

THE CLAVARIACEAE OF INDIA—XI

BY K. S. THIND, F.A.S.C., AND S. S. RATTAN

(*Botany Department, Panjab University, Chandigarh-14*)

Received August 21, 1967

ABSTRACT

This paper gives an illustrated account of 7 species, 2 varieties and one new form of Clavariaceae collected from Dalhousie Hills (North-Western Himalayas) and Darjeeling Hills (Eastern Himalayas). All these are new records for India.

INTRODUCTION

THE senior author, along with his students, has carried out a systematic study of Clavariaceae collected from the Mussoorie Hills (North-Western Himalayas) and in all 46 known species, 11 new species and 9 new varieties are described in 10 papers published under the series "Clavariaceae of the Mussoorie Hills—I-X". Later on, all of these have been incorporated in the senior author's monograph on Indian Clavariaceae published in 1961. Since then the study of Clavariaceae has been extended to other regions of India and this has necessitated a change in the title.

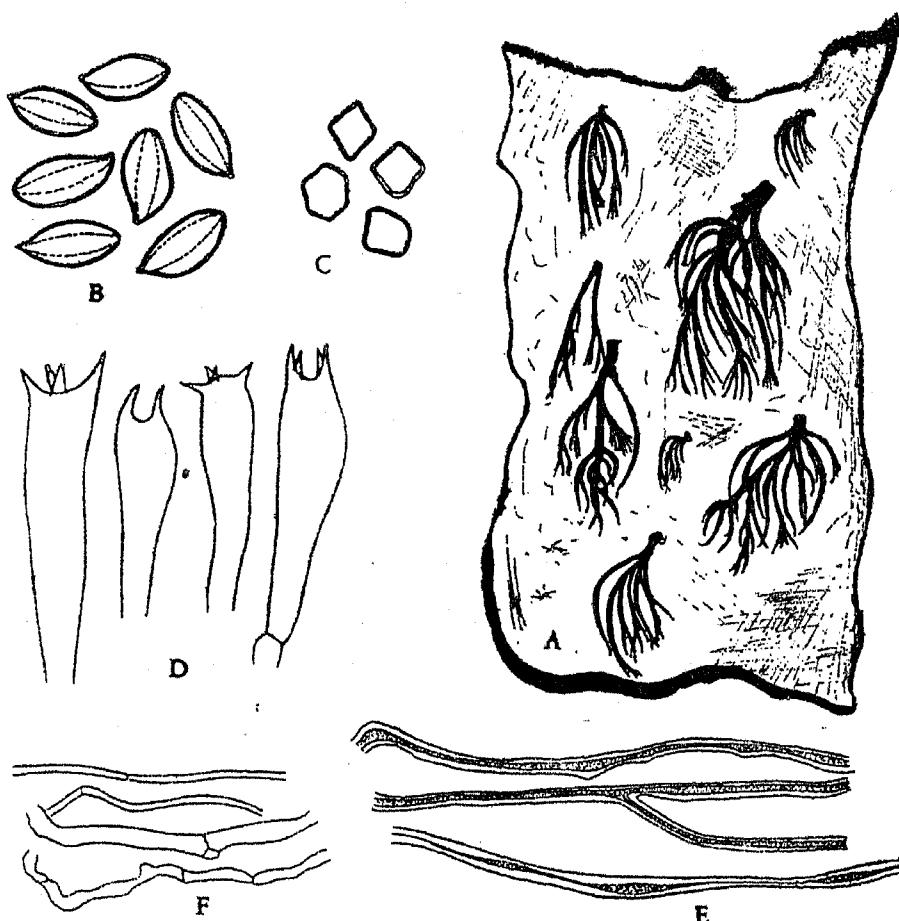
The collections of Clavarias described here have been deposited in the Herbarium of the Panjab University, Botany Department, and in the Botany Department, University of Cambridge, England.

68. *Deflexula subsimplex* (P. HENN.) CORNER

Fructifications up to 25 mm. tall and 15 mm. broad, gregarious, positively geotropic, small-sized, branched, trunk present, slightly tough, smooth, white to dull white in colour; trunk ranges from a stubby base to 12 mm. long and 1-2 mm. broad, cylindrical, sterile, the trunk divides forming a cluster of 2-25 deflexed branches, occasionally with a few abortive branches also; branches up to 2 cm. long and 120-800 μ wide at the base, subulate, each branch may remain simple or branch further once, twice or more times so

* This is a continuous series dealing with the taxonomic study of Indian Clavariaceae started by the senior author. The title "The Clavariaceae of the Mussoorie Hills" has been replaced by "The Clavariaceae of India," since the study is being extended to the other regions in India.

as to form a secondary cluster of branchlets; apices acute, sterile and concolorous; flesh concolorous and unchanging; taste and smell in particular. *Hymenium* spread all over except the trunk, apices and outside of the curvature of the branches, thickening, up to $110\ \mu$ thick. *Basidia* $35-50 \times 7-12\ \mu$, clavate, sterigmata 4, rarely 2, up to $5\ \mu$ long. *Basidiospores* $11-15 \times 6-7.5\ \mu$, subhyaline, broadly ellipsoid or mango-shaped, with 4, rarely 5 or 6, longitudinal ridges so that they appear (in an optical cross-section) squarish, pentagonal or hexagonal in outline, thick-walled, papillate, papilla up to $1\ \mu$ long, aguttate but sometimes with one or more vague guttules also. *Hyphae* dimitic, mostly skeletal *hyphae*, the generative *hyphae* limited in the subhymenium only; skeletal *hyphae* $2-7\ \mu$ wide, thick-walled, wall $0.5-2\ \mu$ thick, aseptate, unbranched to rarely branched; generative *hyphae* $1.5-6\ \mu$ wide, subhyaline, thin-walled, branched, septate, clamped. (Text-Fig. 1).



TEXT-FIG. 1. *Deflexula subsimplex* (P. Henn.) Corner. A. Fructifications, $\times 1$. B. Basidiospores, $\times 770$. C. Optical cross-section of the basidiospores, $\times 770$. D. Basidia, $\times 770$. E. Skeletal hyphae, $\times 325$. F. Generative hyphae, $\times 325$.

Collected on a stump of *Cryptomeria japonica* D. Don, 6-Mila, Darjeeling, W. Bengal, July 22, 1964, 914; on a stump of *C. japonica*, Takdah Cantt., Darjeeling, W. Bengal, October 4, 1964, 915; on a stump of *C. japonica*, Takdah Cantt., Darjeeling, W. Bengal, October 4, 1964, 916.

All the Darjeeling collections are characterised by the fasciculate, branched fruit bodies up to 25 mm. long with branches not secund, and broadly ellipsoid or mango-shaped spores, which are marked by longitudinal ridges. Thus these are quite typical of *D. subsimplex*, as described by Corner, 1952.

69. *Clavaria incarnata* WEINM.

Fructifications up to 7.5 cm. tall and 1-3 mm. broad, gregarious, erect, solitary, rarely caespitose in twos only, radial, simple, trunk present, pale pink in colour; trunk up to 3 cm. long and 2 mm. broad, cylindrical, sterile, deeper concolorous, strigose with white hairs, strigose hairs more prominent near the base; fertile portion up to 5.5 cm. long and 3 mm. broad, cylindrical to subcylindrical, demarcated from the trunk by the light colour, straight, smooth; apices subacute to obtuse, fertile, paler concolorous; flesh paler concolorous and unchanging; taste and smell in particular. *Hymenium* spread all over except the trunk, thickening, up to 120 μ thick. *Basidia* 45-60 \times 6-8 μ , hyaline, clavate with a long tapering base, with a loop-like clamp at the base, sterigmata mostly 4, rarely 2, straight, up to 7.5 μ long. *Basidiospores* 6.5-9.5 \times 5-6.5 μ , hyaline, broadly ellipsoid to ellipsoid-oblong, slightly constricted in the middle, smooth, thin-walled, papillate, papilla up to 0.8 μ long, uniguttate, gutta large and filling one-half to three-fourth of the spore cavity. *Hyphae* monomitic, 2.5-15 μ wide, hyaline, thin-walled to slightly thick-walled, secondarily septate, secondary septa few, constricted in the region of the primary septa, slightly inflated, sometimes wavy, clamps absent (Text-Fig. 2).

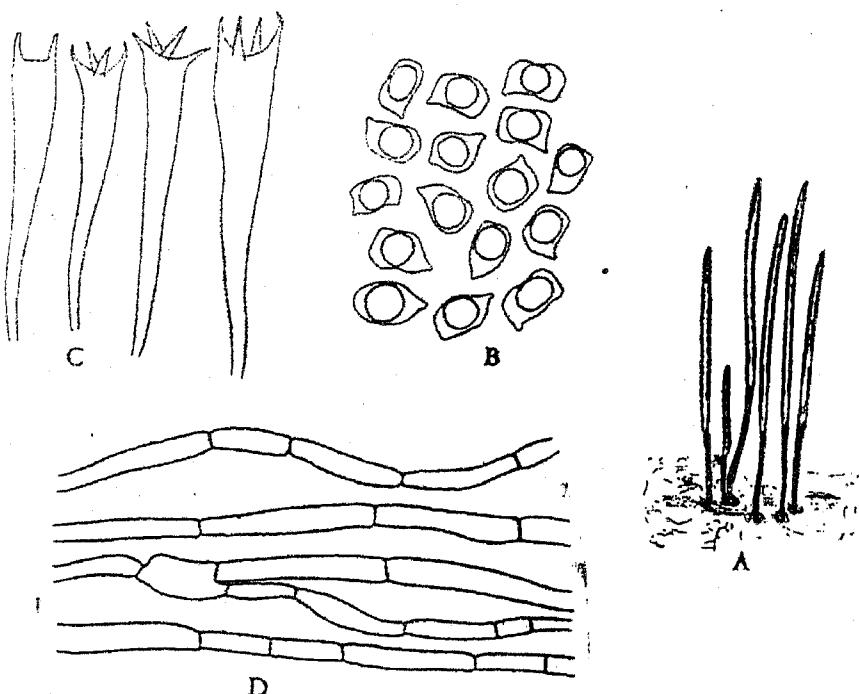
Collected on soil among mosses under a mixed forest, Surel, Darjeeling, W. Bengal, October 2, 1964, 917.

This single Darjeeling collection is the only record of *C. incarnata* in India. This collection is quite typical of the species, which is characterised by light pink, simple fruit bodies, secondarily septate *hyphae*, the presence of a loop-like clamp at the base of the basidium and ellipsoid-oblong spores.

70. *Clavulinopsis amoena* (ZOLL. ET MOR.) CORNER.

Fructifications up to 6 cm. tall and 5 mm. broad, caespitose, gregarious, erect, radial, trunk present, simple to sparsely branched once or twice above,

some are only bifid at the top, solid, fleshy, smooth, glabrous, orange, becoming light brown on drying; trunk up to 2.4 cm. long, paler concolorous, sterile, white villous, more prominently villous near the base; branches small, unequal, in alternating planes; apices obtuse, fertile and concolorous; flesh paler concolorous and unchanging; taste and smell in particular. *Hymenium* spread all over except the sterile trunk, thickening, up to 100μ thick. *Basidia* $53-60 \times 5.5-9\mu$, hyaline, clavate with a long tapering base,



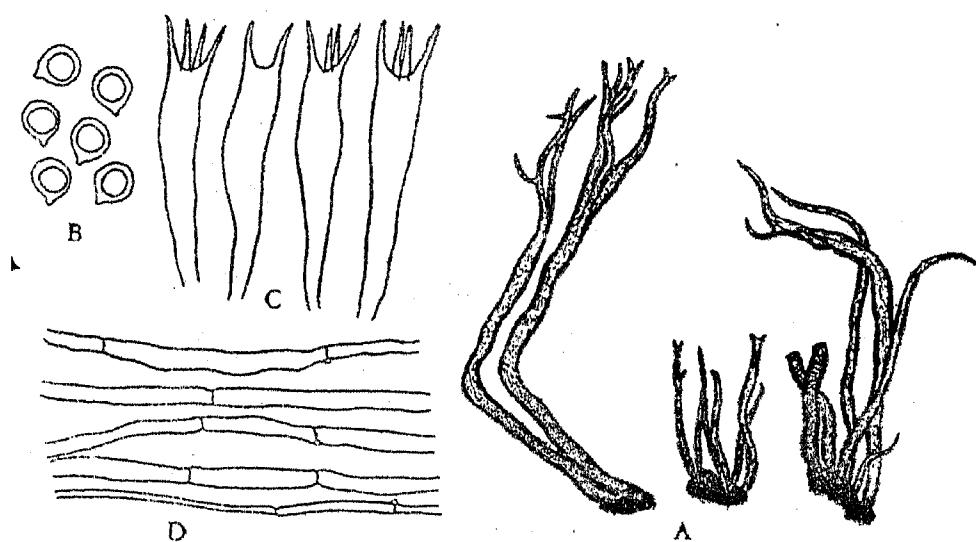
TEXT-FIG. 2. *Clavaria incarnata* Weinm. A. Fructifications, $\times 1/2$. B. Basidiospores $\times 770$. C. Basidia, $\times 770$. D. Hyphae, $\times 325$.

sterigmata mostly 4, rarely 2, straight, up to 9μ long. *Basidiospores* $4.5-7.5 \times 4.5-7\mu$, hyaline, subglobose to globose, smooth, papillate, papilla $0.5-1\mu$ long, uniguttate, gutta large and filling one-half of the spore cavity. *Hyphae* monomitic, $3-12\mu$ wide, hyaline, thin-walled, inflated, branched, septate, septa at short to long intervals, clamped, even to wavy, H-connections present (Text-Fig. 3).

Collected on soil under an Oak forest, Lover's Walk, Dalhousie, H. P., August 28, 1959, 918.

This Dalhousie collection resembles *C. amoena* in all respects except that its fruit bodies are orange-coloured and smaller in size and mostly branched, though very sparsely. This collection of *C. amoena* differs from the Indian collection of *Clavulinopsis pulchra* (Peck) Corner (described below) in having

sparsely branched, orange fruit bodies, villous trunk, smaller globose spores with smaller apiculus.

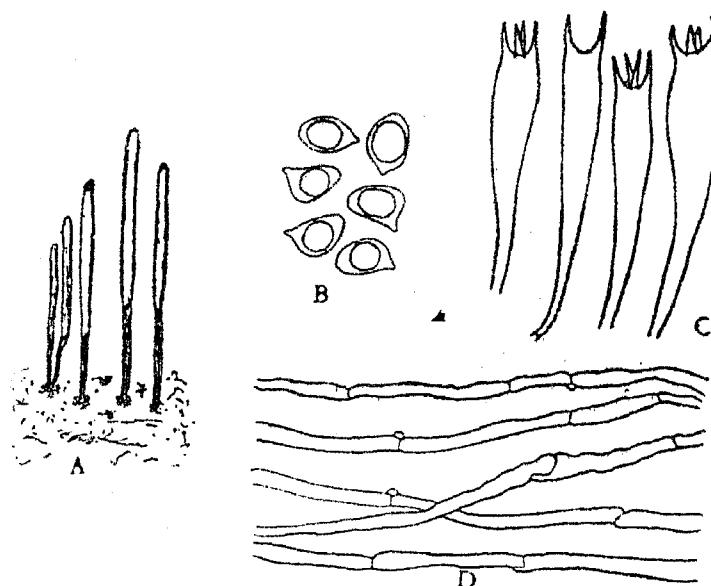


TEXT-FIG. 3. *Clavulinopsis amoena* (Zoll. et Mor.) Corner. A. Fructifications, $\times 1$. B. Basidiospores, $\times 770$. C. Basidia, $\times 770$. D. Hyphae, $\times 325$.

Corner (1950), has discussed in detail the range of variation of *C. amoena* and its differences from other allied species. This Dalhousie collection falls well within the range of variation of the species.

71. *Clavulinopsis pulchra* (PECK) CORNER

Fructifications up to 3 cm. tall and 1-2 mm. broad, erect, solitary, or caespitose with 2-3 clubs in a cluster, gregarious, radial, trunk present, simple, smooth, glabrous, yellow; trunk up to 1.2 cm. long and 1.5 mm. broad, cylindrical, narrower than the fertile portion, concolorous, sterile; fertile portion cylindrical, occasionally becoming flattened also, smooth; apices obtuse, fertile, concolorous; flesh paler concolorous and unchanging; taste and smell in particular. *Hymenium* spread all over except the sterile trunk, non-thickening, up to $50\ \mu$ thick; subhymenium distinct, up to $20\ \mu$ thick. *Basidia* $35-45\ \mu$ long and up to $8\ \mu$ broad, hyaline, clavate with a long tapering base, occasionally becoming thick-walled and persisting in the hymenium, sterigmata mostly 4, rarely 2, up to $7.5\ \mu$ long. *Basidiospores* $6-7.5 \times 4.5-5.5(-6)\ \mu$; hyaline, broadly ellipsoid to subglobose, smooth, prominently papillate, papilla often sublateral, up to $1.5\ \mu$ long. *Hyphae* monomitic, $1.5-7\ \mu$ wide, hyaline, thin-walled, branched, septate, septa at short to long intervals, clamped; subhymenial hyphae up to $3\ \mu$ wide, septate, clamped (Text-Fig. 4).



TEXT-FIG. 4. *Clavulinopsis pulchra* (Peck) Corner. A. Fructifications, $\times 1$. B. Basidiospores, $\times 770$. C. Basidia, $\times 770$. D. Hyphae, 325.

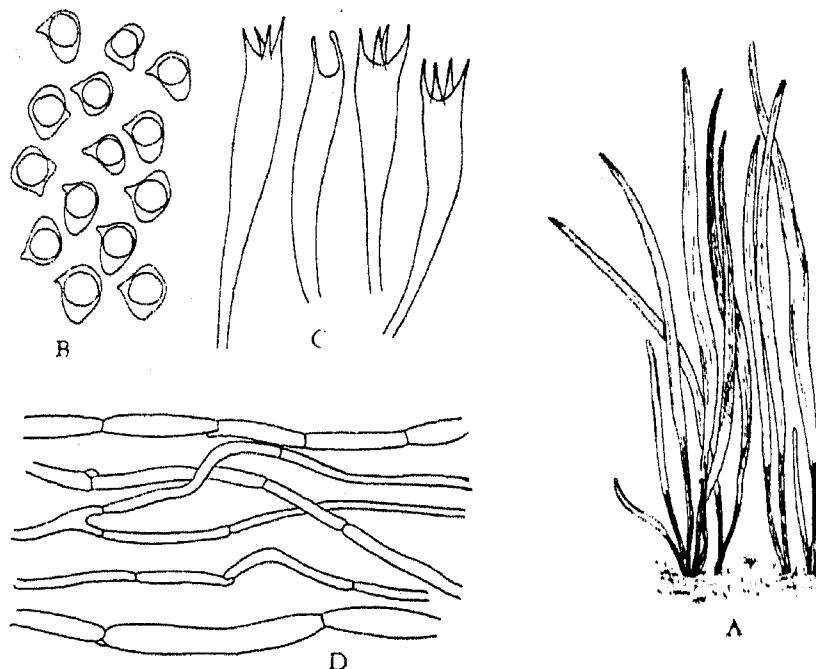
Collected on humicolous soil under a mixed forest, Sukhia Pokhri, Darjeeling, W. Bengal, October 22, 1964, 919.

This Darjeeling collection undoubtedly represents a young stage of *C. pulchra* in which the fruit bodies are smaller, the hymenium is not thickened and the hyphae are not inflated as yet. However, the hymenium is well developed and the spores are quite typical of the species. The basidia of the Darjeeling collection are smaller than those reported for the species by various workers.

72. *Clavulinopsis pulchra* (PECK) CORNER FORM *subtrigona* F. NOV.

Fructifications up to 12 cm. long and 3 mm. broad, erect, mostly caespitose, sometimes solitary, gregarious, radial, trunk present, simple, smooth, glabrous, light yellow in colour, solid, becoming hollow at maturity; trunk up to 2.5 cm. long and 2.5 mm. broad, radial, solid, sterile, paler concolorous; fertile portion cylindrical, becoming flattened and rarely twisted also at maturity; apices obtuse, fertile and concolorous; flesh paler concolorous and unchanging; taste and smell in particular. *Hymenium* spread all over except the trunk, thickening, up to $100\ \mu$ thick. *Basidia* $45-55 \times 6-7.5\ \mu$, hyaline, clavate with a long tapering base, sterigmata 4, straight, up to $7.2\ \mu$ long. *Basidiospores* $4.8-7.2 \times 4.8-6\ \mu$, hyaline, broadly ellipsoid and characteristically triangular in shape due to three or four distinct ridges, papillate, papilla prominent and eccentrically placed, upto $1.5\ \mu$ long, uniguttate, gut-

tule large and filling one-half of the spore cavity. **Hyphae** monomitic, mostly $1.5-7\ \mu$ wide, sometimes may be inflated up to $12\ \mu$, hyaline individually but appear light yellow in mass, septate, septa at short to long intervals, clamped (Text-Fig. 5).



TEXT-FIG. 5. *Clavulinopsis pulchra* (Peck) Corner form *subtrigona*. A. Fructifications, $\times 1/2$. B. Basidiospores, $\times 770$. C. Basidia, $\times 770$. D. Hyphae, $\times 325$.

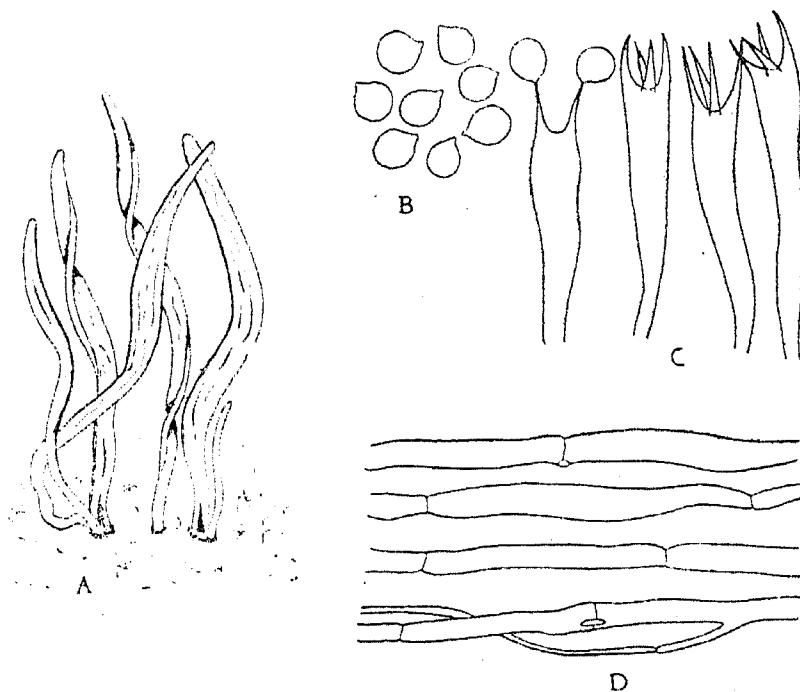
Collected on humicolous soil under an angiospermic forest, Sanchel Lake, Darjeeling, W. Bengal, August 27, 1964, 920.

This Darjeeling collection resembles *C. pulchra* in most respects. However, its spores are characteristically subtriangular. Therefore, it may be regarded as a new form *subtrigona*.

73. *Clavulinopsis miniata* (B.) CORNER

Fructifications up to 10 cm. long and 8 mm. broad, gregarious, erect, solitary to caespitose with 2-3 clubs in a cluster, simple, cylindrical when young, becoming irregularly flattened with age, fleshy, smooth, trunk present, deep pink; trunk up to 2 cm. long and 6 mm. broad, cylindrical to slightly flattened, smooth, sterile, paler concolorous; fertile portion up to 8 cm. long and 8 mm. broad, cylindrical to flattened, often twisted, smooth to somewhat rugulose; apices obtuse, concolorous; flesh deeper concolorous and unchanging; taste and smell in particular. **Hymenium** spread all over except the trunk, thickening, up to $110\ \mu$ thick; subhymenium up to $50\ \mu$ thick and

composed of narrow and closely septate hyphae. *Basidia* $40-60 \times 6-9 \mu$, clavato-elongate, hyaline, sterigmata mostly 4, rarely 2, straight, long, up to 11μ long. *Basidiospores* $5-6.5 (-7.5) \times 4.5-6.5 \mu$, globose to subglobose, hyaline, smooth, papillate, papilla short, up to 0.6μ long. *Hyphae* monomitic, up to 11μ wide, light pink to reddish in mass due to the presence of coloured oil droplets in them, thin-walled, inflated up to 17μ , septate, septa at short to long intervals, slightly constricted in the region of the septa, clamped (Text-Fig. 6).



TEXT-FIG. 6. *Clavulinopsis miniata* (B.) Corner. A. Fructifications, $\times 1/2$. B. Basidiospores, $\times 770$. C. Basidia, $\times 770$. D. Hyphae, $\times 325$.

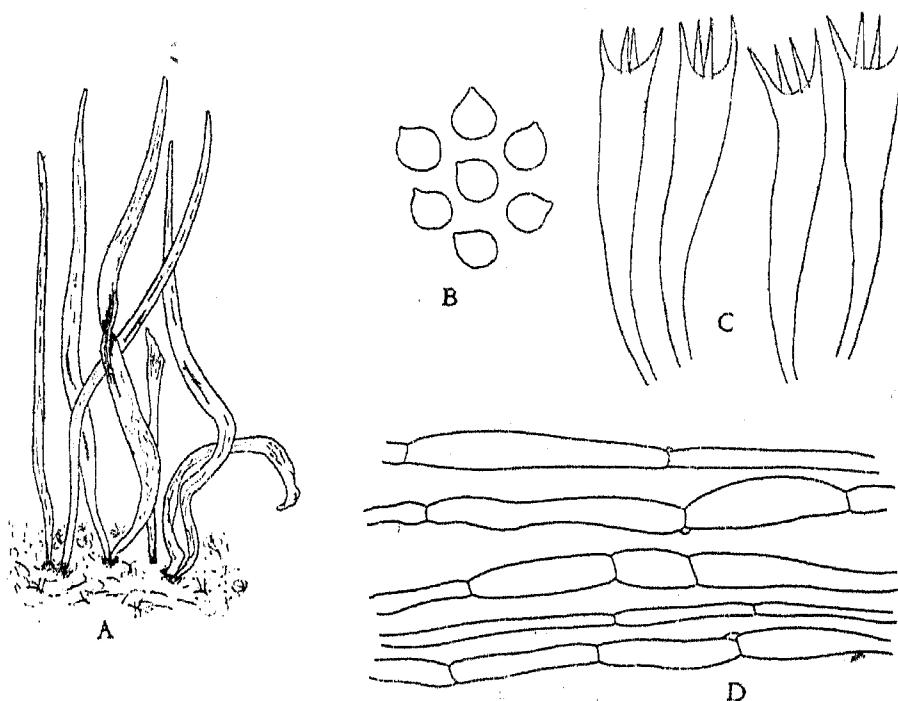
Collected among a grass in a more or less exposed place in an angiospermic forest, Takdah Canit., Darjeeling, W. Bengal, September 16, 1964, 921.

This Darjeeling collection is quite typical of *C. miniata*. The slight branching reported for the species has not been observed in this collection.

74. *Clavulinopsis miniata* (B.) CORNER VAR. *rosacea* CORNER

Fructifications up to 15 cm. tall and 8 mm. broad, gregarious, erect, soliary, or caespitose with 2-3 clubs in a cluster, simple, cylindrical when young, becoming flattened with age, fleshy, smooth, trunk present, light pink to rose pink in colour; trunk up to 3.5 cm. long and 6 mm. broad, cylindrical to

slightly flattened, smooth, sterile, paler concolorous; fertile portion up to 12 cm. long and 8 mm. broad, cylindrical to occasionally flattened, smooth to somewhat rugulose, often twisted; apices subacute to obtuse, paler concolorous, fertile; flesh deeper concolorous and unchanging; taste and smell in particular. *Hymenium* spread all over except the trunk, thickening, up to $120\ \mu$ thick; subhymenium up to $50\ \mu$ thick and composed of narrow and closely septate *hyphae*. *Basidia* $40-70 \times 7.5-9\ \mu$, clavate with a long tapering base, hyaline, sterigmata 4, straight, long, up to $10\ \mu$ long. *Basidiospores* $6-7.5 \times 5.8-7.2\ \mu$, hyaline, globose to subglobose, thin-walled, smooth, papillate, papilla up to $1\ \mu$ long, aguttate. *Hyphae* monomitic, $3-15\ \mu$ wide, hyaline, thin-walled, septate, septa at short to long intervals, constricted in the region of the septa, clamped. (Text-Fig. 7).



TEXT-FIG. 7. *Clavulinopsis miniata* (B.) Corner var. *rosacea* Corner. A. Fructifications, $\times 1/2$. B. Basidiospores, $\times 770$. C. Basidia, $\times 770$. D. Hyphae, $\times 325$.

Collected on humicolous soil under a *Cryptomeria japonica* D. Don forest, Surel, Darjeeling, W. Bengal, October 2, 1964, 922.

This variety differs from the typical form of *C. miniata* in having light pink to rose-pink fruit-bodies. It also differs from the Darjeeling collection of this species in this respect.

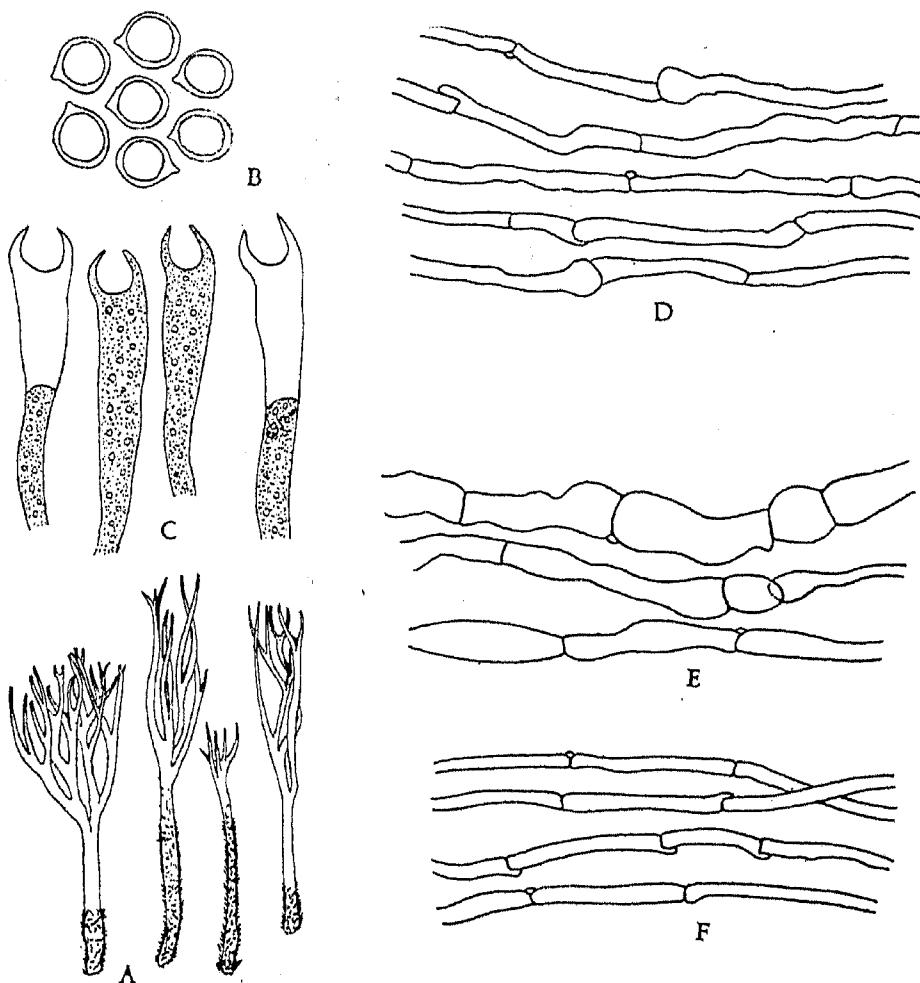
75. *Clavulina ornatipes* (PECK) CORNER

Fructifications up to 9 cm. tall and 3 cm. broad, gregarious, erect, radial to slightly flattened, solitary, rarely caespitose, medium-sized, trunk present, branched, rather tough, dark brown in colour; trunk long, up to 3.5 cm. long and 0.5 cm. broad, cylindrical, dark concolorous, strigose usually in the lower part, sometimes throughout; branching lax, sparse to numerous and compact, dichotomous to palmate, unequal, internodes short to long; primary branches 1-3 mm. broad, cylindrical to flattened, occasionally twisted; ultimate branchlets long; apices acute, paler concolorous, sterile; flesh paler concolorous and unchanging; taste and smell in particular. *Hymenium* spread all over except the trunk and the apices, thickening, up to 240 μ thick; subhymenium indistinct. *Basidia* 45-60 \times 6-7 μ , clavato-cylindrical, hyaline, becoming secondarily septate after spore discharge, sterig mata 2, incurved, up to 6 μ long. *Basidiospores* 8-10 \times 6.8-8.5 μ , subglobose to ovoid, hyaline, smooth, papillate, papilla up to 0.8 μ long, uniguttate, gutta large and filling one-half to three-fourth of the spore cavity. *Context hyphae* monomitic, 3-7.5 μ wide, thin-walled, or slightly thick-walled, wall brown, inflated up to 11 μ , septate, septa at short to long intervals, clamped. *Hyphae of the trunk* composed of an outer cortex and a central medulla; cortical hyphae up to 5 μ wide, uninflated to slightly inflated, septate, septa at short to long intervals, clamped; medullary *hyphae* up to 8 μ wide, inflated up to 25 μ , septate, septa at short intervals, clamped. *Strigose hyphae* up to 4 μ wide, uninflated to slightly inflated, septate, septa at short to long intervals, clamped. (Text-Fig. 8).

Collected on soil under an Oak forest, Glen, Simla, H.P., September 17, 1960, 923; on soil under an Oak forest, Sat Tal, Naini Tal, U.P., October 2, 1961, 924; on humicolous soil under an angiospermic forest, Lebong Cantt., Darjeeling, W. Bengal, July 30, 1964, 925; on humicolous soil under an Oak forest, Lebong Cantt., Darjeeling, W. Bengal, July 30, 1964, 926; on soil among mosses under a mixed forest, Tiger Hill, Darjeeling, W. Bengal, August 8, 1964, 927; on soil under a mixed forest, Rangi Rum, Darjeeling, W. Bengal, August 14, 1964, 928; on humicolous soil, Sanchel Lake, Darjeeling, W. Bengal, August 22, 1964, 929; on humicolous soil, 3-Mila, Darjeeling, W. Bengal, August 25, 1964, 930.

This species appears to be widely distributed in the North-Western, Central as well as Eastern Himalayas. It is easily recognised by the rather tough and dark brown fruit bodies, long and prominently strigose stem, stout but sparse and lax branches, hyaline and subglobose to ovoid spores. The

spores in all the Indian collections are typical of the species except those of Naini Tal collection which are smaller and globose ($7-8.4\mu$). It is interesting to note that the spores in all the Indian collections are uniguttate and thereby resemble the collections from North America.



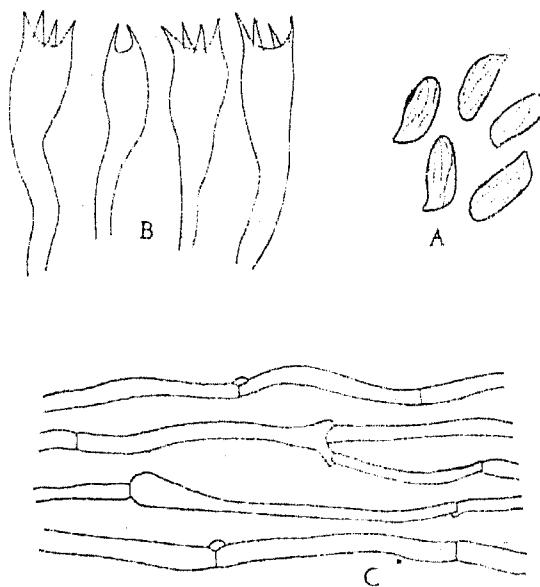
TEXT-FIG. 8. *Clavulina ornatipes* (Peck) Corner. A. Fructifications, $\times 1/2$. B. Basidiospores, $\times 770$. C. Basidia, $\times 770$. D. Context hyphae, $\times 325$. E. Medullary hyphae of the trunk, $\times 325$. F. Cortical hyphae of the trunk, $\times 325$.

Hyphae in all the Indian collections are clamped in all the regions of the fruit bodies—subhymenium, context and cortex and medulla (in the case of trunk), while the clamps are not reported on the context hyphae for the species.

76. *Ramaria holorubella* (ATK.) CORNER

Fructifications upto 12.5 cm. tall and 8 cm. broad, erect, solitary, large-sized, compact, radial, trunk present, branched right from the stubby base,

fleshy, smooth, dull white; branching polychotomous to irregular below and dichotomous above, unequal, compact, with some abortive branches near the base; internodes short to long; ultimate branchlets up to 6 mm. long and are closely crowded together; apices multifid, obtuse to truncate, light pink in colour; flesh concolorous and unchanging; taste and smell in particular. *Hymenium* spread all over except the lower branches, non-thickening, up to $65\ \mu$ thick. *Basidia* $40-55 \times 7-9\ \mu$, clavate, sterigmata 4, rarely 2, straight to slightly curved, up to $7\ \mu$ long. *Basidiospores* $10-11.5 \times 4-4.5\ \mu$, ellipsoid, ochraceous with a brown wall, smooth but faintly and longitudinally striated, papillate, papilla up to $0.5\ \mu$ long. *Hyphae* monomitic, $2-7\ \mu$ wide, hyaline, thin-walled, branched, septate, uninflated to inflated, often swollen on one side of the septum forming a sac-like structure up to $13\ \mu$ broad, clamped (Text-Fig. 9).



TEXT-FIG. 9. *Ramaria holorubella* (Atk.) Corner. A. Basidiospores, $\times 770$. B. Basidia, $\times 770$. C. Hyphae, $\times 325$.

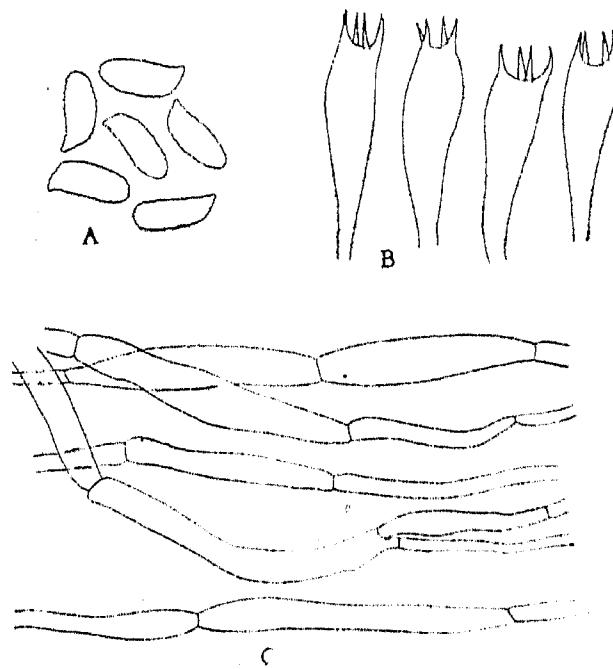
Collected on soil under an Oak forest, Banikhet, Dalhousie, H.P., August 10, 1963, 931.

The trunk which is usually reported for the species is absent in the Dalhousie collection. This collection also differs from the species in having pink-coloured tips.

77. *Ramaria subbotryis* (COKER) CORNER (var.) *intermedia* COKER

Fructifications up to 9 cm. tall and 10 cm. broad, erect, solitary, gregarious, large sized, radial, branched, trunk present, fleshy, smooth, light

pink in colour; trunk up to 2.3 cm. long, cylindrical, smooth, cream-coloured, to paler concolorous, sterile; branching dichotomous to polychotomous below and dichotomous above, unequal, in alternating planes; internodes long; primary branches up to 8 mm. broad; ultimate branchlets up to 1 cm. long; apices obtuse, deeper concolorous, sterile; flesh paler concolorous and unchanging; taste and smell in particular. *Hymenium* spread all over except the sterile trunk and the apices, non-thickening, up to 50μ thick. *Basidia* $6-8\mu$ broad, clavate, hyaline, sterigmata 4, straight, up to 5.5μ long. *Basidiospores* $10-13 \times 4-5\mu$, narrowly ellipsoid, ochraceous, wall brown, verruculose to rough to almost smooth, papillate, aguttate. *Hyphae* monomitic, $3-15\mu$ wide, hyaline, thin-walled, branched, septate, septa at short to long intervals, inflated, clamps absent (Text-Fig. 10, Plate X).



TEXT-FIG. 10. *Ramaria subbotrytis* (Coker) Corner var. *intermedia* Coker. A. Basidiospores, $\times 770$. B. Basidia, $\times 770$. C. Hyphae, $\times 325$.

Collected on humicolous soil under an Oak forest, Lover's Walk, Dalhousie, H.P., August 14, 1963, 932.

This Dalhousie collection resembles the Indian collection of *Ramaria subbotrytis* (Coker) Corner (see Thind's monograph "Clavariaceae of India," 1961, p. 89) in most respects. However, it differs from that in having much lighter colour of the fruit bodies and much larger spores. The spore marking, however, is quite similar in both.

ACKNOWLEDGEMENTS

The authors are especially thankful to the U.S. Educational Foundation for a travel grant for the year 1964-65, which made possible the collection of various fungi from Darjeeling and surrounding Hills. The authors are deeply indebted to Mr. E. J. H. Corner, F.R.S., of the Botany School, Cambridge, England, for the help in the identification of the species and valuable suggestions.

REFERENCES

Corner, E. J. H.: 1. *A Monograph of Clavaria and Allied Genera, Ann. Bot. Memoirs*, No. 1, 1950,
2. "Addenda Clavariaceae I. Two new Pteruloid Genera and Deflexula," *Ann. Bot.*, n.s., 1950, **16**, 269-291.

Thind, K. S. 1. *The Clavariaceae of India*, Indian Council of Agricultural Research, New Delhi, 1961.