Species diversity of *Genea* (Ascomycota, *Pezizales*) in Europe

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Ascomycete.org, 6 (3) : 41-51.
Juillet 2014
Mise en ligne le 01/07/2014

Summary: Here we revisit the species diversity within the genus *Genea* in Europe. Nine new species are proposed: *Genea brunneocarpa*, *G. compressa*, *G. dentata*, *G. fageticola*, *G. oxygala*, *G. pinicola*, *G. pseudobalsleyi*, *G. pseudoverrucosa*, and *G. tuberculata* to accommodate new collections that do not match any previously described taxa. The new species are described with accurate morphological and ecological data. *Genea lobulata* is also proposed as a new combination to elevate the previously recognized variety, *Genea sphaerica* f. *lobulata*, to the species level. Useful macroscopic images and spore drawings of all ten new taxa are included to help discriminate them from closely related species.

Keywords: hypogeous fungi, truffles, Europe, phylogeny, taxonomy, *Pyronemataceae*.

Introduction

The genus *Genea* Vittad. was published by Carlo Vittadini (1831), who dedicated it to zoologist Dr. Joseph Gené. The genus is characterized by its hypogeous ascomata, that are sometimes folded and usually have a basal tuft of hyphae. *Genea* ascomata typically have an apical orifice, but this can be difficult to locate because of the many lobes that sometimes surround it. The ascomata develop an organized hymenium (ptycothecium) that is protected by an epithecium formed by coalescent paraphyses. Asci contain eight ornamented spores and are inamyloid.

Traditionally, a limited number of *Genea* species are recognized in Europe. Vittadini (1831) first proposed the blackish *G. verrucosa* Vittad. and the reddish *G. papillosa* Vittad. Soon after, Dietrich & Klotzsch (1839) published a description of some specimens of *G. verrucosa*, which they considered conspecific with the taxon *Hydnocaryon fragrans* Wallr. (Wallroth, 1833). Berkeley & Broome (1846) proposed that these specimens to be accommodated in the new independent species *Genea klotzschii* Berk. & Broome. However Saccardo (1889) correctly identified the appropriate epithet as *Genea fragrans* (Wallr.) Paoletti. This species has bigger spores than those of *G. verrucosa* (Berkeley & Broome, 1846), although different measures have been reported: 35–38 µm (Corda, 1854), 31–45 × 21–32 µm (Fischer, 1897), or 25–34–45 × 20–27–32 µm (Hawker, 1954). Genea fragrans also has ornamentation formed by large, truncated, block-like warts that are distinct from the small conical warts of *G. verrucosa* (Mattirolo, 1900a). Berkeley & Broome (1846) also published a description of some *G. papillosa* specimens from the United Kingdom that were quite different from those originally described by Vittadini (1831). These were later recognized as a new species by Tulasne & Tulasne (1851) under the name *Genea hispidula* Berk. ex Tul. & C. Tul. This species has small brown ascomata and a peridium coated with pyramidal warts and densely covered by brown hairs. It has a single inner chamber covered with a black, warted epithecium. Its spores are larger than those of *G. verrucosa* (38–42 × 32 µm) and covered with coarse warts that are sometimes bicuspidate (with the appearance of a molar tooth).

A different type of spore ornamentation was recorded by Tulasne & Tulasne (1851) in some French specimens, which were accommodated in the taxon *Genea sphaerica* Tul. & C. Tul. This species produces perfectly sphaerical black ascomata, with a labyrinth-like inner chamber that has characteristic broad white tramal plates. The spores of *G. sphaerica* are ornamented with obtuse roundish warts.

Corda (1854) proposed many new Genea species, although most of them have been rarely collected since they were described. First, he published the easily recognizable species *G. lespiaultii* Corda, which has spores ornamented by flat warts and has been recorded frequently. He also proposed a second species with hairy peridium, *Genea pulchra* Corda, which differed from *G. hispidula* because of its smaller spores (20–28 × 15–24 µm), spore ornamentation composed of minute warts, and a pseudoparenchymatic peridium with scattered lacunae (locules inside the ascomata that are lined with a palisade of hymenium). Finally, he erected two species closely resembling *G. verrucosa*, namely the brownish *G. kunzeana* Zobel, and the more tuberculate *G. perlata* Corda. However, *G. verrucosa* was thought to vary in color from brown to dark, and more rarely black by later authors such as Mattirolo (1900a). In fact, Mattirolo (1900a) regarded *G. papillosa* and *G. kunzeana* as morphological variations of *G. verrucosa* and incorrectly considered them as synonyms of his own *G. verrucosa* var. *badia* Mattir. In addition, he added a new European species, *G. vagans* Mattir., which is easily distinguished because of its large spores (35 × 27 µm on average) that are ornamented with large conical warts tending to coalesce at their bases. This taxon has also been recorded in Russia (Bucholtz, 1901; Ławrynowicz, 1990).

In the 20th century, Velenovský (1922) proposed *Genea neuwirthii* Velen., which has a smooth brownish peridium. It has a single inner chamber and spores that are 35–40 µm long and ornamented with prominent thick warts with blunt rounded edges. Scattered reports about additional specimens of the most commonly accepted European species can be found in the following years. Vacek (1951) presents interesting descriptions of *G. pulchra* (1947, 1949), and the original form of *G. sphaerica* (1951) from the Czech Republic. Eckblad (1954) suggested that *G. pulchra* and *G. hispidula* could represent a single species based on a wide range of spore sizes and ornamentation variability, which they considered developmental stages of this fungus. Later, major reviews of hypogeous fungi did not recognize any additional new *Genea* species in the European mycota. For example, the work on British hypogeous fungi by Hawker (1954) recognized only four species (*G. verrucosa*, *G. fragrans*, *G. sphaerica*, *G. hispidula*) and the publication on Danish hypogeous macromycetes by Lange (1956) recognized only three species (*G. sphaerica* was not included). Ceruti (1960) described and illustrated six European species (those mentioned above as well as *G. lespiaultii* and *G. vagans*). In Sweden, Kers described new reports of *G. verrucosa* (1979) and *G. hispidula* (1990), while Pegler *et al.* (1993) mentions

that *G. hispidula*, *G. verrucosa*, *G. sphaerica* and *G. fragrans* as present in Britain.

In Spain, published reports of *Genea* began with Calonge (1985) and later Vidal *et al.* (1991, 1997a). Recently, *Genea sphaerica* f. *lobulata* Mor.-Arr., J. Gómez & Calonge (Moreno-Arroyo *et al.*, 1998a) was erected. This variety is similar to *G. sphaerica* because of its labyrinth-like inner chamber with broad white tramal plates, but its spore ornamentation does not seem to match the original description. Another species putatively related to *G. verrucosa* was described from southern Spain as *Genea subbaetica* Mor.-Arr., J. Gómez & Calonge (Moreno-Arroyo *et al.,* 1998b). The spores are similar to those of *G. verrucosa* (26–30 × 22–26 µm) and ornamented with 2–3 µm high warts that are conical to cylindrical. However, *G. subbaetica* also has smaller cells in the outer peridial layer (15–30 µm in diam.) and bigger asci (240–280 × 25–30 µm in *G. subbaetica* vs. 200–220 × 26–30 µm in *G. verrucosa*). Furthermore, this species is collected in early winter, while *G. verrucosa* is usually found in spring or early summer. In Italy, the major works by Montecchi & Lazzari (1993), Montecchi & Sarasini (2000) and Gori (2005) contributed with very useful macro and microscopic images to illustrate the species that had already been described by the classical authors. It is also worth mentioning the work on Sicilian hypogeous fungi by Venturella *et al.* (2004). The genus *Genea* has been reported also from Hungary (Hollós, 1911; Szemere, 1965; Bratek *et al.*, 2013), Greece (Diamandis & Perlerou, 2008, Konstantinidis, 2009), and Turkey (Türkoğlu & Castellano, 2014).

For the present work we have studied more than 160 new collections and herbarium specimens from across Europe, with particular attention to brownish European specimens and those with strikingly different spore ornamentation. In a few cases, a combination of morphological characters and ecological traits were also employed to define species. We have also obtained molecular data from all species and these have been compared with described taxa from Europe and North America to support the assertion that the new taxa presented here do not match any of the previously established species.

Material and methods

Morphological study. —All collections are preserved in the herbarium of the Universidad de Alcalá (AH) and Hungarian Natural History Museum (BP) at Budapest, although the codes referring to the origin of each sample used during the study are also provided: AH (Alcalá de Henares Herbarium), AVM (Asociación Vallisoletana de Micología), BM (Baldomero Moreno-Arroyo), CA (Carlo Agnello), GH (Gunnar Hensel), GK (Giorgos Konstantinidis), JC (Julio Cabero), NV (Nicolas Van Vooren), VK (Vasileios Kaounas), and ZB (Zoltán Bratek, from mycotheca of the First Hungarian Truffle Society, EMSzE). Microscopic study was performed in distilled water, lactophenol cotton blue, Trypan blue or Congo red-floxine. KOH 5% and Melzer's reagent were not used for spore measurements because these mounting media have been shown to dissolve spore ornaments in some hypogeous *Pezizales* (Smith *et al.*, 2006). Spores measurements are provided on 50 items outside asci. X represents the average of spore dimensions. Qm represents the mean ratio of the spore length divided by the width. Spore dimensions are given without ornamentation. The width of ornamentation corresponds to the width at the base of warts.

Phylogenetic analysis. — The molecular identity of the new taxa proposed in the present work was studied and compared with other described *Genea* species from Europe and North America. All of the new species described below represent independent monophyletic lineages that are distinct from any of the described taxa. A detailed phylogenetic analysis will be presented as part of an upcoming paper.

Taxonomic results

Genea brunneocarpa G. Moreno, J. Cabero & V. Kaounas, *sp. nov.* — MB 809071

Etymology: *brunneo-* comes from the latin *brunneo*, meaning brown, and *–carpa* is derived from latin *carpus*, fruit, the name meaning *Genea* with brownish ascomata.

Diagnosis: Ascomata hypogeous, reddish to brownish in color, with a single inner chamber with peridium wall projections, lined with a light brown epithecium. Ascospores measuring less than 32 µm, excluding spore ornamentation which consists of truncated-conic warts that are sometimes cubic in appearance. This species fruits under *Quercus ilex* with or without *Pinus halepensis*.

Holotype here designated: SPAIN: Valladolid, Tiedra, Montes Torozos, 784 m asl, under *Quercus ilex*, *leg*. J. Cabero, 03-IV-2011, JC6, AH44112.

Description

Ascomata hypogeous, subglobose or slightly lobed, measuring up to 20 mm, reddish to brown in color, covered with small, irregular, flat warts with the apices somewhat darkened; apical orifice present, and also a basal tuft of hyphae that often adheres to soil particles. **Odor** weak and unremarkable. **Peridium** bilayered measuring 250–340 µm, composed by an external pseudoparenchymatous layer 160–190 µm thick, formed by hyaline subglobose or isodiametric cells measuring 33.5–55.0 × 21.5–35.0 µm, whose walls look thicker, more angular and more pigmented closer to the surface of the peridium, and an inner layer 130–180 µm thick, also pseudoparenchymatous but turning prosenchymatous in the vicinity of the hymenium. **Inner chamber** usually not divided, but sinuose due to wall projections, lined with a light brown epithecium with scattered minute warts with darkened apices, overall appearance and pseudoparenchymatic structure similar to that of the peridium. **Hymenium** arranged as a palisade under the epithecium, composed of cylindrical pedicelate asci, mixed with long paraphyses measuring 3–8 (–10) µm thick, and only slightly exceeding asci in length, not inflated at the top. **Asci** 234–288 × 28–32 µm, containing eight uniseriate or slightly disorganized spores. **Ascospores** ellipsoid or occasionally globose, (26.5–) 28.0–31.5 (–32.5) × (18.5) 19.5–24.0 (–25.0) µm, X = 29.5 × 21.5 µm, Qm= 1.35, ornamented by truncated-conic warts that sometimes look almost cubic, only rarely with secondary warts protruding from the apex; truncated-conic warts measure up to 2.5 × 3.5 µm, while cubic warts up to 3.8–5.5 µm in height; microwarts present and numerous.

Ecology: Fruiting in winter and spring (Feb.-Apr.) in calcareous soils, under *Quercus ilex*, with or without *Pinus halepensis*.

Distribution: known thus far only from Mediterranean Europe (Spain and Greece).

Notes

Genea brunneocarpa can look microscopically similar to *G. fragrans*, but both the spores and spore ornaments are smaller in *G. brunneocarpa*. It also has a brownish peridium and epithecium and the inner chamber is filled with projections from the wall but these internal epithecium projects are not folded as they are in *G. fragrans*. The North American taxon *G. compacta* is also brownish, has a single irregularly cavernous inner chamber, and spores 32–34 × 24–28 µm with spore ornamentation of large irregular truncate or conical warts (Harkness, 1899; Gilkey, 1939). The European specimens have not been accommodated in *G. compacta* because of the dubious status of this exceedingly rare species. *Genea compacta* has only been found a handful of times and this species is morphologically similar to *G. arenaria*. *Genea compacta* also overlaps with the distribution of the highly morphologically variable *G. arenaria*, suggesting that it may actually be a synonym (Smith *et al.*, 2006). In addition, the original description of *G. compacta* suggests that it is

PLATE 1

A. *Genea compressa* JC28 (J. Cabero); B. *G. lobulata* VK122 (V. Kaounas); C. *G. sphaerica* GH20100724 (G. Hensel); D. *G. lespiaultii* RM2140 (R. Martínez); E. *G. fageticola* GK4129 (G. Konstantinidis); F. *G. fragrans* AH39100 (M.A. Sanz); G. *G. pseudoverrucosa* AH39104 (M.A. Sanz); H. *Genea* cf. *anthracina* JC3 (J. Cabero); I. *G. dentata* NV-R (P. Ribollet); J. *G. verrucosa* PSS3703 (F. Sáinz); K. *G. pseudobalsley*i JC29 (J. Cabero); L. *G. vagans* JC17 (J. Cabero); M. *G. oxygala* JC14 (J. Cabero); N. *G. tuberculata* JC32 (J. Cabero); O. *G. brunneocarpa* JC6 (J. Cabero); P. *G. pinicola* JC12 (J. Cabero); Q. *G. hispidula* JC23 (J. Cabero); R. *G. arenaria* JC7 (J. Cabero); S. *G. thaxteri* JC16 (J. Cabero); T. *Genea* cf. *subbaetica* VK3291 (V. Kaounas).

slightly smaller (1 cm), stellate in shape, light brown in color, has a coarsely verrucose peridium, and spore ornamentation that is more crowded than in *G. brunneocarpa*. *Genea papillosa*, *G. kunzeana* and *G. verrucosa* f. *badia* have brownish ascomata, but spores are ornamented with small pointed warts, similar to those of *G. verrucosa*. *Genea neuwirthii* is light brownish, has larger spores (35–40 µm on average), and was collected in central Europe (Czech Republic).

Studied collections: GREECE: Attica, Katsimidi, preference for *Quercus ilex* in a mixed stand with *Pinus halepensis* on calcareous soil, *leg*. V. Kaounas, 24-II-2013, VK2922, AH44113. SPAIN: Guadalajara, Castilblanco de Henares, under *Q. ilex*, calcareous soil, *leg*. M.A. Sánz, 13-III-2011, AH42934. Valladolid, Tiedra, Montes Torozos, 784 m asl, under *Q. ilex*, *leg*. J. Cabero, 03-IV-2011 JC6, AH44112 HOLOTYPE. Valladolid, Urueña, Montes Torozos, under *Q. ilex*, calcareous soil, *leg*. J. Cabero, 20-IV-2014, JC35, AH44111.

Genea compressa Z. Merényi, J. Cabero & G. Moreno, *sp. nov.* — MB 809072

Etymology: *compressa* refers to the compressed peridium wall projections that extend into the inner chamber.

Diagnosis: Ascomata hypogeous, subglobose, lobate, with a black peridium covered with small irregular warts. Inner chamber filled with numerous compressed wall projections. Ascospores measuring on average 25 µm, ornamented with pointed conical warts approximately 3 µm in height. Found under *Quercus* spp. in alpine forests of Mediterranean Europe and hills of central Europe in autumn.

Holotype here designated: SPAIN: Zamora, Parque Natural de Sanabria, Llanes, hypogeous under *Quercus pyrenaica*, 994 m asl, *leg*. J. Cabero, 04-III-2013, JC28, AH44118.

Description

Ascomata hypogeous, subglobose, lobate, measuring 8–14 mm. in diam.; black peridium covered with small irregular to polygonal low black warts. An apical orifice covered with warts similar to those on the peridium is present, and the fungus is attached to the substrate by a basal tuft of hyphae. **Odor** weak and unremarkable. **Peridium** total width of 350–490 µm, bilayered, with an external layer measuring 230–250 µm, composed of cells arranged as a hyaline pseudoparenchyma, appearing subglobose or slightly angular, and pigmented close to the surface with individual cells 38–47.5 × 29–36 µm. The internal layer is 120–240 µm thick, and formed of loose hyphae perpendicularly arranged that can look as diffuse small elements when sectioned. **Inner chamber** containing numerous compressed coarse wall projections, coated with an epithecium that is and more or less similar to the external peridium surface but sometimes more brownish. The epithecium measures 90–130 µm and is pseudoparenchymatic in structure, most cells angular but a few subglobose. **Hymenium** formed by asci and cylindrical, septate, somewhat tortuous paraphyses arranged in a palisade measuring 310–380 × 3–5 µm, forming an epithecium above the hymenium. **Asci** cylindrical, sometimes inflated, indehiscent, 200–280 × 25–38 (–42) µm, with a short, eccentric sinuose or even coiled peduncle. **Ascospores** uniseriate, subglobose to ellipsoid, (23.5–) 24.0–26.5 (–30.5) × (18.0–) 19.0–21.0 (–25.5) µm, X= 25.0 × 21.5 µm, Qm = 1.26, ornamented by conical warts, often digitate at the top, measuring (2.3–) 3.3 (–5.3) × (2.0–) 3.3 (–5.8) µm.

Ecology: Autumn (Sept.–Nov.), under a variety of host plants, including *Quercus pyrenaica*, *Q. cerris*, and *Quercus* sp., in the alpine belt of the Mediterranean basin and in the hill country of central Europe.

Distribution: known from Spain, Hungary, and Morocco; potentially widely distributed across Europe.

Notes

This species is similar to *G. vagans* in several features: it has black ascomata covered with irregular to polygonal warts, a chambered inner cavity, and spores ornamented by conical warts. However, *Genea compressa* has smaller spore ornaments — typically 2–5 µm high — than those of *G. vagans* — typically 5–8 µm high (Mattirolo, 1900a, 1900b; Ceruti, 1960; Vidal, 1997). *Genea compressa* sometimes resembles other blackish species, such as *G. fragrans* or *G. verrucosa*, but these differ from *G. compressa* due to their spore sizes or the morphology of their spore ornaments. Finally, *G. echinospora* Gilkey produces spores with similar ornamentation, but is described as mummy-brown in color and hispid, has conspicuously larger spores (36–40 µm), and was collected at lower elevation sites in North America (Gilkey, 1939, 1954).

Studied collections: HUNGARY: Borsod-Abaúj-Zemplén county, Bogács, Bükk Mountains, 200-250 m asl, under *Quercus* sp., *Quercus cerris* and *Carpinus betulus*, 4-X-1999, ZB1790, BP104836. Komárom-Esztergom county, Szárliget, 250-300 m asl, under *Quercus* sp. and *Carpinus betulus*, 16-IX-2006, ZB3332, BP104837. MOROCCO: Ifrane, road from Azrou to Ain Leuh, under *Cedrus atlantica* with scattered *Quercus* sp., *leg*. M.A. Sánz, P. Alvarado, J.L. Manjón & J. Álvarez, 18-XI-2010, AH42944. SPAIN: Zamora, Parque Natural de Sanabria, Llanes, under *Quercus pyrenaica*, 994 m asl, *leg*. J. Cabero, 04-III-2013, JC28, AH44118 HOLOTYPE.

Genea dentata Van Vooren, J. Cabero & Hensel, *sp. nov.* — MB 809074

Etymology: *dentata* from latin *dens* (tooth), refers to the teeth-like appearance of the spore ornamentation (either fang-like or molar-like).

Diagnosis: Hypogeous ascomata of reduced dimensions (2–5 mm), with a black peridium topped by prominent warts. Ascospores measure less than 32 µm without ornamentation, which is composed of long (5–6 µm) and thin fang-like or molar-like warts that resemble teeth. It can be found under broadleaved trees in temperate Europe.

Holotype here selected: FRANCE: Loire-Atlantique, Orvault, border of stream "Cravatte", under *Corylus avellana*, *Prunus laurocerasus*, *Ilex aquifolium* and *Ruscus* sp., *leg*. P. Ribollet, 31-V-2009, NV-R, AH44121 HOLOTYPE.

Description

Ascomata hypogeous, globose to subglobose, minute, measuring 2–5 mm in diam. Black peridium covered with prominent pyramidal warts. Basal tuft composed of brownish-reddish hyphae. Apical orifice present. Single **inner chamber** lined with brownish flat warts. **Peridium** pseudoparenchymatic measuring 350–500 µm, bilayered; external layer 200–400 µm thick, composed of angular dark brown cells, more or less stretched, e.g. 42 × 23 µm, or triangular, e.g. 35 × 30 µm, with thick wall (4–7 µm); internal layer about 100–150 µm thick, comprised of brownish cells, angular or almost spherical, measuring 7–45 × 7–25 µm, with thin wall. **Asci** cylindrical, 260–300 × 33–40 µm, containing eight uniseriate spores. **Paraphyses** hyaline and septate, forming an epithecium above the palisade of asci. **Ascospores** hyaline, generally uniguttulate, broadly ellipsoid to ellipsoid or even subcylindrical, (26.5–) 27.0–32.0 (–33.0) × (19.0–) 20.0–22.0 (–23.0) µm, X = 29.5 × 21.0 µm, Q=1.3–1.6, ornamented with long warts that are curved and spiny (similar to the fangs of a cat) or sometimes truncated and digitate at the top (like typical human molars), measuring 5.0–6.0 × 1.5–2.5 µm.

Ecology: Under deciduous trees, in siliceous soil of temperate Europe. Spring (May-Jun.).

Distribution: known from France, Germany and putatively from Spain.

Notes

This species is proposed to accommodate two small black specimens with long, spiny spore ornaments that vaguely resemble teeth under the light microscope. A third collection (JC19, AH44120 from Spain) seems somewhat deviant, both genetically and morphologically, but is nevertheless considered conspecific for now. It has slightly larger and more ellipsoid spores that are ornamented with long, scattered warts with more rounded tips. GH20060610 (AH44119) was immature, although the sparsely ornamented spores were morphologically similar to those of the holotype specimen (PR0970 NVR, AH44121). The morphological features reported here should be confirmed with new collections matching the genetic profile of the holotype collection.

Studied collections: FRANCE: Loire-Atlantique, Orvault, border of stream "Cravatte", under *Corylus avellana*, *Prunus laurocerasus*, *Ilex aquifolium* and *Ruscus* sp., *leg*. P. Ribollet, 31-V-2009, NVR, AH44121 HOLOTYPE, Ribollet (personal herbarium) PR0970 ISOTYPE. GERMANY: Nickelsdorf, Zeitzer Forst, MTB5038/1, *leg*. G. Hensel, under *Quercus* sp., in siliceous soil, 10-VI-2006, GH20060610, AH44119. SPAIN: Asturias, Pola de Somiedo, under *Fagus sylvatica*, calcareous soil, *leg*. F. García, 12-VI-2013, JC19, AH44120.

Genea fageticola Konstant., J. Cabero & F. García, *sp. nov.* — MB 809075

Etymology: *fageticola* refers to the apparently strict association with *Fagus sylvatica*.

Diagnosis: Hypogeous blackish ascomata covered with irregular warts, with an abundant basal tuft of hyphae, a single inner chamber lacking wall projections lined with a brownish epithecium. Ascospores larger than 32 µm without ornamentation, which consists of prominent truncated or rounded warts approximately 4 µm in height. It is apparently a strict symbiotic associate of Fagus sylvatica.

Holotype here designated: GREECE: Drosopigi Florina, under *Fagus sylvatica*, along with *Hydnotrya tulasnei* (Berk.) Berk. & Broome, 1150 m asl, *leg*. D. Klisiari (dog Sisi), 27-IX-2009, GK4129, AH44122.

Description

Ascomata hypogeous, subglobose, slightly depressed, measuring 7–15 mm in diam.; black, covered with small, irregular, flat or roundish warts; with an apical orifice and a prolific basal tuft of reddish or brownish hyphae. **Peridium** 200–400 µm thick, bilayered; external layer measuring 150–320 µm, pseudoparenchymatous, composed of hyaline inflated subglobose or angular cells measuring 25.0–60.0 × 20.0–45.0 µm, becoming more pigmented and thick-walled toward the peridium surface. The inner layer is 50–70 µm thick, composed of yellowish inflated subglobose or angular cells measuring 14–40 × 9–25 µm. Single **inner chamber** with some small lobes (but lacking wall projections) lined with a light brown epithecium formed by minute papillae, which is also pseudoparenchymatous in structure and composed mostly of angular cells. **Hymenium** arranged as a palisade, formed by asci measuring 305–370 × 25–26 µm, 8-spored, cylindrical, with a slightly lateral and short, somewhat sinuous peduncle measuring 23.4 × 6.5 µm on average. Interestingly, some asci are much bigger than the space filled by the spores (these inflated asci measure 305–370 × 25–26 µm), even when the ascospores are completely mature and have reached their full size. **Paraphyses** septate, cylindrical, measuring 19.5–24.5 × 3.5–4.9 µm in diam., forming an epithecium over the palisade of asci. **Ascospores** ellipsoid, (28.0–) 29.0–34.5 (–36.5) × (18.0–) 20.5–24.5 (–26.0) µm, X = 31.5 × 22.5 µm, Qm=1.41, thick walled, sometimes with a blackish-lilac oil droplet, ornamented by crowded cylindrical, truncated or rounded warts, measuring 2.1–6.5 × 2.0–6.0 µm.

Ecology: under *Fagus sylvatica*, sometimes with scattered *Quercus petraea* trees. Late summer and winter (Sept.-Feb.).

Distribution: known from Greece and Spain.

Notes

Genea fageticola macroscopically resembles other blackish *Genea* species. The more or less globose ascomata distinguish it from *G. verrucosa*, which has more irregular ascomata, smaller spores, different spore ornamentation, and is more commonly found with *Quercus ilex*. *Genea fageticola* can be confused with *G. fragrans*, which can also be found under *Fagus* and is supposed to have similarly large spores ornamented with prominent truncated warts (Berkeley & Broome, 1846; Tulasne & Tulasne, 1851; Corda, 1854; Hawker, 1954). However, *G. fragrans* usually has folded ascomata and a labyrinthine inner chamber when mature, a small inconspicuous basal tuft of hyphae, a black epithecium covered with warts similar to those of the external peridium, and a more prominent and scattered spore ornamentation, sometimes with tiny secondary warts among the primary warts. Spore ornamentation of *G. fageticola* can also resemble that of *G. hispidula*, another taxon that occasionally fruits under *Fagus sylvatica*. However, these two species can be easily discriminated because *G. hispidula* has a brownish peridium with copious peridial hairs. *Genea vagans* can also be present in the same habitats and has spores that are similar in size to *G. fageticola* (35 × 27 µm on average), but *G. vagans* can be separated due to its conical spore ornamentation and chambered inner cavity. *Genea fageticola* differs from *G. compressa* by its single inner chamber without obvious peridium wall projections, its more conspicuous basal tuft of brownish hyphae, its bigger spores ornamented with truncated or rounded warts, and a host preference for *Fagus sylvatica*. In contrast, *G. compressa* has an inner chamber filled with packed wall projections, an inconspicuous or absent basal tuft of hyphae, smaller ascospores ornamented with conical pointed warts, and is commonly found under *Quercus* spp without *F. sylvatica*.

Studied collections: GREECE: Drosopigi Florina, under *Fagus sylvatica*, along with *Hydnotrya tulasnei* (Berk.) Berk. & Broome, 1150 m asl, *leg*. D. Klisiari (dog Sisi), 27-IX-2009, GK4129, AH44122 HOLOTYPE. SPAIN: León, Soto de Sajambre, bosque de Vegabaño, under *F. sylvatica* and several *Quercus petraea*, humid climate, 1432 m asl, calcareous soil, *leg*. F. García, 16-II-2008 H-139, AH44123.

Genea lobulata (Mor.-Arr., J. Gómez & Calonge) P. Alvarado & Mor.-Arr., *comb. nov.* — MB MB809076

Basionym: *Genea sphaerica* f. *lobulata* Mor.-Arr., J. Gómez & Calonge, *in* Moreno-Arroyo *et al.*, *Boll. Gruppo Micol. 'G. Bresadola' (Trento)*, 41(3): 207 (1998).

Description

Ascomata hypogeous, subglobose to lobed, measuring 15–40 mm in diam. An apical orifice and a basal tuft of hyphae reddish brown in color are present. **Peridium** black, covered with polygonal flat warts, lacking peridial hairs, bilayered, with an external pseudoparenchymatic layer measuring 250–300 µm wide, composed of angular cells measuring 30–70 × 22–50 µm just below the surface, and an inner pseudoparechymatic layer 150–200 µm wide formed of globose cells that turn prosenchymatic near the hymenium. Inner chamber highly folded due to projections of the hymenium, brain-like appearance when cut. **Hymenium** covered by a dark brown, warted pseudoparenchymatous epithecium that is commonly black, but sometimes brownish when young. **Asci** cylindrical, 200–225 × 26–28 µm, containing eight uniseriate spores. **Paraphyses** 210–325 × 6–10 µm. **Ascospores** subglobose to ellipsoidal, 24–30 × 20–26 µm, ornamented with spiny warts, more rarely conical with roundish top, measuring 1–2.5 µm high × 1–2 µm wide, with minute warts among them.

Ecology: This species is found fruiting under *Quercus ilex* in winter, spring and summer (Jan.-Aug.).

Distribution: known from Greece, Spain and Cyprus.

Notes

This species is similar to *Genea sphaerica* due to its black and minutely warted peridium, and labyrinthine inner chamber with thick sterile white tramal plates (Tulasne & Tulasne, 1851; Fischer, 1897; Vacek, 1951). However, several authors observed differences with this taxon, which lead to the proposition of an independent variety (Moreno-Arroyo *et al.*, 1998a), which is here elevated to the species level as a result of molecular studies (data not shown). Three main features can help discriminate *G. lobulata* from *G. sphaerica*. First, *G. sphaerica* is smaller (10–20 mm), almost perfectly round, more or less radially symmetrical, and the projections of the inner cavity are not delimited into closed chambers. In contrast, *G. lobulata* is bigger, often irregularly lobed, and rarely has any obvious symmetry when sectioned. Furthermore, the peridium wall projections produce closed chambers when the ascomata are sectioned. Second, ascospores in *G. sphaerica* are ornamented with conspicuous warts that are very round, while those of *G. lobulata* are ornamented with spiny-tuberculate warts (Mattirolo, 1903; Moreno-Arroyo *et al.*, 1998a). Finally, *G. sphaerica* seems to occur in alpine Mediterranean habitats as well as central and northern Europe lowlands during summer and autumn under deciduous trees such as *Carpinus*, *Corylus*, *Fagus* or Tilia (Hesse, 1894; Fischer, 1897; Vacek, 1951; Ławrynowicz, 1990). In contrast *G. lobulata* is commonly found in winter, spring and summer in lowland Mediterranean Europe under *Quercus ilex* or *Q. faginea* (Mattirolo, 1903; Vidal, 1997; Moreno-Arroyo *et al*., 1998a; Montecchi & Sarasini, 2000). The only other *Genea* species putatively resembling *G. lobulata* and *G. sphaerica* is *G. lespiaultii*, which can be easily separated because of its distinctive spore ornamentation of flat warts.

Studied collections: CYPRUS: unknown location, under deciduous trees, *leg*. Th. Alexandridis, 01-VII-2010, GK5078, AH44141. Unknown location, under deciduous trees, *leg*. S. Mavros, 15-VI-2011, GK5770, AH44143. GREECE: Attica, Parnitha, under *Quercus ilex* and *Q. ithaburensis* subsp. *macrolepis*, argillaceous soil, 500 m asl, *leg*. V. Kaounas, 30-III-2011, VK2122, AH44149. Same locality, 30-V-2011, VK2213, AH44150. Same locality, 17-VI-2011, VK2238, AH44151. Same locality, VK2239, AH44152. Korestia Kastoria, under deciduous trees, *leg*. G. Setkos, 07-XII-2010, GK5384, AH44142. SPAIN: Guadalajara, Valdearenas, under *Q. ilex* in basic soil, *leg*. M.A. Sanz, 30-V-2009, AH42940. Navarra, Salinas de Oro, under *Q. ilex*, *leg*. P.M. Pasaban & F. Sáinz, 01-IV-2011, PSS3501, AH44147. Same locality, 07-IV-2011, PSS3502, AH44148. Valladolid, Santa Espina, Montes Torozos, under *Q. ilex*, calcareous soil, *leg*. J. Cabero, 30-V-2013, JC2, AH44144. Same locality, 26-III-2013, JC4, AH44145. Valladolid, Urueña, Montes Torozos, under *Q. ilex*, calcareous argillaceous soil, 06-VI-2012, JC9, AH44146. Córdoba, Doña Mencía, under *Q. ilex*, *leg*. B. Moreno-Arroyo, 26-V-2013, BM1043, AH44140.

Genea oxygala J. Cabero & F. García, *sp. nov.* — MB 809077

Etymology: *oxygala* is derived from the ancient greek words *oxy-* (acid) and *–gala* (milk), which Galen describes as a fermented milk product. It is still a word applied to yogurt among some greek-speakers formerly inhabiting Turkey (G. Konstantinidis, personal observation).

Diagnosis: Large brownish ascomata, highly lobed, surface covered with minute irregular warts, intense pleasing odor that is similar to yogurt, ascospores not exceeding 32 µm, ornamented with scattered wide hemisphaerical warts measuring 1.5–4 × 2.5–7.8 µm. Strictly associated with *Pinus* spp. in Mediterranean habitats.

Holotype here designated: SPAIN: Zamora, Toro, Bosque de Montelarreina, under *Pinus pinea* and *P. pinaster*, 16-II-2008, JC14, AH44177.

Description

Ascomata hypogeous, subglobose, highly lobed or tuberculate, 10–25 (–32) mm in diam. Surface brown to dark brown with blackish areas when mature, covered with minute irregular warts or papillae, with a basal tuft of dark brownish mycelium, and with an apical opening, sometimes difficult to detect because of the highly folded fruiting body. **Odor** pleasant, similar to yogurt. **Peridium** comprised of one layer, measuring around 320–350 µm thick. Microscopically, it has a pseudoparenchymatic structure composed of hyaline inflated subglobose or isodiametric cells that are angular and pigmented with the cells walls becoming thicker near the surface of the peridium. Peridium cells variable in size, 19–45 × 12–27 µm. Inner cavity divided into a variable number of irregular chambers, lined with a light brown-colored verrucose epithecium. **Hymenium** arranged in a regular palisade, composed of asci and septate paraphyses, which are somewhat more inflated and longer than asci (29–35 µm between each septa, exceeding slightly the length of asci × 3.5–5.0 µm thick), forming an epithecium about 170–200 µm thick, with a pseudoparenchymatic structure composed of angular cells up to 46 × 38 µm. **Asci** irregularly cylindric, 220–290 × 29–35 µm, pedicelate (peduncule measuring approximately 57 × 9.5 µm), and indehiscent, containing eight uniseriate ascospores. **Ascospores** ellipsoid to ovoid, with rounded ends, (24–) 24.5–28 (–29) × (18.2–) 19.0–21.8 (–22.4) µm, X = 26 × 20.5 µm, Qm= 1.28, ornamented by widely separated, low and hemisphaerical warts, measuring 1.5–4 (–5) µm high and 2.5–7.5 µm wide.

Ecology: associated with pine trees such as *Pinus pinea* or *P. pinaster*, in siliceous sandy soil. Fruiting in winter or spring in Mediterranean climates.

Distribution: known only from Spain.

Notes

This species was previously reported as *G. thaxteri* Gilkey by Vidal *et al.* (1997) and Montecchi & Sarasini (2000). *Genea thaxteri* was first collected by Roland Thaxter from Maine and Tennessee (USA) and published by Gilkey (1939). Vidal *et al.* (1997) and Montecchi & Sarasini (2000) reported *Genea thaxteri* from Europe, despite the fact that the European material did not exactly match the original description of this North American species. *Genea thaxteri* is smaller than the European taxon; while *G. oxygala* ranges from 10 to 25 mm in diameter, Gilkey (1939) reported *G. thaxteri* as only 7 mm in diameter. The color of *G. thaxteri* was described as "Sudan brown" (Gilkey, 1954), while that of *G. oxygala* is darker, reported by Vidal *et al.* (1997) as "burnt umber". The ascomata of *G. thaxteri* are only slightly or not at all lobed whereas *G. oxygala* is highly lobed to tuberculate. Finally, ascospores of *G. thaxteri* are reportedly ornamented with crowded, rounded to pointed papillae, while those of *G. oxygala* have widely spaced low hemisphaerical warts that are not pointed. The very rare European species *G. neuwirthii* has smooth, lobed light brownish ascomata with a single inner chamber, and its large ascospores (35–40 µm) are ornamented with prominent thick warts that have rounded edges. These spore ornaments differ dramatically from the low wide hemispherical warts of *G. oxygala*.

Studied collections: SPAIN: Segovia, Cuellar, sandy soil under *Pinus pinea*, *leg*. A. García Blanco & J.M. Sanz Carazo, 14-II-2004, AVM1745, AH44175. Same locality, Pinar de Pociage, under *Pinus pinaster*, *leg*. F. García, 19-I-2013 (H-201). Zamora, Toro, under *P. pinea*, *leg*. A. García Blanco, M. Sanz Carazo, J. Cabero, 18-I-2004, AVM1842, AH44176. Zamora, Toro, Bosque de Montelarreina, under *P. pinea* and *P. pinaster*, 16-II-2008, JC14, AH44177 HOLOTYPE.

Genea pinicola V. Kaounas, J. Cabero & F. García, *sp. nov.* — MB 809078

Etymology: *pinicola* refers to the association of this species with *Pinus* spp.

Diagnosis: Hypogeous brownish ascomata with a single inner chamber lacking peridium wall projections, ascospores measure less than 32 µm and are ornamented with cylindrical warts 1–3 µm. It is apparently associated with *Pinus* sp., with or without other tree species.

Holotype here designated: SPAIN: Valladolid, Rábano, hypogeous under *Pinus pinea*, 795 m asl, *leg*. J. Cabero, 04-III-2013, JC12, AH44153.

Description

Ascomata hypogeous, subglobose to depressed with few lobules, measuring 7–15 mm in diam., yellowish brown, brown or reddish brown in color. **Peridium** covered with minute irregular low warts giving a rough appearance. A large apical opening is present, as well as a basal tuft of adherent hyphae. **Odor** unremarkable. **Peridium** two-layered, 210–260 µm thick, formed by an external pseudoparenchymatic layer, 120–160 µm thick, composed of hyaline subglobose or angular cells, measuring 20–40 × 20–34 µm, the internal layer a prosenchyma, 80–90 µm thick, with scattered inflated cells. Single **inner chamber** lacking conspicuous wall projections, warted, and similar in color to the peridium. **Hymenium** formed by asci arranged in palisade, with interspersed septate, filiform paraphyses measuring 260–400 × 1–4 µm, and forming a pseudoparenchymatous epithecium above asci. **Asci** cylindrical, 220–340 × 23–27 µm, containing eight uniseriate spores. **Ascospores** ellipsoid, 26.0–29.5 × (16.0–) 17.0–20.5 µm, X = 27.5 × 18.5 µm, Qm=1.49, ornamented by crowded truncated-conic or cylindric warts measuring 1–3 µm high and 1–3 µm wide, with or without digitations at their apices.

Ecology: in calcareous soil, under *Pinus halepensis*, *P. pinea* and probably *P. sylvestris*, with or without *Quercus ilex*. In winter and probably spring (March).

Distribution: known from Spain and Greece.

Notes

This taxon appears to preferentially or exclusively associate with species of *Pinus*. DNA from this species has been detected on the ectomycorrhizal roots of *P. sylvestris* in Iran (Bahram *et al.*, 2013) and was likely introduced from the Mediterranean region. Due to its yellowish or brownish color, *G. pinicola* can be confused with young *G. arenaria* or *G. thaxteri*, but *G. arenaria* usually has peridial hairs while the latter has more lobed ascomata when mature. In addition, these two species are not typically collected under *Pinus* spp. *Genea brunneocarpa* is brownish and single-chambered, but is not commonly found with *Pinus* spp., rarely has ascomata that are depressed, has more pointed peridial warts, and more prominent and scattered spore ornamentation. The rare *G. neuwirthii* is described with smooth, lobed, light brown ascomata with a single inner chamber, but this species has bigger ascospores (35–40 µm) that are ornamented with prominent thick warts that have rounded edges.

Studied collections: GREECE: Katsimidi Attica, under *Quercus ilex* and *Pinus halepensis* on calcareous soil, about 650 m asl, *leg*. V. Kaounas, 31-III-2009, VK825, AH44155. Same locality, 31-I-2013, VK2865, AH44154. SPAIN: Valladolid, Rábano, hypogeous under *Pinus pinea*, 795 m asl, *leg*. J. Cabero, 04-III-2013, JC12, AH44153 HOLOTYPE.

Genea pseudobalsleyi Agnello, Bratek & J. Cabero, *sp. nov.* — MB 809079

Etymology: *pseudobalsleyi* refers to the close morphological and phylogenetic relationship with the North American species *G. balsleyi*.

Diagnosis: Subglobose to irregularly lobed hypogeous ascomata with black warted peridium, morphologically similar to the epithecium which lines the peridium wall projections within the inner chamber. Ascospores measure less than 32 µm and are ornamented with truncated or conic warts about 2 µm high.

Holotype here designated: ITALY: Brindisi, Bosco Compare, under *Quercus ilex* on calcareous soil, 30 m asl, *leg*. C. Agnello, 29-V-2010, CA01, AH44156.

Description

Ascomata hypogeous, compact, subglobose and moderately lobed, 7–13 mm in diam., homogenously covered with small polygonal black warts that extend through the apical orifice. A small basal tuft of hyphae is present. **Odor** pleasant, similar to that of *Tuber aestivum* Vittad. **Peridium** a single layer of pseudoparenchymatic tissue 160 µm thick, composed of hyaline subglobose cells measuring 20–40 µm, becoming angular and with thicker and darker walls in the outermost layer. **Inner cavity** sometimes with a single inner chamber but other times with abundant wall projections that create independent sinuous chambers that give the gleba a brain-like appearance. The inner chamber lined with a black or brownish black epithecium with small irregular warts similar to those in the outer peridium surface. Epithecium is 40–70 µm thick, and its structure is also pseudoparenchymatous, composed of angular cells with thick, melanized walls that measure 20–35 µm in diam. **Asci** arranged in a continuous palisade, irregularly cylindrical, 190–270 × 27–38 µm, containing eight uniseriate spores, and with a short peduncle. **Paraphyses** cylindrical, occasionally septate, 44–66 × 3–6 µm, some of them with swollen cells, up to 15 µm in diam. **Ascospores** (21.7–) 23.4–27.7 (–30.2) × (17.7–) 18.6–22.6 (–26.3) µm, X= 25.1 × 20.9 µm, Q=1.06–1.29 (average Qm=1.21), subglobose to broadly ellipsoidal or ovoid, hyaline or pale yellowish in color, with a conspicuous, irregularly located oil droplet (especially visible when mounted in water), ornamented by truncated warts, rarely pointed, occasionally with small digitations at the top, measuring (1–) 1.5–2.5 (–4.0) µm high, and 1.5–2 (–4) µm wide.

Ecology: under *Quercus ilex* and *Q. pyrenaica*, in summer to early winter (Jun.-Dec.).

Distribution: known from Hungary, Italy and Spain.

Notes

This species is morphologically similar to *G. balsleyi* M.E. Smith (Smith, 2007) because of its black peridium surface, spore size, and spore ornamentation. However, *G. pseudobalsleyi* differs in the abundant peridium wall projections that sometimes produce a brain-like, labyrinthine, and chambered inner cavity that is apparently absent in *G. balsleyi*. So far, *G. balsleyi* has been recorded only from North America, while *G. pseudobalsleyi* is present only in Europe. Peridium structure is remarkedly bilayered in *G. balsleyi* whereas this feature was not observed in *G. pseudobalsleyi*. *Genea pseudobalsleyi* differs from *G. verrucosa* because of its crowded, truncated spore ornamentation, which is more scattered and formed of thinner and more pointed warts in *G. verrucosa*. *Genea compressa* can look macroscopically similar, but differs in its conical spore ornamentation. *Genea fragrans* and *G. fageticola* have markedly different spore sizes and ornamentation. The rare American species *G. macrosiphon* Gilkey is macroscopically similar and has ascospores similar in size and ornamentation based on the description of Gilkey (1939), but its pseudoparenchymatic peridium cells are conspicuously inflated to 3–4 times the size of spores.

Studied collections: HUNGARY: Baranya county, Bóly, 20-XI-2007, ZB3804, BP104851. Baranya county, Ormánság, Marócsa, 29-X-1998, ZB1458, BP104850. Pest county, Gyömrő, sandy soil under *Quercus* sp., *leg*. Z. Merényi, É. Bordás, G. Fenyőssy, 18-VII-2010, ZB4192, BP104858. ITALY: Brindisi, Bosco Compare, under *Quercus ilex* on calcareous soil, 30 m asl, *leg*. C. Agnello, 29-V-2010, CA01, AH44156 HOLOTYPE. SPAIN: Zamora, Galende, 1017 masl., under *Q. pyrenaica*, *leg*. J Cabero, 01-XII-2013, JC29, AH44157.

Genea pseudoverrucosa Bratek, Konstant. & Van Vooren, *sp. nov.* — MB 809080

Etymology: *pseudoverrucosa* refers to the close morphological affiliation with *Genea verrucosa* and the fact that this taxon has often been misidentified as *Genea verrucosa*, because of the similarity in spore sizes

Diagnosis: Black folded ascomata covered with minute inconspicuous warts, with a labyrinthine inner chamber, and ascospores not exceeding 32 µm, ornamented truncated warts approximately 3–4 µm high. Fruiting in summer, autumn and winter, but not spring, under deciduous trees of Mediterranean and central Europe.

Holotype here designated: FRANCE: Meurthe-et-Moselle, Sexey-aux-Forges, 250 m asl, under deciduous trees such as *Carpinus*, *Quercus*, *Corylus*, *Cornus*, calcareous-clayey soil, *leg*. J.-B. Perez (dog Fifi), 05-I-2011, NV-D, AH44160.

Description

Ascomata hypogeous, subglobose to highly folded, 6–15 mm in diam., with an inconspicuous basal tuft of dark hyphae. **Peridium** surface black and covered with minute rounded warts, composed by a single layer, pseudoparenchymatic 180–200 µm thick, formed of irregular polygonal cells measuring (22.5–) 27.0 (–34.5) × (33.0–) 37.5 (–45.0) µm. **Inner cavity** highly folded or labyrinthine but scarcely divided or not divided at all, lined with a black epithecium similar to the peridium. Epithecium structure pseudoparenchymatous, 80–150 µm thick, mostly formed by isodiametric cells. Glebal trama whitish, grayish or pale yellowish. **Asci** 197–222 × 26–27 µm, containing eight uniseriate spores. **Ascospores** subglobose to broadly ellipsoid, (23–) 27–30 × 21.5–24 (–24.5) µm, hyaline, ornamented by conical-truncated to irregular warts measuring (2–) 3–4 (–5) µm high and 3–4 (–4.5) µm wide, sometimes with a few interspersed smaller warts.

Ecology: in basic soil, associated with temperate deciduous trees (*Quercus*, *Carpinus*, *Tilia*, *Corylus*), but also in Mediterranean habitats with *Quercus ilex* or *Q. coccifera*, from summer to early winter (Jul.-Jan.), but apparently not in spring.

Distribution: known from France, Greece, Hungary and Romania. Also known in Morocco.

Notes

This taxon macroscopically resembles *Genea fragrans* but has been typically misidentified as *G. verrucosa* on the basis of ascospore dimensions. Spore ornamentation is formed by truncate warts that are similar to those of *G. fragrans*, but those of *G. pseudoverrucosa* are lower, crowded, and are more or less the same size, while those of *G. fragrans* are usually larger (3–7 µm high) and more scattered, with smaller warts that are frequent interspersed among the larger ones (Berkeley & Broome, 1846; Tulasne & Tulasne, 1851; Corda, 1854; Hawker, 1954). Spore size and ornamentation of *G. pseudoverrucosa* can look similar to those of *G. brunneocarpa*, but some warts are more scattered in *G. brunneocarpa*, and macroscopic features and ecology help to discriminate these two species. *Genea pseudobalsleyi* also has a black, warted peridium and has ascospores that are similar to *G. pseudoverrucosa*, but the spore ornaments in *G. pseudobalsleyi* are notably thinner (rarely exceeding 1.5–2 µm wide). Finally, the North American species *G. balsleyi* is similar but can be discriminated because of its bilayered peridium, a more or less regular hollow inner cavity, and mostly conical spore warts (as well as a very different molecular profile).

Studied collections: FRANCE: Sexey-aux-Forges, Meurthe-et-Moselle, 250 m asl, under deciduous trees such as *Carpinus*, *Quercus*, *Corylus*, *Cornus*, calcareous-clayey soil, *leg*. Jean-Baptiste Pérez (dog Fifi), 05-I-2011, NV-D, AH44160 HOLOTYPE. GREECE: Anthohori Ioannina, 1040 m asl, under *Quercus coccifera* and other broadleaf shrubs, *leg*. George Setkos, Katerina Nola and George Konstantinidis (dog Spina), 31-VII-2010, GK5088, AH44158. Kastoria, *leg*. George Setkos (dog Cannelle), 28-X-2010, GK5286, AH44159. HUNGARY: Győr-Moson-Sopron county, Fertőrákos, under *Quercus cerris*, 29-IX-2001, ZB2386, BP104854. Heves county, Szilvásvárad, Bükk Mountains, in a *Quercetum petreae-cerris* phytocoenosis, 11-XI-1998, ZB1473, BP104852. Pest county, Budapest, Budai range, XII-1999, ZB1948, BP104853. MOROCCO: Chefchaouen, Jebel Tissouka, under *Quercus* sp., *leg*. M.A. Sánz, J.L. Manjón, P. Alvarado, J. Álvarez, 14-XI-2010, AH39104. ROMANIA: Harghita, Cristuru Secuiesc, under *Carpinus* sp. and *Fagus* sp., 21-XI-2006, ZB3445, BP104855.

Genea tuberculata J. Cabero & P. Juste, *sp. nov.* — MB 809081

Etymology: *tuberculata* is derived from the latin root *tuberculum*, meaning protuberance, regarding the extremely humped and lobed ascomata of this species.

Diagnosis: Hypogeous ascomycete, with a large brownish humped and lobed ascoma. The peridium is covered with minute irregular warts. It has a chambered inner cavity, and ascospores measuring less than 30 µm that are ornamented with small irregularly conical warts. It grows in gypsiferous marl soils under *Pinus* trees in winter.

Holotype here designated: SPAIN: Valladolid, Aldealbar, 867 m asl, hypogeous under *Pinus pinea* and *Quercus ilex*, *leg*. J. Cabero, 09-III-2014, JC32, AH44178.

Description

Ascomata hypogeous, subglobose, highly lobed (some specimens with more than 60 lobes), measuring 20–30 mm, brownish to dark brownish in color or occasionally reddish brown, becoming darker with age. **Peridium** usually covered with minute irregular warts, but sometimes with flattened warts, a feature that could be related to maturity. The peridium is 185–235 µm thick, composed of a single pseudoparenchymatic layer formed of cells 26.0–38.5 × 19.5–22.5 µm which gradually become smaller in the innermost layers. Apical orifice not conspicuous and difficult to locate due to the many lobes of the ascomata. Small basal tuft of hyphae present. **Odor** intense, similar to yogurt, even in dried specimens. Chambered **inner cavity** due to the lobes of ascomata, but also due to projections of the inner wall. This is lined with an epithecium formed of small warts similar to those of the external peridium, except that they are more darkened at their tips. The epithecium is 110–150 µm thick, pseudoparenchymatic in structure, and formed of mostly subglobose cells, with some angular elements about 23–32 × 18–21 µm. The hymenium is arranged as a regular palisade composed of asci and irregularly cylindric but frequently septate paraphyses, 33.0–38.5 µm between each septum, 10.0–16.5 µm thick, more inflated in the areas near the hymenium and epithecium. **Paraphyses** 310–380 µm in length, considerably exceeding the hymenium. **Asci** cylindrical, pedicelate, inamyloid and indehiscent, with uniseriate

Plate 2 — Ascospores (in Cotton blue).
a. *Genea brunneocarpa* JC6; b. *G. compressa* JC28; c. *G. dentata* NV-R; d. *G. fageticola* GK4129; e. *G. lobulata* BM1043; f. *G. pinicola* JC12; g. *G. pseudobalsleyi* CA01; h. *G. pseudoverrucosa* NV-D; i. *G. oxygala* JC14; j. *G. tuberculata* JC32. Scale bars = 10 µm.

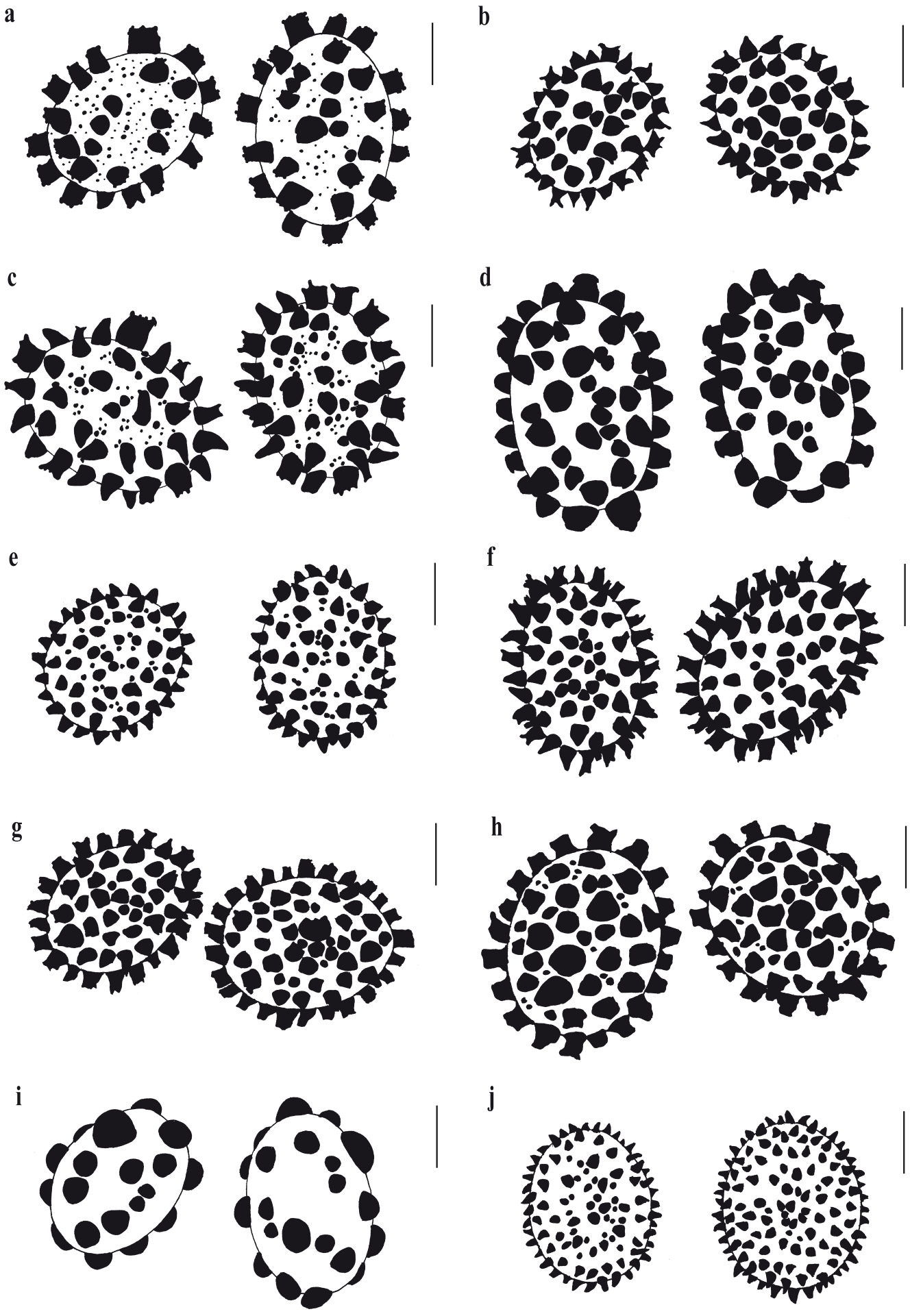

PLATE 2

spore arrangement; many asci are conspicuously larger than the ascospores they contain, reaching up to 252–289 × 28–32 µm, with a central pedicel measuring about 70 × 8 µm. **Ascospores** subglobose, (24.5–) 26.0–29.0 (–29.5) × (19.5–) 21.5–24.0 (–24.5) µm, X= 26.5 × 22.5 µm, Qm=1.20, ornamented by very small scattered conical or truncated-conical warts, measuring 1.3–1.7 (–2.0) × 0.8–1.5 (–1.7) µm.

Ecology: so far found under *Pinus pinea* mixed with *Quercus ilex*, as well as some *Q. faginea* and *Juniperus thurifera* in basic soils (pH near 8.0) with gypsum marl of central Spain. In winter (Jan.-Mar.).

Distribution: known only from central Spain.

Notes

The brownish tones, abundant lobes, intense odor, and particular habitat help to easily distinguish *G. tuberculata* from all other species except for *G. oxygala*, which is morphologically similar. However, *G. oxygala* usually has fewer swellings and lobes in its ascomata and has very different spore ornamentation. *Genea thaxterii* is somewhat or not at all lobed and is lighter in color.

Studied collections: SPAIN: Valladolid, Aldealbar, 867 m asl, hypogeous under *Pinus pinea* and *Quercus ilex*, *leg*. J. Cabero, 09-III-2014, JC32, AH44178 HOLOTYPE. Valladolid, Cogeces del Monte, under *P. pinea* and *Q. ilex*, sandy soil of gypsyferous marl, *leg*. F. García, 12-III-2013, JC34, AH44180. Valladolid, Tudela de Duero, La Manbla, hypogeous under *Pinus pinaster*, *leg*. P. Juste, 23-I-2009, JC33 PJ 124-G, AH44179.

Acknowledgements

We are grateful to Dr. J. Rejos, curator of AH herbarium, for his assistance with the specimens examined in the present study. We also thank P. Chautrand, F. García, A. García Blanco, G. Hensel, P. Juste, M. Loizides, R. Martínez, A. Montecchi, B. Moreno-Arroyo, G. Pacioni, J.-B. Pérez, C.M. Pérez del Amo, P. Ribollet, M.A. Sanz, F. Sáinz, and J.M. Vidal for kindly sending us their collections and images. Funding for the participation of M.E. Smith was provided in part by University of Florida's Institute for Food and Agricultural Sciences (IFAS).

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