Cruise Report No 2/94

PART 2

Survey of the demersal resources

1 to 19 September 1994

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CHAPTER 1 INTRODUCTION

1.1 Objectives

The objectives of the survey were discussed at meetings with the Minister of Fisheries and with the Technical Director and other representatives of Instituto de Investigação Pesqueira (IIP) earlier this year.

The objectives of the survey were to:

- Describe the distribution, composition and abundance of major demersal species, with special emphasis on sparids, hake and deep-water shrimp, from Cabinda to Benguela by a swept-area trawl programme.

- Collect stomach samples of *Merluccius polli* for later quantitative laboratory analysis of the contents, with special emphasis on the content of economically important shrimps.

- Map the general hydrographic regime by using a CTD-sonde on all trawl stations all over the survey area and monitor the temperature, salt and oxygen on IIP standard profiles for hydrographical studies.

- Conduct current measurements with current meter mooring.

1.2 Participation

The scientific staff consisted of:

From IIP, Angola:

Antónia Nelumba, Fidel Quilanda, Francisco de Almeida, Dilkarina Azevedo, Guilherme Camarada and Ana de Sousa.

From IMR, Bergen:

Martin Dahl, Tor Gammelsrød, Ole Gullaksen, Reidar Johannessen and Sigbjørn Mehl.

1.3 Narrative

The vessel left Pointe Noire (Congo) in the afternoon of 1 September and steamed southwards to Cabinda. The sampling programme commenced north of the Congo River ouside the closed oil-drilling area with course tracks approximately 20 nm apart, covering the inner, middle and the outer shelf and the slope to 800 m depth. Semi-random swept-area hauls were carried out on the shelf during daytime and on the slope deeper than 400 m during dark hours. CTD-stations were taken at almost all trawl stations in addition to those taken for the standard profiles. Acoustic registration and integration of main groups were done throughout the survey.

The northern part of the survey area, Cabinda-Luanda, was covered from 2 to 10 September. Three hydrographic transects were sampled in the region; Cabinda, Pta. da Moita Seca and N'Zeto. The Cabinda region was only partially covered due to oil-drilling activities. In the area north of Ambriz a 10 nm wide zone along the coast was not covered for security reasons. From 10 to 11 September current measurements were coducted off Pta. das Palmeirinhas. The southern part of the survey area, Luanda - Benguela, was covered from 11 to 19 September, including the hydrographic transects Pta. das Palmeirinhas, Pta. do Morro and Lobito. The survey was completed off Lobito on 19 September and the vessel steamed suthwards to Walvis Bay.

1.4 Survey effort

Figure 1a-b shows the cruise tracks with fishing stations and the hydrographic profiles.

The number of hauls by area and depth interval and number of CTD-stations were:

	Swept-area hauls			Total	CTD	Distance surveyed
	0-200m	200-400m	400-800m			
Cabinda-Luanda	32	20	21	73	73	990 nm
Luanda-Benguela	38	18	16	72	80	840 nm
Total	70	38	37	145	153	1830 nm

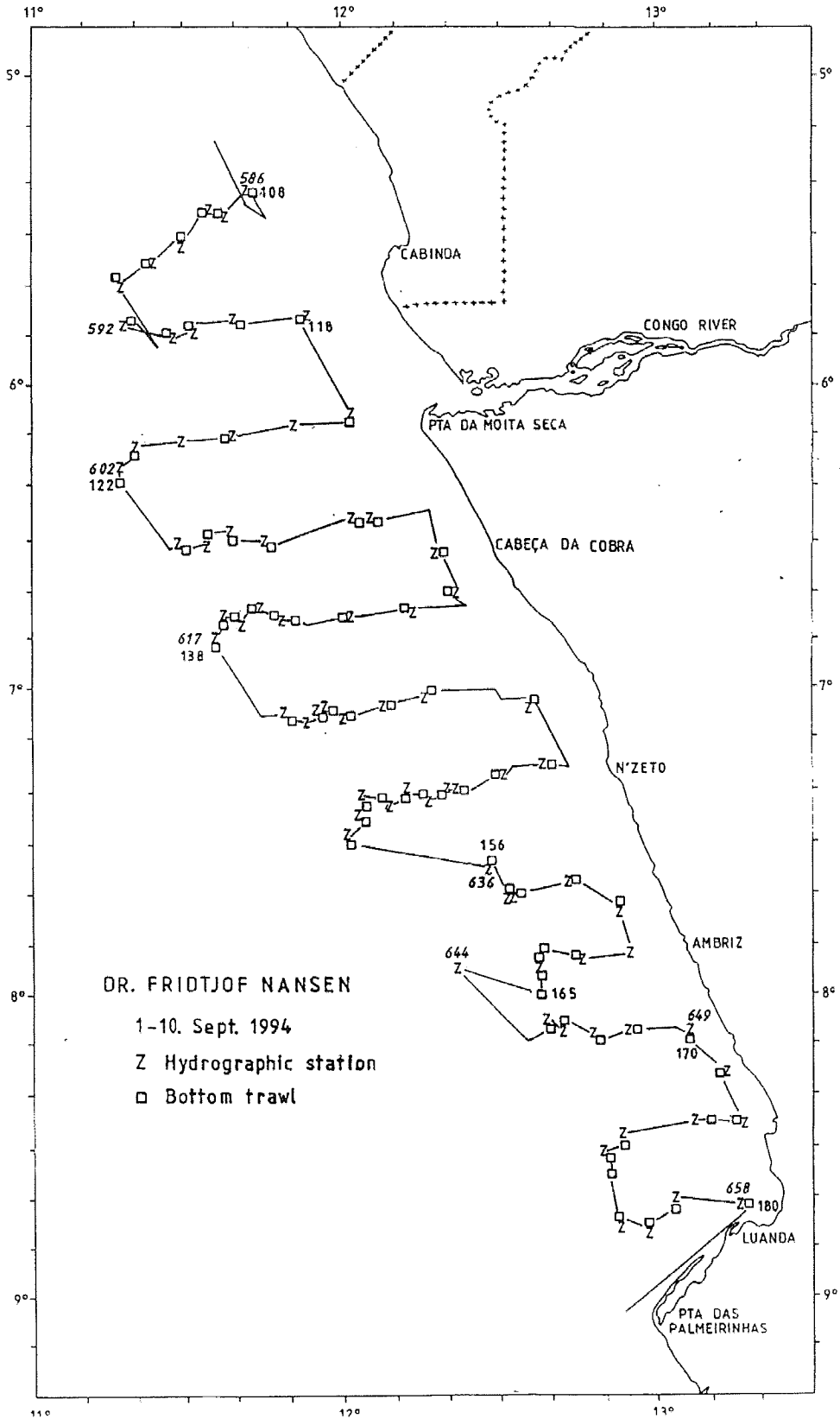

Figure 1a. Cabinda-Luanda. Course tracks with fishing stations and CTD-stations.

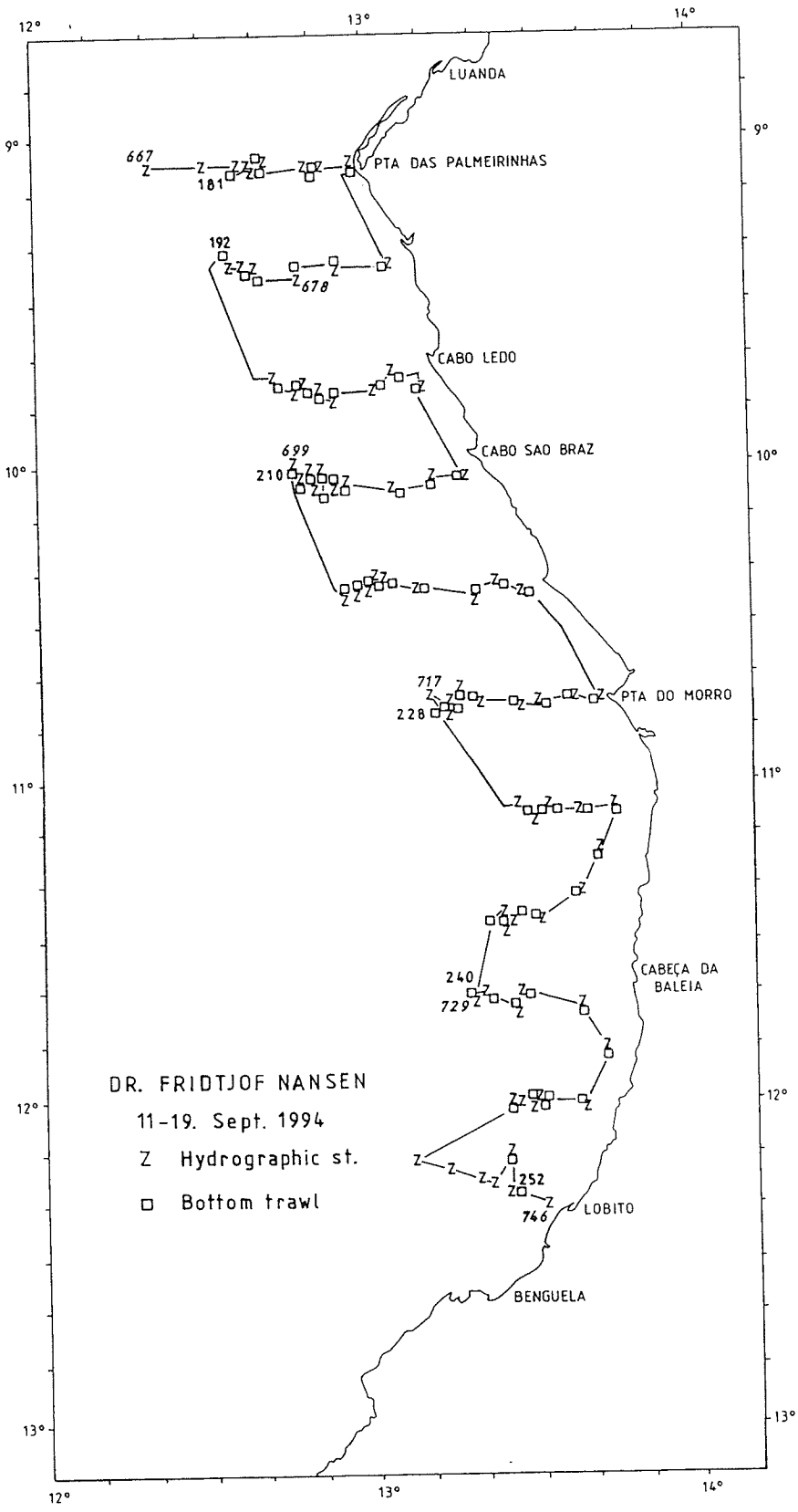

Figure 1b. Luanda-Benguela. Course tracks with fishing stations and CTD-stations.

1.5 Methods

The catches were sampled for species composition by weight and numbers. Length distributions (total length, also for shrimp) were taken for the main species. Biological samples, i.e. length weight, sex and maturity stages, were taken for *M. polli* in connection with stomach sampling. A few samples of *Dentex angolensis* were collected for contamination studies in the areas of highest oil drilling activity. Pooled length frequency distributions (weighted by the catch) of selected species by area, are shown in Annex II. The records of fishing stations are presented in Annex III.

The following areas (nm^2) were used in the swept-area biomass estimates:

	Cabinda-Luanda	Luanda-Benguela
0- 50 m	3 023	1 850
50-100 m	2 693	1 730
100-200 m	2 085	1 252
200-300 m	755	500
300-400 m	660	350
400-500 m	540	445
500-600 m	880	450
600-800 m	1 500	900

The bottom trawl has a headline of 31m (float line), footrope 47 m, estimated headline height 5m and distance between wings during towing about 18m. During trawling a 9.5 m long rope was fastened between the wires 150 m in front of the doors giving a constant distance between the doors of 49-50 m. All trawl hauls were monitored by SCANMAR trawl sensors (bottom contact, headline height and distance between the doors) and the actual time the trawl was fishing on the bottom was determined with improved accuracy. For conversion of catch rates to fish densities the area between the wings is assumed to be the effective fishing area i.e. the retention factor q is equal to 1. With the new vessel a new trawl gear was introduced with smaller bobbins. This gear gives better bottom contact and higher catch rates for some bottom dwelling species (e.g. monk and sole). For other species (e.g. hake) the new gear is assumed to have no difference in performance. The trawl, warp and wire dimensions are as with the former vessel. The length of a haul, recorded as distance over bottom was measured by Doppler log on the bottom. There was some mid-water occurrence of hake on the slope during dark hours, and this may have affected (reduced) the swept area-estimates for the slope deeper than 400 m.

A description of the fishing gear, the acoustic instruments and their standard settings is given in Annex IV.

CHAPTER 2 OCEANOGRAPHY

2.1 Instruments and methods

Hydrography

A Seabird 911 CTD plus was used to obtain vertical profiles of temperature, salinity and oxygen. Real time plotting and logging was done using the Seabird Seasave software installed on a PC. The profiles were taken down to a few meters above the bottom. Two Niskin bottles were triggered for water samples on each station, one near the bottom and one near the surface (3m depth). The samples were analyzed for salinity using a Guildline Portasal salinometer, and the oxygen content was determined using the Winkler method. These laboratory values were used for calibration of the CTD after removing obvious outliers.

Using 142 points for the salinity calibration gave a standard error of 0.0085 without any adjustment of CTD values. This was accepted. It should be noted that a better calibration may be obtained using only the bottom samples, where the gradients in T and S usually are smaller.

For oxygen 118 samples were accepted for the calibration. A linear regression gave the following formula for correcting the oxygen values:

$$O_2 = O_{2ctd} * 1.459 + 0.555$$

Applying this formula a standard error of 0.142 was obtained.

Current measurements

Two Aanderaa RCM7 current meters were deployed for about 24 hours to obtain current speed and direction at 2m depth and 45 m depth. The current meters were also equipped with pressure, temperature and conductivity sensors. Thus salinity may also be calculated. The current meters were set to record at 10 min intervals and the data are stored internally. The Data Storing Units were read by a DSU reader using a PC and the P3059 software supplied by Aanderaa Instruments.

Meteorological data

Wind, air temperature, global radiation and sea surface temperature (5 m depth) were logged automatically every nautical mile using an Anderaa meteorological station. The SST were used as additional information for constructing the horizontal distribution maps, and the wind measurements were useful for interpretation of the current measurements.

2.2 Results

Hydrography

A total number of 161 hydrographic stations (including 8 in connection with the current measuremenst) were obtained. This net of CTD-stations represents the most extensive hydrographic program ever performed on the Angolan coast, see station map (Fig.1). In addition to the standard sections, a CTD station was taken in connection with all the bottom trawls.

Surface distribution

The horizontal distributions of temperature and salinity are shown in Figs. 2 and 3, respectively. Both parameters have a rather flat structure, typical for the season, except the influence of the Congo River on the salinity distribution. The fresh water from this river seems to be deflected northwards by a near shore current, but the minimum surface salinities found in the outer part of the sections south of the Congo river indicate that the fresh water is transported southward by the Angolan current further off shore. Note that the minimum salinities were found at a distance from the coast, indicating the non stationarity in the region. This area is probably dominated by eddies, which perhaps could be revealed in satellite imageries due to the different optical properties of the river water and sea water.

The near shore surface salinity minimum north of Luanda may be due to a similar northward advection of the water from the Kwanza River just south of Pta das Palmeirinhas, but note the off-shore bound currents observed in the surface layer in the area (see below).

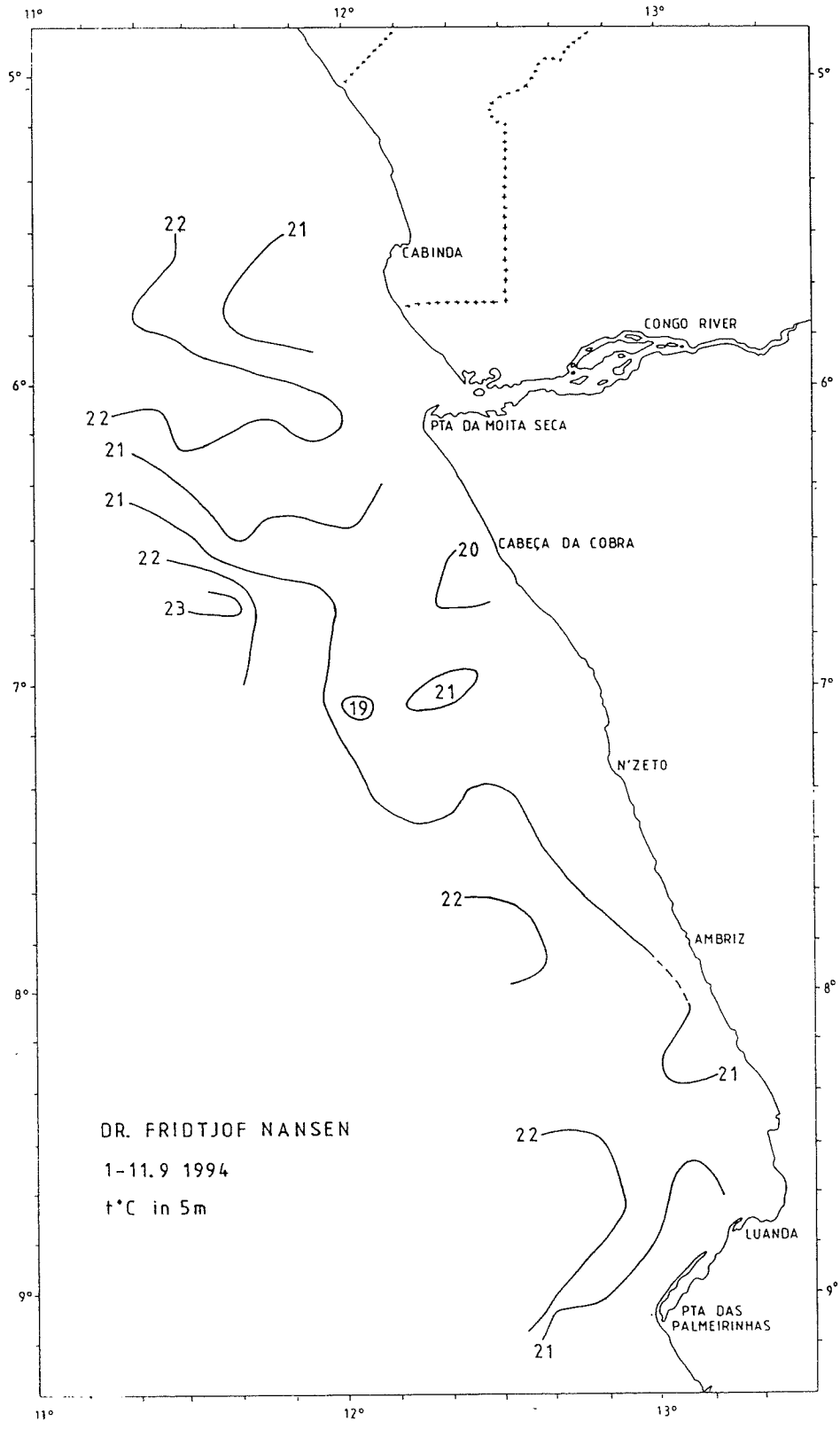

Figure 2a. Horizontal distribution of surface (5m depth) temperature, Cabinda - Luanda.

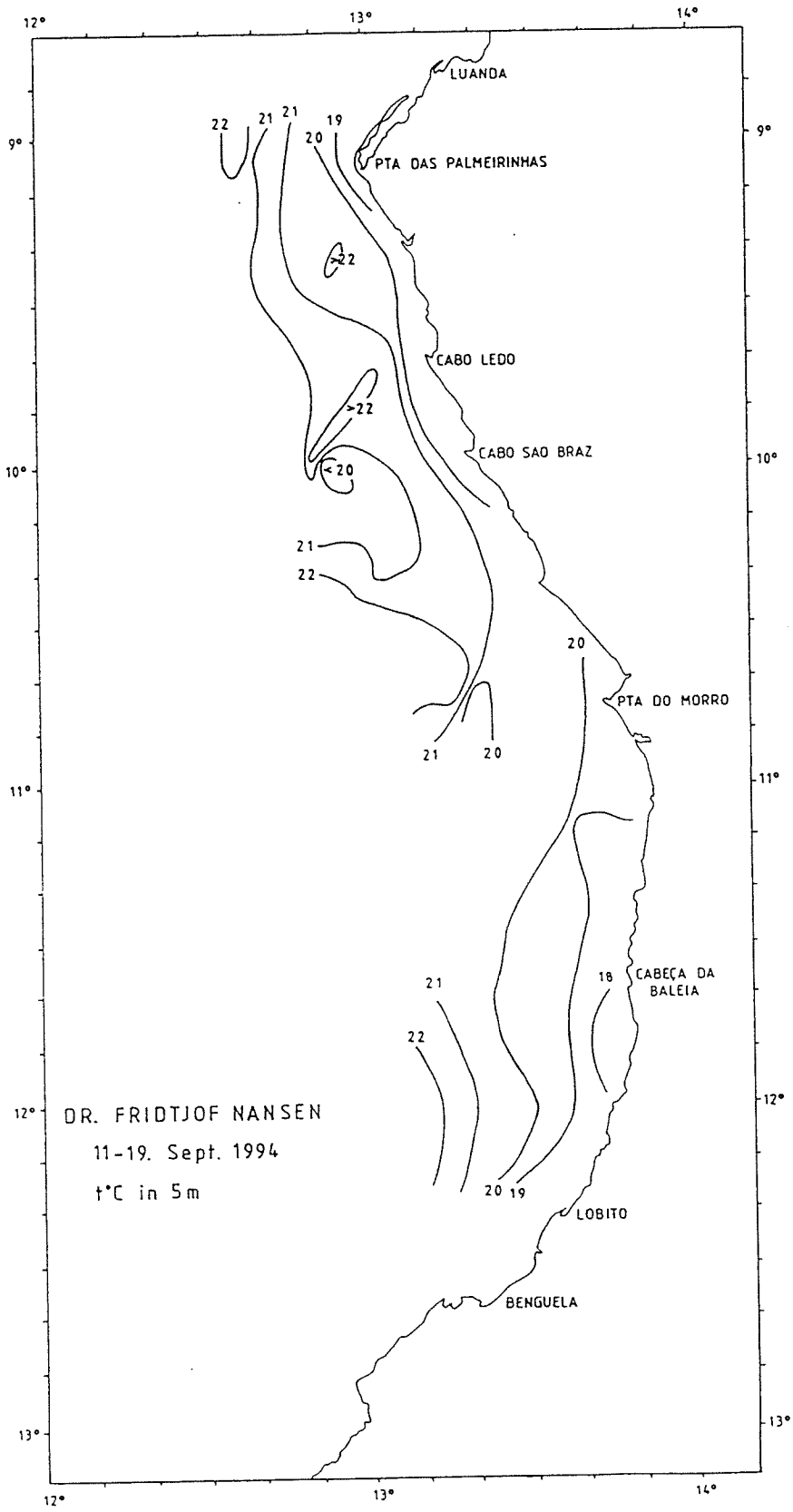

Figure 2b. Horizontal distribution of surface (5m depth) temperature, Luanda - Bebguela.

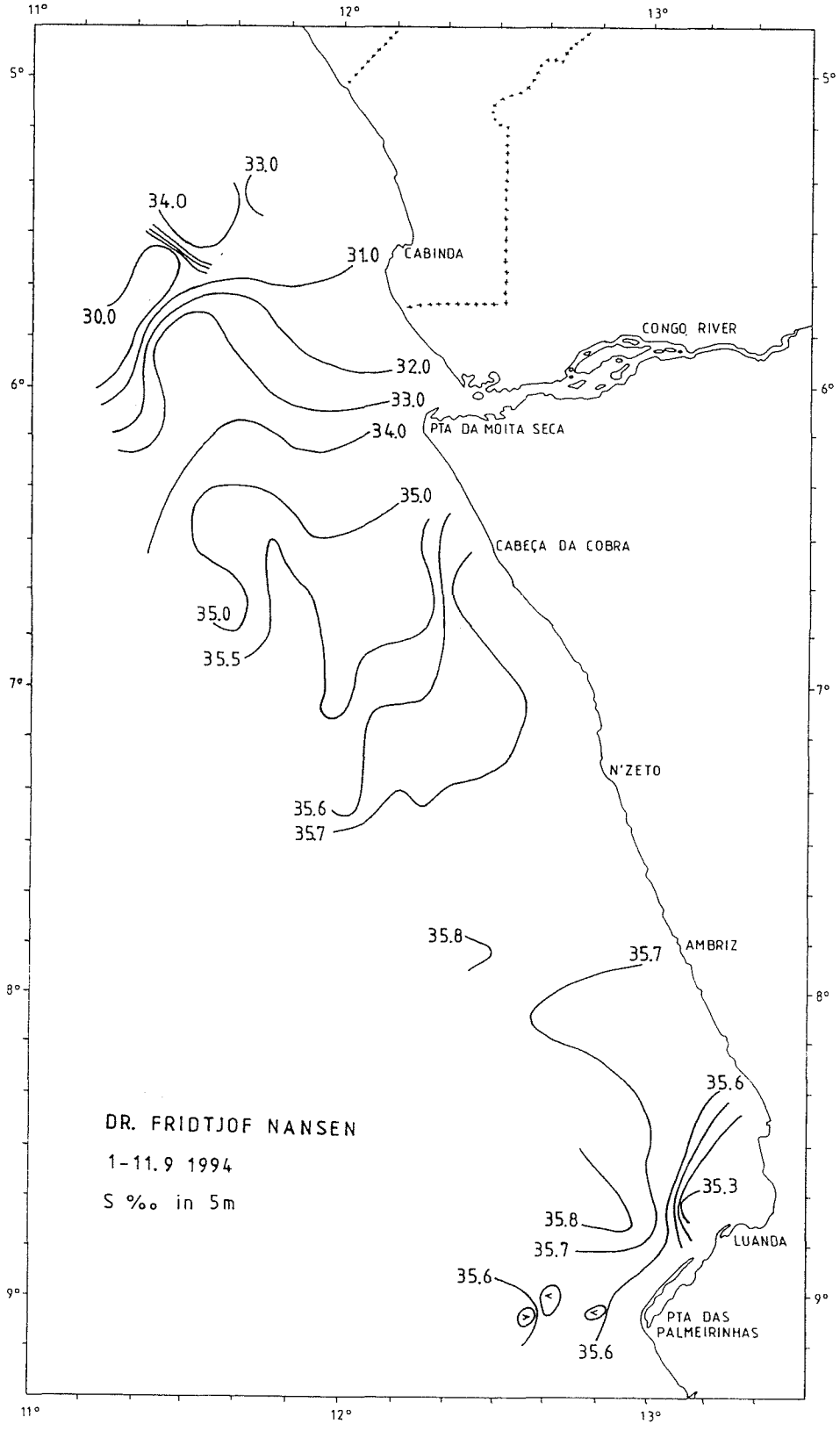

Figure 3a. Horizontal distribution of surface (5m depth) salinity, Cabinda - Luanda.

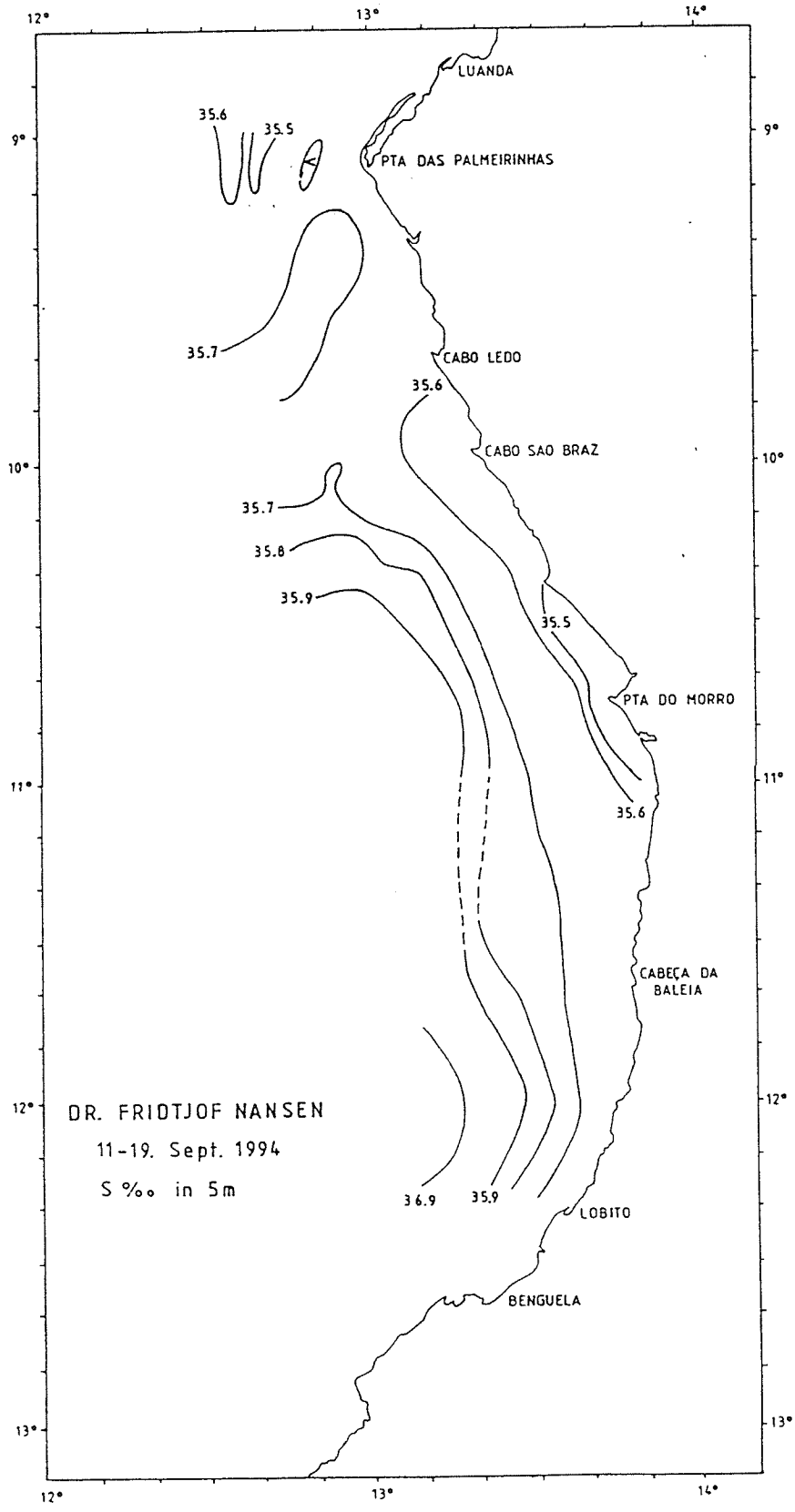

Figure 3b. Horizontal distribution of surface (5m depth) salinity, Luanda - Benguela.

Vertical sections

Several sections were sampled during the cruise (see map Fig.1) and only a subset (the standard sections) are presented here.

Starting in the north, the vertical distributions of temperature, salinity and oxygen are shown in Figs. 4-9. As the density is dominated by the temperature in the region, the maximum temperature is always found near the surface, and the temperature decreases monotonically with depth. A thermocline is often found between 10 and 30 m depth, but note the secondary thermocline at about 300-400 m depth, indicating the influence of different water masses.

A subsurface salinity maximum ($S > 35.8$) may be traced from the northern part as far south as Pta do Morro (Fig. 8), where it hits the surface. Surface salinity above 36 was found in the Lobito section (Fig. 9).

The oxygen distribution reveals an offshore minimum at about 200-400 m depth. This is the same depth range as the deep thermocline, indicating that the water mass penetrating below the upper layer is more rich in oxygen. At the shelf, the bottom oxygen content is also low, especially from Luanda and southward.

From Pta das Palmeirinhas and southward the isotherms, isohalines and the lines for constant oxygen content tend to tilt upwards towards the shore, indicating upwelling. This is particularly visible in the Pta do Morro section (Fig. 8) . However, the low oxygen is also found near the bottom north of Luanda, indicating that biological activity also may contribute to the tilting of the constant oxygen lines.

Current measurements

The current meter rig was anchored at 60 meters water depth near Pta da Palmerinhas at position 9° 05.32' S, 12° 50.63' E, see map Fig.1. The results (Fig. 10) show that both at 45 m and 2 m depth the current is remarkable unidirectional. Surprisingly enough, the current is heading towards West or South-West (although a Northerly current was expected). The current is strongest at 45 m depth, which in the beginning of the registration period revealed speeds above 40 cm/s. Towards the end of the series the speeds at the two levels become more even, but the direction continue to show a difference with the current at 45 m directed towards SW, while the surface flow went approximately westward.

Caution should be taken in drawing conclusion from a short series like this. Thus it is not known if the W and SW currents are representative for the area. One may note however, the absence of a tidal signal, but it should be remembered that the moon phase was near the first quarter at the time of the registration.

In connection with the current registration, a time series of CTD's was taken from the ship near the mooring site (not shown). These measurements show that the opposite trends of the current speeds at the end of the mooring period was associated with a warming of the whole water column. Also the oxygen concentration increased, indicating an advection of warm, oxygen rich water.

On the job training

The Oceanographers, Francisco de Almeida and Fidel Quilanda performed the daily routines for the oceanographic sampling. The vertical sections were analyzed by them. Francisco analyzed most of the horizontal distribution maps. Francisco also analyzed most of the oxygen samples using the Winkler method, while most of the salinity samples were analyzed by Fidel using the Portasal Salinometer. Some training was done on the use of PC for data analyzing.

Fidel wrote a program in QuickBasic for computing the oxygen concentration from the Winkler titration and writing the data to a file. This program is now included in the CTD program library.

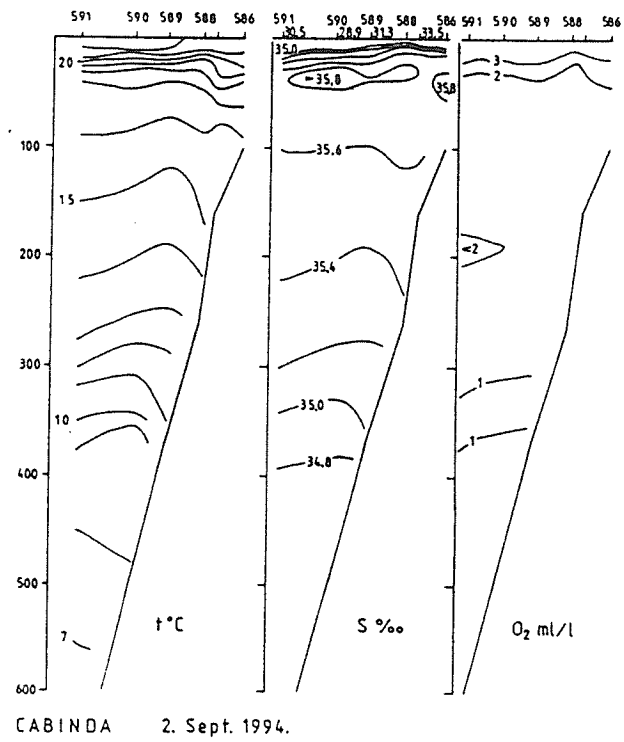

Figure 4. Vertical sections of a) temperature, b) salinity and c) oxygen. Cabinda.

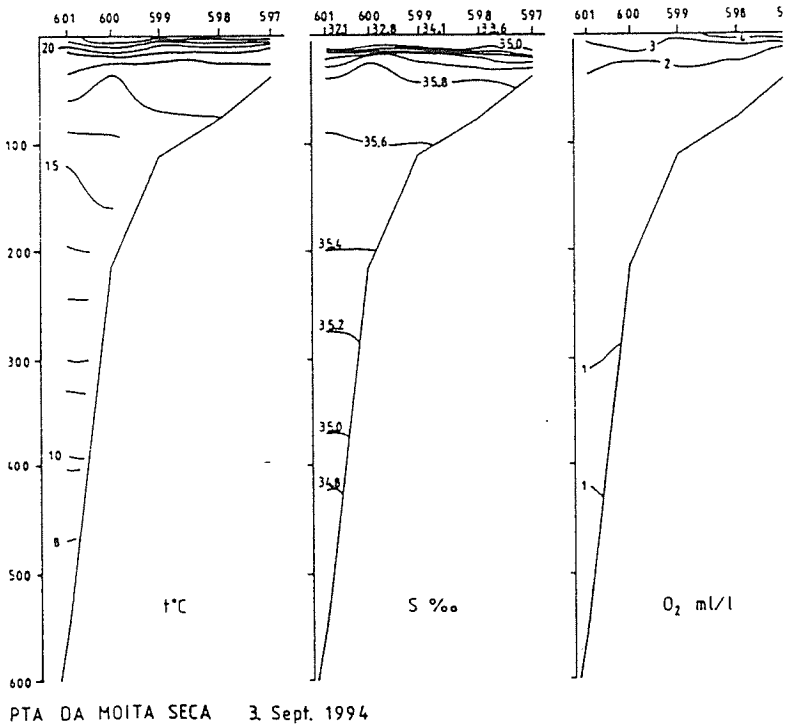

Figure 5. Vertical sections of a) temperature, b) salinity and c) oxygen. Pta da Moita Seca.

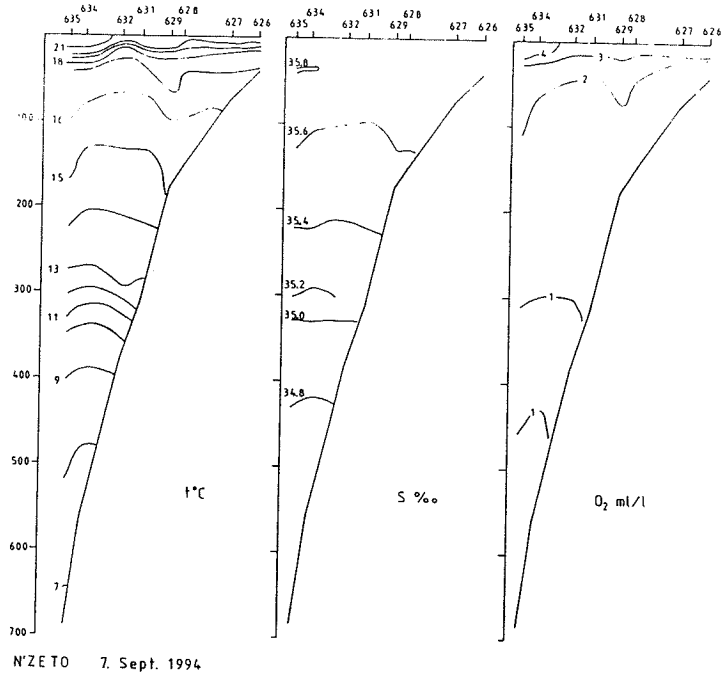

Figure 6. Vertical sections of a) temperature, b) salinity and c) oxygen. N'Zeto.

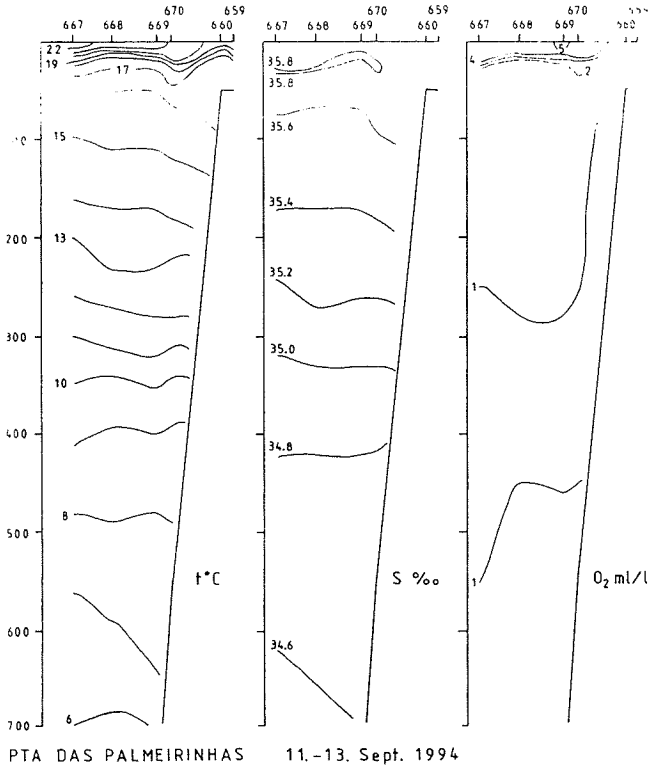

Figure 7. Vertical sections of a) temperature, b) salinity and c) oxygen. Pta das Palmeirhinas.

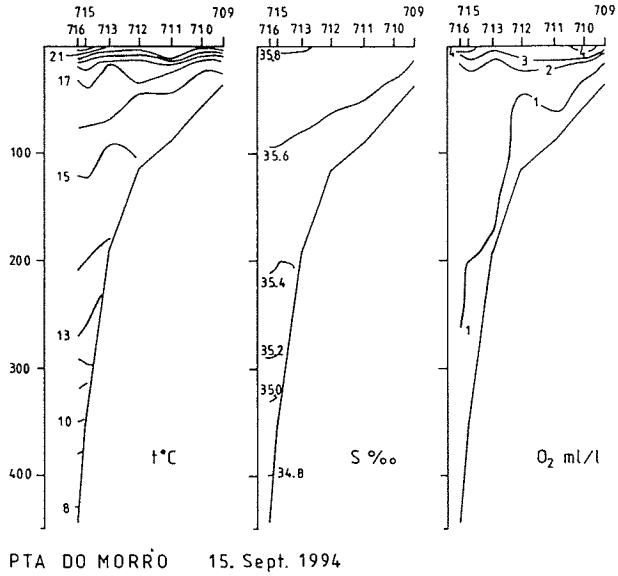

Figure 8. Vertical sections of a) temperature, b) salinity and c) oxygen. Pta do Morro.

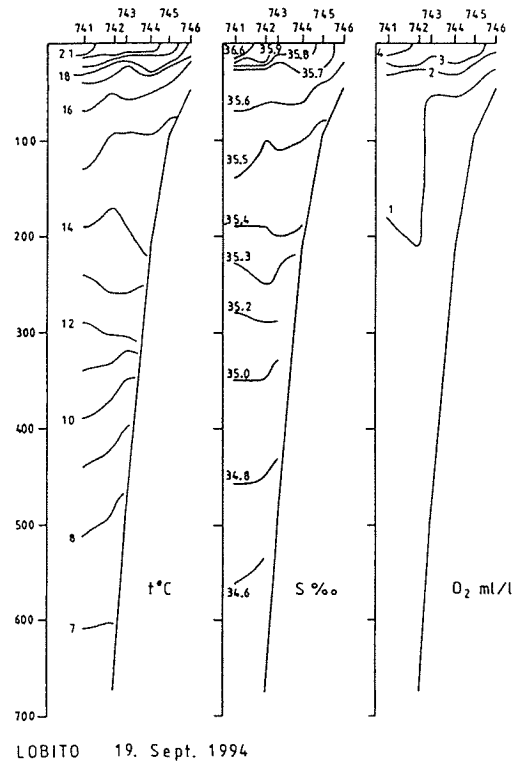

Figure 9. Vertical sections of a) temperature, b) salinity and c) oxygen. Lobito.

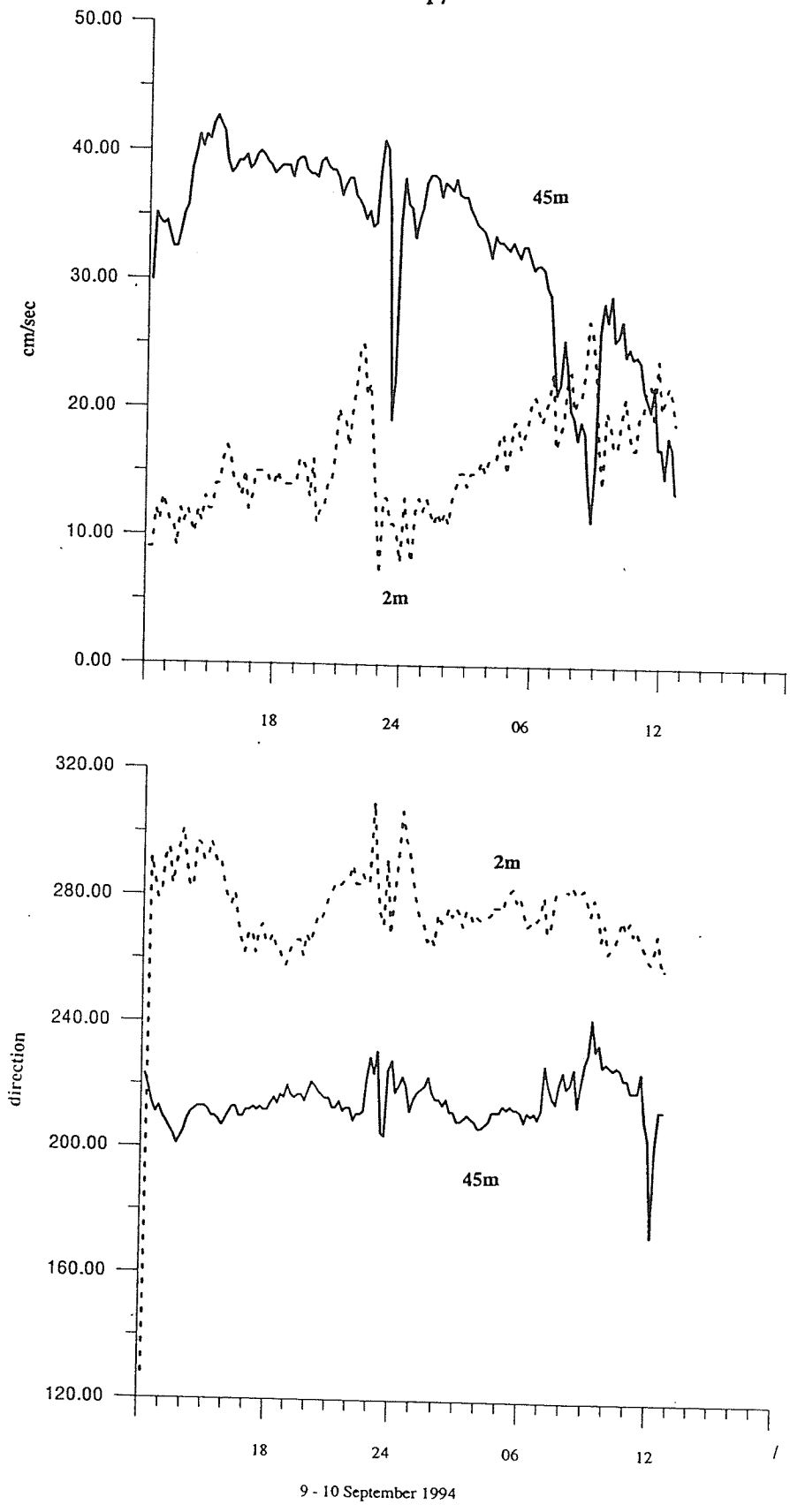

Figure 10. Current measurements Pta das Palmeirhinas: a) Speed, b) Direction.