

Recording the Terrestrial Slug Species *Laevicaulis alte* (Férussac, 1822) (Pulmonata: Veronicellidae) in Ornamental Plants Nursery in Giza Governorate, Egypt

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Received November 15, 2021; Revised February 15, 2022; Accepted March 7, 2022

Cite This Paper in the following Citation Styles

(a): [1] Reham Fathey Ali, David Gwyn Robinson, "Recording the Terrestrial Slug Species *Laevicaulis alte* (Férussac, 1822) (Pulmonata: Veronicellidae) in Ornamental Plants Nursery in Giza Governorate, Egypt," *Universal Journal of Agricultural Research*, Vol. 10, No. 2, pp. 170 - 174, 2022. DOI: 10.13189/ujar.2022.100208.

(b): Reham Fathey Ali, David Gwyn Robinson (2022). Recording the Terrestrial Slug Species *Laevicaulis alte* (Férussac, 1822) (Pulmonata: Veronicellidae) in Ornamental Plants Nursery in Giza Governorate, Egypt. *Universal Journal of Agricultural Research*, 10(2), 170 - 174. DOI: 10.13189/ujar.2022.100208.

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Abstract The tropical leatherleaf terrestrial slug species *Laevicaulis alte* (Férussac, 1822) (Pulmonata: Veronicellidae) is reported for the first time in October 2018. The species was found under the pots of ornamental plants and mango seedlings in nursery in Abo Rawash, El Mansouria, Giza governorate (N 30°05.975' E31°04.717'), Egypt. The species is originally native to southern Africa inhabiting in warmer eastern regions with high precipitation. Recently, *L. alte* has been introduced as big populations in southern and southeastern Asia in addition to the tropical and subtropical regions. *L. alte* may have a high suspect of spreading its population in more surrounding governorates in Egypt for the next few years. This species may become locally widespread and abundant in ornamental, medicinal and aromatic plant seedlings in other nurseries or gardens. *L. alte* reproduces successfully in the new environment by laying egg masses in the field and completing their life cycle. Morphological notes and slug measurements (i.e. length, width, foot length, foot width, width of right and left hyponota and the length from genital pore till posterior end of the slug body) have been recorded in this study as important characteristic features for the species and accurate description. There is a need to carry out further studies to design a considered integrated

pest management program according to the behavior and activity of this pest, which adapted well to a new environment to reduce the increasing of its population.

Keywords *Laevicaulis alte* (Férussac, 1822), Veronicellids, Genitalia, Slug, Egypt

1. Introduction

For the last decades, many countries faced increasing of terrestrial snails and slugs as invasions due to global interconnection such as trade, commerce and exporting plant seedlings and other plant materials [1, 2]. These invasive gastropod species brought into new regions with harmful potential to agricultural field crops, vegetables and fruit orchards [3, 4].

Terrestrial slugs are considered as series agricultural pest that have a wide range of host preferences and the ability to disperse into widespread ranges due to some features of the slug. These features are the flexible body, hiding in the soil cracks, crawling slowly into crevices, in addition to self-fertilization and hermaphroditism [5].

Laevicaulis alte is a herbivorous species that feeds on the vegetation that is available in its habitat with a high increasing rate of infestation [6, 7, 8, 9], feeds on living plant tissues causing severe damage to field crops and consider as detritus feeders [10]. *L. alte* is to be of African origin with a serious economic threat to many field crops, which are native to southern and central Africa [11, 12].

The species is indigenous in southern Africa dwell in the warmer eastern regions, where high precipitation exceed 400 mm per year. However, *L. alte* is capable of tolerating hard drier conditions [13] and have adaptations for living in dry environments.

Laevicaulis alte had been introduced to multiple countries in southern and southeastern Asia such as Sri Lanka [14], Nepal [15], widely distributed in India [16, 17, 18, 19] in addition to other regions such as Australia, Pacific Islands and Hawaiian Islands [20], furthermore the species distributed across the tropical and subtropical regions [21, 22, 23].

L. alte is reported as agricultural pest in India on twenty-four host plants [24], ornamental plants [25], economic important vegetables such as tomato, spinach, cucumber, diverse of leafy vegetables, wide variety of crops [26, 27, 28], decaying wood [25, 28], and oil palm seedlings [29]. The species could be a potential dangerous gastropod pest in Egypt, threatening ornamental plants and other field crops [30].

In the Egyptian agricultural fields, *Laevicaulis alte* was recorded for the first time in October 2018 in a nursery of ornamental plants in Abo Rawash, Giza governorate [31]. Despite the stringent measures of agricultural quarantine laws and the plant protection regulations, dangerous terrestrial mollusk pests are still introduced lately and distributed widely in many agricultural areas causing serious losses to agricultural and horticultural fields.

2. Materials and Methods

The species *Laevicaulis alte* (Férussac, 1822) was collected by hand and visual inspection from ornamental plants nursery located at Abo Rawash, El Saliba district on the road directed to El Mansouria, Giza governorate (N 30°05.975' E31°04.717') (Fig. 1). The slug species was found under plant pots and leaf litter in the nursery where more shade and humid conditions; avoiding the direct sunlight; the species accumulated in big number (Fig. 2).



Figure 1. Map of Egypt show the location under study in Abo Rawash, El Saliba district, Giza governorate (N 30°05.975' E31°04.717').



Figure 2. A) The nursery of ornamental plant seedlings and plant pots under study, B) The species *Laevicaulis alte* (Férussac, 1822) were recorded among the pots where shade and more humidity.

L. alte samples were transferred to laboratory of Malacology of Faculty of Agriculture, Cairo University.

Laevicaulis alte were measured as live adult samples and preserved in 95% Ethanol for more precise and accurate identification. The genitalia of this species were dissected by drowning the samples in cold water for 10-12 hours, or until longer responsive to external stimuli then transferred to 80% non-denatured ethanol, then tentatively identified based on external appearance, and examine the genitalia for confirmation according to Herbert [13].

A digital balance had been used for body weight (g) and electronic caliper for slug body measurements (mm) for essential important characteristic features i.e. length, width, foot length, foot width, width of right and left hyponota and the length from genital pore till posterior end of the slug body, (n= 16) (Fig. 3). Terrestrial slugs can have adapted well into a new environment and reproduce successfully laying high number of egg masses and completing their life cycle, observing egg masses of this species in the field (Fig. 4). The eggs are oval elongated in shape and translucent; the eggs are connected by thin interconnecting thread in the masses.

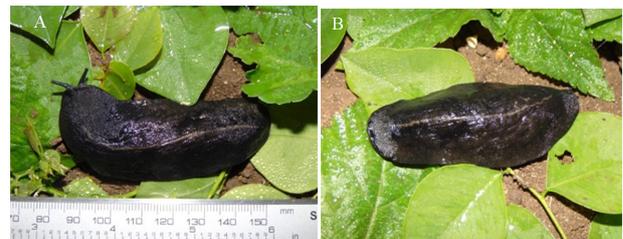


Figure 3. A) *Laevicaulis alte* (Férussac, 1822) were measured as life adult samples, B) The veronicellid slug with black or cool black shiny surface notum with a thin well-defined creamy to pale brown longitudinal dorsomedian line.



Figure 4. A) Egg masses of the slug species *Laevicaulis alte* (Férussac, 1822) at nursery, B) the slug species *Laevicaulis alte* during depositing egg where the egg masses are clear to see on the soil surface.

The species samples were vouchered at the collection of the Faculty of Agriculture, Cairo University, Egypt, and at

the USDA APHIS National Malacology in Philadelphia, USA.

2. Results

2.1. Species Habitat

During the survey, the invasive slug species *Laevicaulis alte* recorded on various ornamental plants and mango seedlings in nursery in Abo Rawash, Giza governorate. The nursery is almost irrigated every day that guarantee a good level of continuous humidity for the slug activity and encourage the reproduction in order to complete its life cycle successfully. One of the distinctive signs of veronicellids infestation in any field is the thick mucus slime trails among plant pots.

The species was able to establish population in the location where the climatic conditions were similar to its native range and favorite conditions, i.e. warmer and humid climate.

2.2. General Description (External Shape)

Laevicaulis alte is commonly known as the “leather leaf slug” due to the notum being covered with fine surface papillae and producing a velvety appearance with a pale light creamy or gray color hyponotum relative clear of genital pore. The mantle is leathery shape with a slightly granulated appearance on the surface [28]. The species is usually large veronicellid slug with gray, black or cool black with shiny surface notum or sometimes rarely dark brown notum with a thin well-defined creamy to pale brown longitudinal dorsomedian line.

The shell is absent and the mantle covers the entire dorsum and overlaps the head. The foot sole is yellowish white to pale orange.

The ventral side is broad with broad hyponotum on both sides of a narrow foot, which is pale, creamy color or more frequently a smoky gray color with very sticky thick mucus; bilobed pair of tentacles (Fig. 5). The live slug samples measured as table (1) shows veronicellid slugs (n= 16).

Laevicaulis alte is usually a large slug body can be up to 10 cm in length [20], and sometimes reach 12 cm [30, 32].

These results correspond to Das and Parida [8] for *L. alte*, which the length 5.71 ± 0.66 with a range 4.4 – 6.5 cm, circumference 3.48 ± 0.45 cm with a range, 2.8 – 4.00 cm for live samples that weight 3.38 ± 0.69 (g) ranged from 2.55 – 4.00 (g).



Figure 5. The ventral side of the terrestrial slug species *Laevicaulis alte* (Férussac, 1822) (Veronicellidae) show the bilobed pair of tentacles.

3. Discussion

Recently, there have been many attempts to determine a database of well-identified invasive gastropods that are recorded in Egyptian fields [33, 34, 35, 36, 37, 38, 39]. Surveys of field work are continuous to add more new records of terrestrial gastropods listed as potential agricultural pests recently.

The danger of Veronicellidae family lie in being host for nematodes parasites and diseases carriers that can be transferred to humans indirectly through consuming contaminated vegetables or fruits with this group mucus and feces [40, 30]. This family is highly adaptive to new environment, which is different from the tropical and subtropical regions climate that recorded on amount of ornamental plants.

Laevicaulis alte reported as a native slug species in central, east Africa, south to KwaZulu-Natal, western parts of southern Africa and has been introduced by translocated plants [13]. This species may spread due to the increase in long distance trade and human activities.

Eradication of potentially invasive species is suggested in the early stages of invasion, when populations are small and localized [42].

4. Conclusions

Considering the survey and distribution of agricultural pests is one of the important pillars in the process of control and eradication of pest programs. Hence, this research presents the basics of the database of recent pest in agricultural fields and nursery, which need a quick action to reduce their numbers and infestation level. Consequently, it should make a plan for local quarantine rules to prevent dispersal of terrestrial slugs of infested localities to new areas.

Table 1. The terrestrial slug species *Laevicaulis alte* as live slugs' measurements (n= 16).

	Body weight (g)	Body length (mm)	Body width (mm)	Foot length (mm)	Foot width (mm)	Width of right hyponota (mm)	Width of left hyponota (mm)	Length from genital pore till posterior end (mm)
Average	8.1 ±	62.98 ±	26.78 ±	48.35 ±	8.89 ±	9.47 ±	9.23 ±	26.02 ±
± SD	0.93	7.79	2.78	7.72	1.15	1.6	1.51	4.09
Range	6.26 – 10.10	54.48 – 79.02	21.32 – 30.64	42.28 – 67.71	5.71 – 11.14	6.57 – 12.34	7.35 – 11.67	21.06 – 33.1

Acknowledgments

We are grateful to **Binational Fulbright Commission** in Egypt for funding **R. F. Ali** her research and stay in the USA, and **Noha A. Abu-Shady**, Assistant Professor at the Department of Zoology and Agricultural Nematology for assistance in collecting the specimens.

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