# Does *Laboulbenia formicarum* (Ascomycota: Laboulbeniales) fungus infect the invasive garden ant, *Lasius neglectus* (Hymenoptera: Formicidae), in Hungary?

Fertőzi-e a *Laboulbenia formicarum* (Ascomycota: Laboulbeniales) gomba az invázív *Lasius neglectus* (Hymenoptera: Formicidae) hangyafajt Magyarországon?

András Tartally & Ferenc Báthori

**Abstract:** *Laboulbenia formicarum* Thaxt. (Ascomycota: Laboulbeniales) fungus is native to N-America and has just been recorded from Europe from the invasive ant *Lasius neglectus* van Loon, Boomsma et Andrásfalvy, 1990 (Hymenoptera: Formicidae). The ant is well-known from Hungary but the fungus is not known from there. We checked the infection of *L. formicarum* at the Hungarian *L. neglectus* localities and had negative results.

**Keywords:** ant, adventive, ectoparasite, fungus, invasive, *Laboulbenia formicarum*, *Lasius neglectus*, Hungary.

**Authors' addresses:**
András Tartally | e-mail: tartally.andras@science.unideb.hu |
Department of Evolutionary Zoology and Human Biology|University of Debrecen, Egyetem tér 1. |H-4032 Debrecen, Hungary (corresponding author)
Ferenc Báthori |e-mail: bathori.ferenc@science.unideb.hu |
Department of Evolutionary Zoology and Human Biology|University of Debrecen, Egyetem tér 1. | H-4032 Debrecen, Hungary

**Összefoglalás:** Az Észak-Amerikában őshonos *Laboulbenia formicarum* Thaxt. (Ascomycota: Laboulbeniales) gomba nemrégiben került elő Európából az invázív *Lasius neglectus* van Loon, Boomsma et Andrásfalvy, 1990 (Hymenoptera: Formicidae) hangyáról. Bár ez a hangyafaj jól ismert Magyarországról, a gomba még nem került elő onnan. Megvizsgáltuk ezért az ismert magyarországi *L. neglectus* lelőhelyeket, hogy megtaláljuk-e hangyákon a *L. formicarum* gombát, azonban negatív eredményeket kaptunk.

## Introduction

Laboulbeniales (Ascomycota) fungi are ectoparasites of arthropods (Kirk et al. 2008; Rossi & Santamaria 2012). Their effects on the host is poorly known (Weir et al. 2005; Báthori et al. 2015; Konrad et al. 2015). The lifespan of infected hosts can shorten a little but not on an extreme level

(Csata et al. 2014; Báthori et al. 2015; Konrad et al. 2015; and references therein). The thalli of these fungi typically grow on their hosts without inflicting any noticeable injury (Espadaler & Santamaria 2012). Most Laboulbeniales fungi exhibit extreme host-specificity; the host spectrum ranges from single (stenotopic) to multiple host species (eurytopic) (Haelewaters et al. 2012 and references therein). Ants are the only known hosts of Laboulbeniales in the order Hymenoptera (Espadaler and Santamaria 2003). Four species of Laboulbeniales fungi have been reported so far to parasitize ants in Europe (Espadaler and Santamaria 2012; Haelewaters 2012; Báthori et al. 2014) and only six of them from all over the world (Santamaria and Espadaler 2014). *Rickia wasmannii* Cavara is the only such fungus species recorded from Hungary up to now (Tartally et al. 2007) and *Laboulbenia camponoti* S.W.T. Batra from other parts of the Carpathian-Basin, close to the Hungarian borders (Báthori et al. 2014). The two other European ant parasitic Laboulbeniales fungi have not been recorded from Hungary yet: *Rickia lenoirii* Santam. have just been described (Santamaria and Espadaler 2014) and *Laboulbenia formicarum* Thaxt. (Figure 1) is an invader to Europe. The latter is native to N-America where it infects 21 ant species and it was recently recorded from Europe only on *Lasius grandis* Forel, 1909 from Madeira and on *L. neglectus* van Loon, Boomsma et Andrásfalvy, 1990 (Figure 1) from Spain and France (for a review: Espadaler & Santamaria 2012).

*Lasius neglectus* is invasive to Europe (Cremer et al. 2008), polygynous (Espadaler et al. 2004) and therefore can form huge supercolonies connecting numerous nests within a large area (van Loon et al. 1990; Tartally 2006; Espadaler et al. 2007). It is able to displace the native ant species and can cause drastic effects on the arthropod assemblages within the area of the supercolonies (Tartally 2000a; Nagy et al. 2009). This ant is originated somewhere from Asia Minor (Anatolia) or Turkey (Seifert 2000) but its exact origin and way to Hungary is unknown (Ugelvig et al. 2008). Its (social)parasites could help to fulfil this gap, as e.g. the case about the Mediterranean *Platyarthrus schoblii* Budde-Lund, 1885 myrmecophylous isopod, which is recorded from Hungary only from and from around (super) colonies of *L. neglectus* (Tartally et al. 2004; Hornung et al. 2005). This ant has several (super)colonies in Hungary (see up-to-date list: Espadaler & Bernal 2015) and was described from there (van Loon et al. 1990). According to the above described reasons which show that it would be interesting to know whether *L. formicarum* occurs in Hungary, we decided to check the infection of *L. neglectus* by *L. formicarum* at all of the recently known (Tartally 2000b; Tartally et al. 2004; and an unpublished colony from

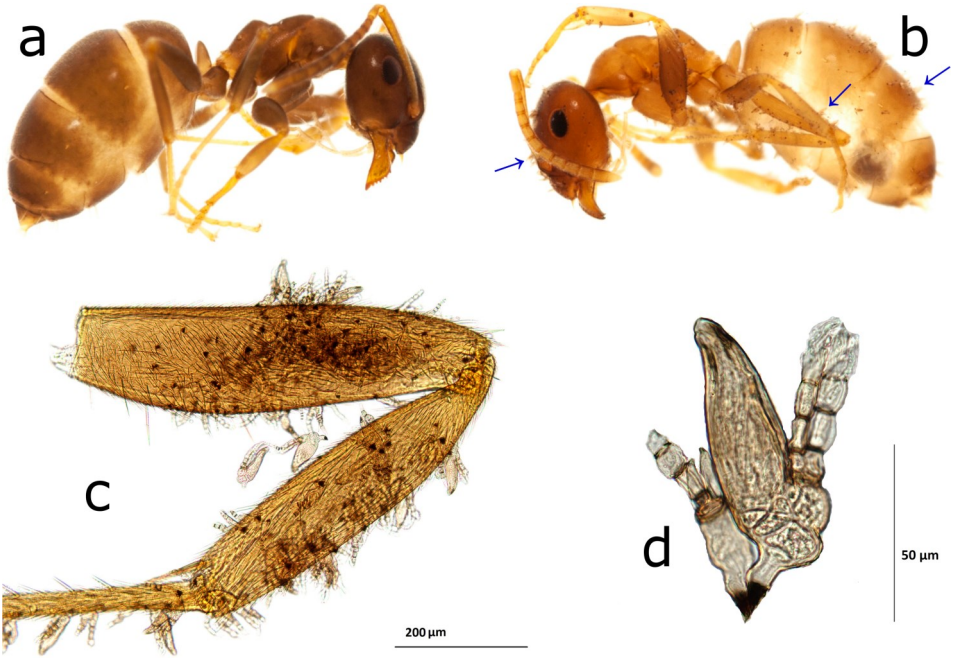


**Figure 1.** *Lasius neglectus* workers uninfected (a) and infected (b, see e.g. arrows) with *Laboulbenia formicarum*, and a *L. neglectus* leg (c) covered with thalli of *L. formicarum* (d) (photos by W. P. Pfliegler; collected by A. Tartally: a, X. Espadaler: b-d)

Solymár, found by A. Meszlényi, pers. comm; and another one from Budapest at Belgrád Quey found by J. S. Pedersen and R. S. Larsen, pers. comm.) Hungarian *L. neglectus* localities.

**Materials and Methods**

We tried to collect samples from all the known Hungarian *L. neglectus* localities in September 2014. This period was chosen because Herriaz & Espadaler (2007) found several infected *L. neglectus* individuals in September, so the infection is detectable this month. The aimed sample size was minimum 100 *L. neglectus* workers per locality. We thought this sample size to be enough because earlier studies found 28.8-88 % of *L. neglectus* workers to be infected in the case of infected supercolonies (Herriaz & Espadaler 2007; Espadaler et al. 2011). When a colony was small, had smaller nesting area than 1 $m^2$, collecting was possible only from one point but in the case of large supercolonies collecting was done from three different points, as far from each other as possible. The collecting points (Table 1) were recorded by a Garmin Oregon 650t GPS. The ants were taken to 67.5% ethanol and the presence of infection was checked under a Leica MZ12.5 stereomicroscope at magnifications of 10x-160x (thalli of *L. formicarum* can be easily realised by stereomicroscope: Espadaler et al. 2011).

## Results

4706 *L. neglectus* workers were checked from 21 Hungarian (super)colonies (Table 1) in total but the presence of *L. formicarum* have not been detected. It should be noted that we had no luck to collect the aimed minimum 100 workers from colonies at Árpád-Bridge (Budapest), Tigris Str. (Budapest), Belgrád Quey (Budapest) and at Solymár. Moreover the earlier supercolony at Galvani Str. (Budapest) seems to have been disappeared despite thorough searching. On the other hand, the colony at Orom Str., thought to be formerly disappeared (Tartally et al. 2004), is rediscovered now (or a new one is discovered) some tens of meters farther from the original locality. The exact locality at Tahi is not known (Tartally et al. 2004), therefore no collecting was possible from there.

## Discussion

It is difficult to prove if some species is missing from an area. According to the results, we can simply conclude that none of the examined 4706 *L. neglectus* workers were infected. It should be noted that there is a big chance that *L. neglectus* is more widespread in Hungary than it is presently known as most of the 21 known (Table 1) Hungarian localities were recorded by luck. On the other hand, it is certain that the presence of *L. formicarum* was checked at all of the detectable Hungarian *L. neglectus* (super)colonies. By these negative results *L. formicarum* has remained recorded from Europe only from Madeira, Spain and France (Espadaler & Santamaria 2012) and we did not receive any new knowledge about the way of introduction of *L. neglecus* to Hungary. However, we still feel to be worth checking the infection of *L. neglectus* by *L. formicarum* in the case of all the known (Espadaler & Bernal 2015) and at all the yet to be discovered supercolonies.

**Table 1.** Number of examined *L. neglectus* workers (4706 in total) from the 37 different sample collecting points of the 21 (super)colonies. "Colony name 1-3" refers to large supercolonies where sampling was repeated from three different points (see Materials and Methods). As the exact locality at Tahi is not known (Tartally et al. 2004), collecting was not possible from there. See collecting points also on this map: https://www.google.com/maps/d/viewer?mid=z-bSN3pfQhko.kGw46LqDaJdc

Table 1.

| Site | North | East | Number |
|---|---|---|---|
| Budapest, Árpád-bridge | 47.532545° | 19.064979° | 42 |
| Budapest, Belgrád Quey | 47.497417° | 19.047333° | 40 |
| Budapest, Budatétény 1 | 47.404844° | 19.008338° | 108 |
| Budapest, Budatétény 2 | 47.400284° | 19.006238° | 98 |
| Budapest, Budatétény 3 | 47.400197° | 19.018056° | 121 |
| Budapest, Campus of Horticultural Science 1 | 47.481596° | 19.040179° | 113 |
| Budapest, Campus of Horticultural Science 2 | 47.481391° | 19.040387° | 102 |
| Budapest, Campus of Horticultural Science 3 | 47.481420° | 19.040137° | 122 |
| Budapest, Castle 1 | 47.495379° | 19.041177° | 115 |
| Budapest, Castle 2 | 47.494411° | 19.041631° | 104 |
| Budapest, Castle 3 | 47.494580° | 19.040882° | 114 |
| Budapest, Cement u. 1 | 47.524018° | 19.221360° | 259 |
| Budapest, Cement u. 2 | 47.524196° | 19.222237° | 131 |
| Budapest, Cement u. 3 | 47.524325° | 19.222442° | 178 |
| Budapest, Dayka G. str. | 47.481003° | 19.011083° | 279 |
| Budapest, Galvani str. | 47.455614° | 19.041444° | 0 |
| Budapest, Lajos str. 1 | 47.526823° | 19.037447° | 97 |
| Budapest, Lajos str. 2 | 47.526560° | 19.037287° | 111 |
| Budapest, Lajos str. 3 | 47.526324° | 19.037361° | 98 |
| Budapest, Orom str. | 47.489973° | 19.041471° | 110 |
| Budapest, Pázmány P. Promenade | 47.469515° | 19.063855° | 146 |
| Budapest, Pétervárad str. | 47.518944° | 19.108388° | 114 |
| Budapest, Szállás str. | 47.475443° | 19.130162° | 114 |
| Budapest, Tigris str. | 47.492333° | 19.031522° | 3 |
| Debrecen, Botanical garden 1 | 47.557216° | 21.621882° | 147 |
| Debrecen, Botanical garden 2 | 47.557888° | 21.621473° | 179 |
| Debrecen, Botanical garden 3 | 47.557983° | 21.620572° | 148 |
| Debrecen, Csap str. | 47.530431° | 21.613693° | 125 |
| Ercsi 1 | 47.250398° | 18.888689° | 330 |
| Ercsi 2 | 47.251144° | 18.888550° | 341 |
| Ercsi 3 | 47.249706° | 18.889525° | 162 |
| Érd 1 | 47.370167° | 18.922934° | 102 |
| Pilisszentiván 1 | 47.606354° | 18.905770° | 119 |
| Pilisszentiván 2 | 47.606275° | 18.906167° | 112 |
| Pilisszentiván 3 | 47.606366° | 18.905658° | 107 |
| Solymár | 47.576982° | 18.959131° | 115 |
| Tahi | ? | ? | 0 |

**Acknowledgements:** We would like to thank András Andrásfalvy, András Meszlényi, Csaba Nagy, Jes Søe Pedersen, Rasmus Stenbak Larsen, József Schmidt and Tamás Szalay for their help in sample collecting; Xavier Espadaler and Walter P. Pfliegler for their help with photography (Figure 1); and Enikő Tóth for revising the manuscript. Both authors were supported by the 'AntLab' Marie Curie Career Integration Grant (of AT) within the 7th European Community Framework Programme. AT was supported by a 'Bolyai János' scholarship of the Hungarian Academy of Sciences (MTA).

**References**

Báthori F., Csata E. & Tartally A. 2015: *Rickia wasmannii* increases the need for water in *Myrmica scabrinodis* (Ascomycota: Laboulbeniales; Hymenoptera: Formicidae). – Journal of Invertebrate Pathology (accepted).

Báthori F., Pfliegler W. P. & Tartally A. 2014: First records of the myrmecophilous fungus *Laboulbenia camponoti* Batra (Ascomycetes: Laboulbeniales) from Austria and Romania. – Sociobiology 61: 338–340.

Cremer S., Ugelvig L. V., Drijfhout F. P., Schlick-Steiner B. C., Steiner F. M., Seifert B., Hughes D. P., Schulz A., Petersen K. S., Konrad H., Stauffer C., Kiran K., Espadaler X., d'Ettorre P., Aktaç N., Eilenberg J., Jones G., Nash D. R., Pedersen J. S. & Boomsma J. J. 2008: The Evolution of Invasiveness in Garden Ants. – PLoS ONE 3 (12): e3838.

Csata E., Erős K. & Markó B. 2014: Effects of the ectoparasitic fungus *Rickia wasmannii* on its ant host *Myrmica scabrinodis*: changes in host mortality and behavior. – Insectes Sociaux 61(3), 247–252.

Espadaler X. & Bernal V. 2015: *Lasius neglectus* a polygynous, sometimes invasive, ant. – http://www.creaf.uab.es/xeg/Lasius/index.htm [visited 16.01.2015].

Espadaler X., Lebas C., Wagenknecht J. & Tragust S. 2011: *Laboulbenia formicarum* (Ascomycota, Laboulbeniales), an exotic parasitic fungus, on an exotic ant in France. – Vie et Milieu 61: 41–44.

Espadaler X., Rey S. & Bernal V. 2004: Queen number in a supercolony of the invasive garden ant, *Lasius neglectus*. – Insectes Sociaux 51: 232–238.

Espadaler X. & Santamaria S. 2003: *Laboulbenia formicarum* crosses the Atlantic. – Orsis 18: 97–101.

Espadaler X. & Santamaria S. 2012: Ecto- and Endoparasitic Fungi on Ants from the Holarctic Region. – Psyche (2012), Article ID 168478, 10 pages.

Espadaler X., Tartally A., Schultz R., Seifert B. & Nagy Cs. 2007: Regional trends and preliminary results on the local expansion rate in the invasive garden ant, *Lasius neglectus* (Hymenoptera, Formicidae). – Insectes Sociaux 54: 293-301.

Haelewaters D. 2012: The first record of Laboulbeniales (Fungi, Ascomycota) on ants (Hymenoptera, Formicidae) in The Netherlands. – Ascomycete.org. 4 (3): 65–69.

Haelewaters D., van Wielink P., van Zuijlen J.-W., Verbeken A. & De Kesel A. 2012: New records of Laboulbeniales (Fungi, Ascomycota) for The Netherlands. – Entomologische Berichten 72 (3): 175–183.

Herraiz J. A. & Espadaler X. 2007: *Laboulbenia formicarum* (Ascomycota, Laboulbeniales) reaches the Mediterranean. – Sociobiology 50 (2): 449–455.

Hornung E., Vilisics F. & Tartally A. 2005: Occurrence of *Platyarthrus schoblii* (Isopoda, Oniscidea) and its ant hosts in Hungary. – European Journal of Soil Biology 41: 129–133.

Kirk P. M., Cannon P. F., Minter D. W. & Stalpers J. A. (eds) 2008: Ainsworth and Bisby's Dictionary of the Fungi (10th Edition). – CABI Europe-UK, Cromwell Press, Trowbridge, 771 p.

Konrad M., Grasse A.V., Tragust S. & Cremer S. 2015: Anti-pathogen protection versus survival costs mediated by an ectosymbiont in an ant host. – Proceedings of the Royal Society B 282: 20141976.

Nagy Cs., Tartally A., Vilisics F., Merkl O., Szita É., Szél Gy., Podlussány A., Rédei D., Csősz S., Pozsgai G., Szövény G. & Markó V. 2009: Effects of the invasive garden ant, *Lasius neglectus* van Loon, Boomsma et Andrásfalvy, 1990 (Hymenoptera, Formicidae) on arthropod assemblages: pattern analyses in the type supercolony. – Myrmecological News 12: 171–181.

Rossi W., Santamaria S. 2012: *Rodaucea*, a new genus of the Laboulbeniales. – Mycologia 104 (3): 785–788.

Santamaria S., Espadaler X. 2014: *Rickia lenoirii*, a new ectoparasitic species, with comments on world Laboulbeniales associated with ants. – Mycoscience 56 (2): 224–229.

Seifert B. 2000: Rapid range extension in *Lasius neglectus* (Hymenoptera, Formicidae) – an Asian invader swamps Europe. – Mitteilungen Museum Naturkunde Berlin, Deutsche Entomologische Zeitschrift 47: 173–179.

Tartally A. 2000a: Notes on the coexistence of the supercolonial *Lasius neglectus* van Loon, Boomsma et Andrásfalvy 1990 (Hymenoptera: Formicidae) with other ant species. – Tiscia 32: 43–46.

Tartally A. 2000b: A Magyarországról leírt invázív *Lasius neglectus* van Loon, Boomsma et Andrásfalvy, 1990 (Hymenoptera: Formicidae) újabb hazai lelőhelyei. – Folia Entomologica Hungarica 61: 298–300.

Tartally A. 2006: Long term expansion of a supercolony of the invasive garden ant *Lasius neglectus* (Hymenoptera: Formicidae). – Myrmecologische Nachrichten 9: 21–25.

Tartally A., Hornung E. & Espadaler X. 2004: The joint introduction of *Platyarthrus schoblii* (Isopoda: Oniscidea) and *Lasius neglectus* (Hymenoptera: Formicidae) into Hungary. – Myrmecologische Nachrichten 6: 61–66.

Tartally A., Szűcs B. & Ebsen J. R. 2007: The first records of *Rickia wasmannii* Cavara, 1899, a myrmecophilous fungus, and its *Myrmica* Latreille, 1804 host ants in Hungary and Romania (Ascomycetes: Laboulbeniales; Hymenoptera: Formicidae). – Myrmecological News 10: 123

Ugelvig L. V., Drijfhout F. P., Kronauer D. J. C., Boomsma J. J., Pedersen J. S. & Cremer S. 2008: The introduction history of invasive garden ants in Europe: integrating genetic, chemical and behavioural approaches. – BMC Biology 6: 11.

van Loon A. J., Boomsma J. J. & Andrásfalvy A. 1990: A new polygynous *Lasius* species (Hymenoptera, Formicidae) from Central Europe. I. Description and general biology. – Insectes Sociaux 37: 348–362.

Weir A. & Blackwell M. 2005: Fungal biotrophic parasites of insects and other Arthropods. In: Vega F.E. & Blackwell M. (eds.): Insect-Fungal Associations: ecology and evolution. – Oxford University Press, Oxford, pp. 119–145.