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THE GASTEROMYCETES OF THE HIMALAYAS II[1]

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ABSTRACT

This paper gives an illustrated account of six species of Gasteromycetes collected from North-Western Himalayas, during various fungal forays (1971—1975). Out of these, *Calvatia candida* (Rostk.) Hollos and *Lycoperdon yetisodale* Kreisel are new records for India. *Lycoperdon setiferum* Demoulin has been described here for the first time from India on the basis of our North-Western Himalayan collections. All the species treated have been fully described and illustrated along with the anatomical details of the peridium.

INTRODUCTION

This is the second paper of the series; the previous paper gives an illustrated account of seven species of Gasteromycetes collected from North-Western Himalayas (Thind and Thind, unpubl.). This paper deals with the six species of Gasteromycetes collected from North-Western Himalayas, of which two were not previously reported from India. Special attention has been paid by the authors to the study of peridial anatomy. Such information is lacking in the treatment of these fungi by Ahmad 1952 and later workers from India. The numbers 8-13 represent the serial numbers of the species being described by the authors from this laboratory.

All the collections have been deposited in the Herbarium of Botany Department, Panjab University, Chandigarh (PAN). In some cases, the duplicate material has also been deposited in National Fungal Collections, Beltsville, Maryland, U.S.A. (BPI) ; the Herbarium Royal Botanic Gardens, Kew, Richmond, Surrey, England (K) ; the University Herbarium, University of Michigan, Ann Arbor, Michign, U.S.A. (MICH) ; the Herbarium, Department of Botany, University of Liege, Belgium (LG).

8. *Calvatia candida* (Rostk.) Hollos Term. Fuzet. **25 :** 112, 1902. Figs. 1-3, 31.

Fructifications scattered, singly, subglobose or broad above and tapering below into a short stem-like base, up to 3.3 cm in diameter. Rhizomorphs well-developed, thick, cord-like, holding much trash of the substratum. Exoperidium yellowish-brown to light brown, sometimes lighter near the lower part, furfuraceous, fungacious. Endoperidium light yellowish-

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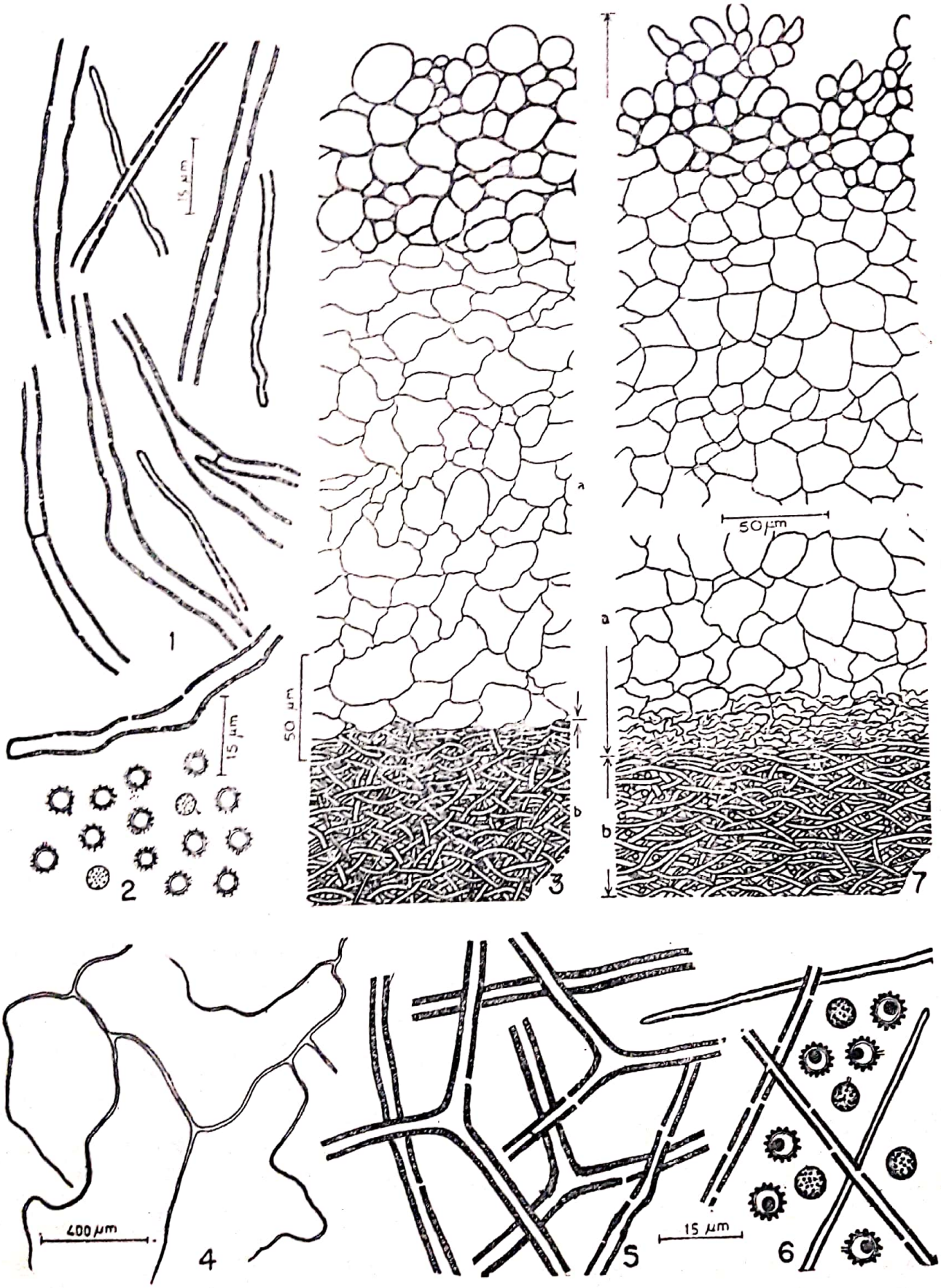
[3]Full name of the collector : Inder Pal Singh Thind.



brown, smooth, membranous ; dehiscing by breaking up into large flakes. Subgleba very small, yellowish, compact. Gleba whitish and chambered first, changing to light brown to greyish-brown or somewhat olivaceous and pulverulent at maturity. Capillitium comprising fragile olivaceous-brown threads with pale and acuminate apices, which may sometimes be broad, sparingly branched, sparsely septate, thin-walled, wall up to 1 μm thick and pitted, up to 5.6 μm wide. Basidiospores globose, (3.5) 4-5 μm in diameter, light olivaceous-brown in mass, pale-olivaceous individually, moderately verrucose, verrucae distinctly visible when stained with cotton blue or congo-red, aguttulate, usually apedicellate, some with a stump of a pedicel.

Anatomy: Exoperidium comprising two zones : outer pale brown, up to 100 μm wide, texture subglobulosa, cells nearly hyaline to paler coloured, thick-walled, 13-36 μm across ; inner subhyaline, up to 550 μm wide, textura angularis, cells hyaline, thin-walled, walls wavy, 16-50 μm across. Endoperidium pale brown, up to 110 μm wide, textura intricata, hyphae subhyaline, unbranched, aseptate, thick-walled, up to 4 μm wide.

Collection examined : Jammu and Kashmir : Gulmarg, on moist humicolous soil, coniferous forest, IPST* 10147 (PAN, BPI), August 27, 1972.

Remarks : Calvatia candida seems to be very rare in the North-Western Himalayas. It could be collected only once from Gulmarg during several fungal forays. It is marked by furfuraceous exoperidium, compact subgleba, and sparingly branched, fragile capillitium with many pores and verrucose spores. It is close to *C. rubroflava* (Cragin) Morg. in some features but differs in having smaller fructifications and pulverulent gleba. This Gulmarg collection resembles closely with the description of the species given by Cunningham (1944) and is quite typical of the species.

9. *Calvatia excipuliformis* (Pers.) Perdeck, Blumea **6** : 490, 1950. Figs. 4-7, 32.

Fructifications scattered, singly, usually with a distinct stem and bulbous base, becoming abruptly broader above into a globose head, sometimes turbinate, sometimes sessile, up to 8.5 cm in diameter. Exoperidium creamish-white first, changing to yellowish-brown to brown at maturity, usually spinose, spines brownish, singly or stellately arranged in groups, with curved apices, equally distributed throughout or gradually replaced towards lower part by granular material, fugaceous. Endoperidium light brown to brown, smooth, membranous ; dehiscing by breaking away into irregular flakes exposing the gleba in the upper part of the fructification. Subgleba very well developed, occupying the whole stem-like part, gradually merging into the gleba above, creamish-white when young, eventually turning olivaceous-brown, chambered, chambers large and distinct. Gleba creamish-yellow and fleshy first, becoming brown or olivaceous-brown and often with a purplish tint, pulverulent. Capillitium light brown to

Figs. 1—3 : *Calvatia candida.* 1. Parts of capillitium showing pitted walls and broadly or narrowly pointed apices. 2. Basidiospores. 3. T. S. part of peridium showing detailed structure, (*a*) exoperidium, (*b*) endoperidium. Figs. 4—7 : *Calvatia excipuliformis.* 4. Capillitium showing general mode of branching. 5. Parts of capillitium showing porous walls. 6. Basidiospores showing strong warts, apices and thin-walled capillitium showing porous walls. 7. T. S. part of peridium showing detailed structure, (a) exoperidium, (b) endoperidium.

brown or greyish-brown, becoming lighter towards apices which are acuminate, branched, aseptate, wall up to 1.4 μm thick, pores many on thin-walled threads, up to 7 μm wide. Basidiospores globose, 5.5-7 μm in diameter, usually greyish-brown, sometimes light brown, strongly verrucose, warts close, up to 1.5 μm long, guttulate, apedicellate, but some with a stump of a pedicel, mixed with numerous fallen pedicels.

Anatomy : Exoperidium comprising two zones : outer light brown, up to 250 μm wide, textura subglobulosa, cells hyaline, thick-walled, 13-16 μm across ; inner hyaline, up to 500 μm wide, textura angularis, cells hylaine to paler, thin-walled, up to 33 μm across, distinct upwards, becoming collapsed near the lower part. Endoperidium light brown, up to 200 μm wide, textura intricata, hyphae paler, unbranched, aseptate, slightly thick-walled, up to 4 μm wide.

Collections examined : Jammu and Kashmir : Gulmarg, on moist humicolous soil, coniferous forest, IPST 10139 (PAN, BPI), August 25, 1972 ; Gulmarg, Ningal Nallah, on decaying coniferous needles, coniferous forest, IPST, 10146 (PAN, BPI, K), August 26, 1972 ; Pahalgam, on coniferous needles, coniferous forest, IPST 10153 (PAN, BPI), September 1, 1972 ; Gulmarg, on moist humicolous soil, coniferous forest, IPST 10295 (PAN, BPI, LG), August 18, 1974.

Remarks : This species was previously reported from India under various names. Hennings (1901) described it as *Lycoperdon saccatum* Vahl ex Schum. based on Gollan's collection from Arnigadh, Mussoorie hills. Later, it was described by Ahmad (1942) as *Calvatia saccata* (Vahl ex Schum.) Morg. on the basis of Fotidar's collection from Baramula, Kashmir, made in November 1940. Both *L. saccatum* and *Calvatia saccata* were regarded as synonyms of *C. excipuliformis* (Pers.) Perdeck, by Kreisel (1962) and Zeller and Smith (1964). It is pertinent to mention here that both Hennings (1901) and Ahmad (1942) gave very meagre description of the species.

During the present study, several collections were made by the authors from Gulmarg and Pahalgam localities of Kashmir valley, where it was found growing in abundance, in the coniferous forests. Apart from Kashmir, it could not be collected from any other locality, including Mussoorie where it was first reported by Hennings (1901). Evidently, its distribution seems to be restricted to the Kashmir valley of North Western Himalayas.

C. excipuliformis can be easily distinguished from other species of the genus by the large size and the peculiar shape of the fructifications, spinose exoperidium, very well developed and distinctly chambered subgleba, olivaceous-brown gleba, strongly poroid capillatial threads and strongly verrucose spores, lying mixed with fallen pedicels. Based on our anatomical study, it is marked by having very large (up to 500 μm) inner zone of exoperidium comprising textura angularis.

These Gulmarg collections resemble *C. excipuliformis* in all important diagnostic features, and some of these represent the typical form of the species. These collections differ from the description of Hennings (1901) in the wider capillitial threads and larger basidiospores, and from that of Ahmad's description, in having larger size of the basidiospores.

C. excipuliformis is very close to *Lycoperdon molle* Pers., and sometimes it is difficult to distinguish between the two, especially the young specimens having no distinct stem. However, the former can

be distinguished from the latter in the larger size of the fructifications and their peculiar shape. Based on our anatomical study of both the species, *C. excipuliformis* differs from *L. molle* in having very large inner zone of exoperidium comprising textura angularis, which is very narrow and of textura intricata in the latter.

10. *Lycoperdon mundkuri* Ahmad. J. Indian bot. Soc. **21** : 286, 1942. Figs. 8-12, 33.

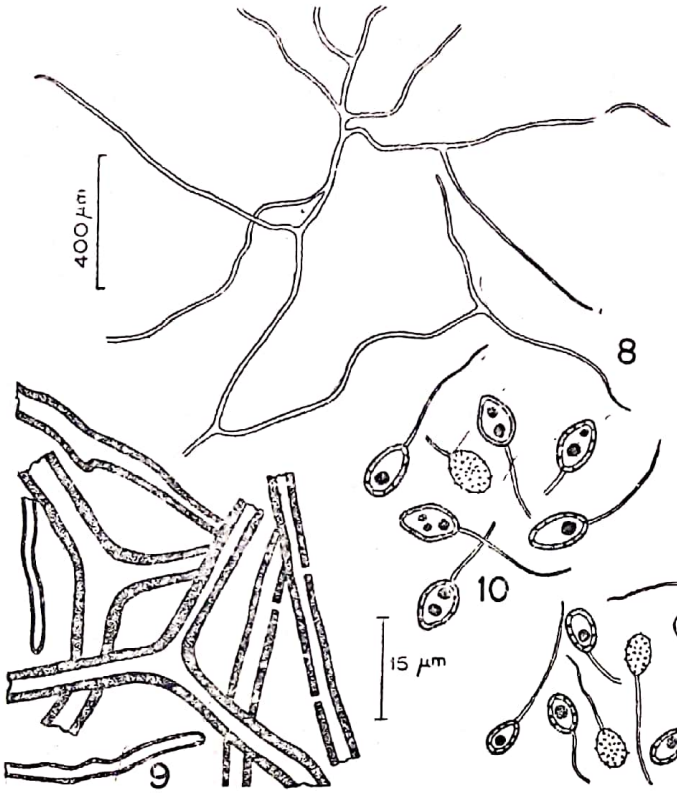
Fructifications scattered, usually singly, sometimes in groups, subglobose to depressed globose or turbinate, up to 3.5 cm in diameter. Rhizomorphs comprising dull-white, branched threads, holding much trash. Exoperidium brown, spinose, spines conical, singly or in groups, light brown to brown, prominent and-numerous in the upper part, smaller and scattered towards lower part, on falling leave paler spots which give somewhat reticulate appearance to the surface in the beginning, becoming smooth with age. Endoperidium light greyish-brown, rough to smooth, shining, membranous ; dehiscing by apical stoma with lobed margin, up to 0.5 cm wide. Subgleba usually well developed, yellowish-brown when young, changing to light brown to brown at maturity, chambered, chambers hyphoid, up to 1 mm across. Gleba usually light brown to brown with purplish tint, pulverulent, sometimes with a columella. Capillitium usually light brown to dark greyish-brown, sometimes yellowish-brown, lighter towards apices, branched, aseptate, thick-walled, wall up to 2.8 μm thick, pores many on thin-walled threads, up to 9.5 μm wide. Basidiospores ovoid to broadly ellipsoid, 4-8.5 $\times$3.5-5.5 μm, yellowish-brown to light greyish-brown, rarely olivaceous-yellow, verrucose, verrucae on the inner wall and distinctly visible when stained with crezyl-blue, uniguttulate or biguttulate, pedicellate, pedicels straight or curved, paler, with blunt or attenuate ends, up to 25 (—30) μm long.

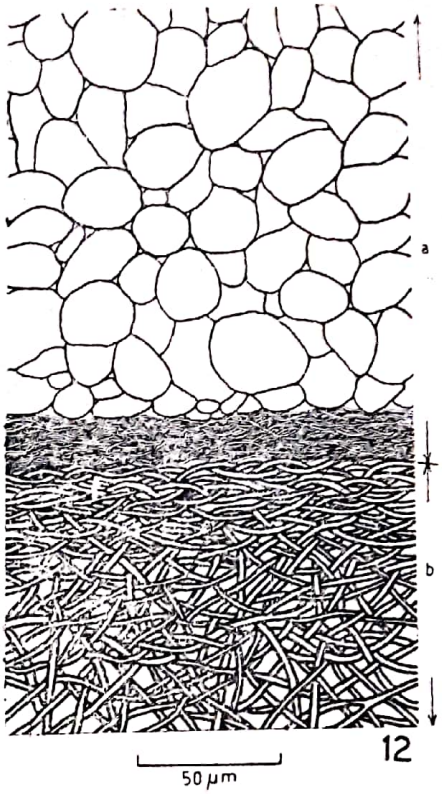
Anatomy : Exoperidium comprising two zones : outer pale brown, up to 300 μm wide, textura subglobulosa, cells hyaline, thin-walled, 10-53 μm across ; inner pale yellow, up to 16 μm wide, textura subintricata, hyphae very narrow, more or less parallel, hyaline, unbranched, aseptate, thin-walled, agglu inated, up to 1 μm wide. Endoperidium light brown, up to 100 μm wide, textura intricata, hyphae subhyaline to pale brown, rarely branched, aseptate, thick-walled, lumen wide to narrow, up to 5 μm wide.

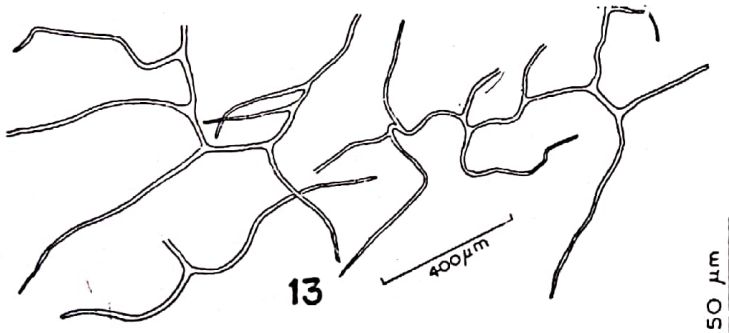
Collections examined : Himachal Pradesh: Simla, Narkanda, on moist humicolous soil, coniferous forest, IPST 10021 (PAN, BPI, MICH, LG), June 27, 1971 ; Simla, Narkanda, on way to Huttoo Peak, on moist humicolous soil, coniferous forest, IPST (10257 PAN, BPI), September 25, 1973 ; Simla, Khara Pathar, on moist humicolous soil, mixed forest, IPST 10272 (PAN, BPI), September 28 1973 ; Simla, Mashobra, on soil amidst mosses, coniferous forest, IPST 10276 (PAN, BPI), September 29, 1973.

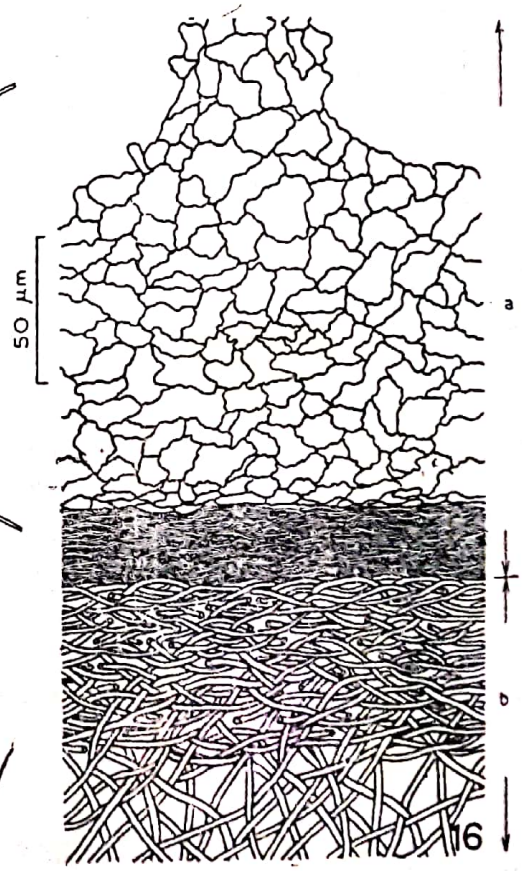
Uttar Pradesh : Mussoorie, The Park, on moist soil mixed forest, IPST 7450 (PAN), September 11, 1968 ; Naini Tal, Laria Kanta, on moist soil, predominantly angiospermic forest, IPST 7466 (PAN, MICH, LG), September 28, 1968 ; Mussoorie, Jabber Khet, on moist soil amidst mosses, mixed forest, IPST 10216 (PAN, BPI), August 28, 1973 ; Mussoorie, Dhanoulti, on moist humicolous soil, mixed forest, IPST 10225 (PAN, BPI), September 1, 1973.

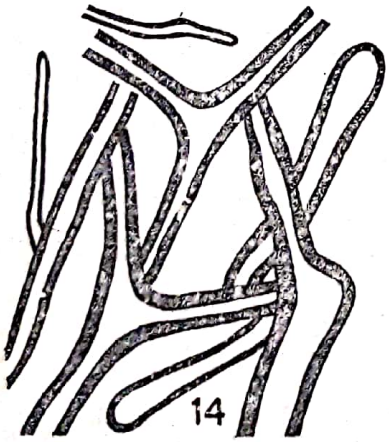
Remarks : *L. mundkuri* was first described by Ahmad (1942) as a new species

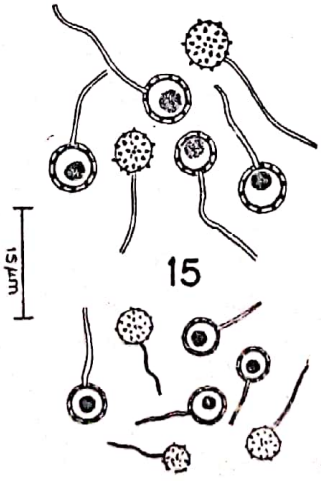












based on a single collection made from Khanag, Kulu hills in the North-Western Himalayas. During the present study it was collected by the authors from Simla, Mussoorie and Naini Tal hills and it seems to be quite common in these localities. However, we have not come across any of its specimens from Kulu, Dalhousie and Jammu & Kashmir hills. It chiefly grows on moist humicolous soil in the coniferous forests. It is marked by spinose exoperidium, shining, smooth, greyish-brown endoperidium, and ovoid to broadly ellipsoid spores with long pedicels. It is close to *L. pedicellatum* Peck in several respects, but the latter differs in having larger frucitifications, sparingly branched, brown, wider capillitial threads which are without pores and subglobose, smaller basidiospores with small pedicels (10-18 μm recorded by Smith, 1951).

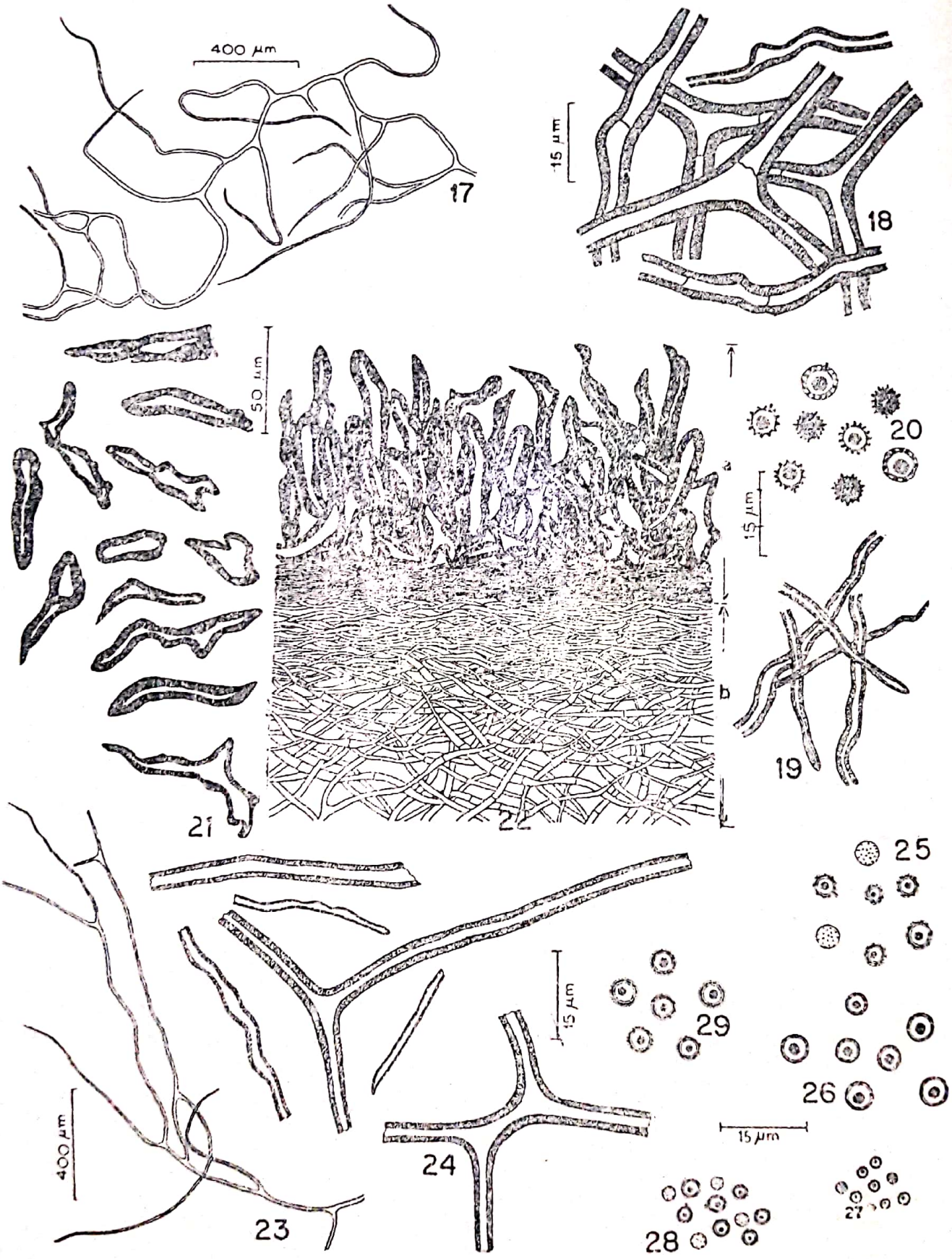
These North-Western Himalayan collections resemble closely with Ahmad's (1942) description of the species in several respects, but differ in having larger fructifications, greyish-brown endoperidium, presence of pores on capillitium and larger, broadly ellipsoid, verruculose basidiospores with long pedicels. Ahmad (1942) described subgleba to be scanty for this species, but some of our collections like Nos. 10021, 10216, 10257 and 10276 possess very well developed subgleba. There is also a wide variation in the shape, size and colour of the basidiospores in these collections. These vary from ovoid to broadly ellipsoid, whereas in 10225 these are larger and predominantly obpyriform.

The variability in the shape and size of basidiospores in these collections may be due to the fact that some specimens were not fully mature, and according to Demoulin (private communication), some members of the Lycoperdaceae under abnormal conditions develop variable and abnormal spores.

11. *Lycoperdon yetisodale* Kreisel, Khumbu Himal. Bd. 6 Lfg. **1** : 30, 1969. Figs. 13-16, 34.

Fructifications scattered, singly, sometimes caespitose, subglobose, some broader than tall and gradually narrowing below into a stem-like part, up to 4 cm in diameter. Rhizomorphs well-developed, comprising pallid-white, branched threads. Exoperidium pallid-white, spinose, spines singly or in groups, sometimes apically fused and free at the base, slender or with broad base and narrowly pointed curved apices, up to 1 mm long, larger and deciduous in the upper part, smaller and persistent in the lower part, on falling leave scars which make the surface rough, becoming smooth with age. Endoperidium light brown to brown with whitish tint around stoma, smooth, shining, papery ; dehiscing by stoma which is silt-like in the beginning, becoming enlarged and torn with age, up to 0.5 cm wide. Subgleba well developed, usually occupies the whole narrower stem-like part, sometimes extending up to the middle of the fructifications, arch-shaped, chambered, chambers small. Gleba yellowish-brown to brown, pulverulent. Capillitium comprising fragile threads, light olivaceous-

Figs. 8—12 : *Lycoperdon mundkuri*. 8. Capillitium showing general mode of branching. 9. Apices and parts of capillitium showing detailed structure. 10. Obpyriform-shaped basidiospore. 11. Ovoid basidiospores. 12. T. S. part of peridium showing detailed structure, (a) exoperidium, (b) endoperidium. Figs. 13—16 : *Lycoperdon yetisodale*. 13. Capillitium showing general mode of branching. 14. Apices and parts of capillitium showing detailed structure. 15. Basidiospores. 16. T. S. part of peridium showing detailed structure, (a) exoperidium, (b) endoperidium.



brown, sometimes dark-brown, becoming lighter towards apices which are narrowly or broadly pointed, branched, branching at short intervals, aseptate, thick-walled, wall dark and up to 2.5 μm thick, occasionally pitted, up to 8.5 μm wide. Basidiospores globose, 5.5-6.5 μm in diameter, light olivaceous-brown, sometimes brown, verrucose, warts up to 1 μm long, guttulate, pedicellate, pedicels straight, curved or bent terminally, pale brown, with attenuate ends, up to 24 μm long.

Anatomy : Exoperidium comprising two zones : outer light brown, up to 250 μm wide, textura angularis, cells hyaline, thin-walled, walls wavy, 10-30 μm across ; inner light brown, up to 25 μm wide, texture subintricata, hyphae very narrow, somewhat parallel, unbranched, aseptate, thin-walled, agglutinated, up to 1 μm wide. Endoperidium brown, up to 130 μm wide, textura intricata, hyphae light brown, branched, aseptate, slightly thick-walled, up to 3.5 μm wide.

Collections examined : Himachal Pradesh : Kulu, Manali, Rohtang Pass, on grassy ground, IPST 10089 (PAN, BPI, MICH, LG), September 25, 9171 ; Kulu, Rohtang Pass, on grassy meadow, IPST 10101 (PAN, BPI), October 6, 1971.

Remarks : This species was erected by Kreisel (1969) on the basis of a collection made by J. Poelt in 1962 from Mahalangur mountain (alt. 3900—4000 m) in Nepal. During the present study, it was collected twice from Rohtang Pass (alt. 3980 m), Kulu hills. It was found growing luxuriantly on the meadows of this alpine locality of the North-Western Himalayas. These collections agree very closely with the description of the species given by Kreisel (1969).

L. yetisodale is marked by spinose exoperidium, shining, smooth, papery endoperidium with whitish tint near the stoma, well-developed, chambered subgleba, basidiospores with long pedicels (up to 24 μm), and its occurrence in the alpine meadows.

12. *Lycoperdon setiferum* Demoulin, Mycotaxon **3**(2) : 284, 1976.
Figs. 17-22, 35.

Fructifications singly, usually subglobose to depressed globose, sometimes broad above but abruptly narrowing below into a short stem-like part, up to 4.5 cm in diameter. Rhizomorphs comprising whitish cord-like, branched threads. Exoperidium brown to dark brown, usually comprising predominantly brown, angular, setose-warts, sometimes with well-developed converged setose-spines, both usually densely distributed throughout, sometimes darker and prominent near stoma, becoming lighter and scattered towards base, deciduous, beginning from stoma and gradually falling away in the whole upper part of the fructification. Endoperidium usually brown, sometimes creamish-white towards base, perfectly smooth, shining, membranous ; dehiscing by apical stoma with lacerate margin, up to 0.7 cm wide. Subgleba reduced

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Figs. 17—22 : *Lycoperdon setiferum.* 17. Capillitium showing general mode of branching. 18. Parts of capillitium showing septa. 19. Apices of capillitium. 20. Basidiospores. 21. Various shapes of setae. 22. T. S. part of peridium showing detailed structures, (*a*) *exoperidium*, (*b*) *endoperidium.*

Figs. 23—29 : *Lycoperdon pyriforme.* 23. Capillitium showing general mode of branching. 24. Apices and parts of capillitium showing detailed structure. 25-29. Showing various types of ornamentation on basidlispores. 25 and 26. Basidiospores showing verrucae on the outer wall and these are projecting into thin hyaline envelope. 27. Basidiospores showing outer wall rough. 28 and 29. Basidiospores showing outer wall smooth.

in globose forms, well-developed in fructifications with stem-like part, creamish-white to light brown, chambered, chambers very small, sometimes not distinctly visible. Gleba light brown to dark brown with purplish tint, pulverulent. Capillitium light yellowish-brown to dark brown, becoming lighter towards apices which are nearly hyaline, acuminate and sinuous, branched, branching at short intervals, septate, wall up to 3 μm thick and without pores, up to 10 (—12) μm wide. Basidiospores globose, (4) 5.5-7 μm in diameter, light yellowish-brown to brown, sometimes greyish-brown, strongly verrucose, warts lighter, with rounded or blunt ends, up to 1.5 μm long, sometimes projecting into thin hyaline envelope, guttulate, apedicellate, but some with a stump of a pedicel, spores intermixed with numerous fallen pedicels.

Anatomy : Exoperidium comprising two zones : outer light brown, up to 100 μm wide, setose, setae hyaline to pale brownish, of various shapes, usually cylindric with sharply pointed or rounded ends, highly thick-walled, wall up to 6 μm thick, lumen wide to narrow, sometimes obliterated, 26-70 × 6-18 μm ; inner light brown, up to 16 μm wide, textura subintricata, hyphae somewhat parallel, very narrow, subhyaline, unbranched, aseptate, thin-walled, agglutinated, up to 1 μm wide. Endoperidium light brown, up to 100 μm wide, textura intricata, hyphae dense, narrow and somewhat parallel outwards, becoming loose and wider inwards, subhyaline to pale-brownish, sometimes branched, septate, septa at short intervals and prominent in the wider part of hyphae, thin-walled, lumen wide to narrow, up to 6 μm wide.

Collections examined : Himachal Pradesh: Kulu, Pulga, on moist humicolous soil, mixed forest (predominantly coniferous), IPST 10080 (PAN, BPI), September 19, 1971 ; Kulu, Manali, Jaggat Sukh, on moist humicolous soil, coniferous forest, IPST 10092 (PAN, BPI, MICH, LG), September 25, 1971 ; Dalhousie, Khajjiar, on moist humicolous soil, coniferous forest, IPST 10282 (PAN, BPI), Auguts 10, 1972.

Uttar Pradesh : Naini Tal, Sat Tal, on moist soil, mixed forest (predominantly angiospermic), IPST 10201 (PAN, BPI), August 17, 1973.

Jammu and Kashmir : Batote, Sanasar, on soil rich in decaying coniferous needles, coniferous forest, IPST 10157 (PAN, BPI), September 5, 1972.

Remarks : L. setiferum has been described recently by Demoulin (1976) as a new species, based on a collection made by Ahmad from Murree hills in Pakistan. He (Demoulin, 1976) has also reported the occurrence of this species from India on the basis of his study of our North-Western Himalayan collections. However, this species is being described here for the first time from India on the basis of our North-Western Himalayan collections. It is fairly distributed in this region as it could be collected from the far distant localities : Batote (Jammu & Kashmir), Pulga (Himachal Pradesh) and Sat Tal (Uttar Pradesh). It is strongly marked by the presence of setae in the exoperidium and prominently verrucose spores.

It resembles very closely *L. delicatum* Berk. and in the field it is very difficult to distinguish between the specimens of the two. However, morphologically *L. delicatum* can be distinguished from *L. setiferum* in the characters of exoperidium and spores.

The strongly verrucose spores separate *L. setiferum* from other species of *Lycoperdon* having setoid elements in the exoperidium. Species like *L. atropurpureum* Vitt. and

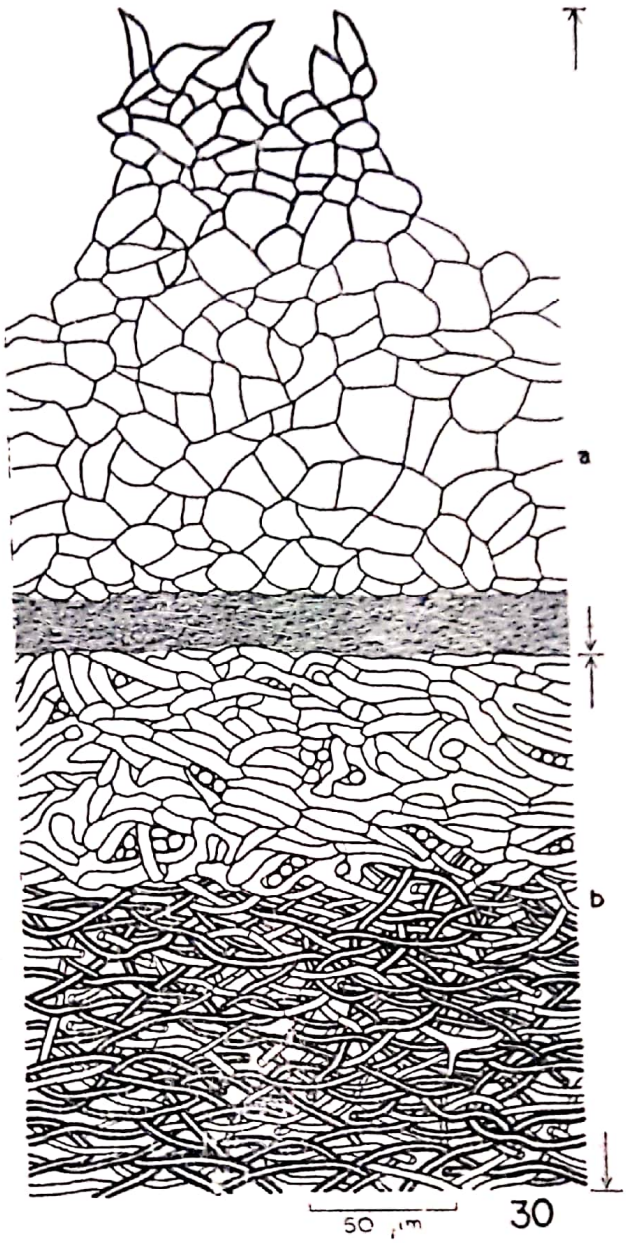

Fig. 30. T. S. part of peridium showing detailed structure, (*a*) exoperidium, (*b*) endoperidium.

L. mauryanum Demoulin resemble *L. setiferum* in having similar spores, but differ in the absence of setose expoeridium.

These North-Western Himalayan collections resemble with the description of the species given by Demoulin (1976) in several diagnostic features. However, these differ from Demoulin's description in minor respects such as presence of septa and absence of pores on the capillitium, and small sized but highly thick-walled setae. (Demoulin (1976) recorded setae to be 130×16 µm and wall up to 2.6 µm thick.

13. *Lycoperdon pyriforme* Schaeff. ex Pers., Syn. Meth. Fung., p. 148, 1801. Figs. 23-30, 36.

Anatomy : Exoperidium comprising two zones : outer light brown, up to

230 μm wide, textura angularis, cells hyaline to light brown, thin-walled, becoming thick-walled at the upper part, 8-30 μm across ; inner light brown, up to 20 μm wide, textura subintricata, hyphae very narrow, somewhat parallel, subhyaline to paler, unbranched, aseptate, thin-walled, agglutinated, up to 1 μm wide. Endoperidium comprising two zones ; outer subhyaline, up to 80 μm wide, textura epidermoidea, hyphae hyaline, branched, septate, thin-walled, up to 6.5 μm wide ; inner subhyaline to pale brown, up to 160 μm wide, textura intricata, comprising two types of hyphae : (i) hyaline, branched, septate, thin-walled, up to 4 μm wide, (ii) subhyaline, rarely branched, aseptate, thick-walled, lumen wide to narrow, up to 4.5 μm wide.

Collections examined : Himachal Pradesh : Simla, Narkanda, on rotten coniferous stump, coniferous forest, IPST 10004 (PAN, BPI), April 28, 1971 ; Simla, Narkanda, on decaying coniferous log, coniferous forest, IPST 10006 (PAN, BPI), April 29, 1971 ; Simla, Khadrala, on rotting coniferous stump, conferous forest, IPST 10025 (PAN, BPI), June 28, 1971 ; Simla, Chail, on the bark of *Cedrus deodara*, mixed forest (predominantly coniferous), IPST 10047 (PAN, BPI), August 5, 1971 ; Simla, Baghi, on rotting coniferous stump, mixed forest (predominantly coniferous), IPST 10065 (PAN, BPI), August 28, 1971; Kulu, Pulga, on decaying coniferous wood amidst mosses, mixed forest (predominantly coniferous), IPST 10084 (PAN, BPI), September 20, 1971; Kulu, Manali, Jagatsukh, on rotting coniferous bark, coniferous forest, IPST 10095 (PAN, BPI), September 29, 1971 ; Kulu, Manali, Gojra, on rotting *Cedrus deodara* wood, coniferous forest, IPST 10106 (PAN, BPI), October 11, 1971 ; Kulu, Manali, Naggar, on the bark of *C. deodara*, mixed forest, IPST 10108 (PAN, BPI), October 11, 1971 ; Dalhousie, Kalatope, on rotting coniferous wood debris, coniferous forest, IPST 10119 (PAN, BPI), July 25, 1972 ; Dalhousie, Khajjiar, on rotting coniferous log, coniferous forest, IPST 10125 (PAN, BPI), August 5, 1972 ; Dalhousie, Lakkar Mandi, on a decaying coniferous log, coniferous forest, IPST 10317 (PAN, BPI), August 26, 1974 ; Dalhousie, Panjpulla, on a decaying stump, predominently angiospermic forest, IPST 10324 (PAN, BPI), August 28, 1974.

Uttar Pradesh : Mussoorie, Dhanoulti, on coniferous wood, mixed forest, (predominantly coniferous), IPST 7455 (PAN), August 27, 1968 ; Mussoorie, Lal Tibba, on rotting wood, mixed forest (predominantly coniferous), IPST 7466 (PAN), September 14, 1968.

Jammu and Kashmir : Gulmarg, Khilanmarg, on rotting coniferous log, coniferous forest, IPST 10134 (PAN, BPI), August 25, 1972 ; Pahalgam, Bisaran, on the bark of coniferous tree, mixed forest, IPST 10154 (PAN, BPI), September 1, 1972.

Norway : Bauram, Akershus, Nedre Ringi, on soil from Porato Cellar, sans leg. and s.n. (0, duplicate PAN), October 8, 1958 ; Fin Wischmann, Otteid, sans leg. and s.n. (0, duplicate PAN), October 3, 1970.

Remarks : This species was first

Figs. 31—36. Fig. 31 : Fructification of *Calvatia candida*. (×1.5). Fig. 32 : Fructification of *Calvatia excipuliformis* showing distinct lower stem-like part and upper globular part. (×1). Fig. 33 : Fructification of *Lycoperdon mundkuri*. (×1.8). Fig. 34 : Fructifications of *Lycoperdon yetisodale* showing prominent spines which are deciduous in the upper part. (×1.5). Fig. 35 : Fructification of *Lycoperdon setiferum*. (×2). Fig. 36 : Fructifications of *Lycoperdon pyriforme* showing well-developed rhizomorphs penetrating into the substratum. (×2).


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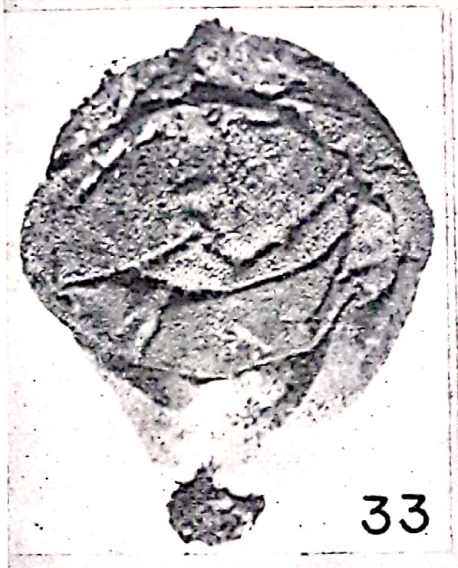
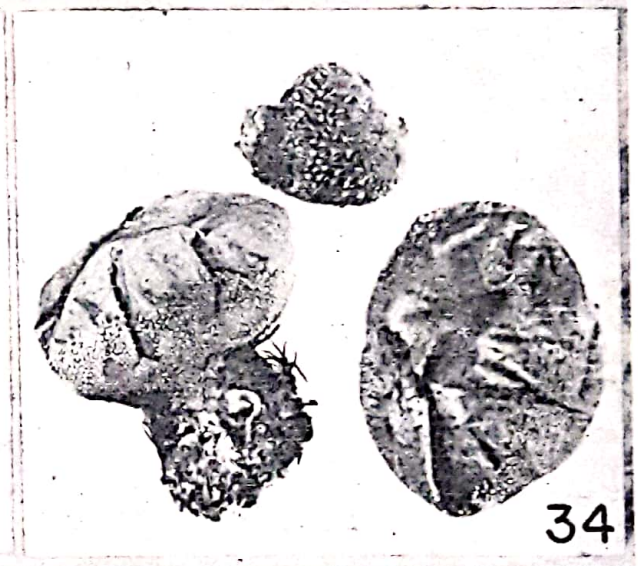
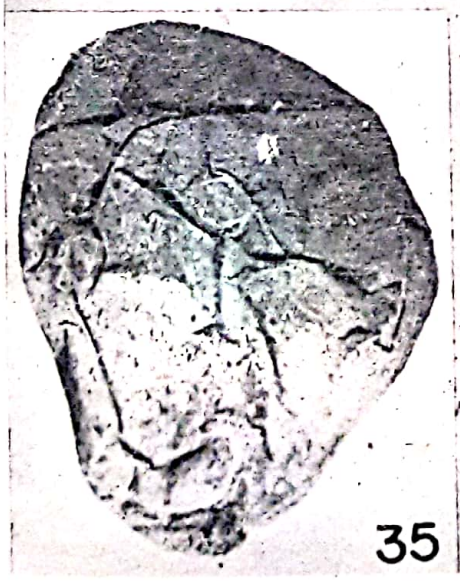
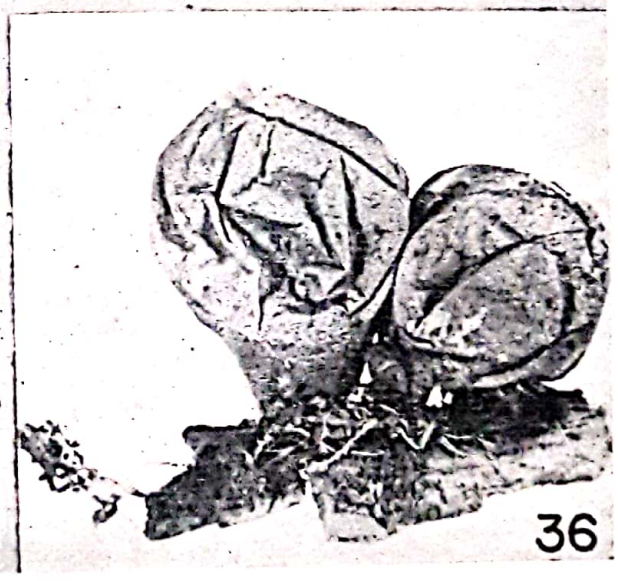

33


34


35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recorded from India by Berkeley (1851), based on the collection made by Hooker from Sikkim (Eastern Himalayas). Later, Ahmad (1942) described it as *L. piriforme* (Schaeff.) Pers., on the basis of his own collections from Naggar (Kulu Hills) and those of Dr. Stewart's from Sonamarg (Jammu and Kashmir).

L. pyriforme is strongly marked by the lignicolous habitat, typically pyriform shape of the fructifications, well-developed, profusely branched, white, thread-like rhizomorphs, areolate or spinose exoperidium and globose, smooth to verrucose basidiospores. Based on our anatomical study, it is characterised in having two zoned endoperidium with outer zone of textura epidermoidea and inner zone of textura intricata comprising two types of hyphae. It is very close to *L. perlatum* Pers. in several respects, but the latter differs in the shape and large size of the fructifications, peculiar arrangement of exoperidial spines, which, on falling, leave scars, somewhat reticulate surface of the endoperidium and smaller basidiospores. Based on our anatomical study of both the species, *L. pyriforme* differs from *L. perlatum*, in having two zoned endoperidium with inner zone comprising two types of hyphae, whereas in the latter species the endoperidium is single zoned with one type of hyphae.

This lignicolous species of *Lycoperdon* is very widely distributed in the North-Western Himalayas throughout the monsoon season, chiefly occurring in the coniferous forests.

These North-Western Himalayan collections resemble very closely with Ahmad's (1942) description of *L. pyriforme* and are quite typical of the species. However, Ahmad (1942) described subgleba to be chambered, whereas it is non-chambered in our collections. These also resemble completely with the Norwegian specimens of *L. pyriforme* examined by us.

There is a marked variation in the size and ornamentation of spores in these collections. The spores are smooth and 3-4.5 μm in diameter in most of the collections and fall well within the range described for the species by Kambly and Lee (1936), Ahmad (1942, 1952), Cunningham (1944), Smith (1951) and Eckblad (1955). However, these are rough to verrucose, smaller (2-3.5 μm in diameter) in other collections (Nos. 7456, 10006 and 10031).

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