

DISCOVERY OF PARASTENOCARIDIDAE(COPEPODA,
HARPACTICOIDA) IN INDIA, WITH THE DESCRIPTION OF THREE NEW
SPECIES OF *PARASTENOCARIS* KESSLER, 1913, FROM THE RIVER
KRISHNA AT VIJAYAWADA¹⁾)

BY

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¹⁾*This paper is dedicated to the fond memory of my elder brother, Yenumula Venkata Ranga Reddy, who, a tower of strength to my family, passed away while this work was in progress.*

ABSTRACT

In a two-year study of the family Parastenocarididae in the River Krishna at Vijayawada, South India, five species belonging to the genus *Parastenocaris* Kessler, 1913, have been met with. Of these, three are new to science: *P. gayatri* n. sp., *P. savita* n. sp., and *P. sandhya* n. sp. The first two of these belong to the *brevipes*-group, the last one to the *sioli*-group. This paper gives an illustrated description of these new taxa, and also briefly discusses their affinities and ecology. The other two species, viz., *P. curvispinus* Enckell, 1970, and *Parastenocaris* sp., will be dealt with elsewhere. This is the first report on Parastenocarididae from India.

Incidentally, it has also been found that parastenocaridids constitute a rather favoured item in the diet of the postlarvae of a commercially important gobioid fish, *Glossogobius giuris* (Hamilton, 1822). A brief note of this finding has been made.

RÉSUMÉ

Au cours d'une étude de deux ans sur la famille des Parastenocarididae, provenant du fleuve Krishna à Vijayawada, Inde du Sud, cinq espèces appartenant au genre *Parastenocaris* Kessler, 1913, ont été rencontrées. Parmi elles, trois sont nouvelles pour la science: *P. gayatri* n. sp., *P. savita* n. sp. et *P. sandhya* n. sp. Les deux premières appartiennent au groupe *brevipes*, la troisième au groupe *sioli*. Ce travail donne une description illustrée de ces nouveaux taxons, ainsi qu'une brève discussion de leurs affinités et de leur écologie. Les deux autres espèces, *P. curvispinus* Enckell, 1970 et *Parastenocaris* sp. seront traitées par ailleurs. Ceci constitue la première étude sur les Parastenocarididae de l'Inde.

Par ailleurs, il a été mis en évidence que les Parastenocarididae constituent un élément apprécié dans l'alimentation de la post-larve d'un poisson d'importance commerciale, *Glossogobius giuris* (Hamilton, 1822). Une note courte relative à cette trouvaille est fournie.

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INTRODUCTION

Parastenocaridids are small harpacticoids (length 0.2-0.6 mm), inhabiting the space between sediment particles of underground and subsoil waters. Aided by their minute, vermiform body and short limbs, they can crawl or swim freely in the capillary system of the interstices between sand grains.

The family Parastenocarididae contains about 200 species in five well-recognized genera: *Parastenocaris* Kessler, 1913, *Forficatocaris* Jakobi, 1969, *Paraforficatocaris* Jakobi, 1972, *Potamocaris* Dussart, 1979, and *Murunducaris* Reid, 1994. Of these, *Parastenocaris* is the most speciose genus and has a world-wide distribution, whereas all other genera, containing few species, are exclusively Neotropical (Reid, 1994). The family is 'primarily freshwater' and only about a dozen species inhabit marine and brackish coastal subsoil water (Wells, 1986). In the whole of Asia, only about 20 species have so far been recorded (see Dussart & Defaye, 1990), but, surprisingly, none from India, as confirmed by H. K. Schminke (pers. comm.).

In the course of a two-year study of parastenocaridids of the River Krishna at Vijayawada, I have come across five species, viz., *Parastenocaris gayatri* n. sp., *Parastenocaris savita* n. sp., *Parastenocaris sandhya* n. sp., *Parastenocaris curvispinus* Enckell, 1970, and *Parastenocaris* sp. The three new species will be described below; accounts of the other two species found will be published elsewhere.

STUDY AREA

The River Krishna is one of the major rivers of India. Originating near Mahabaleswar at an altitude of 1360 m in the Western Ghat mountains, only about 60 km from the Arabian Sea, the river flows across almost the entire peninsular India from the west to the east over a distance of approx. 1300 km before discharging into the Bay of Bengal. It enters the sea by two principal mouths and has built up a large, very fertile delta continuous with that of the Godavari River to the northeast. In the deltaic region, numerous artificial habitats such as tanks, ponds, canals, etc., are fed by the river. The river derives its water from the monsoon rains and has several tributaries, of which the Bhima (north) and the Tungabhadra (south) are the largest ones. It has a catchment area of about 233,229 km².

At the head of the delta at Vijayawada (16°31'N 80°E) there is an important barrage, named Prakasam Barrage, which was constructed in 1955 for regulating the flow of water in a system of irrigation canals, and which is situated 80 km from the river mouth. The river narrows between two hills of gneiss and then spreads

over alluvial plains. The channel there is 1.2 km wide. During summer, the river, downstream of the barrage, becomes a narrow stream, with depths barely reaching 1.5 m. The depth, however, rises to as much as 13 m during flooding times.

The sampling site at Vijayawada is located near the southern end of a road-bridge across the river, called Kanaka Durga Varadhi, about 2.5 km downstream of Prakasam Barrage. Here the river bed has a deposit of fine sand and detritus particles, but with little or no clay, and is almost devoid of macrophytic vegetation. Pure freshwater conditions prevail throughout the year. During the present study, an unprecedented flood was witnessed in the month of October, 1998, which caused serious damage to the benthic communities. The temperature regime was: air 30-38°C, water 28-35°C.

METHODS

Core samples were regularly collected once a month for two consecutive years, i.e., January 1998 to December 1999, using plastic tubes of 70 cm length and 4 cm diameter. On a few occasions, a metal corer was also employed. Moist, exposed as well as submerged parts of the riverbed were sampled. Each time, sampling was done at five sites in c. 100 m², and at each point about ten cores were taken from the sediment surface to a depth of 10-30 cm, pooled into a bucket and vigorously stirred with filtered habitat-water. The supernatant was filtered through a plankton net made of bolting silk (mesh size 70 μ m). The filtrate was then fixed in 10% formalin and preserved in a 5% formalin solution. A few samples were also fixed in 20% alcohol and preserved in 70% alcohol. The water collected in dug-out pits near the water's edge did not yield any parastenocaridids. Specimens were dissected in lactophenol, using a Getner stereoscopic microscope at 90 \times ; the parts were mounted under cover slips and sealed with Araldite. All measurements of preserved animals were made with a calibrated eyepiece micrometer, and drawings were made with a camera lucida mounted on a Meopta compound microscope at magnifications of 270 \times , 450 \times or 675 \times . Some paratypes were largely dissected before drawing the appendages; lateral views were generally drawn in situ. Body length was measured from the base of the rostrum to the end of the caudal rami. All type material has been deposited in The Natural History Museum, London.

DESCRIPTIVE PART

***Parastenocaris gayatri* n. sp. (figs. 1-4)**

Parastenocaris sp.: Reddy, 1977: 337-341, figs. 1-10.

Material examined. — Holotype (adult ♂, 0.47 mm), allotype (adult ♀, paratypes (25 ♂♂, 25 ♀♀), all undissected and preserved in 70% alcohol, deposited in The Natural History Museum, London; registration numbers: holotype 2000.1280; allotype 2000.1281; paratypes 2000.1282-1331. Several dissected and undissected paratypes are kept at the Department of Zoology, Nagarjuna University. Type locality. River Krishna at Vijayawada, South India, 16°31'N 80°E; close to the southern end of Kanaka Durga Varadhi, a road-bridge across the river, from fine sand, about 10 m from the water's edge at a depth of 10 to 30 cm. 11 February 1999; water temperature 29°C.

Description and drawings are based on the study of the c. 75 specimens that constitute the type-series.

Adult male. — Total length (excluding caudal setae) of holotype 0.47 mm, of paratypes 0.42-0.52 mm, average 0.47 mm ($N = 30$). Body elongate, subcylindrical, vermiform, about 9 times as long as wide, slightly tapering posteriorly and without ornamentation. Cephalothorax, excluding rostral projection, as long as next 2 somites combined and with somewhat spherical integumental window. Urosomites 2-5 with 1 distinct rectangular, integumental window each; window on urosomite 2 relatively short and trapezoidal. Anal operculum smooth, posterior border straight, not reaching end of anal somite.

Caudal rami parallel and 40% shorter than anal somite; each ramus 3 times as long as maximum width, subcylindrical, distal third narrow. Armature consisting of 7 setae: dorsal seta inserted almost opposite to a group of 3 poorly developed, unequal lateral setae, located behind the middle of outer margin, and 1 posterolateral and 2 terminal setae, outer terminal strongest and 4.3 times as long as caudal ramus; posterolateral seta longer than, and inner terminal seta as long as, caudal ramus.

Rostrum (fig. 1a, b) prominent, subcylindrical, not defined at base, and tipped with stubby, modified seta (spine?); no sensilla discernible.

Antennule (fig. 2a) haplocer, 7-segmented; segment 2 longest, segments 3 and 4 enlarged; segment 4 with dentiform, lateral process, carrying 1 short seta; segment 6 with strong, lateral, spinous process; segments 1-7 with 0, 5, 2, 3, 0, 0, and 7 setae; segment 4 with long aesthetasc, constricted at midlength and reaching beyond tip of antennule, segment 7 with short aesthetasc.

Antenna (fig. 2b). Coxa small, unarmed. Allobasis 3.6 times as long as maximum width, with 2 groups of minute spinules on anterior margin. Exopodite 1-segmented, cylindrical, 4 times as long as wide, with 1 apical seta, longer than its segment. Endopodite about half as long as allobasis, with 2 spines and some

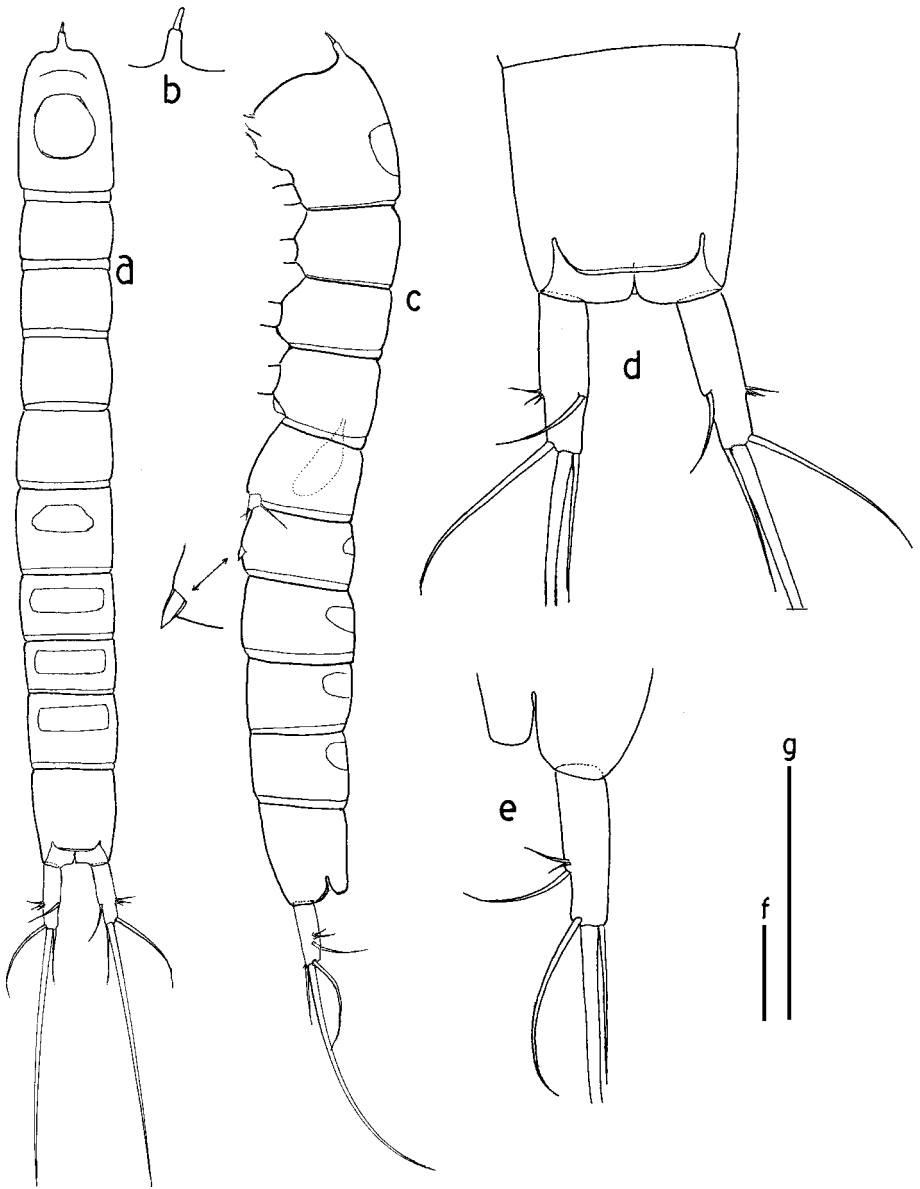


Fig. 1. *Parastenocaris gayatri* n. sp., male. a, holotype habitus, dorsal; b, rostrum; c, habitus, lateral; d, anal somite and caudal rami, dorsal; e, right caudal ramus, lateral. Scale f for a, c; scale g for b, d, e; scales equal 50 μ m.

spinules on anterior edge; distal end with 5 setae, 3 of which geniculate, and with 1 spinule at distal posterior corner.

Mandible (fig. 2c). Gnathobase not studied in detail. Palp 1-segmented, 4 times as long as wide, with 2 apical setae of nearly equal length.

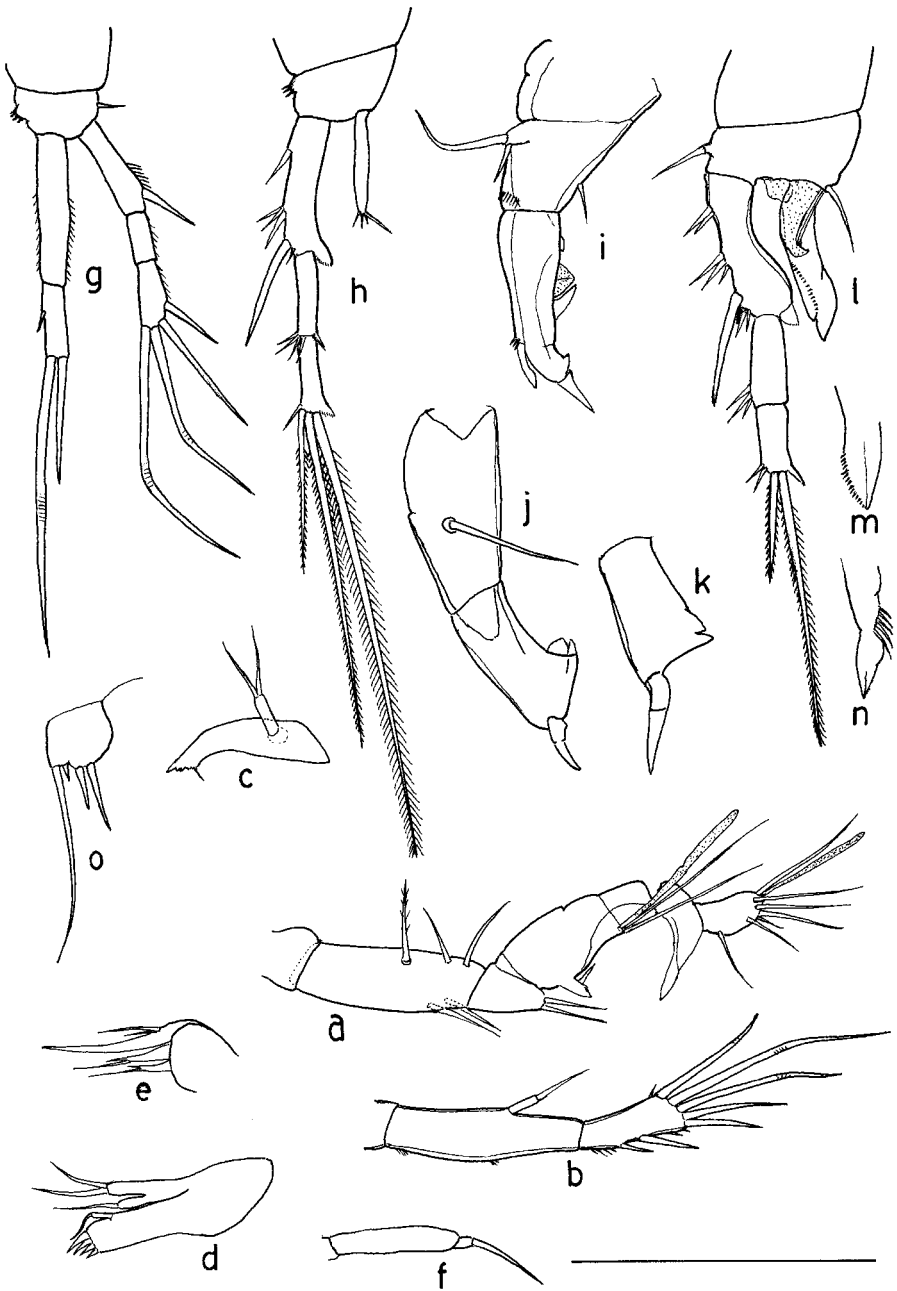


Fig. 2. *Parastenocaris gayatri* n. sp., male. a, antennule, dorsal; b, antenna; c, mandible; d, maxillule; e, maxilla; f, maxilliped; g, leg 1; h, leg 2; i, leg 3, posterior; j, do., exopodite (under cover slip), lateral; k, do., distal exopodite-segment (under cover slip), lateral; l, leg 4, posterior; m, n, do., different views of distal part of endopodite; o, leg 5. Scale equals 50 μ m.

Maxillule (fig. 2d). Arthrite of praecoxa with 1 modified jointed seta on abcoxal surface and 4 terminal spines, increasing in size distally, as figured. Coxa with a single terminal, thick seta. Basis with 2 thick terminal setae. Exo- and endopodite absent.

Maxilla (fig. 2e). Syncoxa with 2 endites, each carrying 2 apical setae, one of which strongly reduced. Basis with 1 strong claw fused to it. Endopodite represented by 2 unequal, slender setae.

Maxilliped (fig. 2f). Basis small, bare. First endopodite-segment subcylindrical, 5 times as long as wide, bare. Second segment small, with 1 short claw.

Leg 1 (fig. 2g). Coxa bare. Basis with a few small spinules on a lobe at mid-inner margin; outer seta short. Exopodite 3-segmented; first segment distinctly longer than third segment, with 1 spine and a few spinules on distal outer margin; second segment shortest and without spine; last segment with 2 geniculate setae and 2 spines; outer margin of distal 2 segments spinulose. Endopodite 2-segmented, extending a little beyond end of exopodite; first segment more than twice as long as second, spinulose along distal lateral margins and without seta. Second segment with 1 spinule at about mid-inner margin, and 1 geniculate seta and 1 spine apically.

Leg 2 (fig. 2h). Coxa bare; basis with 3 or 4 spinules on proximal outer margin. Exopodite 3-segmented; first segment stouter, but shorter than next 2 segments combined; third segment with 3 setae; first and third segments with 'fringed' distomedial corner. Endopodite 1-segmented, slender, 7 times as long as wide, reaching over $2/3$ length of first exopodite-segment; apex with one obliquely directed seta and 3 spinules.

Leg 3 (fig. 2i-k). Modified but not complicated. Coxa unarmed. Basis with small lobe at proximal outer corner, carrying 1 strong outer seta and 1 posteriorly directed spinule; 1 oblique row of fine spinules at distal outer angle; 1 short slender seta near inner distal corner, probably representing endopodite. Exopodite, in posterior view (fig. 2i), consisting roughly of 2 segments, first segment much larger than second, slightly dilated proximally and armed with the following structures: inner margin with 1 large triangular hyaline lobe at midlength, 1 large dentate process close to it and 1 small chitinous knob proximally; distal outer corner with 1 strong but short modified seta ('thumb'), which is shorter than distal segment and 3 or 4 spinules occurring near thumb. Second segment, in lateral view, much expanded distomedially (fig. 2j, k) and armed with 1 bifid chitinous lobe at inner distal angle (hook-like in posterior aspect) and 1 apical, sturdy, straight or slightly curved, pointed spine.

Leg 4 (fig. 2l-n). Coxa bare. Basis with usual outer seta on short papilla. Exopodite 3-segmented; first segment modified, incurved, distally dilated with usual spine near distal outer corner and 1 thumb-like, unfringed lobe at inner

distal angle; third segment with 2 apical setae and 1 small spinule in place of 'fringe' at distal inner corner. Endopodite slender, linguiform, extending beyond posterior border of first exopodite-segment, apical region tapering to blunt or sharp point; 1 oblique row of minute spinules dividing distal half into 2 unequal lobes; 1 longitudinal row of 4 or 5 long spinules or setules at about midlength in posterolateral view. Basal sclerotized part (stippled area) differentiated into 1 large incurved claw and 1 small, nearly spherical lobe; also, 1 slender seta occurring at base of endopodite on inner side.

Leg 5 (fig. 2o). Small, nearly circular plate, with 4 setae on uneven distal border; outer (proximal) seta longest, others short, unequal, spiniform.

Leg 6 (fig. 1c) bare, posteriorly directed, subconical, pointed protrusion.

Adult female. — Total length of allotype 0.50 mm, of paratypes 0.43-0.50 mm, average 0.47 mm ($N = 30$). Habitus similar to male in general appearance. Cephalothorax with ovate dorsal integumental window. Window on genital double-somite large, trapezoidal in outline. Anal somite with transverse row of fine setules and 1 sensillum on either side at distal outer corner of dorsum (fig. 3c-e); another dorsal sensillum on either side anterior to operculum (fig. 3c). Anal operculum as in male. Genital field (fig. 4a) extending to midlength of genital somite.

Caudal rami (fig. 3c-k) same as in male in setal armature, but ornamented with microsetules and spinules, as illustrated; general shape of caudal rami of allotype as in fig. 3a; both length and shape varying widely among paratypes; in lateral view, outer margin always straight, but inner margin variously dilating (fig. 3g-k).

Antennule (fig. 4b) 7-segmented, with 0, 4, 4, 2, 1, 0, and 9 setae; segments 4 and 7 each with aesthetasc; aesthetasc on segment 4 slightly constricted at midlength and extending beyond tip of antennule; that on segment 7 relatively short and slender.

Other cephalic appendages (not illustrated) and leg 1 (fig. 4c) as in male.

Leg 2 (fig. 4d). Basis with a group of 4 small spinules on proximal outer margin. Exopodite 3-segmented; first and third segments with fringed frill at each distomedial corner; inner margin of first exopodite-segment with setules. Endopodite slender, slightly bent at midlength and with 1 curved seta and 2 spinules.

Leg 3 (fig. 4e). Basis with 1 long outer seta and 3 or 4 spinules near its base. Exopodite slender, 2-segmented, each segment produced into small, triangular, fringed lobe at its inner distal angle; second segment with 2 setae. Endopodite slender, lanceolate, slightly shorter than first exopodite-segment and apparently naked.

Leg 4 (fig. 4f). Basis with the usual, single outer seta and 2 or 3 spinules near its base. Exopodite 3-segmented; first and third segments with fringed, triangular process at inner distal angle; third segment with 2 apical setae. Endopodite slender,

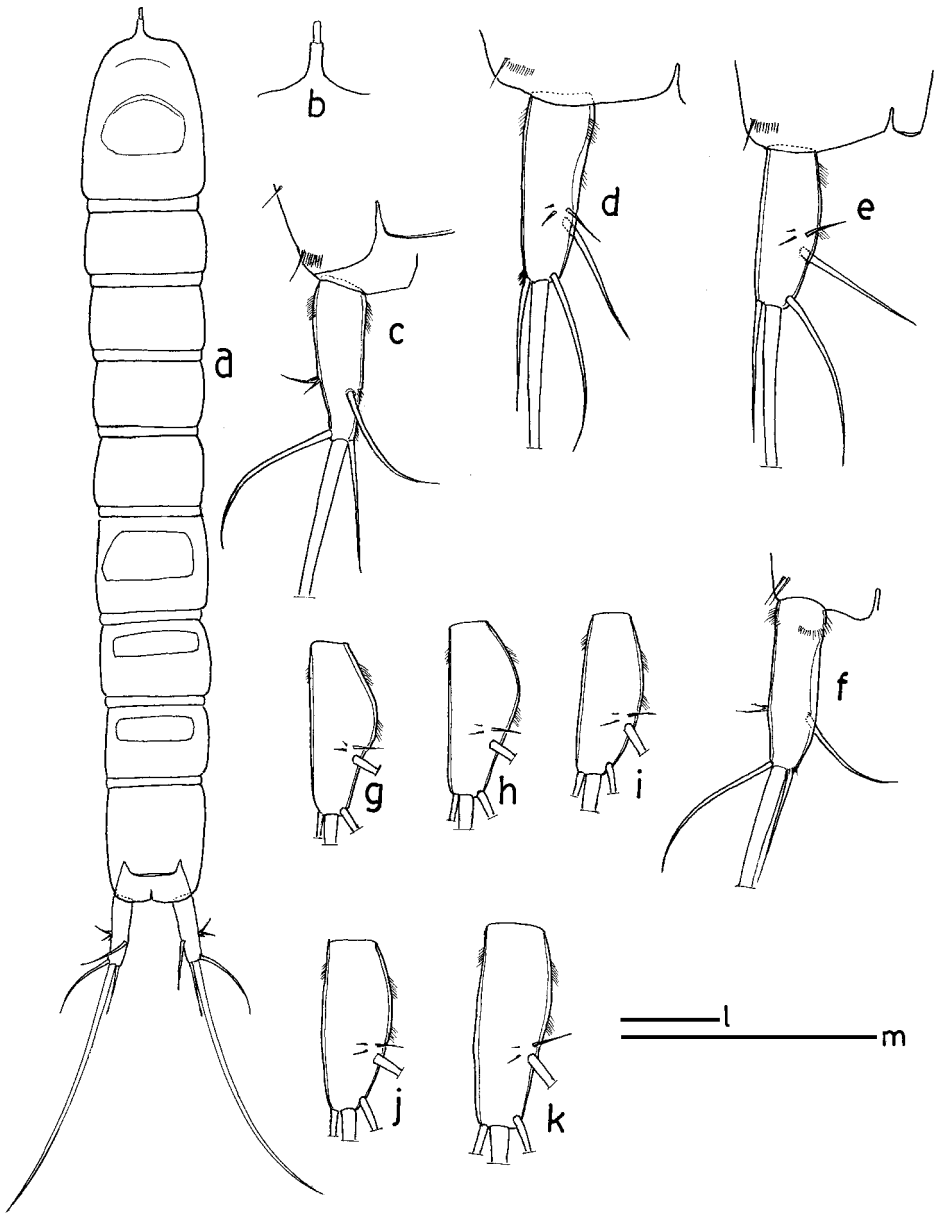


Fig. 3. *Parastenocaris gayatri* n. sp., female. a, allotype habitus, dorsal; b, rostrum; c, part of anal somite and left caudal ramus (under coverslip), dorsal; d, e, g-k, left caudal ramus, lateral; f, right caudal ramus, ventral. Scale l for a; scale m for b-k; scales equal 50 μm .

elongate, doubly curved, reaching midlength of second exopodite-segment; lateral margins of distal half spinulose and with a small circle of 4 or 5 small spinules at midlength.

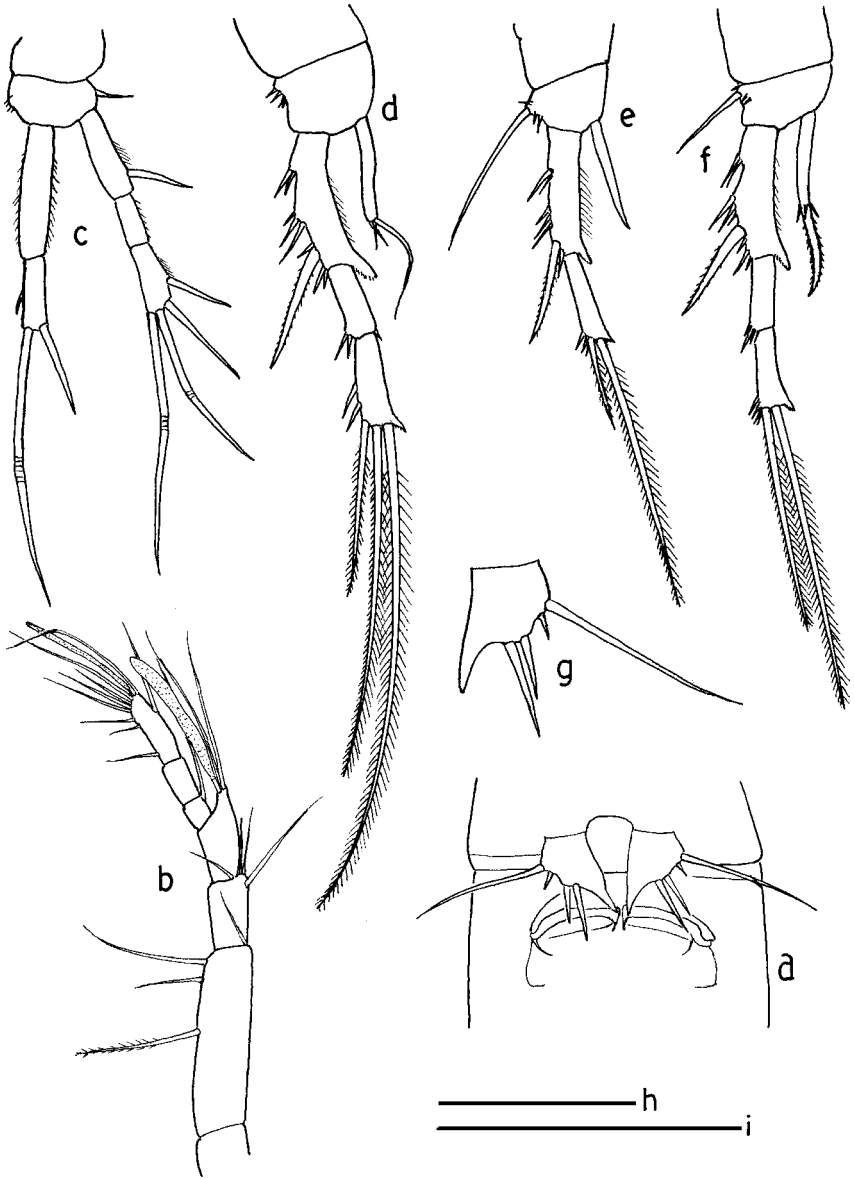


Fig. 4. *Parastenocaris gayatri* n. sp., female. a, leg 5 and genital somite, ventral; b, antennule, ventral; c, leg 1; d, leg 2; e, leg 3; f, leg 4; g, leg 5. Scale h for a; scale i for b-g; scales equal 50 μ m.

Leg 5 (fig. 4g) subquadrate, distal inner corner produced into sturdy spinous process; oblique distal margin with 4 setae in 2 groups; proximal seta longest, all others short, spiniform; second proximal seta shortest.

Etymology. — In the Vedic literature, the term “Gayatri” s. str. is genderless, signifying the cosmic energy; proposed here as a noun in apposition to the generic name.

Remarks and affinities. — Two solitary males of *Parastenocaris gayatri* n. sp. were first noticed by me way back in 1974 in plankton samples of the River Krishna and were later briefly described (see Reddy, 1977). One of these, then designated the paratype, was deposited in whole in The Natural History Museum, London (registration no. 1983: 72).

The membranous endopodite of leg 4 in the male strongly favours the inclusion of *P. gayatri* in Lang’s (1948) *brevipes*-group, by possessing heavily sclerotized structures at the base, a seta at the inner proximal corner, and a longitudinal row of 4 or 5 spinules. However, these latter spinules, unlike in other species of the group in which they are present, occur well below the apex of the endopodite.

Within the Indian subcontinent, the following five species, all described by Enckell (1970) from Sri Lanka, also belong to the *brevipes*-group, which possibly has its epicentre in tropical Asia (Reid, 1995): *P. irenae* Enckell, 1970, *P. noodti*, Enckell, 1970, *P. brincki* Enckell, 1970, *P. lanceolata* Enckell, 1970, and *P. singhalensis* Enckell, 1970. A critical comparison of the new species with these and the other Asian members of the *brevipes*-group reveals that it has the closest similarity to *P. noodti* in the structural details of legs 2, 4, and 5 in both sexes. However, it differs from *P. noodti* in several respects. For example, the anal operculum is straight instead of being convex; the ornamentation of the anal somite and the form of the caudal rami differ in the two species; the endopodite of leg 2 in the male and of leg 3 in the female are longer; in the male leg 3, the basis has an inner and an outer seta, and one spinule, all of which are absent in *P. noodti*; in leg 4, the endopodite is different in shape, and the armature consists of four or five setules in addition to spinules; the setules are wanting in *P. noodti*; leg 5 in both sexes of the new species has four instead of three setae, but without spinules on the inner margin, and in the female, the spinous process at the distal inner corner is larger. No comparison of the integumental windows of the somites is possible because they are not depicted for *P. noodti*. The integumental windows of the somites of the new species are somewhat similar to those of *P. brevipes*, despite differences in shape of these windows between the two taxa (see Reid, 1995).

The prehensile capacity of the male antennules in the new species is greatly enhanced by a powerful claw-like lateral process (not an artifact, I believe) on the fifth segment (reminiscent of a comparable structure frequently found on the antepenultimate segment of the modified right antennule of diaptomid males), and a dentiform process on the fourth segment. Coincidentally, this character is shared by the Indonesian *P. feuerborni* Chappuis, 1931, another member of the *brevipes*-group (no information on this point is available for other members).

P. gayatri n. sp. stands out from its congeners by, inter alia, the prominent rostrum, the distinct integumental windows as seen in habitus, and the various subtle characters of legs 2-5 in both sexes.

The caudal rami are sexually dimorphic; the rami in males are subject to little or no variation, but highly variable in females, as can easily be observed in lateral view. Such variation, according to Schminke (1991), is not uncommon in Parastenocarididae.

Distribution. — Known from the type locality only; its sympatric occurrence with a large number of allied euryhaline forms in different seasons (see under “Co-occurring fauna”, below) points to the possibility of this species to be found all along the lower reaches of the river, including the brackish environment.

Parastenocaris savita n. sp. (figs. 5-7)

Material examined. — Holotype (adult ♂, 0.47 mm), allotype (adult ♀) and paratypes (15 ♂♂, 5 ♀♀), all undissected and preserved in 70% alcohol, deposited in The Natural History Museum, London; registration numbers: holotype 2000.1384; allotype 2000.1385; paratypes 2000.1386-1405. Several dissected and undissected paratypes are kept at the Department of Zoology, Nagarjuna University. Type locality. River Krishna at Vijayawada, South India, 16°31'N 80°E; close to the southern end of Kanaka Durga Varadhi, a road-bridge across the river; from fine sand, about 10 m from the water's edge at a depth of 2 to 25 cm, 31 August 1998.

Description and figures are based on the study of the c. 35 specimens that constitute the type-series.

Adult male. — Total length excluding caudal setae of holotype 0.47 mm, of paratypes 0.42-0.48 mm, average 0.45 mm ($N = 20$). Body elongate, vermiform, only slightly tapering posteriorly, 8 times as long as maximum width near posterior border of cephalothorax, without ornamentation. Cephalothorax as long as next 2 somites combined, and with faintly marked, circular integumental window. Urosomites 3-5 each with indistinct, subquadrate integumental window in proximal half; window on urosomite 3 relatively large; no window discernible on urosomite 2. Anal operculum smooth, and in holotype posterior border slightly convex, not reaching posterior end of anal somite (fig. 5a, e); in a paratype, posterior border concave midway and extending a little beyond posterior end of anal somite (fig. 5h).

Caudal rami divergent, 35% shorter than anal somite; each ramus more than 3 times as long as maximum width (fig. 5e-h) or somewhat shorter (fig. 5g), subcylindrical, distal third a little narrow. Caudal armature, as usual, consisting of 7 setae; 3 anterolateral, in group, located slightly behind middle of outer margin, 2 of these setae well developed; dorsal seta inserted almost opposite to anterolateral setae and shorter than longest anterolateral setae; posterolateral seta sickle-shaped,

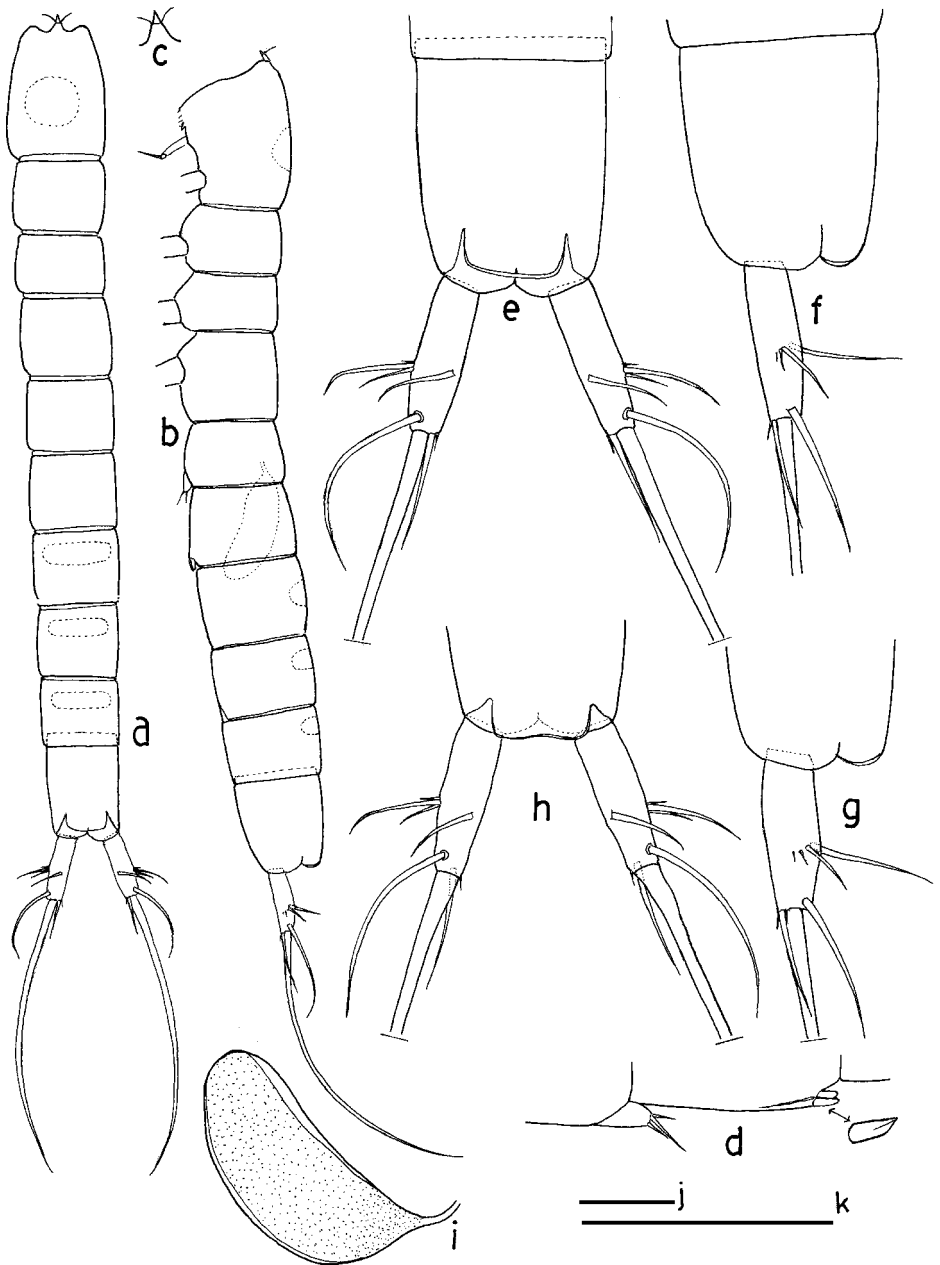


Fig. 5. *Parastenocaris savita* n. sp., male. a, holotype habitus, dorsal; b, same, lateral; c, rostrum; d, pediger 5 and urosomite 1, lateral; e, anal somite and caudal rami, dorsal; f, g, anal somite and left caudal ramus, lateral; h, anal somite (in part) and caudal rami, dorsal; i, spermatophore. Scale j for a, b; scale k for c-i; scales equal 50 μ m.

longer than caudal ramus; outer terminal seta sturdiest, 4.8 times as long as caudal ramus, and in one paratype, basal part dilated (fig. 5h).

Rostrum (fig. 5c) small, not defined at base; with a comparatively long sensillum on each side of acute tip.

Antennule (fig. 6a) haplocer, 7-segmented, with 0, 5, 2, 2, 0, 0, and 7 setae; spinous projection on segment 6 short and broad; aesthetasc on segment 4 constricted midway and extending well beyond tip of antennule; aesthetasc on segment 7 small, only half as long as that on segment 4.

Antenna (fig. 6b). Exopodite 1-segmented, 2.6 times as long as wide, with 1 apical seta, 2.6 times longer than its segment. Endopodite with 2 spines and some spinules on anterior margin; distal end with 5 setae, 3 of which geniculate.

Mandible (fig. 6c). Palp 1-segmented, 2.3 times as long as wide, with 2 apical setae of unequal length.

Maxillule (fig. 6d). Arthrite of praecoxa with 1 modified jointed seta on abcoxal surface and 4 terminal spines, increasing in size distally, as figured. Coxa with a single terminal, thick seta. Basis with 2 thick terminal setae. Exo- and endopodite absent.

Maxilla (fig. 6e). Syncoxa with 2 endites, each carrying 2 apical setae, one of which strongly reduced. Basis with 1 strong claw fused to it. Endopodite represented by 2 unequal, slender setae.

Maxilliped (fig. 6f). Basis small, bare. First endopodite-segment subcylindrical, 5 times as long as wide, bare. Second segment small, with 1 short claw.

Leg 1 (fig. 6g). Basis with short outer seta. First exopodite-segment a little longer than third one. First endopodite-segment nearly twice as long as second one, and about as long as first 2 exopodite-segments combined; 1 minute seta (or spinule?) at distal third of inner margin and 2 short, transverse rows of minute spinules near outer margin.

Leg 2 (fig. 6h, i). Basis with slender spinules on outer edge. First exopodite-segment with fringed triangular lobe at distomedial corner; outer spine relatively long, extending beyond distal end of second segment; third segment with small spinous process instead of fringed lobe at distomedial corner. Endopodite 1-segmented, 59% shorter than first exopodite-segment, gradually dilating apically, somewhat spatulate in outline, lateral and distal margins nearly straight, with 1 obliquely directed seta and 3 spinules at distal outer corner.

Leg 3 (fig. 6j-m). Coxa unarmed. Basis subquadrate, wider than long, with long seta near proximal outer corner, 8 or 9 long spinules in oblique row in distal half and 1 short seta on distal inner margin, perhaps homologous to endopodite. Exopodite large, elongately oval, dilated at midlength in lateral view (fig. 6k), inner margin lined with irregular hyaline lamella (fig. 6l, m); 1 spinule occurring near distal outer corner and small dentiform structure on proximal inner margin;

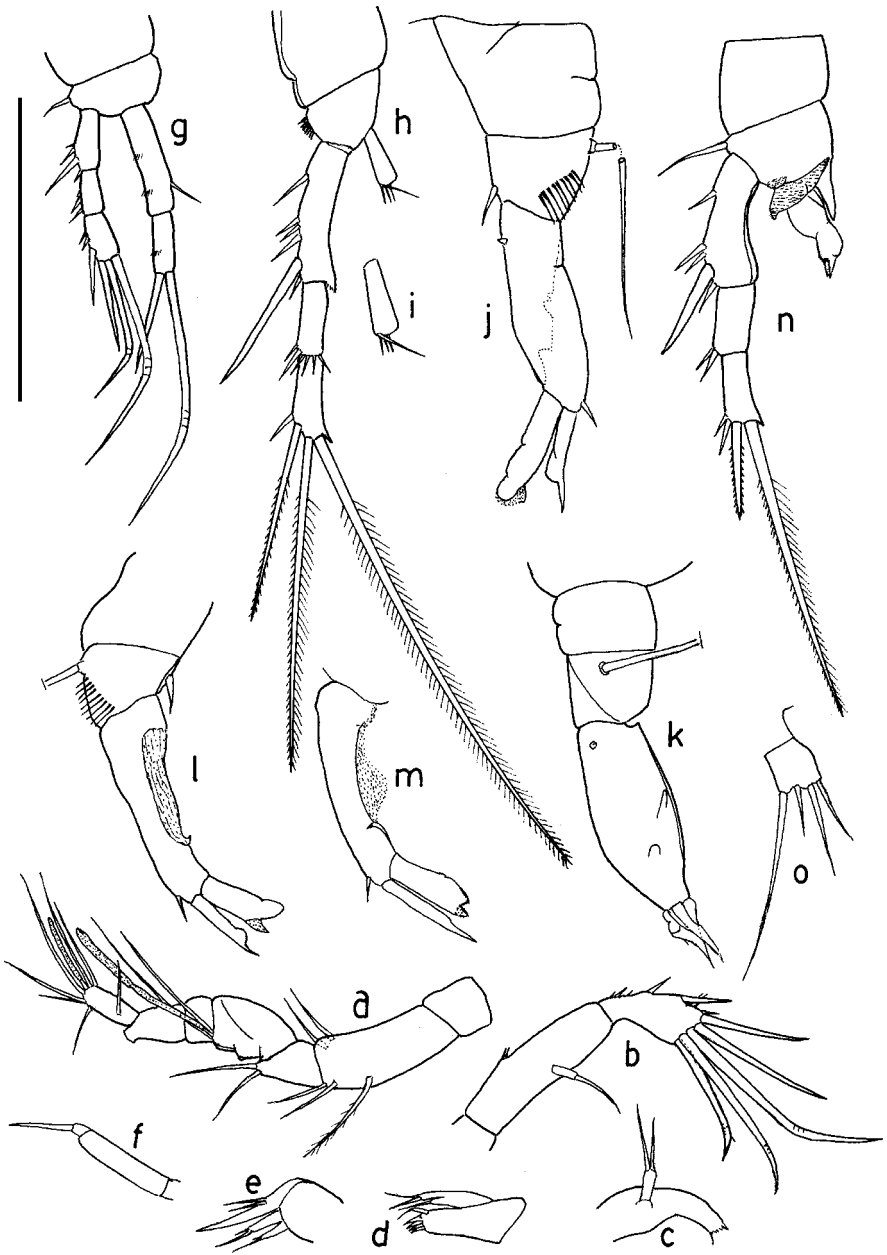


Fig. 6. *Parastenocaris savita* n. sp., male. a, antennule, dorsal; b, antenna; c, mandible; d, maxillule; e, maxilla; f, maxilliped; g, leg 1; h, leg 2; i, do., endopodite, enlarged; j, leg 3; k, do., lateral; l, m, do., posterolateral, in different paratypes; n, leg 4; o, leg 5. Scale equals 50 μ m.

distal end carrying 2 elongate, unsegmented branches of equal length; outer one slender, dilated at subapical inner margin and produced apically into short, spinous process. Inner branch thicker, subcylindrical, apex rounded and provided with hyaline lamella (fig. 6j), varying in size and shape (fig. 6l, m).

Leg 4 (fig. 6n). Coxa bare. Basis with short outer seta. First exopodite-segment curved, distal third dilated; distal inner corner without any lobe; outer distal spine relatively thick. Third segment with 2 apical setae and short, simple, spinous process at distal inner angle. Endopodite short, roughly 2-segmented, barely reaching distal end of first exopodite-segment and ending in 2 short, apical spines, forming beak-like structure; basal sclerotized part consisting of 1 very small, crescented lobe at proximal outer corner and 1 large, triangular lobe, projecting inward into short hook-like process; also, 1 short, stout spine occurring at inner proximal corner of endopodite and another small spine lying adjacent to it and overlapping endopodite.

Leg 5 (fig. 6o) small, subquadrate plate; distal border uneven, with 4 slender, dissimilar setae; outermost seta longest, and seta next to it shortest.

Leg 6 (fig. 5d) bare, posteriorly directed, subcylindrical protrusion, ending in acute tip.

Most of the males examined showed 1 reniform spermatophore (fig. 5i) in their body.

Adult female. — Total length of allotype 0.46 mm, of paratypes 0.44-0.47 mm, average 0.46 mm ($N = 9$). Body (fig. 7a) closely resembling male in general appearance except for maximum width occurring on genital double-somite. Cephalothorax as long as next 2 somites combined and with vague, circular, integumental window. Genital double-somite and succeeding 2 somites each with indistinct, subquadrate integumental window in their proximal half. Anal operculum smooth, with straight posterior border, not reaching posterior end of anal somite (fig. 7a). Caudal rami as well as their setal armature (fig. 7a, c, d), and the rostrum same as in the male.

Antennule (fig. 7e) 7-segmented, with 0, 4, 4, 2, 1, 0, and 8 setae; aesthetasc on segment 4 constricted midway and extending beyond tip of antennule, that on segment 7 shorter and slenderer than that on segment 4.

Other cephalic appendages (not illustrated) and leg 1 (fig. 7f) as in the male.

Leg 2 (fig. 7g, h). Basis with a row of 4 small spinules on proximal outer margin. Exopodite as in male except for fringed distomedial projection of first exopodite-segment being longer. Endopodite 1-segmented, 38% shorter than first exopodite-segment, slender, slightly dilated distally, with 1 seta and 3 spinules; in one paratype, seta directed outward.

Leg 3 (fig. 7i). Basis with 1 long outer seta and 1 spinule on outer edge. Exopodite 2-segmented, proximal segment produced into short finger-like, fringed

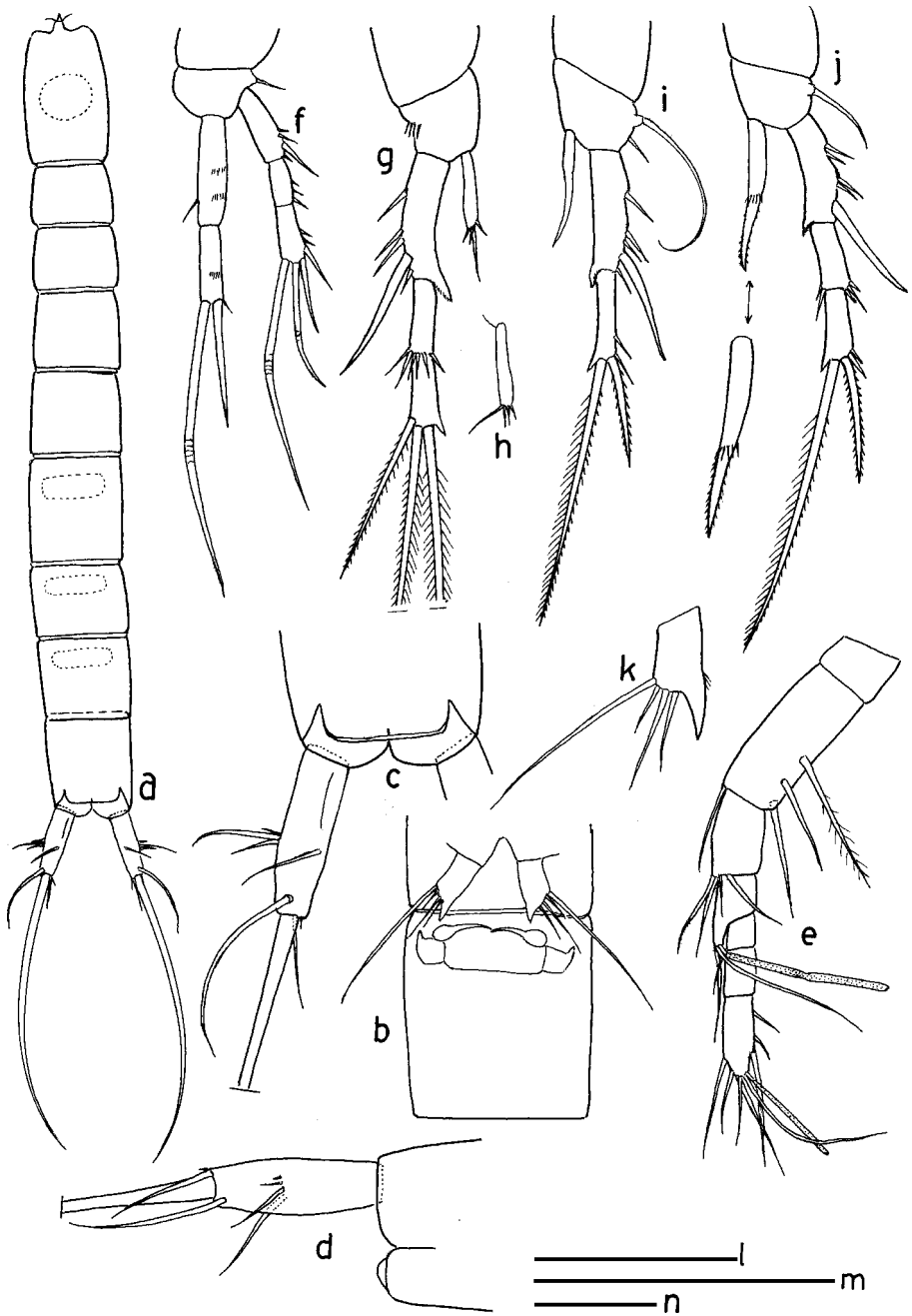


Fig. 7. *Parastenocaris savita* n. sp., female. a, allotype habitus, dorsal; b, leg 5 and genital double-somite, ventral; c, anal somite (in part) and left caudal ramus, dorsal; d, do., left caudal ramus, lateral; e, antennule, ventral; f, leg 1; g, leg 2; h, do., endopodite, another paratype; i, leg 3; j, leg 4 (endopodite enlarged); k, leg 5. Scale l for b; scale m for c-k; scale n for a; scales equal 50 μ m.

process at inner distal angle; second segment with 2 apical setae and short, unfringed, spinous process at inner distal angle. Endopodite 1-segmented, spiniform, somewhat lanceolate, incurved, as long as first exopodite-segment, proximal third slightly thicker, apparently naked.

Leg 4 (fig. 7j). Basis with 1 outer seta. Exopodite 3-segmented; first and third segments produced into unfringed spinous process each at distal inner corner; third segment with 2 apical setae. Endopodite relatively stout, outcurved, lanceolate, extending beyond middle of second exopodite-segment; lateral margins of distal half spinulose, a small circle of 4 or 5 small spinules at midlength.

Leg 5 (fig. 7b, k) subrectangular, 1.6 times as long as wide, distal inner corner produced into strong, outcurved, claw-like structure; 3 spinules lying on inner margin near base of claw; distal margin with 4 setae; outermost seta longest, seta next to it shortest.

Etymology. — In the Vedic literature, the term “Savita” s. str. is genderless, denoting the transcendental energy between the cosmic and the universal energy; proposed here as a noun in apposition to the generic name.

Remarks and affinities. — *Parastenocaris savita* n. sp. also belongs to the *brevipes*-group, and seems rather close to the preceding species. The morphological similarity between the two taxa, especially with regard to the female habitus and appendages, is quite impressive. Yet, the nature of the rostral projection, ornamentation of the caudal rami, relative size and shape of the endopodite of leg 2, and shape and ornamentation of leg 5, etc., can easily separate these females. Further, the caudal rami of *P. savita* show little variation and the integumental windows are vague, as compared with the conditions in *P. gayatri*. As to the male morphology, *P. savita* is distinctly different. The antennule is less prehensile, owing to much reduced lateral projections on segments 4 and 6. The endopodite of leg 2 is shorter and dilated apically. In leg 3, the basis is armed with an oblique row of longer spinules, and the exopodite ends in two branches, instead of one, and has a large hyaline lamella on the inner margin. The endopodite of leg 4 is shorter and more simplified; the sclerotized basal region is reduced, the spinules and the subapical setules are absent, and the seta at the proximal inner corner is strong and spiniform.

The caudal rami show no sexual dimorphism. The variation in shape and position of the anal operculum in males, as opposed to females, is worth noting in this species.

Within the *brevipes*-group, *P. savita* is distinctive especially by the following features of the male: the spatulate endopodite of leg 2, the exopodite of leg 3 ending into two branches, and the simplified structure of the endopodite of leg 4.

Distribution. — Known from the type locality only.

***Parastenocaris sandhya* n. sp. (figs. 8-11)**

Material examined. — Holotype (adult ♂, 0.37 mm), allotype (adult ♀) and paratypes (25 ♂♂, 25 ♀♀), all undissected and preserved in 70% alcohol, deposited in The Natural History Museum, London, registration numbers: holotype 2000.1332; allotype 2000.1333; paratypes 2000.1334-1383; several dissected and undissected paratypes are kept at the Department of Zoology, Nagarjuna University. Type locality, River Krishna at Vijayawada, South India, 16°31'N 80°E; close to the southern end of Kanaka Durga Varadhi, a road-bridge across the river; from fine sand, about 10 m from the water's edge at a depth of 5 to 50 cm, 31 August 1998.

Description and figures are based on the study of the c. 75 specimens that constitute the type-series.

Adult male. — Total length excluding caudal setae of holotype 0.37 mm, of paratypes 0.31-0.36 mm, average 0.35 mm ($N = 20$). Body elongate, vermiform, gradually tapering in posterior direction; 7 times as long as maximum width and without ornamentation or integumental windows. Cephalothorax shows maximum body width near posterior border and is longer than next 2 somites combined. Anal somite with finely spinulose distal inner corners on ventral aspect (fig. 8f, g). Anal operculum smooth, with straight posterior border, not reaching posterior end of anal somite.

Caudal rami divergent and as long as anal somite; each ramus nearly of uniform width, 4 times as long as wide, with generally convex inner and concave outer margins; size and shape varying in paratypes (fig. 8a-g). Armature consisting of 7 setae; 3 anterolateral setae conspicuous and located near base of ramus; dorsal seta inserted at about distal third of inner margin and about as long as longest anterolateral seta; outer terminal seta strongest, plumose, 2.6 times as long as caudal ramus; posterolateral seta generally sickle-shaped, longer than inner terminal seta, but shorter than caudal ramus.

Rostrum (fig. 8a) small, nipple-like protuberance, undefined at base and with 2 minute sensilla.

Antennule (fig. 9a, b) haplocer, 7-segmented, with 0, 5, 2, 2, 0, 0, and 7 setae; segment 6 without spinous projection; segment 5 ending in short, blunt process. Segment 4 with aesthetasc, constricted at distal third and not reaching tip of antennule; segment 7 with short aesthetasc, 0.7 as long as that on segment 4.

Antenna (fig. 9c). Exopodite 1-segmented, 3.5 times as long as wide, with 1 apical seta, longer than segment. Endopodite with 2 spines and some spinules on anterior margin; distal end with 5 setae, 3 of which geniculate.

Mandible (fig. 9d). Palp 1-segmented, 4.3 times as long as wide, with 2 apical setae of nearly equal length.

Maxillule (fig. 9e). Arthrite of praecoxa with 1 modified jointed seta on abcoxal surface and 4 slender, terminal spines, increasing in size distally, as figured. Coxa

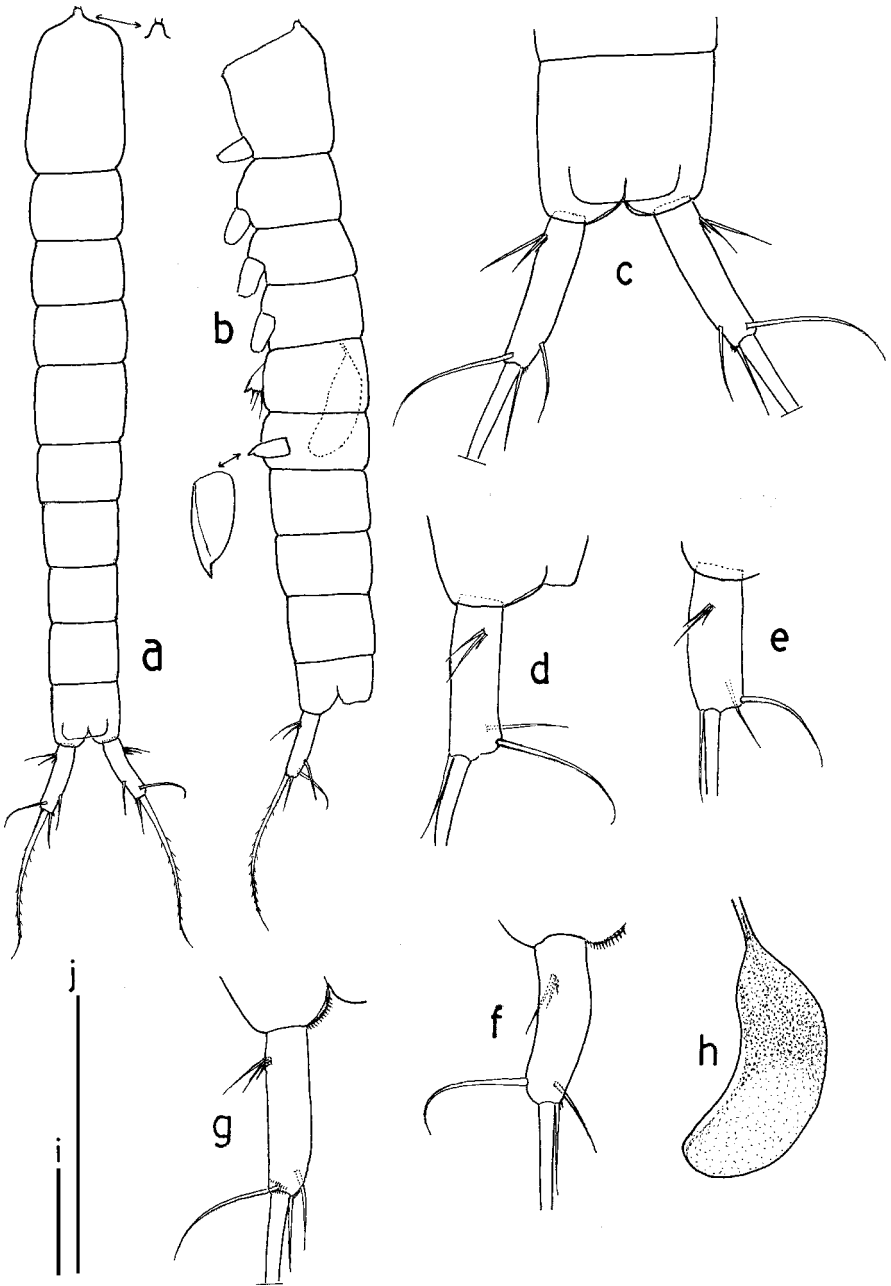


Fig. 8. *Parastenocaris sandhya* n. sp., male. a, holotype habitus, dorsal (rostrum enlarged); b, do., lateral (leg 6 enlarged); c, anal somite and caudal rami, dorsal; d, e, right caudal ramus, lateral; f, g, right caudal ramus, ventral; h, spermatophore. Scale i for a, b; scale j for c-h; scales equal 50 μ m.

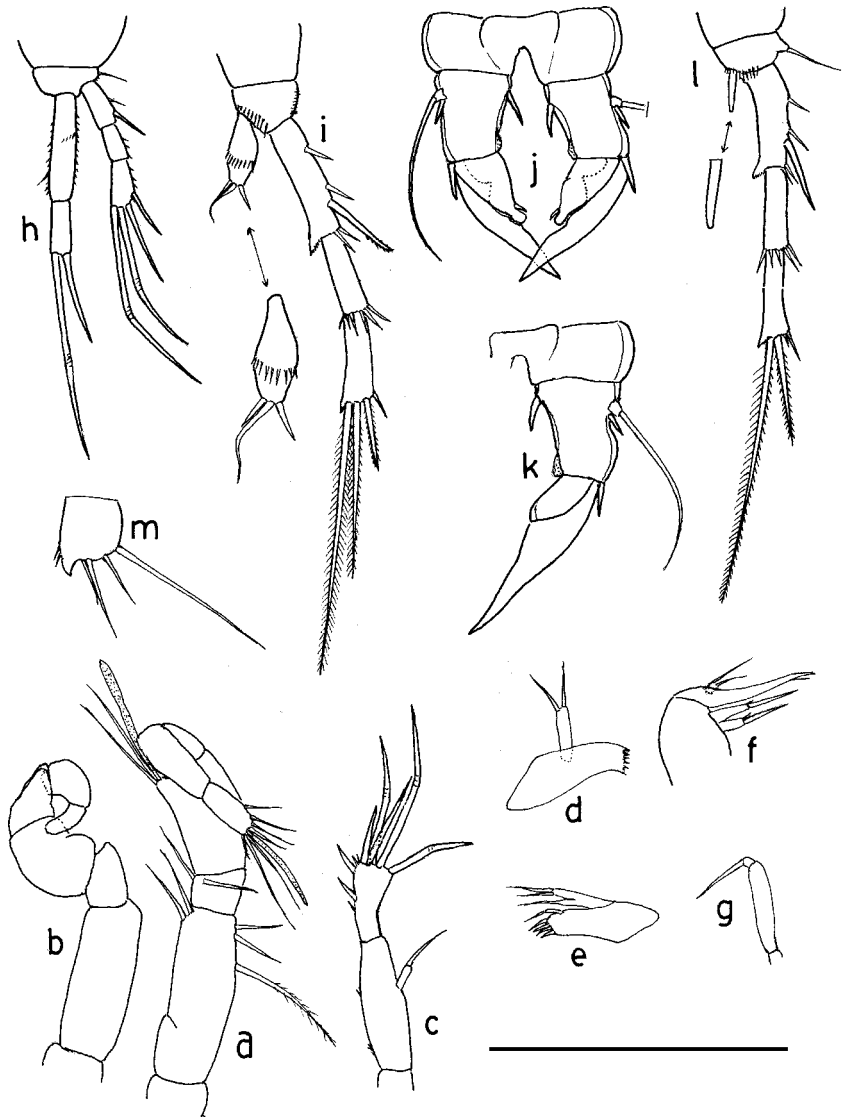


Fig. 9. *Parastenocaris sandhya* n. sp., male. a, antennule, ventral; b, do., in another paratype (armature omitted); c, antenna; d, mandible; e, maxillule; f, maxilla; g, maxilliped; h, leg 1; i, leg 2 (endopodite enlarged); j, third pair of legs, posterior; k, right leg 3, posterior, in another paratype; l, leg 4 (endopodite enlarged); m, leg 5. Scale equals 50 μ m.

with a single terminal, thick seta. Basis with 2 thick terminal setae. Exo- and endopodite absent.

Maxilla (fig. 9f). Syncoxa with 2 endites, each carrying 2 apical setae, one of which strongly reduced. Basis with 1 strong claw fused to it and with 1 subapical

spinule, as figured. Endopodite represented by minute segment, carrying 2 unequal, slender setae.

Maxilliped (fig. 9g). Basis small, bare. First endopodite-segment subcylindrical, 5 times as long as wide, bare. Second segment small, with 1 short claw.

Leg 1 (fig. 9h). Basis with minute spinules near slender, lateral seta. First exopodite-segment short, as long as third segment. First endopodite-segment almost twice as long as second segment, only slightly shorter than exopodite; 1 oblique row of spinules in proximal half and 1 minute seta on distal inner margin; second endopodite-segment without lateral spine.

Leg 2 (fig. 9i). Basis with minute spinules along outer margin and oblique row of somewhat long spinules near base of endopodite. First exopodite-segment with fringed, triangular lobe at distomedial corner; third segment with small spinous process instead of fringed lobe at distomedial corner. Endopodite 1-segmented, basal part narrow, distal 2/3 expanded, with 1 doubly-curved apical seta flanked by 2 short spiniform setae; crescented row of c. 10 spinules in distal half.

Leg 3 (fig. 9j) modified. Coxa short, unarmed, heavily chitinized. Basis also chitinized, nearly rectangular, longer than wide, with small but articulate lobe on proximal outer margin, carrying 1 very long apical seta and 1 short spine near its base; inner margin with 1 spine proximally and 1 small hyaline lobe at distal end. Distal part of leg ('pincers') less chitinized, consisting of 1 outer and 1 inner element, both bent inward and partly overlapping each other; also, 1 spine occurring close to base of outer element; outer element much longer than inner one, distal half tapering to acute point; inner element bell-shaped, with acutely rounded tip and short subapical inner spine; inner element, in some paratypes, undifferentiated as in fig. 9k.

Leg 4 (fig. 9l). Basis with spinules on distal margin; outer seta slender, arising from short papilla. Exopodite 3-segmented; first segment unmodified, with small thumb-like, fringed lobe at distal inner corner; outer spine slender, barely reaching midlength of second segment; third segment with 2 apical setae and short, unfringed, spinous projection at distal inner corner. Endopodite much reduced in size, 1-segmented, digitiform, bare.

Leg 5 (fig. 9m) small, squarish plate, distal inner corner produced into short, outcurved hook; 2 spinules on inner margin near base of claw; distal convex margin with 4 slender setae; proximal seta longest; innermost seta slender and contiguous with its neighbour.

Leg 6 (fig. 8b) bare, ventrally directed, ovate protrusion, ending in small, pointed beak.

Most males examined contained 1 reniform spermatophore (fig. 8h) in their body.

Adult female. — Total length of allotype 0.33 mm, of paratypes 0.33-0.39, average 0.35 mm ($N = 25$). Body (fig. 10a) broadly elliptical, with greatest width at about midlength; 6 times as long as maximum width; without ornamentation, except for some ventral spinules at distal inner corner of anal somite; no integumental windows noticed. Cephalothorax slightly longer than next 2 somites combined, but

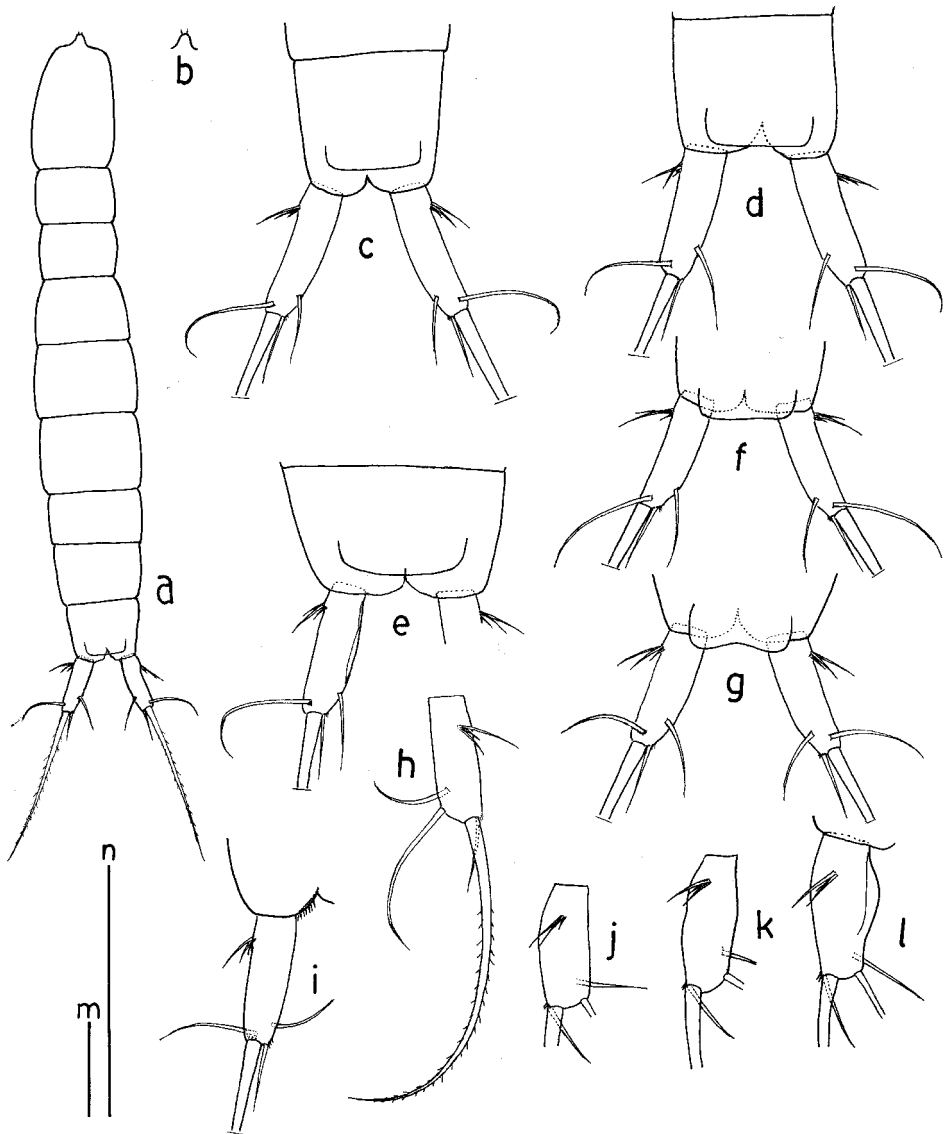


Fig. 10. *Parastenocaris sandhya* n. sp., female. a, allotype habitus, dorsal; b, rostrum, enlarged; c-g, anal somite and caudal rami, dorsal; h, right caudal ramus, lateral; i, do., ventral; j-l, left caudal ramus, lateral. Scale m for a; scale n for b-l; scales equal 50 μ m.

of same width as either of them; pediger 4 dilating posteriorly; pediger 5 and genital double-somite almost equal in size; other somites gradually tapering behind. Anal operculum of allotype (fig. 10a, c) not different from that of holotype, but its shape and position varying in paratypes (fig. 10d-g). Genital field as in fig. 11a;

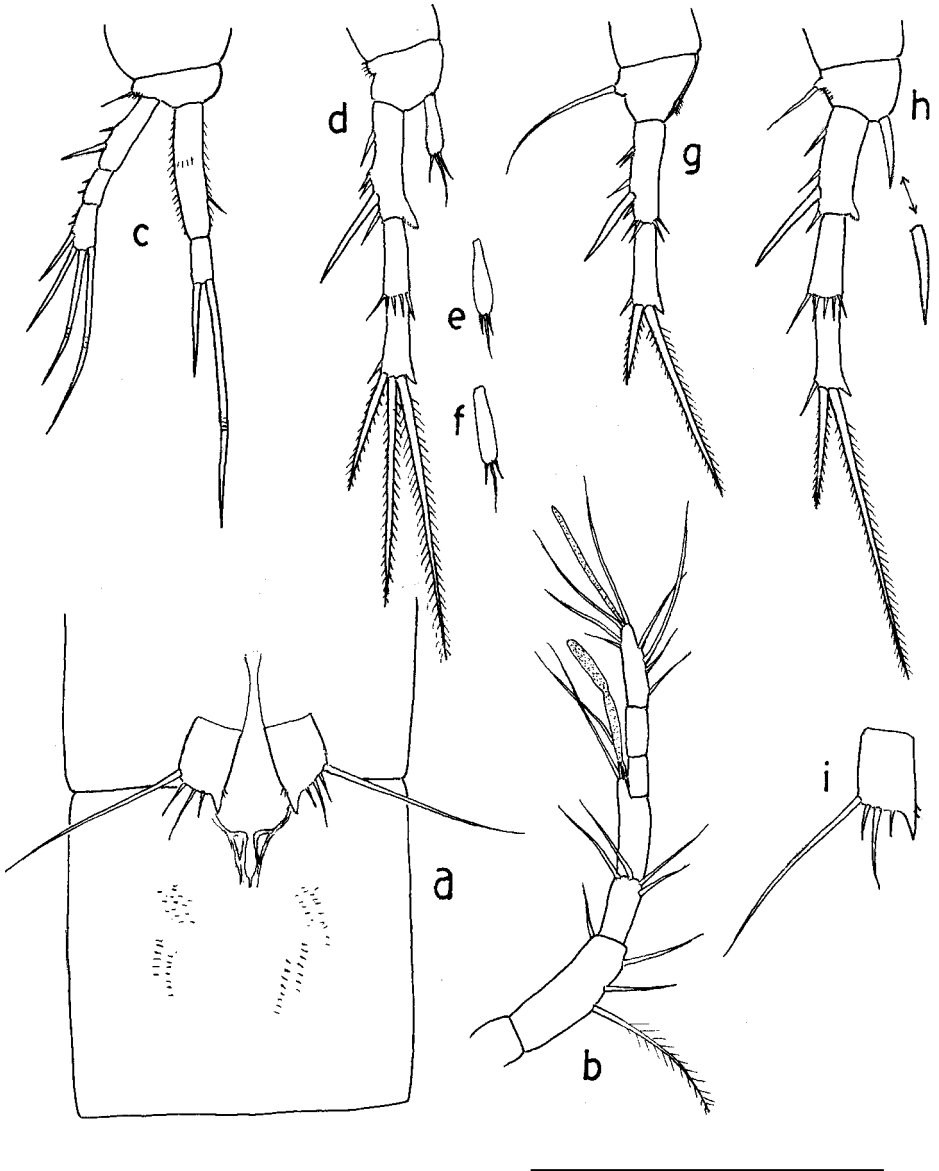


Fig. 11. *Parastenocaris sandhya* n. sp., female. a, leg 5 and genital double-somite, ventral; b, antennule, ventral; c, leg 1; d, leg 2; e, f, do., endopodite in different paratypes; g, leg 3; h, leg 4 (endopodite enlarged); i, leg 5. Scale equals 50 μ m.

ventral surface of double-somite ornamented on either side of median axis, as illustrated. Caudal rami divergent, as long as anal somite, about 3 times as long as wide; armature as in male, but showing greater variation in form (fig. 10j-l).

Rostrum (fig. 10a) as in female.

Antennule (fig. 11b) 7-segmented, with 0, 4, 4, 2, 0, 0, and 8 setae; segments 4 and 7 each with aesthetasc; aesthetasc on segment 4 somewhat slender, constricted at about midlength and reaching tip of antennule; that on segment 7 as long as, but slenderer, than the one on segment 4.

Other cephalic appendages (not illustrated) and leg 1 (fig. 11c) as in male.

Leg 2 (fig. 11d). Basis with a few spinules at proximal outer corner; distal spinules absent. Exopodite as in male except for outer spine on first exopodite-segment being longer and bare. Endopodite small, spatulate, with 1 apical seta and 2 spinules; shape slightly varying in paratypes (fig. 11e, f).

Leg 3 (fig. 11g). Seta on basis long. Exopodite short, 2-segmented; first segment without fringed extension at inner distal corner; second segment with small, unfringed spinous process at inner distal corner and 2 apical setae. Endopodite strongly reduced, being represented by very small, flat chitinous thickening, covered by minute hairs.

Leg 4 (fig. 11h). Basis with short outer seta and a few spinules close to distal outer margin. Exopodite as in male. Endopodite 1-segmented, stronger than in male, spiniform, with acute tip.

Leg 5 (fig. 11i) small, rectangular plate; lateral margins nearly straight; distal inner angle produced into upright, slender spinous process; 2 spinules occurring on distal inner margin. Distal convex border with 4 slender setae; outermost seta longest; other setae dissimilar in size.

Etymology. — In Vedic philosophy, the term “Sandhya” s. str. is genderless, signifying the junction between the past and the future; proposed here as a noun in apposition to the generic name.

Remarks and affinities. — *Parastenocaris sandhya* n. sp. comes very close to the *sioli*-group, established by Noodt (1963) for three Neotropical species: *P. sioli* Noodt, 1963, *P. jakobi* Noodt, 1963, and *P. digitata* Noodt, 1963 (I am unaware of any additions or allocations to this group having been made subsequently). Noodt (1963) characterized the *sioli*-group as follows: Very small and slender parastenocaridids (c. 11 times as long as wide). Caudal rami simple, cylindrical, without essential sexual dimorphism; each ramus with 2 outer marginal setae in the proximal section. Operculum smooth. Anal somite unarmed. Rostrum small. Legs 1 and 2 practically without sexual dimorphism. Endopodite of leg 2 with 1 outer marginal spine and 3 terminal elements. Leg 3 in male strong, pincer-like, sometimes subdivided and hand-like. Endopodite of leg 3 in female almost

completely reduced. Basis of leg 4 in male with setae on inner margin, endopodite very small. Endopodite of leg 4 in female strong, with long, ornamented terminal spine, almost reaching end of second exopodite-segment. Leg 5 in both sexes similar, small, plate-like, with 3-4 elements; both legs of a pair close to each other. Leg 6 in male triangular, small.

P. sandhya differs from the diagnosis of the *sioli*-group especially with regard to the endopodite of leg 2, which is sexually dimorphic and lacking the outer marginal seta. Compared with the three known species of this group, the new species has a closer similarity to *P. jakobi*, though the inner element of the 'pincers' of leg 3 is much reduced, and leg 5 ends in a short, hooked projection at the inner distal corner. Outside the *sioli*-group, pincers, though different from that of *P. sandhya*, are also found in *P. chelififer* Delachaux, 1923, from Surinam, and *P. cruzi* Noodt & Galhano, 1969, from Portugal (H. K. Schminke, pers. comm.).

It may be recalled here that in a parallel case, Enckell (1970) has, perforce, assigned *P. curvispinus* from Sri Lanka to Noodt's (1963) *remanei*-group of species from South America, "although the geographical distribution indicates that a close relationship between this species and the South American ones is unlikely". The same logic seems to hold for *P. sandhya* as well.

No clear-cut sexual dimorphism is noticed in the caudal rami of *P. sandhya*, though the rami are more prone to variation in the females than in the males. Similarly, the shape and position of the anal operculum also vary in the females alone.

Distribution. — Known from the type locality only.

ECOLOGICAL REMARKS

Parastenocaris gayatri n. sp. is an important member of the interstitial community of the River Krishna. It was commonly found in the core samples (2-30 cm), but scarce in the moist, exposed sand. Surface sediments collected near the water's edge, using a plankton net (mesh 70 μ m) also yielded fair numbers of this taxon. It was generally dominant when the habitat was stable following the cessation of the monsoon activity, i.e., from December onwards, but rare or even totally absent during July to October when the river receives huge, turbid inflows from the catchment area. Though no quantitative estimates were made, visual observation has confirmed the occasional dominance of this species over all other parastenocariids. However, it showed no consistent seasonal pattern between the two years of this study. Frequently, it was also also dominated by *P. curvispinus* or *P. sandhya*.

During the summer months, a gobioid fish, *Glossogobius giuris* (Hamilton, 1822) increases its numbers and becomes commercially important. I have found

its early juveniles (length c. 4 cm) heavily preying upon, inter alia, several benthic harpacticoids including parastenocaridids. A large number of harpacticoid carcasses, most of them in excellent shape, have been found in the guts of juvenile fish captured on 25 May 1999. The prey species identified are listed below, in the descending order of their numerical abundance, which closely corresponded with that observed in the contemporaneous core samples: (1) *Leptastacus ?euryhalinus* Krishnaswamy, 1957, adults, copepodids, and nauplii; (2) *Parastenocaris curvispinus* Enckell, 1970, adults; (3) *P. gayatri* n. sp. adults; (4) *Mesochra wolskii* Jakubisiak, 1933, adults (Harpacticoida); and (5) *Chironomus* larvae (Insecta).

The guts of *G. giuris* adults, however, contained only strays of *M. wolskii* and several empty molluscan shells. It is beyond doubt that parastenocaridids constitute a favoured and perhaps easy diet for the juvenile gobioids in the River Krishna.

P. savita n. sp., though co-occurring with other parastenocaridids reported herein, is characterized by its overall sparseness in the river, often with males outnumbering females. Like the preceding species, it was never found in the exposed sand and was rare in the surface sediments sampled with the plankton net.

P. sandhya n. sp., on the other hand, is more common than the preceding two species, frequently co-occurring with these and occasionally dominating them. This study does not reveal any consistent seasonal trend in this taxon, either.

Of the five parastenocaridid species recorded in the River Krishna, *P. curvispinus* is the most common one. Instances of co-occurrence of all five species are not rare. However, none of them was noticed in the samples over a month following unprecedented floods in October, 1998. It was also observed that the presence of algal scum on sediments in the shallow channel, as during summer, greatly restricted the species composition and density of parastenocaridids. Under such apparently unfavourable conditions, *P. sandhya* and *P. curvispinus* alone were noticed, but only as strays. The peaks in the parastenocaridid occurrence coincided with the post-monsoon period (late October to February) and were due mainly to *P. curvispinus*, *P. gayatri*, and *P. sandhya*. Though no quantitative data were collected, the cores showed a profuse presence of the three new species.

Co-occurring fauna

The following species of Harpacticoida, which are predominantly euryhaline, have already been recorded in plankton samples from the River Krishna by Radhakrishna & Reddy (1976): *Stenhelia madrasensis* Wells, 1971 (= *Stenhelia krishnensis* Radhakrishna & Reddy, 1978), *Mesochra wolskii* Jakubisiak, 1933, *Nitokra ?lacustris* (Schmankevitch, 1875), *Onychocamptus chathamensis* (G. O. Sars, 1905), and *O. mohammed* (Blanchard & Richard, 1891). Nauplii and copepodids

of *Pseudodiaptomus binghami* Sewell, 1912, a denizen in the river (Reddy & Radhakrishna, 1982), were found not infrequently in the present core samples. Among the interstitial harpacticoids, *Leptastacus ?euryhyalinus*. Krishnaswamy, 1957, generally dominated all the parastenocaridids almost throughout the study period. *Mesochra wolskii* was fairly common, whereas *N. ?lacustris* and *O. chathamensis* were rather sporadic. *Cletocamptus deitersi* (Richard, 1897) occurred as strays. The cyclopoid genera that were sporadically met with include *Halicyclops*, *Microcyclops*, *Eucyclops*, *Ectocyclops*, and *Paracyclops*. The Cladocera were represented by strays of *Macrothrix* sp. and *Chydorus* sp. Also, *Habrobathynella* n. sp. and another unidentified parabathynellid species were noticed but rarely, and in extremely small numbers. Nematodes were sometimes found in abundance, whereas oligochaetes were rare and few. On one occasion (11 February 1999), a swarm of *Chironomus* larvae co-existed with various parastenocaridid species, which, too, were fairly represented, and simultaneously so. *Philodina*, a rotifer, was fairly abundant on three occasions.

GENERAL MORPHOLOGICAL REMARKS

According to Schminke (1991), most cases of sexual dimorphism in the caudal rami in Parastenocarididae are due to the changes exhibited by the females. A sort of variation-gradient in the female caudal rami is apparent in the three species described herein. The variation observed in *P. gayatri* n. sp. is remarkable, whereas it is tenuous in *P. sandhya* n. sp. and nearly non-existent in *P. savita* n. sp.

As rightly emphasized by Reid (1994), form and location of the integumental windows on the body are constant within species. While the windows on the body are distinctly marked in *P. gayatri*, they exist as vague impressions and are of a slightly different pattern in *P. savita*, but apparently absent in *P. sandhya* as in other members of the *sioli*-group.

The anal operculum shows no variation in either sex of *P. gayatri*. However, its form and location vary appreciably in the females of *P. savita* and, to some extent, in the males of *P. sandhya*. I do not know if such variation could be an artifact, as considered by Reid (1995).

A perusal of the literature shows that leg 1 and the antennule are rarely, if ever, considered important in taxonomy. While it is true that leg 1 is generally the same in both sexes, the relative proportions, besides ornamentation, of its segments on both rami seem to provide useful specific information, as evidenced by the three species in question. Likewise, the relative size of the lateral spinous process on the fourth and sixth segments, especially the latter, of the male antennule, seems to be species-specific. It is strongly developed in *P. gayatri*, reduced in *P. sandhya*, and absent in *P. savita*. Similarly, the length-width ratio of the antennal exopodite as well as of the mandibular palp merits attention.

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