CLAVARIA, A TAXONOMIC STUDY OF
THE GENUS IN OREGON

by

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CLAVARIA, A TAXONOMIC STUDY OF
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PART I

LITERATURE REVIEW, AND CERTAIN EXPERIMENTAL
AND PHILOSOPHICAL CONSIDERATIONS

Introduction

Recent taxonomic revision of the several families of the higher basidiomycetes by various workers, as for example, the studies of W. H. Snell, Lester Miller, and D. P. Rogers, respectively, on the Boletaceae, Hydnaceae, and Thelephoraceae, and that of S. M. Zeller on the gasteromycetes, along with many studies on the Polyporaceae and Agaricaceae by William Bridge Cooke, Alexander Smith, and others, has left only the Clavariaceae awaiting interpretation in the light of modern understanding of classification, phylogeny, and nomenclature.

This thesis represents the author's introduction to the heretofore neglected Clavariaceae. It is a study intended to be a precursor to detailed investigations of a comprehensive and consummate nature. The work here presented is divided into two parts. The first part constitutes a prefatory consideration of the literature, particularly the monographic treatises of various authors, along with the original observations and comments of the
writer. The second part, with accompanying plates, constitutes a taxonomic treatise of the members of the genus Clavaria in Oregon, collected and examined by the author during 1940, in combination with reports of certain other genera or species. The components presented have been studied in the light of present day concepts of classification. Innovations involving nomenclatorial modifications, even though desirable, have been avoided until further studies indicate such changes to be warranted. The reader will, therefore, find the thesis of the nature of a summary of our knowledge, up to 1941, of Clavaria in Oregon.

A survey of the literature

The term Clavaria was used loosely by such eighteenth century writers as Schaeffer (1763) and Linnaeus (1775) in the second edition of Flora Suecica. The mycological nomenclatorial horizon is considered to be 1821; at this time Fries in his Systema Mycologicum (part 1, 1821) revised the Clavariaceae. It is to his work, therefore, that we turn for the earliest authoritative comment. Fries conception of the Clavariaceae embodied the genera Geoglossum, Mitrula, Spathularia, Crenula, Typhula, Pistillaria, and Clavaria. Of these genera, nowadays, only Typhula, Pistillaria and Clavaria are con-
sidered as belonging to the Clavariaceae. *Clavaria*, in Fries' treatment was divided into three sections: Botryo-
cideae, composed of the large terrestrial branched forms; Ramaria, including all the attenuate-branched main-stalked forms; and Corynoidea, embracing those simple forms fasci-
cicled or caespitose, along with the solitary or gregar-
ious clavulae. In 1824 there appeared an issue of Fries' *Observations Mycologicae* which has been discovered to be merely the 1818 edition of the same work with a different title page inserted (Rogers, 1939). If it were truly a second edition of 1824 it would occupy an important place in our literature for a good many important references to the Clavariaceae are made on its pages. Little progres-
sive or consistently sound work was contributed during the remainder of the nineteenth century and for the pur-
poses of a preliminary study of the Oregon species of the family, Clavariaceae, they will not be found of importance.

The first monograph of a systematic sort which, attempted to separate families, genera, and sections of genera upon natural ground with any degree of success was *Essai taxonomique sur le genre et les familles des Hyomen-
ymycetes* by Narcisse Patouillard (1900). In this work Patouillard discards the Friesian criterion for delinea-
tion of families and genera, viz. form of the fructifica-
tion, and adopts an entirely new set of criteria based upon hymenial morphology and spore character. In his
treatment the hymenomycetes are divided into Aphylllophoraceae, Agaricaceae, and Gasteromycetaceae. The latter two are respectively: hemiangiocarpous forms with a definite inferior (or lateral?) hymenium covering gills; and true angiocarpous forms. The Aphylllophoraceae are characterized by their gymnocarpous nature and indefinite, usually amphigenous or unilateral, hymenium. Patouillard further defined this family by its hymenium which is smooth at first but may become configured through the proliferation of warts into spines or tubes by indefinite or indeterminate growth. Likewise he makes a point of the condition that increase in size of hymenial configurations is by the production of new basidia between the already existing hymenial elements and the apex of the configuration. This results in the older hymenium being toward the base of the supporting structure whether spine, pore, or club.

Patouillard divided his Aphylllophoraceae into two tribes in which the resupinate, pileate, or stipitate members with an inferior hymenium are relegated to the tribe Porohyndes, and the dendroid forms with an amphigenous hymenium to the tribe Clavaries. Clavaries is further divided into three series, Thelephores, Clavaries, and Physalacries. The first, Thelephores, is characterized as tough or indurate and is composed of the genera Cristella, Pterula, Thelephora and Lachnocladium. The two remaining
series (Clavaries and Physalacies) are fleshy. They represent a developmental series characterized by increased restriction of the hymenium to a stipitate enlarged or inflated surface. The first of these series, Clavaries, is distinguished from the second, Physalacies, by the hollow head-like receptacle of the latter which is turned back upon itself. The former is composed of Sparassis, Clavaria, Typhula, Pistillaria, Ceratella, Pistillina, and Hirsutella; the latter of Physalacia and Baumanniella. The genus Clavaria in itself becomes further divided into Ramaria (branched forms) and Clavaria (simple forms) and each of these into two subsections, leucospores and ochra-}

In chronological order, Maire's (1902) cytological studies next merit consideration. Maire investigated nuclear phenomena in the basidium in three species of Clavaria and found them all to be stichobasidial. From this observation he proposed the Clavarias to be an extension, involving basidial modification, of the Dacryomyces line from Calocera. Juel (1916), who made a much more exhaustive study of the cytology of Clavaria found that Maire's conception of the nuclear phenomena in Clavaria resulted from the fact that Maire had chosen only three species for his study all of which happened to be stichobasidial. Juel investigated fifteen species and found only five, including Maire's three species, to be
stichobasidial. The rest were chiastobasidial. From this he concluded that the nuclear phenomena were of little value in determining generic or phyletic affiliations among these forms, and that likenesses displayed by Calocera and Clavaria were but parallelism.

During the later part of the nineteenth and early part of the twentieth century Charles Peck, at the New York State Museum, illustrated and described a large number of Clavarias from North America. His efforts, published for the most part, in the bulletins of the New York State Museum, are among the most valuable contributions to American mycological literature and were the pioneer studies of the Clavariaceae in this hemisphere. George A. Atkinson (1908, 1909), also, published two papers which contain careful descriptions of a number of the American species. His complete, careful descriptions and spore studies demand our most careful attention.

About this same time Cotton, in England, published a series of papers (1906, 1907, 1909, etc.) including careful analyses of many of the more confused species. These papers, along with the monograph by Cotton and Wakefield (1919) treating the species of Clavaria found in the British Isles, are particularly noteworthy, since their work was based on exacting morphological and taxonomic comparisons. In 1922 Carleton Rea (1922) published his monograph of British hymenomycetes. No
comprehensive British treatise has appeared since.

Returning now to the literature of the Western Hemisphere, we find the first monograph of North American species in E. A. Burt's compilation (1922) of all recorded data and descriptions of American species, along with plates figuring the type specimens. The arrangement is that of Fries, based on superficial form, but as this is used only as a means of keying and arrangement it is not confusing. Burt's monograph was intended only as a compilation of the literature and knowledge of Clavaria up to that time, and tho it embodies a good many errors it is a very valuable source work. Burt's work was closely followed by another monograph of North American species by W. C. Coker (1923). Coker's work, while excellent in most respects, must be used with caution in certain sections. The introduction of the genus in eleven sections based upon growth habit and spore characteristics, along with the careful attention given to illustration, both of microscopical details and entire fructifications, as well as critical analyses of many of the less well-known species and synonyms, destine this monograph to a permanent place of importance.

_Hymenomycetes de France_ by Bourdot and Galzin (1927) closely follows Patouillard's arrangement in that these authors adopt his Aphylllophoraceae and subdivisions of this family. There are nine genera distinguished
among the French hymenomycetes that Bourdot and Galzin would place in the Clavariaceae, among these are *Sparassis* and *Thelephora*. The Japanese Archipelago is the only other region of the world in which the *Clavaria* flora has been studied. Here Sanshi Imai produced a series of papers (1929, 1930, 1931, 1934) in which many new species are described. It is curious to note that in his treatment the nomenclatorial procedure of citing an authority from Fries (1821) work appears as for example: *C. cristata* Fries ex Holmskiold instead of the usual procedure in which the authorities names would be reversed.

Calvin H. Kauffman and S. M. Zeller each have published a number of papers concerning our Pacific Coast species of hymenomycetes. These papers published during the past twenty years in part, represent the basis upon which the present summary of our knowledge of the genus *Clavaria* in Oregon has been built. Papers by G. W. Martin and by W. C. Coker complete the important taxonomic literature in the field since 1900 with the exception of occasional noteworthy papers by such authors as Edward T. Harper. No comprehensive monograph of the genus has been undertaken and completed; so today there are in the literature about four hundred specific names. Many of these are unrecognizable or hopelessly confused and many of the rest are based upon teratological or poor material.
The Clavaria life cycle

The life cycle of a Clavaria insofar as it is understood is simple. Upon germination, the basidiospores, as is typical of homobasidiomycetes, produce monokaryon mycelium without intermediate production of conidia. The spores of Clavaria stricta in one of the Oregon State College collections (no. 6039) were seen to have begun germination. The first evidence of germination was the appearance of one or few hyaline swellings in the distal half of the spore (Plate I, figure 1). These germinating spores were observed in different stages of development and one spore was seen to have a short-branched mycelium. There were no clamps on this slender first mycelium. It appears likely that the vegetative assimilative phase is monokaryon mycelium ramifying the humicolous or lignicolous substrata, or as in C. mucida, intermingled with algal associates. Just where the transition to the dikaryon phase takes place or how it is brought about is unknown. All mycelium when identified from the fructifications in or about the base has been found to be dikaryotic.

Mycelial anlage which are the immediate precursors of Clavaria fructifications are first visible in the substratum as white shapeless masses of mycelium show-
ing no differentiation. Later the mycelial connections between these knots and the substratum may become thickened into simple rhizomorphic strands, the inner portion of these strands becoming more solid results in definite rhizomorphs. Weir (1917) reports three species of *Clavaria*, and *Sparassis radicata*, to have a sclerotioid base which lives more than one year and from which the fructifications arise. According to Weir, in *Sparassis* a fleshy protuberance appears apically on the sclerotioid body. The same phenomena have been observed by the author to precede the formation of young *Clavaria* fructifications, i.e. the formation of mycelial knots from which a small fleshy protuberance appears. This protuberance enlarges radially and in a linear direction until the trunk's approximate mature diameter is reached. At this time this young fructification may be only a fraction of the mature height but will more nearly approximate the diameter of the mature fruit body. At this stage the first two or three orders of branches become distinct from the upper part if the individual is a member of a branched species. In this early period the branches like the trunk are very short in comparison to their mature length. Further growth is by the elongation of branches and trunk. The hyphae of these structures are, for the most part, parallel to the axis of growth.
In simple forms which are enlarged above or are hollow, the enlargement is accompanied by the growth of hyphae in radial or tangential directions, the first direction being responsible mostly for enlargement and the second for hollowness. Any further increase in diameter other than the above is by the divarication of hyphal branches from their longitudinal course and their passing outward to the surface where they produce, secondarily, the hymenium overlying the deeper sterile subhymenium. Not infrequently the trama is composed of hyphae of two or more sizes or of hyphae irregular in diameter. In one apparently undescribed species from Japan (Plate III, figure 1) brownish thick-walled hyphae run throughout the fruit body and end in pointed setae protruding through the hymenium.

The hymenial layer arises as a dense palisade of hymenial elements formed through clamp proliferation, in a manner similar to that described by Rogers (1936) for the formation of basidia in *Sebacina*, or by Wheldon (1936) for the same process in *Peniophora* and other hyrenomycetes. Linder (1934) states one of the differences between *Myxomycidium* and *Clavaria* to be the lack of typical basidial systems in the later. These systems of basidia from clamp connections have been observed by the writer (Plate I, figures 2 and 3) many times in different species. It is the lower parts of such basidial systems
that the chief constituents of the subhymenium. This layer may be quite thick, or thin, and is frequently indistinct. Certain complexities of hymenial structure often occur. These may be in the form of reduplicate layers of hymenium usually containing imbedded spores, or they may be expressed as various sterile organs. These sterile organs are setae, as mentioned above, elongated cystidia, protruding through the hymenium, or inflated gloeocystidia-like cells. Rarely they are quite slender and paraphysoid in nature. In a few species the cystidia are encrusted. Crystals may be present among the subhymenial hyphae or imbedded in the trama. Only a few discussions of Clavaria species by previous workers mention specific instances of the occurrence of these several complexities. Coker (1923), however, often refers to layering of the hymenium, and Kauffman (1927) points out the often disregarded taxonomic value of cystidia.

The basidia at first are simply the terminal branches of hyphal systems aligned in a palisade over the surface. Following the immigration of two compatible nuclei, segregated by dikaryotic divisions and a resultant basal clamp, each young basidium elongates and swells, assuming a more mature appearance. The basidium of the Clavarias is quite constantly long clavate, usually
largest near the origin of the sterigmata or just below. Variations occur in length relative to diameter, or in flattness of the apex; some basidia are quite tortuous while others are very regular, and a few are conspicuously granular. Often, just prior to spore maturity, the basidia seem to swell and protrude beyond their less ripe fellows. After spore discharge they usually appear quite empty and may either disintegrate or remain conspicuous and empty, evidencing their senility.

The two nuclei allotted to the basidium pass from their last telophase into apparently normal interkinetic states. They advance towards the apex of the basidium and arrive close to the most broad part where they appear to become inflated before fusion. The fusion nucleus, the only diploid nucleus, is many times larger than the two pre-fusion nuclei together. The chromatin material is evenly and finely dispersed throughout the mass. Preparation for the reduction divisions which follow is through an orderly procedure of prophase events.

Basidial nuclear fusion and reduction initiates a not well understood phase into the life history of the Clavariaceae. Spores are produced following nuclear fusion and the reduction divisions. Typically there are three divisions in the basidium resulting in eight nuclei. The third division may be retarded until the nuc-
lei are in the spores or may be entirely supressed. The nuclei are produced and distributed by either one of two types of nuclear division patterns, chiastobasidial or stichobasidial. These division patterns are quite specific and are associated with the production of two and four-spored basidia. This phenomenon has been studied carefully by Bauch (1927) and Smith (1934) as well as by Maire and Juel in their previously cited papers.

The writer's observations have shown the sterigmata to appear first as hemispherical protuberances evenly spaced about the apex of the relatively mature basidium. These hemispherical protuberances are pushed up and away from the basidium by growth at their margins until the sterigmata appear as blunt projecting digitate structures evenly erect from the apex of the basidium. Further prolongation of the sterigmata results first in short acute tips and later in slender tapering forms which may be curved or quite straight, but usually end in very fine filamentous points. Formation of the sterigmata may be simultaneous as in most species or irregular. Sometimes only one is formed (Plate I, figures 4b and 4d). In any case sterigmata formation and spore development are accompanied by vacuolization of the basidial contents (Plate I, figures 4 and 5). When the stigma is very nearly mature the spore appears as a minute enlargement of the sterigmal tip. This swelling is so
small at first that it has been difficult to ascertain whether or not its axis is symmetrical with that of the sterigma. As soon as it has enlarged to a size where it can be readily seen, it is obliquely attached to one side of the sterigmal axis. The swelling (apiculus) becomes well formed before an extrusion or inflation of its distal end enlarges to form the body of the spores. The sterigmata of developing spores, in two species, were seen to be attached more to the side of the apiculus (Plate I, figures 5 and 6) than to the spore body proper.

By visualizing the formation of the spore and its development, often the identity of aberrant spores may be determined. In some cases the spores of different species, whose spores are nearly the same size or of overlapping size-ranges, can be separated. In the Formosa section later described considerations of this sort are invaluable. Such a condition is illustrated by the difference in spores, other than surface configurations, displayed between the two species _C. flava_ and _C. formosa_.

Spores of _C. flava_ (Plate I, figure 7) enlarge from their minute beginnings as though they were being inflated continuously, the distal end increasing constantly in size or remaining nearly even until the spores are almost fully mature. This results in spores that are larger in the distal half. On the other hand the
spores of *C. formosa* (Plate I figure 3) enlarge to full diameter in the center and then if over-long they appear as though enlarged in the proximal half; the distal half usually being noticeably more slender. This is the only sure way known to the author of separating dried material of these two species.

In the ochraceous spored species the spore wall at maturity becomes hard and impervious approximately in proportion to the intensity of the color. The hyaline spored species usually have thin-walled spores that are penetrable by dyes and water. In the genus *Clavaria* if the spores on a slide take up aqueous phloxine stain it seems to be sound reasoning to conclude the spores to be hyaline or immature. In the ochraceous spored species, most often the spore wall is roughened by spines, warts, granules, verrucae or papillae, characteristic for the species involved. These are often absent or imperfectly formed in immature spores even though the spores are of full size. Therefore to obtain mature spores and to ascertain the color, spore prints are desirable.

All the spores on a basidium, at least in the ochraceous species studied, reach maturity at about the same times. Buller (1922) studied spore discharge in *C. formosa* and found it to be entirely typical and like other homobasidiomycetes. When the spores were mature,
weather conditions being favorable, a droplet of liquid appeared between the apiculus and sterigma. This droplet increased in size until it was about one fourth as large as the spore. Suddenly, then, the spores were shot to a distance of .1 to .2 millimeters, i.e. about twenty times the diameter of the spore. This distance is great enough to get the spores away from other developing spores and hymenial structures, and to allow air currents to catch them and bear them away to a new substratum.

Systematic limitations and considerations

The attempted limitation of the family Clavariaceae by orthodox Friesian criteria employing sporophore and hymenial configuration has resulted in some interesting incongruities. These are for the most part brought about by nature's contumacy of man-made rules, particularly when such have been preconceptions—consummated designs formulated without proper consideration for the spontaneous affinities of the members of a given group. Patouillard and other workers of his school of thought have been the only students producing contributions toward solving the real relationships displayed within, or by, the Clavariaceae.

The monographic efforts of certain others have
in many cases led to confusion. The tendency of some workers to use such unnatural taxonomic criteria as erectness, coralloid or clavate form, or the presence or absence of amphigenous hymenium has resulted in certain inconsistencies and freedom in the placing of species. As for example on page 25 of his monograph Burt (1922) states, regarding *Clavaria cervicornis*, that "... the hymenium covers the whole surface of the plant and necessitates the placing of it in the later genus" (*Clavaria*).

By this statement Burt placed *C. cervicornis*, a branched form with flattened ramuli and brownish echinulate spores, in the genus where he thought it belonged. Now on page 196 of his monograph of the Thelephoraceae (part 1, 1914) the statement is found, "*Lachnocladium*, with coriaceous structure, hairy stem, and colorless spores, is an intermediate genus between *Clavaria*, of the Clavariaceae, and *Thelephora*, but can be separated from the latter by the spore characters". If we are to follow the above reasoning we see that there are species placed in the Clavariaceae because they have amphigenous hymenia with rough spores and excluded for the same reason (i.e. *Thelephora palmata*, etc.)

With regard to *Sparassis* Burt could fit the genus into neither family and excluded it from both monographs. Cotton (1911) removed *Sparassis* to the Thelephor-
aceae on the basis of its predominantly unilateral hymen-
ium; though he admits that upon inversion of a growing
sporophore, hymenium is readily developed on the normally
sterile side of the lamellae. Further, he found the
hymenium to be on both sides of erect lamellae, quite
generally amphigenous toward the inside of the fructifica-
tion and often on either or both sides of the lamina when
recurved even if the lamina were one from the exterior of
the fructification. The author has observed, in our
Oregon representatives of the genus, that the sterile
surfaces appear very much like young hymenia (Plate I,
figure 8). Weir (1917) analysed the relationships of
Sparassis and concluded that it should be in the Clavari-
aceae by reason of its fleshy consistency, "sclerotia-
forming habit", and frequently amphigenous hymenium.
Gladys Baker (1941) discusses more thoroughly the falla-
cies of using the placement of hymenium as a taxonomic
character in delimiting the Clavariaceae.

Fleshiness will not separate the Clavariaceae
and Thelephoraceae and attempts to use this character
lead to confusing results. Most authors have readily
admitted to the Clavariaceae Pterula, which is toughish,
often with unilateral hymenium, and Lachnocladium,
toughish but with spores hyaline and smooth. The workers
mentioned have not been the only ones to run into dif-
culty, Bourdot and Galzin (1927) even though following
Fatouillard (1900) met with difficulty in fitting such forms as *Thelephora intybacea* into the Clavariaceae even as they outline the family.

This brief exposition of a few of the discrepancies occurring in any of the previously mentioned taxonomic treatments of the family shows that attention must first be given to a workable concept of the family before a logical system of classification can be evolved. In the modern studies of higher fungi as well as plants it is found that one cannot say "these organisms, as a group, have such and such characteristics". Our knowledge of certain groups, and of all groups to some extent, is becoming so complete that we can no longer draw sharp lines of distinction between the various subdivisions. What may now more logically be done is establish developmental or phyletic series. Our group limitations are to be made by saying then, "this group is a developmental series whose typical members possess the following characters..." Orders, families, genera, and species therefore come to be understood as developmental series of descending rank or size. In some cases it is impossible to tell where one group is to be delineated from another of similar rank, but in others, presumable older, between typical members some of the intergrading forms have dropped out or become scarce. Such isolated series are becoming increasingly rare as our systematic knowledge
becomes more complete. Such series consist frequently of members that are primarily primitive, typical members, secondarily primitive members derived from the typical forms, and advanced members derived from typical forms.

At the time of writing the author prefers to consider the Clavariaceae as a collection of such phyletic series projected together by morphological likenesses and possessing most or all of the above kinds of members. These series, usually referred to as genera, are for the most part unrelated. In other words this family is one of polyphyletic origin. Its members may be primarily derived from simpler forms, presumably the Thelephoraceae for the most part, but some may have been secondarily derived from more advanced forms.

The members of this group of series (Clavariaceae), in the first place, owe their form to the production of large amounts of hymenium in proportion to the amount of sterile flesh produced. This is done at the expense of having the hymenium exposed (Buller, 1922). Proliferation and contortion of the hymenium has been a subsequent developmental factor resulting in the hymenium becoming advantageously placed, facilitating spore dispersal. The interplay of these factors has brought about different modifications of the several developmental series to be discussed below. Parasitism, so often an important developmental factor in the evolution of fungi,
is evidenced in only one generic series, that containing *Sparassis radicata*, a root parasite of conifers. The rest are all saprobic with a few of the simple forms tending toward symbiotism of a lichenoid nature (Coker, 1904; Martin, 1940; and others).

Two-spored basidia in a number of the species of *Clavaria*, in which the plan of nuclear division is stichobasidial, present us with an interesting problem as to their nature and significance. Perhaps their discussion here is out of place but it should be undertaken before any further discussion of the family. Bauch (1927) carefully investigated the nature of such two-spored basidia in three species, *C. rugosa*, *C. cristata*, and *C. cinerea*. In *C. cinerea* he found that usually only two or three of the basidial nuclei (after the first two reduction divisions) underwent a third division so that as few as five to as many as eight nuclei were formed. Two of these passed into the spores; those remaining in the basidium degenerated. Bauch's results show the nuclei of *C. cinerea* to undergo phenomena that seem to be indicative of degeneration. If these are truly degenerative phenomena the species could not be referred to as primitive, at least not insofar as being ancestral. It is by such results as these that Maire (1902) attempted to link *Clavaria* with *Calocera*, considering this section, *Clavulina*, to be primitive.
Still the problem remains: just what is the significance of two-spored forms? Alexander Smith (1934) studied two-spored forms in the basidia of *Mycena* and found the two-spored condition to be the result of either one of two phenomena: (1) The development of monosporous cultures (called parthenogenesis by Smith) resulted in bi-spored nuclei. There was only one nucleus in each basidium and therefore no fusion. The subsequent divisions were two in number, being either chiastobasidial or stichobasidial. If of the former pattern four spores resulted; if of the later two spores resulted. The second division here was seemingly homologous with the third division normally present in the homobasidium. (2) By the second method bi-spored basidia are the result of malorientation of nuclear spindles, mostly those of the second division. However, since some spores were found without nuclei, and for other reasons, Smith doubted that nuclear behavior was responsible for the number of spores produced. Smith from his studies, and following the authors quoted elsewhere in this paper, believed that an eight nucleate basidium (perhaps like that of *C. cinerea*) represented a primitive condition. Walter Neuhoff (1924), in his cytological investigation of the Auricularicae, and Dacryomycetaceae, accentuates the point, made by others also, that the basidium with eight nuclei is more primitive than that with fewer. Upon this basis some authors, notably
Janchen (1923), have assumed the Corticiaceae (Thelephoraceae), Craterellus and Cantharellus to be primitive basidiomycetes. Adherence to the more logical theory of Rogers (1934) and others, precludes any possibility of considering these homobasidiomycetous forms as primitive basidiomycetes. It does not, however, prevent their being set aside as primitive homobasidiomycetes. From the above cited work the primitiveness of the eight spored basidium is acknowledged tentatively among homobasidiomycetes, but it seems best to reserve judgement completely upon the significance of the stichobasidial order of nuclear events until further study has shed more light upon this controversial subject or has corroborated some of the conflicting conclusions. For this reason the writer has entered some of the sections of Clavaria without discussing their relationships to any extent.

Typically the genera and species encompassed by the present limits of the family proliferate hymenium indeterminately as pointed out by Patouillard. Typically there is a fruiting body supporting the lateral or amphigenous hymenium on a plane clavate, filiform, obconic, or lamelloid, tramal structure.

Within the Clavariaceae there are groups of species which stand apart from the rest in seeming to possess common characters of one sort or another. While
some of these groups have been set off as genera others, less distinct, have been allowed to languish in the heteromorphic genus *Clavaria*. It seems appropriate to point out the affinities of some of these genera and of some of the segregations within the genus *Clavaria*. Among the Thelephoraceae, as well as in the Clavariaceae, there are several sections more or less distinct in themselves. There is the section consisting of species with smooth white spores and with few or no cystidia in the hymenium, of which Stereum is typical. *Sparassis* in the Clavariaceae is perhaps an extension of this line. An apparently undescribed *Clavaria* in our collections from Japan (Plates 2 and 3), with brownish setae or cystidia, corresponds in hymenium to the fungi placed nowadays in Hymenochaete. *Craterellus* and *Cantharellus* of the Agaricaceae are hardly separable from the Pistillaris section of *Clavaria*, to be discussed more fully below. The remainder of the *Clavarias* may be separated into ochraceous, usually rough-spored species and hyaline, usually smooth-spored species. Associated with the former is *Thelephora* and the sections of *Clavaria* typified by *C. abietina*, *C. stricta*, and *C. formosa* with four spores on each basidium. The smooth hyaline-spored species, mentioned in the paragraph above seem to represent a line of development beginning with such two-spored species as *C. cristata* and *C. cinerea* and progressing (?) through such four-spored species as *C. vermicularis* and
and *C. ornatipes* to *Lachnocladium* on the one hand and through *C. Kunzei* to the simple clavate species and from these towards such genera as *Pistillaris*, *Typhula*, and *Pterula*.

Coker (1923) recognized eleven sections within the genus, but he did not distinguish them clearly. Patouillard (1900), in his memorable essay, distinguished clearly a number of sections but often somewhat artificially.

The following key has been prepared to illustrate the author's present conception of the family Clavariaceae and some of the interrelationships within the family. As originally planned the discussion would have included the genera of the family that are found in Oregon and perhaps the species of certain closely related genera. However time and lack of material has restricted the scope of the thesis to *Clavaria* alone.

Spores hyaline (rarely tinted), mostly smooth and thin-walled; basidia 2- or 4-spored:

Fructifications lamelloid---*Sparassis* (not included).

Fructifications not lamelloid:

Spores large (9 microns or over), globose, basidia mostly 2-spored:

No distinct stem portion; fleshy putrescent---*Clavulina* section of *Clavaria*.

With distinct stem portion; toughish to woody---*Lachnocladium* (and *Ornatipes* section of *Clavaria*).
Spores distinctly smaller than above or ellipsoidal, basidia typically 4-spored:

Simple or fascicled; spores various:

Simple (unbranched) large clubs; with large (5 by 10 microns or more) ellipsoidal spores—Pistillaris section of Clavaria.

Fascicled; spores under 10 microns—Vermicularis section of Clavaria.

Branched; spores under 10 microns:

Clubs or branches obconic—Pipemata section of Clavaria.

Clubs or branches not as above:

Fungus sporophores not associated with a particular host or substratum, simple or branched:

Branched finely; toughish—Pterula (not included).

Not finely branched, usually simple; fleshy—Simplices section of Clavaria.

Fungus sporophores algal "symbionts" or simple, often hair-like, fine clubs associated with particular hosts or arising from a sclerotium:

Algal "symbionts"; narrowly clavate—Gliocoryne section of Clavaria.

Not algal "symbionts"; filiform:

From sclerotial base—Typhula (not included).

Not from sclerotial base—Pistillaria (not included).

Spores typically ochraceous, mostly roughened or obdurate-walled; basidia 4-spored:
Tough to woody; spores echinulate; hymenium often unilateral—*Thelephora* (not included).

Fleshy; spores rarely strongly echinulate; hymenium amphigenous (*Clavariella* of Schroeter):

Terrestrial, large (over 10 cm.); spores usually over 10 microns in length; rarely bitter—Formosa section of *Clavaria*.

Lignicolous or from undecomposed refuse, smaller (under 10 cm.); spores usually under 10 microns in length, or smooth or fungus bitter:

Spores usually over 9 microns and rarely echinulate; green colorations rare, light-ochraceous and drying so—Stricta section of *Clavaria*.

Spores usually shorter and echinulate; green coloration common, drying dull or drab—Abietina section of *Clavaria*.

**Pistillaris section**

Here are allotted those simple yellow-brown clubs the hymenium of which is made up of 4-sterigmate basidia producing large, slender, smooth spores and which is underlain by white flesh. In older specimens the center of the clubs usually becomes hollow and, in proportion to the thickness of the club, the flesh is then thin. The inclusion of these forms in the same section with *C. vermicularis* and its relatives by authors such as Patouillard (1900) seems untenable. Coker (1923) considers these species to represent a distinct unit within the genus. The writer considers them to be the most distinct section within the heteromorphic genus *Clavaria*. 
Some of the aberrant members have been classified as belonging to Craterellus or Cantharellus. Harper (1913) and Peck (1887) have made detailed investigations of this section of the genus and refer to its close resemblance to the Craterellus pistillaris of some authors and to the lower members of the two aforementioned genera. By aligning these species of Clavaria with the species of the two genera mentioned, a series is formed showing complete transition from distinctly gilled agarics to typical, almost filiform, Clavarias. The figures in Plate IV of one apparently undescribed species belonging to this section preclude the necessity of any further comment concerning this discussed transition.

Of our species C. pistillaris, C. maricola, C. sp. number 1 of this thesis, and C. ligula, along with some species of the above two genera are placeable in this one section.

Piperata section

Reduction of apical conical portions of clavulae has resulted in blunt apices in the members of this section. They are recognizable in the field by flat or concave branch apices. In the laboratory they are found to have small, usually broad elliptical, smooth, hyaline spores. Often there is a strong peppery taste to their
toughish flesh. They represent the extreme in apex reduction among the white spored species. Modification of these species is the same or similar to the modification in the Pistillaris section toward the Agaricaceae.

Though other authors have not done so the writer feels well justified in separating the four species, C. Piperata, C. sp. numbers 7 and 9 of this thesis, and C. pyxidata into an entirely separate section. C. coronata Schw. would fit in this section as a slightly less specialized form.

Gliocoryne section

Another peak in development is represented by C. mucida. It is our representative of a group of small solitary clavulae bearing small white spores, not unlike those of the preceding section. This section, unlike any other, is typified by the "symbiotic" existence of its members with green plants, chiefly algae. C. Pogonati Coker (1939) very likely belongs in this section, as well as C. vernalis Schw., which is found on damp mossy ground with protonema and blue-green algae (Coker, 1923). Other than for the specialized nature of the assimilative hyphae (Coker, 1904; Martin, 1940) they are morphologically not unlike other small simple Clavarias bearing small, ovate or ellipsoid, hyaline spores.
The excellent analysis of this section by C. W. Martin (1940) leaves little the writer could say in addition. Martin, further, believes this section sufficiently distinct to justify the erection of a separate genus. Very likely, as Martin points out, Maire's (1904) proposed genus based on C. uncialis Grev., Gliocoryne, should be accepted.

The morphology of its hymenial elements and its growth habits hint at likenesses to the vagabond general Myxomycidium and Mucronella. A cytological study of the Urnigera section of the Thelephoraceae and C. mucida should be made to determine the validity of their intimated relationship.

Simplices section

In this section are species intermediate between the basic leucosporous sections of the genus and the terminal section of the family. They are not a naturally related lot and their association here should not be implied suggesting natural relationship. The simple species, such as C. Kunzei represent forms leading to Pterula. Perhaps each one or few species should have been set off and treated separately. They are four-spored, mostly simple clubs, not specialized in any particular way. Often they are quite highly colored as
in *C. pulchra* or they may be white as in *C. Kunzei*. The spores are usually small and smooth and in outline broad as in related sections.

Most of the species are those in Synocryne and Holocoryne of Fries or in the leucosporides section of *Clavaria* in Patouillard (1900). In Coker's work these species would fall into groups 1, 2, 8, and others. Our species allotted here are *C. pulchra*, *C. Kunzei*, *C. occidentalis*, *C. nebulosoides*, *C. appalachiensis*, *C. sp.* number 13 of this thesis, and *C. juncea*.

**Vermicularis section**

The simple fascicled species with globose to oblong spores have been placed together in one section here. *C. fumosoides*, *C. vermicularis*, and *C. fusiformis* group themselves nicely, with others such as *C. occidentalis* to be excluded only because this section is for the most part artificial. Very likely combination of this section with the previous section would be desirable and produce a more natural grouping. It is suggested that these species are perhaps derived from the Clavulina section by the acquisition of a four-spored basidium as a constant characteristic. In some members of this section the last division within the basidium has been retarded until after the nuclei have passed into the young
spores. Should the number of spores on the basidia fail to separate the white members of this section from those of the Clavulina section they (ours) may often be separated by the yellow coloration appearing on the fructifications. Kauffman's \textit{C. globospora} and \textit{C. corniculata} Schaeff. ex Fries, the former 2-spored and the later 4-spored, fall between these two sections, that under discussion and Clavulina.

\textbf{Ornatipes section}

It is to be acknowledged that the single species placed here is retained in the genus \textit{Clavaria} for very little reason. Partially because the author wished to include it in this thesis restricted to the genus \textit{Clavaria}. Its slightly toughish nature and the division of the sporophore into a light colored fertile part above and into a dark-colored brown-hirsute stem below make it inconflusible with any of our other fungi. The hymenial characters are the same as for \textit{C. cristata} and the Clavulina section. It is a \textit{Lachnocladium}. Coker refers to it as a \textit{Clavaria} and places it with \textit{Clavaria cristata} and others in his group 4.
Clavulina section

This section is made up of the white to greyish species which grow on the ground in shady woods for the most part. The spores are globose, white or hyaline and large. Juel (1916) and Maire (1902) found these forms to be stichobasidial, and Gaumann and Dodge (1928) prefer to separate this group as the genus Clavulina of Schroeter (1889). There are three nuclear divisions preceding formation of the spores and usually only two sterigmata are formed, though in C. falcata, which we do not have in Oregon, there are commonly about seven. Sometimes the last division is suppressed until after the nuclei have passed into the spores, or is sometimes entirely absent, as in C. cinerea (Bauch, 1927).

According to some of the earlier authors this stichobasidial arrangement producing eight nuclei was sufficient justification for placing these fungi near or among the lowest basidiomycetes. Very likely they have undergone modifications in their nuclear phenomena from time to time with the consequential production of allied groups, but are considered here as derived from certain other homobasidiomycetes. These fungi constitute the genus Ramaria of Holmskiold and other and of the section of Clavaria under the same name as treated by Patouillard. Patouillard, though, includes with them, both white and
ochraceous spored species. The writer has no comment either upon origin or development within this section. Different species of this section gave different positive reactions under ultra-violet light encouraging further their recognizance as separate species instead of reducing them to one. Of our species C. rugosa, C. cinerea, C. cristata, and others belong here. Very likely C. globospora is to be included in this section, and perhaps C. corniculata should be considered even tho it is a four-spored form with very different flesh.

Abietina section

The section includes the species placed by Coker in his C. grandis section. The following is an inclusive unspecific description of the section's members: fungi two to six (eight) centimeters high, much branched above from a small or slender base, usually arising from whish, often copious, mycelium; individuals growing in the woods from leaves, cones or twigs; spores various but usually 3 to 5 by 7 to 10.5 microns, colored, rough (rarely nearly smooth) to echinulate, and agglutinating into clumps in preparations. Green coloration often present on the fruiting body; odor slight; taste bitter. Clavaria abietina, C. myceliosa, and a few unidentified
species, are conspicuous Oregon members. *C. gracilis*, though quite distinct, seems most closely related here. Zeller (1935) considered his *C. brunnea* to belong to the *C. grandis* section of Coker. Because of its different form, habit, and spores it seems rather to belong with *C. formosa*, even though it does have the bitter taste characteristic of the fungi in this section.

This section coincides perhaps with the rough ochraceous-spored genera in the Thelephoraceae. It passes almost imperceptibly into the next section.

**Stricta section**

Medium sized species, with nearly smooth spores that are mostly over 9 microns long, belong here. The fruit body is commonly bitter tasting and there is at least one species with some green coloration. In contrast to the previous section the members of this section are not always concolorous (disregarding green coloration) and when dry remain light colored. Such forms as *C. testaceoflava var. testaceoviridis* connect this section clearly with the Abietina section as do the characteristics of the group as a whole. On the other hand the section is hardly less related to the Formosa section to follow. The species included here are lignicolous or
terricolous and in our collections are \textit{C. stricta}, \textit{C. apiculata} and \textit{C. testaceoflava var. testaceoviridis}, along with some unnamed specimens.

\textbf{Formosa section}

The members of this section are the largest of the family. Generally they are yellowish to brownish forms; mostly over 10 cm. tall; with thick sterile trunks. The tips are often acute and tapering but may be thick and blunt. These species have their trunks conspicuously thicker than the branches, sterile and often white or differently colored from the fertile parts. The spores are usually light ochraceous, varying towards cinnamon in mass. They are mostly smooth, finely verrucose to papillate and in form are almost always oblong-elliptical. Species included here are \textit{C. formosa}, \textit{C. flava}, \textit{C. subbotrytis}, \textit{C. aurea} (if it exists), \textit{C. brunnea}, \textit{C. botrytis}, \textit{C. sanguinea}, \textit{C. conjuncta}, \textit{C. cystidiophora}, \textit{C. gelatinosa}, \textit{C. rufescens}, and \textit{C. obtusissima}. \textit{Clavaria gelatinosa} is placed here though it is very distinct from all other species in the texture of its flesh.

This section represents part of the ochra-
sporous section of Patouillard's segregation Ramaria. Coker forms a similar segregation in his group 10. As Coker has stated the section is very intricately interrelated; illustrating several smaller indefinite sub-groups. The colors of the dry specimens of this section were somewhat brightened under a fluorescent lamp.
ANNOTATED LISTING OF THE OREGON SPECIES OF CLAVARIA WITH DESCRIPTIONS

Generic description and a key to the species

Since the genus Clavaria is not a single natural phyletic series or unit, the description of the genus cannot be made pleasantly exacting. Until there has been sufficient evidence obtained for cleaving off certain of the contemporarily encompassed natural sections of this genus as it now stands we shall have to employ some such more or less ambiguous definition of the genus as follows:

**Clavaria** Val.

Fructifications erect, branched or simple clubs, filiform to clavate; solitary, gregarious, or caespitose; saprophytic or in lichenoid association with lower plants; hymenium a plane surface, amphigenous, with or without sterile components; fleshy, waxy or gelatinous, rarely tough; basidia mostly 2- or 4-spored, rarely 1- to 7-spored, clavate evenly or tortuous; spores hyaline, ochraceous, or brownish, thin-walled, smooth to asperulate, spherical to allantoid; life cycle typical of homobasidiomycetes.
1- Simple obconic clubs with plain or cup-shaped apices (figure 5a), or proliferating (figure 5b) and producing branches of this same kind throughout; spores under 6 microns in length (Piperata section)---25

Branches not obconic clubs with depressed or plain apices; or spores larger---2

2- Solitary or fascicled clubs, rarely branched (about once) above, with branches like or thicker than, the main stems (figures 2 and 3); if spores globose or nearly so then mostly under 9 microns in diameter---3
Repeatedly branched from a sterile thickened trunk (figures 1a and 4a)--6

3- Simple white clubs under 2.5 cm. in height, growing on earth or decorticated logs in association with green algae (Gliocoryne section)--16

Not as above in all points--4

4- Ochraceous species; usually at least one centimeter in diameter and hollow; with spores three times as long as broad (Pistillaris section)--9

Ochraceous or white; slender (under 1 cm. in diameter), usually solid; with broader spores--5

5- Caespitose or fascicled (figure 3); gray-lavender to white, waxy species, often stained with sulfur yellow--16

Solitary or gregarious (figure 2), not white, hygrophanous, or stained with bright yellows--19

6- With brown, hispid, slender, sterile, stipe distinct from the smooth fertile branches above, the stipe making about $\frac{1}{2}$ the height of the fungus; spores sub-globose, hyaline, over 9 microns (Ornatipes section): 20. C. Ornatipes Peck.

Without such stem or spore characters--7

7- Spores white, globose; fungus white to gray-lavender (may be blackened by a parasite below); basidia (figure 6) mostly two-spored (Clavulina section) (if fructification yellow see: 25. C. corniculata)--28

Spores ochraceous, never globose and white (except 25. C. corniculata); fungus colored otherwise or basidia typically 4-spored--8

8- Fungi of large size, i.e. mostly over 3-10 cm. high and 10 cm. broad; base (figure 1a) usually over 1 cm. in diameter, usually radicating, without conspicuous mycelial attachments as rhizomorphs; no green color; branches of the third order not elongate-attenuate if fungus is smaller than the above sizes; spores (figure 16) never echinulate (in ours); terricolous (Formosa section)--42
Fungi of small size, i.e. mostly not over 6 cm. high by five broad, or if taller then the clump narrow and of elongate, attenuate branches (figure 4a) arising from a slender base, usually not 1 cm. in diameter, often with copious mycelium around the base or with green stains or colorations; spores (figure 4b) often echinulate; often lignicolous (Stricta and Abietina sections)---33

9- Spores (9)10.5-15 microns long, cylindric; clubs clavate or large (over 7 or 8 by 4 mm.) from a narrow base; flesh usually thin in comparison to the size of the club; hymenium buffy yellow---10

Spores smaller; clubs slender (usually less than 4 mm. thick)---15

10- White at first; apex remaining white and sterile, mucronate, becoming plane or depressed in age:
1. Clavaria sp.

Buff yellow or brighter; apex not white or mucronate ---11

11- Slender mostly from male pine cones; spores 10-14 by 4-5 microns: 5. C. maricola Kauffman.

Clavate distinctly; not associated so with male pine cones---12

12- Clubs up to 5(7) cm. tall; spores up to 4 by (10)14 microns---13

Clubs larger; spores 18-24 microns long, or broader (up to 12 by 6 microns)---14

13- Pinkish; surface usually rugose; spores usually 4 by 14 microns: 3. C. ligula Schaeffer ex Fries.

Ochraceous; plane clavate; spores mostly 3 by 10 microns: 4. Clavaria sp.

14- Spores under 16 microns long: 2. C. pistillaris Linneaus ex Fries.

Spores over 16 microns long: 2. C. pistillaris form.
15- Clear white or caespitose---16

Not white, solitary or gregarious---19

16- Mostly under 2 cm. tall; clavate clubs associated with algae on barren soil or decorticated logs: 10. *C. mucida* Persoon ex Fries.

Larger and not associated with algae as above---17

17- Yellow; spores spherical 5-7 microns: 18. *C. fusiformis* Sowerby ex Fries.

Not yellow---18

18- Gray-lavender, white mycelial at base; spores 5-6(7) by 3.5 microns: 17. *C. fumosoides* Kauffman.

White often with yellow stains; spores globose, 4.5-6 microns: 19. *C. vermicularis* Swartz ex Fries.

19- Rood's Brown to Wood Brown or Fawn Color---20

Pallid buff to bright orange---21

20- Spores 3.5-4.5 by 5-7 microns, asperulate: 16. *C. occidentalis* Zeller.

Spores 2.5 by 5-6 microns, smooth: 15. *C. nebulosoides* Kauffman.

21- Spores elliptic or longer; clubs slender to almost filiform (under 1.5 mm.) smooth, pale colored---22

Spores ovate or broader; narrowly clavate fungi (usually over 1.5 mm.); pale yellow to bright orange---23

22- Very narrowly clavate; Pale Orange Yellow above, brownish below; spores 2.5-3 by 4-4.5 microns; on conifer needle; 13. *Clavaria* sp.

Filiform above, pale colored; spores 3.3-4.5 by 9-10.5 microns; among deciduous leaves: 11. *C. juncea* Fries.
23- Basidia 2-spored; stem not yellow; clubs terete, smooth: 25. _C. globospora_ Kauffman.

   Basidia 4-spored; stem yellow; clubs usually grooved or roughened---24

24- Stem distinct, smooth shining; clubs pale: 14. _C. appalachiensis_ Coker.

   Stem not distinct, not smooth shining; clubs bright ochraceous to orange: 12. _C. pulchra_ Peck.

25- White; simple: 9. _Clavaria_ sp.

   Brown or ochraceous; branched---26

26- Pallid to Baryta Yellow; 3-10 cm. tall: 8. _C. pyxidata_ Persoon ex Fries.

   Pallid to brownish---27

27- Pallid to Cinnamon Brown; 4-6 cm. tall; spores sub-globose, 4 by 3 microns, smooth, slightly ochraceous under microscope; cystidia lanceolate, projecting 12-15 microns: 6. _C. Piperata_ Kauffman.

   In Cinnamon Drab series; branched once above, under 3 cm. tall; spores ellipsoidal, 2-2.5 microns by 3.8-4.8 microns: 7. _Clavaria_ sp.

28- Basidia 2-spored; spores mostly 9-12 cm. in diameter; sporophores branched at least above; branches usually over 2 or 3 mm. in diameter---30

   Basidia 4-spored; spores smaller; branches usually about 2 mm. in diameter---29

29- Spores 3 by 4 (3-4 by 3-4.5) microns: 26. _C. Kunzei_ Fries.

   Spores 4-4.5 (5) by 7.5-8(9) microns: 27. _Clavaria_ sp.

30- White (or blackened by a parasite below); drying yellow---31

   Cinerous to violaceous; drying drab or cinerous---32
31- Simple or little branched; tips blunt; surface rugose: 22. C. rugosa Bulliard ex Fries.

Branched several times; tips usually cristate; surface smooth: 21. C. cristata (Holmskiold) ex Fries.

32- Spores mostly 7.5-9 microns; fungi 10-15 cm. high; branches mostly hollow; taste like stale nuts when dry: 23. C. cinerea form.

Spores mostly larger than 9 microns; fungi under 10 cm. tall; branches mostly solid: 23. C. cinerea Bulliard ex Fries.

33- Up to 3 cm. tall; branches not slender; terminal branches pluridentate, broad, or flattened; spores 3-4 by 9-11 microns---34

Usually taller, or branches slender; terminal branches not flattened or broad, usually more or less attenuated; spores various---35

34- Flesh-colored; tips green; branches hollow; spores 3-3.5 by 9-11 microns: 35. C. testaceoflava Bres. var testaceoviridis Atkinson.

Dull reddish to pale lilac; tips concolorous; branches solid; spores 4-4.5 by 9-11 microns: 36. Clavaria sp.

35- Spores less than 6 microns long; fructifications concolorous, without blue or green colors or stain---36 (see also 29)

Spores over 6 microns long; often tips light colored, or green stains present---38

36- White at first; not bitter; not from conspicuous mycelium: 23. C. gracilis Persoon ex Fries.

Ochraceous, or not white, from the first, or bitter; often from conspicuous mycelium---37

37- Drab to ochraceous: 29. C. myceliosa Peck.

Capucine Buff to Capucine Orange: 30. Clavaria sp.
38- Branches very divaricate, slender, under 2mm. in diameter: 34. Clavaria sp.

Branches erect, if under 2mm. in diameter then not slender in proportion---39

39- Concolorous, Cinnamon Buff to fleshy tan; spores granular, 4-5 by 9-10.5 microns; drying light ochraceous: 37. C. stricta Fries.

Usually not concolorous, ochraceous drab often with green or blue coloration or stains, or tips white; drying dull---40

40- Young fungi and tips whitish or pinkish; tips often with Horizon Blue cast; spores rough: 33. C. apiculata Fries.

Concolorous or with green stains, but not as above ---41

41- Spores smooth; no green stains or colors; 32. Clavaria sp.

Spores rough or echinulate; often with greenish colors: 31. C. abietina Fries.

42- Spores spherical, 7.5-10 microns; branches light yellow; flesh thin around the hollow center: 24. C. corniculata Fries.

Spores not spherical; colors various; branches usually solid or flesh thick in proportion---43

43- Surface Fawn Color or browner, or flesh carilageno-gelatinous, bitter; spores under twelve microns long---44

Surface pink, yellow, white, or reddish, or the spores longer---45

44- Context gelatinous; taste and odor (at least when dry) tobacco-like: 38. C. gelatinosa Coker.

Context fleshy; taste bitter, odor slight mycelial but neither strong: 39. C. brunnea Zeller.
45- Fungus pink to red when fresh; turning red where bruised; tips lighter: 43. \textit{C. sanguinea} Coker.

Fungus not pink all over, with tips lighter; fructifications not staining red when bruised ---47

46- Tips red (or becoming red from white when very young) or whole fungus redder than Cadmium Orange; spores various---47

Tips yellow, white, or pink; or ochraceous to pink all over (but not as red as above), or spores longer than 11 microns and not striate---48

47- Fungus becoming Apricot Orange from a brighter hue when younger, fading to Honey Yellow; tips remaining pink or red and the flesh concolorous; spores variable, roughened, (7.5-9)10.5-11.5 (15) microns long: 44. \textit{C. subbotrytis} Coker.

Fungus white becoming ochraceous to fleshy; tips only becoming reddish; flesh white; spores striate, over 12 microns long: 49. \textit{C. botrytis} Fries.

48- Spores broad, nearly smooth, 9 by 5 microns, brownish cinnamon under the microscope with a tinge of pink: 41. \textit{Clavaria} sp.

Spores different ---49

49- Spores Clay Color to Pinkish Buff in prints; strongly verucose; 4.5-6 by 9-10 microns: 42. \textit{Clavaria} sp.

Spores not so---50

50- Odor of anise noticeable or fungi clear yellow throughout, base white; flesh white; spores slender---51

No odor of anise; fungi usually with pinkish tinge before maturity, flesh concolorous; spores ellipsoidal (not slender) mostly over 10 microns: 40. \textit{C. formosa} Persoon ex Fries (and 2 forms).
51- No odor of anise; color strictly pure yellow or nearly white throughout until old; spores even or larger distally, over 10 microns long; tips mostly acute—-52

Odor of anise present; tips darker at maturity or spores smaller or red stains on the base; spores various, not as above; tips various—-53

52- Tips and whole fungus Maize Yellow from early youth, sometimes evenly orange tinted in age: 45. C. flava Schaeffer ex Fries.

Tips fleshy or pinkish ar first; fungus light colored becoming yellow in age: 46. C. conjuncta Peck.

53- Tips obtuse, darkened in mature larger forms; spores fusoid, mostly 10-12 microns long: 48. C. obtusissima Peck.

Tips acute; spores oblong, 3.5 by 5.5-7 microns: 47. C. cystidiophora Kauffman.
**Taxonomic treatise of the species**

1. **CLAVARIA** species. Typified by the collection MD 979.

Fructifications up to 7 cm. tall by 4 cm. broad, erect, clavate; gregarious in great troops on coniferous needle mats. The clubs arise from mycelium amongst the needles as slender white clavulae with mucronate tips; with maturity the upper portion swells and the apex becomes flattened, hollow, and finally depressed, remaining white or light colored and sterile, and retaining the mucronate or acuminate tip (rarely blunt). Hymenium darkening through Buff Pink, Light Ochraceous Buff or Salmon Buff to Apricot Buff. No odor; taste very much like *C. pistillaris* but milder. No staining colorations. Drying soft, light if young and darker if old. Flesh of stem white, soft, solid, while the hymenium and top are more or less waxy in appearance. **Hymenium** 75 microns thick, smooth at first becoming rough and folded in large specimens; composed of basidia 7.5-9 microns broad. Sterigmata 4, slender, straight, divergent, and 4.5-5.5 microns long. **Spores** hyaline under the microscope, ellipsoid, 3.5-5(6) by 12-15 microns, curved if narrow, smooth. **Plate IV.**

Specimens examined: Linn County, MD 979 (in
colonies growing from needles around the bases of *Picea Engelmanni*, Santiam Pass, October 30, 1940); Klickitat County, Washington, WBC 9620, WBC 9618 (in Douglas fir woods above Troutlake, October 23, 1937, collected by William Bridge Cooke).

The growth habit of this species is the same as that of *C. ligula*. It appears at the same time of the year and in the same places as this later species. Its growth form and mucronate tip with the coloration differentiate it clearly from any other member of the *Pistillaris* section. Plate V figuring the habit of *C. ligula* serves admirably to illustrate the habit of this small *Clavaria* as well. The two species were growing all about the forest floor where this picture was taken and the colonies often overlapped to some extent. Large, well developed specimens could be quite well assigned to either *Craterellus* or *Cantharellus*. For a more full discussion of this fungus see the discussion of the section on page 28.

Fructifications 10-15(25) cm. tall by 1.5-5 cm. broad; hollow with flesh relatively thin; broadly clavate, where very broad the apex may be short branched or caved in on top (and then sterile), often collapsing in age or upon drying. Odor none, taste mild when fresh; odor of anise and somewhat bitter when dry. Nearly white at first becoming pallid ochraceous, with a waxy bloom, darkening rufous-brownish; drying dark where bruised, remaining light otherwise; flesh drying soft and whitish. Hymenium 65-80 microns thick, composed of 4- (rarely 2-)spored basidia 60-70 by 6.5-8 microns. Spores broadly ellipsoid, pear-shaped when immature, 4.5-6(7.5) by (9)10-12(14) microns, smooth, white in prints, hyaline under the microscope.

Specimens examined: Benton County, MD 662 (Under maples and oaks in mixed woods, Beaver Creek), MD 3164 (collected by Dr. H. M. Gilkey, December 3, 1915, in open woods north of Corvallis), OSC 7117, OSC 6036, OSC 6038, OSC 6034, OSC 7076, OSC 7549, OSC 3565, OSC 3551; Linn County, OSC 7547, MD 978; Lane County, UO 4; Douglas County, OSC 9316.

It is distinguishable from all other species of Clavaria by its large clavate form and broad large spores. Some forms are indistinguishable from species of Craterel-
lus. For a more complete discussion see the discussion of its relationships on page 28. An Apricot Buff fungus (MD 978, Plate 6) tentatively referred here has hymenium, spores, and flesh very much like this species. Its caespitose habit, thick flesh, and growth form (slender, costate, branched, caespitose, clavulae) seem to separate it from C. pistillaris. If subsequent collections are made the erection of a new species will be advisable if this form is found to be so constantly distinct. Among the Oregon State College herbarium collections we have been able to separate one collection of otherwise quite typical C. pistillaris by its abnormally long spores.


Fructifications clavate, simple, 3 to 7 cm. tall and usually 1 cm. broad; very tender, solid; surface usually rugose, folded, flattened, or longitudinally grooved. Base white mycelioid on the substratum, not radicating. Orange Buff very nearly from its first appearance; drying Pale Yellow Orange or darker almost to black. Flesh remaining white, soft when dry with
slight taste (bitter if any) and no odor. Hymenium 60-80 microns thick composed of 4-spored basidia (7-8 microns in diameter according to Coker, 1923). Spores white, 3-4.5 by 12-15 microns, smooth, usually curved when narrow. Plates IV and V.

Specimens examined: Linn County, MD 977 (on needle beds of Abies concolor and Tsuga Mertensiana, Santiam Pass, November); Deschutes County, MD 986 (on needles under Pinus contorta, 8 miles west of Sisters, October 30, 1940); New York State, OSC 11517 (collected by C. H. Kauffman on spruce needles, etc., in the Adirondack Mountains, September 11, 1914).

This species was found during a two week period, just before the snows, in the higher mountains. It grew over the hemlock and fir needles forming gregarious colonies of stiffly erect clavulae, as though the forest floor were dotted with a myriad little men. Kauffman (1925) reports this species from Mount Hood. Peck (1900) states that the clubs are not always obtuse as might be inferred from the published descriptions, but are sometimes acute or even cuspidate at the apex. In ours the tips were always obtuse, but his further observation that the clubs are yellowish when young but assume pinkish or orange tints in age holds true for those found in Oregon. It is easily separated from C. pistillaris
by the narrower longer spores, and in the field by the tender, fragile, solid clubs and the pink-orange tints, as well as by its smaller size.

4. Clavaria species. Typified by the collections WBC 9628 and WBC 9632.

Fructifications up to 3 cm. by 3(4) mm.; simple, clavate, ochraceous when dry, gregarious to caespitose from small white mycelial concentrations on Douglas fir needles. Clubs now about Warm Buff to Light Ochraceous Buff, with no odor or taste, solid, soft and chalky. Hymenium 75 microns thick, composed of basidia 50-60 by 7.5 microns, with four, slender, straight, sterigmata, about 6 microns long; no cystidia present. Spores hyaline under the microscope, long-elliptical, mostly 3-10.5 microns, smooth. Plate III.

This small solid clavate form (WBC 9628 and 9632) collected in Klickitat County, Washington on Douglas fir needles in October, 1937, is definitely referable only to the Pistillaris section of the genus. The collections are very young and there are no accompanying notes, and therefore, it is indeterminable. It seems most nearly related to C. ligula but is separable by the solid clubs which are smaller than those of typical ligula and the spores are shorter.

"Fructification simple, fleshy, erect, surface 'light orange-yellow' to 'orange-buff' (Ridgeway), 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 image.

"Microscopic characters: Spores subcylindric, obtuse, hyaline or very slightly tinted with yellowish, 10-14 by 4-5 microns, smooth, minutely granular within. Basidia slender, 108-112 by 4-5 microns, 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."

This has not been distinguished in the collections available for this study. It definitely belongs with the Pistillaris section, at least from all its described characters, and is perhaps our most conservative member, i.e. varying least towards a **Craterellus** in
form. We have two collections by Cooke (his 9632 and 9628 from Klickitat County, Washington, on fir needles) which are very often attached to male Douglas fir cones. These are very young and separate mention has been made of them above. They might possibly be referable to this species.


"Fructifications 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, locally arranged; primary and secondary branches dilated upwards, with rounded, obtuse sinuses, branching repeated four to five times, terminal branchlets acutely pointed.

"Microscopic characters: Spores suboval to sub-globose, 4 by 3 microns, smooth, slightly ochraceous tinted under the microscope. Basidia elongate, slender, 45 by 4 microns, 4-spored. Cystidia or cystidia-like conducting organs are present; these project about 12-15 microns above the hymenium, slender, 2-3 (5) microns 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."

In the same place Kauffman states that this species differs from *C. pyxidata* "by the colored, differently shaped spores, its peppery taste, different color when fresh and its coniferous substratum." The growth habit and general appearance is the same. No available collection has been definitely referable to this species. It is included here for very likely further search will locate it in Oregon. See discussion under *C. pyxidata*.

7. **CLAVARIA** species. Typified by the collection MD 997.

Fructifications simple or branched once from the margins of the truncate or pyxidate, sterile, apices into branches similar to their parent branch; up to 2 cm. by 3 mm.; branches slender, obconic in form; tinted violaceous (in the Cinnamon Drab series) to buffish, lighter above. Flesh tender, translucent or hygrophanous, concolorous. Growing from side and lower surface of a
rotten coniferous log. **Hymenium** composed of basidia 5 by 25 microns, with 4 slender erect sterigmata 4.5 microns long. Spores ellipsoid, smooth, hyaline, 3.7-4.8 by 2-2.5 microns. **Plate III.**

**Specimens examined:** Lane County, MD 997 (collected in dense coniferous woods about five miles above McCredie Springs, November 1940).

This species might be *C. coronata* Schw. sensu Burt (1922) or closely related at any rate. It is apparently a simple form if this species. The scanty young material prevents its positive determination. The simple nature of the species, its habitat and color, as well as the different spores assure its being distinct from *C. pyxidata* sensu Coker or *C. Piperata* Kauffman.


Fructifications 3 to 10 cm. tall; branching proliferous from the margins of the sterile pyxidate tips; the terminal branches pyxidate, often with a few acute
teeth. Branches solid, obconic, slender, with peg-like concolorous, hairs at the base. Flesh bitter, tough solid, concolorous, translucent. Color pallid white to cinerous (about Baryta Yellow according to Coker), drying dark in dark forms. Hymenium composed of inflated cystidia, elongate cystidia, and 4-spored basidia with spores ovate to elliptic, 2-2.5 by 3-3.5 microns (Burt, 1922).

It is obvious from the literature that there is a great deal of confusion in regard to this species. Coker's fungus is seemingly different from any other. It seems that in his treatment he has included all forms that have pyxidate branches under this one name for that one reason. Cotton and Wakefield (1919) concluded that this is an indeterminable form, and perhaps an abnormal form of C. stricta. It could not be C. stricta for its spores are much smaller, even if the distinctive color, form, and texture were accountable to teratology. Kauffman (1927) describes C. Piperata from a differently branch-ed fungus with subglobose or oval spores 4 by 3 microns.

Very likely C. Piperata has been confused with C. pyxidata previous to Kauffman's distinction. Very likely C. coronata Schw. (Spores 2-2.4 by 3.5-4 microns) is similar to Kauffman's species in form. In the literature we find evidence of confusion between a yellowish or tan form (Coker and Burt as this species), the white forms
of MD 991, MD 996, and Peck (1900), and the dark-drying drab forms (WBC 9833 and MD 997) with slender spores. Examination of the remnant types and careful comparisons will show whether these very different forms should be classified all with C. pyxidata Pers. ex Fries, with C. coronata Schw., with C. Piperata Kauffman, or whether one or all are distinct. For the purposes of this thesis all are listed here separately, tho C. pyxidata has not been reported from this part of the Pacific Coast.

9. CLAVARIA species. Typified by the collection MD 991.

Fructifications simple, mostly under 2 cm. tall by 2 mm. broad at the truncate or pyxidate sterile apex, translucent, tender, slender, obconic in form, white throughout. Growing erect from small bits of charred wood, needles, and small twigs under heavy cover of small Douglas firs in dense coniferous woods. Hymenium composed of four-spored basidia about 25-30 by 4.5-3.5 microns. Spores hyaline, smooth, 2.2-3 by 3.2-3.8 microns, oblong to ovate. Cystidia flexuous, slender, hyaline, 45-55 by 4-6 microns. Plate III.

Specimens examined: Benton County, MD 991 (habitat as above but mostly on very old charred twigs, etc., acrid in taste now, collected five miles south of Philomath in October); Lane County, MD 996 (collected five
miles east of McCredie Springs mostly from needles and among mosses, November, 1940).

This may be the form to which Peck (1900:172) refers. Concerning it he says "This Clavaria (C. pyxidata) is sometimes nearly white, specially in its upper branches. Its stems and branches are tough and solid and it is acrid or hot and peppery to the taste." Ours is not tough and is strictly simple.


Fructifications up to 2 cm. by 1.5 mm., clavate, simple; larger and older specimens collapsed, solid; the younger ones smooth and terete; tips blunt. Taste and odor none. The hymenium, which covers the upper two-thirds of the clubs, white at first, becoming Apricot, later Salmon to Reddish Salmon or darker Terra Cotta; the tips sometimes becoming very dark if exposed to strong sunlight, or the whole plant drying and disintegrating in age with only the pallid colors having appeared. Always found in association with green algae. Hymenium 25 microns thick, composed of 4-spored basidia 15 by 4.5 microns.
Spores hyaline under the microscope, elliptical, 2-3 by 7-7.5 microns, smooth.

Specimens examined: Lane County, MD 3161 (Collected by F. P. Sipe on clay banks with species of Chlorococcum and Polytrichum, Eugene, February 28, 1940.); Douglas County, MD 571; Benton County, MD 827, MD 3162 (Collected by Dr. Helen M. Gilkey on an oak log on Scott's Hill, December 4, 1915.), OSC 6019, OSC 7102.

This species and a few others are peculiar in their lichenoid association with algae. Many authors report this species associated with Protococcus and Coker (1904) figures hyphae surrounding the algal cells with a specialized kind of haustoria. One of our collections was differently associated as shown above. Martin (1940) gives a careful diagnosis of this species and other closely related species.


Fructifications 1.5 mm. by 4-6 cm., simple, filiform; erect from deciduous leaves, smooth; pallid to
yellowish buff; flesh very thin, hollow above; apex acute. Hymenium 45 microns thick, composed of 4-spored basidia 7.5 microns in diameter. Spores hyaline under the microscope, smooth, broadly ovate, 3.8-4.5 by 9-10 microns.

Our collection (MD 3163) fits in every way the findings of Harper (loc. cit.) in his researches on the section; his plate 5 is the best to be found. Likewise our collection fits the description given by Cotton and Wakefield (loc. cit.) who in addition list no odor and a distinctly acrid taste. Ours were in a scattering colonies, radicating on and among the fallen leaves of Castanopsis chrysophylla along Beaver Creek, Benton County, in January. The nature of the club and absence of any sign of a sclerotium eliminates this species from Typhula as ordinarily defined, or used by Remsburg (1940).


Fructifications simple, rarely branched above, 4-7 cm. tall by 2-4 mm. broad, terete and solid or hollow and flattened, often longitudinally grooved; stipe portion
lighter in color, often scurfy hairy; tips mostly blunt. Taste pleasant, odor none. **Color** Deep Chrome to Mikado Orange, fading to tints of these, very base whitish myceloid; **flesh** yellowish; drying bright colored on the surface. **Hymenium** up to 75 microns thick. Sterigmata 4, stout, up to 9 microns long. **Spores** unequally ovate, smooth, or sparsely finely tuberculate, 4-5 by 5-6 (7.5) microns. **Plate 7.**

**Specimens examined:** Lane County, MD 998; Benton County, MD 3156 (In mosses under firs, Beaver Creek, December 8, 1940); Linn County, WBC 9946, MD 3154 (Amongst mosses, South Santiam Pass, October 30, 1940); Coos County, MD 3013 (Amongst needles and humus under heavy growth of coniferous trees, Charleston, November 21, 1940), MD 3023.

There are several species of small yellow *Clavaria* of simple form that are difficult to distinguish. Our fungus is not differently colored at the tip, a point distinguishing this species from many otherwise almost indistinguishable forms. The spores are smooth or finely roughened, eliminating the possibility of its being classified as *C. inaequalis*. It does not differ from Cotton's description of *C. persimilis* except that the apices are not acute in our sense of the word. Its simplicity separates it from *C. corniculata* Schaeffer; different spores and lighter color when dry, characters of the later, make them inconfusable.
13. **Clavaria** Species. Typified by the collection MD 3014.

Fructifications about 1.5 by .05 cm., simple; erect from Douglas fir needles. Clubs smooth, upper third of club Pale Orange Yellow; this part tapering to the acute apex; below brownish to the white incrassate base. **Hymenium** 30-40 microns thick, simple, composed of 2- and 4-spored basidia 22-25 by 3-4.5 (7) microns; sterigmata slender, up to 5 microns long. **Spores** smooth, (2.5)3-5 by 4-5 microns, uniguttulate (3 microns).

This small species was growing gregariously on fir needles with *C. pulchra*. It differs from *C. pulchra* by its pale color, indistinct stem, and smaller size and spores. The center of the club seems to be stuffed, rather than hollow and this character along with the smaller spores and different habitat assure its ready distinction from our only other similar *Clavaria*, *C. juncea*. While the spores are smooth and the clubs more narrow, it might be *C. Macouni* Peck.


In the author's collections there are two packets (MD 3158 and MD 721) and in the herbarium of William Bridge Cooke one collection (his 9761 tentatively identified by him as being this species), whose dry
fit the type description for this species. They differ from our dried specimens of *C. pulchra* in that they are now pale buffy whereas our *C. pulchra* specimens are Orange Yellow even when dried. Cooke's material was gathered from a Douglas fir log along Greasy Creek in Benton County. The author's collections were made one under oaks and the other on cedar needles. Coker's description of the species is as follows:

"Plants simple, single or rarely caespitose in groups of 2-4, gregarious in small numbers; height 3-9 cm., the stem very distinct and sharply defined, 1-4 cm. long, terete, smooth and shining, lemon yellow except for the whitened and subtomentose base. Club 2-6 cm. long, 1.5-5 mm. thick, straight or bent, equal, terete or less often compressed, delicately but very distinctly and regularly ridged and furrowed longitudinally (as in *C. nigrita*); color varying from pale fleshy yellow to light cream or creamy yellow, the rounded tips concolorous, then fading brownish. Flesh of the club concolorous, very tender and brittle, snapping clean at an angle of 45°, solid but usually soon hollowed by grubs, stem tough and pliable, not breaking when bent on self, with a cartilaginous rind and softer center. Taste and odor none.

"Spores (of type) white, smooth, subspherical, 4.8-6.5 by 5.5-7.2 microns, with large oil drop and a
distinct mucro. Basidia 4-spored or (a few) 2-spored, 7.3-8.5 microns thick. Threads of flesh parallel, about 4.8 microns thick under the hymenium, larger towards the center, where they are about 14 microns thick on an average.

"We have found the species only in frondose woods on very rotten deciduous logs (probably chestnut) or on pure leaf mold and at an elevation of about 4000 feet."

The spores, in our collections cited above are smooth, uniguttulate, hyaline under the micoscope, ovate to subglobose, 3-4.5 by 4-4.5(6) microns. The hymenium is 35-45 microns thick, composed of 4-spored basidia mostly 30 by 7.5-9 microns. The differences between the various simple white or yellow species are not well understood, but the spores of this species as illustrated and those of our fungi seem to be identical; other characters might be those of several species in the literature. In the dried condition the distinct nature of the stem is indeterminate.


"Fruit body simple, fleshy, cylindrical, stipitate, fertile portion 3-5 cm. long, 1.5-2 mm. thick, 'wood-brown' to 'fawn color'. Stipe slender 1.5-3 cm. long, minutely pruinose. Spores oblong, 5-6 by 2.5 microns,
hyaline, smooth; cystidia 65-70 by 7-12 microns, fairly abundant, hyaline, thin-walled, lanceolate, pedicel long and slender; basidia 4-spored, 30 by 5 microns.

"On mosses in conifer forest, Mt. Hood, Oregon. October 15. Collected by L. E. Wehmeyer."

Reported only from the type locality by Calvin H. Kauffman as cited above. Apparently this is the only known collection.


"Fructifications simple or seldom once-forked, single or caespitose, narrowly clavate, often flattened with longitudinal furrows on larger plants, up to 15 cm. long and 4 to 8 mm. broad, Rood's Brown when fresh, drying Wood Brown, concolorous throughout except whitish at base in larger plants; odor pleasant, taste slightly acid; flesh white; internal structure in central portion hollow to stuffed with meshy strands of filaments, gradually passing to a subhymenial layer of soft pseudo-parenchyma; basidia subcylindrical to clavate, 55-74 by 7-9 microns, 2-4 spored; spores ellipsoid to inequilateral, hyaline, granular, one-guttulate, asperulate, 6-8 by 3-4 microns. Spore print white. Cystidia few, hyaline, conic above hymenium, projecting 37-52 microns,
sometimes encrusted and gloecystidia-like.

(Type in Zeller Herbarium, 7185, and in Oregon Agr. Coll. Herb., 4935.)

"Clavaria occidentalis bears a close relationship with C. incarnata Weinh., C. purpurea Fr. and C. rosea Fr. from all of which it differs in the slightly rough spores and size of basidia."

The types in the OSC herbarium (numbered OSC 4935 and OSC 6023) are now in color varying from Avellalous and Wood Brown to as light as Chamois. In the same herbarium in addition to the type collections there is one collection (OSC 13,517) that is now not over 2 cm. tall but has the spores and hymenium of this species. Other than these three collections none are known referrable to this species thos it seems distinct from all others with the possible exception of C. fumosoides Kauffman, whose spores are smooth. With the phloxine-KOH technique employed in the examination of dry herbarium material the spores appeared to the writer to be smooth and mostly 3.5-4.5 by 7-9 microns with cystidia protruding 25 to 35 microns, in their entirety about 7.5 to 9 by 100 microns. The types of occidentalis and fumosoides need to be closely compared. They both differ from other closely related forms by the possession of cystidia and their color and spore characters.

"Fructification fleshy, very fragile, composed of dense fascicles of simple clubs which are often somewhat joined at the 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) by 3.5 microns, smooth, hyaline. Basidia elongate, 70-75 by 7-8 microns, 4-spored. Cystidia abundant and crowded in the hymenium, subcylindrical to cylindrical, slightly tapering downwards, rounded-obtuse, hyaline, usually granular within, 110-130 by 5-7(8) microns, base imbedded in subhymenium. Odor slight, earth; taste tardily subnauseous.

"Growing in gregarious tufts in an open grassy slope near lake. Type collected at Lake Quinault, 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 (1919) and by Rea (1922). However, the presence of very abundant 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."

This species has not been reported from Oregon as yet but is included for it seems that further search should produce collections from this state. See the discussion under *C. occidentalis*.


After Coker: "Plants simple, usually densely fascicled, about 3-7 cm. long or rarely up to 18 cm. long, cavernously hollow unless flattened and then often not hollow, cylindrical or more often flattened and grooved on the sides, at times broadest near the tip and narrowly spatulate, again more tapering, abruptly or gradually pointed, 2-12 mm. wide above the middle,
tapering downward to a slender, paler base about 1.5-2 mm. thick, which is not sharply defined from the club. Not rarely the plants are much contorted and fantastically curved, resembling at times a ram's horn. Color a deep primrose yellow, or duller brownish yellow, the tip or the whole becoming water-soaked and brownish in age, the very base light yellow and somewhat increassated. Color unchanged or darker in drying. Texture moderately brittle, cracking at a bend of 45° but not snapping clean. Taste bitter and farinaceous, disagreeable (lost on drying) or varying to quite mild.

"Spores light yellow (fading to cream color in the herbarium) or in some collections white, subspherical with a small mucro, 5.1-6.7 microns in diameter. Basidia club-shaped, about 7.5 microns thick, mostly 4-spored, but usually also some 2-spored in the same plant, the sterigmata about as long as the diameter of the spores."

This species was reported from Oregon by Kauffman from Mt. Hood. No collections have been seen in the material examined that could be classified here. Burt (loc. cit.) wonders whether there is such a species well defined in the United States. Coker (loc. cit.) describes a fungus with somewhat different microscopical characters, but it is very likely this species.

Rea (1922), after Cotton and Wakefield, gives the
following microscopical characteristics for the English forms: "Basidia hyaline, 35-40 by 6.8 microns; sterigmata 4, slightly curved. Spores globose, smooth, minutely apiculate, 5-7 (-8) microns in diameter, at first yellow, then colourless."


**Fructifications** 6 to 15 (25) cm. tall and 2-4 cm. in diameter, simple, rarely branched and then fascicled or appressed so as to be separated only by grooves in the thus larger club; caespitose with a few scattered solitary members. Clubs becoming delicately costate, with increasing size folded, or flattened but solid (in ours); apices blunt. **Flesh** hygrophanous very fragile; odor humicolous; no taste. **Color** white throughout but with some sulphur yellow stains. **Hymenium** 40 (Coker) to 60 (ours) microns thick; composed of 4-spored basidia about 30-35 by 6-7.5 microns. **Spores** smooth, hyaline under the microscope, white in prints, globose or subglobose, 4.5-5 microns. **Plate 8.**
Specimens examined: Linn County, MD 948 (under Acer macrophyllum and its leaves, yet in mixed brush along the roadside, Cascadia, October 19, 1940); Yamhill County, OSC 6044; Benton County, OSC 6039 (in mixed woods, Corvallis, October 19, 1920), MD 3160 (amongst grass in pasture three miles north of Corvallis, December 3, 1915; collected by Dr. Helen M. Gilkey); Lane County, MD 995 (in grasses and fir needles along road bank above McCredie Springs, November, 1940); Hood River County, WBC 9666.

This is a rather common species usually collected amongst grasses at the edges of mixed woods. The clear white color, growth habit, and the tender watery flesh which almost dissolves when chewed distinguishes this species macroscopically in the field from all the rest. Often the clubs will have a bright yellow stain on them. This is not produced by bruising and its origin or cause is unknown.

Fructifications 4 to 8 cm. tall, simple but branching irregularly above from the distinct, sterile, hispid, trunk. Branches irregular, terete, blunt, glabrous, axiles acute. Flesh hygrophanous, solid in fertile branches; toughish with small central hollow in the stipe. Color of the trunks Cinnamon Brown and darker in age and warty or smooth, but Avellaneous and hirsute when young; fertile branches pinkish to whitish, darkening with maturity through the Vinaceous Fawn series until nearly concolorous with the stipe, flesh concolorous with the surface. Hymenium 60-75 microns thick with all elements densely granular; basidia strangulate, 2-spored, 9-11 by (45)50-60 microns. Spores typically broadly ovate and 9 by 12 microns or subglobose and 12 to 15 microns, smooth or sometimes slightly irregular and roughened. Plate 9 and Plate 1, Figure 4.

Specimens examined: Coos County, MD 3016 (in a clearing of moss covered clay among the Ericaceous underbrush of deep coniferous woods on Coos Head, Oregon, November 21, 1940.)

This species is distinct from all others found in Oregon by the sterile hispid brownish trunk. The branching above, rarely are these simple fructifications, is often more or less palmate with the branches being swollen a bit larger than the trunk. Coker (1923:67) notes that the tramal hyphae are "very variable and
irregular, with many septa and no clamp connections". Likewise he states that the subhymenial "thread are replaced by large swollen cells." It has been repeatedly reported from the east coast but this collection and one by Kauffman (1925) from Mount Hood greatly extend its range. The spores of our western representatives have somewhat larger dimensions than those from eastern collections but are otherwise identical.


Fructifications usually under 7 cm. tall, tufted, branched at the base and usually several times above, erect, spreading, gregarious, from coniferous duff, usually in well shaded coniferous woods. Branches solid, smooth, tips blunt to fine or cristate. Flesh brittle, homogenous, often somewhat hygrophanous, concolorous with surface, drying white, taste slight, odor none. Color white, though quite frequently darkened below by a parasite; drying ochraceous. Hymenium composed of 2-
spored basidia 7.5 by (30)50-60 microns. Spores subglobose, 7.5-9(11) by 9-11(12) microns, apiculate, smooth, hyaline, becoming yellow on prints after several months. Plate 3, figure 4.

Specimens examined: Lincoln County, WBC 13046; Lane County, UO 2, MD 3149; Multnomah County, WBC 9715, OSC 9178; Coos County, MD 3015, OSC 5824; Linn County, MD 983, Washington State, WBC 9603, OSC 20,019; Benton County, WBC 9831, Epling 326, OSC 6033, OSC 2128, OSC 9392, OSC 13514, OSC 7868, MD 3081, MD 742.

Following Coker (1923) the following three species and their forms would all be included within this one species. Quite obviously if one were to follow the procedure of using spore and hymenial characters alone as the taxonomic criteria this would still be a good species (i.e. sensu Coker). When consideration is lent to form, habitat, and other characters the collections made from Oregon must be divided into these following three additional segregations. This is the most commonly reported species in the literature and the one which appears most widely in our state. It may be found in lawns or in very dense woods. It grows throughout all but the very highest of the life zones, from the seacoast through the Hudsonian Zone to timber-line. Paper dried after being rubbed with wet specimens of this species
or one of the three following species flouresced under the long wavelengths of ultra-violet light. Perhaps other such criteria if investigated would yield evidence of difference of taxonomic worth within this section of the genus. One such evidence is in the nuclear degeneration in \textit{C. cinerea} as studied by Bauch (1927) and discussed elsewhere in this thesis.

A variation from \textit{C. cristata} appears in a collection (MD 973) made along the Newport Road in Benton County from coniferous forest floor on October 29, 1940. The fructification has many erect acute branches from a slender stem below. The form was that of \textit{C. Kunzei} but the spores were much larger and the microscopic details are the same as for \textit{C. cristata} (Basidia 75 by (6)-9 microns, 2-sterigmate; hymenium 80-100 microns thick; spores as in the species). In addition to its growth form it differed from typical members of this species in having a slight bitter taste and a somewhat cartilagenous stem which was buffy below. This is perhaps the \textit{C. trichopus} of Persoon.

plate 6, figure 42, 1922; and in Zeller, Mycologia 21: 97, 1929; C. cristata (Holmskiold) Persoon in part in Coker, Clav. of the U. S. and Canada p.68ff, plates 9, 17, 19, and 83, 1923.

The characters for this form are the same as those for C. cristata except as noted below. The fructifications are typically unbranched below and at the most only once or twice above, and with very blunt apices. The surface of the branches is rugose to smooth, usually with definite irregular or longitudinal costae. In drying the fructifications usually become bright yellow to orange (Light Salmon Orange or more red). Most typically this form appears in deeper woods than does C. cristata which is more branched, usually with smoother surfaces and non-enlarged apices.

Specimens examined: Benton County, WBC 9987, MD 663, MD 863, OSC 7241, OSC 6040, MD 3146, MD 734 (Common on bare ground or amongst fir needles under Douglas firs, Avery Park, Corvallis, January 5, 1939); Douglas County, WBC 9862, WBC 9854; Marion County, OSC 6024, OSC 7952.

Gard. 9:40, plate 8, figure 60, 1922; _C. cristata_ (Holm-skiold) ex Persoon in part in Coker, Clav. of the U. S. and Canada p.68 ff, plate 9, 17, 19, and 83, 1923.

This species is like _Clavaria cristata_ except as noted below. The fructifications appear in more open woods or in mixed woods more frequently than does _C. cristata_. Fructifications often from well developed sterile base or as in _cristata_, though often more branched and more slender. Colored in the Light Drab series of Ridgeway and drying ochraceous cinerous to almost grayish olivaceous. Hymenial and spore characters same as those of _cristata_. A difference between these two appears in the more greenish yellow florescence of _C. cinerea_ under long wave-length ultra violet light. The nuclear phenomena described elsewhere likewise separate it from other species with like characters.

**Specimens examined:** Curry County, M.M.Ross 1019; Benton County, MD 3150, OSC 13413, OSC 6030, MD 3148; Linn County, MD 714, MD 980; Lane County, MD 3151, MD 3152 (under oaks and fir, five miles west of Eugene, Lane County, December 23, 1940); Lincoln County, WBC 10020; OSC 7544, OSC 8987; Douglas County, WBC 9889, WBC 9879;

One collection (MD 980) of the above was considerable at variance with the usual form. The fruc-
tifications were up to 15 cm. tall, branched five to ten times from a small base buried in coniferous duff. Larger branches hollow, smooth or longitudinally costate, particularly when dry; flesh white, brittle; taste when dry like stale nuts; odor none; color Pallid Quaker Drab where protected, darker to Light Cinnamon Drab where exposed, whitish to light yellowish where completely shaded or below the ground line; drying about Pale Smoke Gray or Pale Olive Gray. The hymenium was like that of \textit{C. cristata} with globose spores 7.5-9 by 7.5-10 microns, hyaline, smooth, irregular in size. \textbf{Plate 10.}


\textbf{Fructifications} slender, up to 8 or 9 cm. tall, branching at the base and then 4 to 6 times above, from coniferous duff; branches hollow, smooth, terete, those of second and third orders long while those of succeeding orders short giving the fungus an appearance of fascicles of fairly simple structures. \textbf{Flesh} thin, white,
at least when dry; odor and taste none or indefinite. Color Apricot Yellow to Cream Buff, drying Salmon Buff to Cinnamon Buff with the base remaining white and the ultimate, short, inflexed tips often blackened. Hymenium composed of a few swollen tipped, sterile structures and basidia 9-10.5 by 60-75 microns. Spores white with conspicuous apiculae, spherical, 7-7.5(10.5) microns in diameter, smooth. Plate 1.

Specimen examined: Linn County, WBC 9948 (under Douglas firs on Peoria Road, January 30, 1938).

Fries first published C. corniculata in 1821 and then later, having changed his mind, adopted C. muscoides. However the former name is the nomenclatorially correct one. Coker says that this species has a "rank, farinaceous and bitter" taste. No taste was discernible in our fungi other than a slightly farinaceous combination taste and odor when dry. This is the second report from the west coast. Zeller (1922) reported the species from Oregon but the packet in the OSC herbarium under the number 1972, which he reported to contain his collection of C. corniculata Shaeff. ex. Fries, now contains only C. myceliosa Peck. This species is peculiar in being our only distinctly ochraceous species with globose white spores. The comparatively large hollow center of the stems and simple appearance further separate this from other species found in Oregon.

"Fructification simple, 6-8 cm. high, strict, subcylindrical, terete, even, glabrous, pale 'cream buff' upward, almost 'colonial-buff' (R.) downwards, solid, fertile portion 1.5-2 mm. in diameter apex obtuse to subacute, base inserted and naked, without sclerotium.


"Scattered-gregarious on very rotten wood of conifers in swampy forest of hemlock, Douglas fir and spruce. Type collected at Lake Quinault, Washington (State), October 28, 1935....

"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 the 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."

This species, like several others found so far only in the State of Washington, is included with the
hope that this inclusion may aid in its being recognized in some future Oregon collection.


Fructifications 2 to 5 cm. in height; humicolous beneath underbrush in coniferous woods; branching 3 to 4 times, the branches much alike and not different from the trunk. **Branches** erect, spreading, terete, axiles broad and rounding, tips blunt. **Color** Pale Orange Yellow, Maize Yellow, or Light Buff above to white below; no change upon bruising, and drying Chamois to Pinkish Buff. Fleshy with no marked odor or taste, drying hard and brittle. **Hymenium** thin, 20 microns thick where simple or up to 55 or 60 microns where complex; composed of slender, clavate basidia 4-5 by 15 microns, or rarely much longer. **Sterigmata** typically 4- but some 2-spored, 1.5 to 3 microns long. **Spores** hyaline under the microscope, globose, 3 by 4 (3-4 by 3-4.5) microns, distinctly sparcely echinulate, verrucose or smooth. **Plate III**, figure 2.

**Specimens examined:** Coos County, MD 3028 (Humus in coniferous woods, Coos Head, November 22, 1940),
MD 3029.

This is regarded here as Kunzei though only a few of the fungus sporophores attained the proportions illustrated by the plates of Burt and Coker. It is very distinct from C. cristata or C. rugosa by the fine branched form and much smaller spores from 4-sterigmate basidia. These characters and its white color will separate it from our other Clavaria species. From C. gracilis it is most easily differentiated by the growth habit and smoother spores.

27. CLAVARIA species. Typified by the collection MD 3026.

Fructifications very delicate, 2 to 4 cm. tall, simple or branched once to four times above, branches spreading, terete, 1 to 1.5 mm. in diameter, white, drying ochraceous with a pinkish tinge, acrid or bitter except when dry. Hymenium 20 microns thick, composed of 4-spored basidia about 7.5 microns broad. Spores very light ochraceous, verrucose, 4-4.5(5) by 7.5-8(9) microns, ovate or broadly ellipsoid. Plate 3, figure 3.

This delicate little species was found once (MD 3026) growing among deciduous leaves on Coos Head, Coos County, In November, 1940. It differs from C. acris in being white, tho the taste and spores are similar. The longer spores and taste distinguish it from C. gracilis.
Its appearance is not unlike C. Kunzei but the spores are obviously different. The spores are of C. abietina shape and roughening, but are lighter in color.


Fructifications 1 to 5 cm. broad by 3-7 cm. tall, branched nine to twelve times into fine, solid, bushy, branches; gregarious from coniferous duff. Branches toughish, usually under 2 mm. in diameter as is the trunk below, which arises from white mycelial strands, no taste, odor reputedly medicinal but not present when dry. Hymenium 45-55 microns thick, composed of 4-spored basidia 4.5-5.5 microns broad. Spores light ochraceous, almost hyaline under the microscope, roughened, 3-3.2 by 5.2-6 microns, ovate-elliptical. Plate 3, figure 1.

Specimens examined: Benton County, MD 3136 (amongst needles and mosses, Beaver Creek, November 3, 1940): Hood River County, WBC 9676.

This fungus has the appearance of a muchly branched specimen of C. myceliosa from which it is to be
distinguished by its smaller spores and white color. It may be distinguished by the lighter color when dried from the other members of the genus otherwise closely related. As far as known this is the first report from west of the Mississippi River.


Fructifications (1)3(5) by (2)4(7) cm.; branched abruptly from the slender base about five to eight times; growing from copious white rhizomorphic mycelial strands in coniferous duff. Branches spreading, slender, usually under 1 mm. in diameter, solid; flesh white, taste bitter, with little odor. Concolorous throughout, Ochraceous Buff, Honey Yellow, Bronze Yellow, or Yellow Lake of Oberthür; Pale Yellow Orange, Warm Buff, or Cinnamon Drab of Ridgeway; no bruising colorations or natural green colors present. Hymenium about 25-30 microns thick, composed of basidia 15-22 by 4.5(6) microns. Sterigmata 4 (rarely 2 or 3), about 2-5 microns long. Spores echinulate (rarely nearly smooth), ochraceous, (2)2.5-3.5(4) by (3.5)4-5(6) microns, ovate to subglobose, often clumped in fresh mounts. Plate 2, figure 13.

Specimens examined: Benton County, OSC 1972
(under *Pseudotsuga taxifolia* five miles south of Philomath, January 15, 1940), OSC 7867, MD 656, MD 3125, MD 666, MD 3080, MD 3135 (growing on needles and dead mosses, Beaver Creek, November 3, 1940), WBC 9751, WBC 9985, MD 3134, WBC 9832, MD 780, OSC 6027; Linn County, MD 675 (Cascadia, on ground amongst needles under hemlocks and *Abies grandis*, January 12, 1940), WBC 9947; Lane County, MD 652; Douglas County, WBC 9841.

The investigation of numerous collections of this species shows the type description to differ from average collections of this species from Oregon in having smaller spores. Peck's original description says the spores are "subglobose 4 microns long"; likewise our fungi are usually more branched than the type description would lead one to believe, and often quite dichotomously so. It is common in all coniferous woods of Western Oregon and usually is referred to *Clavaria flaccida* but may be differentiated by the smaller, echinulate spores. Peck's type collection was from the hills about Stanford University growing on redwood needles.

30. **CLAVARIA** species. Typified by the collection MD 3122.

Fructifications up to 2.5 cm. tall, branched above, branches terete, acute; Capucine Buff from a whitish base, or darker to Capucine Orange particularly on the tips,
bitter, no noticeable odor. Basidia 4-spored; spores ochraceous, echinulate or nearly smooth, ellipsoid, 2.5-3 by 4.5-6 microns. Plate 3.

*C. myceliosa* is the nearest species we have to this fungus: their spores are the same. Our present species here is separable by its habit (MD 3122 growing from a road bank and not in duff or from needles) and color. Collected along the Beaver Creek road, Philomath, Benton County, November 3, 1940. This might be an odd form of *C. acris* Peck.


Fructifications 4 to 7(8) cm. tall, much branched from coniferous duff, rotten leaves or wood, branching about six to eight times into slender straight, upright, ramulae that wrinkle longitudinally when dry, semirad-
icating below when on the ground. Branches solid becoming very hard and brittle upon drying, tips concolorous (or green), often staining blue-green where bruised. Color deep ochraceous or olivaceous often with tips Kildare Green or Turtle Green, or the acute axiles this color, darkening through Olive Ochre to Wood Brown and darker to Auburn below. Flesh tough, bitter or mouldy tasting when dry, little odor, white when fresh, brownish when dry. Hymenium composed of 4-spored basidia 35-45 by 7-8 microns. Spores distinctly ochraceous, mostly 4.5 to 5 by 7.5-10(12) microns, verrucose to smooth. Plate 2, figure 12.

Specimens examined: Benton County, MD 3079 (on Douglas fir needles in dense coniferous woods, Beaver Creek, December 8, 1940), MD 3138 (on rotten coniferous wood, Beaver Creek, November 3, 1940); Douglas County, WEC 9843; Lane County, MD 3116; Linn County, MD 985, MD 3129 (at bases and around elder bushes, Canadian Zone, South Santiam Pass, October 30, 1940).

Only by the inconsistent character of the green stain may C. abietina be distinguished from C. flaccida. The most typical collection made was from an oak woods (MD 3116) with no coniferous trees within 500 feet. These specimens were lined along the side of a rotten oak limb, which was half buried in the ground; about half of them showed green tips and stains and the rest showed no sign
of such coloration. Those with the green were the larger specimens. Others (MD 3129) have been found associated with Sambucus high in the mountains. Its usual habitat is coniferous duff. These two species are here considered synonymous and since the name abietina is published on page 469 and flaccida on page 471, in Fries' Systema Mycologicum, the former has been accepted. Very likely there is as much discussion in the literature of these two species as of any other group of difficult species. All this is because some, otherwise as yet indistinguishable, specimens have natural green colors, others stain green, and others have no green coloration in any state.

32. CVAWARIA species. Typified by the collections MD 812, MD 664 and WEC 9622.

Fructifications 4 to 7 cm. high, branched about 7 to 8 times from the slender trunk arising from whitish mycelium on coniferous twigs and cones. Branches closely erect from acute angles, terete, slender, tips attenuated, concolorous and pointed. Flesh bitter, tough, white, solid, no marked odor. Color ochraceous drab, drying drab olivaceous when old, brownish where bruised and young fungi remaining lighter. Hymenium 40-50 microns thick, composed of 4-spored basidia about 45 by 7.5 microns. Spores ochraceous, (3.7)4.5-5(5.5) by 7.5-10(12) microns, smooth, elliptical.
Specimens examined: Klickitat County, Washington, WBC 9622; Lane County, Oregon MD 812, MD 664 (both collections from Kitson Springs, November and October, respectively, of 1939).

Though diligent search was made these few stood out from the rest and would not fit any known species. Their growth habit (on coniferous twigs and cones), concolorous tips, and smooth spores make them distinct from known members of the section. They differ from *C. apiculata* in the habit and coloration. Possibly they represent Burt's *C. pinicola* if that be distinct from *C. apiculata*.


Fructifications up to 4(6) cm. tall from copious white, subiculoid, mycelium on or amongst coniferous wood or cones, branching quickly and dichotomously about four times. Branches solid, tough, not breaking when reflexed, surface smooth except perhaps in sterile axils. Color Pale Euchre to Flesh below, with light yellow to whitish or Horizon Blue tips when young, becoming Dark Fawn in age, drying about Avellaneous. Flesh white, solid, bitter, without odor; hard but somewhat flexible when dry.
Hymenium composed of clavate basidia 36-45 by 7.5 microns. Sterigmata 4, straight, 6-9 microns long. Spores light ochraceous, smooth, 4.5-5.2 by 9-10 microns, elliptic.

Plate 2, figure 11, Plate 11.

Specimens examined: Union County, MD 268; Lane County, MD 999 (on large solid fir log, five miles above McCredie Springs, November 11, 1940), MD 3116 (attached to wood or cones in Hudsonian Zone, along the Obsidian Trail to Sunshine Shelter, Three Sisters Primitive Area, October 6, 1940); Deschutes County, MD 3128 (lining bits of wood five miles west of Sisters, October 30, 1940); Linn County, MD 958 (terricolous along-side cones and sticks, Santiam Pass, under conifers, October 19, 1940), MD 955; Washington State, WBC 9626, WBC 9624, WBC 9597.

This small Clavaria usually grows in troupns on coniferous needles and there lining the fallen limbs and tree trunks in the higher forests. It branches quickly from the base which arises from large quantities of white conspicuous mycelium. The young fructifications are white, often with tints of pink; the young acute tips remain white even when dried and when fresh are often tinted with blue. Often the branches are somewhat flattened and then these flattened surfaces have an invading sterile area from the axile below. This species may be distinguished from all our others by the growth habit, white tips, and the fact that it dries moderately
dark instead of remaining light-ochnaceous as does C. stricta. It is likely that this species is synonymous with C. pinicola Burt. Seaver and Shope (1935) report C. apiculata from Colorado and publish with their report an illustration that shows their fungus to have a form very much the same as ours.

34. CLAVARIA species. Typified by the collection MD 3139.

Fructifications up to 3 cm. tall, branches less than 2 mm. thick, irregularly (some nearly trichotomously) branched very divaricately from white stringy mycelium on deciduous wood; mycelial strands often erect passing almost imperceptibly into fertile branches above. Brandes remaining terete and smooth when dried. In color Buff Pink or towards the Drab series in parts; no odor; slight bitter taste when fresh; little or no taste or odor when dry. Spores ochraceous, smooth, (4.5)-5-(5.5) by (7.5)-8-9-(9.5) microns, broad ellipsoid. Plates 2, figure 10.

Its large smooth spores and habit preclude any assumption of this collection's (MD 3139 on maple twigs, Beaver Creek, Benton County, November 3, 1940) possible placement with the known forms of C. abietina, with C. decurrens, C. subdecurrens, or C. byssissida.
35. **CLAVARIA TESTACEOFLAVA** var. **TESTACEOVIRIDIS**


Fructifications up to 3 cm. tall, terricolous; branched below from small compound base at the ground level, then erect and unbranched for about .5 cm., branched then about three times with the ultimate tips pluridentate, the whole stout and compact, sometimes branches enlarged above. Branches smooth, terete or flattened, hollow from far down in the stem out into the tips in ours. **Color** Light Pinkish Cinnamon to Chamois, becoming Burnt Umber where bruised, tips Pale Yellowish Green or Sky Green; drying Pinkish Buff to Snuff Brown or Bister, loosing all green coloration. **Flesh** of branches tough, fleshy-cartilaginous, odor none, taste bitter, drying hard and brittle. **Hymenium** about 45-60 microns thick, composed of 4-spored basidia. **Spores** Pale Yellow Orange in mass, nearly hyaline under the microscope, mostly 3.75 by 10.5 (3.2-3.8 by 9-11) microns, verrucose, thin-walled, elliptical, sometimes curved if long and narrow, collecting in the axiles of the branches. **Plate 12.**

**Specimens examined:** Benton County, MD 952

(Collected by Charlotte Doty on the ground along edge
of a pasture and maple-oak grove, 1 mile west of Philomath on the Alsea road, October 22, 1940), OSC 25,889.

This fungus fits the description of Atkinson's variety closely, the type of which is assumed to be lost; it could not be found by Coker (1923). Cotton and Wakefield (1919) say that *C. testaceo-flava* Bresadola differs from their *C. Broomei* in the smaller basidia and the granular not distinctly aculeate spores. It seems to be quite distinct from the description of Bresadola's species and everything but this variety of Atkinson's which is scantily described. It seems advisable to describe it anew as a separate species.

36. **CLAVARIA** species. Typified by the collections MD 661 and OSC 13,515.

Fructifications up to 3 cm. tall, clustered in grass, irregularly branched above two or three times; the tips acute, pluridentate, Branches usually flattened solid, smooth; Blood-Red-Brown or Lighter to Light Reddish Salmon, often becoming nearly Pale Lilac, Lilac Mauve or Parma Violet (Oberthür). Flesh bitter, no odor, white, no bruising stain other than darkening. Hymenium 110 microns thick, composed only of basidia 7.5-8.5 microns broad. Sterigmata 4, erected, 7-10 microns long,
slender. Spores ochraceous, (8)9-11(12) by 3.8-4.5(5) microns, elliptical, nearly smooth to evenly verrucose, often with a spherical vacuole. Plate 2, figure 9.

Specimens examined: Benton County, OSC 13,515, MD 661 (Lawns under American elms on the Oregon State College Campus, Corvallis, Oregon, Late November and early December of 1939).

The different color and habit differentiates this species from C. suecica sensu Coker and C. invalii Cotton and Wakefield. The spores are larger than those of either of these species and it seems to be quite distinct from any of our other Clavarias.


Fructifications 4 to 8 cm. high, branched from a slender trunk, rooting by white rhizomorphs from deciduous wood. Branches of about five to seven orders, erect, mostly terete and dichotomous with acute axiles, rather
densely fascicled, becoming attenuated above. Flesh bitter, white, solid, odor pleasant. Color Cinnamon Buff to fleshy tan according to Coker, darkening where bruised, drying light ochraceous. Hymenium composed of 4-spored basidia 30 to 40 by 7 to 9 microns. Spores hyaline under the microscope but ochraceous in prints, (4)4.5(5) by 9-10.5 microns, elliptical, roughened. Plate 2, figure 8.

Specimens examined: Lane County, UOl; Benton County, OSC 8699 (on alder wood /or maple/, from rhizomorphs, Alsea Mountain, November 9, 1930), OSC 6029, OSC 6032 (in coniferous woods, Corvallis, November 16, 1919); Linn County, MD 962, MD 3130; Lincoln County, WBC 9518; Coos County, MD 3142 (amongst mosses under conifers, Coos Head, October 13, 1940), MD 3137, OSC 8978; Hood River County, WBC 9674, WBC 9668; Washington State, WBC 9623.

Coker (1923) believes that this species is restricted to deciduous wood. Both UOl and OSC 8699 cited above were on alder or maple wood; the rest were either on coniferous wood or terricolous under conifers. No other differences were observed among these collections and so until further study it seems advisable to retain them all under this one specific name. This species differs from C. apiculata in their respective substrata,
different coloration, and growth habit. The only distinction from Coker's *C. suecica* seems to be that the later grows on the ground. *C. flavula* would fall here and very likely *C. circinans* Peck.

38. **CLAVARIA GELATINOSA** Coker, Clav. of the U. S. and Canada p.137-139, plates 48, 49, 50, and 86, 1923.

*Fructifications* up to 13 cm. tall and 10 cm. broad, branching erect from rounded axiles about 8-11 times from a base (5 cm. broad by 6 cm. long) composed of fused tough, gelatinous trunks, interposed by white mycelium, the very tip of base becoming homogenous. *Branches* solid, often anastomosed above and the trunks fused in the compound base where they separate upon tearing; tips acute and fine, drying with longitudinal wrinkles though terete when fresh. *Flesh* bitter, not unlike tobacco as is the odor, tough dark, gelatinous, drying dark and very hard. *Color* when young pale creamy white darkening to Buff Pink according to Coker; our specimens were darker from the beginning to light Cinnamon Brown, drying Light Ochraceous Buff or Pale Orange. *Hymenium* composed of sterile and fertile basidia, these later protruding from the hymenium, sometimes swollen and densely granular, 35 by 10-7.5 microns, 4-spored. *Spores* Ochraceous Buff in in axiles of branches and in prints, slightly lighter than
the hymenium, 8-9(10.2) by 4.5-6 microns, reticulately (?) roughened, elliptical. Plate 2, figure 7, and Plate 13.

Specimens examined: Linn County, MD 946 (terrestrial under conifers, Clear Lake Highway Junction with Santiam Highway, October 19, 1940).

Growing under Mountain hemlock and white fir along the South Santiam Highway on needles, it has the appearance of C. formosa only was darker in color and in growth habit not unlike a large specimen of C. abietina. It is easily separated from other species by the tough gelatinous, translucent flesh and the tobacco-like odor and taste. As far as known this is the first record west of the Atlantic Coast or North Carolina.


Fructifications 10 to 15 cm. high and three-fourths as broad, branching erectly about five times, from a solid central trunk which becomes a subradicating structure below. Smallest branches solid, larger ones hollow, smooth, terete, axils acute, drying longitudinally costate, hard and brittle; "short-forked" tips drying hard as though horny. Flesh white, bitter, remaining unchanged when dry at least in the base. Color
Apricot Buff at first, soon becoming concolorous, Fawn Color and darker in that series; drying Pinkish Cinnamon or Cinnamon Buff to Sayal Brown; only darkening upon bruising, vinaceous colorations were seen on the fresh tips of MD 950. Hymenium 60-75 microns thick; composed of 4-spored, densely-granular basidia 7.5-10.5 by 40-50 microns; sterigmata stout, wide-spread. Spores of the type (OSC 8688) ochraceous, mostly 4.5-5 by 10.5-12(13) microns, verrucose, long elliptical, apiculate.

Specimens examined: Lincoln County, Type OSC 8688; Benton County, OSC 11,518; Linn County, MD 950 (collected on ground under conifers at the junction of the South Santiam and Clear Lake Highways, October 19, 1940), MD 944.

This, one of our most beautiful species, is closely related to *C. formosa*, from which it may be separated by the narrower spores, darker color, and bitter taste. Similarly it differs from *C. flava*. In the Oregon State College herbarium the collection under number 11,518 has shorter, smoother spores, shorter basidia, and its general appearance place it close, but seemingly distinct, from the type. Western Oregon is the only location from which collections of this species have been made.

40. **CLAVARIA FORMOSA** Persoon ex Fries, Systema

Fructifications up to 15 cm. tall and more than half as broad, branched about five times from the compounded trunk, which fuses abruptly into a small, homogenous, subradicating base. Branches terete or flattened; surface rugose or roughened in age by islands of hymenium; distinctly grooved, usually drying acutely costate; erect strictly and sometimes fastigiate; irregularly dichotomous; axiles somewhat flattened and usually inflated with a decurrent line (see plate 16), ranging in thickness from 1 to 1.5 cm in diameter below to the blunt apices one to two millimeters thick. Flesh solid, white at first or becoming pink and concolorous with the exterior, particularly in the tips; odor none, or pleasantly mycelial; taste none or slightly acid when dry or old. Color soon becoming pink at least on the tips (Capucine Buff, Orange Pink, or lighter to Light Ochraceous Salmon or darker to Apricot Buff) and white below, eventually becoming concolorous throughout; often staining dark violet or black where bruised; young bran-
ches below whitish through Barium or Martyn's Yellow to the pink colors. *Hymenium* variable but usually 85 to 110 microns thick; composed of long clavate basidia, 10 by 50-70 microns, usually tortuous, strongly granular when mature. Sterigmata 4 (rarely 2), curved inwards from wide points of attachment, 1.5-2 microns at the base and 7.5 microns long (in MD 971). Spores light ochraceous, 4.5-5.5 by 9.5-11 microns, verrucose, ellipsoid, apiculate. Plate 1, figure 3, and plate 16.

Specimens examined: Benton County, MD 971 (under conifers five miles west of Philomath, October 28, 1940), OSC 13,516, OSC 18,512, MD 3143 (almost buried in deep moss of clear oak-fir woods, McDonald Forest, April 26, 1940), MD 3082 (in needles and mosses at base of Douglas fir, Beaver Creek, December 8, 1940), MD 726, OSC 6025 (terrestrial under maples, northern Benton County, April 12, 1930. "This specimen displayed clearly the characteristic violet stains of European descriptions."); Japan, OSC 9565; Washington County, MD 3010; Lincoln County, OSC 7837; Lane County MD 632 (in coniferous woods on ground amongst mosses, Kitson Springs, November 24, 1939).

Weir (1917) finds sclerotioid bodies, which last over one year, associated with the bases of this species. He reports the same for *C. aurea*, whatever it may be, and
C. amethystina. The size and shape of the spores combined with the colors will distinguish this species from other possibly confused large Clavarias. The spores of C. flava differ in being lighter in color, less rough, longer, and differently shaped. Likewise C. flava is never pink and the flesh is white. C. brunnea is perhaps closest to C. formosa, but is to be distinguished in the fresh condition by the darker non-pink coloration and the bitter taste. C. botryoides has longer spores and more deeply colored tips, contrasting with the more weakly colored lower branches. This is our most common member of the large terrestrial forms.

An interesting variation of this species (MD 949) was found on coniferous needles at about 5000 feet elevation. This form was distinct in growth habit (plate 15) but the hymenial characters were too similar to C. formosa to justify its treatment as a separate species. It is considered at this time to be merely a product of some sort of fasciation. The spores are identical with C. formosa or perhaps a very little bit lighter in color and more smooth. Should the form be found constant in subsequent collections it could be described as a distinct species.

A second interesting variation or form of C. formosa is to be found in the Oregon State College herbarium under the number OSC 7831. Its microscopic
characters (spores light ochraceous, broadly elliptical /plate 2, figure 6/, roughened, 5.5-6 by 11-12(13.5) microns) and the dried appearance, slight but distinct acid taste, and soft texture would place it near *C. formosa*. However the long slender branches of the first three orders (2-3 or 5 cm. long) and the very small base make it obviously distinct. The collection was made by Miss Mary Sayles along the coast in Lincoln County and deposited in the Oregon State College herbarium with insufficient notes for a positive determination, or complete description.

41. **CLAVARIA** species. Typified by the collection OSC 6028.

In the Oregon State College Herbarium is a **Clavaria** (OSC 6028) which is now fragmentary and without collection notes. Its distinct spores permit its special mention and a separate segregation. Its tentative classification could only be a conjecture. Its characteristics are:

**Fructification** of fascicled relatively simple structure; branching as in *C. formosa*; fused together at the very base but not enlarged or united into one. Now colored about Maize Yellow above; darkening towards the base which is whitish; vinaceous russett in some
places as though bruised in collecting or drying. The flesh where freshly broken is whitish, chalky, acid, with no odor or very faintly sweetly mycelial. Spores brownish-ochraceous, pink-tinged under the microscope; broadly ellipsoidal; very finely and evenly granular; mostly 9 by 5 microns but some up to 12 by 6.5 microns.

The pink-tinged spores, which are almost brownish, immediately remind one of Clavaria subbotrytis Coker but the spores of that species are more narrow. Plate 2, figure 5.

42. CLAVARIA Species. Typified by the collection MD 3131.

Fructifications 8 cm. tall dried, much branched above from slender trunks, which below unite into a sterile base; axiles obtuse; branches now hard and brittle with acute longitudinal costae; tips many divaricate, acute. Now dry there is a slight nutty taste and an anise odor; the color is ochraceous above. Hymenium 45-55 microns thick; composed of 4-spored basidia 6-7.5 microns in diameter; no cystidia observed. Spores Clay Color in heavy prints to Pinkish Buff in lighter ones, strongly colored under the microscope; ellipsoid, often curved proximally; 4.5-6 by 9-10.5 microns; strongly verrucose; often uniguttulate. Plate 2, figure 4.

This material, from an unannotated collection (MD 3131), is worthy of mention for its very deeply colored
spores which distinguish it from all other collections observed.


Fructifications 5 to 8 cm. high, branched about six or seven times from the fleshy base, arising from coniferous duff. Branches terete, smooth, repeatedly branched above and closely appressed, forming a rather flat-dense-topped fructification. Flesh according to Coker (1923) is "...colored like the surface, but not changing to red except superficially, mild (faintly acid-woody), odorless or with a faint anise odor on standing..." Colored (Zeller:1935) pink throughout, mostly Spinel Pink or Spinel Red to Alizarine Pink. Hymenium of 4-spored basidia seven microns broad. Spores ochraceous, elongate elliptical, 3.5-4.7 by (9) 10.5-12 microns, verrucose. Plate 2, figure 3.

Specimens examined: Benton County, MD 972 (under conifers, five miles west of Philomath, October 29, 1940); Lincoln County, OSC 9698, OSC 5619 (in dense coniferous forest, Big Creek, south of Waldport, November 28, 1932).

Our specimens are now dried and have a distinct, though elusive acrid taste. The red coloration, the more slender spores, and smooth, not longitudinally ribbed or
grooved branches, separate this species from others in the same group. Coker (1923) reports the tips to be more yellow than ours; his being "...always more yellow than pink except in youngest plants, and are never more than very pale creamy flesh-pink." However he does state that the old fungi are mostly red all over. One collection, MD 972 which was Ochraceous Salmon to Flesh Color when brought into the laboratory, turned white overnight in a moist chamber; its spores were roughened 4.8 by 7.5 to 8 microns. Its placement here is only tentative.


After Kauffman page 150-151: "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 and 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 divaricat-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) by 3-3.5 microns, subhyaline with pink tint under the microscope, 'pinkish buff' (Ridgeway) 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 Quiniault, Washington, October 6, 1925..."

Coker upon describing it list is only as from North Carolina. That author believed it more or less closely related to C. botrytis from which it is clearly distinguishable by the smaller, non-striate, spores concolorous flesh, and growth form which liken it to C. formosa. From this latter species it may be distinguished as Coker says, "from formosa which has yellow tips in youth, it differs in greater brittleness, deeper pink color, narrower and smoother spores of a more cinnamon color, and in the quite different texture when dry."
Kauffman adds further that these two are distinguishable by the reversal of color changes in *subbotrytis*. None of our collections is exactly referable to this species though the two following are tentatively placed here.

The collection MD 906 is referred here. The colors and general description fit the above description, but some of the spores are much too long. A description of this collection is: appearance dried of one of the *flava-formosa* series; the accompanying notes say, "younger specimens rosy-scarlet, becoming Honey Yellow above. Brittle; no odor or taste; spores narrow and larger distally, evenly and finely verrucose; 3.7-4.5(5) by 10.5 (mostly) to 15 microns." The fructifications now are about Ochraceous Buff and up to 8 cm. tall dried; the branches are smooth with longitudinal costae as in *C. brunnea* or *C. formosa*. The packet in the Oregon State College herbarium numbered 11,956 and labeled *C. botrytis* cannot be that species though it looks as though the tips were reddish. It is only about 6 to 7 centimeters high now and the spores are 4.5-5 by 9-10 microns long, verrucose but not striate. This, too, is tentatively placed here though it does not fit very well.


Fructification large, 12 to 15 by 10 to 12 cm., branching about 6 times from the subradicating base. Branches terete, smooth or rugose, somewhat dichotomous; erect but often irregularly fastigate; axiles acute, not flattened; tips mostly acute. Flesh solid, white; odor pleasant mycelial; taste none or slightly bitter or nutty when dry, not changing when bruised; color (of MD 981) Antimony Yellow or brighter nearly throughout; Naples Yellow turning Ochreous Orange with age in MD 982, or Maize Yellow in MD 858; no bruising coloration; tips white when young, never with orange or pink tips; flesh white; base beneath the ground-line white. Hymenium composed of 4-spored basidia, 10 by 45 microns (Cotton and Wakefield loc. cit.). Spores ochreous under the microscope; (3)4-4.5(5.5) by 10-12(15) microns; fusiform elliptic and enlarged distally, incurved proximally; nearly smooth. Plate 14, and Plates 1 and 2.

Specimens examined: Benton County, MD 853 (in mosses on forest floor under Douglas fir, Beaver Creek, February 22, 1940), OSC 6035, MD 858; Lane County, OSC 6042; Linn County, MD 981, MD 982 (under conifers, South Santiam Pass, October 30, 1940).
Some of these specimens collected when old were brownish water-soaked as Coker (1923:120), mentioned as a characteristic old age sign. The youngest specimens collected were white; older ones clear yellows. Later some found were tinged with pink or orange but might be distinguished from *C. formosa* by the white flesh, or in the laboratory by the differently shaped spores. It is to be noted that the series of color changes is the reverse of that in *C. formosa*. These two may be further separated through differences in spore measurements and ornamentation. The OSC collections 6035 and 6042 have been allotted here only on spore characters as no knowledge of their fresh condition is to be had.


Kauffman found this species in Oregon at Takilma as follows: "On humus in conifer forest. Spores 9-12 by 3.5-4 microns, subcylindric, minutely rough, subhyaline with a yellowish tint under the microscope. Cystidia none. Basidia 8-8.5 by 5-6 microns, 4-spored. Fruc-
tifications 10-15 (20) cm. high, with quite a number of main branches on the simple stem which is usually imbedded in humus, "Cream color" to "Naples Yellow" (R.), deeper upward, apices of terminal branchlets pinkish-yellow, soon yellow; rather fragile."

In additions to this Peck's original description reads: "Stems united at base, forming tufts 3-5 inches tall and nearly as broad, erect, crowded, solid branches which are whitish or pale buff, ultimate branchlets terminating in two or more blunt points which are pale pink, sometimes with a yellowish tinge; flesh white, taste mild; spores dingy yellow in a thin stratum, sub-ochraceous in a thick one, oblong, .000,4-.000,5 of an inch long, .000,16-.000,2 broad."

Burt in his compilation (1922) found the spores to be only slightly colored under the microscope, minutely rough, and 9-11 by 3.5-4 microns. The spores preclude the possibility of following Coker in his placement of the species as a synonym of \( C. \) botrytis. Kauffman reports that other than the tips being normally yellow, perhaps tinged with pink when fresh and young, it is not unlike \( C. \) flava. Any collection tentatively classified here should be closely compared with \( C. \) flava for spore shape and hymenial characters as they are very similar otherwise; neither have cystidia.

"Fructification fleshy, moderately fragile, 10-12 cm. high, inclusive of immersed stem, branched, color varying between "buff-yellow" and "Warm buff" (Ridgeway), 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 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 by 3.5 microns, smooth or obscurely punctate under highest power, tinged ochraceous-buff. Basidia elongate, 75-80 by 5-6 microns, 4-spored; sterigmata slender, Cystidia scattered in hymenium, cylindrical upwards, narrowed below, obtuse, 50-70 by 5-8 microns, 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 Quiniall, Washington, October 17, 1925."
Supposedly this species looks very much like *C. flava* Fr., but is distinct by "its cystidia, spore characters and odor, and to a less degree by its color and mode of branching." (Kauffman:1927). From the description this species must appear very similar to our specimens referred to under *C. obtusissima* Pk. The acute tips, their light color, and smaller spores of *C. cystidiophora* should serve to separate it from *C. obtusissima*, though the growth habits and coloration are quite the same.


Fructifications 10 to 15 cm. tall, in clusters scarcely united at the base, up to 20 cm. in diameter. Branches terete, finely grooved; axiles acute, not flattened, dichotomous with the dichotomies in close pairs so that the branching appears falsely quadripartite; erect or decumbent from the erect caespitose bases (2 cm. in diameter by 3 to 4 cm. long); 1 cm. in diameter, then .5 cm., and so reduced about six or eight times to the blunt tips about 1.5 mm. in diameter, which present a solid head-like appearance. Flesh solid, white; taste pleasant and mild in the stems and main branches, but
the tips quite bitter; excellent cooked; odor of anise; when dry taste bitterish not unlike stale nus and odor none. **Color** of tips yellow at first, becoming brushed with Salmon Orange or darker in age; very young tips around the base vinaceous or rosey as are some light stains on the white base; becoming clear Maize Yellow throughout above; where having lain in the collecting basket some branches about Barium Yellow; drying about Warm Buff; flesh white throughout. **Hymenium** 90 to 100 microns thick (Coker, 1923), composed of clavate basidia, 9 by 70 microns; sterigmata 4, very fine, almost straight, 6 microns long. **Spores** (of MD 3153) evenly 4.2 by 12 microns, smooth, incurved proximally, largest in middle (i.e. fusoid-elliptical), light ochraceous under the microscope. **Plate 1**, figures 10 and 11, and **Plate 17**.

Specimens examined: Benton County, OSC 5584, OSC 6021; Lane County, MD 3135 (collected by Dr. and Mrs Harry B. Yocom at bases of alders along the McKenzie River near McKenzie Bridge, March, 1941); Deschutes County, MD 976 (collected from the Skyliner's recreation area near Sisters, October 30, 1940).

Two of these collection were made by Dr. S. M. Zeller under maples and, as noted by the collector, were, "Light Ochraceous Buff to Light Ochraceous Salmon; turning deep vinaceous in all parts when bruised". Both
of these specimens were identified by E. A. Burt as *C. formosa*. The foregoing note and the dried appearance of all specimens might lead one to believe them to be *C. formosa*; however they are quite distinct in the different dry taste and the very different spores. This species differs from *C. botrytis*, sensu Cotton and Wakefield, in the lack of red tips and striate spores. The spores and odor differentiate it from *C. flava*. The odor and growth habit are much like *C. cystidiophora*. It may be distinguished by the larger spores and the blunt apices of the ultimate branchlets from that species. A characteristic of *C. plebja* Wulfen according to Coker (1923) is the violet stained tips, supposedly somewhat like those of *C. formosa* when that species is bruised; perhaps it belong here. MD 976 was very old and the upper parts of the branches were violet. Likewise MD 3153 when cooked turned the same violet color. It was reported by the collectors of MD 3153 to be an exculentary prize winner among Clavarias.

Fructifications large, 10 to 15 (25 in one) cm. in diameter and height, branches of about 5 or 6 orders, forming a compact fleshy, cauliflower-like head from a base which is often swollen just at or below the ground-line. Branches of the first order about 2 cm. long by 1 cm. in diameter, succeeding orders each about half the size of the preceding order, surface smooth or rugose, with a ridge extending to the branches above; tips slender, blunt. Flesh white, solid, odor and taste pleasant when fresh, when dry sweet odor still present but little taste remains. Color white at first, becoming Warm Buff through Light Ochraceous Salmon, base finally becoming Light Buff; tips becoming reddish. Hymenium composed of a few sterile basidium-like structures with a single dactyloid protuberance and 4-spored basidia 60 by 10.5 to 17 microns. Spores light ochraceous, smooth except for fine longitudinal or oblique striations, (4.5)5-6 by (12)14-18(21) microns, elliptical or enlarged distally. Sometimes the smaller spores are verrucose and then not striate. Plate 1, figure 9.

Specimens examined: Jefferson County, OSC 8010; Hood River County, OSC 5521; Lane County, OSC 6022 (in coniferous woods, Blue River, November 7, 1921); Linn County, MD 945; Japan, OSC 7566.
Cotton and Wakefield (1919) say that the most dependable identifying feature of the species under discussion is the striate nature of the spores. Burt (1922) states that the spores of the specimens labelled *C. botrytis* in the exsiccati of Ellis and Everhart and of Shear are not striate and are smaller and "minutely rough". And then he brings up the question as to whether or not we have this species in the United States at all or not. It has been noted that immature spores of the species are not striate and are smaller and minutely rough. The conclusion might be that the Exsiccati material seen by Burt was immature. However that labeled *C. botrytes* Persoon under the number 2022 in fascicle XXI of Ellis and Everhart's exsiccati in the Oregon State College Herbarium has spores that are for the most part by every outward appearance mature. They are ochraceous and decidedly rough and mostly about 12 by 5 to 5.5 microns. This can not be *C. botrytis* Fries sensu Cotton and Wakefield (1919). Burt, therefore, reports this from the United States without seeing or citing any authentic material from our country. Coker (1923) cites his reasons for believing this fungus to be *C. rufescens* Schaeffer. The nomenclatorial problem in the determination of the authenticity of one or the other of these names appears to be one of the most interesting problems for the future.
Laboratory methods of recording and investigation

The descriptions have been drawn from our own Oregon or northwestern collections whenever sufficient material for such a procedure has been available. There are included all species reported from the Pacific Slope of the United States insofar as our knowledge has been complete. When no specimens of the species have been available for examination the type description or some preferrable description has been quoted. The following standard form has been followed for our original descriptions except in a few instances, as for example, where direct quotations from other authorities have been made.

**GENUS SPECIES** Authority, citation to the original description, date; other citations; synonyms.

**Fructification** (size, habit, branching). Branches (appearance, tips, context, surface, etc.). **Flesh** (texture, odor, taste, dry character). **Colors** fresh and dry and any bruising colorations. **Hymenium** (composition and sizes of elements). **Spores** (color in mass and under the microscope, shape, size in microns, surface, guttulae, etc.). **Plates** and figures.

**Specimens examined**: listed by number from the different counties, or by states and counties outside of Oregon; each county or state being separated by a semi-colon and each collection by a comma.
Discussion or annotations of the above data or the finding of other authors immediately follow in this place. The initials preceding the numbers in the above paragraph refer to the herbarium from which the specimens were obtained. MD refers to the author's collections; duplicates of which will be deposited in the Oregon State College Herbarium (OSC) and in the University of Oregon Herbarium (UO); in a like manner the herbarium of William Bridge Cooke is referred to by the initials WBC. Only the more obvious synonyms are listed so that one may find for comparison the descriptions and treatments by other authors. No attempt has been made to cite any more than references to the three most recent monographs of the genus Clavaria and to the papers dealing with our Pacific Coast species.

Colors have long constituted a point of difference between the opinions of the authors and the actual condition in our fungi. In all preceding descriptions, in this paper, those words denoting color, spelled with capital letters and with no authorities' name following in parenthesis, are those of Ridgeway (1912). In a few cases Oberthür's (1905) color standard is cited. The lexicon is that of Snell (1936) as nearly as possible. This has necessitated the adoption of some right-words which do not seem to this author to be quite "common
usage", but they are defined in this standard glossary.

Careful determination of spore dimensions and other dimensions for the most part gives slightly larger values than those in print. Always, with fresh, dry, or preserved material, the same technique has been used, i.e. the Phloxine-KOH technique of Martin (1934). Rechecking the ocular micrometer by different methods and with different stage micrometers has shown the factors for calculating dimensions of objects measured to be correct.

In various ways it seems that our western material is often different from that described in the literature; a condition that has caused no end of confusion. An example of this confusion is found in *C. myceliosa* which, from all existing descriptions based on Peck's type, would be very distinct from *C. flaccida*. In reality they are difficult to separate by spore characters, which overlap, and impossible to separate by superficial characteristics. This is perhaps the result of the description having been made in the East by an easterner from a single collection of western material which did not display a complete or average set of variations. Many such things have been done before. For example, we now have *Anemone oregana* Gray and *Anemone Lyallii* Brit.
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Plate 1

Figure 1. Germinating spores of *Clavaria stricta*. Pages 9 and 97. Collection: OSC 6029.

Figure 2. Basidial system showing an uncommon 2-sterigate basidium of *Clavaria formosa*. Page 101. Collection: MD 971.

Figure 3. Spores of *Clavaria formosa*. Pages 16 and 101. Collection: MD 971.

Figure 4. Basidia of *Clavaria ornatipes*. Pages 14 and 74. Collection: MD 3016.

Figures 5a-c. Basidium and spores of different degrees of maturity and details of sterigmata development and attachment of *Clavaria corniculata*. Pages 15 and 81. Collection: WBC 9948.


Figure 7. Spores of *Clavaria flava*. Pages 15 and 110. Collection: MD 982.

Figure 8. Imperfectly developed hymenium from the upper surface of a blade of *Sparassis crispa*. Page 19.

Figure 9. Characteristically striate spores of *Clavaria botrytis*. Page 117. Collection: OSC 6022.

Figure 10. Spores of *Clavaria obtusissima*. Page 115. Collection: MD 976.

Figure 11. Spores of *Clavaria obtusissima*. Page 115. Collection: MD 5884.
Figure 1. Illustration of the setae in the trama and hymenium of an undescribed species of Clavaria. See also the photomicrograph of this same field on Plate 3, figure 5. Page 25. Collection: OSC 7562.

Figure 2. Spores of Clavaria flava. Page 110. Collection: OSC 6035.

Figure 3. Spores of Clavaria sanguinea. Page 107. Collection: OSC 5619.

Figure 4. Spores of Clavaria species 42 of the thesis. Page 106. Collection: MD 3131.

Figure 5. Two spores of Clavaria species 41 of the thesis. Page 105. Collection: OSC 6028.

Figure 6. Three spores of Clavaria formosa form. Page 104. Collection: OSC 7831.

Figure 7. Three spores of Clavaria gelatinosa. Page 99. Collection: MD 946.

Figure 8. Two spores of Clavaria stricta. Page 97. Collection: MD 3137.

Figure 9. Four spores of Clavaria species 36 of the thesis. Page 96. Collection: MD 661.

Figure 10. Three spores of Clavaria species 34 of the thesis. Page 94. Collection: MD 3139.

Figure 11. Smooth spores of Clavaria apiculata. Page 92. Collection: MD 3128.

Figure 12. Two spores of Clavaria abietina. Page 89. Collection: MD 3129.

Figure 13a-b. Four spores of Clavaria myceliosa. Page 87. Collections: MD 780 and OSC 6027 respectively.
Plate 3

Figure 1. Spores of Clavaria gracilis. Page 86. Collection: MD 3136.

Figure 2. Spores of Clavaria Kunzei. Page 84. Collection: MD 3028.

Figure 3. Spores of Clavaria species 27 of the thesis. Page 85. Collection: MD 3026.

Figure 4. Spores of Clavaria cristata. Page 76. Collection: WBC 13,046.

Figure 5. Photomicrograph of one optical level in the mount from which the drawing Plate II, figure 1, was made. Setae in the hymenium and trama of an undescribed species of Clavaria in the collection: OSC 7562. Page 25.

Figure 6. Clavaria species 9 of the thesis. Page 60. Collection: MD 996. Very slightly enlarged.

Figure 7. Clavaria species 7 of the thesis. Page 57. Collection: MD 997. Very slightly enlarged.
PLATE 4

Figure 1. *Clavaria ligula* Schaeffer ex Fries. Page 52. Slightly reduced. Collection: MD 977.

PLATE 5

A small portion of a colony of Clavaria ligula Schaeffer ex Fries in its typical habitat; i.e. on coniferous needle mats. Page 52. Reduced one-half. Collection: MD 977.
PLATE 7

Clavaria vermicularis Swartz ex Fries.  
Page 73.  Natural size.  Collection: MD 948.
PLATE 10

PLATE 11

PLATE 12

Collection: MD 952.
PLATE 14

Clavaria formosa Persoon ex Fries. Young specimens illustrating the compound nature of the trunks and small ultimate base. Page 101. Reduced one-fourth. Collections: MD 971.
Clavaria obtusissima Peck. A very old specimen but showing well the characteristic caespitose nature and small common radicating base. Page 115. Collection: MD 976.


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