Gastrophysa viridula (Coleoptera: Chrysomelidae) and biocontrol of *Rumex* – a review

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ABSTRACT

Gastrophysa viridula (DeGeer) (Coleoptera: Chrysomelidae) is an oligophagous herbivore which prefers consuming leaves of dock (*Rumex* spp.) species. Because of its feeding specialization this leaf beetle species is considered a potential biocontrol agent of dock plants. This paper reviews geographic distribution, development, life history, herbivory, and natural enemies of this species. Its potential use as a biocontrol agent will be then evaluated. *G. viridula* is an important part of the complex of *Rumex* natural enemies. Its herbivory decreases vigour of *Rumex* plants but cannot cause their mortality alone. The effect of herbivory is enhanced by other biocontrol agents, particularly the rust *Uromyces rumicis* (Schum.) (Pucciniaceae). Combined effects of *G. viridula* and other biocontrol agents increase *Rumex* mortality and thus contribute to its natural control. Attempts at using *G. viridula* in control of *Reynoutria* spp. were still unsuccessful. *G. viridula* may also become a pest of several Polygonaceae crops.

Keywords: *Gastrophysa*; Coleoptera; Chrysomelidae; *Rumex*; geographic distribution; development; life history; herbivory; biological control

Biological control of agricultural pests has three main strategies (Honěk 1983). Today (i) classical biological control, i.e. the introduction and release of exotic insects, mites or pathogens to ensure permanent control (of pest organisms), is a predominant method (McFadyen 1998), popular because of its spectacular successes in the past. Alternative methods consist in (ii) conservation and increasing the efficiency of indigenous natural enemies and their use in the systems of integrated weed management or in (iii) inundative releases of artificially colonized weed herbivores and pathogens. These methods are less popular because their effects are concealed, the application may be laborious or expensive and usually requires large knowledge.

Unlike biological control of insect pests whose reputation consists mainly in few early achievements (Hodek and Honek 1996) biological control of weeds continues its successful progress. The foundations of weed biocontrol became systematically investigated already in the mid-20th century (Charudattan and DeLoach 1988, Wapshere et al. 1989, Harris 1991). Recent important cases of successful weed biocontrol concern the use of biocontrol agents imported against invasive plants, mostly in countries severely plagued by imported weeds (Australia, North America and South Africa). The biocontrol of native weeds is more difficult than the protection against alien ones. Although most native plants host abundant complexes of herbivores and pathogens, these organisms only rarely cause fatal damage because of long co-adaptation between the enemy complex and its host plant. This situation is also faced with attempts at dock (*Rumex* spp.) control in Central Europe.

DOCK SPECIES AND THEIR HERBIVORES

In the Czech Republic, the docks, plants of the genera *Rumex* L. (14 species), *Acetosa* Mill. (5 species) and *Acetosella* (Meissner) Four. (1 species), are abundant indigenous perennials inhabiting a wide range of natural and cultivated habitats (Kubát 1990). Some species are important weeds, mainly those growing on meadows, pastures, in permanent crop cultures (*Rumex obtusifolius* L., *R. crispus* L.) or in eutrophicated habitats bordering mountain farms [*Acetosa alpestris* (Jacq.) A. Löve]. These species survive cutting and their spread is encouraged by grazing. Since chemical and mechanical control is difficult, the use of natural enemies is considered as a useful alternative.

The dock species are associated with a complex of invertebrate herbivores including Hemiptera, Lepidoptera, Coleoptera, Hymenoptera and Diptera

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Table 1. Insect herbivores of dock species (*Rumex* spp., *Acetosa* spp., *Acetosella* spp.)

	Family	Org	Feed	Stage	Bioc	N_{ref}
Coleoptera						
Apion frumentarium (L.)	Curculionidae	St	Mn	L, A	*	5
Apion violaceum Kirby	Curculionidae	St	Mn	L, A		4
Galerucella grisescens Joannis	Chrysomelidae	Lf	Chw	L, A	*	15
Galerucella nympheae (L.)	Chrysomelidae	Lf	Chw	L, A		2
Gastrophysa viridula (DeGeer)	Chrysomelidae	Lf	Chw	L, A	*	26
Hypera rumicis (L.)	Curculionidae	Lf	Chw	L, A	*	2
Diptera						
Liriomyza trifolii (Burges)	Agromyzidae	Lf	Mn	L		1
Pegomya nigritarsis (Zetterstedt)	Anthomyiidae	Lf	Mn	L	*	2
Tipula paludosa (Meigen)	Tipulidae	Rt	Chw	L		1
Heteroptera						
Calocoris norvegicus (Gmelin)	Miridae	St, Lf	Su	L, A		1
Coreus marginatus (L.)	Coreidae	St, Lf	Su	L, A	*	1
Lygus spp.	Miridae	St, Lf	Su	L, A		2
Homoptera						
Aphis etiolata Stroyan	Aphididae	St, Lf	Su	L, A		1
Aphis fabae Scopoli	Aphididae	St, Lf	Su	L, A		3
Aphis rumicis L.	Aphididae	St, Lf	Su	L, A		2
Aphrophora salicis (DeGeer)	Aphrophoridae	St, Lf	Su	L, A		1
Aulacorthum solani	Aphididae	St, Lf	Su	L, A		2
Brachycaudus rumexicolens (Patch)	Aphididae	St, Lf	Su	L, A	*	2
Dysaphis radicola (Mordvilko)	Aphididae	Rt	Su	L, A	*	1
Myzus persicae (Sulzer)	Aphididae	St, Lf	Su	L, A		1
Smynthurodes betae Westwood	Pemphigidae	Rt	Su	L, A		3
Lepidoptera						
Helicoverpa armigera (Hübner)	Noctuidae	Lf	Chw	L		1
Hydraecia micacea (Esper)	Noctuidae	Lf	Chw	L		1
Lycaena dispar (Haworth)	Lycaenidae	Lf	Chw	L		1
Lycaena hippothoe (L.)	Lycaenidae	Lf	Chw	L		2
Ostrinia nubilalis (Hübner)	Crambidae	Lf, St	Chw	L		1
Spilosoma luteum (Hufnagel)	Arctiidae	Lf	Chw	L		1
Psyllodea						
Aphalara exilis (Weber et Mohr)	Aphalaridae	Lf	Su	L, A		1

The table contains species recorded in the Czech Republic and considered in literature between 1990 and 2002 Org – plant organ where herbivory occurs (Rt – root, St – stem and inflorescence, Lf – leaf); Feed – type of feeding (Chw – chewing, Mn – mining, Su – sucking); Stage – development stage when herbivory occurs (L – larva, A – adult); Bioc – asterisked species were explicitly considered for biocontrol of dock species; N_{ref} – number of references concerning the species and dock plants in the CAB pest CD (2003)

Table 2. Effect of temperature on duration (days) of development, adult longevity and pre-oviposition (preo), oviposition (ovi) and post-oviposition (posto) periods in females (Honek et al. 2003)

Temperature (°C)	Egg	Larva	Pupa	Adult					Total	
				female				male	female	male
				preo	ovi	posto	total			
18	7	15	6	8	19	6	33	48	61	76
21.5	5	12	5	8	16	2	26	43	48	65
25	4	9	4	5	10	3	18	28	35	45
28	3	8	3	5	10	3	18	28	32	42

(Salt and Whittaker 1998). Several herbivorous species usually occur together on one dock plant and simultaneously damage its different organs. The species tunnel or graze roots, stems and leaves, and suck on aboveground parts including inflorescences. Twenty-eight herbivores occurring in the territory of the Czech Republic became subjects of research in 1990–2002 (Table 1). Other species causing minor damage certainly escaped attention. Besides herbivores, pathogens also attack dock plants and may increase influence of herbivores.

LEAF BEETLES AS DOCK HERBIVORES

By far the most studied (Table 1) dock biocontrol agent is a small leaf grazer *Gastrophysa viridula* (DeGeer) (Coleoptera: Chrysomelidae) (= *G. raphani* Herbst). This leaf beetle belongs to the subfamily Chrysomelinae, which is represented in the Czech Republic by some 124 species and sub-species, all herbivores. The genus *Gastrophysa* Chevrolat (= *Gastroidea* Hope) is represented by 2 species (Strejček 1993). *G. viridula* preferentially eats dock (*Rumex* spp.), *G. polygoni* (L.) prefers knotweed (*Polygonum aviculare* L.) but both species may also consume leaves of other plant genera. Adults of both species are oblongate, 4–6 mm long, and may be easily distinguished by the pronotum colour (*G. viridula*: metal green to violet, *G. polygoni*: red-yellow) (Mohr 1966). Larvae can also be distinguished on the basis of their coloration (*G. viridula*: dark dorsum, *G. polygoni*: pale yellow dorsum) (Steinhausen 1994). Subspecific taxonomy and character description of the genus *Gastrophysa* was published by Jolivet (1951).

An important foreign dock biocontrol agent of the same family Chrysomelidae is Palearctic *Galerucella grisescens* Joannis. This species is an important dock [(*Rumex japonicus* (Houttuyn)] grazer in Japan (e.g. Toda and Yano 1993a, b), also distributed in Korea, China, Siberia and Eastern Europe. *G. grisescens* has some life history parameters similar to *G. viridula* and is also a candidate of dock biocontrol programme (Lühmann 1938). However, presence of this species in the territory of the Czech Republic is dubious (Strejček 1993) and its use for local dock biocontrol improbable.

BIOLOGY OF *G. VIRIDULA*

Origin and distribution

Gastrophysa viridula is distributed throughout Europe (Mohr 1966). As late as at the beginning of the 20th century, *G. viridula* was common only in alpine areas, on eutrophicated *Rumex*-grown meadows around the farmyards and haylofts (Reitter 1912), and not abundant in the lowland (Kuhnt

Table 3. Thermal constants, lower development threshold LDT (°C) and sum of effective temperatures SET (day-degrees)

	LDT	SET
Egg	8.1 ± 1.9	66.0
Larva	7.0 ± 2.6	164.8
Pupa	6.1 ± 0.5	74.3
Total	7.1 ± 1.9	304.6

Table 4. Net reproduction rate (R_o = number of eggs of female sex), generation time (T = time from egg deposition to producing 50% of progeny) and intrinsic rate of population increase (r_m) of *G. viridula* populations at different temperatures

Temperature (°C)	R_o	T	r_m
18	157.3	45.5	0.111
21.5	100.3	37.2	0.124
25	71.3	25.0	0.171
28	74.5	24.1	0.179

Table 5. Plants recorded as occasional or regular hosts of *G. viridula* (Engel 1956)

Host species	
Borraginaceae	*Symphytum officinale* L.
Brassicaceae	*Brassica oleracea* L., *B. rapa* v. *rapifera* Metzger, *Cochlearia armoracia* L., *Raphanus sativus* L., *Nasturtium* spp.
Chenopodiaceae	*Beta vulgaris* v. *cicla* L.
Daucaceae	*Heracleum sphondylium* L.
Fabaceae	*Lathyrus sylvestris* L., *Phaseolus* spp., *Vicia faba* L.
Geraniaceae	*Trapeolum majus* L.
Polygonaceae	*Acetosela vulgaris* (L.), *Acetosa pratensis* (L.), *Rumex alpinus* L., *Rumex aquaticus* L., *R. arifolius* All., *R. conglomeratus* Murr., *R. hydrolapathum* Huds., *R. maritimus* L., *Rumex patientia* L., *R. obtusifolius* L., *R. scutatus* L., *Oxyria digyna* Hill., *Polygonum amphibium* L., *P. aviculare* L., *P. lapathifolium* L., *P. persicaria* L., *Fagopyrum* spp., *Rheum compactum* L., *R. officinale* Baill., *R. palmatum* L., *R. rhaponticum* L., *R. undulatum* L.
Solanaceae	*Solanum tuberosum* L.
Violaceae	*Viola tricolor* L., *Viola* spp.
Vitaceae	*Vitis vinifera* L.

1911) . Since then it spread along the river streams over the whole area of Central Europe (Franck 1935, Horion 1935). This spread was finished by the 1950s when the species was already abundant in the whole territory of Germany (Renner 1970b). In the Czech Republic *G. viridula* was already found in the mid-1800s (Lokaj 1869). It was rare in lowlands (Prague, Mezní Louka near Hřensko) but common in mountain areas (the district of Loket). This preference did not change until 1950 (Reitter 1912, Fleischer 1930, Roubal 1941). The late expansion of the species could be encouraged by spreading of stands of weedy *Rumex* spp. in lowlands that was favoured by the creation of large farms in the 1950s. The docks then became among the top three important weeds of pastures (Mikulka et al. 2001, Kohout 1984). Thus in lowlands the conditions for *G. viridula* development are now more favourable than 100 years ago.

At present the species is common in the whole territory of the Czech Republic and occurs evenly distributed in all zoogeographic districts and altitudes (Strejček 1993). However, no map of species distribution projected on the zoogeographic reference grid is available. Most populations are confined to dock stands but the distribution is always patchy because dispersal is difficult. A significant proportion of *G. viridula* adults moves only between plants within a patch (Smith and Whittaker 1980a) and migration between patches is rare (Weingartner et al. 1997). When a local population becomes extinct in consequence of natural disasters (flood) or agricultural practices (cutting), recolonization may go on for a long time (Whittaker et al. 1979).

Development

Pre-adult and adult development was investigated in detail (Remaudière 1948), Engel (1956) and Renner (1970b). The pale yellow eggs (1.3 mm long, 0.5 mm wide) are laid in batches of 1–60 (modal number 40), preferentially (97%) on the abaxial side of nearly or fully expanded leaves. Larval development has 3 instars. An additional instar developing and moulting within the eggshell was observed by Renner (1970b). Freshly enclosed larvae remain in a dense group for several hours and eat remnants of eggshells, then they disperse. The 2nd and 3rd instars are separated by moultings lasting 20–30 minutes. Expression of defensive secretions is particular to the last (fourth) instar larvae. At the end of feeding period the larvae leave the host plant and pupate in the soil, preferentially 2–5 cm deep. In the soil, the larva prepares a 6 × 3 mm pupation chamber. Larval-pupal moulting after 4–6 days (pre-pupal) period and pupal-adult moulting occur in the pupation chamber. At high temperatures (≥ 28°C) development of some pupae is substantially prolonged, probably because of dormancy (aestivation) (Honěk unpublished). Freshly ecdysed adults escape the soil and immediately start to feed. Flight of males and females was observed only in the teneral period. The flight distance is small, < 10 m in observed cases. In non-dormant adults reproduction starts after a short feeding period. Then the abdomen of the female becomes conspicuously swollen and oviposition begins. Most of its adult life is occupied by reproduction. The female longevity is shorter than that of the male (Renner 1970b). Although one insemination is sufficient for the whole female life (Remaudière 1948), matings are frequent and always immediately precede oviposition. This timing of copulation probably minimizes the effect of sperm competition of rival males which often try to displace a copulating male from the female's dorsum. Some females are (facultatively) parthenogenetic (Remaudière 1948, Osborne 1879). Their frequency varies between local populations (Engel 1956). The adults born in the autumn hibernate but the dormancy was not studied in detail.

Life history

In the open active adults and larvae of *G. viridula* appear from late April to late October, oviposition was observed (Germany) between early May and mid-October. During this period the species produces several generations whose number varies between local populations and was estimated between 2 and 4. The studies of Western Europe reported three (Smith and Whittaker 1980a) or four (Swatonek 1972) generations per year. Smith and Whittaker (1980a) demonstrated that the number of generations increased as a consequence of cutting followed by regrowth of physiologically young leaves. The number of generations depends on dormancy incidence, temperature and host plant quality. Adult dormancy concerns whole populations and precludes autumn, winter and early spring reproduction. Pupal dormancy concerns only a fraction of the population and depends on temperature.

Temperature determines the duration of development (Honek et al. 2003) (Table 2). At constant 18°C the mean pre-adult development time is c. 28 days, at 28°C its duration decreases to 15 days. Thermal constants (Table 3), lower development threshold 7.1°C and sum of effective temperatures for total development 304.6 day-degrees were calculated. Statistical analysis revealed that the lower development threshold was common for all development stages: egg, larva and pupa (Honek et al. 2003). The existence of an identical development threshold for all development stages is called rate isomorphy (Jarosik et al. 2002) and is of great practical importance because it greatly facilitates calculating the thermal constants. The maximum number of generations *G. viridula* can complete was calculated for populations at Praha-Ruzyně (50°N, 14°E, altitude 350 m). Temperature sum available for *G. viridula* development was 1314 day-degrees above 7.1°C threshold. This sum divided by the mean generation time of *G. viridula* 496 day-degrees (Table 4) gives 2.4 generations per year. In Central European conditions the third generation is probably incomplete, established from a fraction of early born offspring of the second generation.

Individual growth and population dynamics of the beetles depends on host plant quality (Smith and Whittaker 1980a, b, Cottam et al. 1986). The number of generations increases when regrowth of *R. obtusifolius* leaves is induced later in the season by cutting or grazing (Engel 1956). Adult performance is also influenced by temperature (Table 2). The rate of oviposition increased and the duration of oviposition decreased with increasing temperature. Net reproduction rate R_0 and mean generation time decreased and intrinsic rate of population increase r_m increased with temperature (Table 4).

Observations in the open (Engel 1956) revealed that egg mortality was c. 20%, larval mortality c. 50%. These estimates of course vary between populations and years.

HERBIVORY

The list of host plants (Table 5) was compiled by Engel (1956) and completed using data from several authors.

Rumex species

In lowlands, *G. viridula* prefers eating leaves of broad-leaved dock *Rumex obtusifolius* L. followed by *R. crispus* (Hatcher et al. 1994). The larvae graze in the central as well as marginal parts of leaves. Young larvae prefer (c. 80%) to stay on the abaxial leaf side, third instars are evenly distributed. Larval abundance greatly varies between leaves on the same plants and between plants. Up to 8000 larvae were found on large plants. However, dense populations are usually concentrated on patches consisting of few plants surrounded by less infested *Rumex* stands (Engel 1956). Dispersal of larvae is limited, the average distance covering only several tens of centimetres during the whole larval stage. Young larvae firmly keep on the leaves, large larvae drop to the ground after excitation.

Other host plants

G. viridula also accepts several other plant species, preferentially of the family Polygonaceae (Chevin 1968, Smith and Whittaker 1980a) although *G. viridula* may eat several Polygonaceae species including *Acetosa pratensis* Miller (Kovalenkov and Stolyarov 2000) and *Polygonum aviculare* L. (Bulcke et al. 1994). Besides, several species of 10 families were found to support G. *viridula* populations (Table 5). On some of them *G. viridula* only feeds without reproduction, on others development can be completed.

NATURAL ENEMIES

Similarly like other herbivorous species regularly occurring in large quantities, *G. viridula* has a number of natural enemies. The list of observed species (Table 6) is based on Engel (1956). The list of predators comprises only generalists involved in predation of other phytophages (aphids, coleopteran and lepidopteran eggs and larvae, etc.). Wasps are probably the most efficient predators of *G. viridula* (Honek unpubl.). A complex of parasitoids also includes polyphagous species. The most specific is probably *Nemorilla floralis* Fallén (Diptera, Tachinidae). The mortality caused by predation and parasitism was rarely estimated. In observed cases it was low, < 10% (Engel 1956).

G. VIRIDULA IN DOCK BIOCONTROL

Since *G. viridula* has been considered an important biocontrol agent (Swatonek 1972, Barbattini et al. 1986, Hatcher et al. 1997a), its herbivory was studied in detail. Effectiveness of *G. viridula* biocontrol depends on the level of food consumption and species abundance. Intensity of herbivory is proportionate to the quality of dock leaves (Renner 1970a) which decreases in the course of growing season with their age (Brooks and Whittaker 1998). Cutting and regrowth thus increases the nutritional value of host plants (Smith and Whittaker 1980a). Leaf quality is modified by nitrogen fertilization (Hatcher et al. 1997a–c, Brooks and Whittaker 1998) and infection by the rust *Uromyces rumicis* (Schum.) (Pucciniaceae). Both factors decrease leaf N content, increase leaf C and water content and additively raise leaf consumption by *G. viridula* (Hatcher 1995, Hatcher et al. 1995, 1997a–c). However, previous herbivory reduces the infection of *Rumex* leaves by *U. rumicis* (Hatcher et al. 1994, Hatcher and Paul 2000). Air CO_2 content that is expected to increase may also influence leaf acceptability (Pearson and Brooks 1996, Brooks and Whittaker 1998).

Rust infection influences the site of oviposition and decreases the number of deposited eggs and their hatching success (Hatcher et al. 1994) while leaf ageing decreases female vigour and consequently also egg size and viability of resulting larvae (Brooks and Whittaker 1998). Intraspecific competition also sets limits to population size. Females cease to lay eggs and emigrate from leaves densely populated by conspecific larvae (Weingartner et al. 1997) in consequence of deposition of deterrents (Hilker 1989) synthesized by the larvae from precursors sequestered from the food (Feld et al. 2001).

Gastrophysa viridula populations often remove a large proportion of leaf area but usually do not kill the dock plants. Even the seedlings established few weeks before the herbivory, of which 90% leaf area was removed, were able to recover (Hatcher 1996). However, size, root to shoot ratio (Pearson and Brooks 1996, Hatcher 1996), and seed production and quality (Bentley et al. 1980) of regrown plants are influenced. Negative effects of herbivory are exaggerated in plants exposed to interspecific

Table 6. Predators and parasitoids of *G. viridula* (Engel 1956a, Honěk unpubl.)

	Species	Order	Family
Predators	*Adalia bipunctata* (L.)	Coleoptera	Coccinellidae
	Coccinella septempunctata L.	Coleoptera	Coccinellidae
	Saprinus virescens (Paykull)	Coleoptera	Histeridae
	Syrphidae spp.	Diptera	Syrphidae
	Nabis myrmecoides (Costa)	Heteroptera	Nabidae
	Vespa spp.	Hymenoptera	Vespidae
	Chrysopa carnea (Stephens)	Neuroptera	Chrysopidae
Parasitoids	*Nemorilla floralis* (Fallén)	Diptera	Tachinidae
	Meigenia mutabilis (Fallén)	Diptera	Tachinidae
	Meigenia bisignata (Meigen)	Diptera	Tachinidae
	Opius fuscipennis Wesmael	Hymenoptera	Braconidae
	Bracon guttiger (Wesmael)	Hymenoptera	Braconidae
	Pteromalus mandibularis Forster	Hymenoptera	Pteromalidae

competition (Cottam et al. 1986). Moreover, abundance of *G. viridula* is also affected by the complex of natural enemies whose efficiency is encouraged by the diversity of vegetation surrounding the dock patches (Smith and Whittaker 1980a, b). Using this species in the biological control of dock in meadows and pastures was attempted in systems of biological agriculture (Hann and Kromp 2001).

The studies thus defined the use of *G. viridula* in dock biocontrol. It may be efficient in unmown stands where interspecific plant (grass) competition decreases dock fitness. *Gastrophysa viridula* herbivory is potentiated by *U. rumicis* infection and the absence of natural enemies. *Gastrophysa viridula* decreases competitive ability and reproduction success of *Rumex* plants and contributes to dock control, although less efficiently than the laborious methods of mechanical root cutting and removal (Dierauer and Thomas 1994).

The magnitude of biocontrol effects depends on the abundance of *G. viridula* and duration of its herbivory which both increase with the number of generations. Temperature limits the effect of late summer herbivory that could have a significant biocontrol effect, particularly on newly established seedlings. Spring and early summer herbivory is apparently most important for dock biocontrol as *G. viridula* populations are not limited by low temperatures. However, abundance of natural enemies also increases in the course of the season and opposes the development of the second and third generations.

Another plant where *G. viridula* was considered as a biocontrol agent is *Reynoutria* spp. (Zimmermann and Topp 1991). The attempts at biocontrol failed as the species survived only on *R.* × *bohemica* Chrtek et Chrtková (= *R.* × *vivax* Schmitz et Strank), a hybrid of *R. japonica* Houttuyn and *R. sachalinensis* (F. Schmidt) Nakai. The herbivory was reduced to c. 15% in comparison with *R. obtusifolius*. Populations of *G. viridula* on *Reynoutria* could be maintained only by continual immigration from the surrounding *Rumex* stands.

G. VIRIDULA AS A PEST

G. viridula may become a pest of Polygonaceae crops. The most important are the cultures of rhubarb, either *Rheum palmatum* L. grown for consumption (Guile 1984) or *R. palmatum* var. *tanguticum* Rhl. grown as a medicinal plant (Engel 1956, Neubauer et al. 1979). *G. viridula* causes extensive defoliation. Herbivory decreases the yield and aesthetic value of plants grown for consumption. In drug plants the damage is compensated.

G. viridula also became a serious pest of *Rumex* stands grown as an energy source (Petříková 2003, Petříková personal commun.). The permanent cultures of the cultivar called Uteusha, a hybrid of *R. patientia* L. and *R. tianschanicus* A.S. Losinskaja, should live for 15 years. In the year following sowing the damage was small and insular. However, already in the second year the damage became widespread and massive so that it required insecticide spraying.

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ABSTRAKT

Mandelinka ředkvičková (*Gastrophysa viridula*) a biologická kontrola šťovíku (*Rumex* spp.) – studie

Mandelinka ředkvičková *Gastrophysa viridula* (DeGeer) (Coleoptera: Chrysomelidae) je oligofágní herbivor, jehož přednostní potravou jsou listy různých druhů šťovíku (*Rumex* spp.). Kvůli své potravní specializaci je tento druh považován za důležitého biologického činitele, který může být využit v biologické ochraně proti šťovíkům. Studie shrnuje znalosti o původu a zeměpisném rozšíření, vývoji, životním cyklu, potravních vztazích a přirozených nepřátelích mandelinky ředkvičkové. Dále jsou hodnoceny možnosti využití druhu v biologické ochraně proti šťovíkům. *G. viridula* je důležitou součástí komplexu přirozených nepřátel šťovíků. Její požer snižuje životaschopnost těchto rostlin, nemůže však sám způsobit jejich uhynutí. Vliv požeru se zvyšuje v kombinaci s dalšími biologickými činiteli, zejména rzí šťovíkovou *Uromyces rumicis* (Schum.) (Pucciniaceae). Kombinovaný vliv mandelinky ředkvičkové a dalších biologických nepřátel může zvýšit mortalitu šťovíků, a přispět tak k jejich přirozené kontrole. Pokusy o využití mandelinky ředkvičkové v biologickém boji s křídlatkou (*Reynoutria* spp.) byly poměrně neúspěšné. V některých případech byl pozorován škodlivý výskyt mandelinky ředkvičkové na plodinách z čeledi Polygonaceae, zejména na rebarboře (*Rheum* spp.).

Klíčová slova: *Gastrophysa*; Coleoptera; Chrysomelidae; *Rumex*; zeměpisné rozšíření; vývoj; životní cyklus; herbivor; biologická kontrola

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