

CYSTIDIA IN THE GENUS CLAVARIA AND SOME UNDESCRIBED SPECIES*

CALVIN H. KAUFFMAN

THE sudden and recent revival of constructive taxonomic studies in the genus *Clavaria* has resulted in three publications which have appeared since 1919. First, a careful revision of the species found in Great Britain, entitled *A Revision of the British Clavariae*, by A. D. Cotton and E. M. Wakefield (3). Next came a most useful compilation of the descriptions of all American species, accompanied by a critical study of the type material of each species, — a publication that had long been needed by those mycologists who do their own thinking, for the descriptions of American species had become numerous and were published in widely scattered places. This work was ably done by Dr. E. A. Burt under the title: *The North American Species of Clavaria with Illustrations of the Type Specimens* (1). Finally, in 1923, Professor W. C. Coker published a well-illustrated volume, *The Clavarias of the United States and Canada* (2), which bids fair to open up for good this interesting group of fungi for all American students.

There is still much uncertainty as to the variability of mature spores in any one species of the genus *Clavaria*. Coker allows much latitude and, as a result, synonyms pile up in his book. Considering that his excellent plates of the spore characteristics are so clear-cut and decisive, one cannot understand the apparent inconsistency in the great variability often shown by the spore measurements given in the text. My own experience, based almost entirely on the examination of fresh plants in good condition, does not bear out the implied conclusion to be derived from

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Coker's records, that the same species may produce spores of markedly different sizes in different individuals of a species.

The trouble appears to be referable to one of two categories: Either two or more different forms are forced into one species, perhaps by including collections which are not normal or not in condition to be identified; or, immature or abnormally large spores are taken into account in making the spore measurements. As I have often pointed out, only mature spores should be measured, and abnormally large spores should not be given undue emphasis within the range of the spore size given. In this genus, to be sure, maturity of spore is not so easily determined because of the hyaline or pale-colored exospore. The spores of a plant that has developed rapidly to full size may, nevertheless, be largely immature. Hence, whether one employs biometrical methods or direct judgments in obtaining the range of spores in a series of mounts, there is likely to be some discrepancy between the results of observers. But after all, caution and experience bring one's results into harmony with those of other careful workers.

But discrepancies also arise from other causes. For example, a type collection may be composite; or both young and mature plants may be present in a type collection. When two observers, as happened with reference to Peck's type of *Clavaria nebulosa*, report decidedly different spore-sizes, something of the sort is likely to be the cause. Dr. Burt records the spore-size of this type collection to be $6-7 \times 3-3.5 \mu$, while Coker gives it as $7.4-11 \times 3.6-4 \mu$. This difference is doubtless accounted for by the presence of specimens or parts of specimens with a young hymenium. Through the kindness of Dr. House, I was able to examine the type specimens of this species also, and found the spores agreed with the measurements given by Coker. Both these observers, however, failed to note that cystidia are present in the hymenium of this plant. This case also illustrates the weakness in the assumption that conclusions drawn from an examination of "types" are infallible as a starting point in its nomenclature. If the type plants and therefore the spores are immature and the measurements become a part of the type description, it may be difficult ever after to know what collections are identical with it.

The occurrence of *cystidia* in the hymenium of any of this group seems to have been overlooked, with perhaps the single exception of *C. pyxidata* Fr. (Coker, p. 92). Such structures usually do not occur in Clavariaceae. In my studies of this group during the past years, whenever fresh material afforded me the opportunity, I have been able to establish the existence of *cystidia* in a limited number of species. One of these, *C. nebulosoides* Kauff., has been described in another place (5); while a second one was temporarily referred to *C. fumosa* Fr. (4).

CLAVARIA PURPUREA

Specimens from Europe, under the name *C. purpurea* Müll., were distributed by Sydow in Mycotheca germanica, No. 1833.¹ The hymenium of this collection is provided with fairly abundant cylindrical *cystidia*, which are rounded at the apices, and are hyaline, almost smooth or minutely granulate; they measure about $75-85 \times 7-8 \mu$ and project about a quarter of their length above the 4-spored basidia. No record, as far as I can find, is extant concerning their occurrence in this European species. I have a collection from Leal, Colorado, published in a list as *C. fumosa* Fr. (4), which is apparently the same plant, and which also possesses such *cystidia*. Its spores measure $7-9 (10) \times 3.5-4.5 \mu$. Coker (2, p. 53) notes a collection by Clements now at the New York Botanical Garden, also from Colorado, with spores given as " $8-9 \times 3 \mu$ "; it is very probable that Clements' plant is just the same as these others, and *cystidia* should be looked for.

If now Coker's plants from North Carolina have no *cystidia* and notably longer spores, " $8.5-12 \times 3.7-4.5 \mu$," we can assume at least two species confused under this name both in Europe and the United States. The habitat of Sydow's and my own collection is the same, viz. under fir in the mountains. This is also the habitat given by Fries (*Hymen. Europaei*). The species of Coker, with large spores and no *cystidia*, seems to occur under pines, since both Coker's plants and a collection of Karsten's

¹ A one-half per cent solution of KOH was used with all dried material examined.

from Finland were found under pines. No one can say, of course, whether the species figured in *Flora Danica* had cystidia or not, or what its spore-sizes were.

Assuming that the *C. purpurea* of Coker and the plant of Sweden from Romell which Coker studied, as well as Karsten's plant from Finland, possess no cystidia, what described species is available under which these collections can be placed? The first one that comes to mind is *C. fumosa* (Pers.) Fr. Specimens distributed by Sydow under this name (*Mycotheca germanica*, No. 454), a copy of which I have examined in our herbarium, and which Coker examined at Kew, seems to be entirely without cystidia in the hymenium. Coker reports the spores of this to be $5.5-8 \times 3.4-4 \mu$, with which the spores of our copy practically agree. My measurements run $6-8 \times 3.5-4 \mu$. But this cannot be Coker's *C. purpurea* of which the spores, according to Coker, measure $8.5-12 \mu$ long.

Could it be *C. nebulosa* Pk.? As I have already stated (p. 142) this species has cystidia and the spores tend to reach the length of Coker's plant. The latter, if it is found to possess cystidia, is therefore very likely *C. nebulosa* which retains its autonomy.

Clavaria purpurea Fr. (Emended)

C. fumosa Kauff. (4, p. 124).

FRUCTIFICATION fleshy, slightly tough when fresh, soon brittle, composed of dense fascicles of simple clubs. CLAVULAE 5-8 cm. high, 2-5 mm. thick, sometimes forked near the base, without definite stipe, smoky gray with tint of purplish, concolorous within, whitish at base, strict, acuminate upwards but with obtuse apex, usually more narrow at base, hence somewhat elongate-fusiform, subcompressed, often longitudinally furrowed, hollow or the tubule vanishing because of compression.

Microscopic characters: SPORES oblong, $7-9$ (10) \times $3.5-4.5 \mu$, smooth, hyaline or obscurely tinted by the color of the hymenium. BASIDIA 4-spored, slender, subclavate. CYSTIDIA rather abundant, cylindrical upwards, narrowed below, hyaline, $75-85 \times 5-8 \mu$. ODOR and TASTE none.

Growing in abundant, gregarious clusters on the ground in a dense forest of Engelmann spruce and Alpine fir. Collected at Leal, Colorado, August 20, 1917, by C. H. Kauffman.

If the exsiccati and recent accounts of the European *C. fumosa* (Pers.) Fr. are correct, then the Colorado species differs from it by possessing cystidia, by its larger spores, by its colors and by its forest habitat. It differs from *C. nebulosoides* Kauff. (5, p. 118) which also has cystidia in the hymenium, by its stouter habit without a definite stipe, larger spores, color and by its cespitose mode of growth; furthermore in that species the cystidia are lanceolate, each with acute apex. The size to which either may attain is of course not sufficiently known, and further collections may show that the range of the two species is very similar in this regard. This species and *C. fumosoides*, sp. nov., also have much superficial similarity.

Clavaria fumosoides, sp. nov.

FRUCTIFICATION fleshy, very fragile, composed of dense fascicles of simple clubs which are often somewhat joined at base. CLAVULAE 5-8 cm. high, 2-4 (5) mm. thick, more or less fusiform, i.e. rather regularly narrowed to both ends, gray-lavender, white-mycelioid at base, apex blackened by the sun, not stipitate, minutely pruinose, solid and subconcolorous within, often compressed and furrowed.

Microscopic characters: SPORES oblong, 5-6 (7) \times 3.5 μ , smooth, hyaline. BASIDIA elongate, 70-75 \times 7-8 μ , 4-spored. CYSTIDIA abundant and crowded in the hymenium, subcylindrical to cylindrical, slightly tapering downwards, rounded-obtuse, hyaline, usually granular within, 110-130 \times 5-7 (8) μ , base imbedded in subhymenium. ODOR slight, earthy; TASTE tardily subnauseous.

Growing in gregarious tufts in an open grassy slope near lake. Type collected at Lake Quiniault, Washington, October 20, 1925, by C. H. Kauffman.

This is close to *C. fumosa* (Pers.) Fr. in spore-size, habit and color as these characters are given by Cotton and Wakefield (3) and by Rea (6). However, the presence of very abun-

dant and prominent cystidia, the long basidia, the solid stem and the taste could hardly have been overlooked by these writers. It differs from *C. purpurea* Fr. by its spore-sizes, solid stem and habitat; also by tints of lavender which are diffused in the otherwise dark gray color. The minute pruinosity is caused by the projecting cystidia.

Clavaria piperata, sp. nov.

FRUCTIFICATION fleshy, slightly toughish, pallid to cinnamon-brown, paler upwards, 4-6 cm. high, from a single stem or slender trunk, which is about 2-3 mm. thick, dichotomously to polychotomously branched; secondary branches pyxidate, at times candelabra-form, curved-spreading at maturity, loosely arranged; primary and secondary branches dilated upwards, with rounded, obtuse sinuses, branching repeated four or five times, terminal branchlets acutely pointed.

Microscopic characters: SPORES suboval to subglobose, $4 \times 3 \mu$, smooth, slightly ochraceous-tinted under the microscope. BASIDIA elongate, slender, $45 \times 4 \mu$, 4-spored. CYSTIDIA or cystidia-like conducting organs are present; these project about 12-15 μ above the hymenium, slender, 2-3 (5) μ thick, narrowly lanceolate, subhyaline, extending deeply into the trama. TASTE peppery, leaving a distinct burning sensation in back of throat; ODOR none.

Growing on conifer logs, gregarious-scattered, in virgin forest of Douglas fir, Western hemlock and spruce. Type collected at Lake Quinault, Washington. November 2, 1925. Collected by C. H. Kauffman.

This has the growth habit and general appearance of *C. pyxidata* Fr., but differs from the latter by the colored, differently shaped spores, its peppery taste, different color when fresh, and its coniferous substratum. *C. pyxidata* seems to be largely limited to poplar and willow around Ann Arbor. Fries, who collected in a coniferous region, says (*Hymen. Europaei*) "ad ligno putrida. Speciosa in Populo tremula." European notices are scanty with reference to its substratum. Schroeter (7), however, reports it as if on pine alone. Does this mean that

two species occur also in Europe? In all accounts accessible, no mention is made of a peppery or acrid taste in *C. pyxidata* except by Coker (2). An examination of my collections of *C. pyxidata* in the herbarium failed to reveal any cystidia. Here too, Coker seems to report them for the first time. It is entirely probable that the two species occur in the Appalachians, and that some of Coker's plants, those with acrid taste and cystidia, grew on coniferous wood-remains. The spores of the species on poplar are narrow, subfusiform-oblong, hyaline, $4-5 \times 2-2.5 \mu$. The spores of *C. acris* Pk. are echinulate and ochraceous, and the plant has a different growth habit.

Clavaria cystidiophora, sp. nov.

FRUCTIFICATION fleshy, moderately fragile, 10-12 cm. high, inclusive of immersed stem, branched, color varying between "buff yellow" and "warm buff" (R.),¹ apices of the ultimate branches "citron yellow," paler towards the extreme base of stem which is white. MAIN STEM long, immersed and sometimes tufted at very base, 5-8 cm. long, 10-12 mm. thick just below first branching, tapering downwards, ascending or decumbent; primary branches 5-6 or less in number, elongated, solid, whitish within; secondary branches about 3-4 mm. diam., terete or nearly so, becoming repeatedly short-branched, apices of ultimate branchlets acute or subacute, sinuses of all branching obtusely rounded.

Microscopic characters: SPORES oblong, $5.5-7 \times 3.5 \mu$, smooth or obscurely punctate under highest power, tinged ochraceous-buff. BASIDIA elongate, $75-80 \times 5-6 \mu$, 4-spored; sterigmata slender. CYSTIDIA scattered in hymenium, cylindrical upwards, narrowed below, obtuse, $50-70 \times 5-8 \mu$, variable in length and thickness, collapsing in older plants and then hard to recognize. ODOR of anise, very noticeable; TASTE mild or slight.

Growing in deep banks of humus in virgin forest of Douglas fir, cedar and hemlock, Lake Quiniault, Washington. October 17, 1925. Collected by C. H. Kauffman.

¹ Ridgway's *Color Standards and Nomenclature*, 1912.

The plants have the size, habit and somewhat the color of pale forms of *C. flava* Fr. The species is distinct by its cystidia, spore-characters and odor, and to a less degree by its color and mode of branching. The main stems arise from a common point, so that a larger number of plants form a good-sized tuft.

Clavaria globospora, sp. nov.

FRUCTIFICATION simple, 6-8 cm. high, strict, subcylindrical, terete, even, glabrous, pale "cream buff" upwards, almost "colonial-buff" (R.) downwards, solid, fertile portion 1.5-2 mm. in diameter, sterile stipe portion comprising the lower fourth or fifth, 1-2 mm. in diameter, apex obtuse to subacute, base inserted and naked, without sclerotium.

Microscopic characters: SPORES spherical, 5-6 μ , hyaline, smooth. BASIDIA narrowly clavate, 60-65 \times 4-5 μ , *bi-spored*. CYSTIDIA none. ODOR and TASTE none.

Scattered-gregarious on very rotten wood of conifers in swampy forest of hemlock, Douglas fir and spruce. Type collected at Lake Quinault, Washington, October 28, 1925, by C. H. Kauffman.

What generic limits will eventually be given the genera *Clavaria*, *Pistillaris* and *Typhula*, further studies must indicate. At present there is no fixed line between the simple *Clavariae* and the other two genera. Schroeter's scheme (7, p. 438) of basing the separation on the number of spores to a basidium has fallen down. I have found quite a number of species of *Clavaria* with 2-spored basidia. The same is true of *Agarics*. The term "slender" sometimes used to designate a difference between *Typhula* or *Pistillaris* and *Clavaria* is also vague, whether applied to the whole fruit body or only to the stipe. The sclerotium is not used consistently as between *Typhula* and *Pistillaris*. The species just described seems to be as good a *Clavaria* as many others. It differs from *C. appalachiensis* Coker in the fact that the stipe is not yellow and scarcely contrasts in diameter with the fertile portion, nor is it subtomentose at base, but inserted and smooth. The clubs are very nearly cylindrical and

even, not in the least ridged or furrowed; the spores when fresh are truly spherical, and the basidia 2-spored.

Clavaria maricola, sp. nov.

(*Maricola* — from *mas*, 'male,' and *colo*, 'I inhabit')

FRUCTIFICATION simple, fleshy, erect, surface "light orange-yellow" to "orange-buff" (R.), 7-10 cm. high, slender, 2-6 mm. thick, subequal above the basal portion which tapers downwards (rarely very slightly fusiform), erect, more or less compressed but *solid* and white inside the hymenial layer, sometimes twisted and longitudinally furrowed, glabrous, not conspicuously brittle but becoming soft at base in age.

Microscopic characters: SPORES subcylindric, obtuse, hyaline or very slightly tinted with yellowish, $10-14 \times 4-5 \mu$, smooth, minutely granular within. BASIDIA slender, $108-112 \times 4-5 \mu$, 4-spored, rarely 2 or 3-spored. CYSTIDIA none. ODOR and TASTE mild.

Gregarious and often abundantly so; occurring on needle beds of Western yellow pine, attached mostly to the male cones, rarely on the needles. Type collected at Takilma, Oregon, in Siskyou National Forest, November-December, 1925. Collected by C. H. Kauffman.

I am well acquainted with *C. ligula* as it occurs in northern Michigan, in the Adirondack Mountains and elsewhere, and this western species is radically distinct by its form, its colors, its habitat and habit, but less so by its spores. By its copiously gregarious mode of growth alone, it departs far from the often solitary or sparse occurrence of *C. fistulosa* and its allies; the latter have hollow stems. Very rarely luxuriant specimens show the ligulate form, but far more often it is subequal in the upper three fourths of its length. In age and especially after rains, the base of the stem becomes very soft, so that all the plants bend over or collapse. When fresh and young it has more of a pale vinaceous-buff color, but at maturity and when dry its colors are as described above. Its selection for the most part of the old fallen male cones is unique.

CLAVARIA SUBBOTRYTIS Coker

FRUCTIFICATION 4-10 cm. high, fleshy, fragile, dichotomously branched, branches arising from a main trunk, color of upper portion intense and beautiful in the fresh growing condition, every portion of the upper two thirds "begonia-rose" to "geranium-pink" (R.), trunk white shading upwards into the bright colors, all parts gradually fading in wind or sun to shades of rose-incarnate or salmon-pink. TRUNK short, 1-3 cm. thick and high, abundantly branched above, whitish or white, concolorous within, unchanged by bruising; main branches generally crowded, 5-10 mm. thick, secondary and apical branches 2-3 (4) mm. thick, slightly divaricate-curved, dilated below the sinuses, longitudinally furrowed or wrinkled, with obtuse sinuses, apical ones with short, obtuse tips, 1-1.5 mm. diam.

Microscopic characters: SPORES cylindrical, 7-9 (10) \times 3-3.5 μ , subhyaline with pink tint under the microscope, "pinkish buff" (R.) in mass, smooth, CYSTIDIA none. ODOR and TASTE none.

On the ground, among humus or leaf-mold in forests, especially conifers. Ann Arbor, Michigan, August 2, 1912; Lake Cushman, Washington, October 4, 1915; Takoma Park, Maryland, September 1, 1919; Mt. Hood, Oregon, September 30, 1922; Mt. Gretna, Pennsylvania, September 7, 1924; Lake Quinault, Washington, October 6, 1925. All collected by C. H. Kauffman.

The description is drawn from plants of my own collections.

This is a relatively rare species but is widely distributed as can be seen from my list of localities. Coker reports it only from North Carolina. The following comments were written before seeing Coker's book, in which there are two good photographs of it.

It must have been seen by others from time to time in this country and was doubtless referred to one of the old species, like *C. formosa* (Pers.) Fr., although it cannot possibly fit the modern European concept of that species. It differs from *C. formosa* in the entire reversal of the color changes during development, and by its smooth and smaller spores. It becomes quite

a different looking plant after full maturity when faded, but a cluster of it in vigorous young growing condition is a most beautiful forest object as seen against mosses and debris where it grows. Although mostly found in conifer or mixed forests, it was found also in an oak woods near Ann Arbor.

The name selected by Coker is unfortunate, because to my mind *C. subbotrytis* does not remind one of similarities with *C. botrytis* Fr. It seems to me quite uncertain whether the plant Coker has called *C. botrytis* can be accepted as that species. In any case, both "*C. rufescens* Schaeff." and *C. botrytis* as conceived by Coker are subject to debatable nomenclatorial questions, entirely apart from their doubtful identification.

UNIVERSITY OF MICHIGAN

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