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# First Record of an Epizoic *Laboulbenia* (Fungi: Laboulbeniales) on Ants (Hymenoptera: Formicidae) in Africa

K Gómez [1], X Espadaler [2], S Santamaria[3]

1 - Castelldefels, Barcelona, Spain

2 - CREAF - Universitat Autònoma de Barcelona, Cerdanyola del Vallès, Barcelona, Spain

3 - Unitat de Botànica, Departament de Biologia Animal, de Biologia Vegetal i d'Ecologia, Facultat de Biociències, Universitat Autònoma de Barcelona, Cerdanyola del Vallès, Barcelona, Spain

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**Corresponding author**
Xavier Espadaler
Unitat d'Ecologia i CREAF
Universitat Autònoma de Barcelona
Cerdanyola del Vallès
Barcelona 08193, Spain.
E-Mail: xavierespadaler@gmail.com

**Abstract**

The first ant-Laboulbenial interaction in Africa is recorded. The fungus *Laboulbenia camponoti* Batra was detected over the body of workers *Camponotus oasium* Forel collected in Senegal. This is a huge range extension of its Eurasian previously known distribution, to the Afrotropical region. We present the updated global database for *L. camponoti*.

## Introduction

Laboulbeniales is an order of ascomycetous fungi consisting of over 2000 species that have obligate association with arthropods, mostly insects, especially Coleoptera and Diptera, and on a few ant species, mites, thrips and millipedes (Tavares, 1985). Those fungi show a rather high level of host specificity. Their study remains in a challenging interface, between entomologists and mycologists and, consequently, clearly belong in the domain of a very few specialists in the world.

Ants are known to harbor six species of Laboulbeniales: two species of the genus *Rickia* Cavara (on *Myrmica* Latreille or *Messor* Forel hosts), one *Dimorphomyces* Thaxter (on *Nylanderia* Emery) and three species of *Laboulbenia* Thaxter (on *Camponotus* Mayr, *Lasius* Fabricius, *Formica* Linnaeus, *Polyergus* Latreille, *Myrmecocystus* Wesmael, *Prenolepis* Mayr, *Eciton* Latreille). The global database of published ant-Laboulbeniales interactions contains 125 instances, from 95 localities and 28 countries (unpub. data).

In the splendid work on the Ants of the Congo Basin (Wheeler, 1922), Bequaert writes about general ant-fungus relationships, and mentions Laboulbeniales noting *"... they are inconspicuous and, when examined* in situ *on the host insect, appear in general like minute, usually dark-colored or yellowish bristles or bushy hairs, projecting from its chitinous integument either singly or in pairs, more commonly scattered, but often densely crowded over certain areas on which they form a furry coating.*". The thallus attaches to the insect cuticle with a darkened foot. There are no penetrating hyphae or rhizoids into the ant body cavity in *Laboulbenia formicarum* Thaxter and *L. camponoti* Batra, or *Rickia wasmannii* Cavara and *R. lenoirii* Santamaria (Tragust et al., 2016). Therefore, the energy source(s) for growing and reproducing in ant-Laboulbeniales is unknown. This is an intriguing and fundamental issue to unravel in the biology of Laboulbeniales.

## Material and Methods

The *Camponotus* sample was collected during a general ant sampling done close to the N-1 road in Senegal (14º6.11'N 15º41.12'W). The habitat was an open Savannah, mainly agricultural, with scattered Acaciae trees. According to Tappan et al. (2004), the zone belongs to the West Central Agricultural Region close to the Saloum Agricultural Region.

Several mature and immature thalli were scratched off the third leg of one *Camponotus* worker. Permanent slides were prepared following previously described methods (Benjamin, 1971) and are kept in the BCB Mycotheca of Universitat Autònoma de Barcelona (BCB-slides). Ant specimens with attached fungi are kept in the private collections of K.G. and X.E. Photomicrographs were made with a Jenoptik ProgRes 10 Plus digital camera on a Leica DMR microscope equipped with differential interference contrast optics (DIC). Images were processed with Photoshop CS5 software and Dpx View Pro for its included feature of extended focus function. Macroscopic images were taken using a Nikon CoolPix S3600 and a Nikon binocular. Retouched with Microsoft Office Picture Manager. The map was done using CARTO Builder.

## Results

*Camponotus* ants were found inside an abandoned termite nest under an acacia tree.

Six workers were collected:

- Three minor workers of *Camponotus oasium* Forel were detected with *Laboulbenia camponoti* thalli (Fig 1) over nearly all body parts (clypeus, eyes, scape, mesosoma, gaster and legs (Fig 2). Small black spots, the point of insertion of the thallus, contrasting with the yellow integument, were also abundant at the gula and coxae but no thalli were present or had developed, likely because of the frequent frictional forces those body parts bear.

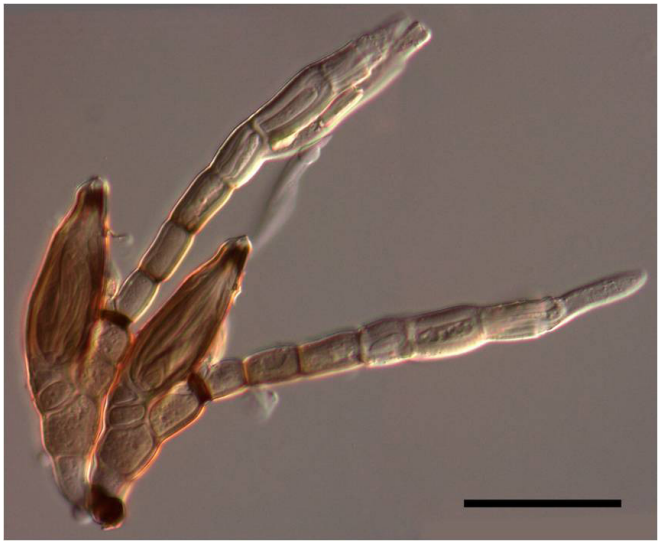

**Fig 1**. *Laboulbenia camponoti* Batra. SENEGAL: Kaolack, road between Birkelane and Kaffrine. Two mature thalli showing the black foot, the perithecium with spores, and the elongated appendages. Scale: 50 µm.

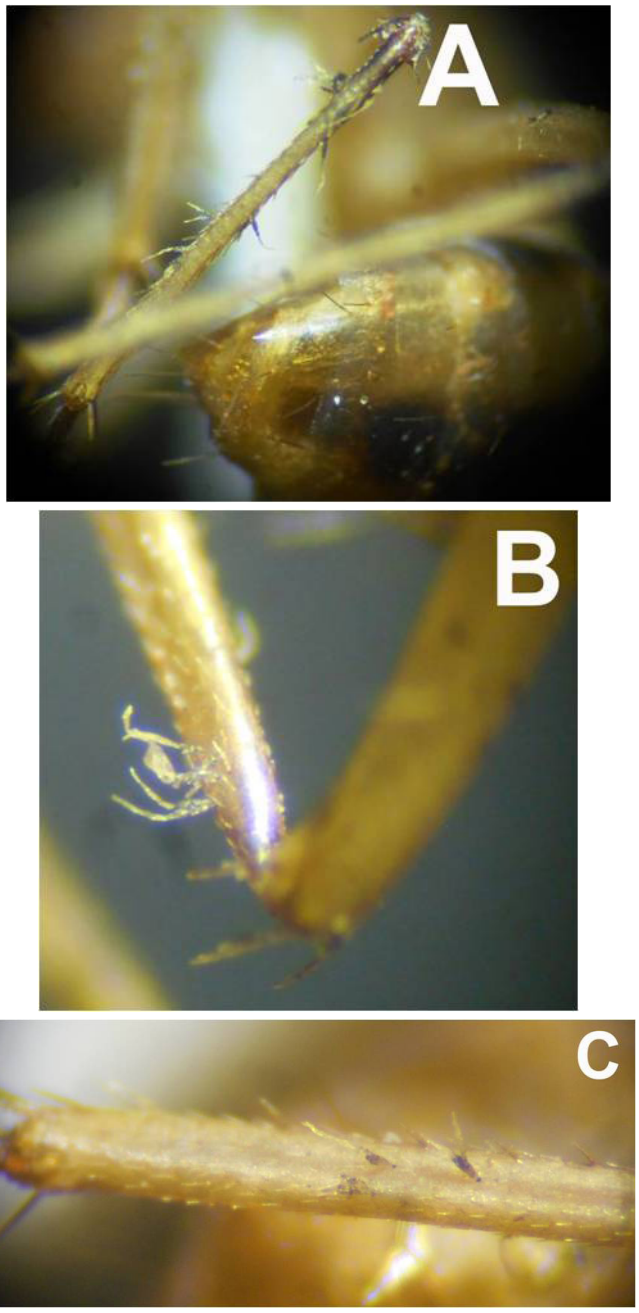


**Fig 2**. Different views of *Laboulbenia.camponoti* Batra on the legs of *Camponotus oasium* Forel. SENEGAL: Kaolack, road between Birkelane and Kaffrine. Mature thalli show a darkened body; immature thalli are still hyaline and have an uninflated perithecium. A) Mature, blackish thalli on the third leg tibia. B) Immature specimens at the proximal end of second tibia. C) One fully mature and one nearly mature thallus on the third tibia.

- Another two recently hatched workers had signs of early infestation, as immature thalli were developed only in the meso- and/or metatibiae, but the insertion points were not so developed and the general aspect is that of long, twisted white setae.
- One recently hatched worker showed no signs of infestation at all.

SENEGAL: Kaolack, road between Birkelane and Kaffrine. 14º6.11'N 15º41.12'W 55 m. 25/09/2016. (Gómez, K. leg.). Savannah, sandy terrain. Abandoned termite nest

[KG03265B-1], [KG03265B-2]. The spot is 120 km distant from the sea and 2.7 km from a small river. Mean annual temperature and precipitation at Kaffrine (14 km from the spot) is 28.5 ºC and 704.5 mm. Other species collected at the spot where *Brachyponera sennaarensis* (Mayr), *Tapinoma demissum* Bolton, *Tapinolepis simulans* (Santschi), *Messor galla* (Mayr), *Monomorium bicolor* Emery and *Trichomyrmex* sp.

## Discussion

The discovery of *L. formicarum* on *C. (Tanaemyrmex) oasium* is the first mention of any ant-Laboulbenial in Africa. At its description, this fungus was described from India, from the Indomalayan region. Later it was recorded from Europe, from the Palaearctic region. Now it is recorded from the Afrotropical region, separated by the Sahara from the Palaearctic. This is a nice example that poor research about the distribution of a species can be misleading about its area.

Senegal is the eighth country known for the fungus. Other countries (discovery publication year) are: India (1963; original description), Spain (1982), Turkey (1983), Bulgaria (2011), Austria and Romania (2014) and Italy (2016). For an updated world database –21 world records, including four new ant-fungus records from Spain– for *L. camponoti*, see Table 1.

All African *Camponotus*, especially those belonging in the subgenus *Tanaemyrmex*, are candidates to harbour *L. camponoti*. A rough appraisal of the number of *Tanaemyrmex* species according to Emery (1925) and Wheeler (1922; as subgenus *Myrmoturba* Forel, 1912) is >130 in Africa south of Sahara. Thus, there are many possible hosts to search for *L. camponoti*.

Other ant genera in the subfamilies Formicinae, Dorylinae, Myrmicinae might be also infected with Laboulbeniales. For a summary of worldwide knowledge of ant-Laboulbenial interactions, see Santamaria and Espadaler (2015: Table 2 and Fig 2).

The enormous range of the known localities for *L. camponoti* (some ten thousand km from Delhi (India) to Dakar (Senegal) (Fig 3) fits well the notion that, among Fungi, those that are parasites on animals tend to have more wide-ranging geographical distribution than all other soil fungi functional groups (Tedersoo et al., 2014). One interesting future aim would be to compare the genetics of the different populations from the various regions.

The majority of data concerning the small group of ant-infesting Laboulbeniales come from Europe and North-America. Meso- and South America have four registers and Asia has a few examples restrained to the Delhi region (India). Nothing is recorded from the Australian region or from the enormous extensions between Japan and the Ural Mountains, Arabian Peninsula and Indonesia. The absence of data for ant-Laboulbeniales in the Australian region and Asia (Santamaria & Espadaler (2015: Fig 2) calls for a geographically focused consideration.

**Table 1**. World records of *Laboulbenia camponoti* Batra. Updated to February, 2017. All specific host identifications belong in the subgenus *Tanaemyrmex* Ashmead.

| | Host | Country (localities) | Reference |
|---|---|---|---|
| 1 | *Camponotus* sp. | India (1) | 1 |
| 2 | *C. pilicornis* (Roger) | Spain (1) | 2 |
| 3 | *C. baldaccii* Emery | Turkey (1) | 3 |
| 4 | *C. pilicornis* (Roger) | Spain (1) | 4 |
| 5 | *C. sylvaticus* (Olivier) | Spain (1) | 4 |
| 6 | *Camponotus* sp. | India (1) | 5 |
| 7-11 | *C. aethiops* (Latreille) | Bulgaria (5) | 6 |
| 12 | *C. universitatis* Forel | Bulgaria (1) | 6 |
| 13 | *C.* sp. (as *pilicornis*) | Bulgaria (1) | 6 |
| 14 | *C. aethiops* (Latreille) | Austria (1) | 7 |
| 15 | *C. aethiops* (Latreille) | Rumania (1) | 7 |
| 16 | *C. aethiops* (Latreille) | Italy (1) | 8 |
| 17 | *C. pilicornis* (Roger) | Puebla de Azaba, Spain[a] | This paper |
| 18 | *C. pilicornis* (Roger) | La Selva del Camp, Spain[b] | This paper |
| 19 | *C. aethiops* (Latreille) | La Selva del Camp, Spain[b] | This paper |
| 20 | *C. sylvaticus* (Olivier) | La Selva del Camp, Spain[b] | This paper |
| 21 | *C. oasium* Forel | Senegal | This paper |

Reference: 1: Batra (1963). 2: Balazuc *et al*. 1983. 3: Espadaler & Lodos (1983). 4: Espadaler & Blasco (1991). 5: Kaur & Mukerji (1995). 6: Lapeva-Gjonova & Santamaria (2011). 7: Báthori *et al.* (2014). 8: Gómez *et al.* (2016).
a. One worker. 2006. L. González leg.
b. 13 workers *C. aethiops*, 2 workers *C. pilicornis* and 11 workers *C. sylvaticus* collected in pitfall traps set 1-3 July 2011 and 6-8 September 2012 in organic citrus grove.

We request the attention of entomologists dealing with African fauna, towards those small and interesting epizoic fungi. Our finding suggests that *L. camponoti* may be more widespread geographically than previously thought. One positive circumstance for the study of Laboulbeniales is the possibility of its detection either in alcohol-preserved or in dry-preserved specimens, also from rather old collections, rendering a new value to Museum collections (Suarez & Tsutsui, 2004). We cannot but expect a growth of information about the ant-Laboulbeniales interaction in Africa, if proper attention is dedicated to those epizoic fungi on ants.

**Fig 3**. Known distribution for *Laboulbenia camponoti* Batra, up to February 2017 (blue dots, known distribution; orange dot, new record).

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