COMMONWEALTH OF AUSTRALIA

Commonwealth Scientific and Industrial Research Organization

Division of Fisheries and Oceanography

REPORT 5

F.R.V. "DERWENT HUNTER"

Scientific Report of Cruise 3/56
September 19 - October 5, 1956

Scientific Report of Cruise 4/56
October 9 - November 6, 1956

Scientific Report of Cruise 5/56
November 8 - December 3, 1956

Marine Biological Laboratory
Cronulla, Sydney
1957

F.R.V. "DERWENT HUNTER"

F.R.V. "Derwent Hunter" is the Division's 72-ft. research vessel operating from Sydney. From 1951 to 1955 the scientific logs of the cruises of the vessel were cyclostyled and distributed to interested institutions.

The vessel was out of commission while she refitted from January - September 1956. She commenced operations with two shakedown cruises DH1/56 and DH2/56, when scientific and fishing gear were tested.

With the first scientific cruises it was decided to depart from the previous method of recording the results of cruises and to issue a limited number of copies of the scientific logs for the use of Divisional officers, and to publish in the Division's Report series Scientific Reports of Cruises compiled by the officers responsible for the planning of each cruise. In this Report three cruises are described: Cruise DH3/56 was a tuna longlining cruise off the New South Wales coast, DH4/56 was a cruise in Bass Strait to determine the correlation between the euphausiid *Nyctiphanes australis* and the barracouta *Thyrsites atun*, and DH5/56 was a cruise by the Division of Meteorological Physics, C.S.I.R.O. in the Port Phillip Bay area.

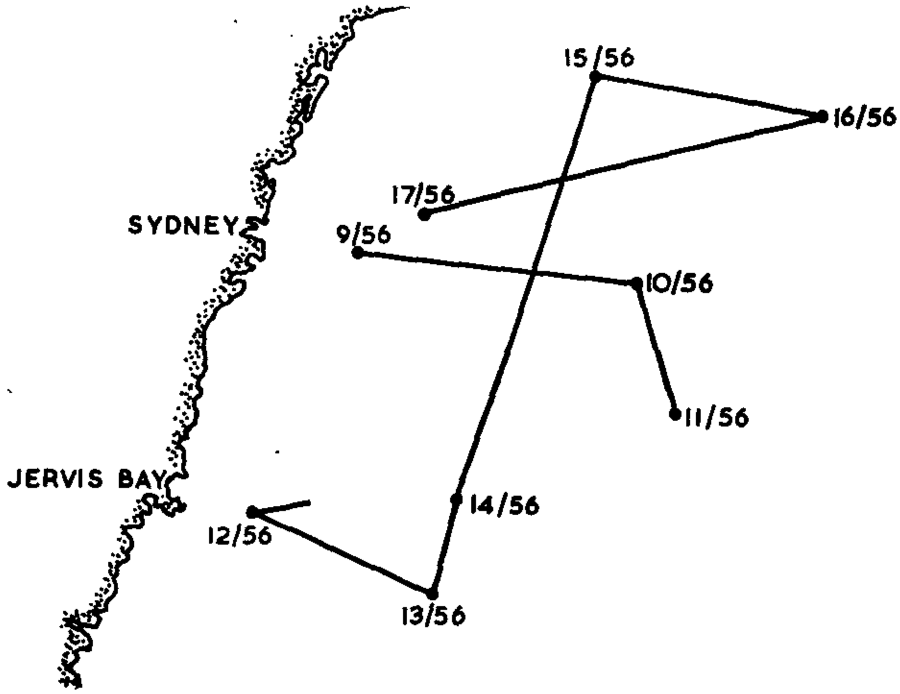

Fig. 1.- Cruise DH3/56. Track chart and hydrology stations.

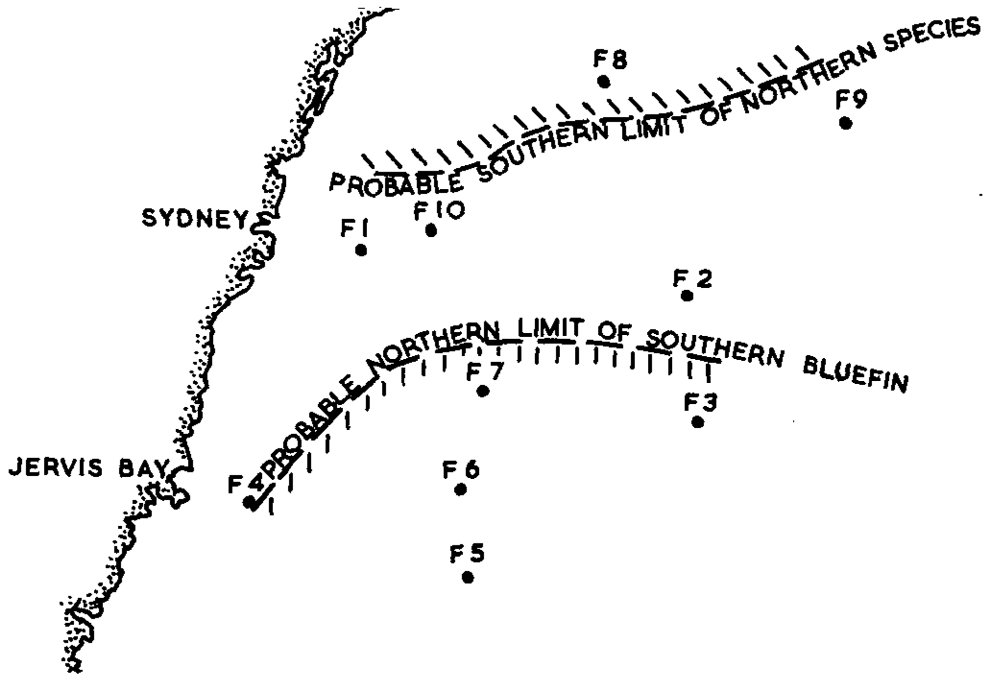

Fig. 2.- Tuna fishing stations.

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE 3/56

September 19 - October 5, 1956

Scientific Personnel
Scientific Officer-in-Charge of Cruise - J. Robins

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Figure 1 shows the positions of the hydrology stations and the track followed on this cruise. Figure 2 shows the positions of the fishing stations.

SCIENTIFIC REPORTS

(a) TUNA.- J. Robins

The purpose of this tuna longline cruise was (i) to test a hypothesis that southern bluefin tuna occur in a particular water mass and that their distribution is controlled by the movement of this water and its interaction with other water masses, (ii) to catch other species of tuna which do not have the same ecological niche as the southern bluefin tuna.

Results.-

1. Southern bluefin tuna were caught at Stations F3, F5, F6, and F7.
2. Albacore were caught at F4 and F8.
3. Big-eye tuna were caught at F8.
4. No tuna were caught at Stations F1, F2, F9, F10.

Gauged from fishing results there were two zones in which tuna species were relatively abundant and these zones were separated by a zone in which tuna did not occur. In the southern part of the area investigated southern bluefin tuna and albacore only were taken, in the central section no fish were taken, and in the northern section big-eye tuna and albacore were captured. Big-eye tuna and albacore are taken in tropical waters in other parts of the Pacific, but albacore have a wider distribution and appear to be cosmopolitan in habit.

Table 1 indicates the relationship found between tuna occurrences and the water masses to 500 m on this cruise. Table 3 in the hydrology report of this cruise, giving percentage water mass types at various levels for each fishing station, indicates the probable explanation of the distribution of tuna species.

TABLE 1

RELATIONSHIP BETWEEN TUNA OCCURRENCES AND SURFACE WATER MASSES

Water Masses	Southern Bluefin Tuna	Albacore	Big-eye Tuna
Sub-Antarctic) Central Tasman)	+	+	
South Equatorial) Central Tasman) S.W. Pacific)		+	+
Sub-Antarctic) Central Tasman) South Equatorial) S.W. Pacific)		+	

The presence of albacore at both Stations F4 and F8 appears to be confusing, but this distribution can be explained by considering the depths at which these fish were caught. At Station F8 an albacore was taken on the deepest hook (100 m) and at Station F4 an albacore was taken on the shallowest fishing hook (30m). Reference to Table 3 will show that these depths were influenced by sub-Antarctic water. This evidence suggests that albacore are inhabitants of the colder water mass types. Albacore are never taken at the surface in Equatorial Pacific waters, but are always caught on the deepest fishing hooks and only in regions of upwelling.

No tuna species were caught at Stations F1, F2, F9, and F10. At present no explanation can be given for this, but it is noted that this zone is a mixture of water mass types. This condition may exclude tuna from the area.

Table 2 indicates the detail of the catch taken on this cruise.

TABLE 2

TUNA CATCH

Station	CATCH Species	No.	Total Wt. in lb.	Per 100 Hooks of Longline	Breakages of Snoods per 100 Hooks
DH3/F3/56	S. bluefin	12	1045	17.3	14.0
DH3/F4/56	Albacore	1	50	0.6	
DH3/F5/56	S. bluefin	3	213	2.0	8.6
DH3/F6/56	S. bluefin	6	524	4.0	9.3
DH3/F7/56	S. bluefin	6	526	3.2	
DH3/F8/56	Albacore Big-eye	1) 3)	135	2.9	5.0

The number of broken snoods per 100 hooks of the long-line indicated the need for modification of the gear so that fish weighing more than 180 lb. could be held. The largest fish caught weighed 185 lb.

(b) HYDROLOGY.- D.J. Rochford

Hydrology Stations 9-11 were worked from September 19 to 21, but because of the fouling of the propeller with fishing gear the ship returned to port and there was a delay of several days before the remaining Stations 12-17 were worked between September 27 - October 4. This time lag probably confuses the synoptic interpretation of the hydrological data.

Figure 3 shows the percentage of the Central Tasman water mass relative to the South Equatorial. These were the major water masses of the upper 50 m. The complete results for all stations are given in Table 3.

TABLE 3

PERCENTAGE OF WATER MASSES AT EACH STATION

Station	Depth	South Equatorial	S.W. Pacific	Central Tasman
9/56	0	0	0	100
	22	0	5	95
(F1)	44	0	0	100
	67	sub-Antarctic	influence	
10/56	0	1	1	98
	22	2	0	98
(F2)	45	0	0	100
	67	0	12	88
	90	0	0	100
	138	sub-Antarctic	influence	
11/56	0	0	0	100
	23	0	0	100
(F3)	44	0	0	100
	65	0	0	100
	88	sub-Antarctic	influence	
12/56 (F4)	0	sub-Antarctic	influence	
13/56 (F5)	0	sub-Antarctic	influence	
14/56 (F6)	0	sub-Antarctic	influence	
15/56	0	28	5	67
	25	26	4	70
(F8)	50	9	12	79
	75	10	12	78
	100	8	11	81
	150	0	8	92
	200	sub-Antarctic	influence	

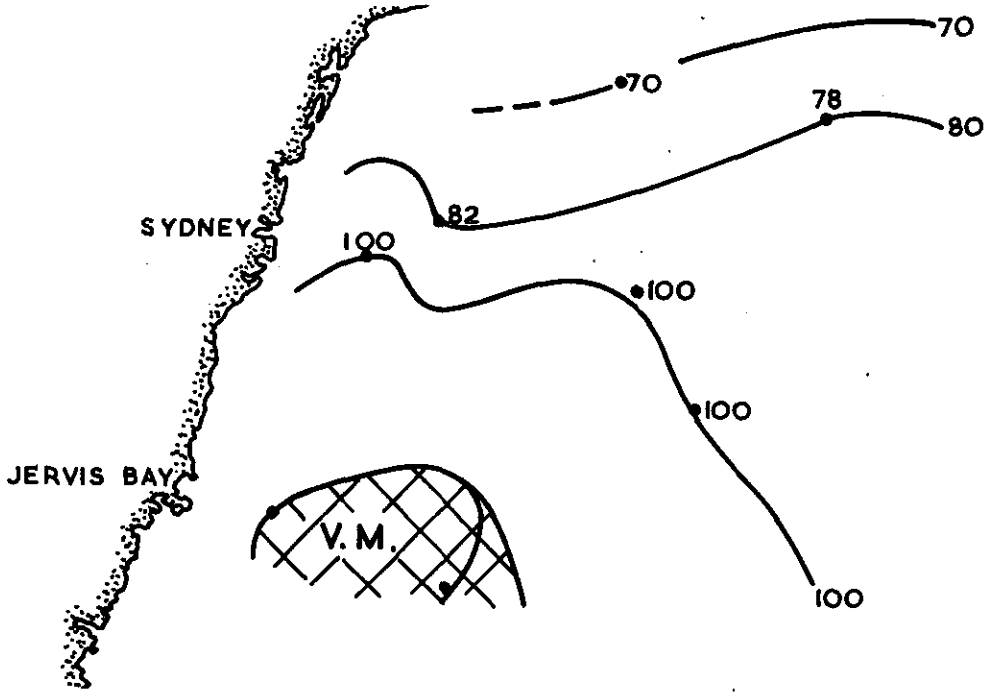

Fig. 3.- Distribution of the Central Tasman water mass.

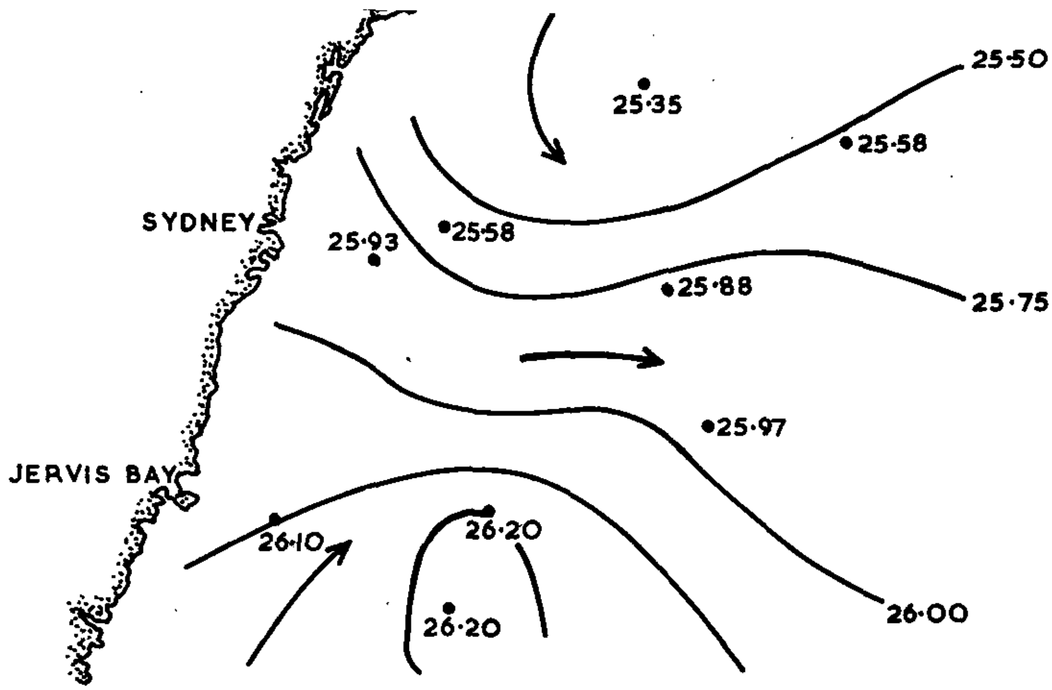

Fig. 4.- Distribution of σ_t and probable major movements of water.

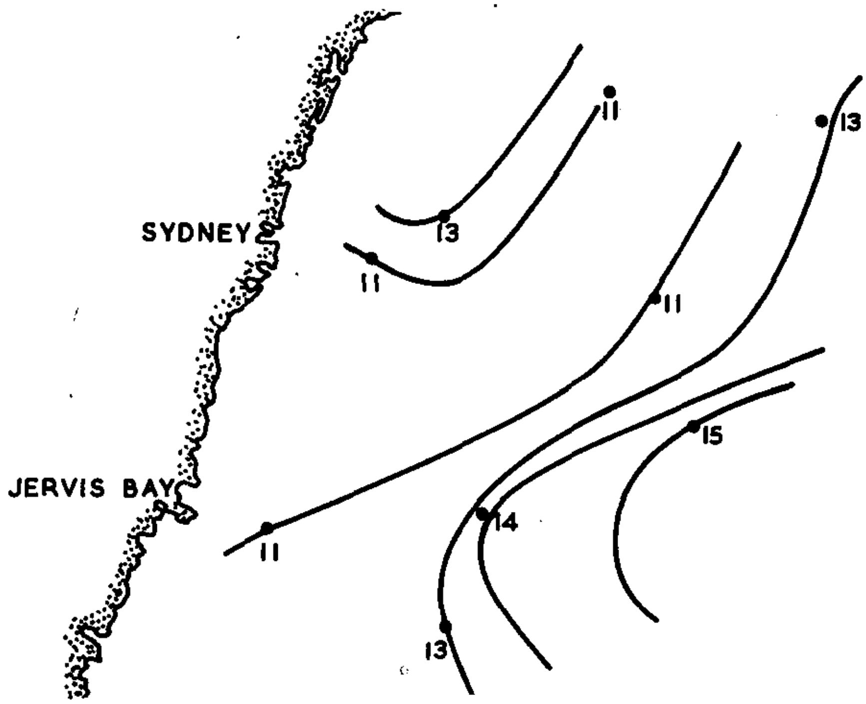

Fig. 5.- Distribution of total phosphorus (μg per litre).

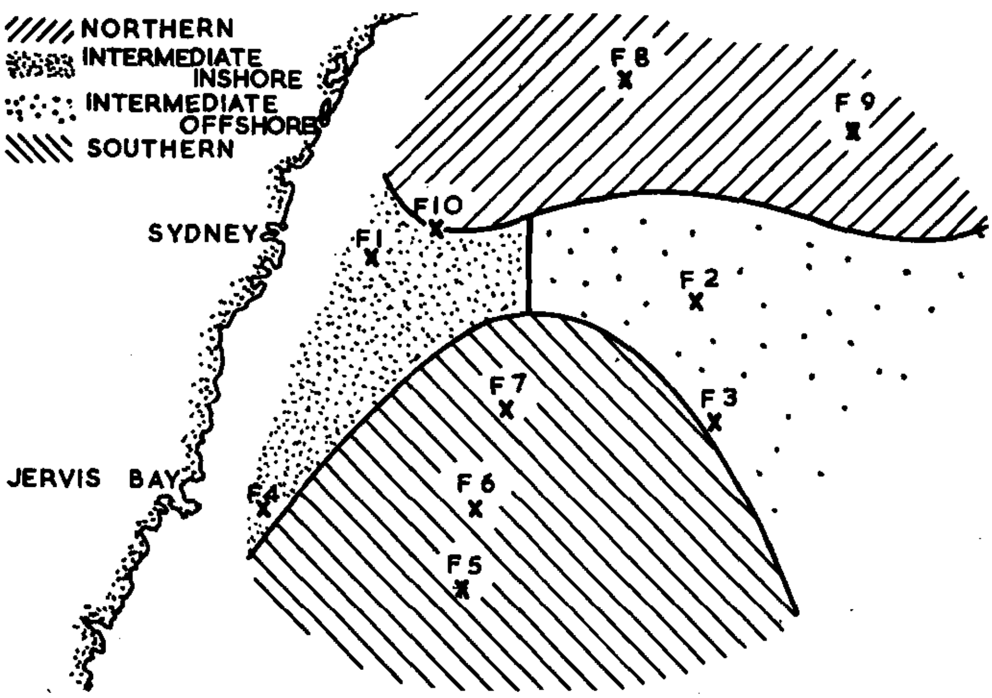

Fig. 6.- Plankton regions. Plankton hauls were made at fishing stations.

TABLE 3 Contd.

Station	Depth	South Equatorial	S.W. Pacific	Central Tasman
16/56	0	9	12	79
	25	6	18	76
(F9)	48	5	18	77
	72	2	17	81
	96	2	17	81
	145	8	15	77
	195	7	15	78
	294	sub-Antarctic	influence	
17/56	0	9	12	79
	23	9	12	79
(F10)	46	9	7	84
	71	9	8	83
	92	8	11	81
	138	4	0	96
	185	sub-Antarctic	influence	

In the north an increasing amount of the South Equatorial water mass was encountered with a maximum at Station 15/56. It appeared to be moving south along the slope region and probably travelled with the general eastward movement of the Central Tasman water mass.

The σ_t distribution (Fig. 4) suggests that south of latitude 35°S the Central Tasman water mass was moving north, and then between latitudes 34° and 35°S, moving east.

In the region of Stations 12-14/56 vertical mixing had introduced sub-Antarctic waters to the surface.

The total phosphorus (Fig. 5) varied little over the area, but the minimum values were found in general association with the easterly movement.

(c) PLANKTON.- W. Dall

Using the differences in distribution of certain of the important dominant copepods in the plankton, the area covered by the cruise has been divided into three regions (Fig. 6). Table 4 gives the distribution and abundance of the zooplankton species taken in hauls on the cruise.

TABLE 4

DISTRIBUTION OF ZOOPLANKTON

Species	Northern	Southern	Intermediate Inshore	Intermediate Offshore	All Stations in Comparable Nos.
COPEPODS:					
Acartia clausii	+	+	+	-	
A. danae	++	++	+	++	
Calanoides carinatus	-	++	+	++	
Calanus helgolandicus	-	+	-	-	
C. minor	+	+	+	+	+
C. tenuicornis	+	+	+	+	+
C. tonsus	-	++	+	+	
Centropages bradyi	-	-	-	+	
Clausocalanus arcuicornis	-	++	+	++	
Ctenocalanus vanus	++	++	++	++	++
Eucalanus crassus	+	-	+	+	
E. attenuatus	+	+	+	+	+
Mecynocera clausi	++	+	+	+	
Paracalanus spp.	+	+	+	+	+
Pleuromamma abdominalis	-	-	+	+	
P. gracilis	-	+	+	+	
Undinula darwinii	+	-	-	-	
Oithona plumifera	++	+	+	+	
Oncaea conifera	+	+	+	+	+
O. media	++	++	++	++	++
O. venusta	++	++	++	++	++
ACOPA:					
Thalia democratica	+	+	++	+	
Salpa maxima	-	-	+	-	

\+ Present
++ Abundant
\- Absent

The northern region was established chiefly on negative evidence, that is, on the absence of species found in the southern region. Species characterizing the latter region are those usually dominant in the latitude of Bass Strait.

The intermediate region contained components of both northern and southern groups, chiefly the latter. Division of the intermediate zone was based on the presence of "inshore" and the paucity of "offshore" species at Stations F1 and F4. Some upwelling in the intermediate zone may be indicated by the presence of *Pleuromamma abdominalis* in daylight hauls. This species is usually found in deep water and caught in surface waters only at night.

In Table 4 it may be seen that eight copepod species are present in comparable numbers at all stations. Euphausiaceae, Chaetognatha, Amphipoda, Ostracoda, and Pteropoda show a similar distribution. This is in accord with previous findings that zooplankton distribution over a large part of the Tasman Sea is mainly homogeneous. Hence the differences in zooplankton distribution in the area covered by this cruise should be considered relatively minor ones.

Owing to a defective flowmeter in the Clarke Bumpus sampler it was not possible to show quantitative distribution. By comparison of duration of hauls, the northern portion of the cruise area appears to have been supporting a greater standing crop than the southern half. Station F1 had the most abundant plankton, both in numbers and in volume.

(d) DYNAMICS.- B.V. Hamon

Figure 7 shows approximate dynamic heights at each station, relative to the 1000 decibar level. The values have been computed from the σ_t values at each station, using the formula

$$h = 200 - \frac{1}{10} \int_0^{1000} (\sigma_t - 25.00)\, dz$$

where z is depth in metres, and h is the approximate dynamic height in cm.

The dynamic heights indicate an appreciable surface current (22cm/sec) to the south between Stations 15/56 and 16/56, and a larger current (about 40 cm/sec) to the south-east between Stations 10/56 and 16/56. This south-east current may be in error due to the difference of more than a week between the times of occupying the two stations.

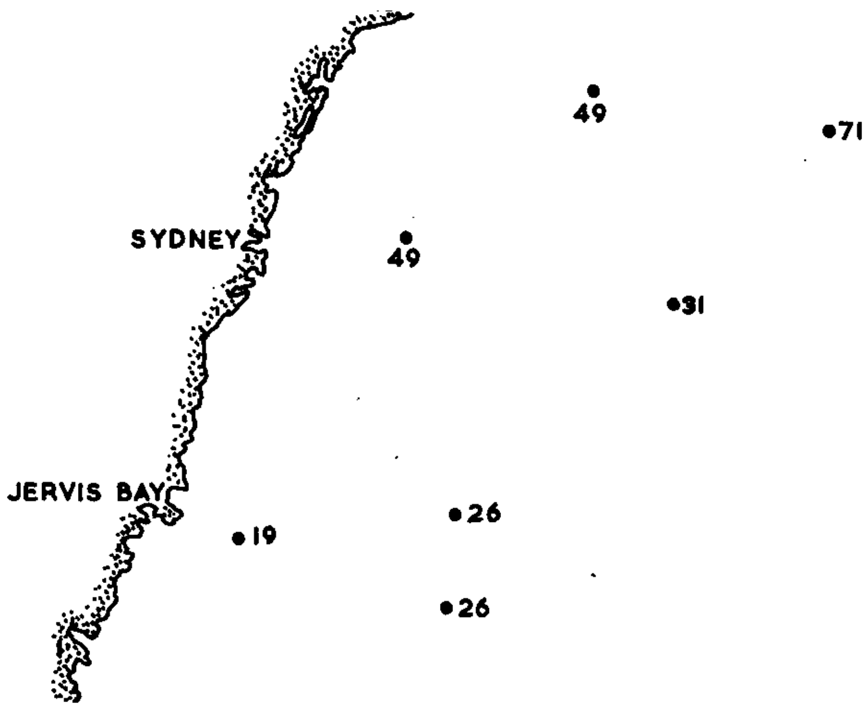

Fig. 7.- Approximate dynamic heights relative to the 1000 decibar level, taken at hydrology stations.

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT ON CRUISE 4/56

October 9 - November 6, 1956

Scientific Personnel
Scientific Officer-in-Charge of Cruise
October 9 - 25 - W. Dall
October 29 - November 6 - T.R. Cowper

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Part 1.- Departed Sydney October 9, 1956 for Bass Strait. Plankton and hydrology stations commenced October 10 off Eden. By October 17 the stations of the eastern half of Bass Strait were completed. Barracouta were located at Station DH4/30/56 (40°27'S, 146°52'E) where 8 were caught with hand lines. Two more were caught on trolling jigs near this station. Left Devonport on October 18. Bad weather made it necessary to sail to the east and north of King Island, then return south to complete stations to the west of the island. Bad weather and winch breakdown prevented the last three stations being completed and on October 25 the vessel entered Port Phillip Heads.

Part 2.- October 25 - 29 spent tied up in Melbourne re-victualling vessel and maintaining deck winch.

Departed Melbourne October 29 for barracouta trolling cruise in Bass Strait. Track of vessel was: Port Phillip Heads, Cape Otway, King Island, Stanley, Tenth Island, Furneaux Group, Kent Group, Wilson's Promontory, Cape Schanck, Port Phillip Heads. Barracouta trolling was conducted at each morning and evening rise on passage. Hardy plankton indicators were streamed at all times, weather conditions permitting.

November 3 - 4 spent weatherbound at Wilson's Promontory so that only 7 days were devoted to the planned programme. Out of the planned cruise period of 40 days only 26 days were available, causing drastic curtailment of the latter half of the cruise.

Figure 1 gives the track chart and the station positions.

SCIENTIFIC REPORTS

(a) BARRACOUTA.- T.R. Cowper

The purpose of the cruise was (a) to test the hypothesis that annual fluctuations in the success of the barracouta fisheries of Bass Strait depend mainly upon corresponding fluctuations in the availability of *Nyctiphanes australis* ("krill") in the coastal waters in summer and autumn, and (b) to determine any relationship between the occurrences of barracouta and the water masses of the area.

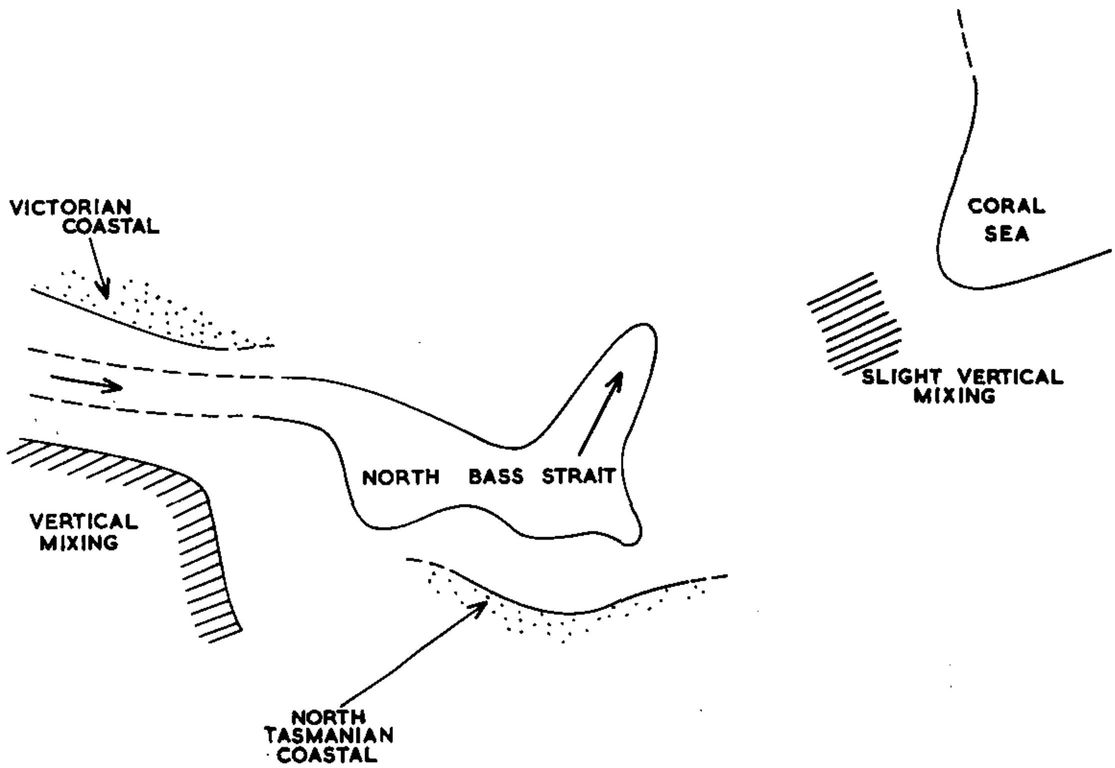
Only 45 barracouta were taken during the cruise - 8 from the western sector and the remainder from the eastern sector. These were taken on surface trolling lines or jig-stick with the exception of 8 which were taken on hand lines west of Cape Barren Island. The areas of barracouta trolling and the positions where fish were caught are shown on Figure 1.

Of these fish the only ones feeding on krill, as determined from stomach contents, were those taken in the western sector in the vicinity of King Island. While most of the fish taken from the eastern sector were empty, those containing food organisms had been feeding mainly on anchovy. Other fish remains, though unrecognizable due to advanced digestion, were probably also anchovy.

From an analysis of the gut contents of fish taken by professional fishermen over the same period, a similar condition was apparent. Gut contents of fish from the western sector (Portland, Port Fairy, Apollo Bay, and Lorne) were:- Nil 61 per cent., euphausiids 37 per cent., anchovy 2 per cent., while those from the eastern sector (Queenscliff, San Remo, and Wilson's Promontory) were:- Nil 73 per cent., euphausiids 9 per cent., anchovy 12 per cent., fish remains (probably anchovy) 6 per cent. Thus, ignoring the percentage of empty stomachs, the fish in the western sector were feeding predominantly on krill while those from the eastern sector were feeding predominantly on fish and particularly on anchovy.

An analysis of the euphausiids throughout Bass Strait at the same period, as determined from vertical plankton hauls and surface Hardy plankton indicator tows, revealed that, though euphausiids were available to barracouta in both sectors, they were probably available in greater quantities in the eastern sector. This was particularly apparent from Hardy indicator tows (Fig. 1).

However, the euphausiid distribution was not reflected in the feeding pattern of the fish. It seems that during


VICTORIAN COASTAL
CORAL SEA
SLIGHT VERTICAL MIXING
NORTH BASS STRAIT
VERTICAL MIXING
NORTH TASMANIAN COASTAL

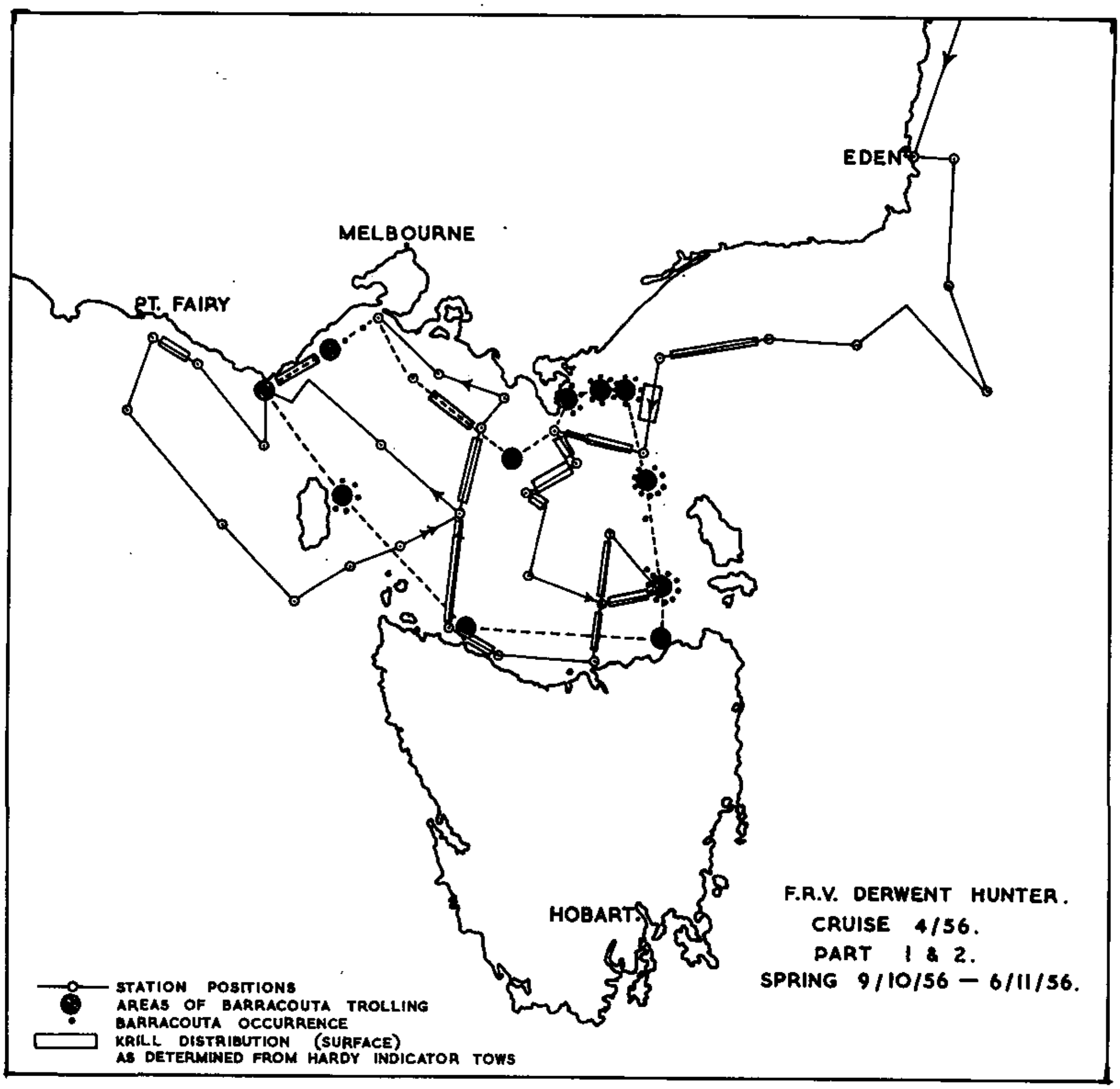


Fig. 1.- Cruise DH4/56. Track chart and hydrology stations. Areas of barracouta trolling and barracouta occurrences and krill distribution at surface as determined from Hardy indicator tows.

Transparency indicates the distribution of water masses.

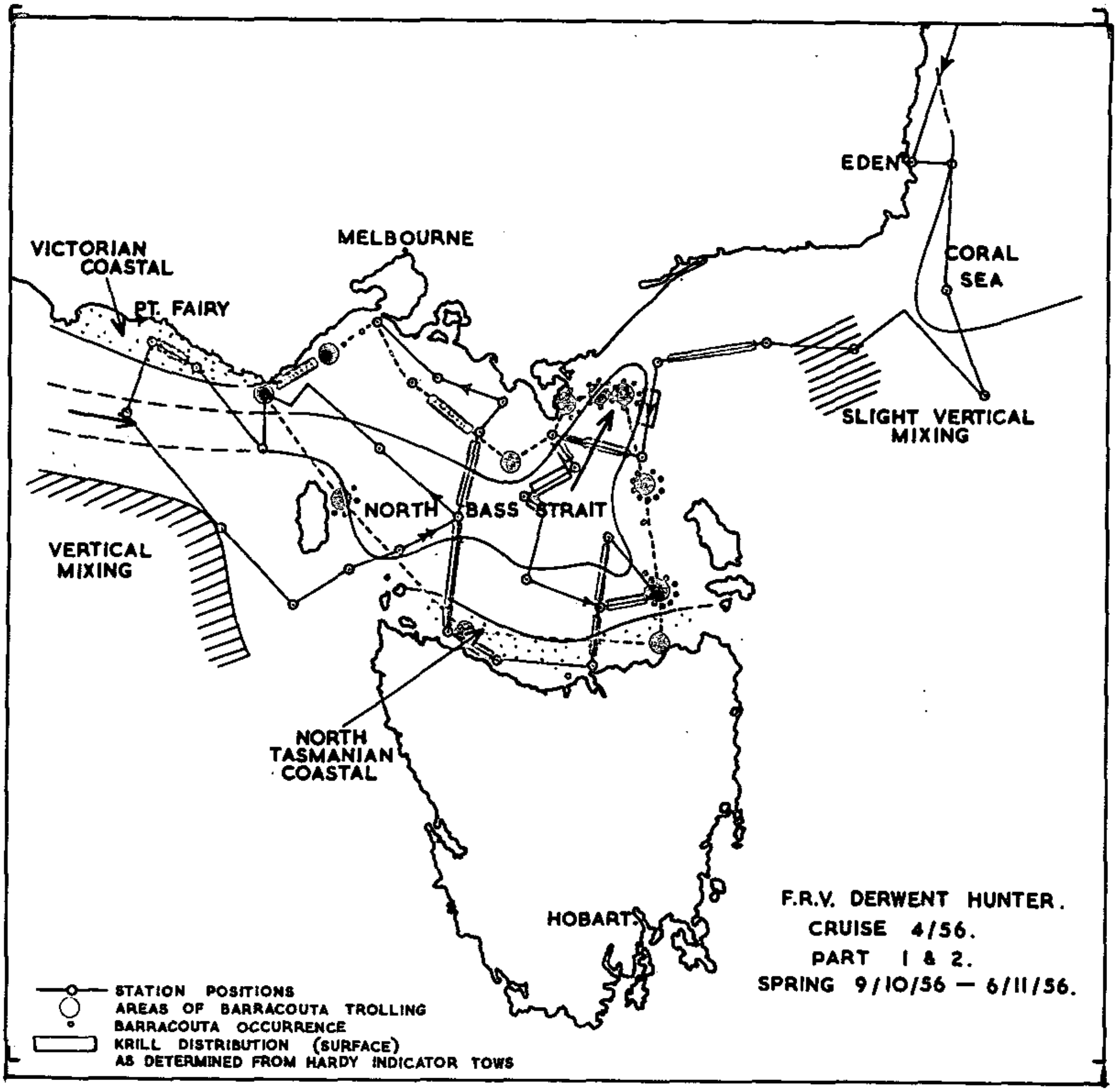


Fig. 1.- Cruise DH4/56. Track chart and hydrology stations. Areas of barracouta trolling and barracouta occurrences and krill distribution at surface as determined from Hardy indicator tows.

Transparency indicates the distribution of water masses.

the spring (October - November for this cruise) anchovy were still available in numbers (at least in the eastern sector) and while they were available the barracouta found them preferable to krill. (At this time of year the anchovy are returning from the open sea to the coastal inlets where they spend the summer and autumn). In the western sector, however, there was evidence of few anchovy being present so that the barracouta had no alternative apparently but to feed on the available krill.

It remains to be seen therefore whether, with the disappearance of the anchovy during summer and autumn, the barracouta turn to krill as their staple food. If this proves to be so then the availability of the euphausiids at those seasons should be reflected in the availability, and consequently the landings, of barracouta from Bass Strait waters.

Data on commercial barracouta landings from Bass Strait waters for the period covered by Cruise DH4/56 are not yet available.

Although very few barracouta were taken during the cruise, they were taken mostly at or close to the periphery of the north Bass Strait water mass (Fig. 1). These scant data may suggest a relationship between the occurrence of the barracouta and the above water mass, though more regular and frequent sampling is required before any satisfactory conclusions can be attempted.

(b) PLANKTON.- W. Dall

The purpose of the cruise was to plot qualitative and quantitative zooplankton distribution throughout Bass Strait.

(1) Plankton Communities.- From previous cruises it has been found that Bass Strait has three basic regions, a Victorian inshore, a north Tasmanian inshore, and a central Bass Strait. The latter is bounded on the east and west by the continental slope, beyond which open ocean zooplankton prevails. The inshore communities appear to be relatively stable, but the central Bass Strait may be invaded by external groups.

In this cruise a large tongue containing western open ocean species extended almost throughout the Strait, pushing the central Bass Strait community to the south and east (Fig. 2). There was also evidence of some invasion to the north-east through the south-west Strait and into the Victorian coastal community (indicated in the figure by arrows).

The boundaries of the western offshore invasion correspond roughly to those of the water mass established hydrologically (see Section (c)), except that in the western portion the zooplankton boundaries are displaced to the north.

(2) Plankton Abundance.- In Figure 3 displacement volumes of zooplankton are plotted. Greatest concentrations were found to the north and south-east of the advancing western water mass. In addition to volumes, the numbers of some crustacean plankton species were also greatest in these areas. Generally the greatest concentrations were round the periphery of the advancing water mass. This behaviour may provide a clue to the concentrations of some zooplankton organisms and may be due to feeding at the water mass boundaries or retreat before a body of water differing appreciably in physical and chemical properties.

(3) Distribution of Larger Planktonic Crustacea.- The copepod *Calanus helgolandicus* and the euphausiid *Nyctiphanes australis* appear to be independent of water masses. *Calanus helgolandicus* was distributed uniformly throughout Bass Strait. Distribution of *Nyctiphanes australis* is shown in Figure 4. The early calyptopis stages were concentrated in the inshore coastal areas except for a tongue in the western approaches, but the later furcilia stages and adults were distributed across the eastern half of the Strait as well. Furcilia and calyptopis stages were present, but in much reduced numbers, in the non-hatched western regions.

(c) HYDROLOGY.- D. Rochford

The purpose was to determine the water mass composition and distribution in Bass Strait during the time of the survey.

From the chlorinity - temperature relationships the following water masses were identified.

TABLE 1

WATER MASSES IN BASS STRAIT
OCTOBER - NOVEMBER 1956

Water Mass	Chlorinity	Temperature °C	Mean Total P. µg/l.
Coral Sea ?	19.63	15.4	11
N. Bass Strait ?	19.70	13.2	16
Victorian coastal	19.57	13.1	14
N. Tasmanian coastal	19.13	12.5	10

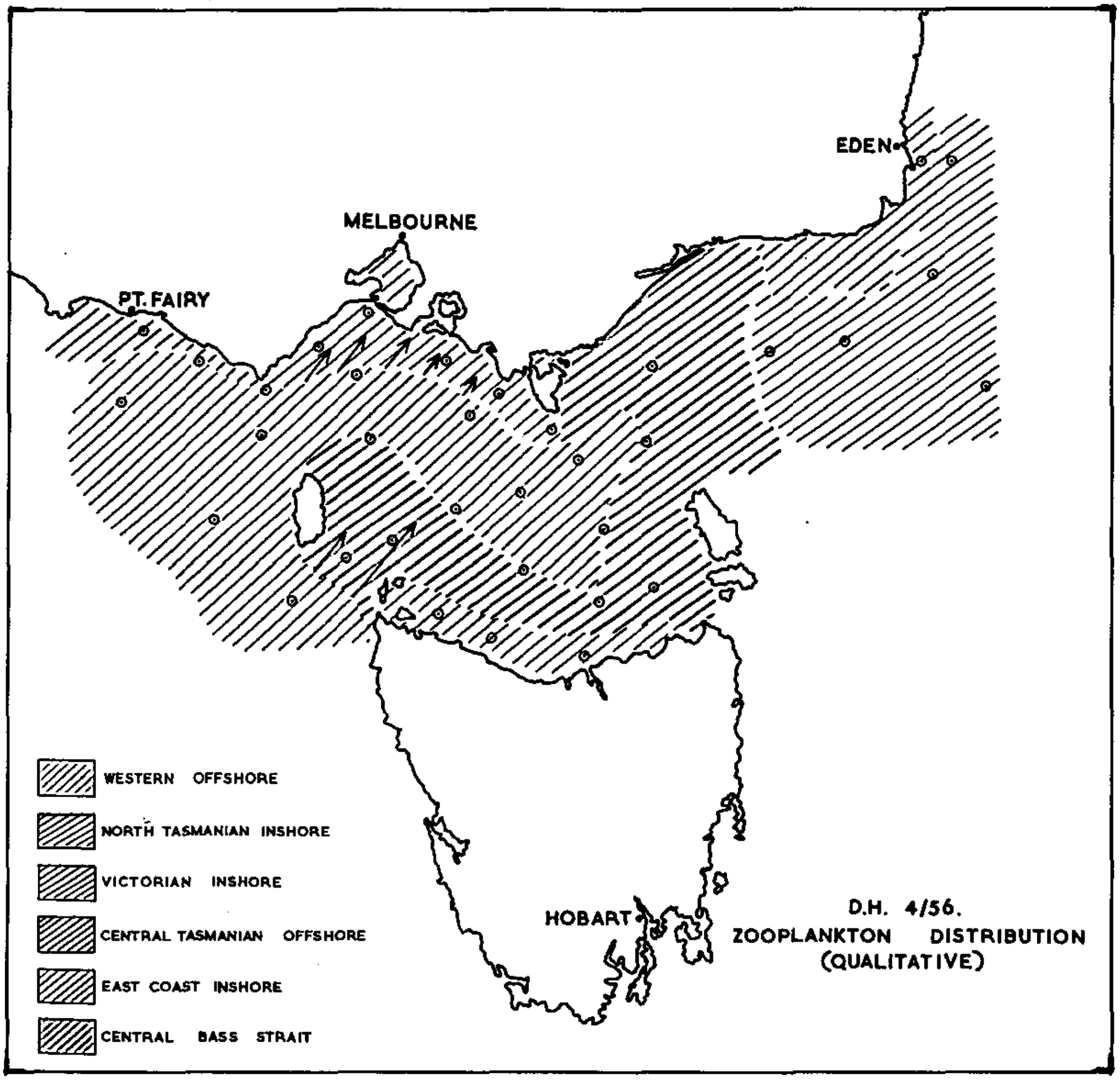


Fig. 2.- Zooplankton distribution (qualitative).

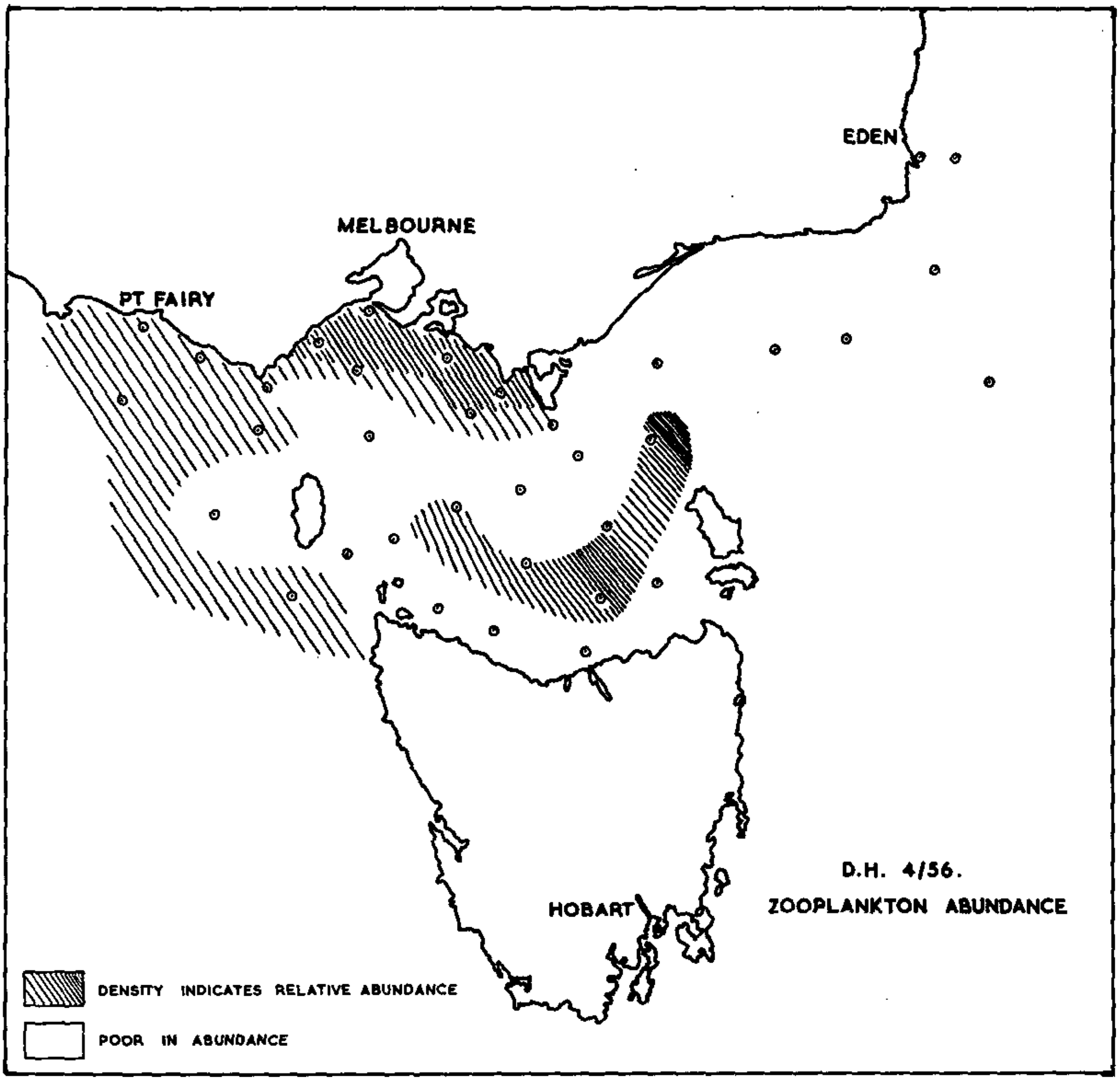


Fig. 3.- Zooplankton abundance. Density of hatching indicates relative abundance; non-hatched areas are poor in plankton.

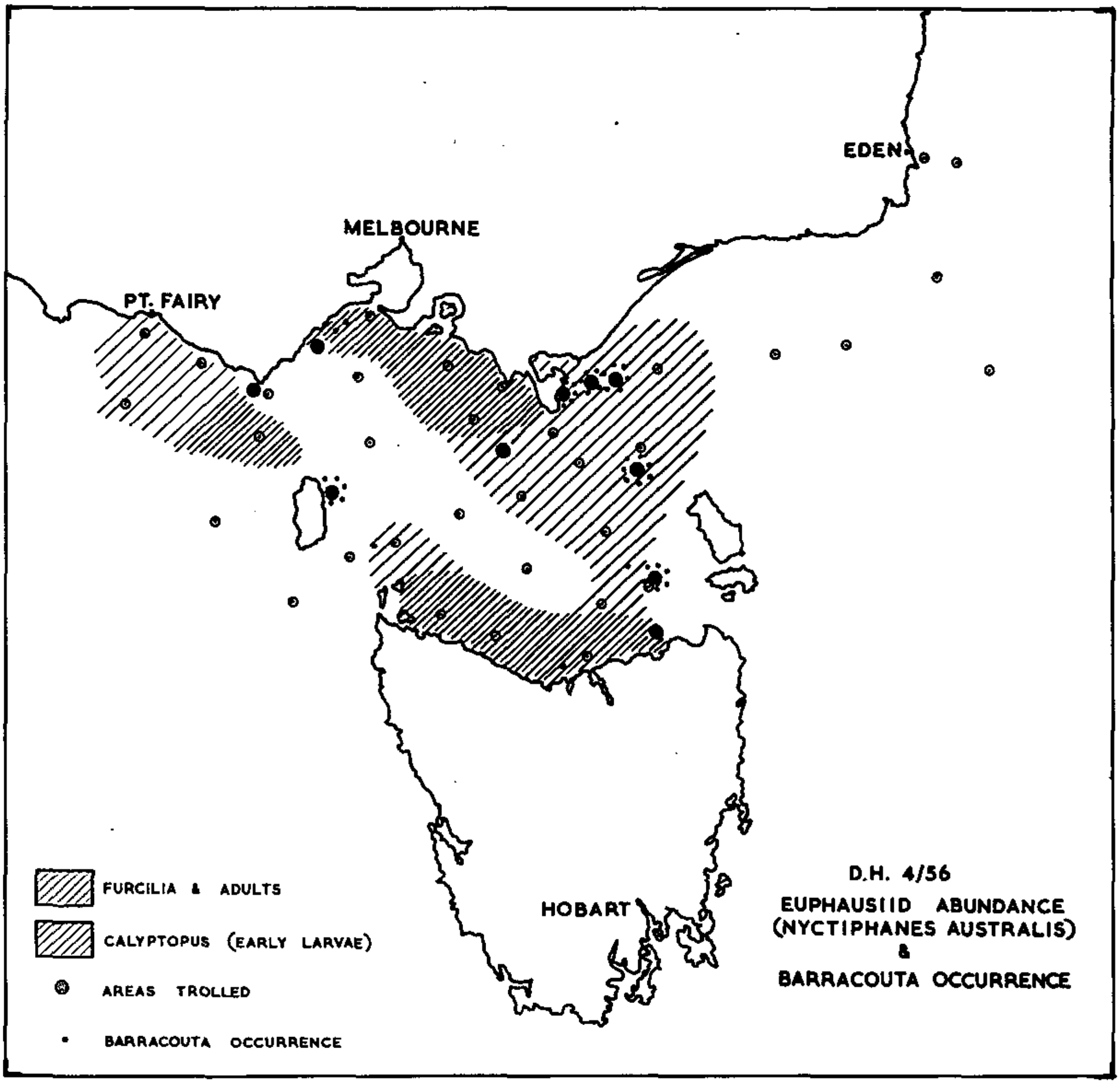


Fig. 4.- Abundance of euphausiid (Nyctiphanes australis) and barracouta (Thyrsites atun).

The total phosphorus was determined on each sample collected and plotted against the percentage water mass composition. The mean figures were then obtained.

The Coral Sea water mass has been so designated because its chlorinity and total phosphorus levels were within the previously defined limits for this water mass, though its temperature was lower than usual.

The north Bass Strait water mass had a higher temperature and total phosphorus level than previously defined and might have been regarded as the central Tasman, except for its degree of westward extension. The north Tasmanian coastal water mass had a lower total phosphorus level than previously recorded.

The distribution and possible movements of these water masses are shown in Figure 1.

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE DH 5/56

November 8 - December 3, 1956

For the period November 8 to December 3, 1956, the vessel was loaned to the Division of Meteorological Physics, C.S.I.R.O., for a programme of meteorological research. The purpose of the cruise was the consolidation of the results obtained on the "Derwent Hunter" in October 1955 and reported in "Wind profiles over the sea and the drag at the sea surface" by E.L. Deacon, P.A. Sheppard, and E.K. Webb. Aust. J. Phys. 9 (4): 511-541, 1956.

After installation of the necessary equipment observations in Port Phillip were commenced on November 11 with the vessel based on Portsea, and continued daily until November 21. As four and sometimes five personnel were needed for the observations it was necessary to return to Portsea each evening. This reduced the observational period to 4-5 hours per day, the remainder of the time being spent in running to and from a suitable station in the deeper parts of the bay. A two day intermission (November 22 and 23) for instrument recalibration and replenishment of stores was followed by a further 6 days observations, the last 4 at stations 5-10 miles south of the Port Phillip entrance to take advantage of a spell of southerly weather giving a very long fetch of the wind over the sea.

Observations were secured on a total of 146 runs, mainly of 20 minutes duration, and a satisfactorily wide range of meteorological conditions was experienced. The variation of wind speed with height from 3 to 13 m above the sea was observed together with measurements of vertical temperature gradient, air-sea temperature difference etc. On 52 of these runs records of the turbulent fluctuations of wind components and of air temperatures were secured and from these values of the turbulent transfer of heat and momentum are being evaluated. Some records of the fluctuations of wet-bulb temperature were also obtained and a few values of water vapour transfer (in practice equal to evaporation) may result from these. Analysis of the results is still in progress.