

PART II

SURVEYS OF THE PELAGIC STOCKS

24 MAY - 21 JUNE 1992

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1 INTRODUCTION

1.1 Objectives of the Cruise

To produce a biomass estimate for three of the commercially important pelagic fish species; pilchard *Sardinops ocellata*, anchovy *Engraulis capensis* and round herring *Etrumeus whiteheadi*.

To determine the distribution of pelagic horse mackerel *Trachurus capensis* and to produce a biomass estimate of this stock.

1.2 Participation

The scientific staff from Namibia on the "DR. FRIDTJOF NANSEN" were:

Janet Coetzee, Bernatitus Birisamub, Victor Hashoongo, Dawid Gawaseb, Benediktus Ushona (until 30 May), and Willem Nauseb (from 31 May).

The scientific staff from the Institute of Marine Research were:

Johannes Hamre, Terje Haugland, Oddgeir Alvheim, Valantine Anthonypillai and Reidar Johannesen.

2 METHODS

From the general knowledge of pelagic fish distribution and from reports of commercial fishing vessels, the survey area is in general limited to the area from Dolphin Head (26°00') to the Cunene River (17°15') and from the shore to the 120 m bathometric line. The southern limit is formed by the cold and oxygen deficient upwelling region centred around Lüderitz and the northern boundary by Namibia's border with Angola. Since the pelagic fish distribution also extends into Angolan waters, permission was obtained from Angolan

authorities to extend the present survey northward to the area west of Tombua (16°00'). To allow comparison with the previous "DR. FRIDTJOF NANSEN" survey, the region was divided into three areas:

1	26°00' to 21°00'	Dolphin Head to Ambrose Bay
2	21°00' to 17°15'	Ambrose Bay to Cunene River
3	17°15' to 16°00'	Cunene River to Tombua

Although horse mackerel catches recently have been reported from an area 60 nm. off Walvis Bay it is assumed that the main distribution area of Cape horse mackerel *Trachurus capensis* is from Ambrose Bay to Tombua.

The "DR. FRIDTJOF NANSEN" left Walvis Bay at 17h00 on 24th May and surveyed the shallow coastal water from Walvis Bay southward to Dolphin Head and returned to Walvis Bay to exchange Norwegian officers and Namibian scientific staff at 07h00 on May 30th. She departed at 12h00 on May 31st. and surveyed the northern region including Angolan waters north to Tombua. The survey was carried out in cooperation with R/V "BENGUELA". The acoustic instruments were calibrated in Baia dos Tigres on the 9th June. An intercalibration with R/V "BENGUELA" was undertaken on the 15th June (Annex IV). The vessel arrived in Walvis Bay on 21th June at 15h00. 5 300 nautical miles were steamed and 102 trawl stations worked.

The course tracks with the fishing stations from Dolphin Head to Ambrose Bay, from Ambrose Bay to Cunene River and from Cunene River to Tombua are shown in Figures 1a, 1b, 1c and 1d. Additional northward and southward coverages of the shallow coastal area Ambrose Bay to Cunene River are shown in Figure 1b. Course tracks worked by R/V "BENGUELA" and used in the biomass estimates are included in the latter Figure.

The distribution and biomass of offshore horse mackerel were assessed by east-west transects, 10nm between the lines. Dr. "FRIDTJOF NANSEN" worked transects with 20nm between the lines and R/V "BENGUELA" worked the intervening transects. The distribution and biomass of small horse mackerel in inshore waters were assessed on the basis of data obtained during the coverage of the clupeids.

All catches were sampled for composition by weight and numbers of each species and the size distribution of commercially important species, using total length, was determined. The length frequencies of these species are given in ANNEX I. The complete records of fishing stations are shown in ANNEX II. Relevant samples from the R/V "BENGUELA" trawl stations were used in the assessment of the stocks.

ANNEX III gives a description of the instruments and the fishing gear used.

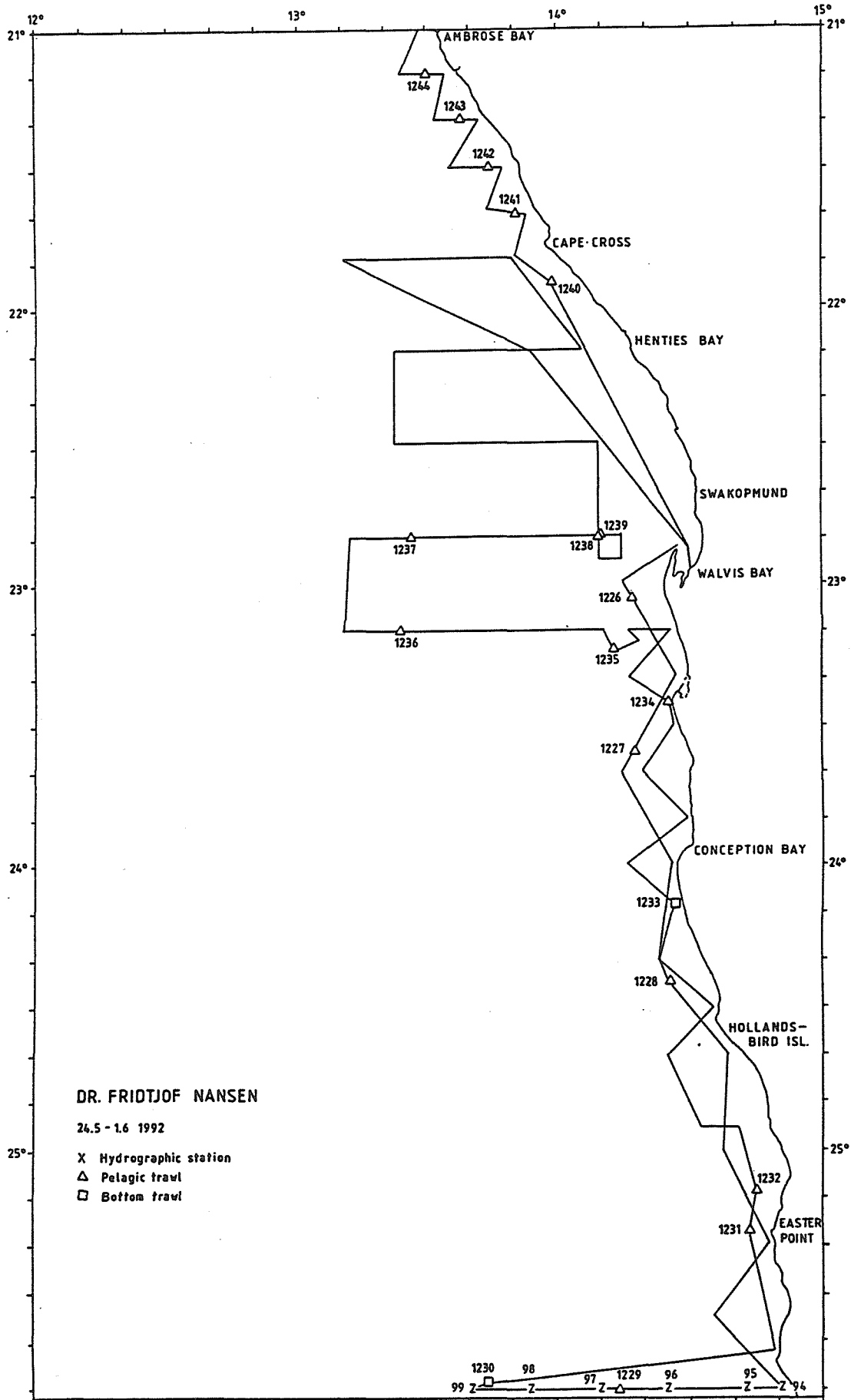


Figure 1a. Course track, hydrographical profile and fishing stations. Dolphin Head to Ambrose Bay.

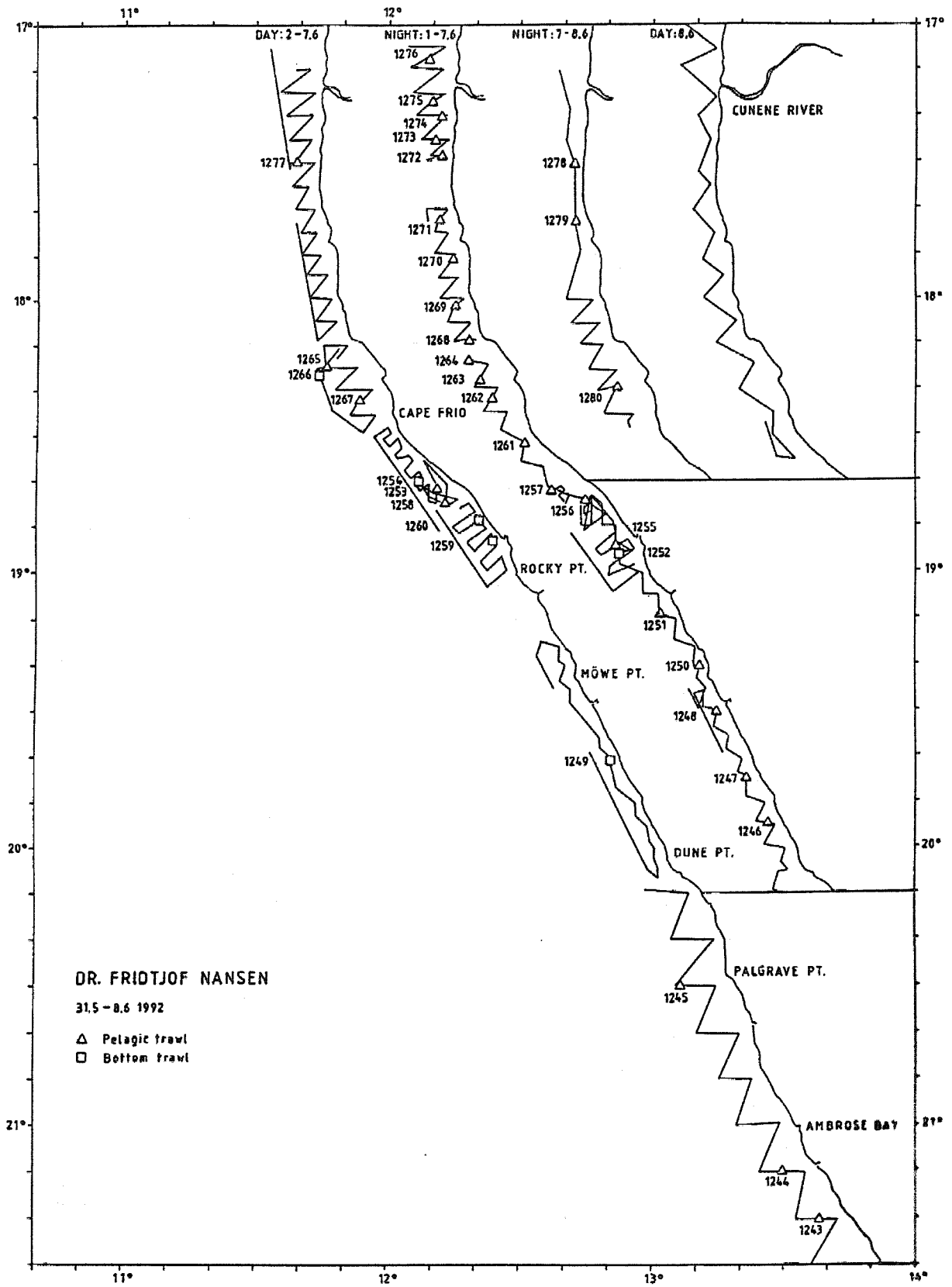


Figure 1b. Course track and fishing stations. Ambrose Bay to Cunene River.

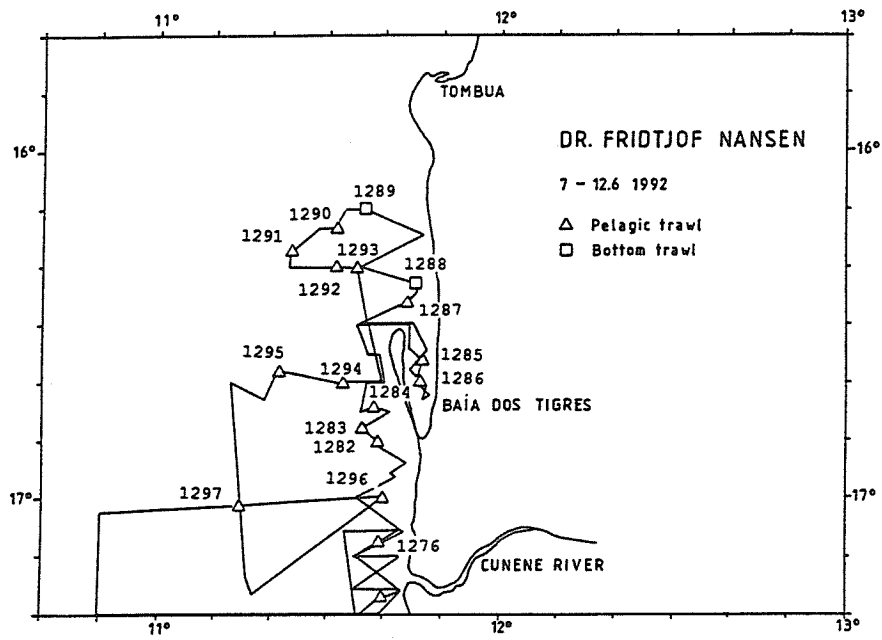


Figure 1c. Course track and fishing stations. Cunene River to Tombua

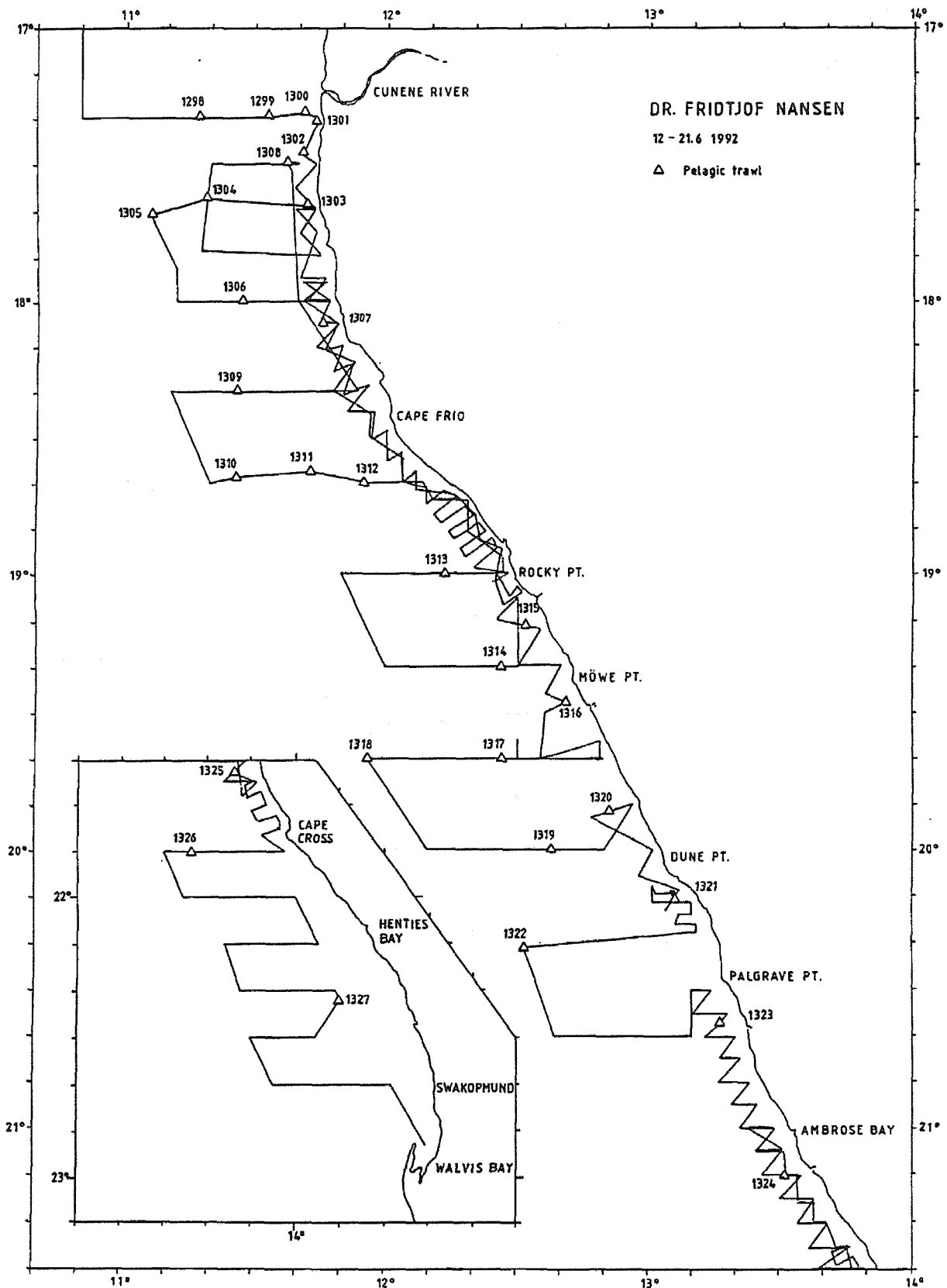


Figure 1d. Course track and fishing stations Rocky Point to Baia dos Tigres. Inshore survey of pelagic fish.

The weather was favourable for an acoustic survey during most of the cruise, except for the two days when the vessels operated in Angolan waters.

Figure 2 shows the hydrographic profile off Dolphin Head. Figures 3a-c show the sea surface temperatures in 4m depth.

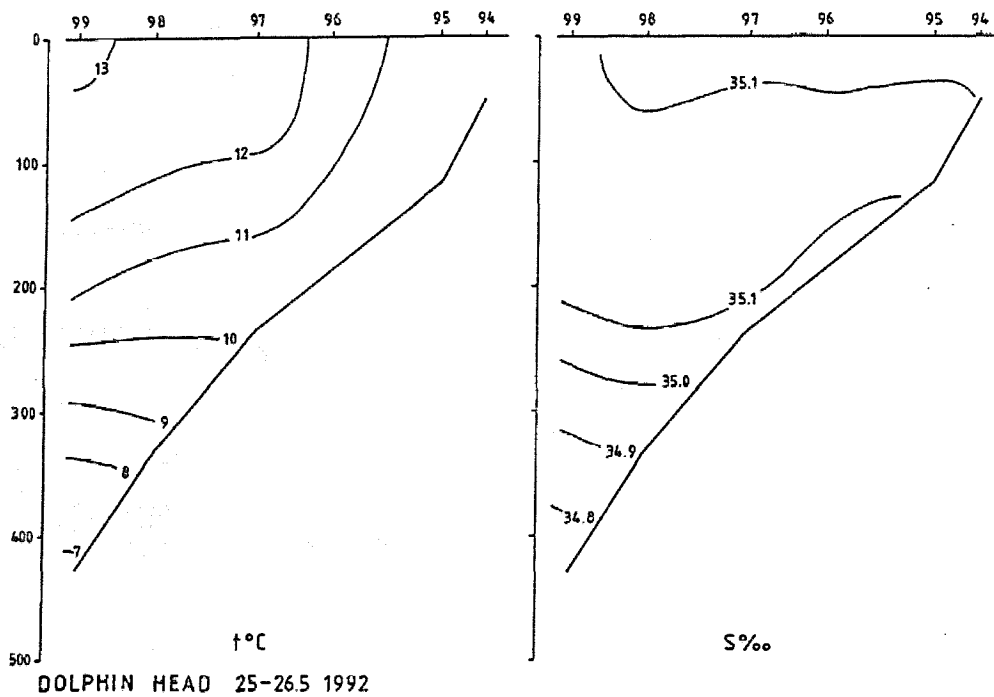


Figure 2. The hydrographic profile off Panther Head.

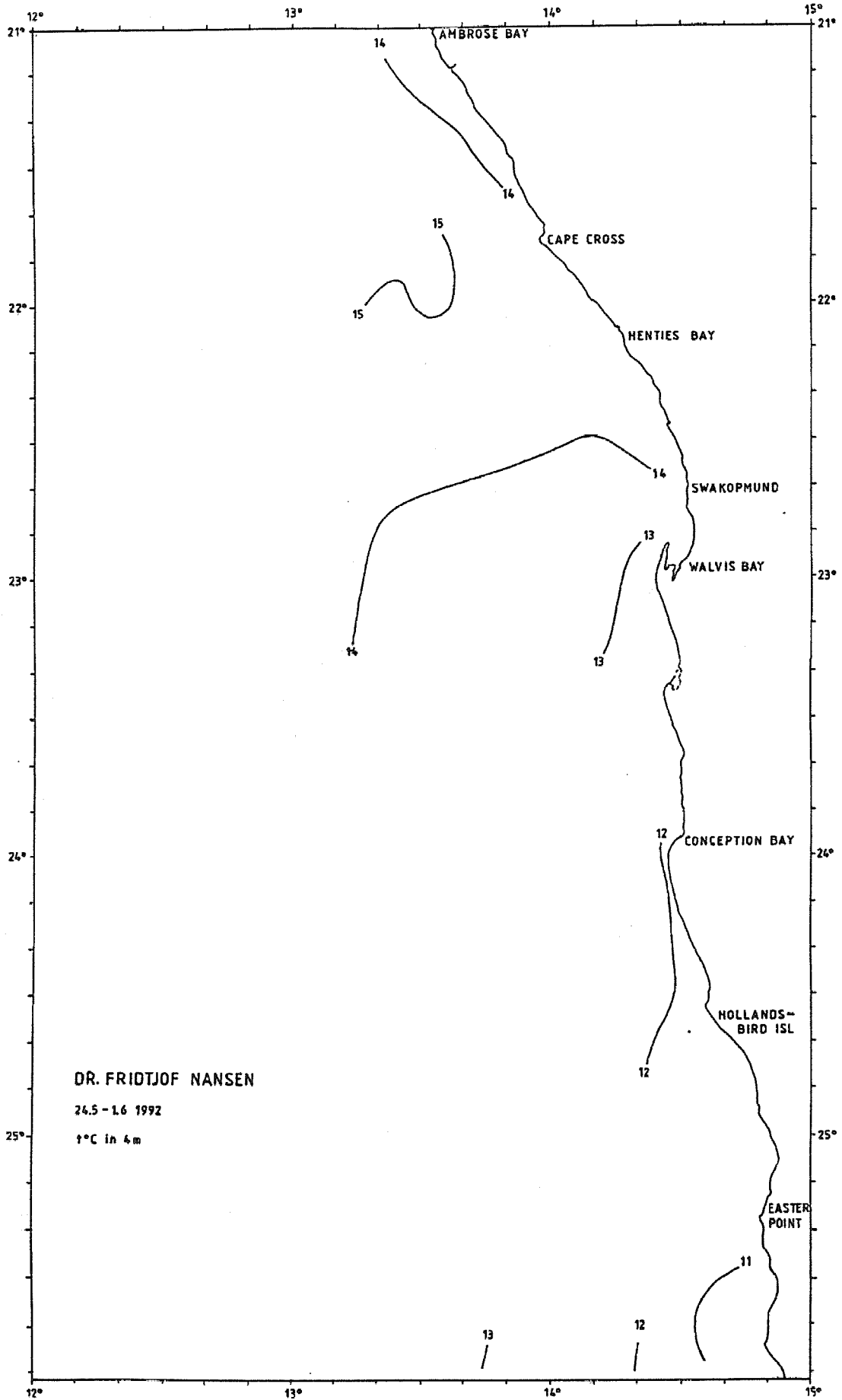


Figure 3a. Sea surface temperatures. Easter Point to Ambrose Bay.

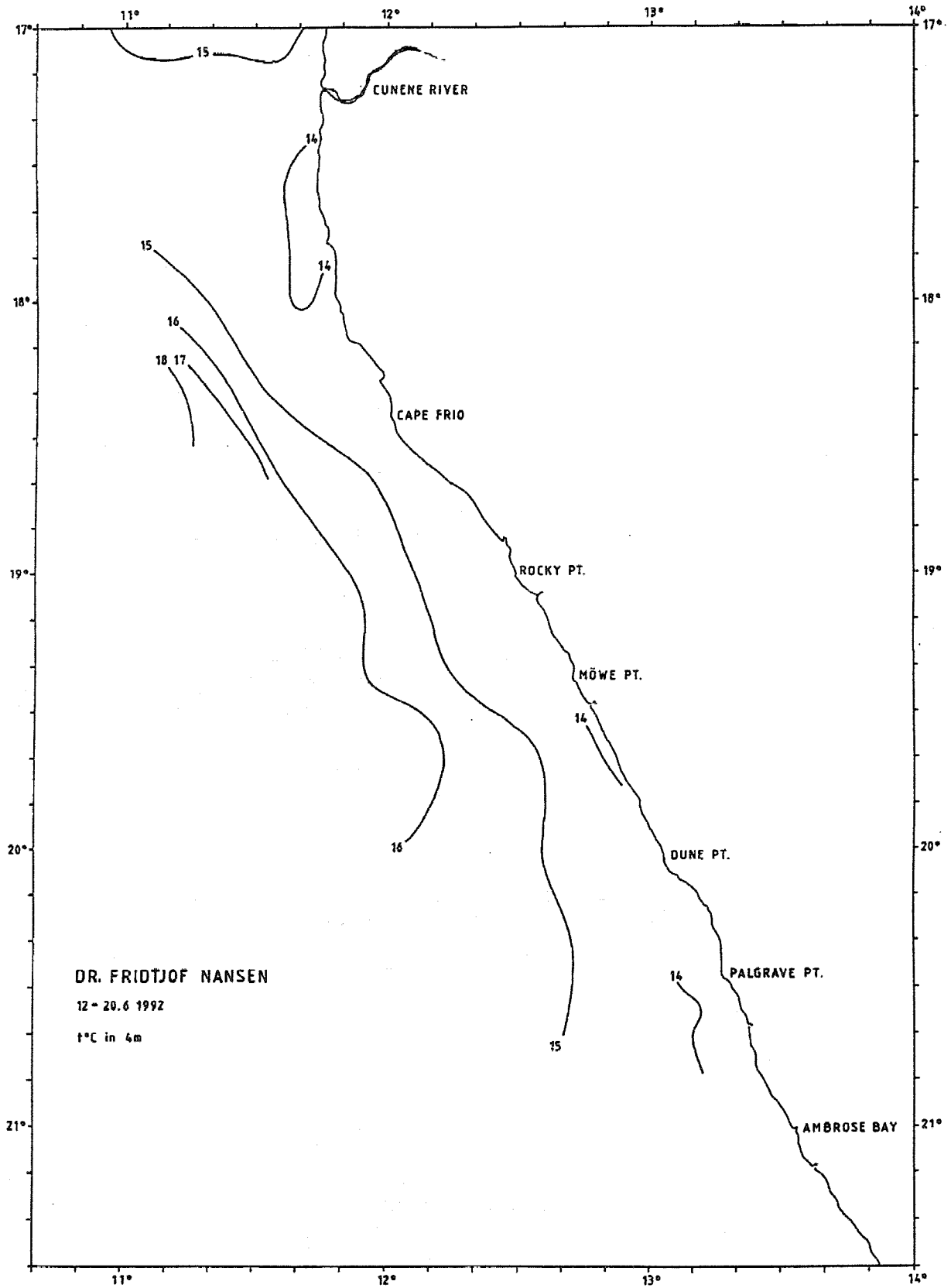


Figure 3b. Sea surface temperatures. Ambrose Bay to Cunene River.

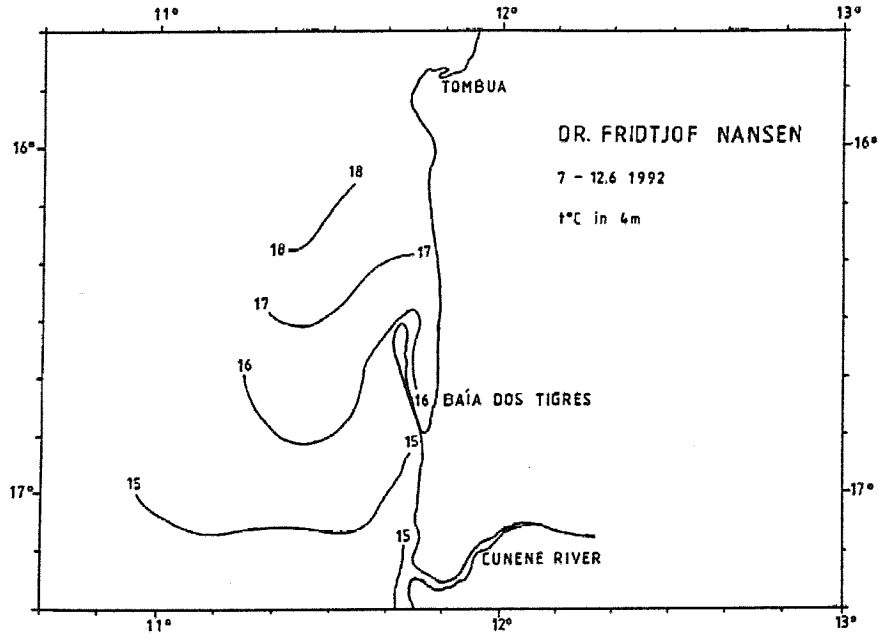


Figure 3c. Sea surface temperatures. Cunene River to Tombua.

3 DISTRIBUTION AND ABUNDANCE OF PELAGIC FISH

The acoustic integration system provided observations of fish densities averaged, usually, over 5 nm distances, but in areas of high fish concentrations over 1 nm. The unit of acoustic reflection used was $0.1 \times \text{m}^2/\text{nm}^2$ reflecting surface. The integrator values from fish targets were allocated to the following groups on the basis of trawl sampling and characteristic behaviour recognised from the echo recordings:

Pelagic fish type 1: Clupeidae (pilchard and round herring) and Engraulidae (anchovy).

Pelagic fish type 2: Carangidae (horse mackerel).

Non-commercial pelagic fish and plankton: myctophids, gobies and, primarily, jellyfish.

The allocation of type 1 fish to species were judge on the basis of the characteristics of the echo traces and on relevant trawl catches.

3.1 Distribution

In summary, some small areas of pelagic fish, mainly anchovy, were found south of Ambrose Bay ($21^{\circ}00'$), while further north several regions with shoals of pilchard, in association with other pelagic species, were surveyed. Layers of plankton, consisting largely of jellyfish and small pelagic gobies and lantern fish were, as in previous surveys, found in offshore waters. In some inshore areas where dense shoals of horse mackerel did occur it was difficult to separate the type 1 species from the type 2 on the basis of the echo traces. In those cases the species composition of the trawl catches was used as identification. Sampling of fish was generally successful, except for some hauls which were disrupted by high concentrations of jellyfish, especially in the region south of Walvis Bay.

The distributions of clupeids and engraulids are shown in Figures 4a, 4b, 4c and 4d, and the distribution of carangids in Figure 5a and 5b. An arbitrary scale was used in the distribution charts to illustrate different levels of density.

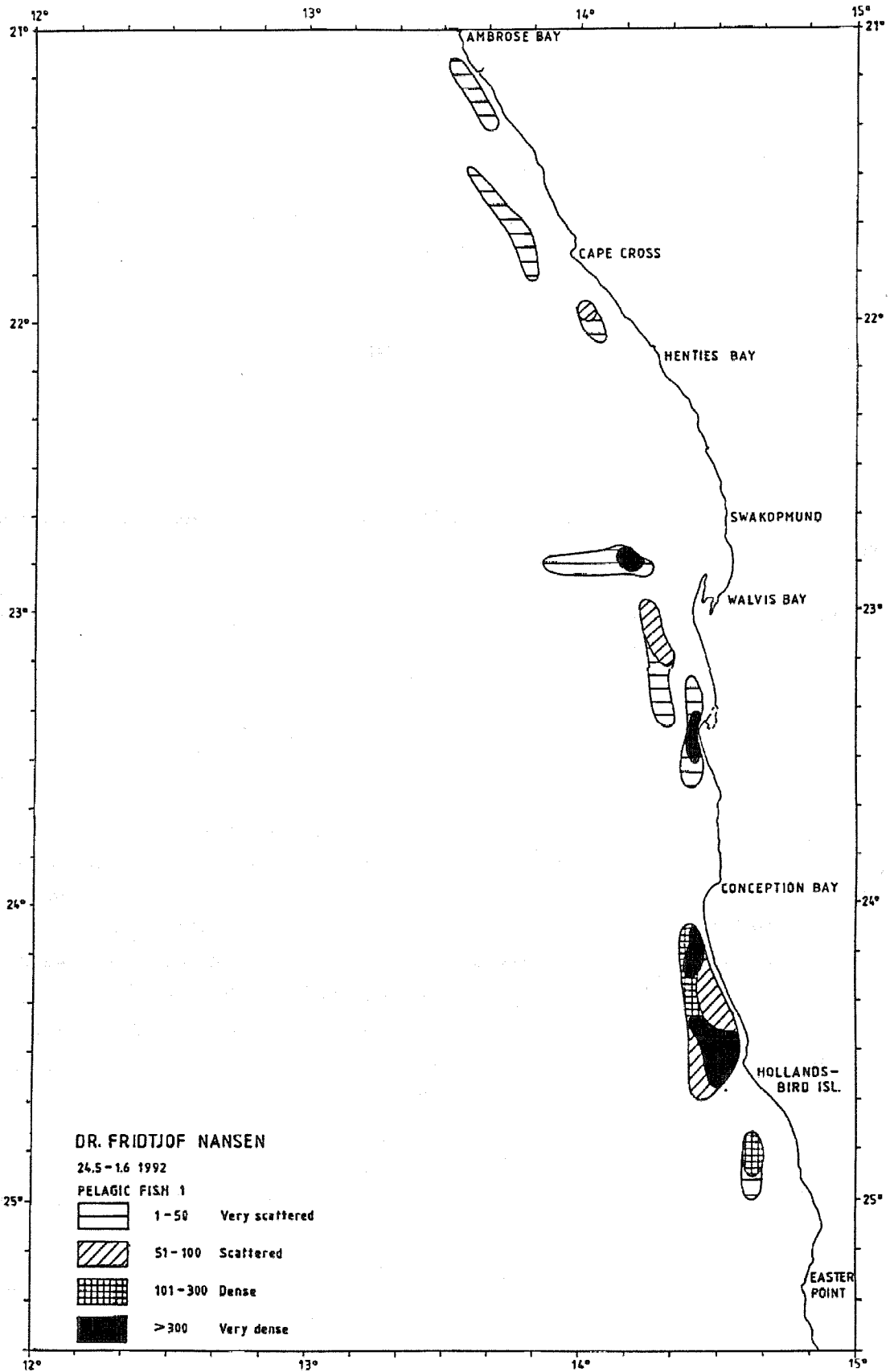


Figure 4a. Distribution of pelagic fish type 1, clupeids and anchovy. Easter Point to Ambrose Bay.

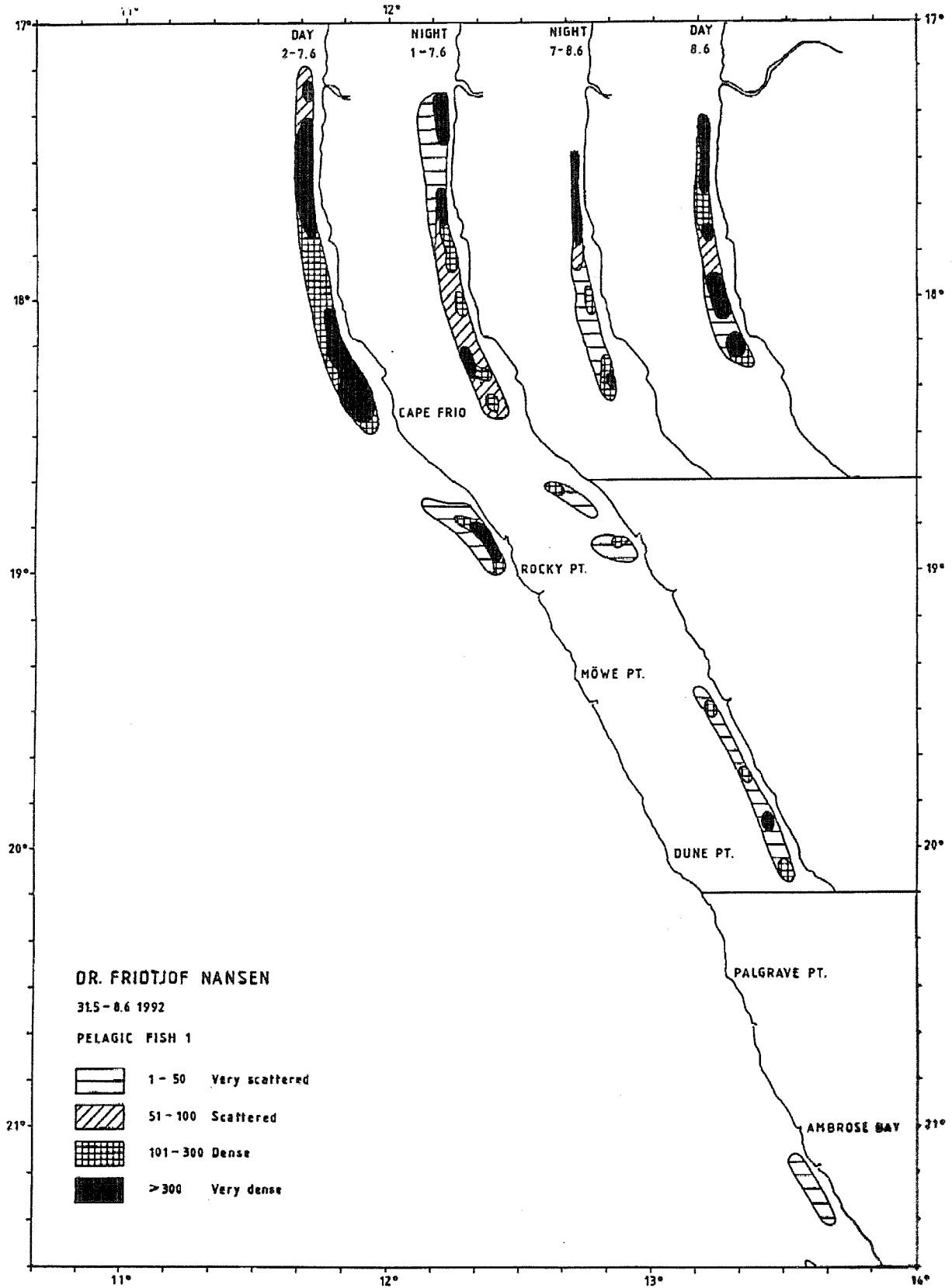


Figure 4b. Distribution of pelagic fish type 1, clupeids and anchovy. Ambrose Bay to Cunene River.

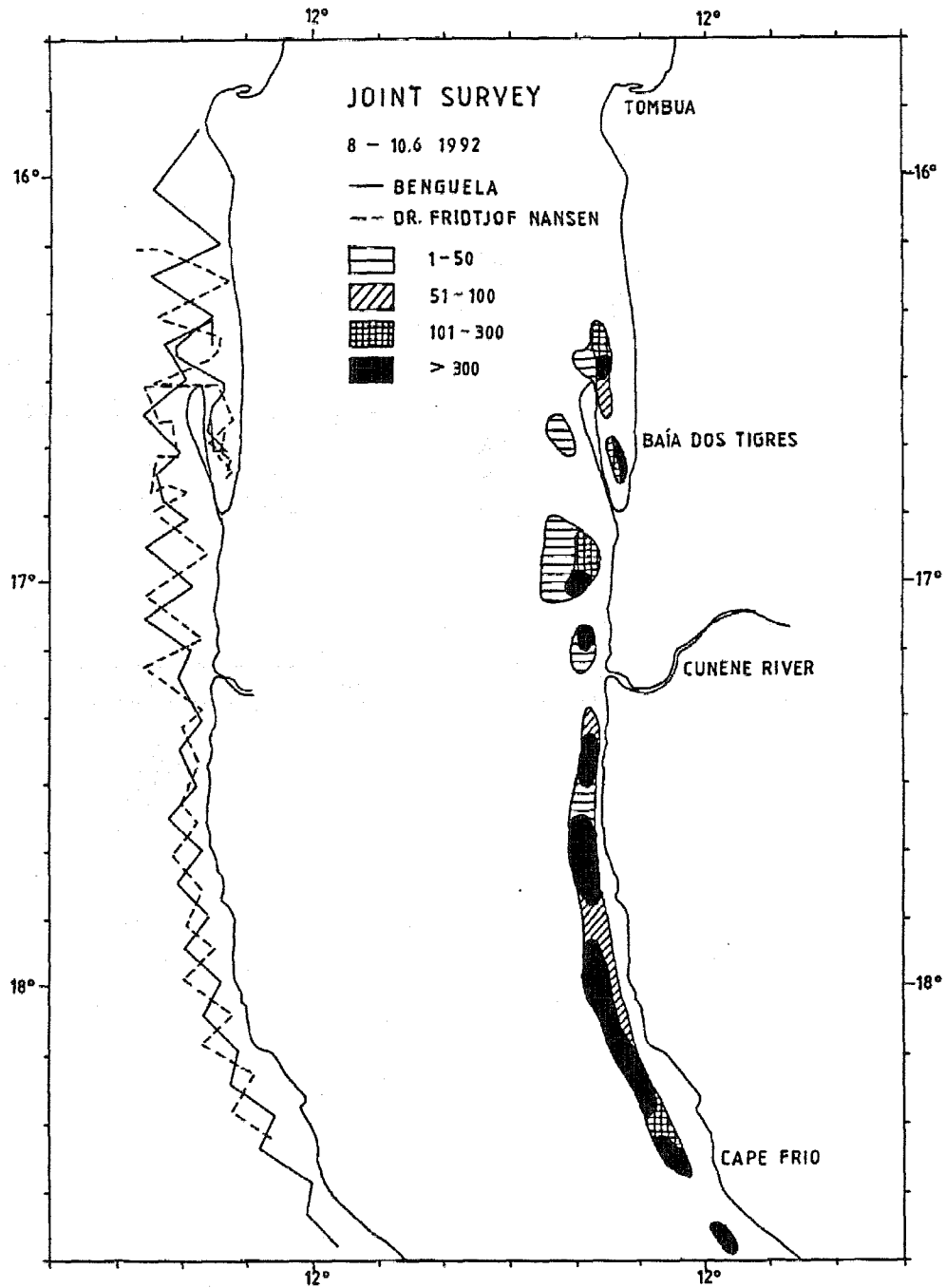


Figure 4c. Distribution of pelagic fish type 1, clupeids and anchovy, joint survey. Cape Frio to Tombua.

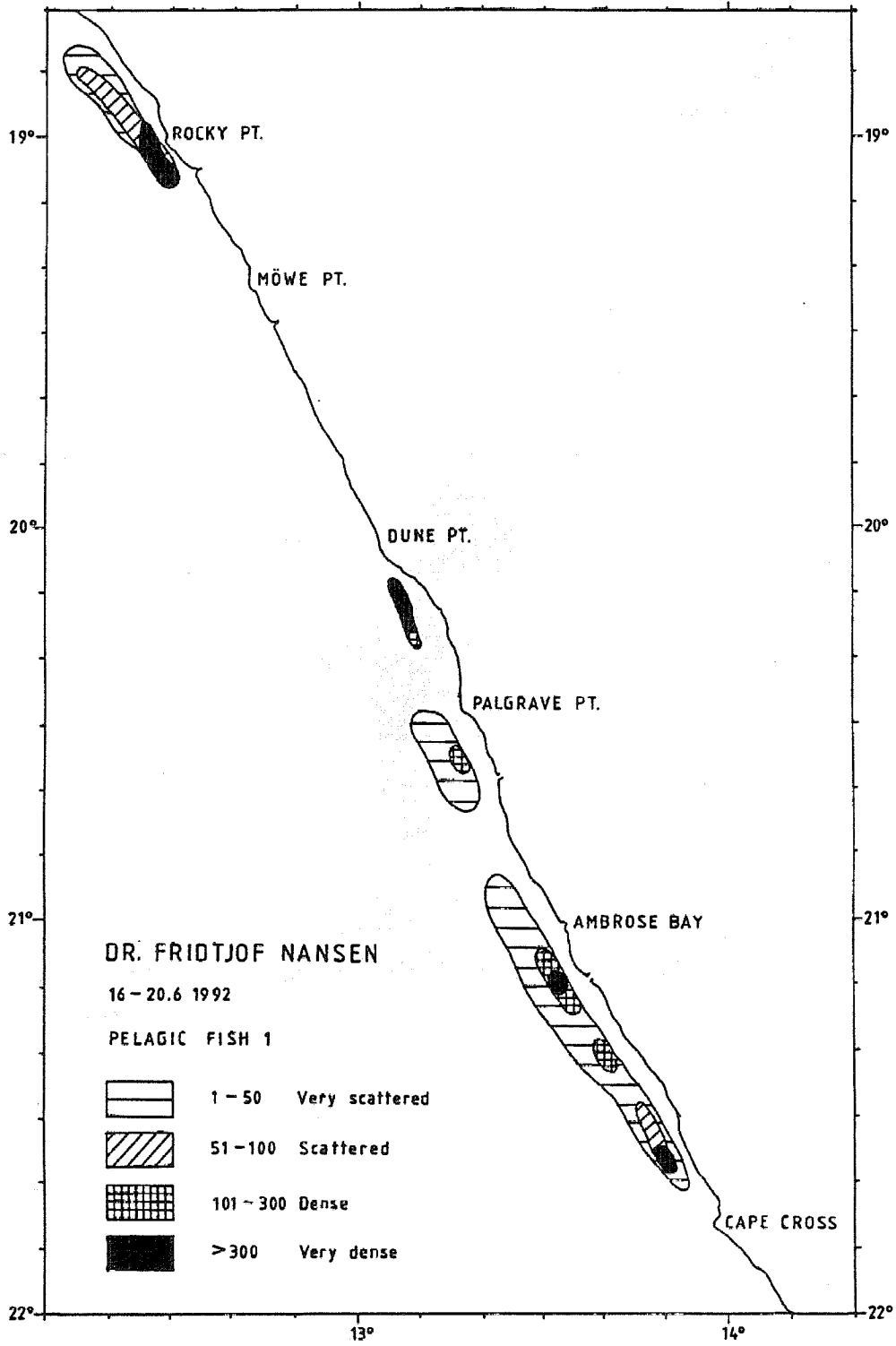


Figure 4d. Distribution of pelagic fish type 1, clupeids and anchovy. Cape Cross to Rocky Point.

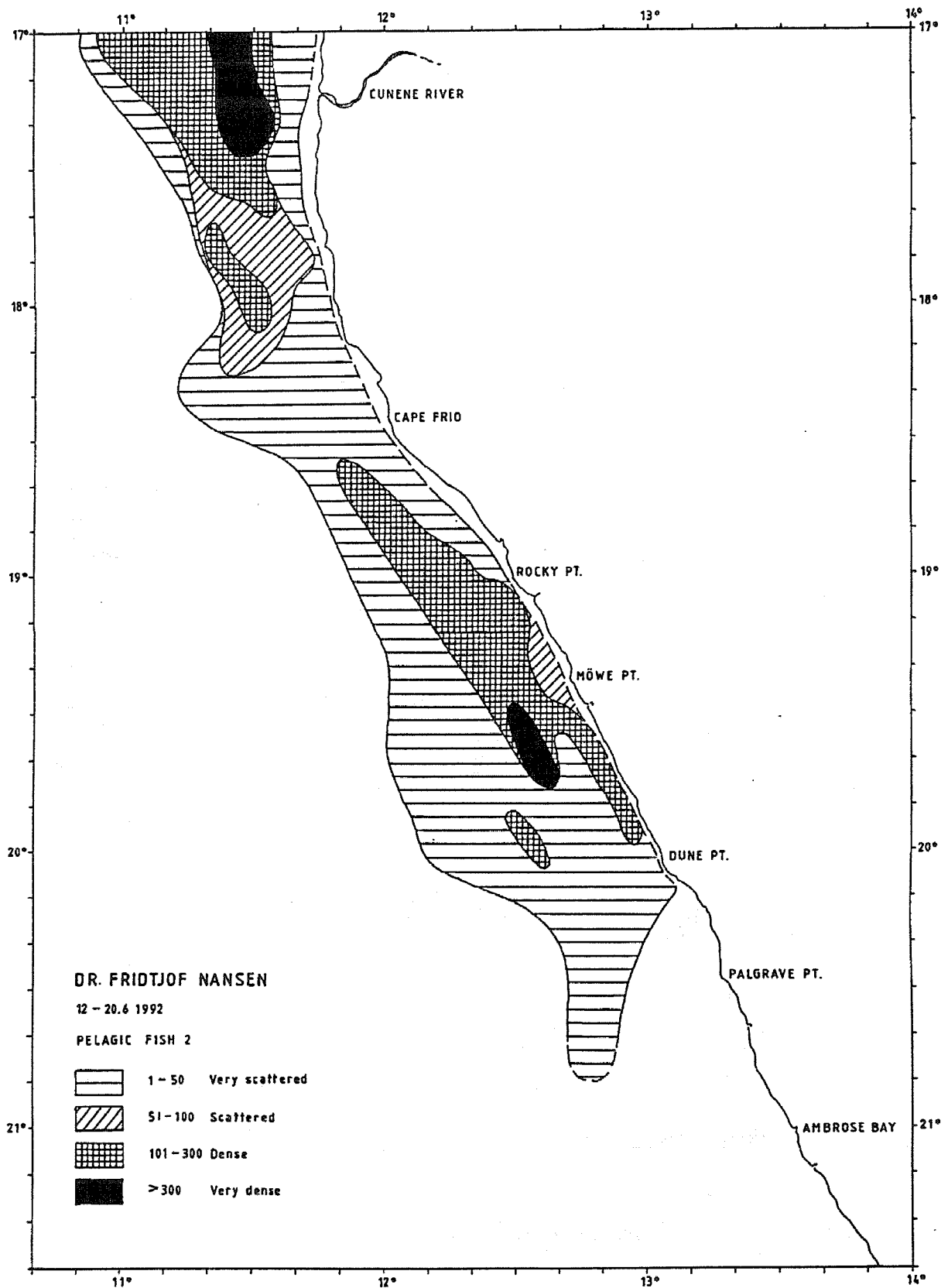


Figure 5a. Distribution of pelagic fish type 2, horse mackerel. Ambrose Bay to Cunene River.

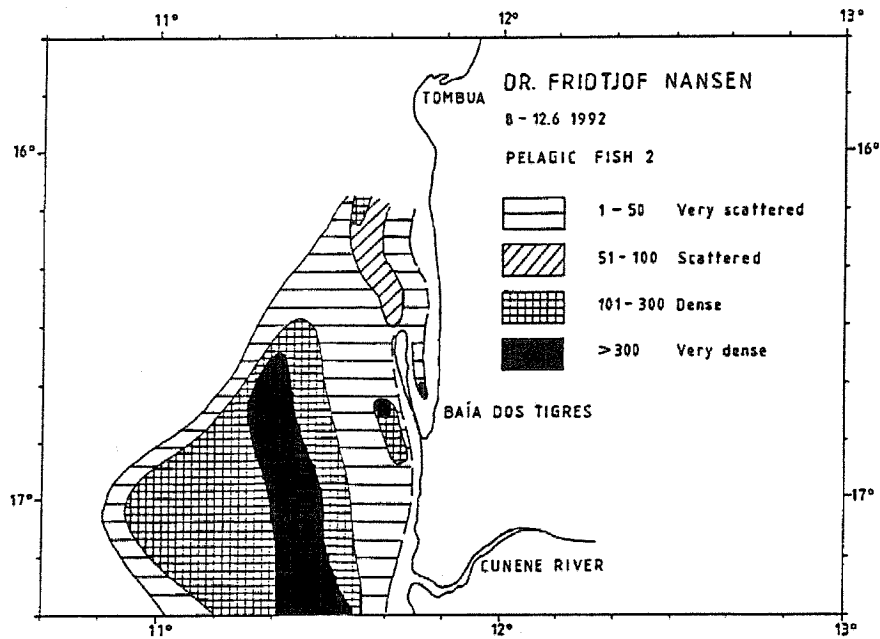


Figure 5b. Distribution of pelagic fish type 2, horse mackerel. Cunene River to Tombua.

3.1.1 Dolphin Head to Ambrose Bay

Dispersed shoals of anchovy were recorded off Cape Cross ($21^{\circ}10'-22^{\circ}00'$), in depths between 30m and 120m, off Walvis Bay ($22^{\circ}50'-23^{\circ}40'$) and north of Hollands Bird Island ($24^{\circ}00'-24^{\circ}40'$). These shoals consisted of fish with modal length of 8cm to 10cm. Few other pelagic fish of commercial value were found in the area, except for large snoek *Thyrsites atun* which were caught in some of the trawls throughout this region. As in previous surveys of this region, most of the reflected echo intensity was allocated to layers of plankton, goby and lantern fish.

3.1.2 Ambrose Bay to Cunene River

Some few and widely dispersed shoals of pilchard between Möwe Point ($19^{\circ}30'$) and Rocky Point ($19^{\circ}00'$) were recorded on the way north and later re-surveyed by R/V "Benguela". One of the shoals was rather big, and had been fished on by purse seiners for several days. The fishermen reported that the shoal was moving in a southward direction. At the end of the survey, this fish was found distributed off Ambrose Bay ($21^{\circ}00'$). This fish was fairly large with a modal size of 23cm. A small area of scattered pilchard shoals was found in shallow water (20m-50m) north of Rocky Point ($18^{\circ}50'$) during the first coverage. These fish, which had a modal length of 20 cm seemed also to have moved south when the area was re-surveyed some days later. A large shoal of fish of similar size was found at the end of the survey between $20^{\circ}10'$ and $20^{\circ}15'$ and considered to be the same fish. Pelagic- 1 type shoals of variable size and density were recorded between Cape Frio ($18^{\circ}30'$) and the

Cunene River, along the coast in depths between 20m and 80m. Many of these shoals were found to be dense and large during the first northward coverage. When the area was re-surveyed in the subsequent days however, considerably less fish was found. No definite explanation of the disappearance of the fish can be given (Annex V). The shoals consisted of pilchard mainly with modal lengths of 11 cm, 15cm and 20cm, but were mixed with round herring and anchovy. This fish distribution continued into Angolan waters.

Juvenile horse mackerel with a modal length of 9cm occurred along the coast from Dune Point (20° 10') to the Cunene River. Transects of 10nm and 20nm between the course line determined the distribution of horse mackerel in offshore waters. Horse mackerel were found beyond the 100 m depth isoline mostly to the north of Palgrave Point. In this area, the distribution extended to some 40 nm from the coast. In the offshore area south of Rocky Point the horse mackerel often occurred in layers of plankton and other small fish, and could only be identified by trawling.

The size of offshore horse mackerel tended to be largest in the northern part of the distribution area. In Angolan waters the horse mackerel had a size distribution with modal peak at 24 cm, whereas samples collected in Namibian waters consisted of fish with a modal size of 16cm.

3.1.3 Cunene River to Tombua

The distribution of dispersed shoals of pilchard, anchovy and round herring found south of the Cunene River extended into Angolan waters, north to 16° 40'. Another distribution area of pilchard was found north of Baia dos Tigres, in inshore waters between 16° 20' and 16° 30'. This fish was large with a modal length of 25cm.

The Cape horse mackerel (*Trachurus capensis*) was dominant in offshore waters north of the Cunene up to 16° 30' whereas the Cunene horse mackerel (*Trachurus trecae*) dominated the catches further north.

3.2 ABUNDANCE OF PELAGIC FISH

The biomass estimates are based on the acoustic integration technique, similar to that used in previous assessments of the same stocks. The North Sea herring target strength was used for all type-1 pelagic fish:

$$TS = 20 \log L - 72$$

Using a condition factor of .78, normalised to a 17 cm fish, the biomass (in tonnes) was calculated by the formula:

$$\text{Biomass} = A * I * 0.167 * L/17$$

where A = Area (nm²)

I = Integrator value

L = Length of fish

This is the same formula as used in the DR. "FRIDTJOF NANSEN" December 1991 survey, and reduces the biomass estimates by some 25% compared to the biomass estimates of type 1 fish given in previous reports.

The biomass estimates, which are supposed to be the most reliable assessment of the state of the stocks, are shown in Table 1.

Owing to the uncertainty of the most appropriate horse mackerel target strength to be used during acoustic biomass estimation, a biomass range is presented. The range corresponds to the values of target strength for the North Sea Herring (lower limit) and the TS proposed by Svellingen (upper limit) for horse mackerel (see "DR. FRIDTJOF NANSEN" Cruise Report No.1). A condition factor of 0.85 is used, which reduces the biomass estimate by 15% compared to those given in previous reports. Table 2 shows the estimates of the present survey.

3.2.1 Pilchard, anchovy and round herring

Several areas were surveyed more than once, both during night-time and during the day. At night the fish often ascended to surface layers and above the transducer range. These data could not be used for assessment purposes. The biomass estimates of the various coverages are listed and discussed in Annex V.

The estimates of 70 000 tonnes, mostly anchovy, of the area Easter Point- Walvis Bay was based on combined intergrater values during day-time from the southward and northward coverages of this area during the first week of the cruise. Another occurrence of anchovy was recorded north of Cape Cross and estimated at 5 000 tonnes.

On the northward coverage in the first week of June a shoal of large pilchard was recorded at Dune Point. Purse-seiners which were fishing in the area reported that the shoal was moving southward. The biomass was estimated as 23 000 tonnes, but was likely an underestimate as the fishing boat disrupted the survey. Dispersed shoals of large pilchard were recorded at Ambrose Bay on the southward coverage at the end of the cruise. This is assumed to be what was left of the same fish. The biomass estimate of 20 000 tonnes obtained in the Ambrose area is therefore used in the stock assessment.

A large shoal of medium size pilchard was recorded south of Dune Point on the southward coverage at the end of the cruise. The shoal was covered by a dense grid, and a biomass estimate of 110 000 tonnes was obtained and is included in the stock assessment. Pilchard of the same size was recorded north of Rocky Point some two weeks earlier. This fish, measured to 23 000 tonnes, was not found when passing the area on the last southward coverage and may be included in the biomass estimate off Dune Point. The fish recorded off Rocky Point is therefore excluded in the assessment.

Most of the type-1 pelagic fish was found north of Cape Frio, between 18°40' and the Cunene River. This area was therefore extensively covered. The first two coverages, one done during day-time and the other during night, yielded biomass estimates of 855 000 and 131 000 tonnes respectively. The low estimate obtained during night-time was obviously due to surface schooling of the fish. During day-time the fish occurred in dense shoals of very variable size, the two largest ones counting for some 1/3 of the total estimate. This suggests that the variance of the estimate is high. Two days later the area was re-surveyed using a combined survey grid by the two research vessels. This combined survey gave a biomass estimate of 500 000 tonnes. The latter estimate is regarded as the most accurate estimate and is used in the assessment (see Annex V).

Another 50 000 tonnes, mostly large pilchard were found in Angolan waters. The estimates allocated to species are shown in Table 1.

Area	Pilchard	Anchovy	Round herring	Total
Baia dos Tigres-Cunene River	45 000	5 000		50 000
Cunene River-Cape Frio	400 000	50 000	50 000	500 000
Dune Point	110 000			110 000
Ambrose Bay	20 000			
Cape Cross		5 000		5 000
Easter Point-Walvis Bay		70 000		70 000
Total	570 000	125 000	50 000	745 000
Total Namibia	530 000	125 000	50 000	705 000

3.2.2 Horse mackerel

Very little horse mackerel was found in the surveyed area south of Ambrose Bay, while northwards some 2.1 to 4.2 million tonnes were recorded. The horse mackerel in the inshore region constituted approximately 10% of the total, with some 0.2 to 0.4 million tonnes. The

estimate for the offshore stocks is probably underestimated due to bad weather in Angolan waters, surface schooling at night and "hiding" in the "dead zone" at the bottom at daytime.

Dolphin Head - Ambrose Bay - Ambrose Bay	Cunene River	Cunene River - Baia dos Tigres	Total
-	1.4 - 2.8	0.7 - 1.4	2.1 - 4.2

4 CONCLUDING REMARKS

The text table below summarize the biomass estimates of Namibian pilchard, anchovy, round herring and horse mackerel during the last two years.

Survey	Clupeiforms	Horse mackerel
June 1990	730 000	1 700 000
March 1991	811 000	1 300 000
November 1991	1 045 000	1 400 000
June 1992	755 000	2 100 000

Nb. A Clupeiform fish condition factor of 0.78 has been used during the last two surveys. The estimates reported in June 1990 and March 1991 have been reduced accordingly.

A horse mackerel condition factor of 0.85 has been used for the June 1992 survey and the previous estimates have been reduced accordingly.

The total Clupeiform biomass estimate obtained during this cruise is lower than that obtained in November 1991, but similar to estimates made during previous surveys. These differences might be due to estimate variability rather than changes in the stock level. In previous years most of the Clupeiform fish have been distributed in the region south of Cape Frio, whereas at present there is a more northerly distribution. This might, however, change in the near future.

The proportion of juvenile horse mackerel in the total stock was much higher in 1991 than this year and accounted for 0.4 million tonnes compared to 0.2 million tonnes this year. This is consistent with the present increase in the adult stock compared to previous years.

Previously noted problems, such as the occurrence of widely dispersed shoals which require tightly spaced transects to ensure adequate coverage of such regions, were encountered north of Cape Frio, where the bulk of the stocks were distributed. These shoals consisted of adult pilchard and although the present coverage was reasonably spaced, the dispersed schooling in the upper 20m surface layer may have led to a substantial underestimate of the mature stock.

Determining species composition of pelagic type-1 fish is difficult solely from the echo recordings and is mostly based on trawl samples. This is a possible source of error, related to differences in the catchability of the species and to the frequency of trawling. It is, however, assumed that this source of error is of minor importance for the pilchard estimate because the large shoals of pilchard which count for the bulk of the pilchard estimate are easy to recognize and are normally unmixed.

Previous surveys have reported that fish migrated at night to surface waters above transducer level, and thus were not available to be surveyed. This behavioral trend was detected in all the target species during this survey and has probably caused an underestimation of the size of both the stocks of pilchard and the horse mackerel in offshore waters.