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# Biology of *Acetes indicus* Milne Edwards in Bombay waters

VINAY D. DESHMUKH
*Bombay Research Centre of Central Marine Fisheries Research Institute, Bombay - 400 001, India.*

## ABSTRACT

Biology of *Acetes indicus* was investigated from coastal waters of Bombay during January 1981 to March 1983. Total length of males and females ranged between 8-25 and 8-36 mm respectively, exhibiting growth rates of 6.02 and 5.83 mm per month. The lifespan of the species was 4-6 months. The length-weight relationship was LogW=1.9925 + 2.9698 LogL for the males and females together. The relationship between total length and carapace length was calculated as C = 0.3828 + 0.2185L. The species subsists mainly on detritus and planktonic organisms by filter feeding mechanism. The size at first maturity was 14-15 mm for males and 17 mm for females. It breeds throughout the year with peak during September- January period. The sex ratio exhibited dominance of males until 20-21 mm size and females thereafter. Fecundity has been estimated to be 4,333-10,300 for females in the size range 19-33 mm.

## Introduction

The non-penaeid prawns occur along the northwest coast of India at an average annual production of 52,400 tonnes, accounting for 24.4% of the total marine fish production and about 65% of the prawn production of Maharashtra (Srinath *et al.,* 1987). The resource is mainly constituted by the tiny species of prawns, namely *Acetes indicus*, *Nematopalaemon tenuipes* and *Exhippolysmata ensirostris* among which the former species is the most dominant.

Biological information on *N. tenuipes* and *E.ensirostris* is available, but in spite of greater abundance and importance in the fishery, very little information is available on the biology of *A.indicus*. The only information available on the biology of *A. indicus* is by Pillai (1973) on larval development (CMFRI,1975) on growth and Deshmukh and Kagwade (1987) on the larval abundance. The present study gives detailed information on the biology of *A.indicus* in Bombay waters.

## Materials and methods

Fresh samples of *A.indicus* were collected at weekly intervals from 'dol' net catches landed at Sassoon dock, Bombay during January 1981- March 1983. The samples were preserved in 5% formalin and used for the investigations within 1-2 days before the specimens became too brittle for the length measurements.

Total length of prawns, from tip of the rostrum to the end of telson, was noted by keeping the specimens stretched dorsoventrally on the scale graduated at 0.5 mm under the illuminated 4 X magnifying apparatus. The specimens were grouped into 2 mm class intervals and the size frequency polygons were drawn for each observation day. The carapace length was noted using micrometer scale of the stage microscope and the relationship between carapace length and total length was estimated by least square method. For length-weight relationship the weight of the prawns was noted in milligrammes by using a single pan electronic balance.

For studying the gut contents, foreguts were removed and the gut contents were carefully teased in a drop of lactic acid and examined under the compound microscope. For the analysis of foreguts occurrence method was followed. In this method, the number of guts in which each item of food occurred was expressed as a percentage of the total number of guts examined. Morphological study of oral appendages was also undertaken to know their functional role in feeding.

The sexes were differentiated by the presence of clasping spine on the lower antennular flagella as well as by the presence of petasma in males. Maturity stages of females were determined by the microscopic examination of the ovary. Since *A. indicus* is a sergestid prawn and the females do not carry the eggs, the maturity stages were classified as given by Rao(1968) for the penaeid prawns. For spawning periodicity, ova diameters were measured using ocular micrometer. The ripe ovaries, which appeared yellowish orange, were picked and examined for fecundity. The fecundity was estimated by gravimetric method.

## Results

### *Age and growth*

During January 1982-March 1983 a total of 1,873 males in the size range 8-24 mm and 2,587 females in the size range of 8-36 mm were measured for size frequency analysis to estimate age and growth.

The date-wise size frequency polygons for the two sexes are presented in

TABLE 1. *Modal progression and growth in the males of* A. indicus.

| Mode | Initial mode | | Final mode | | Increment | Duration | Growth/day |
|---|---|---|---|---|---|---|---|
| | Size (mm) | Date | Size (mm) | Date | in growth (mm) | days | mm |
| $a_1$ | 15 | 6-1-82 | 21 | 6-2-82 | 6 | 31 | 0.194 |
| $b_1$ | 15 | 12-2-82 | 21 | 8-3-82 | 6 | 24 | 0.250 |
| $c_1$ | 15 | 11-3-82 | 21 | 22-4-82 | 6 | 42 | 0.143 |
| $d_1$ | 15 | 13-4-82 | 21 | 18-5-82 | 6 | 35 | 0.171 |
| $e_1$ | 13 | 6-5-82 | 19 | 27-5-82 | 6 | 21 | 0.286 |
| $f_1$ | 15 | 8-6-82 | 21 | 14-7-82 | 6 | 36 | 0.167 |
| $g_1$ | 11 | 21-7-82 | 21 | 2-9-82 | 10 | 43 | 0.233 |
| $h_1$ | 15 | 6-11-82 | 21 | 15-12-82 | 6 | 39 | 0.154 |
| $i_1$ | 15 | 15-12-82 | 21 | 12-1-83 | 6 | 28 | 0.214 |
| $j_1$ | 15 | 6-1-83 | 21 | 9-1-83 | 6 | 34 | 0.176 |
| $k_1$ | 11 | 3-2-83 | 21 | 11-3-83 | 10 | 36 | 0.278 |
| Total | | | | | 74 | 369 | 0.201 |

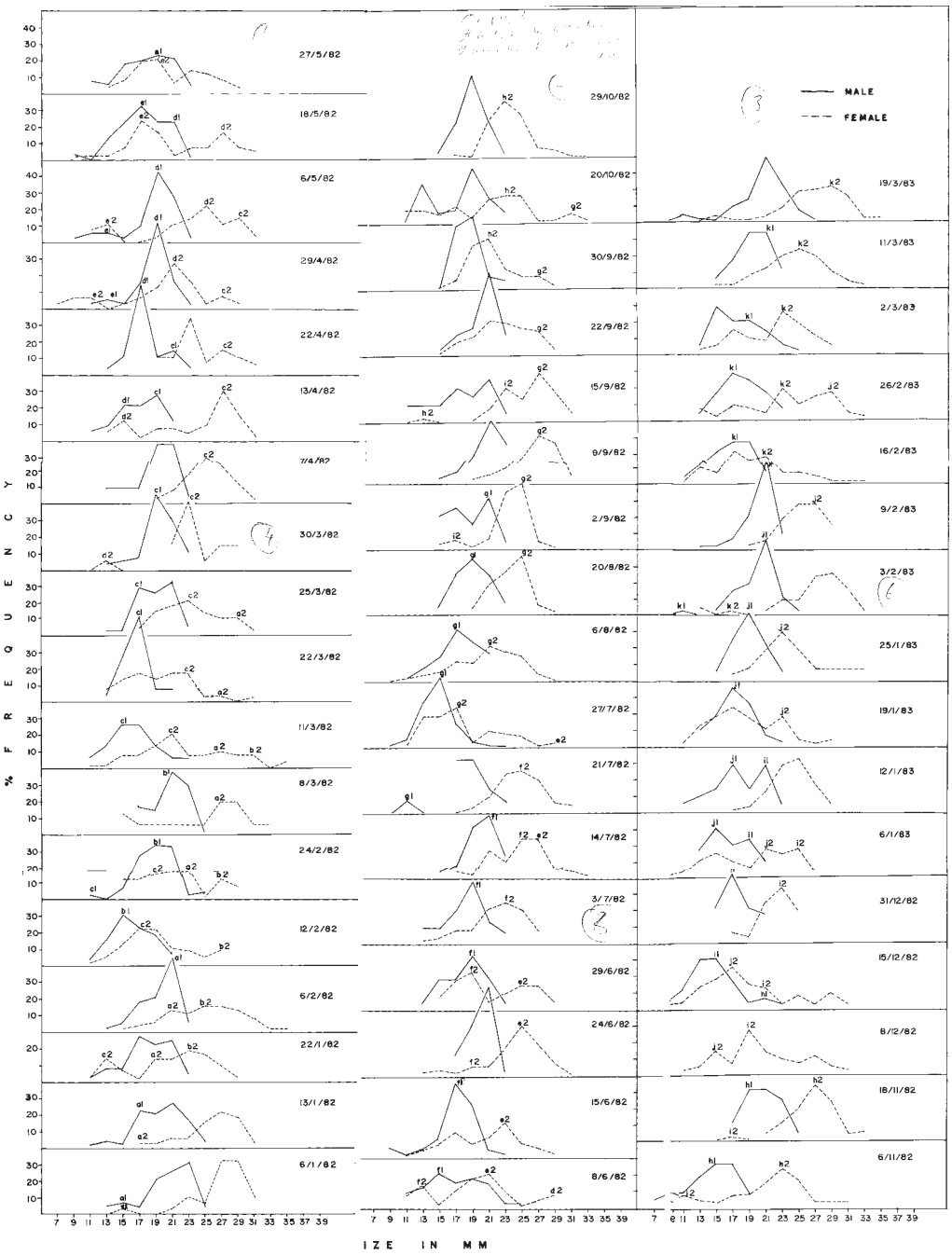


Fig.1. Date wise size frequency polygons of males and females of *A. indicus.*

Fig.1. The modes, which showed clear progression, were traced to investigate the growth patterns. It was seen that in the case of males mode '$a_1$' at 15 mm on 6-1-82 has moved to 21 mm on 6-2-82 showing growth of 6 mm in about 31 days

or 0.194 mm/ day. Similar progression was traced for '$b_1$', '$c_1$'... and '$k_1$' modes and their progression is shown in Table 1. From the eleven progressions of modes it could be seen that in the size range of 11-2l mm, average growth rate of males was 0.20l mm/day or 6.02 mm per month.

The modal progressions and growth increments were similarly traced for the females and shown in Fig. 1 and Table 2. In the case of females, average growth rate for all the modal progressions $a_2$ $b_2$ ...$k_2$ was 0.195 mm/ day or 5.83 mm/ month in the size range of 11-3l mm which indicated that the growth rate of females was slower than that of the males.This apparently slower growth of females is because of the smaller length range of the males (11-23 mm) than that of females (11-31 mm) considered for the average growth rate estimation of the two sexes. If the same size range for the females as that of males was considered, as seen in the case of progressions of the modes '$e_2$', '$f_2$' and '$i_2$', the average growth rate for the females works out to 0.228 mm/ day or 6.84 mm per month.

With the average growth rate of 6.02 mm/ month and 5.83 mm/ month, the size of the males and females at the end of 4 months would be 24.l mm and 27.4 mm respectively. The females however, continue to grow further and reach 34.98 mm at the end of six months.

TABLE 2. *Modal progression and growth in the females of* A. indicus.

| Mode | Initial mode | | Final mode | | Increment | Duration | Growth/day |
|---|---|---|---|---|---|---|---|
| | Size (mm) | Date | Size (mm) | Date | in growth (mm) | days | mm |
| $a_2$ | 15 | 6-1-82 | 29 | 25-3-82 | 14 | 78 | 0.179 |
| $b_2$ | 23 | 22-1-82 | 31 | 11-3-82 | 8 | 48 | 0.167 |
| $c_2$ | 13 | 22-1-82 | 29 | 6-5-82 | 16 | 104 | 0.154 |
| $d_2$ | 13 | 30-3-82 | 29 | 8-6-82 | 17 | 70 | 0.243 |
| $e_2$ | 11 | 29-4-82 | 29 | 27-5-82 | 18 | 18 | 0.202 |
| $f_2$ | 13 | 8-6-82 | 25 | 21-7-82 | 12 | 43 | 0.279 |
| $g_2$ | 17 | 27-7-82 | 31 | 20-10-82 | 14 | 85 | 0.165 |
| $h_2$ | 13 | 15-9-82 | 27 | 18-11-82 | 14 | 64 | 0.219 |
| $i_2$ | 11 | 6-11-82 | 25 | 6-1-83 | 14 | 61 | 0.230 |
| $j_2$ | 15 | 8-12-83 | 29 | 26-2-83 | 14 | 80 | 0.175 |
| $k_2$ | 17 | 3-2-83 | 25 | 19-3-83 | 8 | 44 | 0.182 |
| Total | | | | | 149 | 766 | 0.195 |

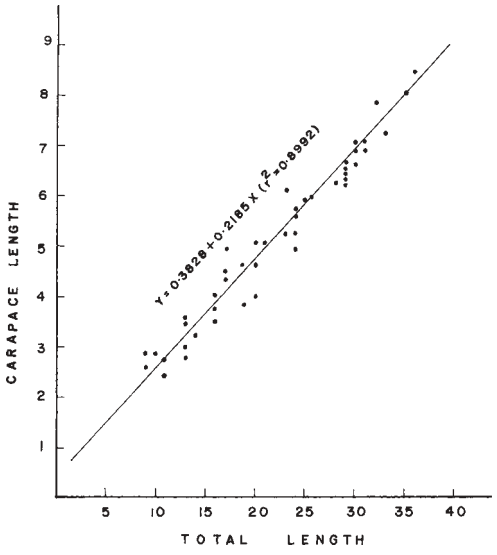


Fig.2. Relationship of carapace length and total length of *A. indicus.*

### *Dimensional relationships*

The relationship between carapace

length (C) and total length (L) based on the measurement of 45 individuals of both the sexes is shown in Fig.2. It can be expressed by:

$$\mathbf{C} = 0.3828 + 0.2185\ L \quad (r^2 = 0.8992)$$

Since males of *A.indicus* were generally smaller than females and also exhibited differential rates of growth, the length-weight relationships were estimated sex-wise. A total of 8l males ranging from 10-24 mm and 110 females of 10-34 mm were used for the length-weight relationship. It can be expressed as:

Males :

Log W = -1.9126 + 2.9068 Log L ($r^2 = 0.8804$)

Or $W = 0.01223\ L^{2.9068}$

Females :

Log W = -1.9389 + 2.9370 Log L ($r^2 = 0.9731$)

Or $W = 0.01151L^{2.9370}$

The length-weight relationships of the two sexes were tested by analysis of co-variance and it was found that the differences were not significant at 5% level. Hence, a common length-weight relationship for the two sexes (Fig.3) was calculated. It can be expressed as:

Log W = -1.9925 + 2.9698 Log L ($r^2 = 0.9626$)

Or $W = 0.01017L^{2.9698}$

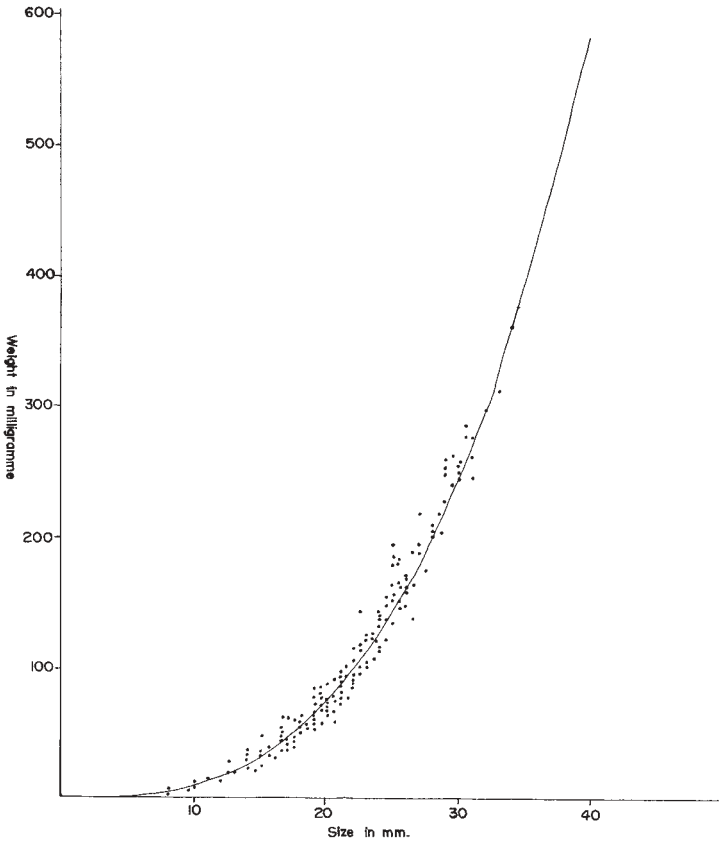


Fig.3. Length-weight relationship of *A. indicus.*

### *Food and feeding*

During the present investigation 216 specimens of 10-32 mm size range were examined for the analysis of foreguts. Among them 28 specimens (12.96%) showed empty foreguts while 51(23.61%) were with 'full', 66 (30.56%) with '1/2 full', 34(15.74%) with '1/4 full' and remaining 37(17.13%) with traces of food in their foreguts.

Qualitative analysis of the food items showed the following results (Table 3). It was seen that in majority of prawns (39.7%), the most frequent food item was detritus, which consisted of fine mud and

TABLE 3. *Occurrence of various food items in the stomach of* Acetes indicus.

| Food items | Number of prawns with food items | % |
|---|---|---|
| Diatoms | 17 | 11.3 |
| Foraminifers | 1 | 0.7 |
| Polychaetes | - | - |
| *Sagitta* | 1 | 0.7 |
| Copepods | 40 | 26.5 |
| Decapods larvae | 19 | 12.6 |
| Molluscan shells | - | - |
| Fish eggs and larvae | 1 | 0.7 |
| Detritus | 60 | 39.7 |
| Mud/slit | 12 | 7.9 |
| Sand particles | - | - |
| Total | 151 | 100 |

well macerated amorphous organaic material. This amorphous material comprise of matted aggregation of fibrous and granular debris, some of which might have originated from fragmented phytoplankton as well as zooplankton. The recognizable remains in coarsely fragmented states in the foreguts consisted of species of calanoid copepods such as *Acartia, Acrocalamus, Euchaeta* and *Paracalanus* which occurred in 26.5% of the prawns. The next frequent food items that occurred in 12.6% prawns were fragments of decapod larvae of crabs and palaemonid prawns, followed by diatom frustules in 11.3% together with fine mud or silt in 7.9% of prawns. The foraminifers, eggs and larvae were rare, whereas food items commonly observed in the foreguts of prawns such as polychaets, molluscs, filamentous algae and sand particles were not seen in *A. indicus.*

In *A. indicus* the oral appendages consisted of mandibles, maxillules, maxillae, and maxillipedes all of which were highly setose. Each mandible had a single tooth and a setose palp, but was devoid of any cutting and grinding surfaces. In addition to setose oral appendages, the pereopods of *A. indicus* were also setose and the chelae on the first three pereopods were elongated and appeared weak. Interestingly, a small lump of detritus containing fine silt or mud was often noticed between highly setose oral appendages and the terminal setose segments of first three pairs of pereopods.

### *Maturity and spawning*

For maturity and spawning, month

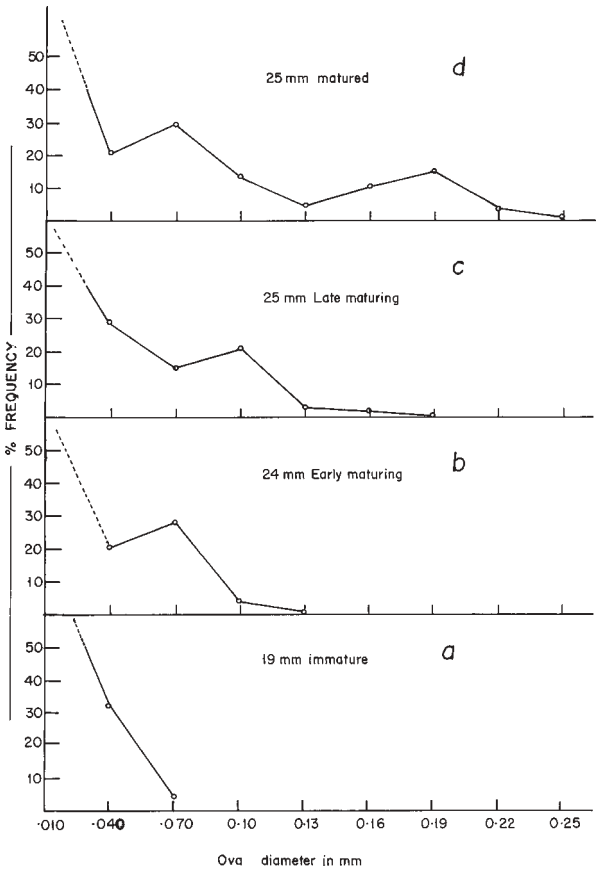


Fig.4. Size-frequency polygons of ova diameters of *A. indicus* **a**. Immature ova, **b**. Early maturing ova, **c**. Late maturing ova, **d**. Mature ova.

wise distribution of different maturity stages of females were collected during January 1981-December 1982. The maturity stages of females were determined based on colour and microscopic examination of ovaries. The diameter of ova in different stages of maturation are shown in Fig. 4.

The immature ovary was very thin, translucent and confined to the posterior part of the cephalothorax and abdomen. The ova were spherical, small, 0.02-0.05 mm in diameter (Fig. 4a) with clear cytoplasm and conspicuous nuclei. Early maturing ovary increased in size and became opaque. The ova showed deposition of yolk granules around the nucleus and increased in diameter ranging from 0.06 to 0.1 mm (Fig. 4 b). Late maturing ovary enlarged further and became yellowish. The ova were opaque and the nucleus became almost completely invisible (Fig. 4 c). The diameter of the late maturing ova was 0.1-0.15 mm. Mature or ripe ovary was deep yellow in colour, which became orange on preservation. It enlarged and extended anteriorly in the cephalothoracic region and posteriorly in the abdomen till the sixth segment. The mature ova were packed with yolk and their diameter ranged from 0.16 to 0.20 mm (Fig 4 d). The mature ova probably attained larger diameter after spawning as reported by Pillai (1973). He observed large, golden brown fertilized eggs of *A. indicus* in plankton samples, collected at Bombay, measuring 0.36-0.40 mm in diameter with large perivitelline space around the embryonic mass and measuring 0.20 mm in diameter. After extrusion of eggs the ovary became greatly reduced, flaccid and opaque. The ova in such spent ovary were mostly immature.

***Size at maturity***

In the case of males of the penaeid prawns, attainment of sexual maturity is closely associated with the joining of the endopodites on the first pair of pereopods to form petasma. Although such petasma is also present in sergestid prawns, in *A. indicus* pars astringens of the inner membranous coupling folds of the endopodites was found to be lacking as a result, the two halves of the petasma remained only juxtaposed and never united permanently. The petasmal endopodites appeared as buds when the males were 8-9 mm and grew fully when they were 14-15 mm in total length. The formation of spermatophores in the genital coxae of the males was also noticed at the same size. Therefore, it may be said that males matured first at 14-15 mm size.

For determination of size at maturity of females, prawns in the late maturing and ripe stages were grouped into 2 mm size intervals and their cumulative percentage was plotted against size. The smallest mature female was 17 mm in length. The percentage of mature females gradually increased after 17 mm size and at 24.4 mm, 50% of the females were mature. All the females were mature at 33 mm.

***Spawning season***

To determine the breeding period, month-wise percentage of 3,774 females collected during January, 1981 to December, 1982 in different maturity stages were analysed (Fig. 5). It was seen that late maturing and ripe females occurred throughout the 2-year period but their percentage was relatively less (30.4%), majority being in immature, early maturing and spent recovering stages. The percentage of late maturing and ripe females was better during January (31.3%) and October (43.3%) in 1981 and in January (43.3%), September (47.3%) and November (25.1%) in 1982. Therefore, it may be

inferred that *A. indicus* breeds continuously throughout the year with peak during September-January period. The abundance of larvae of *A. indicus* in Bombay harbour during September-February period (Deshmukh and Kagwade, 1987) and heavy landings of the species in dolnet catches observed during February-May period also supports this observation.

### *Spawning periodicity*

The frequency polygons of diameters of ova from ripe and mature ovaries (Fig. 4d), revealed 3 distinct sets of ova. A set of immature ova measuring less than 0.04 mm in diameter represented the ground stock; another set is of early maturing ova with 0.07 mm diameter and a third set is of fully mature ova with 0.19 mm diameter. Thus, there were two separated stocks of ova in different stages of maturity, which indicated that the species produces two crops of mature ova, and hence spawns twice during the breeding period. Since mature individuals occurred throughout the year, it may be inferred that the species as a whole is a continuous spawner with peak breeding activity during September-January period, but the individual prawn may spawn twice in its short span of life.

### *Sex ratio*

The sex ratio of males and females above 12 mm is given in Table 4. It could be seen that males dominated until 20-21 mm; however, their percentage fell sharply at 24-25 mm size, after which no males appeared in the population. The sudden fall in sex ratio may be attributed to shorter lifespan of the males. Ikematsu (1953) in the case of *A. japonicus* and Omori (1975) for the genus *Acetes* have opined that the males die after spawning.

### *Fecundity*

Fecundity was estimated by gravimetric analysis of mature ovaries. Since the mature ova of *A. indicus* were densely packed in the tiny elongated ovary, it was with great effort that whole ovaries could be removed and therefore ovaries were collected from only five mature females. The fecundity was found to be 4,333 for 19 mm, 8,574 for 23mm, 7,466 for 28 mm, 10, 300 for 32 mm and 10,275 for 33 mm sized females. The fecundity seemed to increase with the size of the female. Ikematsu (1953) also reported that fecundity of *A. japonicus* was in the range of 680-6800.

TABLE 4. *Distribution of males and females of* A. indicus *at different sizes.*

| Size-groups mm | Males Nos. | % | Females Nos. | % |
|---|---|---|---|---|
| 12-13 | 125 | 55.1 | 102 | 44.9 |
| 14-15 | 217 | 62.4 | 131 | 37.6 |
| 16-17 | 387 | 62.6 | 231 | 37.4 |
| 18-19 | 455 | 64.7 | 248 | 35.3 |
| 20-21 | 406 | 54.5 | 339 | 45.5 |
| 22-23 | 127 | 22.2 | 443 | 77.7 |
| 24-25 | 15 | 3.6 | 398 | 96.4 |
| 26-27 | -- | -- | 333 | 100 |
| 28-29 | -- | -- | 208 | 100 |
| 30-31 | -- | -- | 80 | 100 |
| 32-33 | -- | -- | 20 | 100 |
| 34-35 | -- | -- | 3 | 100 |
| 36-37 | -- | -- | 1 | 100 |

## Discussion

Garcia and LeReste (1981) remarked that because of rapid growth and continuous reproduction, the possibility of studying shrimp growth by modal progression analysis depends very much on the space-time configuration of sampling and precision of the measurements. They suggested that sampling should be close enough to follow micro-cohorts generated by lunar and tidal periodicity in the larval recruitment. It therefore implies that when small sized shrimps with faster growth rate are recruited continuously, sampling should be close enough to trace

the modal progressions. *A indicus* is a tiny, epipelagic shrimp and appears to have continuous recruitment. This probably resulted in stationary modes, particularly in the case of males in which the time interval of a month for modal progression was too large. However, when smaller time interval of a week was adopted, a fairly good progression of modal classes of the cohorts was followed.

The growth rates of 6.02 and 5.83 mm per month for males and females respectively obtained in the present investigation are quite comparable with

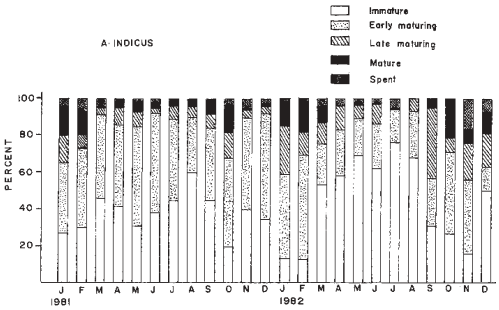


Fig.5. Month wise maturity distribution of females of *A. indicus* during 1981-82.

that of 4.5 mm per month of summer generation of *A. japonicus* estimated by Ikematsu (1953) and Yasuda *et al.* (1953). Ikematsu (1953) in his studies on *A. japonicus* reported two distinct generations with differential growth rates and life spans. The summer generation that hatched in May-June grew rapidly and had life span of 2.5-3.0 months, whereas, the winter generation grew slowly and had life span of 9-10 months. The lengths of the adults of winter generation were 1.5 times more than that of summer generation. In the present study, however, no such seasonal generations or differential growth rates were noticed in *A. indicus* in different months. This may be attributed to more or less uniform tropical temperature conditions in the neritic waters of Bombay, unlike the remarkable variations in temperature experienced in Ariake Sea of western Pacific Ocean. However, the growth rate of 2.0 mm obtained earlier (CMFRI, 1975) for *A. indicus* appears to be too low and the life-span of 1-1.5 years unrealistic. The growth rates of other closely related species occurring in subtropical waters, such as 3.0 mm/ month in *Sergestes similis* (Pearcy and Fross, 1969), 3.6 mm/ month in *Sergestes lucens* (Omori, 1969) and 9.6 mm/ month in *Lucifer chacei* (Zimmerman, 1973) are also comparable with *A. indicus.*

Presence of a small lump of detritus containing fine silt and mud between highly setose oral appendages and the terminal setose segments of 1-3 pereopods, which together formed a sort of a food basket in the oral region was noteworthy in *A. indicus.* The setae on the pereopods probably help in setting up currents in water immediately below the oral region, as a result detritus, suspended mud particles, diatoms as well as zooplanktonic organisms with relatively weak swimming abilities get accumulated in the food basket. The setose oral appendages such as maxillules and the maxillipedes filter them and manipulate the filtered organisms and detritus into a small lump, which is pushed into the mouth by means of mandibular palps and the single toothed mandibles having no grinding and cutting surfaces. Since pereopods as well as their chelae are too weak to hold the prey, the planktonic organisms found in the foreguts must have been due to filter feeding habit which has been described in euphausids (Mauchline and Fisher, 1969) and in *Sergia* sp. (Omori, 1974).

Babenard *et al.* (1973) indicated that in the shallow waters of the continental shelf off northwest coast off India, there exists a good amount of detritus varying

between 2-5 mg/m$^2$ and the quantity off Bombay is higher than 5 mg/m$^2$. This large quantity of detritus in Bombay waters therefore appears to support the abundant biomass of *A. indicus* in the region.

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