

## THE DISTRIBUTION, BIOLOGY, POPULATION DYNAMICS AND HARMFULNESS OF *ARION LUSITANICUS* MABILLE, 1868 (*GASTROPODA: PULMONATA: ARIONIDAE*) IN POLAND

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**Abstract:** Population studies on *Arion lusitanicus*, a slug species introduced into Poland, were carried out over the last decade. The slug occurs commonly in some areas and spreads out relatively quickly. It has an annual life cycle with eggs, and immature individuals overwinter. In the end of July *A. lusitanicus* begins copulation and three weeks later it lays eggs from which the first offspring hatch within a month. The copulation process and egg laying last until late fall. One *A. lusitanicus* can lay over 400 eggs. During the growing season there are two peaks of population density. This species feeds on plant material such as leaves, stems, bulbs, but also consumes animal material. The basic plant material are arable crops particularly vegetables and some species of agricultural crops, some fruit trees, ornamental plants, herbs and weeds. *A. lusitanicus* displays apparent food specialization and prefers certain cultivated and wild growing plants. *A. lusitanicus* shows large reproduction potential, wide food and ecologic tolerance, and is regarded as a serious pests occurring in home gardens.

**Key words:** slug, *Arion lusitanicus*, distribution, occurrence, biology, ecology, food, feeding, damages of plants

### INTRODUCTION

The slug *Arion* (*Arion*) *lusitanicus* (*Gastropoda: Pulmonata: Arionidae*) was first described by Mabille (1868) and is a native of the Iberian Peninsula (Simroth 1891; Altena 1971; Chevallier 1972). From Spain and Portugal it spread out rapidly and was next recorded in Great Britain (Quick 1952, 1960; Ellis 1965; Davies 1987). During the last 35 years *A. lusitanicus* has extended its range to the following European countries including Italy (Altena 1971), France (Altena 1955, 1971; Chevallier 1972), Belgium (Risch and Backeljau 1989), Germany (Schmid 1970), the Netherlands (Winter 1989),

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Switzerland (Altena 1971; Frank 1998), Austria (Reischütz 1984), Bulgaria (Wiktor 1983), Sweden, Norway (Proschwitz 1992, 1994; Proschwitz and Winge 1994) and Poland (Kozłowski and Kornobis 1994, 1995). In Poland the population of *A. lusitanicus* is large. This slug species is a serious pest of several arable crops, particularly vegetables and ornamentals. In addition it grazes on many wild plant species. As in other European countries *A. lusitanicus* spreads out quickly and soon it might be distributed throughout the entire of Poland.

This paper reviews the results of population studies on *A. lusitanicus* appearing in Poland in the years 1995–2005. The aim of this project is to present the most important findings regarding slug distribution, reproduction, estimation of population, feeding preferences, its behavior and pest status.

## RESULTS AND DISCUSSION

### Identification, distribution and occurrence

Occurrence of *A. lusitanicus* population in Poland was first reported in 1993 based on samples collected from sites in Albigowa and Markowa near Rzeszów (Kozłowski and Kornobis 1994, 1995). Individuals from this population displayed traits characteristic of the anatomy of this species i.e. small and short atrium, oval bursa of the spermatheca, large, bipartite oviduct with short and thin posterior section, a bulky, tubular base part where the ligula is present – i.e. two long sheets directly connected to the upper atrium (Davies 1987; Risch and Backeljau 1989; Noble 1992; Kozłowski and Kornobis 1995). The external anatomy of *A. lusitanicus* does not differ from *Arion rufus* (Linnaeus) (Kozłowski and Kornobis 1994; Wiktor 1996).

During the last decade, *A. lusitanicus* spread out from its original habitats localized in grid squares EA 95 and EA 85 (“The Universal Transverse Mercator UTM grid”) throughout the Podkarpackie Voivodeship (EA and FA). In recent years it was also registered in other areas in Poland, for instance near Kracow (DA 43), Brzeg (XS 75) (Kozłowski 2000a, 2001a), Tymbark (DA 62) and Bielsko-Biała (CA 73) (Kozłowski, unpublished). Quick distribution of this species was reported in Austria (Reischütz 1984), Great Britain (Davies 1987), Sweden, Norway (Proschwitz 1992, 1994) and Switzerland (Frank 1998) The distribution of *A. lusitanicus* in some areas in these countries is similar and it is a serious pest of plants. *A. lusitanicus* migrates long distances in search for new shelters and food. It was observed that the slug could crawl 7 m within 2 hours (on average ca 2 m) and despite apparent incoherence in its movement, it always headed in a certain direction (Kozłowska and Kozłowski 2004). Wide distribution of this species is rather passive. It is introduced into new regions by transportation of plant seedlings and plant material assigned for consumption or processing. The slug can be carried with soil and community waste. Numerous instances were reported of egg and young slug presence upon set up for shipping agricultural products (lettuce, cabbage, carrot, beets), seedlings of ornamentals bushes, plant debris and various types of waste. Means of distribution of this slug species in other European countries are similar (Proschwitz 1992, 1994). Transport of vegetables and fruits into woodlands as food for game plays an important role in slug distribution too.

*A. lusitanicus* is present in various habitats both agricultural and horticultural land and uncultivated territory as well. The most common are home gardens and cul-

tivated fields bordering buildings and rivers, ditches, balks, barren lands and thickets adjoining plant crops. The slugs have preferences for crops cultivated on clay and loam soil. Observations carried out in regions with mass slug occurrences (Łańcut, Wysoka, Albigowa), in habitats such as on arable crops, in grassland, barren lands, parks, thickets, cemeteries, riverbanks, and community dumpsters revealed high differentiation in slug incidence (Kozłowski 2000b). Certain vegetable crops such as cabbage, lettuce and beans, flowers, bulbs, strawberries and raspberries are occupied the most frequent. For instance, 30 slugs per 1 m<sup>2</sup> were recorded in cabbage and 50 per 1 m<sup>2</sup> in some raspberries plantings. Significantly fewer slugs (3–8 per 1 m<sup>2</sup>) were found in arable crops such as beets, potato, and wheat or oilseed rape. In other habitats such as balks, field ridges and fields with high weed density and barren lands on average 12 slugs per 1 m<sup>2</sup> were counted. In uncultivated surroundings (parks, cemeteries, thickets, riverbanks, and community dumpsters) the slug density ranged from 3 to 7 individuals per 1 m<sup>2</sup>. *A. lusitanicus* indicates a tendency for abundant gathering in sites that are damp and reach into food sources like fresh plant debris, compost, deep ditches, shaded slopes of watercourses etc. In these areas the slug density is comprised of 100 of individuals per 1 m<sup>2</sup>. Similar distribution can be observed in the evening after slug emergence from their shelters. In Austria and Sweden *A. lusitanicus* is the most abundant in vegetables and ornamentals (Reischütz 1984; Proschwitz 1994). Proschwitz registered (1994) 5–7 slugs per 1 m<sup>2</sup> in vegetable habitats in Sweden. In Switzerland slug density was over 50 individuals per 1 m<sup>2</sup> in some ecosystems such as meadows or wildflower strip plants bordering oilseed rape crops (Briner and Frank 1998). Incidence and distribution of *A. lusitanicus* in particular habitats is dependent upon food, water and shelter availability. Slugs occur more abundantly and uniformly in crops with large plant densities (Kozłowski 2000b). On the contrary, in crops with less plant density slugs can be found only in field ridges, near places providing good shelter during a day. Frank (1998) reached similar conclusions based on the results from the surveys carried out in Switzerland on the slug distribution in crops of germinating oilseed rape plants.

### Reproduction

In the years 1997–1999 the conducted field trials on *A. lusitanicus* bionomy showed that this species has an annual life cycle (Kozłowski 2000c; Kozłowski and Kozłowska 2000). It was confirmed that most slugs live one year. Sometimes, by the end of summer, single, two-year old large individuals (body length ca 15 cm) can be observed. Similar individuals were found in Great Britain (Davies 1987). Eggs are laid in late summer and fall and hatching takes place in late fall and spring. Developmental periods of *A. lusitanicus* occurring in Switzerland are similar (Briner and Frank 1998). There are three phases of growth in the development of *A. lusitanicus*; infantile, juvenile and mature. The infantile phase begins after egg hatching and ends upon reaching puberty. This is followed by the juvenile phase when copulation and egg laying take place. After a period of mating as slugs age they produce smaller batches of eggs and the mature phase begins that is followed by death. The developmental phases of *A. lusitanicus* in the growing season are described in the next paragraph.

## Copulation

The first slugs begin copulation after reaching puberty in the end of July (Kozłowski and Sionek 2001; Sionek and Kozłowski 2001). They are in age range from 5 to 8 months. The time span of copulation is 1.5 to 2.5 months and in some years it continues until the end of October. A temperature below 10°C restricts copulation and below 5°C precludes it. Air temperature is the main factor affecting the length of the copulation period. In Glasgow, Great Britain, due to lower temperatures in fall, the copulation period of *A. lusitanicus* is considerably shorter and ranges from 1 to 2 months (Davies 1987). The body length of individuals that copulate is in a range of 3.0–8.5 cm (on average 6.5 cm), while the mature slugs reach a length of 12 cm while crawling (Kozłowski 2000c). Similar to other species, slugs that are not fully grown can also mate. Frequently, small individuals copulate with large ones. According to Wiktor (1989) slugs of numerous species begin mating with not fully developed albumen glands. Mating of *A. lusitanicus* is horizontal and takes place on wet soil or turf surfaces. Slugs copulate at different times of a day and night, after sunrise, before dawn, and on days with cloudy and rainy weather, throughout day. Copulation in slugs is usually preceded by elaborate courtship behavior and it frequently begins in the evening, after slugs emerge from their shelters, 1–2 hours prior to sunset. The last pairs mate 2 hours prior to sunrise. During pleasant weather the last copulating slugs can be seen in the morning, 2.5–3.5 hours after sunrise. Sunshine prevents slugs from mating and forces them to hide in their shelters. In the shady areas some pairs continue copulation for 1–2 hours. There are four stages in copulation process of *A. lusitanicus*. An initiation stage aims at recognition of a partner and is similar to what was described for other species. It involves an identification of the species and availability for mating (Wiktor 1989). Second stage can be defined as “pairing” and at this phase slugs prepare to mate. Behavior of slugs at this stage differs significantly (Wiktor 1989). “Pairing” of *A. lusitanicus* lasts approximately ca 20 minutes and completes with their genitalia openings being everted. The third phase, the copulation act and transfer of spermatophore, starts with long-term and motionless position (lasting almost 4 hours). This arrangement allows to form and insert a spermatophore into the base of the bursa of the spermatheca (Sionek and Kozłowski 2001). At the end of this phase the slugs cease this immobile stage and the atria are everted. Then the transfer of the sperm mass takes place. This process may last from 15 up to 30 minutes and it varies for different pairs. In the last phase, the genitalia are withdrawn and the animals separate.

The total time taken for the entire copulation process beginning with finding the partner and ending with the separation after the copulation may be from 4 to 5.5 hours. Davies (1987) described that copulation acts lasted 140–150 minutes and one observed pair copulated about 4 hours (copulation body parts everted for 3.5 hours). These results are similar to those collected under Polish climate conditions. For instance the total time of copulation process of another species from *Arionidae* – *Arion rufus* (Linnaeus) is 3 hours (Frömming 1954).

## Egg laying

Egg laying begins in mid to late August, two-four weeks after copulation. Population peak occurs in late September. Slugs lay eggs at age 7–9 months. The duration of egg lying is dependent upon temperature and range from 2.5 to 3.5 months (maximum up to 104 days). The last eggs can be laid in December however the temperature

needs to be above 5°C. Like other slugs *A. lusitanicus* lay eggs that are held together by a mucous strand in batches. These can be found in gardens, fields, greenhouses, meadows, orchards, ornamental nurseries, thickets, parks, cemeteries, ditches, river and creek banks, community dumpsters, basements, drains etc. Eggs are usually laid in holes or crevices in the ground at 2–10 cm in depth or on the soil surface, in sunlit sites or under cover. Eggs were also discovered in holes nibbled in roots, in fruits and vegetables, beneath rocks, logs, branches, in composts and under debris on the ground (Davies 1987; Proschwitz 1994; Kozłowski 2000c). Observations on slug occurrence in plant crops revealed that there can be 1–9 batches per 1 m<sup>2</sup> and each mass contains 12–124 eggs (on average 67.3) (Kozłowski 2000c). During first two weeks of egg laying, the egg batches comprise almost threefold more eggs than in the last two weeks of this process. Most of this (70%) is seen in field ridges and balks, places that are rarely cultivated in the growing season. *A. lusitanicus* reared in field conditions laid 243–541 eggs, with an average of 405. Proschwitz (1992, 1994) obtained similar results. The eggs laid by *A. lusitanicus* are round or oval in shape (size 4.2 × 3.5 mm). Eggs described by Davies (1987) measured over 4 mm in diameter. Most slugs die after reproductive period (Davies 1987; Briner and Frank 1998; Kozłowski and Sionek 2000a). It was confirmed that at temperatures of 17–19°C, RH 93–95%, and day length of 16 h, 75% of slugs died after egg laying (Kozłowski and Sionek 2000a). Other mature individuals decrease in winter and only a small slug population overwinters and then dies the following spring.

### Egg hatching

Late summer and fall slug hatching begins at the end of the first ten days and beginning of the second ten days of September, i.e. a month after first eggs were laid. This period lasts from 50 up to 80 days until temperatures drop to 5°C. The mean number of days from egg laying to hatching is 40 days. Only eggs laid in August and at the beginning of September hatch prior to winter (54–86% of all laid eggs). Eggs that are laid later overwinter and hatching takes place the following spring (Kozłowski and Sionek 2000a). Spring hatching starts in mid-March and continues for 4–6 weeks. Only a few slugs hatch from eggs in January and February at temperatures above 6°C. The last individuals breed at the end of April. Investigations on development rates of eggs under controlled conditions at different temperatures showed that the shortest period (mean 30.3 days) from egg laying to first slugs hatching took place at 20°C (Kozłowski 2000c). Slugs bred at 15°C began hatching six days later, and 14 days later while they were reared at 10°C. The highest percentage of slugs hatching was at 15°C (85.5%) and the lowest at 10°C (30.5%). The temperatures in the range of 15–17°C seem to be the most favorable for egg development.

### Overwintering

*A. lusitanicus* survives into the following year in the egg or juvenile phase. Mature slugs rarely overwinter. Most slugs crawl into winter shelters when temperatures drop below 2°C. They usually stay in upper soil levels and plant debris. During winter months, December–February, if the daily temperature is above 5°C young slugs will emerge from the shelters to graze on fresh or decaying plant debris. As soon as the temperature drops they return to their shelters. Young individuals begin to leave the winter shelters at the end of February however, on days with temperatures above

4°C the slugs might appear at the end of January as well (Kozłowski and Kozłowski 2000). Most of them abandon their shelters by the end of March and this process might be temporary halted or prolonged due to temperature fluctuations.

### Timing of slug occurrence and population dynamics in the growing season

Based of three-year studies, times of occurrence of particular growth phases and population size of *A. lusitanicus* in specific seasons of the year were defined (Kozłowski and Sionek 2000b; Kozłowski and Kozłowski 2000). Young slugs (1.5cm in length) that hatch in late fall of the previous year emerge first. Single, larger individuals (longer than 3 cm) that hatch in mid-September of the previous year can appear at the same time. At the beginning of April young slugs that hatch in March from overwintering eggs start to come out from their shelters. At first they stay close to winter shelters and graze on plants and plant debris in the immediate vicinity. Their number increases along with hatching progress. When the mean, daily temperature is above 10°C, usually in mid-April, there is a build up of numbers of young slugs. That numerous appearance of *A. lusitanicus* juvenile stage in April was also observed in gardens in Great Britain (Davies 1987). From the beginning of May until mid-May the slug population increases several times. This high population of young slugs stays at the same level until mid-May (the first peak of population density). The slugs migrate intensively in a search for food. From mid to late May the slug population consists of not fully mature individuals and few full-grown. The slugs feed vigorously during the following months and they grow quickly. In mid-June, the number of slugs of 3-cm in length increases. At the beginning or in mid-August there is a second peak of slug population. At the same time a peak in *A. lusitanicus* population occurs in oilseed rape crops in Switzerland (Frank 1998). This high density of slugs stays until the end of September and in some years until mid-October. At the beginning of October off-spring hatch from eggs laid in August appear. After the temperature drops, the slugs move gradually to winter shelters and significant group of mature individuals dies after egg laying.

### Food and feeding

*A. lusitanicus*, as are most pulmonary slugs, is polyphagous and consumes a wide range of foods. It grazes on both dead and decaying green plant parts and growing plants as well. Fungi, algae, mosses and lichens are small fraction of its diet. The slugs can also feed on animals, for instance small and dead invertebrates, animal excrements and community waste. However, cultivated and wild growing plants are the basic food for them. Similar to other species *A. lusitanicus* shows the specific food requirements and selects certain plant material in preference to others. It feeds eagerly on new, lush plant parts (germinating seeds, seedlings, leaves, twigs, roots, fruits) and frequently causes severe damage in crops, particularly during plant germination.

The studies on food preferences that included 190 plant species, 30 vegetables, 22 arable plants, 8 stone fruit trees, 46 ornamentals, medicinal plants, and 83 other herbal species showed that *A. lusitanicus* grazed willingly on 30% of these species (Kozłowski and Kozłowska 1998, 2000; Kozłowski 2005). This group consists of mostly vegetables (24 species) and some plants from other families. Vegetables such as lettuce, cabbage, red beet, radish, carrot, parsley and beans were the most frequently consumed and also the most damaged. Sunflower, clover and potato were more

favored among arable plants. Oilseed rape and beet plants, these growing on field ridges were also well tolerated. Among low-growing plants, *A. lusitanicus* grazed on strawberry fruits the most. Severe damage was recorded on some ornamental plants and herbs such as *Althaea rosea* (L.) Cav., *Archangelica officinalis* Hoffm., *Dahlia variabilis* Desf., *Lilium candidum* L., *Ocimum basillicum* L., *Rudbeckia laciniata* L., *Tagetes erectus* L. and *Zinnia elegans* Jacq. From weeds *Aegopodium podagraria* L. was more frequently eaten. A common occurrence of *A. lusitanicus* in summer resulted in a very high damage rate of this; slugs destroyed almost the entire population of this weed (Kozłowski and Kozłowska 2000). Other weed species damaged severely in field conditions are as follows: *Artemisia dracunculus* L., *Centaurea cyanus* L., *Conium maculatum* L., *Malva silvestris* L., *Papaver rhoeas* L., *Rumex acetosella* L., *Trifolium repens* L. and *Urtica dioica* L. Despite high availability of vegetables that are main food source for slugs, *A. lusitanicus* preferred dicotyledonous weeds growing on balks, in ditches and thickets adjoining crops. In Sweden, *A. lusitanicus*, apart from vegetables, feeds harshly on some herbal plants such as *Mercurialis perennis* L., *Melannndrium rubrum* L., *Solanum dulcamara* L. and *Polygonatum multiflorum* (L.) All. According to Proschwitz (1994) these plants were eaten to completely leaflessness. Feeding on mature monocotyledon plants from *Gramineae* family was hardly seen in our studies. Other studies reached the same conclusions (Dirzo 1980; Cook *et al.* 1996; Briner and Frank 1998).

In tests with choice and no-choice on palatability of 82 weed seedlings, medicinal plants, and oilseed rape, 17 species were very well accepted by *A. lusitanicus* (Kozłowski and Kozłowska 2000, 2003, 2004; Kozłowski and Kałuski 2004). This group contained *Brassica napus* L., *Conium maculatum* L., *Coriandrum sativum* L., *Datura stramonium* L., *Papaver rhoeas* L. and *Satureja hortensis* L. The same plants were also selected by other slug species included in this study i.e. *Deroceras reticulatum* (O.F. Müller) and *Arion rufus* (Linnaeus). Moreover, *A. lusitanicus* grazed on seedlings of *A. podagraria*, *Agrostemma githago* L., *Artemisia dracunculus* L., *Artemisia vulgaris* L., *Centaurea cyanus* L., *Cichorium intybus* L., *Cirsium arvense* (L.) Scop., *Taraxacum officinale* Web., *Tripleurospermum inodorum* (L.) Schultz-Bip. and *Verbascum thapsus* L. Other authors demonstrated that *A. lusitanicus* eagerly fed on weed species as *Capsella bursa-pastoris* (L.) Med., *C. cyanus*, *C. arvense*, *Euphorbia helioscopia* L., *Lamium purpureum* L., *Myosotis arvensis* (L.) Hill., *P. rhoeas*, *Sinapsis arvensis* L. and *Tanacetum vulgare* L. (Briner and Frank 1998). These and other findings indicate that weeds might be complementary or alternative food source for *A. lusitanicus*.

Despite fact that plant material is the basic food source for slugs, *A. lusitanicus* feeds also on fungi, mosses, dead invertebrates, animal excrements and community waste. Such behavior has been often documented during observations on occurrence and feeding habits of the slug in different niches. Palatability of 21 food samples of animal or plant origin was tested under laboratory conditions (Kozłowski, manuscript in preparation). The study included slugs, worms, seeds and leaves of plants, dry mushrooms, and plant and animal semi-products such as oats, wheat bran, noodles, cheese, yeast, milk powder, hard boiled eggs and meat. The observations revealed that *A. lusitanicus* did not avoid any of the provided choices. The slug can also graze on material rich in cellulose. As in other slugs the presence of symbiotic bacteria in the digestive system and production of the enzyme cellulose allow digestion of cellulose. The conducted test showed that the slugs reared on poplar bark or filter paper lived by 40 days longer than starved ones (Kozłowski, manuscript in preparation).

In addition, mature slugs that were provided only water survived 36–45 days. This capability allows them to survive unfavorable environmental conditions.

Feeding rate and amount of food consumed by *A. lusitanicus* depend upon food requirements and the slug activity. The slugs are the most active on cloudy and rainy days and mornings with early dew. As far as daily activity is concerned, the slugs are seen mostly at night and early morning hours (Kozłowski 2001b). Their activity is the highest 2–3 hours after the sunset. Most individuals begin moving to their shelters in the third hour after the sunrise. Ratio of a resting time to an active time is 1:1 at a ratio of a day length to night of 5:3. *A. lusitanicus* is feeding throughout the night, with frequent intervals of rest, starting just after leaving shelter until the early morning hours. Laboratory studies revealed that feeding time is on average 2 hours per day and is more intense at the beginning of the night (Kozłowski 2001b). As in many slug species, different meteorological and edaphic factors affect the process of *A. lusitanicus* feeding. The most important factors are light intensity, air temperature, and soil humidity. Some other specific elements such as plant density play an important role in *A. lusitanicus* feeding habits. This species seems to prefer an area with high plant densities. Abundant source of food and availability of shelters in these ecosystems stimulate the slugs to eat longer. Dense plant mass protects them from direct sun and they are more active than in sunlit sites. *A. lusitanicus* occurs in high population in these places and they present a serious threat to arable crops.

## CONCLUSIONS

*Arion lusitanicus* introduced into Polish territory probably in the early of the 1990s became an important element of malacofauna of agrocenosis and a serious pest of plants in certain areas. It first occurred only in Albigowa and Markowa and over last decade has spread throughout the Podkarpackie

Voivodeship. In recent years its presence in four new sites was reported. Probably *A. lusitanicus* was introduced into these places accidentally. There is a possibility that it also appears in other vicinities but might be misdiagnosed as species *Arion rufus*. *A. lusitanicus* are frequently spread out with soil, plant material, garden and community waste. As typical synanthropics the slugs are

ecologically associated with humans. Its mass occurrence is observed in gardens, fields cultivated near buildings, thickets, parks, cemeteries, community waste and riverbanks. The slugs demonstrate preferences for microecosystems and it results in varying population densities. They inhabit most frequently plant crops cultivated on clay and loam soil, crops with high plant densities and areas adjoining watercourses. The highest populations of slugs are found in vegetable crops, flowers, strawberries and raspberries, places providing rich, palatable food and shelters.

*Arion lusitanicus* indicates a stable life cycle responding to seasons of the year. It has an annual life cycle. The process of maturation and reproduction takes place in summer and, at favorable temperatures, continues until late fall. Eggs hatch in fall and spring. The slug overwinters in the egg or juvenile phase and most individuals die after egg laying. There are some instances of mature slugs overwintering however, it does not play important role in its life cycle. There are two peaks of population densities of the slugs; the first takes place in spring. At that time young and immature

slugs dominate in populations. The second mass occurrence takes place by the end of summer and early fall when winter crops begin to germinate.

Capability of the slug to feed on various plant and animal materials increases its chances of surviving in different agrocenosis. Vegetables, certain ornamental plants and some small stone trees, and herbs growing in close proximity in thickets and barren lands are main source of food. The slug shows particular food preferences. It prefers certain arable crops and wild growing plants. *A. lusitanicus* vigorously grazes on some dicotyledonous weeds that substitute main food materials. The slugs damage most plants cultivated in gardens and fields. They consume all plant parts, however, seedlings after germination are the most injured. It results in high losses in yield of vegetables and ornamentals.

*A. lusitanicus* has several traits allowing its easy and quick adjustment into new niches. There are as follow: large body sizes, rapid reproduction, high food and ecological tolerance, high survival rate under unfavorable conditions (lack of food, low temperatures), capability to hide in shelters and eating a variety of food, correlation between mass occurrence and phenology of cultivated plants and lack of natural enemies. These factors decide that *A. lusitanicus* forms high populations and quickly spreads out in Poland, as in other European countries. Difficulties in controlling the slug, its wide geographical distribution and yield losses of economic importance caused by it indicate that *A. lusitanicus* should be considered as a serious invasive pest.

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## POLISH SUMMARY

### ROZMIESZCZENIE, BIOLOGIA, DYNAMIKA POPULACJI I SZKODLIWOŚĆ *ARION LUSITANICUS* MABILIE, 1868 (*GASTROPODA: PULMONATA:* *ARIONIDAE*) W POLSCE

W pracy dokonano podsumowania wyników badań populacyjnych nad ślimakiem *Arion lusitanicus*, prowadzonych w latach 1994–2005 i przedstawiono jego charakterystykę.

*A. lusitanicus* został zawleczony do Polski prawdopodobnie na początku lat dziewięćdziesiątych ubiegłego wieku. Początkowo występował tylko w Albigowej i Markowej w okolicy Rzeszowa, skąd rozprzestrzenił się prawie na całym obszarze województwa podkarpackiego. W ostatnich latach stwierdzono cztery nowe stanowiska występowania tego ślimaka. Niewykluczone, że gatunek ten występuje także w innych miejscach w kraju, ale nie jest odróżniany od *Arion rufus*. Jako typowy synantrop zajmuje siedliska silnie zdegradowane działalnością człowieka. Występuje masowo w ogrodach i na polach uprawnych położonych w pobliżu zabudowań oraz w zaroślach, w parkach, na cmentarzach, na śmietniskach i na brzegach rzek. *A. lusitanicus* wykazuje stałą rytmikę życiową związaną z porami roku. Ma roczny cykl życiowy. Okres dojrzewania i rozrodu przypada na ciepłe miesiące letnie i może trwać do późnej jesieni. Ślimak zimuje głównie w stadium jaj i osobników młodocianych, a większość osobników po złożeniu jaj umiera. W trzeciej dekadzie lipca przystępuje do kopulacji i po trzech tygodniach rozpoczyna składanie jaj, z których pierwsze osobniki wylęgają się po miesiącu. Kopulacja i składanie jaj trwa do późnej jesieni. Wylęganie następuje jesienią i wiosną. Jeden osobnik składa ponad 400 jaj. W sezonie wegetacyjnym występują dwa szczyty liczebności ślimaka. Pierwszy przypada wiosną, kiedy w populacji dominują młode, niedojrzałe osobniki. Drugi masowy pojaw ma miejsce pod koniec lata i wczesną jesienią, w okresie wschodów roślin ozimych. Podstawowym pożywieniem ślimaka są rośliny uprawne, zwłaszcza warzywa oraz niektóre gatunki roślin rolniczych, sadowniczych i ozdobnych. Ślimak chętnie odżywia się dwuliściennymi chwastami oraz pokarmem pochodzenia zwierzęcego. Uszkadza większość gatunków roślin uprawianych w ogrodach i na polach. Żeruje na wszystkich organach roślin, a najbardziej narażone na uszkodzenia są młode ro-

śliny w okresie wschodów. Żerowanie ślimaka wyrządza poważne straty w plonie różnych gatunków roślin zwłaszcza warzyw i roślin ozdobnych.

Duże rozmiary ciała *A. lusitanicus*, szybkie namnażanie, duża tolerancja pokarmowa i ekologiczna, wytrzymałość na głód i niesprzyjające warunki otoczenia, skorelowanie masowych pojawów z fenologią roślin uprawnych i brak wrogów naturalnych sprawiają, że *A. lusitanicus* bardzo dobrze adaptuje się w nowych siedliskach. Dzięki wymienionym cechom tworzy bardzo liczebne populacje i szybko rozprzestrzenia się na terenie Polski. Wyrządzane przez tego ślimaka szkody i trudności w jego zwalczaniu sprawiają, że należy go uznać za groźnego agrofaga o charakterze inwazyjnym.