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SYNOPSIS OF BIOLOGICAL DATA ON THE GREENTAIL PRAWN *Metapenaeus bennettae* Racek and Dall, 1965

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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SYNOPSIS OF BIOLOGICAL DATA ON THE GREENTAIL PRAWN

Metapenaeus bennettae Racek and Dall, 1965

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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.

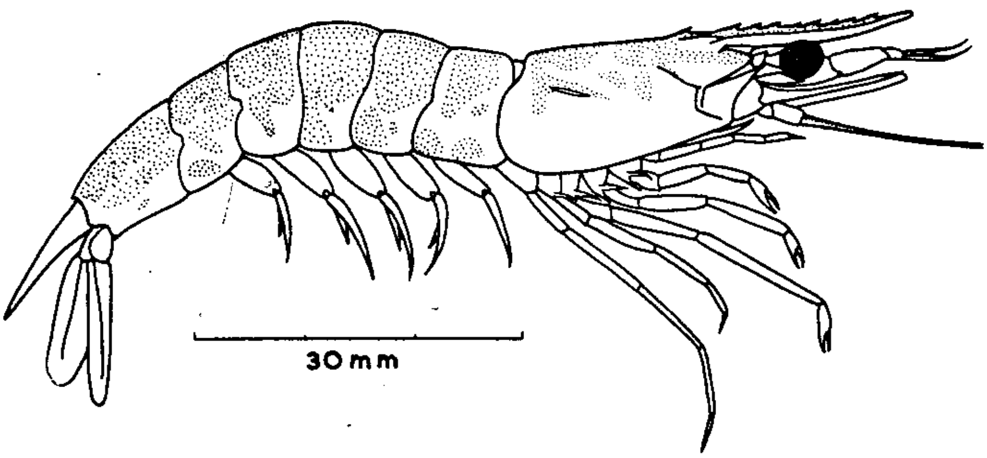

Fig. 1.- Metapenaeus bennettae Racek and Dall, 1965: female, length 92 mm (from Dall, 1957).

1 IDENTITY

1.1 Nomenclature

1.11 Valid name

Metapenaeus bennettae Racek and Dall, 1965, Verh. K. ned. Akad. Wet., 56(3): 1-119.

1.12 Objective synonymy

None.

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: Metapenaeus Wood-Mason and Alcock, 1891, Ann. Mag. nat. Hist., 8(6): 16-34.

Genotype: Penaeus affinis H. Milne Edwards, 1837.

Generic concept is that of Dall (1957, p. 182):

"Rostrum dorsally toothed only. Carapace without longitudinal or transverse sutures, orbital angle usually sharp. Postocular sulcus present, cervical sulcus well defined. Hepatic sulcus not well defined or absent behind level of hepatic spine, but pronounced in front with a well-defined postero-inferior border, usually descending vertically from hepatic spine, then turning towards the pterygostomial angle. Antennal and hepatic spines pronounced. Pterygostomial angle blunt. Telson with deep dorsomedian sulcus, without fixed subapical spines, and with movable dorsolateral spines which may be microscopic and very numerous. First antennular segment without spine on ventral distomedian border. Antennular flagella shorter than carapace. Maxillulary palp with 2 segments, distal small, basal with convex, foliaceous projections on inner and outer edges, and a long spine on inner edge. First to 3rd pereiopods with basial spines, no exopod on 5th. Ischium and merus of 5th pereiopod often modified in adult male. Petasma tubular with thickened median lobes; lateral lobes thicker than median, forming distolateral spout-like projections, each with a dorsal lobule produced posteriorly into an expanded plate-like projection; median lobes with dorsal lobule produced into a thin recurved, plate-like, or hood-like structure. Appendix masculina with a knob-like distal piece which bears either a deep posterodistal depression or is sculptured in some way. Thelycum composed of anterior median plate and two posterior lateral plates more or less enclosing posterior end of median plate; posterior plates often continuous across sternite. Zygocardiac ossicle with 2 rows of teeth which get progressively smaller. Pleurobranchiae on 3rd to 7th thoracic somites, a rudimentary arthrobranch on 1st; anterior and posterior arthrobranchiae on 2nd to 6th, and an anterior vestigial and a posterior fully developed arthrobranch on 7th thoracic somites; mastigobranchiae on 1st, 2nd, 4th-6th thoracic somites. Body usually with at least a few dorsal setose depressed areas, remainder of body surface varying from being completely glabrous to covered with close irregular setose depressed areas."

- Specific

Type specimens: Australian Museum No. P.12525, holotype male 70 mm, allotype female 79 mm, paratypes 23 males and 76 females, 26-95 mm.

Type locality: Lake Budgewoi, Tuggerah Lakes, New South Wales, Australia.

Diagnosis: M. bennettae is illustrated in Figure 1. A colour illustration is given by Grant (1965, Plate 16). The following description is from Racek and Dall (1965, pp. 74-5).

"Rostrum slender, with slight upward curve, reaching tip of 2nd antennular segment in male, usually at least attaining tip of antennular peduncle in female, armed with 7-8 teeth + epigastric. Postrostral carina low, but distinctly visible as glabrous strip extending to about posterior 1/10 of carapace. Adrostral sulcus ending immediately behind epigastric tooth, which latter is situated at 1/4 carapace. Branchiocardiac carina low and short, branchiocardiac sulcus feeble, anterior end of both not exceeding posterior 1/3 carapace. Mature petasma with more or less parallel distomedian projections which are distally twisted dorso-ventrally (Fig. 2a and b). Mature thelycum

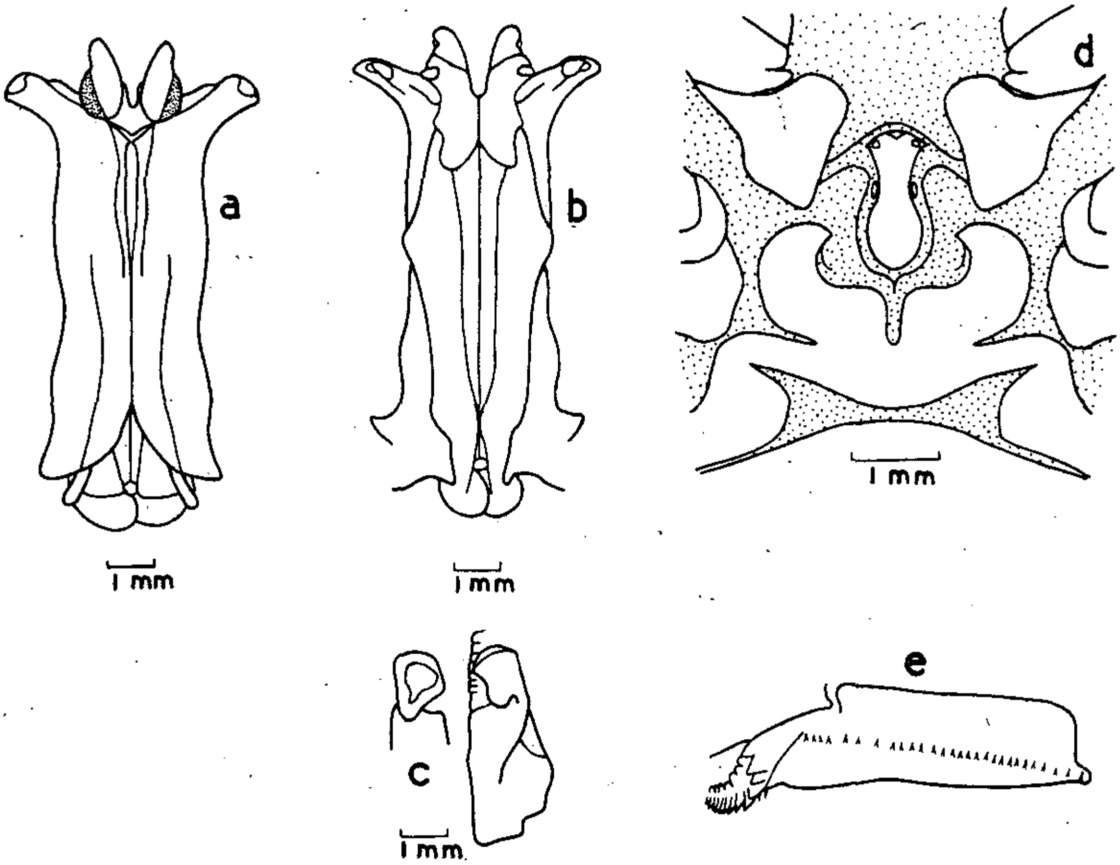

Fig. 2.- Metapenaeus bennettae: a, ventral surface and b, dorsal surface of petasma of male 104 mm long; c, appendix masculina and end view of distal piece; d, thelycum of female 92 mm long; e, cardiac plate and zygocardiac ossicle (from Dall, 1957).

with flask-shaped anterior plate which has a bluntly triangular anterior margin bearing a larger median conical tubercle, and a pair of less prominent anterolateral rounded tubercles; lateral plates kidney-shaped, thin posterolateral margins slightly raised".

Material examined by present authors: A male and female from Noosa River, Queensland have been deposited in the Queensland Museum (Reg. No. W3166).

Subjective synonymy:

Penaeus sp. Whitelegge, 1890 (in Ogilby, 1893), placed in synonymy by Racek and Dall (1965), reasons not given.

Penaeopsis monoceros Schmitt, 1926 (only specimen a female 74mm long, "Endeavour" material, Reg. No. P.4287), placed in synonymy by Racek and Dall (1965), with reasons.

"Dana" Metapenaeus sp. nov. Morris and Bennett, 1952, placed in synonymy by Racek and Dall (1965), reasons not given.

Metapenaeus mastersii (Racek (1955, 1957, 1959) and Dall (1957, 1958) placed in synonymy by Racek and Dall (1965), reasons given.

Key to the species of Metapenaeus (Racek and Dall, 1965):

1 Telson armed with 3 or 4 pairs of conspicuous mobile spines 2
Telson armed with a single row of very minute mobile spinules, with or without 1-2 pairs of somewhat larger distal spines 4

2(1) Three pairs of subequal telsonic spines; rostrum straight, teeth extending to its apex 3
Four pairs of telsonic spines, progressively increasing in size posteriorad; rostrum sigmoidal, anterior $\frac{1}{2}$ edentate, styliform .... M. macleayi (Haswell)

3(2) Branchial region with small pubescent areas; coxal projection of female 4th pereiopod long and curved, dagger-like; thelycum with rounded median boss posterior to lateral plates; distomedian petasmal projections without an anterolateral spinous process .... M. intermedius (Kishinouye)
Branchial region with 2 large pubescent areas; coxal projection of female 4th pereiopod a straight conical spine; thelycum without a rounded boss posterior to lateral plates; distomedian petasmal projections with a distinct anterolateral spinous process .... M. endeavouri (Schmitt)

4(1) Distomedian petasmal projection with fully developed or vestigial apical filament; thelycum of impregnated females usually with white conjoined pads 5
Distomedian petasmal projection without apical filament; thelycum of impregnated females without white conjoined pads 9

5(4) Rostrum wide and short, not reaching to distal end of basal antennular segment; thelycum with ovoid anterior and lateral plates of subequal size; conjoined pads usually set askew; apical filaments of petasma vestigial, represented by a pair of rounded bosses .... M. lysianassa (de Man)
Rostrum projecting beyond basal antennular segment, with a marked edentate distal portion 6

6(5) Posterior part of rostrum with distinctly elevated crest; basial spine on male 3rd pereiopod simple 7
Posterior part of rostrum without distinctly elevated crest; basial spine on male 3rd pereiopod long and barbed 8

7(6) Ischial spine on 1st pereiopod subequal to basial spine; telson usually with 1 distal pair of slightly larger spinules; distolateral petasmal projections directed outwards; apical filaments of distomedian projections slender, slightly converging; thelycum with a large anterior, and small lateral plates .... M. brevicornis (H. Milne Edwards)
Ischial spine on 1st pereiopod much smaller than basial spine; telson usually with 2 distal pairs of slightly larger spinules; distolateral petasmal projections pointing anteriorad; apical filament of distomedian projections lobe-like; thelycum with a small anterior, and very large lateral plates .... M. tenuipes Kubo
(=M. spinulatus Kubo)

8(6) Apical petasmal filaments not readily visible; anterior thelycal plate tongue-like .... M. dobsoni (Miers)
Apical petasmal filaments large and lobe-like, curved dorsally; anterior thelycal plate styliform .... M. joyneri (Miers)

9(4) Branchiocardiac sulcus distinct in at least posterior 1/3 carapace; distomedian petasmal projections flap-like 10
Branchiocardiac sulcus almost completely absent; distomedian petasmal projections anteriorly filiform, each with a serrate ventral margin ... . M. stebbingi (Nobili)

10(9) Ischial spine on 1st pereiopod distinct 11
Ischial spine on 1st pereiopod small or absent 13

11(10) Ischial spine subequal to basial spine; petasmal apices turned at 30° towards midline, semicircular; anterior thelycal plate spoon-like; lateral plates with raised ventral ridges, each with anterolateral and posteromedian spinous process .... M. suluensis Racek and Dall
Ischial spine much smaller than basial spine; anterior thelycal plate tongue-like 12

12(11) Distomedian petasmal projections directed anteriorad; lateral thelycal plates with raised lateral ridges, each with a posterior inwardly-

curved triangular plate; occurrence east of Malacca Strait .... *M. ensis* (de Haan)
(=*M. mastersii* (Haswell); =*M. incisipes* (Bate))
Distomedian petasmal projections directed anterolaterally; lateral thelycum plates with salient and parallel lateral ridges only; occurrence west of Malacca Strait .... *M. monoceros* (Fabricius)

13(10) Ischial spine minute and blunt 14
Ischial spine absent 17

14(13) Rostral teeth more or less evenly spaced; thelycal structure posteriorly open 15
Rostral teeth unevenly spaced, anterior 2 teeth separated from each other and from the rostral apex by a much wider space; thelycal structure posteriorly closed .... *M. demani* (Roux)

15(14) Distomedian petasmal projections not superficially separated into 2 lobes, almost completely overlying distolateral projections; lateral thelycal plates kidney-shaped, with strongly raised ventrolateral ridges .... *M. conjunctus* Racek and Dall
Distomedian petasmal projections more or less superficially separated into 2 lobes, not overlying distolateral projections; lateral thelycal plates ear-shaped, with salient lateral ridges 16

16(15) Distomedian petasmal projections directed anteriorad, parallel, longitudinal sulcus ill-defined; posterior end of salient ridges on lateral thelycal plates curved outwards; spine on merus of male 5th pereiopod slightly bent inwards .... *M. papuensis* Racek and Dall
Distomedian petasmal projections directed anterolaterally, diverging, longitudinal sulcus distinct; posterior end of salient ridges on lateral thelycal plates curved inwards; spine on merus of male 5th pereiopod slightly bent outwards ....*M. elegans* (de Man)
(=*M. singaporensis* Hall)

17(13) Rostrum with a marked edentate distal portion; anterior thelycal plate bluntly pointed, lateral plates large, separated by a narrow fissure .... *M. eboracensis* Dall
Rostrum without edentate distal portion 18

18(17) Branchiocardiac carina distinct, extending from posterior margin of carapace almost to hepatic spine; anterior thelycal plate longitudinally grooved, wider posteriorly than anteriorly; distomedian petasmal projections crescent-shaped .... *M. affinis* (H. Milne Edwards)
(=*M. mutatus* (Lanchester); =*M. necopinans* Hall)
Branchiocardiac carina feeble or ill-defined, anterior end not exceeding posterior 1/3 of carapace 19

19(18) Anterior thelycal plate tongue-like, with a pair of anterolateral rounded tubercles; lateral plates with a characteristic patch of dense setae; distomedian petasmal projections strongly diverging, each forming a broad outwardly-curved tooth .... M. insolitus Racek and Dall
Anterior thelycal plate flask-shaped, with a longitudinal median ridge; distomedian petasmal projections finger-shaped 20

20(19) Anterior margin of anterior thelycal plate with 3 tubercles 21
Anterior margin of anterior thelycal plate with 2 fang-like teeth and a median indistinct tubercle; petasma with slightly diverging tubular distomedian projections .... M. dalli Racek

21(20) Median tubercle more prominent than lateral ones; distal margin of anterior thelycal plate distinctly triangular; petasma with almost parallel tubular distomedian projections, their distal $\frac{1}{2}$ twisted dorsoventrally .... M. bennettae Racek and Dall
All tubercles of equal size; distal margin of anterior thelycal plate convex to indistinctly triangular; petasma with laminose and strongly diverging distomedian projections .... M. burkenroadi Kubo

1.22 Taxonomic status

M. bennettae is a morphospecies.

1.23 Subspecies

M. bennettae is monotypic.

1.24 Standard common names, vernacular names

Standard common name: greentail prawn. Vernacular names: bay prawn (Queensland), greasyback prawn, river prawn.

1.3 Morphology

1.31 External morphology (For description of spawn, larvae, and juveniles, see 3.17; 3.22; 3.23.)

See Diagnosis (1.21).

Apart from the development of sexual structures Dall (1958) found no evidence of allometric growth in juveniles in the Brisbane River. He did find slight proportional changes in rostral growth in the post larvae. This rostral development and the development of the telson were figured by Morris and Bennett (1952). On p. 180 they show the increase in length and number of teeth on the rostrum and the loss of spines and acute elongation of the telson. These developments are quite regular.

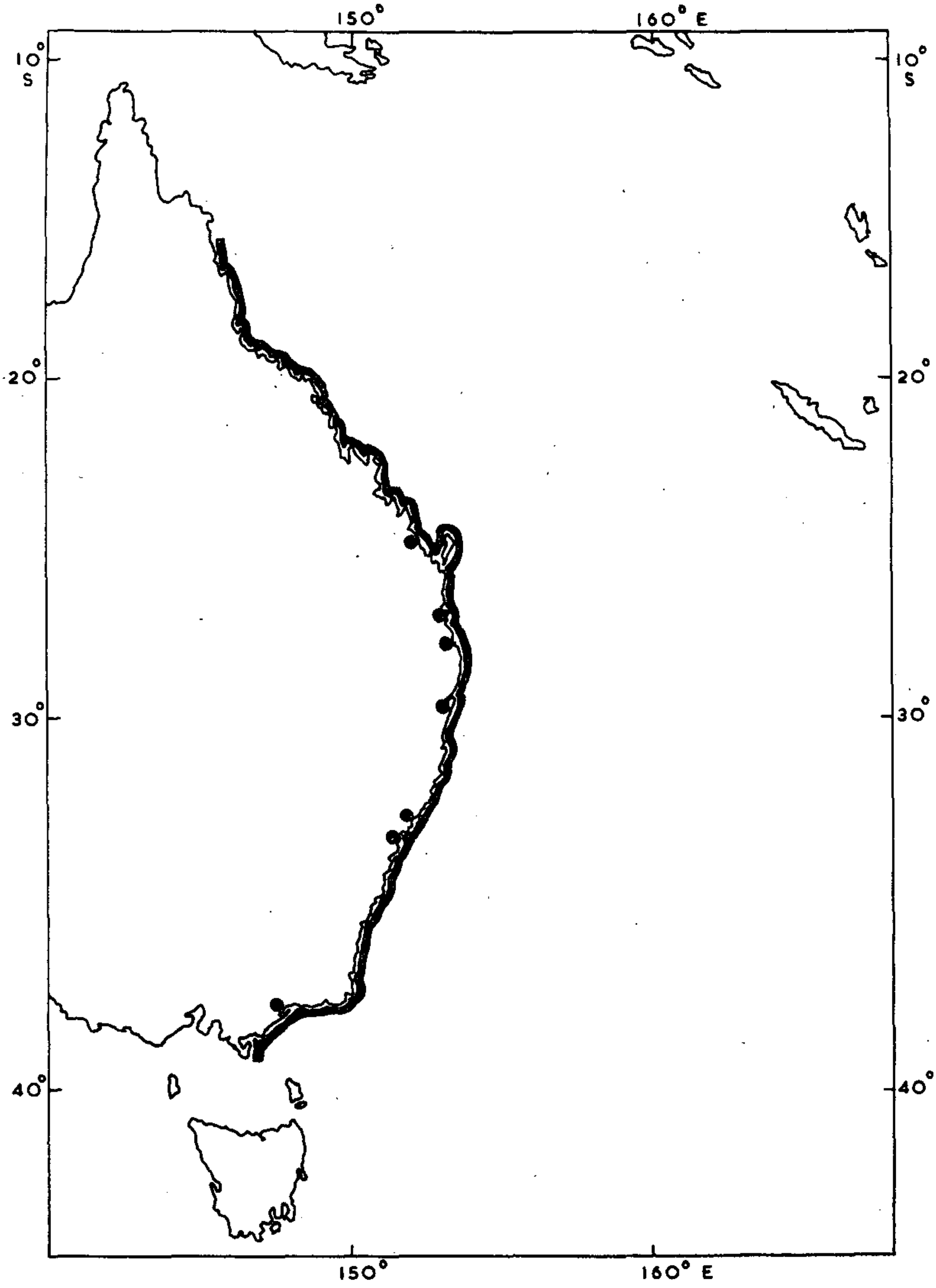

Fig. 3.- Distribution of Metapenaeus bennettae.

2 DISTRIBUTION

2.1 Total area

This species is endemic to the east coast of Australia as far north as Cooktown (Fig. 3, Table 1). All stages are found in estuarine and inshore waters. M. bennettae is one of the few penaeids to breed in enclosed brackish waters. All stages from egg to adult have been found in coastal lakes (Morris and Bennett, 1952).

TABLE 1

AREAS WHERE M. BENNETTAE OCCURS

Land	Code (Rosa, 1965)
Victoria	614
New South Wales	615
Queensland	616

2.2 Differential distribution

2.21 Spawn, larvae, and juveniles

In river systems nauplius and protozoea stages are found around the mouth and out to about 5 fm (10 m), mysis in the estuary proper, and postlarvae and juveniles move upstream to almost fresh waters.

Postlarvae at a carapace size of 1.5-2.0 mm enter the Brisbane River, Queensland and move upstream 24 to 50 miles (40-80 km). Their preferred habitat is a warm, sheltered flat with abundant algal cover and salinity below 20‰ (Dall, 1958).

2.22 Adults

Adults are found in estuaries from October to April and out to a depth of 14 m from November to June (Racek, 1959).

2.3 Determinants of distribution changes

Spawning occurs in areas ranging from coastal lakes or river mouths to 10 miles (16 km) out to sea. Postlarvae and juveniles move upstream to almost fresh waters. Developing juveniles move down river as they grow. Males precede females, as they mature earlier and appear to be less tolerant of low salinities as they mature (Dall, 1958).

Postlarvae and juveniles require algal cover in upstream areas and lack of this may explain why certain areas in rivers are abundantly stocked and others, with similar physical characteristics, are not.

Stocks are often shifted mechanically by freshes and floods (Thomson, 1956). This species forms schools most markedly when it has been washed out of rivers by freshes (see 3.5).

3 BIONOMICS AND LIFE HISTORY

3.1 Reproduction

3.11 Sexuality

M. bennettae is heterosexual and sexually dimorphic. Females have a receptacle or thelycum between the bases of the 4th and 5th pairs of pereiopods. Males have the endopodites of the 1st pleopods united to form a petasma and the endopodites of the 2nd pleopods modified to form a well developed appendix masculina on each pleopod. In adult males there is a notch on the merus of the 5th pereiopod.

3.12 Maturity

M. bennettae probably reaches sexual maturity during summer about 1 year after hatching. Males probably reach sexual maturity earlier than females of the same brood (Dall, 1958). Size at maturity: carapace length - males 16 mm, females 20 mm (Dall, 1958); total length - males 77 mm, females 98 mm (Racek, 1959).

3.13 Mating

In the Brisbane River, Queensland, Dall (1958) found mating in the river mouth.

3.14 Fertilization

Fertilization is external. A spermatophore is placed on the female's thelycum, and fertilization takes place as the eggs are shed.

3.15 Gonads

Ovaries are light green in colour and form a line down the dorsal surface of the abdomen.

The spermatophores are carried at the base of the 5th pereiopods. Presence of these spermatophores is the criterion of maturity in males.

3.16 Spawning

Spawning occurs at full moon from November to March in areas ranging from coastal lakes and river mouths to 10 miles (18 km) out to sea in depths of 14 m (Morris and Bennett, 1952; Dall, 1958).

3.17 Spawn

Racek (1959) gives the following features of the egg of

M. bennettae. Diameter 0.23 mm, pink hue, demersal on mud bottom.

3.2 Pre-adult phase

3.21 Embryonic phase

Morris and Bennett (1952) illustrated and described the development of the egg from the 2-cell stage to the emergence of the first nauplius larva.

3.22 Larval phase

Morris and Bennett described the development of the larvae through 4 nauplius stages (they suggested that there are actually 8 stages), followed by 3 protozoea stages, then 3 mysis and 6 postmysis stages. The time taken for development from egg to late mysis was 10 to 11 days.

The protozoea (Fig. 4), which is the most characteristic larval phase, was a typical *Metapenaeus* type, with a shallow notch to the telson, 7 + 7 spines on the telson in Stage III, and relatively short antennae (I and II).

3.23 Adolescent phase

In the postlarval phase the endopodites to the pleopods develop and the genitalia are differentiated.

3.3 Adult phase

3.31 Longevity

Prawns larger than 25 mm carapace length are rare in Moreton Bay, Queensland and since Dall (1958) claimed that it takes 11 months to reach 20 mm carapace length it seems likely that 25 mm represents a prawn approaching the middle of its 2nd year, at which point it dies.

3.32 Hardiness

After four days without food in a large tank, specimens of *M. bennettae* were relatively inactive. They died after 2-3 weeks without food (Dall, 1964). Below 16-18°C the prawns were inactive but at 20-25°C they were quite active, feeding regularly and moulting every 2 weeks. Above 25°C activity was increased but so was natural mortality (Dall, 1965).

It was found in eyestalk ablation experiments that crushing the eyestalk caused heavy mortality in laboratory animals (Dall, 1965).

Juveniles and adults tolerate water ranging in salinity from almost fresh to full sea-water although males are less tolerant of low salinity than females.

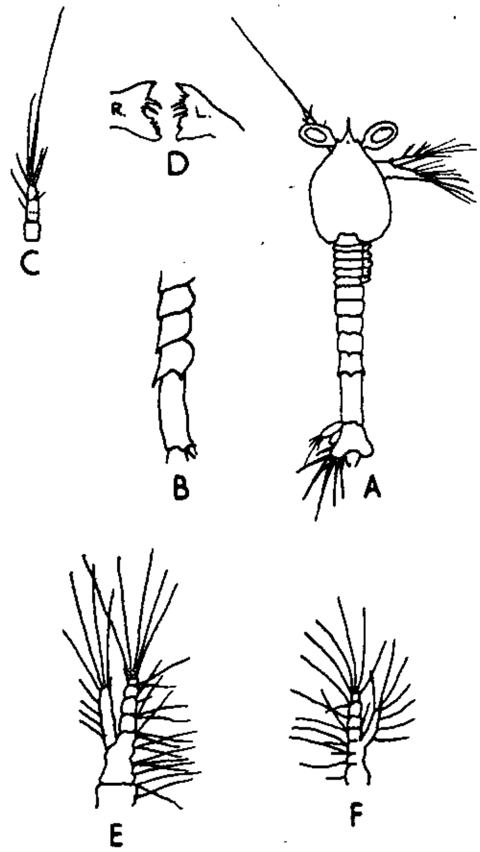

Fig. 4.- Metapenaeus bennettae: A, third protozoea; B, lateral aspect of abdomen; C, antenna; D, mandibles; E,F,G, maxillipeds I, II, III (after Morris and Bennett, 1952).

3.33 Competitors

Racek (1959) listed Chanos chanos as a species associated with M. bennettae. Dall (1958) listed Acetes australis, Halicarcinus australe, and Macrobrachium sp. as associates of M. bennettae in nursery areas in the Brisbane River, Queensland, plus unidentified tanaids and amphipods with a few juvenile Penaeus esculentus, P. merguiensis, and Metapenaeus macleayi.

3.34 Predators

Predators of M. bennettae are listed in Table 2.

TABLE 2

PREDATORS OF M. BENNETTAE
(Racek, 1959)

Species	Zone	Area
Platycephalus fuscus (C. & V.)	Estuarine	New South Wales
Dicotylichthys punctulatus Kaup	Estuarine	New South Wales
Aetobatus narinari (Euphrasen)	Inner littoral	Queensland

3.4 Nutrition and growth

3.41 Feeding

In aquaria, M. bennettae emerges at night to feed. It seems necessary for the prawns to feed daily to maintain blood sugar levels (see 3.44). Dall (1964) suggests that this is the reason M. bennettae will not leave organically rich areas where a steady supply of food is available.

3.42 Food

Racek (1959) found that annelids and small molluscs comprised the food of M. bennettae.

3.43 Growth rate

Under optimal conditions ecdysis occurs about every 2 weeks, but smaller sizes moult more frequently. Aquarium specimens averaged 2.0 mm carapace increase per month. The growth of a specimen of 1.9 mm carapace length in 30 days was 2.2 mm and for a 7.0 mm carapace length specimen in 30 days it was 1.9 mm. These figures apply to the temperature range 24-28°C (Dall, 1958).

In natural populations Dall found modal progressions of 2-3 mm between successive months.

Dall (1958) found that above 10 mm carapace length (48 mm overall) growth did not conform to the equation,

$$V = K \times l^3$$

i.e. volume is a constant of the length cubed. He attributed this anomaly to the over-wintering period when growth would be slower.

3.44 Metabolism

- Blood constituents, osmotic relations

Preliminary to his study of metabolism related to ecdysis, Dall (1964) investigated blood constituents of M. bennettae.

Blood cells were first examined since these could have relevant metabolic functions. He found that there were 3 cell types in blood: a thigmocyte, a lymphocyte-like cell, and a granular amoebocyte (forming and transporting polysaccharides).

Plasma was isotonic at 22% (freezing point depression - 1.25 C). Ca^{2+} concentration was always greater in blood than external levels, Mg^{2+} was reduced at higher external salinities. Na^+, K^+, and Cl^- all varied with external levels (Dall, 1964).

Glucose-6-phosphate was the principal sugar, apparently with some fructose-6-phosphate and glucose. There were also an unknown nucleotide and a mucopolysaccharide present.

Total Reducing Substances (TRS) in blood were estimated as an indication of the blood sugar level. TRS appeared to be readily affected by both feeding and starvation. TRS levels in the blood of starved prawns dropped from about 250 g/ml to 150 g/ml in 4 days and to 100 g/ml in 14 days. Five hours after feeding the TRS was at a peak of 371 g/ml dropping to 202 g/ml after 16 hr.

Proteins in the blood ranged from 1.9-2.2% for intermoult animals to 3.3-4.5% for premoult animals. Non-protein nitrogen values were 13.7-18.4 mg% for intermoult animals and 22.7-25.3 mg% for premoult animals.

Starch-gel electrophoresis of blood revealed four bands. Band 2, the most prominent band, contains haemocyanin. Band 3 was the only band to contain hexosamine. Bands were numbered from the anode (Dall, 1964).

- Composition and structure of the integument

Dall (1965b) described the inorganic and organic constituents of the cuticle and histological and histochemical changes in the epidermis during cuticle formation.

The cuticle at intermoult stages consisted of 38.7% inorganic material, 98.5% of which was calcium carbonate. Chitin composed 34.3% of organic constituents. No inorganic material was resorbed prior to moulting but chitin protein was reduced 39%.

The epicuticle contained vertical submicroscopic structures and procuticle had fibrils parallel to the surface. The epidermal cells elongate in premoult stages and synthesize a new exocuticle and epicuticle. Amongst the apices of the epidermal cells were tegumental glands and amoeboid cells with high concentrations of acid mucopolysaccharides and calcium.

– Endocrine systems and hormones

From his investigations on moulting Dall (1965a) concluded that a moult-inhibiting hormone was produced in the eyestalks. Eyestalk ablation induced frequent but erratic moulting. Dall identified neuro-secretory cells in the brain and thoracic ganglia and post-commissural organs.

There are also an eyestalk ganglion endocrine gland, sinus gland, and sensory pore organ. The sensory pore extract appeared to have some moult-inhibiting action on eyestalkless individuals.

3.5 Behaviour

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

3.51 Migrations and local movements

Migratory movements are described in Sections 2.2 and 2.3. During periods of inactivity the prawns bury themselves in sheltered localities. The burying behaviour of M. bennettae was described by Dall (1958) who also described the respiratory currents and the appendages used for producing these in an individual almost completely immersed in the substrate.

3.52 Schooling

This species forms schools most markedly when it has been washed out of rivers by freshes.

3.53 Responses to stimuli

In aquaria M. bennettae would not emerge in daylight and buried at night (in a time of about 5 seconds) if a light was shone on them (Dall, 1958).

Introduction of food could break certain burying rhythms if the specimens had been deprived of food for several days.

Racek found a tendency for M. bennettae to remain buried during light moon phases.

Lunar rhythms appeared in moulting, which, in estuarine areas, is at a peak on the 8th-10th day after new moon (Racek, 1959).

Dall also found (1965) that moulting was inhibited by constant light or dark. Constant dark caused prawns to remain buried in daylight time up to 14 days after which they emerged at irregular intervals. This suggests an exogenous rhythm which was most firmly established in specimens above 9.0 mm carapace length.

Moulting by 1 or 2 prawns in a tank appeared to induce moulting in most of the other individuals and at such times the water has a characteristic odour (Dall, 1965a).

4 POPULATION

4.1 Structure

4.11 Sex ratio

In the estuaries and inner littoral area the ratio of males: females was about 1:1 in spring, with female proportion increasing from then on (Racek, 1959). Dall (1958) found that in the Brisbane River, Queensland, there is a zone 4 to 18 miles (6 to 29 km) upstream from the river mouth in which males predominate. This is because males are less tolerant of low salinities than are females, and hence tend to move more rapidly from the upper reaches of the estuary. Dall also found a preponderance of females outside the river mouth.

4.12 Age composition

M. bennettae mature at about 1 year after hatching. They probably die at about the middle of the second year (Dall, 1958). From assorted growth data it appears that the fishery is based almost entirely on the 0-I year class.

4.2 Abundance and density

4.22 Changes in abundance

Thomson (1956) found that abundance of prawns along eastern Australia was proportional to rainfall between 6 and 18 months previously (see 2.3).

Catches have steadily dropped in the last few years in Queensland and New South Wales (see 5.43).

4.23 Average density

Catch per boat per day can be as high as 1,000 lb (450 kg) when fishing a school (Grant, 1965). The average catch is nearer 20 lb/boat/day (9 kg) for most of the season in Moreton Bay.

4.24 Changes in density

Changes in density in a given area are almost invariably associated with freshes from rains.

4.3 Natality and recruitment

4.32 Factors affecting reproduction

M. bennettae can spawn in shallow coastal lagoons (Morris and

Bennett, 1952), hence it would appear that reproduction is not dependent upon water of oceanic quality as it does in other species of penaeid prawns.

4.4 Mortality and morbidity

4.42 Factors causing or affecting mortality

Temperatures in excess of 25°C produce greater activity coupled with higher mortality (Dall, 1965).

Pollution in the Brisbane River seems likely to eradicate this species from the river.

4.6 The population in the community and the ecosystem

- Physical features of the biotope of the community

The salinity range for M. bennettae is 0-35‰. The temperature range is approx. 15-25°C. The substrate is usually soft, and rich in small food organisms.

In the nursery grounds of M. bennettae at Indooroopilly in the Brisbane River, Dall (1958) found the mangrove Avicennia marina and the algae Vaucheria, Gracilaria confervoides, Caloglossa leprieurii, and Callithamnion sp. with Melosira epiphytic on most other species. These plants provide shelter for the juveniles of M. bennettae.

- Species composition of the community

In rivers and lakes in New South Wales M. bennettae is associated with Penaeus plebejus. In Queensland it is associated principally with P. plebejus, P. esculentus, P. merguiensis, and Metapenaeus macleayi, which is also commonly associated with it in northern New South Wales. In Queensland in the 6-10 m depth zone, species of Trachypenaeus are also associated with M. bennettae.

These communities are also characterized by the Portunid crabs Portunus pelagicus and Charybdis callianassa.

- Type of fluctuation

Fluctuations are mainly cyclic, since each year class forms the brood stock for the next season. Non-cyclic fluctuations are those produced by freshes (see 3.52).

- Changes in environmental factors

It seems that in the Brisbane River, Queensland, pollution is increasing, and since December 1966 prawning has no longer been carried on in the river. It seems only a matter of time before pollution eradicates this species from the river.

5 EXPLOITATION

5.1 Fishing equipment

5.11 Gears

In the larger estuaries and bays M. bennettae is caught with otter trawls. In rivers and coastal lakes in Queensland beam trawls are used.

In Queensland the maximum headrope lengths for otter trawls are 8 fm (15 m) in estuarine waters and 20 fm (37 m) in ocean waters; beam trawls have a maximum width of 5 m; minimum mesh sizes are 1 in. (2.5 cm) in estuarine waters and $1\frac{1}{2}$ in. (3.8 cm) in the open sea.

In New South Wales otter trawls have a maximum headrope length of 15 m and a minimum mesh size of 2.5 cm.

5.12 Boats

Initially trawling for M. bennettae was carried on in estuaries with boats 14-20 ft (4-6 m) long. These boats were usually open and were powered by inboard petrol engines of 3-12 R.A.C. horsepower rating. The trawl (usually beam trawl) was set by hand. Small boats of this type are still used in enclosed waters but in the larger bays and along the open coast larger boats are now used. These boats fish out to a depth of 10 m and are 7 to 12 m long with diesel engines rated at 50 to 90 b.h.p. These boats have sleeping and cooking facilities in the forecastle and a wheelhouse situated forward. A winch is situated on deck, just aft of the wheelhouse and towing warps pass to the otter boards through a gallows consisting of 2 "A" brackets carrying a tubular beam set athwartships. This beam may carry the blocks or the blocks are suspended from extensible arms which are carried inside the beam. Winches are usually converted rear axles of trucks with friction brakes operating on contraction. The cod-end only is hoisted aboard after each shot and the catch dropped into a sorting tray which covers an insulated ice box.

5.2 Fishing areas

5.21 Geographic distribution

M. bennettae is fished in Queensland and New South Wales, and occasionally Victoria.

5.22 Geographic ranges

Its greatest abundance is along the New South Wales coast to Noosa in Queensland, 32°-37°S.

5.23 Depth ranges

M. bennettae is caught in coastal rivers up to 10 miles (16 km) from their mouths, in coastal lakes, and out to 14 m on the continental shelf.

5.24 Conditions of the grounds

The grounds consist of alluvial fans and bays with soft bottoms rich in organic detritus.

It seems that in the Brisbane River, Queensland, pollution is increasing (as evidenced by mass fish deaths) and since December 1966 prawning has no longer been carried on in this river, it seems only a matter of time before pollution eradicates this species from the river.

5.3 Fishing seasons

5.31 General pattern of season

The season covers the southern summer.

5.32 Dates of beginning, peak, and end of seasons

There is a peak in November to December in the northern limits as the sea temperature rises and a second peak after the February rains. Along the whole coast the fishing terminates about June (Dall, 1958).

In the southern area the season is mainly from November to April.

5.4 Fishing operations and results

5.43 Catches

Production from Queensland in the last 3 years has been

1964-65	975,800 lb (443,545 kg)
1965-66	939,244 lb (426,929 kg)
1966-67	837,672 lb (380,760 kg).

(These figures are from Aust. Fish. Newsl. for March of each year.)

These figures include some juvenile Penaeus spp. and Trachypenaeus and Metapenaeopsis species as well as M. bennettae.

Catch figures for New South Wales are not available. M. bennettae is caught sporadically in Victoria. In 1963-64 25,000 lb (11,000 kg) were caught but no catches have been recorded since then.

The catch has steadily dropped in Queensland and New South

Wales in the last few years (see 5.43). The actual drop has probably been much greater than this because a category known as "Bay prawns" in the Queensland market which was once predominantly M. bennettae now includes species of Metapenaeopsis, Trachypenaeus, and small Penaeus plebejus Hess and P. esculentus Haswell as well as some Alpheidae. The increasing importance of this category coincides with the demise of the Brisbane River fishery which is now virtually non-existent, apparently because of rapidly increasing pollution in these waters.

6 PROTECTION AND MANAGEMENT

6.1 Regulatory (legislative) measures

Regulations govern the prawn fishery in Queensland and New South Wales. There are no regulations in Victoria governing this fishery.

6.11 Limitation or reduction of total catch

- Limitation on the efficiency of fishing units

Maximum size of trawls is controlled in Queensland and New South Wales (see 5.11).

Moreton Bay, Queensland waters are closed to professional fishing at weekends, for the sake of weekend anglers. The effect is to limit effort.

- Limitation on the number of fishing units, fishermen

None.

- Limitation on total catches (quota)

None.

6.12 Protection of portions of the population

Various closures operate to protect juvenile prawns.

- Closed areas

Trawling within one mile of the shore is prohibited on the open sea coast and within Moreton Bay and Hervey Bay in Queensland. This regulation was established to protect stocks of juvenile king prawns (P. plebejus) but its effect has been to protect juvenile and adult greentails.

In Queensland and New South Wales portions of many estuaries and inlets are closed to prawn fishing.

- Closed season

All Queensland waters south of 25°S. are closed during daylight between October 1 and February 1.

In New South Wales portions of inlets and estuaries are closed for periods which usually coincide with the presence of prawns in these areas.

- Limitations on size or efficiency of gear or craft

Regulations provide for minimum mesh sizes and maximum net sizes in all States (see 5.11). Beam trawling only is permitted within estuaries in Queensland.

Fishing is directed mainly at the adult sector of the population from 20 mm carapace up.

7 POND FISH CULTURE

This species is not cultivated in ponds.

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