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澳洲西北部拖網漁場底魚資源調查

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DEMERSAL FISH RESOURCES INVESTIGATION ON TRAWL GROUNDS OFF THE NORTHWEST COAST OF AUSTRALIA

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1. This report was the results of survey on fishing grounds northwestern coast off Australia, including meteorological, sediment, hydrological and biological investigations, estimates of standing stock size as well as mesh experiments, during February 15 to May 18, 1979 by use of R/V Hai-Kung belonging to Taiwan Fisheries Research Institute.

2. It was of fine weather for fishing during the period of investigation. The bottom of northwest shelf was marked by the fine sand, sand and shell in most of the area, which form a belt from southwest to northeastward along the coast in 60 to 120 m deep. It was considered to be a trawlable fishing grounds.

3. Surface water temperature ranged from 26.5 to 30.5°C, salinity attained its highest value of 35.36 ‰ and lowest of 34.22 ‰. Temperature and salinity of northern waters were a little higher than that of southern part of the studied area. In northern Legendre, it seems that an upwelling existed there, where the surface temperature and dissolved oxygen were lower, but salinity was higher than that of surrounding waters.

4. The cod-end of the trawl net used in the experimental trawling meshed 90 ±2 mm, its selective rate was lower than 50% for lizard fish, golden thread, silver grunter, hair-tail and sharp-tooth snapper, but higher than 70% for Russell's snapper, red snapper, batfish, gurnard and skate.

5. A total of 235 species of fish were found in the catch, which consisted of 27 species of cartilaginous fish belong to 18 families and 208 species of bonyfish belong to 80 families. Among them about 60 or more species are of commercial value.

6. The catch composition revealed a great diversity of species without any really dominant. The comparatively abundant species was red snapper composed of 29.25%, which was followed by silver grunter of 12.52%, and 8.64% was accounted for sharp-tooth snapper, 7.80% for lizard fish, 7.31% for butter fish, 4.04% for trevally, 3.60% for Russell's snapper and 3.48% for golden thread.

7. Northern waters was much more productive than the southern part of the studied area. Catch per trawling hour were 20.62 and 14.59 to 16.92 cases respectively. The major species were silver grunter, red snapper, sharp-tooth snapper, butter fish and trevally in northern grounds, and lizard fish, golden thread, red snapper, porgies and Madaras snapper in southern grounds.

8. From the results of test, significant difference was found between daytime and twilight catch. The catch was usually higher in daytime and commonly lower in waters at the depth less than 90 m. Large catch were hauled up at the depth 90 to 105 m or deeper. Difference in body length composition by water depth varied with species.

9. Standing stock density of northwest shelf in March to May was accounted to be around 52 kgs/ha in average, and the maximum standing stock size was estimated about 1345 thousand tons with the potential yield of 672 thousand tons. The annual landings were 44.9 thousand tons in 1976, which was only 6.7% of the potential yield. It may be concluded that there is still great potential of fish resources for a trawl fishery in Australian waters.

INTRODUCTION

Trawling grounds on northwestern coast of Australia were initially developed in 1935 by Japanese research vessel, and discountinued in Nov, 1958, Dec 1962, Dec. 1963-Jan. 1964 and Aug. 1966 to carried out tests on potential trawling. The surveyed area has been reported to be a good trawling ground, but the results were not sufficiently encouraging for them to preserve with the trials or to attempt to set up a fishery there.

Four years later, during the period of 1970 to 1973, eight cruises of exploratory trawlings were made in Timor Sea and Arafura Sea by R/V Hai-Chin (137 tons) of Taiwan Fisheries Research Institute. It was suggested that the northwestern Australia was a productive trawling ground, where had become the most important fishing grounds of Taiwan pair trawlers of deep-sea fisheries since the commercial fishing boats were introduced into that area in 1971. The number of fishing boats conducted fishing in Australian waters and the amount of catch were repidly increased in the later several years.

According to the commercial catch statistics on Taiwan demersal fish fisheries, the fishes caught by pair trawler from Australian waters in 1974 were estimated to be about 83,007.20 tons, which occupied 64.2% of the total catch of pair trawler landed in Taiwan. In 1975 & 1976, the annual landings come from the same area were estimated to be around 49,231.41 and 51,253.74 tons which composed of 37.2% and 46.1% of the total catch respectively. Average catch was nearly constant ranged from 28.94 to 31.70 cases per haul over the past few years.

In order to know the present state of bottom trawl grounds in Australian waters, northwestern sea was selected as a survey area in the cruise HK-79-1 of R/V Hai-Kung (711 tons, 2000HP). The principal aims of the survey was to study the species composition of catch and to assess the magnitude of the demersal fish resources in certain, regions and the entire studied area. The investigation program included meterological observation, studies of bottom topography and sediments, oceanographical observations, the collection of plankton, fish larvae, benthos and commercial fishes. And the experiments on mesh selectivity were also done.

The cruise extended over 93 days from 15 Feb to 18 May 1979. On the way, the research vessel stopped at port Darwin for supply and recreation of researchers and crew on March 30 to April 9. The track is given in Fig. 1. The members of the researcher discussed with research officers of the Northern Territory Fisheries Division during the stay in Darwin. The authers would like to thank director Slack Smith, Dr. Rex Pyne and research officers, for their hearty entertainment and also to Mr. Baker for his help in indentifing the specimens.

MATERIALS AND METHODS

Bottom topography of the studied area was recorded with newly equipped precise depth recorder at 30-minute interval before trawling. Sediments were sampled with special sampler attached to the ground rope of the net during trawling. Weather observation was conducted every 6 hours duing the whole cruise in the sea.

Water temperature was observed with Nansen bottles at 19 stations and at the same time water samples for salinity, dissolved oxygen, pH analysis were taken from various depths. BT operations were made at 29 stations. Position of each stations are shown in Fig. 2. 1.

Trawling tests were done during the period from March 4 to May 5 at 49 stations. Locality of trawling covered 16 fishing area which was divided into 5 regions A to E as shown in Fig. 3. 1. It took about 138 minutes in each trawling at a constant speed of 3 knots. The composition in catch was examined haul dy haul, species were sampled at random; and their body length and body weight were measured. Scale sampling, sex and gonad observation were added. Each species of the fish was photographied by the biological researcher on board of the ship.

Zooplankton samples were taken with NORPAC net (mouth diameter 45 cm) at 19 stations from near bottom to surface vertically. The surface layer was sampled with larval net of 1.4m in mouth diameter, most of the towings were made with the ship speed of 1.5-2.0 knots for 15 minutes. Samples were preserved in 5% formalin after collection.

Nine operations of the mesh experiment with covered net were carried out. Each trawling lasted for 30 to 60 minutes. The design of experimental net (90 mm mesh cod-end) and cover net (30 mm mesh cod-end) is shown in Fig. 4. 1.

I. WEATHER CONDITION AND BOTTOM CONDITION

Tung-Hsin Chi

1. WEATHER CONDITION

There were 93 days within this voyage between sailing away aad sailing back of port Keelung from February 15 to May 18, 1978. Excluing the sailing time, there were 66 days stayed at the investigated area from March 3rd to May 7th. That was the the transitional season from summer to autumn in the southern hemisphere, the wind was unsteady in derection (Fig. 1.1). If that tropical cyclone Hazel at March 10-11 had not happened, it could be always fine weather within the whole period. The atmosphere presure in the center of cyclone Hazel reached its lowest 960 mbs. Maximum wind near center was 65 m/sec.

Air temperature was 28°C-32°C in this period and the difference between night and daytime was only 1°C. As it was always breezing, we could hardly suffer the hot sensation. It was a fine weather for fishing, unless to met the tropical cyclone.

2. BOTTOM CONDITION

A belt of soft bottom suitable for trawling was streached from southwest to northeastward along the depth of 60-120 m, indluding sand, shell, sand & shell, fine sand etc. The hard bottom scattered outside of thes belt, including rock, and stone etc, which was not suitable for bottom trawling (Fig. 1.2). Sponges were scarely. It was good fishing location for bottom trawling.

II. OCEANOGRAPHIC OBSERVATION

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Forty-eight stations including 19 STD and 29 BT stations were observed in this voyage. The investigation area was located between 12 to 21° S and 115 to 125°E. The positions of stations were shown in Fig. 2. 1. The horizontal and vertical destributions of water temperature, pH value, dissloved oxygen content, salinity were described as follows:

Water temperature: maximum 30.5°C and minimum 26.5°C in surface. Most of the water temperature were between 28.0°C-29.6°C, with the average of 29.1°C. The isotherms of different layers were parallel to coast line generally and the horizontal distributions of surface water temperature were symmetric to the isotherm of 29.5°C as Fig. 2.2. The surface water temperature was obviously lower than surrounding area by 0.5°C-1.0°C in the northern sea area of Legendre Island and it was more obviously lower than surrounding area by 2°C-3°C in the northern sea area of Cape Thouin. Water temperature decreased as the depth increase as Figs. 2.5 to 2.7. Thermoclines started at the depth between 30 to 60 m and ended at the depth of 300 m. Average water temperature dropped to 23.0°C with minimum of 22.8°C in 100 m deep and dropped to 17°C with minimum of 15°C in the depth of 200 m. The whole investigated region belong to high temperature area, but an obviously cold water mass in northern part of Legendre Island between the depth 0-30 m was observed.

Salinity: Maximum was 35.36‰ and minimum was 34.22 ‰. Most surface salinity were between 34.60-35.00‰ with the average of 34.90‰. Isolines of salinity were parallel to latitude and decrease gradually from coastal area to open sea in northern sea area of Legendre Island. In western sea area of Legendre Island the isolines make an angle of 70° with coastal line and decreased westward from Legendre Island. It trended to decrease from coastal area to open sea between the depth of 10-75 m. In northern sea area of Legendre Island the salinity reached high value between 35.20 to 35.40‰ especially in the layer between the depth of 0-30 meter as Figs. 2.8-2.10. Vertical distributions of salinity along sections were shown in Figs. 2.11-2.12.

PH: Maximum was 8.25 and minimum was 8.13. on the major area the pH value were between 8.20 to 8.21, average value 8.21. The isolines make an angle of 60°-80° with coast in both western sea area of north part of port Walcott and eastern sea area of north part of port Hedland. The pH value of surface water, being 8.25 in the northern sea area of port Walcott, decreased westward and dropped to 8.14 in northern sea area off Borrow Island, but it being 8.18 in northern sea area off port Hedland, increased eastward and get the value of 8.24 in the sea area near longitude 121°E, as shown in Figs. 2.13-2.15. The isolines were parallel to coastline and increased northward between the depth of 30-75 m. The vertical section distributions almost had the same value between 8.20 to 8.23 between the depth of 0 to 50 m, and decreased slowly between sea surface to 50 m. It being 8.14 at the depth of 100 meters decreases fast under the depth of 100 meters and dropped to 7.90 at the depth of 200 meters.

DO: On the surface, maximum was 5.90 PPM and minimum at 2.40 PPM. Except northern sea area of Legendre Island with low dissloved oxygen between 2.40 to 3.90 PPM, on the other major area the DO was between 4.50 to 5.50 PPM, average value 4.78 PPM. From coastal area to open sea the DO of different layers, as Figs. 2.18 to 2.20, was decreased as the depth increase. Especially the observation stations No. 13 and No. 20 with lower DO value than surrounding area and increased as the depth increase.

On this survey it was found that the water temperature of northern sea of Legendre Island was 0.5-1.0°C lower than surrounding area. On the contrary the salinity obviously higher than the surrounding area, 35.00-35.40‰ on the surface and 34.6-34.80‰ on the bottom, its DO was lower than surrounding area and increased as the depth increase. It seemed that an upwelling existed in this area. On the other aspect there was a high salinity and low temperature water mass in northern part of Cape Thouin.

III. BIOLOGICAL INVESTIGATION OF THE CATCH

Shin-Chin Chen, Chung-Hui Chen

1. CATCH BY FISHING AREA

The total catch landed of the pressent survey was 2153 cases, each case about 30 kg in weight. Average unit catch was 44.85 cases per haul and 19.37 cases per trawling hour. Of the 48 effective trawlings, the least catch was 20 cases in fishing area 3834 and the largest catch 80 cases was in 2748 area. In the southern part of the studied area, no much difference of the catch was found between trawlings, CPUE ranged from 14.59 to 16.92 cases per hour in average at regions A to D. The catch was as low as 9.19 and high as 34.54 with an average of 20.62 cases per trawling hour at region E of northern waters. The northern ground was much more productive than the southern waters of the studied area.

2. CATCH BY SPECIES

The species name of the captured fishes are listed up in appendix Table 3.1. Table 3.1 represents the catch composition of those which are of commercial value, 30 groups belonging to 60 or more species. The most abundant species was red snapper which composed 29.52% of the total catch, silver grunter come next at 12.52%, approximately 8.64% was accounted for sharp-tooth snapper, 7.80% for lizard fish, 7.31% for butter fish, 4.04% for trevally, 3.6% for Russell's snapper, 2.48% for golden thread, the rest contained banded scad, Madras snapper, bigeyes, porgies and some other imporant commercial species. The species composition of the overall area reveal a great diversity of species without any being really dominant.

3. SPECIES COMPOSITION BY AREA

Figs. 3.4–3.5 show the species composition at each fishing area. It become clear that the composition and amount of catch varried with the location of stations. The five most abundant species in each region are:

in RA: Lizard fish (33.23%), red snapper (9.81%), big-eyes (8.97%), golden thread (8.16%), Madras snapper (5.56%).

in RB: Lizard fish (40.15%), golden thread (28.86%), red snapper (8.89%), cuttle fish (4.62%), Madras snapper (2.96%).

in RC: Lizard fish (24.60%), red snapper (22.49%), sharp-tooth snapper (9.70%), Madras snapper (5.48%), big-eyes (5.13%).

in RD: Porgies (16.67%), Madras snapper (13.89%), lizard fish (12.50%), golden thread (9.72%), red snapper (6.94%).

in RE: Silver grunter (19.29%), red snapper (18.87%), sharp-tooth snapper (6.35%), butter fish (5.40%), trevally (5.31%).

4. CATCH BY DEPTHS

Depths of the trawling stations ranged from 60 to 110 m in southern area and ranged from 86 to 153 m in northern waters. The catch in depth shallower than 90 m was generally lower than that in deeper area. Higher catches over

25 cases per hour were obtained mainly from depths of 90 to 105 m, and also found in 120 to 140 m deep. Relations between catch and CPUE is shown in Fig. 4.6.

5. CATCH BY DAYTIME AND TWILIGHT

It was likely that good catch of bottom fishes was usually common in the daytime, but not at night or twilight. The unit catch of daytime ranged from 15.11 to 34.54 cases and 27.61 cases in average, while mean catch of twilight was 16.85 cases (9.19 to 20.89 cases). According to statistical treatment, significant difference ($P<0.05$) was seen between the catch of daytime and twilight. The suitable time in twilight or night was 3 to 4 hours per trawling.

6. DISTRIBUTION OF MAIN SPECIES

Red snapper (*Lutjanus* spp.) were caught abundantly in the northern waters. CPUE ranged from 2.50 to 5.90. The density was lower in sonthern area ranged from 1.09 to 6.87. The most abundant area was found in 3838. Of the four species of red snapper, *L. sanguinus* was accounted for about 60%, *L. sebae* 30% and *L. sp.* 10% in southern waters. *L. sanguinus* composed of 95% and *L. sebae* 5% in northern grounds. About ten specimens of *L. argentimaculatus* an estuary and coral species, was obtained from shallow waters.

Silver grunter (*Pomadasys hasta*) were found only in northern waters in this study. CPUE reached as much as 10.22 cases per trawling hour, the density was the largest one among the caught fishes. It seemed that the large catch of grunter appeared with lower catch of red snapper.

Sharp-tooth snapper (*Pristipomoides multidens*) was widely distributed with the major fishing season in July to September according to the commercial catch statistics. This species was found in regions C, D and E with a good catch in C and E. A lot of sharp-tooth snapper were hauled up in fishing area of 2747.

Lizard fish (*Saurida* spp.), the common species in Australian water, was almost found in each haul. The density was concentrated in southern waters and decreased northward, the largest catch appeared in area 2934. Two species of lizard fish were observed in the catch. *S. undosquamis* was predominant in southern grounds, composed of 71.4-92.6% in region A, 53.8-85.7% in B, 80.0-83.3% in C, 77.8% D, while in northern waters *S. tumbil* was the predominant species.

Butter fish included *Psenopsis humerosus* and *Ariomma indica*. In regions A to D, *A. indica* occupied 83.6-96.2%. In region E, *P. humerosus* composed of 48.6% and *A. indica* 51.4%. Butter fish were mostly taken from northern part of the studied area.

Trevally and Russell's snapper (*Lutjanus russelli*) were more abundant in northern than in southern fishing grounds.

Banded scad (*Atule djeddaba*) were found in area 3838 and region E. The largest catch in area 2847 was 4.44 cases per trawling hour.

Common slipmouth (*Leiognathus fasciatus*) were all caught in northern grounds. A tremendous amount of slipmouth was caught in area 2748.

Madras snapper (*Lutjanus lutjanus*) distributed both in northern and southern waters, density was low during the season of study.

Big-eyes (*Priacanthus* spp.) included *P. macracanthus* and *P. tayenus*, the latter species characterized with filamentous ray in caudal fin, both species were commonly observed in regions A and C of southern waters.

Porgies (*Lethrinus* spp.), one of the most important commercial species in Australian waters, were mostly caught in southern part of the studied area, there was a good fishing ground of porgies in area 3641. Two species of *L. lentjan* and *L. chaerorhychus* were included.

Fig. 3.7 represented the relation between catch and depth of each species. From the figure, it can be found that some epecies with wider range of vertical distribution, such as lizard fish, golden thread, mackerel scad, red snapper, sharp-tooth snapper, but porgies, batfish, black pomfret, sea bream, silver grunter were found in narrower range of depth. According to the stock density, red snapper, sharp-tooth snapper, butterfish, sweetlip were hauled up mainly in depth more than 120 m, Madras snapper, batfish, silver grunter, sea catfish, trevally, goatfish, black pomfret, banded scad, big-eyes, Russell's snapper were taken from waters 85 to 110 m deep. As for cuttle fish, squid, lizard fish, golden thread, painted sweetlip, porgies and rock-cod appeared commonly in depth less than 85 m.

7. BODY LENGTH COMPOSITION OF MAIN SPECIES

Red snapper: Body length ranged from 22 to 74 cm, majority of the individuals were 40-50 cm at deeper area (100-153 m). Range of body length was wider in shallow waters (60-100 m). Fig. 3.8 indicated the small sized fish (less than 35 cm) and larger sized fish (longer than 60 cm) were both appeared in shallow coastal area where could be the spawning ground of red snapper.

Silver grunter: The mode of the body length was at 25-30 cm in depth from 80-102 m, at 32-33 cm in depth of 106-109 m.

Sharp-tooth snapper: Majority of the body length were less than 50 cm. The fishes caught from southern waters were larger than that of northern part of the studied area.

Butterfish: Body length ranged from 15 to 21 cm with a mode at 17 or 18 cm. *A. indica* was generally larger in size compared with *P. hnmerosus*,

Trevally: The mode of body length was at 22 cm in shallow water and at 15-17 cm at deeper water.

Lizard fish: Range of body length was 15-52 cm with a mode of 34-37 cm. Fig. 3.11 shown that *S. undoaquamis* was commonly larger than *S. tumbil*.

Banded scad: Body length ranged from 18 to 27 cm, most of the individuals were 22-23 cm. The mode of the body length was at 25 cm for those obtained from waters 100-110 m deep.

Porgies: Range of body length varied with depth. The mode of body length was at 27 cm in 77-84 m deep, at 29 cm in 79-95 m deep, most of the fish were larger than 29 cm in depth 100-110 m.

Big-eyes: Frequency distribution of the body length was bimodal, the individuals of 16 cm and 26 cm in body length occupied the principal parts of the catch. Of the two species, *P. tayenus* was smaller than *P. macrocanthus*.

Sea bream: Most of the fishes were smaller than 26 cm in body length at 100-110 m depth. Body length ranged from 32 to 35 cm with the mode at 34 cm when the water depth reached 140 m.

Goatfish: Body length in shallow water was smaller than that in deeper waters. The mode of body length were at 22-24 cm and 25-26 cm respectively.

Russell's snapper: Range of body length was 22-39 cm, larger in shallow waters.

Golden thread: Body length ranged from 14 to 30 cm with mode at 22-26 cm.

Madras snapper: Most individuals of the southern waters were larger than that of the northern grounds. Their mode of body length were at 26 cm and 19 cm respectively.

8. RELATIONS BETWEEN BODY LENGTH AND WEIGHT

The relation between the body length and body weight for main commercia fishes were approximately expressed by the following equations:

1) *Lutjanus sebae* $W=1.9377\cdot10^{-5} L^{3.0153}$, $r=0.98$ (kg, cm)
2) *Lutjanus sanguinus* $W=2.6328\cdot10^{-5} L^{2.8193}$, $r=0.90$ (kg, cm)
3) *Pomadays hasta* $W=3.9043\cdot10^{-6} L^{3.2256}$, $r=0.98$ (g, mm)
4) *Pristipomoides multidens* $W=2.4334\cdot10^{-5} L^{2.8935}$, $r=0.99$ (kg, cm)
5) *Glaucosoma burgerii* $W=1.2889\cdot10^{-5} L^{2.0570}$, $r=0.99$ (kg, cm)
6) *Lethrinus lentjan* $W=6.2030\cdot10^{-7} L^{3.6119}$, $r=0.98$ (g, mm)
7) *Platax novemaculeotus* $W=2.6311\cdot10^{-6} L^{3.4239}$, $r=0.97$-(g, mm)
8) *Caranx sexfasciatus* $W=9.1736\cdot10^{-5} L^{2.5602}$, $r=0.90$ (kg, cm)

9. ESTIMATION OF STANDING STOCKS OF DEMERSAL FISHES

Estimation of standing stocks of demersal fish was follow the method of Shindo (Liu, 1978). According to the mechanical studies of the bottom trawl net by R/V Hai-Kung, the actual opening width of the mouth of the net at sea bottom during trawling was about 30 m, the mean trawling speed about 3 knots and generally for 2.3 hours for one haul, so the towed area at each trawling would be approximately 0.3834 km^2. Thetrawlable area of the northwest shelf was estimated about 260.4×10^3 km^2. Tiew (1969) indicated that the degree of avoidance of net by fish was about 50%. From these reports and the catch rate 0.99 metric tons per haul in this survey, the standing stock densities were estimated about 52 kgs/ha in each region of the studied area. The value was about the same as 56 kgs/ha in Sunda Shelf but much higher than 37 kgs/ha of China Mainland Shelf (Liu, 1973). The estimated standing stock size of the entire area was about 1345 thousand tons for the northwest Australia, potential yield was about 672 thousand tons. Each square kilometer has anannual yield pontential of the order of at least 2.5 to 3.0 tons of valuable fishes. The total catch of northwest shelf in 1976 was 44.9 thousand tons (Liu, 1978) which is about 6.7% of the potential yield. Based on the results of the present study, it may be concluded that there is still great potential for a trawl fishery in Australian waters.

IV. STUDIES ON THE SELECTIVE ACTION OF TRAWL NETS

Kuo-Chuan Fan

Mesh experiments with covered trawl net were carried out during the investigation of trawl grounds in northwestern Australia. The design of net adopted for these experiments is shown in Fig. 4.1. The materials used in cod-end was made of 400 D/4/50 P. E. cord, meshed 90±2mm. (2 legs and 1 knot in use) and in cover net was made of 380 D/3/15 P. E. cord, meshed 30±3mm. The cover net was double webbing as shown in Fig. 4.2.

Nine hauls were operated for the cover net used in above experiments (Table 4.1). The names of fishes treated in this report are tabulated in Table 4.2 with species number, Chinese name, English name and species name respectively. The species composition of catch is given in Table 4.3. The following are the conclusions derived from these experiments.

1. The distribution of body length of each fish are illustrated in Fig. 4.3 to Fig. 4.19.
2. The specific selection curve are illustrated in Fig. 4.20 to Fig. 4.28.
3. The selection range represented by the smallest size of fish caught in the cod-end and the largest size in the cover net are given in Table 4.4. From this table, it may be assumed that the selection range is rather large for slender fishes or pliable fishes as hair tails and lizard fish.
4. The selection sharpness and selection factor are shown in Table 4.4. Also the order of selection sharpness are almost the same with the order of selection range except gurnards.
5. There is meaningless to compare the selection factor between different species.

前　　言

澳洲西北部海域有關拖網漁場的調查，最早是在1935年，由日本新京丸（472噸）開始，戰後又陸續於1958年，1963年及1966年分別從事海洋觀測與漁業試驗[1-3]。雖然先後調查結果認爲澳洲海域爲一良好之底拖漁場，但並未促成其本國漁船前往開發此一漁場。直至1970年到1973年間，本所試驗船海慶號(138噸)再度於澳洲北部及西北部漁場分別進行了八個航次的調查[4-8]，發現澳洲海域資源豐富，魚種甚佳，極具開發價值・引導民間漁船前往作業以後，該海域遂成爲我國遠洋拖網漁業最主要之作業漁場，漁船數及漁獲量不斷增加。根據臺灣省底漁業漁獲統計年報資料[9]顯示，1974年本省雙拖漁船在澳洲海域作業的總漁獲量，估計約爲83,007.20噸，佔全省雙拖漁業漁獲量的64.2%。1975年及1976年來自澳洲海域的漁獲量各爲49,231.41與51,253.24噸，分別佔總漁獲量的37.2%及46.1%，此三年間平均漁獲量每網在28.94至31.90箱之間。較本省附近海域拖網漁場之漁獲密度爲高，爲近年來拖網漁業最佳之漁場。

澳洲海域底魚資源在本省雙拖漁船積極開發之下，總漁獲量似有減少傾向，且澳洲政府也考慮即將宣佈二百浬經濟水域，對我遠洋拖網漁業影響頗鉅。目前政府刻正與澳洲有關當局進行談判簽訂漁業合作，期能維持我遠洋拖網漁業之繼續發展。本所爲瞭解澳洲漁場資源現況，特選擇西北海區從事較深海域的底魚資源調查與評估，藉以提供有關當局之決策與漁民作業之參考。

海功號試驗船於完成本航次之初步調查，並駛抵達爾文港(Port Darwin)，承當地漁業局(Fisheries Division, Department of Industrial Development)局長史密斯先生 (Director Slack Smith) 及其同仁 Dr. Rex Pyne, Mr. Darryl Grey, Mr. Arnold Baker, Mr. Colin D. Mellon, and Mr. Tony 熱心招待，幫助辦理補給業務，並招待海功試驗船同仁在達爾文市附近參觀野生動物，泊達爾文港期間該漁業局研究人員經常在海功號試驗船共同研究，給予適當的協助，謹向史密斯局長及其同仁深致謝意。

經由李景星博士及夫人(Dr. Ching Sing Li & Mrs. Anna Li)介紹，拜會了達爾文僑領曾崇昭先生 (Mr. Charles T. See-kee)，曾先生幫助我們安排了兩次機會，於68.4.7與68.4.8在海功試驗船分別與當地政府官員及華僑朋友們相聚，藉機交誼。議員陳兆華先生(Alderman Ernest S. W. Chin)，僑友賴欽章伉儷(Mr. & Mrs. Khim Tchong Lay)及各位達爾文市中華會之會員，中華俱樂部會員，帝汶中華會會員等，經常於工作繁忙之餘抽出時間爲海功號同仁解決很多因爲人地生疏而發生之困難，給予溫暖與友誼，並分別提供各種協助，均敬致謝意。

調查研究項目及方法

1.一般氣象觀測

在航行及試驗作業期間，每六小時觀測並記錄氣溫、氣壓、風向、風力、雲形、雲量等氣象因素之變化。

2.海底地形及底質調查

實施拖網試驗作業前，選擇若干漁區以精密測深儀連續記錄漁場地形之變化。配合拖網作業以特製採泥器繫於沉網採取底質，分析其組成。

3.海洋觀測

使用南森瓶及顚倒溫度計採取 0m,10m,20m,30m,50m,75m,100m 及底層等不同深度的海水，分別測定其水溫、鹽度、溶解氧、酸鹼度，另在觀測站之間投放 B. T.。

4.網目選擇性試驗

採用內套網目爲90mm，外套採用30mm之網袋進行作業試驗，測定內外套網之漁獲量、魚種組成，探討魚種別網目的選擇效果。

5.漁獲試驗調查

記錄每一網次之投網時間、揚網時間、曳網時間、曳網方向、投網位置、投網揚網水源、晝夜別

、拖網距離、曳網長度、漁獲狀況、魚種別漁獲量，以箱數爲單位，平均每約箱爲 30kg 。

6.漁獲生物調查

測定每一網次主要魚種之體長、體重、鱗片採集、性別、成熟度及胃狀態之觀察，各魚種採取標本照相。

使用稚魚網表層水平拖網15分鐘，及北太平洋標準網垂直採集浮游生物，分析生物量之分布與仔稚魚出現的情形。

調 查 航 海 概 要

1.調查船

使用本所 711 噸艉式拖網試驗船海功號實施調查。

2.調查員及船員

計畫主持人：所長兼漁業系主任李燦然博士，調查計畫之擬定與推動。

計畫執行人：水產資源系技正陳世欽，研究員兼領隊、負責調查之執行、報告之撰寫與綜合整理。
水產資源系技士陳春暉，負責魚類之鑑定、標本採集照相，漁獲紀錄，生物測定。
海洋漁業系股長戚桐欣，負責海洋氣象觀測及漁場底質調查，撰寫報告。
海洋漁業系技士范國銓，負責網目選擇效果試驗及報告之撰寫。
海洋漁業系技士劉燈城、蔡日耀，負責海洋觀測及水質分析、報告撰寫。
船長黃國及船員等24員，負責漁撈作業，漁獲處理、協助海洋觀測。

3.航海日程及調查海域

本航次 HK-79-1 澳洲西北部拖網漁場調查，於1979年 2 月15日自基隆港啓航，經菲律賓東部、西里伯斯海、 Makassar 海峽、龍目海峽進入印度洋，3 月 4 日到達漁場並開始觀測調查與試驗作業，3 月27日結束第一調查，於 3 月31日進達爾文港補給，並與當地漁業局研究員討論有關調查事宜及交換資料。4 月 9 日出達爾文港前往漁場繼續試驗作業，至 5 月 5 日結束作業離開澳洲漁場返航，於 5 月18日返抵基隆港，全部航程共93天，其間因船員急病曾一度緊急進印尼泗水，二次緊急進達爾文港就醫，3 月中遇熱帶氣旋，實際在漁場調查作業的日數爲45天，航程如Table 1.，航跡如Fig. 1.所示，調查範圍爲澳洲西北部，在南緯12°～21°，東經115°～125°之間的海域。

Table 1. Itinerary of the cruise HK-79-1 of R/V Hai-Kung to the northwestern sea of Australia.

Departure from Keelung	Feb. 15, 1979
Emergent entry Surabaya	Feb. 26, 1979
Departure from Surabaya	Feb. 28, 1979
Arrival investigation area	Mar. 3, 1979
Hydrographical observation & trawling	Mar. 4. 1979
Departure from survey area	Mar. 25, 1979
Arrival at port Darwin	Mar. 31, 1979
Departure from port Darwin	Apr. 9, 1979
Emergent entry Darwin	Apr. 12, 1979
Departure from Darwin	Apr. 14, 1979
Emergent entry Darwin again	Apr. 25, 1979
Departure from Darwin	Apr. 27, 1979
Experimental trawling	Apr. 30, 1979
Departure from survey area	May. 5, 1979
Arrival at Keelung	May. 18, 1979

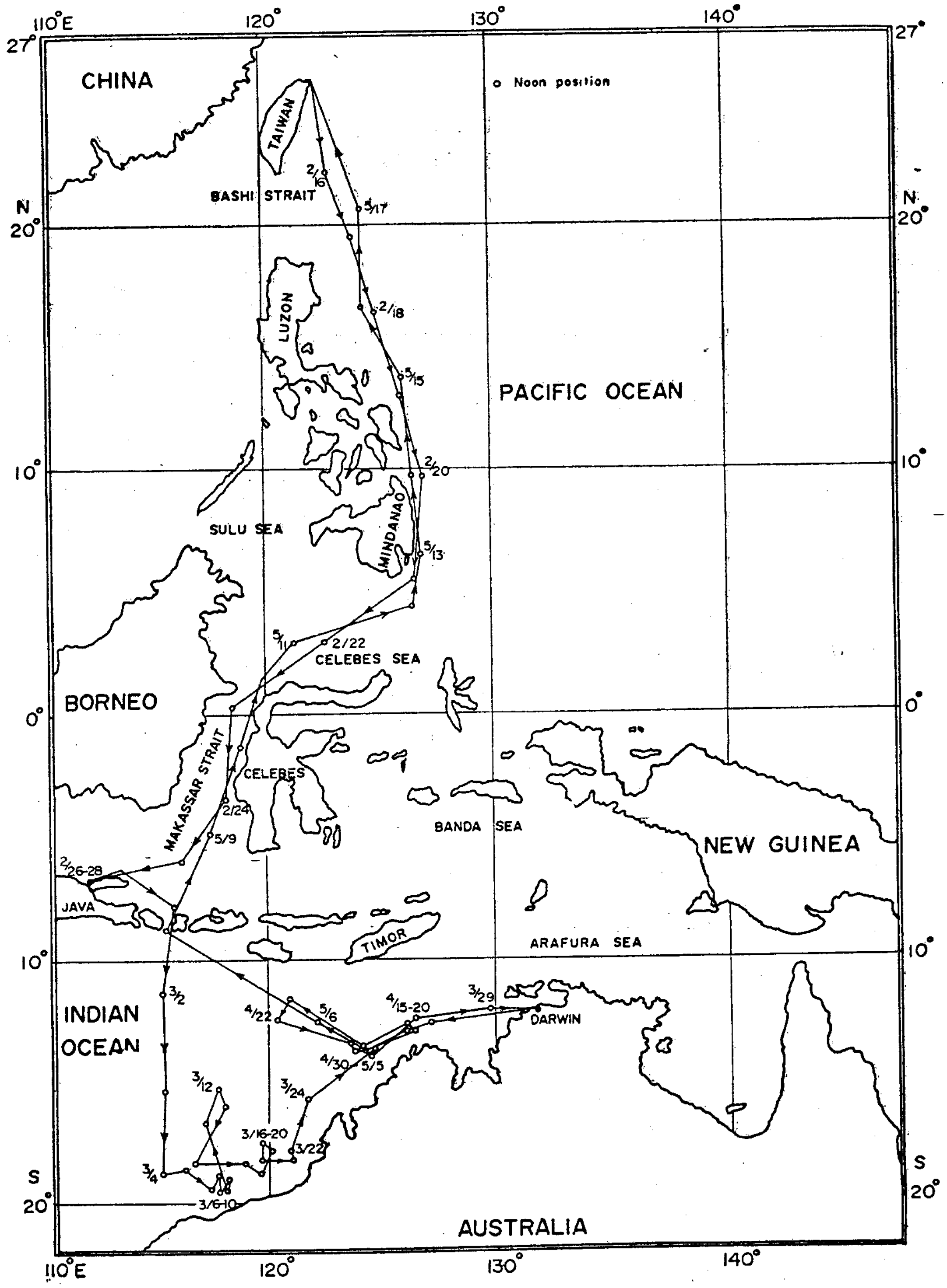


Fig. 1. Route of the cruise HK-79-1 of R/V Hai-Kung to the northwest shelf of Australia during February 15 to May 18, 1979.

調 查 結 果

I 澳洲西北部漁場氣象及底質調查

戚 桐 欣

一 氣 象：

本次航海於68.2.15出基隆港，68.5.18進基隆港，前後共計93天；在北半球爲春夏之際，在南半球則爲秋冬之交，出港航程共16天，返港航程共11天，實際在澳洲西北部漁場（10°S～20°S之間）之時間爲從68.3.3起，至68.5.7止，共計66天；當時太陽赤緯（Declination）由7-08.0°S向北移動，至16-51.0°S止，歷經京直、春分、淸明、谷雨、立夏等五個節氣，其間自 68.3.25起，至68.4.14止，以在達爾文港補給或航行於漁場各處爲主，所以本報告不另外分析這一段時間之風力資料，而將本航海之氣象資料配合作業位置與時間等因素共分爲兩組，第一組位於15°S～20°S與115°E～125°E之間，於68.3.3起，至68.3.24止，共計22天；第二組位於10°S～15°S與120°E～130°E之間，於68.4.15起，至68.5.7止，其中除 68.4.27 因爲泊達爾文港而資料不計外，也是共計22天，以上兩組之風力資料經統計分析結果，如 Fig. 1.1，所取用之資料均以每天中午爲準，所使用之儀器亦合於氣象觀測之規定。

澳洲海域每年共經歷兩次天氣轉換季節，每一次大約需要經過數星期之久，第一次是十月到十二月間由東南貿易風轉換爲西北季節風，其時風向不穩，風力微弱，但並非靜止無風（Rossell, 1972），本次航海恰爲後者之情況，由 Fig. 1.1觀察，風向確實不穩，並且風力微弱。風力1～3級之機會在第一組資料中爲10次，佔45.5%；第二組亦爲10次，佔45.5%。風力 4 級之機會在第一組資料中爲 8 次，佔36.4%；第二組爲 4 次，佔18.2%。風力 5 級之機會在第一組資料中爲 2 次，佔 9.1 %；第二組無。風力8～10級之機會在第一組資料無，在第二組爲 8 次，佔36.4%。

以上第一組資料於68.3.3起，至 68.3.24 止，共計廿二天之間未曾發生靜止無風的狀況，與當地季節轉換期間之特徵相符，而第二組資料於68.4.15起，至 68.5.7 止，共有 8 次靜止無風之機會；而 68.5.1起，至68.5.5止，共連續五天，在漁場範圍內風平浪靜，這是因爲當地緯度甚低，受高緯度氣象因素變化之程度較輕。

此外，在第一組資料之中，經歷風力8～10級之機會共 2 次，係於68.3.10與68.3.11兩天在19-20.0°S,118-10.0°E與16-40.0°S,116-09.0°E附近遭遇熱帶氣旋(Tropical cyclone Hazel)之關係；根據澳國氣象局之報告，其中心最低氣壓爲960mbs，最大風力達65m/sec，爲該海域歷年所罕見，在附近作業之高雄籍拖網漁船和春十二號因此次熱帶氣旋失踪。當時南半球正值秋冬之交，爲熱帶氣旋最强烈的時期，其結構與北半球之颱風相似，而風向及路徑恰好相反，因附近氣象觀測站稀少，所以預報效果比不上北半球準確，在該海域作業之漁船應特別注意防備；除此以外，在本季節內均爲好天氣。

調查期間，本海域氣溫爲28°C～32°C，晝夜相差僅約 1°C ，因爲海風和煦，所以在感受上不會覺得特別酷熱，在熱帶氣旋侵襲之前，氣溫曾高達 34°C ，濕度達90%以上，當時風力微弱，悶熱難受，是暴風雨之前的特殊情況，降水現象則僅限於熱帶氣旋範圍以內。

綜合而言，在這一段季節內，本漁場之氣象狀況若非遭受熱帶氣旋，則爲最理想的作業天氣；一旦遭遇到熱帶氣旋侵襲，則變爲最惡劣的天氣，兼具兩種極端，爲當地典型的季節轉換氣候。

二 底 質：

水深資料藉魚羣探測儀直接觀測，底質資料藉丸川式採泥器於海洋觀測時採樣，或者另以圓筒型採泥器於曳網時繫於沉綱之前採取，然後構圖分析，如 Fig. 1.2。沿大陸棚邊緣，水深 60m～120m 之間，大致爲適於拖網作業之軟底，包含S.，S.Sh.，f.S. 等，呈帶狀分佈，由西南向東北延伸，與海岸平行，均以碎貝殼爲構成主體，其主要差異僅爲顆粒之粗細而已；在此帶狀分佈之外，則散佈不適於拖網作業之硬底，包含 r. St. 等；海棉等底棲動物並不十分密集，就底質情形而言，尙屬良好之底拖網漁場。

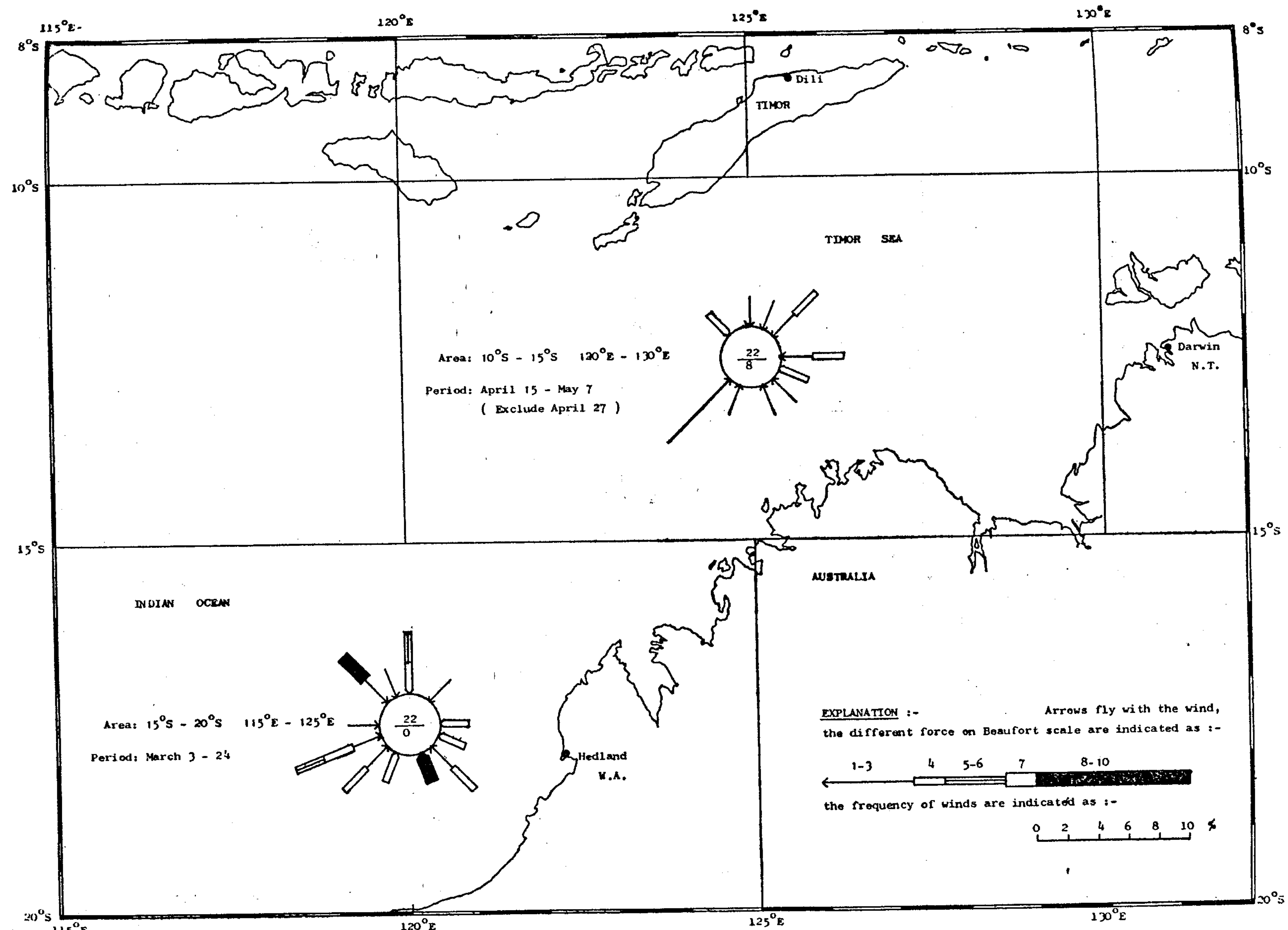


Fig. 1.1 Wind condition of the survey period, the days of observation is shown on the upper part and calms on the lower part of each diagram.

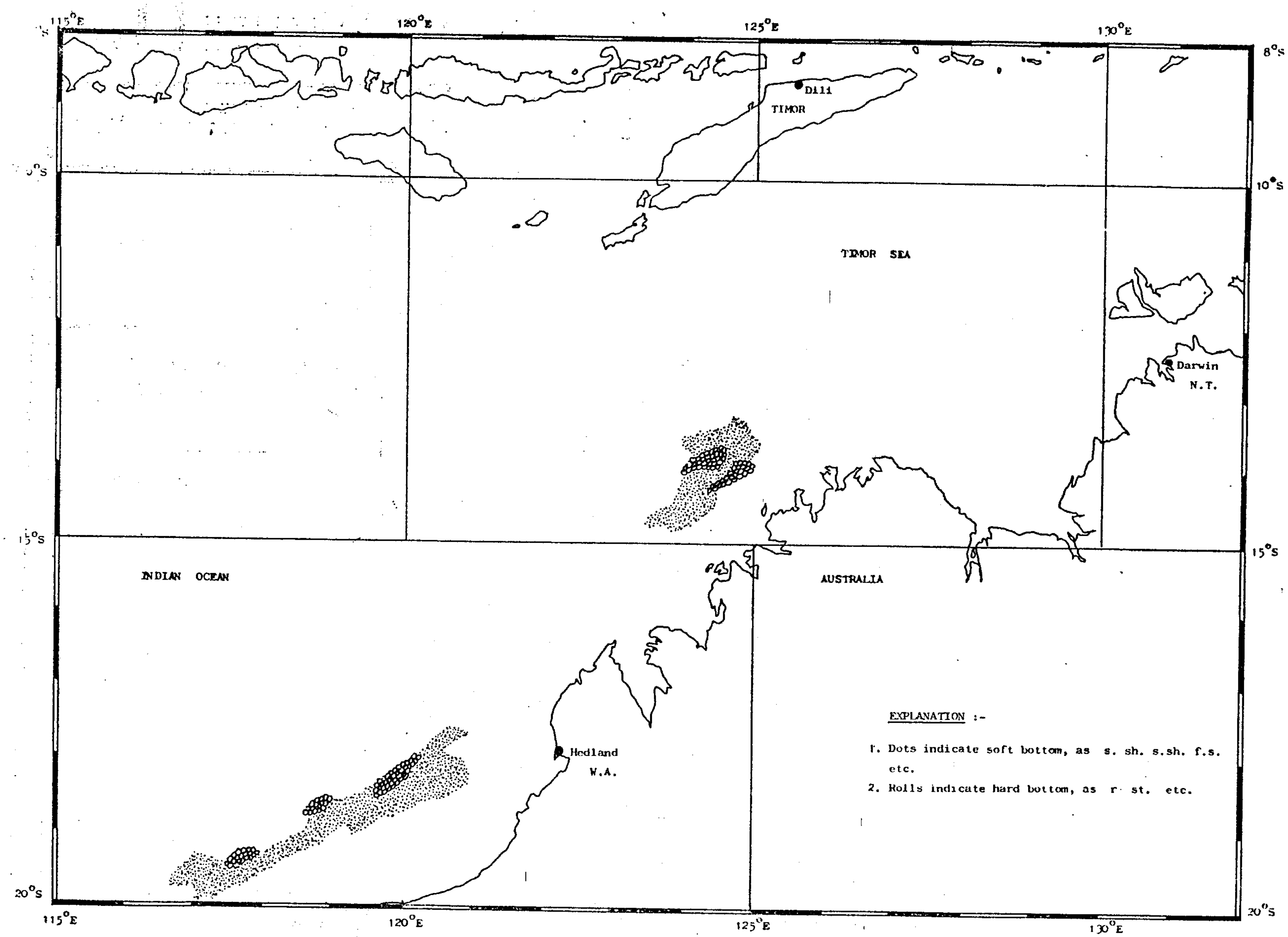


Fig. 1.2 Bottom condition on part of the continental shelf near northwest Australia.

Ⅱ 澳洲西北陸棚海洋調查

劉燈城 • 蔡日耀

此航次海洋觀測點共48站，其中 STD 19 站，BT 29 站，調查範圍12～21°S，115～125°E，觀測站如附，Fig 2.1. 玆將各水層及縱斷面水溫、pH 值、含氧量、鹽度分別敍述如下：

一、水　溫：表層最高達 30.5°C ，最低至 26.5°C ，多數介於 28.0°C～29.6°C 間，其平均水溫為 29.1°C；各水層等溫線大致與海岸線平行（Fig. 2.2～2.4），表層水溫分佈以29.5°C為對稱軸，南北對稱，在 Legendre 島北方（19°20′S～21°20′S，116°E～117°E）水域，表層水溫較四周水域水溫低 0.5°C～1.0°C；在 Cape Thouin 北方水域（18°10′S～19°20′S，118°20′E～119°10′E）表層水溫為26.5°C，較周圍水域顯著低 2～3°C。溫度垂直分佈隨水深增加而遞減（Fig 2.5～2.7）；水溫躍層起於 30～60 公尺，止於 300 公尺；水深 100 公尺時水溫平均降至 23.0°C 左右，最低至 22.8°C ；水深200公尺時水溫平均降至 17°C，最低至 15.0°C 以下；整個調查水域屬高溫水域，水深 0～30 公尺水層有一顯著冷水塊出現於Legendre島北方。

二、鹽　度：表層最高達 35.36‰，最低至 34.22‰ ，多數介於 34.60‰～35.00‰間，平均為 34.90‰；經過 Legendre 島北方一線以東，等鹽度線大致與緯度平行，且有向外遞減傾向；然在 Legendre 島一線以西海域，等鹽度線大致與沿岸成70度交角，且由 Legendre 島向西漸減；水深 10～75 公尺各水層鹽度由近沿岸水域向外遞減；在 Legendre 島北方（19°20′S～21°20′S，116°E～118°E）水域鹽度高達 35.20～35.40‰，0～30公尺水層尤為顯著（Fig. 2.8～2.10）。各觀測線鹽度垂直分佈如 Fig. 2.11～2.12。

三、PH 值：表層最高為 8.25，最低至 8.13 ，多數介於 8.20～8.21 ，其平均值為 8.21；就同一水層而言，水深 0～30 公尺水層，在 Port Walcott 北方以西水域及 Port Hedland 北方以東水域，pH 等值線約與沿岸成60°～80° 交角（Fig. 2.13～2.14），且在 Port Walcott 北方以西水域有向西遞減傾向；而在 Port Hedland 北方以東水域向東有漸增傾向；就表層水層而言，Port Walcott 北方水域 pH 值為 8.25，向西遞減至 Borrow Island 北方水域是 pH 值減為 8.14；Port Hedland 北方水域 pH 值為 8.18 ，向東遞增至東經 121° 附近水域 pH 值為 8.24，水深 75 公尺～100 公尺水層 pH 等值線幾與海岸線平行，而且離岸愈遠 pH 值愈高（Fig. 2.15）；水深 30～75 公尺間水層，調查水域內 Port Walcott 北方以西水域，pH 有緩慢向西遞減之勢。各觀測線 pH 垂直分佈如，Fig. 2.16～2.17 水深 0～50 公尺間 pH 值大致一致，pH 約為8.20～8.23 間；50 公尺以下水深 pH 值緩減，水深 100 公尺以深 pH 值劇減，由 100 公尺之 8.14 降至 200 公尺之 7.90。

四、含氧量：表層最高達 5.90 PPM，最低至 2.40 PPM，除 Legendre 島北方水域含氧量偏低外（介於 2.40 PPM～3.90）其餘大部份介於 4.50 PPM～5.50 PPM，平均值 4.78 ；各水層含氧量由近沿岸水域往外海緩慢增加（Fig. 2.18～2.20）。各觀測線垂直分佈如 Fig. 2.21～2.22 ，大致隨水深增加而遞減，然在13及20觀測站測得其含氧量較周圍水域為低，且隨水深之增加而漸增。

本航次調查結果發現 Legendre 島北方水域較周圍水溫低 0.5～1.0°C；鹽度較周圍水域顯著地高，表層為 35.00‰～35.40‰，底層 34.60‰～34.80‰，水深0～30 公尺水層更顯著地形成高鹽度水域；含氧量也較周圍水域為低，且表層含氧量也較表層以下水層含氧量為低，此水域可能有湧昇流存在。另在 Cape Thouin 北方（18°10′S～19°10′S）亦有一高鹽低溫水域存在。

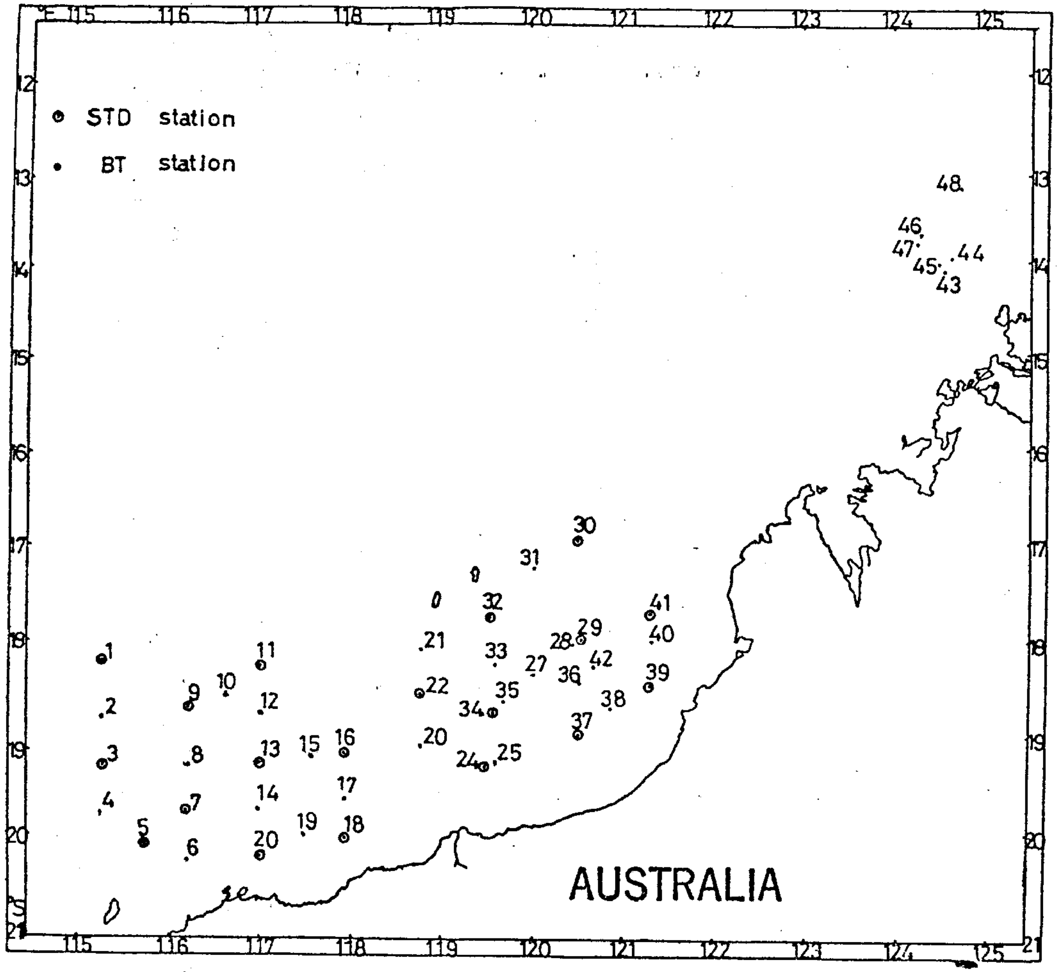


Fig. 2.1 Map showing the position of STD and BT stations.

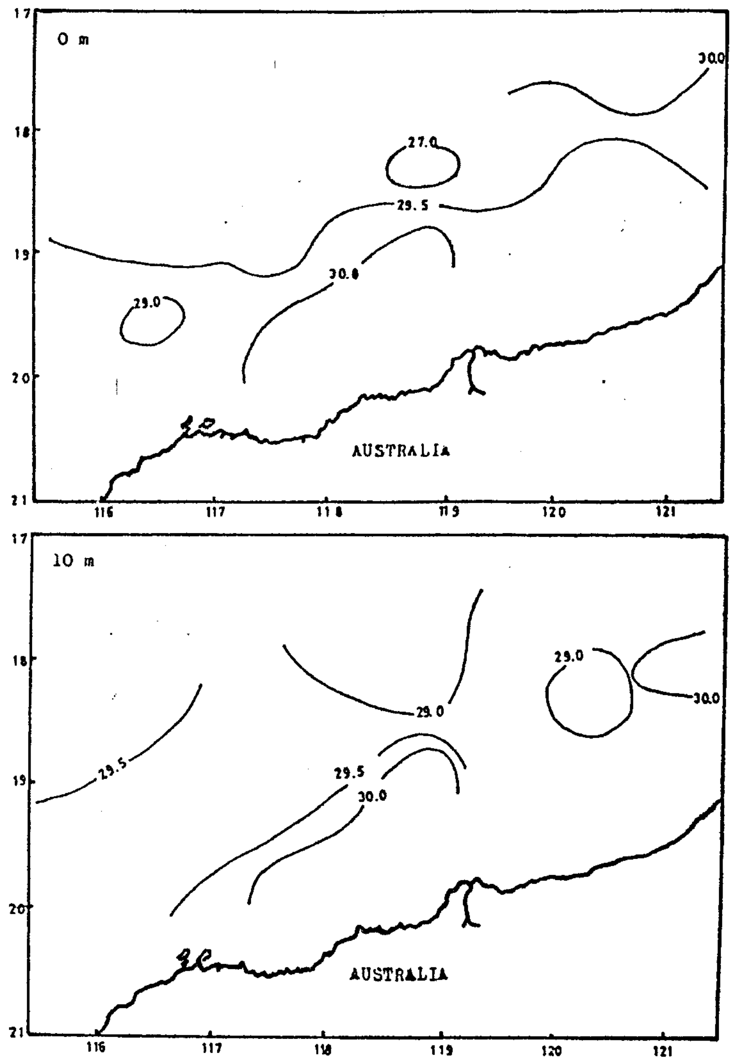


Fig. 2.2 Horizontal distribution of water temperature (°C) at 0m & 10m

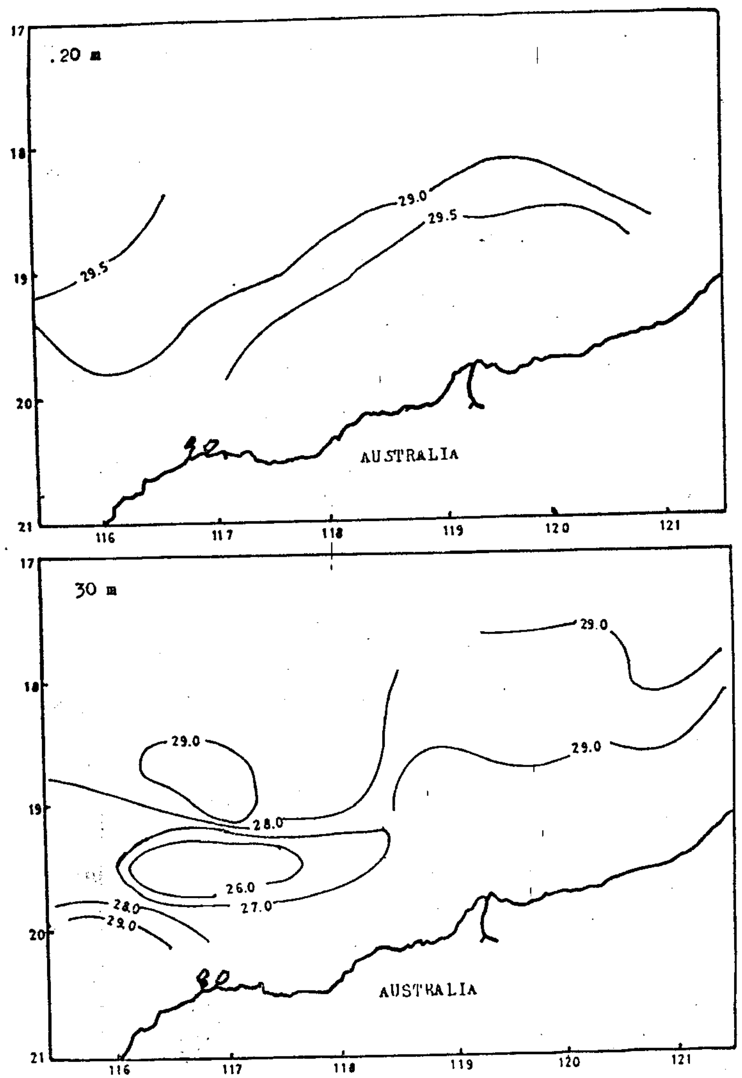


Fig. 2.3 Horizontal distribution of water temperature (°C) at 20m & 30m

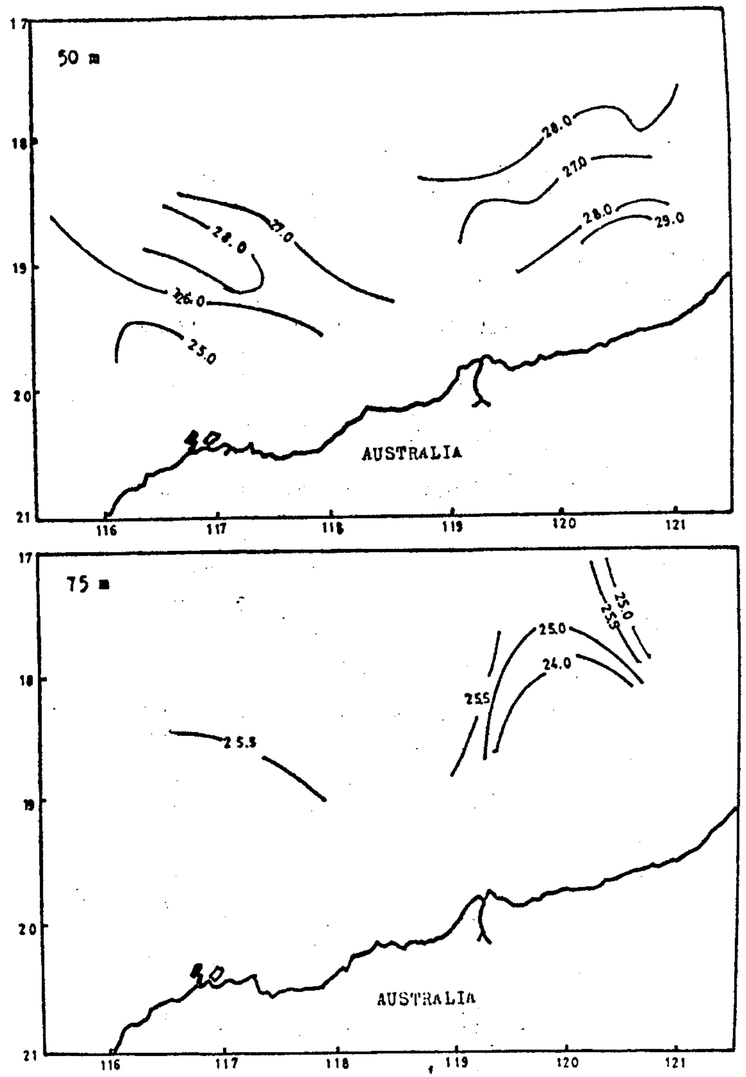


Fig. 2.4 Horizontal distribution of water temperature (°C) at 50m & 75m

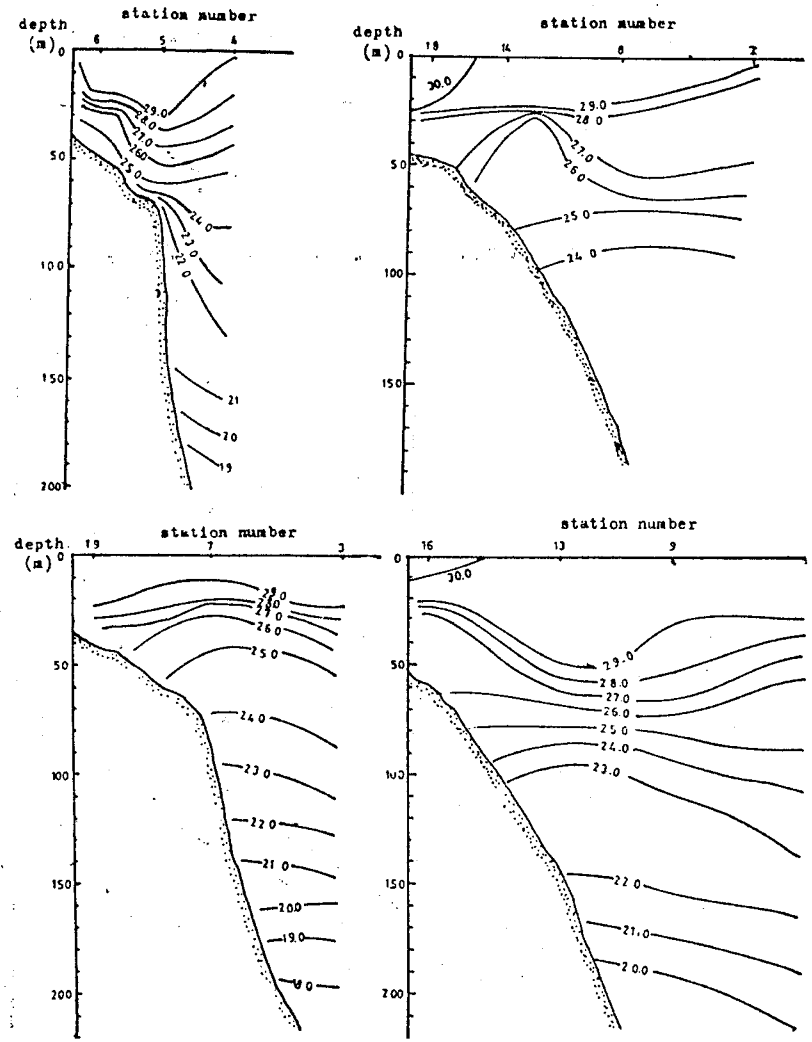


Fig. 2.5 Vertical distribution of water temperature (°C)

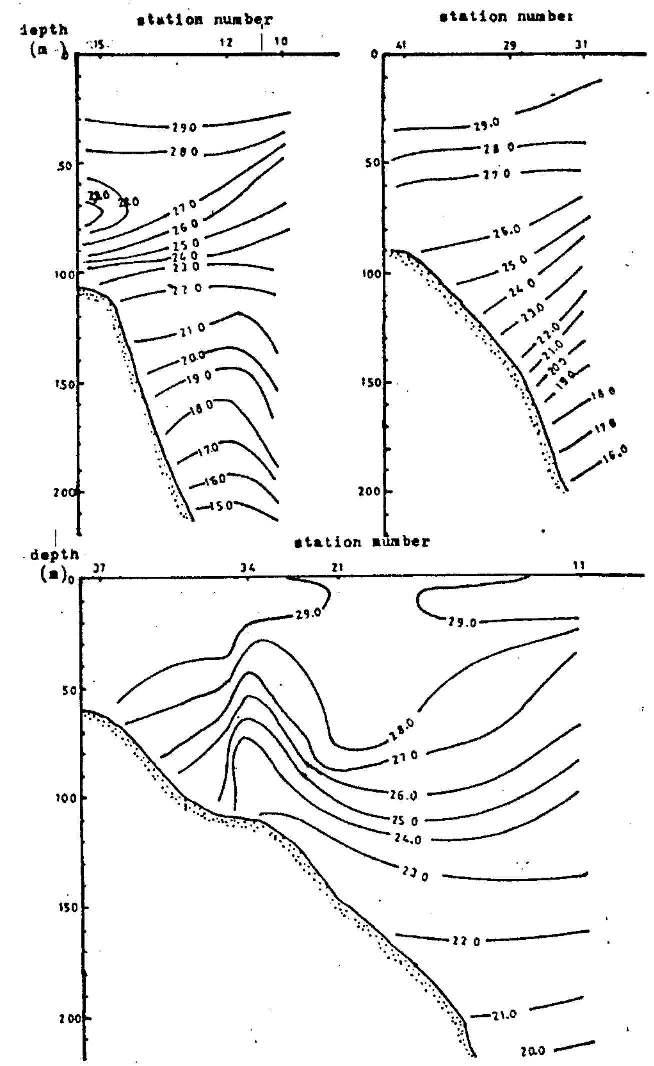


Fig. 2.6 Vertical distribution of water temperature (°C)

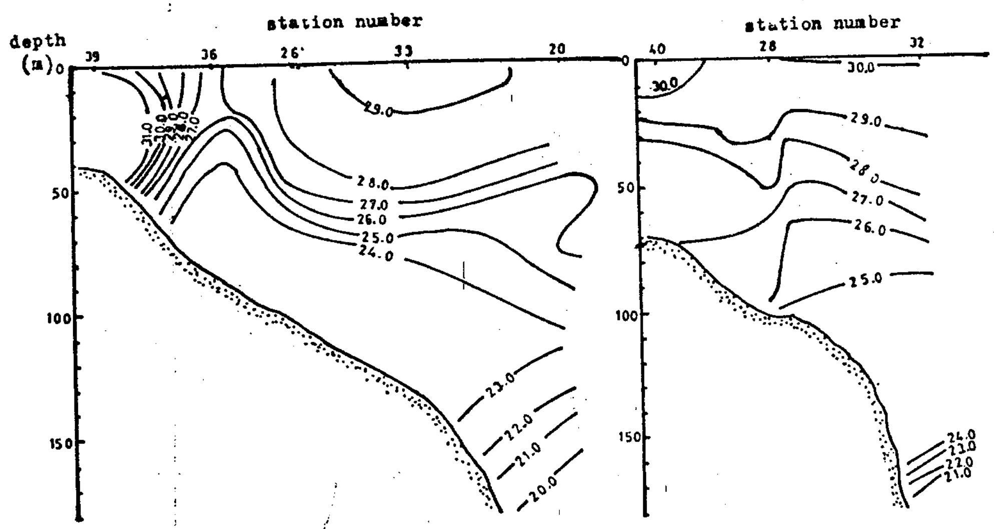


Fig. 2.7 Vertical distribution of water temperature (°C)

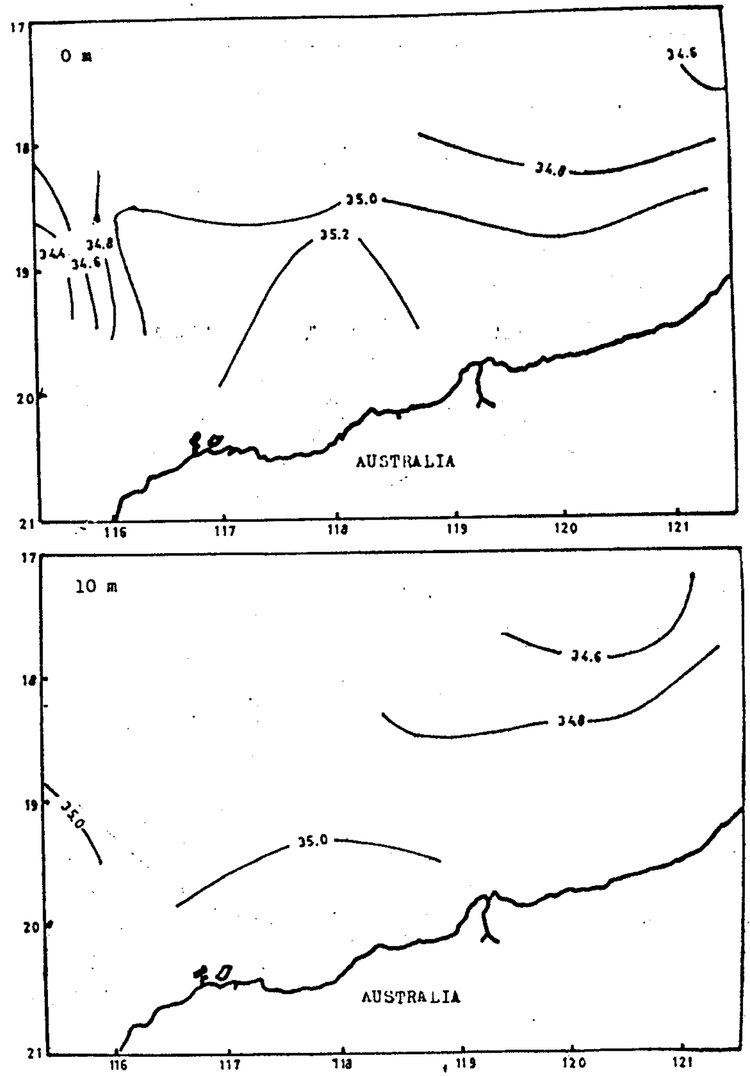


Fig. 2.8 Horizontal distribution of salinity (‰) at 0m & 10m

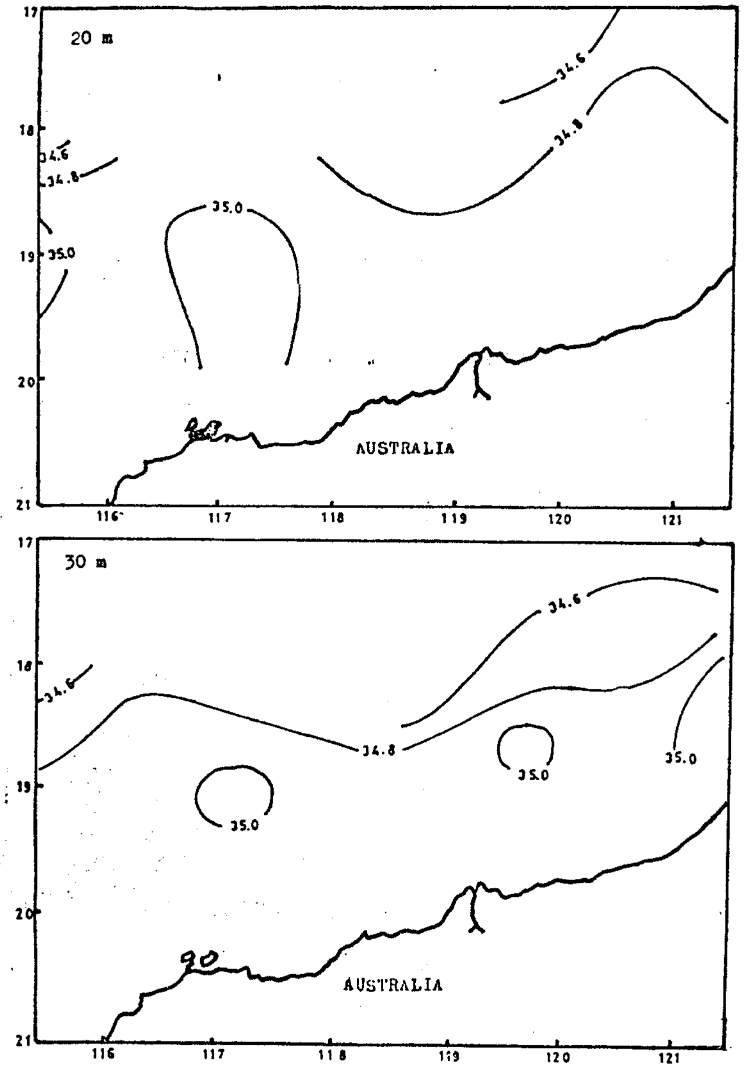


Fig. 2.9 Horizontal distribution of salinity(‰) at 20m & 30m

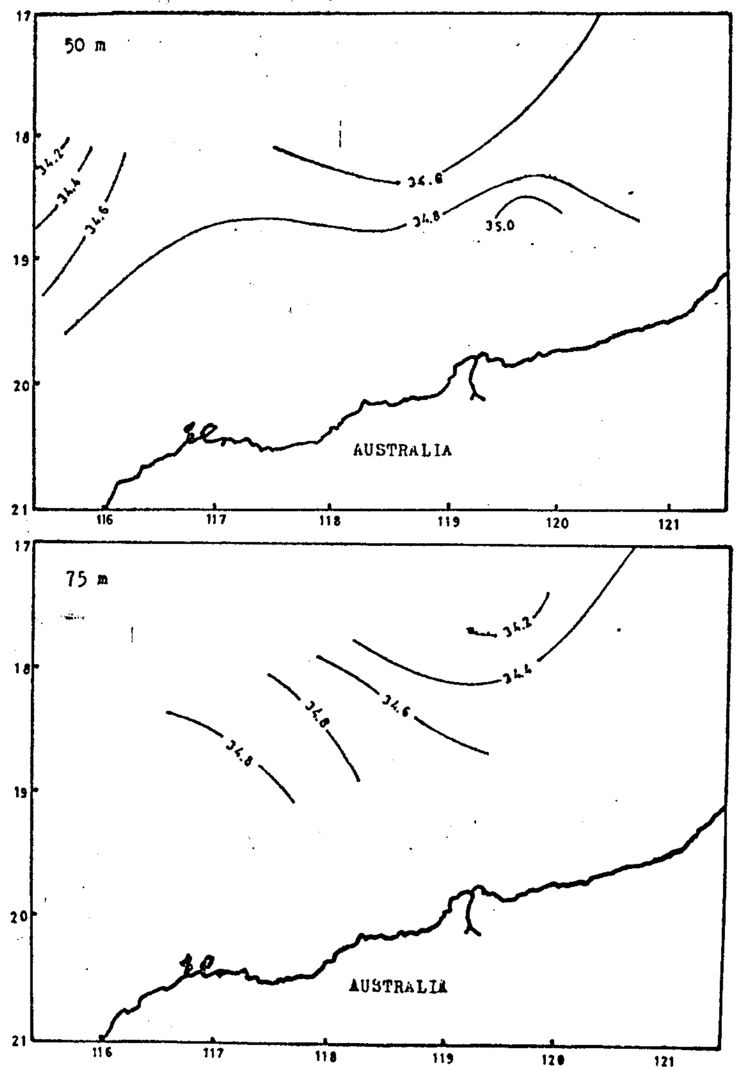


Fig. 2.10 Horizontal distribution of salinity (‰) at 50m & 75m

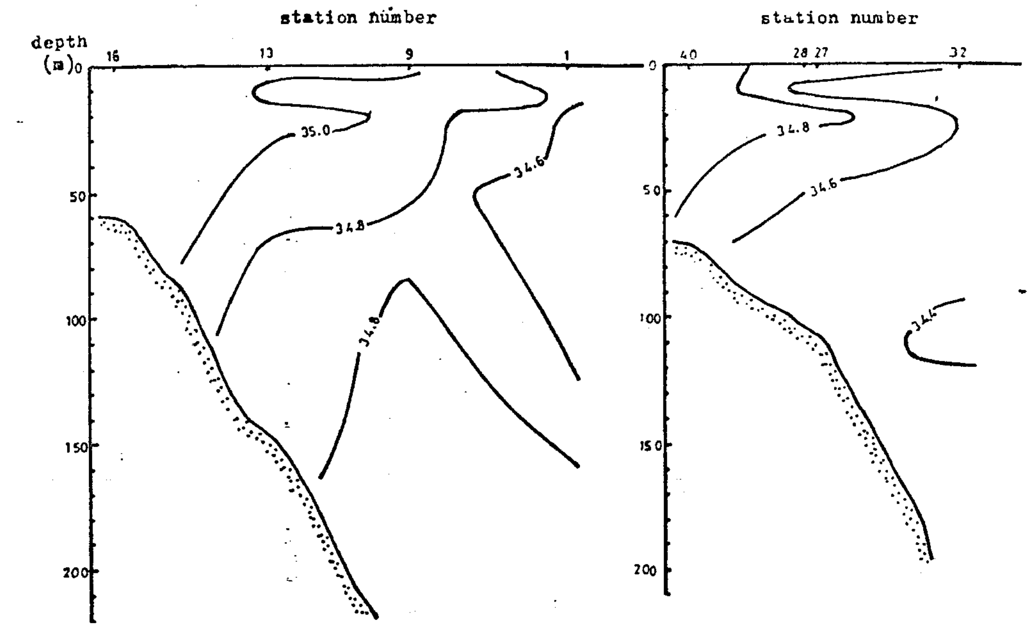


Fig. 2.11 Vertical distribution of salinity (‰)

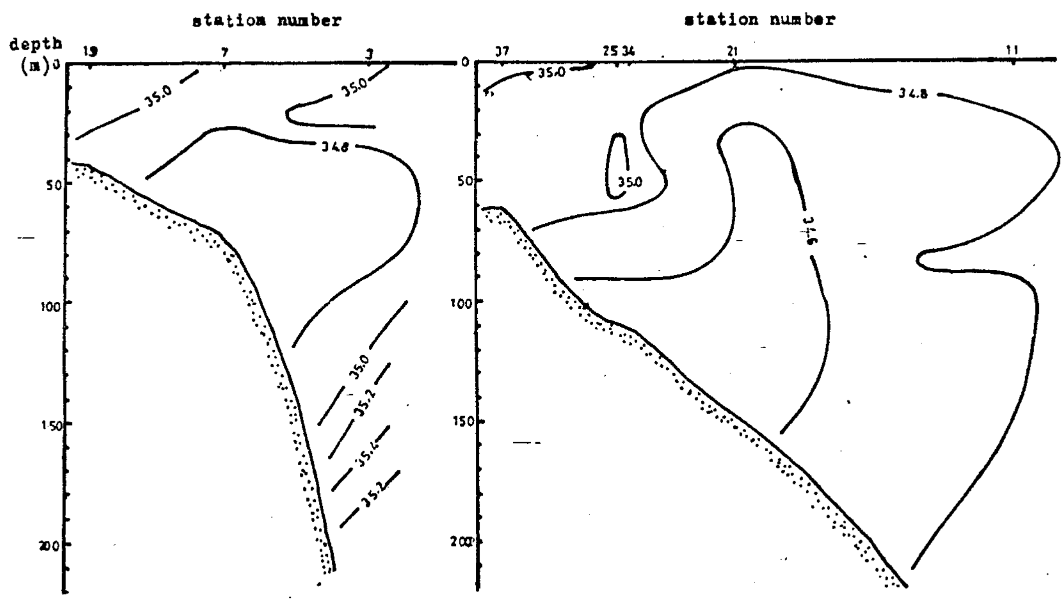


Fig. 2.12 Vertical distribution of salinity (‰)

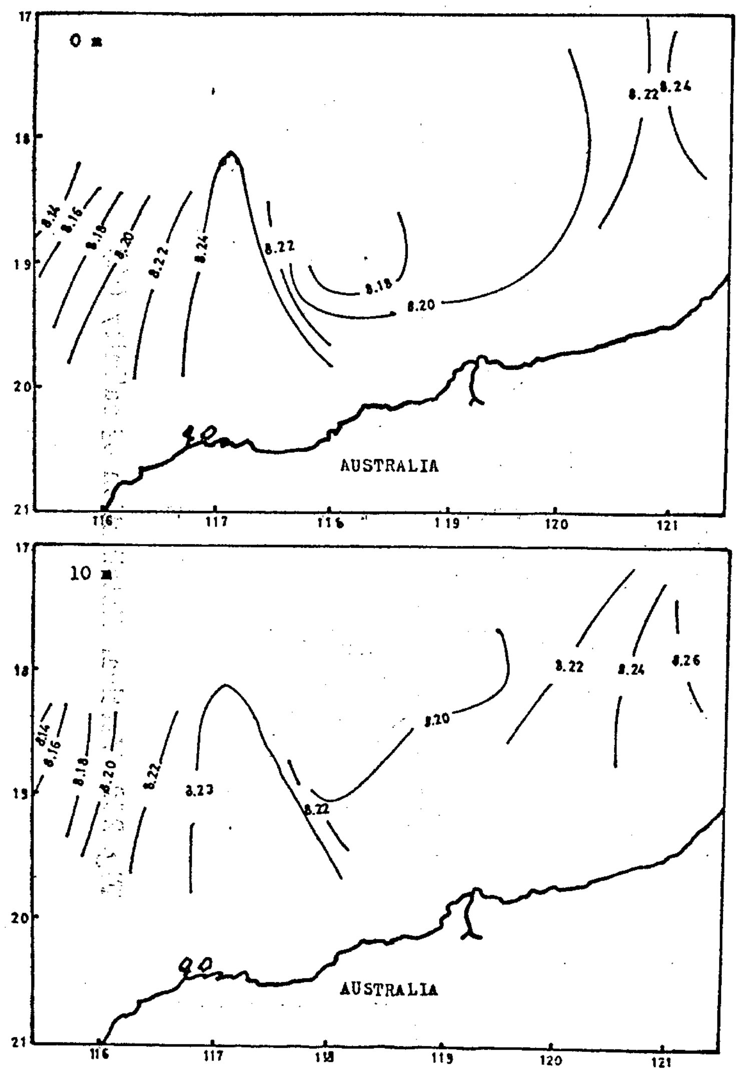


Fig. 2.13 Horizontal distribution of pH at 0m & 10m

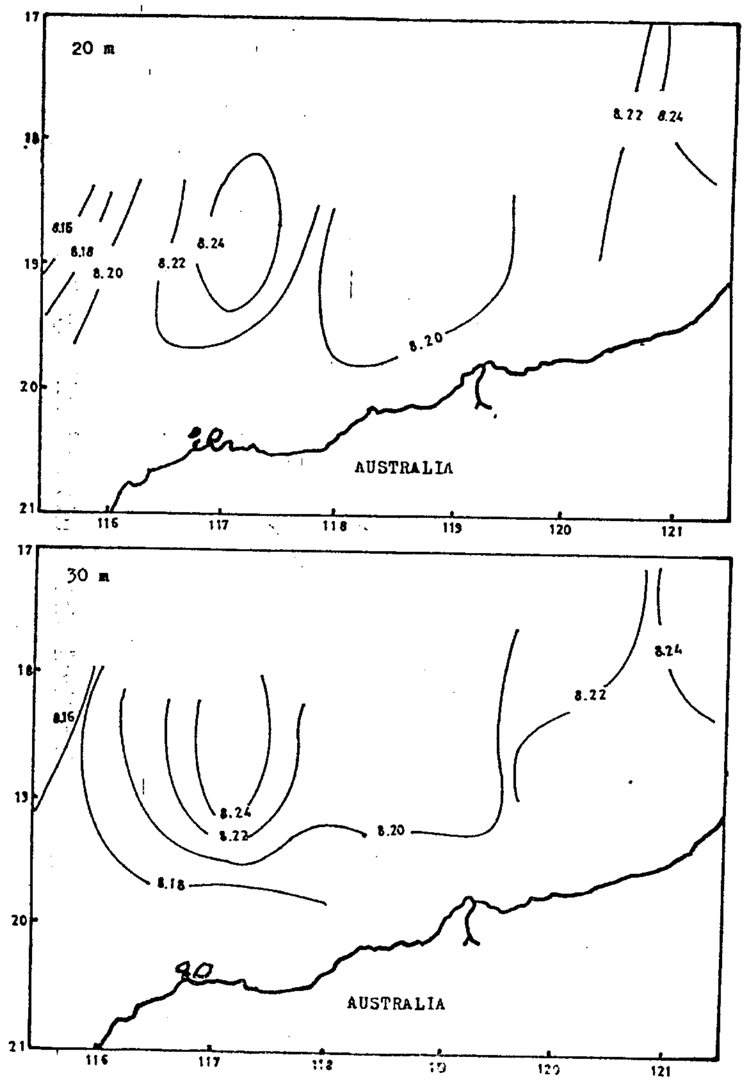
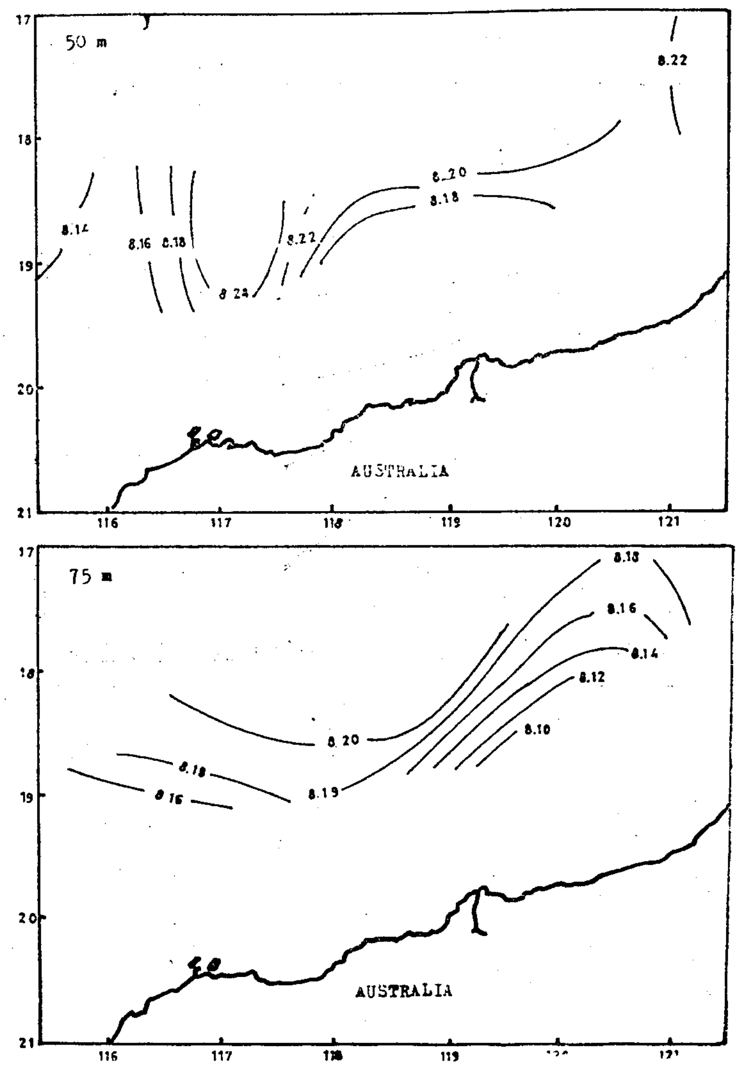


Fig. 2.14 Horizontal distribution of pH at 20m & 30m



Fig, 2.15 Horizontal distribution of pH at 50m & 75m

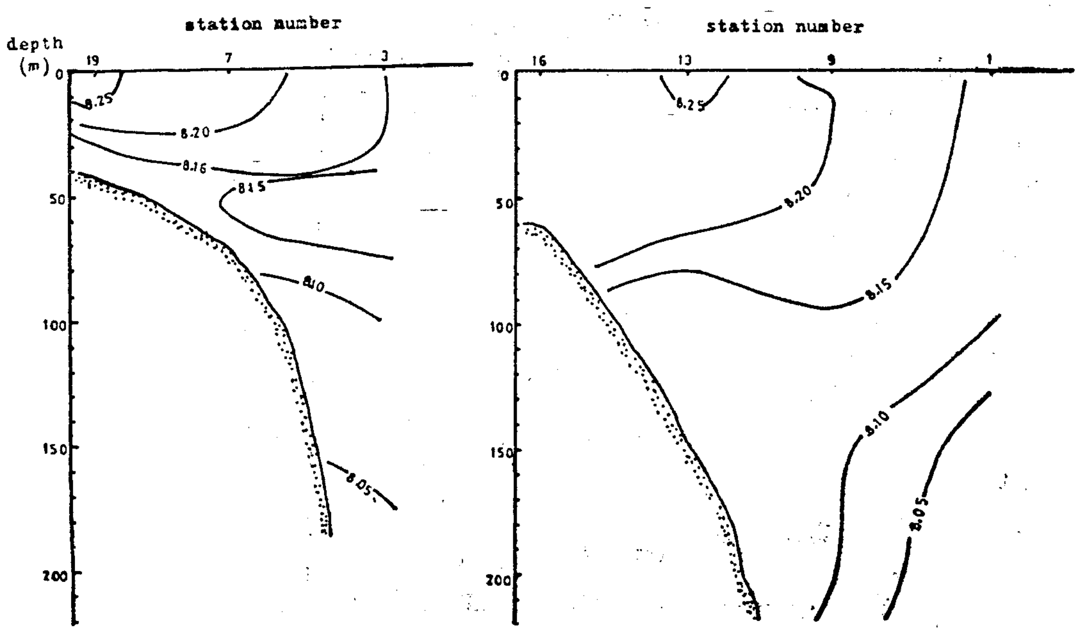


Fig. 2.16 Vertical distribution of pH value

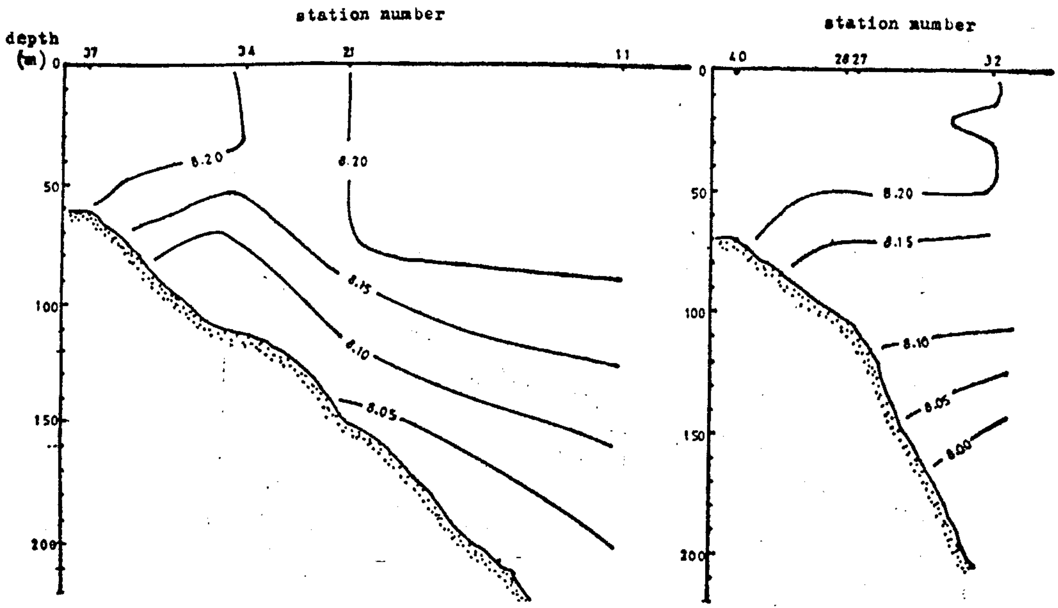


Fig. 2.17 Vertical distribution of pH value

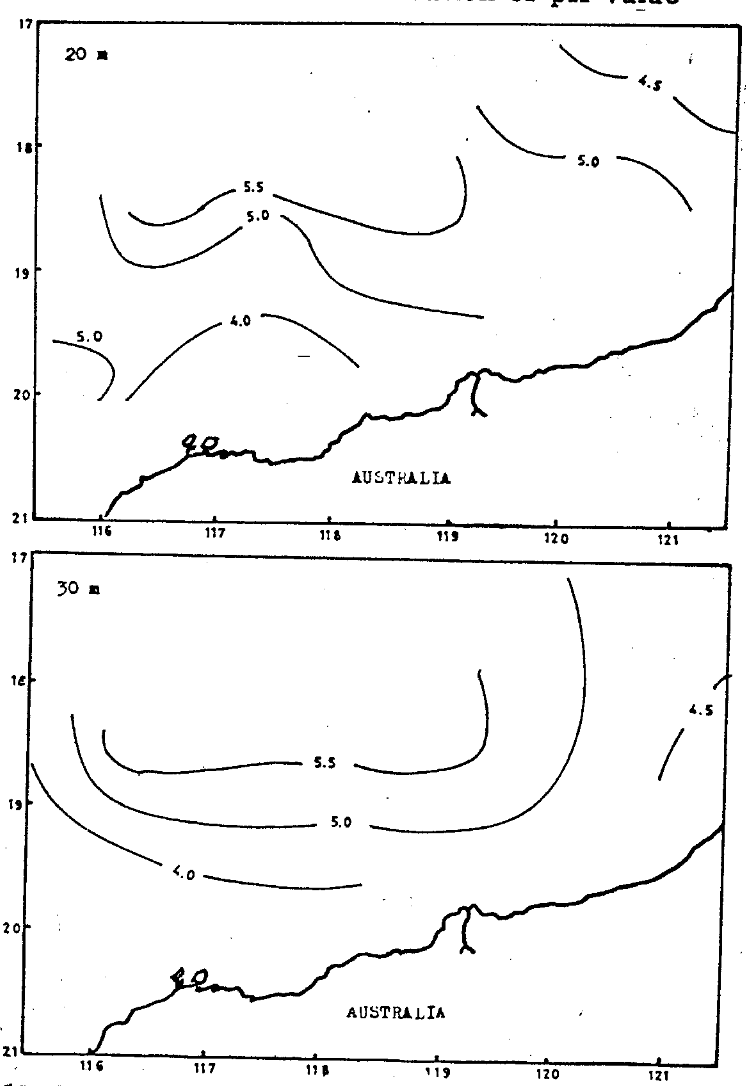


Fig. 2.18 Horizontal distribution of DO (PPM) at 20m & 30m

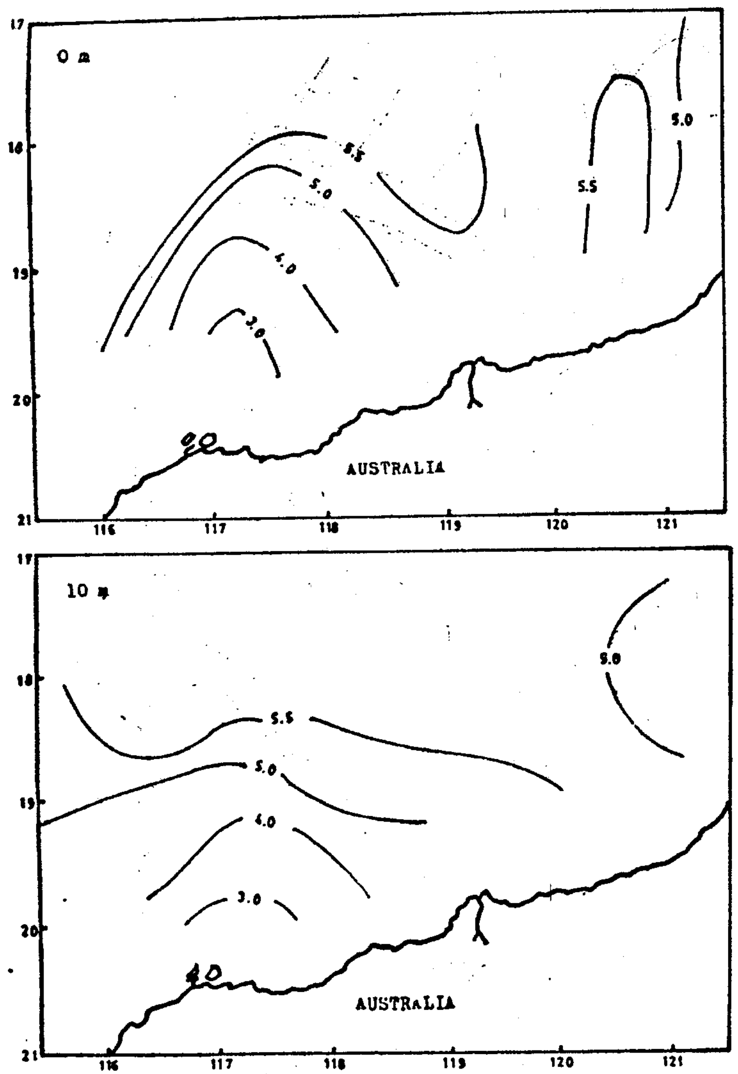


Fig. 2.19 Horizontal distribution of DO (PPM) at 0m & 10m

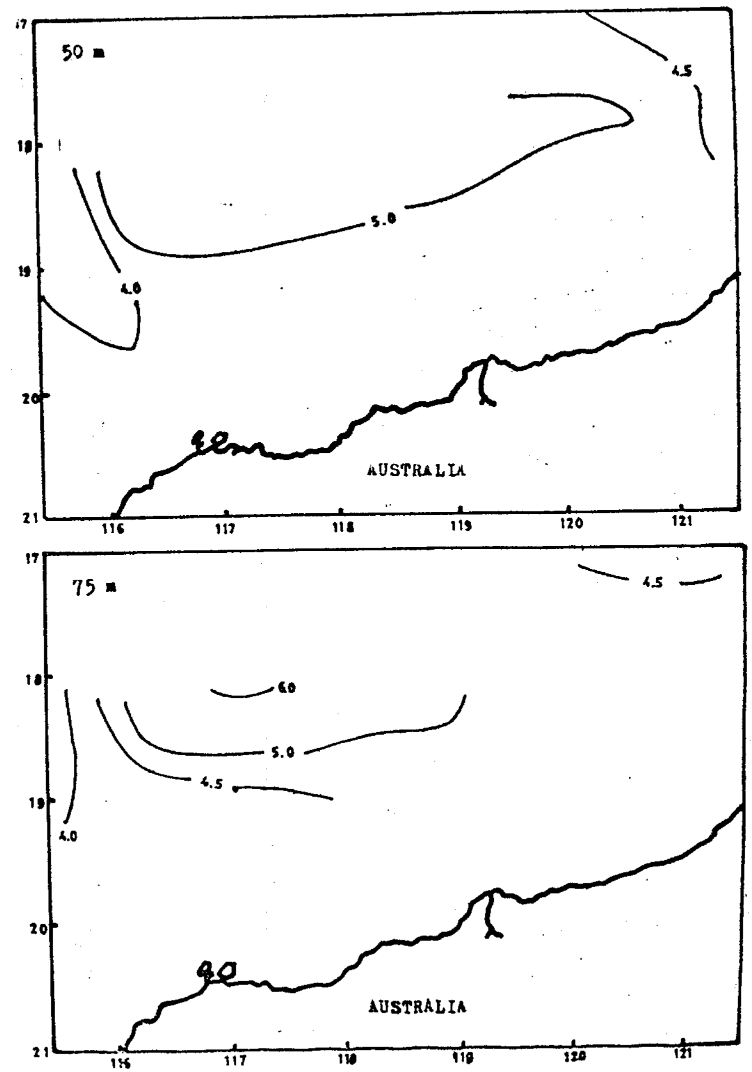


Fig. 2.20 Horizontal distribution of DO (PPM) at 50m & 75m

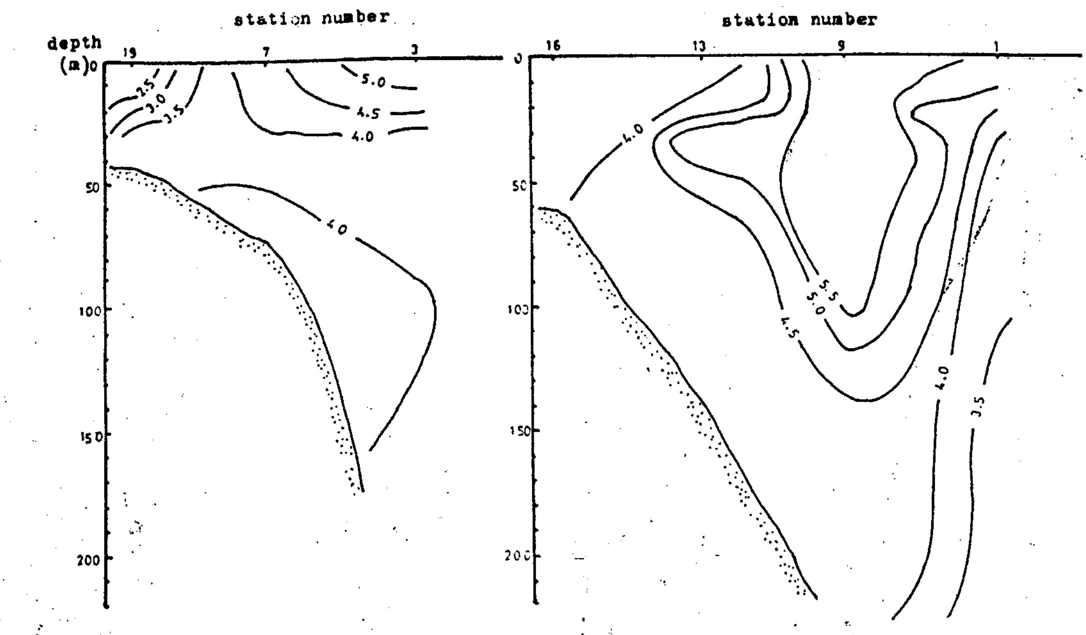


Fig. 2.21 Vertical distribution of DO (PPM)

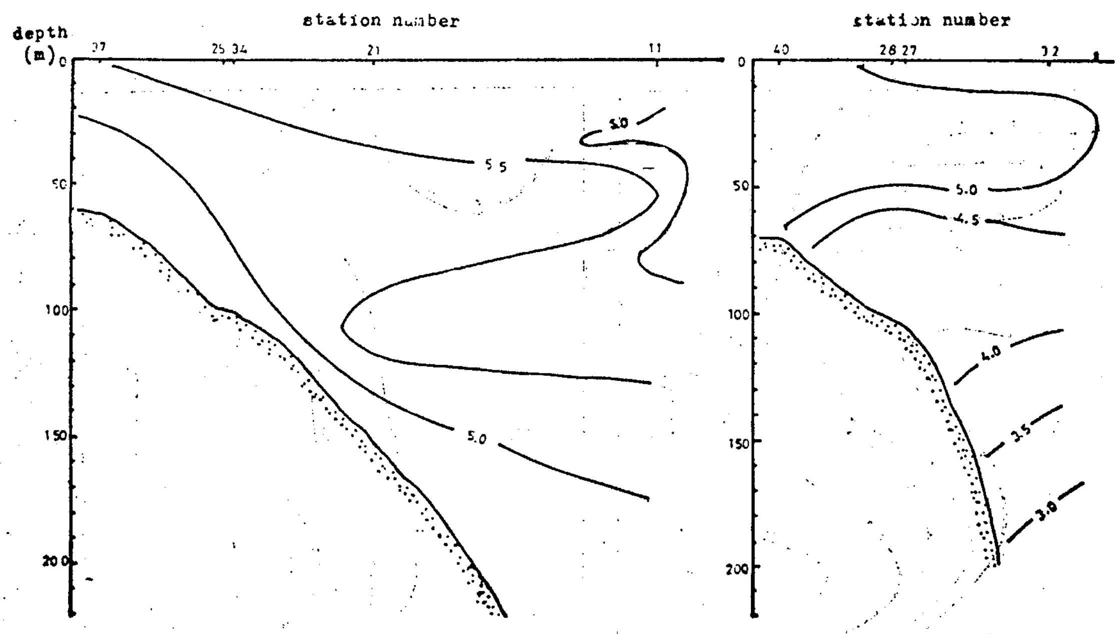


Fig. 2.22 Vertical distribution of DO (PPM)

Ⅲ 澳洲西北部拖網漁場漁獲生物調查

陳世欽 • 陳春暉

1. 試驗作業狀況

本航次調查地區係澳洲西北部 200 m 以淺的大陸棚，實際作業海域在 13.5°～20°S 及 117°～125°E 之間，水深範圍自 60m 至 153m，除一次因網破無漁獲外，全部有效投網數爲 48 網次，拖網時間共計 6667 分，平均每網或網時間爲 138.89 分，投網位置如 Fig. 3.1 所示，計調查16個半度漁區，分爲五個調查區。A區試驗作業 5 網，B區 2 網，C區 3 網，D區 2 網，E區實施36網。主要試驗集中於E區，以試驗同一海區不同水深及晝夜別漁獲量之差異。

2. 漁獲生物種類

魚種之鑑定主要是以 Munro[10,11], Masuda, Araga & Yoshino[12], Grant[13], Carcasson[14], Ehara[15], Taylor[16] 及 FAO[17] 等爲準。本調查漁獲物中包括軟骨魚類18科27種，硬骨魚類80科 208 種，共計 235 種，較澳洲調查第 7 航次 114 種，及第 8 航次94種紀錄超出甚多，主要可能是作業水深不同所致。第 7 、 8 航次調查水深範圍分別在40～95m 及 48～80m之間[7,8]。澳洲海域的漁獲均屬於熱帶性魚種，與臺灣近海底棲魚類相近似，魚種較佳。其他尚有軟體動物如烏賊、鎖管、貝類等，甲殼類有龍蝦、蝦類、蟹類數種，腔腸動物，棘皮動物如海星、海膽，及海綿動物等多種底棲生物。魚類種名見 Appendix Table 4.1。

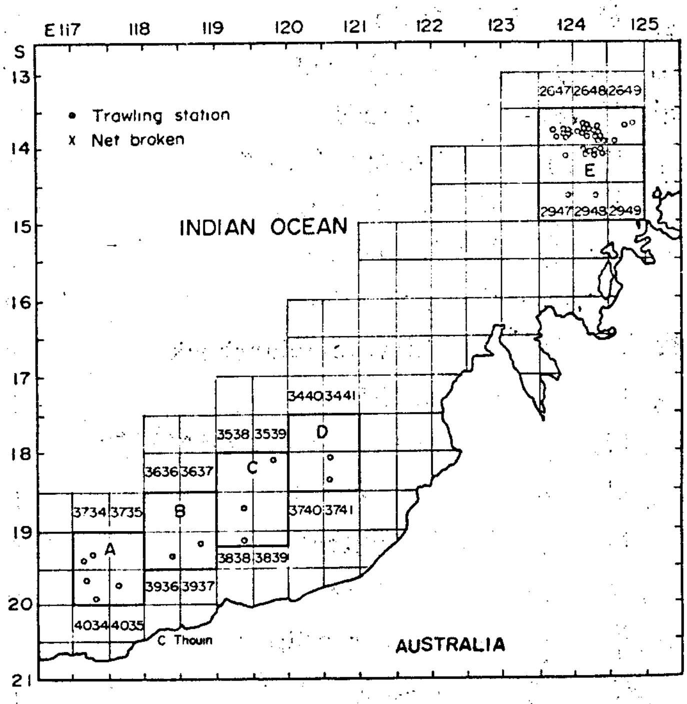


Fig. 3.1 Map showing the position of trawling stations and the fishing regions. Figures indicate the number of fishing area by half-degree square in northwest Australia.

Table 3.1 Main species composition of the total catch taken by R/V Hai-Kung in the cruise to northwestern Australia.

Ranking number	Chinese name	English name	Catch (cases)	Percentage
1	赤海	Red snapper	436	29.25
2	金龍	Silver grunter	269.5	12.52
3	長鯛	Sharp-tooth snapper	186	8.64
4	狗母	Lizard fish	168	7.80
5	肉魚	Butterfish	157.5	7.31
6	平鰺	Trevally	87	4.04
7	黑點仔	Russell's snapper	77.5	3.60
8	金線	Golden thread	75	3.48
9	吉打鰺	Banded scad	47	2.18
10	鰏魚	Common slipmouth	44	2.04
11	赤筆	Madras snapper	42	1.95
12	紅目鰱	Big-eyes	34	1.58
13	龍尖	Porgies	33	1.53
14	石鯽	Sweetlip	23	1.07
15	圓鰺	Mackerel scad	23	1.07
16	赤尾鰺	Round scad	10	0.46
17	石斑	Rock-cod	9	0.42
18	海鯰	Sea catfish	8	0.37
19	沙條	Small shark	8	0.37
20	秋姑	Goatfish	8	0.37
21	海猪哥	Barred face spinecheek	6	0.28
22	花枝	Cuttle fish	5.5	0.26
23	白帶	Hairtail	5.5	0.26
24	銀鯧	Batfish	5	0.23
25	黑鯧	Black pomfret	5	0.23
26	鎖管	Squids	5	0.23
27	加致	Painted sweetlip	4	0.18
28	盤仔	Sea bream	3	0.14
29	海鱺	Sergeant fish	2	0.09
30	青葉鯛	Pearl perch	1.5	0.07

3. 漁 獲 狀 況

3-1 漁區別漁獲量

Appendix Table 4.2 爲各漁區的漁獲情形。本航次總漁獲量爲 2153 箱，平均每網爲 44.85 箱，每小時爲 19.37 箱。在48網次中一網漁獲量最少爲20箱在 3834 漁區，最大爲80箱在2748 漁區。就區域別而言，南部漁場的 A～D 區一網平均漁獲量差別不大，A區爲 31.20 箱，B區爲 34.00 箱，C區爲 37.33 箱，D區爲 36.00 箱，其網次別單位漁獲量如 Fig. 3.2 所示，CPUE 在 10.0～19.74 cose/hr 之間，E區平均漁獲量爲 48.74 箱，較A～D區爲高，各網次單位漁獲量差異甚大，CPUE在 9.19～34.54 cose/hr 之間如 Fig. 3.3。A～E區之單位漁獲量分別爲 14.59，14.85，16.82，15.75，20.62 case/hr ，以北部的E區爲最高其次爲南部的C區。

3-2 魚種別總漁獲量

在235種漁獲中，具有食用價值數量較多的經濟魚類，依一般俗稱分爲30類如 Table 3.1。其中以赤海爲最多，共漁獲 436 箱，佔全部的 29.25%，其次爲金龍 269.5 箱，佔 12.52 %，長鯛 186 箱佔8.64%，狗母 168 箱佔 7.8 %，肉魚 157.5 箱佔7.31%，平鰺87箱佔4.04%，黑點仔77.5箱佔 3.6%，金線75箱佔3.48%，吉打鰺47箱佔2.18%，赤筆42箱佔1.95%，紅目鰱34箱佔1.58%，龍尖33箱佔1.53%。其餘各種所佔比例都不高，從主要魚種百分組成來看，澳洲西北部海域，漁獲種類多，一般都很平均，沒有特別主要的魚種，但就小漁區而言，魚種組成仍略有差異。

3-3 漁區別魚種組成

各小漁區魚種組成情形如 Fig. 3.4～3.5 及 appendix Table 3.3,圖中顯示各漁區有一至二種主要魚種，且在各漁區之組成也不相同。3834 漁區以狗母最多，佔40.38%，其次爲紅目鰱佔 26.92%。3934漁區仍以狗母爲主，佔40.91%，赤海次之佔13.64%，赤筆佔12.12%。3935漁區狗母及金線均佔18.42%，赤海 15.79 %。3836漁區金線及狗母各佔35.14%，赤海8.11%。3837漁區狗母比率最高佔 45.16% ，金線佔 22.58% ，赤海9.68%。3838漁區以赤海較多佔 34.78 %，其次爲狗母

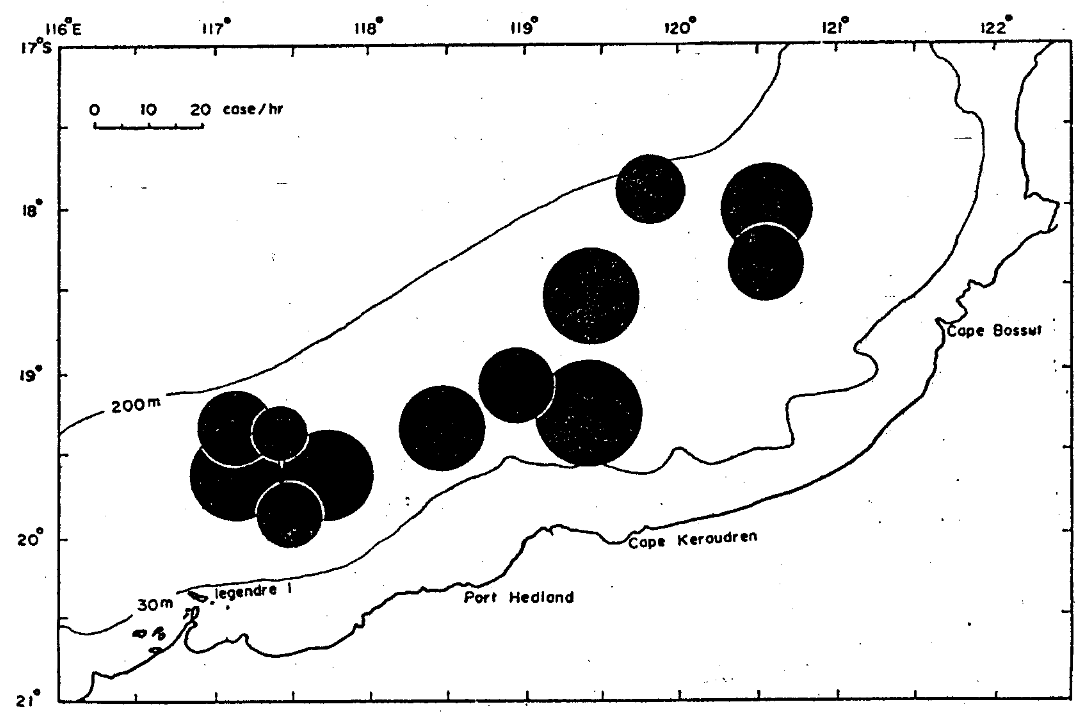


Fig. 3.2 Distribution of catch amount in cases per hour in the southern part of the studied area. Scale indicate the diameter of the circle.

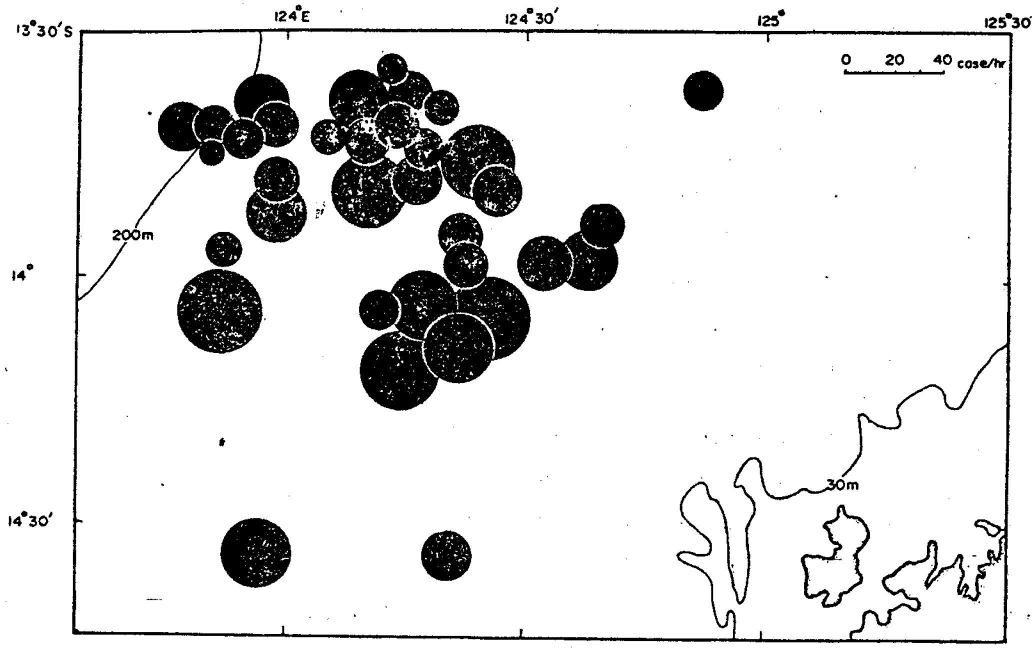


Fig. 3.3 Distribution of catch amount in cases per hour in the northern part of the studied area. Scale indicate the diameter of the circle.

26.09%，長鯛及赤筆均佔8.69%。3738漁區以狗母爲主佔27.03%，其次爲赤海18.92%，長鯛13.51%，赤筆10.81%，3639漁區比率較平均，依次爲狗母20.69%，赤海 13.79% ，金線 13.79% ，龍尖10.34%。3641漁區則以龍尖爲最多，佔16.67%，其次爲赤筆13.89%，狗母12.50%，金線9.72%。2947漁區以金龍最多佔37.70%，平鰺佔11.48%，赤海9.48%，赤筆8.20%。2948漁區金龍 28.26 %，赤海19.57%，金線及平鰺各佔10.87%。2847漁區金龍與吉打鰺均佔13.15%，平鰺11.84%，赤海佔9.21%。2848漁區仍以金龍最多（23.44%），赤海次之（10.84%），平鰺（7.05%），長鯛與肉魚各佔4.61%。2747漁區赤海佔25.80%，金龍14.18%，肉魚12.26%，長鯛11.75%。2749漁區仍以赤海爲主佔23.24%，金龍次之18.31%，龍尖佔6.34%。以上各漁區魚種組成顯示，狗母、金線、赤筆由南而北逐漸減少，赤海、長鯛、肉魚則有向北增加的現象。一般來說，南方海域魚種較少，北方海域魚種多，漁獲量也較高。依調查區域將最主要五種魚種按順位排列如下：

A區：狗母（33.23%），赤海（9.81%），紅目鰱（8.97%），金線（8.16%），赤筆（5.56%）
B區：狗母（40.15%），金線（28.86%），赤海（8.89%），花枝（4.62%），赤筆（2.96%）
C區：狗母（24.68%），赤海（22.49%），長鯛（9.70%），赤筆（5.48%），紅目鰱（5.13%）
D區：龍尖（16.67%），赤筆（13.89%），狗母（12.5%），金線（9.72%），赤海（6.94%）
E區：金龍（19.29%），赤海（18.87%），長鯛（6.35%），肉魚（5.40%），平鰺（5.31%）

3-4 水深別漁獲量

根據澳洲北部漁場調查第 7 航次，作業水深 40～95m ，平均每網漁獲量16.1箱，第 8 航次作業水深 48～84m ，平均每網漁獲量爲 11.6 箱。本航次調查水深 60～153m ，平均每網漁獲量爲 44.85 箱。由 Fig. 3.6 可知漁獲與水深有關。水深在90m以淺海域，一般漁獲普遍較低， CPUE 在 10～16 箱之間， 110m 以深漁獲在 9～23 箱之間，CPUE 在25箱以上之高漁獲量，多出現在 90～105m 水深海域，有時也出現在更深的地區。水深的不同顯示澳洲海域近岸淺水區漁獲密度較低，深海域魚羣密度較高，潛在資源量較大。

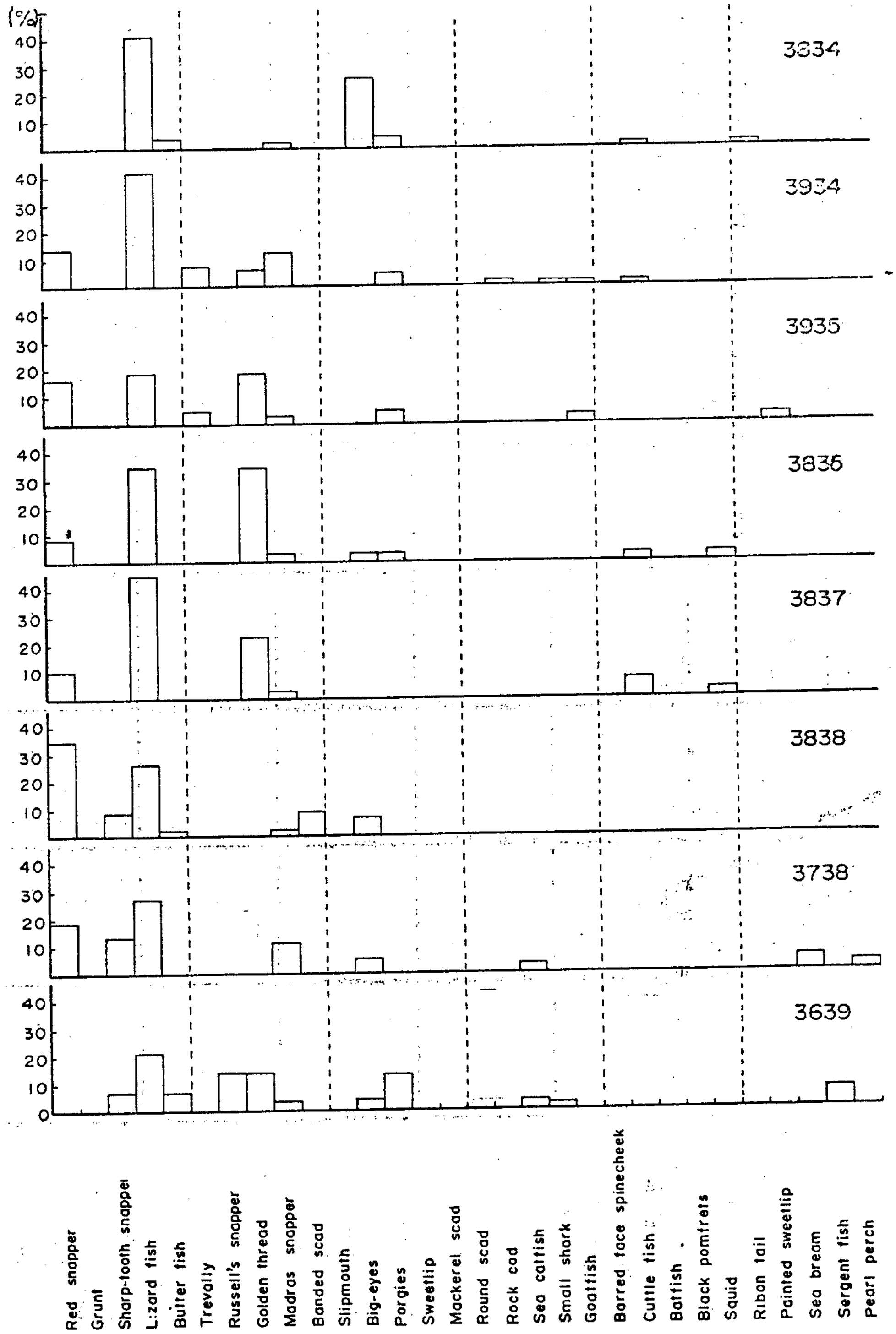


Fig. 3.4 Catch composition of each fishing area in March to April caught by R/V Hai-Kung.

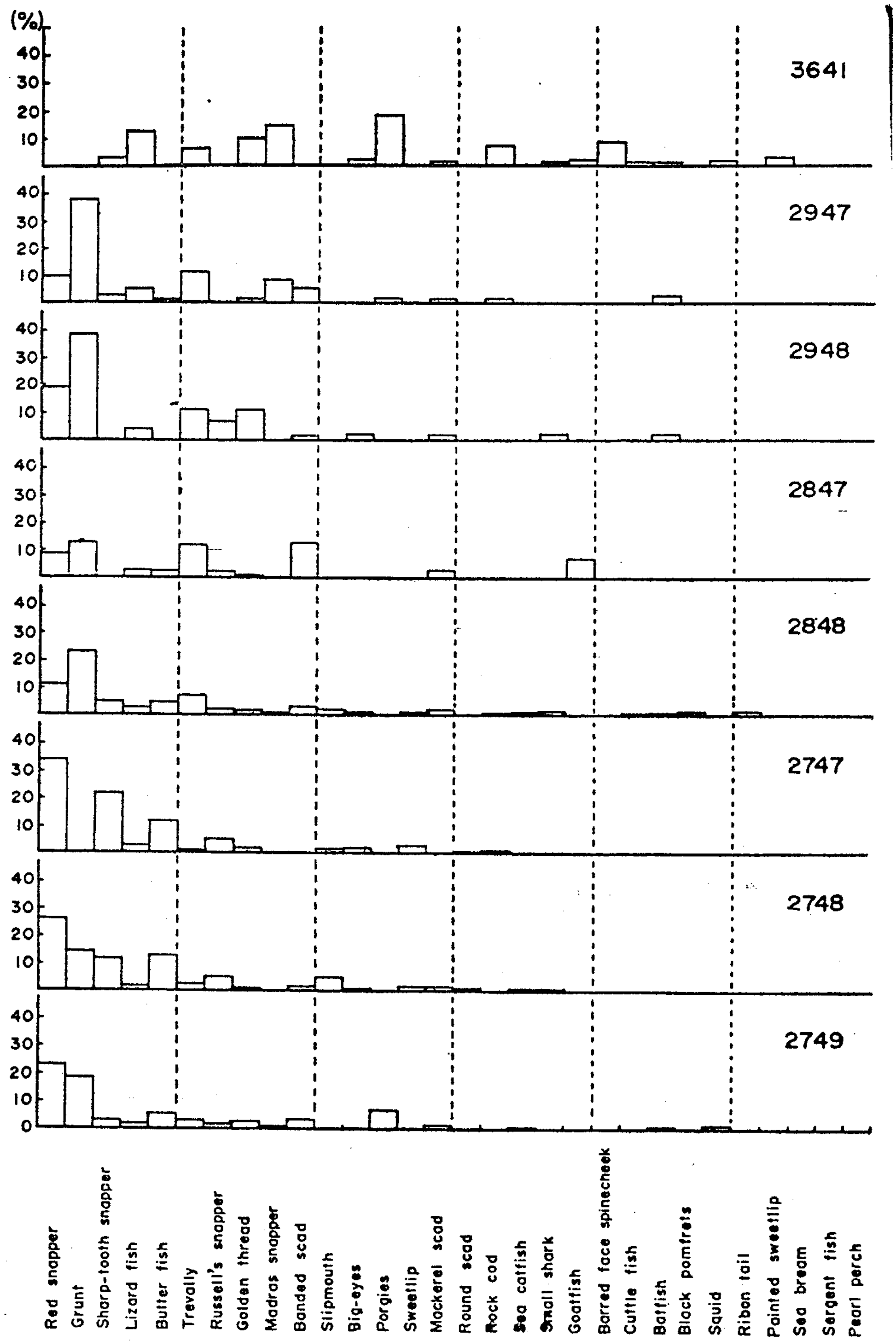


Fig. 3.5 Catch composition of each fishing area in March to April caught by R/V Hai-Kung.

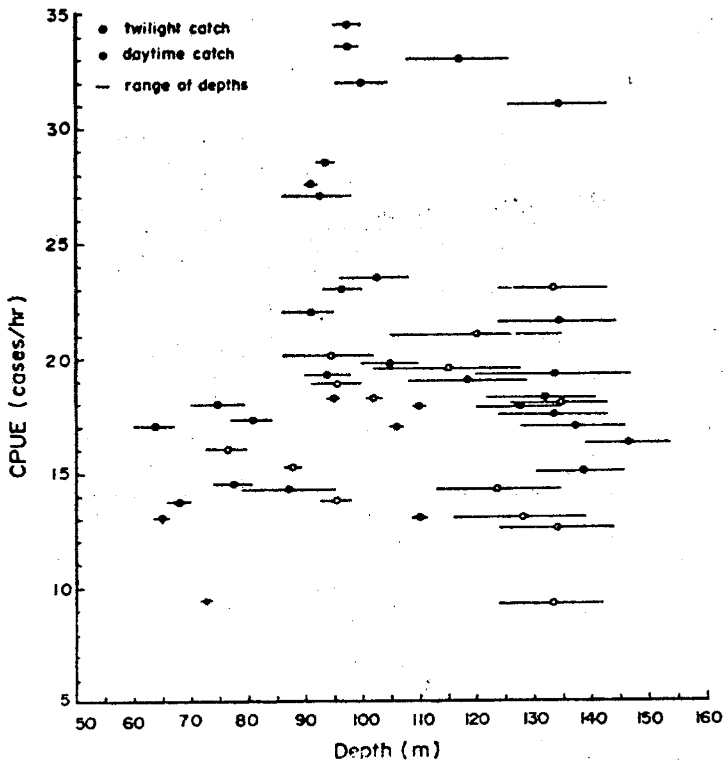


Fig. 3.6 Relations between depth and catch of daytime & twilight in Australian waters.

3-5 晝夜別漁獲量

一般相信底棲魚類之漁獲量與晝夜別有密切關係，通常在夜間漁獲較低，日間漁獲較高，主要是受到底棲魚類日夜垂直運動的影響。本調查發現日間之單位漁獲量最小爲15.11箱，最大爲34.54箱，平均爲23.61箱，黃昏或黎明時之漁獲量在9.19～20.89箱之間，平均爲 16.58 箱 (Fig. 3.6) 。以顯著性測驗得知兩者之平均單位漁獲量有顯著性差異 (Table 3.2) ，卽澳洲海域日間漁獲量較黃昏或黎明時之漁獲爲高。而 Suzuki (1965)[18] 認爲日夜間漁獲量之多寡與種類有關，他發現龍尖 (*Lethrinus ornatus*) 顯然沒有垂直運動的現象。

Table 3.2 The Result of test for the difference of catch between daytime and twilight in Australian waters.

	daytime	twilight
N	21	15
$\overline{X}$	23.61	16.58
S^2	42.62	14.09
$S^2_{\overline{x}}$	2.029	0.939
$t_{(\frac{n}{p}=0.05)}$	2.086	2.131
$t=3.53>t'=2.11$**		

N : Number of trawling

$\overline{X}$: mean of CPUE

S : variance of CPUE

t : the value of testing the significance

** : significant at 5% level

4. 主要魚種分布

4-1 水平分布

主要魚種之漁區別漁獲密度（CPUE, cases/hr）分布如 appendix Fig. 3.1-3.12. 赤海（Red Snapper, *Lutjanus* spp.）分布甚廣，除3834 及 3639漁區無漁獲外，各漁區均有出現，南方海域之密度在 1.09～6.87 之間，最大密度在3838漁區，北方海域密度範圍爲2.50～5.90，平均密度以北方海域較高。赤海共發現四種，南方海域以 *L. sanguinus* 爲最多佔60%， *L. sebae* 30%， *L. altifrontalis* 10%，北方海域以 *L. sanguinus* 爲主佔 95%， *L. sebae* 佔5%。屬於河口及珊瑚礁之魚種 *L. argentimaculatus* 僅在南部漁場發現10餘尾。

金龍（Silver grunter, *Pomadasys hasta*）體呈金黃色背部有數條黑斑爲其主要特徵，在本調查中僅出現於北方海區 CPUE 最小爲2.86，最大爲10.22在2947漁區，漁獲密度爲各種之冠，通常金龍大量出現時，赤海漁獲則較差，可能與水深有關。

長鯛（Sharp-tooth snapper, *Pristipomoides multidens*）根據統計年報，主要漁期可能在7～9月，本調查期間長鯛出現於 C. D. E. 區，以 C. E. 區爲主要漁場，前者密度在0.88～2.40之間，以3738漁區較多，後者密度在0.65～3.74之間，最大密度在2747漁區。

狗母(Lizard fish, *Saurida* spp.)在每一漁區均有出現，主要漁場集中在南部漁區，隨緯度之減少漁獲量顯著降低。A～C區漁獲密度介於 2.67～6.32 之間，D區爲1.97，E區爲 0.39～1.33。最大密度 6.32 出現於 3934 漁區。狗母包括正蜥魚 *Saurida undosquamis* 及錦鱗蜥魚 *S. tumbil* 兩種。南部海域以 *S. undosquamis* 爲主，在A區佔71.4～92.6%，B區佔 53.8～85.7%，C區佔 80.0～83.3%，D區佔 77.8%。北部海域以 *S. tumbil* 爲主， *S. undosquamis* 所佔比率很小。

肉魚（Butter fish）主要出現於E區， CPUE 在 0.44～2.47 之間，以2747 及 2748漁區密度較高，南部漁區僅在 3834 與 3639 區有少量漁獲。肉魚包括 *Psenopsis humerosus*及*Ariomma indica* 兩種。在A～D區以 *A. indica*較多，佔 83.6～96.2%，在E區兩種比率相近，*P. humerosus* 佔 48.6%，*A. indica* 51.4%。*P. humerosus* 分布於南太平洋及印度洋（Munro, 1958），與本省產 *P. anomala* 不同。

平鰺（Trevally, *Caranx* spp.）主要漁期在 4～6 月，澳洲西北部海域均有分布 (9)。本調查平鰺在A及D區有漁獲，密度爲 0.87～1.17 ，主要漁場在E區，密度爲 0.51～4.00 ，最大密度在2847漁區。

黑點仔（Russell's snapper, *Lutjanus russelli*）主要漁場集中於北部，漁獲密度則以 3639漁區最高，CPUE 爲 1.78。

金線（Golden thread, *Nemipterus* spp.）在澳洲北部及西北部分布甚廣，是常見的主要魚種之一，其漁獲密度在A區爲 0.94～3.11 ，B區爲 3.11～5.58 ，C區爲 1.78，D區爲 1.53，E區爲 0.21～2.10 以南部漁區密度較高，主要漁場在3836漁區。

吉打鰺（Banded scad, *Atule djeddaba*）在南部漁區場僅出現於3838漁區，主要漁場在E區，最大密度爲4.44在2847漁區。

赤筆（Madras snapper, *Lutjanus lutjanus*）之分布10～12月及1～3月漁場偏南，4～6月分布較廣 (9)。本調查時南北漁場均有出現，密度不集中，以3934區、3738區3641區及2947區漁獲較多，CPUE分別爲1.87、1.92、2.19及2.22 case/hr。

龍尖（Porgies, *Lethrinus* spp.）多出現於南部，在3641 及 3639區之間有一重要漁場，最高漁獲密度爲2.62，北部漁場以2749區較多。包括 *L. lentjan* 及 *L. chaerorhychus* 兩種。

石鯽（Sweetlip, *Hapalogeny kishinouyei*）僅出現在北部 2848, 2747 及 2748三個漁區，密度在0.12～0.59之間。

4-2 垂直分布

從 Fig 3.7 可發現各魚種之漁獲情形與水深之關係。部份魚種如狗母、金線、圓鰺、沙條、赤海、長鯛等垂直分布甚廣，而花枝、鎖管、加茲、龍尖、銀鯧、黑鯧、盤仔、金龍等則分布較窄。就其密度而言，主要漁獲水深因種類而異，如赤海、長鯛、肉魚、石鯽多出現在 120m 以深水域、赤筆、銀鯧、金龍、海鯰、沙條、平鰺、秋姑、黑鯧、吉打鰺、紅目鰱、黑點仔、盤仔主要出現在 85～110m 深的水域，花枝、鎖管、狗母、金線、加茲、龍尖、石斑等則多發現在 85m 以淺的海區。

5. 主要魚種體長組成

赤海最小體長爲 22cm，最大爲74cm，深水區（100～153m）體長範圍較小，多集中於 40～50 cm 之間，淺水區（60～100m）體長範圍較大， Fig 3.8 顯示 35cm 以下及 60cm 以上赤海同時出現於淺水區。

金龍體長範圍 22～45cm，水深 86～102m，體長主要位於 25～30cm，水深106～109m，體長集中於32～33cm （Fig 3.9）。

長鯛體長範圍 27～63cm ，一般體長多在50cm以下，水深 110m 體長則在 50cm 以上，北部漁場漁獲者體型較小，南部漁區捕獲者體型較大。

肉魚體長範圍15～21cm，型量爲17或18cm，一般而言 *Ariomma indica* 體長較 *Psenopsis humerosus* 爲小，分佈水深則較深。

平鰺體長範圍 10～25cm，Fig 3.10 顯示平鰺體長以淺水區較大，深水區體長略小，前者型量在22cm，後者型量在15～17cm 之間。

狗母體長範圍 15～52cm，主要漁獲位於淺水區，體長以 34～37cm 較多，通常正蜥魚比錦鱗蜥魚體長爲大（Fig 3.11）。

吉打鰺體長範圍 18～27cm，主要位於 22～23cm，水深 100～110m，主要體長集中於 25cm。龍尖體長 23～37cm，水深較深體長也較大，77～84m 體長型量爲 27cm ，79～95m 主要體長在 29cm ， 100～110m 體長多在 29cm 以上，就種類而言紅點龍尖 *L. chaerorhynchus* 較 *L. lentjan* 爲大（Fig 3.12）。

紅目鰱體長 12～41cm，水深在 100m 以淺，一般體長主要位於 22～27cm，水深 100m 以深時體長範圍較廣，有二個高峯出現，一在 16cm，一在 26cm，顯然係屬於不同年令羣。*P. macrocanthus* 通常較 *P. tayenus* 爲大（Fig 3.13A）。

盤仔在 100～110m 水深體長多在 26cm 以下，水深達 140m 時體長在 32～35cm 之間，型量爲 34cm。

秋姑體長範圍 20～27cm ，顯然以淺水區較小，深水區較大，主要體長前者在 22～24cm ，後者在 25～26cm（Fig 3.13C）。

黑點仔體長範圍 22～29cm，以淺水區體型較大。金線體長在 14～30cm，主要位於 22～26cm，赤筆體長範圍，15～33cm，以南部漁場體型較大（.Fig. 3.14, C1～C4）型量爲 25～26cm ，北部漁場體長較小，主要體長多在 26cm 以下，型量爲 19cm 及 21cm（Fig. 3.14, C5～C6）。

其他各魚種體長分布情形與水深之關係如 Fig. 3.15～3.16 所示，一般均以深水區體長較大。

6. 主要魚種體長體重關係

重要魚種如赤海、金龍、長鯛、青葉鯛、銀鯧、龍尖、牛港過等體長體重經測定，分別描繪於座標紙上，求得體長體重之直線關係式，如 Fig. 3.17～3.23，經迴歸係數檢定結果，迴歸係數有顯著性意義，即迴歸直線成立，各魚種體長（L）重量（W）之關係式如下：

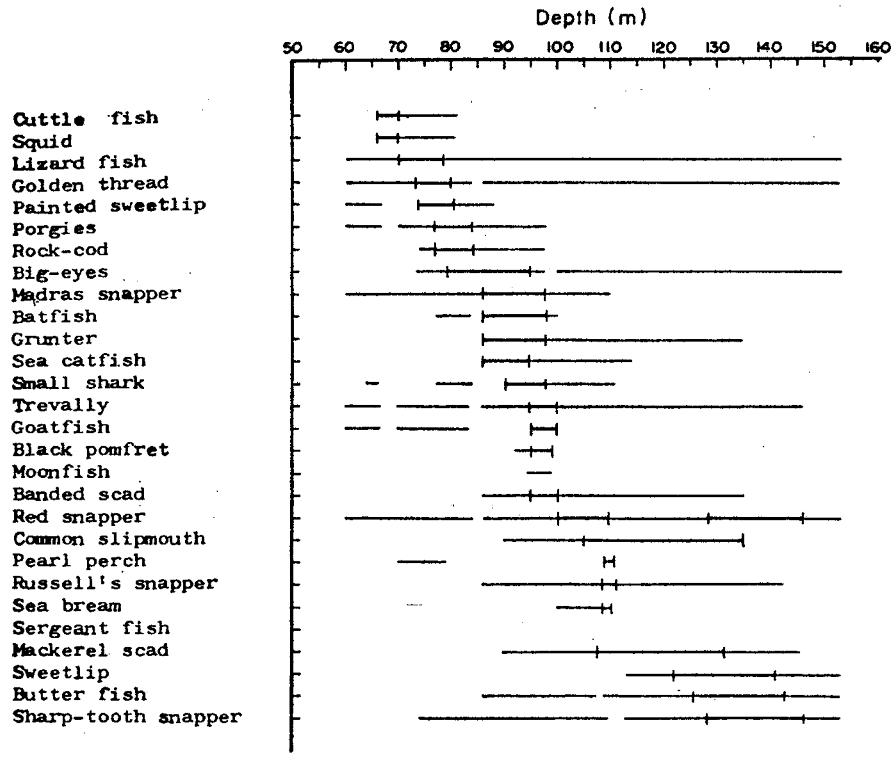


Fig. 3.7 Vertical distribution of demersal groups. Lines indicate the range of depth the species occurred and abundant in bold lines.

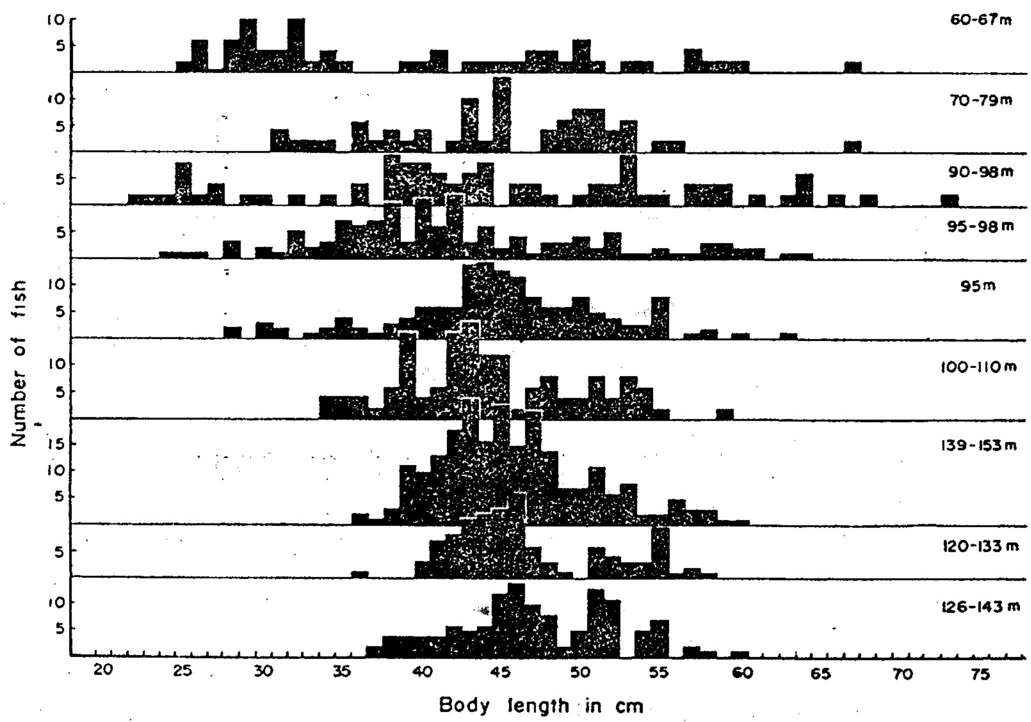


Fig. 3.8 Body length composition of red snapper (*Lutjanus* spp.) by depth.

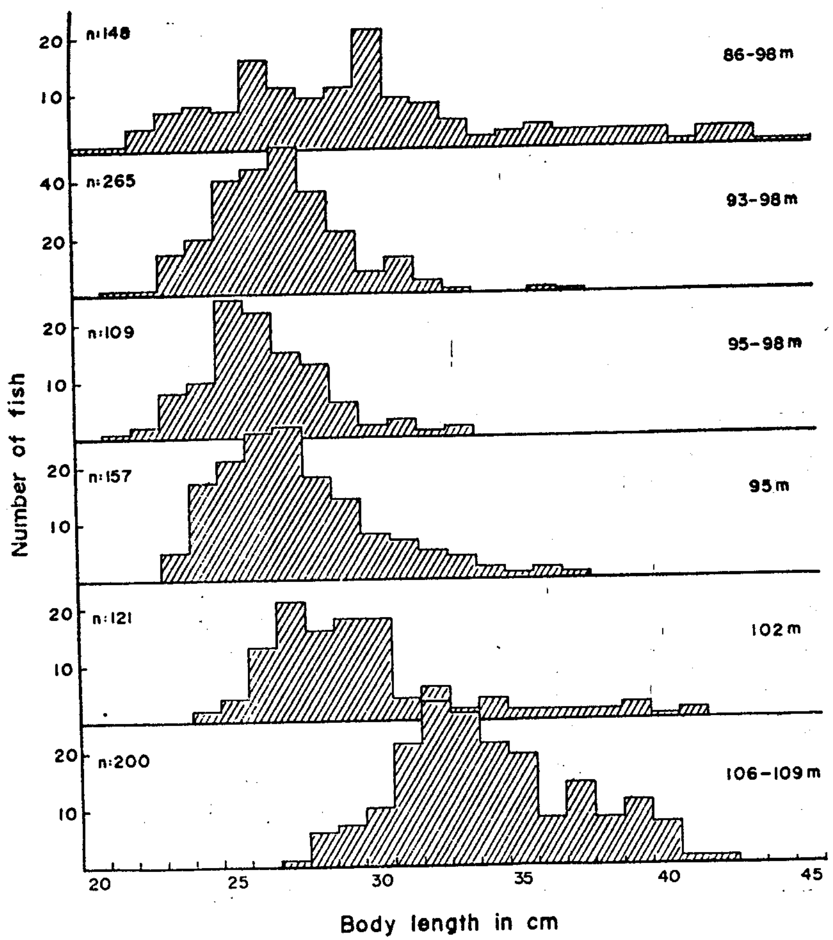


Fig. 3.9 Body length composition of silver grunter (*Pomadasys hasta*).

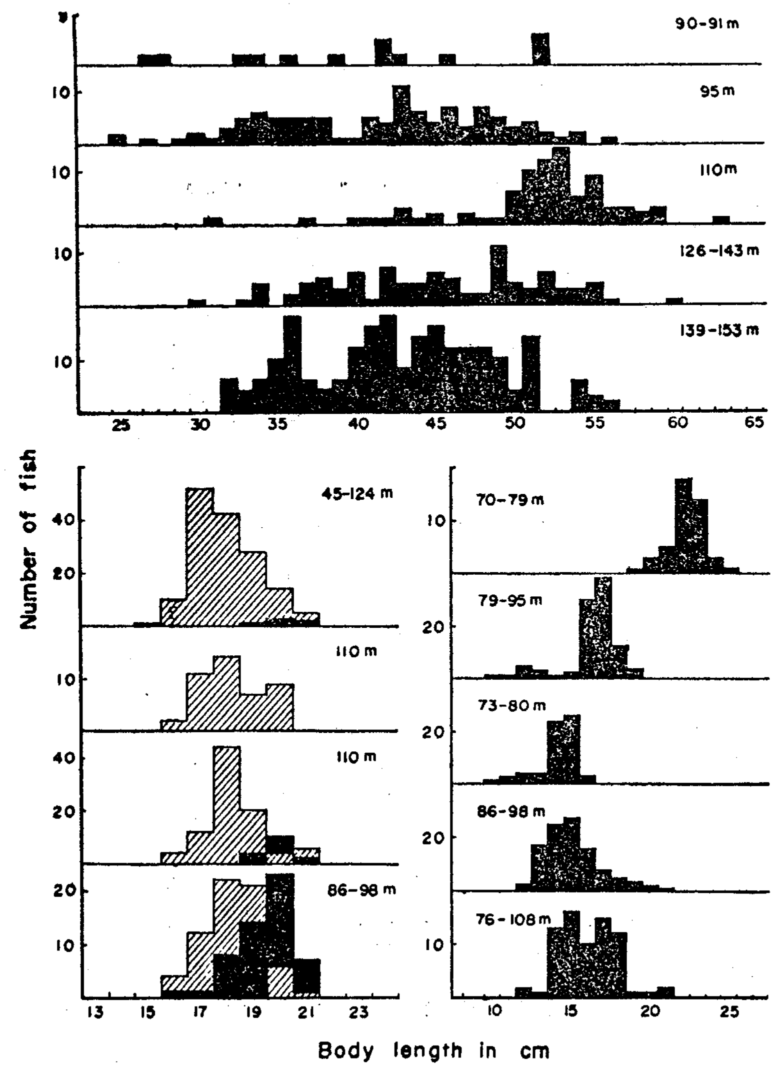


Fig. 3.10 Body length composition of sharp-tooth snapper (upper), butter fish (lower left) and trevally (lower rlight).

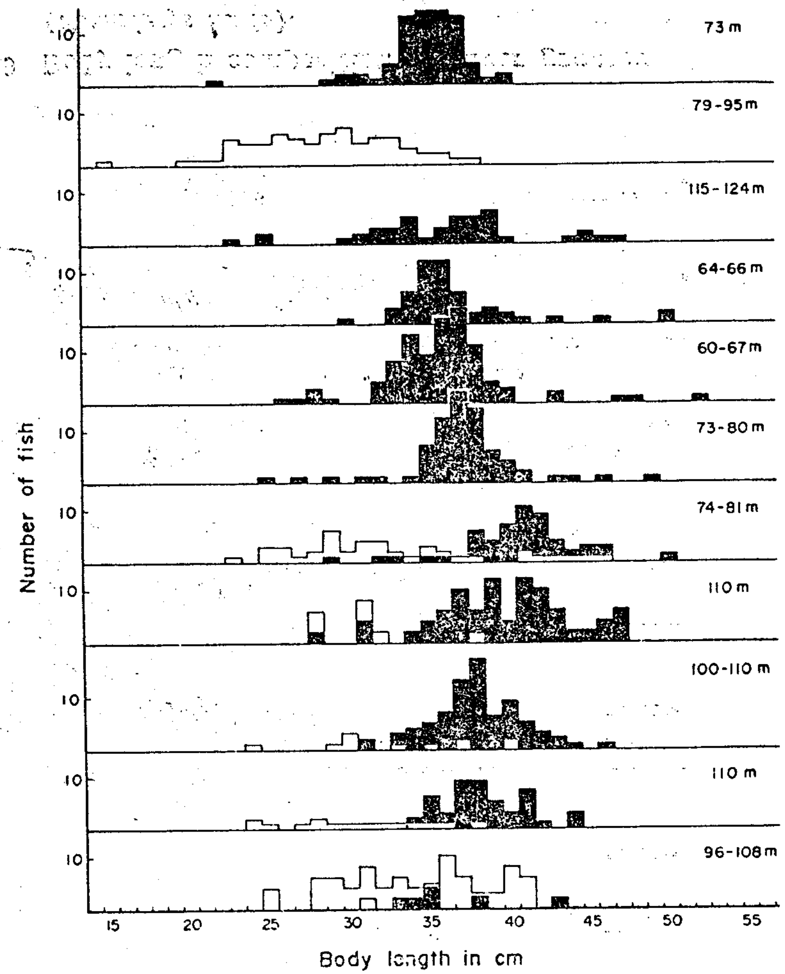


Fig. 3.11 Body length composition of lizard fish, S. *undosquamis* (black) and *S. tumbil* (white).

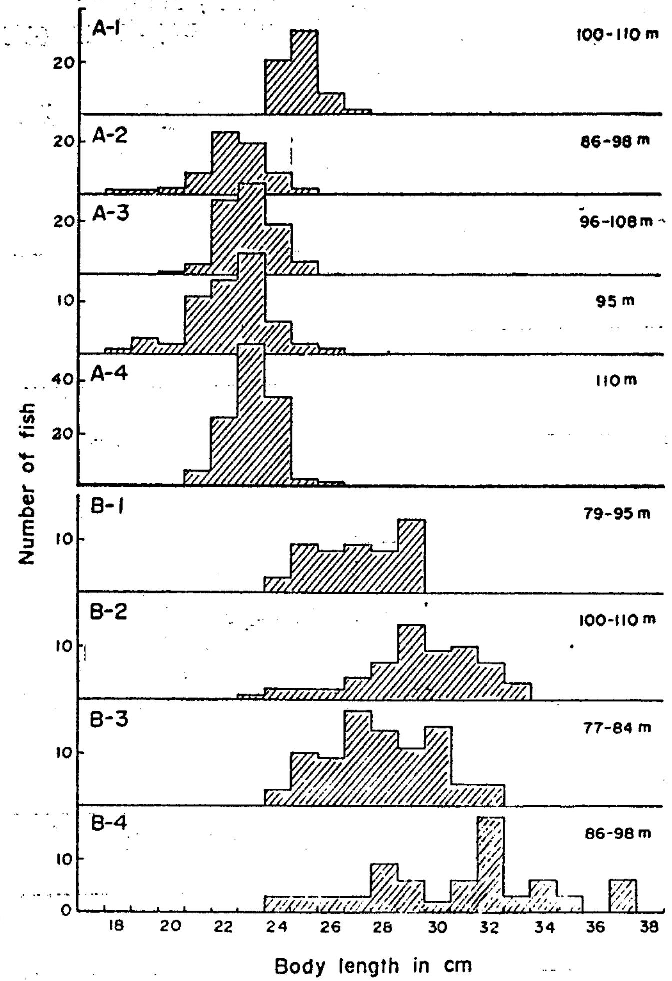


Fig. 3.12 Body length composition of banded scad (A) and porgies (B).

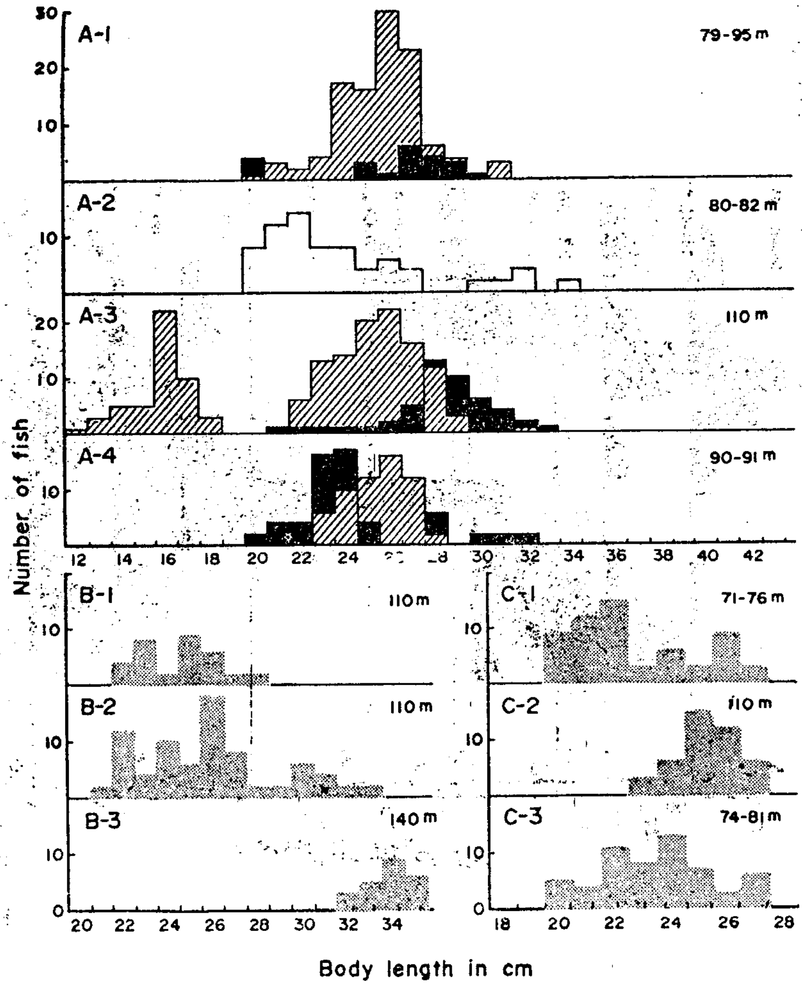


Fig. 3.13 Body length composition of big-eyes (A), sea bream (B) and goat fish (C).

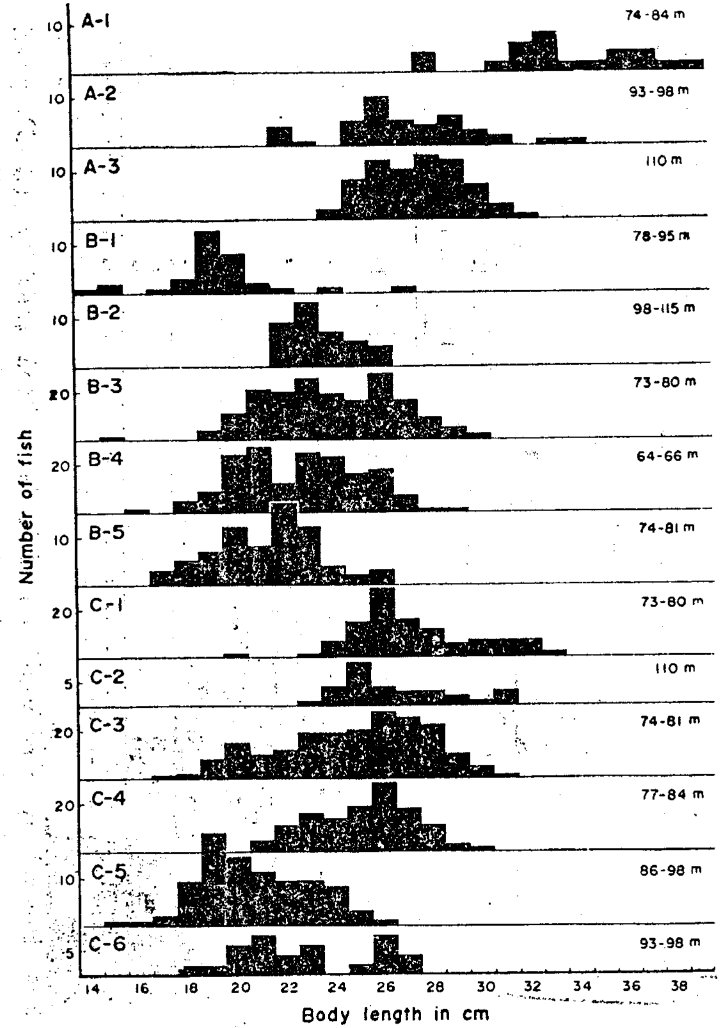


Fig. 3.14 Body length composition of Russell's snapper (A), golden thread (B) and Madras snapper (C)

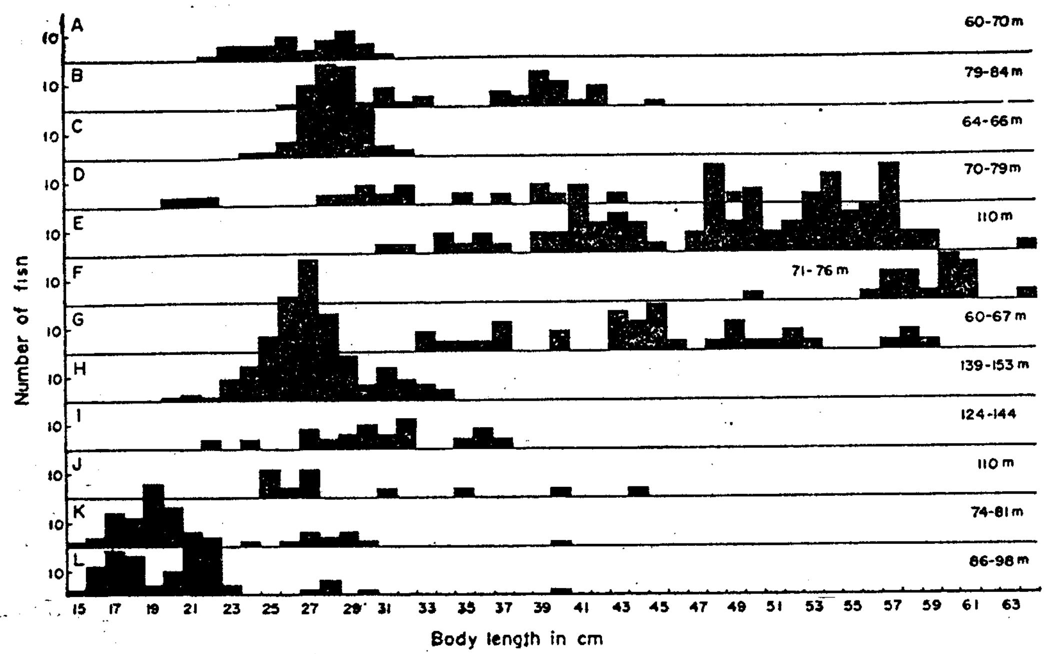


Fig. 3.15 Body length composition of blue spotted trevally (A-C), pearl perch (D-E), great trevally (F), painted sweetlip (G) sweetlip (H), rock-rod (I), black-banded kingfish (J), and batfish (K-L).

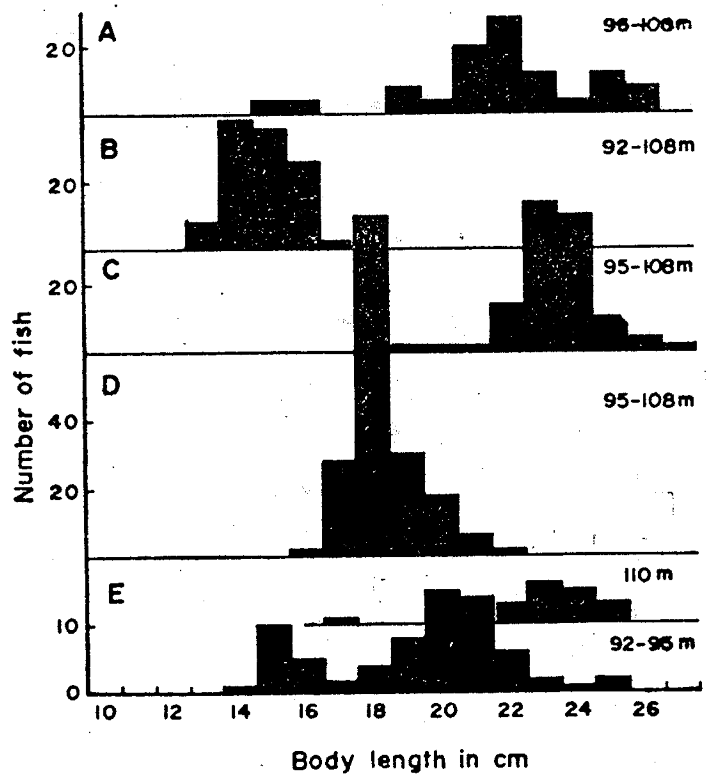


Fig. 3.16 Body length composition of mackerel scad (A), slipmouth (B), finny scad (C), purse-eye scad (C), black pomfret (E).

川紋笛鯛	$W=1.9377\cdot10^{-5}\ L^{3.0153}$,	$r=0.984$	(kg. cm)
赤　海	$W=2.6328\cdot10^{-5}\ L^{2.8193}$,	$r=0.900$	(kg. cm)
長　鯛	$W=2.4334\cdot10^{-5}\ L^{2.8935}$,	$r=0.990$	(kg. cm)
青葉鯛	$W=1.2899\cdot10^{-5}\ L^{3.0570}$,	$r=0.994$	(kg. cm)
金　龍	$W=3.9043\cdot10^{-6}\ L^{3.2256}$,	$r=0.984$	(g. mm)
龍　尖	$W=6.2030\cdot10^{-7}\ L^{3.6119}$,	$r=0.984$	(g. mm)
銀　鯧	$W=2.6311\cdot10^{-6}\ L^{3.4239}$,	$r=0.973$	(g. mm)
牛港過	$W=9.1736\cdot10^{-5}\ L^{2.5603}$,	$r=0.896$	(kg. cm)

7.現存資源估計量

底棲魚類現存資源密度 (Standing stock density) 及現存資源量 (Standing stock size) 之估計一般是採用 Shindo 的方法 (Liu. 1976) 。根據海功號網具試驗結果得知，拖網在 100~150m 深度時實際網口水平距離大約爲 30 公尺，拖網速度爲 3 節，平均每網曳網時間爲 2.3 小時，則其拖網掃過面積一網爲 0.3834 Km^2。魚類逃離網口之比率爲 50% (Tiew, 1969)，而本調查各漁區的漁獲率在 0.86~1.24 Tons/haul 之間，平均爲 0.99 Tons/haul (如 Table 3)，較冥他陸棚之漁獲率 0.75 Tons/haul 爲高 (Liu. 1978) 。依據上述資料求得澳洲西北海域資源平均密度爲 52kgs/ha，遠較大陸沿海陸棚之漁獲密度 37kgs/ha 爲高 (Liu. 1973) 。 澳洲西北陸棚可拖網之面積約爲 260,400km^2 ，估計其最大現存資源量爲 1345 千噸，持續生產量爲 672 千噸。

自 1974 年以來，澳洲海域底棲魚類之總生產量雖有減少現象，但其漁獲率則大致不變的 (Liu. 1978) ，與本調查之結果相同。澳洲西北陸棚 1976 年之總生產量爲44.9千噸，僅達持續生產量 6.7 %，可見澳洲西北陸棚之底魚蘊藏量仍很豐富，倘有大量開發的價值。

Table 3.3. Catch rate & standing stock density of demersal groups by sub-area in northwestern shelf of Australia.

Sub-area	CPUE			Standing stock density	
	cases/haul	tons/haul	kg/hr	cases/ha	kg/ha
RA	28.58	0.86	437.7	1.49	44.7
RB	29.70	0.89	445.5	1.55	46.5
RC	33.64	1.01	504.6	1.75	52.6
RD	31.5	0.95	472.5	1.64	49.3
RE	41.24	1.24	618.6	2.15	64.5
Average	32.93	0.99	495.78	1.72	51.52

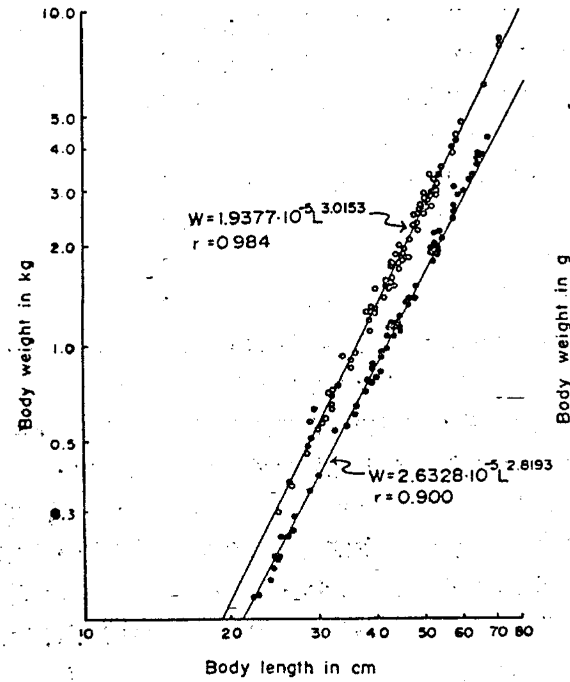


Fig. 3.17 Relation between body length and body weight of red snapper, *L. sanguinus* (dot), and *L. sebae* (circle).

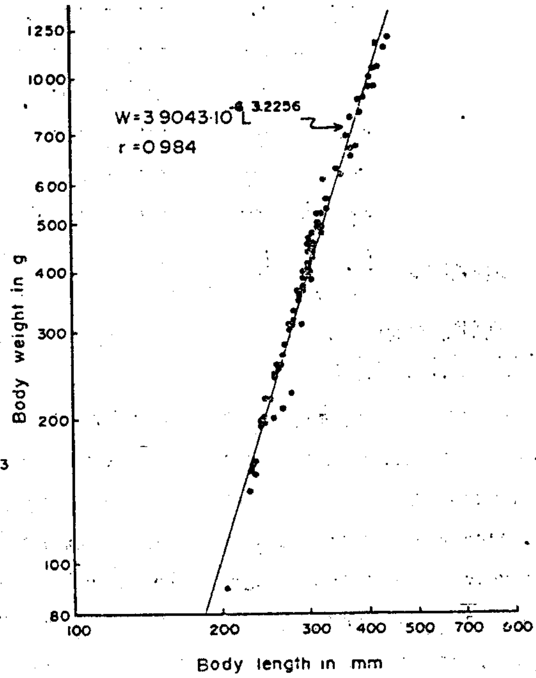


Fig. 3.18 Relation between body length and body weight of silver grunter, *Pomadasys hasta.*

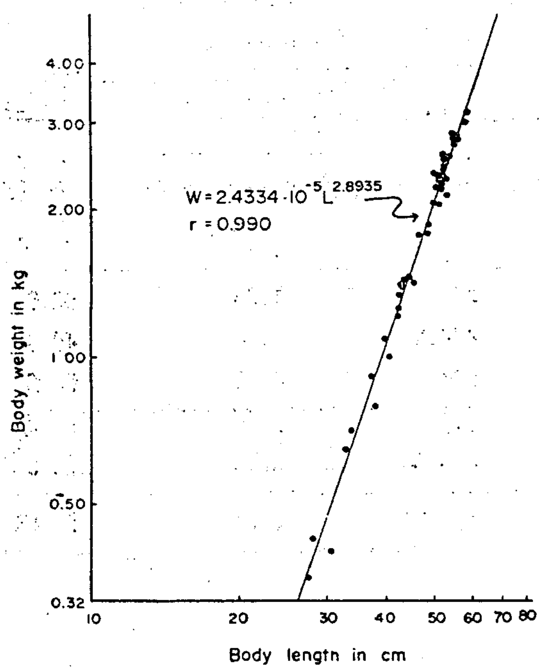


Fig. 3.19 Relation between body length and body weight of sharp-tooth snapper, *prstipomoides multidens*

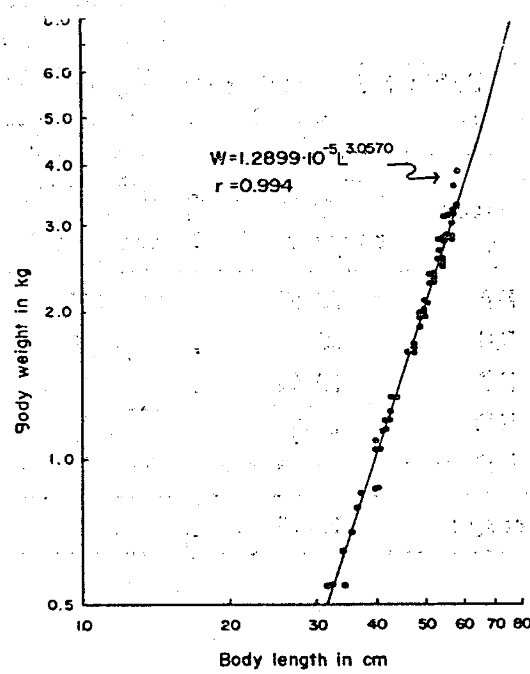


Fig. 3.20 Relation between body length and body weight of peral perch, *Glaucosoma burgerii.*

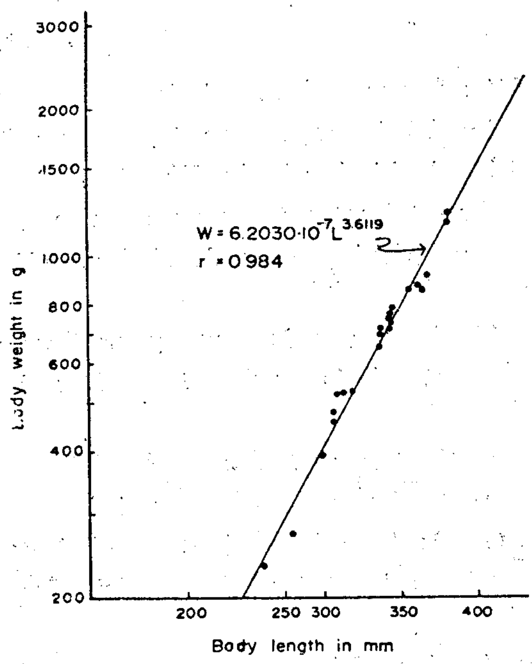


Fig. 3.21 Relation between body length and body weight of porgies, *Lethrinus lentjan*

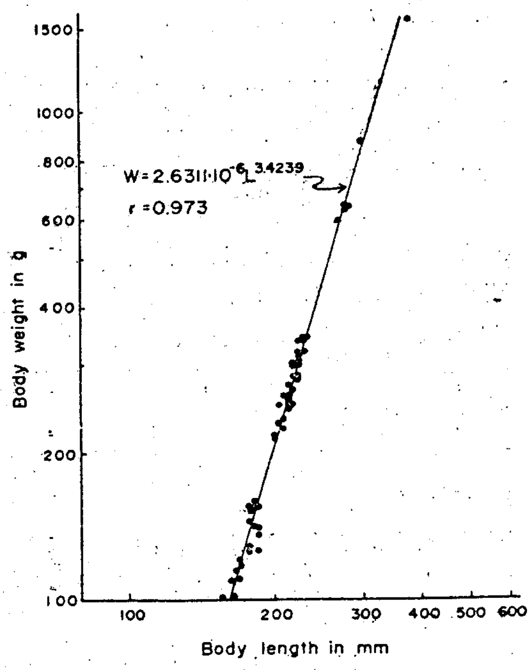


Fig. 3.22 Relation between body length and body weight of batfish, *Platax novemaculeotus.*

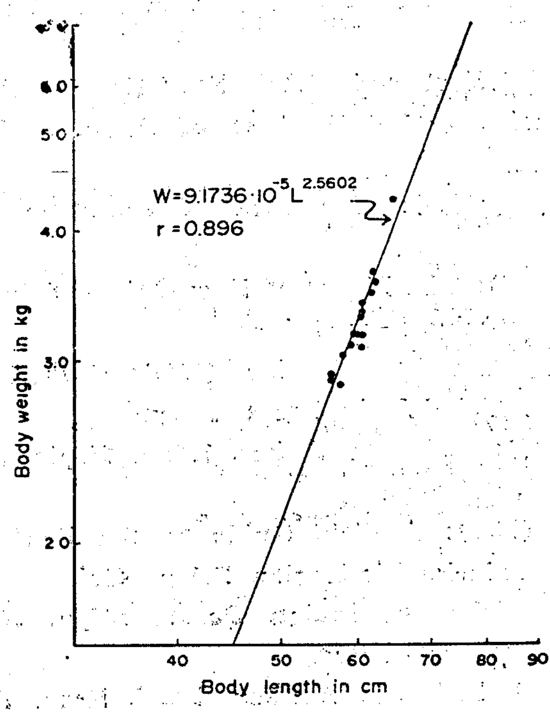


Fig. 3.23 Relation between body length and body weight of great trevally, *Caranx sexfasciatus.*

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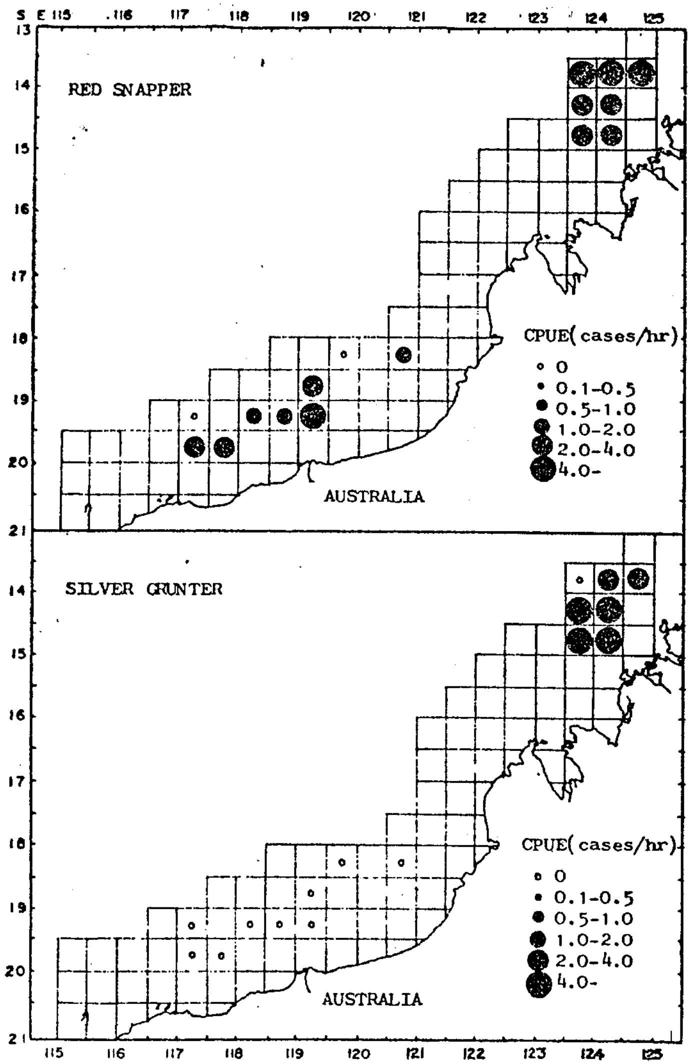
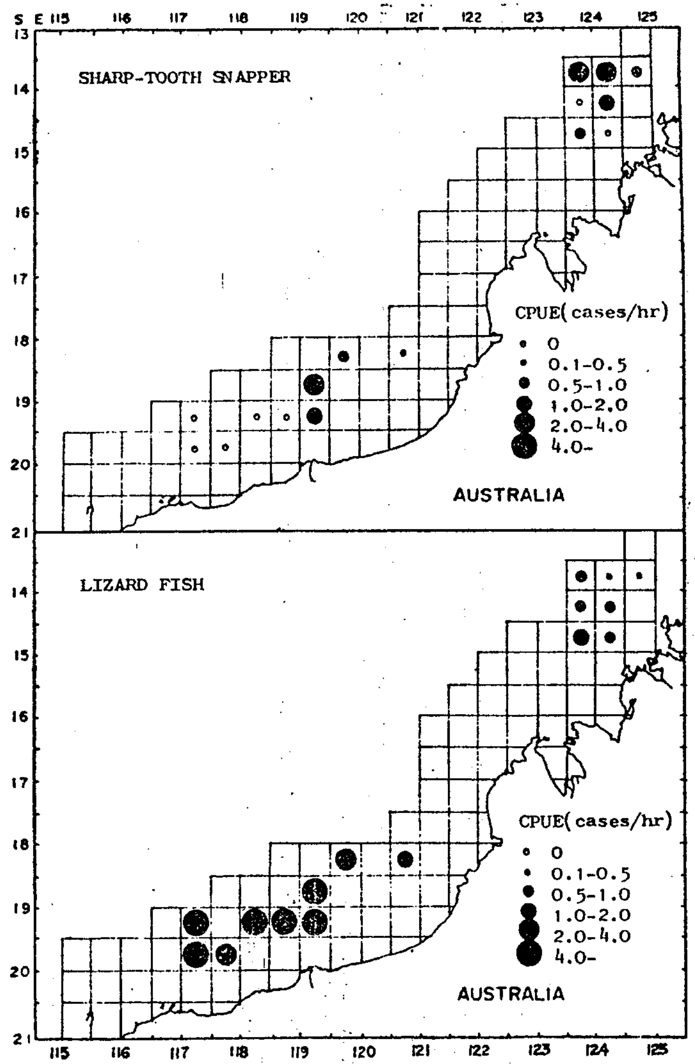
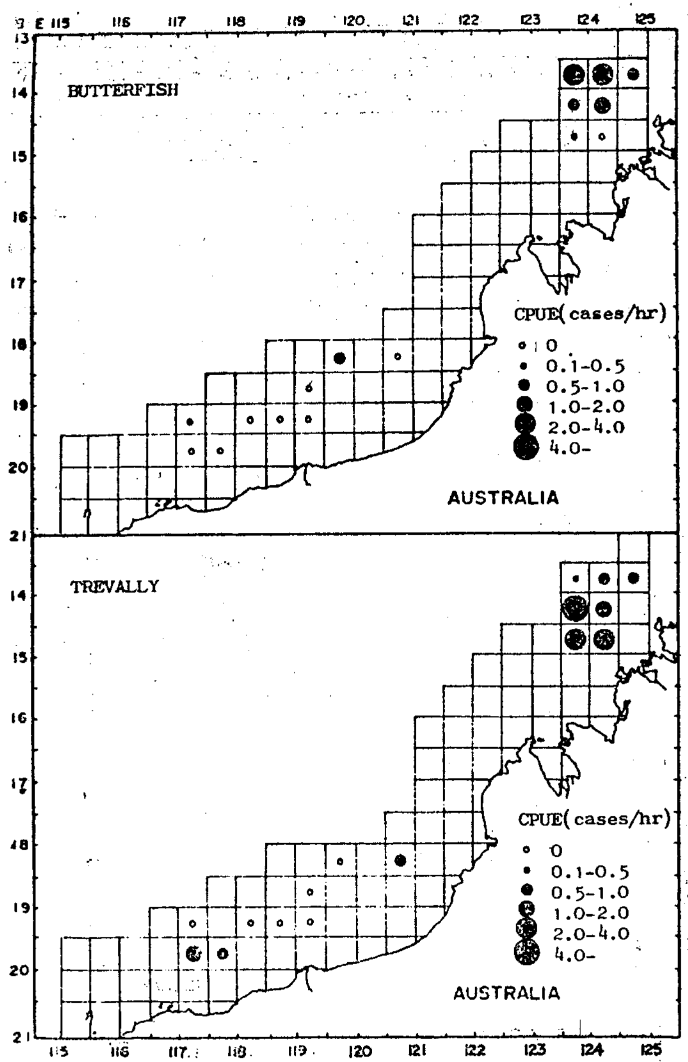


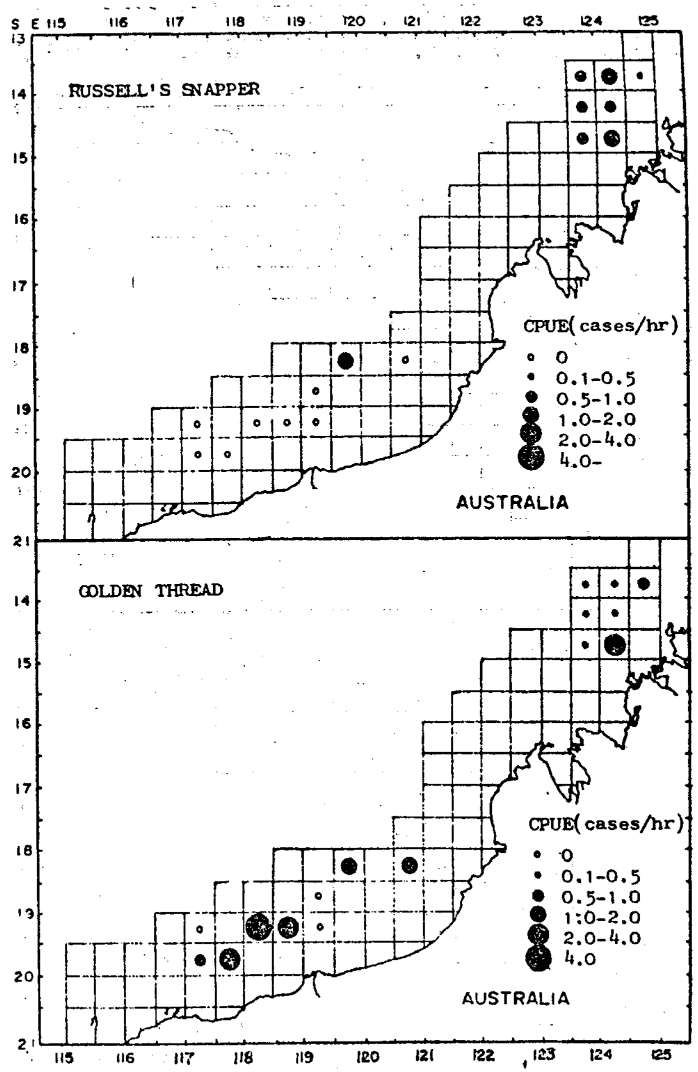
Appendix Fig. 3.1 Geographical distribution of catch rate of red snapper and silver grunter.



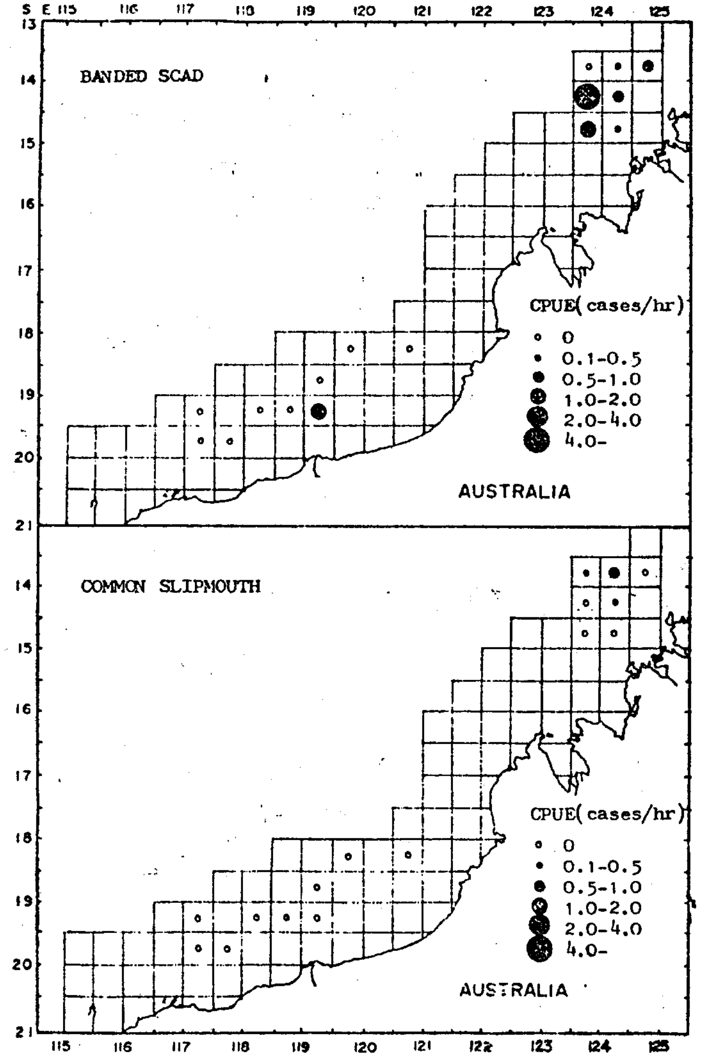
Appendix Fig. 3.2 Geographical distribution of catch rate of sharp-tooth snapper and lizard fish.



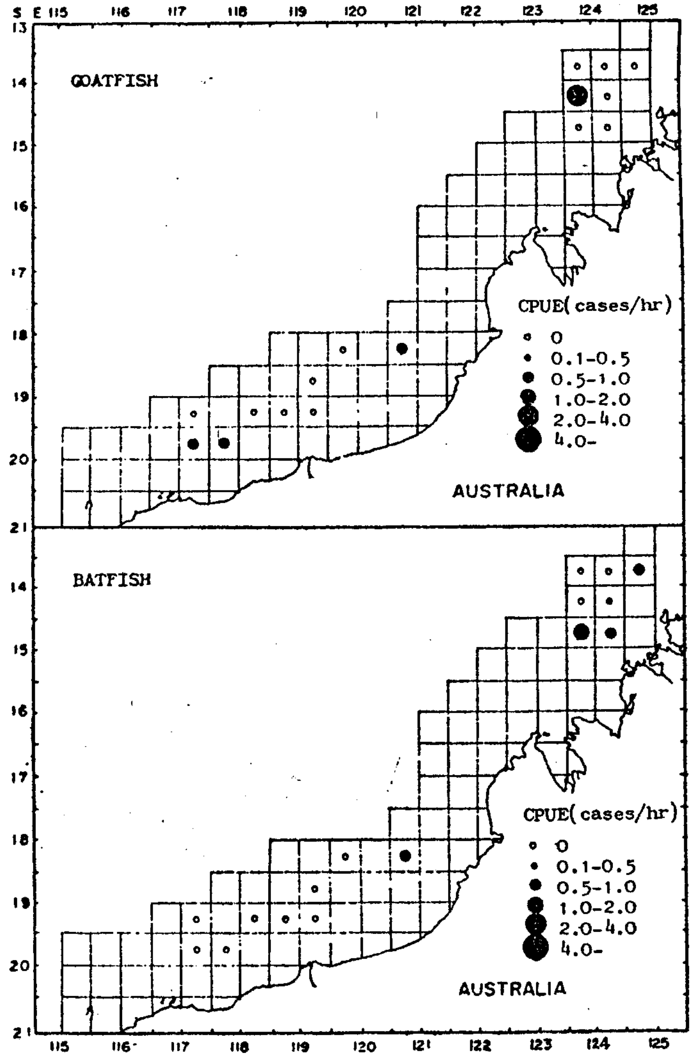
Appendix Fig. 3.3 Geographical distribution of catch rate of butterfish and trevally.



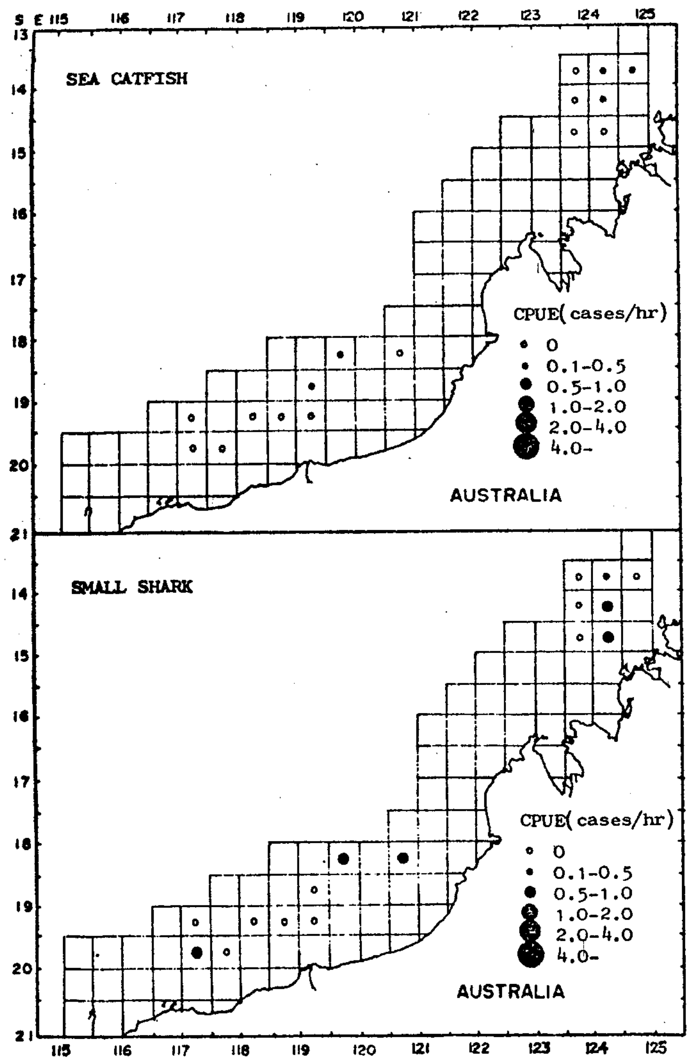
Appendix Fig. 3.4 Geographical distribution of catch rate of Russell's snapper and golden thread.



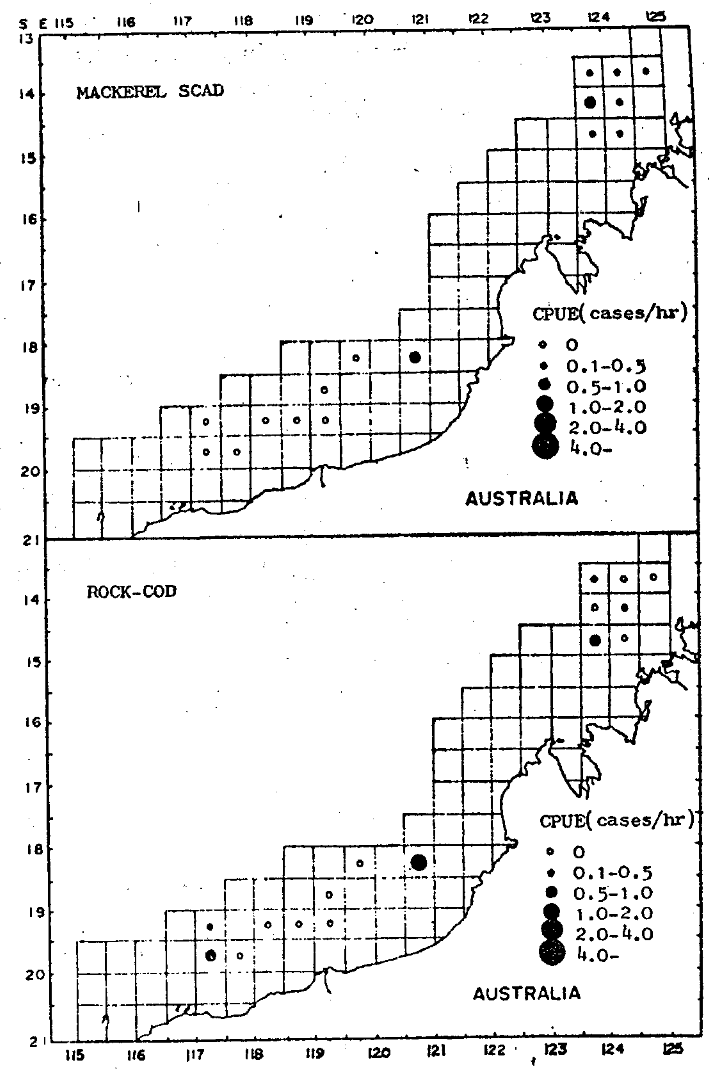
Appendix Fig. 3.5 Geographical distribution of catch rate of banded scad and common slipmouth.



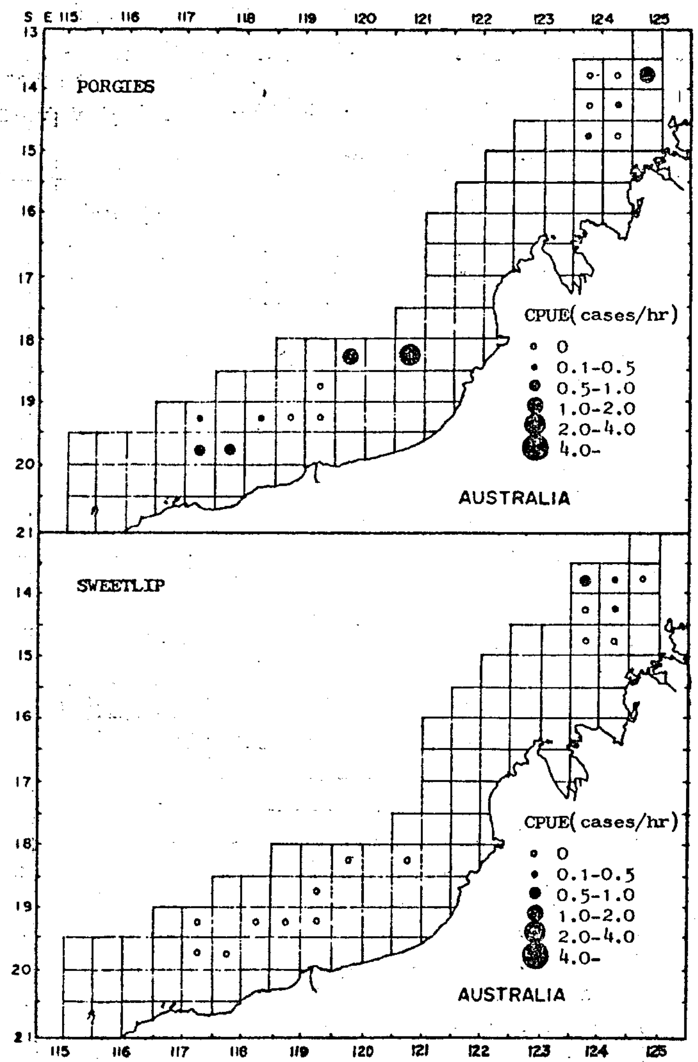
Appendix Fig. 3.6 Geographical distribution of catch rate of goatfish and batfish.



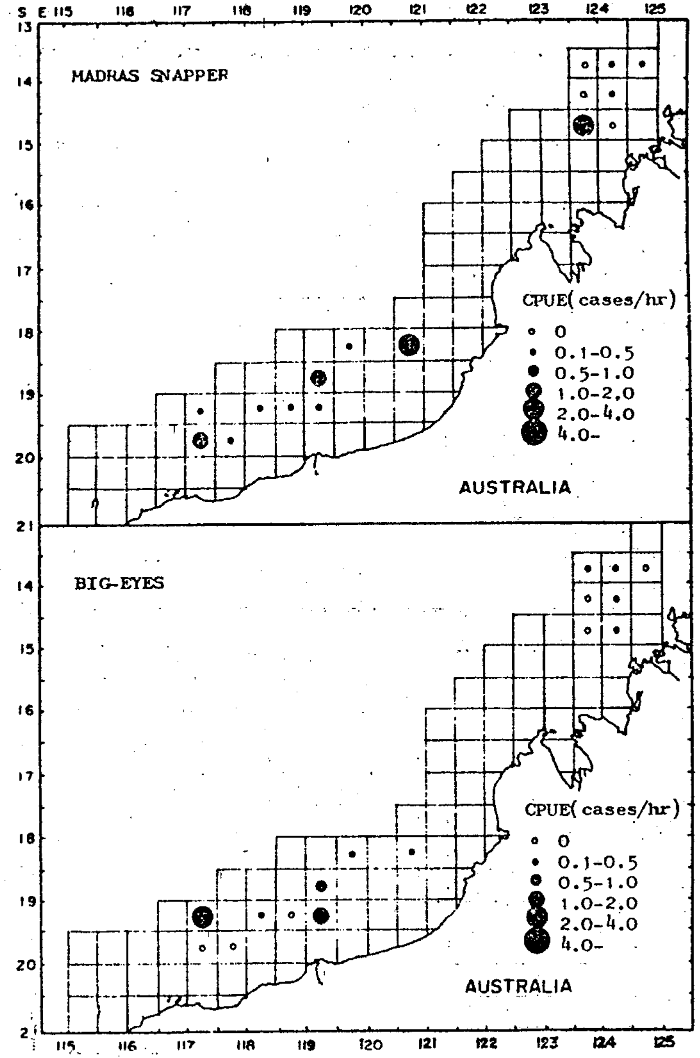
Appendix Fig. 3.7 Geographical distribution of cathcⁱrate of sea catfish and small shark.



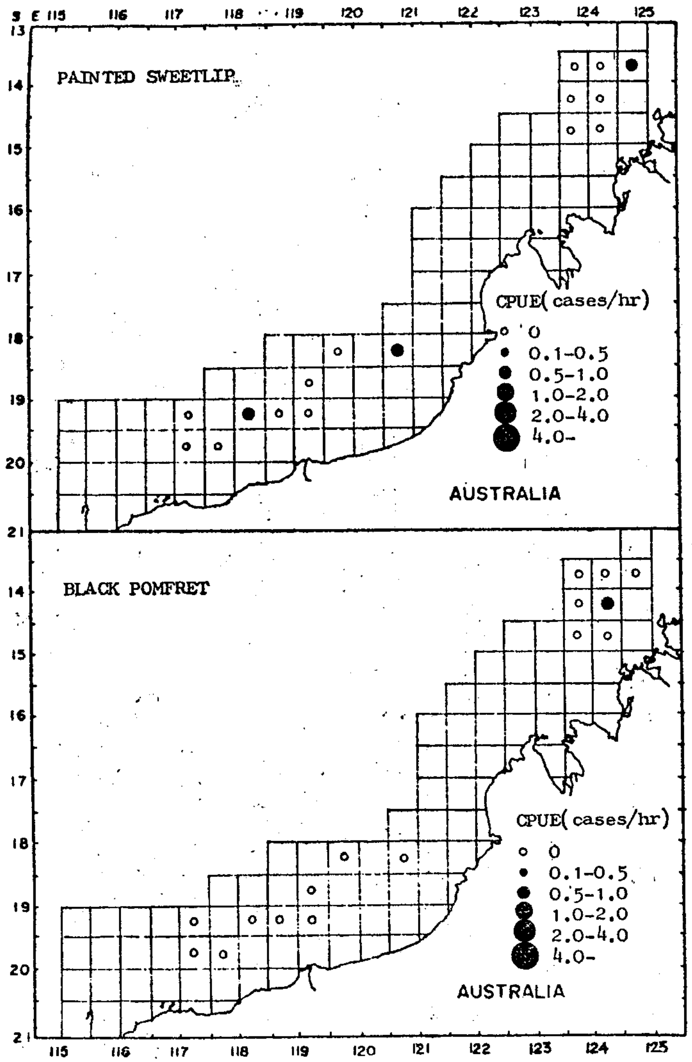
Appendix Fig. 3.8 Geographical distribution of catch rate of mackerel scad and rock-cod.



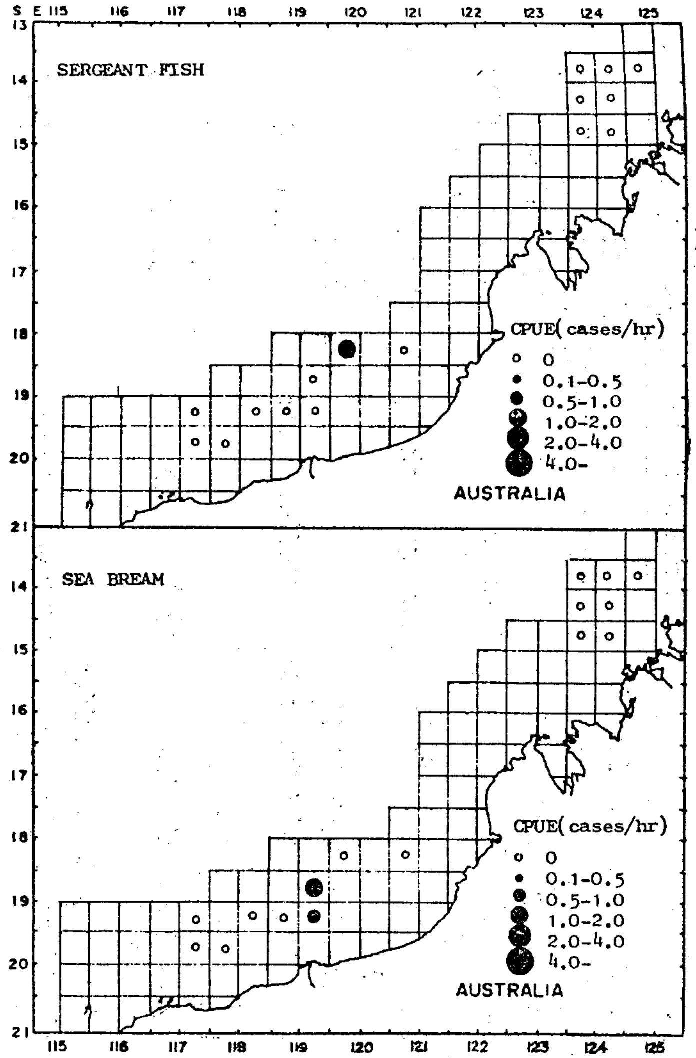
Appendix Fig. 3.9 Geographical distribution of catch rate of porgies and sweetlip.



Appendix Fig. 3.10 Geographical distribution of catch rate of Madras snapper and big-eyes.



Appendix Fig. 3.11 Geographical distribution of catch rate of painted sweetlip and black pomfret.



Appendix Fig. 3.12 Geographical distribution of catch rate of sergeant fish and sea bream.

Appendix Table 3.1 List of fish species taken by R/V Hai-kung from northwest shelves of Australia in March-April 1979.

Family & Species	English name	Chinese name (Commercial name)
I. Family Heterodontidae		異齒鮫科
1. Heterodontus zebra (Gray)	Port Jackson shark	斑紋異齒鮫（虎頭沙）
II. Family Orectolobidae		鬚 鮫 科
2. Stegostoma fasciatum (Hermann)	Zebra shark	大尾虎鮫（長尾虎沙）
3. Ginglymostoma ferrugineum (Lesson)	Tawny shark	銹 鬚 鮫
III. Family Scyliorhinidae		貓 鮫 科
4. Halaelurus burgeri (Muller & Henle)	Spotted catshark	豹　　鮫（狗沙）
IV. Family Isuridae		食人鮫科
5. Carcharodon carcharias (Linnaeus)	White shark	食 人 鮫（煙仔沙舅）
V. Family Carcharhinidae		白眼鮫科
6. Carcharhinus longimanus (Poey)	White-tip shark	汚斑白眼鮫（大翅仔）
7. Carcharhinus coatesi (Whitley)	Coates' shark	科氏白眼鮫（沙條）
8. Carcharhinus spallanzani (Le Sueur)	Black-tip shark	汚翅白眼鮫（沙條）
9. Loxodon macrorhinus Muller & Henle	Sliteye shark	沙仔曲齒鮫（沙條）
10. Negogaleus microstoma (Bleeker)	Weasel shark	小口沙條鮫（沙條）
11. Galeocerdo cuvier (Le Sueur)	Tiger shark	鼬　　鮫（烏沙）
VI. Family Triakidae		平滑鮫科
12. Mustelus manazo (Bleeker)	White-spot gummy shark	星 貂 鮫（花點母）
VII. Family Sphyrnidae		雙髻鮫科
13. Sphyrna lewini (Griffith)	Hammer-head shark	紅肉雙髻鮫（雙髻沙、雙過沙）
VIII. Family Squalidae		棘 鮫 科
14. Squalus megalops (Macleay)	Skittle dog	短吻棘鮫（刺沙）
IX. Family Squatinidae		琵琶鮫科
15. Squatina tergocellata Mc Culloch	Ornate Angel shark	澳洲琵琶鮫
X. Family Pristidae		鋸 鱝 科
16. Pristispsis zijsron Bleeker	Sawfish	鋸　　鱝（劍沙）

XI. Family Torpedinidae		電鱝科
17. Narcine tasmaniensis Richardson	Little numbfish	木鏟電鱝 (電魴)
18. Hypnos monopterygium(Shaw & Nodder)	Numbfish	電　鱝 (電魴)
XII. Family Rhynchobatidae		龍文鱝科
19. Rhynchobatus djiddensis (Forsskal)	White-spotted shovelnose-ray	吉打龍文鱝 (龍文沙)
20. Rhina ancylostoma Bloch & Schneider	Shark ray	波口鰲頭鱝 (鰲頭沙)
XIII. Family Rhinobatidae		琵琶鱝科
21. Rhinobatos bougainvillii (Muller & Henle)	Bougainville's shovelnose-ray	鮑氏琵琶鱝 (犁頭沙)
XIV. Family Rajidae		鯆魮科
22. Raja australis Macleay	Common skate	澳洲老板鯆 (魴仔)
XV. Family Urolophidae	–	平魟科
23. Urolophus testaceus (Muller & Henle)	Common stingray	平　魟
XVI. Family Dasyatidae		土魟科
24. Dasyatis uarnak (Forsskal)	Long-tailed ray	豹紋土魟 (長尾魴)
25. Dasyatis kuhlii (Muller & Henle)	Blue-spotted stingray	古氏土魟
XVII. Family Gymnuridae		鳶魟科
26. Gymnura micrura (Bloch & Schneider)	Short-tailed butterfly ray	鳶　魟 (臭尿破魴)
XVIII. Family Myliobatidae		燕魟科
27. Aetomylus nichofii (Bloch & Schneider)	Eagle-ray	青帶圓吻燕魟(燕魴、燕斗)
XIX. Family Albulidae		狐鰮科
28. Albula vulpes (Linnaeus)	Lady fish; Borofish	狐　鯉 (竹篙頭)
XX. Family Muraenidae		鯙　科
29. Gymonothorax woodwardi Mc Culloch	Woodward's eel	吳氏裸胸鯙 (錢鰻)
30. Gymonothorax prasinus (Richardson)?	Green eel	褐裸胸鯙 (錢鰻)
XXI. Family Congridae		穴鰻科
31. Rhynchocymba nystromi (Jordan & Snyder)	Silvery conger	緋穴鰻
XXII. Family Muraenesocidae		海鰻科
32. Muraenesox cinereus (Forsskal)	Pike eel	灰海鰻 (海鰻、狼牙)

33. Oxyconger leptognathus (Bleeker)	Long-nose Pik eel	狹頜海鰻
XXIII. Family Nettastomidae		鴨嘴鰻科
34. Chlopsis fierasfer Jordan & Snyder	Wire eel	線尾鴨嘴鰻
XXIV. Family Ophichthyidae		蛇鰻科
35. Pisoodonophis cancrivorus (Richardson)	Burrowing snake-eel	食蟹荳齒蛇鰻（鰊仔）
XXV. Family Clupeidae		鯡科
36. Harengula koningsbergeri (Weber & De Beauford)	Spotted herring	青鱗魚（青鱗仔）
37. Pellone ditchela Valenciennes	Ditchelee	庇隆鰳（青鱗仔）
XXVI. Family Engraulidae		鯷科
38. Stolophorus heterdobus (Rüppell)	East Indian anchovy	異葉銀帶鰶（硬骨鰟）
XXVII. Family Chirocentridae		寶刀魚科
39. Chirocentrus dorab (Forsskal)	Wolf herring	寶刀魚（西刀）
XXVIII. Family Synodotidae		合齒科（狗母魚科）
40. Saurida tumbil (Bloch)	Common saury	錦鱗蜥魚（白狗母）
41. Saurida undosquamis (Richardson)	Large-scaled saury	正蜥魚（紅狗母）
42. Synodus smilis McCulloch	Streaky lizardfish	褐狗母（小狗母）
43. Trachinocephalus myops (Schneider)	Painted saury	短吻花狗桿魚（臭腥公仔）
XXIX. Family Ariidae		海鯰科
44. Arius thalassina (Rüppell)	Giant salmon catfish	泰來海鯰（海鯰；成仔魚）
XXX. Family Plotosidae		鰻鯰科
45. Plotosus anguillaris (Bloch)	Striped catfish	鰻鯰（沙毛）
XXXI. Family Brotulidae		鼬魚科
46. Monomitopus sp.	Blindfish	單鬚鼬魚
XXXII. Family Carapidae		隱魚科
47. Jordanicus gracilis (Bleeker)	Lipless Mess mate-fish	隱魚
XXXIII. Family Lophiidae		鮟鱇科
48. Lophiomus setigerus (Vahl)	Fishing frog	鮟鱇
XXXIV. Family Oncocephalidae		棘茄科
49. Halieutaea stellata (Vahl)	Starry handfish]	棘茄魚
XXXV. Family Batrachoididae		蟾魚科
50. Batrachomoeus trispinosus (Gunther)	Estuarine frogfish	三棘蟾魚
XXXVI. Family Psettodidae		大口鰈科

51. Psettodes erumei (Bloch & Schneider)	Queensland halibut	大口鰈
XXXVII. Family Bothidae		左鰈科
52. Grammatobothus polyophthalmus (Bleeker)	Three-spot flounder	三斑左鰈
53. Grammatobothus pennatus (Ogilby)	Pennant flounder	羽冠三斑左鰈
54. Pseudorhambus dupliciocellatus Regan	Cartwright's flounder	三雙斑扁魚
55. Pseudorhambus diplospilus Norman	Twin-spot flounder	四雙斑扁魚
56. Pseudorhambus quinquocellatus Weber & De Beanfort	Five spot flounder	五斑扁魚
57. Pseudorhambus elevatus Ogilby	Deep flounder	高身扁魚
58. Engyprosodon grandisquamma (Temminck & Schlegel)	Spiny-headed flounder	達摩鰈
XXXVIII. Family Soleidae		右鮃科
59. Aesopia cornuta Kaup	Horned sole	角鰨沙
XXXIX. Family Cynoglossidae		左鮃科
60. Cynoglossus robustus Günther	Tongue sole	短壯鞋底魚 (牛舌)
XL. Family Triacanthidae		三棘魨科
61. Pseudotriacanthus strigilifer (Cantor)	Tripodfish	準三棘魨
XLI. Family Baustidae		皮剝魨科
62. Abalistes stellatus (Lacepede)	Starry triggorfish	扁尾皮剝魨
63. Balistes ringens Linnaeus	Brown-lined triggerfish	線紋皮剝魨
64. Balistes sp.	Triggerfish	環領皮剝魨
65. Pseudobalistes fuscus Bloch & Schneider	Brown triggerfish	準皮剝魨
XLII. Family Monacanthidae		單棘魨科
66. Chaetodermis spinosissimus (Ouey & Gaimard)	Prickly leatherjacket	鬚單棘魨
67. Navodon modestus(Gunther)	Leather-jacket	馬面單棘魨
68. Thamnaconus fajardoi Smith?	Leather-jacket	長尾單棘魨
69. Stephanolepis cirrhifer (Temminck & Schlegel)?	Leather-jacket	曳絲單棘魨
70. Scobinichthys sp.	Leather-jacket	單棘魨
XLIII. Family Ostraciontidae		鎧魨科 (箱河魨科)
71. Lactoria diaphanus Linnaeus	Diaphanous cowfish	角棘四稜鎧魨

72. Rhinesomus gibbosus (Linnaeus)	Boxfish	駝背五稜鎧魨
73. Rhynchostracion rhinorynchus (Bleeker)	Small-nosed boxfish	五稜鎧魨
XLIV. Family Tetraodontidae		四齒魨科（河魨科）
74. Canthigaster rivulatus (Temminck & Schlegel)	Toadfish	條紋河魨
75. Pleuranacanthus sclerulus (Forster)	Silver-cheeked Toadfish	仙人河魨
76. Lagocephalus laevigatus inermis (Temminck & Schlegel)	Silver toadfish	滑背河魨
77. Lagocephalus lunaris lunaris (Bloch & Schineider)	Silver toadfish	栗色河魨
78. Amblyrhynchotes hypselogenion (Bleeker)	Bar-cheeked toad fish	縱帶河魨
79. Arothron stellatus (Bloch & Schineider)	Starry toadfish	模樣河魨
80. Fugu sp.	Toadfish	斑紋河魨
XLV. Family Diodontidae		二齒魨科（刺河魨科）
81. Dicotylichthys myersi Ogilby	Myer's porcupine-fish	三斑短刺河魨
82. Tragulichthys jaculiferus (Cuvier & Valenciennes)	Spiny puffers	三斑長刺河魨
XLVI. Family Veliferidae		草 鰺 科
83. Velifer hypselopterus Bleeker	Wing-fish	草 鰺
XLVII. Family Holocentridae		金鱗魚科
84. Ostichthys japonicus (Cuvier & Valenciennes)	Deep body soldier fish	金 鱗 魚
85. Myripristis murdjan (Forsskal)	Crimson squirrel-fish	赤 松 毬
86. Adioryx ruber (Forsskal.)	Red squirrelfish	黑帶金鱗魚
XLVIII Family Monocentridae		松毬魚科
87. Monocentrus japonicus (Houttuyn)	Pine cone Fish	松 毬 魚
IL. Family Fistulariidae		馬鞭魚科
88. Fistularia petimba Lacepede	Smooth flutemouth	馬 鞭 魚
L. Family Centriscidae		蝦 魚 科
89. Centriscus scutus Linnaeus	Groove razor-fish	蝦 魚
LI· Family Zeidae		的 鯛 科
90. Zeus faber Linnaeus	John Dory	的 鯛
LII. Family. Antigonidae		菱 鯛 科
91. Antigonia capros Lowe	Rosy boarfish	高 菱 鯛

LIII. Family Scorpaenidae		鮋科
92. Sebastiscus marmoratus (Cuvier & Valenciennes)	Red rock-cod	石狗公
93. Pterosi russelli Bennet	Russell's firs-fish	魯氏簑鮋
94. Apistus carinatus (Bloch & Schneider)	Short-spined wasp-fish	鬚鮋
LIV. Family Synanceiidae		毒鮋科
95. Inimicus didactylus (Pallas)	Demon stinger	双指毒鮋
96. Erosa erosa (Langsdorf)	Monkey-fish	達摩毒鮋
LV. Family Congiopodidae		絨鮋科
97. Erisphex potti (Steindachner)		絨鮋
LVI. Family Platycephalidae		牛尾魚科
98. Platycephalus arenarius Ramsay & Ogilby	Sand flathead	大牛尾魚
99. Cociella crocodilus (Tilesius)	Flathead	鱷形牛尾魚
LVII. Family Triglidae		角魚科
100. Pterygotrigla hemisticta (Temminck & Schlegel)	Gurnard	深海角魚
101. Lepidotrigla abyssalis Jordan & Starks	Gurnard	角魚
LVIII. Family Peristediidae		黃魴鮄科
102. Peristedion oriental Temminck & Schlegel	Smooth-nose searobin	黃魴鮄
LIX. Family Dactylopteridae		飛角魚科
103. Dactyloptena orientalis (Cuvier & Valenciennes)	Purple flyinggurnard	飛角魚
LX. Family Sphyraenidae		金梭魚科
104. Sphyraena jella Cuvier & Valenciennes	Slender sea-pike	竹梭魚
105. Sphyraenella flavicauda (Rüpple)	Short-jawed sea-pike	金梭魚
LXI. Family Scombridae		鯖科
106. Rastrelliger canagusta (Cuvier)	Rake-gilled mackerel	金帶鯖(花飛)
107. Sarda orientalis (Temminck & Schlegel)	Oriental bonito	齒鰹(煙仔虎)
108. Auxis thazard (Lacepede)	Frigate mackerel	平花鰹(考流煙)
109. Scomberomorus commersoni (Lacepede)	Narrow-barred Spanish mackerel	土托鰆
110. Scomberomorus guttatus (Bloch & Schneider)	Spotted Spanish mackerel	白腹鰆
LXII. Family Gempylidae		帶鰆科

111. Rexea solandri (Cuvier)	King barracouta	梭倫魣
LXIII. Family Trichiuridae		白帶魚科
112. Trichurus coxii Ramsay & Ogilby	Australian hairtail	白帶魚
LXIV. Family Ephippidae		銀鉠科
113. Platax novemaculeatus Mc Culloch	Short-finned batfish	銀 鯧 (銀鯧、鏡鯧)
114. Platax orbicularis (Forsskal)	Narrow-banded Batfish	尖翅燕魚
LXV. Family Chaetodontidae		蝶魚科
115. Parachaetodon ocellatus (Cuvier & Valenciennes)	Six-spinned butterflyfish	背斑蝶魚
116. Coradion chrysozonus (Cuvier & Valenciennes)	Golden-girdled Caralfish	蝶 魚
117. Chelmo rostratus (Linnaeus)	Beaked coralfish	尖吻蝶魚
118. Heniochus acuminatus (Linnaeus)	Pennant coralfish	白吻雙帶立旗鯛
119. Chaetodontoplus douboulayi (Gunther)	Angelfish	波紋刺蝶魚
120. Chaetodontoplus personifer (McCulloch)	Angelfish	頭斑刺蝶魚
121. Heteropyge sexstriatus (Kuhl & Val Hasselt)	Six-banded angelfish	六線刺蝶魚
LXVI. Pomacentridae		雀鯛科
122. Chromis sp.	Puller	雀 鯛
LXVII. Family Mullidae		鬚鯛科 (秋姑魚科)
123. Upeneus moluccensis (Bleeker)	Goldband goatfish	摩鹿加秋姑魚
124. Parupeneus pleursopilos (Bleeker)	Spotted golden goatfish	海 鯉
125. Parupeneus indicus (Shaw)	Yellow-spot goatfish	印度海鯉
126. Pseudu peneus chrysopleuron (Temminck & Schlegel)	Gold-saddled goatfish	紅鱸魚
LXVIII. Family Branchiostegidae		馬頭魚科
127. Branchiostegus japonicus japonicus (Houttuyn)	Tile fish	紅馬頭魚
LXIX. Family Apogonidae		天竺鯛科
128. Gronovichthys atripes (Ogilby)	Two-eyed cardinalfish	眼斑天竺鯛
129. Lovamia septemstriata (Gunther)	Seven banded Soldier-fish	七帶天竺鯛

130. Apogonichthys ocellatus (Weber)	Ocellated cardinal-fish	背斑天竺鯛
131. Apogon sp.	Cardinal-fish	天竺鯛
LXX. Family Priacanthus		大眼鯛科 (紅目鰱科)
132. Priacanthus macracanthus Cuvier & Valenciennes.	Red bigeye	紅目鰱
133. Priacanthus tayenus Richardson	Purple-spotted bigeye	曳絲紅目鰱
134. Priacanthus sp.	Bigeye	大眼鯛
LXXI. Family Acropomidae		螢石魞科
135. Acropoma sp.		螢石魞
LXXII. Family Glaucosomidae		青葉鯛科
136. Glaucosoma burgeri Richardson	Grey bigmoath bream	青葉鯛
137. Glaucosoma fauvelii Sauvage	Banded bigmouth bream	條紋青葉鯛
138. Glaucosoma magnificus Ogilby	Threadfin bigmouth bream	曳絲青葉鯛
LXXIII. Family Histiopteridae		旗鯛科
139. Histiopterus types Temminck & Schlegel	Boarfish	旗鯛
LXXIV. Family Serranidae		鱸科
140. Diploprion bifasciatum (Kuhl & Van Hasset)	Two-banded perch	雙帶鱸
141. Epinephelus latifasciatus (Temminck & Schlegel)		寬帶石斑
142. Epinephelus amblycephalus (Bleeker)	Blunt-headed rock-Cod	鑲點石斑
143. Epinephelus epistictus (Temminck & Schlegel)		小紋石斑
144. Epinephelus rankini Whitley	Rankin's rock-cod	褐石斑
145. Epinephelus akaara (Temminck & Schlegel)	Yellow-grouper	條紋石斑
146. Epinephelus fasciatus (Forsskal)	Black-tipped rock-cod	小石斑
147. Plectropomw maculatum (Bloch)	Coral-cod	豹鱠
LXXV. Family Sciaenidae		石首科
148. Miichthys sp.	Croaker	鮸魚
149. Pseudosciaena axillaris (Cuvier)	Black-spot jewfish	春只
LXXVI. Family Sillaginidae		沙鮻科

150. Sillago ciliata Cuvier & Valenciennes	Sand whiting	沙　鮻（沙腸仔）
LXXVII. Family Gerridae		鑽 嘴 科
151. Pentaprion longimanus (Cantor)	Lorg-fined silver biddy	長臂鑽嘴
LXXVIII. Family Nemipteridae		金 線 科
152. Pentapodus nagasakiensis (Tanaka)	Nagaskiens theradfin- bream	長崎金帶鯛
153. Pentapodus setosus (Valenciennes)	Paradisefish	三帶金帶鯛
154. Nemipterus peronii (Valenciennes)	Rose threadfin brean	裴氏紅姑魚（無線金線）
155. Nemipterus virgatus (Houftuyn)	Golden threadfin bream	七帶紅姑魚（七帶金線）
156. Nemipterus bathybicus (Snyder)	Yellowbelly threadfin bream	三帶紅姑魚（三帶金線）
157. Namipterus hexodon (Ouoy & Gaimard)	Ornate threadfin brean	虹色紅姑魚（黃尾金線）
158. Nemipterus delagoae Smith	Delagoa threadfin bream	紅姑魚之一種（無絲金線）
LXXIX. Family Sparidae		鯛　科
159. Gymnocranius griseus (Temminck & Schlegel)	Grey large-eye bream	白　鱲（白嘉鱲）
160. Argyrops spinifer (Forsskal)	Long-spined snapper	長 旗 鯛（長旗盤仔）
161. Argyrops berda (Forsskal)	Pikey brean	黃 鰭 鯛（赤翅仔）
162. Dentex tumifrons (Temminck & Schlegel)	Yellowback sea bream	赤　鯮
LXXX. Family Lethrinidae		龍 占 科
163. Lethrinus miniatus (Bloch & Schneider)	Long-nosed emperor	長吻龍占（猪哥喬）
164. Lethrinus lentjan (Lacepede)	Red spot emperor	紅點龍占
165. Lethrinus nematacanthus Bleeker	Thread-fin emperor	絲棘龍占
166. Lethrinus sp. 1	Emperor	龍　占
167. Lethrinus sp. 2	Emperor	紅點青龍占
LXXXI. Family Lutjanidae		笛 鯛 科
168. Lutjanus argentimaculatus (Forsskal)	Mangrove red snapper	銀紋笛鯛
169. Lutjanus johni (Bloch)	John's snapper	約翰氏笛鯛
170. Lutjanus rivulatus (Cuvier & Valenciennes)	Blue-spotted snapper	海鷄母笛鯛
171. Lutjanus lutjanus Bloch	Rosy snapper	正 笛 鯛（赤筆）

172. Lutjanus lineolatus (Ruppell)	Bigeye snapper	琴絃笛鯛（火燒仔）
173. Lutjanus spilurus(Bennett)	Blue-line snapper	六線笛鯛
174. Lutjanus russelli (Bleeker)	Russell's snapper	黑星笛鯛（黑點仔）
175. Lutjanus caeruleovittaus (Cuvier & Valeuciennes)	Nine-line snapper	九線笛鯛
176. Lutjanus sebae (Cuvier & Valenciennes)	Emperor red snapper	川紋笛鯛（赤海）
177. Lutjanus sanguineus (Cuvier)	Red snapper	赤海笛鯛（赤海）
178. Lutjanus altifrontalis Chan	High-frontal red snapper	隆額笛鯛（赤海）
179. Lutjanus monostigma (Cuvier & Valenciennes)	One-spot snapper	單斑笛鯛
180. Lutjanus sp.1	Red snapper	（紅赤海）
181. Lutjanus sp.2	Red snapper	（黑赤海）
182. Lutjanus janthinuropterus (Bleeker)	Yellow streaked snapper	黃足笛鯛
183. Pristipomoides multidens (Day)	Sharptooth snapper	長 笛 鯛（長鯛）
184. Coesio lunaris Cuvier & Valenciennes	Rising-moon fusilier	花烏尾冬
185. Coesio chrysozonus Cuvier	Bananafish	金帶烏尾冬
LXXXII. Family Pomadasyidae		石 鱸 科
186. Plectorhynchus pictus (Thunberg)	Painted sweetlips	細鱗石鱸（加苡）
187. Hapalogeny kishinouyei Smith & Pope	Kishinouye's grunt	岸上氏髭鯛（石鯽）
188. Scolopsis eriomma Jordan & Richardson	Rose monoclebream	海　　䲁
189. Scolopsis temporalis (Cuvier)	Rainbow monoclebream	花吻赤尾冬（海猪哥）
190. Pomadasys maculatus (Bloch)	Blotched grunt	斑 鷄 魚
191. Pomadasys hasta (Bloch)	Lined silver grunt	黑 鷄 魚（金龍）
LXXXIII. Family Teraponidae		條紋鷄魚科
192. Terapon jarbua (Forsskal)	Crescent perch	花身鷄魚（花身）
193. Terapon theraps Cuvier & Valenciennes	Banded trumpeter	條紋鷄魚（外海花身）
LXXXIV. Family Carangidae		鰺　科
194. Megalaspis cordyla (Linnaeus)	Finny scad	扁 甲 鰺（鐵甲）
195. Decapterus lajang Bleeker	Round scad	拉 疆 鰺（圓鰺）
196. Decapterus maruadsi (Temminck & Schlegel)	Bule mackerel scad	銅 鏡 鰺（四破）

197. Decapterus russellii (Ruppell)	Russell's mackerel scad	紅瓜鰺 (赤尾)
198. Decapterus kurroides akaadsi Abe	Round scad	安朋鰺 (赤尾)
199. Trachurops crumenophthalmus (Bloch)	Purse-eye scad	白 鰺 (目孔)
200. Alectis ciliaris (Bloch)	Pennant fish	白鬚鰺
201. Alectis indica (Rüppell)	Mirror fish	印度白鬚鰺
202. Gnathanodon speciosus (Forsskal)	Golden trevally	無齒鰺
203. Atule djeddaba (Forsskal)	Banded scad	吉打鰺
204. Uraspis helvolus (Forsskal)	Basset-Hull's trevally	冲 鰺
205. Caranx bucculentus Alleyne & Macleay	Blue-spotted trevally	擬浪人鰺 (平鰺)
206. Caranx sexfasciatus Ouoy & Gaimard	Great trevally	六帶鰺 (老成魚：牛港郭)
207. Carangoides ferdan (Forsskal)	trevally	印度平鰺 (平鰺)
208. Carangoides coeruleopinnatus (Ruppell)	Deep-body trevally	靑羽鰺 (平鰺)
209. Carangoides chrysophrys (Cuvier)	Long-nosed trevally	冬瓜鰺 (平鰺)
210. Carangoides malabaricus (Bloch)	Malabar trevally	瓜子鰺 (平鰺)
211. Zonichthys nigrofasciatus (Rüppell)	Black-banded kingfish	小鮒鰺 (黑鮒)
212. Scomberides commersonianus Lacepede	Leatherskin	大口逆鈎鰺 (七星魚)
LXXXV. Family Formionidae		烏鯧科
213. Parastromateus niger (Bloch)	Black pomfret	烏 鯧 (黑鯧)
LXXVI. Family Leiognathidae		鰏 科
214. Leiognathus elongatus (Gunther)	Slender ponyfish	長身鰏 (金錢仔)
215. Leiognathus fasciatus (Lacepede)	Striped pony-fish	條紋鰏 (大金錢仔、三角仔)
216. Leiognathus bindus (Cuvier & Valenciennes)	Orange-fin pony fish	斑都鰏 (金錢仔)
LXXXVII. Family Menider		皮刀魚科
217. Mene maculata (Bloch & Schneider)	Razor trevally	皮 刀
LXXXVIII. Family Rachycentridae		海鱺科

218. Rachycentron canadum (Linnaeus)	Black kingfish	海 鱺
LXXXIX. Family Echeneidae		印 魚 科
219. Echeneis naucrates Linnaeus	Slender suckerfish	長 印 魚
XC. Family Stromateidae		鯧 科
220. Psenopsis humerosus Munro	Northwest ruffe	澳洲瓜子鯧 (肉魚)
XCI. Family Ariommidae		圓 鯧 科
221. Ariomma indica (Day)	Indian driftfish	印度圓鯧 (肉魚)
XCII. Family Champsodontidae		鱷 鰧 科
222. Champsodon snyderi Franz	Sabre-gill	鱷 鰧
XCIII. Family Parapercidae		虎 鱚 科
223. Parapercis sp.	Grubfish	虎鱚之一
XCVI. Family Uranoscopidae		瞻星魚科
224. Ichthyoscopus sp.	Stargazer	斑紋瞻星魚
225. Uranoscopus oligolepis Bleeker	Stargazer	貧鱗瞻星魚
XCV. Family Callionymidae		鼠銜魚科
226. Callionymus kaianus Gunther	Dragonet	尖鼠銜魚
XCVI. Family Labriidae		隆頭魚科
227. Anampses lennard Scott	Chiseltooth-wrasse	青 鸚 鯛
228. Bodianus perditio (Ouoy & Gaimard)	Golden-spot wrasse	紅 鸚 鯛
229. Choerodon cephalotes (Castelnau)	Purple tuskfish	寒 鯛
230. Choerodon sp. 1	Tuskfish	寒鯛之一
231. Choerodon sp. 2	Tuskfish	寒鯛之二
232. Choerodon sp. 3	Tuskfish	寒鯛之三
XCVII. Family Scariidae		鸚歌魚科
233. Scarus ghobban Forsskal	Blue-barred orange parrotfish	青鸚歌魚
XCVIII. Family Siganidae		臭都魚科
234. Siganus canaliculatus (Park)	White-spotted spine foot	網紋臭都魚 (樹魚、象魚)
IC. Family Acanthuridae		粗皮鯛科
235. Acanthurus dussumieri Curier & Valenciennes?	Surgeonfish	杜氏橄欖粗皮鯛

Appendix Table. 3.2 Catch shown by species and by half degree-square of fishing grounds.

Fishing Area	Catch (casese)	Haul	CPUE (cases/hr)	狗母④	赤筆⑪	紅目鰱⑫	龍尖⑬	金線⑧	石斑⑰	石鯽⑭	赤海①	秋姑⑳	黑點仔⑦	長鯛③	肉魚⑤	金龍②	海鯰⑱	鯿魚⑩	平鰺⑥	圓鰺⑮	吉打鰺⑨	赤尾鰺⑯	沙條⑲
3834	52	2	12.47	21	1	14	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
3934	66	2	15.46	27	8	0	3	4	1	0	9	1	0	0	0	0	0	0	5	0	0	0	1
3935	38	1	16.89	7	1	0	2	7	0	0	6	1	0	0	0	0	0	0	2	0	0	0	0
3836	37	1	15.88	13	1	1	1	13	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
3837	31	1	13.78	14	1	0	0	7	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
3838	46	1	19.74	12	1	3	0	0	0	0	16	0	0	4	0	0	0	0	0	0	4	0	0
3738	37	1	17.79	10	4	2	0	0	0	0	7	0	0	5	0	0	1	0	0	0	0	0	0
3639	29	1	12.89	6	1	1	3	4	0	0	0	0	4	2	2	0	1	0	0	0	0	0	0.5
3641	72	2	15.75	9	10	1	12	7	5	0	5	1	0	2	0	0	0	0	4	1	0	0	0.5
2947	61	1	27.11	3	5	0	1	1	1	0	6	0	2	2	1	23	0	0	7	1	3	0	0
2948	46	1	19.33	2	0	1	0	5	0	0	9	0	3	0	0	13	0	0	5	1	1	0	1
2847	76	1	33.78	2	0	0	0	1	0	0	7	5	2	0	2	10	0	0	9	2	10	0	0
2848	369	7	23.09	13	5	4	0	8	1	2	40	0	9	17	17	86.5	1	7	26	6	13	0	4
2747	268	7	17.57	9	0	4	0	5	1	9	90	0	13.5	57	31.5	0	0	3	4	1	0	0	0
2748	783	16	20.18	17	2	3	0	8	0	12	202	0	41	92	96	111	4	34	20	10	11	10	1
2749	142	3	18.44	3	2	0	9	5	0	0	33	0	3	5	7	26	1	0	5	1	5	0	0
Total	2153	48		168	42	34	33	75	9	23	436	8	77.5	186	157.5	269.5	8	44	87	23	47	10	8
Average			19.37																				

Appendix Table 3.3 The percentage of main species in the catch by different fishing areas.

Area	3834		3934		3935		3836		3837		3838		3738		3639		3641		2947		2948		2847		2848		2747		2748		2749	
Ranking No.	sp* no	%	sp no	%	sp no	%	sp no	%	sp no	%	sp no	%	sp no	%	sp no	%	sp no	%	sp no	%	sp no	%	sp no	%	sp no	%	sp no	%	sp no	%	sp no	%
1	4	40.38	4	40.91	4	18.42	4	35.14	4	45.16	1	34.78	4	27.03	4	20.69	13	16.67	2	37.70	2	28.26	2	13.15	2	23.44	1	33.58	1	25.80	1	23.24
2	12	26.92	1	13.64	8	18.42	8	35.14	8	22.58	4	26.09	1	18.92	1	13.79	11	13.89	6	11.48	1	19.57	9	13.15	1	10.84	3	21.27	2	14.18	2	18.31
3	13	3.85	11	12.12	1	15.79	1	8.11	1	9.68	3	8.69	3	13.51	8	13.79	4	12.50	1	9.84	8	10.87	6	11.84	6	7.05	5	11.75	5	12.26	13	6.34
4	11	1.92	6	7.57	13	5.26	11	2.70	22	6.54	9	8.69	11	10.81	13	10.34	8	9.72	11	8.20	6	10.87	1	9.21	3	4.61	7	5.04	3	11.75	5	4.93
5	5	1.92	8	6.06	6	5.26	12	2.70	11	3.22	12	6.52	12	5.41	3	6.90	21	8.33	4	4.92	7	6.52	20	6.58	5	4.61	4	3.36	7	5.24	8	3.52
6	26	0.96	13	4.55	11	2.63	13	2.70	25	3.22	11	2.17	28	5.41	5	6.90	17	6.94	9	4.92	4	4.35	4	2.63	4	3.52	14	3.36	10	4.34	3	3.52
7	22	0.96	17	1.52	20	2.63	25	2.70			28	2.17	18	2.70	29	6.90	1	6.94	23	3.28	12	2.17	7	2.63	9	3.52	8	1.87	6	2.55	6	3.52
8			19	1.52	27	2.63	22	2.70					30	2.70	11	3.45	6	5.56	7	3.28	23	2.17	5	2.63	7	2.44	12	1.49	4	2.17	9	3.52
9			20	1.52											12	3.45	3	2.78	3	3.28	9	2.17	15	2.63	8	2.17	6	1.49	14	1.53	4	2.11
10			22	0.76											18	3.45	27	2.78	13	1.64	15	2.17	8	1.31	10	1.90	10	1.12	10	1.40	7	2.11
11			30	0.76											19	1.72	12	1.39	8	1.64	19	2.17			15	1.63	17	0.37	15	1.28	11	1.41
12																	20	1.39	17	1.64					11	1.35	15	0.37	16	1.28	25	1.41
13																	15	1.39	5	1.64					24	1.35			8	1.02	23	0.70
14																	22	1.39	15	1.64					26	1.35			18	0.51	29	0.70
15																	25	1.39							12	1.08			12	0.38	18	0.70
16																	23	0.69							19	1.08			11	0.26	15	0.70
17																	19	0.69							14	0.54			19	0.13		
18																									18	0.27						
19																									17	0.27						
20																									23	0.13						
21																									22	0.13						
	31	11.54	31	4.55	31	7.89	31	2.70	31	3.22	31	4.35	31	5.41	31	3.45	31	1.39	31	3.28	31	4.35	31	2.63	31	4.06	31	3.73	31	2.30	31	5.63
	32	11.54	32	4.55	32	21.05	32	5.40	32	6.45	32	6.52	32	8.11	32	5.17	32	4.17	32	1.64	32	2.17	32	5.26	32	4.61	32	3.73	32	3.96	32	3.52

* species number

1. Red snapper
2. Silver grunter
3. Sharp-tooth snapper
4. Lizard fish
5. Butter fish
6. Trevally
7. Russell's snapper
8. Golden thread
9. Banded scad
10. Common slipmouth
11. Madras snapper
12. Big-eyes
13. Porgies
14. Sweetlip
15. Mackerel scad
16. Round scad
17. Rock-cod
18. Sea catfish
19. Small shark
20. Goatfish
21. Bared face spinecheek
22. Cuttlefish
23. Batfish
24. Black pomfret
25. Squids
26. Hairtail
27. Painted sweettlip
28. Sea bream
29. Sergeant fish
30. Pearl perch
31. Mixed high value
32. Mixed low value

Ⅳ 底拖網目選擇性研究

范國銓

近年來由於拖網漁業技術顯着的改進以及大幅度的增加漁獲努力的結果，底棲漁業資源的減產日趨嚴重，因此有關當局及各國漁業人士咸感對漁業資源有加以保護的必要，紛紛提出網目限制的議論。

限制網目爲保護底棲漁業資源最有效的方法之一，但是網目對魚類體長的選擇性並非絕對的，而是有一選擇域存在，而選擇域的範圍及特性亦因魚種的不同而異，在選擇域以外的魚類將奚數被捕獲或逃脫，而選擇域內之魚類，將有一部份逃出網外，一部份殘留網內，一般資源保護即以最小成熟魚體長之50%選擇率網目大小爲標準。是以爲期保護資源必先了解各漁場魚種對網目的選擇性。

自從各國相繼設定200海浬經濟水域以來，如何達成漁業合作已成當務之急，然而在漁業合作時各宗主國爲保護本國資源限制網目，多要求合作國提供網目限制的基本資料。本試驗的目的除研究拖網網目對漁獲物的選擇性，作爲漁業資源管理規劃的基本資料外，並以澳洲漁場之現場研究爲中澳漁業合作舖路。

材料與方法

本航次試驗所使用的網具如Fig.4.1所示爲目前一般大型拖網船所流行使用之底拖網。囊網(Cod-end)和覆蓋的外網(Cover net)如Fig.4.2所示，囊網由400D/4150之P.E. 線單線編織而成，外網由380 D/3/15之P.E.線以雙線編織而成，外網網目之目大爲3.0±0.2cm (1knot 2 legs) 囊網網目之目大爲9.0±0.3cm(1knot 2 legs)然實際內徑爲8.0±0.3cm。

本次試驗爲避免覆蓋效果 (masking effect) 而影響試驗的精確性，外網和囊網均不增減目：外網直接附結於最後一截胴網前部(Belly top)以增加外網和囊網的空間。假設外網和囊網在水中展開後之截面積爲圓形則兩網片間相距41cm，囊網底和袋網底間相距 290cm，事實上網具展開時囊網不一定呈理想的圓形，但以本次試驗之網目大小漁獲對象而言，已有足够的空間不會產生覆蓋效果，且囊網底和袋網的距離亦足够當漁獲最佳時亦不妨礙漁獲自囊網自由逃出。

魚體長的測定係採用體長測定板，起網後卽打開外網取出漁獲堆置一旁，然後再將囊網打開，將兩組漁獲各以魚種別分開，測定各別魚種的體長 (全長尾叉長或幅長) 、尾數，復以 1cm 的間隔爲單位，分別統計內、外網每一體長的尾數，魚種學名係由陳春暉鑑定。

試驗結果

一、作業狀況

本試驗於澳洲西北部海面分別在兩不同漁場從事9個網次的試驗，其作業狀況資料於Table 4.1，其中1～6網次於3月18日及19日在南部漁場實施，而7～9網次則於5月5日改在北部漁場作業。其目的在於改變漁場後能够獲得更多的魚種資料，如金龍，黑點，平鯵，赤海，赤筆，鰛，秋姑，條紋鷄魚，在南部漁場中均未曾見及。另一方面可以捕獲體長組成不一樣的同種漁獲，以增加體長頻度分佈求得更加可靠的選擇曲線(Selection curve)。由 Table4.1 可知二漁場之海況類似，表面海水溫度在29.5°C～30.2°C，北部漁場因緯度低表面水溫稍高，水溫日變化不超過0.3°C。水深介於 100～128m。風速最高爲5m/s。底質爲沙，僅第9網次發現少數的珊瑚殘骸，拖網速度均維持3.0節，拖網時間爲下網完畢到起網開始的實際作業時間。爲避免漁獲擠壓而產生大魚逃逸小魚留滯的現象，以及觀測漁獲物的活存率故拖網時間從二小時減少致一小時。

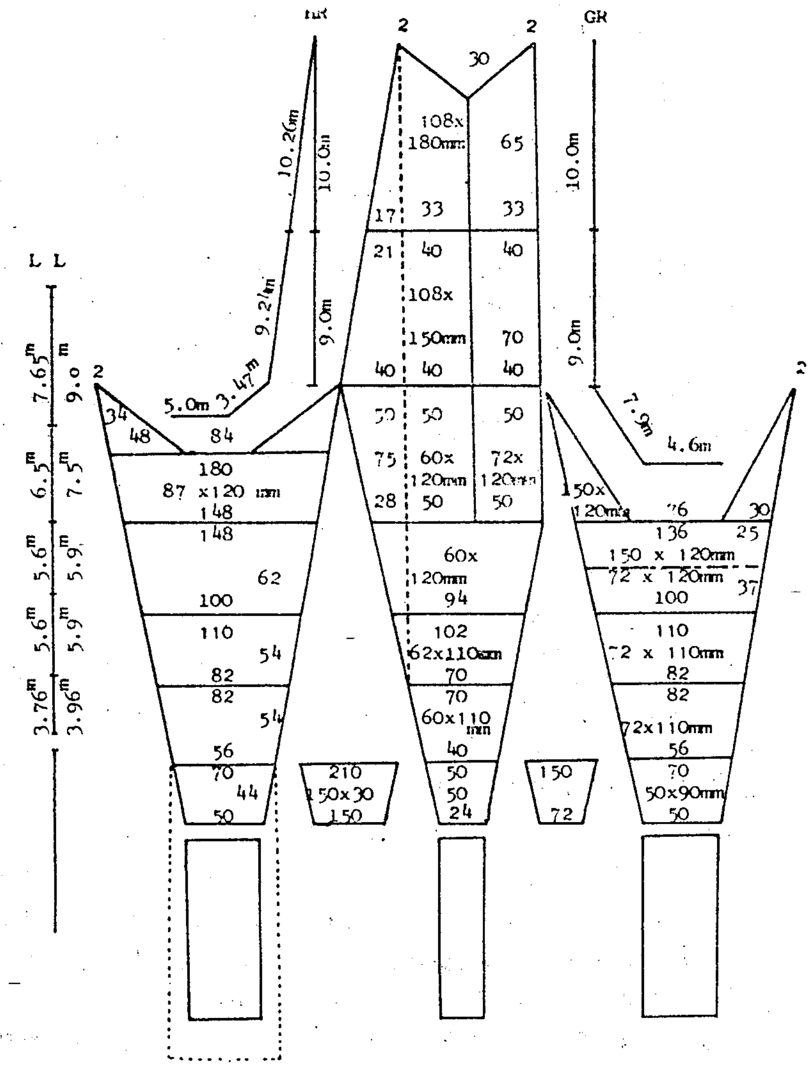


Fig. 4.1 Dimension and construction of trawl net used in this experiment

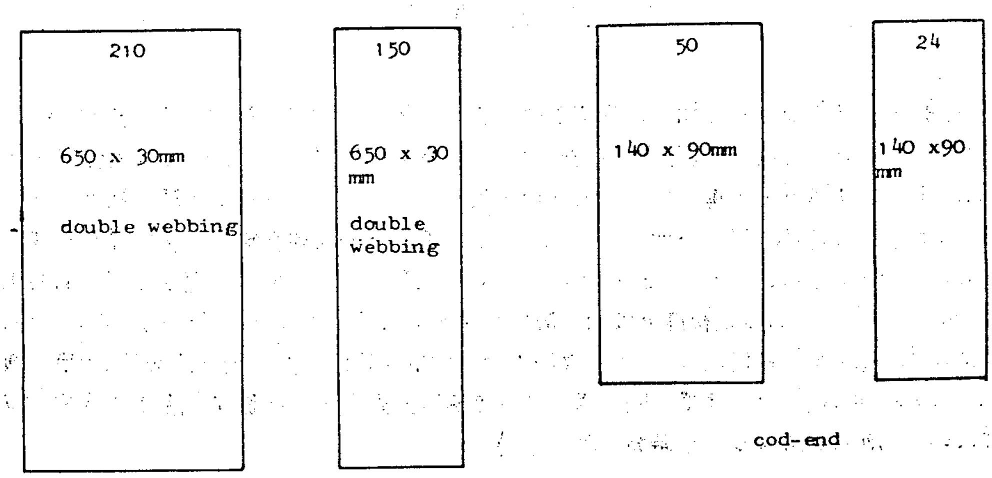


Fig. 4.2 The design of cover net and cod-end

Table 4.1 Data on haulings conducted during mesh experiments

Haul	Date	Location	Beginning of haul		Dur.		Hauling		Course	Depth	Bottom Sediment	Surface Water temperature	Wind	
			(h)	(m)	(h)	(m)	Dis. (miles)	Vel (kt)		(m)		(oC)	Dir	M/S
1	79.3.18	18°20′S 119°59′E	7	30	2	15	6.8	3.0	045°	110	S.	29.8	260	3
2	79.3.18	18°13′S 120°08′E	11	45	2	15	6.8	3.0	065°	112	S.	29.9	200	5
3	79.3.18	18°09′S 120°15′E	14	25	1	20	4.0	3.0	060°	112	S.	29.9	300	4
4	79.3.18	18°05′S 120°22′E	18	50	1	48	5.4	3.0	060°	110	S.	30.0	340	4
5	79.3.19	18°16′S 119°31′E	17	41	1	45	5.3	3.0	235°	128	S.	29.8	230	5
6	79.3.19	18°18′S 119°23′E	19	55	1	45	5.3	3.0	090°	120	S.	29.5	230	5
7	79.5. 5	13°42′S 124°15′E	07	14	0	56	2.8	3.0	265°	120	S.	30.0	-	0
8	79.5. 5	13°48′S 124°10′E	10	15	1	00	3.0	3.0	090°	115	S.	30.0	-	0
9	79.5. 5	14°07′S 124°22′E	14	15	1	15	3.8	3.0	090°	100	S.crl.	30.2	-	0

二、漁獲物組成與選擇率

本次試驗捕獲魚種如 Table 4.2 所示共21種，其各別網次囊網 (Cod-end) 及外網 (Cover net) 捕獲之魚類尾數列於 Table 4.3。

本文所討論的選擇率係採用殘留率 (Retention rate)，即以A代表囊網中魚類總尾數，B代表逃出魚類總尾數，則尾數選擇率 Selection rate 爲$\frac{A}{A+B}$。由 Table 4.3所示得知尾數選擇率爲魚羣體長分布和網目選擇濾過功能的綜合結果。因此不能將尾數選擇率視爲網目本身對該魚種的選擇效果，但却能直接了解該漁場魚種對網具的選擇效果。

由Table 4.3知條紋鷄魚，秋姑和鰮魚之選擇率均爲零，係因該魚種體長較小因此奚數逃出網外，其中條紋鷄魚最大體長爲140mm，秋姑爲 157mm，鰮魚爲 197mm。除此而外低於50%選擇率的魚類尙有九母，金線，金龍，白帶及長鯛，高於70%的魚類有黑點，赤海，銀鯧，河豚，角魚，魟魚。其中角魚因體外有硬棘使網目的濾過性大爲減少，故體長雖小仍有高選擇率，準三棘鮀除具硬棘外鱗片粗糙容易沾附於網上，故雖最大體長僅 168mm仍毫選擇的全部滯留於囊網中。魟魚因體型特殊不易穿越網目。白帶魚 (Hairtails) 體長雖長但因身體柔軟故選擇性仍偏低，九母亦具有相同的效果。因此可知影響尾數選擇率的因素爲魚羣的體長分佈，魚體的外型，柔軟度，活動力及網具的性能。由Table4.3 吾人可明確得知網具對魚羣的選擇效能，但並不表示高於50%尾數選擇率之對象魚類，本網具使用之90mm網目大小卽對該資源構成威脅，因爲資源保護係以所須保護幼魚之最大體長50%選擇率之網目大小爲指標，而不是以該羣對網目的選擇率爲標準。

三、體長頻度分佈與選擇曲線

A.體長頻度分佈：

漁獲種類體長頻度分布如 Fig. 4.3-4.19，其中班點部份表示殘留囊網中漁獲體長組成，白色部份表示逃出囊網被外網羅獲漁獲之體長組成，而黑色部份代表重疊區域，此重疊區域內之體長範圍稱作選擇域 (Selection range)，標準的體長分佈尾數頻度圖，中間爲黑色的選擇域，右邊爲班點的囊網漁獲，左邊爲白色的外網漁獲，如 Fig. 4.3～4.6 之九母，金線，金龍及黑點均爲標準的體長頻度分佈圖，這些圖形表示其漁獲量充份，體長組成分佈適當。 Fig. 4.10 之紅目鰱雖爲相當標準的頻度分佈圖，然漁獲尾數却稍嫌不足。Fig4.7之漁鯰表示外網漁獲不足。 Fig. 4.8 平鯵表示囊網漁獲不足，該現象係因漁場魚體長組成偏大或偏小所致。

B..選擇曲線 (selection curve) 本試驗之選擇曲線如Fig4.20～Fig4.28所示。其相關資料列於 Table 4.4，選擇曲線係將尾數擇率以1cm體長間隔分別計算，然後以選擇率爲縱軸，體長爲橫軸。繪製而成，一般選擇曲線呈「S」形，曲線之兩端平緩斜率較小，中間陡銳斜率較大，有些魚種對試驗網目大小而言體長分佈較爲狹窄，因此選擇曲線僅爲曲線的一部份如Fig4.24之海鯰，至於Fig4.25之平鯵及 Fig4.28 之角魚因上下限附近漁獲不足因此選擇區線變成抛物線。玆將選擇曲線的特徵分項討論如下：

(1)選擇域 (Selection range)

選擇曲線爲了解魚類對網目選擇性最明確而直截了當的方法。但是由選擇域的大小亦可明瞭選擇性的概況，特別是當吾人已明瞭該種魚類選擇曲線的特性時卽能以選擇域來推測該魚種對網目的選擇性。

選擇域爲囊網對漁獲物有選擇濾過效果的體長範圍，卽在選擇域範圍內之魚類有一部份逃出囊網，一部份殘留網內，在選擇域範圍以外之魚類則將全部殘留網內或逃出，殘留網內之最小體長爲選擇域的下限，而逃出網外的最大體長爲其上限，理論上有適當的體長組成及充分的漁獲尾數卽能得到正確的選擇域。當漁獲尾數不够或體長組成不適當時則選擇域實驗値將發生上限値過小或下限値過大的

Table 4.2 List of species treated in this experiment

Species no.	Chinese name	English name	Species name
1	九 母	Lizard fish	*Saurida undosquamis; Saurida tumbil*
2	金 線	Golden thread	*Nemipterus virgatus; N. peronil; N. hexodon; N. bathybur*
3	金 龍	Grunter	*Pomadasys hasta*
4	黑 點	Sea catfish	*Arius thalssinus*
5	海 鯰	Russell's snapper	*Lutjanus russelli*
6	平 鰺	Travelly	*Caranx* spp.
7	鰺	Scad	*Decapterus maruadi; D. kurroioes, D. russelli*
8	赤 海	Red snapper	*Lutjanus sanguinus. L. argentimaculatus; L. sebae*
9	赤 筆	Madras snapper	*Lutjanus lutjanus*
10	紅目鰱	Big-eyes	*Priacanthus macracanthus; Priacanthus tayenus*
11	長 鯛	Sharp-tooth snapper	*Pristipomoides argygrammicus*
12	銀 鯧	Hump-headed batfish	*Platax novemaculeotus*
13	河 豚	Puffers	*Lagocephalus lunaris lunaris*
14	角 魚	Gurnards	*Lepidotrigla abyssalis*
15	肉 魚	Butterfish	*Psenopsis humerosus; Ariomma indica*
16	白 帶	Hair tails	*Trichiurus haumela*
17	鱝	Guitar fishes	*Rhynchobatus djiddensis; Rhinobotus bougainvillii*
18	魟	Sting rays	*Dasyatis kuhlii*
19	鰮	Anchovies	*Stolephorus heterolobus*
20	秋 姑	Goat fishes	*Vpeneus sulphoreus; U. moluccensis; Pseudupeneus indicus*
21	條紋雞魚	Banded Grunter	*Terapon theraps*

Table 4.3 Comparison of number of individuals caught in the cod-end the and cover net.

Haul	1		2		3		4		5		6		7		8		9		Total		Select. Rate	Dimension indicating the body length
No Species \ Net	Cod	Cover	Cod	Cover	Cod	Cover	Cod	Cover	Cod	Cover	Cod	Cover	Cod	Cover	Cod	Cover	Cod	Cover	Cod-end A	Cover B	$(\frac{A}{A+B})$	F.L.
1 九母	28	37	—	—	—	27	48	84	58	137	32	51	8	31	44	38	—	—	218	402	0.35	F.L.
2 金線	—	—	70	58	—	34	15	96	—	—	—	—	38	123	42	145	—	—	165	456	0.27	F.L.
3 金龍	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	444	512	444	512	0.46	F.L.
4 黑點	—	—	—	—	—	—	—	—	—	—	—	—	241	92	65	38	—	—	306	130	0.70	F.L.
5 海鯰	8	15	78	18	13	27	17	—	—	—	—	—	—	—	—	—	—	—	116	60	0.67	F.L.
6 平鯵	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	100	989	100	989	0.09	F.L.
7 鯵	1	7	24	17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	25	24	0.51	F.L.
8 赤海	—	—	—	—	—	—	—	—	—	—	—	—	98	45	—	—	59	23	157	68	0.70	F.L.
9 赤筆	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	13	9	13	9	0.69	F.L.
10 紅目鰱	20	1	14	1	5	16	—	—	—	—	—	—	2	13	8	—	11	—	60	31	0.66	F.L.
11 長鯛	5	2	—	—	—	—	—	—	—	—	—	—	2	11					7	13	0.35	F.L.
12 銀鯧	—	—	—	—	—	—	88	—	2	—	—	—	—	—	—	—	—	17	90	107	0.84	T.L.
13 河豚	20	—	—	—	—	—	—	—	—	—	—	—	9	1	12	—	—	—	41	42	0.98	F.L.
14 角魚	—	—	—	—	179	27	—	—	—	—	—	—	—	—	—	—	—	—	179	27	0.87	F.L.
15 肉魚	12	19	—	—	—	—	—	—	—	—	—	—	7	25	—	—	271	156	290	200	0.59	F.L.
16 白帶	3	16	—	—	—	—	—	—	—	—	—	—	1	—	2	5	—	9	6	36	0.17	T.L.
17 鱝	4	1	—	—	4	—	7	—	2	—	2	—	1	—	—	—	—	—	20	1	0.95	T.L.
18 魟	—	—	—	—	—	—	—	—	5	—	9	—	1	—	—	—	—	—	15	0	1.00	B.W.
19 鰮	—	—	—	—	—	—	—	—	—	—	—	—	—	2 Boxes	—	—	—	—	—	—	0.00	T.L.
20 秋姑	—	—	—	—	—	—	—	—	—	—	—	—	—	3 Boxes	—	—	—	—	—	—	0.00	F.L.
21 條紋鷄魚	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	50 Boxes	—	—	0.00	F.L.

F.L.—fork length, T.L.—total length, B.W.—Body width

現象，各魚種的選擇域示於Table 4.4由Table 4.4及Fig 4.3～4.19可知，九母，金線，金龍，黑點及紅目鰱的選擇域頗爲可靠，海鯰，角魚，則因體長分佈不充份，魚體偏大其下限誤差較大，平鯵體長偏小其上限誤差較大，其餘魚種如長鯛由 Fig. 4.15中可看出由於漁獲不足無選擇域可言，河豚外網僅捕獲一尾故所得選擇域亦僅能提供最初步的參考而已。由表可知體型柔軟的魚類如九母，白帶魚具有較大的選擇域。

⑵選擇尖銳度 (Selection sharpness)

網目對魚類選擇性的靈敏度稱爲選擇尖銳度一般選擇尖銳度的表示法爲

$$Cs = \frac{L_{0.5} - (L_{0.75} - L_{0.25})}{L_{0.5}} \times 100\%$$

Cs爲選擇尖銳度，$L_{0.25}$，$L_{0.5}$，$L_{0.75}$各爲25%，50%，75%之選擇點體長，選擇尖銳度的大小代表選擇曲線的陡銳或遲緩，尖銳度大時表示網目對魚類的選擇性强，小時表示選擇性差，因此當 Cs 接近 100時選性極端敏銳。Cs接近O時選擇性極端遲鈍。

選擇尖銳度不採用選擇域係因選擇域受漁獲物多寡及體長範圍的限制，且作業時如囊網稍有受損則逃出之大魚將使上限增大，而小魚受入網雜物的影響，或受大魚的擠壓而殘留網內，形成下限向下延伸。因此如以選擇域表示網目的選擇性將產生相當大誤差，故以選擇尖銳度表示可得更正確的結果。

選擇尖銳度以25%和75%爲基點其目的在於將上下限附近較不準確之值剔除，該範圍內誤差產生的原因除如上所列述者外，上下限附近漁獲尾數不足亦爲重要的因素。

由 Table 4.4 可知，選擇尖銳度的大小由魚種別依次爲紅目鰱，赤海，黑點，平鯵，金龍，角魚，金線，九母。上述次序除角魚外和選擇域由小而大的次序恰好相同，因此由選擇域大小判斷網目選擇性的方法仍具相當的參考價值。

⑶選擇因素 (Selection factor)

選擇因素爲50%點體長與目大的比率 (Lo.5/Mesh size) 一般在從事材料比較時使用，由表可知由於含有體長因素，因此各魚種別間之選擇因素並無相關關係存在，僅能在種內作比較或材料比較時方具價值。

⑷逃出魚的活力

魚類在擁擠的網中擠壓逃逸後，魚體衰弱甚或死亡，其活存率幾何？實爲今後從事網目試驗資源保護的重要課題，尤其網目保護的對象爲幼小魚類，容易受到傷害或死亡，如僅考慮網目選擇率不計及活存率則對於死亡率偏高之魚類網目保護效果將大爲減低。

本次試驗拖網時間由 1^h50^m～2^h15^m 其逃出魚的活力並無明顯的差異，經觀察結果赤海，赤筆，金龍、長鯛，及條紋鷄魚等大多仍有甚强之活力，放之於水槽中，亦能自然悠游，尤其是條紋鷄魚生趣盎然活躍不已，至於九母、白帶、肉魚等體態柔軟之魚類則奚數死亡未見生存者，其餘魚類則有少部份生存但活力不佳。在死亡的魚類中部份魚類之魚鰾已被壓迫而含在口中，係因水壓急遽降低所致，故爲得較正確之試驗結果起網時應儘量緩慢，以減少單位時間之壓力差，免得漁獲因壓力之遽變而死亡。

討　　論

A.覆蓋效果 (Masking effect)

試驗作業時，覆蓋的外網和囊網的密接是否會影響魚類的逃逸，有關方面的學者一直都議論紛紛莫衷一是，但是如設計得當應該不會有是項問題發生。

本試驗係採用大型底拖網，因此較一般使用小型拖網爲試驗對象者在覆蓋效果上有其先天上的優越條件，況且在設計上已儘量的留下足夠的空間讓魚類逃逸，故對網目選擇試驗而言，本網具應具最小的覆蓋效果。

Table 4.4 Parameters of selection curves

	range at body length (m.m.)	selection range (m.m).	smallest size caught in co-dend	largest size caught in cover net	Lo.5 (m.m.)	Lo.25 (m.m.)	S.SP.	S.F.	C.S.
1. 九 母	102- 450	285	160	445	276	206	139	3.07	50
2. 金 線	80- 335	185	90	275	212	174	78	2.36	63
3. 金 龍	205- 430	165	215	380	296	262	71	3.29	76
4. 黑 點	145- 370	125	190	315	244	216	52	2.71	79
5. 海 鯰	250- 415	165	250	415	300	-	-	3.33	-
6. 平 鯵	100- 235	120	110	230	214	187	46	2.38	79
7. 鯵	175- 340	155	175	330	-	-	-	-	-
8. 赤 海	310- 600	105	355	460	376	348	66	4.18	82
9. 赤 筆	200- 300	185	200	285	-	-	-	-	-
10. 紅 目 鰱	45- 340	75	210	285	230	214	31	2.56	87
11. 長 鯛	195- 555	-	500	235	-	-	-	-	-
12. 銀 鯧	160- 295	135	160	295	-	-	-	-	-
13. 河 豚	250- 445	85	250	335	-	-	-	-	-
14. 角 魚	100- 240	105	110	215	124	110	34	1.38	73
15. 肉 魚	140- 230	75	140	215	-	-	-	-	-
16. 白 帶	670- 910	180	730	910	-	-	-	-	-
17. 鱝	262-1000	316	262	578	-	-	-	-	-
18. 魟	335- 390	-	335	-	-	-	-	-	-

Lo.5 -50% Selection point length
Lo.25-25% Selection point length
Lo.75-75% Selection point length

S.Sp. (Selection span) =Lo.75-Lo.25
S.F. (Selection factor) =Lo.5/Mesh sigl
CS. (Selection sharpness) $= \frac{\text{Lo.5-S.SP}}{\text{Lo.5}} \times 100\%$

B.曳網時間與漁獲量對選擇性的影響

一般而言曳網的時間愈長，魚類有更多的機會逃出囊網，但相反的却漁獲愈多，阻塞的網目愈多，因此後來捕獲的魚類愈不易逃出網外。據Galland比較試驗的結果，發現較長的曳網時間 hake 在囊網的殘留率有較低的傾向但不顯著，本次試驗其作業時間從 2^h15^m 縮短致 1^h 除九母有隨着拖網時間愈長其在囊網的殘留率反而稍有增高的傾向外，其餘魚種因捕獲網次太少未能比較。此試驗結果和Galland的結論相反，蓋因逃出率對漁獲量的變化，隨魚種，漁場，作業條件之不同而迴異。致於漁獲量對選擇性的影響，本網具爲大型底拖網，因此可以減少網內魚類的擁擠效果，對一般試驗而言應有較小的影響。

C.曳網速度對選擇性的影響

曳網速度影響魚類的行動，尤其當魚類失去活動力時，魚類對網目的選擇性即受曳網速度的支配。然而 Aoyama 的報告指出，其結果並無規律性。Boerema 試驗結果認爲只要曳速不極端對於選擇性沒影響。但 Hiyama 認爲曳速增加，選擇性愈低下選擇域增大。由於曳網速度對選擇性的影響各方意見分歧未成定論，因此本次試驗曳速均維持在 3.0kts 不變，求得各網次可疊加的正確試驗值。

D.魚類回入囊網之問題

魚類逃出囊網後是否會再溯游鑽回囊網實爲耐人尋味的問題，事實上魚類要克服强大的水流再進入囊網內非常困難，尤其是一般作業時逃出魚類有高度的方向選擇自由，再返回囊網幾無可能。但附加外網後是否會再返回囊網則頗令人擔憂。本次試驗曾發現一尾赤海羅刺在囊網上頭朝內，但究竟是回入亦或是因起網時壓擠加上赤海活動力强致使倒刺在網上則不得而知，但一般認爲魚類從外網重回囊網的問題可以忽略。

E.逃出魚的活存率

魚類在網中經過長時間擠壓後逃出，其活存率幾何實爲從網限制的先決條件。根據養殖試驗及對逃出魚類的觀察結果認爲大部份的逃出魚仍有活力且受傷害不大。本次試驗作業時間從 2^h15^m～1^h發現拖網時間的改變對羅網魚類的死亡率並無顯着的差異。而許多死亡魚類均口含魚鰾，證明係因水壓遽變而死亡。但魚類究竟係因拖網時間過長疲憊而死亦或是水壓遽降而亡，相信隨作業方式和魚種的差異而不同，但其詳情如何則因僅能做起網後之觀察未能遽下論斷。因此如何改進今後對逃出魚活存率的觀察方法實爲當務之急。

F.網具其他部份的逃出問題

魚類主要逃脫部份爲囊網及胴網後部（belly tops）本試驗爲增加外網和囊網的間隙減少覆蓋效果，因此將外網附結在胴網上，其覆蓋部份達4m。爲避免魚類從胴網逃出，特以 3cm 目大之網片覆結於胴網內部以阻止魚類從該部份逃出（如Fig4.1）。是以本試驗外網捕獲之魚類奚數爲從囊網逃出者。

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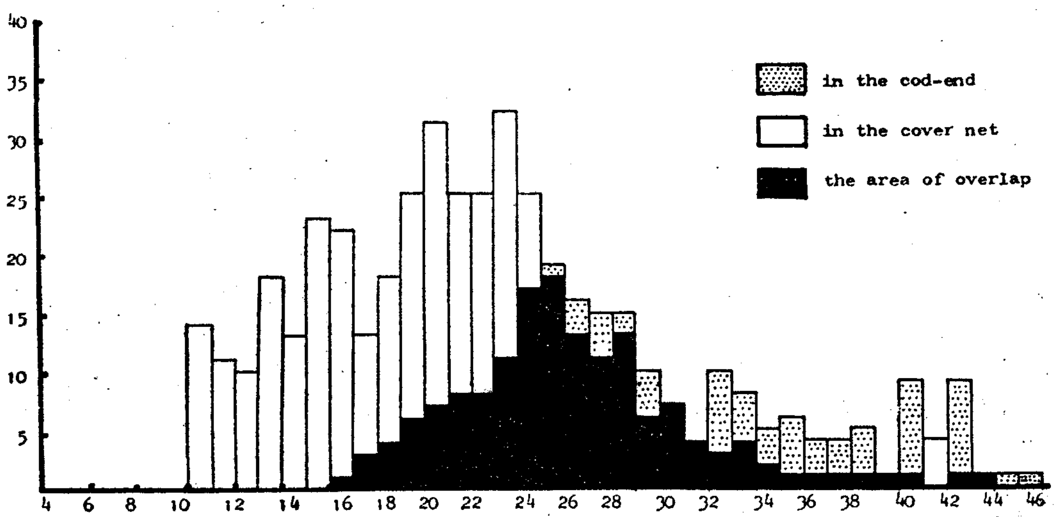


Fig. 4.3 Distribution of body length of lizard fish.

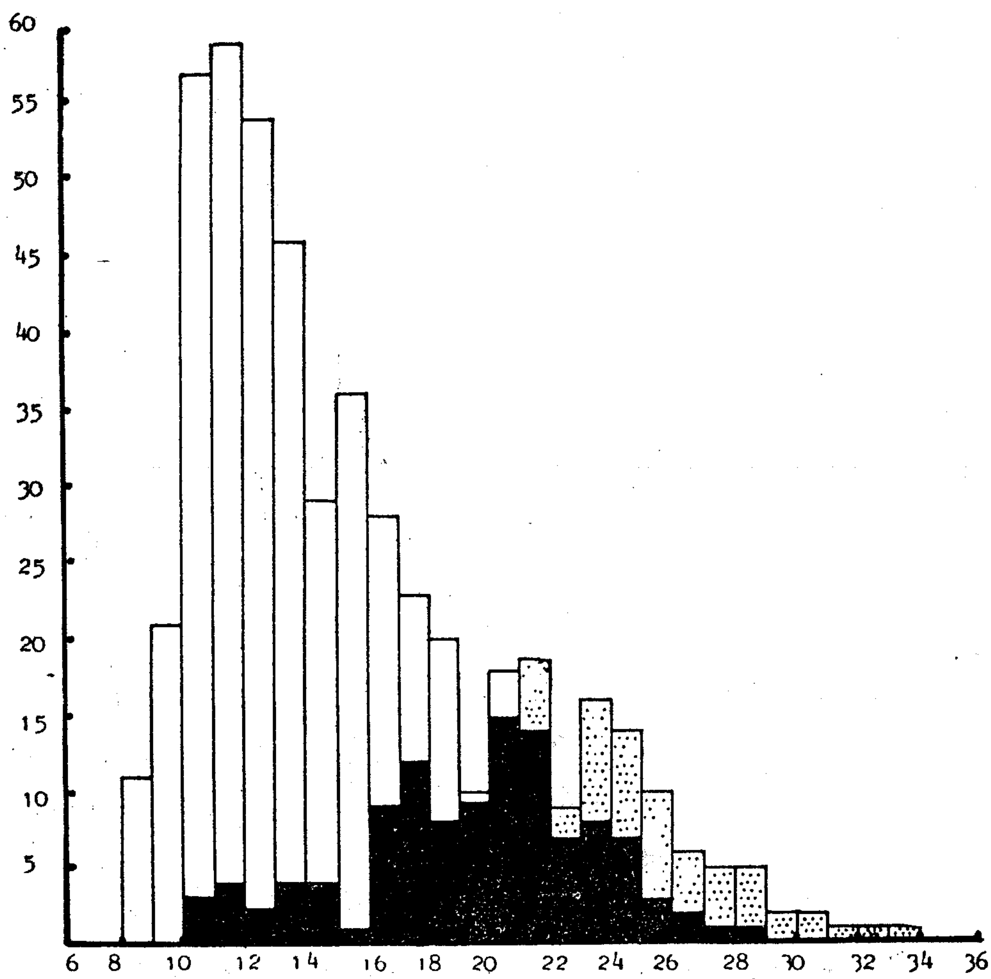


Fig. 4.4 Distribution of body length of porgies.

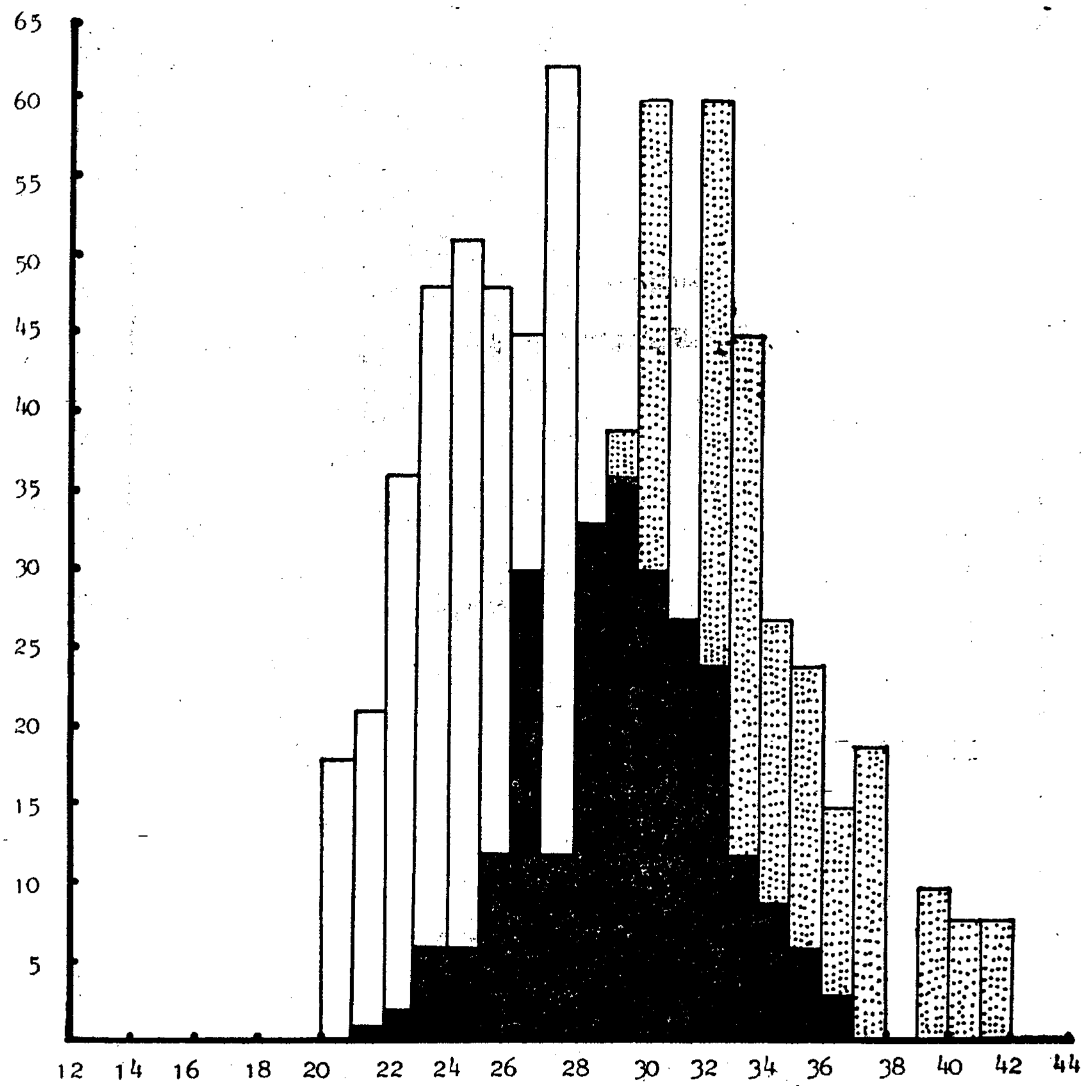


Fig. 4.5 Distribution of body length of grunt.

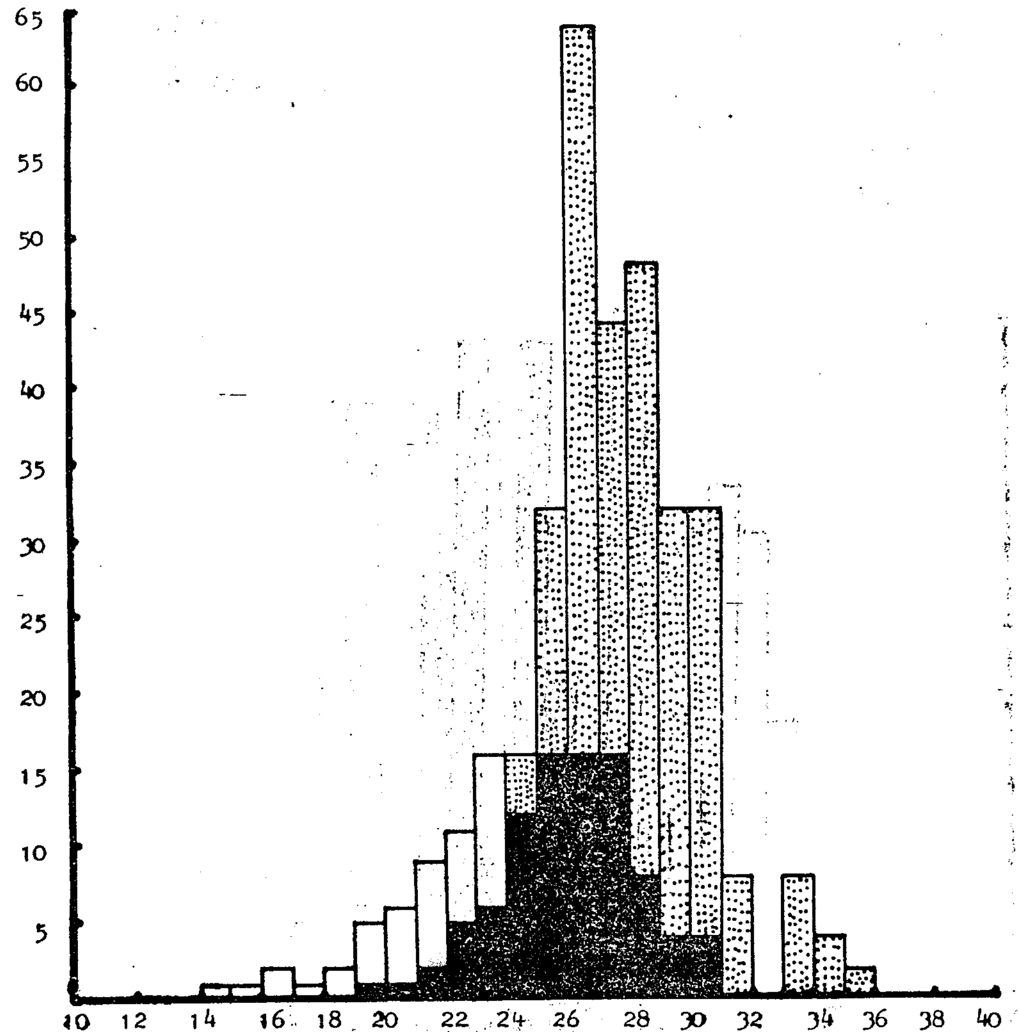


Fig. 4.6 Distribution of body length of Russell's snapper.

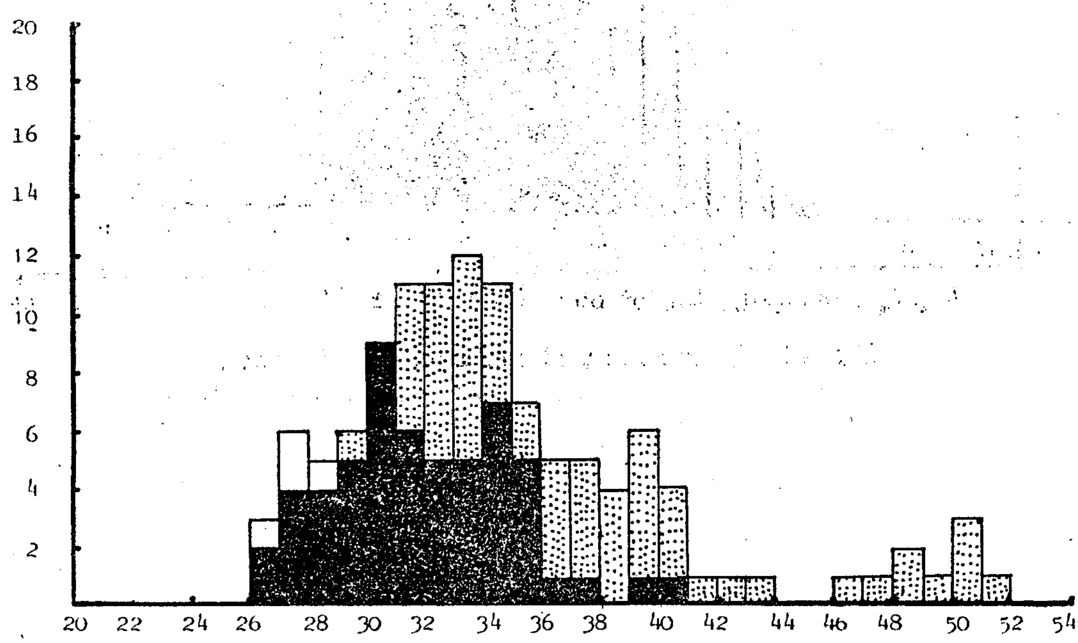


Fig. 4.7 Distribution of body length of sea catfish.

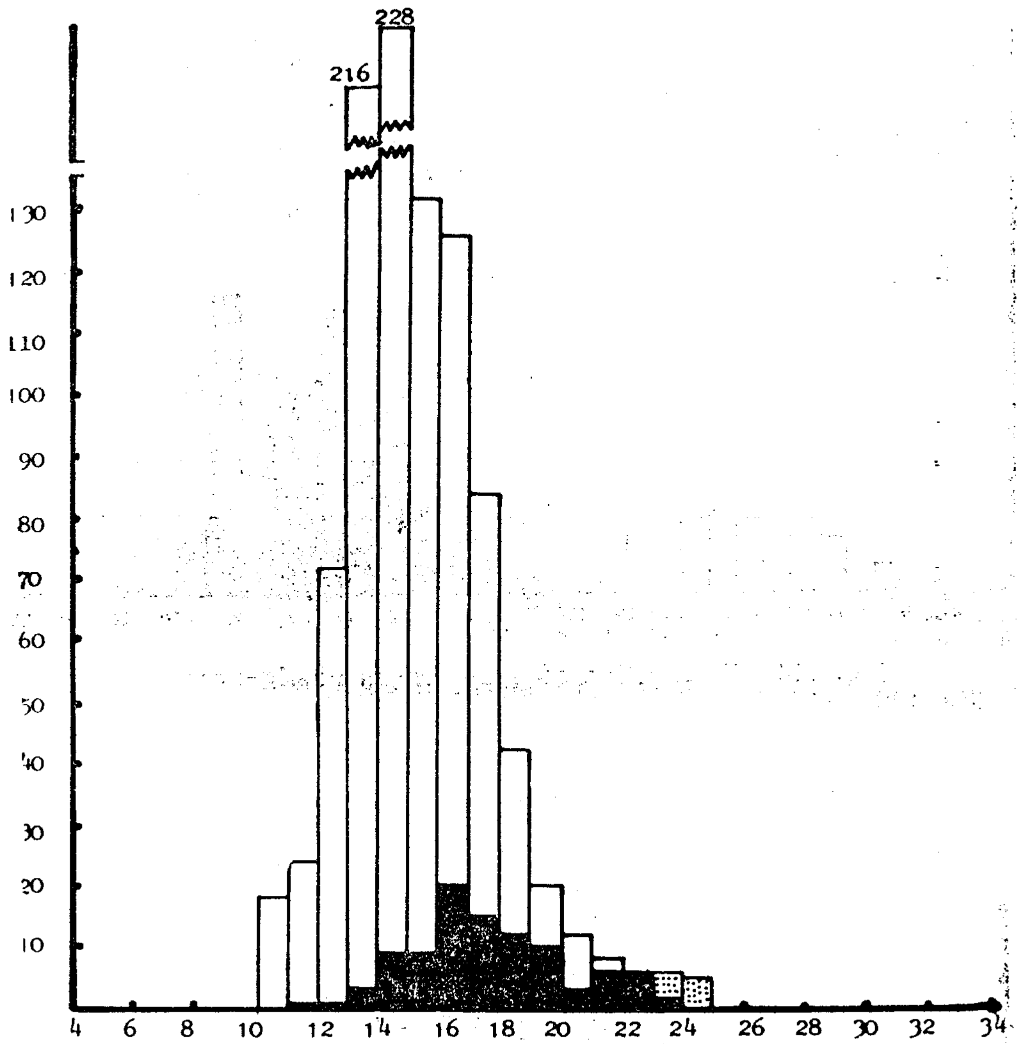


Fig. 4.8 Distribution of body length of trevally.

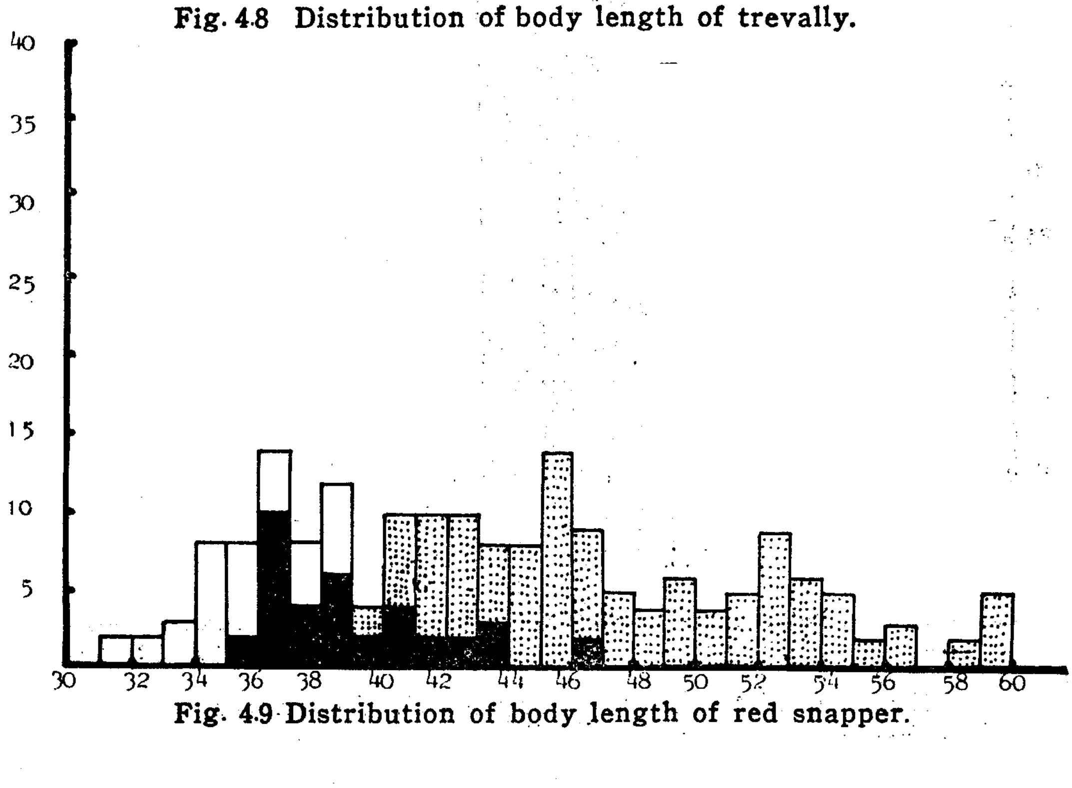


Fig. 4.9 Distribution of body length of red snapper.

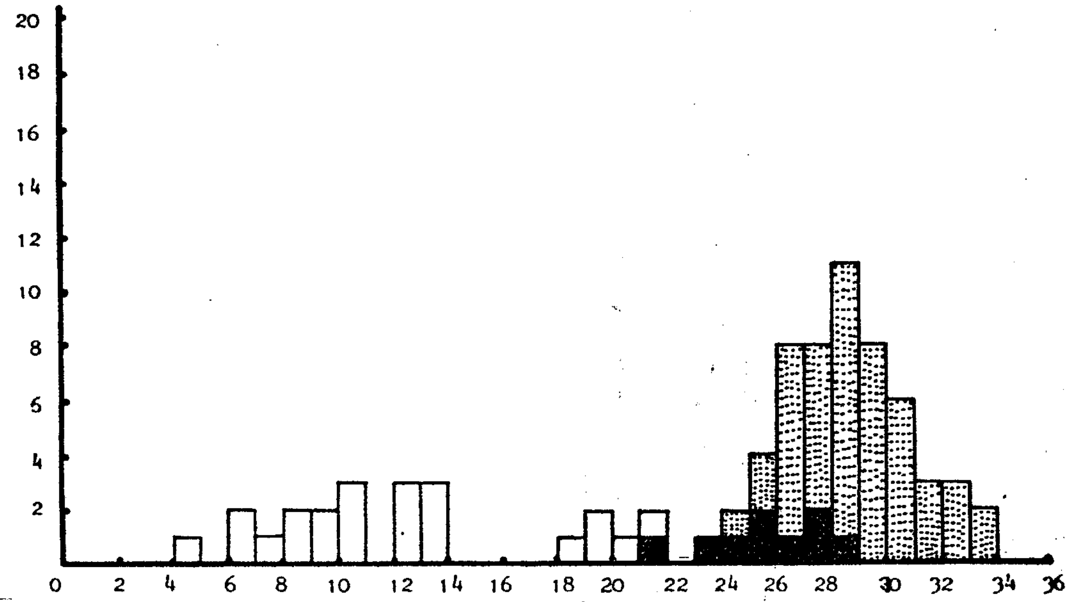
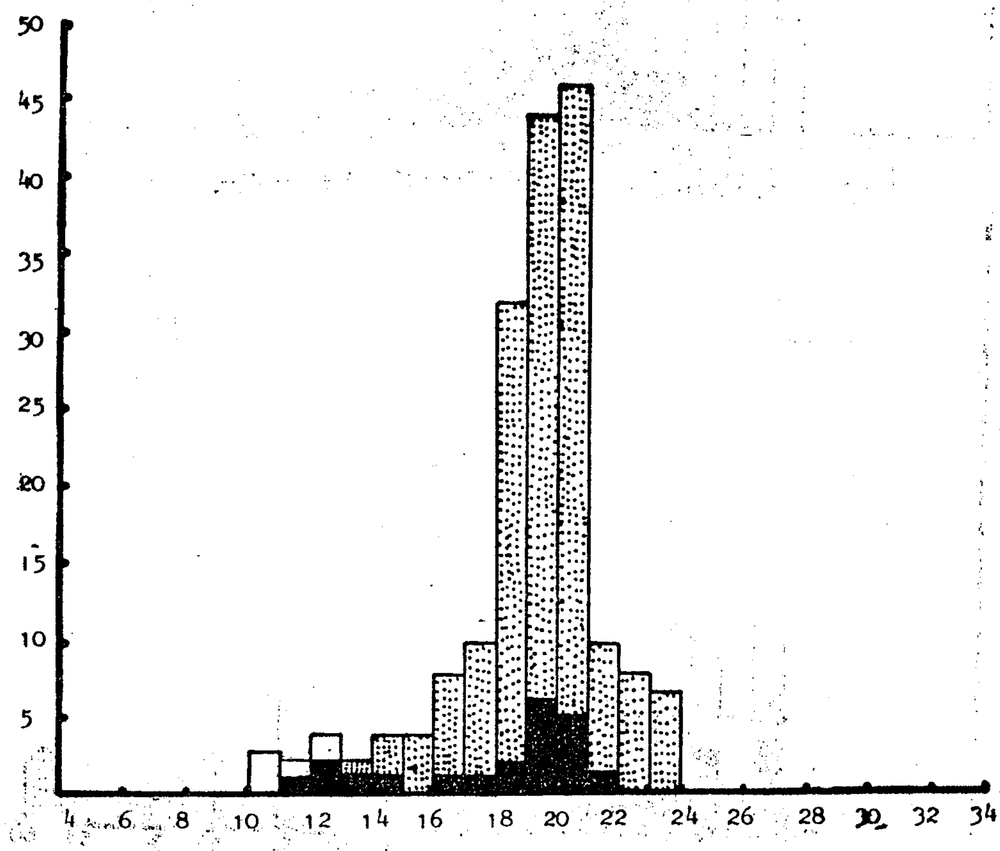


Fig. 4.10 Distribution of body length of big-eyes



Eig. 4.11 Distribution of body length of gurnards

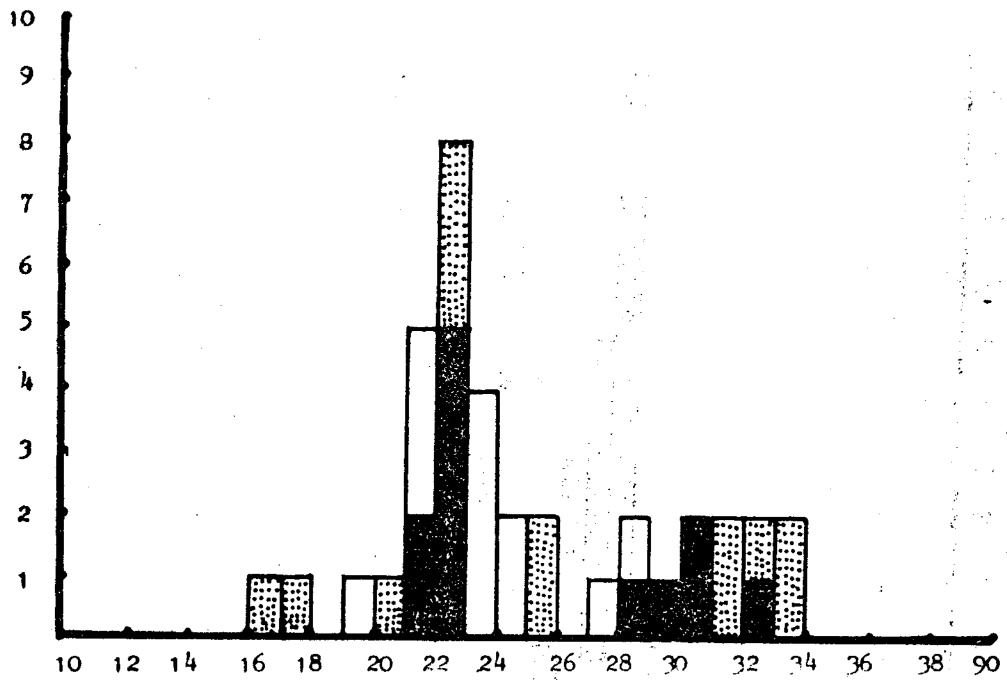


Fig. 4.12 Distribution of body length of scad

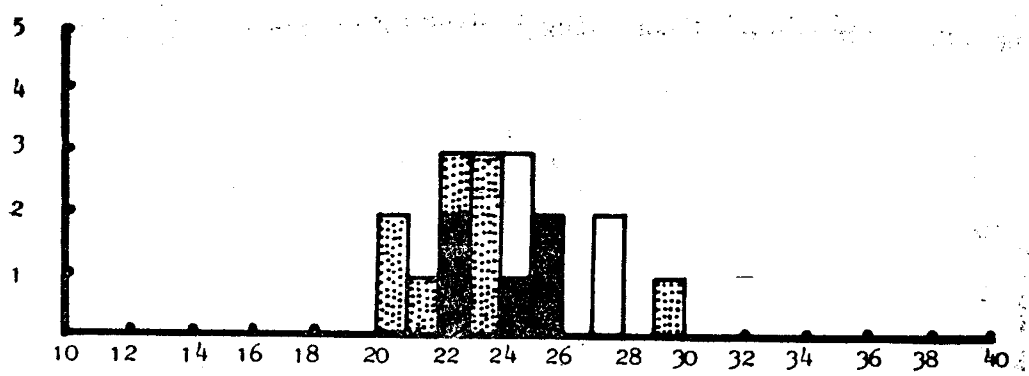


Fig. 4.13 Distribution of body length of Madras snapper

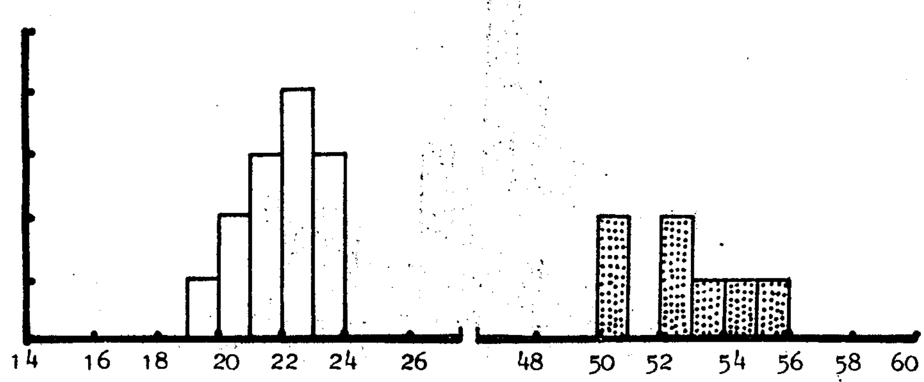


Fig. 4.14 Distribution of body length of sharp-tooth snapper

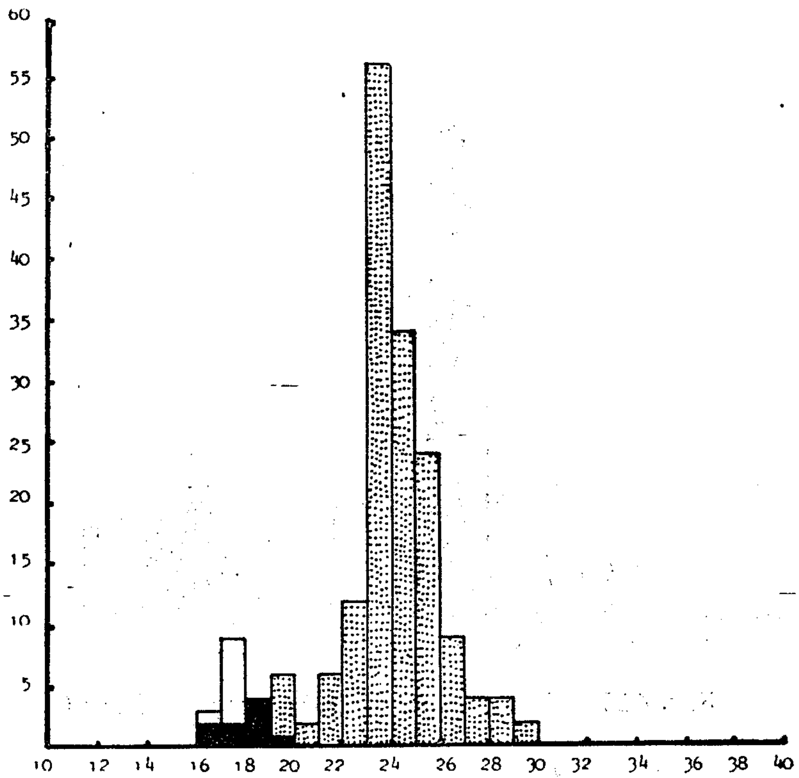


Fig. 4.15 Distribution of body length of hump-headed batfish

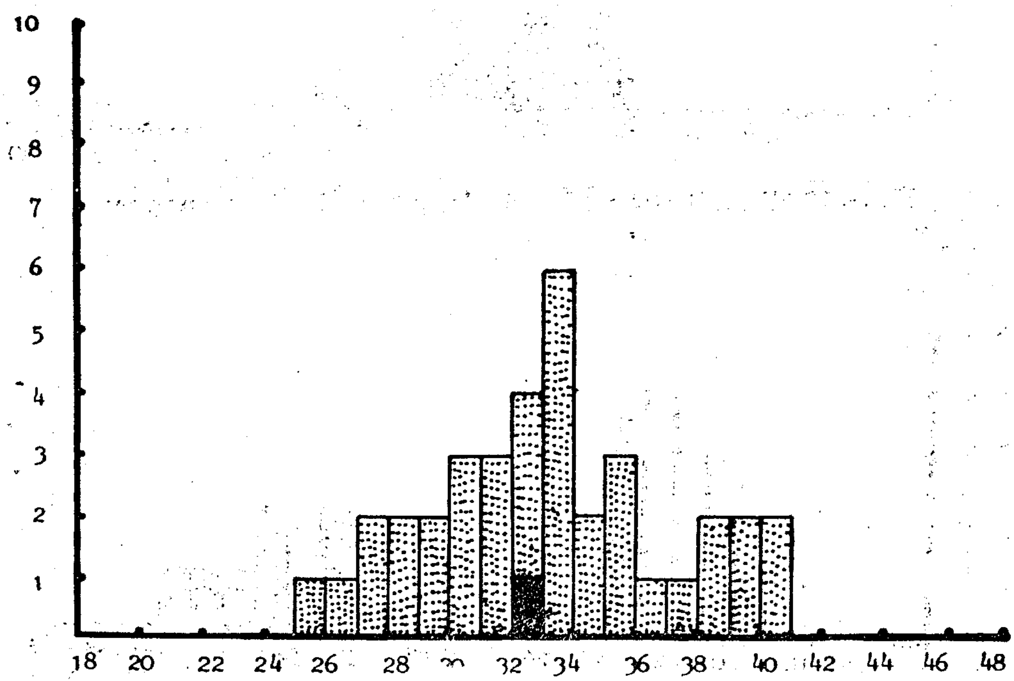


Fig. 4.16 Distribution of body length of puffers

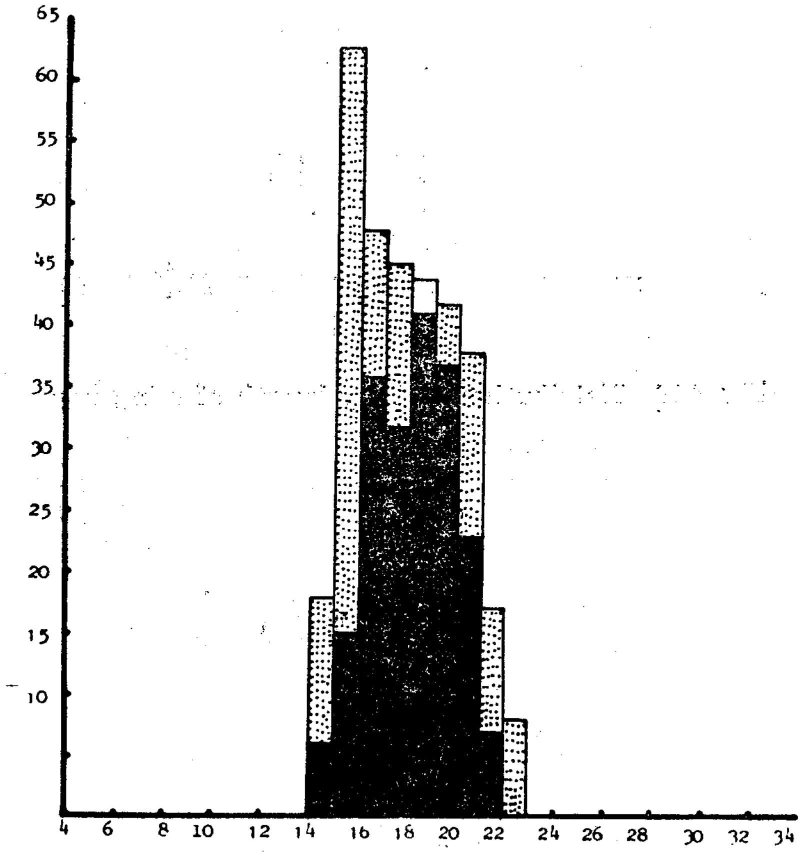


Fig. 4.17 Distribution of body length of butterfish

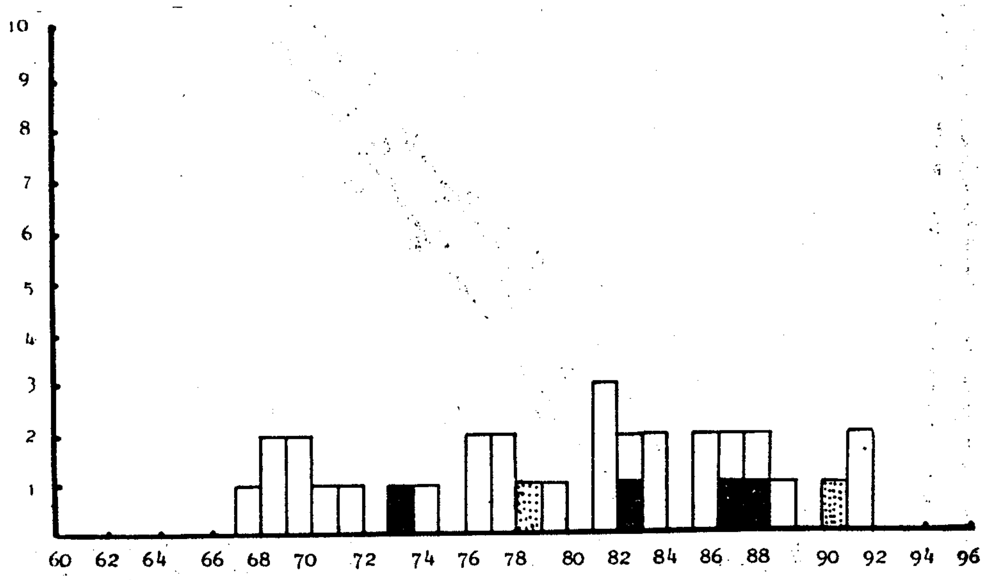


Fig. 4.18 Distribution of body length of hairtail

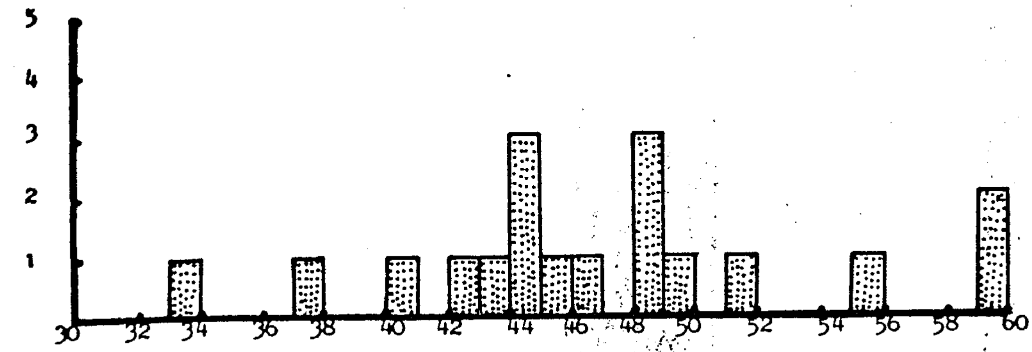


Fig. 4.19 Distribution of body length of sting ray

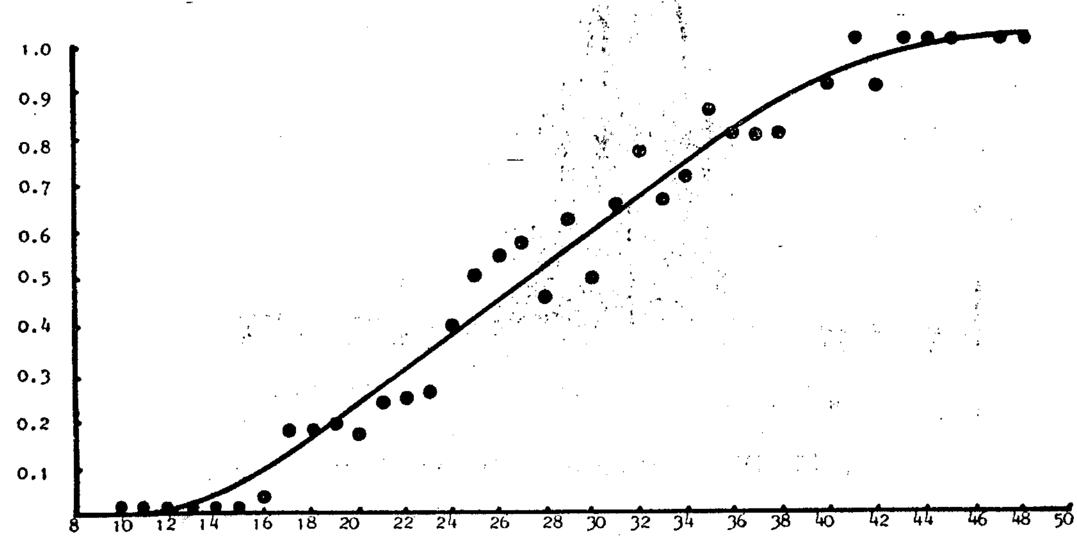


Fig. 4.20 Selection curve of lizard fish

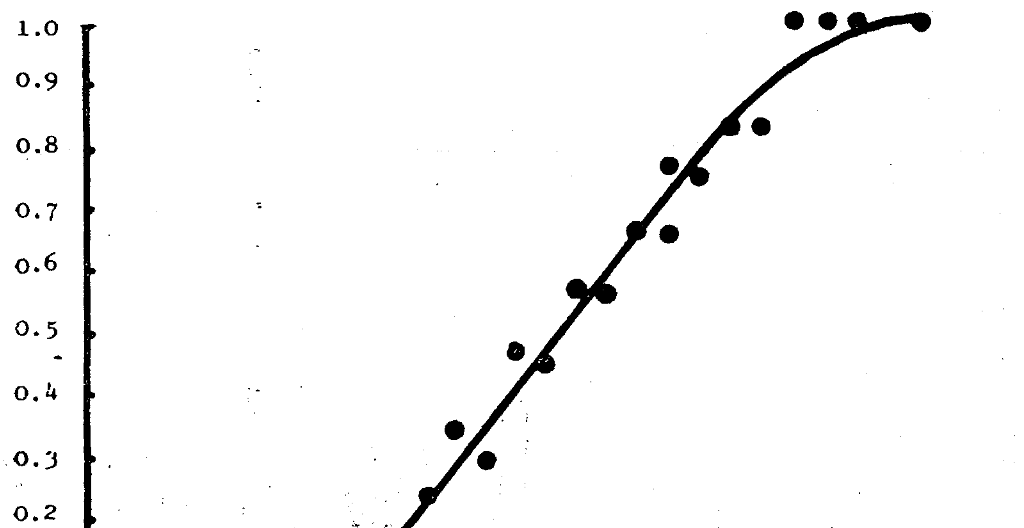


Fig. 4.21 Selection curve of porgies

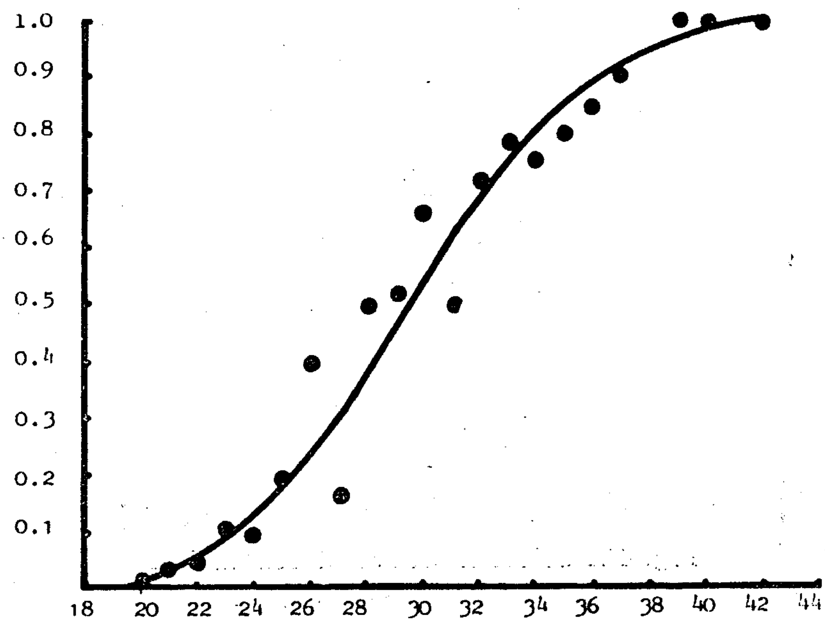


Fig. 4.22 Selection curve of grunt

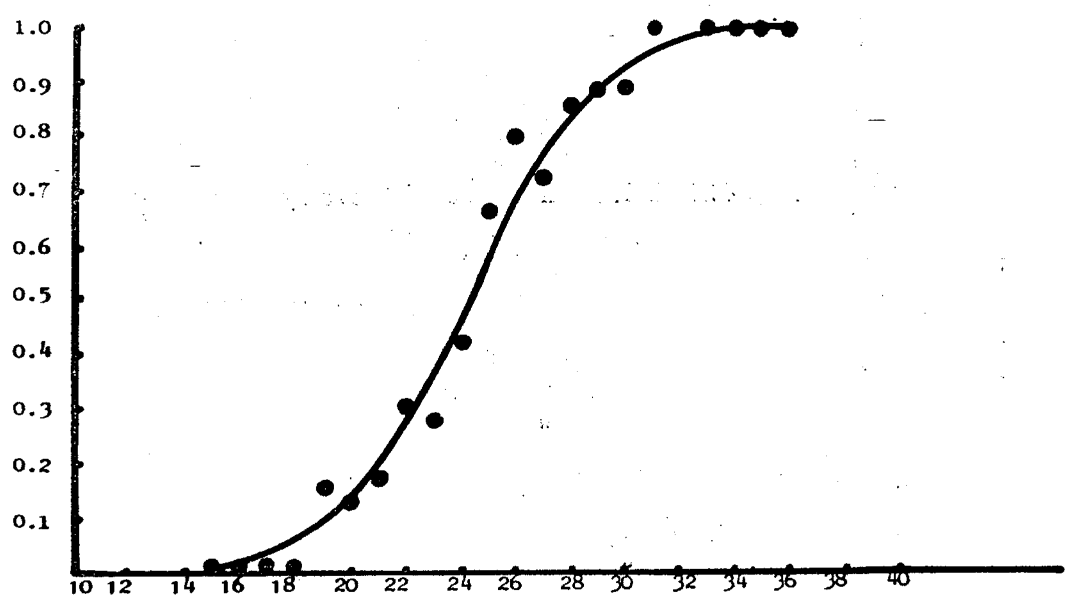


Fig. 4.23 Selection curve of Russell's snapper

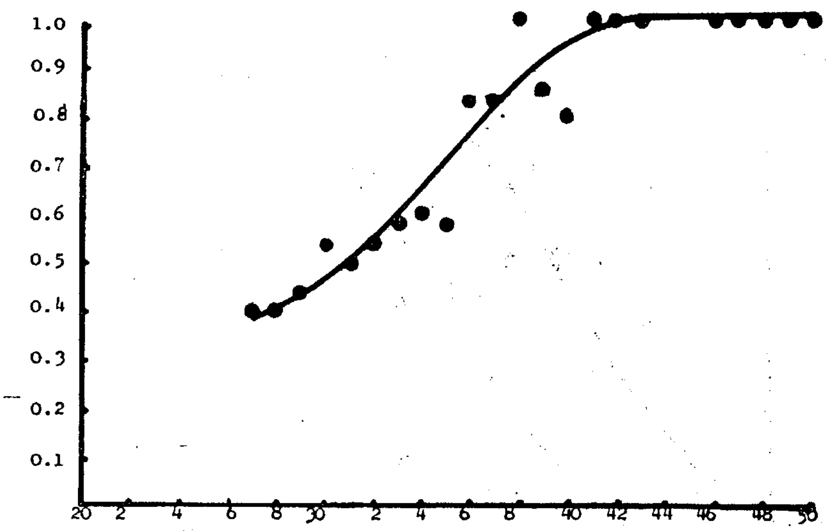


Fig. 4.24 Selection curve of sea-catfish

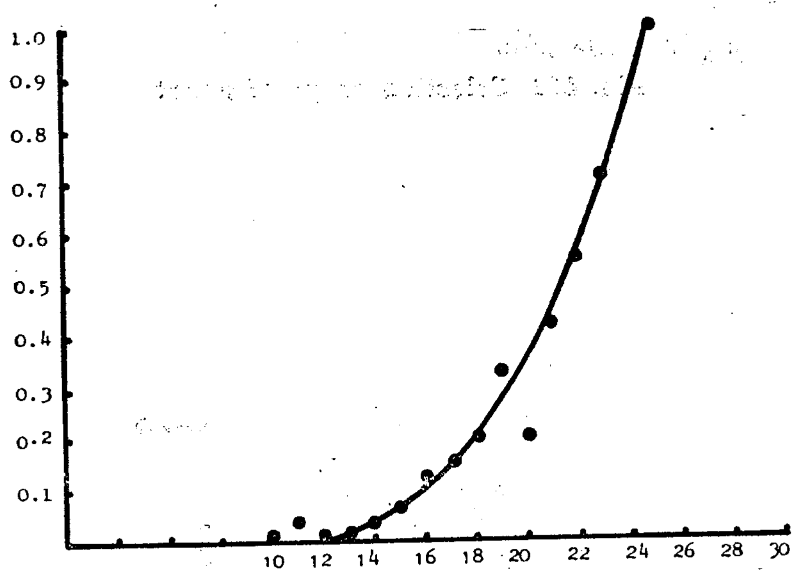


Fig. 4.25 Selection curve of trevally

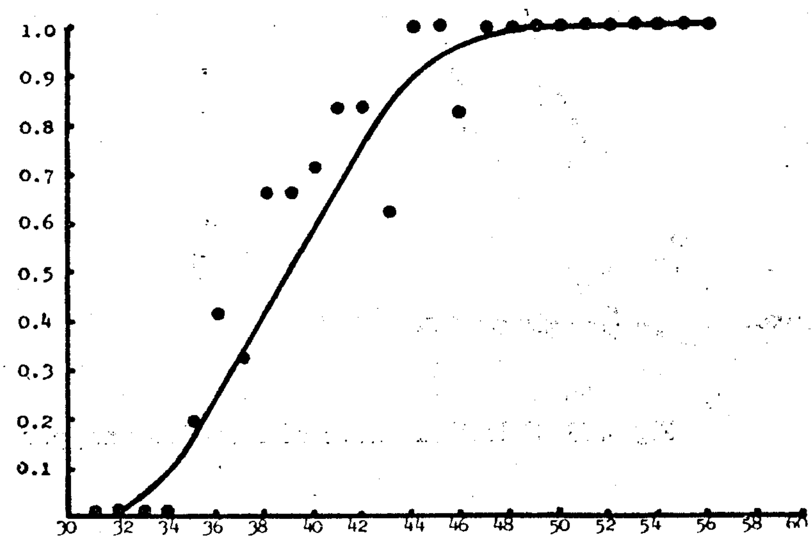


Fig. 4.26 Selection curve of red snapper

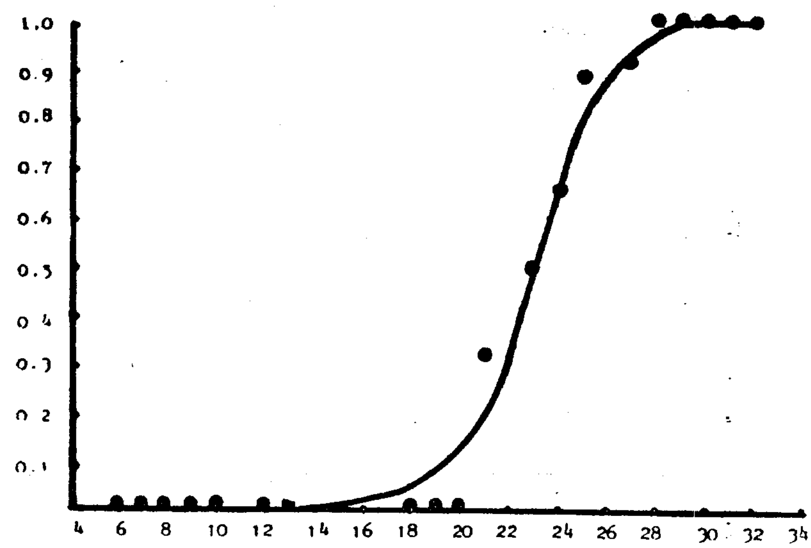


Fig. 4.27 Selection curve of big-eyes

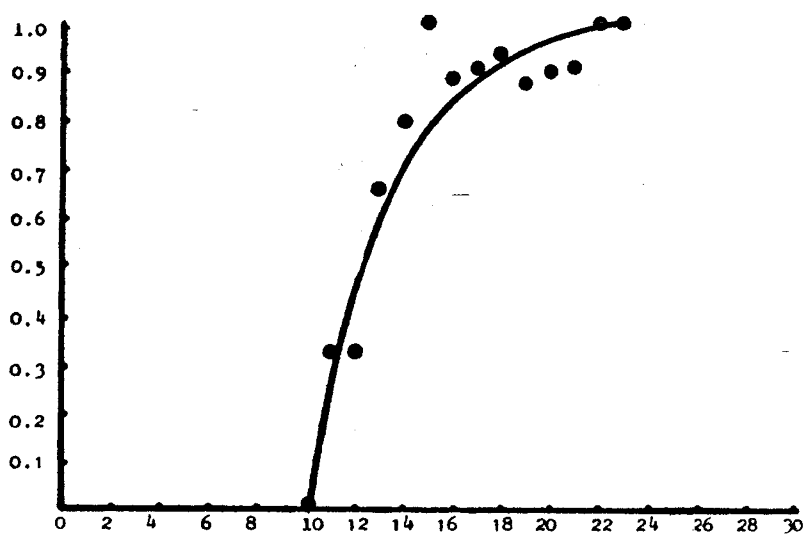


Fig. 4.28 Selection curve of gurnards