

DEEPWATER SURVEY OF CRUSTACEAN RESOURCES OFF
THE NORTH WEST SHELF
(FIRTA 83/62) Final Report

The objective of this one-year project was to determine the distribution, abundance, catch rates and size composition of *Metanephrops* spp., carid and penaeid prawns off the North West Shelf and to relate these parameters to depth, temperature, salinity and substrate.

The survey was conducted in slope waters between 300 and 500 m depth extending from Rankin Bank at approximately 19°30'S, 115°30'E to Ashmore Reef at approximately 12°30'S, 123°0'E in January/February 1984. Five one-hour trawls were made along the 300, 350, 400, 450 and 500 m contours in each of 16 transects approximately 40 nautical miles apart. Some trawls were made outside 300-500 m in those transects where scampi were distributed beyond this depth range. To examine the differences in catch rates between day and night a series of trawls were carried out at one location at four-hour intervals over four days. A marked diel pattern of catch rates was observed with peak catches of scampi just prior to dawn and dusk, and lowest catches at midday and midnight.

Environmental information collected at each trawl included depth, bottom temperature, salinity, oxygen and nutrient levels, sediment composition and surface microtopography. Sediments were collected with a Smith-MacIntyre grab and by tube collectors attached to the footrope of the trawl. Surface microtopography was assessed using a Photosea 1000 35 mm underwater camera attached to the headrope of the trawl.

Throughout the study area the sediment composition ranged from silty-sands to sandy mud, primarily of biogenic origin, with a rippled surface commonly disturbed by animal holes, burrows and tracks. Measurement of water parameters showed that temperatures on the bottom were low ranging from 7.4 to 17.2°C depending on depth, while at some locations dissolved oxygen dropped to less than 50% saturation. The relationship between crustacean distribution and abundance and these environmental parameters will be published at a later date.

The composition by weight of the overall catch was:

Scampi: <i>Metanephrops australiensis</i>	21.5%
<i>Metanephrops andamanicus</i>	12.1%
<i>Metanephrops boschmai</i>	5.4%
Penaeid and carid prawns	50.0%

Scampi were caught throughout the survey area, but each species was mainly caught in a restricted depth range. *M. andamanicus* occurred in 350-400 m, with the highest concentration being in the ground identified previously by CSIRO centred on 18°0'S, 118°18'E. This ground has been shown to hold commercial quantities of scampi by the KJV survey in October 1983. Preliminary estimates suggest an average concentration of 8 kg/hectare of *M. andamanicus* over an area of 1260 km², providing a total biomass of 880 tonnes. This ground is surpassed by two grounds further north.

The first of these grounds is centred on 16°55'S, 119°54'E, and contains *M. australiensis*, the largest most commercially attractive species, in high concentrations through a depth range of 430-470 m. Preliminary estimates suggest an average concentration of 12 kg/hectare over an area of 250 km², providing an estimated biomass of 300 tonnes.

The second ground is situated south of Scott Reef centred at 14°49'S, 121°36'E. This ground contains *M. boschmai*, a small but highly presentable species previously thought to be uncommon. It occurs in much shallower water than other scampi areas (250-350 m). Preliminary estimates suggest an average concentration of 11 kg/hectare over an area of 600 km², providing an estimated biomass of 660 tonnes.

If the natural mortality rates derived from studies on the northern hemisphere scampi (*Nephrops norvegicus*) are used to calculate safe annual catches, an estimate of 184 tonnes per annum results. However, preliminary estimates of natural mortality in *M. australiensis* derived from this survey are much higher than those described for *N. norvegicus* and when these estimates are used, the predicted safe minimum annual catch is raised to the level of 700 tonnes. These results have been reported in Australian Fisheries, 1984, 43(8): 41-47.

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CSIRO finds two new scampi grounds off the North West Shelf

TWO new scampi grounds have been found by CSIRO off the North West Shelf, doubling the size of the potential fishery. Preliminary estimates now indicate that these grounds will sustain a safe minimum annual catch of 184 tonnes.

While this catch figure is small in comparison with production from the northern prawn fishery, the scampi fishery nonetheless offers a valuable supplementary fishery, particularly when the associated catches of deepwater prawns are taken into consideration.

Following the promising catches of scampi by CSIRO off the North West Shelf in 1982-83 (See Reference 1) a survey of the whole north-western slope area was made in January-February 1984. The 31-day survey was carried out using the CSIRO chartered research vessel *Soela* and was funded partly by a grant of \$86 251 from the Fishing Industry Research Trust Account.

The survey was conducted in slope waters between 300 and 500 metres deep extending from Rankin Ban' at about 19° 30'S, 115° 30'E to Ashmore Reef at about 12° 30'S, 123° 0'E (Fig. 1) Five one-hour trawls were made along the 300, 350, 400, 450 and 500-m contours in each of 16 transects about 40 nautical miles apart. Some trawls were made outside 300 to 500 m in those transects where scampi were distributed beyond this depth range.

Environmental information collected during each trawl included depth, bottom temperature, salinity, oxygen and nutrient levels and sediment composition. Sediments were collected with a Smith-MacIntyre grab and by tube collectors attached to the footrope of the trawl. The sea floor surface was photographed, using a Photosea 1000 35-mm underwater camera

by T. L. O. Davis and T. J. Ward
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Division of Fisheries Research.

attached to the headrope of the trawl.

Fishing gear

The net used throughout the survey was an Engel deepsea lobster trawl with a 61-m ground rope. The net was chosen for its strength and durability, as the meshes were made from braided nylon. Mesh sizes ranged from 12 cm in the wings to a codend of 4-cm twisted nylon with a 15-cm braided nylon codend cover.

Despite being bogged down in mud and hooked up on limestone reefs on several occasions the net suffered only minor damage.

The rubber disc ground gear recommended for the trawl was replaced by chain during fishing trials to determine the optimum rigging of the trawl. A compromise between fishing efficiency and the risk of bogging down in soft mud resulted in the net being lightly weighted. The same ground gear-net configuration was used throughout the survey on all bottom types so that the relative abundance of crustaceans throughout the survey area could be compared. All catch rates presented in this article were

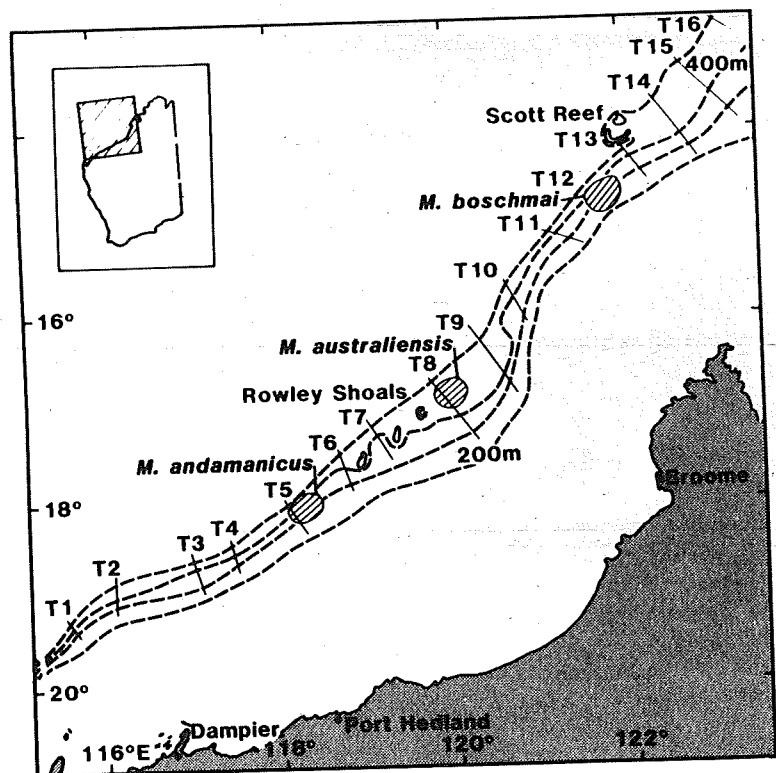
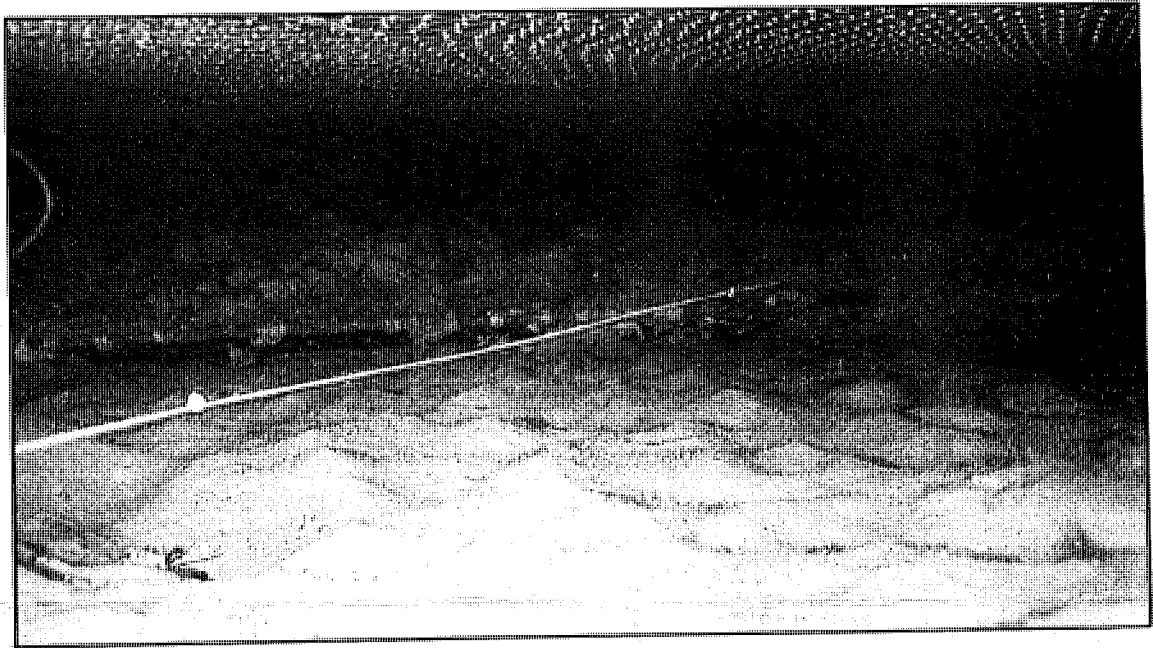


Figure 1. Survey area showing the three main scampi grounds.



The scampi net (without tickler chain) in operation.

determined using this standard gear and net.

After the survey was completed further trawls were carried out in an area of high concentration of scampi, and for these a tickler chain was added and the trawl more heavily weighted to suit the bottom type. At this location an average rate of 15.6 kg an hr was obtained during the 26 trawls using the survey gear. However, the average catch rate jumped to 56.1 kg an hr during four trawls after a tickler chain was added.

Thus catch rates using the Engel deepsea lobster trawl after appropriate adjustment to suit the bottom type could be up to three and-a-half times those presented in this article. Commercial fishing gear may achieve even higher catch rates.

Environmental conditions

Throughout the study area the sediment composition ranged from silty sands to sandy mud, primarily of biogenic origin, with a rippled surface commonly disturbed by animal holes, burrows and tracks. Water temperatures on the bottom were low, ranging from 7.4 to 17.2°C, depending on depth (see Fig. 2), while at some locations dissolved oxygen dropped to less than 50 per cent saturation.

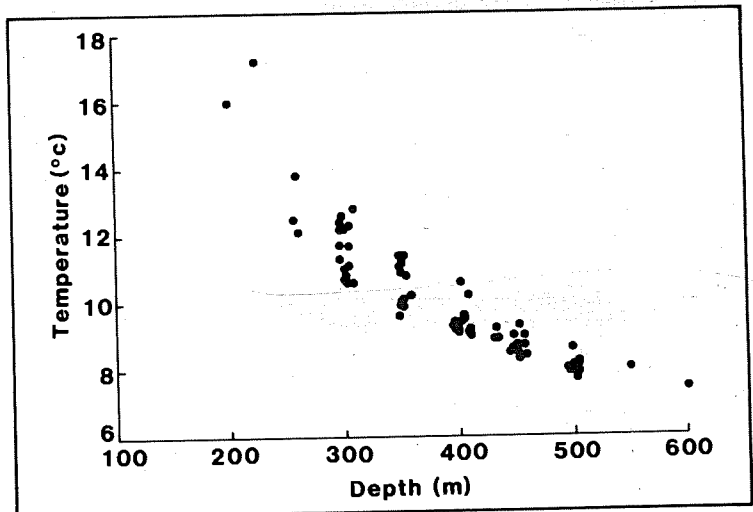


Figure 2: Bottom water temperatures at trawling sites.

Catch rates

The composition by weight of the overall catch was:
Scampi:

<i>Metanephrops australiensis</i>	32.5%
<i>Metanephrops andamanicus</i>	12.1%
<i>Metanephrops boschmai</i>	5.4%

Penaeid and carid prawns: 50.0%

Scampi were caught throughout the survey area but each species was mainly caught in a restricted depth

range. *M. andamanicus* occurred in 350 to 400 m, with the highest concentration being in the ground identified previously by CSIRO (Ref. 1).

Fishing trials by KfV Fisheries (Ref. 3) indicated that commercial catches of *M. andamanicus* could be made on this ground (shown in Fig. 1). A catch rate of 19.4 kg an hr occurred at 400 m on transect 5, which passed through the southwestern edge of this ground. However *M. andamanicus* were also present at 400 m in transects 2,

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3, 4 and 10, with catch rates of 14, 7.7, 9 and 14 kg an hr respectively.

M. australiensis was found in small quantities at 450 m on transect 3 (7.9 kg an hr), transect 6 (7 kg an hr) and transect 7 (5 kg an hr). A good catch of 17.4 kg an hr on transect 8 prompted further investigations of this area, resulting in catch rates up to 44 kg an hr using the survey trawl configuration. *M. australiensis* occurred at high densities in depths between 430 and 470 m on this ground. The limited depth range of *M. australiensis* is clearly demonstrated on transect 8 (Fig. 3) and there is only a small by-catch of prawns of commercial interest.

M. boschmai occurred in transect 2 at 350 m (11.3 kg an hr), transect 4 at 300 m (9.0 kg an hr) and transect 12 at 250 m (17.2 kg an hr), 300 m (26.0 kg an hr), and 350 m (13.0 kg an hr). Additional trawls on either side of transect 12 revealed an extensive area containing *M. boschmai* at high catch rates. A breakdown of the catch into the main crustacean species of commercial interest along transect 12, is shown in Figure 4. *M. boschmai* occurs over a wide depth range and at depths of 300 and 350 m is associated with a large by-catch of prawns.

Daily catch rate patterns

To examine the differences in catch rate of the prawns and scampi between day and night a series of trawls were carried out at one location at four-hour intervals over four days. Two samples, one each at 5 am and 9 am, have been deleted from the data set since they were taken during the onset of a cyclone and are aberrant.

The diel study was carried out on the *M. australiensis* ground on transect 8 at 430 m. As well as *M. australiensis* and *M. andamanicus*, the penaeid prawns *Haliporoides sibogae* (royal red prawn), *Penaeopsis* species type-1, *Hymenopenaeus* sp. 3 and the carid prawns *Plesionika martia*, *Heterocarpus sibogae*, and *Heterocarpus woodmasoni* were the other dominant crustaceans of potential commercial interest.

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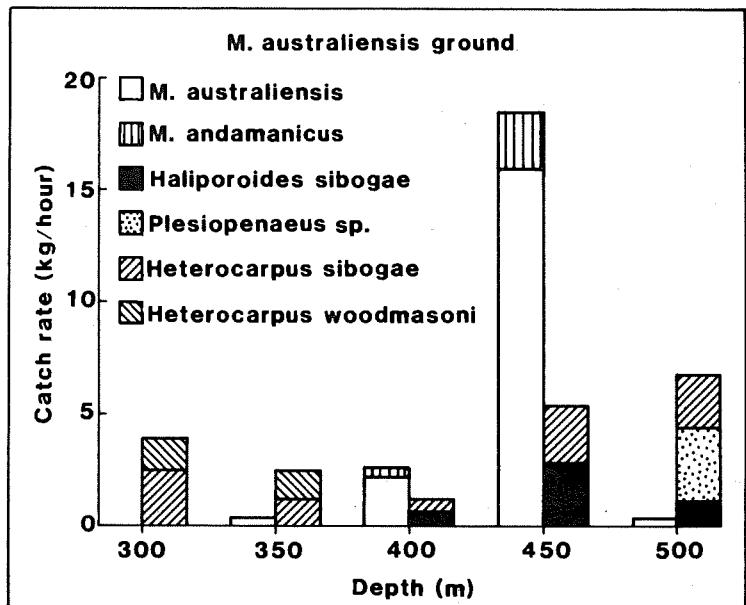


Figure 3: Catch rates of the main crustacean species at each depth on transect 8.

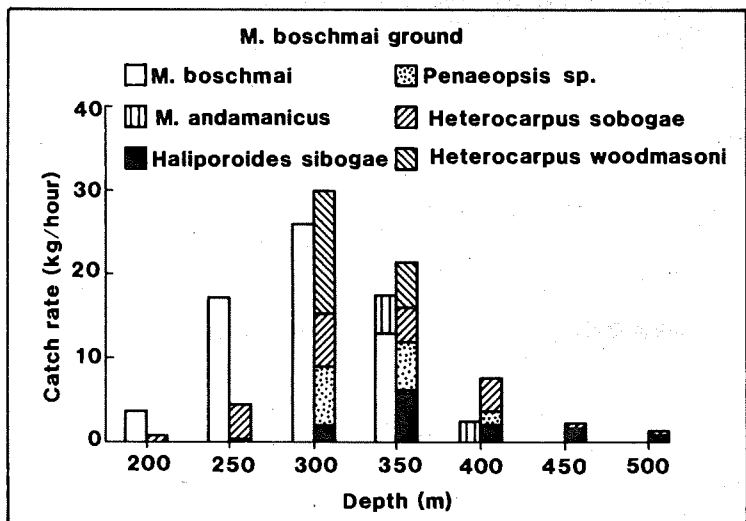


Figure 4: Catch rates of the main crustacean species at each depth on transect 12.

M. australiensis showed distinct changes in catch rate, with the highest rate occurring near dusk and a second lower peak near dawn (Fig. 5). On the other hand *M. andamanicus* showed no distinct changes between day and night although the catch rates at any time were low and variable.

Amongst the prawns, the royal red prawn had the lowest catch rate during the middle of the day, while this time was the best for the two

Heterocarpus species (Fig. 6). The penaeid *Penaeopsis* sp. 1 showed a very pronounced peak prior to dusk.

The results suggest that the best times for fishing this ground are about two hours either side of dusk and dawn, since this would maximise the catch of both scampi and prawns. Despite the great depth of water these animals show cycles of catchability that correlate closely with day-night cycles. Whether these

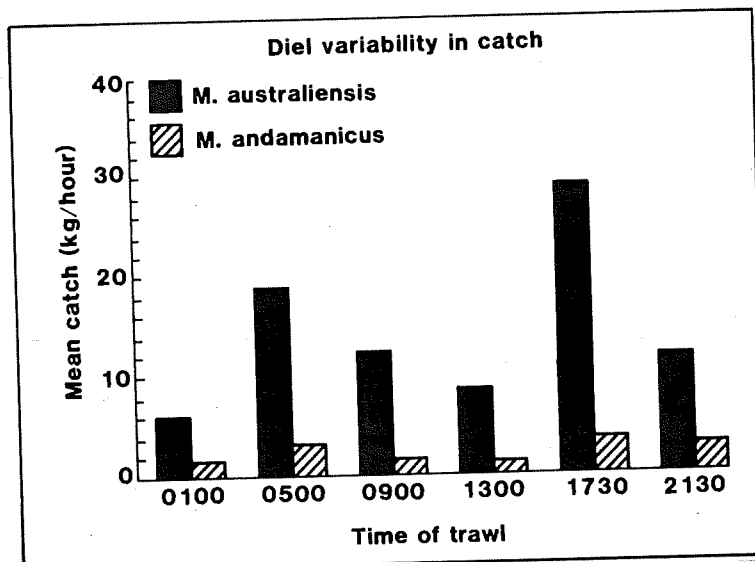


Figure 5: Mean catch of scampi at different times of the day.

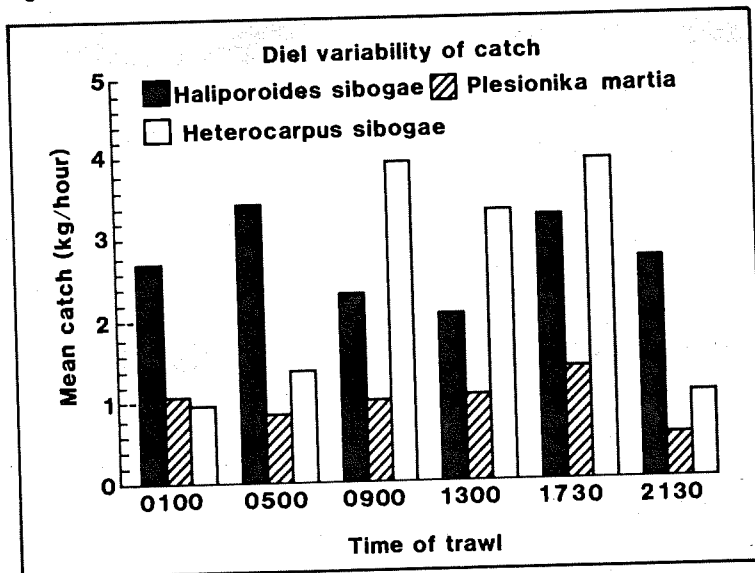
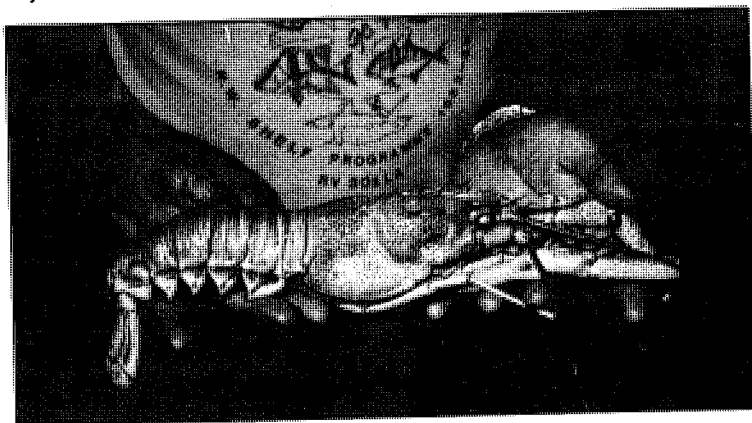


Figure 6: Mean catch of carid and penaeid prawns at different times of the day.



cycles persist throughout all seasons, and the role of tides in their activity patterns, remain to be investigated.

If the marked variability with time of day in catch rates of *M. australiensis* also occurs in *M. andamanicus* and *M. boschmai* then some of the survey catch rates south-west of Rowley Shoals look far more promising.

For example if the trawls for *M. andamanicus* in transects 2, 3 and 4 had been near dusk, the optimum time, one would expect catches using survey trawl configuration of 45, 20 and 20 kg an hr respectively. The 400-m zone in transects 2 to 4 warrants further exploration as it may have greater potential than the previously defined *M. andamanicus* grounds.

Stock assessments

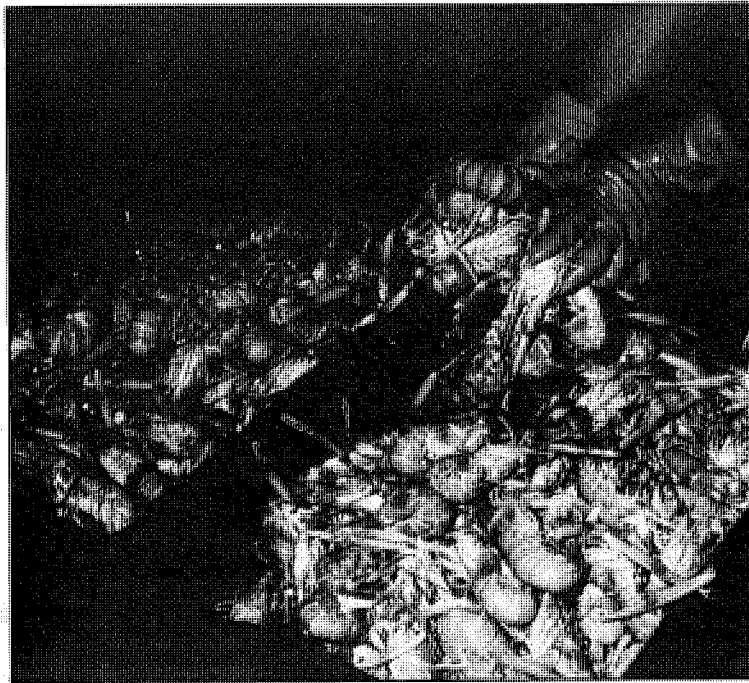
In the area south-west of Rowley Shoals some trawls provided good catches of scampi but areas were not large. The poor resolution resulting from 40-mile gaps between transects made it impossible to define the extent of areas of high concentration. It is likely that some of these areas will provide good commercial catches of scampi after further exploration.

The area previously identified by CSIRO as containing a mixture of *Metanephrops* species, but principally *M. andamanicus*, and since shown to hold commercial quantities of scampi by the KJV Fisheries survey in October 1983, is surpassed by two grounds now identified north of Rowley Shoals.

The first of these grounds is centred on 16° 55'S, 119° 54'E, and contains *M. australiensis*, the largest and most commercially attractive species, in high concentrations through a depth range of 430 to 470 m. Our preliminary estimates, which are conservative, suggest an average concentration for fully recruited scampi of 12 kg a hectare over an area of 250 km². This provides an estimated biomass of 300 t.

The second ground is south of Scott Reef, centred at 14° 49'S, 121° 36'E. This ground contains *M.*

One of the large but so far rare scampi species, M. neptunis.



A catch of *M. australiensis scampi*.

boschmai, a small but highly presentable species previously thought to be uncommon. It occurs in much shallower water than other scampi areas (250 to 350 m). We estimate an average concentration of 11 kg a hectare over an area of 600 km². This provides an estimated biomass of 660 t.

Estimates for both these grounds were based on survey catches and estimated swept area of the trawl. Catches were adjusted to the levels observed when the net was fished with a tickler chain and weighted to suit a particular ground. The swept area of the trawl was estimated from net gape measured using floats and sextant, and the average distance travelled in one hour's trawling.

Based on our survey data and that of the KfV Fisheries survey in October we estimate that the *M. andamanicus* ground contains a mixture of scampi species, but principally *M. andamanicus*, in variable densities of at least 7 kg a hectare over a minimum area of 1260 km². This provides an estimated biomass of 880 t.

Using theoretical natural mortality rates applied to the northern-hemisphere scampi (*Nephrops norvegicus*) and our estimated

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biomasses for these three scampi grounds, we predict a safe minimum annual catch level of 184 t.

There are grounds that have not been included in this assessment, and it should be emphasised that all these estimates are extremely conservative and represent the lower level of exploitation that can be expected off the North West Shelf. Further research is required to refine the population parameters assumed in this article.

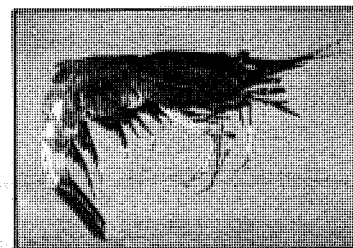
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1. Anon. (1983). CSIRO finds scampi and carid prawns on NW Shelf. *Aust. Fish.*, 42(3), 13
2. Berry, P. F. (1969). The biology of *Nephrops andamanicus* Wood-Mason (Decapoda, Reptantia). South African Association for Marine Biological Research, Oceanographic Research Institute, Investigational Report No. 22, 55 pp.
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4. Farmer, A. S. D. (1975). Synopsis of biological data on the Norway lobster *Nephrops norvegicus* (Linnaeus, 1758). FAO Fisheries Synopsis No. 112, 97 pp.

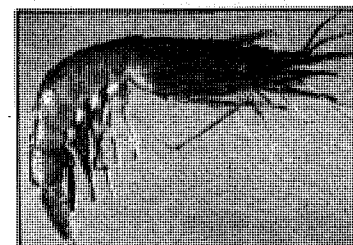
Examples of deepwater prawn species caught as by-catch of scampi trawls.



Heterocarpus sibogae.



Heterocarpus woodmasoni.



Haliporoides sibogae.



Plesiopenaeus sp. 1.



Penaeopsis sp. 1.



Biology of *Metanephrops* species

SEVERAL aspects of the biology of scampi were studied during the January-February surveys.

These included length-weight relationships, sex ratio, length frequencies, reproductive biology, moulting and parasites.

Length-weight relationship

The relationship between carapace length (CL in mm) and body weight (W in g) was of the following form: $W = aCL^b$

Estimates of 'a' and 'b' are shown in Table 1. Applying these equations to the carapace length measurements that were made on all scampi captured during the survey gave average weights of 85.6 and 77.9 g for male and female *M. andamanicus*, 81.1 and 93.2 g for male and female *M. australiensis*, and 43.2 and 42.1 g for male and female *M. boschmai* respectively.

Sex ratio

Overall there was a balanced sex ratio for all three species, being

M:F, 1:1.01 for 5157 *M. australiensis*; 1:1.102 for 2356 *M. andamanicus*; and 1:0.955 for 2366 *M. boschmai*. However some interesting variation in sex ratios were encountered. In *M. australiensis* with carapace lengths of 38 to 42 mm the sex ratio was 1:0.415 for the 341 individuals examined.

Length frequencies

The carapace length frequency distributions of the three species of *Metanephrops* have been plotted for the two main depth zones in which each occurs (Figs 1 to 3). *M. andamanicus* showed similar length frequency distributions at 400 and 450 m with mean lengths of 48.6 and 50.2 mm respectively.

M. australiensis is the largest of the three species, and like *M. andamanicus* shows no variation in length with depth, averaging 50.1 and 48.4 mm at 400 and 450 m.

M. boschmai was the smallest species and showed marked differences in the length frequency distribution

between 300 and 350 m. The mean lengths at 300 and 350 m depth did not differ markedly, being 38.6 and 35.4 mm. However the 30-mm length class of *M. boschmai* was dominant at 350 m but poorly represented at 300 m.

Reproductive biology

A larger number of berried females were used to determine brood sizes. Preliminary results indicate that females carry between 600 and 1500 eggs, depending on maternal size and species. The smallest berried *M. andamanicus* were 38-mm carapace length (22.5 per cent of females examined) with 42 to 58 per cent of all larger females carrying eggs. Overall 45.9 per cent of *M. andamanicus* were berried, whereas in September 1983 only 9.5 per cent were in this condition (Ref. 3).

The smallest berried *M. australiensis* were the 38 to 42-mm length class, with 11 per cent of this group carrying eggs while overall 54.4 per

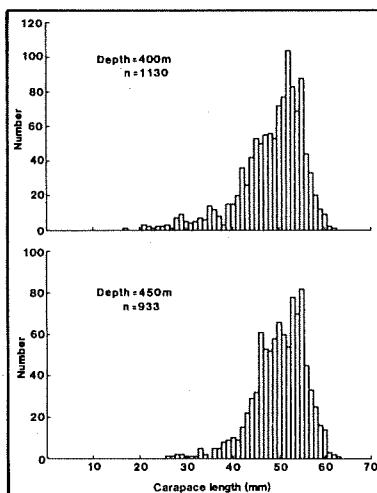


Figure 1: Length frequency distribution of *M. andamanicus* at 400 and 450-m depths.

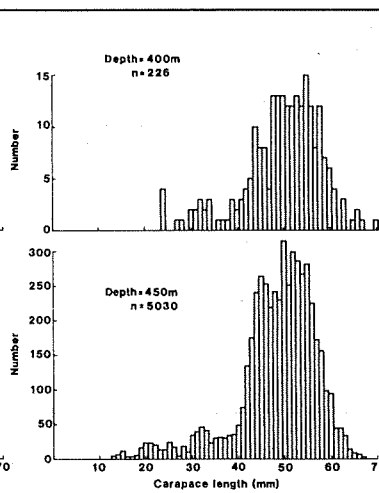


Figure 2: Length frequency distribution of *M. australiensis* at 400 and 450-m depths.

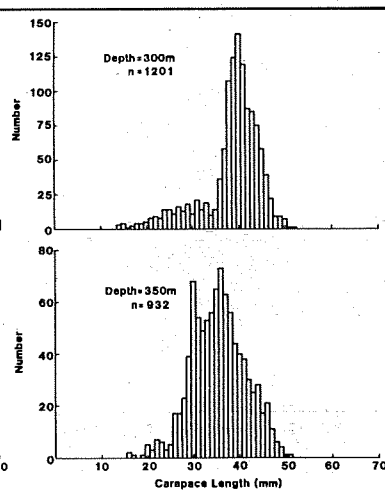


Figure 3: Length frequency distribution of *M. boschmai* at 300 and 350-m depths.

cent of all females were berried. This is substantially higher than the 28.3 per cent observed for *M. australiensis* in September 1983 (Ref. 3).

M. boschmai matures at a smaller size than the other *Metanephrops* species, with 9.5 per cent of females in the 18 to 22-mm length class carrying eggs. However this percentage remains below 10 per cent until the 38 to 42-mm length class is reached, where the proportion of berried females jumps to 60 per cent. This increases to 94 per cent in the 48 to 52-mm length class. Overall an average of 46.3 per cent for all females was recorded.

Mouling

In *M. australiensis* 5.1 per cent of males were 'soft-shelled', being in either the pre-moult or early post-moult condition. Only 0.7 per cent of females were in this condition and the majority of these were immature (less than 38-mm carapace length).

There was a high proportion of *M. andamanicus* males with soft-shells (12.6 per cent) and also a relatively high proportion of fe-

Parameters of the carapace length/body weight relationship for the scampi species, r = coefficient of correlation, n = sample size.

Parameter	<i>M. andamanicus</i>		<i>M. australiensis</i>		<i>M. boschmai</i>	
	Male	Female	Male	Female	Male	Female
a	0.0006*	0.0011*	0.0009	0.0012	0.0013*	0.0010*
b	3.035*	2.863*	2.942	2.885	2.854	2.924
r	0.99	0.98	0.99	0.99	0.99	0.99
n	219	231	217	238	225	227

* significant difference between male and female ($p < 0.05$)

males (3.8 per cent). Of the females, the 38 to 42-mm length class had the highest proportion of soft-shells (17.2 per cent). This was not observed in *M. australiensis* in that size class, and this, together with the uneven sex ratio in this group, suggests that *M. australiensis* females were actively moulting at the time of the survey and not susceptible to capture.

Female Nephropidae species must undergo a moult prior to fertilisation and the laying of eggs (Refs 2,4) and the timing of this moult may be different for the two species. There was no difference in the proportion of male and female *M. boschmai* with soft shells, nor

any trends with size. Only 2.3 per cent of *M. boschmai* were in this condition.

Parasites

M. andamanicus was the only species to carry the parasitic isopod which causes distortion of the carapace and affects marketability. Overall 5.1 per cent of males and 3.8 per cent of females were affected. In both sexes the incidence of parasitism decreased with size after reaching a peak of 27 per cent in males 33 to 37-mm long and 17.2 per cent in females 38 to 42-mm long.

WOULD A LISTER GEN SET HAVE PREVENTED THE MUTINY ON THE BOUNTY?



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