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Issued by the Director
Zoological Survey of India, Calcutta

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# BIOECOLOGY OF FOUR SPECIES OF ANTHOCORIDAE (HEMIPTERA: INSECTA) PREDACEOUS ON THRIPS WITH KEY TO GENERA OF ANTHOCORIDS FROM INDIA

BY


**N. MURALEEDHARAN and T. N. ANANTHAKRISHNAN**



*Edited by the Director, Zoological Survey of India*

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# INTRODUCTION

Anthocorids are polyphagous predaceous bugs mostly frequenting flowers and foliage, barks of trees and dry leaf litter and rarely the nests of birds. They are known to feed on small lepidopterous larvae, small coleopterous grubs, psocids, mites, thrips and aphids. A number of species of anthocorids actively predate on insects of economic importance, like different species of Thysanoptera and attempts have been made to utilize them to a limited extent in biological control investigations. They are represented in all the zoogeographical regions of the world and are very closely related to Miridae and also to Cimicidae particularly because of the haemocoelic mode of insemination.

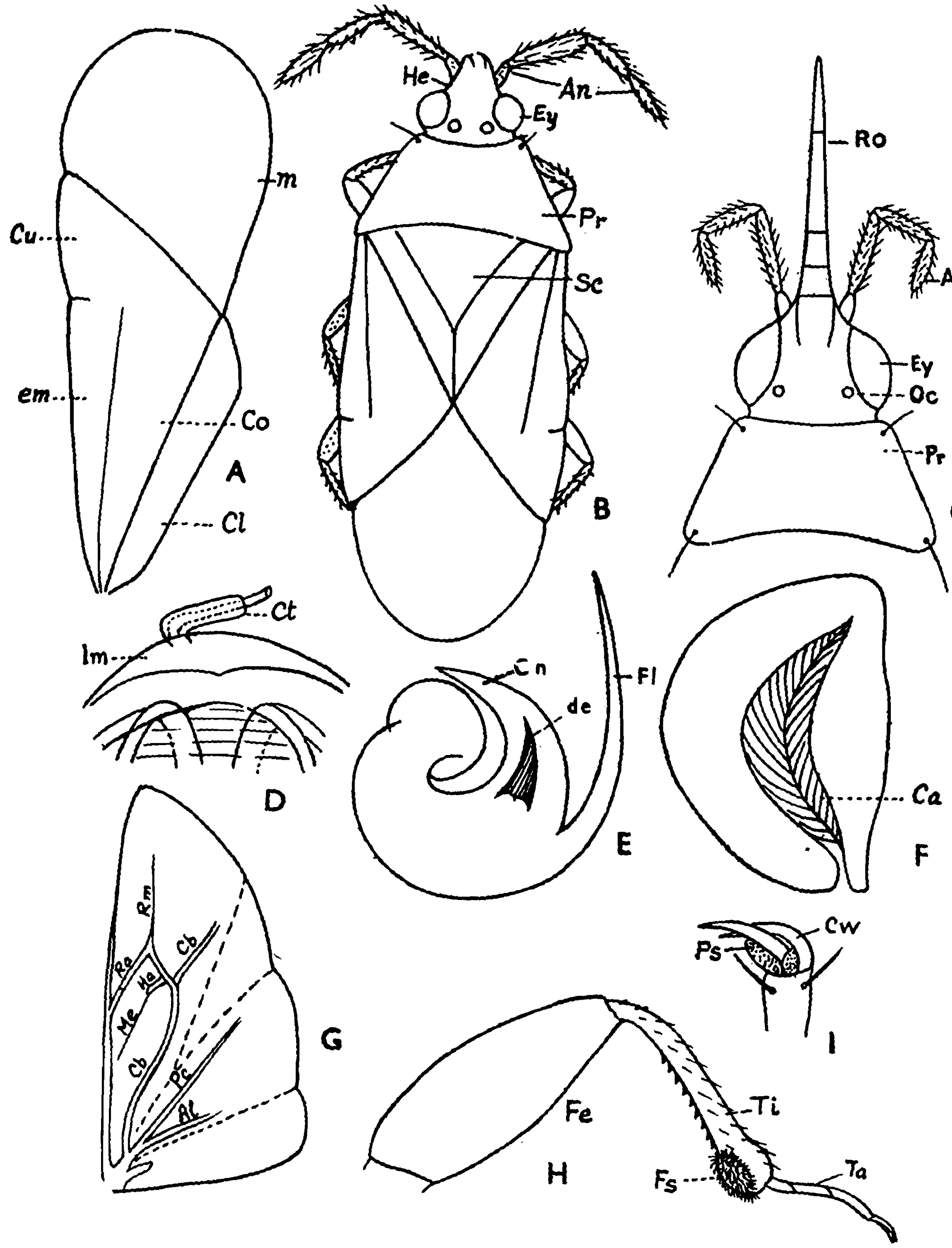


FIG. 1. Parts of a typical anthocorid—(A) Forewing, (B) Adult (C) Head and pronotum (D) Position of copulatory tube, (E) Male genitalia, (F) Metathoracic gland, (G) Hind wing, (H) Foreleg, (I) Pretarsus. Al—Anal vein, An—Antenna, Ca—Scent gland canal, Cb—Cubital, Cl—Clavus, Co—Corium, Cn—Conus, Ct—Copulatory tube, Cw—Claw, Cu—Cuneus, De—Denticulus, Ey—Eye, Em—Embolium, Fe—Femur, Fl—Flagellum, Fs—Fossula spongiosa, Ha—Hamus, He—Head, Im—Inter segmental membrane between VII & VIII, M—Membrane, Me—Median trachae, Oc—Ocellus, Pc—Postcubital, Pr—Pronotum, Ps—Pseudarolia, Ra—Radial, Ro—Rostrum, Rm—Radiomedial, Sc—Scutellum, Ta—Tarsus, Ti—Tibia.

The produced head, elongate clypeus, four-segmented antennae, three-segmented rostrum and tarsi, ocelli in alate forms, metathoracic scent glands, forewings with an embolium and an incomplete cuneus, membrane without basal cell and asymmetrical male genitalia are among the outstanding features serving to distinguish the anthocorids (Fig. 1). The present estimate shows that approximately 90 species are known from the Palaearctic region, 30 species from the Australian, 120 from the Nearctic region, 40 from the Neotropical region, 90 species from the Ethiopian, 50 species from the Oriental region, 20 species from Japan and Formosa and 15 species from Polynesian is lands.

Of all the genera the genus *Orius* is most widely distributed in the world. More than seventy species are known all over the world and the genus is well represented in India also. Most of these species feed on pests of important crops and attempts have been made to utilize these bugs as predators in biological control measures. Of a dozen species reported from India, *O. maxidentex* Ghauri and *O. tantillus* (Mots.) are the most common species occurring in India. *O. maxidentex* (Fig. 2) is distributed in Sudan, India and Pakistan and *O. tantillus* is found in Sri Lanka, Solomon Islands, India and Queensland.

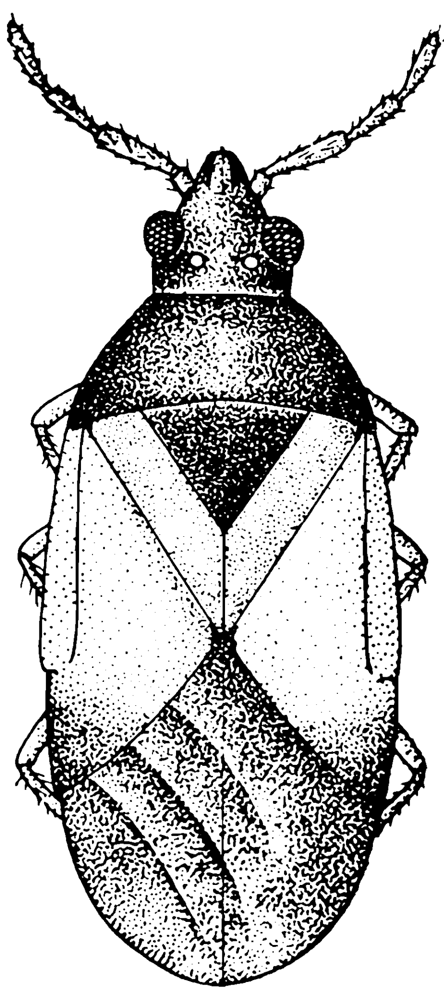

FIG. 2. *Orius maxidentex* Ghauri.

Information on the biology of anthocorids is relatively recent and significant contributions in this line are referrable to Hall (1951) on the distribution, habits and life history of *Piezostethus galactinus* (Fieb.) and Anderson (1962) on the bionomics of six species of *Anthocoris* viz. *A. nemorum* (Linn.), *A. nemoralis* (Fab.), *A. confusus* Reut., *A. sarothamni* Douglas & Scott, *A. gallarum—ulmi* (Deg.) and *A. minki* Dohrn., commonly occurring British species. Hill (1957, 1961) studied the biology of Scottish anthocorids. Information on the bionomics and ecology of *A. confusus* was provided by Hill (1965, 1968). Biological studies on *Nedicola marginata* (Peet, 1973), *Xylocoris galactinus* and *Lyctocoris beneficius* (Chu, 1969) and *Bilia japonica* (Carayon & Miyamoto, 1960) add to our knowledge of the biology of anthocorids.

Basic information on the life history of anthocorids from India is restricted to *Orius indicus* (Rajasekhara & Chatterjee, 1970) and *Montandoniola moraguesi* (Muraleedharan & Ananthakrishnan, 1971). Information on the reproductive behaviour, periodicity, abundance, rate of feeding and growth during postembryonic development are equally important for an understanding of the nature of the concerned species, besides the number and duration of instars. Population studies on Indian anthocorids and their relation to prey populations are also not available in India except for some work like that of Viswanathan and Ananthakrishnan (1974). Attempts have been made here to provide a comparative idea of some of these aspects on the biology of four species of anthocorids occupying different niches and feeding mainly on thrips

(*i*) *Carayonocoris indicus* Muraleedharan (Anthophilous)
(*ii*) *Montandoniola moraguesi* (Puton) (Gallicolous)
(*iii*) *Xylocoris clarus* (Distant) (Litter inhabiting)
(*iv*) *Scoloposcelis parallelus* (Mots.) (Phlaeophilous).

## MATERIAL AND METHODS

Specimens were reared in the laboratory in transparent plastic tubes, open at one end and covered at other end with muslin and provided with flowers, leaves or litter according to the habitat of the species. For a study of the life cycle of the gall inhabiting species, *M. moraguesi* small potted plants of *Cassearia tomentosa* were used with leaves inserted in a glass cage ($10 \times 4$ cm.) open at both ends, with a split cork at the basal end for the passage of petiole of the leaf and covered with muslin at the other end. Larvae and adults of *Gynaikothrips flaviantennatus* were supplied as prey into the cages alongside with the anthocorids. For *C. indicus*, thrips were supplied and for *X. clarus* and *S. parallelus* thrips, mites, psocids and grubs were given as food.

Regular collections were also made from the respective fields to have an idea of the seasonal fluctuations of the various species mentioned. To study the population fluctuations of *C. indicus* inhabiting *Cassia* flowers, inflorescences were collected every fortnight and for every collection a fixed number of inflorescences were collected. Anthocorids were sorted out and sexed. The population fluctuations of *M. moraguesi* were studied and for this purpose monthly samples of galls were collected.

## CLASSIFICATORY SYSTEMS

Our knowledge of Oriental anthocorids is comparatively very meagre. Reuter's monograph (1884) included only two species from India. Poppius (1909, 1910, 1913*a*, *b*) dealt with the anthocorids of Sri Lanka, Java, Sumatra and Lombok recording a few species under the genera *Euspudaeus* Reuter, *Xylocoris* Dufour, *Cardiastethus* Fieber, *Scoloposcelis* Fieber, *Lepidonannella* Poppius, *Blaptostethus* Fieber, *Anthocoris* Fallen, *Anthocoropsis* Poppius and *Lavinia* Poppius. Distant (1906, 1910) described nearly 20 species from India including North West Himalaya, Tibet, Burma and Ceylon. Recently Ghauri (1972) and Muraleedharan and Ananthakrishnan (1974*a*, *b*, *c*) described a few species. A total of 50 species known to date from India appears a poor record as compared with the number known from other regions.

Linnaeus (1758) was the first to describe the anthocorid species *Anthocoris nemorum* (L.) and *Orius minutus* (L.) under the names *Cimex nemorum* and *Cimex minutus* L. Amyot and Serville (1843) proposed the group Anthocorides for these bugs, and Fieber (1851) established the family Anthocoridae. Based on the wing venation and nature of antennae, Reuter (1884) recognised 3 distinct groups within the family and designated them as Lyctocoraria, Anthocoraria and Xylocoraria. The classic work of Reuter (1884) included nearly 300 species described from the different parts of the world. As the presence or absence of hamus in the hind wings varied in the same group (Lyctocoraria and Anthocoraria), Champion (1901) indicated that this was not a useful character, though he accepted the classification of Reuter, specially emphasising the heterogenous nature of Xylocoraria characterised by the absence of hamus. Poppius (1909) considered the separation of Xylocoraria from Lyctocoraria as artificial and combined both the groups under Lyctocoraria, thereby dividing the family into two principal division—Lyctocoraria and Anthocoraria. Van Duzee (1917, 1927) suggested a new name Dufouriellinae for Reuter's Xylocoraria and the family was divided into three sub-families Anthocorinae, Lyctocorinae and Dufouriellinae. However, the classification of Reuter continued to be used even till recently. It was left to Carayon (1972) to completely overhaul the classificatory system of Anthocoridae and on the basis of anatomical, morphological and ecological characters he proposed three sub-families, the Lasiochilinae, the Lyctocorinae and the Anthocorinae. He further designated a number of tribes within the Lyctocorinae and Antho-

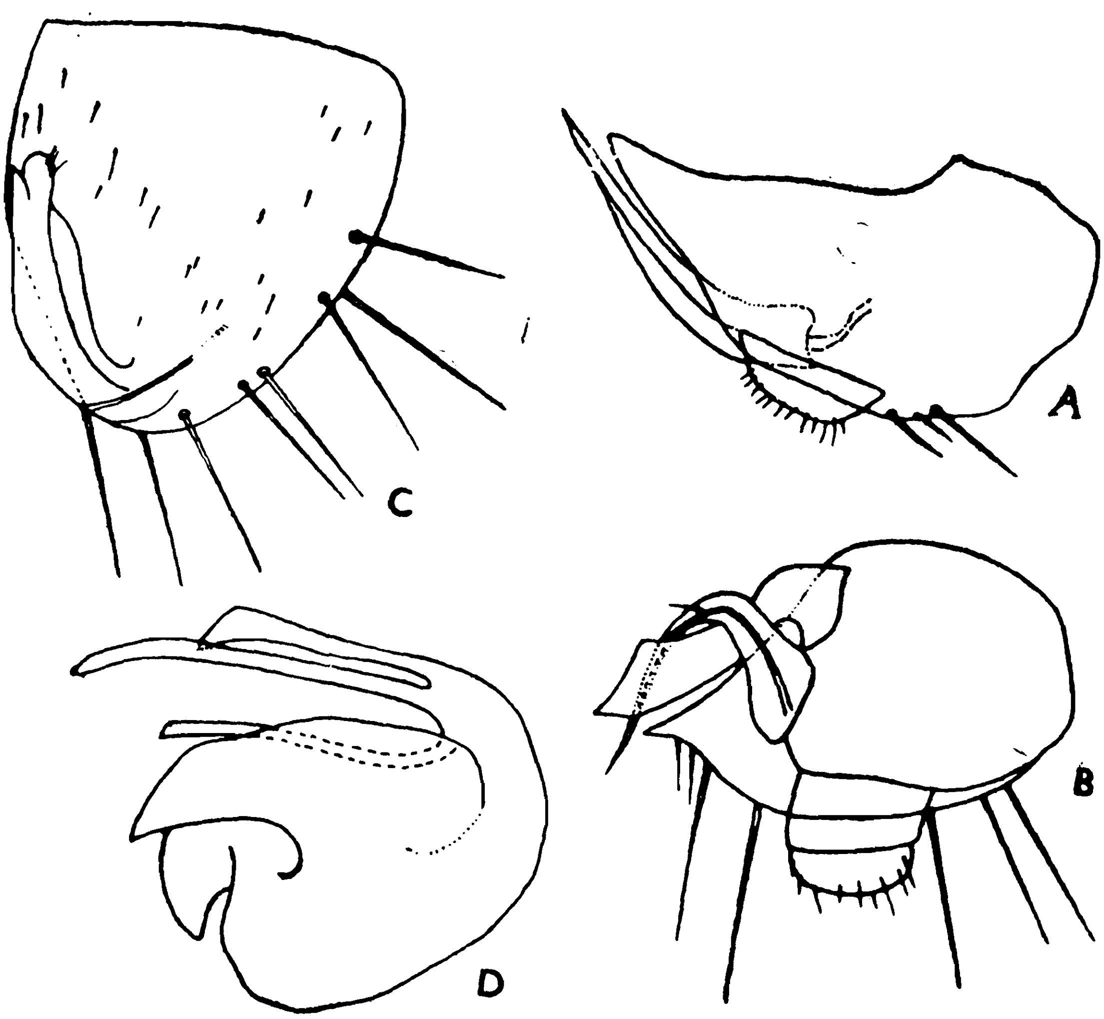


FIG. 3. Male genitalia of some anthocorids—(A) *Xylocoris clarus*, (B) *Cardiastethus pygmaeus*, (C) *Blaptostethus pallescens*, (D) *Orius tantillus*.

corinae including the tribes *Lyctocorini*, *Xylocorini*, *Cardiastethini*, *Almeidini*, *Scolopini*, *Blaptostethini*, *Anthocorini* and *Oriini*. The Lasiochilinae however remained undivided. This classification has been most natural and has gone a long way in our understanding of the classificatory systems of this family.

In recent years new aspects pertaining to taxonomical assessment have been attempted with success. Correlated with the method of extra genital insemination in the majority of anthocorids, the male and female reproductive organs have undergone considerable modification. The male genitalia (Fig. 3) are highly asymmetrical and in females the site of insemination shows

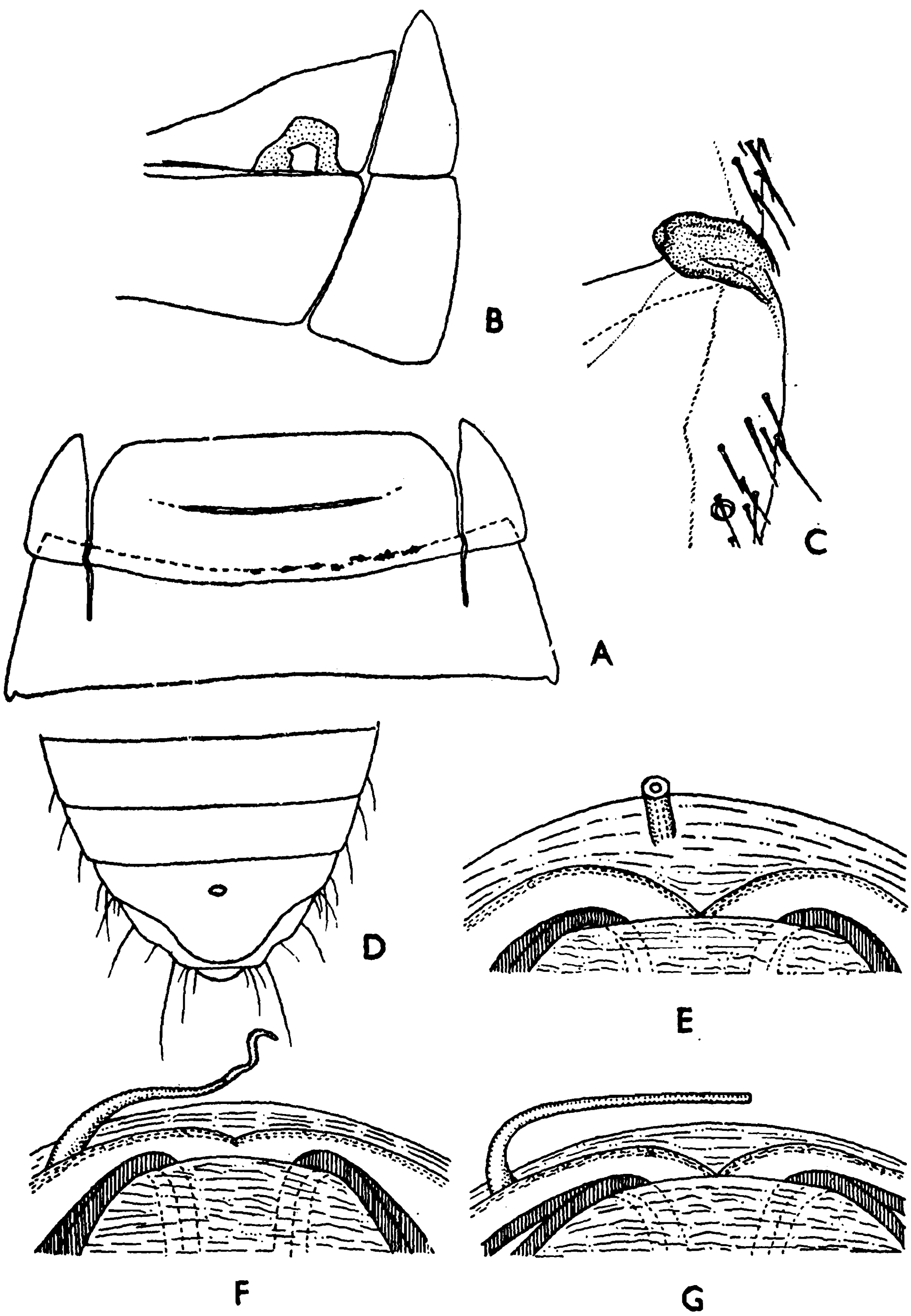


FIG. 4. Paragenital structures in some females of anthocorids—(A) Markings made by piercing abdomen in ♀ of *Xylocoris flavipes*, (B) Ectospermalege of *Xylocoris clarus*, (C) Ectospermalege of *Xylocoris* sp., (D) Omphalophore of *Buchananiella* sp., (E) (F) (G) copulatory tubes of *Orius* spp.

modification. The Paragenital system in Anthocoridae was investigated in detail by Carayon (1946, 1952, 1953*a,b*, 1957, 1964, 1966*a,b*, 1971*a*). In his revisionary work (1971) Carayon has noted that the subfamily Lasiochilinae shows the normal method of insemination where as the Lyctocorinae and anthocorinae are characterised by haemocoelic insemination. The following variations on the modes of insemination appear significant (Fig. 4).

(*i*) *Piercing vaginal wall:* During copulation the intromittant organ pierces the vaginal wall and the sperms are liberated into haemocoel. This probably marks the beginning of haemocoelic insemination. In some *Lyctocoris* sp. this method is met with.

(*ii*) *Piercing body wall anterodorsally:* Inter segmental membrane between tergites II and III of female is pierced by male and sperms are passed on to haemocoel. In *Xylocoris* (*Arrostelus*) *flavipes* (Reuter) this mode of insemination occurs.

(*iii*) *Piercing body wall posterodorsally:* Among the members of the subgenus *Stictosynechia* of the genus *Xylocoris* the region between tergites VII & VIII is pierced during copulation. This subgenus is not represented in India.

(*iv*) *Through Anterodorsal ectospermalege:* In the anthocorids an external structure is developed in some species to receive the male genitalia during copulation. This ectospermalege is situated between tergites II and III. Correspondingly an internal spermalege is also developed. In the members of the subgenus *Proxylocoris* of genus *Xylocoris* this type of arrangement is found.

(*v*) *Posterolateral ectospermalege:* In *Xylocoris* s. str. the ectospermalege is situated between tergites VII and VIII. In all known species of anthocorids where an ectospermalege is present a mesospermalege is also present.

(*vi*) *Posteroventral omphalophore:* Among members of the tribes Cardiastethini on the ventral side of sternite VII or in between VII and VIII there is an aperture or a tube leading to the mesospermalege. In India, the genera *Cardiastethus* and *Buchananiella* are provided with Omphalophore.

(*vii*) *Copulatory tube:* In the subfamily Anthocorinae the spermalege is the most highly evolved. In these species the ectospermalege is in the form of a definite copulatory tube situated in between tergites VII and VIII and the mesospermalege, in the form of a pouch is connected to the oviduct. The size and position of the copulatory tube varies in different genera and even among members of the same genus. This is well represented in species of *Orius*, *Montandoniola* and *Anthocoris*.

(*viii*) *Double copulatory tube:* The tribe Blaptostethini is characterised by the presence of a double copulatory tube and in India the species present are *Blaptostethus pallescens* Poppius and *B. kambu* Rajasekhara.

Haemocoelic insemination shows a number of variations within the family, ranging from the premitive Lyctocorine type of piercing the vaginal wall to the highly evolved anthocorine type, where a tissue bridge connects the ovary to the copulatory tube. Hinton (1964) discussed the evolutionary tendencies of haemocoelic insemination in insects and opined that the process might have had a polyphyletic origin in the different families of Cimicoidea.

Another feature of significance in taxonomic studies relates to the biological aspects. Southwood (1956) made a preliminary attempt to investigate the affinities of anthocorids based on egg structure, while Sands (1957) described the immature stages and egg structure of five species of *Anthocoris* Fallen, two of *Orius* Wolff and one each of *Acompocoris* Reuter *Elatophilus* Reuter *Cardiastethus* Fieber *Xylocoris* Dufour and *Lyctocoris* Hahn in an attempt to utilize these characters in taxonomic studies.

## KEY TO SUBFAMILIES AND TRIBES

1. Ostiolar canal not prolonging into the posterolateral carina. Split of dorsal abdominal segments extending only to I and II tergites. III and IV antennal segments always slender and filiform. Ovipositor always well developed. Insemination normal type. ... LASIOCHILINAE Carayon

   Ostiolar canal prolonging into the posterolateral carina. Split of dorsal abdominal segments extending beyond I and II tergites. III and IV antennal segments not always slender and filiform. Ovipositor not always well developed. Insemination extra genital. ... ... ... ... ... 2

2. Hamus when present, attached to the cubital. Setae on the antennal segments III and IV shorter than double the width of segments. Ovipositor well developed, never vestigial. ... ... ... ANTHOCORINAE Reuter 3

   Hamus when present attached to the m.cu. Setae of III and IV antennal segments longer than double the width of segments. Ovipositor vestigial to well developed. ... ... ... LYCTOCORINAE Reuter 5

3. Pronotum with two pairs of long bristles. Double copulatory tube absent. Males without a setal bunch on the abdomen. ... ... ... ... ... 4

   Pronotum with three pairs of long bristles. Double copulatory tube present. Males with a setal bunch on the abdomen. ... ... ... BLAPTOSTETHINI Carayon

4. Bristles on the surface of head not distinct. Pseudarolia in the pretarsi absent. Copulatory tube corrugated and long. Paramere simple.... ... ANTHOCORINI Carayon

   Bristles on the surface of head not distinct. Pseudarolia in the pretarsi present. Copulatory tube not corrugated and comparatively short. Paramere complex with dent, flagellum etc. ... ... ... ORIINI Carayon

5. Males not provided with abdominal glandular complex. ... ... ... ... ... 6

   Males provided with a glandular complex on the abdomen. ... ... ... ... SCOLOPINI Carayon

6. Pronotum, scutellum and clavus without rounded punctures. ... ... ... ... ... 7

   Pronotum, scutellum and clavus beset with rounded punctures. ... ... ... ... ALMEIDINI Carayon

7. Hind tibiae without strong spines. Ovipositor highly vestigial. ... ... ... CARDIASTETHINI Carayon

   Hind tibiae with strong spines. Ovipositor not vestigial. ... ... ... ... ... 8

8. Ovipositor always well developed. Testes two lobed. Receptaculum seminis ectodermic. ... ... LYCTOCORINI Carayon

   Ovipositor always not well developed. Testes seven lobed. Receptaculum seminis mesodermic. ... XYLOCORINI Carayon

## KEY TO THE GENERA OF INDIAN ANTHOCORIDAE

(excluding *Cyrtosternum* Fieber)

1. Ostiolar canal extending to the posterolateral carina. Split of dorsal tergites extending beyond second tergite. Insemination usually extragenital ... ... ... 2

| | | |
|---|---|---|
| | Ostiolar canal not extending to the posterolateral carina. Split of dorsal abdominal tergite extending to second tergite. Insemination normal type as in other insects. ... ... ... ... | *Lasiochilus* Reuter |
| 2. | Hamus when present, attached to the cubital. Setae on antennal segment II and III shorter than double the width of the segments. Ovipositor well developed, never vestigial. ... ... ... ... ... | 3 |
| | Hamus when present attached to m.cu. Setae on third and fourth antennal segments longer than double the width of segments. ... ... ... ... | 13 |
| 3. | Females with a double copulatory tube. Third and fourth segments of antennae filiform. ... ... ... | *Blaptostethus* Fieber |
| | Females with a single copulatory tube. Third and fourth segments of antennae fusiform. ... ... ... ... | 4 |
| 4. | Body elongate and slender. ... ... ... ... ... | 5 |
| | Body short and rounded. ... ... ... ... | *Bilia* Distant |
| 5. | Posterior angles of pronotum distinctly subangularly produced. ... ... ... ... | *Galchana* Distant |
| | Posterior angles of pronotum not produced. ... ... ... | 6 |
| 6. | Tarsi short and robust. Third and fourth segments of antennae distinctly thickened. ... ... ... | *Pachytarsus* Fieber |
| | Tarsi not robust and of moderate length. II and III antennal segments not very thickened. ... ... ... ... | 7 |
| 7. | Pronotum medially constricted in the middle, anterior part about half the breadth of posterior margin. ... ... ... ... | *Arnulphus* Distant |
| | Pronotum not medially constricted. ... ... ... ... | 8 |
| 8. | Forefemora incrassate and spinose ... ... ... ... | 9 |
| | Forefemora neither thickened nor spinose ... ... ... | 10 |
| 9. | Forefemora with a single spine but without small denticules ... ... ... | *Carayonocoris* Muraleedharan |
| | Forefemora with a single spine but with small denticules ... ... ... ... | *Odontobrachys* Fieber |
| 10. | Foretibiae always with setal cushion (fossula spongiosa) Pretarsi devoid of pseudarolia. ... ... ... ... | 11 |
| | Foretibiae without setal cushion. Pretarsi with pseudarolia ... ... ... ... ... | 12 |
| 11. | Lateral margin of prothorax a little concave and carinate. Metathoracie scent gland canal nearly straight. ... ... ... ... | *Tetraphleps* Fieber |
| | Lateral margins of prothorax not concave and metathoracie scent gland canal gently curved.... ... ... | *Anthocoris* Fallen |
| 12. | Second antennal segment very long, stout and densely setose. Veins of membrane not clearly visible. ... ... | *Montandoniola* Poppius |
| | Second antennal segment not much longer and stout. Veins clearly visible. ... ... ... ... ... | *Orius* Wolff |
| 13. | Males provided with a glandular complex on the dorsal side of abdomen. ... ... ... ... | *Scoloposcelis* Fieber |
| | Males not provided with the glandular complex ... ... ... | 14 |

| | | |
|---|---|---|
| 14. | Ovipositor well developed. ... ... ... ... ... | 20 |
| | Ovipositor vestigial ... ... ... ... ... | 15 |
| 15. | Forefemora provided with a number of spines. ... ... ... | 16 |
| | Forefemora not provided with spines. ... ... ... ... | 17 |
| 16. | Foreacetabula highly expanded; foretibiae highly arched. ... ... ... ... | *Physopleurella* Reuter |
| | Foreacetabula not expanded; foretibiae not highly arched. ... ... ... ... | *Orthosolenopsis* Poppius |
| 17. | Rostrum very short, not reaching beyond posterior margin of head. ... ... ... ... ... | 18 |
| | Rostrum moderately long, extending beyond posterior margin of head. ... ... ... ... ... | 19 |
| 18. | Pretarsi very long. ... ... ... | *Indocoris* Muralee. & Anan. |
| | Pretarsi of normal size. ... ... ... ... | *Buchananiella* Reuter |
| 19. | Metasternum with a median bifurcated projection. ... ... | *Amphiareus* Distant |
| | Metasternum devoid of a bifurcated projection. ... ... | *Cardiastethus* Fieber |
| 20. | Scutellum, clavus and posterior border of pronotum provided with round punctures. ... ... ... ... | 21 |
| | Scutellum clavus and pronotum without round punctures. ... ... ... ... ... | 22 |
| 21. | Lateral margin of pronotum deeply sinuate and posterior margin concavely emarginate. ... ... ... | *Almeida* Distant |
| | Lateral margin of pronotum not deeply sinuate and posterior margin moderately concave. ... ... ... | *Lippomanus* Distant |
| 22. | Posterior half of pronotum with two fovea, medially confluent. Membrane with four distinct veins. ... ... | *Euspudaeus* Reuter |
| | Posterior half of pronotum without fovea. Veins of membrane not distinct. ... ... ... ... | *Xylocoris* Dufour |

## BIOECOLOGY OF ANTHOCORIDS

### ANTHOPHILOUS HABITAT

### (a) **Carayonocoris indicus** Muraleedharan

*Carayonocoris indicus* commonly inhabits the inflorescence of *Cassia marginata* in many parts of South India feeding on *Haplothrips ganglbaueri* Schmutz and *Frankliniella schultzei* Trybom abounding in these flowers. The incidence of flowering of *Cassia marginata* is during the months March–October and the period of floral abundance directly coincides with the abundance of anthocorids. In the laboratory these were provided with both species of thrips as well as caterpillars and grubs and the anthocorids always preferred thrips. Regular collection of anthocorids showed a preponderance of females over the males. *Carayonocoris indicus* originally reported from Kerala (Nilambur) was later found to be widely distributed in India, specimens were also received from Punjab. The preoviposition period in this species was observed to be 4 to 7 days and during oviposition the eggs were inserted into the petioles of flowers in the natural condition, while in the laboratory they laid eggs on moist filter paper. The eggs were deposited singly with the operculum facing upward. Oviposition record for ten females with their longivity periods is given in Table 1. The egg of *C. indicus* is long and slightly curved measuring 0.40–0.43 mm long and 0.14–0.16 mm wide. The eggs are creamy white, smooth and polygonally reticulate. Incubation period ranged from 5–7 days. Under laboratory conditions 30–36 days were required to complete the development from egg to adult and during this period 71–98 thrips were consumed and Table 2 gives the rate of feeding and duration of instars. It has been found that the adults prefer *Haplothrips ganglbaueri* and *Frankliniella schultzei* rather than caterpillars and grubs. Though a large number of thrips are consumed during development these bugs cannot be considered as efficient predators.

*First instar:* The nymph on hatching from the egg is pale yellow, eyes appearing dark spots. Abdominal scent glands visible as orange coloured spots on tergites III, IV and V Two pairs of long bristles present at apex of abdomen. The first instar larva consumes 10.41 thrips (4–19) during the developmental period. Under laboratory conditions the average duration is 4.25 (3–6) days.

TABLE 1. Oviposition records of *Carayonocoris indicus*

| Specimen number | Total eggs laid in week No. | | | | | | | Total number of eggs laid | Longevity of females in days | Average number of eggs per day |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | | |
| 1 | 14 | 10 | 9 | 9 | 7 | 3 | 1 | 53 | 52 | 1·01 |
| 2 | 12 | 10 | 7 | 7 | 5 | 3 | — | 44 | 60 | 0·73 |
| 3 | 6 | 6 | 4 | 4 | — | 2 | — | 22 | 43 | 0·53 |
| 4 | 3 | — | — | — | — | — | — | 3 | 5 | 0·60 |
| 5 | 4 | — | 3 | 4 | — | — | 1 | 12 | 9 | 1·33 |
| 6 | 6 | 6 | 3 | 3 | — | — | — | 18 | 12 | 1·50 |
| 7 | 11 | 7 | 6 | 5 | 5 | 2 | — | 36 | 45 | 0·80 |
| 8 | 7 | 7 | 4 | 3 | 3 | 3 | — | 27 | 50 | 0·54 |
| 9 | 9 | 6 | 9 | 5 | 6 | 3 | 1 | 39 | 62 | 0·62 |
| 10 | 10 | 7 | 7 | 7 | 5 | 2 | — | 38 | 45 | 0·84 |

*Second instar:* Coloured as in the previous instar and the average duration of the instar is 5.5 (4–7) days and the thrips consumed is 11.50 (4–18).

*Third instar:* In this instar the forefemora are a little thickened and a small tooth developed. Average duration of the instar is 5·75 (5–7) days and consumes an average of 14.91 (10–19) thrips during the period.

*Fourth instar:* Body deep yellowish with legs pale yellow. Forefemora with a well developed tooth and wing pads make their appearance. Abdominal glands appear as pale orange coloured spots. This instar feeds on 18.41 (13–21) thrips and the average duration is 5.75 days (4–7).

*Fifth instar:* Body coloured as in the fourth instar. Forefemora incrassate and spinose. Wing pads fully developed and extends to first tergite. Abdominal scent glands pale orange coloured and sexes can be separated at this stage. Under laboratory conditions the nymph takes 5.08 days (4.6 days) to moult into the adult and during this period it takes an average of 26.75 (19–31) thrips.

*Imago:* In the laboratory it takes 31.6 days (26–36) for the complete development into adult and during this period the stadia consume an average of 81.66 (71–98) thrips (Table 2). The adults show sexual dimorphism through their colour differences. The male is bicolourous with head, rostrum, antennal segments, pronotum, scutellum and legs yellowish and abdomen black. In females head, pronotum, sculellum mid and hind femora brown, antennae, rostrum, fore legs, mid and hind tibiae yellow.

*Mating:* When confined to tubes (5×2.5 cm) open at one end and covered with muslin, copulation occurred freely and in general mated females resisted further attempts of males though in certain occasions some males were found mating with the same females. The antennae of males and females remain immobile during this process which lasts for about 30–50 seconds. The females remain stationary for sometime after copulation cleaning its abdomen, while the males are more active running away from their immediate vicinity.

TABLE 2. Incubation period, duration of instars and number of thrips consumed (in brackets) per instar of *Carayonocoris indicus*

| Specimen number | Incubation period | Instars I | II | III | IV | V | Total duration | Thrips consumed |
|---|---|---|---|---|---|---|---|---|
| 1 | 5 | 3(4) | 5(4) | 7(16) | 4(20) | 6(27) | 30 | 71 |
| 2 | 5 | 6(18) | 6(18) | 7(14) | 6(18) | 6(25) | 31 | 93 |
| 3 | 6 | 4(5) | 5(12) | 6(14) | 6(19) | 5(27) | 32 | 77 |
| 4 | 5 | 4(19) | 5(15) | 5(16) | 7(20) | 5(28) | 31 | 98 |
| 5 | 7 | 4(10) | 5(12) | 5(10) | 5(18) | 6(22) | 32 | 72 |
| 6 | 7 | 5(10) | 6(10) | 5(19) | 7(17) | 4(19) | 35 | 75 |
| 7 | 5 | 4(13) | 6(12) | 5(19) | 6(19) | 4(30) | 30 | 93 |
| 8 | 6 | 3(5) | 4(10) | 5(13) | 4(13) | 4(31) | 26 | 72 |
| 9 | 6 | 4(5) | 5(7) | 6(15) | 7(19) | 5(27) | 33 | 73 |
| 10 | 6 | 5(13) | 7(10) | 6(14) | 7(21) | 5(25) | 36 | 83 |

Observations on the seasonal fluctuations of *Carayonocoris indicus* present some interesting data. Incidence of flowering of Cassia occurs during the summer months. The months of May–June which record the peak summer season have the maximum flowers of Cassia. Populations of *C. indicus* were present throughout the flowering season. Although they were present only in small numbers initially, with the progress of season they also increased to be finally replenished at the end of flowering season. The season of abundance of flowers was also the season of abundance of anthocorids. As in many other species of anthocorids females dominated in numbers over the males and the population of females maintained a steady increase and stability while that of the males fluctuated greatly. During the season of abundance viz. May–July females showed oscillations around a constant number while the males varied greatly in their numbers. The beginning of the season had very few individuals of both sexes, but the progress of the flowering season saw a gradual increase in the case of males (Fig. 5).

An abundance of nymphs was a characteristic feature of the population studied. In the months of March both the fortnightly collections had no nymphs and similarly there were no nymphs in the final collection viz. October. While populations were at their peak in July, the nymphal population had already started to fall. While July was the month recording maximum of adults, June had the peak of nymphal population. In the month of May even as the adult populations were on the slow increase, the nymphs were abundant. Even though the number of nymphs per flower per day was more than the number of adults per flower per day, in more than one month in the total population count adults exceeded the nymphs.

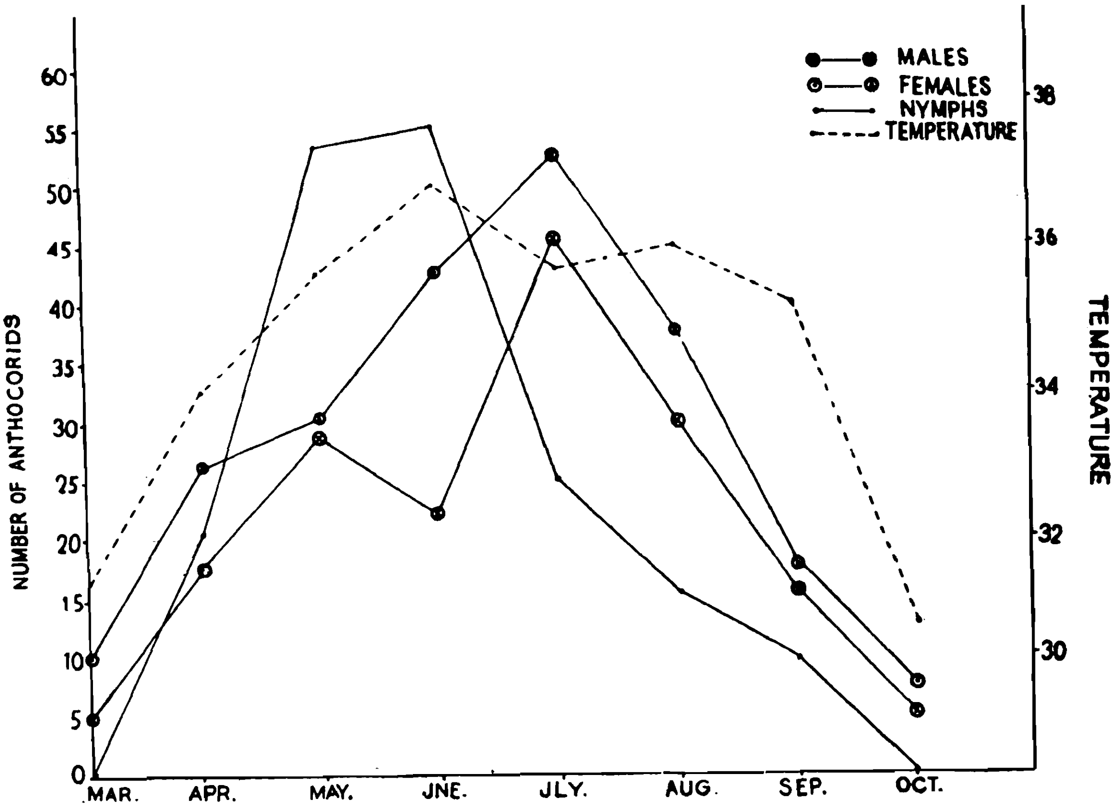


FIG. 5. Graph showing population fluctuations of males, females and nymphs of *Carayonocoris indicus* in 1972 in relation to temperature (in °C).

The existence and survival of any animal not to speak of insects depend largely on the environment which includes its habitat. Influence of density independent and density dependent factors on the inhabiting population determined the latter's distribution and abundance. The nature of the habitat changes the habits of the occupying population. *C. indicus* has synchronised its period of abundance with the period of abundance of *Cassia* inflorescences. Its increase in numbers parallels the increase in temperature and decrease in atmospheric humidity with the progress of summer. Adapted for survival at a time when many other insects find it difficult to withstand the high temperature and low humidity, this species shows a characteristic curve with its peak in July. Swift in movement and relatively high reproductive potential, this species seems to be free from the action of any predators since no serious predator was observed. The only few specimens of a species of spider can be considered an unimportant factor. Absence of any other species of anthocorids is yet another factor favouring the successful survival of the species since there was no fear of any interspecific competition. Chances of intraspecific competition are further reduced since there is an over abundance of thrips on which they feed. Thus there seems to be very little control of the populations by density dependant factors and the fluctuations and oscillations around an average seem to be directed by the existing climatic conditions. According to Andrewartha & Birch (1952) abundance of a population is controlled by the climate, especially so when there is little chances of predation or parasitism. The fluctuations of *C. indicus* closely following the changes of climatic variations clearly illustrate the same.

## GALLICOLOUS HABITAT

### (b) **Montandoniola moraguesi** (Puton)

Diverse types of thrips galls on various host plants are inhabited by the anthocorid species *Montandoniola moraguesi* (Puton) an unique and interesting species both from the view point of its association with different species of gall thrips and also its world wide distribution being known to occur in France, Italy, Japan, Spain, Egypt, South America and the Oriental region. That this species was collected from no less than two dozen different galls made by different species of thrips from various parts of South India appears to be an undoubtedly impressive record for a predatory species (Ananthakrishnan, 1969, 1973).

The following list provides an idea of the gall plant, locality and prey species.

| GALL PLANT | PREY SPECIES | LOCALITY |
|---|---|---|
| (1) *Mimusops elengi* | *Arrhenothrips ramakrishnae* Hood | Madras, Tamil Nadu |
| (2) *Ficus bengalensis* | *Arrhenothrips dhumrapaksha* Ramak. | Kodaikanal, Tamil Nadu |
| (3) *Gymnosporia* sp. | *Alocothrips hadrocerus* (Karny) | Kerala |
| (4) *Cordia* sp. | *Aneurothrips punctipennis* Karny | Madras, Tamil Nadu |
| (5) *Calycopterus floribundus* | *Austrothrips cochinchinensis* Karny | Kerala |
| (6) *Memecylon* sp. | *Crotonothrips gallarum* Anan. | Wynaad, Kerala<br>Mercara, Karnataka |
| (7) *Planchona valida* | *Cercothrips nigrodentatus* (Karny) | Courtallam |
| (8) *Casearia tomentosa* | *Gynaikothrips flaviantennatus* Moulton | Madras, Tamil Nadu<br>Dehra Dun, U.P. |
| (9) *Ficus bengalensis* | *Gynaikothrips malabaricus* Ramak. | Kerala |
| (10) *Ficus retusa* | *Gynaikothrips uzeli* Zimm. | Kerala |
| (11) *Schefflera racemosa* | *Liothrips ramakrishnae* Anan & Jag. | Yercaud, Tamil Nadu |
| (12) *Maytenus senegalensis* | *Liothrips indicus* Anan. | Panchgani, M.P. |
| (13) *Vitis* sp. | *Liothrips pallicrus* (Karny) | Courtallam, Tamil Nadu |
| (14) *Peperomia* sp. | *Liothrips pallipes* (Karny) | Tambaram, Tamil Nadu |
| (15) *Terminalia* sp. | *Lygothrips jambuvasi* (Anan) | Kerala |
| (16) *Mallotus phillipinus* | *Mesothrips extensivus* Anan. & Jag. | Kodaikanal, Tamil Nadu |
| (17) *Ficus benjamina* | *Gynaikothrips bengalensis* Anan.<br>*Mesothrips jordani* Zimm. | Calcutta, W. Bengal |
| (18) *Walsura piscidea* | *Psenothrips priesneri* (Anan.) | Tirupathy, Andhra |
| (19) *Loranthus* sp. | *Phorinothrips loranthi* Anan. | Palghat, Kerala |
| (20) *Pothos scandans* | *Tetradothrips foliiperda* (Karny) | Tamil Nadu |

A common feature in many of these galls is the presence of predatory inquiline thrips *Androthrips flavipes* Schmutz on which also *M. moraguesi* (Put.) feeds.

This anthocorid was reared in glass cages fitted on to a very small potted plant of *Casearia* and the other end was covered with muslin. The anthocorids were supplied with adults and larvae of *Gynaikotrips flaviantennatus* Moult. on which the anthocorids feed. *Oviposition* (Table 3): Eggs were laid on the margin of tender leaves of *Casearia* and the eggs are arranged in a single row, with a portion of the egg inserted into the leaf tissue. Just before laying the eggs, the female moves restlessly on the leaf surface. Anterior part of the body is raised and posterior portion lowered to touch the leaf surface and the egg is laid. When the eggs are laid on leaves of *Casearia* they are arranged on the margin of the leaf in a row with a portion of the egg inserted on to the leaf tissue. On the other hand in *Mimusops elengi* leaves, the eggs were almost completely inserted on to the leaf tissue. In these leaf galls, the predator feeds on *Arrhenothrips ramakrishnae*. These leaf galls are found in many parts of Madras and the predator feeds on the eggs, larval stages, pupae and adults of this tubuliferous thrips. In the case of *A. ramakrishnae* the total duration of the life history is 16–21 days. The incubation period ranges from 5–6 days, I instar from 3–4 days, II instar from 4–5 ,prepupa, 1 day, Pupa I, 2–3 days and pupa II 1–2 days. The duration of the life history is short, so that there is always an abundance of food supply to the predator. Complete insertion of eggs by *M. moraguesi* into the leaf tissue is observed in *Pavetta* and *Memecylon*. This type of oviposition behaviour appears to be influenced by the nature of the leaf tissue.

TABLE 3. Oviposition records of *Montandoniola moraguesi*

| Specimen number | Number of eggs laid per week | | | | | | | Total number of eggs | Longevity of female | Average eggs per day |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | | |
| 1 | 20 | 24 | 10 | 12 | 8 | — | — | 74 | 39 | 1·89 |
| 2 | 24 | 8 | 8 | — | — | — | — | 30 | 25 | 1·20 |
| 3 | 8 | 19 | 12 | 6 | 4 | — | 1 | 50 | 52 | 0·96 |
| 4 | 11 | 20 | 8 | 8 | 12 | — | — | 59 | 38 | 1·55 |
| 5 | 15 | 15 | 9 | 4 | 4 | — | — | 47 | 36 | 1·30 |
| 6 | 10 | 21 | 16 | 7 | 7 | — | — | 61 | 38 | 1·60 |
| 7 | 20 | 14 | 14 | 8 | 3 | — | — | 59 | 36 | 1·63 |
| 8 | 12 | 12 | 9 | 11 | 8 | 2 | — | 54 | 44 | 1·22 |
| 9 | 9 | 13 | 15 | 8 | 10 | — | — | 55 | 40 | 1·37 |
| 10 | 20 | 12 | 10 | 3 | 3 | — | — | 48 | 40 | 1·20 |

The eggs (Fig. 6, B) are elongate, oval and curved with a distinct operculum at the anterior end. Freshly laid eggs are creamy white with polygonal reticulations.

*Incubation:* Colour changes are evident during the incubation period, the creamy white egg at the time of deposition gradually acquiring an orange tinge which becomes intense during the third day. The embryo also becomes visible through the egg-membrane. The incubation period is 4.8 (4–6) days.

*I instar:* Head, thorax and posterior margin of abdomen red, antennae and rostrum yellow. Head triangular with the 'Y' shaped suture clearly visible. Legs pale yellow, slender. Dorsal abdominal glands clearly visible as red patches and abdominal apex with two pairs of long bristles. Under laboratory conditions the duration of the instar is 3.9 days (3–5) and consumes an average of 8.7 (8–14) thrips.

*II instar:* Colour same as in first instar. Legs yellow with a red tinge at the proximal end of femora. Duration of the instar is 4 (3–5) days and the stadium takes an average of 12.2 (7–16) thrips.

*III instar:* Darker than second instar. Head dark brown. Antennal segments I and II red, III and IV pale yellow. Rostrum deep brown. Femora red and tibiae yellow. Abdomen reddish with glands dark red. Bristles at the apex of abdomen well developed. This instar consumes an average of 18.8 (14–22) thrips and moults after 4.3 (3–5) days.

*IV instar:* Body dark red. Antennal segment I and II reddish brown, III and IV pale yellow. Cephalic setae very prominent. Rostrum reddish brown with apex yellow. Wing pads developed and not extending beyond thorax. Abdomen dark red and abdominal glands not clear as in earlier instars. A third pair of setae also developed at the apex of abdomen. This instar consumes an average of 22.4 thrips (17–22) and moults into the fifth instar after 4.9 (4–6) days.

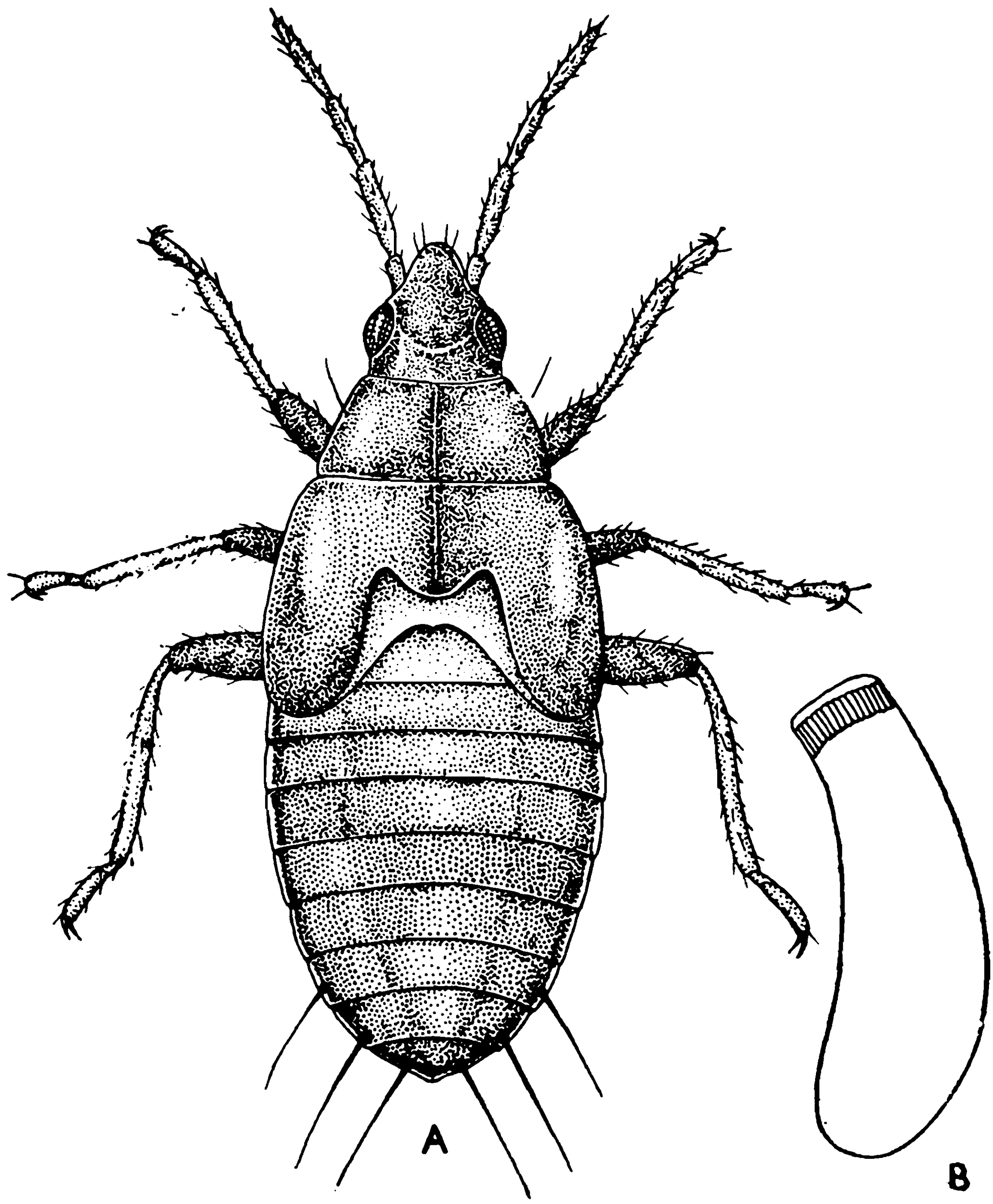


FIG. 6. *Montandoniola moraguesi*—(A) Fifth instar, (B) Egg.

*V instar:* (Fig. 6, A) Body coloured as in the previous instar. Head dark red with setae well developed. Basal antennal segment dark, second segment long, stout and densely setose, third and fourth pale yellow. Terminal part of rostrum yellow and rest red. Femora dark red with tibiae and tarsi yellow. Wing pads extend beyond thorax. Abdomen darker than previous instar and glands visible.

*Imago:* In the laboratory it takes an average of 27.5 (25–31) days for complete development and consumes an average of 91.4 (81–118) thrips during development (Table 4).

*Mating:* Mating usually occurred one or two days after emergence from the V instar, but very rarely females were found mating on the '0' day. But in no case the male was found mating on the day of emergence. In the case of males a minimum of two days was necessary to be ready for mating. In the process of mating no courtship behaviour was exhibited and mating took place irrespective of the time of the day. During mating the males run after the females and mount on her back generally from the right side. In all cases the females struggle and try to escape and in majority of cases the males succeed in having a firm hold on the females. During mating the males vigorously move their antennae but those of females are stretched forward. Mating lasts for 60–170 seconds and the males were found mating with several females, one after another, but the females once mated usually declined to accept males. On many occasions it was found that males were attacked by females after copulation. In many cases when a single pair of male and female is left the females always attacked and killed the males.

TABLE 4. Incubation period, duration of instars and the number of thrips consumed (in brackets) per instar of *Montandoniola moraguesi*

| Specimen number | Incubation period | Duration of instars in days and thrips consumed in brackets | | | | | Total duration | Total No. of thrips |
|---|---|---|---|---|---|---|---|---|
| | | I | II | III | IV | V | | |
| 1 | 4 | 3(8) | 4(12) | 5(18) | 4(21) | 5(28) | 25 | 87 |
| 2 | 5 | 3(10) | 3(10) | 5(21) | 5(21) | 5(19) | 26 | 81 |
| 3 | 4 | 4(6) | 4(7) | 3(21) | 5(23) | 6(29) | 26 | 86 |
| 4 | 4 | 4(8) | 4(7) | 3(17) | 4(25) | 6(27) | 25 | 84 |
| 5 | 6 | 4(7) | 4(12) | 5(19) | 5(25) | 5(30) | 29 | 93 |
| 6 | 5 | 5(12) | 4(16) | 5(21) | 6(28) | 7(41) | 31 | 118 |
| 7 | 5 | 4(8) | 3(14) | 3(16) | 5(21) | 5(25) | 25 | 84 |
| 8 | 5 | 4(14) | 5(16) | 4(14) | 5(20) | 6(29) | 29 | 93 |
| 9 | 4 | 4(7) | 5(16) | 5(19) | 4(17) | 7(38) | 29 | 97 |
| 10 | 6 | 4(7) | 4(12) | 5(22) | 6(23) | 5(27) | 30 | 91 |

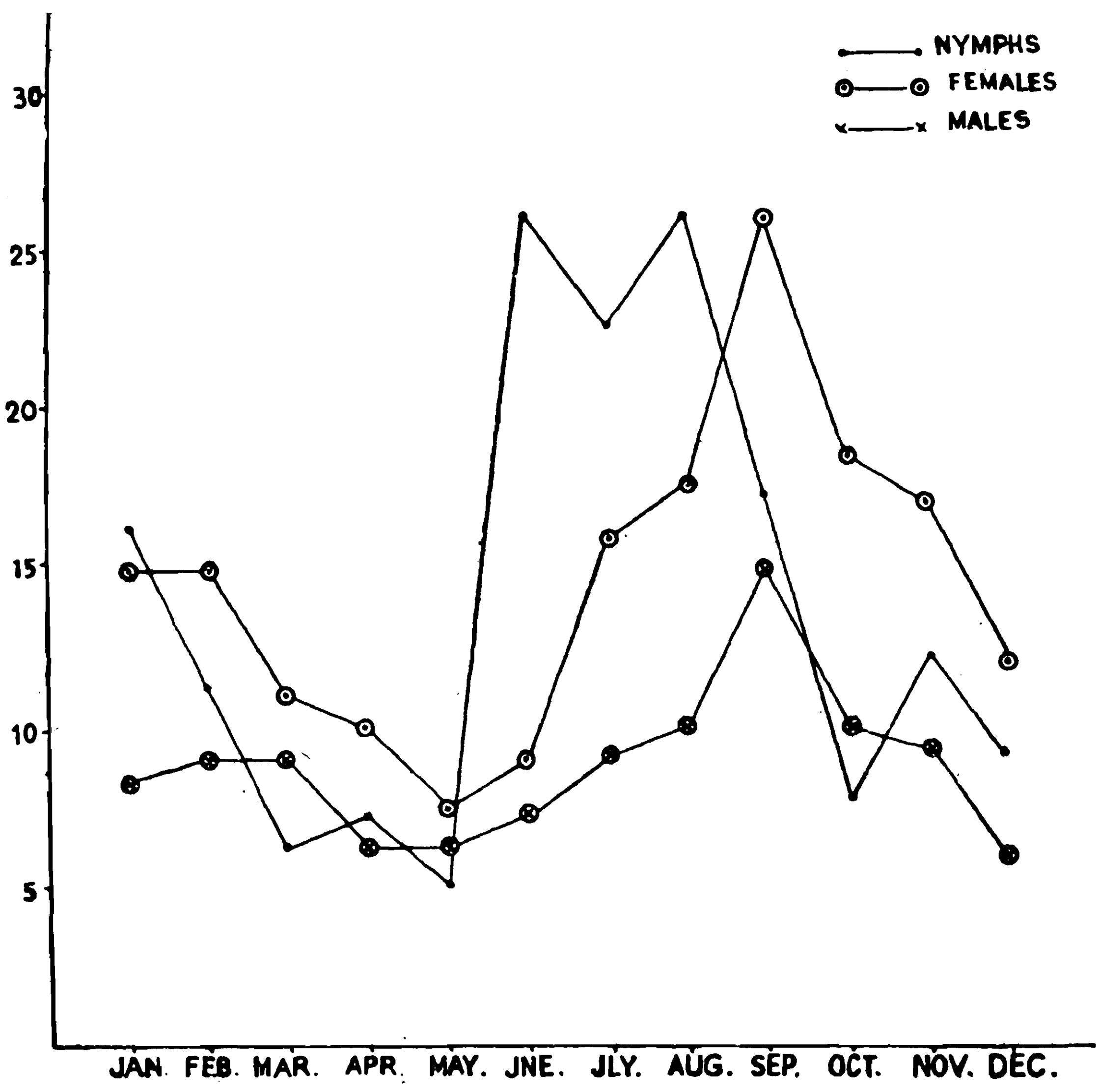


FIG. 7. Population fluctuations of males, females and nymphs of *Montandoniola moraguesi* in 1971.

A feature of interest of the population is the presence of thrips and galls throughout the year and a close correlation was observed in the abundance as well as the decrease of both predator and prey species. Nymphs were more abundant during the months June to August. Although the number of females were always more than that of males, their increase and decrease in the various months were closely followed by that of males. The maximum number of males and females were observed in September, the peak being reached after a decline in the month of May, through a steady increase in the following months (Fig. 7). The gradual increase of anthocorids during September can be correlated with the appearance of new young leaves susceptible for gall formation by thrips and an incidental increase in the populations of *Gynaikothrips flaviantennatus*. However during the month of October when the rainfall is heavy there is a natural decline of thrips and predator populations partly due to the impact of physical factors.

## LITTER HABITAT

### (c) **Xylocoris clarus** (Distant)

Leaf litter abounds in densely vegetated areas and in particular forests, harbouring a wide variety of insect life. Anthocorids are no exception in view of the abundance of food in such habitats since they feed mostly on mites, litter thrips, psocids, small caterpillars and grubs. Mention may be made of the species belonging to *Physopleurella*, *Buchananiella*, *Cardiastethus* etc. collected from such habitats in several parts of Africa and N. America.

Many species have been recorded from similar habitats during the present investigation and in view of the abundance *Xylocoris clarus* (Distant) has been taken up for the study of biology. Apart from the general occurrence in general leaf litter in Madras and in various parts of South India, abundant material was available within large pits wherein leaf litter of *Polyalthia pendulosa*, *Cassia auriculata*, *Bassia longifolia* etc. were generally dumped so that it was easy to obtain both the predators and the prey such as mites and thrips. Besides the commonly occurring litter thrips *Malacothrips madrasensis* and *M. indicus*, small coleopterous grups such as those of staphylinid beetles and plenty of psocids were also found.

Preoviposition period ranges from 6–10 days under laboratory conditions and the eggs were laid (Table 5) on decaying leaves. Eggs (Fig. 8, B) when laid are creamy white with polygonal reticulations, measuring 0.48–0.51 mm long and 0.20–0.25 mm wide.

*I instar:* Just after hatching the nymph is pale white with scattered red pigmentation. Body setose, head broadly triangular and eyes appearing as red spots. Antennal segments II to IV densely setose and pale yellow. Thorax red with long setae; legs pale yellow, hind tibiae with spines. Abdomen pale yellow with scent glands appearing red. Abdominal apex with two pairs of long bristles. In the laboratory the duration of the instar is 6.8 (5–8) days.

*II instar:* Body coloured as in the case of first instar. Legs densely setose and abdominal glands appearing still paler. Nymphal period is 8 (7–9) days.

*III instar:* Body acquired uniform yellow colour with red pigment scattered. I and II antennal segments pale brown, III and IV segments and rostrum pale yellow. Setae on head and pronotum very prominent. Wing pads visible: legs setose and spinose. Moulting takes place after 6.1 (5–7) days.

*IV instar:* Colour still darker. Wing pads further developed. Abdominal apex with two pairs of long bristles and scent glands appearing pale red. This instar moults after an average of 3.9 (3–5) days.

*V instar:* (Fig. 8, A) Body pale brown. Antennal segments, head, thorax and abdomen pale brown with lot of pigmentation. Legs pale brown and spines fully developed. Abdominal scent glands not clearly visible and abdominal apex with two pairs of long bristles. Duration of the instar 5 (4–7) days.

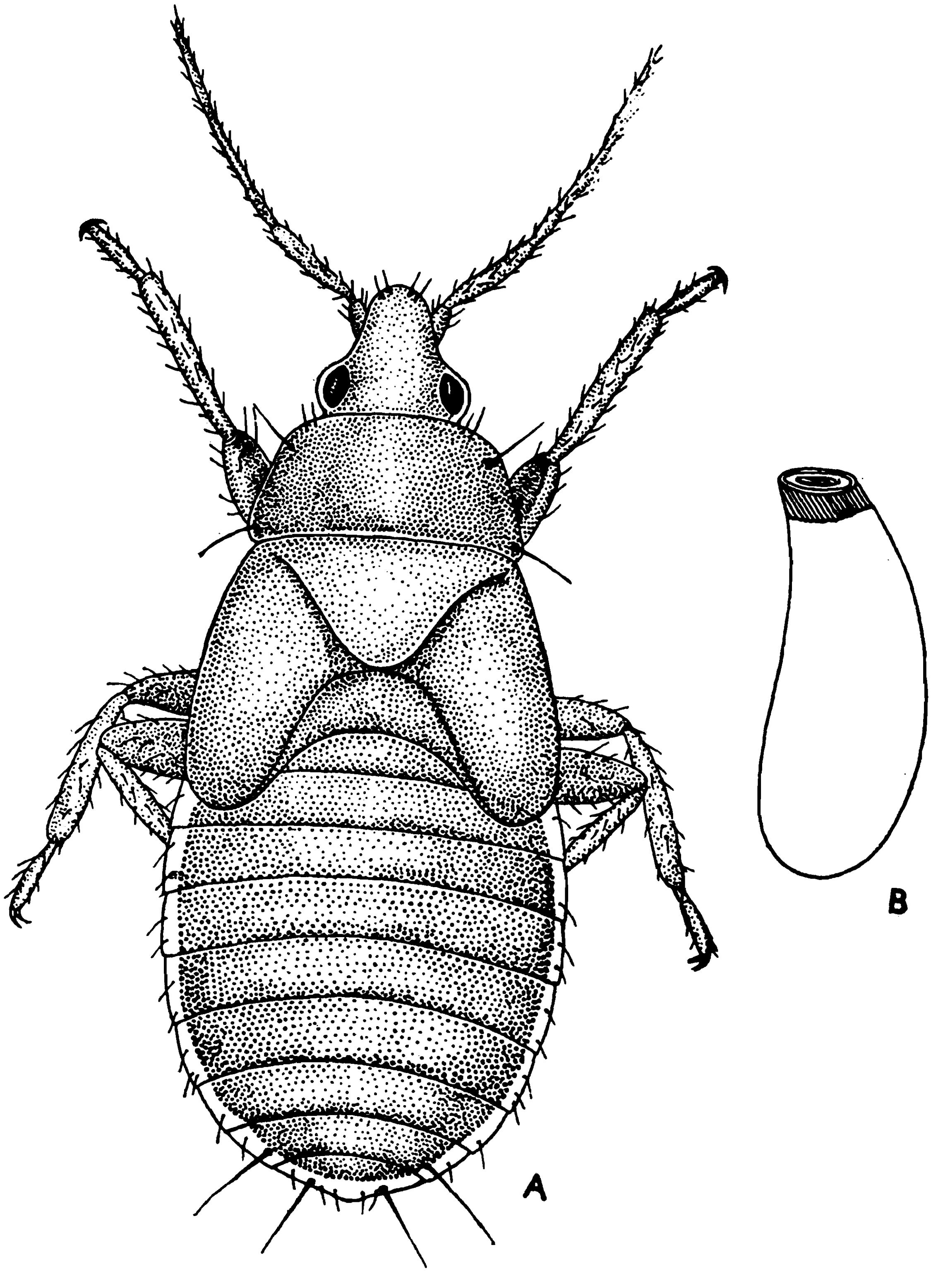


FIG. 8. *Xylocoris clarus*—(A) Fifth instar, (B) Egg.

TABLE 5. Oviposition record for *Xylocoris clarus*

| Specimen number | Number of eggs laid per week | | | | | | Total eggs | Longevity | Eggs per day |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | | |
| 1 | 10 | 24 | 12 | 9 | 2 | — | 57 | 62 | 0·91 |
| 2 | 17 | 21 | 8 | 7 | 3 | 2 | 58 | 57 | 1·01 |
| 3 | 20 | 24 | 12 | 5 | — | 2 | 63 | 59 | 1·06 |
| 4 | 14 | 12 | 6 | — | — | — | 32 | 51 | 0·62 |
| 5 | 16 | 18 | 9 | 12 | — | 4 | 59 | 68 | 0·86 |
| 6 | 20 | 20 | — | — | — | — | 40 | 53 | 0·75 |
| 7 | 10 | 12 | 24 | 2 | 1 | — | 45 | 59 | 0·76 |
| 8 | 21 | 10 | 10 | 7 | 2 | — | 50 | 62 | 0·80 |
| 9 | 5 | 13 | 17 | 9 | 5 | 7 | 56 | 68 | 0·82 |
| 10 | — | 14 | — | 9 | 7 | 3 | 33 | 61 | 0·54 |

Life cycle is completed within 32–42 days (Table 6). The adult female just after hatching is pale brown with red pigmentation and attains the black colour after a day. The matured adult is deep black and slightly pubescent. Rostrum yellow, basal antennal segments brown and terminal segments yellowish brown. Thorax dark, legs pale yellow and forefemora incrassate. Wings fully developed. Abdomen black and pubescent.

TABLE 6. Incubation period and duration of instars of *Xylocoris clarus* in days

| Specimen number | Incubation period | Instars | | | | | Total duration in days |
|---|---|---|---|---|---|---|---|
| | | I | II | III | IV | V | |
| 1 | 6 | 8 | 7 | 5 | 3 | 4 | 33 |
| 2 | 6 | 5 | 7 | 7 | 3 | 4 | 32 |
| 3 | 6 | 8 | 9 | 7 | 5 | 7 | 42 |
| 4 | 8 | 8 | 9 | 7 | 5 | 4 | 41 |
| 5 | 11 | 5 | 8 | 5 | 3 | 6 | 38 |
| 6 | 6 | 7 | 9 | 6 | 3 | 4 | 35 |
| 7 | 11 | 7 | 8 | 5 | 4 | 5 | 40 |
| 8 | 6 | 7 | 8 | 6 | 3 | 5 | 35 |
| 9 | 10 | 6 | 8 | 6 | 5 | 7 | 42 |
| 10 | 10 | 7 | 7 | 7 | 5 | 4 | 40 |

*Xylocoris clarus* (Dist.) is characterised by the ectospermalege on the anterior region of abdomen and when males and females are kept in rearing tubes, mating takes place immediately. No courtship was observed. During mating the male which is comparatively smaller, mounts on the back of female and holds with the first two pairs of legs, the hindlegs remaining free. The posterior part of abdomen touches the anterior part of abdomen of female and copulation is effected. During the process the body of the male is completely on the back of the female which moves about with the male on its back. The antennae of the male touches those of female and the process of copulation lasts for 30–120 seconds. Though only one mating was found enough for starting oviposition, mating occurred several times and the females were found mating with several males.

## PHLAEOPHILOUS HABITAT

### (d) **Scoloposcelis parallelus** (Motchulsky)

The members of the genus *Scoloposcelis* are generally phlaeophilous and the species discussed here occurs in good numbers on the dead and decaying barks of *Erythrina* in Madras during August-September along with the mycophagous thrips, *Ecacanthothrips sanguineus*, staphylinid beetles and Oribatid mites. Viswanathan & Ananthakrishnan (1973) studied the biology, ecology and behaviour of *Ecacanthothrips sanguineus*. It had been found that this species occur in large numbers with their peak of incidence during the months August to October. Their eggs were always laid in clusters, the number ranging from 70–90. The postembryonic development was 13–17 days, the duration of the first instar being 2 days, the second instar 6–8 days, prepupa 1 day, pupa I, 2–3 days and pupa II, 2–3 days and the incubation period was 3–5 days.

Oviposition commenced 3–6 days after mating and one mating was enough for oviposition (Table 7). Eggs (Fig. 9, B) when laid are pale white, long and curved with polygonal reticulations. Eggs are inserted within the decaying barks generally with the operculum facing outward. However there was no uniformity in the arrangement of eggs and they were laid singly. Incubation period is 4.5 (3–5) days.

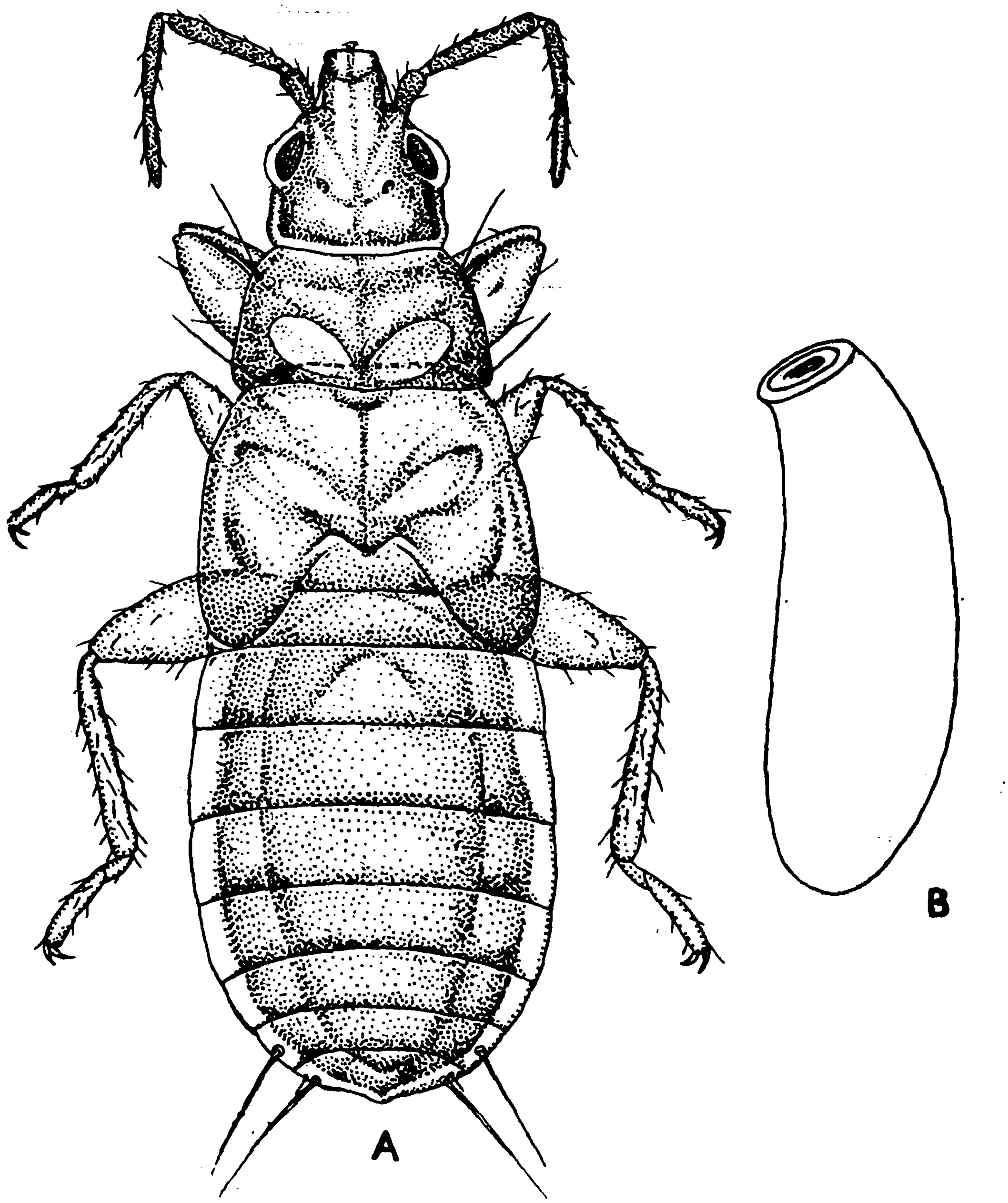


FIG. 9. *Scoloposcelis parallelus*—(A) Fifth instar, (B) Egg.

*I instar:* Body red, eyes appearing as red spots, long setae on head and prothorax well developed. Antennal segments I, II and III yellowish brown and IV segment yellow. Rostrum, thorax and legs yellow. Abdomen with scent glands deep red and apex with long bristles. Under laboratory conditions the duration of the instar is 5.3 (5–6) days.

*II instar:* Colour as in the first instar, legs devoid of spines; fore and hind femora a little incrassate. The duration of the instar is 5.5 days (5–7) under laboratory conditions.

*III instar:* Body red. Antennal segments I–III pale yellowish brown and rostrum yellow. Fore and hind femora incrassate and non-spinose. Abdomen red and abdominal glands deep red. Two pairs of long bristles present at apex of abdomen. The third instar moults after 5.5 days (5–7).

*IV instar:* Body orange red. Antennal segments I–III pale brown yellow, terminal segments beset with long setae. Thorax with four long setae and legs yellow. Wing pads make their appearance as yellow expansions. Abdomen red and scent glands not very distinct as in earlier instars. This instar moults to the fifth instar after an average of 3.7 (3–5) days.

TABLE 7. Oviposition record for *Scoloposcelis parallelus* (Mots.)

| Specimen number | Total eggs laid in week No. | | | | | | Total number of eggs laid | Longevity of females in days | Average eggs per day |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | | |
| 1 | 12 | 21 | 14 | 7 | 2 | 2 | 58 | 53 | 1·09 |
| 2 | 14 | 25 | 21 | 14 | 9 | 3 | 86 | 61 | 1·40 |
| 3 | 15 | 19 | 14 | 6 | — | — | 44 | 40 | 1·10 |
| 4 | 10 | 24 | 21 | 7 | — | 3 | 65 | 51 | 1·27 |
| 5 | 7 | 14 | 14 | 10 | — | — | 45 | 38 | 1·18 |
| 6 | 12 | 25 | 12 | 10 | 6 | 4 | 69 | 51 | 1·35 |
| 7 | 15 | 12 | 9 | 9 | 3 | 2 | 40 | 53 | 0·75 |
| 8 | 10 | 15 | 8 | 8 | 4 | 2 | 47 | 54 | 0·87 |
| 9 | 15 | 15 | 12 | 8 | 3 | 5 | 58 | 60 | 0·97 |
| 10 | 26 | 20 | 20 | 11 | 2 | — | 79 | 51 | 1·55 |

*V instar:* (Fig. 9, A) Body red. Antennal segments I to III more brownish and rostrum yellow. Thorax red with legs yellow; forefemora appearing pale brown, fore and hind femora more incrassate and non spinose. Wing pads pale brown. Abdomen red with a pair of long bristles at apex. The fifth instar takes 5.5 (5–7) days to become the adult.

The duration of the life cycle is 28–32 days (Table 8). When just hatched from the fifth instar it is red in colour, turning black after a day. Antennal segments and rostrum brown. Pronotum black and setose. Fore and hind femora highly incrassate and spinose, mid femora less thickened and non-spinose. The male is coloured like the female and mid femora also provided with one or two spines. Abdomen of male provided with a glandular complex,

TABLE 8. Incubation period and the duration of instars of *Scoloposcelis parallelus* in days

| Specimen number | Incubation period | Instars | | | | | Total duration |
|---|---|---|---|---|---|---|---|
| | | I | II | III | IV | V | |
| 1 | 4 | 5 | 5 | 5 | 4 | 5 | 28 |
| 2 | 5 | 5 | 5 | 5 | 3 | 6 | 29 |
| 3 | 5 | 5 | 6 | 5 | 3 | 5 | 29 |
| 4 | 5 | 5 | 5 | 6 | 5 | 5 | 31 |
| 5 | 5 | 6 | 5 | 6 | 3 | 7 | 32 |
| 6 | 3 | 5 | 7 | 6 | 3 | 5 | 29 |
| 7 | 4 | 6 | 6 | 5 | 5 | 5 | 31 |
| 8 | 5 | 5 | 5 | 5 | 4 | 7 | 31 |
| 9 | 5 | 5 | 5 | 5 | 4 | 5 | 29 |
| 10 | 4 | 6 | 6 | 7 | 3 | 5 | 31 |

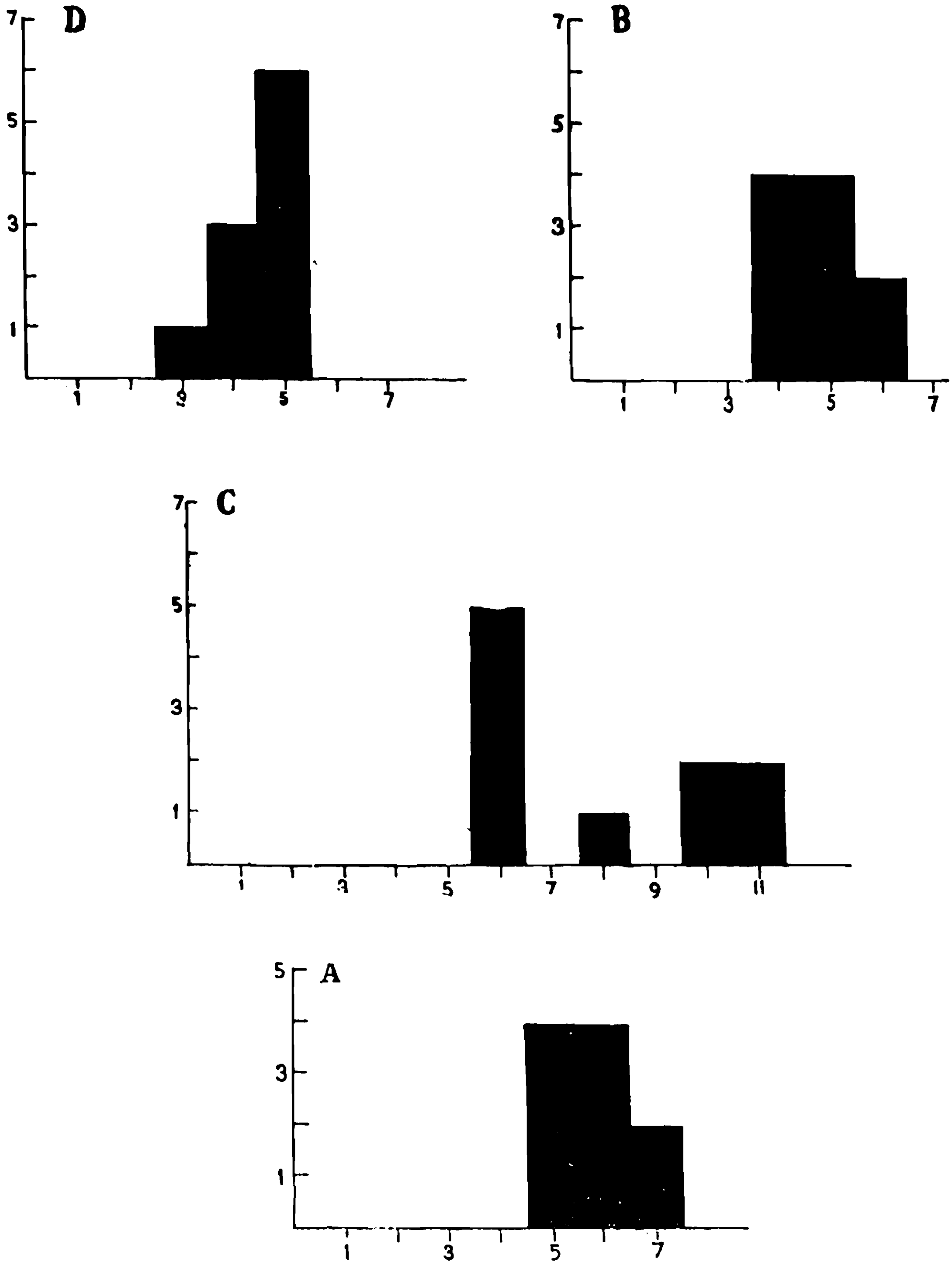


FIG. 10. Frequency distribution histograms of the incubation periods—(A) *Carayonocoris indicus*, (B) *Montandoniola moraguesi*, (C) *Xylocoris clarus*, (D) *Scoloposcelis parallelus*. Abscissae, time in days; ordinates, number of observations.

When males and females are kept in tubes copulation was readily observed. Mating behaviour was seen to be distinctly different from the other species studied here. The male runs after the female and once the antennae of the male touch those of female, the former immediately turns its back, the posterior part of the male comes in contact with that of the female and copulation is effected. In many cases it was observed that the female always easily moved away from copula, probably due to the lack of a firm hold by the male. Unlike in other species of anthocorids discussed here, the male does not mount on the female and does not hold her with his legs. Mating lasts for 1–3 minutes and during this process they face the opposite directions and finally the female starts moving, dragging the male for some distance and shortly the genital contact is separated.

## DISCUSSION

Our knowledge on the biology of this important group of predators is scanty and an attempt has been made here to derive some information regarding the general bionomics of representative anthocorids from different habitats and in this effort attempts have been made to provide information regarding their reproductive behaviour, fecundity and longevity. The mode of egg laying varies from species to species and even within the same species when the

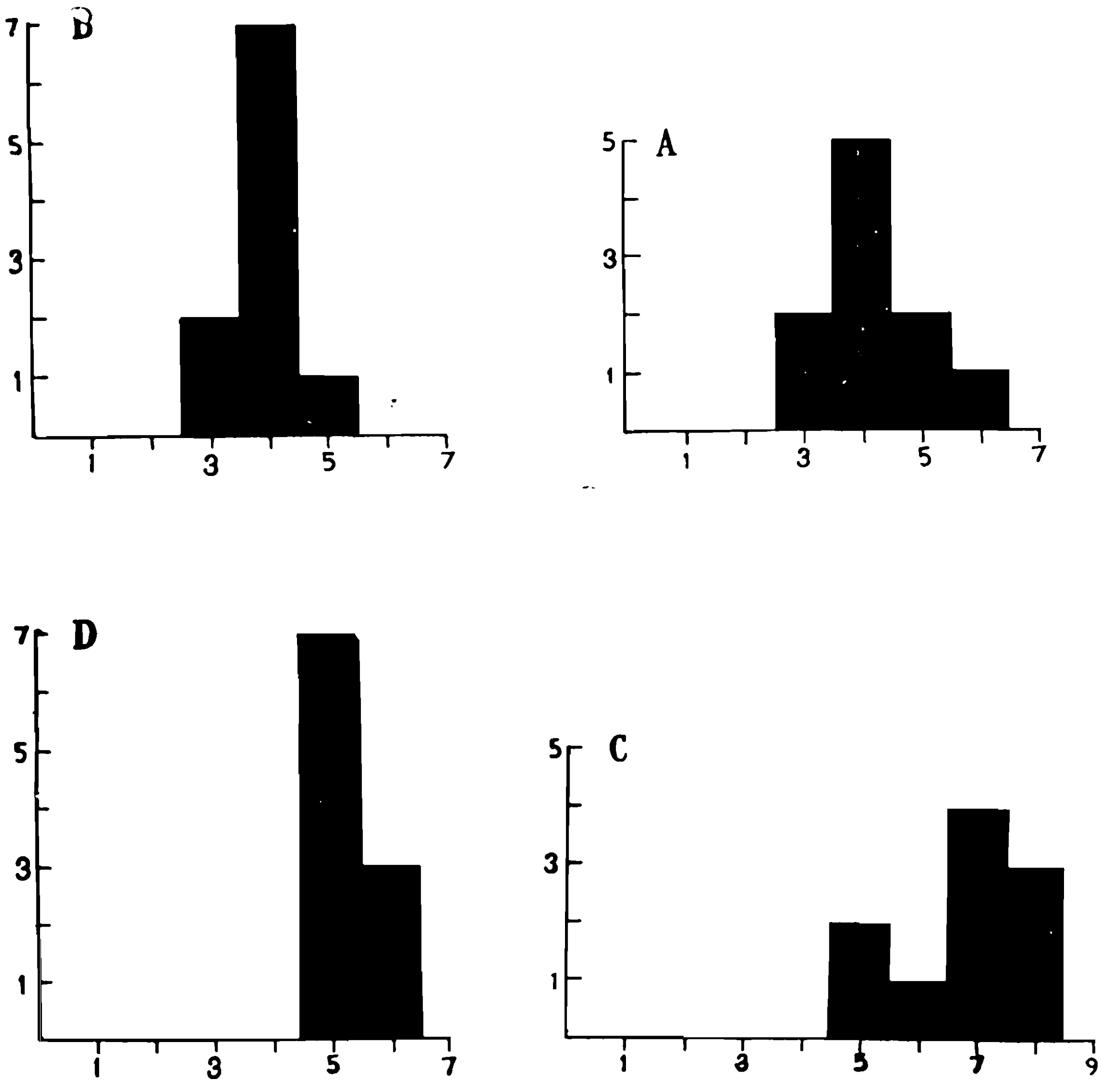


FIG. 11. Frequency distribution histograms of durations of first instars—(A) *C. indicus*, (B) *M. moraguesi*, (C) *X. clarus*, (D) *S. parallelus*. Abscissae, time in days; ordinates, number of observations.

surface of egg laying is different. In *Carayonocoris indicus* the eggs are inserted into the petioles of flowers. The highly polyphagous predator *M. moraguesi* shows different modes of egg laying such as partial insertion in a single row as in *Cassearia* leaves and complete insertion as in leaves of *Mimusops*, *Pavetta* and *Memecylon*, the latter conditions being reflected very clearly when the leaves are held against light, the eggs being discernible as slightly raised dot like structures. These diverse modes of oviposition appear to be correlated with the structure of the leaf, the partial insertion generally occurring in thick and leathery leaves. In *X. clarus* and *S. parallelus* the eggs are laid on twigs or in crevices on the bark.

Observations on the rates of feeding of the four species discussed *Carayonocoris indicus*, *Montandoniola moraguesi*, *Xylocoris clarus* and *Scoloposcelis parallelus* have shown that the earlier instars especially I and II prefer the larvae of thrips whereas the later instars and adults did not show any special preference for larval thrips. *C. indicus* consumed 71–93 thrips during postembryonic period and in *M. moraguesi* the rate of feeding varied from 81–118 thrips. In the case of *X. clarus* and *S. parallelus* the feeding habits vary, since they feed on varied insects like thrips, psocids, caterpillars, small grubs and mites. Van Emden (1969) had shown that the efficiency of predators depend on three factors viz. the voracity of predators, the rate of reproduction of their prey, and synchronisatioı of the predator and prey population. The studies on the efficiency of *Anthocoris* spp. (Russel, 1970) had demonstrated that the aphids

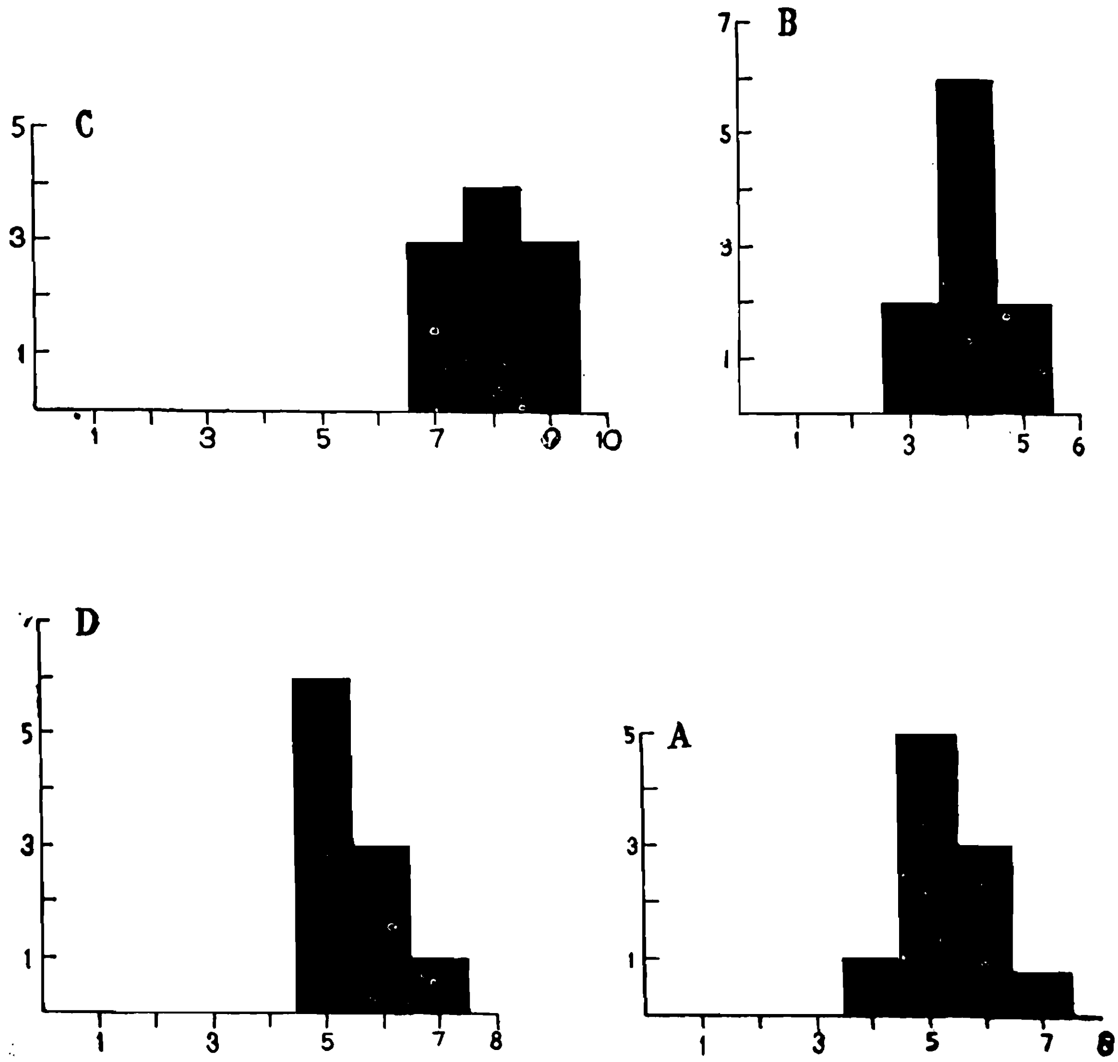


FIG. 12. Frequency distribution histograms of durations of second instars—(A) *C. indicus*, (B) *M. moraguesi*, (C) *X. clarus*, (D) *S. parallelus*. Abscissae, time in days; ordinates, number of observations.

required for the anthocorids indicate that their food requirements are small, compared with those of large predators but predation by anthocorids can have the effect of restraining the numbers of their prey population. The focd requirements of anthocorids were studied by Anderson (1962*b*) and later on Dempster (1968) also showed that egg production in *Anthocoris sarothamni* preying upon the two species of psyllids *Arytaina spartii* and *A. genistae* is controlled by the availability of food. Direct density dependent effect of number of eggs produced is seen in *A. sarothamni* when food supply determines the reproductive success. Typical intraspecific competition for oviposition sites in psyllids upon which *A. sarothamini* feed exists, when direct density is high or there is a shortage of oviposition sites. If there is a food shortage complete absence of reproduction is seen. Anderson (1962) has also shown that *A. sarothamni* will enter a state of reproductive diapause when there is shortage of psyllid prey. As a result of their studies on the efficiency of predation of

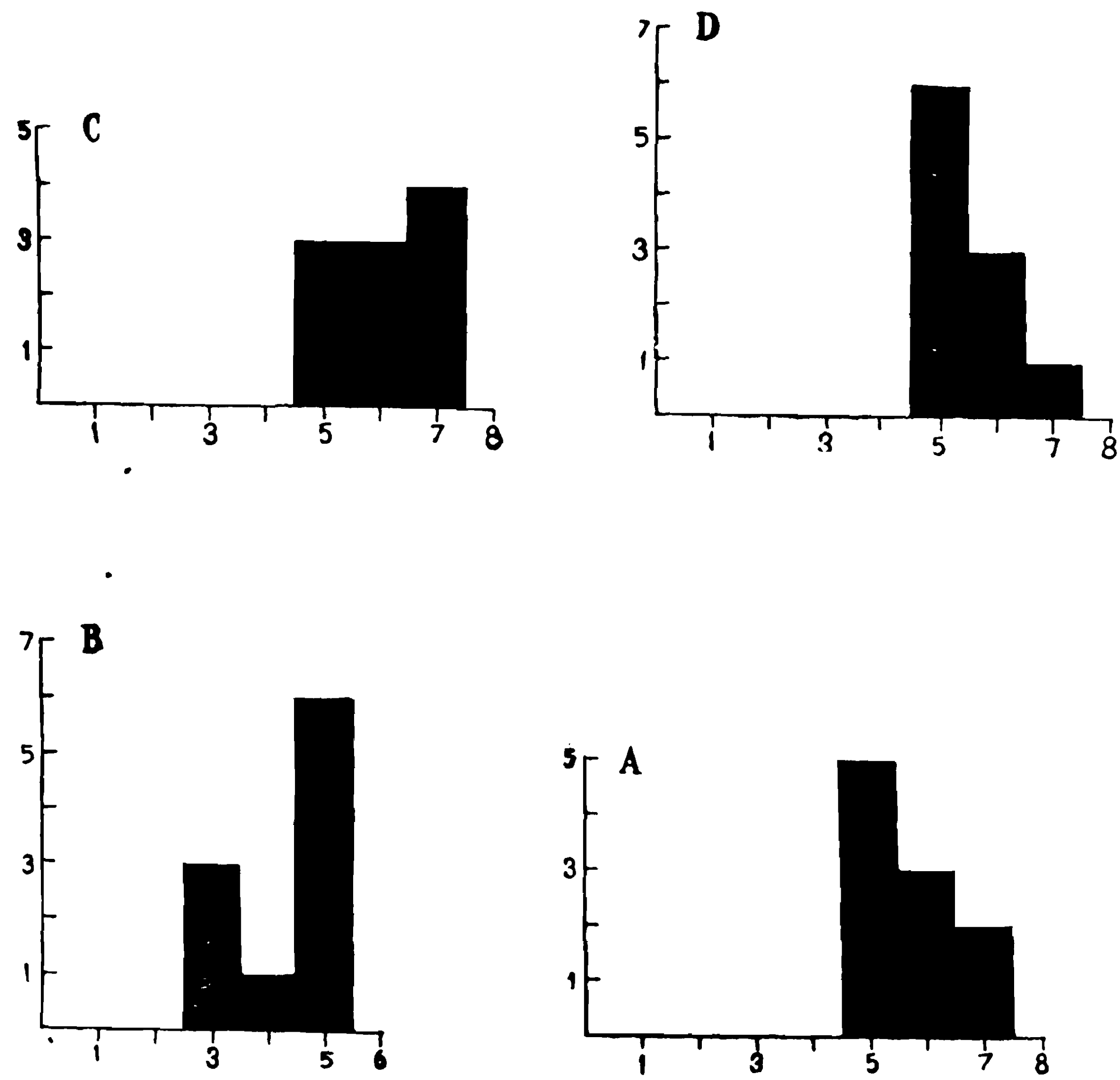


FIG. 13. Frequency distribution histograms of duration of third instars—(A) *C. indicus*, (B) *M. moraguesi*, (C) *X. clarus*, (D) *S. parallelus* Abscissae, time in days, ordinates, number of observations.

*Anthocoris* spp. Dixon and Russel (1972) have found that these species show a subproportional response to the numbers of their prey and hence they cannot exert a regulating effect on the prey population. However, it has also been found that anthocorids by acting as inverse density dependent mortality factors, and operating before the over compensated regulatory plant factor, are likely to increase the amplitude of the fluctuations when the population stability is disturbed by adverse weather factors.

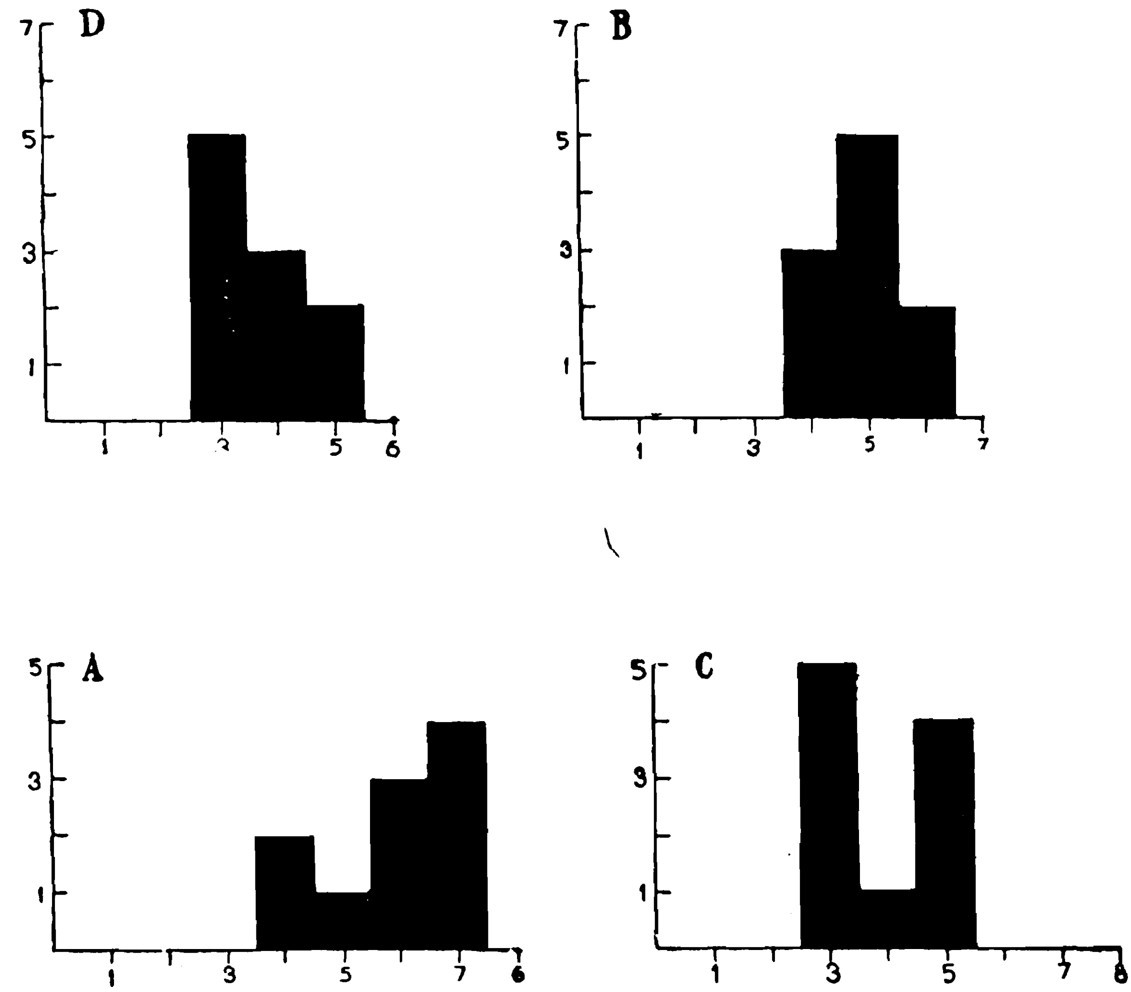

FIG. 14. Frequency distribution hisotgrams of duration of fourth instars—(A) *C. indicus*, (B) *M. moraguesi*, (C) *X. clarus*, (D) *S. parallelus*. Abscissae, time in days; ordinates number of observations.

Observations on the duration of the life cycles on the four species of anthocorids (Figs. 10–15) during present study indicate that *C. indicus* completes its life cycle with in 26–36 days and *M. moraguesi* the period varied from 25–31 days. In *X. clarus* inhabiting leaf litter the duration is 32–42 days and *S. parallelus* from 28–32 days. Fecundity observed in four of the above species varied from species to species and even among same species when kept under laboratory conditions. Females of *C. indicus* were known to lay a maximum of 53 eggs in 52 days and the minimum was 3 eggs. In *M. moraguesi* 30–74 eggs were laid by the females and the maximum longevity observed was 52 days. *X. clarus* laid a maximum of 63 eggs in 59 days and the minimum observed was 32 eggs. Females of *S. parallelus* has a maximum longevity of 61 days, the number of eggs laid varied from 40–86.

Differences in the size and proportions of such structures as head, antennal segments, rostrum, legs etc. appear to be significant characters in taxonomic studies. Matsuda (1961) observed that growth ratios for the different parts in the different species of gerrids were significantly different and that the patterns for the proximal segments of these structures appeared to be more similar in related species than those of the distal segments. This tendency further indicated that the growth pattern of these proximal segments were often generically constant, while those of the distal segments appeared more variable at the specific level. In dealing with the bionomics of four species inhabiting different niches, anthophilous, gallicolous, phlaeophilous and litter inhabiting, a preliminary attempt made towards an understanding of the

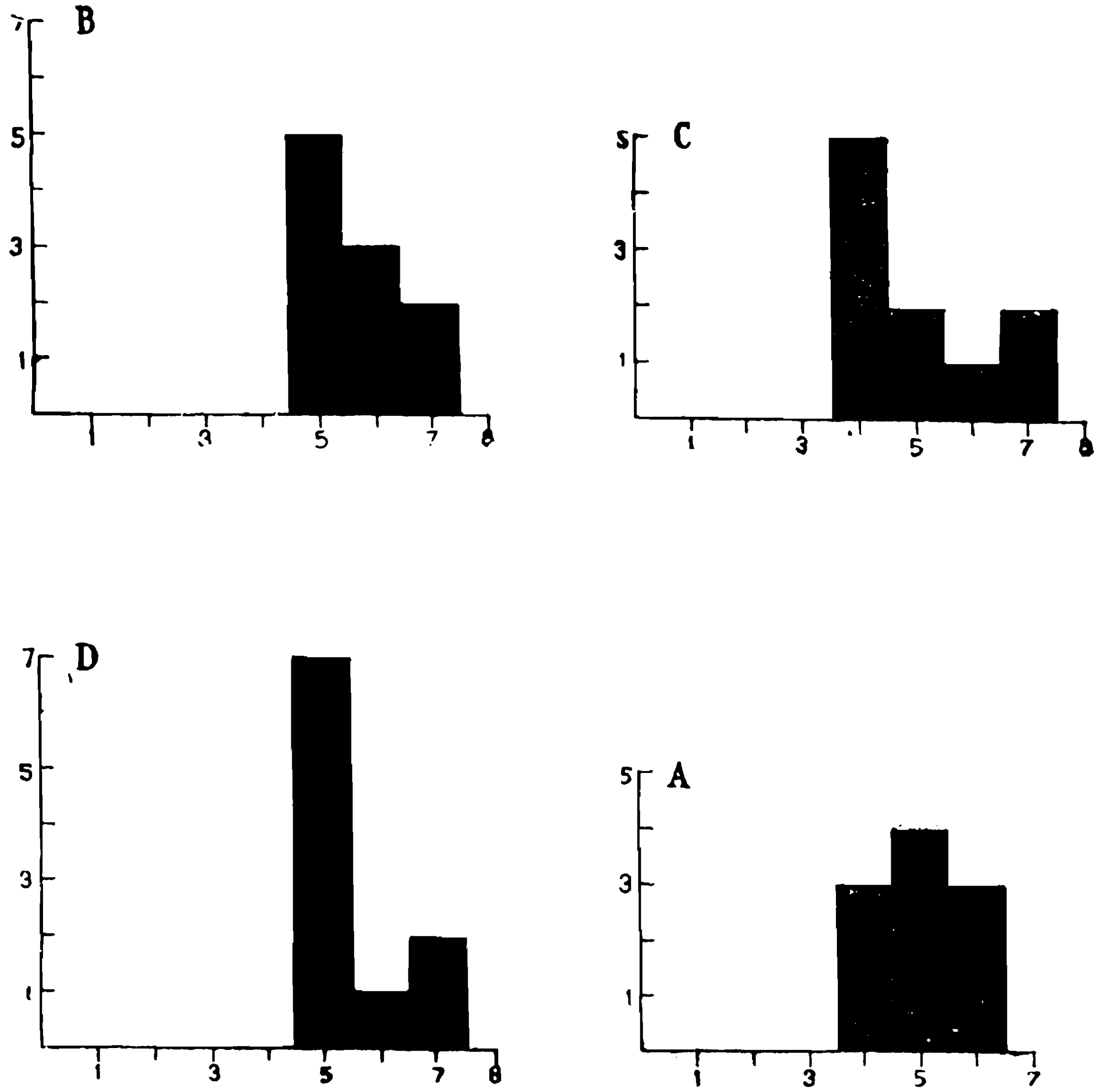


FIG. 15. Frequency distribution histograms of duration of fifth instars—(A) *C. indicus*, (B) *M. moraguesi*, (C) *X. clarus*, (D) *S. parallelus*. Abscissae time in days ordinates; number of observations.

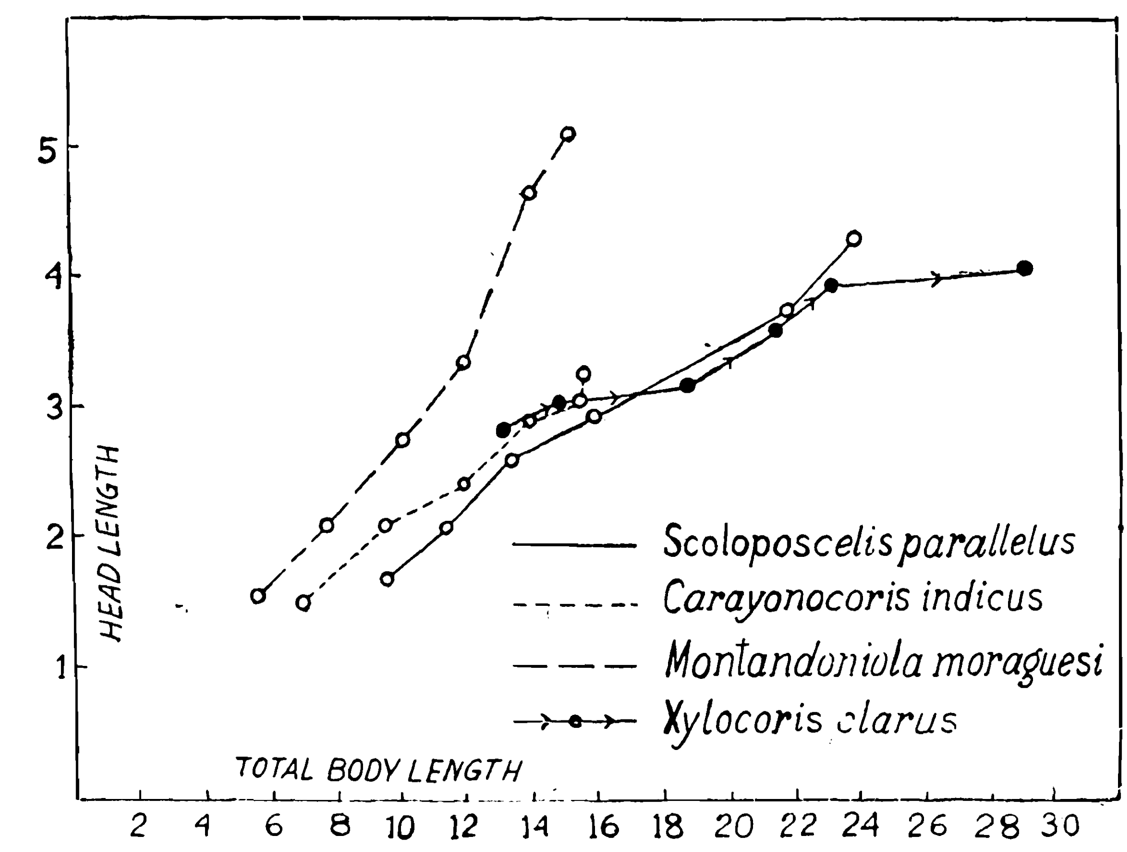


FIG. 16. Graph showing comparative growth rates of head length of *C. indicus*, *M. moraguesi*, *X. clarus* & *S. parallelus* in relation to total length of body.

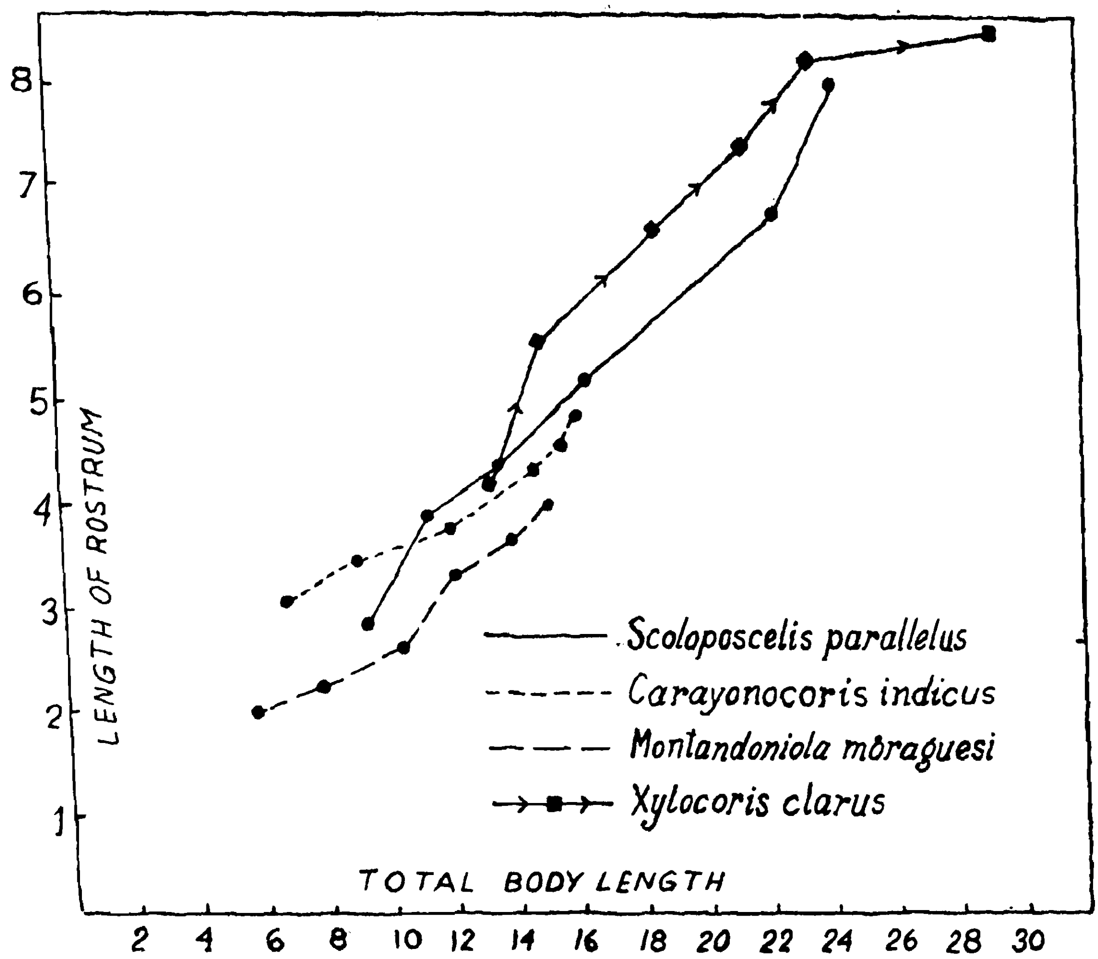


FIG. 17. Graph showing comparative growth rates of rostral length in *C. indicus*, *M. moraguesi*, *X. clarus* & *S. paralellus* in relation to total body length.

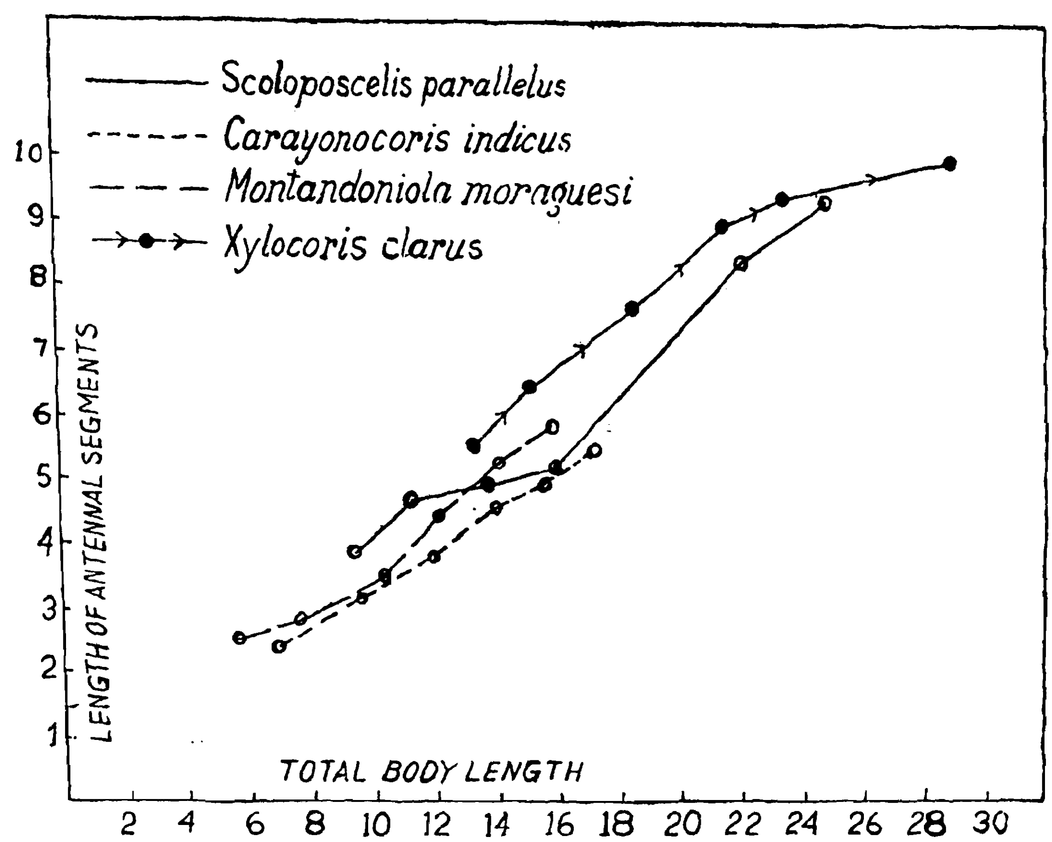


FIG. 18. Graph showing comparative growth rates of antennal segments of *C. indicus* *M. moraguesi*, *X. clarus* & *S. parallelus* in relation to the total length of body.

importance of the patterns of the growth rates of antennae, rostrum, head length etc. in relation to the total length of the body during postembryonic development (Figs. 16–18) reflects the importance of such studies in specific identification of anthocorids. Though of a purely exploratory nature it has served to confirm to some extent the observations of Matsuda on the need for work wherever possible. Growth rates were compared for all the four species of anthocorids.

It has now been realised that anthocorids are effective predators and play an useful role in the natural control of many insect pests in different parts of the World. In Hawaii *Orius persequens* (White) has been reported as predatory on *Thrips tabaci* (Illingworth, 1931) and in Australia *O. australis* (China) has been known to feed on the eggs of *Heliothes obsoleta* (China, 1926) *Orius sauteri* (Poppius) had been reported preying on the Jassids *Erythroneura mori* and *Chlorita felavcens* (Esaki & Hashimoto, 1936) in Japan. Ballard (1921) reported *Orius tantillus* (Mots.) as predaceous on larvae of *Platydera gossypiella* and also on the nymphs of *Oxycaraenus hyalipennis* and Rajasekhara & Chatterjee (1970) recorded *O. indicus* (Reuter) as predator on *Taeniothrips nigricornis* in India. *O. albidipennis* (Reuter) had been observed as feeding on a number of insect pests like *Rhopalosiphum maidis* (Hassan, 1957), *Thrips tabaci* (Ghabn, 1948) larvae of *Prodenia litura* (Bishara, 1934) and also on the tingid *Stephanites pyri* (Gomezmenor, 1956). In Bulgaria *O. niger* (Wolff) had been found to attack *Thrips tabaci* and *Haplothrips aculeatus*. Of all the *Orius* spp. *Orius insidiosus* (Say) is considered as an important natural enemy of many pests in North America. Carayon & Steffan (1959) lists that this species feeds on 13 species of Homoptera, 9 species of Thysanoptera, 7 species of Lepidoptera, 4 species of Heteroptera, 4 species of Diptera, 2 species of Coleoptera and 2 species of Phytophagous acarina. Lewis (1973) records this species as preying on more than 7 species of Thysanoptera.

As has been earlier mentioned the anthocorids are among the major natural enemies of Thysanoptera. Many species of Thysanoptera have reached the status of pests and in India the most important species injurious to agricultural crops are the following and anthocorids freely predate on these species.

(1) *Thrips tabaci* Lind. This is a cosmopolition species feeding on onion and garlic and in India this has been found to feed on a number of plants including Cotton, Cabbage and Carnation. Rahman & Batra (1945) had shown that the female lays 40–50 eggs which hatch in 4–9 days, the total duration of life cycle is 11–21 days.

(2) *Scirtothrips dorsalis* Hood. This species causes major damage to Chillies and Tea, and has an extensive host range. In S. India these are found in large numbers in *Prosopis* and *Acacia* plants. The life history of this species was studied in detail by Raizada (1965). The female lays 40–68 eggs and the life cycle is completed in 15–20 days.

(3) *Baliothrips biformis* (Bangall) is host specific and cause serious damage to rice plants in the nurseries. The eggs hatch within 3–5 days and the life cycle is completed in 13–19 days.

(4) *Caliothrips indicus* (Bagnall) is a polyphagous species mainly found feeding on the leaves of ground nut and *Sesbania* and has recently been found feeding on young leaves of Bajra in S. India. The total duration of the life cycle is 13–33 days.

(5) *Microcephalothrips abdominalis* (Crawford) This species is found mainly in the flowers like Chrysanthemum, Dahlia and Marigold. The life history of this species was studied by Raizada (1969) and the duration of the life cycle varies from 9–20 days.

(6) *Haplothrips ganglbaueri* Schmutz. Commonly occurring all over India on a number of plants. The life history of this species was studied by Ananthakrishnan and Thangavelu, (1976).

These species are preyed upon by species of *Orius* mainly *O. maxidentex* and *O. tantillus* which are found among cultivated plants. It is also of interest to note that when the crop season is over these species can be found among the weeds and feeding on the thrips and other insects occurring in these plants.

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