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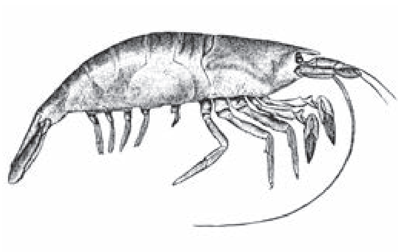
FRESHWATER CRUSTACEA

OF THE MIMIKA REGION - NEW GUINEA

JOHN W. SHORT

THE 7TH BOOK IN A SERIES OF FIELD GUIDES TO THE FLORA AND FAUNA OF MIMIKA REGION, PAPUA



Freshwater Crustacea

of the

Mimika Region

New Guinea

John W. Short

PT FREEPORT INDONESIA
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Cover illustration: Southern New Guinean River Prawn, *Macrobrachium* sp. 1 (Photo by John W. Short)

Title Page Illustrations: Spiny Pacific Fan Shrimp, *Atyopsis spinipes* (after Cowles, 1914), top; Knob-fingered River Prawn, *Macrobrachium mammillodactylus* (Photo by John W. Short), bottom.

Foreword

As in my previous foreword for the Mangrove Estuary Crabs of the Mimika Region book, I herewith would like to thank Dr. John W. Short and all contributors in the Freshwater Crustacea of the Mimika Region book for their hard work and dedication towards documenting the freshwater crustacean habitat in the region for the benefit of broader society. This is the seventh biodiversity book published by PT Freeport Indonesia, in its quest to continuously disseminate knowledge related to biodiversity to the public.

PT Freeport Indonesia, in more than 40 years of its operations in Papua, finds itself located in one of the most exotic and unique environments in the world. The island is one of the most biologically diverse mangrove estuary ecostystems and its 1.75 million hectares of mangrove vegetation is the largest in Indonesia.

Our mangrove estuary ecosystem monitoring efforts since 1996 have identified over 250 species of fish, 300 species of invertebrates, and 20 specis of mangroves. Other monitoring efforts in alpine, sub alpine, rainforest, and swamp ecosystems have also recorded high numbers of varieties of flora and fauna.

More than 30 species of decapod crustaceans have so far been recorded from the fresh waters of the Mimika region, representing approximately 40% of the total decapods of mainland New Guinea. This figure is even more impressive when it is considered that virtually nothing was known of the freshwater decapod fauna of the region until PT Freeport Indonesia began its sampling program in the 1990s. PTFI's sampling program has also been heavily focused on the coastal zone below an altitude of 50 meters and areas in the immediate vicinity of Timika and Kuala Kencana.

We hope the book will bring benefit to people interested in exploring biodivesity in Papua.

Armando Mahler
President Director and CEO
PT Freeport Indonesia

A stream near Kuala Kencana, Ajkwa River catchment (Photo by Gesang Setyadi)

A channel in the lower reaches of the Ajkwa River. (Photo by Gesang Setyadi)

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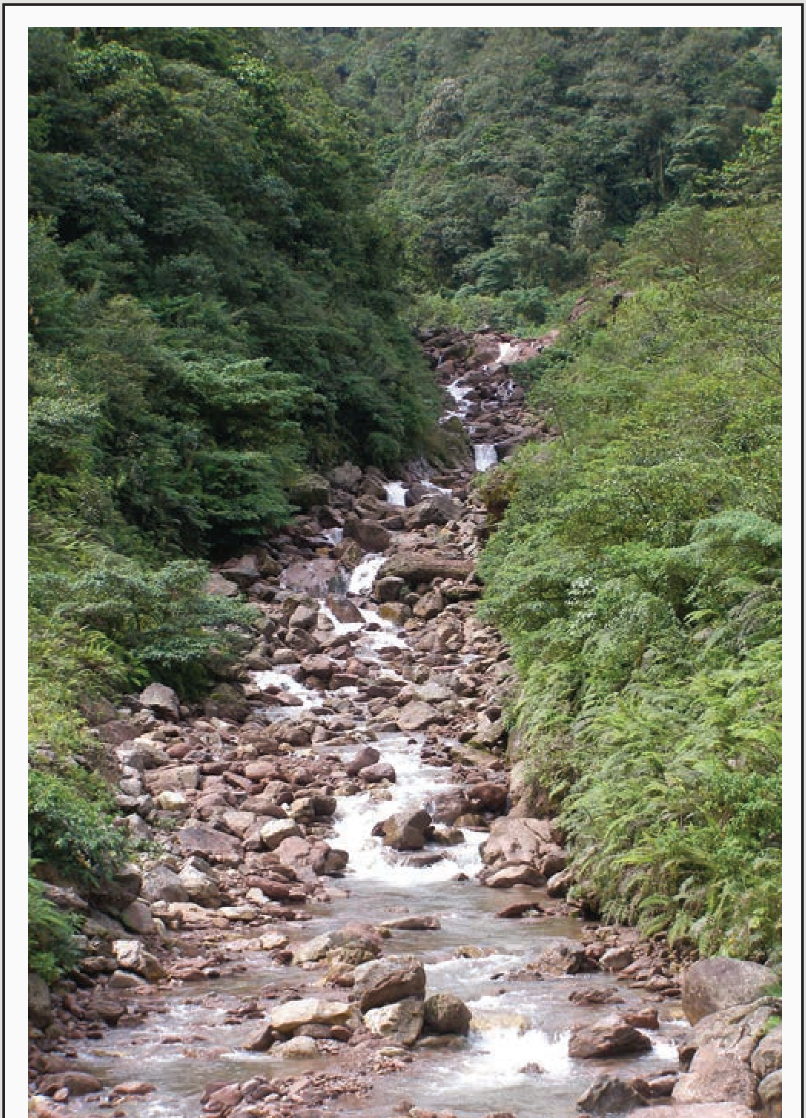


The Uteki River near Tembagapura. (Photo by Gesang Setyadi)

Acknowledgements

The publication of this book was funded by PT Freeport Indonesia (PTFI) as part of their committment towards documenting the flora and fauna of the Mimika region. Especially thanked are past and present employees of PTFI's Environmental Coastal and Marine Monitoring group who were responsible for collecting most of the material on which this book is based. They include: Kent Hortle, Gesang Setyadi, Dwi Listyo Rahayu, Sigit A. P. Dwiono, Amirudin, Johanna Suprihatin, Johnny Prewitt, David Norriss, Wisnu Susetyo, Thomas Magai and Tenius Tabuni.

Jim Dellinger (Crescent Technology Inc.), Gesang Setyadi (PTFI) and Kent Hortle reviewed the manuscript. Gesang Setyadi also provided most of the habitat photographs and the map of the Mimika region. Irfan (Quality Management Service, PTFI) kindly supplied additional photographs of the upper Tsinga River and a headwater stream at Nasura.

Mark Allen designed the first book in this field guide series, *Freshwater Fishes of the Timika region, New Guinea*. The layout of this book is adapted from his design.

Local names and economic importance data were sourced from Kal Muller's book, *Keanekaragaman Hayati Tanah Papua.* He is thanked for his research on the Mimika region over many years and for making an English translation of his work available on the internet via PapuaWeb.

Finally, I would like to thank my wife, Leila, for proof reading the final draft and for her support and encouragement during this project.

Upper Tsinganogong River, Lorentz National Park. (Photo by Irfan)

Introduction

The fresh waters of mainland New Guinea contain the most diverse crustacean fauna of any island on earth. Mostly cloaked in rainforest and supplied with abundant rainfall throughout the year, the island boasts an impressive array of freshwater environments. From alpine conditions at the peaks of the Central Dividing Range, down through the montane, moss-covered forests to the sweltering tropical lowland rainforests and meandering mangrove estuaries, can be seen an impressive zonation of ecosystems unequalled anywhere else in the world

The geographic location of New Guinea has also promoted the development of a rich aquatic fauna. Situated near the equator towards the centre of the vast Indo-West Pacific region, the island is flanked by the continent of Australia to the south, the Indo-Malayan archipelago to the west and oceanic islands of the West Pacific to the east and north. From these neighbouring regions New Guinea has been colonised by both primary freshwater groups and wide-ranging euryhaline species. This crossroads effect, in combination with the highly dissected topography, humid climate and broad variety of potential niches, has resulted in an extraordinarily diverse, speciose fauna.

This book focuses on the freshwater decapod Crustacea of the Mimika region between the Otokwa and Kamora rivers, southern Papua (Fig. 1). The decapod Crustacea include all of the large familiar crustaceans such as prawns, shrimps, crayfishes, lobsters and crabs. As the name implies, all decapods are 'ten-footed' and have in common five pairs of thoracic legs. They also differ from other crustacean groups occurring in New Guinean fresh waters by having a well-developed, shield-like carapace which covers both the dorsal and lateral sides of the thorax. Decapods are the only crustacean group which has been extensively surveyed in the fresh waters of the Mimika region.

All of the decapod Crustacea occurring in the fresh waters of the Mimika region are dealt with in this book with the exception of euryhaline varunid crabs which are covered in another volume of the present series on marine and estuarine crabs.

Knowledge of the freshwater decapod fauna of Papua (formerly Irian Jaya) began in 1858 with a visit by the German naturalist C. B. H. von Rosenberg to Manokwari. Over the next one hundred years there were over 20 more expeditions by Dutch, German, Swiss, Italian, British and Belgian scientists. The most significant in terms of the Mimika fauna were Wollaston's British Expedition to West New Guinea in 1912-1913 and Lorentz's First and Second Southwest New Guinea Expeditions to the Lorentz River between 1907 and 1910.

The most important studies dealing with material from these early expeditions are those by Holthuis (1949, 1950a, 1956, 1958) on freshwater crayfishes; Holthuis (1950a, 1950b) on palaemonid shrimps; De Man (1915) and Chace (1997) on atyid shrimps; and Bott (1974), Holthuis (1974) on freshwater crabs. Holthuis (1982) also provides a useful overview paper on the New Guinean freshwater decapod fauna.

Despite the excellent groundwork provided by these studies, the freshwater decapod fauna of New Guinea remains poorly known compared to knowledge of freshwater fishes. Distributional records of all groups are fragmentary and in the case of New Guinean atyids, extremely limited.

Freshwater decapod Crustacea of New Guinea

Decapod Crustacea occurring in New Guinean fresh waters belong to three easily-recognisable major groups: (1) southern hemisphere crayfishes of the family Parastacidae in the infraorder Astacidea; (2) shrimps of the families Atyidae and Palaemonidae in the infraorder Caridea; and (3) crabs of the families Parathelphusidae, Sesarmidae, Varunidae, Hymenosomatidae and Gecarcinidae in the infraorder Brachyura.

The Parastacidae and Parathelphusidae are well established in fresh water and are never found in the sea. The Atyidae is predominantly comprised of land-locked freshwater species but also includes a number of wide-ranging euryhaline and some anchialine species. The Palaemonidae, Sesarmidae, Varunidae and Hymenosomatidae are dominated by estuarine or marine species, but also include a number of wide-ranging genera which have invaded freshwater habitats to varying degrees e.g. *Macrobrachium* and *Palaemon* (Palaemonidae), *Varuna* (Varunidae), *Geosesarma* (Sesarmidae), *Halicarcinus* and *Amarinus* (Hymenosomatidae). Of these genera, *Macrobrachium* is by far the most diverse and widely-distributed group in fresh waters.

The Gecarcinidae are commonly referred to as 'land crabs'. Although gecarcinids are usually found very close to the sea, some also occur a considerable distance inland and a number are known to burrow along the margins of freshwater streams. Most gecarcinids are only found on small islands but two species of *Cardisoma* are known from the southern New Guinea mainland, viz. *C. carnifex* (Herbst, 1796) and *C. hirtipes* Dana, 1851.

The northern and southern watersheds of mainland New Guinea contain two comparatively different freshwater decapod faunas. The Central Dividing Range, which rises up to 4,886 m above sea level, represents a major barrier to the dispersal of most groups. Parastacid crayfishes are only found in the southern watersheds, demonstrating their close relationship to the fauna of northern Australia. Most land-locked freshwater atyid and palaemonid shrimps are also confined to either northern or southern watersheds. A notable exception to this pattern are the parathelphusid freshwater crabs which presently include a number of species occurring on both sides of the Central Dividing Range.

Unlike freshwater fishes, decapod Crustacea have widely colonised the central highlands of New Guinea and have been recorded at elevations above 3,000 m. This highland fauna is comprised almost exclusively of endemic parastacid crayfishes and parathelphusid crabs. The only other decapods recorded from above 1,500 m are the endemic hymenosomatid crab, *Amarinus angelicus* (Holthuis, 1968), known from a watercress swamp at 1,600 m in the Southern Highlands District of Papua New Guinea, and the palaemonid shrimp, *Macrobrachium natulorum,* from the Wissel Lakes in southern Papua, at altitudes up to 1,700 m.

In total, approximately 80 species of decapod Crustacea are presently known from the fresh waters of mainland New Guinea. Taking into account the large areas of New Guinea which have not yet been surveyed, the real number of species is likely to exceed 100.

Of the described species, about 50% appear to be endemic to New Guinea. The endemics include all of the parathelphusid freshwater crabs and all of the freshwater crayfishes, except for two species which are shared with northern Australia. Some of the small-egged atyid species, which are recorded from New Guinea for the first time in this guide, may also be endemic to mainland New Guinea. However, it is more likely that they will eventually be found in neighbouring areas. Unlike the southern New Guinean freshwater fish fauna, which shows a strong link to the northern Australia fauna (Allen *et al.*, 2000), only three decapod crustaceans appear to be restricted to southern New Guinea and northern Australia.

Freshwater decapod Crustacea of the Mimika region

Thirty-two species of decapods have so far been recorded from the fresh waters of the Mimika region, representing approximately 40% of the total fauna of mainland New Guinea. This figure is even more impressive when it is considered that virtually nothing was known of the freshwater decapod fauna of the region until PT Freeport Indonesia began its sampling program in the 1990s. PTFI's sampling program has also been heavily focused on the coastal zone below an altitude of 50 m and areas in the immediate vicinity of Timika and Kuala Kencana. Most of the highland areas in the region have not yet been surveyed for decapod Crustacea and there are presently no confirmed records above 600 m.

Considering that most records have been from the coastal lowlands, it is not surprising that the Mimika fauna is dominated by euryhaline shrimps of the families Atyidae and Palaemonidae. The Mimika region has a comparatively rich assemblage of species in both of these families. By contrast, land-locked freshwater species presently account for less than one third of the Mimika fauna. With the exception of parathelphusid crabs, the land-locked freshwater fauna of the Mimika region is depauperate compared to some other regions of New Guinea.

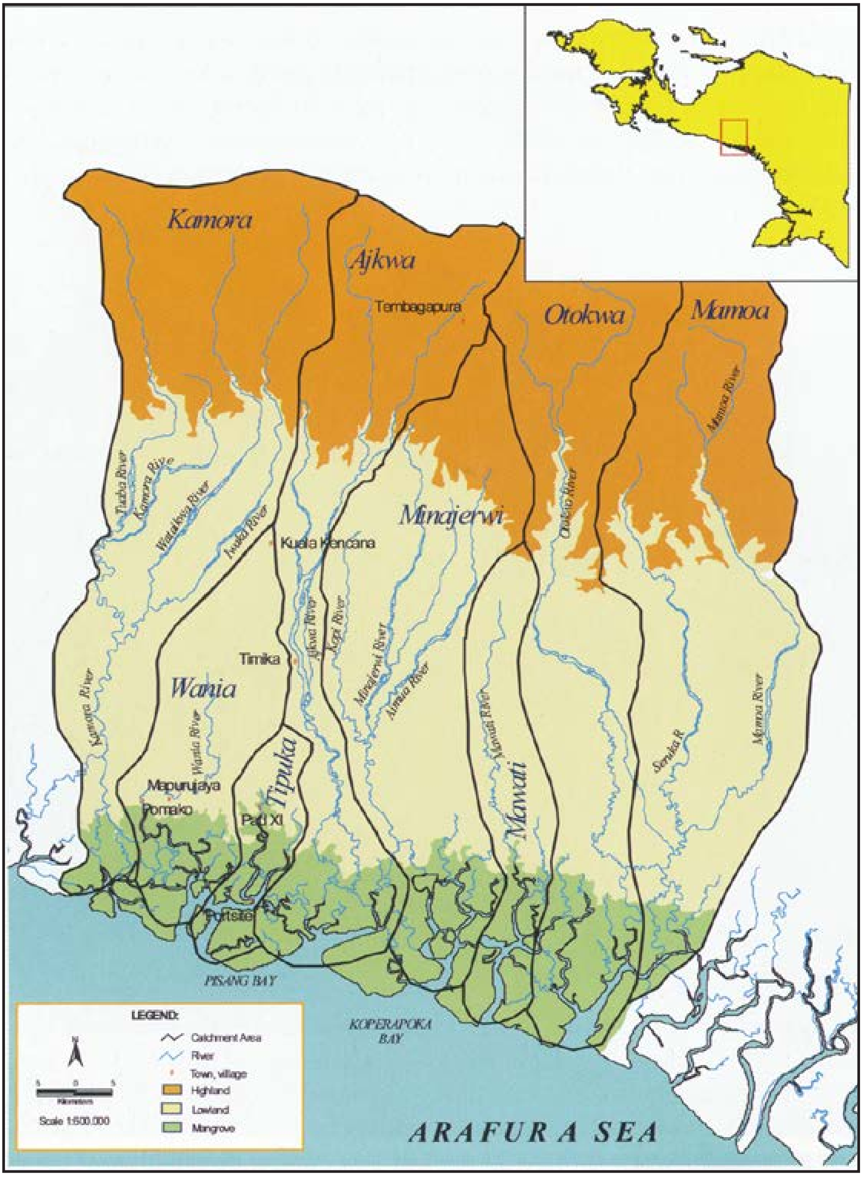


Figure 1. Map of the Mimika region, Papua. Major river catchments are outlined in black.

Endemism

Endemicity in the freshwater biota of New Guinea has been recently studied by Polhemus *et al.* (2004). They defined 5 regions and 29 areas of endemicity, based on distribution patterns shown by aquatic insects and freshwater fishes. The following discussion of endemism in the decapod fauna of the Mimika region and southern Papua utilises their classification.

The coastal lowlands of the Mimika region, at elevations up to 50 m, are included in Area 26 (Arafura Coastal Lowlands) in Region 5 (Southern Coastal Lowlands and associated Continental Shelf islands). This area extends between the Uta and the mouth of the Mappi River in southern Papua and includes extensive areas of mangroves, peat swamp and lowland rainforest. Knowledge of the freshwater decapod fauna of this area is far too limited to be certain if there are any endemic species. In general, decapods occurring in the coastal lowlands are either wide-ranging euryhaline species or land-locked freshwater species with broad habitat requirements. Therefore, it is very likely that most of the species recorded so far will prove to have wide distributions throughout this area of endemicity. Many of the euryhaline species are also likely to have wider distributions in the Central Indo-West Pacific, including the four species of *Caridina* which are presently known from coastal lowlands in the Mimika region. All of the well known, euryhaline species occurring in this area are known to have wide distributions in the Central Indo-West Pacific.

The foothills of the Central Dividing Range in the Mimika region, between 50 and 1200 m altitude, are classified in Area 23 (Arafura Foreland) in Region 4 (Central Mountain Ranges). This area extends between the Uta River in the west and the Lorentz River in the east and includes the middle reaches of the major rivers. The palaemonids, *Macrobrachium lorentzi* (J. Roux), *Macrobrachium* sp. 1 and *M. handschini* (J. Roux) are restricted to this area and Area 24 (Trans-Fly Foreland) immediately to the east. The latter species also occurs in northern Australia.

Above the foothills of the Arafura foreland, at altitudes above 1,200 metres, is Area 20 (West Papuan Central Highlands). This unit includes the Central Dividing Range and the highest mountains in New Guinea, from the Wapoga River basin in the west to the headwaters of the Fly River in the east. It also includes an extensive area of lacustrine habitats, the Wissel Lakes in the west, and an upland plateau, the Baliem River basin, in the central part of the area.

Area 20 is by far the richest area of endemicity for freshwater decapod Crustacea in mainland New Guinea. The Wissel Lakes have a large endemic fauna comprising eight species of *Cherax* crayfish, the palaemonid prawn, *Macrobrachium natulorum* and the parathelphusid crab, *Rouxana roushdyi*. The Baliem River basin also has two endemic *Cherax*, *C. minor* and *C. monticola*.

There have been no definite records of decapod Crustacea from Area 20 in the Mimika region, although freshwater crabs and crayfishes are present in neighbouring areas and at least one freshwater crab collected by the Wollaston Expedition probably originates from this zone.

Biology

Feeding

Freshwater decapods are typically macrophagic omnivores. In addition to feeding on detritus and macrophytes, most will prey on aquatic insects, molluscs and small fish whenever possible. An exception are atyid shrimps which are primarily microphagic. Using the dense brushes of setae on the fingertips of the pincers, they selectively pick and scrape at the substrate (*Caridina* spp.), sweep the substrate for detritus or algae (juvenile *Atyoida*) or filter-feed in running water (*Atyopsis* and adult *Atyoida*). The last two genera are commonly known as fan shrimps, in reference to the chelae which spread out like fans while they are filter feeding (Fig. 27).

Predators

Most freshwater decapods are nocturnal and seek shelter during the day to avoid predators. They commonly shelter in the confines of a burrow or under cover such as rocks, submerged logs, ledges, etc. The main predators are fish, aquatic reptiles and water birds, but they are also preyed upon by mammals such as water rats and pigs.

Growth and moulting

Like other arthropods, all Crustacea have to moult their exoskeleton periodically as they grow. In fresh water, where calcium is often limited, decapods have developed unique ways of conserving calcium during the moulting process. Freshwater crayfishes re-absorb calcium salts from the old shell prior to moulting and store these as a hemispherical stomach stone, the gastrolith. Calcium from the gastrolith is then used to harden the new shell after moulting. Freshwater decapods also commonly eat the old moulted shell, the exuvia, to re-use the precious calcium.

During the moulting process, the old shell splits along predetermined breaking lines on the carapace and the new soft shell gradually squeezes out. The appendages are then pulled out of the old shell. This process may take from just a few minutes to several hours. Generally, it occurs much more quickly in shrimps than in crabs and crayfishes. Hardening of the new shell may take several days and new moulted individuals are largely defenceless. In some crayfishes, the chelipeds are known to harden first.

In juveniles of many tropical freshwater species the time between moults is very short, often less than two weeks, and becomes progressively longer as they reach adulthood. Young adults may moult several times a year whereas old individuals may moult only once or twice per year. In many marine crabs a terminal moult limits growth. In shrimps and freshwater crayfishes there is no terminal moult and individuals continue to grow until they die.

Cannibalism during and immediately after the moulting process is a major threat as the chemicals released during moulting are highly attractive to other individuals. For this reason, many aquatic shrimps and crayfishes move into very shallow water to moult, even though they are more exposed to predators.

Reproductive anatomy

Among freshwater decapods, crabs have the most advanced reproductive biology. In crabs, the abdomens of males and females show strong sexual differences. In males, the abdomen is triangular or t-shaped (Fig. 9A) and bears only two pairs of pleopods (swimmerets). These are modified as special copulatory organs, the

Upper Kwamki Lake near Kwamki Lama, Ajkwa River catchment. (Photo by Gesang Setyadi)

gonopods (Fig. 9B). In mature females, the abdomen is enlarged for brooding the eggs and young and is broadly rounded (Fig.9C). Four pairs of pleopods are present on segments 2–5.

In male parathelphusid crabs, the genital openings (gonopores) from which the penis extends, are at the base of the coxa of the last pair of legs. In sesarmid and varunid crabs, the gonopores are on the sternum near the base of the coxa of the last pair of legs. In all crabs, the female gonopores, or vulvae, are located on the sternum between the third pair of legs. Fertilisation is internal in all crabs – the eggs are fertilised inside the female before they are released. During copulation, the first gonopods (G1) of the male are inserted into the gonopores of the female and spermatophores are delivered via the penis. The second gonopods (G2) act like a plunger forcing the spermatophores through the hollow first gonopods into the vulvae of the female.

Parastacid crayfishes and all freshwater shrimps are more primitive in their reproductive biology and the eggs are fertilised externally. During mating, spermatophores are transferred from the male genital openings at the base of the last pair of legs (Fig. 8) and are attached to the sternum of the female. Mated females fertilise the eggs by rupturing the spermatophores as the eggs are laid (extruded from the genital openings at the base of the third pair of legs). The fertilised eggs are attached to the swimmerets for brooding.

In male parastacid crayfishes and freshwater shrimps, the genital pore is at the end of a genital papilla. The papilla varies in size and shape between different groups. In palaemonid shrimps, there is also a conspicuous flap (genital operculum) covering the papilla (Fig. 3E.). The female genital openings are at the base of the third pair of legs (Fig. 8) and are similar in both parastacid crayfishes and freshwater shrimps. Male palaemonid and atyid shrimps also have a secondary sexual structure, the appendix masculina (Fig. 3F, 3G), on the second pair of pleopods. This aids in transferring spermatophores to the sternum of the female during mating.

Life history and distributional ecology

Both the parathelphusid crabs and parastacid crayfishes are primary freshwater groups and do not require access to estuaries or the sea to complete their life cycle. In comparison to most marine and euryhaline decapod Crustacea, their eggs are relatively large compared to their body size and usually measure more than 1 millimetre. Instead of hatching as pelagic, free-swimming larvae, which must feed immediately, larval development is either completely abbreviated in the egg (parathelphusid crabs) or highly abbreviated while attached to the female swimmerets.

Larval freshwater crayfish use food supplies in their yolk sac and do not need to feed. After larval development is completed, they leave the mother as miniature adults. Hatchling parathelphusid crabs are released from the mother around the time of the first moult and also resemble miniature adults.

Adults of both groups are unable to tolerate immersion in salt water for extended periods and species are usually confined to a single land mass, sometimes within one drainage system or headwater streams above a major waterfall. Some crayfish species have distributions extending from northeast Australia into southern Papua New Guinea, demonstrating a relatively-recent link between the two land masses.

Parathelphusid crabs and freshwater crayfishes are known to disperse over land in humid conditions, particularly at night. Freshwater crabs, in particular, are highly mobile on land. Some species of *Holthuisana* are known from both sides of the Central Dividing Range, indicating that they have been able to cross this major drainage divide. Parastacid crayfish of the genus, *Cherax,* on the other hand, are only known from southern New Guinea and apparently have not been able to disperse across the Central Dividing Range into northern New Guinea.

Unlike parathelphusids, varunid and sesarmid crabs usually undergo larval development in tidal waters. They have relatively small eggs and free-swimming, pelagic, first larval stages which feed on plankton. Some euryhaline varunids are known from upper estuarine and lowland fresh waters close to the sea. In the Mimika region, *Varuna* and *Parapyxidognathus* have been recorded from downstream biomonitoring sites near the upstream limit of tidal influence. In *Varuna*, the eggs are very small and development of the planktonic larval stages occurs in the open sea. After marine larval development, the benthic larval stages and juvenile crabs then migrate *en masse* back up the river systems.

Species of the sesarmid genus, *Geosesarma*, have also been recorded from Papua, though none have yet been found in the Mimika area. Members of this genus are unusual for the family in that the eggs are relatively large and the life cycle is completed in fresh water. Larval development is highly abbreviated, although the first larval stages are still free swimming like other sesarmids.

Atyid and palaemonid shrimps inhabiting fresh waters show a much wider range of reproductive strategies and salinity tolerance than either freshwater crabs or crayfishes. They range from euryhaline, oceanic species with small eggs and extended larval development in the open sea to large egged, land-locked, upper catchment species with highly-abbreviated larval development. Unlike freshwater crayfishes and crabs, larval development is not completed in the egg or on the swimmerets of the female, although it may be highly abbreviated. In some species, hatchlings are benthic and show a general resemblance to adults.

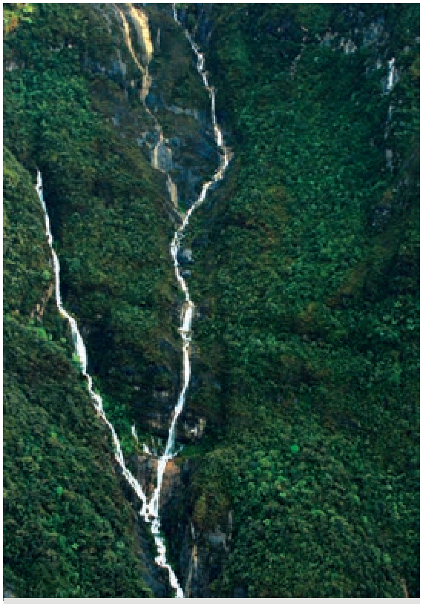
Distributional patterns in freshwater shrimps vary according to egg size. Small-egged species tend to have wide distributions in the Indo-West Pacific. Large-egged species are more likely to have highly-restricted distributions in a single catchment, lake or cave system. Species with moderate-sized eggs are generally land-locked freshwater species with broad habitat requirements.

Atyid shrimps have a long evolutionary history in fresh water and most species no longer require marine influence for larval development. The Palaemonidae, on the other hand, is primarily a marine group which has more recently invaded freshwater habitats. Although the majority of palaemonid shrimps occurring in fresh water still have small eggs and larval development in tidal waters, a significant number now complete their life cycle in fresh water. Like many atyids, land-locked palaemonids also have abbreviated larval development. In the Mimika region, all of the land-locked species recorded to date from both families have moderately-large eggs and appear to have broad habitat requirements.

Many of the euryhaline atyid and palaemonid shrimps with broad longitudinal distributions in fresh water have well-developed upstream migratory behaviour. As juveniles, they are often highly adept at scaling waterfalls and other natural physical barriers. Vertical rock faces are usually scaled at night, generally away from the main current in places where there is a thin film of water. Fan shrimps of the genera, *Atyoida* and *Atyopsis*, are also strong swimmers and move easily through strong currents in the cascade zone of rivers. In some catadromous species, such as *Macrobrachium rosenbergii* (De Man), juveniles are known to migrate upstream *en masse* after completing larval development in tidal waters.

More detailed discussions of the life history and dispersal strategies shown by Indo-West Pacific freshwater shrimps are provided by Storey *et al.* (2000), Short (2004) and Short and Domenq (2003).

Tsinga River adjacent to Tsinga Village, Lorentz National Park. (Photo by Irfan)



A headwater stream at Nasura, Jayawijaya Mountains. (Photo by Irfan)

Economic importance

All freshwater decapod Crustacea are edible and the larger, more common species are generally of interest to fisheries wherever they occur. A number of larger species are also cultured or have high culture potential. The Oriental Giant River Prawn, *M. dacqueti* (Sunier), is one of the most commercially important crustaceans and is widely cultured around the world. Its sister species, the Australasian Giant River Prawn, *M. rosenbergii* (De Man), also grows to an impressive size and is of much interest to fisheries throughout its range, including New Guinea. This species has not yet been cultured commercially on a significant scale, although postlarvae are reared in the Philippines purely for research purposes (Wowor and Ng, 2007).

According to Muller (2006), *M. rosenbergii* contributes greatly to the cash income and diet of the Kamoro in the Mimika region and is in danger of over-exploitation.

It is known locally as *(m)be* (Kamoro), *mbe* (Atuka), *me poawa* (Nawaripi) and *udang hitam* or *udang kali* (Indonesian). Another river prawn mentioned by Muller (2006) as important for home consumption or sale is *M. mammillodactylus* (Thallwitz, 1892). It is known locally as *mbiti* (Kamoro), *me'o* (Nawaripi), *uroko* (Atuka) or *udang putih* (Indonesian). Other species of *Macrobrachium* are generally referred to as *udang kali* in Indonesian.

Atyid shrimps are generally of lesser interest to fisheries, due mainly to the small size of most species. In many developing countries, they are eaten in various ways as a subsidiary food item. In the Mimika region, members of the family are generally referred to as *niti* and *Caridina* spp. as *wautete* (Muller, 2006).

Based on the information provided by Muller (2006), freshwater parathelphusid crabs do not appear to be an important part of the diet in the Mimika region, although they are used as bait by the Nawaripi. They are known locally as *airakopia* (Kamoro), *irakopia* (Nawaripi) or *minako* (Atuka).

Freshwater crayfishes are also familiar to indigenous groups in the Mimika region, although they do not appear to be of high economic importance. According to Muller (2006), they are known locally as *utuau pitao*, *afameme*, *memaptitia* (Nawaripi), *wamero* (Iwaka), and *udang batu* or *udang tanah* (Indonesian). As only *Cherax lorentzi lorentzi* (J. Roux, 1911) is currently recorded from the region, all local names possibly refer to this subspecies.

Among the Mimika decapod fauna, *Cherax l. lorentzi* appears to have the highest potential for aquaculture. It is a warm water, lowland crayfish with limited burrowing behaviour. The subspecies is also widespread in southern Papua and has broad habitat requirements in both lotic and lentic fresh waters. It also has a simple freshwater life cycle and aspects of its reproductive biology have been studied by Tapilatu (1998). It is smaller than the widely cultured Australian redclaw, *Cherax quadricarinatus*, but still attains a respectable maximum weight of around 120 g (Tapilatu, 1998) and a maximum length of 160 mm (Holthuis, 1949).

Freeport biologists using an electrofishing boat to sample crustaceans and fishes near Pauna at the Ajkwa diversion, upper Tipuka River. (Photo by Gesang Setyadi)

Collecting methods

Collecting freshwater decapod crustaceans can be challenging and often requires the use of specialised techniques. Many species are solitary, nocturnal and highly secretive. Although fully aquatic species are generally easy to find in the same habitats where freshwater fishes occur, semi-terrestrial species often occur at considerable distances from watercourses and are much harder to locate. Virtually any well-shaded spot that remains water-logged for extended periods can provide suitable habitat for semi-terrestrial decapods. Freshwater crabs, in particular, have been found in highly unusual places, such as under the moss layer in highland cloud forests or among epiphytes on rainforest trees. All species still require regular access to water, either as runoff water, groundwater at the bottom of a burrow, or

Semi-aquatic habitiat of *Holthuisana* sp. along the banks of a rainforest stream in the Wania River catchment. Under rocks in well-shaded, permanently damp places like this are a good place to find freshwater crabs and crayfishes. (Photo by John W. Short)

rain water held in vegetation.

Fully aquatic, non-burrowing species such as atyid and palaemonid shrimps are often collected incidentally whilst collecting fish. Common collecting techniques used for catching fishes such as scoop netting among aquatic vegetation, along undercut banks, through leaf beds, under overhanging vegetation and through the exposed root mats of trees, are usually effective. Electrofishing in the vicinity of suitable shelter is also a very useful technique for atyid and palaemonid shrimps and is particularly effective for collecting adult and fully developed male *Macrobrachium.* The use of a dedicated electrofishing boat in the freshwater tidal zone of large rivers, as used in PT Freeport Indonesia's biomonitoring program, can also yield a high diversity of palaemonid and atyid shrimps as well as paddler crabs of the family Varunidae. While electrofishing, it is best not to handle live specimens while the muscles of the legs and chelipeds are still contracting, otherwise most of the appendages will be thrown, particularly the chelipeds. If a shocked prawn is not handled until it starts to move naturally, damage is minimised.

Where electrofishing is not available or permissible, baited traps set overnight near suitable shelter are a reliable method of catching aquatic species of freshwater crayfishes and adult *Macrobrachium*. Baits high in animal fat or with a strong persistent odour are the most effective.

Aquatic species which live in shallow flowing water, such as some freshwater crabs, crayfishes and shrimps, can often be collected using a flat-sided scoop net. The net is held with one hand and placed against the substrate downstream of a suitable object, such as a flat-bottomed rock or log. The object is then carefully lifted in an upstream direction with the other hand. Any specimens not swept into the net by the current can usually be chased into the net with the available hand after the water clears. The technique can be further improved by placing rocks or debris to the sides of the net to prevent sideways escape.

Aquatic species which inhabit the cascade zone, such as fan shrimps of the atyid genera *Atyoida* and *Atyopsis*, are often more difficult to collect using nets. Fan shrimps have adapted to life in a high flow environment and hold on firmly to the underside of rocks or boulders. They are often easy to locate and collect by carefully running a hand over the underside of large rocks close to the main flow, particularly immediately downstream of falls. Their clinging behaviour is so well developed that they can easily be grabbed by hand.

Semi-aquatic species such as many freshwater crabs and freshwater crayfishes also require specialised techniques and are not usually collected when targeting fish. Species that prefer to live along the margins of watercourses and lakes and which show limited burrowing behaviour are easily targeted by turning over rocks, logs and other debris near the water's edge or in well-shaded seepage areas. Young individuals may also be found under suitable shelter in shallow water.

Semi-aquatic species not closely associated with watercourses are much more difficult to find. Where surface moisture is limited, the damper darker spots, such as along drainage channels, can be explored for signs of burrowing. If the ground is soft and free of roots or rocks, the burrows can be carefully excavated. Alternatively, investigating the same areas at night by torchlight may find individuals foraging out of their burrows. Torchlight can then be used to stun the animals long enough to push a knife or stick into their burrow to block their retreat.

In perennially wet locations, such as highland cloud forests, collecting decapod Crustacea is often a more random process until suitable microhabitats are located. Again, investigating a potential area at night by torch, when crabs and crayfishes may be actively feeding away from shelter, can be productive. Pitfall traps have also been successfully employed for semi-aquatic freshwater crabs. Wide-mouthed, deep containers, such as bottles or cans, are buried level with the ground and concealed by leaves or debris. A small amount of glycerol is poured into the bottom of the container to help trap and kill crabs which have fallen in while foraging.

When collecting freshwater decapod Crustacea it is best to target adult specimens whenever possible to aid the identification process back at the laboratory. In the case of freshwater crabs, crayfishes and *Macrobrachium* prawns, fully grown males should also be sought. Fully grown males are generally easily recognised in the field by their strongly developed chelipeds (first pereiopods in crabs and crayfishes, second pereiopods in *Macrobrachium*).

Handling and Preservation

Many freshwater decapods are easily damaged if transported live. Freshwater crayfishes, crabs and river prawns are solitary, aggressive animals. If adults, particularly large males, are placed together in a confined space after capture, they will often fight. Chelipeds and walking legs, which are extremely important for identification, are often damaged or thrown during the process. The appendages of small atyid and palaemonid shrimps are also easily damaged if not handled carefully during transportation. Specimens transported live should be kept cool and placed in separate plastic bags of containers with just enough water to cover the body. Leaves, twigs and other organic debris can also be used to separate adult specimens.

If specimens are to be sent to a museum, university or research laboratory, the appropriate staff should be contacted first for instructions on the best method of packing and shipping. If the specimens are to be hand delivered or can be quickly sent by air to the recipient, freezing is often a good option and avoids the use of dangerous chemicals.

If there is no need to bring specimens back to the laboratory alive, it is usually best to kill and preserve them quickly. This is especially the case for material which is going to be transported over a considerable distance and used in molecular studies. These can be dropped straight into preservative.

With samples containing more than one species, it is often preferable to do a quick sort to putative species while in the field using live colour patterns. This can save a large amount of sorting time back at the laboratory after the material is preserved and the colour patterns have largely disappeared.

Live specimens, other than those to be used for molecular studies, should not be dropped straight into preservative, otherwise they are likely to throw legs and chelipeds. Live specimens can be frozen or chilled in ice or by refrigeration before being placed in preservative. Specimens should be chilled gradually. Another alternative is to use an anaesthetic such as clove oil. A few drops of clove oil in a litre or so of water is more than enough to quickly anaesthetise most small shrimps or juvenile crabs and crayfishes. The amount of clove oil used can be adjusted accordingly for large prawns, crabs and crayfishes. If necessary, anaesthetised individuals can be revived by placing them back in fresh water. However, this must be done as quickly as possible after they cease to move.

In general, the most convenient preservative for small to medium-sized specimens is a 70–75% solution of ethanol in water. To ensure the appendages remain flexible and do not easily break off during handling, glycerine should also be added at a rate of about 10 ml of glycerine per litre of alcohol. This also helps to protect specimens from drying out should the alcohol level in a jar drop too low. Specimens which are being kept for future molecular research should be preserved in absolute ethanol, without glycerine, and checked regularly.

During the process of dehydration, ethanol slowly penetrates the body tissues and body fluids are removed. These body fluids lower the alcohol concentration and discolour the solution. This process is most rapid within the first few weeks.

If the ethanol solution is not changed when it drops below 65%, the condition of the specimens will deteriorate. Apart from the first change of alcohol, which usually needs to be done within the first month or two, the alcohol concentration and level needs to be checked at regular intervals. This should be done at least twice yearly.

For very large species, such as the Australasian Giant River Prawn, *Macrobrachium rosenbergii*, or collections which are being preserved with fish, it is often more convenient to initially fix the material in formalin. Formalin is a highly effective fixative which rapidly penetrates and excludes water from the body tissues, thereby preventing decomposition. To make the formalin solution, dilute one part of 40% formaldehyde with nine parts of water. Formaldehyde may be obtained from a pharmacy, university, museum or fisheries department. Specimens should be fully immersed in formalin. If there are only one or two very large individuals to preserve, the internal body tissues can be injected with formalin using a syringe and then the specimens dropped into alcohol.

As formalin is a hazardous chemical, the utmost care must be taken not to breathe the fumes (use a fume hood where possible) or make contact with the skin (always use gloves) or eyes (wear protective eyewear). Formalin can also react with metals, so only plastic or glass containers should be used for storage.

It is best not to preserve freshwater crustaceans in formalin for extended periods as this tends to harden connective tissue, making it difficult to manipulate the appendages. Moreover, unbuffered formalin is acidic and rapidly softens the exoskeleton. To reduce this problem, a pH buffering agent such as a small amount of borax may be added.

If neither formalin or ethanol are available, other alcohol-based solutions such as methylated spirits can be used in the short term, although generally with less satisfactory results.

To prepare a dried specimen, first fix the animal in formalin (as described above) with its appendages in the desired position. After one to two weeks, the specimen can be removed from the fixative and mounted using pins on a display board to dry. As colouration is lost during the fixing process, the fully dried specimen should be painted and then coated with clear resin or varnish.

Colour patterns

In atyid and small palaemonid shrimps the exoskeleton is usually thin and translucent and colour patterns are due to chromatophores on the soft tissue beneath the exoskeleton. These chromatophore patterns may be highly transient and often change dramatically when shrimps are removed from their natural habitat. Shrimps with distinctive colour patterns in the wild often fade to a lightly mottled appearance during transportation to a laboratory.

In *Macrobrachium*, patterning on the carapace is often more developed in juveniles and gradually changes to a more uniform colour in adults. The colouration and patterning on the second pereiopods (main chelipeds), on the other hand, is often more developed in adult males. Species with a broad geographic range often show considerable colour variation across their range, although any distinctive patterning is usually fairly consistent e.g. the presence of banding on the body or chelipeds.

In freshwater crabs and crayfish, which are generally more heavily shelled, colouration is due to pigmentation of the exoskeleton. Colouration is therefore far less transient than in shrimps, although there is often considerable developmental, sexual and geographic variation.

Where available, live colour photographs have been used to illustrate the species in this book. Due to the reasons discussed above, these photographs need to be used with caution for identification purposes.

Using this guide

This book follows a similar format to the first guide book in the series, *Freshwater Fishes of the Timika Region New Guinea*, by Allen *et al.* (2000), and has likewise been designed as a quick identification guide and reference tool.

After the Introduction, the book starts with a key to the seven families of decapod Crustacea recorded from the fresh waters of mainland New Guinea. This is the best place to start for non-specialists making identifications for the first time.

For each of the four families occurring in the Mimika region, there is a brief introductory section including general information on distinguishing features, the local fauna, geographic distribution and biology. For the three families containing more than one species from the Mimika region, a key is then provided.

For the two highly-speciose shrimp families, the scope of the relevant key has been broadened beyond the Mimika region – southern Papua for the Atyidae and southern New Guinea for the Palaemonidae. In the likely event that more species are recorded in the future, particularly from the middle and upper catchments, this is intended to facilitate their identification.

Each identification key in this guide consists of a series of numbered either-or alternatives. For example, at step 1 in each key, the alternatives are numbered 1a and 1b. At each step you make a choice between the two alternatives, depending on which is more correct. The number in bold at the end of each alternative leads you to the next step. When you have been through all the steps leading to an identification, a taxon name is given. If at one point in a key the choice to make is ambiguous, due to missing or damaged appendages etc., work through the key using both alternatives and then check which answer is more appropriate. All identifications made using the keys should be checked against the figures and diagnoses provided.

Although an attempt has been made to make the keys as easy to use as possible, some practice is required before identifications can be made quickly and reliably. A powerful stereo microscope (at least 40x magnification) is also required to clearly see some of the features used for atyid shrimps. The characters used in the keys are also more reliable with sexually mature adult specimens.

In the keys and species accounts, the term 'cheliped' refers to the first pereiopod in crabs and crayfishes, the second pereiopod in palaemonid shrimps, and either the first or second pereiopod in atyid shrimps, unless specified otherwise.

Within each family, species accounts are presented in alphabetic order by their scientific names. Each species account is divided into the following sections:

- **Common name**: in large print and bold above the photograph or line drawing of each species is the English common name, as adopted for this guide. Unlike scientific names, which are regulated by an international code and must be used consistently by scientists around the world, there may be many different common names for a species. Even within a single country, common names are often used inconsistently. Many common names are also based on generic words and are difficult to use precisely. For example, 'shrimp' and 'prawn' are broad, largely interchangeable terms.

Despite the problems associated with the use of common names, they are often easier to remember and pronounce than scientific names and improve communication with the general public.

- **Scientific name**: in smaller print and italics immediately below the common name is the scientific name. This consists of two words, the binomial. The first word of the binomial is the genus (plural: genera) which always starts with a capital letter. The genus is the group name for the species and its closest relatives. The second word in the binomial is the species epithet (the name given to the species when it was described). A species epithet is always given in combination with its genus, although the genus may be abbreviated e.g. *M. weberi* instead of *Macrobrachium weberi*. When the genus is known, but the species identity is uncertain, the species epithet is replaced with 'sp.', e.g. *Macrobrachium* sp.

- **Authority**: immediately below the scientific name in regular print is the person who first described the species and the year of publication. If the species is currently placed in a different genus to that used in the original description, the authority is enclosed in parentheses.

- **Diagnosis**: a summary of the main distinguishing features. Many of the technical terms are explained in the glossary (page 86) and illustrated in Figs 2–10.

- **Habitat and abundance**: the environment in which the species is commonly found and general comments on its relative abundance in the Mimika region.

- **Distribution**: the geographic range. The distribution of wide-ranging Indo-

West Pacific species are given from the western-most occurrence through to the northern, eastern and southern limits in the Pacific. For example, the distribution of *Caridina gracilirostris* is listed as 'wide-ranging in the Indo-West Pacific from Madagascar to the Philippines, Palau, Caroline Islands and Australia'.

- **Other names**: English FAO common names are provided in cases where they differ from the common name used in this guide. Also included are local Indonesian and Papuan names, as listed by Muller (2006).

- **Notes**: special interest information e.g. comments on taxonomic status.

Abbreviations used in text

A, abdominal segment; **a.s.l.**, above sea level; **CB**, carapace breadth, measured at the widest point; **CL**, carapace length, measured between the frontal and posterior margins in crabs and from the orbit to the posterior margin in shrimps and crayfishes; **FD**, fully developed; **G1**, gonopod 1 (first male pleopod of brachyuran crabs); **max.**, maximum; **P**, pereiopod; **PL**, pleopod; **Pl**, plural form; **T**, thoracic sternite; **TL**, total length, measured from the tip of the rostrum to the tip of the telson.

Explanatory Figures

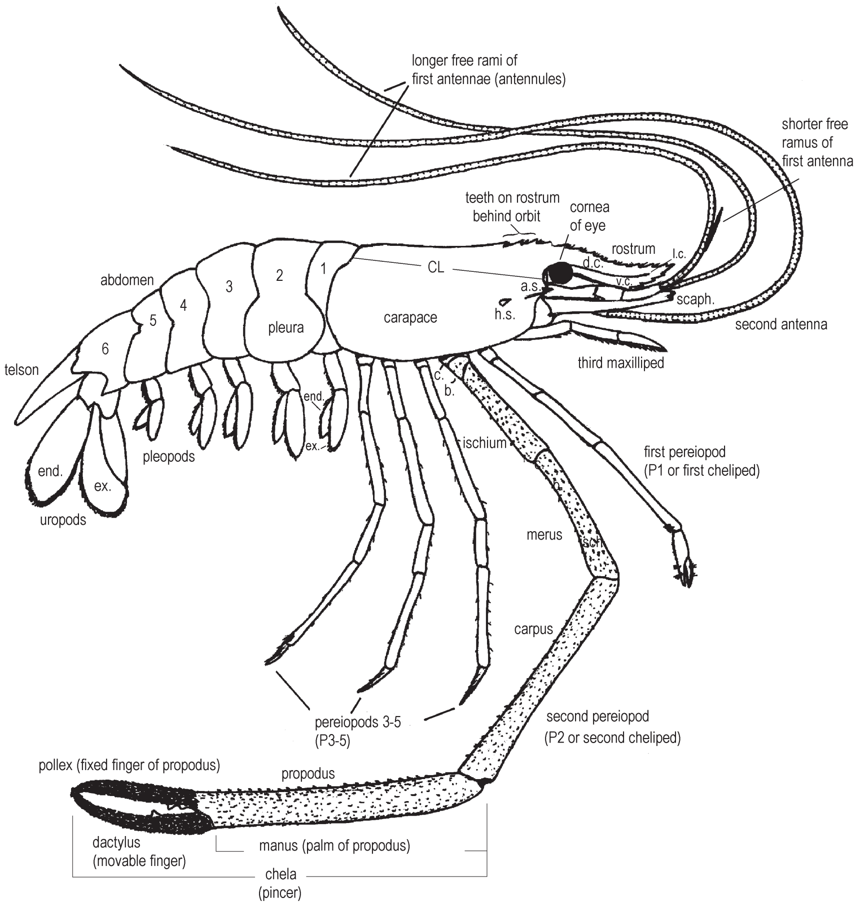


Figure 2. Schematic drawing of a generalised *Macrobrachium* (family Palaemonidae) in lateral view (right appendages only). Abbreviations: **a.s.**, antennal spine; **b**., basis; **h.s.**, hepatic spine; **c.**, coxa; **CL**, carapace length; **d.c.**, dorsal carina (of rostrum); **end.**, endopod; **ex.**, exopod; **isch.**, ischium; **l.c.**, lateral carina (of rostrum); **scaph.**, scaphocerite (antennal scale); **v.c.**, ventral carina (of rostrum). After Short (2004).

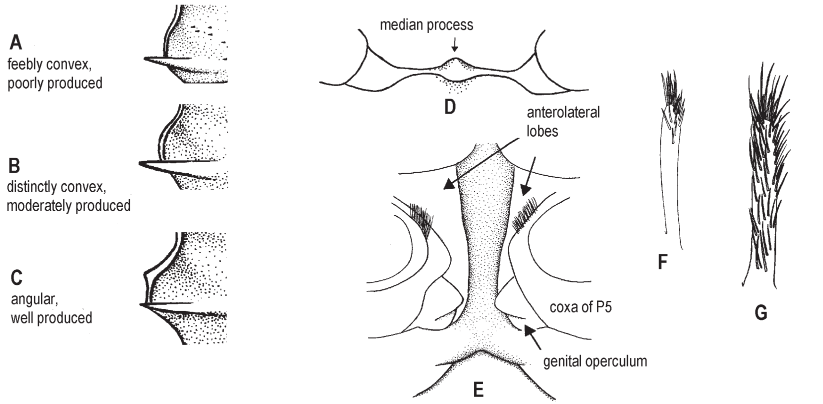


Figure 3. Selected morphological characters of *Macrobrachium* (family Palaemonidae): **A-C**, variation in shape of inferior orbit; **D**, T4 median process; **E**, genital operculae on male T8; **F**, appendix masculina of immature male; **G**, appendix masculina of sexually mature male. After Short (2004).

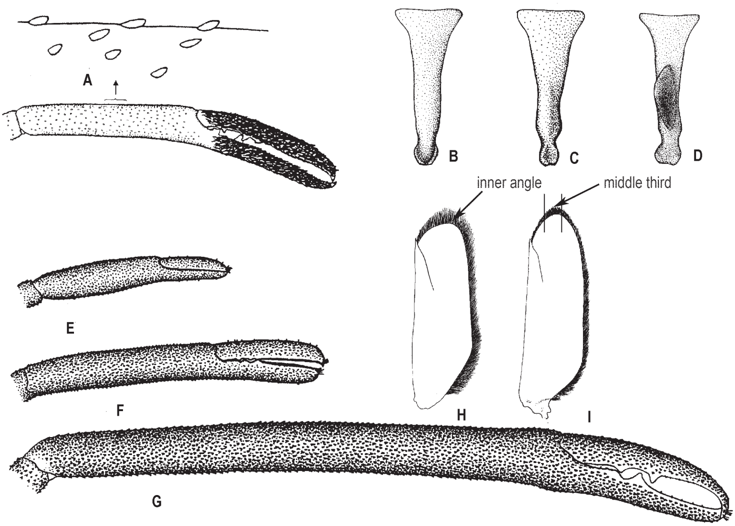


Figure 4. Selected morphological characters of *Macrobrachium* (family Palaemonidae): **A**, magnified view of tubercles on manus of developed male chela of *M. australiense*; **B**, ventral inter-uropodal sclerite without pre-anal carina; **C**, ventral inter-uropodal sclerite with low, rounded pre-anal carina; **D**, ventrolateral view of inter-uropodal sclerite showing high, well-developed pre-anal carina; **E**, undeveloped male chela of *M. tolmerum*; **F**, developing male chela of same; **G**, fully developed male chela of same; **H**, anterior scaphocerite lamina produced forward at inner angle; **I**, anterior scaphocerite lamina strongly produced forward at or near mid-line. After Short (2004).

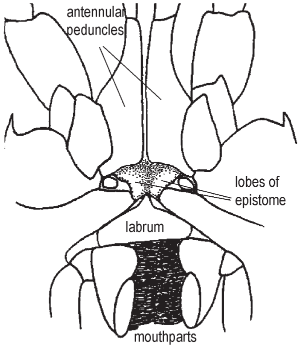


Figure 5. Position of epistome in shrimps.

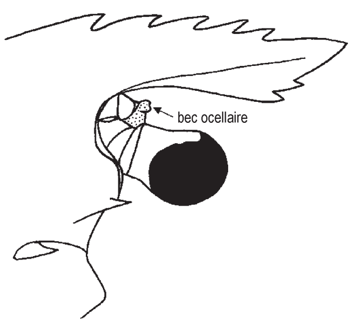


Figure 6. Position of bec ocellaire in palaemonid shrimps.

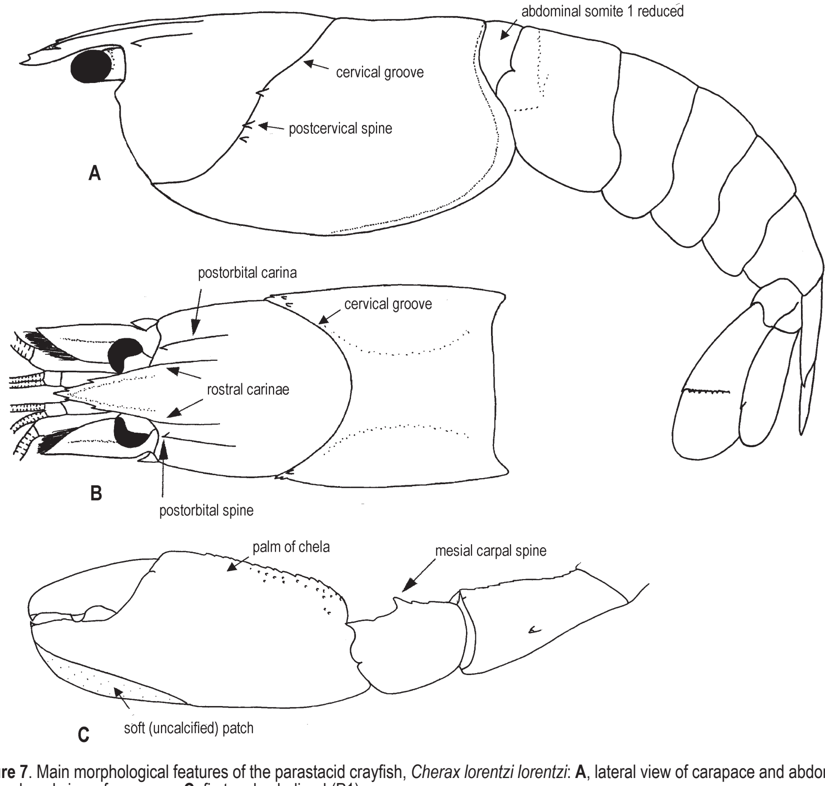


Figure 7. Main morphological features of the parastacid crayfish, *Cherax lorentzi lorentzi*: **A**, lateral view of carapace and abdomen; **B**, dorsal view of carapace; **C**, first male cheliped (P1).

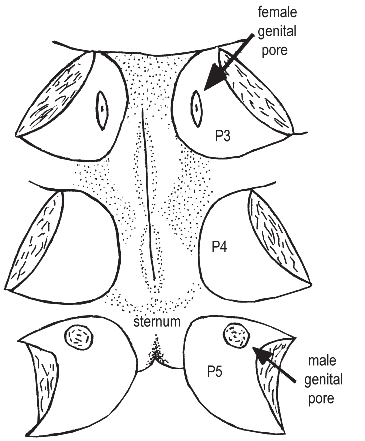


Figure 8. Location of male and female genital pores in freshwater crayfishes of the genus, *Cherax*.

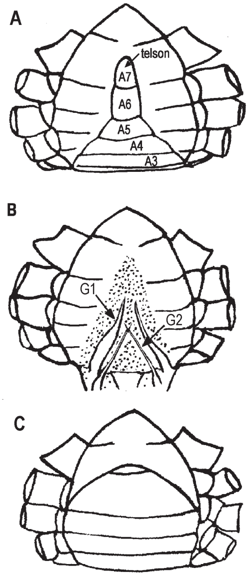


Figure 9. Sexual abdominal differences in a generalised parathelphusid crab. **A**, male abdomen; **B**, male abdomen folded back to show gonopods; **C**, female abdomen.

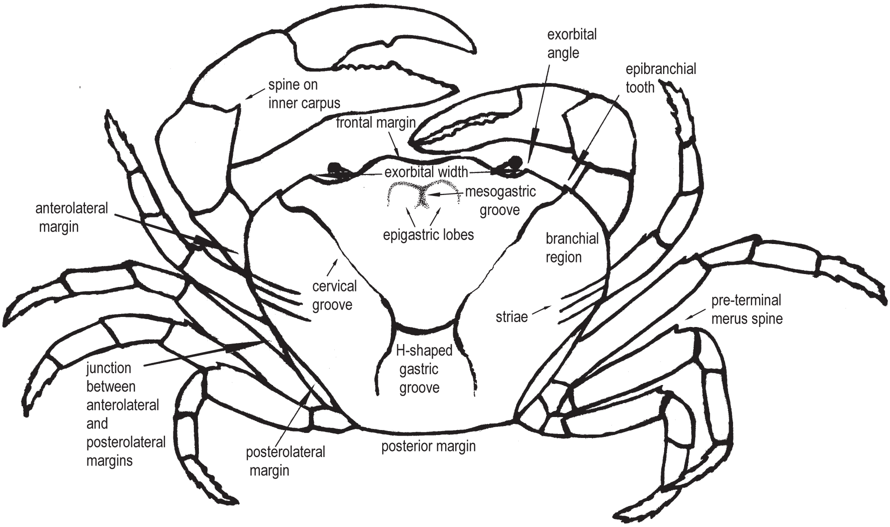


Figure 10. Main morphological features of a generalised parathelphusid crab.

Key to Families

The following key covers the decapod crustacean families recorded from the fresh waters of mainland New Guinea (families recorded from the Mimika region are marked with an asterisk and the relevant page number where the family account begins in the main text given). For the families Varunidae and Sesarmidae, only features common to species occurring in fresh waters have been used.

1a Flattened animals with a reduced tail concealed underneath the body, tail without tail-fan.
. . . . Crabs **2**

1b Elongated animals with a large conspicuous tail and well developed tail-fan.
. . . . Shrimps, prawns and crayfishes **6**

2a Antennulae folding longitudinally (Fig. 11A); carapace poorly calcified, soft, usually with conspicuous rostrum between the eyes; generally small species.
. . . . False spider crabs . . . . **Hymenosomatidae**

[Not yet recorded from Papuan fresh waters. One land-locked freshwater species, *Amarinus angelicus* (Holthuis, 1968), is known from Papua New Guinea from a watercress swamp at an altitude of 1,600 m at Tigibi, Tari Subdistrict, Southern Highlands Province]

2b Antennulae folding transversely (Fig. 11C) or obliquely (Fig. 11B); carapace well calcified and hard; without rostrum between eyes; medium-sized to large species **3**

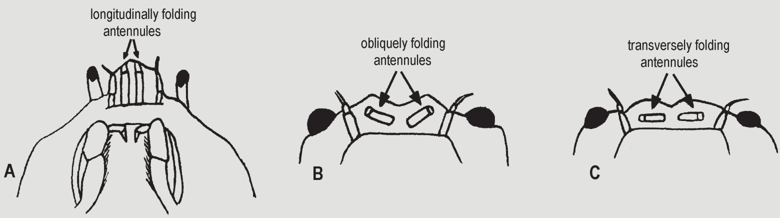


Figure 11. Variation in the position of the antennules in brachyuran crabs: **A**, longitudinally folding; **B**, obliquely folding; **C**, transversely folding.

3a Without distinct rhomboidal gap between third maxillipeds, mandibles never visible with other mouthparts closed (Fig. 12A). **4**

3b Distinct rhomboidal gap between third maxillipeds, mandibles usually visible with other mouthparts closed (Fig. 12B) **5**

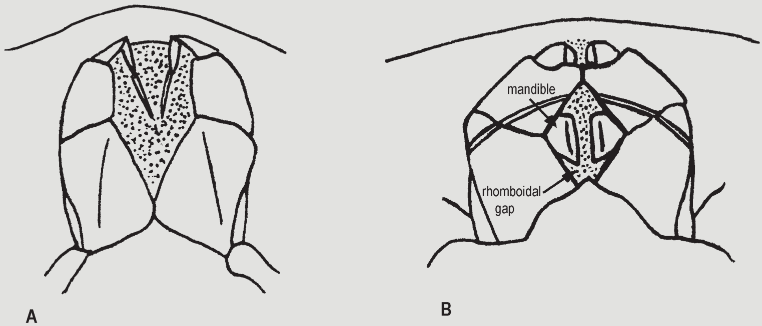


Figure 12. Rhomboidal gap in brachyuran crabs: **A**, without rhomboidal gap, mandibles concealed; **B**, with rhomboidal gap, mandibles visible.

4a Walking legs (P2–5) not strongly developed for swimming although sometimes flattened, not conspicuously paddle like, posterior margins of propodi and dactyli without dense fringes of setae, chelipeds without fringes of setae (Fig. 10). . . . . True freshwater crabs. . . . . .***Parathelphusidae** (p. 76)

4b Walking legs (P2–5) usually strongly modified for swimming, flattened, paddle-like, posterior margins of propodi and dactyli usually with dense fringes of setae (Fig. 13), chelipeds (P1) sometimes also with dense fringes of setae. . . . . Paddle crabs . . . . ***Varunidae**

[Both *Varuna yui* Hwang and Takeda, 1986 and *Parapyxidognathus deianeira* (De Man, 1888) have been recorded from fresh waters in upper estuaries of the Mimika region.]

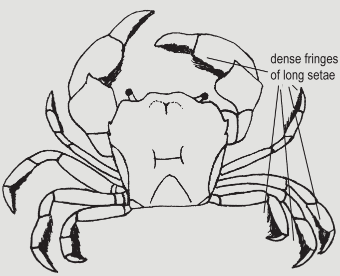


Figure 13. A generalised varunid crab.

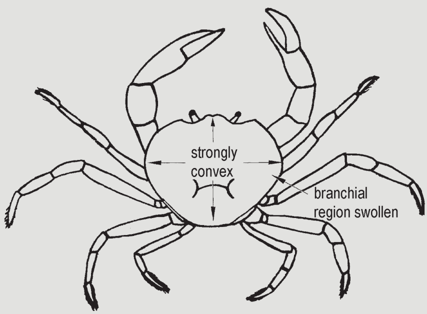


Figure 14. A generalised gecarcinid crab.

5a Third maxillipeds without conspicuous oblique ridge on ischium and merus (Fig. 15A); carapace strongly convex longitudinally and transversely (Fig. 14), transversely ovate, subovate or circular, branchial regions usually markedly swollen.
. . . . Land crabs . . . . **Gecarcinidae**

[*Cardisoma hirtipes* Dana, 1851 and *Cardisoma carnifex* (Herbst, 1796) are both known from southern Papua and occasionally burrow in freshwater soaks and along freshwater streams. Not yet recorded from the Mimika region.]

5b Third maxillipeds with conspicuous oblique ridge on ischium and merus (Fig. 15B); carapace flat to gently convex, generally squarish or rectangular, branchial regions generally not markedly swollen . . . . Vinegar crabs . . . . *__Sesarmidae__

[Although most species of this family are found in the littoral zone of estuaries, the land-locked freshwater species, *Geosesarma gordonae* (Serène, 1968) and *Geosesarma ianthina* Pretzmann, 1985, are known from mainland Papua. No freshwater species of the family are presently known from the Mimika region].

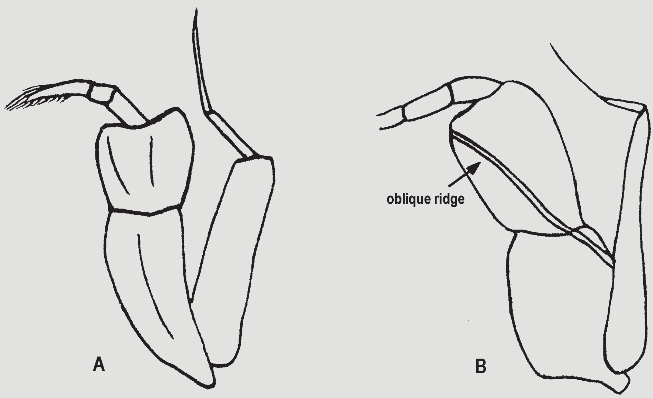


Figure 15. **A**, third maxilliped without oblique ridge; **B**, third maxilliped with oblique ridge.

6a First abdominal segment reduced (Fig. 7A), without pleopods; cephalothorax with cervical groove (Figs 7A, 7B); body depressed.
. . . . Freshwater crayfishes. . . . . *__Parastacidae__ (p. 74)

5b First abdominal segment well developed (Fig. 2), with pleopods; cephalothorax without cervical groove; body laterally compressed.
. . . . Shrimps and prawns **6**

6a Chelae of first and second chelipeds generally of similar size and bearing terminal tufts of dense setae on fingers (Figs 27-29, 33). . . . . *__Atyidae__ (p. 32)

6b Chelae of second chelipeds generally much more developed than those of first chelipeds (Fig. 2), without terminal tufts of dense setae on fingers . . . . . . *__Palaemonidae__ (p. 50)

ATYID SHRIMPS

Family Atyidae

Atyids are small to medium-sized shrimps (up to 124 mm TL) with the chelae of the first and second pereiopods of similar size and typically bearing dense tufts of setae on the finger tips.

The Atyidae are widespread throughout tropical and warm temperate regions of the world. The majority of species have freshwater life cycles and are usually restricted to a single land mass. Some are of high conservation value and have highly restricted distributions in upland streams, lakes or cave systems.

Within the family, there are also a number of euryhaline or anchialine species which are capable of inshore or oceanic dispersal. Some, such as *Caridina typus* H. Milne Edwards, 1837, are widely distributed in the Indo-West Pacific region.

Unlike the Palaemonidae, which is much more diverse in marine environments, very few atyids are found in the sea as adults. Within the family, fertilised eggs vary in size from small (*ca.* 0.4 mm) to large (>2.0 mm) and larval development ranges from extended to highly abbreviated. Eggs hatch as free-swimming planktonic larvae (many species) or crawling benthic larvae (some land-locked freshwater species).

Two wide-ranging genera have so far been recorded from the Mimika region, viz. *Caridina* and *Atyopsis*. *Caridina* is the most common Indo-West Pacific genus and includes relatively small shrimps (< 35 mm) which feed by picking and scraping detritus and algae using the tufts of setae on the finger tips of the chelae. By contrast, fan shrimps of the genus, *Atyopsis*, are more robust and attain a much larger size (up to 70 mm). They filter feed in well-oxygenated, rapidly flowing waters using their outstretched fan-like chelae. Fan shrimps of the closely-related genus, *Atyoida*, are also known from similar habitats throughout the Indo-West Pacific, including southern New Guinea.

Key to the Atyidae of Southern Papua

(species recorded from Mimika region marked with asterisk)

1a Carpus of P2, short, deeply excavate distally, little if at all longer than wide (Fig. 16B). **2**

1b Carpus of P2 long, not deeply excavate distally, distinctly longer than wide (Fig. 16A) . . . . *Caridina* spp. **3**

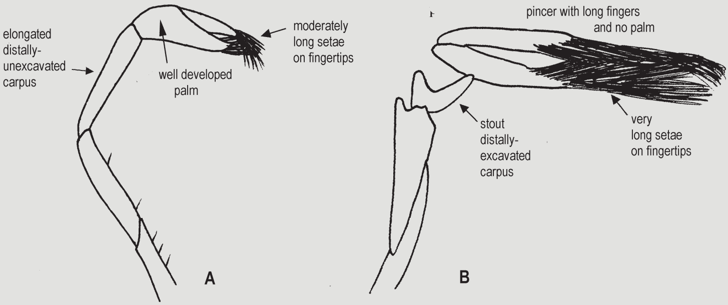


Figure 16. **A**, typical adult P2 of *Caridina* spp., **B**. typical adult P2 of *Atyopsis* and *Atyoida* species.

2a Pterygostome angular or bluntly acute (Fig. 17); rostrum generally without teeth or with single ventral tooth (occasionally with 1 or rarely with 2 ventral teeth), moderately developed supraorbital eave present (Fig. 17) . . . . ***Atyoida pilipes*** (Newport)

2b Pterygostome spinate (Fig. 18); rostrum unarmed dorsally, armed ventrally with 2–6 teeth, without supraorbital eave (Fig. 18) . . . . ****Atyopsis spinipes*** (Newport) (p. 39)

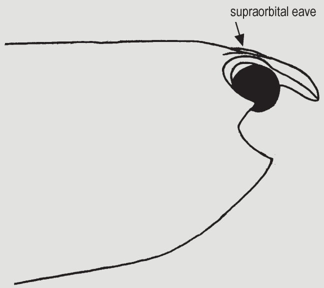


Figure 17. Anterior cephalothorax of *Atyoida pilipes* (Newport).

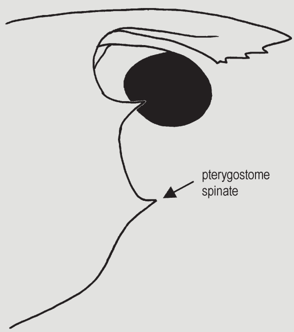


Figure 18. Anterior cephalothorax of *Atyopsis spinipes* (Newport).

3a	Rostrum of medium length to very long; reaching beyond distal end of antennular peduncle, armed dorsally and ventrally	**4**
3b	Rostrum generally short, often failing to reach distal end of antennular peduncle, if reaching beyond antennular peduncle, unarmed dorsally	**13**

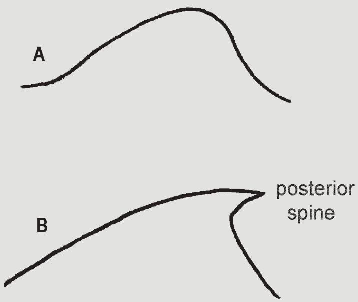


Figure 19. **A**, rounded pre-anal carina, **B**, pre-anal carina with posterior spine.

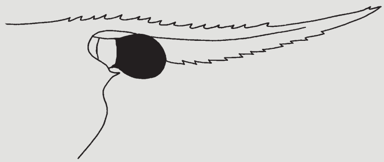


Figure 20. Anterior cephalothorax of *Caridina longirostris* H. Milne Edwards.

4a	Inter-uropodal sclerite with well developed pre-anal carina armed with posterior spine (Fig. 19B)	**5**
4b	Inter-uropodal sclerite without well developed pre-anal carina or with well-developed pre-anal carina lacking posterior spine (Fig. 19A)	**8**
5a	Distal $^1/_3$ – $^1/_2$ of dorsal rostrum armed, typically with 1-3 subapical teeth	**6**
5b	Distal $^1/_3$ – $^1/_2$ of dorsal rostrum unarmed . . . . *Caridina brevicarpalis* De Man [1]	(p. 40)
6a	Rostrum extremely long and slender, about twice length of blade of antennal scale, proximal half of dorsal margin with 5–11 rather widely spaced teeth, dorsal margin otherwise unarmed except for 0–3 (generally 1) subapical teeth, 0–1 rostral tooth on carapace behind orbit (Figs 30A, 30B). . . . . *Caridina gracilirostris* De Man	(p. 41)
6b	Rostrum not extremely long and slender, when over-reaching antennal scale much less than twice length of blade of antennal scale; proximal half of dorsal margin with closely-spaced teeth, 1–5 rostral teeth on carapace behind orbit	**7**

7a Rostrum clearly over-reaching antennal scale, 1–3 dorsal teeth situated on carapace behind orbit, proximal series of closely-spaced teeth continuing un-interrupted to about $^{1}/_{2}$ to $^{2}/_{3}$ of length of dorsal margin, generally followed by conspicuous edentate region, dorsal margin distinctly sinuous or upturned (Fig. 20).
. . . . ****Caridina longirostris*** H. Milne Edwards (p. 42)

7b Rostrum reaching between distal end of antennular peduncle and distal end of antennal scale (sometimes slightly over-reaching antennal scale); 3–5 teeth situated on carapace behind orbit, proximal series of closely-spaced teeth continuing to at least $^{3}/_{4}$ of length of dorsal margin, often followed subdistally by short edentate region, dorsal margin generally straight, sometimes sinuous (Fig. 34) . . . .****Caridina* sp. 1** (p. 45)

8a Antennal spine fused with inferior orbit; rostrum generally without teeth on distal $^{1}/_{3}$ – $^{1}/_{4}$, if with teeth near apex, dorsal margin without edentate region (Fig. 35).
. . . .****Caridina* sp. 2** (p. 46)

8b Antennal spine situated below and distinct from inferior orbit; rostrum with subequally spaced teeth along entire dorsal margin or with subapical teeth and edentate region **9**

9a Dorsal rostrum straight or at most slightly sinuous, usually with sub-equally spaced teeth to near tip (Fig. 36) . . . .****Caridina* sp. 3** (p. 47)

9b Rostrum distinctly sinuous or upturned, 1 or more subapical teeth, subapical teeth separated from proximal dorsal series by edentate region or small number of widely spaced teeth **10**

10a Posterior telson margin with at most a small median projection or 1–2 small spiniform setae; appendix interna present on first male pleopod **11**

10b Posterior telson margin with well developed, acute, median process situated above and slightly anterior to margin (Fig. 21A); appendix interna absent on first male pleopod. . . . .****Caridina* sp. 5** (p. 49)

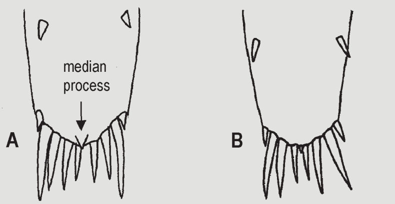


Figure 21. Median process development on posterior telson; **A,** well developed and submarginal; **B,** poorly developed and marginal.

Figure 22. Anterior cephalothorax of *Caridina typus* H. Milne Edwards.

11a P3 propodus length less than 5 times dactylus length; developed eggs moderately large, *ca*. 0.7–0.8 mm . . . . ***Caridina*** **'nilotica' complex** [2]
11b P3 propodus length more than 5 times dactylus length; developed eggs small, < 0.5 mm. **12**

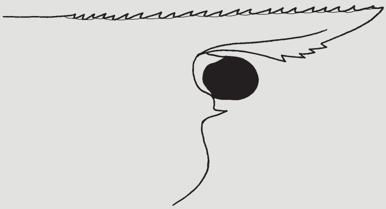


Figure 23. Anterior cephalothorax of *Caridina serratirostris* De Man.

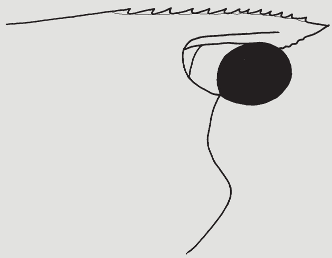


Figure 24. Anterior cephalothorax of *Caridina weberi* De Man.

12a Dorsal rostral margin distinctly sinous or upturned; ventral rostral margin with 18–23 teeth.. . . . . ***Caridina brevidactyla*** J. Roux
12b Dorsal rostral margin more or less straight; ventral rostral margin with 11–12 teeth . . . .***Caridina brachydactyla*** De Man

13a Rostrum with dorsal teeth. **14**
13b Rostrum without dorsal teeth (Fig. 22) . . . . ***Caridina typus*** H. Milne Edwards

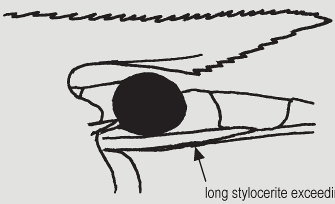


Figure 25. Stylocerite of *Caridina serratirostris* De Man.

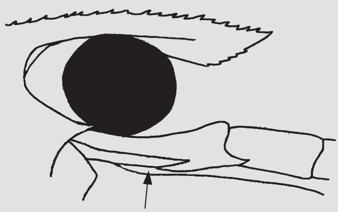


Figure 26. Stylocerite of *Caridina weberi* De Man.

14a Stylocerite reaching past distal end of basal antennular peduncle segment in adults (Fig. 25) . . . . **Caridina serratirostris** De Man [3] (p. 43)

14b Stylocerite failing to reach distal end of basal antennular peduncle segment in adults (Fig. 26) **15**

15a Pre-anal carina on inter-uropodal sclerite armed with posterior spine (Fig. 19B); anterior carapace and rostrum as shown in Fig. 37 . . . . ****Caridina* sp. 4** (p. 48)

15b Pre-anal carina on inter-uropodal sclerite without posterior spine (Fig. 19A); anterior carapace and rostrum as shown in Fig. 24 . . . . ***Caridina weberi** De Man (p. 44)

[1] Material from the Mimika region is intermediate between the two subspecies recognised by Chace (1997) and later regarded as full species by Cai and Shokita (2006), viz. *C. brevicarpalis* and *C. endehensis* both of De Man, 1892. There are 16–23 dorsal rostral teeth (0–2 placed on the carapace behind the orbit) and 2–11 ventral teeth. This falls largely within the rostral formula given by Chace (1997) for *C. endehensis*. Similarly, the posterior telson also has a median projection and the antennal spine is usually located below the inferior orbit, although in some specimens it is almost fused with inferior orbit. However, the length of the rostrum is more similar to *C. brevicarpalis* and reaches to around the distal end of the antennal scale. The rostrum is also somewhat downwardly directed with the dorsal carina convex in the proximal half and straight distally. This is different to that described by Chace for either form. Clearly, the *C. brevicarpalis* complex needs to be studied in more detail before additional subspecies or species should be recognised. In the meantime, I have assigned the Mimika region material to *C. brevicarpalis* in the broad sense.

[2] This complex includes a number of nominal species from the Indo-West Pacific region and is in need of additional study and analysis. The taxon, *Caridina nilotica* (P. Roux, 1833), was described from the Nile River, Cairo and is unlikely to be conspecific with any of the Indo-West Pacific taxa. Unresolved Indo-West Pacific taxa are still commonly lumped under this name, pending a thorough revision of the group.

[3] In the same paper in which De Man (1892) described *C. serratirostris* from Selajar, near Sulawesi, he also described a new variety, '*celebensis*', from Sulawesi. De Man's variety has since been variously treated as a synonym of *C. serratirostris*,

a different subspecies or a valid species. Although the recent trend has been to recognise it as a species, there has been a lack of agreement on how to distinguish it from *C. serratirostris*. After a re-examination of the types of both nominal species, Cai and Shokita (2006) recently concluded that only one character, the presence or absence of an arthrobranch above the first pereiopod, could reliably separate the two nominal species. However, they noted that even in this character there is considerable variation, with the size of the arthrobranch in *C. serratirostris* varying from "almost indiscernable" to "very distinct". I have chosen to follow Chace (1997) in treating *C. celebensis* De Man as a synonym of *C. serratirostris*, until the two nominal species are more clearly defined.

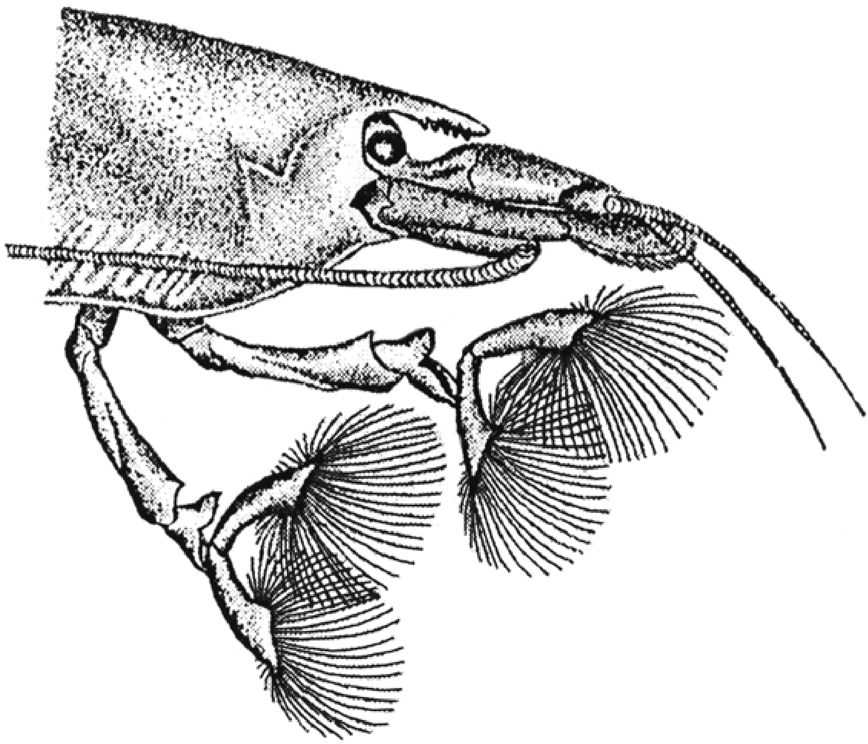
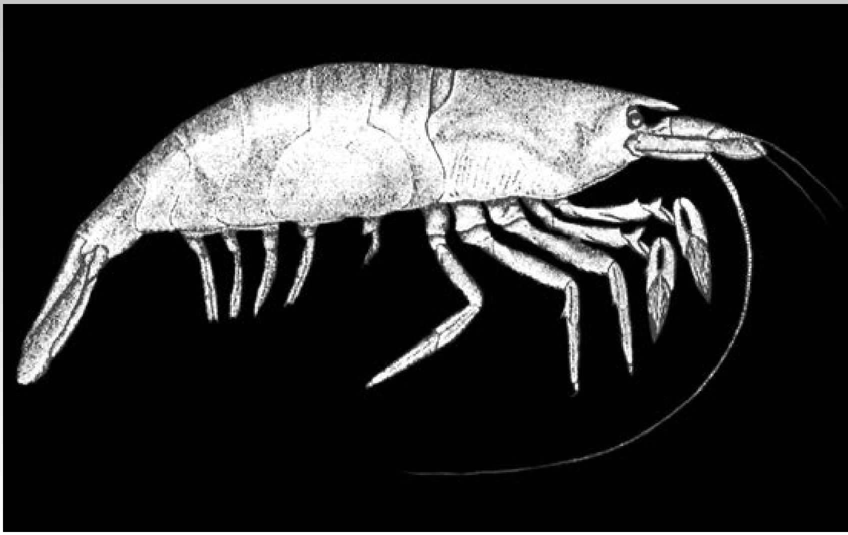


Figure 27. *Atyopsis spinipes* (Newport) with fan-like chelae open in filter-feeding position. After Cowles (1914).

Spiny Pacific Fan Shrimp

Atyopsis spinipes

(Newport, 1847)



After Cowles (1914)

Figure 28. Adult female.

Diagnosis: Rostrum short, failing to reach distal end of antennular peduncle, without supraorbital eave, rostral formula 0/2–6. Carapace with antennal spine fused with inferior orbit. Pterygostome acutely produced as spine. P1 with carpus deeply excavated, wider than long, P2 similar in males and females, with carpus short, little if at all longer than wide, deeply excavated distally. Epipods present on all pereiopods, reduced on posterior pereiopods. Inter-uropodal sclerite with posteriorly acute or spinate pre-anal carina. Endopod of male PL1 with small appendix interna. Posterior telson margin with well developed, acute, median projection. Medium-sized species up to 20 mm CL, 71 mm TL. Body greenish-brown with irregular longitudinal bands laterally and broad mid-dorsal band.

Habitat and abundance: Euryhaline, larval development requiring marine influence, adults torrenticolous, generally in the cascade zone of rivers and streams up to *ca*. 300 m a.s.l. Filter feed by spreading the chelae like fans in moving water. Often congregate in great numbers immediately below falls, where they cling to the underside of rocks, tree roots, submerged vegetation, etc. In the Mimika region, presently known from juveniles collected in the upper Otokwa River estuary.

Distribution: Wide ranging in the Pacific region from the Ryukyu Islands, Taiwan, Philippines and Lesser Sunda Islands to the Caroline, Fijian and Samoan Islands.

Other names: soldier brush shrimp (FAO); torrent prawn; udang grago (Indonesian); niti (Kamoro).

Short-wristed Caridina

Caridina brevicarpalis

De Man, 1892

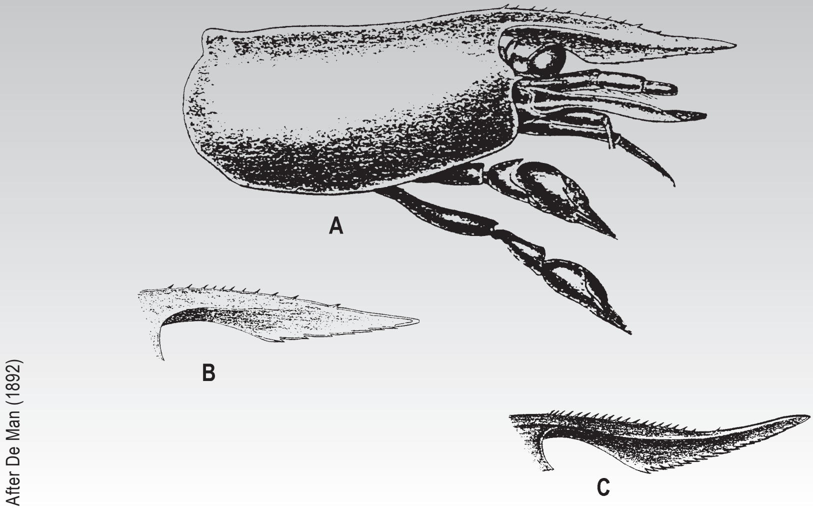


Figure 29. **A**, cephalothorax; **B–C**, rostrum variation.

Diagnosis: Rostrum of medium length, slightly to clearly over-reaching antennal scale, dorsal carina more or less straight or convex in proximal half and straight distally (material from Mimika area), dentate proximally, unarmed on distal 1/3 to 1/2, proximal teeth subequally spaced, rostral formula 11–23/2–24 (16–23/2–11 in material from the Mimika region), 0–2 dorsal teeth postorbital, first ventral tooth located in proximal half or at about mid-length. Carapace with antennal spine situated below inferior orbit, variably distinct from inferior orbit (usually distinct from inferior orbit but sometimes partially fused in material from Mimika region). Pterygostome bluntly angular or obtuse. Stylocerite failing to reach distal end of basal antennular peduncle segment. P1 deeply excavated distally for reception of chela, carpus 1.0–1.5 times longer than broad; P2 carpus not deeply excavated, distinctly longer than wide. Epipods present on all pereiopods except P5. Inter-uropodal sclerite with well developed pre-anal carina bearing posterior spine. Endopod of male PL1 with appendix interna. Posterior telson margin with well-developed, subterminal medial projection. Small species up to *ca*. 7 mm CL, 32 mm TL. Developed eggs small, 0.5 mm max. length.

Habitat and abundance: Euryhaline, adults generally in lowland fresh waters. Commonly recorded from upper estuaries in the Mimika region.

Distribution: Central Indo-West Pacific including the Philippines; Flores, Sumba, Sulawesi, Waigeo Islands, southern Papua, Indonesia; and the Fiji Islands.

Other names: wautete, niti (Kamoro).

Slender-beaked Caridina

Caridina gracilirostris

De Man, 1892

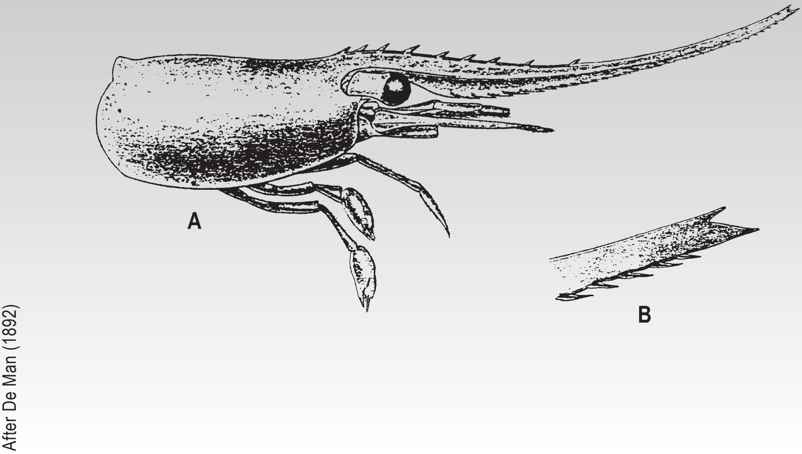


Figure 30. **A**, cephalothorax; **B**, distal rostrum.

Diagnosis: Rostrum slender, extremely long, more than twice length of antennal scale, strongly upturned, rostral formula 7–13/15–34, proximal dorsal teeth widely spaced, 1–2 dorsal teeth postorbital, ventral teeth closely spaced, distributed over most of length. Antennal spine situated below and distinct from inferior orbit. Pterygostome bluntly angular or obtuse. Inferior orbit bluntly angular or bluntly acute. Stylocerite failing to reach distal end of basal antennular peduncle segment. P1 not distinctly excavated for reception of chela, carpus 2.0–2.5 times longer than broad, fingers clearly longer than manus; P2 carpus not deeply excavated, distinctly longer than wide. Epipods present on all pereiopods except P5. Inter-uropodal sclerite with strongly developed, well elevated pre-anal carina bearing posterior spine. Endopod of male PL1 with appendix interna. Posterior telson margin with well-developed, subterminal, medial projection. Small species up to *ca*. 7 mm CL, 37 mm TL. Developed eggs small, 0.6 mm max. length. Body translucent except for few dark transverse lines on abdomen and orange rostrum.

Habitat and abundance: Euryhaline, adults in lowland fresh and brackish waters. Abundant in upper estuaries in the Mimika region.

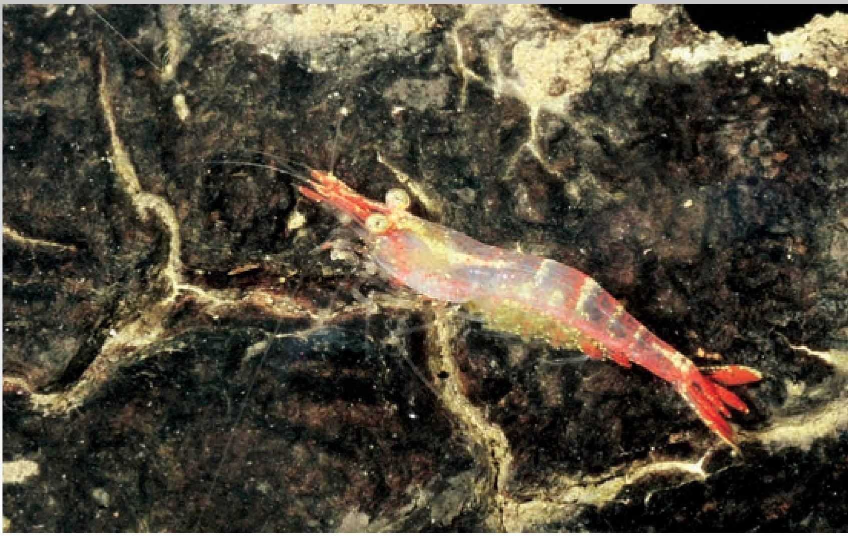
Distribution: Wide-ranging in the Indo-West Pacific from Madagascar to the Philippines, Palau, Caroline Islands and Australia.

Other names: needlenose caridina (FAO); wautete, niti (Kamoro).

Long-beaked Caridina

Caridina longirostris

H. Milne Edwards, 1837



John W. Short

Figure 31. Red-specked colour form.

Diagnosis: Rostrum long, clearly over-reaching antennal scale, dorsal carina often more or less straight in proximal half and upturned distally, otherwise sinuous, dentate, dorsal margin generally with distinct edentate region in distal $^{1}/_{2}$ to $^{1}/_{3}$, proximal series of teeth on dorsal margin more or less equally spaced teeth, rostral formula 5–30/2–22 with 1–3 dorsal subapical teeth, 1–3 dorsal teeth postorbital. Antennal spine situated below and distinct from inferior orbit. Pterygostome obtuse. Inferior orbit obtusely rounded, sometimes subacute. Stylocerite failing to reach distal end of basal antennular peduncle segment. P1 carpus not distinctly excavated distally for reception of chela, 2–3 times longer than broad, fingers clearly longer than manus; P2 carpus not deeply excavated, distinctly longer than wide. Epipods present on all pereiopods except P5. Inter-uropodal sclerite with strongly developed, well elevated pre-anal carina bearing a moderately developed posterior spine. Appendix interna absent to well developed on endopod of male PL1. Posterior margin of telson angular, with well-developed, subterminal, medial spine. Small species up to *ca*. 7 mm CL, 37 mm TL. Developed eggs small, 0.4 mm max. length. Generally translucent except for few markings on side of body, often with light narrow band along dorsal midline and upper rostrum.

Habitat and abundance: Euryhaline, adults generally in middle and lower freshwater reaches, larval development requiring marine influence. Moderately common in upper estuaries in the Mimika region.

Distribution: Wide-ranging in the Indo-West Pacific from Madagascar to the Philippines, Indonesia, Australia and Fiji.

Other names: wautete, niti (Kamoro).

Spiny-beaked Caridina

Caridina serratirostris

De Man, 1892

John W. Short

Figure 32. Dorsal view.

Diagnosis: Rostrum short, failing to reach distal end of antennular peduncle, dorsal carina more or less straight, closely spaced teeth along entire length, rostral formula 16–33/3–7, 7–10 dorsal teeth postorbital. Antennal spine situated below and distinct from inferior orbit. Pterygostome bluntly angular or obtuse. Inferior orbit obtuse, rounded. Stylocerite clearly reaching past distal end of basal antennular peduncle segment in adults. P1 carpus not distinctly excavated distally for reception of chela, 3.5–4.0 times longer than broad, fingers clearly longer than manus; P2 carpus not deeply excavated, distinctly longer than wide. Epipods present on all pereiopods except P5. Inter-uropodal sclerite with well developed pre-anal carina bearing a posterior spine. Endopod of male PL1 without appendix interna. Posterior telson margin rounded, bearing small, subterminal, medial spine. Small species up to 5 mm CL, 25 mm TL. Developed eggs small, 0.35 mm max. length.

Habitat and abundance: Euryhaline, adults generally in lowland fresh and brackish waters, larval development requiring marine influence. Infrequently collected from upper estuaries in the Mimika region. Local specimens dark brown with light broad band along dorsal mid-line.

Distribution: Wide-ranging in the Indo-West Pacific from Madagascar, the Seychelles and Mauritius to Okinawa, New Guinea, Australia and the Fiji Islands.

Other names: wautete, niti (Kamoro).

Weber's Caridina

Caridina weberi

De Man, 1892

Figure 33. **A**, anterior body; **B–D**, rostrum variation.

Diagnosis: Rostrum short, failing to reach end of antennular peduncle, dorsal carina more or less straight or convex, downturned distally or downwardly directed, dentate, with subequally spaced teeth not quite reaching apex, rostral formula 7–20/0–10, 0–6 dorsal teeth postorbital, ventral teeth sometimes minute. Antennal spine generally completely fused to and indistinct from inferior orbit, sometimes partially fused or distinct. Pterygostome bluntly angular or obtuse. Stylocerite failing to reach distal end of basal antennular peduncle segment. P1 carpus variably excavated distally for reception of chela; P2 carpus not deeply excavated, distinctly longer than wide. Epipods present on all pereiopods except P5. Inter-uropodal sclerite with well developed pre-anal carina, carina lacking posterior spine but produced to blunt point. Endopod of male PL1 with appendix interna. Posterior telson margin generally with distinct median process. Small species up to 8 mm CL, 30 mm TL. Developed eggs small, 0.3 mm max. length. Body speckled with light broad longitudinal band along dorsal mid-line.

Habitat and abundance: Euryhaline, adults generally found in middle and lower freshwater reaches, extending to headwaters on some Pacific islands. Larval development requiring marine influence, juveniles tolerant of sea water. Infrequently collected from upper estuaries in the Mimika region.

Distribution: Indonesia, New Guinea, Fiji, Micronesia and Polynesia.

Other names: pugnose caridina (FAO); wautete, niti (Kamoro).

Caridina sp. 1

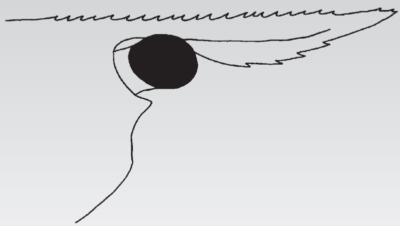


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Figure 34. Anterior cephalothorax and rostrum.

Diagnosis: Rostrum of medium length, reaching between distal antennular peduncle and distal end of antennal scale or slightly beyond antennal scale, dorsal carina more or less straight, dentate, teeth subequally spaced over most of length except for 1–3 subapical teeth either more widely spaced than proximal series or separated by distinct gap, rostral formula 20–26/4–8, 3–6 dorsal teeth postorbital. Antennal spine situated below and distinct from inferior orbit. Pterygostome bluntly angular or obtuse. Stylocerite failing to reach distal end of basal antennular peduncle segment. P1 carpus not distinctly excavated distally for reception of chela, clearly longer than broad; P2 carpus not deeply excavated, distinctly longer than wide. Epipods present on all pereiopods except P5. Inter-uropodal sclerite with strongly developed, well elevated pre-anal carina bearing strongly developed posterior spine. Posterior telson margin with small medial projection. Small species up to 5 mm CL, 23 mm TL. Developed eggs small, 0.4 mm max. length.

Habitat and abundance: Common in upper estuaries of the Mimika region.

Distribution: Ajkwa, Kamora, Mawati, Minajerwi, West Minajerwi and Otokwa Rivers, Mimika region.

Other names: wautete, niti (Kamoro).

Caridina sp. 2

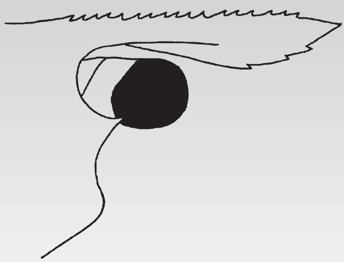

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Figure 35. Anterior cephalothorax and rostrum.

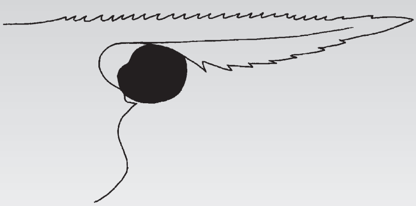
Diagnosis: Rostrum of medium length, reaching slightly beyond distal end of antennular peduncle, dorsal carina more or less straight, dentate, teeth more or less equally spaced along dorsal margin except for edentate tip, rostral formula 12–20/1–4, 1–2 dorsal teeth postorbital. Antennal spine completely fused to and indistinct from inferior orbit. Pterygostome bluntly angular or obtuse. Stylocerite failing to reach distal end of basal antennular peduncle segment. P1 carpus deeply excavated for reception of chela; P2 carpus not deeply excavated, distinctly longer than wide. Epipods present on all pereiopods except P5. Inter-uropodal sclerite with strongly developed, well elevated pre-anal carina, carina without well developed posterior spine, generally produced to blunt point. Small species up to 4 mm CL, 23 mm TL. Developed eggs moderately large, *ca*. 1.0 mm max. length.

Habitat and abundance: Infrequently collected from upper estuaries in the Mimika region. The moderately-large eggs of this species suggest that it has abbreviated larval development in fresh waters and may be more common further upstream.

Distribution: Kamora, Minajerwi, Mawati and Otokwa river systems, Mimika region.

Other names: wautete, niti (Kamoro).

Caridina sp. 3



John W. Short

Figure 36. Anterior cephalothorax and rostrum.

Diagnosis: Rostrum long, clearly over-reaching antennal scale, dorsal carina slightly sinuous or more or less straight, dentate except for edentate region near tip, rostral formula 20–25/4–7, 3–4 dorsal teeth postorbital. Antennal spine situated below and distinct from inferior orbit. Stylocerite failing to reach distal end of basal antennular peduncle segment. P1 carpus not excavated distally for reception of chela, elongate; P2 carpus not deeply excavated, distinctly longer than wide. Epipods present on all pereiopods except P5. Inter-uropodal sclerite without well developed pre-anal carina. Posterior telson margin without medial projection. Small species up to 4 mm CL, 17 mm TL. Developed eggs moderately large, 0.8 mm max. length.

Habitat and abundance: Abundant in upper estuaries in the Mimika region. The egg size of the species is similar to many land-locked freshwater species of the genus with moderately abbreviated larval development, suggesting that the species may also be common further upstream in non-tidal fresh waters.

Distribution: Ajkwa, Kamora, Mawati, Minajerwi, West Minajerwi and Otokwa Rivers, Mimika region.

Other names: wautete, niti (Kamoro).

Caridina sp. 4

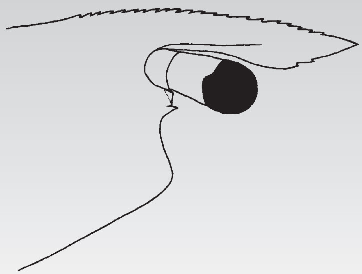


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Figure 37. Anterior cephalothorax and rostrum.

Diagnosis: Rostrum short, failing to reach distal end of antennular peduncle, dorsal carina convex, often downturned distally or downwardly directed, dentate except for subapical margin and tip, teeth closely spaced, rostral formula 15–22/2–4, 4–6 dorsal teeth postorbital. Antennal spine situated below and distinct from inferior orbit. Pterygostome bluntly angular or obtuse. Inferior orbital margin strongly produced, bluntly angular or acute. Stylocerite failing to reach distal end of basal antennular peduncle segment. P1 carpus not distinctly excavated distally for reception of chela, elongate; P2 carpus not deeply excavated, distinctly longer than wide. Epipod present on P1, absent on P2-5. Inter-uropodal sclerite with strongly developed, well elevated pre-anal carina bearing a posterior spine. Posterior telson margin without distinct medial projection. Small species up to 5 mm CL, 20 mm TL. Developed eggs small, 0.4 mm max. length.

Habitat and abundance: Moderately common in the upper estuaries of some river systems in the Mimika region. The small size of the eggs of this species suggest that it has lengthy planktonic larval development and is likely to have a broader distribution in southern Papua.

Distribution: Minajerwi, West Minajerwi, Mawati and Otokwa Rivers, Mimika region.

Other names: wautete, niti (Kamoro).

Notes: This species shows a superficial resemblance to *C. blancoi* Chace, 1997, particularly in the form of the rostrum.

Caridina sp. 5

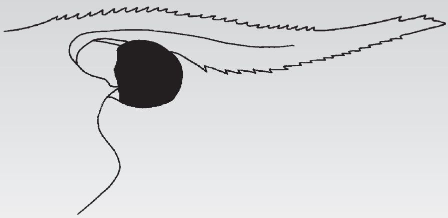

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Figure 38. Anterior cephalothorax and rostrum.

Diagnosis: Rostrum long or of medium length, just failing to reach end of scaphocerite to clearly over-reaching scaphocerite, dorsal carina often more or less straight in proximal half and upturned distally, otherwise sinuous, dentate, proximal series of dorsal teeth more or less equally spaced, separated from 0–3 subapical teeth by distinct edentate region or few widely spaced teeth, rostral formula 14–30/2–22, 0–3 dorsal teeth postorbital. Pterygostome bluntly angular or obtuse. Inferior orbit obtusely rounded. Stylocerite failing to reach distal end of basal antennular peduncle segment. P1 carpus not distinctly excavated distally for reception of chela, elongate, more than 2 times longer than broad, fingers clearly longer than manus. Epipods present on all pereiopods except P5. Inter-uropodal sclerite with moderately developed pre-anal carina lacking a posterior spine. Appendix interna absent on first male pleopod. Posterior telson with small, spinate medial projection situated above and slightly anterior to margin. Small species up to 6 mm CL, *ca*. 28 mm TL. Developed eggs small, 0.4 mm max. length.

Habitat and abundance: Known from upper estuaries of the Kamora and Kopi Rivers in the Mimika region. The small size of the eggs suggest that this species has lengthy planktonic larval development and possibly a broader distribution in southern Papua.

Distribution: Kamora and Kopi Rivers, Mimika region.

Other names: wautete, niti (Kamoro).

Notes: Very similar in general morphology to *Caridina longirostris,* but the pre-anal carina lacks a posterior spine.

PALAEMONID SHRIMPS

Family Palaemonidae

Palaemonids are small to large shrimps (to 320 mm TL) with the chelae of the second pereiopods usually more developed than those of the first pereiopods. Unlike atyids, both the first and second chelae lack dense tufts of setae on the finger tips.

This cosmopolitan family is the most speciose and morphologically diverse of all shrimp families. Palaemonids are particularly abundant on coral reefs where many species live in commensal relationships with other invertebrates. Of the 100 or so genera of Palaemonidae currently recognised, most are marine and comparatively few occur in freshwater and estuarine habitats.

Like atyid shrimps, palaemonids occurring in fresh waters show a wide range of reproductive strategies and salinity tolerance. The size of fertilized eggs vary from small (ca. 0.6 mm) to large (>2.0 mm) and larval development ranges from extended to highly abbreviated. As is the case with atyid shrimps, eggs hatch as free-swimming planktonic larvae (many species) or crawling benthic larvae showing resemblance to the adult form (some land-locked freshwater species).

By far the most widespread and speciose genus occurring in fresh water is *Macrobrachium.* Species of *Macrobrachium* are commonly referred to as river prawns or freshwater prawns. River prawns are solitary, aggressive, secretive, usually nocturnal animals. During the day, adults prefer to shelter among tree roots or under fallen timber, ledges, boulders, rocks, overhanging banks, etc. Most species are opportunistic omnivores. In New Guinea, *Macrobrachium* have been found from sea level to 1,700 m.

In addition to *Macrobrachium*, two wide-ranging Indo-West Pacific species of *Palaemon* occur in coastal fresh waters in New Guinea, viz. *P. debilis* Dana, 1852, and *P. concinnus* Dana, 1852. Only the latter species has been recorded from the Mimika region. Other members of this genus are commonly encountered in the intertidal zone of estuaries and rocky shores.

Key to the Freshwater Palaemonidae of Southern New Guinea

(species recorded from the Mimika region marked with asterisk)

1a Carapace with branchiostegal spine (Fig. 39); second pereiopods not enlarged in developed males, segments smooth, not covered in spinules, tubercles, scales or spines . . . . *Palaemon* spp **2**

1b Carapace with hepatic spine (Fig. 40); second pereiopods enlarged in developed males, often exceeding body length, segments covered with spinules, tubercles, spines or scales . . . . *Macrobrachium* spp **3**

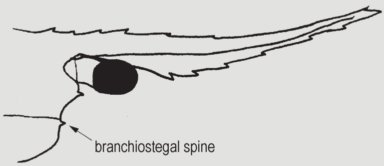


Figure 39. Position of branchiostegal spine.

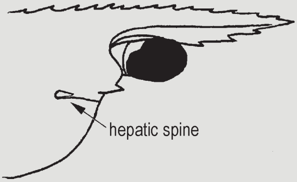


Figure 40. Position of hepatic spine.

2a Branchiostegal spine located well below branchiostegal groove (Fig. 59B); male first pleopod with vestigial appendix interna on inner endopod (Fig. 59A) . . . . ***Palaemon concinnus** Dana (p. 59)

2b Branchiostegal spine located immediately below branchiostegal groove (Fig. 41); male first pleopod without appendix interna on inner endopod. . . . .***Palaemon debilis*** Dana

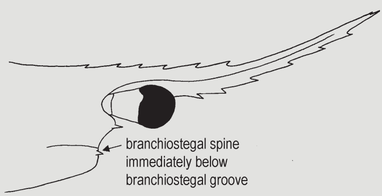


Figure 41. Anterior cephalothorax of *Palaemon debilis* Dana.

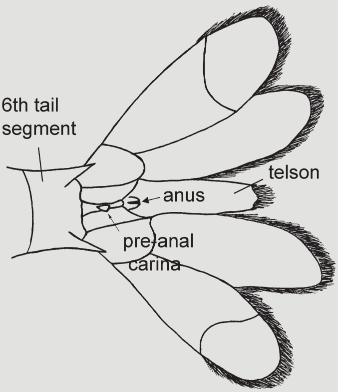


Figure 42. Position of pre-anal carina.

3a Pre-anal carina absent (Fig. 4B) on inter-uropodal sclerite (between ventral uropods) (Fig 42) **4**
3b Pre-anal carina present (Figs 4C, 4D) on inter-uropodal sclerite (Fig 42). **15**

4a Inferior orbit well produced and rounded, post-antennular carapace margin convex (Fig. 3B). **9**
4b Inferior orbit not well produced and rounded, either angular and well produced (Fig. 3C) or poorly produced, appearing truncated (Fig. 3A) **5**

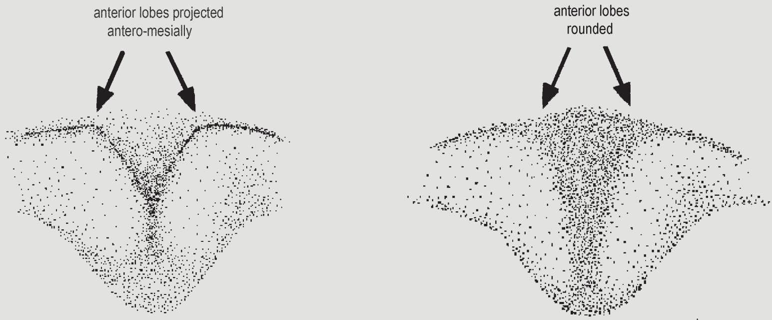


Figure 43. Variation in the anterior shape of epistome lobes. After Short (2004).

5a Epistome lobes rounded (Figs 5, 43B), longitudinally carinate or obliquely carinate, not antero-mesially acute or produced; left and right cheliped of developed males similar in shape (may differ in size); inferior orbit well produced and angular, post-antennular carapace margin concave (Fig. 3C) **6**
5b Epistome lobes antero-mesially acute or produced (Figs 5, 43A); left and right cheliped of developed males differing markedly in shape and size (Figs 65A, 65C); inferior orbit generally poorly produced, appearing truncated (Fig. 3A). . . . . ***Macrobrachium latidactylus*** (Thallwitz) (p. 65)

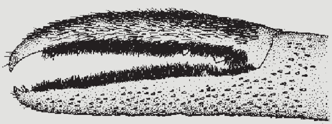


Figure 44. Fingers of FD male cheliped of *Macrobrachium idae* (Heller). After Short (2004).

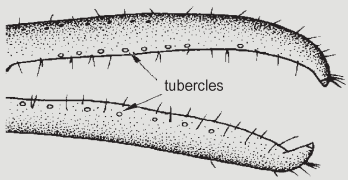


Figure 45. Fingers of FD male cheliped of *Macrobrachium mammillodactylus* (Thallwitz). After Short (2004).

6a Dorsal margin of rostrum with series of closely spaced teeth in proximal half followed by edentate region or few widely spaced teeth distally (sometimes two closely spaced teeth near tip), distal teeth well differentiated from proximal series (Figs 70A-E). . . . . ***Macrobrachium weberi*** (De Man) (p. 70)

6b Dorsal margin of rostrum without edentate region (spacing between teeth may gradually increase from proximal to distal half but proximal series not well differentiated from distal teeth) **7**

7a Teeth on upper rostrum at most a little more closely spaced proximally above cornea of eye than in distal half; developed male cheliped without setal pubescence completely covering both fingers; adults found from upper estuaries to non-tidal, lowland, fresh waters **8**

7b Teeth on upper rostrum much more closely spaced proximally above cornea of eye than distally, spacing between teeth gradually increasing towards apex (except for a number of closely-spaced subapical teeth) (Fig. 61B); developed male cheliped with setal pubescence completely covering both fingers (Figs 61A, 61C); restricted to tidal waters. . . . . ****Macrobrachium equidens*** (Dana) (p. 61)

8a Chela distinctly longer than carpus in adults; developed male chela with submedial rows of tubercles along cutting edges of fingers, setal pubescence absent (Fig. 45); rostrum deep proximally (depth clearly greater than maximum dorsoventral diameter of cornea of eye), abruptly tapered distally (Fig. 47) . . . . ****Macrobrachium mammillodactylus*** (Thallwitz) (p. 68)

8b Chela distinctly shorter than carpus in developed males, equal in length to slightly longer than carpus in females and undeveloped males; setal pubescence on fingers of developed male chela extensive on lateral dactylus but restricted to cutting edge of propodus, tubercles absent along cutting edges (Fig. 44); proximal rostrum moderately deep or slender (depth at most slightly greater than maximum dorsoventral diameter of eye), rostrum gradually tapered in distal half (Fig. 46). . . . . ****Macrobrachium idae*** (Heller) (p. 64)

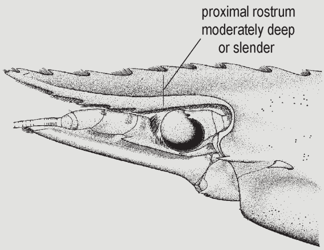


Figure 46. Anterior cephalothorax of *Macrobrachium idae* (Heller). After Short (2004).

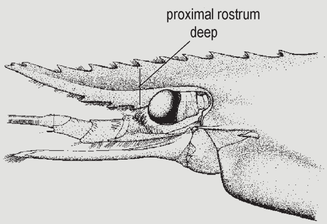


Figure 47. Anterior cephalothorax of *Macrobrachium mammillodactylus* (Thallwitz). After Short (2004).

9a Rostrum generally with less than 15 dorsal teeth, if with 15 dorsal teeth, then more than 2 ventral teeth present or dorsal edge of rostrum straight or only slightly convex **10**

9b Rostrum with 15 or more dorsal teeth and 1–2 ventral teeth, dorsal margin distinctly convex (Fig. 72) . . . . ***Macrobrachium* sp. 2** (p. 72)

10a Dorsal rostrum generally with 10 or more teeth, if with 9 teeth then thoracic sternite 4 (between coxae of first pereiopods) with well developed median process (Fig. 3D) **11**

10b Dorsal rostrum with 8–9 teeth (Fig. 48); thoracic sternite 4 with median process indistinct or absent . . . . ***Macrobrachium* sp. 1** (p. 71)

Figure 48. Anterior cephalothorax of *Macrobrachium* sp.1.

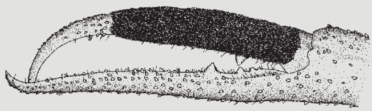


Figure 49. Fingers of developed male cheliped of *Macrobrachium rosenbergii* (De Man). After Short (2004).

11a Thoracic sternite 4 (between coxae of first pereiopods) with distinct median process (may be low and rounded) (Fig. 3D); upper palm of major chela of developed males not produced as carinate flange. **12**

11b Thoracic sternite 4 without median process; upper palm of major chela of developed male produced as carinate flange (Fig. 50) . . . . ***Macrobrachium bariense** (De Man) (p. 60)

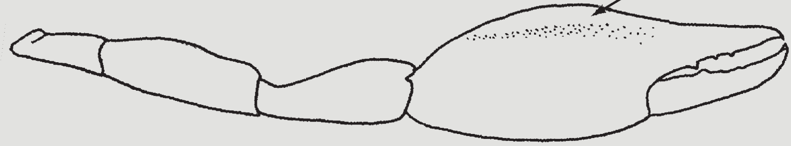


Figure 50. Major cheliped of FD male of *Macrobrachium bariense* (De Man).

12a Epistome lobes rounded anteriorly (Figs 5, 43B); major chela of developed male with dense setal pubescence covering proximal two thirds or more of fingers **13**
12b Epistome lobes antero-mesially acute or produced (Figs 5, 43A); major chela of developed male without dense setal pubescence covering proximal two thirds of fingers **14**

13a Dorsal margin of rostrum with 4 or more teeth on carapace behind orbit; developed male P2 with setal pubescence on both palm and fingers of major chela. . . . . ***Macrobrachium natulorum*** Holthuis
[Restricted to the Wissel Lakes area of southern Papua.]
13b Dorsal margin of rostrum generally with less than 4 teeth on carapace behind orbit; developed male P2 with setal pubescence on proximal two thirds of fingers of major chela, absent on palm (Fig. 67) . . . . ***Macrobrachium lorentzi*** (J. Roux) (p. 67)

14a Major cheliped of developed males with markedly broadened palm (Fig. 62). . . . . ***Macrobrachium handschini*** (J. Roux) (p. 62)
14b Major cheliped of developed males without markedly broadened palm (Fig. 51). . . . . ***Macrobrachium* sp. 3**
[Known from Papua New Guinea. Closely allied to *M. scabriculum* (Heller, 1862)]

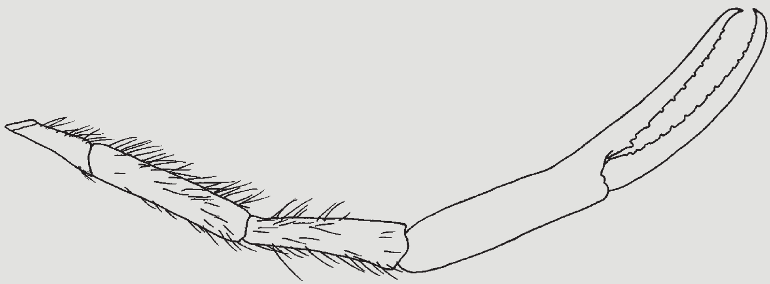


Figure 51. FD male cheliped of *Macrobrachium* sp. 3.

15a Scaphocerite anterior margin produced forward at inner angle (Fig. 4H) or less commonly, evenly rounded, not strongly produced forward at or near mid-line; velvety setal pubescence, if present on fingers of developed male cheliped, not restricted to dactylus **16**
15b Scaphocerite anterior margin strongly produced forward at or near mid-line (Fig.4I);

developed male cheliped with velvety setal pubescence on dactylus, absent on fixed finger (Fig. 49) . . . . ***Macrobrachium rosenbergii*** (De Man) (p. 69)

16a Inferior orbit rounded, post-antennular carapace margin convex (Fig. 3B); minor cheliped of developed males without setal pubescence on all segments **17**

16b Inferior orbit bluntly angular, post-antennular carapace margin straight or slightly concave (Fig. 52); minor cheliped of developed males with all segments covered in setal

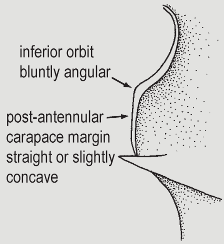


Figure 52. Inferior orbit of *Macrobrachium australe* (Dana).

pubescence.. . . . .***Macrobrachium australe*** (Guérin-Méneville)

17a Dorsal rostrum with 1–2 teeth on carapace behind orbit **18**

17b Dorsal rostrum with 4 or more teeth on carapace behind orbit. **19**

18a Epistome lobes widely separated, not strongly produced antero-ventrally in adults (Figs 5, 53); chelipeds stout, chela with a number of moderately developed teeth on each finger in developed males (Fig. 56) . . . . ***Macrobrachium latimanus*** (von Martens)

18b Epistome lobes narrowly separated, strongly produced antero-ventrally in adults (Figs 5, 54); chelipeds elongated, chela with greatly enlarged incisor tooth on each finger in

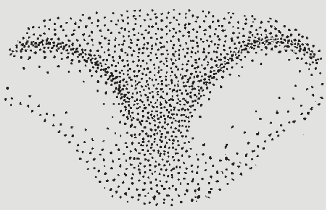


Figure 53. Epistome lobes of *Macrobrachium latimanus* (von Martens).

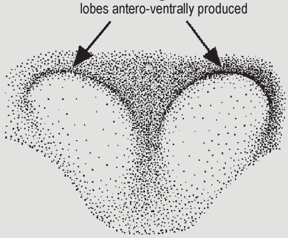


Figure 54. Epistome lobes of *Macrobrachium lar* (Fabricius). After Short (2004).

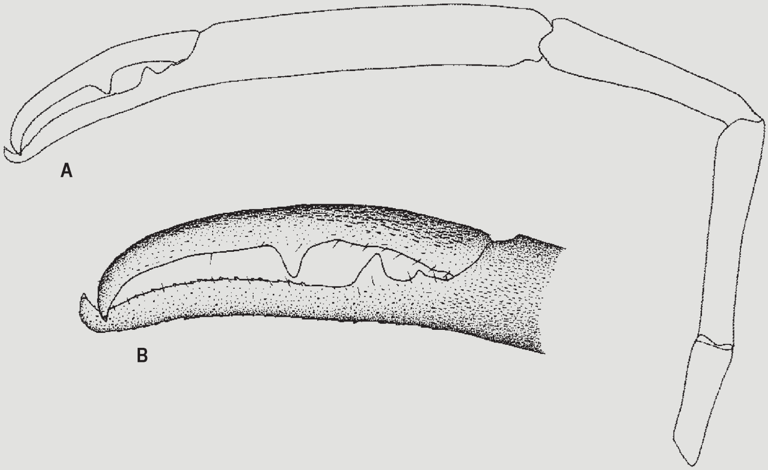


Figure 55. *Macrobrachium lar* (Fabricius). **A**, FD male cheliped (spinules and setae omitted); **B**, fingers and distal palm of same showing spinules and setae. After Short (2004).

developed males (Figs 55A, 55B) . . . . ***Macrobrachium lar*** (Fabricius)

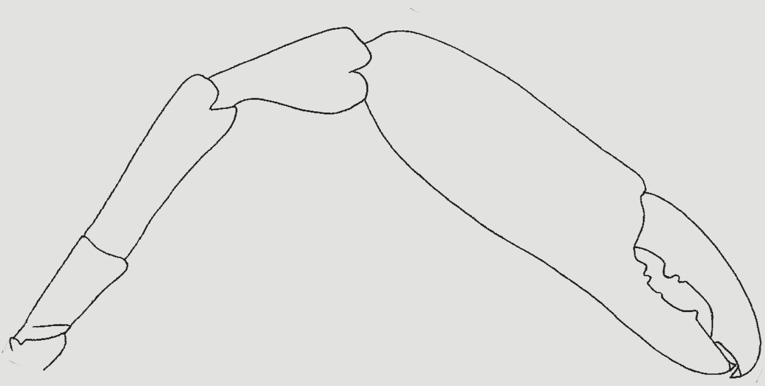
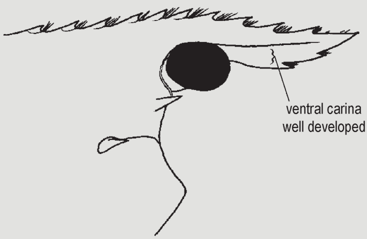


Figure 56. FD male cheiiped of *Macrobrachium latimanus* (von Martens) (ornamentation and setation omitted).

19a Bec ocellaire present (Fig. 6) **20**
19b Bec ocellaire absent. . . . . ***Macrobrachium placidulum*** (De Man)

20a Thoracic sternite 4 with distinct median process (Fig. 3D); second pereiopods of fully



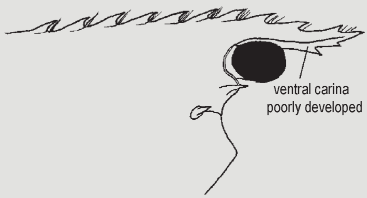


Figure 57. Anterior cephalothorax of *Macrobrachium horstii*.

Figure 58. Anterior cephalothorax of *Macrobrachium gracilirostris*.

developed males similar in shape and setation **21**
20b Thoracic sternite 4 without median process; second pereiopods of fully developed males markedly different in shape and setation, major cheliped with very broad palm and at most scattered stiff setae on cutting edges of fingers, minor cheliped with moderately broad palm and well developed brushes of long stiff setae on cutting edges of fingers (Fig. 66).
. . . .****Macrobrachium lepidactyloides*** (De Man) (p. 66)

21a Rostrum of moderate depth, ventral carina well developed (Fig. 57); live specimens without longitudinal stripes along body . . . . ****Macrobrachium horstii*** (De Man) (p. 63)
21b Rostrum slender, ventral carina poorly developed (Fig. 58); live specimens with longitudinal stripes along body . . . . ***Macrobrachium gracilirostre*** (Miers)

Elegant Mangrove Shrimp

Palaemon concinnus

Dana, 1852

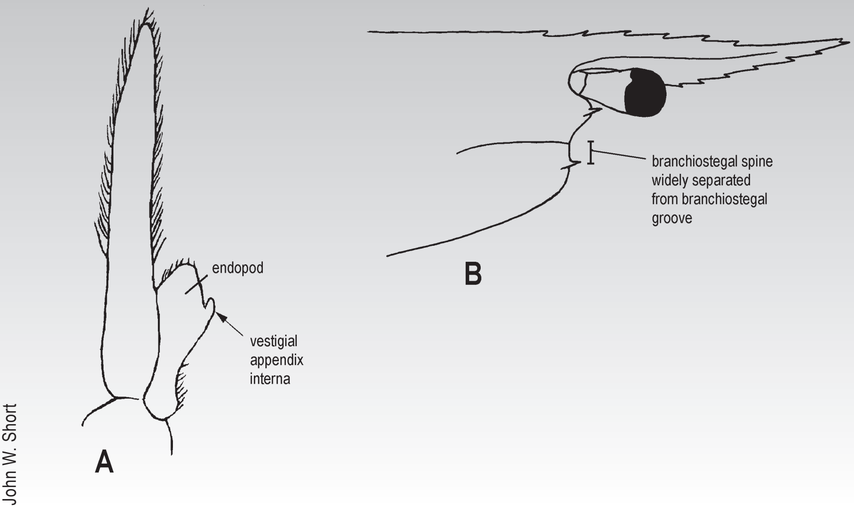


Figure 59. **A**, first male pleopod; **B**, anterior cephalothorax.

Diagnosis: Rostrum long, usually upturned in distal half, dorsal margin usually edentate in distal half except for single subapical tooth, rostral formula 5–8/3–7 teeth, 1 dorsal tooth postorbital. Upper flagellum of antennule with fused portion less than half total length of shorter free ramus. Carapace with marginal or submarginal branchiostegal spine situated well below branchiostegal groove; inferior orbital margin strongly produced, bluntly angular, postantennular carapace margin straight. Bec ocellaire moderately developed, acute. P2 similar in males and females, left and right P2 of similar size and shape, short, reaching tip of scaphocerite by carpus only; smooth, without pubescence, spines, spinules, tubercles or scales. T4 with well-developed spiniform median process. Pre-anal carina absent on inter-uropodal sclerite. Vestigial appendix interna present on male PL1. Small species up to 66 mm TL. Developed eggs small, 0.7 mm max. length. Translucent except for dark blotches on sixth abdominal segment, dark band on lateral carapace and faint orange markings on distal carpus.

Habitat and abundance: Euryhaline, from lowland non-tidal fresh waters to inshore waters, larval development requiring marine influence. Recorded in the Mimika area from the Ajkwa River estuary.

Distribution: Wide-ranging in the Indo-West Pacific from East Africa to Hong Kong, the Philippines, Indonesia, the Marshall Islands, Australia and the Tuamotu Archipelago.

Bari River Prawn

Macrobrachium bariense

(De Man, 1892)

John W. Short

Figure 60. Male, from Pajo R, Luzon, the Philippines. Preserved specimen.

Diagnosis: Rostrum short in FD males, long in young males and females, slightly convex or almost straight, rostral formula 12–15/(1–)2–4, 4–6 dorsal teeth postorbital. Carapace with hepatic spine; inferior orbital margin obtuse, postantennular carapace margin rounded. Bec ocellaire poorly developed. Anterior scaphocerite produced forward at inner angle. Epistome lobes bluntly rounded or sometimes slightly acute antero-mesially. P2 sexually dimorphic, more developed in males; left and right pereiopods of FD males differing markedly in size, shape and setation; short, minor P2 reaching scaphocerite by carpus only; major P2 covered in tubercles, without pubescence; chela of major P2 of FD males with moderate gape at mid-length otherwise fingers almost touching, teeth on cutting edges continuing onto distal half on one or both fingers; manus about equal in length to dactylus, upper manus produced as carinate flange; carpus clearly shorter than chela; merus *ca.* equal in length to carpus. Minor P2 short with long stiff setae on all segments, forming well-developed inwardly-directed brushes on cutting edges of fingers. T4 without median process. Pre-anal carina absent on inter-uropodal sclerite. FD males with spinules on anterior carapace, abdomen smooth. Small species up to 15 mm CL. Developed eggs small, 0.7 mm max. length.

Habitat and abundance: Euryhaline, adults in lowland non-tidal fresh waters and estuaries. Recorded in the Mimika region from the upper Kamora estuary.

Distribution: Eastern Indonesia, the Philippines, New Guinea and Palau.

Other names: udang kali (Indonesian).

Rough River Prawn

Macrobrachium equidens

(Dana, 1852)

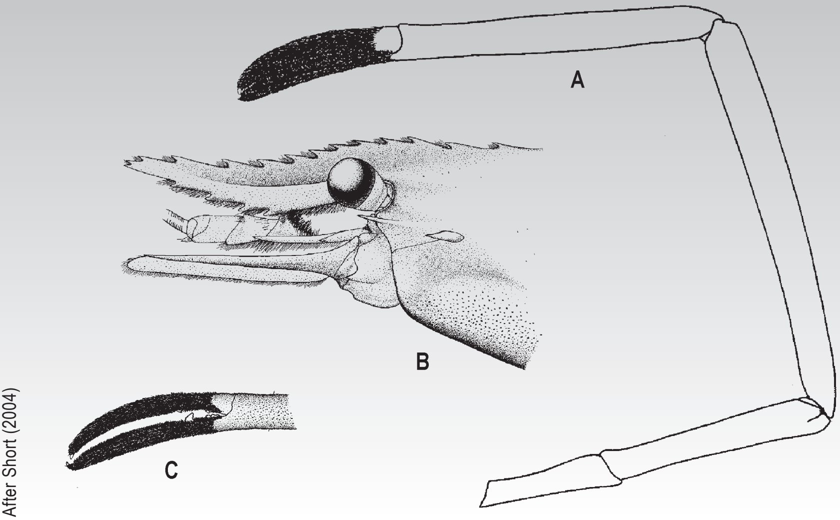


Figure 61. **A**, FD male cheliped (tubercles omitted); **B**, anterior cephalothorax; **C**, fingers and distal palm of FD male cheliped showing tubercles and setae.

Diagnosis: Rostrum of medium length in FD males, long in young males and females, sinuous or upturned; 9–15/4–7 teeth, 2–4 postorbital, upper margin with teeth generally much more closely spaced proximally above orbit than distally. Carapace with hepatic spine; inferior orbital margin moderately produced, angular, postantennular margin concave. Bec ocellaire strongly developed, tip markedly expanded, plate-like. Anterior scaphocerite produced forward at inner angle. Epistome lobes bluntly rounded. P2 sexually dimorphic, more developed in males, left and right P2 of FD males equal in size, shape and setation; long, merus reaching tip of scaphocerite; segments of FD males covered in raised tubercles; fingers completely covered by pubescence, more or less touching along their length, cutting edges dentate proximally; manus clearly longer than dactylus; carpus clearly shorter than chela; merus clearly shorter than carpus. T4 with well-developed median process. Pre-anal carina absent. FD males with spinules on anterior carapace and abdomen. Medium-sized species, males up to 30 mm CL and 115 mm TL. Developed eggs small, 0.7 mm max. length. Adult P2 marbled reddish brown, carapace speckled or with irregular blotches.

Habitat and Abundance: Euryhaline, adults occurring from upstream limit of tidal influence to inshore waters, larval development requiring marine influence. Collected from the lower Ajkwa River estuary and occasionally from the freshwater tidal zone of upper estuaries in the Mimika region.

Distribution: Wide-ranging in the Indo-West Pacific from India to Southern China, New Guinea, Australia, New Caledonia and Fiji.

Other names: udang kali (Indonesian).

Handschin's River Prawn

Macrobrachium handschini

(J. Roux, 1933)

John W. Short

Figure 62. FD male.

Diagnosis: Rostrum short, convex, dorsal margin with closely spaced teeth along length, rostral formula 9–15/2–5, 3–4 dorsal teeth postorbital. Carapace with hepatic spine; inferior orbital margin moderately produced, obtuse, postantennular margin evenly rounded. Bec ocellaire moderately developed, tip moderately expanded. Anterior scaphocerite produced forward at inner angle. Epistome lobes anteromesially acute or produced. P2 strongly sexually dimorphic, more developed in males; left and right P2 of FD males differing markedly in size, shape and setation; short, carpus of minor P2 reaching tip of scaphocerite; proximal segments of both pereiopods of FD males covered in tubercles, tubercles sparse on chelae; all segments without pubescence; chela of major P2 with well developed gape, cutting edges with teeth clearly continuing onto distal half on one or both fingers; manus clearly longer than dactylus, markedly broadened but without carinate flange; carpus clearly shorter than chela; merus clearly shorter than or *ca*. equal in length to carpus; minor P2 with long stiff setae on all segments, forming well-developed inwardly-directed brushes on cutting edges of fingers. T4 with well-developed median process. Pre-anal carina absent. FD males with spinules on anterior carapace, abdomen smooth. Small species up to 19 mm CL, 63 mm TL in males. Developed eggs moderately large, 1.5 mm max. diameter. Local specimens with pale longitudinal band along dorsal mid-line.

Habitat and abundance: Land-locked freshwater species, common in the middle to lower freshwater reaches in the Mimika region.

Distribution: Southern New Guinea and northern Australia.

Other names: udang kali (Indonesian).

Horst's River Prawn

Macrobrachium horstii

(De Man, 1892)

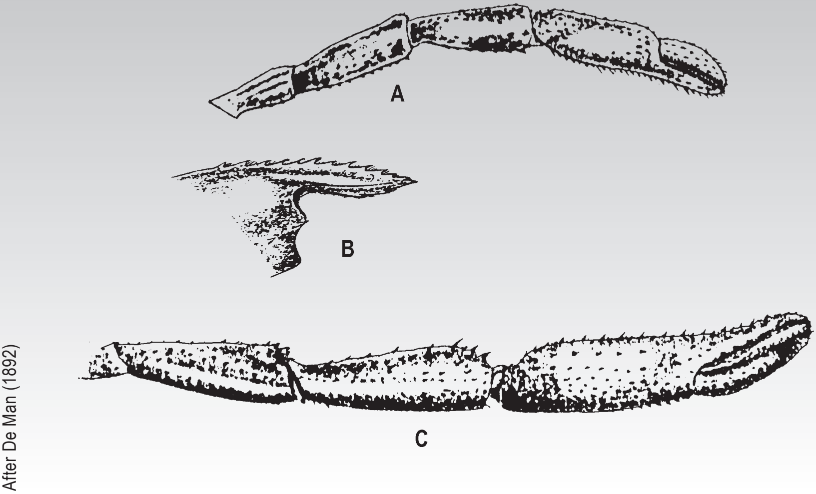


Figure 63. **A**, anterior carapace; **B**, minor cheliped of developed male; **C**, major cheliped of developed male.

Diagnosis: Rostrum short, sinuous, teeth on dorsal margin slightly more closely spaced proximally above orbit than distally, most widely spaced on carapace, rostral formula 10–12/2–3, 4–5 dorsal teeth postorbital. Carapace with hepatic spine; inferior orbital margin moderately produced, obtuse, postantennular margin evenly rounded. Bec ocellaire moderately developed, tip moderately expanded. Anterior scaphocerite produced forward at inner angle. Epistome lobes bluntly rounded. P2 sexually dimorphic, more developed in males; left and right P2 of FD males similar in shape, unequal in length, long, merus of minor P2 reaching tip of scaphocerite; all segments of FD males covered in scales, upper margins of segments with numerous spinules; all segments without pubescence; chela with well developed gape, cutting edges with teeth clearly continuing onto distal half, distal cutting edges with submedial rows of flattened teeth; manus clearly longer than dactylus, carpus clearly shorter than chela, merus *ca*. equal in length to carpus. T4 with well-developed median process. Strongly developed, well-elevated, pre-anal carina present. Carapace and abdomen of FD males smooth. Medium-sized species up to 23 mm CL, *ca*. 75 mm TL. Developed eggs small, 0.7 mm max. length.

Habitat and abundance: Euryhaline, adults commonly found in fresh waters, larval development requiring marine influence.

Distribution: Celebes, Bali and Lombok, Indonesia; New Guinea.

Other names: udang kali (Indonesian).

Ida's River Prawn

Macrobrachium idae

(Heller, 1862)

After Short (2000)

Figure 64. FD male from the Endeavour River, N.Qld, Australia.

Diagnosis: Rostrum of medium length in FD males, long in young males and females, slightly sinuous or almost straight, slender and gradually tapered in distal third, dorsal teeth irregularly spaced, rostral formula 8–12/3–6 teeth, 2–3 dorsal teeth postorbital. Carapace with hepatic spine; inferior orbital margin moderately produced, angular, postantennular concave. Bec ocellaire strongly developed, tip markedly expanded, plate-like. Anterior scaphocerite produced forward at inner angle. Epistome lobes bluntly rounded. P2 sexually dimorphic, more developed in males; left and right P2 of FD males equal in size, shape and setation, long, merus reaching tip of scaphocerite; segments of FD males covered with flattened tubercles; with extensive pubescence on lateral dactylus, restricted to cutting edge on propodus; fingers with weak gape, cutting edges dentate proximally, distally entire; manus clearly longer than dactylus; carpus clearly longer than chela; merus clearly shorter than carpus. T4 with well-developed median process. Pre-anal carina absent. FD males with spinules on anterior carapace and abdomen. Medium-sized species up to 27 mm CL, 110 mm TL. Developed eggs small, 0.6 mm max. length. P2 with dark irregular longitudinal bands or blotches.

Habitat and abundance: Euryhaline, lowland fresh waters to inshore areas. Common in coastal swamps and waterholes. Recorded from West Ajkwa basin and upper Ajkwa estuary.

Distribution: Wide-ranging Indo-West Pacific: east Africa and Madagascar to the Philippines, the Admiralty Islands, New Guinea and Australia.

Other names: Orana river prawn (FAO), udang kali (Indonesian).

Broad-fingered River Prawn

Macrobrachium latidactylus

(Thallwitz, 1891)

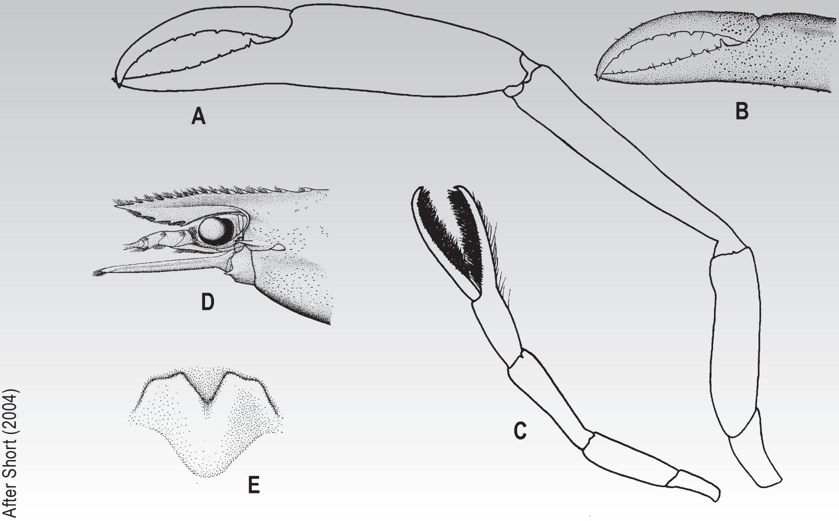


Figure 65. **A**, major cheliped of FD male (tubercles omitted); **B**, fingers and distal chela of same showing tubercles; and setae; **C**, minor cheliped of same; **D**, anterior cephalothorax; **E**, epistome.

Diagnosis: Rostrum short in FD males, convex to straight, dorsal teeth subequally spaced, rostral formula 12–17/(2–)3(–5), 3–4(–5) dorsal teeth postorbital. Carapace with hepatic spine. Inferior orbital margin feebly produced, angular, postantennular carapace margin generally straight. Bec ocellaire moderately developed, expanded and bilobed at tip. Anterior scaphocerite produced forward at inner angle. Epistome lobes moderately produced anteromesially. P2 sexually dimorphic, more developed in males; left and right P2 of FD males differing in size, shape and setation, short, carpus or more distal segments of minor P2 reaching tip of scaphocerite; with elevated tubercles covering most of major P2 in FD males; without pubescence; fingers of major P2 with well developed gape, cutting edges with teeth clearly continuing onto distal half on one or both fingers; manus elongate, compressed, lower margin expanded, clearly longer than dactylus; carpus clearly shorter than chela; merus clearly shorter than carpus; minor P2 with long stiff setae forming inwardly directed brushes on both fingers. T4 with well-developed median process. Pre-anal carina absent. Anterolateral carapace with spinules, abdomen smooth. Medium-sized species up to 24 mm CL. Developed ova small, 0.6 mm max. length. Distinctive dark longitudinal stripe on upper manus of major cheliped.

Habitat and abundance: Adults euryhaline, lowland fresh waters to lower estuaries. Moderately common in Mimika region.

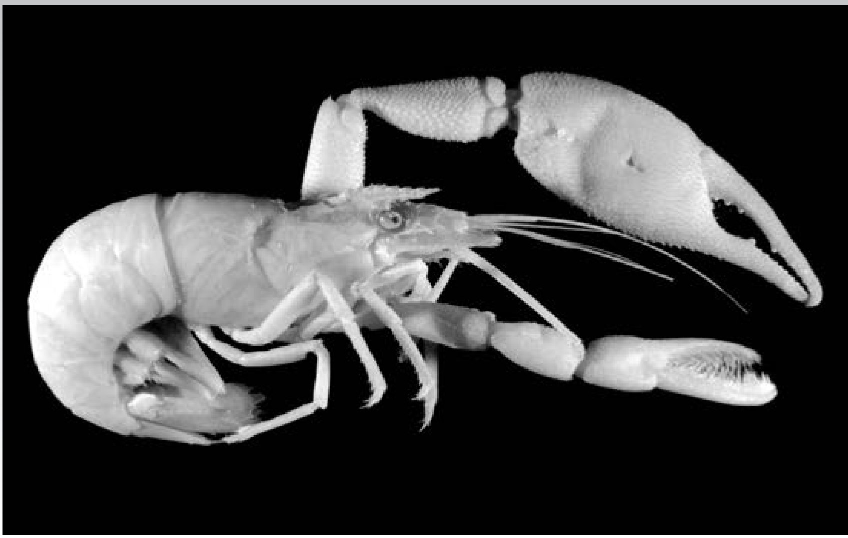
Distribution: Widespread in the Central Indo-West Pacific from Southern China and Malaysia to Australia.

Other names: scissor river prawn (FAO), udang kali (Indonesian).

Broad-palmed River Prawn

Macrobrachium lepidactyloides

(De Man, 1892)



John. W. Short

Figure 66. FD male from Bouganville Island. Preserved specimen.

Diagnosis: Rostrum short in FD males, convex, dorsal teeth subequally spaced; rostral formula 9–13/2–4, 5–7 dorsal teeth postorbital. Carapace with hepatic spine; inferior orbital margin moderately produced, obtuse, postantennular carapace margin evenly rounded. Bec ocellaire moderately to strongly developed in large adults, tip expanded. Anterior scaphocerite produced forward at inner angle. Epistome lobes bluntly rounded. P2 sexually dimorphic, more developed in males; left and right P2 of FD males differing in size, shape and setation, short, carpus reaching tip of scaphocerite; all segments covered with spinules in FD males; without pubescence; fingers with with well developed gape, cutting edges with teeth clearly continuing onto distal half on one or both fingers; manus *ca*. equal in length to dactylus, markedly broadened; carpus clearly shorter than chela; merus *ca.* equal in length to carpus; minor P2 with long stiff setae forming well-developed inwardly directed brushes on fingers. T4 unarmed. Inter-uropodal sclerite with strongly developed, well elevated pre-anal carina. Carapace and abdomen smooth. Medium-sized species up to 25 mm CL, 87 mm TL. Developed ova small, 0.6 mm max. length. Body speckled, orange and brown, with few large irregular blotches on lateral carapace.

Habitat and abundance: Euryhaline, adults often found in upper catchment fresh waters. Known in the Mimika region from one specimen without a precise locality.

Distribution: Wide-ranging in the Indo-West Pacific from eastern Indonesia and the Philippines to French Polynesia.

Other names: malayan scale prawn (FAO), udang kali (Indonesian).

Lorentz's River Prawn

Macrobrachium lorentzi

(J. Roux, 1921)

John. W. Short

Figure 67. Developed male (left cheliped missing) from Lagaip River, Papua New Guinea. Preserved specimen.

Diagnosis: Rostrum short in FD males, sinuous, dorsal teeth a little more widely spaced above cornea of eye, otherwise subequally spaced; rostral formula 11–14/2–3, 2–4 dorsal teeth postorbital. Carapace with hepatic spine; inferior orbital margin moderately produced, obtuse, postantennular carapace margin evenly rounded. Bec ocellaire moderately developed, expanded at tip. Anterior scaphocerite produced forward at inner angle. Epistome lobes bluntly rounded, sometimes slightly transversely carinate anteriorly. P2 sexually dimorphic, more developed in males; left and right P2 of FD males subequal in size, similar in shape and setation, short, carpus reaching tip of scaphocerite; major P2 of FD males with upper carpus covered in tubercles, remaining manus, carpus, merus and ischium covered in scales; fingers with thick pubescence on proximal two-thirds, with well spaced clumps distally, more or less touching along their length, cutting edges with teeth clearly continuing onto distal half on one or both fingers; manus broad, clearly shorter than dactylus; carpus clearly shorter than chela; merus clearly shorter than carpus. T4 with well-developed median process. Pre-anal carina absent. Anterolateral carapace of FD males covered in spinules, abdomen smooth. Medium-sized species up to 35 mm CL, 90 mm TL. Developed ova moderately large, 1.4 mm max. length.

Habitat and abundance: Adults widely distributed in fresh waters from the limit of tidal influence to about 400 m a.s.l. Common in the Mimika region.

Distribution: Southern New Guinea from the Mimika region to the Fly River catchment, P.N.G.

Other names: udang kali (Indonesian).

Knob-fingered River Prawn

Macrobrachium mammillodactylus

(Thallwitz, 1892)

Figure 68. Adult male.

Diagnosis: Rostrum of short to medium length in FD males, usually straight or slightly sinuous with distinctly upturned tip, dorsal teeth tending to be more closely spaced above orbit than distally, rostral formula, 9–18/2–6, 2–3 dorsal teeth postorbital. Carapace with hepatic spine; inferior orbital margin moderately produced, angular, postantennular carapace margin concave. Bec ocellaire strongly developed, with markedly expanded plate-like tip. Anterior scaphocerite produced forward at inner angle. Epistome lobes carinate, carinae oblique. P2 sexually dimorphic, more developed in males; left and right P2 of FD males equal or subequal in length, of similar shape and setation, long, merus reaching tip of scaphocerite; all segments covered with tubercles in FD males; without pubescence; cutting edges dentate proximally, distally entire, with mesial and lateral rows of heavily tanned tubercles on dactylus, similar row on mesial propodus; manus clearly longer than dactylus; carpus clearly shorter than chela; merus clearly shorter than carpus. T4 with well-developed median process. Pre-anal carina absent. Lateral body covered with tubercles. Large species up to 40 mm CL, 137 mm TL. Developed ova small, 0.6 mm max. length. P2 with dark irregular blotches and alternating light and dark bands on fingers.

Habitat and abundance: Euryhaline, adults predominantly in lowland fresh waters. Locally abundant in upper estuaries.

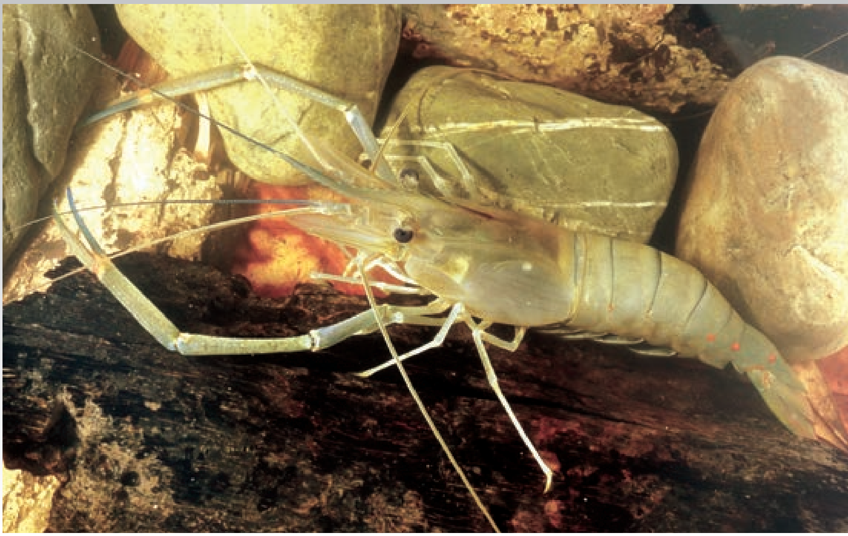
Distribution: Wide-ranging in the Central Indo-West Pacific including southern China, the Philippines, Indonesia, New Guinea and northeast Australia.

Other names: knobtooth prawn (FAO); udang putih, udang kali (Indonesian); mbiti (Kamoro); me'o (Nawaripi); uroko (Atuka).

Australasian Giant River Prawn

Macrobrachium rosenbergii

(De Man, 1879)



John W. Short

Figure 69. Young adult male.

Diagnosis: Rostrum short in FD males, long in young specimens, generally sinuous, sometimes upturned or convex proximally and straightened distally, rostral formula 8–15/6-16, 2–3 dorsal teeth postorbital. Carapace with hepatic spine; inferior orbit moderately produced, generally angular, sometimes obtuse, postantennular carapace margin straight or concave. Bec ocellaire strongly developed, with markedly expanded tip. Anterior scaphocerite strongly produced forward at or near mid-line. Epistome lobes longitudinally carinate, carinae low and broad. P2 sexually dimorphic, more developed in males; left and right P2 of FD males similar in size, shape and setation, long, merus reaching tip of scaphocerite; all segments of FD males except dactylus and ischium covered with spinules interspersed with widely-spaced elevated spines; dactylus with velvety pubescence over proximal 2/3 to 3/4; fingers with weak gape, cutting edges dentate proximally, distally entire; manus clearly longer than dactylus; carpus clearly shorter than chela; merus clearly shorter than carpus. T4 with well-developed median process. Pre-anal carina poorly developed, rounded. Lateral body covered in spinules in FD males. Large species up to 100 mm CL, 320 mm TL. Developed ova small to moderately large, 0.6-1.3 mm max. length. FD males dark, P2 with purplish or bluish tinge, condyles on abdomen orange.

Habitat and abundance: Euryhaline, adults generally distributed from estuaries to middle freshwater reaches. Locally common.

Distribution: Palawan, the Philippines, Palau, eastern Indonesia, New Guinea, Australia.

Other names: udang hitam, udang kali (Indonesian); (m)be (Kamoro); me poawa (Nawaripi).

Weber's River Prawn

Macrobrachium weberi

(De Man, 1892)

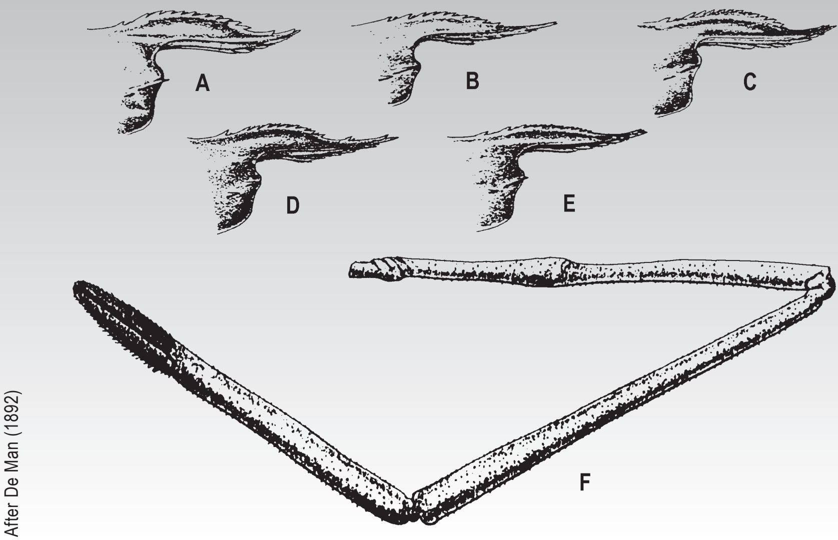


Figure 70. **A–E**, rostrum variation; **F**, FD male cheliped.

Diagnosis: Rostrum long in FD males, sinuous or upturned, dorsal margin generally with distinct unarmed region in distal half or few widely spaced teeth between proximal series and subapical teeth, rostral formula 10–14/4–6 teeth, 1–2 dorsal teeth postorbital. Carapace with hepatic spine; inferior orbital margin moderately produced, angular, postantennular carapace margin straight or concave. Bec ocellaire strongly developed, markedly expanded at tip, tip plate-like. Anterior scaphocerite produced forward at inner angle. Epistome lobes longitudinally or sub-longitudinally carinate. P2 sexually dimorphic, more developed in males; left and right P2 of FD males unequal in length of similar shape and setation, long, merus of minor P2 reaching tip of scaphocerite, segments covered in blunt spinules; fingers pubescent, with weak gape, cutting edges dentate proximally, distally entire; manus clearly longer than dactylus; carpus clearly shorter than chela; merus clearly shorter than carpus. T4 with well-developed median process. Pre-anal carina absent. Anterolateral carapace and lower abdomen covered in tubercles**.** Medium-sized species up to 30 mm CL. Developed ova small, *ca.* 0.6 mm max. length.

Habitat and abundance: Adults euryhaline, found from lowland non-tidal fresh waters to lower estuaries. Abundant in upper estuaries in the Mimika region.

Distribution: Known from the Celebes, New Guinea and New Britain.

Other names: udang kali (Indonesian).

Southern New Guinean River Prawn

Macrobrachium sp. 1

John W. Short

Figure 71. FD adult male.

Diagnosis: Rostrum of short to medium length, dorsal carina straight or slightly convex, dentate along length, teeth subequally spaced, rostral formula 8–9/1–3, 2 dorsal teeth postorbital. Carapace with hepatic spine; inferior orbital margin moderately produced, obtuse, postantennular carapace margin evenly rounded. Anterior scaphocerite produced forward at inner angle. P2 sexually dimorphic, more developed in males; left and right P2 of FD males similar in shape, unequal in length, long, merus of minor P2 reaching tip of scaphocerite; without pubescence; chela with well developed gape, cutting edge of dactylus with teeth clearly continuing onto distal half, reaching to about mid-length on fixed finger; manus much longer than dactylus; carpus clearly shorter than chela; merus clearly shorter than carpus. T4 with indistinct median process or unarmed. Pre-anal carina absent. Small species up to 10 mm CL. Body speckled, P2 cream with dark irregular blotches.

Habitat and abundance: Adults known from middle to upper freshwater reaches. Recorded in the Mimika region from the Kopi and Wania river systems. In the Wania River basin collected under rocks in shallow water in a rainforest stream.

Distribution: Southern New Guinea from the Mimika region to the Fly River, Papua New Guinea.

Other names: udang kali (Indonesian).

New Guinean River Prawn

Macrobrachium sp. 2

John W. Short

Figure 72. Anterior cephalothorax and rostrum of adult female.

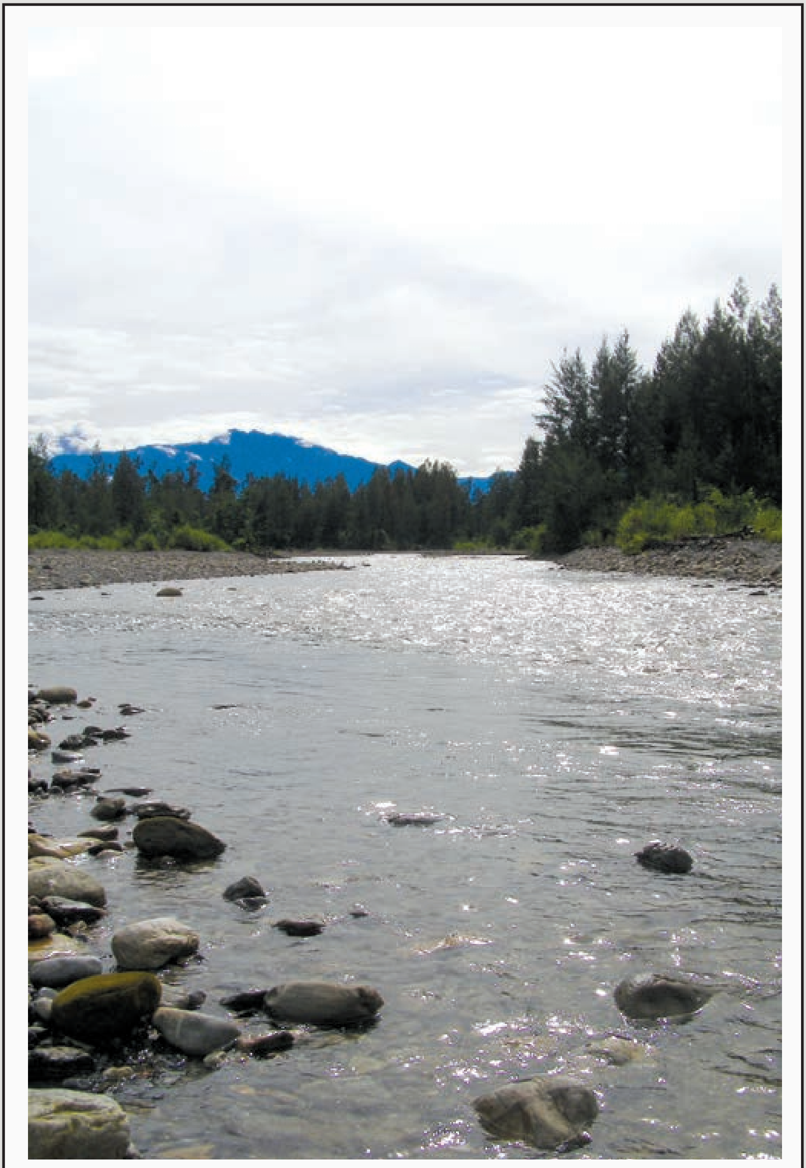
Diagnosis: Rostrum short, convex, often straightened just before tip, dorsal teeth subequally spaced except for first 1–3 teeth on carapace which tend to be more widely spaced than distal teeth, rostral formula 15–18/1–2 teeth, 2–4 dorsal teeth postorbital. Carapace with hepatic spine; inferior orbital margin moderately produced, obtuse, postantennular carapace margin evenly rounded. Bec ocellaire moderately developed, moderately expanded at tip. Anterior scaphocerite produced forward at inner angle. Epistome lobes bluntly rounded. Morphology of P2 of FD males unknown. T4 with variably developed median process, median process reduced to well developed. Developed ova small, 0.6 mm max. length.

Habitat and abundance: In the Mimika region only known from the upper Kamora River estuary.

Distribution: Presently known from Kamora River estuary, southern Papua and Sepik River, northern Papua New Guinea.

Other names: udang kali (Indonesian).

Notes: The rostrum of this species is similar to '*Macrobrachium*' *mirabile* Kemp, 1917, but the fourth and fifth pereiopods are typical for the genus, not unusually long and slender.



The upper Ajkwa River near Kuala Kencana. (Photo by Gesang Setyadi)

FRESHWATER CRAYFISHES

Family Parastacidae

Freshwater crayfishes are easily recognised by their depressed body form, reduced first abdominal segment lacking pleopods, well-developed cervical groove and enlarged, robust, first chelipeds (P1). River prawns of the genus *Macrobrachium* often have strongly developed chelipeds which sometimes resemble the broad stout chelipeds of freshwater crayfishes. However, the second pereiopods are enlarged rather than the first.

All southern hemisphere freshwater crayfishes belong to the family Parastacidae, which shows a typical Gondwanan distribution. Parastacid crayfish occur in New Zealand, Madagascar, South America, New Guinea and Australia, but not mainland Africa or India. Australia has by far the greatest diversity of genera and species, with over 100 species presently recognised.

On mainland New Guinea, parastacid crayfishes are only found in streams draining south from the Central Dividing Range, an area which has historically formed part of the Australian tectonic plate. All New Guinean species belong to the genus, *Cherax*, which is also widely distributed in northern and eastern Australia. New Guinean *Cherax* have been recorded from near sea level to an altitude of 3,300 m. Of approximately 16 species known from mainland New Guinea, only one lowland species, *C. lorentzi lorentzi* (J. Roux, 1911), has been recorded from the Mimika area. This crayfish is closely related to the northern Australian redclaw, *C. quadricarinatus* (von Martens, 1868), a species which is now widely cultured throughout the world.

Freshwater crayfishes are only found in non-tidal fresh waters. Larval development in parastacid crayfishes is highly abbreviated and is completed on the swimmerets under the female abdomen. The postlarvae leave the mother as bottom-living, miniature adults. Unlike shrimps, freshwater crayfishes cannot swim using the swimmerets, although as an escape response they can swim rapidly backwards by flipping the abdomen. Backward 'tail flipping' is also used as a rapid means of dispersal by postlarvae.

Lorentz's Crayfish

Cherax lorentzi lorentzi

(J. Roux, 1911)

John W. Short

Figure 73. Adult male.

Diagnosis: Rostrum long, slender, length more than twice basal breadth, with two pairs of teeth (occasionally with three teeth on one side), rostral carinae distinct, extending to two thirds distance between orbit and cervical groove. Scaphocerite lamina triangular. Postorbital spines well-developed; distinct postorbital carinae extending to half distance between postorbital spine and cervical groove; 2–4 postcervical spines on each side of carapace. P1 enlarged, strongly developed in mature males; chela 2.1–3.5 times longer than broad; fixed finger of mature males with soft, red, uncalcified patch; palm broad, compressed, mesially with submarginal tubercles in addition to marginal row of sharp tubercles; carpus bearing well developed, curved, mesial spine, with dense tuft of setae mesially. Medium-sized species up to 158 mm TL. Greenish-blue with broad dark longitudinal band along dorsal mid-line. Chelae marked with orange at base of movable finger and on distal palm.

Habitat and abundance: Lowland and middle catchment fresh waters to 135 m elevation; known from pandanus and sago palm swamps, rivers and streams. In the Mimika region, collected from the margins of a shallow rainforest stream in the Wania river catchment.

Distribution: Southern Papua from the Manikion district, Vogelkop Peninsula to the Lorentz River.

Other names: udang batu, udang tanah (Indonesian); utuau pitao, afameme, memaptitia (Nawaripi); wamero (Iwaka).

Notes: The subspecies *C. l. aruanus*, is found on the Aru Islands and has much broader chelae.

TRUE FRESHWATER CRABS

Family Parathelphusidae

Parathelphusid crabs can easily be distinguished from other crab families occurring in New Guinean fresh waters, by the transversely folding antennules, the well-calcified hardened carapace, the absence of a distinct rhomboidal gap between the third maxillipeds, and the absence of well-developed, dense fringes of setae on the pereiopods.

The Parathelphusidae are distributed from eastern India and Sri Lanka through mainland South-east Asia to southern China and eastward to the Philippines and Australasia. Parathelphusid crabs have direct development of young in fresh water. Larval development is fully abbreviated and occurs within the egg. Hatchlings resemble miniature adult crabs and are released from the mother around the time of the first moult.

Mainland New Guinea has a rich parathelphusid fauna consisting of at least 16 species in three genera, viz. *Geelvinkia*, *Holthuisana* and *Rouxana.* At present, knowledge of the fauna is highly fragmentary and distributional patterns remain unclear. The current taxonomy indicates that several species have extensive distributions on both sides of the Central Dividing Range. However, some of these wide-ranging species, as currently recognised, may prove to be complexes of cryptic species with more restricted distributions. Based on present knowledge, only one species, *Rouxana roushdyi* Bott, 1974, is restricted to upland localities and altitudes between 1,640–1,740 m.

Many parathelphusid crabs are semi-aquatic and have strongly developed burrowing behaviour. Some are found at a considerable distance from watercourses and rely on runoff water or groundwater in their burrows for moisture. In perennially wet, cloud forests, some parathelphusids are known to live underneath the moss layer.

Four species are known from the Mimika region. Three of these were collected from the Otokwa River during the 1912–1913 British Wollaston New Guinea Expedition, somewhere between sea level and 1,700 m.

Key to the Parathelphusid Crabs of the Mimika region

1a Frontal median triangle poorly developed, without well defined upper border (Fig. 74A); exorbital width (Fig. 10) little more than half CB. . . . . ***Rouxana plana*** (Calman) (p. 81)

1b Frontal median triangle well developed, upper border well defined (Fig. 74B); exorbital width (Fig. 10) much more than half CB **2**

Figure 74. Frontal median triangle variation in parathelphusid crabs: **A**, *Rouxana plana* (Calman); **B**, *Geelvinkia calmani* (J. Roux).

Figure 75. First male gonopod variation in parathelphusid crabs: **A**, with well-defined terminal segment; **B**, without well-defined terminal segment.

2a Male gonopod 1 with well defined terminal segment (Fig. 75A). . . . . ***Geelvinkia calmani*** (J. Roux) (p. 78)

2b Male gonopod 1 without well defined terminal segment (Fig. 75B). **3**

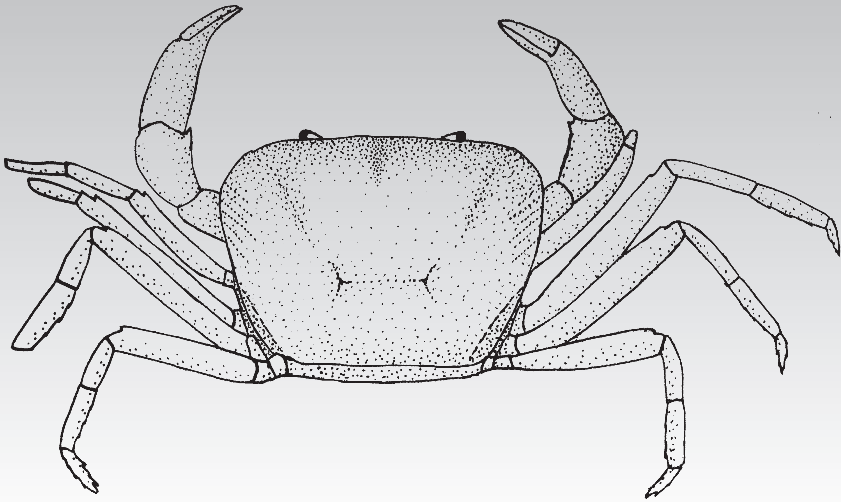
3a Anterolateral margin of carapace strongly convex, maximum CB in anterior third of CL; dorsal carapace surface hardly grooved; P2–5 very slender and long, P2 *ca*. 2.5 times CL . . . . ***Holthuisana wollastoni*** (Calman) (p. 79)

3b Anterolateral margin of carapace moderately convex, maximum CB in middle third of CL; dorsal carapace surface with well developed grooves; P2–5 short, moderately broad, P2 less than twice CL . . . . ***Holthuisana* sp.** (p. 80)

Calman’s Geelvinkia

Geelvinkia calmani

(J. Roux, 1927)



J. W. Short

Figure 76. Adult female.

Diagnosis: Carapace smooth, polished, strongly convex antero-posteriorly, max. CB at *ca*. one third CL, exorbital width clearly more than half CB; frontal median triangle well developed, with well defined upper border; anterolateral margin strongly convex, with oblique striae near border, epibranchial tooth hardly indicated; regions and grooves not well developed, epigastric lobes poorly developed, branchial regions not inflated, mesogastric groove clearly defined, cervical grooves shallow, distinct, more developed in branchial region, not joined to gastric groove. Male chelipeds unequal, fingers gaping, carpus with pointed inner spine followed by a small tubercle, upper merus with small subterminal spine. P2–5 long and conspicuously slender, P2 *ca*. twice CL, meri of P2–5 with subterminal spine. Male abdomen slender, A6 tapered basally, length slighly greater than distal width, telson same length as A6, length greater than basal width, G1 with terminal and subterminal segments clearly demarcated. Medium sized species up to 23.5 mm CB.

Habitat and abundance: Undertermined.

Distribution: Only known from the Otokwa River, Mimika region.

Other names: airakopia (Kamoro), irakopia (Nawaripi), minako (Atuka).

Wollaston's Holthuisana

Holthuisana wollastoni

(Calman, 1914)

After Calman (1914)

Figure 77. **A**, holotype male; **B**, abdomen of same; **C**, major chela of same.

Diagnosis: Carapace smooth, polished, strongly convex antero-posteriorly, less so from side to side, max. CB in anterior third of CL, exorbital width clearly more than half CB, depth over half CB; frontal median triangle well developed, upper border well defined, middle of upper border concave; anterolateral margin slightly granulated, strongly convex, without prominent striae, exorbital angles not prominent, epibranchial tooth indicated only by slight notch; dorsal surface of carapace with regions and grooves poorly developed, epigastric lobes rounded, branchial regions not inflated, mesogastric groove deep, sharply-defined, H-shaped gastric groove poorly developed, cervical groove faintly marked. Male chelipeds very unequal, merus with sharp subterminal spine on granulated upper margin, lower margin almost smooth, inner carpus with large sharp spine and smaller sharp tooth below. P2–5 very long and slender, meri with parallel borders and sharp subterminal spine; P2 *ca*. 2.5 times longer than CL. Male abdomen narrow, A6 slightly widened distally, distal width equal to length, telson tongue-shaped, with convergent sides, slightly longer than A6, G1 without demarcated terminal and subterminal segments. Medium sized species up to 22 mm CB.

Habitat and abundance: Undetermined. Recorded from near seal level to at least 39 m. In the Mimika region known from the Otokwa River.

Distribution: Southern Papua.

Other names: airakopia (Kamoro), irakopia (Nawaripi), minako (Atuka).

Holthuisana sp.

John W. Short

Figure 78. Adult male.

Diagnosis: Carapace polished, punctate, convex antero-posteriorly, max. CB in middle third of CL, exorbital width clearly more than half CB; frontal median triangle well developed, upper frontal margin concave; anterolateral margin moderately convex, without prominent striae, exorbital angles prominent, epibranchial tooth low and blunt, almost confluent with anterolateral margin, epibranchial notch absent; dorsal carapace with well defined regions and grooves, branchial regions moderately inflated, epigastric lobes well developed, mesogastric groove deep, clearly defined, cervical groove distinct, H-shaped gastric groove deep, well defined. Male chelipeds unequal, inner carpus with well developed spine. P2–5 short, P2 less than half CL, merus with blunt subterminal tooth on upper margin. G1 without demarcated terminal and subterminal segments. Medium sized species. Cephalothorax uniformly dark brown, pereiopods blotched light and dark brown.

Habitat and abundance: Collected under rocks on the bank of a shallow rainforest pool in the Wania River basin.

Distribution: Wania River basin, near Kuala Kencana, Mimika Region.

Other names: airakopia (Kamoro), irakopia (Nawaripi), minako (Atuka).

Flat Rouxana

Rouxana plana

(Calman, 1914)

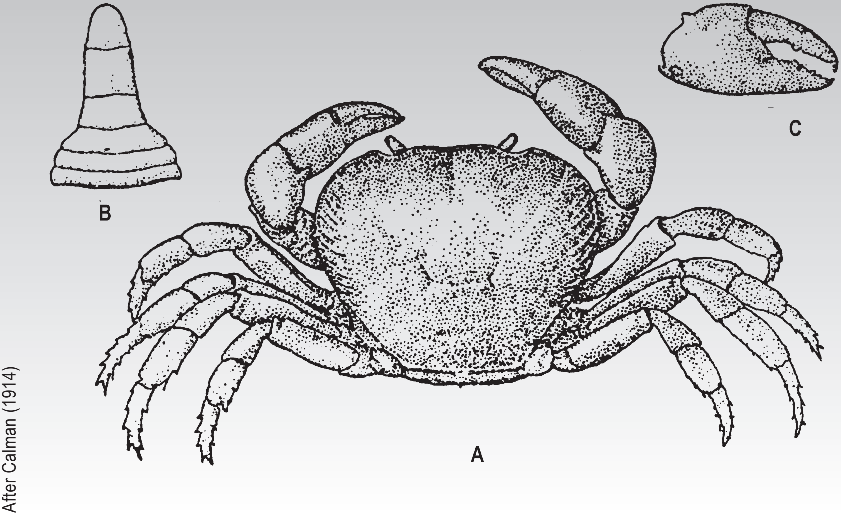


Figure 79. **A**, holotype male; **B**, abdomen of same; **C**, major chela of same.

Diagnosis: Carapace very flat except for strongly downturned anterior in front of epigastric lobes, max. CB at *ca*. one third of CL, exorbital width little more than half CB, depth much less than half CB, punctate; frontal median triangle poorly developed, without well defined upper border; anterolateral margin strongly convex, obscurely granulated, sharply-cut raised oblique striae present, without prominent exorbital angles, epibranchial tooth absent, at most with very small epibranchial notch; regions and grooves poorly developed, cervical grooves almost obsolete anterolaterally, epigastric lobes not prominent, mesogastric groove well-defined, H-shaped gastric groove distinct. Male chelipeds unequal, with distinct gape at base of fingers, carpus with sharp inner tooth, accompanied by small blunt tubercle, merus rugose along upper edge, with subterminal ridge but without distinct subterminal spine, lower margin smooth. P2–5 short and stout, P2 less than half CL, meri with blunt subterminal tooth on upper margin. Male abdomen short and broad, A6 parallel sided, little broader than long, slightly longer than telson, telson tongue shaped, with slightly convergent sides, G1 with terminal and subterminal segments clearly demarcated. Medium sized species up to 33 mm CB.

Habitat and abundance: Recorded from upland localities at elevations of 800 m and 1,050 m a.s.l. In the Mimika region recorded from the Otokwa River without a precise locality.

Distribution: Northern and southern Papua.

Other names: airakopia (Kamoro), irakopia (Nawaripi), minako (Atuka).

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Glossary

Abdomen: the 'tail'; posterior portion of the body; includes pleura, tergites, telson and uropods (Fig. 2).

Anchialine: fresh groundwater systems overlying seawater with limited surface expression.

Acute: pointed, with an angle distinctly less than 90°.

Ambulatory: walking, e.g. ambulatory leg.

Antenna (pl. antennae): sensory appendage or 'feeler' attached to the anterior head below the eye stalks. Two pairs: first pair, the antennules, consisting of basal peduncle and pair of flagella (feelers) at the tip; second pair, the antennae, consisting of scale (scaphocerite) and long whip-like flagellum (Fig. 2).

Antennal scale: blade-like appendage arising from peduncle of second antenna; also known as scaphocerite (Fig. 2).

Antennal spine: spine on or near anterior carapace margin situated immediately below or fused with lower orbit (Fig. 2).

Antennule: the first antenna (Fig. 2).

Appendage: any structure growing out of the body; usually with multiple segments.

Apex: tip (also apical, meaning at the apex).

Appendix interna: small appendage arising from inner side of endopod of pleopods tipped with minute hooks which couple with opposing appendage interna during swimming.

Appendix masculina: accessory sexual organ arising from the inner endopod of the second male pleopod between the endopod and the appendix interna (Figs 3F, 3G).

Articular membrane: membranes between joints of the limbs or appendages permitting movement, particularly those at the bases of legs.

Basal: at or near the base; near the proximal portion of an appendage.

Basis: second most proximal segment of a thoracic appendage (Fig. 2).

Bec ocellaire: beak-like process projecting upwards from between the eyestalks towards the lower margin of the rostrum (Fig. 6).

Benthic: living at the bottom of the water column.

Bifid: cleft.

Bifurcation: divided into two forks.

Biramous: double-branched, e.g. the pleopods in prawns, shrimps and crayfishes.

Branchial region: part of the carapace which covers the gill chamber.

Branchiostegal groove: groove on anterolateral carapace at upper edge of the gill chamber (Fig. 41).

Branchiostegal spine: spine on or near anterior carapace margin below antennal spine (Fig. 39).

Calcified: hardened by the deposition of calcium carbonate.

Carapace: exoskeletal plate covering to varying degrees the dorsal and lateral head-thorax.

Carina: ridge or keel.

Carpus: fourth segment from base (third from tip) or wrist of thoracic appendage (Fig. 2).

Catadromous: migrating from fresh water to tidal waters to breed.

Cephalothorax: anterior portion of the body formed by the fusion of the head segments with one or more thoracic segments.

Cervical groove: groove or series of grooves running transversely/obliquely across the carapace; separates the gastric and hepatic regions from the branchial and cardiac regions (Figs 7, 10).

Chela: the pincer of a cheliped comprising a ‘moveable finger’ or dactylus, a distal projection of the propodus, the pollex or ‘fixed finger’ and in most cases a well defined basal portion of the propodus, the manus or ‘palm’ (Fig. 2).

Chelate: bearing a chela.

Cheliped: chelate pereiopod; pereiopod with a chela (pincer) on the distal end (Fig. 2).

Chromatophore: cell containing pigment granules which through rapid changes in the disposition of the granules can alter the colouration of an animal.

Cornea: faceted, usually pigmented, portion of the eye (Fig. 2).

Coxa: the most proximal segment of the endopod of a thoracic leg (Fig. 2).

Crest: elevated portion of a carina.

Cuticle: dead outer layer of the exoskeleton or 'shell'.

Cutting edge: inner edge of the dactylus or propodus of a chela which in combination with the opposing digit is used for grasping, biting, tearing or cutting.

Dactylus: terminal segment or seventh segment from base of a pereiopod (Fig. 2).

Developed eggs: eggs with eye spots visible, an indication that they are ready to hatch.

Distal: away from the body or point of attachment of an appendage (opposite of proximal).

Dorsal: upper or higher (opposite of ventral).

Downturned: directed or curved downwards (opposite of upturned).

Eave: overhanging rim.

Edentate: without teeth.

Elevated: raised.

Endopod: inner ramus (branch) of biramous (double branched) appendage.

Epigastric lobes: submedial lobes on either side of the mesogastric groove in crabs (Fig. 10).

Epipod: appendage attached to coxa or precoxa; often small and filamentous on pereiopods.

Epistome: transverse plate of antennal sternum lying between the labrum and the bases of the antennules (Fig. 5).

Euryhaline: tolerant of a wide range of salinity.

Excavated: dished or hollowed out.

Exorbital angle: corner of the carapace at the outer edge of the orbit in crabs (Fig. 10).

Eyestalk: peduncle of eye or unfaceted part of the eye supporting cornea.

Exopod: outer ramus (branch) attached to the basis of biramous (double branched) appendage; usually small when attached to legs (Fig. 2).

Fixed finger: the terminal extension of the propodus of a chela; also known as the pollex (Fig. 2).

Fixed spine: immoveable spine.

Flagellum (pl. flagella): 'whip-like' terminal portion of an appendage consisting of many short segments, e.g. antennal flagella, the 'feelers' (Fig. 2).

Flange: projecting rim; strongly produced margin.

Frontal region: front of the carapace between the orbits in freshwater crabs (Fig. 10).

Frontal median triangle: the median part of the frontal margin in parathelphusid crabs which is often dilated to form a triangle (Figs 74A, 74B).

Gape: wide opening or space between cutting edges of fingers (when fingers closed) of chela.

Gastric groove: H-shaped groove in the middle of the carapace dividing the gastric from the cardiac region in parathelphusid crabs (Fig. 10)

Gastrolith: hemispherical stomach stone in freshwater crayfishes which stores calcium salts re-absorbed from the old shell prior to moulting.

Genital operculum: flap on genital papilla on inner articular membrane at the base of P5 which covers the genital opening in sexually-mature, male palaemonid shrimps (Fig. 3E).

Genital papilla: uncalcified protuberance bearing male genital opening at inner base of P5 in caridean shrimps. Covered by a well-developed operculum in palaemonid shrimps.

Gonopod: first or second pleopod in male crabs modified as copulatory organ (Fig. 9B).

Hepatic region: small triangular anterolateral region wedged between branchial and gastric regions.

Hepatic spine: spine on hepatic region (Fig. 2).

Inter-uropodal sclerite: calcified plate underneath the telson between the uropods and in front of the anus; often bearing a pre-anal spine or carina (Fig. 42).

Ischium: third segment from base of a pereiopod. (Fig. 2).

Keel: sharp high carina.

Labrum: 'upper lip' or unpaired structure bordering the front of the mouth (Fig. 5).

Lacustrine: living in lakes or ponds.

Lateral: situated at the side or directed to a side; away from the midline (see medial and mesial).

Lentic: living in static, still or slow-flowing aquatic habitats.

Lotic: living in fast flowing aquatic habitats e.g. rivers and streams.

Macrophagic: feeding on relatively large food particles or prey.

Mandible: paired jaw-like mouth appendage which does most of the work of biting and crushing food.

Manus: palm region of propodus of a chelate pereiopod (Fig. 2).

Microphagic: feeding on relatively minute food particles or very small prey.

Maxilliped: one of first three pairs of thoracopods immediately preceding pereiopods; first two pairs small and function as mouth parts, third pair often resemble legs and are the most easily seen.

Medial: situated along the midline of body, appendage, or segment.

Median: at the middle.

Merus: fourth segment from the base of a pereiopod (Fig. 2).

Mesial: inner; towards the midline of body.

Mesogastric groove: groove on center of carapace just behind frontal region in crabs. Usually bordered by epigastric lobes in parathelphusid crabs.

Montane: cool, moist, upland habitat below the tree line dominated by evergreen trees.

Moveable finger: dactylus or terminal segment of a cheliped (seventh segment from base); closes against pollex (fixed finger) (Fig. 2).

Moveable spine: spine freely moveable in relation to surrounding cuticle.

Ophthalmic: pertaining to the eyes, e.g. ophthalmic somite is the head segment from which the eyes originate.

Ocular: pertaining to the eye.

Orbit: eye socket formed by invagination of anterior carapace near the base of the eye stalk.

Ovigerous: carrying eggs, berried.

Palm: manus region of propodus of chelate pereiopod (Fig. 2).

Peduncle: stalk, e.g. multi-segmented basal portion of the antenna or antennule proximal to the flagella.

Pelagic: living in the open water column of tidal waters or lakes.

Pereiopod: one of the last five pairs of thoracopods. (Fig. 2)

Pleopod: swimmeret; swimming appendage (usually biramous) attached (in pairs) to underside of abdomen (Fig. 2).

Pleuron (pl. pleura): lateral region on the five anterior abdominal segments (Fig. 2).

Pollex: fixed finger (of propodus) of cheliped. (Fig. 2)

Pre-anal carina: carina on inter-uropodal sclerite on underside of abdomen in caridean shrimps (Fig. 42).

Pre-terminal: located just before the tip or apex of an appendage e.g. pre-terminal merus spine (Fig. 10).

Process: prominence or protuberance; may be pointed or blunt.

Produced: projected forward.

Propodus: sixth segment from base (second from distal end) of a pereiopod (Fig. 2).

Proximal: towards the body or point of attachment of appendage (opposite of distal).

Pterygostome: anterolateral corner of carapace.

Pubescence: thick covering of fine soft setae.

Ramus (pl. rami): branch-like structure.

Rheophilic: thriving in, or having an affinity with, running water.

Rhomboidal gap: a rhomboid-shaped gap between the mouthparts of some crabs which clearly reveals the mandibles with the other mouthparts closed (Fig. 12B).

Rostrum: beak-like forward projection of anterodorsal carapace between eyes (Figs 2, 7B). Generally well developed in shrimps, crayfishes and hymenostomtid crabs.

Rostral formula: the number of dorsal and ventral teeth on the rostrum presented in the following way: $x^1–x^2/y^1–y^2$ where x^1 is the minimum number of dorsal teeth, x^2 is the maximum number of dorsal teeth, y^1 is the minimum number of ventral teeth and y^2 is the maximum number of ventral teeth. Atypical values are enclosed in parentheses.

Scaphocerite: antennal scale (Fig. 2).

Serrated: notched or grooved like the edge of a saw.

Seta: arthropod bristle.

Sinuous: bent into a very shallow zig-zag.

Somite: segment**.**

Spinate: bearing a spine (also spinose).

Spine: stiff, pointed, cuticular process.

Spinule: a very small spine.

Sternite: plate or segment of the sternum.

Sternum: ventral plates or segmented wall of thorax or abdomen (Fig. 8).

Subapical: near the apex or tip.

Submedial: near the midline of body or appendage.

Suture: flexible line or seam at the junction of two plates or segments or at the base of a spine.

Striae: oblique ridges near the lateral carapace margin of parathelphusid crabs (Fig. 10).

Telson: the last abdominal segment (Figs 2, 9A, 42).

Tergite: arched dorsal portion of the five anterior abdominal segments.

Thoracopods: thoracic legs.

Tooth: broad-based, spine-like cuticular process.

Torrenticolous: living in river torrents.

Uropods: biramous appendage on either side of telson; forming part of tail-fan (Fig. 2).

Appendix

Checklist of the decapod Crustacea recorded from the fresh waters of the Mimika region

Family Atyidae

1. *Atyopsis spinipes* (Newport, 1847)
2. *Caridina brevicarpalis* De Man, 1892
3. *Caridina gracilirostris* De Man, 1892
4. *Caridina longirostris* H. Milne Edwards, 1837
5. *Caridina serratirostris* De Man, 1892
6. *Caridina weberi* De Man, 1892
7. *Caridina* sp. 1
8. *Caridina* sp. 2
9. *Caridina* sp. 3
10. *Caridina* sp. 4
11. *Caridina* sp. 5

Family Palaemonidae

12. *Palaemon concinnus* Dana, 1852
13. *Macrobrachium bariense* (De Man, 1892)
14. *Macrobrachium equidens* (Dana, 1852)
15. *Macrobrachium handschini* (J. Roux, 1933)
16. *Macrobrachium horstii* (De Man, 1892)
17. *Macrobrachium idae* (Heller, 1862)
18. *Macrobrachium latidactylus* (Thallwitz, 1891)
19. *Macrobrachium lepidactyloides* (De Man, 1892)
20. *Macrobrachium lorentzi* (J. Roux, 1921)
21. *Macrobrachium mammillodactylus* (Thallwitz, 1892)
22. *Macrobrachium rosenbergii* (De Man, 1879)
23. *Macrobrachium weberi* (De Man, 1892)
24. *Macrobrachium* sp. 1
25. *Macrobrachium* sp. 2

Family Parastacidae
26. *Cherax lorentzi lorentzi* (J. Roux, 1911)

Family Parathelphusidae
27. *Geelvinkia calmani* (J. Roux, 1927)
28. *Holthuisana wollastoni* Calman, 1914
29. *Holthuisana* sp.
30. *Rouxana plana* Calman, 1914

Family Varunidae
31. *Varuna yui* Hwang and Takeda, 1986
32. *Parapyxidognathus deianeira* (De Man, 1888)

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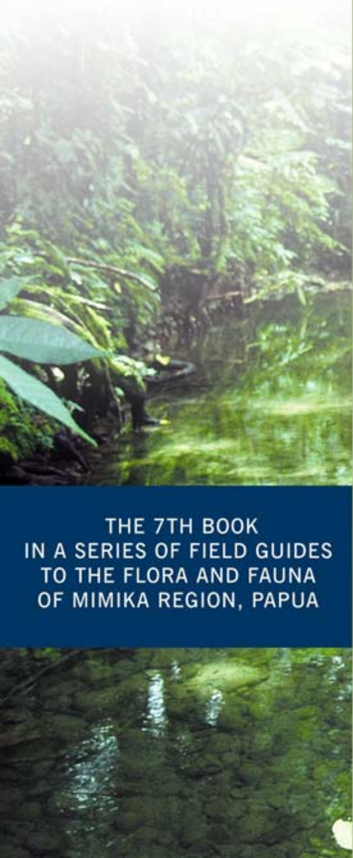

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