



HAL
open science

A survey of half-free morels in Spain reveals a new species: *Morchella iberica* sp. nov. (Ascomycota, Pezizales)

Philippe Clowez, Javier Marcos Martinez, Raymon Sanjaume, Guilhermina Marques, Jean-Michel Bellanger, Pierre-Arthur Moreau

► To cite this version:

Philippe Clowez, Javier Marcos Martinez, Raymon Sanjaume, Guilhermina Marques, Jean-Michel Bellanger, et al.. A survey of half-free morels in Spain reveals a new species: *Morchella iberica* sp. nov. (Ascomycota, Pezizales). *Ascomycete.org*, 2020, 12 (1), pp.11-18. 10.25664/ART-0291 . hal-03249427

HAL Id: hal-03249427

<https://hal.science/hal-03249427v1>

Submitted on 6 Jan 2025

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial - NoDerivatives 4.0 International License

A survey of half-free morels in Spain reveals a new species: *Morchella iberica* sp. nov. (Ascomycota, Pezizales)

Philippe CLOWEZ
Javier MARCOS MARTINEZ
Raymon SANJAUME
Guilhermina MARQUES
Jean-Michel BELLANGER
Pierre-Arthur MOREAU

Ascomycete.org, 12 (1) : 11–18
Mise en ligne le 15/02/2020
doi: 10.25664/ART-0291



Abstract: The authors describe, on the basis of three Spanish collections, a new species of morel: *Morchella iberica*, close to the European species *M. semilibera* (half-free morel), belonging to sect. *Distantes*, subsect. *Papyraceae*. A microscopical analysis and a phylogenetic analysis of the ITS and LSU regions of ribosomal DNA confirm the proximity and the differences between *M. iberica* and *M. semilibera*, as well as with *M. pakistanica*, *M. populiphila* and *M. punctipes*, three other half-free morels.

Keywords: *Morchellaceae*, morels, phylogeny, taxonomy.

Resumen: Los autores describen, en base a tres recolectas españolas, una nueva especie de colmenilla: *Morchella iberica*, próxima a la especie europea *M. semilibera* ("crespillo"), dentro de la sección *Distantes*, subsección *Papyraceae*. El estudio microscópico y el análisis filogenético de las regiones ITS y LSU del ADN ribosomal confirman la proximidad genética y las diferencias entre *M. iberica* y *M. semilibera*, así como con *M. pakistanica*, *M. populiphila* y *M. punctipes*, otras tres especies con mitra semilibre.

Palabras clave: colmenilla, filogenia, *Morchellaceae*, taxonomía.

Résumé : les auteurs décrivent, sur la base de trois récoltes espagnoles, une nouvelle espèce de morille : *Morchella iberica*, proche de l'espèce européenne *M. semilibera* (« morillon »), au sein de la section *Distantes*, sous-section *Papyraceae*. L'étude microscopique ainsi que l'analyse phylogénétique des régions ITS et LSU de l'ADN ribosomal confirment la proximité génétique et les différences entre *M. iberica* et *M. semilibera*, ainsi qu'avec *M. pakistanica*, *M. populiphila* et *M. punctipes*, trois autres espèces à chapeau semi-libre.

Mots-clés : *Morchellaceae*, morille, phylogénie, taxinomie.

Introduction

The taxonomic and phylogenetic revision of the genus *Morchella* ("true morels") by RICHARD *et al.* (2015), together with several more regional surveys from Australia (ELLIOTT *et al.*, 2014), Spain (CLOWEZ *et al.*, 2014, 2015), Cyprus (LOIZIDES *et al.*, 2015, 2016), Turkey (TAŞKIN *et al.*, 2016), North America (VOITK *et al.*, 2016), Central America and the Caribbean (BARONI *et al.*, 2018), and China (DU *et al.*, 2019), currently include 31 phylogenetic species worldwide in sect. *Morchella* ("clade Esculenta" defined by O'DONNELL *et al.*, 2011), 41 in sect. *Distantes* ("clade Elata"), and 2 in the archaic sect. *Rufobrunnea* ("clade Rufobrunnea"). Compared with European countries, Spain is currently the most species-rich (CLOWEZ, 2012; CLOWEZ *et al.*, 2014, 2015; RICHARD *et al.*, 2015; LOIZIDES *et al.*, 2016), with 17 identified species so far, thus representing 25% of the global diversity of morels.

The increasing interest for this genus, stimulated by recent publications and facilitated access to DNA sequencing by citizen scientists, further contributes to unveil novel, rare or misidentified species. Spain appears to be suitable for tracking such hidden biodiversity, with the most favourable environmental and biogeographical conditions ("hot-spot") coupled with a high density of field mycologists. The result of this intensive survey is illustrated here by the description of *Morchella iberica* sp. nov., which represents the third half-free morel thus far known in Europe, in addition to *M. semilibera* DC. and *M. populiphila* M. Kuo, M.C. Carter & J.D. Moore.

Material and methods

Morphological description

The macromorphological description of *M. iberica* is based on pictures provided by the collectors, completed by their *in vivo* observations. Micromorphological features were observed from exsiccata: 1) in aqueous solution of Chlorazol black for spore measurements, previously revived in 10% ammonia for the observation of natural colour of hymenial elements; 2) with the double stain "PhC1" described in CLOWEZ & MOREAU (2018a), consisting in a first staining in aqueous SDS + Chlorazol black solution, then in an alcoholic Phloxine B solution, and observation in a drop of water after washing, for observation of acroparaphyses and other elements embedded in resinous coatings; 3) with the stain "PhC2" described in CLOWEZ &

MOREAU (2018a), consisting in the mount of mature ascospores or minute fragments of hymenium (asci) in a drop of glycerin with addition of a droplet of stamp pad green ink Noris® Color GmbH, for the observation of details of spore surface.

Phylogenetic analyses

DNA extraction and PCR amplification were conducted at the CEFE-CNRS (Montpellier, France) and at CITAB (Vila Real, Portugal), as described in RICHARD *et al.* (2015). The complete ITS region encompassing the internal transcribed spacers and 5.8S rDNA (ITS) of three collections of *M. iberica*, two collections of *M. populiphila* and 10 collections of *M. semilibera*, was amplified with ITS-1F/ITS-4 (WHITE *et al.*, 1990; GARDES & BRUNS, 1993). In addition, the sequence of four other loci was obtained from the isotype PhC335 of *M. iberica*, using the following primers: LR0R/LR7 (28S rDNA, VILGALYS & HESTER, 1990), EF526F/EF3AR (TEF-1, REHNER & BUCKLEY, 2005), gRPB1A/aRPB1C (RPB1, MATHENY *et al.*, 2002) and 9F/3R (RPB2, LIU *et al.*, 1999).

Sequences were edited and assembled using Codon Code Aligner v. 4.1.1 (CodonCode Corp., Centerville, MA USA). The analyzed ITS dataset includes the 17 sequences generated for this study, as well as 33 published GenBank sequences (www.ncbi.nlm.nih.gov/genbank), representing the five currently recognized species of half-free morels (*M. iberica* sp. nov., *M. pakistanica*, *M. populiphila*, *M. punctipes* and *M. semilibera*; Table 1 and Fig. 1). The sequence KC464349 displays signs of poor quality (short and nucleotide differences clustered) and nests as a long branch in the *M. semilibera* clade (Fig. 1). We maintained it in the dataset for biogeographical purpose, as no other sequenced collection from Ukraine is so far available in public databases.

Phylogenetic analyses were performed online at <http://phylogeny.lirmm.fr> (DEREEPER *et al.*, 2008), as described in RICHARD *et al.* (2015).

Taxonomy

Morchella iberica Marcos Martínez, Sanjaume & Clowez, *sp. nov.* – Figs 2–9 – MycoBank MB 834421.

Diagnosis: Ascomata morchelloid, morphologically similar to those of *Morchella populiphila*. Pileus truncated to nearly globose, light yellow-brown to dark brown. Primary crests mostly longitudi-

Table 1 – List of sequences generated for this study (see Fig. 1)

Species	Collection	Herbarium	ITS	Other loci
<i>M. iberica</i>	PAM16042501	LIP 0401128	MN442334	
	PhC181	LIP 0001675	MN442331	
	PhC335	LIP 0001676 (holotype)	MN442540	28S: MN840852 RPB1: MN850425 RPB2: MN850426 TEF1: MN850427
	JMM0036		MN442536	
	JMM442537		MN442537	
<i>M. populiphila</i>	JMM0054		MN238921	
	GM2074		MN217666	
<i>M. semilibera</i>	PhC313		MN442337	
	PhC306		MN442336	
	JMM0029		MN436846	
	PhC180		MN442330	
	PhC218		MN442332	
	PhC296		MN442335	
	JMM0015		MN436845	
	PhC221		MN442333	
	JMM71403M		MN442338	
DP6142MS		MN442339		

nal, flexuous, first concolorous to pileus then darkening from apex. Sulcus remarkably broad, making the pileus free on 1/3 of its height. Stipe hollow, brittle, white, covered with coarse granules turning blackish with age, for a long period not longer than the pileus.

Holotype: SPAIN, Cataluña, Girona, Campdevanol, riparian forest under *Fraxinus* sp. and *Populus* sp., 30 Apr 2019, leg. R. Sanjaume, LIP 0001675; isotypes in pers. herb. J. Marcos n° JMM0016 and P. Clowez n° PhC 335.

Etymology: Latin epithet *ibericus*, from Iberia, Iberic peninsula, where the species has been described from.

Other collections studied: SPAIN, Aragón, Huesca, Castiello de Jaca, under *Fraxinus excelsior* and *Populus nigra*, 26 Apr 2012, leg. L. Ballester & J. García, herb. P. Clowez n° PhC 181 (LIP 0001676); Castilla y León, Valladolid, Aldeamayor de San Martín, riparian forest under *Populus* sp., with *Morchella semilibera*, 21 Apr 2018, leg. J. Mateos, herb. P.-A. Moreau PAM16042501 (LIP 0401128), and herb. J. Marcos JMM0036.

Portrait: a short-stiped “half-morel”, morphologically similar to *M. populiphila*, with a yellowish brown to dark brown, truncated pileus with mostly parallel primary crests, mostly darkening towards apex, a remarkably conspicuous sulcus, and stipe dotted with dark granules, in native riparian forests on wet ground.

Description: **Pileus** 2.5–5 (7) × 2–4 (5) cm, at first frustoconical, ovoid to subglobose with blunt apex, tending to elongate with age, pale yellow getting olivaceous to dark brown tinges with age (Munsell 7.5YR4/4–4/6), becoming dark red brown (2.5YR3/4) in senescence; pits 20–25 per half-pileus in front view, longitudinally oriented, broad and sinuous to verrucose; primary crests longitudinally oriented, sinuous, thick, bifurcate at cap margin, edge truncate, originally whitish to concolorous, turning olive brown then darkening especially at apex, irregularly elsewhere; obtuse, concolorous to pits; secondary crests rare and hardly differentiated, mostly horizontal, somewhat tuberculose, concolorous to pits. **Sulcus** conspicuous, 1–2 cm deep, broad, making the pileus free on 1/3 of its length, white, minutely furfuraceous, wrinkled with age. **Stipe** 2–7 (11) ×

1–2.5 (4) cm, lacunose, cylindrical with equal or slightly enlarged base, at first shorter than pileus then strongly extending with age, hollow, rather brittle; surface white to pale ochraceous, ochraceous grey when altered; densely furfuraceous from the beginning then strongly granulose with pyramidal granules darkening with age.

Context white in pileus and stipe, hyaline grey in stipe cortex, slightly elastic. Inner excipulum white, lobate to grooved, roughly pruinose, turning yellowish from margin. **Smell** raphanoid and spermatic when cut. **Spore print** white.

Ascospores medium-sized, (21) 23–25 (26) × 15–16 µm (average 23.2 × 15.2 µm), type Ba5 of CLOWEZ & MOREAU (2018b) i.e. ellipsoidal with nearly smooth surface only subtly cracked, covered by spumosity mixed with small refringent bubbles up to 2–3 µm wide. **Asci** 350–520 × 14–17 µm, often with immature or aborted ascospores mixed with mature ascospores; base snakehead-shaped, straightly elongate (2–5 µm wide at base) with a subbasal enlargement and a narrowed zone above, often broken on revived exsiccata. **Paraphyses** irregularly arranged in the hymenium, 230–300 µm long, made of 3–4 elements, the shortest at base measuring e.g. 30–50 × 5–9 µm, the apical element much longer measuring 115–160 × 7–15 µm, slightly inflated at apex, sometimes fasciculate or bifurcate and then with 2 shorter basal elements (20–35 × 5–11 µm) and 2 longer apical and subapical elements (115–135 × 8 µm), all pale-coloured; heteroparaphyses sparsed, undistinct from paraphyses at maturity (Fig. 7b). **Acroparaphyses** long, regularly disposed, cystidioid (Fig. 8a–c), made of 1–3 elements, the apical element club-shaped, 100–110 × 20–30 µm (apex) × 8–12 µm (base), the others 35–110 × 10–30 µm. **Stipitipellis** made of long pyrams¹ of broad globose cells (*textura globulosa* to *textura angularis*), measuring 35–60 × 40–50 µm, ending with long, 0- to 4-septate apical hairs (Fig. 9) made of large catenulate elements measuring 15–90 × 17–30 µm, some with a broad rounded basal cell measuring 40–50 × 40 µm, apical element longer than the others, cylindrical gently attenuate at apex.

¹ Term introduced for the epithelioid granules on the stipe of morels (CLOWEZ & MOREAU, 2020).

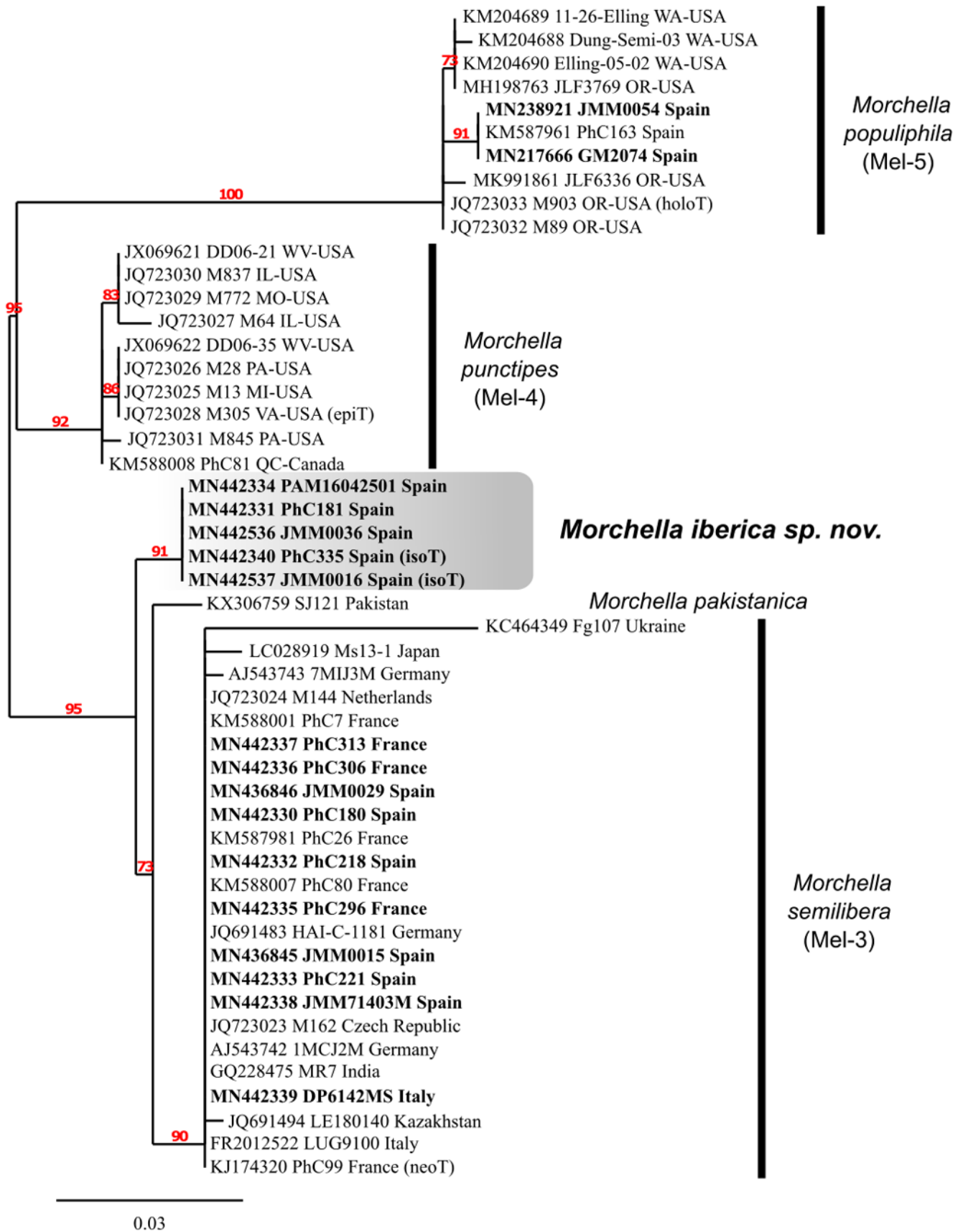


Fig. 1 – Phylogenetic reconstruction of sect. *Papyraceae* (half-free morels) from ITS sequences (see Material & Methods).



Fig. 2 – *Morchella iberica*, ascomata. 1: Type collection, photo R. Sanjaume. 2: Comparison between *M. iberica* (left) and *M. semilibera* (right), Picture J. Mateos. 3–5: collection PAM16042501, photos J. Mateos.

Habitat and distribution: so far only reported from three localities in Northern Spain, in wet riparian forests with *Fraxinus excelsior* and native *Populus* spp., often mixed with *Morchella semilibera*. Also reported under *Castanea sativa* in the Mediterranean Turkish coast (TAŞKIN *et al.*, 2012).

Discussion

All collections of *Morchella iberica* studied in the present work originate from northern Spain, hence the name adopted for this new species. However, sequencing the isotype at 4 additional loci revealed that two published Turkish collections identified as "*M. semilibera*", HT213 and HT215, not sequenced at the ITS locus, actually belong to *M. iberica* (TAŞKIN *et al.*, 2012 and data not shown). It is surprising that these two collections were not distinguished from the other ones by the Turkish authors because they form a well-supported clade within *M. semilibera* (TAŞKIN *et al.*, 2012, Fig. 4). These collections indicate that *M. iberica* is not endemic to northern Spain but is also present in the southern Mediterranean coast of Turkey (Antalya), where it fruits under *Castanea sativa*. Further taxon sampling and careful examination of Mediterranean harvests of half-free morels may unveil a broader distribution of the species here introduced.

In an evolutionary point of view, *M. iberica* is sister to *M. semilibera* and *M. pakistanica* Jabeen & Khalid, from which it differs by, respectively, 7 substitutions + 1 indel and 7 substitutions + 2 indels (Fig. 1 and data not shown). The three species form a well-supported Eurasian clade much more distant from the eastern North American *M. punctipes* Peck and *M. populiphila*, present in both western North America and Spain.

Altogether, these five species correspond to *Morchella* subsect. *Papyraceae* Jacquet. (type: *M. semilibera*), encompassing so-called "half-free morels", within sect. *Distantes* ("Elata-clade"; see CLOWEZ, 2012; RICHARD *et al.*, 2015). It shows the typical features of this subsection, i.e. a broad and deep sulcus ("vallécule") making the pileus edge free on 1/3 to 2/3 of its length, predominantly longitudinal primary crests on the pileus, and a strongly granulose stipe, at least 2–3 times longer than the pileus at maturity. As in most species in sect. *Distantes*, the pileus is more or less triangular-truncated, with numerous and distinct pits (12–25 in front view). Microscopically, the spores are nearly smooth, a rare feature in the genus, almost exclusive of subsect. *Papyracea* in sect. *Distantes* (CLOWEZ & MOREAU, 2018b).

Morchella populiphila has been reported from plantations of hybrid poplars (*Populus* × *canadensis*) originated from North America, and is supposed to be allochthonous in Europe. It is so far only known from Andalusia and Castilla y León (Spain). However, both species are very similar by the rounded or truncated pileus and the stipe extending only late in maturity, primarily not longer than the pileus.

Morchella semilibera and *M. punctipes* share a triangular pileus, rarely truncated, exceptionally rounded. In Europe, *M. semilibera* has a broad ecological range, and may co-occur with *M. populiphila* in Andalusia (J.G. Lopez Castillo, pers. comm.) as well as with *M. iberica* in Northern Spain. The darkening granules on the stipe are characteristic of *M. punctipes*, but may be observed on old specimens of all half-free morels, according to our experience.

Morchella iberica differs from all other half-free morels by more numerous primary pits (in average 20–25 in side view) than the others (less than 20 pits per face), the pileus which is free only on 1/3 of its length (about 1/2 in *M. semilibera* and 2/3 in *M. populiphila*), and somewhat smaller spores.

By its small size and its Mediterranean affinities, *M. iberica* evokes other small species in sect. *Distantes* with strongly developed sulcus, which do not belong to subsect. *Papyraceae*. For instance, *M. disparilis* Loizides & P.-A. Moreau (LOIZIDES *et al.*, 2016) has a rather deep sulcus (but less than 1 cm deep), but smaller-sized ascospores (in av. 22.7 × 14.7 µm) with an angular profile and distinct striations, and more obvious secondary septa and aligned pits (type Bb3: CLOWEZ

& MOREAU, 2018b). Its ecology is also different, since *M. disparilis* is mentioned from dry oro-mediterranean localities with *Arbutus andrachne* in Cyprus and Greece, and *A. unedo* in Spain (personal data).

Finally, it could easily be confused with young specimens in the genus *Verpa*, for instance *V. bohemica* which also has longitudinal, parallel crests. In *Verpa*, however, the pileus is entirely free from the stipe, the crests do not darken with age, and *V. bohemica* is easily identified under the microscope by its bisporic asci.

Acknowledgements

We are especially grateful to Javier Mateos, who provided collections, observations and bibliography for this study, Luis Ballester, Javier García, José Gerardo Lopez Castillo, and Miguel Ángel Martín, who kindly provided additional collections, and Antonia Gasch Illescas for the Spanish version of the abstract. We extend these acknowledgements to all our collaborators and correspondents who participate to our research and contribute to a better understanding of European morels.

Bibliography

- BARONI T.J., BEUG M.W., CANTRELL S.A., CLEMENTS T.A., ITURRIAGA T., LÆSSØE T., HOLGADO ROJAS M.E., AGUILAR F.M., QUISPE M.O., LODGE D.J. & O'DONNELL K. 2018. — Four new species of *Morchella* from the Americas. *Mycologia*, 110 (6): 1205–1221. doi: [10.1080/00275514.2018.1533772](https://doi.org/10.1080/00275514.2018.1533772)
- CLOWEZ P. 2012 [2010]. — Les morilles. Une nouvelle approche mondiale du genre *Morchella*. *Bulletin de la Société mycologique de France*, 126 (3–4): 199–376.
- CLOWEZ P., ALVARADO P., BECERRA PARRA M., BILBAO VILLA T. & MOREAU P.-A. 2014. — *Morchella fluvialis* sp. nov. (Ascomycota, Pezizales): a new but widespread morel in Spain. *Boletín de la Sociedad micológica de Madrid*, 38 (2): 23–32.
- CLOWEZ P., BELLANGER J.-M., ROMERO DE LA OSA L. & MOREAU P.-A. 2015. — *Morchella palazonii* sp. nov. (Ascomycota, Pezizales): une nouvelle morille méditerranéenne. Clé des *Morchella* sect. *Morchella* en Europe. *Documents mycologiques*, 36: 71–84.
- CLOWEZ P. & MOREAU P.-A. 2018a. — Nouvelles colorations microscopiques: application à quelques éléments de l'hyménium des morilles. *Documents mycologiques*, 37: 15–22.
- CLOWEZ P. & MOREAU P.-A. 2018b. — Les spores de morilles en microscopie optique. *Documents mycologiques*, 37: 23–38.
- CLOWEZ P. & MOREAU P.-A. 2020. — *Morilles de France et d'Europe*. Noyon, Cap Régions, 288 p.
- DEREEPER A., GUIGNON V., BLANC G., AUDIC S., BUFFET S., CHEVENET F., DUFA-YARD J.F., GUINDON S., LEFORT V., LESCOIT M., CLAVERIE J.M. & GASCUÉL O. 2008. — Phylogeny.fr: robust phylogenetic analysis for the non-specialist. *Nucleic Acids Research*, 36 (version online): W465–469. doi: [10.1093/nar/gkn180](https://doi.org/10.1093/nar/gkn180).
- DU X.-H., WU D.-M., HE G.-Q., WEI W., XU N. & LI T.-L. 2019. — Six new species and two new records of *Morchella* in China using phylogenetic and morphological analyses. *Mycologia*, 111 (5): 857–870. doi: [10.1080/00275514.2019.1640012](https://doi.org/10.1080/00275514.2019.1640012)
- ELLIOTT T.F., BOUGHER N.L., O'DONNELL K. & TRAPPE J.M. 2014. — *Morchella australiana* sp. nov., an apparent Australian endemic from New South Wales and Victoria. *Mycologia*, 106 (1): 113–118. doi: [10.3852/13-065](https://doi.org/10.3852/13-065)
- GARDES M. & BRUNS T.D. 1993. — ITS primers with enhanced specificity for basidiomycetes – application to the identification of mycorrhizae and rusts. *Molecular Ecology*, 2 (2): 113–118.
- LOIZIDES M., ALVARADO P., CLOWEZ P., MOREAU P.-A., ROMERO DE LA OSA L. & PALAZÓN A. 2015. — *Morchella tridentina*, *M. rufobrunnea*, and *M. kakiicolor*: a study of three poorly known Mediterranean morels, with nomenclatural updates in section *Distantes*. *Mycological Progress*, 14: 13. doi: [10.1007/s11557-015-1030-6](https://doi.org/10.1007/s11557-015-1030-6)
- LOIZIDES M., BELLANGER J.-M., CLOWEZ P., RICHARD F. & MOREAU P.-A. 2016. — Combined phylogenetic and morphological studies of true

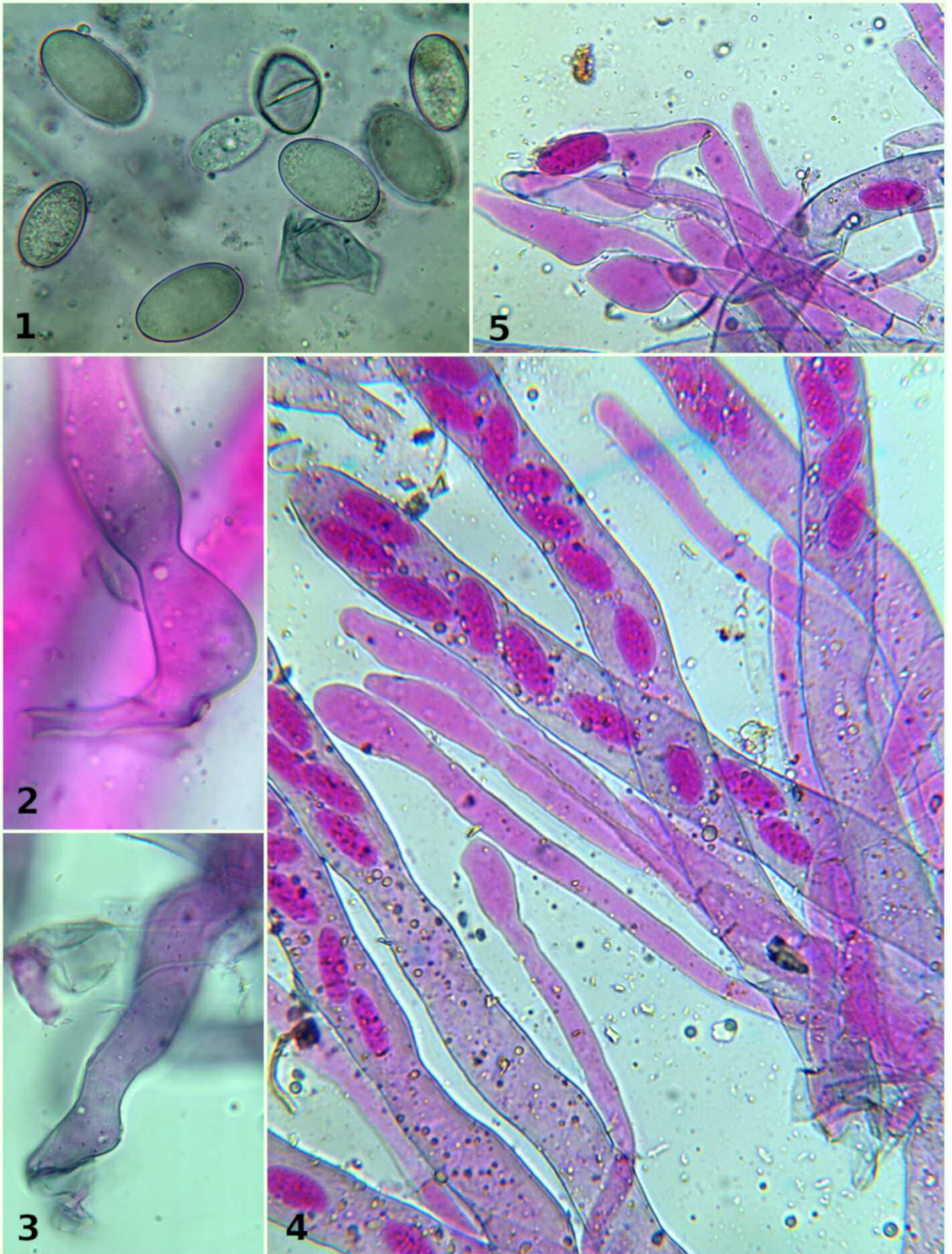


Fig. 3 – *Morchella iberica*, microscopical features. Coll. PhC335. 1: Ascospores (aqueous SDS + Chlorazol black solution). 2–3: Bases of asci (stain PhC1). 4: Paraphyses and asci (stain PhC1). 5: Heteroparaphyses (stain PhC1). Pictures P. Clowez.

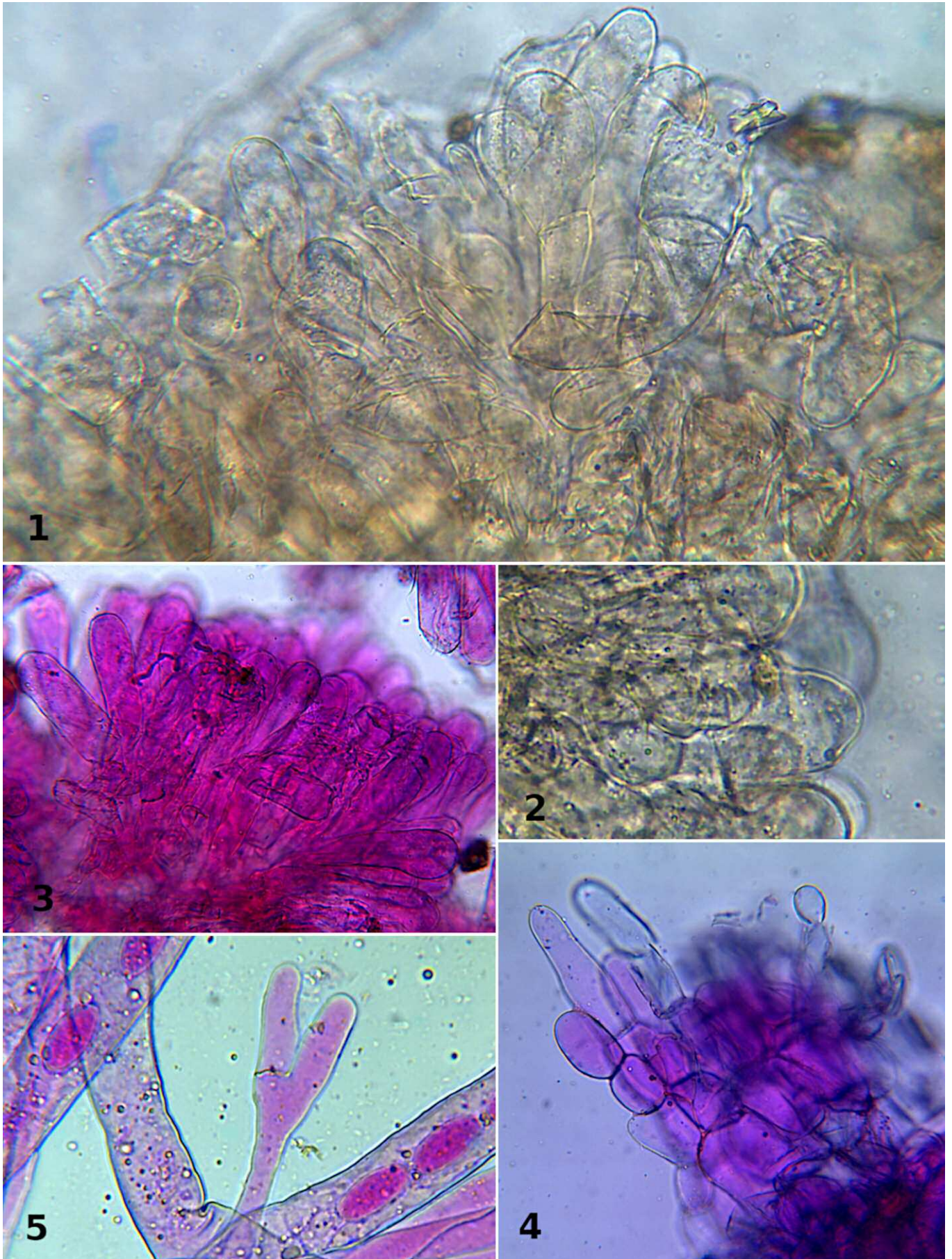


Fig. 4 – *Morchella iberica*, microscopical features. Coll. PhC335. 1–2: Acroparaphyses (in water). 3: Acroparaphyses (stain PhC1). 4: Pyrame on stipitipellis (stain PhC1). 5: Branched heteroparaphysis (stain PhC1). Pictures P. Clowez.

- morels (*Pezizales*, Ascomycota) in Cyprus reveal significant diversity, including *Morchella arbutiphila* and *M. disparilis* spp. nov. *Mycological Progress*, 15: 39. doi: [10.1007/s11557-016-1180-1](https://doi.org/10.1007/s11557-016-1180-1)
- LIU Y.J., WHELEN S. & HALL B.D. 1999. — Phylogenetic relationships among ascomycetes: evidence from an RNA polymerase II subunit. *Molecular Biology and Evolution*, 16 (12): 1799–1808. doi: [10.1093/oxfordjournals.molbev.a026092](https://doi.org/10.1093/oxfordjournals.molbev.a026092)
- MATHENY P.B., LIU Y.J., AMMIRATI J.F. & HALL B.D. 2002. — Using RPB1 sequences to improve phylogenetic inference among mushrooms (*Inocybe*, *Agaricales*). *American Journal of Botany*, 89 (4): 688–698. doi: [10.3732/ajb.89.4.688](https://doi.org/10.3732/ajb.89.4.688)
- O'DONNELL K., ROONEY A.P., MILLS G.L., KUO M., WEBER N.S. & REHNER S.A. 2011. — Phylogeny and historical biogeography of true morels (*Morchella*) reveals an early Cretaceous origin and high continental endemism and provincialism in the Holarctic. *Fungal Genetics and Biology*, 48 (3): 252–265. doi: [10.1016/j.fgb.2010.09.006](https://doi.org/10.1016/j.fgb.2010.09.006)
- REHNER S.A. & BUCKLEY E. 2005. — A *Beauveria* phylogeny inferred from nuclear ITS and EF1- α sequences: evidence for cryptic diversification and links to *Cordyceps* telemorphs. *Mycologia*, 97 (1): 84–98. doi: [10.1080/15572536.2006.11832842](https://doi.org/10.1080/15572536.2006.11832842)
- RICHARD F., BELLANGER J.-M., SAUVE M., CLOWEZ P., HANSEN K., O'DONNELL K., URBAN A., COURTECUISE R. & MOREAU P.-A. 2015. — True morels (*Morchella*, *Pezizales*) of Europe and North America: Evolutionary relationships inferred from multilocus data and a unified taxonomy. *Mycologia*, 107 (2): 359–382. doi: [10.3852/14-166](https://doi.org/10.3852/14-166)
- TAŞKIN H., BÜYÜKALACA S., HANSEN K. & O'DONNELL K. 2012. — Multilocus phylogenetic analysis of true morels (*Morchella*) reveals high levels of endemics in Turkey relative to other regions of Europe. *Mycologia*, 104 (2): 446–461. doi: [10.3852/11-180](https://doi.org/10.3852/11-180)
- TAŞKIN H., DOĞAN H., BÜYÜKALACA S., CLOWEZ P., MOREAU P.-A. & O'DONNELL K. 2016. — Four new morel (*Morchella*) species in the elata sub-clade (*M.* sect. *Distantes*) from Turkey. *Mycotaxon*, 131: 467–482. doi: [10.5248/131.467](https://doi.org/10.5248/131.467)
- VILGALYS R. & HESTER M. 1990. — Rapid genetic identification and mapping of enzymatically amplified ribosomal DNA from several *Cryptococcus* species. *Journal of Bacteriology*, 172 (8): 4238–4246. doi: [10.1128/jb.172.8.4238-4246.1990](https://doi.org/10.1128/jb.172.8.4238-4246.1990)
- VOITK A., BEUG M., O'DONNELL K. & BURZYNSKI M. 2016. — Two new species of true morels from Newfoundland and Labrador: cosmopolitan *Morchella eohespera* and parochial *M. laurentiana*. *Mycologia*, 108 (1): 31–37. doi: [10.3852/15-149](https://doi.org/10.3852/15-149)
- WHITE T.J., BRUNS T., LEE S. & TAYLOR J.W. 1990. — Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: INNIS M.A., GELFAND D.H., SNINSKY J.J. & WHITE T.J. (eds.). *PCR protocols: a guide to methods and applications*. New York, Academic Press: 315–322.



1: P. Clowez – 56 place des Tilleuls, 60400 Pont-l'Évêque, France – pharmacie.clowez@wanadoo.fr

2: J. Marcos Martinez – C/Alfonso IX 30 bajo dcha, 37500 Ciudad-Rodrigo, Salamanca, Spain

3: R. Sanjaume – C/Raval 1, Campdevanol, Girona, Spain

4: G. Marques – CITAB, Universidade de Trás-os-Montes e Alto Douro, Departamento de Agronomia, 5001-801 Vila Real, Portugal

5: J.-M. Bellanger – CEFÉ, CNRS, Université Paul-Valéry Montpellier 3, EPHE, IRD, INSERM, 1919 route de Mende, 34293 Montpellier Cedex 5, France

6: P.-A. Moreau – ULR 4515, Laboratoire de Génie Civil et géo-Environnement (LGCgE), Faculté de pharmacie, Université de Lille, 59000 Lille, France