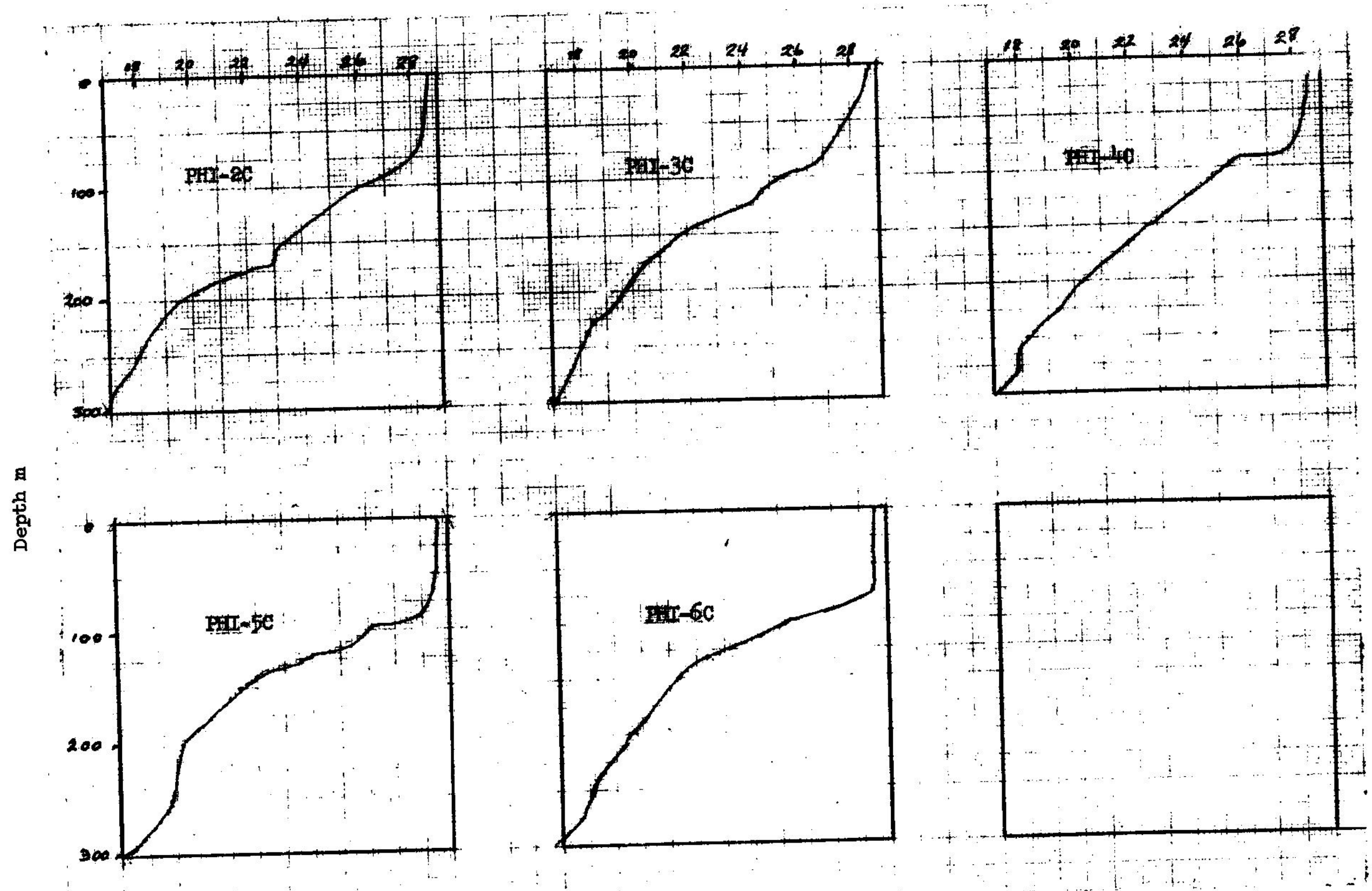
MULTI-STATION VERTICAL PROFILES FOR TEMPERATURE,
SALINITY AND SIGMA-T.
TRANSECT PHI-6, DATE 8/13/73



HYDROSTATION VERTICAL PROFILES FOR DISSOLVED
OXYGEN AND REACTIVE PHOSPHATE.
TRANSECT PHI-6. DATE 8/13/73



PHI-73-3, 8-13-73



R V PALUMBO CRUISE STATION PHI-2A PRNC REFERENCE 36605

DATE	1/15/74	BARO	1020,5	WEATHER	00	WIND VELOC 08	WAVE PERIOD
HOUR	1,5	TEMP DRY	0,0	VISIBILITY	0	WIND DIREC 07	TRANSPAR
LAT	18-20,9 N	TEMP WET	27,0	CLOUD TYPE	0	WAVE DIREC	SONIC DEP 0023
LONG	67-16,2 W	REL HUMID	710	CLOUD AMT	2	WAVE HEIGHT	COLOR

CAST 1 MESS TIME 23,8 GMT, 1945 LOCAL MAX DEPTH 10 WIRE ANGLE 0
OXYGEN TITER 1,075 METER WHEEL FACTOR ,997

DEPTH (M) WIRE	CZ	TZ	BN	TEMP TL	TM	TAVE	SALIN	SIG T	OXYGEN ML/L	MG/L	XSAT	PHOS	NITRA
0	1	0	1	25,75	0,00	25,75	35,004	23,14	4,89	6,99	99,91	,05	,
10	10	0	2	25,84	0,00	25,84	35,047	23,14	4,87	6,96	99,60	,08	,

R V PALUMBO CRUISE STATION PHI-2B PRNC REFERENCE 36606

DATE	1/15/74	BARO	1020,5	WEATHER	02	WIND VELOC 06	WAVE PERIOD 6
HOUR	2,0	TEMP DRY	0,0	VISIBILITY	0	WIND DIREC 07	TRANSPAR
LAT	18-20,5 N	TEMP WET	27,0	CLOUD TYPE		WAVE DIREC 06	SONIC DEP 0185
LONG	67-16,6 W	REL HUMID	770	CLOUD AMT		WAVE HEIGHT 1	COLOR

CAST 1 MESS TIME 0,1 GMT, 20 7 LOCAL MAX DEPTH 100 WIRE ANGLE 5
OXYGEN TITER 1,075 METER WHEEL FACTOR ,997

DEPTH (M) WIRE	CZ	TZ	BN	TEMP TL	TM	TAVE	SALIN	SIG T	OXYGEN ML/L	MG/L	XSAT	PHOS	NITRA
0	1	0	1	25,75	0,00	25,75	35,016	23,14	4,89	6,99	99,91	,09	,
25	25	0	2	25,87	0,00	25,87	35,049	23,13	4,85	6,93	99,19	,10	,
50	50	0	3	25,89	0,00	25,89	35,272	23,29	4,79	6,84	98,28	,07	,
100	100	0	4	25,84	0,00	25,84	36,026	24,12	4,63	6,62	94,78	,10	,

R V PALUMBO CRUISE STATION PHI-2C PRNC REFERENCE 36592

DATE	1/14/74	BARO	1023.5	WEATHER	02	WIND VELOC	06	WAVE PERIOD	1
HOUR	16.2	TEMP DRY	0.0	VISIBILITY	7	WIND DIREC	09	TRANSPAR	
LAT	18-20.0 N	TEMP WET	27.0	CLOUD TYPE	6	WAVE DIREC	08	SONIC DEP	0549
LONG	67-17.2 W	REL HUMID	740	CLOUD AMT	1	WAVE HEIGHT	1	COLOR	

CAST 1 MESS TIME 14.5 GMT, 1020 LOCAL MAX DEPTH 300 WIRE ANGLE 0
OXYGEN TITER 1.075 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	11	25.76	25.77	25.77	35.296	23.35	4.59	6.56	94.13	.09	.
25	25	0	12	25.89	0.00	25.89	35.378	23.37	4.74	6.78	97.46	.07	.
50	50	0	15	25.94	0.00	25.94	35.477	23.43	4.74	6.78	97.66	.06	.
100	100	0	16	25.46	0.00	25.46	36.045	24.01	4.61	6.59	95.03	.09	.
150	150	0	1	21.93	0.00	21.93	36.665	25.52	4.24	6.05	81.05	.25	.
200	200	0	2	19.55	0.00	19.55	36.481	26.03	4.13	5.90	73.19	.42	.
250	250	0	3	18.36	0.00	18.36	36.407	26.28	4.05	5.79	71.24	.50	.
300	300	0	4	17.53	0.00	17.53	36.325	26.42	4.07	5.81	71.00	.55	.

R V PALUMBO CRUISE   STATION PHI-3A   PRNC REFERENCE   36603

DATE	1/14/74	BARO	1020.5	WEATHER	02	WIND VELOC 13	WAVE PERIOD 4
HOUR	23.2	TEMP DRY	0.0	VISIBILITY	7	WIND DIREC 07	TRANSPAR
LAT	18-20.7 N	TEMP WET	20.0	CLOUD TYPE	8	WAVE DIREC 06	SONIC DEP 0229
LONG	67-16.3 W	REL HUMID	720	CLOUD AMT	2	WAVE HEIGHT 3	COLOR

CAST 1 MESS TIME 21.4 GMT, 1725 LOCAL MAX DEPTH 10 WIRE ANGLE 0
OXYGEN TITER 1.075 METER WHEEL FACTOR .997

DEPTH (M) WIRE	CZ	TZ	BN	TEMP TL	TM	TAVE	SALIN	SIG T	OXYGEN ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	1	0.00	0.00	0.00	35.009	0.00	4.85	6.93	*******	.05	.
10	10	0	2	25.87	0.00	25.87	35.043	23.13	4.87	6.96	99.62	.08	.

R V PALUMBO CRUISE   STATION PHI-3B   PRNC REFERENCE   36604

DATE	1/14/74	BARO	1019.5	WEATHER	02	WIND VELOC 13	WAVE PERIOD 4
HOUR	23.5	TEMP DRY	0.0	VISIBILITY	7	WIND DIREC 07	TRANSPAR
LAT	18-21.3 N	TEMP WET	20.0	CLOUD TYPE	8	WAVE DIREC 06	SONIC DEP 0185
LONG	67-17.2 W	REL HUMID	710	CLOUD AMT	1	WAVE HEIGHT 2	COLOR

CAST 1 MESS TIME 21.9 GMT, 1755 LOCAL MAX DEPTH 100 WIRE ANGLE 16
OXYGEN TITER 1.075 METER WHEEL FACTOR .997

DEPTH (M) WIRE	CZ	TZ	BN	TEMP TL	TM	TAVE	SALIN	SIG T	OXYGEN ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	1	25.81	0.00	25.81	35.008	23.12	4.93	7.04	100.62	.05	.
25	24	0	2	25.92	0.00	25.92	35.008	23.09	4.85	6.93	99.17	.03	.
50	48	0	3	25.85	0.00	25.85	35.289	23.32	4.75	6.79	97.52	.00	.
100	96	0	4	25.51	0.00	25.51	35.661	23.70	4.70	6.71	96.47	.07	.

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R V PALUMBO CRUISE STATION PHI-3C PRNC REFERENCE 36593

DATE	1/14/74	BARO	1024.5	WEATHER	02	WIND VELOC		WAVE PERIOD	1
HOUR	17.3	TEMP DRY	0.0	VISIBILITY	7	WIND DIREC	09	TRANSPAR	
LAT	18-21.2 N	TEMP WET	28.0	CLOUD TYPE	8	WAVE DIREC	09	SONIC DEP	0520
LONG	67-18.7 W	REL HUMID	715	CLOUD AMT	2	WAVE HEIGHT	1	COLOR	

CAST 1 MESS TIME 15.5 GMT. 1128 LOCAL MAX DEPTH 300 WIRE ANGLE 5
OXYGEN TITER 1.075 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	11	25.89	25.88	25.89	35.389	23.38	4.73	6.76	97.25	.09	.
25	25	0	12	25.89	0.00	25.89	35.411	23.40	4.74	6.78	97.51	.10	.
50	50	0	15	25.85	0.00	25.85	35.598	23.55	4.71	6.73	97.06	.07	.
100	100	0	16	25.66	0.00	25.66	35.932	23.86	4.67	6.67	96.33	.06	.
150	149	0	1	21.53	0.00	21.53	36.685	25.65	4.27	6.10	81.49	.28	.
200	199	0	2	19.76	0.00	19.76	36.515	26.00	4.20	6.01	74.72	.32	.
250	249	0	3	17.59	0.00	17.59	36.366	26.44	4.11	5.87	71.85	.46	.
300	298	0	4	16.75	0.00	16.75	36.383	26.59	4.08	5.82	70.94	.58	.

R V PALUMBO CRUISE STATION PHI-5A PRNC REFERENCE 36601

DATE	1/14/74	BARO	1Ø19.5	WEATHER	Ø2	WIND VELOC	14	WAVE PERIOD	4
HOUR	22.5	TEMP DRY	Ø.Ø	VISIBILITY	7	WIND DIREC	Ø7	TRANSPAR	
LAT	18-22.5 N	TEMP WET	29.Ø	CLOUD TYPE	8	WAVE DIREC	Ø6	SONIC DEP	Ø219
LONG	67-16.Ø W	REL HUMID	67Ø	CLOUD AMT	2	WAVE HEIGHT	3	COLOR	

CAST 1 MESS TIME 2Ø.8 GMT, 1646 LOCAL MAX DEPTH 1Ø WIRE ANGLE Ø
OXYGEN TITER 1.Ø75 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	XSAT	PHOS	NITRA
Ø	1	Ø	1	25.88	Ø.ØØ	25.88	35.Ø71	23.15	4.84	6.91	99.Ø1	.Ø5	.
1Ø	1Ø	Ø	2	25.89	Ø.ØØ	25.89	35.Ø68	23.14	4.84	6.91	99.Ø1	.Ø3	.

R V PALUMBO CRUISE STATION PHI-5B PRNC REFERENCE 36598

DATE	1/14/74	BARO	1Ø21.5	WEATHER	Ø2	WIND VELOC	16	WAVE PERIOD	4
HOUR	21.4	TEMP DRY	Ø.Ø	VISIBILITY	7	WIND DIREC	Ø7	TRANSPAR	
LAT	18-23.5 N	TEMP WET	29.Ø	CLOUD TYPE	8	WAVE DIREC	Ø7	SONIC DEP	Ø18Ø
LONG	67-16.6 W	REL HUMID	71Ø	CLOUD AMT	3	WAVE HEIGHT	2	COLOR	

CAST 1 MESS TIME 19.6 GMT, 1535 LOCAL MAX DEPTH 1ØØ WIRE ANGLE 6
OXYGEN TITER 1.Ø75 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	XSAT	PHOS	NITRA
Ø	1	Ø	1	25.85	Ø.ØØ	25.85	35.Ø59	23.15	4.79	6.84	97.87	.Ø7	.
25	25	Ø	2	25.92	Ø.ØØ	25.92	35.189	23.22	4.81	6.87	98.55	.Ø6	.
5Ø	5Ø	Ø	3	25.93	Ø.ØØ	25.93	35.2Ø1	23.23	4.84	6.91	99.24	.Ø6	.
1ØØ	1ØØ	Ø	4	25.34	Ø.ØØ	25.34	35.455	23.6Ø	4.66	6.65	95.17	.Ø9	.

R V PALUMBO CRUISE STATION PHI-5C PRNC REFERENCE 36596

DATE	1/14/74	BARO	1022.5	WEATHER	02	WIND VELOC	13	WAVE PERIOD	5
HOUR	19.4	TEMP DRY	0.0	VISIBILITY	7	WIND DIREC	08	TRANSPAR	
LAT	18-24.6 N	TEMP WET	30.0	CLOUD TYPE	8	WAVE DIREC	07	SONIC DEP	0411
LONG	67-17.3 W	REL HUMID	660	CLOUD AMT	2	WAVE HEIGHT	2	COLOR	

CAST 1 MESS TIME 17.7 GMT; 1343 LOCAL MAX DEPTH 300 WIRE ANGLE 0
OXYGEN TITER 1.075 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	11	25.86	25.89	25.87	35.040	23.13	4.93	7.04	100.73	.07	.
25	25	0	12	25.87	0.00	25.87	35.095	23.17	4.89	6.99	100.13	.07	.
50	50	0	15	25.99	0.00	25.99	35.286	23.27	4.85	6.93	99.65	.05	.
100	100	0	16	25.49	0.00	25.49	35.733	23.76	4.68	6.68	96.08	.07	.
150	150	0	1	21.71	0.00	21.71	36.452	25.42	4.39	6.27	83.47	.24	.
200	200	0	2	20.52	0.00	20.52	36.567	25.83	4.24	6.05	80.25	.25	.
250	250	0	3	18.33	0.00	18.33	36.322	26.22	4.20	6.01	73.67	.41	.
300	300	0	4	16.76	0.00	16.76	36.204	26.51	4.12	5.88	71.55	.60	.

R V PALUMBO CRUISE STATION PHI-6A PRNC REFERENCE 36600

DATE	1/14/74	BARO	1020.5	WEATHER	02	WIND VELOC	14	WAVE PERIOD	4
HOUR	22.3	TEMP DRY	0.0	VISIBILITY	7	WIND DIREC	07	TRANSPAR	
LAT	18-22.8 N	TEMP WET	28.0	CLOUD TYPE	8	WAVE DIREC	06	SONIC DEP	0022
LONG	67-15.0 W	REL HUMID	720	CLOUD AMT	2	WAVE HEIGHT	3	COLOR	

CAST 1 MESS TIME 20.5 GMT, 1630 LOCAL MAX DEPTH 10 WIRE ANGLE 0
OXYGEN TITER 1.075 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	1	25.86	0.00	25.86	35.025	23.12	4.87	6.96	99.59	.00	.
10	10	0	2	25.89	0.00	25.89	34.992	23.08	4.86	6.94	99.34	.06	.

R V PALUMBO CRUISE STATION PHI-6B PRNC REFERENCE 36599

DATE	1/14/74	BARO	1020.5	WEATHER	02	WIND VELOC	14	WAVE PERIOD	4
HOUR	22.0	TEMP DRY	0.0	VISIBILITY	7	WIND DIREC	07	TRANSPAR	
LAT	18-24.0 N	TEMP WET	28.0	CLOUD TYPE	8	WAVE DIREC	06	SONIC DEP	0201
LONG	67-15.5 W	REL HUMID	711	CLOUD AMT	1	WAVE HEIGHT	1	COLOR	

CAST 1 MESS TIME 20.0 GMT, 16 3 LOCAL MAX DEPTH 100 WIRE ANGLE 2
OXYGEN TITER 1.075 METER WHEEL FACTOR .997

DEPTH (M)				TEMP					OXYGEN				
WIRE	CZ	TZ	BN	TL	TM	TAVE	SALIN	SIG T	ML/L	MG/L	%SAT	PHOS	NITRA
0	1	0	1	25.85	0.00	25.85	35.005	23.10	4.93	7.04	100.65	.00	.
25	25	0	2	25.92	0.00	25.92	35.136	23.18	4.86	6.94	99.58	.03	.
50	50	0	3	25.92	0.00	25.92	35.159	23.20	4.83	6.90	98.95	.07	.
100	100	0	4	25.12	0.00	25.12	35.828	23.95	4.63	6.62	94.76	.05	.

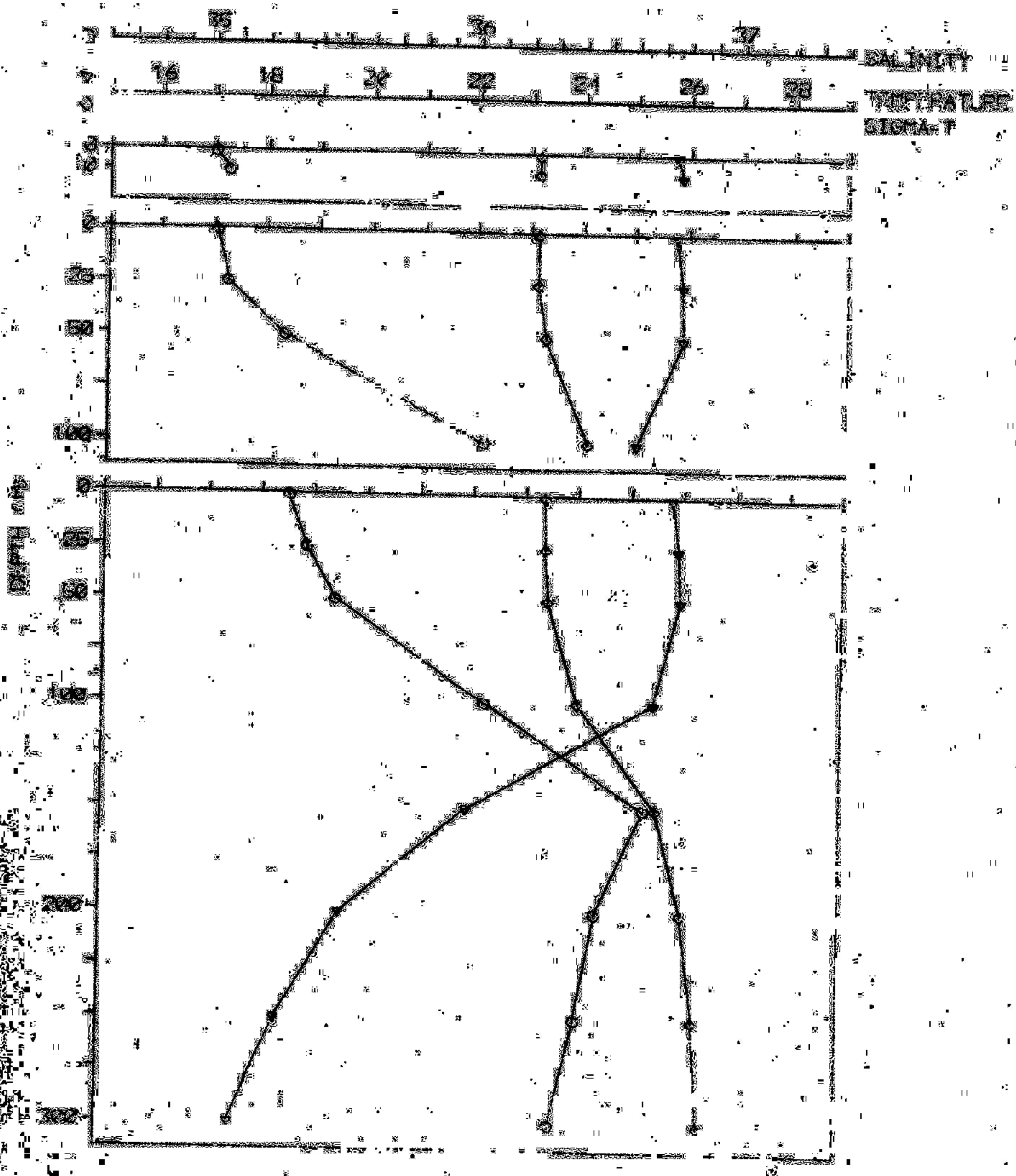
R V PALUMBO CRUISE   STATION PHI-6C   PRNC REFERENCE 36597

DATE	1/14/74	BARO	1Ø22.5	WEATHER	Ø2	WIND VELOC	15	WAVE PERIOD	5
HOUR	2Ø.4	TEMP DRY	Ø.Ø	VISIBILITY	7	WIND DIREC	Ø7	TRANSPAR	
LAT	18-25.2 N	TEMP WET	3Ø.Ø	CLOUD TYPE	8	WAVE DIREC	Ø6	SONIC DEP	Ø475
LONG	67-16.Ø W	REL HUMID	68Ø	CLOUD AMT	2	WAVE HEIGHT	2	COLOR	

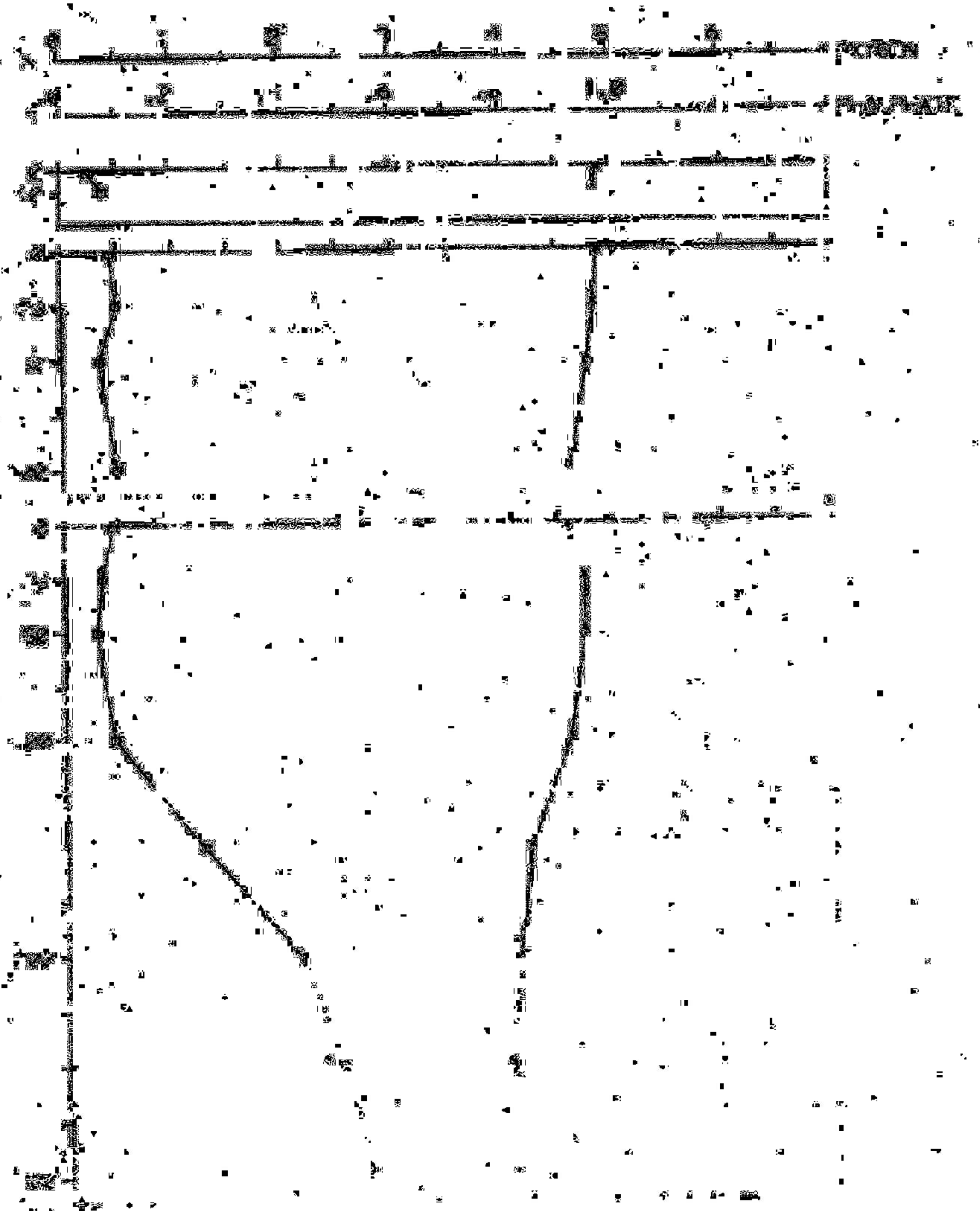
CAST 1 MESS TIME 18.6 GMT, 1435 LOCAL MAX DEPTH 3ØØ WIRE ANGLE 13
OXYGEN TITER 1.Ø75 METER WHEEL FACTOR .997

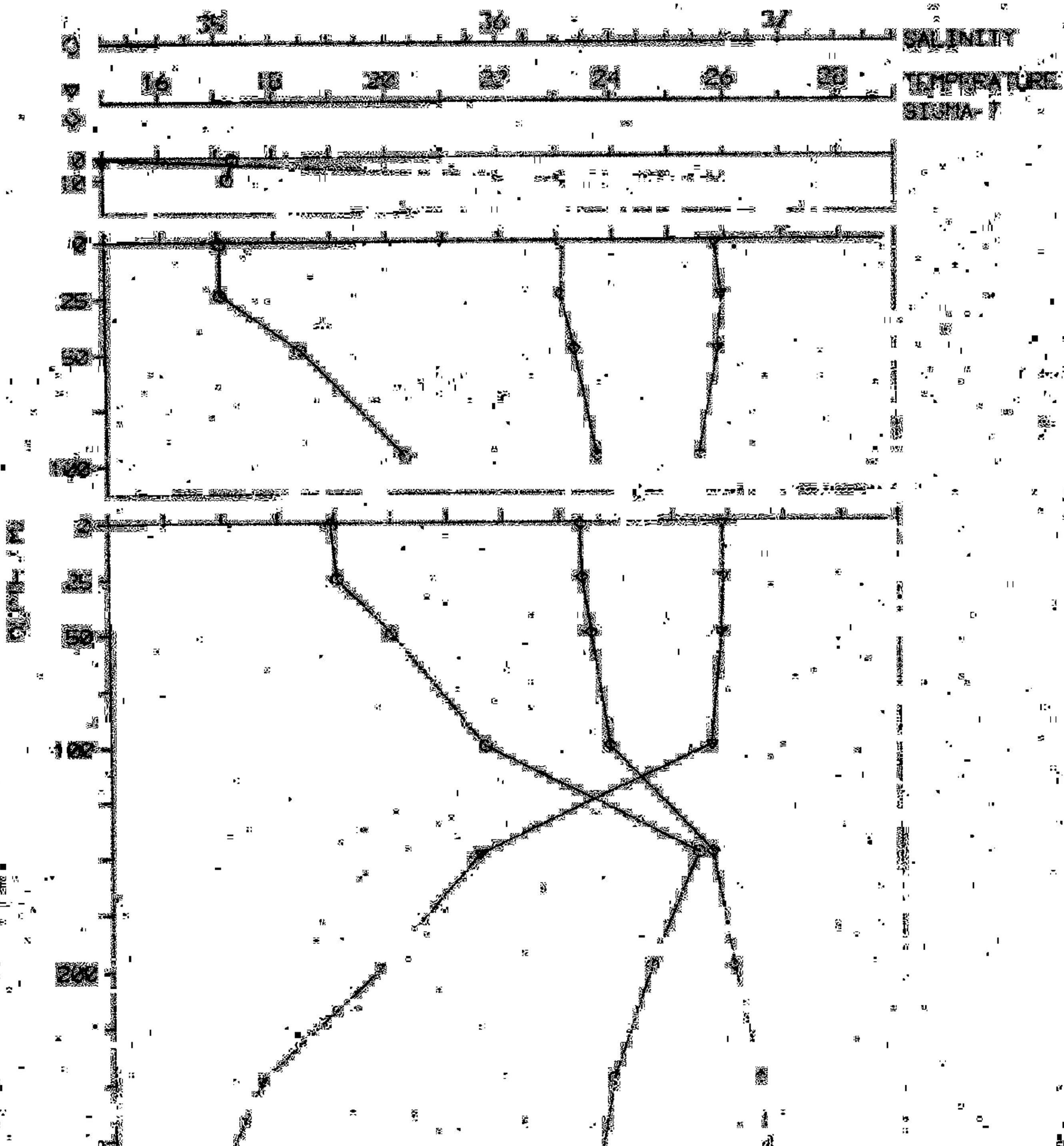
DEPTH (M) WIRE	CZ	TZ	BN	TEMP TL	TM	TAVE	SALIN	SIG T	OXYGEN ML/L	MG/L	%SAT	PHOS	NITRA
Ø	1	Ø	11	25.83	25.84	25.84	35.221 ?	23.27	4.98	7.11	1Ø2.Ø4	.Ø7	
25	25	Ø	12	25.85	Ø.ØØ	25.85	35.Ø54	23.14	4.87	6.96	99.62	.Ø7	.
5Ø	49	Ø	15	25.95	Ø.ØØ	25.95	35.253	23.26	4.81	6.87	98.67	.Ø4	.
1ØØ	98	Ø	16	25.61	Ø.ØØ	25.61	35.832	23.8Ø	4.66	6.65	95.91	.Ø8	.
15Ø	146	Ø	1	21.43	Ø.ØØ	21.43	36.417	25.47	4.32	6.18	82.Ø8	.19	.
2ØØ	195	Ø	2	19.84	Ø.ØØ	19.84	36.297	25.81	4.28	6.11	75.35	.31	.
25Ø	243	Ø	3	18.23	Ø.ØØ	18.23	36.184	26.14	4.2Ø	6.Ø1	73.32	.41	.
3ØØ	292	Ø	4	16.92	Ø.ØØ	16.92	36.Ø47	26.35	4.17	5.96	74.3Ø	.53	.

HYDROSTATION VERTICAL PROFILES FOR TEMPERATURE, SALINITY AND SIGMA-T, TRANSECT S-1-2, DATE 1/15/74

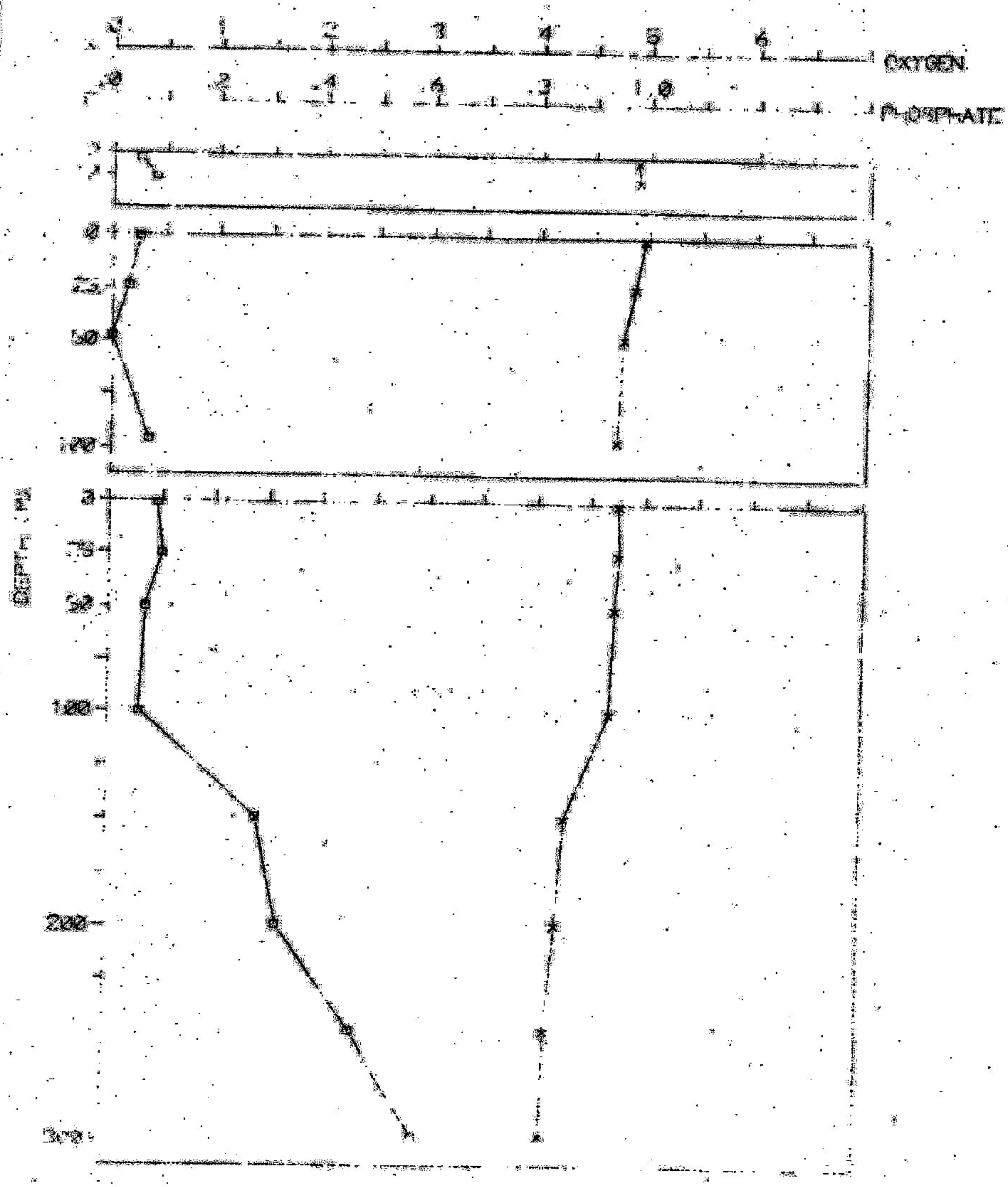


STATION VERTICAL PROFILES FOR DISSOLVED OXYGEN AND REACTIVE PHOSPHATE, TRANSECT [illegible] EAST [illegible]

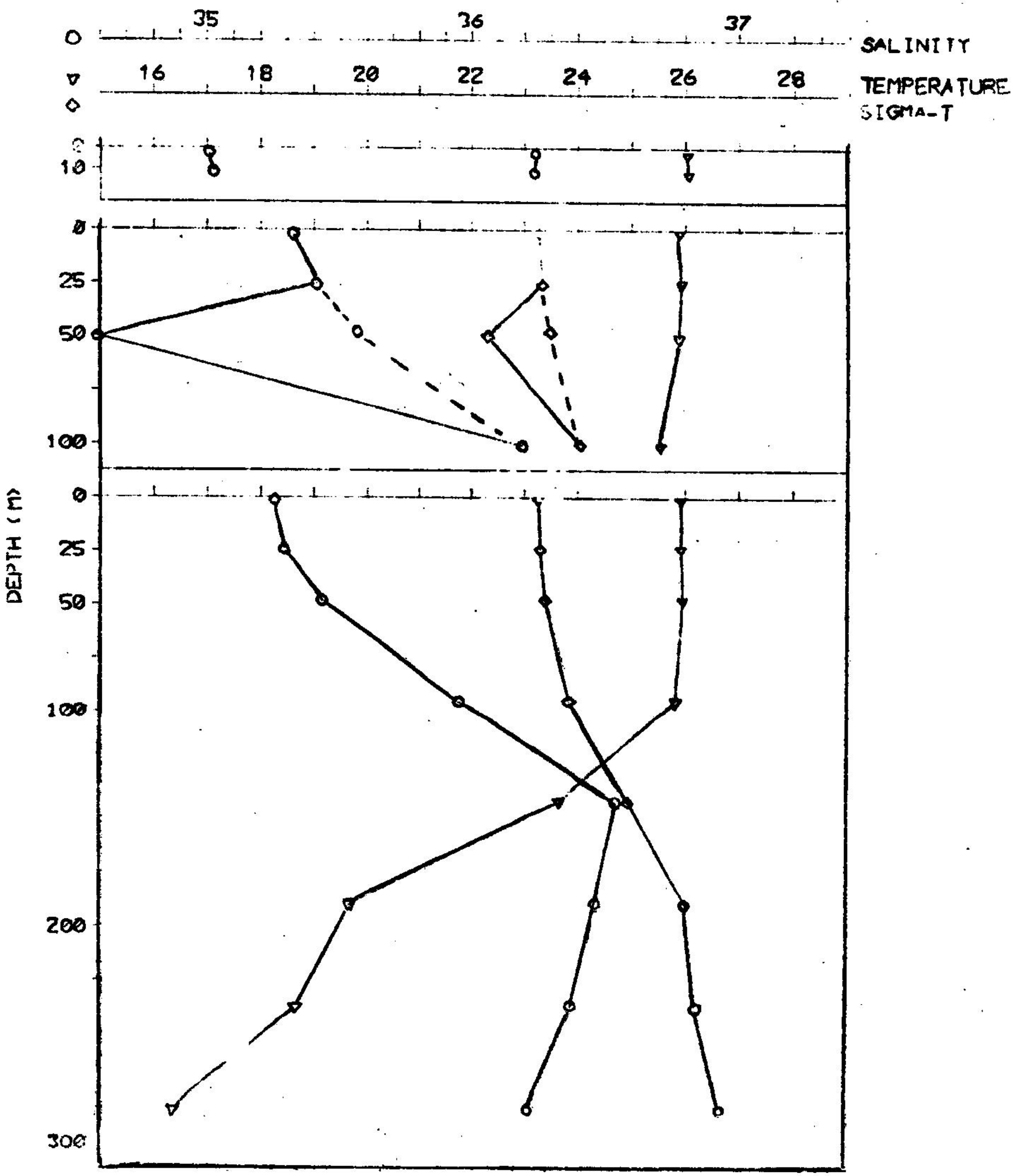



35
36
37
SALINITY
16
18
20
22
24
26
28
TEMPERATURE
SIGMA-T
0
10
25
50
100
200
DEPTH

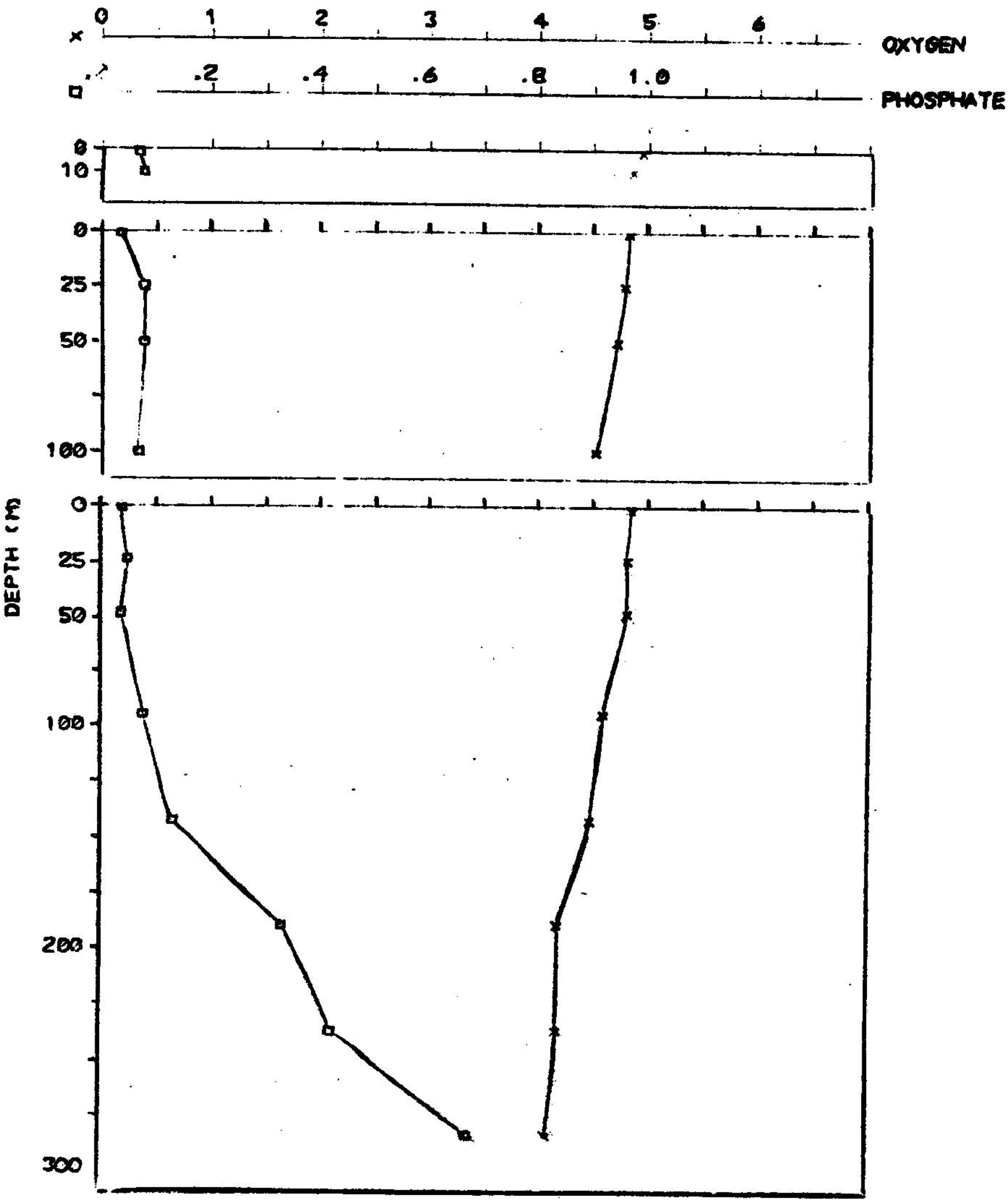
HYDROSTATION VERTICAL PROFILES FOR DISSOLVED OXYGEN AND REACTIVE PHOSPHATE. TRANSECT [illegible] DATE 1/14/74.



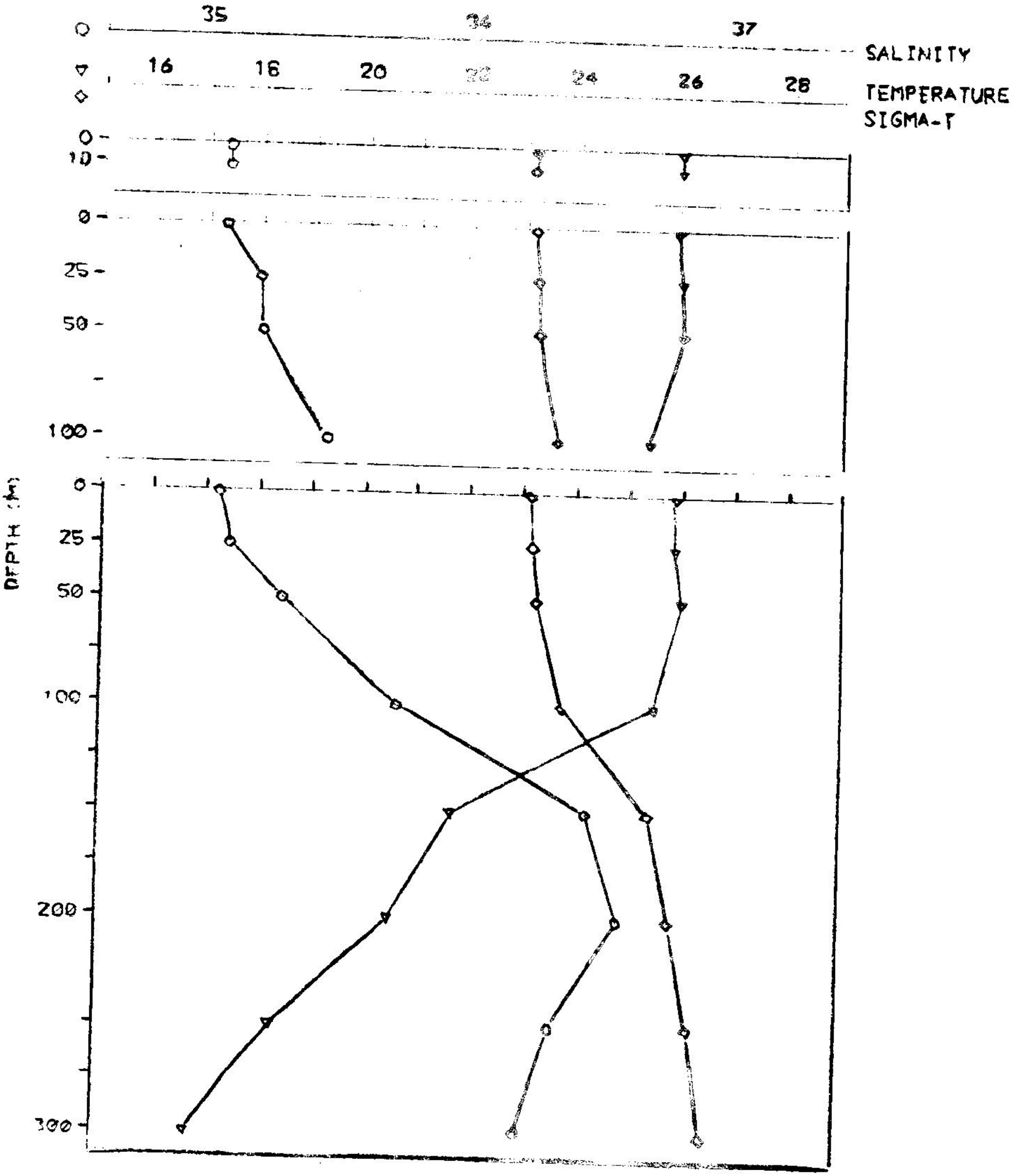
HYDROSTATION VERTICAL PROFILES FOR TEMPERATURE.
SALINITY AND SIGMA-T.
TRANSECT PHI-4. DATE 1/14/74



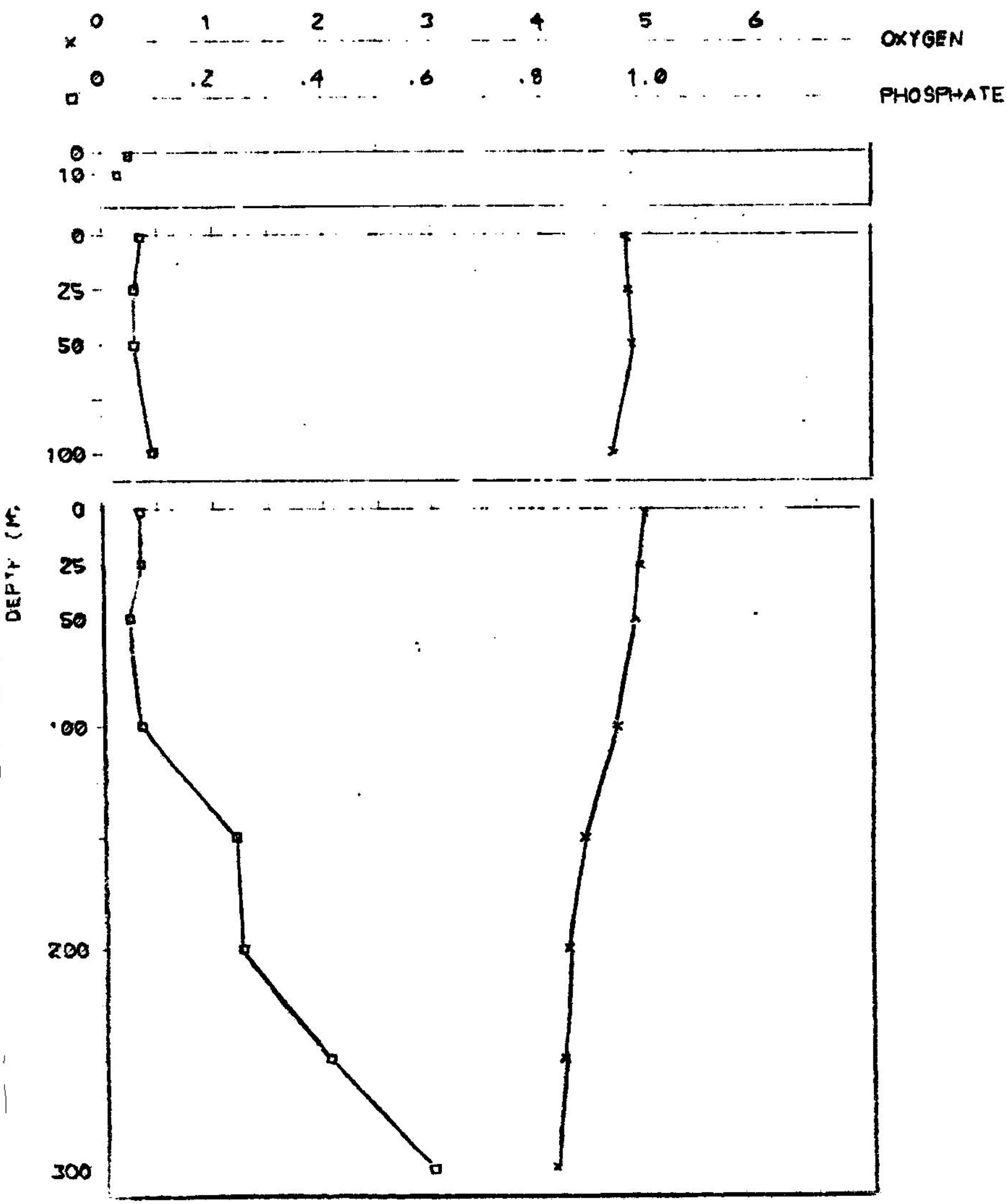
HYDROSTATION VERTICAL PROFILES FOR DISSOLVED OXYGEN AND REACTIVE PHOSPHATE.
TRANSECT PHI-4. DATE 1/14/74



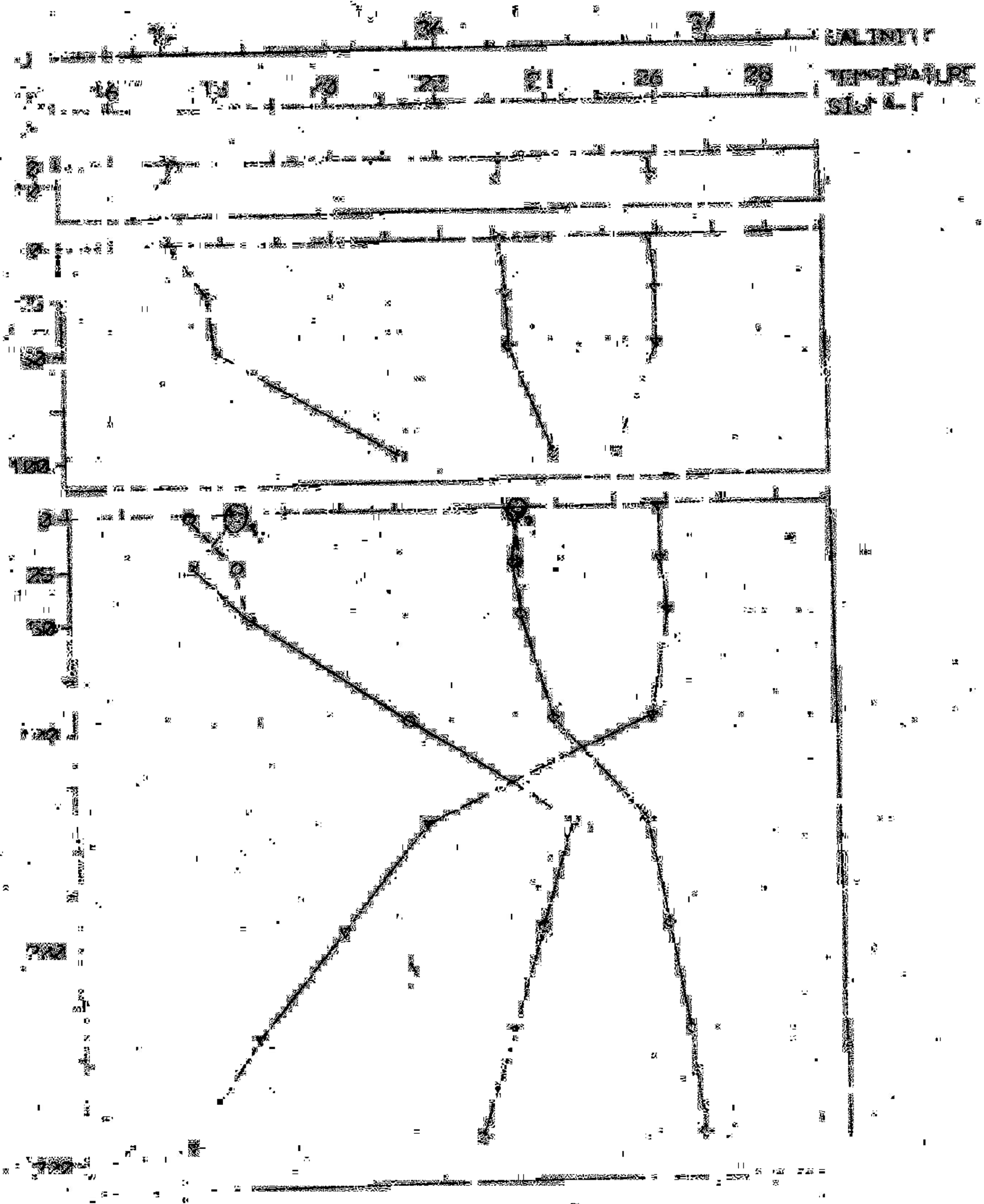
HYDROSTATION VERTICAL PROFILES FOR TEMPERATURE, SALINITY AND SIGMA-T
TRANSECT PHI-5. DATE 1/1?/74



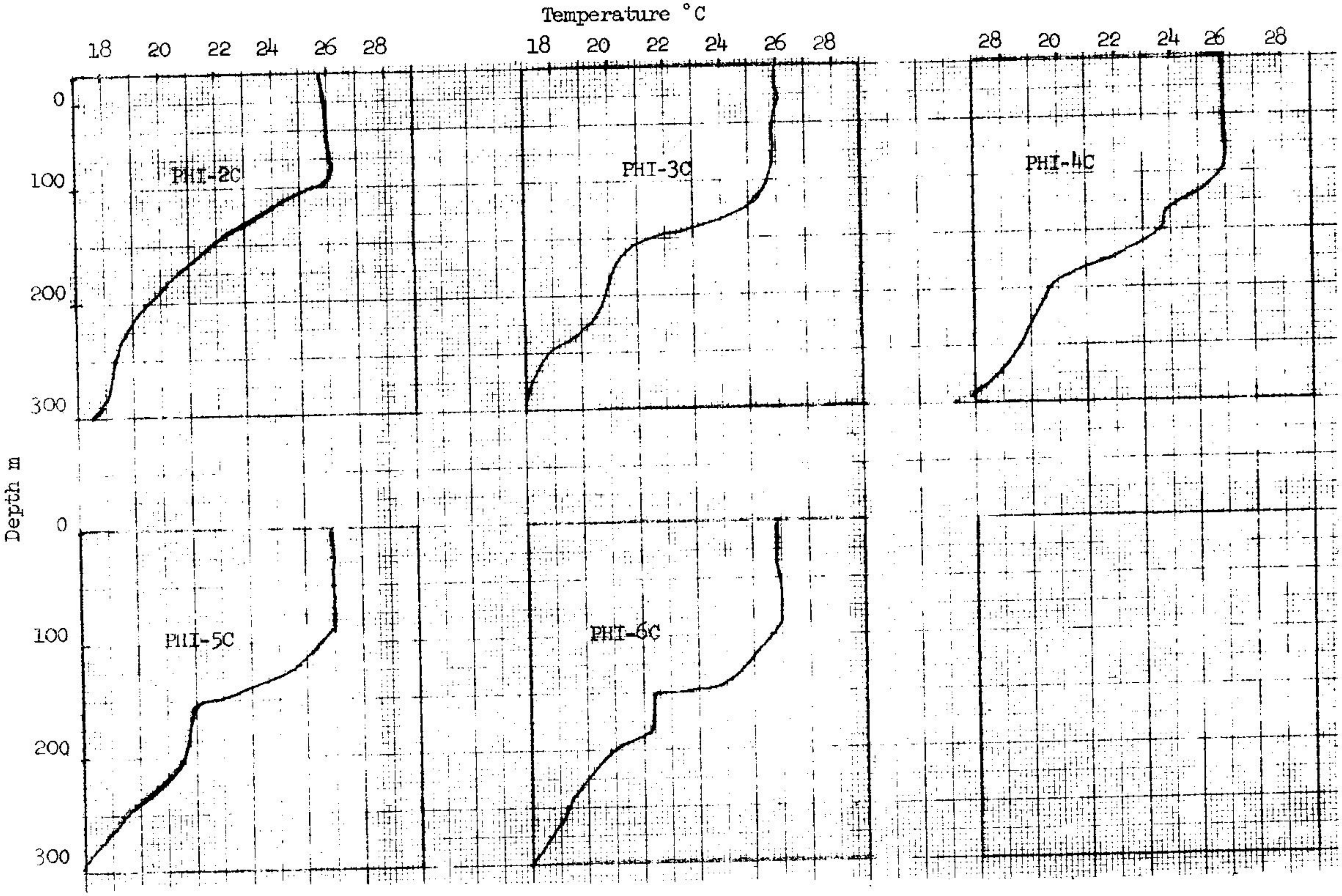
HYDROSTATION VERTICAL PROFILES FOR DISSOLVED
OXYGEN AND REACTIVE PHOSPHATE.
TRANSECT PHI-5. DATE 1/14/74



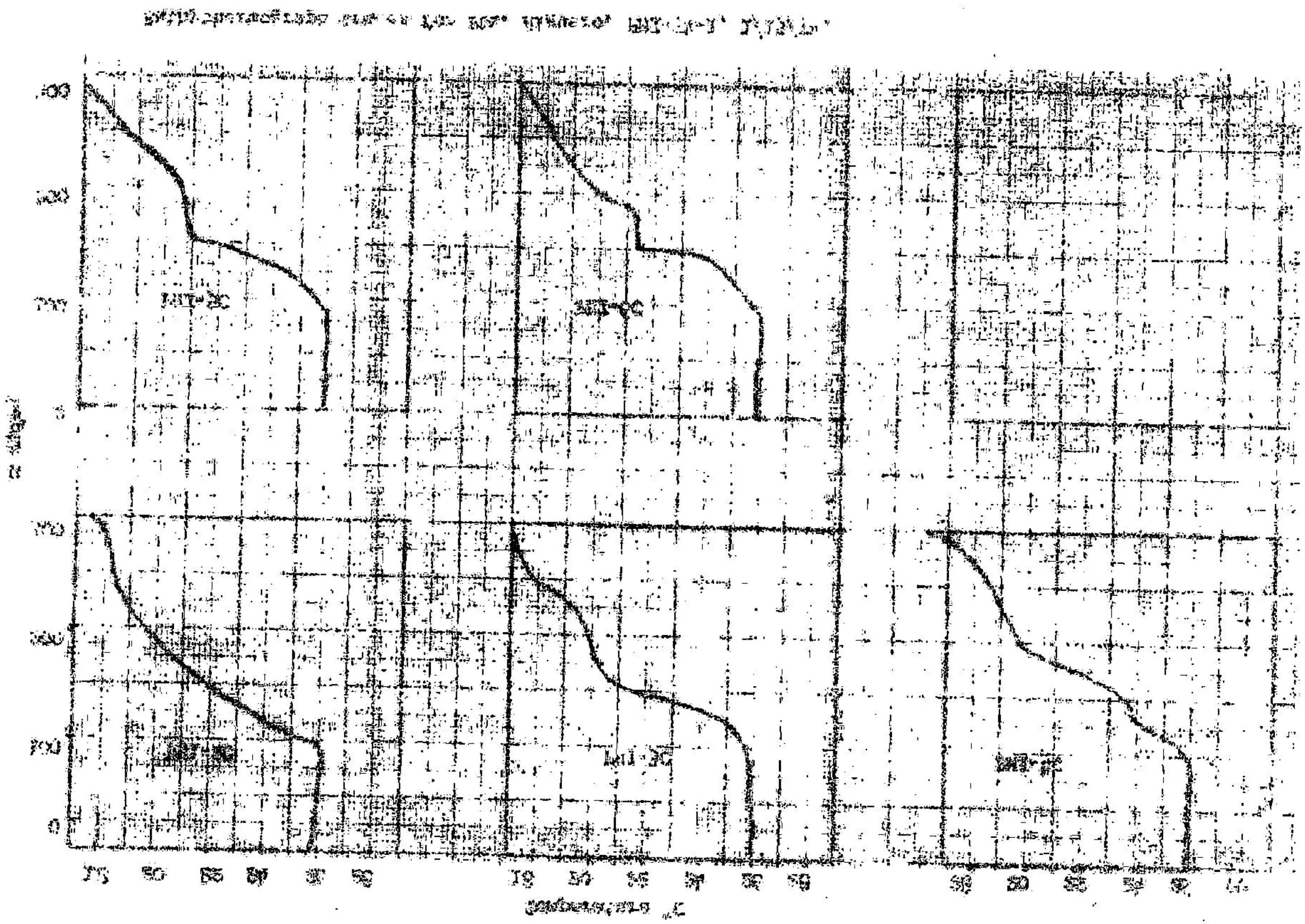
HYDROSTATION VERTICAL PROFILES FOR TEMPERATURE, SALINITY AND SIGMA-T.
TRANSECT PH-I-6. DATE [illegible]



[illegible] VERTICAL PROFILES FOR [illegible] OXYGEN AND REACTIVE PHOSPHATE.
TRANSECT P-1-A DATE [illegible]



Bathythermograph traces for Pta. Higuero, PHI-74-1, 1/15/74.



APPENDIX B

APPENDIX TABLE 1

PLANT KINGDOM

26-28 JUNE 1973

	STATION A					STATION B					STATION C				
	10'	20'	40'	60'	80'	10'	20'	40'	60'	80'	10'	20'	40'	60'	80'
Chlorophyta:															
Acetabularia sp.									X						
Anadyomene stellata		X	X												X
Avrainvillea nigricans	X				X										X
Caulerpa microphysa				X	X			X	X	X					X
Caulerpa prolifera						X									
Caulerpa pusilla									X						
Chamaedoris peniculum	X														
Cladophora fuliginosa						X						X			
Codium sp.							X	X		X					
Dictyosphaeria cavernosa	X														
Halimeda discoidea	X	X				X									
Halimeda opuntia					X			X	X						X
Halimeda simulans				X											
Halimeda sp.	X						X			X		X	X		
Neomeris sp.															X
Penicillus capitatus	X					X									
Penicillus dumetosus	X														
Udotea cyathiformis								X							
Udotea flabellum	X	X		X		X		X	X		X			X	X
Ulva lactuca				X											
Valonia aegagropila							X								
Valonia ventricosa							X	X	X		X				X

PLANT KINGDOM
26-28 JUNE 1973

	STATION A					STATION B					STATION C				
Phaeophyta:	10'	20'	40'	60'	80'	10'	20'	40'	60'	80'	10'	20'	40'	60'	80'
Dictyopteris delicatula	X						X								X
Dictyopteris justeii	X							X							
Dictyopteris sp.							X				X			X	
Dictyota cernicornis														X	
Dictyota dentata		X			X			X		X	X	X	X	X	X
Dictyota dichotoma			X												
Dictyota divaricata				X					X						
Dictyota linearis	X	X				X		X	X				X		X
Dictyota sp.				X								X			
Pocockiella sp.													X		
Sargassum polyceratium									X						
Sargassum sp.				X											
Stypopodium zonale		X				X	X				X	X			
Rhodophyta:															
Amansia multifida		X													
Amphiroa brasiliana															X
Amphiroa fragilissima										X		X	X	X	
Amphiroa rigida		X				X									
Amphiroa rigida var. antillana			X	X	X			X	X	X					
Amphiroa sp.							X					X			X
Amphiroa tribulus				X											
Bryothamnion seaforthii								X		X					X
Bryothamnion triquetrum		X				X	X	X							

PLANT KINGDOM
26-28 JUNE 1973

Rhodophyta:	Station A 10'	20'	40'	60'	80'	Station B 10'	20'	40'	60'	80'	Station C 10'	20'	40'	60'	80'
Ceramium cruciatum										X					
Ceramium sp.		X	X	X	X	X		X	X	X		X	X		X
Coelarthrum albertisii								X	X				X		X
Corallina cubensis	X	X		X		X	X	X	X		X	X	X	X	X
Corallina sp.				X										X	
Corallina subulata						X	X	X							
Cryptonemia crenulata							X								
Cryptonemia sp.										X					
Digenia simplex	X														
Erythrotrichia sp.				X											
Galaxaura sp.		X									X				
Gelidium pusillum		X		X			X			X					
Gelidium sp.												X			X
Gracilaria sp.							X			X					
Griffithsia globulifera									X						
Halymenia sp.														X	
Hildenbrandia prototypus		X	X	X				X	X	X	X	X		X	X
Hildenbrandia sp.					X										
Jania adherens	X	X		X		X	X	X	X			X	X	X	X
Jania sp.			X		X						X				
Laurencia intricata					X				X					X	X
Lithothamnium sp.			X												
Martensia pavonia			X					X	X				X	X	X
Polysiphonia sp.										X					
Pterocladia sp.											X				
Wrangelia sp.										X			X	X	X
Unid sp. 1	X														
Unid sp. 2							X								

PLANT KINGDOM
26-28 JUNE 1973

	STATION A					STATION B					STATION C				
Marine Grasses:	10'	20'	40'	60'	80'	10'	20'	40'	60'	80'	10'	20'	40'	60'	80'
Halophila baillonis										X					
Fam. Hydrocharitaca	X														
Thalassia sp.	X														
Thalassia testudinum	X					X	X								

APPENDIX TABLE 2

PLANT KINGDOM
14-16 JANUARY 1974

	STATION A		STATION C	
	20'	60'	20'	60'
Phylum Chlorphyta				
Anadyomene stellata				X
Caulerpa microphysa		X		X
Caulerpa vickersiae		X		
Caulerpa sp.				X
Cladophora sp.	X			X
Halimeda sp.		X		
Valonia sp.		X		
Phylum Phaeophyta				
Dictyopteris delicatula				X
Dictyopteris hoytii				X
Dictyopteris plagiograma		X		
Dictyopteris sp.	X	X		
Dictyota divaricata		X		
Dictyota linearis	X	X		X
Dictyota sp.	X		X	X
Padina sp.				X
Phylum Rhodophyta				
Amansia multifida	X			
Amphiroa fragilissima		X		
Amphiroa sp.	X		X	X
Bryothamnion seaforthii				X
Coelarthrum albertesii		X		X

PLANT KINGDOM
14-16 JANUARY 1974

	STATION A		STATION C	
	20'	60'	20'	60'
Rhodophyta:				
Corallina cubensis	X	X		X
Cryptonemia sp.	X			
Dictyurus occidentalis	X			X
Galaxaura marginata		X		
Gelidium pusillum	X		X	X
Gelidium sp.		X		
Hildenbrandia prototypus		X		
Hildenbrandia sp.	X			
Jania adhaerens				X
Jania rubens	X			X
Jania sp.			X	
Lithothamnion occidentalis		X		
Martensia pavonii	X	X	X	X
Thuretia borneti		X		
Unid rhod	X	X	X	X

ANIMAL KINGDOM
26-28 JUNE 1973

	STATION A					STATION B					STATION C				
Porifera:	10'	20'	40'	60'	80'	10'	20'	40'	60'	80'	10'	20'	40'	60'	80'
Xestospongia muta				X	X			X			X	X	X		X
Xextospongia sp.				X	X										
Unid sp. A				X											
Unid sp. B															
Unid sp's				X	X										
Unid sp. 9 (Higginsia strigilata?)										X					
Unid sp. 15					X					X					
(Cuidaria) Phylum (Coelenterata)															
Class Hydrozoa															
Order Athecata															
Millepora sp.												X	X		
Stylaster rosea			X							X					
Unid. sp. 1					X										
Unid. sp. 2															X
Unid. sp. 3														X	
Order Thecata															
Pennaria sp.										X					
Class Anthozoa															
Subclass Octocorallia															
Diodogorgia nodulifera										X				X	
Eunicea laxispica		X		X	X		X					X		X	
Eunicea sp.			X		X				X		X	X			

ANIMAL KINGDOM
26-28 JUNE 1973

Class Anthozoa Subclass Octocorallia	STATION A 10'	20'	40'	60'	80'	STATION B 10'	20'	40'	60'	80'	STATION C 10'	20'	40'	60'	80'
Eunicea tourneforti									X		X		X		
Eunicea tourneforti f. tourneforti							X								
Eunicea sp. 1 (young colony)		X													
Eunicea sp. 2		X													
Gorgonia mariae f. plumosa			X												
Gorgonia ventalina												X	X		
Muricea atlantica							X		X						X
Muricea elongata		X					X						X		
Muricea laxa									X						
Muricea pinnata (young colony)								X							
Muricea sp. (elongata?)												X			
Muriceopsis flavida		X										X	X		
Muriceopsis petila							X								
Muriceopsis sp.		X													
Muriceopsis sulphurea		X					X		X			X	X		
Plexaura sp.												X			
Plexaurella grisea				X							X				
Plexaurella sp.											X	X			
Pseudopterogorgia acerosa				X											X
Pseduopterogorgia americana							X								
Pseudopterogorgia sp.					X										
Pterogoria anceps	X			X										X	
Pterogorgia citrina	X				X					X				X	
Pterogorgia guadalupensis				X	X				X			X			
Pterogorgia sp.			X	X								X	X		

ANIMAL KINGDOM
26-28 JUNE 1973

Phylum Cnidaria Class Anthozoa Subclass Zoantharia Order Scleractinia	STATION A 10'	20'	40'	60'	80'	STATION B 10'	20'	40'	60'	80'	STATION C 10'	20'	40'	60'	80'
Dendrogyra cylindricus			X												
Dichocoenia stokesii			X							X					
Diploria sp.			X										X		
Isophyllia sp.												X	X		
Meandrina sp.			X	X							X				
Montastrea annularis											X	X	X		
Montastrea cavernosa											X	X			
Porites asteroides															X
Siderastrea radians											X	X			
Siderastrea siderea													X		
Siderastrea sp.		X													
Order Zoanthidea															
Parazoanthus sp.			X												
Phylum Annelida **Class Polychaeta**															
Ammotrypane fimbrata	X					X									
Eunice rubra						X	X								
Eurythoe complanata	X					X		X							
Glycera abranchiata						X					X				
Glycera sp.															
Glycera tessellata	X												X		
Hermenia verruculosa															
Heteconereis (epitoise of Nereid)							X								
Lysidice sulcata					X										X
Nereid															

ANIMAL KINGDOM
26-28 JUNE 1973

	STATION A					STATION B					STATION C				
Phylum Annelida Class Polychaeta	10'	20'	40'	60'	80'	10'	20'	40'	60'	80'	10'	20'	40'	60'	80'
Fam. Nereidae							X								
Nereis sp.		X				X		X		X			X	X	
Nereis sp. (epitolse form)								X							
Nicidion sp.										X					
Oenone sp.	X														
Onuphis sp.						X									
Paramarphysa sp.							X								
Sabellastarte magnifica												X			
Unid. Sabellidae														X	
Fam. Serpulidae													X		
Stylaroides glabra						X									
Fam. Syllidae															X
Syllis prolifera						X		X		X					
Syllis sp.		X							X						
Terebella annulifilis						X		X							
Terebella sp. (in veribgua spónge)										X					
Unid Terebellid										X					
Unid polych.	X					X	X							X	
Phylum Arthropoda Order Decapoda Suborder Natantia															
Alpheus beanii						X									
Fam. Amphiuridae					X										
Fam. Hyppolytidae															X
Latreutes parvutus															X
Periclimenaeus atlanticus									X						

ANIMAL KINGDOM

26-28 JUNE 1973

Phylum Arthropoda Order Decapoda Suborder Natantia	STATION A 10'	20'	40'	60'	80'	STATION B 10'	20'	40'	60'	80'	STATION C 10'	20'	40'	60'	80'
Periclimen americanus									X						
Sicyonia brevirostris						X									
Synalpheus fritzmuelleri					X										
Synalpheus mcclendoni														X	
Synalpheus minus				X											
Synalpheus pandionis					X										
Synalpheus sp.										X					
Synalpheus tanneri								X							
Synalpheus townsendii														X	
Unid. natantians					X		X								X
Suborder Anomura															
Clibanarius cubensis					X										
Suborder Brachyura															
Epialtus sp.						X	X								
Eurypanopeus sp.	X					X									
Mithrax forceps				X			X								
Mithrax pleuracanthus															X
Panopeus bermudensis				X											
Panopeus herbstii f. crassa								X							
Fam. Portunidae						X									
Unid. Xanthid crab (juv.)										X					
Unid. crab														X	

ANIMAL KINGDOM
26-28 JUNE 1973

	STATION A					STATION B					STATION C				
Phylum Arthropoda Order Isopoda	10'	20'	40'	60'	80'	10'	20'	40'	60'	80'	10'	20'	40'	60'	80'
Accalathura crenulata		X								X					
Suborder Anthuridea	X														
Apanthura sp.						X									
Cirolana parva		X				X									
Paracereis caudata			X												
Stenetrium occidentale				X		X									
Unid. isopod														X	
Order Tanaidacea	X	X				X	X	X						X	
Phylum Mollusca Class Gastropoda															
Alaba incerta					X	X									
Alvania gradata	X														
Arene tricarinata			X												
Bittium varium	X			X	X										
Crithiopsis sp.					X										
Columbella mercatoria							X								
Coralliophila aberrens					X										
Coralliophila caribaea		X										X	X		X
Crassispira fuscescens				X											
Cylichna Krebsi										X					
Cyphoma intermedium											X				
Drillia interpleura								X							
Drupa nodulosa										X					
Euchelus guttarosea					X										
Eulina auricincta	X														
Eulina bifasciata						X									

ANIMAL KINGDOM

26-28 JUNE 1973

Phylum Mollusca Class Gastropoda	STATION A 10'	20'	40'	60'	80'	STATION B 10'	20'	40'	60'	80'	STATION C 10'	20'	40'	60'	80'
Heliacus bisulcatus				X											
Mangelia sp.					X										
Mitrella fenestrata				X	X										
Mitrella lunata					X										
Modulus sp.								X							X
Nassarius albus					X										
Olivella acteocina	X														
Persicula pulcherrima					X										
Persicula sp.					X										
Pusia hanleyi	X			X	X	X									
Pusia sp.				X											
Retusa candei										X					
Rissoina fischeri					X										
Rissoina sp.								X							
Rissoina striatocostata								X							
Stombus pugilis								X							
Tricolia sp.					X										
Triphora melanura					X										
Triphora nigrocineta					X										
Zebina browniara					X										
Unid. gastro 7					X										
Unid gastro	X														

ANIMAL KINGDOM

26-28 JUNE 1973

	STATION A					STATION B					STATION C				
	10'	20'	40'	60'	80'	10'	20'	40'	60'	80'	10'	20'	40'	60'	80'
Class Amphineura															
Acanthochitona elongata	X														
Class Pelecypoda															
Aequipecten gibbus		X													
Arca imbricata				X											
Arcopsis adamsi			X												
Brachidontes citrinus	X														
Glycymeris sp.					X										
Lima lima (juv.)					X										
Musculus lateralis	X				X										X
Ostrea frons															X
Pecten sp.					X										
Pinna carnea		X													
Pinna sp.														X	
Pteria colymbus										X					
Semele nuculoides					X										
Spondylus americanus					X										
Unid. pelecy					X										
Subclass Opisthobrarchia															
Order Nudibranchia															
Unid. nodibranch						X									
Phylum Echinodermata															
Subphylum Eleutherozoa															
Class Ophiuroidea															
Fam. Amphiuridae								X		X					

ANIMAL KINGDOM
26-28 JUNE 1973

	STATION A					STATION B					STATION C				
Phylum Echinodermata Subphylum Eleutherozoa Class Ophiuroidea	10'	20'	40'	60'	80'	10'	20'	40'	60'	80'	10'	20'	40'	60'	80'
Ophiactis savignyi						X									
Ophiolepsis paucispina								X							
Ophionereis sp.		X													
Ophiophragmus sp.								X							
Ophiostigma isacanthum									X						
Ophiothrix angulata						X		X							
Ophiothrix brachyactis		X													
Ophiothrix oerstedii													X		
Ophiothrix sp. (juv.)								X							
Ophiothrix svensonii					X		X	X	X			X	X		
Class Echinoidea Order Cidaroidea															
Eucidaris tribuloides									X						
Order Diadematoidea															
Diadema antillarum						X									
Order Temnopleuroidea															
Lythechinus variegatus							X								
Phylum Bryozoa															
Bryozoan sp. 1					X										X
Bryozoan sp. 2					X										X
Unid. bryozoans			X						X						

ANIMAL KINGDOM
26-28 JUNE 1973

	STATION A					STATION B					STATION C				
Phylum Sipunculida	10'	20'	40'	60'	80'	10'	20'	40'	60'	80'	10'	20'	40'	60'	80'
Unid Sipunculida									X	X		X		X	
Phylum Arthropoda Class Amphipoda															
Gammarid amphipods	X		X	X				X	X	X					
Foraminifers															
Amphistegina gibbosa													X		
Archais angulatus f. compressa		X		X									X		
Zuinqueloculina sp.				X									X		
Heterostegina antillarum													X		

TABLE 4

NEW SPECIES ADDED TO THE CUMULATIVE LIST. 14-16 JANUARY 1974

APPENDIX TABLE 4

ANIMAL KINGDOM
14-16 JANUARY 1974

	STATION A		STATION C	
	20'	60'	20'	60'
Arthropoda:				
Subclass Copepoda				
Cirolana sp.		X		
Subclass Malacostraca				
Order Stomatopoda				
Gonodactylus sp.		X		
Class Crustalea				
Order Decapoda				
Section Brachyura				
Mithrax hispidus				X
Phylum Arthropoda				
Order stomatopoda				
Order Isopoda			X	
Fam. Sphaeromatidae			X	
Phylum Echinodermata				
Class Echinoidea				
Eucidaris tribuloides			X	
Class Ophiuroidea				
Fam. Amphiuridae	X		X	
Ophiocoma pumila			X	
Ophioderma phoenium			X	
Ophiophragmus sp.			X	
Ophiopsila riisei			X	
Ophiopsila st.			X	
Ophiothrix angulata		X	X	
Unid ophiuroid			X	

ANIMAL KINGDOM

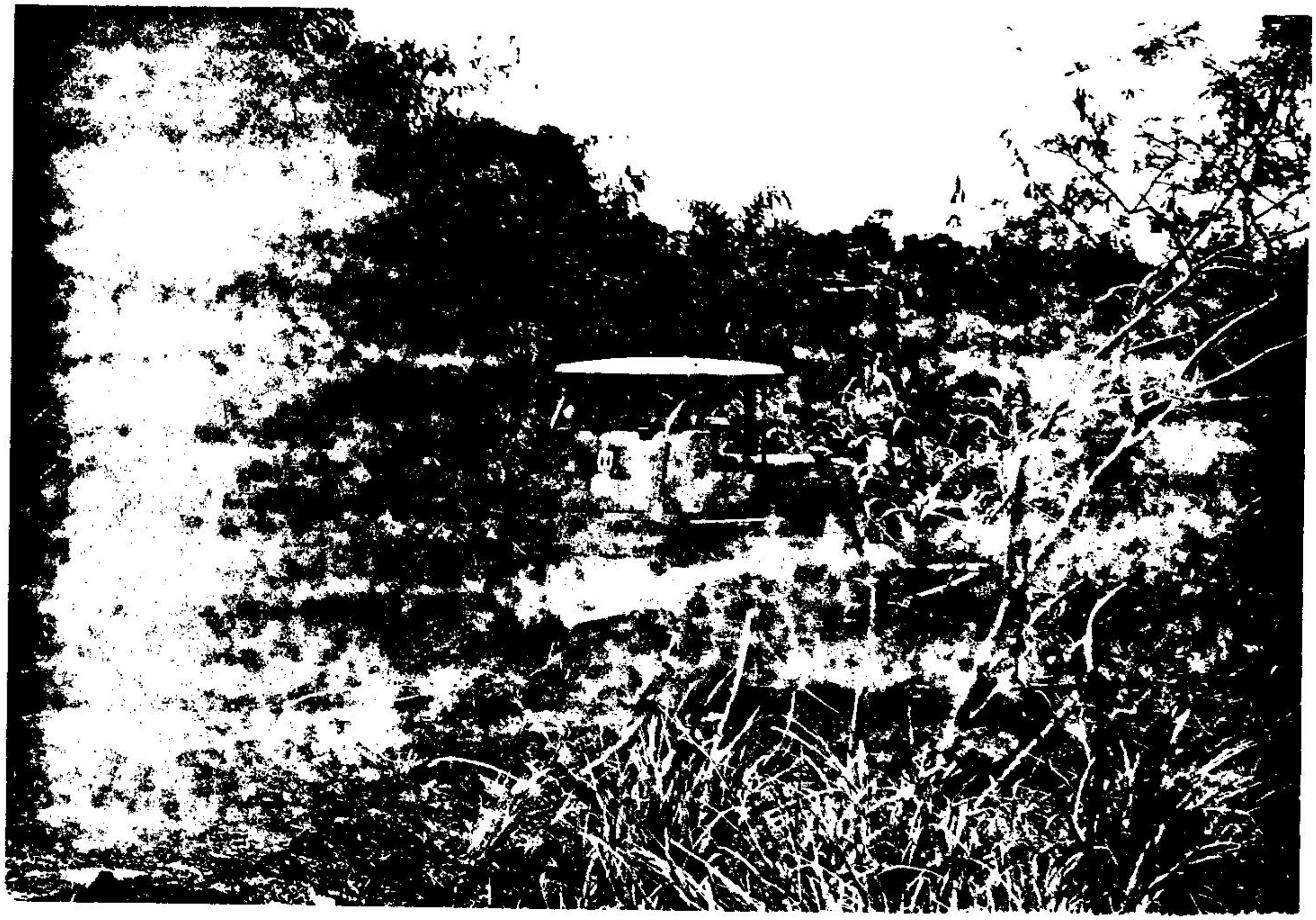
14-16 JANUARY 1974

	STATION A		STATION C	
	20'	60'	20'	60'
Phylum Porifera				
Class Demospongiae				
Cynachira sp.	X			X
Ircinia fasciculata		X		
Order Poecilosclerina				X
Verongia sp.				X
Xestospongia sp.			X	
Phylum Cnidaria				
Class Anthozoa				
Subclass Octocorallia				
Plexaurella sp.	X			
Pseudopterogorgia acerosa				X
Pterogorgia citrina				X
Subclass Zoantharia				
Diploria labyrinthiformis			X	
Montastrea anularia			X	
Porites asteroides			X	
Siderastrea siderea				X
Siderastrea sp.			X	
Phylum Arthropoda				
Class Crustalea				
Order Decapoda				
Suborder Natantia				
Alpheus cristulifrons			X	
Alpheus sp.	X			
Synalpheus sp.	X			

ANIMAL KINGDOM
14-16 JANUARY 1974

	STATION A		STATION C	
Phylum Mollusca	20'	60'	20'	60'
Class Gastropoda				
Cerithium algicola	X			
Mangelia bartletti	X			
Unid gastro M-33		X		
Class Amphineura				
Acanthochitona pygmaea			X	
Class Gastropoda				
Conus cardinalis				X
Conus sp.				X
Heliacus infundibuliformis				X
Strombus gigas				X
Class Pelecypoda				
Chione cancellata				X
Phylum Annelida				
Class Polychaeta				
Fam. nereida	X			
Phylum Sipunculoidea		X	X	
Phylum Chordata				
Surphylum Urochordata				
Class Ascidiacea			X	

APPENDIX C



Bulldozer on east side Punta Higuero site.

New road through Secondary Forest at east side Punta Higuero site.

Grass and Leucaena at Punta Higuero

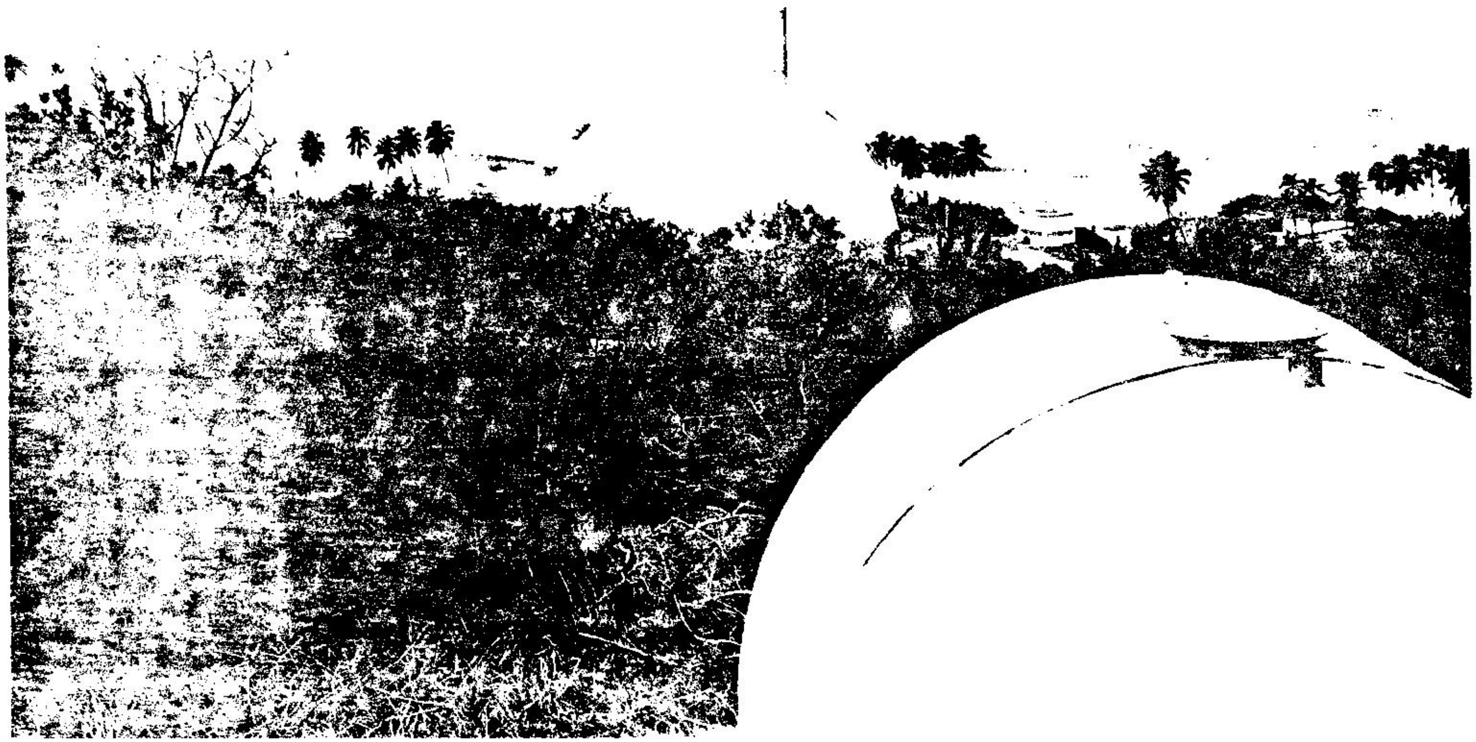
Punta Higuero Panorama - North

Punta Higuero Panorama

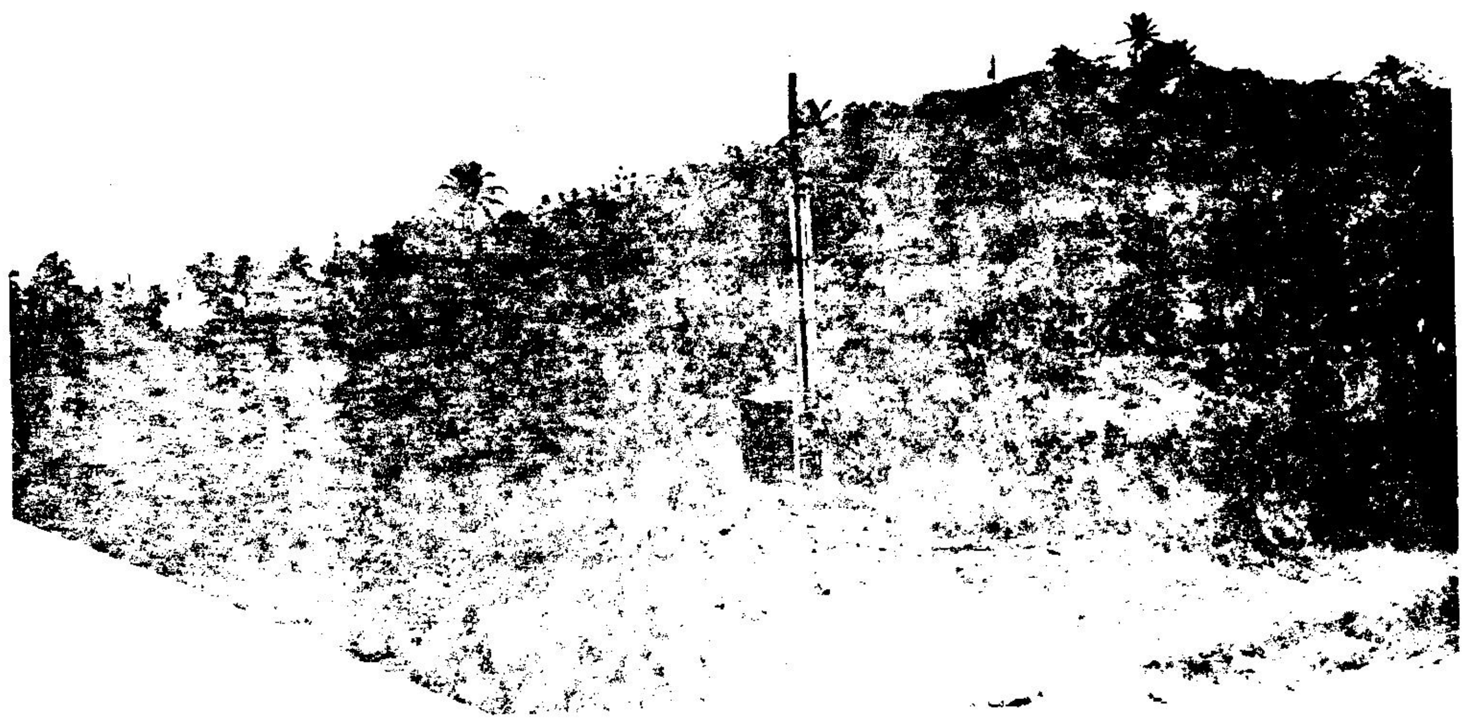
Punta Higuero Panorama - South

Punta Lipuere Pa[illegible]ama

Punta Higuero Pa[illegible]

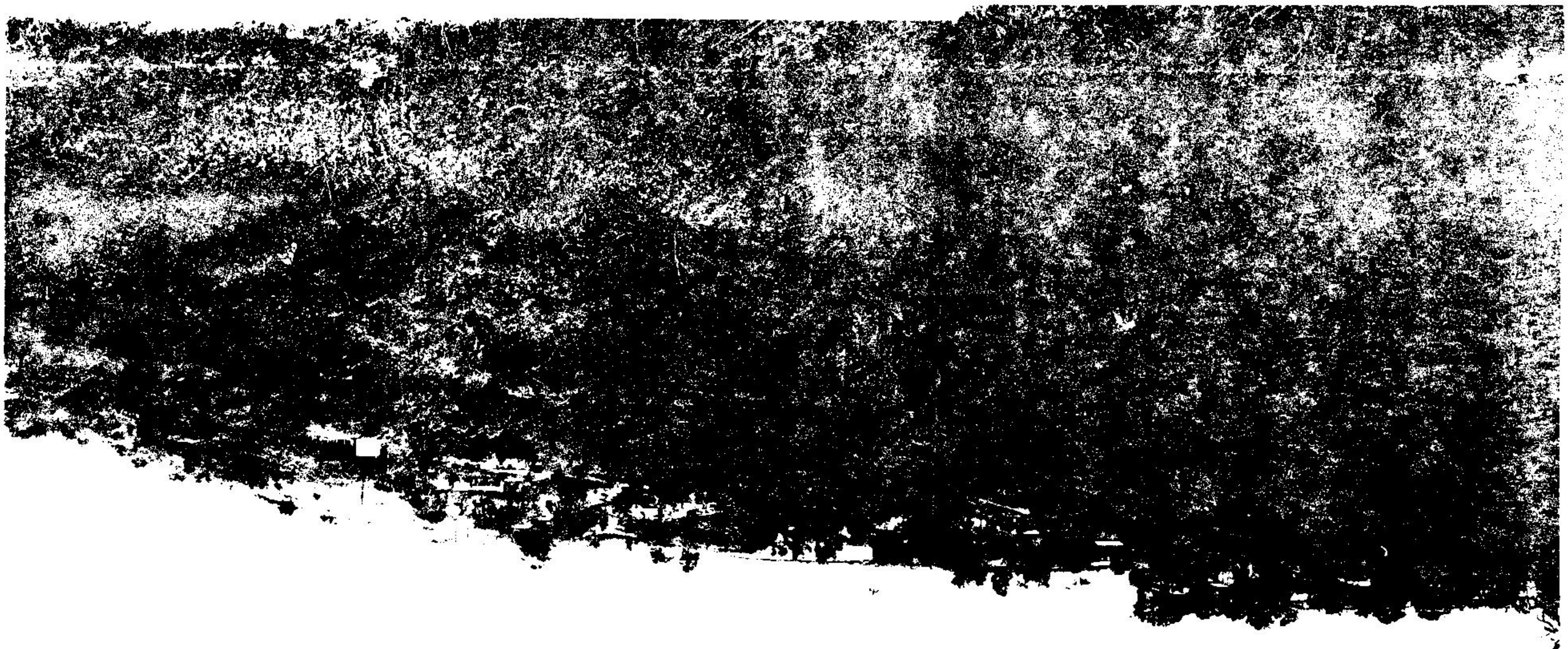


Punta Higuero Panorama - West



Pu [illegible]

Punta [illegible]ero Pan[illegible]



Punta Higuero Panorama - North Northeast

Second Successional Forest - Punta Higuero

APPENDIX D

PRELIMINARY OBSERVATIONS ON THE BENTHIC COMMUNITIES OF THE PUNTA HIGUERO SITE

By

Alina Szmant Froelich, Stephen Martin,
Beverly Buchanan, Robert Castro

INTRODUCTION

The Punta Higuero area is under consideration as a possible site for the construction of a fossil fuel power plant. Sea water is to be utilized as a coolant and is later to be discharged into the immediate environment at an elevated temperature. This action may have detrimental effects on the shallow water communities of the insular shelf surrounding the Punta Higuero site. Unlike fishes and some of the plankton, the benthic organisms, in most cases, cannot relocate themselves permanently or even temporarily if they are being adversely affected by the increased temperature. It is therefore important to determine what benthic assemblages are present, their areal extent, their sensitivity to increased temperatures, and their economic importance to the nearby human communities. The insular shelf surrounding Punta Higuero is very narrow, ranging in width from approximately one to four kilometers. It is an open unprotected area, influenced by the large North Atlantic swell north of the Point and by the Caribbean Sea and Mona Passage currents south of the Point, resulting in a complex current pattern most of the year. The majority of the coastline in this area consists of rocky outcrops and unprotected beaches and there are few protected areas. Also, although no large rivers discharge into the area, it may be influenced occasionally by the Añasco River south of the Point and the Culebrinas River north of the Point.

itial observations in the area (Puerto Rico Nuclear Center, 1972) suggested that the benthic communities north of the Point might be different than those south of the Point. Therefore, our group first swam transects perpendicular to shore in areas north and due west of the Point, and also observed areas south of the Point, to determine the community types present and specifically the areas that would be sampled in detail. Observations from these and subsequent dives seem to confirm that there is a transition from a predominately benthic algal community north of the Point to a predominately coral-sponge community south of the Point. As will be further discussed later, this may be an important consideration in the design and location of the plant.

METHODS

Benthic communities in the near and offshore vicinity of Punta Higuero were observed and sampled from January 16-19, 1973. Preliminary observations began with visual and photographic observations approximately one nautical mile northeast of Punta Higuero, utilizing SCUBA apparatus and swimming a transect perpendicular to the shoreline from 60 to 15 foot depths, covering a bottom area of approximately 4,000 square meters (m^2). Similar bottom observations were obtained adjacent to Punta Higuero (20 to 40 foot depths) observing an area of approximately 2,000 m^2, and also approximately one nautical mile south of Punta Higuero (35 to 45 foot depths) observing an approximate 500 m^2 area (Figure 1). Divers recorded basic information relative to benthic community types, dominant organisms, bottom composition, and physical observations, including current strength and direction, and visibility on plexiglass slates. Also, the area was photographed and representative organisms collected for subsequent laboratory study.

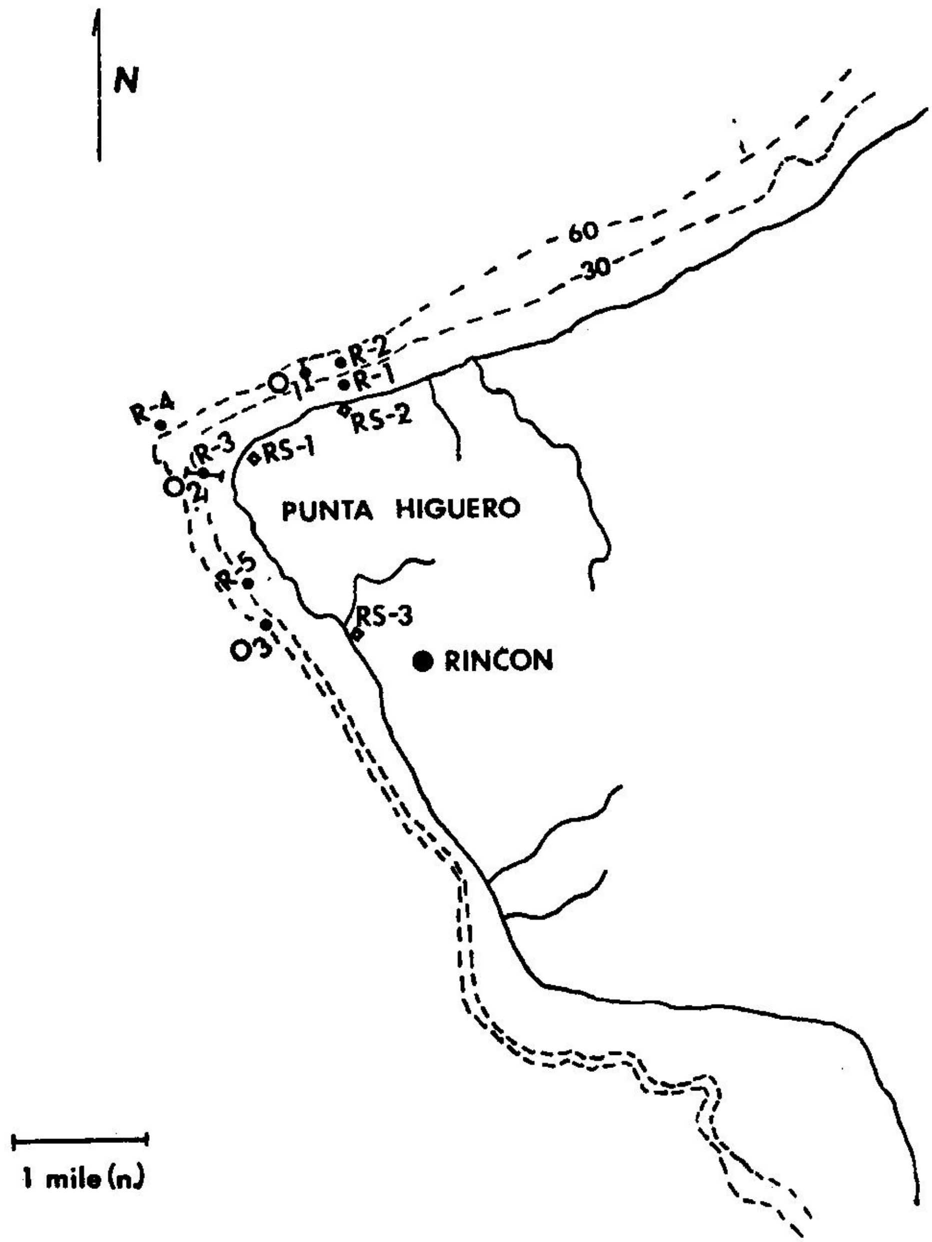


Figure 1. Location of shore and offshore sampling stations at Punta Higuero. Shore stations are listed as RS-1, RS-2, and RS-3, while offshore stations are numbered R-1 through R-5. Observation dives are shown as O_1 to O_3. Dashed lines represent 30 and 60 foot contour lines.

A. Station selection:

Based on these observations and on other previous preliminary observations conducted by Puerto Rico Nuclear Center biologists (PRNC, 1972) five offshore stations were established for more detailed study: Stations R-1 (25 feet depth) and R-2 (45 feet depth) approximately one nautical mile northeast of Punta Higuero; Stations R-3 (35 feet depth) and R-4 (65 feet depth) directly adjacent to Punta Higuero; and Station R-5 (25 feet depth) approximately one nautical mile southeast of Punta Higuero(Fig.1). Also, three shore stations were established, one at Punta Higuero, RS-1, and two others, located one nautical mile northeast and southeast of this point, RS-2 and RS-3, respectively (Fig. 1).

B. Station sampling:

The sampling techniques at Stations R-1, R-2, R-4, and R-5 were conducted as follows: three divers descended to the sample area and assembled the two meter-square quadrat apparatus, consisting of four metal rods, each two meters in length, and six nylon lines connected to the rods at one-half meter intervals, establishing 16 quarter-meter square areas. While one diver photographed each small (1/4 m^2) quadrat in sequence and then the immediate surrounding area, the others recorded observations of bottom organisms on plexiglass tablets and collected representative organisms from the immediate area. Then all divers reassembled and removed the benthic assemblage from a representative 1/4 m^2 quadrat, often using a hammer and chisel to remove sections containing encrusting and/or boring organisms that were impossible to remove otherwise. The samples were immediately placed in large plastic bags, held next to the collecting site by one diver, in order to ensure that small free-living forms such as crabs and brittle stars could not escape. As the bottom area at Station R-3 was composed almost entirely of sand, with little biomass, quadrat samples were not obtained but rather three 400 cm^2 samples were taken with a standard Eckman dredge. These samples were sieved through a series of screens, mesh sizes 1/8 inch to 1/2 inch, and the retained organisms placed in small plastic vials. As for the shore stations, benthic organisms were observed and/or collected from a variety of habitats, including tide pools, attached to rocky substrata, and burrowed in sand. Also, organisms washed up on the beach were collected, usually from the upper sandy beach zone.

C. Laboratory analyses:

All samples were returned to the laboratory, sorted into phylogenetic groups, weighed, and preserved in 70% ethanol for later identification. Corals were weighed, subjected to clorox digestion, dried, and weighed again to estimate the amount of living animal and plant material present. Also, large pieces of rock were split apart and various organisms removed for identification. Finally, pieces of rubble that remained after most encrusting and boring organisms had been removed were weighed and the weights multiplied by a factor obtained from previous work (Szmant, 1972) to estimate the total organics left in the rubble sample.

All major groups of benthic organisms, including sponges, corals, gorgonians, molluscs, annelids, crustaceans, and echinoderms were classified to genus and species when possible. However, due mainly to time limitation, the classification of sipunculids and other minor phyla was not attempted. Therefore, information was obtained on species composition and total biomass for each 1/4 m^2 quadrat sample collected.

D. Photographic analyses:

To augment the laboratory studies, photographs obtained from the transect observations and from station areas surrounding each quadrat were studied and those with representative communities were selected for inclusion in the report. In addition, photographs from the station quadrats were projected onto specially prepared graph paper, and corals, sponges, and algae cover outlined. Then the percentage bottom areas occupied by these groups were calculated and reported as percent 2 m - quadrat cover.

RESULTS

A total of 27 man-diving hours were spent observing and collecting the benthic communities. Two transects, one spot check and five quantitative samples were obtained. In addition, six man hours were spent observing and collecting organisms from the beaches and rocky shore areas. The results will be divided into descriptions of the communities observed and an evaluation of the quantitative data obtained.

Description of Benthic Comminities:

1. Sandy bottom:

Very few organisms seem to live in or on this botto type. No sand dollars, sea pansies, sea pens, or other usual sandy bottom organisms were observed. This bottom type was found near shore, out to 15-20 feet in depth, and interspersed with higher and harder bottom types farther offshore (20 to 40 foot depths) in other areas. In the future, aerial photographs will be used in determining the areal extent of the sandy areas.

2. Shallow algal (soft bottom):

This bottom type was observed in the shallow (15-25 feet) near shore area north of the Point. Figure 2 is a photograph of a 1/4 m^2 section from this area. Tufts of benthic algae on a sandy bottom characterizes this community type. Only an occasional sponge or gorgonian interrupt the fairly homogeneous substratum.

3. Shallow algal (hard bottom):

This bottom type extends outward from the previous one, from approximately 20 to 35 feet in depth. Less sand is present which permits gorgonians and sponges to become much more abundant. In addition, loose cobbles provide many invertebrates (brittle stars, crabs, etc.) with shelter. Only occasional encrusting coral colonies were present. This type of bottom was observed both north and due west of the Point in the above mentioned depth range. Most areas where this community type was found had fairly irregular bottom topographies.

4. Deep algal (hard bottom):

Sponges become increasingly more important with depth. Many of the algae in this zone are small and encrusting.

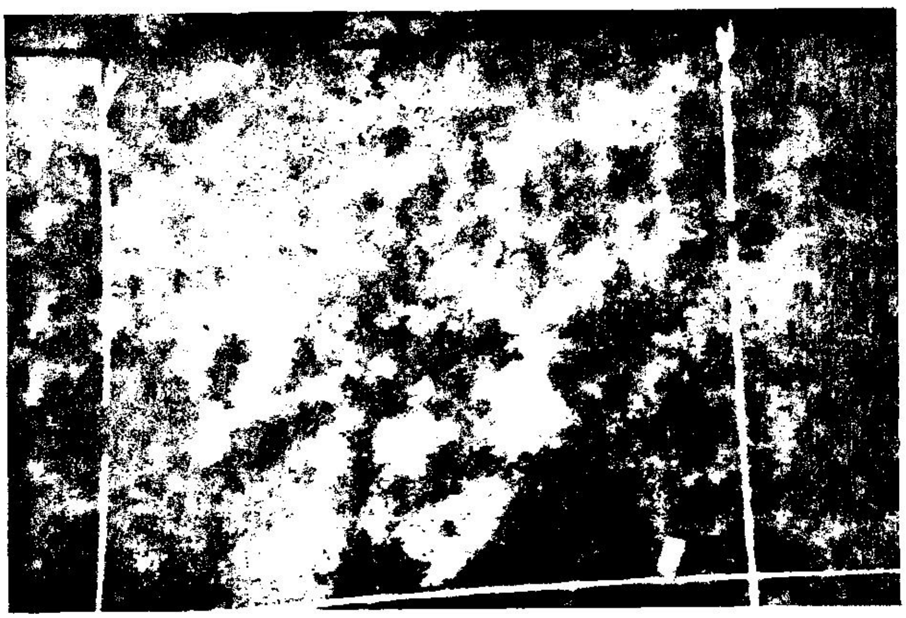


FIGURE 2. Photograph of a 1/4 m^2 area of bottom at Station R-1, showing macroalgae cover and comparatively bare sandy regions. Photography by A.S. Froelich.

Gorgonians also increase in importance. Occasional heads of *Montastrea cavernos* and *Siderastrea siderea* emerge from a gently sloping bottom and many fish were observed swimming in the area, utilizing the corals for food and protection. The transition between the three algal zones is, of course, gradual and the relative extent of each zone depends on the bathymetry and on the wave pattern affecting each particular area.

5. *Deep gorgonian-sponge-coral*:

This bottom type was found only west of Punta Higuero, at a depth of approximately 65 feet, and was characterized by a sparse overall bottom cover. The area was different from other coral communities observed because of a much lower density of cover organisms. Most of the encrusting corals, such as *M. cavernosa*, *Diploria* spp., *Agaricia agaricites*, *Favia fragum*, *Isophyllia* spp., *Mussa angulosa*, *Porites astreoides* and *Mycetophyllia lamarkiana* were present, as well as large gorgonians (many *Euniceas* and *Gorgonias*) and several large basket sponges. The bottom was very irregular with up to 10-foot variations in depth. The deeper areas were covered with soft silty sediment and only a few gorgonians and sponges. Figure 3 is a 1/4 m^2 section of the bottom in this area.

6. *Shallow coral-sponge*:

This bottom type was encountered south of the Point from approximately 20 feet to 35 feet in depth. It is not known how far towards shore this zone continues, nor how far north towards the Point. Figure 4 is a photograph of a few of the many large sponges found in this area.

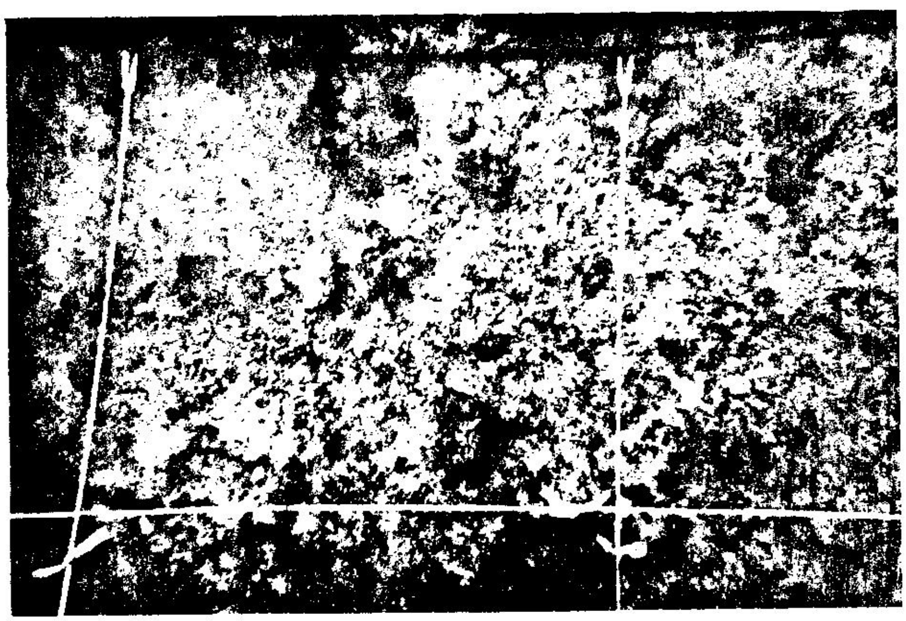


FIGURE 3. Photograph of a 1/4 m bottom area at Station R-4, showing macroalgae interspersed with occasional sponges, rubble and hard sandy substratum. Photograph by A.S. Froelich.

FIGURE 4. Photograph of the bottom at Station R-5. Note the large sponges, including two large basket sponges (Xestospongia sp.) and the smaller sponges at left center and lower right. The remainder of the area is primarily algae on rocky bottom. Photograph by A.S. Froelich.

Large heads of the encrusting coral M. cavernosa, Diploria clivosa, the octocoral Briareum asbestinum, the hydrocoral Millepora alcicornis and the sea urchin Diadema antillarum are some of the more abundant organisms present. Small encrusting algae and sponges covered most of the bottom between the larger corals and sponges. In addition, many encrusting organisms, such as bryozoans, sponges, tubiferous polychaetes, and gastropods live under large, semi-loose boulders. Reef fish were much more common here than around the algal areas and several large lobsters were also sighted.

7. Deep coral:

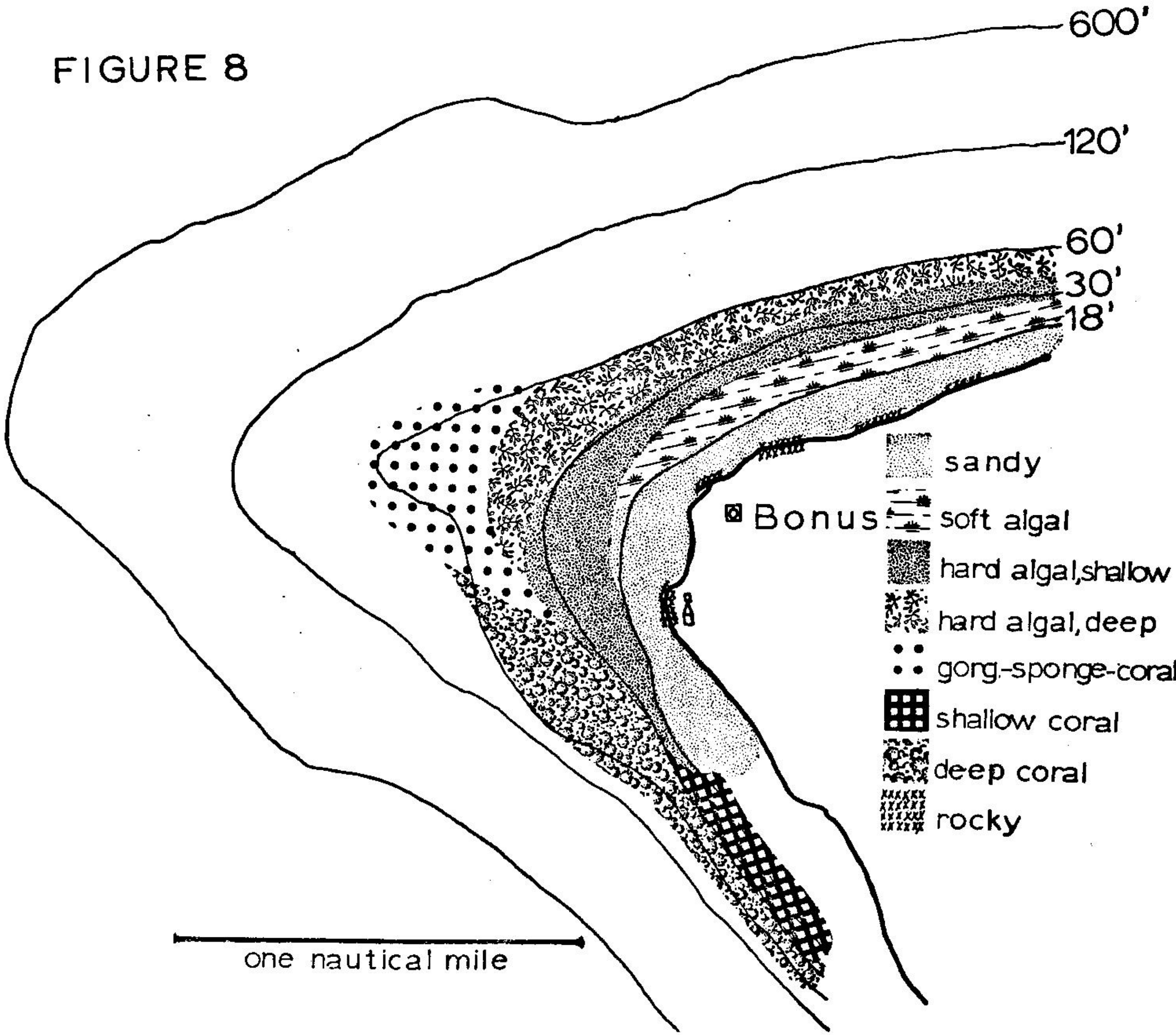
This type of coral community probably exists from around 35 to 40 feet to the edge of the shelf. The area we examined was 45-55 feet deep, with a few deeper holes. Figures 5, 6 and 7 show typical scenes from this area. The bottom is heavily encrusted with M. cavernosa, Diploria strigosa, Porites asteroides and gorgonians, and encrusting algae were observed growing among the colonies. Coral coverage here was approximately 50 percent of the bottom area and is similar to coral communities found on the outer shelf south of Puerto Rico. Fishes were very abundant, especially large parrot fish, snappers, surgeon fish and grunts (Table II). Bottom depressions or holes contained many large schools of the grunts and snappers. A map of the possible distribution of the above bottom types is presented in Figure 8. The sho[illegible] [illegible]eas i[illegible] the vicinity of Punta [illegible]guero are a

FIGURE 5. Photograph of coral formations observed at Station R-6, comprised mainly of Montastrea cavernosa and gorgonians. Photograph by A.S. Froelich.

Figure 6. Photograph of the bottom at Station 6. Present are two porkfishes (Anisotremus virginicus), corals (M. cavernosa and Porites astreoides) and gorgonians. Photo by A.S.Froelich.

Figure 7. Photograph of the bottom at Station R-6. Note the pink form of the encrusting coral M. cavernosa, the coral Diploria sp., [illegible], gorgonians and a hard, algae covered substrate. [illegible] Froelich.

FIGURE 8


600'
120'
60'
30'
18'
Bonus
sandy
soft algal
hard algal, shallow
hard algal, deep
gorg.-sponge-coral
shallow coral
deep coral
rocky
one nautical mile

mixture of rocky shores and sandy beaches. The observed rocky shore communities were similar to those of other rocky shores around the north and eastern coasts of Puerto Rico. A good description of rocky shore biota, which applies as well to the rocky outcrops at Punta Higuero, is that of Glynn (1964). No large tide pools were found on the rocks, but tide pool type organisms were found in the pool behind the breakwater of the old Bonus plant intake.

A shelf of algae-covered beach rock was found a few meters from shore along much of the beach near the Bonus plant. It was not possible to adequately sample this shelf due to high wave action. It was noticed, however, that much of the algal cover on the shelf consisted of *Padina* sp. Some invertebrates from this area were collected by Dr. F.D. Martin (PRNC) while rotenone poisoning for fish. They are included in Table 1 under the heading, "Tide Pool".

Finally, a few samples of beach sand from the swash zone were sieved for beach organisms, however, only a few individuals of *Hippa cubensis* were found. We were not able to examine the sandy area just offshore due to rough weather conditions. Table II is a compendium of organisms that were sighted at various times during the dives or shore work, although they were not collected and identified in the laboratory. They are included here for completeness.

Table 1

Organisms collected at various sampling stations. (See fig. 1 for station locations). R-1, R-2, R-4 and R-5 are 1/4 m^2 quadrat stations; R-3 is from 3 Eckman dredge hauls on a sandy bottom; "Miscellaneous" are specimens collected washed up on the beach at 3 sites; "Tide Pool" includes organisms collected by Rotenone poisoning and by hand collecting; "65 ft. Transect"

	R-1	R-2	R-3	R-4	R-5	Misc.	Tide Pool	65' Transect
Algae								
Chlorophyta								
Anadiomene stellata		X			X	X		
Caulerpa racemosa						X		
Caulerpa sertularioides						X		
Caulerpa verticillata						X		
Dictyospaeria cavernosa	X							
Halimeda sp.	X	X						
Halimeda discoidea						X		
Penicillus capitatus						X		
Spyridia aculeata						X		
Udotea flabellum	X					X		
Ulva lactuca		X						
Valonia ventricosa	X	X		X		X		
Phaeophyta								
Dictyopteris sp.		X				X		
Dictyopteris delicatula	X							
Dictyota sp.					X	X		
Dictyota bartayresii		X				X		
Dictyota cervicornis						X		
Dictyota dichotoma		X			X	X		
Dictyota divaricata						X		
Dictyota jamaicensis						X		
Dictyota linearis	X							
Padina sp.		X				X		
Sargassum sp.					X	X		
Rhodophyta								
Amansia multifida	X							
Amphiroa brasiliana		X			X			
Amphiroa fragilissima	X	X						
Amphiroa rigida				X				X
Amphiroa tribulus		X						
Botryocladia pyriformis				X				
Bryocladia sp.						X		
Bryothamnion triquetrum						X		

Table 1 (cont.)

	R-1	R-2	R-3	R-4	R-5	Misc.	Tide Pool	65' Transect
Rhodophyta								
Ceramium sp.						X		
Corallina sp.		X		X		X		X
Corallina cubensis	X							
Galaxaura sp.	X							
Glacilaria sp.	X	X		X		X		
Gracilaria ferox						X		
Gracilaria verrucosa					X			
Gracilariopsis sp.						X		
Jania sp.		X						
Jania adherens		X			X			
Jania capillacea						X		
Laurencia sp.						X		
Laurencia papillosa	X					X		
Polysiphonia sp.						X		
Pterocladia pinnata						X		
Wrangelia sp.						X		
Angiosperma								
Thalassia testudium	X							
Foraminifera								
Amphiostegna gibbosa					X			
Archaias angulatus forma compressa			X	X				
Quinqueloculina sp.					X			
Porifera								
Callyspongia sp.				X				
Chondrilla nucula					X			X
Cliona sp.		X		X				
Craniella sp.				X				
Erylus ministrogylus					X			
Geodia gibberosa				X				
Higginsia strigilata		X				X		
Verongia fistularis	X	X		X				
Xestospongia muta				X	X			
Zygomycale parishii	X							
Axinella sp.						X		
Anthosignella sp.								
Microcina microchela					X			
Microcina sp.					X			
Clathrina canariensis					X			
Coelenterata								
Hydrozoa								
Cnidoscyphus marginatus				X				X
Diphasia digitalis								X

Table 1 (cont.)

	R-1	R-2	R-3	R-4	R-5	Misc.	Tide Pool	65' Transect
Hydrozoa								
Millepora alcicornis		X				X		
Sertularella speciosa				X				
Anthozoa								
Actiniaria								
Zoanthus sp.						X		
Scleractinia								
Agaricia agaricites		X						
Astrangia solitaria					X			
Diploria clivosa					X			
Isophyllia multiflora					X			
Meandrina brasiliensis		X						
Montastrea cavernosa					X			
Siderastrea radians					X			
Octorallia								
Eunicea tourneforti					X			
Muricea atlantica				X				
Muriceopsis flavida						X		
Plexaura flexuosa					X			
Plexaurella sp.		X			X			
Annelida								
Polychaeta								
Eunice sp.	X				X			
Eunice cariboea		X						
Eunice fucata				X				
Eunice rubra	X							
Glycera sp.				X				
Hermenia verruculosa					X			X
Hesione proctochona								
Laetmonice kinbergii		X			X			X
Leodice rubra								
Lepidonotus branchiatus		X			X			
Lumbrinereis floridana	X							
Lysidice sulcata				X				
Marphysa regalis				X	X			X
Nereis sp.	X				X			
Nereis bairdii	X							X
Nereis dumerilii	X				X			
Nicidion sp.	X							
Nicidion kinbergii				X	X			
Onuphis sp.	X							
Pontogenia sericorna	X							

Table 1 (cont.)

	R-1	R-2	R-3	R-4	R-5	Misc.	Tide Pool	65' Transect
Polychaeta								
Sabella sp.				X				
Sabella alba		X		X	X			
Scoloplos sp.			X					
Stylaroides glabra					X			
Syllis sp.				X	X			
Syllis prolifera	X	X		X	X			
Terebella sp.	X			X				
Sipunculida								
Unidentified	X				X			X
Mollusca								
Amphineura								
Acanthopleura granulata							X	
Chiton marmoratus							X	
Chiton squamosus							X	
Gastropoda								
Acmaea antillarum						X		
Aequipecten gibbas						X		
Arca zebra						X		
Astraea sp.						X		
Astraea tuber						X		
Bulla striata						X		
Cheilea equestris						X		
Cantharus sp.	X					X		
Cantharus lautus						X		
Cardita gracilis						X		
Colubraria obscura						X		
Columbella mercatoria						X		
Conus daucus				X				
Conus mus						X		
Coralliophila aberrans				X	X			
Cymatium sp.						X		
Cymatium pileare						X		
Cyphoma intermedium								X
Cyprea cassis testiculus						X		
Cyprea cinerea						X		
Cyprea spurca						X		
Diodora sp.			X					
Diodora arcuata						X		
Diodora listeri						X		
Drillia interpleura	X							
Drupa nodulosa						X		

Table 1 (cont.)

	R-1	R-2	R-3	R-4	R-5	Misc.	Tide Pool	65' Transect
Gastropoda								
Epitomium lamellosum						X		
Eulima auricincta							X	
Eulima patula			X					
Heliacus bisulcatum	X							
Hemitoma octoradiata						X		
Hipponix antiguatus			X					
Hyalina tenuilabra						X		
Littorina ziczac							X	
Lucapinella limatula						X		
Marginella sp.			X					
Melampus coffeus						X		
Mitra sp.	X				X			
Mitra crenata						X		
Mitra nodulosa			X					
Nerita peloronta							X	
Nerita tessellata							X	
Nerita versicolor							X	
Nitidella nitida						X		
Nodolittorina tuberculata						X		
Odostomia laevigata			X			X		
Odostomia seminuda			X					
Oliva reticularis			X			X		
Olivella dealbata			X					
Olivella petiolita						X	X	
Persicula sp.						X		
Persicula lavalleeana			X					
Persicula pulcherrima			X					
Petaloconchus erectus					X	X		
Petaloconchus floridanus				X				
Phalium sp.						X		
Pisania pusta						X		
Planaxis lineatus						X		
Planaxis nucleus						X		
Polinices lacteus	X					X		
Purpura patula						X	X	
Pussia gemmata	X			X		X		
Pussia hanleyi	X							
Pyrene ovulata						X		
Rissoina multicostata	X							
Serpulorbis decussata						X		
Serpulorbis riisei					X			
Smaragdia virides						X		
Strombus gigas						X		
Strombus raninus						X		
Tectarius muricatus						X	X	
Tegula excavata						X	X	
Tegula lividomaculata						X		

Table 1 (cont.)

	R-1	R-2	R-3	R-4	R-5	Misc.	Tide Pool	65' Transect
Gastropoda								
Thais sp.						X		
Thais rustica						X	X	
Trachycardium muricatum						X		
Tricolia thalassicola			X					
Trimusculus goesi						X		
Trivia antillarum						X		
Trivia nix						X		
Trivia pediculus				X		X		
Trivia suffusa						X		
Trivia quadripunctata						X		
Tonna maculosa						X		
Turritella sp.			X					
Vermicularia knorri		X						
Mollusca								
Pelecypoda								
Anadara lienosa floridana						X		
Anadara notabilis				X				
Arca imbricata						X		
Barbatia dominguensis				X	X			
Banchidontes exustus	X							
Chama sp.						X		
Chama macerophylla						X		
Chione sp.		X						
Chione cancellata		X						
Columbella mercatoria						X		
Gastrochaena hians					X			
Lyonsiabeana				X	X	X		
Lima lima		X		X	X			
Musculus lateralis	X	X						X
Papyridea semisulcata	X		X		X			
Scallops			X					
Sphenia antillensis				X				
Spondylus americanus		X						
Scaphopoda								
Dentalium sp.					X			
Arthropoda								
Crustacea								
Isopoda								
Excorallana sp.					X			
Excorallana tricornis				X				
Cirolana parva	X	X		X				

Table 1 (cont.)

	R-1	R-2	R-3	R-4	R-5	Misc.	Tide Pool	65' Transect
Isopoda								
Paracereis sp.	X							
Paracereis caudata				X				
Stomapoda								
Gonodactylus oerstedii		X			X			
Decapoda								
Reptantia								
Alpheus cristulifrons		X		X	X			
Synalpheus sp.		X		X	X			
Synalpheus apioceros				X				
Synalpheus minus					X			
Synalpheus rathbunae				X	X			
Synalpheus tanneri				X				
Periclemenaeus sp.		X						
Periclemenaeus americanus	X							
Periclimenaeus schmitti					X			
Anomura								
Albunea gibbesii			X					
Coenobita clypeatus						X		
Hippa cubensis						X		
Paguristes sericeus						X		
Brachyura								
Actaea sp.		X						
Epialtus longirostris	X							
Eurypanopeus abbreviatus		X						
Mithrax sp.	X							
Mithrax forceps	X							
Pachygrapsus gracilis							X	
Pachygrapsus transversus							X	
Podochela grossipes		X						
Echinodermata								
Asteroidea								
Asterias forbesii	X							
Echinoidea								
Echinometra lucunter						X		
Echinometra viridis							X	
Eucidaris tribuloides	X	X						
Ophiuroidea								
Amphiura fibulata		X						
Ophiactis mulleri					X			

Table 1 (cont.)

	R-1	R-2	R-3	R-4	R-5	Misc.	Tide Pool	65' Transect
Ophiuroidea								
Ophiactis savignyi		X						
Ophiocoma echinata	X	X		X				
Ophiocoma riisei					X			
Ophioderma sp.	X							
Ophioderma rubicundum					X			
Ophiopsila riisei					X			
Ophiothrix sp.					X			
Ophiothrix angulata	X	X		X	X			X
Ophiothrix suensonii				X		X		
Holothuroidea								
Holothuria sp.	X							
Bryozoa								
Unidentified		X		X	X			
Schizoporella sp.		X						
Chordata								
Ascidiacea								
Microcosmus exasperatus					X			
Stylea plicata		X						
Trididemnum sp.				X				
Total #spp. 268 collected	49	49	2	48	62	108	17	13

Table II - Organisms sighted at the Punta Higuero site.

Porifera:
- Callyspongia sp.
- Haliclona sp.

Coelenterata:
- Anthozoa: Hexacorallia
- Palythoa caribaorum
- Diploria strigosa
- Diploria labyrinthiformis
- Faviafragum
- Montastrea annularis
- Siderastrea siderea
- Eusmilia fastigiata
- Colpophyllia natans
- Manicina sp.
- Meandrina meandites
- Dichocoenia stokesii
- Mycetophyllia lamarkiana
- Isophyllastrea rigida
- Mussa angulosa
- Agaricia agaricites
- Porites porites
- Porites asteroides
- Madracis decactis
- Octocorallia
  - Eunicea laxispica
  - Plexaura homomalla
  - Pterogorgia guadalupensis
  - Gorgonia flabellum
  - Pseudopterogorgia sp.
  - Briareum asbestinum

Annelida
- Pomastegus sp.
- Spirobranchus sp.

Arthropoda, Crustacea
- Panulirus argus
- Grapsus grapsus

Fish
- Melichthys niger
- Balistes vetula
- Acanthurus spp.
- Scarus spp.
- Thalassoma bifasciatum
- Halichoeres bivittatus
- Halichoeres pictus
- Bodianus rufus
- Chromis spp.

Table II (cont.)

Fish

<u>Eupomacentrus partitus</u>
<u>Eupomacentrus fuscus</u>
<u>Pomacanthus arcautus</u>
<u>Pomacanthus paru</u>
<u>Chaetodon striatus</u>
<u>Anisotremus virginicus</u>
<u>Haemulon spp.</u>
<u>Lutjanus jocu</u>
<u>Lutjanus spp.</u>
<u>Scomberomorus regalis</u>
<u>Caranx ruber</u>
<u>Cephalopholis fulva</u>
<u>Holocentrus spp.</u>

Quantitative data:

As yet the quantitative data collected is not sufficient to make conclusions from them about the communities present and the differences between them. At most, only one sample was collected from each bottom type and in some cases none were collected. The bottom types for the five photographed and collected quadrats were as follows:

Station	Bottom Type
R-1	Shallow algal (soft bottom)
R-2	Deep algal (hard bottom)
R-3	Sandy bottom (dredge samples)
R-4	Deep gorgonian - sponge - coral
R-5	Shallow coral - sponge

Total biomass for the stations were (in gms. net weight 1/4 m^2):

Station	Biomass
R-1	320.8
R-2	1667.6
R-3	3.6
R-4	1173.6
R-5	2346.55

The biomass estimates indicate that the sandy and shallow soft bottom algal communities were much lower in biomass than the coral and deeper algal communities. However, the number of species present was approximately the same for all samples except R-3 (Table 1). Insufficient data is available at the present time to look at distribution of biomass among the various phylogenetic groups or to compile trophic level diagrams. Examination of the results of the photographed quadrats Table III) shows the predominance of algae at Stations R-1 and R-2. The category "scattered algae" includes all areas where encrusting or foliaceous algae were growing

...ble III - Percentages of bottom cover for the Rincon 2x2 m quandrats

...ganisms	Station Number			
	R-1 %	R-2 %	R-4 %	R-5 %
Algae	49	49	7	12
Scattered algae**	50	33	65	55
Sponge	0.3	1	9	7
Montastrea cavernosa		2	.1	16
Montastrea annularis		.3		.1
Porites astreoides				.1
Siderastrea siderea				.4
Diploria strigosa				5
Diploria clivosa		2		2
Favia fragum			.1	
Dichocoenia stokesii				.1
Isophyllia strea rigida			.3	
Isophyllia multiflora			.2	
Isophyllia sinuosa				1
Millepora alcicornis				.1
Briareum asbestinum			.2	.2
Gorgonians		4	1	1
No coverage	—	—	—	—
Total	99.3	99.3	99.9	100.0

** This includes areas where the algal tufts were too little or too diffuse to distinguish and outline them.

Amount of algae/area varies in this category, but it would be very difficult to quantify.

in very small patches so that it was not possible to distinguish the actual areas covered by algae and the areas where nothing was growing. Most of this area had around a 30-50% algal coverage on it. Therefore, around two-thirds to one-half of the category "scattered algae" could be added to "no coverage". Although Station R-2 had a few corals, R-4 and R-5 had much more variety in the corals present there.

DISCUSSION

Although the existing data are insufficient for an in-depth analysis of the situation, it is apparent that the benthic communities north of the Point are mostly algae; while in those south of the Point corals predominate.

Algae are usually considered fairly resistant to thermal alterations, while corals have been shown not to be. Also, siltation can usually be overcome more easily by algae than by corals. Since the major possible detrimental effects to the environment by the plants would be 1) sediment disturbance during construction of the plant, 2) sediment disturbance and suspension at the discharge channel of the plant, and 3) discharge of heated sea water into the environment, care should be taken that the heat and sediment laden waters do not affect the coral areas which are of more economic importance to the nearby inhabitants as fishing grounds. Therefore, it is recommended that the discharge channel be well to the north of the Point where it will have time to 1) cool off thru mixing, and 2) drop its sediment load before crossing the highly productive coral - sponge communities.

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