Shrimps of the genus *Acetes* H. Milne Edwards (Crustacea, Decapoda, Sergestidae) from the estuarine system of river Krishna

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Abstract. Four species of *Acetes*, viz. *A. indicus*, *A. erythraeus*, *A. japonicus* and *A. sibogae* are reported from the estuarine system of river Krishna on the east coast of India. Their systematics is discussed in the light of intra-specific variations. The synonymy of *A. cochinensis* with *A. japonicus* is corroborated. *A. australis*, *A. sibogalis* and *A. orientalis* are all shown to be junior synonyms of *A. sibogae*. A key to the identification of species of *Acetes* known from India is given.

Keywords. Krishna estuary; *Acetes* spp.; *A. indicus*; *A. erythraeus*; *A. japonicus*; *A. sibogae*.

1. Introduction

Shrimps of the genus *Acetes* H. Milne Edwards, 1830, constitute an important seasonal fishery along both the coasts of India (Ganapati and Subrahmanyan 1966; Jones 1967; Kunju 1967). However, there is no up to date systematic account of the species from Indian waters. While Kemp (1917) gave a comprehensive account of the species of *Acetes* preserved in the Indian Museum, Hansen (1919) reported on the species collected by the Siboga Expedition. Burkenroad (1935) and Pathansali (1966) defined the taxonomic status of some of the nominal Indo-West Pacific species. Nataraj (1947), Rao (1970), Achuthankutty and George (1973), Achuthankutty (1975), Achuthankutty and Nair (1976) and Nair (1977) made some observations on the species from the west coast of India. From the east coast Menon (1933) described the larval stages of *A. erythraeus*. Patwardhan (1936) gave an account of the gastric mill in *A. indicus*. Most of the earlier taxonomic studies have not taken into account the intra-specific variations in different species. Omori’s (1975) monograph on the genus *Acetes* has filled this lacuna to a large extent. The present observations incorporate the results of a detailed study on the sergestid shrimps of the genus *Acetes* from the estuarine system of river Krishna. They are part of a bigger project on the study of shrimps and prawns from the Krishna estuary (Ravindranath 1977).
2. Material and methods

A total of 23 samples comprising a few thousands of specimens, captured by seasonally operated commercial stake nets, tow nets and boat-seines, were collected by the author intermittently between 1 June 1973 and 23 June 1975 from the estuarine and coastal waters of Saryalanka, Nizampatnam, Kothapalem (all south-west of the mouth of river Krishna and constituting a coastal stretch of about 55 km), and off the western mouth of river Krishna on the east coast of India in the State of Andhra Pradesh. All the samples were sorted and four species of sergestids were identified, viz., *Acetes indicus*, *A. cryithraeus*, *A. japonicus* and *A. sibogae*. Since the material at hand was enormous, 25 to 27 adults of each species were randomly selected from the different samples for detailed examination. Body and carapace lengths (BL and CL) were measured inclusive of the minute rostrum, segments of the antennular peduncle were measured along the inner margin. All measurements were made with a micrometer fitted to a Bausch and Lomb stereoscopic binocular dissecting microscope. Descriptions of the species are mostly confined to the diagnostic characters.

Part of the material of *A. japonicus* studied by Kemp (1917) and preserved in the Zoological Survey of India (ZSI), Calcutta, was also reexamined.

3. Introductory remarks

The lower (external) antennular flagellum of the males is diagnostic, but there is no uniformity in the description of its segmentation by different workers. Its basic structure is the same in all the species, three parts being recognizable (figure 2a): (i) a two-segmented basal shaft, (ii) the (inner) multisegmented main branch and (iii) the (outer) clasping spine(s). The segments of the main branch can be distinguished into four proximal stout ones that generally form an arch and bear conspicuous spines, and five or more distal segments that are more slender and cylindrical. It is however possible that although there are typically four proximal segments in the main branch, one or more septa relating to them may sometimes be indistinct, or there may be extra septa not signifying true segments, so that difficulty may arise in making a precise count of the segments. The clasping spine originates from a short, stout basal segment, the latter being confluent with the distal segment of the shaft.

Kemp (1917) considered that the basal shaft is composed of 2 segments, but Hansen (1919) included the basal segment of the clasping spine in the count and considered that the basal shaft has 3 segments. Kemp did not consider the number of segments in the main branch. Hansen included the '3 segments of shaft' in counting the total number of segments in the lower flagellum, but he also mentioned separately the number of segments in the main branch and distinguished the proximal segments of the main branch from the distal ones. Hansen counted 9 segments in the main branch of *A. serrulatus* Krøyer and his *A. spiniger [= indicus]*, and 10 segments in his *A. sibogae* and *A. dispar [= japonicus]*; he explained the lower number in the former two species as being due to fusion of the first two segments which remain distinct in the latter two species.

Thus, while comparing the number of segments of the lower antennular flagellum in males, as given by different workers, one has to take these facts into account.
4. Systematic account

4.1. *Acetes indicus* H. Milne Edwards (figures 1–3)


*Acetes spiniger* Hansen, 1919: 43.

*Material*: 5 samples containing numerous specimens; estuarine and coastal waters of Nizampatnam; 26 September 1973, 24 December 1973, 31 January 1974, 17 August 1974 and 22 September 1974; stake net and tow net. 1 sample, numerous specimens; coastal waters off the western mouth of river Krishna; 11 December 1973; stake net. 3 samples, numerous specimens; coastal waters of Suryalanka; 30 December 1973, 19 January 1974 and 3 February 1974; boat-seine. 3 samples, numerous specimens; estuarine waters of Kothapalem;

![Figure 1. Acetes indicus H. Milne Edwards. a. Carapace. b. Left anterior half of female. c. Right anterior half of male. d. Scaphocerite. e. Entire telson. f. Telson tip enlarged.](image-url)
24 January 1974, 7 February 1974 and 1 March 1974; stake net. 26 adults were examined in detail:

16 females: 22·2–36·1 mm BL (5·3–8·5 mm CL)
10 males: 15·0–25·5 mm BL (3·7–6·1 mm CL).

Description: Antennular peduncle sexually dimorphic, its total length 4·5–6·5 mm in females and 5·6–8·2 mm in males; its distal segment in females (figure 1b) less than half of proximal and middle segments together, in males (figure 1c) distinctly longer than them; ratios of the three segments of peduncle (taking middle segment as unity) are as follows:

<table>
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<tr>
<th></th>
<th>proximal</th>
<th>middle</th>
<th>distal</th>
</tr>
</thead>
<tbody>
<tr>
<td>females</td>
<td>2·5–3·6</td>
<td>1</td>
<td>1·6–2·2</td>
</tr>
<tr>
<td>males</td>
<td>1·5–1·8</td>
<td>1</td>
<td>2·5–3·2</td>
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Lower antennular flagellum in female simple and composed of 16–25 segments.
Lower antennular flagellum in male: basal shaft consisting of 2 distinct segments; proximal 4 segments of the main branch compressed and arched (figure 2a), appearing broad in lateral view (figure 2b); 1st segment of main branch much longer than the rest (occasionally with an indistinct and incomplete septum) and with a minute tooth near its origin; segments 2 and 3 bearing 1 long marginal spine each and the 4th with 4–7 spines; distal segments of the main branch 5–7 (mostly 5); the total number of segments in the main branch of the flagellum thus 9–11 (mostly 9). Clasping spine long and curved, bearing fine tubercles along its inner margin, its tip opposing the row of marginal spines on 4th segment of main branch; its basal segment with a small accessory spine (figure 2c). Setae of varying length always associated with the different segments of main branch, and clasping spine.

Telson tip usually smoothly rounded (figure 1f); distal ciliated and proximal non-ciliated parts of outer margin of uropodal exopod separated by a distinct tooth (figure 3d, e).
Coxa of pereopod 3 in both sexes bearing proximal and distal teeth along its inner margin (figure 3a, b); basis in both sexes invariably with a conspicuous tooth on inner margin. Third thoracic sternum in female separated from the next (last) one by a deep furrow and both sterna in turn grooved along longitudinal axis (figure 3a). Genital coxae of male rounded anteriorly (figure 3b); spermato- phores with slender stalks visible externally; a strong procurred tooth (figure 3c) present between bases of 1st pair of pleopods in both sexes.

First pair of pleopods in male with the petasma (figure 3g). Each half of petasma with only two of the three main parts, pars astringens (inner membranous coupling fold) being absent, so that the two halves being separate. Pars externa (outer lobe) expanded, proximally thin and distal outer margin thick and recurved. Pars media (middle lobe) with an expanded chitinous proximal processus basalis and a tubular distal capitulum; ventrally, capitulum hollowed along the middle and thickened along the margins; in the hollow of the capitulum lies the processus ventralis with expanded base and needle-like distal part. The capitulum having honey-combed appearance due to minute hooklets in fine pits all over the surface.

Endopod of pleopod 2 in male bearing proximally a flat appendix masculina (figure 3f) which is more than twice as long as wide and with two hook-like spines disto-laterally (exceptionally, one male had 3 hook-like spines).

Discussion: Pathansali (1966) treated A. spiniger Hansen (1919) as a synonym of A. indicus. Hansen’s description of the lower antennular flagellum in male of A. spiniger tallies with that of A. indicus; he states that it consists of 12 segments; subtracting the 3 segments of shaft, it would have 9 segments in the main branch. Kemp’s figure (1917, figure 2a) is also typical, showing a 9-segmented main branch. Omori (1975) gives the total number of segments in the flagellum as 11 or 12, and his figures (15d, e) show a 9- or 10-segmented main branch. The present observations indicate that the main branch has 9-11 segments (4 proximal + 5-7 distal).

Achuthankutty and George (1973, table 1) state that the processus ventralis is absent in the petasma of A. indicus; it would appear that they overlooked its presence.

Table 1. Pattern of segmentation in the lower antennular flagellum in males of four nominal species of Acetes.

<table>
<thead>
<tr>
<th>Species</th>
<th>Number of segments in the different regions of flagellum</th>
<th>Total segments</th>
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<tbody>
<tr>
<td></td>
<td>Basal shaft</td>
<td>Basal segment of claspining spine</td>
</tr>
<tr>
<td>1. sibogae (present material) and australis</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>2. sibogae (type of Hansen) and orientalis</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3. sibogalais</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>
Acetes from Krishna estuary

Omori (1975) distinguished two forms of males: a large form predominating the samples from South-east Asia and a small form wholly constituting the samples from India. He opined that the differences could be largely due to the difference at maturity. The present material conforms to the description of the small form except for the presence of 3 hooks in the appendix masculina of one male. Also, no vestige of pars astringens could be found in the petasma.

Distribution: West and east coasts of India, Gangetic delta, Mergui Archipelago, Malaysia, Singapore, Gulf of Thailand and South China Sea.

4.2. *Acetes erythraeus* Nobili (figures 4, 5)


*Acetes* sp. Hansen, 1919: 37.


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Figure 4. *Acetes erythraeus* Nobili. a. Left anterior half of female. b. Right anterior half of male. c. Right lower antennular flagellum of male. d. Basal shaft-main branch-clasping spine junction enlarged. e. Procurred tooth (found between 1st pair of pleopods). f. Marginal tooth of uropodal exopod. g. Telson tip. h. Intact spermatophore. i. Mass (one half) found below the sternum between 3rd pereopods in mature females.
26 September 1973, 12 October 1973, 24 December 1973, 4 and 20 July 1974, 17 August 1974, 1 and 22 September 1974, 11 May 1975 and 23 June 1975; stake net and tow net. 1 sample, numerous specimens; coastal waters off the western mouth of river Krishna; 11 December 1973; stake net. 1 sample, numerous specimens; coastal waters of Suryalanka; 30 December 1973; boat-seine. 1 sample, numerous specimens; estuarine waters of Kothapalem; 24 January 1974; stake net. 27 adults were examined in detail:

14 females: 21·6 - 33·3 mm BL (5·6 - 8·7 mm CL)
13 males: 16·1 - 32·2 mm BL (4·1 - 7·5 mm CL)

Description: Antennular peduncle sexually not dimorphic (figure 4a, b), its total length 3·4 - 6·1 mm in females and 3·4 - 5·6 mm in males; distal segment in
both sexes about half the length of proximal and middle segments together; ratios of the three segments are as follows:

\[
\begin{array}{ccc}
\text{proximal} & \text{middle} & \text{distal} \\
\text{females:} & 3.0-4.2 & 1 & 1.7-2.9 \\
\text{males:} & 2.7-3.7 & 1 & 1.8-2.2 \\
\end{array}
\]

Lower antennular flagellum in female composed of 14-23 segments.

Lower antennular flagellum in male: basal shaft consisting of 2 unequal and indistinctly separated segments; proximal 4 segments of the main branch cylindrical and narrowing distally (figure 4e); segments 1 and 2 of the main branch with a dorsal ridge, having also a pair of minute teeth near its origin (figure 4d); segments 1-3 bearing distally 1 short marginal spine each and the 4th with 2-4 long, closely-set spines; distal segments of the main branch 7-11 (mostly 8); the total number of segments in the main branch of the flagellum thus 11-15 (mostly 12). Clasping spine long, slightly curved, with a finely serrated inner margin, tip not quite facing marginal spines on the 4th segment of main branch; its basal segment with a very short accessory spine.

Telson tip acute angled (figure 4g); marginal tooth of uropodal exopod prominent (figure 4f).

Coxa of pereopod 3 in both sexes with proximal and distal teeth along inner margin; basis without tooth (figure 5a, b). Third thoracic sternum in female plain. Genital coxae of male with beak-like anterior projection. A procurred tooth (more slender than that in indicus) (figure 4e) present between bases of 1st pair of pleopods in both sexes.

Petasma has all the three main parts (figure 5c): pars astringens well developed, that of either side being coupled by minute hooks along the straight inner margin; pars externa expanded, its disto-lateral margin being thick, recurved and crenulate; pars media with an expanded chitinous proximal part and a characteristic capitulum which is broad and thick in the middle and produced distally into a conspicuous finger-like process (lobus terminalis) directed outwards; proximal to the expanded part of the capitulum arises the stout processus ventralis with a pointed tip directed outwards (figure 5c); on its dorsal side the capitulum with 2 distinct falcate spines (proximal one larger) and many minute spines arranged on the distal finger-like process (figure 5d).

Appendix masculina twice as long as wide, bearing 3-5 hook-like spines distally (figure 5e).

Discussion: Menon (1933) considered *Acetes* sp. Hansen (1919) and *A. erythraeus* as distinct species; Burkenroad (1935) and Pathansali (1966) considered them synonymous. The difference is that in *Acetes* sp. the coxa of pereopod 3 in male has no tooth on the distal inner angle. Omori (1975) has shown that this character in the male of *erythraeus* is variable.

The number of segments in the main branch in Kemp's figure (1917, figure 2b) of the lower antennular flagellum of male is 11. Omori gives the total number of segments in the flagellum as 14-16, which would mean that the main branch has 11-13 segments. In the present material, the main branch has 11-15 segments (4 proximal + 7-11 distal).

The four males from Penang which Kemp (p. 51) referred to as dimorphic males of *A. erythraeus* actually belong to *A. sibogae*. 

**Acetes from Krishna estuary** 

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Distribution: South Africa, Madagaskar, Red Sea, east and west coasts of India, Singapore, Malaysia, Gulf of Thailand, Hong Kong, and Queensland (Australia).

4.3. Acetes japonicus Kishinouye (figures 6, 7)


Acetes dispar var. vel Hansen, 1919: 40.


Figure 6. Acetes japonicus Kishinouye. a. Left anterior half of female. b. Right anterior half of male. c. Right lower antennular flagellum of male. d. Middle portion of figure e enlarged. e. Distal segment of 3rd maxilliped. f. Distal portion of telson. g. Telson tip enlarged. h. Uropodal exopod without marginal tooth. i. Uropodal exopod with marginal tooth.
Figure 7. Acetes japonicus Kishinouye. a. Coxa-basis of 3rd pereopods and last thoracic sternum of female. b. Coxa-basis of 3rd pereopods and genital coxae of male. c-d. Coxa of right 3rd pereopod of female showing genital pore. e. Appendix masculina. f. Left petasmal half in ventral view. g-j. Distal segment of 3rd maxilliped showing variation in sub-segmentation: g. Of a female from Niigata, Japan. h. Of a female from Osaka market, Japan. i. Of a male from Tale Sap, Gulf of Siam. j. Of a male from Osaka market, Japan.

Material: 12 samples containing numerous juveniles and adults; estuarine and coastal waters of Nizampatnam; 1 and 16 June 1973, 29 July 1973, 28 August 1973, 26 September 1973, 12 October 1973, 4 and 20 July 1974, 1 and 22 September 1974, 11 May 1975 and 23 June 1975; stake net and tow net. 25 adults were examined in detail:

13 females: 13·1–24·4 mm BL (3·1–5·7 mm CL),
12 males: 11·3–16·6 mm BL (2·9–3·8 mm CL).

Description: Antennular peduncle sexually dimorphic (figure 6a, b), its total length 2·2–4·0 mm in females and 3·7–4·8 mm in males; distal segment in females less than half the length of proximal and middle segments together, in
males a bit longer than them and 10-12 times as long as wide; ratios of the three segments are as follows:

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<th>proximal</th>
<th>middle</th>
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<tbody>
<tr>
<td>females</td>
<td>2.8-5.4</td>
<td>1</td>
<td>1.7-2.6</td>
</tr>
<tr>
<td>males</td>
<td>1.6-2.6</td>
<td>1</td>
<td>2.7-3.4</td>
</tr>
</tbody>
</table>

Lower antennular flagellum in female composed of 9-12 segments.

Lower antennular flagellum in male: basal shaft composed of 2 segments; proximal 4 segments of main branch forming an arch, their segmentation being indistinct (figure 6c); dorsal surface of segments 1-4 with a ridge bearing 3 minute knobs corresponding to segments 2-4 (figure 6d); under high power the proximal part of the 1st segment showing 3 minute spinous teeth arranged in a row; segments 2 and 3 bearing a long marginal spine each and the 4th with 3 (rarely 2) such spines; distal segments of the main branch 4 or 5 (mostly 5), one or more of these segments may also bear a pair of short marginal spines each; the total number of segments in the main branch thus 8 or 9 (mostly 9). Two unequal clasping spines (figure 6d); the larger one, comparable to that of other species, long and curved, its tip normally facing the 3 marginal spines on the 4th segment of main branch; the smaller clasping spine, about half the length of principal spine, corresponds to the small accessory spine seen in *A. indicus* and *A. erythracus*.

Telson showing a broadly rounded tip under low power, but under high power (figure 6f, g) the postero-lateral corners show a minute tooth (occasionally absent). A minute marginal tooth on the uropodal exopod, at the junction of the ciliated and non-ciliated parts, usually present (figure 6i), being perceptible (unlike in other species) only under high magnification; however, it is not uncommon to find this tooth missing (figure 6h) in larger specimens.

Terminal segment of maxilliped 3 undivided (figure 6e).

Coxa of pereopod 3 in both sexes with proximal and distal teeth along its inner margin, those of female being more pronounced (figure 7a, b). Third thoracic sternum in female produced anteriorly into a pair of knobs and posteriorly drawn over the last thoracic sternum in the form of a plate (figure 7a) whose shape may vary slightly. Genital coxae of male anteriorly blunt (figure 7b). Female genital opening at the base of coxa of pereopod 3 in mature specimens, funnel-shaped (figure 7c, d).

Petasma (figure 7f) without pars astringens, the two halves being separate; pars externa somewhat rectangular, its distal margin thickened, recurved and granulose; pars media with a broad plate-like proximal half, a narrow neck-like middle portion and an expanded bulbous capitulum; the capitulum appears punctate due to numerous minute spinules; from the middle of pars media arises the prominent processus ventralis which has a broad base and a fine needle-like distal part that usually extends beyond the capitulum in mature males.

Appendix masculina slightly less than twice as long as broad and bears 2 or 3 hook-like spines distally (figure 7e).

Discussion: Burkenroad (1935), on the basis of examination of a female of *A. japonicus* from Port Swettenham, Malaysia, and on Kemp’s description of the species, established that Hansen’s *A. dispar* and *A. dispar* var. vel are synonymous with *A. japonicus*. He also suspected that the telson armature, petasma, and
female genital plate of *japonicus* are variable with age, individuals and locality. Pathansali (1966) also remarked on the variability of *A. japonicus*.

Kemp (1917) described two characters as being unique to *A. japonicus*: (i) terminal segment of 3rd maxilliped being divided into three sub-segments, and (ii) uropodal exopod lacking the marginal tooth between ciliated and non-ciliated portions. Neither Brøkenroad nor Pathansali referred to these two characters, so also Hansen (1919) and Nataraj (1947) [in *A. dispar (= japonicus)*]. However, Hansen in his diagnosis of the genus *Acetes* (p. 31) clearly stated that the distal joint of 3rd maxilliped is undivided.

Rao (1970) described *A. cochinensis* based on specimens from near Cochin (S.W. coast of India) and distinguished it from *A. japonicus* chiefly because he observed: (i) the terminal segment of the 3rd maxilliped to be undivided and (ii) the presence of a tooth on the outer margin of uropodal exopod. Obviously Rao had arrived at this distinction on the basis of Kemp's description of *A. japonicus*. Omori's (1975) observations on the above two characters in *A. japonicus* did not agree with those of Kemp; he considered *A. cochinensis* synonymous with *A. japonicus*.

In order to evaluate the above two characters described by Kemp and to ascertain the status of *cochinensis*, this author re-examined part of the material of *japonicus* studied by Kemp (1917: 58), which is now in the collections of the ZSI, Calcutta.

(i) Of 15 adults (No. 9693/10) from Niigata, Japan, seven were examined: in two females a minute but distinct tooth is present on the outer margin of uropodal exopod. In two other females with intact 3rd maxillipeds, the terminal segment of the latter is divided into 3 distinct ‘sub-segments’ (figure 7g) and almost the whole of it extends beyond the scaphocerite. In three males which are damaged, the processus ventralis of the petasma is missing.

(ii) Of many specimens (No. 9692/10) from market, Osaka, Japan (24.XI.15, N. Annandale), 12 large ones were examined; of these, one female bears a minute tooth on the outer margin of uropodal exopod; in another female, while the distal segment of 3rd maxilliped of the right side is distinctly undivided, that of the left side shows two septa of which only the proximal one is distinct (figure 7h); also, in this female 3rd maxillipeds extend only to the tip of scaphocerite; in two males with the 3rd maxilliped intact, the distal segment is undivided (figure 7j); their petasma bear a short processus ventralis. Other eight specimens conform to Kemp's description.

(iii) There are a number of specimens (No. 9691/10) from Tale Sap, Gulf of Siam (Jan. 1916, N. Annandale); they are smaller than those in the above samples from Japan and in good condition. In three males there is a minute tooth on the outer margin of the uropodal exopod and the petasma has a long processus ventralis. In the specimens re-examined, the distal segment of 3rd maxilliped is undivided (figure 7i) and reaches the tip of scaphocerite.

(iv) Of the six specimens (No. 9690/10) from Patani R., below town of Patani, Siamese Malay States (5-2-16, N. Annandale), five show a minute tooth on the margin of uropodal exopod. Only two females had the 3rd maxilliped intact and the distal segment was distinctly undivided. In the petasma of the four males processus ventralis was broken or missing.
(v) Of two males and one female (No. 9694/10) from Ennur Backwater, near Madras (20-1-15, N. Annandale), only the female showed a minute tooth on the uropodal exopod under high power. Patalma in both males had a long processus ventralis. Maxilliped 3 in all specimens extended only to the tip of scaphocerite and had undivided distal segment.

The above observations further confirm the variability of *A. japonicus*, and the characters mentioned by Kemp as unique to it are not consistent even in the material he examined. Thus, *A. cochinensis* is indeed a junior synonym of *A. japonicus*. Other minor distinguishing characters mentioned by Rao are invalid.

Coming to the lower antennular flagellum in male of *A. japonicus*, the main branch is shown by Kemp as 9-segmented; Hansen recorded 10 segments in *dispar [= japonicus]* and Rao recorded 9 segments in *cochinensis [= japonicus]*. Omori’s figures also indicate 9 segments. In the present material there are 8 or 9 segments (4 proximal + 4 or 5 distal).

**Distribution**: West and east coasts of India, Mergui Archipelago, Malaysia, Gulf of Thailand, Korea and Japan.

4.4. *Acetes Sibogae* Hansen (figures 8, 9)

*Acetes sibogae* Hansen, 1919 : 38.


*Acetes australis* Colefax, 1940 : 345; Achuthankutty, 1975 : 469.

*Acetes sibogalis* Achuthankutty and George, 1973 : 139.


*Acetes vulgaris*: Achuthankutty, 1975 : 469.


**Material**: 7 samples containing 41 females and 13 males; estuarine and coastal waters of Nizampatnam; 1 and 16 June 1973, 16 March 1974, 4 and 20 July 1974 and 10 and 23 June 1975; stake net and tow net. 26 adults were examined in detail:

13 females: 11-6-29-4 mm BL (5-7-7-0 mm CL),
13 males: 18-8-21-6 mm BL (4-3-4-7 mm CL).

**Description**: Antennular peduncle sexually dimorphic (figure 8a, b); its total length 3-2-5-0 mm in females and 5-1-5-2 mm in males; distal segment in females about half the length of the proximal and middle segments together and in males about 4/5 their length; ratios of the three segments are as follows:

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<th></th>
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<th>distal</th>
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<td>2·6-4·0</td>
<td>1</td>
<td>1·7-2·5</td>
</tr>
<tr>
<td>males:</td>
<td>1·7-2·2</td>
<td>1</td>
<td>2·4-2·6</td>
</tr>
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Lower antennular flagellum in female composed of 12-19 segments.
Acetes from Krishna estuary

Lower antennular flagellum of male: basal shaft 2-segmented; proximal 4 segments of the main branch broad and arched, with indistinct septa between them (figure 8c); 1st segment of main branch with a set of 3 prominent teeth proximally (figure 8d, e), closely followed by a low ridge extending to the 4th segment; segments 1-3 bearing 1 short marginal spine each and the 4th with 4 or 5 (mostly 5) long spines in a row; distal segments of the main branch 5 in all the 13 males examined, one or more of these segments may also bear a pair of short marginal spines; the total number of segments in the main branch 9. The large clasping spine with a finely serrated inner margin, its tip facing the first of the 4 or 5 marginal spines on the 4th segment of main branch (figure 8c); its basal segment with a fairly well developed accessory spine (figure 8d, e).

Telson tip obtuse-angled (figure 8h); marginal tooth of uropodal exopod prominent (figure 8i).

Coxa of pereopod 3 in both sexes with proximal and distal teeth (the latter prominent) along the inner margin (figure 9a, b). Basis of pereopod 3, in 11 of
the 13 females examined, armed with a prominent (subterminal) tooth along inner margin (figure 9a); of the 13 males examined, only the smallest (18.8 mm BL) bears a distinct basial tooth and the other 12 show no trace of it (figure 9b). In females, the sternum between the coxae of 3rd pereopods bears a pair of triangular knobs; in front of them (not shown in figure) is another pair of incipient knobs hidden from view by the former. Genital coxae of male anteriorly conical.

The two petasomal halves linked by pars astringens; pars externa with a thick and recurved distal margin (figure 9c); pars media characteristic, the expanded proximal part appearing boot-shaped; capitulum comparatively narrow, slightly sigmoid, and ending in a rounded tip; from about the base of capitulum arises the processus carinalis with a broad base and sinuous tip directed outwards. In dorsal view (figure 9d) the capitulum shows proximally, along its outer margin, two distinct falcate spines, of which the distal one is sometimes minute and obscure; the tip of capitulum with 6 or 7 pits, each with a minute hook-like spinule (figure 9e).

Appendix masculina about one and half times as long as broad and armed with 3–7 hook-like spines disto-laterally (figure 9f).

Discussion: Hanson (1919) described the two sexes of *A. sibogae* as follows:

Male:

(i) main branch of lower antennular flagellum with 10 joints,
(ii) coxa of pereopod 3 without any tooth at distal inner angle,
(iii) capitulum with two gigantic hooks (falcate spines) and two or three hooks terminally;

Female: (i) coxa of pereopod 3 with a strong tooth distally and a rounded plate proximally; produced inner end of basis sometimes seen as a free acute angle or minute tooth,
(ii) no trace of protuberance between coxae of 3rd pereopods

Some of these features would at first sight appear to be at variance with those in the present material, but they could be explained as follows: the lower antennular flagellum in the males in the present collection conforms to Hansen’s figure (Pl. III, 4b), except for the fact that while he has depicted 5 distinct proximal segments in the main branch, there are 4 indistinct ones in the present specimens. Tooth at the distal inner angle of the coxa of pereopod 3 was recorded by Pathansali (1966) in both sexes, as is the case in the present specimens also; the absence of this tooth in the male described by Hansen must be considered a variation. As regards the basial tooth, Pathansali observed it in adults of both sexes; in the present specimens, a distinct subterminal basial tooth is usually present in females and usually absent in males. Of the two falcate spines on the capitulum of petasma, the distal one is sometimes obscure and, as observed by Pathansali, may even be absent; also, the minute terminal hooks on the capitulum may be up to 6 or 7 and not just 2 or 3 as mentioned by Hansen. In contrast to the description of Hansen, his figure (Pl. III, 4e) shows a pair of projections between the coxae of 3rd pereopods in the female. These observations indicate variation in the said features of A. sibogae.

Pathansali considered Acetes australis Colefax (1940) to be a synonym of A. sibogae, but Achuthankutty and George (1973, table 1) and Achuthankutty (1975) considered it a distinct species based on Hansen’s description of sibogae. Colefax in his original description compared australis with indicus and erythraeus but not with sibogae; he states that the lower antennular flagellum in male is 11-segmented, but his description and figure 17a show 12 segments (2 of the shaft + basal segment of clasping spine + 9 of the main branch), so that the structure is similar to that of sibogae. According to Colefax, the capitulum in the petasma of australis has only one falcate spine, but as mentioned above, some males of sibogae may also have only one falcate spine. The other apparent differences between australis and sibogae enumerated by Achuthankutty and George are not valid in the light of the variation observed in sibogae. Hence, A. australis must be considered conspecific with A. sibogae.

Omori (1975) treated A. australis as a subspecies of A. sibogae owing to the former’s ‘close affinity’ to the latter. But recently (Omori 1977) expressed that australis could be a distinct species although he did not treat it as such. He further stated that “the distribution of A. sibogae australis is separated from that of A. sibogae sibogae”. Although Achuthankutty (1975) reported the occurrence of A. australis off Cochin (S.W. coast of India), the characters on which his identification is based are applicable even to A. sibogae (ut supra). If populations of A. australis from the east coast of Australia satisfy the 75% rule (Mayr 1969), especially with regard to (i) the presence of only one falcate spine in the petasma and (ii) the third thoracic sternum of female being plain posteriorly figures 27a and 28a in Omori 1975), then australis s.s. could be referred to as
a distinct subspecies of *A. sibogae*. At the same time it is felt that the said two differences and allopatric distribution alone do not warrant distinction at the species level.

*Acetes sibogalis* Achuthankutty and George (1973) and *Acetes orientalis* Achuthankutty and Nair (1976), both species described from south-west coast of India, when viewed in the light of the above-mentioned variations, help bridge the gap between *sibogae* and *australis* and the differences between the former two can be attributed to some extent to the intraspecific variation observed in *sibogae*. Both *sibogalis* and *orientalis* are said to be not only closely related to, but also sharing the characters of *sibogae* and *australis*.

The lower antennular flagellum in males of the four nominal species, viz., *sibogae*, *australis*, *sibogalis* and *orientalis* is essentially similar (see introductory remarks); their segments may be split up as shown in table 1. In all the four nominal species, the tip of clasping spine faces the last of the proximal set of segments (of main branch) bearing 3-5 prominent marginal spines in a row. Therefore, the apparent difference in the total number of segments is only the result of the respective authors observing the first segment of the main branch to be one or subdivided into two or three segments. Finally, *orientalis* is stated to have 2 accessory spines and the single known male of *sibogalis* is stated to have none, as against one accessory spine in *sibogae* and *australis*. Here it may be remarked that anomalies in the lower antennular flagellum of males of *Acetes* spp. are not uncommon (Achuthankutty 1973; Omori 1975; author's observations).

As regards the tooth on the distal inner angle of coxa of 3rd pereopod, it is seen in both sexes of *orientalis* as in the present specimens of *sibogae*, whereas in *sibogalis* it is only in the females that it is present as in Hansen's material of *sibogae*. Regarding the basial tooth of 3rd pereopod, it is said to be absent in both *sibogalis* and *orientalis*. The present study reveals that the basial tooth in *sibogae* has no diagnostic value, since it may or may not be present in either sex.

In the females of *sibogalis* and *orientalis*, the sternum between the coxae of 3rd pereopods bears two pairs and one pair of protuberances, respectively. There appears to be variation in the number of these structures: Colefax recorded two pairs of protuberances in *australis*, whereas Hansen stated that there is no trace of them in *sibogae*, although his figure (Pl. III, 4e) shows a pair of projections. In the females of *sibogae* examined by this author, there is a pair of prominent protuberances between the 3rd coxae, and in all mature females there is also a minute second pair anterior to and hidden by the pair between the coxae. The number of pairs of these protuberances (especially the presence or absence of the anterior pair) is thus subject to variation and it is felt that too much taxonomic significance should not be attached to them.

Another significant fact that further bridges the gap between *sibogae* and *australis* is the presence of one falcate spine in the petasma of *sibogalis* and two spines in that of *orientalis*.

The appendix masculina in the single known male of *sibogalis* has 2 hook-like spines and that of *orientalis* has 4. While *australis* has 4 or 5 such spines, the 13 males of *sibogae* examined by this author have 3-7 such spines. Thus *sibogae* itself shows a great variation in this respect too.
Considering the many similarities the nominal species *A. sibogalis* and *A. orientalis* have in common with *sibogae* s.l., the few apparent outstanding differences could reasonably be attributed to intraspecific variation in *sibogae*. Even if the minor differences between the males of the former two species and those of the latter are accepted as having taxonomic significance, it would still be not possible to distinguish their females.

Although Omori (1975) tentatively treated *A. sibogalis* as a subspecies of *A. sibogae*, he later (Omori 1977) expressed that the specimens of the former (1 male and 2 females) could be either "malformed specimens of *A. sibogae* or hybrids between *A. sibogae* and *A. erythraeus" (p. 4). He also surmised that *A. orientalis* represents one (among many) of the 'ecophenotypes' of *A. sibogae*. Thus, *A. sibogalis* Achuthankutty and George and *A. orientalis* Achuthankutty and Nair are to be considered junior synonyms of *A. sibogae* Hansen.

Achuthankutty (1975) recorded *Acetes vulgaris* Hansen, 1919, from the west coast of India, but his description of the male raises some doubts: he states that the lower antennular flagellum has 12 segments [as against 16–21 in *vulgaris* (Hansen, 1919; Omori 1975)], and that the capitulum in the petasma has 2 large hooks (falcate spines) and few [sic] minute spines [instead of the 3 falcate spines and a series of smaller spines present in *vulgaris*]. These characters and the structure of the appendix masculina indicate that the specimens should actually be referred to *A. sibogae*. Further, according to Omori (1975, 1977), *A. vulgaris* is not known west of the Strait of Malacca.

**Distribution**: *Acetes sibogae* s.l. is known from west and east coasts of India, Malaysia, Singapore, Java Sea, Flores Sea, Thailand, Philippines, and Queensland and New South Wales (Australia).

### 5. Key to the identification of valid *Acetes* spp. known from India

In addition to the four species described in this paper, another valid species, *A. johni* Nataraj 1947 (Omori 1975), is known from the west coast of India.

1. Large procurved tooth between 1st pair of pleopods present... 2
   — Procured tooth between 1st pair of pleopods absent... 3
2. Basis of 3rd pereopods with disto-mesial tooth; petasma without coupling folds; 3rd thoracic sternum of female with +-shaped furrow... *A. indicus*.
   — Basis of 3rd pereopods without disto-mesial tooth; petasma with coupling folds; 3rd thoracic sternum of female plain... *A. erythraeus*.
3. Apex of telson broadly rounded or truncated (under high power a minute tooth seen at either corner); lower antennular flagellum of male with two clasping spines; petasma without coupling folds; 3rd thoracic sternum in female ‘broadly triangular’ with shallow depression, or produced posteriorly into a plate-like structure... 4
   — Apex of telson obtusely angular (without any teeth); lower antennular flagellum of male with one clasping spine; petasma with coupling folds; 3rd thoracic sternum of female roughly rectangular and plain... *A. sibogae*. 

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4. Apex of telson truncated; first segment of the main branch in the lower antennular flagellum of male with a hook-like conspicuous protuberance along the inner margin; processus ventralis snout-like, abutting at right angle from the capitulum of petasma; 3rd thoracic sternum of female not produced posteriorly into any plate-like structure ... *A. johni*.

Apex of telson broadly rounded; first segment of the main branch in the lower antennular flagellum of male without any hook-like protuberance; processus ventralis needle-like, originating from the middle of pars media of petasma; 3rd thoracic sternum of female produced posteriorly in the form of a rectangular plate ... *A. japonicus.*

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