

# NOBANIS – Invasive Alien Species Fact Sheet

## *Arion lusitanicus*

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### Species description

**Scientific names:** *Arion lusitanicus* (Mabille, 1868), Arionidae.

**Synonyms:** *Arion vulgaris* (Moquin-Tandon, 1855) (Anderson 2005)

The taxonomic status of *Arion lusitanicus* is somewhat uncertain as the species contains at least two forms: *A. lusitanicus* (*sensu* Mabille) and *A. flagellus* (Noble 1992). Hybridisation with other large arionids is possible and this is a further complication.

**Common names:** Iberian slug, Spanish slug (GB), Spanische Wegschnecke, Kapuzinerschnecke (DE), Iberisk skovsnegl (DK), Espanjansiruetana (FI), Spanskur snigil, morsnigil (FO), Spánarsnigill (IS), Spānijas kailgliemezis (LV), Ispanikasis liuas (LT), Iberiaskogsnegl, brunsnegl (NO), Spansk Skogsnigel, mördarsnigel (SE), ślinik luzytański (PL).



**Fig 1.** *Arion lusitanicus* Reykjavik, 2 September 2004, photo by Erling Ólafsson.



**Fig 2.** Juvenile individuals of *Arion lusitanicus*, photo by Inger Weidema.

### **Species identification**

*Arion lusitanicus* is a slug, *i.e.* without a shell. The respiratory hole (pneumostome) is located on the right side of the slug in the front half of the mantle (Wittenberg 2005). The colour of *A. lusitanicus* is most often brown but dark brown or reddish to yellowish colours have also been observed. Juvenile specimens may have darker bands along the sides, while adults are more uniform in colour. The large muscular foot looks as if it is “sewn” onto the body with a dark brown tread (like a fringe). The adult body length is 7-15 cm (von Proschwitz and Winge 1994). *A. lusitanicus* is nocturnal and it is most easily observed at twilight or when it rains.

*A. lusitanicus* is closely related to *Arion ater* (which is native to western and central Europe) and *Arion rufus* (introduced) and it can be very difficult to distinguish between these, since there is an overlap in colour and size between these three species (von Proschwitz and Winge 1994). However, identification is possible through dissection and investigation of the genitalia (Noble 1992, von Proschwitz and Winge 1994).

### **Native range**

*A. lusitanicus* occurs naturally in the southern parts of Europe, mainly on the Iberian Peninsula and southern France (von Proschwitz and Winge 1994). Here the species is relatively rare, probably due to the dry and hot conditions that prevail in this region, coupled with the presence of natural enemies.

### **Alien distribution**

#### **History of introduction and geographical spread.**

*A. lusitanicus* is a recent newcomer to the region. The first records of *A. lusitanicus* are from Sweden in 1975 (von Proschwitz 1989, 1996, 1997), from Poland in 1987 (Kozłowski and Kornobis 1995), from Norway in 1988 and from Denmark in 1991 (von Proschwitz and Winge 1994). The first record in Finland was in 1990 (Åland Islands) and in 1994 (on the mainland) (Valovirta 1995, Ilmari Valovirta, pers.comm.).

It arrived in the Faroe Islands in 1996, supposedly from Denmark, from where the species is now being introduced almost continuously (Solhøy 1981, Dorete Bloch, pers. comm.). Today the slug is

a common inhabitant in the gardens and potato fields in the Faroe Islands. The slug was observed in Iceland in 2003 and 2004 (Ingimarsdóttir and Ólafsson 2005).

After the initial records of introductions the species has spread with an alarming rate as opposed to the related species *Arion rufus* that also has been introduced to the region.

### Pathways of introduction

Dispersal of *A. lusitanicus* to and within the region is mainly through unintentional introduction to new areas by humans, as plants are traded. The eggs and small slugs are readily transported in potted plants and with soil.

### Alien status in region

Today *A. lusitanicus* is found in Poland, Germany, Denmark, Sweden, Norway, Finland and the Faroe Islands and Iceland, but is expected to have a potential for establishment in all of the countries of the region, e.g. the species is not yet found in Lithuania, but expected to arrive here soon (Viktoras Didžiulis, pers. comm.). See also table 1.

Where the slug occurs in the Faroe Islands, the species is very numerous. *A. lusitanicus* also occurs in large numbers especially in Southern and Western Norway and is considered a serious pest. In Norway the species is distributed more or less continuously along the coast from the Swedish border to just north of Trondheim (Grong). Reports from Bodø (further north) have yet to be confirmed. It appears to be rare in the inland regions of Norway (Hoffsvang 1995, Hoffsvang and Haukeland 2006).

In Poland the first record of the species was from the vicinity of the city of Rzeszów. At present it is found at many sites of the Podkarpackie district, in the region of Kraków and also on the outskirts of city of Brzeg (between Opole and Wrocław) and is locally very abundant. On some sites it is an important factor limiting plant crop growth because it damages many species of both cultivated and uncultivated plants (Kozłowski 2005).

Country	Not found	Not established	Rare	Local	Common	Very common	Not known
Denmark						X	
Estonia	X						
European part of Russia							
Finland					X		
Faroe Islands					X		
Germany						X	
Greenland	X						
Iceland			X				
Latvia		X					
Lithuania	X						
Norway					X		
Poland				X			
Sweden					X		

**Table 1.** The frequency and establishment of *A. lusitanicus*, please refer also to the information provided for this species at [www.nobanis.org/search.asp](http://www.nobanis.org/search.asp). Legend for this table: **Not found** –The species is not found in the country; **Not established** - The species has not formed self-reproducing populations (but is found as a casual or incidental species); **Rare** - Few sites where it is found in the country; **Local** - Locally abundant, many individuals in some areas of the country; **Common** - Many sites in the country; **Very common** - Many sites and many individuals; **Not known** – No information was available.

## Ecology

### Habitat description

*A. lusitanicus*, like other slugs, prefers moist habitats like deciduous forests, grassland, parks and gardens. *A. lusitanicus* is today mostly confined to cultural habitats, more so than the two closely related species, *Arion ater* and *Arion rufus*. In Sweden 99% of the records of the species are from man-made habitats, while only <1% are from natural woodlands (von Proschwitz 1996). In the Faroe Islands the species is only found in the more fertile infields, but future studies will examine if the slug also has invaded the outfields (Dorete Bloch, pers. comm.). In Poland *A. lusitanicus* is a typical synanthropic species. The places with frequent slug appearance are gardens and field crops near buildings and rivers, ditches, baulks, wastelands and brushwood (Kozłowski 2000a, b). Experience from *e.g.* Austria, where the species has been introduced for a longer period of time, illustrates that the species has the potential to live both in natural habitats and to become a pest in highly managed agricultural landscapes (Reischütz 1984, Grimm 2001).

*A. lusitanicus* is probably adapted to the warmer climate of the Iberian Peninsula, but sufficient survival of the species is seen in northern Scandinavia. In Norway the species is mostly found in private gardens and small grassland areas. More recently it has been reported as a pest in field grown strawberries and vegetables.

### Reproduction and life cycle

The slugs are hermaphroditic; meaning that each individual acts both as female and male during copulation. Outcrossing has been shown to predominate for *A. lusitanicus*, leading to high levels of heterozygosity (Foltz *et al.* 1982, Quinteiro *et al.* 2005), which may lead to a selective advantage relative to the more homozygous *A. ater*. Each individual slug lives one year and may lay approximately 400 eggs during one summer, the eggs are laid in lumps of 20-30 eggs in soil crevices or in compost heaps (Anonymous 1999). After an incubation of 3.5-5 weeks the young slugs emerge.

The adult slugs normally die in autumn after reproduction has been completed. Mild winters and summers with plenty of rainfall increase the survival of the juveniles that overwinter in compost heaps and soil crevices. On rare occasions some adults may even survive winters, *e.g.* an adult specimen was reported to survive winter under protected conditions near a greenhouse wall in Finland (Ilmari Valovirta, pers.comm.).

Apparently *A. lusitanicus* is tougher to eat and produce more mucus than *e.g.* the native *A. ater*, which makes it less palatable to natural slug predators (Sulzberger 1997). The slugs have few natural enemies, but badgers, wild boars and hedgehogs may eat them (von Proschwitz and Winge 1994). Blackbirds (*Turdus merula*) have been observed as new predators on the species in Sweden and Denmark (J. Hagnell, pers.comm., F. Jensen, pers.comm.). Cannibalism is observed, but this is probably only predominant when slugs are very numerous, and only dying fellow slugs are attacked (Solveig Haukeland, pers. comm.).

### Dispersal and spread

Long distance dispersal is mainly by human mediated transport of soil, compost or plant material that contains adults, juvenile individuals or eggs. The species has probably been repeatedly introduced. Transport within countries is also a possible mode of introduction (von Proschwitz and Winge 1994).

Local dispersal by the animals themselves is probably not very far, but once present at a site the slugs have a high reproductive potential compared to native slug species (von Proschwitz 1992).

## Impact

### **Affected habitats and indigenous organisms**

Populations of the native species *A. ater* are reduced at localities where *A. lusitanicus* occur at high densities (von Proschwitz 1992, Hagnell *et al.* 2004, Wittenberg 2005). This effect could be caused by competition for the same food resources or by the fact that *A. lusitanicus* eat *A. ater* – this has not yet been investigated. In grassland, parks and commons in Sweden and Denmark, the species has caused substantial damage to the vegetation (von Proschwitz and Winge 1994). From the Faroe Islands it is reported to eat rhubarb and garden vegetation, as well as being a pest in potato fields (Dorete Bloch, pers.comm.). From Austria severe agricultural effects have been reported (Reischütz 1984). In Poland 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 severely damaged and some plant species from the other groups as well. Indications of the slug feeding were found on 103 plant species. *A. lusitanicus* preferred *Brassica napus* and *Datura stramonium* plants but showed no interest in *Geranium robertianum* (Kozłowski and Kałuski 2004, Kozłowski 2005). In Germany and Switzerland, this slug species attacks many vegetables, ornamentals and strawberries in private gardens and horticulture. In arable farming (mainly oilseed rape, maize, sunflowers), its damage is usually restricted to the first 2-3 m along the crop border (Frank 1998a, 1998b).

### **Genetic effects**

Hybridisation between *A. ater* and *A. lusitanicus* has been observed in Sweden. It has been hypothesised that hybridization might lead to a “Super Slug” which combines the fertility and feeding behaviour of *A. lusitanicus* with *A. ater*’s tolerance for a temperate climate (von Proschwitz 1997, Hagnell *et al.* 2003). However, fitness studies have yet to be undertaken to prove if the introduced *A. lusitanicus* may indeed out compete the native species *A. ater* (Lars Monrad, pers. comm.). Hybrid populations have also been observed in some localities in Norway, no evidence yet of more aggressive feeding behaviour by these populations (Torstein Solhøy, pers. comm.)

### **Human health effects**

No human health effects have been reported. *A. lusitanicus* secretes copious amounts of mucus. This mucus is very sticky and difficult to wash off. Since the mucus may contain *E. coli* bacteria most texts recommends not eating vegetables covered with mucus. Another advice often given to private gardeners wanting to manage the species is to wear gloves or use some device to pick up the slugs.

### **Economic and societal effects (positive/negative)**

*A. lusitanicus* is polyphagous and feeds on a range of crop species as well as dumped plant material and carcasses (Wittenberg 2005). In Sweden the species is reported from strawberry fields and grain storage facilities (J. Hagnell, pers.comm.). No overall assessment of the economic consequences of *A. lusitanicus* has been made, but the species contributes to damage on several horticultural crops (Fischer and Reisschütz 1999, Speiser *et al.* 2001a). Furthermore, there are great impediments to human use of gardens as judged by the number of times this species make headlines in media (often under the alias “killer slug”)(Valovirta 2000).

Strawberry growers in Norway have reported more than 50% loss in yield due to *A. lusitanicus*, but proper economic assessments have not been conducted yet (Solveig Haukeland, pers. comm.). An

example of a societal effect is that home owners have been known to sell their property and move to slug free areas. House prices may also be affected by the presence of this species (Ilmari Valovirta, pers.comm.).

In Central Europe, *A. lusitanicus* is the major pest slug species, and most sales of molluscicide pellets in the home and garden market can be attributed to this species – this gives an indirect estimate of the damage they cause (B. Speiser, pers. comm.).

## Management approaches

### Prevention methods

National border inspection routines to prevent plant pests of being transported with plants and potted material exist, but no special actions are taken as regards *A. lusitanicus*.

In natural surroundings it is very difficult to prevent *A. lusitanicus* from coming in if the species is in the vicinity. In a garden it is possible to use some cultural practices to reduce the slug activity. The method could be called “the method of dry and well managed soils”, because soil cultivation to some extent prevents *A. lusitanicus* from thriving in an area as the slugs prefer moist surroundings with a vegetation to hide in (Speiser *et al.* 2001a).

In small-scale gardening slug fences may also present a preventive possibility. Naturally, this possibility is only relevant when the area is quite small. The idea of the slug fence is to build a fence around your crop, looking much like a no. 1, with a little roof-eave pointing towards where the slugs are. The eaves of the fence have to be bended in an angle of 45-55° to prevent the slugs from crawling over the fence.



**Fig.3 and 4.** Examples of slug-fences, the first with an angle of the eave of 90°, the second with an angle close to 45°, photos by: [direction.dk](http://direction.dk) and Susanne Mørk Jensen, [Den Økologiske Have](http://DenØkologiskeHave.com).

### Eradication, control and monitoring efforts

The occurrence of *A. lusitanicus* varies from year to year primarily determined by rainfall and temperature variations during spring and summer. Long periods with lots of rainfall and not too high temperatures increase the population number of this species. Hot spells for extended periods of time may reduce population size, allowing the slugs only to survive in moist places.

Collecting and killing *A. lusitanicus* has proven the most effective eradication method in home gardens, however, this method has little relevance in professional horticulture or natural or semi-natural sites, since it is labour intensive. Various methods for trapping the slugs have been suggested ranging from homemade tins with beer as bait to ingeniously constructed (and expensive) devices (see *e.g.* Speiser *et al.* 2001a, Hagnell *et al.* 2006,

*A. lusitanicus* become active as temperatures go down and therefore it is easiest to find them during morning or in the evening when dew is falling. Collection of all life stages of the slugs should take place - apart from collecting the adult slugs it is important also to remove the eggs. The eggs are located in lumps of 20-30 eggs under pots, boards and other items that create a moist microclimate. The adults may be attracted with a variety of smelling attractants, such as beer and decaying fruits etc. (Speiser *et al.* 2001a).

Collecting slugs early in the season will contribute to reducing the number of eggs laid later in the season. After collecting the slugs they have to be killed by either decapitation (with a pair of scissors or a sharp spade), putting them in a container and pouring hot boiling water over them or by putting them in a freezer overnight (in a plastic bag) (von Proschwitz, pers.comm., Hagnell *et al.* 2004). The dead slugs should be buried, unless they are used as bait to attract more slugs.

In horticulture biological control has been used to control *A. lusitanicus* (Speiser and Andermatt 1994). The nematode *Phasmarhabditis hermaphrodita* is a microscopic worm that is specific to slugs. The infectious nematode larvae actively seek out slugs and probably enter through a small pore near the respiratory canals. Once inside the slugs bacteria are released which induces the slugs to stop eating - after 1 or 2 weeks the slugs die (Wilson *et al.* 1993, Speiser *et al.* 2001a). Unfortunately, the nematodes have a rather poor effect against this slug species (Speiser *et al.* 2001b). The nematodes are not species specific and it may therefore be expected that they also attack harmless slugs which may affect the overall biological diversity negatively. Non-target studies related to their use against the field slug *Deroceras reticulatum* have however indicated so far that this risk is not very high (Morand *et al.* 2004).

A number of iron compounds are molluscicidal. Iron (III) phosphate is one of these being sold in slug pellets and leads to feeding inhibition, and later to the death of slugs (Koch *et al.* 2000). It varies between countries if these pellets are recommended as a method for controlling *A. lusitanicus* (Speiser *et al.* 2001a). Recently iron (III) phosphate has been taken up on the list of the [Council Regulation \(EEC\) No 2092/91 of 24 June 1991](#) on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs (Annex II, part B) which has the implication that this compound may now be used in organic agriculture.

Other molluscicides, such as metaldehyde or carbamates, are also sold as slug pellets (Speiser 2002). Mostly these compounds are forbidden or there are severe restrictions on the use of these compounds in Scandinavia, since they are very poisonous for other organisms too (birds, mammals, fish and other water living animals). Therefore these compounds are not recommended to combat *A. lusitanicus* (Anonymous 1999). In Norway the only molluscicide available to commercial growers is “Judge” (thiodicarb) (Solveig Haukeland, pers. comm.).

### **Information and awareness**

Since *A. lusitanicus* is found in gardens and probably also has a potential to invade agricultural areas there has been much focus on this particular invasive species in newspapers, radio and television. Several Internet sites have been created which describe the species, the problems it creates and how to eradicate it (see links below). Public awareness is judged to be high in relation to this species (von Proschwitz 1995, Solveig Haukeland, pers. comm., Dorete Bloch, pers. comm.).

By engaging an entire neighbourhood in a joint effort against *A. lusitanicus* the likelihood for a success is increased locally. By a joint effort and common knowledge about possible management methods and the biology of the species it is easier to ensure and effective approach towards this pest

species. In Denmark *A. lusitanicus* has in some municipalities been made a subject some of the local agenda 21 work to ensure a coherent local action (Ankersen 2003).

### **Knowledge and research**

Scientists at Bioforsk, Norwegian Institute for Agricultural and Environmental Research have isolated the nematode *Phasmarhabditis hermaphrodita* in introduced *A. lusitanicus* and in two other *Arion* species from three localities in Norway (Solveig Haukeland, pers. comm.). This nematode is part of a biological control remedy being sold in e.g. Great Britain, Denmark and recently Norway. If natural populations of a biological control agent are present in a given country, this may facilitate the registration or permission to use the agent for biological control. A research project was initiated in 2005 to investigate the distribution, biology and control of *A. lusitanicus* with emphasis on examining the efficacy of the nematode *Phasmarhabditis hermaphrodita*. In 2006 a PhD study has furthermore been initiated on predatory beetles to control *A. lusitanicus* eggs.

At the Institution of Zoology at Göteborg University work is ongoing on the morphological, ecological and physiological impact of *A. lusitanicus* and the interactions with the native *Arion ater*. Pest control aspects are also studied by evaluation of a wide array of substances and control methods (Jan Hagnell, pers. comm.). Some initial studies on the temperature responses comparing *A. lusitanicus* and *A. ater* as well as a hybrid between these two species gives indications that the native species and hybrids might be more adapted a cold climate, but further studies are needed to substantiate this (Hagnell *et al.* 2003).

### **Recommendations or comments from experts and local communities**

It is important to start control measures early in the season and to encourage neighbours to do the same.

## **References and other resources**

### **Contact persons**

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## Links

Göteborg Natural History museum – [information on \*Arion lusitanicus\*](#) (in Swedish)

Norwegian [paper with key to most common slugs](#) (in Norwegian) [www.bioforsk.no](http://www.bioforsk.no) - revised april 2006- see under publications

Slugs in the garden – [guide to control measures](#) (in German)

Institute of Plant Protection - [Slugs - dangerous crop pests](#) (in Polish)

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