

TOMASO LEZZI, GIOVANNI GALEOTTI

DESCRIPTION OF TWO ITALIAN RECORDS OF *SQUAMANITA SCHREIERI***Abstract**

Two records of *Squamanita schreieri* from central Italy are described and illustrated with photos of fresh specimens in habitat and line drawings of the anatomical features. In addition, the parasitised host of each *Squamanita* species is summarized in a comparative table. The Italian version of this paper is available on the AMER website [www.ameronlus.it/ojs/index.php/rmr](http://www.ameronlus.it/ojs/index.php/rmr).

**Riassunto**

Due ritrovamenti di *Squamanita schreieri* effettuati nel centro Italia vengono descritti e illustrati con foto di esemplari freschi in habitat e disegni al tratto delle loro caratteristiche microscopiche. Viene inoltre proposta una tabella in cui vengono messe in relazione le specie di *Squamanita* e gli ospiti parassitati. La versione in Italiano di questo documento è disponibile sul sito AMER [www.ameronlus.it/ojs/index.php/rmr](http://www.ameronlus.it/ojs/index.php/rmr).

**Keywords:** Agaricomycetes, Agaricales, Squamanitaceae, *Squamanita*, Italy, parasitic fungi.

**Introduction**

The genus *Squamanita* encompasses 15 species (<http://www.indexfungorum.org>) which are known to parasitise at least 7 different genera, not closely related to one another: *Amanita*, *Cystoderma*, *Galerina*, *Hebeloma*, *Inocybe*, *Kuehneromyces*, *Phaeolepiota* and perhaps *Mycena* (LIU *et al.* 2021). Of these 15 species, 3 have only recently been described, namely *S. mira*, *S. orientalis* and *S. sororcula* (LIU *et al.* 2021). *Squamanita* mycoparasitism often makes the host species almost unrecognizable and only in relatively recent times, thanks to molecular studies, has it been possible to determine the identity of most of the host species with more accuracy.

The results of the molecular studies allowed, to establish that what was believed to be *S. macrocephala* Huijsman ex M.M. Moser is instead *Pogonoloma macrorhizum* (Qué.) Dima & P.-A. Moreau (ALVARADO *et al.* 2018), and that *S. stangliana* Bresinsky & Pfaff is *Rhodophana stangliana* (Bresinsky & Pfaff) Vizzini (VIZZINI 2014).

To date, there are only a few records of a number of species in the genus *Squamanita*, and the descriptions are often affected by a shortage of illustrations and comprehensive morphological data. The aim of this work is to document two collections of *Squamanita schreieri* recently found in the province of Perugia, central Italy, based on a detailed macro- and microscopical description.

**Materials and methods**

The study was carried out on both fresh and dried material. For the anatomical study, a Nikon Eclipse E400 with Moticam 580 and an Optika B510BF with Optikam C-P6, equipped with 10 ×, 20 ×, 40 ×, 60 × and 100 × oil, plan-achromatic objectives were used. 5% Congo red was used to stain the cells; metachromatic, iodine reactions and presence of pigments were tested by staining the basidiospores in brilliant cresyl blue, Melzer's reagent and water/L4. Spore dimensions were detected with the Piximètre program (HENRIOT & CHEYPE 2020) through 52 measurements.



Fig. 1. *Squamanita schreieri*

Illustration by Francesca Barchiesi



Fig 2. *Squamanita schreieri*

Photo by Tomaso Lezzi



Fig 3. *Squamanita schreieri*

Photo by Tomaso Lezzi

Spore dimensions are reported as follows: (d0) d1-d9 (d10), where the values in parentheses are the extreme measured values, respectively the decile d0 and the decile d10; while the deciles d1 and d9 are the limits of the range, which correspond to 80% of the measurement, excluding the values from decile d0 to d1 and from decile d9 to d10. Q is the ratio between length and width, N is the number of measurements taken, Average represents the average values of length × width, and Qa is the average ratio between length and width. The abbreviations TL and GG refer to the exsiccata preserved in the personal herbaria of the authors.

## TAXONOMY

*Squamanita schreieri* Imbach, Mitt. naturf. Ges. Luzern 15: 81 (1946)

### Original diagnosis

*Squamanita* n.g.

*fungi homogeni velo duplici; velum universale fungo se explicante incrustans; velum partiale minutum; basis stipitis bulbo magno radiciformi praedita; epidermis pilei non separabilis; lamellae longitudine inaequales et irregulariter adnatae; trama normalis; sporae hyalinae, non amyloideae. genera affinia: Lepidella, Lepiota, Tricholoma et Amanita.*

*Squamanita schreieri* n. sp.

*ex bulbo magno crescunt 1-5 fungi pileiformes stipitati. pileus 6-9 cm ex hemisphaerico albido tecto similis, aureus, velo universali incrustato flavo-fibratus aut fusco-squamosus, carnosus. stipes concolor, fibrato squamosus velo partiali minuto, plenus; basis magno bulbo praedita, albida; volva incrustata, flavo-fusca. lamellae albae, angustae, subconfertae, longitudine irregulares, inaequaliter adnatae. Caro alba, tenera, mitis. sporae hyalinae, ellipticae, 3,5-5/4-6,5 μ, non amyloideae. trama normalis cellulis longo-cylindrico-ellipticis. habitatio: in silvis ad flumina situatis, aestate, semper in societate aut in loco Lepidellae echinocephalae et Amanitae pellitae var. strobiliformis, rarus.*

None of the specimens of the type collection of *S. schreieri* has been found in the herbaria and the only original material left is the illustration provided by Imbach which was then designated as lectotype by Liu *et al.* (2021). In order to fix the species concept of *S. schreieri*, a collection of the Swiss Federal Institute of Technology in Zurich was designated as an epitype that fits the original diagnosis and illustration Liu *et al.* (2021).

### Macroscopic characters (Figures 1-9)

**Pileus** convex, with a low flattened umbo, not hygrophanous, evenly covered by appressed, radially arranged, golden yellow to rusty orange scales over a whitish background, pileal surface exceeding the margin and hanging with appendiculate remnants of the general veil, pileipellis exceeding the margin and appendiculated by remains of the general veil (**Figure 8**).

**Hymenophore** lamellate, gills adnate to decurrent with a tooth, crowded, shorter than the pileus context thickness, white ochre, with an irregular and eroded edge that is paler than the faces, lamellulae abundant, of different sizes.

**Stipe** short, large and cylindrical, ornamented by radially arranged golden yellow scales on a whitish background, ending with a large napiform bulb, tapered and white in the basal part, beset by shaggy scales arranged in prominent circles at the insertion with the stipe. This basal structure, which represents the part that has grown with the parasitised species, has been defined over time and by various authors in different ways, the most recent and accredited definition is *mycocecidium/a* (VIZZINI & GIRLANDA 1997; GRIFFITH *et al.* 2019) (**Figure 9**). The stipe exhibits a subannular area.

**Context** whitish throughout on exposure, but a contrasting greyish colour is observed in correspondence with the *mycocecidium*. Odour pungent, fish like, very unpleasant.

## Microscopic characters (Figures 11-16)

**Pileipellis** a trichoderma formed by parallel hyphae, which contain precipitated pigment inside the cells, also intermixed with oleiferous hyphae (Figures 14-15).

**Basidia** 4-spored, clavate.

**Spores** (4.6) 4.8-6.5 (7.6) × (3.4) 3.7-4.8 (5.4) μm; Q = (1.0) 1.2-1.6 (1.7); N = 52; Average = 5.8 × 4.2 μm; Qa = 1.4; ellipsoid, guttulate, thin-walled, smooth, inamyloid, orthochromatic, whitish in mass (Figures 11, 16A).

**Chlamydospores** (8.7) 8.7-9.2 (9.3) × (8.4) 8.5-9.0 (9.1) μm; Q = (1.0) 1.01-1.06 (1.1); N = 12; Average = 9.0 × 8.8 μm; Qa = 1.0; globose, with a warty surface, observed in the tissues of the pileipellis, rare (Figures 12, 16B).

**Hymenophoral trama** subparallel (Figure 13).

**Cheilocystidia** absent.

**Pleurocystidia** absent.

**Clamps connections** abundant, present at the base of the basidia and in other tissues.

**Habitat** both collections have been found in a truffle plantation, with the presence of *Quercus pubescens* Willd., *Quercus ilex* L., *Cedrus atlantica* (Endl.) Manetti ex Carrière and *Pinus nigra* J.F. Arnold.

**Coenosis** almost certainly the specimens found are parasite of *Amanita strobiliformis* (Paulet ex Vittad.) Bertill. (Figure 10), since non-parasitised specimens were observed in the vicinity a few days before the discovery and in the same dates of the findings.

**Examined material** Italy. Umbria. Città di Castello (PG), 18.VIII.2020, leg. G. Galeotti & T. Lezzi (GG200818-01), *ibidem* 01.IX.2020, leg. G. Galeotti & T. Lezzi (TL200901-01).

## Notes

Given the rarity of the findings, the genus *Squamanita* is still the object of in-depth study aiming to better define the mechanisms of parasitism. In *Squamanita* species the upper part of the carpophore down to the pseudo-ring represents the parasitic species, while in the lower part the *mycocecidium* is visible, which consists of a mixture of tissues of the parasite and the host species. In the location where our specimens were collected, we found the presence of *Amanita strobiliformis* from two weeks prior to the finding of *Squamanita schreieri*. *Squamanita* specimens grew in 7-10 individuals originating from a common mass.

These data confirm the observations of other authors regarding the possibility that *Amanita strobiliformis* is parasitised by *Squamanita schreieri* (VIZZINI & GIRLANDA 1997, GRIFFITH *et al.* 2019, LIU *et al.* 2021).

The most similar species to *S. schreieri* are *S. mira*, *S. orientalis* and *S. sororcula*.

*S. schreieri* differs from other *Squamanita* species based on the following characteristics:

*S. granulifera* Bas & Læssøe, *S. contortipes* (A.H. Sm. & D.E. Stuntz) Heinem. & Thoen and *S. fimbriata* Gulden, Bendiksen & Brandrud have amyloid spores;

*S. squarrulosa* G.S. Ridl. and *S. mira* J.W. Liu & Zhu L. Yang have the base of the stipe emerging from a *mycocecidium* similar to a volva;

*S. orientalis* J.W. Liu & Zhu L. Yang, *S. sororcula* J.W. Liu & Zhu L. Yang, *S. umbonata* (Sumst.) Bas and *S. citricolor* Thoen have hymenial cystidia;

*S. pearsonii* Bas, *S. paradoxa* (A.H. Sm. & Singer) Bas, *S. umbilicata* Harmaja, *S. odorata* (Cool) Imbach and *S. basii* Harmaja have a pileus diameter less than 5 cm.

**Table 1** lists the parasitic species belonging to the genus *Squamanita* and their parasitised hosts, (elaboration by the authors from: REDHEAD *et al.* 1994, VIZZINI & GIRLANDA 1997, GRIFFITH *et al.* 2019, LIU *et al.* 2021).

**Tab. 1.** Parasitic species belonging to the genus *Squamanita* and their respective parasitic hosts

Parasitic species	Host species
<i>Squamanita basii</i> Harmaja	<i>Cystoderma</i> sp.
<i>Squamanita citricolor</i> Thoen	?
<i>Squamanita contortipes</i> (A.H. Sm. & D.E. Stuntz) Heinem. & Thoen	<i>Galerina</i> sp. [ <i>Galerina pumila</i> (Pers.) Singer?]
<i>Squamanita fimbriata</i> Gulden, Bendiksen & Brandrud	<i>Kuehneromyces mutabilis</i> (Schaeff.) Singer & A.H. Sm.
<i>Squamanita granulifera</i> Bas & Læssøe	?
<i>Squamanita mira</i> J.W. Liu & Zhu L. Yang	<i>Amanita kitamagotake</i> N. Endo & A. Yamada
<i>Squamanita odorata</i> (Cool) Imbach	<i>Hebeloma mesophaeum</i> (Pers.) Quél.
<i>Squamanita orientalis</i> J.W. Liu & Zhu L. Yang	<i>Amanita sepiacea</i> S. Imai
<i>Squamanita paradoxa</i> (A.H. Sm. & Singer) Bas	<i>Cystoderma amianthinum</i> (Scop.) Fayod
<i>Squamanita pearsonii</i> Bas	<i>Cystoderma amianthinum</i> (Scop.) Fayod (?)
<i>Squamanita schreieri</i> Imbach	<i>Amanita strobiliformis</i> (Paulet ex Vittad.) Bertill. and <i>Amanita echinocephala</i> (Vittad.) Quél.
<i>Squamanita sororcula</i> J.W. Liu & Zhu L. Yang	<i>Amanita sepiacea</i> S. Imai
<i>Squamanita squarrulosa</i> G.S. Ridl.	?
<i>Squamanita umbilicata</i> Harmaja	?
<i>Squamanita umbonata</i> (Sumst.) Bas	<i>Inocybe oblectabilis</i> (Britzelm.) Sacc.



Fig. 4. *S. schreieri*

Photo by Tomaso Lezzi



Fig. 5. *S. schreieri*

Photo by Tomaso Lezzi



Fig. 6. *S. schreieri*

Photo by Tomaso Lezzi



Fig. 7. *S. schreieri*

Photo by Giovanni Galeotti



Fig. 8. *S. schreieri*

Photo by Giovanni Galeotti



Fig. 9. *S. schreieri*

Photo by Giovanni Galeotti



Fig. 10. *Amanita strobiliformis*

Photo by Giovanni Galeotti

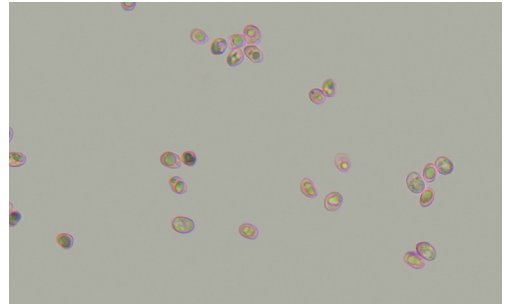


Fig. 11. *S. schreieri*. Spores in Congo red, 1000×.

Photo by Giovanni Galeotti



Fig. 12. *S. schreieri*. Chlamydospore in water, 1000×.

Photo by Tomaso Lezzi

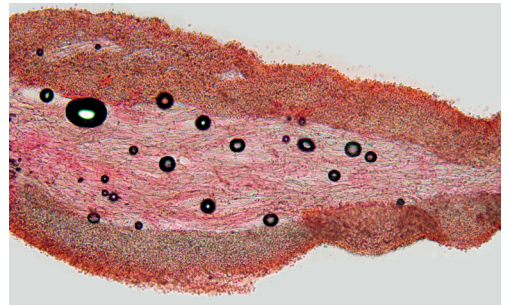


Fig. 13. *S. schreieri*. Hymenophoral trama. Observation in Congo red, 1000×.

Photo by Giovanni Galeotti



Fig. 14. *S. schreieri*. Pileipellis in water, 1000×.

Photo by Tomaso Lezzi



Fig. 15. *S. schreieri*. Pileipellis in water, 1000×.

Photo by Giovanni Galeotti

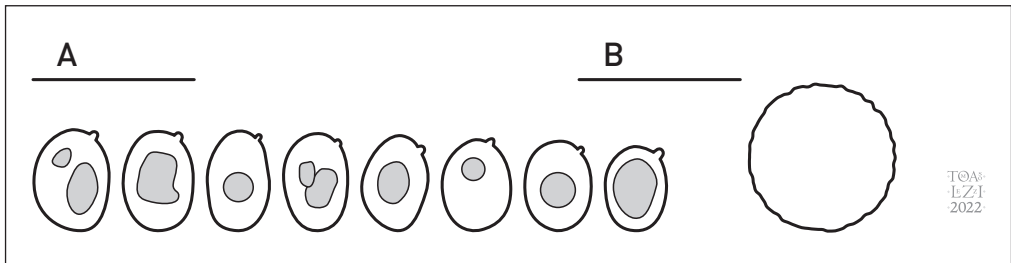


Fig 16. *S. schreieri*. A. Spores; B. Chlamydospore.

Drawing by Tomaso Lezzi

## Acknowledgements

We wish to thank Matteo Gelardi for providing suggestions, Francesca Barchiesi for the realization of the illustration and Eliseo Battistin for providing bibliographic material.

## Authors' addresses

TOMASO LEZZI

Loc. Predio Forno Vecchio, 12 – I 01021 Torre Alfina (VT).

E-mail: tomaso@spyrograph.it

GIOVANNI GALEOTTI

Via Gagarin, 2 – I 06012 Città di Castello (PG).

E-mail: gionnys@hotmail.com

## References

- ALVARADO P., MOREAU P.-A., DIMA B., VIZZINI A., CONSIGLIO G., MORENO G., SETTI L., KEKKI T., HUHTINEN S., LIIMATAINEN K. & NISKANEN T. – 2018: Pseudoclitocybaceae fam. nov. (Agaricales, Tricholomatineae), a new arrangement at family, genus and species level. *Fungal Diversity* 90: 109-133.
- GRIFFITH G.W., GAJDA K.P., DETHERIDGE A.P., DOUGLAS B., BINGHAM J., TURNER A., BOWMAKER V., EVANS D.A., MCADOO W.G. & DENTINGER B.T.M. – 2019: Strangler unmasked: parasitism of *Cystoderma amianthinum* by *Squamanita paradoxa* and *S. pearsonii*. *Fungal Ecology* 39: 131-141 (<https://doi.org/10.1016/j.funeco.2018.11.012>).
- IMBACH E.J. – 1946: Pilzflora des Kantons Luzern und der angrenzen Innerschweiz. *Mitteilungen der Naturforschenden Gesellschaft, Luzern* 15: 5-85.
- LIU J.-W., GE Z.-W., HORAK E., VIZZINI A., HALLING R.E., PAN C.-L. & YANG Z.-L. – 2021: Squamanitaceae and three new species of *Squamanita* parasitic on *Amanita*. *IMA Fungus* 12: 4 (<https://doi.org/10.1186/s43008-021-00057-z>).
- REDHEAD S.A., AMMIRATI J.F., WALKER G.R., NORVELL L.L. & PUCCIO M.B. – 1994: *Squamanita contortipes*, the rosetta stone of a mycoparasitic agaric genus. *Canadian Journal of Botany* 72: 1812-1824.
- VIZZINI A. & GIRLANDA M. – 1997: *Squamanita umbonata* (Sumst.) Bas, a mycoparasite of *Inocybe oblectabilis* (Britz.) Sacc. *Allionia* 35: 171-175.
- VIZZINI A. – 2014: *Index Fungorum* 166.