

Notes on three lichenicolous species of *Acremonium* including two new species

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Two new species of lichenicolous fungi: *Acremonium pertusariae* on *Pertusaria* spp. and *A. bavaricum* on *Melanelixia glabrata* are described. A new combination is proposed for *Dendrodochium subeffusum*.

Key words – Anamorph fungi – Bionectriaceae – Hyphomycetes

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Introduction

The genus *Acremonium* currently comprises more than 100 species (Diederich & Braun 2009); most of them are saprophytes, but some are parasites of other organisms (Gams 1971, Hawksworth 1972). Hawksworth (1979) recorded four *Acremonium* species known only from lichens and one more fortuitously lichenicolous. Now nine species are known as living on lichens, of which seven are described in the genus *Acremonium* and two as anamorphs of *Pronectria*. Within the genus *Acremonium* Gams (1971) and Morgan-Jones & Gams (1982) described or combined the sections *Albo-lanosa*, *Chaetomioides*, *Gliomastix*, *Nectroidea*, and *Simplex* (*Acremonium*). Lowen (1995) added the section *Lichenoidea*, in which most of the lichenicolous species are included.

During our studies in Spain, southern

Italy, and southern Germany, we found two undescribed taxa of *Acremonium* as probable parasites on lichens. The two new species are described and illustrated in this paper and a species of *Dendrodochium* is recombined into *Acremonium*.

Materials and methods

Morphological and anatomical observations were made using standard microscopic techniques. Microscopic measurements were made on hand-cut sections mounted in water with an accuracy up to 0.5 µm. Measurements of conidia are recorded as (minimum–) $\bar{X}-\sigma_x$ – $\bar{X}+\sigma_x$ (– maximum) followed by the number of measurements. The specimens are deposited in the private herbaria of the authors, the holotypes of *Acremonium pertusariae* and *A. bavaricum* in M, cultures of the anamorphs at CIRM.

Results

Acremonium pertusariae Brackel & Etayo, sp. nov. Figs 1–2
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Etymology – pertaining to the host genus *Pertusaria*.

Diagnosis – Coloniae superficiales, pulvinariae, pallide roseae, 200–300 µm diam. Hyphae hyalinae, septatae, leves, 3–4 µm latae. Conidiophora ramosa, septata, hyalina. Cellulae conidiogenae hyalinae, leves, subulatae, phialidicae, (15–)25–45 × 1.5–4 µm. Conidia solitaria, levia, guttulate, late ellipsoidea, apici rotundo, basi truncata vel rotunda, hyalina, (4.5–)5–7(–8.5) × (3–)3.4–4.3(–4.5) µm. Clamydospores absunt; teleomorphosis ignota.

Holotype – Italy, Basilicata, Prov. di Potenza, Bosco Teduri near Bagni, old beech forest, on *Pertusaria pertusa* on *Fagus sylvatica*, 1260 m, 40°06'26"N, 15°58'25"E, W. & G. v. Brackel, 16.8.2010 (M – holotypus, hb ivl 5498 – isotypus, culture deposited at CIRM).

Description – Colonies discrete to confluent, superficial, tufted, pale pinkish, building sporodochial-like cushions 200–300 µm; mycelium partly immersed, hyphae flexuose, thin-walled, smooth, hyaline, 3–4 µm wide. Conidiophores semi-macronematous, richly branched, septate, hyaline, smooth. Conidiogenous cells discrete, terminal, hyaline, thin-walled, smooth, subulate, phialidic, (15–)25–45 µm long, 2–4 µm wide at the base and 1.5–2 µm at the apex. Both conidiophores and conidiogenous cells contain many small (or later some big) oil guttules. Conidia solitary, broadly ellipsoid, rounded at the apex, slightly truncate at the base or rounded, simple, hyaline, smooth, guttulate, (4.5–)5–7(–8.5) × (3–)3.4–4.3(–4.5) µm, l/b = (1.1–)1.3–2.4(–2.8), (n = 72). Clamydospores absent, teleomorph unknown.

Features in culture at 25°C at day light on Difco PDA containing 5mg/L streptomycin– Colonies fast growing, grey-brown whitish from above, brownish from below, very fluffy, abundantly producing conidia. Vegetative hyphae thin-walled, smooth, hyaline, 2–4 µm wide.

Conidiophores semi-macronematous, branched, septate, hyaline, smooth. Conidiogenous cells discrete, terminal, hyaline, thin-walled, smooth, subulate, phialidic, c. 15–30 µm long, 1.5–2 µm wide at the base and 1–1.5 µm at the apex. Both conidiophores and conidiogenous cells contain several conspicuous guttules. Conidia solitary, ellipsoid, rounded at the apex, slightly truncate at the base or rounded, simple, hyaline, smooth, guttulate, (4–)4.5–7.4(–9.5) × (2–)2.1–2.8(–3) µm, l/b = (1.6–)2–2.9(–3.3) (n=20).

Distribution and hosts – Spain (Aragón, Navarra, País Vasco), Canary Islands (La Palma) and Italy (Basilicata), on *Pertusaria albescens*, *P. albescens* var. *corallina*, and *P. pertusa*, thallus and apothecial warts. The fungus is apparently parasitic, as the infected parts of the host thallus become blackened and destroyed. Uninfected parts of the thallus were healthy and no other infecting fungus could be found in the type and some of the Spanish samples, but sometimes it lives together with other fungi, especially *Pronectria pertusariicola*. The latter species has already been recorded, as *A. aff. spegazzinii* D. Hawksw. in Etayo & López de Silanes (2008) and Etayo (2010), on *Pertusaria albescens*.

Discussion – The new species belongs to the sect. *Nectroidea*, as the hyphae are thin-walled and not chondroid, and the conidiophores are richly branched. It clearly does not belong to the sect. *Lichenoidea* because of the lack of wall thickenings in the phialides and the broadly ellipsoid conidia (l/b ratio < 2). According to Lowen (1995) there were only two species of *Acremonium* found on lichens that do not belong to the *Lichenoidea*: *A. psychrophilum* (sect. *Gliomastrix*), and *A. strictum* (sect. *Acremonium*); both are distinguished from the new species by the features of their section (chondroid hyphae respectively unbranched conidiophores). Also *A. hypholomatis*, which was recently found growing on *Physcia stellaris* (Diederich & Braun 2009), is a member of the sect. *Lichenoidea*. Within the sect. *Nectroidea* only *A. zae* has some similarity

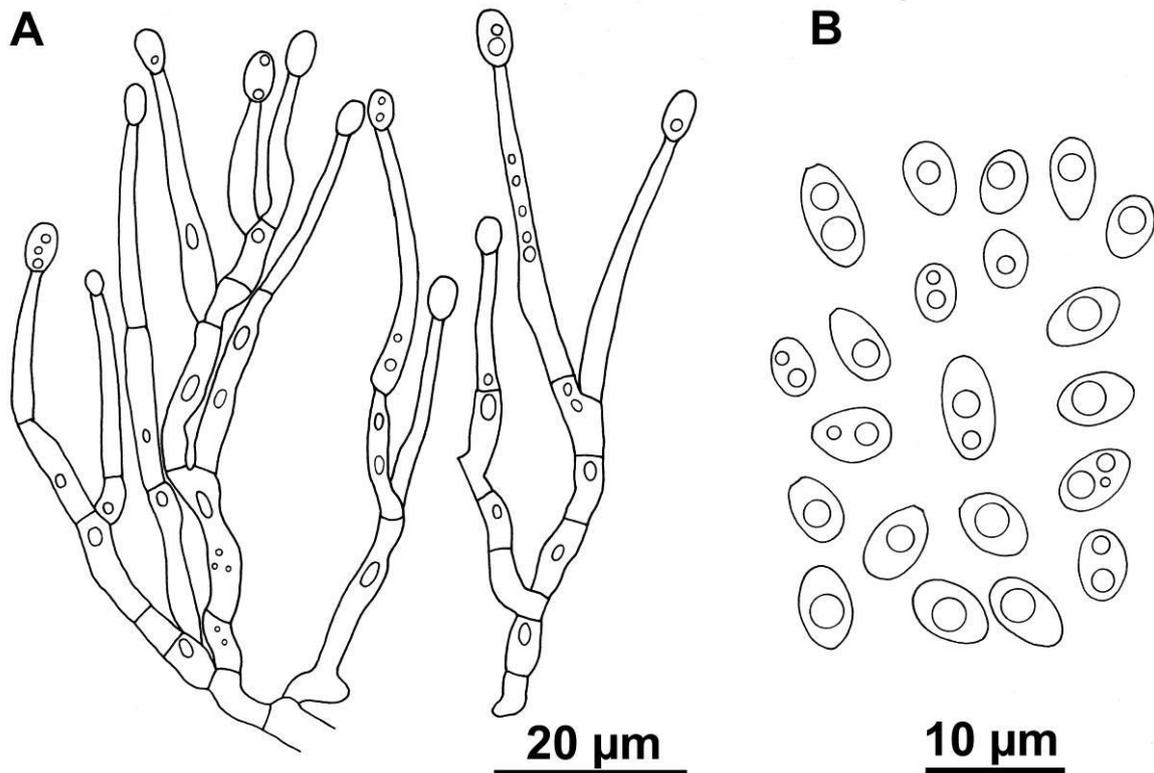


Fig. 1 – *Acremonium pertusariae* (holotypus) **A** conidiophores with conidiogenous cells and conidia. **B** conidia.

with the new species (according to the key in Gams 1971), but this species has distinctly narrower conidia ($3.5\text{--}5.8 \times 1.2\text{--}1.9 \mu\text{m}$).

Acremonium is one of the genera considered as anamorphs on *Pronectria* (Bionectriaceae) species (Rossman et al. 1999). Five taxa of Bionectriaceae are known as parasites on the genus *Pertusaria*: *Nectriopsis frangospora* (on *P. albescens*, *P. rubefacta*), *N. hirta* (on *P. albescens*, *P. pertusa*), *Pronectria pertusariicola* (on *P. albescens*, *P. pertusa*, *Pertusaria* spp.), *Pronectria* sp. (sensu Etayo 2006, on *Pertusaria hymenea*) and *Trichonectria pertusariae* on *P. amara* var. *slesvicensis* and *P. ophthalmiza*. Among these species *P. pertusariicola* seems to be the more widespread and common. It is very common in humid beech forests in oceanic northern Spain and not rare in the higher mountains of southern Italy. Although not in the type material, *Acremonium pertusariae* has been collected on some occasions as well in Spain, as in Italy, growing together or over thallus infected with *P. pertusariicola*

(which might be the teleomorph of the new species); in Spain sometimes also with a *Fusarium* species which we will study in the future. The presence of two different conidial genera on *Pertusaria* thalli infected by *P. pertusariicola* and the fact that several thalli infected by *Acremonium* do not show the presence of *Pronectria*, we cannot ensure the teleomorph-anamorph connection. Moreover, the anamorph of *P. pertusariicola* in culture is clearly distinguished from *A. pertusariae* (see below) even in culture by larger conidiogenous cells and longer and thinner conidia in *A. pertusariae*.

Additional specimens – **Spain**: Álava, entre Santa Cruz y Oteo, pequeño cañón que atraviesa la carretera, on *P. albescens* on *Acer*, 650 m, $42^{\circ}42'13''\text{N}$, $2^{\circ}21'21''\text{W}$, 4.9.2010, J. Etayo 26227 (hb. Etayo). Álava, Muniain, S^a de Entzía, robledal centenario de Muniain, on *P. albescens* on *Q. robur*, 750 m, $42^{\circ}50'\text{N}$, $2^{\circ}20'\text{W}$, 6.2007, J. Etayo 24235 (hb. Etayo). Ibidem, 9.2007, J. Etayo 24323 (hb. Etayo). Ibidem, 26401 (hb. Etayo, culture deposited

at CIRM). Álava, Kontrasta, bosque de *Quercus x pyrenaica*, por sendero desde el pueblo, 42°45'33"N, 2°16'56"W, 850 m, 26.8.2010, sobre *P. albescens* en grueso *Quercus* sp., J.A. Azpilicueta & J. Etayo 26212 (hb. Etayo). Álava, S^a de Urbasa, camino de Larraona a Puerto de Opacua, cerca de la Fuente de la Sierra, en *Pertusaria pertusa* sobre *Acer pseudoplatanus* cercanos carretera, 990 m, 42°48'30"N, 2°19'34"W, 29.8.2010, J.A. Azpilicueta & J. Etayo 26400, 26401 (hb. Etayo, VIT). Huesca, Peña Ezcaurre, on *P. albescens* var. *corallina* on *Fagus*, 1600-1750 m, 28.9.2002, J. Etayo 19768 (JACA). Navarra, Urdiain, on *P. albescens* on *Q. robur*, 20.7.1991, J. Etayo 5962 (hb. Etayo). Canary Isles, La Palma, Los Tilos, subida al mirador de la Baranda, barranco or. NW., on *Pertusaria albescens*, 12.3.1993, J. Etayo 651 (hb. Etayo). **Italy:** (together with *Pronectria pertusariicola*) Basilicata, Prov. di Potenza, between Laurenzana and Monte Caldarosa, forest of beeches and firs, on *P. pertusa* on *Fagus*, 1120 m, 40°24'24"N, 15°57'26"E, 18.8.2010, W. & G. v. Brackel (hb ivl 5632). Type locality, (hb ivl 5600).

Material with thinner conidia – France: Pyrénées-Atlantiques, 1 km del Col d'Ibardin, La Redoute des Emigrés, on *P. albescens* on *Q. robur*, 150 m, 14.3.1995, J. Etayo 12849 & B. Marbach (hb. Etayo).

Pronectria pertusariicola – (hb. Etayo 26401, locality already recorded where both species live together). – Features of the anamorph in culture – Colonies slowly growing, pinkish orange under a whitish cover from above, orange from below, compact to folded in the centre, zoned at the margins. Vegetative hyphae thin-walled, smooth, hyaline, 3.5–5.5 µm wide, often with swollen, short cells, 6–8 × 7–9 µm. Conidiophores mostly branched, septate, hyaline, rough, guttulate. Conidiogenous cells discrete, terminal, hyaline, thin-walled, rough, subulate, phialidic, 15–50 µm long, c. 4 µm wide at the base and c. 2 µm wide at the apex. Conidia solitary, ellipsoid or slightly irregular, rounded at both ends, simple, hyaline, smooth, guttulate, (4.5–)4.8–6(–6.5) × (2.5–)2.8–3.2(–3.5) µm, l/b = (1.3–

)1.6–2.1(–2.4) (n=20). *Dendrodochium subeffusum* Ellis & Galw. was described on *Physcia millegrana* and *Candelaria concolor* from USA, and a concise description of it appears in Hawksworth (1979). It has all features of an *Acremonium*. We have studied an isotype (M) and there are no differences with other members of the genus; conidiophores grow together but do not form a distinguishable or compact structure we can name as a sporodochium. Another lichenicolous species of *Acremonium* like *A. spegazzinii* D. Hawksw., growing on tropical *Leptogium*, has much more compact conidiophores. For this reason we propose the new combination of *D. subeffusum* in the genus *Acremonium*:

Acremonium subeffusum (Ellis & Galw.) Etayo & Brackel, **comb. nov.** Fig. 3
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Bas. *Dendrodochium subeffusum* Ellis & Galw., J. Mycol. 6: 33 (1890).

USA., New York, Farmington, on thallus of some foliaceous lichen, on *Physcia millegrana* and *Candelaria concolor* on trunks of pear trees, August 1889, E. Brown. (M! – isotype).

A. subeffusum has conidiogenous cells distinctly roughened below and conidia of (6–)7–9(–9.5) × 4.5–6 µm (Hawksworth 1972) with conidiogenous cells 20–30(–35) µm tall, and 3–4.5 µm wide at the base and 2–3 µm at the tip.

In M another specimen named *Dendrodochium subeffusum* from the USA is listed in the catalogue (Triebel 2006–2010: M-0041264). The host is *Lobaria quercizans* (in the original label as *Sticta glomulifera*, in the catalogue as *Xanthoparmelia verruculifera*). We saw this specimen and the fungus is quite similar in several features to *A. subeffusum*: the conidiophores are irregularly subverticillately branched, the conidiogenous cells are rough and the conidia are broadly elliptic with a peg-like narrowly truncated base. On the other hand it differs from *A. subeffusum* in the much more compact colonies, the only slightly rough and much shorter (about 15 µm long)



Fig. 2 – *Acremonium pertusariae* (holotypus): infected part of the thallus of *Pertusaria pertusa* with pink cushions of conidiophores.

conidiogenous cells, and the smaller conidia, $4.5\text{--}5 \times 2.5\text{--}3 \mu\text{m}$. More material would be needed for further investigations on this taxon surely different from *A. subeffusum*.

Some of the specimens in Hb. Etayo growing on *Pertusaria* have similar conidiophores but the conidia are smaller and thinner, $3.5\text{--}5 \times 2\text{--}2.5 \mu\text{m}$. For the moment, we cannot assume that they belong to the same species.

***Acremonium bavaricum* Brackel sp. nov.**

Figs 5–6

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Diagnosis – Coloniae superficiales, effusae, pellucidae. Hyphae hyalinae, septatae, leves, $2\text{--}5 \mu\text{m}$ latae. Conidiophora plerumque simplicia, raro septata et ramosa, hyalina, levia. Cellulae conidiogenae hyalinae, leves, anguste subulatae, phialidicae, $35\text{--}50 \times 1\text{--}3.5 \mu\text{m}$. Conidia solitaria, anguste ellipsoidea, apici rotundo, basi truncata, hyalina, levia, $(4\text{--})4.5\text{--}5.6(\text{--}6) \times (1.5\text{--})1.8\text{--}2.3(\text{--}2.5) \mu\text{m}$. Clamydosporeae absunt; teleomorphosis ignota.

Holotype – Germany, Bavaria, Oberpfalz, Kreis Regensburg, Karlswies-

bachtal, on *Melanelixia glabratula* on *Fraxinus excelsior*, 435 m, $49^{\circ}04'32.3''\text{N}$, $12^{\circ}18'51.6''\text{E}$, W. v. Brackel, 28.10.2009 (M – holotypus).

Description – Colonies superficial, effuse, translucent. Mycelium partly superficial, partly immersed, composed of hyaline, cylindrical to irregular cells, $2\text{--}5 \mu\text{m}$ wide. Conidiophores semi-macronematous, mostly simple and unbranched, rarely septate and branched, hyaline, smooth, $3\text{--}15 \times 3\text{--}5 \mu\text{m}$. Conidiogenous cells discrete, terminal, hyaline, thin-walled, smooth, narrowly subulate, phialidic, $35\text{--}50 \mu\text{m}$ long, $3\text{--}3.5 \mu\text{m}$ wide at the base and $1\text{--}1.5 \mu\text{m}$ apically. Conidia solitary, narrowly ellipsoid, rounded at the apex, truncate at the base, simple, hyaline, smooth-walled, $(4\text{--})4.5\text{--}5.6(\text{--}6) \times (1.5\text{--})1.8\text{--}2.3(\text{--}2.5) \mu\text{m}$, $l/b = (1.8\text{--})2.1\text{--}2.3(\text{--}2.5)$, ($n = 20$), often collecting in heads in liquid droplets at the apices of the conidiogenous cells. Clamydospores absent, teleomorph unknown.

Features in culture – Colonies fast growing, grey whitish from above, dark grey from below, compact to folded in the centre, slightly zoned at the margins,

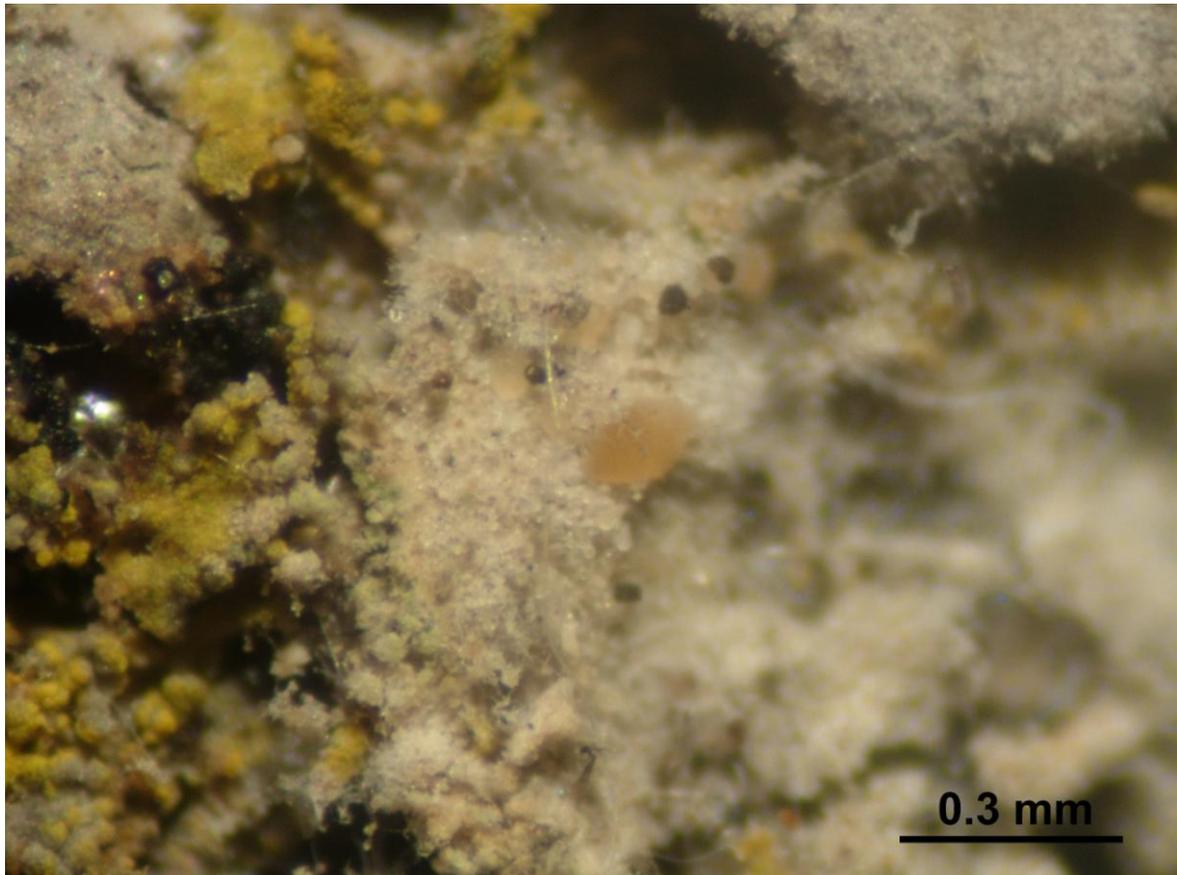


Fig. 3 – *Acremonium subeffusum* (isotypus) growing on corticolous lichens as *Candelaria* and *Physcia*.

abundantly producing conidia. Vegetative hyphae thin-walled, smooth, hyaline to very pale brownish, 1.5–2 μm wide, septate, single cells 10–20 μm long. Conidiophores semi-macronematous, septate, hyaline, smooth, or missing. Conidiogenous cells discrete, terminal, hyaline, thin-walled, smooth, phialidic, c. 40–45 μm long, 2 μm wide at the base and 1 μm wide at the apex. Conidia solitary, ellipsoid, rounded at the apex, slightly truncate at the base, simple, hyaline, smooth, (2.5–)2.6–3.3(–3.5) \times (1.5–)1.7–2 μm , l/b = 1.3–1.9(–2.3) (n = 20).

Distribution and hosts – *A. bavaricum* is known from two closely situated localities in Germany, Bavaria. In both specimens it is growing on *Melanelixia glabratula*, mainly on the isidia. As the isidia are slightly discoloured, the fungus is presumed to be a weak parasite.

Discussion – With its soft colonies, usually unbranched conidiophores and the narrowly ellipsoid, hyaline conidia *A. bavaricum* belongs to the sect. *Lichenoidea*.

In this section, only *A. antarcticum* and *A. spgazzinii* have conidia of similar size. Both are distinguished from the new species by the conidia rounded at both ends and the different hosts (*Caloplaca* respectively *Leptogium*). Furthermore, *A. antarcticum* is distinguished by the much shorter and narrower conidiogenous cells (15–20 \times 1–2 μm), and *A. spgazzinii* by the verruculose conidiophores. Following the key of Gams (1971), no similar species of *Acremonium* could be found.

On hosts of the former genus *Melanelia* only two members of the Bionectriaceae (and Nectriaceae) are known, *Paranectria oropensis* and *Pronectria septemseptata*. Anamorphs of both species were not known until now. *Paranectria oropensis* is widespread and able to grow on several genera of hosts. It is quite common in Bavaria and was found also in the neighbourhood of the type locality. The very rare *Pronectria septemseptata* could be found only 3 km



Fig. 4 – *Acremonium* on *Lobaria quercizans* (M-0041264), growing on the apothecial margins.

distance from the type locality of *A. bavaricum*, but on another host. So both species seemed to be possible teleomorphs of the new species but we have never found them together. Recently we have found a rich population of *P. septemseptata* in northern Spain, but also there no *Acremonium* found in the samples. From a culture of the anamorph of *P. septemseptata* we could see that it is clearly distinguished from *A. bavaricum* in its plurilocular conidiogenous cells and the brownish conidia (see below). As *Paranectria oropensis* also produces a different anamorph in culture (*Fusarium*-like, with fusiform and septate conidia), it is unlikely that one of these species represents the teleomorph of *A. bavaricum*.

Additional specimen – Germany, Bavaria, Oberpfalz, Kreis Regensburg, Otterbachtal W Bruckhäusl, on *Melanelixia glabrata* on *Alnus glutinosa*, 400 m, 49°04'15,6"N, 12°17'26,3"E, W. v. Brackel, 28.10.2009 (hb ivl 5671).

Specimens of possible teleomorphs found in the neighbourhood – *Paranectria oropensis*: Germany, Bavaria, Oberpfalz, Kreis Regensburg, Otterbachtal N Unterlichtenwald, on *Physcia tenella* and *Lecania cyrtella* on *Salix fragilis*, 355 m, 49°03'23"N, 12°15'59"E, W. v. Brackel, 14.11.2008 (hb ivl 5451). – *Pronectria septemseptata*: Germany, Bavaria, Oberpfalz, Kreis Regensburg, Otterbachtal SE Heuweg, on *Melanohalea elegantula* on *Carpinus betulus*, 390 m, 49°03'36"N, 12°16'48"E, W. v. Brackel, 14.11.2010 (hb ivl 5449, culture deposited at CIRM).

Features of the anamorph of *Pronectria septemseptata* in culture – Colonies fast growing, whitish, becoming grey in the centre, brownish from below, fluffy, zoned at the margins, abundantly producing conidia. Vegetative hyphae thin-walled, hyaline to slightly brownish, 1.5–3.5 µm wide, septate, single cells 10–20 µm long, smooth, sometimes slightly rough. Conidiophores arising from the mycelium,

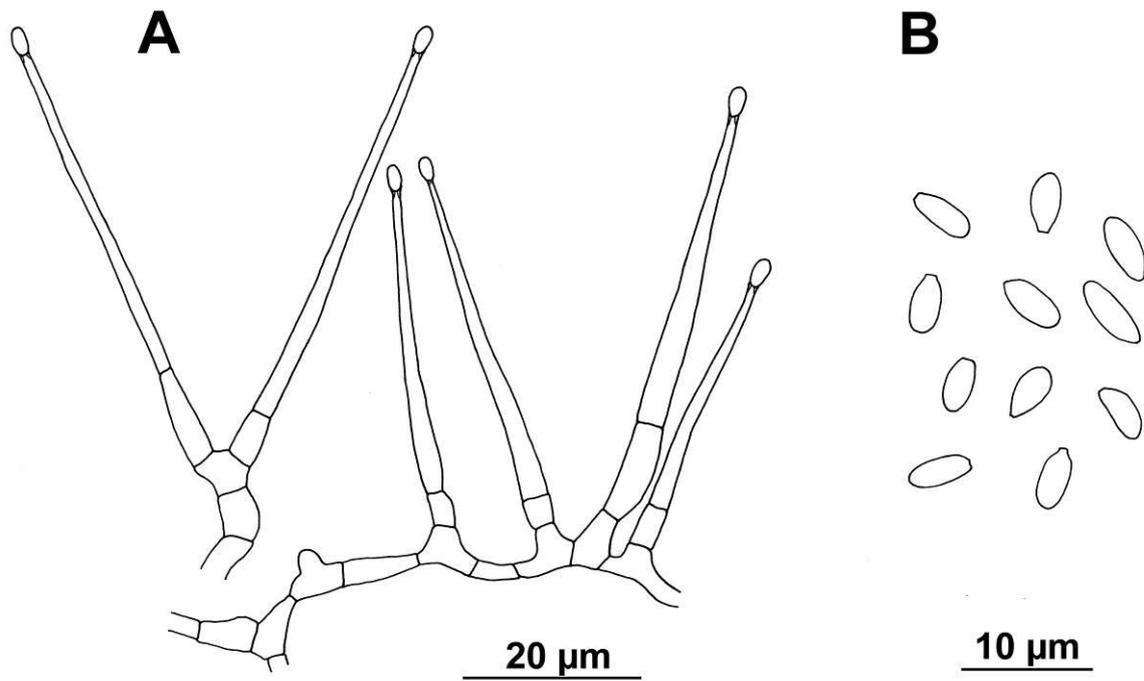


Fig. 5 – *Acremonium bavaricum* (holotypus): A: conidiophores with mycelium, conidiogenous cells, and conidia. B: outlines of conidia.



Fig. 6 – *Acremonium bavaricum* (holotypus): infected part of the thallus of *Melanelixia glabratula* with the effuse, translucent colonies.

mostly single, septate, c. 40 x 2 µm. Conidiogenous cells integrated, terminal and sometimes intercalary, with several (up to 20) conidiogenous loculi, dispersed over the whole cell. Conidia ellipsoid, smooth, slightly brownish to pale brown, both ends rounded, sometimes with a minute scar, with (0–)2 small guttules, (3–)3.2–3.9(–4) × 2–2.4(–2.5) µm, 1/b = (1.4–)1.5–1.9(–2) (n=20).

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