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Diversity and Distribution of Clavarioid Fungi in India, Three Fungi from Central India

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ABSTRACT

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Total 108 Indian clavarioid fungi belonging to 17 genera were compiled from literature. These fungi are distributed in 13 states of India. Genus *Ramaria* represent the largest number of species (39) followed by *Clavaria* (13), *Clavulinopsis* (12), *Clavulina* (11) and *Typhula* (10). Genera like *Aphelaria*, *Artomyces*, *Deflexula*, *Gloeocantharellus*, *Multiclavula* and *Scytinopogon* are least diverse and represented by only one species. Clavarioid fungi were recorded from 131 places of 13 states in India and the maximum diversity of these fungi was shown by the state Uttarakhand (57) followed by Himachal Pradesh (25) and West Bengal (10). Three clavarioid fungi namely, *Phaeoclavulina flaccida*, *Ramariopsis kunzei* and *R. subtilis* were described from Madhya Pradesh and Maharashtra. Earlier these fungi were reported from Uttarakhand and Chhattisgarh.

Introduction

The clavarioid fungi are a group of fungi in the Basidiomycota typically having erect, simple or branched basidiocarps (fruit bodies) that are formed on the ground, on decaying vegetation, or on dead wood. They are colloquially called club fungi and coral fungi. Originally such fungi were referred to the genus *Clavaria*, although clavarioid species are not all closely related and are often studied as a group. Therefore, it is convenient to retain the informal (non-taxonomic) name of

"clavarioid fungi" and this term is frequently used in research papers.

The clavarioid fungi are classified in 9 families namely, Aphelariaceae, Clavariaceae, Clavulinaceae, Clavariadelphaceae, Gomphaceae, Lachnocladiaceae, Lentariaceae, Pterulaceae, and Typhulaceae. At present 35 genera of clavarioid fungi are known out of them 16 genera (*Aphelaria*, *Artomyces*, *Clavaria*, *Clavariadelphus*, *Clavulina*, *Clavulinopsis*, *Deflexula*, *Gloeocantharellus*, *Lachnocladium*, *Lentaria*, *Multiclavula*,

Phaeoclavulina, *Ramaria*, *Ramariopsis*, *Scytinopogon* and *Typhula*) are known from India. Most of the clavarioid fungi are saprotrophic in nature with terrestrial habit. These fungi grow on variety of substrates in nature for example deadwood, leaf litter or on mossy grassland, soil, etc. Some species, particularly in the genera *Clavulina* and *Ramaria*, are also reported as ectomycorrhizal. Some of clavarioid fungi are lichenized with algae (e.g. *Ertzia*, *Lepidostroma*, *Multiclavula*, *Sulzbacheromyces*).

Most clavarioid fungi have simple or branched fruit bodies that are erect (or pendant from wood in the genus *Deflexula*). The spores are born on the sides of the clubs or branches and the spore-bearing surface is typically smooth or ridged, occasionally has wart or weak spiny surface. *Ramaria* is the largest genus, which has species with branched fruit bodies and ochre to brownish spores. *Clavaria delphus*, producing large, club-shaped fruit bodies (Humpert *et al.*, 2001). *Clavaria* in its modern sense is restricted to white-spored species, many simple, some branched. It is not clearly distinguished from two related genera, *Clavulinopsis* and *Ramariopsis* (Dentinger and McLaughlin, 2006).

The genus *Typhula* contains a number of small, sometimes minute species with simple fruit bodies. The major genera of clavarioid fungi are *Clavaria*, *Clavulinopsis*, *Ramaria*, *Ramariopsis* and *Typhula*. Some genera have fewer species for example *Aphelaria*, *Artomyces*, *Clavicornia*, *Clavulina*, *Lachnocladium*, *Lentaria*, *Multiclavula*, *Scytinopogon*, etc. Clavarioid fungi have a worldwide distribution, although some genera such as *Aphelaria* and *Lachnocladium* are principally tropical.

The present article reports 108 clavarioid fungi belonging to 17 genera and distributed in India. These fungi were recorded from 131

places in 13 states and the maximum diversity was shown by Uttarakhand (57) followed by Himachal Pradesh (25) and West Bengal (11). *Phaeoclavulina flaccida*, *Ramariopsis kunzei* and *R. subtilis* were described from Madhya Pradesh and Maharashtra.

Materials and Methods

Specimens of Clavarioid fungi were collected from Madhya Pradesh and Maharashtra during rainy seasons. A part of collected samples were preserved in 70% alcohol just after collection for microscopic study.

The fruit bodies of fungi were dried under the sun or in the wooden or cardboard box lighted with 100W electric bulb. Microscopic slides were prepared by using stain, mountant, clearing and softening chemicals. Slides were observed under advanced research microscope (Leica, Germany) using 5x, 10x, 20x, 40x objectives and 10x and 15x eyepieces. Observations under phase contrast and dark field were also made whenever required.

Photomicrography was done with the help of a digital camera (make, Leica) attached to the advanced microscope. Identification of fungi have been done with the help of published literature, monographs, books, keys, etc. (Banerjee, 1947; Banerjee and Ganguly, 1945; Berkeley, 1852a b; 1856; Corner, 1966; Corner *et al.*, 1956; 1957; 1958; Corner and Thind, 1961; Das *et al.*, 2016; De, 1991; Dehariya *et al.*, 2010; Hennings, 1901; Joseph and Manimohan, 1998; Khurana, 1980; Khurana and Thind, 1979; Methven, 1989; Parndekar, 1964; Rattan and Khurana, 1978; Sharda, 1984; Sharma and Munjal, 1977; Thind and Anand, 1956a b c; Thind and Raswan, 1958; Thind and Rattan, 1967; Thind and Sharda, 1982; 1984; 1986, 1987; Thind and Sukh Dev, 1956; 1957; 1957a b; Tiwari *et al.*, 2013) and matter available on web site.

Results and Discussion

Taxonomic description

Phaeoclavulina flaccida (Fr.) Giachini (Figures 1-4)

=*Ramaria flaccida* (Fr.) Bourdot

≡*Clavaria flaccida* Fr.

=*Clavariella flaccida* (Fr.) P. Karst.

Gregarious, rarely solitary, medium sized, rarely large sized, radial, slender, flaccid, trunk absent, sometimes present, profusely branched, fleshy, smooth, glabrous, yellowish brown, dirty-brown; or dirty yellowish brown, trunk when present, slender up to 1.7cm and up to 3mm broad, branching dichotomous, branches slender, unequal, in alternating planes, sometimes very small or ligulate. Often fused with one another, ligulate or adventitious branches present all over the fructification and become bushy, primary branches slender, only up to 2.5mm broad. Ultimate branchlet thin, small, unequal pairs sometimes minute and ligulate, very minute or 3-20mm long, apices concolorous acute, fertile, flesh lighter colored taste and smell imperticular. Numerous rhizomorphic mycellial thread given out from the base of fructification. Hyphae monomitic, 2-8 µm broad, hyaline, branched, thin walled, septate, septa at long intervals, non inflated, or sometimes slightly inflated, considerably swollen into sac like structures at places near the ends or at the septa, clamped, clamp prominent. Hymenium spread all over except the lighter colored base, compound with numerous embedded spores usually in clusters of four, 70-105 µm thick. Basidia 4-7µm broad, clavate, sterigmata four, slightly incurved, 3-6 µm long. Basidiospore 4-7 x 3-4µm, small ochraceous to brown, ellipsoid, papillate, profusely echinulate, wall dark, aguttate.

Collection examined

On living stem (butt region) of 12 years old *Tectona grandis*, TFRI, Jabalpur, 16/8/2007, Tropical Forest Research Institute, TF 822

Ramariopsis kunzei (Fr.) Corner (Figures 5-8)

≡*Clavaria kunzei* Fr.

=*Clavulina kunzei* (Fr.) J. Schröt.

=*Ramaria kunzei* (Fr.) Quél.

=*Clavulinopsis kunzei* (Fr.) Jülich

This coral like mushroom has a stout, whitish base and densely packed, short branches with pink tips, elongated branches and hard fruiting body 2–6.5cm, long and 3–4.5cm wide, stocky repeatedly short branched, densely packed, basal branches thick, smooth and whitish; terminal branches crowded, short, pinkish, tips cauliflower like, when young, mycelium are septate, 3.7-6.2µm wide. Spores are transparent, irregular shape, measuring 5-12 x 4.5-7.5µm.

Collection examined

On the ground under *Acacia melonoxylon*, Near Devi Point (21°23'43''N 77°19'47''E, Elevation 1075.36 M.) Chikhaldara, Maharashtra, 11/10/2018, specimen deposited in Mycology Herbarium, Tropical Forest Research Institute, TF- 4062

Ramariopsis subtilis (Pers.) R.H. Petersen (Figures 9-12)

≡*Clavaria subtilis* Pers.

Fruit bodies up to 4cm high and up to 2cm broad, branched, branching dichotomously throughout. Stipe up to 2cm long and up to 2mm thick, equal or tapering slightly downwards, white - cream, not brittle, subiculum white, spreading up to 1.5mm from

stipe base, effuse. Branches up to 1.5 mm thick, ascending, bone white, terete, axile narrowly angled below, acutely angled to rounded in ultimate rank, often decurrent by a depressed line, apices swollen, irregularly lobed or cusped to subturbinate up to 2mm broad. Tramal hyphae 1.5-5.5 µm diam, parallel, clamped, tightly packed, hyaline, thin walled. Basidia clavate, clamped, often sinuate, contents divergent, subcoronate, thick walled, minutely granular or with several refringent guttules, sterigmata four, deep orange ochre under phase contrast, 60 – 90 x 7-9 µm. Basidiospores globose to very broadly ellipsoid, hyaline, thin to somewhat thick walled (wall up to 0.3 µm), contents with a single large refringent guttule, spicules prominent, 2 µm or more longer, 5.5-7.5 x 5.5-7.0 µm.

Collection examined

On humus soil near tree stems and hedge, TFRI campus, Jabalpur, MP, 24/7/2013,

Tropical Forest Research Institute TF- 3448 and under *Pongamia pinnata*, 28/09/2017.

Phaeoclavulina flaccida, *Ramariopsis kunzei* and *R. subtilis* were described from Madhya Pradesh and Maharashtra. From India 108 clavarioid fungi spread over 17 genera were recorded. These fungi were distributed in 13 states. Clavarioid fungi from were recorded from 130 places of 13 states and the maximum diversity of occurrence these fungi was shown by the Uttarakhand state (57) followed by Himachal Pradesh (25) and West Bengal (10). On the contrary from states like Andhra Pradesh, Chhattisgarh and Uttar Pradesh only one species were reported. The largest genus recorded was *Ramaria* comprising 39 species followed by *Clavaria* 13 species, *Clavulinopsis* 12 species, *Clavulina* 11 species and *Typhula* 10 species, where as genera like *Aphelaria*, *Artomyces*, *Deflexula*, *Gloeocantharellus*, *Multiclavula* and *Scytinopogon* are least diverse and represented by only one species (Table 1, 2).

Table.1 Clavarioid fungi reported from India

S.No.	Name of fungus	Host/ substrate	Locality	Reference
1.	<i>Aphelaria tuberosa</i> (Grev.) Corner ≡ <i>Merisma tuberosum</i> Grev.	on soil amid mosses	Mussoorie, Uttarakhand	Thind and Sukh Dev (1956)
2.	<i>Artomyces pyxidatus</i> (Pers.) Jülich ≡ <i>Clavaria pyxidata</i> Pers. = <i>Clavicornia pyxidata</i> (Pers.) Doty	on wood	Mussoorie, Uttarakhand	Butler and Bisby (1931)
3.	<i>Clavaria acuta</i> Sowerby	on soil	Mussoorie, Uttarakhand	Thind and Sukh Dev (1956)
4.	<i>Clavaria amoenoides</i> Corner, K.S. Thind & Anand	on soil in pine oak forest	Mussoorie, Uttarakhand	Corner <i>et al.</i> , (1956)
5.	<i>Clavaria angulispora</i> Pat. = <i>Scytinopogon angulisporus</i> = <i>Clavaria atroumbrina</i> Corner	on soil	Chambaghat, Solan, Himachal Pradesh	Sharma and Munjal (1977)
6.	<i>Clavaria cretacea</i> Coker	on soil	Chambaghat, Solan, Himachal Pradesh	Sharma and Munjal (1977)

7.	<i>Clavaria crosslandii</i> Cotton	on soil	Chambaghat, Solan, Himachal Pradesh	Sharma and Munjal (1977)
8.	<i>Clavaria fragilis</i> Holmsk. = <i>Clavaria vermicularis</i> var. <i>gracilis</i> Bourdot & Galzin	on soil under oak forest	Mussoorie, Uttarakhand	Thind and Anand (1956c)
9.	<i>Clavaria gollanii</i> Henn.	on ground	Saharanpur, Uttar Pradesh	Butler and Bisby (1931)
10.	<i>Clavaria incarnata</i> Weinm.	on ground in mosses under mixed forest	Darjeeling, West Bengal	Thind and Rattan (1967)
11.	<i>Clavaria indica</i> Corner, K.S. Thind & Dev	on humus in oak forest	Mussoorie, Uttarakhand	Corner <i>et al.</i> , (1958)
12.	<i>Clavaria jacquemontii</i> Lév.	on ground	Jammu and Kashmir	Leveille (1844)
13.	<i>Clavaria</i> sp.	on dead logs of <i>Tectona grandis</i> , <i>Terminalia</i> <i>tomentosa</i>	Kolhapur, Maharashtra	Parndekar (1964)
14.	<i>Clavaria vermicularis</i> Scop.	on soil under oak forest	Mussoorie, Uttarakhand	Thind and Anand (1956c)
15.	<i>Clavaria versatilis</i> (Quél.) Sacc. & Trotter = <i>Ramaria</i> <i>versatilis</i> Quél.	on forest soil	Nilambur, Kerala	Mohanani (2011)
16.	<i>Clavaria zollingeri</i> Lév.	on soil under oak forest	Mussoorie, Uttarakhand	Thind and Anand (1956c)
17.	<i>Clavariadelphus</i> <i>himalayensis</i> Methven	on soil under <i>Pinus insularis</i>	Meghalaya	Methven (1989)
18.	<i>Clavariadelphus junceus</i> (Alb. & Schwein.) Corner ≡ <i>Clavaria mira</i> Pat.	on soil	Mussoorie, Uttarakhand	Thind and Anand (1956b)
19.	<i>Clavariadelphus truncatus</i> (Quél.) Donk ≡ <i>Clavaria</i> <i>truncata</i> Quél. = <i>Clavariadelphus borealis</i> V.L. Wells & Kempton	on soil	Mussoorie, Uttarakhand	Thind and Sukh Dev (1956)
20.	<i>Clavulina amethystinoides</i> (Peck) Corner ≡ <i>Clavaria</i> <i>amethystinoides</i> Peck	on soil amid mosses	Mussoorie, Uttarakhand	Thind and Anand (1956c)
21.	<i>Clavulina bessonii</i> (Pat.) Corner = <i>Clavulina bessonii</i> var. <i>incarnata</i> K.S. Thind & Anand	on soil	Mussoorie, Uttarakhand	Thind and Anand (1956b)
22.	<i>Clavulina cartilaginea</i> (Berk. & M.A. Curtis) Corner	on soil amid mosses under	Mussoorie, Uttarakhand	Thind and Sukh Dev (1956)

	≡ <i>Lachnocladium cartilagineum</i> Berk. & M.A. Curtis	<i>Cedrus</i> forest,		
23.	<i>Clavulina cinerea</i> (Bull.) J. Schröt. = <i>Clavulina cristata</i> (Fr.) Schroet. ≡ <i>Ramaria cristata</i> Holmsk. = <i>Clavaria cristata</i> (Holmsk.) Pers.	In <i>Cynodon dactylon</i> and on soil amid mosses under oak forest	Patharia forest, Sagar, Madhya Pradesh and Mussoorie, Uttarakhand	Dehariya <i>et al.</i> , (2010); Thind and Anand (1956c)
24.	<i>Clavulina coralloides</i> (L.) J. Schröt. = <i>Clavulina cristata</i> var. <i>brunneola</i> K.S. Thind & Anand	on soil, dead leaves, twigs and bark	Mussoorie, Uttarakhand	Thind and Anand (1956c)
25.	<i>Clavulina hispidulosa</i> Corner, K.S. Thind & Anand	on humus soil under oak forest	Mussoorie, Uttarakhand	Corner <i>et al.</i> , (1956)
26.	<i>Clavulina limosa</i> K.S. Thind & Sharda	on sandy soil under <i>Shorea robusta</i>	West Bengal	Thind and Sharda (1984)
27.	<i>Clavulina mussooriensis</i> Corner, K.S. Thind & Dev	on soil under <i>Cedrua</i> forest	Mussoorie, Uttarakhand	Corner <i>et al.</i> , (1958)
28.	<i>Clavulina ornatipes</i> (Peck) Corner = <i>Lachnocladium ornatipes</i> (Peck) Burt ≡ <i>Clavaria ornatipes</i>	on soil under oak forest and decaying leaves on a side of pond	Shimla, Himachal Pradesh and Kolkata, West Bengal	Berkeley (1856); Thind and Rattan (1967)
29.	<i>Clavulina rugosa</i> (Bull.) J. Schröt. = <i>Clavulina rugosa</i> var. <i>alcyonaria</i> Corner	on soil	Chambaghat, Solan, Himachal Pradesh	Sharma and Munjal (1977)
30.	<i>Clavulina subrugosa</i> (Cleland) Corner ≡ <i>Clavaria subrugosa</i> Cleland	on soil amid mosses	Mussoorie, Uttarakhand	Thind and Raswan (1958)
31.	<i>Clavulinopsis alcicornis</i> (Zoll. & Moritzi) Corner ≡ <i>Clavaria alcicornis</i> Zoll. & Moritzi	on soil	Mussoorie, Uttarakhand	Thind and Anand (1956b)
32.	<i>Clavulinopsis amoena</i> (Zoll. & Moritzi) Corner ≡ <i>Clavaria amoena</i> Zoll. & Moritzi	on soil	Dalhausi, Himachal Pradesh	Thind and Rattan (1967)
33.	<i>Clavulinopsis aurantiocinnabarina</i> (Schwein.) Corner ≡ <i>Clavaria aurantiocinnabarina</i> Schwein.	on soil	Mussoorie, Uttarakhand	Thind and Anand (1956b)
34.	<i>Clavulinopsis corniculata</i> (Schaeff.) Corner ≡ <i>Clavaria muscoides</i> L. = <i>Ramaria</i>	on soil	Mussoorie, Uttarakhand and Sonamarg,	Thind and Anand (1956b); Butler and Bisby (1931)

	<i>corniculata</i> (Schaeff.) Gray		Jammu and Kashmir	
35.	<i>Clavulinopsis dichotoma</i> Corner \equiv <i>Clavaria dichotoma</i> Godey	on soil	Mussoorie, Uttarakhand	Thind and Sukh Dev (1957b)
36.	<i>Clavulinopsis fusiformis</i> (Sowerby) Corner \equiv <i>Clavaria fusiformis</i> Sowerby = <i>Clavulinopsis fusiformis</i> var. <i>bispora</i> K.S. Thind & Sharda	on soil	Mussoorie, Uttarakhand Himachal Pradesh	Butler and Bisby (1931); Thind and Sharda (1982)
37.	<i>Clavulinopsis helvola</i> (Pers.) Corner	on soil under oak forest	Brewery road, Mussoorie	Thind and Raswan (1958)
38.	<i>Clavulinopsis laeticolor</i> (Berk. & M.A. Curtis) R.H. Petersen \equiv <i>Clavaria laeticolor</i> Berk. & M.A. Curtis = <i>Clavulinopsis laeticolor</i> f. <i>bispora</i> K.S. Thind & Sharda = <i>Clavulinopsis pulchra</i> f. <i>subtrigona</i> K.S. Thind & S.S. Rattan = <i>Clavulinopsis pulchra</i> var. <i>coccinea</i> K.S. Thind & Dev	on rotten timber in wet woods, on soil on decaying leaves and in broad-leaved forest on humicolous soil under forest on humicolous soil	Kala Pani, Khasi hills, Meghalaya Chambaghat, Solan, Himachal Pradesh Kolkata, West Bengal Darjeeling, West Bengal and Chakarata, Mussoorie, Uttarakhand	Berkeley (1852a) Sharma and Munjal (1977) Thind and Sharda (1986) (1987); Banerjee (1947) Thind and Rattan (1967) Thind and Dev (1957)
39.	<i>Clavulinopsis semivestita</i> (Berk. & Broome) Corner	on soil	Chambaghat, Solan, Himachal Pradesh	Sharma and Munjal (1977)
40.	<i>Clavulinopsis subtilis</i> (Pers.) Corner	on soil under oak forest	Mussoorie, Uttarakhand	Thind and Raswan (1958)
41.	<i>Clavulinopsis sulcata</i> Overeem = <i>Clavulinopsis miniata</i> Corner	on soil	Darjeeling, West Bengal	Thind and Rattan (1967)
42.	<i>Deflexula subsimplex</i> (Henn.) Corner \equiv <i>Pterula subsimplex</i> Henn.	on stump of <i>Cryptomeria japonica</i>	Darjeeling, West Bengal	Thind and Rattan (1967)
43.	<i>Gloeocantharellus lateritius</i> (Petch) Corner \equiv <i>Paxillus lateritius</i> Petch	on soil	Malappuram, Kerala	Joseph and Manimohan, (1998)
44.	<i>Lachnocladium brasiliense</i> (Lév.) Pat. \equiv <i>Eriocladus brasiliensis</i> Lév.,	on earth and decaying leaves	Kolkata, West Bengal	Berkeley (1856)
45.	<i>Lachnocladium hookeri</i> Berk.	-	Khasi Hills, Meghalaya	Berkeley (1852b)

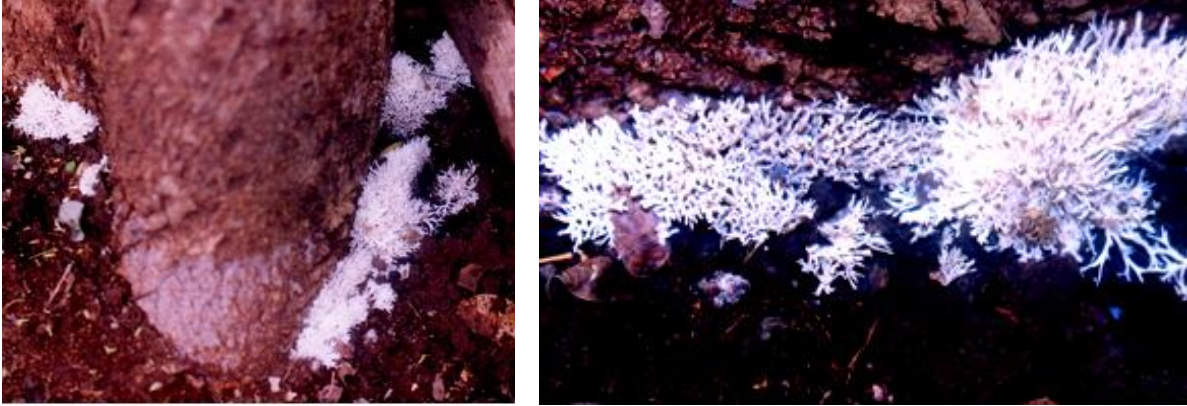
46.	<i>Lachnocladium mussooriense</i> Henn.	-	Arnigadh, Mussoorie, Uttarakhand	Hennings (1901)
47.	<i>Lentaria byssiseda</i> Corner	on dead twigs of <i>Picea morinda</i> in forest	Mussoorie, Uttarakhand	Thind and Sukh Dev (1956)
48.	<i>Lentaria epichnoa</i> (Fr.) Corner = <i>Lentaria epichnoa</i> var. <i>indica</i> Sharda	on wood	Andhra Pradesh	Sharda (1984)
49.	<i>Multiclavula mucida</i> (Pers.) R.H. Petersen ≡ <i>Clavaria mucida</i> Pers. = <i>Lentaria mucida</i> (Pers.) Corner	on decaying logs of <i>Picea morinda</i> , under <i>Picea</i> forest	Kadukhal, Mussoorie, Uttarakhand	Thind and Sukh Dev (1957a)
50.	<i>Phaeoclavulina flaccida</i> (Fr.) Giachini = <i>Ramaria flaccida</i> (Fr.) Bourdot ≡ <i>Clavaria flaccida</i> Fr., = <i>Clavariella flaccida</i> (Fr.) P. Karst.	on humus under oak and pine forests and on living stem of 12 years old teak	Mussoorie, Uttarakhand and Jabalpur, Madhya Pradesh	Thind and Anand (1956a) This article
51.	<i>Phaeoclavulina zippelii</i> (Lév.) Overeem ≡ <i>Clavaria zippelii</i> Lév.	on ground	Lingamala fall, Maharashtra	Senthilarasu (2013a)
52.	<i>Pterula indica</i> Senthil.	on soil in <i>Acacia</i> and <i>Dalbergia</i> , forest	Pune, Maharashtra	Senthilarasu (2013b)
53.	<i>Pterula verticillata</i> Corner	on soil in <i>Acacia</i> and forest	Pune, Maharashtra	Senthilarasu (2013b)
54.	<i>Ramaria apiculata</i> (Fr.) Donk	on soil	Radhanagri, MS and Ariappa, Kerala	Thite <i>et al.</i> , (1976); Patil and Thite (1977); Mohanan (2011)
55.	<i>Ramaria aurea</i> (Schaeff.) Quél.	Rhododendron forest	Shimla, Himachal Pradesh and Sikkim	Sharma and Jandaik (1978); Das (2009)
56.	<i>Ramaria brevispora</i> Corner, K.S. Thind & Dev	on soil in oak forest	Mussoorie, Uttarakhand and Sikkim	Corner <i>et al.</i> , (1958); Das (2009)
57.	<i>Ramaria camelicolor</i> Corner, K.S. Thind & Anand	on soil in oak forest, on soil in forest	Mussoorie, Uttarakhand and Shergaon, Arunachal Pradesh	Corner <i>et al.</i> , (1956) Sharda and Thind (1986)
58.	<i>Ramaria clarobrunnea</i> Corner, K.S. Thind & Anand	on soil in oak forest	Mussoorie, Uttarakhand	Corner <i>et al.</i> , (1956)
59.	<i>Ramaria concolor</i> (Corner)	on wood, on	Mussoorie,	Thind and Sukh Dev

	R.H. Petersen = <i>Ramaria stricta</i> (Pers.) Quél. var. <i>concolor</i> Corner	stumps and logs, on dead leaves in oak forest	Uttarakhand and Shimla, Himachal Pradesh	(1957a b); Sharma and Jandaik (1978)
60.	<i>Ramaria echinovirens</i> Corner, K.S. Thind & Dev	on soil in oak forest	Mussoorie, Uttarakhand	Corner <i>et al.</i> , (1957)
61.	<i>Ramaria eumorpha</i> (P. Karst.) Corner ≡ <i>Clavariella eumorpha</i> P. Karst.	on soil	Nilambur, Kerala and Gulmerg, Jammu & Kashmir	Mohanani (2011); Thind <i>et al.</i> , (1983)
62.	<i>Ramaria flava</i> (Schaeff.) Quél. = <i>Ramaria flava</i> var. <i>sanguine</i>	on soil and humus	Mussoorie, Uttarakhand and Nilambur, Kerala	Corner (1956) Thind and Sukh Dev (1957a); Mohanani (2011)
63.	<i>Ramaria flaviceps</i> Corner, K.S. Thind & Anand	on soil in oak forest	Mussoorie, Uttarakhand	Corner <i>et al.</i> , (1956)
64.	<i>Ramaria flavoalba</i> Corner	in wood land	Solan, Himachal Pradesh	Sharma <i>et al.</i> , (1977)
65.	<i>Ramaria flavobrunnescens</i> (Coker) Corner	on soil amid mosses under oak forest	Mussoorie, Uttarakhand and West Kameng, Arunachal Pradesh	Thind and Sukh Dev (1957a) and Sharda and Thind (1986)
66.	<i>Ramaria flavoviridis</i> Corner & K.S. Thind	on ground in mixed <i>Quercus-Cedrus</i> forest	Bakrota, Dalhaousie, Himachal Pradesh	Corner and Thind (1961)
67.	<i>Ramaria formosa</i> (Pers.) Quél. = <i>Clavaria formosa</i> Pers.	on soil and humus and on soil under oak forest	Khasi hills, Meghalaya; Nilambur, Kerala and Mussoorie, Uttarakhand	Berkeley (1856); Mohanani (2011); Thind and Anand (1956c)
68.	<i>Ramaria gracilis</i> (Pers.) Quél. ≡ <i>Clavaria gracilis</i> Pers.	on soil and humus	Kandaghat, Himachal Pradesh and Peechi, Kerala	Sharma and Jandaik (1978); Mohanani (2011)
69.	<i>Ramaria holorubella</i> (G.F. Atk.) Corner ≡ <i>Clavaria holorubella</i> G.F. Atk.	-	Ranikhet, Uttarakhand and Dalhausi, Himachal Pradesh	Thind and Rattan (1967)
70.	<i>Ramaria kisantuensis</i> (Sacc.) Corner = <i>Ramaria kisantuensis</i> var. <i>indica</i>	on wood	Uttarakhand	Khurana and Thind (1979)

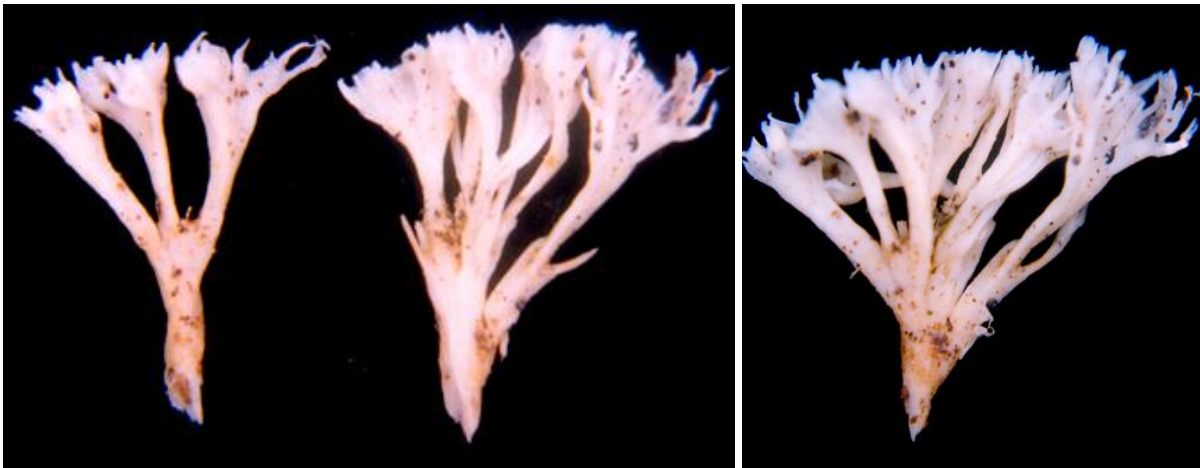
	Khurana & K.S. Thind			
71.	<i>Ramaria laevispora</i> Corner & K.S. Thind	-	Dalhousie, Himachal Pradesh	in Corner (1966)
72.	<i>Ramaria moelleriana</i> (Bres. & Roum.) Corner	on soil	Mussoorie, Uttarakhand	Thind and Sukh Dev (1957b)
73.	<i>Ramaria obtusissima</i> (Peck) Corner	on soil under oak, <i>Cedrus</i> and pine forests	Mussoorie, Uttarakhand and Shillong, Meghalaya	Thind and Sukh Dev (1957a b) and Sharda and Thind (1986)
74.	<i>Ramaria ochrochlora</i> Furrer-Ziogas & Schild	-	Gulmerg, Jammu & Kashmir	Thind <i>et al.</i> , (1983)
75.	<i>Ramaria pallida</i> (Schaeff.) Ricken \equiv <i>Clavaria pallida</i> Schaeff.	On humus rich soil	Sholayar, Kerala	Mohanani (2011)
76.	<i>Ramaria perbrunnea</i> Corner & K.S. Thind	in <i>Quercus</i> forest	Dalhousie, Himachal Pradesh	in Corner (1966)
77.	<i>Ramaria petersenii</i> K.S. Thind & Sharda	in coniferous wood	Himachal Pradesh	Thind and Sharda (1984)
78.	<i>Ramaria pura</i> Corner & K.S. Thind	in <i>Quercus</i> forest	Dalhousie, Himachal Pradesh	in Corner (1966)
79.	<i>Ramaria purpurissima</i> R.H. Petersen & Scates \equiv <i>Ramaria fumigata</i> var. <i>gigantea</i> K.S. Thind & Anand	on soil	Mussoorie, Uttarakhand	Thind and Anand (1956a)
80.	<i>Ramaria pusilla</i> Corner	on soil under oak forest and on dead needles of <i>Cedrus</i> forest	Mussoorie, Uttarakhand	Thind and Sukh Dev (1957b)
81.	<i>Ramaria rasilispora</i> Marr & D.E. Stuntz	on soil under hardwoods	Jamiri-Buragaon, Arunachal Pradesh	Sharda and Thind (1986)
82.	<i>Ramaria rubrogelatinosa</i> Corner & K.S. Thind	-	Dalhousie, Himachal Pradesh and Mussoorie, Uttarakhand	in Corner (1966)
83.	<i>Ramaria sandaracina</i> Marr & D.E. Stuntz	on soil under <i>P. kesiya</i> forest	Elephant falls, Meghalaya and West Kameng, Arunachal	Sharda and Thind (1986)

			Pradesh	
84.	<i>Ramaria sanguinea</i> (Coker) Corner	on moist soil	Mussoorie, Uttarakhand	Thind and Sukh Dev (1957b)
85.	<i>Ramaria sikkimia</i> S.S. Rattan & Khurana	on forest litter	Darjeeling, West Bengal	Rattan and Khurana (1978)
86.	<i>Ramaria stricta</i> (Pers.) Quél. = <i>Clavaria stricta</i> Pers.	-	Khasi hills, Meghalaya	Berkeley (1856)
87.	<i>Ramaria subalpina</i> K. Das & K. Acharya	on soil, associated with <i>Abies densa</i>	Sikkim, Himalaya	Das <i>et al.</i> , (2016)
88.	<i>Ramaria subaurantiaca</i> Corner	on soil amid mosses	Mussoorie, Uttarakhand	Thind and Sukh Dev (1957b)
89.	<i>Ramaria subbotrytis</i> (Coker) Corner	on soil under oak forest	Mussoorie, Uttarakhand	Thind and Anand (1956a)
90.	<i>Ramaria subgelatinosa</i> Corner	on soil	Mussoorie, Uttarakhand	Thind and Sukh Dev (1957b)
91.	<i>Ramaria suecica</i> (Fr.) Donk	on humicolous soil or leaf-litter under angiosperm forest	West Kameng, Arunachal Pradesh	Sharda and Thind (1986)
92.	<i>Ramaria synaptopoda</i> Marr & D.E. Stuntz	on soil under <i>Pinus kesiya</i>	Royle forest Shillong, Meghalaya	Sharda and Thind (1986)
93.	<i>Ramariopsis asterella</i> (G.F. Atk.) Corner ≡ <i>Clavaria asterella</i> G.F. Atk.	on ground	Sodepur, West Bengal	Banerjee and Ganguly (1945)
94.	<i>Ramariopsis biformis</i> (G.F. Atk.) R.H. Petersen = <i>Clavulinopsis biformis</i> var. <i>elongata</i> K.S. Thind & Anand	on humus soil	Mussoorie, Uttarakhand	Thind and Anand (1956b)
95.	<i>Ramariopsis kunzei</i> (Fr.) Corner	in humicolous soil under oak forest	Mussoorie, Uttarakhand and Chikhaldara, Maharashtra	Thind and Sukh Dev (1957a) and This article
96.	<i>Ramariopsis subtilis</i> (Pers.) R.H. Petersen	in wood residues and on humus soil, under <i>Pongamia pinnata</i>	Marwahi, Chhattusgarh, Jabalpur Madhya Pradesh	Tiwari <i>et al.</i> , (2013) This article
97.	<i>Ramariopsis tenuicula</i> (Bourdot & Galzin) R.H. Petersen = <i>Clavulinopsis tenuicula</i> (Bourdot & Galzin) Corner ≡ <i>Clavaria tenuicula</i> Bourdot & Galzin	on soil and on decaying and on rotting leaves of dead mosses under oak forest	Chambaghat, Solan, Himachal Pradesh and Mussoorie, Uttarakhand	Sharma and Munjal (1977); Thind and Raswan (1958)

98.	<i>Scytinopogon angulisporus</i> (Pat.) Corner \equiv <i>Clavaria angulispora</i> Pat.	on ground	Kolkata, Burdwan, Rampurhat, West Bengal	Banerjee (1947); De (1991)
99.	<i>Typhula himalayana</i> (Corner) Khurana \equiv <i>Pistillaria himalayana</i> Corner	on dead leaves and stems of <i>Aconitum</i> sp.	Mussoorie, Uttarakhand and Darjeeling, West Bengal	Khurana (1980)
100.	<i>Typhula longispora</i> Corner, K.S. Thind & Dev	on fern leaflets and rachis	Mussoorie, Uttarakhand	Corner <i>et al.</i> , (1957)
101.	<i>Typhula micans</i> (Pers.) Berthier \equiv <i>Clavaria micans</i> Pers. = <i>Pistillaria granulata</i> Pat.	on dead leaves of compost	Mussoorie, Uttarakhand	Thind and Sukh Dev (1956)
102.	<i>Typhula ovata</i> P. Karst.	<i>Cautlea lutea</i> , on decayed leaves of <i>Pteris cratica</i> and a grass	Mussoorie, Uttarakhand	Thind and Sukh Dev (1957a)
103.	<i>Typhula phacorrhiza</i> (Reichard) Fr. \equiv <i>Clavaria phacorrhiza</i> Reichard	on decaying leaves	Kullu and Langri, Himachal Pradesh	Khurana (1980)
104.	<i>Typhula pteridicola</i> Khurana	on decaying fronds of Pteridophyta	Himachal Pradesh	Khurana (1980)
105.	<i>Typhula pulgensis</i> Khurana	on decaying leaves	Himachal Pradesh	Khurana (1980)
106.	<i>Typhula setipes</i> (Grev.) Berthier \equiv <i>Pistillaria setipes</i> Grev.	on dead and decaying leaves under the thick shade	Mussoorie, Uttarakhand	Thind and Raswan (1958)
107.	<i>Typhula thindii</i> Khurana	on stem and foliage of <i>Hedychium acuminatum</i>	Tiffon's top, Nainital Uttarakhand	Khurana (1980)
108.	<i>Typhula sclerotioides</i> (Pers.) Fr.	On decaying leaves and stem of herbaceous plants	Pulga, Kullu, Himachal Pradesh	Khurana (1980)



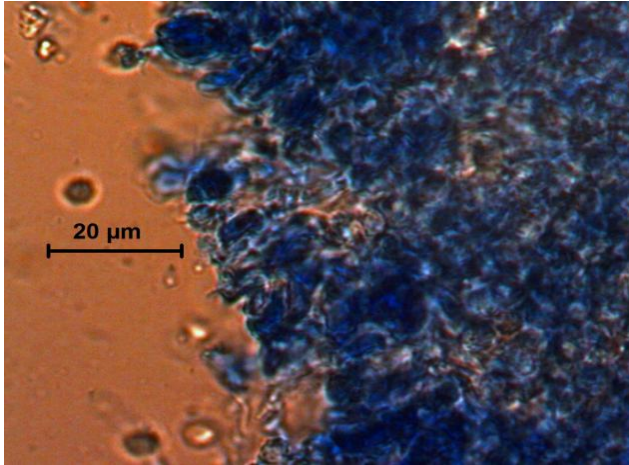
Figs.1-2 *Phaeoclavulina flaccida*, habit, fruit bodies attached to living stem of 12 years old teak tree



Figs. 3-4. *Phaeoclavulina flaccida*. Fruit bodied detached from living stem of 12 years old teak tree



Figures 5-6 *Ramariopsis kunzei*: habit



Figures 7-8 *Ramariopsis kunzei*: 7 basidia and other tissue, 8 basidiospores



Figs. 9-10 *Ramariopsis subtilis*, 9 habit, 10 fruit body

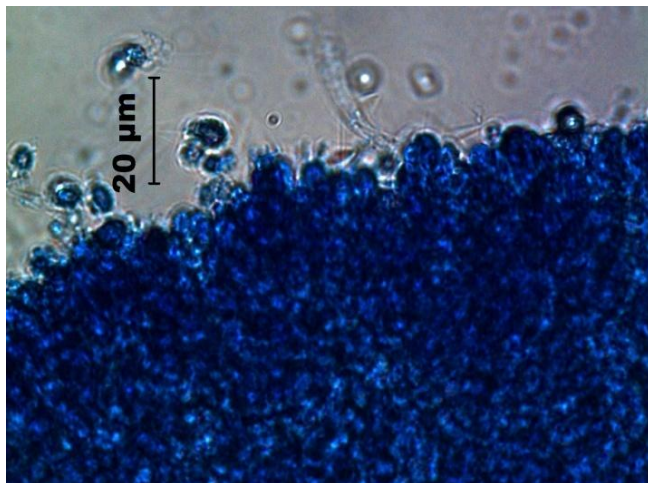


Fig. 11-12 *Ramariopsis subtilis*: 11 cross section showing basidia and 12 basidiospores

Table.2 Distribution of clavarioid fungi in India

S. N.	Genera	(1) UK	(2) HP	(3) JK	(4) Meg	(5) MP	(6) MS	(7) WB	(8) UP	(9) AP	(10) Ker	(11) CG	(12) Sik	(13) Arp	Total
1.	<i>Aphelaria</i>	1	-	-	-	-	-	-	-	-	-	-	-	-	1
2.	<i>Artomyces</i>	1	-	-	-	-	-	-	-	-	-	-	-	-	1
3.	<i>Clavaria</i>	6	3	1	-	-	1	-	1	-	1	-	-	-	13
4.	<i>Clavariadelphus</i>	2	-	-	1	-	-	-	-	-	-	-	-	-	3
5.	<i>Clavulina</i>	8	2	-	-	1	-	2	-	-	-	-	-	-	13
6.	<i>Clavulinopsis</i>	7	4	1	1	-	-	2	-	-	-	-	-	-	15
7.	<i>Deflexula</i>	-	-	-	-	-	-	1	-	-	-	-	-	-	1
8.	<i>Gloeocantharellus</i>	-	-	-	-	-	-	-	-	-	1	-	-	-	1
9.	<i>Lachnocladium</i>	1	-	-	1	-	-	1	-	-	-	-	-	-	3
10.	<i>Lentaria</i>	1	-	-	-	-	-	-	-	1	-	-	-	-	2
11.	<i>Multiclavula</i>	1	-	-	-	-	-	-	-	-	-	-	-	-	1
12.	<i>Phaeoclavulina</i>	1	-	-	-	1	1	-	-	-	-	-	-	-	3
13.	<i>Pterula</i>	-	-	-	-	-	2	-	-	-	-	-	-	-	2
14.	<i>Ramaria</i>	19	11	2	4	-	1	1	-	-	5	-	3	5	51
15.	<i>Ramariopsis</i>	3	1	-	-	2	1	1	-	-	-	1	-	-	8
16.	<i>Scytinopogon</i>	-	-	-	-	-	-	1	-	-	-	-	-	-	1
17.	<i>Typhula</i>	6	4	-	-	-	-	1	-	-	-	-	-	-	11
	Total	57	25	4	7	4	6	10	1	1	7	1	3	5	131

(UK = Uttarakhand, HP= Himachal Pradesh, JK= Jammu and Kashmir, Meg =Meghalaya, MP = Madhya Pradesh, MS =Maharashtra, WB = West Bengal, UP = Uttar Pradesh, Ker =Kerala, Sik =Sikkim, Arp =Arunachal Pradesh)

Occurrence and distribution of *Aphelaria tuberosa* and *Artomyces pyxidatus* are rare, only one species these fungi were reported in literature. *A. tuberosa* was collected on soil from Uttarakhand (Thind and Sukh Dev, 1956), while *A. pyxidatus* was collected on wood from the same state (Butler and Bisby, 1931). Out of 13 species of *Clavaria* reported, 6 are from Uttarakhand these are *C. acuta*, *C. amoenoides*, *C. fragilis*, *C. vermicularis*, *C. zollingeri* and *C. indica* (Corner *et al.*, 1956; Corner *et al.*, 1958; Thind and Sukh Dev, 1956; Thind and Anand, 1956c). Three species were reported from Himachal Pradesh including *C. angulispora*, *C. cretacea* and *C. crosslandii* (Sharma and Munjal, 1977). One species each were reported from Uttar Pradesh, West Bengal, and Jammu & Kashmir these are, *C. gollanii*, *C. incarnate* and *C. jacquemontii* (Butler and Bisby, 1931; Thind and Rattan, 1967; Leveille, 1844). An unidentified species was reported on dead

logs of *Tectona grandis* and *Terminalia tomentosa* from Kolhapur, Maharashtra (Parndekar, 1964). *Clavaria versatilis* =*Ramaria versatilis* was reported from Kerala (Mohan, 2011).

Out 3 species of *Clavariadelphus* reported from India, one species, *C. himalayensis* was reported from Meghalaya (Methven, 1989) and another two, *C. junceus* and *C. truncatus* from Uttarakhand (Thind and Anand, 1956b; Thind and Sukh Dev, 1956). Eleven species *Clavulina* were reported from north and central India and West Bengal. Out of them 8 species namely, *C. amethystinoides*, *C. bessonii*, *C. cartilaginea*, *C. cinerea*, *C. coralloides*, *C. hispidulosa*, *C. mussooriensis* and *C. subrugosa* were reported from Uttarakhand (Corner *et al.*, 1956, 1958; Thind and Anand, 1956b, 1956c; Thind and Raswan, 1958; Thind and Sukh Dev, 1956). *C. cinerea* was reported from Madhya Pradesh and

Uttarakhand (Dehariya *et al.*, 2010; Thind and Anand, 1956c). *C. rugosa* was reported from Himachal Pradesh (Sharma and Munjal, 1977) while *C. ornatipes* was reported from Himachal Pradesh and West Bengal (Berkeley, 1856; Thind and Rattan, 1967) and *C. limosa* from sal forest of West Bengal (Thind and Sharda, 1984).

Fifteen species of *Clavulinopsis* were reported from India out of them 8 species were reported from Uttarakhand these are *C. alcicornis*, *C. aurantiocinnabarina*, *C. corniculata*, *C. dichotoma*, *C. fusiformis*, *C. helvola*, *C. laeticolor* and *C. subtilis* (Butler and Bisby, 1931; Thind and Anand, 1956b; Thind and Raswan, 1958; Thind and Sukh Dev, 1957b). One species, *C. corniculata* was reported from both Uttarakhand and Jammu & Kashmir (Butler and Bisby, 1931; Thind and Anand, 1956b). Four species were reported from Himachal Pradesh namely *C. amoena*, *C. fusiformis* and *C. semivestita* (Sharma and Munjal, 1977; Thind and Rattan, 1967; Thind and Sharda, 1982). 2 species, *C. laeticolor* and *C. sulcata* were reported from West Bengal (Banerjee, 1947; Thind and Rattan, 1967; Thind and Sharda, 1986, 1987) and one species, *C. laeticolor* was reported from Meghalaya (Berkeley, 1852a).

Phaeoclavulina flaccida previously reported as *Ramaria flaccida* is distributed worldwide. It was reported occurring on dead leaves and twigs of oak and pine (Thind and Anand, 1956a) and attached to the base of young teak tree (this article). 3 species, *Phaeoclavulina zippelii* \equiv *Clavaria zippelii*, *Pterula indica* and *P. verticillata* were reported from Maharashtra (Senthilarasu, 2013a b).

Total 39 species of *Ramaria* were reported from 51 places in India and most of the species were from northern India (Uttarakhand and Himachal Pradesh). Out of them 19 were reported from Uttarakhand,

these are: *Ramaria brevispora*, *R. camelicolor*, *R. clarobrunnea*, *R. concolor*, *R. echinovirens*, *R. flava*, *R. flaviceps*, *R. flavobrunnescens*, *R. holorubella*, *R. kisanuensis*, *R. moelleriana*, *R. obtusissima*, *R. purpurissima*, *R. pusilla*, *R. rubrogelatinosa*, *R. sanguinea*, *R. subaurantiaca*, *R. subbotrytis*, *R. subgelatinosa* (Corner *et al.*, 1956, 1957, 1958; Khurana and Thind, 1979; Sharma and Jandaik, 1978; Thind and Anand 1956a; Thind and Rattan, 1967; Thind and Sukh Dev, 1957a b). Eleven species namely, *R. aurea*, *R. concolor*, *R. flavoalba*, *R. flavoviridis*, *R. gracilis*, *R. holorubella*, *R. laevispora*, *R. perbrunnea*, *R. petersenii*, *R. pura* and *R. rubrogelatinosa* were reported from Himachal Pradesh (Corner, 1966; Corner and Thind, 1961; Das, 2009; Sharma and Jandaik, 1978; Sharma *et al.*, 1977; Thind and Rattan, 1967; Thind and Sharda, 1984). Five species each of *Ramaria* were reported from Arunachal Pradesh and Kerala. Species reported from Arunachal Pradesh include, *R. camelicolor*, *R. flavobrunnescens*, *R. rasilispora*, *R. sandaracina* and *R. suecica* (Sharda and Thind (1986) while species reported from Kerala are: *R. apiculata*, *R. eumorpha*, *R. flava*, *R. gracilis* and *R. pallida* (Mohanan, 2011; Sharma and Jandaik, 1978; Thind *et al.*, 1983). Two species, *R. eumorpha*, *R. ochrochlora* were reported from Jammu and Kashmir (Thind *et al.*, 1983). *R. aurea*, *R. brevispora* and *R. subalpina* were reported from Sikkim, Himalaya (Das, 2009; Das *et al.*, 2016). 4 species of *Ramaria* are reported from Meghalaya: *R. formosa*, *R. obtusissima*, *R. stricta* and *R. synaptopoda* (Berkeley, 1856; Sharda and Thind, 1986). One species each of *Ramaria* was reported from Maharashtra and West Bengal these are *R. apiculata* and *R. sikkimia* (Patil and Thite, 1977; Rattan and Khurana, 1978; Thite *et al.*, 1976).

Ramariopsis kunzei \equiv *Clavaria kunzei* was recorded from mixed conifers, redwood and

hard wood forest. The species is distributed in North America, (including Hawaii and Puerto Rico) in Northern Michigan and California, Scotland, the Netherlands, Norway, Czechoslovakia, Germany, Poland and Russia. It has also been reported from China, India, Iran, the Solomon Islands and Australia. In North America, the distribution extends north to Canada, the species reported to be edible. In the present study this species was collected from Maharashtra and described (Fig. 5-8). Earlier it was reported from Uttarakhand (Thind and Sukh Dev, 1957a). *Ramariopsis subtilis* \equiv *Clavaria subtilis* is distributed in U.S.A., North America, Europe and India on different substrates like, humus soil under tree, ferns and Eucalyptus. It was also recorded on wood residues on soil from Chhattisgarh. Two species of *Ramariopsis*, *R. kunzei* and *R. tenuicula* \equiv *Clavaria tenuicula* were reported from Uttarakhand and Himachal Pradesh (Sharma and Munjal, 1977; Thind and Raswan, 1958; Thind and Sukh Dev, 1957a). *R. asterella* from West Bengal (Banerjee and Ganguly, 1945) and *R. subtilis* from Chhattisgarh (Tiwari *et al.*, 2013) were also reported. In the present study the species is again collected and described from Jabalpur, Madhya Pradesh (Fig. 9-12). *Ramariopsis biformis* \equiv *Clavulinopsis biformis* var. *elongata* was reported from Uttarakhand (Thind and Anand, 1956b).

The only species, *Scytinopogon angulisporus* \equiv *Clavaria angulispora* was reported from West Bengal (Banerjee, 1947; De, 1991). 10 species of *Typhula* were reported from Himalayan regions including Himachal Pradesh, Uttarakhand and West Bengal (Darjeeling). These includes: *T. himalayana*, *T. longispora*, *T. micans*, *T. ovata*, *T. phacorrhiza*, *T. pteridicola*, *T. pulgensis*, *T. sclerotoides*, *T. setipes* and *T. thindii* (Corner *et al.*, 1957; Khurana, 1980; Thind and Raswan, 1958; Thind and Sukh Dev,

1956, 1957a). Some clavarioid fungi are also edible, but biomasses in fruit bodies of these fungi are very less. Edible species includes: *Ramaria subalpina* (Das *et al.*, 2016).

Records on 17 genera of clavarioid fungi were compiled from 13 states of India. Uttarakhand have shown maximum diversity of these fungi representing 13 genera and 57 species followed by Himachal Pradesh and West Bengal. *Phaeoclavulina flaccida*, *Ramariopsis kunzei* and *R. subtilis* were described and reported from Madhya Pradesh and Maharashtra.

Clavarioid frungi belonging to 17 genera namely, *Aphelaria*, *Artomyces*, *Clavaria*, *Clavariadelphus*, *Clavulina*, *Clavulinopsis*, *Deflexula*, *Gloeocantharellus*, *Lachnocladium*, *Lentaria*, *Multiclavula*, *Phaeoclavulina*, *Pterula*, *Ramaria*, *Ramariopsis*, *Scytinopogon* and *Typhula* were recorded from 131 places from 13 states of India. Genus *Ramaria* distributed widely and represented by collections from 49 places followed by *Clavulinopsis* (15), *Clavaria* and *Clavulina* (13 each) and, *Typhula* (11). Genera like *Aphelaria*, *Artomyces*, *Deflexula*, *Gloeocantharellus*, *Multiclavula* and *Scytinopogon* are least diverse in distribution and collected from only one place (Table 2).

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