# *Laboulbenia formicarum* (Ascomycota, Laboulbeniales) Reaches the Mediterranean

by

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## ABSTRACT

Laboulbeniales (Fungi) are an infrequent find when growing on ants. We report a new host (*Lasius neglectus*) for *Laboulbenia formicarum*, which is also a new mycological addition for continental Europe. Heavily infested ants were foraging normally on *Tamarix gallica* (salt cedar trees) planted along a seaside walk in North-East Spain. The infestation is spatially much extended (540 m), probably because of the supercolonial social structure of the host ant. Workers of eleven additional ant species from the same locality were collected but none were infested.

Key Words: *Laboulbenia formicarum*, *Lasius neglectus*, supercolony.

## INTRODUCTION

Laboulbeniales (Ascomycotina) are an enigmatic group of ectoparasitic fungi which grow out of the cuticle of arthropods, mainly insects (Tavares 1985; Santamaria 1998, 2003). A majority of species are hosted by coleopterans (80% of species of Laboulbeniales) and dipterans (10%). Among the Hymenoptera, only ants have been detected as hosts. This is a remarkable fact, as ants are known to produce a cocktail of antibiotic substances in their metapleural glands (Maschwitz *et al.* 1970, Beattie *et al.* 1986; Hölldobler & Engel-Siegel 1985; Veal *et al.* 1992) that are used selectively when ants are challenged by pathogens (Fernández-Marín *et al.* 2006). Laboulbeniales –their spores, that is- are among the few microorganisms that seem to have effectively broken that sanitary frontier. General ant behavior has been noted as decreasing infection rate (Oi & Pereira 1993) although allogrooming within nestmates may enhance intracolony dissemination. Alternatively, Laboulbeniales may have evolved exceedingly low levels of pathogenicity to release any defensive physical or immunological reaction. Three genera and

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five species are involved: 1) one species in *Rickia wasmannii* Cavara, infesting several *Myrmica* species in Europe, 2) *Dimorphomyces formicicicola* (Speg.) I.I. Tav., infesting one *Paratrechina* species in Argentina, and 3) three species in *Laboulbenia*. The rare *Laboulbenia ecitonis* G. Blum has been found only once in Brazil, on an army ant, *Eciton*. *Laboulbenia camponoti* Batra has several *Camponotus* ants as hosts (Espadaler & Lodos 1983; Espadaler & Blasco 1990) and is known from India, Turkey and Spain. Here we document the presence of the third of those *Laboulbenia*, *L. formicarum* Thaxter, in continental Europe, an outpost from its current distribution, on a new host ant species, which is also an exotic.

## METHODS AND MATERIALS

Ants were first collected in early September, 2006, foraging on salt cedar trees (*Tamarix gallica* L.) planted in a seaside walk at the coastal locality of L'Escala (N42°7'; E3°7') in NE Spain. Trees were at a distance of 5-10m from the sea. Annual mean precipitation is not high (650 mm; mean of 13 years) but mist from the sea is strong, leaving trees with salty humidity on touch.

A census conducted during the evening at each tree along the walk showed a distinct longitudinal spatial pattern of occupancy in the 108 trees, in that two sectors appeared well defined: a first sector (trees #1-54) with 29 trees with *Lasius neglectus* Van Loon, Boomsma & Andrásfalvy and –interspersed– two with *Crematogaster scutellaris* (Olivier). A second sector (trees #55-108) had *C. scutellaris* in 20 and *Tapinoma nigerrimum* (Nylander) in three. All trees included in the study had only a single ant species. All upgoing and downgoing ants were collected at each *L. neglectus* tree over a period of two minutes.

In late September, a routine survey of other locally occurring ant species was done by conducting a transect (2500 m) along the seaside (urbanized area) looking especially on and around trees .

## RESULTS

Within a total of 669 *L. neglectus*, a majority of individuals had the fungus (Fig. 1). Ants were heavily infested (Fig. 2), in the same manner as was graphically described by Wheeler (1910) when stating that infested ants "resemble hedgehogs". In 30 September 2006, no living aphids were detected but rotting remains of aphid colonies, mummies included, were abundant

at the flowering shoots, and we assume those colonies were tended in early September. Instead, in late September, ants seemed to forage within cracks, although no coccids were seen either. It remains to be specified which food source those ants were seeking in autumn. *Tamarix gallica* L. (Tamaricaceae), a salt cedar, is a naturally occurring Western Mediterranean tree species, widely used in coastal gardening because of its resistance to salinity. The bark is heavily decorated with crevices.

Ants nested at the base of trees (planted at a regular distance of 10 m) and also occupied the cracks and fissures in concrete and sideways. They were seen foraging between trees as well, and thus there is probably a continuum of ants along the >540m in the boulevard in which the majority of *L. neglectus* ants carry *Laboulbenia*. This is a similar situation as that described by Wheeler (1910) who "came upon two localities about a mile apart, in which nearly all the colonies of *Lasius niger* var. *neoniger* were infested...". Interestingly, that station was also at the seashore. Vouchers of the fungus have been deposited

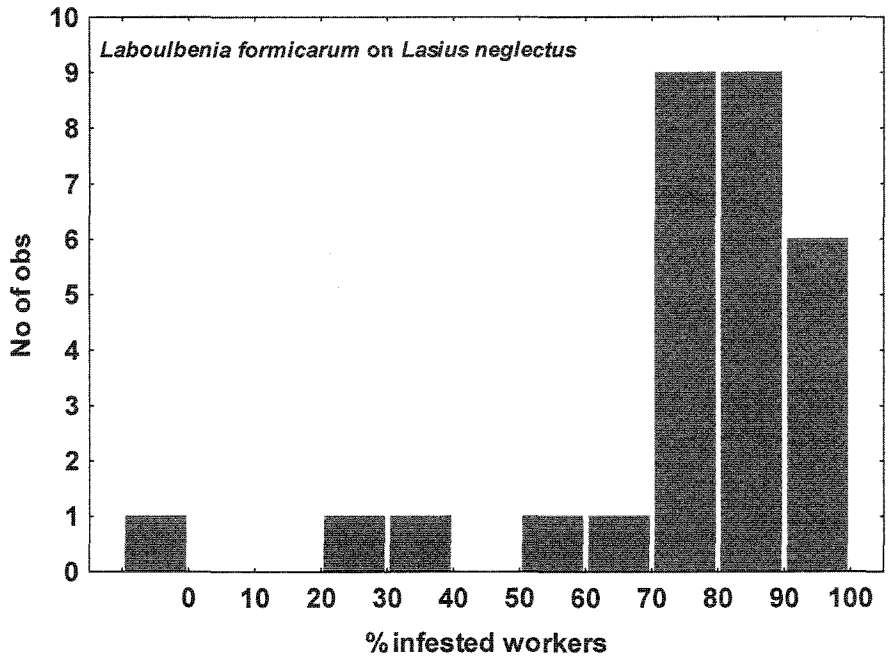


Fig. 1. Frequency distribution of infested *Lasius neglectus* ant workers (as % of workers sampled during two minutes) foraging on tree trunks of salt cedar trees (*Tamarix gallica*) in NE Spain (mean ± s.d. per tree; 77% ± 23%; n=29).

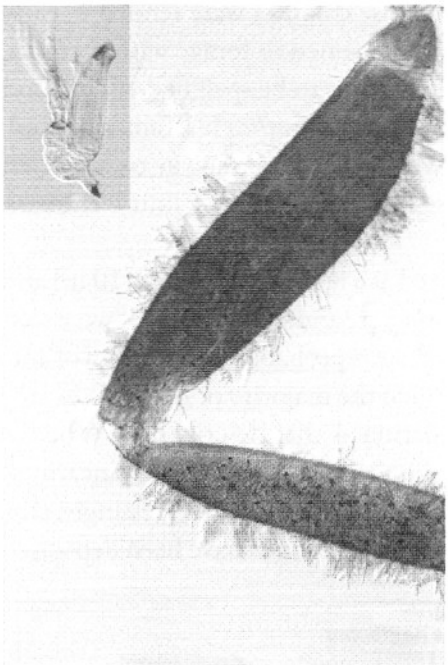

Fig. 2. Leg of *Lasius* showing thalli of *Laboulbenia*. Inset: mature thallus of *L. formicarum*.

at BCB Mycotheca herbarium and two infested ant workers at the Museu de Ciències Naturals de Barcelona.

Syntopic soil surface foraging ants *Tetramorium* sp. (*caespitum* group) (n=117 workers) were also collected at the base of the very same *Tamarix* trees although they were not infested. Other ant species (number of) collected at the seaside (urbanized area) were *Lasius grandis* Forel (72), *Formica rufibarbis* Fabricius (4), *Temnothorax specularis* (Emery) (1), *Crematogaster scutellaris* (Olivier) (205), *Messor barbarus* (L.) (47), *Messor bouvieri* Bondroit (35), *Linepithema humile* Mayr (96), *Tapinoma nigerrimum* (Nylander) (183), and *Hypoponera eduardi* (Forel) (2). Inside town, uninfected *Lasius lasioides* Emery (10) were also collected. In total, 772 ants from 11 species were collected and found clean of the fungus. In contrast, 599 out of 739 *Lasius neglectus* workers collected the same day were infested.

## DISCUSSION

*Laboulbenia formicarum* is known from a wide area in North America, from Ontario and Idaho to New Mexico and North Carolina (Bequaert 1920; Cole 1935, 1949; Judd & Benjamin 1958; Nuhn & Van Dyke 1979; Smith 1917, 1928, 1946, 1961; Wheeler 1910). Hosts belong in the genera *Formica* (14 species known to be infested), *Lasius* (6 species, including the former genus *Acanthomyops*, now a synonym), *Myrmecocystus* (one species), *Polyergus* (one species), and *Prenolepis* (one species). This fungus was recently detected in the island of Madeira (Espadaler & Santamaria 2003) growing on the native ant *Lasius grandis* Forel. How it crossed the Atlantic is entirely speculative. *A fortiori*, is to wonder how it reached the Mediterranean and

infested an exotic ant of undefined origin. *Lasius neglectus* is certainly not a Western Mediterrranean native ant. It has been suggested to be of Asiatic origin (Seifert 2000).

The host, *Lasius neglectus* Van Loon, Boomsma & Andrásfalvy 1990, is an invasive ant that is quickly increasing its range (Seifert 2000) in Europe and Western Asia. In some of its populations the social structure, with multiple queens (Espadaler *et al.* 2004) and very reduced or absent intraspecific aggression (pers. observ.) leads to the formation of huge and dense supercolonies that may inhabit as extended an area > 17ha, resulting in exclusion of the local, native ants. As cross-infestation in Laboulbeniales is through direct contact between hosts, and by sticky spores (Tavares 1985) produced distally from the mature thalli that grow upright in huge numbers over the ant's body, the social milieu is propensive for a massive infestation to occur. Time for the spore to develop into a mature thallus varies from 10 to 21 days (Huldén 1983) but in cavernicolous species, living at low temperatures, it may be as long as six months. It will be interesting to survey the eventual presence of fungi on ant sexuals, which are produced in late May (Espadaler & Rey 2001). Males are short lived but virgin queens, after mating in the nest, remain inside as fertile, laying queens or take a short walk of few meters (budding), accompanied with workers. They could be infested only from the time of cocoon eclosion. Laboulbeniales infesting ants do not seem to harm the hosts in any way; they forage normally, without any detectable behavioral alteration. Therefore, no control of this pestiferous ant is to be expected by using this fungus.

There are several examples in the freshwater fish literature of similar interactions between two organisms from different origins, each one having made the journey their own and specific way, such as the case in Panama of two species of introduced fishes from South America which are infected by an Asian trematode (Scholz & Salgado-Maldonado 2000; Torchin, pers. comm.). Nevertheless, it remains a rare event (Torchin *et al.* 2003) when two (separately) introduced species –here an ant and a fungus in Spain- meet and interact so dramatically. This is another amazing example of the ongoing globalization of world biota, especially in human-modified habitats.

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