

Slugs (of Florida) (Gastropoda: Pulmonata)¹

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Introduction

Florida has an impoverished slug fauna, having only three native species which belong to three different families. Eleven species of exotic slugs have been intercepted by USDA and FDACS-DPI quarantine inspectors, but only one is known to be established. Some of these, such as the gray field slug (*Deroceras reticulatum* Müller), giant garden slug (*Limax maximus* L.), and yellow garden slug (*Limax flavus* L.), are very destructive garden and greenhouse pests. Therefore, constant vigilance is needed to prevent their establishment.

Some veronicellid slugs are becoming more widely distributed (Dundee 1977). For example, the Paraguayan black-velvet leatherleaf, *Angustipes* (= *Veronicella*) *ameghini* (Gambetta), has been found at several Florida localities (Dundee 1974, Gillmore 1982). Slugs are not commonly seen or collected because they are active mostly at night and inconspicuous during the day. In Spanish, they are called "babosas" from the verb "babear" (to drool), because of the copious amount of mucus they secrete. Slugs should be preserved in 75% isopropyl alcohol. It is best to drown them in water overnight in a

covered container without air pockets so the bodies will be extended. After drowning they should be washed under running water to remove excess mucus before placing in preservative. Notes on the color of the mucus secreted by the living slug would be helpful in identification.

Biology

Slugs are hermaphroditic, but often the sperm and ova in the gonads mature at different times (leading to male and female phases). Slugs commonly cross fertilize and may have elaborate courtship dances (Karlin and Bacon 1961). They lay gelatinous eggs in clusters that usually average 20 to 30 on the soil in concealed and moist locations. Eggs are round to oval, usually colorless, and sometimes have irregular rows of calcium particles which are absorbed by the embryo to form the internal shell (Karlin and Naegele 1958). As a result, slug eggs often become more transparent as they grow. As soon as they hatch, young slugs (often lighter in color than adults) are active, crawl and feed if the temperature and humidity conditions are right. It is often several days before any plant injury becomes apparent, because they merely rasp away surface tissues. Slugs,

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especially young and hungry ones, can lower themselves from plants by mucus threads (Key 1902) that may extend several feet.

Identification

Slugs are easily recognized by their soft, unsegmented bodies, dorsally covered completely or in part by a tough leathery skin (mantle). The head has a pair of upper tentacles bearing eyes, and a pair of shorter, olfactory ones. Positive identification of species often depends on internal anatomy. Color is often used, but considerable variation can occur.

The primitive Veronicellidae family of slugs (here represented by *Angustipes ameghini*, *Leidyula* (= *Veronicella*) *floridana* and *Sarasinula plebeia*) is tropical in distribution and possesses several features not found in other slug families. This includes having the eyes on contractile rather than inversible tentacles. In addition, the mantle covers the entire back of the animal and laterally overhangs the narrow foot so that the side walls of the body are hidden. The philomycid slugs have a similar mantle and could be confused with veronicellid slugs. However, differences in breathing pore and anus location can distinguish these two groups of slugs. Philomycid slugs have a breathing pore located anteriorly on the right side of the mantle, and the anus is located anteriorly. In veronicellid slugs no breathing pore is present and the anus is located near the posterior end of the body. The shape of the anus and the flap that covers it offer good generic characters.

Key to Slugs of Florida (including intercepted species)

1. Mantle covering all of the back of the animal (Figs. 1, 3-8, 10) 2

1'. Mantle covering only anterior part of the animal (Figs. 12-13, 15, 17, 20, 22, 24) 5

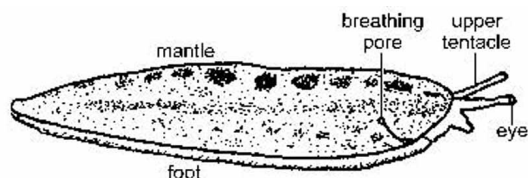


Figure 1. Slug nomenclature.

2(1). Breathing pore visible in short slit near anterior right mantle edge (Fig. 1) (Family Philomycidae) Carolina mantleslug, *Philomycus carolinianus* (Bosc)



Figure 2. *P. carolinianus*

Carolina mantleslug: Length 50 to 100 mm. Albino (Hermann and Dundee 1959) and melanistic forms known but typically yellowish brown with two rows of dark spots along back. Feeds on fungi. Found under loose bark and aerial bromeliads. Native: Maine to Florida, west to Iowa and Texas.

2'. Breathing pore not visible (Figs. 3, 4) (Family Veronicellidae) 3

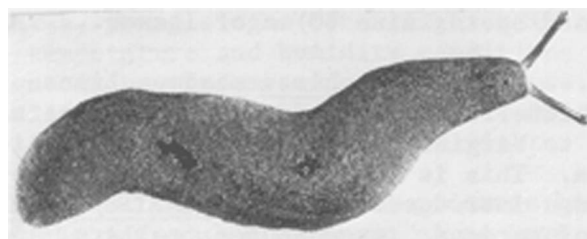


Figure 3.

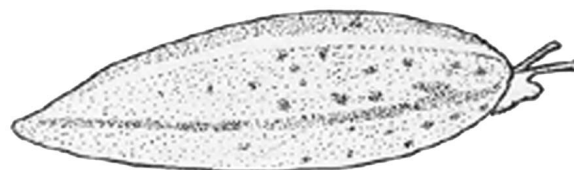


Figure 4.

3(2'). Body velvety black in color (Fig. 5), anus roundish and median in position, usually protected ventrally by dextral flap so superficial crescentic slit is longitudinal (Fig. 6) and normally hidden under end of retracted foot black-velvet leatherleaf, *Angustipes ameghini* (Gambetta)

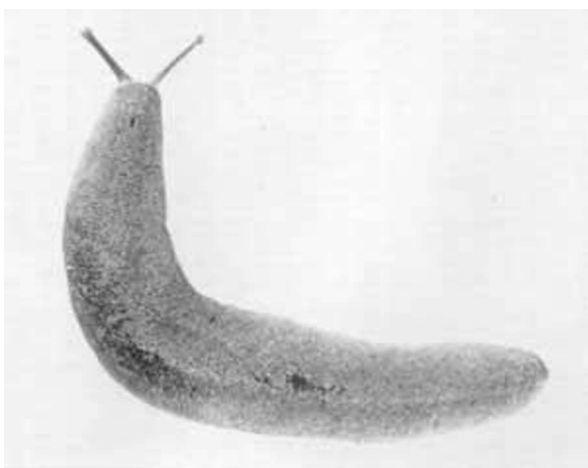


Figure 5. *Angustipes ameghini*.

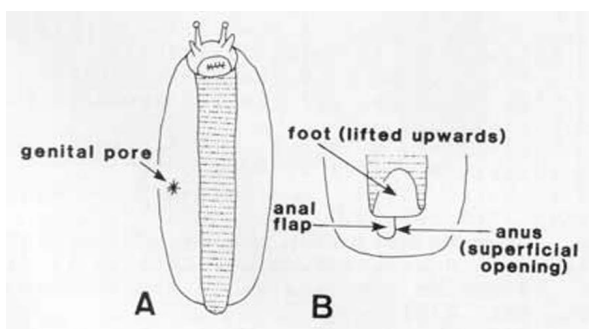


Figure 6. *Angustipes ameghini* (A) ventral view, (B) anal view.

black-velvet leatherleaf: This slug was originally described from Paraguay and first introduced into the United States (Mobile AL, and New Orleans LA) in 1960 (Dundee and Watt 1961). It is now common in the western panhandle of Florida. Records from other parts of Florida (Dundee 1974, 1977) were based on interceptions, but in 1982 this slug was found to be well established in Orange County (Gillmore 1982). Alachua (Newberry) and Pinellas (Palm Harbor) Counties also can now be included based on collections made in 1984. It occurs in greenhouses, nurseries, and grassy fields, where it can be found under boards and potted plants. The slug burrows in soft soil and can enter the root-balls of plants through drainage holes at the base of the containers. Colvin (1962) reported this species eating large amounts of living and decayed leaves. Deisler and Stange (1984) document feeding on living foliage of *Epipremnum aureum* (Linden & Andre) Bunt. Further data on biology and distribution can be found in Baker (1925), Dundee et al. (1965), Dundee (1977), and Deisler and Stange (1984). The slug's velvety black color, which is sometimes interrupted

by a pale median stripe, especially in juveniles, and the elongated form of the body provide easy field characters for identification

3'. Body brown with irregular dark markings, sometimes with dark bands (Fig. 7), anus oval and protected ventrally by anterior flap so that superficial opening is a transverse crescentic slit (Fig. 8) which usually extends beyond the right edge of the retracted foot 4

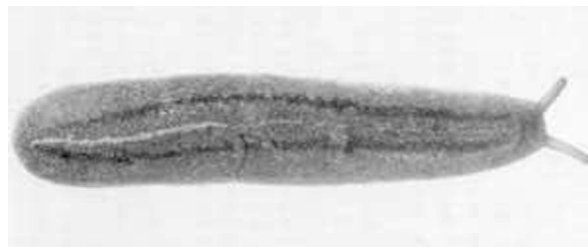


Figure 7.

4. Female opening usually less than 1/4 hyponotal width from foot; dorsum is tan, mottled with black, with long median whitish strip Florida leatherleaf, *Leidyula floridana* (Leidy)

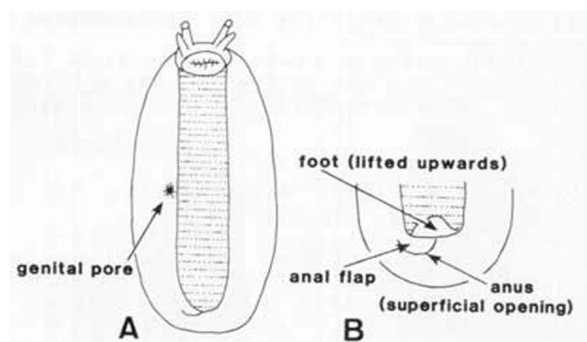


Figure 8. *Leidyula floridana* (A) ventral view, (B) anal view.



Figure 9. *L. floridana*

Florida leatherleaf: This slug is native to the Caribbean (Cuba to Jamaica) and southern Florida. It was first noticed in central Florida in 1968 (Stange 1978) and spread as least as far north as Duval and Jefferson Counties. The slug is also found in Louisiana (Dundee 1977) and Texas (Neck 1976)

suggesting that the species may be even more widespread than available records indicate. It is often found under boards in grassy areas, especially on *Stenotaphrum secundatum* (Walt.) O. Kuntze (St. Augustine grass). No serious economic damage has been reported thus far from Florida, although some damage to beans and tomatoes has been reported (Stange 1978). In Orange County all three species of Veronicellidae slugs were found together under one board, confirming aggregate behavior (Dundee 1975).

4'. Female opening usually more than 1/4 hyponotal width from foot; dorsum with tint of dead leaf, more or less dark, with or without dorsomedian dark stripe (see photograph) Caribbean leatherleaf, *Sarasinula plebeia* (Fischer).

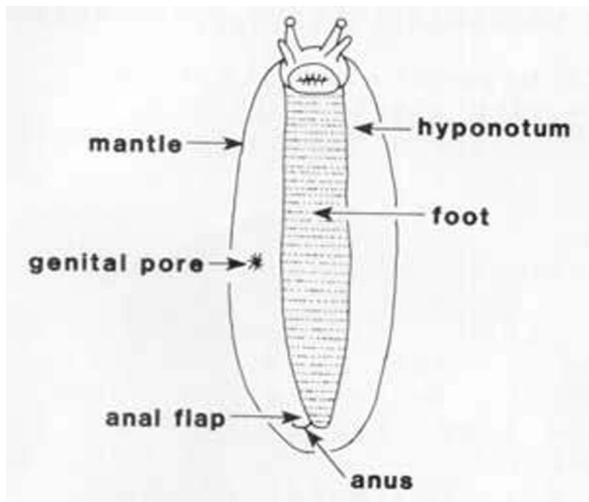


Figure 10. *Sarasinula plebeia* - ventral view.

Caribbean leatherleaf: This slug is native from Mexico to Nicaragua and has been intercepted at ports in Florida (Burch and Van Devender 1980). It was first identified from established populations from Orange County in 1983, but a study of the FDACS-DPI collection revealed specimens collected from Orange County in October 1981, and from Jupiter, Palm Beach County, in 1980. *Sarasinula plebeia* superficially resembles the native *L. floridana* but can be distinguished normally by the position of the female genital pore (more than 1/4 hyponotal width from foot) and by the usual absence of the dorsomedian light stripe found in *L. floridana*. This species is phytophagous and has caused damage to cacao plants in Tabasco, Mexico, citrus stock in Orange County, Florida, and has been observed



Figure 11. *S. plebeia* Credits: Frank Peairs, Colorado State University, Bugwood.org

feeding on nursery plants such as *E. aureum* (Deisler and Stange 1984). This species is probably the most destructive threat to Florida agriculture of the three known Florida veronicellid slugs but has less potential for spread since it is non-burrowing and is reported to be viviparous (Baker 1925). Where this slug is established, control measures may be necessary. Records and further data can be obtained from Deisler and Stange (1984).

5(1'). Breathing pore located in anterior half of mantle (Fig. 12), back never keeled; posterior end rounded when viewed from above (Family Arionidae) brown-banded arion, *Arion circumscriptus* Johnson



Figure 12. *Arion circumscriptus*.

brown-banded arion: Length 25 to 30 mm. Color pattern is distinctive from the other U.S. introduced species of *Arion* with the sole of the foot porcelain white. Mucus clear, but may be yellow-orange if the slug is disturbed, not sticky; head not extended far beyond mantle. Native to

northwestern Europe (Rosetta 2009). Intercepted in Florida from California on potted *Pinus*. Can cause considerable damage in greenhouses and vegetable and flower gardens. *A. ater* (L.) which attains a length of more than 70 mm has also been intercepted in Florida according to Dundee (1974).

5'. Breathing pore located in posterior half of mantle (Figs. 13, 15, 17, 20, 22, 24), back keeled at least at posterior end which is pointed in dorsal view (Family Limacidae) 6

6(5'). Back strongly keeled from the mantle to tip of tail (Fig. 13), mantle granulate with center part bound by groove greenhouse slug, *Milax gagates* (Draparnaud)



Figure 13. *Milax gagates*.



Figure 14. *M. gagates* Credits: Frank Peairs, Colorado State University, Bugwood.org

greenhouse slug: Length 60 to 70 mm. Slug evenly dark grey to black except somewhat lighter sides, no pigment spots. Mantle relatively large (35-40 % of body length), with distinct grooves, keel prominent between mantle and posterior end. Sole with blackish lateral zones and lighter medial zone. More than 100 eggs are laid by an individual, usually 15 at a time. Slugs die approximately 15-30 days after laying eggs. Juveniles hatch after at least 25-30 days, maturity is reached after four to five months under laboratory conditions. Widely introduced in the U.S., but in Florida only intercepted at ports. Originally from Morocco to Tunisia and south Spain to south France but has spread to Atlantic coastlands of France to Belgium, British Isles, and almost

worldwide. This slug usually burrows in the soil and feeds on roots (carrots, potatoes, etc.), preferably close to water. Hides under stones, moist ground litter and in soil cavities (Schultes 2008).

6'. Back keeled only near posterior end; mantle concentrically wrinkled, without groove 7

7(6'). Mantle and body with outstanding yellow or black spots (Figs. 15, 17), length 60-70 mm 8

7'. Mantle and usually back without well defined spots; size 60 mm or less 9

8(7). Black-spotted, mucus colorless giant garden slug, *Limax maximus* Linnaeus



Figure 15. *Limax maximus*



Figure 16. *L. maximus*

giant garden slug: Length 80 to 120 mm. Lives 2.5 to 3 years; eggs clear, about 5 mm diameter, up to several dozen per cluster; this species is noted for its aerial mating in which the pair copulates while suspended from a mucus string. It has a mantle, the organ that builds the shells of shelled snails, covering the anterior portion of its dorsum. In this slug the mantle actually encloses a small vestigial shell. While the mantle is darkly spotted or marbled, the slug's posterior has two or three dark longitudinal stripes. Its upper color varies from brownish green to gray, and its sole (underside) is whitish. Its slime is sticky and colorless, and its penis, which might be observed during mating, is pale blue (Hotopp and Pearce 2005). Native to northwestern Europe, introduced into North America (Rosetta 2009). Massachusetts

south to Virginia, west to Oregon and California. This is the largest of the European slugs introduced in the U.S.A. It is a nocturnal slug that feeds mostly on rotting plant matter and fungi. Important pest of gardens, greenhouses, cellars, and mushroom beds. It is a voracious herbivore, but also feeds upon other slugs (Hotopp and Pearce 2005).

8'. Yellow-spotted, mucus yellow yellow garden slug, *Limax flavus* Linnaeus



Figure 17. *Limax flavus*.



Figure 18. *L. flavus*

yellow garden slug: Length 75 to 100 mm. Found in urban and suburban gardens, greenhouses, and other cultivated places. Nocturnal. One specimen found in 1965 in Tallahassee, Florida. Associated



Figure 19. detail of *L. flavus* mantle

with celery, lettuce, roses. Native to Greece, Italy, Spain.

9(7'). Length 25 mm or less; mantle situated near middle of body (Fig. 20), mucus colorless meadow slug, *Deroceras laeve* (Müller)



Figure 20. *Deroceras laeve*

meadow slug: Smallest of the slugs in Florida. Is without spots or with only indistinct markings; covered with minute white flecks; neck is long, when crawling; most commonly found on or under woody debris; also common on skunk cabbage leaves in spring; eggs oval, transparent becoming yellowish (Rosetta 2009). Widespread (Arctic to Central America) and highly adaptive. Feeds on great variety of plants in cultivated areas as well as in swamps, forests, etc. Can survive subfreezing temperatures (Getz 1959). Native throughout Florida from the Keys to Pensacola.

9'. Length 35 mm or more; mantle situated forward near head (Figs. 22, 24) 10

10(9'). Exudes milky adhesive slime when irritated; breathing pore surrounded by pale ring,



Figure 21. *D. laeve*

usually without well defined dark longitudinal bands gray field slug, *Deroceras reticulatum* (Müller)



Figure 22. *Decoceras reticulatum*

gray field slug: Length 35 to 50 mm with a short keel at the back of the body. The color will vary but is usually whitish, cream or pale brown, often has gray flecks on mantle and gray or blackish mottling on body; sole white or dirty yellow; body with long, low tubercles; mantle extends about 33% of the total length; eggs transparent, 3 x 2.5 mm, up to several dozen per cluster (Rosetta 2009). Feeds on variety of plants below and above the soil surface such as young corn, cabbage, tomatoes, peas, strawberries, also ornamentals, mushrooms, and decaying vegetation. Introduced from Europe. Widespread in U.S. except



Figure 23. *D. reticulatum*

in Gulf states. Intercepted in Florida many times, mostly on ornamentals.

10'. Exudes watery slime; breathing pore not surrounded by pale ring with well defined dark longitudinal bands on mantle and back banded slug, *Lehmannia poirieri* (Mabille)



Figure 24. *Lehmannia poirieri*.



Figure 25. *L. poirieri*

banded slug: Length 50 to 60 mm. Introduced into New York, Arizona, California. Intercepted in Florida several times on *Hydrangea* from California. Recorded from Pensacola (Dundee 1974).

Economic Importance

Little slug damage has been reported in Florida, but elsewhere some of the introduced European slugs have caused great damage on many vegetable plants in urban and suburban gardens and in cellars where they may attack potatoes. They are also fond of mushrooms, and can cause concern for the unsightly slime trails on ornamentals. They may transmit plant pathogens (Western et al. 1964). Little is known of their significance as intermediate hosts of disease parasites of animals (Chichester and Getz 1968). As a precaution, slugs should not be picked with bare hands. Introduced slugs may disturb the natural ecological balance in some areas, leading to the disappearance of native species.

Management

Natural enemies are relatively few (Stephenson and Knutson 1966). Some birds, especially ducks, feed on slugs. Predator snails such as the rosy predator snail, *Euglandina rosea* (Férussac), attack slugs. Few predaceous insects attack slugs, but in Coleoptera the larvae of Lampyridae (lightningbugs) and adult Carabidae (ground beetles) do so occasionally. There are some dipterous parasites (especially Sciomyzidae - marsh flies) (Trelka and Foote 1970). A few fungus diseases are known. *Phasmarhabditis hermaphrodita*, a slug-parasitic nematode not native to the U.S., is used in Britain to control slugs and is under investigation for possible use in the U. S. Initial studies have shown that the nematode is not harmful to earthworms (Wilson et al. 1999, Grewal and Grewal 2003). Other nematodes native to the U.S. have been investigated for slug control, but the results were not encouraging (Kaya 2001).

Adverse climatic conditions (e.g., dry, hot weather or excessive rains) serve to lessen depredations but do not appear to be of great significance. The rather poor slug fauna of Florida may be due to historic factors or perhaps to some natural factor as soil types. Clean surroundings will

aid in controlling slug populations, and removal of boards, sacks, piles of brush, and other debris will limit slug numbers. When chemical control is indicated, the use of baits is recommended in commercial greenhouses.

Florida Insect Management Guide for Ornamentals: http://edis.ifas.ufl.edu/TOPIC_GUIDE_IG_Ornamentals

Florida Insect Management Guide for Vegetables: http://edis.ifas.ufl.edu/TOPIC_GUIDE_IG_Vegetables

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