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Fisheries Synopsis No. 4

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SYNOPSIS OF BIOLOGICAL DATA ON THE RAINBOW PRAWN

Parapenaeopsis sculptilis (Heller, 1862)

Prepared by
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DIVISION OF FISHERIES AND OCEANOGRAPHY
COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION
Cronulla, Sydney, Australia, 1970

SYNOPSES OF FISHERIES BIOLOGICAL DATA

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CSIRO Fisheries and Oceanography DFO/S4
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Parapenaeopsis sculptilis (Heller, 1862)

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C O N T E N T S [1/]

1/ This synopsis has been prepared in accordance with Outline Version No. 2 in H. Rosa Jr, 1965, Preparation of synopses on the biology of species of living aquatic organisms, FAO Fisheries Synopsis 1 (Revision 1).

* As no information was available to the authors, these items have been omitted from the text.

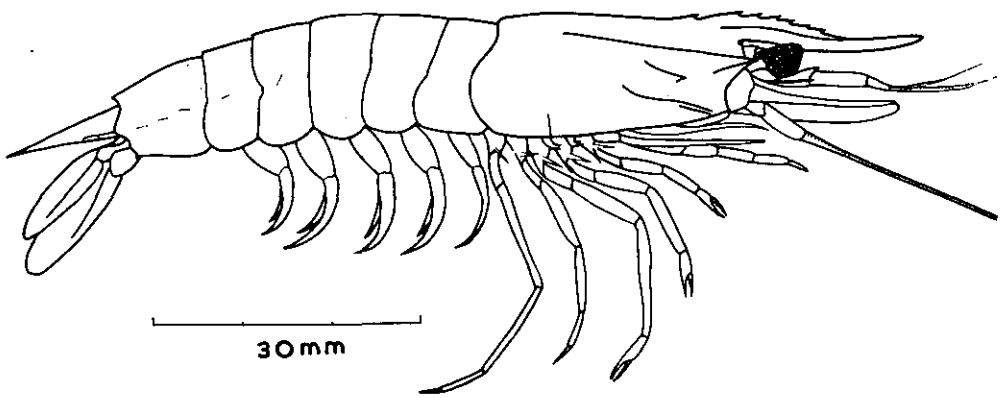


Fig. 1.- Parapenaeopsis sculptilis (Heller, 1862): female, length 116 mm (from Dall, 1957).

1 IDENTITY

1.1 Nomenclature

1.11 Valid name

Parapenaeopsis sculptilis (Heller, 1862), Verh. zool.-bot. Ges. Wien 12: 519-528.

1.12 Objective synonymy

Originally described as Penaeus sculptilis Heller, 1862, placed in synonymy by Nobili (1903), with reasons.

1.2 Taxonomy

1.21 Affinities

- Suprageneric

Phylum Arthropoda
Class Crustacea
Subclass Malacostraca
Series Eumalacostraca
Superorder Eucarida
Order Decapoda
Suborder Natantia
Section Penaeidea
Family Penaeidae
Subfamily Penaeinae

- Generic

Genus: Parapenaeopsis Alcock, 1901, "A descriptive catalogue of the Indian deep-sea Crustacea Decapoda Macrura and Anomura in the Indian Museum." Calcutta, Indian Museum. p. 14.

Genotype: Penaeus styliferus H. Milne Edwards, 1837.

Generic concept is that of Dall (1957, pp. 213-4):

"Rostrum dorsally toothed only. Carapace with longitudinal sutures not reaching as far as median posterior border of carapace and with transverse sutures at base of 3rd or 4th pereiopods. Cervical and orbito-antennal sulci rather feeble; hepatic sulcus present, usually well developed anteriorly. Antennal and hepatic carinae often present. Pterygostomial angle without a spine. Telson armed with small spinules or unarmed. First segment of antennular peduncle without a spine on ventral distomedian border. Maxillulary palp usually with 2 segments, sometimes unsegmented. Exopods on all pereiopods. Petasma tubular, median lobes with simple apices or produced

into laterally directed processes; lateral lobes with short simple spout-like or long, more or less complex distolateral projections, and with proximolateral projections which may be very large. Appendix masculina with 2 or 3 segments, the proximal large in relation to distal segments. Thelycum with a broad, usually concave anterior plate, the posterior plate usually slightly broader than the anterior. Zygocardiac ossicle consisting of 3 large teeth and 2 irregular rows of much smaller teeth. Pleurobranchiae on 3rd-6th thoracic somites; a rudimentary arthrobranch on 1st, anterior and posterior arthrobranchiae on 2nd-6th, and posterior arthrobranch on 7th thoracic somites; mastigobranchiae on 1st, 2nd, sometimes on 4th and 5th thoracic somites. Carapace often minutely pitted."

- Specific

Type specimen: It is not known if the type is still in existence. In Heller's 1868 work (we have not been able to examine the 1862 description) a 130 mm specimen is described which is apparently the type. The female illustrated (Heller, 1868, Tafel XI, Fig. 1) is probably this specimen. However, this illustration does not show some sutures, and the antennular flagella are much longer than would have been the case in a specimen of that size.

Type locality: Java.

Diagnosis: This species is illustrated in Figure 1. The most obvious characteristic of live P. sculptilis is the colour pattern. A black and white reproduction of this pattern is shown in Grant (1965). Dall (1957, pp. 218-9) gives the following diagnosis.

"Rostrum.—Teeth 6-8 usually 6 + epigastric, latter always feeble, often represented by a barely perceptible depression in male. Apparently sexually dimorphic in males 70 mm and above, unarmed portion absent, rostrum curving downwards, reaching to 2nd segment of antennular peduncle; in female rostrum is long, strongly sigmoidal, unarmed distal $\frac{1}{2}$ strongly upcurved and reaching beyond tip antennular peduncle. (In 53 mm male rostrum is of latter shape.) Epigastric tooth at 1/5 carapace, 1st tooth at or slightly behind anterior margin of carapace. Postrostral carina low, of uniform height, ending 1/20 length carapace from posterior end; feebly sulcate, sometimes merely flat-topped, throughout its length and narrowing slightly about the middle. Adrostral carina ending midway between 1st and 2nd teeth (Fig. 2a).

Carapace.—Orbital angle small. Longitudinal suture reaching $\frac{3}{4}$ length carapace from postorbital margin, and reaching level of transverse suture. Orbital-antennal sulcus absent. Antennal spine large, the carina reaching $\frac{1}{2}$ distance between spine and hepatic spine. Cervical sulcus straight, feeble, wide, its upper end indistinct. Hepatic sulcus pronounced 1/3 - $\frac{1}{2}$ length carapace, inclined downwards

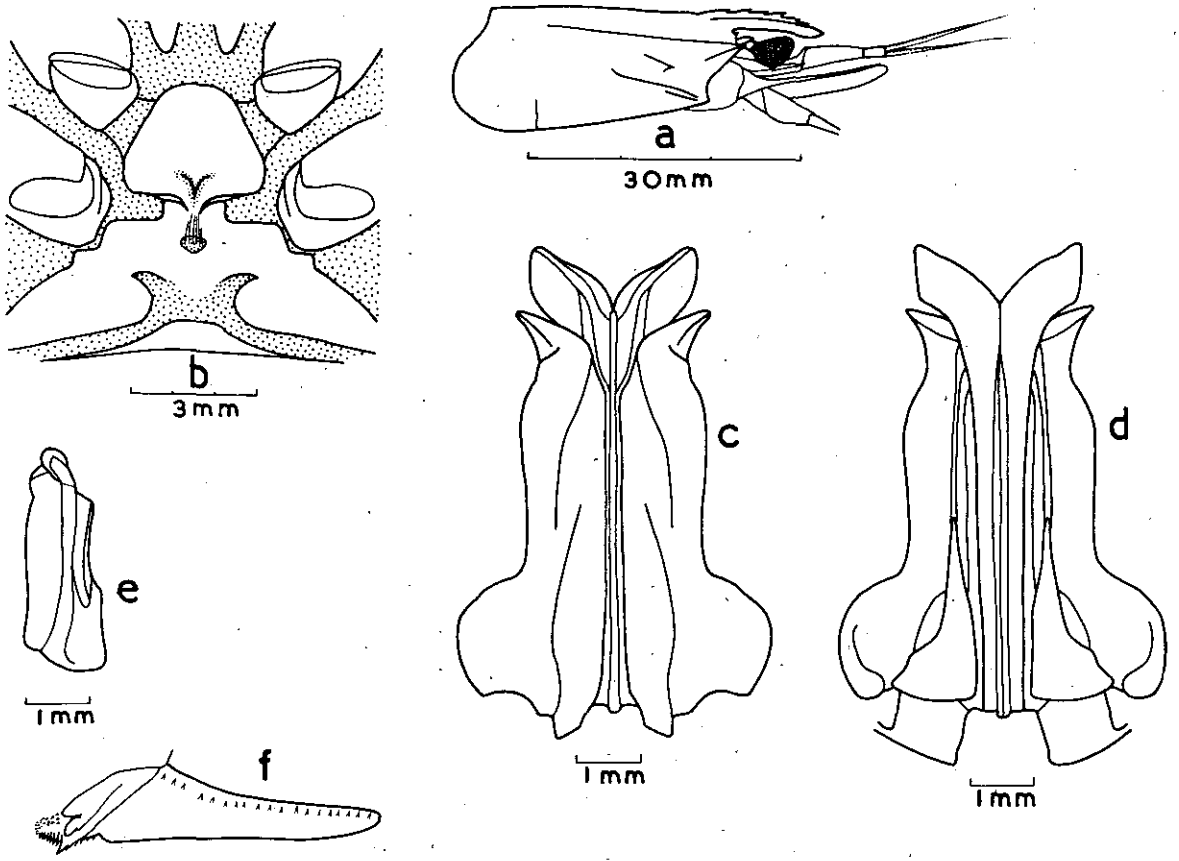


Fig. 2.- Parapenaeopsis sculptilis a, cephalothorax of male, total length 100 mm; b, thelycum of female, total length 128 mm; c, ventral surface, and d, dorsal surface of petasma of male, total length 97 mm; e, appendix masculina; f, cardiac plate and zygocardiac ossicle (from Dall, 1957).

at angle of 15° to horizontal, sinuous, posterior end indistinct and curving upwards, ending at $\frac{1}{2}$ carapace at level of hepatic spine; hepatic carina distinct only for lower $\frac{1}{2}$ sulcus, starting below hepatic spine and running towards sharp pterygostomial angle. Feeble indications of a branchiocardiac sulcus usually present.

Antennules.—Flagella subequal, 0.85 length peduncle, and 0.6 length carapace in male, and $\frac{3}{4}$ length peduncle and $\frac{1}{2}$ length carapace in female. Prosartema reaching tip of junction of peduncle of eye with cornea, stylocerite attaining $\frac{1}{2}$ basal segment.

Thoracic appendages.—Third maxilliped reaching from $\frac{3}{4}$ to slightly exceeding carpocerite; 1st pereiopod reaching from pterygostomial angle, to base of carpocerite; 2nd reaching from base to $\frac{1}{2}$ carpocerite; 3rd reaching from tip to exceeding carpocerite by dactyl; 4th reaching base of, 5th reaching tip of carpocerite. Mastigobranchiae on 1st and 2nd pereiopods, ischial spines absent.

Abdomen.—Dorsally carinated from middle 4th somite, carinae of 4th and 5th ending in angular, sometimes very minutely spinous projections, that of 6th ending in large spine. The 3rd and anterior 4th somites with feeble dorsal sulcus or flat-topped strip indicating its position, often present on 1st and 2nd somites also. Fourth somite with 1, 5th with 1, 6th with 3 pairs of faint lateral cicatrices. Telson unarmed.

Gastric mill.—Cardiac plate with 17-21 spinules. Zygocardiac ossicle 3 principal + upper row of 7-8 smaller and lower cluster of about 25 teeth; 5 teeth on edge of cardiac plate; prepyloric with 9-12 lateral teeth (Fig. 2f).

Petasma.—Reaching basis of 4th pereiopods, with pair apical spout-like projections directed anterolaterally and opening ventrally, distance between their apices almost equal that of distolateral projections, which is 2/5 total length petasma. Petasma constricted at 0.7 its length; a pair of very large prominent lateral proximal projections, slightly curved dorsally, ending posteriorly in knob-like processes (Fig. 2c and d).

Appendix masculina.—Distal piece with expanded, flattened distolateral region inclined at 45° to longitudinal axis and 1/5 length basal piece (Fig. 2e).

Thelycum.—Anterior plate slightly concave, length 0.7-0.8 width; with 2 low tubercles on posterior edge separated by shallow median depression and articulating with corresponding pair of tubercles on rectangular posterior sternal plate, latter with tubercle bearing tuft of setae (Fig. 2b).

Colour (freshly preserved).—Four wide whitish transverse bands evenly spaced along carapace and abdomen, edged with narrow pink bands, region between white and pink bands light to dark brown; appendages pink to red."

Material examined by present authors: Specimens from the Gulf of Carpentaria and the east coast of Queensland have been examined by the authors and a male and a female specimen have been deposited in the Queensland Museum (Reg. No. W3170).

Subjective synonymy:

Penaeopsis (printing error) sculptilis Alcock, 1906.
Parapenaeopsis sculptilis Burkenroad, 1934, placed in synonymy by Racek and Dall, (1965), reasons not given.
Parapenaeopsis cultrirostris Kubo, 1949, placed in synonymy by Dall, (1957), with reasons.
Parapenaeopsis affinis (H. Milne Edwards, 1837) Hall, 1962, placed in synonymy by Racek and Dall, (1965), p. 54, with reasons. The claim by Hall (1962) that P. sculptilis is identical with Penaeus affinis H. Milne Edwards, 1837 is not upheld here. Hall himself casts doubt on the matter (p. 21, para. 2) when he notes that Bate recognized a female specimen of Heller's Penaeus sculptilis but did not identify it with the type female of Penaeus affinis. Heller readily distinguished the two species in his 1868 descriptions. Burkenroad (1963a and 1963b) also dismissed Hall's claim.

Key to the Indo-Pacific species of Parapenaeopsis:

Fifteen species are recognized for the genus Parapenaeopsis and with the exception of P. atlantica Balss from the Atlantic Ocean all are Indo-Pacific and can be separated by the following key (Dall, 1957).

1 Mastigobranchiae on 1st and 2nd pereiopods 2
Mastigobranchiae absent from 1st and 2nd pereiopods 10

2(1) First pereiopods with basial spines 3
First pereiopods without basial spines 9

3(2) Second pereiopods with basial spines 4
Second pereiopods without basial spines ..... P. uncta (Alcock)

4(3) Telson with pair of fixed subapical spines .....
..... P. stylifera (H. Milne Edwards)
Telson without fixed subapical spines 5

5(4) 1/3 or less distal free portion of rostrum unarmed 6
More than 1/3 (almost $\frac{1}{2}$) distal free portion of rostrum unarmed .....
..... P. aroaensis Hall

6(5) Petasma with a pair of long slender caliper-like distolateral projections directed forwards; thelycum with median tuft of long setae behind posterior edge of last thoracic sternite ..... P. cormuta (Kishinouye)
Petasma with a pair of distolateral projections directed laterally or distolaterally, usually short and spout-like 7

7(6) Postrostral carina reaching almost to posterior border of carapace; petasma with pair of short spout-like distolateral projections 8

Postrostral carina reaching $\frac{3}{4}$ carapace; petasma with pair of distolateral projections directed laterally, cap-like distal projections absent ..... P. nana (Alcock)

8(7) Antennular flagella 0.5-0.6 length of carapace; thelycum with median tuft of setae on posterior plate ..... P. sculptilis (Heller)
Antennular flagella 0.7 length carapace or longer; thelycum without a median tuft of setae on posterior plate ..... P. hardwickii (Miers)

9(2) Epigastric tooth present (species restricted to Pacific America) .... P. balli Burkenroad
Epigastric tooth absent (species found other than in Pacific America) ..... P. gracillima Nobili

10(1) Epigastric tooth present 11
Epigastric tooth absent 12

11(10) Rostrum exceeding tip of antennular peduncle; longitudinal suture extending to about 0.9 length carapace from anterior edge .... P. hungerfordi (Alcock)
Rostrum short, reaching tip of 1st segment of antennular peduncle; longitudinal suture reaching as far as hepatic spine .... P. venusta de Man

12(10) Anterior plate of thelycum with V-shaped posterior edge .... P. tenella (Bate)
Anterior plate of thelycum without obvious V-shaped posterior edge.. 13

13(12) Rostrum with 4-5 dorsal teeth ..... P. arafurica Racek and Dall
Rostrum with 7 + dorsal teeth ..... P. acclivirostris (Alcock)

1.22 Taxonomic status

P. sculptilis is a morphospecies.

1.23 Subspecies

Although several subspecies have been described in the past they are no longer recognized (Dall, 1957).

1.24 Standard common names, vernacular names

Standard and vernacular names are listed in Table 1.

TABLE 1

STANDARD AND VERNACULAR NAMES
(Grant, 1965; Filewood, 1964)

Country	Standard name	Vernacular name
Australia	Rainbow prawn	Rainbow prawn Coral prawn
New Guinea	Rainbow prawn	Brown coral prawn Tiger prawn Long-beaked prawn Short-beaked prawn

1.3 Morphology

1.31 External morphology

(For description of spawn, larvae, and juveniles see 3.17, 3.22, 3.23.)

Two compound eyes are borne on eyestalks which arise directly under the anterior edge of the carapace on either side of the rostrum. Thereafter the following pairs of appendages are found attached to the sternites of the cephalothoracic segments; antennules, antennae, mandibles, maxillae I and II, maxillipeds I, II and III, and pereiopods I to V, pereiopods I, II and III with small chelae. In females the sternite of the segment bearing pereiopods V is modified into a thelycum. The abdomen consists of 6 individually distinct segments and a telson. The sternites of the first 5 abdominal segments bear paired pleopods, the sixth bears uropods on its posterior margin. In the male the endopods of the first pair of pleopods are modified into a petasma, and the second pair bear an appendix masculina each.

The rostrum changes in shape with age (see 3.11).

No subpopulations have been defined on the basis of consistent morphological differences.

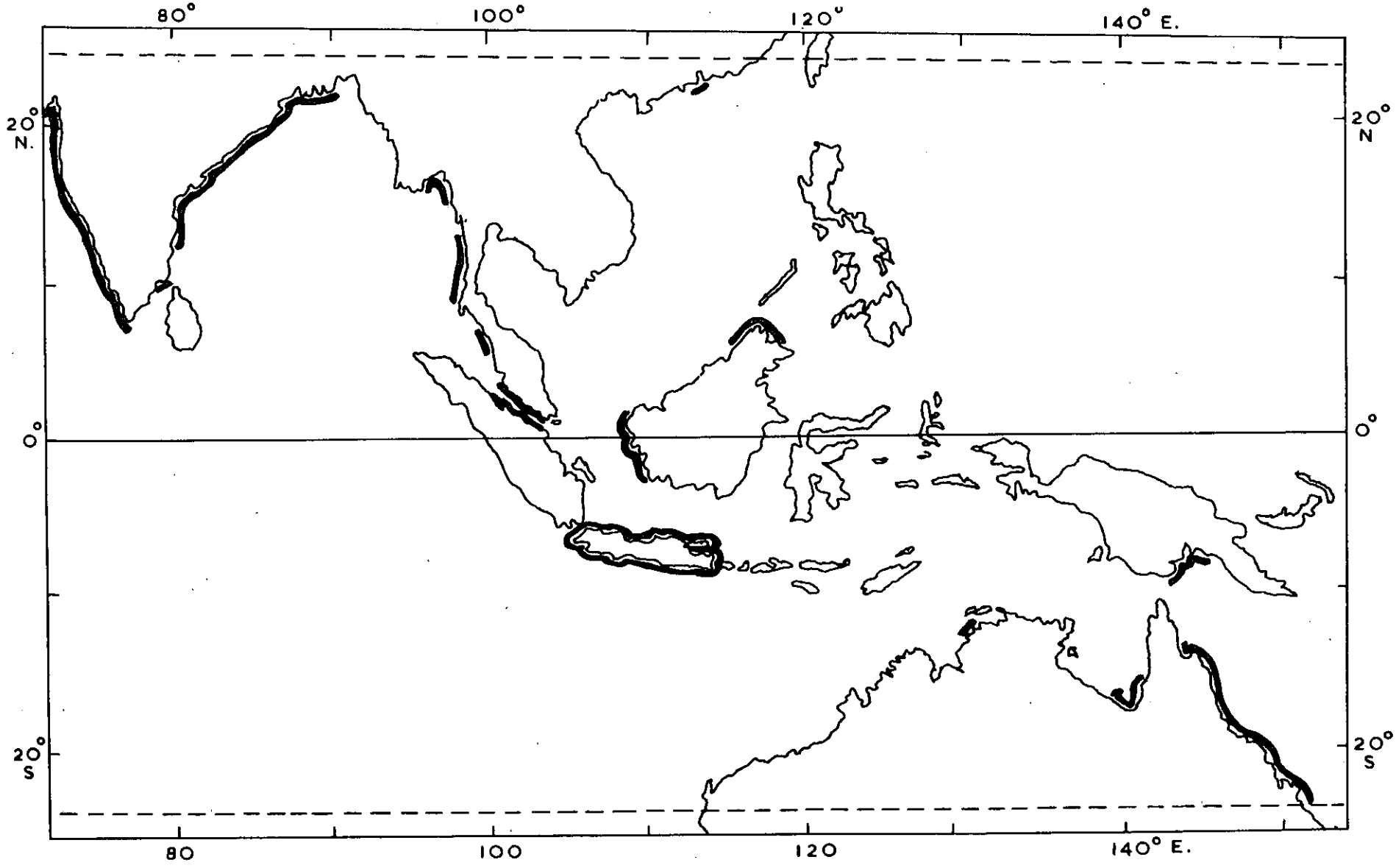


Fig. 3.- Distribution of Parapenaeopsis sculptilis.

2 DISTRIBUTION

2.1 Total area

The northern and southern limits of this species lie just inside the tropics of Cancer and Capricorn (Fig. 3, Table 2). It has not been mentioned in recent records from Ceylon (De Bruin, 1965) or Hong Kong (Cheung, 1960). Information from south-east Asia is sparse but it is quite likely that P. sculptilis is found from Bombay to Hong Kong and throughout most of the Indonesian Archipelago. Distribution is probably continuous along the Queensland coast but the species has not been recorded from Western Australia.

The species occupies estuarine to coastal waters, according to the different stages of its life cycle (see 2.2).

TABLE 2

AREAS WHERE P. SCULPTILIS OCCUR

Land area	Code (Rosa, 1965)
India	423
E. Pakistan	425
Burma	431
Malaysia	433
Hong Kong	442
Indonesia	434
Papua	624
Northern Territory	611
Queensland	616

2.2 Differential distribution

2.21 Spawn, larvae, and juveniles

Spawning has been reported in inshore waters in the Hooghly Estuary area, India, between December and May (Bhimachar, 1963).

Larvae and juveniles have been found in the Norman River, Queensland, Australia (Kirkegaard, unpublished) and the Hooghly Estuary, India (Bhimachar, 1963). Protozoea were found in salinities of 30 to 32‰, mysis stages below 22‰, and juveniles further upstream in water below 5‰ in the Norman River (Kirkegaard, unpublished).

Hall (1962) found that juveniles of his "P. affinis" (=P. sculptilis) occupied tidal flats around Penang, Malaysia for 2-3 months then moved off into deeper water.

2.22 Adults

Juveniles and young adults move out of the rivers with the approach of the monsoon (Bhimachar, 1963; Munro, pers. comm.) and in the Malacca Straits have been taken up to 10 n. miles (18 km) out to sea in a depth of 38 m (Hall, 1962). Munro (pers. comm.) found adults in the Gulf of Carpentaria most abundant around river mouths in less than 3 fm (6 m) although they were found up to 20 n. miles (37 km) from the shore at depths of 7 fm (14 m).

2.3 Determinants of distribution changes

Munro (pers. comm.) and Bhimachar (1963) agree that freshes in the rivers created by the onset of the monsoons cause juveniles and young adults to move into the sea around river mouths.

It is possible that larvae are restricted in their migrations up river by salinity tolerances of each larval phase (see 2.21).

3 BIONOMICS AND LIFE HISTORY

3.1 Reproduction

3.11 Sexuality

P. sculptilis is heterosexual and sexually dimorphic. Adult males have a petasma formed from the joined endopodites of the first pleopods. Adult females have a thelycum between the last 2 pairs of pereiopods.

The rostrum of mature adults is sexually dimorphic. In the female an anterior edentate portion extends beyond the last rostral tooth to beyond the tip of the antennular peduncle. This portion is sigmoidal in form and is lacking in males above 70 mm total length. In smaller males there is some indication of the female rostral pattern (Dall, 1957). Dall suggested this was a traumatic condition whereas Burkenroad (1934) regarded it as a normal instar attained by all males at a certain size, i.e. it was not even a true sexual dimorphism.

3.12 Maturity

According to Rajyalakshmi (1966), mature adults are in the II year group and from growth curves it seems that early spawned stocks of one year contribute the brood stock at the end of the breeding cycle of the second year and late spawned stocks provide the early brood stock of the third year.

Bhimachar (1963) gives the length of males at sexual maturity as 75 mm but does not give a size for females. (Since females grow faster than males (3.43) it is probable that a mature female would be longer than this.)

3.16 Spawning

Bhimachar (1963) states that in the Hooghly River area, India, spawning takes place in inshore waters of the Bay of Bengal and extends from December-January to April-May. Statements by Rajyalakshmi (India, 1966), also indicate that the breeding cycle is prolonged.

3.2 Pre-adult phase

3.22 Larval phase

In the Gulf of Carpentaria, Queensland, an investigation was made into the recruitment of larvae and juvenile prawns into the rivers (Kirkegaard, unpublished). An intensive sampling programme was carried out from the mouth of the Norman River upstream 50 miles (80 km) to Normanton between October 1964 and July 1965.

A series of small protozoea and mysis with 8+8 telson spines

were attributed to P. sculptilis. Juveniles were also found up to 40 miles upstream from the mouth.

3.3 Adult phase

3.31 Longevity

In India, Rajyalakshmi (1966) found that female P. sculptilis live for 3 years and males for 2 years.

3.33 Competitors

Several species of penaeids found with P. sculptilis could be regarded as competitors. In the Gulf of Carpentaria the habitat of P. sculptilis is identical to that occupied by Metapenaeus eboracensis and M. insolitus and juvenile P. merguiensis (Munro, pers. comm.) Filewood (1964) also found an association between P. sculptilis and P. merguiensis.

In Penang, Hall (1962) found 16 species of penaeids associated with "P. affinis" (=sculptilis) and of those prawns which formed more than 1% of the catch 3 species were from the same feeding group as P. affinis. These were Parapenaeopsis hardwickii, P. hungerfordi, and P. tenella.

3.35 Parasites, diseases, injuries, and abnormalities

- Injuries and abnormalities

Dall (1957) considered that the rostrum of males is almost invariably broken off at the last tooth at about the time they reach sexual maturity (see 3.11).

Some samples of P. sculptilis taken in the Gulf of Carpentaria had an iodine-like taint (Munro, pers. comm.)

3.4 Nutrition and growth

3.42 Food

Hall (1962) examined the stomachs of 21 specimens of his "P. affinis" (Table 3). These specimens measured from 1.3 to 3.8 mm carapace and were from the Penang fishery. The stomachs were on average about half full.

TABLE 3

IMPORTANCE OF ITEMS OF DIET OF P. SCULPTILIS

The figures are numbers of individuals
(from Hall, 1962)

Item	Predominant	Residual	Total
Polychaeta	4	5	9
Small crustacea (ingested whole)[1]	-	7	7
Large crustacea (too large to be ingested whole)[2]	3	7	10
Mollusca[3]	11	6	17
Pisces	-	2	2
Vegetable[4]	-	2	2

1/ Only identifiable items were of harpacticoid copepod
2/ Mainly portions of decapods
3/ All the molluscan material seemed to be of a single species of Protobranchiata
4/ This item includes angiosperm and algal tissue

As a result of this examination Hall (1962, p. 66) placed this species into a group, "species with a general carnivorous diet" along with most of the other species of Parapenaeopsis recorded in his investigation. This group also included all the Trachypenaeus species examined.

Hall also places this species in a group of prawns which "appear to have ingested food in approximate proportion to the availability".

3.43 Growth rate

Rajyalakshmi (1966) found that the juveniles apparently grow approximately at a rate of 12-15 mm per month in the very early months after hatching. "This rate appears to decline later and by the end of the first year males attain length of only 45-59 mm and females 50-65 mm. Growth rate appears to maintain a constant proportion during later years. The females appear to have a slightly faster rate of growth than males and live up to III years".

Hall (1962) measured males and females and fitted growth curves to data from the period October to February. The curves indicate an increase in carapace length from below 0.5 cm to 2.0 cm for males and to 2.25 cm for females in that 4 month period.

The maximum size recorded appears to be 152 mm total length (Rajyalakshmi, quoted in Bhimachar, 1963). Filewood (1964) gives a measurement of 6-7 in. (15.2-17.7 cm).

Length-weight relationships have been given by

Bhimachar (1963) $\text{Log } W = -5.1272 + 2.9580 \log L$
Hall (1962) $W = 0.4954\ C^{2.944}$

where L is the total length and C the carapace length.

Hall also gives a graph for the relationship between weight and carapace length (Fig. 4).

3.5 Behaviour

(For feeding behaviour see 3.41, for reproductive behaviour see 3.13, 3.21.)

3.51 Migrations and local movements

On the Batu Maung Flats off Penang, Malaysia, Hall (1962) found that juveniles moved onto the flats in November to December and then after 2 to 3 months, dispersed into deeper water. His only explanation for this was that the flats were very shallow and parts were dry at low tide and apparently unsuitable for juveniles.

The only other movements recorded are the migrations of larvae upstream (see 3.22) and the movements of juveniles and adults out of the rivers after rain had produced freshes in the streams (see 2.3).

3.52 Schooling

Catch rates (see 5.43) indicate that P. sculptilis probably forms loose schools.

3.53 Responses to stimuli

In the Gulf of Carpentaria, Queensland, P. sculptilis were abundant around river mouths following heavy rain. This could be due to physical washout of the prawns by freshes (Munro, pers. comm.), or it could involve a response to lower salinity.

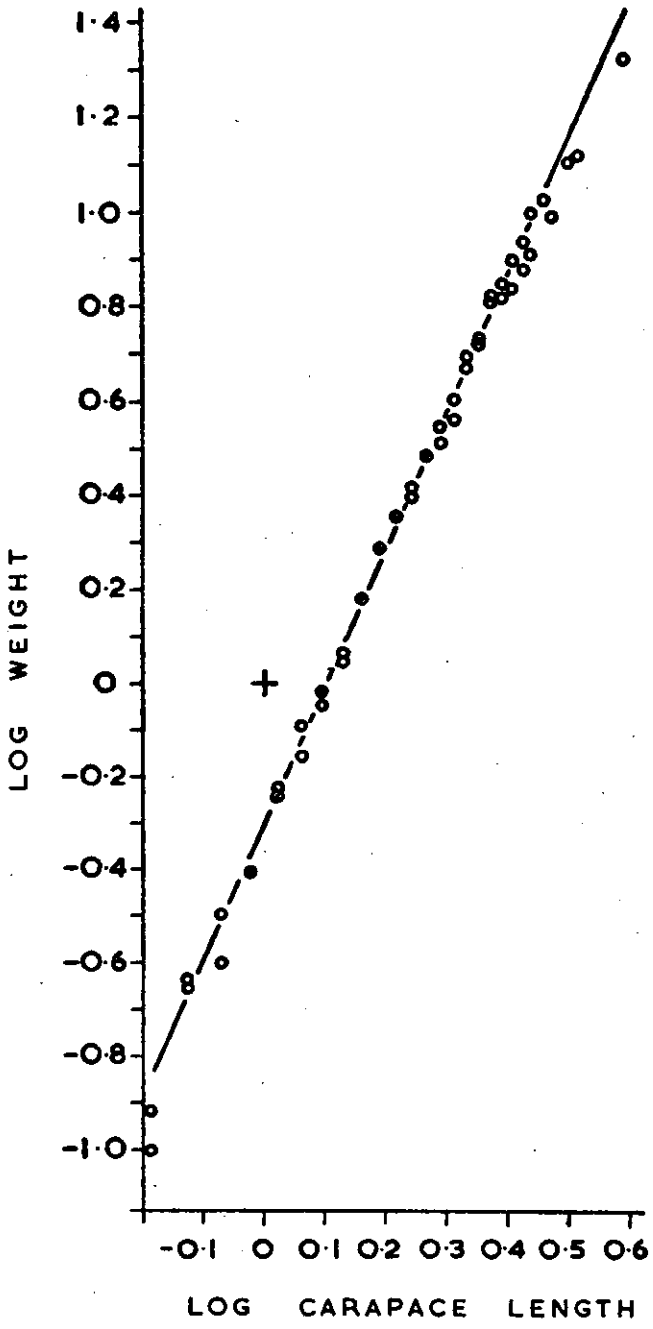


Fig. 4.- Relationship between weight and carapace length of Parapenaeopsis sculptilis (log values) (Hall, 1962, Fig. 26, p. 42).

4 POPULATION

4.1 Structure

4.11 Sex ratio

The sex ratio of P. sculptilis in the Indian fishery examined by Rajyalakshmi (1966) varied with size and with season. The ratio of males to females was equal in the 23 to 26 mm size range (total length) but increased to 1:3.24 in the 29 to 69 mm range and only females were found in the 89+ mm range. In the period January to May the overall ratio of males to females was 1:4.2 and in June to December it was 1:1.9.

4.12 Age composition

Bhimachar (1963) states that 0-I year age groups contribute to the fishery of less saline areas and the largest specimens are caught inshore, these presumably being of II and III year groups.

The year groups in the Queensland fishery are well mixed in the 2-6 m zone (see 4.13), while in India where different gear is used (see 5.11) parts of the fishery depend on populations with a dominance of certain year groups.

Hall's 1962 figures for the Penang fishery indicate a fairly uniform mixing of age groups during most of the year, with an influx of juveniles in the October to December period.

4.13 Size composition

Munro (pers. comm.) found in the Gulf of Carpentaria, Queensland, that counts per pound (heads-on) ranged from 20-173 (44-381/kg) and throughout the season individuals were distributed throughout this full size range.

4.2 Abundance and density

4.22 Changes in abundance

In Queensland fishing does not appear intensive enough to cause any changes in abundance.

Weather appears to cause changes in abundance as far as the fishery is concerned although total population size may not be altered. Hall (1962) states that in Penang "Parapenaeopsis affinis" was relatively abundant on four occasions, once during each steady south-west monsoon, and at the beginning and the end of the north-east monsoon.

Freshes in rivers in Queensland and India cause similar changes in abundance.

4.24 Changes in density

In the Gulf of Carpentaria P. sculptilis is confined mainly to the fringes of the coast out to the 8 m contour, but may be found as deep as 14 m. The greatest concentrations were around river mouths in depths of less than 6 m (Munro, pers. comm.). Occurrence is seasonal but it is likely that the species occurs in rivers throughout the year. This species moves into coastal waters during the monsoon season. Although small numbers were observed as early as August and as late as May, the main period of abundance coincided with the wet season and immediately prior to it, namely November to March (Munro, pers. comm.).

4.6 The population in the community and the ecosystem

- Physical features of the biotope of the community

P. sculptilis has been recorded from the following bottom types: sand/mud, mud flats (Hall, 1962; Ramamurthy, 1963); sand, mud with fine shell particles; fine sloppy alluvial silt; clean sand mixed with coarse shell gravel (Munro, pers. comm.). Ramamurthy (1965) found an increase in percentage of P. sculptilis in catches taken over sandy bottoms instead of muddy bottom.

Water conditions vary (see 2.2) from rivers to open sea waters, from salinities of less than 5‰ to higher than 30‰ (Bhimachar, 1963; Rajyalakshmi, 1966; Hall, 1962; Munro, pers. comm.; Filewood, 1964, and Kirkegaard, unpublished). Filewood classed P. sculptilis as estuarine.

- Species composition of the community

In the Penang fishery, Hall (1962) found this species associated with 15 other penaeid species (Table 4).

TABLE 4

THE RELATIVE IMPORTANCE OF PENAEID SPECIES TAKEN IN 17 RANDOM SAMPLES FROM A PENANG "AMBAI" (Hall, 1962, p. 137)

Species	No.of Specimens	%
Parapenaeopsis hardwickii	1431	42.1
Parapenaeopsis hungerfordi	421	12.4
Parapenaeopsis affinis (=sculptilis)	367	10.8
Parapenaeopsis tenella	306	9.0
Metapenaeus mutatus	260	7.6
Metapenaeus lysianassa	217	6.4
Solenocera subnuda	178	5.2
Parapenaeopsis coromandelica	145	4.3

TABLE 4 (Contd...)

Species	No.of Specimens	%
Metapenaeus stridulans	23	0.7
Parapenaeopsis maxillipedo	19	0.6
Metapenaeus ensis	16	0.5
Metapenaeus brevicornis	9	0.3
Trachypenaeus fulvus	5	0.1
Penaeus semisulcatus	3	0.1
Penaeus penicillatus	1	0.05
Atypopenaeus stenodactylus	1	0.05

Around the Gulf of Kutch, Ramamurthy (1963) found P. sculptilis associated with Metapenaeus monoceros, Metapenaeus brevicornis, Penaeus indicus, Penaeus monodon, Parapenaeopsis stylifera and several caridean shrimps. P. sculptilis represented 2 to 18.8% of the penaeid prawn populations.

In New Guinea, Filewood (1964) found P. sculptilis associated with banana prawns, Penaeus merguiensis, "for which it is regarded as a good indicator".

In the Gulf of Carpentaria, Queensland, P. sculptilis was found closely associated with Metapenaeus eboracensis, M. insolitus and juvenile Penaeus merguiensis (Harrison, 1965).

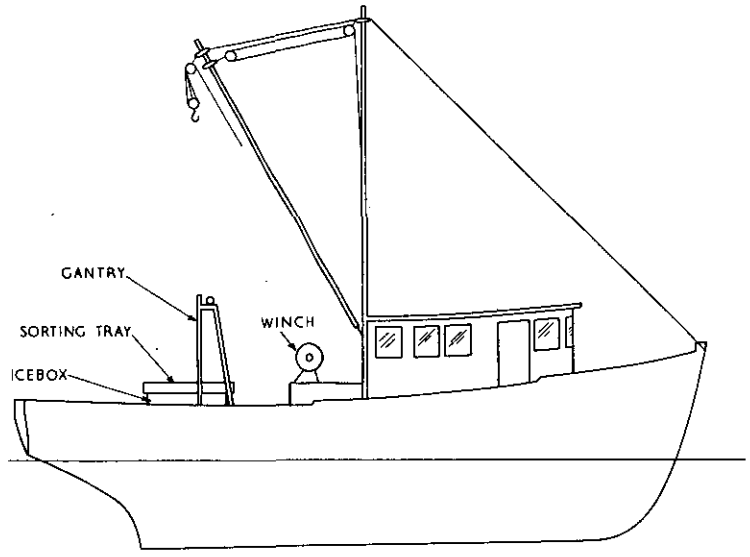
- Interrelationships in the community and the ecosystem

From Hall's (1962) observations on feeding (see 3.42) it is possible to place P. sculptilis between primary and secondary carnivores as it does not belong wholly with either group. It is probably in turn preyed upon by larger crustacea and fish.

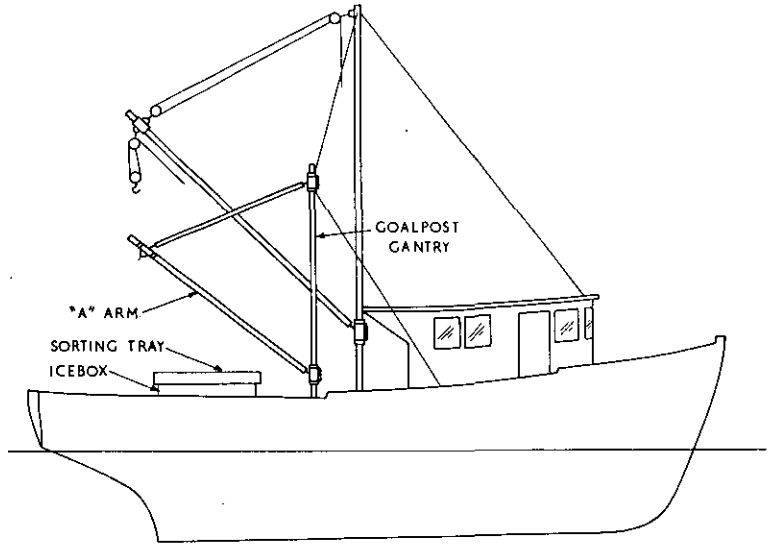
- Changes in environmental factors and their effect on the population

Statements by Rajyalakshmi (1966) indicate that the breeding cycle is prolonged and that entry to the estuarine and inshore fishery is due to gradual downstream migrations aided by freshes during rainy periods of the year.

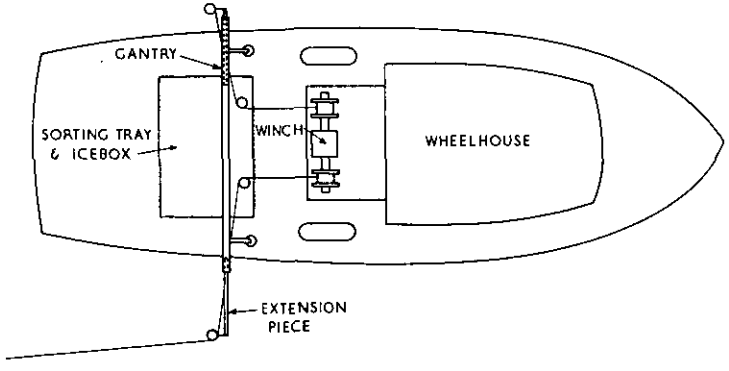
Superimposed on this cyclic fluctuation is the non-cyclic fluctuation in numbers and size groups due to irregular freshes in the river.



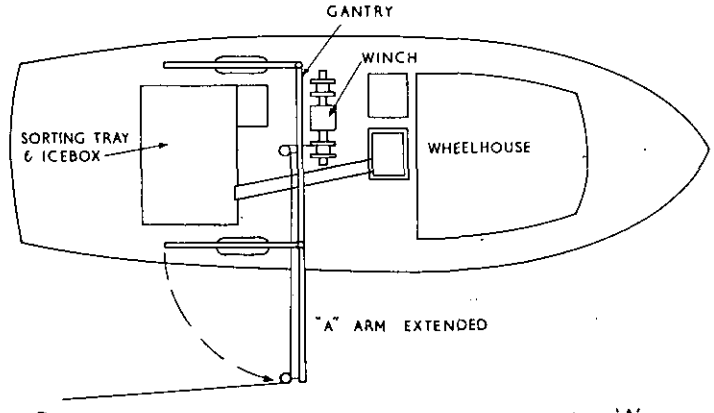
Small stern trawler rigged for single gear



Larger stern trawler rigged for double gear



Deck layout of above showing method of extending gantry.



Deck layout of above showing method of extending 'A' arm.

Fig. 5.- Deck layout of typical Australian prawn trawlers (from Wright, 1966).

5 EXPLOITATION

5.1 Fishing equipment

5.11 Gears

- India

In the Hooghly Estuary bag nets with cod-end mesh size of about 2 cm are used, with a small proportion of the catch from small-meshed shore seines (Rajyalakshmi, 1966).

- South-east Asia

In the Singapore fishery a push net known as the "sondong" replaces the bag net. This is a net hung on two poles 10 to 15 ft (3-5 m) long which cross about 2 ft (3/4 m) from the thicker ends and have shoes fitted to the other ends. The net is made up as a scoop and pushed along in shallow water by the operator. The net is lifted periodically and the catch shaken back to the operator.

The hauling seine used in Singapore is known as the "Pukat Tarek", which has a roughly cone-shaped bag about 36 ft (12 m) deep with wings 500 ft (65 m) long tapering to a depth of 9 ft (3 m) Rattan leads 2500 ft (833 m) long are used for hauling. Cotton twine in 3 sizes (Nos. 6, 9 and 12) is used to make up the net and mesh size tapers from $2\frac{1}{2}$ in. (6.4 cm) in the extremities of the wings to $1\frac{1}{4}$ in. (13.2 cm) at the mouth of the bag. It is handled as a beach seine by up to 16 men from a row boat (Tham, 1955).

The fishery at Penang (Hall, 1962) uses the "Ambai", a device made up with rows of stakes set in a linked set of V-shapes with bag nets at the apices. This can be set to fish a particular tide or both phases of the tide.

- Australia

The Queensland fishery uses either beam or otter trawls. The beam trawl is used from small boats (less than 20 ft (70 m) long) in estuaries. The otter trawls are used from larger boats in the estuaries and outside river mouths. Regulations govern maximum net sizes and minimum mesh sizes. Mesh size used is 1 to $1\frac{3}{4}$ in. (2.5 to 4.4 cm) in the cod end - minimum mesh size is 1 in. (2.5 cm) in estuaries and $1\frac{1}{2}$ in. (3.8 cm) in the open sea. Beam trawl width is 6 to 10 ft (2 to 3 m) - maximum width is 15 ft (5 m). Otter trawl width is up to 48 ft (16 m) - maximum headrope length is 8 fm (15 m) in estuaries and 20 fm (37 m) in ocean waters. The nets are made of cotton or synthetic twine.

5.12 Boats

- South-east Asia

In south-east Asia, in the taking of P. sculptilis, boats are apparently not used except in Singapore seine fishery, where a row-boat may be used (see 5.11).

- Australia

Boats of wooden construction up to 20 ft (7 m) long, often flat-bottomed and with inboard motors of 5 to 20 h.p. are used in estuaries. The beam trawl is towed from a stern post with a single warp. Some of these smaller boats use otter trawls which are set by hand, but boats engaged in otter trawling are usually at least 30 ft (10 m) long with diesel engines of about 50 h.p. with winches worked from this engine. The winch is usually made from the rear axle of a truck and carries drum type brakes with the lining contracting onto the drum.

The deck layout is designed so that the boat and gear can be operated by 2 men or on smaller boats by 1 man if necessary.

The wheelhouse is forward of the centre of the boat and usually leads to a small forecastle with bunks and cooking amenities. The winch is mounted at the centre, as is the motor. The gallows is positioned above the winch and consists of 2 A-brackets supporting a tubular crosspiece about 7 ft (2.2 m) above deck. Extension arms slide into this crosspiece and carry pulleys for the trawl warps.

In operation the warps are taken up until the boards are out of the water, the chains from the boards to the wings of the net are secured inboard and the boat turned through 90°. The lazy line to the cod-end is detached from the board and taken in until a snotter can be secured around the cod-end. The catch is brought in by pulleys working at mechanical advantage from a swinging spar secured to the mast so the cod-end is taken straight out of the water and swung inboard directly over the sorting tray. The gear can be reset in about 3 min.

The sorting tray is on the after section of the boat and usually forms the lid of the ice box.

Larger vessels with more intricate equipment are used in the prawn industry but the fishery for P. sculptilis is more suited to the smaller (and older) boats.

Further information on Australian trawler design is available from Wright (1966). See also Figure 5.

5.2 Fishing areas

5.21 General geographic distribution

Fisheries to which this species contributes occur along most of the Asian mainland coast from Bombay to Hong Kong, much of the Indonesian Archipelago, and New Guinea, and the Queensland coast (Fig. 3).

Table 5 shows areas where P. sculptilis is fished commercially.

TABLE 5

FISHING AREAS

Country	Area
India	Hooghly estuary, Kutch
Malaysia	Penang, Singapore
Indonesia	Java
Australia	Queensland east coast

Commercial quantities only partly exploited have been reported from Papua - (Cape Blackwood), Queensland - (Duck Creek and Van Diemen Inlet in the Gulf of Carpentaria).

5.23 Depth ranges

In the Australian trawl fishery P. sculptilis is caught to a depth of 14 m but is most abundant in 6 m or less. The Asian fisheries operate in depths of 2-4 m.

5.24 Conditions of the grounds

The estuarine grounds are not subject to marked change due to human activities because they are in non-industrialized areas.

5.3 Fishing seasons

5.31 General pattern of seasons

The fishing seasons depend mainly on monsoons. In Queensland P. sculptilis moves into coastal waters from the rivers in November-December.

In south-east Asia a similar situation exists. At Penang this species is available from October on (onset of NE. monsoon) and Bhimachar (1963) reports that in the Hooghly the species is available to the commercial fishery only in the winters and monsoons.

5.32 Dates of beginning, peak, and end of season

In Queensland, India, and Malaysia the season covers the period from November to March.

5.33 Variations in date and duration of season

Movements of P. sculptilis populations are influenced by freshes in the rivers (see 3.51) and these movements can alter times and duration of the season (see 5.31).

5.4 Fishing operations and results

5.42 Selectivity

The gear used in south-east Asia apparently catches all stages of prawns from juveniles on. The sizes given by Hall (1962) for the "Ambai" fishery begin at 5 mm carapace length and Rajyalakshmi (1966) shows length frequencies for specimens at 23 mm total length.

5.43 Catches

The larger catches taken in the Gulf of Carpentaria were of the order of 70 lb (30 kg) per half hour shot (Munro, pers. comm.). No other figures are available.

The only figures available for production are derived from details given by Ramamurthy (1963) where 60% of an annual fishery production of 1250 mt consists of prawns of which P. sculptilis represents about 6% i.e. an annual catch of about 90,000 lb (41,000 kg).

6 PROTECTION AND MANAGEMENT

6.1 Regulatory (legislative) measures

6.11 Limitation or reduction of total catch

- Limitation on the efficiency of fishing units

In Queensland maximum size of trawls is controlled (see 5.11).

- Limitation on the number of fishing units, fishermen

There are no limitations in the Australian fishery.

- Limitation on total catches (quota)

There are no limitations in the Australian fishery.

6.12 Protection or portions of the population

Various closures in the Australian fishery operate to protect juvenile prawns.

- Closed areas

In Queensland trawling within one mile of the shore on the open sea coast is prohibited. This regulation was established to protect juvenile king prawns (Penaeus plebejus Hess). Portions of many estuaries and inlets are closed to prawn fishing. Beam trawling only is permitted in estuaries.

- Closed seasons

There are no closed seasons affecting P. sculptilis fisheries in Australia.

- Limitations on size or efficiency of gear or craft

In Queensland regulations provide for minimum mesh sizes and maximum net sizes (see 5.11). Minimum mesh size supposedly allows escape of juveniles but its success is as yet unproved. Fishermen tend to use bigger mesh sizes to reduce the amount of drag on nets and to eliminate trash organisms.

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