

**BOLBITIUS ELEGANS, A STRIKING NEW SPECIES FROM
SOUTHERN SPAIN**

E. HORAK¹, G. MORENO², A. ORTEGA³ & F. ESTEVE-RAVENTÓS²

Bolbitius elegans spec. nov., a new species with gasteroid habit, is described and illustrated. Its taxonomic relationships with other taxa of *Bolbitius* and members of presumably related secotioid-gasteroid genera are discussed.

While studying the Basidiomycota of several habitats in southern Spain (Andalucía, provinces of Málaga, Huelva and Cádiz), the elegant basidiocarps of a bolbitiaceous agaric attracted our attention by their *Gastrocybe*- or *Galeropsis*-like habit. The weakly deliquescent basidiocarps with brilliant golden-yellow pileus and pale yellow stipe have exclusively been found on horse dung in open and grazed meadows on limestone.

The present taxon has previously been recorded as *Gastrocybe* sp. in the checklist referring to the Basidiomycota in or near the endemic *Abies pinsapo* forests in Andalucía (Ortega et al., 1996). On several later occasions, material in perfect condition was recollected which subsequently allowed a thorough analysis of the taxonomically relevant macro- and microscopic features of the ephemeral basidiocarps. Despite the fact that the basidiocarps are mimicking taxa of gasteroid *Bolbitiaceae*, it turned out that all morphological characters observed in the new taxon clearly indicate that this species belongs to the genus *Bolbitius* Fr. and not, as earlier suspected, to any of the associated secotioid-gasteroid genera (Heim, 1950, 1968; Watling & Gregory, 1981).

MATERIAL AND METHODS

SEM-photographs of the basidiospores, prepared by the critical point method, were taken with a Zeiss-DSM 950. For microscopic examination the material was mounted in KOH (4%), NH₄OH (2%) and Congo Red-solution.

The description of *Bolbitius elegans* is based upon data taken from collections found within close vicinity at three different localities. The holotype is deposited in the Herbarium AH (Alcalá, Madrid); isotypes and paratypes are lodged both in GDAC (Herbarium Granada, Spain) and ZT (Zurich, Switzerland).

Bolbitius elegans E. Horak, G. Moreno, A. Ortega & Esteve-Rav., spec. nov. —

Figs. 1–4

Pileus 10–35 × 4–12 mm, obtuse cylindrico, dein conicocampanulatus, secotioideus, luteus vel sulphureus, viscidus vel glutinosus, substriatus, fragilis, deliquescens. Lamellae liberae vel subattenuatae, densissimae, ochraceae, deliquescentes. Stipes 40–110 × 1–4 mm, cylindricus, stramineus, pruinosis,

1) Geobotanisches Institut ETH, Herbarium, Zollikerstrasse 107, CH-8008 Zurich, Switzerland.

2) Dpto. Biología Vegetal, Universidad de Alcalá, E-28871 Alcalá de Henares, Madrid, Spain.

3) Dpto. Biología Vegetal, Fac. de Ciencias Biológicas, Universidad de Granada, E-18071 Granada, Spain.

fistulosus, fragilis. Velum nullum. Caro fragilissima. Odor saporque nulli. Basidiosporae 12–15(–18) × 6.5–9(–12) µm, leves, ellipsoideae, poro conspicuo instructae, crassetunicatae. Basidia 23–30 × 11–13 µm, sphaeropedunculata, 4-sporigera. Cheilocystidia usque ad 45 µm diam., globosa vel ovoidea, conspicua, hyalina. Pleurocystidia nulla. Caulocystidia 70 × 9–13 µm, polymorphica. Pileipellis ex cellululis clavatis, 40–60 × 12–25 µm, ixohymenidermium formantibus. Fibulae nullae. Ad fimum equinum.

Holotypus: Hispania, Málaga, prov. Ronda, Nava de San Luis, 2 Nov. 1994, Alcoba, Esteve-Raventós, Horak & Ortega, AH 19372 (holotypus). Isotypus: GDAC 39965, paratypus: ZT 5273, AH 19577.

Pileus 10–35 × 4–12 mm, at first narrowly cylindrical-conical with obtuse apex, then conical-campanulate, not or barely expanding, colour varying between golden-yellow, egg-yellow to lemon-yellow when young, gradually changing to grey-ferruginous or ochraceous-brown in ageing and overmature basidiocarps, surface smooth, viscid to strongly glutinous when moist, margin straight weakly transparent-striate, attached to stipe in young and collapsing pilei, but separated in mature specimens, veil remnants absent. Lamellae very crowded, straight and radially arranged (rarely anastomosing but never lacunose), free to adnexed to stipe, slightly ventricose, ochraceous to ochre-orange at maturity, rapidly deliquescent, autolysis beginning at the whitish edges. Stipe 40–110 × 1–4 mm, cylindrical, flexuose, fistulose, brittle, lemon-yellow when fresh, then straw-yellow to isabel, at first conspicuously pruinose to furfureaceous, becoming glabrous with age, dry, hollow, solitary or in groups, rarely cespitose, veil remnants absent. Context in pileus and stipe very fragile. Smell fungoid. Taste not recorded. Spore print brilliant rust orange.

Basidiospores 12–15(–18) × 6.5–9(–12) µm, smooth (also in SEM), ellipsoid, sometimes slightly phaseoliform and constricted in profile, with up to 0.6 µm thick walls, orange-brown in KOH (2%), with broad germ pore (1.2–1.8 µm diam.), mostly with central apiculus, occasionally with attached remnants of sterigmata. Basidia 23–30 × 11–13 µm, sphaeropedunculate, 4-spored, sterigmata up to 3.5 µm. Cheilocystidia up to 45 µm in diam., globose to ovoid, forming a nearly homogeneous sterile band on the lamellar edges, sometimes forming two or even three aggregated rows, easily collapsing, thin-walled, hyaline. Hymenial trama soon collapsing. Pleurocystidia absent. Caulocystidia up to 70 × 9–13 µm, conspicuous, polymorphic, usually cylindrical to clavate or slenderly vesiculose, without irregular, finger- or knob-like excrescences (cf. *Bolbitius vitellinus*), thin-walled, hyaline. Pileipellis an ixohymeniderm, composed of long clavate elements 40–60 × 12–25 µm, embedded in gel, with yellowish plasmatic pigment, hypoderm of cylindrical, parallel hyphae (up to 3 µm in diam.). Clamp-connections absent at all septa of the hyphae and basidia.

Collections studied. SPAIN: Málaga, Nava de San Luis, 2 Nov. 1994, on horse dung in pastures, Alcoba, Esteve-Raventós, Horak & Ortega, AH 19372 (holotype); same locality, GDAC 39965 (isotype); Ronda, Sierra de las Nieves, Pílonas, Casa forestal Felix Rodriguez de la Fuente, 2 Nov. 1994, same habitat, Horak 5273 (ZT, paratype); Huelva, Aracena, 27 Nov. 1999, on donkey dung in pastures, R. Galán, G. Moreno & L. Romero de la Osa, AH 19577 (paratype).

DISCUSSION

The most distinctive characters of *Bolbitius elegans* are the yellow colours of the gasteroid, subdeliquescent basidiocarps, the well-developed ixohymeniderm of the pileipellis and the conspicuous, vesiculose to subglobose cheilocystidia on the lamella edges.

In the field the basidiocarps of this taxon with conical and non-expanding pilei can easily be mistaken either for an aberrant form belonging to the *B. vitellinus*-complex or for a species related to the heterogeneous group of gasteroid Bolbitiaceae (Watling & Gregory, 1981).

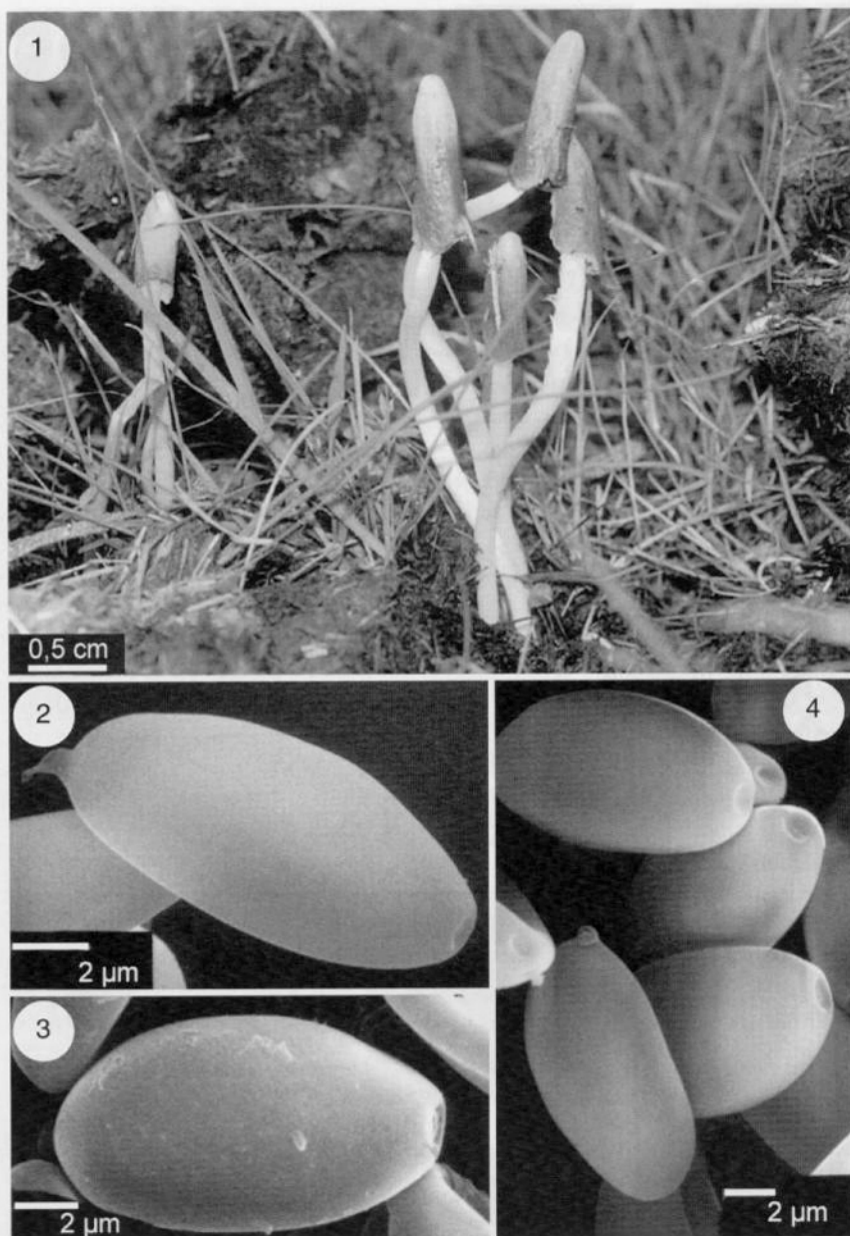


Fig. 1. *Bolbitius elegans* (AH 19372, holotype). — 1. Basidiocarps; 2–4. basidiospores showing germ pore.

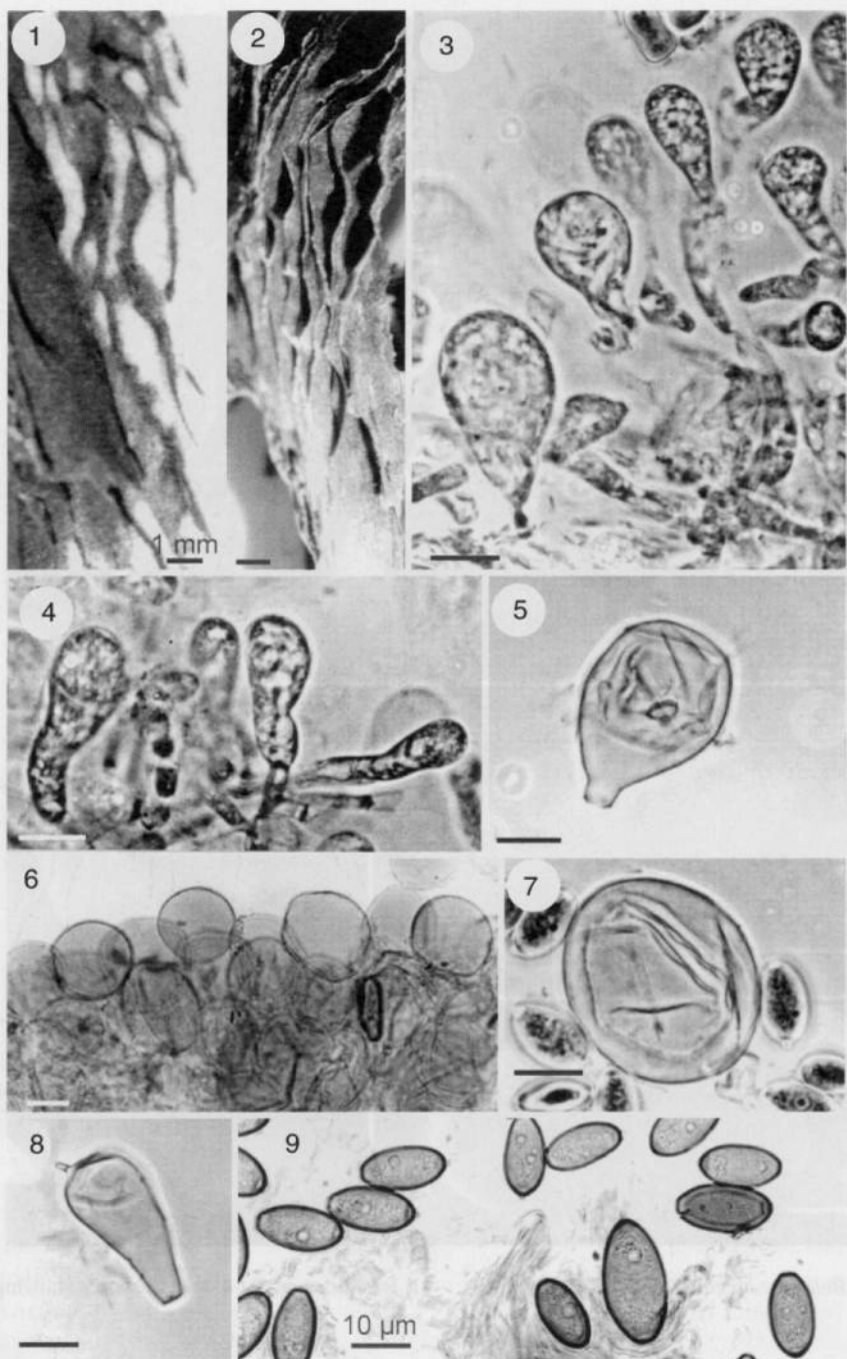


Fig. 2. *Bolbitius elegans* (AH 19372, holotype). — 1 & 2. Collapsed and agglutinated lamellae near pileal insertion (bar = 1 mm); 3 & 4. cells of pileipellis forming an ixohymeniderm (bar = 10 µm); 5. edge of lamella with cheilocystidia (bar = 10 µm); 6 & 7. cheilocystidia (bar = 10 µm); 8. basidium; 9. spores.

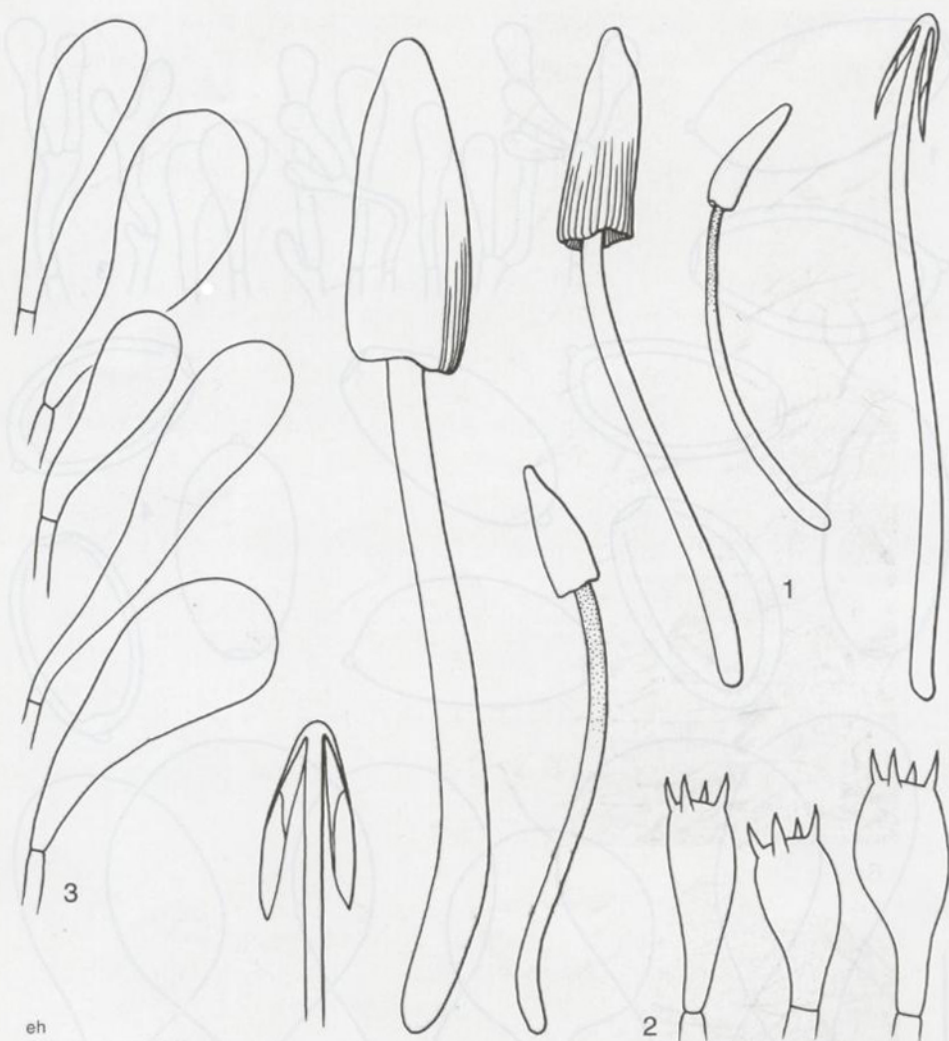


Fig. 3. *Bolbitius elegans* (ZT 5273, paratype). — 1. Basidiocarps (bar = 20 mm); 2. basidia ($\times 1000$, bar = 20 μm); 3. caulocystidia ($\times 1000$, bar = 20 μm).

The pileal ixohymeniderm composed of elongate, clavate cells packed into a gelatinous matrix, clearly suggests a taxon belonging to the genus *Bolbitius*. Some species of *Conocybe* Fayod, which, however, are non-deliquescent, may also have a slightly gelatinized pileipellis, e.g. *C. coprophila* (Kühner) Kühner and *C. rickenii* (Schaeff.) Kühner. In comparison to these taxa the thickness of the ixohymeniderm in *B. elegans* exceeds that of the hymeniderm.

Following the taxonomic concepts proposed by Bon (1992), only a few species of *Bolbitius* (considered as *Conocybe* by some authorities) actually have typical lecythiform cheilocystidia, e.g. *B. tener* Berk. & Broome (= *Conocybe lactea* ss. auct.), *B. lacteus* J.E. Lange and *B. crispus* (Longyear) Bon. In *B. elegans*, however, the edges of the lamellae

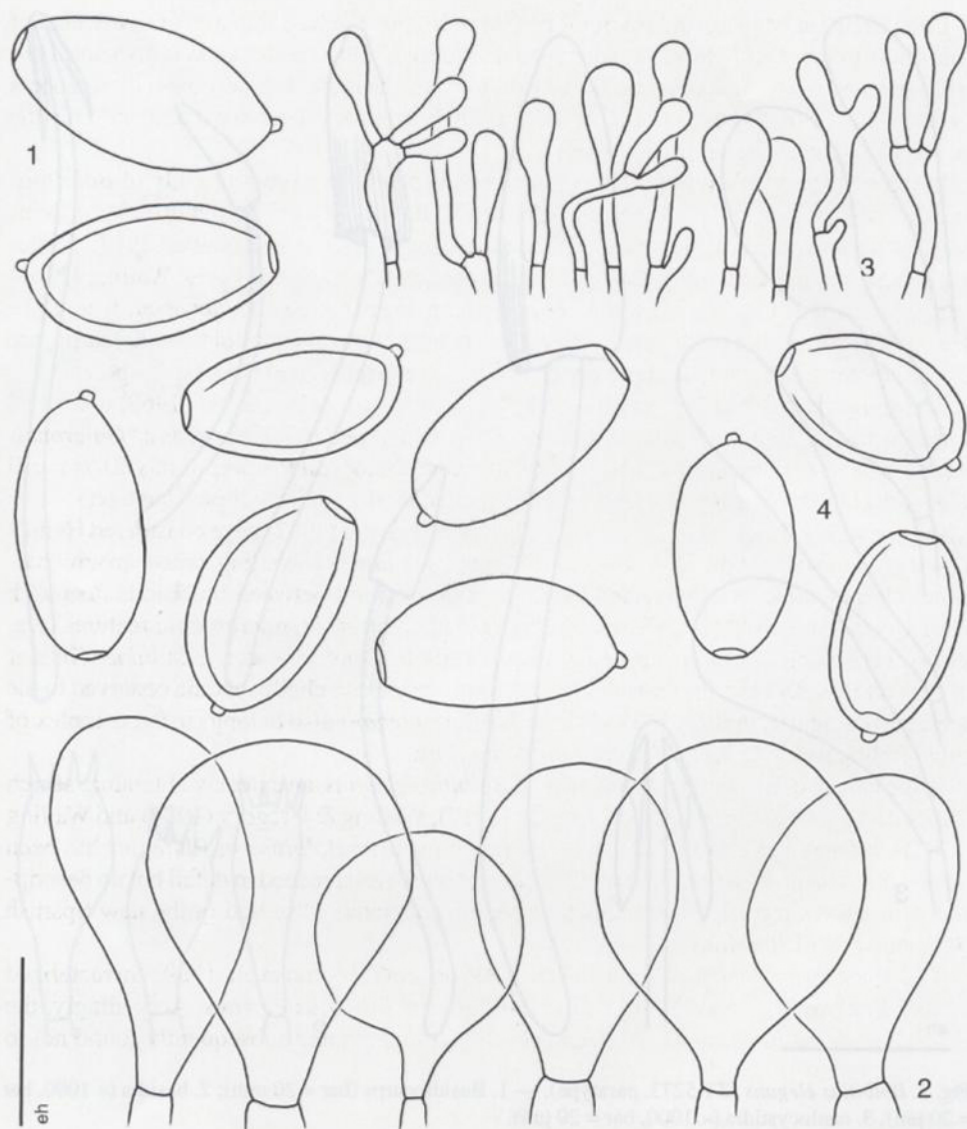


Fig. 4. *Bolbitius elegans* (ZT 5273, paratype). — 1. Basidiospores ($\times 2000$, bar = 10 μm); 2. cheilocystidia ($\times 1000$, bar = 20 μm); 3. pileipellis (ixohymeniderm, $\times 500$, bar = 40 μm). — *Gastrocybe lateritia* Watling (E 18098). 4. Basidiospores ($\times 2000$, bar = 10 μm).

are exclusively composed of large, broadly clavate to globose-vesiculose cheilocystidia. This distinctive character separates *B. elegans* from related taxa belonging to the *B. vitellinus*-complex, in which the shape of the cheilocystidia and/or caulocystidia usually ranges from fusiform or lageniform to irregular (Horak, 1968; Enderle et al., 1985; Cacialli et al., 1995).

Depending on edaphic and microclimatic conditions, the basidiocarps of many taxa of *Bolbitius* more or less exhibit a tendency to deliquesce. This phenomenon is also observed in the new species from Spain. In contrast to other taxa, the rather fast decomposition process observed in *B. elegans* does not allow the narrowly conical pileus to expand and thus the basidiocarps retain the secotioid aspect.

In the opinion of Watling (1968), *Gastrocybe* is probably a secotioid ally of *Bolbitius*. The description of the type species, *G. lateritia* Watling (collected in Michigan, USA), emphasizes the hymeniform pileipellis, formed by pyriform, hyaline cells (Babos, 1987). Exclusively based on the assumption of a passive discharge of the basidiospores, Watling (1968) concludes that *G. lateritia* should be considered a secotioid genus. However, it must be stressed that many taxa of *Coprinus* Pers., developing typical agaricoid basidiocarps, are also characterized by both deliquescence and passive discharge of the basidiospores.

The same year as Watling proposed the new genus *Gastrocybe*, Heim (1968) described *Bolbitius rogersii* (ad. int., nom. nud.) from Africa. This species is defined as a "*Galeropsis* charnu ou *Bolbitius* subangiocarpe?". The macromorphological features of this taxon recall *B. elegans* but the two species are readily separated by their microscopic characters.

Subsequently, Singer (1975) and Singer & Ponce de Leon (1982) have considered Heim's invalidly published taxon as a synonym of *Gastrocybe lateritia* Watling, whose macrocharacters clearly point to its intermediate taxonomic position between bolbitious taxa with agaricoid and secotioid basidiocarps. In the case of *G. lateritia*, microscopic features (e.g. lecythiform cheilocystidia) support a close affinity to *Conocybe* sect. *Candidae* (Kühner ex Singer) Bon. Despite the conspicuous, clavate-vesiculose cheilocystidia observed in the new Spanish agaric, there is no doubt that *Bolbitius elegans* also belongs to the complex of rather polymorphic taxa centred around *B. vitellinus*.

In the course of evaluating the identity of *Bolbitius elegans*, an extensive literature search [supported by the data published in Murrill (1917), Watling & Gregory (1981) and Watling (1982)], referring to taxa described as belonging to either *Bolbitius* or *Pluteolus* has been carried out. The protologues of about 50 species have been screened in detail but no description was discovered which matches the specific characters observed in the new Spanish representative of *Bolbitius*.

The procedure also included taxa of secotioid genera (Moreno et al., 1989) characterized by basidiocarps whose general habit recall those of *Bolbitius elegans*. Accordingly, the following secotioid species have been critically compared and subsequently found not to be conspecific:

Cyttarophyllopsis cordispora R. Heim (1968).

Galeropsis angusticeps (Peck) Singer (1963) (Bas.: *Galera angusticeps* Peck, Bull. Torrey Bot. Club 24 (1897) 143).

Galeropsis aporos Courtecuisse (1993).

Gastrocybe iberica G. Moreno, Illana & Heykoop (1987).

Gastrocybe lateritia Watling (1968).

Panaeolopsis nirimpii Watling & Young (1983).

Additional collections examined for comparison

Bolbitius coprophilus (Peck) Hongo. Mem. Fac. Liberal Arts Educ. Shiga Univ., Nat. Sci. 9 (1959) 82. CZECH REPUBLIC: Moravia, Paskov, in caldario SEMPRA, 21 Feb. 1989, det. Kuthan, CS 89-40 (ZT 6252).

Bolbitius variicolor Atkinson. Stud. Am. Fungi (1900) 154. CZECH REPUBLIC: Moravia, Paskov, in caldario SEMPRA, 6 March 1989, det. Kuthan, CS 89-51 (ZT 6253).

Bolbitius vitellinus (Pers.: Fr.) Fr. Epicrisis (1838) 254. SWITZERLAND: GR, Davos, Teufi, 1680 m, on rotting hay, 27 July 1964, det. Horak, 64-212 (ZT); GR, Susch, 1440 m, in manured meadow, 17 Sept. 1975, det. Horak, 6351 (ZT); SO, Olten, Kappel, among rotting grass, Oct. 1963, det. Horak, 63-263 (ZT). TI; Verzasca, Alpe Tencia near Brione, in manured grassland, 1500 m, 14 Oct. 1966, det. Horak, 66-690 (ZT). — USA: TN, Johnson Co., Shady Valley, among rotting leaves on soil, 17 June 1987, det. Horak, 3963 (ZT).

Gastrocybe lateritia Watling. Michigan Bot. 7 (1968) 20. SPAIN: Barcelona, on lawn in newly arranged garden, autumn 1984, Tabarés, det. Watling, 18100 (E). — CANADA: Ontario, Senator O'Connor school, in lawn, 14 Aug. 1983, Miller, det. Watling, 18098 (E). — ITALY: Rome, in lawn with *Poa pratensis*, July 1984, det. Watling, 18099 (E).

ACKNOWLEDGEMENTS

This contribution has been partly supported by Project PB95-0129 Flora Micológica Ibérica III, granted by the Dirección General de Investigación Científica y Técnica (Ministerio de Educación y Cultura). The authors are grateful to J.A. Pérez and A. Priego (Servicio de Microscopía Electrónica de la Universidad de Alcalá) for processing the SEM photographs.

REFERENCES

- Babos, M. 1987. Weitere Daten zur Verbreitung und Oekologie von *Gastrocybe lateritia* Watling und *Russula atrorubens* Quélet. ss. Lange in Europa. Beitr. Kenntn. Pilze Mitteleuropa 3: 283–288.
- Bon, M. 1992. Clé monographique des espèces galero-naucorioides. Doc. Mycol. 21 (84): 1–89.
- Cacialli, G., V. Caroti & F. Doveri. 1995. Funghi fimicoli e rari o interessanti del litorale toscano. Schede di Micologia, vol. 1. Centro Studi Micologici (AMB).
- Courtecuisse, R. 1993. *Galeropsis aporos* sp. n., genre et espèce nouveaux pour la France. Doc. Mycol. 22: 1–6.
- Enderle, M., E. Kajan & G.J. Kriegelsteiner. 1985. Studien in der Gattung *Bolbitius* Fries. Arbeitsg. Pilzk. Nieder. (APN) 3 (1): 5–34.
- Heim, R. 1950. Le genre *Galeropsis* Vel. (= *Cyttarophyllum* Heim) trait d'union entre Agarics et Gastérols. Rev. Mycol. (Paris) 15: 3–28.
- Heim, R. 1968. Deuxième mémoire sur les *Cyttarophyllés*. Bull. Soc. Mycol. France 84: 103–118.
- Horak, E. 1968. Synopsis generum Agaricalium (Die Gattungstypen der Agaricales). Beitr. Kryptogamenfl. Schweiz 13: 1–741.
- Moreno, G., C. Illana & M. Heykoop. 1987. *Gastrocybe iberica* sp. nov. in Spain (Bolbitiaceae, Agaricales). Cryptog. Mycol. 8: 321–327.
- Moreno, G., C. Illana & M. Heykoop. 1989. Studies on *Galeropsis* and *Gastrocybe* (Bolbitiaceae, Agaricales). Mycotaxon 36: 63–72.
- Murrill, W.A. 1917. *Pluteolus*. N. Am. Fl. 10: 186–193.
- Ortega, A., F. Esteve-Raventós, E. Horak & G. Moreno. 1996. Aportación al catálogo de los macromicetos del área potencial del *Abies pinsapo* en España. Bol. Soc. Micol. Madrid 21: 219–249.
- Singer, R. 1963. Notes on scotiaceous fungi: *Galeropsis* and *Brauniella*. Kon. Nederl. Acad. Wetensch. Proc. C. 66: 106–117.
- Singer, R. 1975. The Agaricales in Modern Taxonomy. 3rd edition. J. Cramer, Vaduz.
- Singer, R. & P. Ponce de Leon. 1982. *Galeropsidaceae* West of the Rocky Mountains. Mycotaxon 14: 82–90.
- Watling, R. 1968. Observations on the Bolbitiaceae. 4. A new genus of gasteromycetoid fungi. Michigan Bot. 7: 19–24.
- Watling, R. 1982. Bolbitiaceae: *Agrocybe*, *Bolbitius* and *Conocybe*. Brit. Fung. Fl. 3: 1–139 (R. Bot. Garden, Edinburgh).

- Watling, R. & N.M. Gregory. 1981. Census catalogue of world members of the Bolbitiaceae. *Bibl. Mycol.* 82: 1-224.
- Watling, R. & T. Young. 1983. A new species of *Panaeolopsis* Singer. *Not. Roy. Bot. Gard. Edinburgh* 41: 395-399.