

# IDENTIFICATION OF WEST AFRICAN ESTUARINE SHRIMP AND CRAB LARVAE

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## ABSTRACT

The paper deals with the decapod crustacean larvae likely to be found in fresh and brackish waters in tropical West African. It summarizes results from an ongoing program of describing larvae hatched directly from adults of known species, to provide the identification keys necessary for applied research on nursery grounds, plankton ecology and pollution effects.

A preliminary key to Stage - 1 larvae is given for approximately 40 species. It includes all the genera, and nearly all the species, known to produce larvae in fresh and low-salinity waters. The common species of higher salinity waters are also included.

## INTRODUCTION

The larvae of decapod crustaceans (shrimps, crabs etc) form an important element in the zooplankton in inshore waters. Even in rivers they may constitute an appreciable proportion of the zooplankton (pers. observations), although their very occurrence in such habitat generally goes unnoticed by freshwater biologists.

The importance of identification of larvae, for fisheries research, is self-evident. A knowledge of them is required for working out life-histories and more so, for determining the location of nursery areas. Their larval development frequently takes place in areas other than the habitat of the adult or exploited populations but the exact location is unknown (Powell, 1985).

The present paper is part of an effort to provide quick identification of the decapod larvae of West African rivers and estuaries. It is intended to facilitate ecological and pollution as well as fisheries studies. The strategy has been to start with the descriptions of Stage 1 larvae hatched from adult females of species known to occur in fresh and brackish waters. Gradually a progressively more refined key may be built up.

The key provided here has been constructed from more detailed information in Ambrose-Hart (1983) and Jonathan (1984). It has been tested during the identification of numerous zooplankton samples from fresh and estuarine waters through southern Nigeria. Although the key omits the larvae (yet to be described) of many small and uncommon species, it allowed the identification of the vast majority of larvae encountered in such samples.

## MATERIALS AND METHODS

Ovigerous (berried) female specimens of each species were kept alive until their eggs hatched. Descriptions and drawings were based on at least 6 larvae. Where possible, larvae from 3 or more females were examined. The larvae were preserved in 10% formalin. Whole specimens or isolated appendages were examined on slides with a few drops of the preservative. Drawings were made free-hand using dissecting and compound microscopes (magnifications 10-100x). For descriptions of pigment patterns, the specimens used were freshly killed with 1 drop of 5% formalin in a few drops of water.

Detailed descriptions of the larvae of each species are given in Ambrose-Hart (1983) and Jonathan (1984).

Information on the adults of most of the species treated are given in one or another of the following references: Monod, 1956; Manning and Holthuis, 1981; Manning, 1982; Powell 1979; 1983a; 1983b, 1985 and in press.

PRELIMINARY KEY TO FRESHWATER AND ESTUARINE DECAPOD LARVAE  
(STAGE 1 ZOEAE) OF NIGERIA

1. Rostrum short or absent. Carapace with a single dorsal spine, or no spines (figure 1a, b) .....2  
 Rostrum long, about 3 times carapace length. Carapace with a pair of posterior spines. Family Porcellanidae (a single medium-salinity species: Rostrum and posterior spines with spinules on both ventral and dorsal margins (figure 5a). Antennule 1-segmented (figure 14a).....*Petrolisthes armatum*.
2. Telson sharply forked, with 3 pairs of setal processes on inner margin of the furcal prongs (figure 2). Second and sometimes 3rd abdominal somites with dorsolateral knobs (figure 9). Infraorder Brachyura .....6  
 Telson triangular, with 14-15 setal processes, and sometimes with deep median notch on posterior border. Second and 3rd abdominal somites without dorsolateral knobs (figure 8) .....3
3. Telson with 2nd outermost pair of setal processes normal (figure 4). Peduncle of antennule bearing a single flagellar segment (figure 13). Infraorder Caridea .....20  
 Telson with 2nd outermost pair of setal processes hair-like (figure 3). Infraorder Thalassinidea. ....4
4. Telson with 14 processes and a long median process (figure 3a). Ventral margin of rostrum and anteroventral margin of carapace bearing minute spines. 2nd - 5th abdominal somites each with a large posterodorsal spine. Family Callinassidae. ....  
*Callichirus balsii* Telson with median cleft (figure 3b, c). Rostrum and carapace without spines. Families Upogebiidae and Diogenidae.....5
5. Innermost pair of telson processes about half as long as adjacent pair (figure 3c). Antennal scale with the outermost seta smooth and spine-like (figure 17a) .....  
*Upogebia furcata*  
 Innermost pair of telson process more than 2/3 as long as adjacent pair (figure 3b). Antennal scale with all the setae plumose (figure 17b).....*Clibanarius spp cooki and africanus*.
6. Third to 5th abdominal somites each with a pair of long lateral sharp spines (figure 9a). Telson furcal prong with a long spine on outer margin (2 extra smaller spines sometimes also present) (figure 2b, c). Families Majidae and xanthidae .....7  
 Third to 5th abdominal somites with a pair of short lateral obtuse projections (figure 9b) Telson furcal prong without outer spines (figure 2a). Families Gecarcinidae, Ocypodiidae and Grapsidae. ....9
7. Carapace bearing rostral and lateral spines. Telson furcal prong with 3 outer spines (figure 2c) Xanthidae. ....8  
 Carapace lacking rostral and lateral spines. Telson furcal prongs with a single outer spine (figure 2b) .....*Achaeus powelli*
8. Rostrum projecting beyond end of antennular aesthetascs (figure 6b). Antennal exopod reaching less than 1/5 of distance to protopod tip (figure 18a) .....  
*Panopeus africanus* Rostrum not reaching tip of antennular aesthetascs (figure 6a) Antenna exopod reaching tip of protopod (figure 18b) .....*Pilumnopus sp.*
9. Carapace with well-developed lateral spines. Gecarcinidae and ocypodid subfamily Ocypodinae. ....10  
 Carapace with lateral spine absent, or very short (less than half the length of any abdominal somite). Grapsidae and ocypodid subfamily Camptandriinae. ....11
10. Rostrum projecting beyond end of antenna and antennular aesthetascs. Rostrum longer than dorsal spine (figure 6c). Ocypodid subfamily Ocypodinae: .....*Uca tangeri*  
 Rostrum not reaching tip of antenna or antennular aesthetascs. Rostrum shorter than dorsal spine (Figure 6d). Gecarcinidae. ....*Cardisoma armatum*

11. Antennule with 2 terminal aesthetascs (figure 15a). Fourth or 5th (sometimes both) abdominal somites laterally expanded. Telson with furcal prong less than half total telson length. *Camptandriinae* and grapsid subfamily *Grapsinae* . . . . . 12  
 Antennule with 3 terminal aesthetascs (figure 15b). Abdominal somites normal. Telson with furcal prong more than 2/3 total telson length. Grapsid subfamily *Sesarminae*. . . . . 18
12. Antennal exopod long, reaching tip of protopod, with a median seta (figure 20). Abdomen (excluding telson) equal or shorter than carapace length.  
*Camptandriinae*. . . . . 13  
 Antennal exopod reduced, reaching less than 1/5 distance to tip of protopod (figure 19). Abdomen (excluding telson) longer than carapace length. *Grapsinae*. . . . . 16
13. Dorsal spine absent (figure 6g). Rostral spine equal or shorter than 2nd abdominal somite  
*Ephantor modestus* Dorsal spine longer than 2nd abdominal somite. . . . . 14
14. Dorsal spine more than half the length of the rostrum. Fourth and 5th abdominal somites with large lateral flaps reaching base of telson (figure 11b) . . . . . 15  
 Dorsal spine about 1/3 length of rostrum. Fourth and 5th abdominal somites without lateral flaps (figure 11a) . . . . . *Telmatothrix powelli*
15. Dorsal spine shorter than total telson length. Antennular aesthetascs reach or extend beyond tip of rostrum (figure 6f) . . . . . *Lillyanella plumipes*  
 Dorsal spine equal or longer than total telson length. Antennular aesthetascs shorter than rostrum (figure 6e). . . . . *Calabarium crinodytes*.
16. Fourth abdominal somite with lateral knobs or flaps near midlength (figure 10b, c). Genus *Pachygrapsus* . . . . . 17  
 Fourth abdominal somite broadly expanded laterally but lacking knobs or flaps near midlength (figure 10a) . . . . . *Goniopsis pelii*.
17. Antennal protopod with a large subterminal spine (figure 19a). Sides of 4th abdominal somites evenly rounded with short flaps at midlength (figure 10c) . . . . . *Pachygrapsus transversus*  
 Antennal protopod lacking a prominent subterminal spine (figure 19b). Sides of 4th abdominal somites angled (figure 10b) . . . . . *Pachygrapsus gracilis*.
18. Carapace with a short lateral spine. *Sesarma angolense* Carapace without lateral spine . . . . . 19
19. Tip of antennal exopod smooth around base of terminal setae (figure 21a) . . . . .  
*Sesarma buettikoferi*. Tip of antennal exopod toothed around base of terminal setae (figure 21b) . . . . . *Metagrapsus curvatus*,  
*Sesarma huzardi*, *Sesarma alberti* and *Sesarma elegans*.
20. Rostrum spine-like, extending beyond eyes (figure 7b). Families *Palaemonidae*, *Atyidae* and *Hippolytidae*. . . . . 21  
 Rostrum absent (figure 7a). Family *Alpheidae* . . . . . 33
21. Sixth abdominal somite continuous with telson *Palaemonidae* and *Atyidae* . . . . . 22  
 Sixth abdominal somite not continuous with telson *Hippolytidae*. . . . . 32
22. Telson bilobed (figure 4a). *Atyidae* . . . . . *Atya*  
 Telson spatulate, not bilobed (figure 4b, c). . . . . *Palaemonidae* 23
23. Antennal scale with 4 distal segments (figure 16a) . . . . . 26  
 Antennal scale with 5 distal segments (figure 16b) . . . . . 24
24. Antennal scale with 11 setae. Chromatophores present on 1st – 5th abdominal somites and telson . . . . . *Periclimenes* sp.  
 Antennal scale with 9 or 12 setae. Chromatophores present only on 2nd and/or 3rd abdominal somites and telson . . . . . 25

25. Antennal scale with 12 setae. Chromatophores present on 2nd – 3rd abdominal somites and telson . . . . . *Palaemonetes africanus*  
 Antennal scale with 9 setae. Chromatophores present on 3rd abdominal somites and telson . . . . . *Macrobrachium vollenhovenii*.
26. Fifth abdominal somite with a pair of short lateral spines (figure 12a). Innermost pair of telson processes more than half the length of the adjacent pair (figure 4c). Genus *Palaemon* . . . . . 27  
 Fifty abdominal somite without spine. Innermost pair of telson processes less than half the length of the adjacent pair (figure 4b) . . . . . 29
27. Antennal scale with 10 setae . . . . . *Palaemon maculatus*  
 Antennal scale with 9 setae . . . . . 28
28. Fourth abdominal somite with a posterodorsal lobe (figure 12b). Chromatophores present on telson . . . . . *Palaemon* sp.  
 A Fourth abdominal somite normal. Chromatophores absent from telson . . . . . *Palaemon elegans*.
29. Antennal scale with marking of segmentation at apex; and with 9 plumose setae and 1 spine-like seta on either side . . . . . *Nematopalaemon hastatus*  
 Antennal scale with no marking of segmentation at apex, and without spine-like setae. Genus *Macrobrachium*. . . . . 30
30. Antennal scale with 4 distal segments and 10 setae. . . . . *Macrobrachium equidens* Antennal scale with 4 distal segments and 11 or 12 setae . . . . . 31
31. Antennal scale with 12 setae. Chromatophores on proximal end of antennule. *Macrobrachium macrobrachion* Antennal scale with 11 setae. Chromatophores absent on antennule. . . . . *Macrobrachium felicinum*.
32. Exopod of maxillipeds each bearing 1–2 segments. Outermost telson process placed in normal position (figure 4c) . . . . . *Lysmata* sp.  
 Exopod of maxillipeds each bearing 4–5 segments. Outermost telson process placed at midlength of lateral border (figure 4d). . . . . *Latreutes parvulus*.
33. Sixth abdominal somite distinct from telson. Chromatophore absent from antenna and antennule. . . . . *Leptalpheus* sp.  
 A Sixth abdominal somite not distinct from telson. Chromatophores present on antenna and/or antennule. . . . . 34
34. Eyes angular. Antennal scale with 4 distal segments and 10 setae. . . . . *Alpheus pontederiae* Eyes rounded. Genus *Potamalpheops* . . . . . 35.
35. Posterior border of telson with minute spinules in between the 4 innermost pairs of processes . . . . . 36  
 Posterior border of telson without spinules in between the processes. Antennal scale with 2 segments and 10 setae. . . . . *Potamalpheops haugi*.
36. Antennal scale with 4 distal segments and 11 setae. Chromatophores absent from 4th abdominal somite . . . . . *Potamalpheops monodi*  
 Antennal scale with 2–3 segments. Chromatophore present on 4th abdominal somite . . . . . 37.
37. Antennal scale with 3 segments and 11 setae. Two chromatophores present on the 2nd abdominal somite. One Chromatophore directly under each eye. No chromatophore at tip of rostrum. *Potamalpheops pylorus* Antennal scale with 2nd abdominal somite. One chromatophore on 2nd abdominal somite. No chromatophore under eyes. One chromatophore at tip of rostrum. . . . . *Potamalpheops* sp. A.

## DISCUSSION

### General Features

Though the present work is based on Stage 1 zoeae, it will assist in the identification of later larval stages especially for crab larvae, which tend to retain the basic features of the early larvae. Moreover Stage I is generally the dominant larval stage in most plankton in samples (Warner, 1977; Ngoc-Ho, 1981; and McConaughy et. al., 1983).

In Nigerian estuarine samples Stage 1 zoeae account for over 80% of decapod larvae (pers. obser., GEJ).

The first task in larval identification is to separate brachyurans, anomurans and carideans. Brachuran (true crab) larvae have a distinct telson type: sharply forked with 3 spine-like processes on the inner margin of each furcal prong. In anomurans and carideans, the telson is usually simple in shape; it may be bilobed but always has 7 (not 3) pairs of setal processes on the posterior border. Seven normal pairs occur in Carideans. In local Anomurans the second outer-most pair is always reduced to a small hair so the apparent number of setae is 6 pairs also the telson is more often bilobed than simple.

Although pigment patterns are often useful at species level (e.g. Fryderyk, 1965) they can only be relied on with freshly preserved material.

### Important species lacking Estuarine/Freshwater Larvae

Some species of commercial interest do not have estuarine larvae. The well known *Penauss* and *Callinectes* species spawn outside the estuary, and their larvae are not estuarine. Freshwater crabs (family Potamidae) have no larvae, but hatch as fully formed juveniles.

### Estuarine Larvae Not Treated in the Key

In the more saline waters of estuaries there occur many small species of Hippolytidae and Alpheidae, and some species of Ogyrididae and Crangonidae. The larvae of these families show much diversity hence lack definition for the families as a whole. Stage 1 carideans lacking a rostral spine are likely to be alpheids.

The large callinassid *Callichirus turneranus* is seasonally abundant in tidal fresh water. Its larva should resemble that of *C. balssi*, described in the key. The family characters include long ventrally-toothed rostral spine, toothed anterior carapace margin, dorsal spines on abdominal somites 2-4 (sometimes only on the 3rd), and a single medial telson spine which may be either longer or shorter than the paired processes (Gurney, 1942).

There are several species of small anomurans (*Pachycheles* and *Pagurids*), and crabs (xanthids, pinnotherids and hexapodids) not treated in the key, but known to occur in high salinity zones of estuaries and probably having estuarine larvae.

### Species-Specific Comments

There is a problem concerning the identity of *Macrobrachium vollenhovenii* larvae. The characters used in the present key are based on the description and figures given by Ville (1971). Ville noted a pair of spines projecting laterally on the 5th abdominal somite. However this has not been detectable on the larvae of the other West African species of *Macrobrachium* examined by us, nor has it been recorded for species from other areas e.g. *Macrobrachium acanthurus* (in Choudhury, 1970), *Macrobrachium rosenbergii* (in Ling, 1969), *Macrobrachium australiense* (in Fielder, 1970) *Macrobrachium lar* (in Atkinson, 1977), *M. idella* (in Pillai and Mohammed, 1973), and *Macrobrachium* sp. (in Willimsan, 1972). Ville's drawings closely resemble the larvae of the genus *Palaemon* and it is not impossible that a misidentification is involved. The characters of *Nematopalaemon hastatus* have been taken from Marioghae (1980), and also need to be confirmed.

The large land crab *Cardisoma armatum* has a larvae closely resembling that of the fiddler crab *Uca tangeri*. Besides the characters used in the key, a further distinguishing feature concerns the innermost pair of telson processes. In *C. armatum* the outer side of each process has only two conspicuously prominent spinules; in *U. tangeri* there are four or more. (The inner margins are more similar; both margins also have a number of shorter, thinner spinules).

Some species lack larval features useful for species-level identifications: the two hermit crabs *Glibanarius africanus* and *G. cooki* can not be distinguished, nor could the four sesarminae crabs *Metagrapsus curvatus*, *Sesarma huzardi*, *S. alberti*, *S. elegans* and *S. buattikoferi*.

A few species have aberrant larvae. *Sesarma argolense* has a lateral spine, which has not been recorded for other species of the genus (Wilson, 1980). The larvae of *Ephantor modestus* lack a dorsal spine.

## REFERENCES

- AMBROSE-HART, A. I. (1983). Key to Stage I larvae of fresh and brackish water shrimps in the Niger Delta. M.Sc. Dissertation in Hydrobiology and Fisheries Biology, University of Port Harcourt. v + 50pp.
- ATKINSON, J. M. (1977). Larval development of a freshwater Prawn *Macrobrachium lar* reared in the laboratory. *Crustaceana* 33 (1): 90-94.
- CHODHURY, P. C. (1970). Complete larval development of the palaemonid shrimp *Macrobrachium acanthurus* reared in the laboratory. *Crustaceana* 18: 113-132.
- FIELDER, D. R. (1970) Larval development of *Macrobrachium australiense* reared in the laboratory. *Crustaceana* 18: 60-74.
- FRYDERYK, P. (1965). Pigmentation and colour change in decapod larvae. *Symposium on Crustacea. Mar. Biol. Assoc. India*. Vol. 3, 1110-1123.
- GURNEY, R. (1942). *Larvae of Decapod Crustacea*. The Ray Society London VIII + 306.
- JONATHAN, G. E. (1984). Stage I larvae of fresh and brackish water decapod crustaceans (excluding Natantia) of the Niger Delta. M.Sc. Dissertation in Hydrobiology and Fisheries Biology, University of Port Harcourt, X + 97.
- LEBOUR, M. V. (1959). The larval decapod crustacea of tropical West Africa. *Atlantide-Report* 5 :119-143.
- LING, S. W. (1969). General biology and development of *Macrobrachium rosenbergii*. FAO Fish. Rep. 57: 589-606.
- MANNING, R. B. (1982). *Achaeus powelli*, a new spider crab from Nigeria (Crustacea, Decapoda, Majidae). *J. Crustacean Biol.* 2 (3): 459-463.
- MANNING, R. B. and L. B. HOLTHUIS (1981). West African brachyuran crabs. *Smithsonian Contributions to Zoology* 300: 1-379.
- MARICHOAE, I. E. (1980). The ecology and commercial fishery of Palaemon (Nematopalaemon) hastatus Aurivillius, 1893. M.Sc. Dissertation in Hydrobiology and Fisheries Biology, University of Port Harcourt.
- MCCONAUGHA, J. R., D. F. JOHNSON, A. J. PROVENZANO and R. C. MARIS (1983). Seasonal distribution of larvae of *Callinectes sapidus* (Decapoda) in the waters adjacent to Chesapeake Bay. *J. Crustacean Biol.* 3 (1): 532-531.
- MONOD, T. H. (1956). Hippidae et Brachyura ouest-africains. *Mémoires de l'Institut Français d'Afrique Noire* 43: 1-374.
- NGOC-HO, M. (1981). A taxonomic study of the larvae of four thalassinid species (Decapoda: Thalassinidea) from the Gulf of Mexico. *Bull. Brit. Mus. (Nat. Hist.), Zool.* 40 (5): 237-273.
- PILLAI, N. N and K. H. MOHAMED (1973). Larval history of *Macrobrachium idella* reared in the laboratory. *J. Mar. Biol. Assoc. India* 15 (1): 359-385.
- POWELL, C. E. (1979). Three alpheid shrimps of a new genus from West African fresh and brackish waters: taxonomy and ecological zonation. *Revue de Zoologie africaine* 93 (1): 116-150.
- POWELL, C. E. (1980a). Fresh and brackish water shrimps of economic importance in the Niger Delta. pp 254-285 in: *Proceedings of the 2nd Annual Conference of the Fisheries Society of Nigeria*. Kainji Lake Research Institute, New Bussa, Nigeria, VI + 295pp ISBN 978-177-010-4.
- POWELL, C. E. (1980b). *Keys for the Identification of Nigerian Crabs*. Mimeograph for African Regional Aquaculture Center, Abuja, Port Harcourt. 15pp.

- POWELL, C. B. (1985). The Decapod Crustaceans of the Niger Delta. pp 226–238 in: B.H.R. Wilcox and C. B. Powell eds, *The Mangrove Ecosystem of the Niger Delta. Proceedings of a Workshop*. University of Port Harcourt Press V + 357pp ISBN 978–2321–43–5.
- POWELL, C. B. In Press. *Guide to the Shrimps of Nigeria* NIOMR Technical Paper. Nigerian Institute for Oceanograph and Marine Research, Lagos.
- VILLE, J. P. (1971). Biologie de la reproduction des *Macrobrachium* de Cote d'Ivoire. III. Description des premiers stades larvaires de *Macrobrachium vollenhovei* (Herklots, 1857). *Ann. Univ. Abidjan, Ser. E., Ecologie, IV* (1): 325–341.
- VILLE, J. P. (1971). Biologie de la reproduction des *Macrobrachium* de Cote d'Ivoire. III. Description des premiers stades larvaires de *Macrobrachium vollenhovei* (Herklots, 1857). *Ann. Univ. Abidjan, Ser. E., Ecologie, IV* (1): 325–341.
- WARNER, G. F. (1977). *The Biology of Crabs*. E. I. S. Science. London XV + 202.
- WILLIAMSON, D. I. (1977). Larval development in a marine and freshwater species of *Macrobrachium*. *Crustaceana* 23: 282–298.
- WILSON, A. K. (1980). Studies on decapod crustacea from the India River region of Florida. XV. The larval development under laboratory condition of *Euchirograpsus americanus* A. Milne Edwards, Milne Edwards, 1880. (Crustacea Decapoda, Grapsidae) with notes on grapsid subfamilial larval characters. *Bull. Mar. Sci.* 30 (4): 756–775.

## LEGENDS TO FIGURES

- Figure 1 Stage 1 larvae of (a) caridean shrimp and (b) brachyuran crab. Al, antennule; A2, antenna; exA2, antenna exopod scA2, antennal scale; aeA1, antennule aesthetascs; ds, dorsal spine; kn, dorsolateral knob; ls, lateral spine; mxp, maxilliped; rs, rostral spine; T, telson. Tp, telson process.
- Figure 2 Brachyuran telson types. (a) Type A; (b) Type B (*Clibanarius*); and (c) Type C (xanthids).
- Figure 3 Anomuran telson types. (a) Type A (*Callichirus*); (b) Type B (*Clibanarius*); and (c) Type C (*Upogebia*).
- Figure 4 Caridean telson types. (a) Type A (Atyidae) (b) Type B; (c) Type C; (d) Type D (*Latreutes*).
- Figure 5 Porcellanid carapaces. (a) *Petrolisthes*; (b) *Pachycheles*.
- Figure 6 Brachyuran carapaces. (a) *Pilumnopus*; (b) *Panopeus*; (c) *Uca*; (d) *Cardisoma*; (e) *Calabarium*; (f) *Lillyanella*; (g) *Ecphantor*.
- Figure 7 Caridean carapaces. (a) Type A., (b) Type B.
- Figure 8 Caridean and anomuran abdomen.
- Figure 9 Brachyuran abdomes (a) Type A; (b) Type B.
- Figure 10. Grapsinae abdomens. (a) *Goniopsis peli*; (b) 4th abdominal somite in *Pachygrapsus gracilis* and (c) *P. transversus*.
- Figure 11 Camptandriinae abdomens. (a) *Telmatothrix powelli* showing 5th abd. somite laterally expanded; (b) Other genera.
- Figure 12 4th and 5th abdominal somites of carideans with (a) lateral spines on 5th somite; and (b) short posterodorsal lobe on 4th somite.
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- Figure 14 Antennule of porcellanids (a) *Petrolisthes* and (b) *Pachycheles*.
- Figure 15. Brachyuran antennules (a) Type A and (b) Type B.
- Figure 16. Caridean antennal scales with (a) 4 distal segments and (b) 5 distal segments.
- Figure 17 Anomuran antennae (a) *Upogebia*; (b) *Clibanarius*.
- Figure 18. Xanthid antennae (a) *Panopeus*, (b) *Pilumnopus*.
- Figure 19. Grapsinae antennae: (a) *Pachygrapsus transversus*; (b) *P. gracilis* and *Goniopsis*.
- Figure 20. Camptandriine antenna.
- Figure 21. Sesarminae antennal exopods (a) Type A with smooth apex; (b) Type B with toothed apex.





