PNIE PROCEEDINGS OF THE NATIONAL INSTITUTE OF ECOLOGY OF THE REPUBLIC OF KOREA

Original Article

PNIE 2024;5(3):86-93
https://doi.org/10.22920/PNIE.2024.5.3.86
pISSN 2765-2203, eISSN 2765-2211

Identifying Potential Food Source through DNA Barcoding Analysis of Feces from Invasive Slug, *Limax maximus* (Linnaeus 1758) (Gastropoda: Pulmonata), in Republic of Korea

Hong Geun Kim[1], Kibeom Park[2], Youngjun Park[3]*, Youngho Cho[3]*

[1]BK21 FOUR R&E Center for Environmental Science and Ecological Engineering, Korea University, Seoul, Republic of Korea
[2]Invirustech, Gwang-ju, Republic of Korea
[3]National Institute of Ecology, Seocheon, Republic of Korea

ABSTRACT

Unintentional dispersal of organisms has explosively increased due to expansion of human activities. Among introduced organisms, some organisms are categorized as invasive species because of their effects on environmental risk, economic loss, and human health. In 2023, a leopard slug (*Limax maximus*) was reported in Suwon, Republic of Korea. This slug was designated as a potential invasive species because a wide range of plant species were identified as food sources for this slug in its original habitats. However, it is difficult to investigate the ecological risk of this newly introduced slug in Republic of Korea. Therefore, the potential ecological risk from this newly introduced slug was estimated by meta-genome analyses of its feces. Through meta-genome analyses, 22 Families, 28 Genera, and 26 Species of land plants were identified. Among these 26 identified plant species, six economically important crops – squash (*Cucurbita maxima*), tomato (*Solanum lycopersicum*), potato (*Solanum tuberosum*), cowpea (*Vigna unguiculata*), rice (*Oryza sativa*), and oriental melon (*Cucumis melo*) – were identified. Therefore, leopard slugs potentially could cause economic losses in Republic of Korea. Further study is required to build a control strategy against leopard slugs.

Keywords: Leopard slug, Invasive species, Meta-genome, Food source, Feces, *Limax maximus*

Received July 5, 2024; **Revised** July 24, 2024; **Accepted** July 25, 2024

***Co-corresponding authors:**
Youngjun Park
e-mail aquatic@nie.re.kr
https://orcid.org/0000-0003-3916-5796
Youngho Cho
e-mail themoth@nie.re.kr
https://orcid.org/0000-0001-5672-5121

Introduction

Unintentional dispersal of organisms has explosively increased; with recently increased human activities (Pimentel *et al.*, 2005). Dispersed organisms that pose a major threat to the new environment or human health may be categorized as invasive species. These invasive species have been focused because they pose significant threats to biodiversity, environment, human health, and economy (Kim and Lee, 2019). However, it is difficult to predict and to estimate threats from newly introduced invasive species because detailed information about invasive species is not enough (Roques *et al*., 2009; Rowson *et al*., 2014; Bradshaw *et al*., 2016). Moreover, the newly introduced organism can adjust their behavior as well as physiological preference when it is introduced into new habitat (Berg *et al*., 2010). Therefore, eradication of invasive organism is almost impossible if the organism has successfully settled down in the new area. Only a small window is open to prevent successful settlement of invasive organism at the early stage of the introduction.

The leopard slug (*Limax maximus*) is known to have a distinctive body coloration similar to a leopard. It also has an extraordinarily large body length of ca. 15 cm. It has a pale brown or grey back with 4 ~6 interrupted dark bands and a mantle with spots (Barker, 1979). It originated in Europe. Its first description was conducted by Linnaeus in 1758. It is also well-known for its unusual mating behavior by a pair of slugs suspended by a mucus thread to exchange sperm (Karlin and Bacon, 1961). In its native habitat, this slug can serve as a detritivore that feeds on dead plant materials and fungi (Barker, 1999; Kozłowski, 2012).

Distribution of *L. maximus* in Europe, North Africa, and Asia has been reported. It has been introduced to other countries in North and South America, Africa, the Pacific Islands, Australia, Hawaii, and New Zealand (Barker and McGhie, 1984; Barker, 1999; Roth and Sadeghian, 2006; Joe and Daehler, 2008; McDonnell *et al*., 2009; Gaitán-Espitia *et al*. 2012). In Japan, this slug was confirmed in 2006 (Hasegawa *et al*., 2009). Based on this expansion of distribution, *L. maximus* is regarded as an invasive slug (Gaitán-Espitia *et al*., 2012). The preferred habitat of *L. maximus* includes forests, hedgerows, and gardens (Kerney and Cameron 1979; Cook and Radford, 1988; Meyer *et al*., 2013).

In Korea, *L. maximus* was detected at Bambat-Cheonggaeguri Park, Suwon in 2023 (Park *et al*., 2024). As it was recently introduced in Korea, it will not be difficult to eradicate this introduced slug with detailed ecological and physiological information of it. However, to make effective plans to eradicate this pest, its current dispersal status and possible dispersal area should be identified.

Before 2002, only two species (*Limax*, *L. flavus* Linnaeus 1758 and *L. marginatus* Müller, 1774) in genus *Limax* have been reported in Republic of Korea (Lee and Min, 2002). In the new habitat, this invasive herbivore species might affect plant species composition and diversity (Buschmann *et al*., 2005; Carlsson and Lacoursière 2005). In Hawaii and Japan, its food preference was tested.

To prepare for its potential ecological risk, possible food source of *L. maximus* was investigated by performing DNA meta-barcoding analyses of *L. maximus* feces. Feces were collected from *L. maximus* wild individuals and processed by meta-barcoding analyses to identify which plants were digested by these slugs. This information might give some clues to assume the potential environmental risk from *L. maximus* settlement on the Korean peninsula.

Materials and Methods

L. maximus habitat in Republic of Korea

Park *et al*., (2024) firstly reported *L. maximus* (Fig. 1) at Bambat-Cheonggaeguri Park (126.971138 E, 37.307072 N),

Fig. 1. *Limax maximus* at its natural habitat in Republic of Korea. (A) Overview of the *L. maximus* habitat in Suwon, (B) Walkin with a dog at the *L. maximus* habitat in Suwon, (C) *L. maximus* found in its natural habitat.

Suwon, Gyeonggi-do in 2023 (Fig. 2). This park is surrounded by newly developed residential area in the south and forested area in the north including hobby farms, agricultural areas, and trails. Mt. Deokseong (160 m above sea level) is located ca. 1.5 Km away from the northern part of this park, and Mt.Gwanggyo (580 m above sea level) is located ca. 7 Km to the north-west side of this site. Therefore, this park has served as a buffer zone between natural environment and human residential area.

Sample collection

A total of 89 individuals of *L. maximus* (15 individuals during daytime and 74 individuals during night) (Fig. 2) were caught at the previously described site on September 19, 2023 (Table 1). These individuals were maintained in a plastic container (34 × 20.5 × 25 cm (H × W × L)) for one day without food source. From this plastic container, all feces were collected and transferred to 1.5 mL Eppendorf tubes. These collected feces were kept in four 1.5 mL Eppendorf tubes for ca. two months before DNA analysis. The collected sample was confirmed as *L. maximus* based on its morphological characters and barcoding analysis with 1,340 bp mitochondrial COI region (Nitz *et al.*, 2009). Two stages of PCR were conducted for its molecular identification. The first fragment was amplified with mtCOI-1F-54 primer (5'-tttcaacaaaycataargatattgg-3') and

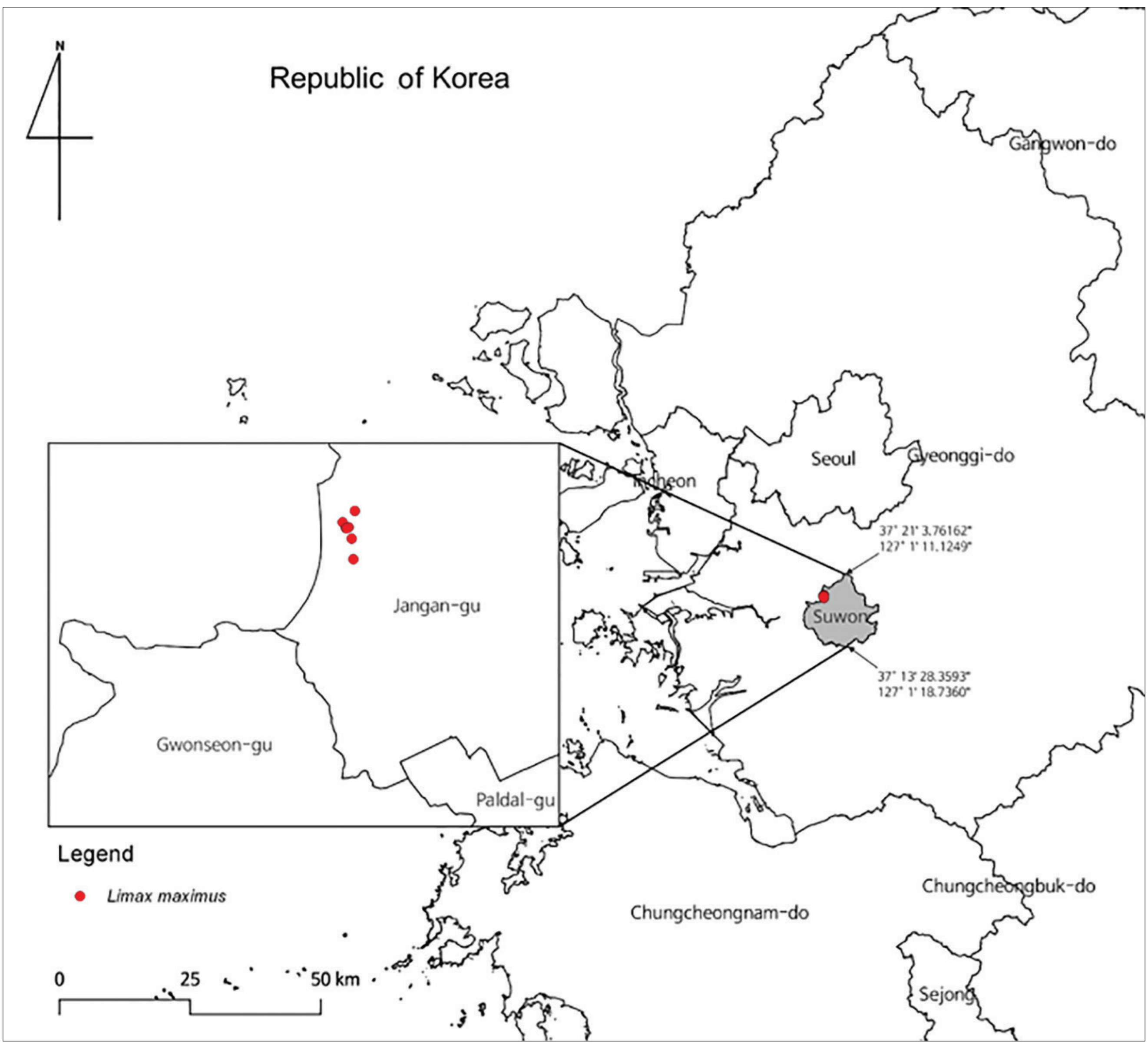

Fig. 2. The field site of collecting *L. maximus* in Republic of Korea. Red dots indicate where *L. maximus* were collected.

Table 1. Collection information for *L. maximus*

Date	Coordinate		Number individuals	Landcover type	Day/Night
	E	N			
2023/9/19	126.97133	37.31483	1	Farm	Day
	126.97052	37.31311	6	Farm	Day
	126.96972	37.31363	3	Farm	Day
	126.97015	37.31302	3	Farm	Day
	126.97026	37.31299	2	Grassland	Day
	126.97113	37.30975	74	Walking trails	Night
	126.97091	37.31191			

mtCOI-1R-53 primer (5'-aayaccaatagaaattatagcataaa-3'). The primer set for the second fragment included mtCOI-2F primer (5'-ttagcrggggcaattactatrc-3') and mtCOI-2R primer (5'-cgaaaaca-gatattaacgaaccat-3'). Amplified sequences were checked by Sanger sequencing and combined to yield a 1,381 bp of mtCOI DNA sequence.

DNA meta-barcoding analyses

Fecal samples collected from *L. maximus* were thoroughly homogenization. After homogenized, 0.1 gram of each sample was transferred to a 2.0 mL tube with 3 mm zirconia ceramic beads for lysis with a Pre-Filled Bead Lysis Tube (Invirustech, Gwangju, Republic of Korea). DNA extraction was conducted using a Beniprep Soil/Fecal DNA Extraction Kit (IVT7003, Invirustech, Gwangju, Republic of Korea) according to the manufacturer's protocol. The quantity and quality of extracted DNA were measured with an Epoch spectrophotometer (Agilent, Santa Clara, CA, USA).

For metagenomic analysis, Shotgun Metagenomics Sequencing was performed. Library preparation and quality control were conducted by Macrogen (Seoul, Republic of Korea). This sequencing generated 85,952,990 reads from fecal samples with a total read base of 13.0 Gbp. The GC content was 55.0%. This Shotgun Metagenomics Sequencing generated 93.1% of the Q30 data.

Pre-filtered reads were analyzed with Kraken2 suite (Lu *et al.*, 2022). These reads were used as queries against the nt database using Kraken2. Analyzed results were summarized at the Streptophyta level to focus on possible food source of the leopard slug.

Results

The fecal sample generated 85,952,990 reads with a total read base of 13.0 Gbp. The GC content was 55.0%. The sequencing generated 93.1% of Q30 data. A total of 115K reads were identified as plants originated from this analysis. Among these, only Streptophyta, a terrestrial plant Phylum, was focused (Fig. 3). As a result, 22 families, 28 genera, and 26 species were identified as potential food sources of the leopard slug based on DNA meta-barcoding analysis.

At the species level, a total of 26 plant species were detected including not only economically important plants including cultivated squash (*Cucurbita maxima*), tomato (*Solanum lycopersicum*), black-eyed pea (*Vigna unguiculata*), and rice (*Oryza sativa*) but also environmentally important plants including pedunculate oak (*Quercus robur*), common ivy (*Hedera helix*), the tree of heaven (*Ailanthus altissimus*), and soft rush (*Juncus effusus*) (Table 2). Moreover, a wide range of plant species including cotton, chrysanthemum, clover, bitter cucumber, and blackcurrant were identified. For genus level identification, a total of 28 genera were identified (Table 3). Among the 28 identified genera, Solanum, Gossypium, Cucurbita, Ipomoea, and Brassica generally include diverse economically important crops.

Among 22 identified Families, Family Brassicaceae might be the major food source of *L. maximus*. Families Leguminosae, Solanaceae, Poaceae, Cucurbitaceae, and Fagaceae were also detected (Table 3).

Therefore, the settlement of this slug will affect not only agriculture but also natural environments. To reduce the ecological risk from this slug, more detailed information about microhabitats as well as the food preferences of *L. maximus* in Republic of Korea might be required.

Discussion

Potential food sources of the leopard slug, an invasive species, in Republic of Korea were investigated by DNA meta-barcoding analysis. Feces of wild individuals of *L. maximus* were collected for this analysis. From this analysis, various plant species were identified as potential food sources of *L. maximus* in Republic of Korea. Komatsu and Saeki (2022) have also reported that 26 plant species are

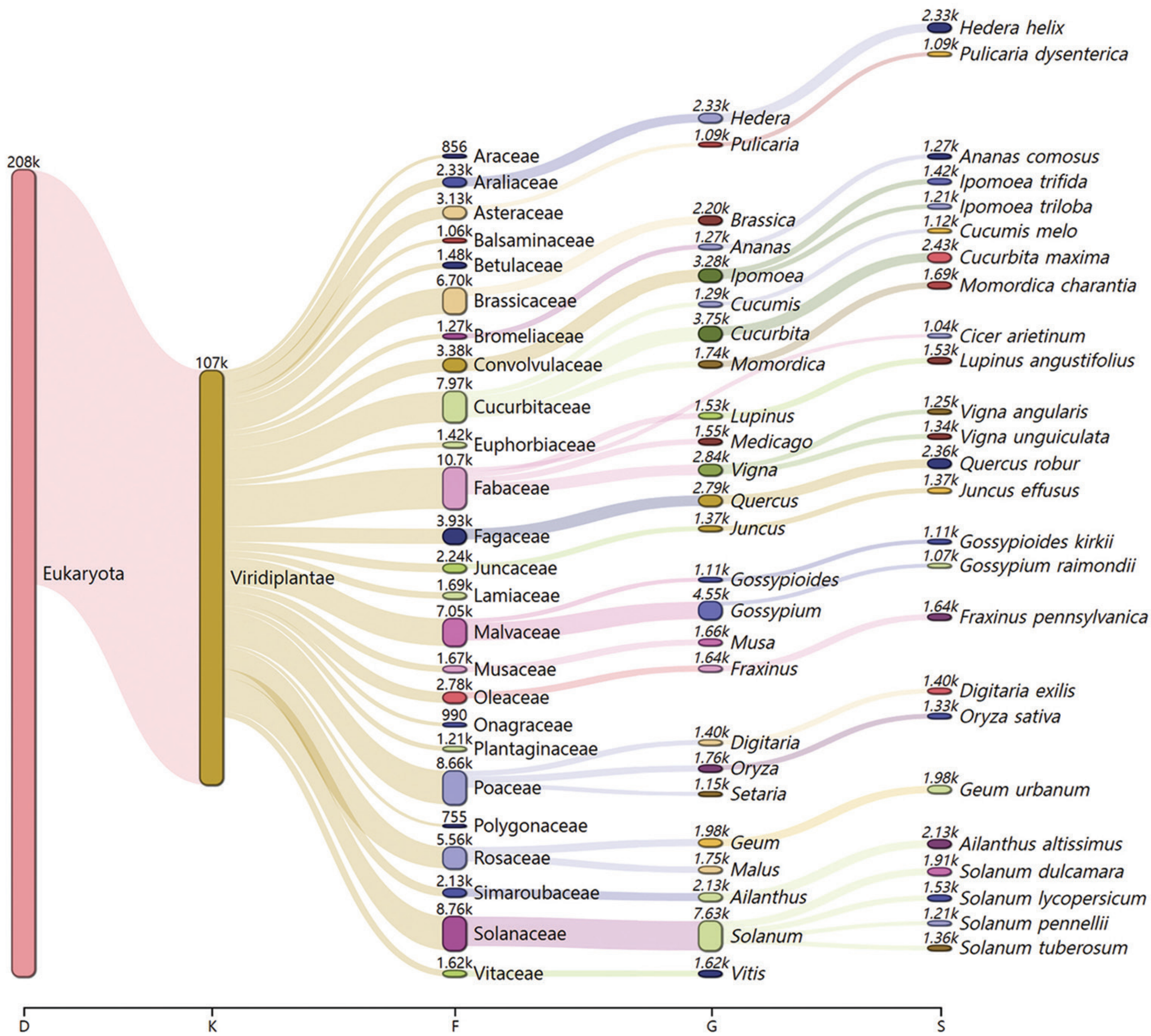

Fig. 3. Sankey visualization of barcoding results focused on Phylum Streptophyta. At the species level, 26 Species, 28 Genera, and 22 Families were identified with more than 1,000 reads after aligned as descending order of all identified sequences. (D = Domain, K = Kingdom, F = Family, G = Genus, S = Species).

possible food sources of *L. maximus* based on barcoding analysis in Japan. However, there was no common plant species detected between Japan and Republic of Korea. This difference might be caused by different flora in these two countries that are close in distance but separated by ocean. These results suggest that *L. maximus* can feed on a broad range of plant species.

In this study, *L. maximus* was found at a park that is highly connected to human activities such as walking with pets and at an agricultural area that is used for pumpkins, tomatoes, beans, rice, and other crops (Table 1). Many slugs can be a disease vector as an intermediate or final host for diverse parasitic nematodes and microorganisms causing various diseases in humans as well as other mammals (Wang *et al.*, 2008; Sudhaus, 2018). It was reported that there was a parasite infection risk when *L. maximus* was handled by naked hands in China and an angiostrongyliasis was reported in a young man who ingested *L. maximus* in a garden in Australia (Senanayake *et al.*, 2003; Li *et al.*, 2024). Angiostronyliasis is known as a Class 4 infectious disease in Republic of Korea, which might be caused by eating raw or undercooked snails or slugs contaminated with parasites.

Table 2. List of plant species identified from *L. maximus* feces in Republic of Korea

No.	Scientific name	Common name
1	*Cucurbita maxima*	Winter squash
2	*Quercus robur*	English oak
3	*Hedera helix*	Common ivy
4	*Ailanthus altissimus*	Tree of heave
5	*Geum urbanum*	Wood avens
6	*Solanum dulcamara*	Bittersweet nightshade
7	*Momordica charantia*	Bitter melon
8	*Fraxinus pennsylvanica*	Green ash
9	*Solanum lycopersicum*	Tomato
10	*Lupinus angustifolius*	Narrow-leaved lupin
11	*Ipomoea trifida*	Wild sweet potato
12	*Digitaria exilis*	White fonio
13	*Juncus effusus*	Common rush
14	*Solanum tuberosum*	Potato
15	*Vigna unguiculata*	Cowpea
16	*Oryza sativa*	Asian rice
17	*Ananas comosus*	Pineapple
18	*Vigna angularis*	Adzuki bean
19	*Ipomoea triloba*	Little bell
20	*Solanum pennellii*	Wild tomato
21	*Cucumis melo*	Melon
22	*Gossypioides kirkii*	Kirkii cotton
23	*Pulicaria dysenterica*	Common fleabane
24	*Gossypium raimondii*	Wild cotton
25	*Impatiens glandulifera*	Himalayan balsam
26	*Medicago arabica*	Spotted medick

Angiostrongyliasis could eventually lead to death or permanent brain and nerve damage in human (Wang *et al*., 2008). In cases affecting dogs, Fuehrer *et al*. (2020) reported that *Crenosoma vulpis* was detected in *L. maximus* and *C. vulpis* is a well-known parasite that could affect the lung and respiratory tract of dogs. It could cause serious respiratory diseases that could be fatal. Among diverse canines in Korea, foxes are the most popular host for *C. vulpis*, but *C. vulpis* infection had been reported in pet dogs (Choi *et al*., 2014). Therefore, more attention is required when waling with pets in Suwon, where *L. maximus*, a potential host for *C. vulpis*, was detected.

As a newly introduced invasive species, *L. maximus* can have diverse impacts on agricultural and natural environment as well as human and pet health. Therefore, further study is needed to perform risk assessment for this slug because of the broad spectrum of its impacts. In addition, a focused control measure will be able to suppress the high density of this slug population before it is extensively dispersed as an early stage of the introduction of this slug.

Table 3. A list for genus and family identified from *L. maximus* feces

No.	Genus	Family
1	*Solanum*	Fabaceae
2	*Gossypium*	Solanaceae
3	*Cucurbita*	Poaceae
4	*Ipomoea*	Cucurbitaceae
5	*Vigna*	Malvaceae
6	*Quercus*	Brassicaceae
7	*Hedera*	Rosaceae
8	*Brassica*	Fagaceae
9	*Ailanthus*	Convolvulaceae
10	*Geum*	Asteraceae
11	*Oryza*	Oleaceae
12	*Malus*	Araliaceae
13	*Momordica*	Juncaceae
14	*Musa*	Simaroubaceae
15	*Fraxinus*	Lamiaceae
16	*Vitis*	Musaceae
17	*Medicago*	Vitaceae
18	*Lupinus*	Betulaceae
19	*Digitaria*	Euphorbiaceae
20	*Juncus*	Bromeliaceae
21	*Cucumis*	Plantaginaceae
22	*Ananas*	Balsaminaceae
23	*Setaria*	
24	*Gossypioides*	
25	*Pulicaria*	
26	*Arabidopsis*	
27	*Impatiens*	
28	*Cicer*	

Author Contributions

The authors confirm contribution to the paper as follows: study conception and design: HK, YP, YC; data collection: YP; analysis and interpretation of results: HK and KP; draft manuscript preparation: HK, KP, YP, YC. All authors reviewed the results and approved the final version of the manuscript.

Conflicts of Interest

The authors have no competing interests relevant to this study to disclose.

Acknowledgment

This work was supported by a grant of "Nationwide Survey of Non-native species in Republic of Korea (NIE-A-2024-12)" funded by the National Institute of Ecology, Republic of Korea.

References

Barker, G.M. (1979). The introduced slugs of New Zealand (Gastropoda: Pulmonata). *New Zealand Journal of Zoology*, 6, 411-437. https://doi.org/10.1080/03014223.1979.10428382

Barker, G.M. (1999). Naturalised terrestrial Stylommatophora (Mollusca: Gastropoda). *Fauna of New Zealand*, 38, 1-254. https://www.landcareresearch.co.nz/publications/fauna-of-new-zealand-series/

Barker, G.M., and McGhie, R.A. (1984). The biology of introduced slugs (Pulmonata) in New Zealand 1. Introduction and notes on *Limax maximus*. *New Zealand Entomologist*, 8, 106-111. https://doi.org/10.1080/00779962.1984.9722482

Berg, M.P., Kiers, E.T., Driessen, G., Van Der Heijden, M.A.R.C.E.L., Kooi, B.W., Kuenen, F., *et al.* (2010). Adapt or disperse: Understanding species persistence in a changing world. *Global Change Biology*, 16, 587-598. https://doi.org/10.1111/j.1365-2486.2009.02014.x

Bradshaw, C.J., Leroy, B., Bellard, C., Roiz, D., Albert, C., Fournier, A., *et al.* (2016). Massive yet grossly underestimated global costs of invasive insects. *Nature Communications*, 7, 12986. https://doi.org/10.1038/ncomms12986 [PMID: 27698460 PMCID: PMC5059451]

Buschmann, H., Keller, M., Porret, N., Dietz, H., and Edwards, P.J. (2005). The effect of slug grazing on vegetation development and plant species diversity in an experimental grassland. *Functional Ecology*, 19, 291-298. https://doi.org/10.1111/j.1365-2435.2005.00960.x

Carlsson, N.O., and Lacoursière, J.O. (2005). Herbivory on aquatic vascular plants by the introduced golden apple snail (*Pomacea canaliculata*) in Lao PDR. *Biological Invasions*, 7, 233-241. https://doi.org/10.1007/s10530-004-0741-4

Choi, S., Sim, C., Kim, H.C., Choi, H.J., and Park, B.K. (2014). Natural infection of Crenosoma vulpis (Nematoda: Crenosomatidae) in an urban Korean dog. *Korean Journal of Veterinary Research*, 54, 127-129. http://doi.org/10.14405/kjvr.2014.54.2.127

Cook, A., and Radford, D.J. (1988). The comparative ecology of four sympatric limacid slug species in Northern Ireland. *Malacologia*, 28, 131-146.

Fuehrer, H.P., Morelli, S., Bleicher, J., Brauchart, T., Edler, M., Eisschiel, N., *et al.* (2020). Detection of Crenosoma spp., Angiostrongylus vasorum and Aelurostrongylus abstrusus in Gastropods in Eastern Austria. *Pathogens*, 9, 1046. https://doi.org/10.3390/pathogens9121046

Gaitán-Espitia, J.D., Franco, M., Bartheld, J.L., and Nespolo, R.F. (2012). Repeatability of energy metabolism and resistance to dehydration in the invasive slug *Limax maximus*. *Invertebrate Biology*, 131, 11-18. https://doi.org/10.1111/j.1744-7410.2011.00255.x

Hasegawa, K., Fukuda, H., and Ishikawa, J. (2009). Discovery of naturalized populations of the introduced slug, *Limax maximus* in Tsuchiura City, Ibaraki Prefecture, Japar. *Chiribotan*, 39, 101-105.

Joe, S.M., and Daehler, C.C. (2008). Invasive slugs as under-appreciated obstacles to rare plant restoration: Evidence from the Hawaiian Islands. *Biological Invasions*, 10, 245-255. https://doi.org/10.1007/s10530-007-9126-9

Karlin, E.J., and Bacon, C. (1961). Courtship, mating, and egg-laying behavior in the Limacidae (Mollusca). *Transactions of the American Microscopical Society*, 80, 399-406. https://doi.org/10.2307/3223598

Kerney, M.P., and Cameron, R.A.D. (1979). *A field guide to the land snails of Britain and north-west Europe*. Collins.

Kim, H.G., and Lee, D.H. (2019). Review of the biology and ecology of a ragweed leaf beetle, *Ophraella communa* (Coleoptera: Chrysomelidae), which is a biological control agent of an invasive common ragweed, *Ambrosia artemisiifolia* (Asterales: Asteraceae). *Biocontrol Science and Technology*, 29, 185-200. https://doi.org/10.1080/09583157.2018.1540032

Komatsu, W., and Saeki, I. (2022). Feeding habits of the exotic invasive slug *Limax maximus*: A basis for risk assessment of herbivory on forest and agricultural ecosystems. *Management of Biological Invasions*, 13(4), 644-658. https://doi.org/10.3391/mbi.2022.13.4.04

Kozłowski, J. (2012). The significance of alien and invasive slug species for plant communities in agrocenoses. *Journal of Plant Protection Research*, 52, 67-76. https://doi.org/10.2478/v10045-012-0012-9

Lee, J.S., and Min, D.K. (2002). A catalogue of molluscan fauna in Korea. *The Korean Journal of Malacology*, 18, 93-217.

Li, H., Zhao, R., Pan, Y., Tian, H., and Chen, W. (2024). Insecticidal activity of Ageratina adenophora (Asteraceae) extract against Limax maximus (Mollusca, Limacidae) at different developmental stages and its chemical constituent analysis. *PloS One*, 19, e0298668. https://doi.org/10.1371/journal.pone.0298668 [PMID: 38625919 PMCID: PMC11020717]

Lu, J., Rincon, N., Wood, D.E., Breitwieser, F.P., Pockrandt, C., Langmead, B., *et al.* (2022). Metagenome analysis using the Kraken software suite. *Nature Protocols*, 17, 2815-2839. https://doi.org/10.1038/s41596-022-00738-y [PMID: 36171387 PMCID: PMC9725748]

McDonnell, R., Paine, T., and Gormally, M. (2009). *Slugs: a guide to the invasive and native fauna of California*. UCANR Publications.

Meyer III, W.M., Ostertag, R., and Cowie, R.H. (2013). Influence of terrestrial molluscs on litter decomposition and nutrient release in a Hawaiian rain forest. *Biotropica*, 45, 719-727. https://doi.org/10.1111/btp.12057

Nitz, B., Heim, R., Schneppat, U.E., Hyman, I., and Haszprunar, G. (2009). Towards a new standard in slug species descriptions: The case of *Limax sarnensis* Heim & Nitz n. sp. (Pulmonata: Limacidae) from the Western Central Alps. *Journal of Molluscan Studies*, 75, 279-294. https://doi.org/10.1093/mollus/eyp030

Park, K., Kim, J., Park, S. G., Mun, C.G., Kim, S.H., Cho, Y., *et al.* (2024). First report of the leopard slug (*Limax maximus*), a new alien species in Republic of Korea. *Proceedings of the National Institute of Ecology of the Republic of Korea*, 5, 50-54.

Pimentel, D., Zuniga, R., and Morrison, D. (2005). Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecological Economics*, 52, 273-288. https://doi.org/10.1016/j.ecolecon.2004.10.002

Roques, A., Rabitsch, W., Rasplus, J.Y., Lopez-Vaamonde, C., Nentwig, W., and Kenis, M. (2009). Alien terrestrial invertebrates of Europe. In Delivering Alien Invasive Species Inventories for Europe (DAISIE) (Eds.), *Handbook of alien species in Europe* (pp. 63-79). Springer. https://doi.org/10.1007/978-1-4020-8280-1_5

Roth, B., and Sadeghian, P.S. (2006). *Checklist of the land snails and slugs of California* (p. 81). Santa Barbara Museum of Natural History.

Rowson, B., Anderson, R., Turner, J.A., and Symondson, W.O. (2014). The slugs of Britain and Ireland: Undetected and undescribed species increase a well-studied, economically important fauna by more than 20%. *PloS One*, 9, e91907. https://doi.org/10.1371/journal.pone.0091907 [PMID: 24740519 PMCID: PMC3989179]

Senanayake, S.N., Pryor, D.S., Walker, J., and Konecny, P. (2003). First report of human angiostrongyliasis acquired in Sydney. *Medical Journal of Australia*, 179, 430-431. http://doi.org/10.5694/j.1326-5377.2003.tb05623.x [PMID: 14558868]

Sudhaus, W. (2018). Various evolutionary avenues of Nematoda to parasitism in Gastropoda. *Soil Organisms*, 90, 115-122. http://doi.org/10.25674/1yds-c108

Wang, Q.P., Lai, D.H., Zhu, X.Q., Chen, X.G., and Lun, Z.R. (2008). Human angiostrongyliasis. *The Lancet Infectious Diseases*, 8, 621-630. http://doi.org/10.1016/S1473-3099(08)70229-9 [PMID: 18922484]