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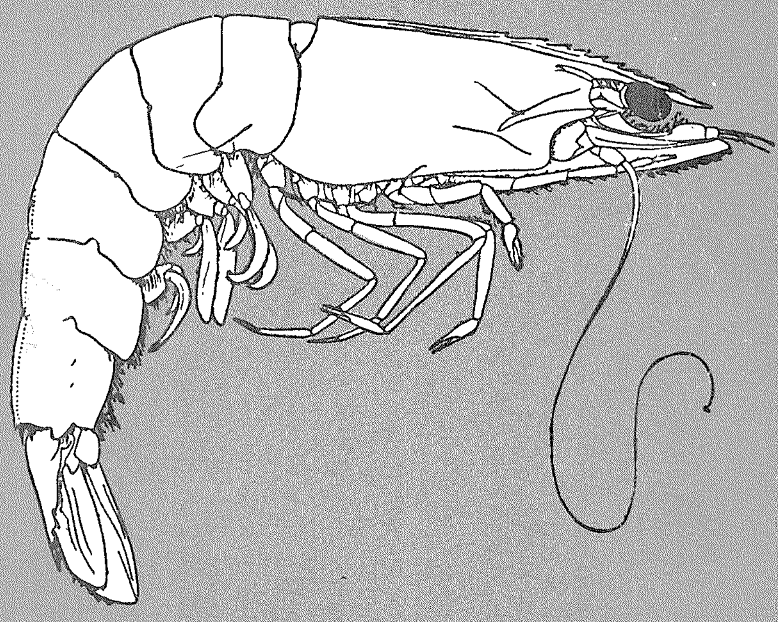

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SYNOPSIS OF BIOLOGICAL DATA ON THE PENAEID PRAWN *Solenocera indica* Nataraj, 1945

Exposé synoptique sur la biologie de *Solenocera indica* Nataraj, 1945

Sinopsis sobre la biología del *Solenocera indica* Nataraj, 1945

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CONTENTS [1]

[1] This synopsis has been prepared according to Outline Version No. 1 (H. Rosa, Jr., FAO Fish. Synops., (1) Rev.1, 1965).

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

1 IDENTITY

1.1 Taxonomy

1.1.1 Definition

Phylum Arthropoda
Class Crustacea
Subclass Malacostraca
Series Eumalacostraca
Superorder Eucarida
Order Decapoda
Suborder Natantia
Section Penaeidea
Family Penaeidae
Subfamily Solenocerinae
Genus Solenocera Lucas 1850
Species Solenocera indica Nataraj 1945

1.1.2 Description

Generic

Solenocera Lucas, 1849, Rev.Mag.Zool.(2) 1: 300. Type species, by monotypy: Peneus siphonoceros Philippi, 1840 (=Penaeus membranaceus Risso, 1816). Gender: feminine. Placed on the Official List of Generic Names in Zoology as Name no. 1444.

The following description is adapted from Kubo (1949).

Rostrum short and serrated dorsally. Cervical and hepatic groove well defined. Antennal, post-orbital and hepatic spines always present, but branchiostegal and pterygostomian spines may or may not be present. Abdomen dorsally carinated. Antennular flagella foliaceous, longer than carapace; upper flagellum rather flat, narrower than lower ramus; lower flagellum concavo-convex, with convex surface outward. Mandibular palp two-segmented, distal joint triangular, rounded at the apex. Maxillary palp not jointed. Maxilla with unsegmented endopod. First maxilliped with slender 5-jointed palp. Second maxilliped inverted J-shaped, consisting of 7 segments. Third maxilliped pediform, consisting of 7 segments, not sexually dimorphic. Exopods present on all thoracic appendages. Petasma bearing a pair of spatulate projections on ventral free edges, and with many setae on distal borders. Appendix masculina with proximal part having a spur-like outgrowth on inner surface; distal part composed of 2 scale-like appendages. Thelycum simple. A pleurobranchia on thoracic somites from 3rd to last (8th). A pair of orthrobranchiae on anterior 7 thoracic somites. A podobranchia on 2nd maxilliped. Mastigobranchiae present on all maxillipeds and anterior pereiopods.

Kubo (1949) first employed the stomodeal ossicles in decapod taxonomy. In terms of his nomenclature, Solenocera has the cardiac plate with many spinules arranged in a longitudinal series on the inner surface, pterocardiac dichotomous at outer end; zygocardiac with teeth gradually decreasing posteriorly; prepyloric provided with many pointed teeth along each postero-lateral border.

Parasolenocera Wood-Mason, in Wood-Mason and Alcock, 1891, type species Parasolenocera annectens Wood-Mason, 1891, is here regarded as a junior subjective synonym of Solenocera Lucas.

Specific

Solenocera indica Nataraj, 1945.

The whereabouts of the type specimen is not known.

Type locality: Bay of Bengal.

Carapace smooth and glabrous. Rostrum straight, lanceolate, slightly ascending, reaching to tip of basal segment of antennular peduncle; armed with 9 to 10 teeth on upper margin, becoming smaller and more closely spaced towards the front, interval between 1st and 2nd twice that between 3rd and 4th; tomentum on sides of rostrum very feeble. Post-rostral carina feeble, becoming distinct towards posterior region of carapace.

Orbital angle dentiform. Post-orbital, antennal and hepatic spines small, thin and sharp. No branchiostegal or pterygostomian spine.

Cervical groove oblique, deep and broad on sides, continuous with that on the other side through very faint notch on post-rostral carina; continues obliquely downwards below hepatic spine towards antero-inferior angle of carapace. Another groove originates from level of hepatic spine, runs upwards to fade before reaching base of post-orbital spine. Cervical groove runs horizontally backwards from base of hepatic spine then turns obliquely downwards towards ventral margin of carapace; branchiostegal sulcus originates from angle of inferio-lateral curve and runs backwards towards posterior border of carapace.

Fourth, 5th and 6th and posterior half of 3rd abdominal segments sharply carinated dorsally; carina of 6th segment terminates in spine. A median sternal spine between bases of each pleopod pair, spines decreasing from anterior to posterior.

Telson deeply sulcate mid-dorsally on anterior two-thirds; lateral margins devoid of spines; tip of telson pointed and shorter than exopod of uropod.

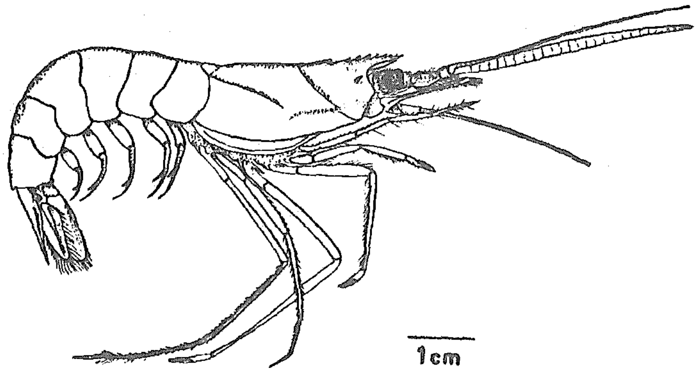

Fig. 1 Solenocera indica Nataraj 1945.(after Kubo, 1949)

Antennular peduncle slightly less than half length of carapace including rostrum, shorter than antennal scale; basal segment of peduncle as long as 2 distal segments combined. Antennular flagella each slightly longer than carapace including rostrum; inferior flagellum twice as wide as superior flagellum.

Mandibular palp 2-jointed, basal joint triangular, as long as distal width; distal joint narrow, slightly less than twice as long as basal segment.

Third maxilliped reaches tip of antennal scale; exopod reaches middle of ischium. Ischium of 1st and basis of 1st and 2nd chelipeds armed on inner sides with spines. All legs with slender exopods which gradually become smaller posteriorly. Second cheliped reaches level of tip of antennal scale; 3rd (longest) cheliped reaches level of middle of antennule. Fifth leg is the thinnest, reaches about to middle of antennules.

The 2 halves of petasma united anteriorly; each half of 4 lobes fused together posteriorly and free at distal margins. Inner lobe is longest, has tip swollen into spongy mass with toothless outer margin; next lobe with angular border, distal portion fringed with row of recurved spines, hard chitinous angular plate projecting from near tip; 3rd lobe with broadly rounded outer border fringed row of small recurved spines, small conical plate projects from inner side; 4th lobe lies inside 3rd, thickened circular distal end curves outwards.

Thelycum consists of: hard plate protruding from sternum behind 5th pair of legs with tuberculous projection between bases of legs, pair of closely approximated small knobs originating from sternum between 4th and 5th pair of legs, hard vertical plate between bases of 4th pair of legs, small inner lobe on coxa of 3rd leg.

Proximal part of appendix masculina with bar-shaped projection on inner surface, convex at apex, directed ventro-laterally; ridge-like elevation on anterior surface.

Cardiac plate armed on inner surface with about 16 pointed spinules arranged in longitudinal series. Cardiac ossicle suboval. Pterocardiac ossicle bar-shaped; antero-median angle produced and pointed, postero-median angle broadly rounded. Prezygocardiac ossicle minute, and subrectangular. Urocardiac ossicle with triangular anterior dilation; anterior point blunt, lateral points sharp. Anterior edge of zygocardiac with 2 large sharp conical teeth, row of 11 acute long teeth just above upper large tooth. Prepyloric with about 10 slender acute teeth on each postero-lateral edge. No tooth near anterior end of inner internal wall of pyloric chamber (1 tooth in other species) (Fig. 1).

1.2 Nomenclature

1.2.1 Valid scientific names

Solenocera indica Nataraj, 1945, Journ. Asiat.Soc. Bengal 11(1):94.

In the original publication the specific name was spelled "indicus", but since the gender of the generic name Solenocera is feminine, it has been changed to indica.

1.2.2 Synonyms

Objective synonyms

None

Subjective synonyms

Solenocera subnuda Kubo, 1949, J.Tokyo Coll.Fish. 36(1).

Solenocera kuboi Hall, 1956, Bull.Raffles Mus., 27.

This is one of the more than 25 described species in the genus Solenocera and seems most closely related to S. prominentis Kubo and S. crassicornis (H. Milne Edwards). Within the last 25 years it has three times been described as new, first by Nataraj (1945), then by Kubo (1949), who evidently was not aware of Nataraj's publication and then by Hall (1956) who at first thought his Singapore material to differ specifically from Kubo's species, but later synonymized the two forms.

Hall (1962) stated that spines on the lateral margin of the telson are present in some juveniles. This finding is significant since the main diagnostic characters of S. indica are the absence of telson spines and the absence of branchiostegal and pterygostomian spines.

1.2.3 Standard common names, vernacular names

None reported.

1.3 General variability

1.3.1 Subspecific fragmentation

No subspecies are recognized.

2 DISTRIBUTION

2.1 Delimitation of the total area of distribution and ecological characterization of this area

In India the species is found all along the west and east coasts. Ahmad (1957) and Nataraj (1945) recorded it from East Pakistan. The material from which the original description was made was partly obtained from the Mergui Archipelago and Singapore. Recently Hall (1956, 1962) reported the species from the west coast of Malaysia (Penang and Singapore); Kubo (1949) recorded it from North Borneo and Cheung (1960, 1963) from around Hong Kong. In terms of the FAO areas code (see Holthuis and Rosa, 1965) it is recorded from parts of sea areas ISW and ISEW, and from the coasts of land areas 423, 425, 433, 436 and 422. While the majority of the species of Solenocerinae are deep sea forms, S. indica is definitely a littoral species, inhabiting waters of 40 m and less, where there is a likelihood of small seasonal fluctuations in temperature and salinity.

2.2 Differential distribution

2.2.1 Areas occupied by eggs, larvae and other junior stages: annual variations in these patterns, and seasonal variation for stages persisting over two or more seasons

Cheung (1963) identified protozoeal and zoeal stages of S. indica from plankton collected near Hong Kong at the surface and at a depth of 6 m. No nauplii were found, but as the later larval stages were found together with mature and spent females, it is unlikely that the naupliar stages did not exist in the same localities.

Around Hong Kong the larvae occurred most abundantly in the months of May to July and were absent in the winter months.

These larvae occurred most abundantly in areas where mixed marine and estuarine conditions prevail, and during the warmest and most rainy season, when the salinity in Hong Kong territorial waters was at its lowest (Cheung, 1959). It seems probable then, that a relatively high temperature and low salinity are favourable conditions during the spawning season of the species to which these larvae belong.

2.2.2 Areas occupied by adult stages: seasonal and annual variations of these

Adults and larvae occur together, within the 40 m depth contour. Females migrate to the deeper parts of the area to spawn (see sections 3.1.6, 3.1.7), but the males remain in the shallower areas.

3 BIONOMICS AND LIFE HISTORY

3.1 Reproduction

3.1.1 Sexuality (hermaphroditism, heterosexuality, intersexuality)

S. indica is heterosexual. The males are considerably smaller than the females.

3.1.2 Maturity (age and size)

Kunju (1968), in his study of the prawn from Bombay, estimated that the ovary begins to mature in females of 51 mm in length and of age 5 to 6 mo. Since the immature ovary takes about 3 mo to attain the spawning stage, the prawn may spawn for the first time when it is 8 to 9 mo old.

The male attains sexual maturity at a length of about 50 mm.

3.1.3 Mating (monogamous, polygamous, promiscuous)

No observations have been made on sexual behaviour, but the species is expected to be promiscuous. Mating takes place in the shallower areas of the habitat.

3.1.4 Fertilization (internal, external)

Fertilization is external, as in other prawns.

3.1.5 Fecundity

Females measuring 25 to 28 mm (carapace length) were found to have 1.36×10^5 to 1.58×10^5 eggs in their ovary (Cheung, 1963).

3.1.6 Spawning

Kunju (1968) found that on the Maharashtra coast of India the prawn spawns from October to May with 2 spawning peaks in December and April. Cheung (1963) also observed 2 peak spawning periods in Hong Kong waters, the 1st from November to December and the 2nd during August and September. He, however, found no spawning from January to May.

3.1.7 Spawning grounds

Kunju (1968) found that the main spawning ground is just outside the fishing grounds on the Maharashtra coast. These grounds are all within 40 m. On the observed fishing grounds a definite pattern of spawning migration was recognized, with the fully mature females moving offshore. He has adduced evidence that these spawners do not go far out, but they liberate the eggs near the 40 m depth contour. Similar findings were recorded by Cheung (1963) in the Hong Kong area.

3.1.8 Egg: structure, size, parasites and predators

Fertilized eggs of S. indica have not been identified from plankton collections. The diameter of an ovarian egg was found to be 0.17 to 0.25 mm. Kunju (1968) recognized the following stages of maturity in ovarian eggs:

Immature: Ovum transluoent, nucleus clearly visible, yolk granules sparsely distributed.

Maturing-early: Nucleus faintly visible through yolk granules.

Maturing-late: Ovum opaque, packed with yolk granules; nucleus not visible.

Mature: Surface of ovum appears corrugated due to presence of rod-shaped peripheral bodies.

3.2 Larval history

3.2.1 Account of embryonic and juvenile life (prelarva, larva, postlarva, juvenile)

Cheung (1963) described the protozoeae and zoeae of S. indica. No naupliar stages nor postlarvae (immediately succeeding the oldest zoeal stage) were found.

Protozoea: Two substages of the 3rd protozoea were recorded. Earlier differs from later in ratio of lengths of leg rudiments and uropods to body length. Telson of earlier protozoea with shorter uropods. Carapace of earlier substage measures 0.97 to 1.17 mm, with several large spines. Rostrum and supra-orbital spines each bear a few spinules, other spines smooth. Surface of entire carapace covered with very minute spinules. Margin of carapace fringed with 5 pairs of lappets, serrated between 1st and 2nd and between 3rd and 4th. Dorsal organ (on anterior median part of carapace) large; small unpaired papilla near posterior border of carapace. None of thoracic segments fused with carapace in either substage. Each abdominal tergum with one dorsal and pair of lateral spines. Telson bifurcate posteriorly, each half with 7 setae. Uropods less well developed in earlier than in older substage; endopod with 3, exopod with 6, terminal setae in each substage.

Antennule 5-segmented with 5 terminal setae. Exopod of antenna 9-segmented; endopod 4-segmented, with 6 terminal setae. Mandible without palp. Functional natatory exopods on 1st and 2nd maxillipeds. Thoracic legs

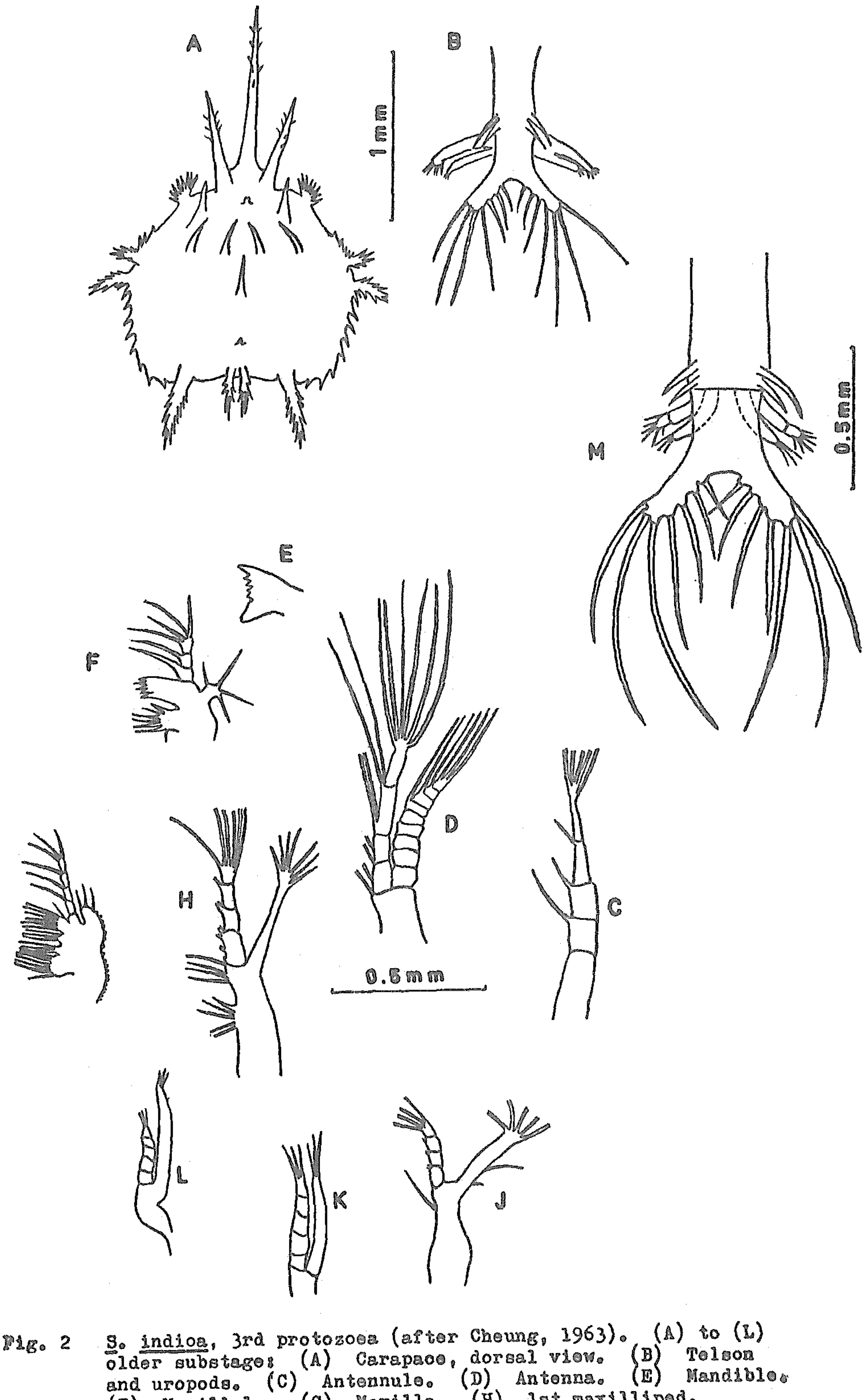

Fig. 2 S. indica, 3rd protozoea (after Cheung, 1963). (A) to (L) older substage: (A) Carapace, dorsal view. (B) Telson and uropods. (C) Antennule. (D) Antenna. (E) Mandible. (F) Maxillule. (G) Maxilla. (H) 1st maxilliped. (J) 2nd maxilliped. (K) 3rd maxilliped. (L) Pereiopod. (M) Younger substage; Telson.

rudimentary, endopod much shorter than exopod. Pleopods not yet developed (Fig. 2).

Zoea (Mysis): Four zoeal stages have been distinguished by Cheung (1963). The 2nd and 3rd stages are intermediate between the 2 stages described here.

First zoeal stage: Carapace 1.37 to 1.59 mm; no spinules on surface of carapace, no lappets; small spines near serrated lateral margins; dorsal organ reduced; carapace fused with all thoracic tergites. Spines on abdominal terga as in protozoea, but lateral spines much smaller and 2nd dorsal spine largest. Telson deeply forked, 4 setae on each inner margin of each prong, pair of small spines on outer margins proximal to fork. Uropods well developed, numerous long setae on each margin of endopod and on inner margin of exopod. Inner flagellum of antennule with 2 terminal setae; outer flagellum slightly longer, with 4 setae. Endopod of antenna shorter than scale-like exopod; exopod with spine on distal 1/3 of outer margin. Mandible with small palp. First 3 pereiopods chelate; all pereiopods with natatory exopods.

Fourth (last) zoeal stage: Carapace 1.9 to 2.24 mm; dorsal organ and spines relatively short. Narrowly forked telson with 4 pairs of spines within the fork. Exopod and endopod of uropod rather broader than in 1st zoea, with more setae. Antennule with much longer flagella. Flagellum of antenna far exceeds scale; scale long, slender, with short subterminal spine on external margin. Mandibular palp longer and narrower; exopod of 3rd maxilliped much reduced. Pereiopods very similar in all zoeal stages. Pleopods well developed, biramous. (Fig. 3).

3.3 Adult history

3.3.1 Longevity

On the basis of average growth rate of juveniles and adults and maximum recorded size, the estimated life span of the female is 14 to 15 mo and that of male 9 to 10 mo (Kunju, 1968). Cheung (1963) is of the view that the prawn lives for considerably less than 2 yr.

3.3.5 Parasites and diseases

Bopyrid parasites are frequently found in the gill chambers of penaeids in general, but no instance of such parasitism has been observed in S. indica.

3.3.6 Greatest size

The largest male and female recorded from Hong Kong (Cheung, 1963) had total lengths of 80 and 116 mm respectively.

3.4 Nutrition and growth

3.4.2 Food (type, volume)

The stomach contents of 10 specimens from Hong Kong, examined by Cheung (1963), contained diatoms, small gastropods, small bivalves, copepods and other small crustaceans. Hall (1962) analyzed the stomach contents in detail and proved that polychaetes are the dominant food in Malaysian waters. Kunju (1968) studied 146 females and 80 males of various size groups from the west coast of India; the stomach contents, in their order of abundance, were crustaceans (Decapoda, Copepoda and others) (44.69 percent), debris (25.84 percent), fish (22.12 percent), polychaetes (2.96 percent), molluscs (1.96 percent), sand grains (1.95 percent) and miscellaneous items (0.53 percent).

3.4.3 Relative and absolute growth patterns and rates

Cheung (1963) stated that no growth takes place in the winter months in Hong Kong. The resumption of growth from February through March to April corresponds to the rise in water temperature in spring. In May, however, no growth can be detected for the males, and a regression is found in the females. This is associated with a remarkable rise in the proportion of the females. In June, regression of size takes place in both sexes, and this might be due to the movement of the larger prawns away from the area, or movement of smaller prawns into the area, or both. This decrease in average size of the population is associated with the lowering of the salinity caused by the outflow from the nearby Pearl River and with the summer rise in temperature. Cheung also stated that the young generation show rapid growth from July to December. Smaller prawns appear in the catches in November and December and might represent another recruitment due to a second smaller spawning in the autumn.

Kunju (1968) studied the growth of the prawn from catch samples collected over a long period in Bombay. From several series of progression of modes, the average growth rates were estimated. The average growth per month in prawns of over 33 mm was 6.96 mm for females and 6.49 mm for males. Recruitment of juveniles of both the sexes, measuring less than 33 mm, was evident in the months of January to March every year. They were probably the progeny of the major spawning group of November to December and would therefore be 2 to 3 mo old when sampled. It therefore appears that young prawns grow at a faster rate than those of more than 33 mm in length.

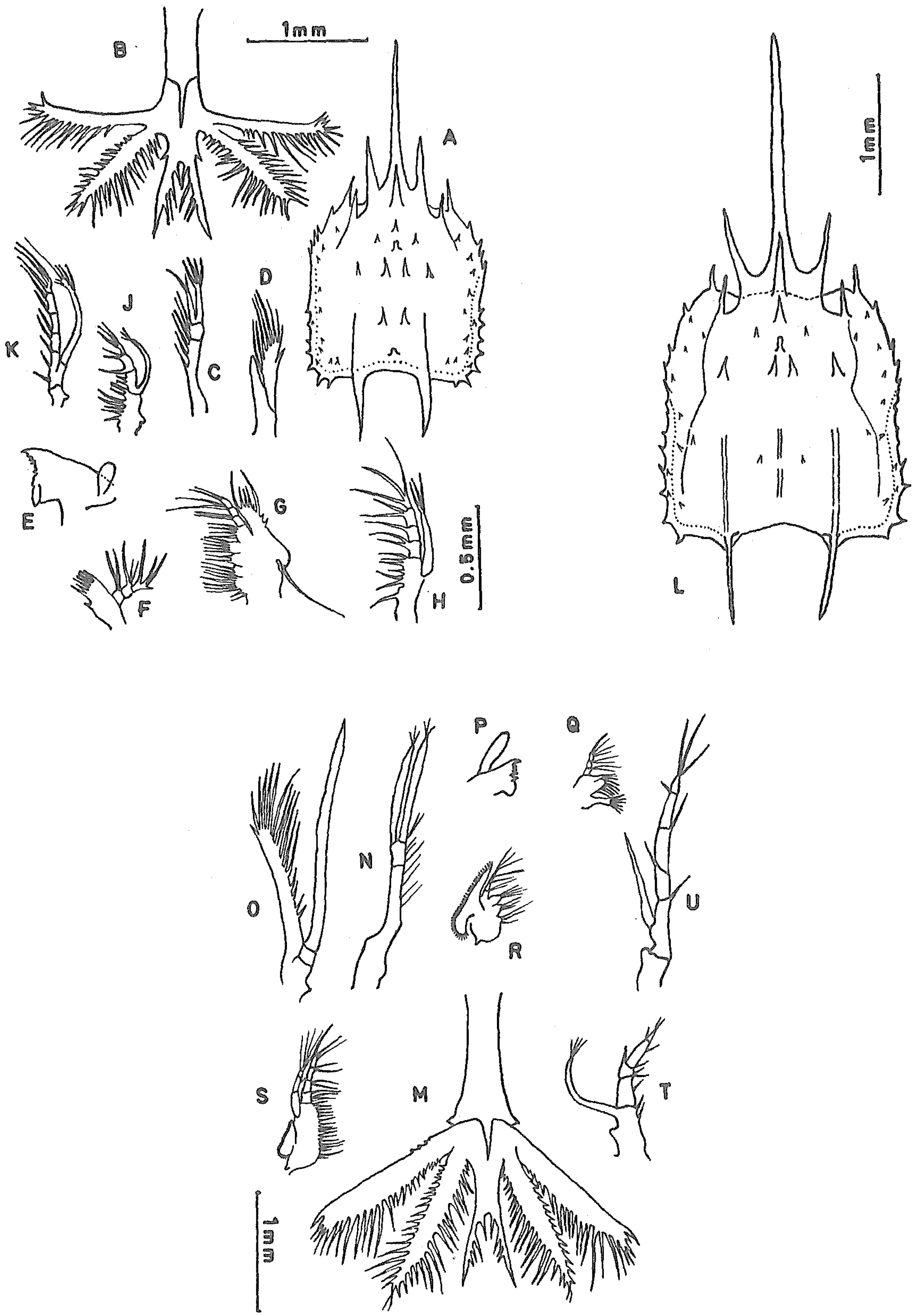

Fig. 3 S. indica, zoeal stages (after Cheung, 1963). (A) to (K) First stage: (A) Carapace. (B) Telson and uropods. (C) Antennule. (D) Antenna. (E) Mandible. (F) to (K) Maxillule to 3rd maxilliped. (L) to (U) 4th stage: (L) Carapace, dorsal view. (M) Telson and uropods. (N) Antennule. (O) Antenna. (P) to (U) Mandible to

3.5 Behaviour

3.5.1 Migration and local movement

In Bombay, Kunju (1968) found 2 types of migratory movement in S. indica, one in connection with spawning and the other in relation to salinity. The females move out of the fishing grounds for spawning but the males remain. The gradual decrease in the number of prawns in advanced stages of maturity could be due to such a movement. This limited spawning migration was found to take place throughout the year, with peak periods in December and April. The population en masse moves offshore when the salinity of the coastal waters decreases from June to early October, as a result of the southwest monsoon rains. There is evidence to show that, as in the spawning migration, the prawns do not move far beyond the 40 m depth contour.

Cheung (1963) found that the prawn in Hong Kong waters does not show marked migratory behaviour such as was found in Penaeus orientalis by Liu (1955). Within the general environment of the prawn, however, small scale movements do take place for various reasons. There is no direct evidence of a migration into offshore waters for spawning in the summer, but length frequencies indicate that no growth takes place from April to May and regression of size appears to take place from May to June. This may be due to migration. A comparison of the catches of the prawn in the 4 areas studied around Hong Kong shows some indications of migration. Thus, in areas where there is some freshwater influence there were decreases in the catches from April to June; on the other hand there were increases in the catches in the marine localities in April and June, but not in May. It may be that migration took place from the estuarine areas to the offshore areas when the adults were maturing. At this time of the year, the outflow of the Pearl River lowers the salinity of the adjacent areas; whether or not this has direct effect on migration is not known. Cheung further stated that the decrease in catches in May in the marine areas might possibly be due to the death of some recently spawned adults, as well as to the migration of others away from the sampled areas.

4 POPULATION (STOCK)

4.1 Structure

4.1.1 Sex ratio

The female to male ratio in the population of S. indica in Bombay waters varied from month to month but there were always more females than males. The disparity between the sexes was least in October and greatest in January, April and May, when more than 2/3 of the population was composed of females. Over the entire period of investigation, there were twice as many females as males (Kunju, 1968).

4.1.2 Age composition

In his investigations conducted around Hong Kong, Cheung (1963) stated that, since the life span of the species is less than 2 yr, the population could contain 2 year classes at most.

4.1.3 Size composition

Cheung (1963) used the carapace length for length-frequency studies and found the relationship between carapace length and total length to be as follows:

$$L = 0.22 + 3.26\ C$$

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

Smaller sizes were poorly represented in his samples because these prawns escape more easily through the net.

Small males, with a modal carapace length of 15 mm, entered the fishery in July. After reaching the 18 mm mode in November, there was a pause in growth, so that from December to February the population stayed at the 19 mm mode. The dominant size group from March to July had a modal length of 20 mm.

Young females of 16 to 18 mm carapace length dominated the population in July, and grew to 30 mm by December, then there was little further growth during January and February. From March to July females of 24 to 29 mm carapace length occurred.

Kunju (1968) studied the length frequency distribution of S. indica in Bombay waters, using the total length from tip of rostrum to tip of telson. In contrast to Cheung (1963), nets with small-meshed cod ends were used, so that the small prawns would be adequately sampled. About half the female population was between 56 and 80 mm, and about 54 percent of males was between 51 and 60 mm. The size distribution varied from month to month in both sexes.

5 EXPLOITATION

5.1 Fishing equipment

5.1.1 Fishing gear

There is no special fishery or fishing equipment for this prawn. It is caught along with other prawns and fish.

The main gear used in Bombay is a fixed bag net locally known as 'dol'. Setna (1949) has given a fairly detailed account of the construction and operation of the net. Its length is between 40 and 60 m and varies from place to place along the coast. The net is fixed against the tidal current; at slack water it is hauled and the catch removed, then it is again set until the next low or high tide.

Around Hong Kong trawls are used.

5.1.2 Fishing boats

The Bombay boats are locally fabricated of teak and are 10 to 15 m in length. They are powered either by sails or fitted with inboard marine diesel engines of 15 to 45 hp.

Prawn junks are the craft in use around Hong Kong.

5.2 Fishing areas

5.2.1 General geographic distribution

The species is commercially exploited from within 30 km from the coast near Bombay, and to a lesser extent along the Visakapatnam coast in India. It is also fished around Hong Kong.

5.2.3 Depth ranges

In Bombay the fishing grounds do not exceed 40 m in depth, and near Hong Kong are distributed in shallow waters.

5.3 Fishing seasons

5.3.1 General pattern of fishing season

In Bombay the fishery is operative throughout the year, excepting the period from June to September when the prawn moves offshore (see section 3.5.1).

Around Hong Kong the prawn is caught all the year round (Cheung, 1963).

5.3.2 Duration of fishing season

See section 5.3.1

5.3.3 Dates of beginning, peak and end of season

The fishery commences in Bombay in October after the southwest monsoon when only small quantities are landed. The maximum catches are recorded in November and December. The season comes to a close at the onset of the southwest monsoon rains in June.

5.3.5 Factors affecting fishing season

In Bombay, several factors, such as the force and duration of the tidal current, the extent of rainfall over the adjoining land mass, the annual cycle of upwelling of coastal waters and the depth and location of fishing grounds, seem to influence the success or failure of the fishery (Kunju, 1967).

5.4 Fishing operations and results

5.4.2 Selectivity

The gear used in Bombay takes all size-groups. Around Hong Kong the nets used appear to allow small prawns to escape (Cheung, 1963).

5.4.3 Catches

The annual total average prawn landings in Maharashtra, India, is 54,862 tons of which 9.61 percent is accounted for by S. Indica (Kunju, 1968).

5.5 Fisheries management and regulations

Cheung (1963) stated that over-fishing of the species is not a problem in Hong Kong, firstly because the local fishermen do not fish intensively in the nursery grounds, and secondly because the mesh diameter of the shrimp trawl commonly used is 15 mm which enables the smaller prawns to escape easily.

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