Rapid Communication

Invasion of the exotic slug, *Laevicaulis haroldi* Dundee, 1980 in Sunderban Biosphere Reserve, India

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Citation: Sreeraj CR (2021) Invasion of the exotic slug, *Laevicaulis haroldi* Dundee, 1980 in Sunderban Biosphere Reserve, India. *BioInvasions Records* 10(1): 21–27, https://doi.org/10.3391/bir.2021.10.1.03

Received: 19 August 2019
Accepted: 26 July 2020
Published: 12 November 2020

Handling editor: Wolfgang Rabitsch
Thematic editor: Kenneth Hayes

Abstract

The members of the heterobranch family Veronicellidae Gray, 1840 (commonly referred to as leatherleaf slugs) include some of the most widespread and agriculturally damaging invasive slugs. In a recent survey at Sagar Island of Sunderban Biosphere Reserve, four specimens hitherto unknown from the Reserve were collected. The specimens were identified as *Laevicaulis haroldi* Dundee, 1980, a native of South Africa. The first observation of this species in India was noted during 2005 in Maharashtra and recently from Uttar Pradesh. The current record from West Bengal affirmed this slug to be an invasive alien species in India. Categorized as IUCN-Endangered in its native range, this species might have a wider distribution in India. In addition, the current study underscores the need of identifying invasive alien species and quantifying their population dynamics in India.

Key words: agricultural pest, alien, invasive, IAS, Sagar Island, Veronicellidae

Introduction

Slug is the common name used for any gastropod mollusc with apparently no shell or a much-reduced shell, or only a small internal shell. Though slugs are generally not plant pests, those that feed on higher plants tend to be defoliators, causing damage similar to caterpillars and other insects (Cowie et al. 2008; South 2012). Some terrestrial slugs and snails have been inadvertently spread by man well beyond their natural range (Hanna 1966; Barker 1979; Robinson 1999; Cowie 2001; Herbert 2010). They may become very common in the introduced region and may cause significant economic damage. In most of the cases, these species will colonise less disturbed areas and the spread will likely occur well before anyone observing the process (Hutchinson et al. 2014). The introduced exotic terrestrial slug, *Lissachatina fulica* (Bowdich, 1822) is a serious crop pest and threat to the local species in most of the parts of India and is still spreading to many interior parts of the country (Sarma et al. 2015; Sajan et al. 2018).

Members of the heterobranch family Veronicellidae Gray, 1840 (commonly referred to as leatherleaf slugs) are terrestrial herbivorous slugs that occur mainly in the tropical and subtropical regions. This family includes some of the most widespread and agriculturally damaging

invasive slugs such as *Laevicaulis alte*, *Veronicella cubensis*, *Deroceras invadens* (Herbert and Kilburn 2004; Hutchinson et al. 2014). However, they are difficult to distinguish and identify to species level based on external morphology because of their intra-specific variability, especially in body color and pigmentation pattern (Kim et al. 2016), with an exception of *Laevicaulis haroldi* which has a distinguishable external morphology (Khan 2019).

During a recent survey in the Island of Sagar in the Sunderban Biosphere Reserve, India the *Laevicaulis haroldi* were observed. The study was carried out as part of the In-House project of the Zoological Survey of India (ZSI) titled "Taxonomy and ecology of heterobranch slugs (Mollusca, Gastropoda, Heterobranchia) of India" which deals mainly with the coastal onchidiid as well as terrestrial slugs.

Materials and methods

The collection of slugs was made by manual search and handpicking near the paddy fields and other agriculture areas of the island. Searching was more specific in the damp areas near the buildings as well as agriculture field. The collected animals were asphyxiated with freshwater. The completely relaxed and freshly dead animals were fixed in 10% formalin solution and later preserved in 70% ethanol for long term preservation. Additional specimens for future DNA studies were preserved directly in 100% ethanol. The preserved animals are deposited in the National Zoological collections of the Zoological Survey of India, Sunderban Regional Centre.

Results

The specimen collected were identified as *Laevicaulis haroldi* Dundee, 1980 and the details are given below:

Taxonomy: Family: Veronicellidae; Species: *Laevicaulis haroldi* Dundee, 1980.

Common Names: Purcell's hunter slug, Caterpillar slug.

Native Range: KwaZul-Natal, South Africa (Herbert 2013).

IUCN Status: Endangered B1+2cd (Data assessed: 2000, published: 2013).

Material examined: 4 specimen, Average size 3 ±1.5 cm, 27.07.2019, Chemaguri Village (21.66258°N; 88.14252°E), Sagar Island, Sunderban Biosphere Reserve, West Bengal, India. Coll. Sreeraj, C.R. Accession No: KN 2654 (National Zoological Collection of Zoological Survey of India, Sunderban Regional Centre).

Diagnostic characters: Oval body with mantle of creamy yellowish colour with white irregular lateral bands and a wrinkled structure resembling a caterpillar (Figure 1). The posterior and anterior end of the mantle is blackish brown in colour. Hyponotum creamy white in colour with patchy white spots. Foot is beige in colour and very narrow, having less than half

Figure 1. Live crawling *Laevicaulis haroldi* Dundee, 1980 recorded from Sagar Island, West Bengal, India. Photo by Sreeraj CR.

of the hyponotum width. Upper tentacles brown in colour with eye spots in the tip whereas lower tentacles translucent white in colour.

Ecology: The slug was found to feed on the leaves of shrubs belonging to the family Urticaceae.

Discussion

Alien species are being moved around the world at an unprecedented rate as a result of the globalization of trade and the greatly increased ability of people to travel widely as evident from the increase in the number of reports of alien species recently (Cowie et al. 2008; Hirano et al. 2019; Alonso et al. 2019; Serniotti et al. 2019). A rapid increase in the number of species introduction (accidental or intentional) is resulting in the displacement of native species and is becoming a serious threat to the regional biodiversity, worldwide (Lowry et al. 2013). There are numerous species of terrestrial slugs globally living in a wide range of habitats from temperate to tropical regions (Barker 2001). Though many of them are not posing any economical or ecological threat, there are, however, several species that cause considerable amounts of economic damage in arable and horticultural crops, commercial nurseries and home gardens (Howlett 2012) in the damp, mild climatic zones such as humid tropical regions (Barker 2002).

Declared in 1989, the Sundarban Biosphere Reserve (SBR) is one among the 18 biosphere reserves in the country (Wildlife Institute of India 2019). Being the single largest mangrove block and the only marshy mangrove tiger habitat in the World heritage sites, the SBR is unique from all other mangrove ecosystems in the world. This region houses a very rich

biodiversity with unique flora and fauna. Apart from the protected areas within this reserve, rest of the areas have human settlements and cultivated fields with majority of the people practicing fishing or farming for a living. Given all these facts, the threat from an alien species to this region can be beyond our prediction, as the slugs generally thrive and establish more in damp areas especially in marshy region. Hence the establishment of an exotic species in the biosphere reserve needs to be addressed seriously.

Species dispersion hypothesis

The pathways, vectors and vehicles via which these alien species travel the world are diverse (Ruiz and Carlton 2003). Consistent reports, from various parts of the world over the past two to three decades, suggest that the horticultural industry, in addition to its role as a vector of invasive plants (Dehnen-Schmutz et al. 2007), is perhaps the most important vector of these small snails and slugs, at least as measured by the numbers of interceptions by quarantine officials (Cowie and Robinson 2003). In a case study on the Hawaiian Islands 31 terrestrial snail/slug species were recorded, all but two of them alien and the horticulture industry is depicted as the source (Cowie et al. 2008). It is important to mention that the Indian horticulture Industry had a steady increase after the National Horticulture Mission of the Govt. of India during 2005–06 (Ramesh et al. 2017). *Laevicaulis haroldi* may have arrived in India through the horticulture industry, similar to many other species of non-native snails and slugs around the world (Cowie et al. 2008). This pathway is supported by *L. haroldi* being predominantly associated with agricultural and horticultural areas (Magare 2015).

Laevicaulis haroldi is endemic to South Africa and categorized as Endangered in the global IUCN Red List (Herbert 2013). The record of this species from Maharashtra (western state of India) was the first report outside its native range (Magare 2015). It is highly probable that *L. haroldi* might have been dispersed through the major ports of Mumbai, with horticulture imports being the vector for the introduction of this species in India. Recently, during 2018, this species was reported from Noida (near Delhi) of Uttar Pradesh (Khan 2019). The current record of this species is from Sagar Island of SBR (eastern state of India) (Figure 2).

Sagar Island, also known as Gangasagar or Sagardwip, is a place of religious interest and millions of devotees from various parts of India visit this place to for oblations. Majority of religious pilgrims come from the states of West Bengal, Bihar, Uttar Pradesh among others. It is hypothesized that; *L. haroldi* might have been introduced to this Island through pilgrimage as the pilgrims carry flowers, holi basil leaves etc. for the worship of deities. Currently this species was found to be established on this Island, highlighting the importance of monitoring for understanding the spread as the environmental conditions are conducive for establishment.

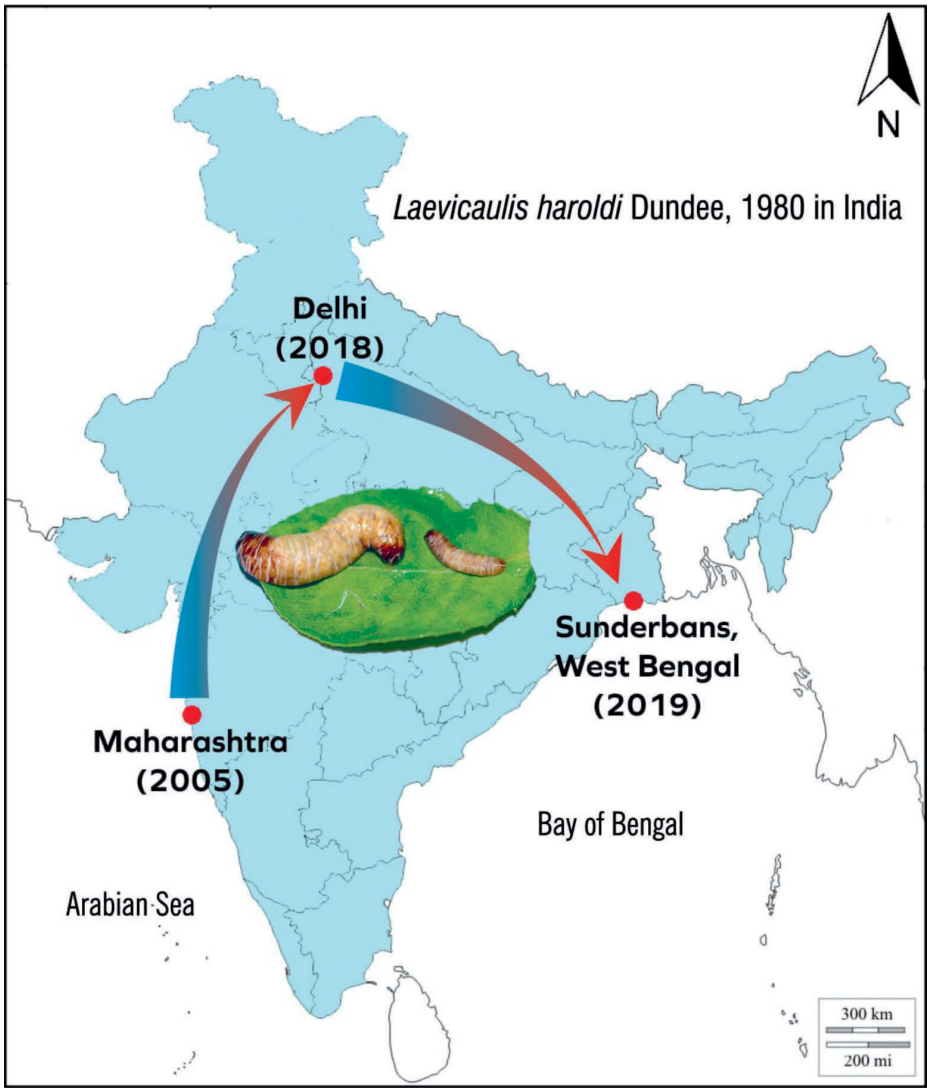

Figure 2. Current and previous records of *Laevicaulis haroldi* Dundee, 1980 in India. Arrows indicate the hypothesized route of spread since introduction.

Conclusion

During the last few decades biological invasions had received much attentions in the scientific research. Even though natural process of biological invasion has been happening since mankind, recently scientists are much concerned about the human mediated biological invasions as this exceeds the natural dispersal by multi-folds (Van der Velde et al. 2006). The non-native or invasive species affect not only the environment or ecology, but also the local economy by dominating the local fauna and overgrazing.

Sagar Island, is an agriculture area and an important pilgrimage centre in the West Bengal. Any changes in the native grazers or native pests can have a major influence on the agriculture, thus impacting the local economy. It was only recently that another major invasive alien species *Lissachatina fulica*, a crop pest in India, was recorded from this Island (Sajan et al. 2018). At present, it is very difficult to predict the impact of these records on the biosphere reserve and this calls for an immediate

scientific investigation on the impact of these species, which they can have on the ecology as well as local economy. The current record is also another interesting record as this species is considered as an endangered species in its native range (South Africa). A detailed study is needed to fully understand the identity and distributions of all invasive species in the biosphere reserve and to develop plans to protect the flora and fauna of the world's only marshy mangrove tiger habitat.

Acknowledgements

The author is grateful to the Director, Zoological Survey of India for providing the necessary facilities for carrying out the survey as part of the In-house project titled "Fauna of Sagar Island, West Bengal". The support provided by the Officer-In-Charge, Sunderban Regional Centre of ZSI as well as the staff are also duly acknowledged. The animals were first saw in the field by Dr. A. Rameshkumar who mistook it as a caterpillar and subsequently the samples were collected by the author, hence the observation skill of Dr. A. Rameshkumar, my colleague is appreciated and duly acknowledged. I thank the editor Dr. Wolfgang Rabtisch and the anonymous reviewers for their constructive comments.

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