

PROTOGLOSSUM AROMATICUM, A SEQUESTRATE FUNGUS RELATED TO *CORTINARIUS*, WIDELY DISTRIBUTED IN EUROPE AND NORTH AMERICA

Josep M. VIDAL

Dept. de Biologia Vegetal, Facultat de Biologia, Univ. de Barcelona, Av. Diagonal 645. E-08028 Barcelona

(Personal address: Massaballs 10. E-17118 Sant Sadurní de l'Heura, Girona, Spain).

*Work dedicated to the friend and colleague
August Rocabrana, in his 80 birthday*

ABSTRACT. *Protoglossum aromaticum*, a sequestrate fungus related to *Cortinarius*, widely distributed in Europe and North America. A new combination, *Protoglossum aromaticum* (Velen.) Vidal, is proposed as a result of the revision of herbarium material from Europe, North America, and Australia currently included in the genera *Hymenogaster* and *Protoglossum*, with the addition of the study of several Spanish collections of *Hymenogaster aromaticus* Velen. The rich synonymy of this taxon is updated, and the available data regarding its ecology, phenology, and distribution in Europe and North America are enriched and summarized.

Key words: *Hymenogaster*, *Protoglossum*, taxonomy, chorology, Europe, North America.

RESUM. *Protoglossum aromaticum*, un fong segregat, relacionat amb *Cortinarius*, ampliament distribuït per Europa i Amèrica del Nord. Com a resultat de la revisió de material d'herbari d'Europa, Amèrica del Nord i Austràlia, inclòs en els gèneres *Hymenogaster* i *Protoglossum*, complementada amb l'estudi de diverses recol·leccions d'*Hymenogaster aromaticus* Velen., fetes a Espanya, es proposa una nova combinació *Protoglossum aromaticum* (Velen.) Vidal. La rica sinonímia d'aquest tàxon ha estat actualitzada, i les dades disponibles referents a la seva fenologia, ecologia i distribució a Europa i Amèrica del Nord han estat enriquides i resumides.

RESUMEN. *Protoglossum aromaticum*, un hongo secuestrado relacionado con *Cortinarius*, y ampliamente distribuido por Europa y Norteamérica. Como resultado de la revisión de material de herbario de Europa, Norteamérica y Australia perteneciente a los géneros *Hymenogaster* y *Protoglossum*, complementada con el estudio de diferentes recolecciones de *Hymenogaster aromaticus* Velen., efectuadas en España, se propone la combinación nueva *Protoglossum aromaticum* (Velen.) Vidal. La rica sinonímia de este taxón se presenta actualizada, y los datos disponibles referentes a su fenología, ecología y distribución en Europa y Norteamérica han sido complementados y resumidos.

INTRODUCTION

The genus *Protoglossum* was created by MASSEE (1891) to accommodate a collection from Australia. It is defined by the angiocarpic basidiomata, of globose or subglobose shape, a loculated gleba, and a sterile basis scarcely developed, sometimes penetrating into the gleba as a dendroid, very reduced, columella. The spores are holotropic, rusty-brown-colored, elliptic to subglobose, verrucose, sheathed with a very thin perisporium. This set of features clearly related with those of the *Cortinarius*. Up to now, only 6 species were known, 5 of them from the Southern Hemisphere (Australia) and living in association with *Eucalyptus*. *Protoglossum luteum* Masee is the type species. *P. cribbiae* (A.H. Sm.) T.W. May, *P. purpureum* (J.W. Cribb) T.W. May, *P. violaceum* (Masee et Rodway) T.W. May and *P. viscidum* (Masee et Rodway) T.W. May, were previously included in the genus *Hymenogaster* or in *Hysterangium*, and they were later recombined by BOUGHER & CASTELLANO (1993) in the genus *Cortinomyces*. As this last genus was later invalidated by MAY (1995), they were ultimately accommodated in the genus *Protoglossum*. The only European species, *P. niveum* (Vittad.) T.W. May

(= *Hymenogaster niveus* Vittad.), do not fits well in this genus, because of its different sporal features, and we find adviceable to keep it in the genus *Hymenogaster*.

The present work has been based upon the study of fresh material, collected by the author and collaborators, labeled JMV and kept in the herbaria MA and BCN, and complemented with the revision of material sent in loan by the following public herbaria BPI (Beltsville, USA), E (Edinburgh, UK), FH (Cambridge, USA), K (Kew, UK), M (München, Germany), MA (Madrid, Spain), NY (New York, USA), OSC (Corvallis, USA), PRM (Praha, Czech Republic), UC (Berkeley, USA) and UPS (Uppsala, Sweden), and by the personal herbarium of G. Gross (GG). The colours has been identified following the color guide of KORNERUP & WANSCHER (1978), after the indication K&W. The measurements and the M.O. photographs has been made on material previously rehydrated with chloral hydrate or KOH.

As a result of the revision of herbarium material of a number of collections of *Hymenogaster* and *Protoglossum*, and of fresh material of *Hymenogaster aromaticus* Velen., we propose the following new combination.

DESCRIPTION

Protoglossum aromaticum (Velen.) Vidal, comb. nov.

Basionym.- *Hymenogaster aromaticus* Velen., *České houby*: 800 (1922)

Syn.- *Hymenogaster remyi* C.W. Dodge et Zeller, *Ann. Mo. Bot. Gard.* 21: 679 (1934); *Rhizopogoniella haasii* Soehner, *Zeitschr. f. Pilzk.* 14: 11 (1953); *Hymenogaster brunnescens* A.H. Sm., *Mycologia* 58: 111 (1966); *H. diabolus* A.H. Sm., *Mycologia* 58: 107 (1966); *H. subcaeruleus* A.H. Sm., *Mycologia* 58: 106 (1966); *H. sublilacinus* A.H. Sm., *Mycologia* 58: 108 (1966); *H. subochraceus* A.H. Sm., *Mycologia* 58: 110 (1966); *H. subolivaceus* A.H. Sm., *Mycologia* 58: 109 (1966)

Misappl.- *Hymenogaster arenarius* sensu Velen., *České houby*: 800 (1922)

Excl.- *Hymenogaster aromaticus* sensu Gregori & Puxeddu, *Micol. Ital.* 24(2): 9 (1995) (= *H. populetorum*)

ICON. AND BIBL. SEL.- VELENOVSKY (1922: 800, f. 149/19 ut *H. aromaticus*); DODGE & ZELLER (1934: 679, pl. 18, f. 30 ut *H. remyi*; 680 ut *H. aromaticus*); ZELLER (1941: 198-199 ut *H. remyi*); SOEHNER (1953: 11-13 ut *R. haasii*); KNAPP (1956: 94-96 ut *R. haasii*); KNAPP (1957: 86, tab. 9/3 ut *H. aromaticus*); SVRČEK (1958: 153-154, f. 37/1 ut *H. remyi*); SMITH (1966: 106-111 ut *H. brunnescens*, *H. diabolus*, *H. subcaeruleus*, *H. sublilacinus*, *H. subochraceus* and *H. subolivaceus*; 122-123 ut *H. remyi*); GROSS *et al.* (1980: 60, 121 ut *H. aromaticus*); CALONGE (1982: 145, f. 3 ut *H. remyi*); STATES (1984: 356-357, f. 3 ut *H. brunnescens*); FOGEL (1985: 79-81 ut *H. sublilacinus*); ARORA (1986: 749 ut *H. sublilacinus*); MONTECCHI & LAZZARI (1990: 27-28, tab. 1/5 ut *H. aromaticus*); STATES (1990: 194, fot. 195 ut *H. sublilacinus*); AUGUADRI *et al.* (1991: 290, fot. 15 ut *H. remyi*); VIDAL *et al.* (1991: 136, f. 3a ut *H. aromaticus*); CAZARES *et al.* (1992: 351, f. 53-55 ut *H. sublilacinus*); MONTECCHI & LAZZARI (1993: 257, fot. 256 ut *H. aromaticus*); MADER & MADER (1994: 9-13, tabs. 1/1-10, 2/1-9 ut *H. remyi*); CALONGE *et al.* (1995: 297, f. 4 ut *H. remyi*); SANCHEZ *et al.* (1995: 273, f. 4 ut *H. remyi*); MONTECCHI & SARASINI (2000: 460-461, fot. 461 ut *H. aromaticus*).

Basidioma angiocarpic, of variable size, 1-7.5 cm diam., typically turbinate, also subglobose, irregular or lobate, often two or more specimens laterally joined, sessile or with a diminute sterile base and a white rhizomorph. Peridium thin, fibrillose, not viscid, partially evanescent and showing the chambers, initially pure white, violaceous (K&W 16C4) or yellow with olivaceous hues (K&W 4A5-4B5), finally maculated of brown (K&W 7E7). Gleba loculated, whitish or violaceous when young, later cinnamomeous (K&W 6D6), brown in exsiccata (K&W 7E7); chambers minute, 0.3-2 mm, void. Sterile base small, sometimes with a pseudostipe up to 1.5 × 0.5 cm. Columella reduced, dendroid, white, yellowish in the sterile base. Odour variable, intense, generally farinaceous, resinaceous or herbaceous, sometimes fruity.

Spores small, 8-12.5-(14) × 5-8-(9) µm (ornam. and hilar appendix excl.), elliptical or ovate, verrucose; warts 0.1-0.2 µm, more developed on the apex, up to 0.5 µm; myxosporium applicated and

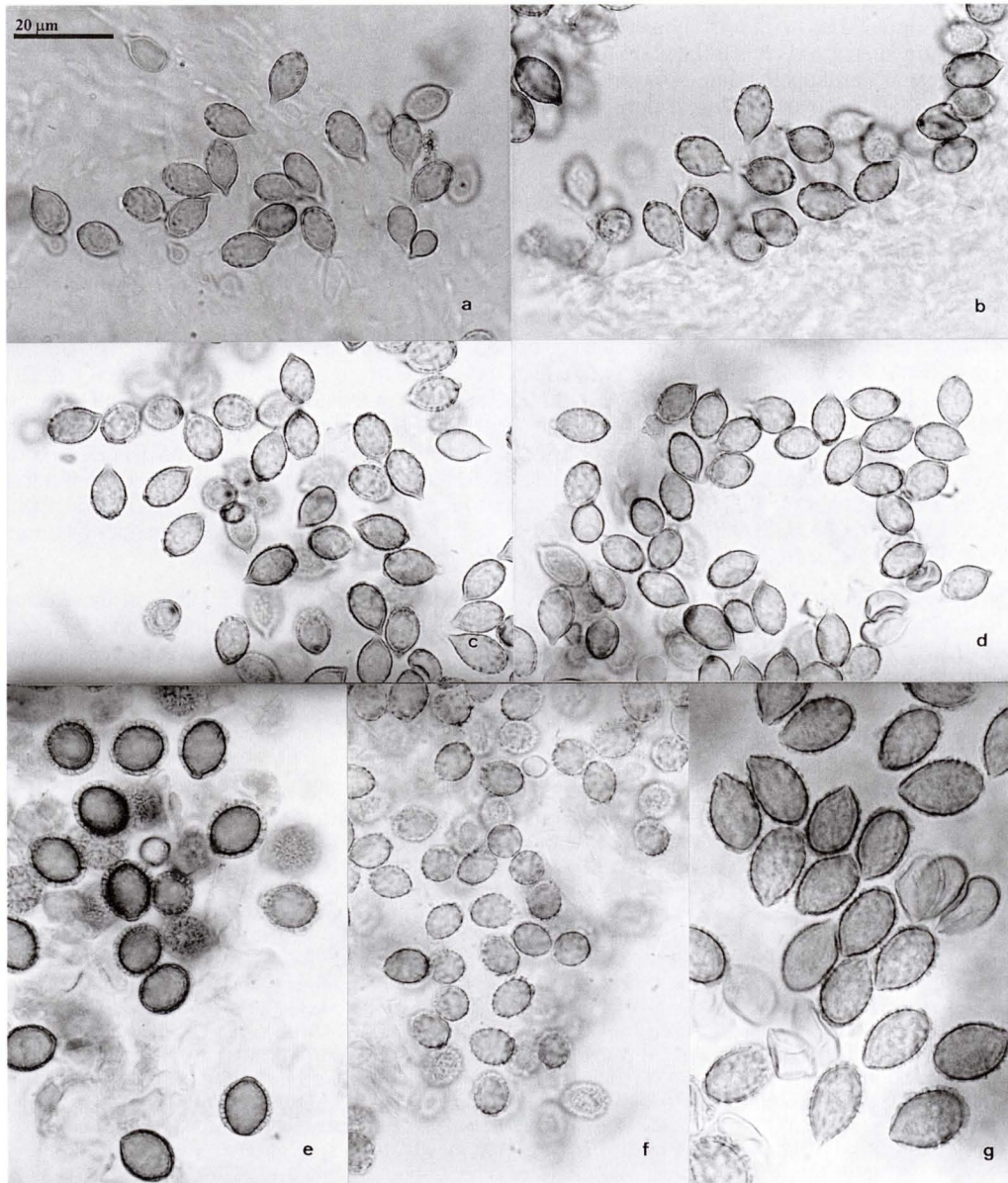


Fig. 1.- Spores of : **a)** *H. aromaticus* (PRM 487425), **b)** *H. remyi* (FH, *lectotypus*), **c)** *R. haasii* (M 2262, *lectotypus*), **d)** *H. sublilacinus* (OSC 39504, mat. orig.), **e)** *P. luteum* (K 69334, *holotypus*), **f)** *P. violaceum* (NY 2596, *isolectotypus*), **g)** *P. viscidum* (NY, Rodway 1272a).

poorly developed; hilar appendix conical, small, 0.5-1.5-(2) μm long, without hilar pore; inamiloid, dextrinoid, yellow in H_2O , red-brownish in KOH. Basidia 4-spored, hyaline, cylindrical, thin-walled, 35-50 \times 6-10 μm . Basidioles clavate, 17-45 \times 8-17 μm . Cystidia absent. Subhymenial layer cellular, with cells inflated up to 25 μm . Hymenophoral trama 80-240 μm , of hyaline hyphae 3-17.5 μm diam., with enlargements and cells inflated up to 30 μm . Clamp connections and oleiferous hyphae present in all tissues. Peridiopellis thin, bi-layered, 200-500 μm , not match differentiated. Suprapellis up to 200 μm , of interwoven yellowish thin-walled hyphae, 3-8 μm diam. Subpellis up to 300 μm , of interwoven thin-walled hyphae, 4-10 μm , becoming inflated up to 22.5 μm , and confluent with the hymenophoral trama.

HABITAT AND DISTRIBUTION.- Frequently gregarious, hypogeous or semihypogeous under acicules, in montane and subalpine conifer woods of *Abies*, *Cedrus*, *Picea* and *Pinus*, between 800-2700 m of altitude, on calcareous or siliceous soil, ripening in spring-summer, after the fusion of the snow, from march to july, in Europe, and from june to august, in North America, following the altitude and the latitude.

DISTRIBUTION IN EUROPE.- Widely distributed, has been found in Central Europe, along the Alps, in Austria (MADER & MADER, 1994), Switzerland (AUGUADRI *et al.*, 1991) and France (DODGE & ZELLER, 1934; MONTECCHI & SARASINI, 2000), and in the adjacent mountains, in Germany (Schwarzwald, SOEHNER, 1953) and Czech Republik (Bohemia mountains, VELENOVSKÝ, 1922; SVRČEK, 1958), and in South Europe, in the Appenine Mountains, in Italy (MONTECCHI & LAZZARI, 1990, 1993), in the Pyrenean Mountains, Sistema Iberico Mountains and Sistema Central Mountains, in Spain (CALONGE, 1982; VIDAL *et al.*, 1991; VIDAL, 1994; CALONGE *et al.*, 1995; SANCHEZ *et al.*, 1995; GARCÍA *et al.*, 1996). The italian citation of Sardegna under *Quercus ilex* by GREGORI & PUXEDDU (1995) is a misidentification for *H. populetorum*.

DISTRIBUTION IN NORTH AMERICA.- It has been found in the West Coast of USA, in the Rocky Mountains, Coast Mountains and Sierra Nevada, from Washington to California and Arizona (ZELLER, 1941; SMITH, 1966; STATES, 1984, 1990; FOGEL, 1985; ARORA, 1986), reaching to North of Mexico, in the Sierra Madre Oriental (CÁZARES *et al.*, 1992).

COLLECTIONS EXAMINED

Protoglossum aromaticum:

CZECH REPUBLIK: Karlštejn, 15-5-1926, *leg.* Klika ut *Hymenogaster aromaticus* Velen. (PRM 487425).- K. Týn, 5-1927, *leg.* Klika ut *H. aromaticus* (PRM 485552).- Mnichovice, without date, *leg.* Klika, ut *Hymenogaster arenarius* Tul. et C. Tul., *rev.* Svrcek? ut *H. remyi* (PRM 486879).- GERMANY: Mainfranken, 15-7-1981, *leg.* Hintz, *det.* G. Gross ut *H. aromaticus* (GG 805).- *Ibid.*, 17-7-1981, *leg.* Hintz, *det.* G. Gross ut *H. aromaticus* (GG 806).- Schwenningen a Neck., 2-6-1950, *leg.* Dr. Haas, *det.* Soehner, ut *Rhizopogoniella haasii* (M 2262, lectotypus of *R. haasii* designated here).- *Ibid.*, 20-6-1950, 21-6-1950, *leg.* Dr. Haas, *det.* Soehner, ut *R. haasii* (M 2266, sintypus).- FRANCE: Hautes Alpes, Briançon, sous les bois sylvestris et bien alpinées, 6-1923, *leg.* M. Rémy, *det.* Patouillard ut *Hymenogaster klotzschii* (FH, Herb. Patouillard, lectotypus of *H. remyi* selectionated here; NY, Herb. Zeller, isolectotypus selectionated here).- Maillane, Chemin Roland, Cedraie du Ventoux, 10-6-1984, under *Cedrus*, *leg.* Rioussat 84020, *det.* G. Gross ut *H. aromaticus* (GG 949).- SPAIN: Avila, Pequerinos, Camping del Valle de Enmedio, 1425 m, 15-3-1998, under *Pinus sylvestris*, on siliceous soil, *leg.* J. Daniel Arranz, *det.* J.M. Vidal and F-D. Calonge ut *H. aromaticus* (MA-Fungi 39163).- Barcelona, Sant Jaume de Frontanyà, 1000 m, 1-5-2000, under *P. sylvestris*, on calcareous soil, *leg.* J.M. Vidal (JMV 20000501-1).- Girona, Alp, Salteguet, 1600 m, 22-6-1996, under *Abies alba*, on siliceous soil, *leg.* J.M. Vidal (JMV 960622-8).- *Ibid.*, Planoles, l'Avetar, 1600 m, 19-5-2002, under *A. alba* and *Pinus uncinata*, on siliceous soil, *leg.* M.A. Pérez-De-Gregorio (JMV 20020519-1).- *Ibid.*, Setcases, Baga de Carboner, 1700 m, 20-6-1998, under *A. alba*, on siliceous soil, *leg.* J.M. Vidal (JMV 980620-6).- Guadalajara, Aldeanueva de Atienza, 4-6-1978, *leg.* B. Moreno, *det.* F.D. Calonge ut *H. remyi* (MA-Fungi 2742).- Lleida, Llés, 1600 m, 12-6-1999, under *Pinus uncinata* and *P. sylvestris*, on siliceous soil, *leg.* J.M. Vidal (JMV 990612-5).- *Ibid.*, Montgarri, 1600 m, 26-6-1999, under *A. alba*, on siliceous soil, *leg.* J.M. Vidal and J. Vila (JMV 990626-2).- *Ibid.*, València d'Aneu, Mata de València, Bosc del Gerdar, 1600 m, 26-6-1999, under *A. alba*, on clayey soil, *leg.* J.M. Vidal and J. Vila (JMV 990626-3).- *Ibid.*, Espot, Plaça del Arbres, 1700 m, under *A. alba*, on siliceous soil, *leg.* J.M. Vidal and J. Vila (JMV 990626-11).- Segovia, Cuéllar, 800 m, 23-3-1995, under *P. sylvestris*, *leg.* F. García (JMV 950323-0).- *Ibid.*, 26-3-1995, under *P. sylvestris*, *leg.* F. García, *det.* F.D. Calonge ut *H. remyi* (MA-Fungi 33404).- Soria, Covaleda, 1200 m, 8-4-1998, under *P. sylvestris*, *leg.* and *det.* A. Suárez Fernández ut *H. aromaticus* (MA-Fungi 39628).- Teruel, Cedrillas, 1-5-1993, under *P. sylvestris*, *leg.* and *det.* F.D. Calonge ut *H. remyi* (MA-Fungi 32175).- *Ibid.*, Mosqueruela, Pinar Ciego, 14-5-1990, *leg.* A. Guerra, *det.* F.D. Calonge ut *H. remyi* (MA-Fungi 31207).- *Ibid.*, Peñarroya, Fuenroya, under *P. sylvestris*, 22-5-1988, *leg.* A. Rocabrana ut *H. remyi* (MA-

Fungi 21555).- USA: California, Mt. Shasta, Horse Camp, 8000 ft., 31-7-1939, under *Abies magnifica* var. *shastensis*, leg. W.B. Cooke 13376, det. S.M. Zeller ut *H. remyi* (NY).- *Ibid.*, Yuba Pass, Sierra Co., about 5 miles south from Hwy. 49, scattered beneath *A. magnifica*, leg. M.T. Seidl, det. H. Saylor 1986 ut *Hymenogaster sublilacinus* (UC 1573156).- *Ibid.*, 9-6-1987, leg. and det. R.E. Halling ut *H. sublilacinus* (MA-Fungi 29751).- Idaho, Valley Co., Payette Lakes, 30-6-1954, leg. A.H. Smith 44426, det. K.A. Harrison ut *Hymenogaster diabolus* (BPI 602548).- *Ibid.*, Brundage Mountain, Valley Co., McCall, under conifers, 7-7-1962, leg. and det. A.H. Smith 65213 ut *H. sublilacinus* (OSC 39504, mat. orig.).- *Ibid.*, 10-7-1962, leg. and det. A.H. Smith 65299 ut *H. sublilacinus* (UPS).- Oregon, Odell Lake, Klamath Co., mixed forest of *Abies*, *Tsuga* and *Pseudotsuga*, 4800 ft., 19-6-1977, leg. R. Molina, det. J.M. Trappe 5042 ut *Hymenogaster subolivaceus* (NY).- Wyoming, Medicine Bow Mountains, Albany Co., 9-7-1950, leg. and det. A.H. Smith 34639 ut *H. subolivaceus* (UC 1473235, mat. orig.).- *Ibid.*, without date, ut *Hymenogaster rufus* (NY 3252). For more localities in USA see FOGEL (1985).

Protoglossum luteum:

AUSTRALIA: Victoria, Clarendon, 859 (K 69334, Herb. M.C. Cooke, holotypus).- Victoria, from Herb. G. Masee, rev. S.M. Zeller ut *H. viscidus* (NY, isotypus?).

Protoglossum violaceum:

AUSTRALIA: Tasmania, Proctoris Road, 8-1922, leg. Rodway 1262, ut *Hymenogaster violaceus* (NY, Herb S.M. Zeller).- *Ibid.*, Rodway 297 (NY 2596, isoelectotypus of *Hymenogaster violaceus*).- Victoria, Grenbrool near Melbourne, 11-5-1990, leg. and det. R. Watling 14870 ut *Hymenogaster violaceum* (E 28025).- *Ibid.*, Marysville, Creekboland Fall, lake Mountain, 5-1982, leg. and det. R. Watling 14647 ut *Gymnoglossum violaceum* (E 28026).- *Ibid.*, under *Eucalyptus regnans*, leg. and det. R. Watling 14855 ut *G. violaceum* (E 28029).

Protoglossum viscidum:

AUSTRALIA: Tasmania, Rodway 1272a, comm. by Rodway ut *Hymenogaster nanus* Masee et Rodway, det. S.M. Zeller ut *H. viscidus* (NY, Herb. S.M. Zeller).

DISCUSSION

Initially, VELENOVSKY (1922) described *Hymenogaster aromaticus* on a collection from Europe, Czech Republic, Jíloviště, near Praha, may 1915. In the work of Velenovsky there are good illustrations of a specimen and three spores but, unfortunately, the original material has been impossible to be localized. But we found the opportunity to check later collections made by Klika, in 1926 and 1927, in Karlštejn and Týn, two places in the neighbourhood of Jíloviště. Some years later, and upon herbarium material collected in France and identified by Patouillard as *H. klotzschii*, ZELLER & DODGE (1934) describe *H. remyi*. ZELLER (1941) publishes a record of this last species in USA. Later, SOEHNER (1953) describes *Rhizopogoniella haasii* from Germany. In the works of SOEHNER (1953) and KNAPP (1956, 1957) a possible conspecificity of *R. haasii*, *H. aromaticus* and *H. remyi* is suggested. Conversely, SVRČEK (1958) suggests that *H. aromaticus* is a synonym of *H. albus*, and is followed by SZEMERE (1965), which proposes the synonymy of *H. aromaticus* and *H. remyi* with *H. albus*. Finally, GROSS *et al.* (1980) and MONTECCHI & LAZZARI (1990, 1993) synonymize *H. remyi* and *R. haasii* with *H. aromaticus*.

In America, SMITH (1966) describes 6 species of *Hymenogaster* from USA (*brunnescens*, *diabolus*, *subcaeruleus*, *sublilacinus*, *subochraceus* and *subolivaceus*), including them in the subgenus *Dendrogaster* (Bucholtz) A.H. Sm., because of the presence of a columella. He also indicates the sporal relationship existing between *H. remyi* and *Protoglossum luteum*. Finally, FOGEL (1985) considers that Smith's species are all synonym of *H. sublilacinus* A.H. Sm., arguing that the smell and the colour of its species peridium are subject to broad variability, following the development phase, and that the differences in the spore size are not significative. We don't have observed any difference, nor macroscopic nor microscopic between the American material of *H. sublilacinus* and its synonymous species, and with the European material of *H. aromaticus*. In consequence, we consider both taxa conspecific. We reach the same conclusion with *H. remyi* and *R. haasii*. In fact, there is a high variability in the shape and colour of the carpophora and in the development of the sterile base, that sometimes shows a pseudostipe look. On the other hand, the specimens collected in cold climate areas have a reduced size, and rarely show a pseudostipe. The specimens collected on calcareous substrata show usually a violaceous hue, but in those growing on siliceous substrate, the violaceous color is absent or faint.

The shape and ornamentation of the spores, similar to those of the genus *Cortinarius* (Pers.) Gray, with a conical hilar appendage, a verrucose exosporium, partially covered by a thin perisporium (fig.

1, a-d), and the lack of a percurrent stipe-columella are a set of characters that fits with the genus *Protoglossum* Massee, and puts our taxon aside from the genus *Hymenogaster* Vittad., that is defined by its fusiform spores, typically papillate, a conspicuous hilar appendage and a broad hilar pore.

If we compare the spores of the Australian material of *P. luteum*, *P. violaceum* and *P. viscidum* (fig. 1, e-g) with those of the European *P. aromaticum*, we find that of *P. aromaticum* are the more similar, in size and ornamentation with those of *P. violaceum*. The genus *Protoglossum* may be considered as an advanced stadium in the process of gasteromycetisation undergone by some species of *Cortinarius*, a progressive transformation that begins in the genus *Thaxterogaster* Singer, a secotoid step in the transformation of *Cortinarius*. The genus *Thaxterogaster* shows a broad world distribution, but it is absent from Europe.

ACKNOWLEDGMENTS

My gratitude to the curators of the herbaria consulted: A.Y. Rossman (BPI), D.G. Long (E), E.W. Wood (FH), E. Woodgye (K), D. Triebel (M), F. Pando (MA), B.M. Thiers (NY), R.R. Halse (OSC), J. Holec (PRM), I. Tavares (UC), R. Moberg (UPS). To X. Llimona for the revision of the text, to A. Sánchez-Cuxart, curator of BCN Herbarium, for the help to the request of loan, and to friends and colleagues F.D. Calonge, F. García, G. Gross, M.A. Pérez-De-Gregorio and A. Rocabrana, for your collaboration.

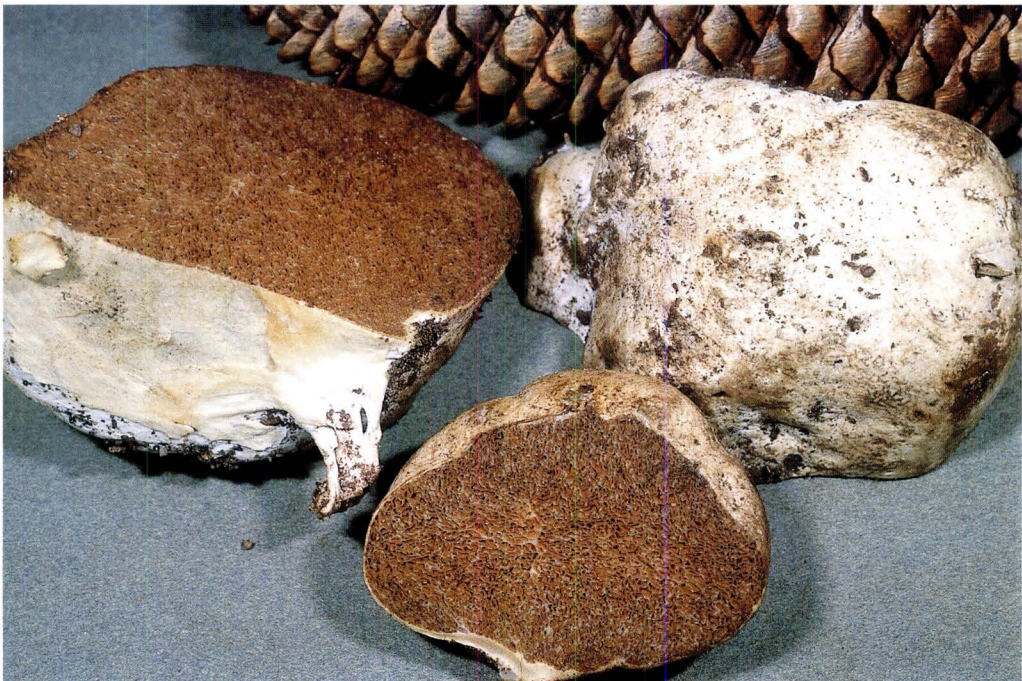
REFERENCES

- ARORA, D. (1986).- *Mushrooms Demystified*. Second edition. Ten Speed Press, Berkeley. 959 pp.
- AUGUADRI, A., LUCCHINI, G., RIVA, A. & E. TESTA (1991).- Tartufe del Cantone Ticino. In *Funghi Ipogei*: 243-307. Soc. Micol. Carlo Benzonei, Chiasso. 307 pp.
- BOUGHER, N.L. & M.A. CASTELLANO (1993).- Delimitation of *Hymenogaster sensu stricto* and four new segregate genera. *Mycologia* 85(2): 273-293.
- CALONGE, F.D. (1982).- Adiciones al catálogo de hongos hipogeos de España. *Garcia de Orta, Sér. Est. Agron. Lisboa* 9(1-2): 143-146.
- CALONGE, F.D., GARCÍA, F., SANTOS, J.C. & P. JUSTE (1995).- Contribución al estudio de los hongos de Valladolid y provincias limítrofes. III. Algunas especies hipogeas interesantes. *Bol. Soc. Micol. Madrid* 20: 291-299.
- CÁZARES, E., GARCÍA, J., CASTILLO, J. & J.M. TRAPPE (1992).- Hypogeous fungi from Northern Mexico. *Mycologia* 84(3): 341-359.
- DODGE, C.W. & S.M. ZELLER (1934).- *Hymenogaster* and related genera. *Ann. Missouri Bot. Gard.* 21: 625-708, pl. 18.
- FOGEL, R. (1985).- Studies on *Hymenogaster* (Basidiomycotina): a re-evaluation of the subgenus *Dendrogaster*. *Mycologia* 77(1): 72-82.
- GARCÍA, F., MAHIQUES, R. & T. CONCA (1996).- Hipogeos de la Comunitat Valenciana. II. *Bull. Soc. Micol. Valenciana* 2: 105-127.
- GREGORI, G. & M. PUXEDDU (1995).- Ancora sui funghi ipogei della Sardegna. *Micol. Ital.* 24(2): 3-10.
- GROSS, G., RUNGE, A., WINTERHOFF, W. & G.J. KRIEGLSTEINER (1980).- Bauchpilze (Gasteromycetes s.l.) in der Bundesrepublik und Westberlin. *Beih. z. Zeitsch. f. Mykologie* 2: 1-220.
- KNAPP, A. (1956).- Die europäischen Hypogaeen-Gattungen und ihre Gattungstypen. II. Familie Hymenogastraceae. *Schweiz. Zeitschr. f. Pilzk.* 34(6): 89-102.
- KNAPP, A. (1957).- Die europäischen Hypogaeen-Gattungen und ihre Gattungstypen. II. Familie Hymenogastraceae. *Schweiz. Zeitschr. f. Pilzk.* 35(6): 81-94.
- KORNERUP, A. & J.H. WANSCHER (1978).- *Methuen handbook of colour*. Third edition. Eyre Methuen, London. 252 pp.
- MADER, K. & A. MADER (1994).- Zur Kenntnis von *Hymenogaster remyi* (Typus, Vergleich mit neuen Funden, primordialentwicklung). *Öst. Zeitschr. F. Pilzk.* 3: 9-14.
- MASSEE, G. (1891).- New or imperfectly known Gasteromycetes. *Grevillea* 19: 94-98.
- MAY, T.W. (1995).- Notes on *Protoglossum* (Fungi: Cortinariales). *Muelleria* 8: 287-289.
- MONTECCHI, A. & G. LAZZARI (1990).- *Hymenogaster* dell'appennino Reggiano-Parmense. *Il Fungo*, suppl. 4: 18-32.
- MONTECCHI, A. & G. LAZZARI (1993).- *Atlante fotografico di Funghi Ipogei*. A.M.B., Centro Studi Micologici, Trento-Vicenza. 490 pp.
- MONTECCHI, A. & M. SARASINI (2000).- *Funghi Ipogei d'Europa*. A.M.B., Centro Studi Micologici, Trento-Vicenza. 714 pp.

- SÁNCHEZ, F., HONRUBIA, M. & P. TORRES (1995).- Gasteromycetes interesantes en el Sistema Ibérico. *Bol. Soc. Micol. Madrid* 20: 269-276.
- SMITH, A.H. (1966).- Notes on *Dendrogaster*, *Gymnoglossum*, *Protoglossum* and species of *Hymenogaster*. *Mycologia* 58: 100-124.
- SOEHNER, E. (1953).- *Rhizopogoniella*. *Zeitschr. F. Pilzk., Karlsruhe, N.F.*, 21(14): 11-13.
- STATES, J.S. (1984).- New records of false truffles in pine forests of Arizona. *Mycotaxon* 19: 351-367.
- STATES, J.S. (1990).- *Mushrooms and Truffles of the Southwest*. The University of Arizona Press, Tucson. 234 pp.
- SVRČEK, M. (1958).- III. Hymenogastrales. In A. Pilát, *Flora ČSR, B1 Gasteromycetes*: 121-208. Acad. Sc. Tchécoslovaquie, Praha. 863 pp.
- SZEMERE, L. (1965).- *Die Unterirdischen Pilze des Karpatenbeckens*. Akadémiai Kiadó, Budapest. 319 pp., 10 tab.
- VELENOVSKY, J. (1922).- *České houby*. České Botanické Společnosti, Praha. 950 pp.
- VIDAL, J.M. (1994).- Algunos hongos hipogeos interesantes para la micoflora catalana. *Bull. Soc. Catalana Micol.* 16-17: 221-248.
- VIDAL, J.M., ROCABRUNA, A. & M. TABARÉS (1991).- Algunos hongos hipogeos (Ascomycotina y Basidiomycotina) interesantes para la micoflora española. *Bull. Soc. Catalana Micol.* 14-15: 131-142.
- ZELLER, S.M. (1941).- Further notes on fungi. *Mycologia* 33: 196-214.



Protoglossum aromaticum (Velen.) Vidal (MA-Fungi 21555), phot. A. Rocabruna.



Protoglossum aromaticum (Velen.) Vidal (JMV20020519-1), phot. J.M. Vidal.