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THE PHYTOPHAGOUS INSECTS ATTACKING *SONCHUS* SPP. (COMPOSITAE) IN EUROPE

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The genus *Sonchus* belongs to the subfamily Cichoriodeae (Liguliflorae) of the family Compositae. According to the classification of Melchior (ed.) (1964) the genus *Sonchus* is placed in the subtribe Crepidinae, together with *Hieracium*, *Prenanthes*, *Lactuca*, *Aposeris*, *Taraxacum*, *Chondrilla* and *Crepis*. The 70 species of *Sonchus* were originally distributed in Europe, North-Africa and Asia. Some species, especially *S. arvensis* L., *S. asper* All., *S. oleraceus* L. and *S. uliginosus* Bieb. (*paluster* L.), are now widely distributed outside their native distribution area, e.g. being now naturalized in the Americas, in Australia and New Zealand. The above named species are typical members of unstable plant communities in fields, fallow land, roadsides, land-fills and waste places. They are considered noxious weeds because they are competing with a number of field crops, and are summer hosts of several aphid species, e.g. *Hyperomyzus lactucae*, the vector of the lettuce necrotic yellows virus, and a pest of black-, and red-currant, as well as gooseberry.

The insects specie recorded in the European literature to feed on Sonchus *spp.*

The records summarized in Table 1 are based on information given in the R.A.E. (vol. 1-60), in the monographs by Buhr (1964/65) on gall-makers, by Barnes (1949) on gallmidges and by Hering (1957) on mining insects, as well as on monographs on important insect orders (Börner, 1952—on Homoptera; Seguy, 1935—on Diptera; Hendel, 1927—on Trypetidae; Hannemann, 1961, 1964, and Koch, 1955, 1958, 1961—Lepidoptera; and Hoffmann, 1950, 1954, 1958—on Coleoptera). Altogether 53 species, belonging to 19 families of 6 orders, are recorded to feed on *Sonchus* spp. in Europe. The order Diptera is best represented (5 families, 22 species), being followed by the Lepidoptera (3 families, 16 species), the Homoptera (3 families, 12 species), and the orders Hemiptera, Coleoptera and Hymenoptera each with one species.

Regarding the specificity of the insect species recorded, it would seem that 21 species are polyphagous, 6 species are restricted to the family Compositae, 20 species to the subfamily Cichoriodeae, and only 6 species, *Contarinia schlechtendaliana* Rübs., *C. sonchi* F. Loew, *Cystiphora sonchi* F. Loew, *Tephritis dilacerata* H. Loew, *Pego-*

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TABLE 1

Insect species attacking *Sonchus* spp. in Europe

Species	Family	Grade of specificity	Rel. frequency during field survey (1971—1973)		
			arvensis	*asper*	*oleraceus*
Endophytic in flower heads					
Contarinia schlechtendaliana Rübs.	Dipt. Cecidomyidae	(A)	—	(*)	—
,, sonchi F. Loew	,, ,,	(A)	**	—	—
Ensina sonchi L.	,, Trypetidae	(B)	**	***	**
Paroxyna tessellata H. Loew	,, ,,	(B)	—	—	—
Tephritis dilacerata H. Loew	,, ,,	(A)	***	—	—
,, formosa H. Loew	,, ,,	(B)	—	*	*
Trypanea amoena Frauenfeld	,, ,,	(C)	—	—	—
Pegohylemyia sonchi Hardy	,, Anthomyiidae	(A)	*	(*)	(*)
Brevisociaria gilvicomana Zeller	Lep. Tortricidae	(B)	—	—	—
Eucosma eypallidana Haworth	,, ,,	(B)	*(?)	—	—
External on flower heads					
Stictopleurus crassicornis L.	Hem.Coreidae	(C)	..	(*)	—
Polia serena Schiff	Lep. Noctuidae	(C)	—	—	—
,, spinaciae View	,, ,,	(D)	—	—	—
Endophytic in stems					
Napomyza lateralis Fall.	Dipt. Agromyzidae	(D)	—	(*)	(*)
Ophiomyia persimilis Hd.	,, ,,	(B)	—	(*)	—
Phytomyza perpusilla Meig.	,, ,,	(B)	—	—	—

TABLE 1 - *Contd.*

Species	Family	Grade of specificity	Rel. frequency during field survey (1971—1973)		
			arvensis	*asper*	*oleraceus*
External on stems and leaves					
Dactynotus sonchi L.	Hom. Aphididae	(B)	(*)	(*)	(*)
Hyperomyzus lactucae L.	,, ,,	(D)	*	***	***
,, pallidus HRL.	,, ,,	(D)	—	—	—
Macrosiphon solanifolii Ashm.	,, ,,	(D)	—	—	—
Myzodes persicae Sulz.	,, ,,	(D)	—	—	—
Myzus ornatus Laing	,, ,,	(D)	—	—	—
Nasonovia compositella Theob.	,, ,,	(A)	—	—	—
Amathes humilis F.	Lep. Noctuidae	(D)	—	—	—
Antitype chi L.	,, ,,	(D)	—	—	—
Aplecta advena Schiff.	,, ,,	(D)	—	—	—
Cucullia lactucae Schiff.	,, ,,	(B)	—	—	—
,, lucifaga Hb.	,, ,,	(B)	—	—	—
,, umbratica L.	,, ,,	(D)	—	—	—
Lithomoia rectilinea Esp.	,, ,,	(D)	—	—	—
Phytometra gamma L.	,, ,,	(D)	—	—	—
Rhyacia praecox L.	,, ,,	(D)	—	—	—
Tenthredo rosii Klug	Hym. Tenthredinidae	(B)	—	(*)	—
Endophytic in leaves					
Orthochaetes setiger Beck	Col. Curculionidae	(D)	—	—	—
Cnephasia chrysantheana Dup.	Lep. Tortricidae	(D)	—	—	—
Cnephasiella incertana Tr.	,, ,,	(D)	—	—	—

TABLE 1 - *Contd.*

Species	Family	Grade of specificity	Rel. frequency during field survey (1971—1973)		
			arvensis	*asper*	*oleraceus*
Cystiphora sonchi F. Loew	Dipt. Cecidomyidae	(A)	—	—	—
Trypeta immaculata Macqu.	,, Trypetidae	(B)	—	—	—
Liriomyza andivae Hg.	Dipt. Agromyzidae	(B)	(*)	(*)	(*)
Liriomyza pusilla Meig.	,, ,,	(B)	—	—	—
,, sonchi Hd.	,, ,,	(B)	—	—	—
,, strigata Meig.	,, ,,	(D)	—	—	(*)
Melanagromyza cunctata Hd.	,, ,,	(B)	—	—	—
,, pulicaria Meig.	,, ,,	(B)	—	—	—
Phytomyza atricornis Meig.	,, ,,	(D)	(*)	—	*
,, sonchi R.D.	,, ,,	(C)	—	—	—
Cheilosia sp.	,, Syrphidae	(D)	—	—	—
External on roots					
Protrama flavescens Koch	Hom. Lachnidae	(C)	—	—	—
Trama mordvilkoi CB.	,, ,,	(B)	—	—	—
,, rara Mordv.	,, ,,	(B)	—	—	—
,, troglodytes v. Heyd.	,, ,,	(B)	—	—	—
Pemphigus bursarius L.	,, Eriosomatidae	(D)	—	—	—
Celypha rurestrana Dup.	Lep. Tortricidae	(B)	—	—	—

(A) — monophagous on Genus *Sonchus*
(B) — oligophagous 1. degree-on Tribe Cichoriae (Liguliflorae)
(C) — ,, 2. degree-on Family Compositae
(D) — polyphagous—on plants of several families

— not found
(*) in up to 10% of samples
* in 11—20% of samples
** in 21—40% of samples
*** in over 40% of samples

hylemyia sonchi Hardy and *Nasonovia compositella* Theob., are specific to the genus *Sonchus*. Although the host specificity of these 6 species has not yet been thoroughly investigated, e.g. it is not yet known whether the species of *Cystiphora* which is found on *Lactuca sativa* L. is not identical with *C. sonchi* (Möhn, pers. comm.), these species seem to have the greatest potential as biocontrol agents outside the native distribution area of *Sonchus* spp. However, 5 of them live endophytically in the flower heads, and may compete with one another, and the sixth species is a rare aphid with little or no potential for biological control.

Among the oliphagous species of group B (Table 1), the majority of which are recorded attacking *Lactuca*, only 5 species seem to warrant closer examination. These are the leaf-miners *Trypeta immaculata* Macqu., *Liriomyza pusilla* Meig., *Melanagromyza pulicaria* Meig. and *Phytomyza perpusilla* Meig., and *Eucosma* (?)sp. feeding on the seeds. None of the species of groups C and D (Table 1) can be considered for the biological control of *Sonchus* spp., unless their host plant records are erroneous, and their host range more restricted than indicated by literature records.

Results of a field survey between 1971 and 1973

A field survey was carried out between 1971 and 1973 in order to collect information on the relative frequency and abundance of the insect species recorded in the literature, as well as to find additional species to those so far listed. At the same time the type of damage and its effect on the vigour of the attacked plant have been studied.

The results of the field survey are presented in Table 1. They are based on collections in 60 different localities in eastern Austria and the Swiss Jura. A total of 25,000 flower heads, 9,000 of *S. arvensis*, 11,000 of *S. asper* and 5,000 of *S. oleraceus*, was dissected, and an uncounted number of flower heads was reared for insect emergence. Between 25 and 50 entire plants of each locality were closely examined, and a larger number of plants were inspected in the field for leaf-mines and for external feeding. During the 3-year survey only 16 species of phytophagous insects have been found, all of which had been formerly recorded. Moreover, the occurrence of the 16 species was rather erratic. With the exception of the polyphagous *H. lactucae*, the oliphagous *E. sonchi*, and apparently monospecific *T. dilacerata* and *C. sonchi*, which occurred in over 20% of the localities, all other species were found in a few localities only.

The data on abundance were also rather disappointing. The only abundant species was *H. lactucae*. *E. sonchi* attacked between 5 and 8% of the flower heads of *S. arvensis* and *S. oleraceus*, and between 5 and 14% of *S. asper*. On *S. arvensis* between 2.5 and 6% of the flower heads were attacked by *T. dilacerata* and between 3 and 15% by *Eucosma* (?) sp. All other species were rare, occurring as a few specimens only.*

* It is of interest to note that a field survey by Zwolfer (1973), carried out in Iran, in Pakistan and in Japan, produced similar poor results.

The rate of parasitism was generally low for all insect species found, with the exception of *T. dilacerata* of which no parasites have been found. It would, therefore, seem that the low population levels of practically all phytophagous species had their cause in some other factor, besides parasitism.

Within the area surveyed, none of the *Sonchus* species suffered any noticeable reduction in numbers due to the attack by phytophagous insects, and no marked weakening of individual plants was observed. Although it was not possible to accurately assess the numerical effect of the destruction of up to 15% of the flower heads by endophytic species, it would seem that the remaining 85% were producing more seeds than were actually needed to assure the continuous existence and the spread of the three species. This is indicated by the general abundance of all three species throughout the survey area, in spite of the scattered occurrence of suitable growing sites within the area. Nevertheless, the insects living endophytically in the flower heads were the only species which caused measurable damage. Within this group, *E. sonchi* was the dominant species on *S. asper* and *S. oleraceus*, whilst *T. dilacerata*, and locally *Contarinia sonchi* and *Eucosma* (?) sp. were the most important species on *S. arvensis*. The flower heads which are attacked by *T. dilacerata* and *Eucosma* (?) sp. do not develop any viable seeds, and a larva of *Eucosma* (?) sp. apparently feeds on several flower heads before it completes its development.

The feeding in the stems of *Napomyza lateralis* Fall. and *Ophiomyia persimilis* Hd. did not affect the growth and seed production of the attacked plants. The survey also indicated that the species, which are recorded to feed externally on the stems, the flower heads and the leaves, are of no importance as limiting factors for *Sonchus* spp. Plants of *S. asper* and *S. oleraceus* developed an average number of flower heads and seeds, even at high densities of *H. lactucae*, the only common and abundant species of this group within the area surveyed. The effect of the leaf-mining species was similarly negligible. Apart from only being found in rather humid environments, they attacked mainly leaves on the lower part of the plants, which died before the plants reached the stage of flowering and seed formation. No trace of insect feeding was observed externally on, or inside, the root-stocks.

Prospects of the biological control of Sonchus *spp. outside their natural distribution area.*

The information available on the complex of phytophagous insects associated with *Sonchus* spp. in Europe would suggest that the prospects for an effective biological control outside their native distribution area are slight. There are only a limited number of species which seem to be restricted in their feeding to the genus *Sonchus*, and under European conditions none of these species causes any serious damage. With regard to the perennial species, *S. arvensis* and *S. uliginosus* it is regrettable that apparently no insect species attacks the root-stock of *Sonchus*, and that no effective stem-miner is available.

Species that warrant further studies are the Cecidomyids *Contarinia sonchi* and *C. schlechtendaliana*, the Trypetid *T. dilacerata*, the Anthomyid *P. sonchi* and the Tortricid *Eucosma* (?) sp., all living endophytic in the flower heads, as well as the leaf-miners *Cystiphora sonchi*, *Trypeta immaculata*, and the Agromyzids *L. pusilla*, *M. pulicaria* and *P. perpusilla*. The main candidate species for oviposition and feeding tests are *T. dilacerata*, *Eucosma* (?) sp. and *Cystiphora sonchi*. Additional species will only be tested if it is found that the feeding range of one or the other of these three species includes plant species of economic importance.

DISCUSSION

The analysis of the complex of phytophagous insects associated with *Sonchus* spp. in Europe has shown that the complex consists of a limited number of specific species, and a variety of polyphagous and oliphagous species. The great majority of the latter are only sporadically found on *Sonchus* spp., and those more constantly associated with plants of this genus occur in small numbers only. The specific species are generally somewhat more frequent, but they rarely build up higher population levels.

The fact that a variety of polyphagous and oliphagous species are attacking *Sonchus*, and are able to complete their development on plants of this genus, would appear to be contrary to the hypothesis that the complex of species is primarily limited by the physiology of the host plants, e.g. the production of latex. This hypothesis also does not explain why the insect species limited to the genus *Sonchus* are not more frequently found.

Observations within the area surveyed between 1971 and 1973 would suggest that the ecology of *Sonchus* is a major handicap for the evolution of a rich complex of well adapted phytophagous species. All species of *Sonchus* were found to occur almost exclusively as early successional species on recently disturbed sites, and disappeared 2 or 3 years after their first appearance, when other plant species, like *Artemisia* spp., *Crepis* spp. and grasses, were invading a site which had formerly almost exclusively been occupied by *Sonchus*. The inferiority in competition with other weeds, and the erratic occurrence of new sites which can be occupied by *Sonchus*, results in a conutinuously changing distribution pattern within a larger area, in which the stands of *Sonchus* are generally isolated from each other. Moreover, many of the suitable sites are small, and support only a limited number of plants. It is quite probable that phytophagous insects cannot easily develop a close relationship with a host plant under these conditions.

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