1. Uma Shaanker, R and Ganeshaiah, K N, *Curr Sci*, 1992, **63**, 732–733
2. DeBach, P and Rosen, D, *Biological Control by Natural Enemies*, Cambridge Univ Press, Cambridge, 1991, pp 440
3. Waterhouse, D F and Norris, K R, *Biological Control, Pacific Prospects*, Inkata Press, Melbourne, 1987, pp 454
4. Harris, P, *Critical Issues in Biological Control*, Intercept, Andover, 1990, pp 289–300
5. Davies, J C and Greathead, D J, *Nature*, 1967, **213**, 102–103
6. Greathead, D J, *CIBC Misc Publ*, 1973, No 6, 89–92
7. Khan, A H, *Indian J Entomol*, 1944, **6**, 149–161
8. Muniappan, R and Viraktamath, C. A, *Trop Pest Manage*, 1986, **32**, 40–42
9. Sridhar, S, *Frontline*, 1991, Nov 9–12, 100
10. Jayaraman, K. S, *Nature*, 1993, **361**, 387
11. Joshi, S, *Plant Soil*, 1991, **132**, 213–218
12. Cock, M J W and Evens, H C, *Trop Pest Manage*, 1984, **30**, 339–350.
13. Schreiner, I, *Proc Hawaii, Entomol Soc*, 1989, **29**, 57–69
14. Townes, H, *Results of an Entomological Inspection Tour of Micronesia*, U. S Commmercial Co, Economic survey, Honolulu, 1946, p 53
15. Fletcher, T B, Proc Second Entomol Meeting, Pusa, 1917, pp 38–40
16. David, B V and Kumaraswamy, T, *Elements of Economic Entomology*, Popular Book Depot, 1982, pp 536
17. Sridhar, S, *Frontline*, 1992, Feb. 28, 127
18. Konig, K, *Manual for Mass Rearing Trichogramma*, Philippine–German Biological Plant Protection Project, Philippines, 1992, pp 106
19. Hokkanan, H and Pimentel, D, *Can J Entomol*, 1984, **116**, 1109–1127
20. Beardsley, J, *Micronesica*, 1991, Suppl 3, 1–4
21. Murphy, S T, and Moore, D., *Biocontrol News Inf*, 1990, **11**, 107–117
22. Murphy, S T and Rangi, D K, *Insect Sci Appl*, 1991, **12**, 27–34
23. Ferrar, P and Lee, B, *Partners in Research for Development*, ACIAR, 1993, **6**, 22–28
24. *SPC Plant Protection News*, 1989, No 20, 6
25. Ooi, P A C, International Institute of Biological Control, Annual Rep 1992, p 48
26. Kumashiro, B R., Lai, P Y, Funasaki, G Y and Teramoto, K K, *Proc Hawaii, Entomol Soc*, 1983, **24**, 261–269
27. Nechols, J R, *Guam Agric Expt Station*, Annual Rep 1981, p 17.
28. *SPC Plant Protection News*, 1990, No 22/23, 3
29. *IOBC Newsl*, 1993, **57**, 11–12.
30. Waterhouse, D F, South Pacific Commision Information Document No 57 p 30
31. Waterhouse, D F., *The Major Arthropod Pests and Weeds of Agriculture in Southeast Asia*, ACIAR, Canberra, p 141


Received 16 July 1993, revised accepted 13 December 1993

R. MUNIAPPAN

*Agricultural Experiment Station*
*University of Guam*
*Mangilao, Guam 96923, USA*

C. A. VIRAKTAMATH

*Department of Entomology*
*University of Agricultural Sciences*
*GKVK, Bangalore 560 065, India*

# Ecological impact of insects introduced for biological control of weeds — conflicting interests

Many plants when introduced intentionally or accidentally into new areas become serious weeds. In the absence of natural enemies they multiply faster in the new environment and occur at much greater population densities than they do in their natural habitat In situations where a single alien weed dominates large areas, biological control by introduced natural enemies alone can provide an economic solution[1]. Up to 1980 there were 174 projects to control 101 species of weeds world-wide, of which 68 projects (39%) were considered successful and led to appreciable control of 48 weeds Although a large number of introductions consisting of 171 species of insects, two mites, one nematode and four fungi were made, there has been no scientific misjudgement nor alteration of insect diet[2].

The first recorded success in biological control of a weed was obtained in India when a bug *Dactylopius ceylonicus* (Green), introduced from Brazil in 1795 for production of cochineal dye, spread on *Opuntia vulgaris* and completely destroyed this cactus in central and northern parts of the country[3]. This was not a deliberate attempt as *D ceylonicus* was mistaken for the true cochineal insect *D coccus* Costa. The first major success in a biological control project was achieved during the 1930s in Australia, where 60 million acres of land were cleared of *Opuntia* spp by the insect *Cactoblastis cactorum* (Bergroth)[4] Excellent results have been achieved recently in India in biological control of the floating aquatic weeds water hyacinth (*Eichhornia crassipes*)[5] and the water fern (*Salvinia molesta*)[6].

The crucial point in a programme for the biological control of a weed is to determine whether a candidate agent can be introduced to control a weed without the danger that it may also damage desirable plants One of the apparent shortcomings of biological control of weeds is that the outcome of its action cannot be predicted in advance. Therefore, most countries including India require that potential biocontrol agents are screened to determine beyond all reasonable doubt, that they will not damage any desirable plant, after release in the area where control of the target weed is required

The currently employed procedures in host specificity determination of exotic biological control agents of weeds' have evolved over a period of 75 years based on experience gained during the execution of various biological control programmes worldwide A series of eight international symposia on biological control of weeds, starting from 1969 provided further opportunities for dis-

# Report of the Fact Finding Committee meeting on parthenium

The second meeting of the Fact Finding Committee on Parthenium constituted by the Indian Council of Agricultural Research, New Delhi, was held in the Project Directorate of Biological Control, Bangalore from 7 to 9 October 1993. The following members participated in the discussion:

1. Dr V. M. Bhan (Director, NRC on Weed Control, Jabalpur), Chairman; 2. Dr S. P. Singh (Project Co-ordinator, Project Directorate of Biological Control, Bangalore), Member; 3. Dr C. A. Viraktamath (Professor of Entomology, UAS, GKVK, Bangalore), Member; 4. Dr T. Sankaran (Retired Entomologist, 193, Ganganahalli Extension, Bangalore), Member; 5. Dr G. C. Tewari (Principal Scientist, Entomology, ICAR, New Delhi), Member; 6. Dr K. P. Jayanth (Sr. Scientist, Entomology, IIHR, Bangalore), Member; 7. Dr K. Virupakshappa (Project Co-ordinator, Sunflower, UAS, GKVK, Bangalore), Member.

## Background

The members of the committee discussed the various issues related to the controversy raised regarding the feeding of *Zygogramma bicolorata* on sunflower. The present meeting was held to review the action taken on the decisions taken in the first meeting on 21.11.92 and also the present status.

## Review of the action taken on information generated and made available as per decisions taken at the first meeting

*Host-specificity (screening of sunflower varieties)*

At the Indian Institute of Horticultural Research, when 19 different varieties of sunflower were raised in a glasshouse and tested in the laboratory, adults were found to starve to death in 7–15 days without feeding. However, when the same varieties were grown in the open from May 1992 and tested in the laboratory, feeding was noticed after 4–7 days of starvation.

Further studies showed that adults that had fed on sunflower failed to lay eggs, even when feeding was noticed continuously in laboratory cages. When adults that had fed on parthenium were directly released on sunflower, oviposition was observed for two days. But the maximum number of eggs was found to be laid on the first day.

However, no further egg laying was noticed at all. They resumed oviposition only after feeding on the natural host for a period of 7–10 days. Larvae that hatched from eggs laid on sunflower failed to feed and died by the second day.

There was no significant feeding difference between the cultivars, which proves that the beetle did not show any preference to a particular cultivar.

When 500 marked adults were released at the rate of 15–20 adults per row (30–35 adults/variety) it was observed that 91.2% of the adults moved away within one day. Only 0.8% of them remained on the crop by the 4th day, 0.4% by the 5th and none by the 7th. These studies showed that adults of *Z. bicolorata* did not migrate as long as parthenium leaves were available for feeding.

As the weed started getting defoliated, a few stray adults were seen to alight on sunflower during the 4th and 5th weeks. The number of adults that alighted on sunflower was negligible, considering the fact that a peak population of about 3.34–4.32 million adults was estimated to be present in the vicinity and also that they had started migrating after defoliating the weed. During this period adults could be collected on the crops such as mango, guava, ber, fig, jasmine, patchouli and china aster. They could also be seen on the following weeds, viz. *Acanthospermum hispidum*, *Amaranthus spinosus*, *Cynodon dactylon*, *Euphorbia geniculata*, *E. hirta* and *Lagasca mollis*. Among these, slight feeding was noticed only on *A. hispidum* and *L. mollis*.

Feeding was not noticed on most of the plants on which adults were present, although up to 11 adults could be counted on some. The few eggs that were laid were noticed to hatch but the larvae failed to feed or develop.

It is clear from the present studies that *Z. bicolorata* is not attracted to sunflower and that their presence is due to chance alighting. The slight feeding noticed on sunflower could be due to overpopulation, presence of parthenium pollen on sunflower plants and starvation following sudden destruction of the weed.

Feeding was found to be restricted to a few border row plants adjacent to parthenium stands. In other parts of the field no feeding was noticed even though adults were noticed to be present.

The committee took note of the fact that a residual non-diapausing adult population of *Z. bicolorata* is reported to be present even during the rabi season when parthenium plants are not abundant and that *Z. bicolorata* does not do any damage to rabi sunflower.

## Species identification

The material submitted to Smithsonian Institution in the USA is still under examination by specialists. They are being reminded to send their report at an early date. However, A. S. McClay, Research Scientist, Pest Management, Alberta Environmental Centre, Alberta

Canada, has confirmed in personal correspondence with ICAR scientists that he has compared specimens of *Z. bicolorata* with the holotype of this species in the American Museum of Natural History, New York, and also that this conclusion was confirmed by the USDA Systematic Entomology Laboratory.

## Phagostimulant and antifeedant studies

Adults of *Z. bicolorata* could be induced to feed on tender leaves of sunflower, within 6 hours, by smearing a 50% crude aqueous extract of parthenium leaves. No feeding was noticed on untreated leaves during this period.

Cochromatography of authentic samples of parthenin with the aqueous methanol fraction from parthenium and sunflower failed to detect the presence of this chemical in sunflower. However, smearing of the aqueous methanol fraction from sunflower on parthenium leaves was found to prevent feeding by *Z. bicolorata* adults for 48 hours, after which it resumed, indicating the presence of a mild antifeedant.

It is already known that pollen grains of parthenium contain parthenin and also that wind-borne parthenium pollen in enormous quantities settle on leaves of adjacent plants. Therefore, tests were carried out by collecting fresh parthenium pollen and smearing the same on sunflower leaves. Such leaves were accepted for feeding within six hours compared to 3–7 days for non-smeared leaves. Laboratory observations also revealed that starved adults of *Z. bicolorata* do feed on anthers of parthenium flowers. The present studies clearly establish that the sesqueterpene lactone parthenin, an allelochemical specific to *P. hysterophorus*, acts as a phagostimulant for *Z. bicolorata*.

## Current status

The PC-AICRP (Sunflower), Department of Entomology UAS, PD-BC and IIHR monitored the field situation of *Z. bicolorata* on parthenium, sunflower and other plants. The monitoring of *Z. bicolorata* on sunflower was also carried out at other AICRP Centres on Biocontrol. There was no report of feeding by *Z. bicolorata* on sunflower although all stages of the beetle were abundant on parthenium.

The committee also visited sunflower fields at four locations in Bangalore and Kolar districts on 7 and 8 October 1993. The beetles were abundantly present on parthenium. Stray presence of adults was also noticed on sunflower and other non-host plants in close proximity of parthenium. In no case any feeding was observed on sunflower plants. Some of the farmers in these areas were contacted and they also confirmed that *Z. bicolorata* was never seen by them to do any damage to sunflower crop throughout the season.

## Future programme

Regular monitoring of *Z. bicolorata* activity on sunflower needs to be done by PD-BC, IIHR, PC-Sunflower and Department of Entomology UAS, Bangalore. Feeding incidence, if any, should immediately be reported to the Fact Finding Committee.

Biological activities of chemical constituents such as phagostimulant and antifeedant present in parthenium and sunflower on *Z. bicolorata* needs to be studied thoroughly by IIHR. ICAR may provide extra financial support, considering the urgency and importance of the problem.

## Conclusions

In spite of the abundance of *Z. bicolorata* beetles on parthenium in close proximity to sunflower fields and the presence of few adults beetles on sunflower plants, there has been no feeding on sunflower crop anywhere in Karnataka, Maharashtra, Tamil Nadu, Andhra Pradesh and Kerala.

- Based on the above facts the Fact Finding Committee does not foresee any threat to sunflower crop by *Z. bicolorata*.
- Critical monitoring of *Z. bicolorata* has to be continued.
- The situation needs to be reviewed by the Fact Finding Committee in next kharif season somewhere in August–September 1994.

cussion at the international level for refining the procedures. Nevertheless, biological control workers are constantly trying to improve the quality of screening tests[8]. Although the risk of host transference has been discussed and discounted repeatedly it still remains a live issue[9].

The recently reported feeding by the Mexican beetle *Zygogramma bicolorata* Pallister, introduced for biological control of the noxious weed *Parthenium hysterophorus* on another weed *Xanthium strumarium* and also on sunflower (*Helianthus annuus*) were considered as pointers towards an expanding host range[10]. This has resulted in reviving apprehensions on the ecological impact of introduced biological weed control agents[11]. On the contrary biological control workers hold the view that the aberrant feeding behaviour does not indicate possibility of host transference and also that such fears are not based on sound knowledge about the mechanism of host-plant selection in insects or the principles and procedures of biological control of weeds. Nevertheless, conflicts of this nature if not resolved quickly, are likely to prove an insurmountable barrier to the further development of the science of biological control of weeds. Such conflicts can only be resolved based on information generated on the mechanism of host-plant selection of the control agent as also the ecology and economics of the target weed.

Only host-specific natural enemies obtained from the native home of the target weed are utilized for biological control of weeds. Specificity is controlled by a series of behavioural and physiological reactions to stimuli originating from the host plant. The insects respond to these stimuli through various types of sensory structures that have co-evolved in the long association and constant interaction between the insect, the host plant and its habitat[12]. It was suggested by Frankael[13] that since basic nutritional requirements of most insects are similar, food selection and specificity must be determined almost entirely by non-nutritional factors. In some insects a series of stimulatory, inhibitory and deterrent substances control host range via characteristic behaviour patterns. In some it is largely determined by the presence of one or more secondary plant products, which act as phagostimulants, such as mustard oil glucosides in the case of *Pieris* sp. and hypericin for *Chrysolina brunsvicensis* (Gravenhorst). In others tactile reactions are important, as that towards spines on thistles stimulating oviposition in trypetid flies[14]. In most insects specificity is determined by the improbability that other plants will have the same pattern and concentration of constituents, especially certain amino acids, sugars, enzymes, plant hormones and secondary plant substances[15].

Host transference involves acquisition by the insect of the ability to survive on a new host[16]. But feeding on unusual or nonhosts may occur for various reasons besides host transference. During laboratory screening tests, under artificial conditions, the potential biological control agents may accept a broader range of plants than in nature. For example, the lantana bug *Teleonemia scrupulosa* Stal fed and reproduced to a limited extent on teak (*Tectona grandis*) during laboratory screening in India. But the lantana bug has not become a pest of teak, although it has coexisted with this plant at least since 1951 (ref. 12). A perusal of the host-specificity test reports of insects which brought about successful biological control of weeds will reveal that the majority of them had fed on unnatural hosts under laboratory conditions, without becoming pests of these plants after field releases.

However, it is difficult to demonstrate that an insect species which is currently host-specific will continue to remain so in the future. An insect's host range can be assumed to be the result of selection to maximize the production of offspring. The extension of host range will theoretically be favoured increasingly by an insect's inability to find or survive on its present host[16]. Host transference would thus be correlated with a number of factors including the disappearance of the original host, introduction into a new environment where the original host does not occur, confrontation with a large population of plants hitherto lacking in the insect's environment or presence of ecologically homologous competitors.

Although host transference has not occurred among insects used for biological control of weeds, there have been reports of local and temporary damage to non-host plants. These are the result of overpopulation and starvation following sudden destruction of the weed. Under these circumstances the insect may feed on adjacent non-host plants if they do not contain deterrants. Feeding by *T. scrupulosa* on *Sesamum indicum* in Uganda[17] and *C. cactorum* on tomato in Australia[18] are two such examples. But it is heartening to note that these insects did not become pests of the crops mentioned.

In situations where an introduced weed control agent temporarily damages a beneficial plant it may be desirable to take a closer look at the cost/benefit considerations of the importance of the weed versus possible crop damage. For example, the ecological and economic impact of *P. hysterophorus*, which has spread throughout India, are enormous. It has been established that the weed affects agriculture, human health and livestock production[19]. But the threat to natural diversity due to uncontrolled weed growth, which can lead to extinction of native vegetation, has not been fully appreciated. Since other methods of control are neither economical nor offer long term solutions to the problems posed by the weed, biological control by host-specific natural enemies remains the only viable alternative.

*Z. bicolorata* has already spread over 50,000 km$^2$ area in Karnataka, Tamil Nadu and Andhra Pradesh, causing large scale defoliation of the weed. This has resulted in reduced flower production by *P. hysterophorus* and an increase in the growth of local vegetation[20]. But the insect was noticed to feed on some sunflower plants in a few isolated plots, after defoliating parthenium in nearby areas. As *Z. bicolorata* was found incapable of completing development or reproducing on sunflower, the aberrent feeding behaviour may be a temporary phenomenon, as discussed earlier. Hopefully once parthenium density reduces, the insect population will decline and there may be no further attacks on sunflower.

The principles and procedures of biological control of weeds are well established and this technique has repeatedly proven its effectiveness and safety. Many of our problem weeds are of exotic origin and biological control has an important role to play in their suppression. Nevertheless we should be ever vigilant about the adverse ecological impact of introduced biological control agents of weeds. Conflicts of interest problems are valuable in that they force us to reexamine our judgement processes, point out gaps in our information and on the whole caution us against lowering our guard. It is also important that such conflicts are resolved, which entails improved communication between the concerned specialists and appreciation of each others points of view.

1. Andres, L. A., *Integrated Control of Weeds* (eds Fryer, J. D. and Matsunaka, S.), Univ. of Tokyo Press, Tokyo, 1977, pp. 153–176.
2. Julien, M. H., Kerr, J. D. and Chan, R. R., *Prot. Ecol.*, 1984, 7, 3–25.
3. Julien, M. H., *Biological Control of Weeds. A world catalogue of agents and their target weeds*, CAB International, UK, 1992, pp. 186.
4. DeBach, P., *Biological Control of Insect Pests and Weeds*, Chapman & Hall Ltd., London, 1964, pp. 844.
5. Jayanth, K. P., *Biological Control of Water Hyacinth in India*, Tech. Bull. 3, IIHR, Bangalore, 1987, pp. 28.
6. Joy, P. J., Sathesan, N. V., Lyla, K. R., Joseph, D., Proc. 10th Conf. Asian Pacific Weed Sci. Soc., Chiangmai, 1985, pp. 622–626.
7. Anonymous, *Screening Organisms for Biological Control of Weeds*, CAB International, UK, 1986, pp. 6.
8. Dunn, P., Proc. IV International Symp. Biol. Control Weeds, Univ. Florida, 1976, pp. 51–56.
9. Howarth, F. G., *Annu. Rev. Entomol.*, 1991, 36, 485–509.
10. Kumar, A. R. V., *Curr. Sci.*, 1992, 63, 729–730.

11 Uma Shaanker, R and Ganeshaiah, K N, *Curr Sci*, 1992, **63**, 732–734
12 Sankaran, T, *Proc Indian Acad Sci (Anim Sci)*, 1990, **99**, 225–232
13 Frankael, G S, *Science*, 1959, **129**, 1466–1470
14 Wapshere, A J, *Ann Appl Biol*, 1974, **77**, 201–211
15 Beck, S D, *Annu Rev Entomol*, 1965, **10**, 207–232.
16 Zwolfer, H and Harris, P, *Annu Rev Entomol*, 1971, **16**, 159–178
17 Greathead, D J, Proc III International Symp Biol Control Weeds, 1971, pp 89–94
18 Williams, J R, *Report VI Commonw Entomol. Conf*, CIE, London, 1954, pp 85–98
19 Towers, G H N., Mitchell, J C, Rodriguez, E, Bennett, F D and Subba Rao, P V, *J Sci. Ind Res*, 1977, **12**, 672–684.
20 Jayanth, K. P, Bioecological and physiological studies on the insect *Zygogramma bicolorata* P. and evaluation of its potential in controlling the weed *Parthenium hysterophorus* L, PhD Thesis submitted to Bangalore University, 1991


ACKNOWLEDGEMENT I thank Dr R M Pandey, Director, IIHR for support

Received 20 March 1993, accepted 23 November 1993

K P. JAYANTH

*Division of Entomology and Nematology*
*Indian Institute of Horticultural Research*
*Hessaraghatta Lake Post*
*Bangalore 560 089, India*

# An 'elusive' leaf beetle from Mexico

*[Kumar, A. R. V., Curr. Sci., 1992, 63, 729–739]*

'Mexican beetle' is not an internationally established name for the beetle introduced into India from Mexico for suppressing *Parthenium hysterophorus* L. (personal communication, Editor-in-Chief, *Agriculture, Ecosystem and Environment*, 1992). Another leaf beetle, *Epilachna varivestis* Muls is commonly called Mexican bean beetle[1]. None of the workers abroad have labelled *Zygogramma* as 'Mexican beetle'. We are not sure if this is the only beetle introduced into India and other countries from Mexico. We suggest that use of 'Mexican beetle' for *Zygogramma* would be a cause for confusion.

When *Zygogramma* beetles collected on *Parthenium* during 1992 from three different districts in Karnataka, South India, were sent to CAB International Institute of Entomology, London, UK, and to the selected three Entomologists in the USA, the beetles were identified as *Zygogramma conjuncta* (Rogers) by the CAB and one entomologist from USA. The other two entomologists were unable to identify the beetle To be sure of the identity of the beetles, further correspondence confirmed that indeed the species is *Z conjuncta* So *Zygogramma bicolorata* Pallister was not the species introduced into India[2] in 1984 and into Australia[3] in 1980 for suppressing *P. hysterophorus* (personal communication, International Institute of Entomology, UK, 1992). *Z. conjuncta* was first described by Rogers in 1856 from Kansas[4]. Later in 1953, Pallister[5] collected and described this species from Mexico while on a David Rockfeller Mexican Expedition of American Museum of National History. *Z conjuncta* is a species different from *Z. bicolorata* and only the experts (beetle taxonomists) can reveal reason for the change of the species.

As *Z conjuncta* is found feeding on *Xanthium*[6] which belongs to the same family as the host plant in India – *Parthenium*, *Xanthium* might well be within the host range of the beetle. The information serving as a basis for feeding is already stored within the central nervous system and is within the innate host range of the insect[7]. Jermy *et al*[8] outlined conditions under which a modification of feeding behaviour may occur. Thus, 'expanding its host range'[6] is inappropriate. Kumar[6] indicates that the beetle was mass-released in Karnataka In fact, the beetle was released at a site in Bangalore[2]. Kumar[6] indicates that the beetle feeding on sunflower was 'strongly contested', citing two references, one of Jayanth and the other of Pandey. The contests were made largely based on the literature published in the past and not based on pertinent experimental data. Also Sridhar[9] replied to the queries raised by Pandey. We expressed our views based on experimental data and field observations and did also circulate a note (mimeographed) indicating that the beetle is indeed 'a pest' on sunflower in the meeting (cited by Kumar on 12 February 1992). The author may also recollect a sequence of colour photographs showing rate of defoliation by the beetle at 24-h intervals on 'Morden' cultivar of sunflower under confined conditions, circulated at the same meeting. Therefore, Director-General, Indian Council of Agricultural Research, New Delhi, constituted a 'Fact-finding Committee'. The Committee after conducting surveys and investigations found the beetle feeding on all the 28 genotypes of sunflower As a result, the Government of India stopped mass multiplication and all releases of the beetle throughout the country[10, 11].

Host specificity tests conducted by authors cited under refs 4, 8, 9 and 10 of ref. 6 on five species of *Zygogramma* pertain to only before or at initial stage of release. Specificity for feeding by an insect depends on a number of factors[12] and it is crucially important to conduct proper feeding tests for achieving meaningful results. Feeding tests using cuttwigs yield erroneous results It is a pre-requisite to starve the beetles before initiating feeding tests. It is also always rather essential to mention at least briefly the conditions under which the feeding tests were conducted. It is better to express the amount of food fed by an insect for a period than on a day basis to account for the damage on the crop-plant. Also in *Z conjuncta*, feeding is discontinuous[13]. Migration implies a two-directional movement What Kumar[6] has observed is probably immigration or orientation (short distance)