

NATURAL ENEMIES ASSOCIATED WITH HIGH ALTITUDE FOREST WEEDS IN PAKISTAN WITH NOTES ON ECOLOGY AND BIOLOGY OF IMPORTANT SPECIES

G. M. Baloch*, M. I. Arif** and M. Irshad***

Abstract

Natural enemies, such as insects and diseases, infesting *Lonicera* spp., *Ribes* spp. and *Pueraria tuberosa* (high altitude forest weeds) were investigated throughout Pakistan. As a result of this, 20 species of insects and a disease of *Lonicera* spp., 12 species of insects on *Ribes* spp. and 8 species of insects on *P. tuberosa* were recorded. Among these, 6 insects (*Ahucita spilotodesma* Meyr., *Psychromnes straphaeothicta* Meyr., *Phyllonorycter montanella* Bradley, *Caloptilia deltosticta* Meyr., *Paraphytomyza* sp. and *Hyadaphis* sp.) and the disease caused by *Lasiobotrys lonicerae* Fr.) Kunze attacking *Lonicera* spp.; 3 insects (*Nematus ribesii* (Scop.), *Zelleria ribesiella* Joanis and *Anthaxia* sp.) damaging *Ribes* sp.; and only one insect (*Callosobruchus* sp.) destroying seeds of *P. tuberosa* caused appreciable damage to their host weeds. Investigations on the biology, ecology, and nature of damage of these promising enemies were carried out.

Introduction

Many species of plants belonging to the genera *Lonicera*, *Ribes* and *Pueraria* are forest undergrowth weeds which overwhelm and strangle other desirable forest vegetation and also act as reservoirs for a number of insects which are either serious pests or vectors of plant diseases. One well-known example of a weed acting as an obligatory alternate host for a vector is that of *Ribes* sp. for white pine-blister rust caused by *Conartium ribicola* Fischer (Helgeson, 1957).

There are three species of *Lonicera* (*Webbiana* Wall. ex D.C. in the Murree Hills, *hypoleuca* DC. in Ziarat, and *quinquelocularis* Hardw. in the Murree Hills, Swat, Ziarat and Kashmir); three species of *Ribes* (*aureum* Pursh in Swat, *himalense* Royle in the Murree Hills, and *orientale* Desf. in the Kaghan, Ziarat and Swat); and only one of *Pueraria tuberosa* (Roxb. ex Wild.) DC. in the karot forest) that occur in Pakistan.

Investigations on the insect enemies and diseases of the weeds belonging to these three genera were carried out from 1973 to 1976. The natural enemies recorded from each of these and some studies on ecology and biology of the apparently promising species are reported in this paper.

*Professor, Department of Plant Protection, Sind Agriculture University, Tandojam.

**Pakistan Central Cotton Research Institute, Multan.

***Pakistan Agricultural Research Council, Islamabad.

Results of Investigations

(I) *Lonicera* spp.

Natural enemies recorded:

These consisted of 20 insects and a disease. The insects recorded were: *Apion* sp. (Col.: Curculionidae); *Melanotus* sp. (Col.: Elateridae); *Lytta flavipennis* (Mots.) and *Mylabris macilentata* Mars. (Col.: Meloidae); *Epurea* sp. (Col.: Nitidulidae); *Hyadaphis* sp. (Hem.: Aphididae); *Adelphocoris* sp. (Hem.: Miridae); *Nezara viridula* L., *Dolycoris indicus* Stall. and *Halys dentatus* F. (Hem.: Pentatomidae); *Hemistola loxiaria* G. (Lep.: Geometridae); *Caloptilia deltosticta* Meyr. (Lep.: Gracilariidae); *Cnephonodes hylas* L. (Lep.: Sphingidae); *Archips* sp. (Lep.: Tortricidae); and *Psychromnestra phaeothicta* Meyr. (Lep.: Yponomeutidae) feeding on leaves; *Paraphytomyza* sp. and *Phytomyza* sp. (Dip.: Agromyzidae); and *Phyllonorycter montanella* Bradley (Lep.: Gracilariidae) mining leaves; *Bradysia* sp. (Dip.: Sciaridae) forming stem-galls; and *Alucita spilodesma* Meyr. (Lep.: Alucitidae) boring stems. The disease, which was very serious and killed many plants of *Lonicera quinquelocularis* during July-August, was caused by the fungal organism *Lasiobotrys lonicerae* (Fr.) Kunze (Paeodosphaeriales).

Most of the insects recorded are either general feeders or known pests of unknown status as they have been determined up to the generic level only. However, since *Alucita spilodesma*, *Psychromnestra phaeothicta*, *Caloptilia deltosticta*, *Phyllonorycter montanella*, *Paraphytomyza* sp. and *Hyadaphis* sp. appeared to be stenophagous and apparently promising enemies, their biology and ecology were studied.

Studies on important species:

1. *Alucita spilodesma* Meyr. (Lep.: Alucitidae)

This stem-borer of *L. quinquelocularis* also occurs in India where it damages leaves of a *Lonicera* sp. (J.D. Bradley, 1975; C.I.E., BM (NH), London; pers. commun.). In Pakistan, although three species of *Lonicera* are found, it bored stems of only *L. quinquelocularis* in Swat, the Murree Hills and Ziarat. Up to 9 larvae were recorded in a branch at Ziarat. Larval populations were higher in shady places and the larvae usually travelled upwards from the entry points consuming approximately 3 inches of the pith per larvae during their feeding period. Larvae were mostly found in newly sprouted side-branches. The minute entrance holes were the only externally visible signs of the presence of larvae in stems. The full-grown larvae cuts a hole in the stem before pupation for the exit of the adult. About 50-60% branches of the weed contained *A. spilodesma* larvae during the peak infestation period (May-June). However, attacked plants did not appear to suffer any visible set-back.

In nature, young larvae appeared in the third week of April and pupation started from mid-July. Adult emergence started from the 2nd week of August and continued up to the 2nd

week of September. Eggs laid in September remained in diapause till late-March next year. It is univoltine.

Moths, when released on host-twigs in jars containing water, mated at night and oviposition commenced two days later. A female laid a maximum of 40 (mean 23) eggs in her life-span of 10 days.

Although no parasites emerged from the 550 larvae and pupae collected from the field, pupae of 2 species, *Scambus lucidus* Gupta & Tikar and *S. Lineipes* (Morely) – Ichneumonidae, were recovered from feeding tunnels possibly of *A. spilodesma*.

2. *Psychromnestra phaeothicta* Meyr. (Lep.: Yponomeutidae)

It damaged about 80% of the leaf-buds in April in the Murree Hills and in May at Kalam (Swat). The immature stages could not be found in the field after April in the Murree Hills though adults were occasionally found even up to mid-June. This species was hitherto known from a solitary female specimen collected in 1923 from India at an altitude of 8130 m. (R.G. Fennah, 1974, C.I.E., BM (NH), London, pers. commun.)

In the laboratory, mating took place in the early morning hours a day after emergence and oviposition commenced 2-4 days after mating. The number of eggs laid per female varied from 50 to 104. However, although eggs were apparently fertile (from mated females), these failed to hatch. Thus, it seems that *P. phaeothicta* is univoltine, going in diapause in the egg-stage when the requisite food is no longer available in the field after April. Field-collected larvae pupated in silken cocoons on either side of leaves and the mean pupal period at 20 + 1°C lasted for 14 days.

Three species of parasites (*Nythobia* sp., *S. lucidus*-Ichneumonidae, and *Apanteles* sp.-Braconidae) killed up to 20% of the larvae in April.

3. *Phyllonorycter montanella* Bradley (Lep.: Gracilariidae)

This leaf-miner is the first record from *L. quinquelocularis* from Murree Hills. According to Bradley (1980), its distribution may be wider as its host also occurs in Afghanistan, Kashmir and the Himalayas to Bhutan and western-central China. Bradley (loc. cit.) states that: "This species is closely related to the *Lonicera* feeders *P. trifasciella* (Haworth) and *P. emberizaepenella* (Bouche), both of which are widely distributed in the western part of the Palaearctic Region and have larvae which mine on the underside of the leaves of *Lonicera xylosteum* and *L. periclymenum*."

P. montanella occurred in very low numbers from late May to late June, was absent in July-August, appeared again in September-October mostly as larvae. Its incidence was compara-

tively higher during November and consisted mainly of pupae. During December the entire population was of pupae. Thus, it seems that *P. montanella* associated with *L. quinquelocularis* in the Murree Hills is adapted to cooler climated and hibernation possibly takes place in the pupal stage. There are apparently two generations in a year. It preferred mature leaves. The mines were of blotch type on the underside of leaves and there was one larvae per mine and one mine per leaf.

4. *Paraphytomyza* sp. (Dip.: Agromyzidae)

Paraphytomyza sp. larvae were present in leaf-mines in very small numbers during mid-April to June, no stage occurred in July-August, both larvae and pupae were present in September and again the larval stage only during October to November. It was more abundant in October-November and overwintered as full-grown larvae.

The number of larvae per leaf was usually 2 to 3 but occasionally as many as 9 were also observed. When full-grown, larvae came out of the mines and dropped to the ground to pupate in the soil. It has apparently two generations per year in the Murree Hills and the larvae of the 2nd generation hibernate till the next active season.

Diglyphus ?minoeus (Walker)-Eulophidae, was reared from pupae formed from field-collected larvae. However, the incidence of parasitism was low.

5. *Caloptilia deltosticta* Meyr. (Lep.: Gracilariidae)

Its larvae rolled the leaves of *L. quinquelocularis* in the Murree Hills. *C. deltosticta* was available only as larvae from late June while both larvae and pupae were present during late July to early August. Larvae reappeared in September and continued to feed till December.

This insect starts rolling leaves from tip to the base on the upper side of leaves. A larvae may damage more than one leaf. Pupation takes place inside the rolled-up leaves. There are two generations in a year and full-grown larvae of the 2nd generation go into hibernation from mid-November.

Three unidentified species of Hymenoptera parasitised 20-50% larvae during the season.

6. *Hyadaphis* sp. (Hem.: Aphididae)

This aphid attacked both *L. quinquelocularis* and *L. webbiana* but caused more damage to the latter. Infested leaves curled upwards and ultimately dried up. None of the other vegetation in and around infested *L. webbiana* was attacked by this aphid. It may well be restricted to the genus *Lonicera*.

(II) *Ribes* spp.*Natural enemies recorded:*

The natural enemies associated with *Ribes* sp. in Pakistan comprised of 12 insects such as: *Apion* sp. (Col.: Curculionidae); *Flata ferrugata* F. (Hem.: Flatidae); *Deraeocoris* sp. and *Orthops* sp. (Hem.: Miridae); *Dolycoris indicus* Stall. (Hem.: Pentatomidae); *Nematus ribesii* (Scop.) (Hym.: Tenthredinidae); *Heliothis armigera* (HB.) (Lep.: Noctuidae); *Vanessa xanthomachus* Denis (Lep.: Nymphalidae); *Archips* sp. and *Archips micaceana* Wlk. (Lep.: Tortricidae); and *Zelleria ribesiella* Joanis (Lep.: Yponomeutidae) feeding on leaves; and *Anthaxia* sp. (Col.: Buprestidae) boring stems. Among these insects, the stem-borer *Anthaxia* sp. and the defoliators *Nematus ribesii* and *Zelleria ribesiella* appeared to be restricted feeders and, therefore, further studies were conducted on them.

Studies on important species:

1. *Nematus ribesii* (Scop.)
Hym.: Tenthredinidae)

According to D.R. Smith of the U.S.N.M., Washington (Pers. commun., 1974), this species is common on *Ribes* in Europe and North America. Literature records also mention *Ribes* spp. as the only host plant for *N. ribesii* in the USA (Walden, 1973), the USSR (Korolkov, 1913), UK and Canada (Miles, 1932).

A fairly good account of the biology of *N. ribesii* (*Pteronius ribesii*) in Europe (Miles, 1932) and the USA (Walden, 1933) has been given. In Pakistan, young larvae were first observed feeding on leaves during mid-May and again in mid-July. Towards the end of August, eggs and young larvae were seen on the leaves while in September only larvae in late instars were present. Thus, it appears that *N. ribesii* has three generations in the Murree Hills and overwintering takes place either as full-grown larvae or as pupae in the soil.

In the laboratory ($22 \pm 2^{\circ}\text{C}$), mating took place during day time soon after emergence. Oviposition commenced 2 to 4 days after mating and eggs were usually deposited in rows on the lower side of leaf-veins (up to 40 eggs on a leaf). Eggs hatched in 4 days and young larvae fed mainly on edges of leaves. The five larval-instar stages together lasted for 11 to 13 (mean 11.5) days. Pupation occurred in soil and pre-pupal and pupal stages together occupied 13 to 15 (mean 14) days. Females lived for 3 to 7 (mean 5) days and laid 50 eggs.

2. *Zelleria ribesiella* Joanis
Lep.: Yponomeutidae)

Larvae of this moth fed on leaves of *R. himalense* in the Murree Hills during mid-May to mid-June and again from August to mid-September after which no stage was found in the field. It also attacked *R. orientale* at Ziarat during June-August. Larvae collected from the

field during September pupated in the laboratory but no adults emerged. Thus, it seems that in this species overwintering takes place as pupae.

Young larvae feed mainly near the leaf-veins and are covered by a whitish silken web. As they grow in size, they feed on all parts of the leaf and, when mature, pupate inside the webs on leaves, etc. Pupal period at $22 \pm 1.6^{\circ}\text{C}$ lasted 15 to 16 days and at $19.6 \pm 1.6^{\circ}\text{C}$ from 15 to 19 days at Ziarat. It is possibly bivoltine in the Murree Hills.

3. *Anthaxia* sp. (Col.: Buprestidae)

Its larvae bored the stems of *Ribes orientale* in July at Ziarat and *R. aureum* during October in Swat. There were 3-5 larvae per stem and such stems were usually dry. It is not known whether the drying up of the stems was due to the attack of *Anthaxia* sp. or the insect had attacked already dead and drying stems.

III. *Pueraria tuberosa* (Roxb. ex Wild.) D.C.

Natural enemies recorded:

None of the 8 species of insects recorded from this weed appeared to be promising biocontrol agent. These consisted of: *Coptosoma cribarium* F. (Hem.: Plataspididae) sucking plant sap; *Lampides boeticus* L. (Lep.: Lycaenidae) damaging flowers; *Coptops aedificator* (F.), *Exocentrus dalbergiae* Fish., *Sthenias grisator* (F.), *Tetraglenes insignis* Newm. and *Pterolophia* sp. (Col.: Cerambycidae) boring stems; and *Callosobruchus* sp. (Col.: Bruchidae) infesting seeds. The last species was parasitised to the extent of 50% by *Oedaule ?stringifrons* Waterston (Hym.: Pteromalidae).

Summary and Conclusions

Natural enemies of the forest undergrowth weeds belonging to the genera *Lonicera*, *Ribes* and *Pueraria* were studied in Pakistan for a period of 3 years. During this time it was possible only to record and take preliminary observations, both in the field and in laboratory, on the biology and phenology of natural enemies of three species each of *Ribes* and *Lonicera* and one of *Pueraria* in the northern and western hilly areas of the country.

Of a number of insects and a disease attacking *Lonicera* spp., *Ahucita spilodesma*, *Psychromnestra phaeothicta*, *Phyllonorycter montanella*, *Caloptilia deltosticta*, *Paraphytomyza* sp. and *Hyadaphis* sp. appeared to be stenophagous. However, only three insects (*Anthaxia* sp., *Nematus ribesii*, *Zelleria ribesiella*) on *Ribes* spp. and one (*Callosobruchus* sp.) on *Pueraria tuberosa* seemed promising for the biocontrol purposes.

The existence of insects on *Ribes*, *Lonicera* and *Pueraria* species that have no other recorded hosts is definitely encouraging, but this in no way proves that they actually are host-

specific. The lack of other host records may be due to the fact that these insects have not been carefully studied. Thus, although the prospects of the possible biological control of *Ribes* spp., *Lonicera* spp. and *Pueraria* spp. in Pakistan are very bright, more investigations on the biology, ecology, phenology, effectiveness as controlling agents and host-plant reanges of the apparently promising enemies need to be carried out.

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