METZNERIA PAUCIPUNCTELLA ZEL. (GELECHIIDAE,LEPIDOPTERA): A POTENTIAL INSECT FOR THE BIOLOGICAL CONTROL OF CENTAUREA STOEBE L. IN CANADA. I/

WOLF-DIETER ENGLERT

COMMONWEALTH INSTITUTE OF BIOLOGICAL CONTROL, DELEMONT

Taxonomy,geographic distribution and host-plants of the genus Metzneria

The genus Metzneria Zeller belongs to the subfamily Gelechiinae of the family Gelechiidae (Lepidoptera). Its species are well characterised by their general appearence, the genital structures of the adults and the morphology of the larvae, which have no abdominal legs. With the exception of two South- and one Central-African species all Metzneria sp. are endemic in the Palearctic region and most of them occur in the Mediterranean region. All I5 species, the host-plants of which are known, are seed-feeders.Most of them (I3) are restricted to the Cynareae. We find Metzneria sp. in all four subtribes, Echinopinae, Carlininae, Carduinae and especially Centaureinae. One species was found on a Anthemideae and one on a Plantaginaceae.

The identity and geographical distribution of M. paucipunctella and C. stoebe

I compared the lectotype of M. paucipunctella (designated by Dr.K.Sattler, British Museum, London) with specimens reared from C. stoebe and found them to be identical. In the literature, the moth is recorded from Europe, Asia minor and western Asia (Gaede,I937), but these records may be based on wrong identifications. We found M. paucipunctella in the upper Rhone Valley, in the Danube Valley and in east Austria. In various collections we found specimens originating from southern Spain, the Maritime Alpes, Bohemia and the Danube Valley in Hungaria and Bulgaria. The indigenous distribution area of C. stoebe is south and east Europe and corresponds well with that of M. paucipunctella. The moth is not found in the USA and Canada where the weed is introduced.

Life history of M. paucipunctella

The moth is univoltine. Adults are found from late May to late July. Under laboratory conditions the oviposition period starts 2-3 days after emergence and within the following three weeks each female lays some 6o - Ioo eggs. The oviposition site in the field is at the base of, or on the stem just below a closed flower-bud. At room temperatures (I9-2I ^{o}C) the egg period lasts Io-I2 days. The first instar larva climbs up the flower-bud, which is now at opening stage and penetrates into the interior. After having fed between or inside the tubular flowers the larva moults. The second instar larva feeds inside one or two immature achenes, which it enters from the distal part. Before it moults again, it closes this entrence hole with a silken web. The third instar larva leaves the achene and starts tunneling through the receptacle, from where it penetrates into several more achenes, completely destroying them. The fourth instar larva feeds laterally through groups of achenes which are spun together by a web. The last instar larva hibernates. Before pupation it spins a tunnel-like web through the flower-head which later serves as an exit hole for the moth. In the field the first pupae are found in late April. In the laboratory the pupation period lasts about three weeks.

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Effect of M. paucipunctella on its host-plant

Being predominantly a bienniel plant, C. stoebe is dependent on the production of achenes. The larvae of M. paucipunctella obviously effect the seed production of C. stoebe by reducing achene viability and by destroying most of them. From a total of 83 heads, in which the moth had successfully completed development, 95.35% of all viable achenes had been destroyed. A larva can destroy all achenes if up to 9 viable achenes have been produced, and about 9o% if Io or more have been produced.

The distribution and frequency of M. paucipunctella in three observation areas

Due to extensive cultivation, stands of several hundred plants of C.stoebe were found in the Swiss Rhone Valley only at Briger Bad. It is remarkable that even isolated plants were often attacked by larvae of M. paucipunctella. This indicates, however, that the female is capable of locating small groups of host-plants or even single individuels. A count of early larval stages made on July 24, I97o at Briger Bad, yielded the figures given in Table I. All flower-heads of Io C. stoebe plants were dissected and an average of 44.2% were found to be attacked by M. paucipunctella . In samples collected in autumn at Briger Bad, St.Michael (Danube Valley near Krems) and Hacklsberg (near Vienna) an average of 34% of all flower-heads was attacked by M. paucipunctella. (Table 2) In spring, however, the attack was considerably lower, at Briger Bad in I969 only 3.I% and in I97o 4.o%, respectively.

Table I: Abundance of M.paucipunctella larvae in Io C.stoebe plants

	Plant nos.	No of heads	No. attacked by larvae
	I	I6	5 = 3I.7%
	2	I6	9 = 56.7%
	3	25	I8 = 72.o%
	4	44	29 = 65.9%
	5	52	8 = I5.4%
	6	83	53 = 63.9%
	7	9I	23 = 25.5%
	8	98	4I = 4I.8%
	9	I44	47 = 32.4%
	1o	I72	94 = 54.7%
Total:	Io	74I	327 = 44.2%

Table 2: Abundance of M.paucipunctella larvae in C.stoebe heads at three localities

Locality	Date	No of flower-heads dissected	No attacked by a larva
Briger Bad	6.x.I97o	345	II6 = 33.6%
St.Michael	3.x.I97o	26I	8o = 32.2%
Hacklsberg	I.x.I97o	246	9o = 36.5%

Parasites and intra- and interspecific competition

The larval parasites of M. paucipunctella belong to the Chalcidoidea, Braconidae and Ichneumonidae. In autumn I97o total larval parasitism was I9.I% in Briger Bad, 38.I% in St. Michael and 3o% on the Hacklsberg. In the field I-3 eggs of M.paucipunctella are deposited per flower-head. Dissections of flower-heads as well as experiments have shown that the excess larvae are killed by the eventual successor. In a large flower-head of C. stoebe, M.paucipunctella can co-exist with other phytophages, such as trypetids, Urophora affinis Frld., which has recently been established in Canada or Terellia virens Loew. If, however, a M.paucipunctella larva comes into contact with these competitors, it kills and feeds upon them. A mature larva of M.paucipunctella is capable of killing young, but not mature larvae of the anobiid, Lasioderma redtenbacheri Bach.

Host specifity of M. paucipunctella

Review of literature

Hering (I94I) and Zwölfer (I965) recorded M.paucipunctella from C. stoebe. Several authors (Kaltenbach 1874, Spuler I9Io, Schütze I93I, Eckstein 1933, L'homme I949, Wörz I955 and others) recorded the moth from C.paniculata, a name formerly used for C.stoebe. Therefore, it is most probable that all these records refer to C.stoebe. The true C.paniculata is a mediterranean species, which we collected for rearings, but M.paucipunctella was never found. Zwölfer records ?M. paucipunctella from C. aspera and C. calcitrapa.The genital examination of the specimens reared from C.aspera showed that another Metzneria sp. was involved. The specimens from C.calcitrapa were not available for examination. Most authors recorded M. paucipunctella also from Anthemis tinctoria L. (Gartner 1864, Kaltenbach 1874, Spuler 191o, Schütze 1931, Eckstein 1933, L'homme 1949 and Wörz 1955). My investigations have shown, that the species associated with A. tinctoria superficially resembles M. paucipunctella, but clearly differs in the genital structures, the larval morphology and biology L'homme (1949) enumerates Staehelina dubia L. as a host-plant of. M. paucipunctella and refers to Walsingham. I examined Walsingham's specimens reared from S. dubia and found that this species is specifically different from M. paucipunctella. A critical review of the host-records in the literature shows that C. stoebe is , with great probability, the only known hostplant of M. paucipunctella.

Personal field records

During the last 8 years at the European Station of the C.I.B.C. about 2ooo samples of flower heads of over 7o European Cynareae sp. have been investigated (Zwölfer 1965 and unpublished records). M. paucipunctella was found exclusively in the heads of C. stoebe. These investigations demonstrate a high degree of host specifity.

Oviposition tests with M. paucipunctella

Multiple -choice x 16 tests were made with 36 Compositae species and one Dipsaceae. We used cages measuring 22 x 3o cm and 3o x 4o x 5o cm. A 15 cm long stem with one bud was offered of each test plant. Due to the lack of sufficient material, different numbers of females were used for the tests. In most tests lo ♂♂ and lo ♀♀ were used, but in some only 6 ♀♀. Food in the form of a honey and sugar solution was offered on plugs of cotton. Every morning the cages were lightly sprayed with water. The cages were placed usually at the window of the laboratory and occasionally under fluorescent lighting. Table 3 summarizes the results of 7 tests which were divided into two groups. Group A: Duration of test was 24 hours, results of three tests pooled. Group B: Duration of test was 3 - 7 days, results of 4 tests pooled. Oviposition tests have shown that C. stoebe received by far the largest number of eggs, followed to a lesser extent by C. diffusa and C. paniculata. Only these three species were accepted for oviposition whenever they were offered. Under natural field-conditions, a female of M. paucipunctella does not deposit more than three eggs per bud. In our tests, however, where the proportion of females to host-plants was extremely high (6 or Io ♀♀ to a single bud) from 5o-I72 eggs were laid on individual stems of C.stoebe. A comparison of group A and B shows that the longer the tests last, the more plant species are accepted for oviposition. The number of plant species accepted, increased from Io to I9 in our tests. Furthermore it is interesting to compare the increase in eggs laid on C.stoebe, C.diffusa and C.paniculata.In group B, 2.5 x as many eggs were laid on C.stoebe as in group A, 6.5 x as many on C.diffusa and I4 x as many on C.paniculata. We think, that the reasons for these differences lie in the fact, that with the increasing duration of the test, the females showed a tendency to change from the highly attacked host-plant to less or not yet attacked plants. In spite of these extreme test conditions, the following plants were never accepted for oviposition: Carthamus tinctorius, Cnicus benedictus, Helianthus annuus, Tagetes erectus, Calendula officinalis, Echinops sphaerocephalus, Arctium lappa, Carduus crispus, Cynara scolymus, Onopordon illyricum, Crepis tectorúm and Sonchus arvensis.

Table 3: Oviposition tests with M.paucipunctella

Plant species	Average no.of eggs per plant			Plant species	Average no.of eggs per plant		
CYNAREAE Centaureinae	A	B	Total	CYNAREAE cont. Carlininae	A	B	Total
Centaurea stoebe L.	43	II4	I57	Carlina vulgaris L.	I	7	8
C.diffusa L.	8	52	6o	Xeranthemum annuum L.	o	5	5
C.paniculata L.	2	28	3o	Echinopinae			
C.nigrescens Willd.	o	8	8	Echinops sphaero-			
C.jacea L.	o	7	7	cephalus L.	o	o	o
C.pseudophrygia May.	I	7	8	CALENDULAE			
C.solstitialis L.	I	4	5	Calendula officinalis L.	o	o	o
C.cyanus L.	2	2	4	SENECIONEAE			
C. scabiosa L.	I	I	2	Senecio jacobaea	o	3	3
C.montana L.	o	I	I	ANTHEMIDEAE			
C.aspera L.	I	I	I	Anthemis tinctoria L.	4	I2	I6
C.calcitrapa L.	-	o	o	Achillea millefolium L.	o	o	o
Cnicus benedictus L.	o	o	o	HELENIAE			
Carthamus tinctorius L.	o	o	o	Tagetes erectus L.	o	o	o
Serratula tinctoria L.	o	5	5	HELIANTHEAE			
Carduinae				Helianthus annuus L.	o	o	o
Arctium lappa L.	o	o	o	ASTEREAE			
A.tomentosum Mill.	o	o	o	Erigeron annuus L.	o	I	I
Carduus crispus L.	o	o	o	CICHORIAE			
Carduus defloratus L.	o	o	o	Crepis tectorum L.	o	o	o
Cirsium vulgare Savi.	o	Io	Io	Sonchus arvense L.	o	o	o
C. arvense L.	2	o	2	DIPSACEAE			
Cynara scolymus L.	o	o	o	Dipsacus sylvester Huds.	o	I	I
Onopordon illyricum L.	o	o	o				

Conclusions

M.paucipunctella is a very effective insect associated with C.stoebe, a single larva being capable of destroying 95% of all viable achenes of one flower-head. A female deposites up to Ioo eggs and demonstrates an excellent host-finding ability. Although this moth is exposed to fairly heavy parasitism, we think that it will be able to built up high populations when released free from its parasite complex. We think that M.paucipunctella should be able to control the biennial population and inhibit the further spread of the perennial population of C.stoebe in Canada. Neither M.paucipunctella nor any other species of the genus are recorded in the literature (including the 58 volumes of the Review of Applied Entomology) as pest insects. Noel (I9I5) records M.lappella from Helianthus tuberosus. Since in the vast literature dealing with Helianthus insects this species has never been recorded again , it is most likely that Noel's record is based on a misindentification. Two chinese authors (Harukawa I9I9 and Chang & LinI939) mention an obscure Metzneria sp.,causing galls on the branches of pear trees, Pyrus sinensis . According to the biological data given by these authors it is obvious that this is not a Metzneria species. A critical review of the literature showed that all records of M.paucipunctella from plants other than C.stoebe are based on erronous identifications. According to an extensive eight year field survey which covered a large part of Europe and dealt with more than 7o Cynareae species, M.paucipunctella was reared exclusively from C.stoebe. In oviposition tests the moth showed a distinct preference for C.stoebe followed by the closely related C.diffusa and C.paniculata. Helianthus annuus, Carthamus tinctorius and Cnicus benedictus were never accepted. According to present field observations M.paucipunctella is monophagous on C.stoebe. Our laboratory experiments suggest that the two closely related species C.diffusa and C. paniculata belong to the potential host-range of M.paucipunctella. All available evidence suggest that M.paucipunctella is a suitable insect for the biological control of C.stoebe in Canada.

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