The Structure and Affinities of British Tuberaceae.

BY

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With Plate XVII.

IT is a somewhat remarkable coincidence, if nothing more, that two of the primary divisions of the Fungi, Ascomycetes and Basidiomycetes respectively, should be represented by subterranean forms possessing many morphological and physiological features in common. Amongst such may be enumerated a comparative absence of differentiation, the large size and marked variability in the number of spores, whether produced on basidia or in asci, and the more or less elaborate ornamentation of the epispore. Hymenogastraceae, the subterranean group belonging to the Basidiomycetes, is characterized by the spores being produced on basidia, whereas in the Tuberaceae, representing the Ascomycetes, the spores are contained in asci. With this marked exception the mode of development and general structure is the same in the two groups.

The sporophore originates as a minute ball from a weft of mycelium, which is generally located some distance underground, and continues to increase in size for some considerable time before differentiation commences. During this period the sporophore consists of a solid mass of densely interwoven hyphae, usually more or less globular in form, although sometimes lobed or irregular. At a later stage the peripheral hyphae become thick-walled and dark-coloured, and form the cortex, which in some species remains smooth and even, in others nodulose, or broken up into pyramidal warts. The ultimate structure of the cortex depends on the relative rate of growth of the peripheral and central portions of the sporophore. If the two portions grow at the same rate and for the same length of time, the cortex remains even. On the other hand, if the cortex ceases to grow and becomes rigid at an early stage of development, before the internal portion ceases to grow, the outward pressure of the latter breaks up the cortex into polygonal warts or pyramids, which become more or less separated from each other at the base, depending on the relative increase in size of the central mass of the sporophore. The warts and spines present on the

peridium or outer wall of the puff-balls originate in a similar manner, and are not in any instance due to local growth of the cortex. Simultaneous with the differentiation of the cortex, the solid mass of the sporophore becomes pierced by numerous tortuous rifts or cracks, the walls of which gradually recede from each other and bear the asci, which project into the cavity. The general appearance of a section of a mature sporophore may be compared to a section of a nutmeg. From the first the sporophore consists of two distinct systems of hyphae; one, the vegetative hyphae, go to form the peripheral portion of the sporophore, including the cortex, also the walls in the interior of the sporophore, whose free faces bear the hymenium. The second system of hyphae give origin to the asci alone. The components of this system have thinner walls, and are more slender than the vegetative hyphae, with which they grow intermingled until the free surfaces of the internal cavities are reached, where they form a compact layer, the free ends giving origin to a succession of asci. At what point, and under what conditions the two systems of hyphae become differentiated in the minute knob representing the future sporophore, is not known. When the spores are mature, the asci along with the hyphae belonging to the ascigerous system, deliquesce, leaving the framework composed of vegetative hyphae in a more or less moist condition for some time. This state of things is more marked in the descendants of the subterranean forms of the Basidiomycetes, the Gasteromycetes or puff-balls, which at a certain stage of development are completely waterlogged, owing to the liquefaction of the system of spore-producing hyphae. At a later stage the sporophore becomes dry, and contains a dense mass of powdery spores, characteristic of a ripe puff-ball.

When mature, the sporophores of subterranean Fungi emit a powerful odour. From the standpoint of humanity, this odour is sometimes very agreeable, as in some of the edible truffles; in many other species it is very unpleasant, resembling asafoetida, and other indescribable odours. From the standpoint of the fungus, these odours are of the nature of advertisements, indicating their whereabouts to rodents, by whom they are eaten, and the spores, after passing through the alimentary tract, are dispersed.

The Tuberaceae are an ancient group of Fungi, as evidenced by their extreme simplicity of structure. In the most typical genera, as *Tuber*, *Elaphomyces*, &c., the sporophore has a perfectly continuous cortex, and the whole mass continues to increase in size for some time after the mycelium from which it originated, has disappeared. In the genus *Terfezia* the cortex is still continuous, but a basal portion is shadowed in, which remains in continuity with the vegetative mycelium until the spores are mature. Finally, in *Genea*, *Choeromyces*, &c., the mycelium remains adherent to the ascophore, and supplies it with food until the spores are

mature, and, in addition, there is a distinct small opening or perforation in the cortex, shadowing in the structure which is characteristic of the great group of Ascomycetes known as Discomycetes, which originated from the Tuberaceae. So far as our knowledge at present goes, there is no advantage to subterranean Fungi in the possession of an opening in the cortex, but as in many other well-known instances, the presence of a structure of no immediate service to the members in which it originated, becomes a factor of primary importance to a subsequent group. Figures 16 to 19 on the accompanying plate illustrate the sequence of evolution from the typical subterranean condition of the Tuberaceae to the equally typical condition of the above-ground Discomycetes. In *Tuber* (Fig. 16), the cortex is quite continuous, without any opening, hence the hymenium is, as it were, hermetically sealed until the decay of the wall of the peridium or cortex. The hymenium is spread over the free surfaces of sinuous plates which practically fill the peridium. In *Genea* (Fig. 17), the peridium has a small opening, and the hymenial plates or tramal walls do not fill the peridium to the same extent as in *Tuber*. In another species of *Genea* (Fig. 18), the opening of the peridium is still more pronounced, and the projecting tramal plates are almost obliterated. All the above species are truly subterranean, and the dispersion of their spores is effected by rodents. In *Sphaerosoma* the ascophore is only partly buried in the ground, the wall has a small opening, and the projecting tramal plates have disappeared, the hymenium lining the inside wall of the ascophore only. *Sphaerosoma* was until recently placed in the Tuberaceae, but is now considered as belonging to the Discomycetes. It is in reality a transitional genus, connecting the two families named above. Finally the genus *Peziza* (Fig. 19) grows above ground, and in the most primitive types, as the one figured, the ascophore is almost indistinguishable from that of *Sphaerosoma*, except in that it develops above ground, has lost the strong aroma characteristic of the Tuberaceae, and depends on wind for the dispersion of its spores. This combination of characters constitutes the group known as Discomycetes, as contrasted with those of the Tuberaceae, from which it evolved. The modifications necessary to enable the asci to eject their spores into the air, for dispersion by wind, in the Discomycetes, is contemporaneous with the modifications of the ascophore, already enumerated in the Tuberaceae. In typical members of the Tuberaceae, the asci play no part whatever in the distribution of the spores, hence they deliquesce and disappear at an early stage, liberating the spores into the cavities of the ascophore; furthermore, such asci are usually globose or broadly elliptical, and contain a variable number of spores, and of various sizes, sometimes a single very large spore is present, whereas a neighbouring ascus may contain as many as six, or even eight spores. It is obvious that the nucleus present in such asci is erratic in its division. On the other hand, in those genera of the Tuberaceae

that shadow in the origin of the Discomycetes, through various morphological and physiological changes in the ascophore, the asci also undergo important changes, resulting in the formation of a cylindrical ascus, containing eight spores of equal size, arranged in a single row, as in the genera *Stephensia*, *Genea*, &c. Such an ascus closely resembles those met with in the genus *Peziza*, only lacking the well-known arrangement for suddenly ejecting the mature spores into the air, by the process known as 'puffing'.

In the Tuberaceae, as in all primitive groups of Fungi, when the advantages arising from dispersion by wind had not been realized, the spores are of exceptional size, and usually with a greater or less amount of ornamentation of the epispore. The object of this ornamentation is obscure, possibly its function is protective, while the spores are subjected to various mechanical processes in the stomach of some rodent. The ornamentation may take the form of raised ribs, anastomosing to form a more or less regular network; of coarse warts or tubercles; or of long spines or finger-like processes. The wall of the spore is in all instances relatively very thick, and of a soft or gelatinous consistency, and is in all cases perfectly smooth and even until approaching maturity, when the ornamentation, of whatever nature, is always due to shrinkage of special portions of the wall, and to the bulging out of other portions to form the ribs, warts, &c. If mature spores are treated with a five per cent. solution of potassic hydrate for some time, the ornamentation of the wall disappears, and it becomes smooth and even. In those genera leading up to the Discomycetes, the spores are smaller, and smooth or nearly so.

GEOGRAPHICAL DISTRIBUTION.

Owing to the subterranean habit, members of the Tuberaceae are almost invariably passed over by travellers, and even in Europe the group has not appealed to mycologists generally; some half-dozen, amongst whom may be mentioned, Berkeley and Broome in England, Vittadini in Italy, Tulasne in France, and Hesse in Germany, having furnished the bulk of information we possess at the present day. Harkness has done some valuable pioneer work in the same direction in California, and Rodway has discovered some very interesting species in Tasmania. Duthie has also met with certain edible species in India. On the whole it may be said that the family is cosmopolitan in its distribution.

Numerically the family is quite a small one, we have in Britain 11 genera and 32 species. The total number of known genera is 27, including 140 species.

The following table gives the known distribution of genera and species throughout the world, and clearly indicates that our knowledge of the number of species recorded for a given continent, is in proportion to the

amount of attention paid to the subject, and does not in any sense indicate the actual distribution of either genera or species.

	<i>Europe.</i>	<i>Asia.</i>	<i>Africa.</i>	<i>America.</i>	<i>Australasia.</i>
*Amylocarpus	1				
*Balsamia	5			4	
*Choeromyces.	6				
Cryptica	1				
Delastria	1				
*Elaphomyces	24				
Genabea	2				1
*Genea	11			2	1
Geopora	2				4
Gyrocraera	1				
*Hydnobolites	4			1	
Hydnocystis	4			1	
*Hydnotrya	3			1	
Leucangium	2				
Lilliputia	1				
Myrmecocystis				2	
*Pachyphloeus	4				
Phaeangium			1		
Picoa			1		
Piersonia			2		
Pseudogenea	1				
Pseudohydnotrya				3	
*Stephensia	2				1
*Terfezia	10	3	6		
Terfeziopsis				1	
Tirmania.			2		
*Tuber	55	3		10	
	140	6	12	25	7

Genera preceded by an asterisk (*) are British.

HABITATS.

Various members of the Tuberaceae are not uncommon in England, nevertheless, the group is not infrequently entirely omitted from county lists of Fungi. Notwithstanding the fact that the Essex Field Club have for the past thirty years held annual Fungus Forays in Epping Forest, two members of the Tuberaceae were added to the list of Essex Fungi for the first time, last year.

Truffles prefer a soil consisting of clay mixed with sand and ferruginous particles, or a rich mixed alluvium. The soil must be porous to secure the proper amount of aeration. Sour soil or the presence of stagnant water is fatal. It is a prevalent opinion that truffles are met with only under beech trees, this however is a mistake. They occur in open woods of chestnut, oak, or beech, also in open woodland districts, in soil consisting of a mixture of humus and sand. The presence of truffles is often indicated in the places where they grow, by a slight cracking or upheaval of the soil, more especially under the drip of trees. The late C. E. Broome, to whose researches first and only records of many of our British species are due,

used a short-handled, strong, long-toothed iron rake when hunting for members of the Tuberaceae.

Tuber aestivum is our best native truffle from an edible standpoint. It occurs in fair abundance under beeches on Salisbury Plain. The neighbourhood of Patching, near Arundel, Sussex, is or was also noted for its truffles.

It is known that the mycelium of certain species of *Elaphomyces* forms mycorrhiza on the roots of conifers. It is also known that success in the cultivation of edible truffles in France depends to a marked extent on keeping the roots of the oaks, under which they grow, near to the surface of the soil. This implies some connexion between the truffles and the oak roots, and further suggests that the truffles benefit to some extent by the formation of mycorrhiza.

TUBERACEAE.

TUBEROIDEAE, Vitt., Mon. Tub., p. 12 (1831)

Ascophore subglobose, irregularly nodulose or sulcate, indehiscent, wall continuous or variously perforated, fleshy or coriaceous, rarely becoming hard and woody. Asci varying from cylindrical to globose, 1–8-spored. *Spores* continuous. Subterranean or rarely more or less exposed.

Key to the Families.

Gleba breaking up into a loose mass of spores at maturity—ELAPHOMYCETAE.

Gleba not breaking up into a powdery mass, but having persistent dissepiments and becoming lacunose or cavernose—TUBEREAE.

FAM. I. ELAPHOMYCETAE.

ELAPHOMYCEI, *Tub.*, Fung. Hypog., p. 100 (1851).

Ascophore subglobose, wall not perforated, firm, becoming hard when dry. *Gleba* without permanent dissepiments, containing numerous silky filaments. *Asci* 1–8-spored. *Spores* globose, coloured, forming a powdery mass at maturity. Subterranean.

ELAPHOMYCES, Nees, Pl. Myc., p. 58 (1820); Sacc., Syll., viii, p. 803 (1889); Cooke, Brit. Fung., p. 749 (1871).

Ascophore subglobose, wall hard, *Asci* subglobose. *Spores* coloured, filling the ascophore with a dusty mass at maturity.

Elaphomyces authracinus, Vitt., Mon. Tub., p. 66, tab. 3, fig. 8 (1831); Sacc., Syll., viii, p. 866 (1889); Cooke, Brit. Fung., p. 749 (1871).

Ascophore subglobose, blackish-brown, rigid, very minutely corrugated, flesh whitish, mycelium usually copious, brownish, 2–4 cm. diam. *Asci* subglobose. *Spores* globose, blackish-brown, opaque, very minutely granulated or sometimes smooth, 16–20 μ diam., mixed with colourless cobweb-like threads.

Hab. In clay soil under trees.

Distr. Britain; France; Italy.

Exsicc. Speg., Dec. Myc. 4.

Described from a specimen from Vittadini in Herb. Kew., rare in this country. Smell weak, somewhat resembling radishes.

Elaphomyces variegatus, Vitt., Mon. Tub., p. 68, tab. 4, fig. 4 (1831); Cooke, Brit. Fung., p. 749 (1871); Sacc., Syll., viii, p. 867 (1889); *El. muricatus*, Berk., Engl. Flora, v, p. 307 (1836).

Ascophore subglobose, thick, hard, golden- or ochraceous-yellow or brownish, densely covered with pointed pyramidal warts, flesh whitish, mottled or streaked with reddish-brown, finally becoming altogether brown, mycelium yellow, scanty. *Asci* subglobose, 1-4-spored. *Spores* globose, blackish-brown, sometimes with a violet tinge, opaque, rather coarsely corrugated, 16-21 μ , when free mixed with a copious cobweb-like mass of capillitium threads.

Hab. Under trees, mostly in upland woods.

Distr. Britain; France; Italy; Germany; Belgium; Sweden and Finland; United States.

Exsicc. Vize, Fung. Brit., 147; Cooke, Fung. Brit., 418; Berk., Brit. Fung. 306; Sacc., Myc. Ven., 1390; Roum., Fung. Gall., 2170 and 2386; Thüm., Myc. Univ., 524.

Specimen from Vittadini in Herb. Kew., examined. Distinguished from its nearest ally, *E. granulatus*, Fr., by the pointed pyramidal, usual four-sided warts on the ascophore, and by the marbled or variegated flesh, hence the specific name. Smell variable, sometimes quite weak at maturity, at others suggesting that of *Ruta graveolens* or burnt hoof. *Claviceps ophioglossoides*, Fr., is often parasitic on this species.

Elaphomyces granulatus, Fr., Syst. Myc. 3, p. 58 (1821); Cooke, Brit. Fung., p. 750 (1871); Sacc., Syll., viii, p. 868 (1889); *El. leocarpus*, Vitt., Mon. Tub., p. 72 (1831).

Ascophore globose or ellipsoid, firm, yellow then tawny or brownish, densely covered with minute rounded warts, flesh tinged red but not marbled when moist, pure white when dry, 2-6 cm. diam., mycelium yellow, scanty and soon disappearing. *Asci* subglobose, 1-8-spored. *Spores* globose, blackish-brown with a purple tinge in the mass, opaque, 20-30 μ diam., mixed in the gleba with a dense mass of silky capillitium threads.

Hab. In woods, especially in dry heathy ground.

Distr. The whole of Europe; N. America.

Exsicc. Berk., Brit. Fung., 279; Moug. and Nest., Fung., 282; Thüm., Fung. Austr., 624; Klotzsch-Rab., Herb. Myc., 174; Karst., Fung. Fenn., 375; Fckl., Fung. Rhen., 1075; Syd., Myc. March., 341; Roumeg., Fung. Gall., 164; Desmaz. Crypt. Fr., sér. 1, 672.

Our commonest species, general throughout England, and has been met with in Scotland, as far north as Glamis. When large the ascophore is sometimes more or less sulcate or nodulose. Smell generally weak, but sometimes pungent.

Parasitic on the roots of trees, and is in turn the host of another fungus, *Claviceps capitata*, Fr.

Elaphomyces leucosporus, Vitt., Mon. Lycop., p. 71, tab. 3, fig. 1 (1841); Tul., Hypog., p. 104 (1851); Sacc., Syll., viii, p. 865 (1889).

Ascophore irregularly globose, usually deeply umbilicate at the base, wall thin, blackish-brown, smooth, flesh dark coloured, about 0.5 cm. diam., mycelium scanty, greenish. *Spores* globose, minutely granulated, at first almost colourless, becoming blackish-brown and almost opaque, 15–20 μ diam., showing a tinge of purple in the mass, held together by very slender hyaline capillitium threads.

Hab. Under oaks.

Distr. Britain; Italy.

This is our rarest species, having been only once found by Broome, near Chudleigh, Devon. The spores are described by Vittadini as white at first, becoming tinged yellow. This, however, only applies to the immature stage, as a specimen sent by Vittadini to Berkeley, and now in the Kew herbarium, has the spores almost black as described above; the same is the case with Broome's British specimens. Hence the specific name is not quite applicable, but must stand. The smell is weak, suggesting that of *Tuber brumale*, Vitt., and is very fugacious.

[*Elaphomyces citrinus*, Vitt., Mon. Tub., p. 65, tab. 4, fig. 16 (1831); Sacc., Syll., viii, p. 865 (1889).

Ascophore irregularly globose, blackish-brown or brownish-olive, smooth, rather soft, covered with a copious web of persistent lemon-coloured mycelium, flesh thick, soft, greyish-white with a tinge of green, then brownish-purple becoming whitish when dry, 0.5–1.5 cm. diam. *Spores* globose, very minutely granulated, smoky green, becoming darker and almost opaque when mature, 8–10 μ diam.

Hab. Under oaks.

Distr. Britain?; Italy.

This species has been recorded as occurring in England, but I have not been able to corroborate its occurrence, and have seen no British specimens. There is a specimen from Vittadini in the Kew herbarium.]

TUBEREAE.

TUBEREI, Fries, Summa Veg. Scand., p. 437 (1849).

Ascophore fleshy, becoming hard. *Gleba* furnished with veins, solid cavernose or lacunose, rarely without veins but always lacunose. *Spores* not forming a powdery mass at maturity. Subterranean or rarely more or less exposed.

Key to the Genera.

A. Gleba without veins, but having one or more cavities,

† Asci cylindrical.

Spores warted, subglobose.

Genea.

†† Asci broadly oblong or subglobose.

Spores elongated, smooth.

Balsamia.

Spores globose, reticulated.

Hydnobolites.

Spores globose, warted.

Hydnotrya.

B. Gleba furnished with veins ; solid or lacunose.

Spores globose, smooth ; asci cylindrical.

Stephensia.

Spores globose, warted ; asci elliptic-oblong.

Pachyphlaeus.

Spores elliptical or globose, reticulated, warted or spinulose ; asci subglobose.

Tuber.

Spores globose, with elongated blunt warts ; asci elliptic-oblong.

Choeromyces.

Ascophore with a distinct obconic base ; spores globose, warted ; asci subglobose.

Terfezia.

Spores globose, hyaline, with long, very slender spreading spines.

Amylocarpus.

GENEA, Vitt., Mon. Tub., p. 27 (1831); Cooke, Brit. Fung., p. 747 (1871); Sacc., Syll., viii, p. 873 (1889). *Hydnocaryon*, Wallr., Fl. Crypt. Germ., ii, p. 860 (1831).

Ascophore fleshy, warted, with a perforation at the apex and a tuft of mycelium at the base. *Gleba* broken up by walls into irregular cavities in communication with the apical opening. *Asci* cylindrical, 8-spored. *Spores* subglobose, colourless.

Genea verrucosa, Vitt., Mon. Tub., p. 28, tab. 2, fig. 7 (1831); Cooke, Brit. Fung., p. 748 (1871); Sacc., Syll., viii, p. 873 (1889). *G. papillosa*, Berk., Ann. Nat. Hist., xiii, p. 356 (1844); not of Vittadini.

Ascophore very variable in shape, sulcate or variously lobed, black, minutely warted, apical opening often large, 0.5–1.5 cm. diam. *Asci* narrowly elliptical, apex obtuse, spores 8, uniseriate. *Paraphyses* filiform, septate. *Spores* globose or very broadly elliptical, colourless, warted, $25 \times 20 \mu$, or $25\text{--}30 \mu$ diam.

Specimen in Kew herbarium from Vittadini examined. *Gleba* white, basal mycelium short and scanty. Smell strong, unpleasant, somewhat resembling that of *Balsamia vulgaris*, Vitt.

Hab. Clay soil, under oaks and chestnuts.

Distr. Britain ; France ; Italy ; United States.

Genea Klotzschii, Berk. and Br., Ann. Nat. Hist., xviii, p. 78 (1846); Cooke, Brit. Fung., p. 748 (1871); Sacc., Syll., viii, p. 847 (1889). *G. verrucosa*, Klotzsch, in Dietr. Fl. Preuss., vii, no. 474 (1833) not of Vitt., Mon. Tub., p. 28, tab. 2, fig. 7 (1831).

Ascophore irregular in form, subplicate, black, warted, attached by black fibrils springing from the base, mycelium abundant, white, floccose, 1–2 cm. diam. *Asci* cylindrical, apex obtuse, spores 8, uniseriate. *Paraphyses* very slender, longer than the asci, septate. *Spores* subglobose, colourless, rather coarsely warted, $25\text{--}30 \mu$ diam.

Hab. Nearly on the surface of the soil.

Distr. Britain ; Germany.

Gleba white or tinged yellow. Smell foetid. Most nearly allied to *G. sphaerica*, Vitt., a species not met with in Britain.

The mycelium spreads for several inches on the surface of the ground like a cob-web, being densest in the centre beneath which two or three ascophores are found.

'The mycelium spreads for some distance on or within the soil, so that the plant is easily detected when the leaves are raked off. This vanishes when the peridia [ascophores] are perfect. One or more individuals are found in each patch of mycelium. In the young peridium [ascophore] the point of attachment is lateral. The sporidia [spores] are large, coarsely granulated, and much exceed in volume those of *G. verrucosa*.' Berk.

Described from Berkeley's type specimens, now in Herb. Kew.

Genea hispidula, Berk., in Tul. Hypog., p. 121, tab. 12 fig. 2; tab. 3, fig. 3 (1851); Cooke, Brit. Fung., p. 748 (1871); Sacc., Syll., viii, p. 875 (1889). *G. papillosa*, Berk., Ann. Nat. Hist., xviii, p. 76 (1844); not of Vittadini.

Ascophore subglobose, everywhere densely covered with bright brown, long tapering, thick-walled septate hairs, apical opening almost hidden, about 1 cm. diam. *Asci* cylindrical, apex obtuse, base abruptly narrowed into a short pedicel, spores 8, uniseriate. *Paraphyses* slender, septate. *Spores* globose or broadly elliptical, $25-30 \times 20-25 \mu$, or $20-26 \mu$ diam.

Hab. In the ground under chestnut trees.

Distr. Britain; France; United States.

The internal cavity is often almost simple.

Described from type specimen in Herb. Kew.

'The whole peridium [ascophore] is of a rich brown, and is densely clothed with brown bristles wherever it extends. The sporidia [spores] are very much larger and more coarsely granulated than in *G. verrucosa*; the granules indeed being often bifid; they often contain two nuclei [oil globules], but sometimes there is but one. From the size of a pea to that of a filbert. Odour faint, not peculiar.' Berk.

Berkeley's remark that the warts are often bifid, means that when sufficiently magnified, they are of various irregular shapes, sometimes curved, at others forked or bifid.

Balsamia, Vitt., Mon. Tub., p. 30, tab. 1, fig. 2, and tab. 5, fig. 6 (1831); Cooke, Fung. Brit., p. 747 (1871); Sacc., Syll., viii, p. 877 (1889).

Ascophore not perforated, rather soft, warted, cavernose. *Asci* elliptic-oblong or subglobose, narrowed at the base into a long, slender pedicel. *Spores* 8 in the ascus, elliptic-oblong, smooth, colourless.

Balsamia vulgaris, Vitt., Mon. Tub., p. 30, tab. 1, fig. 2, and tab. 5, fig. 6 (1831); Corda, Icon., vi, p. 59, tab. 10, fig. 99 (1854); Tul., Hypog., p. 123, tab. 4, fig. 4, and tab. 15, fig. 1 (1851).

Ascophore irregular in form, with wavy ridges and here and there deep depressions, very minutely warted, sometimes almost or quite smooth, dark coloured 2-4 cm. diam., cavities of gleba large, sinuous. *Asci* ovate-oblong or very broadly ovate, obtuse. *Spores* cylindric-oblong, smooth, colourless, $25-35 \times 9-12 \mu$. *Paraphyses* slender, numerous.

Hab. Under trees.

Distr. Britain; France; Italy.

Smell very strong and unpleasant. Apparently rare in England, having only once been collected by Broome at Chudleigh, Devon.

Described from a specimen communicated by Vittadini, and now in the Kew herbarium.

Balsamia platyspora, Berk. and Br., Ann. Nat. Hist. xiii, p. 385 (1844); Cooke, Brit. Fung., p. 747 (1871), Sacc., Syll., viii, p. 878 (1889).

Ascophore irregularly subglobose, minutely warted, yellowish, warts darker, 1-2 cm. diam., internal cavities minute. *Asci* oblong-ovate, with a slender pedicel, 8-spored. *Paraphyses* slender. *Spores* elliptic-oblong, ends rounded, smooth, colourless, $24-30 \times 8-11 \mu$.

Hab. Under trees or bushes.

Distr. Britain; France; United States.

Type specimen in Herb. Kew., examined.

'Globose, about the size of a horse-bean, rufous, with the interstices of the warts of a light yellowish tint, from the exposure of the internal substance. Cells minute; sporidia [spores] broadly elliptic.' Berk.

Balsamia fagiformis, Tub., Hypog., p. 125, tab. 4, fig. 3 (1851); Sacc., Syll., viii, p. 878 (1889); *Balsamia polysperma*, Tul., Ann. Sci. Nat., sér. 2, xix, p. 397 (1843); not of Vittadini, Mon. Tub., p. 31 (1831).

Ascophore globose, usually regular in outline, densely covered with minute warts, which here and there become slender and hair-like, deep dusky brown or rusty, 1.5-3 cm. diam., cavities crowded. *Asci* ovate-oblong, sometimes almost subglobose, with a slender pedicel, 8-spored. *Paraphyses* slender. *Spores* elliptic-oblong, ends rounded, colourless, $16-20 \times 10-11 \mu$.

Hab. In clay soil.

Distr. Britain; France.

Smell very strong at maturity, resembling that of *Tuber brumale*, Vitt.

Only collected in this country as far as I am aware, by Broome, at Batheaston.

Broome's specimens are now in the Kew herbarium. I have not seen a type or authentic specimen, but Broome's plant agrees well with the description and figures given by Tulasne.

HYDNOBOLITES, Tul., Ann. Sci. Nat., sér. 2, xix, p. 278 (1843); Cooke, Brit. Fung., p. 746 (1871); Sacc., Syll., viii, p. 879 (1889); *Oogaster*, Corda, Icon. Fung., iv, p. 60, tab. 14, fig. 121 (1840).

Ascophore fleshy, wrinkled or plicate, cells cavernous, sinuous, opening to the surface. *Asci* elliptic-oblong, 8-spored. *Spores* globose, reticulated.

Hydnobolites cerebriformis, Tul., Ann. Sci. Nat., sér. 2, xix, p. 278 (1843); Cooke, Brit. Fung., p. 746 (1871); Sacc., Syll., viii, p. 879 (1889); *Oogaster cerebriformis*, Corda, iv, p. 60, tab. 14, fig. 121 (1840).

Ascophore subglobose, sinuously wrinkled especially below, base slightly depressed, at first entirely covered with delicate whitish down, soon becoming entirely glabrous and pale yellow, 1.5-3.5 cm. diam., walls of gleba sinuous, covered with white tomentum continuous with that on the outside. *Asci* elliptic-oblong, 8-spored. *Spores* globose, reticulated, tinged yellow, $18-30 \mu$ diam.

Hab. Attached to the ground under moss or fallen leaves in woods.

Distr. Britain; France.

Exsicc. Roumeg., Fung. Gall., 2666.

Smell weak. Specimen from Tulasne in Kew herbarium examined. The

ascophore is covered with sinuous folds resembling a brain, which suggested the specific name.

Hydnotrya, Berk. and Br., Ann. Nat. Hist., xviii, p. 78 (1846); Cooke, Brit. Fung., p. 745 (1871); Sacc., Syll., viii, p. 879 (1889).

Ascophore perforated, minutely warted or velvety, cavities of gleba wavy or sinuous, often opening to the surface. *Asci* irregularly elliptic-oblong. *Spores* globose.

Hydnotrya Tulasnei, Berk. and Br., Ann. Nat. Hist., xviii, p. 78 (1846); Cooke, Brit. Fung., p. 745 (1871); Sacc., Syll., viii, p. 879 (1889); *Hydnobolites Tulasnei*, Berk. and Br., Ann. Nat. Hist., xiii, p. 357 (1844).

Ascophore globoso-depressed, base plicate, with perforations, minutely velvety, rufous, 2.5–6 cm. diam., walls of the tortuous cavities white, pubescent. *Asci* irregularly elliptic-oblong with a long pedicel, 8-spored. *Spores* globose, amber-brown and coarsely tuberculated when mature, 25–35 μ diam.

Hab. Sandy soil.

Distr. Britain.

Exsicc. Berk., Brit. Fung. (as *Hydnobolites Tulasnei*), 302; Roumeg., Fung. Gall., 2219; Rab., Herb. Mycol., ed. ii, 301.

Smell weak. The colour of the ascophore is somewhat variable, but is always some shade of rusty brown or tawny, sometimes with a more or less decided tinge of vermilion. Berkeley describes the spores as reticulated, but examination of his own material shows them to be coarsely warted. Saccardo has repeated this mistake. Superficially closely resembling *Balsamia vulgaris*, Vitt., especially when dry.

Type specimen in the Kew herbarium examined.

Stephensia, Tul., Comp. rend., xxi, p. 1433 (1845); Cooke, Brit. Fung., p. 745 (1871); Sacc., Syll., viii, p. 880 (1889). *Genea*, in part, Vitt., Mon. Tub., p. 29 (1831).

Ascophore irregularly globose, more or less depressed. *Gleba* with tortuous dissepiments or veins, becoming cavernose, deliquescent. *Asci* cylindrical, 8-spored. *Spores* uniseriate, globose, smooth, colourless.

Readily distinguished by the smooth, colourless, globose spores arranged in a single row in the elongated cylindrical ascus.

Stephensia bombycina, Tul., Hypog., p. 130, pl. 11, fig. 4 (1851); Cooke, Brit. Fung., p. 745, fig. 348 (1871); Sacc., Syll., p. 880 (1889); *Genea bombycina*, Vitt., Mon. Tub., p. 29, tab. 3, fig. 19; tab. 4, fig. 8 (1831).

Ascophore subglobose, depressed, often very irregular in form, lobed or with sinuous folds, indented more or less at the base, rather soft, floccose or minutely downy, whitish or with a yellow tinge, 3–6 cm. diam. *Gleba* whitish with yellow sinuous dissepiments. *Asci* cylindrical, 8-spored. *Spores* uniseriate, smooth, globose, colourless, 18–23 μ .

Smell at first pleasant, soon becoming very disagreeable and strong, resembling that of *Melanogaster ambiguus*, Tul. Specimen from Tulasne, in Herb. Kew., examined.

Hab. Subterranean.

Distr. Britain; France; Italy; United States.

Pachyphloeus, Tul., Giorn. Bot. Ital., ii, p. 69 (1844); Cooke, Brit. Fung., p. 743 (1871); Sacc., Syll., viii, p. 881 (1889).

Ascophore fleshy, often warted, with a more or less well-defined apical aperture, base distinct. *Gleba* marbled, dissepiments tortuous. *Asci* oblong or ovate-oblong, 8-spored. *Spores* globose, coloured, warted (in British species, irregularly 2-seriate).

Distinguished by the ascophore having a terminal aperture, and the coloured, warted spores arranged in an irregularly biserial manner in the ascus. In certain exotic species the epispore is reticulated or echinulate.

Pachyphloeus melanoxanthus, Tul., Giorn. Bot. Ital., ii, p. 69 (1844); Tul., Hypog., pl. 4, fig. 6, and pl. 14, fig. 4 (1851); Cooke, Brit. Fung., p. 743 (1871). *Choiromyces melanoxanthus*, Berk., Ann. Nat. Hist., xiii, p. 359 (1844).

Ascophore globose or angularly globose, warted, with a distinct base, yellowish-green becoming black, opening apical or somewhat lateral, 1.5–4 cm. diam. *Gleba* olive-yellow sometimes becoming dusky, marbled with dusky lines and broad, black dissepiments. *Asci* oblong or ovate-oblong, shortly stipitate, 8-spored. *Spores* irregularly 2-seriate, coloured, globose, warted, 14–17 μ diam.

The warts on the ascophore are less prominent when the fungus is dry. Smell weak when young, becoming strong and nauseous. Berkeley states that in his specimens the ascophore was black in every stage of growth.

Hab. Among humus in oak or beech woods. Sometimes attached to sticks or dead leaves, without any connexion with the ground.

Distr. Britain; France; Germany.

Specimen in Herb. Kew., from Tulasne, examined.

Pachyphloeus citrinus, Berk. and Br., Ann. Nat. Hist., xviii, p. 79 (1846); Cooke, Brit. Fung., p. 744 (1871); Sacc., Syll., viii, p. 881 (1889).

Ascophore subglobose, minutely warted, brown, powdered with lemon-coloured particles, apical orifice deep lemon-yellow, base rooting, 1–2.5 cm. diam. *Gleba* floccose, lemon-yellow. *Asci* narrowly ovate-oblong, 8-spored. *Spores* globose, coloured, finely warted, irregularly 2-seriate, 13–14 μ diam.

Allied to *P. melanoxanthus*, Tul., differing in the thinner, much more finely warted ascophore, which is of a uniform gamboge yellow when young, also in the smaller and more finely warted spores. Smell strong, resembling rotting seaweed. Saccardo says the spores are 'reticulato-alveolatis', this is a mistake. Berkeley in his diagnosis does not mention the markings on the spores.

Type specimen in the Kew herbarium examined.

Hab. Underground in woods.

Distr. Britain.

Pachyphloeus conglomeratus, Berk. and Br., Ann. Nat. Hist., xviii, p. 79 (1844); Tul., Hypog., p. 132 (1851); Sacc., Syll., viii, p. 882 (1889).

Ascophore irregularly lobed and plicate, as if composed of several confluent individuals, lobes rounded, smooth, deep rufous-brown or olive-brown, interstices of the lobes clothed with yellow fibres, 2–3 cm. diameter. *Asci* broadly ovate-oblong, 8-spored. *Spores* coloured, globose, with rather large, somewhat distant warts, 16–19 μ diam., irregularly 2-seriate.

Readily distinguished by the much lobed, smooth ascophore, which is shortly stipitate.

Hab. In woods.

Distr. Britain; Italy.

TUBER, Micheli, N. pl. Gen., p. 221, tab. 102 (1729); Link, Obs. in ordin. plant, Diss. I, p. 33, tab. 2, fig. 51 (1809); Vitt., Mon. Tub., p. 31 (1831); Cooke, Brit. Fung., p. 738 (1871); Sacc., Syll., viii, p. 882 (1889); *Lycoperdon*, pro parte, Linn., sp. Pl., II, p. 1183 (ed. i) (1753).

Ascophore irregularly globose, without a distinct rooting base, fleshy or sometimes becoming almost woody, surface glabrous or tomentose, often papillose or warted. *Gleba* marbled with veins, some white and sterile (air chambers), others coloured and producing asci on the walls. *Asci* broadly elliptical or globose, 1-12, most frequently 4-spored. *Spores* elliptical or globose, smooth, warted or reticulated, coloured.

Distinguished by the differently coloured veins in the gleba, and the more or less globose asci.

A. *Epispore reticulated.*

Tuber aestivum, Vitt., Mon. Tub., p. 38, pl. 2, fig. 4 (1831); Cooke, Brit. Fung., p. 738 (1871); Sacc., Syll., viii, p. 891; Chatin, La Truffe, p. 62, pl. 9 (1892); Hesse, Die Hypog. Deutschl., ii, p. 19 (1894).

Tuber cibarium, Sow., Engl. Fung., pl. 309 (1797).

Ascophore irregularly globose, often indented at the base, blackish-brown, covered with large, hard, pyramidal warts which are generally with the sides striated, 2-10 cm. diam. *Gleba* whitish, becoming brown, dissepiments numerous, much branched. *Spores* 2-4 in an ascus, most frequently two, brownish, elliptical or subglobose, reticulated, mesh large, rather shallow, $40-60 \times 30-40 \mu$, or $30-40 \mu$ diam.

Distinguished by the coarsely pyramidally warted blackish ascophore, and the large spores with a shallow, wide-meshed reticulation. Among the best of our edible truffles, but very much inferior in this respect to the Périgord truffle, *Tuber melanosporum*, Vitt., which does not occur in Britain. Taste somewhat insipid, smell somewhat resembling that of beer yeast.

Specimen from Vittadini, in Herb. Kew., examined.

Hab. In woods, especially of beech. Just below the surface of the ground, or sometimes above-ground amongst heaps of leaves, &c.

Distr. Britain; France; Italy; Germany; Bohemia.

Exsicc. Cooke, Brit. Fung. Exs., 663; Rabenh., Fung. Eur., 1425; Klotzsch-Rabenh., Herb. Myc., 246; Fckl., Fung. Rhen., 1077 and 1078; Roumeg., Fung. Gall., 2815; Vize, Fung. Brit., 86; Thüm., Myc. Exs., 312.

Tuber bituminatum, Berk. and Broome, Ann. Mag. Nat. Hist., vii, p. 183 (1851); Cooke, Brit. Fung., p. 739 (1871); Sacc., Syll., viii, p. 892 (1889).

Ascophore globose or ovate, regular, black, covered with small polyhedral warts, with a deep depression at the base, 3-7 cm. diam. *Gleba* with the dissepiments starting mostly from the base. *Asci* subglobose, with long pedicels. *Spores* globose

or broadly elliptical, translucent brown, with large, shallow reticulations, 1-4 in an ascus, 40-50 μ , or 45 $\times$ 60 μ .

Most nearly allied to *T. mesentericum*, Vitt., from which the present species differs in the larger, globose or subglobose spores, and the less tortuous dissepiments. The ridges of the network of the episporium often give off blind ends projecting into the polygons.

Type specimen in Herb. Kew. examined.

'Closely allied to *T. aestivum*, Vitt., but easily distinguished by the odour; it differs also in the general form, being much more regular, and the warts smaller, and in the existence of a basal cavity prolonged into the substance of the fungus, which is thus very light compared with *T. aestivum*. It shrinks very much in drying. The sporangia [asci] have much longer stalks than in *T. aestivum*. The sporidia closely resemble those of that species, but are slightly longer compared with their width, and have somewhat shallower cells. It ranges from the size of a walnut to that of a hen's egg. Odour bituminous and very strong of horseradish.' Berk.

Hab. In deep sand.

Distr. Britain.

Tuber foetidum, Vitt., Mon. Tub., p. 41, pl. 1, fig. 8, and pl. 3, fig. 11 (1831); Tul., Hypog., p. 140, pl. 17, fig. 7 (1851); Corda, Icon. Fung., vi, p. 80, fig. 135 (1854); Sacc., Syll., viii, p. 887 (1889); Chatin, La Truffe, p. 69 (1892).

Ascophore irregularly globose, variously nodulose or lobed, smooth or minutely corrugated, brownish, 1.5-3.5 cm. diam. *Gleba* whitish at first, becoming soft and of a reddish-brown colour, dissepiments whitish, rather thick, very much branched and anastomosing. *Asci* obovate or variable in form, 2-4-spored. *Spores* reticulated, mesh not very large, shallow, 27-36 $\times$ 20-30 μ , brown.

Smell and taste resembling that of rancid oil, with a suggestion of onions.

Specimen from Vittadini, in the Kew herbarium, examined.

Hab. Subterranean.

Distr. Britain; Italy.

Tuber macrosporum, Vitt., Mon. Tub., p. 35, pl. 1, fig. 5 (1831); Tul., Hypog., p. 139, pl. 17, fig. 8 (1851); Cooke, Brit. Fung., p. 739 (1871); Sacc., Syll., viii, p. 887 (1889).

Ascophore globose sometimes nodulose, covered with minute depressed warts and often cracked, blackish and spotted with rusty brown, 2-5 cm. diam. *Gleba* at first white, changing to purplish-brown or blackish, dissepiments numerous, mixed with finer dusky lines. *Asci* subglobose, with long, slender pedicels, 1-3-spored. *Spores* elliptical, brown, reticulated, mesh small, rather shallow, 50-65 $\times$ 35-40 μ .

Readily known by the large, elliptical spores. The network on the episporium is small-meshed, but the size and form of the openings are irregular. Smell strong, resembling onions.

Specimen from Vittadini, in Herb. Kew., examined.

Hab. Underground, under oaks, willows, poplars, &c., often in clay soil.

Distr. Britain; France; Italy; United States.

Tuber excavatum, Vitt., Mon. Tub., p. 49, pl. 1, fig. 7 (1831); Tulasne, Hypog., p. 144, pl. 6, fig. 1, and pl. 17, fig. 5 (1851); Cooke, Brit. Fung., p. 740

(1871); Chatin, La Truffe, p. 67 (1892); Sacc., Syll., viii, p. 886 (1889); *Vittadion Montagnei*, Zobel, in Corda's Icon. Fung., vi, p. 75 (1854).

Ascophore subglobose or irregular in form, with a basal depression, ochraceous, minutely granulated, 1.5–3 cm. diam. *Gleba* tinged ochraceous, becoming hard when dry, dissepiments white, radiating from the excavated base. *Asci* elliptical to subglobose, 2–4-spored. *Spores* elliptical or subglobose, reticulated, mesh large, deep, $35\text{--}53 \times 30\text{--}40 \mu$, yellowish brown.

Distinguished by the minutely granulated or warted ascophore, furnished with a deep depression at the base. There are most frequently three spores in an ascus.

Smell resembling radishes.

Specimen from Vittadini in Herb. Kew. examined.

Hab. Underground in woods.

Distr. Britain; France; Germany; Italy; United States.

Exsicc. Rabenh., Fung. Eur., 911.

Tuber dryophilum, Tul., Giorn. Bot. Ital., ii, p. 62 (1870); Tul., Hypog., p. 147, pl. 5, fig. 3, and pl. 19, fig. 8 (1851); Cooke, Brit. Fung., p. 742 (1871); Sacc., Syll., viii, p. 889 (1889).

Ascophore globose, generally regular in form, even, at first white and minutely downy, becoming glabrous and brownish-violet, variegated with violet, 1.5–3 cm. diam. *Gleba* reddish-brown or purple-brown with whitish dissepiments springing from various points of the cortex. *Asci* 2–4-spored. *Spores* broadly elliptical, orange-brown, reticulated, mesh rather large and deep, $40\text{--}45 \times 25\text{--}30 \mu$.

Characterized by the even wall of the ascophore, purplish gleba, and large, elliptical spores. More closely allied to *T. Borchii*, Vitt., a species not yet recorded for Britain. Smell weak, not unpleasant. Specimen from Tulasne, in Herb. Kew., examined.

Hab. Underground, under oaks and poplars.

Distr. Britain; France; United States.

Tuber rapaeodorum, Tul., Ann. Sci. Nat., sér. 2, xix, p. 380 (1843); Tul., Hypog., p. 147, pl. 5, fig. 4, and pl. 18, fig. 1 (1851); Sacc., Syll., viii, p. 890 (1889); Chatin, La Truffe, p. 67 (1892).

Ascophore globose or irregular in form, smooth, of a yellowish tinge and with whitish spots corresponding to the dissepiments in the gleba, 1.5–2.5 cm. diam. *Gleba* white then brownish with a few white dissepiments. *Asci* obovate or subglobose, 1–2, rarely 3–4-spored. *Spores* elliptical, reticulated, mesh large and somewhat elongated in the direction of the long axis of spore, shallow, $35\text{--}55 \times 24\text{--}30 \mu$, yellowish-brown at maturity.

The size of the spores varies considerably, depending on the number present in an ascus. Smell strong and unpleasant, resembling radishes.

Hab. In sandy soil under trees.

Distr. Britain; France; Germany.

Exsicc. Fckl., Fung. Rhen., 2668.

Tuber puberulum, Berk. and Br., Ann. Mag. Nat. Hist., xviii, p. 81 (1846); Cooke, Brit. Fung., p. 741 (1871); Sacc., Syll., viii, p. 893 (1889).

Ascophore subglobose, somewhat lobed, pinkish-brown, clothed with short, erect

down giving it a pearly appearance, often cracked, 2-4 cm. diam. *Gleba* with whitish dissepiments radiating from the base. *Asci* subglobose. *Spores* globose or subglobose, orange-brown, reticulated, mesh not very large, deep, 35-45 μ diam.

Readily distinguished by the beautiful downy surface of the ascophore, through which the pinkish-brown colour shows. The ascophores are gregarious. Odour of radishes.

Hab. In sandy ground.

Distr. Britain; United States.

Exsicc. Cooke, Fung. Brit. Exs., 480; Rabenh., Fung. Eur., 1424.

B. *Epispore warted or spinulose.*

Tuber brumale, Vitt., Mon. Tub., p. 37, pl. 1, fig. 6 (1831); Cooke, Brit. Fung., p. 740 (1871); Sacc., Syll., viii, p. 895 (1889); Chatin, La Truffe, p. 48, pl. 4 (1892). *Oogaster brumalis*, Zobel, in Corda's Icon. Fung., vi, fig. 127 (1854).

Ascophore subglobose, generally regular in outline, reddish-violet then black, rough with polygonal warts having the apex excavated and crested with points, 2-10 cm. diam. *Gleba* greyish-black with a tinge of violet, traversed by whitish, branched dissepiments. *Asci* numerous, subglobose or broadly elliptical, shortly stipitate, 3-6-spored. *Spores* elliptical or elliptic-oblong, yellowish-brown, spinulose, spines slender, 20-30 $\times$ 15-20 μ .

Distinguished amongst the species with spinulose spores, by the stout polygonal warts on the surface of the ascophore. Edible, said by Chatin to be the best kind after *T. melanosporum*, *T. gulonum*, and *T. montanum*. Size variable, sometimes larger than the measurements given above. Smell strong.

Specimen in Herb. Kew., from Vittadini, examined.

Hab. Underground.

Distr. Britain; France; Italy.

Exsicc. Speg., Dec. Myc. Ital., 1.

Tuber rufum, Pico, Meleth., p. 80 (1788); Vitt., Mon. Tub., p. 48, tab. 1, fig. 1 (1831); Tul., Hypog., p. 141, tab. 6, fig. 2, and tab. 18, fig. 2 (1851); Cooke, Brit. Fung., p. 741 (1871); Sacc., Syll., viii, p. 897 (1889).

Ascophore subglobose or irregular in form, minutely warted, cracked, rusty brown, 2.5-6 cm. diameter. *Gleba* reddish-brown at maturity, dissepiments whitish then livid, mixed with tawny lines. *Asci* broadly ovate, shortly stipitate, 1-4-spored. *Spores* broadly elliptical or sometimes nearly globose, brown, densely covered with short spines, 25-36 $\times$ 17-24 μ .

The wall of the ascophore is thick and somewhat cartilaginous, colour somewhat variable but always more or less rusty. Smell also variable, at times not unpleasant and somewhat acid, at others strong and nauseous. The spores are almost indistinguishable in form and marking from those of *T. nitidum*, Vitt. Sometimes there is only one spore in an ascus, when it is very large and often almost or quite globose.

Specimen from Vittadini, in Herb. Kew., also Berkeley's British specimens, examined.

Hab. In woods, underground or partly exposed.

Distr. Britain; France; Italy.

Exsicc. Roumeg., Fung. Gall., 2816.

Tuber scleroneuron, Berk. and Br., Ann. Mag. Nat. Hist., vii, p. 184 (1851); Cooke, Brit. Fung., p. 740 (1871); Sacc., Syll., viii, p. 887 (1889).

Ascophore subglobose, somewhat lobed, cartilaginous, minutely warted or sometimes almost smooth, cracked, reddish-brown, 2–4 cm. diam. *Gleba* greyish towards the centre, becoming reddish-brown towards the periphery. *Asci* broadly ovate or clavate, shortly pedicellate, 2–4- usually 3-spored. *Spores* subglobose or broadly elliptical, brown, densely bristling with slender spines 4–6 μ long, often slightly curved at the tip, 17–23 $\times$ 25 μ .

Berkeley says the spores are 'minute cellulosa', meaning that they are minutely reticulated. An examination of his type specimens in the Kew herbarium, however, shows that the epispore is spinulose, as stated above.

'This species differs from *Tuber rufum*, Vitt., in its firmer cartilaginous texture, deep red-brown colour, and in the form of its sporidia, which are ovate, not elliptic-elongate, and in its faint aromatic odour. When dried, *Tuber scleroneuron* becomes as hard as a piece of wood.' Berk.

Hab. In the ground.

Distr. Britain.

Tuber intidum, Vitt., Mon. Tub., p. 48, pl. 2, fig. 10 (1831); Cooke, Brit. Fung., p. 741 (1871); Sacc., Syll., viii, p. 897 (1889). *Tuber Berkeleyanum*, Tul., Hypog., p. 151 (1851). *Oogaster Berkeleyanus*, Corda, Icon. Fung., vi, p. 71, pl. 16, fig. 118 (1854).

Ascophore globose or slightly depressed, hard, even, shining, just tinged yellowish-red, 1.5–3 cm. diam. *Gleba* at first whitish then reddish-brown, hard, dissepiments whitish, originating from a pale point at the base. *Asci* obovate or variable in form, 2–4-spored. *Spores* broadly elliptical or subglobose, yellowish-brown, densely covered with rather long, slender spines, 20–30 $\times$ 15–24, or 20–25 μ diam.

Distinguished by the even, polished ascophore and the small, spinulose spores. The asci vary in form according to the grouping of the spores, sometimes four are arranged as a tetrahedron, sometimes two or three more or less in a straight line.

Specimen from Vittadini, in Herb. Kew., examined.

Hab. Underground, under trees.

Distr. Britain; Italy.

Exsicc. Berk., Brit. Fung., 303; Roumeg., Fung. Gall., 2171.

Tuber ferrugineum, Vitt., Mon. Tub., p. 46, pl. 3, fig. 10 (1831); Tul., Hypog., p. 141 (1851); Sacc., Syll., viii, p. 897 (1889).

Ascophore variable and irregular in shape, very soft, rusty brown, minutely warted, often sparingly cracked, 4–9 cm. diameter. *Gleba* soft, dry, granular, pale rusty brown, traversed by a few slender, sparingly branched dissepiments of a whitish colour. *Asci* numerous, subglobose or obovate, 2–4-spored. *Spores* elliptical or sometimes almost globose, brown, densely covered with slender spines, 18–25 $\times$ 15–18 μ .

This species is characterized by the very soft ascophore. Becoming hard when dry, smell somewhat strong.

Hab. Underground.

Distr. Britain; Italy.

CHOEROMYCES, Vitt., Mon. Tub., p. 50 (1831); Tul., Hypog., p. 169 (1851); Hesse, Hypog. Deutschl., ii, p. 37 (1894); Cooke, Brit. Fung., p. 742 (1871); Sacc., Syll., viii, p. 900 (1889).

Ascophore closed, with a distinct basal portion, even, often cracked. *Gleba* with numerous branching fine veins, interstices whitish. *Asci* oblong-ovate with a long slender pedicel, 8-spored. *Spores* globose, warted.

Distinguished by the distinctly elongated asci containing eight warted, coloured spores.

Choeromyces meandriformis, Vitt., Mon. Tub., p. 51, tab. 2, fig. 1, and tab. 4, fig. 10 (1831); Tul., Hypog., p. 170, tab. 19, fig. 7 (1851); Cooke, Brit. Fung., p. 742, fig. 345 (1871); Sacc., Syll., viii, p. 900 (1889). *Rhizopogon meandriformis*, Corda, Icon. Fung., vi, p. 68, fig. 110 (1854). *Tuber album*, Sow., Engl. Fung., pl. 310 (1803).

Ascophore irregularly globose, often nodulose, smooth, pale yellowish brown, becoming much cracked and presenting a tessellated appearance, interstices whitish, base plicate, 5–10 cm. diam., flesh white when fresh, becoming yellowish with age. *Gleba* with numerous fine ochraceous veins. *Asci* ovate or oblong-ovate, tapering into a slender pedicel, 8-spored. *Spores* globose, with numerous elongated blunt warts or spines, 21–26 μ diam. including warts.

Hab. On the ground, often more or less exposed.

Distr. Britain; France; Italy; Germany; Bohemia.

Exsicc. Thüm., Myc. Univ., 1507.

Smell strong, often grows to a large size.

Described from a specimen in the Kew herbarium from Vittadini.

TERFEZIA, Tul., Ann. Sci. Nat., sér. 3, iii, p. 350 (1846); Tul., Expl. Scient. de l'Alger., Bot. i, p. 435 (1846). *Tulasneinia*, Zobel, in Cord. Icon. Fung., vi, p. 64 (1854).

Ascophore subglobose or irregular in form, furnished with a distinct, short, obconic stem-like base, fleshy, not perforated, continuous or variously cracked. *Gleba* fleshy, fertile portion consisting of distinct small masses, sterile portion areolate, paler. *Asci* globose or subglobose, often 8-spored. *Spores* globose, warted, echinulate or reticulated.

Distinguished by the distinct, short, stem-like base of the ascophore, globose asci, and globose warted spores, so far as British species are concerned.

Terfezia leonis, Tul., Expl. Scient. de l'Alger., Bot. i, p. 432, pl. 24, figs. 22–30 (1846); Tul., Hypog., p. 173, pl. 7, fig. 5, and pl. 15, fig. 3 (1851). *Tulasneina leonis*, Zobel, in Corda's Icon. Fung., vi, p. 64 (1854). *Tuber niveum*, Vitt., Mon. Tub., p. 47 (1831).

Ascophore subglobose or piriform, often very large, with a short obconic base, whitish, becoming stained and discoloured with age, 4–10 cm. diam. *Gleba* whitish, becoming discoloured. *Asci* large, globose or very broadly elliptical, 8-spored. *Spores* globose, coarsely nodulose, remaining colourless for a long time, finally slightly coloured, 19–25 μ diam.

Very variable in size; smell weak, not unpleasant.

Hab. Altogether subterranean or partly exposed.

Specimen in Kew herbarium, from Tulasne, examined.

Distr. Britain; France; Germany; Italy; N. Africa; Palestine; United States.

Exsicc. Crypt Lusit., 30; Rab., Fung. Eur., 241; Desm., Cr. Fr., sér. 2, 670; Thüm., Myc. Univ., 525; Ellis and Everh., N. Amer. Fung., 1782.

AMYLOCARPUS, Currey, Proc. Roy. Soc., ix, p. 119 (1857); Cooke, Brit. Fung., p. 743, fig. 346 (copied from Currey) (1871); Sacc., Syll., viii, p. 905 (1889).

Ascophore globoso-depressed, minute, fleshy, more or less convolutedly wrinkled. *Asci* elliptical, soon disappearing. *Spores* globose, colourless, with scattered long, slender spines.

A genus of very uncertain affinities, retained here only because I am unable to suggest a more suitable location. The habit and structure are not at all in accordance with those of any other genus included in the present Family. It has only been met with once, and the material is limited in amount. A careful investigation of recent specimens would in all probability throw more light on this anomalous fungus.

Amylocarpus encephaloides, Currey, Proc. Roy. Soc., ix, p. 119 (1857); Cooke, Brit. Fung., p. 743 (1871); Sacc., Syll., viii, p. 905 (1889).

Ascophore globoso-depressed, with sinuous, brain-like folds, fleshy, dull yellow, about 2–3 mm. diameter. *Asci* elliptical or broadly clavate, shortly stipitate, deliquescing at an early stage. *Spores* globose, hyaline, with sparsely scattered, very slender spines as long as the diameter of the spore, 10–12 μ diam. excluding the spines.

Type specimen in Herb. Kew. examined.

Each individual presents the appearance of a small round somewhat flattened body, of a dull yellow colour, and with an unevenness of surface caused by numberless convolutions of the integument. The diameter of the largest did not much exceed one-eighth inch. Externally with a strong resemblance to *Dacrymyces deliquescens*. The integument is of considerable thickness formed of several layers of cells, the outer large and rounded, the inner long and flat. The asci are broadly clavate, with a very short stem springing from threads proceeding from the inner surface of the integument. They are absorbed at an early period, and the sporidia form a dense mass. *Sporidia* globular, colourless, furnished with long delicate sharp rays, projecting from the surface in every direction. Each sporidium with an internal nucleus, or oil-drop. *Spores* $\frac{1}{2000}$ th inch diameter (Currey).

Hab. Growing gregariously on fragments of wood, on the sands by the sea shore, at Sketty, near Swansea.

Distr. Britain.

EXCLUDED SPECIES.

The species of *Sphaerosoma* have been transferred to the Discomycetes.

Choeromyces ganglionis, Vitt., is not a British species, and was added to our Flora owing to a mistaken identification.

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EXPLANATION OF FIGURES IN PLATE XVII.

Illustrating Mr. Massee's paper on the British Tuberaceae.

- Fig. 1. *Tuber excavatum*, Vitt.
 Fig. 2. „ *melanosporum*, Vitt.
 Fig. 3. *Hydnotrya Tulasnei*, B. and Br.
 Fig. 4. *Choeromyces meandriformis*, Vitt.
 Fig. 5. „ „ „
 Fig. 6. *Hydnotrya Tulasnei*, B. and Br.
 Fig. 7. *Tuber nitidum*, Vitt.
 Fig. 8. „ *melanosporum*, Vitt.
 Fig. 9. *Genea Klotzschii*, B. and Br.
 Fig. 10. *Hydnobolites cerebriformis*, Tul.
 Fig. 11. *Pachyphloeus melanoxanthus*, Tul.
 Fig. 12. *Stephensia bombycina*, Tul.
 Fig. 13. *Balsamia platyspora*, B.
 Fig. 14. *Hydnotrya Tulasnei*, B. and Br.
 Fig. 15. *Terfezia leonis*, Tul.
 Fig. 16. *Tuber mesentericum*, Vitt.
 Fig. 17. *Genea sphaerica*, Vitt.
 Fig. 18. „ *hispidula*, Vitt.
 Fig. 19. *Peziza vesiculosa*, L.
 Fig. 20. *Elaphomyces anthracinus*, Vitt.
 Fig. 21. „ *variegatus*, Vitt.
 Fig. 22. *Amylocarpus encephaloides*, Curr.
 Fig. 23. *Tuber brumale*, Vitt.

The free spores are mag. 500 diam., the asci containing spores, about 250 diam., figs. 16-19 nat. size.

G. Massee del.

Huth lith et imp.

Massee, George. 1909. "The structure and affinities of British Tuberaceae." *Annals of botany* 23, 243–263.

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