Agricultura 2: 12-15 (2003)

Preliminary survey of *Chondrilla juncea* L. (*Asteraceae*) and its natural enemies in Bulgaria

Ivanka LECHEVA and Anna STANTCHEVA

Faculty of Plant Protection and Agroecology, Agricultural University of Plovdiv,
12 Mendeleev blvd, Plovdiv 4000, Bulgaria

Chondrilla juncea L. is a herbaceous, taprooted perrenial, native to Eurasia. It was introduced to Australia and USA where it became one of the major noxious weeds, because of the absence or inefficiency of its natural enemies. We conducted a preliminary survey to locate the populations of *Chondrilla juncea* in Bulgaria and to determine possible agents of biocontrol. The investigation indicates that *juncea* is widespread in Bulgaria mainly on disturbed area and roadsides. It also occurs in orchards, vineyards, rose fields and wheat plots. It was found that the agents, which are established in Australia and North America as a part of a program for biological control, are also associated with *C. juncea* in Bulgaria. Additionally, we found leaf-feeding beetles and moths, root-miners, and seed-feeding flies and moths. Agricultura 2: 12-15 (2003)

Key words: *Chondrilla juncea*; rush skeletonweed; distribution in Bulgaria; fenology; biocontrol agents

INTRODUCTION

Chondrilla juncea L. is a herbaceous, deeply rooted perennial, native to Eurasia, which is characterized by exuding milky latex, when leaves, stems and roots are cut or broken. The Balkans are considered to be close to the center of its origin. The plants are spreading and invading new areas by seed, by sprouting from rhyzomes or by regeneration from root fragments. Currently, this species is widely distributed almost all over the world: in Europe (Germany, Switzerland, France, Spain, Italy, Greece, Hungary, Romania, Macedonia, Bulgaria), Asia and Asia Minor (Lebanon), south-eastern regions of the former USSR, USA (California, Idaho, Maryland, Montana, Oregon, Washington, Virginia) South America (Argentina) and New Zealand. It appears to be well adapted and tolerant to a wide range of climatic and ecological conditions. Rush skeletonweed was introduced to Australia prior to 1910, with the European grapevine stock, and of feed from the United States in 1914 (McLellan 1991). It became a serious problem in fields planted with cereal crops, reducing the yields by 80 % through competition for soil moisture and nutrients and interference with harvesting because of its wiry, latex producing stems (Groves and Cullen 1981). In the northwestern USA it was reported near Spokane, Washington in 1938, and later it was found in Idaho and Oregon during the 1960s, and in California 1965. In some US states such as Montana it appears to be a serious threat to agriculture because its populations continue to spread, occupying pastures, arable areas and forests. The lack of natural enemies is considered to be the main reason for the invasion of this species in the US and Australia, where it became one of the major noxious weeds. Chemical control is not always efficient and depends on the specific environmental conditions. Only repeated applications of herbicides are effective. Because of the negative impact of herbicides on the environment and high cost of the chemical control, demand for alternative methods of control has increased. During the 1960s the first effective biological control program against rush skeletonweed was developed in Australia (Piper and Andres 1995). The program was focused on searching for natural enemies in northern Mediterranean and Iran. As a result three biological control agents were released: the gall midge (*Cystiphora schmidtii* Rubsaamen), the mite (*Aceria chodrillae* G. Canestrini) and the rust (*Puccinia chodrilina* Bubak and Syd) from Italy (1971) and Turkey (1980). They appeared to be successful in controlling most of these weeds in wheat growing areas. Establishment of midges, mites and fungi resulted with slow stem growth, reduced flowering and seed set (Cullen and Groves 1977). The controlling agents also minimized root reserves disallowing normal recovery of the plant after tilling damages (Groves and Cullen 1981). The same biocontrol agents were introduced to the northwestern US, however, they were not effective and the rush skeletonweed continued to spread. In 1995, a program was implemented to search, in Eurasia, for more effective biological control agents which might be useful especially in cooler states such as Montana, Idaho, Washington, and Oregon (Markin and Quimby 1997).

Correspondence to: Dr. Ivanka Lecheva
Faculty of Plant Protection and Agroecology, Agricultural University of Plovdiv, 12 Mendeleev blvd, Plovdiv 4000, Bulgaria
E-mail: lecheva@au-plodiv.bg, Phone: ++359 88 865 712

MATERIAL AND METHODS

The investigation of the distribution of the skeletonweed and its natural enemies in Bulgaria took place during the period 2000-2002. In order to locate the populations,

field surveys were organized from April to October throughout different regions and different altitudes (0-1200 m). We explored many areas along the Black Sea coast, river Danube and West Bulgaria. During these surveys individuals of all insect species, which were found to feed on and cause damage to this weed, were recorded, described and collected. On locations with large and vigorous populations of this weed, we collected the dominating insects regularly every 10 to 14 days. They were collected from all main parts of the plant such as leaves, stems, roots, flowers buds and fruits. For determination of insects and other organism feeding on the rootstocks, 50 to 100 samples of soil were taken. All larvae found to be feeding on roots and on parts above ground were reared in laboratory conditions in Petrie dishes, plastic bags, plastic cages as well as in pots with *Chondrilla juncea* plants. Species were identified in adult stage.

RESULTS AND DISCUSSION

Natural populations of the skeletonweed, which were located in many parts of country varied significantly in size and density of plants; from single plants along roads to 120 plants (stems) per square meter was found in locations up to 1200 m above sea level (Rhodopean Mountains). Dense populations were found on abandoned lands in the southwest, west and central Bulgaria (regions of Blagoevgrad, Dupnitza, Kjustendil and Plovdiv). They were spread roads in the coasted area of the Black Sea (Varna, Bourgas, Primorsko), and the River Danube (Rousse, Vidin). Disturbed areas south from the Balkans mountains along the highway from Sofia to Bourgas were also found to be suitable for its establishment. The distribution of *C. juncea* and associated natural enemies throughout Bulgaria is presented in Table 1. In low density it was found as a weed in wheat fields, sour cherry and peach orchards, vineyards, rose populations. The investigation showed that this species established early and fast where habitat was suitable. It was very well adapted on well drained, light sandy or gravel soils and disturbed areas.

Our fenological observation showed that seeds germinate when soil temperature is above 16 to 18°C and rosettes are established within 15 days. Stems begin to elongate from the center of rosettes in the last decade of April and expand to 50 to 60 cm, at the beginning of May. At this time the rosette leaves are up to 16 cm long while the stem leaves are up to 10 cm long, with the average width of 2-12 mm. The flowering begins in the middle of June and lasts until late November. Yellow inflorescences develop on the stem and branch tips. They remain open for one day. Fruits and seeds reach maturity within 10 to 15 days. The pappuses of fruits/seeds act like parachutes, enabling fruits/seeds to be dispersed by wind, water, machinery and vehicles. On each plant it is possible to find all stages of floral and fruit development: buds, blooming inflorescences and mature fruits. In the mountainous regions and along the Black Sea coast, flowering occurs about two weeks later than in the West Bulgaria and the Tracian Valley. The floral shoots die in late October or November. The autumn rains induce both seed germination and vegetative growth from the rootstock. The rosettes, which develop in autumn, are ready to overwinter.

Table 1: Distribution of *Chondrilla juncea* and associated natural enemies throughout Bulgaria

Locations	1	2	3	4	5	6	7
Plovdiv	+	+++		++		+	+++
Plovdiv (Trud)	++++	+		+	+	+	
Karlovo	++	+++				+++	
Karnare	++++	+++		+		++++	+
Primorsko			++++	+			
Djuni					+++		
Bourgas		+		+			++
Varna	+	+		+		+	+
Shoumen		+					
Rousse		+		+			
Berkovitza	++						
Sofia		+		+			
Kjustendil	++++	++		+		+	
Dupnitza	+					+	+
Bobov Dol	+	+		+		+	+++
Borovetz						+	
Ihtiman	+++	++++		+		+++	+

1-*Mordellistena* sp.: 2-*Schinia cognata*; 3-*Coptocephala scopolina*; 4-*Cytiphora schmidtii*; 5-*Bradyrrhoa gilveollela*; 6-*Mylabris* sp.; 7-*Aceria chondrillae*; + = single individuals; ++ = recorded on 10-25% of the samples +++ = recorded on 25-50% of the samples; ++++ = recorded on more than 50% of the samples

With the increase of temperatures in the spring the growth continues with the formation of one or more stems from each rosette.

All three agents used for biological control of *C. juncea* in the USA and Australia are also associated with the plants in Bulgaria. The first observations showed that the rusts had the greatest effect. The fungi are widespread in Bulgaria, where they have a reduced life cycle that omits the sexual stage of reproduction, and the autumn rosettes can be directly infected by urediospores. From old mature stems the infection spreads on leaves gradually over next few months and transfer to the stems as they begin to bolt in spring.

The other pathogens, identified in Bulgaria, belong to genera *Alternaria*, *Leveilulla* and *Fusarium*, and were found to cause considerable damage to investigated plants.

The gall midge, *Cystiphora shmidtii* is not common in our country. It could be found in very low density and has four or five generations per year. The female individuals insert eggs beneath the surface of stems and leaves. The larvae feed on leaf mesophyll or stem parenchyma. This results in the formation of anthocyanescent, blisterlike galls within the larvae pupate. Mature larvae, prepupae, or pupae overwinter within galls, or as pupae in the soil. We observed galls mainly on stem leaves and in single occasions on rossete leaves.

The gall mite, *Aceria chondrillae*, which is considered to be the most effective biocontrol agent in the USA was found in many locations in western Bulgaria and near the town of Bourgas, in 2001. More rush skeletonweed population attacked by the mite were located in 2002; some plants were severely stunted and did not flower (Bobov dol, Karlovo). The mites cause damages to *Chondrilla juncea* plants in three different ways: stunting plants at the sprouting stage by forming galls at growing points, weakening plants by massive gall production, and reducing seed production by destroying flower buds. They also affect the root carbohydrate reserves, preventing formation of the satellite plants. They have several generations per year and can complete a generation within ten days, under optimal conditions. Low plant density and low humidity (below 40 to 50%) are the main factors. The mites overwinter as non-feeding adults in rosettes, without inducing galls. They invade the axillary and terminal buds of shoots. The mite feeding causes the formation of leafy galls (Fig. 2). The galls continue to grow up to 15 to 20 mm in diameter and each may contain hundreds of mites in various stages of development. The mites are feeding and reproducing within galls as long as they remain green and leave them as they start drying. The environmental humidity is the main factor that redistribution of the mites depends on.

Since mites and midges found in Bulgaria are not abundant they are not responsible for efficient controlling of the weed. The investigations were expanded and included additional insects. During the investigations the following species were identified:

I. Insects attacking the rootstock

The root-miner, *Mordellistena* sp. (Coleoptera, Mordellidae). It normally attacks thicker rooted plants. The larvae feed in the central cylinder of the root causing severe damages. It is active from August to May.

The root-feeding moth, *Bradyrrhoa gilveolella* Tr. (Lepidoptera, Phycitidae). It was found in relatively high density (5 to 7 feeding tubes per plant) on *C. juncea* plants, growing in pure sand along the Black Sea coast (south from Bourgas, near Djuni). The damage is done by the larvae, which feed on the outer cortex of roots, causing a groove in the plant tissue that may extend 2 to 3 mm into the root.

II. Flower-feeders

Schinia cognata Freyer (Lepidoptera, Noctuidae) (Fig. 3), feeding on flower buds and flowers. Larvae totally destroy them and thus reduce the seed production and species distribution. The moth has several populations per year and causes damage to *C. juncea* plants from the beginning of flowering in May, until floral buds are available.

Flower-feeding beetle, *Mylabris* sp. (Coleoptera, Meloidae). Adults were found in high density in many locations throughout the country feeding on the flowers of *C. juncea* and destroying them.

III. Seed-feeders

Seed-feeding midge, *Dasyneura* sp. (Diptera, Cecidomyiidae). It is widespread throughout Bulgaria. Several larvae (4-6) live on the same inflorescence, where the pupae and adult midges emerge. Since the larvae feed mainly on the exterior of the seed they do a little damage to the plant.

Fig. 1. Chonrilla juncea L.

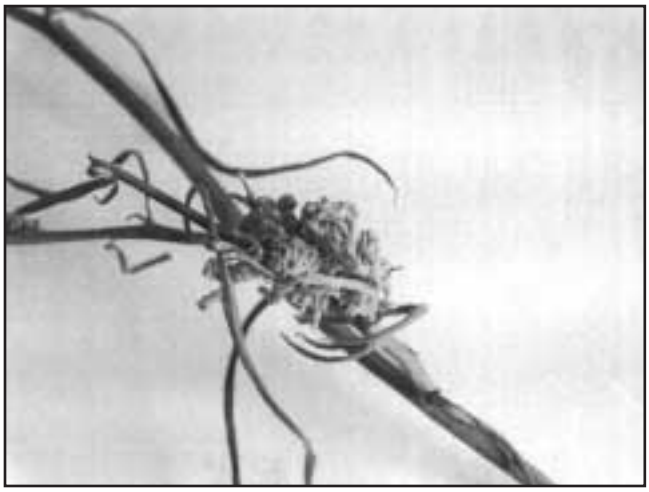

Fig. 2. Galls caused by Aceria chondrillae in Bulgaria.

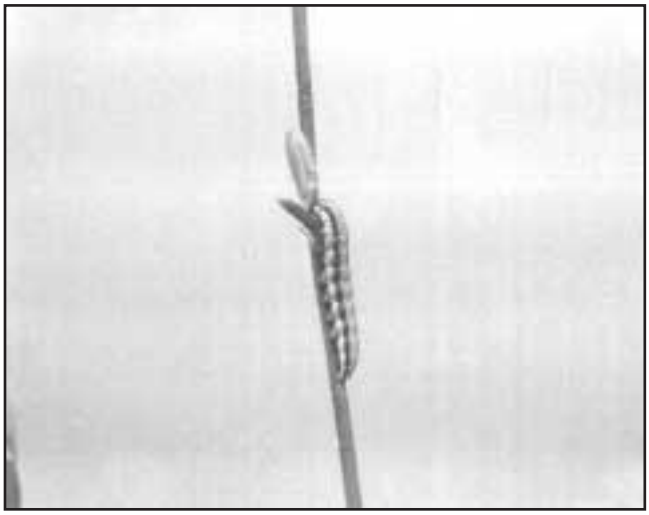

Fig. 3. A caterpillar (Lepidoptera) feeding on a flower bud of Chonrilla juncea L.

IV. Leaf-feeders

Leaf-feeding beetle, *Coptocephala scopolina* L. (Coleoptera, Chrysomelidae), found in high density along the Black Sea coast, south of Bourgas. Adults feed on the leaves and stems of *C. juncea*.

A group of moth species (Lepidoptera, Geometridae and Noctuidae) have been found feeding on *C. juncea* and

some sucking bugs, which attack the inflorescences, leaf-feeding beetles (some of them are polyphagous) and Hymenoptera larvae feeding on stem leaves.

CONCLUSION

C. juncea is widespread in Bulgaria. It is most abundant along the roads, railways and on disturbed areas, but also occurs on cultivated fields. In cultivated fields, the fragmentation of the rootstock by tillage equipment can have significant influence on the density and the rate of spread of this weed. It develops a deep taproot system which means and it advantage in the competition with other vegetation with shallower root systems. Concerning the natural control of *C. juncea*, the observations which took place in 2000, 2001, and 2002 suggest, that the most significant damages are caused by the root-borer, *Mordellistena* sp., and the flower-feeding caterpillar, *Schinia cognata*. Damages done by the gall midge, *Cystiphora schmidtii* are not significant. The mites (*Aceria chodrillae*) were found in most locations but in relatively low abundance. More attention should be paid to root attacking species as well as to flower-feeders, however, more detailed study of their biology and ecology is needed as well as the testing of their host specificity. We consider that a successful biological control of this plant species could only be achieved by using a complex of bio-control agents, attacking both rootstock and flower shoots. In spite of the fact that a number of natural enemies of *C. juncea* are found in Bulgaria we could not ignore the fact that it is widespread throughout the country. Dense populations and even single plants on disturbed areas and along the roads could be a serious threat to the neighbouring crops. The fact that this weed easily establishes and adapts to various conditions and compete successfully with other crop species for limited resources (mainly nitrogen and water), its ability to spread vegetatively or by seed to long distances should not be underestimated.

ACKNOWLEDGEMENTS

The work describe here is a part of a research program on biological control of *Chondrilla juncea* undertaken by the Faculty of Plant Protection and Agroecology at the University of Plovdiv, Bulgaria; USDA Forest Service, Rocky Mountain Research Station Forestry Sciences Laboratory, Bozeman, MT; USDA Agricultural Research Service; European Biological Control Laboratory Montpellier, France and USDA Agricultural Research Service Thessaloniki, Greece. The authors would like to thank particularly Geroge Markin, P. C. Quimby, Jr., and Javed Kashefi for their support, and Dr. Stojan Beshkov from BAS for the identification of *Schinia cognata*.

REFERENCES

1. Caresche, L. A., Wapshere A. J. Biology and host specificity of the Chondrilla gall mite *Aceria chondrillae* (G. Can.) (Acarina, Eriophyidae). Bulletin of Entomological Research. 1974; 64 183-192.
2. Caresche, L. A., Wapshere A. J. The chondrilla gall midge, *Cystiphora schmidtii* Rubsaamen (Diptera: Cecidomyiidae) II Biology and host specificity. Bulletin of Entomological Research, 1975; 65: 55-64.
3. Cullen, J. M., Groves, R. H. The population biology of *Chondrilla juncea* in Australia. In: Proceedings of the ecological society of Australia. 1977; 10: 121-124.
4. Groves , R. H. J. D. Cullen. *Chondrilla juncea* the ecological control of a weed. In: The ecology of pests: Some Australian case histories. 1981.
5. Markin, G. P. P. C. Quimby. Report of work on biological control of rush skeletonweed (*Chondrilla juncea*). USDA Forest service, Rocky Mountain Research Station Forestry Sciences Laboratory, Bozeman MT and USDA Agricultural Research Service, European biological control laboratory Montpellier, France. 1997. 40 pp.
6. McLellan, P. W. The effects of mowing on the efficacy of the, gall mite, *Eriophyes chondrillae*, on rush skeletonweed, *Chondrilla juncea* (Master of science thesis). Washington State University. 1991.
7. Piper, G. L. L. A. Andres. Rush skeletonweed. In: Biological control in the Western United States, University of California, 1995; USA. 252-255.

Received January 6, 2003; accepted in final form August 8, 2003