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## Contributions to the distribution of *Phallales* in Turkey

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### Türkiye'deki *Phallales*'lerin yayılışına katkılar

**Abstract:** New specimens of four previously reported members of the family *Phallaceae*, *Clathrus ruber* P.Micheli ex Pers., *Mutinus caninus* (Huds.) Fr., *Phallus impudicus* L., and *Pseudocolus fusiformis* (E. Fisch.) Lloyd, were collected from Eastern Black Sea region of Turkey. The samples were identified and brief descriptions were prepared. Current and newly determined localities of the collected species were provided together with the photographs related to their macro and micromorphologies.

**Key words:** Biodiversity, *Phallaceae*, stinkhorn fungi, Turkey.

**Özet:** Doğu Karadeniz Bölgesi'nden, daha önceden rapor edilmiş olan dört *Phallaceae* familyası üyesine, *Clathrus ruber* P.Micheli ex Pers., *Mutinus caninus* (Huds.) Fr., *Phallus impudicus* L., ve *Pseudocolus fusiformis* (E. Fisch.) Lloyd, ait yeni örnekler toplanmıştır. Örneklerin teşhisleri yapılmış ve kısa betimleri hazırlanmıştır. Toplanan türlerin mevcut ve yeni belirlenen lokaliteleri, makro ve mikromorfolojilerine ait fotoğrafları ile birlikte verilmiştir.

**Anahtar Kelimeler:** Biyoçeşitlilik, *Phallaceae*, pis kokulu mantarlar, Türkiye

## 1. Introduction

*Phallales* E.Fisch. is an order of fungi in the phylum Basidiomycota. According to Kirk et al., (2008) the order comprises 88 species belonging to 26 genera and 2 families, but Index Fungorum (accessed 10 June 2019) currently list 173 taxa within 39 genera. *Phallaceae* Corda is a well-known family of the order *Phallales* and commonly known as "stinkhorns". Members of the family are generally characterized by a simple hollow pseudostipe and a slimy spore mass which is usually supported by a campanulate receptacle or spread over the pseudostipe surface (Gaona et al., 2017).

Until the end of 2018, 44 records, belonging to 7 species of the *Phallaceae* within the genera *Anthurus* Kalchbr. & MacOwan, *Clathrus* P.Micheli ex L., *Colus* Cavalier & Séchier, *Mutinus* Fr., *Phallus* Junius ex L. and *Pseudocolus* Lloyd have so far been presented from Turkey (Sesli and Denchev, 2014; Akata and Gürkanlı, 2018). These samples were collected from 30 different provinces of Turkey. During our routine field studies fruit bodies of stinkhorn species were collected from Eastern Black Sea Region of Turkey and determined as *Clathrus ruber* P. Micheli ex Pers., *Mutinus caninus* (Huds.) Fr., *Phallus impudicus* L., and *Pseudocolus fusiformis* (E. Fisch.) Lloyd.

The study aims to make a contribution to the mycobiota of Turkey by presenting new distributions for some stinkhorn fungi.

## 2. Materials and Method

Stinkhorn fungi samples were collected from Artvin, Giresun, Rize and Trabzon provinces during routine field studies between 2015 and 2018 within the Eastern Black Sea Region of Turkey. Required characteristics of the samples were recorded and they were photographed in their natural habitat. The samples were dried in air conditioned room and prepared as fungarium materials. Measuremental evaluations were performed in the

fungarium. Micromorphological investigations were carried out under a Nikon eclipse Ci-S trinocular light microscope and the photographs related to micromorphology were taken by a DS-Fi2 digital camera aided by a Nikon DS-L3 displaying apparatus. The specimens were identified with the help of Bessette et al., (1995, 1997), Philips (2010), McKnight and McKnight (1987), Sterry and Hughes (2009), Buczacki (2012), Lincoff, (1981), Pegler et al., (1995), Roberts and Evans (2013), Watling (1973), Akata and Doğan (2011), Miller and Miller (1988), Jordan (1995), Breitenbach and Kränzlin (1986) and Ellis and Ellis (1990).

The specimens are deposited at Biology Department, Kamil Özdağ Science Faculty, Karamanoğlu Mehmetbey University.

## 3. Results

*Basidiomycota* R.T.Moore

*Phallales* E.Fisch.

*Phallaceae* Corda

*Clathrus* P.Micheli ex L.

*Clathrus ruber* P.Micheli ex Pers., Syn. meth. fung. (Göttingen) 2: [241] (1801).

[**Syn:** *Clathrus cancellatus* Tourn. ex Fr., *Clathrus cancellatus c albus* Fr., *Clathrus flavescens* Pers., *Clathrus kusanoi* (Kobayasi) Dring, *Clathrus ruber* \* *columnatus* Schwein., *Clathrus ruber* f. *kusanoi* Kobayasi, *Clathrus ruber* P. Micheli ex Pers. f. *ruber*, *Clathrus ruber* var. *albus* (Fr.) Quadr. & Lunghini, *Clathrus ruber* var. *flavescens* (Pers.) Quadr. & Lunghini, *Clathrus ruber* P. Micheli ex Pers. var. *ruber*]

**Macroscopic and microscopic features:** Immature fruit body 30-60 mm in diam., egg-shaped (Figure 1a), sub-hypogeous to epigeous, consists of an olive-green gleba, a compressed lattice surrounding the gleba (Figure 1b), and a white to creamy and leathery outer membrane (exoperidium), enclosing the gleba and the lattice. Surface

smooth, marked by reticulations indicating the site of insertion of the lattice (Figure 1a), and rooted by a thick mycelial strand at the base (Figure 1b,c). Later on the peridium ruptures at the apex letting the lattice-shaped receptaculum rise (Figure 1c). Receptaculum 90-120 × 65-85 mm, hollow, spherical to globose or somewhat elongated lattice-like network of meshes (Figure 1c,d); arms about 15 mm thick with a spongy structure, salmon-pink to scarlet red, somewhat paler towards the base. The mature fruit body smells like a carrion. Basidia and cystidia not observed. Basidiospores 4.5-6 × 1.5-2 μm, cylindrical to bacilloid, hyaline to pale greenish, smooth, thin-walled (Figure 1e).

*Clathrus ruber* was reported to grow on soil amongst leaf litter in gardens, shrubberies and grassy places at the edge of woodlands (Breitenbach and Kränzlin, 1986; Jordan, 1995; Pegler et al., 1995).

*Clathrus ruber* is the only clathroid species of *Clathrus* known in Turkey.

**Specimen examined:** Rize, Ardeşen, Ortaalan village, roadside, on soil, 41°10'N-41°06'E, 340 m, 09.07.2017,

Yuzun 5637; Güneyköy village, roadside and bean garden, on soil, 41°08'N-41°07'E, 860 m, 11.08.2017, Yuzun 5741; Pazar, Hasköy village, house garden, on soil, 41°06'N-40°51'E, 420 m, Yuzun 6968; Trabzon, Tonya, Hoşarlı village, around bean garden, on soil, 40°56'N-39°18'E, 740 m, 22.05.2016, Yuzun 5129; Karaağaçlı village, hazelnut garden, on soil, 40°55'N-39°17'E, 640 m, 20.06.2016, Yuzun 5147.

*Clathrus ruber* was reported previously from fourteen localities in Antalya, Aydın, İstanbul, İzmir, Kahramanmaraş, Kocaeli, Muğla, Osmaniye, Samsun, Sinop, Trabzon, Uşak, and Yalova province (Afyon and Yağız, 2004; Allı et al., 2007; Baydar and Sesli, 1994; Pekşen and Karaca, 2003; Günay and Demirel, 2006; Türkoğlu and Yağız, 2012; Akata et al., 2014, 2018; Solak and Yılmaz Ersel, 2005; Yılmaz Ersel and Solak, 2004; Solak et al., 2014; Kaya, 2009; Ünal et al., 2016; Allı et al., 2017; Güngör et al., 2016; Akata, 2017).

**Mutinus** Fr.

*Mutinus caninus* (Huds.) Fr., Summa veg. Scand., Sectio Post. (Stockholm): 434 (1849).

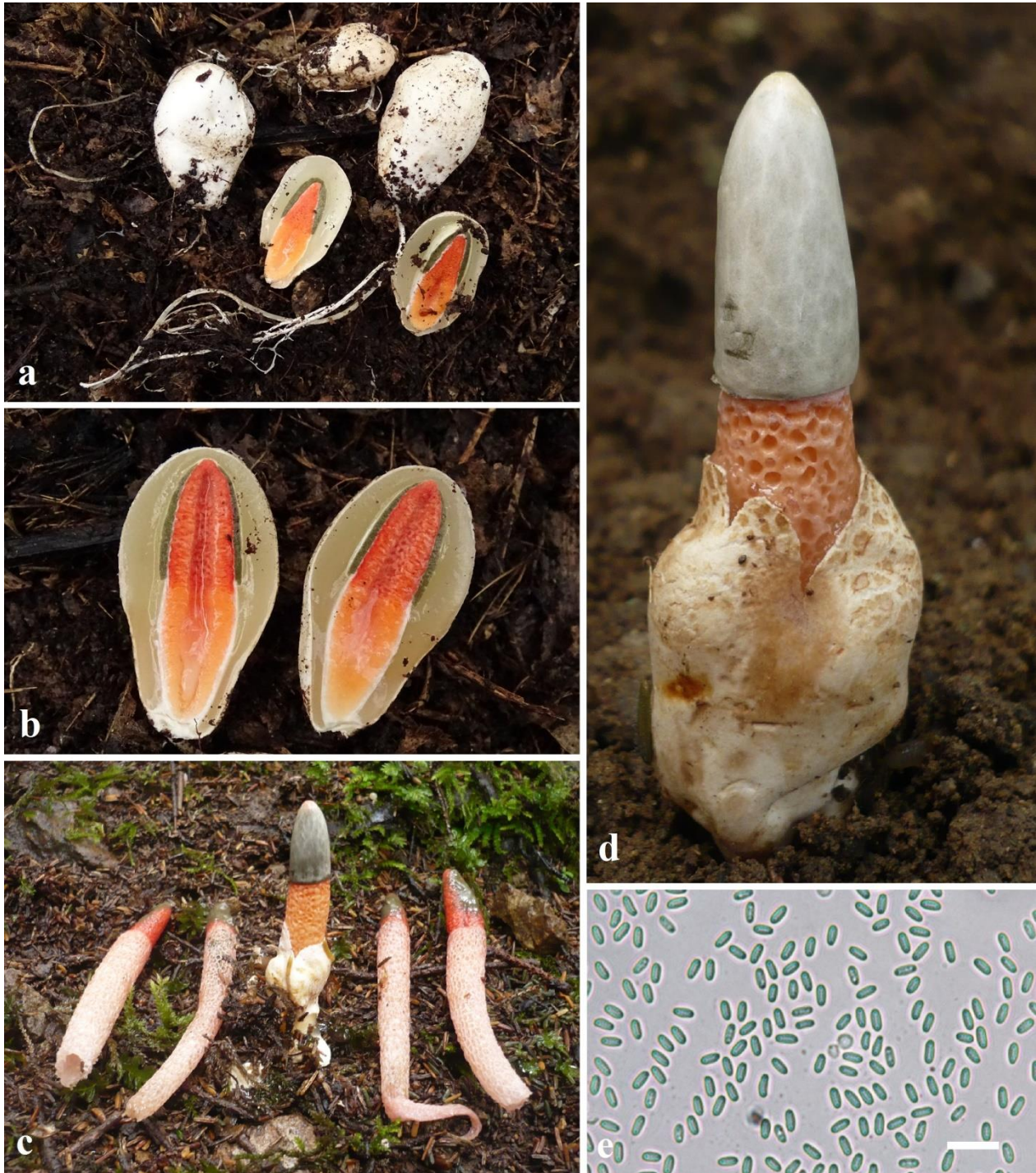


**Figure 1.** Basidiocarps (a-d) and basidiospores (e) of *Clathrus ruber* (bar 10 μ).

[Syn: *Aedycia canina* (Huds.) Kuntze, *Cynophallus caninus* (Huds.) Fr., *Ithyphallus inodorus* Gray, *Mutinus caninus* var. *albus* Zeller, *Mutinus caninus* (Huds.) Fr. var. *caninus*, *Mutinus caninus* var. *levonensis* Noelli, *Phallus caninus* Huds., *Phallus caninus* Huds. var. *caninus*, *Phallus caninus* var. *felina* Schumach., *Phallus inodorus* Sowerby]

**Macroscopic and microscopic features:** Immature fruitbody 15- 35 × 15-30 mm, elongate ovoid to pyriform or egg shaped, at first hypogeous then epigeous, white to dirty white or yellowish rubbery outer exoperidium encloses the gelatinous endoperidium in which the pale

green embryonic spore mass (gleba) and the stalk (receptacle) are kept, basally attached by a white rhizomorph (Figure 2a,b). Following the rupture of the egg, the receptacle becomes volvate (Figure 2d). Receptacle 90-120 × 10-15 mm, cylindrical to tapering above, hollow, spongy, brick-red to orange-red, somewhat paler towards the base. Olive green to dark greyish and slimy-soft glebiferous disappears in a short time and leaves the empty, orange-brown glebal chambers (Figure 2c,d). Basidia cylindrical, 6-spored. Cystidia not observed. Basidiospores 3.5-5 × 1-2 μm, cylindrical to ellipsoid, smooth, hyaline (Figure 2e).



**Figure 2.** Basidiocarps (a-d) and basidiospores (e) of *Mutinus caninus* (bar 10 μ).

*Mutinus caninus* grows on soil amongst leaf litter, around decaying stumps or rarely on rotting woods generally in hardwood forest and more rarely in conifer forests (Breitenbach and Kränzlin, 1986; Jordan, 1995; Pegler et al., 1995).

**Specimen examined:** Trabzon, Yomra, Özdil Village, on soil and dead plant residues, under *Fagus orientalis-Castanea sativa-Rhododendron ponticum* mixed forest, 40°50'N-39°48'E, 1210 m, 25.08.2018, Yuzun 6682; Araklı, near rifle range, on soil and dead plant residues, under *Castanea* and *Corylus* sp, 40°56'N-40°02'D, 195 m, 04.12.2018, Yuzun 6929.

*Mutinus caninus* was reported previously from Turkey twelve times from nine localities in Artvin, Bolu, Gümüşhane, İstanbul, Kastamonu, Kocaeli Samsun, Trabzon and Yalova province (Demirel and Uzun, 2004; Yağız et al., 2006a; Akata et al., 2010, 2014, 2016, 2018; Pekşen and Karaca, 2003; Sesli, 2007; Allı et al., 2017; Akata, 2017).

*Phallus* Junius ex L.

*Phallus impudicus* L., Sp. pl. 2: 1178 (1753).

[**Syn:** *Dictyophora duplicata* var. *obliterata* Malençon, *Hymenophallus togatus* Kalchbr., *Ithyphallus impudicus* (L.) Fr., *Ithyphallus impudicus* var. *carneus* Lemmerm., *Ithyphallus impudicus* (L.) Fr. var. *impudicus*, *Ithyphallus mauritanus* (Lloyd) Sacc. & Traverso, *Kirchbaumia imperialis* Schulzer, *Morellus impudicus* (L.) Eaton, *Phallus foetidus* Sowerby, *Phallus impudicus* f. *adiscus* Houda, *Phallus impudicus* f. *alveolata* Ulbr., *Phallus impudicus* f. *flavida* Henn., *Phallus impudicus* L. f. *impudicus*, *Phallus impudicus* f. *reticulata* Ulbr., *Phallus impudicus* f. *subindusiatus* Pilát, *Phallus impudicus* f. *togatus* (Kalchbr.) Quéł., *Phallus impudicus* var. *americanus* Ulbr., *Phallus impudicus* var. *carneolus* Houda, *Phallus impudicus* var. *imperialis* (Schulzer) Ulbr., *Phallus impudicus* L. var. *impudicus*, *Phallus impudicus* var. *pseudoduplicatus* O. Andersson, *Phallus impudicus* var. *subindusiatus* (Pilát) Lécuro, *Phallus impudicus* var. *togatus* (Kalchbr.) Costantin & L.M. Dufour, *Phallus impudicus* var. *vulgaris* Ulbr., *Phallus mauritanus* Lloyd, *Phallus volvatus* Batsch.]

**Macroscopic and microscopic features:** Immature fruit body 30-55 mm in diam., globose to ovoid (Figure 3a,b), sub-hypogeous to epigeous, white to pale cream, smooth exoperidium covers the gelatinous, translucent endoperidium, the olive-green gleba with the whitish glebal chambers, and in the compressed white receptacle, attached with a stout, white, mycelial cord (Figure 3c). Later on the peridium ruptures and the gleba is lifted up by the elongation of the stalk. Receptacle 140-200 × 14-30 mm, volvate, cylindrical, hollow, fragile, spongy, tapering upward. Pileus glebiferous, attached to the apical portion of the stalk, campanulate, externally pale grey to brownish, reticulate-costate with a truncated apical disc (Figure 3d). Gleba becomes mucilaginous, translucent, greenish black to dark olive-green, with strong foetid odour at maturity. Basidia clavate, 6-spored. Cystidia not observed. Basidiospores 3.5-5 × 1.5-2 µm, ellipsoid, smooth, pale olive (Figure 3e).

*Phallus impudicus* was reported to grow on soil among leaf litter in hardwood and coniferous forest (Watling,

1973; Breitenbach and Kränzlin, 1986; Jordan, 1995; Pegler et al., 1995; Sterry and Hughes, 2009).

**Specimen examined:** Artvin, Borçka, Aralık village, *Fagus-Rhododendron-Alnus-Corylus* mixed forest, on soil, 41°23'N-41°44'E, 580 m, 24.06.2015, Yuzun 4202; Rize, Ardeşen, Eskiarmutluk village, on soil, under *F. orientalis-C. sativa-R. ponticum* mixed forest, 41°07'N-41°08'E, 610 m, 05.08.2016, Yuzun 5184; Trabzon, Tonya, Erikbeli village, on soil, under *F.orientalis-C. sativa-R. ponticum* mixed forest, 40°45'N-39°14'E, 1680 m, 22.09.2015, Yuzun 4606.

*Phallus impudicus* was reported previously from Antalya, Aydın, Balıkesir, Bingöl, Bitlis, Bolu, Denizli, Elazığ, Gümüşhane, Hatay, İstanbul, İzmir, Kastamonu, Kayseri, Kocaeli, Malatya, Mersin, Muğla, Samsun, Trabzon and Uşak (Vlaev, 1915; Gücin, 1990; Işıloğlu ve Öder, 1995a,b; Aşkun ve Işıloğlu, 1997; Işıloğlu, 1997; 2001; Kaya, 2000; Kaşık et al., 2002; Solak et al., 2002; Öztürk et al., 2003; Pekşen ve Karaca, 2003; Yılmaz Ersel and Solak, 2004; Yağız et al., 2006a; 2006b; Sesli, 2007; Allı et al., 2006, 2007; Türkoğlu, 2008; Türkoğlu and Yağız, 2012; Baba et al., 2013, 2014; Akata et al., 2014, 2016, 2018; Güngör et al., 2016; Uzun et al., 2017; Akata, 2017).

*Pseudocolus* Lloyd

*Pseudocolus fusiformis* (E. Fisch.) Lloyd

[**Syn:** *Anthurus javanicus* (Penz.) G. Cunn., *Anthurus rothae* (Berk. ex E. Fisch.) E. Fisch., *Colus elegans* Welw., *Colus fusiformis* E. Fisch., *Colus javanicus* Penz., *Colus rothae* Berk. ex E. Fisch., *Colus rothae* (Lloyd) Sacc. & Traverso, *Colus schellenbergiae* Sumst., *Pseudocolus javanicus* (Penz.) Lloyd, *Pseudocolus rothae* (Berk. ex E. Fisch.) Yasuda, *Pseudocolus rothae* Lloyd, *Pseudocolus schellenbergiae* (Sumst.) M.M. Johnson]

**Macroscopic and microscopic features:** Immature fruit body 20-30 × 20-30 mm, egg-shaped or pear-shaped, grayish brown to pale gray or rarely whitish exoperidium covers the gelatinous endoperidium, receptacle and the olive green glebal content, attached to the substrate with white rhizomorphs at the base (Figure 4a,b). The peridium ruptures at maturity letting the receptacle come up. Stalk 40-70 mm, volvate, divided into 3-4 vertical columns which are tapered upwards and generally united at the apex, whitish at the base, orange, pink or red above. Gleba born on the inner side of the arms, slimy, drying nearly black. olive-green to dark green, borne on the inner side of the arms, slimy, foulsmelling, drying nearly black (Figure 4c,d). Basidiospores 3.5-5 × 1.5-2.5 µm, ellipsoid-ovoid, smooth (Figure 4e).

*Pseudocolus fusiformis* grows on soil or among wood chips in gardens, in coniferous or mixed forest (Bessette et al., 1995; Phillips, 2010).

**Specimen examined:** Giresun, Dereli, Akkaya village, hazelnut garden, on wood shavings and dead hazelnut husks, 40°43'N-38°23'E, 865 m, 18.10.2017, Yuzun 5915; Rize, Ardeşen, Yeni Yol village, near the road of mixed forest, on soil and wood shavings, 41°13'N-41°03'E, 530 m, 06.08.2016, Yuzun 5192; Trabzon, Tonya, Sayraç village, hazelnut garden, on soil and wood shavings, 40°54'N-39°14'E, 945 m, 28.08.2015, Yuzun 4525.



**Figure 3.** Basidiocarps (a-d) and basidiospores (e) of *Phallus impudicus* (bar 10  $\mu$ ).

*Pseudocolus fusiformis* was reported previously from only one locality in Trabzon (Akata ve Doğan, 2011).

#### 4. Discussions

New localities were added to the existing localities of four stinkhorn species within the boundaries of Artvin, Giresun, Rize and Trabzon provinces. *Pseudocolus fusiformis* was previously reported only from Yomra district of Trabzon province. Three new localities were

also presented within Giresun, Rize and Trabzon provinces. *Mutinus caninus* have 9 previously presented localities in Turkey. Two new localities were added in Trabzon. Compared to previous two species, *Clathrus ruber* seems to have more distribution in Turkey. This species were previously reported from 13 provinces of Turkey. Five new distribution localities were also presented for it in Rize and Trabzon provinces. *Phallus impudicus* is the most cosmopolitan species in Turkey



**Figure 4.** Basidiocarps (a-d) and basidiospores (e) of *Pseudocolus fusiformis* (bar 10  $\mu$ ).

among the four taxa. This species has been cited in 33 studies carried out within the boundaries of 21 provinces of Turkey. Two new localities were also presented for this species from Artvin and Rize provinces from which it was not reported before.

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