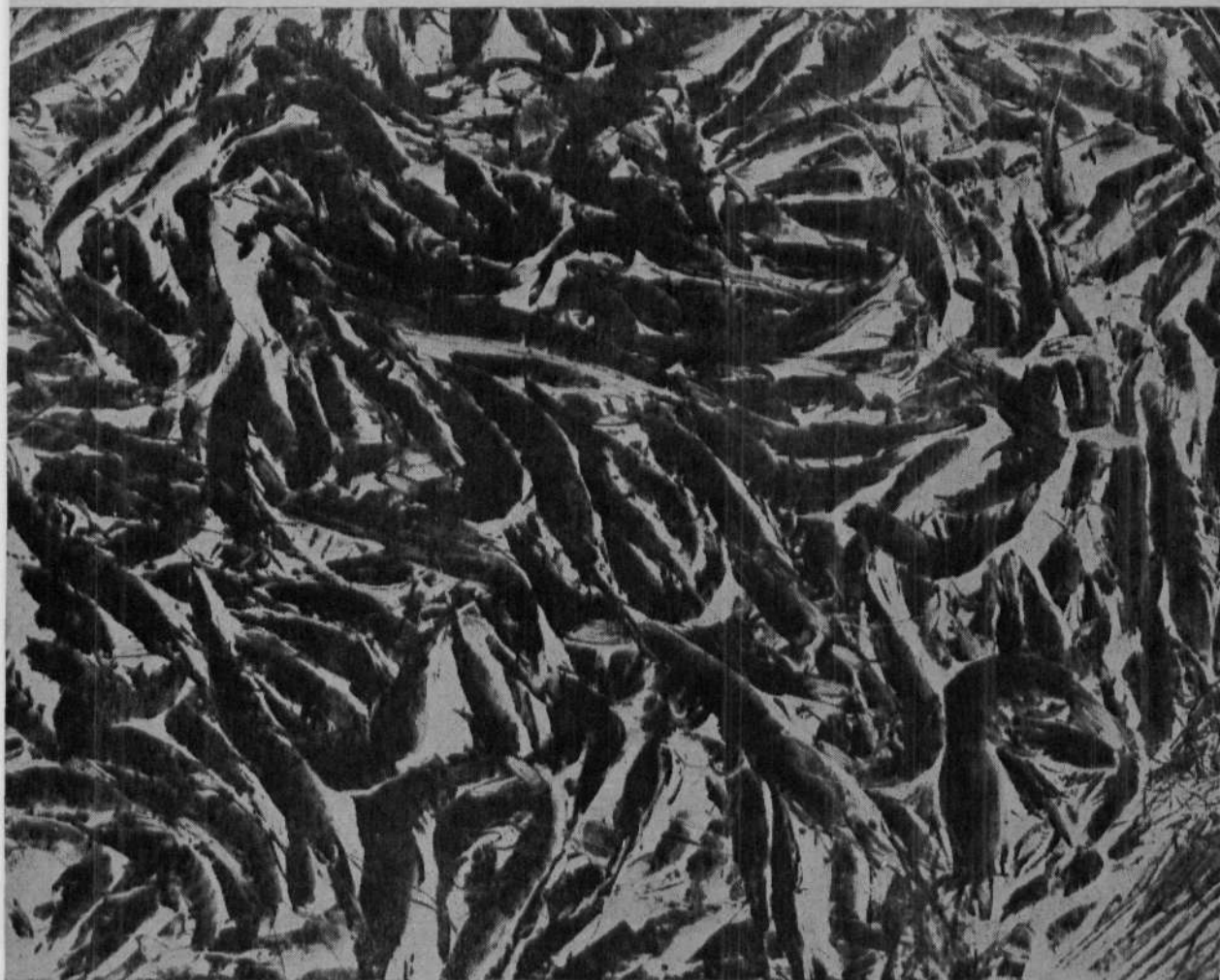




**CMFRI**  
**Special Publication**  
Number 47

**ANNOTATED BIBLIOGRAPHY OF  
COMMERCIALY IMPORTANT PRAWNS  
AND PRAWN FISHERIES OF INDIA**



**Central Marine Fisheries Research Institute**  
COCHIN

*(Indian Council of Agricultural Research)*

P. B. No. 2704, E. R. G. Road, Cochin 682 031, India

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*Compiled by*  
**E. JOHNSON**

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**DECEMBER 1989**

**Restricted circulation**

*Published by*

**Dr. P. S. B. R. JAMES**  
**Director**  
**Central Marine Fisheries**  
**Research Institute**  
**P. B. No. 2704**  
**E. R. G. Road**  
**Cochin-682 031**  
**India**

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**Printed at**  
**S. K. Enterprises, Cochin-18**

## **PREFACE**

Research and Development efforts on marine fisheries of the country have contributed to a rapid growth of literature. However, no attempts have so far been made to develop bibliographies on commercially important species/groups of marine fishes of India, so that the large community of research workers and fishery managers could be benefited. Therefore, to begin with, the Central Marine Fisheries Research Institute has taken up a programme of compilation of 'Annotated Bibliographies' on major commercially important fisheries like those of prawns, oil sardine, mackerel, silver-bellies, ribbon-fishes and Bombay-duck.

Efforts have been made to include all the relevant literature in these bibliographies. There could be some omissions and the bibliography is not claimed to be complete in itself. The Institute would welcome information on omissions of any important citations.

Annotations have been done carefully to give at a glance the correct details from the original publications. Whenever the authors' abstracts are found sufficient these were reproduced as such, otherwise either the available abstracts are modified or fresh abstracts made based on the contents of the original articles.

The present number entitled 'Annotated bibliography of commercially important prawns and prawn fisheries of India' is the first in the series of bibliographies proposed to be published. I hope this will be useful for the scientists and others in the field by enabling them to have a rapid survey of relevant literature.

I appreciate the interest taken and efforts made by Dr. E. Johnson of the Library and Documentation Division for the compilation of this annotated bibliography.

**Dr. P. S. B. R. JAMES**  
Director

Cochin-682 031  
2-9-1989.

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## I. SYSTEMATICS AND DISTRIBUTION

1. ACHUTHANKUTTY, C. T.; SREEKUMARAN NAIR, S. R. 1982. Penaeid prawn population and fry resource in a mangrove swamp in Goa, India. In: Proceedings of the Symposium on Coastal Aquaculture, Coshin, India 12-18, Jan. 1980. Marine Biological Association of India, part 1, p. 190-195.

Penaeid prawns consisting of the commercial species *Penaeus merguensis*, *Metapenaeus dobsoni* and *M. monoceros* abundantly occur in the mangrove swamp during the premonsoon season. Recruitment to the swamp takes place when the individuals are between 10mm and 20mm in size. Growth rate and period of stay in this environment vary with species. About 46.5% of the population is comprised of juveniles ranging in size from 10mm to 30mm.

2. ACHUTHANKUTTY; C. T.; PARULEKAR, A. H. 1986. Distribution of penaeid prawn larvae in the coastal waters of Goa. *Indian J. Mar. Sci.*, vol. 15 (1) : 45-47.

Larval and postlarval distribution of 4 commercially important penaeid prawns were studied in the coastal waters of Goa. The seasonal variation and zone-wise depth distribution of larval and postlarval stages of 4 commercially important penaeid prawns, viz. *Metapenaeus dobsoni*, *M. affinis*, *P. merguensis* and *Parapenaeopsis stylifera*, related to the breeding behaviour of individual species in the coastal waters of Goa have been compared and correlated with their breeding behaviours.

3. AHMAD NAJIR 1957. Prawn and prawn fishery of East Pakistan. Govt. of East Pakistan, Directorate of Fisheries, 31 pp.

Systematic account, East Pakistan prawns- *Penaeus canaliculatus*, *P. semisulcatus*, *P. indicus* var. *penicillatus*, *Metapenaeus monoceros*, *M. lysianassa*, *M. brevicornis*, *Parapenaeopsis stylifera*, *P. sculptilis*, *P. uncta*, *Solenocera indicus*, *Alpheus euphrosyne*, *Leander styliferus*, *Palaemon mirabilis*, *P. lamarrei*, *P. dayanus*, *P. malaccolmsoni* and *P. rudis* and key for the identification are given. Production, methods of fishing, price, preservation and curing are also dealt with.

4. ANDERSON, W. W; LINDER, M. J. 1945. A provisional key to the shrimps of the family penaeidea with special reference to American forms. *Trans. Am. Fish. Soc.*, 37: 284-319.

Species name with detailed illustrations of family and subfamily are given in this key.

5. ALOCK, A. 1901. A descriptive catalogue of the Indian deep-sea Crustacea, Decapoda Macrura and Anomala, in the Indian Museum-Being a revised account of the deep-sea species collected by the Royal Indian Marine Survey Ship "INVESTIGATOR" Indian Museum, Calcutta, India, 286 pp.

In a dependent Part I of this classical monograph (204 pp), 117 species of Macrurous Decapod Crustaceans (Penaeidae-27; Caridea-58; Stenopidea-3; Astacidea-20; Thalassidea-9) dredged by Royal Indian Marine Survey Ship "Investigator" in deep water, some of them in depths beyond 1000 F, between 65°E and the parallels of 5° and 24°N during 1885-1900 are catalogued with detailed descriptions. Of the 117 species, 69 were believed to be proper to the seas of India; while 48 were already known to occur in other seas. Of these 48 widely-ranging species, 25 were known to inhabit the North Atlantic, and 29 the Pacific 6 species being common to the Atlantic and Pacific.

The various criteria adopted for classifications, the distributions of the species and the keys to the families, subfamilies, genera and species are given. Four genera, namely *Sympasiphaea*, n. gen., *Iconaciopsis* n. gen., *Gebicula* n. gen., *Paraphylochelles*, n. gen., 1 new subgenus, namely *Plastocrangon*; and 10 new species, *Sympasiphaea annacctens*, n. sp., *Heterocarpus wood-masoni*, n. sp., *Aegeon affine*, n. sp., *Spongicola andamanica*, n. sp., *Niphropsis ensirpstris*, n. sp., *Willemoesia indica*, n. sp., *Iconaciopsis laccadivensis*, n. sp., *I. andamanensis* n. sp., *Gebicula exigua*, n. sp., *Munida vigillarum*, n. sp., are described for the first time.

The figures of 71 species are given in 20 plates, distributively in Illustrations of Zoology, Indian Museum, Calcutta, Parts I-IV, (1892), II (1894) III (1895) IV (1896) and IX (1901) as follows:



*A. Vistæus (Plesiopeneus) Edwardsianus*, (Johnson); *A. (P) coruscans* (Wood-Mason); *A. (Aristaeomorpha) rostridentata* (S. Bate); *Pasiphsea sivado*, (Risso); *P. unispinosa*, Wood - Mason; *Pasiphaea (Phye) alcocki*, Wood-Mason; *Prapasiphaea Gilesii*, Wood-Mason; *Acanthephyra armata*, A. M. Edw.; *A sanguinea*, Wood-Mason, *A. microphthalmus*, S. I. Smith; *A. Purtirostris*, Wood-Mason, *Nephrops thomsoni*, S. Bate var. *andamanica* Wood-Mason.

#### Part II

*Glyphocrangon investigatoris*, W. M., *G. Smithii*, W. M., *G. priononota*, W. M., *G. unquiculata* W. M., *G. gilesii*, W. M., *G. (Plastocrangon) caecescens*, W. M., *G. (Plastocrangon) caeca*, W. M., *Nephrops thomsoni*, S. Bate var. *andamanica* Wood-Mason, *Polycheles*, *Phosphorus*, Alcock; *Polycheles ceratus*, Alcock, *Pentacheles hextii* Alcock, *Pentacheles heaumontii*, Alcock.

#### Part III

*Sergestes hamifer*, Alc. and Anders, *Pasiphaea sivado*, (Risso) *Psathyrocaris plumosa*, Alc. and Anders, *Psathyrocaris platyophthalmus* Alc. and Anders, *Aegeon (Parapontocaris) andamanensis*, (W. M.) *A. (Parapontocaris) bengalensis* (W. M.) *Glyphocrangon (Prionocrangon) ommatosteres* (W. M.) *G. (Plastocrangon) cerea*, Alc and Anders, *Alpheus macroceles*, Alc and Anders. *Polycheles andamanensis*, Alcock *Pentacheles hextii*, Alcock, *Pentacheles carpenteria*, Alcock.

#### Part IV

*Solenocera hextii*, Wood-Mason, *Haliporus virilis*, S. Bate *Palaemon Brachycarpus Laccadivensis*, *Acanthephyra cristata*, Faxon, *Engystenopus palmipes*, Alc and Anders, *Nephropsis stewarti*, Wood-Mason, *Nephropsis Carpenteri*, Wood-Mason, *Calocaris (Calastacus) investigatoris*, Anderson, *Callianassa garcigena*, Alc. and Anders.

#### Part VII

*Penaeus investigatoris*, Anderson, *Haliporus taprobanensis*, Anderson, *Benthescymus investigatoris*, Anders., *Sergestes rubroguttatus*, Wood-Mason, *Heterocarpus laevigatus*, S. Bate, *Aegeon medium*, (Alc. and Anders) *Alpheus shearmeii* Alc and Anders, *Richardina spongicola*, Alc and

Anders, *Calocaris (Calastacus) felix*, Alc and Anders, *Callianassa lignicola*, Alc and Anders.

*Part IX*

*Penaeus coniger*, Wood-Mason, *Penaeus rectacutus*, Spence Bate, *Solenocera annestens*, W. M., *Sergestes bisulcatus*, Wood-Mason, *Pasiphasa (Phye) alcocoki*, Wood-Mason, *Psathyrocaris fragilis*, Wood-Mason, *Ephyrina hoskynii*, Wood-Mason, *Pandalus (Plesionika) alcocki*, Anders, *Pandalus (Plesionika) bifurca*, Alc and Anders, *Heterocarpus tricarinatus*, Alc and Anders, *Heterocarpus Wood-Masoni* n. sp., *Psolidopus Huxleyi*, Wood-Mason, *Aegeon affine*, n. sp. *Engystenopus palmipes*, Alc. and Anders, *Eryonicus indicus*, Alc and Anders., *Calcaris alcocki*, Mc Ardle.

6. ALCOCK, A. 1905. A revision of the "genus" *Penaeus* with diagnoses of some new species and varieties. *Ann. Mag. Nat. Ser. 7 (16)* : 508-532.

Reviewing the taxonomical changes hitherto undergone by the genus *Penaeus*, that had originally been established by Fabricius in 1778 to contain three species from Indian Ocean and later, in 1981, been dealt with more critically by Milne-Edwards, incorporating in it 11 other species and removing some to a new genus *Penaeopsis* which he created, Alcock thoroughly revises the genus. Sifting carefully all the then existing species including those the author himself had described, he distributes them among 8 genera, namely *Penaeus*, *Heteropenaeus*, *Metapenaeus*, *Parapenaeus*, *Parapenaeopsis*, *Trachypenaeus*, *Atypopenaeus* and *Xiphopenaeus* all of them he describes in detail, giving a key to these and listing the species that are assigned to each. In addition, the diagnoses of nine new forms, viz. *Penaeus indicus* var. *penicillatus* nov., *Parapenaeus longipes*, sp. n., *Metapenaeus stridulens* (Wood-Mason MS), *Parapenaeopsis maxillipedo*, sp. n., ?, *Parapenaeopsis uncta*, sp. n., *Parapenaeopsis nana*, sp. n., *Parapenaeopsis acclivirostris*, sp. n., *Parapenaeopsis hungerfordi*, sp. n., *Trachypenaeus asper*, sp. n., are given.

7. ALCOCK, A. 1906. Prawns of the *Penaeus* Group. Catalogue of the Indian Decapod Crustacea in the Collection of the Indian Museum, Part 111. Macrura. Indian Museum, Calcutta, 55 pp.

This is the Third, but independent, Part of a monograph of the Decapod Crustacea of that portion of the Oriental region which lies within the political boundaries of the then British India: it treats only of the prawns of the manipe *Penaeus*, (Family penaeidae; sub family Penaeinae)

The distinguishing characters of the *Penaeus* group of prawns, their distribution and a key to the various genera, namely *Penaeus*, *Heteropenaeus*, *Metapenaeus*, *Parapenaeus*, *Parapenaeopsis*, *Trachypenaeus*, *Atypopenaeus* and *Xiphiopenaeus*, are given followed by their taxonomic details and keys to the different species comprised by them. The following 29 Species are described in detail, giving beautiful and exhaustive illustrations and known distribution;

*Penaeus monodon*, Fabricius, Bate; *Penaeus semisulcatus*, De Haan; *Penaeus indicus*, Edw; *P. indicus* var *merguiensis*, de Man; *P. var. Penicillatus*; *P. canaliculatus*, Oliv; *Metapenaeus monoceros*; *M. affinis*, Edw; *M. dobsoni*, Miers; *M. brevicornis* Edw., *M. lysianassa*, (de Man); *M. ensis*? (de Maan); *M. coniger*, Wood-Mason; *M. coniger* var *andamanensis* Wood-Mason; *M. stridulans*, Wood-Mason; *M. mogiensis* Rathbun.

*Parapenaeus fissurus* (Spence Bate); *P. investigatory* *P. longipes*, Alcock; *P. rectacutus* Spence Bate; *P.* Wood-Mason; *P. stylifera* (Edw.); *P. sculptilis*, Heller, *P. sculptilis* var. *cultrirostris*, *P. uncta*, Alcock, *P. maxillipedo*; Alcock; *P. nana*, Alcock, *P. acclivirostris*, Alcock; *Trachypenaeus asper* Alcock; *Atypopenaeus compressipes*, Henderson.

A world list of the then known Penaeids is presented toward the end giving the distribution and references pertaining to each.

8. BATES, C.S. 1888.

Reports on the Crustacea Macrura dredged by H. M. S. Challenger during the years 1873-1876 Report of the Scientific Results of the voyage of H.M.S. Challenger during the years 1873-76. Plates pp: 942.

The plates which are 150 in number, illustrating the text of Spence Bates report on 157 species of Crustacea Macrura dredged by Challenger, includes some useful illustrations of *Penaeus indicus*, *Penaeus monodon*,

*Acetes indicus* among numerous other prawns and shrimps that are hardly of Indian interest. There are figures included also of Penaeid, *Sergestes* and *Lucifer* developmental stages.

9. BATE, C. 1888. Report on the Crustacea Macrura dredged by H.M.S., Challenger during the years 1873-1876 *Report on the scientific results of the voyage of H.M.S. Challenger during the Year 1873-76, Zoology*. Vol. XXIV. Text. Reprinted by Johnson Reprint Corporation, Perkeley Square House, London W. 1

In this classical monograph, setting forth the identities, structural descriptions and geographical and bathymetric distributions - all in great detail - of a large number of macrurans, including numerous new ones, that had been collected from the surface down to about 4 miles in Atlantic, Pacific and Indian Oceans, the major portion, of about 700 pages (pp 200-918), deal with prawns and shrimps of the families Penaeidae, Sergestidae, Crangonidae, Nikidae, Alpheidae, Hippolytidae, pandalidae, Thalassocaridae, Atpidae, Palaemonidae, Stylodactylidae, Pasiphæidae, Oodeopidae and Hectarthopidae. Although those that are of interest from the present Indian fisheries point of view are very few among these, namely *Penaeus indicus* Milne Edwards and *Penaeus monodon* Fabricius, the monograph is a taxonomists gold mine in as much as among the 289 species described in it, giving in detail the synonymy, habitat, geographical distribution, comparative accounts, etc., 185 are new to science. Also described are 39 new genera which are created to accommodate not only quite a few new species but also a considerable number of old ones that needed to be revised.

The new genera and the new species are :

*Penaeus canaliculatus*, var *australiensis*, nov., *P. incisipes*, n. sp.,  
*P. anchoralis*, n. sp., *P. philippinensis*, n. sp., *P. fissurus*, n. sp.,  
*P. rectacutus*, n. sp., *P. tenellus*, n. sp.

1. *Philonicus*, n. gen., *P. mulleri*, n. sp., *P. pectinatus*, n. sp.
2. *Artemesi*, n. gen., *Artemesi longinaris*, n. sp., *Haliporus equalis* n. sp.,  
*Sicyonia laevis*, n. sp., *Hemipenaeus gracilis* n. sp.
3. *Peteinura*, n. gen. (Flying tail), *Peteinura gubernata*, n. gen. et. sp.  
*Benthesicymus pleocanthus*, n. sp., *Gennadas intermedius*, n. sp.

4. *Platysacus*, n. gen. (flat shield), *Platysacus crenatus*, n. gen. et. sp., *Mastigopus spiniventralis*, n. sp., *Sergestes intermedius*, n. sp., *S. dorsispinalis*, n. sp., *S. laterodentatus*, n. sp., *S. nasidentatus*, n. sp., *S. ovatoculus*, n. sp., *S. parridens*, n. sp., *S. longirostris*, n. sp., *S. junceus*, n. sp., *S. longispinus*, n. sp., *S. penerinkii*, n. sp., *S. fermerinkii*, n. sp., *S. longicollus*, n. sp., *S. praecollus*, n. sp., *S. semiarmis*, n. sp., *S. laeviventralis*, n. sp., *S. spiniventralis*, n. sp., *S. profundus*, n. sp., *S. ventridentatus*, n. sp., *S. nutringuedens*, n. sp., *S. dissimilis*, n. sp.
5. *Sciacaris*, n. gen., *S. telsonis*, n. sp.
6. *Zoontocaris*, n. gen., *Z. galathea*, n. gen. et. sp. *Z. approximus*, n. sp.
7. *Sestertius*, n. gen., *S. duplicidentis*, n. sp., *Pontophilus gracilis*, n. sp., *P. profundus*, n. sp., *P. junceus*, n. sp.
8. *Pontocaris*, n. gen., *Pontocaris propensalata*, n. sp., *P. pennata*, n. sp., *Glyphocrangon granulosis*, n. sp., *G. podager*, *G. regalis*, *G. hestacauda*, n. sp., *G. acuminata*, n. sp., *Nike processa*, n. sp., *Athanas velocolus*, n. sp.
9. *Parathanas*, n. gen., *P. decorticus*, n. g. en. et. sp., *P. immaturus*, n. sp.
10. *Cheriothrix*, n. gen., *Cheriothrix parvimanus*, n. gen. et. sp., *Alpheus cristicigitus*, n. sp., *A. bermudensis*, n. sp., *A. longimanus*, n. sp., *A. prolificus*, n. sp., *A. intrinsecus*, n. sp., *Betaeus microstylus*, n. sp., *Betaeus malleodigitus*, n. sp.
11. *Paralpheus*, n. gen.
12. *Synalpheus*, n. gen.
13. *Platybema*, n. gen., *P. rugosus*, n. gen. et. sp., *Latreutes planus*, n. sp., *L. unidentatus*, n. sp., *Hippolyte bidentatus*, n. sp., *H. projecta*, n. sp.
14. *Spintocaris*, n. gen.
15. *Nauticaris*, n. gen., *N. marionis*, n. gen. et. sp., *N. futillirostris*, n. sp., *N. unirecedens*, n. sp.

16. *Hatairus*, n. gen., *H. tenuis*, n. gen. et. sp., *H. debilis*, n. sp.
17. *Chorismus*, n. gen., *C. tuberculatus*, n. gen. et. sp.
18. *Merhipolyte*, n. gen., *M. egulhasensis*, n. gen. et. sp., *M. orientalis*, n. sp.  
*Amphiplectus depressus*, n. sp., *Heterocarpus dorsalis*, n. sp.  
*H. alphonsi* n. sp., *H. gibbosus*, n. sp., *H. laevigatus*, n. sp.
19. *Plesionika*, n. gen., *P. uniproducta*, n. gen. et. sp., *P. semilaevis*, n. sp.,  
*P. unidens*, n. sp., *P. brevirostris*, n. sp.
20. *Nothocaris*, n. gen., *N. rostricrescentis*, n. gen. et. sp., *N. ocellus*, n. sp.,  
*N. spiniserratus*, n. sp., *Pandalus magnoculus*, n. sp., *P. amplus*,  
n. gen. et. sp., *Chlorotocus incertus*, n. sp.
22. *Dorodotes*, n. gen., *D. reflexus*, n. gen. et. sp., *D. levicarina*, n. sp.,  
*Thalassocaris danae*, n. sp., *T. stimpsoni*, n. sp.
23. *Diaphoropus*, n. gen., *D. versipellis*, n. gen. et. sp., *D. longidorsalis*, n. sp.
24. *Kyptocaris*, n. gen., *K. stylofrontalis*, n. gen. et. sp., *Atya serrata*, n. sp.
25. *Caricyphus*, n. gen., *C. cornutus*, n. gen. et. sp., *C. serratmarginis*, n. sp.,  
*C. gibberosus*, n. sp., *C. turgidus*, n. sp.; *C. angulatus*, n. sp.
26. *Rhomaleocaris* n. gen., *R. hamulus*, n. gen. et. sp.
27. *Aneboecaris*, n. gen., *A. quadroculus*, n. gen. et. sp.
28. *Bentheocaris*, n. gen., *B. exuens*, n. gen. et. sp., *B. stylostratis*, n. sp.  
*Acanthephyra longidens*, n. sp., *A. media*, n. sp., *A. angusta*, n. sp.,  
*A. sica*, n. sp., *A. acanthitelsonis*, n. sp., *A. edwardsii*, n. sp.,  
*A. carinata*, n. sp., *A. acutifrons*, n. sp., *A. kingsleyi*, n. sp.,  
*A. brevirostris*, n. sp., *A. brachytesoni*, n. sp., *A. approxima*, n. sp.
29. *Systellaspis*, n. gen., *S. lanceocaudata*, n. gen. et. sp., *Ophiophorus*,  
*longirostris* n. sp., *O. brevirostris*, n. sp.
30. *Comphyronotus*, n. gen., *C. semistriatus*, n. gen. et. sp., *C. capensis*, n. sp.,  
*C. vagans*, n. sp.

31. *Brachycarpus*, n. sp., *B. savignyi*, n. gen. et. sp., *B. audouini*, n. sp., *Nematocarcinus lanceopes*, n. sp., *N. undulatipes*, n. sp., *N. lanceopes*, n. sp., *N. longirostris*, n. sp., *N. altus*, n. sp., *N. products*, n. sp., *N. tenuipes*, n. sp., *N. parvidentatus*, n. sp., *N. gracilis*, n. sp., *N. paucidentatus*, n. sp., *N. tenuirostris*, n. sp., *N. serratus*, n. sp., *N. hiatus*, n. sp., *N. intermedius*, n. sp.
32. *Stochasmus*, n. gen. (a conjecture), *S. exilis*, n. gen. et. sp., *Notostomus patentissimus*, n. sp., *N. murrayi*, n. sp., *N. japonicus*, n. sp., *N. perlatus*, n. sp., *N. brevirostris*, n. sp., *N. longirostris*, n. sp.
33. *Tropicaris*, n. gen., (Keeled shrimp), *T. planipes*, n. gen. et. sp., *T. tenuipes*, n. sp., *Hymenodora duplex*, n. sp., *H. rostrata*, n. sp., *H. glauca*, n. sp., *H. mollicutis*, n. sp., *Stylodactylus discissipes*, n. sp., *S. orientalis*, n. sp., *S. bimaxillaris*, n. sp., *Lepotchela serratorbita*, n. sp., *Pasiphaea cristata*, n. sp., *P. amplidesn*, n. sp., *P. acutifrons*, n. sp.
34. *Orphania*, n. gen. (Orphan shrimp), *O. tenuimana*, n. gen. et. sp.
35. *Oodeopus*, n. gen., *O. geminidentatus*, n. gen. et. sp., *O. serratus*, n. sp., *O. armatus*, n. sp., *O. intermedius*, n. sp., *O. duplex*, n. sp., *O. longispinus*, n. sp., *O. gibbosus*, n. sp.
36. *Procletes*, n. gen. (Challenger), *P. biangulatus*, n. gen. et. sp.
37. *Ictopus*, n. gen. (foot-like), *Ictopus arcurostris*, n. gen. et. sp.
38. *Hectarthropus exilis*, n. gen. et. sp., *Hectarthropus*, n. gen., *H. comereus*, n. sp., *H. expansus*, n. sp., *H. tenuis*, n. sp.
39. *Eretmocaris*, n. gen., *E. remipes*, n. gen. et. sp., *E. stylorastris*, n. sp., *E. longicaulis*, n. sp., *E. corniger*, n. sp., *Amphion provocatories*, n. sp.

Another aspect the monograph contains, and by which the work has been made all the more singular, is the life cycle-as complete as the collections would permit-of almost every genus, giving detailed illustrated descriptions and habitats of larval stages.

10. BERNARD, K. H. 1950. Descriptive catalogue of South African crustacea (Crabs and shrimps). *Ann. S. Afr. Mus.*, 38: 1-837

A comprehensive taxonomical monographs of African crabs, prawns and shrimps and stomatopods, covers 490 species in 238 genera in 60 families. Giving detailed taxonomy from the class level it gives keys to general and keys to tribes and subtribes, keys to families, keys to general and keys to species-it gives the history, description etc of each family, genus and species, providing with illustrations wherever necessary and adding a remark under each. 6 out of 148 species in 62 genera in 18 families of prawns and shrimps treated the following species that are relevant to India are included. *Penaeus monodon*, *P. semisulcatus*, *P. indicus*, *P. canaliculatus*, *P. japonicus*; *Penaeopsis hilarulus*, *Metapenaeus monoceros*; *M. affinis* and *Parapenaeopsis acclivirostris*.

11. DALL, W. 1957. A revision of the Australian species of Penaeinae (Crustacea decapoda: penaeidae). *Aust. J. Mar Freshwater Res.* 8 : 136-231.

Twenty-eight Australian species of Penaeidae, of which six are new are fully described and figured 4. Full keys to genera and species, and a glossary of special terms are included. The zoogeography of Australian and Indo-west Pacific region is discussed.

12. DELMENDO, M. N. and RABANAL, H. R. 1973. Cultivation of 'Sugpo', (Jumbo tiger shrimp) *Penaeus monodon* Fabricius in the Philippines. *Philippine J. Fish.*, 8 (?): 159-175.

The cultivation of *P monodon* in the estuarine fish ponds in the Philippines either as pure culture or in combination with *Chanos* was found to be a lucrative investment. In order to minimize the losses due to the difficulty of collecting all the growing sugpo in the nurseries, it is recommended that the nursery ponds should be located adjacent to and at a slightly higher level than the rearing ponds where the sugpo are to be grown to marketable size. In this way, transplantation is effected by simply making a cut in the dike between the nursery and rearing pond



where the sugpo spread without the necessity of handling them. Observations made during limited periods on the rate of growth of the shrimp are recorded, indicating the need for studies to find out suitable feed when the natural food is exhausted. The need to stock sugpo in ponds which have previously been cleaned, drained and dried so as to reduce the danger of predation to a minimum is also indicated. Proper pond layout and construction are also suggested to eliminate the cumbersome methods of collecting and transplanting the stock. As the most important factor that might limit the development of this promising industry being uncertain and limited supply of stocking material, a nation wide survey is suggested to determine sugpo fry grounds and seasons as well as the feasible methods for their capture.

13. DEMAN, 1908. The fauna of brackishwater ponds at Port Canning lower Bengal. Part X. Decapod crustacea with an account of small collections from brackishwater near Calcutta and in the Dacca District, Eastern Bengal. *Rec. Indian Mus.*, 2 : 211-231.

Of the 10 species of decapods recorded, 6 are prawns, namely *Leander* sp., *Palaemon* (Eupalaemon) *Lamarrei*, H. M. Edw; *Palaemon* sp., *Caridina* sp., *Caridina propinqua* sp. nov. Of the unascertained species, the specific identification of *Leander*, sp the collection of which consisted of 70 specimens was not possible mainly because of all the specimens being young, the largest one 23-24mm. However a comparison of it being made with the closely allied species *L. styliferus* and *L. tennipes*. The identification of the *cardinia* sp. was not possible because of the single specimen in the collection was too damaged.

14. DEMAN, J. G. 1911. Decapoda of the Siboga Expedition. *Siboga-Exped.*, XXXIX a<sup>1</sup> : 465 p.

In this monograph 113 sp. and 20 var; belonging to 10 genera of shrimps of the family Alpheidae collected by the Siboga are described, which include 57 new species and 17 new varieties. Key to the known Indo-Pacific species of each genus is given before the detailed description of species of the genus collected by Siboga.

15. DEMAN, J. G. Decapoda of the Siboga Expedition. Part 1. Family Penaeidae. *Siboga-Exped.*, 39a : 131p.

Fifty four species and 2 varieties including 20 new ones of Penaeidae belonging to 3 genera collected during the Siboga Expedition (1899-1900) from the East Indian Archipelago, 24 species from great depths and abysses are described.

The new species described are *Gennadas Passithea* de Man, *Gennadas clavicarpus* de Man; *Hemipenaeus Siboga* n. sp.; *Haliporus propinguus* de Man; *Haliporus Sibogae* de Man; *Solenocera malantho* de Man *Solenocera Faxoni* de Man; *Penaeopsis elegans* (de Man); *Penaeopsis distinctus* (de Man); *Penaeopsis hilarulus* n. sp (?); *Penaeopsis quinque-dentatus* (de Man); *Penaeopsis borradailei* n. sp. *Atypopenaeus dearmatus* de Man, *Trachy penaeus salaco* de Man, *Parapenaeopsis venusta* de Man *Sicyonia benthophila* de Man; *Sicyonia fallax* de Man; *Sicyonia rectirostris* de Man; and *Sicyonia trispinosa* de Man.

Among the species of commercial interest in India covered are *Penaeopsis monoceros*, Fabr; (*M. monoceros*), *P. affinis* Edw; (*M. affinis*); *Penaeus semisulcatus*, de Haan; *P. Carinatus* Dana; *P. indicus* H. W. Edw. var. *longirostris* de Man; *P. merguensis* de Man, *P. canaliculatus* Oliv, *P. latisulcatus* kish.

Given in the monograph also is a comprehensive list of the species of the family Penaeidae including the 54 recorded in this monograph as known September 1010 (along with the place of occurrence of each).

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- 16. DORE, IAN; FRIMODT, CLAUS.** 1987. An illustrated guide to shrimp of the world. O' Spray Books, Huntington, Newyork. 229 p

Meant for people in the seafood business, from fishermen to restaurant operators, the book tries to provide information that are useful to the trade through its five chapters, including the introduction, which is chapter 1. Chapter 2 is a simple guide to help the layman to identify the shrimp Chapter three is a shrimp encyclopedia, giving in alphabetical order all the useful information relating to shrimp and shrimp industry. Chapter 4th illustrated Guide proper is a catalogue of 70 major commercial shrimps species of the world including the Indian ones with pictures in nearly natural colours, and the specific names and the popular names prevalent in various countries. Chapter 5 giving comments on the literature which form the main source for the book, is followed by a bibliography.

17. FISHER, W AND G. BIANCHI (eds). 1984. FAO species identification sheets for fishery purposes. Western Indian Ocean (Fishing Area 51). Prepared and printed with the support of the Agency (DANIDA). Rome, Food and Agricultural Organization of the United Nations, Vols. 1-6 : Shrimps and Prawns.

Having given demonstrative diagrams and general remarks acquaint with the technical terms and principal measurements used in taxonomy as well as one showing the general life history of Penaeids, this section sets out to give the vernacular and scientific names, distinctive characters maximum size, distribution and behaviour, current fishing grounds and catches and the fishing gear and forms of utilization of the commercially important shrimps and prawns of the area, viz, 6 Palaemonids, 36 Penaeids, 6 sergestids, 4 Sicyonids (including 2 uncertain ones) and 4 Solenocenids, are given to aid fishery workers in easy identification. Utility keys to the genera of each family are also given.

18. GEORGE, A. I; M. J. SEBASTIAN, 1972. The prawn fisheries of Kerala backwaters. Problems and prospects with special reference to Aquaculture in the Indo-Pacific region. Fishing News Books Ltd. London, p. 118.

The prawn fishery of Kerala State in India is briefly reviewed. The fishery though assumed great importance in view of the immense export possibilities and consequent earning of foreign exchange, it was facing major problems such as reclamation of backwaters, salt water exclusion projects, pollution and overfishing, leading to serious repercussions. The loss due to reclamation of backwaters and salt water exclusion projects would have to be compensated possibly by economising more intensive prawn-filtration-cum-culture of penaeid prawns and artificial propagation and culture of *Macrobrachium rosenbergii*.

19. GEORGE, M. J. 1967. Mark recovery experiments in Crustaceans. *Proceedings of the Symposium on Crustacea, Marine Biological Association of India, 1965, Part IV : 1284-1295.*

The various methods used in marking studies of prawns, lobsters and crabs are reviewed, describing the typical movements so far are elucidated.

20. GEORGE M. J., 1967. On a collection of Penaeid prawns from the offshore waters of the South-west coast of India. *Proc. Symposium on crustacea, Part 1* : 337-346.

13 species of Penaeid prawns collected during the exploratory and research cruises of *M. V. Kalva* and *R. V. Varuna* respectively in 1962 and 1963 from the offshore waters off south-west coast of India are recorded. Of these, 8 are recorded for the first time from the region, (Author abstract).

21. GEORGE, M. J. 1979. Taxonomy of Indian prawns (Penaeidae, crustacea, decapoda). In : Contributions to marine sciences. Dedicated to C. V. Kurian. Sharma, G. S; Mohandas, A; Antony, A, Ed. Prof. Kurian's Shashtyabdhapoorthi Felicitation committee p. 21-59.

It is general systematic revision of Indian penaeid prawns. Out of the 68 species dealt with, 48 species coming under 9 genera, belong to the sub family Penaeidae. The genera represented in this sub family are *Penaeus* Fabricius (8 species), *Metapenaeopsis* Bouyier (9 species) *Parapenaeus* Smith (3 species), *Penaeopsis* Bate (1 species), *Trachypenaeopsis* Burkenroad (1 species), *Metapenaeus* wood-mason, Alcock (11 species), *Atypopenaeus* Alcock (1 species), *Trachypenaeus* Alcock (3 species) and *Parapenaeopsis* Alcock (11 species). The rest of the species belong to the other sub families namely, *Solenocerinae* (2 genera. *Aristeus* Duvernoy (3 species) and *Parapenaeopsis* Alcock (11 species). *Solenocera* Lucas (8 species) and *Hymenopenaeus* Smith (1 species). *Aristaeinae* (2 general *Aristeus* Duvernoy (3 species) and *Aristaeomorpha* wood-mason (1 species) and *Sicyoninae* (1 species of genus *Sicyonia* H. Milne Edwards). The zoogeographical distribution of these prawns in this region is discussed.

22. GEORGE, M. J. ; S. K. BANERJI; K. H. MOHAMED, 1967. Size distribution and movement of the commercial prawns of the South-west coast of India. *Sea food exporter*, 3 (1) : 143-149.

Contains a study on the distribution pattern of size and abundance of the commercial penaeid prawns of the south-west coast of India. viz. *Metapenaeus dobsoni*, *M. affinis*, *M. monoceros* *Penaeus indicus* and *Parapenaeopsis stylifera*. The movement of these prawns between different

depth zones is discussed. The various species except *M. dobsoni*, are shown enter the fishing grounds from deeper zones by September and to move out of the fishing ground into deeper zones from February-March onwards; But *M. dobsoni* shows a movement which is in the opposite direction. The probable role of monsoon, and upwelling, in bringing about these movements are discussed.

23. GEORGE, M. J.; M. S. MUTHU, 1970. On the occurrence of *Metapenaeopsis barbata* (De Haan) Decapoda; Penaeidae, in Indian waters with taxonomic notes on the genus. *J. mar. biol. Ass. India*, 10(2) : 286-291.

A specimen of *Metapenaeopsis barbata* recorded from Visakhapatnam coast. The structure and taxonomy of the specimen are given.

24. GEORGE, M. J. 1972. On the food and feeding habits of *Metapenaeus monoceros* (Fabricius). Coastal Aquaculture in the Indo-Pacific region, Ed. T. V. R. Pillai. Fishing News Books (London). p. 178.

Based on the analysis of the stomach contents of 1213 specimens from the backwater fishery of Cochin, the food of the penaeid prawn *Metapenaeus monoceros* has been studied. Food of the species in the juvenile stages was found to consist mainly of small Crustacea. Unrecognizable material including mud and detritus formed only a small proportion. Food preference to a certain extent was evident from the study. Selective feeding was more pronounced as the size increased in detail. It was possible to maintain the prawns in laboratory tanks for a considerable length of time on diets consisting of flesh of other crustaceans, including prawns, and boiled rice. The feeding habits are discussed.

25. GEORGE, M. J.; S. C. GOSWAMI, 1977. Observation on the larvae of penaeid prawn of commercial importance in the coastal waters of Goa. *Proc. Symp. warm water N10, 1977*, pp. 146-154.

Five stations in the inshore water of Goa were sampled to study the distribution and abundance of prawn larvae. Among the larvae of five species present in the samples, namely *Metapenaeus dobsoni* (Miners), *Metapenaeus affinis* (Milne Edwards), *Metapenaeus*

*monoceros* (Fabricius), *Penaeus mergulensis* de Man and *Parapenaeopsis stylifera* (Mile Edwards), the larvae of *M. dobsoni* were the most abundant. Stations south of the mouth of the Mandovi and Zuari rivers had fewer numbers of larvae. The peak breeding periods of the different species in this area, based on the presence of larvae appeared to be during premonsoon season, especially in the months of January-February and April-May.

26. GEORGE, M. J.; P. VEDAVYASA RAO, 1966. On some decapod crustaceans from the South-West Coast of India. *Proceedings of the Symposium on Crustacea*, Marine Biological Association of India, 1965. Part I : 327-336.

Fourteen species of decapod crustaceans, 10 belonging to Natanta (7 Caridea and 3 penaeidae) and 1 each belonging to Palinura, Astacura, Anomura and Brachyura, collected during the exploratory and research cruises of the vessels of the Indo-Norwegian Project from the waters of the Kerala Coast are reported. Out of these, 5 species are recorded for the first time from these waters.

27. GEORGE, M. J. ; VEDAVYASA RAO P. V. 1968. A new species of *Metapenaeus* (Decapoda, penaeidae). *J. mar. biol. Ass. India*, 8 (1): 146-151.

Obtained from a collection of prawns from the Gult of Kutch, north-west coast of India, a new species *Metapenaeus alcocki* sp. nov., described in detail.

A comparison of the diagnostic features of three specimens are also given in tabular form.

28. GEORGE, M. J.; SUSEELAN, C. 1982. Distribution of species of prawn in the backwaters and estuaries of India with reference to coastal aquaculture, *Proc. Symp. coastal Aquaculture*, Cochin, India 12-18 Jan. 1980, Marine Biological Association of India, part 1 p. 273-284.

Several of the species of prawns of marine origin as well as some of the species of freshwater origin have a common brackish water phase in their life history. As a result of this many of these species occur in large

numbers in all the estuaries and backwaters of India in their postlarval and juvenile stages. The distribution of these species in the major brackishwater environments of the country has been studied with reference to their composition and seasonal abundance. The most common species which are suitable for culture purposes are *Penaeus indicus*, *P. monodon*, *P. Semisulcatus*, *P. merguensis*, *Metapenaeus dobsoni*, *M. monoceros*, *M. affinis*, *M. brevicornis* and *Parapenaeopsis sculptilis* among the penaeid prawns and *Macrobrachium rosenbergii*, *M. malcolmsonii*, *M. idella*, *M. equidense*, *M. rude*, *Palaemon styliferus* and *P. tenuipes* among the palaemonid prawns. Although *P. indicus*, one of the species very much in demand for culture, is found in almost all the estuaries, it occurs in maximum abundance in the southwest and southeast coastal regions. *P. monodon*, which grows to the largest size among the penaeid prawns, is most commonly distributed in the estuaries of middle and northern regions of the east coast. *M. dobsoni* is the dominant species in the backwaters of the southwest coast.

29. GEORGE, P. C.; GEORGE, M. J.; VEDAVYASA RAO, P. V. 1964. *Metapenaeus kutchensis* sp. nov. a penaeid prawn from the Gulf of Kutch. *J. Mar. biol. Ass. India*, 5 (2) : 284-288.

A new species of penaeid, *Metapenaeus kutchensis* sp. nov., is described based on numerous specimens collected from the inshore region of Gulf of Kutch in 1963. The specimens were in the length range 52-123mm. The diagnostic features of the species are given in comparison with the corresponding features of *M. monoceros*.

30. GIDEON P. W.; MENON, P. K. B.; RAO, S. R. V.; JOSE, K. V. 1957. On the marine fauna of Gulf of Kutch. A preliminary survey *J. Bombay Nat. Hist. Soc.*, 54 (3) : 690-706.

The area surveyed contains a report of the occurrence of *Penaeus*, *Lucifer*, *Hippolytina* and *Alpheus* among others in Okha, Beyt Dwarka Piroten.

31. GOSWAMI, S. C.; ACHUTHANKUTTY, C. T.; GEORGE, M. J. 1977. Occurrence of larvae of commercially important Penaeid prawns along the Central west coast of India. *Mahasagar*, 10 (3 & 4) : 129-137.

Penaeid larvae found occurring in the coastal waters of the Central west coast of India, extending between 5m and 40m depth zones in four transects, and along 10m depth zone between Vengurla and Janjira, six species were identified, viz. *Metapenaeus monoceros*, *M. dobsoni*, *M. affinis*, *Penaeus indicus*, *P. merguensis* and *Parapenaeopsis stylifera*. In general, larvae were more abundant in the southern transects than in the northern transects. In the northern transects, larvae were mainly distributed between 10 and 20m depth zones. *M. monoceros* was found to be the dominant species, their larvae contributing to about 32.12% of the total larvae collected, followed by *M. affinis* with 24.60%. As indicated by larval occurrence, breeding in *M. monoceros*, *M. affinis* and *M. dobsoni* was continuous wherein *P. indicus*, *P. merguensis* and *P. stylifera*, it was discontinuous. Of the 10 stations studied between Vengurla and Janjira, a major portion of the penaeid larvae occurred in Ratnagiri. Larvae of *M. dobsoni* were distributed in all the stations and were contributing to about 67.90% of the total larvae recorded.

32. HEALES, D. S.; POLZIN H. G. STPLES, D. J. 1984. Identification of the postlarvae of the commercially important *Penaeus* species in Australia. Rothlis-berg, P. S. et al. (Ed). *Second Australian National prawn seminar* : 41-46.

Techniques for identifying postlarval penaeus spp. taken during ecological studies in the Gulf of Carpentaria were examined on the basis of both field-collected and laboratory-reared material. A working key was then developed and later extended to include the six main commercial prawn species in Australia. Three groups of species can be identified: (a) banana prawn group, (b) tiger prawn group and (c) king prawn group based on easily observed and quantified morphological characteristics. The distinguishing characters used were carapace : rostrum length ratio and the ratio of two distances measured between telson spines. Species identification within these three main groups is more difficult and uses multivariate numerical identification based on discriminant analysis of known species. At present, *P. esculentus* and *P. semisulcatus* can be separated within the tiger prawn group, and *P. latisulcatus*, *P. longistylus* and *P. plebejus* with a lower degree of accuracy within the king prawn group. The only banana prawn species included in the analysis is *P. merguensis*.

(Author's Abstract)



33. HENDERSON, J. R. AND MATHAI G. 1910. On certain species of *Palaemon* from South India. Rec. Indian Mus. 5 : 277-306.

*Palaemon carcinus* Fabricius, *Palaemon malcolmsonii*, *Palaemon idae* Heller, *Palaemon sulcatus* n. sp., *Palaemon rudis* Heller, *Palaemon dolichodactylus*, *Palaemon dubins* n. sp. are described into illustrations based on materials collected during a number of years from various localities in the old Madras Presidency from Gunjam to Transquepar on the east coast and from Mangalore to Travancore on the west coast. Tables showing the locality of collection of each species and number of specimens collected are given.

34. HOLTHIUS, L. B. 1950. The Decapoda of the Siboga Expedition, Part X. The Palaemonidae collected by the Siboga and Snellius Expeditions with remarks on other species 1. Subfamily Palaemonidae. Siboga-Exped. XXXI 9 : 268 pp.

Balss's earlier classification of the family Palaemonidae is revised by merging his Desmocidinae into Palaemoninae and creating a new subfamily Euryrhychinae nov. sub. fam. to include the genus *Euryrhychnus* which Balss had placed in Palaemoninae. The key to the subfamilies as has thus been revised into is presented, following which the subfamily Palaemoninae, the theme of the monograph, is treated exhaustively. Key to the genera and subgenera (total 18) including the two new genera *Leandrites* and *Leptocarpus* nov. gen. and two new subgenera *Nematopalaemon* nov. subgen and *Exopalaemon* nov. subgen. created based on the Siboga collection, is given. So also is a list of all known species of the different genera (total 187 + 58 spec. incert) together with their detailed synonymy.

Of the species collected by Siboga and each one described in detail in the monograph there are about 100 including 6 new species. Under the description of each species there is available, besides the detailed description based on Siboga materials, an exhaustive synonymy and points of comparisons of specimens collected by Snellius Expedition and those in Museum Leiden and Museum Amsterdam.

The new species that are created and described in the monograph are *Leandrites indicus* nov. spec., *Leandrites stenopus* nov. spec., *Macro-*

*brachium palaemonides* nov. spec., *Macrobrachium subsicarpels* nov. spec.  
*Macrobrachium jacobsoni* nov. spec. and *Macrobrachium geron* i nov. spec.

The species that are of fishery interest in India found place in the monograph are : *Palaemon* (*Nemato-palaemon*) *Knnipes* (Henderson) *Macrobrachium rosenbergli* (deMan), *Macrobrachium lamerri* (H. Milne Edwards), *Macrobrachium malcolmsoni* H. Milne Edwards, *Macrobrachium idae* (Heller), *Macrobrachium idella* (Hilgendorf) and *Macrobrachium Scabriculum* (Heller).

35. HOLTHIUS, L. B. 1952. The Decapoda of the *Siboga Expedition*. Part XI. The Palaemonidae collected by the Siboga and Snellius Expeditions with remarks on other species. II Subfamily Pontoniinae.

The differences in the system *Pomtoniinae* that has been adopted by the author from the system of Kemp are listed with justification, newly erecting the genera *Vir* nov. gen, *Paranchistus* nov. gen, *Phllarius* nov. gen, *Platycaris* nov. gen; *Jocaste* nov. gen, *Cavicheles* nov. gen, and *Hamodactylus* nov. gen. Key to 34 genera in the subfamily including the above, is given, which is followed by the list of the then known species comprised by them, furnishing the history and synonymy of each one.

Of the species described in detail, such as presenting the exhaustive synonymy and illustrated characters, and comparing the materials of Siboga and Snellius expeditions and museum Amsterdam specimens, there are a total of 81 species, including many new ones.

The new species described are: *Periclimens* (*Periclimenes*) *pectiniferus* nov. spec, *Periclimenes* (*Harpilus*) *jugalis* nov. spec, *Periclimens* (*Harpilus*) *sobogae* nov. spec, *Periclimenes* (*Harpilus*) *platycheles* nov. spec, *Paranchistus ornatus* nov. gen. et spec, *Paranchistus nobilli* nov. spec, *Periclimenaeus artbidactylus* nov. spec, *Periclimenaeus minutus* nov. spec, *Onycocaris stenolepis* nov. spec, *Pontinia styrostris* nov. spec, *Platycaris latirostris* nov. gen. et spec, *Dasycaris ceratops* nov. spec, *Conchodytes monodactylus* nov. spec, *Cavicheles kemp* nov. spec, and *Hamodactylus boschmai* nov. gen. etc. spec.

36. HOLTHUIS, L. B. 1955. Recent genera of the Caridean and Stenopoidean shrimps (class crustacea, order decapoda, supersection natantia) with keys for their determination. *Zoologische verhandelingen*, 26, 157 p.

The monograph presents illustrated classification of 174 genera of Caridean and 7 genera of Stenopoidae shrimps with complete synonymy. Keys to the identification of various families, subfamilies and genera are given.

37. HOLTHUIS, L. B. 1980. FAO species catalogue vol. 1-Shrimps and prawns of the world : An annotated catalogue of species of interest of fisheries 271 p.

This is a systematic catalogue of species belongs 15 families to shrimps and prawns of the world. The information pertaining to each species is arranged as follows : (1) Synonymy (2) Vernacular names (3) Literature (4) Distribution (5) Habitat (6) Size (7) Interest to fisheries (8) Remarks. A list of species by major marine fishing areas is also given in the end.

38. JOHN, M. C. 1958. A preliminary survey of the Kayamkulam lake. *Bull. Cent. Res. Inst. Univ. Kerala, Ser., C.,* 6(1) 89-109.

Contains faunistic reference to *Cardina nilotica*, *C. propingua* *Macrobrachium idella*, *M. equidens*, *P. monodon*, *Penaeopsis affinis* *P. dobsoni*, *P. monoceros* and *P. brevicornis*.

39. JOHN, C. C.; KURIEN, C. V. 1959 A preliminary note on the occurrence of the deep water prawn and spiny lobster off the Kerala coast. *Bull. Cent. Res. Inst. Trivandrum, Ser. C.,* 7(1) : 155-162.

The occurrence of the *penaeopsis philippil* is reported along with *Peurulus sewelli* in depths and discusses the distribution and nature of the bottom.

40. KAGWADE, P. V. 1967. Prawn catches by mechanised vessels in the trawling grounds off Bombay and Maharashtra. *Proc. Symposium on Crustacea*, Ernakulam, January 12 to 15, 1965. Marine Biological Association of India, Cochin P 1348-1381.

The relative abundance in the regional seasonal and depthwise distributions of prawns between latitudes 16°N. South of Bombay and

24°N. of Kutch, based on the landings of two sets of bull-trawlers, 'Arnallapaj' and 'Satpati-pilantan' of the new India Fisheries Company and of the otter trawlers M. F. V. Jheenga, M. F. V. 'Bumili' M. L. Meera' and M. L. 'Sagarkanti' of the the Government of India Deep sea Fishing Station, Bombay are given. The average annual yields of 20,890 Kg. of prawns estimated.

41. KAGWADE, P. V. 1981. Hermaphrodite prawn *Hippolytina ensirostris* Kemp. *Indian J. Fish.* 28(1 & 2) : 189-194.

A functional male and female reproductive organs were noticed to be simultaneously present in an ovo-testis in all sizes of *Hippolytina ensirostris*, the species is deemed to be a hermaphrodite. The presence of hooks and well-developed claspers at the distal end of the endopodite of the first pleopod, however, suggests cross fertilization.

42. KATHIRVEL, M.; GOPALAKRISHNAN, K. N.; NALINI, C. 1975. On the occurrence of *Metapenaeus hilarula* (de Man) and *Penaeus penicillatus* Alcock (Decapoda : Penaeidae) in Cochin Backwater. *Indian J. Fish.* 23(1 & 2) ; 236-238.

The occurrence of *Metapenaeopsis hilarula* (de Man) and *Penaeus penicillatus* Alcock from Cochin Backwater is reported for the first time. A brief note on the morphological variations observed on the species is given.

43. KATHIRVEL, M.; GOPALAKRISHNAN, K. N.; NALINI, C. 1976. On the occurrence of *Metapenaeopsis hilarula* (de Man) and *Penaeus penicillatus* Alcock (Decapoda; Penaeidae) in Cochin Backwater. *Indian J. Fish.* 23 (122) : 238.

The occurrence of *Metapenaeopsis hilarula* (de Man) and *Penaeus penicillatus* Alcock from Cochin Backwater is reported for the first time. A brief note on the morphological variation observed on these species is given.

44. KEMP, S. 1910 XVII Notes on Decapoda in the Indian Museum.

1. The Species of Gennadas

*Rec. Indian Mus*, 5(3) : 173-181

*Gennadas alcocki*, sp. nov; *Gennadas sardidus* sp. nov. *Gennadas-seutatus* Bouvier, *Gennadas bouvieri* Kemp, and rarely known *Gennadas carinatus* (Smith) are described. Based on the Indian Museum specimens collected by the 'Investigator'; the last one in revision of the earlier one made by Alcock.

45. KEMP, STANLEY AND R. B. SEYMOUR SEWELL 1912. Notes on Decapoda in the Indian Museum III. The species obtained by R. I. M. S. S. 'Investigator' during the survey season 1910-1911. *Rec. Ind. Mus.* 7 : 15-32.

*Parapeneus rectacutus* (Bate), *Aristaeus semidentatus*, Bate *Hemipeneus crassipes* (Wood-Mason), *Aristaeomorpha rostridentata* (Bate), (a species hitherto known from females only is redescribed also based on 2 males obtained during the season) *Sergestes bisulcatus*, Wood-Mason, *Sympasiphaea annectene*. Alcock, *Hoplophorus gracilirostris* A. Milne Edwards, *Hetrocarpus gibbosus*, Bate, *Merhippolyte calmani* sp. nov. and *Aegeon (Parapontocaris) bengalensis* are recorded on the basis of specimens of varying numbers obtained in hauls taken from deep waters and *Merhippolyte calmani* sp. nov., is described.

46. KEMP, STANLEY. 1913. Pelagic crustacea decapoda of the Percy Sladen Expedition in H. N. S. "Sealark". *Trans. Linn. Soc. London. Second Series*, XVI Zoology : 53-68.

Thirteen determinable species represented by adult and sub-adult individuals, collected from the Arabian Sea and the Bay of Bengal, namely *Sergestes challengerii*, Hanson, *Sergestes gardineri* sp. nov. *Sergestes edwardsi*, Kroyer, *Lucifer acastra*, Dana and *Lucifer reynaudii* H. Milne Edwards of the family Sergestidae *Gennadas scutatus*, Bouvier, *Gennadas*

*alcocki*, Kemp and a *Gennadas* sp. of the family Penaeidae and *Hoplophirus gracilirostris*, A. Milne Edwards *Hodlophorus foliaceus*, Rathbun, *Acanthophyra purpurea*, A. Milne Edwards and *Notostomus perlatus*. Spence Bate are described with figures. A partial synopsis of the species of *Notostomus* and localities of collection are given.

47. KEMP, S. 1913. Zoological results of the Abhor Expedition. Crustacea Decapoda. *Rec. Indian Mus.* 8 : 289-310.

A chapter pp. 289-310 with 5 plates in the monograph on the Zoological collections obtained during the expedition to the Abor country 1911-1912 in which the author had participated the frontiers of Assam, it describes a dozen decapods including *Palaemon hendersoni*, de Man and three species of *Caridinea*, *Caridinea weberi*, de Man and two new species *Caridinea excavata*, sp. nov. and *Caridinea hodgarti* sp. nov. The *Caridinea* occurred in abundance in the tributaries and the main rivers of Brahmaputra. The then distributions of the species are given.

48. KEMP, S. 1914. IV. Notes on crustacea in the Indian Museum. V - Hippolytidae. *Rec. Indian-Mus.* 10 (2) : 80-129.

Twenty species of the family Hippolytidae, including four new ones, *Saron marmoratus* (Oliver), *Saron neglectus*, de Man, *Merippolyte calmani*, Kemp and Sewell, *Alope palpalis*, white, *Alope australis*, Baker, *Spirontocaris*, *Pandaloides* (Stimpson), *Thor paschalis* (Heller), *Hippolyte ventricosus*, H. Milne-Edwards, *Hippolyte australiensis* (Stimpson), *Latreutes pygmaeus*, Nobili *Latreutes mucronatus* (Stimpson), *Latreutes anoplonyx*, sp. nov., (a single adult female), *Tozeuma armatum*, Paulson, *Gelastocaris Peronae* (Nobili), *Lysmata chiltoni*, sp. nov., *Hippolysmata vittata*, Stimpson, (including a suspected variety), *Hippolysmata kukenthall* (de Man), *Hippolysmata dentata*, sp. nov., *Hippolysmata dentata*, sp. nov., *Hippolysmata ensirostris*, sp. nov., (including var. *punctata*, nov) and *Merguia oligodon* (de Man) are described, most of them with illustrations, based on specimens of varying numbers collected from the vicinity of Rameswaram island. A key to the Indo-Pacific genera (15) of *Hippolytidae* and a list of species placed incertae are appended.

49. KEMP, STANLEY. 1915. Fauna of Chilka lake. Crustacea, Decapoda  
*Mem. Indian Mus.* 5: 199-325

Twenty two species of prawns and shrimps, distributed among the families Crangonidae, Palaemonidae, Alpheidae, Atyidae, Pasiphaeidae and penaeidae, of the Chilka lake are recorded and distributed which include 6 new species namely *Pontophilus hendersoni* sp. nov., *Uracaris indica* sp. nov., *Periolimenes demani*, sp. nov., *Ogyrides strialicaudata* sp. nov., *Athanas polymorphus* sp. nov., *Alpheus paludicola* sp. nov. The other species described are: *Palaemon lamerrii* Milne Edwards, *Palaemon malcolmsoni* Milne Edwards, *Palaemon rudis* Heller, *Palaemon scabricutis* Heller, *Leander styliferus* (Milne Edwards), *Alpheus crassimonus*, Heller, *Alpheus malabaricus*, Fabricius, *Caridina nilotica* (Roux) var *bengalensis* de Man, *Caridina porpingua* de Man, *Leptocheila aculeacandata* Paulson, *Penaeus carinatus* Dana, (de Man), *Penaeus indicus* Milne Edwards,, *Penaeopsis monoceros* (Fabricius), *Penaeopsis affinis* (Milne Edwards), *Penaeopsis dobsoni* (Miers) and *Lucifer hansonii* Nobili.

60. KEMP, STANLEY. 1916. Notes on Crustacea Decapoda in the Indian Museum. VI. Indian Crangonidae. *Rec. Indian Mus.* 12: 355-385.

Ten species of *Pontophilus* 6 species of *Aegeon* and one species each of *Prionocrangon* and are *Crangon* recorded as having been representing in the collections. The number and size of the specimens available in the collections and the locality from where they had been collected are given under each case together with the synonymy descriptions wherever needed. Of the ten species of *Pontophilus* six, that had been obtained from the shallow waters off Kelakarai at the northern end of Gulf of Mannar, and four from Port Blair, Andamans being new are described in great detail, revealing for the first time the existence of considerable differences between the sexes in the form of pleopods and the modifications of this appendage affording clues to the affinities among various genera of the family. This point is further brought out by a comparative morphology of the pleopods accompanied by a thorough discussion, under a separate heading at the end of the paper. The six new species described are :

*Pontophilus incisus*, sp. nov., *Pontophilus lowisi*, sp. nov., *Pontophilus candidus*, sp. nov., *Pontophilus pilosus* sp. nov., *Pontophilus plebs*, sp. nov. and *Pontophilus parvirostris* sp. nov. Key to the ten species of *Pontophilus* and six species of *Aegeon* are also given.

51. KEMP, STANLEY. 1916. Notes on Crustacea Decapoda in the Indian Museum. VI. Further notes on Hippolytidae. *Rec. Indian Mus.* 12 : 385-405 (1 plate)

A supplement to Kemp (1914) on the Indian Hippolytidae, the paper records an additional 17 species of Hippolytids from Andamans including *Hippolytina ensirostris* Kemp and three species (new) namely *Thor discosomatis* sp. nov., *Phycocaris simulans*, gen et sp. nov and *Latreutes porcinus* sp. nov, describing these in detail. The creation of new genus *Phycocaris*, of which the type and only species was *P. simulans*, sp. nov., is justified by comparing it with the genera *Trachycaris*, *Thor*, *Hippolyte*, *Cryptocheles* and others.

52. KEMP, STANLEY. 1917. Notes on the fauna of the Matlabriver in the Gangetic Delta. *Rec. Indian Mus.* 13 : 233-241

Three Palaemonids, *Palaemon mirabilis* Kemp, *Leander styliferus* (M. Edwards) and *L. tenuipes* Henderson and three penaeids, *Penaeopsis monoceros* (M. Edwards), *P. brevicornis* (M. Edwards), *Parapenaeopsis sculphilis* (Heller) are recorded to have been taken in varying abundance along with some fishes by a small trawl from the river bed. The physico-chemical characters of the river as well as the bed are touched on.

53. KEMP. 1917. Notes on crustacea Decapoda in the Indian Museum. IX *Leander styliferus* Milne-Edwards and related forms. *Rec. Indian Mus.* 13 : 203-231. pt. 3.

Four species of the genus *Leander*, viz., *Leander tenuipes*, Henderson, *Leander styliferus*, (Milne Edwards), *Leander carinatus* Ortman and *Leander modestus* (Heller) and three new species, *Leander annandalei* sp. nov., *Leander fluminicola*, sp. nov., and *Leander potamiscus* sp. nov and a new Palaemonid, *Palaemon mirabilis* sp. nov., that had been



collected from the brackish waters of the mouth of the Ganges and deposited in the Indian Museum are described in detail with illustrations and morphometric tables.

A key to the 10 species of *Leander* in the Indian Museum including the 7, the author has examined is given. Also furnished is a table giving the locality of collections of these the persons who had collected them and the number of specimens collected of each species.

54. KEMP, STANLEY. 1917. Notes on crustacea Decapoda in the Indian Museum. XI. Atyidae of the genus *Paratya* (Xiphocaridina). *Rec. Indian Mus.* 13 : 293-306.

*Paratya compressa* (de Haan) *sensu stricto*, *P. compresso* sub sp., *Improvise*, nov., *Paratya curvirostris* (Heller), *Paratya australiensis*, sp. nov. and *P. australiensis*, subsp. *norfolkensis*, nov. are described and the synonyms presented. The synonymy and description as well as a key to the species of the genus *Paratya* Miers are also presented.

55. KEMP, STANLEY. 1918. Crustacea decapoda of the Inle lake Basin. *Rec. Ind. Mus.* 14 : 81-102. 2 Plates.

Three species of the family Potamonidae, viz. *Potamon* (Potamon) *brownianum* sp. nov., *Potamon* (Potamon) *acanthicum*, sp. nov., and *Potamon* (Potamon) *curtobates*, sp. nov., two species of *Palaemonidae*, viz. *Palaemon naso*, sp. nov. and *Palaemon hendersoni*, de Man and two species of Atyidae, viz. *Caridina annandalei*, sp. nov., *Caridina weberi*, prox. var. *Sumatrensis* de Man, collected by Annandali and Gravelly in and near the Inle lake in the Southern Shan States are described, of which five, have affinities with Burmese and Assamese forms, had been remarkably undescribed, though had observation greater economic importance in the Shan states than the allied ones had in most inland parts of India. The characters of *C. annandalei*; by which it can be distinguished from its close allies, *C. excavata* Kemp E. *hodgarti* Kemp are listed.

56. KEMP, STANLEY. 1925. Notes on crustacea Decapoda in the Indian Museum. XVII. On various Caridea. *Rec. Ind. Mus.* 27 (4): 249-344.

In this paper the notes on Caridea belonging to 9 families are brought together, adding more observations such as of sexual dimorphism in the breeding season *Leptochela* and *Rhynchocinetes* etc. and describing a number of new species. A total of 42 species in 21 genera, including 3 new genera, namely *Chlorotocoides* gen. nov., *Chlorocurties* gen. nov., and *Paralatrius* gen. nov., are described in detail. The new species created and described are: *Stylodactylus investigatoris* sp. nov., *Rhynchocinete shendersoni* sp. nov., *Parapandalus percicus*, (sp. nov., *Chlorocurtis miser* gen. et. sp. nov., *Leander sewelli* sp. nov., *Leander belindae*; sp. nov., *Palaemonetes hornelli*, sp. nov., *Perielemenes (Perielemenes) Signatus*, sp. nov., *Anchistus pectinis*, sp. nov., *Hippolyte commensalis* sp. nov., and *Paralatrautes bicornis* gen. et sp. nov., key to the species of each genus is also presented under the latter if it comprised more than one species.

57. KEMP, STANLEY. 1925. Crustacea decapoda of the Siju Cave Garo Hills, Assam. *Rec. Ind. Mus.* 26: 41-48. Plata 111.

*Paratelphusa (Barytelphusa) falcidigitis* Alcock (Fam: Polomonidae) and *Palaemon hendersoni* de Man and *Palaemon cavernicola*, sp. nov. (Fam: Palaemonidae) collected from the cave are recorded. *Palaemon cavernicola*, sp. nov., is described in detail with illustrations and a morphometric table. Five Palaemonids hither to recorded from subterranean waters elsewhere are also listed.

58. KUBO, I. 1949. Studies on Penaeids of Japanese and its adjacent waters. *J. Tokyo College of Fisheries*, 36(1): 1-467.

A highly useful monograph on the taxonomy of the Japanese penaeids, it gives detailed and illustrated comparative morphology of sixty-seven species in sixteen genera, including such Indian species as *P. monodon*, *P. penicillatus*, *P. merguensis*, *P. latisulcatus*, *P. indicus*, *M. monoceros*, *M. affinis*, *M. brevicornis* discussing their geneology and phylogenetical relationships and distribution. The external characers and types of

organs of taxonomical importance such as telson, mouth parts, petasma, thelycum, appendix masculina, etc. having been in general described at great length, furnishing many comparative tables and illustrations and providing keys based on each, the systematic study on families, genera and species are taken up, describing each species in detail, Four pages of references are given.

59. KUNJU, M. M. 1960. On new records of five species of Penaeidae (Decapoda Macrura : Penaeidae) on the West Coast of India. *J. Mar. biol. Ass. India*, 2 (1) : 82-84.

Records the occurrence of *Parapenaeopsis hardwickii*, *Atypopenaeus compressipes*, *Parapenaeopsis acclivirostris*, *Metapenaeopsis novaeguineae* and *Trachypenaeus curvirostris* from bombay waters.

60. KUNJU, M. M. 1965. Observations on the prawn fishery of Maharashtra coast. *Proceeding of the symposium on Crustacea*, Ernakulam, January 12 to 15, 1965. Marine Biological Association of India, Cochin P. 1392-1397.

Based on observations carried out from October 1959 to December 1963 from three representative sampling centres, viz Arnala, Versova and Sasoon Dock, the magnitude of the fishery, species and size composition and relative abundance of the various species are given. The main characteristic of the fishery was that the total prawn catch made up of at least ten species of commercial value of which the small shrimps such as *Palaemonetes*, *Hippolytina ensirostris* and *Acetes indicus* accounted for more than 50% of the fishery important feature of the fishery was that the larger prawn *Solenocera indicus*, *Hippolytina ensirostris* and *Atypopenaeus compressipes* were landed in marketable quantities only along this coast.

61. KURIAN, C. V. 1949. On the occurrence of Crangonids (Crustacea, Caridae) in the coastal waters of Trivandrum. *Proc. Indian Sci. Congr.*, 35th Sess., 3: 194 (Abstract).

Contains taxonomic notes on *Pontophilus hendersoni* and *P. parvirostris*.

62. KURIAN, C. V. 1952. On the occurrence of the Crangonids (Crustacea; Caridea) in the coastal waters of Trivandrum. *Curr. Sci.*, 21: 316.

Contains taxonomic notes on *Pontophilus hendersoni* and *P. parvirostris*.

63. KURIAN, C. V. 1954. Contribution to the study of Crustacean fauna of Travancore. *Bull. Cent. Res. Inst. Univ. Travancore, Ser. C. Nat. Sci.* 3(1) 69-91.

Refers to systematics and distribution of shrimps belonging to the family, *Hippolytidae*, *Palaemonidae*, *Penaeidae*, *Crangonidae* *Sergestidae* and *Mysidae*.

64. KURIAN, C. V. 1964. On the occurrence of the deep-water prawn *Penaeopsis rectacutus* (Spence Bate) off the Kerala Coast. *Curr. Sc.*, 33(7) : 216-217.

Records the occurrence and distribution of *P. rectacutus*, at Alleppey Kerala coast.

65. KURIAN, C. V. 1965. Deep water prawns and lobsters off the Kerala coast. *Fishery Technology*, 2(1) : 51-53

Records *Penaeopsis philippi* and *P. rectacutus* from 100-180 fathom area off the Kerala coast on April 1959. Their distribution and ecology and the possibility of their commercial exploitation are discussed.

66. KUTTYAMMA, V. J. 1980. Studies on the prawns and the prawn larvae of the Kayamkulam lake and the Cochin Backwaters. *Bull. Dept. mar. Sci. Univ. Cochin*, 11: 1-38.

Based on monthly observations for one year, 1976-77, seasonal variations occurrence of larvae of common species *P. indicus*, *M. dobsoni* and *M. monoceros* in the two major entrance of Kerala, viz. Kayamkulam and Cochin backwaters, are compared whereas there was only one peak of larval occurrence, ie, September to January, in Kayamkulam, there was two peaks in Cochin back waters ie from September to

December and from February to May. The numbers of larvae per unit area was, however, greater in Kayamkulam. Post larvae and juveniles of *Penaeus indicus* were predominant in the Kayamkulam lake and that of *Metapenaeus dobsoni* dominated in the Cochin backwaters. The prawns obtained in the cast net were larger than those obtained in the stake net, but both large and small prawns were obtained in the chinese dip net. The females significantly outnumbered the males in the Kayamkulam lake whereas in the Cochin backwaters males and females were more or less in equal proportions. In both the estuaries salinity, and to a lesser extent by temperature was found to be the factor influencing the larval occurrence.

67. KUTTYAMMA, V. J., KUKIAN, C. V. 1982. Distribution of post larvae of marine prawn in the coast of India. *Indian J. mar. Sci.*, 11: 270-272.

Occurrence and abundance of the post larvae of different marine prawns along the coast of Quilon-Cochin are given on the basis of Plankton samples collected during 1975 from 19 stations.

68. LLOYD, R. E. 1907. Contributions to the fauna of the Arabian Sea with description of new fishes and Crustacea. *Rec. Indian Mus*: 1: 1-12.

Bases on the collections of investigator taken by trawl between Muscat and Aden in 1906. Two new species of crustaceans, *Squilla investigatoris* sp. nov. and *Munidopsis Spinihirsuta*, sp. nov. (based on the males) are described. The localities and the depths from which the collections has been made are given.

69. MC GILCHRIST, A. C. 1905. Natural history notes from the R.I.M.S.S. "Investigator" Captain T. H. Heming, R. N. commanding - Series 3. Nos. 6 An account of the new and some of the rare Decapod Crustacea obtained during the surveying season, 1901-04. *Ann. Mag. Nat. Hist. Ser. 7* (15): 233-268.

*Penaeus fissures*, *Bentesicymus armatus*, *Gennadas carinatus*, *Heterocarpus longrostris*, *Glyphocrangon longirostris*, *Calastacus longispinis* and *Iconaxiopsis spinigera*.

70. MENON, M. K. 1954. On the paddy-field prawn fishery of Travancore-Cochin, and experiment in prawn culture. *Proc. Indo-Pacific Fish. Coun. Sec. 11*: 131-135.

The quantitative data collected during two seasons 1951-52 and 1952-53 of the paddy-field prawn fishery of the then Travancore-Cochin State, which was limited to trapping as many prawns as possible are presented. And of the three species of Penaeids viz, *M. dobsoni*, *M. monoceros* and *P. indicus* which made up practically the entire catch the fluctuations in proportions, size range, etc. are given. Estimates of the growth of *P. indicus* and *M. dobsoni* in the brackishwater environments of the canals and backwaters are made based on length-frequency curves for each month. Two experiments in prawn culture that were conducted showed that prawns could be kept alive and healthy in completely enclosed fields even in the hottest periods for about 2 months. An estimated annual yield of 1150-1550 lbs. per acre of coastal prawns is stated to be a possibility by prawn and fish culture.

71. MENON, M. K. 1955. Identification of marine and inshore prawns of commercial value of India. *Proc. Indo-Pacific. Fish Council.*, 6(3) : 345-347.

Key to species of *Penaeus*, *Metapenaeus* and *Parapenaeus* along with detailed description, is given.

72. MENON, M. K; RAMAN, K. 1962. Observations on the prawn fishery of the Cochin backwaters with special reference to the stake nets, *Indian J. Fish*, 8 (1) : 1-23

Observations made during the period November 1956 to October 1958 on the catches of two stake nets in the Cochin back waters, one located at Azhikal close to the entrance to Cochin Harbour and the other six to seven miles south of Thevara are recorded and discussed. The total catch and its percentage have been determined for each month. The fluctuations in the prawn catch are correlated with rain fall, tidal flow and other factors. The species of prawns composing the catches, as revealed by regular analysis of fortnightly samples from

both centres, have been listed, and the quantitative variations from month to month exhibited by the four important Penaeids, viz. *P. Indicus*, *M. dobsoni*, *M. monoceros* and *M. affinis* are described. Monthly length-frequencies have been worked out and curves are drawn in respect of the first three species in order to estimate their monthly rates of growth.

73. MIGUEL, J. C. 1984. Notes on Indo-west Pacific *Penaeidae*, 4, on the two subspecies of *penaeus latisulcatus* Kishinouye. *Crustaceana*, 46 (1) : 104-107.

The penaeid material collected by the Siboga expedition, De Man (1911) described and figured the differences in the thelycum of the material of *Penaeus latisulcatus* from Japan and the unique specimen from the Red sea that he had referred previously (De Man, 1880) to *P. Canaliculatus* Olivier.

74. MOHAMED, K. H. 1969. Catalogue of prawns in the reference collection of the central Marine Fisheries Research Institute. *Bull. Cent Mar. Fish. Res. Inst.*, 9 : 27-34.

Taxonomy of thirty genera of prawns from the reference collection of the Central Marine Fisheries Research Institute is given, with illustrations and localities from where they had been collected.

75. MUTHU, M. S. 1965. On the occurrence of *Metapenaeus. ensis* (De Haan) in the Bay of Bengal. *J. mar. bio. Ass. India*, 7 (2) : 465-468.

The occurrence in the Bay of Bengal of *M. ensis*, species hitherto believed to have been confined to the east of Malayan Peninsula/ Sumatra is based on 60 specimens collected from the trawl catches taken from a depth of 36m off false point on the Orissa coast on 20.12.64. The specimen being in very close resemblance to its allied species *M. monoceros*, the salient features which distinguish it from the latter are described with illustrations.

76. MUTHU, M. S. 1968. On some new records of penaeid prawns from the east coast of India. *Indian J. Fish.* 15 (1&2) : 145-154.

*Solenocera melantho* de Man, *Solenocera pectinata* (Bate), *Parapeneopsis tenella* (Bate), *Parapeneopsis cornuta* (Kishinouye), *Trachypenaeus sedill* Hall, *Trachypenaeus granulatus* (Haswell), *Metapeneopsis mogiensis* (Rathbun), *Metapeneopsis hilarulus* (de Man) and *Sicyonia lancifer* (Olivier) are recorded for the first time from the east coast of India. Differences noticed from the existing descriptions and the other relevant morphological features of the species are given.

77. MUTHU, M. S. 1969. *Parapeneopsis indica*, Sp. Nov. (Decapoda, Penaeidae) from the Indian waters. *Indian J. Fish.* 16 (1&2) : 174-180.

Some specimens collected in August 1968 from the Kakinada Canal, Kakinada by and from the near shore waters of Godavary point. A new species *Parapeneopsis indica* sp. Nov. is described. A detailed illustrated description is provided and the features compared with those of closely related species.

78. MUTHU, M. S. 1974. Taxonomic notes on the penaeid prawn *Metapenaeus gallensis* (Pearson, 1905). *J. mar. biol. Ass. India.* 14 (2) : 564-567

*Metapenaeus gallensis* (Pearson) which was hitherto considered as doubtful species appears to be a distinct species belonging to the mogiensis-group of non-stridulating *Metapeneopsis*. The species which is recorded first time from Indian waters is redescribed and compared with the closely related species. (Author abstract)

79. MUTHU, M. S.; GEORGE, M. J. 1972. *Solenocera indica* Nataraj, one of the commercially important prawns of Indian waters as a synonym of *Solenocera crassicornis* (H. Milne Edwards). *J. mar. biol. Ass. India.* 13 (1) : 142-143.

The validity of the species name *Solenocera crassicornis* (H. Milne Edwards, 1837) is discussed and *Solenocera indica* Nataraj (1945)



a commercially important penaeid prawn from Indian seas is shown to be a synonym of the former (Author's Abstract).

80. MUTHU, M. S.; MOTOH, H. 1979. On a new species of *Penaeus* (Crustacea, Decapoda, Penaeidae) from N. Borneo. *Researches on Crustacea*, Carcinological Society of Japan, Odawara Carcinological Museum, Tokyo. 9: 64-70.

A new species of penaeid prawn, *Penaeus silasi* from North Borneo is described in details and compared with the closely related species *P. indicus*, *P. merguensis* and *P. pencillatus*.

(Author's Abstract)

81. MUTHU, M. S.; SAMPSON MANICKAM, P. E. 1973. On the occurrence of mature specimens of *Matapenaeus burkenroadi* Kubo in the Pulicat lake. *Indian J. Fish*, 20 (1) : 214-216.

Mature females and males of *Matapenaeus burkenroadi* with fully developed ovaries and petasmae were collected from the Pulicat lake in January 1972. The possibility of their breeding inside the lake and the feasibility of utilising this species for culturing in the Pulicat lake are indicated. Some morphological features of the specimens which are at variance with previous descriptions of the species are pointed out.

(Author's Abstract)

82. MUTHU, M. S.; SUDHAKARA RAO, G. 1973. On the distinction between *Penaeus indicus* H. Milne Edwards and *Penaeus merguensis* de Man (Crustacea : Penaeidae) with special reference to juveniles. *Indian J. Fish*, 20 (1) : 61-69.

The easily distinguishable characters that would facilitate segregation of the juveniles of *Penaeus indicus* from those of *merguensis* are pointed out, such as the colour pattern of the antennal flagella, antennular flagella and the pleopods, and the disposition of the rostral teeth.

83. NANDAKUMAR, G. 1983. Change in species composition of prawns in the trawl fishery at Mandapam. *J. mar. biol. Ass. India*, 20 (2) : 181-183.

Prawn form an important constituent of the trawl catches at Mandapam- Green tiger prawn, *Penaeus semisulcatus* de Haan, is one of the important species contributing to the prawn fishery. In recent years significant change in the pattern of species composition has been observed and is dealt with.

84. NATARAJ, S. 1947. On some species Acetes (Crustacea Sergestidae) from Travancore. *Rec. Indian Mus.* 45 : 139-147.

Taxonomic notes on *Acetes erythraeus*, *A. Sibogae*, *A. dispar* and *A. Serrulatus* var. *Johni* are given. Seasons of occurrence, breeding and their presence in the stomach contents of shoal fishes referred.

85. NATARAJ, S. 1942. A note on the prawn fauna of Travancore. *Curr. Sci.*, 11 (12) : 468-469.

*Penaeus indicus*, *P. carinatus*, *P. monodon*, *P. canaliculatus*, *Metapenaeus monoceros*, *M. affinis*, *M. dobsoni*, var. nov. *Metapenaeopsis stridulans*, *M. mogiensis*, *Parapenaeopsis stylifera*, *P. maxillipedo*, *P. uncta*, *Palaemon carcinus*, *P. idae*, *P. dolichodactylus*, *P. sulcatus*, *P. dayanus*, *Palaemonetes hornelli*, *Alpheus malabaricus*, *A. paladioclastax*, *Acetes erythraeus*, *A. sibogae*, *A. dispar* *A. serrulatus* var nov. are recorded.

86. NATARAJ, S. 1945. On two new species of *Solenocera* (Crustacea Decapoda Penaeidae) with notes on *Solenocera Pectinata* (Spence Bate). *J. Roy. Asiat. Soc. Bengal.*, 11(1) : 91-98.

*Solenocera choprai* and *S. indicus* described with figures. Distribution and taxonomic notes on *Solenocera pectinata* is given.

87. PANDE, J. N, 1983. A new source of giant freshwater prawn seed in Maharashtra. *Fishing chimes*, 3(9) : 37.

Rich source of seeds of the freshwater prawn *Macrobrachium rosenbergii* is observed in Maharashtra.

88. PAULINOSE, V. T.; GEORGE, M. J. 1976. Abundance and distribution of penaeid larvae as an index of penaeid prawn resources of the Indian Ocean. *Indian J. Fish.* 23 (1 & 2) : 127-133.

Based on 1927 plankton samples collected during the International Indian Ocean expedition (1960-65). An attempt is made to correlate the occurrence and abundance of penaeid larvae with the penaeid prawn fishery of the various regions, especially in the Arabian sea and Bay of Bengal. Larvae of penaeid species were found in large numbers in the Bay of Bengal, particularly in the waters around Andaman and Nicobar Islands and of Madras coast and in the west coast of India mainly in the Malabar coast, in the Arabian sea.

89. PAULINOSE, V. T. 1982. Key to the identification of seed and post larvae of the penaeid prawn (Decapoda, Penaeidae) of the Indian ocean. *Mahasagar-Bulletin of the National Institute of Oceanography*, 15(4) : 223-224.

Some of the major criteria for identifying the larvae and early postlarvae of the penaeid prawn of the Indian ocean are presented, based on the study on material collected during *International Indian Ocean Expedition* (1960-65). They also permits identification of the species of protozoa, mysis and post larvae of 13 genera.

90. PEARL, THOMAS MARY; REDDY, P. SITA RAMI. 1986. On the endophragmal skeleton of prawns a taxonomical approach. *Indian J. Fish.* 33(1) : 27-38.

Endophragmal skeleton of *Penaeus japonicus*, *P. indicus*, *Metapenaeus dobsoni*, *M. monoceros*, *Parapenaeopsis stylifera*, *P. maxillipedo* and *Solenocera indica* are described and compared some unnamed Structures like 'subopthalmic apodeme, supernatennal apodeme' 'oblique sternal rod' have been tentatively named.

91. RACEK, A. A. 1955. Penaeid prawn fisheries of Australia with special reference to New South Wales. *Proc. Indo-Pacific Fish. Council*, 6 : 347-359.

This report gives brief review of the *Penaeus* prawn fishery of Australia which includes the development, fishing grounds, fishing methods, catch statistics, seasonal variations, management regulations and problems of the fisheries. Handling of catches, transport, processing and distribution are also given. Under the biological investigations, which includes the list of species occurring in the commercial catches, their distribution, habitats, migration, sex ratio and spawning grounds. *Penaeus semisulcatus*, *P. merguensis*, *P. indicus* and *P. latissulcatus* are dealt with among other Penaeid species. A working key to the species is also provided.

92. RACEK, A. A. 1972. Indo-west Pacific Penaeid prawns of commercial importance. Coastal Aquaculture in the Indo-Pacific Region *Ed.* T. V. R. Pillai Fishing News (Books) Ltd. London. P. 152-172.

Forty species of commercially important penaeid prawns including some of the Indian species are fully keyed out in this paper and data provided on their zoogeographical distribution and length-weight relationships. A special section deals with the suitability of some of these species for artificial cultivation, describes and discusses the different farming methods and provides information on the artificial cultivation of *Metapenaeus bennettiae*, a euryhaline species recently used in farming experiments in Australia.

93. RAMAMURTY, S. 1964. On a new record of *Metapenaeus stebbing* Nobili in Indian waters. *J. mar. biol. Ass. India*, 6(1) : 170-171.

Thirtyfive males and sixty females of *Metapenaeus stebbing* measuring 56-90mm 67-113mm, respectively, are recorded as having collected from the inshore waters of Gulf of Kutch during July 1961-June 1962.

94. RAO, P. VEDAVYASA. 1968. A new species of shrimp, *Acetes cochinchensis* (Crustacea: Decapoda, Sergistidae) from South west coast of India with an account of its larval development. *J. Mar. Biol. Ass. India*, 10 (2) : 298-320.

A new species, *Acetes cochinensis* sp. nov. obtained from inshore sea and estuarine back waters of Cochin, Southwest coast of India, 3.5-11 metres. Taxonomic features and larval development are described with full illustrations. A comparison of the corresponding stages of the three species, *A. japonicus*, *A. erythraeus* and *A. cochinensis* also made in the end of the paper.

95. RAO, P. VEDAVYASA. 1969. On the identification of juveniles of three species of *Metapenaeus* (decapoda, Penaeidae). *Indian J, Fish*, 16 (1&2) : 51-55

Distinguishing characters of juveniles (10 to 27 mm) body length of three species of commercially important prawns, namely, *Metapenaeus dobsoni*, *M. monoceros* and *M. affinis* collected from the back waters of Cochin are given. Colouration of the body, distribution pattern of chromatophores on carapace and abdominal segments, and length of rostrum of the species are compared. A key for their identification is provided based on the characters.

96. RAO, P. VEDAVYASA. 1973. Some observations on the larval growth of the commercially important penaeid prawns of South West Coast of India. Coastal Aquaculture in the Indo-Pacific Region, Ed., T. V. R. Pillai. Fishing News (Books) Ltd., London. p. p. 279.

Some aspects of larval growth of *Parapenaeopsis stylifera*, *Metapenaeus monoceros*, *M. dobsoni* and *Penaeus indicus* were studied. Growth factor in different larval stages was almost constant for each species and was less than 2, except in protozoal of *P. stylifera* and *M. dobsoni*. During transformation of the last nauplius to protozoal maximum values of growth factor and percentage varied from 4.47 to 76.96 in *P. stylifera*, 4.25 to 25.27 on *M. monoceros* 3.87 to 51.31 in *M. dobsoni* and 12.34 to 24.34 in *P. indicus*.

97. RAMADAN, M. M. 1938. Crustacea : Penaeidae. *John Murray Expedition, 1933-34 Scientific Reports*, 5 (3) : 1-76.

The material upon which this Report is based is primarily the Penaeid collected by the John Murray Expedition and a number of

Penaeidae in the collection of the British Museum, material obtained by the German Deep-Sea Expedition.

Out of 32 species given below, 6 of them are new to the science.

*Aristeus alcocki* sp. nov., *A. antennatus* (Risso), *A. mabahissa* sp. nov., *A. virilis* (Spence Bate), *Hemipenaeus carpenteri* Wood-Mason, *H. crassipes* Wood-Mason, *Plesiopenaeus armatus* (Spence Bate), *Aristeomorpha foliacea* (Risso), *P. edwardisianus* (Johnson), *Aristeomorpha* sp., *Hepomadus tener* Smith, *Solenocera hextii* Wood-Mason, *S. rathbuni* nom. nov., *Hymenopenaeus propinquus* (De Man), *H. lucassi* (Spence Bate), *H. sewelli* sp. nov., *H. fattahi* sp. nov., *P. marginatus* Randall, *Trachypenaeus curvirostris* (Stimpson), *Funchellia woodwardi* Johnson, *Pelagopenaeus balboe* (Faxon), *Penaeopsis rectactus* (Spence Bate), *P. conger* (Wood-Mason), *P. serretus* (Spence Bate), *P. philippi* (Spence Bate), *P. vaillanti* Nobili, *P. faouzi* sp. nov., *Parapenaeus fissurus* (Spence Bate), *P. investigatoris* Alcock & Anderson, *P. murrayi* sp. nov., *Eusicyonia carinata* (Olivier).

Key to the genera of the Aristeae, distribution, occurrence and comparison of the species are also given.

98. RAO, R. M.; GOPALAKRISHNAN V. 1970. Identification of juveniles of the prawn *Penaeus monodon* fabricius and *P. indicus* H. M. Edwards. *Proc. IPFC*, 13 (2) : 128-131.

Certain characteristics i.e. a red streak on the Central side of the body, colouration of the body, size of eyes and eye-stalks and number of rostral teeth have been found to be useful aids for easy identification of juveniles of the prawns, *Penaeus monodon* and *P. indicus* which are the most important species for culture in brackish-water impoundments of India.

99. ROBERTSON, J. W. A.; COLES, R. G.; GOEDEN, G. B. 1985. Distribution pattern of commercial prawns and reproduction of *Penaeus esculentus* around the Wellfleet Islands in the Southeastern Gulf of Carpentaria. IN. Second Australian National Prawn Seminar Ed. by P. C. Rothlisberg, B. J. Hill and D. J. Staples., P. 71-75.

Species composition and distribution of commercially fished penaeid prawns were investigated in waters around the Wellesley islands (139° 30 E, 16° 30's). *Penaeus esculentus* was the most abundant species with *P. latisulcatus* the next major component and *Metapenaeus endeavouri*, *P. mergulensis* and *P. semisulcatus* less numerous. *Penaeus esculentus* migrated to the Fishery from seagrass nursery grounds near southeastern Mornington Island and the Bentinck, Sweers Island. Juveniles, 18 to 26 mm carapace length (CL), first appeared in November and major migration from nursery areas occurred in December. The minimum size of mature female *P. esculentus* was 26 mm CL and 50% attained maturity at 31-32 mm CL. Although there was potential for spawning year round it is most likely to occur in July to September.

100. SHUKLA, G. S.; RAMAMURTHY; OMKAR. 1981. New records of two species of freshwater (*Macrobrachium*) from Gorakhpur region. *Indian J. Fish.* 28 (1&2) : 287-289

Two species of freshwater prawns, *Macrobrachium naso* (Kemp) and *M. dayanum* (Henderson) are reported for the first time from the Gorakhpur region, Uttar Pradesh. The differences observed in the shape of rostrum, number of rostral teeth and in the second pereopod are briefly discussed.

101. SILAS, E. G.; MUTHU, M. S. 1976. On a new species of penaeid prawn of the genus *Metapenaeus* Wood-Mason and Alcock from Andamans. *J. mar. biol. Ass. India*, 16 (2) : 645-648.

A new species of *Metapenaeus* Wood Mason and Alcock closely related to *M. suluensis* Raček and Dall, from which it differs in having distinctly different thelycum, and petasma, is described from Port Blair, Andamans. The diagnostic characters are distomedian lobes of petasma broadly triangular with species barely projecting beyond anterior margin of distolateral projections; anterior plates of thelycum flat, bounded posteriorly by two transverse protuberances bearing tufts of setae (Author's Abstract).

102. SILAS, E. G. MUTHU, M. S. 1979. Notes on a collection of penaeid prawn from the Andamans. *J. mar. biol. Ass. India*, 18 (1) : 78-90

The report records the occurrence of 16 species of the penaeid prawns in the Andaman Islands based on material collected mainly during a survey conducted from the Middle Andamans. Thirteen out of the 16 species collected are new records for the Andaman-Nicobar Islands. The clinal differences observed in some of the species such as *Metapenaeus dobsoni* and *Parapenaeopsis cornata* are discussed.

103. SUSEELAN, C.; KATHIRVEL, M. 1982. Prawn seed calendar of Cochin back water. *Proc. Symp. Coastal Aquaculture*, 1 : 173-182.

The spatial and temporal distribution on the penaeid prawn *Parapenaeopsis stylifera* in the shelf waters off Cochin is described based on the results of experimental shrimp trawling conducted from May 1986 to December 1987. The species shows distinct seasonal pattern of mass migration between the inshore waters up to 65 m depth. During September to May, most of the shrimp stocks including *P. Stylifera* occupy the coastal waters within-the 20 m depth contour. With the commencement of southwest monsoon and the consequent changes in the environmental conditions, the species leave the inshore areas on masses to the deeper zones and remain mostly in the 21-40m depth zone during July and August. By about September the species again recolonize the coastal waters and continue to stay there throughout the non-monsoon period.

104. SUSEELAN, C.; KATHIRVEL, M. 1983. A study of the prawn of Ashtamudi backwaters in Kerala with special reference to penaeids. *Indian J. Fish*, 29 (1&2) : 71-78

Fifteen species of prawns were recorded from the Ashtamudi backwater system which included one species of sergestid Five species of carideans and nine species of Penaeids. The penaeid prawns were chiefly represented by juveniles of *Penaeus semisulcatus*, *P. indicus*, *P. latisulcatus*, *Metapenaeus dobsoni* and *M. monoceros*. While



*M. dobsoni* and *P. indicus* were the dominant species in most parts of the back waters. *P. semisulcatus* occurred more abundantly in some of the deeper areas having relatively higher salinities. (9.42-32.11%) *P. latisulcatus* formed one of the common components of the catches taken during the post-monsoon period. *Parapenaeopsis stylifera*, the most dominant species contributing to the marine fishery of this area, was encountered only in stray numbers. Commercial exploitation and population characteristics of the juvenile penaeid prawns in these nursery areas are briefly discussed.

105. THOMAS, M. M. 1970. *Trachypenaeopsis minicoyensis* Sp. Nov. (Penaeidae, decapada) from the Laccadive sea. *Indian J. Fish.* 11 (1&2): 116-121.

A new species *Trachypenaeopsis minicoyensis* sp. Nov. is described based on collection from Minicoy Island, in 1967. This is also the first record of the genus *Trachypenaeopsis burkenroad* from India. The new species is compared with other known species viz, *T. richtersii* (Miers) and *T. mobilispinis* (Rathbun). A key to the known species of the genus is also provided.

106. THOMAS, M. M. 1974. Decapod crustaceans new to the Laccadive Archipelago. *Indian J. Fish.* 21 (2): 339-344.

Three penaeid prawns, *Penaeus latisulcatus* Kishinoue, *Penaeus canaliculatus*, Oliver and *Trachypenaeus curvirostris* (Stimpson), one gnathophyllid shrimp, and *Hymenocera elegans* Heller, all are recorded from the Laccadive Archipelago for the first time. Taxonomical descriptions of the specimens are given.

107. THOMAS, M. M. 1977. Decapod crustaceans new to Andaman and Nicobar Islands. *Indian J. Fish.* 24 (1&2): 56-61.

The Penaeids, *Penaeus canaliculatus*, *P. merguensis*, *Metapenaeus dobsoni*, *M. affinis*, *M. burkenroadi* and *Parapenaeopsis cornata*; pegeriid

crabs *Carcinus latens* and *Pagurus jointor*, and D. coenobitid *Coenobita clypeata* are reported from Andaman and Nicobar Islands, for the first time. Points of taxonomic interest of these are discussed.

108. THOMAS, M. M. 1977. A new record of *Epipenaeon ingens nobili* (Bopyridae, isopoda) parasitic on *Penaeus semisulcatus* De haan from Palk Bay and Gulf of Mannar. *Indian J. Fish.*, 24 (1&2): 258-261

The isopod *Epipenaeon ingens nobili* as parasitic on *Penaeus semisulcatus* de Haan is reported. A brief description of the parasite is given along with the observed percentage of incidence and how it had affected the host.

109. TIWARI, K. K. 1963. Lower tertiary penaeid shrimps from Kapurdi (Barmer District, Rajasthan, India). *Crustaceana*, 5 (3): 205-212

Description of two fossil Penaeids referable to the genus *Penaeus* Fabricius are given based on impressions gathered from the lower tertiary beds at Kapurdi in the desert of Western Rajasthan in the winter months of 1957-58. This is the first record of occurrence of penaeids in tertiaries and the first ever record of fossil shrimp from India. The new species which are *Penaeus barmerensis* sp. Nov. and *Penaeus glaessneri* are well illustrated as well as providing photographs of impressions.

## II BIOLOGY

110. ACHUTHANKUTTY, C. T., M. J. GEORGE and S. C. GOSWAMI. 1977 Larval ingression of penaeid prawns in the estuaries of Goa. *Proc. Symp. Warm. Water. Zoopl. Spec. Publ. UNESCO/NIO* : 412-424.

Based on sampling at different stations in Mandovi and Zuari estuaries of Goa. The abundance and distribution of larvae of four species of penaeid prawns, namely, *Metapenaeus dobsoni* (Miers), *M. monoceros* (Fabricius), *Penaeus merguensis* de Man and *Parapenaeopsis stylifera* (Milne Edw.) are given. Larvae were more abundant in the stations nearer the mouth than in the upper reaches. *M. dobsoni* was most abundant and more or less equally distributed in these estuaries. *M. monoceros* and *P. merguensis* were mainly restricted to the mouth stations in Zuari, whereas in Mandovi they had a wider distribution in the interior. Early larval stages of *P. stylifera* were also present in the mouth stations.

On the basis of larval abundance, the peak breeding of all the species was in the postmonsoon months. In Mandovi estuary, the larvae had the primary peak in January and two minor peaks, one in December and the other in March-April. In Zuari estuary, while the minor peaks occurred in the same months, the main peak was in November. Species-wise differences in peak abundance was also noticed.

111. ACHUTHANKUTTY, C. T.; PARULEKAR, A. H. 1986 Distribution of Penaeid prawn larvae in the coastal waters of Goa. *Indian J. Mar. Sci.* 15 : 45-47.

Larval and postlarval distributions of 4 commercially important penaeid prawns were studied in the coastal waters of Goa extending up to 40 m depth zone during Jan-Dec. 1981. Larval stages of *Metapenaeus dobsoni* and *M. affinis* were mostly distributed within the 20 m depth zone whereas those of *penaeus merguensis* and *Parapenaeopsis stylifera* were between 20 and 30 m depth zone. Larval

abundance showed species-specific seasonal variation. Statistical analysis indicated that larval and postlarval stages of *M. dobsoni* and *P. stylifera* were significantly dominant at 20 and 30 m depth zones and significantly high density of larval stages. Larval abundance in the coastal waters is correlated to the breeding behaviour.

112. CONTE, F. S. DURONSEET, N. J., CKARK, W. H. PARKER, J. C  
1977 Maturation of *Penaeus stylifera* (Stempson) and *P. setifera* (Linn) in hypersaline water near Corpus Christi, Texas. *Proc. World. Mariculture Soc.* 8 : 327-334

In order to test the feasibility of producing a breeding stock of nonindigenous penaeid shrimp in closed pond systems, tests were performed using second season animals previously overwintered in a heated recirculation system. The Shrimp, originally stocked as postlarvae, were reared to 150.0 mm in length and 30.0 g in weight. The shrimp were then harvested, overwintered, then returned to a 0.1 ha pond in Corpus Christi, Texas. In their second season the shrimp grew to 190.0 mm and 52.0 g and exhibited signs of sexual maturity. Sampling of the pond-produced mated females that were removed from the pond and spawned in the laboratory.

113. GALOIS, R. G. 1984 Variations de la composition lipidique tissulaire au cours de la vitellogenese chez la crevette *Penaeus indicus* Milne Edwards. *J. Exp. Mar. Biol. Ecol.* 84 : 155-166.

Changes in lipid composition were observed in the ovary, the hepatopancreas, the haemolymph and the muscle of the female *Penaeus indicus* Milne Edwards, during the increase of the gonadosomatic index (GSI). Vitellogenesis was characterized by a large accumulation of lipids in the ovary, which seemed to be practically linear when expressed as a function of GSI, if there was no interference from moulting. Phospholipids and triacylglycerols were the major lipid fractions in the ovary, but some classes of minor importance, like wax esters, hydrocarbons, and glyceryl ethers, were also incorporated. These last components possibly played a role in the maturation process.

The lipid reserves of the hepatopancreas contributed partially to the formation of vitellin, but direct input of lipids from feeding seemed to be preponderant. An intraovarian synthesis of lipids might be possible, but probably restricted, considering the low concentrations of free fatty acids and stored acylglycerols found in the ovary. Phospholipids were the main components involved in the increase in lipid concentration of the haemolymph during vitellogenesis. This increase, and the potential rise in the turnover of circulating lipids, suggested a deep alteration in the lipid metabolism of the females during the breeding periods.

114. GANDHI, V. 1982 Biometry and biology of *Pennahia aneus* Bloch. *Indian J Fish.* 29 (1-2), 79-84 (Publ 1983).

Biometry and Biology of *P. aneus* Bloch from Porto-Novo waters are discussed. The total length shows the fastest growth and the eye-diameter has the lowest rate of growth. The food consists of fishes, *Cymatoha* Sp., prawns, prawn mysis and *Squilla* spp. The juveniles feed predominantly on crustaceans. The presence of *Cymathos* spp. on the stomach contents of adults indicates that *Pennahia aneus* may exhibit cleaning association with other hosts of the parasite. The spawning takes place during a short period from September to October. *Pennahia aneus* attains sexual maturity at a length of 134 to 148 mm. Fecundity in the fish measuring 189 to 252 mm varies between 11423 and 79835.

115. GEORGE, M. J. and P. VEDAVYASA RAO, 1968. Observations on the development of the external genitalia in some Indian penaeid prawns. *J. mar. biol. Ass. India.* 10 (1) : 62 3-70

The development of the external genital organs of five commercially important penaeid prawns of India has been traced from early stages to adult form. The development in *Penaeus indicus* was found to follow a simple pattern, while that of *Parapenaeopsis stylifera* and all the species of *Metapenaeus* exhibited specialised conditions such as the well developed longitudinal folds as well as conspicuously modified

distal projections in the petasma, and in the nature of the different plates in the thelycum. The size at which fifty percent of the males had the petasmal endopodites fused was found to be 102.0 mm in *P. indicus*, 74.0 mm in *M. monoceros* 71.6., in *M. affinis*, 53.6 mm in *M. dobsoni* and 59.0 mm in *P. stylifera*. A comparison of the developmental features of the different species is made and their phylogenetic positions are discussed.

116. GEORGE, M. J. 1969. Synopsis of Biological Data on the Penaeid prawn *Metapenaeus dobsoni* (Miers, 1878). IN: Proceedings of the World Scientific Conference on the Biology and Culture of Shrimps and Prawns, Mexico, 12-21 June 1967. *FAO Fisheries Reports* 57 (4) : 1335-1358.

Taxonomy, distribution, bionomics and life history, population and exploitation of *Metapenaeus dobsoni* both from sea and Cochin back-water are reviewed.

117. GEORGE, M. J. 1969. Synopsis of Biological Data on the Penaeid prawn *Metapenaeus monoceros* (Fabricius, 1798). IN: Proceedings of the World Scientific Conference on the Biology and Culture Shrimps and Prawns, Mexico 12-21 June 1967. *FAO Fisheries Reports*, 57(4) : 1539-1557.

Taxonomy, distribution, bionomics and life history, population and exploitation of *Metapenaeus monoceros* are reviewed.

118. GEORGE, M. J. 1969. Synopsis of Biological Data on the Penaeid prawn *Metapenaeus affinis* (H. Milne Edwards, 1837). IN : Proceedings of the World Scientific Conference on the Biology and Culture of Shrimps and Prawns, Mexico, 12-21 June 1967. *FAO Fisheries Reports*, 57 (4) : 1359-1375 (FAO Fisheries Synopsis No.98)

Genus *Metapenaeus* Wood-mason, in Wood-mason and Alcock, 1891, Ann. Mag. nat. Hist., 6 (8) : 271. Type species by original designation : *Penaeus affinis* H. Milne Edwards, 1837. Taxonomy, distribution, Bionomics and life history, population and exploitation of *Metapenaeus affinis* are given.

119. GEORGE, M. J. 1975. Observations on the growth in certain penaeid prawns studied in prawn culture in experiments in paddy field. *Bull. Dep. Mar. Sci. Univ. Cochin.* 7(1) : 41-55.

In culture experiments conducted in a paddy field situated in the backwaters of Cochin, the sizes were traced, average growth rates of 0.35 mm, 0.47 mm, 0.38 mm and 0.49 mm per day were obtained in the case of juveniles *Metapenaeus dobsoni*, *M. monoceros*, *M. affinis* and *Penaeus indicus*, respectively. These rates were slightly higher than their recorded growth for the species in their estuarine phases in earlier works. The faster growth observed in the case of the two species *Metapenaeus dobsoni* and *Penaeus indicus* is taken as probable indication of their being more suitable for culture practices.

120. GEORGE, M. J.; BANERJI, S. K.; MOHAMED, K. H. 1966. Size distribution and movement of the commercial prawns of the Southwest coast of India. *Proc. World. Scientific Con. of the Biology and culture of Shrimps and prawns.* Mexico, 12-21 June 1967. *FAO Fisheries Reports*, 57 (2) : 265-302.

The size distribution and abundance in the southwest coast of India of *Metapenaeus dobsoni*, *M. affinis*, *M. Monoceros*, *Penaeus indicus* and *Parapenaeopsis stylifera* are given based on the catches of the exploratory vessels belonging to the Government of India, Offshore Fishing Station and the Indo-Norwegian Project, Cochin. As seen from the data, the movements of these prawns in different depth zones were size oriented. With the exception of *M. dobsoni*, all the species studied were seen to enter the fishing grounds from deeper zones by September, which was the beginning of the fishing season. They moved out of the fishing grounds into the deeper zones from February, March onwards. *M. dobsoni* however, seemed to exhibit a movement in the opposite direction. The probable role of monsoon and upwelling in causing these movements are discussed.

121. GEORGE, M. J.; MOHAMED, K. H.; PILLAI, N. N. 1967. Observations on the paddy-field prawn filtration of Kerala, India. IN: *Proc. World Scientific Conf. on the Biology and culture of Shrimps and Prawns*, Mexico City, Mexico, 12-21 June 1967. *FAO Fish. Rep.* 57 (2): 427-442.

To find whether the existing prawn filtration practices could be improved upon by introducing culture methods, three experiments were conducted in a 3.16 ha field near Cochin, taken on lease and denoted for the purpose in 1964-66. In all the experiments juveniles were let in with tide every day as was being practiced locally. In Expt. 1 fishing was done only at the end of the experiment. In expt 11 fishing was at intervals of one month. In Exp 111 fishing was as was practiced locally. The yields indicated that culturing of prawns for about a month as in Expt 11 was the most advantageous in that the yield in it was better and was consisted of large prawns. It was also observed that the majority of juveniles that were brought into the field by tides did not necessarily moved out of it when the tide receded.

122. GEORGE, M. J. 1972 Preliminary experiments in marking Penaeid prawns in paddy fields. *Coastal Aquaculture in Indo-Pacific Region*, Fishing News (Books) Ltd., London pp: 173-177,

Costal Aquaculture in the Indo-Pacific region Experiments on marking of penaeid prawns by stain injection method were carried out in a small compartment of a paddy field (650 m<sup>2</sup> in area) used for prawn culture, in the backwater area of Cochin (India). The tidal flow in and out of the field was regulated through a screened sluice gate. Among the three species this experimented *Penaeus indicus* was found to be the most suited for making detection of stained specimens proved to be extremely difficult in the case of *Metapenaeus dobsoni*, especially the smaller ones. Out of the three stains used, fast green FCF was found to be the most suitable.

123. GOPALAKRISHNAN, K; LAURS, R. MICHEAL *Eretmocarid corniger* Bate larvae from the eastern tropical Pacific. Ocean (Cardidae, Hippolytidae). *Crustaceana*, 20 (1), 1971, p. 9-18

The occurrence of *Eretmocarid corniger* in the eastern tropical Pacific. Ocean is reported along with a description of leg. 5 of which is present in



one of the specimens examined. Specimens studied were collected from six locations. The specimens were collected in zoo-plankton hauls using 1.1-m net. The specimens were identified as larval *E. corniger* by the presence of a prominent slightly procurved spine on abdominal somite 3 and a long rostrum with dorsal teeth. The function of leg 5 may be for locomotion or aid in feeding.

124. GEORGE, M. J. 1974 Food of the shrimp *Metapenaeus monoceros* (Fabricius) caught from the backwaters. *Indian J. Fish.*, 21 (2): 495-500. 3 tables.

An analysis of stomach contents of 1213 specimens caught from the backwaters of Cochin showed that the food of the smaller sizes of the penaeid prawn, *Metapenaeus monoceros* (Fabricius), largely consists of small crustaceans. Unrecognizable materials inclusive of mud and detritus were found to compose 50% of the gut contents in specimens below 50 mm long, while in the larger specimens these materials form only a small portion. Food preference exists but this species do not complete with other species in the backwaters.

(Modified Author's Abstract)

125. HILL, B. J.; ALLANSON, B. R. 1981. Temperature tolerance of the estuarine prawn *Upogebia africana* (Anomura, Crustacea). *Mar. Biol.*, 11 (4), p. 337-343).

Continuous temperature measurements were made in a typical South East African estuary, mean summer (November to March) temperatures were in the range 19 to 24 C, and in winter (June to August) from 13 to 16°C. Large daily temperature fluctuations of 6 to 10°C occurred in summer; these appear to result from tidal movement of cool sea water into the estuary. In winter, temperature fluctuations were much smaller (3 to 5°C). The burrowing prawn *Upogebia africana* (Ortman) was found to have an upper lethal temperature of 29°C in both winter and summer. The resistance time of prawns to temperatures above 30°C was much greater in summer than in winter. It was possible to acclimate winter prawns and increase their resistance time to a level comparable to that of summer individuals. A latent period of 40 h occurred before acclimation

effects were detectable. Long-term exposure of prawns to high temperature did not increase their resistance above that of summer prawns. Water at a temperature above this upper lethal temperature is not pumped through the burrows. This avoidance behaviour considerably increases the ability of *U. africana* to withstand short-lived temperature extremes.

126. KABAYASHI, K.; NAKAMURA, Y. ; IMADA, N. 1985 Metabolism of an organophosphorus insecticide, fenitrothion, in tiger shrimp *Penaeus japonicus*. *Bull. Jap. Soc. Sci. Fish* 51 (4) : 599-603.

A study was made on the toxicity, absorption and metabolism of fenitrothion (0,0-dimethyl 0-(3-methyl-4-nitrophenyl) phosphorothioate; Sumithion) in tiger shrimp *Penaeus japonicus*, as the first step to elucidate the cause for the occurrence of its high toxicity to the shrimp.

The 23-h LC 50 value of fenitrothion for tiger shrimp was about 1 ppb, while that for fish was metabolites accumulated to the shrimp were extracted with benzene and separated by thin-layer chromatography with non-radioactive fenitrothion and its authentic metabolites. After 4-h exposure, the concentration of fenitrothion was almost equilibrated at a level of ca. 6.5 pmol/g shrimp, which corresponded to a bioconcentration ratio of 3.6, whereas concentrations of its metabolites, especially 3-methyl-4-nitrophenol, increased with exposure time. At 24-h exposure, the amounts of fenitrothion, fenitrooxon, desmethyl fenitrothion, desmethylfenitrooxon and 3-methyl-4-nitrophenol accumulated in the shrimp were 6.3, 2.9, 3.6, 6.2 and 74.3 pmol/g, respectively.

127. KARBHARI, J. P., ARAVINDAKSHAN, M; WAGMARE, K. N.; RAMADOSS GANDHI. 1985 On the occurrence of *Acetes Johni Nataraj* and *A. Japonicus Kishinouye* in Bombay waters. *J. mar. biol. Ass. India*, 25 (182) : 191-193

Occurrence of *Acetes Johni Nataraj* and *A. Japonicus* regularly in the catches landed at Versova and Saseon Docks in Bombay is recorded.

128. KATHIRVEL, M.; GOPALAKRISHNAN, K. N.; NALINI, C. 1976 *Metapenaeopsis hilarula* (De Man) and *Penaeus penicillatus* Alcock (Decapoda: Penaeidae) in Cochin Backwater. *Indian J. Fish.* 23 (1 & 2) : 236-238.

The occurrence of *Metapenaeopsis hilarula* (De Man) and *Penaeus penicillatus* Alcock from Cochin Backwater is reported for the first time. A brief note on the morphological variations observed on these species is given.

129. KIRKEGGARD, I.; WALKER, R. H. 1970 Synopsis of biological data on the greentail prawn *Metapenaeus benettæ* Racek and Dall, 1965. *CSIRO Fisheries and Oceanography, Fisheries synopsis*, 6 28 p.

A monograph on the greentail prawn *Metapenaeus benettæ*, covering the aspects such as identity, distribution, bionomics and lifehistory, population, exploitation, management and culture.

130. KIRKEGGARD, I.; TUMA, D. J.; WALKER, R. H. 1979 Synopsis of biological data on the banana prawn *Penaeus merguensis* de Man, 1888. *CSIRO Fisheries and Oceanography, Fisheries synopsis*, 8.30p.

A monograph on the banana prawn, *Penaeus merguensis*, covering various aspects, such as identity, distribution, bionomics and life-history, population, exploitation, management and culture.

131. KUNJU, M. M. 1955 Preliminary studies on the biology of the palaemonid prawn, *Leander styliferus* Milne-Edwards in West Bengal, India. *Proc. Indo Pacific*. 5:404-418

Preliminary observations on the food and feeding habits, length-weight relationship, egg-carriage and ovigerous setae, breeding, sex ratio, parasitism, length-frequency distribution, fishery and fishing methods of the prawn *Leander styliferus* collected from the commercial catch of Port canning on the river Matlah, and Kakdwip, Diamond harbour, Falta and Calcutta along the River Hooghly in West Bengal.

132. KUBO, I. 1955 A review of the biology and systematics of shrimps and prawns of Japan. *Proc. Indo-Pacific Council*, 5 : 387-398

Biology, longevity, migration, food, habitual preferences, and activity of shrimps and prawns of Japan has been discussed in this paper. A list of the systematic papers which have appeared on shrimps and prawns in Japan since World War II is appended.

133. KUTTY, M. N.; MURUGAPOOPATHY, G. 1968 Diurnal activity of the prawn *Penaeus semisulcatus* de Haan. *J. mar. biol. Ass. India*, 10 (1) : 95-98

Observation were made on the activity of the prawn at different times of day for 16 days which are graphically presented. It has been suggested that prawns emerge at dusk and remain active at night to avoid their predators.

134. LIAO, I-CHIU; JIIN-JU. 1986. Studies on the tolerance of post-larvae of *Penaeus monodon*, *P. Japonicus*, *P. semisulcatus*, *P. penicillatus*, *Metapenaeus ensis* and *Macrobrachium rosenbergii* to Neomycin, Streptomycin, Oxytetracycline, and Chlorotetracycline. *FOA Fisheries Series*, 8 : 34-39.

The values of Neomycin, Streptomycin, Oxytetracycline and Chlorotetracycline for post-larvae of *Penaeus monodon*, *P. japonicus*, *P. semisulcatus*, *P. penicillatus*, *Metapenaeus ensis* and *Macrobrachium rosenbergii* after 24h of dipping are given. The results were calculated with the Van der Waerden method as follows : The values of Neomycin for postlarvae of the prawns in the above order were 8,281, 10,305, 5,205, 8,436, 19,963 and 18,631 ppm, of Streptomycin were 4,884, 6,616, 9,813, 9,635, 17,173 and 6,325 ppm, oxytetracycline were 954, 936, 908, 916, 1,397 and 1,250 ppm, and of Chlorotetracycline were 559, 538, 753, 377; 64 and 1,097 ppm.

(Authors's Abstract)

135. MURDIJANI, M. 1981 Influence of some pelletized formulated feeds on growth rate of the tiger prawn *Penaeus monodon* (Fabricius). Pengaruh beberapa formula makanan tambahan terhadap lagu

Pertumbuhan udang windu *Penaeus monodon* Fabricius. (M.S. Thesis, Gajah Mada University) 79 pp. (Text in Bahasa).

The effect of pelletized formulated feeds containing different protein contents on the growth of *Penaeus monodon* was studied. Twenty wooden boxes were used measuring 1x1x0.4m. Stocking density was 20 larvae (PL-25) sq. m. Prawns in treatment AF-11 containing the highest percentage protein (60.08%) attained the highest growth rate. Statistically, each treatment was significant different.

(Modified Author's Abstract)

136. MOTOH, H. 1985 Biology and ecology of *Penaeus monodon*. IN: Proceedings of the *First International Conference on the Culture of Penaeid Prawns/Shrimps*, Iloilo City, Philippines, 4-7 Dec. 1984. Ed. by Y. Taki, J. H. Primavera and J. A. Llobrera. Iloilo, Philippines, Aquaculture Department, SEAFDEC. p. 27-36. 11 figs.

The giant tiger prawn, *Penaeus monodon*, the largest and most commercially important species among penaeids reaching 220 mm in body length or 260 g in weight, is suitable for culture in ponds and offers high market prices. This species occurs mainly in Southeast Asian waters, though it is quite widely distributed from 30E to 155E longitude and 35 N to 35 S latitude. Mating and spawning generally take place at night. The maximum number of eggs spawned at a time is more than 800,000. The life history is classified into six phases: embryo, larvae, juvenile, adolescent, subadult, and adult. The biological minimum size is 37 mm carapace length for males and 47 mm CL for females. The food consists mainly of small crustacea, molluscs and annelids. The adult is a predator of slow-moving benthic macroinvertebrates, or opportunistic in feeding behaviour. This prawn is relatively eurythermal and euryhaline, growing rapidly to a large size. The life span may be one and a half to two years, and the female may live for a longer period than the male. In general, the female is larger than the male

(Author's Abstract)

137. MENON, M. KRISHNA. 1951. The life history and bionomics of an Indian Penaeid prawn, *Metapenaeus dobsoni*, Miers. *Proc. IPFC*, 3 (2 & 3) : 80-93.

The larval development of *M. dobsoni* resembled closely to that of *M. stebbingi*, especially in having the same number of stages and numerous common characters. Rostrum, telson and pleopods were observed to acquire approximately adult character in the course of 12 moults. The species was found to breed mainly in the sea in comparatively shallow inshore waters and the breeding period to be extending over 5-6 months. The food of larvae and early post-larvae consisted chiefly of plankton. In later stages their stomach contents showed a good proportion of mud and sand, showing their having acquired the bottom-feeding habit. Sexual maturity was reached probably in 7-8 months. Like some other species of penaeids, *M. dobsoni* also migrated into estuaries and brackishwater areas early in life and return to sea after a period of growth.

138. MOHAMED, K. H. 1969. Synopsis of Biological Data of the Jumbo tiger prawn *Penaeus monodon* Fabricius, 1798. Proceedings of the World Scientific Conference on the Biology and culture of Shrimps and prawns, Mexico, 12-21 June 1967. FAO Fisheries Reports, 57 (2): 1251-1266. (FAO Fisheries Synopsis, 93).

Taxonomy, distribution, bionomics and life history, population, and exploitation of the tiger prawn, *Penaeus monodon*, are reviewed.

139. MOHAMED, K. H.; EL-MUSA, M; ABDUL-GHAFFAR, A. R. 1981 Observations on the biology of an exploited species of shrimp, *Penaeus semisulcatus* De haan, In Kuwait. *Kuwait Bulletin of Marine Science*, 2 : 33-52.

This is a project report on the biology of the exploited species of shrimps of Kuwait. Nine species of penaeid shrimp are recorded and their biology and structure is described. Estimated shrimps landings from the artisanal fishery in Kuwait, seasonal pattern of the percentage of occurrence of different species of shrimps and different stages of maturity of shrimps are furnished in this report.

140. MYDEEN KUNJU, M. 1969. Synopsis of Biological Data on the Penaeid prawn *Solenocera indica* Nataraaj, 1945. Proceedings of the

World Scientific Conference on the Biology and Culture of Shrimps and Prawns, Mexico, 12-21 June 1967. *FAO Fisheries Reports* 67 (4): 1317-1333.

Taxonomy, distribution, bionomics and life history, population and exploitation of the penaeid prawn *Solenocera indica* are reviewed.

The adult, older, substage, and zoel stages are illustrated.

141. NAGABHUSHANAM, R. 1968. Neurosecretory control of red chromatophores in the shrimp, *Alpheus malabaricus*, *J. mar. biol. Ass. India*, 10(2) : 180-183.

A morphological description of the neurosecretory system in the shrimp *Alpheus malabaricus* is given. The supraesophageal ganglia possess five groups of neurosecretory cells. The optic gangli, thoracic ganglion and abdominal ganglia also contained neurosecretory cells. The neurosecretory cells were large (20-30 $\mu$ ) pear-shaped, possessed large cytoplasm and small nucleus. The secretory material stained red with Mallory's and blue-black with Homoti's stain. Removal of both eyestalks in *Alpheus* resulted in accumulation of neurosecretory material in the brain and in the optic nerve stubs. A portion of the accumulated material in the optic stubs contained red pigment concentrating hormone.

142. NALINI, C. 1975. On hypomorphic ovaries in *Metapenaeus monoceros* (Fabricius) *Indian J. Fish*, 22 (1 & 2) :255-258.

The hypomorphic ovaries in three specimens *Metapenaeus monoceros* (Fabricius) obtained from Cochin waters during November 1973, are described. The abnormalities noticed pertain to the underdeveloped state of the posterior lobe of the ovary in two specimens, and of the proximal 3/4th region of the anterior lobe in a third one. The probable causes for such abnormal development of the ovary are discussed.

143. NALINI, C. 1976. Observations on the maturity and spawning of *Metapenaeus monoceros* (Fabricius) at Cochin. *Indian J. Fish*, 23 (1 & 2) : 23-30.

Maturation and spawning of *Metapenaeus monoceros* from Cochin area are reported. Five maturity stages were recognised. The maturation process of the intra-ovarian eggs is described in detail. The minimum size at first maturity was 118 mm. Spawning as a whole was through out the year with peak from October to April. But the spawning of individuals was restricted to a short and definite period; and the occurrence of mature females in various sizegroups suggests that the species spawned more than once during its life time. The fecundity of the species was estimated to be between 155,000 and 338,000.

144. NEAL, R. A. 1969. Methods of marking shrimp. IN: Proc. World Scientific Conf. on the Biology and Culture of Shrimps and Prawns, Mexico City, Mexico, 12-21 June 1967. *FAO Fish. Rep.* 57(3) : 1149-1165.

Methods of staining and tagging shrimp are reviewed. Marking methods discussed are staining by injection, feeding, and immersion, and tagging with internal and external tags. Some aids for handling and releasing live shrimp are also discussed.

145. PAUL, A. L. 1985. Effect of flour meal on the mortality of fresh water prawn, *Macrobrachium handersoni cacherensis* (Tiwari). *Indian Zoologist* 1985, 9 (1-2), 87.

Flour meal is reported to have been observed to have favourable effects on mortality of freshwater hill stream prawn, *M. handersoni cacherensis*.

146. PERSIS, B.; SAROJINI R. 1985, Ovary inhibiting hormone activity in the eye stalk of freshwater prawn, *Caridina rajadhari*. *Uttar Pradesh J. Zool.* 5(2), 159-163.

The activity of the ovary-inhibiting hormone in the eyestalks of freshwater prawn *C. rajadhari* is studied. The mean ovarian index, and the oocyte diameter differed variedly amongst normal animals, eyestalk ablated animals and eyestalk ablated plus eyestalk extract injected animals. In the eyestalk ablated animals, the oocyte diameter and ovarian index increased markedly when compared with other two groups; a rapid maturation of oocytes was observed in eyestalk ablated animals.



147. RAJALAKSHMI, T.; RAMARAJU, T. S.; RAMAKRISHNA RAO, D 1938.  
On the marking of freshwater prawn, *Macrobrachium malcolmsoni*,  
in river Godavari. *Indian J Fish.* 15 (1 & 2) : 61-67.

Marking experiment with the biological stain, Trypan blue, conducted on *Macrobrachium malcolmsoni* of River Godavari, mark recapture technique and the behaviour of the marked prawns, in general freshwater prawn are described.

The period February-March was found to be the most suitable period for marking prawns in the river. The chief observations from the study were (1) Occurrence of recaptures close to the release spot and recoveries from cast net indicating shoreward movement to shallow water; (2) recovery of a greater number within a week of marking; (3) absence of any homogenous trend in the pattern of migration among prawn.

The maximum travelled distance of a marked prawn was 17 km and the percentage recapture varied from 2.77 to 24.2 in the different experiments. The total period of mark retention was 75 days.

148. RAO, P. VEDAVYASA; M. KATHIRVEL 1971. On the seasonal occurrence of *Penaeus semisulcatus* de Haan, *Panulirus polyphagus* (Herbst) and *Portunus pelagicus* (Linn.) in the Cochin backwater. *Indian J. Fish.* 18 : 129-134.

Distribution and abundance of *Penaeus semisulcatus* de Haan and *Portunus pelagicus* (Linnaeus) in relation to salinity and temperature variations in Cochin backwater have been studied. These species disappeared from this environment in July, when the salinity and the temperature decreased and reappeared in November-December when these increased. These species appeared to be less euryhaline than the related species occurring in this backwater. The report of occurrence *Panulirus polyphagus* (Herbst), a truly marine species, is for the first time.

- 149 RAO, P. VEDAVYASA; M. KATHIRVEL 1973. On the breeding of a penaeid prawn, *Metapenaeus dobsoni* in the brackish water medium. *Indian J. Fish* 20 (1) , 228-230.

Laboratory spawning of a mature female *Metapenaeus dobsoni* obtained from the Cochin backwater and kept in brackishwater medium (salinity 30.22‰, temperature 27.8°C) is reported. The eggs reared in the brackish water medium hatched out into nauplii, but none of them developed further. On transferring a few nauplii to the sea water (salinity 32.02‰) after two days, they transformed into abnormally developed protozoae. The importance of this observation in the context of breeding of Indian penaeid prawn and from the point of view of their culture in the coastal estuaries is discussed.

- 150 RAO, A.U.P. 1967. Some observations on the biology of *Penaeus indicus* H. Milne-Edwards and *Penaeus monodon* Fabricius from the Chilka lake. *Indian J. Fish.*, 14(1/2) :

The biology of *Penaeus indicus* (\*kantala chingri\*) and *Penaeus monodon* (Bagda) was studied from May to Dec. 1963. Length-weight relationships, sex ratio, food, moulting, breeding and migration were observed. Males and females of both species have different length-weight relationships. Both species feed on detritus, crustacean remains, plant matter and lamellibranchs. *P. indicus* and *P. monodon* start leaving the lake for the sea to breed at 93 mm and 155 mm respectively. Breeding occurs in June, Aug. and Sept. Sex ratio and number of moults at particular periods are indicated. (Modified Author's Abstract).

- 151 REDDY, P.S.R.; RAMACHANDRAN, K. 1985. Endophragmal skeleton of prawns-A taxonomical tool. *Mahasagar*-18(3) : 407-412.

The endophragmal skeletons of *Macrobrachium javanicum* *M. idae* and *Penaeus monodon* have been described. Endosternal plate, epistomal apodeme epimeral ridges, oblique endosternal rods, epimeral plate and mandibular apodeme, revealed distinct differences, and these structures are tentatively named. The utility of the endophragmal skeleton as a taxonomical tool in prawn is indicated.

- 152 ROBERTSON, J. W. A.; COLES, R. G.; GOEDEN, G. B. 1985. Distribution patterns of commercial prawns and reproduction of *Penaeus esculentus* around the Wellesley Islands in the Southern Gulf of Carpentaria. In: Second Australian National Prawn Seminar Ed. by. P. C. Rothlisberg, B. J. Hill and D. J. Staples., P. 71-75.

Species composition and distribution of commercially fished penaeid prawns were investigated in waters around the Wellesley islands (139° 30 E, 16 30°S).

*Penaeus esculentus* was the most abundant species with *P. latisulcatus* the next major component and *Metapenaeus endeavouri*, *P. merguensis* and *P. semisulcatus* less numerous. *Penaeus esculentus* migrated to the fishery from seagrass nursery grounds near South western Mornington Island and the Bentinck, Sweers Island area. Juveniles, 18 to 26 mm carapace length (CL) first appeared in November and major migration from nursery areas occurred in December. The minimum size of mature female *P. esculentus* was 26 mm CL and 50% attained maturity at 31-32 mm CL. Although there was a potential for spawning all year around, it is most likely to occur in July to September.

153. SHAIKHAHMUD,; F. S. TEMBE, V. B. 1960. Study of Bombay prawns: the seasonal fluctuation and variation in abundance of the commercially important species of Bombay prawns with a brief note on their size, state of maturity and sex ratio. *Indian J. Fish.* 7 (1): 69-81.

Maturity and sex ratio, seasonal fluctuation, composition, abundance, size of commercially important species of prawns in the inshore area of Bombay region during the period July 1952 to July 1954 are given.

154. SIVALINGAM, D; VEDAVYASA RAO, P. 1968. A case of abnormal petasma in the penaeid prawn *Metapenaeus affinis* H. Milne Edwards *J. Mar Biol. Ass. India*, 10 (2): 186-187

An abnormally developed petasma observed in *M. affinis* is identified as a fully developed adricum.

155. SUMITRA VIJAYARAGHAVAN; KRISHNAKUMAR, ROYAN, J. P. 1988 Food conversion by *Penaeus monodon* (Fabricius) fed on decapsulated cysts of *Artemia*. *Indian J. Mar. Sci.* 17:172-173

Growth and food conversion efficiencies were high DK(1-26 to 32±6 K2-29 to 36%) in shrimps (*P. monodon*) fed on decapsulated cysts. Decapsulated cysts as feed led on to higher food conversion efficiency than feeding freshly hatched nauplii.

156. SURENDRAN, P. K.; MAHADEVA IYER, K. ; GOPAKUMAR, K. 1985  
Succession of bacterial genera during iced storage of three species of tropical prawns, *Penaeus indicus*, *Metapenaeus dobsoni* and *M. affinis*. *Fish. Technol.*, 22 (2): 117-120.

The native bacterial flora of ocean fresh tropical prawns, *Penaeus indicus*, *Metapenaeus dobsoni* and *M. affinis* was more or less similar, mainly consisting of bacterial genera during iced storage was observed in these prawns. As the day of iced storage increased, the proportion of *Acinetobacter* and *moraxella* also increased considerably and constituted 70-78 % of the flora at the time of spoilage. Spoilage by *Pseudomonas* was very insignificant in prawns under iced storage. (Author's abstract).

157. SREEKUMARAN NAIR, S. R.; KRISHNANKUTTY, M. 1975.  
Note on the varying the effects of salinity on the growth of the juveniles of *Penaeus indicus* from the Cochin Backwater. *Bull. Dept. Mar. Sci. Univ. Cochin*, V 11, 1: 181-184.

The commercially important prawn *Penaeus indicus* was grown in different salinities. The effect of concentration of the medium on the growth of prawns of different sizes is discussed.

Growth rate was significantly high in low salinity for the postlarval specimens, but the larger juveniles showed a significantly high growth-rate in high saline waters. *Penaeus indicus* enters the backwaters during the early part of its life history and goes back to the sea for maturation and breeding. The study is interesting in view of the implications regarding the physiological mechanisms involved in their seaward migration and maturation.

158. SUBRAMANYAM, M. 1973. Fishery and biology of *Metapenaeus monoceros* (Fabricius) from the Godavari estuarine system. *Indian J. Fish.* 20 (1): 95-107.

*Metapenaeus monoceros* (Fabricius) constituted about 42% of the total prawn landings from the Gautami estuary. It was more abundant in the lower reaches, particularly in the mangrove swamps and backwaters. The main fishing season extended from October to January/February and the dominant sizes in the commercial catches ranged between 25 mm and

65 mm. Drag nets and stake nets were the main gear employed in the capture fishery.

Under laboratory conditions the average growth rate was about 13mm/month whereas the growth estimated from size-frequency distributions ranged between 5 mm and 15mm/month. The size of the prawn leaving the estuary was 45.50 mm. The sexes were more or less in equal proportion. Plant matter, organic detritus, small crustaceans and foraminiferan shells were observed in stomach contents.

159. SUBRAMANYAM, M.; GANAPATI, P. N. 1975 Biology of the prawn, *Penaeus monodon* Fabricius from the Godavari estuarine system. *Bull. Dept. Mar. Sci. Univ. Cochin* 7 (3): 653-670

*Penaeus monodon* Fabricius is one of the important commercial prawns in the Godavari estuarine system. It occurs in the estuary throughout the year, but the commercial abundance is confined to the period October to January/February. It is caught by cast nets, drag nets, push nets and bag nets.

The prawns enters the estuary as postlarvae and settles down in the mangrove swamps and backwaters for growth where it feeds predominantly up on organic detritus. Growth follows ecdysis and this phenomenon is observed to occur more than once during a month. Growth estimation from length frequency distribution is considerably less than natural growth rate and this is confirmed from laboratory reared specimens. The sexes are generally equal in number in the estuary and they do not exhibit any growth disparities in the estuary. The length-weight relationship follows a curvilinear trend as determined by statistical methods. The prawn migrates back to the sea for maturity and spawning when it reaches an average size of about 150 mm.

Observation made on the biology of the *P. monodon* from other estuarine and backwater systems on the east coast of India are given for comparison.

160. SUKUMARAN, K. K. 1973 Observations on the secondary sexual characters of *Hippolyasmata ensirostris* Kemp. *Indian J. Fish*, 20 (1) 626-629.

In *Hippolytina ensirostris* Kemp, hermaphroditism a phenomenon seldom found among prawns has been observed to be a regular feature. The prawn is found to mature first as male in the early part of its life and later to change completely into female for the rest of its life with consequent changes in the secondary sex characters.

161. SUMITRA VIJAYARAGHAVAN; RAMADHAS V. 1980 Conversion efficiency in the shrimp, *Metapenaeus monoceros* (Fabricius), fed decomposed mangrove leaves. *Indian J. Mar. Sci.* 9 (2): 123-125.

Feeding experiments were conducted on *M. monoceros* with mangrove leaves at different stages on decomposition in combination with rice bran. Maximum conversion efficiency was found in shrimps fed completely decomposed mangrove leaves. Difference in the conversion efficiency obtained in the shrimps were attributed to biochemical composition of the feeds which varied as decomposition process proceeded.

(Author's Abstract)

162. THOMAS, M. M. 1972 Food and feeding habits of *Penaeus monodon* Fabricius from Korapuzha estuary. *Indian J. Fish.*, 19 (1/2): 202-204.

Preliminary studies on the food and feeding habits of *Penaeus monodon* from Korapuzha estuary were undertaken. The food of the species consisted of crustaceans, fishes, molluscs, polychaetes and vegetable matter in order of importance. Mud and sand particles were also found among the food items. There was no appreciable variation in the nature of the food in the different size groups.

(Authors's Abstract)

163. TANGKO, A. M.; WARDOYO, S. E. 1985 Adaption of *Penaeus monodon* postlarvae to the freshwater, (Adaptasi postlarvae udang widu *Penaeus monodon* terhadap air tawar). *J. Penelitian Budidaya Pantai*, 1 (1): 1-18. (Text in Bahasa)

The experiment was conducted to determine the tolerance (survival) of *Penaeus monodon* postlarvae against the gradual and different unit drops of salinity from 33 ppt down to 30 ppt within different interval of time

exposure. The result showed an average of survival rate for over all treatments as follows; the salinity drop of 2.5 ppt (S1) = 82.2%, 5ppt (S2) = 78.9%, 7.5 ppt (S3) = 66.7% and 10 ppt (S4) = 56.8%. For all the units of salinity drop, the survival rate were 62.5%, 71.7%, 79.2% for the interval of time exposure of 0, 1 and 2 hours respectively.

(Author's Abstract)

164. THAMPY, D. M.; SEBASTIAN, M. J.; SUSEELA, E. ABRAHAM; RAJENDRAN C.G. 1982. Relative abundance and distribution of the post larvae and juveniles of *Penaeus monodon* Fabricius in the Cochin backwaters and the prospects of their utilization in culture fisheries. *Proc. symp. coastal Aquaculture* Held at Cochin from January 12 to 18 1980, Marine Biological Association of India, 1:223-228.

Survey of seed resources of cultivable species of prawns conducted in the Cochin back waters of Puthuvyppeen for a period of 13 months from May 1978 to May 1979 has shown that the postlarvae of *Penaeus monodon* are available in fairly good numbers during April-May period. Using Midnapore type shooting net, 419 post larvae were collected per hour in May 1978. In June and July their availability dropped markedly consequent to heavy monsoon. In June the catch per hour was 36 and in July it was 24. The catch per net per hour increased to 66 in August and then decreased to 12 in September. From October to December the postlarvae of *P. monodon* were not present in the collection. In March 1979 they appeared again in sizeable quantities, the catch per net per hour being 189. They continued to be available and the catch improved to 232 per hour in April and 253 in May 1979. The percentage of *P. monodon* ranged between 3.7 in June 1978 and 0.17 in July 1978.

Juveniles of *P. monodon* were also obtained in the collections made with Midnapore type shooting net as well as drag net, hapa net and ring nets which underneath the submerged marginal vegetation during September-October period. In drag net and hapa net the percentage of juveniles was only 2.0 in September and 3.1 in October. The prospects of utilization of the seed of *P. monodon* for culture in brackish water ponds and perennial prawn fields are discussed.

165. THOMAS, M. M. 1974. Reproduction, fecundity and sex ratio of the green prawn, *Penaeus semisulcatus* de Haan. *Indian J. Fish.* 21 (2): 152-163.

Reproduction, gonado-somatic index, fecundity and sex ratio of *Penaeus semisulcatus* studied at Mandapam Camp, from April, 1967 to March 1969 are dealt with. Five stages of maturity could be differentiated. Mature females occurred throughout the year indicating continuous spawning. The gonado-somatic index exhibited a variation from 22 to 13.2. The minimum size at maturity in females was 23 mm C L. The fecundity ranged between 51,605 and 6,60904.

166. THOMAS, M. M. 1975 Age and growth, length-weight relationship and relative condition factor of *Penaeus semisulcatus* de Haan. *Indian J. Fish.* 22 (1&2): 133-142.

The age and growth of *Penaeus semisulcatus* is attempted by length-frequency analysis and the results varied by using von Bertalanffy's equation. The male seemed to have grown at the rate of 2mm in carapace length from 7 th or 8th month onwards whereas the corresponding growth of the female seemed to be 3.5mm. Male prawns reached the estimated carapace length of 26.2 mm. at one year and 29.4 mm at two years while the size of females at ages of one and two years were 38.16 mm and 41.08 mm respectively. There was no significant variation in weight relationship through different months of an year while the values exhibited definite difference between sexes. The relative condition of both sexes changed in the various seasons, showing peaks denoting attainment of sexual maturity. This is followed by troughs representing the cyclic gonadal development. These changes were more pronounced during the spawning seasons.

167. THOMAS, M. M. 1976 A sporozoan infection in *Penaeus semisulcatus* at Mandapam. *Indian J. Fish.* 23 (1&2):282-284

A few specimens of *Penaeus semisulcatus* collected from Mandapam area were found infected with a microsporidian parasite tentatively identified as *Thalohania duorara* Iversen and Manning which had been earlier reported only from the U. S. A. Although these parasites resembled *T. duorara* closely, they differed significantly from the American specimens in the shape of the spores and pansporoblasts.



168. THOMAS, T. M.; FISHBOAK, C. L. 1969 A computer programme for handling data on the abundance of shrimp and associated animals. In: Proc. World Scientific Conf. on the Biology and Culture of Shrimps and Prawns, Mexico City, Mexico, 12-21 June 1967. *FAO Fish. Rep.* 57 (3): 1041-1054.

A computer programme is presented to summarize ecological data and to estimate the sample size necessary for establishing an index of abundance from replicate samples. The dimensions of these programs are 10 replicates and 999 individuals per sample. The writing of summary tables is done with an autocoder program compatible with a 1401 computer. Calculations of the sample variance, coefficient of variation and number of replicates necessary to estimate relative abundance are made with a Fortran II program which is compatible with most computer systems.

169. TIWARI, K. K. 1947. Preliminary descriptions of two new species of *Palaemon* from Bengal. *Rec. Indian Mus.* 45 (4) : 329-331

*Palaemon vilsoimanus* and *P. kempfi* are described.

170. TIWARI, K. K. 1947. On a new species of *Palaemon* from Banares with a note on *Palaemon lanchestris* de Man *Rec. ind. Mus.* 45 (4): 335-345.

Biological and taxonomic part of *Palaemon choprai* and *P. lanchestris* are described.

171. TIWARI, K. K. 1952. Diagnosis of new species and sub-species of the genus *Palaemon* Fabricius (Crustacea, Decapoda). *Ann. Mag. Nat. Hist. Ser.* 12, 5 : 27-32.

Availability, distribution and diagnostic characters of 8 new species and 3 sub-species of *Palaemon* are described.

172. TIWARI K. K. 1955. Distribution of Indo-Burmese freshwater prawns of the genus *Palaemon* Fabricius and its bearing on the Satpura hypothesis. *Bull. Nat. Inst. Sci, India*, 7 : 230-239.

30 new species are recorded. Their origin, distribution, migration and a detailed aspect of their biology also given.

173. TIWARI, K. K. 1955. Trend of the evolution in the *Hendersoni* group of species of *Palaemon* Fabricius (Crustacea, Decapoda). *Bull. Nat. Inst. Sci. India*, 7 : 189-197.

Morphological study of the *Hendersoni* group which contain 9 species and sub species are given.

174. TIWARI, K. K. 1958. New species and sub species of Indian fresh-water prawns. *Rec. Indian Mus.*, 53 (1 & 2) : 297-300.

Biological aspect and distribution of new species *Palaemon* and 2 sub-species are given.

175. TRIVEDI, Y. A. CHAYA, N. D.; KOSHY, P. K. 1982 Observation on seasonal abundance of prawn seed in Shetrunji estuary at Sartanpur, Gujarat, India. *Proc. Symp. Coastal Aquaculture*, 1: 187-189.

A survey of prawn seed resources by shooting net operations in shetrunji estuary, Sartanpur (Gujarat) indicated the dominance of postlarvae of *Penaeus indicus* and *Metapenaeus monoceros*. In August 1978. *P. indicus* and *M. monoceros* seed were collected at an average rate of 13256/h and 8652/h respectively. However, the occurrence during the same period in 1977 was considerably low. Presence of the juveniles of *M. brevicornis*, *Palaemon styliferus*.

176. VELANKAR, N. K.; MAHADEVA IYER, K. 1961. On the qualitative distribution of amino-acids in different species of prawn. *J. Sci. & Ind. Res.* 20 C (2) : 64-65.

Study based on amino-acids of prawns, lobsters and crabs are examined and a detailed study has been made.

177. VEDAVYASA RAO, P. 1969 Synopsis of biological data on the penaeid prawn *Parapenaeopsis stylifera* (H. Milne Edwards, 1837). *Proceedings of the World Scientific Conference on the Biology and Culture of Shrimps and Prawns, Mexico 12-21, June 1967. FAO Fisheries Reports*, 57 (4): 1575-1605 (FAO Fisheries Synopsis 106).

Identity, distribution, bionomics and life history, population, exploitation and protection and management of *Parapenaeopsis styliifera* are reviewed in detail, size frequency distribution for the years 1949 to 1951, length-frequencies of males and females in representative samples of November, January and March, 1951. Percentage of females in different size-groups and in different years, Percentage of females in samples from the Cochin trawl fishery during 1962 and 1963, Percentage frequency distribution of prawns caught by nets with cod end of different mesh, percentage of prawns among crustaceans and in overall marine fish landing of India during 1958 to 1965, Prawn landings and their percentage in different state of the west coast of India are given.

178. VENKATARAMAN, R ; SAMBANDA MURTHY, P. S.; MAHADEVAN S. 1958. Some preliminary observations on the prawn catches off Finakayal near Tuticorin. *Proc. Indian Sci. Congr.*, 45th Sess, 3 : 375.

Prawn fishery, sex composition, and food and feeding habit of the prawns of that locality is described.

179. VICTOR B.; SAROJINI R. 1986. Toxicity of an organophosphorus insecticide to the ovaries of the atyid prawn, *Caridina rajadhari* (Bouvier). *J. envir. Biol.* 7 (1): 47-50.

The time-dependent toxicity of dimecron (phosphamidon 85%) to the ovaries of the atyid prawn, *C. rajadhari* (Bouvier) was evaluated histologically. 10-day organophosphorous (OP) exposure caused ooplasmic vacuolation and sudden atresia of mature oocytes. Mature oocytes displayed severe necrotic changes. After 20 days, treated ovaries showed inhibition of oocyte development. 30-day exposure affected the oocytes, have undergone ooplasmic vacuolation, degeneration of oolemma, nuclear pyknosis and hypertrophy of hemocytes. The oototoxicity is evident from the observed histopathological effects.

### III. FISHERY

180. ACHUTHANKUTTY, C. T.; SREEKUMARAN NAIR, S. 1980. Mangrove swamps as fry resource for shrimp culture-a case study. *Mahasagar Bull. Natn. Inst. Oceanogr* 13 (3) : 269-276.

Three species of commercially important penaeid prawn, *Metapenaeus dobsoni*, (Miers), *M. monoceros* (Fabricus) and *Penaeus merguensis* De Man occur in the Pilerne mangrove swamp of Goa. The species composition and abundance, and recruitment of juveniles to mangrove swamps, are described in this paper.

181. AHAMAD NAJIR, 1954. Prawn fishery of East Pakistan. *Proc. Indo-Pac. Fish. Counc. Fifth Meet. Tech. Pap.* 15.

The methods of fishery and processing of prawn are outlined. A list of the common species are given.

182. ANON, 1965. Prawn fishery of Gujarat. Location of new prawn grounds off Veraval. *Fishery Technology*, 2 (1):48-49

Potential prawn fishing ground off Veraval reported. Suitability of gear and composition of catch are given. Possibility of better prawn grounds in deeper areas indicated.

183. ANON, 1984. Report of the workshop on the Scientific management of penaeid shrimp. In: Penaeid shrimp-Biology and management by Gulland, J. A. and Rothschild, B. J. posting News Books p. 9-29.

The importance of the shrimp and the various problems associated with shrimp management suggested bringing together experts on the management of shrimp to consider the problem and bring them close to solution.

184. APPUKUTTA PANICKER P.; SIVAN T. M. 1965. On the selective action of the cod end meshes of a shrimp trawl. *Fish. Technol.* 2 (2), 5:220-248.

Results of some cod end selectivity studies using cod end covers that were carried out at Cochin to determine the optimum cod end mesh size for commercial shrimp trawls are presented. The findings are reported to have been pointing the necessity of increasing the mesh size from the then existing 25.4, 31.70 mm to 41.65 mm to avoid depletion. Use of larger mesh would not only obviate much of the undersized prawns but also allow a better flow of water, increasing the efficiency of the net. Further, increasing the mesh size of the cod end would help increase the mesh size at the different parts of the trawl as well.

185. ARAVINDAKSHAN, M.; KARBHARI, J. P. 1987. Shrimp fishery of Bombay Coast. National Symposium on Research and Development in Marine Fisheries at Mandapam Camp. 16-18 September 1987. *CMFRI Spcl. Publ.* 40 : 19.

The prawn fishery of Bombay region during the period from 1982 to 1986 is presented based on landing data of trawlers and dolnetters collected from the two fishing harbours.

186. AQUACOP, 1982 Reared brood stock of *Penaeus monodon*. Proc. Symp. Coastal Aquaculture, Held at Cochin, January 12 to 18, 1980. Marine Biological Association of India. 1 : 55-62.

Since 1975, maturation and spawning in captivity of *Penaeus monodon* has been achieved in the Centre "Oceanologique du Pacifique", a CNEXO Centre in Tahiti. The five first animals were imported from Fiji Islands and by May 1979 four generations were obtained. Under the rearing conditions followed at the Centre, reproduction was achieved all through the year. Maturation was induced by unilateral eyestalk ablation on pond-reared animals maintained in tanks on adequate food. Mass production of postlarvae was routinely achieved.

Results concerning mating behaviour, ovarian development, number of spawnings per female and egg viability are given. The rearing and the maintenance conditions of the captive brood stocks particularly important to obtain reliable results necessary to sustain commercial hatcheries are discussed.

187. BANERJI, S. K. 1965. A note on the production trend of marine shrimps in India. *Fishery Technology*, 2 (1): 43-47.

Review of the production statistics of marine shrimps in different maritime states of India from 1950 to 1962. The status of the fishery of *Metapenaeus dobsoni* being discussed with reference to the data on catch and effort obtained from trawler operations off Cochin.

188. BANERJI, S. K. 1969. Crustacean production in India. In *prawn fisheries of India Bull. Cent. Mar. Fish. India*, 14: 259-279.

10 years data of crustaceans is analysed in this paper.

189. BELL, T. A.; LIGHTNER, D. V. 1984. IHHN virus: infectivity and pathogenicity studies in *Penaeus stylirostris* and *Penaeus vannamei*. *Aquaculture*, 38:185-194.

Infectivity studies of infectious hypodermal and hematopoietic necrosis virus (IHHNV) were conducted on *Penaeus stylirostris* and *P. vannamei* (representing species highly susceptible and highly refractory to the disease) via intramuscular injections of the virus. Distinctive histological lesion patterns were observed between species. Six target organ systems were compared interspecifically. The gills and nerve cord/ganglia were shown to undergo significantly higher degrees of tissue damage in infected *P. stylirostris* compared with infected *P. vannamei*; Pathogenetic differences correlated well with observed differences in epizootiology between the two species.

The infectivity study confirmed that IHHN disease is virus-caused. Cell free extracts from IHHNV-infected shrimp, when injected into healthy, susceptible shrimp, produced mortalities and Cowdry type A intranuclear oesinophilic inclusion bodies presently considered pathognomic for the disease,

190. BONEN, B. K., HANCOCK, D. A. 1985 Review of penaeid prawn fishery management regimes in Australia. Rothlisberg, P. C. *et al* (Ed). *Second Australian national prawn seminar* : 247-266

This paper reviews and compares the management regimes which have been developed in the penaeid prawn fisheries of Australia.

191. CHANDRABOSE VICTOR S.; VENKATESAN, V. 1982. Prawn and fish seed resources of Merakanam estuary *Proc. Symp. Coastal Aquaculture*, Held at Cochin 1 : 196-201.

Investigations carried out on the seed resources of commercially important species of prawns and fishes of the Merakanam estuary.

192. CHACKO, P. I. 1955. Prawn Fisheries of Madras State, India, Contribution from the Marina Biological Station, West Hill, Malabar Coast, No. 3, Govt. Press, 14 pp.

The main fishing area; bionomics of the common species that occur in Madras; statistics of prawn fisheries; prawn culture in paddy fields; crafts and gears employed in prawn fisheries; utilization and curing methods and the future of prawn fishing industry are discussed.

193. CHACKO, P. I. 1956 Prawn fisheries of Madras State, India. Madras Govt. Publication, Madras, India.

A detailed description of prawn fishery is given.

194. CHANDRASEKHAR, B. 1964 Note on the prawn fishing by the Training Centre boats, Mangalore. On Prawn Fisheries: In India Society of Fisheries Technologists (India), Cochin, 1964 p. 10.

Gives the information regarding the species available, fishing season, fishing grounds and the efficiency of trawl nets.

195. CHAKRABORTHY, N. M. 1981. Fishery and culture Possibilities of estuarine prawn in Sunderban, West Bengal. *Sea food export J.* 13 (5):17-23

Environmental factors, ways and means of the culture of estuarine prawn in Sunderban, West Bengal is discussed.

196. CHAKRABORTHY, S. K., DESHMUKH, V D.; KUBER VIDYASAGER; RAMAMURTHY, S. 1987 Bycatch of shrimp trawlers in Greater Bombay. *Mar. Fish. Infor. Ser. T&E Ser.* 54:7-15.

Sasoon Dock and New Ferry Wharf are two important bases in Greater Bombay for commercial trawling. The first account attempts to give a picture of the trawl fishing with special reference to prawn and bycatches during 1979-82.

- 197 CHENG, YE CHANG. 1984 Prawn (*Penaeus orientalis* Kishinouye) in in Pohai sea and their fishery. Gulland, J. A. and Rothchild, B. J. (ed). *Penaeid shrimp—their biology and management*, 49-60.

Distribution and migration, growth and mortality, forecasts of stock and recruitment of the prawn fishery discussed.

198. CHIDAMBARAM, K.; RAMAN R. S. V. 1944 Prawn and crab fishery in Madras. *Indian Farming*, 5:454-455.

Statistics and nutritive values are given.

199. CHOPRA, B. N. 1943 Prawn fisheries of India. *Proc. Indian Sci. Congr.*, 30 (2):153-173.

Information on the commercially important prawns and shrimps occurring in sea, estuary and backwaters of India are given. The methods employed in curing and preservation are described. Further studies of all the commercially important prawns, their bionomics, morphology, food habits, migration, reproduction, life history, etc., are suggested.

200. CHOPRA, B. N. 1943 Prawn fisheries in India. *Curr. Sci.* 12 (2):71

A brief account of prawn fishery of India with special reference to *Penaeus carinatus* and *Palaemon carcinus* is given.

201. CHOPRA, B. N. 1939 Some food prawns and crabs of India and their fisheries. *J. Bombay Nat. Hist. Soc.*, 41 (2):221-234.

The common food prawns—*Penaeus carinatus*, *P. Indicus*, *Metapenaeus brevicornis*, *M. monoceros*, *Palaemon carcinus*, *P. lamarrei*, *P. rudes*, *P. malcolmsonii*, *Caridine gracillirostris*, and the shrimps *Macropsis orientalis*, *Potamomysis assimilis* are listed. The Salient features of the bionomics and life history, the prawn resources of Bombay and Malabar coasts and of Chilka and Colliar lakes, methods of fishing in different place are discussed. The need for further study on prawn bionomics, fishing grounds, breeding and life histories, and migration is pointed out.



202. CMFRI. 1969. Prawn fisheries of India. *Bull. Cent. Mar. Fish. Res. Int.* 14pp. 383. (Mimeographed)

The bulletin reviews in detail by different authors the systematics, (with key for identification), distribution, life history, biology, fisheries, population estimates, etc of the species of commercially important genera of *Panopeus* Fabricius 1798. *Metapenaeus* wood-mason Alcock 1891, *Solenocera* Lucas 1850 *Atypopenaeus* Alcock 1905 *Hyppolysmata* stimpson 1860, *Palaeomon* Weber 1795 and *Acetes* Edwards 1830 of Indian waters: prawn grounds on the continental shelf fished by trawlers, the crustacean production in India based on 10 years data from 1959-1968 and the export figures for the period 1960-68 are given. An extensive bibliography is provided.

203. CMFRI. 1978. Synopsis of marine prawn fishery of India for the second quarter of 1978. *Mar. Fish. Infor. Serv. T&E Ser* 4:1-9

The all-India total catch, state-wise catch trends and effort and percentage of prawn for the period April-June 1978 are tabulated and discussed in comparison with the corresponding period of 1977.

204. CMFRI. 1979 Synopsis of marine prawn fishery of India for the third quarter of 1978. *Mar. Fish. Infor. Serv. T&E Ser*, 7:1-10

The all-India total catch state wise catch trends and effort and percentage of prawn for the period July-September 1978 are tabulated and discussed in comparison with the corresponding period of 1977.

205. CMFRI. 1979 Synopsis of marine prawn fishery of India-1978 *Mar. Fish. Infor. Serv. T&E Ser*, 10: 1-17.

The all-India total catch, statewide catch trends and effort and percentage of prawn for the period October-December 1978 are tabulated and discussed in comparison with the corresponding period of 1977.

- 206 CMFRI. 1980 Synopsis of marine prawn fishery of India 1980. *Mar. Fish. Infor. Serv. T & E Ser*. 35 : 9-14

The all-India total catch, statewide catch trends and effort and percentages of prawn for the period 1980 are tabulated and discussed in comparison with the corresponding period of 1979.

- 207 CMFRI. 1982 Synopsis of marine prawn fishery of India-1981. *Mar. Fish. Infor. Serv. T & E Ser.* 43 : 8-23

The all India total catch, statewise catch trends and effort and percentages of prawn for the period 1981 are tabulated and discussed in comparison with the corresponding period of 1980.

- 208 COOK, D.C; TENAKANI, C.D. 1965 Small scale prawn trawling in Western province, P.N.G: A pilot study. In proceeding of *Torres fisheries seminar* edited by A.K. Haines, G.C. Williams, D. Coats. p. 262-270.

The feasibility of village level beam trawling was examined and three designs of beam trawls were constructed and used.

- 209 CUSHING, D. H. 1984 Nephrops fishery in the northeast Atlantic. Gulland, J. A. and Rothchild, B. J. (Ed). *Penaëid shrimp-their biology and management* : 258.

Production and assessment on the estimates of catch.

210. DAS, K. N 1935. Developmental stages of *Palaemon lamarrei* H. M. Edw. *Proc. Indian Sci. Congr.* 22nd. (Abstract).

Descriptions of number of stages within the egg case and the free stages reared in the laboratory are given. Life history also explained.

- 211 DESHPANDE, S.D ; GEORGE V.C.; SIVAN T.M. 1964. Experiments in fishing with shrimp trawls : On the effectiveness of beam trawl net. *Proc. Indo-Paci. Fish. Coun.*, 11(2) 191-192

1.52 m. and 3.04 m. beam trawl nets were simultaneously test operated for their effectiveness from a motorized boat, of which the results are presented. About 21% of prawns and 11% of fishes were observed to have escaped from the larger net, indicating its inferiority.

212. DESHPANDE S.D.; KARTHA, K.N. Experiments in fishing with shrimp trawls : On the standardisation of tickler chain *Fish. Technol.* 4 (2) 1967 : 62-64.

The experiments conducted off Gujarat coast on the standardisation of tickler chain for shrimp trawls gave the following results : Of the Shortlink chains made of 3.2mm, 4.8mm, and 6.2mm rods, the second one showed an increase in the yield without affecting the performance of the gear. The different chains used had no influence on the fish catch.

213. DHULKHED, M. H.; ANNIGERI G. G.; NANDAKUMAR G ; NAIK, D. Y. 1984 Bumper catch of prawn, pomfrets, little tunnies, black shark and alter fished at Karwar. *Mar. Frsh. Infor. Serv. T & R Ser.* 59 : 16-18.

Bumper catches of prawn *Metapenaeus dobsoni* amounting to about 3 qt. were hauled up by purse seine boats at Karwar.

214. DE SILVA, E. R. A. 1955. The prawn fisheries of Ceylon. *Proc. Indo-Pac. Fish. Coun.*, 6th Sess : 324-327.

Discusses the present status of prawn fisheries of Ceylon, important gears employed, off-shore fishing etc.

215. EMERSON, W. D. 1984 Predation and energetics of *Penaeus indicus* (Decapoda: Penaeidae) larvae feeding on *Brachionus plicatilis* and *Artemia* nauplii *Aquaculture*, 38 : 201-209.

*Penaeus indicus* larvae were fed on *Brachionus plicatilis* and *Artemia* nauplii to determine ingestion rates, larval energy requirements, and to establish at which stage larval predation commenced. The raptorial feeding rates were then constricted on an energy base with filter feeding rates for *P. indicus* larvae to compare the relative efficiency of these two feeding mechanisms. *Brachionus* was first eaten as early as protozoa 1 to protozoa 2, while the maximum ingestion rate of 300 rotifers larvae  $\text{d}^{-1}$  ( $1.06 \text{ J larvae}^{-1} \text{d}^{-1}$ ) was obtained during protozoa 3 to mysis 1. *Artemia* were effectively ingested by *P. indicus*

protozoa 3 (4.1 J larva<sup>-1</sup>d<sup>-1</sup>) to postlarva (8.1 J1 larvae<sup>-1</sup>d<sup>-1</sup>). Daily energy intake rate from filter feeding increased from 1.1 J larva<sup>-1</sup>d<sup>-1</sup> during protozoa 1 to reach a peak of 5.32 J larva<sup>-1</sup>d<sup>-1</sup> during mysis 3 after which it declined to 2.66 J. larvae<sup>-1</sup>d<sup>-1</sup> during the post larval stage. This decline in energy intake from filter feeding with a concomitant increase in energy intake from *Artemia* predation demonstrates a predominant feeding mode change over point during mysis 3. Energy intake was consistently low with *Brachionus*, indicating that it may be unnecessary for commercial culture purposes.

216. FRUSHER, S. D. 1985 Prawn research Papua New Guinea and its application to Torres Strait. IN: Proceedings of Torres Strait fisheries seminar edited by A. K. Haines, G. C. Williams and D. Coates. p. 271-274.

Parameters needed for the determination of stock assessment.

- 217 GANAPATHI, P. N. 1969 Prawn fishery in Godavari estuarine systems. *Seafood Exp. J.*, 1 (9): 11-14.

Forty three species of prawns were recorded as occurring in the Godavari estuarine systems, among them 33 were of marine origin and the remaining from fresh water. The seasonal variation in availability in the estuary varied from species to species.

218. GANAPATHY, P. N.; SUBRAHMANYAM, M. 1966. The prawn fishery in Godavari estuary. *J. Zool Soc. India*, 16 (1&2):11-20

The systematics and seasonal distribution of the prawns of the Gautami-Godavari estuary have been described. Some aspects of the biology and fishery of important estuarine prawns, craft and gear, curing methods have been dealt with.

- 219 GANGULY, D. N. 1964 Suggestions for the scientific utilisation of the sources and production of commercially important prawns and shrimps of India. Symposium on Prawn Fisheries in India, Society of Fisheries Technologists, India, Cochin, 1964. (Abstract only), p. 7

Suggestions for studying exploitation and breeding areas, selection of suitable types and size for commercial purposes, artificial culture and storage are given.

220. GNANADOSS, D. A. S.. 1955 Standardisation and mass production of shrimp trawlers and other fishing boats in India. *Fish. Tech*, 2 (1): 93-95

This paper deals with the existing fishing crafts, new types of vessels boat building programmes, their standardisation and mass production in India.

221. GEORGE, M. J. 1961. Studies on the prawn fishery of Cochin and Alleppey coast. *Indian J. Fish.*, 8 (1): 75-95

The prawn fishery at Alleppey, Narakkal and Chellanum is compared with a special emphasis on recruitment. The probable influence of mud banks on the increased prawn landings at Alleppy discussed.

222. GEORGE, M. J. 1962. Observations on the size groups *Panæus indicus* (Milne Edwards) in the commercial catches of different nets from the backwaters of Cochin. *Indian J. Fish.*, 9 (2):468-475.

The backwater catches of *Panæus indicus* from the Chinese dip net, the stake net and the cast net for the years 1955 through 1958 have been analysed and it is found that the Chinese net catches show the maximum sizes in population mean and modal lengths. The cast net catch sizes come next and stake net catches show minimum sizes. The probable factors influencing the size distribution in the catches of the same species caught in the different nets from the same area of operation are discussed.

223. GEORGE, M. J. 1968. *Metapenæus dobsoni*, *Seafood Exp. J.*, 3 (1): 139-141

*M. dobsoni*, new species, biology, growth rate and market value explained.

224. GEORGE, M. J. 1969. Genus *Metapenæus* Wood-Mason & Alcock 189/ In: Prawn fisheries of India. *Bull. Cent. Mar. Fish. Res. Inst.*, 14: 77-125.

*Metapenæus dobsoni*, *M. monoceros*, *M. affinis*, *M. brevicornis*, *M. ensis*, *M. lysianassa*, *M. burkenroadi*, *M. stebbingi*, *M. kutchensis*, their Common name, distribution, life-history, nutrition and growth, behaviour and movements, reproduction, age composition, fishing methods are discussed.

225. GEORGE, M. J. 1982. Scientific basis for the management of penaeid shrimp fishery. *Mar. Fish. Infor. Serv. T & D Ser.*, 39 : 6-11.

A review of the scientific basis for the management of penaeid shrimp fishery as a recommendation for future value is attempted here. The biology of shrimp such as rate measurements, the database, environment and management are discussed.

226. GEORGE, M. J. 1987 Monsoon prawn fishery of Neendakara Coast, Kerala : A critical study. *Mar. Fish. Infor. Serv. T & D Ser.*, 53 : 1-16.

Trends in seasonal fishery, monthly catch variations, species composition and variations in abundance, fluctuations in catches, size distribution, sex ratio, spawning stock, relationship of catch and rainfall, are discussed in this report.

227. GEORGE, M. J. 1987 Shrimp resources of the coastal waters of Kerala and the effect of mechanisation. National Symposium on Research and Development in Marine Fisheries, Mandapam Camp 16-18 September 1987. *CMFRI Special Publication*, 40:18 Abstract

This paper deals with the shrimp production right from the time of initial introduction of mechanisation in Kerala coast.

228. GEORGE, M. J.; RAMAN, K.; KARUNAKARAN NAIR, P. 1963 Observations on the off-shore prawn fishery of Cochin, *Indian J. Fish.*, 10 A (2).

Species composition, seasonal abundance, size distribution, age and growth, maturity, sex ratio, and the general fishery are discussed.

229. GEORGE, M. J.; VEDAVYASA RAO, P. 1967. Distribution of sex ratios of penaeid prawns in the trawl fishery off Cochin. *Proceedings of the Symposium on Crustacea*, Marine Biological Association of India, 1965, Part II: 698-700

Sex ratio data of four penaeid prawns are studied and their movement are discussed.

230. GEORGE, M.J.; MUTHU, M. S. 1968. On the occurrence of *Metapenaeus barbata* (De haan) (Decapoda/Penaeid) in Indian waters with taxonomic notes on the genera *J. Mar. Bio. Ass. India*, 10 (2): 286-291.

Detailed studies on a collection of penaeid prawns from Visakhapatnam coast showed that it contained two species belonging to the genus *Metapenaeopsis*. Out of these, *M. barbata* (De Haan) is not so far reported from Indian waters.

231. GEORGE, M. J.; BANERJI S. K.; MOHAMED. K. H. 1968 Size distribution and movement of the commercial prawns of the Southwest coast of India. *Seafood export. J.* 3 (1) : 143-149

Size distribution, movement of prawn in different coastal directions are discussed in this paper.

232. GEORGE, P. C.; GEORGE, M. J. 1964. On the location of a possible spawning area for the penaeid prawn, *Metapenaeus monoceros* Fabricius off Cochin. *Curr. Sci.*, 33 (8):251-252

Spawning area for *Metapenaeus monoceros* off Cochin in the 50-60 metre has been located.

233. GEORGE, P.C; RAO, P. VEDAVYASA. 1976. Annotated bibliography of the biology and fishery of the commercially important prawns of India Proceedings of the Symposium on crustacea held at Ernakulam from Jan. 12 to 15 1965, p 1521-1547.

Annotation of 346 references have been given in this bibliography.

234. GEORGE, N. A.; DESHPANDE, S. D. 1965. On the effect of tickler chain on the catches landed by a 55 ft trawl net. *Fishery Technology*, 2 (1):82-86.

The results of the operation of trawl net with and without chain discussed.

235. GEORGE, M. J.; SUSEELAN, C. 1980 Changing pattern of prawn production in small scale fisheries of India. *Proc. Indo-Pacific Council 19th session* Kyoto, Japan: 2-4, May 1980: 402-425.

The present indications are that further increase in effort by small mechanised vessels in the fishing grounds in the inshore regions may not bring any substantial increase in production.

236. GEORGE, M. J.; SUSEELAN, C.; BALAN, K. 1981 Bycatch of the shrimp fishery in India. *Mar. Fish. Infor. Serv. T&E Ser.*, 28:1

Crafts and gear employed in shrimp fishing, estimation of quantity of bycatch, species and size composition in bycatches, utilization of bycatch, fish curing methods, products of bycatch are discussed in this service.

237. GEORGE, M. J.; SUSEELAN, C.; THOMAS, M. M.; KURUP, N. S.; RAJAN K.N.; KAKATI V., S.; GOPALAKRISHNAN, K.N.; CHELLAPPAN, K.; BALASUBRAMANIAN, K. K.; NALINI, C. 1983. Monsoon prawn fishery of Neendakara coast, Kerala- A critical study. *Mar. Fish. Infor. Serv. T&E Ser.* 53:1-8.

Trends in seasonal fishery, monthly catch variations, month wise trawling effort and catch details at Sakthikulangara during the monsoon period from 1973 to 1982, Production trend of Neendakara, catch composition of prawn landings at Sakthikulangara, and size distribution are discussed in this paper.

238. GEORGE, M. J.; ALAGARAJA, K. 1986 Shrimp resources. R&D series for marine fishery resources management No.3

Estimate of shrimp production and its importance, area wise landings, stock assessment studies made by CMFRI are discussed in this paper.

239. GEORGE, M. J. 1973. The influence of backwaters and estuaries on marine prawn resources, *Proc. Living Res. around India. CMFRI Special Publ.* P. 563-569.

The marine prawn resources of the country functionally related to the vast brackish water ecological systems instituted by the various estuaries.



inland bays, lakes and backwaters along the entire coast line. This report summarises the knowledge concerning the association of prawn stocks in the face of man's steady incursion of estuaries and the effect of increased prawn fishing activities for the juveniles in brackish water areas on the adults from marine environment are considered. The need for further studies on the above aspects to enable measures to be taken to counteract adverse effects, if any, owing to the rapid agro-industrial development taking place in and around estuaries and backwaters in the country is emphasised.

240. GEORGE, M. J. 1987. Shrimp resources of the coastal waters of Kerala and its effect to mechanisation. National Symposium on Research and development in Marine Fisheries, Mandapam camp 16-18 September 1987. *CMFRI Special Publ.* 40:18-19

The trend in the shrimp production from the time of introduction of shrimp trawls, in the fifties through 1985 is studied to evaluate the resource from the point of view of the total production and the production separately by the two sectors namely mechanised and traditional. The total production rose from less than 15 thousand tonnes before the introduction of mechanisation to nearly 85 thousand tonnes in 1973, but thereafter declined to 30-40 thousand tonnes in recent years. The production data from important fishing centres also showed the same trend, clearly showing that the coastal resource was increasingly overstrained by the increased fishing pressure.

A comparative study of shrimp production data of the traditional sector and the mechanised sector showed that while the catches of the former decreased considerably, that of the latter increased resulting in the present conflict between the two sectors and raising serious management problems. Some management measures which could be adopted in this context are discussed.

- 241 GOPALAKRISHNAN, V. 1951. Note on the chemical composition of the penaeid prawns of Madras. *Curr. Sci.*, 20:331

Chemical composition of *Penaeus indicus*, *P. carinatus*, *Metapenaeus monoceros*, and *M. dobsoni* are made.

242. GOPALAKRISHNAN, V. 1952. Food and feeding habits of *Penaeus indicus* M. Edw. *J. Madras Univ.*, 12B (1): 69-75.

Study has been made on the stomach contents of 380 specimens of *P. indicus*. Observations also made on the food and feeding habits.

243. GOPINATH, K. 1953. Some interesting methods of fishing in the backwaters of Travancore. *J. Bombay Nat. Hist. Soc.*, 51:466-471.

Different fishing methods of Kayamkulam and Vembanad lakes are given. 'Prawn Junkhar' or 'Pachil' are the common methods practised in those places.

244. GOSWAMI, S.C., ACHUTHANKUTTY; GEORGE, M.J. 1977. Occurrence of larvae of commercially important penaeid prawns of the Central West Coast of India. *Mahasagar-Bull. Nat. Inst. of Oceanogr.* 10 (3&4):124-137

Penaeid larvae occurring in the coastal waters of the Central West Coast of India extending between 5 and 40 m depth zones in four transects and along 10 m depth zone.

245. GOVINDAN, T. K. 1962. Some new indices of quality for iced prawns. *Sci. and Cult.* 28 (1): 36-37

Various aspects of the quality of prawn stored in ice are given.

246. GRAHAM, K. J.; T. B. GORMAN. 1985. New South wales deep water prawn fishery research and development. Rothlisberg, P. C. et al (Ed) *Second Australian national prawn seminar*: 231-243

Investigations on continental slope prawn stocks give a first estimate of the total stock size and discussed some of the problems of handling and processing the catch.

247. HANCOCK, D. A.; HENRIGUOZ, G. 1968 Stock assessment in the shrimp (*Heterocarpus reedi*) fishery of Chili *In. Proc. World Scientific Conf.*

On the Biology and Culture of Shrimps and Prawn, Mexico City Mexico 12-21 June 1967. *FAO Fish Rep*, 57 (2):442-466

248. HAYSOM, NOEL M. 1985 Review of the penaeid prawn fisheries of Australia. Rothlisberg, P. C. *et. al.* (Ed). *Second Australian National Prawn Seminar*: 195-203.

Brief description of the development of the prawn fisheries of Australia.

249. HEMPEL, ERIK; JEF VAN S. 1985. Shrimp industry-markets, quality problems and competition from aquaculture. *Info-fish Digest*, 1/85:22-26

Major shrimp markets are importing more and more shrimp. The present status of the shrimp trade and the potential of shrimp aquaculture are discussed.

250. HENDERSON, J. R ; MATHAI, G. 1910. On certain species of *Palaemon* from South India *Rec. Indian Mus*, 5: 277-306

Detailed study has been made on *Palaemon carcinus*, *P. malcolmsonii*, *P. idae*, *P. sulcatus*, *P. rudis*, *P. nobilii*, *P. scabriculus*, *P. dolichodactylus* and *P. dublius*.

251. HICKLING, C. F. 1963. Expanding tropical prawn fisheries. *Fishing News International*, 2 (1): 37-39

A Sheet described of various aspects of tropical prawn fisheries is given.

252. HUNDOLE, TOR J. 1985 Financial and economic health of the northern prawn fishery and the effect of ship building bounties. Rothlisberg, P. C. *et al.* (Ed). *Second Australian National Prawn Seminar*: 289-295

This paper presents the findings of a financial and economic analysis of Australia's most important prawn fishery, the declared management zone of the Northern prawn fishery.

253. HYLAND, S. J. 1985. Moreton Bay, Queensland, beam trawl fishery for penaeid prawns. Rothlisberg, P. C. *et al* (Ed). *Second Australian National Prawn Seminar*: 205-212

Trawl fishery with respect to *M. bennettiae* stock in Moreton Bay and *M. macleayi* fishery in South Eastern Queensland were discussed.

254. IBRAHIM, K. H. 1962. Observations on the fishery and biology of the freshwater prawn *Macrobrachium malcolmsonii* Milne Edwards of River Godavari. *Indian J. Fish.*, 9A (2):433-467

Age and growth, length-weight relationship, feeding habits, sex ratio, fecundity and breeding habits of the fresh water prawn *Macrobrachium malcolmsoni* Milne Edwards are given.

255. IBRAHIM, K. H. 1962. On the early embryonic development of *Macrobrachium malcolmsonii* H. M. Edw. and *Macrobrachium scabriculum* Heller from river Godavari. *Sci. and Cult*, 28 (5):232-233.

Detailed study of egg cleavages, gastrulation and comparisons with that of *M. scabriculum* are given.

256. IYENGAR, J.R, VISWESWARIAH, MOORJANI, M.N; BHATIA, D.S. 1960 Assessment of the progressive spoilage of ice stored shrimp. *J. Fish. Res. Bd. Canada*, 17 (4): 470-485.

Study has been made to discuss the findings of the results obtained by employing total bacterial plate-count method, pH determinations, estimation of trimethylamine and total volatile nitrogen. *Penaeus indicus* and *Metapenaeus monoceros* are the specimens used for this study.

257. JAMES, D. B.; THIRUMALAI, P. 1983 Good season for prawns predicted off Madras. *Mar. Fish. Infor. Serv. T&E Ser.* 53:23-25

Occurrence of juveniles shows that the fishery for the species *P. semisulcatus*, *P. indicus*, and *P. monodon* are good at Madras.

258. JANARDHANA RAO, K.; GOPALAKRISHNAYYA, G. H. 1974 Penaeid prawn catches from Pulicat lake in relation to migration of post-larvae and lake hydrography *Nation. J. Fish. Cent.* 51 (2):445-454.

The relationship between recruitment of the post-larvae of *Penaeus indicus*, *P. monodon* and *P. semisulcatus* into Pulicat lake and the commercial catches were discussed taking into consideration the rainfall and the prevailing hydrographic features during the period July 1968 to December 1970. This study determines the magnitude of the subsequent prawn production in the lake.

259. JAYAWICKREMA, S. J. C., JAYAKODY, D. S. 1988. Population dynamics of *Penaeus indicus* (H. Milne Edwards) in the west coast of Srilanka. *Symposium on tropical marine living resources*, Cochin, India 12-16 Jan. 1988. Marine Biological Association of India. *Abstract No.* 65

Growth and mortality parameters of *Penaeus indicus* from Srilanka (Nogombo and Chilaw) caught between September 1982 and June 1986 were analysed on annual basis. From the relative yield, isopleths were drawn.

260. JOHN, M. C. 1947. Bionomics and life-history of *Palaemon carcinus*. *Proc. Indian Sci. Congr. 34th sess.* p. 117

(Abstract)

Morphology, food and feeding habits of *Palaemon carcinus* are discussed.

261. JOHN, M. C. 1957. Bionomics and life-history of *Macrobrachium rosenbergii* (de Man). *Bull. Cent. Res. Inst. Univ. Trivandrum ser. C.* 5 (1):93-102.

Life history and ecological factors influencing the prawn fauna of Travancore are discussed.

262. JONES, S. 1967. The crustacean fishery resources of India *Proc. Symp. on Crustacea*, Cochin, January 12-15, Marine Biological Association of India, Cochin. p. 1328-1340.

The importance of the crustacean fisheries particularly of the prawns and lobsters in the context of frozen prawns.

263. JONES, S. 1969 The prawn fishery resources of India, IN: *Proc. World Scientific Conf. on the Biology and Culture of Shrimps and Prawns*, Mexico City, Mexico, 12-21 June 1967. *FAO Fish. ep.* 57 (2): 735-747.

The growth of the prawn fishing industry in India is reviewed and the increasing value of Prawn exports is tabulated.

The commercially important species on all Indian coasts are listed, The geographical areas in which they are fished are defined, and notes are given on the maximum size attained by the species, the depth in which they are fished and the nets and boats used, More extensive culturing of prawns are recommended and, as the prawn stocks are in general not overfished, the fishing effort is supported to be increased.

264. JONES, S.; SUSANSINGANI, K. H. 1954 Fish and fisheries of the Chilka lake with statistics of fish catches for the years 1948-'50. *Indian J. Fish.* 1:256-344.

Refers to *Penaeus indicus*, *P. carinatus*, *Metapenaeus monoceros*, *M. affinis*, *M. dobsoni*, *Palaeomon rudis*, *P. malcolmsoni*. The behaviour of young prawns discussed. Export trends for the years 1948-'50 and the important fishing methods are given

265. JONES, D. A.; KANAZAWA, A.; ABDUL RAHMAN, S. 1979. Studies on the presentation of artificial diets for rearing the larvae of *Penaeus japonicus* Bate. *Aquaculture*, 17:33-43.

The preparation of microencapsulated diets for rearing the larvae of *Penaeus japonicus* is described. Once the correct microcapsule size and feeding concentration had been determined, experiments showed that survival rates of 50% to post-larvae were possible. Comparative experi-

ments using artificial diets in the form of free particulates indicate the survival rates may be even higher (66-68%) on these diets providing precautions are taken to avoid bacterial blooms. Further investigations revealed that microencapsulated semi-defined diets may be used to determine the nutritional requirements of *Penaeus* larvae.

266. JOSE, M. M.; MATHEW, P. M.; MRITHUNJAYAN, P. S.; SUSHEELA JOSE, 1988. Cultivable prawn and fish seed resources of Cochin barmouth area. *Symposium on Tropical Marine Living Resources, Cochin, India, 12-16 Jan. 1988.* Marine Biological Association of India. Abstract No. 19pp

The study indicate that there is large quantity of prawn and fish seed at barmouth area of Cochin.

267. JOSEPH, K. M. 1967. Exploratory trawling off the south-west coast of Mysore by M. F. V. Tarpon, November 1960 May 1955. *International Indian Ocean Expedition News letter*, 4 (4 : 14 pp. (Abstract only)

The results of the exploratory trawling in the off-shore waters between latitudes 12°N and the longitudes 74°E and 75°E are presented. Specieswise composition of catch with special reference to prawns has been discussed. A comparative study of the productivity of different fishing centres in the area of survey and between other areas along the west and east coasts has been made. The commercial possibilities of trawl fishing in the area have been discussed.

268. KAGWADE, P. V. 1967. Prawn catches by mechanised vessels in the trawling grounds of Bombay and Saurashtra. *Proceedings of the Symposium on Crustacea*, Marine Biological Association of India, 1965, Part IV : 1348-81.

The relative abundance in the regional, seasonal and depth-wise distribution of prawns in Bombay and Saurashtra waters are discussed.

269. KAMASASTRY, P. V.; PRABHU, P. V. 1961. Preparation of chitin and glucosamine from prawn shell waste. *J. Sci. and Ind. Res.*, 20 D (12) : 466.

Manufacture of chitin and glucosamine are described.

270. KATHIRVEL, M.; SELVARAJ, V.; RAMAKRISHNAN, A.; PALANI-CHAMY, S; SHAHUL HAMEED, K.; POOVANNAN, P.; BOSE, M. 1985 An unusual bumper catch of white prawn *Penaeus indicus* from Kovalam near by Madras. *Mar. Fish. Infor. Serv. T & E Ser.* 65 : 15-17.

Bumper catch of white prawn, *Penaeus indicus*.

271. KING, M. G. 1986. The fishery resources of Pacific island countries. Part 1. Deep-water shrimps. *FAO Fish. Tech. Pap.* (272.1) : 45 p.

Potential for development of fishery resources, particularly in deep-water shrimps and it covers biology, method of fishing and marketing in Pacific Island. Fishery resources, deep-water shrimp.

272. KLIMA, EDWARD F; PATTELLA FRANK, J. 1986. synopsis of the Tortugas pink shrimp, *Penaeus duorarum*, fishery 1981-84, and the impact of the Torugas sanctuary. *Marine Fisheries review*, 47 (4) : 11-18.

Review of the characteristics of the Tortugas fishery. It also deals with the catch per unit effort of the *Penaeus duorarum* fishery from 1981-1984.

273. KRISHNAKUMAR, K.; PILLAI, N. N, 1984. Studies on survival of postlarvae of *Penaeus indicus* H. Milne Edwards under Oxygen packing. *J. Mar. Biol. Ass. India.* 26(1 & 2) : 145-153.

When 20-day old postlarvae of *P. indicus* were packed at a density of 250/l for 2 hours in flexible oxygenated polyethylene containers the survival rate was 70%.When the duration was increased to 36



and 48 hours where the density reduced to 100/litre. The same survival was obtained, however, for the 8-day old postlarvae the same survival rate was obtained at packing densities of 300 and 150 postlarvae per litre for 24 and 36 hours respectively. Mortality of the postlarvae under oxygen packing were attributed to cannibalism, accumulation of carbondioxide and increase in ammonia.

274. KRISHNA MENON, M ; RAMAN, K. 1961. Observations on the prawn fishery of the Cochin backwaters with special reference to the stake net catches. *Indian J. Fish.*, 8(1) . 1-28.

Quantitative study of the catches of a couple of stake nets carried out for a long period in Cochin backwaters.

275. KUNJU, M. M. 1967. Observation, on the prawn fishery of the Maharashtra coast. *Proceeding of the Symposim on Crustacea Marine Biological Association of India, 1965, Part IV* : 1387-1397.

The magnitude of fishery, species and size composition, relative abundance of various species of the Maharashtra coast are given.

276. KURIEN, C. V. 1953. A preliminary survey of the bottom fauna and bottom deposits of the Travancore coast within the 15 fathom line. *Proc. Nat. Inst. Sci. India*, 19(6) : 745-775.

This paper dealt with 20 species of shrimps belonging to the family *Hippolytidae*, *Palaemonidae*, *Penaeidae*, *Crangonidae*, and *Sergestidae*.

277. KURIEN, G. K. 1965. Trends in development in the prawn fishing technique in India - A review. *Fish. Tech.* 2(1) : 64-68.

Reviews the development in prawn fishing techniques with reference to indigenous gears, dredges, beam trawls and other trawls.

278. KURIAN C. V.; SEBASTIAN, V. O. 1982. Prawn and prawn fisheries of India. Hindustan Publishing Corporation (India) : 286 p.

Classification of prawn, development of marine and fresh water prawns of commercial importance, prawn fishing methods, prawn culture methods and processing of prawns are discussed.

279. KURUP, P. SURENDRANATH. 1985. Prawn fishery of Alleppey coast during the S. W. Monsoons of 1972-1976.

Detailed study of *M. dobsoni*, on its distribution, food, sex ratio, maturity and feeding habits.

280. KURUP, N. S. 1979. The mudbank prawn fishery of Kerala-decline trends. *Mar. Fish. Infor. Serv. T & E Ser.* 9 : 1-5.

Different aspects of the possibilities and reasons for the decline of prawn fishery in mudbank of Kerala is discussed.

281. KUTHALINGAM, M. D. K. 1970. Prawn fishery by trawl off commence during 1965-1968 *Indian J. Fish.* 17(1 & 2) : 173-178.

The prawn catches by trawl of commence have been assured from the landing data of the shrimp trawl at depths 15-26Metre or fathan during January 1965 to June 1968. Annually an average catch of 6 tonnes of prawns was landed by the mechanised boats at commence. The catch rates, the dominant size ranges and the depth wise distribution of the different species of prawn which form the bulk of the fishery during different months are also given.

282. KUTTYAMMA, V. J. 1988. Prawn fry resources off Kasargod in the South West Coast of India. *Symposium on Tropical Marine Living Resources*, Cochin, India, 12-18, Jan. 1980. Marine Biological Association of India. Abstract No. 25.

Occurrence and abundance of the post-larvae and early juveniles of different marine prawns were studied on the basis of plankton samples collected from the Arabian Sea off Kasargod.

283. LALITHA DEVI, S. 1989. Observation on the fishery and biology of Penaeid prawns from Godavari estuary. *Indian J. Fish.* 35(1) : 52-63.

The Godavari estuarine system of Andhra Pradesh supports around the year penaeid prawn fishery. The annual average penaeid prawn landings at Matlapalem, B. V. Palem and P. G. Moga landing centres was 806.3 t, during 1979-83 with peak catches during October-December. Twenty three species of penaeid prawns contributed to the fishery of which *M. monoceros*, *P. indicus*, *M. dobsoni*, *P. monodon*, *P. semisulcatus*, *P. merguensis* and *P. Japonicus* are important in the order of abundance. Variations in the seasonal abundance of the constituent species between years and between the landing centres were noticed. Prawns in the length range of 40-100 mm (2.4 months old) formed bulk of the catch. A growth rate of 16-18 mm/month in *M. monoceros* 27.5-32.5 mm/month in *P. indicus* and 32.5-37.5 mm/month in *P. monodon* was discernible. In most of the species female dominated in almost all the months and also in the larger length groups. The species composition in the Godavari estuary during December and February-May was similar to that obtained in the marine catches landed at Kakinada Fisheries Harbour. This may be due to the existence of somewhat marine conditions (physico-chemical) in the estuary in those months.

284. LAKSHMI, A.; GOVINDAN, T. K.; MATHEW, A.; PILLAI, V. K. 1963. Studies on frozen storage of prawns. *Proc. Indo-Pacif. Fish. Counc. Occas. Paper* 63/2.

Studies on the physical, chemical and bacteriological characteristics of the raw material and frozen prawn muscle conducted and the results discussed.

285. LAL MOHAN, R. S. 1984. Acetes shrimp resources of Andaman and Nicobar Islands. *Mar. Fish.Infor. Serv. T & E Ser.* 53 : 15-17.

This report is on Acetes resources in the Andaman and Nicobar Islands during the survey conducted there in February-April 1978.

286. LAKUMB, N. C. 1960. Prawn fishery of Kutch, Gujarat State. The fishing Industry of Gujarat. Souvenir Published by the Directorate of Fisheries, Gujarat State, on the Occasion of Fishery Festival, October, 1960, 49-54.

Production fishery, species composition, processing of prawns, by-products and the socio-economic conditions of fishermen are discussed alongwith suggestions for improvement.

287. LARSEN, K. 1964. Fishing of the West coast of India. *Fishing News International*, 3(2) : 128-131.

Trawling for shrimp, weather, monsoons, charting of the ground off West coast of India explained.

288. LAZARUS, S.; NANDAKUMAR, K. 1988. Prawn seed resources around Calicut area. *Symposium on Tropical Marine Living Resources*, Cochin, India 12-16, Jan. 1988. Marine Biological Association of India. Abstract No. 24.

There is large quantity of prawn seed resources mainly belongs to that of *Penaeus indicus*, *P. monodon* and *Metapenaeus dobsoni*.

289. LEWIS, NORMA F. 1978. Radiation preservation of sea foods development of dehydroirradiation process for shrimp (*Penaeus indicus*) and Bombay duck (*Harpodon nehereus*). In : Symposium on Fish Utilization Technology and Marketing in the IPFC Region, Manila, 1978. List of papers (by session), Rome, FAO, *Agriculture Organisations of the United Nations*. 8 p. (IPFE/78/SYMP/36) Indo-Pacific Fishery Commission, IPFC/78/SYMP/inf. 3).

The hydro-irradiation process developed for Bombay duck laminates and shrimp offered good scope for stabilising these sea food an ambient temperature. The products obtained were far superior in organoleptic attributes than those prepared by the conventional sun-drying method.

290. LIAO, I. C.; MIRANO, R. 1984. Status and problems of grass prawn in Taiwan. *Proceedings of ROC Japan Symposium on Mariculture* December 14-15, 1981. Taiwan. *Tml. Conf. Proc. No. 1* 81-98.

The culture of grass prawn, *Penaeus monodon*, has been practised in Taiwan for several hundred years. The grass prawn was usually stocked with milkfish, *Chanos chanos* and was considered as a by-product of milk fish pond production. Grass prawn, *Penaeus monodon*, Aquaculture development.

291. MARY K. MANISSERI; MANIMARAN, C. 1981. On the fishery of the Indian white prawn *Penaeus indicus* H. Milne Edwards along the Tirunelveli coast, Tamil Nadu. *Indian J. Fish.* 28 (1 & 2): 208-216.

The fishery is seasonal, June-July to October-November. The total landings of prawn by mechanised boats recorded in 1978 was estimated at 539/- of which nearly 63.4% was large scale *P. indicus*. The species occurs in the adjacent waters of Pumaeppiyed and also, round-the-year of lesser magnitudes.

292. MARY K. MANISSERY, 1982. On the fishery of juveniles of *Penaeus semisulcatus* along the Thirunelveli coast, Tamil Nadu. *Indian J. Fish.*, 29 (1 & 2) : 20-28.

The juvenile of *Penaeus semisulcatus* is stated to be occurring in large concentrations in the very shallow inshore sea between Pattanamurudur and Tuticorin, on the southeast coast and contributing to a considerable fishery, through out the year, by 'Ola Valai'. The peak abundance was observed to be in November January and June-July. The size ranged from 40 mm to 150 mm total length, majority measuring less than 100 mm, indicating that this area was a nursery ground of the species.

293. MATHAI, T. JOSEPH; SATHIARAJAN, R. 1964. Stake net an indigenous gear for the capture of shrimp in the back-waters of Cochin. Symposium on Prawn Fisheries in India, Society of Fisheries Technologists (India), Cochin, 1964 (Abstract only), p. 8.

Deals with the design, construction and method of operation; assesses the efficiency and environmental factors influencing the catch.

294. MENON, M. K. 1938. Early stages of the species of *Palaemon* Proc. Indian Acad. Sci. 8(4) : 288-294.

Descriptions of first two larval stages of *Palaemon rudis*, *P. carinus* are given.

295. MENON, M. K. 1953. Notes on the bionomics and fishery of the prawn *Parapenaeopsis stylifera* (M. Edw.) on the Malabar coast. J. Zool. Soc. India, 5(1) : 153-162.

Breeding, growth sex ratio, migration and fishery are discussed.

296. MENON, M. K. 1955. Notes on the bionomics and fishery of the prawn *Metapenaeus dobsoni* Miers on the Southwest-Coast of India. Indian J. Fish. 2(1) : 41-56.

Some aspects of the bionomics of *M. dobsoni* such as growth, sex ratio and migration are discussed.

297. MENON, M. K. 1958. Prawn fisheries. Fisheries of West Coast of India. Edited by S. Jones.

The total estimated landings of prawns and shrimps from India, brief account of the fishing grounds, composition of catches, fishing methods, seasonal variation, processing and marketing, salient features of the important species and the suggestions for future development of the fishery with mechanised fishing are given.

298. MENON, M. K. 1965. Life history of prawns-A review of recent studies with special reference to Indian species. Fish. Tech. 2(1) : 12-18.

A brief review of the studies on the life histories of Indian species of prawns chiefly belonging to the family *Penaeidae*. The post-larval development of one species that has been studied in detail *Metapenaeus dobsoni* is indicated in the outline.

299. MENON, M. K.; RAMAN, K. 1961. Observations on the prawn fishery of the Cochin backwaters with special reference to the stake net catches. *Indian J. Fish.*, 8(1) : 1-23.

Fluctuations in the stake net catches, their correlation with the rainfall, strength of tidal flow and other factors, length frequency distributions of the important species are discussed.

300. MHALATHAKAR H. N.; JAGADEESAN G. 1970. Belly depth studies for shrimp trawl. Part II *Fish. Technol.*, 7 (2), 177-179.

The paper is on some experiments conducted on belly depth studies using four seam shrimp trawlnet. Reduction of the belly depth beyond a certain limit was detrimental to the catching efficiency as well as the mechanical characteristics of the net. The optimum depth of belly was found to be 70 meshes for this design.

301. MHALATHKAR H. N.; JAGADEESAN G. 1971. Belly depth studies for shrimp trawls Part III. *Fish. Techn.* 8 (2), 167-170

Some additional experiments were conducted with 17.07 m (56') four seam trawl to determine the possibility of reducing the depth of belly for shrimp fishing and also to evolve a possible mathematical equation to determine the maximum depth of belly in shrimp trawls. The results obtained not only gave corroborating evidence to the earlier findings but also helped in arriving at a relationship that for a given stretched width of belly 'L' the stretched depth of belly could be either  $2L/5$  or 40% of 'L' with an allowance of 2 meshes.

302. MHALATHKAR, N. N.; KRISHNA IYER, H. 1966. Belly depth studies for shrimp trawls. *Indo. Pacif. Fish. Coun., Occ. Pap.* 67/6, 1966.

The results of an investigation carried out to find the optimum belly depth of shrimp trawls operating 13.62m (45 ft) four-seam cotton trawlnet of which the depth of the belly was cut short to approximately one-third of its original depth in three stages are presented.

303. MIYAMOTO, H.; DESHPANDE, S. D.; GEORGE, N. A. 1962. Recent development in trawl fishing for shrimps from mechanised boats on the west Coast of Peninsular India. *Proc. Indo-Pacif. Fish., Coun.*, 10 (2) : 264-279

The development of trawling on the west coast of India is reviewed, an account of the experimental fishing operations made with various types of trawls, boats and engines of different horse power.

The experimental operations showed that when more floats were attached to the net, fish catch was more than the prawn catch, indicating that for selective fishing the number of floats on head rope are to be accordingly adjusted. Tickler chain improved the catch of prawns and fish. Tests on the other trawl showed that using long sweeps was advantageous.

304. MOHAMED, K. H. 1961. Penaeid prawns in the commercial shrimp fisheries off Bombay with notes on species and size fluctuations. *Proc. Symp Crustacea*, Marine. Biological Association of India held at Ernakulam 12-15 IV : 1408-1418.

Species composition, size frequencies, recruitment and spawning season of important prawns off Bombay area studied.

305. MOHAMED, K. H. 1969. Genus *Penaeus* fabricius 1798 : In prawn fisheries of India *Bull. Cent. Mar. Fish. Res. Inst.* No. 14 : 49-95

*Penaeus semisulcatus* and *Penaeus indicus* H. Milne-Edwards, their distribution, biology life history, food and feeding, growth, movements, maturation reproduction and fishery are discussed.

306. MOHAMED K. H. 1967. Prawn fisheries In: Souvenir 20th Anniversary, Central Marine Fisheries Research Institute. p. 75-81.

In this general account of the prawn fisheries in India, various aspects such as all-India and state wise productions, species compositions, fishing seasons and the various types of gear employed in the fishery and the export are discussed.



307. MOHAMED, K. H. 1973 Penaeid prawn resources of India. *Proc. Symp. Living Resources seas around India, CMFRI Special Publ.* 548-556.

The article is a brief appraisal of the prawn fishery of India, then spread over a narrow inshore area of about 15 km, based on the data for 10 years from 1958 to 1967. The penaeid prawn landing and their percentage contribution to the total marine catches are given for the period, so also the mean sizes of different species, a comprehensive list of the Penaeid Prawns known to occur in the Indian region is furnished.

308. MOHAMED, K. H.; RAO, P. VEDAVYASA. 1971. Estuarine phase in the life-history of the commercial prawns of the West coast of India. *J. mar. biol. Ass. India.* 13 (2) : 148-161

Thirty-two species of prawns and shrimps were recorded from the Cochin backwater. Among these, *Penaeus indicus*, H. Milne-Edwards, *Metapenaeus monoceros*, (Fabricius), *M. dobsoni* (Miers) and *M. affinis* (H. Milne-Edwards) belonging to *Penaeidae* and *Macrobrachium rosenbergii* (de Man) and *M. idella* (Hilgendorf) belonging to *Palaemonidae* were commercially important. The minimum period of stay in the backwater and the size at the time of leaving this ecosystem were estimated to be in the order 5 months and 50 mm for *M. dobsoni*; 4 months and 40 mm for *M. affinis*; 10 months and 85 mm for *M. monoceros* and 6 months and 80 mm for *P. indicus*. From size frequency distribution of the juvenile in the estuary, the growth rate of each of these species is assessed and it is found that the average growth rate is highest in *M. dobsoni* (9.88 mm/month) and lowest in *M. monoceros* (6.72 mm/month). The freshwater prawn *M. rosenbergii*, is found to utilise the estuary for about 5 months. A general appraisal of the dynamics of each of the prawn is presented in the light of the data obtained from the three different ecological niches, estuarine areas, inshore and offshore regions of the sea. Prospects of utilisation of the estuarine areas for culturing different species of prawns and associated problems are discussed.

309. MOHAMED, K. H. SUSEELAN, C. 1973. Deep-sea resources off the South-west coast of India. *Proceedings Symp. Living Res. around India, CMFRI Spl. Pub. p.* 614-633.

The exploratory trawling operations carried out by the Indo-Norwegian project vessels from 1964 onwards in depths ranging from 120m to 430 m covering over 5000 square kilometers, along the South-West coast of India shows the presence of considerable quantities of deep-sea prawns, lobsters, crabs and fishes. The analysis of catch data of over 250 hauls made from these depths has enabled to assess the productivity of these grounds in respect of the newly found prawn resources. Although more than a dozen species of prawns were found in the catches, only seven of them, viz. *Aristeus semidentatus*, *Heterocarpus wood-masoni*, *Parapandalus spinipes*, *Plesionika martia*, *P. ensis* and *Penaeopsis trectacuta* were present in such large quantities as to form sizable portions of the catch. The analysis also indicated that the southern areas (off Quilon and Alleppey) were more productive and that their there sources were more concentrated in the depth range 300.325 m. Hydrographic conditions of the water of the deep water trawling grounds off question, list of decapods observed in the deep-sea catches, depth-wtse catch distribution of prawns in areas between latitude of 8°00' N and 14°00' N of south west coast.

310. MUTHU, M. S. 1969. *Parapenaeopsis* India, SP. Nov. (Decapoda, Penaeids) from the Indian waters. *Indian J. Fish.* 16 (1 & 2) : 174-187.

*Parapenaeopsis* India, a new species is described based on materials collected from Kakinada along the coast of India. The features that distinguish *P. indicus* from the clearly related species are discussed.

311. MUTHU, M. S. 1988. Some thoughts on conservation of marine prawn resources in India. *Symposium on Tropical Marine Living Resources, Cochih*, 12-16 Jan. 1988. Marine Biological Association of India. Abstract No. 198.

Biological, behavioural and environmental parameters which have a bearing on conservation of penaeid prawn stocks are discussed.

312. MYDEEN KUNJU, M. 1966. The genera *Solenocera* ducloux 1950, *Atyopeneaeus* Alcock 1805, *Hippolysmata* stimpson 1860, *Palaemon* vebeni 1795 and *Acetes* Milne Edwards 1830. In *prawn fisheries of India*, Bull. Cen. Mar. Fish. Res. Inst. 14:159-171.

Biology, Life fishery, Diagnostic characters, distribution, reproduction, and fishery of *Solenocera indica*, *Hippolysmata ensirostis* kemp, *Palaemon tenuipes* Henderson, *Acetes indicus* are discussed in this paper.

313. NAGABHUSHANAM, R; KULKARNI, G. K. 1982. Reproductive biology of the female of a Penaeid prawn *Parapenaeopsis hardwickii* (Miers) *Indian J. Fish.* 29 : 151-159.

The ovarian changes in the female *P. hardwickii* were studied histologically based on monthly observation for a year on samples collected from trawl catches as well as by experimentation of injections of hormones and eye stalk ablation in the laboratory. The results are discussed.

314. NAIR, R.S., VARGHESE, C.P.; RAMACHANDRAN, C.; KRISHNA IYER H. On the operation of small shrimp trawls in shallow waters: scope ratio and size-depth relation. *Fish. Technol.*, 3 (1) 1966 : 59-71.

An attempt at assessing the effective ratio of warp required for the operation of trawls at shallower depth and judging the suitable size of trawl indicated that a trawlnet of size between '35 and 45' would be suitable for operation in the region.

315. NAIDU, M. R. 1939. Report on a survey of Fisheries of Bengal. Govt. of Bengal, Dept. of Agriculture and industries, Bengal, India.

Different aspects of prawn fisheries of Bengal discussed.

316. NAIR, M. R. IYER, K. M; APPUKUTTAN, P. N.; JACOB, S. 1962. Storage characteristics of prawns held in crushed ice and chilled sea-water. *Proc. Indo. Pacif. Fish. Council.*, 10th Sess. 295-297.

The effect of holding prawns in crushed ice (ice : Prawn=3:1) and chilled sea-water (sea-water : prawn=1:1) on their storage characteristics has been studied and the results discussed.

317. NANDAKUMAR, G. 1980. Observations on the prawn fishery of the Mandapam area *Indian J. Fish.* 27 (1 & 2) : 257-260.

Trawling of prawns is carried out at night. The prawn fishery showed annual fluctuations and the average annual prawn catch was estimated to be 309-12 tonnes forming 17-78% of the trawl landings.

318. NARAYANAN NAMBIAR, V; MAHADEVA IYER K. 1970. Common microflora involved in spoilage of canned prawns. *Fish. Tech.* 7 (1&2) : 116-119.

An elaborate survey was carried out to ascertain the common types of micro-organisms responsible for spoilage in canned prawns.

319. NATARAJAN, P. 1989. Persistent locomotor rhythmicity in the prawns. *Penaeus indicus* and *P. monodon*. *Mar. biol.* 101 : 339-346.

The locomotory activity of adult *Penaeus indicus* Milne Edwards and *P. monodon* (Fabricius) collected from the Vellar estuary, South India, in 1983 was monitored continuously for a period of 40 days in the laboratory. Both species exhibited persistent circatidal and circadian rhythmicity, the former displayed peak activity during predicated times of high water in their original habitat. The latter exhibited peak activity during periods corresponding to insitu night-time with almost no activity during the day, except at the time of high tide. The tidal and daily rhythms were evident for only 3 to 4d and 5 to 6d, respectively, under laboratory conditions. The amplitude of the rhythms displayed variations in each semilunar period, reflecting the synchrony and dissynchrony of the tidal and daily rhythms. Activity was correlated with phases of the moon, peaking at times of new and full moon, and showing a scattered pattern with smaller peaks during the first and third quarters.

320. NATARAJAN, P. 1986. External synchronizers of tidal activity rhythms in the prawns *Penaeus indicus* and *P. monodon*. *Mar. Biol.* 101 : 347-534.

Phasing of persistent circatidal rhythmicity to an artificial tidal cycle was assessed in the prawns *Penaeus indicus* Milne Edwards and *P. monodon* (Fabricius) collected from the Vellar estuary, South India, in the period between June and December 1984. Simulated 6h cycles of 20 and 30‰ S, and 6h cycles of 20° and 30°C induced a persistent tidal rhythmicity after 20 cycles. The imposed 6h cycles of 25 and 30‰ S, and 30°C induced tidal rhythms after 30 cycles. In both cases, re-established tidal activity rhythms were evident for at least 48h—higher activity occurring during the higher salinity and lower temperature phases of the simulated tidal cycles. Artificial tidal cycles of still water and running water synchronized the tidal rhythms after 20 cycles. Combined 30‰ S, 20°C, for 6h and 20‰ S and 30°C for 6h established a persistent tidal rhythm after 10 cycles, whereas wave action had no influence on tidal synchronization. The influence of possible interactions of tidal rhythms and in situ tidal variables on circatidal activity is discussed.

321. PANIKKAR, N. K. 1937. The prawn industry of Malabar coast. *J. Bombay Nat. Hist. Soc.* 39(2) : 343-353.

The characteristic of the backwaters of Travancore, the prawns that inhabit backwaters, sea and fresh waters, the fishing operation in the paddy fields, curing and marketing of prawns and suggestions for improvement of prawn industry is given.

322. PANTULU, V. R. 1965. Inland prawn fisheries resources of India and their development. *Fish. Tech.* 2(1) : 54-58.

The magnitude and disposition of the inland prawn fishery resources have been described with suggestions for organised survey of resources and researches on culture practices.

323. PANIKKAR, N. K.; MENON, M. K. 1955. Prawn fisheries of India. *Proc. Indo-Pacif. Fish. Council.* 6(3) : 328-344.

A general review of the prawn fisheries in India, the fishing grounds, the species caught, the fishing methods, seasonal variations

technology and marketing, salient features of the biology of the commercial species, are discussed with suggestions for exploratory fishing up to a depth of 30-40 fathoms and expansion of prawn fishing.

324. POERNOMO, A. 1968. Studies on the larvae of commercial prawns and the possibility of their culture in Indonesia. Paper presented to the 13th session, Indo-Pacif. fish Coun., document IPFC/C68/Fish. 24.

Important species of commercial prawns in Indonesia has been discussed. Culture of these prawns are possible and also it is economic.

325. POTTER, M. A.; DREDGE, M. C. L. 1985. Deepwater prawn resources off southern and central Queensland. Rothlisberg, P. C. et al. (E). *Second Australian national prawn seminar*: 221-229.

Deepwater trawl surveys for prawn resources were conducted and located, unexploited stocks of prawns in waters of the outer continental shelf and slope.

326. PILLAY, T. V. R. 1948. Marine Fisheries of Kodinar in Kathiawar. *J. Bombay Nat. Hist. Soc.*, 48(1): 47-61.

A general survey of the fishing industry of Kodinar area given. Fishing crafts, nets, methods of fishing, catch composition, by-products are dealt with.

327. POINER, I. R.; HARRIS, A. 1985. The effect of commercial prawn trawling on the demersal fish communities of the South Eastern Gulf of Carpentaria. In: *Proc. Torres strait fisheries seminar* Haines, K. Williams, G. C.; Coates, D. p. 239-261.

Statistical comparisons of species richness and abundance per site were made using matched pairs of sites and grounds of sites generated using numerical classification.

328. PATEL, B. H.; BALAPATEL, I. A. 1982. Some observations on the prawn fishery of Gulf of Khambhat, Gujarat. *Indian J. Fish.* 29(1 & 2) :63-70.

The prawn fishery in the Gulf of Khamphat during August 1978 to July 1980 is dealt with. The prawn landings consisted principally of *Parapenaeopsis sculptilis* (Jeller) and *Metapenaeus dobsoni* (Miers) through out the year. Seasonal abundance, maturity and spawning of these species together with certain environmental factors are discussed.

329. PRIMAVERA, H. H.; YOUNG, T.; REYES, C. De, LOSS. 1982. Survival, maturation, fecundity and hatching rates of unablated and ablated *Penaeus indicus*, H. M. Edwards from Brackish water ponds. Proc. Symp. Coastal Aquaculture, Held at Cochin from January 12 to 18, 1980. Marine Biological Association of India. 1 : 48-54.

*Penaeus indicus* H. M. Edwards harvested after three months of rearing in the brackishwater ponds, averaging 6.9 g for females and 5.6 g for males, were stocked in two 12 cu. m. flow through ferro-cement tanks at the rate of 240 females and 200 males per tank. The females in one tank were ablated on one eyestalk in one tank and remained unablated in the other tank; all males were unablated. Ablated females spawned upto 7 times but unablated females spawned to a maximum of only 3 times during the two months duration of the experiments. Ablated females produced a total number of  $17.5 \times 10^6$  eggs,  $6.6 \times 10^6$  nauplii and an average of 23,480 eggs/spawning and 37.8% hatching rate from a total of 757 spawnings. Unablated females produced a total of  $2.0 \times 10^6$  eggs,  $1.1 \times 10^6$  nauplii, and an average of 26,990 eggs/spawning and 53.9% hatching rate from a total of 74 spawnings. Survival of ablated females was 53.5% compared to 69.4% for unablated females; males in both tanks averaged more than 90% survival.

330. QURESHI, M. M. R. 1955. Shrimp fisheries of Pakistan. *Proc. Indo-Pacific Fish. Council.*, 6th Sess : 359-362.

A general account of the shrimp fisheries, fishing gears and boats, catch statistics seasonal variations, processing and marketing, distribution of shrimps and a list of the species recorded from the commercial catches are given.

331. QURESHI, S.; HASHMI, T. A. 1965. Shrimp fisheries of West Pakistan. *Proceedings of the Symposium on Crustacea*, Marine Biological Association of India, p. 73. (Abstract only)

The paper deals with the taxonomy of the marine shrimps, length-weight relationship, growth rate, breeding season, sex ratio of *Penaeus merguensis*, fishing crafts, fishing grounds, exports and foreign markets.

332. RADHAKRISHNAN, N. 1967. On the prawn resources of Karwar region. *Proceedings of the Symposium on crustacea*, Ernakulam January 12 to 15, 1965. Marine Biological Association of India. P. 1421-1423.

*M. affinis*, *M. dobsoni*, and *P. stylifera* are the important species occurring in the trawl fishery of Karwar form the high catch rates in some of the months. It appeared that the prawn fishery was better in September to February. The highest figures of catch-per-hour-of-trawling among 8-10 f, 10-15 f and 15-20 f, zones were 3.48 kg, 17.61 kg and 12.56 kg, respectively, thus pointing to better availability of prawns in 10-15 f region.

333. RAJAN, K. N.; SUKUMARAN, K. K.; KRISHNAPILLAI, S. 1982. On 'Dol' net prawn fishery of Bombay during 1966-76. *Indian J. Fish*, 29(1 & 2) : 29-36.

The best prawn catches of 2330 t at Versova were in 70-71 and 1917.5 t at Sasoon Docks were in 1968-69. The peak fishery was generally during October-December and March-May. The fishery was supported mainly by seven species of penaeids and three species of non-penaeids the latter contributing upto 80% of the catches obtained on Dol nets.

334. RAJYALAKSHMI, T. 1964. The prawn fisheries of Hooghly estuarine system. *Symposium on Prawn Fisheries in India*, Society of Fisheries Technologists (India), Cochin, 1964, P. 18.

Trend of distribution of 7 species of prawns in the estuarine system studied and regulations in mesh sizes of bag nets to improve the fishery suggested.



335. RAJYALAKSHMI, T. 1943. Report of the fisheries of Madras. Dept. of Industries & Commerce, Madras.

Prawn fisheries of Madras discussed.

336. RAJYALAKSHMI, T.; PILLAI, S. M.; RAVICHANDRAN, 1988. Some observations on the biology and fishery of the banana prawn *Penaeus merguensis* De Man off Orissa coast. *Symposium on Tropical Marine Living Resources*, Cochin, India, 12-16 Jan. 1988. Marine Biological Association of India. Abstract No. 67.

Biology and fishery of the banana prawn *Penaeus merguensis* off Orissa on the east coast were studied and the details have been given in this paper.

337. RAJAN, K. N.; SUSEELAN, C. 1988. Some observations on the prawn fishery of Sakthikulangara, Kerala State. *Symposium on Tropical Marine Living Resources, Cochin, India* 12-16 Jan. 1988. Marine Biological Association of India. Abstract No. 142.

This paper deals with the production of prawn catch composition and certain aspects of population of the major species contributing to the trawler fishery of the centre for the period 1972-86.

338. RAJAGOPAL, M. V. 1965. Effect of different media on the determination of number of micro-organisms in frozen prawns (shrimp). *Fish. Tech.*, 1(1) : 151-154.

Changes in the medium for total bacterial count have been suggested and the reasons for the same discussed.

339. RAMAMURTHY, S. 1967. On the prawn fishery of Gulf of Kutch *Proceedings of the Symposium on Crustacea*, Marine Biological Association of India, 1965, Part IV : 1424-1436.

Fishery, growth, sex ratio, breeding, migration and survival rates are discussed.

340. RAMAMURTHY, S.; MUTHU, M. S. 1969. Prawn fishery methods. In: Prawn fisheries of India. *Bull. Cent. Mar. Fish. Res. Inst.* 14 : 235-257.

Fishing crafts, fishing gear, seine-nets, scoop-nets, drift-nets and miscellaneous devices are discussed in this paper.

341. RAMAMURTHY, S. J.; ANNIGERI, G.G.; KURUP, N. S. 1978. Resource assessment of the penaeid prawn *Metapenaeus dobsoni* (Miers) along the Mangalore coast. *Indian J. Fish.* 25 : 52-66.

The fishery and certain aspects of the population characteristics of *M. dobsoni* from 1962 to 1971 are reported. The fishery was generally bimodal with peaks during March-April and September-October and showed wide annual fluctuations.

342. RAMAMURTHY, S. 1982. Prawn seed resources of the estuaries in the Mangalore area. *Proc. Symp. Coastal Aquaculture Held at Cochin from Jan. 12 to 16, 1989* 1 : 160-172.

A survey of the juvenile prawn resources of three estuaries at Kasargod, Mangalore and Mulki along the Karnataka coast. The magnitude of the resources and its comparison and the reasons of availability are discussed.

343. RAMAMURTHY, S.; SUKUMARAN, K. K. 1984. Observations on the fishery off Mangalore coast during 1970-1980. *Indian J. Fish.* 31(1), 100-107.

The annual yield of prawns in the Mangalore coast showed considerable fluctuations. The MSY is estimated to be around 180-1900 that an effort level of 28,000 boat-days. The annual mean length of males and females of *M. dobsoni* and *M. affinis* and males of *P. stylifera* decreased considerably during the present period of observation.

344. RAMAMURTHY, S.; MESTRY, A. Y. 1985. Heavy landing of *Parapenaeopsis stylifera* (H. M. Edw.) at Bombay during Post-monsoon 1984. *Mar. Fish. Infr. Serv T & E Ser.*, 65:18.

Heavy catch of *P. stylifera* (H. Milne Edwards).

345. RAMAN, K.; MENON, M. K. 1963. A preliminary note on an experiment in paddy field prawn. *Indian J. Fish.* 10A(1) : 33-39.

The results of the experiments to find out the effect of variation in size and number of sluice gates, area of the field, etc., on the catch are given.

346. RAMAMURTHY, S. 1963. A note on the prawn fishery at Adesar camp. *J. mar. biol. Ass. India*, 5(2) : 318-320.

The prawn fishery at Adesar Camp, situated in the Little Rann of Kutch. The fishery was on the stock that had migrated from the creeks into this area during the monsoon season. The fishing season under observation lasted from September to December 1960. The majority states the sizes of prawns were comparable to those from the sea, indicating that *M. monoceros* did not attain maturity in the area.

347. RAMAMURTHY, S. 1985. Prawn resources of the Maharashtra coast with special reference to Penaeids. *Harvest and harvest technology of fish*. Society of fisheries technology of fish, Cochin pp. 37-48.

Maharashtra with an annual average catch of 66250 t contributed to 49% of the nation's marine prawn production. Non-penaeid prawns constituted the bulk, was 9090 t the largest share of Indian non-penaeid catch. Penaeids accounted for 30% of the prawn fishery of the state and 23% of the country. Statistical analysis showed an upward trend in the annual production of prawns during 1961-80. For non-penaeids, the trend was upward till 1977, and downward thereafter. The variations in the annual fishing efforts are discussed.

In view of the importance of penaeid in the export market, its resource characteristics such as CPUE, species composition, size and maturity are presented based on observations made at New Ferry Wharf, Bombay Centre during 1979-81.

348. RAMAMURTHY, S.; SURENDRANATHA KURUP, N.; ANNIGERI, G. G. 1975. Studies on the fishery of the penaeid prawn *Metapenaeus*

*affinis* (Milne Edwards) along the Mangalore coast. *Indian J. Fish.* 22 (1 & 2) : 243-254.

The transfer fishery and some of the features of population of *M. affinis* from 1962 to 1971 are reported. The fishery was chiefly bimodal and was dominated by large size groups early in the season and smaller size groups later. The maximum number of broods entering the fishery was four. Age and growth studies indicated that the males attained a length of about 95 mm, 140 mm and 160 mm and females, 100 mm, 145 mm and 170 mm at the end of first, second and third year respectively. The minimum size at first maturity for males was 116 mm. The average annual instantaneous fishing mortality was 3.76 for males and 2.50 for females.

349. RAO, R. MALLIKARJUNA, 1965. Breeding behaviour in *Macrobrachium rosenbergii* (De Man). *Fish. Tech.* 2(1) : 19-25.

A description of the mating behaviour and its pattern discussed.

350. RAO, P. VEDAVYASA, 1969. Genus *Parapenaeopsis* Alcock 1901. In: Prawn fisheries of India *Bull. Cent. Mar. Fish. Res. Inst.* 14 : 127-158.

*P. stylifera*, *P. sculptilis*, *P. hardwickii*, *P. hungerfaldi* and *P. tenella* are the species recorded in the Indian region. Their distribution, life history, differential growth of species, movement, reproduction, maturation stages of females, spawning, sex ratio, size composition and fishing methods are discussed.

351. RAO, P. VEDAVYASA, 1980. Penaeid prawn seed resources in the estuaries and backwaters of Karnataka and Kerala. *Mar. Fish. Infor. Ser. T & E Ser.* 20 : 9-11.

This report is based on the results of investigations on penaeid prawn fry resource in the estuaries and backwaters of Kerala and Karnataka. This study is operated by MPEDA and implemented by CMFRI.

352. RAO, P. VEDAVYASA, 1986. A view of the present status of the prawn fishery of India. In: Recent advances in marine biology,

P. S.B.R. James (Ed), Today and Tomorrow's printers and publishers: 367-404.

The paper presents a review of the investigations carried out so far on the biology of the commercially important prawns of India and the present status of the exploited prawn fishery of the country.

353. RAVINDRANATH, K. 1982. Krishna estuarine complex with reference to its shrimp and prawn fishery. *Indian J. Fish.* 29 (1 & 2) : 168-176.

The physiography of the lower reaches of river Krishna and the adjoining coast is described. Annual variation in salinity, temperature and dissolved oxygen of the coastal waters at one station is presented. A brief account of the fishing craft and gear, and a list of 47 species of shrimps and prawns recorded from the area are given.

354. ROTHSCHILD, B. J.; BRUNES MEISTER, S. C. 1984. The dynamics and management of shrimp in the Northern Gulf of Mexico. In: Penaeid shrimp, their biology and management by Gulland, J. A. and Rothchild, B. J. *Fishing News Book* London P. 145-172.

An improved understanding of stock structure, stock productivity, effects of fishing on recruitment, effects of harvest size on biological production, effects of environment on reproductive success, and introduction among species will facilitate management of the U. S. Gulf of Mexico. shrimp fishery.

355. ROY CHOUDHARY, R. L. 1964. Some considerations in the selection of sizes of shrimp trawlers. *Symposium on Prawn Fisheries in India*. Society of Fisheries Technologist (India), Cochin 1964 p. 5.

Factors affecting the length of voyage are discussed briefly and it is found that the cost of indices are least for vessels between 40 to 45 feet length.

356. SHAIKHAHMUD, F. S.; MAGAR, N. G. 1956. Bacteriological study of Bombay prawns *Parapenaeopsis styllifera* (M. Edw.). *J. Sci. & Indust. Res.* 15 C (7) : 174-176.

Bacterial flora on *Parapenaeopsis styllifera* described.

357. SHAIKHMAHMUD, F. S. 1957. Studies on the nutritive value of Bombay prawns Chemical composition of prawns. *J. Sci. & Indust. Res.* 16 A (1) : 44-46.

Fat, protein, glycogen, lactic acid, mineral and vitamin contents of prawns from Bombay coast are studied.

358. SHAIKHMAHMUD, F. S. 1961. Studies on the nutritive value of Bombay prawns. 11 Chemical composition and nutritional constituents of penaeid prawns. *J. Sc. & Indust. Res.* 20 D (4) : 157-158.

The protein, fat, glycogen, mineral and vitamin contents of *Acetes indicus*, *Penaeus cerinatus*, *P. indicus*, *Metapenaeus monoceros*, *M. brevicornis*, *Parapenaeopsis sculptilis*, *P. maxillipedo* and *Solenocero indicus* are studied.

359. SHAIKHMAHMUD, F. S. Studies of prawn spoilage, 11. Handling and storage of prawns. *J. Bombay Univ.* 29(3 & 5) : 16-21.

Study has been conducted on the spoilage rates of prawns stored at 0°C under different conditions.

360. SHAIKHMAHMUD, F. S. 1961. Studies on the prawn spoilage. 11. The role of pH in determining the quality of prawns. *J. Bombay Univ.* 29 (3 & 5) : 22-26.

Spoilage pattern and the seasonal changes in the pH value and the bacterial count are studied.

361. SHAIKHMAHMUD, F. S. 1961. Studies of prawn spoilage. 11. Conditions affecting the quality of prawns. *J. Sci. & Ind. Res.* 29 (3 & 5) : 23-30.

An account of the conditions affecting the quality of prawns is given.

362. SHAIKHMAHMUD, F. S. 1961. Studies of prawn spoilage, IV. Study of the spoilage and standard quality of prawns in relation to different species, sizes and sex. *J. Sci. & Ind. Res.* 29 (3 & 5) : 31-38

Experiments were designed to study the spoilage and standard quality of 5 varieties of prawns. The results are given and discussed.

363. SHAIKHMAHMUD, F. S. 1965. Evaluation of chemical tests for the quality of prawns. *Fish. Tech.* 2(1) : 102-108.

This study was to determine the value of physical, bacteriological and chemical tests used to find out and compare the indices of quality of prawns stored at 0°C and at 18°C.

364. SHAIKHMAHMUD, F. S. 1965. Preservation of prawns with chemicals. *Fish. Tech.* 2(1) : 109-114.

The preservation of prawns with boric acid, dipotassium hydrogen phosphate, sodium bisulphite, ascorbic acid, citric ascorbic acid mixture, acronise pd, ferromycin and penicillin are investigated and the results discussed.

365. SHAIKHMAHMUD, F. S.; TEMBE, V. B. 1958. Study of Bombay prawns. The reproductive organs of *Parapenaeopsis stylifera* (M. Edw.) *J. Bombay Univ.* 27(3) : 99-110.

The reproductive organs of the prawn studied anatomically. The important difference found from other decapods given.

366. SHAIKHMUHMUD, F. S.; TEMBE, V. B. 1960. Study of Bombay prawns. The seasonal fluctuation and variation in abundance of the commercially important species of Bombay prawns with a brief note on their size, state of maturity and sex ratio. *Indian J. Fish.* 7(1) : 69-81.

The seasonal fluctuations as well as variations in abundance of various, commercially important species have been studied and a brief account of the results of the investigations discussed.

367. SHAIKHAHMUD, F. S. 1961. Brief account of the changes in the developing ovary of Penaeid prawn, *Parapenaeopsis stylifera* (M. Edw.) in relation to maturation and spawning cycle. *J. Bombay Univ.* 29 (3 & 5) : 62-77.

The general pattern of ovarian development, microscopical changes in the ovary development, the different maturity stages, and the breeding season studied.

368. SUBRAMANIAM, M. 1964. Fluctuations in prawn landings in the Godavari estuarine system. *Proc. Indo-Pacif. Fish. Counc.* 11th Sess. Sec. 11 : 44-48.

Studies on the fluctuations in the fishery of two species of prawns in the Gautami estuary in relation to the monthly river discharge are made and the results discussed.

369. SHARIF, A. T. 1959. Shrimp trawling along the Malabar coast during the years 1955 and 1956. *Indian Fish. Bull.* 6(3) : 40-43.

The potential shrimp ground along the inshore belt from Tanur to Mangalore and the increased landings along the whole Malabar coast from January to April mentioned.

370. SAMPSON MANICKAM, P. E.; ARPUTHARAJ, M. R.; VEDAVYASA RAO 1987. Survey of the exploration of juveniles of green tiger prawn *Penaeus semisulcatus* along Palk Bay and its impact on the prawn fishery of the region. National Symposium on Research and Development in Marine Fisheries, Mandapam Camp 16-18 September 1987. *CMFRI Spl. Publ.* 40 : 20-21.

The green tiger prawn, *Penaeus* (*Penaeus*) *semisulcatus*, contributed to over 50% of the total prawn catch landed along the Palk Bay coast. They were caught by the indigenously developed trawl-like bottom nets and trawl nets operated by non-mechanised and mechanised fishing vessels within the 12m depth zone. With the increasing demand for prawns by the export trade, the fishing for juvenile prawns inhabiting the seagrass ecosystem near the shore became more



intense from 50 fishing villages between Adirampattinam and Thangachimadam 2,500 country craft were involving in the fishery. They operated in the 3.4 m depth zone mainly during night. The gear was basically a miniature two-seam bottom trawl without otter boards. Depending on the size of the boat, either one or two nets were operated.

The prawn catch, which was mainly composed of juvenile *Penaeus semisulcatus* varied from 2 kg to 10 kg per unit per day. The size of the juvenile *P. semisulcatus* ranged from 31 mm to 100 mm TL. 45-70 mm size groups were dominating. The method of operation of the craft and gear are given.

371. SATHYANARAYANA, A. V. V.; KURIAN, G. K.; NAIR, R. S. 1962. Commercial prawn trawling gear of Cochin (India). *Proc. Indo-Pacif. Fish. Coun.* 10(2): 226-263.

The designs of various trawls used commercially for prawn fishing in Cochin are described along with details of boats.

372. SATHYANARAYANA, A. V. V.; NAIR, R. S. 1962. Designs of otter trawls for shrimps. *Indian J. Fish.*, 9(4): 4-23.

Systematic studies on the designs of otter trawls are attempted with a view of designing suitable designs for small and medium sized mechanised boats. Some of the trawl and otter boards designed are presented.

373. SATHYANARAYANA, A. V. V.; NAIR, R. S. 1964. Towing resistance of otter trawls used for shrimps from small mechanised boats. *Fish. Technol.*, 1(2): 183-188.

Some attempts that were made at Cochin to determine the tow resistance of the shrimp otter trawls operated from small trawlers are presented. The actual resistance on the warps under normal fishing conditions was measured. Engine horse power utilised for towing the gear at normal speed and fishing was also estimated.

The horizontal spread between the otter doors was between 50% and 60% of the total length of the head rope including sweeps. The relationship between the BHP to engine and the actual H.P. utilized followed a linear pattern suggesting that these factors were directly proportional.

374. SAMBANDAM, K. P. 1988. A comparative study of prawn seed resources of estuaries in Ramnad district, Tamilnadu. *Symposium on Tropical Marine Living Resources*, Cochin, India. 12-16 Jan. 1988. Marine Biological Association of India. Abstract No. 198.

This study reveals the availability of prawn seeds in different estuaries of Ramnad district.

375. SAMBANDAM, K. P.; LAWRENCE, L.; NOBLE, J. 1982. Some observations on penaeid prawn seed resources in the Vellar estuarine system. *Proc. Symp. Coastal Aquaculture*, 1 : 308-313.

Investigation on the seeds of fast growing and commercially valuable prawns amenable for developing aquaculture in the vellar-coleroon estuarine complex.

376. SEBASTIAN, A. V.; SATHYANARAYANA, A. V. V.; NAIR, R. S. 1964. On the prawn trawling experiments conducted off Kakinada (Andhra Pradesh). *Proc. Indo-Pacif. Fish. Council*. 11th Sess., Sec. II : 198-201.

Presents the results of trial fishing for prawns with beam and otter trawls and results encourage large scale exploratory fishing for prawns in the Bay of Bengal.

377. SEWELLAR, B. S. 1934. A study of the fauna of the salt lakes. Calcutta. *Rec. Indian Mus.* 36.

378. SATHYANARAYAN, A. V. V. 1965. Note on the size groups of prawns landed by shrimp trawls of four different cod end meshes. *Fish. Tech.* 2(1) : 87-92.

The size groups of prawns landed by shrimp trawls were studied in relation to their cod end meshes. The small sized prawns of mean length 77.15 mm were caught by nets which had 23.38 mm cod end operated at 5.6 fathoms. Medium prawns of mean length 105.22 mm were caught in 25.21 mm and 19.88 mm cod end operated at fathoms and big-sized prawns of mean length 117.98 mm were caught in 21.29 mm cod end operated at 10-12 fathoms.

379. SEBASTIAN, A. V.; SADANANDAN, K. A ; SATHYANARAYANA A. V. V. 1964. On the prawn trawling experiments conducted off Kakinada (Andhra Pradesh). *Proc. Indo-Pacif. Fish. Council.*, 11(2) : 198-203.

The results of some trial fishing operations for prawns conducted off Kakinada with both beam trawl and otter trawl are presented. Corroborating the earlier findings at Cochin, the catches of beam trawl comprised mainly of small prawns of average length between 8 cm and 10 cm, whereas the otter trawl catch composed of both big and small-sized prawns.

380. SHARMA, G. S.; MURTY, A. V. S. 1973. Prawn fishery off the west coast of India in relation to hydrographical conditions of the shelf waters. *Proc. Symp. Liv. Res. seas around India, CMFRI Spl. Publ.* 414-423.

The data on the prawn fishery of the South West Coast of India between Cape comerin and Colachel for the period 1960-1966 were correlated with the hydrographic data such as temperature, density (sigma-t) and dissolved oxygen. The study is reported to have indicated that the prawn fishery flourished when the colder denser water prevailed along the shelf during the monsoon period (Modified author's abstract).

381. SILAS, E. G.; GEORGE, M. J.; JACOB, T. 1984. A review of the fisheries of India : a scientific basis for the management of the resources. In: Penaeid shrimps their biology and management Ed. by Gulland, J. A. and Rothschild, B. J. P. 83-103.

Shrimp is caught along most of the 6000 km coastline of India. Between 1965 and 1973 the total catches expanded rapidly but since then the catches have fluctuated, and most recent catches have been below the peak of 220,000 tonnes of 1976. A number of different species are caught, with a variety of gear including trawlers, from the offshore grounds, and upto several types of traditional gear from the inshore and lagoon areas. Examination of catch and effort statistics from the different areas suggest that many stocks are fully exploited. In most fisheries shrimp make up only a small part of the total catch, but except for some large trawlers on the east coast, this by-catch is brought ashore. The geographical and seasonal variations in the by-catch are discussed.

The varying objectives of management, biological, economic and social (including reducing conflicts between user groups)-are discussed. Others from sex, or inflexion point in juvenile stage. The moulting cycle of shrimp weighing 11.5 to 15 g was 6 to 17 days at a water temperature of 20° to 26°C. The moulting cycle was prolonged in proportional to the size of the shrimp; shortened as the water temperature increased.

382. SILAS, E. G.; MUTHU, M. S.; KATHIRVEL, M. 1983. Penaeid prawn resources and potential for prawn culture. In: Mariculture potential of Andaman and Nicobar Islands. An indicative survey. *Bull. Cent Mar. Fish. Res. Inst.*, 34 : 54-60.

Data on penaeid prawn landings for the period, 1665-81, prawn samples were analysed in detail for species composition, size distribution, sex-ratio and maturity. 19 species of penaeid prawns were listed in this report.

383. SOMERS, I. F. 1985. Maximising value per recruitment in the fishery of banana prawns, *Penaeus merguensis*, in the Gulf of Carpentaria. Rothlisberg, P. C. *et al* (Ed), *Second Australian national prawn seminar* : 185-192.

A computer model is described which is used to analyse the relationship between monetary value per recruit and opening date of the fishing season for banana prawns, *P. merguensis*, in the Gulf of Carpentaria.

384. SREEKRISHNA, Y.; NARAYANAPPA, G. 1970. On the trend of prawn catches in bottom trawls in inshore waters off Kakinada (Andhra Pradesh). *Fish. Tech.* 7(1) : 33-37.

Based on fishery data of 3 years, the availability of prawns for bottom trawls is estimated. Prawns formed 22.5% of the total catch with an average catch rate of 12.3 kg/trawling hour. The prawns were found to be abundant during November to February and again from April to July. The depth range of 11-15 m yielded better catch rate.

385. SRIVATSA, K. R. 1953. A survey and comparative analysis of the prawn (shrimp) fishery of the Gulf of Kutch in Saurashtra in Western India. Govt. of Saurashtra Publication, Saurashtra, India.

386. SRINIVASAN, S.; RAMAN, K.; JOSEPH, K. O.; ABDUL KADIF, P. M.; KRISHNAN S. 1988. Prawn, crab and fish seed resources of four brackish water bodies off Madras. *Symposium on Tropical Marine Living Resources*, Cochin, India, 12-16, Jan. 1988. Marine Biological Association of India. Abstract No. 18.

This paper deals with the observations made during 1980-81 on the availability of commercially important prawn, crab and fish seed from Pulicat Lake, Ennore Estuary, Adayar Estary and Kovalam backwaters of Madras region.

387. SUBRAMANYAN, M.; GANAPATI, P. N. 1975. Biology of the prawn *Penaeus monodon* Fabricius from the Godavari Estuarine System. *Bull. Dept. Mar. Sci. Uni. Cochin*, 7(3) : 653-670.

*P. monodon* Fabricius occurred in the Godavari estuary throughout the year, but the commercial abundance was confined to the period October to January/February. It was caught by cast nets, drag nets, push nets and bag nets. The prawn is stated to enter the estuary as post-larvae and move to the mangrove swamps and backwaters for growth, feeding on detritus. Growth is estimated from length frequency distribution, was considerably less than the observed growth. The sex ratio and the length-weight relationship are determined by statistical methods. The prawn was found to migrate back to sea when it reached 150 mm or so.

388. SUSEELAN, C. Resource and exploitation of juvenile penaeid prawns from Manakkudy estuary. *Indian J. Fish.* 22(1 & 2) : 96-106.

The Manakkudy estuary, situated about 8 kilometers north of Cape Comorin in Tamil Nadu, had an important resources of juvenile penaeids, which were exploited to be used as bait in hook and line fisheries and seed for culture along the coasts of Kanyakumari District. It is estimated that 4 tonnes of juvenile prawns were exploited annually with peak catches in February and March. The fishery was constituted by *Penaeus indicus*, *P. monodon*, *Metapenaeus dobsoni* and *M. monoceros*. Of these *P. indicus*, alone was forming 90% of the catch. Tracing modal progression the growth of this species was estimated to be at a rate of 24.3 mm/month for males and 26.2 mm/month for females. The growth rates tended to be higher when the bar mouth remained closed reducing to salinity to 8-14‰.

389. SUSEELAN, C.; KATHIRVEL, M. 1982. A study on the prawns of Ashtamudy backwaters in Kerala with special reference to penaeids. *Indian J. Fish.* 29 (1 & 2) 71-78.

Fifteen species of prawn were recorded from Ashtamudi backwater system, including a sergestid, five carideans and nine penaeids. The penaeids were chiefly the juveniles of *Penaeus semisulcatus*, *P. indicus*, *P. latisulcatus*, *Metapenaeus dobsoni* and *M. monoceros*. While *M. dobsoni* and *P. indicus* were generally dominant in most parts of the backwaters, *P. semisulcatus* occurred more abundantly in some of the deeper and most saline areas *P. latisulcatus* formed one of the common components during the post monsoon period. *Parapenaeopsis*

*stylifera*, the most dominant species contributing to the marine fishery of this area, was encountered only in stray numbers. Commercial exploitation and population characteristics of the juvenile penaeid prawns in these nursery areas are briefly discussed.

390. SUBRAMANYAM, M. 1964. Fluctuations in prawn landings in the Godavari estuarine system. *Proc. Indo-Pacific Fish. Council.*, 11th Sess., Sec. II : 44-48.

Studies on the fluctuations in the fishery of two species of prawns in the Gautami estuary in relation to the monthly river discharges and the results are discussed.

391. SUBRAMANYAM, M. 1966. Fluctuations in the prawn landings in Chilka lake. *Proc. Indo-Pacif. Fish. Council.*, 12th Sess. IPFC/C66/TECH.

392. SUNDARARAJ, V. N.; SUKUMARAN, S. O.; FELIX; SRIKRISHNADHAS, S. 1988. Some key issues in prawn resource, utilization and management. *Symposium on Tropical Marine Living Resources*, Cochin, India, 12-16, Jan. 1988, Abstract No. 200.

This study deals with the development in prawn production, the cultivable species, suitable areas, technology development, their location and specific adoption with reference to Tamil nadu prawn fishery.

393. SUSEELAN, C. 1985. Studies on the deep-sea prawns off Southwest coast of India. Thesis for doctorate submitted to The University of Cochin.

This is a comprehensive study of the shrimp resources of the deeper waters between 100 and 450 depth along the Southwest coast of India between Cape comorin and Bhatkal (Lat. 7°N-14°N). Thesis is presented in two parts. First part deals with the taxonomy of the deep-sea prawns occurring in the Southwest coast of India. Second part elucidates the resource characteristics and certain aspects of the biology of the important species contributing exploratory catch.

394. SUDARSAN, D. 1977. Prospects of prawn fishery off W. Bengal. *Seafood export J.* 9 (9) : 23-26.

The survey conducted by exploratory fishery project sources shows that prawn fishery got good scope. Important species represented in catch are *P. monodon*, *P. semisulcatus* and *P. indicus*.

395. SUDARSAN, D.; JOSEPH, P. S 1980. On the location of potential prawn fishery ground off the West Bengal coast. *J. Mar. Biol. Assn. India*, 17 (2) : 248-249.

The location of potentially rich fishing ground for prawns off West Bengal during exploratory surveys of M. V. Matsya bagyari is reported. The concentration of prawns appears to be of depths of 60 to 70 m *Metapenaeus ensis* forms an important constituent.

396. SUDHAKARA RAO, G. 1979. Observations on the marine prawn fishery by shore seine at Kakinada. *Indian J. Fish.*, 26 (1 & 2) : 52-64.

This paper deals with the data collected during May 1966 to December 1971 at Kakinada. The catch was composed of *Metapenaeus brevicornis*, *M. monoceros*, *M. affinis*, *M. dobsoni*, *Penaeus monodon* and *P. indicus*. A brief account of prawn fishery by the shore-seiners in the inshore waters is also given.

397. SUDHAKARA RAO, G. 1983. Observations on the seasonal prawn fishery of the little Rann of Kutch during 1980. *Indian J. Fish.*, 30 (1) : 124-134.

The little Rann of Kutch supports lucrative seasonal prawn fishery, principally constituted by juveniles of *Metapenaeus kutchensis*, during the monsoon months. About 2770 fishermen are actively engaged in the fishing cult 307 boats and 160 inf. The existing processing and marketing methods are described along with comments on socio-economics.



398. SUDHAKARA RAO, G.; MOHAMAD KASIM, H. 1985. On the commercial trawl fishery off Veraval during 1979-1982. *Indian J. Fish.* 33 : 296-308.

Estimated annual fish landings by the commercial trawlers at Veraval fluctuated between 22-221 t and 31-380 t during the three years from 1979 to 1982. The catches of individual groups varied at random without any seasonal trend.

399. SUDHAKARA RAO, G. 1988. An appraisal of the fishery of *Metapenaeus monoceros* (Fabricius) along the Kakinada coast. *Symposium on Tropical Marine Living Resources*, Cochin, India 12-16 Jan. 1988. (Abstract No. 7)

It is a review of the work done on the fishery aspect of the prawn *Metapenaeus* along the Kakinada coast. The data for the 12 years period has been analysed and estimated.

400. SUDHAKARA RAO, G. 1988. Mortality rates and stock assessment of *Metapenaeus monoceros* along the Kakinada coast. *Symposium on Tropical Marine Living Resources*, Cochin, India 12-16 Jan. 1988. Marine Biological Association of India. (Abstract No. 68.)

Instantaneous total mortality coefficient (Z) in *Metapenaeus monoceros* has been estimated from the length frequency distributions. Different methods on mortality rates also discussed. Stock assessment by 'surplus yield' model and yield-per-recruit model indicate that the stock is fished just at the optimum level.

401. SUKUMARAN, K. K.; NANDAKUMAR, G. 1983. A potential new resources of prawn from the Kakinada Coast. *Mar. Fish. Infor. Serv. T & E Ser.* 54 : 16-18.

Penaeid prawns form the important prawn fishery in Karnataka. A new species of prawn *M. moyebi* was identified and its biology, size composition and other details are given in this report.

402. SUKUMARAN, K. K. 1985. Night trawling for prawns at Mangalore. *Mar. Fish. Infor. Serv. T & E Ser.* 65 : 7-12,

Study has been made on the estimated landings of different category of prawns and by catches by night trawlers at Mangalore during 1982-83. Various aspect like catch composition, annual area landing, annual income has been covered in this report.

403. SUKUMARAN, K. K. 1985. The prawn fishery of South Kanara Coast with emphasis on the unusual catches of *Metapenaeus dobsoni* by purse seiner and trawls during the first half of September, 1983. *Mar. Fish. Infor. Serv. T & E Ser.* 65.

Prawn production during the first half of September 1983, centre-wise analysis of prawn landings were made in this report. From the landings study has been made on the resources of *M. dobsoni*.

404. SUKUMARAN, K. K. 1987. Monsoon prawn fishery by indigenous gears along the Mangalore coast. *Mar. Fish. Infor. Serv. T & E Ser.* 76 : 1-4.

An appraisal of the prawn fishery by indigenous gears in the monsoon season during 1979-85 is presented in this account. Fishing methods and season, catch trends at Ullal and Ealcapady, species composition, size distribution, sex ratio and maturity are given.

405. THOMAS, M. M. 1972. Studies on Indian Decapods. Doctorate thesis submitted to the Kerala University.

This work has done during the period November, 1966 to November, 1969. In this study the descriptions of 31 species of Penaeid prawns, 5 species of *Hippolytids*, 9 species of *Palaemonids*, 5 species of *Alpheids*, 1 species of *Gnathophyllid*, 31 species of *Diogenid*, 5 species of *Pagurid* and 4 species of *Coenobitid hermitorabs* totalling 92 species belonging to 31 genera are given in the first part of the thesis dealing with the taxonomy.

The second part consists of a section on the biology of *P. semisulcatus* with detailed studies on the food and feeding habits,

length/weight relationship, relative condition factor, gonado-somatic index, age and growth, sex ratio, maturity and spawning, etc., and the other sections dealing with the important features of the fishery of the species in the Palk Bay and Gulf of Manar.

406. THOMSON, JOHN, R. 1967. Development of a commercial fishery for the penaeid shrimp *Hemalopenaeus robustus* on the continental slopes of the *South eastern United States Proc. Symp. Crustacea*, 4 : 1454-1460.

Development of shrimp industry with reference to *H. robustus* in south eastern United States.

407. TRIVED, Y. A.; CHAYA, N. D.; KOSHY, P. K. 1982. Observation on seasonal abundance of prawn seed in Shertrunji estuary at sartanpur, Gujarat India. *Proc. Symp. Coastal Aquaculture*, Held at Cochin from Jan 12 to 18, 1980. Marine Biological Association of India, 1 : 187-189.

A survey of prawn seed resources by shooting net operation in Shetrunji estuary.

408. THAM, A. K. 1968. Unit stocks of shrimps and prawns in the IPFC region and unit fisheries exploiting them. Paper presented to the 12th session *Indo-pacific Fisheries council document IPFC/C66/Wp5*, VIPs, 1967. In *Proc World Scientific Conf. on the biology and culture of shrimps and prawns*, Mexico city, Mexico, 12-21 June 1967. *FAO Fish Rep. 57 (3)* : 1041-1054.

This paper dealt with the study on the stock assessment and unit stocks of shrimps and prawn in IPFC Region.

409. THAM, A. K. 1968. Prawn culture in Singapore. In *Proc World Scientific Conf. On the biology and culture of shrimps and prawn*. Mexico city, Mexico, 12-21 Jul, 1967. *FAO Fish. Rep 57 (2)* : 85-94.

Different aspects of prawn fishery in Singapore has been discussed.

410. UNAR, M.; NAAMIN, N. 1984. Review of the Indonesian shrimp fisheries and their management. *Gulland, J. A. and Rothchild, B. J.* (Ed). *Penaeid shrimp-their biology and management*. 104-110.

Management of shrimp fisheries, including increase of fish production, improvement of livelihood of fishermen employment opportunities and the maintenance of the biological yield of the resources are discussed.

411. VENKATARAMAN, R.; CHARK, S. T.; SRINIVASAN A. 1955. Some aspects of preservation of prawns in Madras. *Proc. Indo-Pacif. Fish. Counc.* 6 (3) : 434-438.

Various methods of curing and preservation are described. The nutritive value of different prawns and the methods of capture and transportation are given.

412. VIRABHADRA RAO, K.; DORAIRAJ, K. 1974. Shrimp resources on the continental shelf as revealed by trawler landings from offshore waters of India. *Proc. Living Resources Seas around India CMFRI Special Publ.* P 596-613.

An account of the region-wise shrimp landings by the trawlers operating from Bombay, Karwar, Mangalore, Cannanore, Cochin, Mandapam, Tuticorin, Visakhapatnam and Calcutta bases during the years is given. The catch per hour of shrimp by the trawlers is taken as the basis for the determination of area-wise and regional abundance. Productive areas, which had given fairly constant high catch rates in different regions have been charted. In the west coast the catch rates were found to increase north to south from Kutch to Cochin. Productive areas occurred on the continental shelf in Gulf of Cambay, off Bombay, Ratnagiri, Vengurla-Dabhol, Karwar, Mangalore, Cannanore, Cochin and Alleppey. On the east coast, the shrimp catches were comparatively few. However, some productive prawn grounds were located off Tuticorin, Mandapam, Kakinada and Visakhapatnam. In west Bengal also fairly productive grounds were recorded from the Eastern Channel off Debi-Prachi rivers and the Western Channel.

413. VIRABHADRA RAO, K.; DORAIRAJ, K. 1969. Prawn records of the continental shelf fished by trawlers. In prawn fishery of India *Bull-Cent. Mar. Fish. Res. Insti* 14 : 217-234.

Prawn landings in the north western, south western division south eastern and north-eastern division are described.

414. VENKATARAMAN R.; SAMBANDA MURTHY P S.; MAHADEVAN S. 1958. Some preliminary observations on the prawn catches off Punkayal near Tuticorin. *Proc. Indian Sci. Congr.* 45th Sess. 3 : 374.

Prawn fishery, Sex composition, biometrical values, hydrography of the ground described.

415. VILLEGAS, L.; DRAGOVICH, A. 1984. Guianas-Brazil shrimp fishery, its problems and management aspects. *Gulland, J.A. and Rothschild, B. J* (ed) *Penaeid shrimp - their biology and management*: 60-70.

The main problems related to the management of the Guianas-Brazil shrimp fishery is in view of the existing knowledge on the fishery and the socio-economic conditions prevalent in the region.

416. WALKER, R. H. 1984. Australian prawn fisheries. In : *Penaeid shrimps- their biology and management* by *Gulland J. A. and Rothschild, B. J.* Fishing news Books Limited, London P. 36-48.

Production of penaeid shrimp (prawn) in Australia doubled in the decade to 1980, reaching out 20000 tons. Catches are taken throughout most of Australia, but the main fisheries of the west coast is from Sydney to northern Queensland.

417. WILLIAMS, G. C. 1985. The Torres strait prawn fishery. In : *Proc. Torres strait fisheries seminar*, ed. by A. K. Haines, G. C. Williams, D. Coats. P. 233-238.

A brief account of prawn activity in Torres strait based on observations.

418. WILLIAM, R.; GARCIA, S. M. 1985. A bio-economic model for the analysis of sequential artisanal and industrial fisheries for tropical shrimp (with a case study of surinam shrimp fisheries) *FAO Fish. Tech. Pap.*, (270) : 49 p.

This paper presents the design and the parameters of a bio-economic of sequential artisanal and industrial fisheries for tropical shrimp.

419. WILLIAMS, A. B. 1968. Penaeid shrimp catch and heat summation: An apparent relationship. In : *Proc. world scientific conf. On the biology and culture of shrimps and prawns*, Mexico city, Mexico, 12-21 June 1967. *FAO Fish Rep.* 57 (3) : 643-656.

Commercial catches of penaeid shrimps in the south eastern United States fluctuate seasonally and annually in patterns intimating dependence on warm annual catch effect indices treated as dependent on four types of heat summation, calender year, plus proceeding.

420. WOOD-MASON, J. ALCOCK, A. 1891. Natural history notes from H. M. Indian Mnrine Surveying Steamer "Investigator" Commander R. F. Hoskyn, R. N Commanding. No. 21, Notes on the results of the last seasons deep sea dredging. *Ann. Mag. Nat. Hist.*, Ser. 6 (7) : 186-202.

421. YEEDA, E. 1987. Twin trawling. A boon to the shrimp industry. *Fishing chimes*, 2 (10) : 22-25.

Projects of shrimp industry, trawling methods and development are discussed.

422. ZALINGE, VAN, N. P. 1984. Shrimp fisheries in the Gulf between Iran and the Arabian Peninsula. Gulland, J. A. and Rothchild, B. J. (ed) - *Penacid shrimp - their biology and management* : 71-83.

Data collection and analysis and in stock assessment through national and regional activities are viewed.

#### IV. PRAWN CULTURE

423. ABDUL KADIR, P. M ; RAMAN, K., MUNAXAR SULTANA. 1982. Notes on some aspects of the biology of *Macrobrachium rude* (Heller) from the Pulicat lake, India. *J. Inland Fish. Soc. India*, Vol. 14 (2): 80-91.

A few aspects on the biology of *Macrobrachium rude* of Pulicat lake, have been studied. The relationship between the total length and carapace length and viceversa were estimated. The length-weight relationship was determined by the general formula  $\log W = a + n \log L$  and it was found that the increase in weight was slightly higher than the cube of lengths. Sex ratios were worked out for different years, months, and length groups, showed different variations. Number of eggs carried by females varied from 316 to 38123 depending upon different sizes. Ripe ovary weight varied from 0.010 gm to 800 gm as per the size of the prawn. Berried and spent females were observed in all the months in which they were available. Repeated breeding of the species was observed. Their distribution has been briefly discussed.

424. ACHUTHANKUTTY, C. T. 1987. Commercially important penaeid shrimp larvae in the estuaries of Goa. *Mahasagar*, 20 (4) : 217-234.

Larval stages of *Metapenaeus dobsoni* (Miers) *M. affinis* (Milne-Edwards) and *Penaeus merguensis* De Man were mostly distributed at the lower reaches of Mandovi and Zuari estuaries. While *M. dobsoni* and *M. affinis* were encountered largely during the postmonsoon season, and *P. merguensis* was abundant during the pre-monsoon season, Zuari estuary had a higher density of larvae of all the three species. Larval distribution indicated continuous breeding in *Metapenaeus*. In the case of *P. merguensis*, breeding was found to be discontinuous with a principal peak during February. Larval stages of all the species were either poorly distributed or absent during the monsoon season. Their abundance in the estuaries was found to be a reliable tool for studying the breeding behaviour of adults in the sea.

425. AHAMAD ALI, SYED. 1982. Relative efficiencies of pelletized feeds compounded with different animal proteins and the effect of protein level on the growth of the prawn *Penaeus indicus*. *Proc. Symp. Coastal Aquaculture*, held at Cochin Jan. 12 to 18, 1980. Marine Biological Association of India, Part 1 : 321-328.

An attempt has been made to study the relative efficiencies of some of the locally available animal protein materials to be included in prawn diets and the protein requirement in the feeds in terms of the raw materials for the culture of *P. indicus*.

426. AHAMAD ALI, SYED. 1982. Effect of carbohydrate (starch) level in purified diets on the growth of *Penaeus indicus*. *Indian J. Fish.* 29 (122) : 201-208.

Four purified diets were formulated using casein, gelatin, starch, fish oil, groundnut oil, vitamins, minerals and cellulose. The carbohydrate in the diets was increased from 10 to 40% by varying the starch content to study the effect of dietary carbohydrate level on the growth, survival and food conversion of the prawn *Penaeus indicus*. The protein and the lipid contents were kept constant in all the diets. Feeding experiments conducted in the laboratory on the juvenile *P. indicus* indicated that the growth of prawn increased with increase in the dietary carbohydrate level from 10 to 40% (P 0.01). The food conversion efficiency and the rate of survival improved with the increase of carbohydrate level in the diet. The growth also increased with the increase of carbohydrate calorie ratio, while it was better with lower protein carbohydrate ratio of the diets.

427. AHAMAD ALI, S.; MOHAMED, K. H. 1985. Utilization of prawn waste and mantis-shrimp for compounding feeds for the culture of penaeid prawns. *Harvest and post harvest Technology of fish, Society of Fisheries Technologists, Cochin, India* : 615-618

The nutritional values and characteristics of prawn waste and Mantis shrimp, low cost animal protein sources as feed ingredients have been discussed and detailed methods of preparation described.



428. AHAMAD ALI, S; AND SIVADAS, M. G. 1983. Compounded feeds for post larval rearing of marine prawns. *Proc. National Symp. shrimp seed production and hatchery management*, 21-22, Jan. 1983, Cochin p. 159.

Attempts have made to develop compounded feeds for rearing different stages of prawn at the Narakkal Prawn culture Laboratory of CMFRI.

429. AHAMAD ALI, S. 1988. Water stability of prawn feed pellets prepared using different binding materials with special reference to tapioca. *Indian J. Fish.* 35 (1) : 46-51.

This is an attempt to study the quantitative loss of prawn feed pellets prepared using selected binding agents with special reference to tapioca.

430. ADISUKRESNO; SUKOTJO. 1977. Preliminary study on the culture of the freshwater prawn (*Macrobrachium rosenbergii*) *Bull Brackish-water. Aquicult. Dev. Cent* , 3 (1 & 2) : 227-236

Experiments on the culture of *Macrobrachium rosenbergii* were conducted at the Brackishwater Aquaculture Development Centre, Jepara. One of the experiments was conducted in plastic pools with sandy garden soil on the bottom, with three treatments and two replications: fed with pellet feed, fertilized order and the last was fertilized and fed on pellet feed. Based on prawn survival and growth the culture with the last treatment gave the best result. The other experiment was conducted in 800 m<sup>2</sup> pond which were fertilized and fed irregularly. This produced approximately 500 kg/ha/yr.

431. ADISUKRESNO, SUKOTJO, 1980. "Field test of *Macrobrachium rosenbergii* (de Man) in Central and East Java, Indonesia", by Sukotjo Adisukresno, Gregorio L. Escritor, Djoko Tribawono and Budi Wijarsno. *IV: Giant Prawn an international conference on Macrobrachium farming Bangkok, 1980 Proceedings Stockholm, Sweden*, International Foundation for Science. p. 520-535. (International Foundation for Science. Provisional report, no 9)

Field tests conducted in Central and East Java provinces to the farmers prove that the newly introduced *Macrobrachium rosenbergii* was profitable and technically acceptable are described. The test ponds varied from 600 sq. m. to 2,000 sq. m. in area, and stocking rate varied from about 1.5 to 5.8 juveniles/sq. m. Mono and polyculture with finfish were carried out in the test. Prawns were fed with rice bran and chicken broiler *starter* on varying amount. The culture period was 3 to 7 months and the yield correspondingly ranges from 516 kg to 2,240 kg/ha yr with survival rate of 22-73%.

432. ALIKUNHI, K. H.; HAMEED ALI, K. 1980. Induction of maturation and spawning in pond-grown stocks of penaeid shrimps for large scale seed production. In: National Symposium on Shrimp Farming (1st: 1978: Bombay). Proceedings, Cochin: Marine Products Export Development Authority. pp. 31-36. (Abstract only)

Controlled breeding of penaeid shrimps based on pond grown male spawners collected from the wild is subjected to serious fluctuations depending on the breeding season, the weather and availability of spawners. To ensure planned year round production of stocking material, spawners should be available through out the year. The first successful attempts at induction of gonadal maturation and spawning in pond grown stocks of penaeid shrimps was reported by Alikunhi *et al.* in 1975.

433. ALIKUNHI, K. H. 1980. Role of hatcheries on commercial farming of penaeid shrimps. In: National Symposium on Shrimp Farming (1st: 1978: Bombay). Proceedings, Cochin: Marine Products Export Development Authority. pp. 31-36.

Emphasising the various techniques adopted for shrimp farming, a detailed description of the different aspects for the formation of good hatchery are discussed in this paper. Natural seed resources, controlled breeding, induced maturation and spawning of penaeid shrimps, mass rearing of larvae on artificial feed, are the important components in the formation of a hatchery. A model hatchery and major equipment and supplies at a shrimp hatchery are also given.

434. AL. SHOUSHANI, M.; ABDUL-GHAFFAR, A. R.; SHALASH, I.; ARAR, M. 1983. Mark-recapture experiments on the shrimp *Penaeus semi-sulcatus* in Kuwait waters. *Annu. Res. Rep. KISR*, 1983: 74-76.

Tagged shrimps were released in June and September, 1982. Of 6191 released in June, 9.1% were recaptured in seven to eight months. Of 5847 released in September, 7% were recaptured in five to six months. Majority of recoveries were from the same area of release. The greatest distance between release and recapture during the June experiment was 80 km., representing a minimum migration speed of 1.74 km/day. The greatest distance recorded during the September experiment was 116 km with a minimum migration speed of 1.13 km/day. Growth rates were generally poor and inconsistent for both sexes during the two experiments. Total mortality and fishing mortality during the June release experiment was 8.0-9.0%, and 1.3 and 1.8% for males and females, respectively, whereas it was 7.6% and 7.5%, and 1.3% and 0.9% during the September release for males and females, respectively. (Modified Author's Abstract).

435. ANIELLO, MARK S; TARLOCHAN SINGH. 1980. "Some studies in the larviculture of the giant prawn (*Macrobrachium rosenbergii*)". In: Giant Prawn an international conference in *Macrobrachium* farming Bangkok, 1980. Proceedings, Stockholm, Sweden, International Foundation for Science. p. 50-58. (International foundation for Science, Provisional report, No. 9).

Larval culture of the giant prawn (*Macrobrachium rosenbergii*) was carried out under two different temperature ranges and using clear and "Green water". It was observed that the two tanks in the higher temperature range (27-35°C) gave widely differing results (e.g. 10.6% and 2.9% survival to postlarvae). The mean percentages survival of postlarvae in higher and lower temperature are 6.75% and 3.4%, respectively.

An experiment was also carried out to determine the feasibility of using the cladoceran (*Moina* sp.) as a substitute for *Artemia* as an overnight feed for prawn larvae. *Moina* was found to be not an efficient substitute for *Artemia* based on lower production and survival obtained in the prawns.

436. ANON. 1960. India-Shrimp industry. *Comm. Fish. Rev.* 22(5) : 50-51.

Discusses various aspects of fisheries, landings, fishing fleets, prices, exports and taxes.

437. APPANNA; DEVADATTA. 1942. Comparative studies on the nutritive value of fish and prawn muscle *Curr. Sci.* 11 : 333-335.

The prawn selected for the study are *Metapenaeus parapeenaeopsis* and *Acetes*. The results show that prawn muscle constitute cheap sources of animal proteins and essential minerals such as phosphorus, calcium and iron. Proteins are found to possess high biological value and digestibility coefficient. In the prawn muscles the digestibility coefficient is as high as 87.09 when the level of intake is 10% but is lowered to 73.22 when the level of intake is 10% but is lowered to 73.22 when the intake increases to 15%.

438. APUD, FLORENTINO D; BENAGUA S. H. 1981. Survival, growth and production of *Penaeus monodon* and *P. indicus* at different density combinations with milkfish. *O. Res. Rep. SEAFDEC Aquacult. Dep.*, 5(1) : 5-9.

*Penaeus monodon* and *P. indicus* juveniles were stocked at different density combinations with *Chanos chanos* in 500 m<sup>2</sup> earthen ponds and reared for 3 months. Results indicated that intra-specific and interspecific competition occurred between *P. monodon* and *P. indicus* and were reduced with the reduction in stocking density. Negligible competition existed between *C. chanos* and the Penaeids at high densities. The summary of the experimental results and the competition among the species cultured are tabulated.

439. AQUACOP. 1977. "Observations sur la maturation et la reproduction en captivité des crevettes penaeids en milieu tropical". In : Third Meeting of the working Group on Mariculture of the International Council for the exploration of the sea, Brest, France, 1977 Proceedings. Edited by Michel Girin and Klaus Tiews. Paris. p. 157-178. (Publ. CNEXO (France) (Acetes Colloq.) no. 4 (Text in French).

At the Centre Oceanologique du Pacifique of CNEXO *Penaeus merguensis*, *P. aztecus*, *P. japonicus*, *P. monodon*, *P. vennamei* and *P. stylirostris* were reared and maintained in 12m<sup>2</sup> outdoor tanks.

At temperature between 25° and 32°, a salinity of 35‰ and a pH of 8.2, maturations and spawnings were obtained throughout the year, and several generations were raised (*P. merguensis* F7; *P. aztecus* and *P. japonicus*; F3; *P. monodon*, F2; *P. stylirostris* and *P. vennamei*, F1). In *P. aztecus* and *P. monodon* maturation was induced by unilateral eyestalk ablation.

The animals, behaviour, population and external signs of ovarian development are described. The factors which seemed essential to the proper progress of maturation were the temperature, the light intensity, the food and the state of health of the animals. Although the viability of the eggs was not always satisfying, it seemed, it would be possible in the near future to sustain a commercial operation depending only on captive brood stock.

440. AQUACOP. 1977 "Production de masse de post-larvae de *Macrobrachium rosenbergii* (de Man) en Milieu tropical : unite pilote", in: Third Meeting of the Working Group on Mariculture of the Internal Council for the exploration of the Sea, Brest, France, 1977 Proceedings Edited by Michel Girin and Klaus Tiews. Paris. p. 213-232. (Publ. CNEXO (France) (Actes Colloq.), no. 4) (Text in French).

Since 1973, in a common venture with the Territory of French Polynesia, the CNEXO Centre Oceanologique du Pacifique (Vairao-Tahiti), has set up a new technique for mass production of *Macrobrachium rosenbergii* postlarvae, at an experimental scale : high density (more than 100 larvae/litre) clear water, preliminary treated, daily changed, with daily close controls of the water conditions and of larvae, average production of 50 post-larvae/litre.

A pilot hatchery was set up in the third quarter of 1976. The facilities and the first production, which ended with the stocking of half million post larvae in ponds, are described and analyzed. The results confirm that the technique is reliable and that the production tanks of 1m<sup>3</sup> give as good results as the experimental 800-litre

tanks. The production cost was 16 US \$/ 1,000 P. L. (81 FF) and it looks likely it could be easily lowered to 9 US \$. The plainness of the installation and the close controls of the rearing may enable easy fitting in various conditions.

441. AQUACOP. 1984. Review of ten years of experimental penaeid shrimp culture in Tahiti and new Caledonia (South Pacific). *J. World Mariculture. Soc.*, 15:73-91.

Since 1973, the Centre Oceanologique du Pacifique has been conducting, in its Tahitian and New Caledonian facilities, tropical penaeid shrimp rearings. Up to now, among the different species tested *Penaeus monodon*, *P. stylirostris*, *P. indicus* and *P. vannamei* have been selected and currently cultured for several generations. *P. monodon* is a fast-growing species especially adapted to tropical semi-intensive culture conditions with a 2-3 tons/ha/yr production from postlarvae. *P. stylirostris* is particularly suitable for cultures at lower temperatures (22-28°C). Yield are similar to those obtained with *P. monodon*, and *P. indicus*, a smaller species, easily bred in captivity. In semi-intensive cultures, production is slightly inferior (1.5-2 tons/ha/yr). However, *P. indicus* tolerates high density culture conditions (100/m), though at a lower growth rate (yields, 15 tons/ha/yr). *P. vannamei* excels in intensive systems. Production, obtained in small volumes (10m<sup>3</sup>), averages 40 tons/ha/yr but results in larger volumes (100 to 1,000m<sup>3</sup>) are still lower. (*Author's abstract*).

442. ARAVINDAKSHAN, P. N ; PAULOSE, V. T.; BALASUBRAMANYAN, T; GOPALAMENON, P; KRISHNANKUTTY, M., 1952. On the growth of *Penaeus indicus* experimented in cages at different densities in a selected nursery ground. *Proc. Symp. Coastal Aquaculture*, : Held at Cochin from 12 to 18, 1980 Marine Biological Association of India, Pt I : 398-402

Effect of different densities on the growth of *Penaeus indicus* was studied using cages at Ramanthuruth island. Eight cages of the same size were stocked with different densities prawns, and growth was recorded once in a fortnight for six months. The average growth in the first month in different densities were 28.1, 22.00, 18.6, and 10.4 mm, respectively, which progressively decreased in subsequent months. The relevance of the present experiment in culture practices is discussed.

443. ARIELI, Y. S. SARIG Y. BEJERANO., 1981 Observations on pond growth of *Macrobrachium rosenbergii* at the Ginosar Fish Culture Station in 1978 and 1979. *Bamidgeh*, 33 (2) :57-68

In the context of the relatively short period (180 days) in which the optimal temperature (20°C) for *Macrobrachium rosenbergii* growth is posing a problem in Israel to examine the individual growth rate of prawns stocked at different densities under prevalent climatic conditions. Survival rates were also determined. Preliminary experiments on the resistance of *M. rosenbergii* to Diuron-80, an algicide were also conducted. Average daily growth increment from postlarval stage to 8g size was 0.05-0.08 with no change in growth rate at prawn densities ranging from 4-13 pcs/m<sup>2</sup>. Diuron-80 proved an effective algicide and the recommended range is 1-2mg/l. Economics of *M. rosenbergii* marketing was questionable due to small individual prawn size of less than 40g.

444. ARMSTRONG, DAVID A., 1978 Interaction of ionized and un-ionized ammonia on short-term survival and growth of prawn larvae, *Macrobrachium rosenbergii*. *Biol. Bull*, 154 (1) : 15-13.

The toxicity of ammonia to *Macrobrachium rosenbergii* larvae was tested at pH 6.83, 7.60 and 8.34, and the respective 144 h LC<sub>50</sub> values were 80, 44, and 14 mg ammonia/litre. Toxicity of ammonia was not due solely to the NH<sub>3</sub> molecule. In solutions of different pH and equal NH<sub>3</sub> concentrations, survival was greatly reduced as NH<sub>4</sub><sup>+</sup> levels increased. Retardation of growth was documented in sublethal concentrations of ammonia at 6.8 and 7.6. The average dry weight was about 26% less than that of controls (P less than 0.05) after a seven day exposure. Results are discussed relevant to the culture and maintenance of crustaceans, and it is concluded that ammonia will not pose a substantial threat in adequately managed systems

445. ASOKAKUMARAN UNNITHAN, K. 1985 A guide to prawn farming in Kerala. *CMFRI Spl. Publ.* 21.92p.

With a view to encourage prawn culture in the waste brackish water areas, some ways and means of improving the prevalent culture practices are suggested in this handbook by way of adopting more scientific methods tested and proved in the Institute.

446. BAGES, M.; SLOANE, S. 1981 Effects of dietary protein and starch levels on growth and survival of *Penaeus monodon* (Fabricius) postlarvae. *Aquaculture*, 25 : 117-128.

Several levels of protein (25%, 35%, 45% and 55%) and starch (10%, 20%, 30% and 40%) were combined in seven isolipidic (10%) diets and fed to 14 - day old postlarvae of *P. monodon* stocked in 5.8m<sup>2</sup> tanks at a density of 552/m<sup>2</sup>. Initial live mean weight was 2 mg. Growth was proportional to the amount of protein in the diet and was not affected by the starch content. The protein/starch ratio had an effect on the survival and biomass increase which were higher for the 1.2 to 3.5 range of the ratio. Feeding small postlarvae exclusively on compounded diets gave slow growth. Survival after 55 days was between 39% and 74%. Analyses showed that the dry alginate-bound food particles lost an average of 28% protein and 50% lipid during processing and rehydration prior to feeding. After six hours in seawater, total loss of protein and lipid amounted to 39%-47% and 38%-76%, respectively.

447. BASKAR, T. I. C. J.; ALI, S. A. 1984. Studies on the protein requirement of postlarvae of the penaeid prawn *Penaeus indicus* H. Milne Edwards using purified diets. *Indian J. Fish.* 31 (1) : 74-81.

Six purified diets were formulated and prepared using casein, starch, fish and groundnut oil mixture (1:1 ratio), vitamins, minerals and other additives, with protein content varying from 20-70%, to study the protein requirement of the postlarvae (PL 1 to PL 42) of the prawn *Penaeus indicus*. Results are reported to have indicated that the growth of group 1 (PL 1 to PL 10) increased with increasing protein requirement was between 30-50%. In group 3 (PL 27 to PL 42), maximum growth was obtained at 30% protein, P. 0. 05). It is concluded that dietary protein requirement of postlarvae decreased from 40% to 30% as they grew to advanced stages. (*Modified author's abstract*).

448. BAUTISTA, M. N. 1986. Response of *Penaeus* juveniles to varying protein/energy ratios in test diets. *Aquaculture*, 53: 229-242.

Two sets of factorial experiments were conducted for 8 weeks to determine the response of *Penaeus monodon* Juveniles (average



weights - 0.60 + / - 0.16 g and 0.80 + / - 0.05 g) to diets containing various protein/energy ratios. The first experiment used casein as the sole source of protein, while the other used a combination of 70% 30% casein : gelatin for its protein source. A two-fold increase in the body weight was achieved for prawns diet combinations of 50-50% protein, 5-10% lipid and 20% carbohydrate with energy values of 285-370kcal/100 g, regardless of the protein source used. Reduction in protein content of the diet from 50% to 40% while maintaining the total energy level at 330kcal/100g resulted in a non-significant decrease in growth. The inclusion of 15% lipid in the diet produced adverse effects on the animal while sucrose levels beyond 20% resulted in a decreased growth rate. An increase in energy level, at constant dietary protein level resulted in improved utilization of protein and feed conversion efficiency. Survival of the prawn was higher with diets containing casein as the sole source of protein.

449. BELL, T. A.; LIGHTNER, D. V. 1984. IHHN virus : Infectivity and pathogenicity studies in *Penaeus stylirostris* and *Penaeus vannamei*, *Aquaculture*, 38 : 185-194.

Infectivity studies of infectious hypodermal and hematopoietic necrosis virus (IHHNV) were conducted on *Penaeus stylirostris* and *P. vannamei* (representing species highly refractory to the disease) via intramuscular injections of the virus. Distinctive histological lesion patterns were observed between species. Six target organ systems were compared interspecifically. The gills and nerve cord / ganglia were shown to undergo significantly higher degrees of tissue damage in infected *P. stylirostris* compared with infected *P. vannamei*. Pathogenetic differences correlated well with observed differences in epizootiology between the two species.

The infectivity study confirmed that IHHN disease is virus-caused. Cell free extracts from IHHNV infected shrimp, when injected into healthy, susceptible shrimp, produced mortalities and Cowdry type A intranuclear eosinophilic inclusion bodies presently considered pathognomonic for the disease.

450. BENSAM, P. 1982 Some problems in commercial culture of marine prawns in India. *Proc. Symp. Coastal Aquaculture*, 1:251-253.

Some common problems that were confronted in the culture of marine prawns in India are reviewed and solutions are suggested.

451. CACES-BORJA, PRISCILLA; RASALAN, S. B. 1966. Review of the culture of Sugpo, *Penaeus monodon* fabricius, in Philippines. Proc. World. Scientific Conf. on the Biology and Culture of Shrimps and Prawns, Mexico City, Mexico, 12-21 June 1967. *FAO Fisheries reports* 57 (2) : 111-123.

The culture of sugpo *Penaeus monodon* (Fabricius) in the Philippines in association with bangos (*Chanos chanos*), which has been carried out for a very long time is reviewed. The sugpo was initially a secondary product and had never been raised alone. But, with the exploitation of the sugpo fry fishery, the more lucrative business of pure sugpo culture was developed. The different methods of catching fry, the selection of site for cultivation, the construction and preparation of a pond and the raising and harvesting of sugpo that are being practiced are described.

452. CASTILLE, F. L.; LAWRENCE, A. L. 1986. Toxicity of erythromycin, minocycline, malachite green, and formalin of the shrimp *Penaeus stylirostris*. *Journal of the World Aquaculture Society*, 17 (1/4): 13 - 18.

The toxicities of erythromycin, minocycline, malachite green, and formalin to nauplii of the shrimp *Penaeus stylirostris* were determined in a static bioassay. Toxicity was assessed on the basis of survival of nauplii after 12 and 24 hours of exposure to the compounds and metamorphosis of the nauplii to protozoa. The results suggested that metamorphosis to protozoa is more susceptible to toxic effects than is naupliar survival. Metamorphosis was either reduced or completely inhibited by lower concentrations of erythromycin, minocycline, and malachite green than was naupliar survival at 12 or 24 hours. Metamorphosis was either reduced or completely inhibited by erythromycin, minocycline, malachite green, and formalin concentrations of 80, 100, 0.08 and 27 mg/L. respectively. Toxic effects were not observed at erythromycin, minocycline, malachite

green, and formalin concentrations of 16,62.5, 0.016, and 2.7 mg/L, respectively. The results suggest that formalin may be toxic at therapeutic levels frequently recommended for post larvae and older penaeids, but that erythromycin, minocycline and malachite green are not

(Author's Abstract).

453. CAUBRE, J. L.; LAFON, R; RENI, F; SALES, C. 1976. Etude de la maturation la Ponte Chez *Penaeus japonicus* en captive. *Advances in Aquaculture* p. 277-284.

This is an attempt to obtain early maturation of postlarval of *Penaeus japonicus* that had been imported from Japan, four batches each consisting of 80 animals were exposed to accelerated increasing photo-and thermoperiods from Dec. 1973. It was possible in this way to obtain repeated maturation from March to October 1974. This maturation led to about 15 depositions of spawn, producing nearly one million nauplii (June-July 1974 and September-October 1974). The postlarvae from this cycle were fattened during the summer of 1974 up to a weight of 12 g on 30 September 1974. It was possible to follow the sexual cycle of the females, evolution of the ratio of gonad size to body size, the macro-and microscopic changes in the gonads, the variations of the electrophoregrams of the haemolymph and finally to the induced and natural spawning of the animals.

454. CAULTON, M. S. 1980. Changes in mass and chemical composition during the moult cycle and ovarian development in immature and mature *Penaeus indicus* Milne Edwards. *Comp. Biochem. Physiol.* 66(43) : 431-437 Eten.

Absolute changes in body composition (mass, water, protein, lipid, ash, energy) during the moult cycle and ovarian development and expressed in terms of standard prawn of given length. During postmoult (A-B) the water content remained approximately constant but increased significantly to reach a maximum at stage Dz. Water was lost with increasing ovary maturation. Changes in fresh mass, protein and lipid followed a similar pattern during the moult cycle but during ovary development, due to water loss, the fresh mass decline; while the mass of the organic body constituents increased. The inorganic body constituents rose sharply from stage A to B of the moult cycle and then remained constant, but did not change during ovary development.

455. CHAIYAKAM, K. 1978. Experimental pond culture of tiger prawn, *Penaeus monodon* Fab. with various stocking rates. *Annu. Rep. Songkhla Fish. Stn.*, 50-60. (Text in Thai)

Pond experiment with tiger prawn, *Penaeus monodon* Fab. was conducted at Songkhla Fisheries Station during March-September, 1978. Post larval shrimps (P18) were stocked in a 400 square meters pond at various stocking rates of 3/m<sup>2</sup>, 9/m<sup>2</sup> and 12/m<sup>2</sup>. The result of the growth rate was 0.40-0.68 mm/day, survival rate was 46.8-82.33%, food conversion rate was 13.76-29.40 and yield was 60.60-143.84 kg/rai. (Author's Abstract).

456. CHEN, H. P. 1979. Report on rearing of the juveniles of gravid *Penaeus monodon* matured by ablation of eyestalk (sic) China Fish. Mon., (319): 15-18.

The growth and survival of *Penaeus monodon* juveniles bred from eyestalk ablated spawner were observed in comparisons with those from natural spawners. The survival rate of the prawn after 152 days was observed to be 73% with size ranging from 10.3-11.7 cm body length and 16-23 g body weight. *Penaeus penicillatus* cultured together with *P. monodon* for 101 days grew to the average size of 11.4 cm body length and 17.5 g body weight. A locally formulated compound feed was given to the prawn throughout the culture period. Trash fish were given occasionally. ((Modified author's abstract).

457. CHEN, J. C.; CHIN, T. S., 1988. Acute toxicity of nitrite to tiger prawn, *Penaeus monodon* larvae. *Aquaculture*, 69 : 253-262.

Larval prawn *Penaeus monodon* exhibited a progressive increase in nitrite tolerance as the larvae metamorphosed from nauplius to the postlarva stage. The 24-h LC<sub>50</sub> nitrite effects on nauplii, zoea, mysis and postlarvae were 5.00 mg/l, 13.20 mg/l, 20.65 mg/l and 61.87 mg/l NO<sub>2</sub>-N, respectively. The 48-h LC<sub>50</sub> values on mysis and postlarva were 8.30 mg/l and 33.17 mg/l NO<sub>2</sub>-N, while the 92-h and 96-h LC<sub>50</sub> values on postlarva were 20.53 mg/l and 13.55 mg/l NO<sub>2</sub>-N, respectively. "A safe level" of nitrite was estimated at 1.36 mg/l NO<sub>2</sub>-N on the basis of 96-h LC<sub>50</sub> for postlarvae while more conservative estimate of a "safe level" is 0.11 mg/l NO<sub>2</sub>-N based on an estimated 96-h LC<sub>50</sub> for nauplii.

458. CHIANG, PETER; LIAO, COIU I. 1986 The practice of grass prawn (*Penaeus monodon*) culture in Taiwan from 1918 to 1934. *J. World Maricul. Soc.*, 16 : 297-315.

Grass prawn (*Penaeus monodon*) culture in Taiwan started more than 300 years ago as a by-product in milkfish (*Chanos chanos*) culture. Since 1968, however, with the success achieved in larval rearing, prawn farming developed into a major aquaculture industry.

On the basis of information gathered from 50 farmers the present status of the industry is given. The prawn hatcheries achieved a state of over-production and the postlarvae prices were driven below cost. The Culture ponds evolved from a primitive low-density type to a well designed high-density type. The formulated feed, its use and its role in the continuing development of the prawn industry, harvesting techniques and processing procedures all that went in the development of the industry are discussed. Prawn diseases remained a problem for some farms and investigation suggested that further research was required in this area.

An economic analysis of cost and profit of both family-run and commercial farms is also presented. A list of fixed and variable costs for operating all types of farms is provided; and relationship between cost and final profit is evaluated. The problems facing the present grass prawn industry in Taiwan as well as some future prospects are also discussed.

459. CHIDAMBARAM, L. 1980. Prawn culture proved highly profitable in Pondicherry. *Mar Fish. Info. Serv. (Tech Ext. Ser.) CMFRI*, (17) : 11.

An experimental prawn culture was conducted on a one-acre natural pond formed by tide, manuring at the start with 500 kg of cow dung. The stocking was by letting in river water at high tide followed by adding a seedstock of 5,000 prawns consisting of *Penaeus semisulcatus*, *P. indicus*, and *P. monodon*. On harvesting after 80 days of culture (till the time the river mouth was closed) 330 kg of prawns, 200 kg of fishes and 50 kg of crabs were obtained.

460. CHIN, T. S.; CHEN J. C, 1987. Acute toxicity of ammonia to larvae of the tiger prawn, *Penaeus monodon*. *Aquaculture*, 66 : 247-253.

The tolerance of larval *Penaeus monodon* to ammonia increased as the larvae metamorphosed from the nauplius to the postlarva stage. The 24-h LC 50 values of ammonia for nauplius, zoea, mysis and postlarva were 6.00, 8.48, 24.04, and 52.11 mg/l ammonia-N (0.54, 0.76, 2.17, and 4.70/mg1 NH<sub>3</sub>-N). The 48-h LC 50 values of ammonia for mysis and postlarvae were 14.39 and 27.73 mg/l ammonia-N (1.30 and 2.50 mg/1 NH<sub>3</sub>-N). The 72-h and 96-h LC 50 values of ammonia for postlarva were 17.05 and 11.51 mg/l ammonia-N (1.54 and 1.04 mg/1 NH<sub>3</sub>-H). A "safe level" of ammonia was 1.15 mg/l ammonia-N (0.10 mg/1 NH<sub>3</sub>-N) on the basis of the 96-h LC 50 value for postlarvae. A more conservative estimate of the "safe level" for rearing larval *P. monodon* was calculated on the basis of an estimated 96-h LC 50 for the nauplius to be 0.13 mg/l ammonia-N (0.01 mg/1 NH<sub>3</sub>-N).

461. CHINEAH, V. 1980 "Recent innovation in the larval rearing technique of *Macrobrachium rosenbergii* (De Man) in Mauritius". In: Giant Prawn = an International conference on Macrobrachium farming = Bangkok, 1980 Proceedings = Stockholm, Sweden, International Foundation for Science. p. 107-111 (International Foundation for Science. Provisional report, no.9).

The improvements made in the larval rearing technique of the giant prawn since 1975 are briefly reported. These include modifications of the larval rearing tanks to facilitate easy and efficient cleaning, introduction of 'clear water' rearing technique, improving the hatching and collection of *Artemia* nauplii and improving the method of preparation of particulate feed. The innovations have substantially contributed towards increasing the production of post larvae.

462. COHEN, DAN; ADRIAN BARNES. 1980 The domestication and commercialisation of the freshwater prawn *Macrobrachium rosenbergii* in Israel's aquaculture: general outlines and specific problems of pond ecology". In: Giant Prawn = an international conference on Macrobrachium farming = Bangkok, 1980 = Proceedings = Stockholm, Sweden, International Foundation for Science. p. 666. 676. (International Foundation for Science. Provisional report, No.9).

The special limitation of freshwater prawn production in Israel, the temperate climate, the limitation of agriculture water and the existing

inland pond infrastructure created a symbiosis between basic research performed at the Hebrew University of Jerusalem and the Kibutz aquafarms. Achievements include the development of a site independent modular recycle-system hatchery. Geothermal and solar heat nurseries which are in commercial use and are being optimized in the laboratory and in the field.

463. CRUZ-RICQUE, L; ELIZABETH; GUILLAUME, JEAN. 1987 Squid protein effect on growth of four Penaeid shrimp. *J. World Aquaculture Soc.* 18 (4) : 209-217.

The growth response to supplementation of mixed diets with a protein extracted from frozen squid (squid protein fractions : SPF) was tested at levels of 1.5, 3.0, 6.0 and 16.4% in the diet in four species of shrimp, *Penaeus stylirostris*, *P. vannamei*, *P. monodon* and *P. indicus*. In *P. stylirostris* and *P. vannamei*, growth rates were significantly improved by SPF even at the lowest level of supplementation. Improvement was obtained only with 6 and 16 percent in *P. indicus*. The growth promoting effect of SPF at 16% of the diet could be explained by its nutritional value, particularly by its amino acid content, although all diets were supposed to be well balanced in all known nutrients. However, at lower levels the results obtained seemed to be due to the unknown growth factor (UGF) already mentioned in previous reports.

464. DALL, W. 1985. A review of penaeid prawn biological research in Australia. IN : Second Australian National Prawn Seminar. Ed. Rothlisberg, P. C; Hill, B. J; Staples, D. J. Queensland, Australia, p 11-21.

By 1974 the present day penaeid fisheries were almost fully developed in New South Wales (NSW) (*Penaeus plebejus*, *Metapenaeus macleayi*); Queensland (*P. plebejus*, *P. esculentus* and lesser commercial species); Northern Territory (*P. merguensis*, *P. esculentus*, *P. semisulcatus* and lesser commercial species); Western Australia (*P. latisulcatus* *P. esculentus*); South Australia (*P. latisulcatus*). Research groups existed in all these areas and most of the research was on problems directly related to management-defining fisheries, population dynamics including tagging studies, recruitment of juvenile prawns and reproductive biology.

NSW had established the Brackish Water Fish Culture Station at Port Stephens in 1971, which included major studies on *M. macleayi*. In 1974, the Commonwealth Scientific and Industrial Research organization (CSIRO) phased out the East Coast Prawn Project (mainly on *P. plebejus*) and the Northern Prawn Project (*P. merguensis*) and started the Tropical Prawn Research Project. The latter aimed to study those aspects of prawn biology which affect the yield of the fishery, namely larval, juvenile, adult ecology, population dynamics, feeding and nutrition, behaviour and physiology. The ensuing decade saw an overall maturing of prawn research in Australia. Various projects in universities were started on prawn ecology, behaviour and larval development and CSIRO started a field project on *P. esculentus* and *P. semisulcatus*. Major achievements have been in larval and postlarval biology, juvenile recruitment into the fishery and prediction models, population dynamics, tagging and migration, and aspects of behaviour and physiology. In addition to these applications, the research provided management with the information necessary for the nursery ground and seasonal closures and optimisation of yield. (Author's abstract)

465. DALL W SMITH, D. M. 1986. Oxygen consumption and ammonia-N excretion in fed and starved tiger prawns. *Penaeus esculentus* Haswell. *Aquaculture*. 55 (1) : 23-33.

Prawns, 17.7 plus or minus 0.25g wet weight, were held at 25°C (full moulting cycle at this size, 18-20 days) until 2 days after moulting. Groups of seven, eight or nine were then starved for 5, 10 or 15 days, respectively. Control groups of seven prawns each were fed ad lib for the same periods. The oxygen consumption and ammonia-N excretion over 24h of each prawn was measured, using antibiotics to minimise bacterial growth during the excretion measurements. Oxygen consumption fell sharply by 24-29% during the first 5 days of starvation and then levelled out. Ammonia-N excretion increased 46-73% with starvation. O:N ratios fell to about 7:1 after the first 5 days of starvation and remained at this level up to 15 days, indicating that protein is virtually the only energy substrate under these conditions. These results support previous research that showed that the carnivorous *P. esculentus* uses muscle protein preferentially as a source of energy during starvation. In fed prawns, O:N ratios were also low (13.6-16.4:1), indicating that protein is normally a major source of energy. (Author's Abstract).



466. DALLA VIA, G. J. 1986. Salinity responses of the juvenile penaeid shrimp *Penaeus japonicus*. I. Oxygen consumption and estimations of productivity. *Aquaculture*, 50 (4) : 297-306.

The oxygen consumption of *Penaeus japonicus* was measured in relation to low salinity stress and crowding. Within 48h, *Penaeus japonicus* shows no mortality in a salinity range of 25-40 ppt and a mortality of only 25-39% within a salinity range of 10-55ppt. With a change in salinity from 37 ppt to oxygen consumption increases rapidly to 300% of the initial value and stabilizes at 200 % after a few hours. After the initial conditions are restored, oxygen consumption remains raised for at least 6h. The calculated loss of productivity caused by a reduction of salinity can amount to 33% of total animal weight. Crowding also increases oxygen consumption at a stocking density above 400 postlarval prawns/m<sup>2</sup>. In consequence, a stable environmental salinity range of 30-40 ppt and low stocking densities are recommended for extensive aquaculture. (Author's Abstract).

467. DALLA VIA, G. J. 1986. Salinity responses of the juvenile penaeid shrimp *Penaeus japonicus* II. Free amino acids. *Aquaculture*, 55 (4) : 307-316.

The free amino acid (FAA) of juvenile *Penaeus japonicus* were measured after 48h of exposure of the shrimps to hypo- and hyperosmotic salinity stress. The concentrations of FAA decreased linearly with decreasing salinity from 50 ppt. to 10 ppt. The highest amounts of individual FAA in seawater-adapted *P. japonicus* are exhibited by glycine (51%), followed by taurine (14%), arginine (10%), proline (9%), and alanine (6%). The main osmoeffectors are glycine, proline and alanine, which together lower the FAA pool by 80% after a hypoosmotic shock from 40 to 10‰. The concentrations of taurine, arginine, ornithine and glutamate are not affected by external salinity change. Under hypoosmotic conditions taurine, glutamate, and arginine decreased by only 13-15%, and aspartate, ornithine, and lysine by 28-24%. All other amino acids in the FAA pool are reduced by 50 to 88% - the greatest loss is shown by proline (by 96%). Below 25‰ intracellular volume regulation is maintained entirely by proline and glycine, whereas the other FAA concentrations remain more or less constant. After hyperosmotic shock, the concentrations of nearly all FAA increase. This is also true for the essential FAA (+80%) - indicating protein hydrolysis. A salinity range between 25 ppt and 40 ppt is recommended for the extensive aquaculture of *P. japonicus* (Author's Abstract).

468. DAS, N. K.; GHOSH, A. N; CHAKRABARTI, N. M. 1982. Food of some penaeid prawns in relation to their culture in Brackishwater ponds of Sunderbans. Proc. Symp. Coastal Aquaculture, 1 : 202-205.

The food of *Penaeus indicus*, and *P. monodon* in the length range of 21-120 mm and *Metapenaeus monoceros* and *M. brevicornis* in the length range of 21-100 mm cultured in brackishwater ponds was studied. The major food of these prawns consisted of Bacillariophyceae or diatoms, Myxophyceae or blue-green algae, crustacean and plant parts in the order mentioned.

In *P. indicus* Bacillariophyceae (53.48-83.43%), plant parts (1.25-26.92%) and crustaceans parts (1.26-17.74%) constituted the main food. In *P. monodon*, Bacillariophyceae (43.78-95.87%) formed main food upto the size of 80 mm while plant parts (2.28-44.0%) and the Myxophyceae (1.43-26.0%) observed in the stomach contents of the specimens ranging from 21 to 120 mm size. Crustaceans (semi-digested) parts were found as food item of prawns of the size of 60 mm and above.

Consumption of Bacillariophyceae were observed to maximum both in *M. monodon* and *M. brevicornis* forming 54.03. - 83.74% and 31.0-60.71% of food material for the above species respectively. Among the next items, plant parts (11.50-31.29%) for *M. monoceros* and crustaceans parts (12.20-31.99%) for *M. brevicornis* constituted the major portion of food.

469. DAVE, H.B; BHASKARAN, M; CHAYA, N. D.; MULIA, K. D. 1982. Results of a pilot survey for prawn and Mullet seeds at Jodiya, Gujarat, India. Proc. Symp. Coastal Aquaculture, Cochin, January 12-18, 1980 Marine Biological Association of India, Cochin pt. 1 : 183-186.

The availability of prawn and mullet juveniles at Jodiya, where a brackishwater fish farm was coming up is briefly presented. *Penaeus merguensis*, *Metapenaeus brevicornis* and *M. kutchensis* were the dominant species of which the juveniles were in the creek around the farm site. Juveniles of *Macrobrachium rosenbergii* were also noted in sizable quantity during restricted period of year. Ecological parameters such as water temperature, salinity and pH observed at the time of collection are presented with a view to correlate any.

470. DAVID KAHAN. 1982 Mass cultivation of food organisms in hatcheries, problems and proposed solutions. *Proc. Symp. Coastal Aquaculture*. Cochin, January 12-18, Marine Biological Ass India, Cochin p. 314-320.

Though various organisms, unicellular and small invertebrates (mostly copepods) had been found to be efficient as the diet of the hatchery larvae, only a few *Artemia salina* and *Brachionus plicatilis* were used with success. Relatively early available *Artemia* nauplii, however, were not always suitable for the small-mouthed fry and the cultivation of *B. plicatilis* was laborious and expensive.

So, alternation or such as copepods are, pointing out their advantages. The results of some experiments to raise some of these are given.

471. DEJARME, HENRY E.; JAIME B. DOMINISAC SONIA M. DEJARME. 1980. "Notes on spawner collection methods and larval rearing of giant prawn *Macrobrachium rosenbergii* (de Man) at MSU-IFRD Station, Naawan, Misamis Oriental Philippines". In: Giant Prawn—an international conference on *Macrobrachium* farming Bangkok, 1986 Proceedings Stockholm, Sweden, International Foundation for Science. Provisional report, no. 9

The methods of collection of adult giant prawns (*Macrobrachium rosenbergii* de Man) from Panguil Bay using local collecting gears such as cast net (laya), motorized push net (sudsod), hartier net (panira) and fish corral (bungsod) are presented with description of each gear. The prawns caught were generally in good condition and fit for transport except those caught by motorized push net. A total of 66 berried females, 46 non-berried females and five males were transported to the Mindanao State University. Institute of Fisheries Research and Development at Naawan, Misamis Oriental, Philippines between 1976 and 1979.

About 380,060 larvae that hatched out in 14 batches from berried females were reared in brackish greenwater and fed fish flesh (*Katsuwonus pelamis*): brine shrimp (*Artemia salina*) nauplii and rotifer (*Brachionus* sp.). Mass mortalities in various stages of larval development characterized most larval rearing attempts but around 120 larvae were able to metamorphose to postlarval stages in 39 days. Infestation of *Epistylis* sp. and various physicochemical parameters such as high ammonia nitrite level and low water temperature, etc. are suspected to have caused the mortalities.

472. DJAJADIREDA, RUSTAMI; HAMISH H. SUHARTO, 1980. "Notes of results of *Macrobrachium rosenbergii* culture in ponds, in Indonesia". In: Giant Prawn an international conference on *Macrobrachium* farming Bangkok, 1980 Proceedings stockholm, Sweden, International Foundation for Science. Provisional report, no. 9).

In the three years, of experiment polyculture of giant prawn (*Macrobrachium rosenbergii* de Man) gave biomass production higher than in monoculture, but lower survival rates and smaller sizes of prawns. In polyculture, where the stocking density of prawns was 24 per m<sup>2</sup> and the average production of prawn was 213 kg and that of Java carp 313 kg per period. The average gain in prawn biomass under monoculture in 4 different localities was 399.8 kg (range 385-439). Recoveries of initial prawn stocking varied from 39.2% to 83.6% in ponds. Average prawn weight was 22.9 g (range 13.0-32.0 g).

When freshwater prawn stocked at an average weight of about 0.11 g and at a density of 2/m<sup>2</sup> in two ponds of 600 sq. m containing carp fry (*Cyprinus carpio* L) and nilem (*Osteochillus hasselti* C. v.) were reared for 4 months the biomass averaged 246 kg/ha with individual weight of 35.3 g.

In two rice fields of 1984 m<sup>2</sup> and 1218 m<sup>2</sup> where intensive culture was no sudden mortality of prawn due to diazinon sprayed for rice peste control was observed. Recoveries of initial prawn stock was 50.8% and 31.4%. The results of observations are discussed.

473. DJUNAIDAH, I. S. ; SAIMUN S.; ADIWIDJAJA, D. 1984. Effect of of R1 and R2 formulation to the growth rate and survival rate of *Penaeus monodon* in the experiment. (Pengaruh makanan buatan R1 Diet I&II dan R2 Diet I & II terhadap pertumbuhan dan survival rate udang windu (*Penaeus monodon*) dalam back-back perchobaan). Jepara, Balai Budidaya Air Payau. 10p. (Text in Bahasa).

Feed formulation of R1 and R2 was given to *Penaeus monodon* larvae at stage PL 15 to investigate growth rate and percentage survival. Feed was administered three times daily at 50% body weight. Results indicated good growth in prawn fed with R2 formulation and better survial for prawns given R1 formulation (Modified Author's Abstract).

474. DJUNAIDAH, I. S.; SALEH, B. 1986. Growth and survival rate of *Penaeus monodon* postlarvae given four different formulated feeds. *Bull. Brackishwat. Aquacult. Dev. Cent*, B (1) : 20-24.

Four kinds of feed formulae (A&D) were tested in the wet laboratory of the Brackishwater Aquaculture Development Centre (BADC) Jepara to find out their effect on growth and survival rate of *Penaeus monodon* postlarvae (PL6-PL-36). From the observation on growth and survival rates of the larvae within one month of rearing experiment it could be concluded that treatment D, which was composed of fish meal 40%, soy meal 35%, wheat flour 9%, aquamix 2% alginate 2.5%, calgon 1%, soy waste meal 10.5%, showed the best result (Author's Abstract).

475. DE LA CRUZ, C. R.; GUERERO, L. A.; BOLIVAR, H. L. 1984. Development of techniques for rearing giant freshwater prawn (*Macrobrachium rosenbergii* de Man) in hatchery tanks and earthen ponds. *Fish. Res. J. Philipp.*, 9) (1/2) : 84-90. 2 tables.

Larval rearing trials were done in the laboratory to develop hatchery techniques of giant prawn, *Macrobrachium rosenbergii*, Hawaiian strain for the Philippines from the 1981 to 1983. Berried female prawns collected from the Freshwater Aquaculture Center of Central Luzon State University broodstock ponds hatched their eggs in aquaria. Larvae were given brine shrimp, *Artemia salina*, egg custard, minced mussel and tilapia flesh feed. Water quality requirements in rearing larvae using green water and clear water media were also monitored. The larvae metamorphosed to post-larvae in varying periods, the shortest was 23 days and the longest, 43 days. As of July 1983 the production of post-larvae (PL) had improved to 40 per cent or 21 PL per Liter. Post-larvae produced were stocked in 500m<sup>2</sup> ponds and after six months of rearing, the sampled prawn had attained mean body weights of 24.8 g and 56.1 g each in the two ponds.

476. EMERSON, W. D.; 1983. Maturation and growth of ablated and unablated *Penaeus monodon* Fabricius. *Aquaculture*, 32 : 235-241.

Both single-eyestalk-ablated and unablated *Penaeus monodon* were induced to spawn domestically under reduced light conditions. Ablated

females developed their ovaries almost immediately, whereas unablated females took 1-2.2 months or two or three moult cycles to develop, and often never beyond ovarian stage 3. Ablated females spawned up to four times per moult cycle and unablated up to three times. Most of the spawns were first ones in the moult cycle from 36.4% for ablated females to 67% for the unablated ones. The average moult cycle duration for unablated spawners (28 days) was slightly longer than for ablated females (26 days) but this was not statistically different. Moult cycle duration increased with increasing female mass although correlation was poor ( $r=0.38$ ). Generally females smaller than 120 g gained mass, while females larger than 120 g lost mass. Suggestions to improve mass loss are given. A 1:1 male:female ratio did not appear to be adequate (unviable ova) so that this ratio could be increased or the "male tank" method of Board and Wickins (1980) could be employed, (Author's Abstract).

477. EMERSON, W. D. 1984. Predation and energetics of *Penaeus indicus* (Decapoda: Penaeidae) larvae feeding on *Brachionus plicatilis* and *Artemia nauplii*. *Aquaculture*, 38: 201-209.

*Brachionus plicatilis* and *Artemia nauplii* were fed to a number of larval stages of the penaeid prawn *Penaeus indicus* to determine ingestion rates, larval energy requirements and to establish at which state larval predation commenced. The raptorial feeding rates were then contrasted on an energy basis with filter feeding mechanisms. *Brachionus* was first eaten as early as protozoa 1 to protozoa 2, while the maximum ingestion rate of 300 rotifers larva<sup>-1</sup>d<sup>-1</sup> (1.06 J larva<sup>-1</sup>d<sup>-1</sup>) was obtained during protozoa 3 to Mysis 1. *Artemia* were effectively ingested by *P. indicus* protozoa 3 (4.1 J larva<sup>-1</sup>d<sup>-1</sup>) to post-larva (8.2 J larva<sup>-1</sup>d<sup>-1</sup>). Daily energy intake rate from filter feeding increased from 1.1 J larva<sup>-1</sup>d<sup>-1</sup> during protozoa 1 to 2.66 J larva<sup>-1</sup>d<sup>-1</sup> during the post-larval stage. This decline in energy intake from filter feeding with a concomitant increase in energy intake from *Artemia* predation demonstrates a predominant feeding mode changeover point during mysis 3. Energy intake was consistently low with *Brachionus*, indicating that it may be unnecessary for commercial culture purposes.

478. FENNUCIL, J. L.; FENNUCIL, A. C.; LAWRENCE, A. L.; ZEIN-ELDIN, Z. P. 1982. Assimilation of protein and carbohydrate from prepared diets by the shrimp, *Penaeus stylirostris*. *J World Maricult Soc.*, 13 : 134-145

Assimilation (apparent digestibility and absorption) of protein and carbohydrate from selected diets was tested using *Penaeus stylirostris*. The largest shrimp (approximately 10 g) assimilated squid meal proteins better than a-soy protein but smaller shrimp (1.3 and 3.8 g) did not. All sizes assimilated protein from diets containing a-soy better than those containing brewer's yeast. Carbohydrate assimilation was less efficient than protein for all diets. There was no relation between carbohydrate and protein assimilation and the percentage in the diets over the limited range tested. Although assimilation of these two groups of compounds was greater in the larger shrimp, there was no correlation between the growth and protein and carbohydrate assimilation for the diets tested for similar size animals of the same species.

479. FUJINAGA, MOTOSAKU. 1969. Kuruma shrimp (*Penaeus japonicus*) cultivation in Japan. In: Proc. World Scientific Conf. on the Biology and Culture of shrimps and prawns, Mexico City, Mexico, 12-21 June 1967. *FAO Fish. Rep.* 57 (2) : 811-832.

The history of Kuruma shrimp cultivation in Japan is traced from the first attempts to rear *Penaeus japonicus* in the laboratory in 1933 to the large-scale commercial rearing practiced in 1967.

Successful rearing on a large scale was first achieved in indoor tanks, using culture of the diatom *Skeletonema costatum* as food for the zoeal stages, *Artemia* nauplii for the mysis and postlarval stages and crushed clam meat for the juvenile stages. The scale of operations was greatly increased and the cost of production lowered by using large outdoor tanks filled with natural seawater to which nutrient salts were added. The resulting bloom of phytoplankton made the separate culture of diatoms unnecessary, and wild zooplankton and benthos developed to a considerable degree, so that only relatively small amounts of *Artemia* and clam meat need be added.

480. FRUSHER, S. D.; GWYTHER, D.; LINDHOLM, R. 1985. Growth of the banana prawn, *Penaeus merguensis* de Man. as estimated from tagging studies in the Gulf of Papua. *Austr. J. Mar. Freshw. Res.* 36 (6) : 793-796.

To estimate the growth parameters of the banana prawn, *P. merguensis*, a tag-recapture study, using vinyl streamer tags (Floy FTSL-73), was undertaken throughout the northern Gulf of Payua. Recapture data were analysed using Fabens' derivation of the von Bertalanffy growth curve. A differential growth rate was found between male and female banana prawns:  $L_{\infty}$  and  $K$  values for males were 29.34mm carapace length (C. L.) and 0.136 per week, and for females 35.34mm C. L. and 0.117 per week, respectively. The assumptions applied in estimating the parameters by the Fabens method were not invalidated. These prawns were shown to have a smaller maximum size than banana prawns from the Gulf of Carpentaria, and it is proposed that two discrete populations exist. (Author's Abstract)

481. GANAPATHY, R. 1983. Prawn hatchery management part 11, Larval rearing techniques. *Seafood Exp. J.* XV (5) : 15-20.

Food and feeding habits of the larvae, larval stages, hatchery procedures, preparation of rearing tanks, stocking of larvae, feeding procedure are discussed in the paper.

482. GAMBA, A.L.; RODRIGUEZ, G. 1987. Migratory behaviour of postlarval white. *Penaeus schmitti* and river shrimps. *Macrobrachium offersi* and *Macrobrachium acanthurus*. in their zone of overlap in a tropical lagoon. *Bull. Mar. Sci.* 40 (3) : 454-463.

The daily activity of postlarval *Penaeus schmitti* and two river shrimps, *Macrobrachium offersi* and *M. acanthurus*, was studied during 1 year by means of fortnightly samples taken hourly during 24-h periods in Tacarigua, a coastal lagoon in Venezuela. *P. schmitti* and *M. offersi* occurred throughout the year, whereas *M. acanthurus* was present only in January, November and December. The three species showed an alternation of benthic and planktonic distribution. Planktonic activity is nocturnal in the three species, but occurs during incoming tide in *P. schmitti* and during outgoing tide in *Macrobrachium*. Activity observations in experimental chambers showed the presence of a bimodal



endogenous rhythm of a 12-h period with outbursts of activity at dawn and dusk in *M. offersi*, whereas in *P. schmitti* a similar endogenous rhythm is phased with the times of high water. The postlarvae of *P. schmitti* possibly represented older stages of larvae that use currents to move onto inshore nursery grounds, and which still retained their complex pattern of vertical movements, responding to circadian illumination cycles and non-circadian tidal cycles, related to the need of the species to arrive and stay in the lagoon, whereas the activity observed in *Macrobrachium* during the seaward flow, when salinity decrease, causes the postlarval to remain within the limits of salinity required for their normal development. (Author's Abstract).

483. GEORGE, K. V. 1974. Some aspects of prawn culture in the seasonal and perennial fields of Vypeen Island. *Indian J. Fish.* 21 (1) : 1-19.

Prawn culture is reported as having been extensively practised in the paddy fields (seasonal fields) and other low lying areas seasonal as well as perennial (Perennial fields) of Vypeen Island. The seasonal fields were more productive than the perennial fields near Cochin. Though prawns stayed longer and attained larger size in the latter. The average annual production of prawns was 903.3 and 838.6 kg/ha respectively in the seasonal and perennial fields. Higher catch rates were generally observed in January-March. Four species of penaeids *Metapenaeus dobsoni*, *M. monoceros*, *Penaeus indicus* and *P. monodon* constituted this culture fishery, of which *M. dobsoni* contributed more than 50%. *M. dobsoni* in the perennial fields was seen to grow at an average rate of 10.0 mm per month. Although the total expenditure to run the seasonal field was higher, the net income realised from the seasonal field was always higher than that from the perennial fields.

484. GEORGE, M. J. 1974. Food of the shrimp *Metapenaeus monoceros* (Fabricius) caught from the back waters. *Indian J. Fish.* 21 (2) : 495-500.

An analysis of stomach content of 1213 specimens caught from the back waters of Cochin showed that the food of the smaller *Metapenaeus monoceros* mainly consisted of small crustaceans. Unrecognizable materials including mud and detritus were found in more than 50% of the

gut contents in specimens below 50mm length, while in the larger sized specimens the detrital materials formed only a small proportion.

The feeding habits of this species were observed that there was no likelihood of competition of any of the species coexisting in the backwaters.

485. GEORGE, M. J.; SUSEELAN, C. 1982. Distribution of species of prawns in the backwaters and estuaries of India with reference to Coastal Aquaculture. *Proc. Symp. Coastal Aquaculture*, 1:273-284.

The most common species were *Penaeus indicus*, *P. monodon*, *P. semisulcatus*, *P. merguensis*, *Metapenaeus dobsoni*, *M. monoceros*, *M. affinis*, *M. brevicornis* and *Parapenaeopsis sculptilis* among the penaeid prawns and *Macrobrachium rosenbergii*, *M. malcolmsonii*, *M. idella*, *M. equidens*, *M. ruda*, *Palaemon styliferus* and *P. tenuipes* among the palaemonid prawns. Although *P. indicus*, was found in almost all the estuaries, it occurred in maximum abundance in the southwest and southeast areas *P. monodon* the largest of the penaeids was most common in the estuaries of middle and northern regions of the east coast. *M. dobsoni* was the dominant species in the southwest coast.

In general, the postlarval and early juveniles of these prawns were occurring almost throughout the year. However October-May was the peak season in the west and southeast coast whereas January-April and August-December were the peak season in the estuaries of the middle and northern regions of the east coast. The spatial distribution of the different species in Vembanad during their peak season are described and charted in relation to salinity.

486. GHOSH, P. K ; NANDA, D. K. 1985. Effects of thermal stress on the cerebral neurosecretory cells of brackishwater prawn, *Penaeus monodon* (Fabricius). *Philipp. J. Sci.*, 114 (1-2) : 113-124.

Unsuitable temperatures when exerted towards the neurosecretory cells (NSCs) of the eye and brain in *Penaeus monodon*, the cell showed multiple cytoarchitectural alterations suggesting over-all impairment of secretion. The X-organ (optic) HSCs were more susceptible than the cerebral and exhibited marked engorgement and cessation of axonal transport in chill-coma (20C). Marginal depletion with moderate

axonal flow was obvious during high temperature (40°C). Statistical data concerning cellular activity were consistent with histomorphological alterations in the photocephalic neurosecretory centres. Under such temperature extremes, the gland (SG) demonstrated minimal or insignificant quantities of neurosecretory material (NSM) very likely due to impaired axonal transport.

487. GOPALAKRISHNAN, P.; KRISHNARAJU V. 1987. Marine Prawn farming along the coast of the Gulf of Kutch its prospects and problems. *In* National Symposium Research and Development in Marine Fisheries, Mandapam Camp 16-18 September 1987. CMFRI Special publi, 40 : 46-47. Abstract.

Juvenile prawns ascending the creeks in the little rann of Kutch in great number used to be caught by staked bagnets and marketed for meagre revenue. However they were not suitable to form seed for ordinary culture because they were not quick growing varieties. An experimental project was initiated in 1979 to explore the feasibility of using them in culture in low-saline reservoirs of the solar salt works in Okhamandal. During the period from September 1986 to March 1987, juveniles of *Penaeus merguianus* and *Metapenaeus kutchensis* @ 36332, na were stocked in three 1.92 ha ponds. Growth rates of 0.437 mm/day (0.56g/day) in respect of the former and 0.33 mm/day (0.37 gm/day) in respect of latter in 187 days of rearing period was achieved. The values realised and the problems encountered are presented.

488. GOPALAKRISHNAN, V. 1951. A Note on the chemical composition of the Penaeid prawns of Madras. *Current Science*, 20 : 331.

The chemical compositions of *Penaeus indicus*, *P. carinatus*, *Metapenaeus monoceros* and *M. dobsoni* are estimated in which the difference due to sex are irregular and not marked.

489. GOPALAN, U.K.; PURUSHAN, K. S.; SANTHAKUMARI, V; MEENAKSHI KUNJAMMA, P. O. 1982. Proc. Symp. Coastal Aquaculture Cochin January 12-18, 1980, Marine Biological Association of India, Cochin. p. 151-159.

High density, short-term culture experiments on the shrimp *Penaeus indicus* were carried out by setting three identical enclaves (25m<sup>2</sup> each)

using plastic netting and bamboo stakes in a paddy-cum-prawn filtration field at Narakkal during January-April, 1979. Each of the enclaves was stocked with 500 juveniles of 24-48 mm length with a modal size of 36 mm and average weight of 272 mg. Feeding with groundnut oilcake was done once daily at the level of 5% of the body weight of shrimps. Harvestings were done after 4, 8 and 12 weeks, when the survival rates of 85.2%, 81.85% and 65.0%, respectively, were obtained.

At the first harvest, shrimps measured 69-96 mm with a modal size of 84 mm and weighed 3.76 g on average. At the second the length range was 75-108 mm with mode at 93.0 mm and average weight of 5.35 g which was 1.42 times greater than the preceding. At the third harvest, the range was 105-129 mm with 117 mm mode, and had an average weight of 11.22 g, i. e. 42.25 times greater than that of the initial stock. The total yields of 1.601, 2.186 and 3.64 kg realised from these cultures become equivalent to 649.0, 874.0 and 1458.0 kg/ha.

Since it was possible to take a minimum of two short-term crops of 12 weeks duration, it was reasonable to assume that, at 80% harvesting efficiency, the production of about 1750 kg/ha of marketable shrimps valued at Rs. 35.00 could be possible from fertile 'Pokkali' fields of Kerala.

During the course of the experiments the temperature, salinity, pH and secchi disc reading of the field varied between 28.5° and 35.5° C, 17.2 and 26.15‰, 7.0 and 7.8 and 35 and 60 cm respectively, Diurnal oxygen level fluctuated between 1.0 ml/l and 6.8 ml/l.

(Author's Abstract)

490. GOPINATHAN, C. P.; RAMACHANDRAN NAIR, P. V.; KUNJUKRISHNA PILLAI, V.; PARAMESWARAN PILLAI, P.; VIJAYAKUMARAN, M.; BALACHANDRAN, V. K. 1982. Environmental characteristics of the seasonal and perennial prawn culture fields in the estuarine system of Cochin. *Proc. Symp. Coastal Aquaculture, 1* : 369-e89.

The environmental characteristics of the prawn culture fields in the estuarine system from Azhikode in the north to Kumarakam in the south have been studied. Primary productivity and related

hydrobiological parameters were measured during December '77 to May '78 at 50 stations when prawn and brackishwater fishes were cultivated in the adjacent fields are presented; also the epifauna, benthic fauna and the chemical constituents of mud of these fields were observed. Based on the productivity parameters, an attempt is made to categorise the prawn culture fields then existed.

491. GOSWAMI, S. C. 1985. Chromosomal studies in *Penaeus aztecus* Ives prawn larvae. *Mahasagar*, 18 (1) : 75-77.

Larvae of prawn *Penaeus aztecus* showed a diaploid number of 88 chromosomes, the karyotype formula is 18 SM. 52 A. The chromosomes have a size range of 0.30 to 3.12  $\mu$ m. (Author's abstract).

492. HAMID, S. N. 1986. Production of shrimp juvenile in earthen nursery pond. *Bull. Brackishwat. Aquacul. Dev. Cent.*, 8 (1) : 8-14

Two earthen nursery ponds of 400 m<sup>2</sup> size were used for the rearing of shrimp larvae for 30 days in 1983-84. In the first run, *P. merguensis* larvae were stocked at a density of 50 individuals/m<sup>2</sup> and the second run at 100 individuals/m<sup>2</sup>. In the third run, it was stocked with *P. merguensis* ranged from 79-96% with average individual weight of 146-179 mg. In the third run, *P. monodon* was harvested with survival rate of 53-79% and average final weight of 112 mg. The method of culture, feeding, harvesting and growth rate are described. (Modified author's abstract).

493. HARDIAL SINGH, A.; CHOWDHURY, R.; PAKRASI, B. B. 1982. Experiments on the transport of postlarvae of tiger prawn *Penaeus monodon* Fabricius, *Proc. Symp. Coast. Aquaculture.*, 1 : 232-235.

*Penaeus monodon* postlarvae of 11-14 mm size collected from nature were conditioned for 24 hours in earthen pits and packed in knotless polythene bags (18 litre capacity) with oxygen in different water salinities at the rate of 375 no/l of water. Encouraging results were obtained when the postlarvae were put in 8‰ water salinity at the rate of 375 no/l for a duration of 26 h. Chloral hydrate was used as a sedative for the transport of prawn. A dose of 400 mg/l was found to be the most effective dose for successful transportation of 375 No/l up to a period of 28h. The range of temperature between 29° and 30°C was found to be the optimum.

494. HARPAZ, S.; SCHMALBACH, E. A. 1986. Improved growth and health of the Malaysian prawn, *Macrobrachium rosenbergii*, by addition of fresh leaves to the artificial diet. *Aquaculture*, 55(2) : 81-85.

Supplementation of dry artificial feed with fresh leaves of *Ailanthus altissima* (Simaroubaceae) and *Mala parviflora* (Malvaceae) during a 12-month-long laboratory trial resulted in elimination of molt death syndrome in a considerable reduction of black spot disease incidence in *Macrobrachium rosenbergii* adults. An additional effect of this supplement was the shortening of intermolt intervals, as well as increased average body weight. (Author's abstract).

495. HASEGAWA, A.; ISHIOKA, K.; GEMA, G.; HYAMA, S. 1976. Economic effectiveness of liberation of kuruma-prawn seedlings. *Bull. Tokai Reg. Fish. Res. Lab.*, (83) : 7-23.7. (Text in Jap).

The large-scale experimental liberations of artificially propagated kuruma prawn seedlings, *Penaeus japonicus*, were carried out from 1971-74. In addition, 3 typical methods of liberation (direct scatter method, protective net method and artificial tideland method) were compared, evaluating the economic viability of the liberations. It was estimated that the recapture rate would be 42% and the income per effective seeding would be 16.2 yen in shallow water. On the other hand, in offshore fishing ground, the income per effective seeding was estimated at 25-30 yen. (Modified author's abstract)

496. HILL, B. J.; WASSENBERG, T. J. 1985. Laboratory study of the effect of streamer tags on mortality, growth, moulting and duration of nocturnal emergence of the tiger prawn *Penaeus esculentus* (Haswell). *Fisheries Research*, 3 (3) : 223-235.

Under laboratory conditions, negligible mortality occurred in *Penaeus esculentus* larger than 24 mm carapace length (C. L.) when tagged with 2-mm wide streamer tags. About 2% of prawns smaller than 19mm C. L. tagged with 1.5-mm tags died each week during a 10-week experiment. This was significantly more than in controls. Tagged prawns had a shortened intermolt period and a reduced size increment at each moult, but overall growth of all sizes tested

was not affected by streamer tags. The presence of a tag did not alter the time of night at which ecdysis occurred nor the duration of ecdysis, although tagged prawns required significantly more flicking movements to remove the abdominal exuviae than did control prawns. Newly trawled but untagged prawns had a severely reduced duration of nocturnal emergence, but under laboratory conditions this effect disappeared after 14 days. Prawns held in the laboratory for 14 days and then tagged showed a reduction in the duration of nocturnal emergence for the first 5 days after tagging. Newly tagged prawns exposed to light do not bury in the substrate as rapidly as control prawns, and thus may be vulnerable to predation if released near dawn or in daylight. (Author's abstract)

497. HOWLADER, M. S.; TURJOMAN, A. M. A. 1984. Some results of rearing giant prawn, *Macrobrachium rosenbergii*, in the oasis water of Al Hassa, Saudi Arabia. *J. World Mariculture Soc.* 15 : 92-94.

Imported adults and postlarvae of giant prawn, *M. rosenbergii* were reared in the oasis water of Al-Hassa, Saudi Arabia, to examine the suitability of the water for prawn farming. Results showed that the prawn fry survived and grew in the oasis water. However, as the prawn grows, rate of growth is reduced by the hardness of the oasis water. Factors pointed out that may have affected prawn farming were, limited water supply and unsuitable water management system which was designed for irrigation purposes. (R. P. G.)

498. HUANG, H.; ALDRICH, D. V.; STRAWN, K. 1986. Laboratory and pond evidence for shrimp (*Penaeus stylirostris*) predation by damselfly nymphs (*Inchnura ramburi*) *J. World Maricul. Soc.* 16 : 347-353.

A negative relationship was found between damselfly nymph population density and final shrimp population density in ponds. The predatorship of damselfly nymphs on post-larval shrimp and the effect of shrimp size, salinity, and type of substrate on this relationship were assessed by a series of laboratory experiments. When 5-10 nymphs and 15 post-larval shrimp were stocked in tanks of 0.96 m<sup>2</sup> bottom area containing 150 litres of water, a nymph on an average

killed 1.7 shrimp per day at 10 ppt salinity and 0.6 shrimp per day at 20 ppt. The predation was inversely related to the size of the shrimp (average 8.55, 12.89 and 17.30 mm). Presence or absence of a natural muddy substrate had no effect on predation.

499. JABIGUER, MERGLO S.; ALEX APONGAN; QUINTIN BAUTISTA; HERMINIO SIMBOL; ROLANDO ARCENAL; HELEN J. VINCENTE 1978. Mass culture of penaeids, *Penaeus monodon*, Fabricius and *P. indicus* (Milne Edwards) in MSU-IFRD. MSU-IFRD Tech., : 11 p.

In a mass culture of penaeids (*Penaeus monodon*) Fabricius and *P. indicus* (Milne Edwards) at the MSU-institute of Fisheries Research and Development in Naawan, covering the period from January 1978 to December 1978, a total of 441,200 *P. monodon* (Sugpo) fry was harvested. Out of this, 385,000 fry were used from various experimental purposes in the MSU-IFRD's rearing ponds and a total of 56,000 fry was transported to Siay, Zamboanga del Sur. For *P. indicus* (hipong puti), a total of 173,000 fry was utilized in the URC-funded project at MSU-IFRD experimental ponds and 60,000 fry were transported to Siay, Zamboanga del Sur.

500. JANAKIRAM B.; VENKATESWARLU, Y.; RAJARAMI REDDY, G.; SASIDARABABU, K. 1985. Oxygen uptake rhythm in prawn *Penaeus indicus* (H. Milne Edwards) in different salinities. *Indian J. mar. Sci.* 14(4), 222-223.

Dial variation in and variation at different salinities. Oxygen uptake in brackishwater *P. indicus* are studied. Prawns exposed to  $20 \times 10^{-3}$  sal, had Oxygen uptake rhythm with peak and nadir values at 1800 hrs and 0500 hrs respectively. Average oxygen consumption was maximum in  $20 \times 10^3$  sal. than in other salinities. Negative phase shifts (—) were observed in 20, 25 and  $30 \times 10^3$  sal. Whereas positive phase shifts (+) were observed in 15 and  $10 \times 10^{-3}$  sal.

501. JAYASANKAR, P.; MUTHU, M. S. 1983. Toxicity of nitrite to the larvae of *Penaeus indicus*. *Indian J. Fish.*, 30(2) : 231-240

Short-term experiments revealed that there was progressive increase in tolerance in the larvae of *Penaeus indicus* for nauplius,



protozoa and mysis the 24-h LC 30 were respectively, 10.23 mg/l 30.43 mg/l and 33.87 mg/l NO<sub>2</sub>-N. The 48-h LC<sub>30</sub> for protozoa was found to be 15.37 mg/l NO<sub>2</sub>-N. Whereas, showed that the 9-day incipient LC<sub>60</sub> in long term experiments was 3.29 mg/l NO<sub>2</sub>-N. The FI<sub>60</sub>, the concentration at which 50% of the larvae did not metamorphose into post-larvae in 9 days, for nitrite was 1.8 ppm NO<sub>2</sub>-N. 'Safe level' of nitrite to be maintained in sea water for larval rearing, calculated on the basis of the incipient LC<sub>60</sub> value was a 0.33 ppm NO<sub>2</sub>-N. More sensitive estimate of 'safe level' based on EC<sub>60</sub> value was 0.18 ppm NO<sub>2</sub>-N.

502. JAYASANKAR, P.; MUTHU, M. S. 1983. Toxicity of ammonia to the larvae of *Penaeus indicus* H. Milne Edwards. *Indian J Fish* 30 (1), 1-12.

Short-term experiments revealed a progressive increase in tolerance of the larval stage of *P. indicus* to ammonia, 24h LC<sub>60</sub> values for nauplius, protozoa and mysis were 3.58 mg ammonia N/l (0.29 mg NH<sub>3</sub>-N/l), 17.86 mg ammonia-N/l (0.95 mg NH<sub>3</sub>-N) and 46.01 mg ammonia-N/l (3.17 mg NH<sub>3</sub>-N/l), respectively 48-h LC value for protozoa was 16.8 mg ammonia-N per liter (1.18 mg NH<sub>3</sub>-N/l). Long-term chronic toxicity experiments on nauplius to postlarval (showed that the 9-day incipient LC<sub>60</sub> level was 11.99 ppm of ammonia N/l (0.93 ppm NH<sub>3</sub>-N). The EC<sub>60</sub> (the concentration at which the percentage of larvae that metamorphosed to post larvae was reduced to 50% of that of the controls) for ammonia was 3.23 ppm ammonia-N/l (0.25 ppm NH<sub>3</sub>-N). "Safe level" of ammonia that should be maintained in these a water used for larval rearing was calculated on the basis of incipient LC<sub>60</sub> value at 1.2 mg ammonia N/l or 0.093 ppm NH<sub>3</sub>-N/l. More sensitive estimate of 'safe level' based on EC<sub>60</sub> value was 0.32 ppm ammonia-N/l or 0.25 ppm NH<sub>3</sub>-N 16 ref.

503. KANAZAWA, A.; TESHIMA, S. I.; K. CHALAYONDEJA, K. 1974. Biosynthesis of fatty acids from acetate in the prawns. *Penaeus monodon* and *Penaeus merguensis* Mem. Fac. Fish., Kagoshima Univ. 28, 21-26.

After injection of acetate 114C, polar lipids (PL) and neutral lipids (NL) were isolated from the whole body of the prawns, and

the proportional radioactivity of individual fatty acids constituting PL and NL was investigated by using argentation thin-layer chromatography and preparative gas-lipid chromatography on 10% DEG S followed by radioactive measurements of the trapped samples. In both *P. monodon* and *P. merguensis* radioactivity was mainly associated with palmitic acids (16:0), palmitoleic acid (16:1), stearic acid (18:0) and oleic acid (18:1) but scarcely or slightly with linoleic acid (18:2), linolenic acid (18:3), eicosapentaenoic acid (20:5), and octadecaenoic acid (22:6). These results suggest, that 18:2, (18:3, 20:5, and 22:6) may be essential for *P. monodon* and *P. merguensis*.

504. KANAZAWA, A. 1985. Nutrition of penaeid prawns and shrimps, *In* : Proceedings of the *First International Conference on the Culture of Penaeid Prawns/Shrimps*, Iloilo City, Philippines, 4-7 Dec. 1984. Ed. by Y. Taki, J. H. Primavera and J. A. Llobrera, Iloilo, Philippines, Aquaculture Department, SEAFDEC. p. 123-130.

Techniques for rearing the prawn *Penaeus japonicus* have been improved in Japan. The prawn was found to require proteins, lipids, carbohydrates, minerals and vitamins for normal growth. On this basis, compounded artificial diets are used practically for commercial production. However, seed production of penaeids has depended on live food (*Chlorella* and *Artemia*). Therefore, the development of artificial diets for larval penaeids is one of the most important research areas in the field of penaeid culture. In this paper, an overview of penaeid nutrition is provided (Modified Author's Abstract)

505. KARTHA, K. N. R.; KARUNAKARAN NAIR, P. 1986. Grow more prawns. (*Krishi Vigyan Patrika, Mariculture Series 5 (a)*)

Traditional paddy/prawn farming, Prawn farming by selective stocking and better management procedures and the problems and solutions are explained in this publicity Booklet.

506. KATHIRVEL, M.; SELVARAJ, V. On an experimental seed collection and field culture of king prawn, *Penaeus latisulcatus*. *Indian J. Fish.*, 34 (4) : 365-373.

Early juveniles of the King prawn, *Penaeus latisulcatus* Kishinouye, were caught from the sandy barmouth area of Kovalam backwater, near Madras, during May-July 1986. These were successfully cultivated in an earthen pond at the Muttukadu Mariculture Centre of the Institute for a period of 80 days supplementing backwater clam (*Meritrix casta*) for feed. Over this time the females were found grown up and with developing ovary. The size-frequency analysis of the juveniles obtained from the wild and those reared showed a growth of 29-30 mm per month. The hatchery-raised postlarvae of the species were reared on a diet of zooplankton (copepods, rotifers and freshwater cladocerans) and molluscan meat (boiled flesh of clam and mussel). Those reared on copepod diet exhibited faster growth and those reared on a combination of zooplankton and molluscan meat exhibited higher survival.

507. KIRON V, DIWAN A. D. 1985. Influence of eyestalk ablation on ammonia excretion in the prawn *Penaeus indicus* (H. Milne Edwards) *Indian J. mar. sci.* 14 (4), 220-1

Eyestalk hormones influence the excretion of ammonia in *P. indicus*. Unilaterally and bilaterally ablated animals excrete more ammonia than control animals. When eyestalk extract is injected to destalked animals the excretory rate is brought down to normal level.

508. KIRON, V.; DIWAN, A. D. 1984. Influence of eyestalk ablation on the regulation of haemolymph sodium concentration in the prawn *Penaeus indicus* H. Milne Edwards, *Indian J. Fish.*, 31 (2) : 244-249.

Removal of eyestalks in the prawn *Penaeus indicus* resulted in an increase in haemolymph sodium level. This increase was more evident in bilaterally ablated animals. Injection of eyestalk extract into destalked animals helped them to restore the level almost similar to that of normal animals. (Author's Abstract).

509. KIRON, V.; DIWAN, A. D. 1984. Chloride ion regulation in an eyestalk ablated prawn *Penaeus indicus* H. Milne Edwards. *Indian J. Fish.*, 31 (3) : 345-351.

The removal of the eyestalks caused a substantial increase in the haemolymph-chloride level in batches of prawns *Penaeus indicus* that were kept in laboratory and, when the eyestalk extract was injected into them, the chloride level decreased again and reverted back to normal. The findings are deemed as a pointer to the possible role of eyestalk endocrine ionic regulation. (Author's Abstract)

510. KITABAYASHI, K.; KURATA, H.; SHUDO, K.; NAKAMURA, K.; ISHIKAWA, S. 1971. Studies on formula feed for kuruma prawn-l. On the relation among glucosamine, phosphorus and calcium. *Bull. Tokai Reg. Fish. Res. Lab.*, (66) : 91-107. (Text in Jpn).

The quantitative requirements of glucosamine phosphorus and calcium of prawns *P. japonicus* are evaluated based on their effects on the growth of the prawns. The highest growth rate was at the concentration of 0.53% glucosamine, 1.04% phosphorus and 1.24% calcium. However, excess of any of the three ingredients was found to inhibit growth. (Modified Author's Abstract)

511. KITANI, H. 1986. Larval development of naupliar stages of the northern brown shrimp *Penaeus aztecus* Ives and comparison with its earlier description. *Bull. Jap. Soc. Scient. Fish.* 52 (8) : 1285-1288.

Larval development in naupliar stage of *Penaeus aztecus* was studied and compared with earlier study. Nauplii of penaeid shrimps molt frequently for their growth, and five naupliar substages were reported in the earlier study, but the present study reveals that they pass six naupliar stages to reach the first protozoa. It is also revealed that the naupliar development of this species is very similar to that of the other penaeid shrimps such as *P. duorarum*, which is distributed in the Gulf of Mexico, and other species distributed on the Pacific coasts. (Author's Abstract)

512. KOBAYASHI, K.; NAKAMURA, Y.; ROMPAS, R. M.; IMADA, N. 1986. Difference in lethal concentration *in vivo* between fenitrothion and its oxo-form in tiger shrimp *Penaeus japonicus*. *Bull. Jap. Soc. Scient. Fish.* 52(2) : 287-292.

A study was undertaken to elucidate the relation between the mortality of tiger shrimp *Penaeus japonicus* and the accumulation of fenitrothion (FS) and its oxo-form (fenitrooxon, FO) in the shrimp during the exposure to FS at lethal level, and also to eliminate the lethal concentrations *in vivo* of FO and FS by intramuscular administration to the shrimp. The amounts of (<sup>14</sup>C)FS and its metabolites extracted with benzene from the surviving and dead shrimps during exposure to 2ppb (<sup>14</sup>C)FS-sea water were determined by thin-layer chromatography with non-radioactive FS and its authentic metabolites. In comparison with the amounts of FS and FO found in the surviving and dead shrimps, the major cause for the occurrence of high mortality was presumed to be FO rather than its parent compound FS and the estimated lethal concentration of FO was ca. 14 pmol/g body weight. From another experiment on the toxicity of FO and FS intramuscularly administered to the shrimp, the minimum lethal concentration of FO and FS *in vivo* in tiger shrimp were estimated to be 8-20 pmol/g and ca. 200 pmol/g-body weight respectively.

(Author's Abstract)

- 513 KONTARA, E. K. 1986. Preliminary results in larval rearing of tiger shrimp, *Penaeus monodon* that receive *artemia* naupli fed with lipid containing W3-HUPA. *Bull. Brackishwat. Aquacult. Dev. Cent.* 8(1) : 43-52.

An experiment carried out to improve the dietary value of *Artemia naupli* by allowing, them to feed directly on lipid containing W3-HUFA is described. The lipid was emulsified into a stable emulsion with a small amount of raw egg yolk and water. The freshly hatched *Artemia naupli* took up lipid very easily. *Penaeus monodon* larvae stocked at densities of 15 larvae per litre in fibre glass tanks 49 cm x 50 m were fed on these naupli. The shrimp larvae thus fed had higher growth and survival rate than the shrimp larvae fed *artemia naupli* of the same strain.

514. KRISHNA KARTHA, K. N. Ed. 1978. Coastal aquaculture : Marine prawn culture, part I Larval development of Indian Penaeid prawns. *CMFRI Bulletin*, 28. p. 90.

The bulletin records in 11 authored chapters the successful breeding in the laboratory of 8 species of Indian prawns and rearing them from eggs to postlarvae, all for the first time. These breakthroughs, achieved all but one at the Narakkal field laboratory of CMFR Institute (one was achieved all but one at the Narakkal field laboratory of at its centre at Kakinada), were a prelude to culturing and propagation of marine prawns, then an adhoc project of the Institute. The species are *Penaeus monodon* Fabricius, *P. indicus* Milne Edwards, *P. semisulcatus* de Haan, *Metapenaeus dobsoni* (Miers), *M. affinis* (Milne Edwards), *M. monoceros* (Fabricius), *M. brevicornis* (Milne Edwards) and *Parapenaeopsis stylifera* (Milne Edwards). The eggs of the species and the numbers and durations of the nauplius, zoeal and mysis stages, and in most of the cases postlarval stages are well detailed. The structures of the eggs and the larval stages are described in detail and all of them well illustrated, and are compared with the then available description, which were based on collected materials. Besides discussing an observed general penaeid pattern of development, keys to the identification of larvae of the different species are given, as well as giving another key, together with a comparative table, to the identification of early postlarval stages that are found in the brackishwater.

515. KRISHNAMOORTY, R. V.; VENKATARAMIAH, A.; LAKSHMI, G. J ; PATRICIA BIESIOT. 1982. Effect of starvation and algae-feeding on the tissue cholesterol levels in commercial shrimp *Penaeus aztecus*. *Proc. Symp. Coastal. Aquacul.* pt. 1 : 215-222.

Tissue lipid cholesterol contents of starved green algae-fed and pelleted-diet-fed *Penaeus aztecus* were compared in the laboratory.

Shrimp fed on the pelleted diet showed an increase in cholesterol content with increased body weight. The females showed a greater hepatopancreatic mass and higher cholesterol content in muscle, eyes, and hepatopancreas than males fed on the same diet. The eyes

contained the most cholesterol of all tissues tested; the level increased linearly in males but geometrically in females. Hepatopancreatic cholesterol level increased linearly with size in females but remained essentially unchanged in males. Muscle cholesterol increased linearly as body weight increased among females, whereas males maintained a steady level independent of size. Starvation reduced the body weight and hepatopancreatic cholesterol level of both sexes while levels in other tissues remained essentially unchanged. And the shrimp which fed on green algae *U. lactuca* and *Enteromorpha* sp, had significantly reduced cholesterol levels in the muscle, hepatopancreas and blood. The levels in the eyes were not modified by algae-feeding.

516. KUMARDAS, P. S. 1980. Strategy for the development of commercial shrimp farming in Kerala. *In*: National Symposium on Shrimp Farming (1st: 1978: Bombay) Proceedings. Cochin, India: The Marine Product Export Development Authority. 238-241.

Contains a general review of background information on the shrimp farming industry in Kerala. Strategies for development of prawn farming are given, emphasising on the need of technical know-how and training facilities.

517. KUNGVANKIJ, P. 1984. Overview of Penaeid Shrimp Culture in Asia. *In*: Proceedings of the First International Conference on the Culture of Penaeid Prawns Shrimps, Iloilo City, Philippines. p. 11-21.

Marine shrimp farming is a century-old practice in some Asian countries. Past sluggish development of the industry is mainly due to the inadequacy of hatchery technology resulting in consistent and insufficient supply of shrimp fry hence off-setting large scale development of the industry. Recent success in hatchery techniques coupled with high market demand have generated world-wide interest in developing shrimp farms in Asia. The paper attempts at review the various aspects confronting the development and expansion of the shrimp farming industry in Asia.

The culture significance of *Penaeus monodon*, *P. japonicus*, *P. indicus*, *P. merguensis*, *P. orientalis* and the various penaeid shrimps

cultivated in Asia reviewed in relation to the subtropical species such as *P. stylirostris* and *P. vannamei* cultivated in South America. The major constraints in the large-scale cultivation of *P. monodon* and other commonly important species are discussed and research gaps outlined. Present status of hatchery techniques is discussed and the need for standardisation of viable techniques for technology packaging and verification is highlighted to ensure reliable source of seed supply. The various problems in hatchery development, including development of artificial larval feeds, are emphasised. The growout technology in relation to farming intensity and level of investment are outlined with special reference to the socio-economic condition in Asia. The need to develop viable and appropriate shrimp farming technology within the technical and financial capabilities of the rural small shrimp growers are discussed.

518. KURATA, H.; SHIGUENO, E. 1976. Recent progress in the farming of Kuruma shrimp (*Penaeus japonicus*). In: Advances in aquaculture, (Ed.) Pillai, T. V. R.; Dill, W. A. Fishing News Books Ltd., London p. 258-268.

Progress in development of Kuruma shrimp (*Penaeus japonicus*) production techniques and pond culture methods since the inception of shrimp farming in 1933 are reviewed, as well as the technical advances achieved in shrimp stocking techniques.

The first steps towards mass production of shrimp fry were simple, largely supported by experience and intuition, these were followed by development of the community-culture method in which an adequate concentration of shrimp larvae and food organisms were maintained by the addition of nutrients. The next development, just coming into practice, is the establishment of an automatic rearing system in which feeding and physio-chemical conditions are carefully controlled.

Pond culture of shrimp for consumption has been expanded significantly and in 1974 there were almost 50 shrimp culture enterprises in Japan, farming an area of 245 ha and producing almost 600 tons of live shrimp. Considerable effort was then devoted to development of a suitable compounded feed in place of the fresh shortnecked



clams and blue mussels previously used, thus developing a new culture method in a controlled environment.

There was general agreement in Japan that liberation of sedentary fry of Kuruma shrimp not only had the potential of increasing local shrimp production but could also support a considerable fishery if adequate quantities of fry were released. Effort has now to be made to improve the economic feasibility and cost benefit of this practice.

519. KUTTY, M. N. 1969. Oxygen consumption of prawns *Penaeus indicus* E. Milne Edwards and *Penaeus semisulcatus* de Haan. In : Proc. World Scientific Conf. on the Biology and culture of shrimps and prawns, Mexico City, Mexico, 12-21 June 1967. *FAO Fish. Rep.*, 57(3) : 111-124.

The routine oxygen consumption of *Penaeus indicus* and *Penaeus semisulcatus* (acclimation and test in seawater at 30°C) starved for 5-10 days declined sharply by about the second day of starvation, and no marked change from the reduced rate was observed during the subsequent days of starvation in either species. The reduced level of metabolism attained due to starvation was 0.404 mg/g/h, being 32 percent less than the metabolic rate for the first day of starvation in the case of *P. indicus*, whereas the corresponding values for *P. semisulcatus* were 0.151 mg/g/h and 57 percent. When the amount of available dissolved oxygen was the same, *P. indicus*, and *P. semisulcatus* starved for two days or over could be expected to survive for 1.7 and 2.3 times as long as those not starved, under the conditions of the present tests.

The regression of long oxygen consumption on log weight in *P. indicus* had a slope of 0.501. While the highest routine metabolic rate of *P. indicus* declined with the decrease in ambient oxygen concentration, such oxygen dependence was not to be exhibited in all cases. There was possibility of an increase in the standard metabolic rate of *P. indicus* at an oxygen level of 1-2 ppm when the prawns were allowed to bring down the ambient oxygen concentration by their own respiration.

520. LAMBIER-BONICHON, A.; LAUBIER, L. 1976. Reproduction controlled chez la Crevette *Penaeus japonicus*. *Advances in Aquaculture*, (Ed.) Pillai, T. V. R.; Dilli, W. A. Fishing News Books Ltd., London. p. 273-277.

In a series of experiments, on reproduction of *Penaeus japonicus* bred in captivity from the first larval stage in which temperature and the daily duration of lightening were vigorously controlled, complete maturation was possible to be obtained in three months from about 60 one-or two year-old females (April-June). In the four months following (10 July-10 November), 87 depositions of spawn totalling 1,322,800 larvae were collected. At the same time, an induced spawning technique applied to isolated females has made it possible to obtain an initial deposition of spawn with 4,55,000 eggs with a hatching rate higher than 98%, followed by another deposition of spawn with 159,000 eggs in two consecutive nights. The ecological conditions yielding the best results were those of a tropical climate: temperature at 24°C and daily illumination lasting for 14 h 45 min.

521. LEANGPHIBUL, P.; NILAKUL, C.; SORNACHAI, C.; TANTIMAVANICH, S.; KASEMSUKSAKUL, K.; 1986. Investigation of pathogenic bacteria from shrimp farms. *Kasetsart Journal of Natural Sciences*, 20(3): 333-337.

The isolation and enumeration of pathogenic bacteria from shrimp farms in Samutprakarn Province were carried out from October 1983 to December 1984. A total of 306 specimens including 139 samples of water, 144 samples of sediments and 23 samples of shrimp were investigated. The enteropathogenic bacteria isolated were *Vibrio parahaemolyticus*, *V. alginolyticus*, *V. fluvialis*, Non O1 *Vibrio cholerae*, *Salmonella* spp., *Aeromonas hydrophila*, *A. sobria* and *Plesiomonas shigelloides*, but the numbers were not higher than the standard level. The result may be used to indicate the water quality and the quality of natural water resources affecting consumer's safety and exportation.

(Author's Abstract)

522. LEKA, N. 1985. Effect of giving *Artemia salina* Leach on the growth and survival rate of giant tiger shrimp *Penaeus monodon* (Fabricius) larvae stage PL-10-39. (Pengaruh pemberian *Artemia salina* Leach terhadap pertumbuhan dan persentase hidup udang windu (*Penaeus monodon* Fabricius) stadia PL-10-39. (M. Sc. Thesis, Diponegoro University) 62 p. (Text in Bahasa).

This study seeks to determine the amount of *Artemia salina* given as food necessary to optimize growth and survival of the giant tiger shrimp larvae, PL-10-39. Results indicated a significant difference on growth and survival at all levels tested. Optimum growth was observed at 42.75 *Artemia* while 40 for survival.

(Modified Author's Abstract).

523. LIAO, I. C. 1977. Study on grass prawn, *Penaeus monodon* in Taiwan: the patterns, the problems and the prospects. *J. Fish. Soc. Taiwan*, 5(2) : 11-29.

The culture of prawn, especially grass prawn *Penaeus monodon*, is attracting interest among aquaculturists. The culture of *P. monodon* in Taiwan has developed from traditional extensive polyculture into intensive monoculture. Because of such development and the bright future of grass prawn culture, a comparative analysis is carried out based on collected data of research institutions and private companies. (W. P. G.)

524. LIO-PO, G. D.; SANVICTORES, E. G. 1986. Tolerance of *Penaeus monodon* eggs and larvae to fungicide against *Legnedium* sp. and *Haliphthoros philippinensis*. *Aquaculture*, 51(3/4) : 161-168.

The invivo effect of mycostatic levels of fungicides against the fungi *Legnedium* sp. and *Haliphthoros philippinensis* was tested on *Penaeus monodon* eggs and larvae. Hatching rate and survival of nauplii, zoeae, mysis and postlarvae exposed to 10mg/l benzalkonium chloride, 1mg/l Clotrimazole, 1mg/l crystal violet, 10mg/l 2, 4-D, 10mg/l Daconil, 20 mg/l laundry detergent, 1mg/l Econazole nitrate, 10mg/l Resiguard, 0.2mg/l Treflan-R, and 0.01mg/l and 0.2mg/l trifluralin

were monitored daily for 96h in a static bioassay in glass aquaria. Test chemicals did not have an inhibitory effect on hatching rate but survival rate of hatched nauplii was significantly reduced in most treatments except those with 0.2mg/l Treflan-R and 0.2mg/l trifluralin. Tests with zoeae, mysis and postlarvae indicated that 0.2mg/l Treflan-R as well as 0.01mg/l and 0.2mg/l trifluralin did not adversely affect survival. In addition, application of 10mg/l benzalkonium chloride caused no significant mortalities among exposed mysis.

(Author's Abstract).

525. LIGHTNER, D. U. 1985. Review of diseases of cultured penaeid shrimps and prawns with emphasis on recent discoveries and developments. *In* : Proceedings of the First International Conference on the Culture of Penaeid Prawns/Shrimps, Iloilo City, Philippines, 4-7 Dec. 1984. Ed. by Y. Taki, J. H. Primawara and J. A. Ilobraera. Iloilo, Philippines, Aquaculture Department, SEAFDEC. p. 79-103.

The development of the commercial culture of shrimps/prawns has been accompanied by the occurrence of disease. Many diseases are caused by organisms that of the normal microflora and fauna of the shrimps. The most important disease causing agents are the viruses which begins to spread outside their normal range due to the shipment of broodstock and larvae from culture facilities like hatcheries. The final group of important diseases are the nutritional, physical and toxic disease syndromes. Areas of research that should be given emphasis in the next years in shrimp disease research are pointed out. (Modified author's abstract).

526. LAXMINARAYANA, A; KUTTY, M. N. 1982. Oxygen consumption, ammonia excretion and random activity in *Penaeus semisulcatus*, *Macrobrachium malcolmsoni* and *Paratelphusa hydrodromus* with reference to ambient oxygen. *In* : Proceedings of the Symposium on coastal Aquaculture, Cochin, India 12-10, Jan. 1980. Marine Biological Association of India, part 1. P. 117-122.

Oxygen consumption, ammonia excretion and random activity in relation to ambient oxygen have been investigated in a marine prawn, *Penaeus semisulcatus*, a freshwater prawn, *Macrobrachium malcolmsonii*

and a freshwater crab, *Paratelphusa hydrodromus*. At normoxia, *P. semisulcatus* maintained an ammonia quotient (A. Q. = volume of mole relation of ammonia excreted to oxygen consumed) of about 0.06, *M. malcolmsonii* maintained an A. Q. of about 0.08 and *P. hydrodromus* an A. Q. of about 0.25. Under hypoxic conditions all these three crustaceans showed high ammonia quotients. The 2 to 5 fold increase in A. Q. values in hypoxic conditions indicates increased protein degradation and may be of value in combating acid base balance as in the case of fishes. The random activity increased in hypoxic conditions in the case of *P. semisulcatus* and *M. malcolmsonii* whereas in the case of *P. hydrodromus* the activity decreased in hypoxic conditions indicating a dichotomy in behaviour which appears to have ecological significance. The metabolic rate decreased in hypoxic conditions in all the three species.

527. KUI, C.; DAI, D.; XU, T; LUI, J. 1985. Study on culture techniques of high density of juvenile prawns (*Penaeus orientalis*) in laboratory. *J. Fish. China*, 9 (1): 1-11.

The effect of food, salinity and other related factors on growth and survival of juvenile *Penaeus orientalis* was studied in the laboratory. The optimum salinity was observed to be 25 ppt. *Artemia salina* was used to feed day-old larvae for four days. In addition to brine shrimp, *Tubifex* sp. and *Uenerupis philippinarum* meat could be fed to prawn from the 5th to 20th day. It was also observed that keeping terramycin at a concentration of 0.5-1. ppm. in culture seawater did not only prevent diseases, but also enhanced growth of prawn. In the experiment, 1.41 mm juvenile prawns with an average length of 0.95 mm were harvested from 13 ponds of 23 M3 seawater having a survival rate of 83.3%. (Modified author's abstract).

528. LUSICA, NANCY. M. 1982. "The effects of *Nitzschia closterium* on the survival and development of *Penaeus monodon* from zoea-1 to post larva-1". M. S. Thesis, University of the Philippines in the Visayas. 431.

*Penaeus monodon* were reared from Z1 to M1 and from M1 to P1 using *Nitzschia closterium* at various feeding levels. Concentrations employed were 15, 50, 100, 150, 200 and 250 x 10<sup>3</sup> cells/ml. Algal

density of  $100 \times 10^3$  cells/ml seemed optimal for zoeal stages, where highest survival of 65.22 was obtained. However, not all larvae passed into mysis as compared to a zoeae fed at higher densities ( $150-250 \times 10^3$  cells/ml). Feeding concentrations of  $150 \times 10^3$  cells/ml also seemed optimal for mysis. Larvae fed at this feeding level yielded a high survival percentage of 62.22 and a faster rate of development. All larvae reached P1 on the fourth day of culture. Using *N. closterium*, *C. calcitrans* and *P. tricornutum* as food, *N. closterium* respectively than *P. tricornutum*-fed larvae.

629. MAHESWARI, R. U. 1983. Studies on the cage culture of prawn, *Penaeus indicus* and *P. monodon*. In: Proceedings of the National Seminar on Cage and Pen Culture, Tuticorin, India, 18-19 Mar 1983. Tuticorin, India, Fisheries College, Tamil Nadu Agricultural University. p. 95-98.

Cage culture of *Penaeus indicus* and *P. monodon* was carried out in the Ennore estuary. Supplementary feeding was given in addition to the natural food. The growth rate and survival in relation to stocking density are discussed. (Author's abstract)

530. MAGINNISS, L. A. 1974. Glucose transport by the isolated midgut of the Malaysian prawn, *Macrobrachium rosenbergii*, *Am. Zool.* 14(4) : 1292 p. (Abstract).

Different aspect of Glucose transport by the isolated midgut of the Malaysian prawn discussed.

531. MALECHA, S. R ; BUCK, D. H.; BAUR, R. J.; ONIZUKA, D. R. 1981. Polyculture of the freshwater prawn, *Macrobrachium rosenbergii*, Chinese and common carps in ponds enriched with swine manure. I. Initial trails. *Aquaculture*, 25 : 101-116.

The feasibility of raising the freshwater prawn *Macrobrachium rosenbergii* without supplemental feeding was tested in an integrated

polyculture system. The experimental design involved two flow-through units of two ponds each with size from 0.09 to 0.18 ha. One pond in each unit received fresh manure from swine (67 61-ha<sup>-1</sup>) housed on the pond banks, and was stocked with silver, big head, and grass carps and later with common carp in a ratio of 65:1:4:12 with a combined density of about 5,500 ha<sup>-1</sup>. The second pond in the unit received only effluent from the first and was stocked with macrophytic plants and a lighter density of fish (i. s. silver carp at 650 ha<sup>-1</sup>, big head carp at 79 ha<sup>-1</sup>, no common carp) and sufficient grass carp (10-15 ha<sup>-1</sup>) to crop the macrophytes. After 15 days prawns were stocked at 7.9 m<sup>-2</sup> in the manure ponds and 4.6m<sup>-2</sup> in the effluent ponds. After grow-out periods averaging 175 days for fish and 131.5 days for the prawns the ponds were drained and the stock censused. Gains in fish biomass averaged 2516 kg ha<sup>-1</sup> (14.38 kg ha<sup>-1</sup> day<sup>-1</sup>) in the manured ponds and 613 ha ha<sup>-1</sup> (6.06 kg ha<sup>-1</sup> day<sup>-1</sup>) in the effluent ponds. Gains in prawn biomass averaged 322.3 kg ha<sup>-1</sup> (range : 264-414, or 2.46 kg ha<sup>-1</sup> day<sup>-1</sup>). Survival ranged from 17. 4% in a pond which suffered a partial kill in August to an average of 48.1% in other ponds. Prawns weights from individual ponds averaged 127 g (range : 10.5-10.6). Fastest prawn growth occurred in an effluent pond (no common carp). Swine biomass gain was 179.3 kg and the system-wide food conversion ration dry weight gain (pig feed) to wet weight (fish, prawns, pigs) was about 1:1:3. Prawn weight gains compared favourably with those achieved under monoculture with supplemental feeding, and demonstrated that prawns derived a significant, if not complete, portion of their nutritional requirements from heterotrophic productivity stimulated by a manure/ polyculture regimen. Fish and swine gains and the non-existent prawn feed costs demonstrated that polyculture holds a high potential for economic culture of *M. rosenbergii* (Author's Abstract)

532. MALECHA, S. R.; MASUNO, S.; ONIZUKA, D.; 1984. The feasibility of measuring the heritability of growth pattern variation in juvenile freshwater prawns, *Macrobrachium rosenbergii* (de man) *Aquaculture*, 38 : 347-367

The feasibility of estimating genetic variance among full and half sib families of the freshwater prawn, *Macrobrachium rosenbergii*, was investigated. The broad sense heritability,  $h^2$ , for juvenile prawns was estimated to be low, about 0.35 (t0.15) for females and not statistically

different from zero for males. This sexual dimorphism of  $h^2$  values was attributed to sex-linkage variance but caution is urged in interpreting these values for indications of possible response to selection. Heritability estimates were made on individuals from 50 full and half sib families nested within 16 sires in an unbalanced design of 5, 4, 3 and 2 dams per sire for 3, 3, 3 and 7, respectively, sire families. Sibships were spawned over a 7-day period using a prechosen pool of sires and dams, the latter especially picked for their ovigerous condition and pre-ecdysis nuptial molt stage. Expected molt patterns which allowed selection of the dam pool were derived in advance. Mating and spawning success of both dams and sires was high; about one-third of the ovigerous females chosen were unable as dams and nearly all of these, as well as the sires, gave successful spawns. Post-larvae rearing tables were used in the juvenile growth phase. Bearing table main effects were encountered in the latter stages of the study and therefore separate  $h^2$  estimates were made for each table. The table rearing individuals, thereby eliminating the need for individual tagging, up to an average weight 2 g. Temperatures (26-28°C) needed for acceptable growth rate were maintained. One management related episode of acute hypoxia developed which caused a large mortality. Recommendations to minimize these risks are made.

533. MANASVETA, P.; PANICHAYAKUL, S.; PIYATIRATITIVORAKUL, P ; PIYATIRATITIVORAKUL, S. 1984. Effects of different diets on survival of giant prawn larvae (*Macrobrachium rosenbergii* de Man). *J. Sci. Soc. Thailand*, 10 : 179-187.

Effect of live food and different compound diet on survival of giant prawn larvae were studied. Two sequential experiments were carried out. The first experiments dealt with five types of diets. Each diet was fed to a group of prawn larvae. The diets were *Artemia* nauplii and four types of compound diet comprising of fish protein, milk protein and shrimp head extract. The second experiment consisted of alternated feeding, i.e. 12th compound diet and 12th *Artemia* nauplii. The compound diet of this experiments were the same with the first experiment. The larvae receiving a single diet (1st experiment) exhibited lower survival than those of the alternated feeding experiment. In regards to the alternated feeding, the diet comprising fish protein resulted in better larvae survival than the milk protein diets; although there was statistically no significant difference in survival. The diets containing shrimp head extract always gave better survival when compared with those without the shrimp head extract.

(Author's Abstract)



534. MARICHAMY, R. 1987. Prawn farming in the tidal flat of Kallar estuary. *J. Mar. Biol. Ass. India*, 29(1 & 2) : 63-68.

Prawn farming is gaining importance in South-east coast of India in recent years. Derelict area along the edge of Kallar River at Veppalodai has been developed in to productive culture ponds. Potential grounds for the collection of euryhaline species of prawn have been identified in the tidal inlets along Gulf of Mannar. Culture is done in 2 seasons in a year. Juvenile prawn *Penaeus indicus* of model size 25-35 mm obtained from wild and stocked in August 1985 grew to marketable size of 138 mm in five months and those stocked in February 1986 are harvested from July onwards. A difference in the growth has been noticed in two different sets of experiments and causes attributed mostly to the environmental features of the culture ground. Better survival and production are obtained in the summer crop. Supplementary feed was given in the form of pelletized feed and trash fishes. Production rate was 530-1200 kg/ha/crop although salinity ranged from 31-48‰. The present results indicate the scope for further development of unutilized areas for culture practice by improving certain management practices.

535. MARICHAMY, R; RAJAPACKIAM, S. 1982. The culture of milkfish, mullet and prawn in an experimental marine fish farm at Tuticorin. *Proc. Symp. Coastal Aquaculture*, Held at Cochin From January 12 to 18, 1980. Marine Biological Association of India, Cochin. 1 : 256-265

Some preliminary polyculture experiments carried out in saltpan reservoir using *Chanos chanos*, *Mugil cephalus* and *Penaeus indicus* are stated. The seedlings collected from nearby estuarine areas were stocked at different intensities. The major problems were the prevalence of competitors and maintenance of water quality. Of the three species, mullet appeared to grow well and survive better resulting in an increased rate of production. Marketable size of 31 cm was attained in a period of 9 months. A marked difference in rate of growth and production observed among the three sets of experiments is discussed. Based on the observations, improvements in the saltpan-culture management are suggested.

536. MARY A.; NAGABHUSHANAM R.; SAROJINI R., 1986. Toxicity evaluation of organophosphorus and chlorinated hydrocarbon pesticides in freshwater prawn *Macrobrachium lamerrii*. *J. envir Biol.* 7 (3), 189-96.

The comparative tolerance study showed that among the organophosphates, Fenitrothion and Dichlorvos were more toxic than organochlorine compound tested, viz. BHC, DDT Aldrin. Fenitrothion was highly toxic to *M. lamerrii*. The order of organophosphorus toxicity was Fenitrothion Dichlorvos Metasystox Dimethoate. At 24 h DDT is more toxic than BHC and Aldrin. At 72 h exposure, low concentrations, caused significant reduction in the survival of *M. lamerrii* and they showed the time and dose response relationship. 13 ref.

537. MATHEW, K. J.; RENGARAJAN, K.; SELVARAJ, G. S. D.; GOPALAKRISHNAN, K. N. 1982. A sample device for the quantitative assessment of prawn and fish seed resources in the estuarine areas. *Proc. Symp. Coastal Aquaculture*, Held at Cochin from January 12 to 18, 1980, Marine Biological Association of India, Cochin 1 : 302-307.

A Quantitative seed Sampler (Qss) devised for sampling in the estuaries and backwaters is described. It consisted of an aluminium foldable cage of the size of 100x75 cm open at top and bottom. All the four sides of the cage were covered with nylon netting. Besides this, a square scoop net of 95 x 95 cm which would almost fit into the cage, was used to scoop out the Invenile/fry trapped inside the cage. Fabrication of the sampler, materials used, dimensions, method of operation, results of the efficiency studies made and advantages and disadvantages are discussed in detail.

538. MATHEW, P. M. 1987. Prospects of tiger prawn culture in Kerala. National Symposium on Research and Development in Marine Fisheries, Mandapam Camp 16-18 September 1987. CMFRI, Sp, Publ, 40 : 47.

The growth rate and the yield potential of the prawn, *Monodon*, are stated to be discussed in the paper to follow, on the basis of the experience gained from the culture of this species in Vyttila Fish Farm, Cochin and the main problems in the development of its culture in this are pointed out and the probable solution to these are suggested.

539. MANNING, S. F. 1964. Trends in American shrimp cultivation. *World Fish.*, 13(12) : 34-36.

Different aspects of shrimp culture including the scope and constraints are discussed.

540. MENON, M. K. 1957. Contributions to the biology of Penaeid prawns of the South-west Coast of India. I. Sex ratios and movements. *India J. Fish.*, 4(1) : 62-74.

The sex ratio, different periods in the life of 4 species of penaeid prawns, *Metapenaeus dobsoni*, *M. affinis*, *Penaeus indicus* and *Parapenaeopsis stylifera*, and their inshore and off-shore movements are discussed. Sex-wise, year and class wise average percentage contribution to the annual fishery at Narakkal are also determined.

541. MENON, M. DEVIDAS. 1967. "Carpe Diem". *Seafood Trade Journal* 2 (1) : 99-106.

The Problem of natural environments and conditions that facilitate the growth of shrimps and other crustaceans, the difficulties these organisms face in their natural habits by many and varied changes and developments that take place in estuaries and backwaters by reclamations are discussed. Production, biological data of important prawns, breeding grounds of prawns are also given.

542. McFARLAND, W. N.; LEE, B. D. 1963. Osmotic and ionic concentrations of penaeidean shrimps of the Texas Coast. *Bull. Mar. Sci. Gulf Caribb.* 13(3) : 391-417.

Bioenergetics study of the shrimp has been made.

543. MEERAN, N. K.; SEBASTIAN, M. J. 1972. On rearing the larvae of fresh water prawn, *Macrobrachium rosenbergii* (de Man). In : Proc. Seminar on Mariculture and mechanised fishing, Madras (India) 28 & 29 Nov, 1972, 94-95.

Various aspect of the rearing the larvae of freshwater prawn, *Macrobrachium rosenbergii* (de Man) has been discussed.

544. MOHAMED, K. H.; VEDAVYASA RAO, P. V.; GEORGE, M. J. 1963. Post larvae of penaeid prawns of South-west coast of India with a key to their identification. Proc. World Scientific Conf. on the Biology and Culture of Shrimps and Prawns Mexico City, 12-21 June 1967. *FAO Fisheries Reports*, 57(2) : 487-504.

The first postlarva of *Penaeus indicus*, *Metapenaeus monoceros*, *M. affinis*, *M. dobsoni* and *Parapenaeopsis styliifera* are described. A comparison of their identification are given together with notes on distribution and on swimming behaviour.

545. MOHAMED SULTAN, K. M.; SIDDHARAJU, S.; RAMACHANDRA MENON, V. 1982. Artificial prawn feed compounded with frog flesh waste as the main ingredient. *Proc. Symp. Coast. Aquaculture* Held at Cochin from January 12 to 18, Marine Biological Association of India, Cochin 1 : 344-348.

Preliminary investigations conducted by the Tamil Nadu Mariculture Research Station at Kovalam, near Madras, on prawn feed formulation by the using frog flesh waste collected from processing plants as main ingredient were proved to be nutritious and quite acceptable with high conversion value. Conversion ratio ranged from 3.01 to 4.96 with regard to *Penaeus indicus* and from 5.87 to 8.21 with regard to *Penaeus monodon*.

546. MOHAMED, K. H.; MUTHU, M. S.; PILLAI, N. N.; SYED AHAMED ALI; PANDIAN, S. K. 1983. A simplified hatchery technique for mass production of penaeid prawn seed using formula feed. *Indian J. Fish.*, 30(2) : 320-332.

A technique for large-scale production of penaeid prawn seed using a dry microparticulate formula feed, PNCL-17 is described. The details of preparing the feed which is compounded from inexpensive, locally available raw materials such as groundnut oil cake, fish meal, dried mantis shrimp, prawn waste and tapioca and fortified with vitamins and minerals are given.

547. MOHAMED, K. H. 1983. Hatchery production of prawn seed. *Proc. National Symp. Shrimp, seed production and hatchery management* Cochin, 21-22 Jan. 1983. pp. 117-137.

Various aspect of hatchery production of prawn seed discussed.

548. MOTOH, H. 1984. Biology and ecology of *Penaeus monodon*. In : Proceedings of the First International Conference on the Culture of penaeid prawns shrimps, Iloilo City, Philippines. p. 27-36.

The identity distributions, bionomics and life history of *Penaeus monodon* are briefly renewed. The method of measuring the prawn is given giving a diagramatic sketch of the external morphology of the prawn. The developmental phase from egg to adult are illustrated and tabulated, and a diagramatic sketch of the external morphology of the prawn. The developmental phase from egg to adult are illustrated and tabulated, and a diagramatic representation of the life history is given to show its reproduction movements between the outer littoral regions and keys to the post larval penaeus appearing in the show waters bares both on morphological features and on chromatophore patterns are given. Also given is a set of recommendations for the conservation of the species.

549. MOTOH, HIROSHI, NOEL SOLIS; MILAGROS GELANGRE. 1979. Diel flucuations in catch of the postlarval *Penaeus japonicus* group. *O. Res. Rep. SEAFDEC Aquacul. Dep.* 3(4) : 21-22

Sampling of postlarval *Penaeus japonicus* and *Peneus latisulcatus* was done during a 96-h period. Peak catching periods were round to be 0 to 2 h before lower low tides and 0 to 2 h before higher high tides. All peak occurrences were during night time.

550. MUTHU, M. S.; KATHIRVEL, M.; VEDAVYASA RAO, P.; PILLAI, N. N. 1982. Research progress in the culture of penaeid prawns along the coasts of Indian Ocean and Indo-Pacific. *Proc. Symp. Coast. Aquacult.*, Cochin, January 12 to 18. Marine Biological Ass. India, Pt. 1 : 1-1g

A compilation of information covering the areas such as breeding rearing, seed production, nutrition and diseases of important species of penaeid prawns being cultured along the coasts around the Indian Ocean and Indo-Pacific is presented.

551. MUTHU, M. S.; LAXMINARAYANA, A. 1977. Induced maturation and spawning of Indian penaeid prawns. *Indian J. Fish.* 24(1 & 2) : 172-180.

Using the technique of unilateral eyestalk ablation *Penaeus indicus*, *Penaeus monodon*, *Metapenaeus dobsoni* and *Parapenaeopsis stylifera* were induced to mature and spawn successfully in the Institute. These prawns generally attained full maturity within 10-16 days after eyestalk removal and spawned viable eggs that gave rise to normal, healthy larvae.

552. MUTHU, M. S.; LAXMINARAYANA, A.; MOHAMMED, K. H. 1984. pH as a factor influencing maturation of *Penaeus indicus* in captivity. *Indian J. Fish.*, 31(2) : 217-222.

Unilaterally eyeablated females of *Penaeus indicus* have matured and spawned in 3-4 days time when pH of the maturation pools was maintained at a level similar to that of the sea, between 8 and 8.2, by daily addition of sodium carbonate. But eyeablated females kept in pools where the pH was allowed to fall below 7.9 did not attain full ovarian development and no spawning was obtained.

(Author's Abstract)

553. NAKAMURA, KAWORU. 1983. Identification of midgut gland motoneurons derived from suboesophageal ganglion of the prawn *Penaeus japonicus* Bate. *Bull. Jap Soc. Sci. Fish.* 49 (11):1669-1672.

The suboesophageal ganglion of the prawn *Penaeus japonicus* was composed of five neuropile, locally distributed nerve cells, and dorsal axon bundles connecting with the superior and inferior nervous systems.

554. NARAYANAN KUTTY, M. 1967. Oxygen consumption of the prawn, *Penaeus indicus* Milne-Edwards and *Penaeus semisulcatus* de Haan. F. A. O. World Scientific Conference on the Biology and Culture of Shrimps and Prawns, Mexico, 12-24 June, 1967. *FAO Fish. Rep.*, 57 (3) : 1075-1101.

The results of the experiments showed that oxygen consumption of *P. indicus* and *P. semisulcatus* declined sharply by about the second day of starvation. Changes in the metabolic rates due to starvation in these species are discussed.

555. NAGABHUSHANAM, R; KULKARNI, G. K. 1982. Endocrine regulation of reproduction in the marine female prawn *Parapenaeopsis hardwickii* (Miers) Crustacea, Decapoda, Penaeidae). *Proc. Symp. Coastal Aquaculture, Cochin, January, 12-18, 1980. Marine Biological Association of India*, p. 40-47.

Effects of bilateral eyestalk extirpation and injections of eyestalk (ES) brain (Br) and thoracic ganglia (ThG) extracts on the ovarian development of eyestalkless (Experiment-I) and normal (Experiment-II) *Parapenaeopsis hardwickii* are reported. Associated changes in the biochemical reserves of ovaries were estimated. The results of experiments showed that eyestalk ablation and injections of brain and thoracic ganglia extracts into both eyestalkless and normal. *P. hardwickii* led to the acceleration of ovarian growth. Injection of eyestalk extract had suppressed the ovarian growth.

556. NAGABHUSHANAM, R; JOSHI, P.K.; KULKARNI, G K. 1982. Induced spawning in *Parapenaeopsis stylifera* (H. Milne Edwards) using a steroid hormone, 17-hydroxy-progesterone. *Proc. Symp. Coastal Aquaculture, Cochin, January 12-18, 1980. Marine Biological Association of India*. p. 37-39.

Mature female *Parapenaeopsis stylifera* having full grown ovaries were selected and divided into two groups (A and B), each containing 10 prawns and maintained them at low temperature (20°C) for 48 before use. A single dose of 17 Hydroxy-progesterone (50 µl/prawn=50 µg/prawn), prepared in 100% Acetone : 6% NaCl. (1:9) solution, was injected into the prawns of group A, whereas control prawns of group B

received the same quantity of Acetone: NaCl solution. It was found that within 12h the prawns of group A spawned, whereas control prawns of group B were still carrying the mature ovary indicating that the steroid hormone, 17 Hydroxy-progesterone, was useful to induce spawning in this penaeid prawn at the lower temperature at which the prawn naturally did not spawn.

557. NAGARAJ, M.; NEELAKANTAN, B. 1982. Fish and shell fish seed resources of Kali estuary along with a note on the mariculture potentialities in Uttara Kannada. *Proc. Symp. Coastal Aquaculture*, 1:383-387.

Juveniles of *Penaeus indicus*, *P. monodon*, *Metapenaeus dobsoni*, *M. monoceros* suitable for farming are reported to have been available among fish and molluscs in the estuary.

558. NAIR, S. R. S.; GOSWAMI, U.; GOSWAMI, S. C. 1977. Effect of salinity on the survival and growth of the laboratory reared larvae of *Macrobrachium rosenbergii* de Man *Mahasagar*, 10(3/4) : 139-144.

Three sets of experiment were conducted to determine the optimum of salinity and the effect of its sudden increase or decrease on the survival and growth of the larvae of *Macrobrachium rosenbergii*. In the first experiment, larvae were transferred to salinities ranging from 5-35 ppt after prior acclimation in each range. In the 2nd experiment, the larvae were transferred suddenly to each salinity and in the last experiment, the larvae were acclimatized to a salinity of 20 ppt and then suddenly transferred to lower salinities (0-15 ppt). It was noticed that salinity had a marked influence on the survival and growth of the early larval stages and that 15 ppt was the optimum salinity, at which maximum growth and survival had occurred. A sudden increase or decrease, was detrimental.

559. NATARAJAN, M. V ; SHAIKJALALUDDIN, R. 1982. Studies on the possibility of intensive culture of prawns. *Proc. Symp. Coastal Aquaculture*, 1 : 229-231.

The influence of stocking rate on growth of *Penaeus indicus* was studied stocking them at a rate of 200 postlarvae per sq.m for nursery rearing and 100 juveniles per sq.m. for grow-out. The observations are discussed.



560. NATARAJAN, P.; SHETTY, H. P. C.; RAJAGOPAL, K. V. 1982. Observations on certain parasites and diseases of freshwater prawn *Macrobrachium equidens* Dana. *Proc. Symp. Coastal Aquaculture* 1 : 354-361.

*Macrobrachium equidens* Dana, collected for a period of one year from June 1978 to May 1979, from the Nethravathy river in Dakshina Kannada was examined for parasites and diseases. The prawns were found to be infected by bacteria, protozoan and isopod parasites. The bacteria that were found to produce a type of shell disease was chitinoclastic, like *Pseudomonas* spp., *Bacillus* spp., *Aeromonas* spp. and *Serratia* spp. Large number of *Microsporidian* cysts were found to have attained to the prawn body. The cysts were more in the rostral cavity, antennal scale and uropods and less on the inner wall of the carapace and appendages. A bopyrid isopod parasite attacking the brachial chamber was also encountered. The incidence and intensity of infection notices and pathology of these infections are described. An instance of a tumour on the carapace is also recorded.

561. NEAL, R. A. 1982. Status of Penaeid shrimp farming in the USA. *Proc. Symp. Coastal Aquaculture*, Cochin. January 12-18, 1989. Marine Biological Ass. India, pt 1:12-15.

A brief analysis is presented of the basic reason for the failure of shrimp farming. Consideration is also given to the question whether technology could be improved to the point that culture would be profitable in the U. S. A. Comparison is made between penaeid shrimp farming and the farming of other high-priced species such as trout, which was being raised successfully in the U. S.

562. NEW, M. B. 1980. A bibliography of shrimp and prawn nutrition. *Aquaculture*, 21 : 101-128.

This paper contains a bibliography of papers published on dietary and nutritional work with shrimps and prawns. In addition, selected papers on related topics, such as the nutrition of other crustacea, the natural food of shrimps and prawns, and physiology

are included. The bibliography is intended to be an aid to existing workers in the field of shrimp and prawn nutrition, to be a launch pad for scientists entering this field for the first time, and to assist those wishing to review specific aspects of this subject.

563. OTSUZ ABRILL, ACRO; CECCALDI, H. J. 1984. Influence de carotenoides purifies ajoutées dans les éléments composés sur la pigmentation de *Penaeus japonicus* (Crustacea, decapoda). Influence of purified carotenoids added to compound diets on pigmentation of *Penaeus japonicus* (Crustacea, decapoda). *Aquaculture*, 36(3) : 217-228.

Penaeid shrimps were fed with a compound diet containing various ratios of carotenoid pigments as carophyll red canthaxanthin.

564. OWENS, L.; GLAZEBROOK, J. S. 1985. Biology of bopyrid isopods parasitic on commercial penaeid prawns in northern Australia. *Second Australian national prawn seminar* : 105-113.

A survey for bopyrid isopod parasites of commercial penaeid prawns from northern Australia was undertaken using samples taken at processing plant.

565. PANIKKAR, N. K.; VISWANATHAN, R. 1948. Active regulation of chloride in *Metapenaeus monoceros*, Fabricius. *Nature*, 16(4082) : 137-138.

Changes in the chloride content of the blood is studied by employing the micro-production of the Volhard titration. The results obtained were presented and discussed.

566. PALISOC, F. Jr. 1987. Observations on the host-parasite relationship of *Epipenaeon ingens* Nobili (Epicaridea: Bopyridae) and *Penaeus semisulcatus* de Haan. *Philippine Journal of Science*, 116 (3) : 281-293.

Samples of *Penaeus semisulcatus* or Tiger shrimp ("hipong bulik") from Manila Bay and Tayabas Bay, and from waters off Palawan, Cebu, Samar and Capiz were obtained from the Navotas Fishery Port, during the

period from March, 1978 to February, 1979. The prevalence of *Epipenaeon ingens* in *P. semisulcatus* is 4.83/1000. No significant difference ( $P > 0.05$ ) in the prevalence of infection between the sexes was found. The parasite *E. ingens* was lodged on either side of the host's carapace and there was no significant difference in the regression analyses of tumor size on carapace length whether tumor is on the right or left side of the carapace of either male or female host. Despite the homogeneity of regression lines in the comparative analyses of length-weight relationship of infected and uninfected *P. semisulcatus*, the slope of the regression lines of the infected samples are always higher than the values of the uninfected ones. (Author's abstract)

567. PANIKKAR, N. K. 1946. Further observations on the osmoregulation of some crustacea. *Proc. Indian Sci. Congr.* 33rd Sess., 3 : 118.

The paper deals with the results of the experiments conducted on the osmoregulations of palaemonid prawns.

568. PANIKKAR, N. K. 1948. Osmoregulation in penaeid prawns. *Proc. Indian Acad. Sci. Congr.* 35 th Sess., 192-193.

Osmotic behaviour of *Metapenaeus monoceros*, *Penaeus carinatus* and *P. indicus* studied and the results of cryoscopic data and their significance on the distribution of these species with the general problems of osmoregulation discussed.

569. PANIKKAR, N. K. 1948. Penaeid prawns breeding in fresh water. *curr. Sci.* 17 (2): 58.

With reference to Chacko's (1947) paper, the author discusses the breeding of penaeids and their tolerance to salinity.

570. PANIKKAR, N. K. 1951. Physiological aspects of the adaptation to estuarine conditions. *Proc. Indo-Pacif. Fish. Council; 2nd meet.. Sec. B.*, 168-175.

Important prawns of the family Penaeidae and Palaemonidae found in the estuarine habitats listed. Gives a brief account of the Physical features

of estuarine habitat, temperature and salinity, adjustments to low salinities adaptation without osmoregulation, hyper and hypo osmotic regulation, active regulation of chlorides and transport of ions, adaption of fresh water invertebrates and vertebrates entering estuaries. temperature osmotic regulation, and reproduction, influence of calcium and biochemical adaptations.

571. PANIKKAR, N. K. 1968. Osmotic behaviour of shrimps and prawns in relation to their biology and culture. *Proc. World. Scientific. Conf. on the Biology and culture of Shrimps and Prawns. FAO Fisheries Reports, 57 (2) : 527-538.*

The importance of prawns such as *Macrobrachium* in culture practices and their migration patterns between marine and freshwater environments are briefly reviewed, and their capacities for osmotic regulations by which they become adaptable to these variable surroundings are mentioned. The influence of environmental factors like temperature and salinity on the osmotic behaviour and the optional ranges of these parameters are discussed.

572. PARKER, J. C.; CONTE, F. S.; MACGRATH, W. S.; MILLER, B.W. 1974  
An intensive culture system for penaeid shrimp *Proc. World Mar, Cult. Soc, 5 : 66-80.*

A shrimp production module was constructed on a pilot scale at Corpus Christ, Texas and operated on a demonstration basis from 21 April through 10 November, 1973. The unit, consisting of three adjacent ponds of 0.05 ha (nursery), 0.1 ha (intermediate) and 0.2 ha (grow out) through which shrimp were rotated as they grew, provided a better utilization of space then previously realized in single pond units. Properly designed and operated, this module has production capabilities of 2,000 to 3,000 kg of shrimp during the 6 to 7 months growing season available in Texas and up to 6,000 kg in arere where year-round operation is feasible.

573. PATRICK SORGELOOS; KULASEKARAPANDIAN. 1984. Production and use of *Artemia* in Aquaculture. *CMFRI Spl. Publ.* 15-73 p

The biology and ecology, and the life cycles of *Artemia* are renewed giving illustrations). The methods of exploitation of the species from nature, of obtaining nauplii from cysts, of production of *Artemia* in controlled systems etc. are presented, in a manual form.

574. PATWARDHAN, S. S. 1935. On the structure and mechanism of the gastric mill. The structure of the gastric mill in the Narantous *Macrura Caridea*. *Proc. Indian Acad Sci.*, 11B 1-18

18 types of caridea are examined. A complete account of the foregut of *Palaemon malcolmsonii* a comparative account of the same in the remaining types is given. The salient features and the differences found in different species are discussed.

575. PAULINOSE, V. T. 1977. Argmmetry of the mandibles in the larvae of some penaeidae (Penaeidae) decapoda, *Proc. symp. Warm. water Zool. spl. Publ. UNESCOINIO*, 1977 pp : 75-79.

Mandibles of the larval stages of genea of penaeid prawn of the Indian Ocean are described and figured. An interesting phenomenon observed is the argmmetry of the mandibles in the larvae of the species of the genera *Metapenaeus penaeopsis*. Teadry penaeus.

576. PAULRAJ, R.; SANJEEVA RAJ, P. J. 1982. Effect of salinity on growth and survival of three species of Penaeid prawns. *Proc. Symp. Coastal Aquaculture*, 1:236-243

Based on laboratory experiments, the effects of different salinities (5‰, 15‰, 25‰, 35‰, 45‰) on the growth and survival of post larvae of *Penaeus indicus*, *P. monodon* and *P. semisulcatus* are given. Post-larvae collected from the Pulicat Lake were acclimated to the respective test salinity levels gradually from the brackishwater from which they were collected and the experiments were conducted for a period of 60 days. In *P. indicus* highest mean weight gain (37 mg/day) was attained at 25‰ level followed by 15‰ and 5‰ levels of salinity and the lowest weight gain (4 mg/day) was attained at 45‰ salinity level. Survival rates were

also high in low salinity levels of 5‰, 15‰ and 25‰ compared to that of high salinity levels of 35‰ and 45‰. *P. monodon* showed the highest mean weight gain (48/mg/day) at 25‰ level followed by 15‰ and 5‰ levels, and growth was comparatively poor at 45‰, and 35‰ salinity levels. However, high survival rates (85% to 100%) was obtained for this species in all tested salinities. Among the three species studied, *P. semisulcatus* showed poor growth and survival at 50‰ and at 45‰. This species showed better growth and survival rates at salinity levels of 15‰ and 25‰. Thus *P. monodon* showed better growth and survival rates in all salinities. However, both *P. monodon* and *P. indicus* appeared to show a preference for low salinity, ranging from 5‰ to 25‰. The lowest mean weight gain attained at 45‰ for all the three species indicated the unsuitability of hypersaline water bodies for penaeid young ones.

577. PAUL A. SANDIFER; THEODORE I. J. SMITH, 1975. Effect of population density of growth and survival of *Macrobrachium rosenbergii* reared in recirculating water management systems. *Proc. World Mari. Cult. Soc.* 6 : 43-54.

Growth and survival were monitored among juvenile *Macrobrachium rosenbergii* (de Man) reared at different population densities in recirculating water management systems. Four cylindrical tanks, each with a bottom area of approximately 2.5 m<sup>2</sup>, and two rectangular raceways with bottoms about 2.8 m<sup>2</sup> in area were used in the experiments. The cylindrical tanks were stocked with 0.12 g prawns at densities of 10 to 200 animals/m<sup>2</sup> of bottom area. Juveniles of similar size were stocked in the raceways at about 200 and 400/m<sup>2</sup> in one study, and slightly smaller animals (0.07 g) were reared at densities approximating 200 and 500/m<sup>2</sup> in a second raceway experiment.

578. PAYNTER, J. L.; D. V. LIGHTNER; R. G. G. LESTER 1984 Prawn virus from juvenile *Penaeus esculentus* Rothsberg, P. C. et. al. (Ed) *Second Australian National prawn seminar*: 61-64.

Six virus diseases have been described from penaeids and the first record of a marine virus from Australian waters identified.

579. PEEBLES, JOHN B. 1980. Competition and habitat partitioning by the giant freshwater prawn *Macrobrachium rosenbergii* (de Man) Decapoda, (Palaemonidae). *Crustaceana*, (38 (1) : 49-54.

Under certain predictable conditions *Macrobrachium rosenbergii* kill one another. Under other "field" conditions these prawns appear to segregate by molt stage into different microhabitats. Experiments were conducted to determine if this segregation was the result of competition or a change in habitat selection associated with a change in molt state. Apparently segregation was the result of competition, and not the result of a change in habitat preference associated with a change in molt state. The process of segregation by molt stage seemed to increase the chance that a prawn in a susceptible molt state would survive that period of vulnerability.

580. PENNUCI, J. L.; CASAL de PENNUCI, A; LAWRENCE, A. L.; ZEIN-ELDIN. Z. F. 1982. The assimilation of protein and carbohydrate from prepared diets. *J. World maricul. Soc.* 13 : 134-145.

A total of 59 artificial inseminations were performed in conjunction with 4 cruises in the western Gulf of Mexico. Sperm was removed from spermatophores of males found within the catch and attached between the third and fourth pairs of pereopods of unmated, mature females which were then chilled to 20°C to inhibit spawning until return to the laboratory. Of 53 spawns produced by artificially inseminated females, at least 41 (77) resulted in fertilised eggs and nauplii (range: 100 to 260,000 nauplii per spawn). Of the 41 fertile spawns, 29 produced 50,000 or more nauplii and 20% produced more than 100,000 nauplii per spawn. Approximately 2 million larvae were produced by artificial insemination, while only about one million were obtained from naturally mated females on the same cruises. Thus, the production of nauplii from the cruises was tripled by using artificial insemination in addition to spawning of naturally inseminated females. (Modified author's abstract).

581. PERRY, W. G.; TARVER, J. 1987. Polyculture of *Macrobrachium rosenbergii* and *Notemigonus crysoleucas*. *Jour. World Aquacul. Soc.*, 18 (1) : 1-5.

A polyculture study was conducted in southwest Louisiana comparing production of Malaysian prawns, *Macrobrachium rosenbergii* in mono-

culture and polyculture with Golden shiners, *Notemigonus crysoleucas*. This test revealed stocking of shiners at 24.7/m<sup>2</sup> with prawns at 4.4/m<sup>2</sup> resulted in increased total pond production over monoculture of prawns at 4.4/m<sup>2</sup> with equal prawn yields in both systems and little increase in labor. Feeding rates were based on prawn biomass. Food conversion rates ranged from 0.5 to 1.0 in polyculture and 0.0 to 1.1 in monoculture when total production was considered. Prawn production averaged 640 kg/ha in polyculture and 629 ha in monoculture. Mean size of prawns was 19 g in polyculture and 20g in monoculture. The polyculture of shiners with prawn added an average of 307 kg/ha of the bait fish to pond production. Shiners did not compete seriously with prawns when stocked at these rates. This practice could result in added revenues to producers culturing these species together. (Author's abstract.)

582. PIEDAD-PASCUAL, COLOSO, F TAMSE, R. M. 1983. Survival and some histological changes in *Penaeus monodon* Fabricius juvenile fed various carbohydrates. *Aquaculture*, 31 (2-4) : 169-180.

Juveniles of *P. monodon* Fabricius were fed on semi-purified diet.

583. PILLAI, N N.; MUTHU, M. S. 1988. Experimental stake net fishing in Cochin backwater in relation to the tides and lunar phases. *Symposium on Tropical Marine Living Resources*, Cochin, India 12-16 Jan 1988.

The total catch, species composition and size range of different species of prawns caught by the experimental net during low and high tides are discussed in relation to the new moon and full moon phases.

584. PILLAI, N. N.; MUTHU, M. S. 1988. Observations on the stake net fishery at Thoppumpadi in the Cochin backwater. *Symposium on Tropical Marine Living Resources*, Cochin, India 12-16 Jan 1988. Abstract No. 146.

Observations on the prawn landings from a row of one hundred stake nets at Thoppumpadi for a period of five years from 1969 to 1973 were made. Fluctuations in the stake net prawn fishery and the changes in the size of prawn are discussed in relation to environmental factors and lunar periodicity.



585. PRABHAKARA RAO, A. V.; RAGHAVULU, B. V. 1982. Utilization of Saline ground water for prawn and fish farming. *Proc. Symp. Coastal Aquaculture*, 1 : 295-301.

In the Gurajanappalli-Penuguduru belt in Andhra Pradesh, where a large number of salt pans depended on saline ground water for the manufacture of solar salt, the ground water at the point of its emergence was found to have a pH of 6.8, PO<sub>4</sub>-P of 0.12 pm, NO<sub>3</sub>-N in traces, dissolved oxygen nil, free carbon dioxide 60 ppm, and total alkalinity 884 ppm with salinity varying between 5.54 and 30.00 ppt. But this water flowed through 200 m of very shallow evaporation channels and fed into two ponds was found to have improved in all these parameters and become suitable for aquaculture.

After application of bimonthly dose of inorganic fertilizers, namely, urea, and single superphosphate at a rate of 100 kg each/ha, a rapid improvement in the nutrient status was observed both in the oil and water phases. Thick mats of blue green algae developed within a month. The pond were then stocked with juveniles of tiger prawn *Penaeus monodon* (Fabricius), 65 to to 69 mm in total length, at a rate of 50,000 nos/ha. In the case of *Penaeus monodon* a gain of 89.6 mm in average length and 15.8 g in average body weight was recorded in 75 days. Changes in the abiotic characters and management measures resulting in maintaining them at level conducive for fast growth of the cultured species are described.

586. PRESTON, NIGEL. 1984. Effects of temperature and salinity on survival and growth of larval *Penaeus plebejus*, *Metapenaeus macleavi* and *M. bennettiae*. Rothlisberg, P. C. et al, (Ed). *Second Australian National prawn seminar* : 31-40.

Combined effects of temperature and salinity on the hatching success and survival, growth and development of the larval stages of *Penaeus plebejus*, *Metapenaeus macleavi* and *M. bennettiae* were investigated.

587. PRIMAVERA, J. H. 1978. Induced maturation and spawning in five-month-old *Penaeus monodon* Fabricius by eyestalk ablation. *Aquaculture*, 13 : 355-359.

Sugpo (*Penaeus monodon* Fabricius) females of only five-month old, which were pond-reared from coastal fry and harvested after 4 months, were successfully induced by eyeablation to mature and spawn. The unilaterally ablated females were stocked in an indoor concrete tank with an equal number of males. The first two spawnings were obtained 22 d after ablation, and the eggs hatched into viable nauplii. The duration of each stage observed in the experiment is given.

588. PRIMAVERA, JURGENNEH. 1985. A review of maturation and reproduction in closed thelycum of Penaeids. *Proceedings of the First International conference on the culture of penaeid prawns/shrimp*, Indocits, Philippines p. 47-64.

Study has been made on the important penaeid of the closed thelycum. Ovarian maturation, effect of ablation on maturation and spawning, environmental factors/reproduction, fertilization, incubation and hatching are discussed.

589. PRIMAVERA, J. H. 1982. Studies on broodstock of sugpo *Penaeus monodon* fabricius and other penaeids at the seafdec aquaculture department. *Proc. Symp. Coastal Aquaculture*, Cochin, January 12 to 18, 1980. Marine Biological Association of India. p. 28-36

For hatchery production of *Penaeus monodon* and other penaeid fry, the Seafdec Aquaculture Department is dependent mainly on captive brood stock in the form of ablated females, using up to 1,500 spawners in one year. The availability of such broodstock has enabled us to gather information on the reproductive biology as well as brood stock techniques for *P. monodon* and other species. This paper discusses studies on courtship and mating behaviour, fecundity, egg quality and rematuration; and requirements for induced maturation (source and age of stock, sex ratio, feeding, tank management, etc.) of *P. monodon*. A comparison of biological and construction requirements of two broodstock systems—land based tanks and marine pens is made. Work on other penaeids, mainly *P. indicus* is discussed. Lastly, areas for future research on penaeid maturation are highlighted.

590. PRIMAVERA, J. H.; YOUNG, T.; DE LOS REYES. 1982. Survival, maturation, fecundity and hatching rates of unablated and ablated *Penaeus indicus* H. M. Edwards from Brackish water ponds. *In*: *Proc. Symp. Coastal Aquaculture, Cochin, India, 12-18 Jan. 1980.* MBI pt 1 : 48-54

Study deals that *P. indicus* matures in captivity with or without ablation and that both larval and pond culture are relatively easy.

591. PRIMAVERA, J. H. 1985. Review of maturation and reproduction in closed thelycum penaeids. *In*: proceedings of the First International Conference on the Culture of Penaeid Prawns/Shrimps, Iloilo City, Philippines, 4-7 Dec. 1984. Ed. by Y. Takir J. H. Primavera and J. A. Llobreara. Iloilo, Philippines, Aquaculture, Department, SEAFDEC. p 47-64.

The scope of controlled reproduction in penaeids covers maturation, spawning, hatching of eggs into viable larvae and the production of postlarvae to constitute next batch of broodstock. Spawners used in commercial hatcheries and research laboratories are either wild-caught or matured in captivity. To induce maturation three basic approaches are employed singly or in combination : endocrine, nutritional and environmental. For normsting penaeids, manual spermatophore transfer is being developed. (Modified author's abstract)

592. POTTER, I. C.; PENN, J. W.; BROOKER, K. S. 1986. Life cycle of the western school prawn, *Metapenaeus dalli* Racek, in a Western Australian estuary. *Australian Journal of Marine and Freshwater Research*, 37(1) : 95-103.

The absence of marine records for *M. dalli* below latitude 31°S, together with data on gonadal stages and spermatophore deposition on females of this species in the Swan estuary, provide very strong indications that the western school prawn typically breeds in estuarine environments in south-western Australia. The O+ recruits, which first appeared in samples in February, remained in the estuary during the following months and by November had reached a size suitable for exploitation. At this time they were approaching sexual maturity and were starting to move from the shallow to the deeper waters of the

estuary where they remained for their second year of life. In contrast to Australian *Penaeus* species, *M. dalli* mates during the intermoult period when the shell is hard rather than immediately after moulting.  
(Author's abstract)

593. RAI, B. S. 1964. Some aspects of shrimp processing. *Symposium on Prawn Fisheries in India*. Society of Fishery Technologists (India), Cochin, 1964. p. 17.

Experiments carried out on semi-drying of small sized prawns are presented.

594. RAJAGOPALAN, T. 1984. Food availability and selectivity in prawn culture pond. *CMFRI Special Publication* 19 : 54-57.

This study deals with the selectivity of food organism, if any by prawn in a few selected natural prawn culture environments by making a study of the food item of the prawn as well as the availability of these items in the particular environment.

595. RAJAGOPAL, M. V. 1965. Effect of different media in the determination of number of micro-organism in frozen prawns (shrimp). *Fishery Technology* 2 (1): 151-154.

Changes in the medium for total bacterial count have been suggested and the reasons for the same discussed.

596. RAJYALAKSHMI, T. 1980. Food and feeding in prawns in hatchery and intensive rearing systems. *Proc. Indian Nat. Sci. Acad. B.* 46 (1) : 63-71.

The importance of feed requirements in different type of prawn culture systems is presented in this paper.

597. RAJYALAKSHMI, T. 1981. Further studies on maturity, breeding, age and growth of the estuarine prawn, *Metapenaeus brevicornis* (H. Milne Edwards). *J. Inland Fish. Soc. India*, 13(1) : 57-72.

*M. brevicornis* (H. Milne Edwards) had a prolonged breeding period with two peaks, in summer and monsoon. Females were indicated

to be predominant in all size groups and seasons, and the almost complete absence of males, particularly in the size above 90 mm, indicated lack of tolerance of males attaining maturity to lower salinities.

The modal progression in the length-frequency distribution and the probability plot were used for age determination, and it seemed that the males lived up to 1 year and the females up to 2 years.

598. RAJYALAKSHMI, T. *et al.* 1982. Studies on rearing of *Penaeus monodon* fabricius in brackishwater ponds using pelleted feeds. *J. Inland Fish. Soc. India*, Vol. 14(1) : 28-35.

The results of field experiments on growth and survival of *P. monodon* fabricius using three compounded feed are presented in this paper. The feeds termed 1. using soybean powder as the main ingredient 2. Fish meal as main ingredient 3. squid meal as the main ingredient.

599. RAJYALAKSHMI, T. 1964. On the age and growth of some estuarine prawns. *Proc. Indo-Pacif. Fish. Council*, 11th Seas., Sec. II : 62-83.

Age and growth of some commercially important prawns from the Hooghly Estuary have been estimated by length-frequency method. It has been observed that in the majority of the cases each age group is bimodally distributed. Normally, females are observed to have a faster rate of growth, though the reverse situation was also observed in a few cases. Usually prawn with identical maximum sizes had identical rate of growth.

600. RAJYALAKSHMI, T. 1961. Studies on maturation and breeding in some estuarine *Palaemonid* prawns. *Proc. Nat. Ind. Sci. India*, 27B(4) 179-188.

An account of the studies on ova maturation, fecundity, spawning and breeding period is given.

601. RAJYALAKSHMI, T. 1961. Observations on the biology and fishery of *Metapenaeus brevicornis* (M. Edw.) in the Hooghly estuarine system. *Indian J. Fish.*, 8(2) : 383-401.

Deals with the fishery, growth, migrations, spawning, etc.

602. RAJYALAKSHMI, T. 1961. Larval development of *Palaemon lamarrei* H. M. Edw. and *Leander flumicola* Kemp. *J. Zool. Soc. India*, 13(2) : 220-237.

An account of the structure of the four stages in the development of *P. lamarrei* and the first three stages in that of *L. flumicola* is given. A comparison is made with larvae of similar types of development occurring in species of other waters.

603. RAJAMANI, M. 1982. Biochemical studies on soft prawns: 1, protein nitrogen and non-protein nitrogen contents in *Penaeus indicus*. *Proc. Symp. Coastal Aquaculture*, 1 : 349-353.

The tail portions of the healthy and 'soft' prawns (*Penaeus indicus*) collected from experimental ponds were analysed for protein nitrogen (PN) and non-protein nitrogen (NPN) to find out to what extent the two fractions of the total nitrogen (TN) varied under these two conditions. The analysis revealed that the NPN fraction was considerably higher in the case of 'soft' prawns. It is assumed that the increase of NPN content in 'soft' prawns might be due to endogenous protein metabolism caused by changes in the ecosystem during the period of extreme ecological conditions.

604. RAJE, P. C. ; RANADE, M. A. 1978. Economical implications of shrimp farming *Proc. Nat. Symp. on Shrimp farming Bombay*, 15-18 August 1978. 123-130.

This paper deals with the (1) farm site development and preparation. (2) Shrimp seed production/procurement (3) Cultivation operation. (4) Harvesting and marketing of shrimp farming. (5) Aquaculture economics.

605. RAJE, P. C.; RANADE, M. R. 1972. Larval development of Indian penaeid shrimps-II *Metapenaeus monoceros* (Fabricius) *Jour. Indian. Fish. Ass.* Vol. 2 (1&2):30-46

*Metapenaeus monoceros* (Fabricius), a commercially important penaeid shrimp of the Indo-Pacific region was spawned and reared throughout the post larval stage in laboratory. The species under went three nauplii and mysis stages before becoming a post larvae. The only Indian penaeid shrimp, where larval stages are in complete *M. dobsoni*. The Stages out the appendages of *M. monoceros* are compared with those of *M. dobsoni* Larva, development, *M. monoceros* and *M. dobsoni*.

606. RAMACHANDRAN NAIR, P. V.; MATHEW, K. J., PARAMESWARAN PILLAI, P.; VINCENT, D.; RENGARAJAN, K. 1979. Prawn culture in Quilon. Proc. of the first workshop on technology transfer in Aquaculture, Cochin 23-24 Madras 27-28 year 1979. C.M.F.R.I. Special publication No. 6: 41-45.

Lab to-land programme in Quilon District for the prawn culture. Transfer of technology.

607. RAMACHANDRAN NAIR, P. V.; PILLAI, N. N.; KUNJUKRISHNA PILLAI, V.; PARAMESWARAN PILLAI, P.; MATHEW, K. J.; GOPINATHAN, C.P.; BALACHANDRAN, V. K.; VINCENT, D. 1982. Brackish-water prawn farming in the Ashtamudi Lake area (S. W. Coast of India)-its prospects and problems. *Proc. Symp. Coastal Aquaculture*, 1 : 285-294.

Culture operations carried out in the Ashtamudi Lake area Quilon Dist, Kerala. The results shows that the growth rate of species the first 29 days after stocking was constantly faster in both the years *Penaeus indicus* seed were used for the experiment. *Penaeus indicus*, Estuaries, Quilon, Ashtamudi lake, Kerala.

608. RAMACHANDRAN, K. K.; BOSE, A. N; 1964. Dehydration of prawns by rotary dryers *Proc. Indo-Pacif. Fish. Counc*, 11 th Sess. 11. 272-277.

The use of rotary drum dryer for drying, deshelliling and deveining of prawns discussed.

609. RAMACHANDRAN NAIR, P. V.; LUTHER, G.; CLEMENT ADLOPH. 1965. An ecological study of some pools near Mandapam (South India) formed as a result of the cyclone and tidal wave of 1964. *J. Mar. Biol. Ass. India* 7 (2): 420-439

Refers to *Penaeus indicus*, *P. merguensis*, *P. semisulcatus*, *P. monodon*, *Metapenaeus affinis*, *M. dobsoni*, *M. burkenroadi*, *M. lysianassa*, *P. canaliculatus* and *Acetes* sp. The total number, size range, dominant size and total weight, salinity tolerance of the species are given. The hydrobiological and phytoplanktological characteristics of the pools discussed.

610. RAMACHANDRAN NAIR K. G.; MADHAVAN, P. 1984. Chitosan for removal of mercury from water. *Fishery Techno*, 21 (2): 109-112.

Chitosan from prawn waste was used for the removal of mercury from solutions.

611. RAMADHAS, V., SUMITRA VIJAYARAGHAVAN. 1979. Efficiency of energy utilization in the shrimp. *Metapenaeus monoceros* fed mangrove leaves. *Indian J. Mar. Sci.* 8 : 114-115.

Energy budget of *M. monoceros* was estimated using three species (*Rhizophora mucronata*, *Avicennia officinalis* and *Acanthus ilicifolius*) of mangrove leaves in combination with rice bran as food. The results indicated high assimilation efficiency and low conversion efficiencies and the latter was attributed to the source of protein in the food.

612. RAMAMURTHY, S.; MANICKARAJA, M. 1980. An experiment on the culture of *Penaeus indicus* (Milne Edward) in an estuarine pond at Mangalore. *Indian J. Fish.* 24 (1&2) : 210-212.

The culture of *Penaeus indicus* in the estuarine region of Mangalore holds bright prospects in view of its fast rate of growth. The present investigations revealed that a size of 118 mm is reached within a span of six months. *Penaeus indicus*, intensive culture, Karnataka, Mangalore.



613. RAMAMURTHY, S. 1977. Prawn farm. *Summer Institute in breeding and realising of marine prawn CMFRI Special Publication No.3* 92-103.

Classification of farms, selection of farm site, construction of field farms, engineering and preparation of field farm are discussed in the paper, Prawn farm management.

614. RAMAMURTHY, S.; ANNIGERI, G.G.; KURUP, N. S. 1978. Resource assessment of the penaeid prawn *Metapenaeus dobsoni* (Miers) along the Mangalore Coast. *Indian J. Fish*, 25 (1&2) : 62-66

The fishery and certain aspects of the population characteristics of *M. dobsoni* from 1962 though 1971 are reported. The fishery was generally bimodal with peaks during March-April and September-October and showed wide annual fluctuations. The fluctuations in the annual rainfall seem to bear a direct relation to the magnitude of the fishes.

615. RAMAMURTHY, S ; MANICKARAJA, 1978. Relation between tail and total lengths and total and carapace lengths for three commercial species of penaeid prawn of India. *Indian J. Fish* 25 (1&2) : 233-236.

Prawns are brought to the processing factories in deheaded condition in view of the fluctuating nature of the prawn fisheries and the importance of size composition in population studies the relation between tail length and total length, carapace length for male and females of *Metapeaus dobsoni*, *M. affinis* and *Parapenaeopsis stylifera* was calculated.

616. RAMAKRISHNA, K. V.; RAMAMOHANA RAO, G; PRASAD, R. D.; RAMAN K.; KADIR, M. A.; KRISHNAN, S; JOSEPH, K. O. 1982. Observations on the mixed culture of brackishwater fishes and prawns in a pond at Adyar, Madras. *Proc. Symp. Coastal Aquaculture*, 1 : 244-250.

Mixed-culture experiment conducted in a brackishwater pon 0.045 ha with milkfish, mullets and prawn to know how the stock-harvest manipulation would influence the yield is described. Various methods of stocking, harvesting, such as (1) single stocking and single harvesting, (2) single

stocking and multiple harvesting (3) multiple stocking and single harvesting (4) multiple stocking and multiple harvesting, were tried, mixing milkfish, mullets and prawns. different stocking rates, such as 4,444/ha, 11,111/ha, 5,448/ha and 3,333/ha for milkfish; nil, 5,555/ha, 6,800/ha and 2,644/ha for mullets and 20,000/ha, 16,666/ha, 29,443/ha and 37,777/ha for prawns, were experimented.

Multiple stocking and multiple harvesting when stocked with *Chanos chanos*, *Mugil cephalus* and *Penaeus indicus* resulted in the lowest yield of 680.4 kg/ha/year. highest was 2,986.2 kg/ha/year. The highest was 2,986.3 kg/ha year from the single stocking and multiple harvesting in which *C. chanos*, *Liza macrolepis*, *P. indicus* and *P. monodon* were stocked.

A mixture of rice bran and groundnut oilcake in the ratio of 1:1 was used as supplementary feed in the 2nd and 3rd experiments at 5 to 10% of body weight for fingerlings and growing fish and prawns. Hydrological characteristics of the pond water are also presented and discussed.

617. RAMAKRISHNA, K. V. 1982. Observations on the mixed culture of brackishwater fishes and prawns in a pond at Adyar, Madras. *Proc. Symp. Coastal Aquaculture*, 1:244-250.

Experiments were conducted with milkfish, mullets and prawns with view to have a preliminary information on how the stock harvest manipulation influences the yield from a single brackishwater pond. Mixed culture, Adyar, Madras, prawn, milk fish, mullet.

618. RAMAN, MUNAWAR SULTANA; ABDUL KADIR, P. M. 1982 Evaluation of supplementary feeds for *Penaeus indicus*, *Proc. Symp. Coastal Aquaculture*, 1 : 337-343.

Three sets of yard experiments were conducted to determine the effect of the supplementary artificial feeds prepared from cheap and locally available materials on the growth and survival of *Penaeus indicus*. Feeds were prepared using eleven items, fish meal, prawn-factory waste, groundnut-oilcake, gingely-oilcake, blackgram husk, bengalgram husk, bajara (Kambu), wheat flour, wheat bran, rice bran and

tapioca. A combination of fish meal, rice bran and tapioca in two proportions; 1:1:1 and 2:2:1, proved to be the best among the feeds experimented with, giving good growth, survival and conversion. Though equally rich in protein content, the feeds prepared with prawn-factory waste were not as efficacious as the one with fish meal. Shell powders and other additives did not give any desired effect.

619. RAMAN, K.; SULTANA MUNAWAR; ABDUL KADIR, P. M. 1982. Evaluation of supplementary feeds for *Penaeus indicus*. *Proc. Symp. Coastal Aquaculture 1*: 337-343.

Study on the combinations of cheap and locally available feed stuffs as supplementary feeds for *Penaeus indicus* to assess their effect on its growth.

620. RAMAN, K. 1979. Techniques of shrimp culture. *Madras J. Fish.* 8: 206-211.

Possibilities and requirements of shrimp culturer is discussed. Collection of seed, pond construction, all these aspects elaborated.

621. RAMAN, K. 1967. Observations on the fishery and biology of the giant freshwater prawn *Macrobrachium rosenbergii* de Man. *Proceedings of the Symposium on Crustacea, Marine Biological Association of India, 1965, Part II* : 649-669.

Methods of fishing, annual trends in production, effort and catch rate, monthly fluctuations in the fishery, age and growth, maturity, breeding, fecundity and seasonal migrations are dealt with. The possibility of over-fishing problems posed and certain conservation methods suggested.

622. RAMESH BABU, T; SURENDRANATH, P; RAMAN RAO, K. V. 1987. Comparative evaluation of DDT and Fenvalerate toxicity on *Penaeus indicus* (H. Milne Edwards). *Mahasagar 20 (4)* : 240-253.

The toxicity of DDT and Fenvalerate to *Penaeus indicus* was evaluated by using static bioassay tests. The LC50 values were found to be 0.063 ppm and 0.037 ppm for 48 h and 96 exposure periods of DDT and 0.00054 ppm and 0.00038 ppm for 24 h and 48 h exposure periods of Fenvalerate respectively.

623. RANOEMIHARDJO, B. S. 1980. *Penaeus monodon* culture, (Budidaya udang windu). In : Lokakarya Pembinaan Udang National, Jakarta Jepara, 20 Nov. 1980. Jakarta. Directorate General of Fisheries. 5p (Text in Bahasa).

In rearing *Penaeus monodon*, soil should be fertile and not porous, and water should have a pH of 7-8, temperature of 25-28°C and salinity of 10-25 ppt. To minimize if not eliminate pest, treat pond with 4 ppm derris. Pond should be fertilized using organic material as a base fertilizer. Seed stocking preferably at noon with a stocking density of 25/sq m. After one month, shrimps are transferred to the growout pond where supplemental feeding is given. Four to five months later, partial or total harvesting can be done. (Modified author's abstract).

624. RAO, S. S.; GOPALAN, U. K.; GEORGE, M. J. 1976. Mariculture experiments at the regional centre. National Institute of Oceanography, Cochin. In : 10th *European Symposium on Marine Biology*, Ostend, Belgium, September 17-23, 1975. Edited by G. Persone and E. Jaspers., Vol. 1. p. 357 (Abstract only).

The mariculture experiments conducted on a laboratory scale at the Regional Centre are meant to evolve suitable techniques for culturing of marine organisms. Larval forms of penaeid shrimps obtained from Cochin backwaters were fed on a mixed culture of phytoplankton. Mariculture, shrimp culture.

625. RAO, S. N.; VASAN, A. G. 1981. Some aspects of prawn drying in Kerala. *Proc. Indo-Pacif. Fish. Counc. Occas. Paper* 81.

626. RAO, G. SUDHAKARA 1975. Problems and prospects of prawn farming in India. *Seafood Export Journal*, 6 (3) : 35-41.

Problems in the beginning of pond construction and other constraints regarding prawn culture is discussed in general.

627. RAO, P. V. 1970. Some observations on the larval growth of the commercially important penaeid prawns of Southeast Coast of India. Paper presented to the Indo-Pacific Public Council, 14th Session, document I PFC/C70/Sqm 36, 10p. Aco. *In: coastal aquaculture in the Indo-Pacific Region*. Fishing News held, London, 1973, 279 (Abstract).

Larval growth of the commercially important penaeid prawn, *Parapenaeopsis stylifera*, *Metapenaeus monoceros*, *M. dobsoni* and *Penaeus indicus* were studied.

628. RAO, D S. 1983. Alfalfa promotes growth in prawns. *Mar. Fish. Infor. Serv. T & E Ser.* 53 : 17-19.

This respect deals with the result of the experiments to assess the impact of Alfalfa on the growth rate of prawns.

629. RAO, P. VEDAVYASA. 1966. Maturation and spawning of the Penaeid prawns of the Southwest coast of India. *Proc. World Scientific Conf. on the Biol. and Culture of Shrimps and Prawns, Mexico, 12-21 June, 1967. FAO Fisheries Reports, 57(2) : 285-302.*

Some aspects of the maturation and spawning of *Metapenaeus dobsoni*, *M. affinis*, *Penaeus indicus* and *Parapenaeopsis stylifera* of the southwest coast of India are dealt with.

In all the species the mature ovary consisted of anterior, middle and posterior lobes. Five maturity stages : immature early.

630. RAO, P. VEDAVYASA 1967. Maturation and spawning of the penaeid prawns of the south-west coast of India. F. A. O. World Scientific Conference on the Biology and Culture of Shrimps and Prawns, Mexico, 12-24 June, 1967. *FAO Fish. Rep., 57 (2) : 285-302.*

Maturity stages, maturation process, minimum size at first maturity, breeding season, spawning frequencies, fecundity, salinity, temperature and spawning are given.

631. RAO, P. VEDAVYASA. 1969. On the identification of juveniles of three species of *Metapenaeus* (Decapoda) Penaeidae *Indian J. Fish.*, 16 (1 & 2) : 51-55.

Distinguishing characters of juvenile of three species of commercially important prawns, namely *M. dobsoni*, *M. monoceros* and *M. affinis* are described. A key for their classification is provided based on their characters.

632. RAO, P. VEDAVYASA. 1973. Some observations on the larval growth of the commercially important penaeid prawns, Southwest coast of India. *Indian J. Fish.* 20 (2) : 308-317.

Larval growth of *Parapenaeopsis stylifera*, *Metapenaeus monoceros*, *M. dobsoni* and *Penaeus indicus* are studied.

633. RAO, P. VEDAVYASA. 1973. The influence of salinity and temperature on the breeding and development of some cultivable marine prawns. Proc Seminar on mariculture and mechanised fishing, Madras. Dept. of Fisheries, Govt. of Tamil Nadu, pp. 4 : 67-69.

Influence of salinity on the breeding and larval distribution of penaeid prawns are studied.

634. RAO, P.; VEDAVYASA 1987. 'Soft' prawn syndrome and its control. R&D Series for Marine Fishery Resources Management. 15.

This report deals with the incidence of 'soft' prawn, in the culture system. External symptom, species of prawns affected and occurrence, pathobiological, ecological and physiological observations, and feeding experiments on 'Soft' prawns are discussed.

635. RAO, K. P. 1958. Oxygen consumption as a function of size and salinity in *Metapenaeus monoceros* Fab. from marine and brackish-water environment *J. Exp. Biol.* 35 : 307-313.

Physiological aspect *M. monoceros* has been studied. The results have been discussed in this paper. Oxygen consumption *M. monoceros*.

636. RAO, G. 1975. Problems and prospects of prawn farming in India. *Seafood Export J.*, 7 (3) : 35-41.

A brief review of the existing farming practices in India is given and the scope for more scientific approaches is pointed out. The problems that might be inherent in such approaches and the methods of resolution are covered in detail.

637. RAO, D. S ; PILLAI, P. P.; MATHEW, K. J.; RENGARAJAN, K.; VINCENT, D; KHAMBADKAR, L R. 1983. Alfalfa promotes growth in prawns. *Mar. Fish. Infor. Serv. T & E Ser.* 53 : 17-19.

Alfalfa, a known growth promoter was added to the supplementary feed and experimented with juveniles of *Penaeus indicus* in the laboratory and in the field culture ponds. Details of the experiment conducted by rearing the juveniles in tanks at the laboratory is explained in this paper.

638. RAO, P. V.; DIWAN, A. D.; KAKKATI, V. S. 1984. Fluctuation in calcium levels in the exoskeleton, muscle and haemolymph of *Penaeus indicus*, cultivated in brackishwater. *Indian J. Fish.*, 26 (1-2), 160-7.

The calcium content in the exoskeleton of *P. indicus* cultivated in a brackishwater pond was found between 4 and 15%, which was low compared to other crustaceans. The haemolymph calcium was observed always at a higher level than the calcium in the pond water. Calcium content of pond water and haemolymph showed a direct relationship with the salinity. Relatively high levels of calcium in muscle and low levels in exoskeleton were observed in June, the probable reasons for this abrupt fall in the values are discussed 23 ref.

639. RAPSON, A. M. 1981. Crown of thorns and prawn culture. In : *proceedings of the fourth international Coral reef symposium, Cul.* 2 Edit by Gomez, E. D and Athers P.

Careful management of Coral reef is a better way of looking after them than rigid conservation.

640. RAVICHANDRAN, P.; VARGHESE, P. V.; KARMAKAR, H. C.; RAJYALAKSHMI, T. 1982. Effect of stocking density and size of *Penaeus monodon* (Fabricius) postlarvae in nursery rearing experiments. In: Proceedings of the Symposium on Coastal Aquaculture, Part I, Cochin, 12-18 Jan. 1989. Cochin, India, Marine Biological Association of India. p. 412-413.

Nursery rearing of 14-15.5 mm *Penaeus monodon* post-larvae in a 200 m<sup>2</sup> brackishwater earthen pond was conducted in the different stocking densities of 2.5 to 15 No./m<sup>2</sup> without supplementary feeding. After 28-31 days, survival ranged between 30 and 68.4%, with the lowest observed for the highest density. The size attained under different stocking densities were 47.2-66.4 mm for 2.5 No./m<sup>2</sup>; 45.4-58.7 for 5 No./m<sup>2</sup>; 36.8 for 7.5 No./m<sup>2</sup>; 40.9-64.4 for 10 No./m<sup>2</sup>; 58.4 for 15 No./m<sup>2</sup>. The growth rates were found to be independent of the stocking density until one month of rearing. Weekly growth pattern in relation to the physico-chemical parameters and the possible means of increasing survival are discussed. (Modified author's abstract)

641. RAVICHANDRAN REDDY, S. 1978. Preliminary investigations on the rearing of post larval stages of *Penaeus merguensis* on mysis to stockable stage. *Proc. Nat. Symp. on shrimp farming*, Bombay 16-18, Aug. 1978. 47

642. REDDI, D. V. 1978. Economics of shrimp farming in Karnataka area. *Proc. Nat. Symp. on shrimp farming*, Bombay, 15-18, 1978. 139-141.

Investment, production and outcome of shrimp farming in Karnataka area is outlined. *Aquaculture economics*.

643. REDDY, M. S.; MURTHY, B. N.; VENKATESWARALU, Y.; RAMA-RAO, K. V. 1985. Toxicity of insecticide phosphamidon on tissue carbohydrate catabolism of *Penaeus indicus* (H. Milne Edwards) *Indian J. Mar. Sci.* 14(4), 224-226.

Phosphamidon toxicity induced carbohydrate breakdown in the tissues indicated that the prawn is under toxic stress. Carbohydrate, glycogen, lactate dehydrogenase and succinate dehydrogenase levels decreased in phosphamidon exposed prawns. 16 ref.



644. REDDY, P. S. R.; RAMACHANDRAN, K. 1985. Endophragmal skeleton of prawns - a taxonomical tool. *Mahasagar*, 18(3) : 407-412.

Descriptions of the endophragmal skeletons of *Macrobrachium javanicum*, *M. idae* and *Penaeus monodon* have been given. 'Endosternal plate', 'epistomal apodeme' 'epimeral ridges' 'oblique endosternal rods', 'epimeral plate' and 'mandibular apodeme' revealed distinct differences and these structures have been tentatively named for the first time. The utility of endophragmal skeleton as a taxonomical tool in the prawns has been indicated. (Author's abstract)

645. ROBERTSON LOBY; BRAY WILLIAM; LEUNG-TRUJILLO JOANNA; LAWRENCE ADDISON. 1987. Practical molt staging of *Penaeus setifera* and *Penaeus stylirostris*. *Journal of World Aquaculture Society*, Vol. 18(3) : 180-185.

Molt staging has many applications in penaeid aquaculture as a routine procedure. Using criteria developed for various crustaceans, a method of rapid molt staging was applied setiferus adults.

646. ROYAN JOSEPH, P.; WAFAR, M. V. M.; SUMITRA VIJAYARAGHAVAN. 1978. The brine shrimp, *Artemia salina* and its culture potential in India. *India J. Mar. Sci*, 7 : 116-124.

Studies on a natural population of *A. salina* in the salt pan of Tuticorin indicate several characters differentiating the Indian strain from other strains. The Indian strain shows completely parthenogenetic reproduction and predominance of oviparity.

647. ROYAN, J. P ; SUMITRA VIJAYARAGHAVAN; KRISHNAKUMARI, 1987. Adult *Artemia* as food for juvenile prawns. *Mahasagar*, 20(2) : 109-113.

In the feeding experiments on *Penaeus indicus*, *Metapenaeus dobsoni* and *M. monoceros*, using adult *Artemia* as feed, good growth and food conversion efficiencies were obtained at 15% feeding level in all the three species. The advantages of using adult *Artemia* for cultivable species are discussed.

648. RUANGPANTT, N.; MANEVONK, S.; PECHMANEE, D.; TATTANON, T. 1978. Rematuration and spawning in captivity of *Penaeus monodon* Fabricius. Annu. Rep. Songkhla Fish Stn., 1987 : 203-211. (Text in Thai).

Due to the scarcity of gravid female to support hatchery work, the study to obtain maturation and spawning in captivity is necessary. *P. monodon* from the Indian Ocean was used for the study. Forty one males and 166 females were raised in 50 m<sup>2</sup> cement tank with continuous water circulation through sand bed by air lift at a rate of 1,500 litres/hour. Water was also continuously changed at 1,000 litres/hour. Rematuration is induced by pinching the eyestalk. After 11-18 days of eye ablation, gravid females were available which produced 746,933 post larvae. Throughout the experiment, water temperature is 26.5-29.0°C, salinity 30-31 ppt and pH 8.1-8.4.

(Author's abstract)

649. RUANGPHANIT, N.; PECHMANEE, D. 1978. Experiment on rearing mysis larvae (*Penaeus monodon*) by using three kinds of zooplankton. Annu. Rep. Songkhla Fish. Stn., 1978 : 185-191. (Text in Thai)

Nine plastic containers of 30 litres were used in the experiment on rearing mysis larvae (*Penaeus monodon*) using *Artemia salina*, *Brachionus plicatilis* and *Moina* Sp. as food. Mysis larvae were fed as in the following : A1, A2 and A3 *Artemia salina*; B1, B2 and B3; *Brachionus plicatilis*; M1, M2 and M3 : *Moina* Sp. The results showed that the larvae in A containers developed as usual but the survival rates (23.6%, 12.6% and 19.0%) are lower than the others. The larvae in B and M containers developed nearly usual. The survival rate of larvae in M containers are 11.0%, 39.0% and 18.0% but the size of the post larvae is smaller than the others. (Author's abstract).

- 650 RUBINO, A. J.; LAWRENCE, A. L ; ZEIN-ELDIN, Z. P. 1983. The polyculture of *Penaeus stylirostris* Stimpson and *Penaeus aztecus* in tanks. *J. World Maricul. Soc.* 14 : 96-108.

*Penaeus aztecus*, obtained from the wild, and hatchery-reared *P. stylirostris* were placed together in 65 litre tanks in 5 ratios. Two experiments were done. *P. aztecus* does not seem to be influenced by the presence as much as *P. stylirostris* is influenced by *P. aztecus* in the same tank.

651. SACCAYANAN, E. B.; HIRATA, H. 1986. Circadian rhythm of feeding and respiration in Kuruma prawn *Penaeus japonicus*. Mini Review and Data File of Fisheries Research, 4 : 63-76.

The feeding activity and oxygen consumption of *P. japonicus* was investigated under natural lighting conditions. Feeding in kuruma prawn was found to begin immediately after dusk and at its height from 1600-2000 h, with a secondary peak appearing at 0100 h. Night time mean oxygen consumption rates were almost twice higher than day time rates in the three size groups tested. The small size group had 0.32 mg O<sub>2</sub>/g/h, and 0.51 mg O<sub>2</sub>/g/h; the medium size group, 0.21 mg O<sub>2</sub>/g/h, and 0.37 mg O<sub>2</sub>/g/h, and the large size group, 0.18 mg O<sub>2</sub>/g/h and 0.31 mg O<sub>2</sub>/g/h; and 0.31 mg O<sub>2</sub>/g/h, for day and night mean oxygen uptake rates, respectively. Result suggests that feeding should be done simultaneously during periods of high metabolic activity of the prawn in order to minimise leaching of nutrients from the feeds. In culture practices, higher food conversion efficiencies will consequently results. (Author's abstract)

652. SBORDONI, V.; De MATTHAEIS, E.; COBOLLI, SBORDONI, M.; La ROSA, G.; MATTOCCIA, M. 1986. Bottleneck effects and the depression of genetic variability in hatchery stocks of *Penaeus japonicus* (Crustacea, Decapoda). Aquaculture, 57(1)/4:239-251.

Aquaculture of *Penaeus japonicus* is developing in Italy at a production level. Genetic analysis of the founder stock and five subsequent hatchery generations revealed a constant reduction in levels of allozyme polymorphism. Average heterozygosity decreased from 0.102 to 0.039. The magnitude of the reduction in heterozygosity was much higher than expected from the numbers of breeders placed into spawning tanks at each reproductive cycle. We estimated under the assumption of neutrality, that the effective number of parents contributing to each broodstock might have been as low as four, although the number of shrimp pairs held in spawning tanks varied from 50 to 300 after an initial bottleneck occurred in the first generation. This discrepancy may be explained as the combined effect of some common farming practices and it points out the importance of a careful check of the number of spawners actually contributing to each reproductive cycle. (Author's abstract).

653. SAMPATH, K.; SRITHAR, R. T. 1987. Studies on the effects of feeding frequency on food intake and production in *Penaeus monodon* J. Aqua. Trop., 2(2) : 127-132.

Effects of feeding frequency (once in 5 days, once a day, twice a day, thrice a day, and 4 times a day) on food intake and production were studied in *Penaeus monodon*. Rates of feedings, absorption and production were increased as the frequency of feeding was raised from once in 5 days to twice a day; a further increase in feeding frequency, however did not influence these parameters, while the feeding rate improved with increase in feeding frequency, the meal size (amount of food consumed meal) declined in frequent feeding regimes. The meal size of prawns fed 2 times a day feeding regime was twice that of 3 or 4 times feeding schedule. Gross production efficiency of prawns fed at 2 or 3 times a day did not vary and it averaged 39%. Considering the rate and efficiency of production two meals a day may be optimum for *P. monodon*. At low feed schedule *P. monodon*, adopts the following strategies to cope up with under feeding i, increase the meal size, ii, elevated the efficiency of absorption and production and iii, reduces the metabolic loss. (Author's abstract)

654. SANDIFER, PAUL, A.; HOPKINS, J. STEPHEN; STOKES, ALVIN, D. 1987. Intensive culture potential of *Penaeus vannamei*, Journal of World Mariculture Society, vol. 18 (2) : 94-100.

Tank and pond rearing studies were conducted to assess the potential for intensive culture of *Penaeus vannamei* in South Carolina. Post larvae were stocked in intensive nursery tanks at 500/m<sup>2</sup>. Growth and survival were compared for shrimp reared in control fibreglass tanks and in tanks with artificial substrates.

655. SANJEEVA RAJ, P. J. 1978. Pulicat lake as a giant pond for prawn culture under rural science and technology. Proc. First Nat. Symp. on Shrimp farming, Bombay 16-18 Aug. 1978, 227-229.

Pulicat lake prawn resources, prawn services, human resources and strategy of Pulicat lake is discussed, prawn culture planning, Pulicat lake.

656. SAMBANDAM, K. P.; LAWRENCE, L.; NOBLE, J.; 1982. Some observations on penaeid prawn seed resources in the Vellar estuarine system (Porto Novo). *Proc. Symp. Coastal Aquaculture*, 1 : 308-313.

Juveniles of *Penaeus indicus*, *P. monodon* and *P. semisulcatus* were collected from three regions of the Vellar estuarine system on year-round basis. In the overall abundance, *P. indicus* was dominant in the estuarine system followed by *P. monodon* and *P. semisulcatus*. Two peaks were observed in their abundance, a primary peak during September-October and a secondary peak in January-February. *P. indicus* and *P. semisulcatus* were more towards the lower reaches of the estuary, *P. monodon* was abundant in the middle reaches which had many creeks with plenty of algal vegetation. The hydrographical feature of the estuarine system is discussed in relation to the availability of seed.

657. SAMIPATH, V.; RAMACHANDRA MENON, V. 1975. Preliminary experiments in large culture of prawns at Kovalam in Tamilnadu. *Bull. Dept. Mar. Sci. Univ.*; Cochin, VII(3) : 467-476.

The backwater of Kovalam, about 36 km, South of Madras City, is rich in prawn. Post larvae and juvenile of *Penaeus indicus*, *P. monodon*, *Metapenaeus monoceros* and *M. dobsoni* collected from Kovalam backwaters and Adyar estuary formed the planning motile for the experiments in the culture of prawns in cages. Results of the two experiments with artificial feeding explained in this paper.

658. SANKARANARAYANAN, V.N.; KUMARAN, S.; BALASUBRAMANIAN, T. ROSAMMA STEPHEN; PANAMPUNNAYIL, S. U. 1982. Studies on the environmental conditions of tidal ponds in the Ramanthuruth Island (Cochin). *Proc. Symp. Coastal Aquaculture*, 1 : 362-368.

Temperature, salinity pH, dissolved oxygen, nutrients, chlorophyll 'a' and particulate organic carbon of certain enclosures and tidal ponds in Ramanthuruth Island where prawn naturally grow in abundance are recorded. The environment was subject to seasonal variations due to the monsoons. The ponds were highly productive year round (70 ug/1 Chlorophyll 'a') due to a high amount of particulate, organic matter and, since the ponds were tidal, there was also no depletion of oxygen, showing that the ponds were suited for the culture of prawns.

659. SANKOLI, K. N.; SAKUNTHALA SHENOY; JALIHAI, D. R.; ALMELKAR, G. B. 1980. "Crossbreeding experiment with the giant fresh water prawn *Macrobrachium rosenbergi* and *M. malcomsonii*", In: Giant Prawn — an international conference on *Macrobrachium* farming — Bangkok, 1980 — Proceedings. Stockholm, Sweden, International Foundation for Science. P. 367-378. (International Foundation for Science. Provisional report No. 9).

The mature spermatozoa of *Macrobrachium* sp. were mushroom-shaped with a discoid upper half and a lower stalk. The seminal plasma was secreted by the gland cells lining the lumen of the vas deferens through nearly its entire length. Spermatophore appeared to be formed within the seminal vesicle which housed two spermatophores at a time. Each spermatophore contained a mass of ground substance pushed to the periphery, and a large number of mature spermatozoa.

In winter, the male sex ducts and gonads appeared to be only partially active. Though the seminal vesicle appeared practically devoid of spermatophores, semen could be detected in significant amounts all along the vas deferens. The androgenic gland was characterised by vacuolated cytoplasm and highly pycnotic nuclei during the winter. The total or near-total inactivity of the male system, common in crayfishes in temperate regions, was not detectable in *Macrobrachium* sp., the level of activity during this season was comparable to that of the male freshwater crab, *Paratephysa hydrolomous* inhabiting the same locality.

Eyestalk ablation experiments conducted during winter months indicated that the physiological tilt in *Macrobrachium* sp. was more in favour of somatic growth than reproduction.

660. SANKOLI, K. N.; SHAKUNTHALA SHENOY, 1975. Larval development of mud shrimp *Calinassa (callicherus) Kewalramanii sankoli*, In the laboratory (Crustacea. Decapoda). *Bull. Dept. Mar. Sci. Cochin* VII (4) : 705-720.

The paper deals with the laboratory rearing of *Calinassa (callicherus) Kewalramanii sankoli* collected from Bellikeri Creek, Kowal and the development of the species compressing two zoeal and two post larval stages.

661. SANTHANA KRISHNAN, G. 1986. Brackishwater shrimp culture in India-Part III Economics. *Sea Food Export Journal* 08(11) : 9-11.

This paper deals with the established economics of shrimp culture in India to invite the attention of the entrepreneurs and other related to the sea food industry, enabling them to venture in shrimp farming Shrimp culture, Aquaculture economics.

662. SATHIADAS, R.; PANIKKAR, K. K. P.; JACOB, T.; SATHYAVAN, U. K. 1987. Economics of paddy-cum-prawn culture in Kerala. *R & D series for marine fishery resources management* No. 14.

Cost of production, productivity and income (1981-82), estimated prawn production and employment in Ernakulam District, production trend policy implications are discussed in this paper.

663. SANTHANA KRISHNAN, G. 1986. Brackish water shrimp culture in India part 11. Future prospects. *Sea Food Export Journal* vol. 18(10) : 13-16.

This paper deals with the requirements such as seed, feed, technical know how for effective implementation of shrimp farming in the country. Brackish water shrimp culture, India.

664. SEAFDEC, 1985. Modular pond system also works for prawn. *SEAFDEC Asian Aquaculture*, vol. 7(11) : 1.

Modular pond system found successful for prawn culture.

665. SEAFDEC, 1986. Semi-intensive prawn culture sets record. *SEAFDEC Asian Aquaculture*, vol. 8(2) : 1-2.

Production record of prawn culture.

666. SMITH, D. M.; DALLI, W. 1982. Blood protein blood volume and extracellular space relationship in two *Penaeus* spp. (Decapoda crustacea) *J. Exp Mar Biol. Ecol.*, 63 : 1-15.

The blood volume and extracellular space in two species of penaeid prawn were investigated using five different radioisotope labelled

tracers and by the analysis of haemocyanin copper. Haemocyanin copper analysis gave a measure of the actual blood volume while the tracers gave estimates of extracellular fluid space, (14 C) thiocyanate giving the largest estimate. Different tracers gave different estimates of blood volume and this has been related to the molecular weight of the tracer. The results support the concept that the extracellular space in decapod crustacea consists of at least two functionally separate compartments. The total amount of protein in the blood of well fed *Penaeus esculentus* Haswell did not vary significantly throughout the moulting cycle. Protein concentration decreased significantly immediately after moulting and increased to a maximum prior to moulting again. These changes were mainly due to blood volume changes. With starvation the total amount of blood protein decreased with time but with a concomitant increase in blood volume so that there was a far greater decrease in blood protein concentration. A linear relationship has been found between the reciprocal of blood volume (ml 100 g animal-d) and the blood protein concentration in *P. esculentus* and *P. plebejus* Hess. With the construction of an appropriate calibration curve, this relationship may be used to predict the blood or extracellular fluid volume from the blood protein concentration. Previous work with other Decapods has been discussed with particular reference to the role of changes in blood volume on reported variations in blood protein concentration.

667. SENGUPTA, A. 1978. Construction and maintenance of shrimp farm for commercial production. *Proc. Nat. Symp. on shrimp farming*. Bombay 15-18 August 1978 : 91-95.

Selection of farm site, layout of ponds and lands, design of farm construction of the dyke and maintenance of the farm are the salient features of designing a shrimp farm design of farm.

668. SEIDMAN, EPHRAIM ROSS; LAWRENCE, ADDISON LEE 1986. Growth, feed digestibility, and proximate body composition of juvenile *Penaeus vannamei* and *Penaeus monodon* growth at different dissolved oxygen levels. *J. World Maricul. Soc.* 16 : 333-346

Growth, feed digestibility (apparent total dry-matter digestibility), and proximate body composition of Juvenile *Penaeus vannamei* and



*Penaeus monodon* at dissolved oxygen (DO) levels of 1, 2, 3 and 4 ppm at a mean temperature of 28° C has been evaluated. The four different DO levels were obtained by aerating rates of nitrogen gas counter-current to a constant flow of sea water. A standard formulated diet containing the marker material Cr<sub>2</sub>O<sub>3</sub>, and mean 28% exchange of 30 to 32 ppt seawater per day were used. Initial wet weights of shrimp were 60.2 and 55.5 mg for *P. vannamei* and *P. monodon*, respectively. Final mean wet weights for shrimp maintained at 1, 2, 3 and 4 ppm Do level after a 16-days growth trial were 0.24, 0.40, 0.42, 0.46 g, and 0.16, 0.26, 0.29 g for *P. vannamei* and *P. monodon*, respectively. For both species, a significant reduction in growth and in the instantaneous growth rate (k) was obtained at the lowest DO level. No significant differences were observed for apparent feed digestibility in either shrimp. No difference in moisture and lipid content was noticed for both species, while protein content differed in *P. monodon* growth at different DO levels. A description of the experimental system and a discussion as the significance of the data to the production of shrimp in ponds are presented.

669. SELVARAJ, G. S. D.; MATHEW, K. J.; GOPALAKRISHNAN, K. N. 1980. Techniques for the collection and transportation of prawn seed. *Mar. Fish. Inf. Serv. (Tech. Ext. Ser.) CMFRI, (19)* : 11-12

A series of field experiments were conducted to determine the best and low cost method for prawn seed collection and transport. A shallow scoopnet made of velon screen, mounted on a 1 x 1.5 m metal frame was found favourable for large-scale seed collection in shallow creeks and back-waters. The best time for collection was the early morning hours covering the lowest tide. Results also indicated that 50 prawn fry (20-30 mm in length) per liter of water was the optimum number under unoxygenated conditions and the best for survival up to 24 h. Earthenware containers the most suitable for storing as they could maintain low temperature. Thick polythene bags of 15 l capacity could be conveniently used with 10 L water and 3 L of O<sub>2</sub> filled. No feed should be given during transporting to prevent pollution and dissolved oxygen level of 2.5 ml/l should be maintained.

670. SHIGUENO, KUNIHICO, 1975. Shrimp culture in Japan. Association for International Technical promotion, Falyer, Japan 153 pp.

History, production of fry, growing of shrimp in ponds, harvest, development of techniques, disease of shrimp are discussed in this book. Penaeid shrimp. *Penaeus japonicus* Bate. (all species).

671. SHIGUENO, KUNIHICO, 1978. Problems in prawn culture. (Aqua-culture Series. 19) Amerind Publishing Co. Pvt. Ltd. New Delhi p. 103

The book intended mainly for prawn culturists, gives the relevant results of 30 years of continuous research since 1933, by Hudinaga and several other Scientists under him Bibliography appended at the end of the book make the prawn culture in Japan a practicability. The book having reviewed the current status of prawn culture in Japan, gives the tested technologies of seedling production, culture, harvesting, packing and marketing, as well as presenting briefly the problems that had been encountered and prospects indicated.

672. SHIGUENO, K. 1985. Intensive culture and feed development in *Penaeus japonicus*. In: Proceedings of the First International Conference on the Culture of Penaeid Prawns/Shrimps Iloilo City, Philippines, 47 Dec. 1984. Ed. by Y. Taki, J. H. Primavera and J. A. Llobrera, Iloilo, Philippines. *Aquaculture Department, SEAFDEC*. p. 115-122.

The economic feasibility of shrimp culture with high productivity of over 18 ton/ha crop is still under evaluation in some research Institute. However, there is one exception. In a limited area in Japan, there are 63 tanks that are actually in operation and are commercially productive. One of the trials to to grow *Penaeus japonicus* is herewith introduced to represent the intensive culture of penaeid shrimp. Tank design, faeding, growth, survival water management, cost analysis and disease are described. In addition, an illustration of successful semi-intensive culture in earthern ponds is shown to help explain how to intensify and stabilize production.

(Author's abstract)

673. SHUDO, K.; NAKAMURA, K.; ISHIKAWA, S.; KITABAYASHI, K. 1971. Studies on formula feed for kuruma prawn IV. On the growth promoting effects of both squid liver oil and cholesterol. *Bull. Tokai Reg. Fish. Res. Lab.*, (65) : 129-137. (Text in Jpn).

Effect of squid liver oil and cholesterol on the growth of kuruma prawns, *Penaeus japonicus*, using a formula feed as basal diet is being studied. Largest growth rate occurred in prawns fed with a diet containing 4% squid liver oil and 2% cholesterol. An excess of squid liver oil was observed to lower growth rate of prawn. Based on the analytical data on squid liver oil, a similar investigation was carried out using various amounts of cholesterol. Growth promoting activity was observed in prawns fed with diets containing 0.1-2, 2% with the highest at 0.1% concentration. However growth-promoting effect was slightly lower for cholesterol than that of squid liver oil.

(Modified author's abstract).

674. SIDDHARAJU, S ; RAMACHANDRA MENON, V. 1982. Experiments on shrimp farming in Kovalam brackishwaters of Tamil Nadu. *Proc. Symp. Coastal Aquaculture 1* : 134-145.

The extensive back waters of Kovalam about 36 km South of Madras city is potential area for intensive shrimp farming. Seeds of *Penaeus monodon* and *P. indicus* from nearby tidal creeks were utilised fully for rearing. A full account on shrimp feed formulation with the pellets and its beneficial effect on shrimp growth has discussed.

675. SIDDARAJU, S.; MOHAMMAD SULTAN, K. M.; SREENIVASAN, A. 1978. New System of prawn culture. *Proc. Nat. Symp. on shrimp farming*, Bombay 16-18, Aug. 1978. 174.

Three species of penaeid prawns, *Penaeus indicus*, *P. monodon* and *Metapenaeus monoceros*, were cultured in Nylon Cages fixed in the Kovalam backwater near Madras and Pulicat lake respectively experience results also discussed.

676. SILAS, E. G. 1977. Research and development programme in the culture and propagation of marine penaeid prawns. *Summer institute in breeding and rearing of marine prawns, CMFRI Special Publication No. 3* : 17-25

Penaeid prawns such as *Penaeus indicus*, *P. monodon*, *Metapenaeus monoceros*, *M. affinis*, *M. dobsoni* and *Parapenaeopsis stylifera* are the culturable species. Significance and methods of prawn culture, polyculture of prawn and fishes and problems also discussed in this paper. *M. affinis*, *M. dobsoni*, *Penaeus indicus*, shrimp culture *P. monodon* management *Metapenaeus monoceros*.

677. SILAS, E. G. 1978. Larval development. *Bull. Cent. Mar. Fish. Res. Inst.*, 28 : 1-2.

Introductory part of the larval development of Indian penaeid prawn is discussed. Larval development.

678. SILAS, E. G.; MUTHU, M. S.; PILLAI, N. N.; GEORGE, K. V. 1978. Larval development *Penaeus monodon* Fabricius. *Bull. Cent. Mar. Fish. Res. Inst. No. 28* : 2-12.

*Penaeus monodon*, the giant tiger prawn, has spawned in the Narakkal prawn culture Laboratory of CMFRI. Larvae has been reared to the juvenile stage. The detailed structure of the larval substages is described. Larval development. *P. monodon* Narakkal prawn culture laboratory.

679. SILAS, E. G. 1978. Status of prawn culture in India and strategy for its future development. *Proc. Nat. Symp. on shrimp farming Bombay 16-18, August 1978.*

Research efforts and developmental efforts, of prawn culture in India and water resources, cultivable species, Technological base, strategy, for future development are discussed in this paper.

680. SILAS, E. G. 1983. Objections and scope of summer Institute prawn culture and its importance in National development Social benefits from coastal aquaculture. *Proceedings of the summer Institute in hatchery production of prawn seeds and culture of marine prawns* 18 April — 17 May 1983 p. 1-8.

Scope of prawn culture in India, prawn culture technology and states in India, constraints and prospects are discussed in this paper.

681. SILAS, E. G. 1985. Hatchery production of Penaeid prawn seed *Penaeus indicus*, *CMFRI Spl. Publ.* 23, 41 p.

This handbook is a practical guide to developing hatchery for the mass production of prawn larvae to form seed in culture practices based on the experiences gained by the CMFRI at its then Narakkal Prawn Hatchery Laboratory. Having briefly renewed the biology and larval histories (with illustrations) of local species that are suitable for culture, the book gives guidelines on selection of site, development of infrastructure operation of hatchery, precaution against problems, etc. Manpower requirement and the economics are also given.

682. SILAS, E. G.; MUTHU, M. S.; PILLAI, N. N.; GEORGE, K. V. 1982. Breeding of the marine prawn *Metapenaeus dobsoni* in brackish-water ponds. *J. Mar. Biol. Ass. India.* 24(1 & 2) : 147-149.

Female *Metapenaeus dobsoni* have attained full ovarian maturation in the ponds of the Marine Prawn hatchery of the CMFRI at Narakkal during the summer months when the salinity was 28.0-29.0 ppt. These females were made to spawn in the pond water kept in 50 litre plastic basins and the resulting nauplii were successfully reared up to the late post larval medium. The possibility of breeding *M. dobsoni* is discussed in this paper.

683. SINDERMAN, N.; CARL, J. 1977. Disease, diagnosis and control in North American Marine Aquaculture (Developments in Aquaculture and Fisheries Science, 6). Fisheries Scientific Publishing Company, Newyork, 329 p.

Sources of Information, crustacean diseases, Molluscan diseases, Fish diseases, Marine Turtle diseases are discussed in this book.

684. SINGH, TARLOCHAN, 1978. "The isosmotic concept in relation to the aquaculture of the giant prawn, *Macrobrachium rosenbergii*". In: International Foundation for Science and University Malaysia Regional Meeting on Aquaculture, Muka Head Biological Field Station, Penang, 1978 - Proceedings. Stockholm International Foundation for Science - P. 245-257. (IFS Provisional report, No. 2)

Growth and osmoregulatory studies did not show in *M. rosenbergii* the maximal growth in osmotic media that is believed to be occurring in organisms as they would not be extending energy in doing osmotic work. The paper attempts to explain the phenomenon.

685. SIVALINGAM, P. M.; ALLAPICHAY, I.; KOHIMA, H.; YOSHIDA, T. 1988. Nutritive evaluation trace metals as well as persistent pesticides content in shrimp paste produced in the state of Penang, Malaysia. *Proc. Symp. Coastal Aquaculture, 1* : 329-336.

Investigations on the nutritive values, trace metals, PCBs and pesticides contamination in 19 shrimp pastes, viz, belacan; the local product of solid paste, cecaluk; the local product of liquid paste, produced by various companies in the State of Penang indicated the following.

From the nutritive point of view the moisture, crude protein, crude lipids and ash contents varied between a range of 28.6-70.7%, 32.7-56.6%, 2.77-6.48 and 25.5-57.6% respectively. High levels of Ca 11,300-27,400 ppm, K 4,300-12,800 ppm, Mg 1,400-5,100 ppm, Na 20,700-96,300 ppm, and P 8,000-14,700 ppm were also detected.

With regards to trace metals content of Cd, Co, Cr, Cu, Fe, Hg, Mn, Ni, Pb and Zn the elements of Cd, Co, Cr, Ni, and Pb were below detectable levels (BDL) while Cu, Fe, Hg, Mn and Zn ranged between 5.8-22, 82-54p, BDL-0.073, 6.9-35 and 36-75 ppms respectively.

PCBS and P, P'DDE contents in the shrimp pastes ranged between non-detectable level (ND) -0.046 ppm and ND-9.0195 ppm respectively. These results indicated that the solid and liquid shrimp pastes produced in the State of Penang were of high nutritive value and and was barely contaminated by contaminants of trace metals, PCBs or persistent pesticides which might culminate in health hazards.

686. SHANMUGAM, S.; BENSAM, P. 1982. Experimental culture of prawns and fishes in coastal pens at Tuticorin during 1976-78. *Proc. Symp. Coastal Aquaculture*, 1 : 266-272.

An account of experimental culture of *Penaeus semisulcatus* and fishes *Chanos chanos* and mugil in split Bamboo Screen pens, constructs in the shallow bay at Tuticorin.

687. SHIGUENO, K. 1984. A general view of shrimp farming in Japan *Proceedings of ROC Japan Symposium on mariculture*, December 14-15, 1981. *Tml Conf. Proc.* No. 1 : 73-80.

Major technical problems incurred in the shrimp farming in Japan are discussed considering the following areas: Pond management, fry production: artificial diet, and major causes of mortality in the growing pond. Shrimp farming, pond management.

688. SIVAKAMI, S. 1989. Observations on the effect of fertilizer and feed applications on the growth of *Penaeus indicus*, H. Milne Edwards. *Indian J. Fish.* 35 (1) : 18-25.

Growth of *P. indicus*, in relation to phosphate fertilizer and feed applications was studied in marine microcosms. The first dose of fertilizer did not appear to have any bearing on chlorophyll and zooplankton production. An increase in sediment phosphate was obvious following addition of first dose of fertilizer in the treated pools. Shrimp production was the highest in pools treated with fertilizer and feed and was the lowest in the control. Difference in shrimp growth among various treatments was highly significant except between control and the pools treated with feed alone (Author's abstract)

689. SORGELOOS PATRICK; KULASEKHARA PANDIAN, 1984. Production and use of *Artemia* in Aquaculture. *CMFRI Special Publication*, 15. 74 p.

Biology and ecology of *Artemia*, from natural habitats, separation of hatched nauplii from the hatching debris and *Artemia* production in temporal salt pans are discussed in this report.

690. SPARKS ALBERT, T. 1971. Research priorities for penaeid shrimp mariculture. In : *Proc. Second Annual work shop world mariculture society* P. 221-122.

Three major areas of investigation must be given priority of shrimp mariculture is to become economically feasible. There are studies of mortality and its causes in hatcheries and ponds, nutritional studies and general maturation of female shrimp

691. SPOTTS, D. 1984. The development of shigueno-style shrimp culture in Southern Japan. *Aquaculture Mag.* 10 (4) : 26-28.

Concrete tanks were used for this culture technique. Shrimp (*Penaeus japonicus*) culture trials yielded production approaching 2.65 kg per square meter compare to 0.3 kg per square meter typical of more traditional pond shrimp culture. Feed conversion rates were nearly 1 and survival was 93%.

692. SREEKUMARAN NAIR, S. R. 1986. Studies on the growth of penaeid prawns. 2. Growth of *Penaeus indicus* under different levels of breeding. *Mahasagar*, 16 (1) : 31-36.

*Penaeus indicus* was subjected to four different levels of feeding with live earth worm. The growth increment irrespective of the feeding level did not show any decreasing trend throughout the experimental period. This is probably because the growing prawns were getting more or less constant proportion of food to body-weight although varied with the frequency of feeding. This study also confirmed the high growth potential of this species of prawn. Growth, feeding *Penaeus indicus*, India.

693. SREEKUMARAN NAIR, S. R.; CHANDRASEKHARAN NAIR; GOPALAKRISHNAN, T. C.; KRISHNANKUTTY, M. 1983 Studies on the growth of penaeid prawns III growth pattern of *Penaeus indicus* and *Metapenaeus dobsoni*, *Mahasagar* 18 (1) : 37-46.

Experimental studies on the growth *P. indicus* and *M. dobsoni*, for three and a half months under different levels of feeding gave a growth pattern different from the of von Bertalanffy. The two distinct growth patterns observed under field and laboratory conditions are evaluated in this paper.



694. SREEKUMARAN NAIR, S. R.; KRISHNA IYER, H.; LALITHAMBIKA-DEVI, C. B.; KRISHNANKUTTY, M. 1982. Studies on the growth of penaeid prawns : 1. Length-weight relation and condition factor under different levels of feeding. *Mahasagar*, 15 (1) : 95-104.

Length-weight relation and earth-worm feeding conditions under different levels for *Penaeus indicus* and *Metapenaeus dobsoni*, were estimated. Length-weight exponent in both species was unaffected by the feeding levels and the consequent differences in the growth rate. The coefficient of condition was surprisingly constant in both the species although the growth rates varied considerably with the feeding level.

695. SREEKUMARAN NAIR, S. R. 1987. Invitro fertilization of Banana prawn *Penaeus merguensis* De man. *Mahasagar*, 20(3) : 187-190.

Invitro fertilization of *Penaeus merguensis* is reported. In suspensions kept for a day in which sperms and ova had been mixed and agitated for five minutes, healthy nauplii were observed, which subsequently developed to the mysis stage by the tenth day. It is estimated that 42% of the eggs had hatched to nauplii and 28.5% reached the mysis stage.

696. SRINIVASAN, R.; SABAPATHY, N. 1964. Prawn proceeding practices and experiments in Madras State *Symposium on Prawn Fisheries in India*, Society of Fisheries Technologists (India), Cochin.

Experiments conducted on the canning, preservation of prawns using brine pack, oil pack, and 'masala' pack and the scope of prawn processing industries in Madras discussed.

697. SRINIVASAN, R.; VENKATESAN, V.; CHANDRABOSE VICTOR, S. 1982. Development of brackishwater prawn farming in Tamil Nadu. *Proc. Symp. Coastal Aquaculture*, 1 : 394-395.

Brackishwater prawn farming in Tamil Nadu.

698. SRINIVASAN, R. 1984. Studies on benthos in prawn culture fields of Vypin Island, Cochin, Kerala *CMFRI Special Publications*, 19 : 69-73. (M. Sc. dissertation).

The study was carried out in three different ecosystems prevalent of Narakkal (Cochin) namely, two earthen ponds in the field complete belonging to the Prawn Culture Laboratory of the CMFRI, representing the perennial culture system. Canals in the coconut grove representing typed brackishwater environment Vypin Island Benthos, Kerala.

699. SRIRAMAN, K.; ANANTHA NARAYANAN, R. 1988. Culture of *Penaeus indicus* (Milne Edwards) with different stocking densities *J. Mar. Biol. Ass. India*, 29(1 & 2) : 108-114.

Culture of white prawns *P. indicus* with different stocking densities i. e. 15,000 nos/ha to 75,000 nos/ha was tried by giving prawn head waste as artificial feed in the Estuarine Fish Farm at Portonovo. hydrographical parameters of pond waters like salinity, dissolved oxygen, pH, Temperature and depth have been studied and growth rate of prawn head waste in all the experiments has been explained. Stocking density ranging from 30,000 nos/ha to 45,000 nos/ha seems to be ideal based on the production rate.

700. SRINIVASULU REDDY, M.; VEERABABU, C. R.; RAMANA RAO, K. V. 1989. Changes of lipid components in midgut gland and muscle of penaeid prawns, *Metapenaeus monoceros*. and *Penaeus indicus* exposed to phosphamidon. *Mahasagar*, 22 (1) : 43-46.

The present report deals with the effect of exposure to sublethal concentrations of phosphamidon on lipids and lipid derivatives in penaeid prawns, *M. monoceros* and *P. indicus*.

701. SRINIVASULU REDDY, M. 1985. Toxicity of insecticide phosphamidon on tissue carbohydrate catabolism of penaeid prawn *Penaeus indicus* (H. Milne Edwards). *Indian J. Mar. Sci.* 14 (4) : 224-225.

Phosphamidon toxicity induced carbohydrate breakdown in the tissues indicated that the prawn is under toxic stress.

702. SUBRAMANIAN, P. 1988. Spawner-result distribution *Penaeus indicus* in Parangipettai coastal ecosystem. *J Mar. Biol. Ass. India*. 29 (1 & 2) : 23-36.

Tamil Nadu ranks third in marine prawn production in India. Prawn fishery in Parangipettai Coast is considered the best among the east coast of India. The Indian white prawn *Penaeus indicus* and Tiger prawn *P. monodon* are the commercially valuable components harvested from both estuarine and marine environments. Present study gathered informations about population distribution and abundance of different stages of *P. indicus* both from marine and estuarine phases. Among marine prawn production *P. indicus* contributes 46.18% and 56.18% in the estuarine production. The adult *P. indicus* exhibited high fecundity. Naturally the spawn in open sea, far away from the shore, but within the continental shelf. The hatched out nauplius and protozoa are planktonic and marine in habitat. The mysis and postlarvae were migrated mainly during postmonsoon and summer seasons, to the inland brackish water such as estuary, backwater and mangrove along with tidal currents where they nourished for about 6-9 months as juveniles (upto 120 mm), while approaching maturity they migrated back to sea for breeding and spawning. From the manipulation of field data it was evident that about 14 months are required for a postlarvae to become a viable spawner. The peak value of mean 'Kn' between 105 mm and 115 mm length group indicates the approaching maturity of *P. indicus* and other five peaks between 130 and 175 mm length group reveals five spawning activities and the declining of peaks reveals the subsequent salinity. From the length-weight relationship it was evident that for given carapace length male prawn possessed a greater total length and weight than female counterparts.

703. SUMITRA VIJAYARAGHAVAN; ROYAN, J P.; KRISHNAKUMAR, L. 1981. Use of slaughter house waste as feed for shrimps and prawns. *Indian J. Mar. Sci.*, 10 (4) : 390-392.

Feeding experiments on (*Metapenaeus monoceros*, *M. dobsoni*, *Sarotherodon mossambicus*, *Etroplus suratensis*) using slaughter house waste as feed showed that both the shrimps and *Sarotherodon* were able to thrive on slaughter house waste more efficiently than *E. suratensis* (Author's abstract).

704. SUNARYANTO, A. 1986. Chemical treatment of larval culture : the use of Chloramphenicol, Sodium-EDTA and malachite green in larval culture of *Penaeus monodon* Fab. *Bull. Brackwat. Aquaculture Dev. Cent.*, 8 (1) : 25-30.

Two experiments have been conducted at the Brackish water Aquaculture Development Centre (BADC), Japara, Indonesia, experiment I was run to test the use of Chloramphenicol, Sodium-EDTA, Malachite Green and combinations among them in the larval culture of *Penaeus monodon*. It is proved that the antibiotic treatment is absolutely needed in the culture of larvae. Dealt with the results Experiment I, Experiment II was run to test the use of two seawater sources as larval culture media, with and without antibiotic. Water taken from deep-sea region showed better results than that from original shallow region. The best result is showed by deep-sea water media with antibiotic treatment (Author's abstract).

705. SUDHAKARA RAO, G. 1975. Prawn fishery of the Kakinada back-water. *Bull. Dept. Mar. Sci. Univ., Cochin* VII 427-447.

The Kakinada backwater of Andhra Pradesh, with an area of 320 square km. support an active prawn fishery throughout the year. *Metapenaeus monoceros* dominate the prawn fishery in almost all months of the year. *M. affinis* is very little backwater area.

706. SUMITRA VIJAYARAGHAVAN; VIJAYAKUMARAN, M. 1976. Caloric content of *Metapenaeus dobsoni*, *Indian J. Fish.*, 23(1 & 2):112-126.

Measurement of Caloric content of *M. dobsoni* were made (1) from organic carbon (2) using Kaezimhin (3) Tarkovskaya method and (4) from proximate comparision of body tissues. The results showed that any one of the three methods could be used with reasonable according.

707. SUMITRA VIJAYARAGHAVAN, WAFAR, M. V. M.; ROYAN JOSEPH, P. 1978. Feeding experiments with the shrimp, *Metapenaeus monoceros* (Fabricius) *Indian J. Mar. Sci.* 7(3) : 195-195.

Feeding experiments have been carried out with *M. monoceros* using 4 different compounded diets composition of the results is made with them of other available data for this species. The importance of using natural feeds to obtain greater food conversion efficiencies has been indicated.

708. SUNDARARAJAN, D.; BOSE, S. V. C.; VENKETESAN, V. 1979. Brackishwater fish and prawn culture at Santhome Brackishwater fish farm, Madras *J. Inland Fish Soc. India.* 11(1) : 109-116.

Results of experiments on mixed culture of six prawn species are processed. The ponds 0.09 ha in area were stocked with *Chanos chanos* and reared for six months.

709. SUNDARARAJAN, D ; VICTOR CHANDRA BOSE; VENKETESAN, V. 1978. Preliminary experiments in prawn culture at Santhome Brackishwater farm, Madras. *Proc. First National Symp. on Shrimp farming, Bombay* 16-18 Aug. 1978 143-146.

Juveniles of *Penaeus indicus* and *P. monodon* collected and experiments were conducted at the Brackishwater Fish Farm, Madras, from 1976-1978. The results shows that the growth and survival of *P. monodon* are encouraging.

710. SUSEELAN; C. 1983. Candidate species and their special characteristics for aquaculture. *Proc. Summer Institute in Hatchery production of prawn seed and culture of Marine prawn* 18 April - 17 May 1983 P. 31-42.

Name of penaeid prawn culture in different parts of the world and their characters are explained. Cultivable species.

711. SUSEELAN, C. 1975. The prawn culture practices in salt-pan resources at Manakudy near Cape Comorin. *Bull. Dept. Mar. Sci. Univ., Cochin*, VII(3) : 477-486.

The methods employed for culturing *Penaeus Indicus* in the brackishwater services of the Salt water adjoining Manakudy Estuary near Capecomorin are described together with notes on the biology of the species.

712. SUHARTO, H. H.; DJA JADIREDDHA, R. 1977. Present status of freshwater prawn (*Macrobrachium rosenbergii*) farming in Indonesia, First Asian meeting of experts on aquaculture, Semarang, Indonesia. 21 January to 6 February 1977 Technical report 1. *Proceedings of technical sessions* 2. *Working papers* 1977 : 195-212. ASEAN 77/FA A/Doc. Wp. 13 En

There has been an increasing demand for production of *M. rosenbergii* in Indonesia. There is need for further attention to 1. Pond management technique 2. Growth of prawn in ponds 3. Supplementary feeding 4. Cultivation systems.

713. SURENDRANATHA KURUP, N. 1977. Features of prawns which contribute to their suitability for culture. *Summer Institute in breeding and rearing of marine prawns. CMFRI Special Publication No. 3* : 40-44.

Reproductive characteristics, Larval development, growth rate feeding, economic factors are the suitability of species for cultivation, Prawn farming management.

714. SWAMINATHAN, M. S. 1978. Shrimp farming a new dimension to the scientific utilisation of our aquatic wealth. *Proc. First Nat. Symposium on shrimp farming, Bombay* 10-18, Aug. 78 : 1-10.

General view of the shrimp farming. Induced breeding, nutritional requirements are discussed in this paper. Induced breeding, nutritional requirements, prawn pathology.

715. TAKAHASHI, Y.; SHIMOYAMA, Y.; MOMOYAMA, K. 1985. Pathogenicity and characteristics of *Vibrio* sp. isolated from cultured kuruma prawn *Penaeus japonicus* etc. *Bull. Jap. Soc. Sci. Fish.* 51 (5) : 721-730.

The disease which occurred among cultured *Penaeus japonicus* showed symptoms of cloudiness of muscle, brown spot on gill and lymphoid organ. A bacterium isolated from the heart, lymphoid organ and muscle was proven to be pathogenic to kuruma prawn. The organisms gave positive oxidase and catalase reaction and were sensitive to the vibriostatic agent O/129 and novobiocin. The above mentioned properties of the organisms isolated from *P. japonicus* suggest that it belongs to the genus *Vibrio* Sp.

(Modified Author's abstract)

716. TATTANON, T.; RUNGPANICH, N.; MANEEVONG, S.; PECHMENE, T. 1981. Seeding production of giant freshwater prawn (*Macrobrachium rosenbergii* de Man) in 1981. *Annu. Rep. Natl. Insti. Coast Aquacul. Dep. Fish.*, (1981) 59-70. (Text in Thai)

The giant freshwater prawn (*Macrobrachium rosenbergii*) was reared on Jan-Sep. 1981. Larvae were stocked in a 10 ton tank at 15-20 larvae per liter. It took about 20-22 days for the larvae to become juveniles at 30-33°C water temperature. Of the 785, 800 juveniles (survival rate 52.5%), 382, 800 were distributed to prawn farms and 304,000 were released into the natural water for restocking.

(Modified Author's abstract)

717. TASUM, W. M.; TRIMBLE, W. C. 1978. Monoculture and polyculture and polyculture pond studies with pompano (*Frachinotas*) and penaeid shrimp *Penaeus aztecus*, *P. duorarum* and *P. setiferus* in Alabome, 1075-77. *Proc. world mari. soc.* for 9 : 433-486.

Three methods of stocking polyculture ponds were investigated studies were conducted seasonally from 1975-77 in 0.08 ha brackish water ponds at the Claude Peteet Mariculture Centre on monoculture of Florida pompano *Frachinotus carolinus*, *Penaeus aztecus*, *P. setiferus* and *P. duorarum* polyculture *Penaeus aztecus*, *P. duorarum*, *P. setifera*.

718. TESHIMA, S.; TOKIWA, S. 1979. Biosynthesis a fatty acids from palmitic acid in the prawn, *Penaeus japonicus*. Kanazawa, Mem. Fac. Fish. Kagoshima Univ. 28, 17-20 (1979) Enten.

The biosynthesis of fatty acids from palmitic acid (16:0) was examined in *P. japonicus*, at the intermoult stage. After injection of 16:0- $^{14}C$ , polar lipids (PL) and neutral lipids (NL) were isolated from the whole body of *P. japonicus* and the proportional ratio activity of individual fatty acids constituting PL and NL was determined by preparative gas liquid chromatography followed by radioactive measurements of the trapped samples. In PL and NL radioactivity was mainly associated with 12:0, 14:1, 16:0, 18:19 and 20:19 but not or scarcely with 18:26, 18:33, 20:59, 22:63 may be essential for the prawn, *P. japonicus*.

719. TESHIMA, S.; KANAZAWA, A.; LALITA, Y. 1986. Effects of dietary phospholipids on growth and body composition of the juvenile prawn. *Bull. Jpn. Soc. Sci. Fish.*, 52(1) : 155-158.

The prawn *Penaeus japonicus* was reared with diets containing 3% soybean lecithin (diet) and no supplemental phospholipids (PL) (diet D) for 30 days. The deficiency of PL in diets significantly reduced the weight gain and feed conversion efficiency. The prawn receiving diet D. without supplemental PL contained a lower concentration of PL such as phosphatidylcholine and phosphatidylinositol, in the whole body than the ones receiving diet A with supplemental PL. The retention (%) of dietary lipids, especially cholesterol, in the body was also significantly lower in the prawns receiving diet D than those receiving diet A. These data indicate that the juvenile prawn requires dietary sources of PL for good growth; suggesting that the dietary PL.

720. TESHIMA, S.; KANAZAWA, A. 1986. Nutritive value of sterols for the juvenile prawn. *Bulletin of the Japanese Society of Science Fisheries*, 52(8) : 1417-1422.

Feeding experiments were conducted using 5 test diets to examine the nutritive value of several sterols for the juvenile prawn *Penaeus japonicus*. The prawn showed a markedly lower weight gain, feed



conversion efficiency (FCE), and protein efficiency ratio (PER) on a sterol-deficient diet, than diets with 0.5 % levels of cholesterol, B-sitosterol, B-sitosterol cholesterol (9:1, w/w), or 24-methylcholesta-5,22-dienol as sterol sources. Cholesterol was most effective among the sterols examined in improving the weight gain, FCE, and PER. Although both 24-methylcholesta-5,22-dienol and B-sitosterol were effective in improving growth, the former had a higher efficacy than the latter. The addition of small amounts of cholesterol to a B-sitosterol-diet improved the FCE and PER somewhat, but, not the gain in weight. The retention rates (%) of dietary proteins and lipids to the body were markedly lower in the prawn receiving the sterol-deficient diets than in those receiving the diets containing sterols. The retention rate of dietary total sterols to the body varied with the kind of sterols in diets, the highest retention rate being observed on a cholesterol-diet. Dietary 24-methylcholesta-5,22-dienol and B-sitosterol were less retained in the body than dietary cholesterol, although the two former sterols were likely to be converted to cholesterol in the body.

(Author's abstract).

721. THAMPY, D. M.; SÉBASTIAN, M. J.; SUSEELA, E. A.; RAJENDRAN, C. G. 1982. Relative abundance and distribution of the postlarvae juveniles of *Penaeus monodon* Fabricius in the Cochin Backwater and prospects of their utilization in culture fisheries. *Proc. Symp. Coastal Aquaculture*, 1 : 223-228.

A survey of the seed resource of cultivable species of prawns conducted in the Cochin Backwaters at Puthuvypeen for a period of 14 months from May 1978 to May 1979 showed that the post-larvae of *P. monodon* were available fairly well during April-May. Using Midnapore type shooting net 419 postlarvae were collected per hour in May 1978. In June and July the availability dropped, consequent to heavy monsoon. In June the catch per net per hour was 36 and in July it was 24. The catch per net hour increased to 66 in August and then decreased to 13 in September. From October to December the post larvae of *P. monodon* were not present in the collection. In March 1979 they appeared again in sizeable quantities, the catch per net per hour being 189. These continued to be available and the catch improved to 232 per hour in April and 253 in May

1979. The percentage availability of *P. monodon* ranged between 3.7 in June 1978 and 0.17 in July 1978.

Juvenile of *P. monodon* were obtained in collections made with Midnapore type shooting net, drag net, hape net and ring net, the maximum being with ring net operated underneath the submerged marginal vegetation during September-October period. With drag net and hape net the percentage availability of the juveniles was only 2.0 in September and 3.1 in October. The prospects of the utilization of the seed of *P. monodon* for culture in the brackishwater ponds and perennial prawn culture fields are discussed.

722. THIRUNAVUKKARASU, A. R. 1983. Culture of penaeid prawns in coastal waters. *Proc. summer institute in Hatchery production of prawn seed and culture of marine prawns* 18 April-17 May 1983. P. 266-288.

Culture systems, preparation of the pond, stocking, feeding, water management, harvesting methods, polyculture with compatible species are the points dealt with the coastal Aquaculture.

723. THOMAS, M. M. 1975. Reproduction, fecundity and sex ratio of the green tiger prawn, *Penaeus semisulcatus* De Haan. *Indian J. Fish.* 21 (1) : 152-163.

Investigations on the reproduction, *gonado-somatic* index, fecundity and sex ratio of *P. semisulcatus* were carried out at Mandapam camp from April 1967 to March 1969. The samples examined contained more or less same number of males and females, although, during certain months the males were more in number while in other months the females were dominating.

724. THOMAS, M. M. 1976. As protozoan infection in *Penaeus semisulcatus* at Mandapam. *Indian J. Fish.*, Vol. 23 (1 & 2) : 282-284.

A few specimens of *P. semisulcatus* collected from Mandapam area were found infected with a microsporidian parasite tentatively identified as *Thelohania decorald*.

725. THOMAS, M. M.; GEORGE, K. V.; KATHIRVEL, M. 1974. On the spawning and early development of the marine prawn, *Parapenaeopsis stylifera* (H. Milne Edwards) in the laboratory. *Indian. J. Fish.* 21 (1 & 2) : 263-271.

Marine penaeid prawn of the species, *P. stylifera* left in tanks in the laboratory have successfully spawned. The larvae were reared up to mysis 1 stage. The eggs have taken on average of 7 hrs for hatching. Brief examinations of various larval stages also discussed.

726. THOMAS, M. M.; KATHIRVEL, M.; PILLAI, N. N. 1974. Spawning and rearing of the penaeid prawn *Metapenaeus affinis* (H. Milne Edwards) in the laboratory *Indian. J. Fish.* 21 (2) : 543-556.

The results of two experiment on the spawning and large-scale rearing of *M affinis* under laboratory conditions are reported. The morphological features of the different larval stages are described in detail.

727. THOMAS, M. M ; KATHIRVEL, M.; PILLAI, N. N. 1974. Observation on the spawning and rearing of *Metapenaeus dobsoni* under laboratory conditions. *Indian. J. Fish.* 21 (2) : 575-579.

Provide females of *M. dobsoni* (Miers) collected from the fishing grounds of Cochin spawned in the laboratory and the larval development was traced up to post larvae IV. After 8-9 h of spawning, Nauplius 1 larvae emerged and they reached protozoa brief description of the various larval stages are given.

728. THOMAS, M. M.; KATHIRVEL, M ; PILLAI, N. N. 1974. Laboratory spawning and early development of *Parapenaeopsis acclivirostris* (Alcock) Decapoda; penaeidae) *J. Mar. Biol Assn India* 16(3):731-740.

Information on egg, naupliar and protozoal stages of *Parapenaeopsis acclivirostris* (Alcock) are given for the first time as the result of the spawning of the species in the laboratory. The spawning took place in the midnight and the nauplius 1 emerged at 0800 hrs next morning. Eggs, five naupliar and three protozoal detail stages are described and illustrated.

729. THOMAS, M. M.; EASTERSON, D. C. V.; KATHIRVEL, M. 1984. Energy conversion in the prawn *Metapenaeus dobsoni* (Miers) fed on artificial feed. *Indian J. Fish. Cul.* 31 (2) : 309-312.

Measured quantities of feed containing 33.33% by weight of tapioca powder 16.67% of fish meal and 8.33 to mineral supplements (starnus PS) binding agent, were fed to *M. dobsoni* average efficiency was of the order 80.99% *M. dobsoni*.

730. TRIMBLE, W. C. 1980. Production trials for monoculture and polyculture of white shrimp (*Penaeus vannamei*) or blue shrimp (*Penaeus stylirostris*) with Florida pompano (*Trachinotus carolinus*) in Alabama 1978-79. *Proc. Annu. Meet World Maricult. Soc.*, Vol. 11 : 44-59

White shrimp *P. vannamei*, blue shrimp *P. stylirostris* and Florida pompano *Trachinotus carolinus* were reared in 0.08 ha managed nursery and monoculture and polyculture production ponds in coastal Alabama. In polyculture, yield of white shrimp and pompano averaged 265kg/ha with 0.9 feed conversion. In polyculture yield of blue shrimp and pompano averaged 1,285 kg/ha with 3.0 feed conversion. *P. vannamei* *P. stylirostris*, *Trachinotus carolinus*, feed commission.

731. TRIVEDI, Y. A.; CHAYA, N. D.; KOSHY, P. K. 1982. Observation on seasonal abundance of prawn seed in Shetrunji estuary at Sartanpur, Gujarat, India. *Proc. Symp. Coastal Aquaculture*, Pt. 1 : 187-189.

A survey of prawn seed resources by shooting net operations in Shetrunji estuary, Sartanpur (Gujarat), indicated the dominance of postlarvae of *Penaeus indicus* and *Metapenaeus monoceros*. In August 1978, *P. indicus* and *M. monoceros* seed were collected at an average rate of 13256/h and 8652/h respectively. However the occurrence during the same period in 1977 was considerably low. Presence of the juveniles of *M. brevicornis*, *Palaemon stylirostris* and *Macrobrachium rosenbergii* in the estuary was also noteworthy. An attempt is made to correlate the abundance of prawn seed with the temperature and salinity of estuarine water and rainfall data of the area.

732. UNAR, M.; NAAMIN, N. 1984. A review of the Indonesian shrimp fisheries and their management. *In*: Penaeid shrimps their biology and management. Ed. by Gulland, J. A.; Rothschild, B. J. Fishing News Books Ltd., London. p. 103-110.

Total catches of shrimp in Indonesian waters totalled over 100,000 tons annually, with peak export earning of over US \$ 200 million in 1980. Shrimp were caught both by a variety of traditional gears and by relatively modern trawler. This led to conflicts between the two groups, and therefore since January 1981 trawling was banned through Indonesia except in the eastern waters. Several species of shrimp were caught and so the biology of the major species has been described. Recruitment to the fishery seemed to be related to conditions in the nursery grounds, and there was a linear relation between the size of the stocks in different parts of Indonesia and the extent of mangrove areas.

Management of the shrimp fisheries was carried out within the general objectives of the Indonesian national plan which were to increase fish production, to improve the livelihood of fishermen; to increase employment opportunities, and to maintain the biological yield of the resources.

733. UNO, YUTAKA 1985. A Biological approach to mariculture of shrimp; shrimp rearing fisheries. *Proceeding of the First International conference on the culture of penaeid prawn/shrimps*, Iloilo City, Philippines p. 37-45.

Mariculture production in Japan has grown recently to nearly one million tons per year. Mariculture production in the shallow coastal water of Japan mainly consists of few species of finfish, six species of shell fish and three species of algae.

734. VARGHESE, P. U. 1983. Principles of scientific prawn farming *Seafood Export Journal* 15 (10) : 21-23.

Management of prawn farming and its effectiveness explained in the paper.

735. VARGHESE, P. U.; VARGHESE, A. G.; CHANDRAN, K.K.; ALEXANDER THOMAS, SIMON JOHN, 1982. Improved prawn production through selective stocking. *Proc. Symp. Coastal Aquaculture*, 1 : 388-393.

Prawn farming demonstration conducted in the farmers' pond around Cochin with the technical assistance of the Marine Products Export Development Authority, to propagate scientific prawn farming are briefly outlined. To culture operation in ponds located at Pandarachira and Vallarpadom, having an area of 0.22 ha and 1.16 ha, are reported in detail along with the economics. In a 0.22 ha pond, mixed culture of *Penaeus indicus* and *P. monodon* was undertaken for a period of 90 days during January April 1979 of which the net production was 112.5 kg. Monoculture of *P. indicus* conducted in a 1.16 ha pond for 65 days from March to May 1979 yielded 560 kg. The production rates were 511 kg/ha/90 days and 483 kg/ha/65 days in these operation. A strategy for converting the traditional prawn filtration fields in Cochin into selective culture farms is discussed in the light of these results.

736. VEDAVYASA RAO, P. 1972. Seasonal abundance of larvae and post-larvae of the commercially important penaeid prawns in the inshore waters Cochin. *Indian J. Fish.* 19, p. 86-96.

From the seasonal distribution of the larvae and post larvae of five species of the commercially important penaeid prawns in the inshore waters of Cochin studied during the years 1966-67, 1967-68 and 1968-69, it has been found that the larvae and post larvae of *Metapenaeus dobsoni* alone formed (80%) of the total larval population. The larvae and post-larvae of *Parapenaeopsis stylifera* formed the next in the order of abundance. The annual fluctuations in the occurrence of the larvae and post-larvae of *M. monoceros*, *M. affinis* and *Penaeus indicus* were very wide. The percentage reduction in the total number from larvae to post-larvae, which was attributed as mortality rate, varied from year to year in different species. Most of these species bred throughout the year, with two peaks, one during October-December and the other, which was less pronounced, extending from May to August. The larvae of most of the species were able to withstand a wide range in salinity. The larvae of *P. stylifera* were generally absent in the inshore waters during the monsoon months. The abundance of the larvae in the inshore water appeared to indicate the magnitude of the prawn fishery in the subsequent season.

737. VEDAVYASA RAO, P. 1978. Seed requirements for intensive culture of penaeid prawns in coastal water particularly in Kerala. *Proc. National Symp. on shrimp farming*, Bombay 16-18 Aug. 1978, 73-82.

Cultivable species penaeid prawns are *P. indicus* and *P. monodon*. Seed requirements, intensive culture is possible these points discussed in this paper.

738. VEDAVYASA RAO, P.; DIWAN, A. D.; KAKATI, V. S. 1982. Fluctuation in calcium levels in the exoskeleton, muscle and haemolymph of *Penaeus indicus* cultivated in brackishwater pond. *Indian J. Fish.* 29 (1 & 2): 160-167.

The calcium content in the exoskeleton of *P. indicus*, cultivated in a brackishwater pond was found between 4 and 15%, which was low compared to other crustaceans. The haemolymph calcium was observed always at a higher level than the calcium in the pond water. Calcium content of pond water and the haemolymph showed a direct relationship with the salinity. Relatively high levels of calcium in muscle and low levels in exoskeleton were observed in June. The probable reasons for this are discussed.

739. VEDAVYASA RAO, P. 1987. Penaeid prawn culture at Valappu village near Cochin. An experience, *Proceedings of the Symposium on management of Coastal Ecosystems and Oceanic Resources of the Andamans* p. 88-91

The paper presents a success story of a village welfare society consisting of Harijans of village Valappu in Kerala, which was adopted under Lab to Land programme for transfer of technology on prawn culture. The members not only adopted rice-cum-prawn culture on the reclaimed area but also produced coconuts and vegetables on the raised bunds made for impounding the backwater. Their success generated considerable interest in the neighbourhood farmers to take up prawn culture also in their field. Such an organised prawn culture is suggested to be practised also in Andamans giving reasons.

Two species of marine shrimp (*Penaeus monodon* and *P. merguensis*) were produced in Jan-Sept. 1981 at NICA. Gravid females

of *P. monodon* were obtained through induced maturation and rematuration in concrete tanks while gravid females of *P. merguensis* were collected from the wild. Total postlarvae production was 3,074,300 with 2,146,300 for *P. monodon*, and 928,000 for *P. merguensis*. The fry were distributed to the farmers while the remaining (917,300) were released to the sea. (Modified author's abstract).

740. VENKATASAMY, G. 1983. Studies on the culture of *Penaeus indicus* in cages. In: *Proceedings of the National Seminar In Cage and Pen Culture*, Tuticorin, India, 18-19 Mar. 1983. Tuticorin, India Fisheries College, Tamil Nadu Agricultural University. p. 99-102.

Studies on the growth of *P. indicus* was made at four localities i. e., Kundakkal Channel, Porites Bay, Sponge Bed and Marine Fish Farm at Krusadai Island, Employing velon-screen-hapa cages and bamboo baskets. Growth of *P. indicus* was more in Kundakkal Channel because of great abundance of Plankton. The factors that were found to limit prawn production were high salinity, temperature and low level of dissolved oxygen. The suitability and durability of the types of cages employed are discussed. (Author's abstract)

741. VENKATESAN, V.; BOSE, S. V. C.; SUNDARARAJAN, D. 1980. Approach for brackishwater prawn farming in Tamil Nadu. In: *National Symposium on Shrimp Farming* (1st 1978 Bombay). Proceedings Cochin : Marine Products Export Development Authority pp-231-235.

A perspective of the potentials of Tamil Nadu for large scale brackishwater prawn culture with broad suggestions and recommendation, for making the culture possible.

742. VENKATESAN, V.; BOSE, S. V. C. 1982. Observations on the culture of tiger prawn *Penaeus monodon* Fabricius in Brackish-water ponds. *Proc. Symp. Coastal Aquaculture*, Cochin January 12-18, 1980, Marine Biological Association of India, Cochin p. 146-150.

Experiments on the Culture of tiger prawn, *P. monodon*, were conducted in the brackishwater ponds in Santhome Fish Farm, Madras.



The size of the ponds ranged from 0.1 to 1.14 ha. After removing the predatory fishes, the ponds were manured with inorganic fertilisers. Juveniles of tiger prawn ranging from 20.0 to 445.0 mm in length were stocked at densities ranging from 25,000 to 40,000/ha and reared for a period of 80 days. No supplementary feed was given to the prawns. But fertilizers were applied at regular intervals.

The prawns are stated to have attained an average size of 154.5mm and a weight of 25.7 g in 90 days at a stocking density of 25,000/ha and 129.5 mm and 14.4 g in 90 days at a density of 40,000/ha. Survivals of prawns varied from 81.02 to 86.2%. Maximum production or 521.2 kg/ha 90 days were achieved at a stocking density of 25,000/ha and the maximum of 496.5 kg/ha in 90 days was obtained at a density of 40,000/ha.

743. VERGHESE, P. U.; GHOSH, A. W.; DAS, P. B. 1975. On growth, survival and production of jumbo tiger prawn *Penaeus monodon* Fabricius, in Brackishwater ponds. *Bull. Dept. Mar. Sci., Univ. Cochin*, VII(4) : 781-789.

Experiments on selective culture with jumbo tiger prawn *P. monodon* Fabricius, were undertaken at the brackishwater fish farm, West Bengal in order to study the commercial possibility of prawn farming. The problems encountered in the course of the experiments are discussed.

744. VERGHESE, P. U. 1978. Potentials of brackishwater prawn culture in India. *Proc. Nat. Symp. on Shrimp Farming* Bombay 16-18 Aug. 1978, 189-203.

Traditional prawn culture practices, selective culture of prawns, seed resources of cultivable prawns, prawn culture technique and future prospect and potentials of prawn culture are discussed in this paper. *Brackishwater prawn culture*.

745. VERGHESE, P. U. 1982. Extension service for shrimp culture in India by MPEDA. *Seafood Export J.* 14(4) : 21-22.

Extension service is a basic necessity for shrimp culture MPEDA Programmes in this aspect is discussed.

746. VERGHESE, P. U.; VARGHESE, A. G.; CHANDRAN, K. K.; THOMAS, ALEXANDER 1982. Improved prawn production through selective stocking. *Proc. Symp. Coastal Aquaculture*, Part I, Cochin. 12-18 Jan. 1980, P. 388-392.

Various methods for prawn production is discussed.

747. VENKATESAN, U.; BOSE, S. V. C. 1982. Observations on the culture of the tiger prawn *Penaeus monodon* Fabricius, in brackish water ponds. In; *Proc. Symp. Coastal Aquaculture*, part 1, Cochin 12-18 Jan. 1980. p.146-150:

Without supplementary feeding, *P. monodon* of 20-45 cm length is stocked at densities ranging from 25-40/m<sup>2</sup> in an inorganically fertilized brackish water pond. Maximum production of 521-2kg/ha is obtained at 25/m<sup>2</sup> density having an average size of 154.5 mm and weighing 25.7 g.

748. VENKATESAN, V.; BOSE, S. V. C.; SUNDARARAJAN, D. 1978. In approach for the development of brackish water prawn farming in Tamil Nadu. *Proc. First Nat. Symp. on Shrimp Farming Bombay*, 16-18 August 1978, 231-235.

Achievements of the past and future prospects of the cultivable species of prawn farming in Tamil Nadu are discussed, Brackish water prawn farming.

749. VENKATESWARALU, Y. B.; JANAKIRAMAN; RAJARAMI REDDY, G.; SASIRA BABU, K. 1985. Oxygen uptake rhythm in penaeid prawn *Penaeus indicus* (H. Milne Edward) in different structures. *Indian J. Mar. Sci.*, 14: 222-223.

Oxygen uptake was studied in brackish water *P. indicus* at the interval. average oxygen consumption was maximum in 20 x 10<sup>-3</sup>gal.

750. VERA RIVAS PLAJA, J.; BERGER BEBRELLI, C. 1980. Reserve of penaeid shrimp culture in Peru. *Memoris of the 2nd Latin American Emporium on Aquaculture*, Cal. 1 : 2020-2035.

The culture of penaeid shrimp in Peru is discussed. The culture is carried out mainly in the northern Coast. The penaeid species present are *Penaeus vannamei*, *P. stylirostris*, *P. occidentalis*.

751. VELANKAR, N. K.; GOVINDAN, T. K. 1958. A preliminary study of the distribution of non-protein nitrogen in some fishes and marine invertebrates. *Proc. Indian Acad. Sci.*, 47 (4) : 202-209.

The distribution of non-protein nitrogen in some fishes, crustaceans, and molluscs studied. The significance of the results from the comparative aspects and in the processing discussed.

752. VELANKAR, N. K.; GOVINDAN, T. K. 1960. Trimethylamine oxide content of marine prawns occurring in the backwaters and in the sea of Cochin. *Proc. Indian Acad. Sci.*, 52B (4) : 111-115.

Trimethylamine oxide content of marine and backwater prawns determined and the results obtained were discussed in relation with the habitat. The use of this test for spoilage is suggested.

753. VETTER ELIZABETH, F.; HOPKINSON, CHARLES, S. 1986. Influence of white shrimp (*Penaeus setiferus*) on benthic metabolism and nutrient flux in a coastal marine ecosystem: measurements in situ. *Contribution in marine Science*, vol. 28 : 95-107.

A study on the short term effect of aggregated adult white shrimp (*Penaeus setiferus*) on net rates of benthic metabolism and nutrient flux.

754. VICTOR, B.; MAHALINGAM, S.; SAROJINI, R. 1985. Cytopathological effects of Cadmium on the freshwater prawn *Macrobrachium idella*. *Indian J. Fish.*, 32 (4) : 478-480.

Experience for 30 day 100 PP6 of Sodium Chloride induced in freshwater prawn *M. idella* several Cytopathological effects, both in gills and in ovaries.

755. VICTOR CHANDRA BOSE, S.; VENKATESAN, V. 1982. Prawn and fish seed resources of Marakanam Estuary. *Proc. Symp. Coastal Aquaculture*, Part I, Cochin 12-18 Jan. 1980 P : 196-201.

A seed survey conducted during 1977 and 1978 showed that Marakanam Estuary had adequate seed potential of culturable prawns

and fishes. Among prawns, *Penaeus indicus*, *Metapenaeus monoceros*, *M. dobsoni*, *P. semisulcatus* and *P. monodon*, in that order of abundance were encountered. Information on species-wise occurrence, and their seasonal and spatial distribution pattern of the prawn seeds in the estuary and suitable gear for collection is presented and discussed.

756. VISWANATH, KIRON. 1984. Endocrine Control on osmoregulation in the prawn *Penaeus indicus* H. Milne Edwards *CMFRI special publication No. 19* : 58-60.

This work deals with the origin of endocrine factor and their control on osmoregulation in the prawn *Penaeus indicus*. (MSc Dissertation)

757. VYAS, A. A.; CHAYA, N. D.; BUCH, A. U.; BHASKARAN, M.; PATEL, A. J.; MOHILE, V. J. 1986. Mass culture of Centric diatom *Chaetoceros affinis* (Lauder) – A promising live feed for prawn larvae. *Indian J. Mar. Sci.*, 15 : p. 55.

Unialgal mass culture of *C. affinis* has been made with seawater enriched with synthetic culture medium (F). Dark greenish brown peak blooms are obtained with cell counts (no. ml<sup>-1</sup>) ranging from 3.5 x 10<sup>8</sup> to 5.5 x 10<sup>8</sup>. It is observed that lower the temperature, longer the time taken to reach peak bloom stage and vice versa.

758. WALKER, R. H.; GULLAND, J. A.; ROTHCHILD, B. J. (ed). 1984. Report on national fisheries. Penaeid shrimp their biology and management : 36-48.

Shrimp production, biology and population dynamics of the major species in these fisheries are described.

759. WANG, J. K.; LAM, C. Y. 1986. Physical dimension relationships of juvenile *Penaeus stylirostris*. *Journal of the World Aquaculture Society*, 17(1/4) : 25-32.

Stocking of juveniles is widely practiced in marine shrimp production. A simple mechanical device is needed to sort juvenile

shrimp by their physical dimensions. By analysing a sample of 561 commercially produced *P. stylirostris* juveniles, ranging from 0.07 to 10.33 g, it was determined that a regression equation of the form  $Y = (A \cdot X^B)^C$  can be used to adequately describe the relationships between weight, width and length. In particular; weight (g) =  $0.01223427 \cdot (\text{length, cm})^{2.943696}$ ;  $R = 0.989978$ ; Width (cm) =  $0.6172958 \cdot (\text{weight, g})^{0.3317764}$ ;  $R = 0.989318$ ; Width (cm) =  $0.1422887 \cdot (\text{length, cm})^{0.9808952}$ ;  $R = 0.983662$ .

(Author's abstract)

760. WATANABE, T. 1981. Notes on commercial culture trials using shigueno type tanks (H1 and H2) in 1979. *KISS Tech. Rep. No. 190* 16 pp.

A preliminary culture trial was conducted using *Penaeus semisulcatus* and *Metapenaeus affinis* in intensive shrimp culture tanks based on the design and subsequent development of the shigueno system. Both species grew reasonably well but survival rates were extremely poor. *P. semisulcatus*, *M. affinis*, Kuwait.

761. WANG, WEN-CHENG; YEH, HEWI-LING, 1987. Studies on the requirement of lipids for grass prawn (*Penaeus monodon*). *Bulletin of Taiwan Fisheries Research Institute*, 43 : 41-51.

This study states soyabean oil, fish liver oil and purified squid viscera oil were the main lipid source in diet for grass shrimp, such were compared with the domestic diet.

762. WARD, D. G.; MIDDLEDIRCH, B. S.; MISSLER, S. R.; LAWRENCE, A. L. 1979. Fatty acid changes during larval development of *Penaeus setiferus*. *Proc. World Maricul. Soc.* 10 : 464-471.

The fatty acid compositions for five stages of development of the shrimp *P. setiferus* were determined. Among 12 fatty acids identified, the four major fatty acids in the egg and one two day post larvae were 16:1, 16:0, 18:1 and 20:4, and 20:4 and 22:6, respectively. The significance of these results to understand shrimp larval nutrition is discussed.

763. WICKINS, J. F.; BEARD, T. W. 1974. Observations on the breeding and growth of the giant freshwater prawn *Macrobrachium rosenbergii* (de Man) in laboratory. *Aquaculture*, 3(2) : 159-174.

Three male and 20 female prawns, *M. rosenbergii* (de Man), were observed for 390 days. They were maintained in brackish water (5‰ salinity) at 28°C which was recycled continuously through a percolating biological filter. Illumination was artificial and did not exceed 10 lm/ft<sup>2</sup> (approx. 0.2 m<sup>2</sup>) at the water surface. Mating readily occurred in the experimental tanks (48 x 28 x 25 cm deep). Eggs were incubated for 20 days; the mean number of larvae per brood was 24,000 (range 50-98 100). Over 750,000 larvae were hatched during the experiment.

764. WICKINS, J. F. 1985. Ammonia production and oxidation during the culture of marine prawns and lobsters in laboratory recirculations systems. *Aquaculture engineering* vol. 4(3) : 155-174.

Data the rates and diurnal patterns of ammonia excretion, food utilization and nitrification rates in biological filters during the culture of tropical prawns *Penaeus* and European lobsters *Homarus gammarus*.

765. WILLIAMS, B. R.; BELL, T. A.; LIGHTNER, D. V. 1986. Degradation of trifluralin in seawater when used to control larval mycosis in penaeid shrimp culture *Journal of World Aquaculture Society*, 17(1/4) : 8-12.

Treflan (trifluralin, Elanco) is among the compounds used in the treatment of larval mycosis in penaeid shrimp caused by the phycomycetous fungi *Lagenidium* sp. and *Sirolopidium* sp. Some culturists have reported treatments for these fungi with trifluralin to be ineffective while others have found it to be quite efficacious. To study losses of trifluralin in seawater systems, experiments were conducted under varying conditions of aeration, lighting, and algal biomass using nominal concentrations of 19.3 to 65.5 ppd trifluralin. There was no detectable loss of trifluralin over a six hour period in seawater mechanically stirred and covered to prevent photo-degradation. Under varying conditions of aeration and light, the estimated half-life of trifluralin ranged from 30 to 136 min. When diatoms were added to seawater, trifluralin levels dropped to 4% of theoretical within two to three min. These observations confirm the need for a continuous administration for trifluralin to be effective in treating larval mycosis in penaeid shrimp hatching facilities.

(Author's abstract)

766. WILLIAMSON, D. I. 1968. The type of development of prawns as a factor determining suitability for farming. *FAO Fish. Rep.* 57 : 77-84.

The problems of rearing decapod larvae are discussed and it is suggested that selection species which hatch in the near adult form would largely eliminate some of the problems. Examples of species with direct or rapid development are given. Their distribution and biology are briefly discussed. Other recommendations include studying the chemical composition of the water and its effects on development.

767. YANO, I. 1984. Rematuration of spent kuruma prawn, *Penaeus japonicus*. *Aquaculture* 42 : 179-183.

Rematuration of spent kuruma prawn, *P. japonicus*, was investigated under tank culture conditions. Oil globule stage I oocytes were seen in the ovaries of spent kuruma prawns cultured for 9 and 17 days after spawning. Oil globule stage II, yolkless stage and primary yolk granule stage oocytes were found in the turgid opaque ovary of spent kuruma prawn cultured for approximately 1 month after spawning. *P. japonicus* females successfully matured again shortly after spawning under tank culture conditions.

768. YASUNAGA, Y.; KOSHI, Y. 1980. Basic studies on searching of prawn seedlings (*P. japonicus*) after being seeded into the sea. *Bull. Jap. Sea Reg. Fish. Res. Labl.*, (31) : 129-151.

Ecological observation on prawn seedlings, *P. japonicus*, released into the sea area facing the open sea was conducted at Igarashihama beach in Niigata City, Niigata prefecture. It was concluded that most of them didn't move so far from the release place and were caught by predators in a day after release. Remarkable predation was done by juveniles of plaice, *Paralichthys olivaceus* (5-19 cm TL). In addition, survival rate of released seedlings was calculated on the basis of changes of captured number after release. Then seedlings were dyed with neutral red solution to test the tagging method. The effect of tagging by dyeing was recognized for five days in water tanks and only one day in the sea after release. Influence of dyeing on behaviour and survival of seedlings was a little inferior compared with those of non-tagged ones.

## V. ADDITIONS

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and 40°C (16.0 meq/kg) were significantly higher than those exposed to 0°C and 10°C (2.9 meq/kg). The highest survival rate (76%) and feed conversion (8.9%) were observed for prawns fed diets stored at low temperatures (0°C or 10°C). Severe necrosis of the hepatopancreatic cells was observed in *P. monodon* fed with diet stored at the high temperature.

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Maturation was induced in indoor tanks, with control of light and temperature, with a regular supplementation of fresh food and the use of unilateral eyestalk ablation.

Density was 5 to 7/m<sup>2</sup> with 1:1 sex ratio.

Spawning indices were more than 3 spawns female/month on a routine basis. Using artificial insemination, about 100 million nauplii were produced for the last three years from 2000 females.

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few darkly-stained, irregularly shaped primary oocytes. Individuals classified as stages II + and III + showed similarity in size and shape of all lobes in the posterior thoracic region, and histologically, corresponded to the revised stages V and C, respectively. Histochemical staining shows that glycoproteins and lipids are absent in the primary oocytes and present in yolky oocytes. Glycoproteins but not lipids occur in the cortical rods. Analysis of variance showed significant differences in mean gonad weight and gonadosomatic index values but not in the mean body length and body weight values in stages P to C. Uniformity in the number, stage and composition of oocytes in the four regions of the ovary at each stage showed that stage of ovarian maturity in wild prawns can be represented by any regions of the ovary. Differences in the oocyte size frequency and mean values of average and maximum oocyte diameter in the four stages showed that these are good indicators of stage of maturation in wild *P. monodon*.

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