OBSERVATIONS ON THE BOLBITIACEAE 16:* CONOCYBE SECT. GIGANTAE

ROY WATLING

ABSTRACT. The history of *Conocybe intrusa* and *C. hebelomatoides* is discussed. Statistical and developmental evidence suggest that both names refer to the same species, the prior name being *C. intrusa. C. hebelomatoides* is considered as a form worthy of recognition, possibly representing recurrent monocaryotic fruitings. *C. intrusa* is redescribed and the main characters of *Conocybe* sect. *Gigantae* Singer given. The section is considered distinct enough to maintain on the morphology of the basidiocarp alone; less importance than in previous studies is placed on the morphology of the basidiospore. The relationship of the genus *Meliderma* Velenovský to sect. *Gigantae* is discussed.

INTRODUCTION

C. intrusa (Peck) Singer is the largest member of the genus *Conocybe*, and is the type and only species accepted by Singer (1951, 1962) in sect. *Gigantae* of subgenus *Conocybe*. This uniqueness was challenged when *C. hebelomatoides* Middlehoek & Reijnders (1952) was described from the Netherlands. The full extent of the discussion embracing these two agarics was, however, not appreciated fully until *C. intrusa* was located amongst the undetermined species of *Galera* in the Edinburgh herbarium (Watling 1964; fig. 1 F; 2 H–I) and many collections of the complex, gathered from all over the eastern United States and now in the Univ. of Michigan herbarium, were examined.

It has been possible through the kindness of Stanley Smith, New York State Museum, to examine Peck's collections of *C. intrusa*, including the type specimens which were the subject of an account by Singer (1950). Dr A. M. Reijnders, Amersfoot, kindly allowed me to examine the material and a coloured illustration on which *C. hebelomatoides* is based, and on which he conducted his developmental studies.

Singer's view that *C. intrusa* is conspecific with *C. hebelomatoides* is based on a comparison of the original descriptions and observations only on herbarium material of the former. However, this opinion would not be supported at first sight by solely comparing published illustrations of *C. intrusa* with water colour sketches of *C. hebelomatoides* executed by Reijnders and Mrs N. Ernste. With the recent widespread collecting in Europe of *C. intrusa* it appears that agarics in this complex are apparently spreading; this indicates the time is now ripe to assess the real differences between the two taxa and explore the variation they exhibit. The present paper is therefore an attempt to analyse the conflicting information and collate that obtained from the examination of herbarium specimens with that from descriptions of material from France (Romagnesi, 1964), Germany (Benkert, 1971; Beyer, 1975; Bregazzi, 1975), Netherlands (Daams, 1972) and England (Reid, 1968). This study has been extended to include a North American collection, several further records from the Netherlands of members of the same complex and a collection of a large, possibly distinct taxon from Belgium (Heinemann, pers. comm.).

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* Cont. from *Revue de Mycologie* 40:31–37 (1976).

The techniques outlined in this paper for assessing the status of two closely related species could equally well be applied to similar problems throughout the larger fungi.

TAXONOMY

The Edinburgh collection, the American and European material and their accompanying notes indicate an agaric with a facies of *Cortinarius* or *Hebeloma* but with the hymenophoral trama, gill-edge characteristics and basidiospores of *Conocybe* (Bolbitiaceae). This agrees with Singer's observations on Peck's specimens of *Cortinarius intrusus*. Peck related his fungus to *Cortinarius multiformis* (Fr.) Fr., although he also drew attention to its similarity with *Hebeloma fastibile* (Fr.) Kummer.

Atkinson on first encountering *C. intrusa* confused it (in his private papers) with *Hebeloma parvifructum* Peck but concluded the two were autonomous. The bright red-brown gills and spore-print induced Atkinson to place his collection in *Cortinarius* referring to it provisionally as *C. cystocephalus*, in allusion to the capitate cells on the gill-edge. He also pointed out that 'by virtue of the gills being nearly free or quite free with age it suggests *Pluteolus*'; indeed in the Edinburgh material the gills on drying have pulled away from the stipe-apex so that the dried specimen now resembles a species of *Pluteus* or *Pluteolus*—observations incidentally made before Atkinson's herbarium notes had been examined. The capitate cells on the gill-margin suggested to Atkinson a relationship with *Galera* (Atkinson's *Galerula*, 1918) as he then understood the genus. However, he goes on to say 'but the plant does not have the habit of *Galera*!' It was only later, after correspondence with Peck that a name was finally provided for this extraordinary agaric.

Kauffman, judging from his personal notes was also very familiar with *C. intrusa* and he too had some difficulty placing it, finally accommodating the taxon in *Cortinarius* subgenus *Bulbopodium*. Peck in relating *C. intrusa* to *C. multiformis* placed it in subgenus *Phlegmacium*, a treatment as Kauffman's emphasising the viscid pileus. Thus the spectrum of characters exhibited by this agaric perplexed the early North American mycologists. It was finally Singer (1950) who formerly transferred Peck's fungus to *Conocybe* but stressed as Peck, Atkinson, Kauffman and later Smith (pers. comm.) the similarity of stature with *Cortinarius*.This is in contrast to Reijnders (1952) who maintained a similarity between his species and *Hebeloma*—hence the name *C. hebelomatoides*. Reijnders (1963; pers. comm.) continues to emphasise that there is only a superficial similarity between it and *C. intrusa*.

DEVELOPMENT OF THE BASIDIOCARP. The primordia of *C. intrusa* develop slowly at or just below soil-level and then expand rapidly pushing up the soil. Palmer in correspondence with Atkinson indicated that because of their rapid development only mature basidiocarps were found, continuing 'that even when the soil cracked, suggesting the presence of a developing mushroom the pilei had already expanded'. It is the feature of pushing up the soil which probably lead Peck to use the epithet *intrusus*. Johnson, who recently collected this agaric in Washington State, indicated (in notes) that basidiocarps appeared from early summer to late autumn after every rain and his

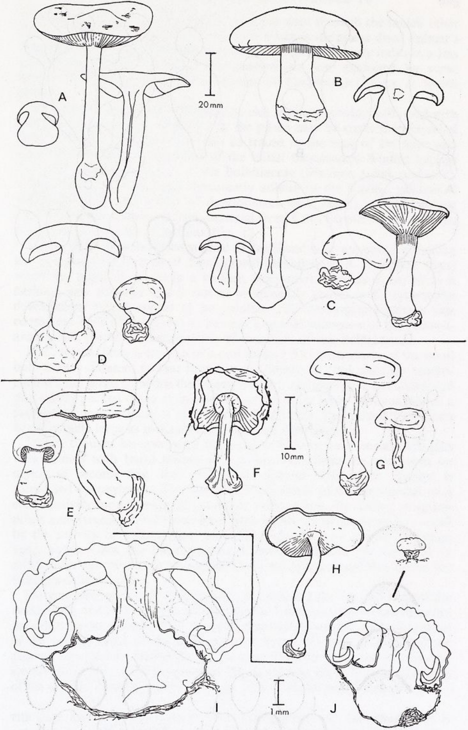

FIG. 1. Fruit-bodies of A, *Conocybe hebelomatoides* and B–J, *C. intrusa*. A, from water-colour and type description. B, France, Valence-en-Brie; C, UK, Kew, Temp. and Australian Houses; D, USA, Michigan, Detroit, Knock's Nursery (photo. Kauffman): E, USA, Boston, *E. T. Forster* (holo.); F, Scotland, Edinburgh, Royal Botanic Garden, central house; G, USA, New Jersey, Haddonfield, *McIlvaine*; H, USA, New York, Orange Co., Highland Falls, *Palmer*; I and J, primordia of 'C'.

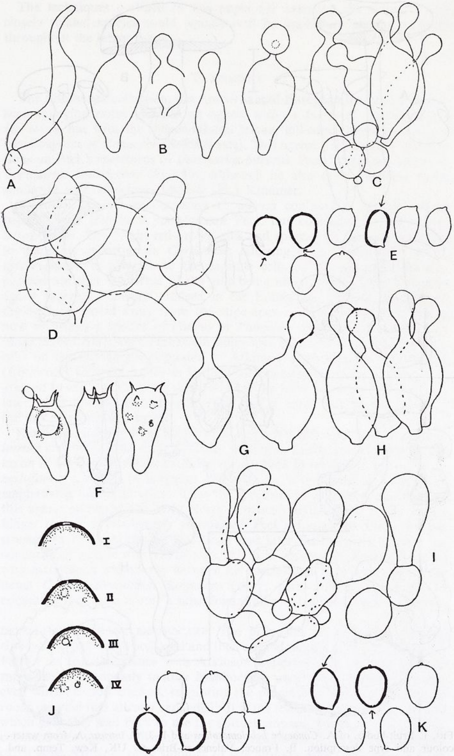

FIG. 2. A–K, *Conocybe intrusa*, Scotland, Edinburgh, Royal Botanic Garden, central house. A, superficial hypha on pileipellis; B, caulocystidia; C, group of caulocystidia from apex of stipe; D, pileal palisadoderm; E, basidiospores; F, basidia; G, cheilocystidia; H, group of cheilocystidia; I, section of pileipellis; J, types of spore apex as scored in analysis, types I–IV (see p. 284); K, basidiospores. L, *C. hebelomatoides*, basidiospores of type.

notes further state 'It barely makes an appearance through the mulch other than to produce a mound at the centre of which is the pileus disc.' Palmer's notes and examination of the specimens in the present study indicate a less accentuated although parallel phenomenon to that exhibited by some recently described subhypogeous species of *Cortinarius* (Thiers & Smith 1969).

The initially slow growth through the rich humus probably infiltrated with hyphae of other fungi, explains why the pileus may be covered in mycelial threads. Some of these threads can be traced to the base of the stipe and represent proliferating remnants of the initial blematogen. Similar hyphae are found in other members of the Bolbitiaceae (Watling, 1965), and in *C. intrusa*, along with detritus, consistently adhere to the slightly gelatinised pileipellis. The latter stages of development have been plotted in young specimens located amongst fresh material from Kew, supplemented with the numerous herbarium collections (fig. 1).

C. hebelomatoides has been studied in detail and is an example illustrating the gymnangiocarpic type of development (Middlehoek & Reijnders, 1952) where the pileus is seated in a swollen primordial stipe, as if buried in a cushion, and although this is not as prominently shown in *C. intrusa* the development would appear to be parallel. This development-pattern was considered by Watling (1965) to be only a special extension of the paravelangiocarpic model so characteristic of members of the Bolbitiaceae.

In *C. intrusa* there is no sign of a cortina and the construction of the basal bulb is very different to that found in *Cortinarius* sg. *Phlegmacium* (*Bulbopodium*), the genus to which the fungus was first assigned. It is not composed of a tightly packed tissue as in *Cortinarius* but in its lower part consists of a loosely arranged mixture of mycelium and substrate. This mixed 'tissue' can be often quite large as in Kauffman's material from Detroit.

Palmer thought his specimens belonged to *Pilosace* because, as their gills were flushed with burnt umber and pulled away from the stipe-apex on drying to become free, they resembled *Agaricus* with which *Pilosace* is considered synonymous. The free gills are a result of the drying-out of a comparatively loosely textured yet rather bulky pileus. Darkening of spore-prints and hymenophoral tissue have been shown in *Agrocybe* to be caused by the activity of invertebrates probably collembola or psocids (Watling 1964, 1975). Once the basidiospores in such specimens are mounted in alkali solutions their true colour and shape are revealed and this is true for Palmer's collection also.

Extreme environmental changes take place during the development of the basidiocarp of *C. intrusa*; for a long time the basidiocarp is protected under the substrate but then the stipe suddenly and rapidly extends. The elongation of the central areas of the stipe tends to break the surface into floccose patches superficially similar to the pattern observed in certain *Cortinarius* species where the veil collapses onto the elongating stipe. This breaking up of the surface, however, is not uniform even in single populations.

THE CASE FOR A SINGLE SPECIES: MICROMORPHOLOGY. *C. hebelomatoides* is reported as differing from *C. intrusa* in the shape and structure of the basidiospores, the morphology of the cheilo- and caulocystidia, and the colours of the basidiocarp.

Before any analysis of micro-structure could be carried out it was necessary to ascertain whether Bouin's fixative induced structural changes in *C. intrusa* as Reijnder's material was liquid-preserved and not dried. If so, these changes might account in part for the discrepancies between the differently preserved types. Fresh material from Kew was subjected to picric acid fixation for comparison but the results from these tests indicated that the differences in basidiospores and cheilo- and caulocystidial dimensions were within the range expected of a single specimen, and were not a result of chemical treatment.

The basidiospores of *C. hebelomatoides* possess a small, narrow, supposedly quite distinct germ-pore (fig. 2L) whereas the corn-kernel shaped spores of *C. intrusa* lack a very distinct germ-pore (fig. 2K, but cf. Singer in Sydowia 4:134, 1950—'with distinct germ-pore'). In the latter, the spore-wall thins towards the apex producing a pale or almost hyaline spot, or at most a very small channel.

The spores from three prints accompanying dried material of *C. hebelomatoides* contained spores of one type only and these spores corresponded to those of the type material of *C. intrusa* in their lack of germ-pore. Mounts from all dried collections have been examined and scored as illustrated in fig. 2J I–IV for the occurrence of: a, type I—distinct germ-pore; b, type II—small germ-pore; c, type III—thin-channel at the apex of the spore; d, type IV—thinning of the wall to produce a hyaline spot. This scoring was supported by observations on carbon replicas examined by the transmission electron microscope and by treatment of the mature basidiospores with concentrated sulphuric acid, and with cotton-blue in lactophenol.

In the first technique, germ-pores were observed neither in spores from material collected by Reid, Reijnders or Romagnesi, nor in the type material of *C. intrusa*. However, Pegler & Young (1971) show that using similar techniques contraction and collapse may occur, even in species known to possess a distinct germ-pore; therefore, there is even less of a chance for the small structure found in *C. intrusa* to be clearly seen except by sectioning. The endospore of dispersed spores, as might be expected from these observations, fail to balloon-out in the presence of concentrated sulphuric acid, the usual phenomenon when a germ-pore is present. Cotton-blue treatments did not reveal a prominent germ-pore, except in a few abnormally large spores from the hymenium of dried specimens. In more typically sized spores a very thin channel through the epispore was observed terminating in a small apical patch in the exospore and overlaid by the ectospore, but lacking the pigmentation normally associated with the bolbitiaceous spore.

Except for collections from Kauffman, Roper, Snell and some from Daams the specimens examined possessed spores with apical areas of type III and IV (fig. 2). A few spores in material from Boston were similar to spores of type II and no doubt led to Singer's inconsistency noted above. All the collections which scored type I and II had a considerable number of elongated spores sufficient to skew the average for spore length and width.

Although at first sight *C. hebelomatoides* and *C. intrusa* might from ecological parameters be suitable culture material, attempts to grow *C. intrusa* in the laboratory have been unsuccessful and only the collection of Heinemann has been successfully grown in pure culture but then only limited growth was recorded; the progress of sporogenesis has not been studied. The pattern of spore development was therefore constructed from examination of spores in prints and from herbarium material at various stages of maturity.

In *C. hebelomatoides* elongation of the basidiospore apparently continues past the final stage normally found in *C. intrusa*. In the latter fungus sporogenesis and subsequent wall thickening follows that described by Corner (1948) and Watling (1975) but in some poorly developed specimens, formation of the epi- and exospore does not take place over the entire surface of the basidiospore. This phenomenon is found in several other species of *Conocybe* where abnormally large spores accentuate the typical characters e.g. outline, ornamentation and germ-pore structure. These spores usually collapse onto the gill surface and rarely if ever find their way into the spore-print. This again emphasises the care with which spore information from herbarium material must be interpreted (Watling 1975).

The basidiospores of *C. hebelomatoides* are reported as slightly larger than those of the type *C. intrusa* but enough collections have been seen to bridge the gap and for a statistical analysis to be undertaken. The concept of fiducial limits as outlined by Watling (1964) has been employed in studying spore dimensional data, especially important because spore-prints as well as herbarium collections have been examined.

All recent Dutch collections of putative *C. hebelomatoides*, some of which are the subject of a communication by Damms (1972), have been submitted to analysis. They possess basidiospores within the range 6·83–(7·21)–7·46(–9) × 4·36–(4·59)–5·50 *μm* with Q values of 1·36–1·57. The type specimen of *C. hebelomatoides* (6·50 × 4·58 *μm*; Q value 1·42) falls close to this pattern although of shorter length. Parallel figures for *C. intrusa* are 5·79–(5·99)–6·36(–6·75) × 4·03–(4·17)–4·25 *μm* and 1·26–1·42 respectively, and for the type 5·41 × 3·88 and Q values 1·39. Thus the type of *C. hebelomatoides* appears to have a closer morphology to *C. intrusa* than subsequent collections from the Netherlands, judging from the available material, but a comparison of the ratio of the sum of fiducial limits and differences between means reflects a great range of variation in spore-size. This variation may be an expression of the semi-sterile nature of a great number of collections of *C. hebelomatoides*, although Reijnders (pers. comm.) has fertile specimens which agree in all ways with the 1952 material.

In order to obtain an estimate of the spore-production of these recent collections transects were made across the gills at their greatest width. The spore numbers were found to be 65–398, 740–1279 and 81–195 spores in three collections, whereas for *C. intrusa* it was at least 4 times as high over transects of similar sized gills and then in one focal plane only! It is suggested the colour is a reflection of this inadequacy of spore production.

THE CASE FOR A SINGLE SPECIES: MACROMORPHOLOGY. Apart from taste, which is farinaceous in *C. hebelomatoides* and slightly astringent or radishy in *C. intrusa*, macromorphology might support the retention of two taxa.

Basically, the painting of the original collection of *C. hebelomatoides* depicts an agaric with a bright orange-tawny pileus, dull gills and an elongated primuline yellow stipe. Subsequent paintings received from Holland show a much paler fungus lacking the bright yellow and tawny colours. These specimens, however are semi-sterile which might account for the colour differences; Singer & Smith (1958) have described shifts in pileus-colours in sterile members of the Strophariaceae.

In many agarics the gill-colour before maturation of the basidiospores is often quite different to the final colour of the gills. The hymenium of immature basidiocarps of undoubted *C. intrusa*, and of two thirds of the Dutch collections of *C. hebelomatoides*, has an isabelline colour. These colours parallel the olivaceous hue noted by Reijnders in his original study.

Sterile and semi-sterile basidiocarps of *Stropharia semiglobata* (Batsch ex Fr.) Quél., *Psathyrella obtusata* (Fr.) A. H. Smith and *Hypholoma fasciculare* (Huds. ex Fr.) Kummer are not infrequent in the field, and *Psilocybe collybioides* Singer & Smith is indeed based on such a state; the colour of these gills is dull-straw colour, white, primuline yellow and pallid to pure white respectively. Even basidiocarps of *Coprinus lagopus* (Fr.) Fr. have been collected with mottled semi-sterile gills in parallel to those of a mutant of *C. cinereus* (Schaeff ex Fr.) S. F. Gray recorded in culture under the name *C. lagopus* by Day (1959). Monocaryotic basidiocarps of *Psathyrella coprophila* Watling have been produced in culture and these exhibit not only greater mottling of the gills than found in nature because of disturbance of spore production but also an increase in the variation in shape of cheilocystidia. Although only slightly, there is also an observable development of pleurocystidia in this same species under these conditions.

Colour differences of the basidiocarp appear not only to be correlated with hymenophore colour but also with stature. Daams (pers. comm.) has indicated there are two 'forms' in the Netherlands, a more slightly built 'form' which is invariably semi-sterile judging from the material received from Daams and pale in colour. The larger 'form' is reported as 'often covered with layered bands of fibrils (chiné in French)'—just as in *C. intrusa*. The sturdy form also possesses a thick, short stipe.

THE CASE FOR A SINGLE SPECIES: CONCLUSION. Evidence from spore-data indicates that *C. intrusa* and *C. hebelomatoides* are parallel in all ways. No microscopic differences can be seen between the sturdy and slender forms of *C. hebelomatoides* and between these and N American collections of *C. intrusa*. The type-material of both species conform to this pattern. The range of cystidial morphology exhibited in the collections studied is that which might be expected for a single species.

It is therefore concluded that the difference between the Dutch material and the North American collections is basically one of developmental inconsistency, either in the basidiocarp and consequently the basidiospores, or in the hymenium alone. This could be explained by the persistence of a fruiting monocaryotic strain or some other state which on occasion can be compensated to produce a seemingly fertile fruit-body. The hybridisation experiments of Yen (1948) between the bolbitiaceous *Agrocybe praecox* (Pers. ex. Fr.) Fayod and *A. sphaleromorpha* (Bull ex. Fr.) Quél. probably represent either such fruitings and not the formation of a hybrid as suggested by Yen, or may be misidentification of the collections.

The distribution of basidiocarps in the glasshouses according to Daams (pers. comm.) is quite random, rarely more than two developing from the same mycelium. The differences in stature and cheilocystidial dimension between this genetic state and a normal dicaryotic basidiocarp might parallel differences observed in monocaryotic fruiting of *Psathyrella coprophila*. The lack in these same species of the explosive development typical of *C. intrusa*, results in the developing hymenium being exposed for a long period to possible atmospheric interference and so further upset the differentiation between pileus, stipe and hymenium.

The weight of evidence indicates that *C. intrusa* and *C. hebelomatoides* represent the same species for which the former is the prior name. The differences are apparently more superficial than real. Certainly the study offers a cautionary note to all mycologists wishing to describe taxa even though in several characters they appear superficially distinct. One now awaits cultural analysis to test the hypothesis. The following new combination is proposed.

Conocybe intrusa forma **hebelomatoides** (Middlehoek & Reijnders) Watling, **comb. nov.**

Syn.: *Conocybe hebelomatoides* Middlehoek & Reijnders apud Reijnders in Med. Ned. Mycol. Ver. 30:116 (1952).

The following emended description is offered.

Conocybe intrusa (Peck) Singer in Sydowia 4:133 (1950). [*C. destrusa* (Peck) Singer in Sydowia 2:36, 1948—sphalm.]

Syn.: *Cortinarius intrusus* Peck in Bull. Torrey Bot. Club 23:416 (1896).

Pileus 20–60 mm, obtuse or convex when young expanding to become plane or with centre slightly depressed, glabrous, whitish to dull clay-colour or ochraceous tan with flush of ochraceous tawny to tawny, or pale salmon-buff to ochraceous salmon-buff, viscid when fresh, smooth or roughened with adhering soil and plant detritus, becoming evenly to radially wrinkled; minutely sulcate-striate at margin when young. *Stipe* 25–50 × (4–)8–13 mm (15–23 mm at base), equal or tapering upwards except for clavate or more or less abruptly bulbous base, stuffed but becoming hollow with age, even or striate particularly at apex minutely white-floccose at first, but then becoming smooth, or surface splitting into small patches of floccules. *Gills* rounded behind, adnexed to almost free and on drying pulling away from the stipe-apex, thin, crowded moderately broad to narrow, whitish at first soon cream to pale isabelline, yellowish to tawny ochraceous, finally rich ferruginous or even flushed amber; at first with white crenulate edges. *Flesh* pallid, sepia line above gills, thin, whitish becoming flushed ochraceous with age particularly in stipe; taste mild and odour slightly radishy or earthy almost suggesting earth-balls; stipe-base attached to white mycelial threads and floccose vegetative growth.

Basidia 4-spored, (15–)20–25(–28) × (7–)7·5–8·5 (–10)*μm*, clavate, hyaline in aqueous potassium hydroxide and ammoniacal solutions and yellowish in Melzer's reagent. *Basidiospores* (4·5–)6–6·5(–8) × 3·3–4·5(–5·5) × 4–5(–6) *μm*, very slightly lens-shaped, ovate to broadly ellipsoid (corn-kernel shaped), rich golden brown, red brown in alkali, little or no change in Melzer's reagent or picric acid fixative, smooth, thick-walled, thinning towards a pale apical spot, or with very small indistinct germ-pore in some larger spores, apiculus distinct although small. *Pleurocystidia* not seen; *cheilocystidia* lecythiform, 17–28(–30) × (5·2–)6·6–10 *μm*, with capitulum (2·2–)3–4·5 *μm*, neck 2·5–3·5 *μm* in length, hyaline in potassium hydroxide and ammoniacal solutions, slightly yellowish in Melzer's reagent. *Caulocystidia* in tufts especially at stipe-apex, lecythiform similar to cheilocystidia although more variable 25–35 × 6–16 μm, apex 3·5–5·5 μm, hyaline in potassium hydroxide and ammoniacal solutions intermixed with a few claviform cells at the base of the stipe about the lip of the bulb. *Pileipellis* a palisadoderm of pyriform to clavate cells up to 50 μm long and 10–28 μm broad, hyaline or some slightly yellowish towards base, with a few elongate cells some even differentiating into superficially rudimentary basidia. *Pileocystidia* absent or a few somewhat elongate, irregularly capitate cells. *Hymenophoral trama* or regular hyaline short cells 8–18 μm broad, thin-walled but some more swollen and even angular, thin-walled cells present up to 20 μm broad. *Clamp-connections* present. *Ammonia reaction* negative.

Amongst manured soil in greenhouses, propagation and cold frames etc. North America and Europe.

AMERICA. Mass., Boston, in mushroom beds, *E. T. Forster* (holo. NYS)—fig. 1 E. Boston, Mass., April, *G. B. Fessenden*. Haddonfield, New Jersey. *L. McIlvaine* (NYS)—fig. 1 G. In carnation bed in hot house, J. P. Morgan's Nursery, Highland Falls, Orange Co., New York State, *E. Palmer* 30 i 1906 (MICH, NYS)—fig. 1 H. In greenhouse, Salem, Boston, Massachusetts, 26 iv 1910, *W. H. Roper* (NYS). Menando, Albany, New York State, June, *Hailes* (NYS). Knock's Nursery, Detroit, Michigan, i 1913 (MICH—photograph in *Agaricaceae of Michigan* by Kauffman)—fig. 1 D. New York Botanic Garden, New York State, 23 ii 1940, *F. Seaver* (MICH). In greenhouse, Providence, Rhode Is, 26 vi 1942, *W. H. Snell* (MICH). In hot bed in greenhouse, Worthing, Indianapolis, Indiana, 14 iii 1949 *Cottingham* (MICH). Behind a pine windbreak, Ellensburg, Washington State, ix 1968, *A. Johnson* (E, MICH).

EUROPE. Belgium. In backyard on rich soil, Chatalet, vi-vii 1962, ex P. Heinemann, *Watling* G. 439 (slide in E). Britain. Central House, Royal Botanic Garden, Edinburgh, 16 vi 58, ex D. M. Henderson, *Watling* G. 438 (E)—fig. 1 F. Temperate House, amongst S African plants, Royal Botanic Gardens, Kew, 14 i 1967 and Australian House J, 15 i 1967, *D. Reid* (E, K) and 4 ii 1967 (E, K)—fig. 1 C. France. On old bonfire site, Valence-en-Brie, *M. Jean Vivien*, 4 v 1964, ex H. Romagnesi (slide in E)—fig. 1 B. Netherlands. In garden of C. Ph. Verschuetien, Roermond, 28 viii 1965 (L). In greenhouse on heavily manured soil, Kortenhoef, iii 1968, *J. Daams* (L.) In tomato house, Kortenhoef, 29 x 1968, *J. Daams* (L.) In greenhouses, Gravenland, Boekesteyn, 9 x 1968, *J. Daams* (L.) In cucumber house, Vleuten, J. Daams, *Watling* G. 1325 (E). In glasshouse, Kortenhoef, 10 v 1975, *J. Daams* (painted Mrs N. Ernste), *Watling* G 1381 (E). On manured soil, Hengelo, *M. Meyer* (*C. hebelomatoides*—holo. in herb. Reijnders; slide in E)—fig. 1 A.

ECOLOGY. From scanning the available data the following points would seem to emerge: i, the majority of collections are found in greenhouses or structures giving similar protection; ii, basidiocarps are invariably found early in the year (April to July); iii, basidiocarps develop on base-rich material probably high in both soluble potash and nitrogen.

One must be cautious in interpreting collections found in greenhouses etc., for their presence may be the result of a variety of unrelated phenomena. They may for instance have been introduced with soil or with plant material from abroad or other parts of the same country. They also may be fruiting under conditions rarely found in the wild in the same locality; in this connection Singer (1961) considers *C. intrusa* thermophilic but this has not been tested experimentally.

Romagnesi's collection was made at the site of an old bonfire and he speculated as to its connection with the presence of the American armed services in the area during the last war. Brigazzi's collection was from amongst *Freesia hybrida* and Daam's specimens were from manured soil in commercial cucumber glasshouses.

The Edinburgh material was found in the now demolished Central Glass-House amongst leafy debris on rich soil under an unnamed *Camellia*. Enquiries revealed that the site had previously been dressed with John Innes Compost No. 1 with a little additional animal manure. The house was maintained at a minimum night temperature of 45°C throughout the year. A watch for the reappearance of this fungus in other glasshouse structures has been kept but without success. At Kew the agaric appeared under very similar conditions where hop manure had been worked into the soil.

Atkinson's personal notes indicate: 'The gardener says the soil in which the fungus grew was sterilised by steam before being used. The carnation cuttings were grown in sterile soil planted out in the garden before being transplanted into beds in the greenhouse which had had a good dose of wood ash. The fungus was never seen in the garden only in the beds.'

The change in fungus flora about woodland bonfire sites or on sterilised plots is well known to field-mycologists; undoubtedly there is a change of soil acidity and/or chemical balance particularly in respect to soluble components, and this may explain the appearance of the basidiocarps. Mulching and application of fertilisers equally makes soluble nutrients readily available.

THE GENUS MELIDERMA

Interest in the genus *Meliderma* Velenovský (1920) was aroused by an interpretation of one of the original constituent species *M. crassum* by the distinguished Czech mycologist Melzer (1947). The figure accompanying his account depicts a species of *Conocybe* and from what is reported there is little doubt that the description is of a fungus of sect. *Gigantae*.

Meliderma was introduced by Velenovský to incorporate a species which had been previously placed in *Cortinarius* and another species from *Hebeloma*. It is significant that *Cortinarius* and *Hebeloma* are the self-same genera with which members of sect. *Gigantae* have been connected in the past. Velenovský's first species, i.e. *Hebeloma mussivum* (Fries) Saccardo has been chosen as type species of *Meliderma* by both Cooke (1953) and Donk (1962). There is some doubt as to the actual identity of this fungus and some authors especially Quélet (1888), Konrad & Maublanc (1930) and Henry (1935) have equated it with *Cortinarius percomis* Fr. a member of subgenus *Phlegmacium*, i.e. species with a viscid pileus. There is doubt as to whether their interpretation is that of Fries and, indeed the same as that of Velenovský.

The second species *M. crassum* was based on the Friesian species *Cortinarius crassus* but Josserand considered this erroneous too and in its place gave the invalid name *C. pseudocrassus*; Orton (1960) validated the name giving a full description based on material collected from Scotland. Ricken (1915) was also uncertain as to the true relationship of this fungus and transferred it to

Hebeloma but later (1920) to *Inoloma*, i.e. *Cortinarius*. Moser (1967) considered *C. pseudocrassus* to belong to *Phlegmacium* but my own field notes indicate that it really belongs to the recent subgenus *Sericeocybe* of *Cortinarius*. This continual taxonomic uncertainty parallels the problems in the history of *C. intrusa* only resolved after microscopic examination.

The late Dr A. Pilát (pers. comm.) reported that not all the taxa described by Velenovský in *České Houby* are preserved. Some species are missing and many of the collections which have been preserved are very mixed; some bottles of formalin contain as many as ten species belonging to a number of genera. A list of Velenovský's collections does not exist but Dr Svrček has made a preliminary inspection (pers. comm.) some results of which have been published (1966) but *Meliderma* was not included. What is certain is that Melzer's and Velenovský's interpretations do not agree.

From Melzer's illustration the young primordium resembles that of *C. intrusa* and the mature basidiocarps parallel the illustrations of Romagnesi (1964) and Reid (1968). However, turning to the basidiospore measurement the size range is very close to that given by Reijnders for *C. hebelomatoides*. Unfortunately Melzer does not illustrate a germ-pore—was this simply missed or was it so small? Could not Melzer have been confused as much as other authors and referred his collection of *Conocybe intrusa* wrongly to *Meliderma*? From all the information available this might be possible but because of the absence of material such a hypothesis cannot be confirmed. It is hoped that in the future material agreeing with Melzer's description of *Meliderma* will come to light.

How unusual is the tricholomatoid habit in the genus *Conocybe*? Two species, *C. hebelomatoides* and *C. intrusa* with which the former is equated, have been formally described and *Meliderma crassum* has been discussed above. Heinemann (pers. comm.) has drawn my attention to a possible third undescribed species from Belgium and hinted that *Naucoria bokotensis* Beeli is also possibly related. Romagnesi (1944) records a large fungus resembling *Inocybe asterospora* Quélet under the name *Galera bulbifera*, and two recent collections from Britain both have stipes over 80 mm long.

Whilst Heinemann's collection from Belgium and Melzer's from Czechoslovakia are undoubtedly related if not conspecific with *C. intrusa*, *Naucoria bokotensis* is a true *Agrocybe*, a genus in which the tricholomatoid habit is widespread and indeed can be considered characteristic for it.

The 1944 collection of Romagnesi, of which dried material has been examined, would be accommodated outwith any section erected to house *C. intrusa*. The stipe, although long, is fairly thin: the ratio of length/width being 20/1 whereas in *C. intrusa* and *C. hebelomatoides* the ratio would be 5/1. A bulky stipe is one of the most significant macroscopic characters of *C. intrusa* and reflects the nature of the entire basidiocarp.

The elongate stipe and the basidiospores with strongly developed germ-pore, more ellipsoid and larger dimensions tend in themselves to exclude Romagnesi's *C. bulbifera* from close proximity to *C. intrusa*. The two unnamed British collections mentioned above parallel Romagnesi's material.

Recent authors have expressed surprise when encountering *C. intrusa* and trying to reconcile the stature of the basidiocarp with the microscopic characters. Smith in an unpublished manuscript states 'the stature is unique in *Conocybe*' and Singer (1950) in response to these and his own observations erected a new section in *Conocybe* to accommodate it, although in error he referred to the fungus as *C. destrusa*.

Although tall taxa appear in other groups within the genus *Conocybe*, the robust nature of *C. intrusa* sets it aside, and when coupled with the fact that the basidiospores are fairly thick-walled and tending to be comparatively small, strongly or slightly compressed in one view, support is given to Singer's erection of a special section for this fungus. The developmental characters also support the retention of a distinct section since they do not indicate a close relationship between *C. intrusa* and any other group within *Conocybe*. By virtue of the lecythiform caulocystidia, sect. *Gigantae* is parallel to the pale coloured species placed in sect. *Candidae*, although there are greater similarities between this last and the *C. silignea* group i.e. sect. *Pilosellae*. The presence of lecythiform caulocystidia might suggest a relationship with the *C. tenera* group i.e. sect. *Conocybe*.

In retaining sect. *Gigantae* the following enlarged description is offered:—
Conocybe subgenus **Conocybe** sect. **Gigantae** Singer in Sydowia 2:36 (1948).

Pileus convex, expanding or not, thick-fleshy usually fairly brightly coloured in the range salmon buff to ochraceous buff, viscid under favourable conditions; *pileipellis* a well-developed palisadoderm but lacking distinctive dermatocystidia. *Stipe* robust, swollen at base, bulbous to clavate, white to yellowish (even primuline yellow), striate throughout or at apex only, with well-developed lecythiform caulocystidia.

Cheilocystidia lecythiform. *Basidiospores* fairly to strongly pigmented, darkening in aqueous alkali solutions, fairly to strongly thick-walled with either a small narrow and indistinct germ-pore or a distinct thinning at the apical end giving a small hyaline patch. *Basidia* pyriform to clavate, normally 4-spored. Development typically gymnangiocarpic.

Basidiocarp developing on base-rich and nitrogen-rich soil in some way connected with man.
Type: *C. intrusa* (Peck) Singer.

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