Omori, M. 1975

With the Compliments of the Author

THE SYSTEMATICS, BIOGEOGRAPHY, AND FISHERY OF EPIPELAGIC SHRIMPS OF THE GENUS *ACETES* (CRUSTACEA, DECAPODA, SERGESTIDAE)

by

MAKOTO OMORI

Ocean Research Institute, University of Tokyo,
Nakano, Tokyo, Japan 164

Reprinted from

BULLETIN OF THE OCEAN RESEARCH INSTITUTE
UNIVERSITY OF TOKYO
No. 7, December, 1975

OCEAN RESEARCH INSTITUTE
UNIVERSITY OF TOKYO
MINAMIDAI, NAKANO, TOKYO
JAPAN

THE SYSTEMATICS, BIOGEOGRAPHY, AND FISHERY OF EPIPELAGIC SHRIMPS OF THE GENUS *ACETES* (CRUSTACEA, DECAPODA, SERGESTIDAE)

MAKOTO OMORI

Ocean Research Institute, University of Tokyo

(Received August 9, 1975)

ABSTRACT

The species of the genus *Acetes* are small planktonic shrimp living mainly in the estuaries and coastal waters of the tropical and subtropical regions. Fourteen species and 5 subspecies are recognized, of which 2 species, *Acetes intermedius* and *A. marinus*, are new. *Acetes serrulatus johni* is given specific rank, whereas *A. australis* and *A. sibogalis* are ranked as subspecies of *A. sibogae*. The male of *A. binghami* is described for the first time. Keys are given to the species of the genus. Ten species are distributed in the Indo-West Pacific, and the Indo-Malayan region is particularly rich in species. One species is restricted to Pacific America and 2 species are found in Atlantic America. No species are known either from East Atlantic-Mediterranean or from the islands of the Central Pacific. Available information on geographic distribution is summarized for each species. Specific relationships and biogeography are discussed.

Acetes affords a major source of protein to some of the people in Asia and East Africa. Present status of the *Acetes* fishery in various countries is reviewed. The shrimp is mainly fished with various kinds of push nets and bag nets set near the shore against the flow of the tide. Boat seines and shore seines are used, too. The average world catch is estimated at 170,000 metric tons per year. It accounts for 26% of the total shrimp catch in the Indo-West Pacific and 15% of that of the world. Only a very small proportion of the catch is sold as fresh shrimp, but the greater proportion is dried, salted or fermented with salt for food in various ways. A shrimp paste is manufactured extensively throughout Southeast Asia.

The fishery is characterized by a restricted fishing season during the year and the catch fluctuates considerably. The fishing season corresponds with the swarming season in the area where the *Acetes* fishery is carried out. The swarming behaviour of *Acetes* is described in connection with the wind direction.

CONTENTS

I. INTRODUCTION

The shrimps of the genus *Acetes*, family Sergestidae, are a minor planktonic crustacean group represented by a small number of species, but are one of the economically important organisms in Asian and East African waters. During certain part of the year *Acetes* forms conspicuous aggregations near the shore and is fished on a large scale. The small size of the individuals is compensated by the great abundance in which they are taken.

For the past few years I have been interested in the biology and fishery of *Acetes* in the tropical and subtropical coastal waters. During the investigation I encountered several difficulties in the taxonomy and felt the need for an up-to-date review of the genus. Therefore I attempted to examine all existing species of *Acetes* in the world. The first part of the present paper deals with the species assigned to the genus *Acetes*. Fourteen species and 5 subspecies are recognized, of which 2 species are new. Their geographical distribution is reviewed.

Little is known about the fishery of *Acetes*. The fishery statistics are particularly inadequate, because the shrimps are mainly consumed locally. Observation of the commercial fishing as well as sampling and examination of specimens landed, was attempted in various localities in Japan, Taiwan, Hong Kong, South Viet Nam, Thailand, Malaysia, Singapore, Indonesia, and India. The second part of the present paper is based on published data and information, as well as discussions with authorities dealing in fisheries research or administration, and on personal observations made during travels in those areas in March 1970, May and October 1973, March–April and October 1974, and October–November 1975. I hope these notes will serve to bring this important but insufficiently studied group of animals to the attention of marine biologists in general.

II. MATERIAL

For this study I have had available the *Acetes* collections at various places during my trips in Japan, Southeast Asia, India, and U.S.A. The collections used in the present study and now deposited in the Plankton Laboratory, Ocean Research Institute, are from the following:

JAPAN – Specimens from the Ariake Sea, the Seto Inland Sea and from Suruga Bay, collected by myself with help of Mr. M. SONE and Mr. K. TERADA of the Fukuoka Prefectural Fishery Experiment Station and Mr. S. TERASHIMA of the Okayama Prefectural Fishery Experiment Station: cruise of the Tokai University R/V "Bosei Maru" in the Ariake Sea, sent to me by Mr. T. KUBOTA, Tokai University: specimens from Toyama Bay, sent to me by Mr. S. DOI, Toyama Prefectural Fishery Experiment Station, and collected by myself: specimens from the mouth of Shinano River, given to me by Mr. S. SAWAMOTO, Tokai University.

KOREA – Specimens from Mo Island, given to me by Dr. K. I. YOO, Hanyang University, Seoul.

CHINA – Specimens from Po Hai and Kuangtung, sent to me by Dr. J. Y. LIU, Institute of Oceanology, Tsingtao.

TAIWAN – Specimens from Tungkiang, sent to me by Mr. P. W. YUEN, the Joint Committee of Rural Reconstruction, Taipei: specimens from Matsu Island, given to me by Dr. H. P. YU, Taiwan Provincial College of Marine Technology, Keelung.

PHILIPPINES – Specimens from Luzon, sent to me by Dr. I. A. RONQUILLO, Bureau of Fisheries, Manila: specimens from Panay, sent to me by Mr. A. C. SANTIAGO, Jr., Southeast Asian Fisheries Development Council, Iloilo.

VIET NAM – Specimens from the Mekon Delta, given to me by Dr. BUI THI LANG, Saigon, and collected by myself.

THAILAND – Specimens from Phanga, collected by myself: specimens from Krabi, given to me by Mr. BOON BOONRUANG, Phuket Marine Fihseries Station, Phuket.

MALAYSIA – Specimens from Penang, sent to me by Mr. D. PATHANSALI, Fisheries Research Institute, Penang: specimens from Sabah, sent to me by Dr. T. E. CHUA, University Sains Malaysia, Penang.

SINGAPORE – Specimens made available to me by Dr. A. K. THAM, University of Singapore, and Mr. D. PATHANSALI: additional specimens collected by myself.

INDONESIA – Specimens from Jakarta and Pelabuhan Ratu, collected by myself.

AUSTRALIA – Specimens from Moreton Bay, Lake Coombaba and Port Hacking, sent to me by Ms. V. A. WADLEY, CSIRO Division of Fisheries and Oceanography, Cronulla: those from Lake Macquarie, sent to me by Dr. J. MACINTYRE, University of New South Wales.

INDIA – Specimens from Cochin, sent to me by Dr. M. J. GEORGE, Indian Ocean Biological Centre, Cochin, and Dr. E. G. SILAS, Central Marine Fisheries Research Institute, Cochin: specimens from Goa, sent to me by Mr. C. T. ACHUTHANKUTTY, National Institute of Oceanography, Goa: specimens from Porto Novo, sent to me by Mr. K. SRIRAMAN, Centre of Advanced Study in Marine Biology, Porto Novo.

KENYA – Specimens from Mombasa, sent to me by Mr. J. KAMANYI, East African Marine Fisheries Research Organization, Mombasa.

MADAGASCAR – Specimens from Ambaro Bay, sent to me by Dr. A. CROSNIER, Mission ORSTOM de Nosy Be.

U.S.A. – Specimens from Galveston, given to me by Dr. A. FLEMINGER, Scripps Institution of Oceanography, La Jolla, and Dr. T. S. PARK, Texas A & M University, Galveston.

ECUADOR – Specimens from the Gulf of Guayaquil, given to me by Dr. A. FLEMINGER, Scripps Institution of Oceanography.

BRAZIL – Specimens from Rio Tocantins and Santos, sent to me by Dr. M. IWAI, Universidade de São Paulo.

Mr. S. L. H. FULLER, the Academy of Natural Sciences of Philadelphia; Dr. D. J. G. GRIFFIN, the Australian Museum, Sydney; Mr. W. CHAN, Fisheries Research Station, Hong Kong; Mr. UMPOL PONGSUWAN, Marine Fisheries Laboratory, Bangkok; Dr. B. F. KENSLEY, South African Museum, Cape Town; Dr. TORBEN WOLFF, Universitetets Zoologiske Museum, Copenhagen; Dr. F. A. CHACE, Jr., National Museum of Natural History, Washington, D. C.; Dr. V. K. PREM KUMAR, Zoological Survey of India, Calcutta, have kindly made it possible for me to examine specimens from their museums and institutions.

I examined all species hitherto described, except for *A. sibogalis* which I provisionally regard as a subspecies of *A. sibogae*. Grouped together and omitting seasonal and other replication, the geographical array of samples examined is shown in Figure 1.

The following abbreviations are used throughout this paper:

AM	The Australian Museum
ANSP	The Academy of Natural Sciences of Philadelphia
SAM	South African Museum, Cape Town
UCZM	Universitetets Zoologiske Museum, Copenhagen
USNM	National Museum of Natural History, Washington, D. C.
ZSI	Zoological Survey of India, Culcutta

III. MEASUREMENTS

Measurements for individuals considered adult are either from literature or from specimens examined. Body length is determined to the nearest 0.5 mm from tip of the rostrum to apex of the telson. Different segments of the antennular peduncle are measured to the nearest 0.1 mm from anterior margin to posterior edge. Figures were drawn with the aid of a camera lucida.

IV. SYSTEMATICS

The family Sergestidae is divided into 2 subfamilies, Sergestinae and Luciferinae. The former subfamily now comprises 6 genera: *Acetes* H. MILNE-EDWARDS, *Peisos* BURKENROAD, *Petalidium* BATE, *Sergestes* H. MILNE-EDWARDS, *Sergia* STIMPSON, and *Sicyonella* BORRADAILE. The latter subfamily consists of a genus *Lucifer* THOMPSON.

The genus *Acetes* is readily distinguished from the following diagnosis, based largely on HANSEN (1919):

Rostrum short, without or with 1 or 2 dorsal denticles; supraorbital and hepatic spines present. Lower antennular flagellum in male with clasping organ. First maxilla without palp; second maxilla with a single undivided lobe; first maxilliped without palp. Branchial lamellae as well as arthrobranchs present. First 3 pairs of pereiopods elongate; first pereiopod with a small chela like second

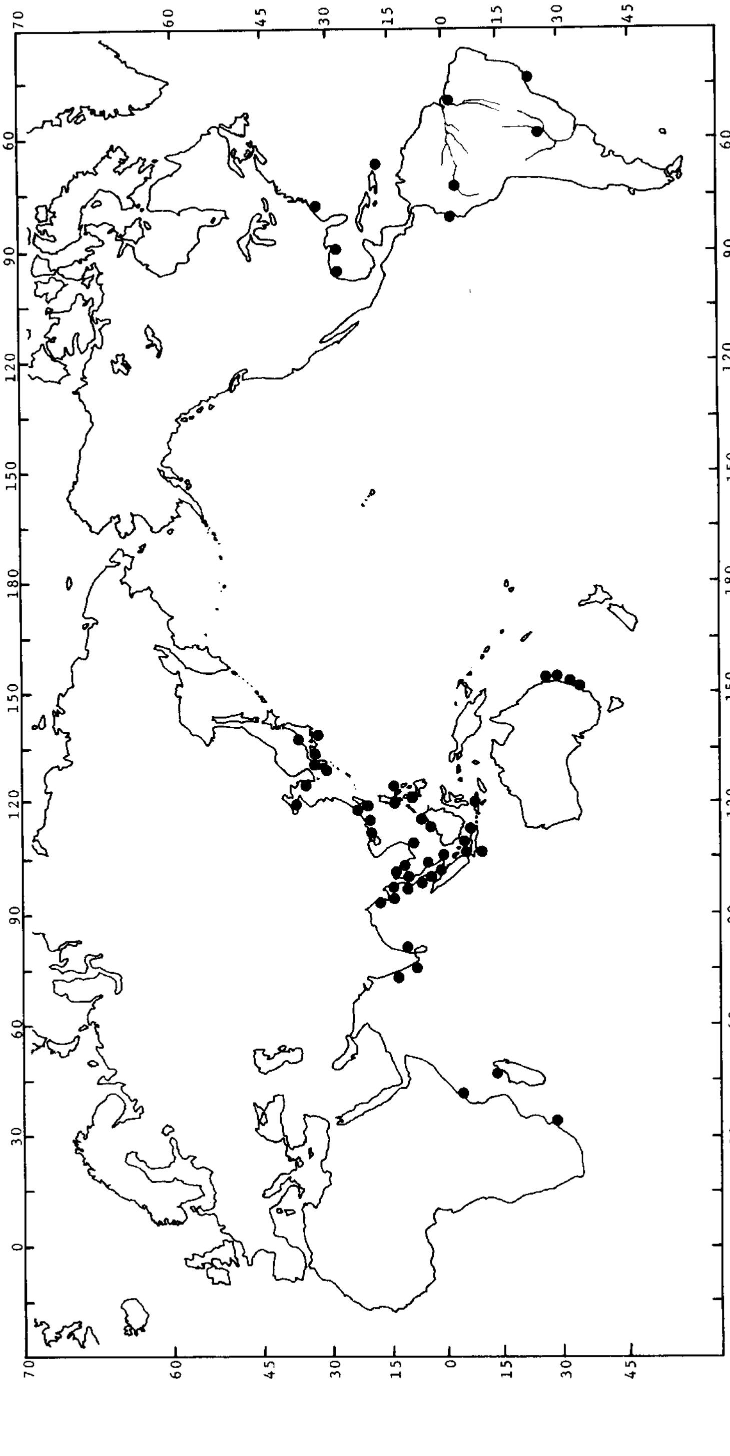

Figure 1. Geographical array of samples of *Acetes* examined.

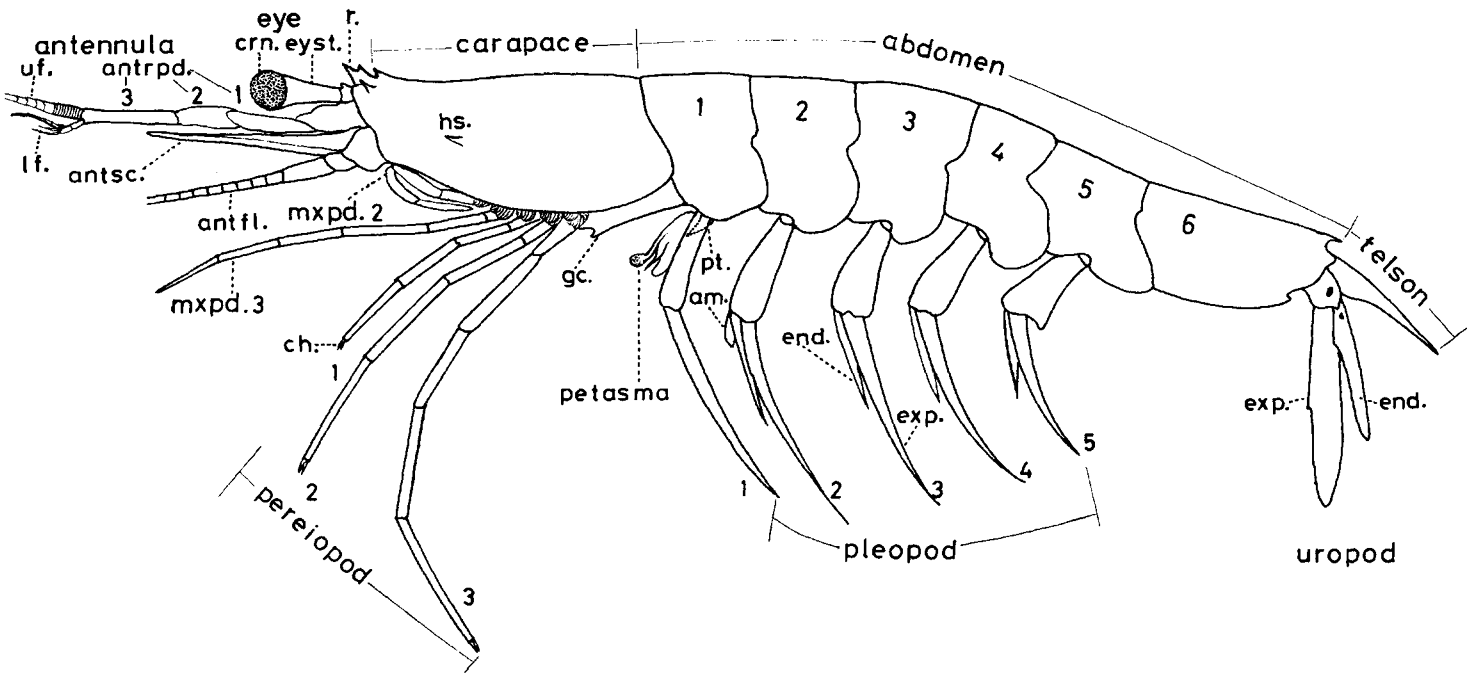

Figure 2. Diagram of a male *Acetes*. am.-appendix masculina; antfl.-antennal flagellum; antrpd. -antennular peduncle; antsc.-antennal scale; ch.-chela; crn.-cornea; end.-endopod; eyst.-eyestalk; exp.-exopod; gc.-genital coxa; hs.-hepatic spine; 1f.-lower flagellum; mxpd.-maxilliped; pt.-procurved tooth; r.-rostrum; uf.-upper flagellum. Red pigment spots on uropod are indicated by dark dots.

Table 1. List of distinct species and synonym of the genus *Acetes*

	Distinct species	Synonym
Indo-West Pacific		
1.	*A. chinensis* HANSEN	
2.	*A. erythraeus* NOBILI	*A.* sp. HANSEN
3.	*A. indicus* H. M.-EDWARDS	*A. spiniger* HANSEN
4.	*A. intermedius* new species	
5.	*A. japonicus* KISHINOUYE	*A. disper* HANSEN, *Acetes cochinensis* RAO
6.	*A. johni* NATARAJ	
7.	*A. natalensis* BARNARD	
8.	*A. serrulatus* (KRØYER)	*A. insularis* KEMP
9a.	*A. sibogae sibogae* HANSEN	
9b.	*A. sibogae australis* COLEFAX	*A. australis* COLEFAX
9c.	*A sibogae sibogalis* A.-KUTTY and GEORGE	*A. sibogalis* A.-KUTTY and GEORGE
10.	*A. vulgaris* HANSEN	
Pacific America		
11.	*A. binghami* BURKENROAD	
Atlantic America		
12a.	*A. americanus americanus* ORTMANN	*A. brasiliensis* HANSEN
12b.	*A. americanus carolinae* HANSEN	*A. carolinae* HANSEN
13.	*A. marinus* new species	
14.	*A. paraguayensis* HANSEN	

and third pereiopods. Fourth and fifth pereiopods entirely lacking except for a pair of protuberances (genital coxae) of male.

The species of *Acetes* are small shrimps of which the body length ranges approximately between 10 and 40 mm. The females are usually somewhat larger than the males. To assist the reader, a diagram of a typical male *Acetes*, with the parts labelled, is given in Figure 2 (see also Figs 13a, 13e, 13h). The body is transparent or semitransparent with black cornea and pairs of red pigment spots, which are considered to be photogenic by OKADA (1928), on the basipod and endopod of the uropods.

Since the genus *Acetes* was established by H. MILNE-EDWARDS in the year 1830 on a species collected in the Ganges estuary and names *A. indicus*, 20 species have been reported from the world by ORTMANN (1893), KISHINOUYE (1905), NOBILI (1905), KEMP (1917), HANSEN (1919, 1933), BURKENROAD (1934b), COLEFAX (1940), BARNARD (1955), RAO (1968) and ACHUTHANKUTTY and GEORGE (1973). These reports, however, contain some names which have been considered to be synonymous by URITA (1926), BURKENROAD (1934a, b), HOLTHUIS (1959), and PATHANSALI (1966). The number of distinct species is now 14 including 2 new species described in the present paper (Table 1). *Acetes americanus* consists of 2 subspecies and *A. sibogae* includes 3 subspecies. I regard the polytypic nature of these 2 species to result from two causes: 1) insufficient information about the species in nature, and in particular where two or more local populations appear to have contact and 2) the small magnitude of morphological divergence between different populations in the genus. Further study of *A. americanus* and *A. sibogae* from many more localities than are available at present will be required to determine whether some or all of the subspecies may be raised to full species.

Many coastal areas, particularly of the Indian Ocean, around New Guinea, and around Central and South America, have been inadequately sampled, and probably the species within the genus have not been sorted out thoroughly as yet.

For the identification of the species the structure of the lower (inner) antennular flagellum and the petasma of the adult male are the most important and reliable guides. A good character of the adult female is the structure of the genital area, particulaly the third thoracic sternite (genital plate). The species may

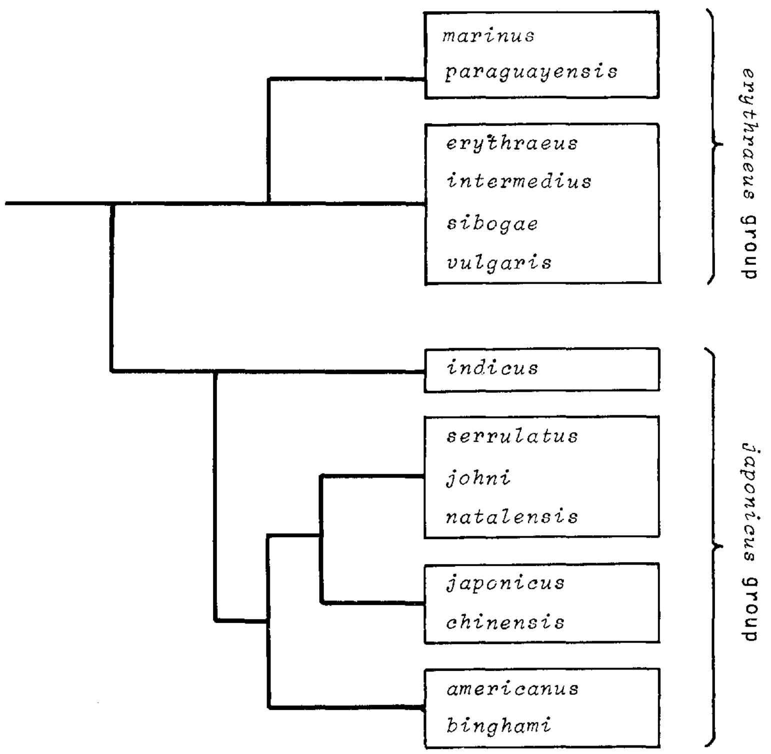

Figure 3. Diagram showing relationships of the genus *Acetes*.

also be distinguished by the combination of such characters other than sexual as; number of denticles on the rostrum behind the terminal point, size of the eye, proportional lengths of the 3 segments of the antennular peduncle, detailed structure of the basis (trochanter) and coxa of the third pereiopod, presence or absence of a procurved tooth between the bases of the first pair of pleopods, shape of the telson, and proportional length of the non-ciliated part of the outer margin of the exopod of the uropod to the entire margin. However, there are considerable intraspecific variations in these characters. The variations are found not only among the specimens living in different regions but also among those of different sizes, maturity, and types of generation. For instance, in many species the length of the third segment relative to that of the first segment of the antennular peduncle and the number of segments of the lower antennular flagellum of males, both of which most previous authors have considered to be important characters for identification of the species, tend to increase with increasing body length.

Generally, size at sexual maturity varies considerably depending on not only the locality, but also the different types of generation. *A. japonicus* in the Ariake Sea has two generations a year (IKEMATSU, 1953): the average body length of the winter generation is more than 1.5 times that of the summer generation.

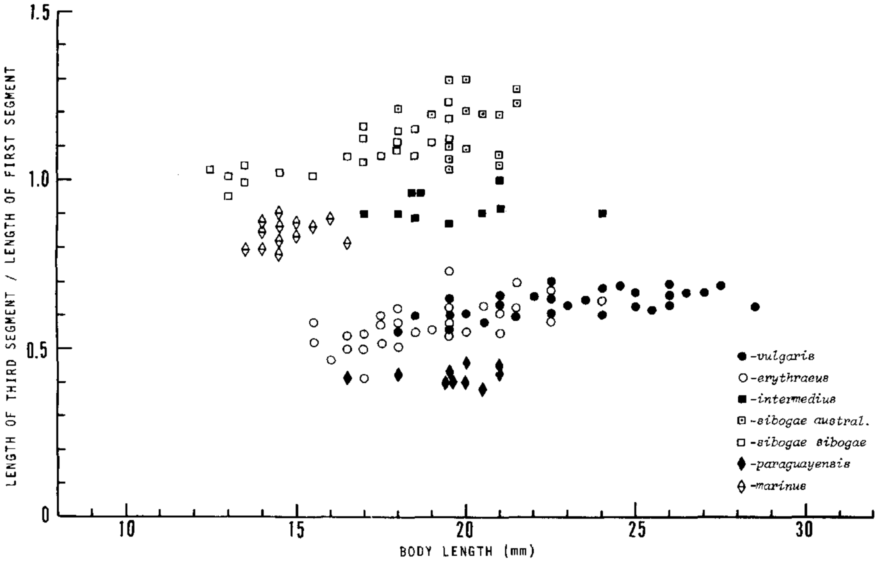

Figure 4. Correlation of body length and proportionate length of first segment and third segment of antennular peduncle in males of seven species and subspecies of the *erythraeus* group of *Acetes*.

The phylogeny of Sergestidae is still difficult to surmise, and the detailed family-tree has not been constructed as yet (see BURKENROAD, 1945). Regarding the genus *Acetes*, the species can be divided into 2 groups, i.e. the *erythraeus* group and the *japonicus* group (Fig. 3).

The *erythraeus* group has the following characteristics: 1) female, a pair of conspicuous protuberances on anterior part of third thoracic sternite when viewed ventrally; 2) male, anterior margin of genital coxa pointed; petasma with pars astringens; antennular peduncle with third segment shorter than first segment except for *A. sibogae* (Fig. 4). *Acetes erythraeus, A. intermedius, A. marinus, A. paraguayensis, A. sibogae,* and *A. vulgaris* belong to this group, but *A. marinus* and *A. paraguayensis* are readily distinguished from the rest of the species of this group by the peculiar shape of the third thoracic sternite of the female and by the lower antennular flagellum of the male.

On the other hand, the *japonicus* group has the following characteristics: 1) female, no conspicuous protuberances on the thoracic sternite; 2) male, petasma without pars astringens; anterior margin of genital coxa rounded; antennular peduncle with third segment longer than first segment (Fig. 5). This group consists of *A. americanus, A. binghami, A. chinensis, A. indicus, A. japonicus, A. johni, A. natalensis,* and *A. serrulatus* and can be classified into 4 subgroups.

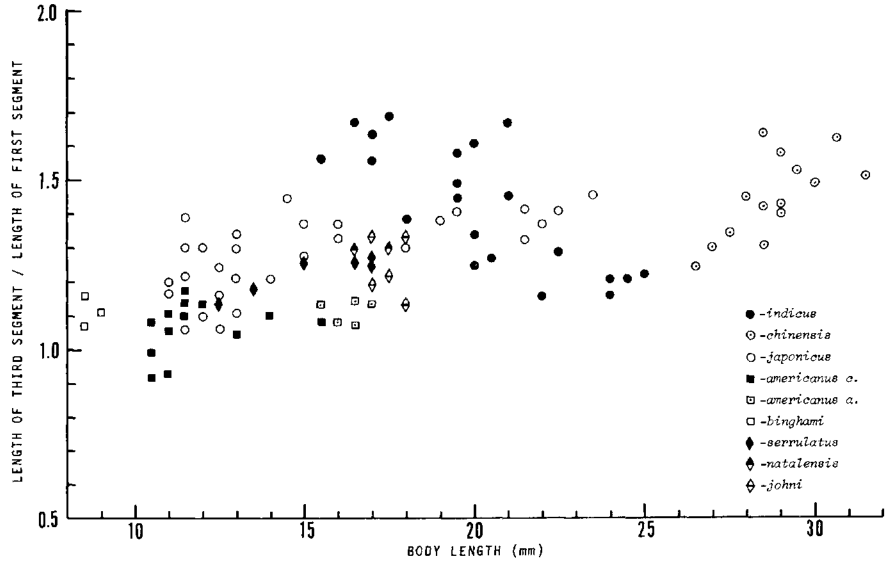

Figure 5. Correlation of body length and proportionate length of first segment and third segment of antennular peduncle in males of nine species and subspecies of the *japonicus* group of *Acetes*.

Acetes indicus is first distinguished from others by having a combination of characters of the *japonicus* group and the *erythraeus* group: there is only 1 clasping spine on the lower antennular peduncle in the male. *Acetes americanus* and *A. binghami* stand apart from the rest of the species by having no clasping spine on the lower antennular peduncle and the rostrum without or with only 1 denticle behind the terminal point. Those remaining are divided into two: the *japonicus* subgroup is distinguished from the *serrulatus* subgroup by the female third thoracic sternite produced posteriorly and by the male petasma with processus ventralis.

I regard *A. erythraeus* as retaining the strongest similarity to the ancestral stock of the genus *Acetes* because of its wider geographical range of the distribution in comparison to the restricted distributions of other congeners and the pronounced resemblance of its sexually modified structures to those of the genus *Sicyonella* which is considered the most primitive of living Sergestidae. Presumably a precusor of *A. indicus* derived from the stem of the *erythraeus* group gave rise to the *japonicus* group.

Tables 2, 3, and 4 show the selected 16 structural characters of the genus used in the identification of 14 species which I examined. The sex and species may be recognized by these tables and the following keys with the help of a number of figures.

SEX

Pair of protuberances between third pereiopods and first pleopods. Lower antennular flagellum with 1–2 clasping spines or modification thereof. Petasma present on first pleopods. . . . . Male

No protuberance in genital area. Lower antennular flagellum without spine. Petasma absent. . . . . Female

Key to the species of the genus *Acetes*

FEMALES

1. Rostrum without denticle behind terminal point . . . . ***A. binghami***
   Rostrum with 1 denticle behind terminal point. . . . . ***A. americanus***
   Rostrum with 2 denticles behind terminal point. 2
2. Apex of telson rounded or truncated. 3
   Apex of telson triangular. 9
3. Third thoracic sternite produced posteriorly. 4
   Third thoracic sternite not produced posteriorly. 7
4. Third thoracic sternite with pair of protuberances. Exopod of uropod broad; 3.3–3.9 times as long as broad 5

Third thoracic sternite without protuberance. Exopod of uropod slender; 4.2–4.7 times as long as broad 6

5. Coxa of third pereiopod with large acute tooth. . . . . ***A. paraguayensis*** p. 54
   Coxa of third pereiopod with small blunt tooth . . . . ***A. marinus*** **n. sp.** p 49
6. Emargination of posterior margin of third thoracic sternite deep. Endopod of uropod with 4–8 red spots . . . . ***A. chinensis***
   Emargination of posterior margin shallow. Endopod of uropod with 1 red spot . . . . ***A. japonicus*** p. 43
7. Tooth absent on distal inner margin of coxa of third pereiopod . . . . ***A. natalensis*** p. 52
   Tooth present on distal inner margin of coxa of third pereiopod 8
8. Anterior margin of fourth thoracic sternite pointed laterally; median part broadly grooved . . . . ***A. johni*** p 46
   Anterior margin of fourth thoracic sternite smooth and convex . . . . ***A. serrulatus*** p. 59
9. Procurved tooth present between bases of first pair of pleopods. 10
   Procurved tooth absent 12
10. Inner margin of basis of third pereiopod with sharply pointed projection. Third and fourth thoracic sternites deeply channelled longitudinally . . . . ***A. indicus*** p. 36
    Inner margin of basis of third pereiopod without sharply pointed projection. Third and fourth thoracic sternites not channelled longitudinally 11
11. First segment of antennular peduncle at most as long as second and third segments combined. Distal inner margin of basis of third pereiopod ending in blunt projection . . . . ***A. intermedius*** **n. sp.** p. 40
    First segment of antennular peduncle longer than second and third segments combined. Distal inner margin of basis of third pereiopod ending without projection . . . . ***A. erythraeus*** p. 32
12. Lower antennular flagellum with 20 segments or less. Distal inner margin of basis of third pereiopod ending in projection. Pair of small protuberances on anterior part of third thoracic sternite. . . . . ***A. sibogae***
    Lower antennular flagellum with 20 segments or more. Distal inner margin of basis of third pereiopod ending without projection. Pair of large protuberances on anterior part of third thoracic sternite . . . . ***A. vulgaris***

MALES

1. Anterior margin of genital coxa rounded. Petasma without pars astringens 2
   Anterior margin of genital coxa pointed. Petasma with pars astringens 9

2. Rostrum without or with only 1 denticle behind terminal point. Lower antennular flagellum without large clasping spine .3
   Rostrum with 2 denticles behind terminal point. Lower antennular flagellum with 1–2 clasping spines 4
3. Rostrum with 1 denticle behind terminal point. . . . . ***A. americanus***
   Rostrum without denticle behind terminal point . . . . ***A. binghami***
4. Procurved tooth between bases of first pair of pleopods. Lower antennular flagellum with 1 clasping spine . . . . ***A. indicus***
   Procurved tooth absent. Lower antennular flagellum with 2 clasping spines 5
5. Lower antennular flagellum with triangular projection from upper end of first segment of main branch 6
   First segment of main branch of lower antennular flagellum without triangular projection 8
6. Petasma with processus ventralis; capitulum cylindrical and elongated . . . . ***A. natalensis***
   Petasma without processus ventralis; capitulum expanded on outer margin 7
7. Capitulum of petasma with large ventral projection at right angles to long axis of pars media . . . . ***A. johni***
   Capitulum without ventral projection; broad end cut off transversely and armed with 1 large hook . . . . ***A. surrulatus***
8. Distal expanded part of capitulum of petasma cucumber-shaped; much longer than basal part of capitulum. Endopod of uropod with 4–8 red spots . . . . ***A. chinensis***
   Distal expanded part of capitulum of petasma bulb-like; proportionally shorter than basal part of capitulum. Endopod of uropod with 1 red spot . . . .***A. japonicus***
9. First segment of main branch of lower antennular flagellum with large swelling; clasping spine not reaching end of second segment of main branch. Apex of telson rounded or truncated 10
   First segment of main branch of lower antennular flagellum with small swelling; clasping spine extending beyond end of second segment of main branch. Apex of telson triangular. 11
10. First segment of antennular peduncle longer than second and third segments combined. Petasma with rudimentary capitulum. . . . . ***A. paraguayensis***
    First segment of antennular peduncle shorter than second and third segments combined. Petasma without capitulum.. . . . . ***A. marinus* n. sp.**
11. Procurved tooth between bases of first pair of pleopods 12
    Procurved tooth absent 13

12. First segment of antennular peduncle shorter than second and third segments combined. Capitulum of petasma with 3–5 subequally large hooks along outer margin . . . . *A. intermedius* **n. sp.**
    First segment of antennular peduncle longer than second and third segments combined. Capitulum of petasma with 1 large hook along outer margin . . . . *A. erythraeus*
13. Lower antennular flagellum with 12 segments or less. Capitulum of petasma with 1 large and often 1 small hook along outer margin . . . . *A. sibogae*
    Lower antennular flagellum with 17 segments or more. Capitulum of petasma with 3 large hooks along ouιer margine. . . . . *A. vulgaris*

Table 2. Definition of the structural characters for use in identification of adult *Acetes*. Characters seen in male only are denoted by asterisk.

Character Number	Description
1	Body length in mm
2	Number of denticles on the rostrum behind the terminal point
3	Ratio of cornea width to length of cornea and eye stalk, X:100
4	Ratio of length of second to first segment of antennular peduncle, X:100
5	Ratio of length of third to first segment of antennular peduncle, X:100
6*	Number of clasping spines on lower antennular flagellum
7	Number of segments of lower antennular flagellum
8	Details of basis of third pereiopod: 0.-projection absent; 1.-projection present on distal inner margin; 2.- projection present on distal inner margin a little before end
9	Details of coxa of third pereiopod: 0.-tooth rudimentary or absent; 1.-tooth present on distal inner margin
10	Details of third thoracic sternite: 0.-protuberances rudimentary or absent; 1.-a pair of conspicuous protuberances present
11*	Anterior margin of genital coxa: 1.-round; 2.-pointed
12*	Details of petasma: 0.-pars astringens absent; 1.- pars astringens present
13	Procurved tooth between first pleopod: 0:-absent; 1.-present
14	Ratio of length of telson to exopod of uropod, X:100
15	Details of apex of telson: 1.-round; 2.-truncate; 3.- triangular
16	Ratio of length of non-ciliated part of outer margin of exopod of uropod to entire margin (non ciliated part plus ciliated part), X:100

Table 3. Values of characters defined in Table 2 for adult female *Acetes*, based on the author's examination

Species name	1 Range	Mean	Sd.*	2	3 Range	Mean	Sd.	4 Range	Mean	Sd.	5 Range	Mean	Sd.
americanus americanus	16.5–19.5	18.05	*0.95*	1	40–48	44.60	*3.38*	23–30	26.25	*2.31*	41–53	43.00	*3.84*
americanus carolinae	14.5–16.5	15.69	*0.52*	1	26–41	34.92	*4.51*	21–28	24.83	*2.03*	39–53	44.58	*3.96*
binghami	8.0– 9.2	8.60	–	0	35	35.00	–	19	19.00	–	33	33.00	–
chinensis	30.0–40.0	34.61	*3.00*	2	43–53	47.00	*2.87*	30–42	35.83	*3.51*	56–68	60.83	*3.85*
erythraeus	16.0–29.5	23.05	*2.93*	2	38–53	43.84	*4.07*	27–37	30.75	*2.72*	39–59	48.18	*4.92*
indicus	16.5–31.0	26.11	*4.08*	2	38–47	43.21	*2.39*	34–44	38.40	*3.52*	51–76	58.26	*7.26*
intermedius	20.0–24.0	22.20	*1.30*	2	36–46	41.66	*3.24*	33–42	37.09	*2.94*	56–67	62.36	*3.77*
japonicus	12.5–29.0	20.02	*5.42*	2	43–58	47.25	*3.83*	24–39	28.65	*4.01*	38–60	47.70	*6.98*
summer population**	14.0–16.0	15.25	*0.64*	2	44	44.00	*0.00*	24	24.00	*0.00*	40–42	41.00	*1.15*
winter population**	25.5–29.0	27.58	*1.49*	2	43–58	48.50	*5.39*	24–32	28.50	*3.27*	49–54	52.83	*3.54*
*johni****	–	–	–	2	31	–	–	51	–	–		–	–
marinus	17.0–19.5	18.40	*1.08*	2	49–55	52.20	*2.38*	26–32	28.60	*2.19*	37–41	38.40	*1.94*
natalensis	22.0	22.00	–	2	44–46	45.00	–	32–33	32.50	–	43–53	48.00	–
paraguayensis	18.5–21.5	19.61	*1.06*	2	47–58	53.90	*4.27*	24–31	28.90	*2.39*	34–43	39.36	*2.64*
serrulatus	14.0–19.5	17.12	*2.32*	2	42–48	45.25	*2.75*	29–37	32.75	*3.50*	46–51	49.00	*2.16*
sibogae australis	18.0–31.5	24.47	*3.82*	2	43–55	49.95	*2.96*	30–39	34.04	*2.85*	45–63	54.13	*4.50*
sibogae sibogae	14.0–27.0	18.70	*3.94*	2	41–53	47.85	*2.93*	30–37	34.14	*2.03*	44–59	52.07	*4.19*
vulgaris	20.0–33.5	27.06	*4.43*	2	45–54	49.14	*3.38*	30–40	35.33	*3.04*	45–55	50.55	*3.28*

* Standard deviation   ** only specimens from the Ariake Sea   *** according to Nataraj (1947)

Table 4. Values of characters defined in Table 2 for adult male *Acetes*, based on the author's examination

Species name	1 Range	Mean	Sd.*	2	3 Range	Mean	Sd.	4 Range	Mean	Sd.	5 Range	Mean	Sd.
americanus americanus	15.5–17.0	16.30	*0.53*	1	40–44	42.60	*1.51*	48–51	48.80	*1.30*	107–114	111.00	*3.24*
americanus carolinae	10.5–15.5	11.85	*1.63*	1	30–39	35.60	*3.02*	36–53	44.50	*5.23*	92–117	107.80	*7.39*
binghami	8.5– 9.0	8.67	–	0	33–39	35.00	–	33–40	37.00	–	106–116	110.66	–
chinensis	26.5–31.5	28.63	*1.34*	2	39–48	45.40	*2.59*	47–59	53.27	*3.28*	124–164	141.88	*14.13*
erythraeus	15.5–24.5	19.27	*2.46*	2	37–54	45.60	*4.37*	29–41	34.31	*3.77*	41– 73	*55.32*	*6.92*
indicus	15.5–25.0	19.97	*2.82*	2	36–55	45.40	*4.48*	56–75	64.14	*4.97*	115–169	142.61	*18.49*
intermedius	17.0–24.0	19.65	*2.02*	2	40–47	44.10	*1.79*	45–51	48.70	*1.88*	87–100	92.00	*4.02*
japonicus	11.0–23.5	15.92	*4.25*	2	39–55	48.25	*4.04*	43–58	51.31	*4.28*	107–144	125.26	*12.05*
summer population**	11.0–11.5	11.33	*0.28*	2	44–47	45.50	–	48–58	54.66	*5.77*	120–139	129.50	–
winter population**	21.5–23.5	22.00	*0.86*	2	50–55	52.00	*2.44*	53–55	54.50	*1.00*	131–144	137.75	*5.56*
johni	17.0–18.0	17.37	*0.47*	2	40–45	41.20	*2.16*	48–56	53.40	*3.28*	113–134	121.60	*7.89*
marinus	13.5–16.5	14.57	*0.88*	2	48–54	50.57	*1.98*	43–52	47.84	*3.78*	78– 90	84.15	*4.27*
natalensis	16.5–17.5	17.00	–	2	46	46.00	–	52	52.00	–	128	128.00	–
paraguayensis	16.5–21.0	19.53	*1.36*	2	46–59	54.87	*3.87*	24–36	29.10	*3.44*	37– 45	41.40	*2.59*
serrulatus	12.5–17.0	15.25	*1.91*	2	43–52	46.33	*3.14*	43–54	49.16	*4.16*	113–125	120.33	*4.96*
sibogae australis	18.0–21.5	20.10	*1.02*	2	45–60	51.28	*4.32*	44–59	51.40	*4.40*	103–130	116.40	*9.19*
sibogae sibogae	12.5–19.5	16.72	*2.40*	2	43–57	49.90	*3.41*	37–62	53.09	*6.10*	96–122	108.66	*6.67*
vulgaris	18.0–28.5	22.88	*2.57*	2	45–58	51.14	*4.70*	39–58	46.33	*5.33*	56– 69	63.33	*4.20*

* Standard deviation   ** only specimens from the Ariake Sea

6	7	8	9	10	11	12	13	14 Range	Mean	Sd.	15	16 Range	Mean	Sd.	1 No. of inds.	2–16
–	7–10	0	0	0	–	–	0	57–65	60.14	*2.73*	2	57–63	59.71	*2.42*	16	8
–	6–10	0	0	0	–	–	0	55–63	58.46	*2.14*	2	61–64	62.76	*0.83*	17	13
–	6– 7	0	0	0	–	–	0	–	–	–	2	50–66	53.00	–	2	2
–	15–24	0	1	0	–	–	0	60–66	63.14	*2.47*	1	50–55	51.45	*1.91*	23	12
–	14–18	0	1	1	–	–	1	62–70	66.35	*2.13*	3	57–63	59.42	*1.45*	97	26
–	18–21	2	1	0	–	–	1	53–68	62.20	*3.58*	3	54–59	55.80	*1.56*	45	19
–	12–15	1	1	1	–	–	1	60–71	64.88	*3.14*	3	60–62	60.20	*0.63*	44	11
–	11–14	0	1	0	–	–	0	57–73	62.72	*4.36*	1–2	49–52	50.75	*0.96*	57	20
–	11	0	1	0	–	–	0	59–61	60.00	*0.51*	1–2	51–52	51.25	*0.01*	4	4
–	12–14	0	1	0	–	–	0	61–66	63.12	*2.02*	1	49–52	49.80	*1.01*	16	6
–	–	0	1	0	–	–	0	–	–	–	2	–	–	–	0	0
–	12–13	0	1	1	–	–	0	64–65	64.40	*0.54*	1	58–61	59.20	*1.30*	6	5
–	11	0	0	0	–	–	0	54–59	56.50	–	2	62–65	63.50	–	1	2
–	13–17	0	1	1	–	–	0	60–68	63.90	*2.34*	1–2	52–65	60.00	*3.40*	12	11
–	10–12	0	1	0	–	–	0	52–57	55.00	*2.12*	2	55–59	57.40	*1.67*	5	5
–	14–20	1	1	1	–	–	0	57–69	63.81	*3.63*	3	57–61	58.72	*1.38*	60	22
–	11–20	1	1	1	–	–	0	63–73	66.81	*2.94*	3	57–64	60.31	*2.12*	32	16
–	20–24	0	1	1	–	–	0	60–75	66.55	*4.55*	3	58–63	60.85	*2.11*	73	29

6	7	8	9	10	11	12	13	14 Range	Mean	Sd.	15	16 Range	Mean	Sd.	1 No. of inds.	2–16
0	10	0	0	0	1	0	0	56–63	59.20	*2.77*	2	60–61	60.60	*0.54*	11	5
0	9–11	0	0	0	1	0	0	52–57	55.66	*1.73*	2	62–66	63.80	*1.13*	16	13
0	10–11	0	0	0	1	0	0	55–58	56.33	–	2	58–60	58.66	–	3	3
2	10–13	0	1	0	1	0	0	57–64	60.85	*2.11*	1	49–53	50.85	*1.57*	14	14
1	14–16	0	0–1	1	2	1	1	60–69	65.06	*2.74*	3	59–63	60.12	*1.20*	52	29
1	11–12	2	1	0	1	0	1	56–70	62.95	*3.15*	3	52–60	56.04	*1.88*	26	29
1	13–14	1	0	1	2	1	1	55–68	62.66	*3.60*	3	57–62	60.22	*1.64*	11	10
2	10–12	0	1	0	1	0	0	58–64	60.91	*2.06*	1–2	50–54	51.33	*1.61*	42	29
2	10–11	0	1	0	1	0	0	59–60	59.50	–	1–2	54	54.00	–	3	3
2	11–12	0	1	0	1	0	0	61–64	62.60	*1.51*	1	50	50.00	*0.00*	5	5
2	11–12	0	0	0	1	0	0	54–63	59.80	*3.83*	2	63–64	63.40	*0.54*	5	5
1	10–11	0	0–1	1	2	1	0	60–65	62.85	*1.86*	1	59–62	60.71	*1.38*	13	13
2	11	0	0	0	1	0	0	56–60	58.00	–	2	59–61	60.00	–	2	2
1	11	0	1	1	2	1	0	60–69	62.00	*3.16*	1–2	56–63	59.50	*2.56*	10	10
2	11	0	1	0	1	0	0	51–55	54.00	*1.73*	2	55–60	57.66	*1.75*	6	6
1	11–12	1	1	1	2	1	0	63–68	65.78	*1.57*	3	57–63	58.92	*1.68*	33	15
1	11–12	1	0–1	1	2	1	0	62–70	66.70	*2.73*	3	56–63	60.10	*1.65*	56	21
1	17–21	0	1	1	2	1	0	64–72	67.09	*2.30*	3	60–64	61.25	*1.42*	61	29

V. BIOGEOGRAPHY AND ECOLOGICAL NOTES

Ten of 14 existing species in the genus *Acetes* are found in the Indo-West Pacific, and the Indo-Malay archipelago region is particularly rich in species. The latitudinal range is between 41°N and 34°S. *Acetes chinensis* occurs as far northwards as Po Hai (Gulf of Chihli), China, whereas *A. sibogae australis* is distributed along the coast of New South Wales, Australia. No species have yet been recorded from New Guinea and the Persian Gulf areas, but this may be largely due to the lack of survey. Three species, *A. americanus, A. marinus,* and *A. paraguayensis,* are restricted to Atlantic America; the last species occurring in fresh water. The latitudinal range in the Atlantic is between 35°N (*A. a. carolinae*) and 32°S (*A. a. americanus*). In Pacific America *A. binghami* is recorded from the Gulf of Panama and the Gulf of Guayaquil. No species are known either from East Atlantic-Mediterranean or from the islands of the Central Pacific including Hawaii and New Zealand.

Figure 6 shows the geographical range of the distribution of the species of *Acetes*. The geographical area enveloping all capture records of two groups of *Acetes* are compared with selected mean isotherms at 10 m for winter season of each hemisphere. The localities for the *erythraeus* group are largely enveloped by the mean winter season position of the 24°C isotherm, the lower thermal limit of Tropical Surface Water. The localities for the *japonicus* group, however, are more widespread and extend to the 15°C isotherm in both hemispheres.

FLEMINGER and HULSEMANN (1973) state that epiplanktonic copepods occurring in the lower equatorial latitudes, i.e. species with their breeding range restricted to lower latitudes between the Equator and 20–30° north and south, tend to show regional provincialisms. A similar tendency emerges from the distribution of *Acetes* whose northern and southern limits fall roughly between the 30° parallels. All species of *Acetes* are restricted to either Atlantic, Indo-West Pacific, or the eastern tropical Pacific Ocean. In addition to continental barriers to the spread of the species, the coastal habitats favored by *Acetes* may be equally or even more significant in isolating populations and in producing short-range species and subspecies.

Morphological characters of the species of the genus *Acetes,* described in Chapter IV, indicate that all present species were derived from two common precursors. One gave rise to the *erythraeus* group and the other produced the *japonicus* group. Probably the precursor of the *erythraeus* group was associated primarily with equatorial (tropical) waters and that of the *japonicus* group with tropical-subtropical (tropical-warm temperate) waters. It is considered that the two precursors were distributed widely in the Tethys Sea, both in the Indo-European province and American province, during the Eocene and Oligocene. Because of the late tertiary climatic deterioration, however, these precursors disappeared from East Atlantic-Mediterranean. The formation of the landbridge between Asia and Africa also divided their habitat into two regions, namely

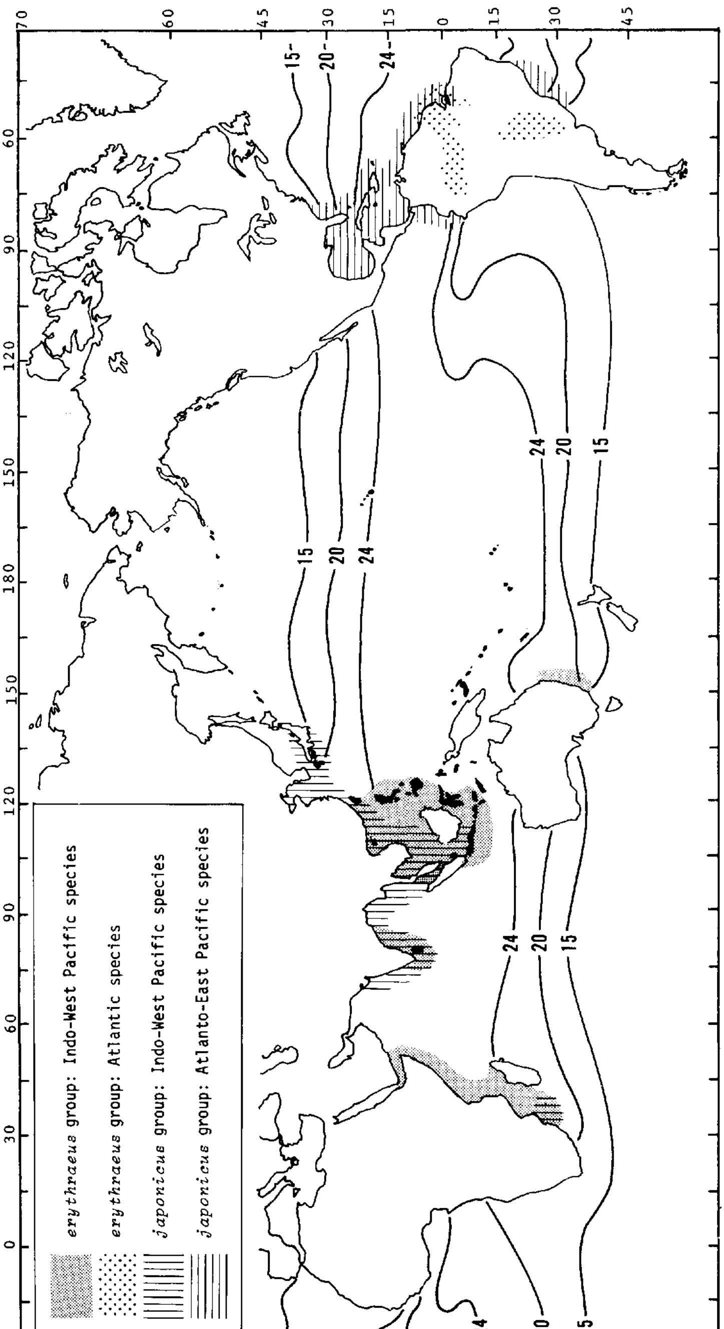

Figure 6. Comparison of geographical distribution of two groups of *Acetes* with selected mean isotherms (°C) at 10 m for winter season of each hemisphere. Temperature data from MUROMTSEV (1958, 1963) and WYRTKI (1971), cited by FLEMINGER and HULSEMANN (1974).

Atlant-East Pacific and Indo-West Pacific (UMBGROVE, 1930). After that they developed gradually on different lines in the two separate regions.

The climatic change after middle of Miocene took place in American side, though it was not so catastrophic for the tropical fauna (EKMAN, 1953: 71). However, it might have caused immigration of tropical-subtropical species (the *americanus* subgroup) to the lower equatorial latitudes, and forced the equatorial species (the *paraguayensis* subgroup) to take refuge in rivers and estuaries of the central and northeastern South America. *Acetes paraguayensis* in the Parana basin could have been introduced directly from the upper region of the Amazon basin without passing through the sea.

The fact that *A. binghami* shows stronger morphological affinity to *A. americanus* indicates that they must have been recently derived from a single subtropical precursor. JORDAN (1908) introduced the term "geminate species" or "twin species" for amphi-American species having a common ancestor. Until Pliocene the Pacific had a direct connection with the Atlantic across the present Central America. Presumably, simultaneous development of *A. americanus* and *A. binghami* occurred after formation of the Panama Isthmus.

Attention has often been called to the faunistic resemblance between the Indo-West Pacific and Atlantic America and the faunal richness of the Indo-Malayan region, as demonstrated in *Acetes*, as well as various other common families and genera such as the decapod shrimp genus *Lucifer*, the squid genus *Sepioteuthis* and the eel genus *Anguilla*. The faunal richness of the Indo-Malayan region is sometimes explained by the assumption that this region is a center for the generation of marine organisms. However, EKMAN (1953:79) notes that the explanation is rather that, in contrast to the Atlantic, the Indo-Malayan region has been able to preserve this inherited richness until the present time, and that in addition new forms have been able to develop continuously.

Acetes is a typical neritic, epipelagic shrimp and it is common in estuaries and backwaters where fresh water from the land greatly influences the situation. It can withstand a great change of salinity. For instance, adults of *A. erythraeus* are found in water where the salinity fluctuates seasonally between 1.5 and 35.0‰ (LE RESTE, 1970). Other common environmental features correlated with appearance of the species are: 1) the sea is shallow for a great distance from the shore; 2) the area is separated from the open ocean by a peninsula, submarine sills or numerous islands; 3) the tidal range is considerable; 4) the bottom is covered with mud or sandy-mud. *Acetes* is generally distributed in depths shallower than 50 m; swarming and gregariousness are usually found from the surface to a depth of 20 m. The swimming activity of the shrimp becomes highest at night. In the shallow area of the Seto Inland Sea (10–20 m in depth), *A. japonicus* often intimately associates with the bottom during daytime, but in Toyama Bay where the bottom slope is very steep, the species aggregates at depths of 40–90 m.

It is most probable that *Acetes* produce steady emission of greenish-blue light. Fishermen in various localities always point out the occurrence of massive dull glow by swarms of *Acetes* in the sea. They locate the position of large swarms of *Acetes* by the luminescence at night.

VI. ANNOTED LIST OF SPECIES OF THE GENUS *ACETES* H. MILNE-EDWARDS

1. *Acetes americanus* ORTMANN
Figures 7, 8

a. *Acetes americanus americanus* ORTMANN

Acetes americanus ORTMANN,1893, p. 39, pl. 2, fig. 2.- HOLTHUIS, 1959, p. 49. fig. la, lc. (male only).- CHACE, 1972, p. 12.
Acetes brasiliensis HANSEN, 1919, p. 45, figs. 1-7.
Acetes americanus limonensis BURKENROAD, 1934b, p. 99, fig. 38. (male only).

MATERIAL – Puerto Rico: 1.75 miles south-southwest of Playa de Guayanes, 12 July 1969, (USNM 134696, *A. americanus,* determined by F. A. CHACE, Jr., 1970), 4 ad. females (16.5–18.0 mm), 1 ad. male (broken). Brazil: off Santos, collected by M. IWAI, 11 Nov. 1970, (*A. americanus,* determined by L. B. HOLTHUIS, 1970), 12 ad. females (17.0–19.5 mm), 10 ad. males (15.5–17.0 mm).

TYPES – Type specimens should be in Zoologisches Museum der Humbolt Universität, Berlin.

DIAGNOSIS – In the females the cornea breadth/cornea and eye stalk length ratio is 0.40 to 0.48. The lower antennular flagellum is 7- to 10-segmented. The antennal scale reaches midlength to distal 1/3 of the third segment of the antennular peduncle. The basis of the third pereiopod lacks a projection; the coxa is produced on the inner margin but lacks a tooth; it has a large truncate flap on the posterior corner. The third thoracic sternite is produced posteriorly and its posterior margin is recessed medially. This median emargination is shallow and the sublateral part is broadly rounded.

In the males the cornea breadth/cornea and eye stalk length ratio is 0.40 to 0.44. The third segment of the antennular peduncle is elongated and the antennal scale reaches slightly beyond the end of the second segment of the antennular peduncle. The lower antennular flagellum is 10-segmented; there is no enlarged clasping spine but there are 2 spinules (the modification of clasping spines) on the projection of the second segment; the projection is fused with the third segment which bears 6–8 finger-like, obtuse spinules and a strongly curved, robust projection. The basis and coxa of the third pereiopod are as in the females. The anterior margin of the genital coxa is

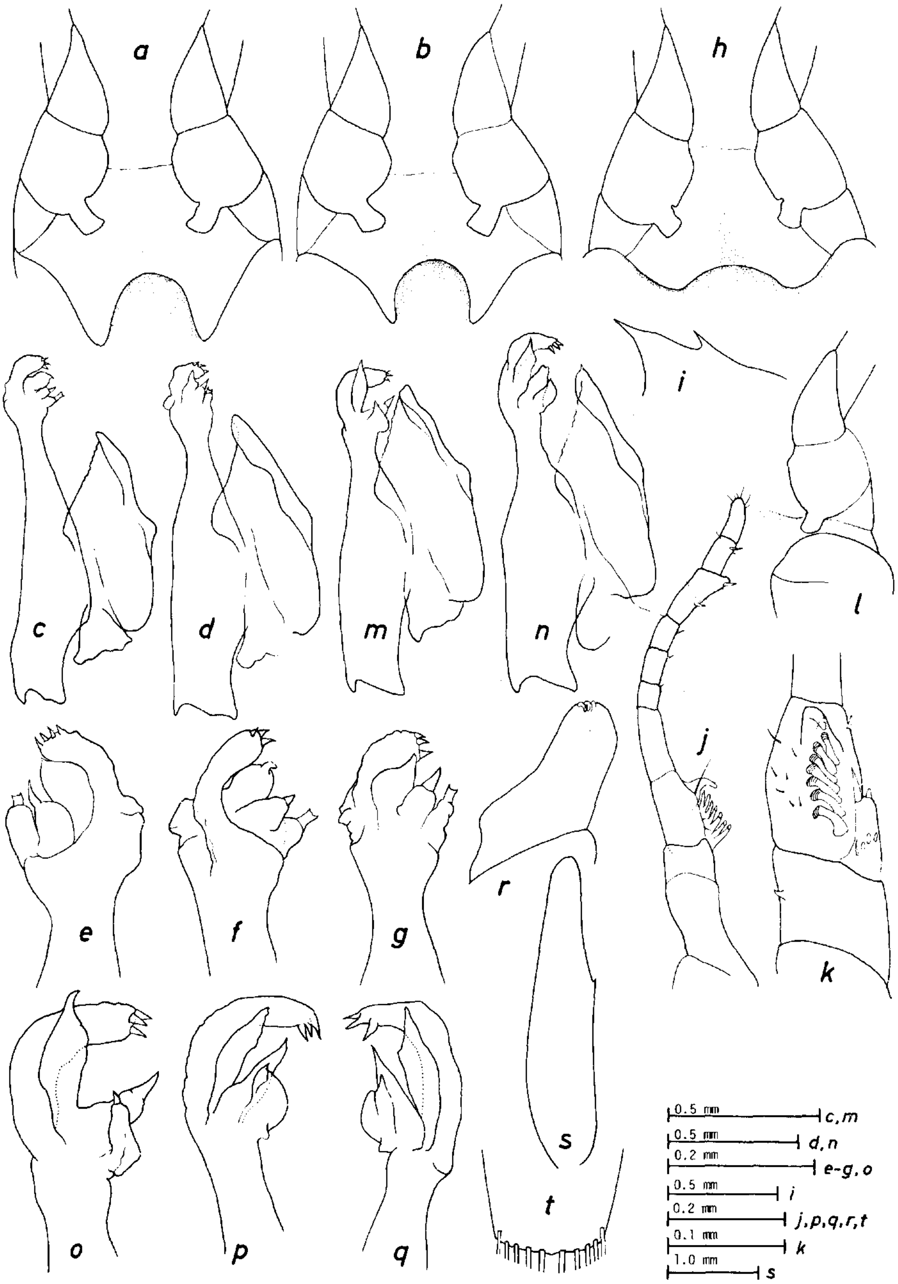

Figure 7. *Acetes americanus carolinae.* female: a, basal segments of third pereiopods and third thoracic sternite, ventral view; b, same. male; c, petasma; d, same; e, capitulum of petasma; f, same; g, same.

Acetes americanus americanus. female: h, basal segments of third pereiopods and third thoracic sternite, ventral view. male: i, rostrum; j, lower antennular flagellum; k, proximal part of lower antennular flagellum; l, basal segments of third pereiopod and genital coxa, ventral view; m, petasma; n, same; o, capitulum of petasma; p, same; q, same; r, appendix masculina; s, endopod of uropod; t, apex of telson (a, c, e, f, from North Carolina; b, d, g, from Louisiana; m, o, from Puerto Rico; h–l, n, p–t, from Santos).

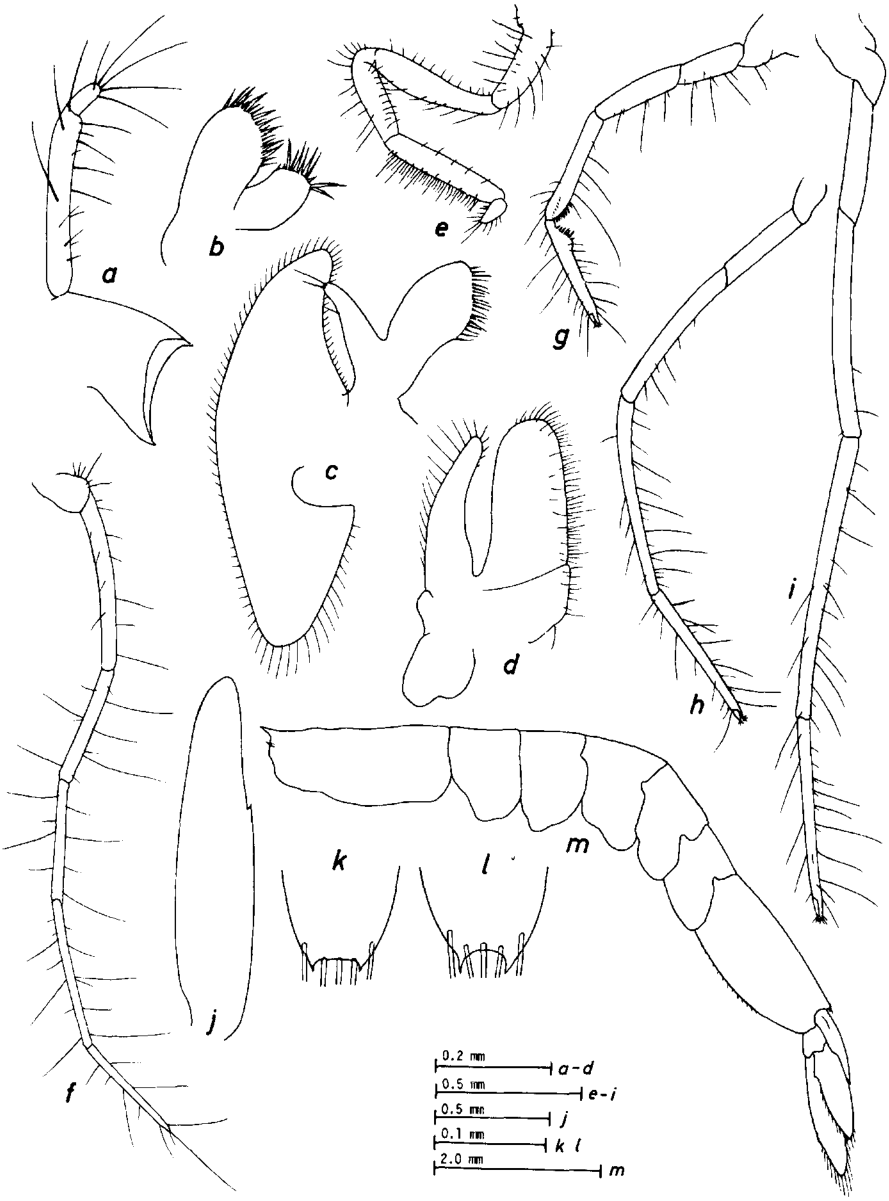

Figure 10. *Acetes binghami.* male: a, mandible; b, first maxilla; c, second maxilla; d, first maxilliped; e, second maxilliped; f, third maxilliped; g, first pereiopod; h, second maxilliped; i, third maxilliped; j, exopod of uropod; k, apex of telson; l, same; m, carapace and abdomen. (a–m, from the Gulf of Guayaquil).

The rostrum in both females and males has no denticle behind the acute terminal point. The antennal scale reaches the end of the second segment of the antennular peduncle. There is a large round projection between the first pleopods. The exopod of the uropod is 4.5 times as long as broad. The apex of the telson is truncated; the lateral margins often curved inward to 2 short teeth between which is the slightly convex posterior margin; there are 3 setae between the terminal teeth.

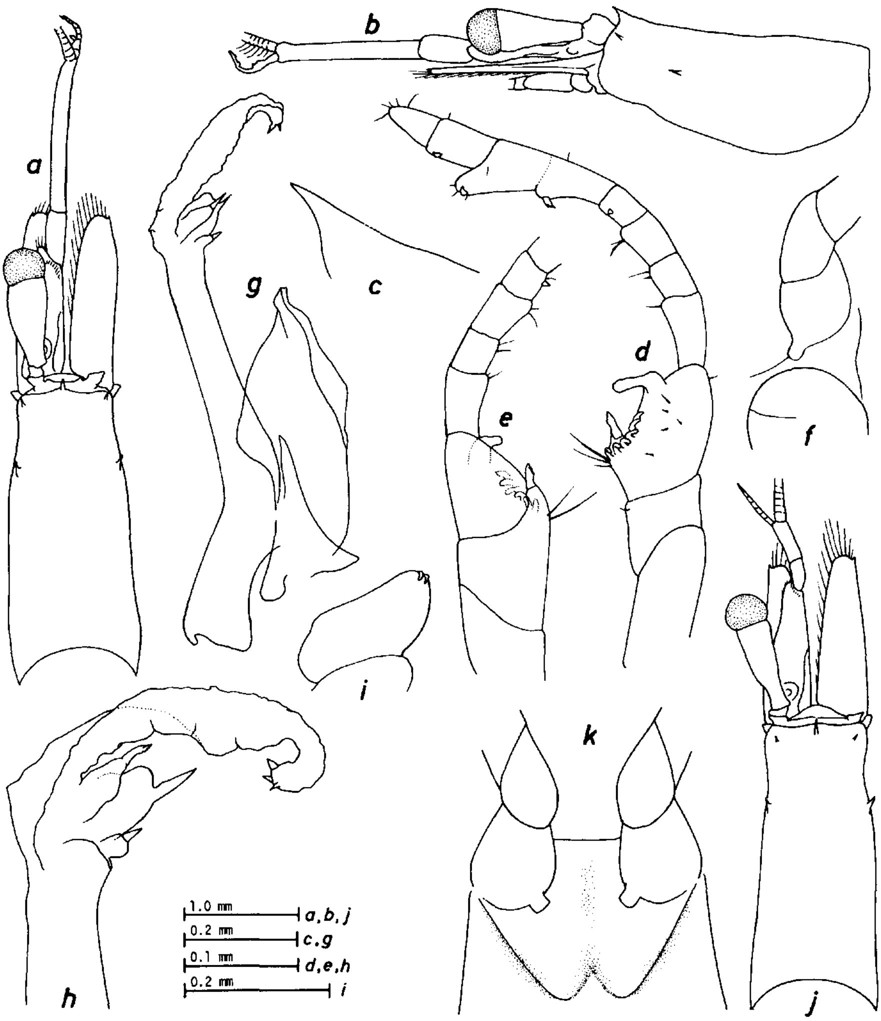

Figure 9. *Acetes binghami.* male: a, anterior region, dorsal view; b, same, lateral view; c, rostrum; d, lower antennular flagellum; e, same, another view of proximal part; f, basal segments of third pereiopod and genital coxa, ventral view; g, petasma; h, capitulum of petasma; i, appendix masculina. female: j, anterior region, dorsal view; k, basal segments of third pereiopods and third thoracic sternites, ventral view. (a-k, from the Gulf of Guayaquil).

pereiopod are as in the females. The anterior margin of the genital coxa is rounded. The petasma lacks a pars astringens; the capitulum is subglobular and is produced along the outer margin into 4 lobes; the first (proximal) lobe is shortest, the second and third lobes each terminate in a spine; the fourth (distal) lobe is longest and strap-like; it is 2.5–3.0 times as long as the third lobe and possesses 2–3 spinules on the distal end. The appendix masculina bears 2 hooks.

slightly larger than those of northern form (*a. carolinae*), but except for these differences two subspecies are generally indistinguishable. I think their genetic divergence has not attained at specific significance as yet. BURKENROAD (1934b) noted that the end of the fourth lobe of the capitulum of the petasma was armed respectively with 2 spinules in North Carolinian males, 3 in Panamanian males, and 4 in Brazillian males. However, the number of spinules varies from 3 to 5, mostly 3, in both northern and southern males examined in the present study. The appendix masculina bears 2 hooks in *a. carolinae,* and 2–3 hooks in *a. americanus.* A comparative study of extensive material from many localities from north and south remains desirable to define the relationship between two subspecies and the range of their distribution. *Acetes a. carolinae* has warm temperate range while *A. a. americanus* is tropical. Similar distribution are seen in coastal decapods in the region: PEREZ FARFANTE (1969) for *Penaeus* and WILLIAMS (1974) for *Callinectes.*

2. *Acetes binghami* BURKENROAD
Figures 8, 9, 10

Acetes binghami BURKENROAD, 1934b, p. 101, figs. 39, 40.

MATERIAL – Ecuador: Gulf of Guayaquil, 2°31'S, 80°04'W, Sta. 5 (11), collected by T. GOMEZ, 24 Apr. 1962, 1/2 m-net, 1 ad. female (8.0 mm), 1 juv. male (6.8 mm); same locality, Sta. 5 (14), collected by T. GOMEZ, 8 May 1962, 1 ad. female (9.2 mm), 3 ad. (8.5–9.0 mm) and 1 juv. (8.2 mm) males.

TYPES – Holotype (B.O.C. 105) should be in the Bingham Oceanographic Collection, New Haven. Reference specimens, 1 ad. male (9.0 mm), USNM 152726, and 1 ad. female (9.2 mm), USNM 152727, from the Gulf of Guayaquil, Sta. 5 (11), are here selected and deposited at the U.S. National Museum of Natural History.

DIAGNOSIS – In the females the lower antennular flagellum is 6- or 7-segmented. The basis of the third pereiopod lacks a projection; the coxa is produced on the inner margin but lacks a tooth; it has a large truncate flap on the posterior corner. The third thoracic sternite is produced backwards and its posterior margin is depressed medially; it is concave in the median part.

In the males the third segment of the antennular peduncle is elongated. The lower antennular flagellum is 10- or 11-segmented; like *A. americanus,* there is no enlarged clasping spine but there is an obtuse spinule on the second segment; the third segment bears 6–7 finger-like, obtuse spinules and 1 procurved, robust projection. The basis and coxa of the third

Other structures in both females and males closely agree with those of *A. a. americanus.*

BODY LENGTH – Females 14–17 mm, males 10–16 mm.

TYPE-LOCALITY – Beaufort Inlet (about 34° 47'N), North Carolina.

DISTRIBUTION – *Acetes a. carolinae* occurs mainly from North Carolina (Beaufort Inlet), along the east coast of Florida, to the Gulf of Mexico (Louisiana and Texas), but the distribution appears to extend to Caribbean Sea (Panama), Surinam (mouth of Surinam River) and French Guiana (Cayenne).

REMARKS – With regard to *Acetes americanus* s. l. the present specimens from North Carolina, Louisiana, and Texas provide characters of *A. a. carolinae* in both females and males. Those from Puerto Rico and Santos strongly resemble the type-specimens of *A. a. americanus.* The depth/breadth ratio of the emargination in the posterior margin of the third thoracic sternite is 0.56–0.80 (average 0.68) in the specimens from North Carolina and 0.50–0.83 (0.66) in those from Louisiana and Texas. On the other hand, it is 0.20–0.29 (0.24) in the specimens from Puerto Rico and 0.21–0.31 (0.26) in those from Santos. In the specimen from the mouth of Rio Para it is 0.29 (HANSEN, 1919). In the present study specimens were not available from the western and southern Caribbean Sea coastlines where two forms appear to have contact. However, figures of female specimens from Panama and Surinam (BURKENROAD, 1934b; HOLTHUIS, 1959) provide character of *a. carolinae,* the depth/breadth ratio of the posterior emargination of the third thoracic sternite is 0.70 and 0.53 respectively. On the other hand, those of males resemble *a. americanus* as the end of the pars externa of the petasma reaches the middle of the capitulum. Based upon the differences of characters of the female genital area and the male petasma in material from the various regions from north and south, BURKENROAD (1934b) recognized 4 subspecies: *A. americanus carolinae* (type-locality: Beaufort Inlet), *A. a. louisianensis* (type-loc: Louisiana coast from the Mississippi River west to Timbalier Island), *A. a. limonensis* (type-loc: the mouth of Sweetwater River, Limon Bay, Panama), and *A. a. americanus* (type-loc: mouth of Rio Tocantins). The subspecies *a. louisianensis* and *a. limonensis* have characters intermediate between the subspecies *a. carolinae* and *a. americanus.* HOLTHUIS (1948) considered these to be clinal variants, with the northern and southern representatives being the most widely divergent, and proposed that the extreme northern and southern forms deserve to retain subspecific rank.

In addition to the small morphological differences in sexually modified structures, the body length and cornea of southern form (*a. americanus*) are

BODY LENGTH – Females 16–26 mm, males 15–17 mm.

TYPE-LOCALITY – Mouth of Rio Tocantins, Brazil.

DISTRIBUTION – This Atlantic American species has been reported from the Caribbean Sea (Panama, Puerto Rico), Surinam (mouth of Surinam River), French Guiana (Cayenne), and Brazil (Amazon estuary, mouth of Rio Tocantins). According to Dr. M. IWAI (personal communication) the species is abundant off São Paulo in winter and its distribution extends further southward to off Rio Grande.

b. *Acetes americanus carolinae* HANSEN

Acetes carolinae HANSEN, 1933, p. 30, figs. 1–8.
Acetes americanus carolinae HANSEN.-WILLIAMS, 1965, p. 79, figs. 30, 31.
Acetes americanus louisianensis BURKENROAD, 1934a, p. 128, fig. 15.
Acetes americanus limonensis BURKENROAD, 1934b, p. 99, fig. 37. (female only).
Acetes americanus ORTMANN.-HOLTHUIS, 1948, p. 1105, fig. 1.- 1959, p. 49, fig. 1b. (female only).

MATERIAL – North Carolina: Beaufort, collected by J. S. GUTSELL,, 30 Oct. 1929, (USNM 67581, *A. carolinae*, determined by W. L. SCHMITT), 6 ad. females (16.0–16.5 mm), 5 ad. males (10.5–12.0 mm).
Louisiana: 28°56′N, 89°09′W, M/V "Oregon" Sta. 851, 25 Oct. 1953, (USNM 96281, *A. carolinae*, determined by F. A. CHACE, Jr.), 7 ad. females (15.0–16.0 mm), 4 ad. males (11.0–15.5 mm).
Texas: off Galveston, collected by A. FLEMINGER, 3 Apr. 1957, 3 ad. males (10.5–12.0 mm); off Galveston, 1960, (Texas A. & M. University reference collection, *A. americanus louisianensis*), 4 ad. femeles (14.5–15.5 mm), 4 ad. males (10.5–11.0 mm).

TYPES – Type specimens should be in Universitetets Zoologiske Museum, Copenhagen.

DIAGNOSIS – In the females the cornea breadth/cornea and eye stalk length ratio is 0.26 to 0.41. The lower antennular flagellum is 6- to 10-segmented. The median emargination of posterior margin of the third thoracic sternite is deep and each sublateral part makes an acute angle.

In the males the cornea breadth/cornea and eye stalk length ratio is 0.30 to 0.39. The lower antennular flagellum is 9- to 11-segmented. In the petasma the tip of the pars externa reaches only to the base of capitulum; four lobes on the capitulum are thick and short; the first lobe has a bifid plate on top; the first, second and third lobes are nearly equal in length; the fourth lobe extends slightly over the tip of the third lobe.

rounded. The petasma lacks a pars astringens; the distal 2/5 of the pars externa is triangular; the tip of the pars externa reaches the middle of the capitulum; the capitulum is subglobular and produced along the outer margin into 4 lobes; the first (proximal) lobe is thick and short; the second and third lobes are longer than the first lobe and terminate in a spinule; the fourth (inner) lobe is largest and possesses 3–5 spinules on the end; the fourth lobe is slender and extends over the tip of the third lobe by the distal 1/4 of the length.

The rostrum in both females and males has only 1 denticle behind the acute terminal point. The apex of the telson is round or truncated. The exopod of the uropod is slender; 4.7 times as long as broad; there is a red spot each on the basipod and endopod of the uropod.

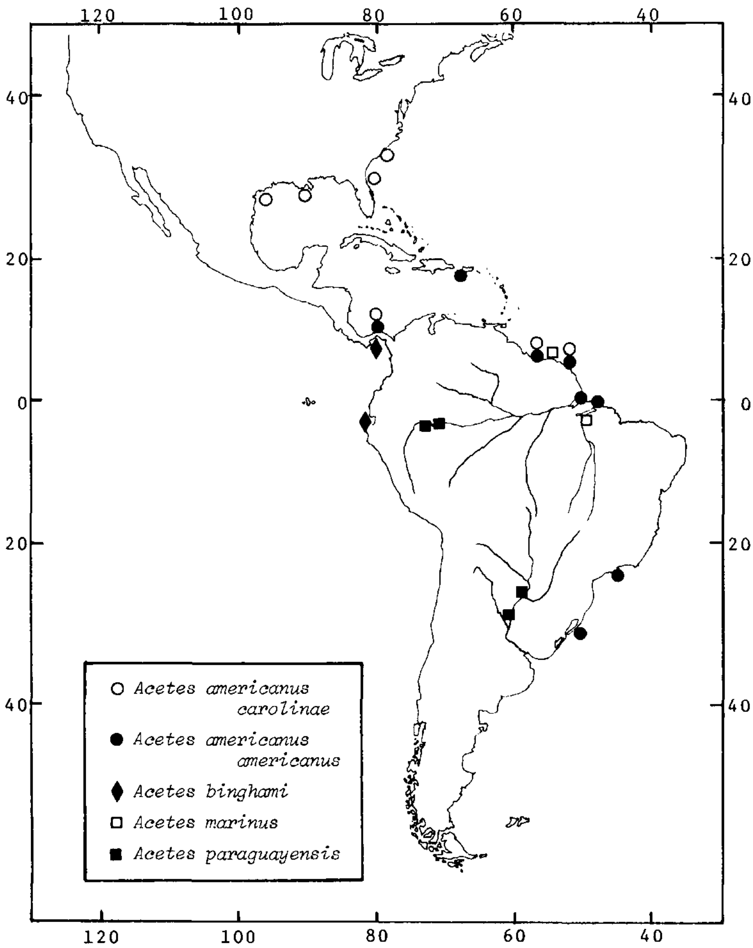

Figure 8. Distribution records of *Acetes americanus americanus, A. a. carolinae, A. binghami, A. marinus,* and *A. paraguayensis.*

BODY LENGTH–Females 8–12 mm, males 8–9 mm.

TYPE-LOCALITY–Bella Vista Beach, Panama City.

DISTRIBUTION – The Pacific coast of equatorial America; Gulf of Panama (Panama City) and Gulf of Guayaquil.

REMARKS – *Acetes binghami* was incompletely described by BURKENROAD (1934b) from a single slightly distorted female specimen. He noted that the third thoracic sternite had a narrow elevation extending anteriorly between the bases of the second pereiopods, but this structure was not seen in the present specimens. Excepting for this difference, however, the present females agree well with the original description. I believe that the present material is referrable to *A. binghami*. The male is here described for the first time. *Acetes binghami* is most closely related to *A. americanus* but is readily distinguished by the absence of a denticle behind the terminal point of the rostrum. The structure of the female genital area and that of the male petasma, particularly of the elongate pars media and of the extremely large fourth lobe of the capitulum, are also unique. This is the smallest species of the genus and the only species from the eastern Pacific.

3. *Acetes chinensis* HANSEN
Figures 11, 12

Acetes chinensis HANSEN, 1919, p. 41, pl, 4 figs. 3a, 3b.-URITA, 1926, p. 423, fig.- YU, 1935, p. 169.- LIU, 1955, p. 19, pl. 7; 1956, p. 30, pls. 1–3; 1959, p. 37.- YOO and KIM, 1973, p. 62, figs. 2, 3.-YU, 1974, p. 60, fig. 1.
Acetes japonicus KISHINOUYE.-(part) YOSHIDA,1941, p. 18, fig. 12.

MATERIAL – Korea: Gyonggi Bay, Mo Do, 37°31.5'N, 126°25.1'E, collected by K. I. YOO, 10 July 1974, 7 ad. females (33.0–36.5 mm), 7 ad. males (27.5–31.5 mm); Locality unknown, frozen material given by A. MITSUISHI, 28 Nov. 1974, many juveniles.
Japan: off Sasebo, 33°10'N, 129°18'E, collected by SUENSON, 17 Sept. 1897, (UCZM, *A. chinensis* n. sp. syntypes), 5 juv. females (19.5–22.0 mm).
China: Po Hai, the mouth of Yellow River, collected by CHEN, 10 July 1956, (*A. chinensis*, determined by J. Y. LIU), 2 ad. females (39.0, 40.0 mm), 2 ad. males (29.0, 30.0 mm); Formosa Channel, collected by SUENSON, 23 May 1897, (UCZM, *A. chinensis* n. sp. syntype), 1 ad. female (32.0 mm); Fukien, Matsu Island, Dec. 1972, 13 ad. females (30.0–35.0 mm), 5 ad. males (26.5–28.5 mm).

TYPES – Syntypes here examined are in Universitetets Zoologiske Museum, Copenhagen.

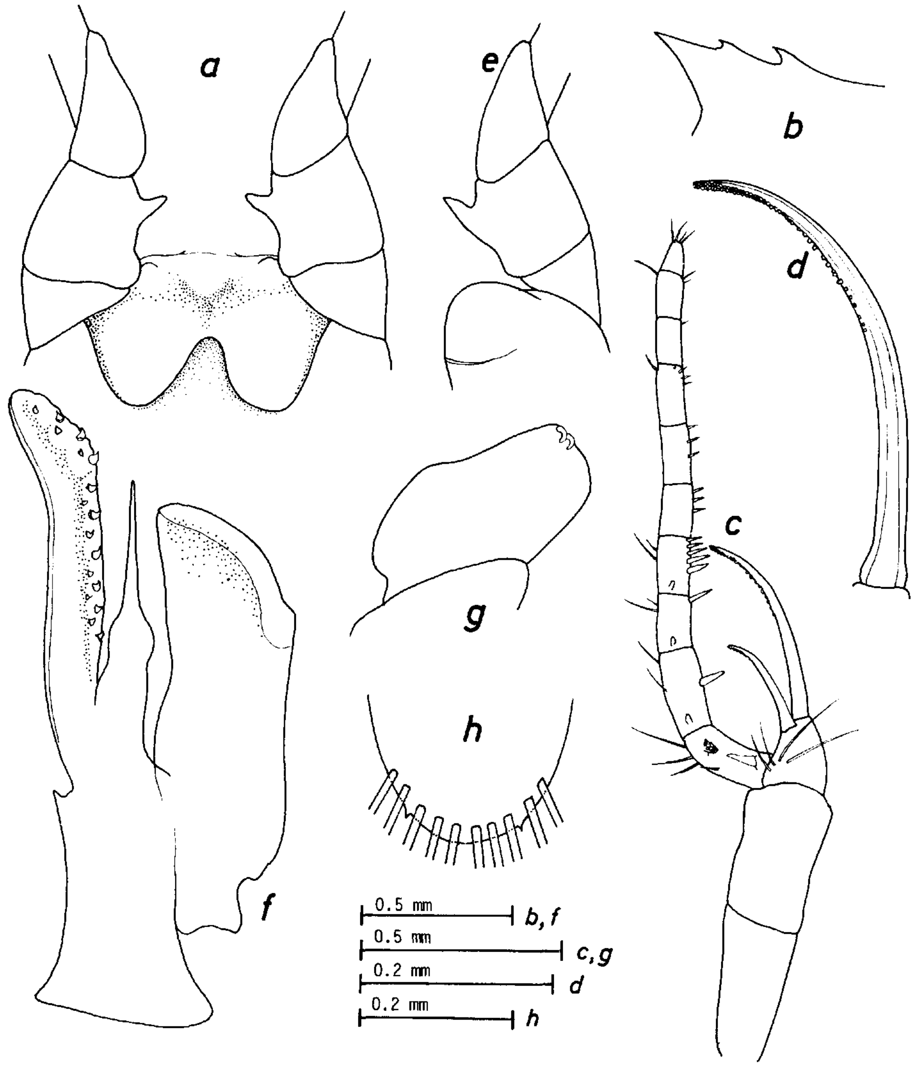

Figure 11. *Acetes chinensis.* female: a, basal segments of third pereiopods and third thoracic sternite, ventral view. male: b, rostrum; c, lower antennular flagellum; d, longer clasping spine; e, basel segments of third pereiopod and genital coxa, ventral view; f, petasma; g, appendix masculina; h, apex of telson. (a–h, from Matsu Island).

DIAGNOSIS – In the females the lower antennular flagellum is 15- to 24-segmented. The antennal scale reaches the middle of the third segment of the antennular peduncle. The coxa of the third pereiopod has a tooth on the inner margin. The third thoracic sternite is produced backwards as a large plate, overlying the fourth sternite; the emargination of the median part of the posterior margin is deep.

In the males the lower antennular flagellum is 10- to 13- segmented; there

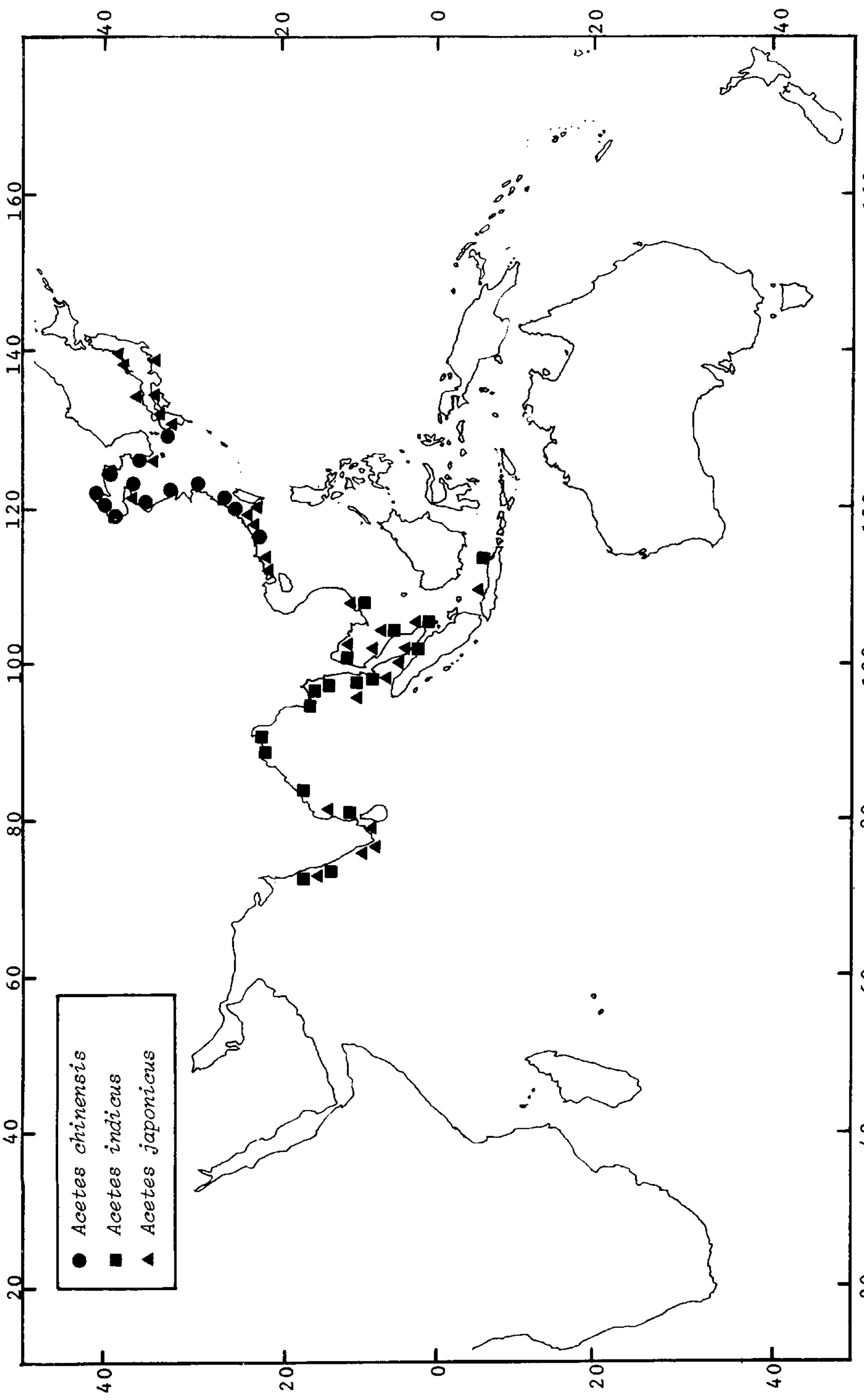

Figure 12. Distribution records of *Acetes chinensis*, *A. indicus*, and *A. japonicus*.

are 2 clasping spines which have irregularly arranged tubercles on the distal inner surface; the first segment of the main branch (the third segment from the base) bears 1 spinule and 1 swelling; the segment opposite the tip of the longer clasping spine bears 2–5, mainly 4, spinules; the following 3 segments each have 2–4 spinules. The antennal scale reaches the proximal 1/18 to 1/6 of the third segment of the antennular peduncle. The basis and coxa of the third pereiopod are as in the females. In the petasma the distal part of the capitulum is expanded like a cucumber and has several large hooks; in many specimens there is a vestige of a pars astringens on the inner margin of the pars media. The appendix masculina bears 2 hooks.

BODY LENGTH – Females 25–42 mm, males 20–35 mm.

TYPE-LOCALITY – Off Kyushu, Japan at 33°10′N,129°18′E and Formosa Channel.

DISTRIBUTION – This is the only species of *Acetes* that occurs as far northward as 40°50′ N (Liaotung Bay). The species is most abundant along the coasts of Po Hai and the Yellow Sea, and is the only species in the former waters. The distribution extends southerly along the Chinese coasts (Chekiang, Fukien, Kwangtung) to Canton. The species has also been recorded from west coast of Korea (Sokmo Channel, Mo Island) and off Sasebo, Japan.

REMARKS – The lower antennular flagellum is 23- or 24-segmented in the females from Po Hai; it is 20- to 22-segmented in the specimens from Mo Island and 15- or 16-segmented in the specimens from Matsu Island. *Acetes chinensis* shows close affinities with *A. japonicus,* but it has 4–8 red spots on the endopod of uropod, whereas *A. japonicus* has only 1 spot in the same position. As mentioned by LIU (1956), the figures of the uropod and third thoracic sternite given by YOSHIDA (1941) for *A. japonicus* indicate that his female specimens from central part of Korea are not *A. japonicus* but *A. chinensis.*

4. *Acetes erythraeus* NOBILI
Figures 13, 14

Acetes erythraeus NOBILI, 1905, p. 394, fig. 1; 1906, p. 23, pl. 1 figs. 5, 5a-5f.-KEMP, 1917, p. 51, figs. 1c, 1d, 2b, 3b, 5a, 5b, 7b.-MENON, 1933, p. 2, pls. 1–3.-BURKENROAD, 1934a, p.126.-NATARAJ, 1947, p.143, fig. 2a.-BARNARD, 1950, p. 822.-THAM, 1955, p. 150, figs. 38–40, 47.-LIU, 1956, p. 30.-CROSNIER and FOURMANOIR, 1962, p. 87, fig.-GANAPATI and SUBRAMANYAM, 1964, p. 14.-FREITAS, 1966, p. 3.-PATHANSALI, 1966, p. 60.-GEORGE, 1969, p. 47.-LE RESTE, 1970, p. 35.-KENSLEY, 1969, p. 154; 1971, p. 226, fig. 4.

Acetes sp. HANSEN, 1919, p. 37, pl. 3 fig. 3a.

MATERIAL – China: Kuangtung, Tienpai, collected by J. Y. LIU, 15 Dec. 1954, (*A. erythraeus*, determined by J. Y. LIU, 1974), 2 ad. females (25.0, 26.0 mm), 2 ad. males (20.5, 23.0 mm).
Hong Kong: fish market, collected by P. MOK, Sept. 1965, 5 ad. females, 2 ad. males.
Philippines: Luzon, Manila Bay, collected by I. A. RONQUILLO, 14 ad. females (20.5–24.5 mm), 6 ad. males (16.5–21.0 mm); Paracale Bay, collected by I. A. RONQUILLO, Feb. 1966, 14 ad. females (20.5–27.0 mm), 3 ad. males (19.0–21.5 mm).
Thailand: Gulf of Siam, Chumporn, 31 Jan. 1967, 9 ad. females (22.0–25.5 mm), 3 ad. males (20.5–22.5 mm); Gulf of Siam, Rayong, 12 July 1973, 2 ad. females, 2 ad. males; Phanga Province, Tay Muang Beach, 14 Dec. 1969, 11 ad. females (16.0–19.0 mm).
Malaysia: Kuala Trengganu, collected by D. PATHANSALI, 3 ad. males (16.5–19.5 mm); Sabah, Kudat, fish market, collected by T. E. CHUA, 20 Mar. 1974, 4 ad. females (16.0–21.5 mm), 2 ad. males (15.5, 22.5 mm); Sabah, Labuan, fish market, collected by T. E. CHUA, 23 Mar. 1974, 10 ad. females (21.5–25.5 mm), 1 ad. male (21.0 mm).
Indonesia: Java, Surabaya, collected by ANDREA, 1870, (UCZM, *A. erythraeus*, determined by M. D. BURKENROAD, May 1938), 1 ad. (17.0 mm) and 1 juv. (14.0 mm) males: Bay of Bima, Siboga Expedition Sta. 47, 8-12 May, 1899, (UCZM, *A. erythraeus*, determined by M. D. BURKENROAD), 3 ad. females (16.0–19.0 mm), 2 ad. males (15.5, 17.5 mm); Jakarta, 23 Mar. 1974, 2 ad. females (24.5, 28.5 mm), 2 ad. (21.0, 22.0 mm) and 2 juv. (17.0, 17.5 mm) males.
India: Cochin, collected by the Central Marine Fisheries Research Institute, June 1968, 1 ad. male (15.5 mm).
Kenya: Mombasa, collected by the East African Marine Fisheries Research Organization, 24 Mar. 1971, 6 ad. females (23.5–29.5 mm), 5 ad. males (22.0–24.5 mm).
Madagascar: Ambaro Bay, collected by A. CROSNIER, 15 ad. females (18.0–24.5 mm), 17 ad. males (15.5–22.0 mm).

TYPES – Type specimens should be in Museum National d'Histoire Naturelle, Paris.

DIAGNOSIS – In the females the antennular flagellum is 14- to 18-segmented. In the genital area the third thoracic sternite is trapezoid in ventral view; its anterior part is elevated with a small protuberance on either side.

In the males the lower antennular flagellum is 14- to 16-segmented; the first segment of the main branch has 3–5 basal and 1 marginal spinules and a swelling; the next 3 segments bear 1–2, 1–3, and 3–4 spinules respectively; there is 1 clasping spine which has many tubercles on the inner surface. The coxa of the third pereiopod may or may not have a tooth on the distal

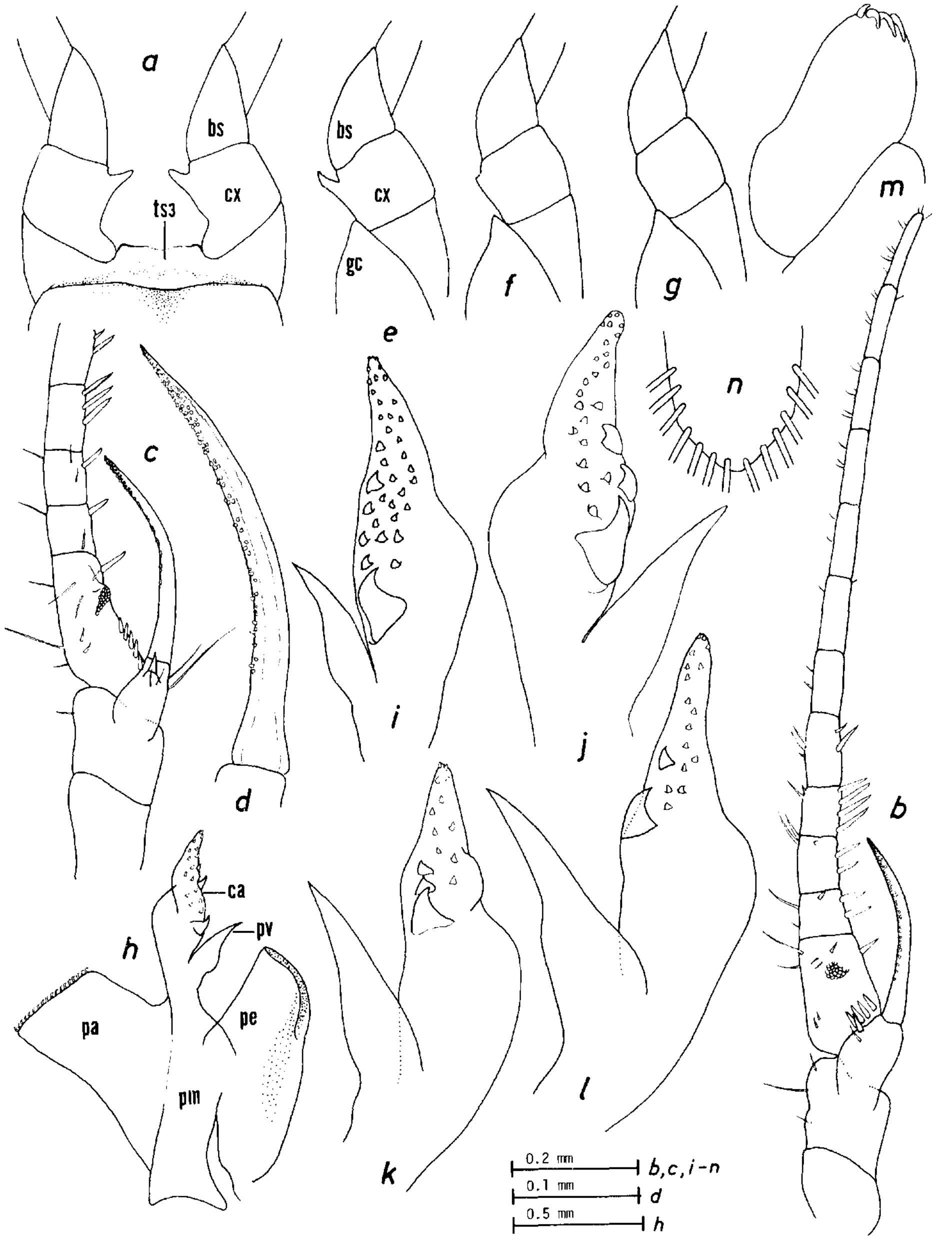

Figure 13. *Acetes erythraeus.* female: a, basal segments of third pereiopods and third thoracic sternite, ventral view. male: b, lower antennular flagellum; c, promixal part of lower antennular flagellum; d, clasping spine; e, basal segments of third pereiopod and genital coxa, ventral view; f, same; g, same; h, petasma; i, capitulum of petasma; j, same; k, same; l, same; m, appendix masculina; n, apex of telson. (a, from Labuan; b, d, e, h, i, m, n, from Kuala Trengganu; c, g, l, from Ambaro Bay; f, k, from Bay of Bima; j, from Kudat).
bs.-basis; ca.-capitulum; cx.-coxa; gc.-genital coxa; pa.-pars astringens; pe.-pars externa; pm.-pars media; pv.-processus ventralis; ts3.-third thoracic sternite.

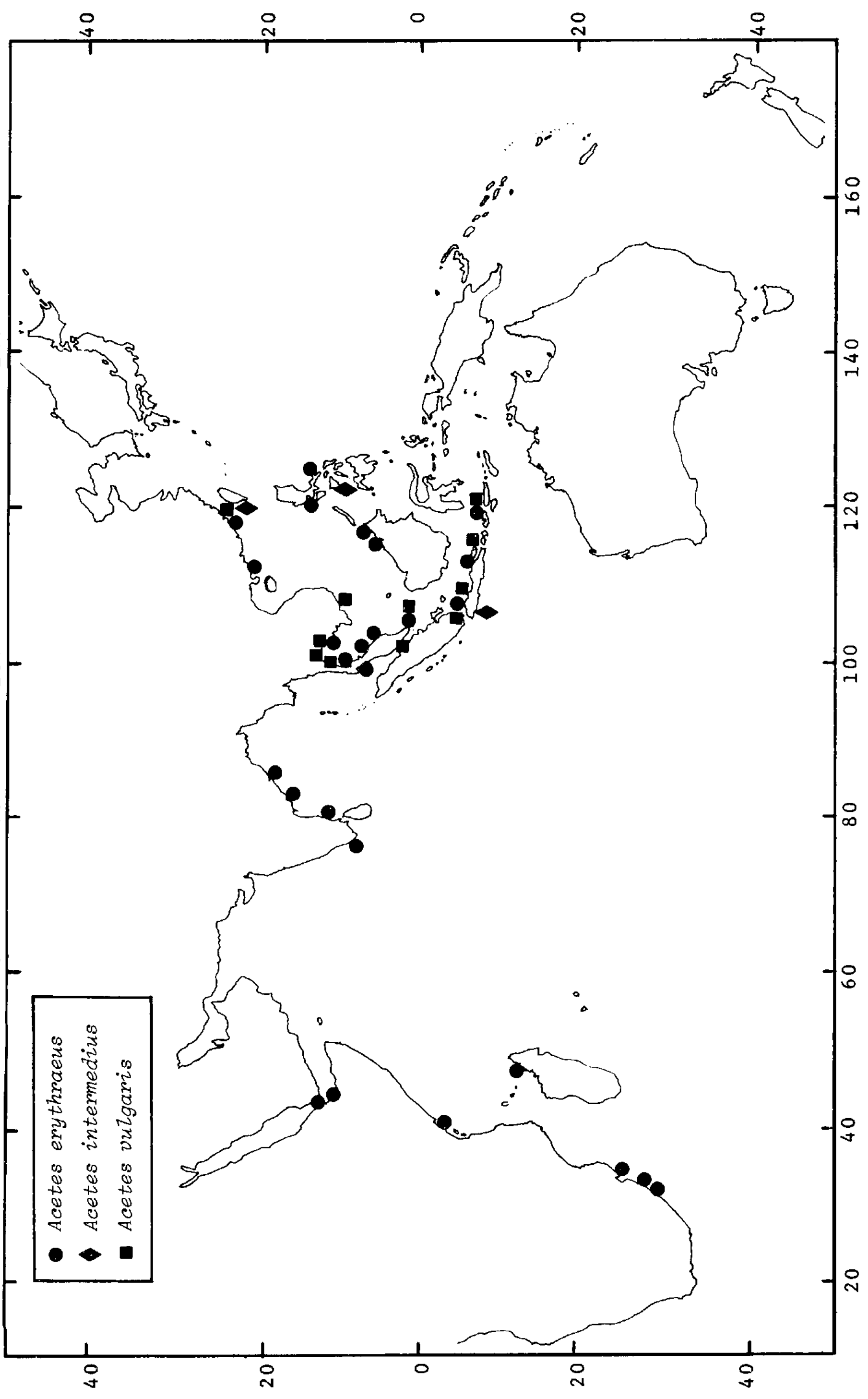

Figure 14. Distribution of *Acetes erythraeus*, *A. intermedius*, and *A. vulgaris*.

inner margin. At the outer margin of the capitulum of the petasma, there is 1 very large hook proximally and a little beyond it there are often 1–2 hooks of considerable size; besides them, there are many minute hooks on the surface from near the proximal hook to the distal end. The appendix masculina bears 3–4 hooks.

There is a large procurved tooth between the bases of the first pleopods in both females and males. There are 1–3 red spots on the endopod of uropod.

BODY LENGTH – Northern specimens measure 16–33 mm in females and 16–26 mm in males, but lengths up to 40 mm in females and 32 mm in males are attained around 30°S. FREITAS (1966) reports a maximum length of 48 mm but that specimen appears to be exceptional.

TYPE-LOCALITY – Red Sea, Djibouti and Abdelkader.

DISTRIBUTION* – The species has the most extensive geographical distribution in the Indo-West Pacific, ranging from Hong Kong through the Gulf of Siam (Chumporn, Rayong), Sumbawa (Bima), Sabah (Kudat, Labuan), Java (Surabaya), the Malay Peninsula (Kuala Trengganu, Singapore, Phanga), India (Puri, Vishakhapatnam, mouth of Godavari River, Madras, Trivandrum) to the entrance of the Red Sea. It is also reported along the east coasts of Africa from French Somaliland, Kenya (Mombasa), Madagascar (Ambaro Bay), Mozambique (Lingamo), and South Africa (Richards Bay, Delagoa Bay, Port Shepstone). The collection from Luzon (Manila Bay, Paracale Bay) recorded in the present study appears to be the easternmost record. On the west coast of India the species seems to be restricted to the Trivandrum coasts where it occurs in large quantities from December to April.

* See note added in proof on page 65.

REMARKS – In a few female specimens from the Bay of Bima and Cochin, the protuberance of the third thoraçic sternite is not rounded but is acutely pointed. The coxa of the third pereiopod of the males show considerable variation in structure. One specimen from Paracale Bay and 2 specimens from Tienpai, Kuala Trengganu, and Chumporn respectively have a well-developed tooth on the inner margin, as in females. In all others the tooth is rudimentary or nearly missing. The position of the large proximal hook on the capitulum of the petasma and the size of the processus ventralis relative to the capitulum also vary considerably.

5. *Acetes indicus* H. MILNE-EDWARDS
Figures 12, 15

Acetes indicus H. M.-EDWARDS, 1830, p. 351, pl. 11 figs. 1-9.- KEMP, 1917, p. 47, figs. 1a, 1b, 2a, 3a, 4a, 5c, 7a.-BOONE, 1935, p. 101, pl. 25, fig. 9.- GANAPATI and SUBRAMANYAM, 1964, p. 12.-PATHANSALI, 1966, p. 60.- KUNJU, 1967, p. 174, fig. 38.- GEORGE, 1969, p. 46.
Acetes spiniger HANSEN, 1919, p. 43, pl. 4 figs, 5a-5h.

MATERIAL – Viet Nam: Dong Hoa, collected by B. T. LANG, 12 Dec. 1972, 23 ad. females (23.0–31.0 mm), 14 ad. males (16.5–25.0 mm).
Thailand: Gulf of Siam, Samudpragarn, 23 June 1967, 2 ad. females.
Indonesia: Java, Surabaya, collected by ANDREA, (UCZM, *A. spiniger* n. sp. syntypes), 6 ad. females (27.5–30.5 mm).
Burma: 10 miles off Rangoon, collected by HANSEN and THALIBITZER (UCZM, *A. spiniger* n. sp. syntypes), 11 ad. females (23.0–27.5 mm), 6 ad. (18.0–20.0 mm) and 1 juv. (14.5 mm) males; Amherst, Green Island, collected by "Investigator" (ZSI 3430/10, *A. indicus*, determined by S. KEMP), 2 ad. females (24.0, 31.0 mm), 2 ad. males (19.0, 21.0 mm); Sandowa and Mergui, dried material given by H. TAKAHASHI, 4 Dec. 1974, many.
India: Goa, off Calangule, collected by C. T. ACHUTHANKUTTY. 1 Dec. 1972, 1 ad. female (23.5 mm), 4 ad. males (15.5–19.5 mm).

TYPES – Type specimens should be in Museum National d'Histoire Naturelle, Paris.

DIAGNOSIS – *Acetes indicus* can be easily distinguished from other species of the genus by having a sharply pointed projection on the inner margin, a little before distal end, of the basis of the third pereiopod. There is a large procurved tooth between the basis of the first pleopods. The endopod of the uropod has 2–4 red spots.

In the females the lower antennular flagellum is 18- to 21-segmented. The third thoracic sternite is deeply channelled longitudinally, the channel being continued backwards on the anterior part of the fourth sternite.

In the males the lower antennular flagellum is 11-or 12-segmented; there is 1 clasping spine which has 1–2 rows of small tubercles on the inner surface; the first segment of the main branch bears 1 spinule at the base; the segment opposite the tip of the clasping spine bears 6–10 spinules. In the petasma the distal part of the capitulum is expanded and bears numerous small hooks along the outer margin and at the end; the pars astringens is absent; the processus ventralis, which originates from the middle of the pars media, is needle-like; it reaches almost to the end of the capitulum.

BODY LENGTH – Matures sexually at 23–34 mm in females and 15–25 mm in males; maximum length about 40 mm in females.

TYPE-LOCALITY – The Ganges Delta.

DISTRIBUTION – The species occurs in the central part of the Indo-West Pacific. The distribution ranges from the South China Sea (Dong Hoa) through the Gulf of Siam (Samudpragarn), Java (Surabaya), Strait of Malacca (Singapore, Malacca), Andaman Sea (Green Island, Merugui, Rangoon, Bassein, Sandowa) and the Bay of Bengal (mouths of the Ganges,

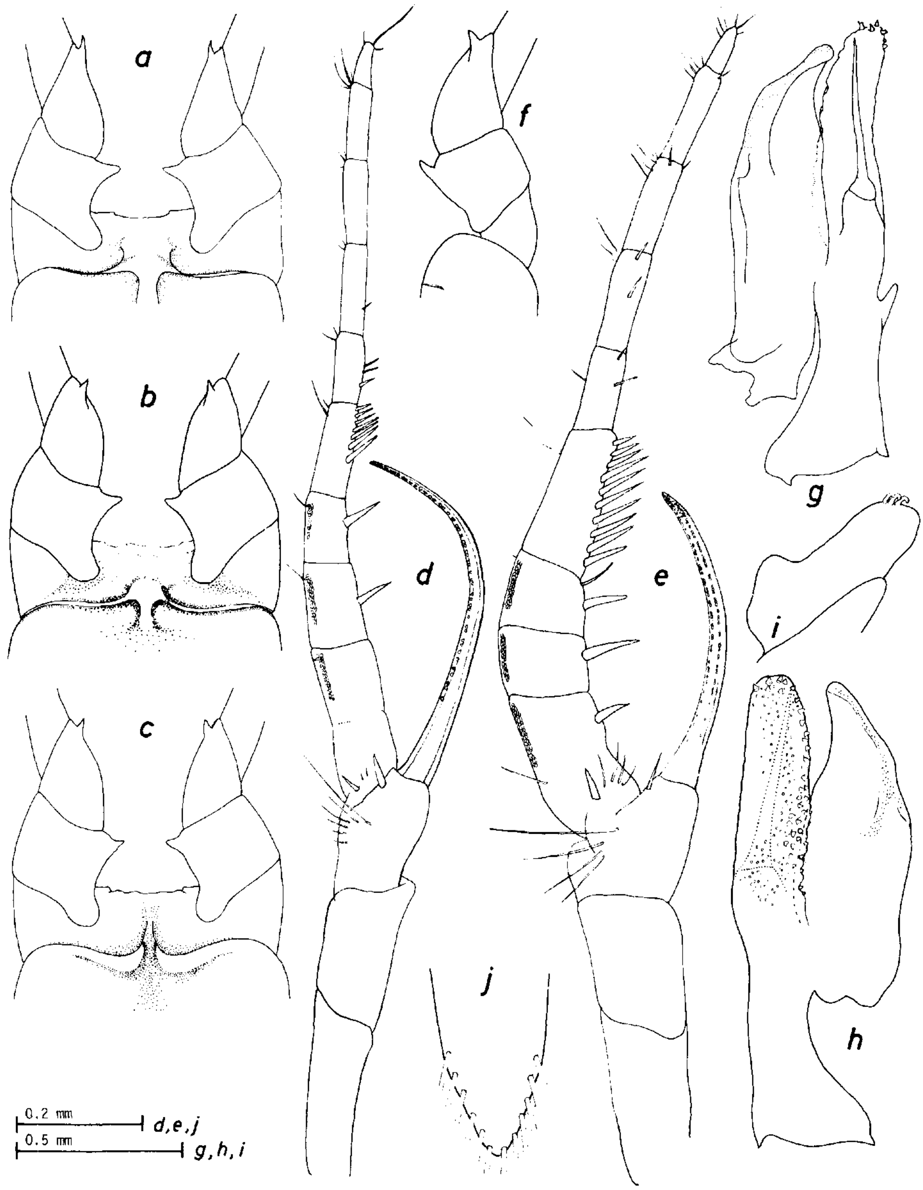

Figure 15. *Acetes indicus.* female: a, basal segments of third pereiopods and third thoracic sternite, ventral view; b, same; c, same. male: d, lower antennular flagellum, small form; e, same, large form; f, basal segments of third pereiopod and genital coxa; g, petasma, posterior side; h, same, anterior side; i, appendix masculina; j, apex of telson. (a. from Goa, body length 23.5 mm; b, from Rangoon, 27.0 mm; c, from Dong Hoa, 31.0 mm; d, from Rangoon, 18.5mm; e. i, from Dong Hoa, 24.0 mm; f, h, j, from Rangoon, 21.0 mm; g, from Goa, 16.5 mm).

Kakinada, mouth of Godavari River, Madras) to the Arabian Sea (Bombay). The species is most common along the Maharashtra coast, western North India, where it contributes to a considerable part of the shrimp fishery of India.

REMARKS – The proportional length of the third segment to the first segment of the antennular peduncle, unlike other species, tends to decrease with increasing body length. There are 2 distinct forms of males in the present specimens. The one is large, 17.5–25.0 mm with an average body length 21.8 mm, whereas the other form is small, 15.5–19.5 mm with an average length 17.1 mm.

In the large form the antennal scale extends beyond the proximal 1/10 of the third segment of the antennular peduncle. In the lower antennular flagellum the clasping spine is comparatively short and robust; there are 2 rows of tubercles on the inner surface. The first segment of the main branch has 1 marginal spinule. The segment opposite the tip of the clasping spine is long and bears 8–10 spinules on its entire margin; the proportional length of this segment to the 2 preceding segments combined is 85–102:100. The appendix masculina bears 3 hooks.

In the small form the antennal scale reaches only to the distal 9/10 of the second segment of the antennular peduncle. The clasping spine is slender and curves sharply inwards; there is 1 row of tubercles on the inner surface. The first segment of the main branch lacks a marginal spinule. The segment opposite the tip of the clasping spine is short and bears 6–8 spinules only on the distal 2/3 of the segment; the proportional length of this segment to the 2 preceding segments combined is 55–66:100. The appendix masculina bears 2 hooks.

There is no clear difference in the structure of the petasma between these two forms, but a vestige of the pars astringens is seen on the inner margin of the pars media in only a few specimens of the small form. The processus ventralis is broken off at the base in most of specimens of the large form. The material from Viet Nam was composed of 12 specimens of the large form and 2 of the small form. That from Burma (samples from UCZM and ZIS) was comprised of 5 individuals of the large form and 3 of the small form, whereas that from India was composed entirely of the small form. Such clear separation of the two forms is difficult in the case of females. In the extremely large females from Viet Nam the posterior margin of the third thoracic sternite and the anterior margin of the fourth sternite swell so remarkably that the longitudinal channel becomes very narrow. The difference between these two forms may be largely due to the difference at maturity, but more detailed study remains desirable to define the relation of these forms. Until then I assign all present specimens to *A. indicus*.

6. *Acetes intermedius* new species
Figures 14, 16, 17

Acetes erythraeus NOBILI.-YU, 1974, p. 61, fig. 2.

MATERIAL – Taiwan: off Tungkiang, commercial catch, Dec. 1972, 21 ad. females (20.0–24.0 mm), 4 ad. males (17.0–18.5 mm).
Philippines: Panay, Iloilo, 23 Mar. 1974, 3 ad. females (20.5–22.5 mm), 4 ad. males (18.0–21.0 mm).
Indonesia: Java, Pelabuhan Ratu, commercial catch, 24 Mar. 1974, 20 ad. females (21.0–26.0 mm), 3 ad. males (19.5–24.0 mm).

TYPES – Holotype, 1 ad. male (18.5 mm), USNM 150621, allotype, 1 ad. female (23.5 mm), USNM 152728, and paratypes, 4 ad. females and 1 ad. male, USNM 150622, from Tungkiang deposited at the U.S. National Museum of Natural History. Paratypes, 3 females and 2 males from Java deposited at Universitetets Zoologiske Museum, Copenhagen.

DIAGNOSIS – In the females the first segment of the antennular peduncle is at most as long as the second and third segments combined. The lower antennular flagellum is 12- to 15-segmented. The basis of the third pereiopod has a small projection on the distal inner margin. There is a pair of distinct protuberances on the anterior part of the third thoracic sternite; the sternite is concave in the median part, and is not produced backwards.

In the males the third segment of the antennular peduncle is nearly as long as the first and second segments combined. The lower antennular flagellum is 13- or 14-segmented; the clasping spine has, like that of *A. sibogae sibogae*, a row of 7–11 large teeth; the first segment of the main branch has, in addition to a swelling, 4 basal spinules and 1 marginal spinule; the latter spinule is twice as long as that on the second and third segments; the segment opposite the tip of the clasping spine bears 5 spinules of which the distal one may be short; the next segment bears 2–3 spinules. The coxa of the third pereiopod lacks a tooth on the distal inner margin. The capitulum of the petasma is slender, 3.5 times as long as broad; its distal half tapers to a narrow end; there are 3–5 large falcate hooks on the proximal half and a few small hooks on the distal half along the outer margin; the large hooks on the proximal half of the capitulum increase gradually in size distally. The appendix masculina bears 3 hooks.

There is a small procurved tooth between the bases of the first pereiopod in both females and males. The apex of the telson is sharply pointed. There is a red spot on the proximal part of the endopod of uropod.

BODY LENGTH – Females 20–26 mm, males 17–24 mm.

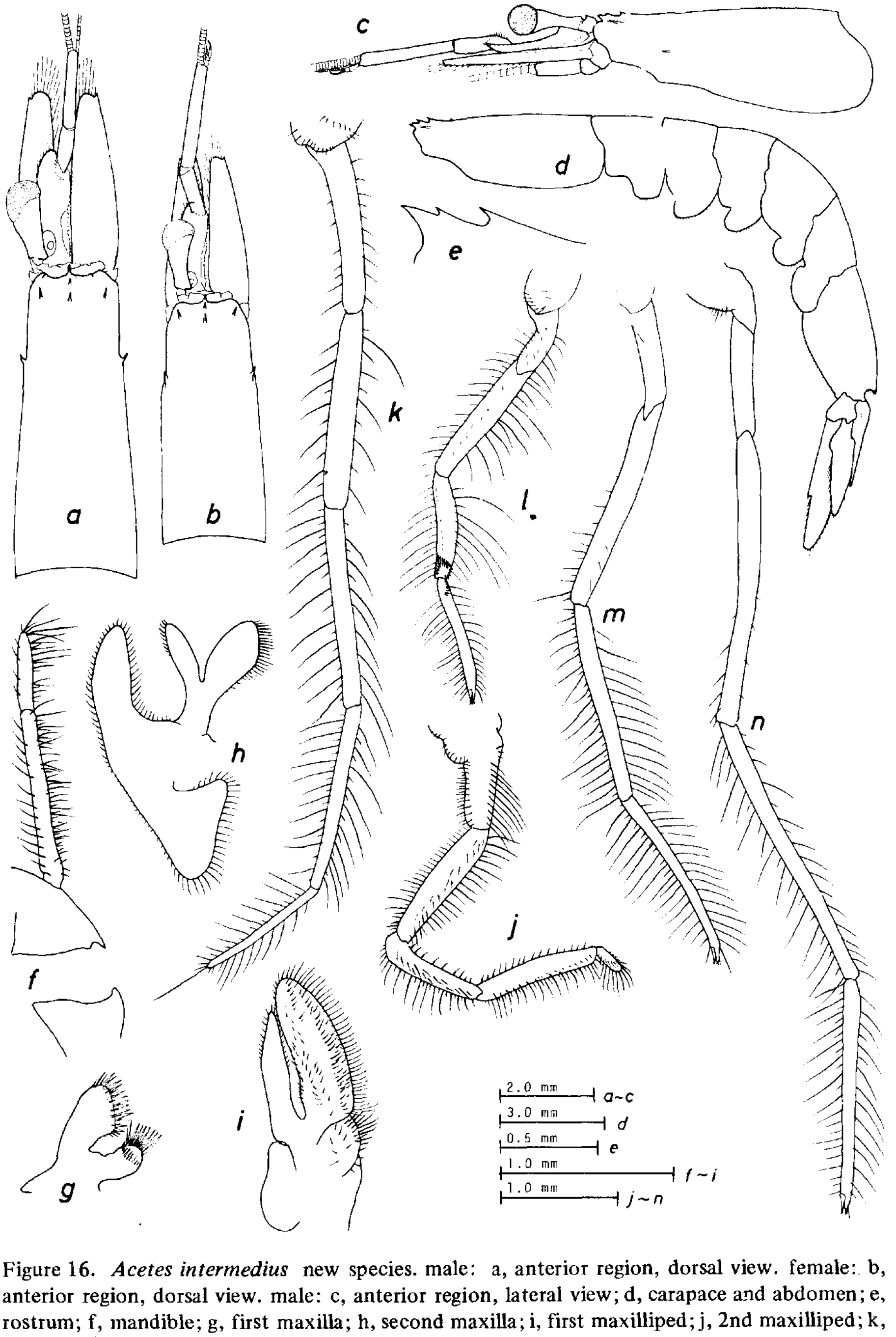

Figure 16. *Acetes intermedius* new species. male: a, anterior region, dorsal view. female: b, anterior region, dorsal view. male: c, anterior region, lateral view; d, carapace and abdomen; e, rostrum; f, mandible; g, first maxilla; h, second maxilla; i, first maxilliped; j, 2nd maxilliped; k, 3rd maxilliped; l, first pereiopod; m, second pereiopod; n, third pereiopod. (a, c–n, paratype from Tungkiang, body length 18.0 mm; b, paratype from Tungkiang, 23.5 mm).

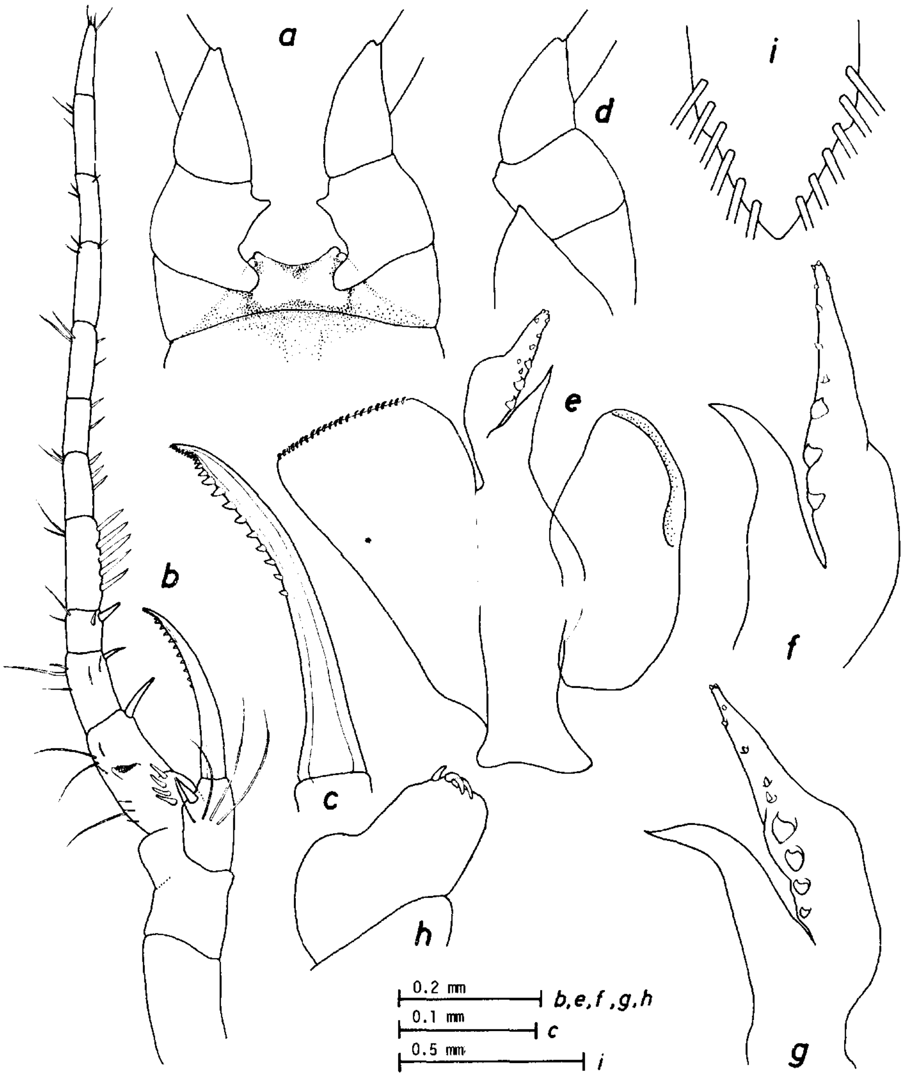

Figure 17. *Acetes intermedius* new species. female: a, basal segments of third pereiopods and third thoracic sternite, ventral view. male: b, lower antennular flagellum; c, clasping spine; d, basal segments of third pereiopod and genital coxa, ventral view; e, petasma; f, capitulum of petasma; g, same; h, appendix masculina; i, apex of telson. (a, paratype from Tungkiang; b–f, h, i, holotype from Tungkiang; g, paratype from Pelabuhan Ratu).

TYPE-LOCALLY – Off Tungkiang, Taiwan.

DISTRIBUTION – The species is found from Taiwan (Tungkiang), Panay (Iloilo) and south coast of Java (Pelabuhan Ratu).

REMARKS – *Acetes intermedius* is so named because it has a combination of characters of *A. erythraeus* and *A. sibogae.* The specimens described as *A. erythraeus* by YU (1974) are the same material that I regard here as new species *A. intermedius.* The most characteristic features of the present species which separate it from *A. erythraeus* are the proportional lengths of the first, second, and third segments of the antennular peduncle and the structure of the petasma. The species can be distinguished from *A. sibogae* by the structure of the petasma and the presence of a procurved tooth on the first abdominal segment between the bases of the first pleopods.

7. *Acetes japonicus* KISHINOUYE

Figures 12, 18

Acetes japonicus KISHINOUYE, 1905, p. 163, figs.- BALSS, 1914, p. 18. - KEMP, 1917, p. 56, figs. 1h, li, 2d, 3d, 4d, 5f, 6, 7d.- SOEJIMA, 1926, p. 153, figs. 1–6.- BURKENROAD, 1934a, p. 127.- YOSHIDA, 1941, p. 18; 1949, p. 51.- IKEMATSU, 1953, p. 771, fig. 3; 1963, p. 21, pl.1 figs. 1–4.- YASUDA et al., 1953, p.1, figs. 2–4, 7.- LIU, 1955, p. 22, pl. 8 figs, 1–5; 1956, p. 35, pl. 4; 1959, p. 37.- PATHANSALI, 1966, p. 60.-HARADA, 1968, p. 97.
Acetes disper HANSEN, 1919, p. 39, pl. 3 figs. 5a-5f, pl. 4 fig. 1a. - NATARAJ, 1947, p. 145, figs. 2d, 2e.- CHENG, 1953, p. 37, figs. 1–6.- THAM, 1955, p. 150, figs. 43, 44.
Acetes cochinensis RAO, 1968, p. 298, figs. 1–10.

MATERIAL – Japan: Ariake Sea, 32° 45'N, 130°25'E, R/V "Bosei Maru" Sta. 13, 30 Aug. 1973, 4 ad. females (14.5–16.0 mm), 3 ad. males (11.0–11.5 mm); Ariake Sea, off Okinohata, collected by M. SONE, 7 June 1973, 16 ad. females (25.5–29.0 mm), 4 ad. males (21.5–23.5 mm); Ariake Sea, off Hizenhama, 25 Oct. 1973, 22 juv. females (16.5–20.0 mm), 7 juv. males (16.5–18.5 mm); Seto Inland Sea, off Imazu, 18 Oct. 1973, 5 juv. females (19.0–21.0 mm), 5 juv. males (18.5–19.5 mm); Seto Inland Sea, off Ushimado, 22 Oct. 1973, 13 juv. females (18.0–20.5 mm), 5 juv. males (18.0–20.0 mm); Suruga Bay, off Yui, 18 Aug. 1972, 5 ad. females (16.0–17.0 mm), 2 ad. males (14.5, 15.0 mm); Toyama Bay, off Iwase, collected by S. DOI, 26 June 1973, 2 ad. females (24.0, 24.5 mm); Toyama Bay, off Shinminato, commercial net, 1 Nov. 1974, 10 juv. females (19.5–23.5 mm) and 10 juv. males (14.0–21.0 mm); mouth of Shinano River, 23 Oct. 1975, many juv. females and males.
China: Kuangtung, Chapo, collected by J. Y. LIU, 15 Nov. 1954, (*A. japonicus,* determined by LIU, 1974), 2 ad. females (21.0, 22.5 mm), 2 ad. males (19.0, 19.5 mm).
Viet Nam: Dong Hoa, 2 ad. females (18.5, 19.0 mm); Vung Tau, collected by B. T. LANG, 23 Dec. 1972, 1 ad. (14.5 mm) and 3 juv. (11.0–13.5 mm)

females, 9 ad. males (12.0–14.0 mm).
Thailand: Phanga Province, Goh Pangi, 4 Apr. 1974, 12 ad. females (13.0–13.5 mm), 10 ad. males (11.5–14.0 mm); Klong Nam Bo, 21 July 1972, 2 ad. females (12.5, 13.5 mm), 2 ad. males (11.5, 13.5 mm).
India: Cochin, collected by the Central Marine Fisheries Research Laboratory, June 1968, (*A. cochinensis*, determined by P. V. RAO), 1 ad. female (18.5 mm), 1 ad. male (13.0 mm); Cochin, 1968, 7 ad. females (13.5–19.0 mm), 9 ad. males (12.5–16.0 mm); Cochin, off Kuzhupilly, collected by C. T. ACHUTHANKUTTY, 27 June 1973, 3 ad. females (19.5–21.5 mm), 1 juv. male (11.5 mm).

TYPES – Repository of the type specimens is unknown.

DIAGNOSIS – In the females the lower antennular flagellum is 11- to 14-segmented. The structure of the genital area is similar to that of *A. chinensis*, but the third thoracic sternite is produced backwards more strongly and the emargination of its posterior margin is shallower than that of *A. chinensis.*

In the males the lower antennular flagellum is 10- to 12-segmented; there are 2 clasping spines which have irregularly arranged tubercles on the distal inner surface; the first segment of the main branch has a basal spinule and a swelling; the segment opposite the tip of the longer clasping spine has 3–4 spinules; the following 4 segments each have 2–5 minute spinules distally. In the petasma the distal part of the capitulum is expanded like a bulb and has numerous hooks. The appendix masculina has 2 hooks.

The endopod of the uropod has 1 red spot on the proximal part in both females and males. The apex of the telson is usually rounded but it is truncated in a few specimens.

BODY LENGTH – In the western part of Japan the summer generation grows to 15–21 mm in females and 11–16 mm in males, whereas the winter generation grows to 22–30 mm in females and 18–24 mm in males.

TYPE-LOCALITY – The Ariake Sea and Seto Inland Sea, Japan, and Mokpho, Korea.

DISTRIBUTION – The species shows a considerably wide geographical distribution along the coasts of the Yellow Sea (Tsingtao, west coast of Korea), South China Sea (Amoy, Shangchwan Shan, Kaohsiung), Gulf of Siam (Lem Ngob, Songkhla), Java Sea (Cheribon), and Strait of Malacca (Penang, Port Swettenham). It has also been reported sporadically from both east and west coasts of South India (Madras, Kilakarai, Trivandrum, Marmagao). In Japan the species is found in the neritic waters around Kyushu and western part of Honshu, and is commercially fished in the Ariake Sea, the Seto Inland Sea and in Toyama Bay. The easternmost record of the occurrence is at the

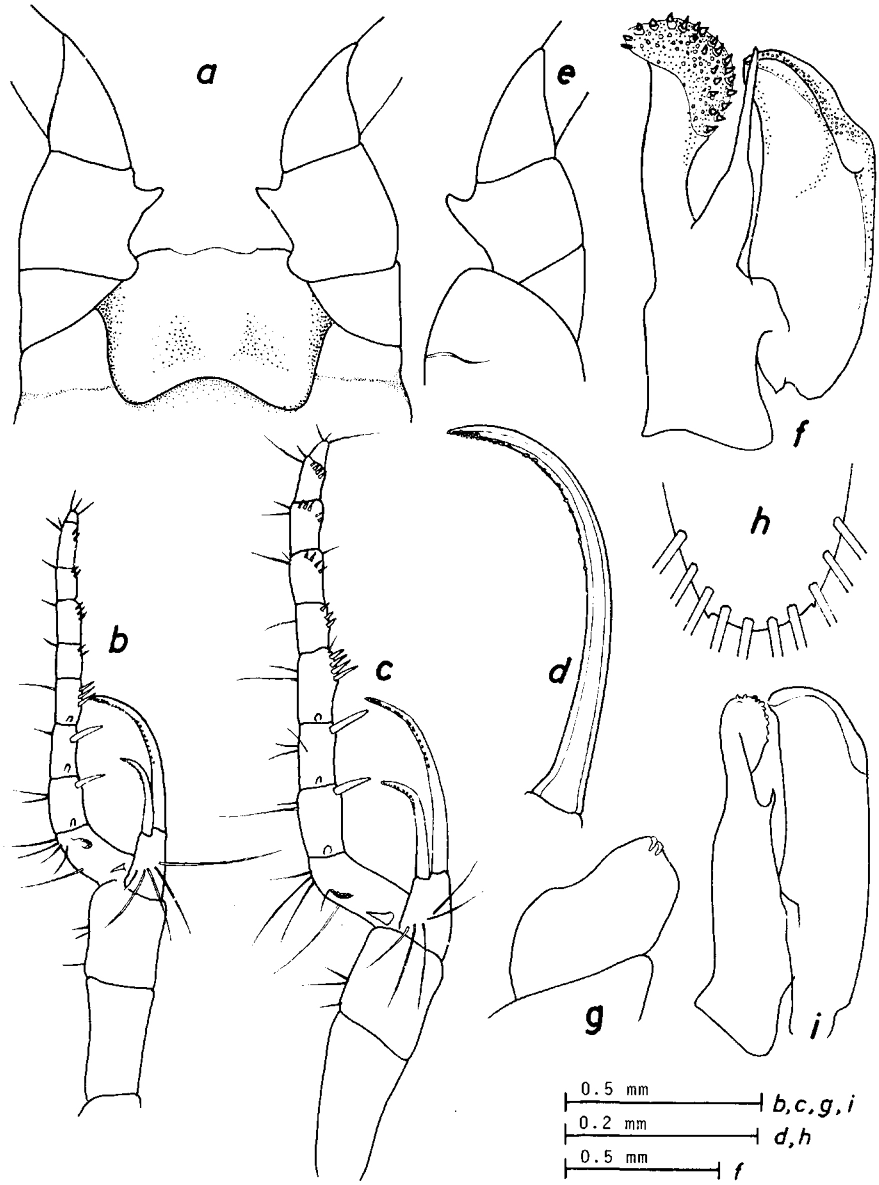

Figure 18. *Acetes japonicus.* female: a, basal segments of third pereiopods and third thoracic sternite, ventral view. male: b, lower antennular flagellum; c, same; d, longer clasping spine; e, basal segments of third pereiopod and genital coxa, ventral view; f, petasma; g, appendix masculina; h, apex of telson; i, petasma, immature. (a, b, d–f, h, from Cochin; c, g, from Okinohata; i, from Shinminato).

mouth of Shinano River, the Sea of Japan. Great swarms appeared unusually in Suruga Bay in July and August of 1972. The species is recorded here for the first time from Viet Nam.

REMARKS – KEMP (1917) noted that the terminal segment of the third maxilliped of *A. japonicus* was divided into 3 segments but this was not seen in all present specimens. The length of the processus ventralis of the petasma depends on the stage of development; it is quite short in the younger males, but as shown by IKEMATSU (1953) and YASUDA *et al.* (1953), it reaches or extends beyond the end of the capitulum in the fully grown ones. Generally, the tooth between the ciliated and non-ciliated parts of the outer margin of the exopod of the uropod is obscure or completely absent, although it is minute but distinct in a few males. The telson is armed with a pair of small teeth in a majority of the specimens, but a few adult females of the winter generation lack the teeth.

I am of the opinion that *A. cochinensis* which has been recorded once from Cochin is *A. japonicus.* In describing the species RAO (1968) appears to have compared his specimens with the description of *A. japonicus* by KEMP (1917). However, obviously he did not examine typical specimens of *A. japonicus,* particularly those of the summer generation, from Japan. Except for the structure of the genital plate of the females, all characters mentioned by RAO to distinguish *A. cochinensis* from *A. japonicus* are invalid. RAO noted that the genital plate of *A. cochinensis* was characterized by having a pair of protuberances on the anterior margin of the third thoracic sternite between the coxae of the third pereiopods, but I have been unable to detect it in his specimens from Cochin. Even if this character is valid, the difference is not worth more than subspecific recognition.

8. *Acetes johni* NATARAJ , new rank

Figures 19, 20

Acetes serrulatus johni NATARAJ, 1947, p. 139, fig. 1.

MATERIAL – India: Trivandrum, collected by S. NATARAJ, Dec. 1941, (ZSI C2554/1, *A. serrulatus johni* n. var. syntypes), 5 ad. males (17.0–18.0 mm).

TYPES – Syntypes here examined are in the Zoological Survey of India.

DIAGNOSIS – In the males the lower antennular flagellum is 11- or 12-segmented; there are 2 clasping spines; the structure of the lower antennular flagellum is quite similar to that of *A. natalensis* and *A. serrulatus* but the projection from upper end of the first segment of the main branch is more

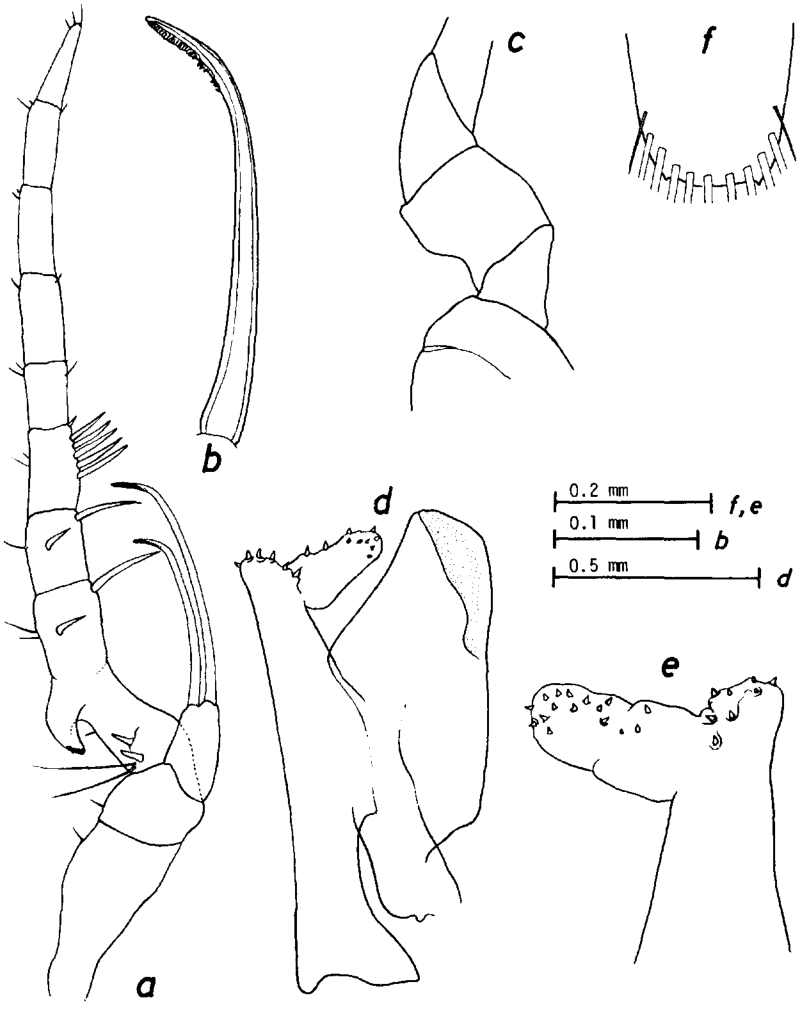

Figure 19. *Acetes johni.* male: a, lower antennular flagellum; b, longer clasping spine; c, basal segments of third pereiopod and genital coxa, ventral view; d, petasma; e, capitulum of petasma, posterior side; f, apex of telson. (a–f, from Trivandrum).

prominent; the first segment bears 2 spinules at the base; the marginal spinule of the second segment is as long as that of the third segment; the segment opposite the tip of the longer clasping spine bears 4–5 spinules. The basis of the third pereiopod has no projection on the distal inner margin; the coxa lacks the tooth. The petasma lacks a pars astringens; the capitulum has a large ventral projection which is placed at right angles to the long axis of the pars media, with the tip directed towards the pars externa; there are numerous minute hooks on the distal and outer margin of both the capi-

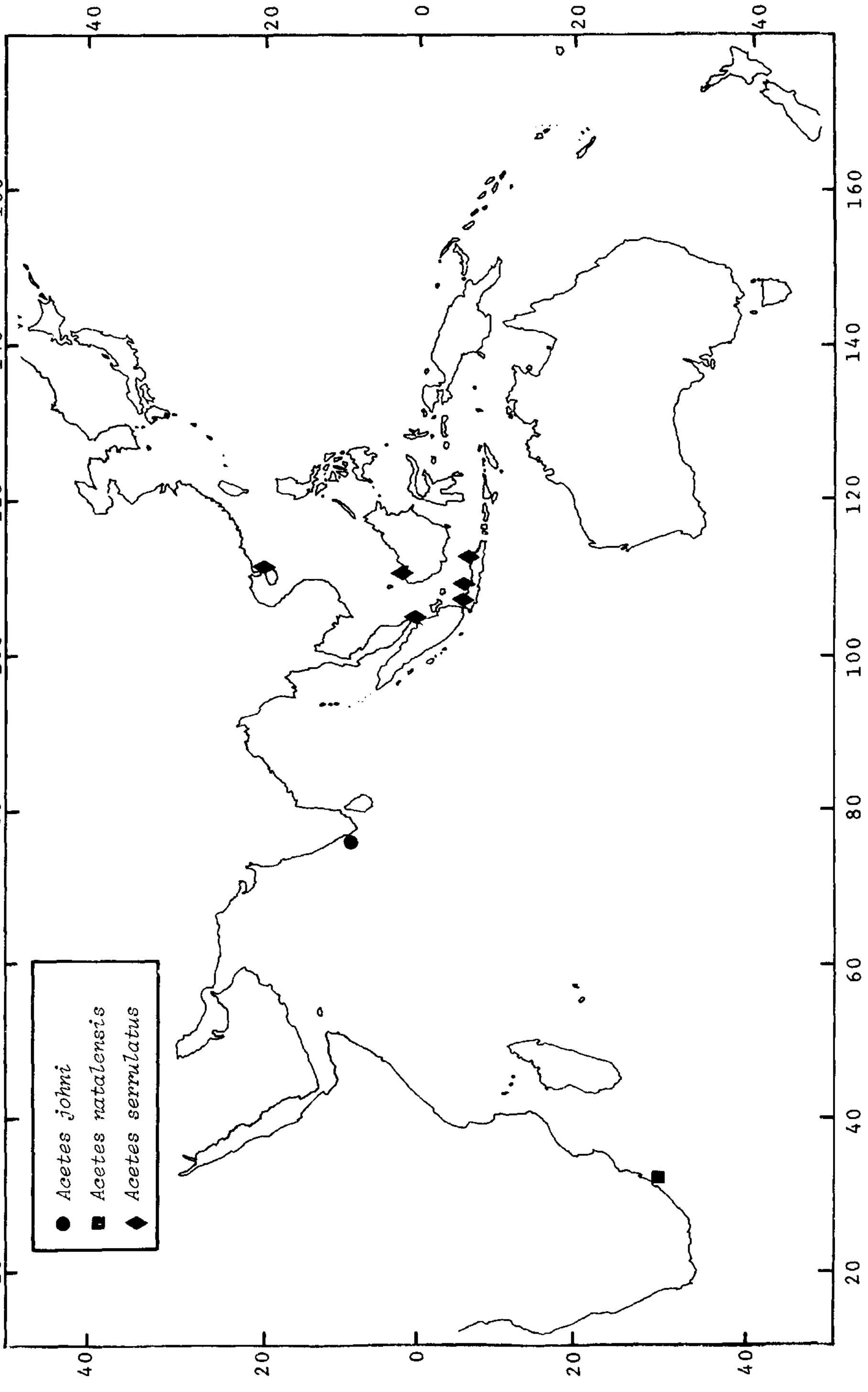

Figure 20. Distribution records of *Acetes johni*, *A. natalensis*, and *A. serrulatus*.

tulum and the ventral projection. The apex of the telson is truncated and bears a small tooth on either corner; occasionally one of the teeth may be missing.

BODY LENGTH – Males 15–20 mm.

TYPE-LOCALITY – Coastal waters of Travancore, India.

DISTRIBUTION – According to NATARAJ (1947), this species occurs abundantly on the Travancore coast from the middle of December to the middle of April. JONES (1967) reported that *A. serrulatus* is fished along the Madras and Kerala coasts. This record is more likely to be of *A. johni* than *A. serrulatus.* So far, the typical *A. serrulatus* has not been found in India (Mr. C. T. ACHUTHANKUTTY, personal communication).

REMARKS – I believe that NATARAJ's subspecies should be given specific rank. *Acetes serrulatus* and *A. johni* are probably allopatric and evidence of intergradation is nonexistent. I consider that the difference between *A. serrulatus* and *A johni* is of about the same magnitude as the difference between *A. serrulatus* and *A. natalensis.*

NATARAJ (1947) noted that the capitulum of the petasma is hemispherical and lacks a hook, but I saw many hooks in the type specimens. The female was not available to me, because all female type specimens are in a damaged condition at ZSI (Dr. G. RAMAKRISHNA, personal communication). According to NATARAJ the females of the present species have the following characteristic structure. The proportional lengths of the first, second, and third segments of the antennular peduncle are 55:17:28. The third maxilliped reaches almost to the end and in some cases even extends beyond the end of the third antennular peduncle. The coxa of the third pereiopod bears a tooth on the distal inner margin; the third thoracic sternite is trapezoid in ventral view; it is gently grooved and the anterior margin is slightly depressed; the fourth sternite, unlike that of the other species of the genus, is acutely pointed at both ends, while the median part is broadly grooved.

9. *Acetes marinus* new species

Figures 8, 21, 25

Acetes paraguayensis HANSEN.-HOLTHUIS, 1959, p. 51, fig. 2.

MATERIAL – Brazil: Rio Tocantins near its junction with Rio Para, collected by M. IWAI, 17 Jan. 1974,(*A. paraguayensis*, determined by M. IWAI), 6 ad. (17.0–19.5 mm) and 1 juv. (14.5 mm) females, 13 ad. males (13.5–16.0 mm).

TYPES – Holotype, 1 ad. male (16.0 mm), USNM 152729, allotype, 1 ad. female (17.0 mm), USNM 152730, and paratypes, 1 ad. female and 3 ad. males, USNM 152731, from Rio Tocantins deposited at the U.S. National Museum of Natural History. Paratypes, 3 ad. females and 3 ad. males, from the same locality deposited at Universitetets Zoologiske Museum, Copenhagen.

DIAGNOSIS – In the females the lower antennular flagellum is 12- or 13-segmented. The antennal scale hardly reaches the end of the third segment of the antennular peduncle. The coxa of the third pereiopods is swollen on the inner margin and has a small, blunt tooth.

In the males the antennular peduncle is elongated; the first segment is shorter than the second and third segments combined. The antennal scale reaches at most the end of the second segment of the antennular peduncle. The lower antennal flagellum is 10- or 11-segmented; its structure agrees with that of *A. paraguayensis.* The coxa of the third pereiopods has a structure similar to that of the females; the inner margin is remarkably swollen but the tooth may be entirely absent in some specimens. The petasma has a broad pars astringens; the pars astringens is nearly as long as the pars externa; the pars media lacks capitulum; it is as high as the pars astringens; the distal margin of the pars media and the pars astringens is broad and flat in general.

Other characteristics in both females and males closely agree with those of *A. paraguayensis.*

BODY LENGTH – Females 17–23 mm, males 13–19 mm.

TYPE-LOCALITY – Rio Tocantins near its junction with Rio Para, Brazil.

DISTRIBUTION – The present species inhabits slightly brackish water of the Saramacca Canal, Paramaribo, Surinam, and Rio Tocantins near its junction with Rio Para, Brazil.

REMARKS – *Acetes marinus* resembles *A. paraguayensis* in general appearance. However, it is distinguished from the latter by the absence of a large tooth on the coxa of the third pereiopods in both females and males; in the males the second and third segments of the antennular peduncle are more elongated than those of *A. paraguayensis.* The pars astringens/pars externa length ratio of the petasma is 0.88–1.05 (average 0.97) in *A. marinus* from Rio Tocantins, whereas it is 0.46–0.77 (0.60) and 0.72–0.78 (0.76) in *A. paraguayensis* from Rio Nanay and Rio Paraguay respectively. Diagnostic features used to distinguish populations at the specific level

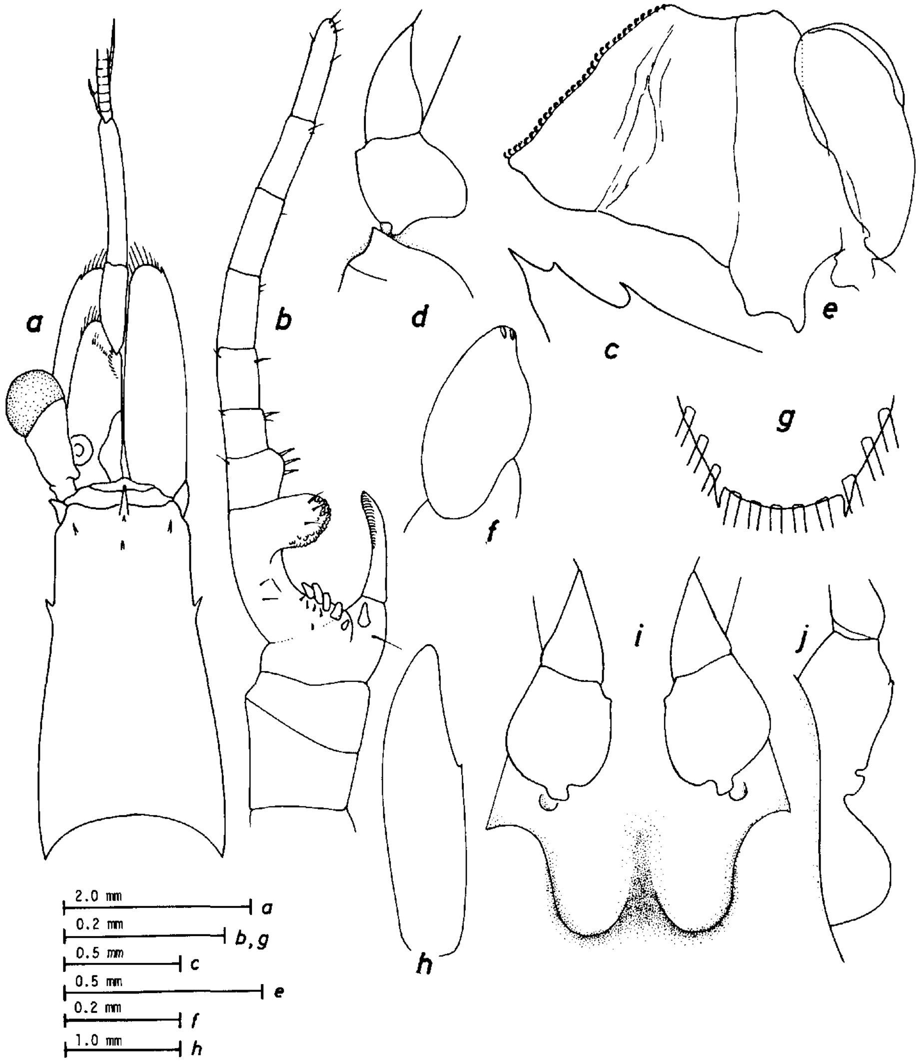

Figure 21. *Acetes marinus* new species. male: a, anterior region, dorsal view; b, lower antennular flagellum; c, rostrum; d, basal segments of third pereiopod and genital coxa; e, petasma; f, appendix masculina; g, apex of telson; h, exopod of uropod. female: i, basal segments of third pereiopods and third thoracic sternite, ventral view; j, same, lateral view. (a–j, paratypes from Rio Tocantins).

include morphological characteristics that appear at sexual maturity. Constant differences in secondary sexual characters among otherwise morphologically similar forms are assumed to express the existence of prezygotic mating barriers, and therefore completion of the evolutionary process of speciation (FLEMINGER and HULSEMANN, 1973). From this point of view the present specimens were treated as a distinct species. The proportional lengths of the segments of the antennular peduncle of the males and the structure of the coxa of the third pereiopod of the females appear to be constant characters. An intraspecific variation of the tooth on the inner margin of the female coxa has never been observed in any species of *Acetes*.

Acetes marinus inhabits slightly brackish water, whereas *A. paraguayensis* are restricted to completely fresh water more than several hundred kilometers from the mouth of the river. The above-mentioned morphological differences evidently must reflect the remarkable environmental differences between two habitats. Two species appear to show independent geographical distribution, but the considerable similarity between them may suggest the possible evidence of intergradation between two populations in the lower part of the Amazon basin, particularly in the brackish waters or in the intermixing areas between different watermasses, where salinity will change markedly from place to place and from time to time. As TOKIOKA (1974) showed in the chaetognath *Aidanosagitta crassa*, ecophenoty due to differences in ionic concentrations might influence gill area to body surface, body size, and perhaps indirectly affect relative size of sensory organs and feeding appendages. Although confirmation requires analysis of extensive material from many localities, it can hardly be considered that great salinity change causes differentiation of sexually modified structures that are clearly adapted for reproductive processes. On the other hand, as Dr. A. FLEMINGER mentioned (personal communication), if two populations had overlapping ranges, and they were better adapted as separate gene pools than any hybrid offspring they might produce, development of a pre-mating barrier (e.g. ethological or a key and lock mechanism) would be adaptive and advantageous by reducing wasted gametes. *A. marinus* is so named because it is distributed where marine water is an important environmental factor.

The specimens reported as *A. paraguayensis* from Surinam (HOLTHUIS, 1959) are identical to this new species. HOLTHUIS observed in his specimens that the first denticle of the rostrum is placed close to the terminal point. A similar rostrum is seen in several specimens of *A. marinus* and *A. paraguayensis*. Thus this is not a constant character for the new species.

10. *Acetes natalensis* BARNARD

Figures 20, 22

Acetes natalensis BARNARD, 1955, p.43.-KENSLEY, 1971, p. 226. fig. 5.

MATERIAL – South Africa: Durban Bay, collected by the University of Cape Town, 1951, (SAM A11976, *A. natalensis* n. sp. syntypes), 2 ad. females (22.0 mm, one is broken), 2 ad. males (16.5, 17.5 mm).

TYPES – Syntypes here examined are in the South African Museum.

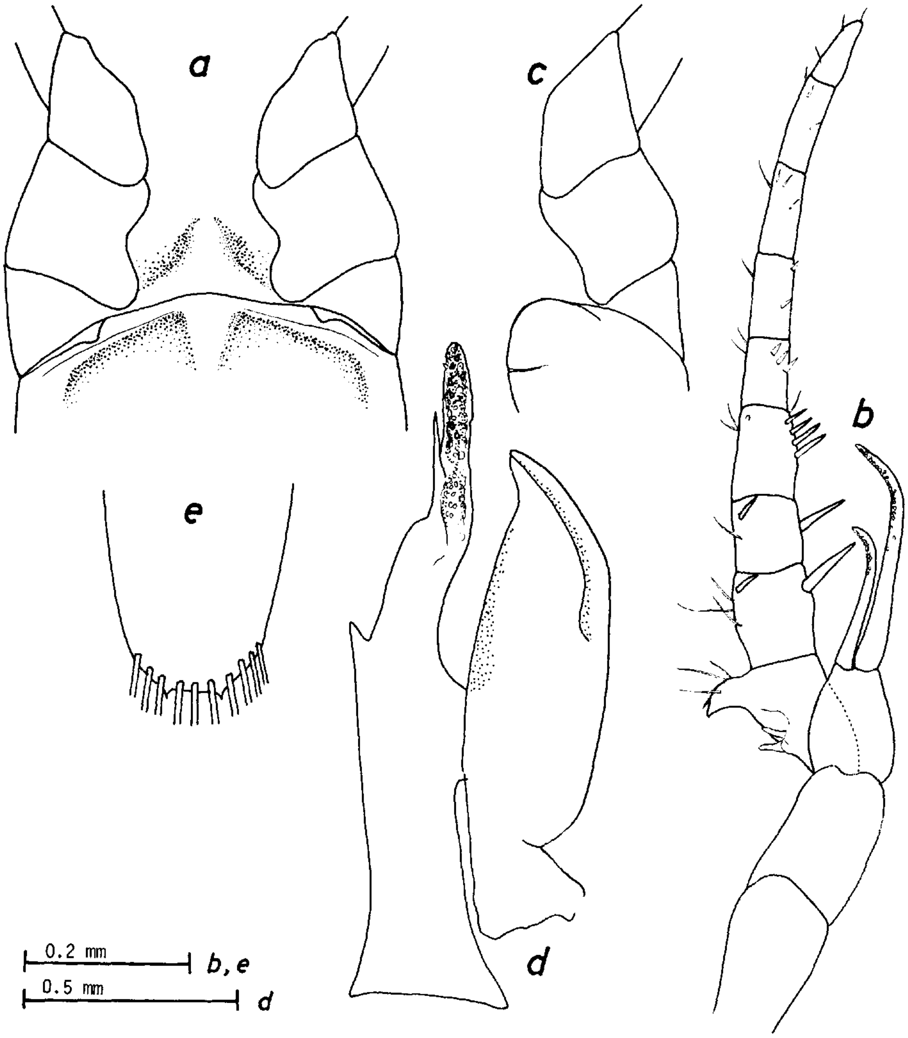

Figure 22. *Acetes natalensis.* female: a, basal segments of third pereiopods and third thoracic sternite, ventral view. male: b, lower antennular flagellum; c, basal segments of third pereiopod and genital coxa, ventral view; d, petasma; e, apex of telson. (a–e, from Durban Bay).

DIAGNOSIS – In the females the lower antennular flagellum is 11-segmented. The coxa of the third pereiopod is swollen but it lacks a tooth on the distal inner margin. The anterior part of the third thoracic sternite is elevated and more or less transverse.

In the males the lower antennular flagellum has a structure similar to that of *A. serrulatus*; it is 11-segmented; there is a triangular projection from the upper end of the first segment of the main branch; the first segment bears 2 spinules at the base; the marginal spinule of the second segment is nearly as long as that of the third segment; there are 2 clasping spines; the segment opposite the tip of the longer clasping spine bears 3–4 spinules. The coxa of the third pereiopod lacks a tooth. In the petasma the processus ventralis makes a sharp fork at the middle of the inner margin of the capitulum; the apical cylindrical part of the capitulum has tubercles and hooks; there is a distinct triangular process (a vestige of the pars astringens) on the inner margin of the pars media.

BODY LENGTH – Females 22–23 mm, males 16–18 mm.

TYPE-LOCALITY – Durban Bay, South Africa.

DISTRIBUTION – The species is distributed in Durban Bay, Sourth Africa.

REMARKS – The apex of the telson in both females and males is truncated, with a small tooth on either side; the tooth is situated not at the corner but on the inner side of the apex. One specimen lacks the teeth entirely.

11. *Acetes paraguayensis* HANSEN
Figures 8, 23, 24, 25

Acetes paraguayensis HANSEN, 1919, p. 46, figs. 8–14.- RINGUELET,1949, p. 82, pl. 1 figs. 1–4, pl. 5 fig. 1.-ALDRICH, 1962, p. 1, figs. 1, 2.

MATERIAL – Paraguay: Rio Paraguay near its junction with Rio Parana, collected by W. SORENSEN, 9 Dec. 1893, (UCZM, *A. paraguayensis* n. sp. syntypes), 3 ad. (18.5–20.5mm) and 4 juv. (11.0–16.0 mm) females, 1 ad. (16.5 mm) and 3 juv. (11.5–14.0 mm) males.

Peru: Rio Nanay, opposite the navy base in the vicinity of Iquitos, Loreto, collected by C. C. G. CHAPIN, M. HOHN, and J. HENRY, 12 Oct. 1955, (USNM 102889, *Acetes* sp. near *A. paraguayensis*, determined by F. A. CHACE, Jr., Feb. 1959), 5 ad. (19.0–21.0 mm) and 4 juv. (15.5–17.5 mm) females, 6 ad. (19.5–20.5 mm) and 7 juv. (15.0 – 18.0 mm) males; from same sample as above, (ANSP 5753a, *A. paraguayensis*, determined by F. A. ALDRICH), 4 ad. females (18.5–21.5 mm), 3 ad. (19.5–21.0 mm) and 7 juv. (13.6–16.0 mm) males.

TYPES – Lectotype, 1 ad. female (20.5 mm) and allo-lectotype, 1 juv. male (14.0 mm) from a lagoon of Rio Paraguay are here selected and deposited at Universitetets Zoologiske Museum, Copenhagen. Reference specimens (here selected), 2 ad. females and 1 ad. male from Rio Nanay deposited at the same museum.

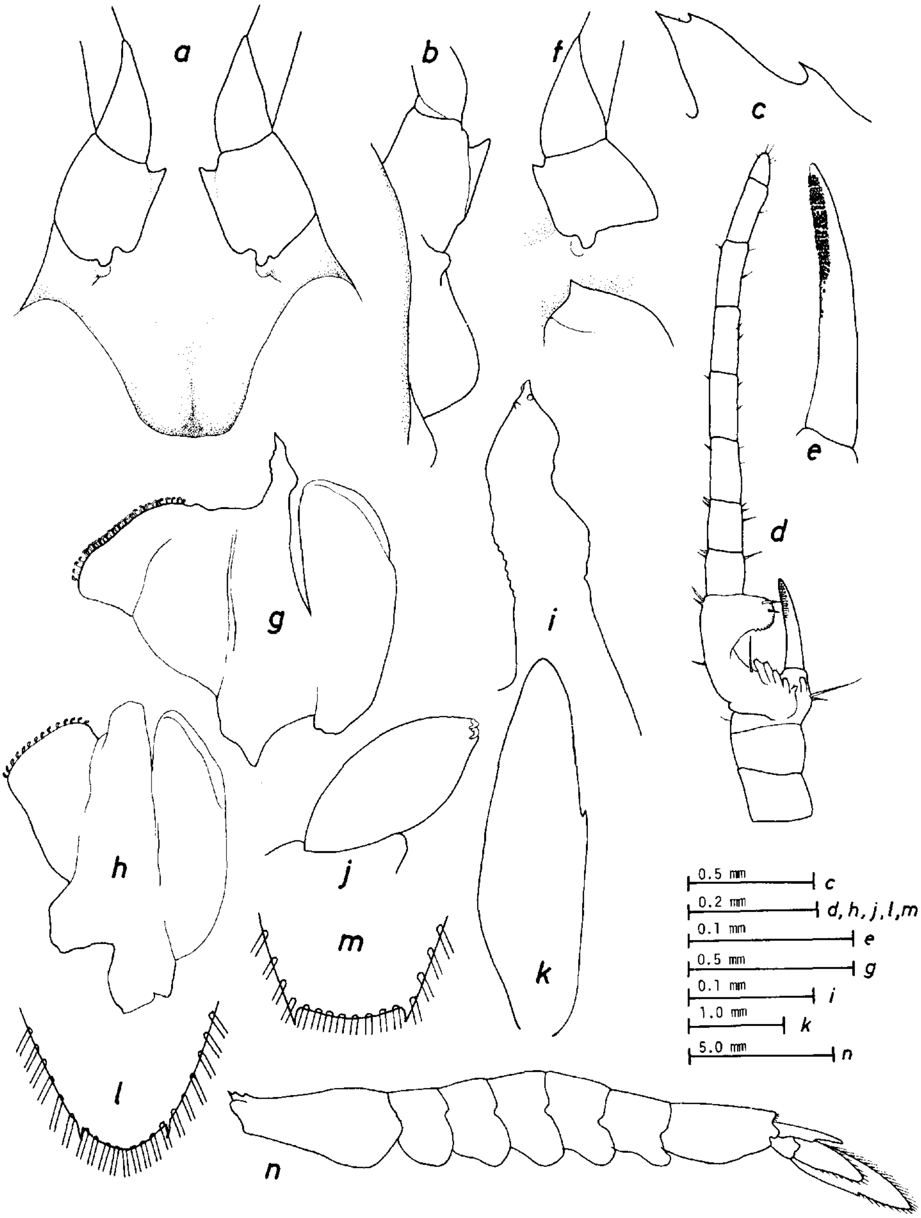

Figure 23. *Acetes paraguayensis.* female: a, basal segments of third pereiopod and third thoracic sternite, ventral view; b, same, lateral view. male: c, rostrum; d, lower antennular flagellum; e, clasping spine; f, basal segments of third pereiopod and genital coxa, ventral view; g, petasma; h. petasma of immature male; i, capitulum of petasma; j, appendix masculina; k, exopod of uropod; l, apex of telson; m, same; n, carapace and abdomen. (a–n, from Rio Nanay).

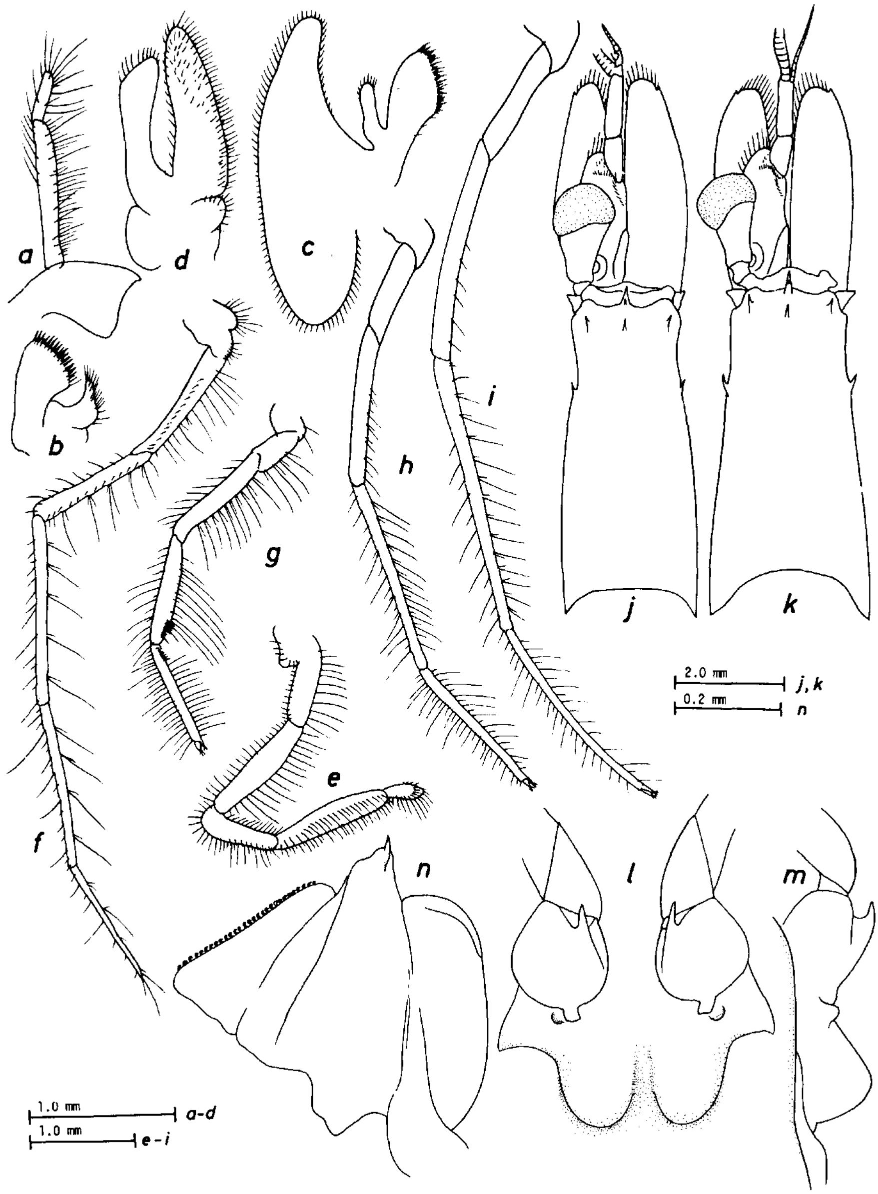

Figure 24. *Acetes paraguayensis.* male: a, mandible; b, first maxilla; c, second maxilla; d, first maxilliped; e, second maxilliped; f, third maxilliped; g, first pereiopod; h, second pereiopod; i, third pereipod; j, anterior region, dorsal view. female: k, anterior region, dorsal view; l, basal segments of third pereiopods and third thoracic sternite, ventral view; m, same, lateral view. male: n, petasma. (a– k, from Rio Nanay; l–n, from Rio Paraguay).

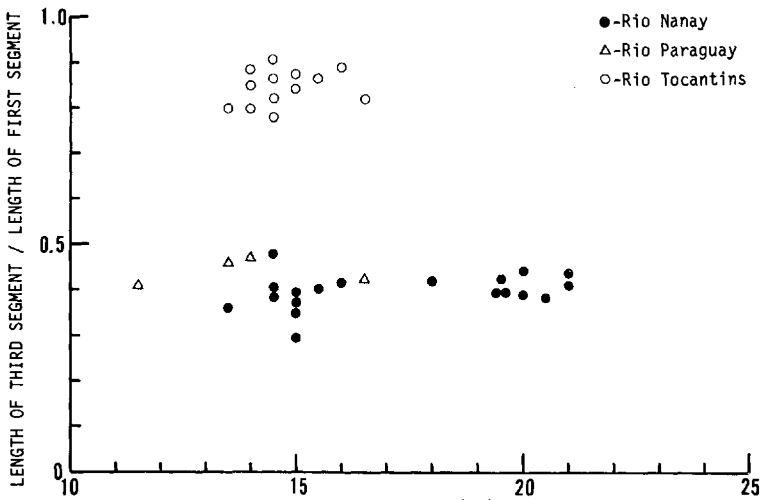

Figure 25. *Acetes marinus* and *A. paraguayensis* from three localities. Correlation of body length and proportionate length of first segment and third segment of antennular peduncle (adults and juveniles included). Open circle, *A. marinus*; solid circle and open triangle, *A. paraguayensis.*

differences are also apparent. In the males from Rio Nanay the petasma has a distinct capitulum which has never been figured previously. In general, the type-specimens from Rio Paraguay show characters morphologically intermediate between the Nanay population and the closely related new species *A. marinus* from Rio Tocantins, but the magnitude of the divergence between the type and the Nanay specimens is smaller than that between the type and *A. marinus.* According to the previous authors, the distal corners of the pars media of the petasma of *A. paraguayensis* are broadly rounded and have neither capitulum nor processus ventralis. However, a few of the syntypes possess a vestige of the capitulum as figured in the present paper. Their petasma is apparently of juvenile form, although the length of the pars astringens is slightly greater than that of the juveniles of the Nanay specimens. The type-specimens are smaller than the Nanay specimens, but they are indistinguishable from the juveniles of the Nanay specimens by the proportional length of 3 segments of the antennular peduncle (Fig. 25). The female third thoracic sternite of the Nanay specimens is in most cases narrowly produced backward and the knots on it are less remarkable than the type-specimens. However in 2 specimens from the Nanay the structure of the genital area agreed completely with that of the type-specimens.

Dr. F. A. CHACE, Jr. identified the Nanay specimens as "*Acetes* sp. near *paraguayensis*". Judging from the comparison of various characters mentioned above, it is suspected that the differences between the Nanay- and type-specimens are largely due to the difference at maturity. In this connection, DIAGNOSIS – In the females the lower antennular flagellum is 13- to 17-segmented. The antennal scale reaches the end of the third segment of the antennular peduncle. The coxa of the third pereiopods has on the inner margin a large, acute tooth which is set longitudinally like a blade; there is a small round flap on the lower side near the proximal corner. The third thoracic sternite is swollen into 2 large knots separated by a median impression and is produced posteriorly as the breast; it has a small protuberance behind the flap of each coxa of the third pereiopods; this protuberance is prominent when viewed laterally.

In the males the first segment of the antennular peduncle is longer than the second and third segments combined. The antennal scale extends beyond the midlength of the third segment of the antennular peduncle. The lower antennular flagellum is 11-segmented; there is a thick, short and nearly straight clasping spine which has numerous minute tubercles on the distal half; there is 1 or rarely 2 accessory spinules on the base of the clasping spine; the first segment of the main branch has 4–5 thumb-like spinules at the base and a large round swelling at the distal end; the swelling is as deep as the breadth of the segment; it is serrated and bears 2–3 setae dorsally. The coxa of the third pereiopods has a structure similar to that of the females; there is a protuberance on the third thoracic sternite behind the flap of the coxa of the third pereiopod. In the petasma, the pars media has a poorly developed capitulum which is less than 1/3 the length of the pars media and is tapered to a sharp point at the end; no hooks but a few minute tubercles are seen on the distal part of the capitulum.

The exopod of the uropod is 3.3–3.9 times as long as broad; the endopod has 1–3 red spots on the proximal part in both females and males. The apex of the telson is truncated or rounded; usually it bears 1 small tooth on either side.

BODY LENGTH – Females 18–22 mm, males 16–21 mm.

TYPE-LOCALITY – Rio Paraguay near its junction with Rio Parana.

DISTRIBUTION – This South American species has been found from Rio Paraguay, Rio Nanay, Rio Amazonas (at Iquitos, Peru) and Rio Parana (Rio Parana Mini near La Invernada Island, Argentina). According to HANSEN (1919) the species was also collected from "the outlet of the Riacho del Oro in Rio de la Plata". This locality is unknown, though it is probably the southernmost record of the occurrence of the species (see RINGUELET, 1949). This is the only [redacted]species of *Acetes* occurring in completely fresh water.

REMARKS – The present specimens of *A. paraguayensis* from widely separated two localities agree with each other in many characters, but some most of the specimens in a vial labelled as "*A. paraguayensis* types" at UCZM are juveniles 4 to 11 mm in body length (more than 60 individuals). The specimens described by RINGUELET (1949) from Rio Parana are identical with the type-specimens.

12. *Acetes serrulatus* (KRØYER)

Figures 20, 26

Sergestes serrulatus KRØYER, 1859, p. 268, figs. 12a–12g.
Acetes serrulatus (KRØYER).- HANSEN, 1919, p. 41, pl. 4 figs. 4a–4h.- THAM, 1955, p. 150, figs. 45, 46.- LIU, 1956, p. 30; 1965, p. 131.-WICKSTEAD, 1961, p. 103.- PATHANSALI, 1966, p. 61.
Acetes insularis KEMP, 1917, p. 54, figs. 1f, 1g, 2c, 3c, 4c, 5b, 5e, 7c.

MATERIAL – Kattegat (?): (UCZM, *Sergestes serrulatus* n. sp. syntype), 1 juv. male (12.0 mm).
Singapore: collected by D. PATHANSALI, 2 ad. males (16.5, 17.0 mm).
Indonesia: Java, Cheribon, collected by ANDREA, 1870, (UCZM, *A. serrulatus*), 1 ad. male (17.0 mm); Surabaya, collected by ANDREA, 1870, (UCZM, *A. serrulatus*), 4 ad. (15.0–18.0 mm) and 4 juv. (13.0–14.0 mm) females, 3 ad. males (12.5–15.0 mm); Jakarta, fish market, 23 Mar. 1974, 1 juv. female (11.5 mm).
Indo-Chinese Sea: collected by SCHMIDT, (UCZM, *A. serrulatus*), 1 ad. female (19.5 mm).

TYPES – Syntype here examined is in Universitetets Zoologiske Museum, Copenhagen.

DIAGNOSIS – In the females the lower antennular flagellum is 10- to 12-segmented. The coxa of the third pereiopod has a small tooth on the distal inner margin and a flap on the proximal corner. The structure of the genital area is simple; there is a pair of obscure elevations between the coxae of the third pereiopods; a deep, convex furrow runs transversally across the surface of the body.

In the males the lower antennular flagellum is 11-segmented; the first segment of the main branch has a triangular projection on the upper end and 2 basal spinules at the proximal part; there are 2 clasping spines; they are nearly straight but curve inwards at the end, with tubercles only on the distal part; the marginal spinule of the second segment is shorter than that of the third segment; the segment opposite the tip of the longer clasping spine bears 3 spinules. The petasma has neither pars astringens nor processus ventralis; the capitulum bears 5–7 hooks on the convex outer margin; there is 1 large hook at the end; the inner margin of the pars media is smooth. The appendix masculina has 2 hooks. The apex of the telson is truncated and bears on either corner a small tooth in both females and males. There is 1 red spot

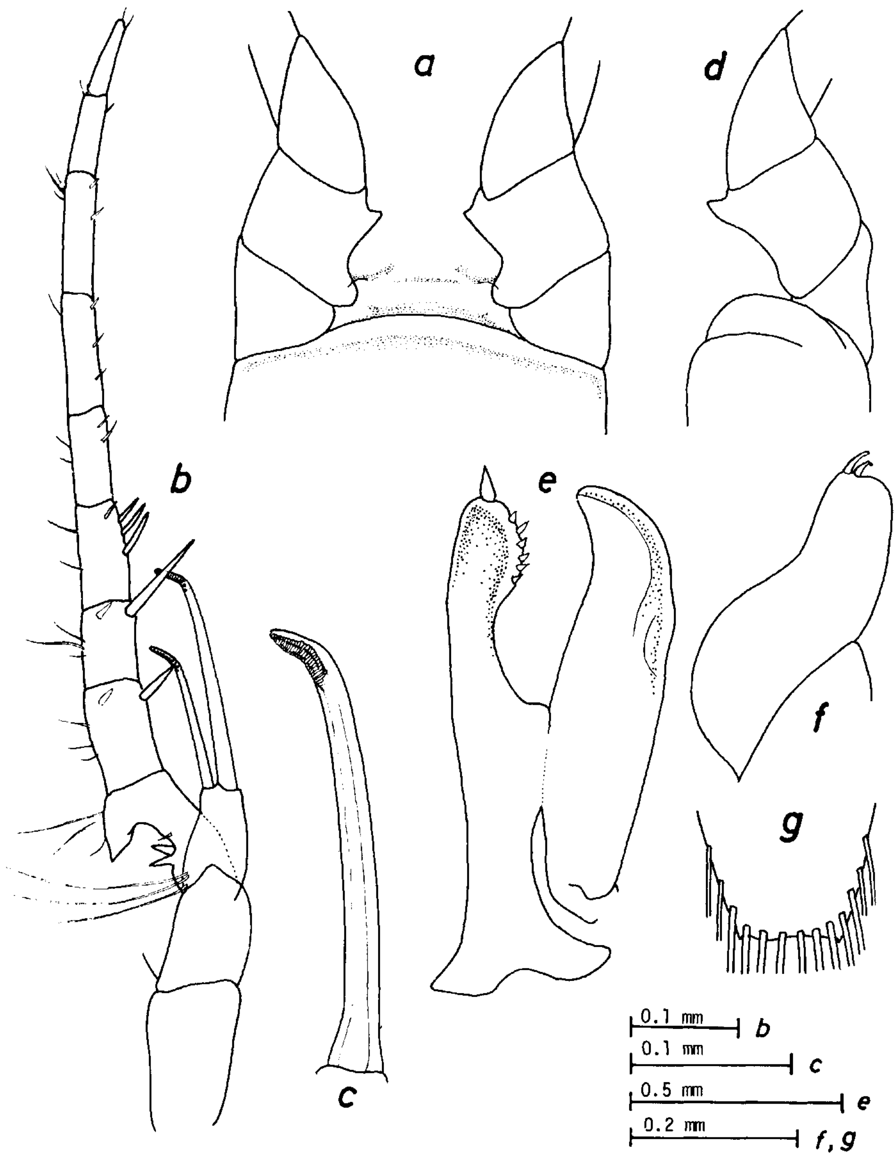

Figure 26. *Acetes serrulatus.* female: a, basal segments of third pereiopods and third thoracic sternite, ventral view. male: b, lower antennular flagellum; c, longer clasping spine; d, basal segment of third pereiopod and genital coxa, ventral view; e, petasma; f, appendix masculina; g, apex of telson. (a–g, from Surabaya).

each on the basipod and endopod of the uropod.

BODY LENGTH – Grows to 15–21 mm in females, 12–17 mm in males.

TYPE-LOCALITY – Unknown.

DISTRIBUTION – The species has been found from rather limited areas around Leichou Peninsula, off Singapore, Sarawak (mouth of Rajang River), and Java (Cheribon, Jakarta, Surabaya).

REMARKS – The type-locality of the species is written as "northern Kattegat" but as already mentioned by HANSEN (1919) it is incredible.

13. *Acetes sibogae* HANSEN
Figures 27, 28, 29

a. *Acetes sibogae sibogae* HANSEN

Acetes sibogae HANSEN, 1919, p. 38, pl. 3 figs. 4a–4h.- NATARAJ, 1947, p. 143, figs. 2b, 2c.- PATHANSALI, 1966, p. 61.
Acetes erythraeus NOBILI.-(part) KEMP, 1917, p. 51, fig. 1e.

MATERIAL – Philippines: Manila Bay, off Cavite, collected by I. A. RONQUILLO, Oct. 1973, 4 ad. females (14.0–16.5 mm), 16 ad. males (13.0 –17.0 mm); Malak, fish market, collected by I. A. RONQUILLO, Oct. 1958, 10 ad. females (14.0–16.5 mm), 10 ad. males (13.5–15.0 mm); Panay, Iloilo, 23 Mar. 1974, 2 ad. females (17.0, 17.5 mm).
Thailand: Krabi Bay, 19 May 1971, many ad. females and males; Phanga Province, Klong Nam Bo, 21 July 1972, 1 ad. female (17.5 mm) and 1 ad. male (16.0 mm).
Malaysia: Malacca, collected by M. JENSEN, 1901,. (UCZM, *A. sibogae*, determined by M. D. BURKENROAD, 1938); 8 ad. (17.5–19.5 mm) and 9 juv. males; Penang, collected by D. PATHANSALI, 2 ad. males (12.5, 13.0 mm); Sabah, Kudat, fish market, collected by T. E. CHUA, 20 Mar. 1974, 4 ad. females (16.5–21.5 mm), 2 ad. males (15.5, 17.5 mm).
Singapore: Ponggol, 29 Mar. 1974, 1 ad. female (17.0 mm), 8 ad. males (15.5–18.0 mm).
India: Cochin, June 1968, 4 ad. females (14.5–19.5 mm), 3 ad. males (13.5–17.0 mm); Porto Novo, Vellar estuary, collected by K. SRIRAMAN, 15 Jan. 1975, 6 ad. females (21.5–27.0 mm), 6 ad. males (18.0–19.5 mm).

TYPES – Syntypes should be in Universitetets Zoologiske Museum, Copenhagen. Reference specimens, 5 ad. females and 5 ad. males, from Porto Novo are here selected and deposited at the U.S. National Museum of Natural History (USNM 152733).

DIAGNOSIS – In the females the lower antennular flagellum is 11- to 20-segmented. The distal inner margin of the basis of the third pereiopod ends in a projection; the coxa has a tooth on the distal inner margin. In the genital

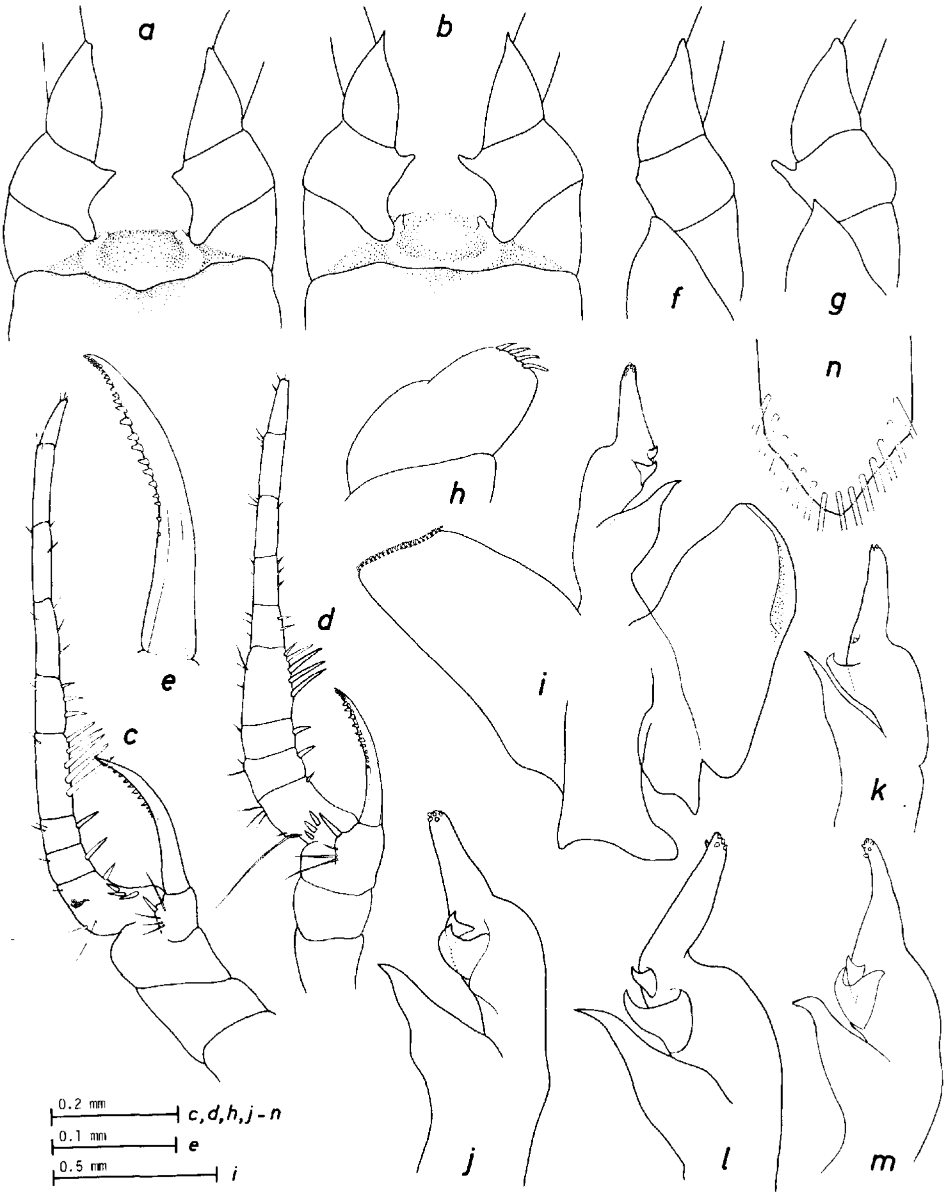

Figure 27. *Acetes sibogae sibogae.* female: a, basal segments of third pereiopods and third thoracic sternite, ventral view; b, same. male: c, lower antennular flagellum; d, same; e, clasping spine; f, basal segments of third pereiopod and genital coxa, ventral view; g, same; h, appendix masculina; i, petasma; j, capitulum of petasma; k, same; 1, same; m, same; n, apex of telson. (a, f, h, j, from Cavite; b, d, m, from Cochin; c, e, i, l, n, from Malacca; g, k, from Penang).

area the third thoracic sternite forms a fairly large plate, the lateral and posterior margins of which are elevated; there is a pair of small protuberances on the anterior part; the posterior margin may produce slightly backwards medially, so that the deep transverse furrow between the third and fourth thoracic sternites is recurved in the median part.

In the males the lower antennular flagellum is 11- or 12-segmented; there is 1 clasping spine which is thick with a row of 8–15 large teeth; the first segment of the main branch has, in addition to a swelling, 1 marginal spinule and 3 basal spinules; the segment opposite the clasping spine bears 4–6, mostly 5, spinules of which the distal one is often short. In the petasma the capitulum carries 2 falcate hooks; the distal hook is smaller than the proximal one; there are a few minute hooks on the end of the capitulum. The appendix masculina has 4–5 hooks on the distal margin.

In both females and males there is a small round projection between the first pleopods, but it is not procurved as in *A. erythraeus*. There is 1 red spot on the endopod of uropod.

BODY LENGTH – Females 14–27 mm, males 13–20 mm.

TYPE-LOCALITY – Bay of Bima and Bawean Island, Indonesia.

DISTRIBUTION – The species had been collected sporadically from the Java Sea (Bawean Is.), Flores Sea (Bima), Strait of Malacca (Penang), and South India (Porto Novo, Cochin, Quilon). The occurrences of the species in the Philippines (Manila Bay, Iloilo), Thailand (Krabi Bay, Phanga), Borneo (Kudat), and Singapore are new records.

b. *Acetes sibogae australis* COLEFAX, new rank

Acetes australis COLEFAX, 1940, p. 341, figs. 1-19a.- MORRIS, 1948, p. 1, figs. 1–73.

MATERIAL – Australia: Queensland, Lake Coombaba, 30 Oct. 1970, beam trawl, 8 ad. females (23.0–24.0 mm), 18 ad. males (19.5–21.5 mm); Queensland, Moreton Bay, Deception Bay, 12 Apr. 1972, beam trawl on the seagrass *Zostera* bed, 7 juv. females (15.5–18.5 mm), 10 juv. males (16.0–18.0 mm); Moreton Bay, Serpentine Creek, 1 Feb. 1973, beam trawl on sandy mud, 4 ad. females (18.0–24.5 mm), 5 ad. males (18.0–21.5 mm), 1 aberrant form (21.5 mm); New South Wales, Lake Macquarie, C. Hollish Whalf, collected by S. HAPPER, 15 May 1972, 18 ad. (19.0–22.0 mm) and 48 juv. (15.5–17.0 mm) females, 6 ad. (18.0–19.0 mm) and 39 juv. males, 3 aberrant forms (19.5–20.0 mm); New South Wales, Newcastle, off Hunter River, collected by N. V. RUELLO, 1967, (AM. P16178, *Acetes* sp.), 4 ad. females (30.0–31.5 mm), 1 aberrant form (28.0 mm); New South Wales, Port Jackson, Folly Point, Middle Harbour, collected by F. CONNALLY, 19

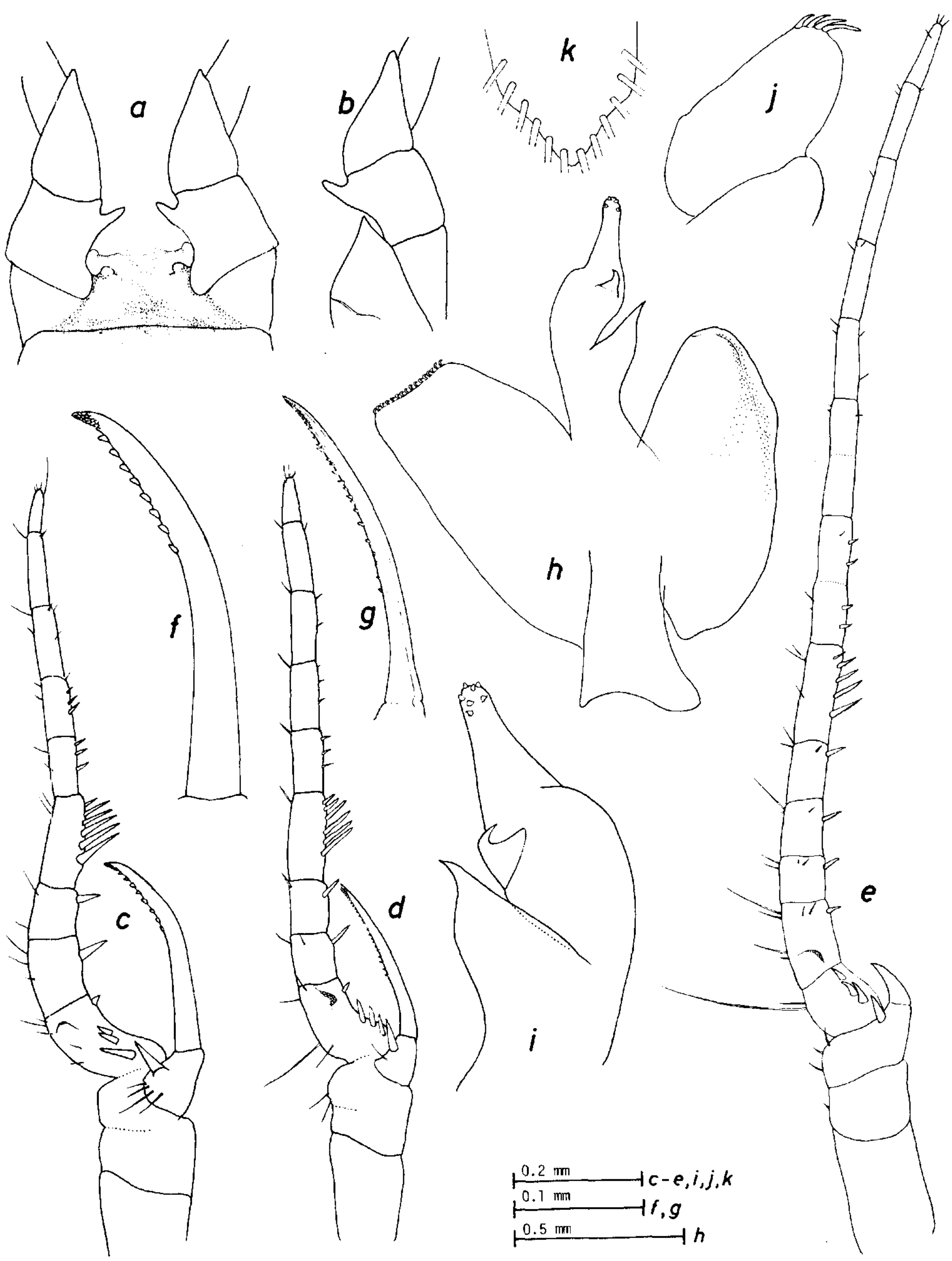

Figure 28. *Acetes sibogae australis.* female: a, basal segments of third pereiopods and third thoracic sternite, ventral view. male: b, basal segments of third pereiopod and genital coxa, ventral view; c, lower antennular flagellum; d, same; f, clasping spine; g, same; h, petasma; i, capitulum of petasma; j, appendix masculina; k, apex of telson. aberrant form: e, lower antennular flagellum. (a, b, d, g–k, from Lake Macquarie; c, f, from Serpentine Creek; e, from Newcastle).

June 1923, (AM. P15075, P15076, *A. australis* n. sp. syntypes), 15 ad. females (19.5–22.5 mm), 4 ad. (19.0–20.0 mm) and 11 juv. males; New South Wales. Athol Bight, 14 Mar. 1951, (AM. P12121, *A. australis*), 10 ad. females (26.0–29.0 mm); New South Wales, Port Hacking, Southwest Arm, 27 Nov. 1974, hand net, 1 ad. female (26.0 mm), 1 aberrant form (22.5 mm).

TYPES – Syntypes here examined are in the Australian Museum. Reference specimens, 2 ad. females and 3 ad. males, from Serpentine Creek are here selected and deposited at the Australian Museum: 2 ad. females and 3 ad. males from the same locality deposited at the U.S. National Museum of Natural History (USNM 152732).

DIAGNOSIS – In the females the lower antennular flagellum is 14- to 20-segmented. The antennal scale reaches the middle of the third segment of the antennular peduncle. The distal inner margin of the basis of the third pereiopod ends in blunt projection, the coxa has a strong tooth on the distal inner margin. The third thoracic sternite has a fairly large flat plate in ventral view; there is a pair of protuberances on the anterior part between the coxae of the third pereiopod; another pair is obscurely seen behind that; the deep furrow runs transversally between the third and fourth thoracic sternites; the posterior margin of the third sternite is not produced backwards.

In the males the lower antennular flagellum is 11- or 12-segmented; there is 1 clasping spine having a row of 7–10 teeth; the first segment of the main branch has, in addition to a swelling, 1 marginal spinule and 3 basal spinules; the first 3 segments of the main branch are comparatively longer than those of *A. sibogae sibogae*; the clasping spine hardly exceeds the base of proximal spinule of the fourth segment; the fourth segment bears 5–6 spinules. The antennal scale exceeds slightly beyond the end of the second segment of the antennular peduncle. The basis and coxa of the third pereiopod have a structure similar to that of the females. The capitulum of the petasma carries only 1 large falcate hook; there are a few small hooks at the end. The appendix masculina bears 4–6 hooks.

BODY LENGTH – Females 18–34 mm, males 18–25 mm.

TYPE-LOCALITY – Port Jackson, New South Wales, Australia.

DISTRIBUTION* – The present subspecies is distributed along the east coast of Australia from Moreton Bay to Port Hacking.

*Note added in proof: Mrs. Peggy Hamner of Australian Institute of Marine Science, Townsville, has recently sent to me samples of *Acetes sibogae australis* from the harbour off Townsville and from Weipa, Queensland. The latter specimen was removed from the gut of a cubomedusa *Chironex fleckerii*. It is the northernmost record of occurrence for *A. s. australis*. Besides that, *Acetes erythraeus* has been found in *Chiropsalmus quadrigatus* from Mossman, Queensland (collected by J. H. Barnes, Dec. 1960 and Jan. 1961). This occurrence is the new record from Australia.

c. *Acetes sibogae sibogalis* ACHUTHANKUTTY AND GEORGE, new rank

Acetes sibogalis ACHUTHANKUTTY and GEORGE, 1973, p. 139, figs. 1-19.

DESCRIPTION – ACHUTHANKUTTY and GEORGE, 1974.

TYPES – Holotype and paratypes (IOBC. 0151) are in the Indian Ocean Biological Centre, Cochin.

BODY LENGTH – Females 18–21 mm, male 16 mm.

TYPE-LOCALITY – Aroor region of the Cochin backwater, India.

DISTRIBUTION – Cochin backwaters, India.

REMARKS – The females of *Acetes sibogae sibogae* from southern coasts of India and west coast of Thailand, i.e. the Indian Ocean, differ from those from Singapore eastward in the following structures: the projection on the distal inner margin of the basis of the third pereiopod is acute; the tooth on the coxa is large; the median part of the posterior margin of the third thoracic sternite is often not produced backwards. The males agree with those from other localities. There is a distinct tooth on the inner margin of coxa of the third pereiopod in the males from India, the Malay Peninsula, and Sabah, but the specimens from Manila Bay lack the tooth, as described and figured by HANSEN (1919). The distal hook on the outer margin of the capitulum of the petasma from Malaysia was often very tiny: PATHANSALI (1966) noted that some males of *s. sibogae* had only 1 hook on the capitulum.

PATHANSALI (1966) states that *Acetes australis* COLEFAX is *A. sibogae* or only a variety of this species. As far as the present examination is concerned, the specimens from Australia (*A. australis*) are so similar to *A. sibogae* that it is considered that their genetic divergence is at the subspecific rather than the specific level. Although the actual level of divergence from their ancestor cannot be ascertained from available collections, they apparently have been recently derived from a common ancestor. Since the two subspecies are distributed in geographically and oceanographically separated regions, there seems to be no possibility of gene flow between them at present. It is necessary, however, to define their geographical distribution particularly around New Guinea and northern Australia in order to know if this complete isolation is real state of distribution.

In the males *A. s. australis* is distinct from *s. sibogae* in the character of the petasma which has only 1 hook on the capitulum. The different body length may help to distinguish these two subspecies. However, the females of *s. australis* are only distinguishable from *s. sibogae* from the Indian Ocean by

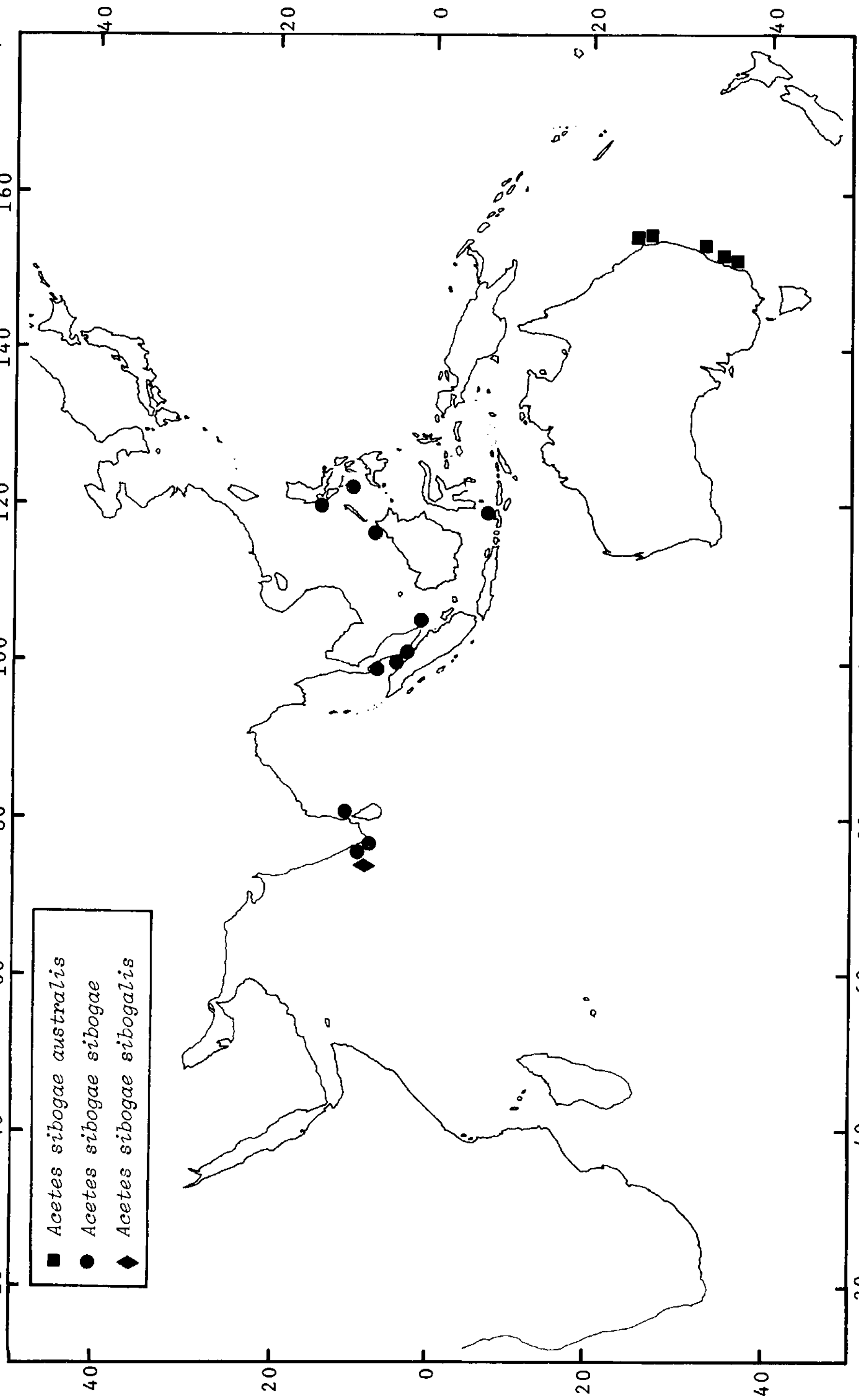

Figure 29. Distribution records of *Acetes sibogae australis*, *A. s. sibogae*, and *A. s. sibogalis*.

the shape of projection on the distal inner margin of the basis of the third pereiopods.

Most of the males of *A. s. australis* hitherto examined seemed to be younger adults. Their lower antennular flagellum and petasma are less developed than those of *s. sibogae*; in *s. australis* the marginal spinule on the first segment of the main branch of the lower antennular flagellum is often absent or still very tiny; their clasping spine is short and has irregularly arranged tiny teeth.

One large specimen of *A. s. australis* from Newcastle appears to be intermediate between female and male. The proportional length of the first, second, and third segments of the antennular peduncle are 100:37:57, like the females. The lower antennular flagellum is much elongated and incompletely 18-segmented with a degenerate small clasping spine which is only twice as long as the accessory spinule. The structure of the third thoracic sternite is similar to that of the female; the genital coxa absent. The petasma is, however, typical of the males. A similar specimen occurs in Port Hacking. The proportional lengths of the 3 segments of the antennular peduncle are 100:35:57. The lower antennular flagellum, 13-segmented, is similar to that of the females, but it bears 2 large spines on the third segment. The genital coxa absent; the petasma has regressed. A few specimens from Lake Macquarie are also aberrant. No parasitic organism was seen from these aberrant specimens. The specimens appear to indicate that the male characters regress after the shrimp grow past the maximum size reported for males, but I think that these can be mere abnormalities since the frequency of occurrence is not large. A similar phenomenon has been reported in *A. erythraeus* and *A. sibogalis* (ACHUTHANKUTTY, 1973).

The body length frequency histogram and the variation of sexually modified characters indicate that *A. s. australis* breed between November and March in New South Wales. MORRIS (1948) suggested that the most active breeding period of the species was during mid- and late summer.

The third subspecies of *A. sibogae* has recently been described as a new species, *A. sibogalis*. This animal has a combination of characters of *A. s. sibogae* and *s. australis*. Although I have not had opportunity to examine the types, the holotype female strongly agrees with *s. australis* when each character is compared with that of *s. australis* (see Table 3). The only clear difference is that *s. sibogalis* has the basis of the third pereiopod devoid of the blunt projection on the distal inner margin. In the male of *A. sibogalis* the lower antennular flagellum is 14-segmented; the clasping spine of the lower antennular flagellum and the coxa of third pereiopod are as in *s. sibogae*, whereas the petasma has 1 hook on the capitulum as in *s. australis*. All species of the *erythraeus* group have the accessory spinule near base of the clasping spine of the lower antennular flagellum; also there are few basal spinules in the segment anterior to the one on which the clasping spine is situated. Although *A. sibogalis* belongs to the *erythraeus* group, it lacks both of them. The appendix masculina bears only 2 hooks. These characters distinguish *A. sibogalis* males from either *A. s. sibogae* or *s. australis*, but the difference is no greater than that between *s. sibogae* and *s. australis*. Comparative study of extensive material of *A. sibogalis* remains desirable to define the species and the relation with *A. s. sibogae* and *s. australis*.

Occurrence of various local forms and aberrant specimens indicates that *A. sibogae* s. l. is highly variable species. In order to define the relation among *A. s. sibogae, A. s. australis*, and *A. sibogalis*, analysis with extensive material is desired to test whether there is any tendency for hybridization and intergradation of *A. sibogae* s. l. especially in the coastlines of southern India where *A. s. sibogae* and *A. sibogalis* occurred. Until then, I designate *A. sibogalis* provisionally as a subspecies of *A. sibogae*.

14. *Acetes vulgaris* HANSEN
Figures 14, 30

Acetes vulgaris HANSEN, 1919, p. 35, pl. 3 figs. 2a–2r.- YU, 1935, p.169.-THAM,1955,p. 150, figs. 41, 42.- JOHNSON, 1965, p. 8.- PATHANSALI, 1966, p. 61.

MATERIAL – Viet Nam: Vung Tau, 16 Apr. 1974, 2 ad. (24.0 mm) and 6 juv. (13.5–15.0 mm) females, 3 juv. males (15.0–17.0 mm).
Thailand: Gulf of Siam, Koh Kahdat, collected by T. MORTENSEN, 25 Jan. 1900, (UCZM, *A. vulgaris*), 23 ad. females (25.0–27.0 mm), 1 ad. male (22.0 mm); Gulf of Siam, Chonburi, 21 July 1963, 6 ad. females (22.0–23.0 mm), 11 ad. males (18.0–20.0 mm); Gulf of Siam, Samudpragarn, 23 June 1967, 8 ad. females and 2 ad. males; Gulf of Siam, Rayong, 12 July 1973, 1 juv. female, 2 juv. males.
Singapore: Ponggol, collected by A. K. THAM, 2 ad. (23.5, 25.5 mm) and 2 juv. (17.5, 20.0 mm) females, 21 ad. males (22.5, 24.5 mm); Ponggol, 29 Mar. 1974, 6 ad. females (21.5–24.5 mm), 7 ad. males (19.5–24.0 mm).
Indonesia: Java, Cheribon, collected by ANDREA, 1870, (UCZM, *A. vulgaris* n. sp. syntypes), 5 ad. females (24.0–33.5 mm), 7 ad. males (22.5–26.0 mm); Java, Jakarta, fish market, 23 Mar. 1974, 21 ad. (20.0–33.5 mm) and 7 juv. (17.0–21.0 mm) females, 12 ad. males (19.5–29.5 mm).

TYPES – Syntypes here examined are in Universitetets Zoologiske Museum, Copenhagen.

DIAGNOSIS – In the females the lower antennular flagellum is 20- to 24-segmented. The genital area is of characteristic shape, having a pair or large round protuberances on the anterior part of the third thoracic sternite; behind the protuberances a deep procurved furrow runs transversally across the body; the surface of the fourth sternite has a distinct depression.

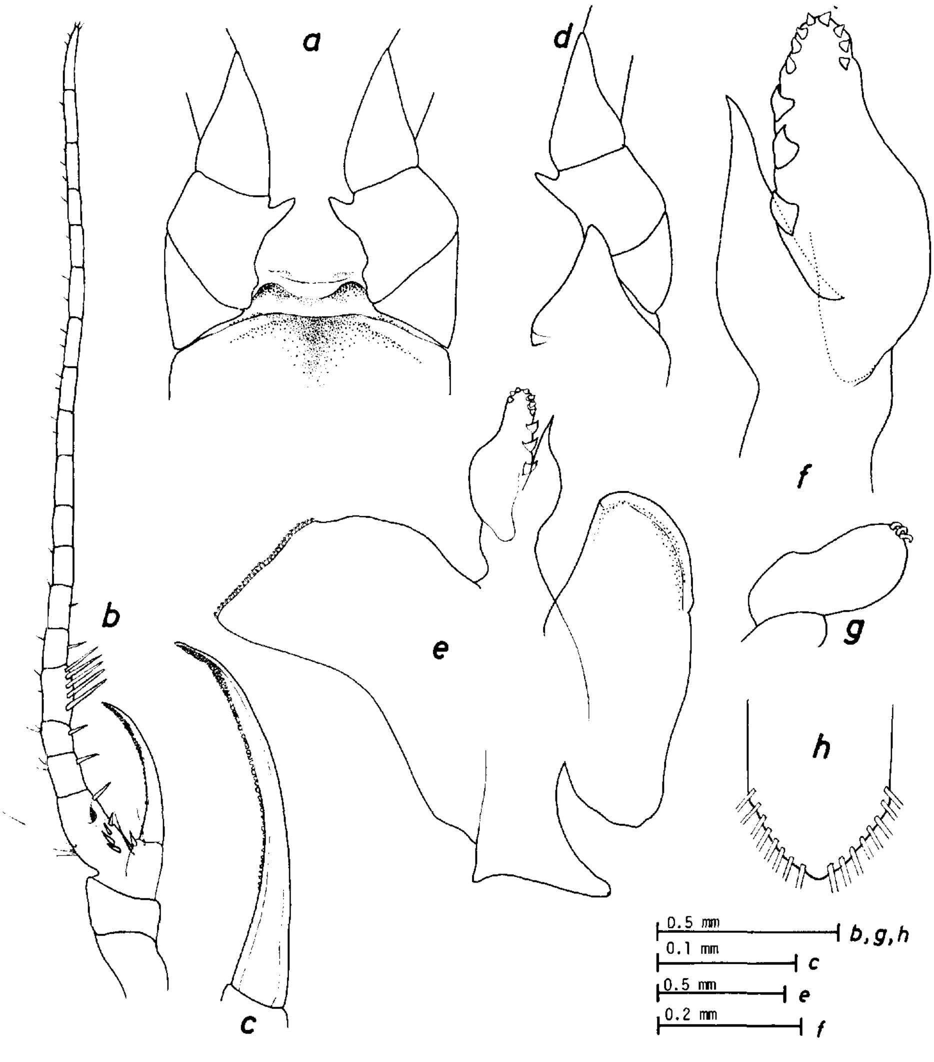

Figure 30. *Acetes vulgaris.* female: a, basal segments of third pereiopods and third thoracic sternite, ventral view. male: b, lower antennular flagellum; c, clasping spine; d, basal segments of third pereiopod and genital coxa, ventral view; e, petasma; f, capitulum of petasma, posterior side; g, appendix masculina; h, apex of telson. (a–h, from Cheribon).

In the males the lower antennular flagellum is 17- to 21-segmented; there is 1 clasping spine with many obtuse tubercles on the inner surface; the first segment of the main branch bears 4–6 basal spinules; the segment opposite the tip of the clasping spine bears 4–5 spinules. In the petasma the processus ventralis is robust; the capitulum is thick, twice as long as broad; there are 3 large hooks on the outer margin; the distal part of the capitulum is broadly obtuse with 7–8 small hooks. The appendix masculina has 3 hooks.

There is no procurved spine but a small conical projection between the bases of the first pleopods in both females and males. The endopod of the uropod has 1–2 red spots on the basal part; in addition, the larger females have a red spot on either anterolateral part of the sixth abdominal segment.

BODY LENGTH – Females 20–34 mm, males 17–26 mm.

TYPE-LOCALITY – Bay of Bima and Sapeh Bay, Flores Sea; Cheribon and Djangkar, Java; Malacca; Koh Kahdat, the Gulf of Siam.

DISTRIBUTION – The species has been recorded from the South China Sea (Amoy), Gulf of Siam, Strait of Malacca (Singapore, Malacca), Java Sea (Cheribon), and Flores Sea (Bima, Sapeh Bay). The occurrence of the species from Vung Tau is the first record from the waters of Viet Nam.

REMARKS – In some males from Singapore the processus ventralis of the petasma is placed nearly at right angles to the long axis of the pars media.

VII. THE FISHERY

In this chapater I attempt to compile information concerned largely with fishing methods, locations, and landing statistics in various countries of Asia and Africa. Main localities where the *Acetes* fishery takes place are shown in Figure 31. These are either from the literature or from my observations. The fishing grounds are mostly located in the calm, muddy intertidal zone or waters shallower than 5 m in depth.

CHINA

Acetes chinensis (local name 'Maoxia') is one of the most important marine resources in Northeast China. The size of the catch in Po Hai (Gulf of Chihli) is large, totaling 60,000 to 70,000 tons a year (LIU, 1956). *Acetes* is mainly fished by fixed bag nets. According to KOBA (1941), the areas near Yingkow and the mouth of Luan River have been centers of the fishery for the past 200 years. One of the bag nets used there has a rectangular mouth opening 3–9 m wide, 2–4 m high and 6–10 m long. Daily one hundred or more bag nets are set along the shore against the flow of the ebbing tide. The fishing season in Po Hai has two periods; from late May to mid-July and from mid-September to late October. In other months the shrimp do not enter the net. In addition two species, *A. chinensis* and *A. japonicus*, are caught together along the coast of the Yellow Sea. The fishing is prosperous around Shihtao (URITA, 1926). LIU (1956) reports that the annual catch from the Yellow Sea is about 6,000 tons. *Acetes erythraeus* and *A. serrulatus* are exploited along the southern coast of China (LIU, 1965).

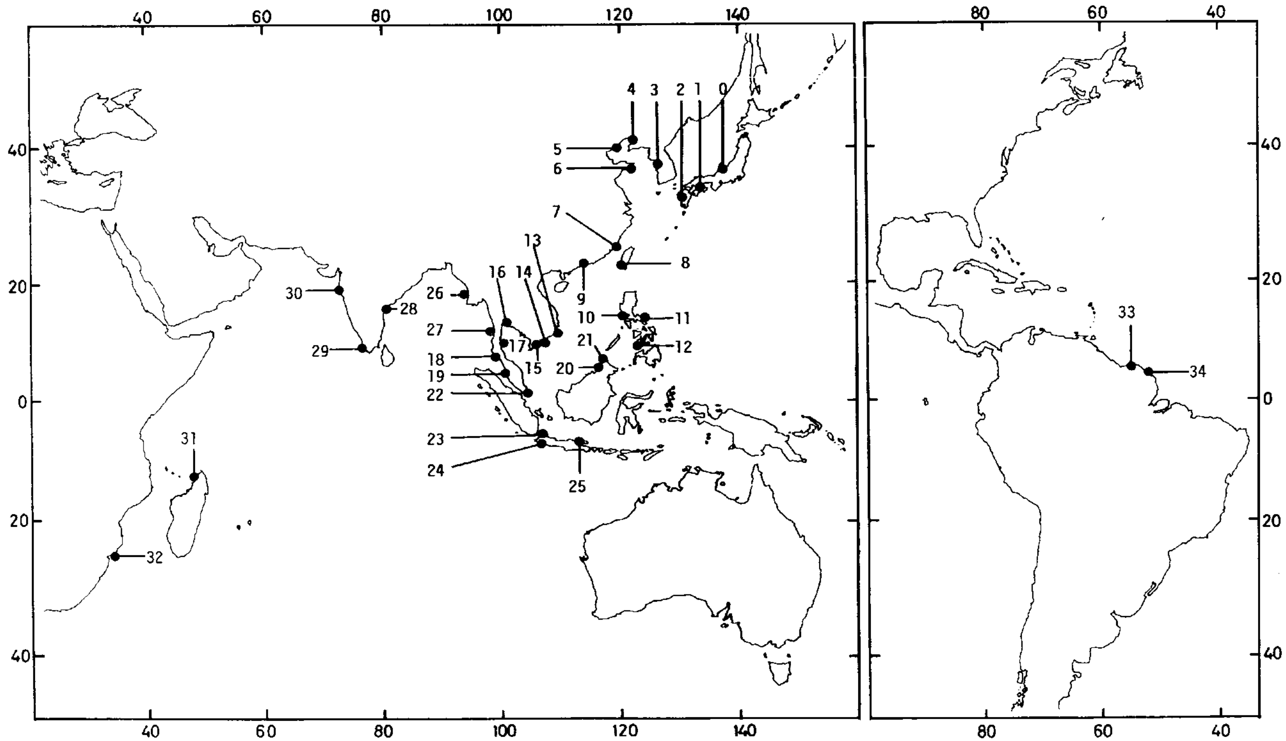

Figure 31. Confirmed fishing ground of *Acetes* in the world.
0, Toyama Bay; 1, Seto Inland Sea; 2, Ariake Sea; 3, Gyonggi Bay; 4, Yingkow; 5, mouth of Luan River; 6, Shihtao; 7, Matsu Island; 8, Tungkiang; 9, Hong Kong; 10, Cavite; 11, Paracale; 12, Iloilo; 13, Nhatrang; 14, Vung Tau; 15, Bac Lieu; 16, Chonburi; 17, Chumporn; 18, Goh Pangi; 19, Penang; 20, Labuan; 21, Kudat; 22, Ponggol; 23, Jakarta; 24, Pelabuhan Ratu; 25, Surabaya; 26, Sandowa; 27, Mergui; 28, mouth of Godavari River; 29, Cochin; 30, Versova; 31, Ambaro Bay; 32, Lingamo; 33, Paramaribo; 34, Cayenne.

KOREA

Acetes chinensis and *A. japonicus* (local name 'Baek-Ha') have been fished along the west coast of Korea. The catches from Whanghainam Do, Gyonggi Do, and Chollanam Do have been particularly large (YOSHIDA, 1941). The waters around Ryongmai, Dukjuk, and Ul Islands in Gyonggi Bay are known as the main fishing ground. The shrimp are caught by various types of bag nets (stow nets) which have been developed to take advantage of the great tidal range, up to 7 m, in the Yellow Sea. The most common net is called 'Haesunmang'. This conical net, 7 m in mouth diameter and 25 m long, is fixed to the sides of a boat which is anchored firmly to the bottom during the fishing operation. According to YOSHIDA (1941), the fishing season is from August to November on the northern coasts along Pyonganpuk Do, whereas it is from the end of March to July and from the end of September to November in Gyonggi Bay. Fishery statistics from South Korea indicate that the annual catch of *Acetes* including mysids totals 5,000 to 17,000 tons and constitutes about 80% of the total shrimp catch in this country (Table 5).

Table 5. Annual catches of *Acetes** and total shrimps in South Korea in 1965–69

Year	*Acetes* (tons)	Total shrimps (tons)	*Acetes* to total shrimps (%)
1965	14014	17195	81.5
1966	9637	12115	79.5
1967	16595	21003	79.0
1968	8044	11425	70.4
1969	5404	6784	79.7

* In the fishery statistics from South Korea, *Acetes* landing is not reported but included in the category 'other shrimps'. According to Dr. K. I. YOO (personal communication), however, the 'other shrimps' are almost entirely composed of *Acetes*.

JAPAN

Acetes japonicus (local name 'Aki-ami', 'Hon-ami' or 'Shirafuge-ebi') has been commercially exploited for a long time in the Ariake Sea, the Seto Inland Sea, and in Toyama Bay (Fig. 32).

The Ariake Sea lies on the western coast of Kyushu and is about 1,700 km^2 in total area. The average depth of this shallow inlet is about 20 m; only 4.8 % exceeds a depth of 50 m. As the tidal range is about 6 m, 14 % of the total area becomes tidal flats at low water. Average surface water temperature ranges between 9°C in January and 28°C in August at the innermost part of the inlet where *Acetes* fishing is carried out. Salinity varies from 27.0 to 31.5 ‰ in general but occasionally it drops below 18 ‰ in June and July due to heavy rainfall. The innermost part of the inlet is mostly muddy; the water transparency around the tidal flats is 1 m or less. *Acetes* is fished from April to early December, but more than 80 % of the annual catch is taken between August and October. The towns of Hama, Okinohata, and Azuma have prospered as centers of the fishery. The fishing is carried out with various types of bag nets. The common one has a triangular mouth opening, 2–5 m at the base, 2–4 m at the sides and 7–10

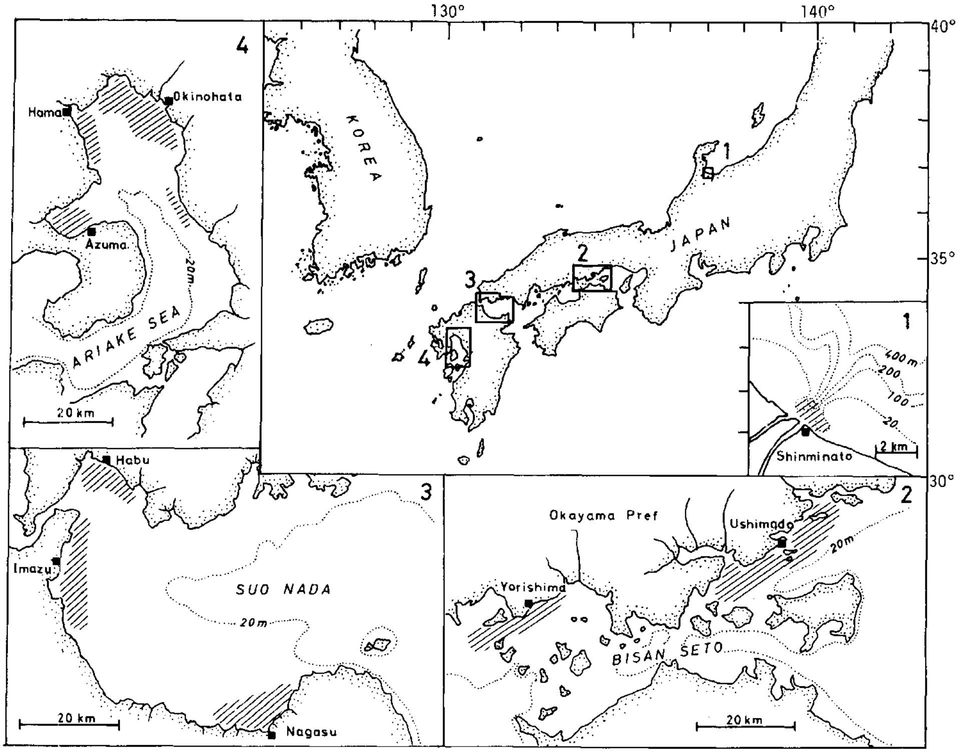

Figure 32. Fishing grounds (hatched area) of *Acetes japonicus* in Japan. 1, Toyama Bay; 2 and 3, Seto Inland Sea; 4, Ariake Sea.

m long. The net is fixed by a bomboo pole against the flow of the tide so that the swarms of *Acetes* enter the net at both the flood and ebb tides (Plate 1-d). Another net is trapezoid at the mouth opening 3 m wide at the base, 2.5 m high, and 7–8 m long. A pair of the nets is fixed individually to the sides of an anchored boat against the flow of the tide. The mesh openings of these nets are always 2.0–3.5 mm. Usually good catches are recorded in the few days before and after the neap tide. The total number of good fishing days is about 60 per year.

Along the coast of Okayama Prefecture in the central part of the Seto Inland Sea (Bisan-Seto), large catches are taken from the middle of September to November. The boat seine called 'Amikogi' is the most popular fishing gear used for the last 70 years. *Acetes* is fished from September to November in the western part of the Seto Inland Sea (Suo-nada). The shrimp are scooped up in the intertidal zone by the push net called 'Amisashi'. This net has a structure very similar to 'Sondong' which is widely used along the coasts of the Malay Peninsula. Boat seines are used offshore. In these areas the average surface temperature fluctuates

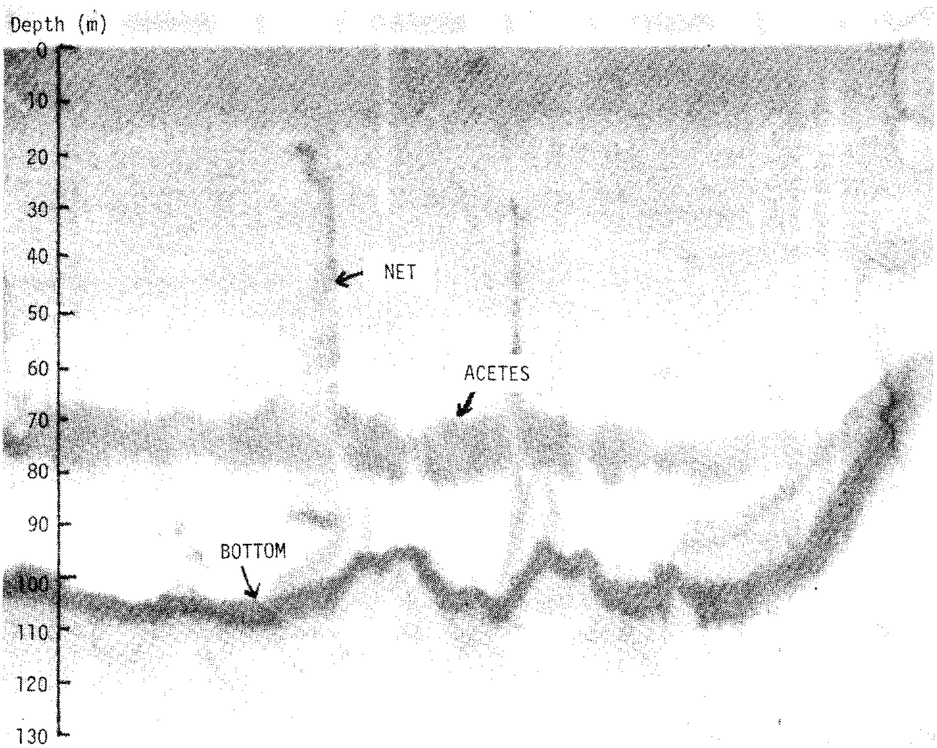

Figure 33. Swarms of *Acetes japonicus* recorded on echo-sounder (frequency 50 KHz) in Toyama Bay. 1000–1011 hours, 1 Nov. 1974.

between 6°C in January and 28°C in August, and the salinity from 27.1 to 32.0 ‰. Water transparency in the estuary is 3 m or less.

In contrast with the preceding waters, the bottom slope of Toyama Bay is very steep. Narrow, V-shape submarine canyons extend from the greatest depth at the mouth of the bay towards the shore. *Acetes* swarms by day at depths of 40–90 m on the slope off Shinminato, the mouth of Sho River, where the fishing is concentrated. The fishermen locate the shrimp with an echo-sounder operating at a frequency of 50 KHz (Fig. 33). The water temperature above 100 m fluctuates annually between 8 and 27°C, and the salinity from 18.8 to 34.6 ‰. The fishing by boat seines is seen from November to April, with the greatest catch in November*. The net 45 m long and 70 m high; the length of the bag is about 30 m. The finest mesh used in the bag is 3.5 mm. The net is hauled 5–8 times a day. Total number of fishing days is about 80 per year.

---

* In my previous paper (OMORI, 1974) the fishing season is reported incorrectly as occurring from March to May.

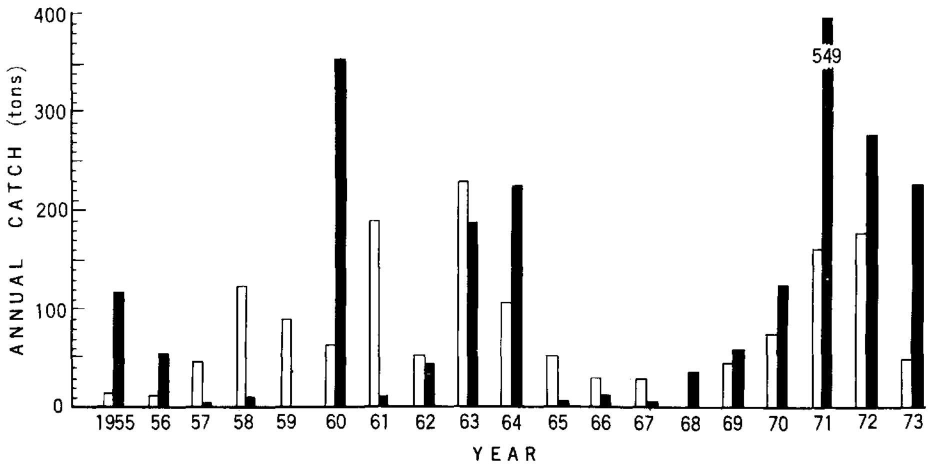

Figure 34. Fluctuation of annual catch of *Acetes japonicus* at Okinohata, Ariake Sea (open square) and off Okayama Prefecture, Seto Inland Sea (solid square) in 1955–73.

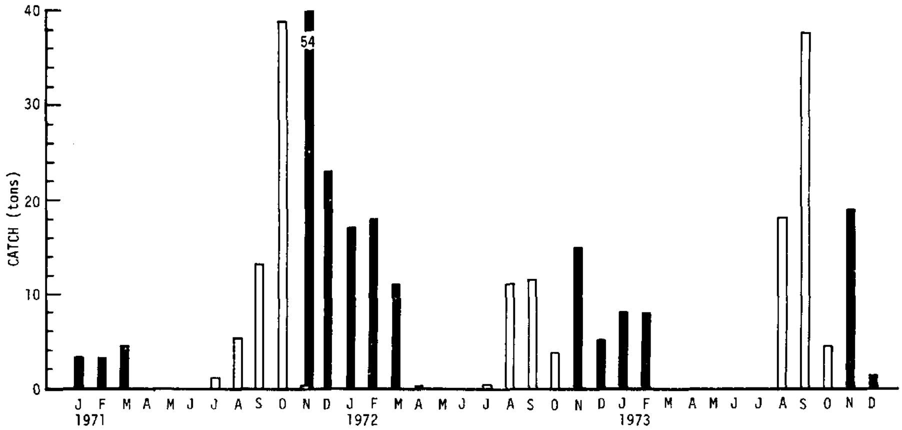

Figure 35. Fluctuation of monthly catch of *Acetes japonicus* at Azuma, Ariake Sea (open square) and Shinminato, Toyama Bay (solid square) in 1971–73.

The fluctuation of the annual catch of *Acetes* at Okinohata and Okayama Prefecture, and that of the monthly catch at Azuma and Shinminato are shown respectively in Figures 34 and 35. The fishing effort tends to decrease when the catch is poor, because *Acetes* fishery is of secondary interest to many local fishermen. However, the figures can be considered to show the large variation of the occurrence, size, and densty of swarming *Acetes* in each locality. An average annual catch from the whole Ariake Sea amounted to 1,000 tons around 1951 (IKEMATSU 1953) but has fallen to 200–500 tons in recent years. The catch from the Seto Inland Sea is 100–700 tons, whereas that from Toyama Bay amounts to 30–100 tons.

TAIWAN

Acetes chinensis is caught off Matsu Island while *A. intermedius* is taken in Tungkiang. According to Mr. P. W. YUEN (personal communication), the catch from Taiwan amounts to about 1,000 tons per year.

HONG KONG

Acetes is fished by push net which is attached to the front of a small boat. I found *A. erythraeus* in the markets. The size of the annual catch is not recorded, but is probably on the order of 100 tons per year.

PHILIPPINES

Acetes (local name 'Alamang') is fished in most parts of the country when the wind blows toward the land. During the NE monsoon, from December to March, they are taken on the eastern coasts of Luzon, Paracale, Camarines, and Norte. During the SW monsoon, from May to October, the fishing occurs along the western coasts of the islands (Dr. I. A. RONQUILLO, personal communication). The fishing gear includes push net, bag net, lift net, set filter net, etc. The catch from Manila Bay contained *A. erythraeus* and *A. s. sibogae* in October 1973, whereas that from Iloilo in March 1974 was composed of *A. intermedius* and *A. s. sibogae.* The statistics for the *Acetes* fishery are not available to estimate the country's annual production.

SOUTH VIET NAM

Acetes (local name 'Con ruốc') is exploited along the entire coast. *Acetes indicus* and *A. japonicus* appear to be very abundant in the Mekon Delta. In the fishing village Phuoc Lam, near Vung Tau, the fishing is mainly done from April to August by means of large fixed bag net set about 20 km upstream from the sea. Usually the largest catch is obtained in May, but occasionally the swarms of *Acetes* appear again in December–January. The bag net is 10–12 m wide at the mouth opening and 40 m long; it consists of a graded series of different mesh sizes. A fisherman puts out 10–30 nets in one set. According to Miss B. T. LANG (personal communication) there is a night fishery using light off Nhatrang in November and December. It is considered that the recent catch of *Acetes* including some mysids in South Viet Nam exceeds 10,000 tons per year.

THAILAND

The fishing of *Acetes* (local name 'Kwei-Kung') is undertaken along the coasts of the Gulf of Siam and the Andaman Sea. Creeks in mangrove swamps and culture ponds of penaeid shrimps are good fishing ground for *Acetes*. *Acetes erythraeus*, *A. indicus*, and *A. vulgaris* were sold at the fish markets along the Gulf of Siam, whereas *A. erythraeus*, *A. japonicus*, and *A. s. sibogae* were marketed in Phanga Province, the Andaman Sea coast.

The fishing village on Goh Pangi in Phanga Province where I visited was founded about 200 years ago because *Acetes* was most abundant there. All houses are made of wood and are constructed on the water where mangrove swamps extend over vast areas. Today the villagers, about 1,200 in all, get the livelifood by the *Acetes* fishery. *Acetes* is mainly fished by the bag net called 'Chanta' and the push net 'Wa'. The Chanta is about 10 m wide at the mouth opening and 30 m long; the Wa is similar in structure to the 'Sondong' (Plate 1-c). The fishing takes place throughout the year but the best season is from April to June. According to the fishermen *Acetes* gradually migrate from deep waters (10–20 m in depth) in November to shallow area of the mangrove swamps in May. Annual catch from Goh Pangi and neighbouring villages is estimated to be 1,000–1,500 tons.

The average annual catch of *Acetes* in Thailand in 1968–72 reached 13,600 tons and formed about 18% of the annual total shrimp catch (Table 6).

Table 6. Annual catches of *Acetes* and total shrimps in Thailand in 1967–72

Year	*Acetes* (tons)	Total shrimps (tons)	*Acetes* to total shrimps (%)
1967	9062	58199	15.6
1968	11290	71045	15.9
1969	13059	71372	18.3
1970	15617	79269	19.7
1971	8870	67122	13.2
1972	19129	86016	22.2

MALAYSIA

Both east and west coasts of the Malay Peninsula (West Malaysia) are known to be very rich in *Acetes* (local name 'Udang gragok'). Various species such as *A. indicus* and *A. japonicus* are exploited. In recent years the annual catch exceeded 5,600 tons and constitutes 11-30% of the total shrimp catch in West Malaysia (Table 7). The bag net, the push net called 'Suongkor', and to a lesser extent the shore seine are the most frequently types of gear used by the Malaysian *Acetes* fishery. Fishing occurs off Penang throughout the year, but the main season is from May to September. During that period the average monthly catch per boat is about 3.5 tons. It is thought that the catch from the west coast comprises

85 % or more of the total *Acetes* catch in West Malaysia. In East Malaysia (Sabah and Sarawak) *Acetes* (local name 'Bubok') is also a very important product, although statistics are not available. At Lubok Termiang on Labuan *Acetes* is mainly fished from November to March (MALLEY and HO, 1975). The catch was composed of *A. erythraeus* and *A. s. sibogae* at markets in Kudat and Labuan in March 1974.

Table 7. Annual catches of *Acetes* and total shrimps in West Malaysia in 1965–72. Values in parenthesis show the catches from the west coast of West Malaysia

Year	*Acetes* (tons)	Total shrimps (tons)	*Acetes* to total shrimps (%)
1965	– (4557)	–	–
1966	– (5450)	–	–
1967	– (5711)	–	–
1968	– (3336)	–	–
1969	– (6753)	–	–
1970	5646 (5303)	46310	12.2
1971	5678 (4805)	54142	10.5
1972	16874 (15814)	55987	30.1

SINGAPORE

Acetes is fished along the northeastern coast of the island with the push net called 'Sondong' during the NE monsoon, December to March (THAM, 1950, 1955). The Sondong (Plate 1-a, b) consists of two poles of 3–5 m long which are crossed at a point 0.6–1 m from the proximal ends. The distal ends of the poles are each fitted with sled-like runners made of wood or coconut husk to facilitate the pushing operation. The fine-mesh scoop-like net is fastened to the longer arms. The gear is pushed by the fisherman on muddy bottom. THAM (1955) states that *A. erythraeus* is the most abundant species, but I have seen only *A. vulgaris* in the commercial catches. During the SW monsoon *Acetes* occurs sporadically in the catches of large fish traps which are used further offshore (THAM, 1950).

BURMA

Acetes indicus is fished along the whole coast of this country. The main fishing season is between November and February (Mr. H. TAKAHASHI, personal communication). The catches around Mergui Archipelago are very large; it is said that swarms of *Acetes* often change the water-colour in the estuary.

INDONESIA

Acetes appears to be exploited in many localities of the country. I saw *A. intermedius* and *A. vulgaris* at markets in Jakarta and Pelabuhan Ratu in March 1974. According to fishermen at Pelabuhan Ratu on the southern coast of Java, *Acetes* is mainly fished in the shallow southeastern part of Wijnkoup Bay by means of the lift net called 'Bagan' and the push net. Bagan is set at a depth of 10–20 m and *Acetes* is attracted to the net by light. The net is rectangular, about 20 m long and 8 m wide, and is lifted 2–3 times at night. There is no fishing off Pelabuhan Ratu during the W monsoon from December to February because landward winds are too strong. *Acetes* is caught from the end of March to June, that is, the transitional period between the W and E monsoons. A mixture of *Acetes* with such small crustaceans as mysids and post-larvae of penaeids is called 'Rebon' or 'Djembret'. The amount of Rebon caught was about 750 tons from Java and 1,100 tons from Madura in 1954 (DJAJADIREDJA and SACHLAN, 1956).

INDIA

Acetes indicus (local name 'Jawla' in Marathi) is exploited mainly at Versova and Sassoon Dock along the Maharashtra coast throughout the year, but the best catch, about 60 % of the total, is obtained from January to April (KUNJU, 1967). *Acetes* is also fished along the coasts of Madras, Andhra, and Sundarbans, but more than 97 % of the catch is from Maharashtra. The average annual catch of *A. indicus* off the Indian coast during 1959–68 was 13,514 tons and constituted 16 % of the total crustacean fishery in India (BANERJI, 1969). In addition, *A. erythraeus* is fished in the Godavari River estuary and along the Madras and Kerala coasts (GANAPATI and SUBRAMANYAM, 1964; JONES, 1967) but the annual catch of this species amounts to only 1,000 tons (BANERJI, 1969). The fishery uses the push net and bag net; the beach seine is also used along the east coast. Their structure and operation are described by RAMAMURTHY and MUTHU (1969).

AFRICA

In Madagascar *A. erythraeus* (local name 'Tsivakihiny') is fished throughout the year in the estuaries and bays along the western and northwestern coast. CROSNIER and FOURMANOIR (1962) state "it is often observed that some hundred kilograms of Tsivakihiny are being dried in a village". The same *Acetes* is also exploited with small crustacean and fish on the tidal flat in Mozambique. At Lingamo, near Lourenço Marques, scoop-nets with a rectangular mouth opening are operated by a pair of fishermen shorewards against the outgoing tide (FREITAS, 1966). *Acetes* is abundant in shallow waters of Kenya and Tanzania. It is extensively caught by women using fine-meshed seines by wading in the estuary (Dr. A. J. BRUCE and Dr. A. KOYAMA, personal communication).

VIII. OCCURRENCE, SWARMING, AND FISHING SEASON

In many localities coastal swarms of *Acetes* are strongly seasonal. The fishing season corresponds with the swarming season of *Acetes* in the given area. The swarming season changes slightly from year to year; the size and density of the swarm also vary considerably. Therefore the fishery is characterized by a fishing season restricted to a few months in many localities and the catch fluctuates considerably. These facts lead to instability of the fishery.

The swarming of euphausiids and sergestids has been described in connection mainly with maturation, predation, light intensity, and water temperature (KOMAKI, 1967; OMORI, 1974). It is apparently a complex form of behaviour not readily explainable by any one mechanism or function. The largest swarms of *Acetes erythraeus* and *A. johni* occur during their shared spawning season from January to April in South India (NATARAJ, 1947). *Acetes chinensis* spawns from late May to September (LIU, 1955) and is fished most abundantly in June in Liaotung Bay (KOBA, 1941). Similar swarming which is considered to be the prespawning aggregation have been reported for *A. americanus* and *A. japonicus* (JOYCE, 1966; ACHUTHANKUTTY *et al.*, 1973). However, swarming is seen not only adults but also in postlarval stages and juveniles. For example the commercial catch of *A. japonicus* in Japan is composed mostly of juveniles. The juvenile *A. sibogae australis* forms remarkable aggregations over beds of sea-grass *Zostera* in the estuaries of the east coast of Australia during April–May.

Massive accumulation of swarms of *A. japonicus* is sometimes observed in the surface layer (0–5 m). The water shows a brick-like red at that time because of conspicuous aggregation of the species. The swarms are often elongated with 20–30 m wide and 200–300 m long along the water-way at the mouth of river. An estimate of population density within a swarm of *A. japonicus* in the intertidal zone of the Seto Inland Sea based on catches from a push net suggested that the concentration was approximately 30,000 individuals per one cubic metre of water.

Figure 36 shows the general fishing season in various localities. In Japan nearshore swarms most frequently occur when the prevailing wind is landward. In the Indian Ocean and South-east Asian waters, the NE monsoon prevails from December to February in the Northern Hemisphere. March–April is a transitional period. The May–June period witnesses the commencement of the SW or SE monsoon. The monsoon is well established from July to September. October–November is a transitional period. In the Indo-Southeast Asian region there seems to be a tendency for fishing to take place from the transitional period to the early period of monsoon when the wind blows landward or the transitional period soon after the landward monsoon. An exception is the fishing during the NE monsoon along the west coasts of Burma and India. The off-season of the fishing in the tropical region may be caused by either 1) offshore migration of the shrimp, 2) bad weather conditions, or both. Shrimping is probably impossible in some areas during months when the sea is rough. Swarming and horizontal migration of *Acetes* will require a great deal of field observations and experimental analysis to be understood but it can be said that as far as shore swarming is concerned, the wind direction and tide are very important causative factors. Surface water currents accumulate or stimulate *Acetes* to swarm in shallow inshore waters when the wind blows moderately towards land. The peak of spawning may follow this period in many regions of the tropical waters and hence the larvae can remain in favourable neritic environments and avoid being transported offshore to the open sea.

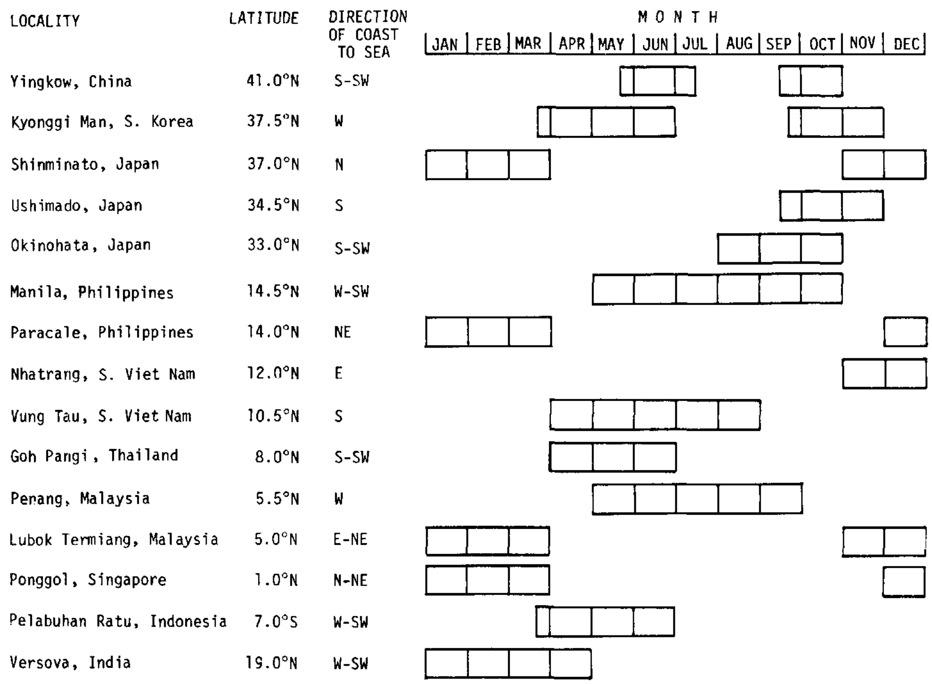

Figure 36. Main fishing season of *Acetes* in the various coastal areas of the Indo-West Pacific. Periods over which the fishing has been carried out are shown by rectangles.

IX. ABUNDANCE AND CATCHES

Catches of pelagic crustaceans like sergestids, galatheids, euphausiids, and mysids are not recorded in the FAO's "Yearbook of Fishery Statistics" as a result of the lack of statistical data on these fisheries. Therefore, it would be worth while to estimate the amount of commercial catches of *Acetes* at present and to evaluate the potential of *Acetes* as a fishery resource. Approximate average annual catches of *Acetes* and their proportions to the catches of total shrimps in seven Asian countries are summarized in Table 8. The catches of *Acetes* in the table total 130,000 tons, but these records must be considered as minimal because reliable statistics are only available for a few of the larger markets. Although data is not complete as yet, *Acetes* certainly supports a subsistence fishery of considerable importance in North Korea, Taiwan, Hong Kong, Philippines, North Viet Nam, Cambodia, Burma, Singapore, and Indonesia. It is probably fished in Bangla Desh, Pakistan, and Sri Lanka. Catches from Kenya, Tanzania, Mozambique, and Madagascar may not be ignored. In South America, a small amount of *A.*

americanus is consumed in Surinam and French Guiana (HOLTHUIS, 1959). I would judge the *Acetes* harvest from areas not reporting regional fishery statistics to exceed 40,000 tons per year. Therefore, the world catch of *Acetes* is estimated to be at least 170,000 tons per year.

Table 8. Approximate recent annual catches of *Acetes* and their contribution to the shrimp fishery in seven Asian countries

Country	Year	*Acetes* (tons)	Total shrimps* (tons)	Other crustaceans** (tons)	*Acetes* to total shrimps (%)	*Acetes* to total crustaceans (%)
China	1955	71000	–	–	–	–
South Korea	1965–68	10700	13700	3900	78.1	60.8
Japan	1968–72	800	57700	92300	1.4	0.9
South Viet Nam	1972	10000	54300	–	19.4	–
Thailand	1968–72	13600	75000	35700	18.1	12.2
Malaysia (West)	1970–72	9400	52200	2000	18.0	17.3
India	1959–68	14500	81700	3000	17.7	17.3

* Natantia
** *Panulirus, Portunus, Scylla, Paralithodes*, etc.

The annual catch of total shrimps (Natantia) excluding planktonic forms reached about 474,000 tons in 1970 in the Indo-West Pacific; it was 930,000 tons in the world (FAO, 1971). If the present estimate is correct, *Acetes* accounts for 26 % of the total shrimp catch in the Indo-West Pacific and 15 % of that in the world. Furthermore, *Acetes* probably exists in potentially exploitable quantities in other areas but is not fished due to lack of appropriate method of food processing, the richness of other fishery resources, and/or the small size of the local market.

The life span of *Acetes* is less than 3–10 months and the adult dies soon after spawning. Thus the adults represent an ephemeral stock with very rapid turnover; new individuals being consistently recruited from the nearby waters. Since planktonic shrimps such as *Acetes, Peisos*, and *Lucifer* often occupy a key trophic level in neritic communities (OLIVIER *et al.*, 1968; OMORI, 1974), the exploitation should be carefully managed so that it is not excessive and unbalance the food web. However, it seems reasonable to conjecture that a potential world fishery of 50,000–100,000 tons of *Acetes* would not be excessive.

X. PROCESSING AND UTILIZATION

Many kinds of *Acetes* products can be seen at markets, but they can be classified into the following types: 1) raw; 2) boiled; 3) dried in the sun; 4) dried after boiling and sometimes processed further by having the carapace removed from each shrimp; 5) pickled in salt; 6) fermented with salt (shrimp paste and shrimp sauce).

Generally, only a very small proportion of the *Acetes* catch is sold as fresh shrimp, but the greater proportion is dried, pickled or fermented for food in various ways. The dried shrimp is marketed in all countries of Asia and it appears the exclusive use of *Acetes* in Africa. In Japan 'Amizuke', where *Acetes* is pickled whole in salt and fermented, is the main product; a similar product is very common in South Korea. In China and South-east Asia *Acetes* is highly desired in the form of fermented shrimp paste and shrimp sauce.

Table 9. Biochemical composition of shrimp paste 'Blachan' and *Acetes japonicus*

Sample	Water (%)	Carbon	Nitrogen (% in dry weight)	Ash
Blachan	26.9	32.3	7.9	22.7
Acetes japonicus				
(8 Aug. 1972: Suruga Bay)	79.8	42.9	11.5	13.3
(25 Oct. 1973: Ariake Sea)	79.1	42.3	11.0	10.7

The paste includes 'Xiajiang' in China, 'Mam-tep' in Viet Nam, 'Blachan' in Malaysia and Singapore, 'Gapi' in Thailand, and 'Ngapi' in Burma. Blachan is manufactured in the following way. Fresh *Acetes* is mixed with salt and dried in the sun for 5–8 hours. It is then put through a mincer and packed tightly in a wooden tub which is covered with burlap and set aside for a week to cure. The paste is then removed from the tub and again spread out to dry in the sun. This is followed by a second mincing and again the paste is packed into the tub, covered and allowed to cure for about a month. The process of fermentation, mincing, and drying is repeated at least three times and finally the product is pressed into a hard mass. Blachan is deep purple in colour and has a salty strong shrimp flavour (Plate 1-e, f). This product remain in good condition for 2 months or more. The biochemical composition of the Blachan from Penang was determined and compared with that of fresh *A. japonicus* (Table 9). The results indicate that about 3.7 kg of fresh shrimp are needed to make 1 kg of Blachan and that Blachan is a highly nutritive product containing 36% protein. In the market 1 kattee (about 600 g) of good Blachan costs 100 yen in 1973. About 80% of the *Acetes* landed in West Malaysia was used to make Blachan and the amount of production, mainly from Selangor, Johor, and Penang, attaind 4,072 tons in 1972. The taste and nutritional value of Blachan is highly favoured by people of South-east Asia, and a considerable amount is exported from Malaysia to Singapore and Thailand.

Gapi is an important condiment in the food of the Thai people; the best quality is made from *Acetes* and mysids. Fresh shrimp is mixed with salt and allowed to drain overnight. The material is dried in the sun for 5–8 hours, ground, and again dried. Then it is packed tightly in wooden tub and fermented for 15 to 120 days. It is considered to be most marketable after aging for 2–3 months. Gapi contains 35–40% water and 15–35% salt.

The shrimp sauce ('Xiayou' in China, 'Nam-pla' or 'Nam-keow' in Thailand) is made from the supernatent fluid which is drained or skimmed from the semi-cured shrimp paste. There is another products called 'Chinchalok' in Malaysia in which the shrimp is pickled whole in salt and fermented with cooked rice.

XI. DISCUSSION

As I have already emphasized (OMORI, 1974), we must pay more attention to the biology and ecology of *Acetes*, as well as to its present and future potential as a commercial fishery resource. Little is known about *Acetes*; its propagation, growth, migration, swarming behaviour, feeding habits, etc. *Acetes* is assumed to play a significant role in the food web of coastal waters. In particular, it must be important in the dynamics of ecosystems in lagoons, sea-grass beds, and mangrove swamps which extend over vast areas in tropical and subtropical regions.

Acetes certainly affords a major source of protein to some of the people in the Indo-West Pacific. Among 14 species of the genus, *A chinensis, A. erythraeus, A. indicus, A. japonicus,* and *A. vulgaris* are most important in the plankton fishery. In the report on the crustacean resources of the countries bordering the South China Sea, MISTAKIDIS (1973) mistakenly lists *Sergestes* spp. in place of *Acetes* spp. as one of the most important commercial shrimps in the area. No species of the genus *Sergestes* have so far been exploited in Southeast Asia.

The possibility of using plankton as a food source for mankind has been discussed for a long time. While much interest has focused on the practicality of fishing Antarctic krill *Euphausia superba*, few seem aware that planktonic fisheries have existed for many years utilizing the pelagic crustaceans, *Acetes* spp., *Sergia lucens, Neomysis intermedia, Acanthomysis mitsukurii,* and *Euphausia pacifica* (see MURANO, 1963; KOMAKI, 1967; OMORI *et al.*, 1973) and the jellyfish, *Rhopilema esculenta* and *Stomolophus nomurai*. Harvesting krill is technologically feasible. During 1974/75 season two Japanese exploratory stern trawlers took a combined catch of about 3,000 tons of krill in Antarctic waters. Some scientists suggest that a potential of at least 20–30 million tons of krill exist for the world fishery. At present, however, a satisfactory large scale method for processing krill for human consumption is lacking, although various possibilities of industrial and agricultural use; e.g. as meal for cultivated animals, as a source of lipids for pharmaceuticals, as a source of protein flour for human consumption, etc., are considered. Solution of this problem is indispensable for development of commercial fishery of Antarctic krill.

In Japan fresh pelagic shrimps such as *Acetes* and *Sergia* cost 300–800 yen per kg. The price of *Acetes* is often only 30–50 yen per kg in Southeast Asian countries. The fishing and processing methods of *Acetes* are rather primitive. The catch by hand net and push net often contains considerable numbers of the post-larvae of economically important penaeids. In managing the current fishery, it is desirable to reduce penaeid contamination of the *Acetes* catch. In our experience the composition of catches of swarming *Acetes* is usually monospecific and the individuals are of uniform size. Apparently the microdistribution of the swarms is quite distinct from that of other organisms. Study of *Acetes* swarming behaviour should be carried out in connection with improvement of fishing methods. At the same time, it is necessary to improve techniques for processing *Acetes* for human consumption.

XII. ACKNOWLEDGEMENTS

It is pleasure to acknowledge to Dr. FENNER A. CHACE, Jr. and Dr. ABRAHAM FLEMINGER for their helpful criticism and kind reading of the manuscript. I am most grateful to the persons listed in Chapter II who kindly provided or loaned the materials for this study. Without their support, the work would not have been possible. In addition, Dr. A. J. BRUCE, Mr. F. B. GRIFFITHS, Mr. M. HUTOMO, Mr. K. KINOSHITA, Dr. A. KOYAMA, Mr. E. L. LIM, Mr. M. NAKAHIRA, Dr. P. V. RAO, Mr. SAYAN RONGMUANGNSART, Mr. T. SAKURAI, Dr. A. SOEGIARTO, Mr. H. TAKAHASHI, Dr. R. G. WEAR, and Dr. J. C. YALDWYN have helped to complete this study either by answering letters or assisting my field trip. I wish to express my gratitude to them. Thanks are also due to Dr. R. MARUMO and Dr. R. L. BROWNELL, Jr. for useful suggestions and discussions.

Finally, I would like to thank the HIDAKA Foundation for Marine Science Promotion which has financially supported the present study.

XIII. REFERENCES

ACHUTHANKUTTY, C. T. (1973) Sexual abnormalities in the genus *Acetes* (Sergestidae, Decapoda). *Curr. Sci.*, 42: 827–828.

ACHUTHANKUTTY, C. T. and GEORGE, M. J. (1973) *Acetes sibogalis* sp. nov. (Crustacea: Decapoda, Sergestidae) from Cochin backwaters with a note on its impregnation. *Indian J. mar. Sci.*, 2: 139–144.

ACHUTHANKUTTY, C. T., NAIR, K. K. C., and PURUSHAN, K. S. (1973) A shoal of sergestid shrimp *Acetes* in association with a swarm of gammarid amphipods in the south-west coast of India. *Curr. Sci.*, 42: 840.

ALDRICH, F. A. (1962) Results of the Catherwood Foundation Peruvian Amazon Expedition. The distribution of *Acetes paraguayensis* HANSEN (Crustacea; Decapoda). *Notul. Nat.*, (351): 1–7.

BALSS, H. (1914) Ostasiatische Decapoden II. Die Natantia und Reptantia. *Abh. math.-phys. Kl. K. Bayer. Akad. Wiss.*, Suppl. 2 (10): 1–101, pl. 1.

BANERGI, S. K. (1969) Prawn fisheries of India. Crustacean production in India. *Bull. cent. mar. Fish. Res. Inst.*, (14): 259–272.

BARNARD, K. H. (1950) Descriptive catalogue of South African decapod Crustacea (crabs and shrimps). *Ann. S. Afr. Mus.*, 38: 1–837.

BARNARD, K. H. (1955) Additions to the fauna-list of South African Crustacea and Pycnogonida. *Ann. S. Afr. Mus.*, 43: 1–107.

BOONE, L. (1935) Scientific results of the world cruise of the yacht "Alva," 1931, WILLIAM K. VANDERBILT, commanding. Crustacea: Anomura, Macrura, Euphausiacea, Isopoda, Amphipoda and Echinodermata: Asteroidea and Echinoidea. *Bull. Vanderbilt mar. Mus.*, 6: 1–264, pls. 1-96.

BURKENROAD, M. D. (1934 a) The Penaeidea of Louisiana with a discussion of their world relationships. *Bull. Am. Mus. nat Hist.*, 68: 61–143.

BURKENROAD, M. D. (1934 b) Littoral Penaeidae chiefly from the Bingham Oceanographic Collection. *Bull. Bingham oceanogr. Coll.*, 4: 1–109.

BURKENROAD, M. D. (1945) A new sergestid shrimp (*Peisos petrunkevitchi*, n. gen., n. sp.), with remarks on its relationships. *Trans. Conn. Acad. Arts Sci.*, 36: 553–593.

CHACE, F. A., Jr. (1972) The shrimps of the Smithsonian-Bredin Caribbean Expeditions with a summary of the West Indian shallow-water species (Crustacea: Decapoda: Natantia). *Smithsonian Contr. Zool.*, (98): 1–179.

CHENG, C. (1953) [Studies on marine planktonic crustacean. 1. *Acetes.*] *Shia-Men Da Shue Shue Pau* (Rep. Shia-Men Univ.), 2: 37–44. (In Chinese.)

COLEFAX, A. N. (1940) An Australian species of *Acetes* (Crustacea Macrura, Sergestidae), with remarks on the distribution and literature of the genus. *Rec. Aust. Mus.*, 20: 341–353.

CROSNIER, A. and FOURMANOIR, P. (1962) La Tsivakihiny. *Naturaliste malgache*, 12: 87–88.

DJAJADIREDJA, R. R. and SACHLAN, M. (1956) Shrimp and prawn fisheries in Indonesia with special reference to the Kroya district. *Proc. 6th Indo-Pacif. Fish. Coun.*, Sect. 2 and 3: 366–377.

EKMAN, S. (1953) Zoogeography of the sea, 417 pp. Sidgwick and Jackson, London.

FLEMINGER, A. and HULSEMANN, K. (1973) Relationship of Indian Ocean epipelogic calanoids to the world oceans, p. 339–347. *In* B. ZEITZSCHEL (ed.), The Biology of the Indian Ocean. Springer-Verlag, New York-Heidelberg-Berlin.

FLEMINGER, A. and HULSEMANN, K. (1974) Systematics and distribution of the four sibling species comprising the genus *Pontellina* DANA (Copepoda, Calanoida). *Fishery Bull.*, 72: 63–120.

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS (1971) Year Book of Fishery Statistics, 30: i-xxii, 1-476.

FREITAS, A. J. de, (1966) An analysis of the shrimp catch on the intertidal mudflats of Lingamo (Matola, Moçambique). *Mems Inst. Invest. cient. Moçamb.*, 8, Ser. A: 3–12.

GANAPATI, P. N. and SUBRAMANYAM, M. (1964) The prawn fishery in Godavary estuary. *J. zool. Soc. India*, 16: 11–20.

GEORGE, M. J. (1969) Prawn fisheries of India. Systematics: Taxonomic considerations and general distribution. *Bull. cent. mar. Fish. Res. Inst.*, (14): 5–48.

HANSEN, H. J. (1919) The Sergestidae of the Siboga Expedition. *Siboga Exped.*, 38: 1–65, pls. 1–5.

HANSEN, H. J. (1933) A North American species of *Acetes*. *J. Wash. Acad. Sci.*, 23: 30–34.

HARADA, E. (1968) Seasonal changes in distribution and abundance of some decapod crustaceans. *Spec. Publs Seto mar. biol. Lab.*, Ser. 2, 75–103.

HOLTHUIS, L. B. (1948) Notes on some Crustacea Decapoda Natantia from Surinam. *Proc. K. ned. Akad. Wet.*, 51: 1104–1113.

HOLTHUIS, L. B. (1959) The Crustacea Decapoda of Suriname (Dutch Guiana). *Zool. Verh. Leiden*, (44): 1–296, pls. 1–16.

IKEMATSU, W. (1953) On the life-history of *Acetes japonicus* KISHINOUYE in Ariake Sea. *Bull. Jap. Soc. scient. Fish.*, 19: 771–780. (In Japanese.)

IKEMATSU, W. (1963) Ecological studies on the fauna of Macrura and Mysidacea in the Ariake Sea. *Bull. Seikai reg. Fish. Res. Lab.*, (30): 1–124. (In Japanese.)

JOHNSON, D. S. (1965) A review of the brackish water prawns of Malaya. *Bull. natn. Mus. Singapore*,(33): 7–11.

JONES, S. (1967) The crustacean fishery resources of India. *Proc. Symp. Crustacea*, 4: 1328–1340.

JORDAN, D. S. (1908) The law of geminate species. *Am. Nat.*, 42: 73–80.

JOYCE, E. A., Jr. (1966) Acetes shrimp on the Florida east coast. *Q. J. Fla Acad. Sci.*, 29: 38.

KEMP, S. (1917) Notes on Crustacea Decapoda in the Indian Museum. VIII. The genus *Acetes*, MILNE-EDWARDS. *Rec. Indian Mus.*, 13: 43–58.

KENSLEY, B. F. (1969) Decapod crustacean from the south-west Indian Ocean. *Ann. S. Afr. Mus.*, 52: 149–181.

KENSLEY, B. F. (1971) The family Sergestidae in the waters around southern Africa (Crustacea, Decapoda, Natantia). *Ann. S. Afr. Mus.*, 57: 215–264.

KISHINOUYE, K. (1905) On a species of *Acetes* from Japan. *Annotnes zool. jap.*, 4: 163–167.

KOBA, K. (1941) [*Acetes* in Manchu]. *Curr. News cent. natn. Mus. Manchoukuo,* (14): 1–19. (In Japanese.)

KOMAKI, Y. (1967) On the surface swarming of euphausiid crustaceans. *Pacif. Sci.,* 21: 433–448.

KRØYER, H. (1859) Forsög til en monografisk Fremstilling af Krebsdyrslaegten Sergestes, med Bemaerkninger om Decapodernes Höreredskaber. *K. danske Vidensk. Selsk. Skr.* 5, *Naturv.-math.*, 4: 217–304.

KUNJU, M. M. (1967) Observations on the prawn fishery of Maharashtra coast. *Proc. Symp. Crustacea,* 4. 1382–1397.

LERESTE, L. (1970) Biologie de *Acetes erythraeus* (Sergestidae) dans une baie du N. W. de Madagascar (Baie d'Ambaro). *Cah. O.R.S.T.O.M. Ser. Oceanogr.,* 8 (2): 35–56.

LIU, J. Y. (1955) [Commercial shrimps of North China], 73 pp. pls. 1–24. Science Press, Peking. (In Chinese.)

LIU, J. Y. (1956) Notes on two species of *Acetes* of the family Sergestidae (Crustacea Decapoda) from the coasts of North China. *Acta zool. sin.,* 8:29–40, pls. 1–4. (In Chinese.)

LIU, J. Y. (1959) Notes on the economic macrurous crustacean fauna of the Yellow Sea and the East China Sea. *Oceanol. Limnol. sin.,* 2: 35–42. (In Chinese.)

LIU, J. Y. (1965) [Studies on the genus *Acetes* in Chinese waters], p.131–132, *In* Zoological Society of China (ed.), 30th Annual Meeting of Zoological Society of China, Abstr. Pap. (1). (In Chinese.)

MALLEY, D. F. and HO, S. C. (1975) Prawns and other invertebrates, p. 113–142, *In* T.-E. CHUA and J. A. MATHIAS (ed.), Coastal Resources of West Sabah. Universiti Sains Malaysia, Penang.

MENON, M. K. (1933) The life-histories of decapod Crustacea from Madras. *Bull. Madras Govt. Mus. new Ser. nat. Hist.,* 3 (3): 1–45.

MILNE EDWARDS, H. (1830) Descriptions des genres *Glaucothoë, Sicyonie, Sergeste et Acète* de l'ordre des Crustacés décapodes. *Annls. Sci. nat.,* 19: 333–352, pls. 8–11.

MISTAKIDIS, M. N. (1973) The crustacean resources and related fisheries in the countries bordering the South China Sea. FAO South China Sea Fisheries Development and Coordinating Programme, 1973, (7), 39 pp.

MORRIS, M. C. (1948) Life-history of an Australian crustacean, *Acetes australis* (Decapoda, tribe Penaeidae). *Proc. Linn. Soc. N. S. W.,* 73: 1–15.

MURANO, M. (1963) [Fisheries biology of a mysid *Neomysis intermedia* CZERNIAWSKY. I. Role of the mysid in the production of lakes]. *Aquiculture (Japan),* 11: 149–158. (In Japanese.)

NATARAJ, S. (1947) On some species of *Acetes* (Crustacea, Sergestidae) from Travancore. *Rec. Indian Mus.,* 45: 139–148.

NOBILI, G. (1905) Diagnoses preliminaires de 34 espèces et variétés nouvelles, et de 2 genres nauveaux de Décapodes de la Mer Rouge. *Bull. Mus. Hist. nat. Paris,* 11: 393–411.

NOBILI, G. (1906) Faune carcinologique de la Mer Rouge. Dècapodes et Stomatopodes. *Annls. Sci. nat. Zool.,* 4: 1–347, pls. 1–11.

OKADA, Y. K. (1928) Note on the tail-organs of *Acetes. Ann. Mag. nat. Hist.,* (Ser. 10), 1: 308–310.

OLIVIER, S. R., TORTI, M. R., and BASTIDA. R. (1968) Ecosistema de las aquas litorales. *Publico Servicio de Hidrografia Naval, Armada Argentina,* H1025: 1–45.

OMORI, M. (1974) The biology of pelagic shrimps in the ocean. *Adv. mar. Biol.,* 12: 233–324.

OMORI, M., KONAGAYA, T., and NOYA, K. (1973) History and present status of the fishery of *Sergestes lucens* (Penaeidea, Decapoda, Crustacea) in Suruga Bay, Japan. *J. Cons. perm. int. Explor. Mer,* 35: 61–77.

ORTMANN, A. (1893) Decapoden und Schizopoden der Plankton-Expedition. Part 2Gb in *Ergebn. Atlant. Ozean Plankton exped. Humboldt-Stift.,* 1–120, pls. 1–10.

PATHANSALI, D (1966) *Acetes* (Sergestidae) from Malay Peninsula. *Bull. natn. Mus. Singapore,* (33): 59–63.

PEREZ FARFANTE, I. (1969) Western Atlantic shrimps of the genus *Penaeus. Fishery Bull.,* 67: 461–591.

RAMAMURTHY, S. and MUTHU, M. S. (1969) Prawn fisheries of India. Prawn fishing methods. *Bull. cent. mar. Fish. Res. Inst.,* (14): 235–257.

RAO, P. V. (1968) A new species of shrimp, *Acetes cochinensis* (Crustacea, Decapoda, Sergestidae) from south-west coast of India with an account of its larval development. *J. mar. biol. Ass. India,* 10: 298–320.

RINGUELET, R. (1949) Camarones y Cangrejos de la Zona de Goya. *Notas Mus. La Plata,* 14 (Zool. 119): 79–109.

SOEJIMA, I. (1926) [On the development and ecology of *Acetes japonicus* KISHINOUYE in the Ariake Sea.] *Suisan Gakkwai Ho,* 4: 153–163, pl. 4. (In Japanese.)

THAM, A. K. (1950) The food and feeding relationships of the fishes of Singapore Straits. *Fish. Publs, Colonial Office,* (1): 1–35.

THAM, A. K. (1955) The shrimp industry of Singapore. *Proc. 5th Indo-Pacif. Fish. Coun.*, Sect. 2 and 3: 145–155.

TOKIOKA, T. (1974) Morphological differences observed between the generations of the same chaetognath population. *Publs Seto mar. biol. Lab.*, 21: 269–279.

UMBGROVE, J. H. F. (1930) Tertiary sea-connections between Europe and the Indo-Pacific area. *Proc. 4th Pacif. Sci. Congr., Java, 1929,* 2A: 91–104.

URITA, T. (1926) [On decapod crustaceans found around Tsingtao, China.] *Zool. Mag., Tokyo,* 38: 421–438. (In Japanese.)

WICKSTEAD, J. H. (1961) A quantitative and qualitative study of some Indo-West-Pacific plankton. *Fish. Publs, Colonial Office,* (16): 1–200.

WILLIAMS, A. B. (1965) Marine decapod crustaceans of the Carolinas. *Fishery Bull.,* 65: 1–298.

WILLIAMS, A. B. (1974) The swimming crabs of the genus *Callinectes* (Decapoda: Portunidae). *Fishery Bull.,* 72: 685–798.

YASUDA, J., TAKAMORI, S., and NISHINA, S. (1953) Study on the ecology of 'Akiami' (*Acetes japonicus* KISHINOUYE) and its multiplication and protection. *Bull. Naikai reg. Fish. Res. Lab.*, (4): 1–19. (In Japanese.)

YOO, K. I. and KIM, D. (1973) The biology of *Acetes chinensis* HANSEN (Decapoda:Crustacea) in Korean waters. I. Systematics and external anatomy. *J. oceanol. Soc. Korea,* 8: 61–67.

YOSHIDA, H. (1941) Important marine shrimps and lobsters of Tyosen (Korea). *Bull. Fish. Exp. Stn. Fusan,* (7): 1–36, pls. 1–13. (In Japanese.)

YU, H. P. (1974) On two species of *Acetes* (Crustacea, Decapoda, Sergestidae) from Taiwan and its adjacent waters. *Aquiculture (Taiwan)*, 2: 59–63. (In Chinese.)

YU, S. C. (1935) On the Chinese Penaeidea. *Bull. Fan meml. Inst. Biol.*, 6 (Zool.): 161–173.

Plate 1. a and b, *Acetes* fishing with the push net 'Sondong' in Singapore; c, *Acetes* fishing with the push net 'Wa' in Thailand; d, *Acetes* fishing with the triangular bag net in the Ariake Sea; e. 'Blachan', press and hardening; f. 'Blachan'