Critical notes on the taxonomy and nomenclature of the Dutch *Macrolepiota* species with ring with double crown are given. *Macrolepiota bohemia* (Wichansky) Krieglst. & Pázmány is regarded as a synonym of *M. rachodes* (Vitt.) Sing. The new combination *M. gracilenta* (Fr.) Mos. and *M. rickenii* (Velen.) Bellù & Lanzoni are synonymized. *Macrolepiota permixta* (Barla) Mos. is considered merely a variant of *M. procera* (Scop.: Fr.) Sing.; notes on the nomenclature of *M. nympharum* Kalchbr. Wasser are presented. *Agaricus emplastrum* Cooke & Mass. and *A. tepidarius* Weinm. are regarded as nomina dubia.

The genus *Macrolepiota* Sing. is, within the family Agaricaceae, characterized by having dextrinoid, strongly congophilous, metachromatich and large (7–20 × 5–10 µm) spores, with a truncate apex and a large germ pore. The velum universale is an intricately trichoderm, and a volva is absent. The number of species recognized in western Europe varies from 11 (Moser, 1983) to 18 (Bon, 1993). Six species occur in the Netherlands (de Kok, 1992). Only *M. rachodes* and *M. procera* are common; *M. excoriata* is uncommon, and has declined considerably since 1950 due to changes in agriculture; *M. konradii* and *M. mastoidea* are both rare species in the country, and *M. nympharum* was found once in southern Limburg in 1986 (see also Nauta & Vellinga, 1995 and Vellinga in Arnolds et al., 1995).

*Macrolepiota rachodes* and its synonyms, and the complex of *M. mastoidea* are discussed in detail. Nomenclatural notes on *M. procera* and *M. nympharum* are provided.

Fresh and herbarium material of all Dutch species have been studied. Colour codes are according to Munsell (1975). Spores were measured in 5% KOH (aq) or 10% NH₃ (aq), stained with Congo red; spores were measured in side view. The notation [630, 59, 53] stands for ‘630 spores from 59 basidiocarps of 53 collections measured’. The following abbreviations are used: Q = quotient of length and width, av. = average. All collections are in L.

This research was begun as part of an undergraduate project in 1990–1991 at the Rijksherbarium in Leiden. An unpublished report contains more data and a detailed discussion on the Dutch *Macrolepiota* species (de Kok, 1991).

### 1. Macrolepiota rachodes* (Vitt.) Sing.


1) Centre for Plant Biodiversity Research, Australian National Herbarium, CSIRO Plant Industry, GPO Box 1600, Canberra ACT 2601, Australia.
2) Rijksherbarium/Hortus Botanicus, P.O. Box 9514, 2300 RA Leiden, The Netherlands.

E-mail: vellinga@rulrhb.leidenuniv.nl


The spelling of the name rachodes is somewhat controversial. The word rachodes lacks a meaning, but the word rhacodes is derived from the Greek word 'ῥάκος' meaning rag (Muller, 1926). This has led many authors (Fries, 1857; Locquin, 1942; Wasser, 1980) to believe that Vittadini (1835) had made a spelling mistake. This however is unlikely, as he is very consistent in the spelling of this taxon. We therefore agree with Singer (1951) in using Vittadini's spelling for the name of this taxon.

The taxon M. rachodes is macroscopically very variable; this has led some authors to split the species up. Two names are important in this aspect, viz. hortensis and bohemica. Pilát (1951: 422) described a new variety Lepiota rhacodes var. hortensis; as no Latin description was given this variety is not validly published. Pilát presented only a macroscopical description and a reference to an illustration in Michael (1918: pl. 195). The thin ring of the species illustrated makes it clear that this new species belongs to the Excoriata-group of Macrolepiota (simple ring and smooth stipe), and not to the Rachodes-group (ring with a double crown and smooth stipe). This same plate (Michael, 1918: pl. 195) was cited by Bon (in Bon et al., 1979: 13), when he described the new species M. venenata, which is characterized by a thin annulus.

In Pilát & Usák (1952: pl. 111) another illustration of Lepiota rhacodes var. hortensis is given. The specimen depicted here, has a distinct ring with a double crown, implying that this specimen belongs to the Rachodes-group. And this interpretation of var. hortensis has been followed by subsequent authors.

Macrolepiota bohemica, described by Wichanský (1961: 102), is considered to be very closely related to M. rachodes. All material of M. bohemica and M. rachodes available in Leiden was examined, and the following observations were made. According to the original description of M. bohemica the variation in spore length and width is 11–13 × 7.5–9.5 μm. In Fig. 1 the average spore length and width of all examined specimens are depicted. Clearly M. rachodes is very variable in spore length and width, and the variation of M. bohemica falls completely within its range. This is in accordance with the results of other authors (Bon, 1981: 73–74; Candusso & Lanzoni, 1990: 534, 540).

The germ pore is mentioned by some authors (Bon, 1981: 73–74 and Candusso & Lanzoni 1990: 534–540) as a good character to distinguish M. bohemica (germ pore narrower than 1 μm) from M. rachodes (germ pore wider than 1 μm). In the specimens examined no discontinuity was found for this character.

Bon (1981: 73–74), Candusso & Lanzoni (1990: 532 & 538) and Bellù & Lanzoni (1987: 191–192) mentioned that the stipe and the bulb of M. bohemica are wider than those of
**M. rachodes.** In accordance with the results of Lavorato (1989: 274–276), no discontinuity in the variation of this character was found.

Other characters used to distinguish the taxa are: shape of velum, colour of velum and shape of the annulus (Moser, 1983: 245, and Bellù & Lanzoni, 1987: 191–192). Environmental factors like moisture and temperature influence the expression of these characters, and can therefore not be used to separate the taxa. As a result *M. bohemica* is considered a synonym of *M. rachodes*.

During fieldwork in the Netherlands it was observed that *M. rachodes* specimens found in conifer woods were generally darker than the ones from other habitats (Fig. 2). If one plots the average spore length of a specimen against the light/dark indicators (Munsell colour code) of its pileus surface (i.e. not the veil) (Fig. 2), a separation based on these two characters is visible. The small-spored specimens (average spore length < 9.2 μm) have in general a darker pileus than the larger spored specimens (average spore length > 8.6 μm). Furthermore all small-spored darker specimens have been found near conifers (Fig. 2) (in the Netherlands near *Picea*). There is overlap between the two groups, but most specimens can be easily assigned to one or to the other. No doubt this darker, smaller spored group of *M. rachodes* represents a different forma. Fortunately, a name is already available. In examining the type of *Lepiota olivieri* Barla, Bellù & Lanzoni (1987: 195) found that it had a spore range of 7–8.5(–9.5) × 4.5–6 μm. The average spore length must be well below 8.6 μm. The specimen depicted by Barla (1889: pl. 9bis, figs. 6–10) is also darker then the typical *M. rachodes* specimen depicted on the same plate. Furthermore the type of *Lepiota olivieri* Barla is clearly depicted as standing in the litter of a conifer. This specimen must be a representative of the small-spored dark form of *M. rachodes*.

---

Fig. 1. *Macrolepiota rachodes*. Scatterdiagram of average spore length against average spore width (in μm).
KEY TO THE FORMAE OF MACROLEPIOTA RACHODES

1a. Pileus surface (not the veil) white to (very) light brown or reddish yellow, sometimes light yellow or yellowish red (10 YR 8/2, 5–8/3–4, 7.5 YR 6/4, 7/6, 2.5 Y 7/4, 6/6, 5 YR 5/8, 6/4); spores in average 8.7–11 × (5.2–)5.5–7.5 μm . . . . . . . M. rachodes f. rachodes

b. Pileus surface (not the veil) yellowish brown to light brown (10 YR 5–6/3–4, 7/3, 7.5 YR 6/4, 3/2); spores in average 8.1–9.0 × 5.0–6.0 μm . . . . . . . . M. rachodes f. olivieri

Macrolepiota rachodes f. rachodes


Pileus 42–205 mm, when young hemispherical, expanding to plano-convex, depressed to umbonate, white to (very) light brown or reddish yellow, sometimes light yellow or yellowish red (e.g. 10 YR 8/2, 10 YR 5–8/3–4, 7.5 YR 6/4, 7.5 YR 7/6, 2.5 Y 7/4, 6/6, 5 YR 5/8, 6/4), smooth to ragged; velum at centre 24–100 mm in diameter, starshaped to round,
with indistinct border, sometimes cracked, surrounded by irregular concentric rings of squamular patches, flat or curved upwards, dark red to yellowish red or (deep) brown (2.5 YR 3/6, 5 YR 3–6/2–8, 10 YR 4–5/3–4, 10 YR 6/3–6, 5/6, 7.5 YR 5/8, 3/4, 6/4, 5/6, 4/4), always the darkest at centre. Lamellae, L = 7–17 per 10 mm halfway radius, free, 1–4 mm remote from stipe, 4–18.5 mm wide, sometimes forked, white (10 YR 8/3), when touched reddish yellow (5 YR 7/6) to light red (10 R 6/8), orange (7.5 YR 7/8), or yellow, later brown (7.5 YR 5/4), usually with light to dark brown, sometimes olive (5 Y 5/6), even to eroded edge. Stipe 2.6–160(–225) × 7–26(–29) mm, cylindrical with (marginate) bulb, 17–45(–60) mm wide, hollow, white, when touched light brown or yellowish red (10 YR 7/4, 5/4, 6/6, 5 YR 5/6, 7.5 YR 6/4, 5/6, 7/6, 4/4, 5/8), smooth, sometimes with rhizomorphs at base. Ring membranous, with double crown, 18–57 mm wide, 1–12 mm thick, whitish to buff brown (5 YR 7/3) above, sometimes adhered, brown (5 YR 6/3–10 YR 6/6, 8/4) at underside. Context white, turning brown when aging (7.5 YR 5/4), when cut sometimes first turning yellow (10 YR 7–8/6), then reddish yellow (7.5 YR 8–6/6–8, 5 YR 6–7/6–8 or 5 YR 5/8) to weakly red (10 R 5–6/6–8 or 2.5 YR 6/6, 4/8, 6/8), and finally brown (5 YR 3/3, 10 R 5/8), in pileus 5–18 mm thick. Smell fungoid, earth-like or like rubber. Taste fungoid or earth-like.

Spores [± 630, 59, 53] 7.5–12(–14) × 4.5–8.5 μm, in average 8.7–11 × (5.2–)5.5–7.5 μm, Q = 1.1–2.1, av. Q = 1.35–1.9. Basidia 4-spored, with clamp-connections. Cheilocystidia clavate, after a frost-period sometimes rostrate. Velum on pileus an intricate trichoderm, with clavate terminal elements, with vacuolar pigment, usually situated in upper part of trichoderm. Hymenophoral trama (sub)regular. Clamp-connections present.

Habitat & distribution — Solitary or gregarious, saprotrophic and terrestrial, on rather nutrient-rich soil, in gardens, orchards, grasslands, greenhouses, deciduous and coniferous woods, and on roadsides and compost heaps. Common, (April–)Sept.–Dec.


Macrolepiota rachodes f. olivieri (Barla) de Kok, **comb. & stat. nov.**


Pileus 46–127 mm, when mature plano-convex, aplannate, sometimes (sub)umbonate, yellowish brown to light brown (10 YR 5–6/3–4, 7/3, 7.5 YR 6/4, 3/2), smooth to ragged; velum star-shaped to circular, with indistinct border, 21–38 mm wide, with concentrical zones of aplannate or upwards curving squamulose patches, dark brown to reddish brown (7.5 YR 3/4, 3/2, 5 YR 3/4, 10 YR 5/4–6, 7/3), at centre always the darkest. Lamellae 10–14 per 10 mm halfway radius, free, 1–7 mm remote from stipe, 8.5–15 mm wide, whitish, when touched light red (2.5 YR 6/8) to yellowish red, with brown dark eroded edge. Stipe (45–)80–190 7–13 mm, smooth, bulbous to subbulbous, with 21–32 mm wide bulb, white, when touched (darker) yellowish brown or darker reddish brown (10 YR 4/4, 10 YR 5/4–6, 5 YR 3/4, 7.5 R 3/4). Ring membranous, with double crown, 25–30 mm in diameter, 1–5 mm thick, very light brown (10 YR 7/4) at upper side, sometimes adhered, lower side coloured as pileus. Context white, 7–17 mm thick in pileus, when cut turning reddish yellow (7.5 YR 6–7/8, 5 YR 6/8), later red (10 R 4–6/6–8 or 2.5 YR 5/6). Smell none, earth-like or fungoid. Taste unpleasant.

Spores [± 200, 13, 13] 7.0–10.5(–11.2) × 4.0–6.5 μm, on average 8.1–9.0 × 5–6 μm, Q = 1.2–2, av. Q = 1.4–1.7. Basidia 4-spored, with clamp-connection. Cheilocystidia clavate, not rostrate. Velum on pileus an intricate trichoderms with clavate terminal elements, with vacuolar pigment. Hymenophoral trama subregular.

Habitat & distribution – Solitary or gregarious, saprotrophic and terrestrial in woods with coniferous trees (in the Netherlands only with *Picea*). Rather rare, Sept.–Nov.


2. *Macrolepiota mastoidea* (Fr.: Fr.) Sing.


Selected icons. Barla, Fl. mycol. ill. (1889) pl. 11. figs. 1–10; M. Bon, Champ. Eur. occid. (1989) 291 (as M. gracilenta & M. konradii); Breitenb. & Kränzl., Pilze Schweiz 4 (1995) 251; Bres., Iconogr. mycol. 1 (1927) pl. 21 (as L. gracilenta) & 23 (as L. mastoidea); Candusso & Lanzoni, Lepiota s.l. (1990) pl. 73 & 74, fig. 127; Cooke, Ill. Brit. Fung. 1 (1881) fig. 24, (23) (as Agaricus mastoideus); J. Lange, Fl. agar. dan. 1 (1935) pl. 8c (as L. umbonata).

Ever since the description of M. gracilenta in 1836, taxonomists have struggled to find characters to separate M. mastoidea from M. gracilenta. Among the characters used, are spore length and width. Macrolepiota gracilenta is supposed to have slightly smaller spores than M. mastoidea. In this research, based on 18 collections from seven countries, no gap in the variation of the average spore width and length was found (de Kok, 1991).

According to Pázmány (1985: 54–55), who studied ten collections from Rumania in detail, in M. mastoidea the ratio of pileus diameter and stipe length (measured on exsiccates) is 0.5–0.83 and in M. gracilenta 0.35–0.6. Furthermore, he found a correlation between this character and the spore length and width. After combining Pázmány’s data with the present data (measured on exsiccates), no discontinuity or correlation between these two characters was found (Fig. 3).

![Fig. 3. Macrolepiota mastoidea. Scatterdiagram of average spore length (in μm) against ratio of pileus diameter and stipe length.](image-url)
Pázmány (1985: 54–55) stated that the ratio of stipe length and stipe diameter of *M. mastoidea* is 10–23 and in *M. gracilenta* 25–30 (measured on exsiccat). In the combined data set, most collections have relatively short stipes (ratio 10–15; measured on exsiccates), the longest stiped specimens having been found in Rumania. However, there is a continuum, and no correlation between this character and the average spore length could be found.

Velum colour is considered to be an important character by several authors. An overview of the literature is given in Table I. *Macrolepiota mastoidea* is considered darker, and more distinctly ochraceous, whereas *M. gracilenta* is paler, and slightly pink-coloured. Two collections, among the 18 studied, clearly show an intermediate colour range: *Bas 7381* from Austria: reddish yellow to very light brown (7.5 YR 6/6 to 10 YR 8/3), and *Boekhout 1026* from Belgium with pileus pink (7.5 YR 7/3) to beige brown.

Other characters like pileus and stipe diameter, pattern of velum on pileus and stipe, and shape of the cheilocystidia are either too much influenced by environmental factors, or else the differences are too small to justify a separation into separate species. Therefore, *M. gracilenta* is considered a synonym of *M. mastoidea*.

Some authors (Bellù & Lanzoni, 1987; Bon, 1993) do not use the name *M. gracilenta* anymore, as in the original diagnosis the lamellae are stated to be pale greenish (‘pallide virescentibus’), reminding of a representative of the genus *Chlorophyllum*. The name *M. rickenii* (Velen.) Bellù & Lanzoni is used instead, for the interpretation of *M. gracilenta*, without greenish lamellae. *Macrolepiota rickenii* is considered to be as dark as or even darker than *M. mastoidea* (Bellù & Lanzoni, 1987; Candusso & Lanzoni, 1990; Bon, 1993). For an overview of the colours see also Table I. In view of the colour variation, and the absence of correlating characters, *M. rickenii* is also synonymized with *M. mastoidea*.


Macrolepiota permixta Barla (1886) has always been considered to be very closely related to M. procera. The main difference between the two species is that unlike that of M. procera, the context of M. permixta turns red when cut (Barla, 1886). Most Macrolepiota species turn reddish brown when they are cut. Such reddening of basidiocarps is considered to be a sign of tyrosinase activity (Marr, 1984). In some cases, varietal status is given on account of this discolouration (e.g. M. excoriata var. rubescens (Dufour) M. Bon, M. mastoidea var. coccineobasalis (Locq.) M. Bon). The discolouration largely depends on the age of the fruit-body and other conditions like moisture and temperature. Collections of Macrolepiota species (including M. procera) can be found in which some specimens discoulour red when cut, while others, in the same collection, hardly discoulour at all. Therefore, discollouring is considered an unreliable character within this genus. Consequently, M. permixta is regarded as a synonym of M. procera.

4. Macrolepiota nympharum (Kalchbr.) Wasser


Selected icons. Bellù, Boll. Gr. micol. G. Bres. 25 (1982) 112 (as M. puellaris); Breitenb. & Kränzl., Pilze Schwitz 4 (1995) pl. 255 (as M. puellaris); Candusso & Lanzoni, Lepiota s.l. (1990) pl. 66 (as M. puellaris); Cetto, Funghi Vero, Ed. 5, 1 (1975) pl. 23 (as L. puellaris); J. Lange, Fl. ager. Dan. 1 (1935) pl. 9b (as L. rhacodes var. puellaris); Kalchbr., Ic. sel. Hymenomyc. Hungariae (1873) pl. 2, fig. 2; Migl. & Bizio, Funghi Amb. 66 (1994) 14 (as M. puellaris).

Macrolepiota nympharum was first described by Fries (1863: 285) as Agaricus hacodes* puellaris (i.e. Agaricus rhacodes var. puellaris). Later authors named this taxon as a subspecies or forms of M. rhacodes or M. procera. Only as late as 1922 was it recognized on species level (Rea, 1922: 65).

Kalchbrenner’s (1873: 10, pl. 2, fig. 1) description and illustration of the new species Agaricus nympharum clearly show a Macrolepiota of the Rachodes-group (double crowned ring and smooth stipe). The colour of the pileus and habitat (conifer woods) makes it clear
that this taxon is similar to *M. puellaris. Macrolepiota nymphaeum* is the oldest valid name on species level, and is therefore the correct name for this taxon.

**NOMINA DUBIA**


*Agaricus tepidarius* Weinm. was described as a large mushroom, growing in a greenhouse, hence the name. Judging from the description it is clear that this taxon belongs to the genus *Macrolepiota*. However, a ring is not mentioned. Without particulars of the ring or a microscopical examination of the type specimen it is impossible to identify this species as either *M. rachodes* or *M. venenata*. The epithet was well known in the last century. Fries (1836–1838: 13), Saccardo (1887: 29) and also Kickx (1867: 130) mentioned it as a synonym of *M. rachodes*. However, until the type collection is found *Agaricus tepidarius* remains a nomen dubium.

*Agaricus emplastrum* Cooke & Mass. in Cooke, Grevillea 18 (1889) 51; *Lepiota emplastrum* (Cooke & Mass.) Sacc., Syll. Fung. 9 (1891) 8.

*Lepiota emplastrum* resembles *M. rachodes*, except for the spores. The spores of *Lepiota emplastrum* measure 20 × 10–12 μm, and are angular. No material of the type or other Cooke & Massee specimens of this taxon could be found at Kew. However, a drawing of this species by Miss Wakefield exists. She worked with Massee in her early years, and she might have known the species. In her drawing the spores are smaller than those of the original description, but are still too large for *M. rachodes*. In Miss Wakefield’s drawing a ring is conspicuous in the mature specimen, and there is even a young specimen depicted with a closed partial veil.

Hora (1960: 447–448) described a collection, which he identified as *L. emplastrum*, on account of the striking resemblances with Cooke & Massee’s fungus, as depicted in Cooke, 1890: pl. 1164 (1106), and because of the same habitat. Hora’s collection, however, is provided with a fugacious ring, but also with distinct evidence of a volva. Hora suggested that Massee, who made the drawing of *L. emplastrum*, mistook the circumscissile volva for a dropped movable ring, and lifted it in his painting. A volva is absent in *Macrolepiota* species, but present in the closely related genus *Volvolepiota*, which is so far only known from South America (Singer, 1986; Heinemann & de Meijer, 1996). The spores of Hora’s specimen are 10–12 × 7–8 μm, and lack a germ pore. According to Hora a germ pore is lacking in *M. rachodes* as well, which is contradictory to our findings. Hora also presumed that the original Cooke & Massee collection had been contaminated with *Entoloma*-spores.

Until the type collection or better material of *L. emplastrum* is found this epithet is best regarded as a nomen dubium.

**ACKNOWLEDGEMENTS**

The authors would like to thank John Lennie for editorial and linguistic advice, Sandra Roscoe for correcting the English and Dr. C. Bas for his supervision during this research. Furthermore we would like to thank all members of the Netherlands Mycological Society who sent fresh specimens or accompanied the first author during field trips.
REFERENCES


