Meghimatium pictum

Scientific Name
Meghimatium pictum (Stoliczka, 1873)

Synonyms:
Philomycus pictus Stoliczka, 1873
Philomycus tonkinensis Simroth, 1902
Philomycus fruhstorferi var. *picta* Collinge, 1901

Figure 1. *Meghimatium pictum* specimen (Paulo Lenhard, Project AM, http://terrslugs.lifedesks.org/pages/31164).

Common Name
Chinese slug

Figure 2. *Meghimatium pictum* specimen (Paulo Lenhard, Project AM, http://terrslugs.lifedesks.org/pages/31164).

Type of Pest
Mollusk

Taxonomic Position
Class: Gastropoda, **Order:** Sigmurethra, **Family:** Philomycidae

Reason for Inclusion in Manual
CAPS Target: AHP Prioritized Pest List for FY 2014

Pest Description
The mantle covers the entire back in this family. "There is a large shell sac but no shell and the foot sole is undivided. The genital orifice is on the right side of the head…In general, they resemble Arionidae" (Runham and Hunter, 1970).

This species is a relatively small and slender slug. The extended length is up to 6 cm (approx. $2\ ^{3}/_{8}$ in) long and 1.5 cm (approx. $^{9}/_{16}$ in) wide (Gomes et al., 2011).

Adults: "Elongated cylindrical body, with a rounded anterior margin and a pointed posterior margin. The head is long and extends out from beneath the anterior portion of the mantle. The sole occupies the entire ventral body region. There is a visible respiratory pore formed by a short slit near the anterior right mantle edge. Background color of mantle from yellowish to opaque beige, with two dark brown to black lateral stripes, and one medial stripe, often lighter than the lateral ones. Below the lateral stripes (laterally) and surrounding the central medial stripe (dorsally) are found scattered dark brown irregular spots or even short lines (in general lighter than the

lateral stripes). Sole cream colored. The head is also cream colored although the ocular tentacles are dark" (Gomes et al., 2011).

Reproductive system: "The vagina, evertophallus, and duct of bursa copulatrix [gametolic gland] open into a large, barrel-shaped atrium. The vagina is short and of similar length to the atrium. The evertophallus is short and thick (compared to other species of the genus) and has a constriction halfway along its length. The vas deferens is short and only slightly longer than the penis. The bursa copulatrix is nearly spherical to oval-shaped and is situated a short distance from the atrium through a thin duct. The other genital organs appear to lack distinguishing characteristics in relation to the other species of the genus" (Gomes et al., 2011).

Radula and jaw: "Radula with approximately 138 rows and tooth arrangement 31:1:31 and with elongated teeth with slightly curved and arrow-shaped apices; small central tooth with a wide and triangular base; lateral tooth with a retangular base and with twice the size of the central teeth. Jaw horseshoe-shaped with about 25 plates, in which the central ones are more developed" (Gomes et al., 2011).

In Malaysia, samples of this species showed substantial phylogeographic divergence, diversity in body color pattern, and some genitalia differences suggesting that there may be at least two or three subspecies present (Schilthuizen and Liew, 2008).

Biology and Ecology

This species is a hermaphrodite and can self-fertilize. It has a high rate of reproduction (Gomes et al., 2011).

In Brazil, this species is found in high-humidity sites in a variety of areas (from highly disturbed to undisturbed). In disturbed areas, this species could be found alongside other exotic species including *Lissachatina fulica*, *Limacus flavus*, and *Subulina octona*. During the day, this species has been observed on the edge of populated areas, under fallen trunks, limbs, stones, and garbage. In forest settings, this species has been observed inside hollow trunks, or next to or under bryophytes (i.e. mosses). Some *M. pictum* were found up to 1.5 m (approx. 5ft) off the ground (Gomes et al., 2011). In Sabah, Malaysia, this species is found in primary lowland and lower mountain forests (500 – 1,500 m altitude).

Eggs are laid in the environment. In Brazil, adults were often found close to eggs. In Brazil, *M. pictum* were often numerous and found in groups (Gomes et al., 2011). The population numbers for this species and feeding damage is highest in the warmest and wettest months in Brazil as well as during the vines' growth and fruiting period (Baronio et al., 2014).

Damage

Damage in Brazil vineyards is mostly seen during grape harvest season (January to March). Soil moved by the slugs can be found on vine shoots at harvest. Slugs will feed on berries damaged by other insects or pathogens, but do not pierce the berries on

their own. Movement by *M. pictum* in the clusters causes mucus trails, which compromises the visual appearance of the grapes and customer acceptance (Baronio et al., 2011a). In Brazil, injury caused by this species usually occurs during the grape harvest period between December and March, although some losses were recorded during the production period (Baronio et al., 2014).

Pest Importance

This species has been found in Brazil causing damage to private kitchen gardens. It has also been found in protected areas alongside native species (Gomes et al., 2011). *Meghimatium pictum* has recently been found in large clusters in grape vineyards (Baronio et al., 2011b). Baronio et al. (2014) reported that this species was causing damage to *Vitis labrusca* (fox grape) in Brazilian vineyards. The species was found at densities exceeding 20 slugs per m^2 in six municipalities of Southern Brazil's viticulture region. Infestation levels were highest in areas with cover crops within the vineyards which provided excellent humidity and shading conditions. "[Infestations can cause] losses that significantly affect vineyards in the region with the largest Brazilian grape producers for *in natura* consumption, processed juice and vinification" (Baronio et al., 2014).

Baronio et al. (2011b) states that this species can affect the marketing of fresh grapes and also the quality of wine and juice prepared from the fruits. Damage is caused by residual mucus left on the grapes and consumption of grapes that have already been perforated by other organisms, like insects and birds, or mechanically damaged by in situ compression (Baronio et al., 2014).

This species was recently found in Argentina. It is currently unclear whether this species is currently affecting incipient grape vines in the country. It could cause issues in the future if this species spreads to western provinces where 97% of the domestic production of wine in concentrated (Gregoric et al., 2013).

Known Food Sources*

This species is polyphagous.

Vitis labrusca (fox grape) and *Vitis vinifera* (grape) (Baronio et al., 2011a; b; Baronio et al., 2014).

*Terrestrial mollusks do not show host specificity and can feed on multiple crops as well as other materials, like decaying organic matter.

Pathogen or Associated Organisms Vectored

Human and Animal Pathogen

Although this species can be found in the same environment as other introduced mollusks that can carry *Angiostrongylus costaricensis*, it is currently unknown whether this species can serve as a vector (Gomes et al., 2011).

A closely related species, *Meghimatium bilineatum* has been reported as a host of *Angiostrongylus cantonensis* (rat lungworm) (Li et al., 2006). *Angiostrongylus cantonensis* can cause symptoms similar to meningitis in humans including headache, stiff neck, tingling or painful feelings in the skin, lowgrade fever, nausea, and vomiting (USDA-APHIS, 2010).

Note: While most cases of human infections result from consumption of raw or partially cooked snail meat, government inspectors, officers and field surveyors are at-risk due to the handling of live snail, samples, and potential exposure to mucus secretions. ***Wear gloves when handling mollusks and wash hands thoroughly after any mollusk survey or inspection activities.***

Plant Pathogens
Unknown.

Known Distribution

Asia: China, Malaysia, Taiwan, and Thailand; **South America:** Argentina and Brazil (Schilthuizen and Liew, 2008; reviewed in Gomes et al., 2011; Gregoric et al., 2013).

This species is possibly found in India as well (reviewed in Baronio et al., 2014).

Pathway

Land mollusks are known to move successfully through human-mediated movement. It is believed that *M. pictum* was introduced accidentally into Brazil through agricultural products (Gomes et al., 2011). This species was recently found in Argentina. Gregoric et al. (2013) hypothesize that this species was introduced through active dispersal of the slug from Brazil and/or through commerce of flora from infested Brazilian areas.

Since its introduction into Brazil, it has been intercepted once at U.S. ports of entry. The interception occurred on *Brassica oleracea* in ship stores and originated from Brazil. This genus has also been intercepted 9 times at U.S. ports of entry. All interceptions originated from China (6), Vietnam (2), and Taiwan (1), on permit cargo (5), and mail (3), and baggage (1). All interceptions occurred on plant material, including: unknown plant (3), *Ficus* sp. (3), Cycadaceae (1), *Sageretia thea* (1), and *Zelkova* sp. (1) (AQAS, 2012, January 1, 2012).

Meghimatium bilineatus has been intercepted on mushrooms and plants of *Cycas* sp. (Godan, 1983).

Potential Distribution within the United States

No risk documents exist for any of the tropical terrestrial mollusks that give potential distribution in the United States. Host material is unlikely to limit their distribution since they are all polyphagous, but these species are limited by climate. If introduced, the tropical terrestrial mollusks would most likely be limited to the southern part of the United States and possibly the West Coast where the climate is similar to native ranges.

This is supported by detections of these species which have all been in either the southern United States or West Coast (USDA-APHIS, 2010).

Survey

CAPS-Approved Method*:

Visual. See the Introduction to the mollusk manual for specific information on visual surveys.

Survey Site Selection

New introductions of terrestrial mollusks will likely be related to commerce and human-assisted movement. The habitat and land-use type of each survey site may be variable, ranging from agricultural land, to residential or industrial features. When planning the survey route for a particular site, examine the following microhabitats:

- Near heavily vegetated areas, especially gardens and fields where plants have been damaged by feeding;
- Under rocks, asphalt or cement pieces that are in loose contact with the ground surface;
- Discarded wooden boards and planks, fallen trees, logs, and branches;
- Damp leaf litter (not wet or soggy), compost piles, and rubbish heaps; and
- Under flower pots, planters, rubber mats, tires, and other items in contact with the soil.

In Brazil, this species has been found in vineyards, private kitchen gardens, and urban areas within peripheral areas under fallen trunks, limbs, stones, and garbage. “In relatively undisturbed forests, they are found in woody stems, inside hollow trunks or near or under bryophytes. They were generally found in humid and dark places, buried or underneath various objects” (Baronio et al., 2014).

Trap Placement

Trapping ***cannot*** be used alone but can be used to supplement visual surveying. Trapping for terrestrial mollusks is not species-specific and will attract non-target species, including non-mollusks. Platform or baiting traps can be used to supplement visual inspection. Trap placement can occur in the same areas that visual surveys occur.

Time of year to survey

Most species of terrestrial mollusks are active during nocturnal hours, when environmental conditions are cool and wet. Some species may also be active during daylight, especially during overcast and rainy days in the spring and fall. If possible, plan surveys during spring and fall, during the early morning, and on overcast days. Many slugs and snails have diurnal patterns of activity, so early morning and evening hours may be the best time to carry out a survey (Pearce and Örstan, 2006).

Key Diagnostics/Identification

CAPS-Approved Method*:

Morphological: Confirmation requires a morphological identification. All specimens should be submitted to Dr. Robinson for morphological identification.

*For the most up-to-date methods for survey and identification, see Approved Methods on the CAPS Resource and Collaboration Site, at http://caps.ceris.purdue.edu/.

Easily Confused Species

This species was originally recorded as *Pallifera* sp. in Brazil. Samples have also been misidentified as *Philomycus carolinianus* (Gomes et al., 2011). Schilthuizen and Liew (2008) state that this species is similar to *Meghimatium striatum*.

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Revisions

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1) Added information from Baronio et al. (2014) to the following sections: **Biology and Ecology, Known Food Sources, Pest Importance, Known Distribution,** and the **Survey Site Selection** section within the **Survey** section.