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Zoological Survey of India

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FRESHWATER PRAWNS OF THE GENUS *MACROBRACHIUM* BATE, 1868 (CRUSTACEA, DECAPODA, PALAEMONIDAE) FROM KARNATAKA, INDIA.

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CONTENTS

INTRODUCTION

The inland northern part of the Karnataka State abounds in varieties of freshwater bodies such as rivers, lakes, tanks, reservoirs, nerennial and seasonal ponds, stagnant pools etc and contributes to a subsistence level freshwater prawn fishery locally. However, practically no information was available on these prawns. As such, the present work on the freshwater prawns was undertaken. The study is based mainly on the material collected in and around Dharwad (Dharwad District) in the jurisdiction of the Karnatak University where most of work was carried out though material was also obtained from other areas such as Kadra (North Kanara or Uttara Kannada District), Karkala (South Kanara or Dakshina Kannada District), Khanapur (Belgaum District), Gulbarga (Gulbarga District) and Bangalore (Bangalore District) representing the three natural geographical regions viz. coastal strip, Sahyadris or Western Ghats and Deccan plateau of the Karnataka State (latitudes 11^0 to 18^0 North and longitudes 74^0 to 78^0 East).

The freshwater prawns of the Karnataka State belong to two families viz. Atyidae — represented by the genera *Caridina* and *Caridinides* and Palaemonidae — represented by the genus *Macrobrachium*. The genus *Caridina* comprising five new species has been described elsewhere (Jalihal *et al*, 1984) while studies on *Caridinides* are still under progress. In the present paper, only the genus *Macrobrachium* representing the following ten species has been dealt with :

1. *M. lamarrei lamarrei* (H. Milne Edwards, 1837)
2. *M. canarae* (Tiwari, 1958)
3. *M. sankollii* n. sp.
4. *M. unikarnatakae* n. sp.
5. *M. tiwarii* n. sp.
6. *M. kistnensis* (Tiwari, 1952)
7. *M. banjarae* (Tiwari, 1958)
8. *M. hendersodayanum* (Tiwari, 1952)
9. *M. scabriculum* (Heller, 1862)
10. *M. idella* (Hilgendorf, 1898)

Of the above ten species, *hendersodayanum* has already been described in detail from the study area by Jalihal and Sankolli (1975 a) and, therefore, only relevant remarks are given here. *M. lamarrei lamarrei*, *canarae* and *idella* have already been reported from this State by Anantha Raman *et al* (1978), Tiwari (1958) and Henderson and Matthai (1910) respectively. *M. kistnensis*, *banjarae* and *scabriculum* are new records while the remaining three viz. *sankollii*, *unikarnatakae* and *tiwarii* are new to science.

Besides detailed description, information on synonymy, material examined, type material and locality, ecology and live colouration is given for each species. Also, information on eggs, larvae and development based on laboratory rearings (to be published elsewhere) is specially given to complement the taxonomic account. Keeping in view the taxonomic confusion prevailing in the group, an exhaustive identification key incorporating most of the above information is formulated for the first time.

The abbreviations ZSI and NMNH are used for Zoological Survey of India, Calcutta and National Museum of Natural History, Smithsonian Institution, Washington, D. C. 20560, U. S. A. respectively.

1. Macrobrachium lamarrei lamarrei (H. Milne Edwards)

Palaemon Lamarrei H. Milne Edwards, 1837, *Hist. nat. Crust.*, 2 : 397.

Palaemon (Eupalaemon) lamarrei : De Man, 1908, *Rec. Indian Mus.*, 2 : 222.

Palaemon lamarrei : Henderson & Matthai, 1910, *Rec. Indian Mus.*, 5 : 301.

Palaemon lamarrei : Kemp, 1915, *Mem. Indian Mus.*, 5 : 265.

Palaemon lamarrei : Chopra & Tiwari, 1949, *Rec. Indian Mus.*, 45 : 214.

Macrobrachium lamarrei : Holthuis, 1950, *Siboga Exped. Monogr.*, 39 a (9) : 119.

Palaemon lamarrei lamarrei : Tiwari, 1952, *Ann. Mag. nat. Hist.*, 5 : 28.

Palaemon lamarrei : Tiwari, 1956, *J. Bombay nat. Hist. Soc.*, 53 : 490.

Non Palaemon lamarrei : Rajyalakshmi, 1961, *J. zool. Soc. India*, 13 : 220 (larvae).

Macrobrachium lamarrei : Anantha Raman, Reddy, Katre & Ayyappan, 1978, *Vignana Bharati*, 4 (2) : 79.

Macrobrachium lamarrei : Holthuis, 1980, *F.A.O. Fish. Synopsis No. 125*, 1 : 95.

Macrobrachium lamarrei lamarrei : Jalihal, Almelkar, Shenoy & Sankolli, 1983, *Proc. First All India Symp. Invert. Repr.*, 1980 : 239 (larvae).

Material examined.— 15 specimens collected from Jagat, an impounded freshwater body near fort area, Gulbarga on 26-9-1974. Sizes : 6 berried

females—55.0 to 68.0mm and 9 non-berried (apparently spent) females—51.0 to 66.0mm. (No males in the collection.) One damaged non-berried female of 56.0mm given by Mr. Ayyappan from his collection from A.S.C. tank, Bangalore (date not known). Besides, material was also collected, especially for males, from museum tank of ZSI, which is one of De Man's (1908) collection localities, on 30-11-1975.

Diagnosis : Rostrum equal to or slightly longer than antennal scale and slightly upturned distally. Rostral formula $\frac{6 \text{ to } 9+0 \text{ to } 2+1 \text{ or } 2}{4 \text{ to } 8}$ $\left(\text{i.e. } \frac{7-11}{4-8}\right)$ with 1 or 2 postorbital teeth. Upper margin with a distal gap between a proximal series of large 6—9 teeth and distal 1 or 2 subapical teeth, sometimes this gap being interrupted by 1 or 2 teeth. Proximal toothed portion 1.50 to 3.70 times as long as distal gap. Teeth on lower margin equidistant. Carapace 1.05 to 1.30 (average=1.20)—times as long as rostrum. Second chelipeds slender, equal and a little more than $\frac{1}{3}$rd body length ; chela always longer than half (except in one female of 64.0mm where it was shorter than half) but shorter than $\frac{3}{4}$th of carpus ; palm invariably shorter than half of carpus ; carpus 8.6 to 11.75 (average=10.36)—times as its distal diameter. The average percentage lengths of various segments of second cheliped is as given below :

Ischium	Merus	Carpus	Palm	Fingers
20.14%	24.53%	33.58%	11.65%	10.07%

Second pleopod of male with a characteristic *appendix masculina* which is almost non-hairy, long, slender and reaching upto or beyond endopod (Fig. 2, q1). Exopods of uropods characterised by absence of accessory subapical spine. Body transparent without any red spots either on chelipeds or on walking legs. Eggs greenish, large, oval or elliptical and measuring 0.95 to 1.25 × 1.15 to 1.47mm. Fecundity : 65 to 275. Development partially abbreviated comprising 3 zoeal stages before postlarvad ; first zoea with typical, triangular telson having 7+7 (14) processes and postlarva characterised by absence of uropod accessory subapical spine as in adult.

Remarks : Macrobrachium lamarrei which is one of the oldest known and widely distributed Indian *Macrobrachium,* remained as a much confused species until De Man (1908) gave its detailed account. Subsequently Tiwari

(1952) described a new subspecies viz. *lamarroides* from the Logtak lake, Manipur, which differs from the nominate subspecies *lamarrei* in having a shorter rostrum with lesser number of teeth.

Both the subspecies, however, have a common characteristic feature of the male pleopod viz. a long, slender, almost non-hairy *appendix masculina* that extends atleast upto tip of endopod, unlike the usual short, stout and hairy one, which is a unique feature amongst the species of the genus (Tiwari, 1951 & 1956).

Unfortunately in the present collection there are no males as also experienced by Kemp (1915). However, the present material is assigned to *M. lamarrei lamarrei* based on certain characteristics of the subspecies such as absence of accessory subapical spine on uropod exopod, upturned and slender rostrum with a distal gap on dorsal margin, typical rostral formula and rostrum to carapace ratio, proportions of different segments of second cheliped and the egg size.

As regards the uropod accessory subapical spine, Holthuis (1950) found out its absence in De Man's (1908) *lamarrei* material. This feature is shared by the present material as well as three other species described in the present paper viz. *canarae, tiwarii* and *kistnensis.*

The absence of males and presence of large number of berried females in his brackish water Chilka lake collection of the species, prompted Kemp (1915) to think that this species migrates from freshwater in the neighbourhood to release the larvae in the saline part of the lake. However, the presence of berried females in impounded waters as in the present collection and also the completion of larval development in freshwater alone (Jalihal *et al,* 1983) indicates that this species does not have to necessarily depend upon salinity for metamorphosis.

According to De Man (1908) and Tiwari (1951) the young specimens of this species have shorter rostrum which barely equals antennal scale whereas in larger individuals it exceeds scale by $\frac{1}{4}$th to $\frac{1}{3}$rd its length. In the present material, however, the rostrum just equals the scale as in Kemp's (1915) females. The rostral formula in the present material agrees with that given by De Man (1908) and Tiwari (1951) except for a single specimen which has lesser ventral teeth (only 4 instead of 5).

In proportions of different segments of second cheliped, the present material agrees with those given by De Man (1908), Kemp (1915) and Tiwari (1951) but carpus in the present material is apparently stouter (8.6 to 11.75— times as long as broad) than in Tiwari's material (12.0 to 14 0 times as long as broad).

This species has been reported in Karnataka from Bangalore by Anantha Raman *et al* (1978). However, based on rostral formula and rostrum to carapace ratio their material apparently resembles more to *canarae* than *lamarrei.* But *canarae* has so far not been reported outside its type area in South Kanara District of the Karnataka State. Therefore, attempts were made to collect this species from almost all freshwater bodies in Bangalore which, however, proved to be futile. As such, Dr. Anantha Raman and his co-authors were personally approached for their *lamarrei* material which unfortunately could not be traced except for a single specimen from A.S.C. tank collected by Mr. S. Ayyappan. This specimen, a damaged female without any pleopods, does conform with *lamarrei.* The *lamarrei* material was supposed to have been collected by above authors in Bellandur tank near Bangalore Air Port (personal communication with Drs. Shakuntala Katre and Ravichandra Reddy). Our attempts for collection in that tank, however, did not yield any prawns. Infact, the local fishermen informed us that no prawns were available in the tank since last ten years because of the pollution due to discharge of effluents which turned the water so acidic and black in colour that the State Department was forced to even close down its Research Station situated on its bank. Perhaps due to this non-availability of *lamarrei* in recent years Anantha Raman (1982) himself has not included this species in his Ph. D. thesis dealing with ecology of freshwater prawns of the Bangalore area.

The Karnataka State Fisheries Department had released *M. malcolmsonii* in 1971 in some of the tanks in Bangalore. Both *malcolmsonii* and *lamarrei* are commonly associated in the Godavari River (Shenoy *et al,* 1984). Some *lamarrei* might have accidentally got stocked alongwith *malcolmsonii* lot, which can explain the occurrence of *lamarrei* in Bangalore in the past. However, subsequent non-availabilty of the species indicates that both the species seem to have failed to establish in Bangalore area.

Based on the larvae obtained from adults collected from one of De Man's (1908) localities viz. museum tank of ZSI, Jalihal *et al* (1983) have

already indicated that *Palaemon lamarrei* of Rajyalakshmi (1961) from Hooghly estuary may not be true *lamarrei.*

This subspecies is found almost all over India in freshwaters in the plains —both in northern and peninsular region, brackish waters (Tiwari, 1951) and sometimes it is even subterranean as reported by Holthuis (1950) but is not found in the hill streams (Tiwari, 1951). It is not recorded either from extreme south or in Western Ghats area (Tiwari, 1955).

2. Macrobrachium canarae (Tiwari)

(Figs. 1 & 2)

Palaemon canarae Tiwari, 1958, *Rec. Indian Mus.*, 53 : 298.

Material examined.—40 specimens collected from the Ramasamudrum tank at Karkala in February 1975. Sizes : 20 males—25.0 to 44.0mm, 16 non-berried females—24.0 to 55.0 mm and 4 berried females 40.0 to 45.0 mm. The following type material deposited in ZSI was also examined : Holotype—a berried female of 49.0mm (Regd. No. C $\frac{3124}{1}$) and Paratypes—4 males measuring 22.0 to 38.0 mm and 2 berried females+5 non-berried females measuring 37.0 to 46.0mm (Regd. No. C $\frac{3125}{1}$).

Description : Rostrum 1.0 to 1.75 (average=1.35)-times as long as carapace, extending much beyond antennal scale by last one or two ventral teeth (in a single specimen of 55.0mm it was equal to antennal scale), narrow, with usually slightly upturned tip which in some rather straight or more upturned. Rostral formula $\frac{7—10}{4—7}$, usually $\frac{8—9}{4—6}$ $\left(\text{average}= \frac{8.25}{5.10}\right)$ with 2 (rarely 1) postorbital teeth. A large, smooth subdistal gap on upper margin between apical (1 or 2) and large and evenly spaced proximal teeth, in some cases this interspace interrupted by a single median tooth.

Eyes well developed, cornea broad and well pigmented.

Stylocerite and anterolateral spines of basal segment of antennular peduncle rather slender, former being fairly long reaching lower $\frac{1}{3}$rd of segment. Both branches of outer flagellum fused basally for 8 to 10 segments. Antennal scale about 3.5-times as long as broad.

Mouth parts normal as in figure. Third maxilliped extending slightly beyond antennal scale, usually with half of its terminal segment.

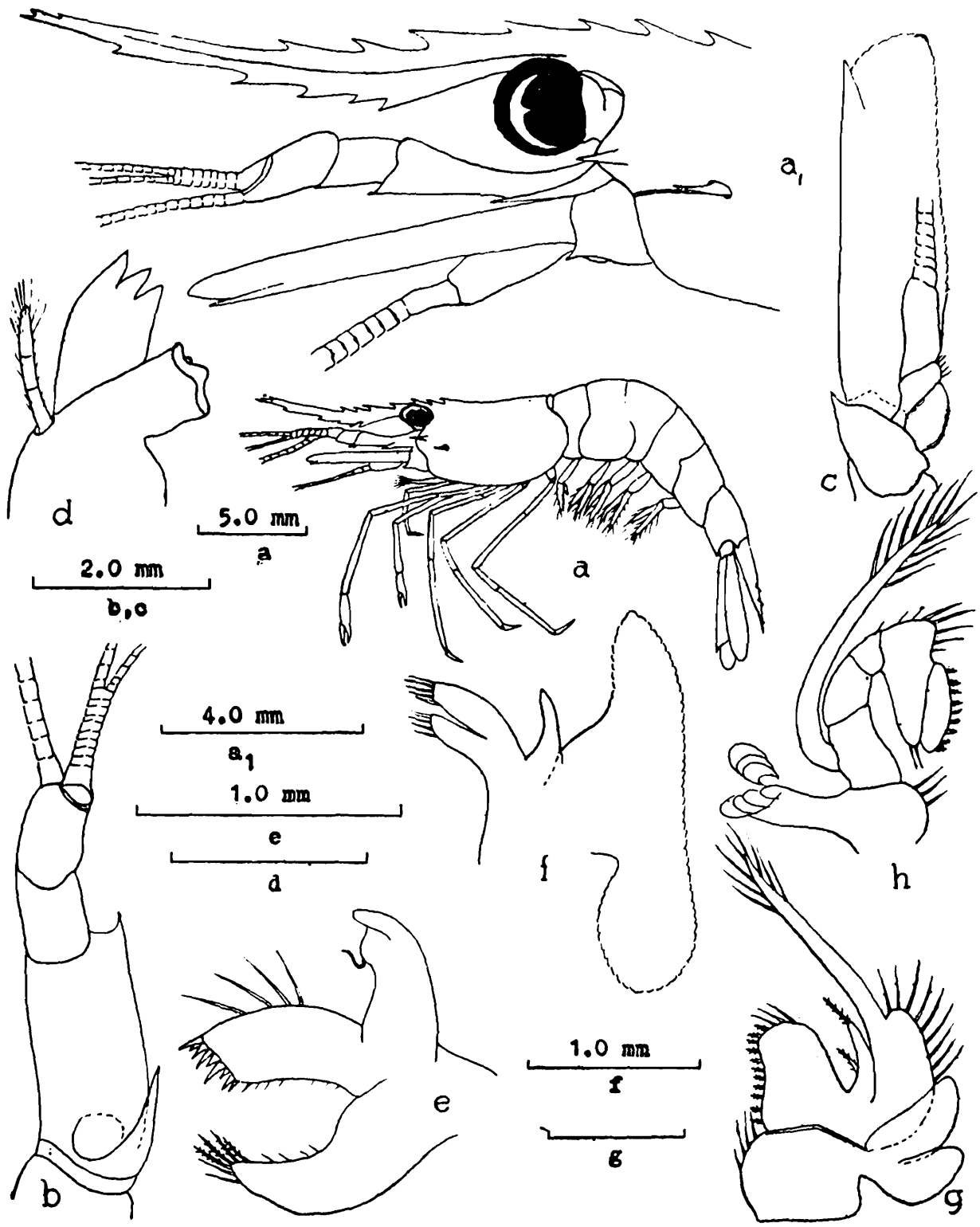

FIG. 1. *Macrobrachium canarae* (Tiwari)—Male, 38.0 mm.
a. entire animal (lateral view), a_1. anterior part, b. antennule,
c. antenna, d. mandible, e. first maxilla, f. second maxilla,
g. first maxilliped, h. second maxilliped.

First chelipeds slender, equal and extending upto tip of antennal scale. Fingers as long as palm, carpus more than twice as long as chela and about 0.8 –times as long as merus. Second chelipeds longer than first pair, slender, equal and similar in both sexes, about half of total body length and extending upto tip or even beyond antennal scale with chela. Fingers 0.72 to 0.88 (average=0.8)-times as long as palm, with a small proximal gap when closed and with a few delicate hairs, slightly more in distal half. Cutting edge of movable finger usually armed with 2 microscopic teeth proximally (in some absent), while fixed finger with a similar tooth fitting in gap between teeth of movable finger when closed. Rest of cutting edges sharp but smooth. In few cases no teeth on cutting edges. Chela always longer than $\frac{1}{2}$ but shorter than $\frac{3}{4}$th (average=0.64)—times of carpus (except in one female of 54.0mm where it is longer than $\frac{3}{4}$th). Palm dorsoventrally compressed and invariably shorter than half of carpus. Carpus longer than merus, cylindrical and 10.55 to 14.75 (average=12.66)—times as long as its distal diameter. Average percentage lengths of various segments of this cheliped are as under :

Ischium	Merus	Carpus	Palm	Fingers
21.52%	22.98%	33.88%	12.03%	9.62%

Third to fifth pereiopods similar in structure with simple dactylus.

First pleopod with endopod about $\frac{1}{3}$rd exopod in females and about $\frac{1}{2}$ in males. *Appendix masculina* 1.8 to 2.0—times as long as *appendix interna*, about 0.7—times endopod and with 10 to 15 setae along its inner margin and 3 or 4 stiffer setae terminally.

Telson about 1.5—times as long as sixth abdominal segment and with 2 pairs of dorsal spines in posterior half ; posterior margin with a triangular median point, flanked by 2 pairs of spines of which inner pair stouter and 3.5 to 4.0—times longer than outer, 3 or 4 short plumose setae ventrally between inner spines and 2 pairs of small hairs dorsally.

Uropods characterised by absence of accessory subapical spine on exopod.

Eggs and development. Eggs rather large, oval or elliptical, measuring 1.25 to 1.40 × 1.70 to 1.90mm. Immature eggs deep green, turning slightly brownish on maturation. Fecundity : 50 (counted in a single specimen only). Development partially abbreviated comprising 3 larval+1 postlarval stages.

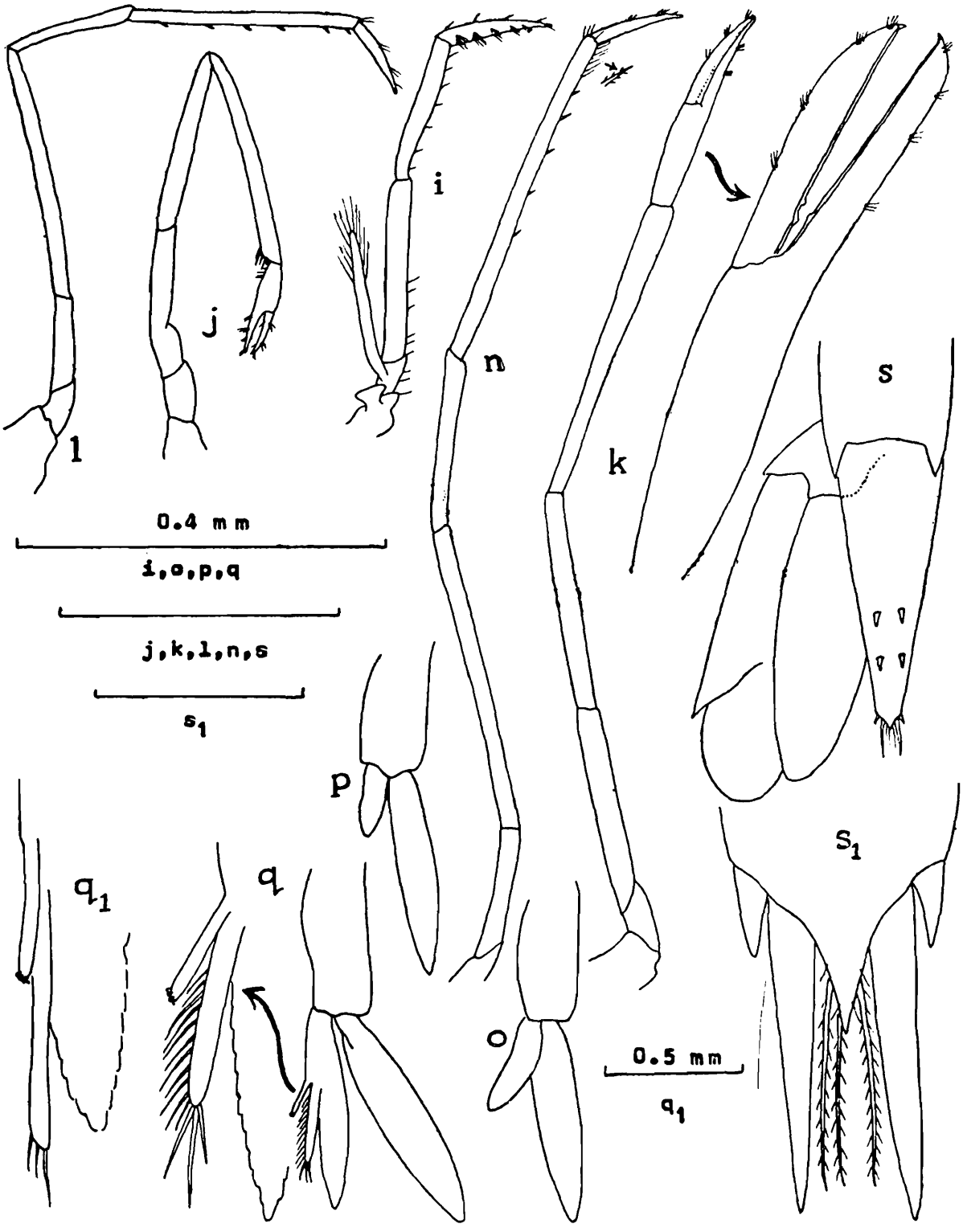

FIG. 2. *Macrobrachium canarae* (Tiwari)—Male, 38.0 mm.
i. third maxilliped, j. first cheliped, k. second cheliped,
l. third pereiopod, n. fifth pereiopod, o. first pleopod,
p. first pleopod of female, q. second pleopod, q_1. second pleopod of *M lamarrei lamarrei*, s. telson+uropods,
s_1. posterior part of telson magnified.

First zoea with a typical triangular telson having 7+7 (i.e. 14) processes and postlarva characterised by absence of accessory subapical spine on exopod of uropod as in adults.

Colouration. Body almost transparent with a few orange-red chromatophores distributed as follows : A characteristic prominent, deep chromatophore at base of fingers of second cheliped which are bluish in colour. Lighter chromatophores at junctions of each segments of all pereiopods, except first and at bases of third maxilliped, second and third pereiopods.

Ecology. Tiwari's (1958) original material is reported from both riverine (Sitanadi and Yenni Holi) and impounded (temple tank) waters near Karkala (South Kanara District). The present material is collected from the Ramasamudram which is a freshwater perennial tank, situated in the rocky valley of Karkala with a smaller distinct deeper zone and quite an extensive shallow peripheral region. The shallow region is as good as marshy, covered with aquatic weeds and floating plants, offering an excellent shelter and ideal habitat for these prawns.

Remarks : Tiwari (1958), the original author of *canarae*, gave only a diagnostic account of the species without any illustrations. Therefore, this species is described in detail for the first time in the present paper, based on material collected from Karkala which is within the type area and also after comparing the type material of the species deposited in ZSI.

The present species closely resembles both the subspecies of *M. lamarrei* i.e. *lamarrei* and *lamarroides* in general appearance, shape of rostrum and absence of uropod accessory subapical spine. They differ, all the same, from one another as under :

	Characters	*M. canarae* (Tiwari)	*M. lamarrei lamarrei* (H. Milne Edwards)	*M. lamarrei lamarroides* (Tiwari)
1.	Rostral formula	$\frac{7—10}{4—7}$ (av. $\frac{8.25}{5.10}$)	$\frac{5—11}{5—9}$ (av $\frac{8.2}{7.8}$)	$\frac{4—8}{3—5}$ (av. $\frac{6.13}{4.25}$)
2.	Carapace	Shorter than (0.57 to 1.0, av.=0.74—times) rostrum	Subequal to (0.9 to 1.3, av.=1.11—times) rostrum	Distinctly longer than (1.84 to 2.0, av.=1.89—times) rostrum

3.	*Appendix masculina*	Distinctly shorter than (only about 0.7—times endopod, hairy with 3 or 4 stiff setae terminally	Atleast equal to endopod, usually slightly longer than it, almost naked but for 3 to 5 terminal delicate setae	Same as in *M. lamarrei lamarrei*
4.	Colouration	Orange-red chromatophores at base of (bluish) fingers of second cheliped, at junctions of each segments of all pereiopods except first and at the bases of third maxilliped, second and third pereiopods—	No chromatophores either on chelipeds or on other pereiopods	No information
5.	Distribution	So far known only from the type area i.e. South Kanara District of the Karnataka State	Commonly found all over India and in Indwagi Lake (upper Burma)	So far know only from the type locality i.e. Logtak lake, Manipur

What Anantha Raman *et al* (1978) described as *M. lamarrei* from Bangalore, and now confirmed as *lamarrei* (see discussion under *lamarrei* of present paper), can be easily confused with *canarae* in rostral formula $\left(\frac{5-9}{4-7}, \text{average} = \frac{8.0}{5.26}\right)$ and carapace to rostrum ratio $\left(\frac{\text{Carapace}}{\text{rostrum}} = 0.58 \text{ to } 0.91, \text{average} = 0.7\right)$ and also because of their material consisting of juveniles (14.0 to 22.0 mm) lacking information on important distinguishing characters of adults like colouration, male pleopod, egg size etc.

3. **Macrobrachium sankollii** Jalihal and Shenoy, n. sp.*

(Figs. 3 & 4)

Palaemon kistnensis partim Tiwari, 1952, *Ann. Mag. nat. Hist.*, 5 : 28.

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* As cited, the authors for this species are only Jalihal and Shenoy and the description of this species is the responsibility of these two authors alone.

Material examined.—50 specimens collected on 15-12-.975 and 13-3-1976 in the river Malaprabha at Khanapur near the old bridge and Vattoli forest plot, both localities about 20 km away towards east of origin of the river in Western Ghats at Kanakumbi (about 850 metres above the Mean Sea Level). Sizes : Males-27.0 to 41.0 mm, non-berried females-30.0 to 55.0 mm and one berried female-51.0 mm.

Holotype : 1 male of 29.0 mm deposited in ZSI (Regd. No. C $\frac{2702}{2}$).

Paratypes : 3 females measuring 36.0 to 40.0 mm and 1 male measuring 35.0 mm deposited in ZSI (Regd. No. C $\frac{2703}{2}$) and 1 female of 40.0 mm and 1 male of 33.0 mm deposited in NMNH (Regd. No. 170248).

Type lacality : Malaprabha River, near old bridge, Khanapur.

Description : Rostrum always longer than antennular peduncle, mostly equal to but in a few cases slightly longer or shorter than antennal scale; upper margin straight or slightly convex above orbital region, tip normally slightly upturned. Rostral formula $\frac{5-10}{3-6}$, usually $\frac{7-9}{3-4}$ (average $= \frac{7.8}{3.7}$) with 1 or 2 postorbital teeth ; both margins with teeth almost equidistant, upper margin usually with a small subapical tooth widely separated from remaining teeth. Carapace smooth, equal to or longer than (1.0 to 1.3-times) rostrum.

Eyes well developed, cornea broad and well pigmented.

Stylocerite small and stout reaching only proximal $\frac{1}{4}$ th of basal segment of antennular peduncle. Two branches of outer flagellum fused basally for about 7 segments. Antennal scale 3.0 to 3.2 times as long as broad.

Mouth parts normal as in figure, third maxilliped extending slightly beyond antennal peduncle.

First chelipeds extending upto tip of antennal scale ; carpus almost twice as long as chela and 1.2 to 1.3 times as long as merus. Second chelipeds equal, similar in both sexes and about half as long as body, extending with chela beyond antennal scale. Fingers 0.7 to 0.86 (average=0.75)-times as long as palm, with a few delicate hairs near tips and when closed leave a small gap basally. Cutting edge of movable finger usually armed with 1 (rarely 2) minute, tubercle-like tooth proximally while fixed finger unarmed or rarely with a single tooth ; even movable finger unarmed in many

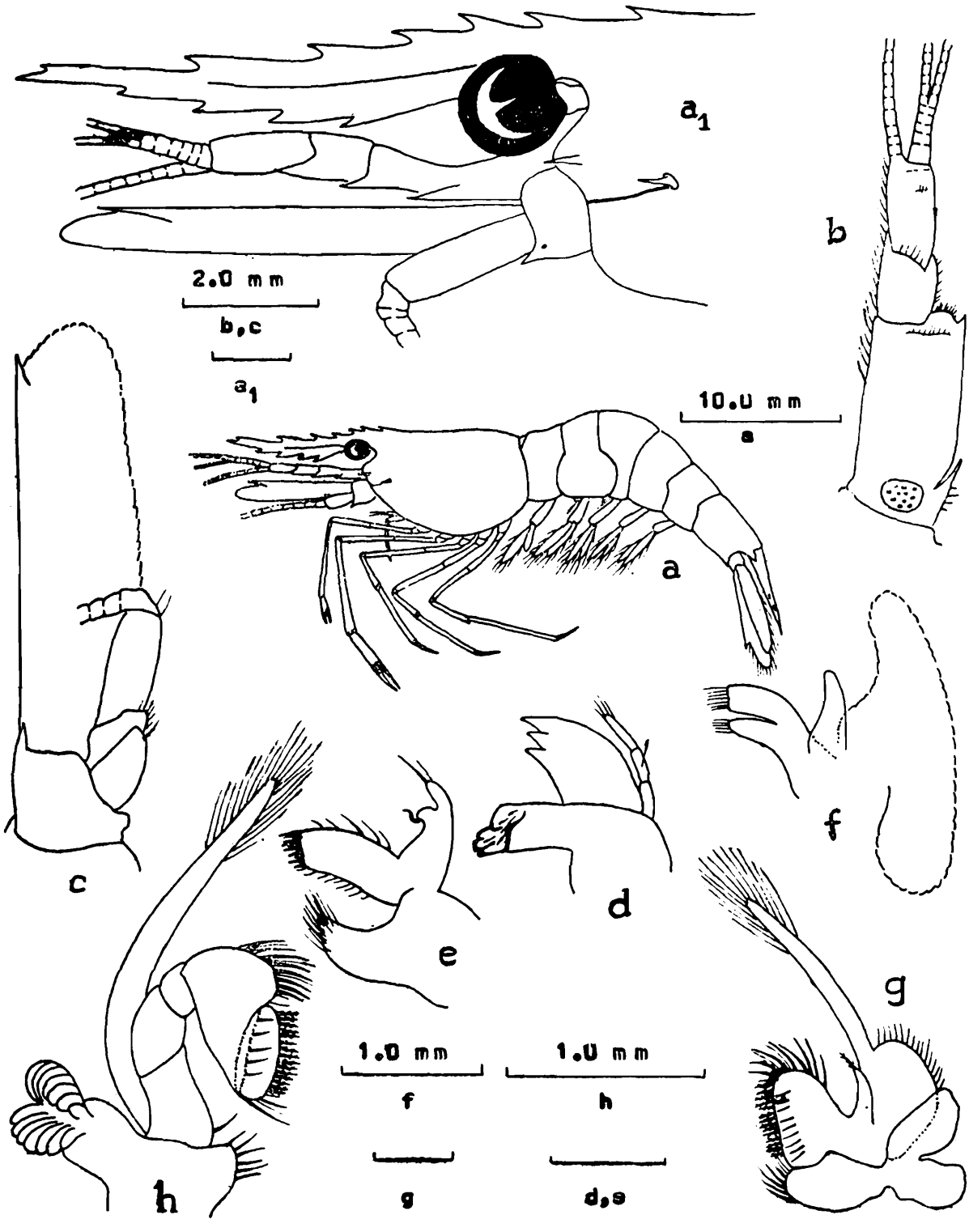

FIG. 3. *Macrobrachium sankollii* n. sp.—Male, 37.0 mm.
a. entire animal (lateral view), a_1. anterior part, b. antennule, c. antenna, d. mandible, e. first maxilla, f. second maxilla, g. first maxilliped, h second maxilliped.

instances, chela being completely unarmed in such cases. Chela always longer than half but shorter than $\frac{3}{4}$th of carpus. Palm somewhat flattened dorsoventrally and invariably shorter than half of carpus. Carpus longer than merus, cylindrical and 8.72 to 11.40 (average=10.40)—times as long as its distal diameter.

The average percentage lengths of various segments are given below :

Ischium	Merus	Carpus	Palm	Fingers
19.53%	23.76%	33.24%	13.36%	10.07%

Third and fourth pereiopods equal to or slightly shorter than tip of antennal scale while fifth extending beyond antennal scale with its dactylus.

Sixth abdominal segment about 1.5—times the 5th in length. First pleopod with endopod being much smaller than exopod — in males about 0.6 times and in females about 0.35—times exopod. *Appendix masculina* 1.92 to 2.04 (average=2.0)-times as long as *appendix interna*, about 0.68 to 0.72 (average=0.7)—times as long as endopod, fringed along inner margin with spine-like setae and 1 long+2 to 4 subequal, shorter and stiffer but smooth setae terminally.

Telson about 1.2—times as long as 6th abdominal segment and with 2 pairs of dorsal spines in posterior half. Posterior margin ending in a triangular median point, flanked by 2 pairs of spines of which inner pair stouter and much longer than (about 3.5—times) outer. Between inner spines, 1 to 3 pairs of long plumose setae arising ventrally and 1 to 3 pairs of small hairs dorsally.

Uropods typical, with a movable accessory subapical spine on exopod.

Eggs and development, Size and number of eggs could be studied in only one berried female which carried 60 eggs measuring 1.10 to 1.30×1.60 to 1.80 mm. Colour of eggs greenish, tending towards brownish with advancement. Larval development partially abbreviated consisting of 3 larval+1 postlarval stages. First zoea with a triangular telson having 7+7 (i.e.14) processes and postlarva typical with presence of uropod accessory subapical spine.

Colouration : Body almost transparent with a few orange-red chromatophores distributed as follows : Fingers of second cheliped with a prominent

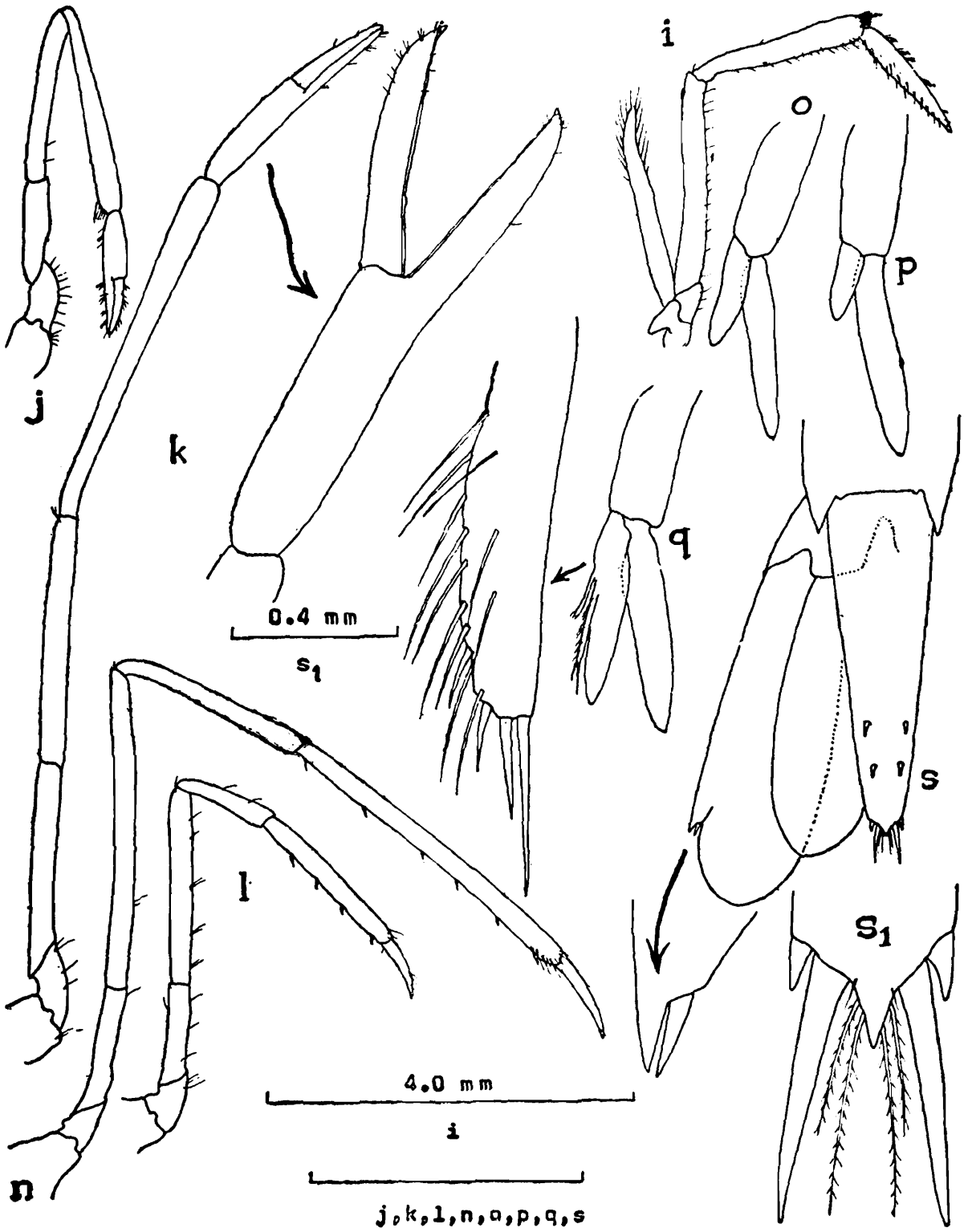

FIG. 4. *Macrobrachium sankollii* n. sp.—Male, 37.0 mm
i. third maxilliped, j. first cheliped, k. second cheliped, l. third pereiopod, n. fifth pereiopod, o. first pleopnd, p. first pleopod of female, q. second pleopod, s. telson+ uropods, s_1. posterior part of telson magnified.

deep chromatophore at base and a lighter chromatophore each at junctions of all pereiopod segments except first pereiopod.

Ecology : The species was collected at the riverhead of Malaprabha at an altitude of about 670 meters above the Mean Sea Level. The prawns are generally found between heaps of decaying leaves, among grass and other aquatic weeds, in crevices along the river bank etc.

Remarks : Based on literature alone, the new species *M. sankollii* closely resembles the Malayan specics *M. lanchesteri* (De Man, 1911) in general appearance, shape and dentition of rostrum and proportions of different segments of second cheliped. But unfortunately *lanchesteri* itself has been a much misunderstood species since none of the previous authors like Lanchester (1901), De Man (1911) and Kemp (1918) have taken into both sexes consideration and the complete size range while describing the species. Infact, Kemp (1918) based on material collected from Tale Sap, near the type locality of the species i e. Singora, was led to believe that *lanchesteri* does not exhibit sexual dimorphism probably because the maximum size of adult males and females in his material was small—just 34.0 and 42.0 mm respectively (personal examination of Kemp's material deposited in ZSI—Regd. No. $\frac{9607}{10}$). It was Johnson (1968) who could for the first time point out that large males (upto 62.0 mm) of *lanchesteri* (collected from Research ponds of the Tropical Fish Culture Research Station at Batu Berendam, Malacca) differ from smaller individuals though he did not specify the exact nature of these differences. He assigns the presence of large males possibly to the predator-free artificial pond condition, allowing full growth as in his collection from Research ponds of Malacca.

Recently Chong (in press—personal communication) has redescribed *lanchesteri* based on a large series of material from Singapore. He (Mr. Samuel Chong) was kind enough to send 2 non-berried females (31.0 mm), 1 berried female (50.0 mm) and 1 large male (52.0 mm) of *lanchesteri* collected from the PPD ponds of the Sembawang Field Experimental Station, Singapore, alongwith the first stage larvae. The information, given for *lanchesteri* in the following comparative table is thus based not only on the personal examination of Kemp's (1918) material but also of specimens sent by Mr. Samuel Chong (identity confirmed by Dr. L. B. Holthuis) and examination of first larval stage. The new species differs from *lanchesteri* (Fig. 5) in the following characters :

Characters	*M. sankollii* n. sp.	*M. lanchesteri* (De Man)
I. *ADULTS :*		
1. Second cheliped		
(a) Colouration	A distinct red spot at base of fingers irrespective of sex or size	Without any red chromatophore but in fully developed males fingers light blue in colour
(b) Extension	Only chela extends beyond antennal scale irrespective of sex or size	Chela extends beyond antennal scale in individuals upto 40.0 mm while in larger females distal half of carpus + chela and in fully developed males entire carpus + chela extend beyond it
(c) Chela	Always longer than half but shorter than $\frac{3}{4}$ th of carpus	Always longer than half of carpus, generally being shorter than $\frac{3}{4}$th of carpus in examples upto 45.0 mm but in larger examples be coming longer than $\frac{3}{4}$th of carpus while in fully developed males distinctly longer than entire carpus
(d) Fingers	Smooth without any pubescence in both sexes	Smooth in females and small males only while in larger males covered with pubescence formed by bunch of hairs arising from fluted fingers
(e) Palm	invariably shorter than half of carpus	Shorter than half of carpus in females and smaller males but in fully developed males about $\frac{3}{4}$th of carpus
2. *Appendix masculina*	Longer being 1.92 to 2.04 (av. 1.99) times as long as *appendix*	Shorter being only 1.28 to 1.37 (av. 1.33)—times as long as *appendix interna*

	interna and with 1 long+2 to 4 subequal, shorter and unsegmented setae	and with 2 long + 6 to 10 subequal, shorter setae most of which are distinctly segmented
3. Eggs		
(a) Fecundity	About 60 (counted in a single specimen)	About 290 (counted in a single apecimen)
(b) Size in mm	1.10 to 1.30 x 1.60 to 1.80	0.70 to 0.88 x 0.90 to 1.20
4. Habitat	So far found only in hill streams (river head)	Found only in slow moving or stagnant water bodies (of the plains)
II. LARVAE:		
5. First zoea	Larger being 4.40 to 4.50 mm and with well developed biramous pleopods	Smaller being 3.60 to 3.80 mm and without any traces of pleopod buds
6. Development	Comprises only 3 larval stages	Comprises a series of larval stages

In light of above table what Anantha Raman *et al* (1978) and Narasimha Rao *et al* (1981) reported as *M. lanchesteri* from Bangalore definitely is not true *lanchesteri* since it differs distinctly from *lanchesteri* in absence of sexual dimorphism, chela of second cheliped always longer than $\frac{3}{4}$th of carpus (but never equal to carpus) and presence of larger eggs (1.12 to 1.20×1.39 to 1.72 mm). The account of *'lanchesteri'* by both the above authors lacks information on such important characters as colour pattern, male pleopod etc. Therefore, personal collections were specially made in various freshwater bodies in and around Bangalore to decide the exact identity of their *'lanchesteri'* Detailed adult and larval studies based on the above collection revealed that what they refer to as *lanchesteri* infact belongs to a new species viz. *M. unikarnatakae* of the present study.

Another Indian material wrongly assigned to *lanchesteri* was by Tiwari (1949), collected from hill-tracts of Baroda and Nagpur (unlike the true *lanchesteri* which essentially is a species occurring in freshwater bodies

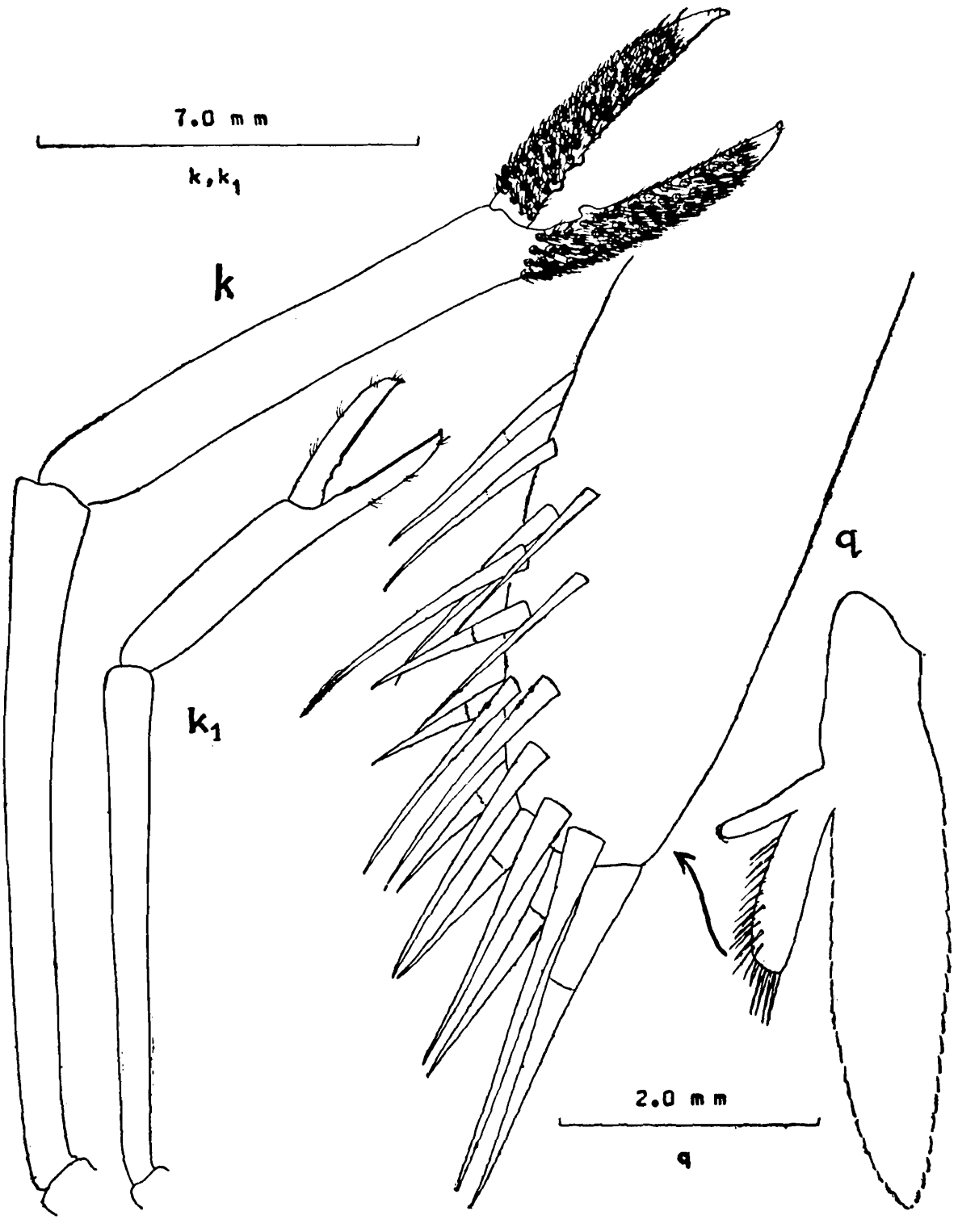

FIG. 5. *Macrobrachium lanchasteri* (De Man)—Male, 52.0 mm
k. second cheliped, k_1. second cheliped of female of 50.0 mm,
q. endopod of second pleopod.

of plains—Johnson, 1963 & 1968). However, subsequently Tiwari (1951 and personal communication with Dr. K. K. Tiwari) synonymised his '*lanchesteri*' under his new species *kistnensis* since he thought that it differed from true *lanchesteri* in possessing larger eggs (1.00 to 1.20 x 1.2 to 1.64 mm). This fact unfortunately is not mentioned in the original published account of *kistnensis* (Tiwari, 1952). Therefore, Tiwari's *kistnensis* material deposited in ZSI was examined for comparison with the present new species.

The huge collection of *kistnensis* kept in big specimen jars (bearing numbers 8969, 8970, 8998 etc and containing numerous vials) is actually found to be an assemblage of different and distinct species collected from widely separated parts of India including the Karnataka State. Of this lot, the material from River Kistna, Wai, Satara District, Bombay State (presently Maharashtra) bearing Regd. No. C $\frac{3141}{1}$ is the type material (though not designated in literature) as per personal communication and discussion with Dr. Tiwari who is the original author of *kistnensis*, and this material is characterised by absence of uropod accessory subapical spine (Jalihal *et al*, 1979 a) unlike in *lanchesteri*. The material from the Karnataka State includes one bottle (Regd. No. C $\frac{3136}{1}$) containing prawns collected at Khanapur (type area of the present new species). The detailed examination of this material revealed the presence of 8 specimens out of the total 70, which differed from *kistnensis* but resembled the new species in possessing—i) uropod accessory subapical spine and ii) a shorter second chela which is not more than $\frac{3}{4}$th of carpus. This part of the material is, therefore, synonymised here with the new species.

Thus the records of *lanchesteri* from India by Tiwari (1949), Anantha Raman *et al* (1978) and Narasimha Rao *et al* (1981) are erroneous in view of the above discussion. This is further substantiated by the fact that true *lanchesteri* has a restricted distribution and so far has not been recorded outside the Malayan peninsula as also stated by Johnson (1963).

Etymology : The new species is named after Dr. K. N. Sankolli, the then Head of Post-Graduate Department of Marine Biology, Karwar of the Karnatak University, Dharwad.

4. Macrobrachium unikarnatakae n. sp.

(Figs. 6 & 7)

Macrobrachium idae Katre & Pandian, 1972, *Hydrobiologia*, 40 : 1 (hatching machanism).

Macrobrachium lanchesteri : Anantha Raman, Reddy, Katre & Ayyappan, 1978, *Vignana Bharati*, 4 (2) : 80.

Macrobrachium lanchesteri : Narasimha Rao, Katre & Reddy, 1981, *Proc. Indian Acad. Sci. (Anim. Sci.)*, 90 (1) : 39 (moult - reproduction).

Material examined.– 250 specimens collected from various impounded freshwater bodies like University pond, Saptapur pond, Lamanikeri, Hosayellapur tank (Hirekeri), Sadhankeri, Nuggikeri etc in Dharwad and nearby places such as Mugad (Honnavvankeri), Narendra (Hirekeri), Tadkod (Uramundinkeri), Navalur (Navalurkeri) and Neersagar reservoir. 120 specimens collected from different freshwater bodies in and around Bangalore such as Jakkasandra tank in Madiwal, Hebbal tank, Hesaraghatta tank, fish ponds of University of Agricultural Sciences on 27-10-1984 and 6-12-1984. Sizes : males—26.0 to 52.0 mm, non-berried females—27.0 to 69.0 mm and berried females—40.0 to 68.0 mm.

Holotype : 1 male of 44.0 mm deposited in ZSI (Regd. No. C $\frac{2704}{2}$).

Paratypes : 1 male of 42.0 mm and 3 berried females of 54.0 to 56.0 mm. deposited in ZSI (Regd. No. C $\frac{2705}{2}$) and 1 male of 43.0 mm and 1 berried female of 64.0 mm deposited in NMNH (Regd. No. 170247).

Type locality : Hosayellapur tank (Hirekeri), Dharwad.

Description : Rostrum always longer than antennular peduncle, generally reaching tip of antennal scale (longer than it in 5%, equal to in 50%, nearly equal to in 24% and shorter than scale in 20%) and exhibits considerable range of variation in its shape and dentition. Upper margin characteristically slightly convex above orbital region ; lower margin usually convex. Rostral formula $\frac{5—10}{2—6}$ usually $\frac{6—8}{3—4}$ (average=$\frac{7\,06}{3.49}$) with 1 or 2 postorbitals, teeth almost equidistant, usually with a small subapical tooth widely separated from remaining on upper margin but in some no wide distal gap. Carapace always longer than (1.05 to 1.57, average=1.35—times) rostrum.

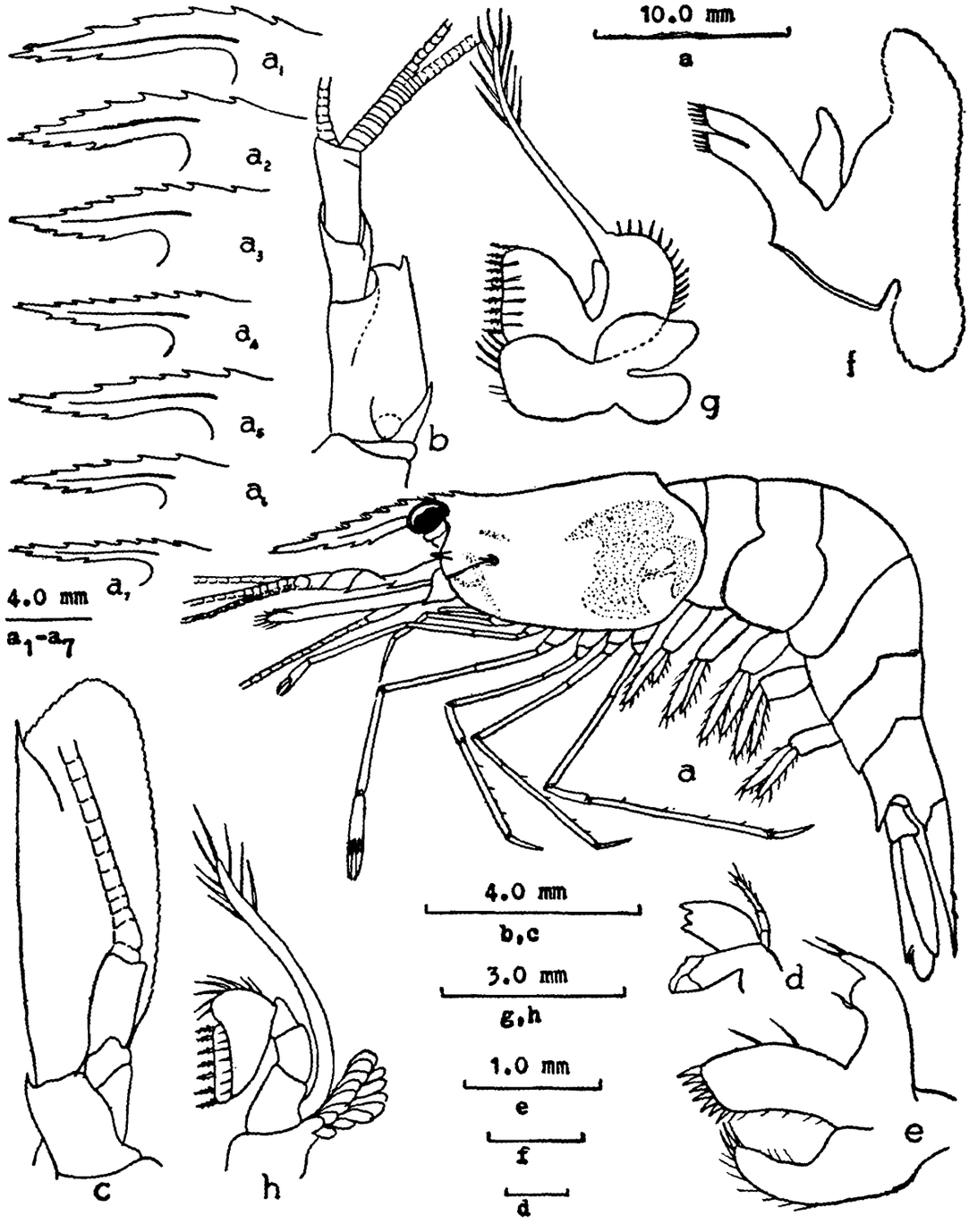

FIG. 6. *Macrobrachium unikarnatakae* n. sp.—Male, 52.0 mm.
a. entire animal (lateral view), a_1 to a_7.—rostrum of 7 different specimens, b. antennule, c. antenna, d. mandible, e. first maxilla, f. second maxilla, g. first maxilliped, h. second maxilliped.

Cornea broad and with brownish green pigmentation.

Basal segment of antennular peduncle rather broad ; stylocerite small and stout ; anterolateral spine extending about $\frac{3}{4}$th of 2nd segment ; two branches of outer flagellum fused basally for 7 to 14 segments. Antennal scale 2.80 to 3.0—times as long as broad.

Mouth parts normal as in figure ; third maxilliped reaching upto or slightly beyond antennal peduncle by its dactylar tip.

First chelipeds about $\frac{1}{3}$rd as long as body and extending upto tip of antennal scale. Fingers as long as palm ; carpus about twice as long as chela and 1.25 to 1.35—times as long as merus. Second chelipeds equal, similar in both sexes, about half as long as body and reaching with chela beyond tip of antennal scale. Chela always longer than $\frac{8}{4}$th of carpus but never equal to it. Fingers 0.6 to 0.85 (average=0.71)—times as long as palm, with a few delicate hairs near tips with a small basal gap when closed. Cutting edge of movable finger usually armed with 2 (rarely 3 but never more) minute tubercle-like teeth proximally, while that of fixed finger with a similar tooth fitting in gap between those of movable finger when closed, rest of cutting edge sharp but smooth (in a few cases no teeth at all on cutting edges, or only 1 each on both fingers or a single one on movable finger only). Palm somewhat flattened dorsoventrally and generally less than half of carpus in smaller and even in many larger specimens but in a few larger specimens (above 55.0 mm) slightly longer than half. Carpus longer than merus, cylindrical and 8.50 to 13.5 (average=10.02)-times as long as its distal diameter.

The average percentage lengths of various segments are as given below :

Ischium	Merus	Carpus	Palm	Fingers
19.49%	22.58%	31.93%	15.07%	10.92%

Third to fifth pereiopods structurally similar.

Sixth abdominal segment 1.30 to 1.70—times 5th in length. Endopod of first pleopod much smaller than exopod—about $\frac{1}{3}$rd in females and about half in males. *Appendix masculina* 2.0 to 2.56 (average=2.29)—times as long as *appendix interna*, 0.69 to 0.77 (average=0.74)—times as long as endopod, fringed along inner margin with usual setae and with 1 long+4 to 6 short, subequal, smooth, stiff setae terminally.

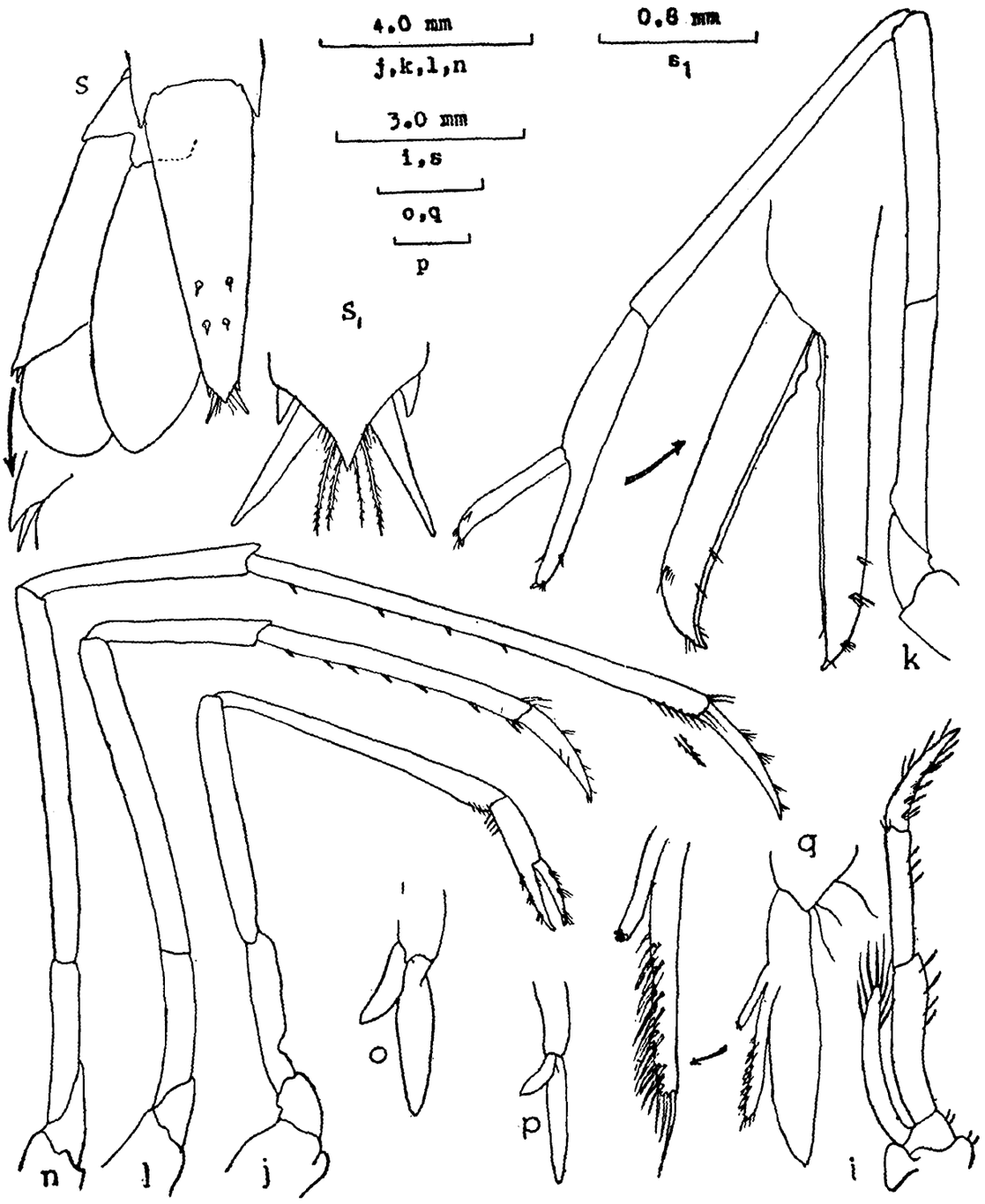

FIG. 7. *Macrobrachium unikarnatakae* n. sp. Male, 52.0 mm.
i. third maxilliped, j. first cheliped, k. second cheliped,
l. third pereipod, n. fifth pereiopod, o. first pleopod,
p. first pleopod of female, q. second pleopod, s. telson+uropods
s_1. posterior part of telson magnified.

Telson about 1.6—times as long as 6th abdominal segment and dorsally armed with 2 pairs of spines in posterior half. A triangular median point on posterior margin flanked by 2 pairs of spines of which inner pair stouter and much longer (3.3 to 5.8—times) than outer. Between inner spines 1 to 5 pairs of long plumose setae arising ventrally and 1 to 4 pairs of small hairs arising rather dorsally (submarginally) from posterior margin.

Uropods typical with a movable accessory subapical spine.

Eggs and development. Eggs rather large, oval or elliptical, measuring 1.10 to 1.40 x 1.40 to 1.90 mm. Immature eggs deep green in colour but turning slightly brownish nearing hatching. Fecundity : 70 to 260. Development partially abbreviated consisting of 3 larval+1 postlarval stages. First zoea with a typical triangular telson possessing 7+7(=14) processes and postlarval uropods with typical accessory subapical spine.

Colouration : A few orange-red chromatophores distributed as follows : Fingers of second chelipeds with a prominent characteristic much branched chromatophore at their base and a single but lighter chromatophore at junctions of each of the segments of all walking legs and second cheliped. Carapace with a broad lateral hazy patch (greyish) in the posterior half and inner flagellum of antennule deep violet.

Some of the berried females were greyish brown or blackish in general colouration but on moulting took to normal colour pattern.

Ecology : This is a common and the only species of *Macrobrachium* available in almost all (both seasonal and perennial) impounded freshwater bodies in and around Dharwad. It is found abundantly in perennial tanks such as Hirekeri, Nuggikeri, Kelgeri, Mugad tank etc which are rich in vegetation. In seasonal tanks which are poor in vegetation the yield is comparatively much less and the prawns get crowded at muddy bottom in deeper parts (1 to 2 metres depth) rather than on banks.

Remarks : M. unikarnatakae inhabits practically almost all impounded freshwater bodies, perennial or seasonal, in and around Dharwad and constitutes the bulk of local prawn fishery.

Though this new species closely resembles *M. sankollii* (present paper) both in adult and larval characters, it can be easily separated from the latter as under :

	Characters	*M. unikarnatakae* n. sp.	*M. sankollii* Jalihal and Shenoy
	(I) ADULTS :		
1.	Shape of rostrum	Always slightly convex above orbital region	Mostly straight above orbital region
2.	Second cheliped		
	(a) Chela	Always longer than $\frac{3}{4}$th (though not equal to) carpus	Always shorter than $\frac{3}{4}$th of carpus
	(b) Palm	Generally shorter to slightly longer (in some individuals above 55.0 mm) than half of carpus	Always shorter than half of carpus
3.	*Appendix masulina*		
	(a) $\frac{masulina}{interna}$ =	2.2 to 2.56 (av. 2.43)	1.92 to 2.04 (av. 1.99)
	(b) Terminal armature	With 1 long+5 or 6 shorter, subequal, stiff setae	With 1 long+2 to 4 shorter, subequal, stiff setae
4.	Maximum size	69.0 mm	52.0 mm
5.	Habitat	Impounded waters	River-head (Hill-stream)
	(II) LARVAE :		
6.	First zoea	Abdomen without any dorosal chromatophare and with ventral chromotophore only on 4th and 5th segements	Abdomen with a large chromatophore dorsally on 3rd segment and a ventral chromatophore each on all 5 segments

The new species differs from the Malayan species *lanchesteri* in the same way as does *sankollii.*

As already discussed in 'remarks' under *sankollii*, what Anantha Raman *et al* (1978) and Narasimha Rao *et al* (1981) describe as *lanchesteri* actually belongs to the present new species in possessing larger eggs (1.12 to 1.20 × 1.39 to 1.72 mm) and chela of second cheliped always longer than $\frac{3}{4}$th but shorter than entire carpus (calculated based on Anantha Raman *et al*, 1978, Table—2 on page 81).

Also, what is reported as *M. idae* by Katre and Pandian (1972) from Bangalore is in all probabilities the present new species in view of following features in their material : i) General appearance as per Figs. 1 A to 1 D on pages 3 & 4. ii) Red chromatophore at base of fingers of second cheliped (as seen clearly in Fig. 1 B on page 3), (iii) Size of berried females—43.0 to 51.0 mm and (iv) Fecundity—40 to 160.

That the above '*lanchesteri*' and '*idae*' from Bangalore are actually *unikarnatakae* is further substantiated by detailed study of a good series of fresh material collected in and around Bangalore (personal collection) and observations on their larvae.

Etymoloay : The present species is the most commonly available *Macrobrachium* in and around Dharwad. Since greater part of the present work was carried out in the Karnatak University, Dharwad, which is telegraphically known as 'Unikarnatak', the new species is named as *unikarnatakae* in honour of the Alma mater.

5. Macrobrachium tiwarii n. sp.

(Figs. 8 & 9)

Palaemon (Eupalaemon) Danae Nobili, 1903, *Boll. Musei Zool. Anat. comp. R. Univ. Torino*, 18 : 7.

Palaemon (Eupalaemon) ritsemae : Roux, 1931, *Revue suisse Zool.*, 38 : 43.

Palaemon kistnensis : partim Tiwari, 1952, *Ann. Mag. nat. Hist.*, 5 : 28.

Material examined :—100 specimens collected between January to May of 1975 and 1976 in the river Malaprabha near old bridge at Khanapur and Vattoli forest plot near Khanapur. 150 specimens collected from various impounded freshwater bodies in and around Bangalore such as Jakkasandra tank in Madiwal, Hebbal tank, Sanki tank, State Government tank and fish ponds of University of Agricultural Sciences at Hesaraghatta on 27-10-1984

and 6-12-1984. Sizes : males—28.0 to 49.0 mm, non-berried females—37.0 to 67.0mm and berried females—45.0 to 61.0 mm.

Holotype : 1 male of 45.0 mm deposited in ZSI (Regd. No. C $\frac{2706}{2}$).

Paratypes : 2 males of 33.0 and 35.0 mm and 4 females of 36.0 to 52.0 mm deposited in ZSI (Regd. N0. C $\frac{2707}{2}$) ane 1 male of 42.0mm and 1 berried female of 50.0 mm deposited in NMNH.

Type locality : Malaprabha River near old bridge, Khanapur.

Description : Rostrum always longer than antennular peduncle, mostly equal to antennal scale and sometimes extending beyond it by last dorsal tooth, with quite a considerable range of variations in its shape and dentition. Upper margin straight or slightly convex above orbital region. Rostral formula $\frac{7—11}{2—6}$ usually $\frac{8—10}{3—5}$ (avreage=$\frac{8.66}{4.42}$) with 1 or 2, rarely 3 postorbital teeth. Upper margin with almost equidistant teeth and usually with 1 or 2 smaller subapical teeth. Carapace smooth, shorter than (0.94 to 0.99-times) rostrum in examples upto 30.0 mm but longer (1.01 to 1.50-times) in larger specimens.

Cornea broad and well pigmented.

Basal segment of antennular peduncle rather broad ; stylocerite stout ; anterolateral spine extending from half to $\frac{1}{3}$rd of 2nd segment ; two branches of outer flagellum fused basally for 7 or 8 segments. Antennal scale about 3—times as long as broad.

Mouth parts normal as in figure ; third maxilliped reaching upto tip of antennal peduncle or extending slightly beyond it by half of its last segment.

First chelipeds always equal to tip of antennal scale, mostly tips of fingers being in line with tips of setae of antennal scale. Fingers as long as palm ; carpus about 2.0 to 2.4—times as long as chela and 1.10 to 1.30-times as long as merus. Second chelipeds equal and similar in both sexes, about half as long as body, extending with anterior $\frac{1}{4}$th of carpus beyond tip of antennal scale. Chela generally only slightly shorter than (always longer than $\frac{3}{4}$th of) carpus, but in larger individuals (above 50.0 mm) becomes longer than carpus. Fingers about 0.68 to 0.88 (average=0.76)—times as long as palm, leaving a small gap when closed and with a few

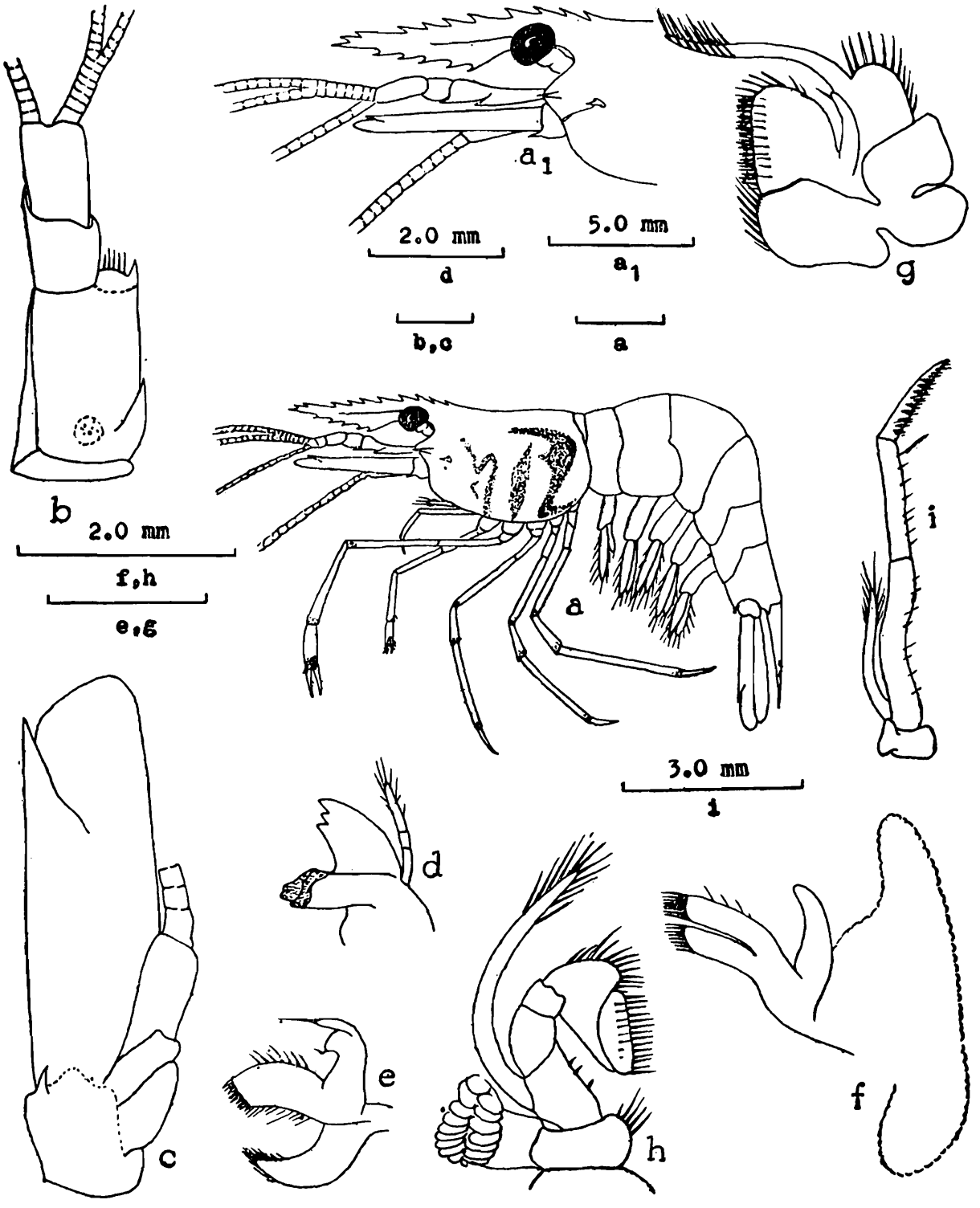

FIG. 8. *Mucrobrachium tiwarii* n. sp.—Male, 42.0 mm.
a. entire animal (lateral view), a_1. anterior part, b. antennule, c. antenna, d. mandible, e. first maxilla, f. second maxilla, g. first maxilliped, h. second maxilliped, i. third maxilliped.

delicate hairs near tips. Cutting edge of movable finger usually armed with 2 (rarely 3) minute tubercle-like teeth proximally, while that of fixed finger with a similar tooth fitting between those of movable finger when closed, rest of cutting edge sharp and smooth, in few, both fingers without any teeth. Palm shorter than half of carpus in individuals upto 45.0 mm but in larger forms invariably longer than half of carpus. Carpus longer than merus, cylindrical, and 6.61 to 11.33 (average=9.03)—times as long as its distal diameter.

The average percentage lengths of various segments are as given below :

Ischium	Merus	Carpus	Palm	Fingers
19.68%	22.85%	30.81%	15.09%	11.52%

Third to fifth pereiopods similar in structure.

Sixth abdominal segment about 1.5 times 5th in length. *Appendix masculina* 1.8 to 1.96 (average=1.84)—times as long as *appendix interna*, 0.6 to 0.7 (average=0.64)—times endopod, fringed along inner margin with spine-like setae and with 1 long+2 to 4 subequal, shorter and stiffer but smooth setae, distally.

Telson about 1.5—times as long as 6th abdominal segment. Dorsal spines 2 pairs. Posterior margin ending in a triangular median point, flanked by 2 pairs of spines of which inner pair stouter and longer than (2.7 to 2.8—times) outer. Between inner spines 2 to 5 pairs of long plumose setae arising ventrally and 2 to 4 pairs of small hairs arising rather dorsally from posterior margin.

Uropods characterised by absence of accessory subapical spine on outer margin of exopod.

Eggs and development : Eggs rather large, oval or elliptical, measuring 1.0 to 1.4×1.4 to 1.9 mm, their number varying from 70 to 100. Immature eggs which are deep green in colour turn slightly brownish on maturation. Larvae pass through 3 stages before postlarva and characterised by telson being fan-shaped with process formula 10 to 13+10 to 13 in first stage. Postlarvae without uropod accessory subapical spine.

Colouration : Carapace with 3 distinct dark-coloured vertical stripes, proximal one broadest with its upper arm directed anteriorly. All 3 antennu,

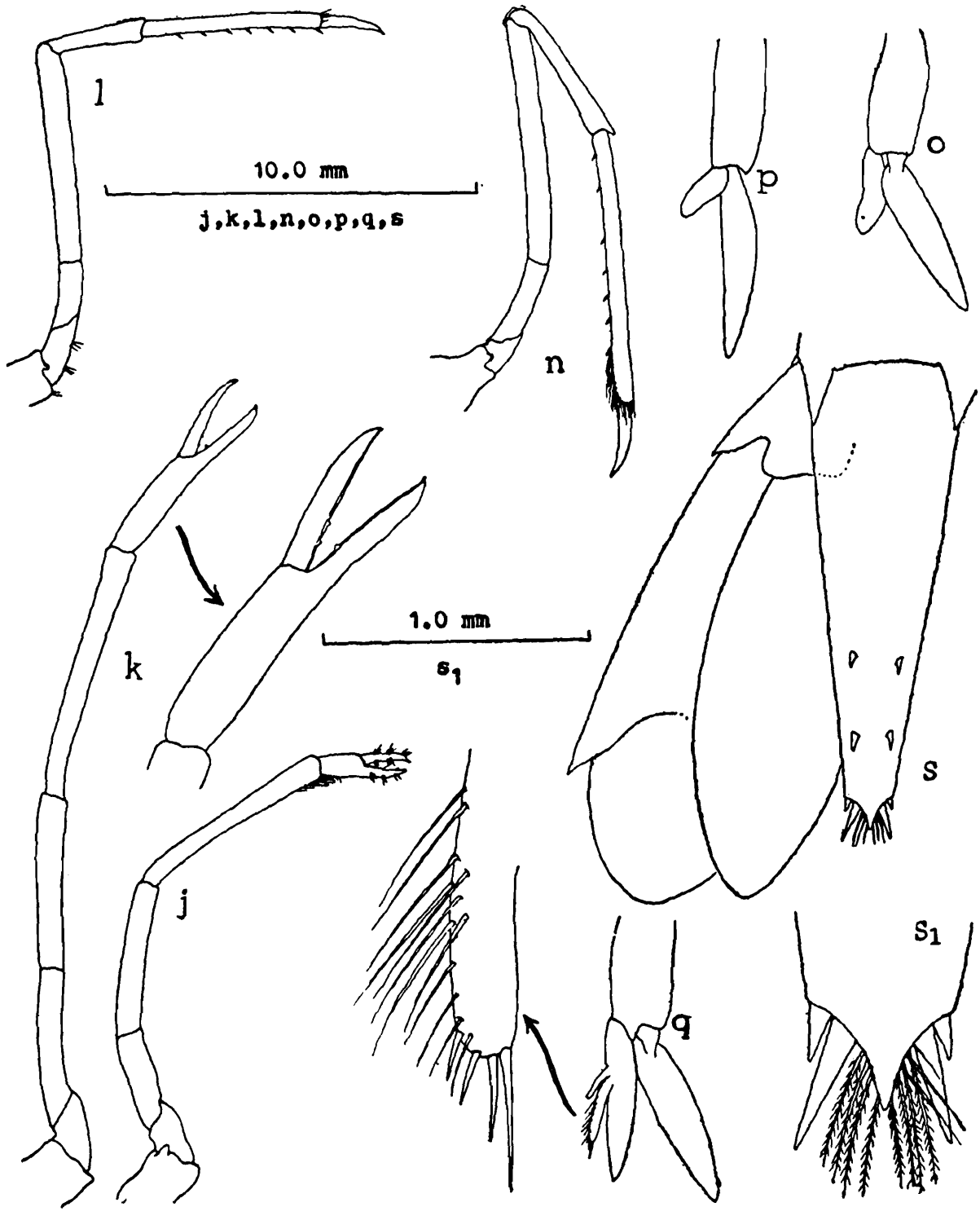

FIG. 9. *Macrobrachium tiwarii* n. sp. Male, 42.0 mm.
j. first cheliped, k. second cheliped, l. third pereiopod,
n. fifth pereiopod, o. first pleopod, p. first pleopod of female,
q. second pleopod, s. telson+uropods, s_1. posterior part of
telson magnified.

lar flagella transparent without any colouration. A prominent orange-red chromatophore at base of fingers of second cheliped and a lighter one at junctions of each segments of all pereiopods except first.

Ecology : This species was collected from the upper basin of the Malaprabha River on the Western Ghats, at an altitude of 6 0 metres above the Mean Sea Level. The prawns are generally found between heaps of decaying leaves, grass and other water weeds, mud crevices along the bank etc and found together alongwith other prawns viz. *Macrobrachium hendersodayanum, sankollii, caridina williamsoni, C. shenoyi and C. gurneyi.*

Remarks : The present new species *M. tiwarii* closely resembles *kistnensis* (Tiwari, 1952), *ritsemae* of Roux (1931) and *danae* of Nobili (1903).

It can be separated from *kistnensis* by its comparatively longer rostrum with more number of teeth, male pleopod, live colouration of second cheliped, carapace and inner flagellum of antennule, less fecundity and also in larval characters (authors, unpublished). For details, please refer to key at the end of this paper.

Also, the *kistnensis* material deposited in ZSI contains specimens (Regd. No. C $\frac{3136}{1}$—from a small stream near rest house, Khanapur i.e. type area of the present species) of which 8 specimens belong to *sankollii* as discussed earlier, while the remaining 62 specimens in which uropod accessory subapical spine is absent agree well with the present new species and, therefore, synonymised here.

The present study has shown that *tiwarii* is the dominant species of *Macrobrachium*, alongwith *unikarnatakae*, forming the bulk of freshwater prawn fisheries of the Bangalore area (personal collection). It is, therefore, rather surprising how the earlier workers like Anantha Raman *et al* (1978) and Anantha Raman (1982) could miss or probably overlook it in their collection, or like *unikarnatakae* even this species must have been considered by them as *'lanchesteri'*.

The *kistnensis* material of ZSI, however, contains several specimens collected at settling tank of Water Works Department, Bangalore (Regd. No. C $\frac{3142}{1}$), all of which lack uropod accessory subapical spine and after examination were found to belong to the present species.

As regards *ritsemae*, this species was originally described by De Man (1897) from Jawa but has now been synonymised by Holthuis (1950) under *idae* which is a larger species. Roux's (1931) material which was assigned by him to *ritsemae* was collected from various localities in the plateau of Mysore (at an altitude of 900 to 1000 metres above Mean Sea Level) and comprising smaller specimens (upto 57.0 mm) differs distinctly from De Man's *ritsemae* and resembles *kistnensis* in size, rostral formula and habitat. Based on this, it was synonymsed under *kistnensis* by Tiwari (1951) and Jalihal *et al* (1979a). But careful comparison with Roux's (1931) account reveals that in rostral formula and extension it agrees more with *tiwarii* than *kistnensis* as also supplemented by its occurrence in the range of *tiwarii* area (both Madhumalai and Malayandi Pattanum are quite near to Bangalore) and therefore, is synonymised here.

Similarly as regards *danae*, this species was originally described by Heller (1865) from Sydney (Australia) and is now synonymised with *australe* by Holthuis (1950) and is, therefore, altogether a different species. But what Nobili (1903) described *as danae* from Pondichery appears to belong to present new species though Henderson and Matthai (1910) considered it as mere juveniles of *malcolmsonii* while Tiwari and Pillai (1974) as possibly *kistnensis*. The actual comparison by the present authors, of specimens of *malcolmsonii* of corresponding size, both from field and laboratory reared material (Shenoy *et al*, 1984), and of *kistnensis* with Nobili's (1903) account reveals that Nobili's '*danae*' is neither *malcolmsonii* (which has more ventral teeth on rostrum i.e. 5 to 7 instead of 3 or 4 of '*danae*') nor *kistnensis* and is infact *tiwarii*, particularly in respect of rostral formula and extension. Therefore, Nobili's (1903) '*danae*' is also considered here as a synonym of the new species.

It is thus seen that *tiwarii* has a quite an extensive distribution in the southern part of the Deccan plateau where it has probably replaced *kistnensis*.

Etymology : The new species is named as *tiwarii* as our token of affectionate recognition of mighty contributions of Dr. K. K. Tiwari, Ex-Director of Zoological Survey of India, Calcutta and presently Vice-Chancellor of Jiwaji University, Gwalior, to the knowledge of Indian prawns after Late Dr. S. Kemp and also since the new species can be easily confused with Tiwari's (1952) *kistnensis*.

6. Macrobrachium kistnensis (Tiwari)

Palaemon lanchesteri Tiwari, 1949, *Rec. Indian Mus.*, 45 : 340.

Palaemon kistnensis : partim Tiwari, 1952, *Ann. Mag. nat. Hist.*, 5 : 28.

Palaemon kistnensis : partim Tiwari, 1955 a, *Bull. natn. Inst. Sci. India*, 7 : 233 (distribution).

non *Macrobrachium kistnensis* : Chinnayya, 1971, *Marathwada Univ. J. Sci.*, 10 : 139.

Macrobrachim kistnensis : Jalihal, Shenoy & Sankolli, 1979 a, *Bull. Fish. Fac. Konkan Agri. Univ., India*, 1 (1) : 57.

Macrobrachium kistnensis : Jalihal, Shenoy & Sankolli, 1979 b, *Bull. Fish. Fac. Konkan Agri. Univ., India*, 1 (1) : 73 (larvae).

non *Macrobrachium kistnensis* : Nagabhushanam & Kulkarni, 1981, *Indian J. Fish.*, 26 (1 & 2) : 1 (larvae).

Material examined.—48 specimens collected from Sharanabasaveshwar tank near fort area, Gulbarga on 26-9-1974. Sizes : males—30.0 to 58.0 mm, non-berried females—40.0 to 64.0 mm and berried females—50.0 to 65.0 mm.

Diagnosis : Rostrum reaching atleast half distance between tips of antennular peduncle and antennal scale, usually slightly shorter or equal to scale but sometimes slightly extending beyond it. Rostral formula $\frac{5—11}{3—5}$, usually $\frac{8—9}{4}$ (average=$\frac{8.62}{4.08}$)with 1 or 2 postorbital teeth. Carapace always longer than (1.15 to 1.60, average=1.31—times) rostrum. Distal $\frac{1}{4}$th to half of dactylus of third maxilliped extending beyond antennal peduncle. First cheliped extending beyond antennal scale with its fingers. Second cheliped extending beyond antennal scale with entire chela. Chela always longer than $\frac{3}{4}$th of carpus—shorter than carpus in examples upto 50.0 mm but longer than it in larger individuals. Palm generally shorter than half of carpus in examples upto 45.0 mm but invariably longer than half of carpus in larger examples. Carpus longer than merus and 6 77 to 8.87 (average=7.90)—times as long as its distal diameter. Average percentage lengths of various segments of second cheliped is as given below :

Ischium	Merus	Carpus	Palm	Fingers
18.79%	22.88%	29.46%	16.22%	12.62%

Appendix masculina 1.33 to 1.36—times as long as *appendix interna*, 0.67 to 0.77 (average=0.73)—times as long as endopod, fringed all along inner margin with setae and with 1 long+2 to 4 subequal, shorter, stiff terminal setae which are characteristically spinulose. Uropods without acce-

ssory subapical spine on exopod. Eggs deep green (all immature), rather large, oval or elliptical, measuring 0.8 to 1.10 × 1.10 to 1.30 mm. Fecundity : 140 to 170. Development partially abbreviated with 3 larval stages before postlarva, first zoea being characterised by a fan-shaped telson bearing 11 to 14 + 11 to 14 (23 to 27) processes and postlarva being characterised by absence of uropod accessory subapical spine as in adults. *Colouration* : Chelipeds with two large orange-red spots-one at base of fingers and another at tip of carpus ; coxa and basis of third pereiopod with violet chromatophore ; carapace with three transverse bands, posterior one being broadest and with its upper arm pointing forwards ; inner flagellum of antennule deep violet-red.

Remarks : The present material from Gulbarga agrees fully with the description of *kistnensis* given by Jalihal *et al* (1979 a) based on specimens collected from the type locality, Wai (Maharashtra State). The complexity of "*kistnensis* group/assemblage" deposited in ZSI has been fully discussed by Jalihal *et al* (1979 a).

As regards the report of *kistnensis* from Kham River in Aurangabad (Maharashtra State) by Chinnayya (1971), his account is too brief to compare or comment on the true identity of the material. But it is worth mentioning here that the eggs and larvae obtained from the above material (from Kham River) by Nagabhushanam and Kulkarni (1981) distincly differ from those obtained from the type locality material of *kistnensis* (from Wai) by Jalihal *et al* (1979 b).

Characters	*M. kistnensis* from type locality Wai (by Jalihal *et al*, 1979 b)	'*M. kistnensis*'—from Kham River, Aurangabad (by Nagabhushanam and Kulkarni, 1981)
(I) Average egg size	Larger, being 1.32x 1.70 mm	Smaller, being 0.50 × 0.90 mm
(II) No. of larval stages	3 larval+1 postlarval stages	4 larval+1 postlarval stages
(III) First zoea		
(a) Carapace	With pterygostomial spine	Without any spines

(b) Second maxilla	Scaphognathite with 20 setae and endites with only minute denticles	Scaphognathite with only 9 to 12 setae and endites with plumose setae
(c) Maxillipeds	with unsegmented exopod bearing 4 natatory setae	With 8 to 17—segmented exopod bearing 6 natatory setae
(d) First maxilliped	With well developed epipod	Without epipod
(e) Pereiopods	Only first 3 pairs biramous	First 4 pairs biramous

In view of above larval differences it seems with certainty that the Aurangabad material is not *kistnensis* proper.

According to Tiwari (1951, 1952 & 1955a), the distribution of *kistnensis* (actually the "*kistnensis* complex") follows the pattern of hill-stream fishes and extends from Vindhyan-Satpuran range of mountains to Ceylon (Sri Lanka) through the Western Ghats. Its occurrence in Gulbarga in the Deccan plateau, however, indicates that this species is not essentially a hill-sream species as was presumed by Tiwari (1951).

7. Macrobrachium banjarae (Tiwari)

(Figs. 10 & 11)

Palaemon banjarae : Tiwari, 1958, *Rec. Indian Mus.*, 53 : 299.

Material examined —Only 2 non-berried females measuring 33.0 and 36.0 mm collected from Sharanabasaweshwar tank near fort area, Gulbarga on 26-9-1974.

Description : Rostrum equal to or slightly longer than antennal scale, lanceolate in profile, broadest in middle ; upper margin slightly convex with compactly arranged teeth and with slightly upturned tip, lower margin distinctly convex. Rostral formual $\frac{11-12}{5}$ with 2 postorbital teeth. Carapace about 1.06—times as long as rostrum.

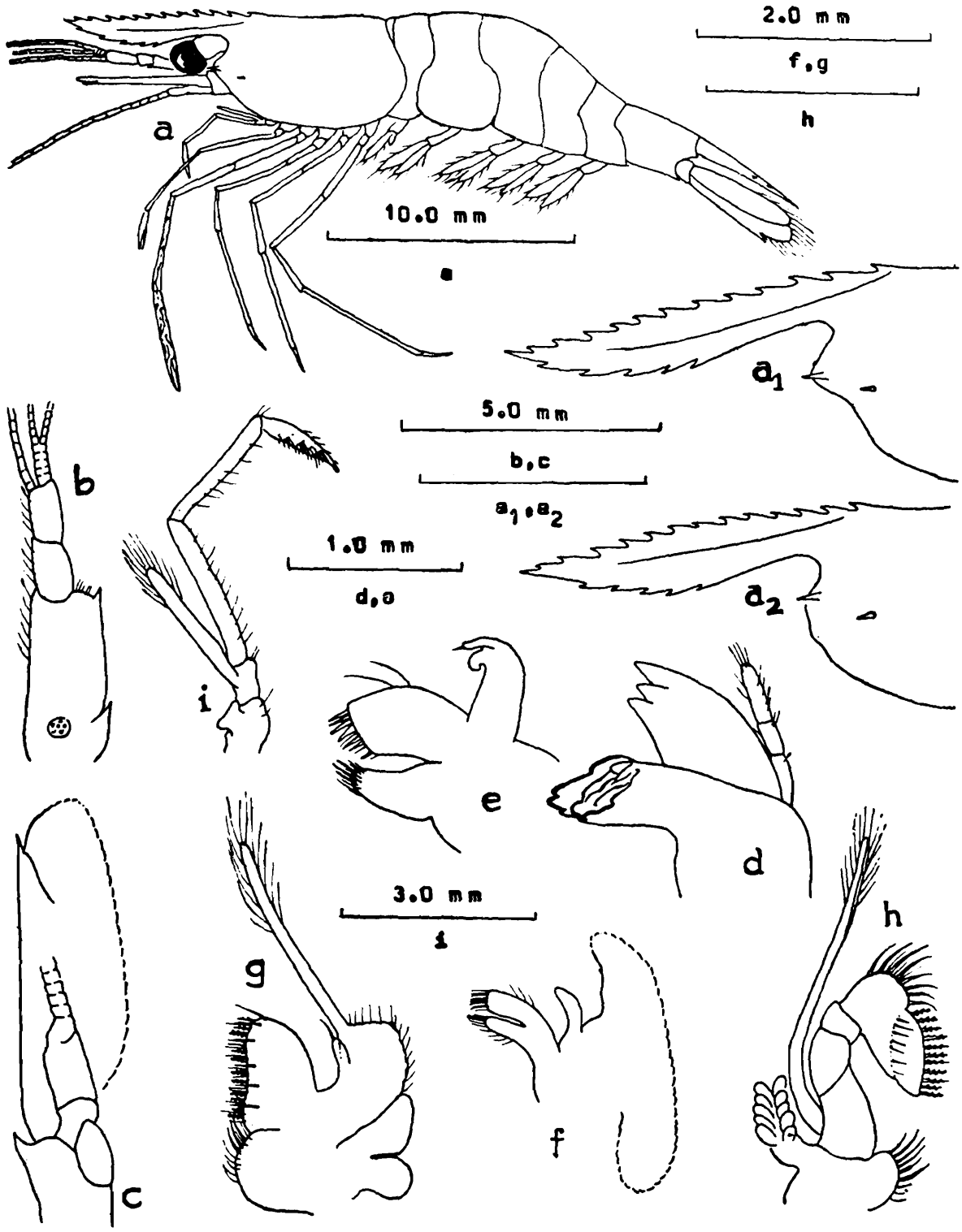

FIG. 10 *Macrobrachium banjarae* (Tiwari)—Famale, 33.0 mm.
a. entire animal (lateral view), a_1. rostrum anterior part of carapace, a_2. rostrum+ anterior part of carapace of type specimen of *M. banjarae* from ZSI b. antennule, c. antenne, d. mandible, e. first maxills, f. second maxilla, g. first maxilliped, h. second maxilliped, i. third maxilliped.

Cornea about 1.1—times broader than long and darkly pigmented.

Stylocerite rather small, reaching about $\frac{2}{3}$th of basal segment and antero-lateral spine reaching about $\frac{1}{3}$rd of 2nd segment; two branches of outer flagellum fused basally for 5 segments. Antennal scale about 3.1—times as long as broad.

Mouth parts normal as in figure; third maxilliped extending beyond antennal peduncle with its last segment.

First chelipeds slender, about $\frac{1}{3}$rd as long as body, 1.5—times as long as carapace and extending upto tip of antennal scale. Carpus about twice as long as chela. Second chelipeds stouter than first, about half as long as body and extending with chela beyond antennal scale. Chela about 1.06—times as long as carpus. Fingers about 0.6 times as long as palm, with a few delicate hairs at tips. Cutting edges of both fingers with 2 small, denticle-like teeth, those on movable finger being bigger, first one of which fits into the gap between 2 smaller denticles on fixed finger. Palm about 0.65—times as long as carpus. Carpus longer than merus, cylindrical and about 8.85—times as long as its distal diameter.

Third to fifth pereiopods structurally similar and extend as far as tip of antennal scale.

Telson elongated, about 3.7—times as long as broad, 1.1—times as long as 6th abdominal segment and with 2 pairs of dorsal spines in the posterior half. Posterior margin ending in a rather blunt median point, flanked by two pairs of spines of which inner pair stouter and about 3.4—times as long as outer pair. Between two long inner spines ventrally 5 plumose setae longer than spines, while dorsally 2 pairs of fine hairs present.

Uropods typical with an accessory subapical spine on exopod.

Colouration: Ground colour of body transluscent to opaque white with branched reddish-brown chromatophores extending from carpus to finger tips of second chelipeds and at joints of remaining pereiopods. Characteristic bluish colouration at base of third maxilliped and third pereiopod. Carapace with bluish combined with red and orange markings arranged laterally in broken lines which are interspersed with red and orange chromatophores. Entire inner margin of antennular peduncle and base of inner flagellum bluish with orange-red chromatophores scattered inbetween.

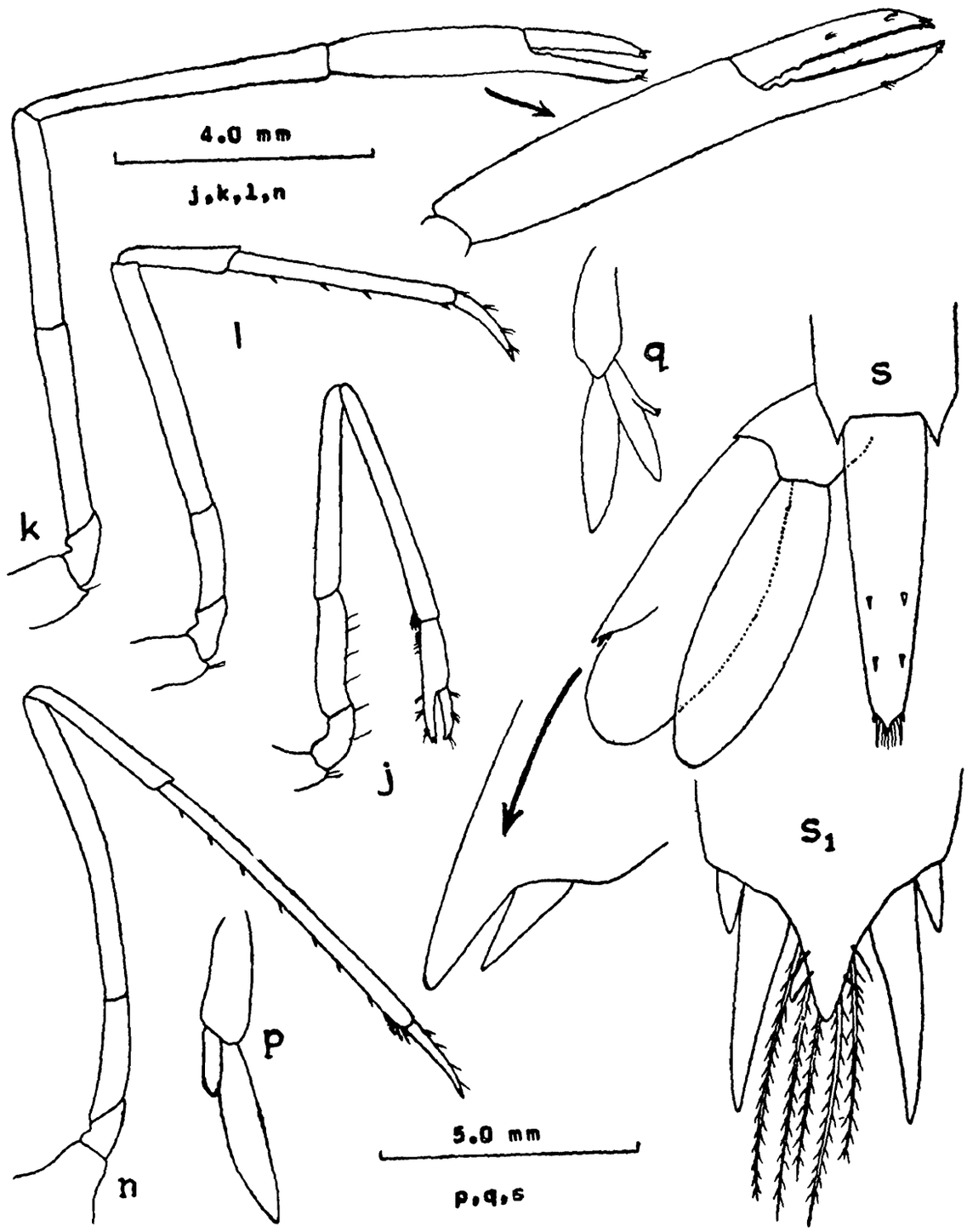

FIG. 11. *Macrobrachium banjarae* (Tiwari).—Female, 33.0 mm.
j. first cheliped, k. second cheliped, l. third pereiopod,
n. fifth pereiopod, p. first pleopod, q. second pleopod,
s. telson+uropods, s_1. posterior part of telson megnified.

Remarks : The present specimens agree well with Tiwari's (1958) account of *banjarae* from Banjar River in Madhya Pradesh. Tiwari, however, gives only a brief diagnosis without any illustrations. Therefore, the present material was compared with the type material of *banjarae* from ZSI (Regd. No. C $\frac{3433}{1}$) and though both compare well they also show differences mainly in respect of rostrum as under :

Characters	Gulbarga specimens (present material)	*M. banjarae* (Tiwari) (typical form)
1. Rostral formula	$\frac{11-12}{5}$	$\frac{12-15}{4-6}$
2. Upper margin of rostrum		
(a) shape	Only slightly convex with upturned tip	Distinctly convex in middle and tip not upturned
(b) Arrangement	Teeth less compactly arranged than in typical form	Teeth more compactly arranged than in present material

In absence of males in the present collection, males of the two could not be compared and, therefore, in spite of the above differences in rostral characters, the Gulbarga specimens have been assigned to *banjarae*. Study of more material may even indicate the possibility of a new subspecific status for the Gulbarga material.

Almelkar (1983, unpublished), in his work on freshwater prawns of Bombay area, describes an identical form from Lonavala, based on extensive series of material comprising berried females and males. Therefore, information on rostral formula, second cheliped and larvae given in the key for this species is taken from his account with his permission.

This is the first record of *banjarae* in the Karnataka State as well as outside its type locality.

8. Macrobrachium hendersodayanum (Tiwari)

Palaemon henderso—dayanus Tiwari, 1952, *Ann. Mag. nat. Hist.*, 5 : 29.

Palaemon hendersodayanus : Tiwari, 1955 a, *Bull. natn. Inst. Sci. India*, 7 : 236 (distribution).

Palaemon henderso—dayanus : Tiwari, 1955 b, *Bull. natn. Inst. Sci. India*, 7 : 190.

Macrobrachium hendersodayanus : Chinnayya, 1971, *Marathwada Univ. J. Sci.*, 10 : 140.

Macrobrachium hendersodayanum : Jalihal & Sankolli, 1975 a, *J. Karnatak Univ. Sci.*, 20 ; 297.

Macrobrachium hendersodayanum : Jalihal & Sankolli, 1975 b, *J. Karnatak Univ. Sci.*, 20 : 283 (larvae).

Material examined.—64 specimens collected from river Malaprabha near old bridge at Khanapur and Vattoli forest plot (670 metres above Mean Sea Level) in May 1974 and December 1974 to May 1975. Sizes : males—29.0 to 59.0 mm, non-berried females—37.0 to 58.0 mm and berried females—39.0 to 62.0 mm.

Remarks : The observations on the above material have been already published by Jalihal and Sankolli (1975a) who gave for the first time the detailed description, alongwith illustrations, of *hendersodayanum.* Therefore, except for the key characters at the end of this paper no separate description or diagnosis of this species is given in the present paper.

The earlier published accounts of the species including the original one (Tiwari, 1952 & 1955b ; Chinnayya, 1971) are rather too brief and lack illustrations. The detailed account of species based on the material from Koyna River near Bamnoli of Satara District, Maharashtra State (type locality), Bhadra River at Bhadravati, hill-stream at Sagar near Jog falls and Malaprabha River at Khanapur (all belonging to Karnataka State) has been given in the Ph. D. thesis of the original author Tiwari (1951) which unfortunately has not been published till todate.

The present material shows some differences with Tiwari's (1951) thesis account of the species which was not available at the time of earlier (Jalihal and Sankolli, 1975a) publication. These differences are as under :

	Characters	Present material	Tiwari's (1951) material
1.	Rostrum	69% specimens with 2 teeth on lower margin	None (0%) with 2 teeth on lower margin
2.	Second cheliped		
	(a) Chela	1.36 to 2.12—times as as long as carpus	1.70 to 2.0—times as long as carpus

(b) Carpus	Irrespective of size or sex either shorter, equal or longer than merus and 3.0 to 6.0—times as long as broad.	Irrespective of size or sex always somewhat longer than merus and 4.0 to 5.0—times as long as broad
(c) Palm	Irrespective of sex or size, either shorter (0.75 to 0.99—times), equal or longer (1.01 to 1.22—times) than carpus	A little longer than (1.01 to 1.1—times) carpus in females but shorter than (0.7 to 1.0—times) carpus in males
3. Adult size		
(a) Males	29.0 to 9.0 mm	40.6 to 50.6 mm
(b) Females	37.0 to 62.0 mm	44.2 to 58.5 mm

In being a hill-stream species and possessing longitudinal grooves beset with pubescence on fingers of second cheliped ('fluted fingers'), *hendersodayanum* fits in to '*hendersoni* group' of prawns (Tiwari, 1955b). Amongst the species of this group *assamensis assamensis* (Tiwari, 1958), *siwalikensis* (Tiwari, 1952) and *dayanum* (Henderson, 1893) closely resemble *hendersodayanum* as also discussed by Tiwari (1951), but can be differentiated mainly on rostrum and second cheliped characters as in Table 1.

According to Tiwari (1952 & 1955b) *hendersodayanum* is so far known only from Western Ghats from Satara District (Maharashtra State) to Mysore (Karnataka) State.

9. Macrobrachium scabriculum (Heller)

(Figs. 12 & 13)

Palaemon scabriculus Heller, 1862, *Verh. zool.-bot. Ges. Wien*, 12 : 527.

Palaemon scabriculus : Heller, 1865, *Reise Novara Zool.*, 2 (3) : 117.

Palaemon (s. s.) *dolichodactylus* : Hilgendorf, 1879, *Mber. Akad. Wiss. Berlin*, 1878 : 840.

Palaemon scabriculus : Koelbel, footnote in De Man, 1892, *Max. Weber's Zool. Ergebn.*, 2 : 462.

Palaemon scabriculus : Henderson, 1893, *Trans. Linn. Soc. Lond.*, 5 : 442.

Table 1

Table showing differences between *Macrobrachium hendersodayanum* (Tiwari, 1952), *M. assamensis assamensis* (Tiwari, 1958), *M. siwalikensis* (Tiwari, 1952) and *M dayanum* (Henderson, 1893).

Characters	*M. hendersodayanum* (present work)	*M. hendersodayanum* (Tiwari, 1951 Thesis unpublished)	*M. assamensis assamensis*	*M. siwalikensis*	*M. dayanum*
1. Rostrum					
(a) Extension	Extends upto tip of antennal scale	Extends upto tip of antennal scale	Upto midway between tips of antennular peduncle and antennal scale	At the most upto the tip of antennular peduncle	Upto tip of antennal scale
(b) Rostral formula	$\frac{6—9}{2—5}$ (av. $=\frac{7.03}{2.50}$)	$\frac{6-8}{3—5}$ (av. $=\frac{7.28}{3.88}$)	$\frac{7—10}{2—5}$ (av. $=\frac{8.87}{2.90}$)	$\frac{5—9}{2—5}$ (av. $=\frac{6.70}{3.50}$)	$\frac{7—11}{4—7}$ (av. $=\frac{8.80}{5.50}$)
2. Second cheliped					
(a) Chela	1.36 to 2.12—times as long as carpus	1.7 to 2.0—times as long as carpus	1.74 to 3.0—times as long as carpus	1.43 to 1.85—times as long as carpus	1.2 to 1.7—times as long as carpus
(b) Carpus (i)	Shorter, equal or longer than merus	Longer than merus	Shorter than merus	Longer than merus	Longer than merus
(ii)	3.0 to 6.0—times as long as broad	4.0 to 5.0—times as long as broad	3.5 to 4.5—times as long as broad	About 3.0—times as long as broad	4.0 to 6.0—times as long as broad
(c) Plam	0.75 to 1.22—times as long as carpus irrespective of sex or size	In males 0.7 to 1.0—times and in females 1.0 to 1.1—times as long as carpus	0.9 to 1.48—times as long as carpus	0.7 to 1.06—times as long as carpus	Rarely more than 0 8—times as long as carpus

Palaemon (Parapalaemon) dolichodactylus : Hilgendorf, 1898, *Deutsch Ost-Afrika*, 4 (7) : 31.

Palaemon (Parapalaemon) dolichodactylus : Coutiere, 1900, *C. R. Acad. Sci. Paris*, 130 : 1267.

Palaemon (Parapalaemon) scabriculus : Nobili, 1900, *Annali Mus. civ. Stor. nat. Genova*, 40 : 483.

Palaemon dolichodactylus : Coutiere, 1901, *Annls Sci. nat. Zool.*, 12 : 283.

Palaemon (Parapalaemon) dolichodactylus : Coutiere, 1902, *Bull. Mus. Hist. nat., Paris*, 8 : 516.

Palaemon (Parapalaemon) scabriculus : Nobili, 1903, *Boll. Musei Zool. Anat. comp. R. Univ. Torino*, 18 (452) : 12.

Palaemon (Parapalaemon) dolichodactylus : Nobili, 1903, *Boll. Musei Zool. Anat. comp. R. Univ. Torino*, 18 (452) : 13.

Palaemon scabriculus : Henderson & Matthai, 1910, *Rec. Indian Mus.*, 5 : 296.

Palaemon dolichodactylus : Henderson & Matthai, 1910, *Rec. Indian Mus.*, 5 : 300.

Palaemon dubius : Henderson & Matthai, 1910, *Rec. Indian Mus.*, 5 ; 300.

Palaemon dolichodactylus : Stebbing, 1910, *Ann. S. Afr. Mus.*, 6 : 385.

Palaemon scabriculus : Kemp, 1915, *Mem. Indian Mus.*, 5 : 272.

Palaemon scabriculus : Panikkar, 1937, *J. Bombay nat. Hist. Soc.*, 39 : 346.

Palaemon dolichodactylus : Panikkar, 1937, *J. Bombay nat. Hist. Soc.*, 39 : 346.

Palaemon dolichodactylus : Nataraj, 1942, *Curr. Sci.*, 11 : 468.

Palaemon (Parapalaemon) dolichodactylus : Vatova, 1943, *Thalassia*, 6 (2) : 12.

Macrobrachium scabriculum : Holthuis, 1950, *Siboga Exped. Monogr.*, 39 a (9) : 224.

Palaemon (Parapalaemon) dolichodactylus : Barnard, 1950, *Ann. S Afr. Mus.*, 38 : 779.

Macrobrachium scabriculum ; Maccagno & Cucchiari, 1956, *Boll. Inst. Mus. Zool. Univ. Torino*, 5 : 361.

Palaemon scabriculus : Rajyalakshmi, 1960, *Proc. natn. Inst. Sci. India*, 26 : 395 (larvae).

Macrobrachium scabriculum : Johnson, 1963, *Bull. natn. Mus. St. Singapore*, 32 : 15.

Macrobrachium scabriculum : Costa, 1972, *Bull. Fish. Res. Stn. Sri Lanka (Ceylon)*, 23 (1 & 2) : 132.

Macrobrachium scabriculum : Tiwari & Pillai, 1974, *J. zool. Soc. India*, 25 : 20.

Material examined.—15 specimens collected at Kadra in Mahamai creek (freshwater) joining the Kali River, about 35 km away from its mouth near Karwar, on 23-10-1974. Sizes : 3 males—40.0 to 64.0 mm, 6 non-berried females—40 0 to 52.0 mm and 5 berried females—42.0 to 51.0 mm.

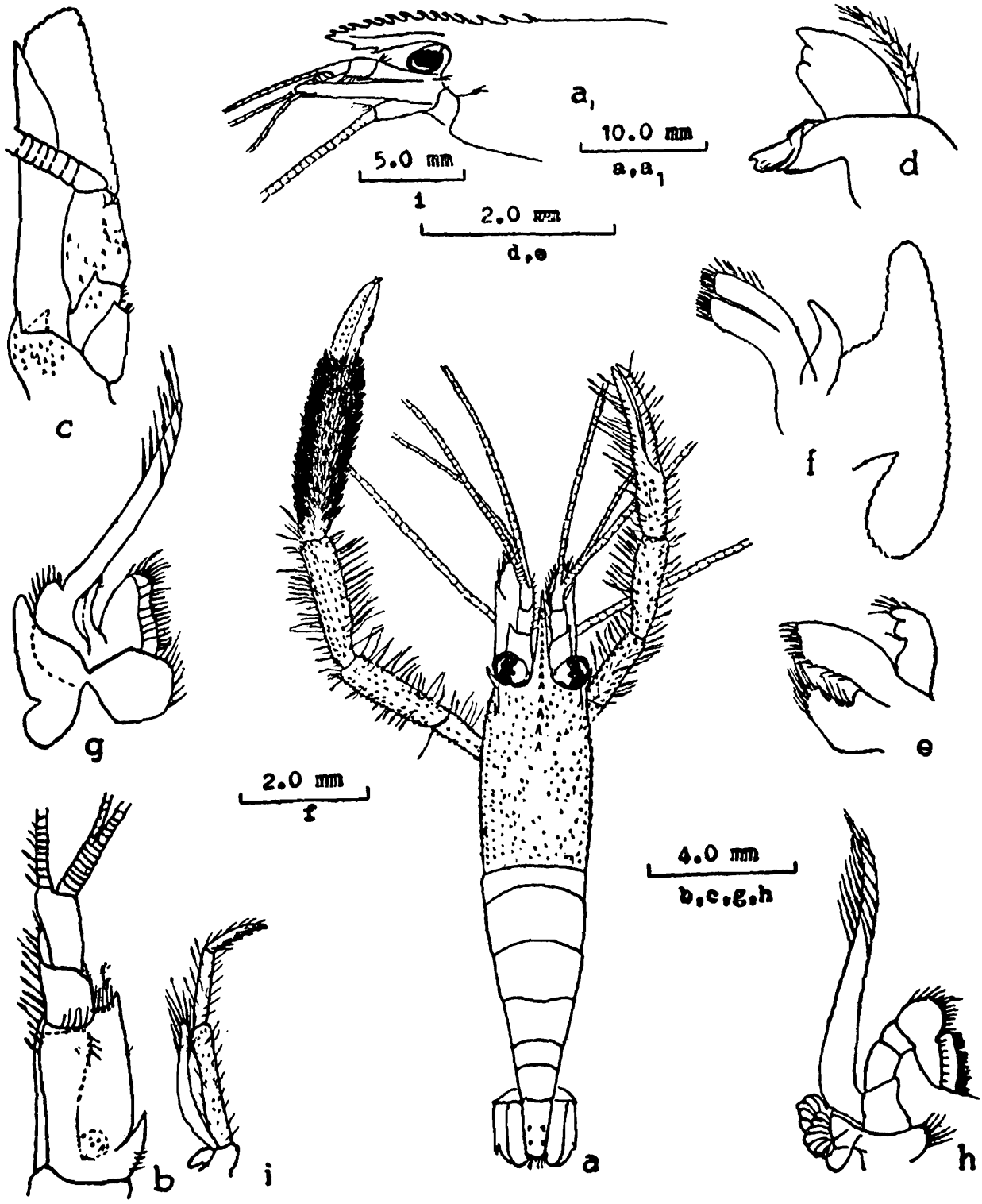

FIG. 12. *Macrobrachium scabriculum* (Heller)—Male, 55.0 mm.
a. entire animal (dorsal view), a_1. anterior part (lateral view),
b. antennule, c. antenna, d. mandible, e. first maxilla,
f. second maxilla, g. first maxilliped, h. second maxilliped,
i. third maxilliped.

Description : Rostrum always extending upto tip of antennular peduncle sometimes slightly beyond it ; depth and convexity of upper margin variable, in some being practically straight. Rostral formula $\frac{12—15}{4—3}$, usually $\frac{12—14}{2}$, with 4 or 5 postorbital teeth. Teeth on upper margin closely arranged except for first 2 to 4 teeth, distance between first tooth and posterior margin of orbit being 0.3 to 0.4—times that of entire carapace. Carapace in males scabrous as shown in figure or more in distal half to $\frac{3}{4}$th only while in females only anterior half scabrous.

Cornea broad and well pigmented.

Anterolateral spine on basal segment of antennular peduncle extending from half to $\frac{3}{4}$th of 2nd segment ; 2nd and 3rd segments rather subequal ; two branches of outer flagellum fused basally for 7 to 10 segments. Antennal scale 3.0 to 3.3—times as long as broad, its outer margin slightly concave, terminating in a strong tooth overreached by slightly narrower and rounded lamella.

Mouth parts normal ; third maxilliped extending upto middle of antennal scale.

First chelipeds extending beyond antennal scale by chela. Fingers nearly as long as palm. Carpus 2.0 to 2.3—times as long as chela and 1.2 to 1.3—times as long as merus.

Second chelipeds stout, exhibiting sexual dimorphism in adult—in males unequal in size and shape. Larger cheliped, either right or left, subequal or mostly longer than body, much stouter than smaller cheliped and characterised by presence of velvety pubescence on palm and more than proximal half of fingers. Entire surface of chelipeds beset with minute spinules, fewer on lower surface while developed on carpus and covered throughout with long hairs, those on inner margin being longer. Fingers much longer than palm and nearly of equal thickness. Cutting edge of movable finger armed with a row of 18 to 28 tubercles of which 3rd or 5th is largest, while that of fixed finger with 22 to 29 tubercles of which 4th or 6th being largest and fitting behind largest tooth of movable finger, tubercles on both gradually decreasing in size distally. Tip of movable finger more strongly incurved than that of fixed one, crossing latter at tip, so that cutting edges meet when fingers closed. Palm not wider than distal end of carpus and in most cases

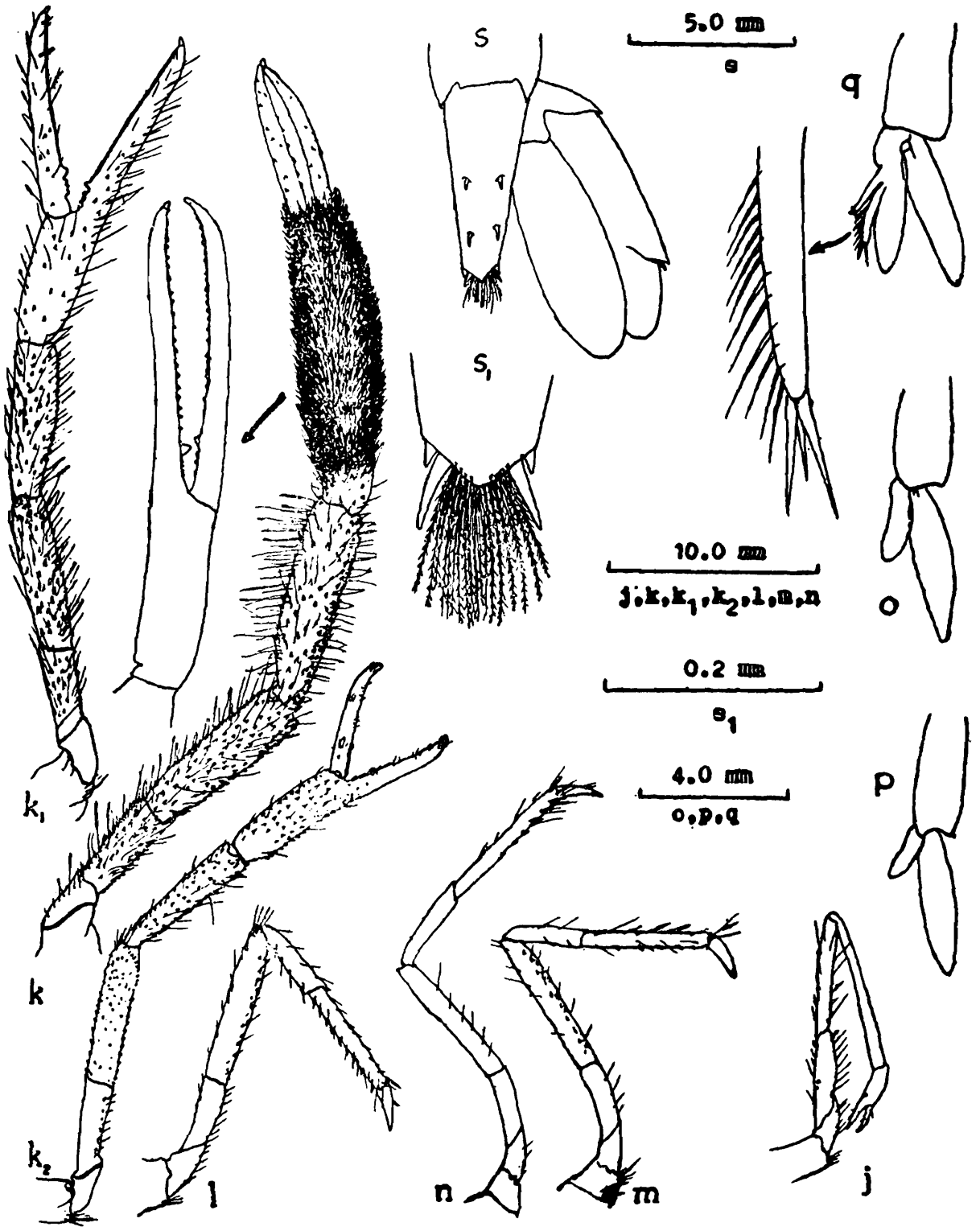

FIG. 13. *Macrobrachium scabriculum* (Heller)—Male, 55.0 mm.
j. first cheliped. k. larger second cheliped. k_1. smaller second cheliped,
k_2. second cheliped of female, l. third pereiopod,
m. fourth pereiopod, n. fifth pereiopod, o. first pleopod,
p. first pleopod of female, q. second pleopod, s. telson uropods,
s_1. posterior part of telson magnified.

of the same width. Carpus longer than both palm and merus. Exhibits great variation in relative lengths of different segments. Smaller cheliped shorter than body and without pubescence. Fingers longer than palm, with tips slightly incurved, cutting edges not meeting when fingers closed. Cutting edge of movable finger with 4 or 5 basal tubercles of which last one largest, while that of fixed finger with 5 or 6 basal tubercles (smaller than those of movable finger) last being largest and fitting behind last tooth of movable finger. Palm shorter than carpus. Carpus subequal to merus. Measurements of different segments in 3 males are as follows :

No.	Body length	Cheliped	Ischium	Merus	Carpus	Palm	Movable finger	Fixed Finger
1.	58.0	Larger-Left	6.0	9.0	10.0	8.5	15.0	14.0
		Smaller-Right	5.5	7.5	8.0	6.0	9.0	8.5
2.	64.0	Larger-Right	7.0	13.5	14.5	13.5	20.0	20.0
		Smaller-Left	6.0	9.5	10.0	8.0	12.5	11.5
3.	40.0	Larger	4.5	7.0	8.0	7.5	11.0	10.0
		Smaller	-	-	-	-	-	-

(N. B. : All measurements are in millimetres.)

In females, second chelipeds equal or subequal, about half as long as body and sparingly setose. Fingers equal or subequal to palm. Cutting edges of movable finger with 3 or 4 basal tubercles, last one largest, while that of immovable finger with 5 or 6 basal tubercles, last one largest and fitting behind largest tooth of movable finger. Carpus longer than both palm and merus. Measurements of different segments in 3 females are as follows :

No.	Body length	Ischium	Merus	Carpus	Palm	Fingers
1.	52.0	4.0	4.6	4.8	4.3	4.8
2.	40.0	3.9	5.0	5.3	4.4	4.4
3.	44.0	3.0	4.7	4.9	4.2	3.8

(N. B. : All measurements are in millimetres.)

Third to fifth pereiopods similar in structure with simple dactylus. In males, merus of third pereiopod scabrous anteriorly, that of fourth comparatively less scabrous while that of fifth completely naked. In females no such scabrous nature of merus on any pereiopods.

Abdomen smooth, 6th segment 1.2 to 1.5—times 5th in length. *Appendix masculina* long, narrow, about 1.55—times as long as *appendix interna*, 0.6 to 0.7—times as long as endopod, fringed along inner margin with setae and with 2 long+1 shorter stiff setae terminally.

Telson 1.3 to 1.7—times as long as 6th abdominal segment and armed with 2 pairs of dorsal spines in posterior half. Posterior margin variable, either broadly triangular or rounded, and flanked by 2 pairs of spines of which inner pair stouter and much longer than (2.7 to 3.2—times) outer. Between inner spines 15 to 20 long plumose setae (about twice as long as inner spines) arising ventrally and 6 or 7 pairs of small hairs arising rather dorsally from posterior margin as shown in figure.

Uropods with movable accessory subapical spine on exopod.

Eggs and development : Eggs brownish, numerous, elliptical or oval in shape and small measuring 0.44 to 0.48 x 0.57 to 0.62 mm. Development prolonged comprising more than 10 larval stages before postlarva. First zoea with a typical 7+7 (14) telson process formula.

Colouration : Colour note is based mainly on females : A longitudinal brownish yellow band running middorsally from base of telson to posterior region of 3rd abdominal segment (in males, this band continues upto base of rostrum) with deep violet patches on either sides. Besides, 3rd abdominal segment with 2 thick horizontal bands—a proximal brownish yellow and distal deep violet. Teeth on upper margin of rostrum with deep violet tips. Second cheliped with patches of chocolate colour, fingers deep bluish black with white tips. Propodus of last three pereiopods white, but remaining segments with chocolate patches.

The colouration of *scabriculum* described by Henderson and Matthai (1910) slightly differs from above in having uropods deep violet with white border which is absent in present material.

Ecology : The prawns are usually found hidden in crevices or under stones in knee-deep water. They can be easily collected with the help of a

simple hand net either by lifting the stones or by inserting sticks into crevices.

Remarks : *Palaemon scabriculus* Heller (1862), *P.* (s.s.) *dolichodactylus* Hilgendorf (1879) and *P. dubius* Henderson and Matthai (1910) were synonymised by Holthuis (1950) under *Macrobrachium scabriculum* based on following characters suggested by Henderson and Matthai (1910) :

1. Occurrence of all three 'species' together in same locality.
2. Similarity of females and young males of the three which are dificult to separate.
3. Presence of adult males with transitional characters.

The extent of variation of the second cheliped of males amongst the three 'species' being very wide, cannot be easily enumerated and, therefore, is given in a tabulated form (Table 2).

From the table it is seen that Tiwari and Pillai's (1974) Andaman material appears to be closest to the original Ceylon (Sri Lanka) material of *scabriculus* while the present material resembles closely the original *dolichodactylus* from East Africa but differs from the rest in having comparatively much slender antennal scale (being 3.0 to 3.3—times as long as broad) with lamella distinctly overreaching outer spine and also in palm of larger second cheliped of male being considerably shorter than (0.85 to 0.95, average= 0.90—times) carpus.

Amonst the three 'species', *scabriculus* and *dolichodactylus* resemble closely as also revealed by examination of their *appendix masculina* (in material of Henderson and Matthai, 1910, deposited in ZSI—*scabriculus*, Regd. No. $\frac{7077}{10}$ and *dolichodactylus*, Regd. No. $\frac{7085}{10}$) and larval similarities (larvae of both being common in lacking any chromatophore on 3rd abdominal segment) observed by present authors by actual rearing of *'dolichodactylus'* from Kadra (present material) and *'scabriculum'* from Ratnagiri (Maharashtra State).

Thus, *dolichodactylus* is accepted here as a synonymy of *scabriculum* as suggested by Holthuis (1950). However, the validity of *scabriculum* character of antennal scale spine overreaching lamella as suggested by Holthuis (1950) in his Java material and Tiwari and Pillai (1974) in their Andaman material cannot be confirmed here.

Regarding *dubius*, however, it appears to be distinct from *scabriculum* in characters of (i) larger second cheliped of male which is much shorter than body and its fingers practically without pubescence besides being shorter than (0.65 to 0.8, average=0.71—times) palm and (ii) *appendix masculina*. Thus, the original status of *dubius* as an independent species may be restored

Macrobrachium scabriculum is a rather widely distributed species in the Indo-Pacific region. From Karnataka State this is its first record.

10. Macrobrachium idella (Hilgendorf)

(Figs. 14 to 16)

Palaemon (Eupalaemon) idae idella Hilgendorf, 1898, *Deutsch Ost-Afrika*, 4 : 29.

Pataemon (Eupalaemon) multidens : Coutiere, 1900 a, *C. R. Acad. Sci. Paris*, 130 : 1266.

Palaemon (Eupalaemon) multidens : Coutiere, 1900 b, *Bull. Mus. Hist. nat., Paris*, 6 : 23.

Palaemon multidens ! Coutiere, 1901, *Annls Sci. nat. Zool.*, 12 : 327.

Palaemon idae : Henderson & Matthai, 1910, *Rec. Indian Mus.*, 5 : 285.

Palaemon idae : Panikkar, 1937, *J. Bombay nat. Hist. Soc.*, 39 : 346.

Palaemon idae : Nataraj, 1942, *Curr. Sci.* 11 : 468.

Palaemon idae : Chopra, 1943, *Proc. Indian Sci. Congr.*, 30 (3) : 5.

Palaemon idae : Nataraj, 1947, *Rec. Indian Mus.*, 45 , 89.

Macrobrachium idella : Holthuis, 1950, *Siboga Exped. Monogr.*, 39 a (9): 146.

Macrobrachium idella : Pillai & Mohamed, 1973, *J. mar. biol. Ass. India*, 15 : 359 (larvae).

Macrobrachium idella : Holthuis, 1980, *F. A. O. Fish. Synopsis No. 125*, 1 : 93.

Material examined.—1 male subadult of 45.0 mm and 1 female subadult of 36 0mm collected at Mahamai creek (freshwater) in Kadra near Karwar, on 23-10-1974. To supplement the above collection of subadults with adults, material was also collected from the following 3 localities along the west coast in Maharashtra State : (1) Savitri River near Mahad on 26-5-1979. Sizes: 20 male subadults —31.0 to 58.0 mm and 10 non-berried females—27.0 to 41.0mm. (2) Savitri River in Goregaon, on 28-8-1979. Sizes : 3 males—75.0 to 97.0mm, 9 non-berried females—45.0 to 63.0mm and 2 berried females—61.0 and 65.0 mm. (3) Kasarveli creek near Ratnagiri on 1-9-1981. Size : 1 male of 99.0 mm.

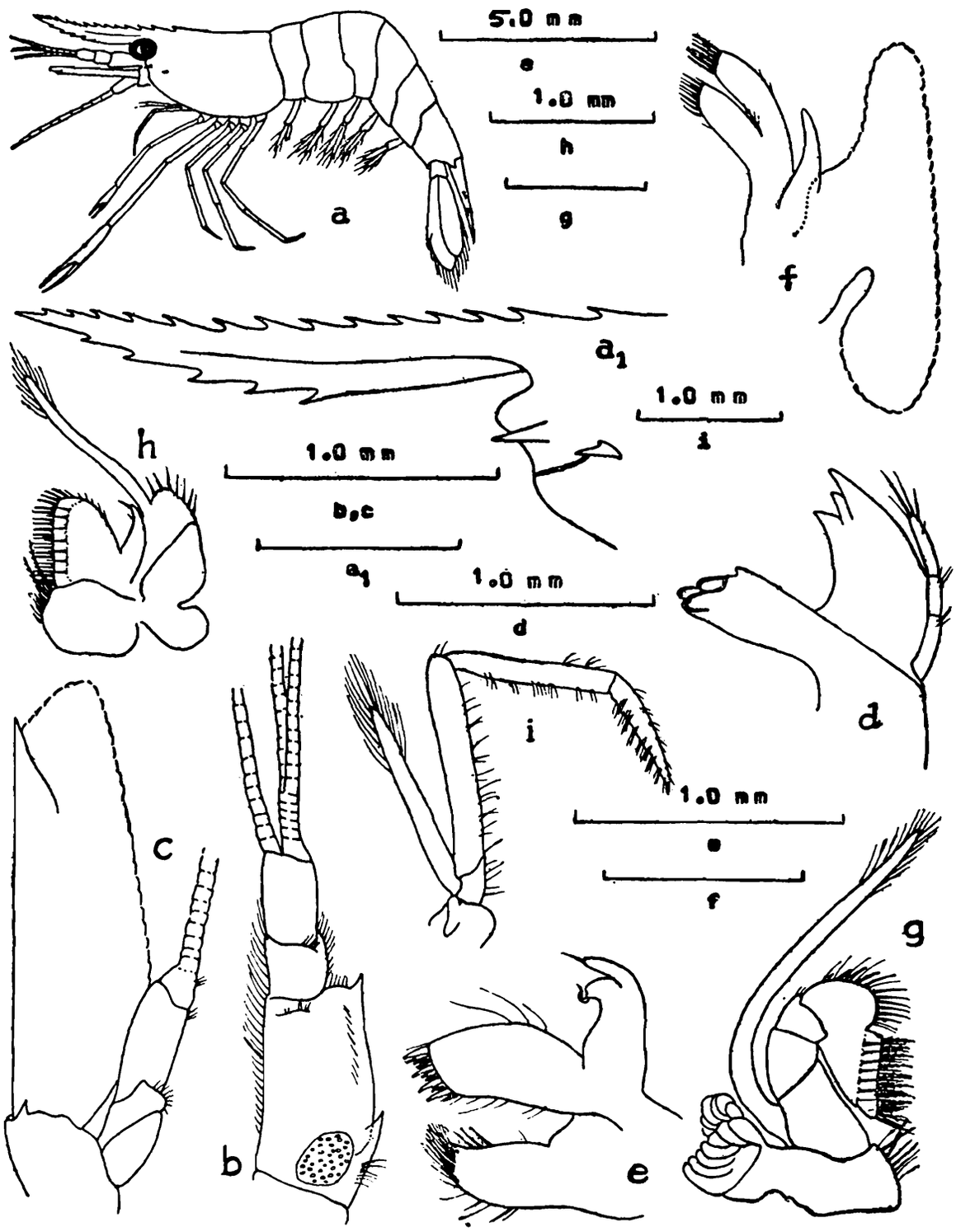

FIG. 14. *Macrobrachium idella* (Hilgendorf)—Male subadult, 45.0 mm.
a. entire animal (lateral view), a_1. rostrum + anterior part of carapace, b. antennule, c. antenna, d. mandibla, e. first maxilla, f. second maxilla, g. first maxilliped, h. second maxilliped, i. third maxilliped.

Description : Rostrum usually slightly longer than antennal scale in young ones and females but slightly to considerably shorter than it in large males (always longer than antennular peduncle), its proximal portion quite broad, distal portion either straight or gradually sloping down with tip sometimes slightly upturned. Rostral formula $\frac{11-14}{4-6}$ with 2 postorbital teeth. Distance between two postorbitals as well as 2nd and 3rd teeth from apex greater than remaining teeth on upper margin, last 2 teeth separated by a narrower gap. Carapace shorter than (0.8—times) rostrum in younger (below 40.0 mm) individuals but longer than (upto 1.7—times) rostrum in larger examples ; smooth in young ones and females but scabrous in antero-lateral and dorsal surfaces in larger males (generally above 70.0 mm).

Cornea broad and well pigmented (black).

Two branches of outer flagellum of antennule fused basally for 5 to 11 segments. Antennal scale 2.9 to 3.1—times as long as broad.

Mouth parts normal ; third maxilliped extending from proximal half to $\frac{2}{3}$rd of antennal scale.

First chelipeds about $\frac{1}{3}$rd body length and extending upto tip of antennal scale in young ones but beyond antennal scale in adults—with only chela in females and chela + half of carpus in males.

Second chelipeds equal, smooth, slender and considerably (0.42 to 0.65—times) shorter than body in young ones and females but subequal, entirely covered with tubercles (better developed along inner margin), comparatively stouter and distinctly (1.20 to 1.7— times) longer than body in males. In young ones and females fingers smooth without any pubescence while in males entire movable finger and inner $\frac{1}{4}$th margin of fiixed finger covered with pubescence. Cutting edge of movable finger with 2 basal denticles and that of fixed finger with mostly 1 or sometimes 2 denticles (smaller than those on movable finger) in young ones and females while in large males movable finger with 2 large basal teeth and fixed finger with 3 to 5 denticles on a distinct ridge (last or last but one being most prominent) followed by a large tooth (largest amongst all teeth and fitting into the gap between 2 teeth of movable finger). Palm cylindrical, broader than distal end of carpus, 3.28 to 5.16—times as long as broad and 1.0 to 1.35 — times as long as fingers in young ones and females but laterally compressed in distal part, narrower

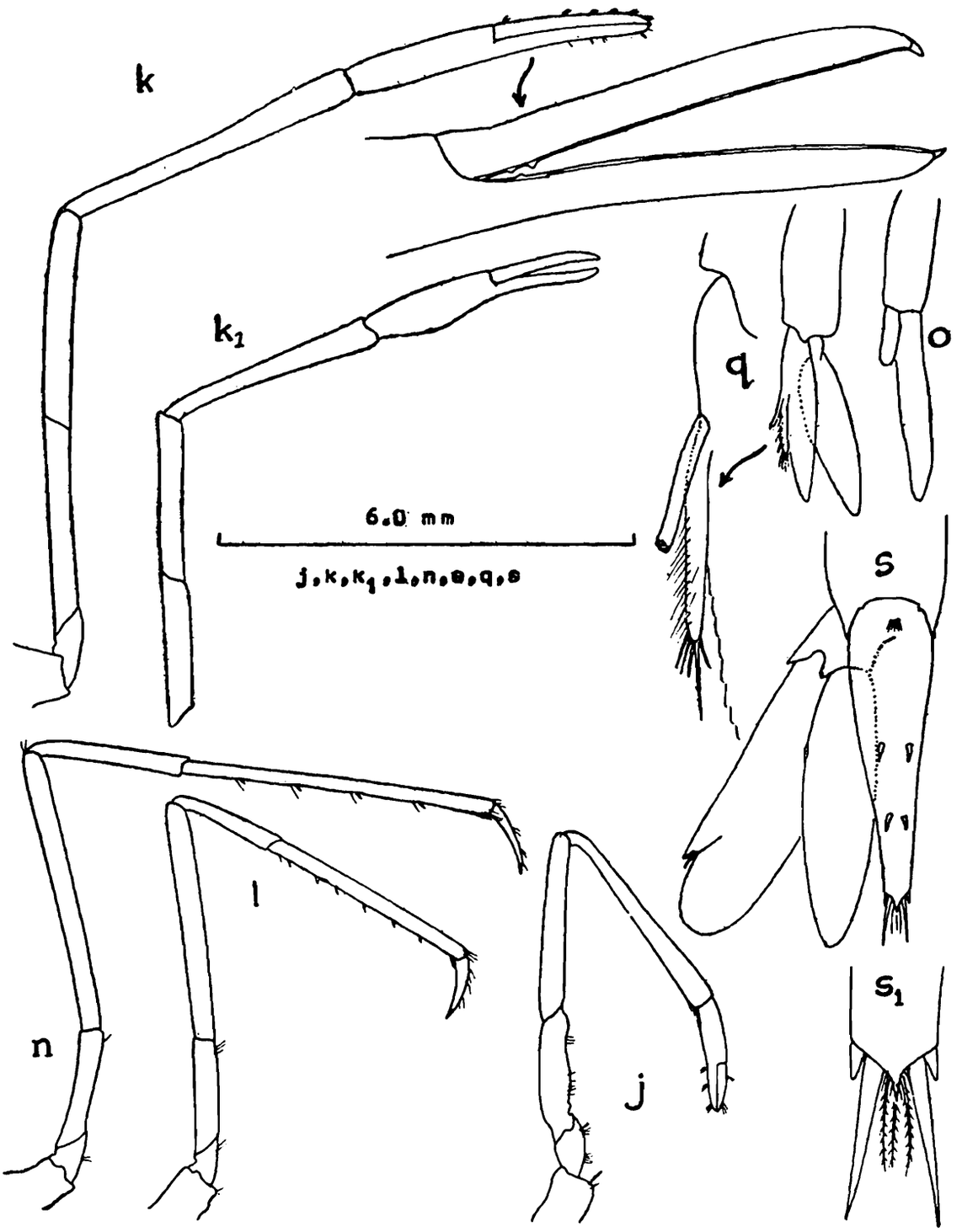

FIG. 15. *Macrobrachium idella* (Hilgendorf)—Male subadult, 45.0 mm
j. first cheliped, k. second cheliped, k1. second cheliped of female subadult of 36.0 mm, l. third pereicpod, n-fifth pereiopod, e. first pleopod, q. second pleopod, s. telson uropods, s1. posterior part of telson magnified.

than distal end of carpus, slender being 9.0 to 10.0—ttmes as long as broad and longer being 1.38 to 1.9—times as long as fingers in large males. Carpus, irrespective of size or sex, about as long as (0.83 to 1.16, average=1.0—times) chela, but 1.45 to 2.3 (average=1.9)—times as long as palm in young ones and females and 1.4 to 1.76 (average=1.58)—times palm in large males, 7.8 to 1.00—times as long as broad in young ones but longer being 10.0 to 12.7—times as long as broad in larger females and males. Merus longer than ischium and more than half but less than $\frac{3}{4}$th of carpus. Measurements of different segments in 4 large males are as follows :

No.	Body length	Cheliped	Ischium	Merus	carpus	Palm	Fingers
1.	75.0	Right	10.0	12.0	20.0	12.0	8.0
		Left	10.0	13.0	21.0	13.0	8.0
2.	83.0	Right	14.0	19.0	35.0	21.0	11.0
		Left	12.0	16.0	25.0	17.0	9.0
3.	97.0	Right	18.0	24.0	44.0	25.0	18.0
		Left	-	-	-	-	-
4.	99.0	Right	19.0	31.0	51.0	35.0	19.0
		Left	19.0	31.0	52.0	3.50	19.0

(N. B. : All measurements are in millimentres.)

Third to fifth pereiopods structurally similar.

Abdomen smooth in young ones and females but entire 6th segment and pleurae of remaining segments scabrous with tubercles in large males. Sixth segment 1.5 to 1.7—times as long as 5th segment and sharply pointed posterolaterally.

Appendix masculina 1.3 to 1.6—times as long as *appendix interna*, 0.55 to 0.65—times as long as endopod, densely hairy and with 1 long+4 to 7 subequal, shorter stiff setae terminally.

Telson smooth and about 1.5—times as long as 6th abdominal segment in young ones and females but 1.85—times as long and densely covered with tubercles in males. Posterior margin of telson ending in a sharp acutely triangular tip—much shorter than inner lateral spines in young ones and females but blunt and almost equal to latter in adult males. In very large

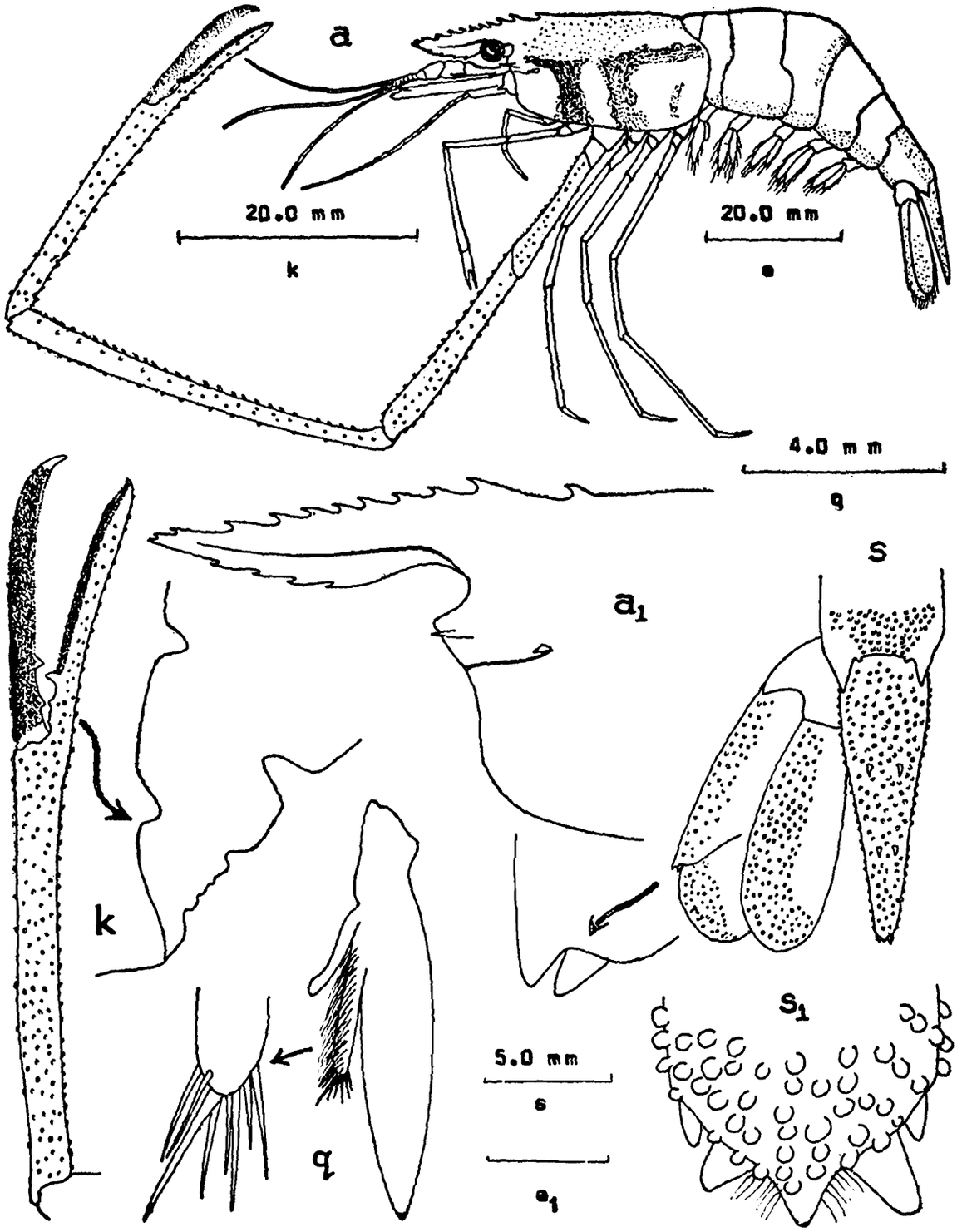

FIG. 16. *Macrobrachium idella* (Hilgendorf)—Male, 97.0 mm. a. entire animal (lateral view), a_1. rostrum+anterior part of carapace, k. second cheliped, q. endopod of second pleopod. s. telson+uropods, s_1. posterior part of telson magnified.

males spines on posterior margin completely worn out. Number of processes between inner spines varying 3 or 4 shorter (than inner spines) in young ones, 6 longer (than inner spines) in females but highly reduced to a few delicate hairs in males.

Uropods typical with accessory subapical spine on exopod and beset with characteristic tubercles (denser on endopod than exopod) in adult males.

Eggs and development : Eggs deep greenish when freshly laid but turning brawnish on maturation, numerous, elliptical or oval in shape and small measuring 0.41 to 0.50 x 0.47 to 0.60 mm. Development prolonged consisting of more than 10 zoeal stages. First zoea with a typical 7+7 (=14) telson process formula.

Colouration : Young ones and females almost transparent to greenish while males usually slightly brownish. Carapace with 2 distinct transverse inverted 'L' (i.e.)—shaped bands as shown in figure. Posterior margin of 3rd abdominal segment with a faint transeverse band. Second chelipeds mottled all along their length with brown in females but with dark chocolate in males. Females with characteristic broad chocolate-brown patches on upper margins of pleura of first 4 abdominal segments.

Ecology : Generally found hidden under stones and crevices in slowly flowing fresh or slightly saline water creeks.

Remarks : From the time it was originally described, *idella* has been many times confused by several workers with its closely allied from *idae* leading to lengthy synonyms. It was Holthuis (1950) who for the first time clearly differentiated them into two distinct species based mainly on rostrum and second cheliped of male as under :

Characters	*M. idella* (Hilgendorf)	*M. idae* (Heller)
1. Rostrum		
(a) Dorsal teeth	11 to 17	9 to 11
(b) Postorbitals	2 (very rarely 3)	3 (invariably)
2. Male second cheliped		

(a) Carpus	Subequal to (0.83 to 1.16, average=1.0 times) chela	Invariably longer than chela being only slightly longer than (1.05 to 1.1, average = 1.07—times) chela in young ones to distinctly longer than (1.18 to 1.29, average= 1.23—times) chela in larger examples.
(b) Fingers	Cutting edge smooth except for usual basal teeth (present study)	With a row of tubercles on either side of cutting edge in larger males (Johnson, 1963)

Taking into consideration only the taxonomic works on *idae* and *idella*, Holthuis (1950) synonymised all the Indian material under *idella*. He, however, retained all the Indian references based on fisheries accounts of *idae* (Panikkar, 1937 ; Nataraj, 1942 & 1947 and Chopra, 1943) under true *idae* although apparently these authors had followed Henderson and Matthai (1910) for using the name *idae* instead of *idella*. Hence, the present authors are of the opinion that true *idae* is distributed only in East Africa and Malayan archipelagoes and not in India where it appears to be replaced by *idella*.

M. idella has so far been reported from Tanganyika (East Africa) and West Madagascar (Pfeffer, 1889 ; Hilgendorf, 1898 and Coutiere, 1900 & 1901). In India it has been reported from Tentuliah River, Piali River, Uttarbhag and Hooghly Rivers near Calcutta in Gangetic West Bengal (Tiwari, 1951). However, it appears to have a common occurrence along the west coast of India in Kerala, Karnataka and Maharashtra States (Henderson and Matthai, 1910 ; personal communication with Mr. Anil Angre of the Marine Biological Research Station, Ratnagiri and present study). Therefore, the assumption of Pillai and Mohamed (1973) that this species is endemic to Kerala backwaters is erroneous. So also the record of *idae* in Bangalore by Katre and Pandian (1972) is erroneous since their material actually belongs to *unikarnatakae* (as per the present study) and not *idae* or *idella*.

Henderson and Matthai's (1910) observation on shorter or subequal carpus in the young ones of this species becoming longer than chela in adult males, though rare in the genus, is further confirmed in the present study. This is unlike Ortmann's (1891) assumption that once the carpus is shorter in young it can never exceed the chela in length with growth.

DISCUSSION

The freshwater prawns belonging to the genus *Macrobrachium* are known to be taxonomically a very complex group owing to their extreme range of variations and overlapping of characters. Sizewise, it comprises small to medium-sized as well as fairly large-sized species (referred herein as 'minor' and 'major' *Macrobrachium* respectively), both of which show their own distinctive characters. Interestingly, the two groups also differ in size with reference to sex—while males are much bigger in 'major', it is the females which are predominant and larger in the 'minor'.

In this highly complex group, the second cheliped of male is considered to be of taxonomic importance in separating the species (Henderson and Matthai, 1910 ; Cowles, 1915 ; Holthuis, 1950 and Tiwari, 1951). Based on this character, Tiwari (1951) divides the Indo-Burmese *Macrobrachium* species into following two groups :

I. Rather small-sized species in which second pair of chelipeds are slender, shorter than body, equal on both sides and similar in both sexes without exhibiting any sexual dimorphism. Following six species were included by Tiwari in this group : *lamarrei lamarrei, lamarrei lamarroides, mirabile, naso, kistnensis* and *peguensis.* Of the present material *canarae, sankollii, unikarnatakae, tiwarii* and *banjarae* belong to this group.

II. Fairly large-sized species in which second pair of chelipeds are strongly developed, sexually dimorphic, generally as long as or even longer than total length of body. Chelipeds of the two sides may be subequal or strongly unequal (in adult males), in case of latter may even differ in structure and proportions of individual segments. In young females and males these are less strongly developed. Tiwari assigns most of the Indian species to this group. In the present material *hendersodayanum, scabriculum* and *idella* belong to this 'II group'.

As regards 'I group', the relative lengths of carpus and chela (palm+ fingers) are considered to be significant and can help in separating individual species. Short chela and a comparatively long, slender carpus is perhaps a primitive feature as per Tiwari (1951 & 1952). Depending on their carpus to chela ratio, the species (including the present work) belonging to this group can be further subdivided into four subgroups as under :

Subgroup—A :	1. *M. mirabile* 2. *M. lamarrei lamarrei* 3. *M. lamarrei lamarroides* 4. *M. canarae* 5. *M. sankollii*	Chela about or more than half but less than $\frac{3}{4}$th of carpus.
Subgroup—B :	6. *M. unikarnatakae*	Chela more than $\frac{3}{4}$th but never equal to carpus.
Subgroup—C :	7. *M. peguensis* 8. *M. tiwarii* 9. *M. kistnensis*	Chela generally subequal or longer irrespective of size in *peguensis*, but in remaining species longer only in larger individuals.
Subgroup-D :	10. *M. banjarae* 11. *M. naso*	Chela invariably longer than carpus.

Thus, there is a tendency of second cheliped towards progressive elongation of chela (maximum being longer than carpus) indicating advancement as in *banjarae* and *naso*.

The 'II group' is represented in the present work by three species. Of these, *hendersodayanum* wnich has strong and stout chelipeds, but shorter than body and without exhibiting sexual dimorphism, is more primitive compared to *scabriculum* and *idella* which show distinct sexual dimorphism. However, some degree of sexual dimorphism is shown by the rostrum in *hendersodayanum* (being comparatively longer in males i.e. on an average 75% of carapace as against 63% of carapace in females) and as such it can be considered as a transitional or intermediate form between the two groups.

Despite the importance of second cheliped in males, it is a common experience that this cheliped gets normally broken away easily even while

collecting. In such cases it becomes necessary to have other constant reliable taxonomic characters like reproductive appendages. In this regard the present study revealed, as also found in other decapod crustaceans including penaeids, brachyurans etc, the second pleopod of male (especially the *appendix masculina*) to be very useful. Unfortunately, no description or figure of this character was given by most of the earlier workers and even by recent workers no proper and complete description is given. Therefore, realising its systematic importance, it is suggested here that this appendage should be fully described and properly illustrated.

Often taxonomic confusion is created by juveniles of many species owing to overlapping characters etc. As such, juvenile study assumes an equally important role as adults in taxonomy.

Also, with the growing importance of aquaculture, the taxonomic studies of both sexes is becoming imperative, especially in those allied species occurring together and where the males are easily separable while the females are not e.g. 'species' like *scabriculum*, *dolichodactylus* and *dubius*. As such, instead of over-emphasising on the male characters alone as usually done, due importance should also be given to the study of females.

A significant finding of the present study is regarding the taxonomic validity of the uropod accessory subapical spine. Holthuis (1950), while defining the genus *Macrobrachium*, considers the presence of this spine as a generic feature since in his study he could observe this spine in all species except only in *lamarrei*. In light of the present study, however, Holthuis' definition (1950, page No. 101) regarding this character needs to be modified to "...inner side mostly with a longer movable spine or without this spine." It is worthwhile specially mentioning here that this feature of presence/absence is indicated right from postlarval stage as experimentally observed in the larval studies conducted by the present authors (Jalihal and Sankolli, 1975 b ; Jalihal, 1978 and Jalihal *et al*, 1979b & 1983). Incidentally, the absence of this spine is observed so far in the species of 'minor' group only.

Evolution-wise, the genus is considered to be of marine origin (Ortmann, 1902 and Tiwari, 1955a) which is duly supported by experimental evidence (Jalihal *et al.* 1981) and larval studies (Jalihal, 1978). Yet it has already made and continues to make several attempts towards freshwater habitation/freshwaterization. This has been amply reflected in the developmental patterns essentially a live aspect of evolution.

The 'minor' *Macrobrachium* gronp seems to have successfully invaded freshwater environment as evident by their developmental patterns with generally greenish and large-sized eggs (more than 0.70 mm) and fully or partially abbreviated development added by preponderance of females. Besides, the small to medium size of the members of this group itself appears to be one of the factors contributing to its success and diversity whereby they can occupy all different niches of the freshwater ecosystem.

On the other hand, the larger 'major' species of *Macrobrachium* have not yet fully established in freshwater as indicated by their natural occurrence in saline to freshwater, generally brownish and small-sized (less than 0.70 mm) eggs and their freshwaterization is perhaps restricted by their specialised features/requirements like prolonged development and its salinity dependence, dromous behaviour, distinct sexual dimorphism etc.

It is also interesting to note that three of the species *viz, sankollii, tiwarii* and *hendersodayanum* occur together in the same locality, are exposed to same environmental conditions (in the Malaprabha River at Khanapur) and yet they are found to belong to three different groups (of Tiwari and present authors) discussed above. Even their larvae and developments show three distinct patterns. This perhaps reflects not only the diversity of the species but also that *Macrobrachium* is not a homogenous genus and appears to be a polyphylatic group.

The present study is from a very small geographical area covering hardly 10 species. Yet within this itself it reveals taxonomic and habitat diversity, different developmental and larval patterns etc, thereby suggesting that amongst the decapod crustaceans the freshwater prawns, especially the palaemonid genus *Macrobrachium,* is one of the most successful groups invading the freshwaters.

Key to the species of the genus *Macrobrachium* from Karnataka

1. Second pair of chelipeds similar in both sexes, equal or subequal and shorter than body. Inland species with eggs large than 0.70 mm and not more than about 300 in number. Development fully or partially abbreviated with 1 or 3 larval stages without requiring salinity or prolonged with 8 or 9 stages requiring some salinity (at the most 1.5 ppt) for matamorphosis. First zoea with all 5 pairs of pereiopod buds. 2

— Second pair of chelipeds in males either similar and subequal being much longer than body or dissimilar and distinctly unequal, the larger being subequal to body. Coastal species with eggs smaller than 0.70 mm and usually more than 1000 in number. Development prolonged comprising more than 10 larval stages (moults) and essentially requiring salinity of atleast 5 ppt. First zoea with only first 2 pairs of pereiopod buds 9

2. Second cheliped slender, its carpus distinctly longer than merus and fingers without any pubescence. General body colour almost transparent. Eggs greenish in colour and less than 2.0 mm in size. Development consisting generally of 3 or sometimes 8 or 9 larval stages. First zoea with pereiopods and pleopods represented as non-functional, unsegmented buds and telson triangular or fan-shaped. 3

— Second cheliped stouter, its carpus subequal to merus and fingers with velvety pubescence on their $\frac{1}{4}$th to $\frac{3}{4}$th part of inner margin. General body colour yellowish brown with deep violet or black strips and patches. Rostral formula $\frac{6-9}{2-5}$. Eggs brownish in colour, very large, measuring 1.45 to 1.60×1.80 to 2.40 mm and 25 to 105 in number. Development totally abbreviated consisting of only 1 larval + 1 postlarval stages, completed in purely freshwater. First zoea with pereiopods and pleopods segmented and functional, telson rounded and bearing 11 or 12+11 or 12 (=22 to 24) processes. *hendersodayanum* (Tiwari)

3. *Exopod of uropod with a distinct movable* accessory subapical spine appearing right from postlarval stage. 4

— Exopod of uropod without any accessory subapical spine right from postlarval stage. 6

4. Body glassy transparent with localised deep orange-red spots at base of fingers of second cheliped. Rostrum rather straight or slightly concave with teeth not compactly arranged. Rostral formula $\frac{5—10}{2—6}$. Chela of second cheliped always shorter than carpus. Eggs deep green, distinctly larger than 1.0 mm and not more than 200 in number. Development partially abbreviated comprising 3 larval+1 postlarval stages, completed in purely freshwater. First zoea with first 3 pereiopods biramous and with pleopod buds. 5

— Body transluscent with branched reddish-brown chromatophores extending from carpus to finger tips of second cheliped. Rostrum convex with compactly arranged teeth. Rostral formula $\frac{8—13}{4—6}$. Chela of second cheliped always longer than carpus. Eggs chalky green, smaller than 1.0 mm, measuring 0.70 to 0.87×0.82 to 1.02 mm and 105 to 310 in number. Development prolonged, comprising 8 larval 1 postlarval stages and requires atleast 1.5 ppt salinitly for its successful completion. First zoea with first 4 pereiopods biramous and without pleopod buds. ... *banjarae* (Tiwari)

5. Chela of second cheliped always less than $\frac{3}{4}$th of carpus. *Appendix masculina* shorter, being 1.92 to 2.04 (av. 1.99)—times as long as *interna* and with 1 long+2 to 4 short, subequal stiff setae terminally. Rostral formula $\frac{5—10}{3—6}$. Egg size : 1.10 to 1.30 × 1.60 to 1.80 mm. Fecundity , 60 (counted in a single specimen). First zoea with a prominent chromatophore dorsally on 3rd abdominal segment. A riverine species. ... *sankollii* n. sp.

— Chela of second cheliped always more than $\frac{3}{4}$ th of carpus. *Appendix masculina* longer, being 2.20 to 2.56 (av. 2.43)—times as long as *interna* and with 1 long+5 or 6 short, subequal stiff setae

terminally. Rostral formula $\frac{5—10}{2—6}$. Egg size : 1.10 to 1.40 × 1.40 to 1.90 mm. Fecundity : 70 to 260. First zoea without any dorsal chromatophore on abdomen. An impounded water species. ... ... *unikarnatakae* n. sp.

6. Rostrum long, slender being atleast equal to or mostly considerably longer than antennal scale and with a distinct distal gap on the upper margin. Chela of second cheliped always less than $\frac{3}{4}$th (but more than half) of carpus. First zoea with a triangular telson bearing 7+7 (=14) processes. 7

— Rostrum short, stout, being at the most subequal to antennal scale and without any distal gap on upper margin. Chela of second cheliped always more than $\frac{3}{4}$th of carpus, becoming longer than carpus in larger individuals. First zoea with a fan-shaped telson bearing 20 to 27 processes. 8

7. Second cheliped with a prominent orange-red spot at base of fingers. Rostrum equal to or mostly longer than (1.0 to 1.75, av. 1.35—times) carapace. Rostral formula $\frac{7—10}{4—7}$. *Appendix masculina* hairy and distinctly shorter than (0.7—times) endopod. Egg size : 1.25 to 1.40 × 1.70 to 1.90 mm. Fecundity : 50 (counted in a single specimen). First zoea without any chromatophore on third abdominal segment. A species with so far restricted distribution in South Kanara District of the Karnataka State. ... ... *canarae* (Tiwari)

— Second cheliped without any chromatophores. Rostrum subequal to (0.76 to 1.11, av. 0.9—times) carapace. Rostral formula $\frac{5—11}{5—9}$ *Appendix masculina* almost naked, very long, being atleast equal to endopod or mostly slightly longer than it. Egg size : 0.95 to 1.25 × 1.15 to 1.47 mm. Fecundity : 65 to 275. First zoea with a pair of dorsolateral chromatophores on

3rd abdominal segment. Very widely distributed species. ... *lamarrei lamarrei* (H. Milne Edwards)

8. Carpus and chela of second cheliped bluish with two equally prominent orange-red spots i.e. at base of fingers and tip of carpus. Inner flagellum of antennule deep violet in colour. Rostrum very rarely longer than antennal scale. Rostral formula usually $\frac{7-9}{3-5}$ Terminal stiff setae of *appendix masculina* with spinulose margins. Egg size : 1.03 to 1.62 × 1.47 to 1.92 mm. Fecundity : comparatively more being 80 to 195. First zoea with lateral chromatophores on 4th and 5th abdominal segments and arms of telson. *kistnensis* (Tiwari)

— Second cheliped with only chela being slightly bluish and with a single prominent orange-red spot i.e. at base of fingers. All antennular flagella colourless. Rostrum mostly longer than antennal scale. Rostral formula usually $\frac{8-10}{3-6}$. Terminal stiff setae of *appendix masculina* smooth. Egg size : 1.0 to 1.40×1.40 to 1.90 mm. Fecundity : comparatively less being 70 to 115. First zoea without any lateral chromatophores on abdominal segments and arms of telson. ... *tiwarii* n. sp.

9. Rostral formula $\frac{11-14}{4-6}$ with only 2 postorbital teeth. Second pair of chelipeds in males subequal, distinctly longer than body, structurally similar with pubescence covering entire movable finger and inner half of fixed finger, cutting edge of fingers with not more than 6 teeth/denticles. Eggs greenish, measuring 0.41 to 0.51×0.47 to 0.60 mm. First zoea with a prominent dorsal chromatophore on 3rd abdominal segment. *idella* (Hilgendorf)

— Rostral formula $\frac{12-15}{2-3}$ with 4 or 5 postorbital teeth. Second pair of chelipeds in males distinctly unequal, structurally different with larger one being subequal to or longer than body and with velvety pubescence covering its palm proximal half of fingers, cutting edge of fingers

with 15 to 30 denticles. Eggs brownish. measuring 0.44 to 0.48 0.57 to 0.62 mm. First zoea without any chromatophore on 3rd abdominal segment. ...	...	*scabriculum* (Heller)

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SUMMARY

The information on inland or freshwater prawns of the genus *Macrobrachium* (Family-Palaemonidae) from the Karnataka State (India) is rather meagre despite the abundance of variety of freshwater bodies and the subsistence level fishery in many areas. The present work, which for the first time deals exclusively with the inland prawns of the state, gives exhaustive systematic account inclusive of information on synonymy, material examined, type material (in case of new species), ecology, live colouration, eggs, larvae and development based on laboratory rearings on the following ten species collected from areas representing three major geographical regions of the state : *(1) lamarrei lamarrei, (2) canarae, (3) sankollii* n. sp., *(4) unikarnatakae* n. sp., *(5) tiwarii* n. sp., *(6) kistnensis, (7) banjarae, (8) hendersodoyanum, (9) scabriculum* and *(10) idella.* Of these, 3 species (nos. 6, 7 & 9) are new records to the state while 3 are new to science. Wherever necessary, type material or type area material of the concerned species or of comparable species has been examined for rectifying long-standing taxonomic confusions. Thus, considerable new information has been added not only on the species covered in the present study but also on some of the allied but ill-defined species such as *lamarrei, lamarroides, lanchesteri, dubius, idae* etc. A detailed key has also been formulated for easy identification of the species so far recorded in the Karnataka State.

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*Not referred in original.

TABLE — 2

Table showing differences between the different 'froms' of *Macr*

CHARACTERS	*Macrobrachium scabriculum* based on present material	*Palaemon scabriculus* based on Heller (1862) syntype studied by Koelbel, 1892	*Palaemon* (s. s.) *dolichodactylus* based on Hilgendorf (1879)	*Palaemon scabriculus*-based on Henderson (1893)	*Palaemon* (*Parapalaemon*) *dolichodactylus* based on Coutiere (1902)	*Palaemon* (*Parapalaemon*) *dolichodactylus* based on Nobili (1903)	*Palaem scabric* on Hen Mattha
(1)	(2)	(3)	(4)	(5)	(6)	(7)	
I. ROSTRUM :							
(A) Rostral formula :	$\frac{12-15}{2-3}$	$\frac{13-15}{?}$	$\frac{13-15}{2-3(5)}$	$\frac{11-15}{2}$	$\frac{14}{5}$	$\frac{13-15}{3}$	$\frac{12-15}{2-3}$
(B) Postorbitals :	4 or 5	4 or 5	—	4 or 5	5	4	4 or 5
(C) Extension :	Equal to or slightly longer than antennular peduncle.	—	—	Longer than antennular peduncle and reaching nearly tip of antennal scale.	Extending slightly beyond antennal scale.	Longer than antennlar peduncle but shorter than antennal scale.	Subequ nularp shorte nal sc
II. ANTENNAL SCALE :	3.0 to 3.30—times as long as broad and outer spine distinctly shorter than lamellar tip.	—	—	—	—	—	—
III. SECOND CHELIPED (MALE) :							
(A) Larger cheliped :							
(a) Size :	Subequal to body.	Shorter than body.	Longer than body.	Subequal to body.	Longer than body.	—	Long
(b) Pubescence :	On palm+more than proximal half of fingers.	—	On palm+base of fingers.	On fingers.	On palm.	On palm+base of fingers.	On F finge
(c) Fingers :							
(1) Number of tubercles :	18—29	10—20	21	—	25.30	16.20	12—
(2) When closed :	Opposed margins meet.	—	Opposed margins do not meet.	—	—	—	Opp do r
(3) Movable finger :	Equal to or longer than fixed finger.	—	Shorter than fixed finger.	—	—	—	Sho fing

L'E — 2

ıs' of *Macrobrachium scabriculum* (Heller, 1862)

li	*Palaemon scabriculus*– based on Henderson and Matthai (1910)	*Palaemon dolichodactylus*— based on Henderson and Matthai (1910)	*Palaemon dubius*—based on Henderson and Matthai (1910)	*Palaemon scabriculus*—based on Kemp (1915)	*Macrobrachium scabriculum*—based on Holthuis (1950)	*Palaemon (Parapalaemon) dolichodactylus*—based on Barnard (1950)	*Macrobrachium scabriculum*—based on Tiwari and Pillai (1973)
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	12—15 / 2—3	—	—	12—13 / 2	—	13—15 / 2—4	12—18 / 2—5
	4 or 5	—	—	4	—	3 to 5	3 to 5
er	Subequal to antennularpeduncle and shorter than antennal scale.	Subequal to antennular peduncle and shorter than antennal scale.	Subequal to antennular peduncle and shorter than antennal scale.	Slightly longer than antennular peduncle.	—	Longer than antennular peduncle and nearly to tip of antennal scale.	Longer than antennular peduncle but shorter than antennal scale.
	—	—	—	—	Outer spine atleast equal to or slightly longer than lamellar tip.	—	About 2.30—times as long as broad and outer spine almost equal to lamellar tip.
	Longer than body.	Longer than body.	Shorter than body.	Shorter than body.	—	—	Shorter than body.
	On Palm+base of fingers.	On plam+proximal half of fingers.	So sparse that joints almost appear naked.	Scanty.	Over a larger part of fingers.	On palm+bases of fingers.	On parts of palm and fingers.
	12—23	23—32	11—18	—	—	—	8—14
	Opposed margins do not meet.	Opposed margins meet.	—	—	—	—	—
	Shorter than fixed finger.	Subequal to fixed finger.	—	—	—	—	—

TABLE —2 (*Contd.*)

en the different 'froms' of *Macrobrachium scabriculum* (Heller, 1862)

(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
—	Wider than carpus.	Narrower than carpus.	Wider than carpus.	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
1.13 to 1.34 (average =1.23)	0.80 to 1.10 (average=0.93)	1.20 to 1.65 (average=1.46)	0.65 to 0.80 (average=0.71)	0.79	Finger : Palm ratio variable	1.50	0.75 to 1.00 (average=0.86)
1.48 to 1.60 (average=1.54)	1,35 to 1.60 (average=1.50)	1.55 to 1.75 (average=1.62)	1.00 to 1.20 (average=1.12)	0.88	—	—	0.90 to 1.28 (average=1.00)
1.18 to 1.31 (average=1.24)	1.30 to 2.00 (average=1.61)	0 95 to 1.35 (average=1.11)	1.30 to 1.70 (average=1.56)	1.11	—	—	1.10 to 1.35 (average=1.18)
0.91 to 0.92 (average=0.915)	0.84 to 1.05 (average=0.92)	0.97 to 1.14 (average=1.08)	0.85 to 1.00 (average=0.91)	0.96	—	—	0.95 to 1.16 (average=1.03)
—	Opposed margins meet	—	—	—	—	—	—
1.12 to 1.42	1.08 to 1.45	1.40 to 1.65	0.95 to 1.10	—	—	Less than 1.0	1.00 to 1.25
1.12 to 1.25	1.01 to 1.21	1.12 to 1.30	1.00 to 1,06	—	—	—	0.85 to 1.00
—	—	—	—	—	0.40 x 0.53	—	0.43 to 0.50 x 0.57 to 0.71
—	58.0 to 88 0	59.0 to 75.0	62.0 to 75.0	47.8	26.0 to 43.0 (males +	93.0	16.80 to 51.70
—	40.0 to 53.0	—	—	54.0	females combined)		41.00 to 55.80

Table showing differences between the different

(1)	(2)	(3)	(4)	(5)	(6)	(7)
(d) Palm :	Narrower or equal to carpus and 2.4 to 2.9 times as long as broad.	—	Wider than carpus and 3.70—times as long as broad.	—	—	—
(e) Carpus :	2.90 to 3.61 times as long as broad.	—	4-times as long as broad.	—	—	—
(f) Merus :	3.35 to 3.35 times as long as broad.	—	5-times as long as broad.	—	—	—
(g) Fingers / Palm =	1.45 to 1.75 (average=1.56)	0.88 to 1.13 (average =0 96) but fingers longer than palm as per Heller's description and figure.	1.37 (as per figure)	Fingers longer than palm.	1.09	1.13 to 1.34 =1.23)
(h) Fingers / Carpus =	1.35 to 1.50 (average—1.40	1.12 to 1.16 (average=1.14)	1.65 (as per figure)	—	1.35	1.48 to 1.60 (average=1.5
(i) Palm / Carpus =	0.85 to 0.95 (average=0.90)	1.02 to 1.31 (average=1.19)	1.20 (as per figure)	Palm almost equal to carpus.	1.23	1.18 to 1.31 (average=1.2
(j) Carpus / Merus =	1.05 to 1.15 (average=1.10)	1.00 to 1.12 (average=1.06)	1.05 (as per figure)	—	1.08	0.91 to 0.92 (average=0.9
(B) Shorter cheliped :						
(a) Fingers when closed :	Opposed margins meet.	—	—	—	—	—
(b) Fingers Palm	1.50 to 1.56	—	—	—	1.30	1.12 to 1.42
(c) Fingers Carpus	1.12 to 1.25	—	—	—	0.94	1.12 to 1.25
IV. EGG SIZE (in mm) :	0.44 to 0.48 x 0.57 to 0.62	—	—	—	—	—
V. ADULT SIZE (in mm)						
(a) Males :	40.0 to 64.0	35.0 to 37.0	35.0 to 80.0	About 42.0	90.0	—
(b) Females :	40.0 to 52.0	—	—	—	—	—