Bulletin of Insectology ***66*** *(2): 269-272, 2013*
ISSN 1721-8861

First record of the genus *Ilyomyces* for North America, parasitizing *Stenus clavicornis*

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Abstract

The ectoparasitic fungus *Ilyomyces* cf. *mairei* (Ascomycota Laboulbeniales) is reported for the first time outside Europe on the rove beetle *Stenus clavicornis* (Coleoptera Staphylinidae). This record is the first for the genus *Ilyomyces* in North America. Description, illustrations, and discussion in relation to the different species in the genus are given.

Key words: ectoparasites, François Picard, *Ilyomyces*, rove beetles, *Stenus*.

Introduction

Fungal diversity is under-documented, with diversity estimates often based only on relationships with plants. Meanwhile, the estimated number of fungi associated with insects ranges from 10,000 to 50,000, most of which still need be described from the unexplored moist tropical regions (Weir and Hammond, 1997). Despite the biological and ecological importance the relationship might have for studies of co-evolution of host and parasite and in applications in biological control, insect-parasites have received little attention, unfortunately. One group of insect-associated fungi, the Laboulbeniales (phylum Ascomycota, class Laboulbeniomycetes), is thought to be the most diverse and it is intriguing as well, because of the many unresolved taxonomical, morphological, and ecological questions.

Laboulbeniales, with currently some 2,050 described species in 140 genera (Rossi and Santamaría, 2012), live attached to the cuticle of their invertebrate hosts: insects (mainly beetles and flies), millipedes, and mites. About 80% of the Laboulbeniales described so far is parasitic on Coleoptera (Weir and Blackwell, 2005). They do not form a mycelium but instead produce small thalli of determinate growth, bearing antheridia and perithecia on a receptacle with appendages (Tavares, 1985). Most Laboulbeniales exhibit a high degree of host specificity, ranging from occurrence on one single host species to several related or congeneric species (Thaxter, 1896; Scheloske, 1969; Tavares, 1985; Majewski, 1994; De Kesel, 1996), and are also often restricted to a precise portion of the host integument (Thaxter, 1896; Benjamin and Shanor, 1952; Santamaría, 2001; Rossi and Proaño Castro, 2009; Goldmann and Weir, 2012).

The genus *Ilyomyces* F. Picard comprises four species, all infesting beetles of the subfamily Steninae (Coleoptera Staphylinidae). Members of this genus are characterized by cells I and II being more or less parallel, separated by an oblique septum, because of which cell I is in contact with cell III; cells II and VI are also separated by an oblique septum; appendage consisting of two to five superposed cells, of which the upper one to three bearing antheridia (Weir, 1995).

Exactly one hundred years ago, François Picard (1879-1939) described *Acallomyces lavagnei* F. Picard (Picard, 1913), which he later reassigned to a new genus *Ilyomyces* while adding a second species, *Ilyomyces mairei* F. Picard (Picard, 1917). For a long time both species were only known from France, until Santamaría (1992) reported *I. mairei* from Spain. Weir (1995) added two more species to the genus: *Ilyomyces dianoi* A. Weir and *Ilyomyces victoriae* A. Weir, parasitic on Steninae from Sulawesi, Indonesia. This paper presents the first record of *Ilyomyces* for the New World.

Materials and methods

In the context of an All-Taxa Inventory of Laboulbeniales Biodiversity at the Boston Harbor Islands National Recreation Area, dried insect specimens deposited at the entomology collection of the Harvard University Museum of Comparative Zoology (MCZ) were examined for Laboulbeniales. Insects were carefully screened under dissecting microscope at 50× magnification. Individual thalli were transferred using a BioQuip Minuten Pin and embedded in Amann solution (Benjamin, 1971). Coverslips were ringed with transparent nail varnish. Observations and measurements of fungal specimens were made using an Olympus BX40 light microscope with Olympus XC50 digital camera and MicroSuite Special Edition software 3.1 (Soft Imaging Solutions GmbH). Photography was done at the Harvard Center for Biological Imaging using a Zeiss AxioImager microscope running on ZEN software. Microscope slides are deposited at the Farlow Herbarium, Harvard University (FH).

Taxonomy and results

Ilyomyces cf. *mairei* F. Picard (Ascomycota Laboulbeniales) (Picard, 1917), figures 1 and 2.

Known distribution and hosts

Described from France on *Stenus elegans* Rosenhauer (Coleoptera Staphylinidae) and since then only reported from Spain (Santamaría, 1992) and a second time from

France (from Balazuc's microscopic slides, originally labelled as *I. lavagnei*; Santamaría, 2003). Rove beetles of the genus *Stenus* Latreille 1797 are common in riparian areas but are seldom parasitized by Laboulbeniales.

New records from the USA

On a single specimen of *Stenus clavicornis* (Scopoli) (Coleoptera Staphylinidae), Massachusetts, Suffolk County, Thompson Island (Boston Harbor Islands National Recreation Area), N42°18'59.6" W71°0'39.9", 3 Jul. 2007, litter sample, leg. J.Rykken, det. A.Brunke, MCZ-ENT00601500, permanent slides FH 00313250 (seven immature specimens from elytra), FH 00313251 (one immature specimen from elytra).

Description of thalli

Cells I and II separated by a strongly oblique septum. Cell III 18-21 µm long, triangular to trapezoidal, in contact with cell I, with the anterior side adnate to cell VI. Cell VI broader than long, with the posterior side higher than the anterior; subtending the immature perithecium, with trichogyne. Primary appendage 51-72 µm long, with the septum between cell III and the basal cell suffused with brown; consisting of two superposed cells, the lower of which (basal cell) is 16-18 × 9-12 µm, on average 1.3× longer than the upper (suprabasal) cell; the latter giving rise to two smaller cells, each supporting one pair of flask-shaped antheridia, one of the latter cells also bearing a spinous process.

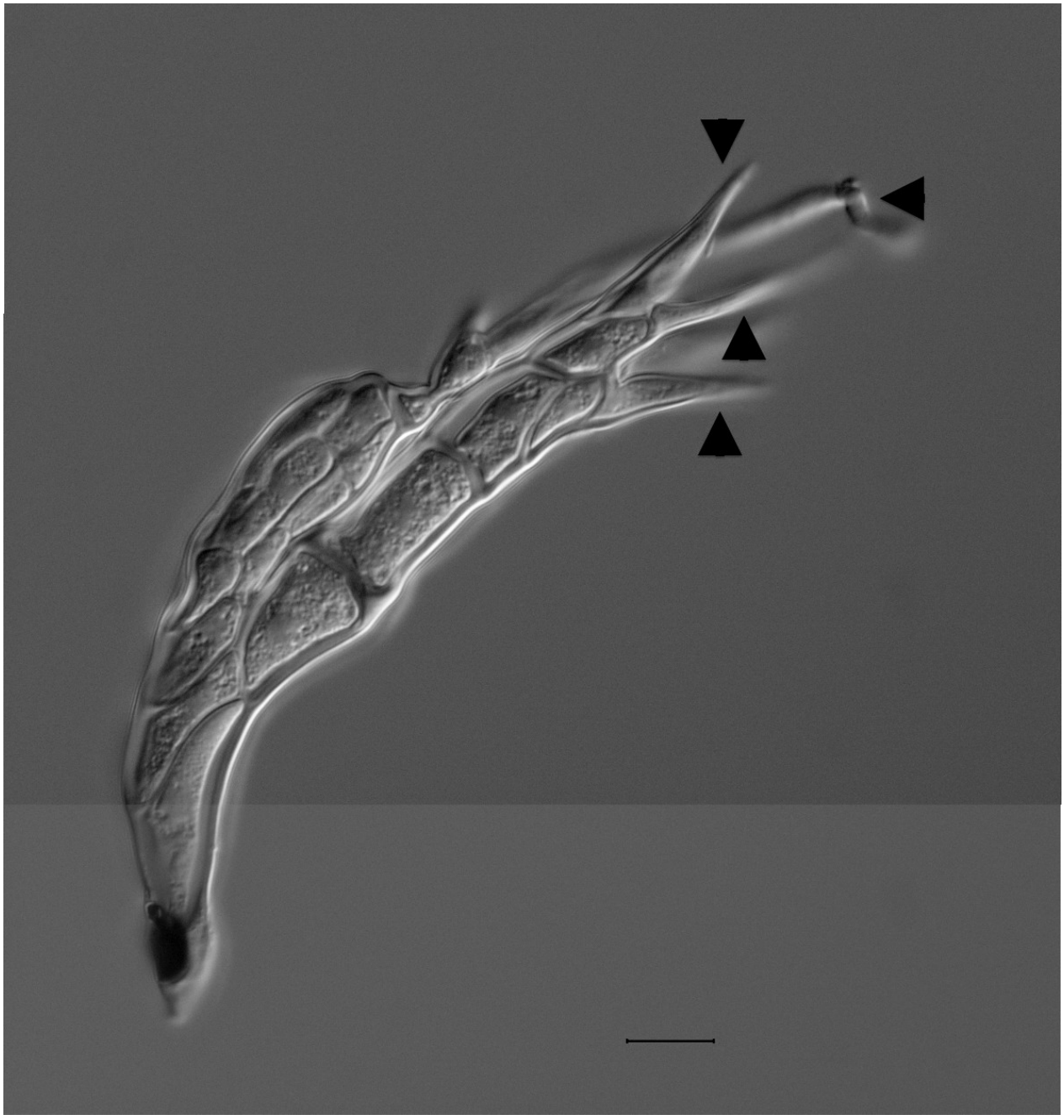

Figure 1. *Ilyomyces mairei* F. Picard, juvenile thallus focused to show three antheridia (arrowheads facing up and down) and the trichogyne (arrowhead facing left) (thallus 5 in FH 00313250). Scale bar = 10 µm.

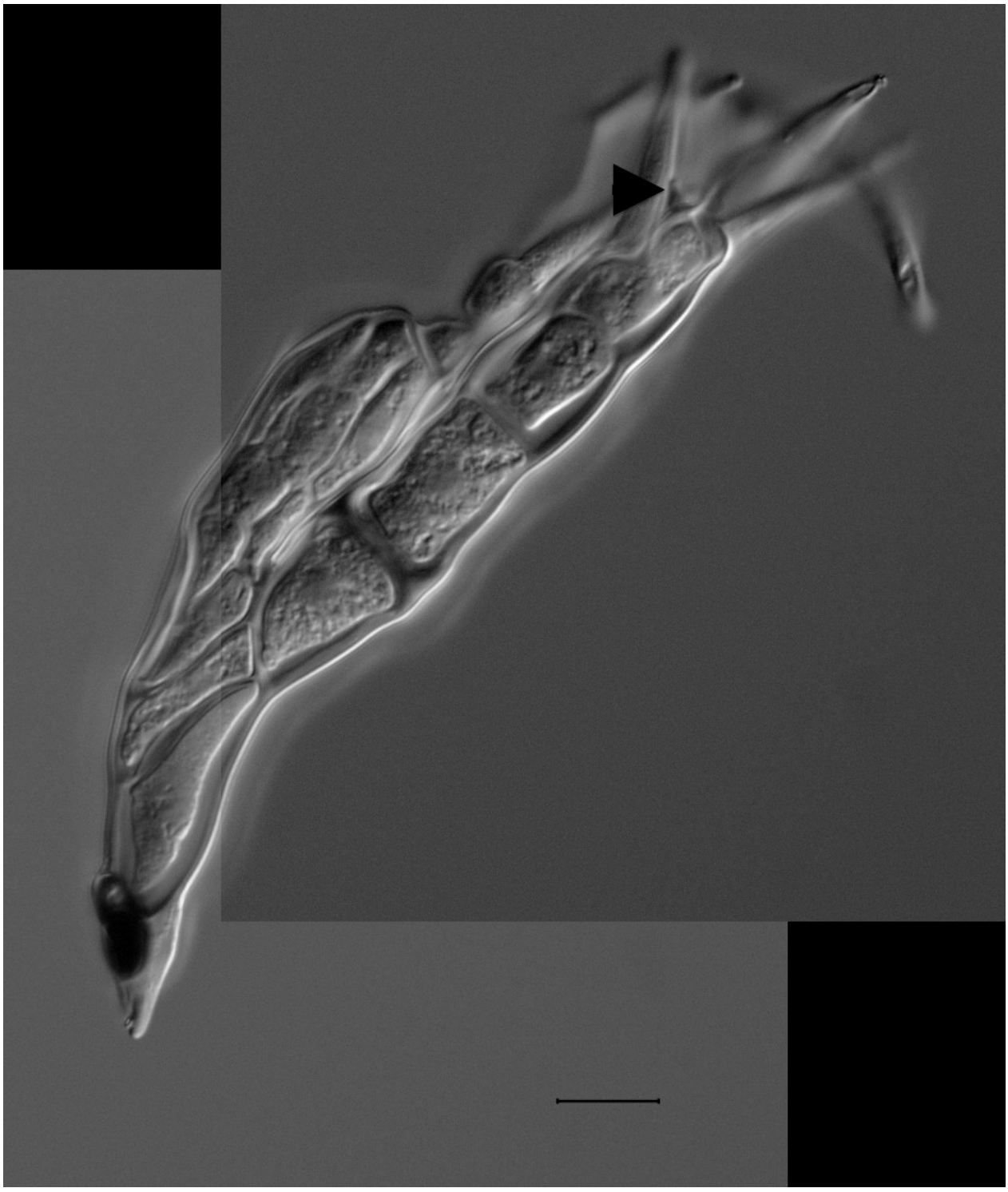

Figure 2. *Ilyomyces mairei* F. Picard, juvenile thallus showing the spinous process, the remnant of the spore apex (arrowhead) (thallus 3 in FH 00313250). Scale bar = 10 µm.

Discussion

I. mairei is easily separated from *I. dianoi* and *I. victoriae*, for the number of superposed cells of the primary appendage - two, five, and four, respectively. Confusion arises about the validity of *I. lavagnei* against *I. mairei*. *I. mairei* was described from the same host specimen bearing *I. lavagnei* (Picard, 1917); the species are not easily distinguished and the types are lost (Santamaría, 1992). The American material most probably belongs to *I. mairei* because of the following characteristics that are diagnostic for this species: the septum between cell III and the basal cell of the appendage is suffused with brown; in addition, the appendage is arranged in two superposed cells, the uppermost carrying two smaller cells, each bearing two antheridia (Picard, 1917; S. Santamaría, personal communication). However, since no mature specimen was detected some uncertainty remains.

I. cf. *mairei* is the first representative of the genus found in North America. In addition, this record significantly increases the known geographical distribution for the genus, as it was previously recorded only from France (Picard, 1913; 1917; Santamaría, 2003), Spain (Santamaría, 1992; 2003), and Indonesia (Weir, 1995).

According to Weir (1995) in *I. mairei* there are "possible three" appendage cells of which only the terminal one is fertile. According to observations of the present material, the suprabasal cell of the appendage gives rise to two smaller cells, which are separated from the former by oblique septa and in contact with each other only at their bases. Both of these cells give rise to two antheridia.

In all thalli but one a spine-shaped outgrowth at the top of one of the cells bearing antheridia is present, representing the original spore apex. I do not agree with Santamaría's (1992) suggestion that one of the four antheridia corresponds to the spore apex, but instead believe that one of the two supporting cells corresponds to the apex of the spore, therefore bearing the process, and that the antheridia "overgrow" this process during development.

Only 41 thalli of the genus *Ilyomyces* have been studied since Picard (1913; 1917), including my recent collection of North American *I.* cf. *mairei* (Picard's specimens are lost; 27 specimens in Santamaría, 1992; six specimens in Weir, 1995; eight specimens in this study), making this a very uncommon genus of Laboulbeniales.

Acknowledgements

I want to thank Miss Rebecca E. Handlin, undergraduate student at Harvard College, for her attentiveness in screening insects; I would also like to express my gratitude to Dr. Sergi Santamaría (Universitat Autònoma de Barcelona) for constructive suggestions and to Dr. André De Kesel (National Botanic Garden of Belgium) for critical reading of the manuscript.

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Received June 25, 2013. Accepted September 9, 2013.