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Thrips-Parasite Interactions in Some Panchaetothripine Thysanoptera (Insecta : Arthropoda)

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Biological aspects of reproduction, behaviour, efficiency of parasitisation and interaction with the host thrips population of the two larval parasites, *Ceranisus menes* Walker, *Goetheana thripsivora* Narayanan et al. and an egg parasite, *Polynema indica* Narayanan and Subba Rao are discussed. Seasonal occurence, variation in the parasite efficiency and sex-ratio are also included.

Key Words : **Thrips-parasites,** *Zaniothrips ricini, Retithrips syriacus, Caliothrips indicus, Arachis hypogaea, Ricinus communis*

Introduction

Thrips are known to be parasitized by many Hymenoptera belonging to the families Eulophidae, Trichogramatidae, and Mymaridae (Ferriere 1958, Clausen 1940, Boucek & Askew 1968, Lewis 1973, Ananthakrishnan & Swaminathan 1977, Varadarasan & Ananthakrishnan 1981). Unlike the predators, the parasites are more host specific and appear more effective in preventing population increase at low densities, because of their inability to switch on to another host. Reproductive strategies and the limits of fecundity also influence the efficiency of the parasite. In order to assess their role as biocontrol agents, information on aspects such as the biology of reproduction, behaviour and efficiency of the parasite appear necessary and an attempt has been made here in this direction with reference to two larval parasites, *Goetheana thripsivora, Ceranaisus menes* Walker and an egg parasite *Polynema indica.*

Materials and Methods

For biological studies of parasites and their interaction with the host, the parasitized thrips larvae and the adult parasites were collected from the field by careful examination of infested plants, the adult parasites being collected with the help of an aspirator. These parasites along with those that emerge from the parasitized larvae in the laboratory were released into a modified feeding chamber (Varadarajan 1979). A small portion of fresh leaves instead of sucrose solution was introduced as food for the host and a cotton wick dipped in honey and dried (to prevent the parasite from sticking to it) was kept as a source of food for the parasite. The infested larvae stopped feeding, became lethargic 6–8 days after parasitisation. At this stage they were separated into groups (5 in each) and reared in small glass vials (5.5 0.5 cm), which were partially immersed in water to keep the immediate surroundings cool. To assess the percentage of parasitisation by *Ceranisus menes* and *Goetheana thripsivora,* 200 to 500 larvae of *Zaniothrips ricini, Retithrips syriacus* and *Caliothrips indicus* were collected at random from the field on alternate days and cultured for 3–4 days in the laboratory and the parasitized larvae separated

under a stereoscopic binocular microscope. Based on the total number of parasitized larvae and adult parasites, the percentage of parasitization in the field was calculated. The efficiency of parasitisation was studied by using a known number of parasites (5) and a known number of host larvae (100–200/culture). The number of larvae released for parasitization was gradually increased in multiples of 50 to know the maximum efficiency of the parasite. The competition for parasitization was recorded by releasing a limited number of larvae (20/culture) with varied number of parasites. The population of parasites was also assessed simultaneously with the population of thrips.

Behaviour and Biology of the Parasites

Ceranisus menes, the eulophid parasite, has been known to attack the panchaetothripine species *Zaniothrips ricini* and *Retithrips syriacus* on *Ricinus communis*. Neither copulation nor any sexual excitement by the adult parasite was noticed in captivity. *C. menes* mostly selected the early second instar or the late first instar larvae of *Z. ricini* or *R. syriacus* for parasitisation, but the late second instar, prepupae, or pupae of *Z. ricini* were also rarely attacked and no parasitisation of the prepupae and pupae was noticed in *R. syriacus*. *Ceranisus menes* suddenly attacked *Z. ricini* and *R. syriacus* larvae, which remained stationary while feeding, attempting to insert its ovipositor into the abdomen of the host. If the parasite failed at the first attempt, the host larvae became active and escaped from being parasitised. The females of *C. menes* deposited a single egg inside the abdomen of the paralysed larvae. After 30–40 seconds of oviposition the host larvae slowly recovered and within 80–90 seconds became normal like any other non-parasitised larvae. The post-embryonic development was faster in *Z. ricini* than in *R. syriacus* (table 1). No variation was evident in the incubation period of *C. menes* in both larval hosts. Host mortality occurred in prepupal or pupal stage, depending upon the stage of the development of the host at the time of attack. The parasite larvae consumed the entire body contents of the larval host and pupated inside its empty shell. Adult parasites emerged from the host by breaking open the posterior abdominal segments of the late larvae or pre pupae. The sex ratio was observed to be 3 : 2.

Goetheana thripsivora, parasitizing the larvae of *Caliothrips indicus* on *Arachis hypogaea* and *Achyranthes aspera*, also selected the late first instar larvae for parasitisation and rarely attack the second instar larvae, prepupae or pupae. *G. thripsivora*, on finding a suitable larval host, pounced on it and inserted its ovipositor into the abdomen. Unlike *C.menes*, if the larval host escaped during the first attempt repeated attack on the same larvae was noticed. Once *G. thripsivora* immobilised the larval host by inserting its ovipositor, it deposited a single egg inside the abdomen of the host. After this the parasite was stationary on the leaf, awaiting a chance for the next attack. Frequent movements of the antennae and wings were evident, while *G. thripsivora* settled on the leaf. The infected larvae became immobile in 2–4 seconds, and within 20–40 seconds from the time of attack, the larval host regained its normal movements. Till the parasite eggs hatched into larvae (3–4 days after parasitisation) the latter behaved just like any other non-infested larvae. Some times the parasite made repeated attempts on the same larva and oviposited more than once inside the body of the host; only one adult parasite emerged from the parasitised host larva, and the life cycle was completed in 17–20 days (table 1). Whenever *G. thripsivora* deposited its eggs inside the host pupae, there was no hatching of the parasite before the emergence of the host adult in view of the pupal duration of the host *C. indicus* being only 1–2 days. As a result the adults of *C. indicus* which emerged normally, did not survive for more than 2–3 days after emergence. The duration of 2–3 days did not

Table 1 *Life-cycle of larval parasites*

Parasites	Thrips hosts	Duration*			
		Incubation	Larva	Pupa	Total
Ceranisus menes	*Zaniothrips ricini*	2.3 ± 1.8	3.5 ± 1.5	5.0 ± 1.2	10.8 ± 1.4
	Retithrips syriacus	2.6 ± 1.2	5.4 ± 1.4	8.3 ± 0.9	16.3 ± 0.5
Goetheana thripsivora	*Caliothrips indicus*	3.3 ± 0.7	5.8 ± 1.1	9.5 ± 0.5	18.6 ± 2.2

*In days
Value represent mean ± Standard deviation

appear sufficient for the parasite larvae to attain maturity. As a result, along with the death of the host, there was mortality of the parasite. Under normal conditions, after emergence the parasite larvae developed inside the larval host (plate 1) by consuming its body fluid and killed the larval host 1–2 days before its pupation. The pupae (plate 1) emerged slowly from the empty host shell and before emergence from the host shell, they were whitish, gradually turning brown and subsequently black. The posterior end of the pupae stuck to the leaf surface with the help of the exuvium of the dead larval host. Both sexes of *G. thripsivora* emerged from the host, the male parasites being easily identifiable by their antennal dimorphism. The sex-ratio was 4 : 1 when *G. thripsivora* first appeared in December, it was 2:1 at the time of its population reduction in the fields.

Under experimental study, the larvae were removed one by one from the culture, after they were attacked by the parasite for the first time. These larvae were reared separately, free from the parasite for 2–3 days and afterwards they were exposed to the attack of the parasite. It was observed that *G. thripsivora* laid its eggs again inside the body of these parasitised larvae. The larvae parasitised twice or thrice were removed from the glass cage and reared as a fresh culture till the emergence of the adult parasite from the host. By correlating the duration of life cycle of parasite with the time taken by the parasite to emerge from the larvae, it was found that only the eggs which were laid earlier developed into normal adults whereas the development of the other eggs was suppressed.

Polynema indica exhibited random searching during host finding. The parasite first probed the leaf surface of the host (*Achyranthes aspera* or *Arachis hypogaea*) especially with its antennae close to the venal region where the host *C. indicus* normally laid their eggs. By probing the leaf surface *P.indica* located the host eggs which were embedded inside the plant tissue. *P.indica* moved around the area where the host egg was located, for 30–45 seconds and with the help of the ovipositor assessed the suitability of the host egg for oviposition. The parasite inserted its ovipositor into a suitable host egg and laid a single egg in it. Once parasitised, the eggs were not attacked for the second time. Normally the eggs of *C. indicus* hatched after 6–8 days of incubation, whereas the eggs parasitised by *P. indica* remained unhatched till the emergence of the adult parasite (12–15 days). This revealed that the parasitisation of *P. indica* killed the host egg before eclosion. The developing parasite larva completed its life-cycle in 12–15 days, and only a single adult emerged from each host by making hole in the egg blister. The sex-ratio of *P. indica* always remained constant as 3 : 2. Unlike *C. menes*, in *Polynema indica* mating was observed frequently and lasted only a few seconds (20–30 secs). Both males and females were promiscous.

Efficiency of Parasitisation

In the laboratory each *C. menes* (reared in groups of five) laid on an average 46 ∅ 2.6 eggs per day. The active oviposition period commenced on the second or third day of adult emergence and continued till the end of its life span. In captivity the percentage of parasitisation on the hosts *Zaniothrips ricini* and *Retithrips syriacus* ranged from 75 to 80%, whereas in the field, the maximum parasitisation on *Z. ricini* (in December) was observed to be 48% and on *R. syriacus* (in March) 20%.

Goetheana thripsivora appears to be an effective larval parasite of *Caliothrips indicus*, and a single female laid an average of 78 ∅ 3.1 eggs per day. Under laboratory conditions, *G. thripsivora* parasitised 53–105 larvae in a day. Unlike *Ceranisus menes*, the adult life span of *G. thripsivora* was very short, ranging around 3–4 days. Oviposition started within 24 hours of their emergence, resulting in an active oviposition period of only 2–3 days. The percentage of *G. thripsivora* in the field was noticed during the end of December

As the host eggs (eggs of *Caliothrips indicus)* were found inside the plant tissue the egg laying capacity of *Polynema indica* was assessed based on the number of adult parasitised emerging from the host eggs. An average of 18 ∅ 3.2 adult parasites emerged from the egg mass of a single *C. indicus*. There was great variation in the percentage of parasitisation between the thrips in the crop and in the weed. The percentage of parasitisation on the weed *(Achyranthes aspera)* varied from 12 to 17 and the maximum percentage parasitisation of *P. indica* on *C. indicus* eggs in *Achyranthes aspera* was noticed during November and on the crop *Arachis hypogaea* during September. Parasitisation on the crop was upto 9%.

Interaction of the Parasites with the Thrips Population

To understand the interaction of *Ceranisus menes* with the population of *Zaniothrips ricini* and *Retithrips syriacus*, observations were made in *Ricinus communis* fields for two years (1980 & 81). *Ceranisus menes* appeared on *Ricinus*

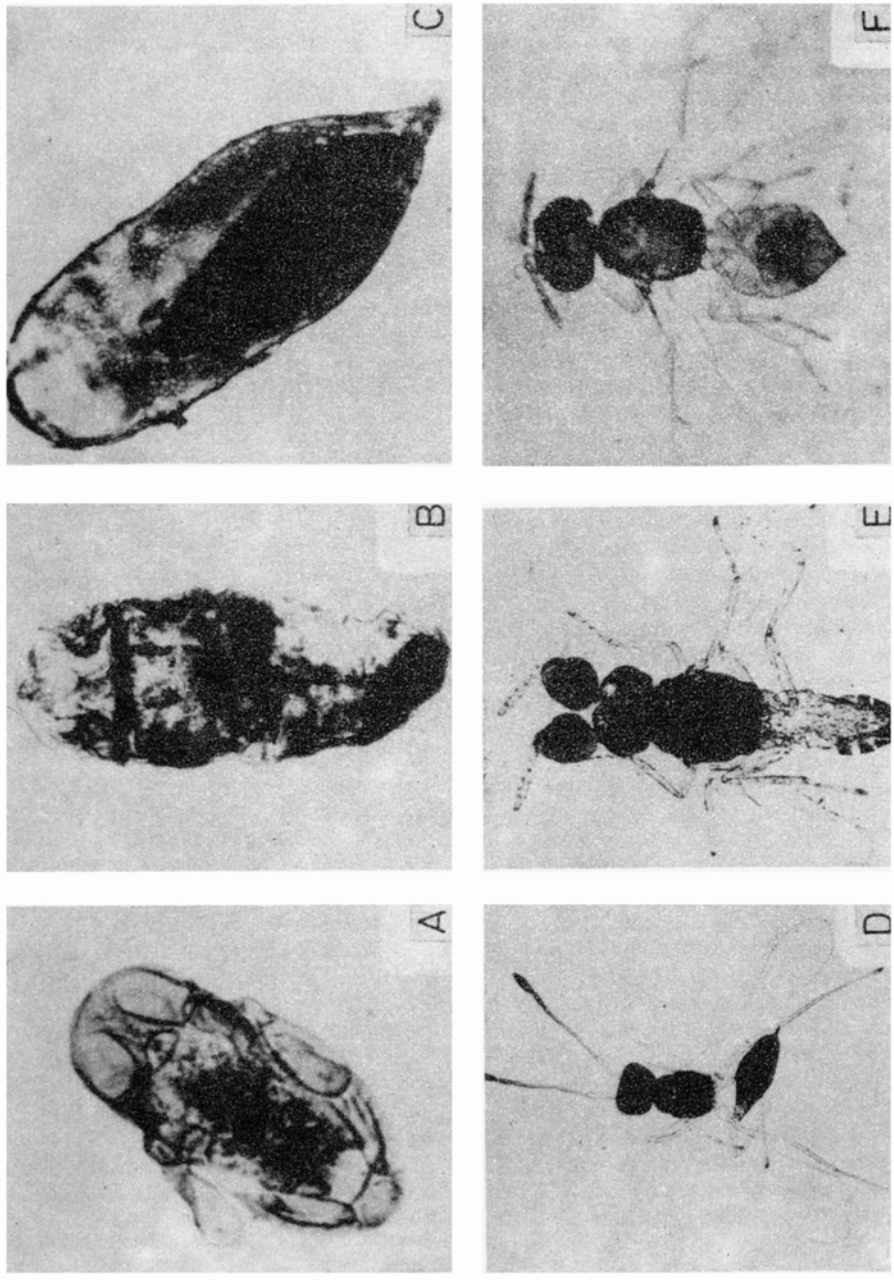

Plate I, figures A–F. **A**, Pupa of *Goetheana thripsivora*; **B**, Pupa of *G. thripsivora* emerging out from the anterior end of *Caliothrips indicus* larva; **C**, Larva of *G. thripsivora* developing inside the larva of *C. indicus*; **D**, Adult of *Polynema indica* (Female); **E**, Adult of *G. thripsivora* (Male); **F**, Adult of *Ceranisus menes* (Female)

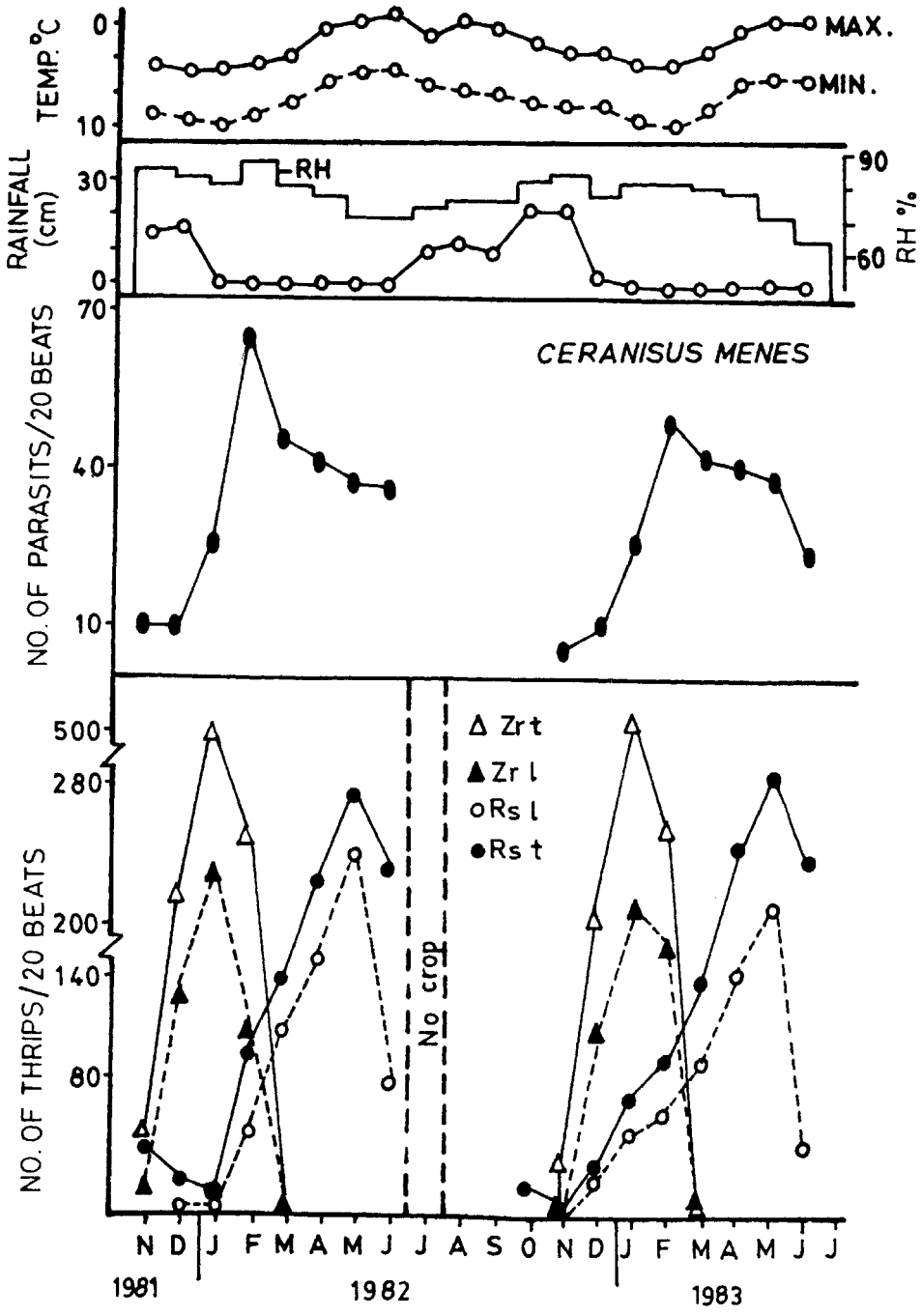

Figure 1 Population trends and host-parasite interactions of *Ceranisus menes:* **Zr.t.**, Total population of ***Zaniothrips ricini;*** **Zr.l.**, Larval population of *Zaniothrips ricini;* **Rs.t.**, Total population of *Retithrips syriacus;* **Rs.l.**, Larval population of *Retithrips syriacus*

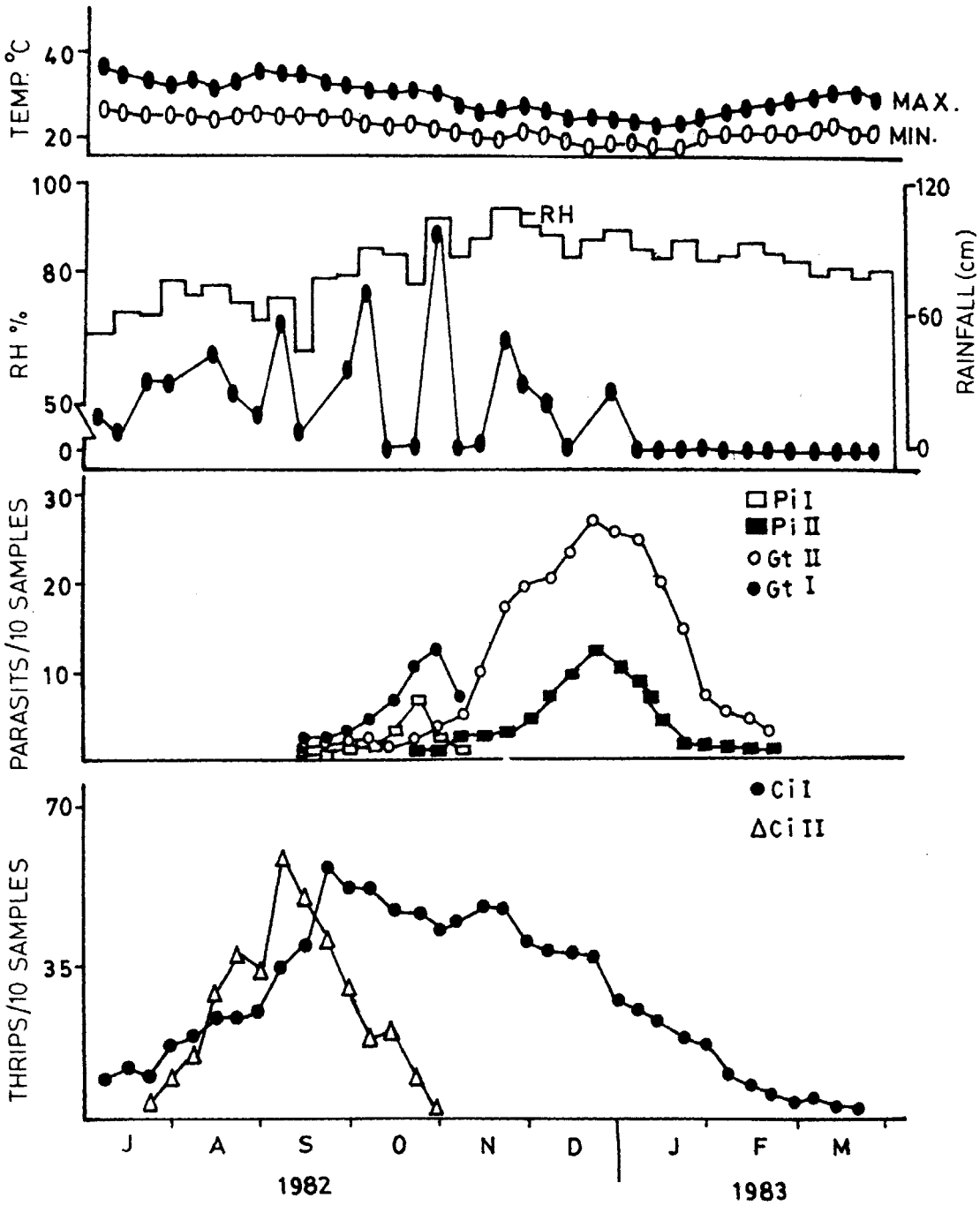

Figure 2 Population trends of the parasites and their interactions with *Caliothrips indicus*: **Pi.I.**, *Polynema indica* on *Arachis hypogaea*; **Pi.II.**, *P. indica* on *Achyranthes aspera*; **Gt.I.**, *Goetheana thripsivora* on *Arachis hypogaea*; **Gt.II.**, *G. thripsivora* on *Achyranthes aspera*; **Ci.I.**, *Caliothrips indicus* on *Achyranthus aspera*; **Ci.II.**, *C. indicus* on *Arachis hypogaea*

communis during November following the infestation of *Zaniothrips ricini* and Retithrips *syriacus*. Every year the parasite population exhibited a single peak (figure 1). During November, though a low population of *Retithrips syriacus* was noticed along with *Zaniothrips ricini*, the parasite preferred only *Z. ricini* for its attack, and only a very slight incidence (2%) was noticed on *R. syriacus*. *C. menes* attained the population peak in February, just a month after *Z. ricini* reached its maximum population in January (figure 1). From February onwards, with a gradual fall in the population, *Ceranisus menes* was found to switch over its attack to *Retithrips syriacus*. Incidentally, no population build up of *C. menes* was observed when they attacked *Retithrips syriacus*, but sustained its population on this host at a low level till June and completely disappeared from *R. communis* by early June (figure 1). With the removal of the crop from the fields. *C. menes* was also an important factor responsible for the fluctuations in *Z. ricini* population, but had no impact on the population of *R. syriacus*.

The incidence of *Goetheana thripsivora* and *Polynema indica* on *Arachis hypogaea* and *Achyranthes aspera* was highly seasonal because they occurred in 2–3 months on the crop and 5–6 months on the weed. On both the plants the larval parasite *Goetheana thripsivora* appeared by the middle of September when the population of *Caliothrips indicus* was almost at its maximum on these host plants, and reached the population peak by October on *Arachis hypogaea*, while on *Achyranthes aspera* it was attained only by the end of December. The population fluctuation of both the parasites followed a similar trend during the period of their occurrence but a slight variation in the weekly observation was noticed (figure 2). A comparative study of the incidence of *Goetheana thripsivora* and *Polynema indica* on *Arachis hypogaea* and *Achyranthes aspera* revealed that the parasites on the crop were few. A comparison of the total population revealed that the population of the larval parasite *Goetheana thripsivora* was higher than that of the egg parasite *Polynema indica*. The population fluctuations of these parasites were mainly governed by host availability. An increase in the population of the parasites resulted in a gradual decline in the population of *Caliothrips indicus* (figure 1).

Discussion

The eulophid larval parasite *C. menes* is a well known parasite of many thrips species, including *Kakothrips robustus* Uzel. *Microcephalothrips abdominalis*, *Taeniothrips alliorum* Priesner *Thrips flavus* Schrank, *Thrips tabaci* Lind. *Isoneurothrips fullawayi* Moulton (Boucek & Askew 1968), and *Kakothrips pisivorus* (Ferriere 1958). Studies presented here indicate that *Ceranisus menes* parasitises both *Z. ricini* and *R. syriacus* on the host plant *Ricinus communis* because of the simultaneous occurrence of both the species on the same plant. The infestation of *C. menes* is well pronounced *Z. ricini*, its preferred host, which is evident from the decline in population only in *Z. ricini* with the peak population of the parasite. *C. menes* is used as a biocontrol agent against *Thrips tabaci* in Japan (Sakimura 1937b), because of its high efficiency of parasitisation, reducing considerably the thrips population which gets well established during favourable seasons. The larval parasite *G. thripsivora*, along with the egg parasite *Polynema indica* appears to play an important role in bringing down the population of *Caliothrips indicus* in the crop *Arachis hypogaea* as well as in the weed *Achyranthes aspera*. Parasitisation of *G. thripsivora* is upto 92% in the fields and this results in a remarkable decline in the host population. *G. parvipennis*, a closely related species of *G. thripsivora*, was employed to control the population of another panchaetothripine species *Selenothrips rubrocinctus* in Trinidad, Puerto Rico and Jamaica, but well established its population only in Jamaica (Clausen 1978). Wolcott observed that *G. parvipennis* is of little value in the biocontrol of thrips pests, because the parasite builds up its population only during wet-weather, whereas the thrips infestation reaches its peak during the dry season of the year. But the results regarding *G. thripsivora* show that the parasite appear just two months after the pest *C. indicus* (Daniel et al. 1983) has made its appearance, following the peak population of the pest. The population of the parasite is greater on the reservoir weed *A. aspera* than on the crop *A. hypogaea* (figure 2). The pest occurs on this weed almost throughout the year, but on the crop its incidence is seasonal. Hence *G. thripsivora* has a high parasitising efficiency (92%), its seasonal appearance along with the pest species, and its high incidence on the reservoir weed (*Achyranthes aspera*), *G. thripsivora* may be helpful for the biocontrol of the groundnut pest *C. indicus*.

It appears that the host has some relation to the developmental duration of the parasite because *C. menes* develops quicker on *Z. ricini* than on *R. syriacus*. Besides the host, even the stage of

development of the same host at the time of attack also influences the developmental duration of *C. menes* (Sakimura 1937a). This parasite is also known to reproduce unisexually in Europe (Clausen 1978), but no such phenomenon is observed in the present study. Though the eulophids studied in this work are solitary internal parasites, under experimental conditions *G. thripsivora* repeatedly oviposits inside the same larva, but only a single adult parasite emerged from each of these host larvae. Williams (1916) has also reported multiple oviposition by the parasite inside the terebrantial hosts. Only one of the numerous eggs laid develops from the terebrantian host. As Askew (1971) has indicated the parasitic Hymenoptera being solitary, only one develops on every host. When more than one egg is laid by one or more female of a solitary species, all supernumereries perish. In the egg parasite *P. indica* also, only a single parasite emerges from each host egg, as in the *Megaphragma priesneri*, a parasite of *R. syriacus* (Priesner 1960).

A distinct variation in the percentage of parasitisation is noticed between captivity and in natural conditions. When compared to the laboratory studies in the fields, the rate of oviposition of the parasite is much slower. Such variation in the rate of oviposition and efficiency, can be attributed to the longer time required for the location of the hosts by the parasites in the fields. Unlike the larval parasites referred to in work the efficiency of the egg parasite *P. indica* is very low. This shows that the percentage of parasitisation also depends on the extent to which the host is exposed to the parasitic attack. It is also observed that in *T. thripophonus*, a larval parasite of the gall forming thrips, *Schedothrips orientalis*, *Arrhenothrips ramakrishnae* and *Thilakothrips babuli*, the percentage of parasitisation is low, because the region available within the gall for parasitisation of the thrips is very limited. Parasitisation of *A. ramakrishnae* is restricted to individuals found at the exposed basal parts of the leaf folds. Similarly in *T. babuli*, parasitisation is noticed only in the outer whorls of the rossette galls of *Acacia leucophloea*, because only there the parasite has a free access to the host thrips (Varadarajan 1979) Hence, variations in the percentage of parasitisation between those that prefers the eggs and those that attack the larval forms may be attributed only to the exposure and free availability of the host for parasitisation.

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References

Ananthakrishnan T N and Swaminathan S 1977 Host-parasite and host-predator interactions in the gall thrips *Schedothrips orientalis* Ananthakrishnan (Insecta: Thysanoptera); *Entomon.* **2** 247–251

Askew R R 1971 *Parasitic Insects* (London: Heinmann Educational Books), 316 pp

Boucek Z and Askew R R 1968 *Index of Entomophagous Insects* Palearctic Eulophidae (excl. Tetrastic hinae) (Hym., Chalcidoidea); (Paris: Le Franccois) 260 pp

Clausen C C 1940 *Entomophagous Insects* (New York: McGraw-Hill Book Co.) 688 pp

—— 1978 *Introduced Parasites and Predators of Arthropod Pests and Weeds* A world review U S Dept. Agr; *Agr. Handbook No. 480.* 551 pp

Daniel A M, Sureshkumar N and Bakthavatsalam N 1983 Bioecology of *Zaniothrips ricini* Bhatti (Panchaetothripinae: Terebrantia: Thysanoptera) A new thrips pest of castor *Ricinus communis* (Euphorbiaceae); *Proc. Indian Acad. Sci.* **92** 87–94

Ferriere C Un nouveau parasite de thrips en Europe centrale (Hym., Euloph); *Mitt Schweiz ent. Ges.* **31** 320–324

Lewis T 1973 *Thrips, their Biology, Ecology and Economic Importance*, (London: Academic Press) 349 pp

Preiesner H 1960 *A Monograph of the Thysanoptera of Egyptian deserts Publ. Inst. Desert. Egypte* **13** 1–549

Sakimura K 1937. On the bionomics of *Thripoctenus brui* Vuillet, a parasite of *Thrips tabaci* Lind. in Japan (I); *Kontyu.* **11** 370–390

—— 1937b On the bionomics of *Thripoctenus brui* Vuillet, a parasite of *Thrips tabaci* Lind. in Japan (II); *Kontyu* **11** 410–424

Varadarajan S 1979 Bioecological investigations on some gall-inhabiting Thysanoptera (Insecta: Arthropoda) A Ph.D. thesis submitted to the University of Madras, December 1979

—— and Ananthakrishnan T N 1981 Biological studies on some gall-thrips; *Proc. Indian natn. Sci. Acad.* **B 48** 35–43

Williams L T 1916 A new species of *Thripoctenus* (Chalcidoidea); *Psyche.* **43** 54–61