INSECTS ASSOCIATED WITH HALOGETON AND SALDOA
IN PAKISTAN WITH NOTES ON THE BIOLOGY,
ECOLOGY AND HOST SPECIFICITY OF THE
IMPORTANT ENEMIES /

By

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INTRODUCTION

Halogeton glomeratus Cav. occurs in sandy soils along river banks and mountain slopes at Goli, Kirtha, Kuthi, Kushta, Sagar, Astakhow and Shengus in the Baltistan agency and at Gilgit, Hotmil, Grunthangas and Ghilas in the Gilgit agency, both in the northern part of West Pakistan (see map). Saloia ruthenica Tjfin is widely distributed in sandy areas in these agencies and also occurs in Baluchistan (eastern West Pakistan) and at Warsak in the North-West Frontier Province. A variety of S. ruthenica (var. pseudoguttae (Beck.) Tjfin = var. samitocia Tausch.) grows sporadically in the Gilgit agency.

The Baltistan and Gilgit agencies are located in the Western Himalayas. The Halogeton localities in the former are situated at altitudes of 1,750 to 2,600 metres and lie roughly between 35° 41' and 39° 44' N latitude and 79° 50' and 76° 31' E longitude, while in the latter they are between 1,050 and 2,000 metres between 35° 24' and 36° 8' N, and 74° 6' and 70° 11' E. The mean annual rainfall and mean temperature at Skardu (Baltistan) and Gilgit are 160 mm and 10.4° C, and 132 mm and 16.4° C, respectively. Most of the Halogeton localities in Baltistan have cold winters (with frequent frost and snow) and mild summers, while those in Gilgit have less severe winters and warmer summers. The amount of precipitation, however, varies greatly from year to year in both areas with some years being almost completely dry, which adversely affects the growth of the weeds and consequently the activities of their insect enemies. Warsak is near Peshawar with a mean annual rainfall of 156 mm and temperature of 22.2° C.

Studies on the insect enemies of Halogeton and Saloia have been carried out since 1963 under a USDA PL-480 project. Investigations were restricted to Baltistan until 1968 and then extended to Gilgit. At Warsak regular studies of Saloia insects were made during the last two years, while only casual observations have been made on the insect associations of Saloia in Baluchistan.

RESULTS OF INVESTIGATIONS

The insects found in association with H. glomeratus and S. ruthenica are given in Table 1.

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<tr>
<th>Order/Family</th>
<th>Name</th>
<th>Nature of damage</th>
<th>Distribution</th>
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<tr>
<td>Coleoptera</td>
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<td>Buprestidae</td>
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<td>Cerambycinae</td>
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<td></td>
<td>Cnephasia</td>
<td>Larvae boring roots and adults feeding on foliage</td>
<td>All localities in Baltistan and Gilgit</td>
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<td></td>
<td>mandarinia</td>
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<td>Curculionidae</td>
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<td>Conophisius</td>
<td>Adults feeding on leaves and stems</td>
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<td>magnificus</td>
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<td>Linus salosalae</td>
<td>Larvae boring stems and adults feeding on foliage</td>
<td>Warsak and Baluchistan</td>
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<td>Order/Family</td>
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<td>Hemiptera</td>
<td>Aphididae</td>
<td>nymphs and adults sucking sap</td>
<td>All localities in Baltistan and Gilgit</td>
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<td>Braconidae</td>
<td>adults on foliage</td>
<td>Gilgit</td>
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<td>Carpoecus coreusm</td>
<td>adults on foliage</td>
<td>Baltistan</td>
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<td>Crotalaria ornata</td>
<td>nymphs and adults sucking sap</td>
<td>Waserak</td>
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<td>Lepidoptera</td>
<td>Coleophoridae</td>
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<td>Waserak, Gilgit, Yamal and Hardtangla in Gilgit; Shengus and Astakeb in Baltistan; and Baluchistan</td>
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<td>Coleophora</td>
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<td>Kiris and Shigar in Baltistan</td>
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<td>Coleophora parthenia</td>
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<td>Spodoptera exigua</td>
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<td>Physidae</td>
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<td>Waserak</td>
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<td>Tetranychus monst cincta</td>
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<td>Pyralidae</td>
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<td>All localities in Baltistan and Gilgit</td>
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<td>Lomastera malala</td>
<td>larvae feeding on leaves</td>
<td>Shengus and Astakeb in Baltistan; all localities in Gilgit; and at Waserak</td>
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</table>
Of all these, C. (C.) mandarina, L. salicola, C. parthenica, Z. neloloides, Z. trifoliolata, Z. potaninii, Z. n. hylaeomorpha, Z. n. macrostoma, and L. nadalia appeared promising and therefore were studied further.

1. Schizoptera (Chrophthalmus) mandarina Thury

This insect occurs on both Halogon and Saladola. However, populations are usually very low, possibly due to high mortality in the overwintering stage. Examination of dry roots in the beginning of the growing season showed that although about 60% were infested, more than 80% of the larvae, pupae and adults in them were dead. Shvel'tzov (1931) reported 80% mortality in hibernating larvae of the root-borer Paria scolopacea Germ. in the Eastern U.S.S.R., Ukraine, U.S.S.R.

In Baltistan adults appear in the field during July and oviposition commences by the second half of the month. Eggs are deposited in the roots near ground level and the hatching larvae bore downward. From 2 to 6 early instars or 1 to 2 full-grown larvae could be found in a root of normal size. The larva maintains a U-shaped position in the tunnel with the head pointing downwards. When pulled out, an infested root could be recognized by its swollen condition. The growth of the plant has a profound effect on larval development. Stunted plants with small, slender roots could not support complete larval development. This results in death of the larvae which are unable to move out of original roots and enter another.

Hibernation, as full-grown larvae, occurs by the end of November with the drying up of the plants. Pupation occurs inside the roots at the beginning of the next growing season. The insect is univoltine.

Screening tests were conducted only with Beta vulgaris (Chenopodiaceae). Laboratory reared adults fed very well on this plant and lived up to 19 days, but did not oviposit during this period. Neither Halogon nor Saladola were available at this time to be used as controls. Further screening tests are warranted.

2. Ligne salicola Becker

This species has been recorded only from Saladola. At Warsaw, activity starts during May when oviposition occurs in soft terminal shoots and the hatching larvae bore into stems. High larval populations are reached in June when almost every branch is infested. Considerable adult and larval populations continue to keep the plants under stress until the first fortnight of November when the species disappears with the complete drying up of the weed. No larvae or pupae could be found in the dry plants and it is not known therefore how overwintering occurs. Presumably this could be in the adult stage. The controlling effect on the plants is quite apparent, as the infested branches usually die before seed-formation. There are possibly three generations a year.

Screening tests have been conducted with Beta vulgaris and Spinacia oleracea (Chenopodiaceae). Laboratory reared adults fed very well and lived for a period of 4 to 14 months on these plants. Eggs were freely deposited in the stems of the two plants and the hatching larvae developed to maturity on both but died before pupation, except one which pupated in S. oleracea. Thus, it appears that L. salicola probably will not prove specific to Saladola.

3. Coleophora parthenica Meyr.

This moth occurs on Saladola at Warsaw. However, a Coleophora sp. attacks mainly Halogon and very rarely Saladola in the Baltistan and Gilgit agencies. It is not yet known whether this is also parthenica or a different species. The studies reported here
were made on C. parthenica attacking Salsola at Warilla.

C. parthenica, like L. salicola, becomes active in May and activity continues until November when full-grown larvae hibernate in the dry stems. Solitary eggs, which are laid on leaves, hatch in 4-5 days. The larvae enter directly into the leaves and feed for about 3 days and then move into the stems, feeding downwards. At the completion of the feeding period the larvae retreat and before pupating prepare an exit hole at about the middle of the tunnel. The length of the tunnel made by a larva varied from 5 to 15 cm depending upon the thickness of the stem.

Larval populations usually remain low until September, during which period Salsola is also attacked by the stem-borer L. salicola and the leaf-feeders L. medialis and gen. sp., Heterographa. However some increase in larval populations occurs during October when the two defoliators shift over to Sunga sp. and Atriplex sp. These two Chenopods are present in the field during the entire season but are rarely attacked by the leaf-feeders until in October, when Salsola starts flowering. There are probably 2-3 generations of C. parthenica a year.

Unidentified ectoparasites were reared from both larvae and pupae. Ants also appeared to have damaged pupae inside the tunnels.

Screening tests were conducted by transferring 25 eggs each onto Atriplex sp., Beta vulgaris, Kochia indica, Salsola oleracea, Sunga sp. (Chenopodiaceae); Lactuca sativa (Compositae); Hibiscus rosa-sinensis (Malvaceae); and Fortulaca oleracea (Compositae). The eggs had been laid on Salsola. The same number of eggs were transferred in a similar manner on to Salsola as a control. In another test, 25 second and third instar larvae (9 and 11 days old, respectively) were removed from Salsola stems and put into those of each of the above test plants, as well as Salsola as a control.

Although the embryonic development of the eggs was completed on all the plants, the larvae failed to come out of the egg shells on any of the test plants. Normal hatching and subsequent larval feeding took place on the Salsola control. The second and third instar larvae also failed to feed in the stems of the test plants, but did feed in those of Salsola.

The fact that larvae in nature remained confined to the original stems until maturity, and in the laboratory they failed to re-enter fresh stems and died when removed from the original ones, indicated that only those plants on which the females oviposited could be suspected of serving as host plants. Thus, five reproductively active females were exposed to each of the above test plants as well as Salsola for a control.

Only 1, 2 and 2 eggs were deposited on Atriplex sp., P. oleracea and Sunga sp., respectively, while the corresponding number of eggs laid during the same period on Salsola was 35, 123 and 27. Again the larvae from the eggs on the three test plants failed to emerge from the egg shells.

All these tests indicate that C. parthenica is apparently specific to its hosts and might prove a useful biocontrol agent of Salsola and Halogoton under suitable conditions.

4. Serchipalma monogoloides Pov.

This moth was collected from Halogoton only during the years 1965 and 1966, which were almost completely dry. The insect was observed during October in both years when the Halogoton plants were small in size but flowering profusely. It was also obtained in small numbers from Salsola during the same period. Larvae usually attack the seeds of those flowers borne on branches touching the ground. The larvae construct
a tube made of silk and sand, one end of which is attached to the calyx of a flower and the other touching the soil. When full-grown, the larvae pass through the tube into the sand, where they pupate. The populations during the two years were quite high with the result that almost all those flowers touching the sand were infested. However, the insect has not been observed during the rest of the period, the reasons for which are not known. No screening tests have been conducted with this.

Its larvae were parasitized by Cheloms (Cheloms) sp. and Chaloms (Micronchelomis) sp.

5. *S. trifoliis* Bott.

This was obtained from both *Heliozethe* and *Scolia*. Larvae from the overwintering generation usually appear in July and activity continues until the end of September when the insect hibernates in the soil in the pupal stage. It is univoltine under Baltistan conditions but at higher temperatures (24°C ± 1) it appeared to be multivoltine.

Screening tests with newly hatched larvae were made on the following plants (number of larvae given in parentheses): *Beta vulgaris* (30), *Chenopodium album* (60), *Sicasia oleacea* (160) (Chenopodiales); *Lactuca sativa* (50) (Compositae); *Convolvulus arvensis* (35) (Convolvulaceae); *Brassica campestris* var. *sarson* (60), *Raphanus sativus* (44) (Cruciferae); *Trifolium arvense* (60) (Leguminas); *Pisum sativum* (60), *Phase sativum* (50) (Leguminas); *Coriandrum sativum* (60) and *Daucus carota* (40) (Umbelliferae). Feeding and larval development took place on all the test plants except *S. sativa*. However, pupae from *S. oleacea* and *D. carota* failed to transform into adults, while only males emerged from pupae from *B. vulgaris*, *C. arvense* and *R. sativus*. Adults of both sexes from the remaining seven plants again oviposited on their respective plants, except those from *S. sativa*, and the larvae completed development.

Thus, in view of these results and the literature records (Drea and O'Connell, 1969; Oden and Nicker, 1964), *S. trifoliis* is apparently polyphagous and should not be considered for biological control purposes.

6. *Heterogrosis monostictella* Ragounot

This is mainly a stem-borer of *Scolia* but occasionally also attacks *Heliozethe*. Unlike most of the other insects, *H. monostictella* was present in the field every year throughout the investigation period, though its populations remained low during dry years. Aduits from the overwintering generation usually appear in appreciable numbers during July in Baltistan and June in Gilgit, and oviposition commences. The moths are abundant on the host plants during morning and evening hours while the hot part of the day is passed on nearby bushes, such as *Sorbaria scopoletoides* and *Lamium arvense*.

Although *H. monostictella* was only occasionally obtained from the stems of *Heliozethe* in nature, oviposition and larval feeding occurred on *Heliozethe* in the laboratory, both in the presence and absence of *Scolia*. Newly hatched larvae, when left on *Heliozethe* plants growing in front of the laboratory, entered the stems and bored through them, resulting in the death of the plants in about 12 months.

Eggs are laid on leaves or leaf-axils and hatch in about 3-5 days. The hatching larvae feed first in the leaves or leaf-buds for some time, and then bore into the stems, feeding downwards. The larvae feed for about 50 days and then hibernate in the soil till the next season. The effect of *H. monostictella* on its host is quite apparent and, if the attack is early, the infested branches usually die before seed-production.
Feeding tests with first instar larvae have been made with the following plants (number of larvae given in parentheses): *Beta vulgaris* (46), *Spinacia oleracea* (52), *Vicia indica* (30), *Sesua sp.* (19) (Chenopodiaceae); *Lactuca sativa* (5) (Compositae); *Hibiscus esculentus* (17) (Malvaceae); and *Porotaica oleracea* (53) (Portulacaceae). Slight feeding was observed on *B. vulgaris*, *S. oleracea* and *V. indica*, but the larvae died within a week. However, normal feeding and development took place on both *Sesua* and *Porotaica* used as controls.

Thus, it seems that *H. neposictella* is quite specific and may be a useful biocontrol agent on *Sesua* and is also likely to prove a good enemy of *Halogrenon* in areas where *Sesua* does not occur.

7. Gen. nr. *Heterorrhagia*

Confined to Warak, its activity starts about the same time as that of *L. salicola*, *G. parthenica* and *L. nuda* and continues until the end of October, when it probably overwinters as full-grown larvae in the soil.

Solitary eggs are laid on the leaves and stems. The larvae feed mainly on soft terminal leaves and pass through six instars, which last a total of about 25 days. The pupal stage lasts 11 days. Adult longevity under captivity averaged about 11-12 days for both sexes.

Larval populations remain at a low level throughout the season, possibly due to competition with *L. nuda*, and the adverse effect of *L. salicola* and *G. parthenica* on *Sesua* plants. The larvae also feed on *Atriplex* sp. and *Sesua* sp. in nature, but this is noticeable only when *Sesua* starts flowering. There are probably three generations a year.

In screening tests the first instar larvae were offered the following plants (number of larvae given in parentheses): *Atriplex* sp. (30), *Beta vulgaris* (60), *Hibiscus nuda* (30), *Spinacia oleracea* (60), *Sesua* sp. (30), *Halogrenon aliqueratius* (30) (Chenopodiaceae); *Lactuca sativa* (50) (Compositae); *Broussia napus* (30) (Cruciferae); *Ps. mara* (27) (Cramineae); *Hibiscus esculentus* (30) (Malvaceae); *Porotaica oleracea* (20) (Portulacaceae); *Solania pachypoda* (30) and *S. tuberosum* (30) (Solanaceae). Although slight feeding occurred on almost all the test plants, larval development was completed and adults emerged only from *Atriplex* sp., *Sesua* sp., *H. indica* and *H. aliqueratius*. Larvae fed for a period of 17 to 26 days on *B. vulgaris*, *S. oleracea* and *S. mara*, but ultimately died without pupating. Thus, apparently, gen. nr. *Heterorrhagia* is eury- or cyclops or at least its status is still doubtful.

8. ? *Sesvia* sp.

This seems to be the most important enemy of *Halogrenon*, and to a lesser extent of *Sesua*, but its activity is adversely affected by drought. It is almost completely absent during dry years when plant growth is stunted and scanty.

In the years of good growth of *Halogrenon* and *Sesua*, insect activity starts in May at Gilgit (especially the Chilas area) and July in Baltistan. Maximum larval populations occur a month later, but thereafter the numbers continue to decrease gradually until the end of September or October when hibernation takes place as pupae in the soil. There are probably 2 generations a year in Baltistan and 3 in Gilgit.

Eggs are laid usually on the leaves, but may also be laid on the stems. These hatch in about a week and the larvae feed on the leaves, inside silken webs, for about a month and then pupate in the soil. There are five larval instars and the pupal period lasts approximately two weeks. In captivity adults lived for an average of about two weeks and a single female laid up to 266 eggs during a 5-day oviposition period.
When the larval populations are high, the webbing of *Haloperetum* plants is extensive, with the result that the growth is retarded and seed-production is almost completely eliminated. In addition to *Haloperetum* and *Deltia*, the insect also attacks *Chenopodium botrys* in nature.

The larvae of *Spottedalka* sp. are parasitized by a *Campoplegini*, *Tetragonula* sp. (Ichneumonidae) and *Exoploeta fallax* Kj. (Tachinidae). The highest combined parasitism so far observed has been about 5%.

In screening tests, some first instar larvae, but mainly field-collected larvae of unknown stages, were used. The plants tested and the larval stages used (given in parentheses) were as follows: *Beta vulgaris* (first, 4); *unknown 15*, *Spinacia oleracea* (first, 37; unknown 10) (Chenopodiaceae); *Lactuca sativa* (first, 123; unknown 19) (Compositae); *Citrullus vulgaris* (unknown, 10), *Lycopersicon esculentum* (unknown, 10), *C. melo* (unknown, 10), *C. melo* (unknown, 10), *Tomosilica chlorophila* (unknown, 10), *Pumilio chlorophila* (unknown, 10) (Cucurbitaceae); *Arctium lappa* (unknown, 15), *Ficus carica* (unknown, 10) (Umbelliferae); *Ribes uva-crispa* (unknown, 15) (Malvaceae); *Portulaca oleracea* (first, 15; unknown 15) (Portulacaceae); *Capsicum annuum* (unknown, 10), *Lycopersicon esculentum* (unknown, 10), *Solanum melongena* (unknown, 10), *S. tuberosum* (unknown, 15) (Solanaceae) and *Tubocarpa carota* (unknown, 10) (Umbelliferae).

Of the first instar larvae, some died for about 10 days on *B. vulgaris* and then died, while on other plants they died within a week after some nibbling. However, field-collected larvae fed slightly and pupated within a week of their release (some pupating even without feeding, e.g. on *L. sativa* and *L. carota*) on *B. vulgaris*, *L. sativa*, *B. oleracea*, *F. sativa*, *S. melongena* and *L. carota*. Thus, although *Spottedalka* sp. appears to be oligophagous, further screening tests with first instar larvae are warranted. If proved specific, this should be a promising biocontrol candidate for *Haloperetum*.

9. *Ionosteoma medulla* HB.

*J. medulla* is found in the field at the same time as *S. trifoliata* and *Spottedalka* sp. in the agaves and gen. *Heterocarpus* at Narsak. Comparative high populations occur in July, but thereafter the numbers decrease gradually until October, when hibernation occurs as full-grown larvae. There are about 3 generations a year in Baltistan and 4 in Gilgit.

Eggs are laid on the leaves and hatch in 4-6 days. The larvae pass through six instars, each lasting for about 3 days. The pupal period is 7-9 days. In captivity females lived for an average of 13 days and a maximum of 335 eggs were laid by a female in her life span.

In addition to *Haloperetum* and *Deltia*, the insect also attacks *Spinacia* sp., *Atriplex sp.*, *Chenopodium botrys* and *Araucaria* sp. in the field when larval population levels are high.

High larval parasitism (about 40%) by an Ichneumonid and two Braconids was observed at Shangsa and at the Kishin in the Baltistan agency. Large numbers of empty parasite cocoons were also seen in the field.

First instar larvae were screened on the following test plants (number of larvae used is given in parentheses): *Atriplex sp.* (60), *Beta vulgaris* (50), *Edelis indica* (8), *Spinacia oleracea* (75), *Lycopersicon esculentum* (60) (Malvaceae); *Lactuca sativa* (50) (Compositae); *Hibiscus vestitus* (49); *Portulaca oleracea* (55) (Portulacaceae). Feeding and completion of larval development took place on *B. vulgaris*, *L. oleracea*, *F. sativa*, *L. angustifolia* and *Atriplex sp.*. *J. medulla* is also known to attack sugar-crops in Turkey (Cherbak, 1929) and Bulgaria (Cherbak, 1929) and cotton and beets in the Russian Turkistan (Tasiriev, 1926).
Thus from both the laboratory screening tests and the literature records, it appears that L. mundalis is a polyphagous pest species and hence should not be considered for the biological control of Halocrenon and Saulola.

**DISCUSSION AND CONCLUSIONS**

Although the survey for phytophagous insects associated with Saulola and Halocrenon in the Gilgit and Baltistan agencies and at Warsak is almost complete, investigations on the ecology, phenology and host-specificity of the important enemies are by no means so. This has been due mainly to the persistence of drought in the agencies, resulting in scanty plant growth and the absence of many of the insects. However, some leads have been obtained as to the host-specificity and effectiveness of some of these insects.

Whilst Sitonotermes mandarina at times infests as many as 60% of the plant roots, it is usually of little value as there is very little apparent effect on the infested plants. This is possibly due to the destruction of a considerable proportion of the population by unfavourable weather conditions and the late appearance of the insect. Though the damage inflicted to Saulola by Lixus saulolae is considerable it is apparently polyphagous, as also are Scotogramma trifolii and Locustaga mundalis.

Gen. spp. Heterographini occurs under the warmer conditions of Warsak but with only low populations, possibly, though by no means certainly, due to competition from other Saulola insects. Under the prevailing conditions this insect does not hold much promise and is probably not host specific. Acrobia longa being a seed destroyer, would seem to be more useful, but this has been observed only at the close of the growth period in two seasons when there was very little rainfall and plant growth was late. Its status is also not known, although Dr. Pavlovsky of Czechoslovakia (personal communication), who identified the species, stated that this insect was known only from Mongolia and that there was no previous host record.

Heterographini monosictella for Saulola, and Coleophora parthenica and Tisucophora spp. for both Saulola and Halocrenon appear to be the promising insect enemies at the present time. The specificity of the first two has been fairly well established, while young larvae of T. bucephala spp. fed for about 3 weeks on Beta vulgaris, but failed to complete development.

This is perhaps not very significant, and all three might merit consideration as candidate species for the biocontrol of Halocrenon and Saulola under suitable ecological conditions. One can, however, expect competition between C. parthenica and H. monosictella (both stem-borers) on Saulola, if used together. Such competition has been observed for C. parthenica and L. saulolae at Warsak. H. monosictella seems to have the added advantage of not being affected by drought to the same extent as the others, and its effect on the host is much more evident in the field.

While, generally speaking, the controlling effects of the insect enemies of Halocrenon and Saulola in the Baltistan and Gilgit agencies are usually not very pronounced, they may be more effective in a different climate. The climatic conditions in the agencies are very unstable (especially the rainfall) so that in some seasons it is even difficult to find a good growth of the plants. Moreover, the summers are short, with the result that even in favourable years most of the insects can produce one or at the most two generations a year, resulting in low populations. Under stable conditions some of these insects, especially H. monosictella, C. parthenica and T. bucephala spp., might well prove more useful than under the conditions prevailing in West Pakistan.
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REFERENCES


