Boletoid fungi (Boletaceae, Basidiomycota) of protected areas of Kon Tum Plateau (Central Highlands of Vietnam)

T. H. G. Pham1,4, O. V. Morozova2,5*, A. V. Alexandrova1,3,6

1 Joint Russian-Vietnamese Tropical Research and Technological Center, Nguyen Van Huyen Str., 63, Cau Giay, Hanoi, Vietnam
2 Komarov Botanical Institute of the Russian Academy of Sciences, Prof. Popova Str., 2, Saint Petersburg, 197376, Russia
3 Lomonosov Moscow State University, Leninskiye Gory Str., 1, 12, Moscow, 119234, Russia
4 ORCID iD: https://orcid.org/0000-0002-4137-7213
5 E-mail: ovm.leptonia@gmail.com; ORCID iD: https://orcid.org/0000-0002-7329-528X
6 ORCID iD: https://orcid.org/0000-0003-2359-4780

Keywords: biodiversity, boletoid basidiomycetes, Central Highlands of Vietnam, Kon Chu Rang, Kon Ka Kinh, Kon Plong, Tây Nguyên, tropical forests.

Summary. The article continues the series of publications devoted to the boletoid fungi of Vietnam. It summarizes the results of the observation of their diversity in three nature protected areas of the Central Highlands (Tây Nguyên) – Kon Ka Kinh National Park, Kon Chu Rang (Kon Chư Răng) Nature Reserve and Kon Plong Protected Forest, where middle-mountain evergreen broad-leaved and coniferous-deciduous forests prevail at altitudes of 900–1500 m. An annotated list of 22 revealed species is presented. Of these, two species (Fistulinella aurantioflava and Tylopilus subotsuensis) have been recently described from this territory as new to science. Hortiboletus rupicapreus is reported “ad interim”. Information on eight species (Aureoboletus sinobadius, Hourangia nigropunctata, Ionosporus longipes, Neoboletus multipunctatus, Phylloporus luxiensis, Pulveroboletus subrufus, Tylopilus atripurpureus, T. atroviolaceo-brunneus) is published for the first time for Vietnam. Strobilomyces aff. echinocephalus, S. aff. glabriceps, and Tylopilus aff. balloui (two different lines) are close to known species but genetically not identical. Six more specimens are identified only to the genus, and they probably represent species new to science. The color photographs of new to Vietnam and noteworthy species are presented. The nucleotide sequences obtained during the study were deposited in NCBI GenBank.

Болетовые грибы (Boletaceae, Basidiomycota) особо охраняемых природных территорий плато Контум (Центральное нагорье Вьетнама)

Т. Х. Ж. Фам1, О. В. Морозова2, А. В. Александрова1,3

1 Совместный Российско-Вьетнамский Тропический научно-исследовательский и технологический центр, ул. Нгуен Ван Хуен, д. 63, Кау Зай, г. Ханой, Вьетнам
2 Ботанический институт им. В. Л. Комарова РАН, ул. Проф. Попова, д. 2, г. Санкт-Петербург, 197376, Россия
3 Московский государственный университет им. М. В. Ломоносова, Биологический факультет, 119234, Ленинские горы, д. 1, стр. 12, г. Москва, Россия

Ключевые слова: биоразнообразие, болетоидные базидиомицеты, Конкаккинь, Конплонг, Контьыранг, особо охраняемые природные территории, тропические леса, Тэйнгуэн, Центральное нагорье Вьетнама.

DOI: 10.14258/turczaninowia.24.3.5
http://turczaninowia.asu.ru
Annotacija. Статья продолжает серию работ, посвященных болетовым грибам Вьетнама. Здесь обобщены результаты изучения разнообразия этой группы грибов трех охраняемых природных территорий Центрально-го нагорья (Тэйнгуэн) – национального парка Кон Кэ Кинь, природного заповедника Конгынг и охраняемого лесного массива Конплюнг; на высотах 900–1500 м преобладают среднегорные широколиственные и хвойно-широколиственные леса. Приводится аннотированный список 22 идентифицированных видов. Из них два недавно описаны с этой территории как новые для науки виды (Fistulinella aurantioflava и Tylopilus subotsuensis). Hortiboletus rupicapreus приводится “ad interim”. Информация о восьми видах (Aureoboletus sinobadius, Hourangia nigropunctata, Ionosporus longipes, Neoboletus multipunctatus, Phylloporus luxiensis, Pulveroboletus subrufus, Tylopilus atripurpureus, T. atroviolaceobrunneus) публикуется впервые для Вьетнама. Strobilomyces aff. echinocephalus, S. aff. glabriceps и T. aff. ballouii незначительно отличаются генетически от соответствующих известных видов. Еще шесть образцов определены только до рода и, вероятно, представляют новые для науки виды. Приводятся цветные фотографии новых для Вьетнама и редких видов. Нуклеотидные последовательности, полученные в ходе исследования, депонированы в GenBank NCBI.

Introduction

This article continues the series of publications devoted to the diversity of the boletoid fungi in Vietnam (Pham et al., 2018; Pham, Morozova, 2020). The results of the work in three nature protected areas of the Central Highlands (Tây Nguyên) – Kon Chu Rang (Kon Chư Râng) Nature Reserve, Kon Ka Kinh National Park and Kon Plong Protected Forest – are summarized here. Before the beginning of our research, there was no information on the mycobiota of this territory. Then, the data on the agaricoid genera Entoloma, Volvariella, Pluteus were published (Morozova et al., 2018; Malysheva et al., 2019, 2020).

An annotated list of 22 species of Boletaceae is presented here. Of these, two species (Fistulinella aurantioflava and Tylopilus subotsuensis) have been recently described by us from this territory as new to science (Crous et al., 2020, 2021). Hortiboletus rupicapreus is reported here “ad interim”, it will be published soon. Eight species (Aureoboletus sinobadius, Hourangia nigropunctata, Ionosporus longipes, Neoboletus multipunctatus, Phylloporus luxiensis, Pulveroboletus subrufus, Tylopilus atripurpureus, and T. atroviolaceobrunneus) are published for the first time for Vietnam. But most of them (by the exclusion of Aureoboletus sinobadius and Tylopilus atripurpureus) were reported previously in the manuscript of the dissertation work of the first author (Pham, 2020).

Materials and methods

Collections were made by route method in different types of tropical forests on Kon Tum plateau in 2015–2017 in course of the investigation of mycobiota of the Central Highlands (Tây Nguyên).

The information on the nature conditions of the territories studied is provided below.

Kon Ka Kinh National Park

Kon Ka Kinh National Park (Vườn quốc gia Kon Ka Kinh) is located in the northern part of Gia Lai Province (Mang Yang County, A Yun Commune) between 14.15°N–14.5°N and 108.25°E–108.45°E and covers an area of 417.8 km². About 80 % (331.46 km²) of the park's territory is covered with forests. The territory of the park lies between Pleiku and Kon Ha Nung plateaus and has mountainous terrain with an average altitude of 1200–1500 m a. s. l. (the highest Kon Ka Kinh – 1748 m). The rivers flowing through the park belong to the basins of the Ba Pe, and A Yun rivers. The park's climate is tropical monsoon, with distinct rainy (May – November) and dry (December – April) seasons. The average annual temperature ranges from 21 to 25 °C. The average annual precipitation is from 2000 to 2500 mm, the peak of precipitation falls in July-August (400–450 mm). There is practically no precipitation in January – February (Sourcebook of Existing ..., 2004; Ha et al., 2011, 2014).

The forest vegetation of Kon Ka Kinh National Park is represented by three main types (Thai, 1978; Le et al., 2000). The most widespread are mountain evergreen broad-leaved forests, which occupy heights of 900–1000 m a. s. l. and higher. They are characterized by the dominance of species of Fagaceae (Castanopsis, Lithocarpus, Quercus), Lauraceae, Euphorbiaceae, Meliaceae, Sterculiaceae, Theaceae, Rubiaceae. In mountain evergreen mixed forests found south of the Kon Ka Kinh Mt, at altitudes from 1300 m, in addition to species from the families Fagaceae, Theaceae, Euphorbiaceae, Hamamelidaceae, Elaeocarpaceae, Myrtaceae, and Meliaceae, species of conifers present (Fokienia hodginsii, Dacrycarpus imbricatus, Dacrydium
elatum, Nageia fleuryi, Podocarpus neriifolius). Below 900 m a. s. l., low-mountain evergreen broad-leaved forests are developed, dominated by Dipterocarpaceae (Shorea siamensis, S. roxburghii), Fabaceae, Irvingiaceae, Euphorbiaceae, Moraceae, Burseraceae, Lauraceae, Apocynaceae, Meliaceae, Fagaceae, and Magnoliaceae. Rather large area is occupied by plantings of Pinus latteri.

Kon Chu Rang Nature Reserve
The KBTTN Kon Chu Râng is located in the northeastern part of Gia Lai Province (K’Bang District, Son Lang Commune), between 14.5°N–14.58°N and 108.5°E–108.65°E, and is bordered by the provinces of Binh Dinh, Quang Ngai, and Kon Tum. The area of the reserve is 159 km², of which 156.1 km² (99 %) are primary and intact forests. The relief of the reserve is mostly hilly, mountainous in the northern part, with heights from 800 to 1452 m a. s. l. (Kon Chu Râng). The average annual temperature is about 21 °C (maximum in May +28 °C, minimum in January +12 °C). The average annual precipitation is about 1900–2000 mm, the peak of precipitation falls in September (340 mm). The dry season is relatively short, with up to 60 mm of precipitation per month in January–April (New et al., 2002; Sourcebook of Existing ..., 2004). Numerous rivers flowing through the reserve belong to basin of the Kon River (Sông Kôn), which has a number of waterfalls, the most famous and tallest of which is 50 m high.

The main forest type is middle-mountain evergreen broad-leaved and mixed forest distributed at elevations between 900 and 1500 m in the northwest of the nature reserve. Canopy cover of this forest type is 70 to 80 %, and the tree flora is dominated by species from the Fagaceae (Lithocarpus, Quercus, Castanopsis), Lauraceae, Fabaceae, Clusiaceae, Myrtaceae, Ericaceae, Burseraceae, and Magnoliaceae, mixed with gymnosperms (Dacrycarpus imbricatus, Dacrydium elatum). Lowland evergreen forest occurs at elevations below 900 m. Only 2 % of the nature reserve is covered by secondary vegetation, mainly scrub with scattered trees.

Kon Plong Protected Forest
The Kon Plong Protected Forest is located in the northeast of Kon Tum Province (Kon Plong County), within the state forestry enterprises of Mang Canh II, Tan Lap, and the Ngok tem (Ngök tem) Water Protection Forest. The massif has an area of 650.8 km² and is located on the highly dissected mountain basalt plateau Kon Ha Nung (Kon Hà Nùng), at an altitude of 1100 to 1757 m a. s. l. The studied territory is located in the basin of the Lo (Đắk Lo), Te (Nước Che) rivers and the lower reaches of the Khe (Đắk Khê) river within 14.7125°N–14.7589°N and 108.3°E–108.3233°E. The climate is characterized by moderate temperatures (average annual temperature is about +18 °C, and the coldest month +16 °C) and heavy rainfall (up to 2800 mm per year).

The vegetation cover above 1000 m a. s. l. is dominated by middle-mountain evergreen mixed forests, the upper tier of which is dominated by Fagaceae (Lithocarpus, Quercus, Castanopsis), Lauraceae, Hamamelidaceae, Theaceae, Dipterocarpaceae (Dacrycarpus imbricatus, Dacrydium elatum, Podocarpus neriifolius), Pinaceae (Pinus dalatensis, Keteleeria Evelyniana), Cupressaceae (Fokienia Hodginsii), etc. There are areas of monodominant coniferous forests with Pinus lateri. At altitudes up to 900–1000 m a. s. l. low-mountain evergreen broadleaf forests are developed with the participation of Dipterocarpaceae (Shorea siamensis, Parashorea stellata, Dipterocarpus obtusifolius), Fagaceae, Myrtaceae, Sterculiaceae, Annonaceae, etc. On a large area, natural forests are disturbed by economic activity and are replaced by secondary forests, bamboo, shrub and herbaceous communities (Eames et al., 2001; Pham et al., 2001).

Morphological study
Macromorphological features were studied on the basis of fresh and dried material, as well as through the analysis of photographs and descriptions taken in the field.

Micromorphological structures were studied using herbarium material. The collected specimens were examined using light and electron microscopy, as well as by analyzing DNA sequences (ITS and tef1a sites). Microscopical characters were studied with a light Zeiss Axioscope A1 microscope with AxiosCam1Cc 3 camera and program tools AxioVisionRel.4.6. (Carl Zeiss, Germany). Basidiospores, basidia, and hymenial cystidia were observed in squash preparations of small parts of the tubes in 5 % KOH. The pileipellis was examined on a radial section of the pileus, the stipitpellis – on longitudinal slice of the stipe in 5 % KOH. Basidiospore dimensions are based on 20 measurements, whereas cystidia and basidia dimensions are based on observing at least 10 structures per collection.
SEM photos were also used for the identification of material. They have been made by L. A. Kartseva on a scanning analytical electron microscope JEOL JSM-6390LA of Core Facility Centre ‘Cell and Molecular Technologies in Plant Science’ of Komarow Botanical Institute and by A. V. Alexandrova (Lomonosov State University) on scanning analytical electron microscopes JSM-6380LA and Camscan-S2 (Cambridge Instruments, 1990).

Molecular-genetic study

The molecular study is based on a phylogenetic species recognition (Taylor et al., 2000). To assess the taxonomic status of the identified phylogenetic lineages and put forward species hypotheses, we relied on the accepted boundaries of the possible variability of the ITS1–5.8S–ITS2 region within the species (Petersen et al., 2008; Hughes et al., 2009).

DNA was extracted from herbarium material using NucleoSpin® Plant II kit (Macherey-Nagel, Düren, Germany). The ribosomal ITS1–5.8S–ITS2 region was amplified with primers ITS1F and ITS4B (Gardes, Bruns, 1993), and elongation translation factor (tef1α) – with Boletaceae-specific primers EF1-B-F1 and EF1-B-R (Wu et al., 2014). PCR products were purified with the Fermentas Genomic DNA Purification Kit (Thermo Fisher Scientific, Waltham, MA) and sequenced on an ABI model 3130 Genetic Analyzer (Applied Biosystems, Waltham, MA). Raw data were edited and assembled in MEGA X (Kumar et al., 2018). Newly generated sequences were deposited in NCBI GenBank (Table).

Collections studied are kept in the Mycological Herbarium of the Komarov Botanical Institute (LE).

Results and discussion

Twenty-two species revealed in the Kon Tum plateau are listed below including ten species published for the first time for Vietnam (marked with “!’”).

Annotated list of species of Boletoid fungi of the Kon Chu Rang Nature Reserve, Kon Ka Kinh National Park, and Kon Plong Protected Forest

Subfamily Austroboletoideae G. Wu et Zhu L. Yang

Fistulinella aurantioflava T. H. G. Pham, A. V. Alexandrova et O. V. Morozova: “Kon Ka Kinh National Park, 14.217129°N, 108.310132°E, 1220 m a. s. l., on slopes of mountain, on soil in the tropical mountain polydominant forest with the participation of Myrtaceae, Meliaceae, Anacardiaceae, Fagaceae, Theaceae. 16 V 2016. A. V. Alexandrova” (LE 315616) (Pham, 2020, as “Pulveroboletus” curtisii; Crous et al., 2021).

Subfamily Boletoidae Burnett

Hortiboletus rupicapreus Svetash., A. V. Alexandrova, O. V. Morozova et T. H. G. Pham, ad interim: “Kon Ka Kinh National Park, 14.219917°N, 108.325667°E, 1200 m a. s. l., ridges on slopes, on soil in tropical mountain forests dominated by Myrtaceae, Meliaceae, Anacardiaceae, Fagaceae, Theaceae. 18 V 2016. A. V. Alexandrova” (LE 312677); ibid., “14.205190°N, 108.316312°E, 1000 m a. s. l., on soil in plantations of Pinus kesiya with some Fagaceae. 15 V 2016. A. V. Alexandrova” (LE 312678).

Porphyrellus nigropurpureus (Hongo) Y. C. Li et Zhu L. Yang: “Kon Plong Protected Forest, Mang Canh Commune, 5 km north of Kondu Village, 14.73295°N, 108.31203°E, 1100 m a. s. l., on soil in polydominant rainforest with participation of Podocarpaceae, Magnoliaceae, Myrtaceae, Calophyllaceae, Elaeocarpaceae. 10 VI 2016. O. V. Morozova” (LE 315621).

!’Strobilomyces aff. echinocephalus’ Gelardi et Vizzini: “Kon Ka Kinh National Park, 14.219917°N, 108.325667°E, 1200 m a. s. l., on soil in polydominant rainforest with participation of Podocarpaceae, Magnoliaceae, Myrtaceae, Anacardiaceae, Fagaceae, Theaceae. 18 V 2016. O. V. Morozova” (LE 312681, fig. 1a, b).

!’Strobilomyces aff. glabriceps’ W. F. Chiu: “Kon Ka Kinh National Park, on slopes of the mountain, 14.217129°N, 108.310132°E, 1220 m a. s. l., on soil in tropical mountain polydominant forest with the participation of Myrtaceae, Meliaceae, Anacardiaceae, Fagaceae, Theaceae. 16 V 2016. O. V. Morozova” (LE 312682, fig. 1c).

!’Strobilomyces seminudus’ Hongo: “Kon Ka Kinh National Park, on slopes of the mountain, 14.20414°N, 108.32143°E, 970 m a. s. l., on soil in tropical mountain evergreen broadleaf forest with the participation of families Magnoliaceae, Myrtaceae, Anacardiaceae, Fagaceae. 20 V 2016. O. V. Morozova” (LE 315628, fig. 1d, e, f).

!’Tylopilus atripurpureus’ (Corner) E. Horak: “Kon Ka Kinh National Park, 14.20414°N, 108.32143°E, 970 m a. s. l., on soil in a middle-mountain evergreen broadleaf forest with the participation of families Magnoliaceae, Myrtaceae, Lauraceae, Fagaceae. 16 V 2016. O. V. Morozova” (LE 312682, fig. 1c).

!’Tylopilus atripurpureus’ (Corner) E. Horak: “Kon Ka Kinh National Park, on slopes of the mountain, 14.217129°N, 108.310132°E, 1220 m a. s. l., on soil in tropical mountain polydominant forest with the participation of Myrtaceae, Meliaceae, Anacardiaceae, Fagaceae, Theaceae. 16 V 2016. O. V. Morozova” (LE 312682, fig. 1c).
participation of families Magnoliaceae, Myrtaceae, Theaceae, Lauraceae, Fagaceae. 20 V 2016. O. V. Morozova” (LE 312683, fig. 1g).

Tylopilus atrovioalaceobrunneus Yan C. Li et Zhu L. Yang: “Kon Ka Kinh National Park, on soil

Table
Boletaceae species in the nature protected areas studied, with voucher and Genbank numbers

| Species                     | Protected areas | Alt. (m) | LE numbers | GenBank numbers |
|-----------------------------|-----------------|----------|------------|-----------------|
|                             | Kon Ka Kinh     | Kon Chu Rang | Kon Plong |                 |
| Aureoboletus sinobadius     | +               | 1220      | LE 312680  | MZ451340        |
|                             |                 |           |            | MZ424885        |
| Boletellus areolatus        | +               | 980       | LE 315577  | MZ451341        |
|                             |                 | 1030      | LE 315576  | MZ451342        |
| Boletus sp. 1               | +               | 1300      | LE 312687  | MZ451343        |
| Boletus sp. 2               | +               | 1050      | LE 312698  | MZ451344        |
| Chalciporus sp. 1           | +               | 1000      | LE 312688  | MZ451345        |
| Chalciporus sp. 2           | +               | 1000      | LE 312689  | MZ451346        |
| Chiua viridula              | +               | 1000      | LE 315611  | MZ451347        |
|                             |                 |           | LE 315612  | MZ451348        |
| Crocinobolus rafroauraeus   | +               | 1280      | LE 315607  | –                |
|                             |                 |           | LE 315561  | MZ424887        |
| Fistulinella aurantiolava   | +               | 1220      | LE 315616  | MW784159        |
| Horticobolus rupicapreus    | +               | 1000      | LE 312677  | MW784161        |
|                             |                 | 1200      | LE 312678  | MZ424894        |
| Hourangia nigropunctata     | +               | 1270      | LE 315626  | MZ451348        |
| Ionosporus longipes         | +               | 1000      | LE 315589  | MZ451349        |
| Neoboletus multipunctatus   | +               | 830       | LE 315625  | MZ451350        |
|                             |                 | 1080      | LE 312474  | MZ451351        |
|                             |                 | 1280      | LE 315637  | –                |
| Neoboletus obscureumbrinus  | +               | 1090      | LE 315548  | MZ451352        |
| Phyloporus luxiensis        | +               | 1020      | LE 315622  | –                |
| Phyloporus rubiginosus       | +               | 1000      | LE 315623  | MZ451353        |
| Phyloporus sp. 1            | +               | 1000      | LE 312684  | –                |
| Phyloporus sp. 2            | +               | 1020      | LE 312685  | MZ451354        |
| Porphyrellus nigropurpureus | +               | 1100      | LE 315621  | –                |
| Pulveroboletus subrufus     | +               | 1050      | LE 312686  | MZ451355        |
| Strobilomyces aff. echinocephalus | +     | 1200      | LE 312681  | –                |
| Strobilomyces aff. glabriceps| +               | 1220      | LE 312682  | –                |
| Strobilomyces seminudus     | +               | 970       | LE 315628  | MZ451356        |
| Tylopilus atripurpureus     | +               | 970       | LE 312683  | –                |
| Tylopilus atrovioalaceobrunneus | +         | 1000      | LE 315627  | –                |
| Tylopilus aff. balloui 1    | +               | 1300      | LE 312532  | MZ451357        |
| Tylopilus aff. balloui 2    | +               | 1000      | LE 312700  | MZ451358        |
| Tylopilus subotsuensis      | +               | 1000      | LE 312527  | –                |
| Total                       | 20              | 6         | 4          | 28              |
Fig. 1. Basidiomata *in situ*: a, b – *Strobilomyces* aff. *echinocephalus* (LE 312681); c – *Strobilomyces* aff. *glaibrate* (LE 312682); d, e, f – *Strobilomyces seminudus* (LE 315628); g – *Tylopilus atripurpureus* (LE 312683); h – *Tylopilus atroviolaceobrunneus* (LE 315627); scale bar = 1 cm.
Tylopilus aff. balloui [1] (Peck) Singer: “Kon Ka Kinh National Park, 14.21988°N, 108.30936°E, 1300 m a. s. l., on the soil in a tropical mountain polydominant forest with the participation of Myrtaceae, Meliaceae, Anacardiaceae, Fagaceae, Theaceae. 20 V 2016. A. V. Alexandrova” (LE 312532).

Tylopilus aff. balloui [2] (Peck) Singer: “Kon Chu Rang Nature Reserve, 14.50516°N, 108.58140°E, 1000 m a. s. l., on soil in middle-mountain evergreen mixed forest. 27 V 2016. A. V. Alexandrova” (LE 312700).

Tylopilus subotsuensis T. H. G. Pham, A. V. Alexandrova et O. V. Morozova: “Kon Chu Rang Nature Reserve, 14.50042°N, 108.56338°E, 1000 m a. s. l., on soil in middle-mountain evergreen mixed forest. 27 V 2016. A. V. Alexandrova” (LE 312700). (Crous et al., 2020).

Subfamily Leccinoideae G. Wu et Zhu L. Yang

Ionosporus longipes (Masee) Khmeln., Davoodian, Raspé, S. M. L. Lee et Halling: “Kon Chu Rang Nature Reserve, Son Lang Commune, vicinity of waterfalls, 14.51413°N, 108.54630°E, 1000 m a. s. l., on the soil in a middle-mountain evergreen mixed forest with a predominance of Podocarpaceae (Dacrydium elatum, Dacrycarpus imbricatus), Magnoliaceae, Burseraceae, Myrtaceae. 25 V 2016. O. V. Morozova” (LE 315589, fig. 2a).

Fig. 2. Basidiomata in situ: a – Ionosporus longipes (LE 315589); b – Aureoboletus sinobadius (LE 312680); c – Hourangia nigropunctata (LE 315626); d – Phylloporus luxiensis (LE 315622).
Subfamily Xerocomoideae Singer

! *Aureoboletus sinobadius* Ming Zhang et T.H. Li: “Kon Ka Kinh National Park, 14.21226°N, 108.31318°E, 1090 m a. s. l., on the soil in tropical mountain polydominant forests with the participation of Myrtaceae, Meliaceae, Anacardiaceae, Fagaceae, Theaceae. 16 V 2016. A. V. Alexandrova” (LE 312680, fig. 2b).

*Boletellus areolatus* Hirot. Sato: “Kon Ka Kinh National Park, 14.20948°N, 108.31276°E, 980 m a. s. l., on soil in a middle-mountain evergreen broadleaf forest with the participation of families Magnoliaceae, Myrtaceae, Theaceae, Lauraceae, Fagaceae. 16 V 2016. O. V. Morozova” (LE 315577); “Kon Plong Protected Forest, Mang Canh Commune, 5 km north of Kondu Village, 14.72222°N, 108.316°E, 1030 m a. s. l., on soil in a middle-mountain polydominant forest, 23 IV 2015. A. V. Alexandrova” (LE 315576).

! *Hourangia nigropunctata* (W.F. Chiu) Xue T. Zhu et Zhu L. Yang: “Kon Ka Kinh National Park, 14.222330°N, 108.310347°E, 1270 m a. s. l., on soil in a tropical mountain polydominant forest with the participation of Myrtaceae, Meliaceae, Anacardiaceae, Fagaceae, Theaceae. 20 V 2016. A. V. Alexandrova” (LE 315626, fig. 2c).

! *Phylloporus luxiensis* M. Zang: “Kon Ka Kinh National Park, 14.209184°N, 108.314681°E, 1020 m a. s. l., on the soil in a tropical mountain polydominant forest with a predominance of Myrtaceae, Meliaceae, Anacardiaceae, Fagaceae, Theaceae. 16 V 2016. A. V. Alexandrova” (LE 315622, fig. 2d).

*Phylloporus rubiginosus* M. A. Neves et Halling: “Kon Ka Kinh National Park, 14.2187°N, 108.3168°E, 1000 m a. s. l., on the soil in tropical middle-mountain polydominant forest dominated by Lauraceae, Myrtaceae, Meliaceae, Fagaceae, Dipterocarpaceae. 15 V 2016. O. V. Morozova” (LE 315623).

Subfamily Zangoideae G. Wu, Y. C. Li et Zhu L. Yang

*Chiua viridula* Y.C. Li et Zhu L. Yang: “Kon Ka Kinh National Park, 14.20791°N, 108.31500°E, 995 m a. s. l., on the soil in a middle-mountain middle-mountain polydominant forest with a predominance of Myrtaceae, Meliaceae, Anacardiaceae, Fagaceae, Theaceae. 16V 2016.E. S. Popov” (LE315611); “Kon Chu Rang Nature Reserve, vicinity of waterfalls, 14.51413°N, 108.54630°E, 1000 m a. s. l., on the soil in a middle-mountain evergreen mixed forest with a predominance of Podocarpaceae (*Dacrydium elatum, Dacrycarpus imbricatus*), Magnoliaceae, Burseraceae (*Canarium*), Myrtaceae (*Syzygium*). 25 V 2016. O. V. Morozova” (LE 315614, fig. 3a, b); ibid. “01 VI 2016. O. V. Morozova” (LE 315612).

**Pulveroboletus-group**

*Crocinoboletus rufouaureus* (Massace) N. K. Zeng, Zhu L. Yang et G. Wu: “Kon Plong Protected Forest, 5 km north of Kondu Village, headwaters of the La and Khe rivers, 14.7455°N, 108.3019°E, 1280 m a. s. l., middle-mountain polydominant forest dominated by Podocarpaceae, Magnoliaceae, Myrtaceae, Calophyllaceae, Elaeocarpaceae, Betulaceae. 05 VI 2016. A. V. Alexandrova” (LE 315607).

! *Neoboletus multipunctatus* N. K. Zeng, H. Chai et S. Jiang: “Kon Ka Kinh National Park, 14.211846°N, 108.313694°E, 1080 m a. s. l., on soil in a tropical mountain polydominant forest with the participation of Myrtaceae, Meliaceae, Anacardiaceae, Fagaceae, Theaceae. 13 V 2017. A. V. Alexandrova” (LE 315637).

*Neoboletus obscureumbrinus* (Hongo) N. K. Zeng, H. Chai et Zhi Q. Liang [= *Sutorius obscureumbrinus* (Hongo) G. Wu et Zhu L. Yang]: “Kon Ka Kinh National Park, 14.21226°N, 108.31318°E, 1090 m a. s. l., on the soil in tropical mountain polydominant forests with the participation of representatives of the families Myrtaceae, Meliaceae, Anacardiaceae, Fagaceae, Theaceae. 16 V 2016. A. V. Alexandrova” (LE 315625, fig. 3c); ibid., “14.21946°N, 108.30940°E, 1280 m a. s. l. 20 V 2016. A. V. Alexandrova” (LE 312474); ibid., “Krong commune, K’bang district, 14.310920°N, 108.438320°E, 830 m a. s. l., on soil in tropical middle-mountain polydominant forest with the participation Myrtaceae, Meliaceae, Anacardiaceae, Fagaceae, Theaceae. 13 V 2017. A. V. Alexandrova” (LE 315637).

Totally, the presence of 28 species of Boletaceae in the studied area were confirmed by the molecular data (Table).

![Strobilomyces aff. echinocephalus](https://example.com/aff.echinocephalus.png), S. aff. *glabriceps*, and *Tylopilus aff. balloui* (two different lines) morphologically are close to known species but genetically not identical with the
Fig. 3. Basidiomata *in situ*: a, b – *Chiua viridula* (LE 315614); c – *Neoboletus multipunctatus* (LE 315625); c – *Pulveroboletus subrufus* (LE 312686); e, f – *Neoboletus obscureumbrinus* (LE 315548).
sequences kept in the NCBI GenBank. In addition, 6 more genotypes were revealed on the base of the molecular study. They could not be attributed to any known species either by molecular or morphological data; there are: *Boletus* sp. 1, *Boletus* sp. 2, *Chalciporus* sp. 1, *Chalciporus* sp. 2, *Phylloporus* sp. 1, *Phylloporus* sp. 2.

The species are distributed between 17 genera belonging to 5 subfamilies and the *Pulveroboletus* group. Among the territories studied, the highest diversity of boletoid species was found in the Kon Ka Kinh National Park due to the higher diversity of the communities represented there and more favorable weather conditions during the collection period. The mountain evergreen broad-leaved and coniferous-deciduous forests of this park are richest in the diversity of the Boletaceae species.

Acknowledgments
The authors are grateful to staff of the Joint Russian-Vietnamese Tropical Research and Technological Center for organizing the expeditions and to management of the Kon Ka Kinh National Park, Kon Chu Rang Nature Reserve, and Kon Plong Protected Forest for their help and permission to collect in the forests. We thank Dr. E. S. Popov (Komarov Botanical Institute) for his assistance with collecting and providing literature. The study of Olga Morozova was conducted in the framework of a research project of the Komarov Botanical Institute of the Russian Academy of Sciences (no. AAAA-A18-118022090078-2) using equipment of its Core Facility Centre “Cell and Molecular Technologies in Plant Science” with the financial support of Russian Foundation for Basic Research (project no. 20-04-00349). The study of Alina Alexandrova was conducted as part of the Scientific Project of the State Order of the Government of Russian Federation to Lomonosov Moscow State University (no. 121032300081-7).

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