

Short Communication: Two newly recorded species of Agaricales (Basidiomycota) from Banggai Kepulauan, Sulawesi, Indonesia

ATIK RETNOWATI*, ANNE KUSUMAWATY, ISMAIL APANDI, AGUS HARYADI

Herbarium Bogoriense, Botany Division, Research Center for Biology, Indonesian Institute of Sciences. Jl. Raya Jakarta-Bogor Km. 46, Cibinong, Bogor 16911, West Java, Indonesia. Tel.: +62-21-8765066, Fax.: +62-21-87907612, *email: marasjamur@gmail.com

Manuscript received: 9 October 2020. Revision accepted: 16 November 2020.

Abstract. Retnowati A, Kusumawaty A, Apandi I, Haryadi A. 2020. Short Communication: Two newly recorded species of Agaricales (Basidiomycota) from Banggai Kepulauan, Sulawesi, Indonesia. *Biodiversitas* 21: 5615-5621. Two species of Agaricales are reported here as new records for Indonesia, *Mycena picta* (Fr.) Harmaja (Mycenaceae) and *Inocybe stellata* E. Horak, Matheny & Desjardin (Inocybaceae). These new records will contribute to the information on mushroom diversity in Indonesia. *Mycena picta* is characterized by having cylindrical and olive pileus; adnate to slightly decurrent and distant lamellae; filiform, greyish-yellow to dull yellow stipe. *Inocybe stellata* is distinguished by having brown conical pileus with squamules surface; adnexed or sinuate and close lamellae with 2 series of lamellulae; terete, glabrous with finely pruinose, base slightly bulbous, light brown stipe; echinulate, globose or subglobose basidiospores; metuloid hymenial cystidia and caulocystidia present. Photographs, descriptions, and line drawings of both macroscopic and microscopic features of the new records are provided herein and give a brief discussion on their taxonomy.

Keywords: Inocybaceae, Mycenaceae, species diversity, taxonomy

INTRODUCTION

Agaricales is one order within Basidiomycota, which is one of the most well-known groups of mushrooms. The order has been traditionally classified into three suborders; Agaricineae, Boletineae, and Russulineae, consists of a total of 18 families with 230 genera (Singer 1986). While in recent advance of Basidiomycota classification, those three suborders were elevated to be order Agaricales, Boletales, and Russulales within the subphylum Agaricomycotina (Hibbett et al. 2007). Ecologically, the order plays significant roles as saprotrophs, parasitic, or mycorrhiza. Some species contain dangerous toxins, and some species are edible. They are diverse in form of pileus, lamellae, and stipe. They mostly grow on the ground in woods, on compost, in the lawns, or in parks, and other habitats.

Until recently, only limited information on the Agaricales of Indonesia has been published and it was mostly published the species from Java and Bali (Leveille 1844, 1846; Moritzi 1845-1846; Zollinger 1844; Hennings 1900; Overeem and Overeem-de Haas 1922; Boedijn 1940; Desjardin et al. 2000; and Retnowati 2018). Publication on the diversity of Basidiomycota from other parts of Sulawesi was documented by Samuels et al. (1990), nonetheless, it has accommodated order Aphylloporales, family Ganodermataceae, Hymenochaetaceae, and Polyporaceae (Rivarden 1990). The report was made primarily based upon collections from equatorial rain forest of North Sulawesi during the Project Wallacea carried out in 1985. The mushrooms from the order Agaricales have not become the attention.

Banggai Islands is a group of islands, which is located in Central Sulawesi, Indonesia. The islands comprises Banggai, Bangkuruung, Bangkalan, Peleng, as well as several small islands, and these islands are as a connection to the mainland of Sulawesi Island and the eastern Indonesian archipelago. Banggai Islands is divided into two districts, namely: Banggai Kepulauan (Bakalan, Peleng) and Banggai Laut (Banggai, Bangkuruung, etc.). Most of the parts of the Banggai are lowland forests up to 800 above sea level. Meanwhile, Peleng and western parts of Bakalan represent the mangrove ecosystem, mainly along Peleng coastal area. A report on the flora and fauna diversity of the archipelago has been published by Rahmadi et al. (2014), but Agaricales have not been reported. As a part of a biodiversity survey to Banggai Islands conducted by the Research Center for Biology (LIPI) in 2019, mycological exploration was carried out. A species of *Mycena* and a species of *Inocybe* are reported here as new records for Indonesia.

The genus *Mycena* consists of approximately 500 species in the world (Kirk et al. 2008) and it is a cosmopolitan genus as saprobic or parasitic fungi. According to Largent (1988), the following were the defining characters of *Mycena*: a small to medium fruiting body, campanulate, transparent-striate, and moist pileus; adnate to adnexed, and often decurrent; some glutinous stipe; white basidiospores, diverticula elements of hyphae. Some species are known as bioluminescent mushroom and bioluminescence becomes an important taxonomic character to define certain species within the genus (Corner 1994).

Inocybe is well-known as an ectomycorrhizal mushroom and the genus has potential importance in

forestry and forest ecology (Singer 1986). The genus is found associated with Dipterocarpaceae (Pradeep et al. 2016), Pinaceae, Fagaceae, and Salicaceae, Fabaceae (Matheny et al. 2012), Myrtaceae, and Tiliaceae (Horak 1980). It comprises between 500-700 species worldwide (Kirk et al. 2008, Matheny et al. 2009). Species in the family can be recognized by their small or medium fruiting body, conical to convex, fibrillose pileus, adnexed to adnate lamellae, typically appressed fibrillose stipe, often present of the veil in the young specimens, brown, smooth or angular basidiospores, present thick-walled and crystal-encrusted cheilocystidia (Largent 1988). The genus contains some edible species, *I. cutifracta* Petch (tropical Asia) and *I. jurana* Pat. (Europe), and some are poisonous which produced muscarine (Singer 1986).

Species of both genera will be presented in this paper with the data on various morphological features and notes on each species.

MATERIALS AND METHODS

Study area

Biodiversity survey to Banggai Kepulauan, Central Sulawesi, Indonesia was conducted in 2019, as shown in Figure 1. Geographically, Banggai Kepulauan are located between 1° 06' 30" LS-2° 20' 00" LS and 122° 40' 00" East Longitude-124° 13' 30" East Longitude in the northeast of Sulawesi Island (Rahmadi et al. 2014). The specimens of *Mycena* and *Inocybe* were collected from Kokolomboi Hamlet, Leme-leme Darat Village, Buko Subdistrict and Kautu Hill, Salakan Village, Tinangkung Subdistrict, Banggai Kepulauan District, Central Sulawesi Province, Indonesia.

Procedures

The specimens of Agaricales were collected in Banggai Kepulauan by Purposive Random Sampling. An adequate number of basidiocarps were collected representing as many growth stages as were available in order to examine variability within the species. As needed, photographs were taken of suitable basidiocarps. Each collection was put in plastic boxes. If possible, spores prints were made in the field on white paper or on a microscope slide. Successful prints were usually obtained after about 24 hours, then spore print color was recorded. Notes on macro-morphological features were made in the field soon after collecting, paying particular attention to: (i) size, shape, surface, color, and margin characteristics of different parts of the pileus; (ii) thickness, texture, color, taste, and odor of the flesh; (iii) presence or absence of a collarium; spacing, color and edge color of lamella; (iv) size, shape, color, and surface features of stipe; the attachment of the stipe to the substrate; (v) type of substrate; and (vi) the presence or absence of rhizomorphs. Brief notes were completed on fungus habit and habitat. Then collections were numbered and dried in the drier, afterward boxed, labeled, and stored, accompanied by a field label.

Macroscopic features were based on fresh material, while microscopic characters were described and illustrated using dried fungal specimens. Microscopic observation was made in material mounted in 3% of KOH. The size of basidiospores was measured from the collections. Colour notation was determined using Kornerup and Wanscher (1978). Examined specimens are deposited in Herbarium Bogoriense (BO) of Botany Division, Research Center for Biology, Indonesian Institute of Sciences. Macroscopic and microscopic characters were compiled and presented here as a species description.

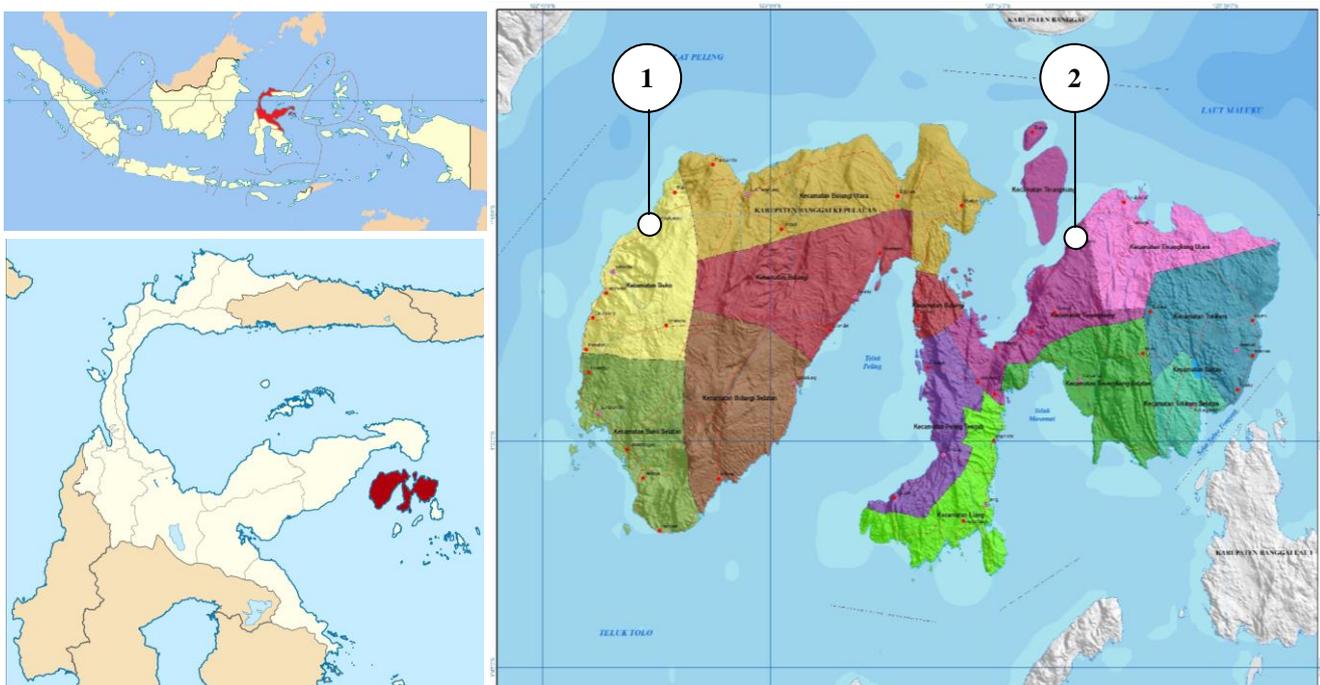


Figure 1. Sampling sites and locality of a biodiversity survey in Banggai Kepulauan District, Central Sulawesi, Indonesia (Badan Informasi Geospasial Republik Indonesia 2015-2019). Note: 1. Kokolomboi Hamlet, 2. Kautu Hill.

Data analysis

The variations found on the morphological characters of the specimens were used as the primary data to identify them up to species level. The size, shape, color, and other features can be utilized for identification analysis. Identification of the materials can be performed based on agarics flora from several regions; East Africa (Pegler 1977), Lesser Antilles (Pegler 1983), and Srilanka (Pegler 1986). All line drawings of the micro-characters were made with the aid of a camera lucida attached to a compound microscope using 40× or 100× (oil immersion) objectives. Spore range was obtained by measuring 25 mature basidiospores. Basidiospore statistics include: the arithmetic mean of the spore length by spore width (\bar{x}_m); the range of spore means (x_{mr}), and the mean of spore means (\pm SD) when more than one specimen is available (x_{mm}); the quotient of basidiospore length and basidiospore width in any one basidiospore, indicated as a range of variation in n basidiospores measured (Q); the mean of Q-values in a single specimen (Q_m); the range of Q_m -values where more than one specimen is available (Q_{mr}); and the mean of Q_m -values where more than one specimen is available (Q_{mm}) (Retnowati 2018).

RESULTS AND DISCUSSION

Results

Based on morphological features, the examined materials from Banggai Kepulauan were identified as *Mycena picta* (Fr.) Harmaja and *Inocybe stellata* E. Horak, Matheny & Desjardin. These two species were confirmed as new records for Indonesia that have increased the number of reported species of the genus *Mycena* and *Inocybe* in Indonesia. According to Horak (1980), three species of *Inocybe*; *I. fuscospinulosa* Corner & Horak, *I. olorinata* Horak, and *I. subgeophylla* Hennings apud

Warburg, were previously collected from Cibodas Botanical Garden, West Java, in 1972–1977. More additional records of three species of *Inocybe*, and eighteen species of *Mycena*, were from personal data of Retnowati (2019 unpublished data).

Taxonomy descriptions and notes on each species

Mycena picta (Fr.) Harmaja, Karstenia 19: 52. 1979. Figure 2–3.

Syn. *Omphalia picta* (Fr.) Gillet, *Omphalina picta* (Fr.) Quél., *Xeromphalina picta* (Fr.) A.H. Sm. (Maas Geesteranus 1983).

Fruiting body small. Pileus 2–4 mm diam, 2–4 mm high, cylindrical, greyish-yellow to dull yellow edges, flattened disc, glabrous, dry, translucent striate, olive. Context thin, pale olive. Odor and taste not distinctive. Lamellae adnate to slightly decurrent, distant (22 attached stipe), edges horizontal, greyish-yellow to dull yellow. Stipe 30–43 × 0.5 mm, filiform, cylindrical, glabrous, greyish-yellow to dull yellow.

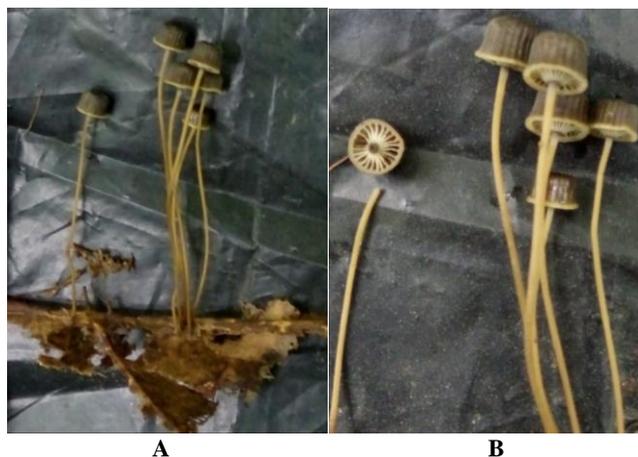


Figure 2. *Mycena picta*: A. Fruiting body, cylindrical and olive pileus; B. Lamellae (Photographs by: Idang Sumanta)

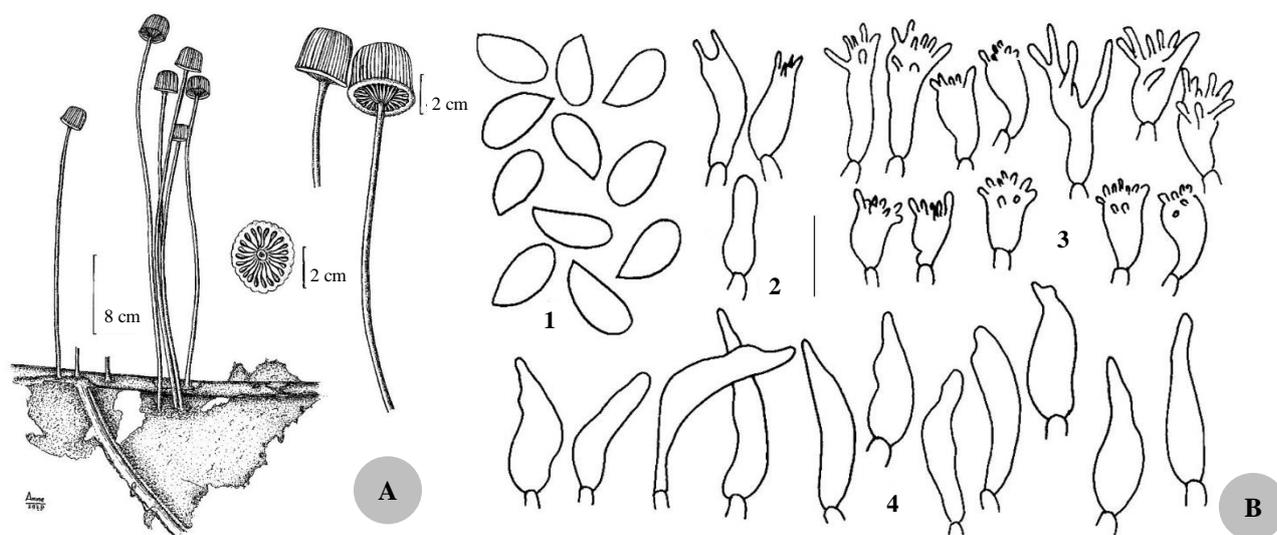


Figure 3. *Mycena picta*: A. Morphological characters of fruiting body (Drawn by A. Kusumawaty); B. Microscopic characters: 1. Basidiospores; 2. Basidia and Basidioles; 3. Cheilocystidia; 4. Pleurocystidia. Scale bar: B1 = 10 μ m; B2–B4 = 20 μ m. Drawn by A. Retnowati from Banggai 79.

Basidiospores $7.2-8.8 \times 4.0-4.8(5.6) \mu\text{m}$ ($x_m = 8.16 \pm 0.61 \times 4.38 \pm 0.41$, $Q = 1.50-2.20$, $Q_m = 1.87 \pm 0.19$, $n = 25$ spores per 1 specimen), ellipsoid, thin-walled, hyaline, smooth, amyloid. Basidia $20-28 \times 5.6-8.8 \mu\text{m}$, clavate, bearing 2–4-spored. Basidioles clavate. Pleurocystidia $28-40 \times 4.0-4.8(5.6) \mu\text{m}$, common on sides, clavate to fusoid, or submucronate, hyaline, thin-walled. Cheilocystidia common, terminal cell forming *Siccus*-type broom cells; main body $12-32 \times 7.2-8.8 \mu\text{m}$, cylindrical to clavate, often branched in the apical, hyaline to yellowish-brown; apical setulae $2.4-9.6 \times 0.8-1.8 \mu\text{m}$, cylindrical to conical, obtuse, thin to thick-walled. Pileipellis a cutis; hyphae $2-8.5 \mu\text{m}$ wide; hyphae $3.2-8.0 \mu\text{m}$, thin-walled, hyaline to yellowish-brown. Stipe tissue monomitic; cortical and medullary hyphae undifferentiated, thin-walled, hyaline to yellowish-brown. Clamp connections present.

Habit, habitat, and distribution. Gregarious on dicot leaves in forest. Banggai Kepulauan (Sulawesi).

Material examined. Indonesia: Sulawesi, Central Sulawesi, Banggai Kepulauan, Peleng Island, Kokolomboi, 5 July 2019, Banggai 79, collected by Idang Sumanta.

Notes. *Mycena picta* is a member of Mycenaceae, and it was placed in section *Pictae* (A.H. Sm.) Maas Geest. of the genus *Mycena* (Pers.) Roussel. Macroscopic and microscopic characters confirm that the species belongs to the genus *Mycena*, following the generic concept of Singer (1975). Singer (1975) suggested that it belonged to *Mycena* or some other genus than *Xeromphalina* Maire. In addition, Harmaja (1979), Maas Geesteranus (1983), Miyamoto et al. (1996), and Halama and Romański (2010) placed it in the genus *Mycena* as *Mycena picta* (Fr.) Harmaja.

The cylindrical pileus is a distinctive character of the species with additional characters of centrally depressed, glabrous, translucent-striate, dark olive-gray (5Y-3/2) to olive-brown, pale yellow at the margin (Miyamoto et al. 1996). The species grows gregariously on several different kinds of substrate. In Japan and Finland, it is on needles of *Abies sachalinensis* Masters or *Picea abies* Karst. (Miyamoto et al. 1996) (Harmaja 1979), while in Poland, the species grew on dry but standing, the mossy trunk of black alder, in the phytocoenosis of *Fraxino-Alnetum* W. Mat. (Bujakiewicz 2002) and on the rotten stump of the coniferous tree (Halama and Romański 2010). In several areas in the world, *M. picta* is recognized as a rare species; United Kingdom (Latha and Manimohan 2017), Netherlands (Arnolds and Veerkamp 2008), Germany

(Benkert et al. 1992), Finland (Harmaja 1979). Bujakiewicz (2002) stated that in Poland this species should be classified as vulnerable (V).

Mycena picta has been reported from several regions, Finland (Harmaja 1979), Japan (Miyamoto et al. 1996), Poland (Halama and Romański 2010), Russia (2018). The species occurs in different areas and present variations of morphological characters (Table 1). However, the variations are within range of the existing characters. Poland materials have the biggest pileus and largest stipe compared to Indonesian, Japanese, or Finland materials. The biggest basidiospores are found in Japanese materials, and no different sizes of basidiospores of Indonesian, Poland, and Finland materials. Pleurocystidia is a presence in the Indonesian material only, and it is absent in Japan and Poland materials.

Inocybe stellata E. Horak, Matheny & Desjardin, Phytotaxa 230(3): 215 (2015). – Type: A. Horak ZT10097, 1 Jul. 2002 (SFSU, holotype; ZT, isotype). – Figure 4–5.

Pileus 15×20 mm diam, conical, conical apex not seen clearly; surface squamules, slightly hygrophanous; margin incurved, becoming decurved in age; brown. Lamellae adnexed or sinuate, close with 2 series of lamellulae, broad, concolorous with pileus. Stipe $90-120 \times 4-6$ mm, central, terete, equal or slightly tapering towards the apex, surface dry, glabrous with finely pruinose, base slightly bulbous, light brown. Context thin, off-white to pale brown. Odor and taste not distinctive.

Basidiospores (8.8) $9.6-12(13.6) \times (8.8)9.6-12 \mu\text{m}$ ($x_m = 11.49 \pm 0.98 \times 10.94 \pm 0.92$, $Q = 1.00-1.15$, $Q_m = 1.05 \pm 0.06$, $n = 25$ spores per 1 specimen), echinulate, with conical projections up to $5 \mu\text{m}$, globose or subglobose, slightly thick-walled, pale brown. Basidia $34.4-62 \times 12-13.6 \mu\text{m}$, clavate, bearing 4-spored. Basidioles clavate. Hymenial cystidia $36-88 \times 14.4-20 \mu\text{m}$, broadly fusoid, metuloid, thin to thick-walled up to $4.0 \mu\text{m}$, hyaline. Pileipellis cutis; hyphae $6-8 \mu\text{m}$ wide, thin-walled, hyaline to yellowish-brown, slightly incrustated. Stipe tissue monomitic; cortical hyphae $4.0-9.6 \mu\text{m}$ diam, parallel, cylindrical, thick-walled up to $3.2 \mu\text{m}$, inamyloid, yellowish-brown; medullary hyphae $3.2-4.8 \mu\text{m}$ diam, thin-walled, inamyloid, hyaline to slightly yellowish-brown. Caulocystidia similar to hymenial cystidia, $36-52 \times 16-21.6 \mu\text{m}$, broadly fusoid, metuloid, thin to thick-walled up to $4.0 \mu\text{m}$, hyaline. Clamp connection present.

Table 1. Variations of morphological characters of *Mycena picta* from different areas.

Characters	Indonesia	Finland (Harmaja 1979)	Japan Miyamoto et al. 1996)	Poland (Halama and Romański 2010)
Pileus (mm in diam)	2-4	2-4	2.5-4	1.5-6.5
Pileus high (mm)	2-4	3-6	2-4	2.0-7.0
The number of lamellae (lamellae)	22	-	5-18	19-22
Stipe (length x width (mm))	$30-43 \times 0.5$	$20-30 \times 0.5-1$	$18-27 \times 0.4-0.7$	$8-61 \times 0.5-0.9$
Basidiospores (length x width (μm))	$7.2-8.8 \times 4.0-4.8(5.6)$	$6.0-8.0 \times 3.5-4.2$	$(5.6-6.4-9.4(-1)) \times (2.6-3.3-5.2)$	$6.8-7.3(7.9) \times (3.0) 4.0-4.3(4.7)$
Pleurocystidia (μm)	$28-40 \times 4.0-4.8(5.6)$	not mentioned	not seen	Pleurocystidia absent
Cheilocystidia (μm)	<i>Siccus</i> -type broom cells	<i>Siccus</i> -type broom cells	<i>Siccus</i> -type broom cells	<i>Siccus</i> -type broom cells

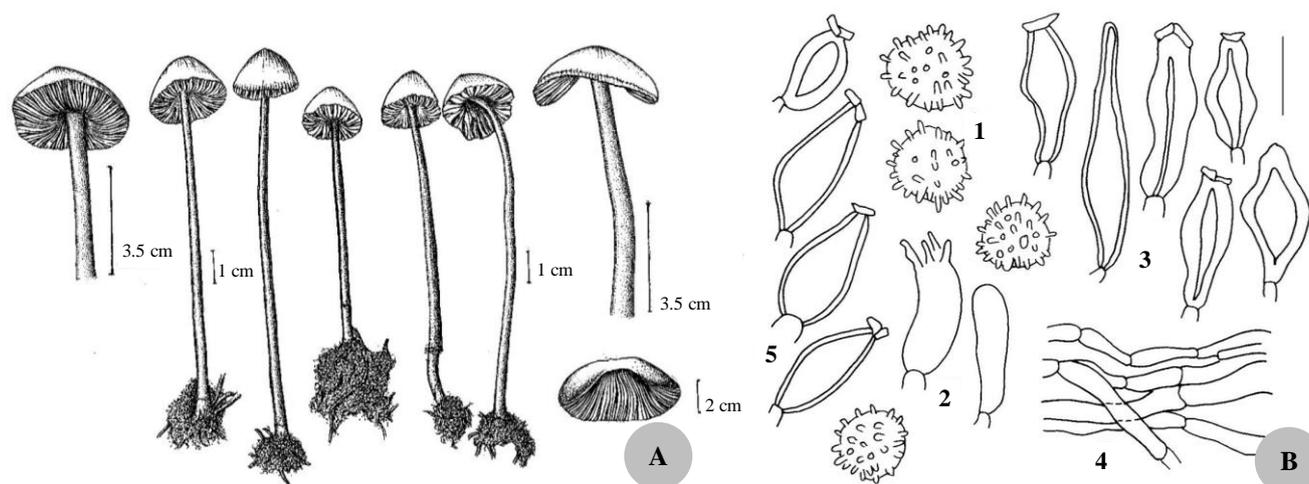


Figure 5. *Inocybe stellata*: A. Morphological characters of fruiting body (Drawn by A. Kusumawaty); B. Microscopic characters: 1. Basidiospores; 2. Basidia and Basidioles; 3. Hymenial cystidia; 4. Pileipellis; 5. Caulocystidia. Scale bar: B1 = 15 μ m; B2-B5 = 30 μ m. Drawn by A. Retnowati from Banggai 08.



Figure 4. *Inocybe stellata*: 1. Fresh materials of fruiting body with brown pileus; 2. Lamellae and lamellulae (Photographs by: Idang Sumantha)

Habit, habitat, and distribution. Solitary to gregarious on the soil in forest. Banggai Kepulauan (Sulawesi).

Material examined. Indonesia: Sulawesi, Central Sulawesi, Banggai Kepulauan, Peleng Island, Kautu Hill, Desa Salakan, Kecamatan Tinangkung, 29 June 2019, Banggai 08, collected by Idang Sumanta.

Notes. *Inocybe stellata* belongs to the family Inocybaceae. The species was originally described from Thailand and it occurred on lateritic soil (in recently burned) tropical lowland forest (dominated by *Dipterocarpus obtusifolia*, mixed with *Tectona grandis*) (Horak et al. 2015). This *I. stellata* is distinguished by having conical and squamules pileus. The characters of the Indonesian material confirm that is *I. stellata*. However, the conical apex is usually distinctive character of the species, but it can not be seen clearly in Indonesian material. The closest species to the *I. stellata* is *I. petchii*. The latter species is having bigger pileus up to 60 mm, papilla umbo present, a small bulb, and longer stipe up to 200 mm.

In conclusion, two species of Agaricales from Banggai Kepulauan, Sulawesi were identified as *M. picta* and *I. stellata* based on morphological characters. Both were new records for Indonesia. More studies of other materials from Banggai will yield more species of Agaricales, either as a new species or new record. The result of the taxonomic study of the Agaricales in these archipelago becomes one of the important data for making conservation decisions.

ACKNOWLEDGEMENTS

The authors greatly thank Idang Sumanta who collected materials from research sites. Kusuma Rahmawati and a team of Biodiversity Survey, Research Center for Biology to Banggai Kepulauan are also thanked for who made the fieldwork possible. The authors are also indebted to Prof. Egon Horak who compared the description of Indonesia collection with the protologue of *I. stellata* in order to ensure the correct identification of the species. The survey was funded by The Indonesian Government to LIPI.

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