

## HOST PLANTS AND HARMFULNESS OF THE *ARION LUSITANICUS* MABILLE, 1868 SLUG

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**Abstract:** In the years 2002–2003, observations were carried out in Podkarpackie area on the intensity of occurrence of *Arion lusitanicus* and damage degree caused to cultivated and uncultivated plants. It was found that *A. lusitanicus* feeds on a wide range of plants, both on crops and commonly occurring weeds. Almost all vegetable species were damaged severely and some plant species from the other groups as well. Indications of the slug feeding were found on 103 plant species.

**Key words:** slug, *Arion lusitanicus*, intensity of occurrence, damages of plants

### INTRODUCTION

The slugs occurring in the agricultural environments are polyphagous animals. They feed on alive and dead plants as well as on animal food. Plants are the main component of their diet. The slugs mostly feed on fresh plant material, mainly on the young and delicate plant organs. In some countries of western and middle Europe, slugs are very important pests of crops (Glen et al. 1993; Mesh 1996; Frank 1998; Moens and Glen 2002; Port and Ester 2002). *Deroceras reticulatum* (Müller) is the most widespread harmful slug. In some places another slug species also occur commonly, for instance *Arion lusitanicus* Mabilie. This slug came from the Iberian Peninsula and has spread in numerous European countries including also Poland (Schmid 1970; van Regteren Altena 1971; Wiktor 1983; Reischütz 1984; Davies 1987; Rish and Backeljau 1989; de Winter 1989; von Proschwitz 1994; Kozłowski and Kornobis 1995; Frank 1998). In Austria, Great Britain, Sweden and Switzerland, *A. lusitanicus* slug occurs in large amounts in gardens and is a dangerous pest of vegetables and ornamental plants (Reischütz 1984; Davies 1987; von Proschwitz 1994; Frank 1998). In Poland for the first time it was found in the early 90s only in Albigowa near Rzeszów (Kozłowski and Kornobis 1994, 1995), and at present it can be found on many sites of Podkarpackie district and also on the outskirts of Kraków and Brzeg (Kozłowski 2000a, 2001). As a typical synanthropic species,

*A. lusitanicus* inhabits very different sites degraded by man activity. The places with frequent slug appearance are gardens and field crops near buildings and rivers, ditches, baulks, wastelands and brushwood (Kozłowski 2000b). This slug occurs in very abundant populations and damages many species of cultivated and uncultivated plants (Kozłowski and Kozłowska 1998, 2000).

The paper presents a list of plants damaged or did not damage by *A. lusitanicus*, the intensity of this slug occurrence at different locations on particular plant species and the degree of their damages.

## MATERIAL AND METHODS

The investigations were carried out in the years 2002–2003 in the area of Podkarpackie district in the vicinity of Łańcut and Wysoka, on the sites of a numerous occurrence of *A. lusitanicus*. Observations were carried out on vegetables, agricultural crops and fruit plants at the stage of harvest maturity and on ornamental, herbaceous plants and weeds at the flowering stage. Damages were also observed on vegetables and agricultural crops at the stage of seedlings and development of the first leaves. The observations were conducted in gardens, on arable fields, meadows and wastelands (baulks, ditches, brushwood). For each of the studied plant species 10 randomly selected places with 10 plants were observed. The intensity of the slug occurrence per 1 m<sup>2</sup> as well as the number and damage degree of particular plant species were determined. The slug density was observed in the evening after the slugs left their shelters and crawled on the ground and plants. Damage degree was estimated visually on the basis of the percent of injured plant surface by using a 5-degree scale (0% – no damages; 1–25%, 26–50%; 51–75%; 76–100% plant damages). The date and place of observations, the species and plant developmental stage, the kind of crop or its site, were noted. On the basis of the obtained data it was possible to define the average damage of particular plant species and the average number of slugs.

## RESULTS

### Agricultural plants

*A. lusitanicus* slugs occurred on agricultural crops most frequently in the range from 6 to 10 individuals per 1 m<sup>2</sup> and the largest number was observed on the field edges nearby baulks and ditches (Table 1). From among 22 studied plant species these from the families: *Asteraceae* (sunflower), *Solanaceae* (potato) and *Fabaceae* (Persian clover) were severely damaged by slugs. Plants of common sunflower (*Helianthus annuus* L.) were damaged during the initial phases of development. On potato plants (*Solanum tuberosum* L.), leaves and tubers were damaged by slugs from the moment of germination until maturity of this vegetable. Besides, the slugs made holes in potato tubers below the ground or in the tubers ploughed during harvest. Persian clover (*Trifolium resupinatum* L.) damages occurred at the seedling phase and at later phases of plant development. Because of compact leafage mass the older crops of Persian clover were used as shelters by slugs where they could hide during the day. Fields with other papilionaceous plants were used similarly, mainly common vetch and serradella. Some plant species, such as sugar beet (*Beta*

Table 1. Intensity of *Arion lusitanicus* slug occurrence on fields with different species of agricultural plants and the degree of plant damages

Plant species	Family	Group	Growth habit	Duration	Slug density	Degree of damages
<i>Avena sativa</i> L.	Poaceae	Monocot	G	A	0	0
<i>Beta vulgaris</i> L. var. <i>altissima</i> Döll	Chenopodiaceae	Dicot	F/H	A/B	xx	++
<i>Beta vulgaris</i> L. var. <i>rapacea</i> K. Koch	Chenopodiaceae	Dicot	F/H	A/B	xx	+
<i>Brassica juncea</i> (L.) Czern.	Brassicaceae	Dicot	F/H	A/P	x	+
<i>Brassica napus</i> L. ssp. <i>napus</i> L.	Brassicaceae	Dicot	F/H	A/B	xx	++
<i>Brassica rapa</i> L. ssp. <i>oleifera</i> (DC.) Metzg.	Brassicaceae	Dicot	F/H	A/B	x	+
<i>Fagopyrum esculentum</i> Moench	Polygonaceae	Dicot	F/H	A	x	0
<i>Helianthus annuus</i> L.	Asteraceae	Dicot	F/H	A	xx	+++
<i>Hordeum vulgare</i> L.	Poaceae	Monocot	G	A	xx	0
<i>Lupinus luteus</i> L.	Fabaceae	Dicot	F/H	A	x	++
<i>Medicago sativa</i> L. ssp. <i>sativa</i> L.	Fabaceae	Dicot	F/H	A/P	xx	++
<i>Nicotiana tabacum</i> L.	Solanaceae	Dicot	F/H	A/P	x	+
<i>Ornithopus sativus</i> Brot.	Fabaceae	Dicot	F/H	A	x	+
<i>Panicum miliaceum</i> L.	Poaceae	Monocot	G	A	0	0
<i>Phacelia tanacetifolia</i> Benth.	Hydrophyllaceae	Dicot	F/H	A	x	0
<i>Solanum tuberosum</i> L.	Solanaceae	Dicot	BS/S	P	xxx	+++
<i>Trifolium repens</i> L.	Fabaceae	Dicot	F/H	P	xx	+
<i>Trifolium resupinatum</i> L.	Fabaceae	Dicot	F/H	A	xxx	+++
<i>Triticum aestivum</i> L.	Poaceae	Monocot	G	A	xx	+
<i>Vicia faba</i> L. var. <i>minor</i> Harz	Fabaceae	Dicot	V/F/H	A	xx	++
<i>Vicia sativa</i> L. ssp. <i>sativa</i> L.	Fabaceae	Dicot	V/F/H	A	xx	+
<i>Zea mays</i> L.	Poaceae	Monocot	G	A	x	+

Group: Monocot – monocotyledon, Dicot – dicotyledon

Growth habit: F/H – forb/herb, BS – subshrub, S – shrub, V – vine

Duration: A – annual, B – biennial, P – perennial

Slug density on 1 m<sup>2</sup>: (x) to 5 individuals, (xx) from 6 to 10, (xxx) over 10

Degree of plant damages: (0) no damages, (+) to 5%, (++) 6–15%, (+++) over 15%

*vulgaris* L. var. *altissima* Döll), fodder beet (*Beta vulgaris* L. var. *rapacea* K. Koch), oilseed rape (*Brassica napus* L.) and field bean (*Brassica rapa* L.) were damaged only on the field edges. The highest damage of these plant species occurred at the seedling phases right away after sprouting. For example, 14% winter oilseed rape seedlings were damaged on the field edges. *A. lusitanicus* did not feed on the majority of cereal species. Low damages (below 5%) were observed only on the seedlings of winter wheat (*Triticum aestivum* L.) and maize (*Zea mays* L.).

### Vegetable plants

On vegetable crops (Table 2), *A. lusitanicus* slugs occurred most frequently in the number from 6 to 10 individuals per 1 m<sup>2</sup>. On plants such as cabbage, bean and carrot, about 30 slugs per 1 m<sup>2</sup> were recorded. On some plants, the number of slugs after leaving their shelters reached a dozen of specimens: cabbage – 15 slugs/head, potato – 14 slugs/plant, carrots – 12 slugs/plant. From among 30 studied vegetable species the most severely damaged by slugs were: carrot (*Daucus carota* L., Apiaceae), turnip-rooted parsley (*Petroselinum crispum* (Mill.) Nym., Apiaceae), head lettuce (*Lactuca sativa* L., Asteraceae), white cabbage (*Brassica oleracea* L. convar. *capitata* (L.)

Table 2. Intensity of *Arion lusitanicus* slug occurrence on fields with different species of vegetable plants and the degree of plant damages

Plant species	Family	Group	Growth habit	Duration	Slug density	Degree of damages
<i>Allium cepa</i> L. var. <i>cepa</i> Helm	Liliaceae	Monocot	F/H	P	x	+
<i>Allium sativum</i> L. var. <i>sativum</i> L.	Liliaceae	Monocot	F/H	P	x	+
<i>Allium schoenoprasum</i> L.	Liliaceae	Monocot	F/H	P	x	+
<i>Apium graveolens</i> L. var. <i>rapaceum</i> (Mill.) Gaud.	Apiaceae	Dicot	F/H	P	x	+
<i>Armoracia lapathifolia</i> Gilib.	Cruciferae	Dicot	F/H	P	xxx	++
<i>Beta vulgaris</i> L. var. <i>conditiva</i> Alef.	Chenopodiaceae	Dicot			xxx	++++
<i>Brassica oleracea</i> L. convar. <i>botrytis</i> (L.) Alef. var. <i>botrytis</i> L.	Brassicaceae	Dicot	F/H	P	x	++
<i>Brassica oleracea</i> L. convar. <i>capitata</i> (L.) Alef. var. <i>sabauda</i> L.	Brassicaceae	Dicot	F/H	P	xx	+++
<i>Brassica oleracea</i> L. convar. <i>capitata</i> (L.) Alef. var. <i>capitata</i> L.f. <i>alba</i> DC.	Brassicaceae	Dicot	F/H	P	xxx	++++
<i>Brassica oleracea</i> L. convar. <i>caulocarpa</i> (DC.) Alef. var. <i>gongylodes</i> L.	Brassicaceae	Dicot	F/H	P	xx	++
<i>Brassica oleracea</i> L. convar. <i>fruticosa</i> (Metz.) Alef. var. <i>gemmifera</i> DC.	Brassicaceae	Dicot	F/H	P	xx	++
<i>Brassica rapa</i> L. ssp. <i>pekinensis</i> (Lour.) Hanelt	Brassicaceae	Dicot	F/H	P	xx	++++
<i>Capsicum annuum</i> L.	Solanaceae	Dicot	BS/S/F/H	A/P	x	++
<i>Cichorium intybus</i> L. var. <i>foliosum</i> Hegi	Asteraceae	Dicot	F/H	B/P	xx	0
<i>Cucumis melo</i> L.	Cucurbitaceae	Dicot	V/F/H	A	x	++
<i>Cucumis sativus</i> L.	Cucurbitaceae	Dicot	V/F/H	A	xxx	++
<i>Cucurbita maxima</i> Duch.	Cucurbitaceae	Dicot	V/F/H	A	xxx	++
<i>Cucurbita pepo</i> L.	Cucurbitaceae	Dicot	V/F/H	A	x	+
<i>Daucus carota</i> L. ssp. <i>sativus</i> (Hoffm.) Schübl. et G. Martens	Apiaceae	Dicot	F/H	B	xxx	++++
<i>Lactuca sativa</i> L. var. <i>capitata</i> L.	Asteraceae	Dicot	F/H	A/B/P	xxx	++++
<i>Lycopersicon esculentum</i> Mill. var. <i>esculentum</i>	Solanaceae	Dicot	F/H	A/P	x	++
<i>Petroselinum crispum</i> (Mill.) Nym. ex Hill convar. <i>radicosum</i> (Alef.) Danert	Apiaceae	Dicot	F/H	A/B	xx	++++
<i>Phaseolus vulgaris</i> L. var. <i>nanus</i> (L.) Aschers	Fabaceae	Dicot	V/F/H	A	xxx	++++
<i>Phaseolus vulgaris</i> L. var. <i>vulgaris</i>	Fabaceae	Dicot	V/F/H	A	xxx	+++
<i>Pisum sativum</i> L. convar. <i>axiphium</i> Alef.	Fabaceae	Dicot	V/F/H	A	x	+
<i>Portulaca oleracea</i> L.	Portulacaceae	Dicot	F/H	A	x	0
<i>Raphanus sativus</i> L. var. <i>niger</i> (Mill.) S. Kemer	Brassicaceae	Dicot	F/H	A/B	x	0
<i>Raphanus sativus</i> L. var. <i>sativus</i>	Brassicaceae	Dicot	F/H	A/B	xxx	+++
<i>Vicia faba</i> L. var. <i>major</i> Harz	Fabaceae	Dicot	V/F/H	A	x	+
<i>Zea mays</i> L. convar. <i>saccharata</i> Koem.	Poaceae	Monocot	G	A	x	0

Group: Monocot – monocotyledon, Dicot – dicotyledon

Growth habit: F/H – forb/herb, BS – subshrub, S – shrub, V – vine

Duration: A – annual, B – biennial, P – perennial

Slug density on 1 m<sup>2</sup>: (x) to 5 individuals, (xx) from 6 to 10, (xxx) over 10

Degree of plant damages: (0) no damages, (+) to 5%, (++) 6–30%, (+++) 31–60%, (++++) over 60%

Alef., *Brassicaceae*), Chinese cabbage (*Brassica rapa* L. ssp. *pekinensis* (Lour.) Hanelt, *Brassicaceae*), radish (*Raphanus sativus* L. var. *sativus*, *Brassicaceae*), red garden beet (*Beta vulgaris* L. var. *conditiva* Alef., *Chenopodiaceae*), French bean (*Phaseolus vulgaris* L., *Fabaceae*). Plant damages of some vegetables (red beet, cabbages, carrot) reached nearly 70%. Some of plant species were damaged at the seedling phase (red beet, carrot, parsley, radish, bean) while others at the phase of young plants (cabbage, lettuce). On the fields abundantly inhabited by *A. lusitanicus* at some places the slugs damaged 100% of young plants during several days. Observations of ripe plants showed severe leaf damage of white cabbage, Chinese cabbage and head lettuce, leaves and roots of red garden beet as well as leaves of French bean pods. Slugs made irregular holes in leaves of cabbage and lettuce that were filled with mucus and excrements and these injuries also led to head rotting. In the case of carrot and red beet, slugs ate their leaves, but the largest damages occurred on the roots. For example, in carrots shortly before harvest the slugs gnawed out holes in the root tops protruding from the ground, and then bored canals along the core. So damaged carrot roots are frequently attacked by fungal and bacterial diseases. The vegetables less damaged by slugs (below 5%), were: onion (*Allium cepa* L., *Liliaceae*), garlic (*Allium sativum* L., *Liliaceae*), chive (*Allium schoenoprasum* L., *Liliaceae*) and celery (*Apium graveolens* L., *Apiaceae*). Almost no damages were recorded on vegetables such as: leaf chicory (*Cichorium intybus* L., *Asteraceae*), purslane (*Portulaca oleracea* L., *Portulacaceae*), black radish (*Raphanus sativus* L. var. *niger* (Mill.) S. Kemer, *Brassicaceae*) and sugar corn (*Zea mays* L. convar. *saccharata* Koem., *Poaceae*). Generally, almost all species of vegetables were damaged at the initial stages of plant development. However, the main period of vegetable damages was the time when vegetable plants were fully leaved and provided a required amount of food and a high air moisture and light conditions favourable for their development and activity.

### Fruit plants

Among 9 investigated fruit plant species, strawberry – *Fragaria ananassa* Duch. (*Rosaceae*) was the mostly damaged (on average 34.4% damaged fruits), with the slug density of 21.6 per 1 m<sup>2</sup> of the field. The slugs damaged also raspberries – *Rubus idaeus* L. (*Rosaceae*) (12.0% of damaged raspberries). On the observed raspberry crop, on sward, about 50 slugs were found per 1 m<sup>2</sup>. The slugs fed on the raspberries in the lower parts of raspberry canes inclined to the ground. Among the remaining berry plants included in survey (wild strawberries, black, red and yellow currants, black choke-berry, grape, blackberry), symptoms of slug feeding were observed only on wild strawberries (*Fragaria vesca* L., *Rosaceae*). In the orchards slugs willingly fed on windfalls of almost all species of fruit trees, especially on mature, soft fruits.

### Ornamental plants

*A. lusitanicus* slugs fed on both cultivated and wild growing ornamental flowers as well as on medical herbs (Table 3). The slugs damaged more than a half of the observed plant species. The most numerous inhabited were sites with the following plants: *Rudbeckia laciniata* L. (27.1 slugs/m<sup>2</sup>) and *Paeonia corallina* Retz. (24.3). A numerous slug occurrence was also observed on the plants: *Archangelica officinalis*

Table 3. Intensity of *Arion lusitanicus* slug occurrence on the habitants of different species of horticultural and herbaceous plants and the degree of plant damages

Plant species	Family	Group	Growth habit	Duration	Slug density	Degree of damages
<i>Althaea rosea</i> (L.) Cav.	Malvaceae	Dicot	F/H	B/P	xx	+++
<i>Antirrhinum majus</i> L.	Scrophulariaceae	Dicot	F/H	A/P	x	0
<i>Aquilegia caerulea</i> James	Ranunculaceae	Dicot	F/H	P	x	+
<i>Archangelica officinalis</i> Hoffm.	Apiaceae	Dicot	F/H	P	xxx	+++
<i>Begonia tuberhybrida</i> Voss	Begoniaceae	Dicot	F/H	P	xx	0
<i>Borago officinalis</i> L.	Boraginaceae	Dicot	F/H	A	xxx	0
<i>Calendula officinalis</i> L.	Asteraceae	Dicot	F/H	A	xx	++
<i>Callistephus chinensis</i> (L.) Ness	Asteraceae	Dicot	F/H	A	x	++
<i>Campanula</i> L.	Campanulaceae	Dicot	F/H	P	x	0
<i>Chrysanthemum parthenium</i> (L.) Bernch	Asteraceae	Dicot	F/H	P	x	++
<i>Chrysanthemum</i> L.	Asteraceae	Dicot	F/H	P	xx	++
<i>Clematis</i> L.	Ranunculaceae	Dicot	V/BS	P	x	+
<i>Convallaria majalis</i> L.	Liliaceae	Monocot	F/H	P	xx	0
<i>Coriandrum sativum</i> L.	Apiaceae	Dicot	F/H	A	x	+
<i>Dahlia variabilis</i> Desf.	Asteraceae	Dicot	F/H	P	x	+++
<i>Delphinium elatum</i> L.	Ranunculaceae	Dicot	F/H	P	x	0
<i>Dianthus superbus</i> L.	Caryophyllaceae	Dicot	F/H	P	x	0
<i>Digitalis grandiflora</i> P. Mill	Scrophulariaceae	Dicot.	F/H	B/P	xx	++
<i>Fuchsia magellanica</i> Lam.	Onagraceae	Dicot	S	P	x	+
<i>Hosta lacifolia</i> Engl.	Liliaceae	Monocot	F/H	P	x	++
<i>Hyssopus officinalis</i> L.	Lamiaceae	Dicot	BS/S/F/H	P	xx	0
<i>Impatiens balsamina</i> L.	Balsaminaceae	Dicot	F/H	A	xx	0
<i>Impatiens parviflora</i> DC.	Balsaminaceae	Dicot	F/H	A	x	0
<i>Impatiens roylei</i> Walp.	Balsaminaceae	Dicot	F/H	A	x	0
<i>Iris germanica</i> L.	Iridaceae	Monocot	F/H	P	x	+
<i>Lavandula angustifolia</i> P. Mill.	Lamiaceae	Dicot	S	P	x	0
<i>Levisticum officinale</i> Koch.	Apiaceae	Dicot	F/H	P	x	+
<i>Lilium candidum</i> L.	Liliaceae	Monocot	F/H	P	xxx	+++
<i>Mentha piperita</i> L.	Lamiaceae	Dicot	F/H	P	xx	++
<i>Ocimum basilicum</i> L.	Lmiaceae	Dicot	F/H	A/P	x	+++
<i>Orchis</i> L.	Orchidaceae	Monocot	F/H	P	x	+
<i>Paeonia corallina</i> Retz.	Paeoniaceae	Dicot	F/H	P	xxx	0
<i>Phlox</i> L.	Polemoniaceae	Dicot	BS/S/F/H	P	x	0
<i>Rudbeckia laciniata</i> L.	Asteraceae	Dicot	BS/S/F/H	P	xxx	+++
<i>Ruta graveolens</i> L.	Rutaceae	Dicot	BS/S/F/H	P	xx	0
<i>Salvia officinalis</i> L.	Lamiaceae	Dicot	BS/S/F/H	P	x	+
<i>Salvia pratensis</i> L.	Lamiaceae	Dicot	F/H	P	x	++
<i>Satureja hortensis</i> L.	Lamiaceae	Dicot	F/H	P	xx	0
<i>Tagetes erecta</i> L.	Asteraceae	Dicot	F/H	A	xx	+++
<i>Thymus vulgaris</i> L.	Lamiaceae	Dicot	BS/S	P	xx	++
<i>Tropaeolum majus</i> L.	Tropaeolaceae	Dicot	V/F/H	A/P	xxx	0

<i>Tulipa gesneriana</i> L.	Liliaceae	Monocot	F/H	P	x	+
<i>Verbascum nigrum</i> L.	Scrophulariaceae	Dicot	F/H	P	x	0
<i>Verbascum thapsus</i> L.	Scrophulariaceae	Dicot	F/H	B	x	0
<i>Viola odorata</i> L.	Violaceae	Dicot	F/H	P	x	+
<i>Zinnia elegans</i> Jacq.	Asteraceae	Dicot	F/H	P	xx	+++

Group: Monocot – monocotyledon, Dicot – dicotyledon; Growth habit: F/H – forb/herb, BS – subshrub, S – shrub, V – vine; Duration: A – annual, B – biennial, P – perennial; Slug density on 1 m<sup>2</sup>: (x) to 5 individuals, (xx) from 6 to 10, (xxx) over 10; Degree of plant damages: (0) no damages, (+) to 5%, (++) 6–30%, (+++) over 30%

Hoffm. (19.4 slugs/m<sup>2</sup>), *Tropaeolum majus* L. (15.4) and *Lilium candidum* L. (14.9). No symptoms of damages were found on *P. corallina* and *T. majus* despite a numerous occurrence of slugs. The most severely damaged were plants grown in gardens: *R. laciniata* (Asteraceae) and *L. candidum* (Liliaceae). Comparatively strongly damaged were also plants of: *Zinnia elegans* Jacq. (Asteraceae), *A. officinalis* (Apiaceae), *Tagetes erecta* L. (Asteraceae), *Dahlia variabilis* Desf. (Asteraceae), *Althaea rosea* (L.) Cav. (Malvaceae) and *Ocimum basilicum* L. (Lamiaceae). The slugs damaged all organs of plants. They fed mainly on young leaves making irregular holes on them. On some plants species, such as: *Callistephus chinensis* (L.) Ness, *D. variabilis*, *L. candidum*, *Salvia officinalis* L., *T. erecta* and *Z. elegans*, inflorescences were the most willingly attacked and damaged. The slugs fed on all eight decorative plant species under studies from the family Asteraceae. The plant species the least damaged by slugs (below 2%) were: *S. officinalis* L. (Lamiaceae) and *Mentha piperita* L. (Lamiaceae). The number of slugs on the sites of these plants amounted to 4.8 and 6.5 individuals per 1 m<sup>2</sup>, respectively. No damages on 20 plant species were observed despite the occurrence of slugs. They did not accept three plant species representing the family Balsaminaceae.

### Herbaceous Plants

*A. lusitanicus* slugs occurred regularly on the weeds growing in gardens, on arable fields as well as in brushwoods (Table 4). The intensity of slug occurrence ranged from 0.8 to 7.9 individuals per 1 m<sup>2</sup>. The largest numbers of slugs (6–8 individuals per 1 m<sup>2</sup>) were encountered on the sites of: *Aegopodium podagraria* L., *Conium maculatum* L., *Sisymbrium officinale* L., *Sonchus arvensis* L. and *Urtica dioica* L. The most seriously damaged were: *A. podagraria* L. (Apiaceae) and *U. dioica* (Urticaceae). Less damaged by slugs were plants of *Conium maculatum* L. (Apiaceae), *Papaver rhoeas* L. (Papaveraceae), *Artemisia dracuncululus* L. (Asteraceae) and *Centaurea cyanus* L. (Asteraceae). Damages of the remaining species of herbal plants were not more than 5%. Symptoms of the slug feeding in the form of holes were observed mainly on leaves. On some plant species, for example on *Malva sylvestris* L., slugs damaged mainly flower buds. Slugs did not damage plants of 52 species. The largest number of undamaged species was noted in the families: Rosaceae (5 species) and Onagraceae (3 species). The palatability of particular plant species within some families was diverse to the slugs. For instance, 11 plant species from the family Asteraceae were damaged and 9 species were not damaged. In the family Polygonaceae – 2 species were damaged and 7 species were not damaged.

Table 4. Intensity of *Arion lusitanicus* slug occurrence on the habitants of different species of herbal plants and the degree of plant damages

Plant species	Family	Group	Growth habit	Duration	Slug density	Degree of damages
<i>Achillea millefolium</i> L.	Asteraceae	Dicot	F/H	P	x	0
<i>Aegopodium podagraria</i> L.	Apiaceae	Dicot	F/H	P	xx	+++
<i>Ajuga reptans</i> L.	Lamiaceae	Dicot	F/H	P	x	0
<i>Alchemilla pastoralis</i> Bus.	Rosaceae	Dicot	F/H	P	x	0
<i>Anagallis arvensis</i> L.	Primulaceae	Dicot	F/H	A/B	x	0
<i>Anthemis arvensis</i> L.	Asteraceae	Dicot	F/H	A	x	+
<i>Arctium lappa</i> L.	Asteraceae	Dicot	F/H	B	x	+
<i>Artemisia dracunculus</i> L.	Asteraceae	Dicot	F/H/BS/S	P	x	+++
<i>Bellis perennis</i> L.	Asteraceae	Dicot	F/H	P	x	0
<i>Caltha palustris</i> L.	Ranunculaceae	Dicot	F/H	P	x	0
<i>Calystegia sepium</i> (L.) R. Br.	Convolvulaceae	Dicot	T/H/BS/V	P	x	0
<i>Capsella bursa-pastoris</i> (L.) Med.	Brassicaceae	Dicot	F/H	A	x	+
<i>Centaurea cyanus</i> L.	Asteraceae	Dicot	F/H	A	x	+++
<i>Chamaenerion angustifolium</i> (L.) Scop.	Onagraceae	Dicot	F/H	P	xx	0
<i>Chelidonium majus</i> L.	Papaveraceae	Dicot	F/H	B	x	0
<i>Chenopodium album</i> L.	Chenopodiaceae	Dicot	F/H	A	x	+
<i>Cichorium intybus</i> L.	Asteraceae	Dicot	F/H	B/P	x	0
<i>Circaea lutetiana</i> L.	Onagraceae	Dicot	F/H	P	x	0
<i>Conium maculatum</i> L.	Apiaceae	Dicot	F/H	B	xx	+++
<i>Convolvulus arvensis</i> L.	Convolvulaceae	Dicot	F/H/V	P	x	0
<i>Datura stramonium</i> L.	Solanaceae	Dicot	F/H/BS	A	xx	+++
<i>Echinochloa crus-galli</i> (L.) Beauv.	Poaceae	Monocot	G	A	x	+++
<i>Epilobium hirsutum</i> L.	Onagraceae	Dicot	F/H	P	x	0
<i>Erigeron canadensis</i> (L.) Cronq.	Asteraceae	Dicot	F/H	A/B	xx	0
<i>Erodium cicutarium</i> (L.) L'Hér. ex Ait.	Geraniaceae	Dicot	F/H	A/B	x	0
<i>Euphorbia cyparissia</i> L.	Euphorbiaceae	Dicot	F/H	P	x	0
<i>Euphorbia helioscopia</i> L.	Euphorbiaceae	Dicot	F/H	A	x	+
<i>Ficaria verna</i> Huds.	Ranunculaceae	Dicot	F/H	P	x	+
<i>Galinsoga parviflora</i> Cav.	Asteraceae	Dicot	F/H	A	x	+++
<i>Galium aparine</i> L.	Rubiaceae	Dicot	F/H/V	A	x	0
<i>Geranium dissectum</i> L.	Geraniaceae	Dicot	F/H	A/B	x	+
<i>Geranium pratense</i> L.	Geraniaceae	Dicot	F/H	P	xx	0
<i>Geum rivale</i> L.	Rosaceae	Dicot	F/H	P	x	0
<i>Geum urbanum</i> L.	Rosaceae	Dicot	F/H	P	x	0
<i>Glechoma hederacea</i> L.	Lamiaceae	Dicot	F/H	P	x	0
<i>Gnaphalium uliginosum</i> L.	Asteraceae	Dicot	F/H	A	xx	0
<i>Lamium album</i> L.	Lamiaceae	Dicot	F/H	P	x	+
<i>Lamium amplexicaule</i> L.	Lamiaceae	Dicot	F/H	A/B	x	0
<i>Leontodon autumnalis</i> L.	Asteraceae	Dicot	F/H	P	x	0
<i>Lotus corniculatus</i> L.	Fabaceae	Dicot	F/H	P	x	0
<i>Lycopsis arvensis</i> L.	Boraginaceae	Dicot	F/H	A	x	+
<i>Lysimachia nummularia</i> L.	Primulaceae	Dicot	F/H	P	x	0



Plant species	Family	Group	Growth habit	Duration	Slug density	Degree of damages
<i>Lythrum salicaria</i> L.	Lythraceae	Dicot	F/H/BS	P	x	0
<i>Malva moschata</i> L.	Malvaceae	Dicot	F/H	P	x	0
<i>Malva sylvestris</i> L.	Malvaceae	Dicot	F/H	A/B/P	x	++
<i>Matricaria chamomilla</i> L.	Asteraceae	Dicot	F/H	A	x	++
<i>Medicago lupulina</i> L.	Fabaceae	Dicot	F/H	A/P	xx	0
<i>Melandrium album</i> (Mill.) Garcke	Caryophyllaceae	Dicot	F/H	B/P	x	0
<i>Myosotis arvensis</i> (L.) Hill	Boraginaceae	Dicot	F/H	A	x	0
<i>Oxalis stricta</i> L.	Oxalidaceae	Dicot	F/H	P	xx	0
<i>Papaver rhoeas</i> L.	Papaveraceae	Dicot	F/H	A	xx	++
<i>Plantago lanceolata</i> L.	Plantaginaceae	Dicot	F/H	A/B/P	x	+
<i>Plantago major</i> L.	Plantaginaceae	Dicot	F/H	P	x	+
<i>Poa annua</i> L.	Poaceae	Monocot	G	A/B	x	0
<i>Polygonum convolvulus</i> L.	Polygonaceae	Dicot	F/H/V	A	x	0
<i>Polygonum aviculare</i> L.	Polygonaceae	Dicot	F/H	A/P	x	0
<i>Polygonum bistorta</i> L.	Polygonaceae	Dicot	F/H	P	x	0
<i>Polygonum dumetorum</i> L.	Polygonaceae	Dicot	F/H/V	P	x	0
<i>Polygonum nodosum</i> Pers.	Polygonaceae	Dicot	F/H	A	x	0
<i>Polygonum persicaria</i> L.	Polygonaceae	Dicot	F/H	A/P	x	0
<i>Potentilla anserina</i> L.	Rosaceae	Dicot	F/H	P	x	0
<i>Potentilla reptans</i> L.	Rosaceae	Dicot	F/H	P	xx	0
<i>Ranunculus repens</i> L.	Ranunculaceae	Dicot	F/H	P	x	+
<i>Rumex acetosa</i> L.	Polygonaceae	Dicot	F/H	P	x	0
<i>Rumex acetosella</i> L.	Polygonaceae	Dicot	F/H	P	xx	++
<i>Rumex crispus</i> L.	Polygonaceae	Dicot	F/H	P	x	+
<i>Saponaria officinalis</i> L.	Caryophyllaceae	Dicot	F/H	P	x	0
<i>Senecio viscosus</i> L.	Asteraceae	Dicot	F/H	A	x	0
<i>Senecio jacobaea</i> L.	Asteraceae	Dicot	F/H	P	x	0
<i>Senecio vulgaris</i> L.	Asteraceae	Dicot	F/H	A/B	x	0
<i>Sisymbrium officinale</i> L.	Brassicaceae	Dicot	F/H	A	xx	0
<i>Solanum nigrum</i> L.	Solanaceae	Dicot	BS/S	A/P	x	0
<i>Solidago canadensis</i> L.	Asteraceae	Dicot	F/H	P	x	0
<i>Sonchus arvensis</i> L.	Asteraceae	Dicot	F/H	P	xx	+
<i>Stellaria media</i> Vill.	Caryophyllaceae	Dicot	F/H	A/P	x	+
<i>Tanacetum vulgare</i> L.	Asteraceae	Dicot	F/H	P	x	+
<i>Taraxacum officinale</i> Web.	Asteraceae	Dicot	F/H	P	x	+
<i>Trifolium repens</i> L.	Fabaceae	Dicot	F/H	P	x	+
<i>Tripleurospermum inodorum</i> (L.)	Asteraceae	Dicot	F/H	A	x	+
<i>Urtica dioica</i> L.	Urticaceae	Dicot	F/H	P	xx	+++
<i>Veronica arvensis</i> L.	Scrophulariaceae	Dicot	F/H	A	x	0
<i>Veronica hederifolia</i> L.	Scrophulariaceae	Dicot	F/H	A	x	0
<i>Vicia tetrasperma</i> (L.) Schreb.	Fabaceae	Dicot	F/H	A	x	0

Group: Monocot – monocotyledon, Dicot – dicotyledon; Growth habit: F/H – forb/herb, BS – subshrub, S – shrub, G – graminoid, V – vine; Duration: A – annual, B – biennial, P – perennial; Slug density on 1 m<sup>2</sup>: (x) to 5 individuals, (xx) from 6 to 10; Degree of damages: (0) no damages, (+) to 5%, (++) 6–30%, (+++) over 30%

## DISCUSSION

The slug *A. lusitanicus* damaged many cultivated and uncultivated plant species. It has been found that likewise to other slug species, *A. lusitanicus* shows different food preferences for particular plant species. The results of the earlier field studies and laboratory trials on seedling damages of different plant species caused by this slug provided similar data (Briner and Frank 1998; Frank and Friedli 1999; Kozłowski and Kozłowska 1998, 2000, 2003, 2004). On the observed site, *A. lusitanicus* ate most willingly vegetables, mainly plants from the families: *Apiaceae*, *Asteraceae*, *Brassicaceae*, *Chenopodiaceae* and *Fabaceae*. The most severely damaged were: carrot, turnip-rooted parsley, lettuce, white and Chinese cabbages, red garden beet and French bean. Similar observations were obtained in earlier studies (Kozłowski and Kozłowska 1998). Severe vegetable damages were observed also in Austria (Reischütz 1984), in Sweden (von Proschwitz 1992, 1994) and in Switzerland (Frank 1998). Leafy and root vegetables, especially *Brassicaceae*, are frequently attacked and damaged by other species of slugs, for instance by *Deroceras reticulatum* (Müller) (Port and Ester 2002). Among the studied agricultural plants, strongly damaged were only some species, such as sunflower (*Asteraceae*) and potato (*Solanaceae*). Plant species not damaged by the slugs were first of all monocotyledon – *Poaceae* (*Gramineae*) plants. This confirms the earlier observations that slugs do not accept mature plants of the majority of species from the family *Gramineae* (Dirzo 1980; Cook et al. 1996; Briner and Frank 1998). Ornamental plants (perennials and flowers), herbal plants grown in gardens and weed species are a separate group. This group of plants willingly eaten by slugs contained some plants from the families: *Asteraceae*, *Apiaceae*, *Liliaceae* and *Lamiaceae*. No damages were observed on other species from these families; for instance plants of *Asteraceae* family represented in these studies by 28 species of ornamental plants and weeds. Damages on these plants were found only on 17 species and the lack of feeding signs – on 11 plant species. However, no damages were observed on the plants of all studied species from the families: *Balsaminaceae* (3 species), *Rosaceae* (5 species) and *Onagraceae* (3 species) and also on single species from a dozen or so other families. Among damaged species of ornamental plants, perennials were predominating (73%), whereas among damaged weeds the number of annual species and perennials was similar. In laboratory experiments Briner and Frank (1998) have showed that annual species are more palatable to *A. lusitanicus* than species of perennial plants, but this has not been confirmed by our studies.

The density of *A. lusitanicus* on the fields with crops and on weed sites was very diverse. The number of slugs depended first of all on food sources, i.e. on host plants and the presence of shelters. Slugs preferred places with lush vegetation providing suitable humidity and hiding place during the day. Such places were provided by some species of cultivated plants at the stage of their full development and weeds growing on baulks, in ditches and on the field edge. On the fields of some vegetables and flower plants, the number of slugs per 1 m<sup>2</sup> reached 30 individuals. For a comparison, on horticultural crops in Sweden from 5 to 7 individuals of *A. lusitanicus* were observed per 1 m<sup>2</sup> (von Proschwitz 1994), but it is unknown at

what time of the day these observations were made. However, in Switzerland, on such habitats as meadows or wildflower strip plants on the plantation edges of winter oilseed rape, the recorded density of slugs exceeded 50 individuals per 1 m<sup>2</sup> (Briner and Frank 1998). Single plants of some species of vegetables can be a good source of food and provide a hiding place for slugs. It was observed that during the daytime the slugs hid under outside leaves in the heads of cabbages and lettuce and went out for feeding only in the evening. For example, at night a dozen individuals of *A. lusitanicus* were found in mature heads of white cabbage. Other slugs behave similarly, for instance *D. reticulatum* (Godan 1973).

Indications of *A. lusitanicus* feeding on plants were holes in the leaves and roots as well as presence of slug mucus and excrements. Such damages lead to reduction of plant yield and to decrease of the commercial value of plant products. Similar damages are caused by other species of harmful slugs, for instance by *D. reticulatum* (Port and Ester 2002). Plants damaged by slugs are weakened and susceptible to fungal and bacterial diseases. The most subjected to damages are plants directly after germination. Young plants at this stage of the majority of vegetables and some species of agricultural plants can be damaged to 100%. This mainly concerns plants growing on field edges, to which slugs migrate from their shelters in baulks, ditches, brushwood, etc. For instance, it was found on the winter oilseed rape crops in Switzerland that the majority of seedling damages by *A. lusitanicus* occurs on edge strips of fields 1–2 m wide (Frank 1998). Similar observations were made on the crops of winter oilseed rape in the vicinity of Łañcut and Wysoka. The most important period of vegetable damage occurrence is the stage of full development of above-ground plant parts when the mass of leaves, stems and other plant organs cover the ground forming a compact canopy, which can be used as a shelter by slugs (Port and Ester 2002). Plants at this phase of development provide slugs with a proper food and a shelter. Under such conditions, slugs rapidly feed causing considerable damages to plants.

A wide range of host plants for *A. lusitanicus* and the possibility of feeding on wild growing herbal plants increase this slug survival in habitats of cultivated plants to a considerable degree. The basic food for this slug are cultivated plants, however, as our observations showed some widespread weeds might be also the source of food. Among the investigated 83 weed species, *A. lusitanicus* was found eating on 31 plant species. There is a large probability that slugs can feed also on many other plant species, not considered in this paper. For example in Sweden, *A. lusitanicus* besides vegetables damages very severely some herbs, such as: *Mercurialis perennis* L., *Melanndrium rubrum* L., *Solanum dulcamara* and *Polygonatum multiflorum* (L.). These plants, as reported by von Proschwitz (1994), were completely deprived of leaves by the slug. Similar damages were observed in the vicinities of Łañcut, on the plants of *Aegopodium podagraria* L. (Kozłowski and Kozłowska 2000). In laboratory tests with and without choice on acceptation of seedlings of 82 species of weeds, medicinal herbs and oilseed rape, 17 plant species were willingly eaten by *A. lusitanicus* (Kozłowski and Kozłowska 2000, 2003, 2004; Kozłowski and Kałuski 2004). The conducted field studies supported slug feeding on the majority of these species. Briner and Frank (1998), in laboratory trials with 77 plant species have showed that

*A. lusitanicus* prefers seedlings of oilseed rape and seedlings of some other plant species, for instance *Capsella bursa-pastoris* (L.) Med. Results of the mentioned studies indicate that some weeds can be a supplemental or alternative food for the *A. lusitanicus*.

Based on the performed observations it can be confirmed that *A. lusitanicus* occurs in very abundant populations and causes severe damages on many species of cultivated plants, mainly on vegetables and also of some agricultural, fruits, ornamental and herbal plants. Besides, this slug very willingly feeds on some commonly occurring weeds.

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## POLISH SUMMARY

### ROŚLINY ŻYWIEMIENSKIE I SZKODLIWOŚĆ ŚLIMAKA *ARION LUSITANICUS* MABILLE, 1868

W latach 2002–2003, na terenie województwa podkarpackiego wykonano obserwacje nad nasileniem występowania ślimaka *Arion lusitanicus* i uszkodzeniami roślin uprawnych i nieuprawnych. Obiektem badań były: warzywa, rośliny rolnicze, sadownicze, ozdobne, zielarskie i chwasty. Wykazano, że *A. lusitanicus* ma szeroki zakres roślin żywicielskich. Odżywia się zarówno roślinami uprawianymi jak i pospolicie występującymi chwastami. Zagęszczenie ślimaków na plantacjach poszczególnych gatunkach roślin i na stanowiskach chwastów było silnie zróżnicowane. Na plantacjach niektórych warzyw i roślin kwiatowych liczba ślimaków na 1 m<sup>2</sup> sięgała 30 osobników. Objawy żerowania ślimaków występowały na 103 gatunkach roślin. Pomimo liczego występowania ślimaków nie stwierdzono uszkodzeń na roślinach 88 gatunków. Silnie uszkodzane były prawie wszystkie gatunki warzyw oraz niektóre gatunki z pozostałych badanych roślin. Największe szkody obserwowano w uprawach takich roślin, jak: marchew, pietruszka, sałata, kapusta, burak ćwikłowy, fasola, słonecznik, ziemniak, truskawka i malina.