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PARASITIC FLORIDEAE, I

BY

WILLIAM ALBERT SETCHELL

CONTENTS

I. INTRODUCTION

For upwards of twenty years the writer has been paying such attention to the assembling and investigation of various parasitic Florideae as has been possible from his opportunities and leisure for such work. The work was started on the coast of New England and continued on the western coasts of North America. He has received great help from students and friends, due acknowledgment of which will be made in the proper places. It is hoped that the present paper will be the first of a series dealing with the various materials brought together at the University of California and the results of their investigation.

The attention of algologists was called to various protuberances found on various red algae as being parasitic members of the Florideae by Reinsch (1874–75, pp. 61–69) under the names of *Choreocolax*, *Syringocolax*, etc., but he did not find cystocarps in any of his species nor did he distinguish as clearly as desirable between parasites and other warty growths. The first fully to describe a parasitic red alga with characteristic reproductive organs was Solms-Laubach (1877), who founded the genus *Janczewskia*. It seems fitting, therefore, to begin the series with a consideration of this genus.

II. HISTORY

The genus *Janczewskia* was founded by Professor Graf Hermann zu Solms-Laubach in 1877 to receive a most interesting member of the Florideae which he discovered parasitizing the fronds of *Laurencia obtusa* ("*Chondria obtusa*") in the Bay of Naples. He named the type species *Janczewskia verrucaeformis*, describing and figuring its essential characters (1877, pp. 209–224, pl. 3), thus bringing to the notice of the botanical world the first to be clearly recognized of a series of holoparasites belonging to the Florideae. Ardissone (1883) included it in his *Phycologia Mediterranea* and Hauck (1885, p. 524) added the information that *Janczewskia verrucaeformis* was to be found also in the Adriatic Sea. In 1892 Bornet (p. 301) lists *Janczewskia verrucaeformis* as occurring on the Mediterranean coast of France. In 1892 Schmitz (p. 625) makes mention of *Janczewskia* among other tubercular growths on Florideae and in 1893 (p. 390) mentions it again as a true parasitic member of the Florideae growing on a closely related genus. In 1897 (p. 432, fig. 243, C), Schmitz and Falkenberg described *Janczewskia* as consisting of three species: *J. verrucaeformis* Solms on *Laurencia obtusa* in the Mediterranean Sea, *J. tasmanica* (not described) on *Laurencia Forsteri* on the shores of Tasmania, and an unnamed and undescribed species on *Cladhymenia oblongifolia*, a New Zealand plant. In 1901 Falkenberg (pp. 255–261, pl. 24, figs. 16–19) published a more extended description and discussion of the species of *Janczewskia*, treating more or less fully of *J. verrucaeformis* Solms and *J. tasmanica* Falk., mentioning (p. 257) the species occurring on *Cladhymenia oblongifolia*, and also one on a species of *Laurencia* from South Africa, concerning which he is in doubt whether to refer it to *J. verrucaeformis* or not. Oltmanns (1904, pp. 615, 644; 1905, p. 329) includes descriptions of various details of the morphology and physiology of both *J. verrucaeformis* and *J. tasmanica* in his work on the algae. Reinbold (1899, p. 47) mentions a species of *Janczewskia* under the name "*Janczewskia australis?* Falk.," found on a host identified as *Laurencia obtusa* at "Investigator Street" (Investigator Strait) in South Australia by Miss Nellie Davey. No exact description is given, but Reinbold says that his plant agrees with the figure of Falkenberg (cf. Schmitz and Falkenberg, 1897, p. 431, fig. 243 C). Evidently *J. tasmanica* is the species really referred to. De Toni (1903, pp. 811, 812) includes *Janczewskia* with two named species in his *Sylloge Algarum.* These are practically all the references to species of *Janczewskia* up to the present date, with the exception of a few notices of the occurrence of species of the genus in California.

The first announcement of the occurrence of *Janczewskia* in California was made by Charles P. Nott in 1897 (p. 83). He states that he found a species of this genus, supposedly *J. verrucaeformis* Solms, on the shores of Monterey Bay, growing on *Laurencia pinnatifida* Lam'x and also on *Rhabdonia Coulteri* Harv. (*Agardhiella Coulteri* (Harv.) Setchell). Concerning the plant on the latter host, it was sterile, and further study will be necessary properly to refer it generically. It seems certain, however, that it does not belong even to the genus *Janczewskia.*

In 1901 a specimen labeled *J. verrucaeformis* and parasitic on *Laurencia pinnatifida* was distributed from Fort Ross, California, in the Phycotheca Boreali-Americana (Fasc. 18, no. 887, 1901). In 1903 Setchell and Gardner (p. 326) credited *J. verrucaeformis* to Whidbey Island, Washington, as occurring on *Laurencia pinnatifida.* In 1905 the writer (p. 59) simply mentioned the work of Nott in a short account of "The Parasitic Florideae of California."

As will be seen below, the species of *Janczewskia* thus referred to *J. verrucaeformis* is to be found along the whole Pacific Coast of the United States. Careful examination has shown it to be a distinct and unnamed species.

III. MATERIALS

The materials for further study of *Janczewskia* have been accumulating at the University of California since 1896, when Nott made his first collections on *Laurencia pinnatifida.* The writer has also collected the form on *Laurencia pinnatifida* several times. It has also been collected at various localities on the western coast of North America by Dr. N. L. Gardner. The greater amount of the material, however, has been collected at San Pedro and Santa Monica on the coast of Southern California by Dr. Gardner and has occurred on *Laurencia subopposita* (J. Ag.) (*Chondria subopposita* J. Ag., 1892, p. 149), *Chondria nidifica* Harv., and *Ch. atropurpurea* Harv. The material, thus gathered together, has been subjected to critical examination, particularly by Miss Mabel E. Brown in 1911 and by John E. Guernsey in 1913. The notes and drawings of these graduate students in the University of California have been available and have been of the utmost assistance in the preparation of the following account.

IV. HOST PLANTS

From what has been said above it will be noticed that all the specimens of *Janczewskia* thus far noted by others or mentioned by the writer have been found upon members of the Rhodomelaceae, the same family to which *Janczewskia* itself belongs. Further than this, the hosts are species of *Laurencia*, *Chondria*, and *Cladhymenia*, members of two subfamilies of the Rhodomelaceae, viz., the Laurencieae and the Chondrieae, while the genus *Janczewskia* itself is clearly closely related to *Laurencia* and is a member of the Laurencieae. Among the hosts are four or five species of *Laurencia: L. obtusa* of southern Europe, *L. Forsteri* of Tasmania and Australia, *L. subopposita* and *L. pinnatifida* of the western coast of North America, and an unidentified species in South Africa. Two species of *Chondria* are found among the hosts of *Janczewskia*, *Ch. nidifica*, and what passes at present for *Ch. atropurpurea*, both on the southern coast of California. The last of the possible eight hosts is *Cladhymenia oblongifolia* of New Zealand. So far as the studies of others thus far published and our own as reported below tend to show, there is evidence that each host plant is infested with its own peculiar species of *Janczewskia*. This seems certain for six of the eight hosts, where the material has been sufficiently ample for detailed study and comparison. It is probable that careful search and study will reveal still other species of *Janczewskia* on other Chondrieae and Laurencieae. It certainly affords material for careful consideration to discover that *Janczewskia*, a laurencioid genus of several species at least, is confined in its parasitism to laurencioid and closely related chondrioid hosts.

V. MORPHOLOGY

All the species of *Janczewskia* thus far published and all those investigated by the writer agree in certain general details of structure. They all possess certain organs of contact or even of penetration of the host plant, all possess a basal structure or tubercle made up of coalescent branches to form a solid tissue, and all possess branches projecting more or less from the wart, in some species conspicuously free, but in others barely projecting beyond the surface of the tubercle. The degree of extension beyond the basal tubercle varies in the same species according to the nature of the individual plant, projecting more in the cystocarpic and tetrasporic plants and much less, as a rule, in the antheridial plants. For general discussion, it seems best to consider here only the facts as published by Solms-Laubach (1877) and by Falkenberg (1901) for *Janczewskia verrucaeformis* and for *J. tasmanica*, since these two species represent the extremes of structure thus far discovered in the genus.

The details of the penetration of the host by the parasitic *Janczewskia* have been followed in both species. Solms-Laubach (1877, p. 220, pl. 3, fig. 16) describes the penetration of the host, *Laurencia obtusa*, by a young plant of *Janczewskia verrucaeformis*, as being effected by filaments resembling the hyphae of a fungus. These hyphal filaments are numerous, extending into the tissues of the host, penetrating between the epidermal cells of the host and filling the spaces between the interior cells without, however, entering the cells themselves. The hyphal filaments form a more or less extended network, are flexuous, and are composed of elongated cells which differ from those of the rest of the parasite in shape and smaller dimensions. Falkenberg (1901, pp. 259, 260, pl. 24, fig. 17) describes and discusses a very young plant of *Janczewskia verrucaeformis*, just at the stage of breaking through the epidermis of the host. The stage described and figured is just where the monosiphonous, or "protonema," stage ceases, and the outer portion is passing over into the complex shoot which is to develop into the tubercle. The inner monosiphonous portion has already penetrated into the host, where it is to establish pit connections with the internal cells of the host and act as an haustorium. Falkenberg (*loc. cit.*, pl. 24, fig. 16) also figures the haustoria in a somewhat older plant of *J. verrucaeformis*. The haustoria of *J. tasmanica* (cf. Falkenberg, 1901, p. 258, pl. 24, figs. 18, 19) resemble those of *J. verrucaeformis* in being penetrating hyphal filaments, occasionally united into strands of tissue. The infection undoubtedly takes place at the point where the *Janczewskia* is situated.

Solms-Laubach (1877, p. 211) states that *J. verrucaeformis* causes a bending in the branches of the host, the tubercles being situated on the convex side. Falkenberg (1901, p. 257) says that *J. tasmanica* encircles the branch of its host and does not cause any curvature.

From the relations between the *Laurencia* and the haustoria of the *Janczewskia*, it is evident that the latter is a parasite upon the former in each of the two species thus far described. The color of *J. verrucaeformis* is described as intense yellow, orange, or dark red (cf. Solms-Laubach, 1877, p. 209). The color of *J. tasmanica* is not mentioned. The color of the various California species investigated by the writer varies from yellowish white to light pink. From the color, then, it seems as if the degree of parasitism might vary from more or less hemiparasitic to absolutely holoparasitic (cf. Eddelbüttel, 1910, p. 230).

Solms-Laubach (1877, p. 221) considers the tubercles, or solid basal portion, as composite, formed by the uniting of several sets of branched filaments. Falkenberg (1901, p. 256), after considering this view, decides that each tubercle is an individual, although he allows that two tubercles, growing side by side, may coalesce to form what may seem like one. He argues particularly from the uniformity of reproductive bodies borne on each tubercle. There can be no other view of the matter from the evidence presented to the writer in his investigation of the California species, which amply confirms the account of Falkenberg in every particular. The tubercle varies in size and proportion to the whole thallus in the different species. In none of the species is it over a few millimeters in any diameter and in some cases only some fraction of a millimeter. In *Janczewskia verrucaeformis* there is little but tubercle represented in the external portion of the thallus, the only projections being slight and most pronounced in the cystocarpic plants. In *J. tasmanica*, on the other hand, the tubercle is less developed proportionally to the free branches or arms. Although the tubercle appears, and is, solid, it is a branching affair, the branches being coalescent. Each branch has its own apical cell, situated at the base of a deeper or shallower pit, exactly as is the case in the various species of *Laurencia*. This has been clearly brought out by both Solms-Laubach and Falkenberg for both *Janczewskia verrucaeformis* and *J. tasmanica*. It is particularly well described and illustrated for *J. verrucaeformis* by Falkenberg (1901, pp. 255, 256, pl. 24, fig. 16). The sterile leaves of the *Janczewskia* are also represented as occurring on the sides of the apical pits in the same way as in species of *Laurencia*. The apical cell is also similarly situated at the base of an apical pit in each and every one of the Californian species to be described below (pl. 6, fig. 30).

In *Janczewskia tasmanica*, as figured by Falkenberg (1901, pl. 24, fig. 18) there radiate out from the tubercle free branches, very slender and cylindrical in the tetrasporic plant. The figure in the *Pflanzenfamilien* (1897, p. 431, fig. 243, C) is stated by Falkenberg (1901, p. 257) to be defective in not representing the free branches sufficiently slender and cylindrical. Such free branches are practically absent in *J. verrucaeformis*, but are well represented in some of the California species, at least in the tetrasporic and cystocarpic plants as well as in *J. tasmanica*.

All three sorts of reproductive bodies usually found among the Florideae are known in *Janczewskia*, and are represented on different plants which differ slightly in other details of structure from one another. The tetrasporangia are subepidermal, cruciate, or tripartite, and borne either on the outer surface of the tubercle or its free branches, or immersed in conceptacles. The antheridia are in conceptacles formed of enlarged apical pits, are transformed leaves, and variously plumose (cf. Solms-Laubach, 1877, p. 212, pl. 3, fig. 15). The procarps are transformed leaves, arising in the apical pits, and developing into cystocarps provided with a pericarp and carpostome (cf. Solms-Laubach, 1877, pl. 3, figs. 5, 7, 11–14, 17). From a basal placenta within the cystocarp arise branching filaments, each ultimate branch ending in a long pyriform spore (cf. Solms-Laubach, 1877, pl. 3, fig. 17). This closely corresponds with the cystocarpic structure as found in species of *Laurencia*, as does also the structure of the antheridia and of the tetrasporangia. In all respects, then, except in reduced form and parasitic habit, *Janczewskia* is very closely related to *Laurencia*.

VI. TAXONOMY

Janczewskia verrucaeformis Solms

Solms-Laubach, Mem. de la Soc. Nation. d. Sci. de Cherbourg, vol. 21, pp. 209–224, pl. 3, 1877.

Ardissone, Mem. Soc. Critt. ital., vol. 1, p. 351, 1883.

Hauck, Die Meeres Algen, p. 524, 1885.

Bornet, Mem. de la Soc. Nation. d. Sci. de Cherbourg, vol. 28, p. 301, 1892.

Schmitz und Falkenberg, in Engler und Prantl, Die Natürl. Pfl.-fam., 1 Th., abth. 2, p. 432, 1892.

Falkenberg, Fauna und Flora des Golfes von Neapel, Monogr. 25, pp. 259–261, pl. 24, figs. 16, 17, 1901.

De Toni, Syll. Alg., vol. 4, sect. 3, p. 812, 1903.

Oltmanns, Morph. und Biol. der Algen, vol. 2, p. 329, figs. 583, 1 and 3, 1905.

(References to *J. verrucaeformis* by Nott (1897), Setchell (1901, 1905), and Setchell and Gardner (1903) are shown below to refer to another species.)

This species, the type of the genus, is parasitic on *Laurencia obtusa*, growing scattered over its stem and branches, often occurring at the intersection of two branches and forming a tubercular growth up to 3 or 4 mm. in diameter. The stems and branches of the *Laurencia* are bent at the point of parasitism, the tubercle being situated on the convex side. The color varies from deep yellow through orange to dark red. The surface of the tubercle in the tetrasporic and antheridial plant is somewhat wrinkled or slightly tessellated-warty, as it is also in the young cystocarpic plant. After the development of the cystocarps, however, the surface of the last mentioned plant becomes covered with the projecting, nearly globular cystocarps to form a botryoidal mass resembling a raspberry.

The penetration of the host is by means of a network of slender hyphal filaments. Tetrasporic, antheridial, and cystocarpic plants are known. The tetraspores are subepidermal, in the second or third layer of cells, on the outer surface of the thallus, but are not described as being situated on the sides of conceptacles formed by the enlargement of apical pits, as in the next species. They are cruciately divided. The antheridia are found in broad-mouthed conceptacle-like pits, apparently occupying the base and lower sides, and are formed of broad, plumose, profusely branched tufts which end in rows of swollen globular cells of a clear yellow color. The procarps are formed in the apical pits. The young cystocarps finally emerge and at maturity become almost or entirely superficial. The pericarp is nearly globular, somewhat contracted above about the carpostome and at maturity is not very thick.

Janczewskia verrucaeformis is parasitic on *Laurencia obtusa*, is abundant in the Bay of Naples in summer (cf. Falkenberg, 1901, p. 259), is found in the Adriatic Sea (cf. Hauck, 1885, p. 525), and has been collected on the Mediterranean coast of France (cf. Solms-Laubach, 1877, p. 218, Bornet, 1892, p. 301). It is said to occur in summer and autumn.

The writer has been unable to examine specimens of *Janczewskia verrucaeformis* and has been compelled to rely entirely upon the descriptions of Solms-Laubach and of Falkenberg. It is desirable that this species be studied anew and a more extended description published, especially as regards points of difference from, and resemblance to, the following species.

Janczewskia Solmsii Setchell et Guernsey sp. nov.

Pl. 2, figs. 7, 8; pl. 3, figs. 17–19; pl. 5, figs. 26, 27

Parasitic on a species of *Laurencia* which has commonly passed under the name of *L. virgata* (cf. Harvey, 1853, p. 71; Collins, Holden, and Setchell, nos. 293, 1495), but which is probably not that species but the *Chondriopsis subopposita* J. Ag. (1892, p. 149), wholly or in part, as was determined by a study of the type specimens. The host, then, being a true *Laurencia*, must receive the name.

Laurencia subopposita (J. Ag.) comb. nov.

Chondriopsis subopposita J. G. Agardh, Anal. Alg., p. 149, 1892.

Well-developed plants of this *Janczewskia* are 5–8 mm. in longest diameter, globular to reniform in shape, and ivory white in color. They are attached to the host for a quarter to nearly one-half its circumference and the branch is strongly bent away from the point of infection, as a rule over 90 degrees, the tubercle occupying a position on the convex side of the curve. The surface of the sterile, antheridial, and tetrasporic plants is very slightly tessellated, while that of the cystocarpic plant is botryoidal in true raspberry fashion on account of the projecting cystocarps. The penetration into the host plant is fairly deep through scattered and slender hyphal filaments. There is no considerable difference between the cells of the tubercle and those of the host as to size, shape, walls, or contents, so that it is not an easy matter to decide just where the one ceases and the other begins. In young plants it is possible to find the apical pits of the coalescent branchlets thickly scattered through the surface tissues, but in adult plants each apical pit shows reproductive bodies and have consequently suffered change. The tetrasporangia are subepidermal, tripartite or cruciate, and line the walls of conceptacles, or enlarged apical pits, which thickly stud the outer surface of the tubercle and which bear leaves (pl. 3, fig. 18; pl. 5, fig. 26). The antheridia are in broad, ovate-pyriform conceptacles, arising in a more or less conical mass from its broad, slightly rounded bottom (pl. 3, fig. 19; pl. 5, fig. 27). Each tuft of antheridia is broadly conical (broadly triangular as seen in radial section) and the main axis is almost equaled by the several oblique lateral axes from towards the base of the cluster, making a bouquet-like mass. These tufts resemble those figured for *Janczewskia verrucaeformis* by Solms-Laubach (1877, pl. 3, fig. 15), but they do not end in moniliformly swollen terminal hairs of a deep yellow color. The cystocarpic plants are thickly covered with nearly globular cystocarps in various stages of emergence from the frond (pl. 2, fig. 7; pl. 3, fig. 17). They may be compared, also, to Solms-Laubach's figures (1877, pl. 3, figs. 7, 17) of the cystocarps of *J. verrucaeformis*, which they resemble, but the pericarp of the adult cystocarps is as thick as, or nearly as thick as, the horizontal diameter of the cavity, consequently much thicker proportionally than as figured for *J. verrucaeformis.* The carpostome seems to be a narrow, elongated aperture at the apex of the pericarp, which is not contracted just below it.

Janczewskia Solmsii resembles closely *J. verrucaeformis*, and these two species are undoubtedly much more closely related to one another than any other two of the six species to be considered here. *J. Solmsii*, however, differs from the descriptions and figures of *J. verrucaeformis* in being somewhat larger, in lacking color, having a different disposition of the tetrasporangia, having a somewhat differently shaped, thicker-walled cystocarp, and in lacking the apparently conspicuous sterile, moniliformly swollen hairs on the antheridial tufts. Adding to these differences a different species of *Laurencia* as a host and a widely separated locality, it seems best to consider it distinct and to describe it as a separate species, which Mr. Guernsey and the writer take pleasure in dedicating to Professor Hermann Graf zu Solms-Laubach, the discoverer of the type species and founder of the genus.

Janczewskia Solmsii has been collected by Dr. N. L. Gardner, in some abundance and at various times, at Redondo and at San Pedro, California, always growing upon *Laurencia subopposita*.

Janczewskia moriformis sp. nov.

Pl. 1, figs. 1–3; pl. 3, figs. 20, 21; pl. 4, figs. 22, 23; pl. 5, fig. 24

Parasitic on a species of *Chondria*, seemingly *Chondria atropurpurea* Harv., this proposed new species forms tubercular growths of 3–5 mm. in their greatest diameters. The thalli are at first nearly globular, becoming broadly flattened reniform at maturity. The color is creamy white, totally destitute of any trace of red. The host plant is only slightly if at all bent at the point of infection, forming a great contrast to the last mentioned species in this respect. The contact between the tubercle and the host may extend from one-quarter to one-half the circumference of the latter. The penetration into the host is by means of slender hyphal branched filaments, whose cells are very granular and which form masses in the intercellular spaces of the host very similar to those figured by Falkenberg (1901, pl. 24, fig. 19) for *Janczewskia tasmanica*. The haustoria penetrate to the central, elongated, conducting cells of the host and descend along them. Both the cells of the parasite and those of the host, in the immediate region of infection, at least, are usually gorged with granules.

The tubercle forms the greater part of the mass of this species, in fact all of the antheridial plant (pl. 1, fig. 2; pl. 3, fig. 21), as a rule, although occasionally an antheridial plant may show some very short free branches. The free branches or arms are always present on the tetrasporic plants, although short, reaching in length, in some cases, 0.6–0.8 mm. These branches are blunt, each provided with an apical leaf-bearing pit, and are of equal diameter throughout their length. The cystocarps are also borne at the tips of short branches of about equal length, which become swollen above as the cystocarp develops (pl. 1, fig. 3).

The tetrasporangia are subepidermal on the outer surface of the free branches, resembling those of *Janczewskia tasmanica* Falk. (1901 pl. 24, fig. 18) rather than those of *J. Solmsii*.

The antheridia occupy conceptacles either immersed completely in the tubercle or only slightly projecting and provided with a pore (pl. 3, fig. 21). In this they resemble those of *J. verrucaeformis* and of *J. Solmsii*, but the structure and arrangement of the antheridia in the conceptacle are very different. The antheridia are found lining the walls of the conceptacles with the exception of the opening and projecting out from them in long, simple, plumose tufts which extend radially towards the center (pl. 4, fig. 23). There are no terminal sterile portions as in *Janczewskia verrucaeformis*, as in *Laurencia pinnatifida* (cf. Falkenberg, 1901, pl. 23, fig. 22), and as in *L. obtusa* (cf. Falkenberg, *loc. cit.*, fig. 13). In structure and arrangement they resemble those of the two following species.

The cystocarps are immersed in the tips of the free branches, often two together in the same tip, and the tip is more or less swollen. The wall is only one-third to one-half the diameter of the cystocarpic cavity in thickness and opens by a narrow carpostome (pl. 5, fig. 24).

Janczewskia moriformis is intermediate in habit between the almost purely tubercular species, *J. verrucaeformis* and *J. Solmsii* on the one hand and the species with free branches, such as *J. tasmanica* and the two new species next to be described on the other. In the structure and arrangement of antheridia, however, it is distinctly to be arranged with the latter group. *Janczewskia moriformis* has been found growing in abundance on *Chondria atropurpurea* at Santa Monica, California, by Dr. N. L. Gardner, both in November, 1912, and February, 1913.

Janczewskia Gardneri Setchell et Guernsey sp. nov.

Pl. 1, figs. 4–6; pl. 3, figs. 15, 16; pl. 5, fig. 25

J. verrucaeformis Nott, Erythea, vol. 5, p. 83, 1897; Setchell *in* Collins, Holden and Setchell, Phyc. Bor.-Am., Fasc. 18, no. 887, 1901; Setchell & Gardner, Univ. Calif. Pub., Botany, vol. 1, p. 326, 1903 (not of Solms-Laubach).

Parasitic on *Laurencia pinnatifida*, this species forms large, irregular masses of a light pinkish tint on all portions of its host, its shape being much more irregular than that of any other species, due partly, perhaps, to the flattened stems and branches of the host plant. It may occur on one surface, in which case the flattened host is bent back from it, sometimes even to a right angle, or it may also occur on the short and almost cylindrical branchlets of the host with little if any bending. It often partially encircles the host plant.

The penetration of the host takes place by means of slender hyphal branches which penetrate to the central elongated cells of the host and often form masses in the intercellular jelly. At the regions of penetration the epidermal cells of the host elongate in the anticlinal direction to twice their length and become less than half their normal width, thus producing a conspicuous palisade-like layer.

The tetrasporic plant is the largest, at least among those observed by the writer, reaching 10 mm. in its greatest diameter, ordinarily, however, as much as 8 mm., and is a more or less flattened cushion (pl. 1, fig. 5), covered with slender, free branches projecting as much as, or a little more than, 2 mm. These free branches are blunt, of equal diameter throughout, and simple. The antheridial plant is usually much smaller, about 4 mm. in greatest diameter, more nearly globular or somewhat flattened (pl. 1, fig. 6; pl. 3, fig. 16), more or less moriform, with the crowded short free branches which are 0.6–0.8 mm. long and slightly enlarged above in fertile condition. The cystocarpic plant (pl. 1, fig. 4; pl. 3, fig. 15) is nearly as large as the tetrasporic, reaching a greatest diameter of 8–9 mm., is flattened and irregular, with its crowded free branches 1.0–1.5 mm. long and more or less swollen above at maturity of the cystocarps, of which two frequently occupy the same summit.

The tetrasporangia are tripartite and subepidermal on the outer surfaces of the free branches. The antheridia occur in almost globose or ellipsoidal conceptacles lining the entire inner surface. They occur in closely crowded, elongated, simple plumes which project inwards towards the center (pl. 5, fig. 25). They are in structure and arrangement very similar to those of *J. moriformis*, but they are more slender and more crowded.

The cystocarps occur singly or in twos at the tips of the free branches. The walls are moderately thick and the spores and sporiferous filaments are more slender and more crowded than in any of the preceding species.

Janczewskia Gardneri differs from *J. moriformis* in the uniformly greater length of the free branches and in the dimensions and abundance of the antheridial plumes and the sporogenous tissues in the cystocarp.

Janczewskia Gardneri is found on *Laurencia pinnatifida*, particularly on that broad, coarse form called *L. spectabilis* by Postels and Ruprecht. It has been collected on Vancouver Island, B. C., by John Macoun; at Whidbey Island, Washington, and near San Francisco, Pacific Grove and San Pedro, California, by N. L. Gardner; at Fort Ross (cf. Phyc. Bor. Am., no. 887) and about San Francisco, California, by the writer; and at Monterey and Pacific Grove, California, by C. P. Nott and the writer. It is the plant, as noted above, which has been confused with *Janczewskia verrucaeformis* by the writer and others, and will doubtless be found wherever the Pacific Coast form of *Laurencia pinnatifida* is abundant.

It may be mentioned here that Reinsch (1874–5, p. 65, pl. 58) has figured and described a parasite on *Laurencia pinnatifida* from the Straits of Magellan which he names *Chorocolax macronema*. It is possible, but by no means certain, that this plant of Reinsch may ultimately prove to be a *Janczewskia* and possibly even identical with *J. Gardneri*. Were it not for the host plant being identified as the same, however, the suspicion would not obtrude itself in this connection.

Janczewskia lappacea sp. nov.

Pl. 2, figs. 9–14; pl. 6, figs. 28–32

Parasitic on *Chondria nidifica* Harv., the plants of this species form pink burrlike growths on the stems or branches, or at the intersections of the two, and reach a maximum diameter of from 3–5 mm. The thalli in this species are more regular in general outline than those of the last species, being flattened globular with radiating free branches which are proportionally long, especially in the tetrasporic and cystocarpic plants.

The penetration of the host plant is most conspicuous and most complete and there is usually a slight bending at the point of infection. The cells of the body of the tubercle are gorged with granules, as are also the short cells of the branched, hyphal, penetrating filaments which encircle all the inner cells of the host and show, in a cross-section (pl. 6, figs. 28, 29), as a perfect network, the slender, granular cells of the hyphal filaments being conspicuous among the large, rounded, clear cells of the host. Pit connections between the haustoria of the parasite and the cells of the host are conspicuous (pl. 6, fig. 29). The epidermis of the host has the cells very much elongated in the region of the attachment of the parasite.

The tetrasporangial plant (pl. 2, figs. 10, 13) is about 5 mm. in greatest diameter, flattened globular, with the tubercle rounded and the numerous spreading, slender free branches 1.5–2 mm. long.

The antheridial plant (pl. 2, figs. 11, 14) is nearly globular, about 3 mm. in greatest diameter. The tubercle is flattened and thin and the free arms bearing the male conceptacles short, 0.2–0.6 mm. in length.

The cystocarpic plant (pl. 2, figs. 9, 12) reaches a greatest diameter of about 5 mm., is flattened globular, and has sprawling free branches up to about 2 mm. in length.

The tetrasporangia are subepidermal and tripartite on the outer surfaces of the free branches.

The antheridial conceptacles are single or double (pl. 6, figs. 31, 32) at the tips of the free branches, which are slightly enlarged above. The conceptacles are ellipsoidal and the plumose antheridial tufts line the entire cavity radiating towards the center. The plumose tufts are shorter and less regular than in *J. moriformis* and *J. Gardneri*, approximating the shape of those of *J. Solmsii* and *J. verrucaeformis*, but being, however, more plumose and less bouquet-like.

The cystocarps are mostly single in the slightly enlarged apex of the free arm (1.0–1.5 mm.) with a moderately thick pericarp.

Janczewskia lappacea differs from *J. moriformis* and *J. Gardneri* in proportions chiefly, viz., in general dimensions and in proportion of length of free branch to thickness of tubercle, these two giving the plants a decidedly different aspect. It differs also somewhat in details of the shape of the antheridial clusters. From *J. verrucaeformis* and *J. Solmsii* it differs fundamentally in arrangement and shape of antheridial clusters as well as in the much greater development of free branches. It is probably closely related to *J. tasmanica* Falk., and a comparison of the two species is to be found under the latter.

It has been collected on several occasions in as many years by Dr. N. L. Gardner, parasitic on *Chondria nidifica* in the waters of Southern California in the neighborhood of San Pedro.

Janczewskia tasmanica Falk.

Falkenberg, *in* Schmitz und Falkenberg, *in* Engler und Prantl, Die natürl. Pfl.-fam., 1 Th, abth. 2, p. 432, 1907 (*nomen nudum*); Fauna und Flora des Golfes von Neapel, 25 Monogr., pp. 257–259, pl. 24, figs. 18, 19, 1901 (descr. and figures).

De Toni, Syll. Alg., vol. 4, sect. 3, p. 812, 1903.

Oltmanns, Morph. und Biol. der Algen, vol. 2, pp. 329, 330, figs. 583, 2, 1905.

Falkenberg in Schmitz und Falkenberg, in Engler und Prantl, *Die natürl. Pfl.-fam.* (1 Th., abth. 2, p. 432, 1897), mentions a *Janczewskia* which he names *J. tasmanica* as occurring in Tasmania, and the inference is that it occurs on *Laurencia Forsteri.* He also figures this species (*loc. cit.*, fig. 243 C) on the previous page. These references, of course, constitute only a *nomen nudum.* Later Falkenberg (1901, p. 257; pl. 24, figs. 18, 19) describes and figures *Janczewskia tasmanica*, thus placing it among the species to be considered as established. Much, however, remains to be investigated before it can be regarded as fully known. The writer, although he has not had the opportunity of examining any specimens, has attempted below to state what is known about this species and to compare it with the species described above.

Parasitic on *Laurencia Forsteri, Janczewskia tasmanica* forms its more or less stellately branched tufts most commonly where a side axis springs from the main axis. It does not cause any curvature or bending of the host plant at the point of infection.

The penetration into the host plant does not disturb even the epidermal cells of the host, except that they are separated from one another to allow the penetration of hyphae, or occasionally of more complex filaments or strands of tissue which make their way between the cells of the host plant to the very center. Only the tetrasporangial plant is figured or described. From the figure, that seems to be a plant of 3–4 mm. in greatest diameter. The tubercle or solid portion is 0.5–1.0 mm. thick, flattened, and encircling the entire host plant at the region of infection. From about one-third of the surface of the tubercle arise slender simple, or occasionally branched, free branches, 1–2 mm. in length and not over 0.5 mm. in diameter. The tetrasporangia are borne subepidermally on the upper portions of the free branches. Falkenberg does not mention having examined either antheridial or cystocarpic plants, consequently extended comparison with the species of *Janczewskia* described above is impossible.

Janczewskia tasmanica is close to *J. lappacea*, which it seems to resemble closely in habit. The differences, so far as may be relied upon at present, are: (1) that of host plant; (2) some difference in details of penetration of host plant and especially the less effect, in *J. tasmanica*, upon the epidermal cells of the host; (3) that *J. tasmanica* encircles the host where *J. lappacea* does not; and (4) possible differences which may be found in the antheridia. On the whole, it seems best to regard *J. lappacea*, for the present at least, as a distinct but closely related species.

Janczewskia tasmanica is said by Falkenberg (1901, p. 257) to be abundant on *Laurencia Forsteri* in South Australian waters.

Janczewskia, *species imperfecte cognitae*

Besides the six species enumerated above, there are certain species of *Janczewskia*, as has been mentioned earlier, which are too little known for description or comparison. They are of interest in connection with the six species described, as indicating that the genus *Janczewskia* is likely to be found to be a considerable one. It seems best to enumerate these in this place in order that attention may be called to them in the hope that more material may be obtained and further search made for members of the genus on hosts likely to be infested.

1. Janczewskia on Cladhymenia oblongifolia

Schmitz, *in* Schmitz und Falkenberg, *in* Engler und Prantl, Die natürl. Pfl.-fam., 1 Th., abth. 2, p. 432, 1897.

Falkenberg, Fauna und Flora des Golfes von Neapel, Monogr. 25, p. 257, 1901.

The only information published of this species is that given by Schmitz, which is merely a mention of it, and Falkenberg's statement that it remains unknown to him.

2. Janczewskia on a species of *Laurencia* from South Africa

Falkenberg, Fauna und Flora des Golfes von Neapel, Monogr. 25, p. 257, 1901.

All that is known of this is Falkenberg's statement that he found a parasite on a species of *Laurencia* from South Africa which he feels compelled to consider a species of *Janczewskia*, but which was so undeveloped that he could not determine whether it might be *J. verrucaeformis* or not.

3. "**Janczewskia australis?** Falkbg." in Reinbold, Meeres Algen von Investigator Street (Süd Australien). Hedwigia, vol. 38, p. 47, 1899; De Toni, Syll. Alg., vol. 4, sect. 3, p. 812, 1903 (under *J. tasmanica* with a query).

Apparently this *nomen nudum* was intended for *J. tasmanica* to apply to a plant found on a *Laurencia*, determined as *L. obtusa*, sent to Reinbold from Investigator Strait near Adelaide, South Australia. In view of the results of the investigations on California species detailed above, it seems that further investigation of this plant is needed to settle definitely its exact status within the genus. It seems probable to the writer that this plant may belong to a distinct and, as yet, unnamed species, since Reinbold compares it with the figure in the *Natürlichen Pflanzenfamilien* (I, 2, p. 431, f. 243 C), which Falkenberg later (1901, p. 257) states does not properly represent his *Janczewskia tasmanica*.

VII. RELATIONSHIPS

In the first place are to be considered the relationships between the genus *Janczewskia* and other genera. These have been adequately dealt with by Solms-Laubach (1877, p. 217), who recognized his plant as a member of the Rhodomelaceae and not distantly removed from *Laurencia* itself. Schmitz and Falkenberg (1897, p. 432) and all following writers have placed *Janczewskia* in the Rhodomelaceae in close proximity to *Laurencia* in the sub-family Laurencieae. Schmitz (1893, p. 390) has called attention to the fact that *Janczewskia* is one of the several parasitic Florideae whose host plant is a member of the same family, and Batters (1892, p. 66), in describing *Gonimophyllum Buffhami*, a delesseriaceous parasite on the delesseriaceous genus *Nitophyllum*, also speaks of *Actinococcus* and *Janczewskia* as examples of Florideae parasitic on plants of the same family to which they themselves belong. All four new species proposed above have cystocarps which agree in all essential details with those of *Janczewskia verrucaeformis* and with those of the Rhodomelaceae in general. Besides the structure of the cystocarp, all the species of *Janczewskia*, including the four new species described above, have the same sort of apical pit with the apical cell projecting slightly from the bottom of it, which is characteristic of the Laurencieae and not found in any of the other sub-families, although something remotely like it occurs among the Chondrieae.

There remain to be considered briefly the interrelationships of the species of *Janczewskia*. The species may be divided into two groups on account of their more obvious resemblances, of which the first may receive *J. verrucaeformis* and *J. Solmsii* and the second the remainder of the species, but which certainly includes *J. moriformis*, *J. Gardneri*, and *J. lappacea*. *J. tasmanica*, undoubtedly, belongs to the second group, but our knowledge of it is, as yet, fragmentary.

The members of the first group, viz., *J. verrucaeformis* and *J. Solmsii*, are practically devoid of free branches, the projecting cystocarps hardly counting as such. Besides the absence of free branches, these two species differ from those referred to the second group in the shape of the antheridial tufts and their arrangement in the antheridial conceptacle. In *Janczewskia verrucaeformis* and in *J. Solmsii* the antheridial tufts are as broad as, or broader than, they are long, being bouquet-like rather than elongated plumose, and occupy the base and but very little of the sides of the antheridial receptacle, thus giving the conceptacles a very characteristic appearance in radial section. Since *Janczewskia verrucaeformis* is the type of the genus, it is proposed that this section of the genus be called *Eujanczewskia*. The second section of the genus may similarly be designated as *Heterojanczewskia*. The four species, viz., *J. moriformis*, *J. Gardneri*, *J. lappacea*, and *J. tasmanica*, assigned to this section agree in having a greater or less, but always, if we except perhaps the antheridial plant of *J. moriformis*, a decided development of free, armlike branches. The antheridia of the species of this section, with the exception of *J. tasmanica*, where they are not yet described, are long plumose and line the whole antheridial conceptacle, radiating from the point of attachment on the wall towards the center of the conceptacle.

In the species of *Heterojanczewskia* the length of the free branches varies, being least in *J. moriformis*, where the antheridial plant is nearly, or at times, quite devoid of them, through *J. Gardneri*, where they are of intermediate length, to *J. lappacea* and *J. tasmanica*, which have the longest free branches.

At the close of this account these various relationships will be brought out in connection with the formal diagnoses attached to the new names proposed.

VIII. DISTRIBUTION

Falkenberg (1901, p. 257) has already called attention to the extraordinarily extensive distribution of the members of the parasitic genus *Janczewskia*. In his account, species of this genus are credited to the Mediterranean Sea, to New Zealand, South Australia, and to the Cape of Good Hope. Later references and the present account have shown that the genus is also well developed on the coast of California. There seems to be no reason why they may not also be found in intermediate regions and thus be world-wide in their distribution, especially since *Laurencia* species are found in practically all the warmer waters of the world.

Thus far the species have been found in temperate seas, and it may be that they will be found to be restricted to such waters. Laurencieae and Chondrieae, their hosts, while not occurring in the colder waters, are abundant in both the warmer temperate and the tropical waters. It seems, certainly, a reasonable expectation that *Janczewskia* species may be found wherever *Laurencia* and *Chondria* species flourish.

IX. DIAGNOSES

Janczewskia Solms.

Sectio I. *Eujanczewskia* sect. nov.

Thallis externis tuberiformibus, solidis, lente lobatis aut mammoso areolatis, ramis liberis nullis; antheridiis in thyrsis latis basim conceptaculorum masculorum vestientibus.

1. *J. verrucaeformis* Solms.

2. *J. Solmsii* Setchell et Guernsey sp. nov.

Thallis tuberiformibus, sphericis vel late reniformibus, 5–8 mm. diam. max., luteo-albis; masculis parvioribus femineis sporangiferisque majoribus; tetrasporangiis in parietibus conceptaculorum immersis, sub epidermide positis, triangulo divisis; antheridiis in thyrsis late conicis, basim conceptaculorum masculorum investientibus, pilis sterilibus nullis; cystocarpiis maturitate prominentibus, globulis, pericarpio crasso.

In thallis *Laurenciae suboppositae* parasitica prope "San Pedro" et "Redondo," in ditione Californiensi ubi detexit Dr. N. L. Gardner.

Sectio II. *Heterojanczewskia* sect. nov.

Thallis externis e partibus duabus; parte solida basali (tuberculo) et parte a ramis liberis constituta; antheridiis in thyrsis anguste plumosis parietes totos conceptaculorum masculorum vestientibus.

3. *J. moriformis* sp. nov.

Thallis initio globulis deinde late reniformibus, 3–5 mm. diam. max., dilute roseis, tuberculis solidis basilaribus ramos breves gerentibus; thallis masculis parvioribus ramos liberos brevissimos aut nullos gerentibus; thallis sporangiferis femineisque ramos breves, 0.6–0.8 mm. gerentibus; tetrasporangiis sub epidermide in parte superiore ramorum liberorum brevium triangulo divisis; antheridiis longe et anguste plumosis, parietes totos conceptaculorum masculorum vestientibus ad centrum radiantibus, pilis sterilibus nullis; cystocarpiis in apicibus ramorum brevium immersis, pericarpio moderate crasso.

In thallis *Chondriae atropurpureae* parasitica, prope Sanctam Monicam in ditione Californiensi ubi detexit Dr. N. L. Gardner.

4. *J. Gardneri* Setchell et Guernsey sp. nov.

Thallis initio globulis deinde irregulariter complanatis lobatisque, 4–10 mm. diam. max., dilute roseis, tuberculis solidis complanatis ramos liberos moderate longos gerentibus; thallis masculis parvioribus globulis, ad 4 mm. diam., ramos liberos congestos, 0.6–0.8 mm. longit gerentibus; thallis sporangiferis ad 10 mm. diam. max., complanatis et lente lobatis, ramos congestos ad 2 mm. longit. gerentibus; thallus femineis complanatis ad 8 mm. diam. max., ramos congestos 1.0–1.5 mm. gerentibus; tetrasporangiis sub epidermide in parte superiore ramorum liberorum, triangulo divisis; antheridiis in thyrsis longe et anguste plumosis parietes totos vestientibus, ad centrum conceptaculorum masculorum radiantibus; cystocarpiis in apicibus lente tumidis ramorum liberorum immersis, pericarpio moderate crasso.

In thallis *Laurenciae pinnatifidae* parasitica, in oris insulae "Vancouver" ditione Columbiae Brittanicae, ubi detexit J. Macoun; in oris insulae "Whidbey", ditione Washingtoniensi, ubi detexit N. L. Gardner; in ditione Californiensi ad "Fort Ross," ubi detexit W. A. Setchell, prope "San Francisco," ubi detexit N. L. Gardner, prope "Monterey," ubi detexit C. P. Nott, et prope "San Pedro," ubi detexit N. L. Gardner.

5. *J. lappacea* sp. nov.

Thallis perfecte aut complanate globulis, 3–5 mm. diam. max., albis, tuberculis solidis exiguis ramos liberos radiantes gerentibus; thallis sporangiferis, complanato globulis, ad 5 mm. diam. max., ramis liberis congestis, gracilibus, 1.5–2.0 mm. longit.; thallis masculis regulariter globulis, ad 3 mm. diam., ramis liberis divergentibus et distantibus, 0.2–0.6 mm. longit.; thallis femineis complanato globulis, ad 5 mm. diam. max., ramis liberis irregulariter divergentibus, gracilibus, 1.0-1.5 mm. (?) longit.; tetrasporangiis sub epidermide in parte superiore ramorum liberorum triangulo divisis; antheridiis in thyrsis moderate anguste plumosis brevioribus, parietes totos, conceptaculorum masculorum vestientibus et ad centrum radiantibus; cystocarpiis in apicibus lente tumidis ramorum liberorum immersis, pericarpio moderate crasso.

In thallis *Chondriae nidificae* parasitica prope "San Pedro" in ditione Californiensi ubi detexit Dr. N. L. Gardner.

6. *J. tasmanica* Falk.

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EXPLANATION OF PLATES

PLATE 1

Janczewskia moriformis Setchell

1. Portion of a plant of *Chondria atropurpurea* bearing two cystocarpic plants of *Janczewskia moriformis.* × 10 diam.

2. Portion of a plant of *Chondria atropurpurea* bearing two antheridial plants of *Janczewskia moriformis.* × 10 diam.

3. Portion of a plant of *Chondria atropurpurea* bearing a tetrasporic plant of *Janczewskia moriformis.* × 10 diam.

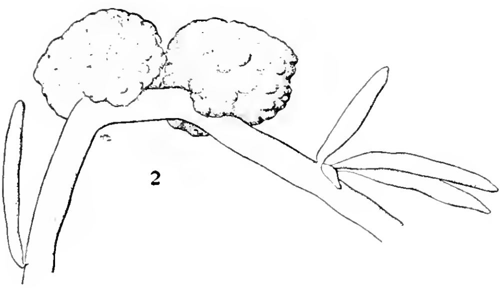
Janczewskia Gardneri Setchell & Guernsey

4. Portion of a plant of *Laurencia pinnatifida* bearing a cystocarpic plant of *Janczewskia Gardneri.* × 10 diam.

5. Portion of *Laurencia pinnatifida* bearing a tetrasporic plant of *Janczewskia Gardneri.* × 10 diam.

6. Portion of *Laurencia pinnatifida* bearing an antheridial plant of *Janczewskia Gardneri.* × 10 diam.

1



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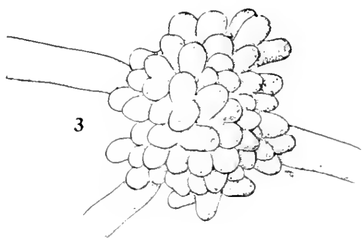

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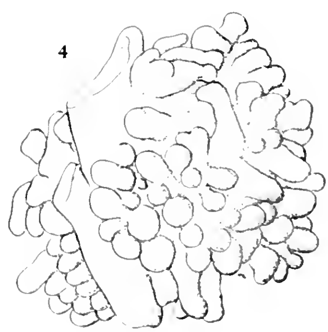

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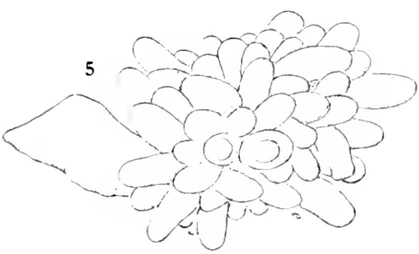

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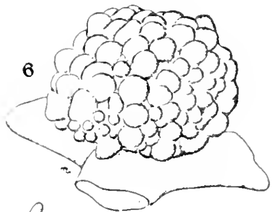

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PLATE 2

Janczewskia Solmsii Setchell & Guernsey

7. Portion of *Laurencia subopposita* bearing a cystocarpic plant of *Janczewskia Solmsii*. × 10 diam.

8. Portion of *Laurencia subopposita* bearing an antheridial plant of *Janczewskia Solmsii*. × 10 diam.

Janczewskia lappacea Setchell

9. Portion of *Chondria nidifica* bearing a cystocarpic plant of *Janczewskia lappacea*. × 10 diam.

10. Portion of *Chondria nidifica* bearing a tetrasporic plant of *Janczewskia lappacea*. × 10 diam.

11. Portion of *Chondria nidifica* bearing an antheridial plant of *Janczewskia lappacea*. × 10 diam.

12. Diagram of section through a cystocarpic plant of *Janczewskia lappacea* on *Chondria nidifica*. × 10 diam.

13. Diagram of section through a tetrasporic plant of *Janczewskia lappacea* on *Chondria nidifica*. × 10 diam.

14. Diagram of section through an antheridial plant of *Janczewskia lappacea* on *Chondria nidifica*. × 10 diam.

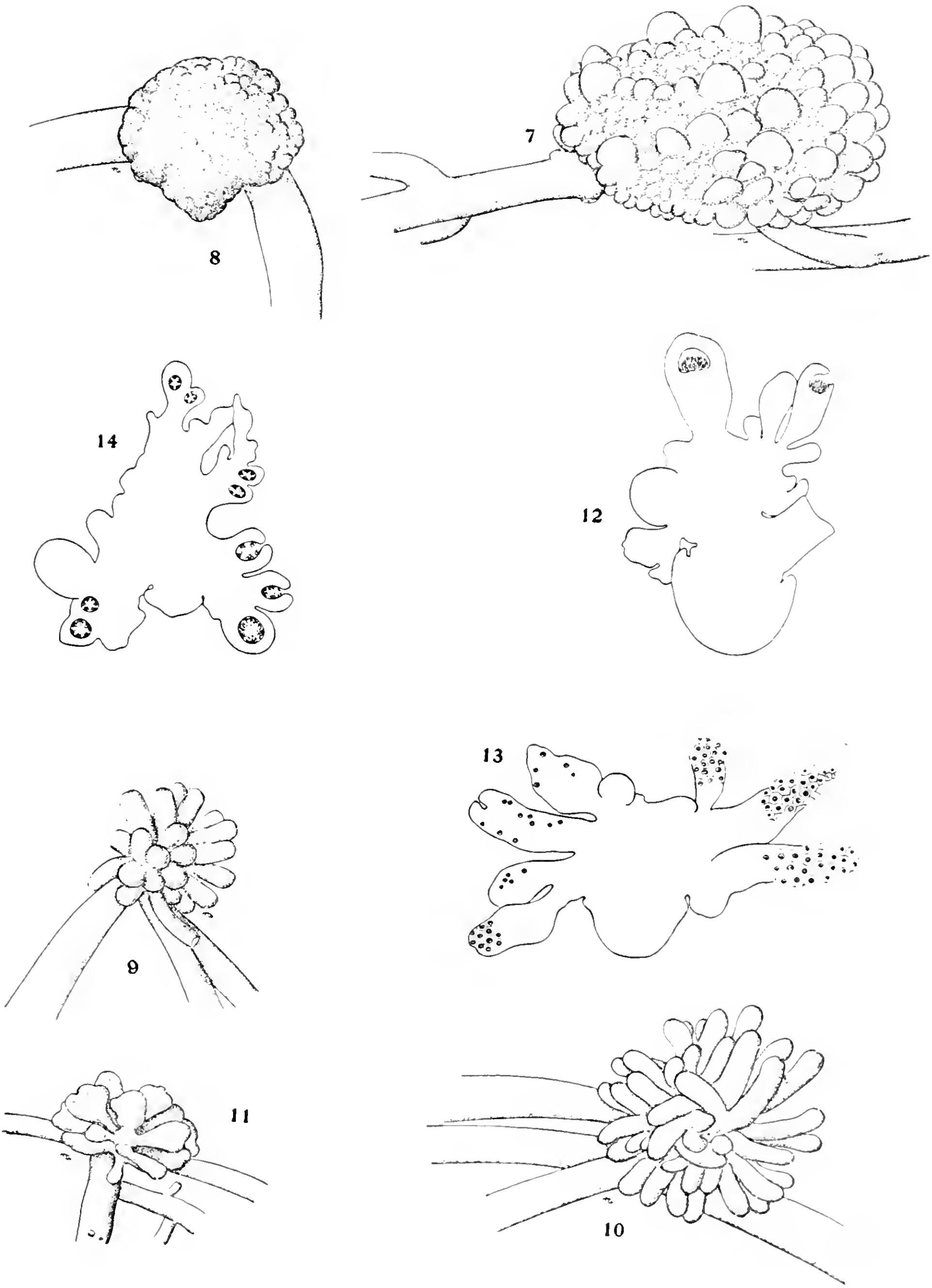
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PLATE 3

Janczewskia Gardneri Setchell & Guernsey

15. Diagram of section through a cystocarpic plant of *Janczewskia Gardneri* on *Laurencia pinnatifida*. × 10 diam.

16. Diagram of section through an antheridial plant of *Janczewskia Gardneri* on *Laurencia pinnatifida*. × 10 diam.

Janczewskia Solmsii Setchell & Guernsey

17. Diagram of section through a cystocarpic plant of *Janczewskia Solmsii* on *Laurencia subopposita*. × 10 diam.

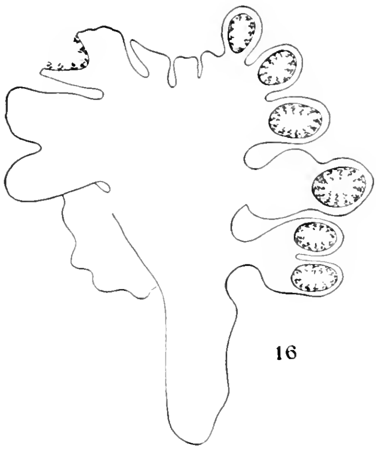
18. Diagram of section through a tetrasporic plant of *Janczewskia Solmsii* on *Laurencia subopposita*. × 10 diam.

19. Diagram of section through an antheridial plant of *Janczewskia Solmsii* on *Laurencia subopposita*. × 10 diam.

Janczewskia moriformis Setchell

20. Diagram of section through a tetrasporic plant of *Janczewskia moriformis* on *Chondria atropurpurea*. × 10 diam.

21. Diagram of section through an antheridial plant of *Janczewskia moriformis* on *Chondria atropurpurea*. × 10 diam.



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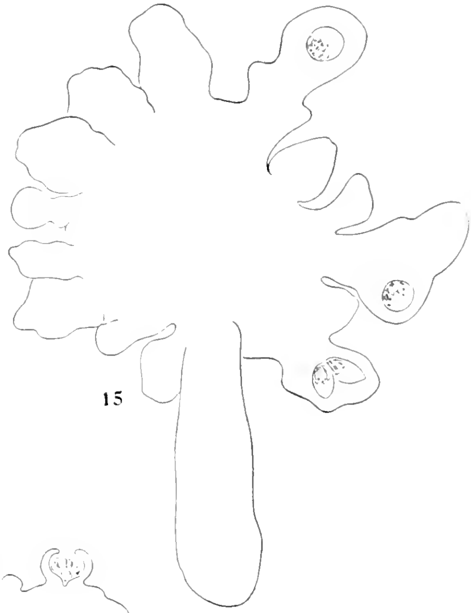

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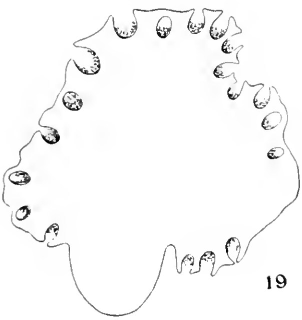

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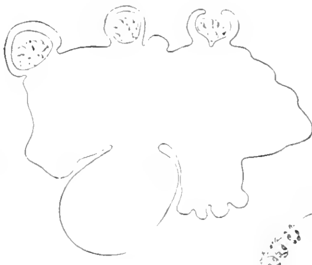

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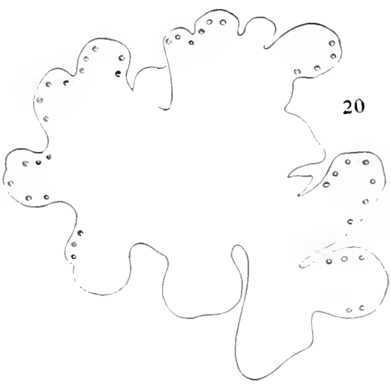

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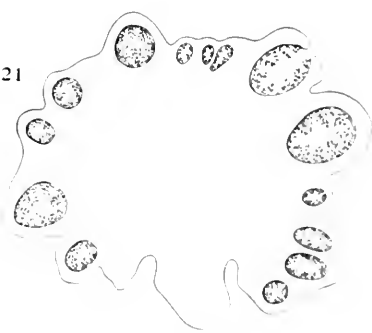

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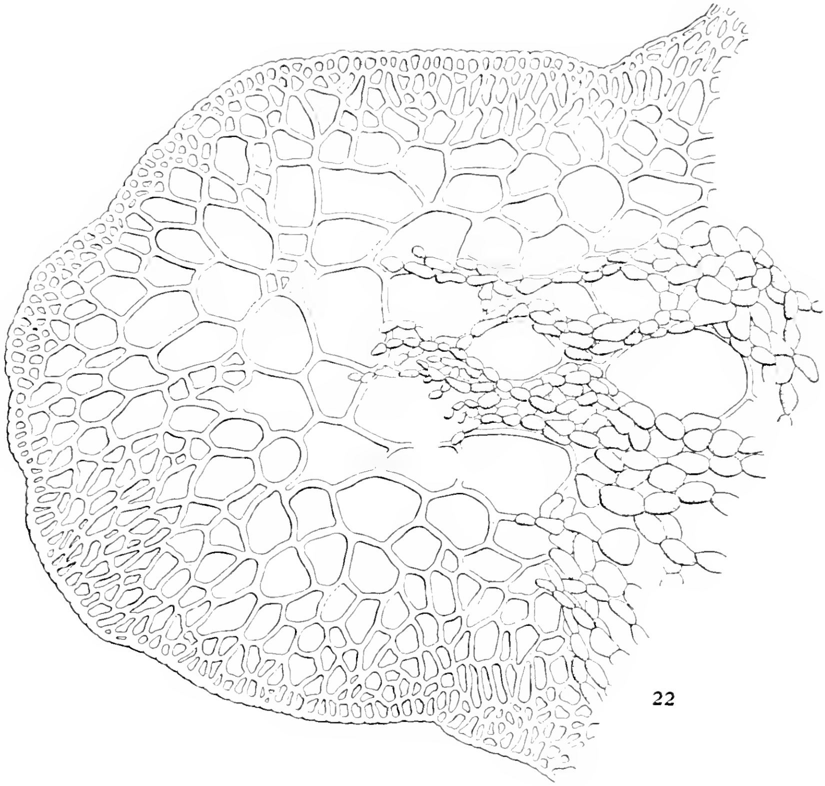
PLATE 4

Janczewskia moriformis Setchell

22. Transverse section through the frond of *Chondria atropurpurea* at point of parasitism of *Janczewskia moriformis* showing penetration of parasite (shaded filaments) into the host plant. × 300 diam.

23. Vertical section through an antheridial conceptacle of *Janczewskia moriformis.* × 300 diam.



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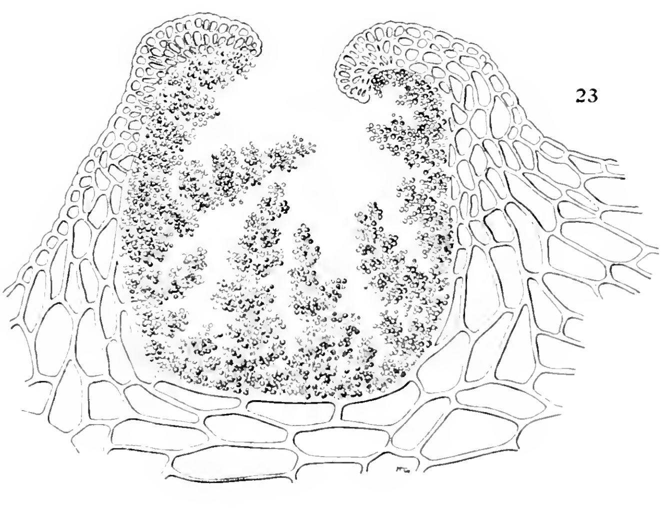

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PLATE 5

Janczewskia moriformis Setchell

24. Vertical section through a cystocarp of *Janczewskia moriformis*. × 300 diam.

Janczewskia Gardneri Setchell & Guernsey

25. Vertical section through an antheridial conceptacle of *Janczewskia Gardneri*. The dotted lines show position of opening. × 300 diam.

Janczewskia Solmsii Setchell & Guernsey

26. Vertical section through a tetrasporic conceptacle of *Janczewskia Solmsii*. × 300 diam.

27. Vertical section through an antheridial conceptacle of *Janczewskia Solmsii*. × 300 diam.

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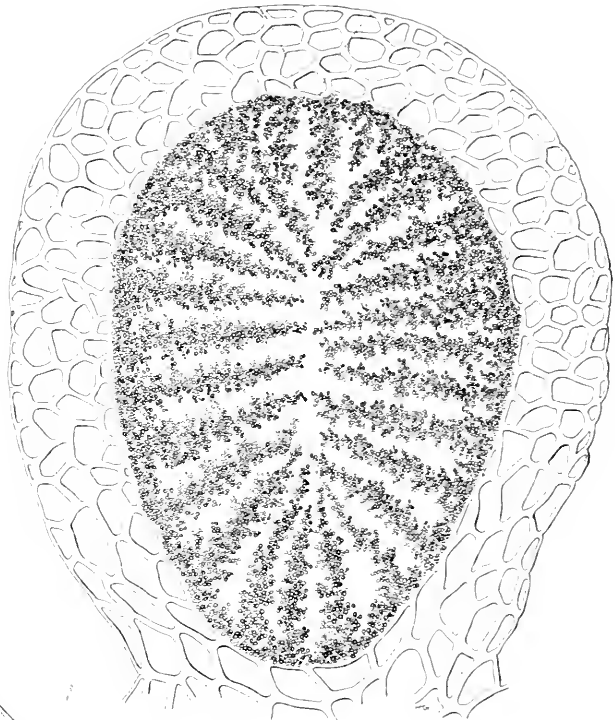

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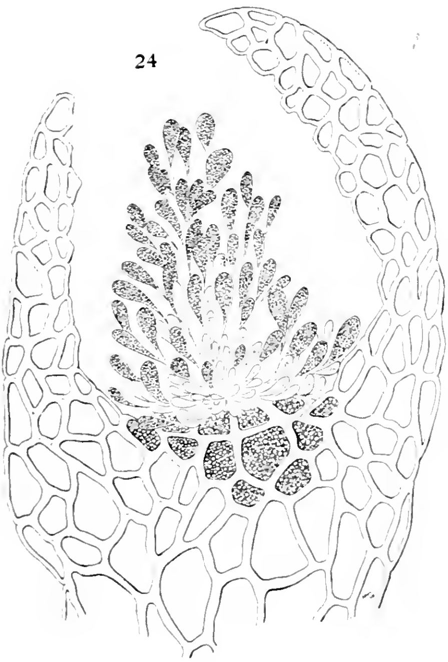

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PLATE 6

Janczewskia lappacea Setchell

28. Transverse section through the frond of *Chondria nidifica* at point of parasitism of *Janczewskia lappacea* showing penetration of parasite (shaded filaments) into the host. × 300 diam.

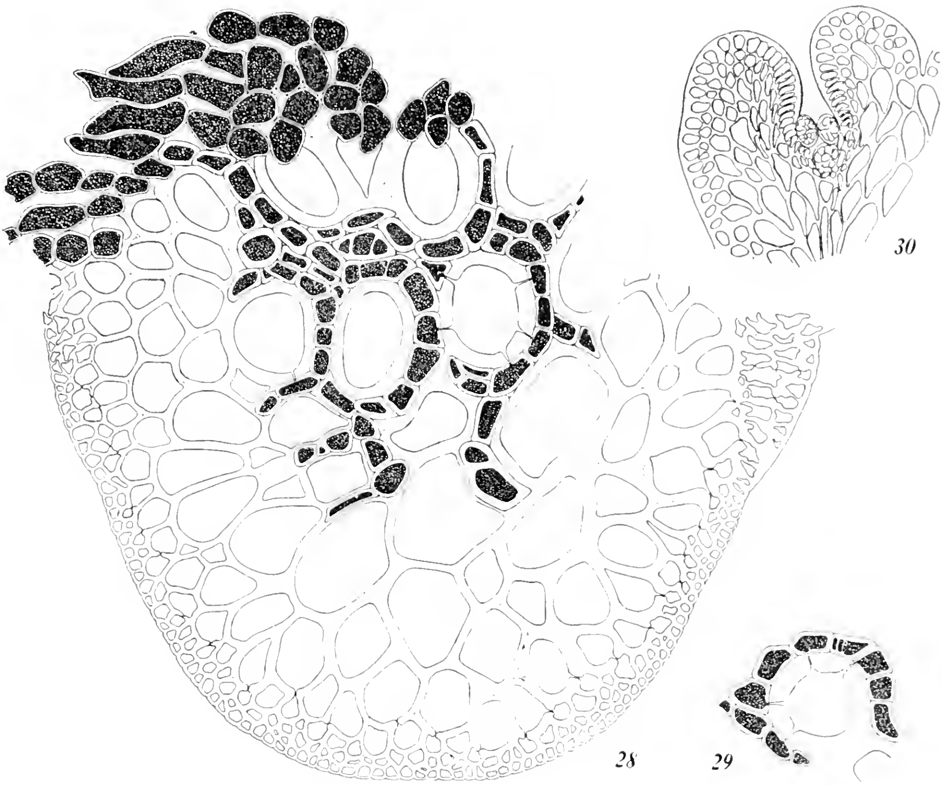
29. Portion of section shown in fig. 28 to show relation of pits of the parasite (shaded cells) and those of the host (unshaded cells). × 300 diam.

30. Vertical section of tip of free branch of *Janczewskia lappacea* to show apical pit with hairs, etc., arising towards the base. × 300 diam.

31. Vertical section through the tip of a free branch of *Janczewskia lappacea* to show an antheridial conceptacle. × 300 diam.

32. Vertical section through the tip of a free branch of *Janczewskia lappacea* to show two antheridial conceptacles. × 300 diam.

All the drawings were made by Miss Helen Gilkey under the direction of W. A. Setchell.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UNIVERSITY OF CALIFORNIA PUBLICATIONS
IN
BOTANY

Vol. 6, No. 2, pp. 35-40, plate 7 Issued April 11, 1914

PHYTOMORULA REGULARIS, A SYMMETRICAL PROTOPHYTE RELATED TO *COELASTRUM*

BY

CHARLES ATWOOD KOFOID

A protophyte with a coenobium of exceptional regularity and remarkable resemblance to a lenticular egg with equal cleavage, in a sixteen-cell stage, was discovered in a local reservoir in Berkeley in March, 1912. This reservoir is mainly used for pressure, receiving from time to time some water pumped from the alluvial fan at Niles, California, but mainly fed at this season of the year by creek and spring water from the Berkeley Hills. Its plankton contains only species normal to the season and to clear, spring-fed waters of brief impounding. It is composed principally of *Anuraea cochlearis*, *A. tecta*, *A. aculeata*, with a few *Daphnia hyalina*, and *Diaptomus Bakeri*. It was remarkably free from phytoplankton this year, having only a few *Synedra*, *Pediastrum boryanum*, *Scenedesmus quadricauda*, *S. curvatus* and *S. obliquus*, some small spheroidal forms resembling the smallest phases of *Sphaerocystis Schroeteri*, a species which is abundant in the summer, a few *Volvox*, sp., and numerous minute flagellates. In comparison with other standing or spring-fed waters in this season of the year the water of this reservoir is exceptionally free from phytoplankton. Its cement bottom and walls bear a slight coating, largely of diatoms which the wind and bubbles of oxygen tend to strew through the open water, but the accessions from this source to the plankton are slight. During the past twelve years in which I have inspected the microscopic life of many fresh waters in California, the organism here described has never been seen elsewhere, and it is at the most very rare where it was discovered.

The coenobium (pl. 7, fig. 1) is subcircular in axial view, elliptical in lateral view, and lenticular in general form, but modified in detail by the exposed surfaces of the constituent cells. Its major axis is short, the axial diameter of the coenobium being about one-half that in the minor axes. It is made up, in the individual figured, of sixteen subequal cells with a very characteristic arrangement. At either pole is a group of four cells and in the periphery of the lenticular mass are arranged the other eight cells in four groups of two each. The circular outline is thus somewhat modified toward the quadrangular by this grouping of the marginal row of cells. The coenobium is solid, without central cavity, since the two polar quartets abut one upon the other in the equatorial plane about the main axis. They thus form a sort of axial parallelopipedon with rounded ends and corners and constricted equatorial region where the inner ends of the two quartets meet. Into this equatorial depression the outer circle of eight cells fits as an automobile tire into the rim of the wheel. The cells of each apical quartet form a quadrangular group, each almost exactly superposed upon the other, with an axial depression at the pole, rounded angles, and a slight notch at each furrow as seen in axial view. Thus the two furrows which separate the cells of one of the quartets are directly continuous with those of the other, and also coincide with two of those parting the cells at the peripheral ring. These two main planes thus divide the coenobium completely into quadrants and lie in the two minor axes.

The two apical quartets are similar in all respects, except that the apical depression at one pole (fig. 1) is not so large as at the other (fig. 2) and the line of apposition of two diagonally opposite cells which stand at a slightly higher level than the other diagonally opposing pair, is less pronounced. The opposite pole (fig. 2) is also somewhat flatter, but this may be mere individual variation and have no significance suggestive of a sessile habit or attachment at some phase of the life-history, or of some relation to other coenobia in development.

A consideration of the the arrangement of the individual cells in the coenobium (pl. 7, figs. 1–3) at once suggests certain similarities to a morula stage of an animal egg, in which equal cleavage of the radial type has progressed through the fourth division, resulting in sixteen cells of the fourth generation. The arrangement of cells here described could be derived from an eight-cell stage with radial superposed quartets by division and shifting of the proximal (equatorial) daughter quartets into an intercalated peripheral row, while the two distal polar daughter quartets remain in an axial position with the inner end of each in contact with that of a cell of the quartet of the opposite pole.

The process of development of the coenobium unfortunately has not been observed, but there is some evidence in the mutual adjustment of the cells, as observed, which is confirmatory of the conception of the derivation suggested. In the first place, the cells of the peripheral row can be plainly separated into two quartets whose cells alternate in position and lie at slightly different levels, as indicated in the diagram (fig. 4*b*, and, seen in a lateral view, fig. 3). One quartet is at a slightly higher level (viewed from the apex) than the other. In a similar way, as before noted, two of the cells of each polar quartet are at a higher level than the others and come more nearly into apposition in an apical cross-line. It seems probable that the members of the apical quartets are sister cells respectively of the cells of the quartet of the peripheral ring which are nearest them, i.e., are at the higher level as seen from the pole in question. This relationship is indicated in the diagram (fig. 4) by the connecting arrows.

This simple organism with the elemental geometrical relations of its constituent cells affords a unique species for an analysis of the play of mechanical forces and their integration in the formation of the lenticular colony. The adhesion of the quartets of the eight-cell stage by their equatorial ends in the plane of the equator and the consequent crowding to the periphery of the proximal sister cell upon their division would afford an immediate basis for the formation of the lenticular colony of the type here observed. The lack of developmental stages precludes for the present any further consideration of this phase of the subject.

The cells of the coenobium are subequal, those of the apical quartets being somewhat flatter distally and more squarish than those of the peripheral ring, which have a broadly rounded exposure and with opposite instead of contiguous faces flattened. Each of the cells bears upon its exposed surface a centrally located, slightly squarish area which is the least bit elevated. This is delimited by a minute depression in the surface which involves the cell-wall and slightly indents the protoplasm below and is best seen in optical section. There are no processes on this area, and it is detected only by close scrutiny and is with difficulty demonstrable upon the surface of the apical cells. It is presumably homologous with the more pronounced elevations or distal outgrowths on the cells of other Coelastraceae such as *Coelastrum cambricum*. The cell-wall is thin, with an exceedingly thin transparent gelatinous film upon the surface. The protoplasm is applied immediately to the wall. The chromatophore is peripheral, very pale light green in color, with numerous minute pyrenoids. The nucleus is centrally located.

No trace of the methods of reproduction has been found.

The relationships of this organism are with the family Coelastraceae, subfamily Sorastreae and the genus *Coelastrum*, within which both hollow and solid coenobia are included, though the latter are less usual. The Coelastraceae are separated by Wille, in his "Nachträge" to Engler and Prantl, from the Hydrodictaceae on the basis of the absence of zoospores in the former. No evidence is at hand upon this point with regard to the organism here described, so that its allocation in Coelastraceae is provisional in so far as this character is concerned. Its structural relations are with both of these families in the matter of coenobium and surface differentiation in the cells, but the form of colony and type of cell protrusion is somewhat more like that of the Coelastraceae and it may therefore be provisionally assigned to that family.

Phytomorula gen. nov.

Coenobio solido, subcomplanato; cellulis, 16, firmiter adherentibus.

Phytomorula regularis sp. nov.

Coenobio solido, subcomplanato, orbiculato, cellulis 16, firmiter adhaerentibus in coenobio, 8 alternantibus in peripheria, 4 ad polum pertinentibus utrimque, superficie gibbosa, 15μ in longum, 30μ in latitudine, cellulo 10μ in latitudine.

Transmitted April 2, 1914.

EXPLANATION OF PLATE 7

All figures of *Phytomorula regularis* magnified 1500 diameters.

Fig. 1. Apical view of coenobium.

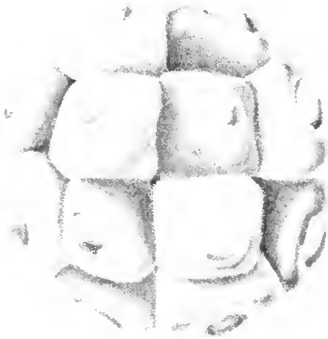
Fig. 2. Apical view of same, the other apex.

Fig. 3. Lateral view of same.

Fig. 4. Cell contents.

Fig. 5. Diagram showing superposition of cells, apical view.

Fig. 6. Diagram of coenobium from the opposite pole, showing the smaller quartet of apical cells.



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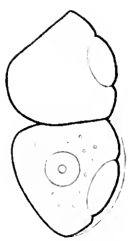

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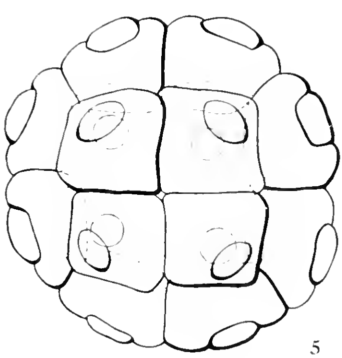

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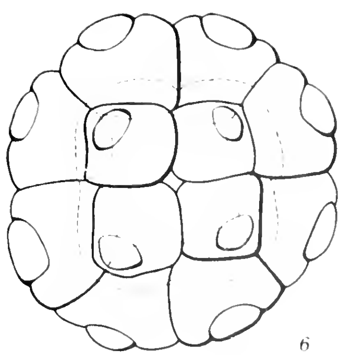

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UNIVERSITY OF CALIFORNIA PUBLICATIONS
IN
BOTANY

Vol. 6, No. 3, pp. 41-50, pls. 8-9 Issued June 13, 1914

VARIATION IN *OENOTHERA OVATA*

BY

KATHARINE LAYNE BRANDEGEE

This plant was brought to notice in the first volume of Torrey and Gray's *Flora of North America*, published in the year 1840. The text is here given because to many botanists the book is not readily accessible:

§8. Stigma capitate or subclavate: tube of the calyx filiform, very long (tardily deciduous), slightly dilated at the summit: stamens erect; the alternate filaments usually shorter: anthers linear, fixed near the middle: acaulescent: flowers rather small yellow. Perennial: flowers unchanged in fading.—PRIMULOPSIS.

Oe. ovata (Nutt.! mss.): stemless, pubescent; leaves ovate or oblong, erose-denticulate, tapering into a slender petiole; tube of the calyx nearly as long as the leaves; the segments oblong-lanceolate, shorter than the roundish entire petals; stamens almost equal; anthers linear, nearly as long as the filaments, fixed near the middle; stigma small, somewhat clavate.

In moist plains in the immediate vicinity of Monterey, California: common. March.—Leaves almost exactly those of *Viola primulaefolia*. Flowers bright yellow, about an inch in diameter. Ovaries radical, obtuse: the capsules unknown. Stigma somewhat clavate. *Nutt.*—Mr. Nuttall justly remarks, that the present plant shows the insertion of the anthers and the relative length of the filaments to be of less consequence in this genus than has been supposed.

Mr. Nuttall collected the plant in 1836, so early in the year that its most important characters were undeveloped, but though extending along the coast from central California to southern Oregon, its imperfect description appears in later works, with little improvement, even by local botanists living in its abundance.

The species appears to be confined to a narrow strip along the seaboard. It has been occasionally reported from far inland, but in such cases as I have seen, *Oe. heterantha*, a plant of similar habit, had been mistaken for it.

In former years it was very common in this general region, but cultivation of the lands and extension of villages has considerably restricted it, and the following appreciative note of Mr. C. H. Shinn scarcely represents the present fact:

There is a glowing California field-flower that possesses many charms, and well deserves introduction to the garden. In its season this lovely Californian *Oenothera*, with its dwarf growth and its compact clusters of golden bloom, appears as distinct and as striking a feature of the landscape as the great flame-red Eschscholtzias. One can almost claim that, when the Wild Poppy became the state flower, the modest merits of this perennial Evening Primrose were sadly neglected.

The other day—it was May 10th—I walked up the long seaward slopes of Berkeley. Every vacant lot and the very streets were golden with little plats of shining blossoms. I began to remember that for three or four months this brilliant display continues; I bent down and counted the flowers and yet unopened buds on the nearest plant of *Oenothera ovata*. The plant was nowise conspicuous among its fellows that dotted the slope; in fact, many showed far more flowers and covered a greater area. The sample plant, however, made a very respectable display. The circle of its outer leaves was about a foot in diameter; they rested upon the turf, hardly rising four inches above it at any point. Fifteen open flowers rose well above the foliage, and no less than thirty-six buds could be counted without pulling the crown apart and descending to the microscopic sizes. Each of the four-petaled flowers was fully as large as a fifty-cent piece; one almost covered a silver dollar. The rich clear yellow hue and the regularity of the petals and stamens, with the golden ball of the erect pistil, formed a charming whole.

Botanists are interested in this little *Oenothera* on account of its peculiarly long calyx-tube, which is never less than one inch, and usually is from three to five inches long. The ovary is concealed in the very crown of the plant, and is thus protected from accident in as complete a manner as one could well imagine. There are not many flowers of this curious type, and none is better adapted for a garden-flower. *Oenothera ovata*, if planted on the lawn in a solid bed of, say, ten feet square, would surprise every beholder by its abundant bloom and its glowing color.[1]

The observations, extending over several years, that follow have been made on the uncultivated grounds of the University of California at Berkeley, where *Oe. ovata* grows about and between the older buildings. From their location, as may be imagined, the plants are subject to many vicissitudes, and attempts at continuous observation have been cut short by vandalism, or by the lawn-mower, for which reasons several questions, notably of duration, remain unsettled.

The very great variation in *Oenothera ovata* has perhaps escaped notice on account of its low growth, and it has never had a synonym. This, together with the fact that no nearly related species, nor one flowering at the same time, occurs in its range, eliminates at once all

[1] Garden and Forest, vol. iv, (1891), p. 285.

questions of interspecific hybridity and simplifies the nomenclatural difficulties that encumber many species. For these reasons the plant is much more satisfactory as an example of pure variation than many others that have been more studied.

The plant is perennial, or at least biennial, having a large and deep root, the outer blackened layer splitting and cracking, showing the inner white portion. It abounds in starch and might be used as food in necessity, though it is slightly acrid. Below the surface of the ground it often branches, forming two or more nearly flat crowns 1–3 cm. across. With the help of Miss H. A. Walker, I counted the fruits, flowers, and buds of a large plant of this kind. There were in all, separable by a hand lens, 247. About twenty flowers were expanded at the time.

Around the outer border of the crown the leaves spread horizontally, making flat mats 10–45 cm. across, the later leaves being shorter and more or less upright. The specific name is somewhat of a misnomer, the leaves being usually lanceolate, with long, margined petioles (cf., however, pl. 8, fig. 3). The blades are broad or narrow, usually undulate, occasionally pinnatifid, smooth or bullate, rarely quite entire, glabrous above, ciliate on the margins, and on the veins below, occasionally sparsely muricate.

The color variation in the vegetative parts of these plants is much more striking than in the forms of *Oe. biennis-Lamarckiana* that have furnished us such a quantity of segregates. Plants growing side by side may have their petioles, midribs, calyx lobes and "tube" a glowing ruby-red or an ivory white. Either of these may be shining or may be dull. The shining leaves appear to be confined to sunny spots, as do the deepest reds, while white plants are found also in the shade. Every gradation is to be seen between the extremes of coloring; sometimes the red is less in depth, sometimes it affects particular organs—as, for instance, the inside of the calyx, leaving the outside green; rarely all the veins are red, usually, however, only the midrib shows the color.

The plants begin to flower early in the spring, sometimes even as early as January, the time varying especially with the time of the early rains. In most cases the fullest bloom begins and ends with the month of April. They require abundant moisture and are particularly at home in oozing slopes, all parts above ground soon dying as the ground dries. The forms noted in this paper and figured in the accompanying plates were not isolated variations occurring on otherwise normal plants, but characteristic at least of one plant, mostly of large numbers. They are not in any way exaggerated, having been carefully drawn and measured by Miss Helen M. Gilkey from U. C. Herbarium sheets Nos. 112837–9, 146812–3, 146832, 146845–6, 167928, 167946, 167948, 173052.

The calyx (figs. 20, 21) varies with the shape and size of the enclosed petals. It has no proper tube, as will be shown below. The throat (fig. 16), short and broad, is closed at the bottom of the disk, which has a hairy ring encircling the base of the style. The lobes are united at the apex, two of the tips being somewhat shorter than the others. The buds are long or short, broad or slender, straight or curved, shining or dull, pubescent to nearly glabrous, light green to ruby red, the color extending to the end of the visible "tube" or stopping at any particular part.

The flowers open in bright weather soon after sunrise, the petals becoming later widely expanded, even recurved, closing late in the afternoon. Normally, of course, the petals are four, but five is a common variation, three (fig. 9) and six (fig. 10) less so. Variation in petal number is usually, though not always, accompanied by similar variation in sepals and stamens; the ovaries difficult to reach have not been examined for variation in number of cells.

The color of the petals runs from clear white to deep yellow. Pure white is rare on the campus, but examples from a few miles away have recently been brought to me by Mrs. Inez R. Smith, who said they were not unusual in that locality. In dried specimens the white darkens and the yellow fades, so that color distinction is soon lost.

In size the flowers are from 1.5 cm. to 5 cm. in diameter (the smaller not figured). The petals vary in shape from nearly round (fig. 9) to oblanceolate (fig. 13) or linear (fig. 14) and are sometimes wanting. The broad petals overlap, the narrow are cruciate. Usually they are rounded at tip, rarely emarginate (fig. 12), often trilobed acute or obtuse (figs. 11, 15). The very pronounced side-lobing as in figure 8 is very common. It is not usually present in all the flowers on a plant or even in all the petals of a flower, and while it is a striking variation, is probably mechanically produced by folding in the bud.

The stamens (figs. 27, 28) are arranged as usual in outer and inner rows, the filaments of the latter considerably shorter than the others, while the anthers, contrary to the usual habit, are decidedly longer, so that their summits, on the whole, are nearly even. The stout style little surpasses the stamens.

The ovaries spring from the axils of the densely crowded leaves that protect and conceal them as wel as the almost membranous capsules. The slender, long-produced empty portion of the ovary which has been confounded with the calyx-tube of other species is not tubular "with the style united with the tube" as is often said, but is a solid body, through the center of which the placentae and even the ovules can be traced upward for some distance above the fruiting portion. The length of this sterile portion of the ovary is often very great, reaching in the outer early flower 18 cm. (figs. 17, 18). The later "tubes" are successively shorter, coming down to 3 cm. The structure is of nearly uniform diameter between the throat above and the seed-bearing part below. This long sterile portion was described twenty-five years ago, but the note appears to have been overlooked.[2]

The capsules, the fruiting parts, are of very irregular shape, sometimes broad at base, sessile, conical (fig. 22), sometimes narrow or linear and occasionally more or less pedicellate (fig. 23). The walls are thin, pale and conformed to the turgid, rather large (2 mm.) seeds (fig. 29) which are purplish at first, becoming yellowish-white by the development of the shaggy-pubescent outer coating. Later the seeds become of a dark color, if remaining long in the ground. The inner coat is purple, becoming nearly black. The embryo (fig. 30) is oval, with no visible distinction in outline between cotyledons and radicle.

The seeds are ripened usually by the middle of June, the leaves and sterile capsules withering and breaking away so that scarcely a trace of the plant is to be seen, a circumstance which may account in part for the general ignorance concerning its fruiting habits.

The capsules are not regularly dehiscent, but split more or less along the sutures, especially if removed from the ground. The seeds are disseminated by cultivation, by rooting or gnawing animals or by torrential rains. Considering their unusual shagginess it is difficult to understand why, when mentioned, they have always been described as "smooth."

Sex-variation shows itself not in dimorphism but in great difference in size of stigmas and anthers, connected by copious intergrades. The stigma varies from linear-clavate to globular of greatly increased diameter (figs. 9, 17, 24, 25, 26), either borne on a style equaling the stamens in length, or nearly sessile (fig. 26), often more or less unilateral. The anthers are frequently effete, sometimes atrophied, but

[2] Proc. Cal. Acad. Sci., ser. 2, i, p. 255.

often of normal size with the pollen imperfect, the pollen grains often enlarged and stuffed with innumerable spore-like bodies, the nature of which has not been determined. The healthy pollen is of very unequal size especially in certain plants.

In this species, self-fertilization is the rule in normal plants, the anthers opening a day before the bud, and in my observation the stigma always showing pollen at the time of the opening of the flower, but from failure of viable pollen, crossing is probably not rare. Judging from the grouping of forms and their spreading from parent localities it seems probable that most of the forms here described come true from seed.

Little attention has been given to disease forms in *Oe. ovata*, partly from lack of time, partly because its low growth and hidden fruit make its study difficult. Fasciation occasionally occurs, and is, so far as my experience goes, always associated with abundance of aphis. Double forms are rare and usually are produced by transformation of the stamens.

It will be apparent from the foregoing that there are quite as many "elementary species" in *Oenothera ovata* as in the better known *Oe. biennis-Lamarckiana* group. In this connection I wish to call attention to some remarks by De Vries[3] that seem to be overlooked by many systematists:

> Species is a word which always has had a double meaning. One of them is the systematic species, which is the unit of our system. But these units are not at all undivisible. . . . Today the vast majority of the old systematic species are known to consist of minor units. These minor entities are called varieties in systematic works. However, there are many objections to this usage. . . Some of these varieties are in reality as good as species, and have been "elevated," as it is called, by some writers, to this rank. This conception of the elementary species would be quite justifiable, and would at once get rid of all difficulties, were it not for one practical obstacle. The number of the species in all genera would be doubled and tripled, and as these numbers are already cumbersome in many cases, the distinction of the native species of any given country would lose most of its charm and interest.
>
> In order to meet this difficulty we must recognize two sorts of species. The systematic species are the practical units of the systematists and florists, and all friends of wild nature should do their utmost to preserve them as Linnaeus has proposed them.

[3] De Vries, *Species and Varieties, Their Origin by Mutation*, pp. 10–12.

EXPLANATION OF PLATE 8

Oenothera ovata Nutt.

Fig. 1. Young plant showing cotyledons and first leaf.

Figs. 2-6. Leaves characteristic of various plants. All of natural size.


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EXPLANATION OF PLATE 9

Oenothera ovata Nutt

Figs. 7–15. Corollas from as many different plants.

Fig. 16. Calyx cup opened, with lobes and stamens cut off to show the hairy base of the style and the ring of hairs near the bottom of disk.

Figs. 17–18. Ovaries, broken above seeding part.

Fig. 19. Medium-sized root sliced lengthwise and cut across.

Figs. 20–21. Buds.

Figs. 22–23. Forms of ovaries.

Figs. 24–26. Comparative sizes of stigmas and length of style.

Fig. 27. Stamen from inner row.

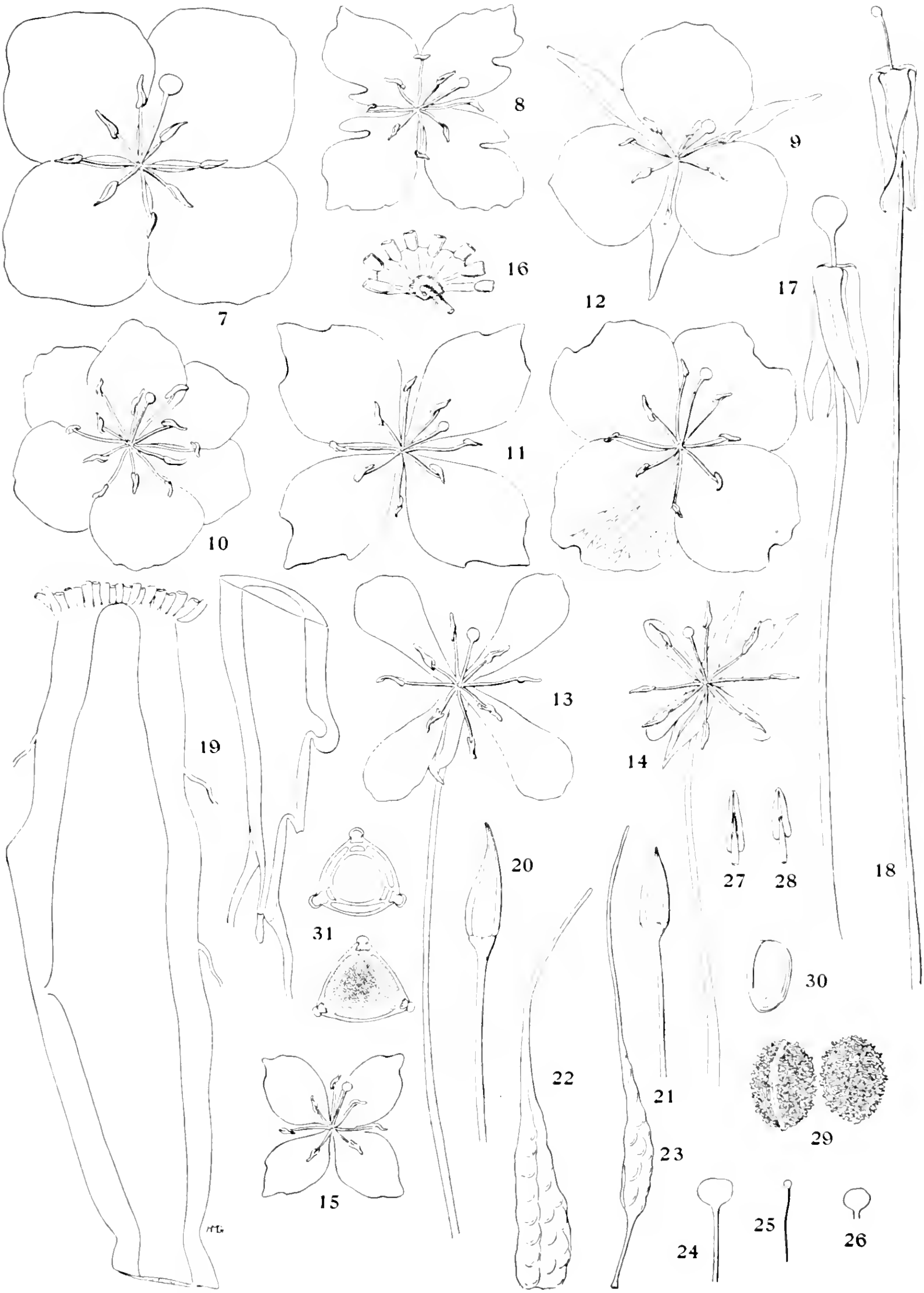
Fig. 28. Stamen from outer row.

Fig. 29. Dorsal and ventral views of seed. ×

Fig. 30. Embryo. One cotyledon pushed slightly aside to show indistinct radicle. ×

Fig. 31. Pollen. ×

All of natural size excepting seed, embryo, and pollen.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PLANTAE MEXICANAE PURPUSIANAE, VI

BY

TOWNSHEND STITH BRANDEGEE

The collection of plants gathered during the year 1913 was made mainly in the State of Chiapas, in a region of almost incessant tropical summer rains, evidently botanically unexplored and certainly conducive to sickness as exemplified by the personal experience of Dr. Purpus, whose severe illness caused loss and injury to many of his specimens.

Whenever any of the following new species came from any other locality than Chiapas the state is indicated, otherwise Chiapas is the habitat.

Tradescantia parvula sp. nov.

Radix fibrosa: caulibus erectis, 4–5 cm. altis, apice florigeris, paululum pubescentibus: foliis oblongo-lanceolatis, glabris, ca. 15 mm. longis, 4 mm. latis; vaginis ca. 5 mm. longis, parum pilosis; pedunculis brevibus, 4–8-floris; pedicellis congestis, ca. 4 mm. longis; sepalis ovato-acutis, ca. 4 mm. longis, sparsim glanduloso-hirsutis; petalis carneis sepalis aequantibus; filamentis inaequalibus, barbatis; staminum breviorum antheris dissimilibus: capsula 3-loculari, loculis 2-spermis.

Collected at Boca del Monte, Puebla, growing in moist soil. No. 6486. Type, Herb. Univ. Calif., No. 155258.

Aristolochia ferruginea sp. nov.

Suffruticosa, volubilis: caulibus sulcatis, setis ferrugineis, patentibus, instructis: foliis ovato-acutis, margine integris, ciliatis, basi incisis sinu profondo auriculas rotundatas separante, supra glabris, subtus pubescentibus, laminis ca. 11 cm. longis, 8 cm. latis; petiolis ca. 5 cm. longis, dense ferrugineo-setosis: floribus solitariis, axillaribus; pedunculis setosis, ca. 1 cm. longis; periantho extus setoso; utriculo ca. 14 mm. longo; tubo recto ca. 1 cm. longo, basi intus annulo incrassato instructo; labio ca. 3.5 cm. longo, lurido, sicco complicato; staminibus 6; columna stylina superne in lobos 6 divisa; fructu fusiformi.

Collected in the State of Chiapas. No. 6931. Type, Herb. Univ. Calif., No. 173035.

Aristolochia (Gymnolobus) **Purpusii** sp. nov.

Verisimiliter prostrata: caulibus sulcatis, pubescentibus: foliis e basi 5-nerviis, apice acutis vel acuminatis, basi cordatis, supra glabris, subtus pubescentibus, nunc cordato-ovatis nunc basi auriculatis, ca. 6 cm. longis, 3 cm. latis; petiolis ca. 1.2 cm. longis: floribus axillaribus, solitariis: periantho ca. 3.5 cm. longo, extus pubescenti, utriculo oblongo superne contracto, intus membrana reflexa instructo, limbo lurido, valde curvato, ovato-acuminato; pedunculo ca. 1 cm. longo, prope apicem bracteam foliosam gerenti; antheris 6.

Collected on Sierra de Tonala. No. 6826. Type, Herb. Univ. Calif., No. 172533.

Mimosa (Eumimosa) **tetraneura** sp. nov.

Suffruticosa vel annua, caulibus decumbentibus ca. 4 dm. longis, ramosis, setosis; setis ca. 2.5 mm. longis, flavidis, patentibus: aculeis infrastipularibus, geminatis, rectis, quam setis longioribus: pinnis confertim 2-jugis, petiolis ca. 2.5 cm. longis; foliolis 6–7-jugis, oblongis, obtusis, e basi 4-nerviis, margine setosis, utrinque fere glabris, ca. 7 mm. longis, 3 mm. latis, jugis inferioribus minoribus: pedunculis solitariis, axillaribus vel ad apices ramorum racemosis, 3–4 cm. longis, quam foliis longioribus; capitulis globosis; lobis corollae purpureis; leguminibus oblongis, ca. 2 cm. longis, 4 mm. latis margine setosis setis patentibus; valvis utrinque glabris, 4–5-articulatis.

Collected on Sierra de Tonala, growing in rocky soil. No. 6626. Type, Herb. Univ. Calif., No. 169739.

Mimosa pusilla Benth. The specimens referred to this species differ from the original description and Palmer's Acapulco plant somewhat. They are more erect, more setose and the leaflets of each pinna number about twenty-four. Collected on the Sierra de Tonala. No. 6629. Univ. Calif. Herb., No. 169741.

Desmodium (Nephromeria) **campestre** sp. nov.

Hirsutulum, diversifolium: caulibus ramosis, ca. 3 dm. altis: foliis simplicibus vel 2–3-foliolatis; foliolis ovato-acuminatis, usque ad 6 cm. longis, 3 cm. latis, breviter petiolulatis; petiolis 1–4 cm. longis: floribus parvis, racemoso-paniculatis; paniculis terminalibus; pedicellis ca. 1 cm. longis, saepissime ternis; calycis lobis lanceolatis: leguminis lobo terminali elliptico, glabro, minute ciliato.

Some of the specimens have only simple leaves, of some all the leaves are trifoliolate and some bear leaves of all forms, simple, bifoliolate, and trifoliolate. Collected Picacho—San Geronimo, Oaxaca, growing on dry plains. No. 6810. Type, Herb. Univ. Calif., No. 172517.

Desmodium Purpusii nom. nov. *D. lunatum* Brandg. Zoe, V. 246 (1908) non *D. lunatum* Huber, Bol. Mus. Para, IV. 568 (1906). *Meibomia lunata* Rose & Standley, Cont. U. S. Herb. XVI. 215 (1913).

Desmodium (Chalarium) **chiapense** sp. nov.

Suffruticosum, racemosum, pubescens: caulibus crassis, 5–6 dm. altis: foliis trifoliolatis; foliolis ellipticis apice mucronatis, breviter petiolatis, supra pubescentibus, subtus dense albo-pubescentibus, ca. 5 cm. longis, 2.5 cm. latis, terminali majori; floribus purpureis, parvis, numerosissimis, racemoso-paniculatis, breviter pedicellatis; paniculis terminalibus, valde ramosis; bracteis lineari-lanceolatis, mox deciduis: leguminibus hirsutis, saepissime 4-articulatis; articulis suborbicularibus.

In appearance this species resembles *D. plectocarpum* Hemsley. Collected on rocky slopes of Sierra de Tonala. No. 6809. Type, Herb. Univ. Calif., No. 172516.

Acalypha Purpusii sp. nov.

Multicaulis e radice lignosa: caulibus frutescentibus ca. 2 dm. altis, primum pubescentibus: foliis ovato-acuminatis, basi cuneatis vel truncatis, 5-nerviis, margine crenato-serratis, ca. 2 cm. longis, 15 mm. latis, utrinque parce pubescentibus; petiolis usque ad 15 mm. longis, pubescentibus; stipulis lineari-lanceolatis, apice setosis, deciduis: spicis femineis plerumque terminalibus interdum axillaribus, saepe in pedunculos steriles apice abeuntibus, ovatis, ca. 15 mm. longis; bracteis ca. 3 mm. longis, pubescentibus, 3–5 dentatis, dentibus subulatis e basi lata; stylis exsertis, laciniligeris; ovario hirsuto; seminibus sub lente rugosis; spicis masculis tenuibus, axillaribus, usque ad 4 cm. longis.

Collected Picacho—San Geronimo, Oaxaca, growing on dry plains. No. 6894. Type, Herb. Univ. Calif., No. 172976.

Euphorbia (Cyttarospermum) **chiapensis** sp. nov.

Glabra: caulibus erectis, ca. 10 dm.? altis; ramis oppositis, axillaribus, usque ad 15 cm. longis: foliis oppositis vel superioribus ternatis, ovato-lanceolatis, basi cuneatis, margine integris, majorum laminis ca. 4.5 cm. longis, 2.3 cm. latis, mucronulatis; petiolis 2–4 cm. longis, filiformibus: cymis terminalibus vel axillaribus, 4–10-floris; pedicellis ca. 2 mm. longis; involucris ca. 1 mm. altis, puberulis; glandulis 5 oblongis, appendicibus 2, anguste linearibus, ca. 1 mm. longis, instructis; stylis bipartitis. Fructus deest.

Collected in rocky woods on Sierra de Tonala. No. 6895. Type, Herb. Univ. Calif., No. 172975.

Euphorbia (Cyttarospermum) **enalla** sp. nov.

Herbacea: ramis sulcatis, pubescentibus, superioribus oppositis vel ternatis, laminis ovato-acutis, usque ad 6 cm. longis, 3 cm. latis, utrinque parce pubescentibus; petiolis 1–5 cm. longis: cymis terminalibus; pedunculis ca. 1.5 cm. longis pubescentibus; pedicellis brevibus: involucris campanulatis, pubescentibus, ca. 1 mm. altis; lobis fimbriatis: glandulis 4, appendicibus albis, crenatis, quam iis latioribus; stylis bipartitis: capsula profunde sulcata, glabra; seminibus ovatis, favoso-foveolatis.

This species was distributed under the not well-chosen name *Euphorbia tetradenia*. Collected on Cerro del Boqueron. No. 7035. Type, Herb. Univ. Calif., No. 173056.

Euphorbia (Alectoroctonum) **padifolia** sp. nov.

Fruticulus, late ramosus: ramis glabris: foliis ellipticis, basi acutis, utrinque glabris, laminis ca. 2.5 cm. longis, 1.5 cm. latis, petiolis ca. 5 mm. longis: cymis terminalibus, brevibus, paucifloris; involucris campanulatis, pubescentibus, glandulis concavis 5, appendicibus albis minute crenatis latioribus; stylis brevibus, bifidis; capsula glabra, coccis dorso rotundatis; seminibus ovatis, rugosis.

This species is near *E. Schlechtendalii* Boiss., differing conspicuously on account of its shorter petioles and concave glands. The leaves have fallen from the specimens, but they appear to have been opposite and ternate. Collected on dry, rocky plains Picacho—San Geronimo, Oaxaca. No. 6950. Type, Herb. Univ. Calif., No. 173014.

Euphorbia (Laurifoliae) **elata** sp. nov.

Arbor glabra, ca. 7 m. alta: foliis oblanceolatis, apice obtusis vel retusis, basi in petiolum brevem attenuatis, ca. 3 dm. longis, 8 cm. latis, alternantibus: cymis axillaribus, longe pedunculatis, subcorymbosis: pedicellis 5–8 mm. longis: involucris campanulatis, ca. 9 mm. latis; lobis rotundatis, laceratis: glandulis 5, orbicularibus, magnis, prope basim bracteis duabus interdum instructis; bracteis late ovatis, acutis, margine erosis, involucro parum longiori: involucri bracteolis interioribus latis apice laceratis; ovario calyculo tripartito, glabro, cincto; stylis omnino connatis, apice minute lobatis. Fructus deest.

When the cymulae are 3-flowered the central involucre has no bracts. This plant is related to *E. calyculata* HBK., which is described as having lanceolate leaves, a 3-parted style, and the limb of the involucre with round entire teeth. Collected at Finca Irlanda. No. 7026. Type, Herb. Univ. Calif., No. 173064.

Phyllanthus Purpusii sp. nov.

Arbor 7–8 m. alta, monoica, glabra, foliosa: ramis rubescentibus, plus minus anguste alatis: foliis distichis, ovato-acuminatis, basi cuneatis, subtus pallidioribus, 2–3.5 cm. longis, 8–10 mm. latis; petiolis brevibus; stipulis lanceolatis, petiolis longioribus: racemis axillaribus, brevibus; pedicellis 4–6 mm. longis; floris masculi calycis laciniis inaequalibus, coriaceis, majoribus 3 oblongo-acutis, ca. 5 mm. longis, minoribus 3 deltoideis, ca. 2 mm. longis; staminibus 4 mm. longis, filamentis monadelphiis, antheris verticaliter birimosis in conum abeuntibus: disci glandulis 3; floris feminei calycis laciniis majoribus, ovatis, ca. 5 mm. longis, 4 mm. latis, minoribus oblongo-acutis, disci glandulis urceolatis, stylis basi tantum connatis, breviter bifidis; seminibus minute rugulosis pubescentibusque.

Collected in open forests on Cerro del Boqueron. No. 6960. Type, Herb. Univ. Calif., No. 173007.

Pedilanthus tehuacanus sp. nov.

Tomentoso-pubescens: foliis ad ramos juvenes tantum vigentibus, linearibus, apice acutis, basi angustatis, sessilibus, ca. 2.5 cm. longis, 6 mm. latis; cymis terminalibus, corymbosis: involucris sessilibus vel breviter pedicellatis, in bracteis 2, magnis deinde deciduis clauditis, urceolatis, profunde lobatis, ecalcaratis; appendicibus ad involucrorum dorsum arcte applicatis, bipartitis, basi 2-glandulosis: filamentis glabris; capsulae pediculo pubescenti longe exserto; capsula conica, tomentoso-pubescenti, ca 1.2 cm. longa lataque; seminibus glabris.

The specimens are not sufficient for a more complete description. Collected at Tehuacan, Puebla. No. 7065. Type, Herb. Univ. Calif., No. 173431.

Pedilanthus campester sp. nov.

Caulibus verisimiliter brevibus, ramosis: foliis ovatis, acutis, basi cuneatis, ca. 6 cm. longis, 3 cm. latis, utrinque pubescentibus: cymis caules vel ramos breves terminantibus; involucris glabris, rubris, ca. 14 mm. longis, postice appendice instructis; pedicellis ca. 7 mm. longis; labio inferiori paululum retuso, ca. 4 mm. longo; glandulis in fundo appendicis 2; capsula oblonga; seminibus glabris.

Collected on dry, rocky plains Picacho—San Geronimo, Oaxaca. No. 6885. Type, Herb. Univ. Calif., No. 172985.

Myginda macrocarpa sp. nov.

Frutex ramosus, glaber: caulibus teretibus: foliis plerumque oppositis, oblongo-ovatis, acuminatis, basi cuneatis, margine indistincte sinuatis vel serratis, ca. 9 cm. longis, 4 cm. latis: petiolis ca. 5 mm. longis: paniculis axillaribus, paucifloris, quam foliis brevioribus; pedicellis pedunculisque filiformibus, puberulis: floribus parvis, calycis lobis 4, rotundatis; petalis 4, reflexis, dilute rubris; stylo paululum bilobato; fructu obovoideo, rugoso, ca. 15 mm. longo, putamine osseo, 1-loculari; semine erecto.

Collected at Finca Mexiquito. No. 7063. Type, Herb. Univ. Calif., No. 172804.

Ayenia dentata sp. nov.

E radice lignosa multicaulis: caulibus dense albo-pubescentibus, ca. 2 dm. altis: foliis ovatis, acutis, serratis, ca. 2.5 cm. longis, 1.6 cm. latis, supra puberulis, subtus stellato-pubescentibus; petiolis ca. 7 mm. longis, pubescentibus: floribus axillaribus; pedicellis ca. 4 mm. longis; calycis segmentis ovato-lanceolatis; petalis tenuiter unguiculatis; laminis subquadratis dorso saepe glandula pedicellata auctis, margine integris: antheris 2-locularibus: capsulis dense pubescentibus, molliter echinatis.

This species differs from *A. pusilla* L. in having the lamina of the petals furnished with a gland and the anthers are 2-celled. The stems are more pubescent and the plant has a very different appearance. Collected on dry, rocky plains Picacho—San Geronimo, Oaxaca. No. 6694. Type, Herb. Univ. Calif., No. 172441.

Lunania mexicana sp. nov.

Ramis teretibus, flexuosis, juvenibus puberulis: foliis oblongo-acuminatis, basi cuneatis, 3-nerviis, margine serratis, utrinque glabris, ca. 9 cm. longis, 3 cm. latis: racemis ramosis, ramos terminantibus, ca. 5 cm. longis; pedicellis 1–2 mm. longis; calyce demum in sepala 2.

membranacea, reflexa, valvata, fisso; petala 0; staminibus 5, circa discum hypogynum insertis cum ejus dentibus alternantibus; ovario 1-loculari; stylis 2–3, brevibus; capsula oblonga.

Collected at Finca Irlanda in damp barrancas. No. 7024. Type, Herb. Univ. Calif., No. 173066.

Conostegia Purpusii sp. nov.

Caulibus tetragonis fere glabris; foliis in eodem jugo inaequalibus nervis prominentibus, pergamentaceis, glabris, margine integris, apice abrupte acuminatis, basi cuneatis, 5-nerviis, majoribus ca. 24 cm. longis, 14 cm. latis; petiolis 4–7 cm. longis; paniculis ca. 1 dm. longis; alabastris ca. 5 mm. longis, glabris, conicis, acutis; staminibus 10; stylo crassiusculo, ca. 4 mm. longo.

Collected in damp forests at Finca Mexiquito. No. 6784. Type, Herb. Univ. Calif., No. 172471.

Heterocentron suffruticosum sp. nov.

Decumbens, suffruticosum; radicibus tuberiferis; caulibus tetragonis, parce setulosis, 3–4 dm. longis; foliis late ovatis, margine integris, e basi cuneata triplinerviis simul penninerviis, supra parce setulosis, subtus pallidioribus glabrioribus, 3–5.5 cm. longis, 2.5–3 cm. latis; petiolis ca. 7 mm. longis; floribus solitariis axillaribus; petalis roseis, ca. 14 mm. longis; pedicellis ca. 3 cm. longis; calycis tubo hemisphaerico, paululum setuloso, lobis 4 lineari-lanceolatis, glabris tubo longioribus; ovario apice setis instructo; antherarum majorum connectivo infra loculos producto, appendice elongato bifido instructo, minorum connectivo vix ullo basi bituberculato; seminibus cochleatis.

This plant is related to *Heterocentron elegans* (Schlecht.) O. Ktz. Collected on Cerro del Boqueron. No. 6775. Type, Herb. Univ. Calif., No. 172460.

Acisanthera simplex sp. nov.

Annua; caulibus plerumque simplicibus, erectis, appresse setosis, tetragonis, ca. 2 dm. altis; foliis ovatis, apice acutis, margine integris, e basi cuneata trinerviis simul penninerviis, utrinque plus minus setosis, ca. 3.5 cm. longis, 2 cm. latis; petiolis ca. 5 mm. longis; floribus tetrameris, axillaribus, solitariis vel breve racemosis caules terminantibus, fere sessilibus; calycis tubo ca. 5 mm. longo, valde costato quam lobis triangulari-acutis paululum breviori; ovario 4-loculari, apice paucis setis instructo; staminibus glabris, antheris majorum brevibus, apice uniporosis, connectivo infra loculos longiuscule producto, antice bifido; minorum antheris imperfectis, sessilibus, antice bituberculatis; petalis mox deciduis, ovato-acuminatis, 4 mm. longis; stylo clavato; seminibus cochleatis.

By some of its characters this is related to *Heterocentron*. Collected on Sierra de Tonala. No. 6804. Type, Herb. Univ. Calif., No. 172493.

Tibouchina aliena sp. nov.

Frutescens: caulibus appresse setulosis, racemosis: foliis 5-nerviis, ovato-lanceolatis, 5–7 cm. longis, 2–2.5 cm. latis, margine minute serratis, utrinque appresse setulosis; petiolis ca. 1 cm. longis: floribus pentameris, corymboso-racemosis, pedunculis axillaribus folia aequantibus vel superantibus, pedicellis basi bracteatis, 2–10 mm. longis; calycis tubo late ovato, appresse setuloso, ca. 5 mm. longo, lobis persistentibus lineari-lanceolatis aequali; staminibus fere aequalibus, glabris; antheris apice truncatis non attenuatis, poro magno dehiscentibus: seminibus cochleatis.

The longer anthers are slightly more attenuate than the shorter five which are truncate, resembling according to the description those belonging to the South American section Purpurella. Collected on Cerro del Boqueron. No. 6772. Type, Herb. Univ. Calif., No. 172457.

Tibouchina spathulata sp. nov.

Frutescens: caulibus hirsutis, pilis patentibus, ramosis: foliis 5-nerviis ovato-lanceolatis, 4–6 cm. longis, 2–2.5 cm. latis, margine minute serratis, supra appresso-setulosis, subtus appresso-villosis; petiolis ca. 1 cm. longis: floribus pentameris paucis, ad apices ramulorum breve pedicellatis; calycis lobis acutis, usque ad 15 mm. longis, tubo longioribus, spathulatis, appresse setulosis; petalis rubris, oblongo-ovatis, ca. 1.1 cm. longis, margine ciliatis; staminibus inaequalibus, minoribus 5 antheris apice non attenuatis poro magno dehiscentibus; majoribus apice attenuatis, connectivo longiori; filamentis styloque glabris: capsula quam calycis tubo breviori apice setullis instructa: seminibus cochleatis.

Collected on Cerro del Boqueron. No. 6771. Type, Herb. Univ. Calif., No. 172456.

Blakea Purpusii sp. nov.

Fruticosa: ramis teretibus glabris: foliis juvenibus dense ferrugineo-tomentosis; adultis pergamentaceis, ca. 14 cm. longis, 9 cm. latis, ovatis, apice abrupte acuminatis, basi cuneatis, margine integris, supra glabris, subtus ad venas ferrugineo-tomentosis, 5-nerviis, nervis marginalibus adjectis; petiolis ca. 3.5 cm. longis; floribus axillaribus; pedunculis ca. 1.7 cm. longis; bracteis 4 liberis, coriaceis; exterioribus majoribus, ovatis, acutis, ca. 1.5 cm. longis ferrugineo-tomentosis; interioribus minoribus; calyce cylindraceo, 6-dentato, dentibus deltoideis; petalis 6; ovario apice convexo.

The specimens are young and have no opened flowers. Collected on Cerro del Boqueron in rocky forests. No. 6786. Type, Herb. Univ. Calif., No. 172468.

Fuchsia chiapensis sp. nov.

Frutex; caulibus juvenibus dense tomentosis; foliis late ovatis, apice acutis, basi cuneatis, margine integris, ca. 3.5 cm. longis, 1.3 cm. latis, supra puberulis, subtus hirsutis; petiolis pubescentibus, 5–8 mm. longis; floribus axillaribus; pedunculis ca. 1.3 cm. longis, erectis hirsutis; calycis tubo hirsuto cylindraceo, superne parum ampliato, supra ovarium globoso hirsuto, constricto, ca. 6 mm. longo, lobis deltoideo-acuminatis; petalis fere rotundatis, apiculatis, lobis calycis brevioribus; filamentis brevissimis; stylo vix exserto; stigmate 4-lobato.

The specimens of this very hirsute species bear few flowers. Collected on Cerro del Boqueron. No. 6707. Type, Herb. Univ. Calif., No. 172491.

Lopezia conjugens sp. nov.

Annua; caulibus 15–35 cm. altis, basi curvatis; foliis late ovatis, plus quam 3 cm. latis, glabris vel glabrescentibus, ad caulis medium congestis, inferioribus deficientibus, margine integris; petiolis longis marginatis; floribus purpureis supra caulis medium terminalis, racemosis, bracteatis; pedicellis gracilibus, minute glandulosis, minus quam 2 cm. longis; alabastris gracilis, glabris, ca. 6 mm. longis; petalis venosis, superioribus late oblanceolatis margine infra medium plus minus glandulosis; inferioribus late linearibus, margine eglandulosis, supra medium parum angustatis, macula glandulosa notatis; stamine altero ananthero petaloideo quam petalis pallidiori, margine minute serrato forsitan glandulosoque; stamine altero anthera purpurea, filamento styloque petalis aequilongis; capsula paullo magna, fere globosa, basi paullo cuneata; placenta magna, carnea; loculis 3–4-spermis; seminibus brunneis, valde curvatis, transverse rugosis, facie ventrali sulcati.

This species is intermediate between *Lopezia* proper and *L. clavata* which has been included by Dr. Rose in his genus *Pelozia*.

Collected by T. S. Brandegee near Cofradia, Sinaloa. Type, Herb. Univ. Calif., No. 107887.

Lopezia foliosa Brandg. has again been collected by Dr. Purpus at the type locality. Some of the specimens are more than a metre long (54 inches.) No. 7076. Univ. Calif. Herb., Nos. 173584–173588, 174254.

Gaultheria montana sp. nov.

Frutex: foliis ovato-acutis, margine serrulatis, ca. 4.5 cm. longis, 2 cm. latis, utrinque glabris, subtus nigro-punctulatis, petiolis brevibus: racemis terminalibus; bracteis ca. 1 cm. longis pedicellos multitoties superantibus, rachi ferrugineo-hirsuti, bracteolis lineari-lanceolatis calycis segmenta aequantibus: corolla extus pubescenti; filamentis pubescentibus; antheris apice 4-artistatis.

The long bracts of the raceme distinguish this species. Only one specimen was collected along with *G. hirtiflora* Benth. Cerro del Boqueron. No. 6948. Type, Herb. Univ. Calif., No. 173019.

Ipomoea (Cephalanthae) **chiapensis** sp. nov.

Volubilis: caulibus gracilibus plerumque glabris, interdum pilis retrorsis paucis instructis: foliis ovato-acuminatis, basi auriculatis, auriculis saepe acutis, 5–7 cm. longis, 4–6 cm. latis, utrinque fere glabris; petiolis 1.5–2.5 cm. longis: pedunculis 2–15 mm. longis, 5–10-floris, pedicellis 1–3 mm. longis; bracteis calyces aequantibus, lineari-lanceolatis, margine piloso-ciliatis, prope basim sparse longeque pilosis; sepalis lanceolatis bracteis similibus, ca. 8 mm. longis, infra medium longe denseque pilosis: corolla ca. 2.5 cm. longa, late infundibuliformi, violacea: capsula 4-sperma; seminibus pubescentibus.

This Ipomoea is related to *I. rubra* Millsp. but seems very different from the description of that species. The bracts and sepals on different plants vary much in width. Collected at Tonala. No. 6907. Type, Herb. Univ. Calif., No. 172963.

Jacquemontia chiapensis sp. nov.

Praeterea flores glabra, volubilis: foliis oblongis, basi rotundatis vel in petiolum attenuatis, apice obtusis mucronulatis; laminis 5–7 cm. longis, 2–3 cm. latis; petiolis ca. 1 cm. longis: pedunculis 3–5 cm. longis, paucifloris; sepalis disimilibus, exterioribus 3, cordato-ovatis, apice acutis, ca. 2 cm. longis, 1.2 cm. latis, pubescentibus; interioribus 2 minoribus ovato-acuminatis; corolla campanulata, dilute caerulea, 1.5 cm. longa, extus albo-pilosa; seminibus apice pilos paucos fuscos gerentibus.

Collected at Tonala, growing on plains in wet soil. No. 6916. Type, Herb. Univ. Calif., No. 172955.

Salvia oxyphylla sp. nov.

Herbacea: caulibus inferioribus glabris, obtuse angulatis sulcatis: foliis ovatis longe acuminatis, basi cuneatis, margine dentatis, supra paululum subtus ad venas pubescentibus, ca. 7 cm. longis, 3 cm. latis; petiolis 1–2 cm. longis: racemis caules vel ramos terminantibus usque ad 6 cm. longis, bracteis deciduis, ovato-acuminatis, brevibus: verticellis congestis, 2–8-floris; pedicellis ca. 3 mm. longis, pubescentibus; calycis tubo ca. 4 mm. longo quam dentibus longiori; corolla ca. 2 cm. longa, dilute purpurea, prope apicem curvata, extus pubescenti; labiis aequalibus; stylo glabro.

The specimens, which do not show the full length of the plant, are 4 dm. long. Collected on Cerro del Boqueron. No. 6874. Type, Herb. Univ. Calif., No. 172995.

Salvia tonalensis sp. nov.

Fruticosa: caulibus glabris, ramosis, purpureis: foliis oblongo-lanceolatis, longe acuminatis, basi cuneatis, margine incurvo-dentatis dentibus apice callosis, utrinque glabris atomiferisque; laminis 6–8 cm. longis, 2–3 cm. latis; petiolis ca. 1 cm. longis; verticillastris in racemis 1 dm. longis, ramos terminantibus, congestis, usque ad 20-floris; bracteis lanceolatis deinde deciduis; pedicellis 2–3 mm. longis; calyce ca. 5 mm. longo, glabro, labio superiori acuto, inferiori bilobo; corolla caerulea, extus pubescenti, calyce duplo longiori; galea concava; stylo pubescenti; connectivis antice connexis.

The whole plant excepting the corolla is glabrous; dots and glistening atoms abound on the leaves, bracts, and calyces. Collected on Sierra de Tonala. No. 7006. Type, Herb. Univ. Calif., No. 173083.

Browallia melanotricha sp. nov.

Annua, erecta, pauciramosa: caulibus 3–4 dm. altis: foliis ovato-acuminatis, basi cuneatis, ca. 7 cm. longis, 3 cm. latis; petiolis 1–1.5 cm. longis: floribus solitariis; calycibus tubulosis, ca. 12 mm. longis, quam pedicellis longioribus, lobis 4–5, tubo brevioribus: corolla calycem paululum superanti, dilute violacea, infundibuliformi, tubo gradatim parum ampliato, lobis brevibus; staminibus 4 supra medium tubum affixis, inclusis; antheris duorum 2-locularibus, loculis confluentibus, filamentis glabris; duorum loculo altero perfecto altero nano abortivo filamentis ampliatis cum pilis atris ciliatis: stylo superne incrassato: capsula calyce breviori; seminibus angulatis minute foveolato-muricatis.

Collected on Cerro del Boqueron, growing in moist soil of fields. No. 6662. Type, Herb. Univ. Calif., No. 172308.

Solanum (Polymeris) **Purpusii** sp. nov.

Fruticosum: caulibus teretibus, flexuosis, hirsutis pilis patentibus, fuscis; foliis ovato-acuminatis, basi obtusis, margine ciliatis, interdum geminis, supra parce hirsutis, subtus praecipue ad venas stellato-pubescentibus, usque ad 12 cm. longis, 5 cm. latis; petiolis ca. 5 mm. longis, hirsutis; pedicellis 1–2, axillaribus, ca. 1.5 cm. longis fusco-hirsutis; calyce cupulari, margine undulato, extus dense hirsuto cum pilis apice stellatim ramosis, appendicibus 10, anguste linearibus, ca. 7 mm. longis, dense fusco-hirsutis; staminibus 2 longioribus; bacca diametro ca. 1.5 cm.

Collected in damp forests near Finca Mexiquito. No. 7011. Type, Herb. Univ. Calif., No. 173078.

Castilleia (Hemichroma) **chiapensis** sp. nov.

Suffruticosa, ramosa, pubescens, ca. 4 dm. alta; foliis lineari-lanceolatis, 4–5 cm. longis, 2–3 mm. latis, sessilibus; floribus pedicellatis, laxe racemosis; bracteis obovatis, ca. 15 mm. longis, calyce ca. 2.5 cm. longo; corolla ca. 3 cm. longa, galea dorso dense pubescenti, labio inferiori brevi, longe 3-dentato.

Collected in the high region of Cerro del Boqueron. No. 6884. Type, Herb. Univ. Calif., No. 172986.

ALLOPHYTON gen. nov. Scrophulariacearum

Calyx 5-fidus. Corollae tubus cylindraceus, limbi lobis parvis, rotundatis. Stamina 4, didynama, 2 inclusa, 2 exserta; antherarum loculi divaricati demum explanati. Staminodium nullum. Stylus apice 2-lobus; ovula in loculis numerosa. Capsula ovoidea, acuta, demum in valvis 4 dehiscens. Semina numerosa, globosa, rugosa. Herba, foliis oppositis. Cymae pauciflorae, pedunculis axillaribus. Corollae coccineae.

Allophyton megaphyllum sp. nov.

Caulibus crassis, puberulis; foliis elliptico-acutis, basi attenuatis, fere sessilibus, margine integris vel crenatis, ca. 24 cm. longis, 9–10 cm. latis, utrinque glabris; pedunculis 6–10 cm. longis, 4–8-floris; pedicellis 1–2 cm. longis; calycis lobis lanceolatis brevibus; corolla ca. 2.5 cm. longa.

The specimens are not complete enough to give the size of the plant. The leaves are large and crowded and on the under side the veins are very distinct. The flowers resemble those of *Russelia*. Collected at Finca Irlanda, growing in moist soil of damp barrancas. No. 6855. Type, Herb. Univ. Calif., No. 172562.

Hemichaena fruticosa Benth. This central American plant was collected by Dr. Purpus on Cerro del Boqueron. No. 6883. Univ. Calif. Herb., No. 172987.

AMALOPHYLLON gen. nov. Scrophulariacearum

Calyx alte 5-fidus, segmentis oblongis, acutis. Corollae tubus brevissimus, limbus patens 5-fidus. Stamina 4; antherarum loculi subglobosi divergentes prope basim dehiscentes. Stylus apice integer; ovula in quoque loculo numerosissima. Capsula conico-ovata in valvas 4 dehiscens. Semina numerosa, levia, fusiformia. Herba, foliis fere radicalibus saxa humida habitans.

Amalophyllon rupestre sp. nov.

Fere glabrum; foliis oblongo-ovatis, margine crenato-dentatis, 3–5 cm. longis, ca. 2 cm. latis; petiolis ca. 1 cm. longis; pedicellis ca. 2.5 cm. longis, ebracteatis; calyce campanulato, ca. 2 mm. alto; segmentis ca. 4 mm. longis; corolla diametro ca. 6 mm.; lobis oblongo-ovatis, ca. 4 mm. longis; capsula quam lobis calycis breviori, chartacea.

The leaves are of a very thin texture. Each plant bears 1–4 one-flowered pedicels. Collected near Finca Irlanda. No. 7064. Type, Herb. Univ. Calif., No. 174245.

Stemodia micrantha sp. nov.

Annua, dense hirsuta; caulibus plerumque simplicibus, ca. 14 cm. altis; foliis oppositis, late ovatis, margine crenato-serratis, basi truncatis, ca. 4 mm. longis, 6 mm. latis; petiolis ca. 2 mm. longis; floribus axillaribus, solitariis vel geminatis; pedunculis foliis longioribus; calyce 5-partito, segmentis ca. 4 mm. longis, quam corolla dilute caerulea, dimidio brevioribus; antheris stipitatis, loculis valde inaequalibus; capsulis acutis.

Collected on Sierra de Tonala. No. 6806. Type, Herb. Univ. Calif., No. 172487.

Episcia inclinata sp. nov.

Herbacea; caulibus basi radicantibus, tetragonis, villosis pilis hyalinis, ca. 2 dm. longis; foliis oppositis, ovato-acuminatis, margine crenato-serratis, usque ad 10 cm. longis, 5.5 cm. latis, supra cum pilis hyalinis villosis, subtus fere glabris; floribus axillaribus, fasciculatis; pedicellis tomentosis, ca. 2 cm. longis; calycis lobis ovato-lanceolatis, ca. 1 cm. longis, interdum dentatis; corolla ca. 3 cm. longa, recta, cylindracea, superne parum ampliata; lobis rotundatis patentibus; disci glandula magna; ovario supero; stylo filiformi, stigmate dilatato-concavo.

Collected at Finca Mexiquito, growing in wet soil. No. 6851. Type, Herb. Univ. Calif., No. 172565.

Episcia truncicola sp. nov.

Prostrata e nodis radicans: caulibus crassis, paululum pubescentibus, flexuosis, ca. 1.5 dm. longis: foliis ovato-acutis, basi angustatis, margine supra medium crenato-serratis, utrinque villoso-hirsutis; laminis ca. 2.2 cm. longis, 6 mm. latis; petiolis ca. 1 cm. longis: pedicellis axillaribus, ca. 8 mm. longis, villoso-hirsutis pilis albis patentibus; calyce hirsuto, turbinato, ca. 8 mm. longo, fere usque ad basim 5-partito; lobis lanceolatis; corolla rubra ca. 15 mm. longa, extus pubescenti, basi aequali, superne ampliata; staminibus basi in membranam postice fissam connatis; disci glandula postica magna apice tridentata. Fructus deest.

A single specimen was found in Sierra del Boqueron, growing on an old log. No. 7008. Type, Herb. Univ. Calif., No. 173081.

Besleria chiapensis sp. nov.

Frutex: ramis teretibus, paululum pubescentibus: foliis oblongo-acuminatis, basi cuneatis, margine integris vel calloso-dentatis, ca. 11 cm. longis, 6–7 cm. latis, utrinque paululum pubescentibus; petiolis 1–2 cm. longis; pedunculis solitariis, axillaribus, petiolis duplo longioribus; pedicellis 2–5, subumbellatis pedunculis aequantibus; calyce ca. 5 mm. alto fere usque ad basim 5-lobato, lobis late ovatis, margine ciliatis; corolla coccinea, cylindracea, ca. 2 cm. longa; disco annulari; ovario supero, ovoideo; stylo recto, stigmate 2-lobo.

Collected at Finca Mexiquito. No. 7003. Type, Herb. Univ. Calif., No. 173086.

Drymonia chiapensis sp. nov.

Super arbores scandens: caulibus juvenibus puberulis: foliis ellipticis, acutis, basi cuneatis, margine sinuato-dentatis, supra hirsutulis, subtus pallidioribus, pubescentibus, 10–13 cm. longis, 5–8 cm. latis: floribus solitariis, pedicellis ca. 15 cm. longis; calycis lobis foliaceis puberulis, ovato-acutis, basi cordatis, margine dentatis, ca. 18 mm. longis; corolla rubescenti, basi puberula, postice gibba, ca. 4 cm. longa; tubo ventricoso; limbi lobis latis, margine denticulatis; antheris basi calcaratis; disci glandula postica magna; ovario pubescenti.

Collected near Finca Mexiquito. No. 6875. Type, Herb. Univ. Calif., No. 172994.

Solenophora Purpusii sp. nov.

Fere glabra; foliis ovato-acuminatis, basi cuneatis inaequilateralibus, oppositis, disparibus, margine duplicate serratis, ca. 2 dm. longis, 11 cm. latis, subtus pallidioribus; petiolis 6–7 cm. longis; pedunculis ca. 7 mm. longis, 1–3-floris, pedicellis 1.7 cm. longis; calycis tubo ca. 2 cm. longo cylindraceo, lobis valde inaequalibus, denticulatis; corollae tubo ca. 3 cm. longo, superne ampliato, lobis rotundatis, amplis, purpureo-maculatis, margine sinuato-denticulatis; disci glandula magna; capsula infera.

Collected on Cerro del Boqueron. No. 6857. Type, Herb. Univ. Calif., No. 172996.

Napeanthus saxicola sp. nov.

Herbaceus, parce molliter pubescens; caulibus brevibus vel vix ullis; foliis oppositis vel subradicalibus, ovatis, margine crenato-serratis, ca. 3 cm. longis, 2 cm. latis; petiolis brevibus; pedicellis 2–3 cm. longis, ebracteatis, axillaribus; calycis lobis 5, oblongo-ovatis, obtusis, crenato-serratis, 3–4-nerviis, ca. 3 mm. longis; corolla ca. 6 mm. lata; tubo brevissimo; lobis parvis, ovatis, patentibus; staminibus 4, filamentis corollae basi affixis; antheris liberis; loculis distinctis parum divergentibus, subglobosis; stylo curvulo; stigmate parum dilato, 2-fido; capsula conico-ovata quam calycis lobis breviori.

A small plant having the leaves often apparently rosulate, growing on wet rocks near Finca Covadonga. No. 6701. Type, Herb. Univ. Calif., No. 172448.

Diastema rupestre sp. nov.

Annuum, paululum pubescens; caulibus usque ad 1 dm. altis; foliis ovato-acutis, serratis, ca. 6.5 cm. longis, 3 cm. latis; petiolis ca. 2 cm. longis; racemis axillaribus terminalibusque, ca. 9-floris, 3–4 cm. longis; pedicellis ca. 7 mm. longis, bracteis brevibus, linearibus multo longioribus; calycis lobis triangulari-acuminatis; corollae tubo violaceo, cylindraceo, superne parum ampliato; disci glandulis lineari-clavatis; capsula semi-infera.

The color of the flowers seems to have been a light yellow with a purple tinge to the tube. Collected on wet rocks near Finca Mexiquito. No. 6849. Type, Herb. Univ. Calif., No. 172557.

Kohleria chiapensis sp. nov.

Suffruticosa, hirsuta: caulibus subtetragonis, appresse sericeo-hirsutis: foliis ternatis, disparibus, oblongis, acuminatis, basi cuneatis, saepe inaequilateralibus, margine serratis, discoloribus, supra hirsutis, subtus densissime sericeo-villosis, usque ad 14 cm. longis, 6 cm. latis; petiolis 5–10 mm. longis, dense sericeo-villosis: pedicellis ca. 8 mm. longis, in axillis foliorum bracteorumque aggregatis, racemum terminalem ca. 1 dm. longum formantibus; calyce campanulato, ca. 6 mm. alto, dentibus deltoideis tubo brevioribus; corolla cylindracea superne ampliata, ca. 14 mm. longa, extus pilis cinnabarinis dense villosis, faucibus parum angustatis: capsula semi-infera; disci glandulis 5, distinctis, oblongis.

Collected at Finca Mexiquito. No. 7049. Type, Herb. Univ. Calif., No. 173276.

Kohleria collina sp. nov.

Suffruticosa, villosa: caulibus erectis parum ramosis: foliis discoloribus, oppositis, oblongo-acuminatis, basi cuneatis, margine serratis, ca. 8 cm. longis, 3 cm. latis; petiolis 1–2 cm. longis: pedicellis axillaribus, solitariis, 2–3 longis, medio interdum bracteatis; calycibus turbinatis, lobis lanceolatis tubum aequantibus; corolla coccinea gradatim paululum ampliata, ca. 3 cm. longa; filamentis basi dilatatis tomentosisque; capsula semi-infera, vertice conico, obliquo; disci glandulis parvis, indistinctis.

Collected on Cerro del Boqueron. No. 7070. Type, Herb. Univ. Calif., No. 173596.

Kohleria saxicola sp. nov.

Annua: caulibus subtetragonis fere glabris, 2–3 dm. altis: foliis oppositis, interdum purpureis, disparibus, ovato-acuminatis, basi cuneatis margine serratis, supra pubescentibus, subtus fere glabris, usque ad 5 cm. longis, 2.3 cm. latis: pedicellis axillaribus solitariis, ca. 1.5 cm. longis, interdum prope basim bracteatis; calycis tubo turbinato, lobis lineari-lanceolatis, ca. 5 mm. longis; corolla cylindraceo superne ampliato, ca. 5 mm. longa, tubo recto purpureo-maculato, lobis patentibus, filamentis filiformibus, antheris globosis, stigmate dilatato-concavo; disci glandulis distinctis, oblongis; capsula infera, vertice conico curvato.

This plant has the appearance of an *Achimenes* but with the five distinct oblong glands of *Kohleria*. Collected on moist rocks of Cerro del Boqueron and at Finca Mexiquito. No. 6853. Type, Herb. Univ. Calif., No. 172560.

Kohleria fruticosa sp. nov.

Fruticosa, ramosa: caulibus purpureis superne magis villosis, plus quam 4 dm. altis: foliis oppositis, oblongo-acuminatis, basi cuneatis, margine indistincte serratis, discoloribus, supra glabris, subtus appresse villosis, ca. 6 cm. longis, 2.5 cm. latis; petiolis 5–10 mm. longis: pedicellis axillaribus, solitariis, filiformibus, paululum villosis, ca. 7 cm. longis, medio bibracteatis bracteis linearibus, ca. 3 mm. longis: corolla ca. 3 cm. longa, coccinea, basi aequali, gradatim paululum ampliata, recta; limbi lobis erectis, brevibus; calyce turbinato, appresse villoso; lobis 5, lineari-lanceolatis, ca. 1.4 cm. longis: capsula plus quam usque ad medium infera, vertice obliquo, rostrato: disci glandulis parvis, indistinctis.

The specimens seem to have come from a bush. Collected at high elevations of Cerro del Boqueron. No. 7007. Type, Herb. Univ. Calif., No. 173082.

Kohleria pedunculata sp. nov.

Suffruticosa, ramosa: caulibus pubescentibus: foliis discoloribus, oblongo-acuminatis, basi saepe inaequalibus cuneatis, margine serratis, supra parce hirsutis, subtus ad venas appresse villosis, usque ad 1 dm. longis, 4.5 cm. latis; petiolis ca. 1.2 cm. longis: pedunculis 1–4-floris, axillaribus, solitariis, pubescentibus, 5–6.5 cm. longis, apice bracteatis; pedicellis 1–3 cm. longis: calyce turbinato, appresse villoso, ca. 1.2 cm. longo, lobis lanceolatis tubo longioribus: corolla coccinea, gradatim paululum ampliata, ca. 2.8 cm. longa; staminodio manifesto: capsula plus quam usque ad medium infera, vertice obliqua, rostrata; disci glandulis parvis vel nullis.

The species *K. collina, fruticosa,* and *pedunculata* form a group characterized by woody stems, corollas not contracted at the mouth and rudimentary disk glands. Collected on Cerro del Boqueron. No. 6664. Type, Herb. Univ. Calif., No. 172271.

Hansteinia Purpusii sp. nov.

Herbacea: caulibus 3–5 dm. altis, teretibus, pubescentibus: foliis ovato-acuminatis, basi in petiolum brevem attenuatis, utrinque pubescentibus, ca. 5.5 cm. longis, 2.5 cm. latis: paniculis, ca. 7 cm. longis, laxifloris caules terminantibus; calycis lobis lanceolatis: corolla ca. 2 cm. longa tubo supra ovarium contracto, superne inflato-ventricoso; labio postico lineari erecto, antico breviter 3-lobo: staminibus exsertis. Fructus deest.

Hansteinia, of the Pflanzenfamilien, is mainly Glockeria of Bentham and Hooker's Genera Plantarum.

This species was collected on Cerro del Boqueron. No. 6842. Type, Herb. Univ. Calif., No. 172549.

Louteridium Purpusii sp. nov.

Herbaceum, glabrum: ramis tetragonis sulcatis: foliis oblongo-lanceolatis, basi in petiolum angustatis; laminis 15–20 cm. longis, 4–5 cm. latis; margine crenato-dentatis, nervis lateralibus utrinque ca. 16; petiolis 1–2 cm. longis: calycis segmentis tribus fere aequalibus oblongo-lanceolatis pinnato-venosis, lateralibus 2 dorso valde costatis, 2–8 cm. longis; pedicellis 3–4 cm. longis, basi bracteolatis; cymis ad axillas 4–8-floris paniculam aphyllam ca. 3 dm. longam formantibus; corolla flava calyce duplo longiori, tubo ca. 4 mm. longo; staminibus 2 longe exsertis, filamentis basi dilatatis superne gradatim angustatis: capsula ca. 2 cm. longa, ca. 10-sperma, oblonga, apiculata; disco crasso annulato.

The specimens have no open flowers. Collected at Finca Irlanda, growing along creeks. No. 6969. Type, Herb. Univ. Calif., No. 172997.

Diodia aspera sp. nov.

Caulibus teretibus, pilis patentibus hirsutis, ramosis, 2–3 dm. altis: foliis internodiis longioribus, lanceolatis, sessilibus, margine scabris, revolutis, dorso nervo medio setoso, utrinque plus minus setosis, ca. 2.5 cm. longis, 3 mm. latis; stipulis foliis connatis, setis vagina multo longioribus: floribus axillaribus, solitariis, sessilibus; corolla alba, infundibuliformi, ca. 4 mm. longa; calycis limbo 4-lobo, lobis inaequalibus: fructu 2-cocco, lobis calycinis coronato, setoso.

A few specimens only were collected on Sierra de Tonala. No. 6830. Type, Herb. Univ. Calif., No. 172537.

Crusea elata sp. nov.

Annua, 5–6 dm. alta: caulibus hirsutis: foliis parum hirsutis, lanceolatis, sessilibus, subtus nervis validis, ca. 8 cm. longis, 17 mm. latis; stipulis in vaginam ciliatam connatis: floribus in capita involucrata congestis; bracteis majoribus involuceri oblongo-lanceolatis, 3–4 cm. longis; calycis lobis lineari-lanceolatis, ca. 6 mm. longis; tubo hirsutissimo; corolla violacea, hypocrateriformi, tubo gracili, ca. 8 mm. longo; staminibus longe exsertis: styli ramis linearibus.

Collected on Sierra de Tonala, growing in rocky soil. No. 6640. Type, Herb. Univ. Calif., No. 172353.

OTOCALYX gen. nov. Rubiacearum

Calycis tubus turbinatus; limbi lobi 4, unus in laminam foliaceam dilatatus, persistentes. Corollae tubus cylindraceus, superne parum ampliatus, extus sericeus; limbi lobi 4, imbricati. Stamina 4, fauce corollae inserta, filamentis brevissimis; antherae dorso affixae, oblongae, basi et apice obtusae. Ovarium 1-loculare; stylus brevis ramique oblongi, obtusi, glabri; ovula numerosissima, placentis in laminam dorsifixam, reflexis, expansis. Bacca globosa, calycis limbo coronata. Semina angulata, tuberculata. Frutex ramosus, ramulis teretibus. Folia opposita. Stipulae interpetiolares, deltoideae. Flores in cymas paucifloras, pedunculatas, axillares vel terminales, dispositi.

Otocalyx chiapensis sp. nov.

Caulibus juvenibus hirsutulis: foliis ovato-acuminatis, basi cuneatis, margine integris, usque ad 5.5 cm. longis, 2.5 cm. latis, utrinque fere glabris; petiolis 3–5 mm. longis, appresse hirsutis; pedicellis ca. 5 mm. longis; calycis lobis 3 lanceolatis, ca. 3 mm. longis, altero foliaceo lanceolato, ca. 8 mm. longo; corollae coriaceae tubo ca. 1 cm. longo, limbi lobis rotundatis, crenatis, brevibus; bacca crasse coriacea, hirsuta.

The placentae and fruit are peculiar for a Rubiaceous genus, resembling those of some species of Gesneraceae. Collected on Cerro del Boqueron. No. 7041. Type, Herb. Univ. Calif., No. 173047.

PLOCANIOPHYLLON gen. nov. Rubiacearum

Calycis tubus oblongus: limbi lobi 4 lanceolati, persistentes. Corolla tubo brevi: limbi patentis lobi 4, valvati. Stamina 4, filamentis brevibus; antherae basi affixae, lineari-oblongae, obtusae, erectae. Ovarium 2-loculare; stylus filiformis, apice minute 2-lobus: ovula in loculis numerosa, placentis affixa, conferta. Capsula? parva, oblonga, chartacea, 2-locularis, polysperma. Semina minuta, irregularia, rugosa, exalata. Frutex glaber, ramulis teretibus. Folia opposita, petiolata, membranacea, venulis creberrime lineolata. Stipulae parvae, deciduae. Flores in cymas paucifloras, axillares, dispositi, flavi.

Plocaniophyllon flavum sp. nov.

Caulibus ramosis: foliis oblongo-lanceolatis, basi cuneatis, laminis discoloribus, 4–5 cm. longis, 2–2.5 cm. latis; petiolis ca. 3 mm. longis: pedunculis filiformibus, stramineis, 2.5–3.5 cm. longis; pedicellis 1–3 mm. longis; corolla 2.5 mm. longa, lobis explanatis, ca. 4 mm. longis, anguste oblongis, quam staminibus longioribus; fructu ca. 6 mm. longo, lenticellis lineolato.

The fruit of the specimens is not mature enough to show its dehiscence. It may be that of *Hoffmannia*. The leaves are striolate in the manner of those of *Sommera*. Collected in a barranca near Finca Mexiquito, growing on wet rocks. No. 7019. Type, Herb. Univ. Calif., No. 173077.

Rondeletia suffrutescens sp. nov.

Suffrutescens: caulibus teretibus pubescentibus: foliis oppositis, ovatis, longe acuminatis, petiolulatis, margine integris, utrinque paululum hirsutulis, ca. 11 cm. longis, 4.5 cm. latis: stipulis lanceolatis interpetiolaribus: floribus rubris pentameris, cymis terminalibus vel axillaribus laxe dispositis; calycis lobis lineari-lanceolatis, ca. 1.5 cm. longis, patentibus, glabris: corolla hypocraterimorpha; tubo glabro, ca. 2.2 cm. longo; lobis obovatis, alabastro imbricatis, faucibus oreque flavo-tomentosis; staminibus fauci corollae insertis; filamentis brevibus, antheris dorso supra basim bifidam affixis, lineari-oblongis, inclusis; stylo incluso, ramis 2 brevibus: capsula globosa, 2-loculari, loculicide 2-valva, polysperma; seminibus angulatis.

The long foliaceus calyx lobes and large flowers are not found with other species of the genus. In nearly all other characters it seems to agree with those of *Rondeletia*. Collected on Cerro del Boqueron, growing on moist rocks and rocky slopes. No. 6704. Type, Herb. Univ. Calif., No. 172451.

STYLOSIPHONIA gen. nov. Rubiacearum

Calycis tubus oblongus; limbi lobi 5, oblanceolati vel lineari-lanceolati valde inaequali, decidui. Corolla gracilis, elongata; limbi lobi 5, lanceolati, elongati. Stamina 5, tubo corollae inserta, inclusa, filamentis brevibus; antherae dorso affixae, lineari-oblongae, erectae, obtusae. Ovarium 2-loculare; stylus ramis 2. Capsula ovoidea, coriacea, 2-locularis, septicide 2-valvata, valvis 2-partitis, polysperma. Semina angulata, rugosa. Frutex ramulis teretibus. Folia opposita, petiolata, membranacea. Stipulae interpetiolares, lanceolatae. Flores in cymas paniculatas, pauciflores, axillares vel terminales dispositi.

Stylosiphonia glabra sp. nov.

Caulibus ramosis: foliis oblongo-lanceolatis, acuminatis, basi angustatis, margine integris, 10–13 cm. longis, ca. 3 cm. latis; petiolis 1–2 cm. longis: pedunculis filiformibus, ca. 2 cm. longis, 3–4-floris: pediculis 1–1.5 cm. longis: calycis tubo ca. 1.8 mm. longo, 0.5 mm. lato, superne parum ampliato, lobis angustis ca. 1 cm. longis; capsula ca. 9 mm. longa.

Collected in Chiapas, the exact locality not given. No 7057. Type, Herb. Univ. Calif., No. 173437.

Anisomeris Purpusii sp. nov.

Frutex inermis: ramis lenticellis pluribus instructis: foliis late ovato-acuminatis, oppositis, margine integris, supra glabris, subtus parce hirsutis praecipue ad venas, laminis ca. 6 cm. longis, 4.5 cm. latis; stipulis triangulari-cuspidatis; petiolis hirsutis ca. 7 mm. longis:

pedunculis ca. 3 cm. longis, paucifloris; calycis lobis 4, lanceolatis, persistentibus, ca. 3 mm. longis; corolla extus appresse hirsuta, tenui, infundibuliformi, ca. 17 mm. longa, lobis 4, lanceolatis, ca. 3 mm. longis; antheris linearibus basi alte bifidis, sessilibus, dorso fauci corollae affixis, ca. 3 mm. longis; styli ramis 2 brevibus; drupa ovoidea, ossea, 2-loculari; seminibus pendulis cylindraceis; radicula elongata, supera.

The leaves are striolate after the manner of those of *Sommera*. *Chomelia Pringlei* has similar indistinctly striolate leaves. Collected near Tonala. No. 6940. Type, Herb. Univ. Calif., No. 173028.

Hamelia chiapensis sp. nov.

Frutex glaber; foliis plerumque oppositis, oblongis, apice acuminatis, basi in petiolum attenuatis; laminis ca. 7 cm. longis, 2.5 cm. latis; petiolis ca. 1.5 cm. longis; stipulis lanceolatis, brevibus; cymis caules vel ramos axillares terminantibus; pedicellis 2–7 mm. longis; calycis tubo cylindraceo dentibus lineari-lanceolatis longiori; corolla ca. 2 cm. longa, flavescenti, e tubo ca. 5 mm. longo gradatim ampliato, lobis deltoideis; antheris basi longe mucronatis; fructu ca. 8 mm. longo, costato, calycis lobis deciduis annulum cartilagineum relinquentibus.

Collected at Finca Mexiquito. No. 7030. Type, Herb. Univ. Calif., No. 173058.

PINAROPHYLLON gen. nov. Rubiacearum

Calyx turbinatus, tubo ovario omnino adnato; lobi 4 subaequales. Corolla tubo parvo, 4-loba, lobis imbricatis. Stamina 4, basi corollae affixa, filamentis brevibus; antherae oblongae, loculis parallelis. Stylus crassiusculus, stigmate parum dilatato. Capsula paululum supera, vertice dehiscenti, 2-loculari. Semina numerosissima, exalata. Herba perennis, caule brevissimo. Folia sessilia, stipulis foliaceis cito deciduis. Pedunculi ad axillas solitarii.

Pinarophyllon flavum sp. nov.

Foliis ad caulem brevem congestis, parce hirsutis, late lanceolatis, ca. 13 cm. longis, 2.5 cm. latis, margine integris, basi longe attenuatis; floribus 8–10 prope apicem pedunculi secundis, flavis; pedicellis ca. 2 mm. longis; pedunculis ca. 5 cm. longis; calycis lobis 1.5 mm. longis tubo aequantibus; corollae lobis ca. 4 mm. longis; capsula costata.

Collected on wet rocks of barrancas near Finca Mexiquito. No. 6700. Type, Herb. Univ. Calif., No. 172447.

Elaterium saepicola sp. nov.

Caulibus striatis fere glabris: foliis diversiformibus, margine dentatis, nunc ovato-cordatis acuminatis, nunc 5-angulatis, sinu latitudine variabili basi 3-nerviis, nervis lateralibus bifurcatis sinum imum non marginantibus; laminis utrinque parum hirsutulis, 5–7 cm. longis, 7–9 cm. latis; petiolis 2–5 cm. longis, glabris: cirrhis 2-fidis: pedunculis masculis foliis longioribus usque ad 10-floris; calycis tubo ca. 2 cm. longo, superne parum ampliato, petalis 5, anguste lineari-lanceolatis, ca. 1 cm. longis, dentibus subnullis; capitulis antherarum oblongis; ovario longissime denseque hirsuto; fructu compresso, oblique ovato, apice mucronato, sparse setoso, pedicellis ca. 5 mm. longis. Flores feminei desunt.

Collected at Finca Covadonga, growing in hedges. No. 6904. Type, Herb. Univ. Calif., No. 172967.

PTEROSICYOS gen. nov. Cucurbitacearum

Calycis tubus pateriformis, dentibus subnullis. Corolla rotata, profunde 5-partita, segmentis oblongo-acutis cum calyce omnino confluentibus. Staminum filamenta in columnam brevem connata; antherae 3 ad apicem columnae sessiles in capitulum oblongum connatae, loculis conduplicatim flexuosis. Flores feminei ad apicem pedunculi subumbellati. Calyx supra ovarium breviter stipitatus et corolla maris; stylus brevis, stigmatibus 2. Fructus membranaceus, valde compressus, oblongus, alatus. Semen ab apice loculi pendulum. Herba prostrata?. Folia profunde 5–7-loba. Cirrhi 3-fidi.

Pterosicyos laciniatus sp. nov.

Caulibus striatis, glabris: foliis in circumscriptione orbicularibus, fere usque ad basim 5–7-fidis; laciniis lanceolatis, dentatis vel integris, usque ad 10 cm. longis, ca. 2 cm. latis, laciniis lateralibus brevibus, auriculatis, sinum parvum formantibus, subtus glabris, supra furfuraceis: floribus masculis racemoso-paniculatis, racemis 2–3 cm. longis, multifloris; corolla ca. 12 mm. lata: florum feminorum pedunculo ca. 10-floris, ca. 7 mm. longo, pedicellis 4–8 mm. longis; fructu plano, ca. 4 cm. longo, basi cordato, medio ca. 7 mm. lato, apice retuso cum stipite calycis mucronatis.

Collected at middle elevations of Cerro del Boqueron. No. 6915. Type, Herb. Univ. Calif., No. 172957.

Laurentia pedunculata sp. nov.

Annua, erecta, paululum hirsutula: caulibus teretibus simplicibus: foliis anguste ovato-lanceolatis, basi in petiolum brevissimum attenuatum, margine serratis: floribus solitariis, axillaribus; pedunculis ca. 3 cm. longis, rectis, patentibus, foliis longioribus; calycis lobis ca. 3.5 mm. longis, linearibus, acutis, hirsuto-ciliatis, tubo vix ullo: corolla caerulea parva, calycem paululum superanti: capsula libera.

Collected at Finca Covadonga, growing in moist soil. No. 6705. Type, Herb. Univ. Calif., No. 172452.

Centropogon sp. *Laurentia insignis* Brandg. The plant may be an extreme variation of *C. grandidentatus* A. Zahlbr.

Lobelia longicaulis sp. nov.

Hirsutula, herbacea: caulibus procumbentibus, elongatis, ramosis: foliis ovatis acuminatis, basi cuneatis, acute serratis, ca. 4 cm. longis, 1.5 cm. latis; petiolis ca. 5 mm. longis: floribus solitariis axillaribus; pedunculis ca. 1.5 cm. longis; calycis tubo turbinato, lobis lineari-lanceolatis, ca. 2 mm. longis; corolla dilute caerulea, ca. 1 cm. longa, lobis angustis; antheris 2, apice penicillatis; capsula infera.

Collected at Finca Covadonga, growing in moist soil. No. 6697. Type, Herb. Univ. Calif., No. 172444.

Tridax scabrida sp. nov.

Annua, ramosa: caulibus scabrido-hirsutis, brevibus: foliis late ovatis, apice acutis, basi cuneatis, margine ciliatis, tuberculato-dentatis, subtus paululum hirsutis, supra scabridis pilis e basi pustulatis, ca. 2 cm. longis, 1.7 cm. latis; petiolis ca. 4 mm. longis: capitulis pedunculos ca. 10 cm. longos terminantibus, involucri squamis 2–3-seriatis, exterioribus ovato-lanceolatis, scabrido-hirsutis; ligulis parvis, albis, lineis notatis, oblongis, tridentatis dente medio parvo; pappi squamis ca. 12, inaequalibus, achaeniis sericeis multo longioribus.

Collected at Picacho—San Geronimo, Oaxaca. No. 6801. Type, Herb. Univ. Calif., No. 172502.

Desmanthodium tomentosum sp. nov.

Frutex: caulibus tomentosis cum pilis ferrugineis: foliis ovatis, acuminatis, basi in petiolum breve longe attenuatis, usque ad 15 cm. longis, ca. 8 cm. latis, margine dentatis ciliatis, utrinque pubescentibus, subtus ad nervos tomentosis: glomerulis 3–5-capitulatis, dense cymoso-paniculatis; bracteis lanceolatis, tomentosis: involucri bracteis scariosis, oblongis, striatis, floribus foemineis aequantibus; floribus hermaphroditis longe stipitatis in speciminibus plerumque delapsis; achaeniis oblanceolatis.

Collected on Cerro del Boqueron, growing in moist soil. No. 6683. Type, Herb. Univ. Calif., No. 172428.

Palafoxia latifolia DC. This rare and little known plant was collected by Dr. Purpus at Picacho—San Geronimo, Oaxaca. No. 6790. Univ. Calif. Herb., No. 172473.

Tragoceros flavicomum DC. The specimens do not exactly agree with the short description of this species in DC. Prodomus, but the callous rugosity, ribs of the achenes and other characters are so variable even on the same plant that they may represent a form of the species. No. 6676. Univ. Calif. Herb., No. 172263.

Viguiera gracillima sp. nov.

Ramosa 3–5 dm. alta: caulibus parum strigoso-pilosis: foliis sepius alternis, ovato-acuminatis, margine serratis, e basi cuneata trinervatis, supra scabridis simul paululum strigoso-pilosis, subtus strigoso-pilosis; laminis usque ad 3 cm. longis, 1.5 cm. latis; petiolis ca. 7 mm. longis: pedunculis 2–4 cm. longis multos ramos terminantibus, axillaribusque: capitulis ca. 7 mm. altis, 15–20-floris: involucri campanulati squamis lineari-lanceolatis appresse pilosis: radii floribus neutris; ligulis flavis: achaeniis maturis turgidis, dense sericeo-villosis; pappi aristis 2, inaequalibus, quam achaeniis longioribus cum squamis laceratis intermediis.

A species bearing many flowers on numerous small branches. Collected at Picacho—San Geronimo, Oaxaca. No. 6675. Type, Herb. Univ. Calif., No. 172254.

Perymenium Purpusii sp. nov.

Plus quam 4 dm. altum, superne ramosum: caulibus angulatis, strigosis: foliis ovato-lanceolatis, margine serratis, basi cuneatis, supra strigoso-pubescentibus, subtus praecipue ad venas pubescentibus: laminis ca. 8 cm. longis, 3 cm. latis; petiolis ca. 1.5 cm. longis: capitulis corymbosis caules vel ramos breves terminantibus: involucris hemisphaericis, ca. 4 mm. altis; squamis ca. 3-seriatis, coriaceis, late ovatis, obtusis, inferioribus paululum minoribus: ligulis aureis: achaeniis glabris.

This plant somewhat resembles *P. chalarolepis* Rob. & Greenman, with which species Dr. Robinson has obligingly compared it. Collected on Cerro del Boqueron. No. 6639. Type, Herb. Univ. Calif., No. 172354.

TONALANTHUS gen. nov. Helianthearum

Capitula heterogama, radiata, floribus radii sterilibus, disci hermaphroditis. Involucrum hemisphaericum, bracteis 3-seriatis, exterioribus oblongis, obtusis, coriaceis. Receptaculum columnare, paleis complicatis flores disci amplectentibus. Corollae radii ligulatae apice 3-dentatae, disci regulares tubo limbum cylindraceum aequanti, limbo apice longe 5-fido. Antherae basi minute 2-mucronatae. Achaenia subcompressa apice pappo squamoso, lanceolato, coronata. Herba perennis. Folia opposita. Capitula longe pedunculata.

Tonalanthus aurantiacus sp. nov.

Caulibus simplicibus, crassis, foliosis, albo-tomentosis, ca. 1 dm. altis: foliis cordatis, grosse crenato-dentatis, apice acutis, laminis ca. 9 cm. longis, 8 cm. latis, utrinque parum pubescentibus, basi abrupte in petiolum alatum ca. 7 mm. longum abeuntibus; pedunculis 1–3, axillaribus, 1-floris, ca. 3 dm. longis; capitulo diametro ca. 18 mm. radiis excludentibus; involucri squamis exterioribus brevioribus, tomentosis; receptaculo ca. 5 mm. longo, 2 mm. lato; paleis scariosis acuminatis; floribus radii discique aurantiacis; ligulis 8 mm. longis; pappi squamis ca. 8, anguste lanceolatis, achaeniis aequilongis.

Collected on Sierra de Tonala. No. 7002. Type, Herb. Univ. Calif., No. 173087.

Zexmenia Purpusii sp. nov.

Arbor: ramis pubescentibus: foliis late ovatis acuminatis, supra scabridis, subtus pilosis, basi in petiolum attenuatis, margine serratis, ca. 9 cm. longis, 6 cm. latis: floribus ramos terminantibus subcorymbosis: involucris campanulatis, ca. 7 mm. altis latisque: squamis 2-seriatis, oblongis, coriaceis, acutis, pubescentibus, margine ciliatis, ligulis flavis, ca. 6 mm. longis: radii achaeniis 3-quetris, anguste 3-alatis, aristis pappi ad angulos inaequalibus; disci achaeniis a latere compressis, sepius anguste alatis, interdum alis cum aristis pappi adnatis, aristis duabus achaenia aequantibus, squamellis nullis: paleis apice obtusis, aristatis.

This plant is a small tree about twenty feet high. It differs from the description of *Z. scandens* Hemsley in having the ciliate scales of the involucre 2-seriate, no squamellae between the awns of the pappus and wings often adnate to the awns. Collected on Cerro del Boqueron. No. 6660. Type, Herb. Univ. Calif., No. 172310.

Bidens chiapensis sp. nov.

Caulibus glabris, tetragonis: foliis oppositis; foliolis 3, ovato-acuminatis, basi cuneatis, margine serratis, minute ciliatis, utrinque glabris, ca. 6 cm. longis, 2.5 cm. latis; petiolis 2–3 cm. longis; pedunculis 1–2, caules vel ramos terminantibus, 8–24 cm. longis; capitulis multifloris, involucri squamis exterioribus ca. 25, linearibus, apice acutis, ciliatis, ca. 1 cm. longis, quam squamis interioribus oblongo-acutis, longioribus; ligulis flavis ca. 7 mm. longis; corollis flavis; achaeniis biaristatis.

The uppermost leaves are often reduced to a single leaflet. Collected at high altitude of the Cerro del Boqueron. No. 6945. Type, Herb. Univ. Calif., No. 173022.

Cosmos sulphurea Cav. exaristate form. The specimens of this species collected on Sierra de Tonala are awnless, but there seems to be no other divergence from the usual form of the species. No. 6793. Univ. Calif. Herb., No. 172476.

Bidens geraniifolia sp. nov.

Undique fere glabra: caulibus striatis: foliis pinnatisectis, lobis sectis, 4–5 cm. longis, 2–3 cm. latis; petiolis ca. 1 cm. longis, basi paululum pilosis; capitulis solitariis pedunculos ca. 1.5 dm. longos terminantibus; pedunculis caules terminantibus vel axillaribus: involucri bracteis exterioribus linearibus patentibus interiores aequantibus: ligulis 7–10, albis multilineatis, apice 3-dentatis: achaeniis juvenibus planis breve 2-aristatis.

This is a species much resembling *B. odorata* Cav. Collected in the high region of Cerro del Boqueron. No. 6679. Type, Herb. Univ. Calif., No. 172257.

Dahlia Purpusii sp. nov.

Perennis, glabra: foliis plerumque simplicibus, ovatis, acuminatis, sessilibus, margine crenato-serratis, ca. 12 cm. longis, 6.5 cm. latis: involucri bracteis exterioribus late ovatis, acutis, ca. 1 cm. longis: ligulis ca. 4 cm. longis, 1.3 cm. latis, acutis, purpureis: achaeniis calvis.

This simple leaved Dahlia, according to the notes of Dr. Purpus, is a large perennial. Collected in the high region of Cerro del Boqueron. Only a few specimens could be found. No. 6680. Type, Herb. Univ. Calif., No. 172256.

Baccharis scabridula sp. nov.

Erecta, ramosa: caulibus purpureis, striatis, teretibus, fere glabris: foliis alternis, ovato-acuminatis, basi in petiolum brevissimum attenuatis, penniveniis, margine mucronato-serratis, supra scabridis, subtus glabris, ca. 7 cm. longis, 2.5 cm. latis: paniculis axillaribus, terminalibusque multifloris: capitulis parvis: involucri campanulati bracteis lineari-lanceolatis; pappi setis rufescentibus.

This species is very much like *B. scandens* Less. but is an erect plant with larger leaves, more attenuate at each end and scabrous on the upper surface. The staminate specimens are more pubescent. Collected in the high region of the Cerro del Boqueron. No. 6665. Type, Herb. Univ. Calif., No. 172432.

Baccharis androgyna sp. nov.

Frutex glaber, ramosus: caulibus teretibus striatis: foliis alternis, anguste lanceolatis, basi in petiolum brevem angustatis, penniveniis, margine calloso-serratis, ca. 9 cm. longis, 1.2 cm. latis: paniculis axillaribus terminalibusque ad apices ramorum multifloris; capitulis foemineis saepe flores masculos gerentibus; involucri bracteis linearibus, acutis, margine scariosis.

This species somewhat resembles the preceding, but is easily separated from it by the glabrous leaves. Staminate flowers intermingled with pistillate ones are found in *B. oaxacana* Greenman, *B. Hieracifolia* Hemsley and other species. Collected on Cerro del Boqueron. No. 6666. Type, Herb. Univ. Calif., No. 172268.

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THE *SCINAIA* ASSEMBLAGE

BY
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I. INTRODUCTION

The genus *Scinaia* was established by Baron Antonio Bivona-Bernardi in 1822. The description and plate were evidently published at Palermo in some journal, or other ephemeral publication, entitled *L'Iride* (cf. J. G. Agardh, 1851, pp. 420, 421). It seems to be a very rare publication at present, but the writer was enabled to consult the three unnumbered pages and the single unnumbered plate at the British Museum of Natural History at South Kensington through the kindness of Mr. A. Gepp. There can be no doubt that the genus was founded on the common Mediterranean plant which has usually been referred to as *Scinaia furcellata*. A condensed account of the new genus was published in *Flora* in 1824 (cf. Bivona, 1824), but without the figures. The name *Scinaia*, however, was lost sight of for a series of years, but was brought to the attention of algologists by J. G. Agardh (1851, p. 420) who clearly defined it and established its prior right over the two genera, *Ginnania* of Montagne and *Myelomium* of Kuetzing. The genera *Endymonema* and *Schestedtia* of Schousboe were probably never published except as synonyms (cf. Bornet, 1892, p. 265).

The genus *Ginnania* was apparently suggested as a genus but not named by Lamouroux (1813, p. 45), but was published by Montagne (1840, p. 162) to receive the plant of the Atlantic Coast of southern Europe and of northern Africa. The name has been spelled in all the various ways possible, e.g., *Ginannia* Montagne (1842, p. 257, 1844–46, p. 60, and 1856, p. 436), *Ginnannia* J. G. Agardh (1876, p. 510) and the correct spelling, *Ginnania* Montagne (1840, p. 162) and Kuetzing (1866, p. 24). Montagne held to his own name even after J. G. Agardh brought forward *Scinaia* and (1856, p. 436) explains his reasons in the sentence: "non qui modo nominat, sed qui characterem enucleat, is verus generis fundator existimari debet." It is certainly true that Bivona gave no diagnosis or discussion of *Scinaia* as a genus. *Ginannia* and *Ginnania* have each been proposed once or twice, also, for genera of flowering plants, but in every case have been relegated to the categories of synonyms so far as the writer has been able to determine.

The third genus, *Myelomium*, was proposed by Kuetzing (1843, p. 393), who seemed unaware of the existence of either *Scinaia* or *Ginnania*, although he includes as a species *Myelomium undulatum*, citing as a synonym *Halymenia undulata* J. Ag., but without citing any definite reference. This species had been described by Montagne in 1842 (p. 257) without any synonym but, from Montagne's statement in connection with his description (*loc. cit.*) and the references of Kuetzing (1843, p. 393) and of J. G. Agardh (1851, p. 422), it seems a proper inference that the specific name was first applied, though not published, by J. G. Agardh.

The type of the genus *Scinaia* is the *Ulva furcellata* of Dawson Turner (1801, p. 301), variously referred as may be seen from the synonymy quoted later. The type locality is Sheringham, in Norfolk on the eastern shore of England, i.e., on the North Sea. It has been customary to refer all slender and even broader specimens of *Scinaia* to this species, until its recorded distribution is practically world-wide. Even certain constricted forms have been referred to this species, e.g., *Scinaia furcellata* var. *subcostata* J. Ag. (1851, p. 422). Montagne

(1842, p. 393) proposed a species from the western coasts of South America, *Ginannia undulata*, which Agardh reduced to a variety of *Scinaia furcellata* (1851, p. 422) and Kuetzing (1849, pp. 715, 716) referred to *Ginnania* (as he correctly transcribed Montagne's name) five species. One of these, viz., *G. irregularis* has been later referred to *Nemastoma dichotoma* J. Ag. (1842, p. 91). It is evidently not a member of the genus *Scinaia* (cf. Kuetzing, 1866, pl. 69, *a-c*), while his *G. furcellata*, *G. pulvinata*, and *G. undulata* have usually been considered as all appertaining to *Scinaia furcellata*. Concerning the "*Ginnania undulata*" of Kuetzing, it may be noted here that the later figure of this plant published by Kuetzing (1866, pl. 69, *d-f*) seems more like a *Callophyllis* or some such plant than like *Scinaia* in structure. This point will be taken up again later. The fifth species of Kuetzing, *G. Salicornioides* from Port Natal in South Africa, is abundantly different in habit and structure (cf. also Kuetzing, 1866, pl. 70) from *Scinaia furcellata*. It is a regularly constricted form and so different in certain details of structure from the type of the genus *Scinaia*, that J. G. Agardh (1861, p. 423) refers it to *Scinaia* with a query ("?").

In 1866 (p. 30, pl. 83) Kuetzing described and figured under the name "*Ginnania carnosa*" a plant from Ceylon which existed in Herb. Sonder under the unpublished name of *Scinaia carnosa* Harv. This is undoubtedly the plant issued by W. H. Harvey under No. 38 of his Algae of Ceylon (Exsicc.), with printed label, but without diagnosis. The plant is fairly close to *Scinaia Salicornioides* (Kuetz.) J. Ag. in habit and structure and its status will be discussed later on.

In 1876, J. G. Agardh (p. 512) described a var. *australis* of *Scinaia furcellata*, to receive a plant from New Zealand. In 1876 J. G. Agardh, then, recognized three varieties of *Scinaia furcellata* besides the type, viz: var. *undulata* (Mont.) J. Ag., var. *australis* J. Ag., and var. *subcostata* J. Ag.,—besides *Sc. carnosa* Harv. and *Sc. Salicornioides* (Kuetz.) J. Ag. He also separated from the genus *Scinaia* (*loc. cit.*, p. 510), under the name *Gloiophloea Scinaioides*, a plant from Australia which had previously been referred to *Scinaia furcellata*. Finally, in 1884 (p. 72), J. G. Agardh made his final addition to the genus *Scinaia*, in the form of *Scinaia moniliformis*, a very distinct, regularly constricted plant from Port Phillip, Australia, collected by J. Bracebridge Wilson.

In later years, only two additions have been made to the genus *Scinaia*. In 1901, F. S. Collins distributed a plant from Florida under

No. 836 of Fascicle XVII, of the Phycotheca Boreali-Americana, under the name of *Scinaia furcellata* forma *complanata*. He states that: "The frond is flattened throughout even when quite fresh" and suggests that it may possibly be the same as *Isymenia angusta* J. G. Agardh (1899, p. 66). Collins (1906, p. 110) reprinted the diagnosis and remarks later in a botanical journal. Cotton (1907, p. 260) raised this variety to a species.

The last species to be added to the genus is a plant from the Gulf of California to which M. A. Howe (1911, p. 500, fig. 1 and pl. 28) has given the name of *Scinaia latifrons*. It is a large and broad, flattened species with cystocarps largely marginal.

At present, then, the genus *Scinaia* is credited with six species and three varieties, as follows: *Sc. furcellata* with varr. *undulata*, *subcostata*, and *australis*, *Sc. complanata*, *Sc. latifrons*, *Sc. carnosa*, *Sc. Salicornioides*, and *Sc. moniliformis*. It is the intention of the writer to examine into the structure and the status of each of these so far as possible.

II. MATERIALS AND TECHNIQUE

The writer has been gathering together materials of what usually passes for *Scinaia* for many years in connection with a study of the puzzling forms of the California coast. His impressions have varied from those of recognizing a few widely distributed species to those of very considerably multiplying the number of species to be recognized. Comparatively little study, however, had been made of the details of structure until very recently, partly because of the difficulty of obtaining good results from dried material. Most of the materials at hand consist of dried specimens and it is difficult to make specimens resume their original form after being dried under even slight pressure. The material is mostly Californian, on which coast there are four or five well-marked species or varieties of *Scinaia*-like plants, only one of which has been seen in living condition by the writer. The writer has also collected considerable living material of *Scinaia* in the vicinity of Woods Hole, Massachusetts, and has received dried specimens from others. There is a fair amount of dried material available from Florida and from the Mediterranean. Other specimens are individual and scattering, but there are available good dried and formalin specimens from the Hawaiian Islands. Practically all of this material has been examined. Some work has also been done on certain type specimens in different herbaria, but most of such work was necessarily superficial.

The general method of procedure, in the case of herbarium specimens, has been, after moistening first with 95 per cent alcohol and then with water, to remove a sufficient portion for examination. The selected portion was then soaked for some time in water, passed through a strong solution of potassic hydrate, three separate and prolonged washings in water, 10 per cent hydrochloric acid, then three more washings in water, and finally preserved in 70 per cent alcohol to which a trace of formalin had been added. The specimens were finally sectioned on a freezing microtome. Through an ingenious adaptation of the freezing device of Osterhout (1896, p. 195), Dr. N. L. Gardner has modified it so as to use it on the Minot rotary microtome, thus making it possible to cut very thin and uniform sections. Most of the sections used have been 5μ or 10μ thick and were cut by Dr. Gardner or by Dr. T. H. Goodspeed. The stain used was Fuchsin S. (Grübler's) in acidified alcohol.

In spite of the treatment with swelling reagents, none of the specimens was brought back absolutely to its original shape, although in most cases it was possible to determine whether the specimens were either cylindrical or else at least not very much flattened.

III. MORPHOLOGY

In dealing with the general matters of structure before taking up the special morphology and taxonomy, it seems desirable to speak of a *Scinaia* assemblage, because it was found on careful study that no less than three genera are represented among the plants usually referred to *Scinaia* and have the external form of that genus as well as some of the histological characters.

In habit and color there is general agreement among all the plants, but there are some differences which assist in distinguishing the species at sight. In general the plants arise from a discoid holdfast from which one or more short, solid stipes arise which branch dichotomously and fairly regularly and repeatedly, to produce a more or less ample frond anywhere from 4 to 30 cm. in height. The tips are even or uneven in height according, apparently, to the conditions of development and are as a rule blunt rather than acute, though more or less abruptly tapering. The color varies from a delicate pink through shades of red to a very dark red or reddish purple. The diameter of the branches is nearly the same throughout and varies from 2 mm. up to 12 mm. The branches are cylindrical in most species and in some are constricted more or less regularly, giving a moniliform appearance, while in certain species the branches are evidently decidedly flattened or complanate. In many of the species the branches are evidently or obscurely narrowed below, while in a few the branches are conspicuously of the same diameter below as above. The number of dichotomies varies in different species but less so in individuals of the same species, and seems to be a diagnostic character of value.

At the tips of the branches are one, or usually two, circular, shallow sunken areas which from growth proceeds by a multitude of filaments exactly as in *Galaxaura* (Kny, 1872, p. 704; Oltmanns, 1904, p. 556), but in one species of *Scinaia* the growing region seems convex (cf. p. 102 of text). Below the tip is to be found an axile strand, stouter or more slender according to the species and composed of few to many coarser filaments longitudinally parallel or somewhat intertwined. From these are given off slender, more or less horizontal filaments, dichotomously branched and ending in the closely connecting cells of the continuous cortex. Between the axile strand and the cortex is, in the fresh condition, a sort of watery jelly filling the interior of the branches.

The structure of the cortex in *Scinaia furcellata* has been subject to some discussion which is outlined admirably by Bornet and Thuret (1876, p. 19) and generally consists of one or more layers of colored cells under an external compact layer of colorless cells. It is the existence of this colorless epidermal layer that is said to distinguish the genus *Scinaia* from *Gloiophloea* J. Ag.

The epidermal layer of colorless cells was not recognized by the earlier algologists and there seems to be differences of opinion as to its structure. Bornet and Thuret (1876, p. 20) describe the epidermal layer as made up of colorless cells scattered between which are small colored cells, but this structure is not shown in their figure (*loc. cit.*, pl. VI). Kuetzing, however, does show it (1866, pl. 68, *b*) in the way it appears to the writer, and Crouan (1867, pl. II, f. 118, 6) also shows the general appearance of colored and colorless cells in surface view. The horizontal filaments from the axile strand end in corymbs of short cells, the central one of each corymb being enlarged and colorless. This is particularly true of *Scinaia furcellata* but is found to some extent in other species of *Scinaia*. In extra-European plants, hitherto referred without question, the relation of colored and colorless cells is different, as will appear during the discussion below. Berthold (1882, p. 697) speaks of the development of the colorless outermost layer of cells and says that they do not divide after they are formed but as the thallus develops, the under cells push out through and become enlarged and hyaline. Berthold looks on this colorless layer as a protection against high light intensity. J. G. Agardh (1880, p. 61) also treats of this layer of utricles in *Scinaia*.

The colorless epidermal cells, or utricles as they may be called, vary in size and proportions in the different species and also as to the admixture or absence of colored cells, affording trustworthy evidences of specific difference, as will be shown later.

In the new genus, *Pseudoscinaia*, to be proposed below, the outer layer is made up of utricles as in *Scinaia*, but in the genus *Gloiophloea* of J. G. Agardh the outer layer is described as being made up of fasciculate moniliform dichotomo-fastigiate filaments. An examination shows, however, as will be indicated below, that the same cymose-corymbose structure prevails as in *Scinaia*, i.e., the central cell of the corymb ceases to grow, enlarges, becomes hyaline and thus changes into a utricle. The surrounding cells of the corymb, however, grow on and repeat the process at a higher level, branching corymbosely in turn, forming a utricle in the center, while the lateral branches grow on and finally form a complete series of fasciculate moniliform anticlinal filaments. The utricles are thereby hidden and usually collapse sooner or later, becoming inconspicuous and often difficult of detection. This is particularly true of the antheridial areas. In cystocarpic plants, especially when younger, the appearance is much that of *Scinaia*, except that the colored cells surrounding the utricles are unusually numerous.

At the base, in the disk and the stipe, the structure is more solid than above in the branches and the colorless epidermal cells are practically absent. The hypodermis, that is, the layer or layers of colored cells under the colorless "epidermis," varies in number, arrangement and size of cells in the different species. The number of layers varies from one to three, the size varies considerably, and the arrangement in some species is looser than in others.

Within the hypodermis of the cortex and more or less closely applied to it, running longitudinally downwards, are very slender filaments. These filaments vary in abundance in the different species and in flattened species are more abundant just within the margins. This layer will be referred to as the "corticating layer." In the center of the frond is an axis of intertwined longitudinal filaments of two sorts, coarser and finer. The coarser filaments originate from the apical meristem, the finer are corticating filaments. This axial strand varies in coarseness even in the same species, but in different species the difference may be sufficient to attract attention. This happens when it is invisible in pressed specimens of one species and visible in others. Some discussion has arisen in this connection (cf. Harvey, 1846, pl. LXIX, J. G. Agardh, 1851, p. 423, Bornet et Thuret, 1876, p. 20, etc.) and it is not possible even yet to separate species definitely according to whether the axis shows in the dried (and pressed) specimens or not. Something, however, may be said, as will be seen below in the discussions under the separate species recognized in this paper.

Antheridia and cystocarps are known in *Scinaia*, but as yet no tetrasporangia have been detected.

The antheridia of *Scinaia furcellata* have been briefly described by Bornet and Thuret (1876, p. 20) as forming very small bouquets disseminated between the peripheral cells of the frond, which renders them difficult of detection. Antheridia have been seen in almost all of the species of *Scinaia* described below and in all species of *Gloiophloea* and of *Pseudoscinaia*. In all the species of *Scinaia* and *Pseudoscinaia* they occur scattered single, or in small groups, and probably always on the same plant with the cystocarps. In *Gloiophloea* the antheridia cover extensive areas, either on the same plant with the cystocarps or on separate plants. They occur singly or in twos on longer or shorter supporting cells which grow out between the utricles in all three genera.

Although it is not so stated by any authority, so far as the writer is aware, *Scinaia furcellata* is monoecious and bears the antheridia singly or in small fascicles, as Bornet describes, between the colorless epidermal cells. Possibly all the species of *Scinaia* are monoecious, but in a few species described below the writer has not been able to demonstrate this to his own satisfaction because of the lack of abundant material. The writer suspects that a certain group of species, in which the colored cells in the epidermal layer are scanty, may possibly be dioecious. Farther discussion may be left until the conditions in the individual species are taken up.

The cystocarp in *Scinaia furcellata* has been the subject of considerable controversy which is so well summed up by Bornet and Thuret (1876, p. 19). It is a pyriform structure borne just under the cortex through which it opens by a distinct carpostome. The point in dispute was the possession of a cellular envelope. This was pointed out by Montagne (1842, p. 257) but was either passed over in silence (Kuetzing, 1849, p. 715, 1866, pl. 68, *b*, Harvey, 1846, pl. 69, figs. 3 and 7) or denied (J. G. Agardh, 1851, p. 421, and 1876, p. 512). Later it was acknowledged and made plain (Harvey, 1853, p. 136; Thuret, 1855, p. 155; Crouan, 1867, pl. 17, no. 118, fig. 4; Bornet and Thuret, 1876, p. 19, pl. 6, fig. 6, 7.; Schmitz, 1896, p. 337, fig. 206, *b*; J. G. Agardh, 1880, p. 245) so that there remains no reason for doubt. In some species, however, it seems fairly certain that the envelope consists of fairly distinct filaments whose points are neither enlarged nor combined (consequently) into a pseudoparenchymatous structure. In dealing with dried specimens, however, it is often difficult to settle such a question entirely satisfactorily.

Concerning the cystocarps in other species of *Scinaia* little has been said except as to position in the frond (M. A. Howe, 1911, p. 500), yet, as will be shown later, the shape, size and peculiarities of the enveloping tissue show sufficient and constant variations, to afford valuable diagnostic characters.

Two species have been found which in external appearance have such close resemblance to *Scinaia furcellata* (as generally conceived) that they would ordinarily be referred to that species, whose cystocarps are not strictly of the *Scinaia*-type, but are more of the *Galaxaura* type, in that the gonimoblasts, instead of all rising or radiating from a more or less distinct cellular placenta and being free, have some free while some adhere to the walls of the periderm and line the lower half to two thirds of the cystcarpic cavity (cf. pl. 16, fig. 61). It has seemed necessary to remove these two species from *Scinaia* and even to create a new genus (*Pseudoscinaia*) to receive them, since the vegetative characteristics are distinctly scinaioid. In all the species of *Scinaia* and *Gloiophloea*, on the other hand, the gonimoblasts in the cystocarps, both of *Scinaia* and of *Gloiophloea*, arise from a small, but varying placenta, and are all free from the periderm.

The development of the cystocarp in *Scinaia furcellata* has been thoroughly described and illustrated by Bornet and Thuret (1876, p. 20, pl. 6, figs. 1–7). The procarps are always formed in the apical region of a branch and consist of a three-celled branchlet bearing the carpogonium with the long trichogyne at its apex. The sporogenous tissue is produced directly from the apical cell, i.e., the carpogonium, the middle cell, even before fecundation of the carpogonium, begins to send out processes which become filamentous and later grow up around the sporogenous mass as it develops. The filaments are at first separate, but become pressed together so tightly that when their individual cells enlarge the whole growth of filaments forms a sort of parenchymatous envelope surrounding the sporogenous tissue in a pyriform cavity which opens out above, forming a narrow carpostome. The basal cell of the procarpic branch enlarges to form a more or less conspicuous stalk-cell or pedicel. Nothing is known, apparently, of the germination of the carpospore and of the early stages of any of the species of *Scinaia*.

Each of the points connected with the cystocarp needs much further discussion than is possible even after an examination of all the material at the present disposal of the writer.

Nearly all the specimens of *Scinaia* proper, accessible to the writer, show cystocarps in the adult stage and as a rule very plainly in the pressed condition. They form, to the naked eye, more or less conspicuous, larger or smaller dots of a decidedly darker color than the frond. In almost all the species they are scattered over the surface of the frond in no regular order. In two species, however, *Scinaia latifrons* Howe (1911, p. 500, fig. 1, pl. 28) and *Scinaia Cottonii* sp. nov., the cystocarps show a decided tendency to aggregate themselves along the margins of the flattened fronds.

IV. TAXONOMY

In taking up the matter of the systematic arrangement it will also be possible to amplify the preceding statements about general structure as the special morphology of each genus and species is considered. In the following account is taken up each and every specimen accessible to the writer for examination and study, and an attempt is made to place each one as accurately as possible. As will be seen, considerable differences are brought out and a considerable number of new names proposed. It is hoped that they may be justified and made clear in the following account.

SCINAIA Bivona

The two particular characteristics of this genus within the Chaetangiaceae are the cystocarp and the epidermis consisting largely of swollen colorless cells or utricles. As at present recognized it has been credited with six species as well as three varieties. In the present account, all these species have been retained and one of the varieties has been elevated to specific rank but has been removed, however, from *Scinaia* to *Gloiophloea*. The remaining two varieties remain as in previous accounts because of lack of accessible material for investigation. Five new species have been proposed, and certain plants which have the habit and vegetative structure of *Scinaia* have been the basis for proposing a new genus on account of differences in the structure of the cystocarp. As represented here, then, *Scinaia* is a genus of eleven species and two varieties.

I. Cylindrical, Normally Unconstricted Species

To this section of the genus three species and two varieties are referred. The members of this section are fairly readily to be distinguished from those of the other two sections, although there are difficulties. In the first place, dried specimens, particularly those dried under pressure, do not fully recover their shape. Such specimens and especially specimens dried under any considerable pressure are not always to be readily distinguished from those in which the frond is naturally complanate. In the second place, while the characteristic plants are lacking in any regular constrictions and show such only when proliferating after injury, there are two cases, seemingly closely related here, in which the forms are constricted. They may be and probably are, however, of only occasional appearance. In spite of these two difficulties, it seems to the writer that this is a natural group, sufficiently sharply delimited to deserve special mention.

The cylindrical group may be again segregated into two subgroups of one or two species each, by the structure of the utricles or colorless cells of the epidermal layer. In the first subgroup the outer ends of the utricles are convex outwardly and bulge somewhat, giving a superficial view of bluntly rounded polygonal cells not closely packed together, while in the second subgroup, the outer ends of the utricles are flattened and give, in surface view, the hexagonal appearance of honeycomb.

1. **Scinaia furcellata** (Turner) Bivona

Plate 10, figs. 1–12; plate 14, figs. 41–43.

Scinaia furcellata Bivona, l'Iride (with pl.) 1822; Flora, vol. 1, p. 135;
J. G. Agardh, Spec. Alg., vol. 2, 2, p. 422, 1851, *ibid.*, vol. 3, 1, p. 512, 1876;
Harvey, Ner. Bor.-Amer., part 2, p. 136, 1853 (in part);
Thuret, Mem. Soc. Nat. Cherbourg, vol. 3, p. 155, 1855;
Crouan, Fl. Finist., p. 146, pl. 17, f. 118, 1867;
Kny, Botan. Zeit., vol. 30, p. 704, 1872;
Farlow, Proc. Amer. Acad., vol. 10, p. 367, 1875; Rept. U. S. Fish Comm. for 1876, p. 699, 1876; Mar. Alg. New England, p. 118, 1881;
Bornet et Thuret, Notes Algol., p. 18, pl. 6, 1876;
Le Jolis, List Alg. Mar. Cherbourg, p. 108 (1864), 1880;
Berthold, Pringh. Jahrb., vol. 13, p. 697, 1882;
Ardissone, Phyc. Medit., p. 269, 1883;
Schmitz, Befrucht. Florid., p. 15, pl. 5, f. 5, 1883;
Hauck, Meeresalgen, p. 61, 1885;
Holmes and Batters, Ann. Bot., vol. 5, p. 88, 1890;
Batters, Journ. of Botany, vol. 29, p. 274, 1891;
Bornet, Alg. Schousb., p. 265, 1892;
Hariot, Atlas des Alg. Mar. etc., p. 18, 1892, Ann. de l'Inst. Oceanog., vol. 4, fasc. 15, p. 51, 1912;
Debray, Bull. Sci. de France et de la Belgique, vol. 25, p. 13 (of repr.) 1893; *ibid.*, vol. 32, p. 102, 1899; Cat. Algues du Maroc, Algerie & de Tunisie, p. 50, 1897;
Schmitz und Hauptfleisch, *in* Engler & Prantl, Die natürl. Pfl.-fam., 1 Th., Abth. 2, p. 337, 1896;
De Toni, Syll. Alg., vol. 4, sect. 1, p. 104, 1897;
Collins, Rhodora, vol. 2, p. 52, 1900;
Oltmanns, Morph. u. Biol. der Algen, vol. 1, pp. 557, 686, 1904;
Börgesen and Jönsson, Botany of the Faeroes, Appendix, pp. iii, xxxi, 1905;
Adams, Proc. Roy. Irish Acad., vol. 27, sect. B, p. 52, 1908;
Rosenvinge, Mar. Alg. Denmark, p. 149, 1909;
Cotton, Algae, Clare Island Survey, pp. 98, 133, 1912;
Vickers, Ann. Sci. Nat., 8 ser., vol. 4, p. 302, 1896;
Davis, B. M., Bull. Bureau Fisheries (U. S.), vol. 31, part 2, p. 814, 1913;

Ulva furcellata Turner *in* Schrader's Journ. für Bot., vol. 1, zweites Stück, p. 301, pl. 1, fig. A, 1801;
Engl. Bot., pl. 1881;

Ulva interrupta Poiret, Encyc. Meth., vol. 8, p. 171, 1808;
De Candolle, Fl. Franc., vol. 6, p. 3, 1815;

Fucus pseudocrispus Clemente, Ensayo, p. 311, 1807 (*fide* C. A. Agardh);

Fucus Stackhousei Clemente, Ensayo, p. 312, 1807 (*fide* C. A. Agardh with a query);

Dumontia interrupta Lamouroux, Dict. class. d'hist. nat., vol. 5, p. 645, 1824;
Duby, Bot. Gall., pars. 2, p. 941, 1830;

Dumontia triquetra Lamouroux, Essai, p. 45, 1813;

Halymenia furcellata C. Agardh, Spec. Alg., vol. 1, p. 212, 1821, Syst. Alg. p. 244, 1824;

Greville, Alg. Britt., p. 163, 1830;

Hooker, Brit. Flora, vol. 2, part 1, p. 308, 1833;

Harvey, *in* Mackay, Fl. Hibern., part 3, p. 189, 1836, Man. Brit. Algae (1st edn.), p. 52, 1841, Man. Brit. Algae (2nd edn.), p. 149, 1849;

J. G. Agardh, Alg. Medit., p. 98, 1842;

Ginnania furcellata Montagne, *in* Webb. et Berth., Phyt. Canar., part 2, sect. 3, p. 162, 1840 (by implication), Voy. Bonite, p. 61, 1844–46, Fl. Alger., p. 111, 1846, Syll. Gen. et Spec. Crypt., p. 437, 1856;

Zanardini, Syn. Alg., fig. 1, 1841, Saggio di class. nat. d. Ficee, p. 49, 1843;

Endlicher, Gen. Pl., Supp. III, p. 40, 1843;

De Notaris, Giorn. Bot., vol. 1, p. 311, 1844, Atti Riun. Sc. it., p. 495, pl. 11, 1845;

Rabenhorst, Deutschl. Krypt.-Flora, bd. 2, abth. 2, p. 149, 1847;

Harvey, Phyc. Brit., pl. 69, 1846;

Kuetzing, Spec. Alg., p. 715, 1849, Tab. Phyc., vol. 16, pl. 68, fig. II, 1866;

Myelomium pulvinatum Kuetzing, Phyc. Gener., p. 393, 1843;

Myelomium furcellatum Kuetzing, Phyc. Gener., p. 393, pl. 73, fig. 1, 1843;

Ginannia pulvinata Kuetzing, Tab. Phyc., vol. 16, pl. 68, fig. *a*, *b*, 1866;

Fucus succosus Schousboe, *in* Bornet, Alg. Schousb., p. 265, 1892 (as synonym);

Schesteedtia humilis Schousboe, *in* Bornet, Alg. Schousb., p. 265, 1892 (as synonym);

Endymonema massiliense Schousboe, *in* Bornet, Alg. Schousb., p. 265, 1892 (as synonym);

Schesteedtia purpurea Schousboe, *in* Bornet, Alg. Schousb., p. 265, 1892 (as synonym);

Exsiccatae.

Lloyd, Alg. Ouest., No. 112 (under *Scinaia furcellata*).

Crouan, Alg. Mar. Finist., No. 225 (under *Scinaia furcellata*).

Desmazières, Pl. Crypt. de France, No. 1288 (under *Dumontia interrupta*).

Wyatt, Alg. Danm., No. 79 (under *Halymenia furcellata*).

Plant rosy red to red purple, 2–8 cm. high, 3–9 (usually 7–8) times dichotomous, slender (0.75–3.0 mm. diam. dried), cylindrical, continuous, branches slightly attenuated downwards, apices blunt to slightly acute; axis very obscure (dried) as a rule; monoecious; cystocarps minute, barely visible to the naked eye, scattered; — axial strand broad, of a few larger filaments and many slender filaments loosely applied and intertwined; ascending filaments obscure downwards; epidermal layer of large colorless cells or utricles surrounded by numerous slender colored cells; utricles oblong or obovate, 13–22μ (T) and 22–24μ (R), commonly 13μ (T) by 22μ (R), with outer ends rounded and decidedly convex; colored cells of epidermis about 22μ (R) by 3μ (T), single or fascicled, very abundant, loosely encircling the colorless cells, and each finally bearing antheridia which project beyond the colorless external cuticula; hypodermal cells in 2–3 layers, oblong or obpyriform, 6–18μ (T); corticating layer (within hypodermis) broad, loose, of slender intertwined filaments; antheridia single or double, borne successively on single or slightly fasciculate slender colored cells among the colorless cells of the epidermis; cystocarps narrow or broadly pyriform (according to age), 135–195μ (T & R), broad and rounded at the base and tapering gradually from just below the middle to the carpostome; gonimoblasts slender, numerous, crowded, radiating upwards and inwards from a placental group of a few large cells, forming a dense pyriform mass, abjointing oblong spores in succession; pedicel distinct; periderm of 2–3 layers, coarsely pseudoparenchymatous below, separating into distinct filaments above.

The structure of *Scinaia furcellata* is of importance, since this species is the type of the genus and all considerations as to generic agreement or disagreement must be settled, or at least discussed, on a basis of comparison with *Sc. furcellata.* The axis of the frond in the various specimens examined is comparatively broad and made up of a few larger filaments, parallel to one another or very loosely entwined, surrounded by few to many very slender, more or less intricately entwined corticating filaments. The horizontal, later "ascending" filaments are numerous above but more scanty below. The cortex is made up of three layers, the epidermal layer, the hypodermal layer, and a layer of corticating filaments. The corticating layer is fairly broad and made up of slender filaments, arising from the cells of the ascending filaments as well as from those of the hypodermal layer. These slender filaments are vertical, oblique, or nearly horizontal in their course and loosely entwined. The hypodermal layer is made up of two to three layers of colored cells of various shapes according to situation in the plant (i.e., according to age and development). When younger (i.e., above) they are spherical to ovoid, becoming elongated and obovate or clavate with age (i.e, below). The epidermal layer is composed of cells which are colored or very nearly alike at first, but soon begin to differentiate. Certain of these cells, regularly placed, enlarge and become lighter colored, until, at maturity, they are swollen and seemingly devoid of solid contents. Their shape varies according to age and development. At first globular (cf. fig. 2, pl. 10), or very nearly so (cf. fig. 3, pl. 10), they later become larger and flattened (cf. fig. 5, pl. 10) or oblong (cf. fig. 5, pl. 10), then elongated and narrowed more or less above (cf. fig. 4, pl. 10), but at maturity they agree in being obovate or inversely pear-shaped (cf. figs. 6–11, pl. 10), the outer end being obtusely rounded and the inner end contracted. These large hyaline cells of the epidermal layer are the so-called utricles. Among them are scattered elongated, slender, colored cells, which later bear the antheridia. In *Scinaia furcellata*, so far as the material examined shows, these slender colored cells of the epidermal layer are abundant. Crouan (1867, pl. 17, fig. 118) and Bornet and Thuret (1876, p. 20) indicate that they also find them abundant. The growth of the peripheral filaments in *Scinaia*, and also in the related genera to be considered in this account, is corymbose and cymose. The central cell of the cluster ceases to grow and becomes a utricle, while the lateral cells grow on into the slender, colored cells (cf. also Bornet and Thuret, *loc. cit.*). A similar growth is to be found in species of the genus *Gloiophloea* J. Ag. as will be shown below, but in the species of the latter genus the process proceeds farther than it does in species of *Scinaia*.

The antheridia are developed from the slender, colored cells of the epidermal layer. These cells bear one to four antheridial cells, or may bear one to four branches, each of which, in turn, bears one to four antheridial cells (cf. figs. 1, 6, 7, and 8 on pl. 10). It is difficult, as Bornet and Thuret say (1876, p. 20), to make out the exact antheridial structure and it was only in the thinnest sections that the details could be at all clearly perceived. In vigorous plants of *Scinaia furcellata* they are very abundant.

The structure and development of the cystocarp in *Scinaia furcellata* must also be carefully considered because this species is the type of the genus. The development has been carefully and most accurately described by Bornet and Thuret (*loc. cit.*, p. 20, pl. 6, figs. 1–5). The carpogonium gives rise to a glomerule of cells from which the gonimoblasts arise, while the cells of the carpogonial branch immediately below the carpogonium send out a dense circle of bracteoid filaments which grow up around the developing gonimoblasts. As these bracteoid filaments develop, the cells of the lower two-thirds become swollen and are consequently pressed together and adhere to form a pseudoparenchymatous periderm, while the cells of the upper third remain distinct and filamentous, in the region of, and surrounding, the carpostome. The filaments of the periderm send off slender free branches into the cavity of the cystocarp. The gonimoblast filaments branch and form a broader or narrower ovoid and very compact mass. The spores are elongated ellipsoidal successively abjointed above.

The type locality of *Scinaia furcellata* is Sheringham, in Norfolk, England, on the North Sea, whence it was described by Turner (1801) as *Ulva furcellata*. Through the kindness of the Director of the Royal Botanical Gardens at Kew, a search for the type specimen was made by Mr. A. D. Cotton, at my request, and what seems, in all probability, to be it has been found. It is evidently a Turner specimen and is labelled "U. furcellata . . . (specimen drawn) . . . Sept. 1800." It does not agree in every detail with Turner's figure (1801, pl. 1, fig. A), but it does correspond to parts of it and it seems likely that portions only of the specimen were drawn. The specimen, moreover, has the base complete while the drawing lacks the base. It seems allowable to consider this specimen as the type since its agreement with the figure is as close as in certain other undoubted types and drawings of Turner. Through the kindness of the Director, Dr. Prain, and of Mr. Cotton, I have been able to make a microscopical examination of the type, and a section through the cortex is represented in figure 1 on plate 10. The details of structure are the same as in all the other European plants I have been able to examine and I have little hesitation in referring them all to one and the same species (cf. figs. 1–10, pl. 10). The question whether there is one species in Europe, or more than one, must still be left for future investigation. That there is reason for suspecting that there may be more than one species will appear from the fact that Harvey (1841, p. 52; 1846, pl. 69, and 1849, p. 149) speaks of larger specimens (up to half an inch in diameter) than normal and the writer has seen a specimen from Gibraltar in the Herbarium of the British Museum of Natural History which is 6 mm. broad. Mere size may not indicate a different species, but it may also be associated with histological differences. Unfortunately, at present, it is not possible to make any study of the structure of the specimens mentioned.

The distinguishing features of the European specimens, all of which seem to be identical with the type of *Scinaia furcellata* in structure, are the low slender habit, the turgid tips of the utricles and the large number of colored cells usually present in the epidermis.

Scinaia furcellata var. **subcostata**

J. G. Agardh, Spec. Alg., vol. 2, 2, p. 422, 1851, *ibid.*, vol. 3, 1, p. 513, 1876;
Crouan, Fl. Finist., p. 146, 1867;
De Toni, Syll. Alg., vol. 4, sect. 1, p. 105, 1897;
Holmes and Batters, Ann. Bot., vol. 5, p. 88, 1890;
Batters, Journ. of Botany, vol. 29, p. 274, 1891;
Bornet, Alg. Schousb., p. 265, 1892.

Halymenia furcellata var. *subcostata* J. G. Agardh, Alg. Med., p. 98, 1843.
Ginnania furcellata var. *subcostata* Harvey, Phyc. Brit., vol. 1, pl. 69, 1846.

The plant described by J. G. Agardh as var. *subcostata* under the species is unknown to me except from the description. Agardh emphasized particularly the strong (i.e., visible) axis which, in pressed specimens, has the appearance of a midrib. This character will vary in prominence according to the condition of the specimen and the method of preparation. The second character emphasized by Agardh is the constrictions of the upper portion of the frond into cylindrical segments. Agardh does not say how regular this may or may not be. If regular, I am inclined to separate the plant from *Scinaia furcellata*. The description of Agardh also indicates a more robust plant than typical *Scinaia furcellata*. Both Harvey and the Crouan brothers mention the greater diameter, the brighter color, and the midrib effect, but say nothing as to the constrictions. The status of the plants included under this reference cannot be settled, therefore, until the various specimens can be examined critically. These statements, however, together with my impressions of certain broader specimens seen in the Herbarium of the British Museum of Natural History (but not sectioned), lead me to believe that here may be at least two species on European coasts additional to *Scinaia furcellata* as limited to type.

Scinaia furcellata var. australis

J. G. Agardh, Spec. Alg., vol. 3, 1, p. 512, 1876;
De Toni, Syll. Alg., vol. 4, sect. 1, p. 105, 1897.
Scinaia furcellata Hooker & Harvey, Flora New Zealand, vol. 2, p. 245, 1855 (*fide* J. G. Agardh, *loc. cit.*); Handbook of the Flora of New Zealand, p. 691, 1867.

The var. *australis* is unknown to me except from Agardh's description. The plant has a firmer wall and the branches are more evidently fasciculate fastigiate. Agardh does not discuss any possible relationship to be suspected between this plant and his *Gloiophloea Scinaioides* earlier described (1870, p. 29) from South Australia, except as he queries whether all the austral *Scinaia furcellata* may not be referred under *Gloiophloea Scinaioides*. The fact that he later established the var. *australis* seems to indicate that he considered the latter plant to be a true *Scinaia*. As will be shown below, J. G. Agardh in his account of the New Zealand algae (1877, p. 26) includes *Scinaia furcellata* without comment and cites the references of Harvey and Hooker (1845) which he in the "Epicrisis" (1876, p. 512) has cited under the var. *australis*. I have been able to examine a specimen from the Bay of Islands in the North Island of New Zealand collected by Berggren and named and cited by Agardh under the above reference (J. Ag., 1877, p. 26). As I shall show later, this is a *Gloiophloea* and, as I assume, identical with *Gloiophloea Scinaioides* J. Ag. However, a specimen collected at Port Phillip Heads near Melbourne. Australia, by J. Bracebridge Wilson and distributed by him under the name of *Scinaia furcellata,* is, in my opinion, neither a *Scinaia* nor a *Gloiophloea,* but a member of a new genus which later on in this paper I have named *Pseudoscinaia.* This may prove to be identical with the *Scinaia furcellata* var. *australis* J. Ag. It seems questionable, therefore, whether there exists any species of cylindrical. unconstricted *Scinaia* on the Australian or New Zealand coasts.

The distribution of typical *Scinaia furcellata* as limited to what seems to be strictly its proper specific limits, must be stated, in the light of my investigations, as confined to the North Atlantic Ocean and Mediterranean and Adriatic Seas. In the Mediterranean, it seems to be more or less abundant on the northern coasts, but thus far I have no certain knowledge as to its occurrence either on the eastern or on the southern shores. It certainly occurs on the French coasts of the English Channel, in the southern half of the North Sea, in the Irish Sea and on the southwestern Atlantic coasts of Ireland. It is reported from the Canary Islands (Vickers, 1896, p. 302). It also occurs on the southern coasts of New England (Massachusetts and Rhode Island). It does not seem desirable to quote all the localities whence I have examined specimens, but I may note that, besides the type specimen, I have been enabled through the kindness of Dr. Paul Kuckuck to examine a series collected at Helgoland, as well as a number from the northwestern shores of France. I have also studied a number of specimens collected on the western shores of Italy, kindly supplied by Dr. Angelo Mazza and by Miss Minnie Reed, and from the southeast coast of France collected by Dr. W. G. Farlow. The New England specimens are largely of my own collecting in the neighborhood of Woods Hole, Massachusetts, and of Watch Hill, Rhode Island. They differ slightly but apparently not essentially from those of Europe.

In the second subgroup of the cylindrical, continuous species, the colorless cells of the epidermis, or utricles, are flattened on the outer ends and closely pressed together, so that a surface view (tangential section) shows them as polygonal (5–7-gonal) areas of fairly uniform size, of a honeycomb-like appearance. Both the species referred here are North Pacific Ocean as to their distribution and have fewer colored cells scattered through their epidermis than the species here taken to be true *Scinaia furcellata.* Both species, also, are decidedly more robust than *Scinaia furcellata.*

Scinaia Johnstoniae sp. nov.

Plate 11, figs. 14, 15.

Scinaia furcellata var. *undulata* M. A. Howe, Bull. Torrey Botan. Club, vol. 38, p. 502, 1911 (not *Ginnania undulata* Mont.).

Plants dark red purple, 8–12 cm. high, 7–8 times dichotomous, cylindrical, continuous, broad, 3–5 mm. in diameter (dried); branches attenuated downwards; axils narrow; axis obscure (dried); cystocarps minute but visible, scattered; — axial strand loose, broad, of a few larger filaments and a loose diffuse admixture of slender filaments; epidermis of large colorless flat-topped cells, or utricles, with few, scattered colored cells in groups of one to four; utricles flattened outwards, closely pressed together, 5–7-gonal in surface view (T), fairly uniform in size, square or slightly flattened (in sections), 21–25μ (T) and 20–21μ (R), thin walled; colored cells of epidermis scanty, scattered, 1–4 together; hypodermal cells in a single layer, scattered, orbicular, 16–28μ in diameter; corticating layer thin, loose, of straggling slender filaments; antheridia sparse, 1–4 together or in small clusters; cystocarps broadly pyriform, abruptly narrowed into a short neck, 180–265μ (T) and 128–170μ (R); gonimoblasts slender, very numerous, radiating from a small stalked, cellular placenta, forming a broadly reniform sporogenous mass, abjointing successively ellipsoidal spores; periderm thin, of about 4 layers of pseudoparenchymatous cells.

The type specimen of *Scinaia Johnstoniae* is a specimen collected at San Pedro, California, by Mrs. H. D. Johnston (Herb. Univ. Calif., No. 96356) and the species is, therefore, gratefully dedicated to Mrs. H. D. Johnston, not only in acknowledgment of her discovery of this specimen, but also in recognition of her valuable services in collecting and donating interesting algae from Southern California. Mrs. M. S. Snyder has also collected this species at La Jolla, California, for the use of the writer. The writer also feels safe in referring here the *Scinaia furcellata* var. *undulata* of M. A. Howe (1911, p. 502) from La Paz, California Baja, Mexico, after examining a fragment (Vives 11d) kindly communicated by Dr. Howe. The type of *Ginnania undulata* Mont., as has been stated above, has been found to be a *Gloiophloea* rather than a *Scinaia*. *Scinaia Johnstoniae*, therefore, ranges along the coasts of Lower (Baja) California and Southern California from La Paz to San Pedro, and may be expected as far north as Santa Barbara, California, at least.

Scinaia Johnstoniae is a robust, thin-walled species, differing in aspect from the preceding species. The epidermal layer and the hypodermis, both distinguish the species from others in this same subgroup but are much like those of *Scinaia latifrons*. *Scinaia Johnstoniae*, however, appears to be cylindrical and the cystocarps are scattered through the superficial layers of the frond. The differences between *Scinaia Johnstoniae* and *Scinaia japonica*, referred to this same subgroup, will be discussed under the latter.

Scinaia japonica sp. nov.

Plate 11, figs. 16–18.

Scinaia furcellata Okamura, Icones of Japanese Algae, plate III, 1907 (not *Ulva furcellata* Turner).

Plant of a dark red opaque color, 15 cm. high, 9–11 times dichotomous, moderately broad, 1–3 mm. in diameter (dried); axils narrow; substance dense (in appearance) cartilaginous; axis invisible (dried); cystocarps invisible (dried); — axial strand stout, of numerous large filaments and few slender filaments; epidermis of large colorless cells, or utricles, and very scanty slender colored cells; utricles large, uniform, closely placed, with flattened outer ends, 5–7-gonal in surface view (T), palisade-like in section, 30μ (R) by 8–12μ (T), with radial walls finely wrinkled thus showing delicate striae (in sections of dried specimens well treated with KOH); hypodermis of 2–4 layers of globular cells; corticating layer thin of sparse slender filaments; antheridia not seen; cystocarps globular-pyriform with short, abruptly tapering, very short neck, 400μ (T) by 300–350μ (R); gonimoblasts very numerous, slender, radiating from a distinct cellular placental tissue, abjointing successively oblong spores; periderm of 5–7 layers, pseudoparenchymatous.

Scinaia japonica is founded on a single specimen (Herb. Univ. Calif., No. 90835) collected at Misaki, Bay of Tokyo(?), Japan, by K. Yendo, in April, 1900, and referred by the collector to *Scinaia furcellata*. It seems also to be the same plant as the one figured by K. Okamura in his *Icones of Japanese Algae* (1907, pl. III) under *Scinaia furcellata*. It is not, however, represented by the specimen distributed by Okamura in his Algae Japonicae Exsiccatae under No. 2, at least, so far as the copy in the writer's possession is concerned. That will be referred to later under *Gloiophloea*.

Scinaia japonica is a dark opaque red, fairly robust plant, seemingly thick and cartilaginous, nearest in appearance and structure to *Scinaia Johnstoniae* and *Sc. articulata*, but is longer, more branched, with distinctly palisade epidermal layer and a greater number of layers in the hypodermis. It approaches *Scinaia articulata* in structure but *Scinaia articulata* has less elongated colored cells in the epidermis, fewer layers in the hypodermis, and smaller cystocarps than *Scinaia japonica*. Both, however, show the delicate and regular tangential crinklings of the radial walls of the colorless cells of the epidermis in sections of dried specimens however much swollen by reagents (KOH); these may be artefacts but show regularly and constantly in each form (cf. pl. 11, fig. 17).

As to the extent of the distribution of *Scinaia japonica* along the coast of Japan, it will be necessary to have more data. According to Okamura (1907, p. 11) *Scinaia furcellata* extends along the Pacific coast of Japan from Nagasaki to Province Hitachi and on the west coast in Province Idzumo, but, as already stated above, there has been confusion with a species of *Gloiophloea*. Probably *Scinaia japonica* has an equally wide distribution, but more specimens must be examined before the matter can be considered as definitely settled.

II. Flattened or Complanate Unconstricted Species

To this section of the genus three species are to be referred, viz., *Scinaia complanata* Cotton (*Scinaia furcellata* var. *complanata* F. S. Collins, 1901, No. 836 and 1906, p. 110), *Scinaia Cottonii* sp. nov., and *Scinaia latifrons* M. A. Howe (1911, p. 500). One of these has been observed to be flattened even in the living condition (cf. Collins, *loc. cit.*) and the other two have structural peculiarities definitely indicating flattened structure (cf. Howe, *loc. cit.* and *Cotton*, 1907, p. 260). While it is very difficult to be certain whether any of the forms are cylindrical or slightly flattened because of the failure of specimens dried under pressure to fully recover their shape, there is sufficient evidence, it seems to the writer, to be certain that these three forms are at least complanate and that the rest of the species of *Scinaia*, as here limited, are very nearly if not quite cylindrical. A character of importance here is the axis, which is not visible in dried specimens and when investigated microscopically is found to be distinct only just below the apices of the branches but which soon broadens and becomes diffuse below.

It is to be noted that one of the species included in this group is found in Florida, one in the corresponding latitudes of the Pacific Coast, in Southern and Lower (Baja) California, and the third on the coast of Japan.

Scinaia complanata (F. S. Collins) Cotton

Plate 11, figs. 19–22.

Cotton, *in* Kew Bulletin, No. 7, p. 260, 1907 (excl. Japanese plant).

Scinaia furcellata var. *complanata* F. S. Collins, *in* Phyc. Bor. Am., Fasc. 17, No. 836, 1901, Rhodora, vol. 8, p. 110, 1906.

Scinaia furcellata Harvey, Nereis Boreali-Americana, part 2, p. 136, 1853 (in part, incl. Key West plant only).

Plant pale rose red; 5–8 cm. high, 8–9 times dichotomous, axils rather broad, flattened, not constricted, 1.5–6(?)mm. in diameter (dried); axis obscure; cystocarps scattered, visible; — axial strand of 6–8 broad filaments, plain above, soon diffuse and disappearing below; epidermis of large colorless cells, or utricles, uniform and closely packed together with very scanty colored cells, except near the apices of the branches; utricles flattened at outer end, uniform and closely placed, 5–6-gonal in surface view (T), in section flattened rectangular, 34–35μ (T) by 22μ (R); colored cells of epidermis slender, very few except at tips of branches; hypodermis of a single layer, of loosely placed round or pyriform cells 8–9μ in diameter; corticating layer narrow, loose; antheridia scattered, single or two together; cystocarps broad pyriform, globular below abruptly narrowed outwards into a short neck, about 200μ (T) by 165μ (R); gonimoblasts slender, very numerous, forming a reniform mass, radiating from a few celled placenta, and abjointing successively elliptical oblong spores; periderm thin, of 2–3 layers of pseudoparenchyma, loosely placed; *punctum vegetationis* convex projecting (at least in young tips).

Scinaia complanata is based on specimens from Indian River Inlet, Florida, collected by Mrs. G. A. Hall. The description, as given here, has been drawn chiefly from No. 836 of the writer's copy of the Phycotheca Boreali-Americana (a co-type).). This is a specimen about 3 mm. in diameter (dried). Other specimens which seem to belong here are narrower and have modified some details of the description. These specimens are: (1) a specimen collected at Key West, Florida, by W. H. Harvey in February, 1850 (Herb. Univ. Calif., No. 68340) which has a diameter of 1.5 mm. (dried); (2) a specimen collected at Gilbert's Bar, Florida by A. H. Curtiss (Herb. Univ. Calif., No. 96361), also about 1.5 mm. in diameter (dried); and (3) a specimen collected at the Bermuda Islands by Dr. W. G. Farlow in 1881. While it is difficult to be absolutely certain whether the narrower forms are flattened or not, they seem to be so and they agree in structure with No. 836 Phycotheca Boreali-Americana. Harvey states (1853, p. 137) that his Key West specimens of *Scinaia furcellata* varied in diameter about a tenth of an inch (about 2 mm.) to a *quarter* of an inch (about 6 mm.). Yet he says nothing of their being flattened. The structure of the axis and its disappearing below (flattening out) is as definitely to be seen in the narrower as in the broader specimens. In structure *Scinaia complanata* is closely related to *Scinaia latifrons*, as will be discussed further below, but the species is smaller and narrower and has the cystocarps scattered with no indication of aggregation at the margins.

From *Scinaia furcellata*, the other North Atlantic species, it is to be distinguished, not only by its being complanate but by the fact that the outer ends of the utricles are flattened and by the utricles themselves being flattened rectangular in shape as well as by minor peculiarities in each case.

In connection with *Scinaia complanata*, *Isymenia angusta* J. Ag. (1899, p. 66) has been mentioned (cf. F. S. Collins, 1901, No. 836, and 1906, p. 110). An examination of the material under this name in Herb. J. Agardh at Lund shows seven specimens; three were collected at Indian River Inlet, Florida, by Mrs. G. A. Hall and were evidently considered by J. G. Agardh to be young and not typical. One of them, at least, is certainly *Scinaia complanata* and the other two appear to be. Of the other four, one from Indian River, Florida, collected by Mrs. G. A. Hall, is typical *Scinaia complanata*, as is also another specimen from Florida collected by Mrs. Hall, while the remaining two are seemingly species of *Halymenia*, or a related genus, one of them, collected at Key West by Mrs. G. A. Hall, being tetrasporic, while the other collected at the same locality and from the Melville Collection, is cystocarpic. *Isymenia angusta*, then, is *Scinaia complanata* in part and in part possibly a proper species, the latter matter not to be settled at the present time.

From the North Pacific species, *Scinaia Johnstoniae* and *Scinaia japonica*, *Scinaia complanata* differs, not only in being complanate, but also particularly in having the colorless cells of the epidermis flattened and it differs in the same way from all members of the constricted group, as well as in being complanate and unconstricted.

In a young growing tip examined, the *punctum vegetationis* was found to be convex and projecting above the rest of the tissue. Whether this is normal or not, it is strikingly different from the depressed *punctum vegetationis* as observed in all other species of *Scinaia* examined.

Scinaia latifrons M. A. Howe

Plate 11, fig. 23.

M. A. Howe, Bull. Torrey Botan. Club, vol. 38, p. 500, fig. 1 and pl. 28, 1911.

Plant deep rose red, 12–15 cm. high, 6–7 times dichotomous, flat, broad, 5–12 mm. in diameter (dried), branches decidedly narrowed below; axils rather broad; no axis visible (dried); cystocarps large, scattered but with strong tendency to marginal aggregation; — axial strand distinct at the apices but flattening out and diffuse below, largely of slender filaments; epidermis of uniform large colorless cells, or utricles, and sparse scattered slender colored cells, 1–4 together; utricles 5–6-gonal in surface view (T), with flattened outer ends, flattened to square to slightly radially elongated rectangular, 30–35μ (T) by 20–30μ (R); colored epidermal cells scattered, 1–4 together; hypodermis in 1–2 layers, orbicular, large, 18–20μ in diameter; corticating layer thin and loose; antheridia scanty (so far as seen); cystocarps large aggregated at or very near the margins, but some usually appearing scattered over the disk, broad pyriform, globular below, abruptly narrowed outwards into a short stout neck, 250–300μ (T) by 200–250μ (R); gonimoblasts very numerous, radiating from a few celled placenta to form a broadly reniform mass and abjointing successively globular to ellipsoidal spores; periderm thin, of about four layers of pseudoparenchyma; *punctum vegetationis* broad, slightly concave.

The type was collected at La Paz, Lower (Baja) California, Mexico, by G. J. Vives and is in the Herbarium of the New York Botanical Garden. Through the kindness of Dr. M. A. Howe I have been able to examine a fragment of one of Vives' specimens and Dr. Howe has kindly examined fragments of, and given his opinion on, certain specimens from Southern California in the Herbarium of the University of California. The latter specimens are from Santa Monica and San Pedro, floated in from deep water, and were collected by Miss Sarah P. Monks. The species seems to be of rare occurrence. Its range probably extends throughout the north subtropical province of the

Pacific Coast of North America extending from La Paz at the mouth of the Gulf of California north to San Pedro and Santa Monica, California, and may be expected as far north as Santa Barbara, California.

Scinaia latifrons is nearly related to *Scinaia complanata*, from which it is amply distinguished by the marginal position of the great majority of the cystocarps. It differs in several minor details also, as well as being a larger and broader, but slightly less branched plant. In structural peculiarities it resembles *Scinaia Johnstoniae*, which inhabits the selfsame territory with it. *Scinaia Johnstoniae*, however, is barely if at all flattened and its cystocarps are uniformly scattered with no tendency whatsoever towards marginal aggregation. From all other species, as here included, it is amply distinct.

From *Scinaia Cottonii*, *Scinaia latifrons* is to be separated on account of its larger, more ample frond, slight differences in the shape and dimensions of the utricles, and the greater tendency to intra-marginal aggregation of the cystocarps.

Scinaia latifrons is the broadest and most conspicuous species of the genus, being, in its most ample development, nearly if not quite twice as broad as any other species. There are other broad species, however, existing, and a full study of all material now in different herbaria may at some time alter the claims of this species to superiority in this line. Any detailed study of the development was precluded by the lack of abundant material, for most of the specimens are somewhat battered, but the *punctum vegetationis* is broad and slightly concave and the axial strand is plainly evident for 1–2 mm., then broadens out and loses its identity.

Scinaia Cottonii sp. nov.

Plate 11, fig. 24.

Scinaia complanata Cotton, *in* Kew Bulletin, No. 7, p. 260, 1907 (as to Japanese plant only).

Plant rose red, 4–5 cm. high, 5–7 times dichotomous, axils moderately broad more or less acute, branches attenuated downwards, flattened, not constricted, 3–10 mm. in diameter (dried); axis not visible; cystocarps scattered, with some tendency toward intramarginal aggregation; — epidermis of a layer of utricles which are nearly cubical to rectangular oblong, 16–20μ (T) by 13–17μ (R), flat-topped; hypodermis loose; corticating layer narrow, loose; antheridia in small clusters, scattered; cystocarps not examined.

Scinaia Cottonii is represented by two specimens in Herb. E. M. Holmes (No. 9) in the University of Birmingham, collected at Enoura, Japan, by Saido. Through the kindness of Mr. A. D. Cotton of the Royal Botanical Gardens at Kew I have been able to examine a tracing of one plant and through the kindness of Professor G. S. West, of the University of Birmingham, I have been able to examine a photograph of, and a bit of the other. From these the description has been drawn up and a name given to this species. Unfortunately I have been unable to study the structure of the cystocarp.

Scinaia Cottonii is very close to *Scinaia latifrons*, from which it differs in smaller size, slightly different dimensions of the utricles, and less marked intramarginal aggregation of the cystocarps. It differs from *Scinaia complanata* in much greater breadth, shape and dimensions of the utricles, and the tendency towards intramarginal aggregation of the cystocarps.

III. Cylindrical, Normally and Fairly Regularly Constricted Species

J. G. Agardh (1876, p. 513) has referred a constricted form under *Scinaia furcellata* as var. *subcostata*, but the regularity and frequency of the constrictions are not definitely described. There are, however, five species which seem to be cylindrical and normally more or less regularly constricted. Two of these are inhabitants of the southern and central Pacific Ocean, one inhabits the northern Pacific Ocean, while the other two are found within the proper confines of the Indian Ocean. The two former have the utricles broad and only slightly elongated with a scanty development of the corticating layer, while the two latter species have more or less narrow, palisade-like utricles and a broad, dense corticating layer. The fifth species, in the North Pacific Ocean, is temporarily to be referred here. The joints of the first two species are short (or at least shorter) proportional to the diameter, while the points of the other three are long (or at least longer) proportional to their diameter. The jointed species may, so far as present knowledge is concerned, be looked upon as austral rather than boreal in distribution and possible origin, especially since no cylindrical and continuous (i.e., unconstricted) species of *Scinaia* (as here limited) occurs with certainty in the Southern hemisphere. It is possible that farther search may, however, invalidate this statement.

Scinaia moniliformis J. Ag.

Plate 12, figs. 31, 32; plate 13, fig. 38.

J. G. Agardh, Til. Algernes Systematik, IV, p. 72, 1884;
J. Bracebridge Wilson, Proc. Roy. Soc. Victoria, new ser., vol. 4, part 2, p. 173, 1892;
De Toni, Syll. Alg., vol. 4, sect. 1, p. 105, 1897.

Plant rose pink(?), 8 cm. high, 7–8 times dichotomous, stout, 3–5 mm. in diameter (dried), from a stout solid(?) stipe, regularly and frequently constricted; joints oblong to oblong-cuneate, 3–5 mm. in diameter and 7–13 mm. long, never globular or short pyriform (except perhaps at the extreme apex), thin walled; axis apparent (dried), especially below; cystocarps sparse (in specimens seen), visible; — axial strand fairly stout, of interwoven filaments at the nodes; epidermis of colorless cells, or utricles, with very few widely scattered slender colored cells; utricles broad palisade-like, flat topped, uniform, 5–6-gonal in surface view (T), 20–22μ (T) by 38μ (R) as extremes; colored epidermal cells slender, sparse and widely scattered; hypodermis of one layer of loosely placed, flattened globular to broadly pyriform cells, 8–16μ in diameter; corticating layer thin of scanty slender filaments; antheridia not seen; cystocarps (all young in specimen examined) elongated pyriform, apparently of the type of true *Scinaiae*.

Scinaia moniliformis is known to the writer from the type specimen in Herb. J. G. Agardh at Lund and specimens in Herb. British Museum of Natural History at South Kensington. All these specimens were collected by J. Bracebridge Wilson at Port Phillip Heads near Melbourne, Australia. It has been possible to examine one of the specimens in the J. Bracebridge Wilson collection at South Kensington, to supplement the description of Agardh. That specimen, as are all of them, was young, so that a detailed description of the mature cystocarp is impossible for the present account. The young cystocarp examined had the narrow pyriform shape usual in the *Scinaia* assemblage and seemed distinctly to have the gonimoblasts radiating free into the cystocarpic cavity. This, with the possession of an epidermis largely composed of utricles, distinctly stamps this species as a member of the genus *Scinaia* as limited in the present account.

From the following species, *Scinaia moniliformis* is to be distinguished by the usually longer, more regularly oblong joints and certain minor details of structure which will be discussed below. From *Scinaia carnosa* and *Scinaia Salicornioides*, it is amply distinct as to structure of cortex throughout.

Scinaia hormoides sp. nov.

Plate 12, figs. 33–35; plate 13, figs. 36, 37.

Plant deep red purple (to brownish when dried), 4–6 cm. high, 7–8 times dichotomous, with short solid stipe, branches all regularly and uniformly deeply constricted into globular to obovate, at times even oblong, joints, 3 mm. in diameter and 3–10 mm. long; axis barely visible (dried); cystocarps scattered, plainly visible; — axial strand distinct, at first of few large parallel tubes, soon re-enforced by slender corticating filaments; epidermis of large colorless cells, or utricles, and frequent regularly distributed slender colored cells, 1–4 together; utricles flat-topped, 5–7-gonal in surface view (T), nearly square in section, 24–25μ (R) by 20–22μ (T); colored epidermal cells frequent, somewhat distant, but rather regularly placed; hypodermis in one layer of distant, irregular, obpyriform cells, 8–10μ in diameter; corticating layer thin, of sparse slender filaments; antheridia in small stellate clusters; cystocarps broadly pyriform, globular and abruptly contracted outwards, 250–350μ in each diameter; gonimoblasts slender, very numerous, arising from a few-celled placenta, successively abjointing short ellipsoidal spores; periderm of 3–4 layers, pseudoparenchymatous.

The type of *Scinaia hormoides* is a specimen collected at Haleiwa on the Island of Oahu, Hawaiian Islands, by J. F. Rock (No. 56 Rock). It was collected in the same locality by Miss Minnie Reed (No. 985) and a specimen preserved in formalin solution is available for study. There is also a specimen in the herbarium of the Bernice Pauahi Bishop Museum collected by E. Bailey, at Kahalui on the Island of Maui. What appears to be the same species has been collected on the reef at Puro, Province of La Union, Island of Luzon, Philippine Islands, whence a specimen (Philippine Bureau of Science, No. 13014) has been available through the kindness of Dr. M. A. Howe.

Scinaia hormoides is very closely related to the preceding *Scinaia moniliformis*, but is of very different aspect due to the different shape of the joints which are shorter and less oblong than in the Australian species. In the most typical specimens of *Scinaia hormoides*, the joints are nearly globular or more or less pyriform. Some of the joints in a specimen may, however, be nearly as oblong as those of *Scinaia moniliformis*. The joints in the latter species, however, are always and uniformly oblong. Too few specimens, however, are available to make as full a comparison in this respect as is desirable. The utricles in *Scinaia hormoides* are nearly square or slightly flattened while those of *Scinaia moniliformis* are radially elongated. The colored cells of the epidermis are decidedly more numerous in *Scinaia hormoides* than in *Scinaia moniliformis*.

Scinaia carnosa Harv.

Plate 11, figs. 25–27.

Harvey, Algae of Ceylon (Exs.) No. 38, and *in* J. G. Agardh, Spec. Alg., vol. 3, 1, p. 513, 1876, vol. 3, 2, pp. 15, 112, 1880.

Ginnania carnosa Harvey, *in* Kuetzing, Tab. Phyc., vol. 16, p. 30, pl. 83, 1866.

Plant deep red, opaque, up to 17 cm. high, 9–10 times dichotomous, slender, 2 mm. in diameter (dried), cylindrical, deeply constricted at irregular intervals; axils narrow; no axis visible (dried); cystocarps scattered, barely visible; — axial strand of stout and slender filaments intertwined; epidermis of colorless cells; colorless cells flat-topped, closely packed, palisade-like, 20–22μ (R) by 5–8μ (T); hypodermis of 2–3 compact layers of nearly globular cells; corticating layer thick, compact; antheridia not seen; cystocarps broad pyriform, abruptly narrowed into a very distinct cylindrical neck, 280–300μ (T) by 240–260μ (R); gonimoblasts very numerous and slender, radiating from a distinct and considerable cellular placenta, abjointing successively globular(?) spores; periderm compact, of 6–8 layers, fibrous-pseudo-parenchymatous.

Scinaia carnosa Harvey is founded on a plant from Ceylon distributed by Harvey under No. 38 of his Ceylon Algae, with printed label giving the name but no description. The specimen in the writer's possession agrees exactly with the description and figure of Kuetzing (1866, pl. 70, f. *a*, *b*, under *Ginnania carnosa*) in habit and structure.

By the structure of the cortex, viz., the very much elongated palisade-like utricles of the epidermis, the compact hypodermis and the thick, compact corticating layer, this species differs from all other *Scinaiae* except *Scinaia Salicornioides* with which it may be identical. The reasons for keeping the two distinct in this account are given below under the latter species. Both *Scinaia carnosa* and *Scinaia Salicornioides* are irregularly constricted and it seems probable that the constriction is due to accident rather than to a regular process of growth. The scarcity of specimens does not allow any satisfactory settlement of this question just at present, but since the descriptions and figures show constrictions and all specimens mentioned or available show them, it seems best to refer both species to this particular group until farther observations and study are possible.

Scinaia Salicornioides (Kuetz.) J. Ag.

Plate 11, figs. 28–30.

J. G. Agardh., Spec. Alg., vol. 2, 2, p. 423, 1851; *ibid.*, vol. 3, 1, p. 513, 1876;
Barton, Journ. Botany, vol. 31, p. 144, 1893; *ibid.*, vol. 34, p. 197, 1896;
De Toni, Syll. Alg., vol. 4, sect. 1, p. 106, 1897.
Ginnania Salicornioides Kuetzing, Spec. Alg., p. 716, 1849; Tab. Phyc., vol. 16, p. 25, pl. 70, 1866.

Plant dark red, up to 26 cm., 7–11 (or more?) times dichotomous, 2–3 mm. broad (dried), frequently but irregularly constricted, dense and opaque; axis invisible (dried); cystocarps scattered; — axis stout of broader thin walled filaments and more slender thick walled filaments intermixed; epidermis palisade-like, of slender elongated utricles and no colored cells or antheridial filaments (so far as seen); utricles radially elongated, 28–35μ (R) and 6–9μ (T), flat topped and closely placed together; colored hypodermal cells in 2–3 layers, globular to pyriform; corticating layer very broad, very dense in older portions; antheridia not seen; cystocarps flattened globular, 240–250μ (T) and about 200μ (R), with a thick periderm of 6–8 fibro-pseudoparenchymatous layers.

Scinaia Salicornioides is the largest and most robust of all the species of *Scinaia*. The figures of Kuetzing (1866, pl. 70) give a very good idea both of habit and of structure. The palisade-like layer of utricles, the broad, dense corticating layer and the stout central axis distinguish it readily from all except *Scinaia carnosa*, and from the latter species it is to be distinguished by the size and proportions of the utricles as well as by the greater width and density of the corticating layer.

Scinaia Salicornioides is confined, so far as known, to the shores of South Africa. The original specimens were collected at Port Natal, by Guenzius. Through the kindness of Mme. Weber van Bosse, I have been able to make a microscopic examination of this specimen. It has also been collected at The Kowie by Dr. H. Becker and at Cape Morgan by Danvers (cf. Barton, 1893, p. 144). I have drawn the description chiefly from a Becker specimen kindly loaned by F. S. Collins. It is very desirable that living specimens be studied to determine more accurately the structure of the cystocarp and the details of the occurrence and structure of the antheridia.

Since 1851, when J. G. Agardh (p. 423) placed it as a doubtful synonym under *Scinaia Salicornioides*, the *Corallopsis dichotoma* Suhr (Flora, vol. 22, p. 70, fig. 44, 1839) has regularly appeared in the doubtful synonym of this species. The specific name *dichotoma* antedates that of *Salicornioides* and must replace it if, as certainly seems from the description of Suhr (*loc. cit.*), the plant of Suhr should prove to be identical with that of Kuetzing. Dr. A. J. Ewart, at my request, kindly allowed me to examine a fragment of Suhr's type which is preserved in the National Herbarium of Victoria. While the habit is close, the microscopic structure is entirely different from that of *Scinaia Salicornioides* and exactly that of a *Galaxaura*. The type of *Corallopsis dichotoma* Suhr is well represented in Suhr's figure (*loc. cit.*), is faded and lacking calcification (decalcified?). In habit and structure it agrees well with the description and figures of *Galaxaura magna* Kjellman (1900, p. 82, pl. 15, figs. 1–10, pl. 20, fig. 46) and were it not for the lack of calcification might be referred to that species without hesitation. It is to be removed, however, from even the doubtful synonymy of *Scinaia Salicornioides* and is to be farther considered when the status of both name and rank of *Galaxaura magna* may be under investigation.

Scinaia articulata sp. nov.

Plate 13, figs. 39, 40.

Plant deep rose red, 10 cm. high, 7 times dichotomous, broad, 3–5 mm. in diameter (dried), cylindrical, regularly and frequently constricted, segments elongated cylindrical; branches slightly attenuated below; axis conspicuous throughout; cystocarps sparse, scattered, of medium size; — axial strand broad, stout, dense, largely of slender filaments; epidermis of large colorless cells, or utricles, and almost no colored cells; utricles flattened outwards, 5–7-gonal in surface view (T), uniform, slightly rectangular in section, 17–20μ (R) by 10–15μ (T), closely placed together; colored epidermal cells so few as to practically escape notice; hypodermal cells in 1 layer, scattered orbicular, 12–14μ in diameter; corticating layer thin, loose; antheridia not seen; cystocarps broadly pyriform, flattened globular, abruptly narrowed into a short broad carpostome, 215–235μ (T) by 165–170μ (R); gonimoblasts slender, very numerous, radiating from a scanty central, cellular placenta forming a compact spore mass, abjointing successively globose-ellipsoidal spores; periderm of 2(–3?) layers, pseudoparenchymatous.

The writer has seen but two specimens of this puzzling plant, one, No. 32172 in Herb. J. G. Agardh from Santa Barbara, California, collected by Mrs. Bingham, the other in Herb. F. S. Collins, sent from Santa Barbara by J. W. Calkins. It is possible that the two specimens may be only portions of one and the same plant and that that plant may be an abnormality. Certain it is, that there is need of farther material before it can be satisfactorily placed. J. G. Agardh did not refer his plant to any definite species or variety but placed it apart, labelling it "*Scinaia fronde prolifera.*"

Were it not for the constrictions, the writer would unhesitatingly place it in the first subgroup and hesitate only as to whether to refer it to *Scinaia japonica* or *S. Johnstoniae*.

The question of the value of constriction as a diagnostic character is, as stated above, a puzzling one. All species of *Scinaia* probably present constricted forms, but such forms in the cylindrical continuous form are irregular and plainly the results of proliferation following injury. The plant under discussion, however, is as regularly constricted as, or even more regularly constricted than, *Scinaia Salicornioides* and cannot be such an injured plant as those just referred to. It is, perhaps, to be compared with *Scinaia furcellata* var. *subcostata* J. Ag. which the writer, however, has not examined. Agardh, however, evidently did not refer the present plant to his variety and *Scinaia furcellata* var. *subcostata* may, of course, be nothing more than a chance constricted form of *Scinaia furcellata*, as the writer sometimes suspects the present plant to bear a similar relation to *Scinaia Johnstoniae*, or perhaps more likely to *Scinaia japonica*.

There are certain differences, however. The rather stronger axial strand and certain differences in the utricles attract attention. The latter differences may or may not be important, but the utricles certainly approach those of *Scinaia japonica* in size, shape, and in certain markings (artefacts?) on the radial walls.

The utricles of the proposed new species under discussion are more elongated radially than those of *Scinaia Johnstoniae*, giving more of the palisade character of *Scinaia japonica*. Besides, in both the present species and in *Scinaia japonica* the radial cell walls, in all sections examined, have narrow, very definite transverse folds, appearing as striations in surface view. These are probably artefacts, due to incomplete swelling of the walls of the dried specimens, but they are different from the coarse and irregular wrinkles noticed under similar conditions in other species. They may be of no diagnostic value whatsoever, yet they are striking in their appearance and constant in their occurrence.

GLOIOPHLOEA J. G. Agardh

Cylindrical, unconstricted, dichotomous plants, with axial strand arising from a much depressed *punctum vegetationis* and giving off dichotomous filaments excurrent obliquely upwards, whose outer ends form at first a layer of utricles intermixed with colored cells, later, however, by the continued growth of the latter developing into a cortex of anticlinal rows of fasciculate moniliform anticlinal filaments intermixed with more or less collapsed utricles at different levels; monoecious or dioecious; antheridia forming a continuous covering over large portions of the frond; cystocarps scattered and irregularly aggregated, arising in the inner layers of the cortex, pyriform, opening outwardly through a narrow carpostome; gonimoblasts free, arising from a few celled placenta, abjointing spores in succession; periderm of few layers, pseudoparenchymatous or closely filamentous.

As defined and described by J. G. Agardh (1870, p. 29), *Gloiophloea* is a genus to be distinguished from *Scinaia* by the structure of the cortex. This is true of the adult frond where the cortex consists of more or less closely placed anticlinal filaments whose inner cells are large and rounded and whose outer cells are gradually smaller. A study of the development of the cortex, however, shows that it passes through a *Scinaia*-like stage. At first the outer cells are transformed into utricles, but the cells below the utricles give off branchlets which grow out between the utricles and ultimately form the anticlinal rows described by Agardh. The utricles first formed collapse and are to be detected only in thin sections and upon very careful examination. Younger parts and young specimens, especially on the cystocarpic plants of the dioecious species, have the appearance of being true members of the genus *Scinaia*. It is possibly a question whether it is better to retain the genus *Gloiophloea* or not, but, on the whole, I think it better to retain it for the present at least. The species of *Gloiophloea* show the cymose method of branching of the peripheral filaments in a pronounced fashion. The terminal cell becomes a utricle and does not divide farther. The later branchlets grow up around the utricle, overtop it and may, in turn, become utricles, to be overtopped in turn by their lateral branches. The utricles are gradually compressed and become inconspicuous on account of their lack of color, thus giving the appearance of a cortex of anticlinal filaments.

The cystocarps have the structure of those of *Scinaia* as Agardh has stated. The antheridia occupy more extended areas than those of any species of *Scinaia* thus far known, and in certain species which are dioecious they cover the whole plant. In structure they agree with those of *Scinaia*.

The type of the genus is *Gloiophloea Scinaioides* J. Ag. of Australia, of which I have not had the opportunity of examining the type specimen; but I have had the privilege of examining a New Zealand specimen collected by Berggren, which seems clearly to be Agardh's species. The statements made above, as to the structure and relationships of *Gloiophloea*, are justified by a study of this specimen which is in Herb. Farlow.

This species of *Gloiophloea*, like those of *Scinaia* and also those of the new genus *Pseudoscinaia*, to be proposed later in this paper, resemble one another and those of the other two genera. From my examination of the material available, I have been convinced that there are five species, possibly even six, but the technical points of distinction are not completely satisfactory. The main distinction separating the species into two groups is whether the species are monoecious (three or four species) or dioecious (two species). This separation seems to rest on a basis that is constant and readily to be determined. Within each group the thickness of the cortex presents seemingly constant differences which are associated with less tangible differences in general appearance and with geographical segregation. I have, as will be seen from the analytical keys to species given farther on, used it as a main character for separating the species. A study of larger suites of specimens and in the living condition will, I feel certain, add to the list of differences.

Gloiophloea Scinaioides J. Ag.

Plate 15, fig. 48.

J. G. Agardh., Bidr. Florid. Syst., p. 29, 1870, Spec. Alg., vol. 3, 1, p. 510, 1876, Florid. Morph., pl. 28, figs. 1–5, 1879;

J. Bracebridge Wilson, Proc. Roy. Soc. Victoria, new ser., vol. 4, p. 173, 1892;

De Toni, Syll. Alg., vol. 4, sect. 1, p. 107, 1897.

Scinaia furcellata Harvey, Phycologia Australica, vol. 5, p. xxxviii, 1863 (in part, at least as to specimen from Western Port);

J. G. Agardh., De Alg. Nov. Zel. Mar., p. 26, 1877 (in part?);

Laing, Trans. N. Z. Inst., vol. 34, p. 348, 1901 (at least in part).

Plant up to 8 cm. high, 12–15 times dichotomous, fastigiate, cylindrical, continuous, 1.5–2 mm. broad (?), soft, deep red; axis obscure; cystocarps scattered; — axis broad of loosely intertwined large thin walled filaments accompanied by numerous longitudinal and oblique slender thick walled corticating filaments more or less intertwined; adult outer cortex 85–110μ thick, the outer portion 65–85μ thick, of moniliform anticlinal rows of colored cells with oval utricles at two or three different heights; corticating layer averaging about 100μ thick, dense in older parts, of interwoven slender thick-walled filaments, often very nearly filling the entire cavity between axis and cortex; monoecious; antheridia single on slender stalk cells, over the entire surface; cystocarps obpyriform, like those of *Scinaia*, with thick pseudoparenchymatous periderm.

The description of this species must necessarily remain imperfect since only a small fragment of a specimen presumably of this species has been available for study. This specimen is in Herb. Farlow and was collected at the Bay of Islands, New Zealand, by Berggren. It was identified as *Scinaia furcellata* by J. G. Agardh (1877, p. 26). The specimen is clearly a *Gloiophloea* and answers to Agardh's description. It is monoecious as I suspect from Agardh's figures the species is, since his figure 5 (1879) represents a very young cystocarp with what I interpret as an antheridial branchlet (fig. 5*h*) on each side of it. It is to be compared then with *Gloiophloea Okamurai* from Japan and other monoecious species, which are less branched and darker as well as more rigid. I have been able to examine an abundance of antheridia but only a few very young cystocarps in the New Zealand specimen. Consequently the description of the cystocarp must remain incomplete. Agardh's figure of the cystocarp (1879, fig. 4) is manifestly imperfect and represents the periderm as filamentous(?). The young cystocarps of the New Zealand specimens show a pseudoparenchymatous periderm. Agardh's type was one of the specimens distributed by Harvey under No. 348 of his Australian algae and comes from Western Port near Melbourne.

Gloiophloea undulata (Mont.) comb. nov.

Plate 15, fig 49.

Ginannia undulata Montagne, Ann. Sci. nat. bot., 2 ser., vol. 18, p. 247, 1842, Voyage Bonite, Bot., vol. 1, p. 59, and Atlas, pl. 145, fig. 3, 1844–1846, *in* Gay, Hist. fisc. pol. de Chile, Bot., vol. 8, p. 432, 1852, Syll. Gen. et Spec. Crypt., p. 437, 1856;

Endlicher, Gen. Plant., Suppl. III, p. 40, 1843;

Kuetzing, Spec. Alg., p. 715, 1849.

Scinaia furcellata var. *undulata* J. G. Agardh, Spec. Alg., vol. 2, 2, p. 422, 1851, *ibid.*, vol. 3, 1, p. 512, 1876;

De Toni, Syll. Alg., vol. 4, sect. 1, p. 105, 1897.

Myelomium undulatum Kuetzing, Phyc. Gen., p. 393, 1843.

Halymenia undulata J. Ag. Mss. *in* Spec. Alg., vol. 2, 2, 1851 (as synonym), *ibid.*, vol. 3, 1, p. 512, 1876 (quoted by Montagne, Harvey, J. G. Agardh, and others).

Plant up to 6 or 7 cm. high, 9–10 times dichotomous, cartilaginous, dark red, cylindrical continuous, 1.5–3 mm. broad (dried); axis invisible, cystocarps irregularly aggregated; — axis slender, adult cortex 83–90μ broad; outer cortex 50–70μ, commonly 50–60μ broad, of 2–3 layers of large rounded hypodermal cells and short anticlinal rows alternating with single larger cells, the utricles; inner cortex 20–30μ thick, of loosely interwoven corticating filaments; monoecious; antheridia in groups, borne singly on elongated supporting cells; cystocarps (young in fragments examined) of the *Scinaia* type with a periderm pseudoparenchymatous below, but filamentous above.

For some years the writer has looked upon a certain plant of the *Scinaia* assemblage, more or less frequent on the coast of California and differing in aspect from other members of the *Scinaia* group especially in its abundant branching, darker color, and a certain robustness, as probably the same as the *Ginannia undulata* Mont., the *Scinaia furcellata* var. *undulata* (Mont.) J. Ag. A superficial examination of the specimens in Herb. Montagne at the Museum d'Histoire Naturelle at Paris seemed to confirm this impression and antheridial plants colected by C. P. Nott at Monterey, California, were distributed under J. G. Agardh's combination (Phyc. Bor.-Amer., No. 422). Recently, however, through the kindness of Dr. Paul Hariot, the writer has been able to make a more thorough examination of the Montagne specimens, with the result that the previous impression has been dissipated and the discovery made that the specimens upon which Montagne founded his species belongs to the genus *Gloiophloea* rather than to *Scinaia* and that the California specimens referred to do not agree with them. Consequently *Gloiophloea undulata* (Mont.) is proposed as a new combination to refer solely to the Chilian and Peruvian species.

From the literature, it seems that the specific name *undulata* chosen by Montagne for his *Ginannia undulata* was taken from a manuscript name given to the species by some one else (cf. Montagne, 1842, p. 257) and the original combination was probably the *Halymenia undulata* J. Ag. Mss., quoted by Montagne (*loc. cit.*), J. G. Agardh (1851, p. 422), Kuetzing (1843, p. 393), and others. The original specimen seems to be one collected by Bertero, but Montagne evidently founded his species on specimens collected by Gaudichaud on the voyage of the "Bonite." These specimens have been examined and particularly one marked, apparently in Montagne's handwriting, "*Ginannia undulata* Montag. in Gaudichaud Voy. Bonite c. icone Chile." Besides this are two other specimens from Chili. All three, with the specimen marked "Chile—ex coll. Berteroana" seem to be the same. There is one specimen, however, in Herb. Montagne, which is different, possibly a slender sterile *Callophyllis*. This is marked "Coquimbo (Chili), lgt. Gaudichaud." This specimen agrees with the figures of Kuetzing (1866, pl. 69) which are evidently not taken from any species of *Ginannia* as conceived by Montagne. The other Chilean specimens in Herb. Montagne agree with the figures in the Voyage Bonite (pl. 145, under f. 3). The cortex there represented is not distinct, otherwise the details are characteristic of the specimen that I have taken to be the type.

The plant from La Paz, referred to *Scinaia furcellata* var. *undulata* by M. A. Howe (1911, p. 502), has been found to be a true *Scinaia* and will be found above under *Scinaia Johnstoniae*.

Gloiophloea undulata is a monoecious species with a thin cortex and is to be compared with *Gloiophloea Okamurai* of Japan, to which it comes very close. It appears to be a slightly broader, somewhat lower species than *Gl. Okamurai*, with a cortex intermediate in thickness between it and *Gl. Scinaioides*. These differences, together with the widely separated geographical distribution of the two species, make it seem best to keep them separate, for the present at least. From *Gloiophloea Scinaioides* it differs in its broader, lower, less branched frond and in its much thinner cortex, while from *Gl. Halliae* it is to be distinguished by its lower stature, greater number of dichotomies, and somewhat thicker cortex. From the other two species, viz., *Gloiophloea capensis* and *Gl. confusa*, it differs fundamentally in being monoecious.

Thus far *Gloiophloea undulata* is known only from the type material from the coasts of Chili and Peru.

Gloiophloea Okamurai sp. nov.

Plate 15, figs. 50–56; plate 16, fig. 57.

Scinaia furcellata Okamura, Alg. Jap. Exs., No. 2, 1899 (excl. synonymy), not *Scinaia furcellata* Okamura, Icones of Japanese Algae, vol. 1, no. 1, p. 10, pl. 2, fig. 19, pl. 3, fig. 16–20, 1907;

De Toni, Phyceae Japonicae Novae, p. 19, 1895 (at least in part);

Diekie, Journ. Linn. Soc., Bot., vol. 15, p. 451, 1876 (in part?).

Plant up to 9 cm. high, 10–11 times dichotomous, cartilaginous, dark red to almost black in drying, cylindrical continuous, 1–1.5 mm. broad (dried); axis invisible; cystocarps irregularly aggregated; axis slender; adult cortex 70–100μ thick, the outer portion 35–50μ thick, of anticlinal moniliform rows of colored cells, enclosing pear-shaped or elliptical utricles at 1–2 heights, the inner 35–50μ thick, of loosely interwoven corticating filaments; monoecious; antheridia nearly or entirely covering the surface, consisting of slender branches abjointing solitary(?) oblong antherozoids; cystocarps pyriform, 105–120μ (R) (160–180μ with neck) by 120–135μ (T) with a periderm of 6–7 layers of interwoven coarse filaments, opening gradually outward by a long carpostome.

Gloiophloea Okamurai is founded on a specimen distributed by Okamura under No. 2 of his Algae Japonicae Exsiccatae and labelled as *Scinaia furcellata.* This is not the same, however, as the *Scinia furcellata* of his Icones of Japanese Algae (vol. 1, no. 1, p. 10, pl. 2, fig. 19, and pl. 3, figs. 16–20, 1907) which is a true *Scinaia* and is referred above to *Scinaia japonica.* While this statement refers to No. 2 of the copy of Okamura's Algae Japonicae Exsiccatae in my own possession so far as the type specimen is concerned, I have found that identical specimens are to be found also in three different sets of the same exsiccatae in Herb. Farlow. These specimens were all credited to Enoshima, Japan, whence also there is a specimen of *Gloiophloea Okamurai,* collected by H. M. Richards. H. M. Richards also collected the same species at Kamakura, Japan, according to a specimen in Herb. Farlow. I have been able therefore to examine some six specimens of this proposed new species and find them to agree in all essential characters.

Gloiophloea Okamurai is a monoecious species and may be distinguished from *Gloiophloea Scinaioides* by its darker red color, less fastigiate branching, less number of dichotomies, and its thinner cortex; from *G. undulata*, of the same group, it is to be distinguished chiefly by its thinner cortex; while from *G. Halliae* of Florida it is to be separated by its somewhat thicker cortex.

Gloiophloea Halliae sp. nov.

Plate 10, fig. 13.

Plant 11–13 cm. high, 5–7 times dichotomous, cylindrical, continuous, 2 mm. broad (dried), deep wine red; cystocarps scattered;—axis slender; adult outer cortex 22–40μ thick of anticlinal corymbose colored filaments with ovate utricles at two heights; corticating layer 20–45μ thick, very lax; monoecious(!); antheridia thickly covering the surface, fasciculate; cystocarps globular pyriform 100–118μ (T) by 66–88μ (R, without the broad carpostome); periderm filamentous, thick, of 5–6 layers.

A slender species, known only from two specimens in Herb. Farlow, collected at St. Lucie, Florida, by Mrs. G. A. Hall. *G. Halliae* approaches *G. Okamurai* but is thinner-walled, somewhat taller, with less number of dichotomies, and is widely separated geographically. The other species of the genus are either found in the Pacific Ocean or in the Indian Ocean and the occurrence of an undoubted species of this genus in the North Atlantic suggests the extreme possibility of there being other members of the genus *Gloiophloea* on the American or European coasts.

Gloiophloea capensis sp. nov.

Plate 16, figs. 58, 59.

Scinaia furcellata Barton, Journ. of Botany, vol. 31, p. 144, 1893(?).

Plant 7–9 cm. high, 7–11 times dichotomous, cylindrical, continuous, 1–3 mm. broad (dried), dark red, fleshy cartilaginous; axis invisible; cystocarps irregularly aggregated; — axial strand slender, loose; adult cortex 110–150μ thick, the outer cortex 60–85μ thick, of anticlinal moniliform rows of colored cells with 1–2 sets of utricles at different heights, the inner cortex 50–65μ thick, of loosely interwoven hyphae; dioecious; antheridia covering almost the entire surface of the antheridial plant, single at the tips of slender elongated cells, oblong; cystocarps broadly obpyriform, 65–130μ (R) by 115–150μ (T), with a filamentous periderm of 5–9 layers of filaments.

Gloiophloea capensis is founded on an antheridial plant collected at Port Alfred, Cape Colony, by J. Burtt Davy in 1908. Another antheridial plant collected in the Cape Colony region by Poeppig exists in Herb. Farlow and has been examined. Finally I have found a cystocarpic plant collected at "The Kowie," South Africa, by Dr. H. Becker among the specimens of *Scinaia* kindly loaned from the Herbarium of the Königliche Biologische Anstalt zu Helgoland through the kindness of Dr. Paul Kuckuck. This account then has been drawn up after a study of these three specimens.

Gloiophloea capensis is a true *Gloiophloea* in the light of what has been said here of the genus and is dioecious. From *Gloiophloea confusa*, the other dioecious species known to me, it is to be distinguished by its small number of dichotomies and its decidedly thicker outer cortex. The cortex is comparatively thin in the cystocarpic plant and noticeably thicker in the antheridial plant. It is probable that the various references to the occurence of *Scinaia furcellata* on the South African coasts refer to this species wholly or in part.

Gloiophloea confusa sp. nov.

Plate 14, figs. 44–47.

Scinaia furcellata Farlow, Rept. U. S. Fish Comm. for 1875, p. 699, 1876 (as to Pacific Coast references only);
C. L. Anderson, Zoe, vol. 2, p. 222, 1891;
McClatchie, Proc. So. Calif. Acad., vol. 1, p. 356, 1897 (not *Ulva furcellata* Turner).

Scinaia furcellata var. *undulata* Farlow, Proc. Amer. Acad., vol. 10, p. 367, 1875, Rept. U. S. Fish Comm. for 1875, p. 699, 1876;
Cleveland, Marine Algae of San Diego;
Setchell *in* Collins, Holden and Setchell, Phyc. Bor.-Am., no. 422, 1898 (Exsicc.!);
Collins, Marine Algae of Vancouver Island, p. 114, 1913 (not *Ginannia undulata* Mont.).

Plant dark red purple, 10–15 cm. high, 10–15 times dichotomous, 2 to 3 mm. in diameter (dried), branches of the same diameter throughout, cylindrical, continuous; axils moderately broad; no axis visible; dioecious(!); antheridia forming a continuous coating over the plant; cystocarps numerous, scattered, obscure; — axial strand stout, of parallel longitudinal coarse filaments, slightly agglutinated together; outer cortex 40–60μ broad, of 5–6 layers of cells, the inner large and rounded, becoming smaller toward the surface, the outermost slender and elongated in short anticlinal rows; utricles at first forming a layer later overtopped by the anticlinal filaments; corticating layer just within the cortex, 105–120μ broad, loose; excurrent, oblique filaments from strand to cortex, numerous, persistent, enclosed in a dilute jelly; dioecious; antheridia forming a close layer over the outer surface of the antheridial plant, short, oblong; cystocarps broad pyriform, tapering gradually to a carpostome, 250μ (T) by 280–300μ (R) gonimoblasts numerous, slender, radiating from a distinct, few-celled placenta, abjointing successively ellipsoidal spores; periderm of 5–6 flattened pseudoparenchymatous layers.

As stated under *Gloiophloea undulata* and also indicated by the synonymy quoted above, the plant of the western coast of North America has been confused with *Gloiophloea undulata*. It is, however, a dioecious species, as careful study of the Californian material has demonstrated, while *Gloiophloea undulata* has been shown, by a study of the type specimen, to be monoecious. From *Gloiophloea capensis*, the only other dioecious species known at present, it is to be distinguished by being more branched and by having a thinner cortex. It has been collected in California at San Pedro by the writer, about Monterey Bay by C. P. Nott and the writer, at Santa Cruz by Dr. C. L. Anderson, near Half Moon Bay by Dr. Carl Skottsberg, Dr. N.

L. Gardner, and the writer, and in British Columbia near Victoria by John Macoun. Its distribution along the western coasts of North America, then, extends from the southern boundary of the United States (or below it in all probability) to Vancouver Island.

Gloiophloea(?) articulata Weber van Bosse

Trans. Linn. Soc., 2 ser., Zool., vol. 5, no. XIV, p. 276, pl. 16, fig. 1, pl. 18, figs. 26, 27, 1914.

Just at the time of writing there has been referred doubtfully to genus *Gloiophloea* a species from the westerly portion of the Indian Ocean. Through the kindness of Mme. Weber van Bosse I have been able to examine a specimen of this plant. The habit resembles that of the constricted species of *Scinaia* but the structure is not of that group. Neither has it the structure of cortex or apical pit of *Gloiophloea*, at least as I understand it and have described it above. It seems to me that the plant is likely to prove to be found to be a member of the Chaetangiaceae, as Mme. Weber van Bosse has already suggested, but, in my own estimation, it is probable that it will also be found to belong to an, as yet, undescribed generic type close to the genus *Chaetangium*. At present it seems best to leave it under the name assigned to it, but still farther emphasizing the doubt as to its generic designation.

PSEUDOSCINAIA gen. nov.

Frond arising from a disk, cylindrical, continuous, repeatedly dichotomous, with blunt apices and branches of the same diameter throughout, devoid of calcification; — axial strand of nearly parallel thin walled broad filaments more or less firmly agglutinated together, whence slender branchlets are obliquely upwardly excurrent, whose terminal portions are combined into a continuous cortex whose inner layers are colored but whose outer layers, or "epidermis," is made up largely of inflated colorless cells, or utricles, between which slender colored cells are more or less regularly scattered, the whole being clothed externally by a distinct cuticula; slender corticating filaments may accompany the axial strand and clothe the inner surface of the cortex; the space between the axial strand and the inner surface of the cortex is filled with a dilute jelly; tetrasporangia unknown; antheridia single or few together; inserted between the utricles; cystocarps scattered, originating within the cortex and partially or nearly entirely suspended in the interior jelly, more or less globular to pyriform, with more or less elongated carpostome; gonimoblasts projecting into and also lining the walls of the sporiferous cavity, variously grouped and abjointing successively more or less elongated spores; paraphyses absent; periderm distinct, pseudoparenchymatous; growing point slightly depressed, as in *Scinaia*.

A genus of two species, one, the type, from Southern California, the other from southeastern Australia. Both these species have all the external appearance of being genuine species of *Scinaia*. In habit, however, there is a slight difference in that the branches are not at all attenuated downwards as is the case in practically all species of *Scinaia*. In vegetative structure *Pseudoscinaia* is exactly like *Scinaia* in having the epidermis of colorless utricles. The cystocarps, however, are very much like those of *Galaxaura* and *Whidbeyella*, from both of which it differs in the structure of the epidermis. It seems best therefore to create a new genus for the reception of these two species and the name *Pseudoscinaia* is proposed for it.

Pseudoscinaia Snyderae sp. nov.

Plate 16, figs. 60, 61.

Plant dark red, 12–20 cm. high, 9–13 times dichotomous, cylindrical, continuous; axils narrow; branches not narrowed downward but nearly uniform in diameter throughout, 1–2 mm. in width (dried); axis distinct (dried); cystocarps abundant, scattered, small, readily seen (dried); — axial strand stout, of numerous broad parallel filaments strongly agglutinated together; epidermis of irregular colorless cells, or utricles, and frequent scattered slender colored cells; utricles, of the epidermis, convex at outer end and not closely appressed at the tips thus giving an irregular and only bluntly polygonal appearance in surface view (T), low palisade-like, 20–26μ (R) by 12–20μ (T); hypodermis of 1–3(?) layers (mostly one), of loosely placed globular or pyriform cells; corticating layer broad, compact; antheridia single or in small (2–4 together) clusters, scattered through the epidermis; cystocarps globular to globular pyriform below, narrowed abruptly into a slender carpostome, 165–205μ (T) by 130–170μ (R, exclusive of the carpostome), but the carpostome itself is 75–100μ long; gonimoblasts spreading out from a few-celled placenta, lining the basal half to two-thirds of the sporiferous cavity, curving up and bearing short branchlets successively abjointing elongated pyriform spores, somewhat grouped; periderm of 4–5 layers, pseudoparenchymatous.

The specimen chosen for the type of the genus *Pseudoscinaia* and of the species *Pseudoscinaia Snyderae* is No. 77886 of the Herbarium of the University of California. It was collected at "Pacific Beach" near San Diego, California, on June 30, 1898, by Mrs. M. S. Snyder, to whom the species is dedicated in token of appreciation of her interest, industry, and generosity in collecting, studying, and distributing marine algae of Southern California. Specimens collected at La Jolla by Mrs. Snyder and by M. B. Nichols and at San Pedro by Mrs. H. D. Johnston and Dr. N. L. Gardner have also been used for study.

Pseudoscinaia Snyderae is closely allied to the next species below both in habit and structure. It is, however, a more robust plant with smaller cystocarps and more radially elongated utricles. The vegetative structure in both species is distinctly close to that of *Scinaia furcellata*, but the cystocarps are not those of *Scinaia furcellata* but rather those of *Galaxaura*. It is, in turn, entirely free from calcification and has colorless utricles in the epidermis. It is of a certain peculiar appearance due to the considerable number of dichotomies and the uniform diameter of base and apex in its branches. It is to be expected from Santa Barbara to La Paz, if arguments may be drawn from the distribution of other members of the *Scinaia* assemblage.

Pseudoscinaia australis sp. nov.

Plate 16, fig. 62.

Scinaia furcellata J. Bracebridge Wilson, Proc. Roy. Soc. Victoria, new ser., vol. 4, p. 173, 1892? (not *Ulva furcellata* Turner).

Plant pink purple, 9–10 cm. high, about 10 times dichotomous, slender, 1 mm. in diameter (dried); axils broad; axis obscure but often visible (dried); cystocarps scattered, minute, barely visible; — axial strand slender of coarser and finer filaments nearly parallel, loose; epidermis of colorless cells (utricles) with frequent scattered slender colored cells; utricles oblong to square in radial section, 20–21μ (T) by 13–21μ (R), convex at the outer end presenting an appearance of irregular, loose, blunt polygons in surface view (T); hypodermis of two layers of globular cells, 4–5μ in diameter; corticating layer thin and loose; antheridia scattered, mostly solitary; cystocarps globular or flattened globular, abruptly narrowed into a slender carpostome, 150–175μ (T) by 130–150μ (R, exclusive of carpostome); gonimoblasts spread out over the basal half to two-thirds of the cystocarpic cavity and abjointing successively pyriform spores in several groups; paraphyses wanting; periderm pseudoparenchymatous, of 5–6 layers.

Of *Pseudoscinaia australis* there is only a single specimen, the type, which is No. 74793 of the Herbarium of the University of California. It was collected by J. Bracebridge Wilson on January 17, 1893, at

Port Phillip Heads near Melbourne, Australia, and was distributed under the name of *Scinaia furcellata.*

Pseudoscinaia australis differs from *Pseudoscinaia Snyderae* in being less robust, in having slightly smaller cystocarps and having the utricles ordinarily less elongated. The cystocarp is very distinctly like that of *Galaxaura*, but lacks paraphyses.

It may be that this plant is the same as the *Scinaia furcellata* var. *australis* J. Ag. (1876, p. 512), but it has not been compared with authentic material. Consequently it is necessary to consider it for the present as distinct. It is known, at present, only from the type locality. It is probably the plant referred to by J. Bracebridge Wilson in his "Catalogue of Algae collected at or near Port Phillip Heads and Western Port" (1892, p. 173 as above) under *Scinaia furcellata* and may also be included under Harvey's reference to *Scinaia furcellata* in the "Synoptic Catalogue of Australian and Tasmanian Algae" in the fifth volume of the "Phycologia Australica" (1863, p. xxxviii). A specimen collected by Harvey at Western Point and referred to *Scinaia furcellata* is, however, the type of *Gloiophloea Scinaioides* J. Ag.

V. SYNOPSIS OF GENERA AND SPECIES

Scinaia Bivona

A. Cylindricae—
- *a.* Utricles outwardly convex and tumid.
  - 1. *S. furcellata* (Turner) Bivona
- *b.* Utricles outwardly flattened.
  - 2. *S. Johnstoniae* sp. nov.
  - 3. *S. japonica* sp. nov.

B. Complanatae—
- 4. *S. complanata* (Collins) Cotton
- 5. *S. latifrons* M. A. Howe
- 6. *S. Cottonii* sp. nov.

C. Constrictae—
- 7. *S. moniliformis* J. Ag.
- 8. *S. hormoides* sp. nov.
- 9. *S. carnosa* Harvey
- 10. *S. Salicornioides* (Kuetz.) J. Ag.
- 11. *S. articulata* sp. nov.

Gloiophloea J. Ag.

A. Monoicae—

1. *G. Scinaioides* J. Ag.
2. *G. undulata* (Mont.) comb. nov.
3. *G. Okamurai* sp. nov.
4. *G. Halliae* sp. nov.

B. Dioicae—

5. *G. capensis* sp. nov.
6. *G. confusa* sp. nov.

C. Dubia—

7. *G.*(?) *articulata* Weber van Bosse

Pseudoscinaia gen. nov.

1. *P. Snyderae* sp. nov.
2. *P. australis* sp. nov.

VI. KEY TO GENERA AND SPECIES

A. Gonimoblasts radiating, forming a single unlobed sporogenous mass, all free

a. Utricles present forming the outer layer even in the adult, colored cells fewer or even wanting .... Scinaia.

1. Fronds cylindrical continuous .... *Cylindricae.*

x. Adult utricles strongly convex on the outer end........1. *S. furcellata.*

xx. Adult utricles flattened on the outer end.

*. 7–8 dichotomies, utricles square or slightly flattened radially, 21–25μ (T) × 20–21μ (R) ....2. *S. Johnstoniae.*

**. 9–11 dichotomies, utricles elongated radially, 8–12μ (T) × 30μ (R) ....3. *S. japonica.*

2. Fronds cylindrical, more or less constricted .... *Constrictae.*

x. Constrictions regular and frequent, utricles not palisade-like.

*. Segments long, cylindrical.

z. Utricles 20–22μ (T) × 38μ (R) ....7. *S. moniliformis.*

zz. Utricles 10–15μ (T) × 17–20μ (R) ....11. *S. articulata.*

**. Segments short, globular to obovate ....8. *S. hormoides.*

xx. Constrictions less regular and frequent, utricles palisade-like.

*. Utricles shorter, 5–8μ (T) × 20–22μ (R) ....9. *S. carnosa.*

**. Utricles more elongated, 6–9μ (T) × 28–35μ (R) ....10. *S. Salicornioides.*

3. Fronds complanate to much flattened .... *Complanatae.*

x. More slender, cystocarps scattered ....4. *S. complanata.*

xx. Broader, cystocarps more or less marginal.

*. Cystocarps mostly marginal, utricles 30–35μ (T) × 20–30μ (R)........5. *S. latifrons.*

**. Cystocarps partly marginal, utricles 16–20μ (T) × 13–17μ (R) ....6. *S. Cottonii.*

b. Utricles present, more or less conspicuous when young, but obscured by a later growth of short moniliform anticlinal filaments of colored cells .... Gloiophloea.

1. Fronds monoecious.
   x. Outer cortex 85–110μ thick ....1. *G. Scinaioides.*
   xx. Outer cortex 50–70μ thick ....2. *G. undulata.*
   xxx. Outer cortex 35–50μ thick ....3. *G. Okamurai.*
   xxxx. Outer cortex 22–40μ thick ....4. *G. Halliae.*
2. Fronds dioecious.
   x. Outer cortex 60–85μ thick ....5. *G. capensis.*
   xx. Outer cortex 40–60μ thick ....6. *G. confusa.*

B. Gonimoblasts radiating, variously grouped, the central free, the lateral longer and applied closely to the periderm ....Pseudoscinaia.
1. Plant more robust, utricles 12–20μ (T) × 20–26μ (R)..........1. *P. Snyderae.*
2. Plaut more slender, utricles 20–21μ (T) × 13–21μ (R)..........2. *P. australis*

VII. DIAGNOSES OF NEW GENUS AND OF NEW SPECIES

Scinaia Johnstoniae sp. nov.

S. atropurpurea, 8–12 cm. alta, 7–8-plo dichotoma, cylindrica, continua, lata, 3–5 mm. diam. (sicca); ramis inferne attenuatis; axillis angustis; axi obscuro (sicco); cystocarpiis minutis, sed visibilibus, dispersis; — filo axiali laxo latoque, filamentis paucis majoribus et gracilibus laxe intermixtis; epidermide cellulis magnis, decoloratis (aut "utriculis"), extus truncatis et cellulis coloratis paucis gracilibus dispersis et singulis aut tetraplo aggregatis intermixtis composito; utriculis extus truncatis, arcte appressis, superficie 5–7-goniis, in magnitudine prope uniformibus, quadratis aut leviter complanatis, parietibus tenuibus; cellulis epidermidis coloratis paucis, dispersis, 1–4-plo aggregatis; cellulis hypodermalibus in strato singulo laxoque positis, orbicularibus, 16–18μ diam.; strato corticato tenui, laxi, filamentis tenuibus percurrentibus composito; monoica(!); antheridiis dispersis, 1–4-plo aut leviter aggregatis; cystocarpiis late pyriformibus, in collum angustum abrupte contractis, 180–265μ (T) et 128–170μ (R); filamentis gonimoblasticis gracilibus, numerosissimus, e placenta parva, cellulari et breve pedicellata radiantibus corpus sporogenum late reniforme efficientibus, sporas ellipsoidales deinceps abscidentibus; peridermio tenui, prope 4 stratis cellularum pseudoparenchymaticarum composito; in California australi prope "San Pedro" a Domina H. D. Johnston et "La Jolla" a Domina M. S. Snyder atque in California inferna prope "La Paz" a Domino Vives detecta.

Scinaia japonica sp. nov.

S. atrorubra, 15 cm. alta, 9–11-plo dichotoma, modice lata, 1–3 mm. diam. (sicca), cartilaginea; axillis angustis; substantia, ut videtur, densa et carnoso-cartilaginea; axi invisibili (sicco); cystocarpiis obscuris (siccis); — filo axiali robusto, filamentis latis numerosis et filamentis gracilibus paucis composito; epidermide cellulis magnis decoloratis (utriculis) et cellulis gracilibus coloratis perpaucis composito; utriculis magnis, conformibus, stricte aggregatis, extus truncatis, superficie 5–7-goniis, vallatoideis, 30μ (R) et 8–12μ (T), parietibus radialibus tenui-rugosis (siccis); hypodermide 2–4 stratoso, cellulis globosis; strato corticato tenui filamentis gracilibus composito; antheridiis nondum detectis; cystocarpiis globuloso-pyriformibus, collo brevi abrupto contractis, 400μ (T) et 300–350μ (R); filamentis gonimoblasticis numerosissimis, gracilibus, e placenta cellulari distincta radiantibus, sporas oblongas deinceps abscidentibus; peridermio 5–7-stratoso, pseudoparenchymatico; in Japonia prope Misaki a K. Yendo lecta.

Scinaia Cottonii sp. nov.

S. roseo-rubra, 4–5 cm. alta, 5–7-plo dichotoma, moderate lata apicibus plus minusve acutis, ramis inferne attenuatis, continua, 3–10 mm. diam. (sicca); axi obscuro; cystocarpiis dispersis aut parce intra marginem positis; — utriculis prope quadratis ad rectangulo-oblongis, 16–20μ (T) et 13–17μ (R), extus truncatis; hypodermide laxo; strato corticato angusto, laxo; antheridiis in fasciculis parvis; cystocarpiis adultis nondum examinatis; in Japonia prope "Enoura" a Saido lecta.

Scinaia hormoides sp. nov.

S. atropurpurea (siccitate fuscescens), 4–6 cm. alta, 7–8-plo dichotoma, stipite perbrevi solida, ramis uniformiter et regulariter constrictis, segmentis globularibus ad obovatis, deinde oblongis, 3 mm. latis et 8–10 mm. longis; axi plus minusve obscuro (sicco); cystocarpiis dispersis, visibilibus; — filo axiali distincto, primo filamentis latis paucis parallelis composito deinde filamentis gracilibus corticantibus intertextis; epidermide cellulis magnis decoloratis (utriculis) cum cellulis gracilibus coloratis frequentis et regulariter positis interspersis, 1–4 aggregatis composito; utriculis extus truncatis, superficie 5–7-goniis, in sectione prope quadratis, 24–25μ (R) et 20–22μ (T); cellulis epidermidis coloratis numerosis, distantibus, subregulariter positis; hypodermide unistratoso, cellulis irregulariter obpyriformibus distantibus, 8–10μ diam., composito; strato corticato tenui, filamentis gracilibus sparsis composito; antheridiis in fasciculis parvis stellulatis; cystocarpiis late pyriformibus, globulis et extus abrupte contractis, 250–350μ in diametro utro; filamentis gonimoblasticis numerosissimis, gracilibus, e placenta cellularum perpaucarum orientibus, sporas brevi-ellipsoideas deinceps abscidentibus; peridermio 3–4 stratoso, pseudoparenchymatico; in insulis Hawaiiensibus a J. Rock, Dom. Minnie Reed, et E. Bailey lecta, nec non in insulis Philippensibus unde specimen a Doctore M. A. Howe benevolente communicatum examinavi.

Scinaia articulata sp. nov.

S. profunde roseo-rubra, 10 cm. alta, 7-plo dichotoma, 3–5 mm. diam. (sicca), cylindrica, regulariter et frequenter constricta, segmentis elongatis oblongo-cylindricis; ramis inferne leviter attenuatis;

axi omnino conspicuo (sicco); cystocarpiis sparsis, dispersis, moderate magnis; — filo axiali lato, robusto, denso, maxime filamentis gracilibus composito; epidermide cellulis magnis decoloratis, aut utriculis, et cellulis coloratis perpaucis composito; utriculis extus truncatis, superficie 5–7-goniis, conformibus, in sectione transversali subrectangularibus, 17–20μ (R) et 10–15μ (T), congestis; cellulis epidermidis coloratis perpaucis ut observationem evadere; hypodermide 1-stratoso, cellulis dispersis, orbicularibus, 12–14μ diam.; strato corticato tenui, laxo; antheridiis nondum detectis; cystocarpiis late pyriformibus, complanato-globulosis, abrupte in carpostomium latum breveque contractis, 215–235μ (T) et 165–170μ (R); filamentis gonimoblasticis gracilibus, numerosissimis e placenta exigua cellularique radiantibus, sporas globoso-ellipsoideas deinceps abscidentibus; in California ad oras Sanctae Barbarae lecta.

Gloiophloea capensis sp. nov.

Gl. 7–9 cm. alta, 7–11-plo dichotoma, cylindrica, continua, 1–3 mm. lata (sicca) saturate rubra, carnoso-cartilaginea; axi obscuro; cystocarpiis irregulariter aggregatis; — filo axiali tenui, laxo; cortice adulto externo 85–110μ crasso, seriebus anticlinis cellularum coloratarum moniliformiumque composito inter quibus 1–2-seriebus periclinis laxis utriculorum vacuorum collabentiumque interspersis; cortice interno 50–65μ crasso, filamentis gracilibus laxe intertextis composito; dioica; antheridiis superficiem prope totam plantarum mascularum vestientibus, singulis in apicibus cellularum gracilium positis, oblongis; cystocarpiis late pyriformibus, 65–130μ (R) et 115–150μ (T), peridermio filamentoso, 5–9 stratoso; ad oras Capitis Bonae Spei.

Gloiophloea Okamurai sp. nov.

Gl. ad 9 cm. alta, 10–11-plo. dichotoma, carnoso-cartilaginea, saturate rubra aut fere atra (sicca), cylindrica, continua, 1–1.5 mm. lata (sicca); axi invisibili; cystocarpiis irregulariter aggregatis; axi gracili; cortice adulto 70–100μ crasso, externo 30–50μ crasso, seriebus anticlinis cellularum coloratarum moniliformiumque composito inter quibus 1–2 seriebus periclinis utriculorum pyriformium ellipticorumque vacuorum et collabentium laxe interspersis, interno 35–50μ crasso, filamentis gracilibus laxe intertextis composito; monoica; antheridiis superficiem plantarum mascularum fere aut totaliter vestientibus; solitariis in apicibus cellularum gracilium; antherozoidiis oblongis; cystocarpiis pyriformibus, 105–120μ (R) (160–180μ cum collo) et 120–135μ (T), peridermio 6–7 stratoso, laxe filamentoso; ostiolo longo latoque extus contracto; ad oras Japoniae a K. Okamura et H. M. Richards lecta.

Gloiophloea Halliae sp. nov.

Gl. saturate rubra, 11–13 cm. alta, 5–7-plo dichotoma, cylindrica, continua; — filo axiali gracili; cortice externo 22–40μ lato, seriebus anticlinis cellularum coloratarum moniliformiumque composito, utriculis ovatis in stratis duobus intermixtis; strato corticato 20–45μ lato, laxissimo; monoica (!); antheridiis superficiem totam dense vestientibus, fasciculatis; cystocarpiis globuloso-pyriformibus, 100–118μ (T) et 66–88μ (R sine collo lato); peridermio filamentoso, crasso, 5–6-stratoso; ad oras ditionis "Florida," ubi detexit Domina G. A. Hall.

Gloiophloea confusa sp. nov.

Gl. saturate rubro-purpurea, 10–15 cm. alta, 10–16-plo dichotoma, 2–3 mm. diam. (sicca), ramis prorsus diam. equalibus, cylindricis, continuis; axillis moderate latis; axi invisibili; dioica!; antheridiis stratum continuum superficiale in planta mascula tota efficientibus; cystocarpiis numerosis, dispersis, obscuris; — filo axiali robusto, filamentis latis paralellis laxe agglutinatis composito; cortice externo 40–60μ lato, 5–6 stratoso, cellulis in seriebus anticlinis curtis cellularum coloratarum moniliformiumque intus magnarum rotundarumque extus successive parviorum; utriculis primo stratum proprium efficientibus, deinde seriebus anticlinis cellularum coloratarum superantibus; cortice interno (corticato) 105–120μ lato, laxo; dioica (!); antheridiis stratum compactum superficiem plantae masculae totaliter vestientibus curtis, oblongis; cystocarpiis late pyriformibus, lente ad carpostomium contractis, 250μ (T) et 280–300μ (R); filamentis gonimoblasticis numerosis, gracilibus, e placenta distincta et pauci-cellulari radiantibus, sporas ellipsoideas deinceps abscidentibus; peridermio 5–6 stratoso, pseudoparenchymatico; ad oras Pacificas Americae borealis e Columbia Brittanica usque ad Californiam australem.

PSEUDOSCINAIA, gen. nov.

Frons e disco radicali oriens, cylindrica, repetite dichotoma, apicibus obtusa et diametro prorsus equalis; — filo axiali filamentis latis et parietibus tenuibus, plus minusve agglutinatis, composito unde ramellis gracilibus oblique sursum excurrentibus, quorum partibus externis in cortice externo agglutinatis; cortice externo utriculis decoloratis composito inter quibus cellulis gracilibus coloratisque, plus minusve regularibus insertis, cuticulo distincto; filamentis gracilibus corticantibus filum axiale circumdantibus et corticem internum vestientibus; gelina diluta spatium inter filum axiale et corticem internum implente; sporangiis ignotis; antheridiis singulis aut perpaucis, inter utriculos insertis; cystocarpiis dispersis, in cortice interno orientibus et in gelina medullari plus minusve suspensis, globosis aut pyriformibus, carpostomio plus minusve elongato; filamentis gonimoblasticis in cavum cystocarpiorum prominentibus et parietes cystocarpiorum vestientibus, varie aggregatis et sporas plus minusve elongatas deinceps abscidentibus; peridermio distincto, pseudoparenchymatico; puncto vegetationis depresso. Genus in structura vegetativa ad Scinaiam congruens, sed in structura cystocarpiorum ad Galaxauram vergens.

Pseudoscinaia Snyderae sp. nov.

P. saturate rubra, 12–20 cm. alta, 9–13-plo dichtoma, cylindrica, continua, non calce incrustata; ramis non basim contractis sed in diametro e basi ad apicem prope aequalibus, 1–2 mm. latis (siccis); axi distincto (sicco); cystocarpiis numerosis, dispersis, parvis, facile visibilibus (siccis); — filo axiali robusto, filamentis numerosis, parallelis, latis firme conjunctis composito; epidermide cellulis irregularibus decoloratis (utriculis) et cellulis gracilibus coloratis composito; utriculis extus convexis et tumidis superficie (T) verisimiliter irregularibus, disjunctis et obtuse polygoniis, humile vallatoideis, 20–26μ (R) et 12–20μ (T) hypodermide 1–3(?) (maxime 1) stratoso, laxo, cellulis globosis pyriformibusve; strato corticato lato, compacto; antheridiis singulis aut in fasciculis (2–4 conjunctim) parvis, per epidermidem dispersis; cystocarpiis inferne globosis aut globoso-pyriformibus supra in carpostomio abrupte contractis, 165–185μ (T) et 130–135μ (R, sine tuba carpostomii), sed carpostomio 75–100μ longo; filamentis gonimoblasticis e placenta pauci cellulari radiantibus, mediis liberis, lateralibus parietes cystocarpiorum vestientibus, sporas longe pyriformes aliquantum aggregatas deinceps abscidentibus; peridermio 4–5 stratoso, pseudoparenchymatico; ad oras Californiae australis.

Pseudoscinaia australis sp. nov.

P. roseo-purpurea, 9–10 cm. alta, prope 10-plo dichotoma, gracilis, 1 mm. diam. (sicca); axillis latis; axi obscuro sed frequenter visibili; cystocarpiis dispersis, minutis, vix visibilibus; — filo axiali filamentis latis gracilibusque prope paralellis intermixtis, laxis; epidermide cellulis decoloratis (utriculis) et cellulis coloratis frequentis gracilibus et dispersis, composito; utriculis in sectione transversali oblongis aut quadratis, 20–21μ (T) et 13–21 (R), extus convexis tumidisque, superficie (T) verisimiliter irregulariter et obtuse polygoniis; hypodermide 2 stratoso, cellulis globosis, 4μ diam. composito; strato corticato tenui et laxo; antheridiis dispersis, maxime solitariis; cystocarpiis globosis aut complanato-globosis, abrupte in carpostomio gracili contractis, 150–175μ (T) et 130–150μ (R, sine collo carpostomii); filamentis gonimoblasticis et liberis et parietes cystocarpiorum vestientibus, sporas pyriformes varie aggregatas deinceps abscidentibus; paraphysibus absentibus; peridermio 5–6-stratoso, pseudoparenchymatico; ad oras Novae Hollandiae australis.

VIII. GEOGRAPHICAL DISTRIBUTION

In considering the matter of the geographical distribution of any group of plants, whether large or small, it is a matter of great consequence to determine generic, specific, and even varietal or form differences with as great exactitude as possible. This is of especial importance when the study of the distribution is to include some attempt to explain the facts of distribution from any physical, physiological, or evolutionary points of view. The older method has been to lump together plants of similar morphological characteristics, no matter how widely separated in locality and this has been done with little question. It seems desirable, however, to examine these widely distributed genera and species, particularly among the more highly differentiated groups such as Florideae, to determine, if possible, how far the seeming uniformity of structure extends and whether it is really one species occurring so widely distributed or whether, in reality, it may not be a group of more or less nearly related species, each occupying its own limited domain. The cases thus far carefully investigated have shown that the latter is the truth. One of the most striking examples of this is *Ceramium rubrum*. Another is, as shown above, the alleged wide distribution of *Scinaia furcellata*.

Scinaia furcellata has been reported from the Mediterranean and southwest coasts of Europe, from southern New England and Florida, from the Cape of Good Hope, and from the Hawaiian Islands, from New Zealand, Tasmania and Australia, from the west coasts of South America, from the west coasts of North America, and from Japan. As limited above, typical forms of *Scinaia furcellata* are found only in Europe and Mediterranean north Africa and on the Atlantic coasts of North America. Whatever else may be said of the various distinctions drawn between the various species in the present paper, it certainly seems demonstrated that none of them is true *Scinaia furcellata* except as noted above. The distribution of this species, then, seems natural from the point of view of occurring within limited temperature variation and with other temperate species of similar distribution. Most of the regions credited with the possession of *Scinaia furcellata* shows forms having a similar habit but of differing cortical or even of differing cystocarpic structure. In the Australian region are two species, externally resembling *Scinaia furcellata* but assigned, in the present account, to different genera, viz., *Gloiophloea Scinaioides* and *Pseudoscinaia australis*. It is yet to be satisfactorily demonstrated that any plant closely related to *Scinaia furcellata* occurs in the southern hemisphere, the only species of the genus *Scinaia* absolutely known to occur below the equator being *Scinaia moniliformis* and *Scinaia Salicornioides*, regularly constricted species of decidedly different utricular structure. At the Cape of Good Hope occurs a cylindrical and unconstricted form previously referred to *Scinaia furcellata* but which careful examination shows to be a *Gloiophloea*. This has been given the name of *Gloiophloea capensis* in this account. A study of the plants of the western coasts of the Americas shows no true *Scinaia furcellata*. The South American plant is clearly a

Gloiophloea, viz., *Gloiophloea undulata*. On the California coasts the plants usually referred to *Scinaia furcellata* and resembling it in habit are not strictly of the genus *Scinaia*. One is *Gloiophloea confusa* while the other is *Pseudoscinaia Snyderae*. Three species of *Scinaia* are credited to the Californian coast in the present account: one is *Scinaia latifrons*, a broad, flattened species; another is *Scinaia articulata*, a regularly constricted species; while the third, *Scinaia Johnstoniae*, is a robust species of entirely distinctive utricular structure, so that none of these can be considered as being closely related to *Scinaia furcellata*.

The Japanese *Scinaia furcellata* has been found to consist of two species, *Scinaia japonica*, quite distinct from the European plant, while the other is *Gloiophloea Okamurai* of the present account.

The nature of the plant referred to *Scinaia furcellata* from the Hawaiian Islands must remain unsettled for the present. It is referred to by Harvey (1846, p. 69 (text) and 1863, p. xxxviii). No unconstricted, cylindrical *Scinaia*-like plant has occurred to me among the extensive collections of marine algae from the Hawaiian Islands in my possession. On the other hand, *Scinaia hormoides*, a regularly moniliformly constricted species, closely related to *Scinaia moniliformis* of Australia, does occur there. It does not seem probable, however, that this is the plant referred to by Harvey.

The result, then, is that *Scinaia furcellata*, instead of being a nearly cosmopolitan species, is found to be restricted to a fairly wide but natural area, through which it might readily spread and with temperature limits between 15° and 25° C, being mostly between about 18° C and 25° C, a not altogether unusual temperature range for a member of the Florideae.

Attention may now be called to the accompanying table (p. 131) showing the distribution of the various members of the *Scinaia* assemblage as they are limited and established in the present paper. In the table an × indicates established range and an 0 indicates a range previously reported but shown above to be erroneous.

The northern Atlantic Ocean has three species in two genera, the southern Atlantic, if we count South Africa as Atlantic, as well as perhaps also of Indian Ocean, has two species in two genera, if we count South Africa as exclusively of the Indian Ocean in its algal affinities, which is perhaps more natural, it has none. The north Pacific Ocean, on the other hand, has nine species in three genera, and the south Pacific Ocean has four species also in three genera; or the whole

Pacific Ocean can count thirteen species distributed through all the genera recognized. The Indian Ocean strictly limited has one species, but if we include, as seems natural, South Africa and the Philippine Islands, it has four species in two genera. Taken by zones, there is none of the species reported as occurring in the frigid zones or even much below 15° C of temperature of surface waters, except possibly one species (*Gloiophloea confusa*); the tropical zone has two species, the warmer temperate or subtropical zones have ten in the north and six in the south.

	Temperate Atlantic					Temperate Indian	Tropical			Temperate Pacific						
	Mediterranean	Southwestern Europe	New England	Florida	Bermuda	Cape of Good Hope	Ceylon	Philippine Islands	Hawaii	Southeastern Japan	South Vancouver Id.	Middle California	S. and Lower California	Peru and Chili	Southeastern Australia	Northern New Zealand
S. furcellata	×	×	×	0	..	0	..	..	0	0	0	0	0	0	0	0
S. Johnstoniae	..	..	..	..	..	..	..	..	..	..	..	..	×	..	..	..
S. japonica	..	..	..	..	..	..	..	..	..	×	..	..	..	..	..	..
S. complanata	..	..	..	×	×	..	..	..	..	..	..	..	..	..	..	..
S. latifrons	..	..	..	..	..	..	..	..	..	..	..	..	×	..	..	..
S. Cottonii	..	..	..	..	..	..	..	..	..	×	..	..	..	..	..	..
S. moniliformis	..	..	..	..	..	..	..	..	..	..	..	..	..	..	×	..
S. hormoides	..	..	..	..	..	..	..	×	×	..	..	..	..	..	..	..
S. articulata	..	..	..	..	..	..	..	..	..	..	..	..	×	..	..	..
S. carnosa	..	..	..	..	..	..	×	..	..	..	..	..	..	..	..	..
S. Salicornioides	..	..	..	..	..	×	..	..	..	..	..	..	..	..	..	..
G. Scinaioides	..	..	..	..	..	..	..	..	..	..	..	..	..	..	×	×
G. Okamurai	..	..	..	..	..	..	..	..	..	×	..	..	..	..	..	..
G. undulata	..	..	..	..	..	..	..	..	..	..	0	0	0	×	..	..
G. Halliae	..	..	..	×	..	..	..	..	..	..	..	..	..	..	..	..
G. confusa	..	..	..	..	..	..	..	..	..	..	×	×	×	..	..	..
G. capensis	..	..	..	..	..	×	..	..	..	..	..	..	..	..	..	..
P. Snyderae	..	..	..	..	..	..	..	..	..	..	..	..	×	..	..	..
P. australis	..	..	..	..	..	..	..	..	..	..	..	..	..	..	×	..
×= occurence.	North Atlantic Ocean					Southwest Indian Ocean	Tropical Indian Pacific Oceans			North Pacific Ocean				South Pacific Ocean		
0 = false report.																

In regard to temperature ranges of the different species, it may be well to state our present knowledge. Two species, at least, endure a low winter temperature (down to 5° C or below in the case of *Scinaia furcellata*) but are probably seasonal in their appearance (at least in *Scinaia furcellata*). It seems probable that the other species are at least more vigorous in summer than in winter, even though they do not have to endure so much cold. Taking the distribution according to summer temperatures, the following statements as to the relation of the occurrence (so far as known) to isotheres may be of interest. Between isotheres 10°–15° C possibly two species may be found, viz.: *Scinaia furcellata* and *Gloiophloea confusa*, but probably always nearer the 15° C than the 10° C line. Six species, viz., *Scinaia furcellata*, *S. moniliformis*, *Gloiophloea Scinaiodes*, *G. undulata*, *G. confusa*, and *Pseudoscinaia australis*, are to be found between the isotheres of 15° and 20° C, while between the isotheres of 20° to 25° C are to be found eleven species, viz.: *Scinaia furcellata*, *S. Johnstoniae*, *S. japonica*, *S. latifrons*, *S. Cottonii*, *S. Salicornioides*, *S. articulata*, *Gloiophloea Okamurai*, *G. capensis*, *G. confusa*, and *Pseudoscinaia Snyderae*. These are subtropical species. The tropical species occurring between the isotheres of 25° and 30° are five, viz., *Scinaia Johnstoniae*, *S. complanata*, *S. hormoides*, *S. carnosa*, and *Gloiophloea Halliae*. The true tropical species is *S. carnosa* because it lives constantly in tropical heat; *Scinaia hormoides* is at times subject to a temperature of 23°–24° C. *Scinaia complanata* and *Gloiophloea Halliae* have about the same temperature relations as *Scinaia hormoides*, while *Scinaia Johnstoniae* endures much colder waters still (winter temperature as low as 14° C at least).

The *Scinaia* assemblage, then belongs to the warmer waters, mostly being the subtropical waters (20°–25° C) and entirely absent from the colder waters. They may be contrasted with the other members of the Chaetangiaceae. The species of *Galaxaura* are all tropical, or at least very nearly so. The single species attributed to *Actinotrichia*, while widespread, is, however, strictly tropical. The ill understood genus *Chaetangium* has ten species, only one of which is tropical. Three of these species, however, are subtropical, i.e., inhabiting waters between 20–25° C. Four species are credited with inhabiting waters between 15° and 20° C, and the other two with inhabiting waters between 5° and 10° C.

While the temperature of the water has the absorbing interest as presumably regulating and restricting the limits of the particular distribution of the species, there are certain general facts of distribution which are generally emphasized and which, also, are usually looked upon as throwing light upon the origin and spread of the various members of such a group as the *Scinaia* assemblage.

In the European-East North American region, viz., the North Atlantic, are to be found two (possibly three) species, viz., *Scinaia* *furcellata*, *Sc. complanata*, and the Florida species, *Gloiophloea Halliae*. There is then a representative of both the cylindrical and the complanate groups of true *Scinaia* and one representative of *Gloiophloea*. In the Northwest North America-Northeast Asia region, viz., the North Pacific (i.e., above the tropic of Cancer), on the other hand, there are eight (out of nineteen) species and all three genera represented. In fact, no group or subgroup lacks representation, even that of the constricted *Scinaia* species having one representative. This general mixture of representative forms will probably be found characteristic of many other groups of algae as well. It is certainly very characteristic of the Laminariaceae (cf. Setchell, 1893, pp. 355–358). Two other areas stand out and are more or less related, viz., those of the Australian seas or South Pacific (south of the tropic of Capricorn) and the Indian Ocean (including the Cape region of South Africa). The South Pacific region possesses three species representing all three genera, but the species of *Scinaia* is of the regularly constricted type. The Indian Ocean (or South Atlantic?) temperate region is known to have two species, one a constricted *Scinaia*, the other a *Gloiophloea*. The intermediate tropical regions between these two south temperate (or subtropical) regions and the north temperate and subtropical Pacific regions, viz., the tropical Indian Ocean and tropical Pacific, show only two species, both of the constricted type of *Scinaia*.

In summary, then, it may be said that *Scinaia* seems to be essentially a northern hemisphere type, since nine of its eleven species are confined to a position north of the equator and these represent all the various types of structure within the genus, while on the other hand only two species of *Scinaia*, and those two restricted to the constricted type, are found south of the equator. Of the other genera, *Gloiophloea* has three species in the southern hemisphere and three in the northern while *Pseudoscinaia* has one species in each hemisphere. Yet, arguing from the similar distribution of Pacific and Indian Ocean Laminariaceae, the center of distribution is probably austral and the northward extension along the western coasts of the Americas to Japan a later development. In fact, the *Gloiophloea* and *Pseudoscinaia* species, in their distribution, call strongly to mind the distribution of the Lessonioid and Ecklonioid Laminariaceae in their relation to members of the other tribes of kelps. That this is also true of certain other families and genera of marine algae is also apparent and will give an added interest to the study of antarctic and australio-indio-pacific forms as compared with those of the North Atlantic and Arctic Oceans. The occurrence of a *Gloiophloea* in the North Atlantic (Florida coast) seems, from this point of view, anomalous. It is to be suspected, however, that an increase in our knowledge may show other similar cases.

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EXPLANATION OF PLATES

PLATE 10

Scinaia furcellata (Turner) Bivona

Fig. 1. Radial section through the cortex of the specimen appearing to be Turner's type, in the Herbarium of the Royal Botanical Gardens at Kew (dried specimen). × 391 diam.

Figs. 2–5. Radial sections through the cortex of a plant collected at Helgoland, August 25, 1905, by Dr. Paul Kuckuck, showing different stages in the development (alcoholic material). × 391 diam.

Fig. 6. Radial section through the cortex of a plant collected at Helgoland by Dr. Paul Kuckuck, August 16, 1905 (dried specimen), showing mature utricles and antheridia. × 391 diam.

Fig. 7. Section through the cortex of a plant collected at Antibes, France, by Dr. W. G. Farlow (Herb. Univ. Calif., No. 96345, dried specimen), showing adult utricles and antheridia. × 391 diam.

Fig. 8. Radial section through the cortex of a plant collected at Palermo, Italy, by Angelo Mazza, May 22, 1902 (Herb. Univ. Calif., No. 90897), showing mature utricles and antheridia (dried specimen). × 391 diam.

Fig. 9. Radial section through the cortex of a specimen collected at Naples, Italy, by Miss Minnie Reed, showing small utricles and antheridia (alcoholic material). × 391 diam.

Fig. 10. Sketch from another part of same plant as shown in figure 9, showing larger utricles. × 391 diam.

Fig. 11. Radial section through the cortex of a plant collected at Gay Head, Massachusetts, by C. P. Nott, August 10, 1895 (Herb. Univ. Calif., No. 96350, dried specimen). × 391 diam.

Fig. 12. Tangential view (of surface) of same plant as shown in figure 11, showing disassociated tips of utricles and colored cells. × 391 diameters.

Gloiophloea Halliae sp. nov.

Fig. 13. Radial section through the cortex of a plant in Herb. Farlow, collected at St. Lucie, Florida, by Mrs. G. A. Hall, April 1, 1899 (dried specimen). × 391 diam.

All the figures drawn by Miss Helen M. Gilkey under the direction of W. A. Setchell.

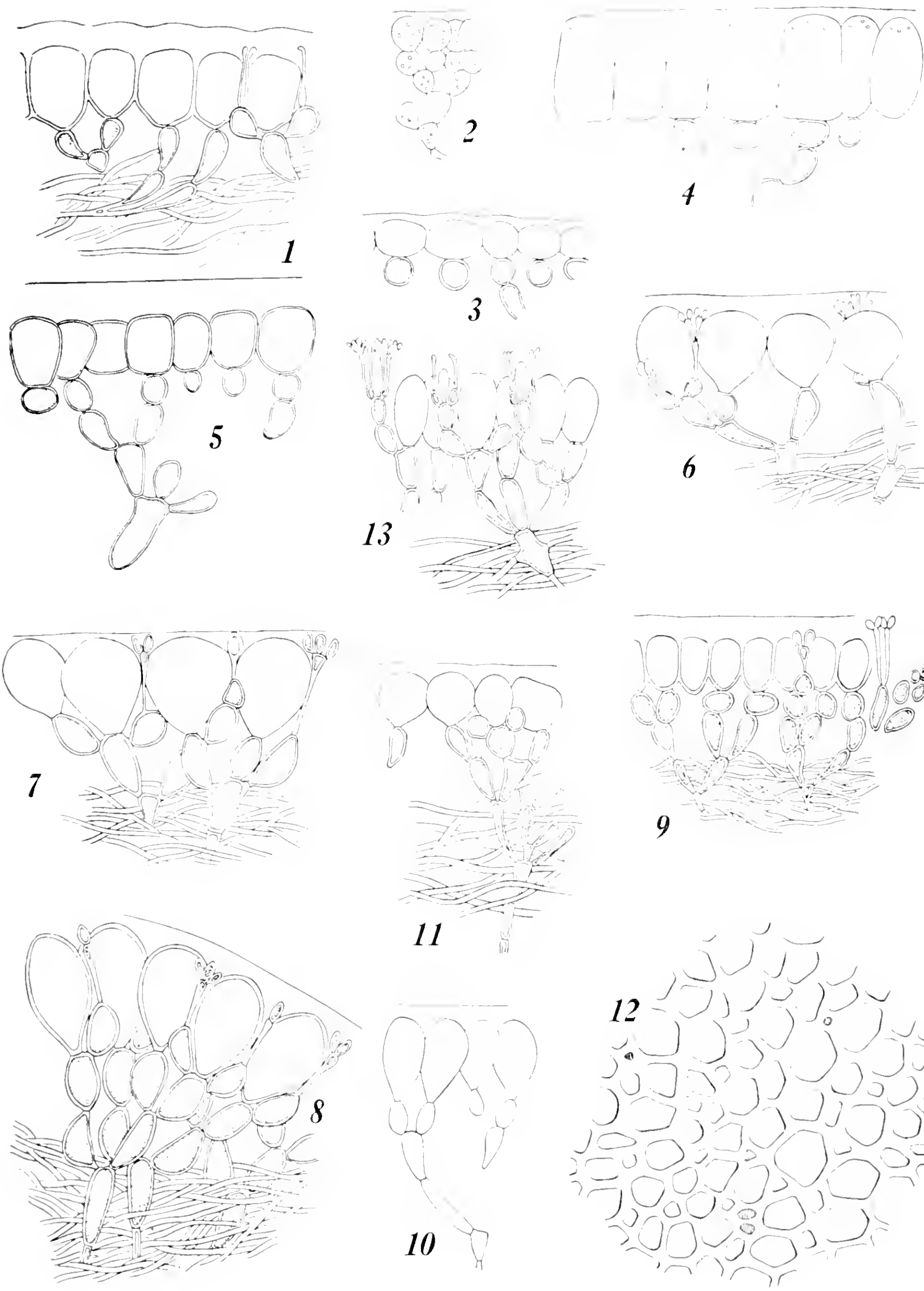
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PLATE 11

Scinaia Johnstoniae, sp. nov.

Fig. 14. Radial section through the cortex of a plant collected at San Pedro, California, by Mrs. H. D. Johnston, June 28, 1900 (Herb. Univ. Calif., No. 96356, dried specimen). The utricles in this drawing are less flattened than in the next, but flattened utricles also occur.

Fig. 15. Radial section through the cortex of a plant collected at La Jolla, California, by Mrs. M. S. Snyder (Herb. Univ. Calif., No. 90727, dried specimen), showing extreme of flattening of utricles and also antheridia.

Scinaia japonica, sp. nov.

Fig. 16–18. Radial sections through the cortex of a plant collected at Misaki, Japan, by Professor K. Yendo, April, 1900 (Herb. Univ. Calif., No. 90835, dried specimen). Figure 17 shows the peculiar striae in the walls of the utricles due to wrinkling. The sections shown in figures 17 and 18 have not recovered their shape as well as the sections shown in figure 16.

Scinaia complanata (Collins) Cotton

Fig. 19. Radial section through the cortex of the plant distributed under No. 836 Phycotheca Boreali-Americana, collected at Indian River Inlet, Florida, by Mrs. G. A. Hall, April, 1899 (dried specimen in writer's copy). × 391 diam.

Fig. 20. Radial section through the cortex of a plant in Herb. Farlow, collected at Gilberts Bar, Florida, by A. H. Curtiss, March, 1897 (dried specimen). × 391 diam.

Fig. 21. Radial section through the cortex of another plant collected at the same time by the same collector (Herb. Univ. Calif., No. 96361, dried specimen). × 391 diam.

Fig. 22. Radial section through the cortex of a plant in Herb. Farlow, collected at Coopers Island, Bermuda, by W. G. Farlow in 1881 (dried specimen). × 391 diam.

Scinaia latifrons M. A. Howe

Fig. 23. Radial section through the frond of a plant collected at San Pedro, California, by Miss Sarah P. Monks (Herb. Univ. Calif., No. 132817, dried specimen). × 391 diam. The section did not fully recover its original proportions.

Scinaia Cottonii sp. nov.

Fig. 24. Radial section through a specimen in Herb. Holmes (number 9) at the University of Birmingham, collected at Enoura, Japan, by Saido (dried specimen). × 391 diam. The utricles and antheridia are very well shown.

Scinaia carnosa Harvey

Fig. 25. Radial section through the cortex of a plant distributed by Harvey under No. 38 of his Algae of Ceylon (Herb. Univ. Calif., No. 77093, dried specimen). × 391 diam. This represents a younger state of the utricles than that represented in the next.

Fig. 26. Radial section through the cortex of another plant distributed by Harvey under the same number (38, Alg. Ceylon) and preserved in Herb. Farlow (dried specimen). × 391 diam.

Fig. 27. Radial section through a plant dredged near Observation Island (No. 5165), Philippine Islands, by the U.S. Fish Comm. Str. "Albatross," February 24, 1908, and submitted for determination by F. S. Collins (dried specimen). × 391 diam. This plant is referred to *Scinaia carnosa* with considerable doubt.

Scinaia Salicornioides (Kuetz.) J. Ag.

Fig. 28. Radial section through the cortex of a plant collected on the coast of Natal by Dr. H. Becker and preserved in Herb. Weber-van Bosse (dried specimen). × 391 diam.

Fig. 29. Sketch of another radial section from the same plant as represented in figure 28, to show variation in utricles. × 391 diam.

Fig. 30. Radial section through the cortex of a plant collected at "The Kowie," South Africa, by Dr. H. Becker and preserved in Herb F. S. Collins (dried specimen). × 391 diam.

All the figures were drawn by Miss Helen M. Gilkey under the direction of W. A. Setchell.

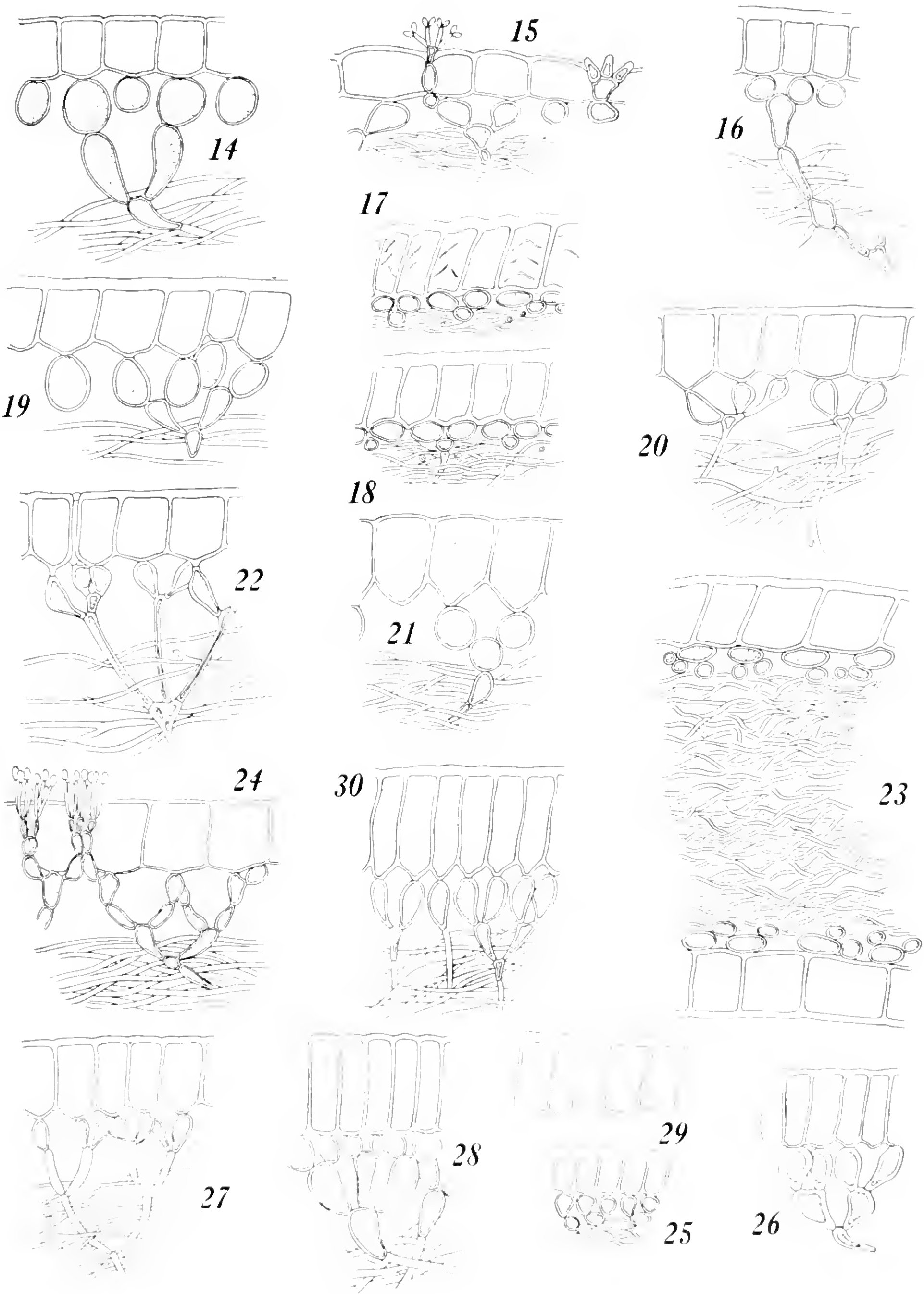
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PLATE 12

Scinaia moniliformis J. Ag.

Fig. 31. Habit sketch from a "rubbing" made by the writer of a cotype specimen in Herb. British Museum of Natural History and collected at Port Phillip Heads by J. Bracebridge Wilson (dried specimen). Natural size.

Fig. 32. Radial section through the cortex of same specimen. × 391 diam.

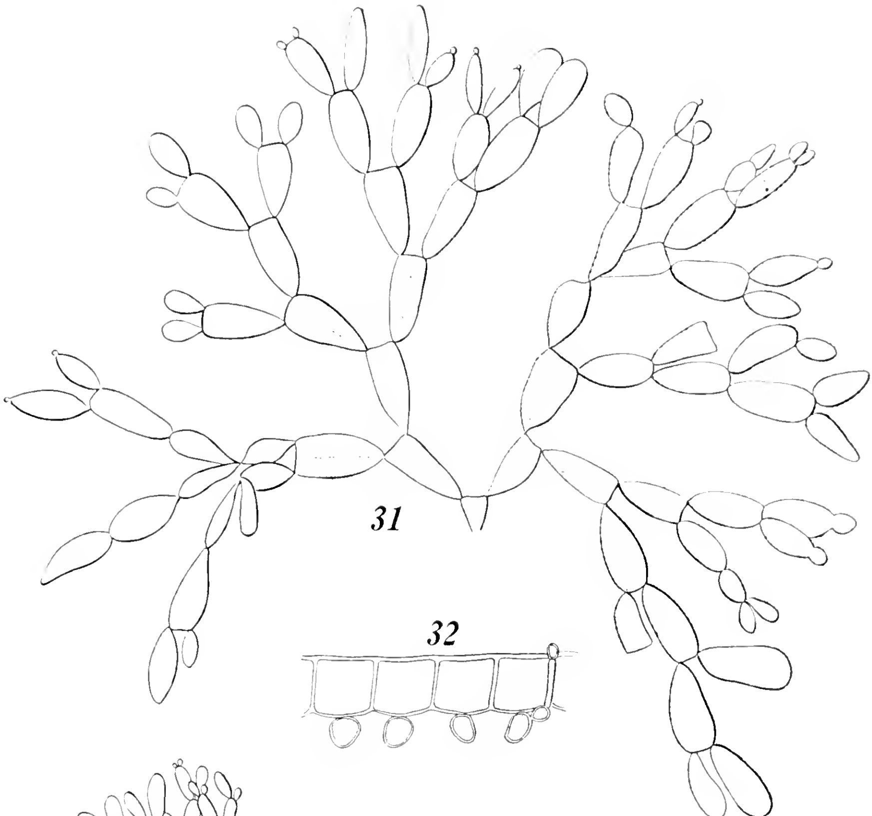
Scinaia hormoides sp. nov.

Fig. 33. Habit sketch from a plant collected at Haleiwa, Oahu, Hawaiian Islands, by Mr. J. T. Rock, May 2, 1908 (dried specimen). Natural size.

Fig. 34. Radial section through a plant collected at Haleiwa by Miss Minnie Reed (No. 985, formalin specimen). × 391 diam.

Fig. 35. Radial section of a plant collected at Puro, Province of La Union, Luzon, Philippine Islands, by E. Finix (Philippine Bureau of Science, No. 13014, Herb. Univ. Calif., No. 163388, dried specimen). × 391 diam.

All the figures were drawn by Miss Helen M. Gilkey under the direction of W. A. Setchell.



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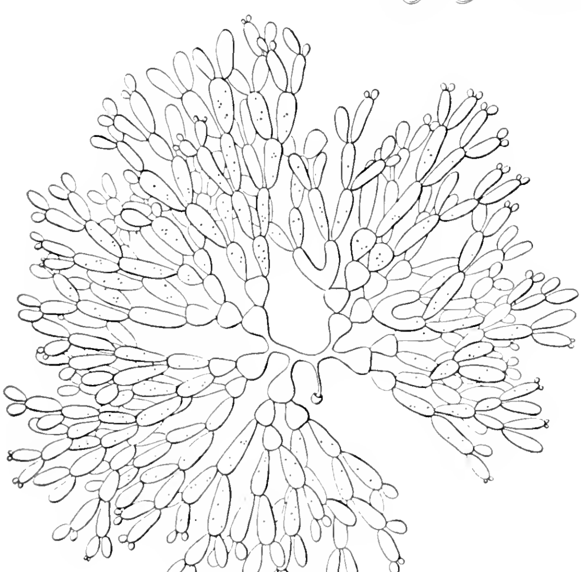

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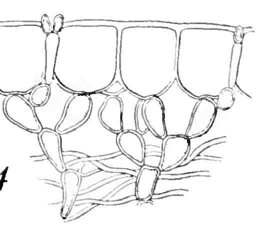

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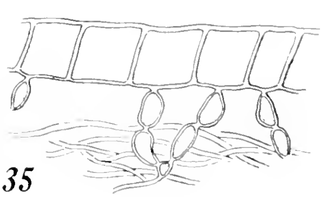

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PLATE 13

Scinaia hormoides sp. nov.

Fig. 36. Habit sketch of a plant collected at Haleiwa, Island of Oahu, Hawaiian Islands, by J. T. Rock (No. 43, dried specimen). Natural size.

Fig. 37. Surface view of a portion of a plant collected at Haleiwa, Island of Oahu, Hawaiian Islands, by Miss Minnie Reed (No. 985, formalin material). × 391 diam.

Scinaia moniliformis J. Ag.

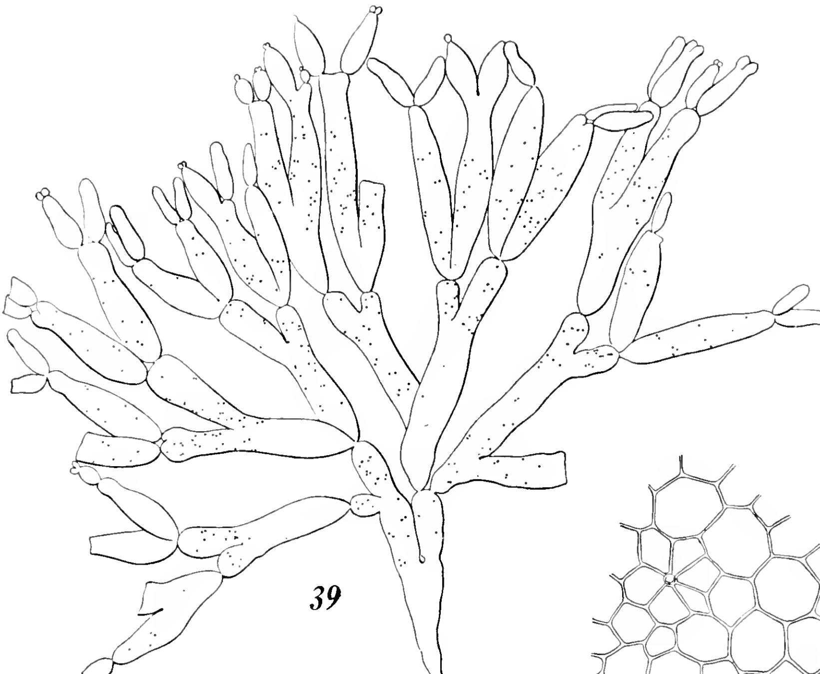
Fig. 38. Surface view of a portion of a plant in the British Museum of Natural History, collected at Port Phillip Heads by J. Bracebridge Wilson (dried specimen). × 391 diam.

Scinaia articulata sp. nov.

Fig. 39. Habit sketch of a plant in Herb. F. S. Collins, sent from Santa Barbara, California, by Mr. J. W. Calkins (dried specimen). Natural size.

Fig. 40. Radial section through a portion of the plant represented in figure 39 (dried specimen). × 391 diam.

All the figures were drawn by Miss Helen M. Gilkey under the direction of W. A. Setchell.



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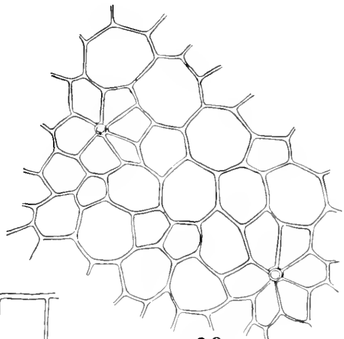

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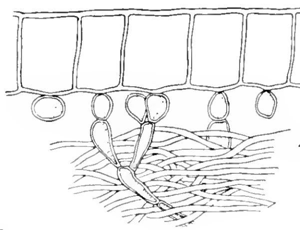

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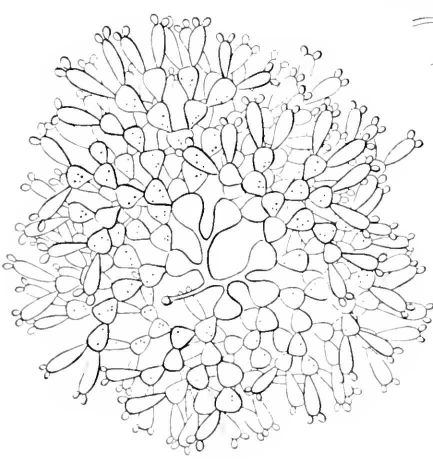

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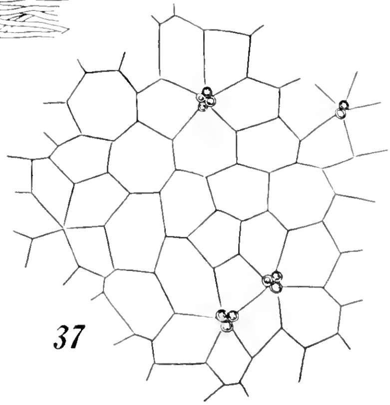

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PLATE 14

Scinaia furcellata (Turner) J. Ag.

Fig. 41. Radial section through the cortex and mature cystocarp of a plant collected at Helgoland by Dr. Paul Kuckuck, August 25, 1905 (alcohol specimen). × 391 diam.

Fig. 42. Young cystocarp (isolated) of a plant collected at Antibes, France, by W. G. Farlow (dried specimen, Herb. Univ. Calif., No. 96345). × 391 diam.

Fig. 43. Somewhat older cystocarp from same plant as shown in figure 42, isolated and slightly crushed. × 391 diam.

Gloiophloea confusa sp. nov.

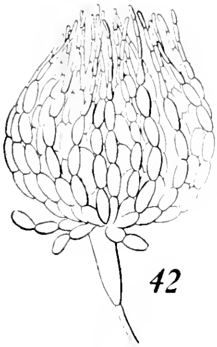
Fig. 44. Radial section through the cortex of an antheridial plant collected at Monterey, California, by W. A. Setchell, June 11, 1901 (specimen killed in corrosive sublimate and preserved in 2 per cent formalin solution). × 391 diam.

Fig. 45. Radial section through the cortex of a cystocarpic plant collected at Moss Beach, San Mateo County, California, by Dr. Carl Skottsberg (alcoholic specimen). × 391 diam.

Fig. 46. Radial section through the cortex of an antheridial plant collected at San Pedro, California, by W. A. Setchell, December, 1895 (dried specimen, Herb. Univ. Calif., No. 96351). × 391 diam.

Fig. 47. Radial section through the cortex of a cystocarpic plant, collected at Moss Beach, San Mateo County, California, by Dr. N. L. Gardner, December, 1908 (dried specimen, No. 2104). × 391 diam.

All the drawings were made by Miss Helen M. Gilkey under the direction of W. A. Setchell.



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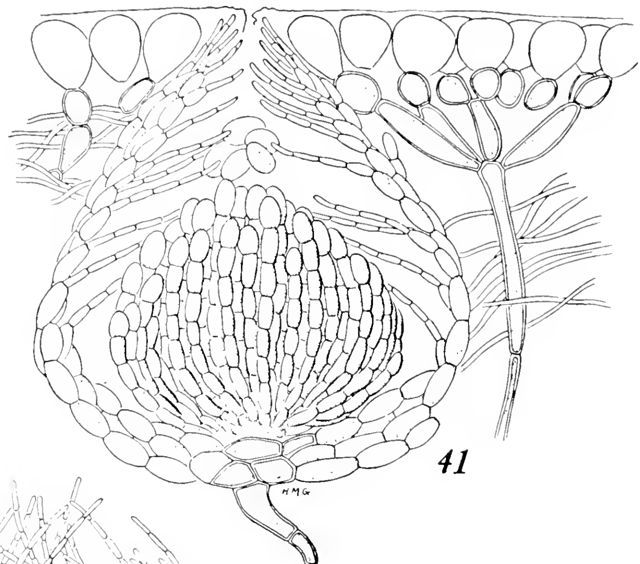

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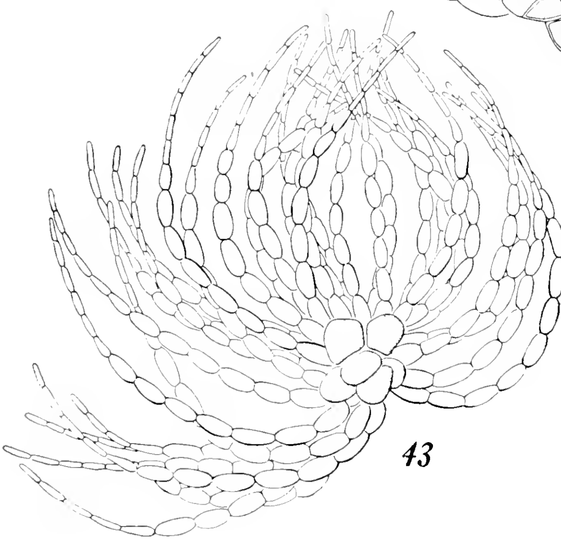

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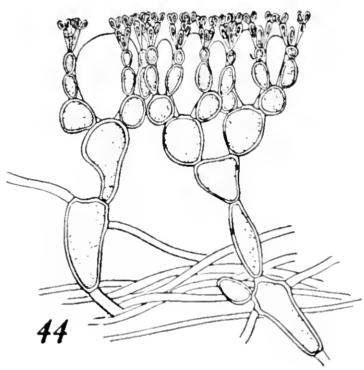

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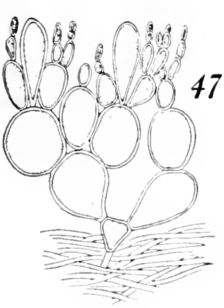

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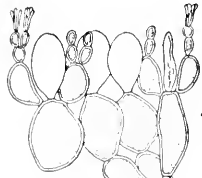

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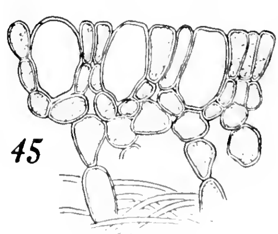

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PLATE 15

Gloiophloea Scinaioides J. Ag.

Fig. 48. Fragment of a radial section through the cortex of a plant in Herb. Farlow, collected at the Bay of Islands, North Island of New Zealand, by Dr. Sven Berggren, and distributed by J. G. Agardh under the name of *Scinaia furcellata* (dried specimen). × 391 diam.

Gloiophloea undulata (Mont.) comb. nov.

Fig. 49. Radial section through the cortex of a plant in Herb. Montagne in the Mus. d'hist. nat. at Paris, collected by Gaudichaud on the voyage of the "Bonite" and consequently assumed to be the type, or at least a cotype (dried specimen). × 391 diam. The drawing shows the structure of the cortex, antheridia, and a portion of a cystocarp.

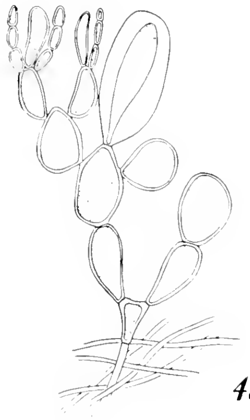
Gloiophloea Okamurai sp. nov.

Figs. 50–53. Radial section through the cortex of three different plants distributed as *Scinaia furcellata* by K. Okamura under No. 2 of his Algae Japonicae Exsiccatae and collected at Enoshima (Sagami), Japan, March, 1898. Figures 50 and 51 are from the specimen in the writer's copy and represent younger cortices, while figures 52 and 53 are each from a different specimen in Herb. Farlow and represent adult conditions (dried specimens). × 391 diam.

Figs. 54, 55. Radial sections from a specimen in Herb. Farlow, collected at Kamakura, Japan, by Dr. H. M. Richards, June 12, 1900 (dried specimen). × 391 diam.

Fig. 56. Radial section through the cortex of a specimen in Herb. Farlow, collected at Enoshima, Japan, by H. M. Richards, June 14, 1900 (dried specimen). × 391 diam.

All the drawings were made by Miss Helen M. Gilkey under the direction of W. A. Setchell.



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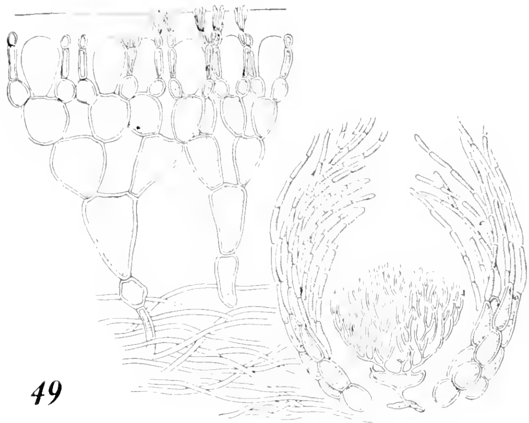

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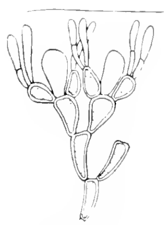

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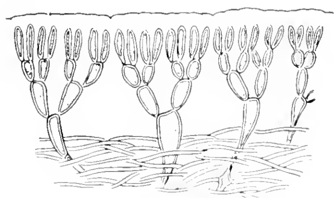

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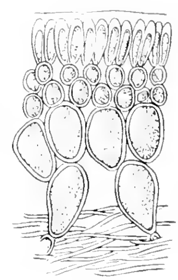

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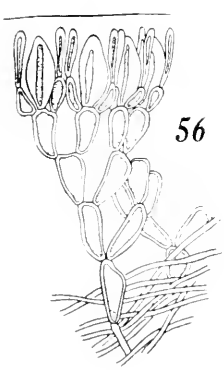

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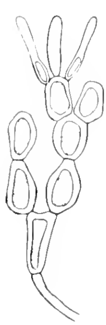

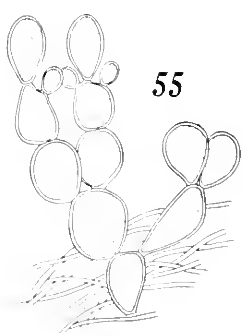

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PLATE 16

Gloiophloea Okamurai sp. nov.

Fig. 57. Radial section through the cortex of a plant in Herb. Farlow, distributed under No. 2 by K. Okamura in his Algae Japonicae Exsiccatae as *Scinaia furcellata*, and collected at Enoshima (Sagami), Japan, March, 1898 (dried specimen). × 391 diam. The drawing shows adult cortex and a nearly median longitudinal section of a cystocarp.

Gloiophloea capensis sp. nov.

Fig. 58. Radial section through the cortex of a plant collected on the coast of Cape Colony by Mr. J. Burtt Davy (dried specimen). × 391 diam. The collapsed utricles are not shown.

Fig. 59. Radial section of a plant in Herb. Farlow collected at the "Cape of Good Hope" by Poeppig (dried specimen). × 391 diam. The adult utricles of two series and the young antheridial filaments are shown.

Pseudscinaia Snyderae gen. et sp. nov.

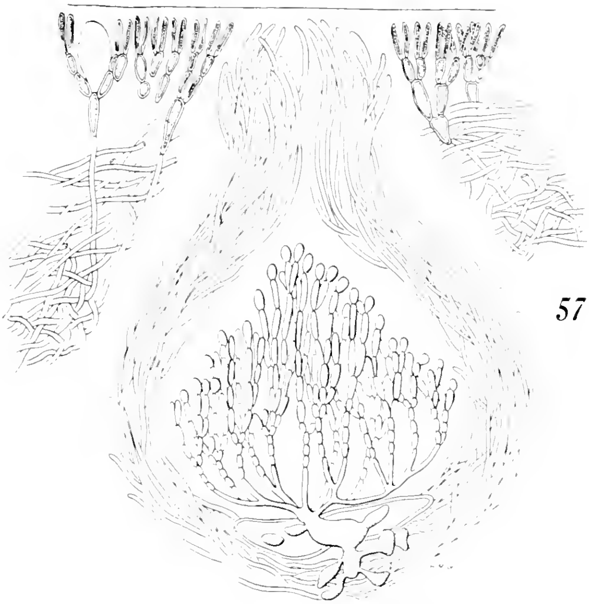
Fig. 60. Radial section through the cortex of a plant collected at San Pedro, California, by Dr. N. L. Gardner, September, 1908 (dried specimen). × 391 diam.

Fig. 61. Radial section of the same plant as shown in figure 60, showing a cystocarp in nearly median longitudinal section (dried specimen). × 391 diam.

Pseudoscinaia australis gen. et sp. nov.

Fig. 62. Radial section through the cortex of a plant in Herb. University of California (No. 74793), collected at Port Phillip Heads, Australia, by J. Bracebridge Wilson, January 17, 1893 (dried specimen). × 391 diam.

All the drawings were made by Miss Helen M. Gilkey under the direction of W. A. Setchell.



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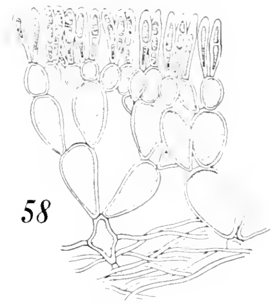

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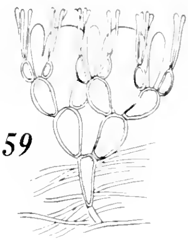

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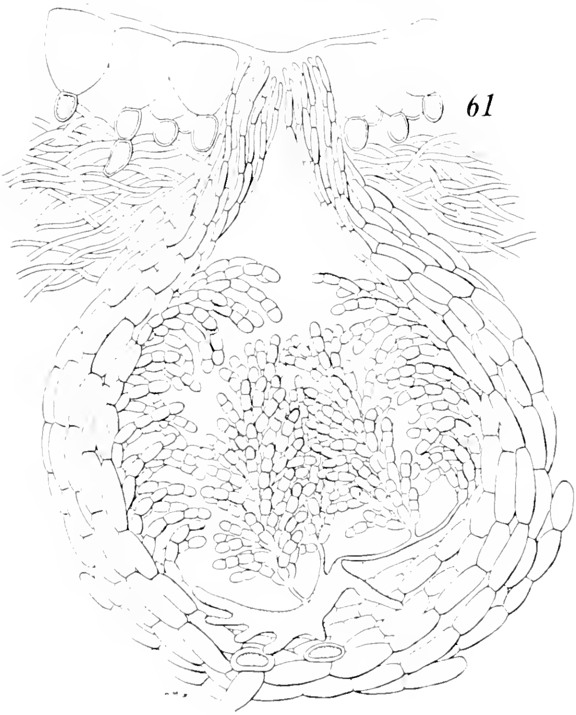

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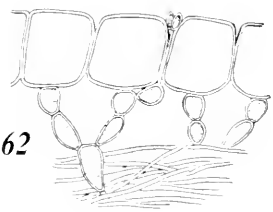

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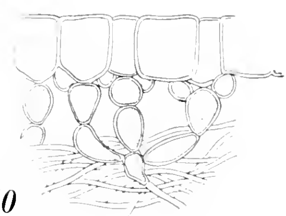

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UNIVERSITY OF CALIFORNIA PUBLICATIONS
IN
BOTANY

Vol. 6, No. 6, pp. 153-164, pls. 17-19 Issued May 7, 1915

NOTES ON PACIFIC COAST ALGAE
I. *PYLAIELLA POSTELSIAE* N. SP., A NEW TYPE IN THE GENUS *PYLAIELLA*

BY
CARL SKOTTSBERG

In a paper entitled "New and little known brown algae of the Pacific Coast" (published in *Erythea*, Vol. VII, 1899), De Alton Saunders has reported *Leptonema fasciculatum* Reinke from the coast of California. When collecting with Professor W. A. Setchell at the Farallon and Monterey Bay in 1913 I found numerous small brown tufts on *Postelsia*, and Professor Setchell informed me that this was the plant called *Leptonema fasciculatum* by Saunders. Being familiar with that species, whose occurrence on the Californian coast was rather surprising, I at once looked at some fresh material and found that, although it bore a certain resemblance to *Leptonema*, there were important points of difference. After my return to Sweden I undertook a more careful investigation, the result of which is published here.

The alga in question forms dark brown tufts 5–10 mm. long on the stems and leaves of *Postelsia palmaeformis* Rupr. I have not seen it on other algae or on any other substratum. Saunders says that occasionally it grows also on mussel-shells in the vicinity of *Postelsia*. I have no right to doubt the correctness of this statement, but at the same time it has to be confirmed by a critical examination, for everybody knows that many of the tiny brown algae look alike on a superficial glance.

Several semi-endophytic species are reported to be confined to one special host plant. We are far from understanding why they should be so exclusive in their choice of habitat, as they are not true parasites

In this special case one might suppose that the epiphyte is adapted to the same kind of locality as *Postelsia*, the exposed upper or even supra-littoral rocks, where the surf is very constant and violent and where *Postelsia* forms a pure or almost pure stand. If Saunders' statement as to his plant also inhabiting "mussel-shells in the vicinity of tufts of *Postelsia*" is right, it forms a support for our theory that it is the nature of the locality more than an adaptation to life on *Postelsia* that explains why the epiphyte does not occur on other algae in other situations.

The tufts of "*Leptonema*" are sometimes very dense, covering only a very small area, sometimes, especially on the stems of the host, assuming the shape of somewhat larger patches of a short velvety indument. They consist of innumerable simple filaments, monosiphonous while sterile (pl. 17). The basal part is formed by branching, densely interwoven filaments, creeping on the surface of the host or penetrating between the cortical cells. How this penetration first takes place I am not able to tell—whether the filaments are able to break through the thick cuticle or whether, what I think more probable, they take advantage of small epidermal fissures or irregularities. It is difficult, either by scratching off small tufts and dissecting them or by cutting sections through the cortex of *Postelsia*, to get a clear view of the basal parts. The creeping filaments seem to grow by apical cells. Narrow, thick-walled hyphae penetrate deeper between the cortical cells, but they remain intercellular, and we have no reason to believe that the plant is a true parasite. On plate 18 sections with various fragments of basal layers with erect filaments are figured, growing quite superficially or in small cracks in the cortex. Figure 4 shows a piece scraped off and seen from the lower surface, the prostrate filaments being dotted. It has a strong resemblance to certain *Myrionema* disks, which become more or less dissolved when growing between paraphyses or assimilators of a host plant. The conditions are different here, consequently I believe that the disk figured on plate 18 belongs to the same species. I have seen long filaments producing the characteristic sporangia grow up from similar disks. However, though the dimensions of our "*Leptonema*" vary to a certain extent, some of the disks that carry narrower filaments with shorter basal cells may belong to another organism, possibly a *Myrionema*. I did not, however, see any hairs or reproductive organs developed.

In the system of erect filaments there is a distinct difference between long and short branches. Long branches come only from the prostrate threads; in a few cases I have seen them forked quite near their base. The long branches remain simple or carry short ones. The lowest cells differ from the rest by their thicker walls. They are two to four times as long as wide, measuring 12 to 15μ across. From these cells scattered hyphae branch off, growing downwards and serving, as usual, to fix the tufts better (pl. 19, fig. 1). Then follow shorter and slightly wider cells, 15–20μ across. All the lower cells are quite cylindrical; only higher up a slight constriction at the septa can be noticed. In very young filaments there is little or no difference between different parts, but as they become mature the long and thin basal cells, which do not divide any more, become more obvious. The meristematic part is situated near the base, but generally does not form a narrowly circumscribed zone. In the long filaments we observe scattered places where the cell division is more active than in others. This is the same mode of growth as in other Ectocarpaceae.

The erect filaments frequently remain quite unbranched, or, when they have reached a considerable length, give off pairs of short branchlets under an angle of 60–80°. Saunders speaks (p. 40) of two forms of this plant, one branched, one unbranched; but filaments with and without branches occur mixed together on the same individual (pl. 17). The branches occur in regular pairs and these are separated by long stretches of unbranched cells. It happens that only one branch of a pair is developed (pl. 19, fig. 2). Two or three times I have seen the cell carrying a pair of branches divided by a longitudinal wall[1] (pl. 17), but otherwise the sterile filaments remain strictly monosiphonous. The short branches never branch again, and I have never seen one of them develop into a long filament. Thus there is *one* generation of long and *one* of short branches, which gives to this alga a very characteristic appearance. I have not found any hairs.

The cells contain numerous chromatophores in the shape of small round disks, as in so many other Phaeophyceae (pl. 19, fig. 3).

Only plurilocular sporangia are known. As a rule, the formation of sporangia begins when the filaments have attained a considerable, perhaps their maximum, length. But it happens, in this species as in many others, that a young and still very short filament may become fertile (pl. 19, fig. 1). The divisions begin in the apical part of the thread and progress in basipetal order. This is easily understood from plate 17. Generally all the cells, except those in the basal part,

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[1] Possibly in these cases the cell in question was about to form spores, which otherwise never happens.

become fertile. They increase considerably in thickness, measuring 21–33μ across. The short branches, first the upper (older), then gradually the lower (younger), are transformed, at the same rate and in the same manner, to unbroken chains of sporangia; they appear slightly club-shaped (pl. 19, figs. 4, 5). Only the basal cell remains sterile, and the mother-cell of a pair of branches never seems to form spores; sometimes one or two cells above and below also are sterile. Each full-grown cell gives rise to 32 or 64 zoospores, about 4–5μ across.

The reason why Saunders regarded this plant as conspecific with Reinke's *Leptonema* was that, in both, the upper part of large erect threads are transformed into plurilocular sporangia. But he emphasized the fact that unilocular sporangia—being basal in *Leptonema* as in other Elachistaceae—must be discovered before the identity can be proved. However, even if such organs were found, making it possible to regard the plant as a *Leptonema*, it is not identical with *L. fasciculatum*, nor with any other known species of that genus. The process in the formation of sporangia is different in the two cases, and the ramification of the long filaments has no correspondence at all in *Leptonema*. And even if the mode of growth is about the same, it does not happen here, as in *Leptonema*, that the vegetative divisions soon become localized in the basal zone; only when, in our plant, the entire upper parts have become fertile there remains only the basal zone where cell divisions can take place.

We cannot include our plant within the same family as *Leptonema*. Its characters speak entirely in favor of the Ectocarpaceae, with *Ectocarpus*, *Streblonema* and *Pylaiella*. Those authors who regard the latter genera as sections or subgenera of *Ectocarpus* in a wider sense would probably not hesitate to bring our species to that same genus. It is of course not possible to bring it to *Euectocarpus*, in spite of the fact that plurilocular sporangia sometimes, though only very occasionally, are formed by a series of cells in the filaments, which otherwise always remain sterile, e.g., in *E. tomentosus* (Huds.) Lyngb. (see Boergesen, *Marine algae of the Faeroes*, Copenh., 1902, p. 414, fig. 43). We have as little reason to compare it with *Streblonema*, even if we include *E. tomentosoides* Farl. For, in spite of the "Phycocelis-stage" of this species (see Kuckuck, *Ueber Polymorphie bei einigen Phaeosporeen*, Festschrift für Schwendener, Berlin, 1899), the lateral, "ectocarpoid" sporangia is the typical type in *Streblonema*.

So far as the author is able to judge, there are, however, no serious obstacles against bringing our plant to *Pylaiella*, as a new species.

I regard this genus as distinct from *Ectocarpus*. I was inclined to give it a more independent position, as the type of a new genus; but after having discussed the matter with Professor P. Kuckuck I have abandoned this first idea.

Bornet divided the genus *Pylaiella* in two subgenera, *Eupylaiella* Born.[2] and *Bachelotia* Born. ("Note sur l' *Ectocarpus fulvescens* Thuret," *Rev. génér. de bot.*, 1889), the first having numerous, richly branched, erect filaments, the latter scarce, with very few branches, and including three species—*P. fulvescens* (Thur.) Born., *P. Hooperi* (Crouan) De Toni, and *P. nana* Kjellm. Intercalary chains of unilocular sporangia have been found in them all, plurilocular only in *P. nana*, where they have a peculiar shape, being branched as in *Streblonema fasciculatum* Thur. Unilocular sporangia are unknown in our new species, and there seems to be little hope of finding them. Saunders collected sterile material in the spring, and late in August he found plurilocular sporangia He suggests that the other kind may occur later in the season. On my material, collected on September 27, there is no trace of them, nor is anything of the kind to be seen on material collected by Professor Setchell on November 4. Just as its host, the epiphyte is probably an annual species, disappearing with *Postelsia* during the winter. But even if unilocular sporangia were to be discovered, arranged like the other kind, I can not find a suitable position for the new species in either of the two subgenera, for it differs from both in the position of the sporangia and in the ramification. The plurilocular sporangia are not intercalary, but terminal, developed in a basipetal order. In some plants I have seen one or two sterile cells breaking the otherwise continuous chain, not counting the mother-cells of the branchlets. It is only the character of these latter cells that would justify the use of the term "intercalary" in this case, and, further, the fact that the different "internodes" are, to a certain extent, independent of one another, so that cell divisions may have gone very far in a lower internode before all the sporangia in the one above it are mature (pl. 19, fig. 4). In conformity with this state of things, the divisions in a pair of branches may have almost come to an end, and the upper sporangia already be emptied, before the fertilization has advanced to the base of the internode just above (pl. 19, figs. 4, 5).

There is no *Pylaiella* in which we have a distinction between long and short branches such as in our new species. In *P. varia* Kjellm.

[2] The name given by De Toni in Syll. Alg. 3, p. 351.

(*Algae of the Arctic Sea*, p. 282, pl. 27) two kinds of branches occur, but the short ones do not form a separate generation, but occur on long branches of all orders. They become transformed into sporangia; Kuckuck calls them "fertile Kurztriebe" ("Beiträge zur Kenntnis der Ectocarpus-Arten der Kieler Föhrde," *Botan. Centralbl.*, 48, 1891, p. 38). The erect filaments of the *Bachelotia* species sometimes branch again, but the branches then are of the same nature as the filaments themselves ("ramis sparsis conformibus erectis," Bornet, *l. c.*, p. 8). Finally, when short basal branches are described in *P. Hooperi* these evidently are of the same kind as the more or less short branches, emitted from the creeping filaments in *P. fulvescens* and described and figured by Sauvageau ("Note sur l' *Ectocarpus* (*Pilayella*) *fulvescens* Thuret," *Journ. de bot.*, 10, 1896, pp. 166–167). But they are not much like the well-defined system of branchlets we have met with in the new species. According to my opinion, it deserves to be placed in a separate subgenus, for which I have chosen the name *Panthocarpus*, thus wishing to express the remarkable fact that the whole plant minus the basal parts is used up for reproduction.

Pylaiella Bory subg. **Panthocarpus** nov. subg.

Fila erecta numerosa, simplicia vel ima basi furcata, interdum in parte dimidia superiore ramulis brevibus sparsis regulariter oppositis ornata. Sporangia plurilocularia terminalia, longe catenulata, e transformatione filorum ramulorumque orta, multiseriata. Sporangia unilocularia ignota. Pili non inveniuntur.

P. Postelsiae n. sp.

Syn. *Leptonema fasciculatum* Saunders non Reinke

Dense caespitosa, obscure fusca, ad 10–12 mm. alta. Fila primaria radicantia, rhizoideis praedita ramosa, ± endophytica, 8–10μ crassa; secundaria erecta longissima, simplicia vel sparse ramulosa. Cellulae basales duplo longiores quam latae (12–15μ diam.), infimae membrana crassiore et interdum rhizoideis praeditae, ceterae 15–20μ diam. et 2–4plo longiores quam crassae, dein breviores et ad septa leniter constrictae. Ramuli breves vel brevissimi, oppositi, obtusi, sub angulo c. 60—80° egredientes. Sporangia plurilocularia 21–23μ diam., sporae 4–5μ.

Hab. ad oras *Californiae* in truncis foliisque *Postelsiae palmaeformis* Rupr. (D. A. Saunders, W. A. Setchell, C. Skottsberg).

Pylaiella Postelsiae represents a rather primitive type among the Ectocarpaceae. The special development of the basal parts excepted, there is hardly any differentiation in the thallus. The short branches serve exactly the same purpose as the long ones. It does not require much imagination to derive the *Bachelotia* type from *Panthocarpus*, and the same may perhaps be said of the other *Pylaiellae*. It is doubtful whether we should regard the continuous chains or the intercalary ranges of sporangia as the more primitive type. To me the latter seem to represent a slightly more advanced stage, a step towards the origin of special reproductive organs. In *Pylaiella varia* we can almost speak of such; in *Ectocarpus* they have assumed a more distinct shape. If, in *P. Postelsiae*, the long threads should remain sterile and the short branches alone become fertile, we would come near the type of *P. varia*, and if the branches were of a more uniform length we should get a *Euectocarpus*. It is hardly necessary to mention that, with these ideas, I do not at all pretend to unravel the phylogeny of these forms.

It was Professor W. A. Setchell who kindly drew my attention to the small alga described above. I use this opportunity to thank him in public for the hospitality he showed me during my stay with him in California. The success I had in collecting and getting acquainted with the magnificent marine vegetation of the Pacific Coast was almost entirely due to his kind and utterly unselfish assistance.

Transmitted February 19, 1915.

EXPLANATION OF PLATES

All figures represent *Pylaiella Postelsiae* Skottsb.

All figures drawn by the author

PLATE 17

Part of a tuft, showing complete filaments with sporangia, × 120 diam.

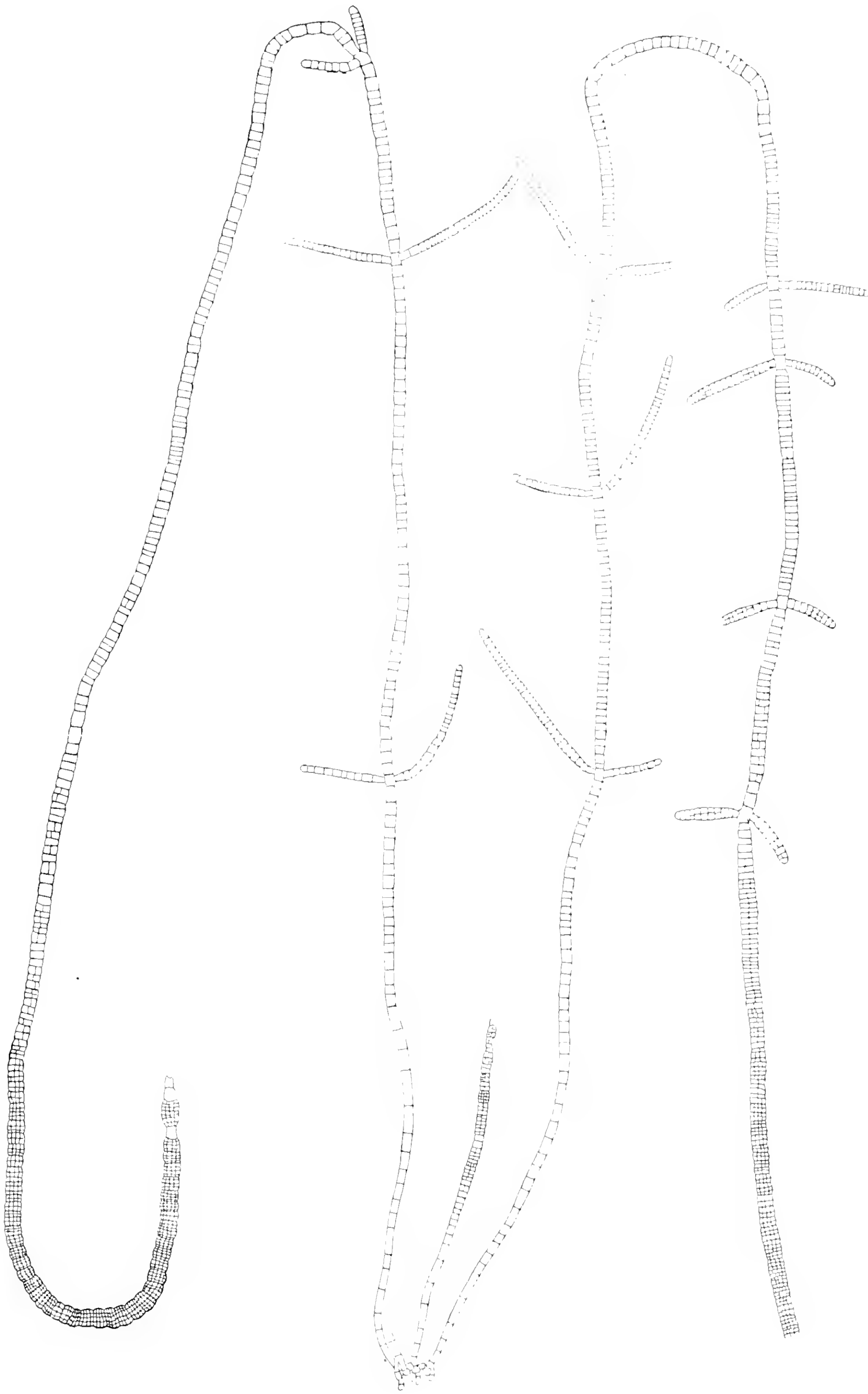


PLATE 18

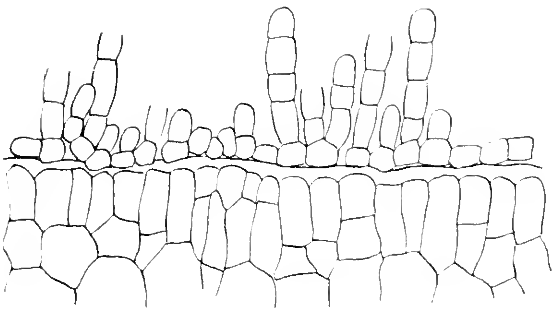
Fig. 1. Part of the margin or a tuft, established on the epidermis of *Postelsia*, × 480 diam.

Fig. 2. Endophytic part of small tuft (dotted), × 480 diam.

Fig. 3. Endophytic part of small tuft, × 480 diam.

Fig. 4. ? *Pylaiella Postelsiae*, basal stratum (dotted) with young erect filaments, scratched off from a stem of *Postelsia* and seen from lower surface, × 480 diam.

Fig. 5. Fragment of the base of a dense tuft, × 240 diam.



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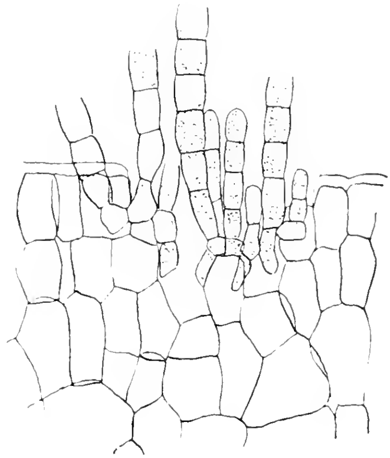

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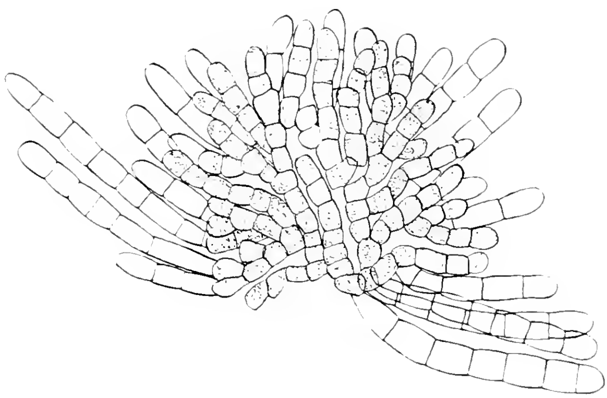

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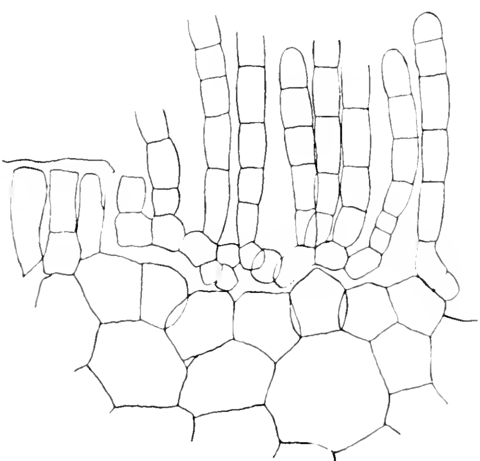

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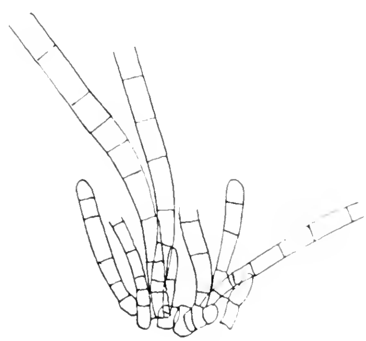

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PLATE 19

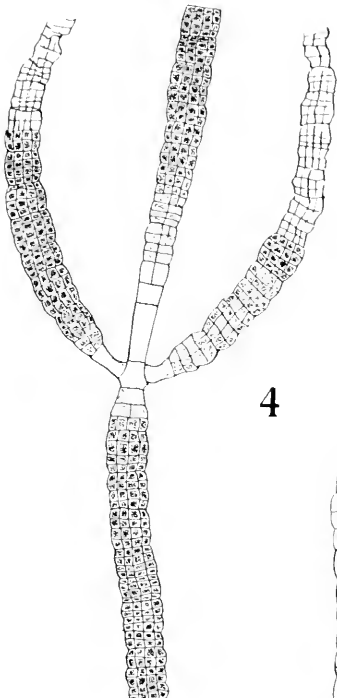
Fig. 1. Young erect filaments. To the left, premature formation of sporangia; to the right the meristematic zone is clearly seen; × 480 diam.

Fig. 2. Solitary lateral branch, resembling an *Ectocarpus* sporangium, × 240 diam.

Fig. 3. Three sterile cells showing disk-shaped chromatophores, × 480 diam.

Figs. 4–5. Parts of fertile filaments with lateral branches, × 240 diam.

Fig. 6. Mature plurilocular sporangia, × 480 diam.



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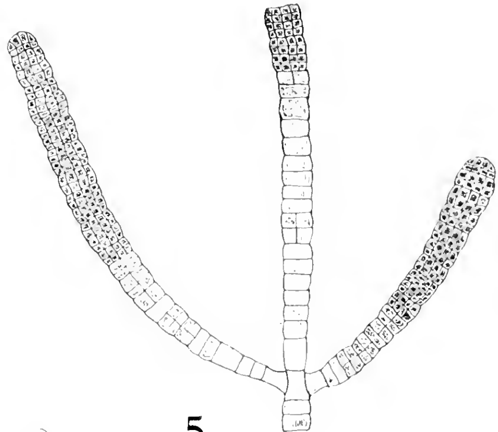

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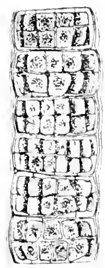

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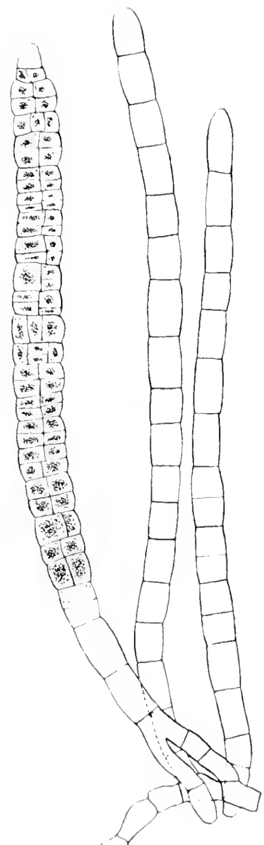

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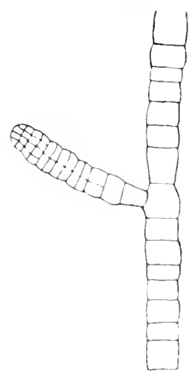

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UNIVERSITY OF CALIFORNIA PUBLICATIONS
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Vol. 6, No. 7, pp. 165-176, plate 20 Issued October 28, 1915

NEW AND NOTEWORTHY CALIFORNIAN PLANTS, II

BY
HARVEY MONROE HALL

The present contribution consists of descriptions of new species of Californian Spermatophytes and of records of the occurrence within the state of species not heretofore considered as belonging to the Californian flora. The new species here described have been withheld from publication for some time because of a desire first to compare them with related forms as represented in eastern herbaria and especially with the types of related species. Through the courtesy of the curators of these herbaria I have now had opportunity to make the necessary comparisons, and am therefore able to present the proposed species and to discuss their relationships with more confidence than would otherwise have been possible.

Zygadenus brevibracteatus, comb. nov.

Zygadenus Fremontii var. *brevibracteatus* M. E. Jones, Contrib. West. Bot. No. 12, p. 78 (1908).

An examination of portions of the type specimens of *Z. Fremontii* var. *brevibracteatus*, kindly submitted by Mr. Jones, leaves no doubt that they are specifically the same as those collected at various stations along the southerly borders of the Mohave Desert and cited below. The material at hand indicates that this form is not closely related to *Z. Fremontii*, differing in the shape of the perianth-segments, all of which are distinctly clawed, and in many other characters, some of which are indicated in Mr. Jones' description. It is more closely related to *Z. paniculatus* (Nutt.) Wats., to which it has been referred by some of those who have collected it, but differs in its widely spreading pedicels and much larger flowers with very obtuse segments. The stamens are only about two-thirds the length of the sepals and petals while in that species they exceed the perianth.

Since the only description of the form was very brief and in English, a Latin diagnosis is here given. It has been drawn chiefly from my no. 6020, but it also applies to the types of *Z. Fremontii* var. *brevibracteatus*, at least as to infloresecence and flowers, which are the only parts of the types that I have seen.

Bulbo ovoideo, membranaceo-tunicato, ca. 3 cm. longo, diametro 2–2.5 cm.: caule tenui, erecto, 4–6 dm. alto: foliis subradicalibus, caulis basim amplectentibus, linearibus, 15–20 cm. longis, usque ad 6 mm. latis, saepe falcatis plicatisque, glabris, minute papillosis praecipue margine; foliis superioribus bracteaeformibus: panicula laxa, 2–4 dm. longa; paniculae ramis inferioribus divaricatis, 7–17 cm. longis; pedicellis fere horizontalibus, 1–3 cm. longis; bracteis scariosis, ovatis, acuminatis, ca. 5 mm. longis: floribus albis, omnibus ut videtur fertilibus: sepalis ca. 7 mm. longis, ca. 5 mm. latis, late ellipticis, obtusis, abrupte unguiculatis: petalis ca. 7 mm. longis, 3.5 mm. latis, anguste ellipticis, obtusis, basi in unguem brevem angustatis: nervis sepalorum et petalorum ca. 12, saepe supra ramosis; glandula ad apicem unguis, transversa, dubia: staminibus ca. 5 mm. longis, basi segmentorum adherentibus: filamentis basi leviter dilatatis: ovario omnino superiore: capsula erecta, oblonga, untrinque plus minus contracta, ca. 15 mm. longa.

The following specimens have been seen:

Among rocks at Victor, California, on the Mohave Desert, altitude about 800 m., May 18, 1903, *Marcus E. Jones;* gravelly mesas just north of Cottonwood Springs, in the Lower Sonoran Zone of the Colorado desert of Riverside County, California, at an altitude of about 700 m., May 10, 1905, *H. M. Hall*, no. 6020; Burcham's Ranch, Mohave River, San Bernardino County, altitude 1070 m., May 29, 1901, *S. B. Parish*, no. 4958; Warren's Well, San Bernardino County, May 16, 1902, *T. S. Brandegee;* north slope of Cajon Pass, San Bernardino County, altitude 1070 m., May 20, 1905, *H. M. Hall*, no. 6219; Hesperia, San Bernardino County, May 29, 1914 (in mature fruit), *W. L. Jepson*, no. 6140.

Brodiaea modesta, sp. nov.

Scapo levi, tenui, erecto, 1.5–2 dm. alto: foliis linearibus, planis, 10–15 cm. longis, 1–4 mm. latis: bracteis acuminatis, usque ad 6 mm. longis: umbella subcapitata, 4–8 floris; pedicellis 4–10 mm. longis: periantho subcaeruleo, anguste infundibuliformi, basi attenuato, ca. 15 mm. longo; segmentis tubum aequantibus, apice crassis caeruleis; segmentis exterioribus lanceolatis, acutis; segmentis interioribus paululum brevioribus, obtusis: staminibus inaequalibus; inferiorum antheris 1.5 mm. longis, faucibus alte affixis, fere sessilibus; superiorum antheris 1.8 mm. longis, segmentis interioribus affixis, filamentis 2 mm.

longis subdilatatis; antheris omnibus caeruleis, lineari-oblongis, versatilibus erectis; ovario 6 mm. longo stipem crassum includenti; stylo 1.5 mm. longo.

Castle Lake, Siskiyou County, California, at an altitude of 1850 m., July 27, 1911, *I. J. Condit* (Herb. Univ. Calif. no. 160439), type; duplicate type in Herb. Calif. Polytechnic School, San Luis Obispo.

This species is of the section *Triteleia* and is most closely related to *B. peduncularis* Wats. although its slender habit and small flowers give it a decidedly different aspect. It differs from that species and from *B. laxa* Wats. in the much shorter pedicels, higher insertion of the stamens, and slender, short-stiped ovary. The same characters will probably serve to distinguish our proposed species from *Triteleia angustiflora* Heller, which differs also in its indigo-blue flowers.

Polygala acanthoclada Gray

Proc. Am. Acad., xi, 73 (1876).

This shrub has been collected for the first time in California by the original collector of the species, *Mr. T. S. Brandegee*, who found it in July, 1912, at Barnwell, in the Mohave Desert of eastern San Bernardino County. The plants are decidedly shrubby, densely cinereous pubescent, and with leaves up to 13 mm. long. The capsules are broadly elliptic, emarginate, and 5 mm. long.

Coelopleurum maritimum C. & R.

Bot. Gaz., xiii, 145 (1888).

A very broad-leaved and narrow-fruited form of this was sent to the University herbarium from Loleta, Humboldt County, August 17, 1908, by *Mr. John Matthiesen*, with the report that it was poisoning cattle. The genus has not been reported heretofore from south of Astoria, Oregon. The description of the species now needs amplification to include this form, the differentiating characters of which are: rootstocks thick, erect, chambered as in *Cicuta* (and as in perhaps all species of *Coelopleurum*); leaflets up to 12 cm. in length by 6 to 10 cm. broad; fruit oblong, even when fully mature only 4 mm. wide by 8 mm. long, the lateral wings scarcely wider that the others.

To some botanists these characters might seem sufficiently important to constitute a new species. However, tracings and fruits from the type specimens in the Coulter Herbarium, supplied through the courtesy of Dr. C. F. Millspaugh, indicate that the leaflets are slightly larger than originally described, some running to 8 cm. wide, and that the fruits differ from the Loleta form only in having wider lateral wings. The following collections, also made in Humboldt County, probably belong to this species, for although the leaflets are rather acute, as in *C. longipes*, yet the mature fruits are quite typical of *C. maritimum*: Southbay, July 25, 1904, *J. W. Congdon;* near Hookton, south end of Humboldt Bay, at edge of salt marsh, July 12, 1914, *J. P. Tracy*, no. 4581.

Cymopterus deserticola T. S. Brandegee sp. nov.

Acaulescens: pedunculis inter petiolos vetustos orientibus, ca. 15 cm. altis, folios superantibus; foliis glabris, circumscriptione triangularibus, bipinnatis, laminis ca. 5 cm. longis latisque; pinnarum lobis acutis in setas terminantibus; petiolis ca. 8 cm. longis: floribus atropurpureis in caput diametro ca. 2 cm. congestis; involucri bracteis brevibus linearibus: fructu ca. 5 mm. longo, in capite globoso sessili, alis lateralibus crassis subereis angustis pubescentibus, margine sinuatis.

The dark-purple flowers of the globose heads easily distinguish this species from *C. globosus* Watson. Collected by *Mrs. K. Brandegee* on the Mohave Desert at Kramer, San Bernardino County, California, May, 1913 (Herb. Univ. Calif. no. 173143), type.

(The above description and notes are inserted at the request of Mr. Brandegee.—H. M. H.)

Oxypolis occidentalis C. & R.

Contrib. U. S. Nat. Herb., vii, 196 (1900).

The genus *Oxypolis* has not been reported heretofore from California, although specimens were collected in Mariposa County by the late Judge J. W. Congdon as early as 1895. Eight collections of *O. occidentalis* are now at hand, all from the middle and southern Sierra Nevada. In order to make a positive determination of these it was first necessary to distinguish clearly between *O. occidentalis*, known up to this time only from Oregon, and *O. Fendleri* (Gray) Heller, of the Rocky Mountains. This study was undertaken at the National Herbarium, where authentic material of both species was consulted and where much helpful assistance was received from Dr. J. N. Rose. This specialist on the Umbelliferae is not responsible for the following determinations, since he did not see all of the material here cited. It seems that although the presence of involucels is the only constant character by which *O. occidentalis* may be distinguished, it possesses still other characters which, though variable, still point towards a specific segregation. These include the taller and coarser habit, the stouter rays of the involucre, which are usually but not always nearly equal, and the larger flowers and fruit. The leaflets are 9 to 13 in number, while in *O. Fendleri* they are usually 5 to 9, but occasionally 11 or even 13 leaflets occur (e.g., Hermits Peak, New Mexico, *F. H. Snow*). In all of these characters, and especially in the uniformly present involucel, the Sierran specimens ally themselves with the Oregonian species. This is also in accord with our present views as to the origin of the Sierran flora. The following specimens have been seen from California:

Chilnualna Creek, Mariposa County, August, 1895 and October, 1896, *Congdon;* Kuntz Place, Mariposa County, August 11, 1899, *Congdon;* base of Clouds Rest, August 5, 1898, *Congdon;* Peregoy Meadows, just south of Yosemite Valley, in the Canadian Zone at 2225 m. alt., *Hall*, no. 9676 (leaflets lanceolate, 5 to 15 mm. wide); Natural Bridge of Volcano Creek, Basin of the Upper Kern River, *Hall and Babcock*, no. 5443 (leaflets ovate, 12 to 25 mm. wide); Giant Forest, Tulare County, August, 1905, *Mrs. Katharine Brandegee*, Herb Univ. Calif. no. 173212 (leaflets broadly lanceolate to ovate, 20 to 40 mm. wide); same locality, date, and collector, Herb. Univ. Calif. no. 173214 (leaflets elliptic to nearly orbicular, 30 to 55 mm. wide).

Pentstemon Bridgesii × heterophyllus hyb. nov.

Herbage glabrous except in the inflorescence, which is glandular as in *P. Bridgesii*: inflorescence compound, the pedicels erect; flowers either erect or ascending, never horizontal: sepals lanceolate, acute, glandular: corolla rose-pink, the color sometimes dominated by yellow, sometimes by orange-color, about 15 mm. long, funnelform with no distinction between tube and throat, bilabiate; lower lip 5–8 mm. long, of 3 narrowly oblong obtuse spreading lobes; upper lip erect, 2-lobed at summit: anthers sagittate, the cells dehiscent across the confluent apex, scabrous on the edges of the orifice; pollen grains sterile, flat and angular: sterile filament glabrous.

Vicinity of Nellie, a stage station on Palomar Mountain, San Diego County, *Mrs. A. R. Valentien*, July 15, 1910.

This form resembles *P. Bridgesii* in the foliage, pubescence, branching of the inflorescence, and sepals, but the flowers stand erect or nearly so, as in *P. heterophyllus*, which species it also resembles in the flaring corolla. In shape of corolla, however, the new form is intermediate between the two species mentioned and the flowers are smaller than in either of them. The color is decidedly toned down from the scarlet of *P. Bridgesii*, apparently by the admixture of purple from the other parent. Although not accepted as conclusive proof, the sterility of the pollen tends to confirm our suspicions that this form is of hybrid origin. Both *P. Bridgesii* and *P. heterophyllus* are found on Palomar Mountain, but whether or not they grow near where the hybrid was found is not known. They are to be expected, however, along the lower edge of the Transition Zone and this is the belt in which the hybrid occurs. Only a few plants were seen.

This is the second hybrid *Pentstemon* reported from southern California, the other being *P. Parishii* Gray, a supposed hybrid between *P. centranthifolius* and *P. spectabilis*.[1]

Pentachaeta fragilis T. S. Brandegee, sp. nov.

E basi multicaulis: caulibus ca. 12 cm. altis, prope basim paullo villosis, superne glabris: foliis oblongis sessilibus, apice obtusis, basi paululum angustatis, margine ciliatis, usque ad 1 cm. longis, 1.5 mm. latis: capitulis diametro ca. 1 cm.; involucri squamis glabris, ca. 20, oblongis, apice obtusis vel mucronulatis, margine scariosis erosis, 4–6 mm. longis: radii floribus ca. 10, styliferis, ligulis apice obtusis, ca. 4 mm. longis: achaeniis oblongis compressis, basi angustatis, interdum hirsutulis: pappi setis 20–24, gracilibus barbellatis, basi non dilatatis, achaeniis aequilongis: styli ramis breviter complanatis, appendicibus longe subulatis, hirtis.

This species is easily separated from the others of the genus by its short oblong leaves. Collected at Havilah, Kern County, California, May 16, 1891, by *T. S. Brandegee* (Herb. Univ. Calif. no. 88032), type. Collected at Havilah also by *Purpus*; at Goodwin, southern San Luis Obispo County, by *Jared*; and on the easterly slopes of the Greenhorn Range, Kern County, by *Hall* and *Babcock*, no. 5067. All of these localities are on the warm lower slopes of the southern Sierra Nevada Mountains except Goodwin, which is in the inner South Coast Ranges.

(The above description is here inserted at the request of Mr. Brandegee.—H. M. H.).

Haplopappus eximius sp. nov.

Plate 20, figs. 1–15

E radice paululum lignosa: caulibus herbaceis, erectis, plerumque simplicibus, 2–10 cm. altis, foliosis, dense glandulosis: foliis non sempervivis, plerumque spatulatis, interdum oblongis, obtusis, parce dentatis, glandulosissimis, inferioribus in petiolum latum angustatis; laminis

[1] Hall, Univ. Calif. Publ. Bot., 1, 119 (1902); Davidson, Bull. So. Calif. Acad. Sci., 1, 141 (1902).

2–3 cm. longis, 8–18 mm. latis; capitulo solitario, caules terminanti; involucro anguste hemisphaerico, 8–10 mm. alto; squamis exterioribus viridibus, herbaceis, glandulosis, e lanceolatis usque ad obovatas variantibus, apice obtusis vel acutis, cuspidatis; squamis interioribus lanceolatis, attenuatis, rubescentibus, margine minute fimbriatis; radii floribus 15–20, femineis; ligulis flavis, ca. 8 mm. longis; disci floribus numerosis, hermaphroditis; corollis anguste infundibuliformibus, glabris, ca. 7 mm. longis, profunde 5-dentatis; styli ramis tantum ultra partem stigmosam pubescentibus; stigmatis appendicibus obtusis, ad partem stigmosam subaequalibus; achaeniis cylindrico-fusiformibus, dense adpresso-pubescentibus, 4 mm. longis; pappi setis mollibus, scabridis, sordidis, ca. 8 mm. longis.

Crevices of granitic rocks at an altitude of 2680 meters on a peak 1 kilometer s.s.w. of Angora Peak, El Dorado County, California, July, 1910, *Geo. R. Hall* (Herb. Univ. Calif. no. 180321), type. Found also on the north side of Ralston Peak, El Dorado County, at 2800 m. alt., July 30, 1910, by the same collector, and gathered on Ralston Peak in 1912 by *Miss Helen D. Geis*, no. 18. These stations are both in the Hudsonian Zone and lie in the Tahoe district of the Sierra Nevada Mountains.

The affinities of this species are undoubtedly with *H. pygmaeus* (T. & G.) Gray and *H. Lyallii* Gray, from both of which it differs in its deeply toothed leaves, more foliaceous involucral bracts, and other characters. In habit and pubescence it closely simulates *Macronema aberrans* Nelson, but differs in the outer foliaceous bracts of the involucre (not to be confused with the uppermost leaves of *M. aberrans*), in the radiate heads, and in the broader style-branches.

Although the affinities of *H. eximus* are quite clear, there is opportunity for much difference of opinion as to the genus to which this proposed species and its relatives should be referred. *H. pygmaeus* was first described as a *Stenotus*,[2] was later transferred to *Haplopappus*,[3] and was considered by Greene (perhaps through a misconception as to the style-branches) to be a *Macronema*. *H. Lyallii*, originally described as a *Haplopappus*,[4] was once referred to *Pyrrocoma* by Rydberg,[5] but is now accepted by this same author as a species of *Tonestus*,[6] a genus recently proposed by Nelson[7] to accommodate these two species and *Haplopappus laceratus* Henderson,[8] all of which

[2] Torrey and Gray, Flora of North America, 2, 237 (1842).

[3] Gray, Am. Journ. Sci., ser. 2, 33, 239 (1862).

[4] Gray, Proc. Phila. Acad. for 1863, 64 (1863).

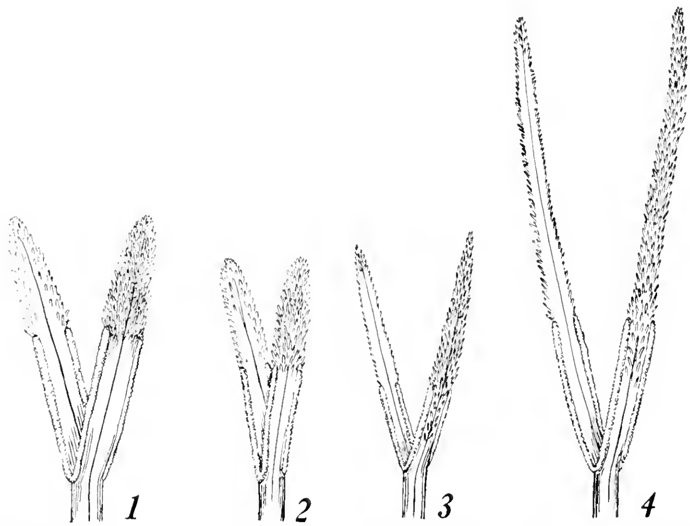
[5] Rydberg, Mem. N. Y. Bot. Gard., 1, 382 (1900).

[6] Rydberg, Fl. Colorado, 345 (1906).

[7] Nelson, Bot. Gaz., 37, 262 (1904).

[8] Henderson, Bull. Torr. Club, 27, 347 (1900).

seemed aberrant in any previously accepted genus. Professor Nelson's treatment possesses merit in that it emphasizes the close affinity between the members of this group, to which *H. eximius* is now added. But, this relationship may also be expressed by the use of a subgeneric name under *Haplopappus*, and this method is to be preferred, since no morphological characters of the flower which would serve to separate *Tonestus* have as yet been pointed out. Furthermore, it is very undesirable to increase further the number of *Haplopappus* segregates until some investigator has had opportunity to make an exhaustive study of all of the forms, including those of South America, the home of the original species.



Style-branches of disk-flowers in Haplopappus and Macronema.—Fig. 1. *Haplopappus* (*Tonestus*) *Lyallii* Gray, from Cusick's no. 2093, Oregon. Fig. 2. *Haplopappus* (*Tonestus*) *eximius* Hall, from type material. Fig. 3. *Macronema aberrans* Nelson, from type collection (Herb. Gray). Fig. 4. *Macronema suffruticosa*, from Congdon's Mariposa County, California, specimens. —All the figures are enlarged about seventeen diameters.

Whatever the ultimate fate of *Tonestus* may be, it seems certain that it is more closely related to true *Haplopappus* and to *Stenotus* than to *Macronema*. A technical character of considerable importance for the separation of *Tonestus* from *Macronema* was apparently overlooked by Nelson, although since used by Rydberg in his *Flora of Colorado*, namely the shape and relative lengths of the appendage and stigmatic portion of the style-branches. In the former the appendage is somewhat obtuse and shorter than or only equalling the stigmatic portion, while in *Macronema* the branches are more slender, long-exserted from the corolla-tube, and the acute appendage is much longer than the stigmatic portion. These differences are illustrated in the accompanying figures.

Aster cognatus sp. nov.

Suffrutescens: caulibus ramosis, ca. 7.5 dm. altis, albis glabrisque, vel superne viridescentibus glandulosisque, usque ad capitulos foliosis: foliis oblongo-ovatis, sessilibus, basi subcordatis, apice acutis vel obtusis, 2–4 cm. longis, 1–2 cm. latis, margine spinoso-dentatis, rigidis, reticulatis, minute et sparse glanduliferis: capitulis solitariis, ramos foliosos adscendentesque terminantibus; pedunculis brevibus vel nullis: involucro hemisphaerico, diametro ca. 3 cm.; involucri squamis exterioribus viridibus, linearibus, attenuatis, usque ad 25 mm. longis, glanduliferis; involucri squamis interioribus brevioribus, lanceolatis, acuminatis, margine pallidis erosisque: radii floribus ca. 30; ligulis subcaeruleis vel violaceis, 15–20 mm. longis: disci floribus numerosis; corolla glabra, tubulosa, ca. 10 mm. longa: styli ramis oblongis, obtusis: acheniis dense longe villosis: pappi setis corollae aequilongis, rigidulis, scabridis, fulvis.

Foothill slopes about 3 kilometers north of Indio, along the northerly side of Coachella Valley, in Riverside County, California, May 7, 1905, *H. M. Hall*, no. 5994 (Herb. Univ. Calif. no 68930), type. Shavers Well, *E. E. Schellenger*, no. 70. Rock crevices, Red Cañon, near Mecca, June 28, 1912, *S. B. Parish*, no. 9112. All of these localities are within the Lower Sonoran Zone and along the northerly borders of the Colorado Desert.

This species is closely related to *A. Orcuttii* Vas. & Rose, a species which ranges from the southerly part of the Colorado Desert (Borregos Springs and Split Mountain) southward into Lower California; but it differs in the relatively broader leaves, in the glandular inflorescence, and in the narrow and elongated outer bracts of the involcure. However, in the Parish specimen cited above these outer bracts, although quite narrow, are shorter than the inner ones. As contrasted with *A. tortifolius* (T. & G.) Gray, a related species of more northerly distribution but also reaching the borders of the Colorado Desert, *A. cognatus* is of very different aspect. Its leaves are much shorter, broader, and never attenuate, the herbage is never tomentose nor the heads long-peduncled, and the inner bracts of the involucre are broader.

Since the proposed species has thus far been found only at stations intermediate between those reported for *A. Orcuttii* and *A. tortifolius*, and since its characters are in some respects also intermediate, the possibility of a hybrid origin suggests itself. However, the former species has not been found within 20 km., of localities where *A. cognatus* grows, the known ranges of the two being separated by the Coachella Valley, in the lower parts of which it is reasonably certain that no Aster of this group occurs. The pollen-grains in the proposed species are well formed and apparently fertile.

Erigeron aequifolius sp. nov.

Perennis, multicaulis e rhizomatibus tenuibus; caulibus erectis, 15–20 cm. altis, simplicibus vel ramosis, villosis atomiferisque; foliis numerosis, quam internodiis multo longioribus, lineari-lanceolatis vel lineari-oblongis, acutis, integris, 10–15 mm. longis, 1–3 mm. latis, dense breviter villosis; pilis saepe curvatis sed patentibus; inflorescentia minute glandulifera; capitulis solitariis, caules simplices vel ramos breves foliosos adscendentesque terminantibus; pedunculis 1–3 cm. longis, nudis vel interdum setoso-bracteatis; involucro hemispherico, 4–5 mm. longo, minute glandulifero; involucri squamis lineari-acuminatis, paucis exterioribus brevioribus; radii floribus 20–40; ligulis lilacinis vel subcaerulis, angustis, 5 mm. longis; disci floribus numerosis; corolla glabra vel sparse puberula; tubo tenuissimo, ca. 1 mm. longo; faucibus cylindraceis, 3–5 mm. longis; styli ramis oblongis, obtusis; acheniis linearibus, compressis, dense breviter villosis; pappi setis corollae aequilongis, paucis exterioribus multo brevioribus.

Dry ridges at Trout Meadows, eastern Tulare County, California, in the Transition Zone of the Sierra Nevada Mountains at an altitude of about 1980 m., July 16, 1908, *H. M.* and *G. R. Hall*, no. 8386 (Herb. Univ. Calif. no. 180112), type.

The affinities of this species are plainly with *E. miser* Gray, but aside from the conspicuous rays it differs in the very slender, freely branched rootstocks, slender stems, and long-pedunculate heads. The stems are as slender as in *E. Elmeri* Greene, but they are more leafy and not at all decumbent, and the pubescence is very different from what it is in that species, being more copious and spreading on the foliage and decidedly glandular on the inflorescence.

Arnica venosa sp. nov.

Perennis, e rhizomatibus reptantibus; caulibus simplicibus, interdum superne 1–3 ramosis, 3–4.5 dm. altis, undique breviter pilosis, superne glandulosis, prope apicem foliosis; foliis inferioribus squamosis, ovatis, ca. 5 mm. longis, oppositis, basi connatis longe amplexicaulibus; caulis foliis oppositis arcte sessilibus, basi latis non cordatis, ellipticis, 4–6 cm. longis, 1.5–3 cm. latis, acutis, valde dentatis vel supremis integris, sparse breviterque pilosis, rigidis, subtus valde venosis; pedunculis 3–8 cm. longis; capitulis 18–20 mm. altis, eradiatis; involucris ca.

12 mm. altis, pilosis glandulosis, 20–30 floris; involucri squamis 8–13, oblongis, acutis; corollis cylindraceis, pubescentibus, acute 5-dentatis; styli ramis obtusis, pubescentibus, sine appendicula; achaeniis teretibus, ca. 7 mm. longis, canescentibus, adpresse pilosis, glandulosis; pappi setis rigidulis barbellatis.

Salt Creek, Shasta County, California, at an altitude of 430 m., June, 1903, *H. M. Hall* and *E. B. Babcock*, no. 4013 (Herb. Univ. Calif. no. 53880), type.

Notwithstanding the perplexing array of species described under *Arnica* in late years, this one appears to have no near relatives. It grows on hot, dry slopes of the foothills and may be an offshoot of *A. amplexicaulis*, a species of stream banks and moist meadows in the higher mountains, but its dry, rigid and prominently veined foliage and canescent akenes at once distinguish it. The leaves are strongly 3–5-nerved from the base and with numerous cross-veinlets.

Transmitted April 23, 1915.

EXPLANATION OF PLATE 20

Haplopappus eximius sp. nov.

Fig. 1. Entire plant. × 1 diam.

Figs. 2, 3, 4, 5, 6. Leaves from plants of the type collection, showing variation in outline. × 1 diam.

Fig. 7. Portion of stem, taken from about the middle, showing character of pubescence. × 4 diam.

Fig. 8. Inner bract of the involucre. × 3 diam.

Fig. 9. Intermediate bract of the involucre. × 3 diam.

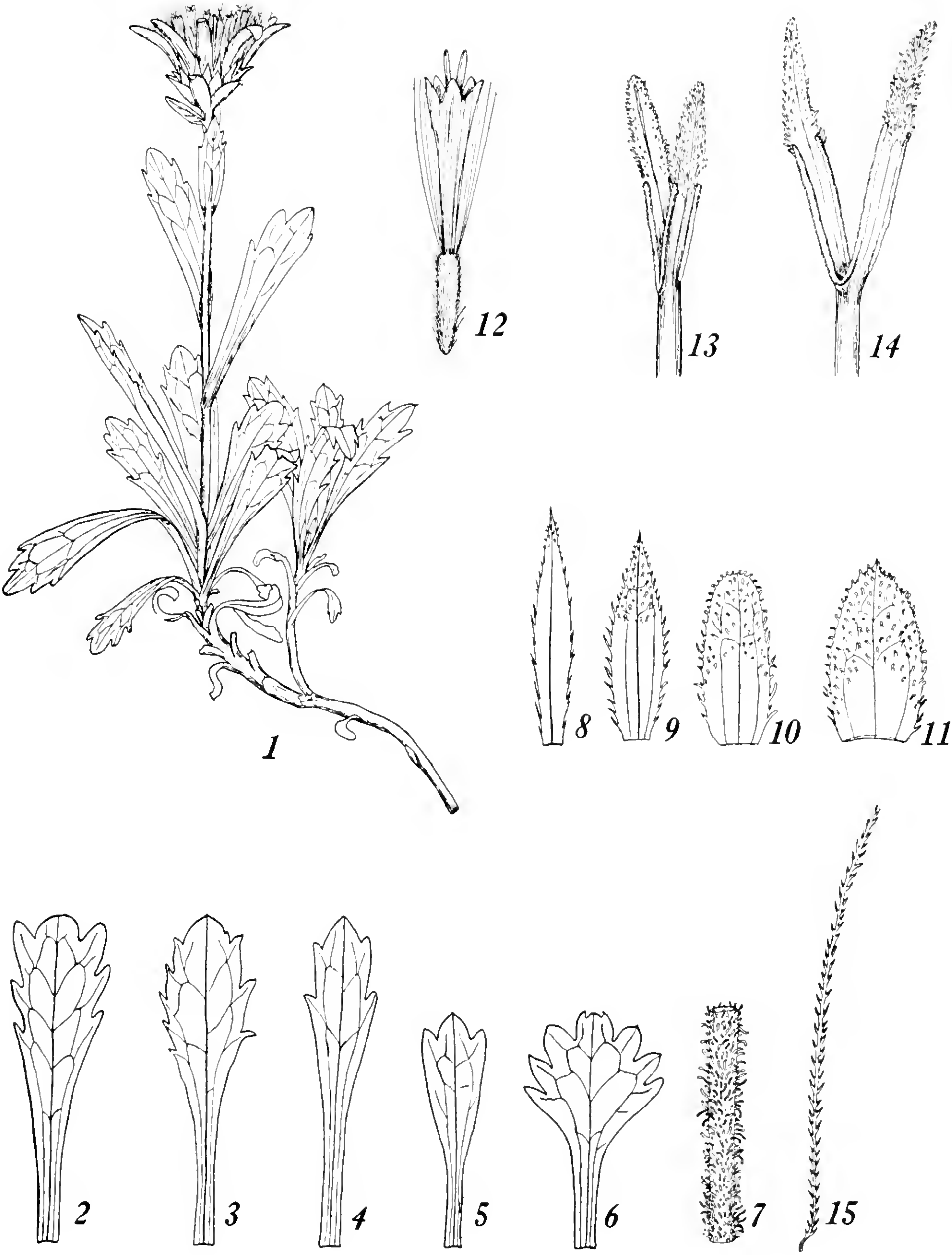
Figs. 10, 11. Outer bracts of the involucre. × 3 diam.

Fig. 12 Disk-flower. × 3.5 diam.

Figs. 13, 14. Style-branches of disk-flowers. × about 17 diam.

Fig. 15. Pappus-bristle of a disk-flower. × 8 diam.

All the figures were drawn by Mrs. Carlotta Case Hall.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PLANTAE MEXICANAE PURPUSIANAE VII

BY
TOWNSHEND STITH BRANDEGEE

The collection of 1914 came mainly from Chiapas and Southern Oaxaca, from the same region as that of the preceding year. Owing to the disturbed condition of affairs in the country and as only species not previously collected were distributed, their number is smaller than usual.

Tradescantia deficiens sp. nov.

Caulibus debilibus, nodis inferioribus radicantibus, uno latere villoso; foliis ovato-acuminatis; laminis utrinque glabris, ca. 4.5 cm. longis, 1.7 cm. latis; petiolis brevibus; vaginis margine longe piloso-ciliatis; umbellis sessilibus caules ramulosque terminantibus, pauci-floris; bracteis spathaceis foliiformibus complicatis, ca. 1.5 cm. longis, glabris; sepalis 3, exteriori dorso piloso-ciliato; petalis 3, roseis; staminibus 6, consimilibus, loculis antherae ad latus inferius connectivi late flabelliformis positis; filamentis barbatis; stylo 3-lobo; ovario 3-loculari, loculis 2-ovulatis; fructu 1-spermo, semine oblongo-ellipsoideo, rugoso.

Collected on Cerro del Boqueron, Chiapas. No. 7172. Type, Herb. Univ. Calif. No. 175032.

Smilax Purpusii sp. nov.

Inermis; ramis glabris striatis ramosis; foliis ovato-acuminatis, basi obtusis vel subcordatis, margine integris, 7–9-nerviis, utrinque glabris, opacis, usque ad 7 cm. longis, 5.5 cm. latis; petiolis 2–3 cm. longis, breviter vaginatis, cirrhiferis; pedunculis in axillas foliorum vel superne bractearum petiolis aequantibus vel longioribus; pedicellis umbellatis, ca. 8 mm. longis, paululum pubescentibus, e bracteis minutis ferrugineo-pubescentibus glomeratis orientibus; umbellis 15–30-floris; florum femineorum sepalis petalisque excurvatis, ca. 4 mm. longis, staminibus sterilibus 3; ovario oblongo. Flores masculi et fructus desunt.

This species seems nearest to *S. subpubescens* A. DC. Collected on Cerro del Boqueron, Chiapas. No. 7420. Type, Herb. Univ. Calif. No. 178141.

Trophis chiapensis sp. nov.

Frutex ramosus; ramis glabris; foliis anguste ovato-lanceolatis, apice longe acuminatis, basi cuneatis, margine supra medium obtuse dentatis; laminis ca. 7.5 cm. longis, 2.2 cm. latis; petiolis puberulis ca. 5 mm. longis; florum racemis feminorum axillaribus puberulis paucifloris, 3–6 cm. longis, pedicellis 5–7 mm. longis; periantho tubuloso rugoso, ore contracto dentato; ovario infero, stylo subcylindraceo, apice exserto 2-partito, ramis patentibus brevibus crassis; ovulo ex apice loculi pendulo; fructu globoso carnoso grosse tuberculato; semine globoso, cotyledonibus inaequalibus, radicula supera brevissima. Flores masculi desunt.

The specimens bear only immature fruit and pistillate flowers, and the seed is not perfectly globular but when mature would probably become so. The raceme is very different from that of other species of the genus and the cotyledons are very unequal. It somewhat resembles *T. mexicana* Bureau. Collected in forests of low elevation of Cerro del Boqueron, Chiapas. No. 7091. Type, Herb. Univ. Calif. No. 174219.

Aristolochia asclepiadifolia sp. nov.

Caulibus viminalibus teretibus, dense pubescentibus; foliis sessilibus oblongis acutis, e basi 1-costatis, penninerviis nerviis cum nervulis connexis, basi auriculatis, auriculis rotundatis amplexicaulibus, supra fere glabris, subtus dense pubescentibus, usque ad 15 cm. longis, 10 cm. latis; floribus axillaribus solitariis; pedicellis ca. 1.5 cm. longis, recurvatis; calyce pubescenti, ca. 6 cm. longo, tubo brevi; columna stylina apice in lobos 3 latos obtusos partita; capsula ca. 3 cm. longa, pubescenti.

The limb of the perianth being hard pressed upon the tube it is difficult to determine the exact shape of the flower. Collected among rocks in a barranca near Consoquitla, Vera Cruz. No. 7394. Type, Herb. Univ. Calif. No. 178091.

Cleome guianensis Aubl.

Hist. d. Plantes de la Guiane Franc., vol. II, p. 675, 1775.

The specimens collected at Picacho, No. 7142, growing in crowded masses, agree closely with the description, figure and specimens of this species, except that they are smaller. *Cleome ephemera* Brandg., Proc. Calif. Acad., ser. 2, vol. iii, 112, from Cabo San Lucas, appears to be the same, the earlier description not being accessible at the time.

Acacia picachensis sp. nov.

Frutex glaber: aculeis brevibus petiolaribus recurvis: foliis ca. 1 m. longis, pinnis 7–12-jugis; foliolis 10–20-jugis, ca. 7 mm. longis, obtusis; petiolis medio glandula elliptica concava praeditis: racemis axillaribus vel paniculam terminalem formantibus: capitulis diametro ca. 7 mm., albis: legumine basi cuneato, margine sinuato, ca. 6 cm. longo, 1.5 cm. lato, plano.

In general appearance this species suggests *A. filicina* Willd. but differs in having petiolar glands and stipular spines. Collected at Picacho, Oaxaca. No. 7204. Type, Herb. Univ. Calif. No. 174960.

Cassia (Lasiorhegma) **enneandra** sp. nov.

Frutex: ramulis juvenibus breviter viscoso-hirsutis: foliolis unijugis interdum bijugis late obovatis, ca. 7 mm. longis, 6 mm. latis, glabris: petiolis ca. 2.3 cm. longis, glandulis petiolaribus nullis: floribus in racemis paucifloris ramos terminantibus, pedicellis viscoso-hirsutis, 1–2 cm. longis: calycis segmentis paululum pubescentibus: antheris 9, oblongis subaequalibus, loculis apice poro demum secus suturas laterales villoso-barbatas usque ad basim dehiscentibus: filamentis brevibus: ovario albo-sericeo ca. 5-ovulato: legumine ca. 3 cm. longo.

Collected on rocky slopes of Cerro de Picacho, Oaxaca. No. 7136. Type, Herb. Univ. Calif. No. 173400.

Cassia trichoneura sp. nov.

Frutex: ramulis juvenibus pubescentibus: foliis ca. 6 cm. longis; petiolis pubescentibus: foliolis 3–4-jugis, obovatis, ca. 2 cm. longis, 1.3 cm. latis, margine ciliatis, utrinque fere glabris: glandula inter jugum infimum vel ad petiolum posita; stipulis lanceolatis deciduis: pedunculis in axillis binis, unifloris pubescentibus, ca. 3.5 cm. longis: floribus amplis: sepalis glabris ovatis inaequalibus; petalis unguiculatis extus ad venas pubescentibus, majoribus ca. 1.5 cm. longis; staminibus 3 longioribus rostratis, 4 brevioribus brevissime curvato-rostratis, staminodiis 3: ovario stipitato albo-sericeo: legumine plano recto, margine sinuato, inter semina articulatim secedenti, 5–7 cm. longo, ca. 7 mm. lato.

This Cassia is related to *C. biflora* L., from which it differs in having an articulated pod with a sinuate margin, pubescent veins on the petals and differently beaked anthers. Collected near San Geronimo, Oaxaca. No. 7153. Type, Herb. Univ. Calif. No. 175075.

Cassia (Chamaecrista) **picachensis** sp. nov.

Suffrutescens, erecta e radice lignosa, patenter pilosa: caulibus ca. 2 dm. longis, pilosis simul pubescentibus: foliis ca. 2.5 cm. longis fere usque ad basim foliolatis: foliolis ca. 20-jugis, sessilibus oblongo-acutis, ca. 8 mm. longis, 2 mm. latis, e basi inaequilaterali 3–4-nerviis, glandula nulla; stipulis insignibus semi-sagittatis striatis, longe acuminatis, ca. 1 cm. longis, 5 mm. latis: floribus axillaribus solitariis; pedunculis 1–2 cm. longis, supra medium 2-bracteolatis; sepalis membranaceis, ovato-lanceolatis, ca. 1 cm. longis, 5 mm. latis, pubescentibus; petalis ca. 2 cm. longis; antheris inaequalibus, 5 longioribus; ovario pubescenti: legumine ca. 4.5 cm. longo.

Collected on Cerro de Picacho, Oaxaca. No. 7201. Type, Herb. Univ. Calif. No. 174963.

Cynometra oaxacana sp. nov.

Frutex: ramis crassis puberulis: foliolis unijugis coriaceis glabris late semiovatis inaequilateralibus sessilibus, apice acutis obtusis vel retusis, 1-costatis, penninerviis, 3.5–6 cm. longis, 2.7–3.7 cm. latis; petiolis ca. 4 mm. longis: racemis usque ad 15-floris, prope basim squamis brevibus late ovatis fuscis striatis cymbiformibus cito deciduis instructis; pedicellis puberulis 1–3 mm. longis: sepalis 3–5, inaequalibus late ovatis rubescentibus, ca. 3 mm. longis; petalis 3–5, ellipticis acutis inaequalibus sepalis aequilongis, rubescentibus; staminibus 10, liberis, 5 longioribus, glabris; ovario pubescenti, 1–2-ovulato sessili verrucoso; stylo inflexo. Fructus deest.

Collected on Cerro de Picacho, Oaxaca. No. 7382. Type, Herb. Univ. Calif. No. 178084.

Calliandra Purpusii sp. nov.

Frutex ramulis juvenibus pubescentibus: pinnis 1-jugis; foliolis 2-jugis, inferioribus inaequalibus, late oblongo-ovatis, apice retusis mucronulatis, basi valde inaequalibus, utrinque pubescentibus, usque ad 1.5 cm. longis, 8 mm. latis; petiolis ca. 2 cm. longis: pedunculis ad axillas vel nodos vetustos solitariis, ca. 2 cm. longis: staminibus rubris, ca. 1.3 cm. longis, tubo stamineo exserto: legumine ca. 9 cm. longo, apiculato pubescenti curvato.

Only a few specimens of this plant were collected, on Cerro de Picacho, Oaxaca. No. 7199. Type, Herb. Univ. Calif. No. 174965.

Tephrosia scopulorum sp. nov.

Villosa, e radice lignosa multicaulis: caulibus angulatis, pilis patentibus vel retroversis instructis, ca. 3 dm. altis: foliis fere sessilibus, 2–4 cm. longis; foliolis 7–13, oblongis basi angustatis apice obtusis, ca. 2.5 cm. longis, 6 mm. latis, utrinque pilis adpressis hirsutis; stipulis lineari-lanceolatis: racemis terminalibus vel oppositifoliis, foliis longioribus; floribus dilute rubris; stylo apice penicillato; calycis lobis 5, lanceolatis; legumine pubescenti ca. 10-spermo, ca. 5 cm. longo, 4 mm. lato.

Collected near San Geronimo, Oaxaca, on rocky plains. No. 7151. Type, Herb. Univ. Calif. No. 175091.

Galactia argentea sp. nov.

Undique dense argenteo-sericea, suberecta, multicaulis e radice crassa lignosa: foliis trifoliolatis; foliolis ovatis acutis, ca. 4 cm. longis, 2 cm. latis, terminali majori; stipulis stipellisque filiformibus brevibus deciduis: racemis axillaribus terminalibusque foliis longioribus, usque ad 1 dm. longis, multifloris; calyce 4-lobato; lobis inaequalibus lineari-lanceolatis, ca. 5 mm. longis; corolla dilute purpurea, ca. 7 mm. longa; ovario hirsuto, ca. 5-ovulato; legumine plano-compresso, ca. 4 cm. longo, glabro.

Collected on Cerro de Picacho, Oaxaca. No. 7149. Type, Herb. Univ. Calif. No. 173385.

Aeschynomene oaxacana sp. nov.

Frutex; ramis strictis glabris; foliis ca. 2.5 cm. longis; petiolo fere usque ad basim foliolato; foliolis 20–40-jugis, oblongis, basi obliquis, apice acuminatis, adpresse hirsutis; stipulis filiformibus; floribus fasciculatis; pedicellis ca. 4 mm. longis; bracteis ovato-acuminatis; bracteolis oblongo-acutis striatis; calycis lobis inaequalibus adpresse hirsutis; ovario sericeo-villoso; legumine 1–3-articulato, articulis semiellipsoideis adpresse hirsutis, articulo terminali mucronato.

Collected on Cerro de Pichacho, Oaxaca. No. 7179. Type, Herb. Univ. Calif. No. 175011.

Aeschynomene picachensis sp. nov.

E radice crassa lignosa multicaulis; caulibus prostratis viscoso-pubescentibus; foliis abrupte vel imparipinnatis; foliolis utrinque parce hirsutis, ciliatis; floribus eis *Ae. viscidulae* similibus; ovario glabro sepius 2-ovulato; fructo glabro.

This species is very near *Ae. viscidula* Mx. of Florida. It has the same habit, stipules, bracts, inflorescence, a similar legume, etc. The greatest difference is the glabrous ovary and legume. Collected on Cerro de Pichaco, Oaxaca. No. 7162. Type, Herb. Univ. Calif. No. 175043.

Calopogonium lanceolatum sp. nov.

Caulibus fulvo-hirsutis: foliolis ovato-lanceolatis minute adpresse hirsutulis, ca. 7.5 cm. longis, 2.5 cm. latis; petiolulis 3–5 mm. longis, fulvo-hirsutis: petiolis 4–9 cm. longis, fere glabris: racemis ca. 6 cm. longis, fulvo-villosis paucifloris; calycis lobis 5, lanceolatis fulvo-villosis; bracteis bracteolisque lanceolatis dense fulvo-hirsutis: ovario hirsuto: legumine recto lineari, ca. 3.5 cm. longo, adpresse fulvo-hirsuto.

The mature leaflets of this species are apparently glabrous and only by the aid of a lens can the minute hairs be seen: the young leaflets are densely yellow-hirsute, the older ones bright green above and paler beneath. The calyx lobes are nearly equal in length and taper to a sharp point. Collected on Cerro del Boqueron, Chiapas. No. 7436. Type, Herb. Univ. Calif. No. 178081.

Krameria collina sp. nov.

Fruticulus erectus sericeo-hirsutus ramosus, ca. 2 dm. altus: ramis gracilibus, vetustis glabris: foliis sessilibus oblongo-lanceolatis, ca. 6 mm. longis: floribus axillaribus; pedicellis quam foliis longioribus, medio bibracteatis: sepalis 4, exterioribus acutis, interioribus obtusis; petalorum 3 unguibus connatis, petalis 2, crassis orbiculatis; staminibus usque ad basim liberis: fructu globoso dense tomentoso, spinoso, spinis rectis apice minute glochidiatis.

Collected on rocky slopes of Cerro de Picacho. No. 7160. Type. Herb. Univ. Calif. No. 175036.

Heteropteris pallida sp. nov.

Caulibus glabris: foliis oppositis ovatis apiculatis glabris, ca. 7 cm. longis, 5 cm. latis; foliolis panicularum glandulas magnas gerentibus: petiolis ca. 12 mm. longis: floribus paniculatis, pedicellis adpresse hirsutis; sepalis obtusis hirsutis, glandulis 8 magnis; petalis oblongis integris unguiculatis pallidis, ca. 5 mm. longis, laminis basi cordatis; samaris pallidis adpresse sericeo-villosis, margine superiori auriculatis, ca. 2.5 cm. longis.

The body of the mature samara is coarsely reticulated. Collected near San Geronimo, Oaxaca. No. 7262. Type, Herb. Univ. Calif. No. 174915.

Guaiacum unijugum sp. nov.

Frutex ca. 2 m. altus: foliis fasciculatis puberulis; foliolis unijugis sessilibus inaequilateralibus, ca. 6 mm. longis latisque, apiculatis glabris; petiolis 2–3 mm. longis, pubescentibus: floribus singulis; pedicellis ca. 8 mm. longis; sepalis 5; petalis 5 caeruleis, ca. 1 cm. longis: ovario pubescenti; fructibus glabris 2–5-angulatis apiculatis.

The single pair of broad leaflets well mark this species. It is the plant noted in Proc. Calif. Acad. Ser. 2, 119, as "*Guaicum sanctum* L.?" Collected by T. S. Brandegee near San Jose del Cabo, Baja California. Type, Herb. Univ. Calif. No. 109558.

Esenbeckia collina sp. nov.

Foliis ternatis ad apices ramulorum confertis, foliolis obovatis fere glabris, usque ad 7 cm. longis, 4 cm. latis, basi cuneatis, foliolo terminali majori; petiolulis brevibus; petiolis 1.5–3 cm. longis pubescentibus: floribus pentameris paniculatis; paniculis ca. 9 cm. longis ramis paucis; sepalis latissime ovatis, pustulatis ciliatis; petalis (ex siccis) brunneo-purpureis marginibus albis, crassis oblongis, 4 mm. longis, pellucido-punctatis, alabastro imbricatis: ovario alte 5-lobato valde tuberculato. Fructus deest.

Collected on Cerro de Picacho, Oaxaca. No. 7140. Type, Herb. Univ. Calif. No. 173396.

Acalypha capitellata sp. nov.

Frutescens monoica: caulibus hirsutis: foliis ovatis longe acuminatis margine crenato-serratis, laminis ca. 8.5 cm. longis, 5 cm. latis, utrinque sparsim hirsutis; petiolis hirsutis ca. 5.5 cm. longis: spicis axillaribus; masculis ca. 6 cm. longis, laxifloris sessilibus; femineis capitatis paucifloris longe pedunculatis, bracteis unifloris parvis, usque ad basim in lacinias 3–5 lineares dactyliformes stipitato-glanduliferes sectis, sepalis hirsutis; stylis ca. 10-lacinulatis; pedunculis hirsutis superne stipitato-glandulosis, ca. 4 cm. longis. Fructus deest.

Easily recognized by its long-peduncled, small, capitate female inflorescence. Collected on the eastern slope of Cerro del Boqueron, Chiapas. No. 7348. Type, Herb. Univ. Calif. No. 174839.

Acalypha sabulicola sp. nov.

E radice lignosa 1–2 dm. alta, undique pilosa: caulibus ramosis: foliis ovato-acuminatis basi cuneatis margine crenato-serratis, usque ad 3 cm. longis, 1.4 cm. latis; petiolis ca. 1 cm. longis: floribus masculis axillaribus, congestis in spicas graciles ca. 1.1 cm. longis apice flore femineo sessili praeditas, bracteis minutulis; floribus femineis 1–3 axillaribus plerumque solitariis, pedicellis filiformibus demum 1.5 cm. longis, unifloris; sepalis ovarioque dense albo-hirsutis; stylis 3, ca. 5 mm. longis, ultra medium in lacinias divisis. Fructus deest.

Pilose throughout, especially about the leaves. The staminate flowers are borne on axillary spikes which always bear a single female flower at the top. The axillary female flowers are sometimes 2–3, their bracts not evident, the filiform one-flowered pedicels become finally 1.5 cm. long, the laciniae of the styles of the flower terminating the spike of male flowers are much shorter than those of the axillary flowers. Collected at San Geronimo, Oaxaca, on gravelly plains. No 7346. Type, Herb. Univ. Calif. No. 174853.

Acalypha lignosa sp. nov.

Fruticulus verisimiliter dioicus: ramulis novellis pubescentibus: foliis ovatis acuminatis, basi interdum angustatis, margine crenato-dentatis, utrinque glabris, usque ad 6.5 cm. longis, 2.5 cm. latis; petiolis pubescentibus ca. 1 cm. longis, stipulis lineari-lanceolatis ca. 5 mm. longis: spicis femineis ramulos terminantibus ca. 1.8 cm. longis; bracteis 1-floris, 4 mm. altis quam latitudine brevioribus, ca. 7-dentatis, hirsutis simul pilis glanduliferis instructis; ovario hirsuto; stylis supra medium paucilacinuligeris: capsula hirsuta; seminibus levibus.

The leaves are confined to the new growth terminating the branches. The specimens are all female and probably came from one bush. Collected near San Geronimo, Oaxaca. No. 7158. Type, Herb. Univ. Calif. No. 175045.

Croton Purpusii sp. nov.

Ramis crassis, juvenibus dense stellato-tomentosis: foliis late ovatis, basi cordatis, apice obtusis, margine integris, usque ad 11 cm. longis, 13 cm. latis, supra viridibus parum stellato-pubescentibus, subtus dense incano stellato-pubescentibus, basi 5-nerviis, simul pinnato-venosis; petiolis ca. 7.5 cm. longis: racemis terminalibus monoicis; florum masculorum staminibus ca. 15, filamentis glabris, receptaculo pubescenti, calycis lobis ovatis acutis 5, extus incano-stellatis, intus glabris, petalis oblongis calycem aequantibus: floribus femineis apetalis, calycibus alte lobatis, lobis spathulatis dense pubescentibus; stylis usque ad basim semel partitis, ramis stellato-barbatis: capsula quam calyce paululum longiori, extus stellato-pubescenti; seminibus glabris.

A very robust species bearing large white leaves and short racemes of crowded flowers. Collected near San Geronimo, Oaxaca. No. 7146. Type, Herb. Univ. Calif. No. 173390.

Phyllanthus oaxacanus sp. nov.

Frutex glaber: foliis ovatis apice acutis utrinque viridibus, ca. 6.5 cm. longis, 4.4 cm. latis: petiolis 3–4 mm. longis; stipulis brevibus deciduis subulatis: floribus paniculatis, paniculis dioicis vel monoicis, usque ad 7 cm. longis; laciniis calycis florum feminorum 6, oblongis obtusis, disco urceolato crenulato, stylis nullis; laciniis calycis florum masculorum 6, disci glandulis 6 geminatis, staminibus 3, filamentis connatis brevibus, antheris horizontaliter aperientibus: capsulis glabris, ca. 5 mm. latis, seminibus levibus.

This species belongs to Euphyllanthus with *P. adenodiscus* Müll. Arg. and related species. It differs slightly from the description of the section in the length of the styles. Collected near San Geronimo, Oaxaca. No. 7154. Type, Herb. Univ. Calif. No. 175048.

Euphorbia (Anisophyllum) **picachensis** sp. nov.

Prostrata: radice crassa lignosa: caulibus dense albo-tomentosis, ca. 1 dm. longis: foliis oblongis obtusis utrinque tomentosis, supra viridioribus, basi valde inaequilateralibus, margine crenato-dentatis, ca. 1 cm. longis, 5 mm. latis; stipulis brevibus lanceolatis: involucris parvulis subsessilibus, 1–2-axillaribus in ramulos breves foliosos tomentosos dispositis; glandulis 4 appendicibus minutis vel latis, interdum auriculatis; stylis bifidis: capsula tomentosa breviter stipitata: seminibus acuto-oblongis tetragonis transverse sulcatis.

This Euphorbia is related to *E. adenoptera* Bertol. but is more densely tomentose than that species. Collected on Cerro de Picacho, Oaxaca. No. 7163. Type, Herb. Univ. Calif. No. 175035.

Stillingia propria sp. nov.

Frutescens glabra ramosa: foliis oppositis vel alternis anguste ellipticis apice acuminatis basi in petiolum brevem attenuatis, margine brevissime glanduloso-dentato-serratis, usque ad 5.5 cm. longis, 1.5 cm. latis: spicis gracilis solitariis terminalibus, ca. 2 cm. longis; floribus masculis sub bractea quaque singulis, calyce campanulato, staminibus 2; floribus femineis sub bracteis inferioribus solitariis vel in axillis ramulorum singulis pedicellatis, bracteolatis, stylis usque ad medium in columnam connatis apicibus reflexis: capsula in coccos 2-valves dissilienti columellam plerumque bene evolutam reliquenti, receptaculo divaricato-3-cornuto indurato persistenti: seminibus subglobosis apice acutis, juxta apicem depressis.

The fruit of this species has a well developed columella with which character it is not alone in the genus for other species usually referred to *Stillingia* have the columella more or less developed. The seeds seem to resemble those of *Stillingia* (*Gymnostillingia*) *acutifolia* Müll. Arg. of Guatemala. Collected on Cerro del Boqueron, Chiapas, in rocky, mountain meadows. No. 7343. Type, Herb. Univ. Calif. No. 174856.

Connarus lentiginosus sp. nov.

Frutex?: ramis glabris: foliis 20–25 cm. longis; foliolis 5–7, glabris ellipticis, apice obtuse acuminatis, basi cuneatis, margine integris subtus venosis, 8–14 cm. longis, 3–7.5 cm. latis; petiolulis ca. 5 mm. longis: paniculis ca. 15 cm. longis, rufescentibus puberulis terminalibus vel lateralibus, basi foliosis, multifloris; calycis lobis ovato-lanceolatis, ca. 2.5 mm. longis; petalis oblongo-acutis purpureo-punctatis, ca. 3.5 mm. longis, medio marginibus connatis; staminibus inaequalibus subulatis glabris, basi connatis; ovario purpureo-punctato pubescenti, 2-ovulato: fructu coriaceo paululum fusco-puberulo oblique ellipsoideo, stipitato, ca. 2 cm. longo.

Collected at Huitla and Finca Irlanda, Chiapas. No. 7379. Type, Herb. Univ. Calif. No. 178083.

Thouinia riparia sp. nov.

Frutex: foliis ca. 1 dm. longis, glabris pinnatis, foliolis 3–6-jugis, usque ad 6 cm. longis, 1.5 cm. latis, lanceolatis, margine serratis: floribus in cymis paniculatis ramos terminantibus; sepalis 5, orbiculatis inaequalibus margine ciliatis; petalis 4, unguiculatis, intus infra medium tomentosis; disco crasso; staminibus 8, filamentis tomentosis; ovario 3-lobo, 3-loculari, pubescenti, ovulis in loculis solitariis; stylo 3-partito: samaris fructus juvenis 3, divaricatis, longe alatis.

This plant belongs to *Thouinidium* of the Pflanzenfamilien, a genus reduced to Thouinia in the Kew Index. Collected along the Rio San Geronimo, Oaxaca. No. 7161. Type, Herb. Univ. Calif. No. 175044.

Laplacea grandis sp. nov.

Arbor grandis: foliis ovatis obtuse acuminatis, basi in petiolum attenuatis, margine crenato-serratis, utrinque glabris, laminis ca. 12 cm. longis, 4 cm. latis; petiolis ca. 2 cm. longis: floribus axillaribus solitariis, pedicellis ca. 1 cm. longis; sepalis 5 coriaceis, ca. 4 mm. latis puberulis, margine ciliatis: staminibus multiseriatis; alabastris globosis; petalis coriaceis, exterioribus furfuraceis; stigmatibus 5 fere sessilibus: capsula conico-ovata, ca. 3 cm. longa, 5-loculari loculicide dehiscenti; seminibus apice in alam productis: ovario pubescenti.

The few specimens came from Finca Mexiquito and Irlanda, Chiapas. Of the one from Finca Mexiquito, Dr. Purpus notes "a tree so large I could not climb it and was unable to get more." The specimens have only the coriaceous buds and mature fruit, which resembles an acorn in shape. No. 7092. Type, Herb. Univ. Calif. No. 174218.

Ternstroemia Purpusii sp. nov.

Frutex glaber: foliis alternis ellipticis nitentibus, basi angustatis, apice obtuse acuminatis, margine interdum sinuatis, ca. 9 cm. longis, 3.7 cm. latis; petiolis ca. 2 mm. longis; pedunculis 1-floris fasciculatis, axillaribus lateralibusque, ca. 8 mm. longis; bracteolis sub floribus 2, parvis sepalis consimilibus; sepalis 5 crassis valde imbricatis, basi in tubum campanulatum coalitis, orbicularibus, margine minute ciliatis; petalis 5 imbricatis orbicularibus quam petalis longioribus, basi subconnatis; staminibus 20–40 1-seriatis, filamentis basi connatis filiformibus; antheris erectis basifixis, apice connectivo loculis aequilongo excurrente setiformi instructis, loculis rima fere ad basim dehiscentibus; stylis 2 fere a basi liberis ca. 4 mm. longis; ovario late sessile, ovulis nonnullis. Fructus deest.

The two styles and the setiform appendages of the anthers well distinguish this from other Mexican species. The dried flowers have a reddish tinge. Collected in Chiapas. No. 7434. Type, Herb. Univ. Calif. No. 178086.

Cuphea chiapensis sp. nov.

Fruticosa ramosa: caulibus fuscis scabriusculis, junioribus viscoso-pubescentibus: foliis oppositis ovato-acuminatis, basi cuneatis, usque ad 4 cm. longis, 2.4 cm. latis, supra scabrido-hirsutulis, subtus glabris nunc pubescentibus nunc scabris; petiolis 7–15 mm. longis; calycibus ca. 23 mm. longis, setulosis, basi paulo calcaratis, intus bialatis vel costatis, appendicibus quam lobis brevioribus setulosis; staminibus 11, glabris, 9 exsertis; petalis 6, duabus ca. 12 mm. longis, 5 mm. latis, sanguineis, 4 inaequalibus ca. 3 mm. longis dilute rubris; stylo exserto; disco brevibus suberecto; seminibus ca. 10.

Collected on Cerro del Boqueron, Chiapas. No. 7271. Type, Herb. Univ. Calif. No. 174879.

Heterotrichum scopulinum sp. nov.

Frutex ca. 1 m. altus, eglandulosus: caulibus sulcatis fusco-setosis: foliis late ovatis basi cordatis apice acuminatis, margine denticulatis setosis, 7-nerviis, supra paulo setosis, subtus ad venas hirsutis, usque ad 18 cm. longis, 15 cm. latis; petiolis 6–13 cm. longis pubescentibus: floribus in paniculas setosas terminales dispositis, 4–5-meris; calyce campanulato ore constricto 4–5-lobato paulo setoso, lobis triangulis dorso appendice lineari-lanceolata setosa ca. 2 mm. longa instructis; petalis obovatis roseis, ca. 3 mm. longis; staminibus 8–10; bacca globosa calycis limbo coronata apice depressa, diametro ca. 5 cm.

According to the collector's notes this is a small bush growing on rocky banks and bearing rose-colored flowers. The stems are retrorsely setose in the manner of *Maieta setosa* Cogn. Collected on Cerro del Boqueron, Chiapas. No. 7358. Type, Herb. Univ. Calif. No. 174832.

Cavendishia chiapensis sp. nov.

Fruticosa glabra epiphytica; foliis coriaceis ellipticis apice longe acuminatis basi obtusis, 3–5-nerviis, usque ad 14 cm. longis, 5.5 cm. latis; racemis axillaribus vel terminalibus, 3–5.5 cm. longis; pedicellis 1.3 cm. longis; bracteis coloratis cito deciduis; calyce campanulato, margine membranaceo, breviter 5-dentato; corolla ventricoso-tubulosa dilute rubra ore valde contracta, ca. 15 mm. longa, dentibus oblongis obtusis reflexis ca. 1 mm. longis; filamentis liberis basi complanatis superne gradatim angustatis tubo corollae affixis; bacca diametro ca. 8 mm.

Collected from trees on Cerro del Boqueron, Chiapas. No. 7342. Type, Herb. Univ. Calif. No. 174857.

Jacquinia arenicola sp. nov.

Ramuli puberuli; foliis glabris ellipticis coriaceis, basi in petiolum brevem transeuntibus, apice acumine pungente praeditis, ca. 5 cm. longis, 2 cm. latis, margine incrassatis, subtriplinerviis obscure costulatis; inflorescentiis terminalibus corymboso-racemosis, racemis usque ad 8-floris, ca. 4 cm. longis, pedicellis ca. 6 mm. longis, bracteis ovato-acuminatis ciliatis; floribus ca. 9 mm. longis, corolla saturate aurantiaca, tubo quam lobis paululum longiori; lobis oblongis obtusis; staminodiis late ovatis acutis quam lobis brevioribus; staminibus staminodiis brevioribus, antheris oblongis truncatis; fructu rubro diametro ca. 15 mm., cum stylo mucronato.

Collected near San Geronimo, Oaxaca, growing on sandy plains. No. 7132. Type, Herb. Univ. Calif. No. 174148.

Parathesis lanceolata sp. nov.

Ramis juvenibus ferrugineo-tomentosis demum glabris; foliis elliptico-lanceolatis, apice acuminatis, basi in petiolum attenuatis, margine integris, punctulis minutis ob lucem visis, 8–12 cm. longis, 2–3 cm. latis, utrinque demum glabris; petiolis ca. 7 mm. longis; inflorescentia terminali ferrugineo-tomentosa 2–3-pinnata folios plerumque superanti; pedicellis brevibus; calycis tubo lobis triangulis lineato-pictis aequanti; corollae lobis reflexis lanceolatis, ca. 4 mm. longis; antheris obtusis dorso area atra instructis; ovario glabro. Fructus deest.

Collected in damp barrancas near Finca Irlanda, Chiapas. No. 7371. Type, Herb. Univ. Calif. No. 174817.

Parathesis reflexa sp. nov.

Frutex; caulibus ferrugineo-tomentellis; foliis anguste ellipticis, apice acuminatis, basi in petiolum attenuatis, margine integris, supra glabris subtus venosis, ferrugineo-tomentellis demum glabris, usque ad 17 cm. longis, 5 cm. latis; petiolis ca. 2 cm. longis; inflorescentia terminali foliis aequanti 2–3-paniculata, umbellulis ca. 6-floris; pedicellis ca. 5 mm. longis reflexis; calyce fere usque ad basim lobato, lobis brevibus triangulis; corollae tubo subnullo, lobis ovato-lanceolatis puberulis reflexis, ca. 5 mm. longis; filamentis antheras aequantibus liberis; stylo corollae lobis aequilongo.

Collected near Finca Irlanda, Chiapas. No. 7334. Type, Herb. Univ. Calif. No. 175050.

Ardisia Purpusii sp. nov.

Undique glabra; foliis pallidis ellipticis crassis, apice acuminatis, basi in petiolum breve marginatum angustatis, margine integris, usque ad 25 cm. longis, 10 cm. latis; inflorescentia terminali tripinnatim paniculata foliis multo breviori; pedicellis ca. 11 mm. longis; sepalis fere liberis ovatis; petalis oblongo-acutis deinde reflexis, basi breviter connatis; staminibus quam petalis paululum brevioribus; antheris filamentis quadruplo longioribus.

Dots and lines usually found in the genus are not conspicuous in the specimens, perhaps owing to their poor condition. Collected in damp barrancas near Finca Irlanda, Chiapas. No. 7119. Type, Herb. Univ. Calif. No. 174412.

Polystemma scopulorum sp. nov.

Caulibus apice volubilis, hirsutis pilis patentibus, usque ad 5 dm. longis; foliis ovato-acuminatis basi cordatis sinu lato, utrinque paulo hirsutis, laminis ca. 8 cm. longis, 4.5 cm. latis, petiolis 3–5 cm. longis; cymis paucifloris, pedunculis ca. 2.5 cm. longis; calycibus alte 5-lobis, lobis lanceolatis ca. 5 mm. longis; corolla rotata, lobis ca. 8 mm. longis intus reticulatis; coronae squamellis 5 anguste oblongis apice tridentatis stigma superantibus cum lobis 20 inaequalibus basi squamellae affixis; gynostegio brevissimo; stigmate plano; antheris membrana hyalina magna inflexa terminatis. Fructus deest.

Collected on rocky slopes near San Geronimo, Oaxaca. No. 7275. Few specimens were found. Type, Herb. Univ. Calif. No. 174875.

Fischera aristolochiaefolia sp. nov.

Volubilis: caulibus hirsutis pilis patentibus: foliis oblongo-acuminatis, margine hirsuto-ciliatis, basi caudato-acuminatis sinu aperto, supra paulo pubescentibus, subtus praecipue ad venas hirsutis, laminis usque ad 16 cm. longis, 7 cm. latis, petiolis ca. 3 cm. longis hirsutis: cymis umbellatis, ca. 6-floris; pedunculis interpetiolaribus, ca. 1.5 cm. longis; pedicellis ca. 1.8 cm. longis: calycibus alte 5-lobis, lobis late spathulatis fere glabris; corolla rotata, lobis oblongis ca. 7 mm. longis apice undulato-emarginatis: corona exteriori tubulata crassa margine exteriori lobata, lobis intus pubescentibus, margine interiori squamata; corona interiori 5-squamata a dorso antherarum radianti, squamis crassis oblongis; antherarum appendicibus membranaceis inflexis; disco stigmatis plano angulato. Fructus deest.

Collected on Cerro del Boqueron, Chiapas. No. 7277. Type, Herb. Univ. Calif. No. 174873.

Vincetoxicum (Gonolobus) **chiapense** sp. nov.

Volubilis: caulibus patenter pilosis: foliis ellipticis acuminatis basi cuneatis, ca. 9 cm. longis, 3.5 cm. latis, utrinque pilosis; petiolis ca. 1.3 cm. longis pilosis: umbellis axillaribus 3–4-floris; pedunculis ca. 4 mm. longis; pedicellis 5–10 mm. longis; calycis lobis lanceolatis pilosis ca. 4 mm. longis; corollae lobis late lanceolatis extus pilosis, ca. 5 mm. longis; corona simplici annulata margine undulata; stigmatis disco atro-purpureo angulato plano. Fructus deest.

Very few specimens were found. Collected on Cerro del Boqueron, Chiapas. No. 7279. Type, Herb. Univ. Calif. No. 173113.

Evolvulus campestris sp. nov.

Perennis: caulibus prostratis, parce adpresse hirsutis: foliis oblongo-ovatis, apice obtusis, basi cuneatis, utrinque glabris vel interdum subtus ad venas hirsutulis; petiolis brevibus; pedunculis folios superantibus, 1–2-floris, quando 2-floris bracteatis; sepalis ovato-lanceolatis hirsutulis; corolla ca. 1 cm. lata, dilute caerulea, alabastro extus adpresse hirsuto.

Collected on rocky plains near San Geronimo, Oaxaca. No. 7182. Type, Herb. Univ. Calif. No. 175008.

Ipomoea silvestris sp. nov.

Volubilis: caulibus teretibus hirsutis: foliis trilobatis, basi cordatis, lobis acutis, discoloribus utrinque pubescentibus, ca. 7 cm. longis latisque; petiolis 4–6 cm. longis: pedunculis brevibus paucifloris quam foliis multo brevioribus; bracteis ca. 1 cm. longis lineari-lanceolatis pubescentibus, pedicellis brevibus; sepalis oblongo-obtusis fere aequalibus, exterioribus hirsutis, ca. 1.4 cm. longis: corolla purpurea ca. 4 cm. longa e basi gradatim ampliata ore parum angustata, ca. 1 cm. lata, lobis brevissimis; staminibus inclusis e basi usque ad medium pubescentibus: ovario 2-loculari. Fructus deest.

The form of the corolla perhaps would place this species in the doubtful genus *Exogonium*. Collected in forests near Zacuapan, Vera Cruz. No. 7309. Type, Herb. Univ. Calif. No. 174944.

Beureria Purpusii sp. nov.

Frutex: ramis puberulis: foliis late ovatis apice acutis basi subcordatis margine integris, supra paulo pubescentibus, subtus pallidioribus, praecipue ad venas pubescentibus, 8–12 cm. longis, 7–8 cm. latis; petiolis ca. 2 cm. longis puberulis: paniculis ramulos terminantibus laxifloris; calyce paulo pubescenti, lobis triangulis intus puberulis; corolla ca. 1.3 cm. lata; staminibus basi intus incrassatis pubescentibus; styli ramis brevibus. Fructus deest.

Collected on banks of arroyos at San Geronimo, Oaxaca. No. 7369. Type, Herb. Univ. Calif. No. 174819.

Borreria tonalensis sp. nov.

Herbacea; caulibus paululum pubescentibus, 3–5 dm. altis, ramosis: foliis ovato-acuminatis, ca. 6 cm. longis, 2–2.5 cm. latis, basi in petiolum alatum ca. 1 cm. longum attenuatis, supra plerumque glabris, subtus praecipue ad venas hirsutulis, nervis utrinque-secus 6–8, stipularum setis quam vaginis longioribus: floribus in verticillastris axillaribus vel terminalibus congestis; bracteis filiformibus; calycis lobis late ovato-acutis margine cum setis albis brevibus ciliatis, ca. 1 mm. longis; corolla ca. 1 cm. longa, tubo filiformi, lobis 4 brevibus.

Collected on Sierra de Tonala, Chiapas. No. 7116. Type. Herb. Univ Calif. No. 174414.

Aegiphila paludosa sp. nov.

Fruticulus: caulibus glabris, lenticellis multis instructis: foliis ovato-acutis, basi cuneatis, punctatis, interdum ad nodos congestis, ca. 2.5 cm. longis, 13 mm. latis; petiolis ca. 3 mm. longis: inflorescentia puberula axillari et terminali paniculam foliosam formanti; calyce campanulato 5-dentato; corolla ca. 1.4 cm. longa, coccinea, tubo tenuiter cylindraceo superne parum ampliato lobis 5 ovatis; staminibus 4 longe exsertis; ovario 4-loculari. Fructus deest.

Collected about ponds near San Geronimo, Oaxaca. No. 7181. Type. Herb. Univ. Calif. No. 175009.

Cestrum chiapense sp. nov.

Frutex, cortice badio; foliis ovatis concoloribus plerumque acutis, ad venas fusco-puberulis, usque ad 5.5 cm. longis, 3 cm. latis, petiolis puberulis ca. 2 cm. longis; floribus axillaribus vel terminalibus in ramis brevibus; calyce cylindrico puberulo, laciniis inaequalibus longe acuminatis; corolla ca. 2.4 cm. longa, infundibuliformi, lobis acuminatis fuscis intus pubescentibus; staminibus glabris endentulis, usque medium tubi adnatis, basi tumidis. Fructus deest.

Collected near Rancho del Boqueron, Chiapas. No. 7170. Type, Herb. Univ. Calif. No. 175033.

Solanum hamatile sp. nov.

Scandens? glabrum; caulibus gracilibus; foliis solitariis, margine integris, oblongo-ellipticis, laminis ca. 8 cm. longis, 3 cm. latis, apice acutis, basi cuneatis; petiolis ca. 1.5 cm. longis, costis petiolisque aculeis hamatis compressis instructis; floribus in racemos corymbosos dispositis; calycibus campanulatis 5-dentatis; staminibus 5, inaequalibus; antheris linearibus apice poris deinde rimis lateralibus dehiscentibus; ovario 2-loculari pyramidato. Fructus deest.

Collected along Rio San Geronimo, Oaxaca. No. 6164. Type, Herb. Univ. Calif. No. 175042.

Solanum (Polymeris) **chiapense** sp. nov.

Glabrum nitens inerme; caulibus debilibus geniculatis; foliis anguste ellipticis, apice acuminatis, basi cuneatis interdum geminatis, ca. 10 cm. longis, 2.5–3.5 cm. latis; petiolis ca. 7 cm. longis; pedicellis 1–2 axillaribus, ca. 13 mm. longis; calyce margine undulato chartaceo, appendicibus linearibus; corolla dorso crasso-angulata, angulis in lobos breves extensis membrana colorata connexis; antheris 4 aequalibus altera majori. Fructus deest.

Collected near Finca Irlanda, Chiapas. No. 7328. Type, Herb. Univ. Calif. No. 175061.

Solanum huitlanum sp. nov.

Caulibus spinosis densissime flavo-stellato-pubescentibus, spinis rectis; foliis ovatis, supra dense stellato-pubescentibus, venis spinis paucis validis interdum armatis, subtus dense flavo-stellato-pubescentibus, margine profunde repando-lobatis, basi cordatis, usque ad 22 cm. longis, 15 cm. latis; petiolis armatis stellato-pubescentibus, ca. 5 cm. longis; cymis lateralibus brevibus, floribus congestis; calycis lobis 5, ovato-acutis extus stellato-pubescentibus intus adpresse villosis, ca. 1.8 cm. longis; corolla calycem paulo superanti, lobis oblongo-ovatis extus stellato-pubescentibus intus glabris venosis; filamentis brevibus complanatis; antheris superne attenuatis apice 2-porosis; stylo recto sepalis staminibusque aequilongo; ovario setifero; bacca diametro ca. 2.5 cm. densissime setifera, setis ca. 4 mm. longis.

This species is near *S. flavescens* Dunn, but seems to differ materially. It is a coarse plant of a tawny color; the stems and upper side of the leaves are armed with straight spines; the upper side of the leaf is greener than the lower side. The fruit is densely covered with tawny stout bristles. Collected near Huitla, Chiapas. No. 7313. Type, Herb. Univ. Calif. No. 173380.

Solanum dasyanthum sp. nov.

Fruticulus ramosus, parce ad ramulos atque foliorum costas aculeatus; aculeis plerumque rectis, basi dilatatis; ramis vetustis glabris cinereis, junioribus dense flavo-stellato-pubescentibus; foliis singulis vel geminis ovatis, basi inaequalibus; laminis usque ad 4 cm. longis, 3 cm. latis, utrinque dense stellato-tomentosis, subtus pallidioribus, margine integris; petiolis ca. 5 mm. longis, stellato-pubescentibus; floribus singulis suboppositifoliis; pedicellis ca. 2 cm. longis, pilis apice stellatis instructis; calyce stellato-pubescentibus usque ad medium 5-lobato; corolla alte 5-lobata, laciniis calycem aequantibus oblongis angustis intus venosis extus stellato-pubescentibus; staminibus 5 aequalibus; antheris oblongis apice primum in rimam brevem deinde usque ad basim dehiscentibus; filamentis brevibus dilatatis; bacca atropurpurea glabra.

A small bush having the appearance of some shrubby Crotons. Collected near San Geronimo, Oaxaca. No. 7178. Type, Herb. Univ. Calif. No. 175012.

Diastema rupestre Brandg.

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Kohleria saxicola Brandg.

Appear to be only forms of the same variable species, which is *Diastema* rather than *Kohleria*.

Besleria chiapensis Brandg.

Univ. Calif. Publ. Bot. vi, 64

The glands of the disk are very variable. Some flowers have no glands; some have 2–4 long glands and with some the gland is nearly completely annular. The mature fruit is globular and mucronate by the indurated style. The pericarp becomes membranaceous. The seeds are bright scarlet.

Kohleria viminalis sp. nov.

Fruticosa: caulibus gracilibus debilibus ramosis intricatis glabris: foliis ovato-lanceolatis apice acuminatis, basi anguste cuneatis, margine hirsuto-ciliatis interdum paulo denticulatis, 3–6 cm. longis, 1–2 cm. latis, supra glabris, subtus ad venas hirsutulis; petiolis ca. 6 mm. longis: pedunculis solitariis axillaribus filiformibus unifloris, ca. 7 cm. longis, medio bracteolatis, bracteolis filiformibus ca. 6 mm. longis; calycis tubo turbinato ultra medium adnato, lobis lineari-lanceolatis ca. 1 cm. longis; corolla rubra extus pubescenti, basi aequali, tubulosa ad medium paulo ampliato, ca. 3 cm. longa; disci glandula crassa annulata.

This species is a woody vine-like plant bearing red flowers on long, bracted peduncles. The gland of the disk is annular like that of *Achimenes* but in other characters it is nearer *Kohleria*. Collected near Finca Irlanda on moist rocks. No. 7282. Type, Herb. Univ. Calif. No. 174923.

Episcia Purpusii nom. nov.

Solenophora Purpusii Brandg. Univ. Calif. Publ. Bot, vi, 65. Additional and better specimens received from Dr. Purpus show that this plant is not a Solenophora but probably belongs to the genus Episcia. To its description add: calycis lobis foliaceis: corollae tubo recto, staminibus prope basim affixis, filamentis liberis: fructu omnino supero, ovoideo, 2-valvato; placentis in laminam dorsifixam sessilem expansis, facie interiori ovulifera.

Justicia hians (Brandg.) nom. nov.

Beloperone hians Brandg. Proc. Cal. Acad. Ser. II, ii, 1889, 194. *Justicia Palmeri* Rose, Cont. U. S. Nat. Herb. I, 1890, 75. Lacking seeds the plant was erroneously described as a Beloperone. Unfortunately the rules of nomenclature necessitate a change of the specific name. It is a common species of the lower half of the peninsula of Baja California.

Justicia (Dianthera) **chiapensis** sp. nov.

Suffrutescens: caulibus geniculatis puberulis teretibus nodis radicantibus: foliis oppositis ovato-acutis supra paulo pubescentibus subtus glabris, ca. 5 cm. longis, 1–3 cm. latis; petiolis ca. 5 mm. longis: spicis laxifloris caules terminantibus usque ad 8 cm. longis interdum geminis altera breviori; floribus singulis in axillis bractearum sessilibus, bracteis late ovatis foliosis venosis petiolulatis fere glabris, ca. 4 mm. longis, 3 mm. latis, bracteolis lanceolatis calycis lobos aequantibus, ca. 3 mm. longis, corollae tubo brevi, labio postico integro, labio antico 3-lobo, staminibus 2 fauci affixis, antherarum loculis connectivo lato disjunctis: capsula ca. 6 mm. longa.

Well marked by the broad bracts of the spike, sometimes, however, with the shorter spikes the bracts are absent. The spike somewhat suggests *Tetramerium*, but the capsule is that of *Dianthera*. Collected on rocky banks of Cerro del Boqueron, Chiapas. No. 7285. Type, Herb. Univ. Calif. No. 173117.

Jacobinia Purpusii sp. nov.

Fruticosa ramosa: caulibus teretibus pubescentibus: foliis ovato-acuminatis interdum basi cuneatis, margine integris, utrinque pubescentibus subtus praecipue ad venas, ca. 6 cm. longis, 3 cm. latis: petiolis 1.2–2.5 cm. longis: floribus 1–4 ramulos terminantibus sessilibus; calycis lobis lanceolatis quam bracteis foliosis oblongo-lanceolatis ca. 6 mm. longis brevioribus; corolla ca. 7 cm. longa pubescenti alte bilabiata, tubo superne paulo ampliato, labio postico apice curvato integro, labio antico angusto breviter trilobo demum deflexo, staminibus 2, lobum posticum aequantibus; antheris ecalcaratis oblongis loculo altero altius affixo. Fructus deest.

A species having long yellow flowers. Collected in damp barrancas near Finca Irlanda, Chiapas. No. 7284. Type, Herb. Univ. Calif. No. 173108.

Odontonema glabra, sp. nov.

Suffrutescens, undique glabra: caulibus parum ramosis, teretibus: foliis oblongo-acuminatis, basi in petiolum brevem attenuatis, margine integris, usque ad 2 dm. longis, 7 cm. latis: floribus paniculatis caules ramosque terminantibus, bracteis lineari-lanceolatis parvis; calycis tubo turbinato brevi, laciniis 5 lanceolatis, ca. 2 mm. longis: corolla ut videtur dilute flava, ca. 2 cm. longa, paululum bilabiata, superne parum ampliata, labio postico breviter 2-lobo, antico usque ad medium 3-lobo; antherarum loculis aequalibus vel inaequalibus, filamentis medio tubo affixis, staminodiis 2 plus minus longis; capsula 2 cm. longa.

Specimens from Cerro del Boqueron were distributed under the name of *Jacobinia saxatilis* Brandg. ined. Collected at Finca Irlanda and on Cerro del Boqueron, Chiapas. Nos. 7286 and 7208. Type, Herb. Univ. Calif. No. 174149.

Aphelandra speciosa sp. nov.

Suffruticosa, glabra: foliis ovato-acuminatis in petiolum usque ad 8 cm. longum attenuatis, laminis 10–23 cm. longis, 6–14 cm. latis, margine integris: spicis terminalibus ca. 12 cm. longis; bracteis coloratis margine integris ca. 3 cm. longis, 1.5–2.6 cm. latis, inferioribus vacuis acutis, superioribus obtusis minoribus: calycis segmentis lanceolatis ca. 7 mm. longis; corolla ca. 38 mm. longa, rubra, tubo ca. 20 mm. longo, labio postico integro, labio antico usque ad basim 3-fido, laciniis lateralibus multo minoribus; antheris quam corolla paulo longioribus; capsula ca. 2 cm. longa, seminibus minute tuberculatis.

Collected at Finca Mexiquito, Chiapas. No. 6995. Type, Herb. Univ. Calif. No. 172800.

Sommera chiapensis sp. nov.

Foliis obovato-lanceolatis, margine integris, basi in petiolum attenuatis, subtus praecipue ad venas hirsutulis, supra glabris, venulis creberrime lineolatis, ca. 15 cm. longis, 6 cm. latis, junioribus subtus adpresse hirsutis: petiolis 3–6 cm. longis: stipulis cito deciduis lanceolatis glabris ca. 3 cm. longis: racemis axillaribus paucifloris usque ad 5.5 cm. longis; pedicellis ca. 1 cm. longis; calycis tubo urceolato, lobis 5–6 oblongis, 1–2 mm. longis; corollae tubo brevi, basi glabro, lobis 5, ca. 1 cm. longis, oblongo-ovatis acutis extus pubescentibus intus dense villosis; staminibus 5 fauci corollae insertis, filamentis brevibus, antheris brevibus oblongis, styli ramis hirsutis; bacca immatura subglobosa glabra.

This plant is closely related to the *Sommera arborescens* Schl. from Zacuapan, but the calyx lobes, fruit and flowers are very different. Collected near Finca Irlanda, Chiapas. No. 7263. Type, Herb. Univ. Calif. No. 174914.

Mannettia flexilis sp. nov.

Caulibus gracilibus volubilibus puberulis, junioribus hirtellis: foliis ovato-lanceolatis fere glabris, basi cuneatis, breviter petiolatis, ca. 6 cm. longis, 2 cm. latis: floribus in umbellas vel racemos 2–4-floros dispositis: pedunculis brevibus vel nullis; pedicellis ca. 5 mm. longis: calyce campanulato, lobis 4 ovato-lanceolatis demum reflexis tubo aequilongis; corolla tubulosa ca. 5 mm. longa, lobis brevibus triangulis, intus pubescentibus; styli ramis brevibus e tubo corollae breviter exsertis: capsula turbinata septicide 2-valva.

Collected on moist rocky banks of Cerro del Boqueron, Chiapas, Oaxaca. No. 7118. Type, Herb. Univ. Calif. No. 174907.

Zexmenia (Anchenocarpa) **chiapensis** sp. nov.

Suffrutescens: caulibus pubescentibus: foliis ovato-lanceolatis, basi in petiolum ca. 1.3 cm. longum pubescentem attenuatis, margine serratis, supra parum strigosis subtus villosis usque ad 10 cm. longis, 3 cm. latis: capitulis ad apices vel in axillis ramulorum brevium subumbellatis; pedicellis 0.5–2.5 cm. longis; involucri pubescentis squamis exterioribus oblongis acutis, ca. 1 cm. longis, basi ampliatis; interioribus 2-seriatis late ovatis acutis ciliatis: radii floribus flavis styliferis: disci achaeniis compressis, faciebus convexis, marginibus plus minus alatis, pappo supra achaenium in annulum constricto, aristis 2 quam achaenium pilosulum longioribus, cum squamellis intermediis brevibus: radii achaeniis 3-quetris pappo minori.

Collected near Finca Irlanda, Chiapas. No. 7192. Type, Herb. Univ. Calif. No. 175001.

Vernonia Purpusii sp. nov.

Frutescens: caulibus teretibus pubescentibus: foliis ovato-lanceolatis breviter petiolatis, basi obtusis vel cuneatis, apice acuminatis, margine integris, ca. 7 cm. longis, 2.5 cm. latis, supra molliter pubescentibus, subtus dense adpresse villosis: capitulis cymoso-paniculatis caules terminantibus, ca. 20-floris; involucri squamis ovato-acuminatis, 3–4-seriatis; corollis verisimiliter albis; antheris basi sagittatis; achaeniis adpresse setosis; receptaculo convexo; pappo caducissimo, setis interioribus quam squamis exterioribus duplo longioribus.

Collected on Cerro del Boqueron, Chiapas. No. 7189. Type, Herb. Univ. Calif. No. 174998.

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FLORAL RELATIONS AMONG THE GALAPAGOS ISLANDS

BY
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In Professor B. L. Robinson's valuable and fundamental treatise on the Flora of the Galapagos Islands,[1] he speaks repeatedly of the many unexplained anomalies between the florulae of the various islands of this group, and concludes his monograph by inferring from these differences and discrepancies that botanical evidence on the whole opposes the theory of the formation of the islands by subsidence and favors the hypothesis of their emergence.

> Of the species of Albemarle nearly half are common to Charles and Chatham, and about one-third to James, while scarcely more than one-fifth have been found on Indefatigable, although it attains about the same height and lies directly between Albemarle and Chatham.
>
> Of its [Barrington's] 40 species, 26 occur upon Charles and Chatham islands, while but 18 have been found on the nearer Indefatigable.
>
> More than half the plants of Bindloe occur upon Charles, Chatham, and Albemarle respectively, while the proportion found on Abingdon and Tower [nearer islands] is considerably less.
>
> It is another of the unaccountable anomalies in the florulae of these islands that the common element between Duncan and Charles or Chatham is greater than between Duncan and the nearer islands of Albemarle, Indefatigable, and James.
>
> It is a curious fact that of the twenty-two plants observed on this island [Jervis] only nine have been found on the adjacent James Island, although twelve have been collected upon Chatham, and no less than fifteen on Charles,, both much more distant.
>
> It is noteworthy that less than half the plants of the Seymour Islands have as yet been found upon Indefatigable, near as it is; indeed the common element is considerably greater with the much more distant islands of Charles, Chatham, and Albemarle.

[1] Proc. Am. Acad. Arts and Sciences, 38, 77–269, 1902.

The most noteworthy feature of these differences is not, however, their extent, but rather the fact that for the most part they stand in no relation to the distance of the islands from each other or to the depth of the intervening channels. Thus the florulae of Albemarle and Chatham at opposite sides of the archipelago are more alike than either is to that of the intervening Indefatigable; Jervis lying near James has a greater common floral element with the more distant Charles; the florulae of the Seymour Islands have a greater number of plants in common with Charles, Chatham, and Albemarle than with Indefatigable, of which the Seymour Islands are merely a detached spur. Although a high percentage of ferns has been recorded on James, not a single representative of this group has thus far been found on the adjacent Indefatigable. The common floral element between Duncan and the relatively remote Chatham is greater than with any of the three large islands, James, Indefatigable, and Albemarle, which to a considerable extent surround it. In fact, the only cases in which it appears that proximity between two islands has brought about any marked similarity in their floras are on the one hand Narborough and Albemarle, and on the other Gardner and Charles, and even in the former of these pairs, the likeness is by no means close, for not over 71 per cent of the plants of Narborough have been observed on Albemarle.

These anomalies in the different florulae must find their explanation in peculiarities of climate and soil, together with an element of chance—arising partly from imperfect exploration, and partly from the accidents of seed-dispersal. Although they are not fully explained by the theory that these are islands of emergence casually seeded, they are much less in accord with the Baur theory of subsidence; for, were the florulae remnants of a common flora persisting upon islands separated by gradual subsidence, it is evident that those islands would possess the most floral similarity which were nearest together and divided by the shallowest channels, since these would have been separated from each other more recently than the remoter islands, which are cut off by a greater depth of ocean. As we find no such relation prevailing in the Galapagos Islands, but have observed just the reverse, namely, that the more distant islands, separated by relatively deep channels, often show greater floral similarity than the nearer ones, it is necessary to conclude that the botanical evidence, so far as it has been made out, is opposed rather than favorable to the subsidence theory.[2]

On the respective hypotheses of subsidence and emergence of the Galapagos group, I have no particular conviction and no view to press. But the basis of Professor Robinson's inferences on this point seems questionable; and a re-examination of the facts presented by him has led me to a very different opinion of the irregularity of the inter-island floral relations of the Galapagos.

The statistical summary on which Professor Robinson bases most of his conclusions is the following table of species and forms common to the several islands.[3]

[2] *Ibid.*, pp. 244–259.

[3] *Ibid.*, p. 253.

TABLE I

Island	Abingdon	Albemarle	Barrington	Bindloe	Charles	Chatham	Culpepper	Duncan	Gardner	Hood	Indefatigable	James	Jervis	Narborough	Seymour	Tower	Wenman
Abingdon	50	34	11	15	36	31	0	10	13	14	18	26	9	14	7	11	1
Albemarle	....	205	23	24	100	93	2	29	17	33	46	74	13	42	25	7	2
Barrington	....	......	40	11	26	26	2	13	14	20	18	19	5	15	16	10	0
Bindloe	....	......	....	42	25	22	1	7	8	13	15	14	5	15	8	9	1
Charles	....	......	....	....	267	126	2	35	31	40	48	78	19	38	30	13	2
Chatham	....	......	....	....	......	231	2	34	22	42	51	64	12	33	31	15	4
Culpepper	....	......	....	....	......	......	5	2	1	2	0	0	0	2	2	1	1
Duncan	....	......	....	....	......	......	..	51	17	26	20	21	8	9	16	7	1
Gardner	....	......	....	....	......	......	..	....	33	22	17	15	6	7	13	9	1
Hood	....	......	....	....	......	......	..	....	....	59	20	29	8	15	20	10	0
Indefatigable	....	......	....	....	......	......	..	....	....	....	76	33	12	14	23	9	2
James	....	......	....	....	......	......	..	....	....	....	....	153	10	27	19	10	1
Jervis	....	......	....	....	......	......	..	....	....	....	....	......	22	1	7	3	1
Narborough	....	......	....	....	......	......	..	....	....	....	....	......	....	59	8	7	0
Seymour	....	......	....	....	......	......	..	....	....	....	....	......	....	....	47	6	2
Tower	....	......	....	....	......	......	..	....	....	....	....	......	....	....	....	19	2
Wenman	....	......	....	....	......	......	..	....	....	....	....	......	....	....	....	....	11

It is true that at first sight this table seems to show many surprising anomalies. Bindloe island was known to have forty-two species of vascular plants at the time of Professor Robinson's writing, and James, which is one of the nearest to it, 153; fourteen species being common to the two. Charles, with 267 species, is much farther from Bindloe than is James; but Charles and Bindloe share twenty-five species. But it is clear that the absolute numbers are misleading in this connection, on account of the enormous difference between the numbers of species, or known species, on the several islands. Charles, according to these figures, is florally nearly twice as rich as James; and, conditions being reasonably equal, a greater number of its plants than of those of James should therefore recur on Bindloe. As a matter of fact, the *proportion* of fourteen James-Bindloe to twenty-five Charles-Bindloe is less than that of 153 James to 267 Charles; so that a greater similarity between adjacent James and Bindloe than between distant Charles and Bindloe could be more properly asserted than the contrary finding of Professor Robinson.

TABLE II

	Narborough	Albemarle	Jervis	Duncan	Barrington	Seymour	James	Indefatigable	Charles	Hood	Gardner	Chatham	Abingdon	Bindloe	Tower
Narborough (59)	....	20	9	18	*37*	17	18	18	14	26	21	14	28	*35*	41
Albemarle (205)	***71***	....	59	57	57	53	49	***61***	38	56	52	40	***68***	57	41
Jervis (22)	2	6	....	16	12	15	7	16	7	14	*18*	5	*18*	12	16
Duncan (51)	15	14	*36*	....	32	34	20	25	13	16	*52*	15	20	17	*37*
Barrington (40)	25	11	23	25	....	*34*	12	22	10	12	*42*	11	22	26	*53*
Seymour (47)	14	12	*32*	31	*40*	....	12	30	11	15	*39*	13	14	19	*32*
James (153)	46	37	45	41	47	40	....	43	29	*49*	15	28	*52*	33	*53*
Indefatigable (76)	24	22	*55*	39	45	*49*	22	....	18	34	*52*	23	48	36	47
Charles (267)	64	49	***86***	69	65	64	51	63	....	68	***94***	50	***72***	60	68
Hood (59)	25	16	36	*51*	50	43	18	26	15	....	***67***	18	28	31	*53*
Gardner (33)	12	8	27	*33*	28	*29*	10	22	12	18	....	9	26	19	*47*
Chatham (231)	56	45	55	67	65	66	42	67	47	***71***	67	....	62	52	***78***
Abingdon (50)	24	16	*41*	20	27	15	17	24	13	24	39	13	....	*36*	***58***
Bindloe (42)	*35*	12	23	14	27	17	9	20	9	22	24	9	*30*	....	*47*
Tower (19)	12	3	14	14	*25*	13	7	12	5	17	*27*	6	*22*	11	....

In Table II, Professor Robinson's figures have been converted into percentages. The islands have also been listed in approximate geographical instead of alphabetical order. Since any number denoting the species common to two islands can be expressed as a percentage of the total number of species on each island, the horizontal rows and vertical columns of figures are not identical. As one reads downward, one encounters the various percentages of the number of species found on the island heading the column, occurring also on the various other islands. Thus, of Narborough's fifty-nine forms, forty-two, or 71 per cent, recur on Albemarle, one, or 2 per cent, on Jervis, nine, or 15 per cent, on Duncan, and so on. Reading horizontally for Narborough, however, one encounters the figures twenty, nine, eighteen, and so forth; which denote that the forty-two Narborough-Albemarle species constitute 20 per cent of Albemarle's total of 205, the two Narborough-Jervis 9 per cent of the twenty-two on Jervis, etc.

But these percentages are also unsatisfactory, since it is obvious that when they are read vertically the high figures are regularly encountered for large and florally well-stocked islands, and that when they are read horizontally the figures run higher just in proportion as the islands referred to are small or poor in variety of vegetation. This is made clear by the italic and bold-faced numerals introduced into the table. The three highest numbers in each column have been printed in black type. A glance shows that these heavy numerals all come in rows for Charles, Chatham, and Albemarle, the three islands which with respectively 267, 261, and 205 species are the richest in the group. Even the three vacancies caused by the intersection of the row and the column for each of these islands are instructive; their place is taken in each case by a black number in the row for James, the next richest island, with 153 species. The only two exceptions are for Gardner, 67 per cent of whose species recur on nearby Hood as against only 52 on richer but much more distant Albemarle; and isolated and scantily vegetated Tower, for which nearby Abingdon with 58 per cent also replaces Albemarle with 41. These two exceptions are interesting, it is true, because they indicate the influence of geographical position, contrary to Professor Robinson's statements. But they are too few to be of much significance; and in general, the results reveal too little, other than the overwhelming influence exerted on the results by the absolute number of species growing on each island, to endow the method employed with much validity as a means of determining inter-island relationships.

The same is true when the largest numbers encountered in each horizontal row are selected, as has been done in the table by the use of italics; only in this case it is of course the poor or small islands that appear most frequently. Thus it will be seen that Charles, Chatham, Albemarle, and James are not represented at all by italics; while Tower, Gardner, Abingdon, and Jervis, with only nineteen, thirty-three, fifty, and twenty-two species respectively, appear from ten to five times.

It therefore occured to me to combine the two sets of percentages given in the rows and columns of Table II into their means. Mathematically this procedure does not seem justifiable, as this mean does not express anything intrinsic. It would have been preferable, perhaps, to give the percentage which the number of species, common to each pair of islands, formed of the total number of distinct species found on the two islands. But this plan, besides involving some computation, seemed open to the objection that after all its results would depend too directly on the wealth of the various floras. Thus, only 3 per cent of all the species found on Albemarle (205) and Tower (19) are common to both; but 11 per cent of those occurring on Albemarle and Seymour (47), and as much as 27 per cent of those on

Albemarle and Charles (267). The first method suggested was therefore followed, and the results are given in Table III. The figure forty-five which appears at both intersections of Narborough and Albemarle is thus the mean of the 71 per cent of the Narborough flora recurring on Albemarle and of the 20 per cent of the Albemarle flora found on Narborough: that is, half of seventy-one and twenty.

TABLE III

	Narborough	Albemarle	Jervis	Duncan	Barrington	Seymour	James	Indefatigable	Charles	Hood	Gardner	Chatham	Abingdon	Bindloe	Tower
Narborough (59)	....	**45**	3	16	31	15	**36**	21	**39**	25	16	35	26	30	26
Albemarle (205)	**45**	....	32	35	34	32	**43**	41	**43**	36	30	42	42	34	22
Jervis (22)	3	**32**	....	26	17	23	26	**35**	**47**	25	22	30	29	17	15
Duncan (51)	16	35	26	....	28	32	30	32	**41**	33	**42**	**41**	21	15	26
Barrington (40)	31	34	17	28	....	37	29	33	**37**	31	35	**38**	24	26	**39**
Seymour (47)	15	32	23	32	**37**	....	26	**39**	**37**	29	34	**39**	14	18	22
James (153)	**36**	**43**	26	30	29	26	....	32	**40**	33	12	35	34	21	30
Indefatigable (76) ..	21	**41**	35	32	33	39	32	....	**40**	30	37	**45**	36	28	29
Charles (267)	39	43	**47**	41	37	37	40	40	....	41	**53**	**48**	42	34	36
Hood (59)	25	36	25	33	31	29	33	30	**41**	....	**42**	**44**	26	26	35
Gardner (33)	16	30	22	**42**	35	34	12	37	**53**	**42**	....	38	33	21	37
Chatham (231)	35	42	30	41	38	39	35	**45**	**48**	**44**	38	....	37	30	42
Abingdon (50)	26	**42**	29	21	24	14	34	36	**42**	26	33	37	....	33	**40**
Bindloe (42)	30	**34**	17	15	26	18	21	28	**34**	26	21	30	**33**	....	29
Tower (19)	26	22	15	26	**39**	22	30	29	36	35	37	**42**	**40**	29	....

In this table the three highest numbers appearing in each horizontal row have been indicated by heavy type. Charles, the island with the largest number of species, keeps its lead in high numbers in its vertical column, but Chatham begins to fall behind, and Albemarle still more so. It is also apparent at a glance that geographical position is not without influence. The group of southeastern islands, appearing in the third framed square in the table, particularly evidence a close relationship to one another: of the twelve high numbers relating to them, nine are confined to themselves. The distinct northern group also has three, out of the six numbers appearing in its frame, of the "highest" or bold-face type. Narborough and Albemarle, constituting a western group, show a higher common figure (45), than either does with any other island. Only the central group has miscellaneous affinities in all directions.

The situation is still clearer if we regard only the nine larger islands. In Table IV these are given, arranged by geographical groups, each followed by the three islands with which its mean percentage relation is highest according to Table III; and each of these three names is followed by a number from 1 to 8, indicating the respective degrees of geographical proximity of these islands to the one in question. Those of the same group are in heavy type.

TABLE IV

Island	Resemblances					
Narborough	**Albemarle**	1	Charles	6	**James**	2
Albemarle	**Narborough**	1	Charles	4	James	2
James	Albemarle	1	Charles	6	Narborough	3
Indefatigable	Chatham	4	Albemarle	2	Charles	3
Charles	**Chatham**	4	Albemarle	2	Abingdon	8
Hood	**Chatham**	1	**Charles**	2	Albemarle	4
Chatham	**Charles**	3	Indefatigable	2	**Hood**	1
Abingdon	[Albemarle	3	Charles	6]	Chatham	7
Bindloe	[Albemarle	3	Charles	7]	**Abingdon**	1
		24		34		31

Again the western group is a unit, not only in its internal relation, but in the fact that the same non-western islands come next in each case. Much the same holds of the northern group. The three southern islands are again clearly linked together. The addition of the numbers indicating proximity points in the same direction: 24, 34, and 31 total 89. Divide by 27 (3 numbers each for 9 islands), the product is 3.3. If, however, geographical relations did not exist, the numbers would have appeared at random, and their average would have been the mean of the sequence 1 to 8, or 4.5. The difference between 4.5 and 3.3 is some index of the effect of geographical proximity in increasing floral relationship between islands.

Another and more nearly correct method of demonstrating such influence of geography upon flora as there might be, subsequently occurred to me. This was to arrange the islands, not in alphabetical sequence as Professor Robinson had done, nor in geographical order, as in Tables II, III, and IV, but in the order of their wealth of

TABLE V

	Total Species	Chatham	Hood	Charles	Gardner	Indefatigable	James	Brattle	Barrington	Duncan	Jervis	Seymour	Albemarle	Narborough	Abingdon	Bindloe	Tower	Wenman	Culpepper
Total Species	......	306	79	319	48	193	224	16	48	103	42	52	325	80	119	47	22	14	7
Chatham	306	......	60	188	31	128	121	13	36	69	30	38	175	56	80	29	18	7	2
Hood	79	60	....	66	37	49	47	10	29	45	16	26	58	26	35	18	13	4	3
Charles	319	188	66	......	44	123	124	12	33	75	32	38	173	52	79	33	16	6	4
Gardner	48	31	37	44	....	30	27	6	23	24	13	20	35	13	23	14	11	4	4
Indefatigable	193	128	49	123	30	......	111	11	27	59	32	38	145	45	75	27	13	7	2
James	224	121	47	124	27	111	......	10	22	64	29	27	169	46	80	24	13	6	2
Brattle	16	13	10	12	6	11	10	....	7	4	3	7	10	6	11	4	5	5	1
Barrington	48	36	29	33	23	27	22	7	....	20	14	19	29	18	18	11	10	2	2
Duncan	103	69	45	75	24	59	64	4	20	....	24	23	75	25	49	13	9	4	2
Jervis	42	30	16	32	13	32	29	3	14	24	....	13	32	14	25	10	7	1	1
Seymour	52	38	26	38	20	38	27	7	19	23	13	....	34	15	26	11	8	5	2
Albemarle	325	175	58	173	35	145	169	10	29	75	32	34	......	69	99	36	15	7	2
Narborough	80	56	26	52	13	45	46	6	18	25	14	15	69	....	34	18	8	4	2
Abingdon	119	80	35	79	23	75	80	11	18	49	25	26	99	34	....	26	16	6	3
Bindloe	47	29	18	33	14	27	24	4	11	13	10	11	36	18	26	....	10	5	2
Tower	22	18	13	16	11	13	13	5	10	9	7	8	15	8	16	10	....	6	1
Wenman	14	7	4	6	4	7	6	5	2	4	1	5	7	4	6	5	6	..	1
Culpepper	7	2	3	4	4	2	2	1	2	2	1	2	2	2	3	2	1	1	..

species. Meanwhile, however, a large body of fresh information on the botany of the Galapagos had been released for use through the publication of Dr. Alban Stewart's "A Botanical Survey of the Galapagos Islands,"[4] which it had been my lot to conduct on its course through the press. This monograph not only incorporates all the data available to Professor Robinson, but includes a wealth of new material secured by the author during a stay of more than a year in the archipelago. Many irregularities in Professor Robinson's data, due to imperfect exploration up to his time of writing, are corrected by Dr. Stewart. Thus Albemarle, by far the largest of the islands, now is known to have also the largest number of species, whereas before it was reckoned only third. So also Indefatigable, the second greatest in area, was formerly represented by less than a third as many species as much smaller Chatham, whereas now the figures are 193 and 306. It is therefore preferable to use Dr. Stewart's data. These are first shown in Table V, which is a direct reproduction from Dr. Stewart's monograph,[5] except that it is geographically rearranged.

Dr. Stewart's essay is only part of what he hopes to issue on Galapagos botany,[6] and his discussion of botanical conditions on each island is reserved for the unpublished portion of his work. His table from which my Table V is taken is, however, based on the same unfortunate alphabetical arrangement as Professor Robinson's; and at the only point where he touches on the question of inter-island relationships, he seems to incline to Professor Robinson's view that the distribution of Galapagean plants runs counter to the geographical position of and distances between the islands. Thus:[7]

> If oceanic currents were an important factor in the transport of seeds . . . the several islands of each group [in the archipelago] should have a larger floral element common among themselves than with any of the islands of the other group. The following table shows the percentages of floral relationships between the islands of the northern group, as well as their relationships with some of the more important islands of the southern[8] group.

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[4] Proc. California Acad. Sciences, ser. 4, I, 7–288, 1911: Expedition to the Galapagos Islands, 1905–1906, II.

[5] *Ibid.*, p. 237.

[6] *Ibid.*, p. 9.

[7] *Ibid.*, p. 240.

[8] Dr. Stewart's "groups" here are different from mine. His "northern" islands are Abingdon, Bindloe, Tower, Wenman, Culpepper, his "southern" ones all the remaining islands of the archipelago.

Floral Relationships of Northern Islands

	Abingdon	Albemarle	Barrington	Bindloe	Brattle	Charles	Chatham	Tower
Abingdon	....	83.1	....	....	....	66.3	67.2	....
Bindloe	55.3	76.5	....	....	....	68.5	61	....
Tower	72.7	68.1	48.4	48.4	....	72.7	81.8	....
Wenman	38.5	50	....	35.7	35.7	38.6	50	38.5

From the above table it is seen that in the majority of instances the islands of the northern group have a larger percentage of their floras common with the islands of the southern group than with each other.

These computations by Dr. Stewart suffer from the same defect as my Table II. Abingdon and Albemarle have ninety-nine forms in common; this joint element forms 83 per cent of the flora of Abingdon, it is true, but only 30 per cent of that of Albemarle. Furthermore, his table ignores the all-important factor of size of the floras. Abingdon, indeed, is only half as distant from Tower as is Albemarle; but this does not raise any presumption in favor of a higher percentage of common forms for Abingdon, as soon as it is borne in mind that the flora of Albemarle is nearly three times as rich as that of Abingdon. When in view of this latter difference 73 per cent of Tower's flora is found to occur on Abingdon and only 68 per cent on Albemarle, it is clear that the distance between the islands, or other geographical factors such as the oceanic currents which Dr. Stewart is discussing in the passage cited, are of considerable influence in determining the various island floras. If the geographical relations of Abingdon and Albemarle to Tower were exactly alike, the infinitely richer flora of Albemarle would certainly be more abundantly represented on meagerly clothed little Tower than that of Abingdon.

Table VI, then, gives Dr. Stewart's data with the islands arranged in order of the richness of their floras. It is obvious from this at once that in general the number of species common to any two islands depends not so much on their location relative to each other, nor their altitude, rainfall, or position in certain winds or currents, nor on any as yet unknown or mysterious cause, but on the mere wealth and variety of their plant lives. This is the all-important factor, beside which every other is comparatively insignificant. When this element is considered, the internal floral relations of the Galapagos are substantially accounted for; when it is disregarded, they become unintelligible. The general regularity of the decreasing series from left

TABLE VI

	Total species	Albemarle	Charles	Chatham	James	Indefatigable	Abingdon	Duncan	Narborough	Hood	Seymour	Barrington	Gardner	Bindloe	Jervis	Tower	Brattle	Wenman	Culpepper
Total species	......	325	319	306	224	193	119	103	80	79	52	48	48	47	42	22	16	14	7
Albemarle	325	......	173	175	169	145	99	75	69	58	34	29	35	36	32	15	10	7	2
Charles	319	173	......	188	124	123	79	75	52	66	38	33	44	33	32	16	12	6	4
Chatham	306	175	188	......	121	128	80	69	56	60	38	36	31	29	30	18	13	7	2
James	224	169	124	121	......	111	80	64	46	47	27	22	27	24	29	13	10	6	2
Indefatigable	193	145	123	128	111	......	75	59	45	49	38	27	30	27	32	13	11	7	2
Abingdon	119	99	79	80	80	75	......	49	34	35	26	18	23	26	25	16	11	6	3
Duncan	103	75	75	69	64	59	49	......	25	45	23	20	24	13	24	9	4	4	2
Narborough ..	80	69	52	56	46	45	34	25	....	26	15	18	13	18	14	8	6	4	2
Hood	79	58	66	60	47	49	35	45	26	....	26	29	37	18	16	13	10	4	3
Seymour	52	34	38	38	27	38	26	23	15	26	....	19	20	11	13	8	7	5	2
Barrington ..	48	29	33	36	22	27	18	20	18	29	19	....	23	11	14	10	7	2	2
Gardner	48	35	44	31	27	30	23	24	13	37	20	23	....	14	13	11	6	4	4
Bindloe	47	36	33	29	24	27	26	13	18	18	11	11	14	....	10	10	4	5	2
Jervis	42	32	32	30	29	32	25	24	14	16	13	14	13	10	....	7	3	1	1
Tower	22	15	16	18	13	13	16	9	8	13	8	10	11	10	7	....	5	6	1
Brattle	16	10	12	13	10	11	11	4	6	10	7	7	6	4	3	5	....	5	1
Wenman	14	7	6	7	6	7	6	4	4	4	5	2	4	5	1	6	5	....	1
Culpepper	7	2	4	2	2	2	3	2	2	3	2	2	4	2	1	1	1	1	....
Sum	....	1163	1098	1081	922	922	685	584	451	542	350	320	359	291	296	179	125	80	36

to right, or from above downward, leaves no other inference possible. It is true that there are some important exceptions to this regularity: and these, as will be shown, possess a positive meaning; but they acquire this significance only with reference to the general trend of relationship as based on absolute number of species. It would be possible to establish an exact, quantitatively expressed correlation between the numbers of species on the various islands and the numbers of species possessed jointly by them with any given island. The range of floral wealth, however, is great, and the series are small; so that the degree of their trend, and its uniformity, are readily visible without more elaborate mathematical treatment. The point of the basic importance of richness of flora can therefore be accepted as established without further analysis or discussion; and I will proceed to examine briefly for each island the meaning of the departures from normal tendency of its series.

ALBEMARLE

The fairly considerable though secondary effect of geographical nearness is evident from the first three figures in Table VI. Nearly as many Albemarle species have been found on nearby James as on more remote Charles and Chatham, though these are almost half as rich again in total species as James. Narborough and Hood point the same moral. Their total species number the same—eighty and seventy-nine, to be exact; those which they share with Albemarle are, however, sixty-nine and fifty-eight. Hood, however, is about a hundred miles distant, while Narborough is separated from Albemarle by only a narrow channel, and moreover is shielded by it from all the remainder of the group. In view of this location it might be presumed that the difference between the Narborough and the Hood identities would be much greater: evidently position, while a factor, is not the primarily determining one.

Five islands have a flora of nearly the same size: Seymour with fifty-two species, Barrington with forty-eight, Gardner near Hood[9] with forty-eight, Bindloe with forty-seven, Jervis with forty-two. Their forms held in common with Albemarle are respectively thirty-four, twenty-nine, thirty-five, thirty-six, and thirty-two. The one signifi-

[9] Dr. Stewart gives figures also for Gardner near Charles, but as the number of species reported from this island is minimal, I have omitted all reference to it. Professor Robinson mentions only "Gardner Island," and treats it as if near Charles, but the number of species attributed by him to it shows that his data probably pertain to Gardner near Hood.

cant break in this series is the twenty-nine of Barrington. This I cannot explain by location, for while Barrington is much farther from Albemarle than is Jervis, it is much nearer than Gardner; and if it is near enough to Indefatigable to have been especially stocked by local species from that large island, Seymour is nearer still, and Gardner is almost a part of Hood, yet these both show the presence of more Albemarle forms. Such cases as this, of which several occur, must therefore be set down as due to "accident," as we may call the various unknown minor causes that it is impossible to follow in detail.

CHARLES

Charles shows more affinity with Chatham—188 to 173—than with nearer, larger, and florally richer Albemarle. This is the first instance of several pointing to a special relationship between the southeastern islands of Charles, Chatham, Hood, and Gardner, which constitute a fairly defined botanical province of the Galapagos. It is clear for one thing that the conditions at least for the variety of plant life are on the whole more favorable in these islands than elsewhere in the archipelago. Charles and Chatham are very much smaller than Albemarle, yet contain virtually as many species as it; they are considerably surpassed in area by Indefatigable, yet, according to available information are fully half as rich again in forms. Hood has as many species as Narborough, yet is only a fraction as large. Gardner seems to be distinctly the smallest and lowest of the five islands referred to in the preceding paragraph, yet it has no fewer different forms.

Narborough and Hood stand in a relation to Charles opposite to that which they hold towards Albemarle. From sixty-nine and fifty-eight, the figures reverse to fifty-two and sixty-six. It is probably not so much that Hood is nearer in miles than Narborough, as that it forms part with Charles of the southeastern province just referred to, whereas Narborough from its peculiar position must be in some measure especially dependent on Albemarle. The same may be said concerning the high figure (forty-four) which Gardner shows toward Charles as compared with the thirty-eight, thirty three, thirty-three, thirty-two of the four other islands of similar floral wealth.

CHATHAM

Chatham reveals the same affinities with the members of its own province as Charles, though not in so pronounced a form: species in common with Albemarle (325), 175, with Charles (319), 188; with

Narborough (80), 56, with Hood (79), 60. There is, however, no closer affinity to Gardner than to Seymour, Barrington, Bindloe, and Jervis.

JAMES

The nearness of this large island to Albemarle and Indefatigable is clearly reflected in the figures: Albemarle (325), 169, Charles (319), 124, Chatham (306), 121, Indefatigable (193), 111. Again, Jervis is only a few miles from James: the common species number twenty-nine while Seymour, Barrington, Gardner, and Bindloe, all slightly richer in species but more remote, share twenty-seven, twenty-two, twenty-seven, and twenty-four forms with James. I must admit that these differences are in themselves not very impressive; but my contention is that absolute wealth of flora is the primary factor, and geographical position only the chief of the secondary causes governing distribution.

INDEFATIGABLE

This great but apparently either unusually arid or botanically unduly neglected island of the central group shows somewhat the same effects of location as James, though in less marked form as regards the other large islands, no doubt owing to somewhat greater proximity to both Charles and Chatham. For the five smaller islands the significant figures are: Seymour thirty-eight, Barrington twenty-seven, Gardner thirty, Bindloe twenty-seven, Jervis, thirty-two. Seymour is almost on top of Indefatigable; and Jervis, while as far removed as Barrington, lies toward allied James, while with Barrington the more alien southeastern group is approached.

ABINGDON

This, not the largest but the highest and by far the richest island of the northern group, appears to have fairly uniform relations with the other groups, as might be expected from its rather detached position. There is, however, a perceptible leaning toward the nearer western and central flora rather than toward the farther southeastern. Compare Albemarle ninety-nine, Charles seventy-nine, Chatham eighty, James eighty, Indefatigable seventy-five. As James and Indefatigable run to only two-thirds as many species as Charles and Chatham, the practical equality of the present figures is certainly not accidental.

So, also, compare Seymour twenty-six, and Jervis twenty-five—both in James–Indefatigable waters—with Gardner twenty-three, and Barrington eighteen, one in and the other near the southeastern province.

Abingdon clearly has some direct affinity with the two other northern islands; but this is less marked than might be surmised, until one remembers that the three northern islands are rather small and not closely grouped, so that in the long run the chances would be more favorable of their receiving species from the large islands of the mass of the archipelago than from one another. Even if the Galapagos are not risen volcanoes but a gradually sunken land-mass, distinct local species must have been often communicated from one island to another; so that the point would hold. Proximity to Abingdon has, however, had some influence in shaping the floras of Bindloe and Tower, as will be shown; but on the other hand they are both too poor to have affected Abingdon appreciably.

DUNCAN

Duncan, considering its size, has a remarkably varied flora, due perhaps to the comparative variety of environment afforded by its unusual altitude. It lies between Albemarle and Indefatigable and near James. Its affinities are distributed about as one might expect from its position and the relative wealth of species of the other islands, except that the figure for Albemarle—seventy-five as compared with seventy-five and sixty-nine for distant Charles and Chatham—sinks rather low, and that for Narborough is surprisingly small. Evidently Duncan has not been stocked in any great measure from the west, and is itself too small to have had much influence on the larger western islands.

NARBOROUGH

The unusual position of this island is of interest. It is the most westerly of the Galapagos, and is half surrounded, and shut off from all the remainder of the archipelago, by crescent-shaped Albemarle. Of the large islands, it is distinctly the poorest in flora, according to our data. A large part of its area is covered by recent lava flows. It might therefore be anticipated that Narborough would show a very high degree of dependence on Albemarle, and little except the most general relationship to the other islands. This is only partially true. 86 per cent of its species are found on Albemarle; but this ratio is substantially equalled by the 84 per cent of Hood species occurring also on Charles; and Hood is by no means as closely linked geographically to Charles as Narborough is to Albemarle. Again, therefore, location appears to be of only subsidiary potency.

HOOD

The bonds between all the southeastern islands are revealed again by Hood. Thus, Albemarle fifty-eight, Charles sixty-six, Chatham sixty; and adjacent Gardner thirty-seven, but four more distant islands of similar floral range, twenty-nine to sixteen. With Indefatigable, possessing 193 species, Hood shares forty-nine; with James, possessing 224 but lying on the farther side of Indefatigable, forty-seven. The narrowness of the difference is as significant as its existence. Duncan (103), near Indefatigable, has forty-five Hood species; Abingdon (119), far to the north, only thirty-five; Narborough (eighty), twenty-six. Barrington, on the Hood side of Indefatigable, has twenty-nine Hood forms out of a total of forty-eight; Seymour and Jervis, on the James side of the same island, twenty-six out of fifty-two and sixteen out of forty-two.

SEYMOUR

Seymour is a small island, or rather pair of islets, separated from the north shore of Indefatigable by the narrowest and shallowest of straits. 73 per cent of its species, or thirty-eight out of fifty-two, are found on Indefatigable. For Charles and Chatham to the southwest, the figures are the same; for Albemarle and James to the west, only thirty-four and twenty-seven. Again it is apparent that specific abundance is the most influential cause in the establishment of inter-island relationships, and that proximity, especially when close, comes second. As a third factor we can add the greater potency of the southeast than of the remainder of the archipelago, especially upon the central province. Thus Hood has twenty-six Seymour species, to fifteen on Narborough and twenty-three on nearer and more varied Duncan; Barrington and Gardner show nineteen and twenty Seymour identities, Bindloe and Jervis only eleven and thirteen.

BARRINGTON

I have heretofore reckoned Barrington as one of the smaller central islands, on the basis of its geographical situation; but its affinities tend somewhat to the southeastern group, towards which it lies off Indefatigable. Thus:

Albemarle	29 of 325	Charles	33 of 319
James	22 of 224	Chatham	36 of 306
Narborough	18 of 80	Hood	29 of 79
Duncan	20 of 103		
Jervis	14 of 42	Gardner	23 of 48
Seymour	19 of 52		

The nearest land is Indefatigable, 14 per cent of whose flora it possesses, as against 12 per cent of Charles', 10 of Chatham's, 10 of James', and 9 of Albemarle's. After all, close proximity counts for more than distinct exposure to the strong southeastern influence.

GARDNER

This island lies close by Hood and fifty miles from Charles; but it has forty-four of the larger island's species and only thirty-seven of the nearer ones.

Within its usual limits, however, location makes itself observable: compare forty-four species shared with Charles, thirty-five with Albemarle; thirty with Indefatigable, twenty-seven with James; twenty-four with Duncan, twenty-three with Abingdon—the more remote island being in each case also the richer, though less represented on Gardner.

I cannot explain the low number (thirty-one) of Chatham species on Gardner as compared with the forty-four from Charles. Usually Charles and Chatham appear substantially as a unit in their relationship with other islands; and even in the case of Hood—to which Gardner is attached—the difference in favor of Charles is comparatively slight.

BINDLOE

Bindloe is the largest of the northern islands and the nearest to the central group, but, either on account of a lower elevation or for some unknown reason, it has less than half as many species as Abingdon. The affinities of its flora are very evenly distributed, except for somewhat higher percentages for species shared with the other northern islands, as indeed is only natural and might be expected, though Dr. Stewart's cited passage professes the opposite for the northern islands in general. Thus it has twenty-six of Abingdon's species, as against twenty-seven, twenty-four and twenty-nine of Indefatigable's, James' and Chatham's, although these average more than twice as many total forms; and similarly, the figures for Tower are ten out of twenty-two, as against ten out of forty-two for Jervis and eleven out of fifty-two for Seymour.

JERVIS

Jervis lies closest to James, but is also near Indefatigable and Albemarle. Its proximity to the two former is reflected by the figures in Table VI—twenty-nine and thirty-two—but the number for Albemarle species is unexpectedly low (thirty-two) and substantially equalled by the numbers of distant Charles and James. Exactly the same status holds for Duncan, the nearest small island to Jervis.

TOWER

This smallest and poorest of the northern islands shows a special affinity with Abingdon, 13 per cent of whose species it possesses as against, for instance, 6 of James', 5 of Albemarle's, 6 of Chatham's, and 9 of smaller Duncan's.

The southeastern influence is perhaps slightly stronger on Tower than that of the central and western groups. Compare Albemarle fifteen with Charles sixteen and Chatham eighteen; Duncan nine and Narborough eight, with Hood thirteen; Seymour eight, Barrington ten, and Jervis seven, with Gardner eleven.

BRATTLE

The little island of Brattle lies off that shore of Albemarle which faces Charles. Only sixteen plants have been reported from it. Considering the proximity of Brattle to Albemarle, it is significant that it possesses only ten species of that large island but twelve and thirteen from Charles and Chatham. The number shared with Hood is above the average. Evidently the southeastern influence has operated much as in the case of Jervis and Duncan, which also lie not far east of Albemarle.

WENMAN AND CULPEPPER

These two islets lie far to the north of the main Galapagos archipelago, and must not be confounded with what I have heretofore called the northern group, consisting of Abingdon, Bindloe, and Tower. Their flora is so monotonous that little inference can be drawn from the few species, out of their total fourteen and seven, which they share with the other islands. It does appear, however, that the southeastern group is again represented a little more than proportionately, although it is the most remote; and that on the other hand the three northern islands, no doubt because they are nearer, also share more, on the whole, in the floras of Wenman and Culpepper than the western and central groups.

For the sake of completeness, though it does not seem to add much that is new, I have included Table VII. This is a computation, along the lines suggested above, of the proportion which the number of species common to each pair of islands bears to the total number of different species known from the same two islands. The percentages are based on Dr. Stewart's data, with the islands rearranged in order as in my Table VI.

It is obvious that in a percentage table of this sort the high numbers will not all be at the heads of the columns and at the left of the rows, as in Table VI, but must cluster about the intersections of columns and rows. For instance, if all of the forty species on a given island are found also on a second island whose total number of forms is forty, and again on a third island whose wealth of species however reaches 200, the percentage for islands one and two will be 100, and for one and three only twenty. I have indicated by heavy type the highest percentage occurring in each column. It will be seen that these bold-face numbers practically all occur about where they should come as a matter of mathematical probability; namely, in close proximity to the row of spaces which diagonally bisects the table. (If corresponding entries had been made also in the horizontal rows, the arrangement of the heavy-type numbers would of course have been symmetrical to this diagonal axis.) This distribution once more corroborates mere floral wealth as the fundamental factor in island relationships. At the same time, the notable perturbations from probability are practically all due to geographical situation. Compare the high figures for Bindloe–Abingdon and Jervis–Duncan, to which Narborough–Albemarle just fails of being added.

If the distribution of the heavy-type numbers were mathematically regular, the entry of the one such number in each column should result in their appearance also one in each row; which is approximately the case. The one conspicuous deviation from this theoretical rule is afforded by Gardner, whose horizontal row will be seen to contain as many as five heavy numbers. This can scarcely be an accident, and I am inclined to attribute it to the slightly preponderating influence of the southeastern islands on the remainder of the archipelago. A similar influence appears deducible as regards southeastern Hood, with

TABLE VII

	Total species	Albemarle	Charles	Chatham	James	Indefatigable	Abingdon	Duncan	Narborough	Hood	Seymour	Barrington	Bindloe	Gardner	Jervis	Tower	Brattle	Wenman	Culpepper
Albemarle	325	....	37	38	**44**	**39**	29	21	21	17	10	8	10	11	10	5	3	2	1
Charles	319	37	....	**48**	30	32	22	22	15	20	11	10	14	10	10	5	4	2	1
Chatham	306	38	**48**	....	30	35	23	20	17	18	12	11	10	9	9	6	4	2	1
James	224	**44**	30	30	....	36	30	24	18	18	11	9	11	10	12	6	4	3	1
Indefatigable ..	193	39	32	35	36	....	**32**	25	20	22	18	13	14	13	16	6	6	3	1
Abingdon	119	29	22	23	30	32	....	28	**21**	21	18	12	16	**19**	19	11	9	5	2
Duncan	103	21	22	20	24	25	28	....	16	33	17	15	19	9	**20**	8	4	4	2
Narborough	80	21	15	17	18	20	21	16	....	20	13	16	14	17	13	8	7	4	2
Hood	79	17	20	18	18	22	21	**33**	20	....	25	30	**41**	17	15	15	12	4	4
Seymour	52	10	11	12	11	18	18	17	13	25	....	23	29	12	16	12	11	8	2
Barrington	48	8	10	11	9	13	12	15	16	30	23	....	33	13	18	17	**12**	7	4
Gardner	48	10	14	10	11	14	16	19	14	**41**	**29**	**33**	....	17	17	19	10	7	**8**
Bindloe	47	11	10	9	10	13	19	9	17	17	12	13	17	....	13	17	7	9	4
Jervis	42	10	10	9	12	16	19	20	13	15	16	18	17	13	....	12	5	2	2
Tower	22	5	5	6	6	6	11	8	8	15	12	17	19	17	12	....	15	**20**	4
Brattle	16	3	4	4	4	6	9	4	7	12	11	12	10	7	5	15	....	5	5
Wenman	14	2	2	2	3	3	5	4	4	4	8	7	7	9	2	**20**	5	....	5
Culpepper	7	1	1	1	1	1	2	2	2	4	2	4	8	4	2	4	5	5	..

two entries in its row, as compared with western Narborough, which possesses an equal number of species but has no entry in its row.

Examination of the individual figures in Table VII also shows a distinct but definitely limited influence of proximity paralleling that which has been established on the basis of Table VI. Only it must be remembered that in the present tabulation the high numbers must be expected to come not near the edges of the table but along the diagonal axis, dwindling away from this in all directions. A high percentage, such as that of thirty-three between Hood and Duncan, is therefore not indicative of operation of proximity, but is an effect of the similar number of species, seventy-nine and 103, occurring on the two islands. Viewing the figures with this point in mind, it could be pointed out, for instance, that the percentage of species common to Albemarle and James, and Albemarle and Indefatigable, is greater than the percentage common to Albemarle and Charles, and Albemarle and Chatham—unquestionably as a result of proximity, since theoretical probability would reverse the figures. In the same way scarcely a row or a column can be followed through without analogous deviations due to the same cause. The relationships established in this way, however, follow so closely those already discovered in Table VI and discussed at length, that it would be mere repetition to cite and analyze them.

CONCLUSIONS

It follows, therefore, that, so far as the number of joint species is concerned, the floras of the various Galapagos islands do not show any unaccountable relations or mysteries, but almost exactly such connections as might be expected.

The first and fundamental element that determines the number of species which two islands have in common, is clearly the number of species found on each. So obvious is this both from my own tables and those of Professor Robinson and Dr. Stewart, that practically all of the foregoing discussion of the characteristics of individual islands has concerned departures from this rule. A given island will always share more of its species with an island containing 300 species than with one containing fifty. This is clearly the result of the working of mathematical probability, and just in proportion as the influence of this element transcends that of any other, are these more specific causes relegated to a subsidiary station.

Secondly, though far behind, comes the factor of geographical position. Islands in proximity have more species in common than those that are far apart—at least in most cases, and to some degree.

Thirdly, there appears to be a slightly greater influence of the southeastern than of the western and central groups upon most of the smaller islands. This may be due to the southeastern islands being nearer the continent, or being the first to be washed by the flow of the Humboldt current, or lying to the windward of the others. At best, however, this southeastern preponderance is little more than nominal.

As regards the origin of the islands—a question which is primarily a geological one, though of interest to the biologist because its answer will enable him better to trace the processes of evolution of animal and plant life—Professor Robinson inclines rather to the emergence theory, Dr. Stewart favors that of subsidence, and I do not believe that a satisfactory answer can be given on botanical grounds, at least not without some new method of attack. If the islands arose from the ocean, and were gradually stocked with plants, different species would be bound to reach the individual islands at various times; but some, at least, of these would again be communicated to other islands. On the other hand, if the archipelago should be the remnant of a larger sunken block of land, there would no doubt have been greater original uniformity of distribution; but with the lapse of time there would be increasing diversity due to the formation of local varieties as well as the dying out in certain islands of species originally occurring there; while on the other hand the factor of dispersal and transmission of species from island to island would be operating simultaneously. It thus seems impossible to decide from a mere knowledge that such and such species are or are not now common to such and such islands, how far each of these various and conflicting processes has been at work.

The origin of the Galapagos Islands, then, is scarcely a soluble botanical problem. As regards the internal floral relationships of the archipelago, it appears that there is little that is not explainable on the basis of mathematical chance operating evenly as if all the islands formed a unit; with this factor disturbed in some measure by ordinary geographical influences.

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THE COMPARATIVE HISTOLOGY OF CERTAIN CALIFORNIAN BOLETACEAE

BY
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The Boletaceae constitute a relatively small family of the group of fungi known as the Hymenomycetales (Hymenomyceetineae, Hymenomycetes.) The Hymenomycetales are fungi whose spores are abjointed from basidia which are all at the same level and form a layer known as the hymenium. Until quite recently the Boleti have been considered as a subdivision under the Polyporaceae or "pore fungi." In this more comprehensive sense the Polyporaceae embrace all fungi in which the spore-bearing surface lines the interior of tubes, together with certain related forms included under the genera *Lenzites*, *Irpex*, and *Merulius*. More recently Dr. W. A. Murrill of the New York Botanical Garden has adopted a division of the Polyporaceae, or "pore fungi," into two families, the Polyporaceae and Boletaceae. The Polyporaceae are commonly leathery, corky, or woody in texture and the tubes, as a rule, do not separate readily from the pileus. Moreover the plants usually grow upon wood (epixylous). The Boletaceae are fleshy in texture, the tubes, in nearly all cases, separate very readily from the rest of the pileus and furthermore only a few species grow upon wood.

The Boletaceae are a small group of fleshy fungi with the hymenium lining the interior of tubes which are placed close together on the underside of the pileus or cap. The plants have both a pileus and a stipe or stalk. Frequently a veil is present, at least during the earlier stages, but sometimes the Boleti are practically gymnocarpous (compare Zeller, 1914). Nearly all the Boletaceae are terrestrial; only three or four species occur upon wood. With few exceptions the Boleti are seemingly saprophytic, mostly on decaying leaves or twigs. The plants grow in woods or along their borders. In California the writer has never found them in open fields. Some of the species are quite closely restricted to the neighborhood of a single genus or species of the higher plants. The Boleti putrefy very soon after reaching maturity, usually within two or three days after they first appear above the ground, especially if the weather be moist or wet. This putrefaction is usually hastened by the attacks of certain insect larvae to which these plants are particularly subject. The tendency to rapid putrefaction makes their collection and preservation a somewhat difficult matter. The difficulty of collection is increased by the fact that the fruiting bodies of most of our Californian species appear only after the first rains of the season and then are not found again until the following year, being present only in the form of the inconspicuous white or yellowish mycelium.

The Boleti are often brilliantly colored in shades of red, brown or yellow. The colors, however, are seldom retained to any exact degree in herbarium specimens. Both poisonous and edible species are found among the Boletaceae, but these plants conform even less than do the Agaricaceae to any rules which one may follow to avoid those which are poisonous.

History

In looking through the literature we find a considerable number of proposed classifications for the Boletaceae. However, there are but few of these systems of classification which have had any marked effect upon the study of this group in America.

Turning back to Fries, from whom, by authority of the third Brussels Congress in 1910, our system of nomenclature has its beginning, we find in the *Systema Mycologicum* (1821) that he considers *Boletus* a genus of the pileate Hymenomycetes of equal rank with *Polyporus*, *Agaricus*, etc. In this work the genus *Boletus* is divided into four subdivisions based upon the presence or absence of a ring, color of the spores, etc., and contains some twenty species, together with several varieties and forms. Fries later revised his classification, and we find in *Epicrisis Systematis Mycologici* (1836) that he places the Boleti under the family Polyporaceae. He furthermore divides them into seven subdivisions. In this latter work Fries lists, in all, about sixty species.

Later writers, have as a rule, followed the classification of Fries very closely. The divisions and subdivisions proposed by him have been treated variously, but in this country the subdivisions made by Fries have been largely followed up to the time of Murrill.

Peck, 1889, writing upon the Boleti of the United States, lists some one hundred and ten species in three genera as follows: *Boletus*, one hundred and three species; *Boletinus*, five species; and *Strobilomyces*, two species. He also includes a few forms which he does not definitely place.

As defined by Peck, the genus *Boletus* includes all forms in which the tubes separate readily from each other and from the pileus. The forms in which the tubes do not separate readily he placed in the two genera *Boletinus* and *Strobilomyces*, according to whether there is a perceptibly radiating arrangement of the tubes or not.

Peck further divided the genus *Boletus*, as he limited it, into eleven subgenera or tribes, corresponding very closely to the subdivisions of Fries. In fact, Peck's classification of the group is simply that of Fries modified so as to meet American conditions.

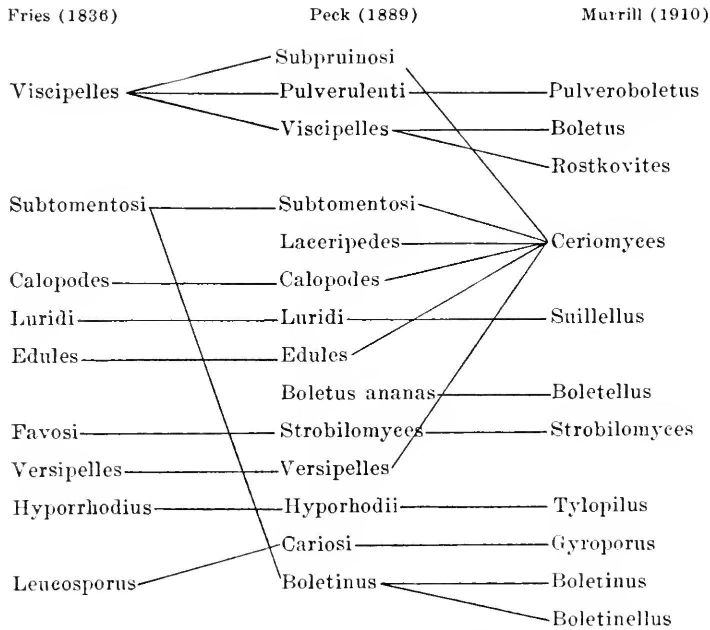
Hennings (1898), in his account in Engler and Prantl, *Die Natürlichen Pflanzenfamilien*, which has probably had great influence on modern work along this line, names eight genera of Boletaceae, which are placed as a subfamily under the Polyporaceae. However, there are probably only six of these genera which should be included in the family as now characterized. The genus *Henningsia* admitted by him, should probably be excluded, as suggested by Hennings himself, since the fruiting body is sessile and tough. The genus *Campbellia* is described as including forms with a fruiting body of gelatinous consistency and is probably better placed with *Merulius*, as was also suggested by Hennings. The remaining six genera appear to be separated by very good characters, such as spore color, presence or absence of a veil, and, in one genus, the presence of a volva.

The latest American account, that of Dr. W. A. Murrill (1910), separates the Boleti from the Polyporaceae and raises them to the rank of a family.

Dr. Murrill has divided the Boletaceae into eleven genera and has followed Peck rather closely in certain respects. Murrill has retained all of Peck's generic names and has raised several of the latter's tribes to generic rank. Murrill bases his distinctions largely upon spore characters and morphological characters which can be readily recognized even in dried material. In attempting to work over the Californian species Murrill's generic distinctions have proved to be the most satisfactory of any that we have at the present time.

In this publication (1910) Murrill lists seventy-five species as North American, divided among the eleven genera as follows: *Gyroporus*, three; *Tylopilus*, four; *Ceriomyces*, forty-four; *Suillellus*, five; *Rostkovites*, three; *Boletus*, four; *Boletellus*, one; *Pulveroboletus*, one; *Strobilomyces*, one; *Boletinellus*, three; *Boletinus*, six. Subsequently he has described one species of *Gyroporus*, five species of *Ceriomyces* and one species of *Rostkovites*.

The following tabulation shows the relation of the classifications adopted by Fries, Peck, and Murrill:



It is evident from the tabulation given above that Murrill's work has consisted chiefly in changing subdivisions to genera and in the grouping of a large number of forms under the genus *Ceriomyces*. The forms included in *Ceriomyces* by Murrill are those which, in the earlier classifications, depended upon color or minor morphological characters for their distinction. On the whole, Murrill's work has tended toward a classification based more nearly upon what appear to be the natural relationships within the family rather than upon mere superficial resemblances due to color or surface characters. The chief difficulty one finds in working with his keys is in the genus *Ceriomyces*, which includes a great number of species depending, as in the earlier classifications, upon color or slight structural differences. This genus seems to be a sort of a general assembling-ground for forms which do not fit anywhere else, and it does not seem to be based upon natural affinities. In my own study of the histological details of various North American species of *Ceriomyces*, differences of seeming importance have been found between individuals which, in other characters were apparently to be referred to the same species.

Material

The present study of the Boletaceae was started in the fall of 1912, when individuals of three species were collected. Certain differences noticed among individuals apparently belonging to the same species and discrepancies between the plants and the descriptions raised the question whether such plants were of different species, or forms of the same species. The lack of agreement between certain of the plants and the published descriptions presented the problem whether there might not be distinct differences between our Californian plants and the eastern representatives of the same species. For the purpose of comparison with our Californian plants, Dr. W. A. Murrill has very kindly contributed several specimens of Eastern representatives presumably of the same species.

In addition to the proposed study of histological details of the various plants accessible, it was deemed desirable to make as detailed a study as material and time would permit of the distribution of the Boleti in California, particularly in the San Francisco Bay region, and of the seasons when the plants appear, habitat, economic importance; above all, a study of their histology to determine whether there might be certain characters which would supplement the usual keys and descriptions for the determination of dried material and even furnish additional criteria for distinguishing the living plants. There is frequently great difficulty in the determination of dried material due to the fact that most of the species are determined in whole or in part by color characters. For this reason the determination of dried specimens often becomes quite impossible, especially if sufficient and exact notes on the living material are lacking, as they usually are when the plants have been collected by persons not familiar with this family.

Since 1912 I have collected Boleti as opportunity offered and have attempted to secure specimens of all the species growing in the San Francisco Bay region. This has been a somewhat difficult matter, since most of these plants appear above the ground immediately after the first rains in the fall, putrefy within two or three days and do not appear again until the following year. The only exceptions to this rule seem to be *Ceriomyces communis* and *Rostkovites granulatus*. The former has been collected from October until February, and the latter from October until April, or, in other words, at any time during the rainy season.

In addition to the plants secured by the writer a number of forms have been brought in by others, particularly several specimens from Mendocino County furnished by Mr. R. P. Brandt.

The Boleti of California have not been sufficiently worked over to make it possible to state definitely the number of species occurring in this region.

Harkness and Moore (1880) list sixteen species of Boleti occurring in California, but such of their collections as may have been preserved were probably destroyed in the San Francisco fire of 1906, so that a verification of this list has been rendered difficult or impossible.

Peck (1889) names eleven species as occurring in California, but quotes Harkness and Moore as his authority in each case. Strange to say, Peck does not mention the occurrence of *Boletus granulatus* (*Rostkovites granulatus*) in California, where it is our most common species and occurs under pines in abundance.

In southern California McClatchie, who collected extensively in that region, mentions only *Boletus subtomentosus*, now *Ceriomyces subtomentosus* according to Murrill.

Murrill (1910) describes three new species of Boleti from California, *Suillellus Eastwoodiae* Murrill, *Ceriomyces flaviporus* (Earle) Murrill, and *Ceriomyces tomentipes* (Earle) Murrill. In addition to these plants there are some eleven species listed by Murrill which may be expected in California. These eleven species include forms whose names are synonymous with species listed as occurring in California by Harkness and Moore, and plants which we may expect to find here from an extension of their range as given by Murrill.

Of these plants the following list includes the forms which I have been able to collect and examine:

Ceriomyces crassus Batt.
Ceriomyces communis (Bull.) Murrill
Rostkovites granulatus (L) P. Karst
Rostkovites californicus Murrill
Suillellus Eastwoodiae Murrill
Boletus luteus (L) Murrill

The following are the species of eastern Boletaceae received through the kindness of Dr. W. A. Murrill and which have been examined as to their histology and other details by the writer. I wish to express here my indebtedness to Dr. Murrill of the New York Botanical Garden, both for the use of material and for his assistance in the identification or verification of all my specimens.

Ceriomyces auriflammus (Berk. and Curt.) Murrill
Ceriomyces crassus var. separans (Batt.) Peck
Ceriomyces communis (Bull.) Murrill
Suillellus Frostii (Russell) Murrill
Rostkovites granulatus (L) P. Karst

Individuals of the following eastern species were also seen by the writer, but due to lack of material or other reasons their histology was not thoroughly investigated:

Gyroporus castaneus (Bull.) Quel
Ceriomyces eximius (Peck) Murrill
Ceriomyces auriporus (Peck) Murrill

All of our Californian Boleti are terrestrial and probably saprophytic upon decaying leaves and twigs. They are all fungi that inhabit woods, none having been found in open fields or any considerable distance from trees or bushes. Some of our species are restricted to the vicinity of definite species or genera of the higher plants. *Rostkovites granulatus*, our most common species, is never found except in the vicinity of pine trees, usually *Pinus radiata*. *Ceriomyces communis* occurs only near oak trees, usually coast live-oak (*Quercus agrifolia*.) On the other hand, certain species appear to grow almost anywhere in moist, shady woods. *Boletus luteus*, for example, has been collected under redwood (*Sequoia sempervirens*), Douglas fir (*Pseudotsuga taxifolia*), madrone (*Arbutus Menziesii*), coast live-oak (*Quercus agrifolia*), tan oak (*Pasania densiflora*) and Bishop pine (*Pinus muricata*).

Certain of the Boletaceae are reported to be poisonous but in the course of this study I have been unable to collect any information to add to our knowledge of the edibility of our Californian species. The Italians are the only people in this region who use the Boleti for food to any extent. They collect certain of the plants in considerable quantities and even expose them for sale in their markets. It is probable that not many of our species are poisonous, since I can find no cases of reported mushroom poisoning in California attributed to them.

Many of our species of Boleti are very subject to the attacks of various species of insect larvae. The insects concerned have not been thoroughly investigated and their life-histories are not well known. In my study the only plants not subject to the attacks of insect larvae were *Boletus luteus* and one form of *Ceriomyces communis.*

Technique

In this study sections were secured and compared from both dried and living material. The living material was cut into small pieces and killed by placing in boiling water. This process was sufficient, since sections showing nuclear behavior were not essential. After boiling, the material was passed up through the alcohols to 95 per cent to harden and dehydrate, and then down through the alcohols to pure water again. It was then frozen in gum arabic solution and the sections cut on the rotary microtome (compare Osterhout, 1904).

Section 25μ to 50μ in thickness were found to be the most satisfactory for study. Sections thinner than this showed a tendency to fall to pieces.

Dried material was placed in cold water and then boiled for perhaps ten minutes when glycerin was added to about one per cent. The material was then allowed to cool in the water, which was later poured off. The subsequent preparation of the material was after the same fashion as in the case of the living specimens.

Comparatively few sections of living material were cut and mounted by the paraffin method, but they were so little superior for the purpose of this study to those secured by freezing that the paraffin method was discontinued.

Flemming's triple stain was tried with the paraffin mounts but with little success. Safranin and Delafield's haematoxylin were also tried and both gave fairly satisfactory results. However, most of the sections used in the study were not stained, as it was found that practically as good detail could be secured without staining. The greater portion of the work was done on unstained material; observations were, however, checked up with material put through the staining process. Except for certain purposes, the stained material presented no decided advantages over the unstained.

Structure

Search of the literature fails to disclose any special papers on the structure of the Boleti. A few scattered references in connection with discussions of other problems give an idea of their structure in general. Levine (1913) in a paper on the cytology of the Boleti deals with certain general details of their structure, but in looking through the literature the writer failed to find any description of the histology of any species of the Boletaceae which would aid in the sort of work that it was proposed to carry out.

The details of the histology of a plant differ, of course, according to the part with which we are working. The structure of the stipe differs from that of the pileus. Furthermore the stipe is differentiated into an interior context and an exterior covering or rind, whose comparative histology differs very considerably in many of the species. The pileus, exclusive of the hymenium, is also differentiated into the context and a more or less definite rind, with marked differences in the histology of the two parts. The hymenium also has a very definite and characteristic structure.

The histology of the Boleti is so definitely associated with the development of the fruiting body that it seems advisable to discuss the early stages in the formation of the complex fruiting body in the Boleti.

In this connection practically the only literature is summarized in Zeller's (1914) paper, the conclusions of which are confirmed by the small amount of work that I have been able to do on the development of the carpophore, particularly in *Rostkovites granulatus*. However, it should be stated that I have found a veil present during the early stages of certain individuals of both species of *Ceriomyces* occurring in the San Francisco Bay region. Zeller's results may be summarized as follows:

The carpophore, or fruiting body, first appears as a small knob or button on the mycelium. Then this button, at first nearly spherical, begins to elongate and the hyphae in the center arrange themselves parallel to each other and to the long axis of the fruiting body. The hyphae in the peripheral portion are parallel to the surface. At this period there is no visible differentiation of tissue. There then appears a narrow ring of more deeply staining tissue a short distance below the summit and this area gradually broadens. While this is taking place the hyphae of the upper part, which later becomes the pileus, begin a radial growth and finally give rise to the surface rind. At the same time the hyphae of the deeply staining area grow downward through the deeply staining tissue, which now becomes a plane of cleavage, the hyphae breaking apart in this zone to form a furrow. The hyphae from above the furrow form a palisade layer, which later becomes the hymenium. At first this layer is quite smooth, then slight elevations appear which are formed by the differential downward growth of the hyphae. As the hyphae grow downward they branch and curve outward on each side to form the hymenium. While the hymenium is being differentiated, the ends of the hyphae from below, which were cut off by the formation of the annular furrow, project upward to form a palisade layer. This palisade layer is carried downward during the elongation of the stipe and forms the surface rind of, at least, the upper portion of the stipe. From the above description it is evident that at no time during the development of the fruiting body, is there any evidence of a veil being present in this species of *Ceriomyces*.

Structure of the Stipe

The stipe is usually, though not always, differentiated into an outer or surface rind and a context. The context is made up either of hyphae lying parallel to each other or, in other plants, the hyphae branch more or less and are sometimes quite intricately interwoven. In either case, however, they always maintain a general position parallel to the long axis of the stipe. Usually the hyphae become greater in diameter and less closely interwoven as the center of the stipe is approached. In some species the hyphae toward the center of the stipe are so loosely interwoven that they break apart during growth. This results, in extreme cases, in a stipe which is either hollow or fibrous.

The surface of the stipe is usually differentiated to some degree at least. In the forms in which the least differentiation is found, the surface layer consists merely of very closely packed hyphae, lying parallel to the long axis of the stipe and differing from the hyphae of the context only slightly in size and in having a darker color. In all the plants examined by the writer the hyphae of the context were colorless, or at most slightly granular in appearance, while those of the surface layer were some shade of yellow or brown.

In many of our Californian species of Boleti we find a distinct rind covering the stipe. This rind is usually formed of branches from the context curving outward until their tips stand in a position perpendicular to the surface of the stipe. These branches may be either larger or smaller in diameter than are the hyphae of the context. The tips of the hyphae forming the rind are often more or less swollen. In a few species reticulations are found on the stipe. These reticulations are usually folds of the rind.

Pileus

The pileus in the Boletaceae may be divided into two parts, whose structure should be considered separately. The tubes should be considered apart from the rest of the pileus, since their histology is very different from that of the context and rind.

The pileus, exclusive of the tubes, may be divided into a surface rind and the context. The rind varies greatly in its structure in the different species. Sometimes this surface layer is formed merely of densely interwoven hyphae differing from those of the context only in their size and in their color. In such cases the hyphae of the rind may be either larger or smaller in diameter; their color, however, is always dark. Such a structure of the surface rind is often characteristic of plants whose pileus is described as glabrous. In other cases we find in addition to the layer described above a second layer outside of this made up of long hairs or hyphae standing in a position perpendicular to the surface. The hairs, according to the species, may be branched or unbranched, septate or non-septate. Sometimes they are embedded in a jelly, and in such cases the pileus is usually viscid or slimy. In other plants the hairs are not embedded in a jelly and then the pileus is tomentose, or scaly, depending on the arrangement of the hairs. The hairs are usually colored some shade of brown. In some species the hairs occur alone without any other differentiated layer between them and the pileus. In this case the hairs pass over directly into the context merely by a loss of coloring matter and by the hairs becoming intertwined with each other. There may or may not be a difference in size between the hairs and the hyphae which make up the context.

Context

The context consists of hyphae which branch and anastomose frequently and which are densely interwoven. These hyphae vary greatly in diameter, which, however, is usually constant, within certain limits, in a given species. Immediately above the tubes the hyphae are less densely interwoven and fewer in number, enabling the tubes to be readily separated from the pileus.

Hymenium

The structure of the hymenium lining the interior of the tubes varies but little in the different forms. The hyphae of the trama, or tissue between the tubes, maintain a position parallel to the long axis of the tubes, branching and curving outward toward the hymenial layer, whose basidia, paraphyses, and cystidia (when present) are formed by the swollen tips of these hyphae.

The basidia are club-shaped structures with four projections at the tips known as sterigmata. From each sterigma a single spore is abjointed. Along with the basidia we find other club-shaped structures known as paraphyses. The paraphyses are usually somewhat shorter than the basidia but, like the latter, they are formed by the club-shaped, swollen tips of the hyphae. They differ from basidia only in their usually somewhat smaller size and by the absence of sterigmata. The paraphyses are probably merely sterile or possibly immature basidia and originate in the same manner. The function of the paraphyses is unknown. They tend, perhaps, to keep the basidia apart and thus give the spores more space in which to develop.

In addition to the basidia and paraphyses, structures known as cystidia are found in a few species of the Boletaceae. Except in species of *Rostkovites*, which will be described later, the cystidia are few in number and are easily overlooked. They are usually more or less club-shaped or cone-shaped and project for some little distance out from the hymenium towards the center of the tubes. The function of the cystidia is unknown. De Bary suggests the theory that the cystidia belong morphologically to hair-structures and that they may serve to protect the basidia. He states, further that in some species of *Coprinus*, one of the black-spored Agaricaceae, the cystidia extend across the space between the gills and, in this instance, appear to serve the function of keeping the spore-bearing surfaces of the gills from coming in contact with each other. No such function for the cystidia appears probable in the case of the Boletaceae. In none of the plants that I have examined do the cystidia project above the hymenium more than a very small fraction of the diameter of the tubes, so that they never approach the opposite side of the tubes.

In species of *Rostkovites* we find certain peculiar structures resembling cystidia in certain respects and which for lack of a better term may be designated as "glands." These "glands" are found in clusters or nests, both in the tubes and on the surface of the stipe. They excrete a whitish liquid, which may be seen in young specimens adhering in drops to the mouths of the tubes and on the surface of the stipe. This liquid becomes black when dry and then takes the form of black granules. The "glands" seem to be quite characteristic of the genus *Rostkovites* and will be taken up in some detail when we come to the consideration of this genus.

Special Histology

The species and forms discussed below have all been either determined by or verified by Dr. W. A. Murrill. They have, however, all been carefully studied by myself, and the segregation of forms resulting from differences in histology or morphology in the plants under consideration has been made by the writer.

CERIOMYCES Batt.

The genus *Ceriomyces* as limited by Murrill contains some forty-nine species occurring in North America. Hence it contains by far the largest number of North American species of any of the genera of Boletaceae.

According to Murrill, the genus *Ceriomyces* is made up of annual terrestrial plants with ochraceous or yellowish-brown, smooth, oblong-ellipsoidal spores. The stipe is central and exannulate. The surface of the stipe is either even or reticulate. The stipe is solid except in one or two species. The pileus is dry or rarely viscid and may be either glabrous or variously ornamented. The context is usually white or some shade of yellow and may be sometimes tinged with other colors. The tubes are either free or adnate, small and cylindric or often large and angular near the stipe. A few species are reported to be poisonous.

Ceriomyces is a genus of negative characters. It differs from other Boleti with ochraceous or brown spores which lack a radial arrangement of the pores by the following negative characters. It differs from the genus *Suillellus* by the absence of red mouths to the tubes; from *Rostkovites* it differs by the absence of glandular dots on the stipe; and from the genera *Boletus*, *Boletellus*, *Pulveroboletus*, and *Strobilomyces* it differs by the absence of an annulus.

It may be remarked here concerning the presence or absence of a transverse veil that there seems to be a lack of definite information. The general statement, for example (Murrill, 1910), is that the species of *Ceriomyces* are exannulate. So far as my own experience goes, this statement is undoubtedly true, but as to the presence or absence of a veil the evidence is not so clear. The condition of things in regard to the presence of a veil in the Boletaceae is similar in a way to the conditions in the Helvellales and Pezizales (Dittrich, 1898; Durand, 1908; McCubbin, 1910). Schröter (1897, p. 62) places *Boletus* under the Hemiangiocarpeae, in which by definition the hymenium is enclosed at first but is later exposed. Hennings (1898, p. 108) states that certain of the "Boletaceae" (*Boletus*) have their tubes exposed from the beginning. Zeller (1914) makes a definite statement that in the species with which he was working (*Ceriomyces Zelleri*) there were no traces of a veil present from the beginning. On the other hand, I have found a very definite veil present in young plants (10 to 15 mm. high) referred to two different species of *Ceriomyces*. In both cases, however, the veil later entirely disappears, leaving no trace either as an annulus on the stipe or as a fringe on the margin of the pileus.

From the above it would seem that the distinction between *Ceriomyces* and *Boletus* based on the presence or absence of an annulus is a question only of development and consequent persistence, as it is also among various genera of the Agaricaceae.

The distinction between *Suillellus* and *Ceriomyces* appears to be merely a color character which disappears upon drying, and hence is of no value in the determination of dried material. No traces of any histological structures to which the red color might be referred, were found at the mouths of the tubes in *Suillellus*.

As stated above, the distinction between *Ceriomyces* and *Rostkovites* is based chiefly upon the occurrence of glandular dots on the stipe of the latter. As will be described later in this paper, structures appearing to be very similar to the "glands" characteristic of *Rostkovites* were found upon the stipe of two forms of *C. communis*.

In *Boletus luteus*, a representative of another genus, which, like *Rostkovites*, is said to have glandular dots on the stipe, it was found that the dots were of very different origin from that of the dots in *Rostkovites*.

Thus far I have been able to find two species of *Ceriomyces* in California, namely, *Ceriomyces communis* and *Ceriomyces crassus*, as usually separated by the characters ordinarily used. From the study of our Californian material it has seemed desirable to distinguish four forms of *C. communis* and two forms of *C. crassus*, making six forms belonging to these two species. Of eastern material I have had for comparison three species of *Ceriomyces*, namely *C. crassus*, var. *separans*, *C. communis* and *C. auriflammeus*. The plants from the eastern United States all differ in certain details from Californian plants referred to the same species, and as a consequence I find that the Californian material, although referred by the ordinary characters to the same species as the eastern material with which it is compared, does differ sufficiently to compel consideration in so far as the discussion of the histological details is concerned.

Ceriomyces communis (Bull.) Murrill

Ceriomyces communis, at least so far as the general agreement with the description of that species is concerned, is a rather common plant in the San Francisco Bay region. It here occurs in open or shady woods and always under or in the vicinity of some species of *Quercus*, usually *Quercus agrifolia*. The plants begin to appear in October and continue coming up from time to time under favorable conditions of moisture and temperature until February or perhaps even later. In the study of the living plants as they occur in the Bay region, four distinct forms or varieties were noted, differing from each other not only in certain minor morphological characters, but also in certain histological details of seeming importance and constancy. For the above reasons there has been made a more detailed study of these plants, perhaps, than of others of which material is either not so abundant or where such marked variation has not been met with.

Taking Murrill's (1910) description as a basis, *Ceriomyces communis* may be distinguished by its plane (not reticulate) stipe, the tomentose or roughened surface of the pileus, and the large, angular tubes which change to blue where wounded. The pileus is convex to plane or depressed with age, varying in diameter from 4 to 8 cm. The surface of the pileus is tomentose to cottony, with minute scales, or often rimose-areolate and varies in color from reddish to purple or becoming brown in older individuals. The context is usually from 1 to 2 cm. in thickness, varying in color from yellowish-white to flavous, and usually changing to blue or greenish where wounded. The context of the pileus is often red beneath the cuticle. The margin is entire. The tubes are adnate, and slightly decurrent, convex in mass or occasionally depressed with age. The yellow or yellowish-green tubes change quickly to greenish-blue when wounded. The large mouths of the angular and irregular tubes are 0.5 to 1.0 mm. in diameter. The smooth, spindle-shaped spores are olivaceous when fresh, fading to a pale brownish color. The spores measure 11 to 13 by 4 to 5μ. The solid stipe is subcylindric or contorted and tapers toward the base. The surface is flavous above, red or streaked with red below, and longitudinally furrowed with a smooth or minutely scurfy surface. The stipe varies in diameter from 0.3 to 1.5 cm. and in length from 3 to 8 cm.

On account of the variations in our Californian plants noted above, it has seemed best to give an account of both the morphological differences and the histological structures of certain plants to be designated as forms A, B, C, D, etc.

Ceriomyces communis, Form A

Plate 21, figure 2

A single plant from the eastern United States, contributed by Dr. W. A. Murrill, was available for study. On account of the specimen being dried nothing definite can be said of the color characters. In its morphology, however, this plant exhibits certain variations from our California plants referred to this species. The stipe is not at all swollen in the lower portion nor does it become abruptly attenuate at the base. This abrupt narrowing of the stipe almost to a point is very characteristic of certain of our California forms. As far as may be judged from dried material, the context of the pileus is thicker in this specimen than it is in most of the plants in this region, the tubes are also shorter, and the mouths neither so large nor so irregular as in Californian plants.

Histology

The surface of the pileus is but very slightly differentiated. The tips of the hyphae at the surface of the pileus are slightly swollen and brownish in color but otherwise there is no difference between the hyphae of the surface and those of the context. There is neither a prolongation of the surface hyphae into hair-like structures, nor are the hyphae more densely interwoven. There is likewise no evidence of a gelatinous covering to the pileus. The hyphae of the context are closely interwoven, hyaline, branching, and anastomosing. These hyphae are 4 to 6μ in diameter but vary considerably in different parts of the same hypha (pl. 24, fig. 24).

The hymenium lining the interior of the tubes is made up of basidia and paraphyses, together with certain dark red or black bodies imbedded among the basidia and paraphyses and projecting above them. These bodies are, however, confined to this one specimen and have not been observed in any other material. They may be peculiar cystidia or perhaps some parasite. They are 12 to 15μ in length and 6 to 8μ in their shorter diameter. The bodies project above the general level of the paraphyses some 3 to 4μ. Sometimes there are one or more light yellow projections at the tip of these structures. No actual connection was observed between these structures and the hymenium. As is usual among the Boleti, the basidia project slightly, in this case 3 to 4μ, above the paraphyses. The trama, or tissue between the tubes, is formed, as is usual among the Boleti, of hyphae containing a granular substance appearing gray under the microscope. These hyphae are but little intertwined and maintain a position parallel to the long axis of the tubes branching and curving outwards towards the layer of basidia and paraphyses.

The stipe is differentiated into context and a rind. The rind is 20 to 25μ in thickness and is formed of hyphae, brownish in mass, and 2 to 4μ in diameter. These hyphae are curved outward so as to form a definite palisade layer.

The hyphae of the context lie nearly parallel to each other and to the long axis of the stipe. They are nearly hyaline, 4 to 6μ in diameter just beneath the rind, increasing in diameter to 6 or 8μ as the center is approached (pl. 24, fig. 22).

Ceriomyces communis, Form B

Plate 21, figure 4

This is the Californian form referred to *Ceriomyces communis* by Dr. W. A. Murrill, which is most frequently met with. Form B differs from the above description of *Ceriomyces communis* in the following details. The surface of the pileus is rarely red but usually varies from grayish-brown to almost black in the living condition. The context is rarely or never reddish beneath the cuticle and though the flesh changes to blue when exposed to the air it then changes back to white or sometimes to a brownish color. The pileus varies in diameter from 3 to 11 cm., which is somewhat larger than is described. The stipe is usually very short in proportion to the diameter, frequently contorted. The lower portion of the stipe is often swollen and at the base it is abruptly attenuate, almost to a point. The stipe is somewhat larger in diameter than described, never having been found with a diameter below 0.8 cm. in mature specimens and it may be even as large as 3 cm. in large individuals.

The description of this form is based upon the examination of a considerable number of plants collected under No. 77 on the campus of the University of California, No. 32, collected at Brookdale in the Santa Cruz Mountains, and No. 245, collected at Point Reyes, Marin County. In addition to the plants collected under the above numbers, field observations have been made of a large quantity of individuals on the campus of the University of California, in the Santa Cruz Mountains, at Point Reyes, and in the vicinity of Muir Woods, Marin County.

Histology

Under the microscope the pileus is seen to be covered with long hyphae or hairs. These hairs are somewhat tangled, though they maintain a position which is, in general, perpendicular to the surface of the pileus. They are brownish in color, 25μ or more in length and 6 to 8μ in diameter. They are frequently septate but rarely branched, and gradually pass over into the hyphae of the context through a loss of their brownish color, more frequent branching and more tangled appearance. The hyphae of the context are, however, of about the same diameter as the hairs (pl. 23, figs. 18, 17).

The hymenium consists of paraphyses and basidia, the later projecting 4 to 6μ above the paraphyses. No cystidia are present. The trama is made up of long, rarely branched, hyphae filled with a granular substance and lying nearly parallel to each other.

The surface of the stipe is covered with a dense rind some 20μ in thickness. This rind is formed of brownish hyphae about 4μ in diameter lying parallel to each other and to the long axis of the stipe. Scattered over the surface are peculiar tufts formed by certain of the hyphae curving outward until they stand in a position perpendicular to the surface of the stipe. The tips of these hyphae are swollen to about 8 to 10μ in diameter. The tufts project a distance of 40 to 60μ above the surface of the stipe and they vary in diameter from 40 to 100μ. These tufts resemble in some respects the "glands" formed on the stipe in *Rostkovites*, to be discussed later (pl. 24, fig. 26). The hyphae of the context become lighter in color and larger in diameter as the center of the stipe is approached. The hyphae of the context differ from those of the rind only in their loss of the brown color. At the center the hyphae are 10 to 12μ in diameter but vary considerably in their diameter and in the length of the segments between the septa.

Ceriomyces communis, Form C

Plate 21, figure 1

The plants considered under Form C are rather larger than those of Form B of *Ceriomyces communis*. The following description is based upon four plants collected near Mill Valley, Marin County, and filed under No. 240 in the Herbarium of the University of California. The plants grew in dense shade under redwood (*Sequoia sempervirens*), though not far from the margin of the woods where there were individuals of *Quercus agrifolia*. The pileus is 8 to 11 cm. in diameter, nearly flat, and the surface is brownish, tomentose, and rimose, and divided off into irregular areas 1 to 2 cm. across, separated by deep cracks showing the yellowish context. The context, where not exposed to the air, is white in color and does not become blue when exposed to the air. Where the context is exposed to the air in the cracks it is a light yellow. The tubes are long, yellow and do not change to blue. The mouths are large and irregular. The stipe is long (9 cm.) and slender (1.2 to 1.4 cm. in diameter), but in one individual the base was much larger. The surface of the stipe is red above and yellow below the middle. The context is white and does not change to blue.

Form C differs from all other forms of *C. communis* seen by the writer in the deeply cracked surface of the pileus and the unusually long, slender stipe. It differs from all our Californian plants referred to *C. communis*, except Form E, in the unchanging color of the context.

Histology

Examined under the microscope the surface of the pileus is found to have a very characteristic surface layer. This rind is about 160 to 200μ in thickness and is formed of hyphae united to form definite tufts. These tufts are formed by the repeated dichotomous branching of hyphal branches from the context. The hyphae making up these tufts are 8 to 10μ in diameter, divided by cross partitions into cells 15 to 30μ in length. The walls are yellowish brown in color and are pitted in a very characteristic fashion. Below the tufts, the hyphae are 8μ in diameter and densely interwoven, passing gradually over into the typical hyphae of the context, which are hyaline, with unpitted walls and are repeatedly branched (pl. 23, fig. 19).

The hyphae of the context are large in diameter (10 to 12μ) and so woven together that the tissue appears somewhat pseudo-parenchymatous.

The structure of the hymenium is the same as in the case of Form B described above.

The surface of the stipe is not differentiated, except that the hyphae at the surface have a somewhat smaller diameter (4 to 6μ) and are darker in color that those of the context. As the center of the stipe is approached, the hyphae increase in their diameter until in the central portion hyphae occur which are 12 to 14μ in diameter.

Ceriomyces communis, Form D

Plate 21, figure 5

The plants referred to under Form D differ from those of Form B in the following respects. The plants are smaller than is usual in those referred to Form B, the pileus is 4 to 5 cm. in diameter, and the stipe is about 6 cm. in length, somewhat enlarged below, with a diameter at the top of 1.5 to 2.0 cm. and near the base of about 3.0 cm. The base of the stipe is blunt and rounded and not attenuate into a point as in Form B. The plants often occur two or three in a cluster attached to one another at the base. The surface of the pileus is tomentose and almost black in color. The flesh of both pileus and stipe is white, changing slowly to blue when wounded. The spores in this form are 14 to 16 by 4 to 5μ, being slightly longer in proportion to their diameter than those in Form B. A rather noticeable difference between these plants and all other of our forms referred to *C. communis* is their freedom from attack by insect larvae. Insects are rarely found in plants referred to this form, while in our other plants referred to *Ceriomyces communis* it is not at all unusual to find the context of both stipe and pileus almost entirely eaten away.

The description of Form D is based upon six plants collected near Muir Woods, Marin County. Dried specimens of this form are deposited in the herbarium of the University of California under no. 238. Plants which appeared to be identical with those referred to Form D were observed in a field at Point Reyes, Marin County, and at Brookdale in the Santa Cruz Mountains.

Histology

Upon microscopic examination the surface of the pileus is seen to be covered with hyphae arranged in tufts very much as described above under Form C. In these plants, the tufts are, however, not so widely separated from each other at the base as described above in the case of Form C. The tufted surface layer is about 200μ in thickness. The tufts are formed by hyphae arranged in a way very similar to that of the tufts described above, although the hyphae do not branch so frequently. This difference in structure is perhaps due to the fact that the specimens referred to Form D are not so old as are the plants described under Form C. The hyphae are brown in color, 8 to 10μ in diameter and from 20 to 30μ between the septa (pl. 23, fig. 20).

The structure of the hymenium is similar in every respect to the hymenium of Form B previously described.

The surface of the stipe is covered with a rind 12 to 15μ in thickness, made up of interwoven brownish-colored hyphae 4μ in diameter. Scattered over the surface we find tufts similar in every respect to those described on the stipe in Form B (pl. 24, fig. 26). The hyphae immediately below the surface rind lie very closely together and are but little interwoven. They occupy a position parallel to each other and to the long axis of the stipe. Toward the center of the stipe the hyphae become larger (8μ) in diameter and more closely interwoven. The hyphae of the context are nearly hyaline, as is usual in all these forms.

Ceriomyces communis, Form E

Plate 21, figure 3

Some half-dozen plants collected in chaparral made up of manzanita (*Arctostaphylos canescens*), coast live oak (*Quercus agrifolia*), madrone (*Arbutus Menziesii*), *Ceanothus thyrsiflorus*, and hazel (*Corylus rostrata* var. *californica*) near Mill Valley, Marin County, showed certain rather important histological and morphological variations. These plants are deposited in the Herbarium of the University of California under No. 241.

The pileus in these plants is 5 to 6 cm. in diameter, thin (1 cm.), nearly plane. The surface of the pileus is light brown in color and tomentose. The context is light yellow or reddish beneath the cuticle and does not change to blue when wounded. The tubes are 4 to 5 mm. long, yellow changing to blue when bruised. The mouth of the tubes are large, angular. The stipe is about 5 cm. long and 1.0 cm. in diameter, even, not enlarged below nor attenuate at the base, surface smooth, color yellow streaked with red, or entirely red. Context of the stipe is of the same color as that of the pileus.

These plants are distinguished from Form B by the shape of the stipe and by the fact that the context does not change to blue when exposed to the air.

It is a remarkable fact that a young individual about 1.3 cm. in length collected with these plants showed a distinct veil. In older individuals this veil completely disappears, leaving no trace either as an annulus on the stipe or as a fringe on the margin of the pileus. This is the only form of *Ceriomyces communis* of which I have a specimen showing the presence of a veil (No. 241), though I have a suspicion, which is not, however, verified by actual specimens, that a veil exists in certain, if not all, of the other forms of *C. communis*, of which I have seen living material.

Histology

In form E the pileus is covered with an outer layer 60 to 80μ in thickness formed of separate hyphae 20 to 30μ in diameter. The walls of these hairs are light brown in color. Beneath the hairs is a dark brown tissue made up of densely interwoven hyphae 2 to 4μ in diameter and frequently branching. The second layer is about 16 to 20μ in thickness. Below these two layers is the context, composed of interwoven hyaline hyphae 4 to 8μ in diameter (pl. 23, fig. 16).

The structure of the hymenium and of the rind and context of the stipe are exactly the same, as has been described in the case of Form B described above.

Ceriomyces crassus Batt.

Ceriomyces crassus is another species commonly occuring in the Bay region of California. The plants are found growing on the ground among decaying leaves and twigs under redwood (*Sequoia sempervirens*), tan oak (*Pasania densiflora*), Douglas fir (*Pseudotsuga taxifolia*), and madrone (*Arbutus Menziesii*). Unlike certain other species of Boletaceae, the plants referred to *Ceriomyces crassus* do not appear to be restricted to the vicinity of any particular genus or species of the higher plants. The plants usually appear only after the first rains, which generally come in October, and they remain above ground only a short time, though occasionally one may find them until December. Form C described below was, however, collected February 1, but as it has never been found except this one time it is impossible to state definitely that this was the normal time for it to appear.

In studying the living plants referred to *Ceriomyces crassus* as we find them growing in the San Francisco Bay region we find two quite distinct forms, differing not only in certain histological characters but also in certain seemingly important morphological details.

Taking Murill's description as a basis, *Ceriomyces crassus* may be distinguished from other North American species of this genus by its smooth or reticulate stem and the color of the tubes, which are some shade of yellow or brown, usually becoming darker with age and changing to greenish-ochraceous when wounded. The tubes are stuffed when young. The plants are gregarious or cespitose, growing on the ground or rarely solitary on much decayed wood. *Ceriomyces crassus* is usually a large plant. The pileus is 6 to 20 cm. broad and 3 to 4 cm. thick, while the stipe is 5 to 10 cm. long by 3 to 4 cm. in diameter. The pileus is broadly convex with a dry (or viscid when moistened) subopaque surface, ochraceous brown to reddish brown in color, and glabrous or finely tomentose. The flesh is firm, white or yellowish in color or sometimes reddish beneath the cuticle. The flesh does not change in color when wounded. The taste is sweet and nutty. The tubes are adnate, plane in mass or at length depressed. The angular mouths are medium-sized with thin edges. The greenish yellow or ochraceous-brown spindle-shaped spores are 13 to 15 by 5 to 6μ. The solid stipe is subequal or enlarged below. The stipe is concolorous or paler, becoming bluish or discolored when wounded. The surface of the stipe is either wholly or partially reticulate. The context of the stipe is tough and fibrous, yellowish within and often tinged with red near the surface.

Because of the variation in our Californian plants referred to *Ceriomyces crassus* by Dr. Murrill it has seemed necessary, in order to discuss the rather pronounced morphological and histological differences, to designate our plants as Form A, Form B, etc.

Ceriomyces crassus var. **separans** (Batt.) Peck

Plate 22, figure 13

A single specimen of this variety from the eastern United States was contributed by Dr. W. A. Murrill and is described here for purposes of comparison. Since the specimen was dried nothing definite can be said of the color characters. The only distinctive difference noted between this plant and our Californian Form A is the shape and size of the tubes. In this plant the mouths of the pores are at least three times the diameter of those of our Californian plants and are also widely separated from each other, while in the Californian plants the pores are very close together.

Histology

Under the microscope the surface of the pileus is seen to be covered by a rind similar in every way to that of *C. crassus* Form A described below (pl. 22, fig. 11).

The structure of the hymenium is also the same as in that of Form A.

The stipe is covered by a rind 20 to 30μ in thickness, formed of a tangled mass of delicate hyphae 1 to 2μ in diameter, arising as branches from the hyphae of the context (pl. 22, fig. 13). The context of the stipe consists of somewhat interwoven hyphae 4 to 6μ in diameter. While branched and interwoven to a considerable degree of complexity, the hyphae of the context always maintain a general position parallel to the long axis of the stipe.

Ceriomyces crassus, Form A

Plate 22, figure 12

This is the most common form occurring in this region which has been referred to *Ceriomyces crassus* by Murrill. The plants are medium-sized, the pileus being 5 to 7 cm. broad, while the stipe is 5 to 6 cm. in length and 1.0 to 1.5 cm. in diameter. The surface of the pileus is convex or sub-hemispherical, reddish in color and dry. The context of the pileus is 8 to 10 mm. thick, white and turning to a faint pink when cut and then returning slowly to the original color. The tubes are 5 to 6 mm. long, white, not changing to blue, and stuffed when young, mouths small (4 to 5 to a mm.) and circular. Spores smooth, yellowish brown, 14 to 16 by 4 to 5μ. The surface of the stipe is a dirty white, somewhat roughened but not at all reticulate. The stipe is slightly enlarged below. Context white and changing as does the flesh of pileus. All parts of the plant turn blue when attacked by insects but there is no change in color when the flesh is cut with a knife.

Form A differs from the description of *Ceriomyces crassus* in the following details. The flesh turns a faint pink when exposed to the air and then slowly regains its original color. The tubes are white, and do not change color. The mouths are circular and very small (4 to 5 to a mm.). The spores are slightly more elongated. The surface of the stipe is nearly white, roughened but never reticulate. All parts of the plants turn blue where attacked by insects.

Emphasis should be placed upon the fact that a well-devoloped and fairly thick veil is present in young individuals referred to this form. This veil can be seen in plants up to 1.0 to 1.5 cm. in length but disappears later, leaving no trace either upon the stipe or upon the margin of the pileus.

Specimens of this form of *Ceriomyces crassus* are filed in the herbarium of the University of California under the following numbers: No. 33 collected at Brookdale in the Santa Cruz Mountains, and No. 72 collected near Muir Woods, Marin County. Material showing the presence of the veil in the button state is preserved in alcohol under No. 72.

Histology

Upon examination under the microscope the surface of the pileus is seen to be covered to a depth of 200 to 220μ with a felt of reddish-brown hairs. These hairs are 4 to 8μ in diameter and have occasional septa. They contain a reddish-brown substance which is found in greatest abundance near the tips of the hairs. These hairs are embedded in a brownish jelly to form a rather compact cuticle or rind. Beneath this rind is the context, composed of tangled or felted hyaline hyphae 4 to 8μ in diameter (pl. 24, fig. 21).

The hymenium is made up of basidia and paraphyses only, no cystidia having been observed in these plants. The basidia project 1 or 2μ above the paraphyses. The subhymenial tissue is formed of hyphae 2 to 4μ in diameter, which contain a granular material and which are but little interwined. At the center of the tissues between each four tubes we find a darker mass of hyphae. These hyphae are 2 to 4μ in diameter and filled with a densely granular substance. The hyphae are woven very closely together to form a dense and rather opaque mass.

The surface of the stipe is covered with a dense yellowish-brown rind 50 to 60μ in thickness made up of densely compacted hyphae 2 to 4μ in diameter. The context of the stipe consists of hyphae 4 to 8μ in diameter which are very much branched and crowded together. The hyphae forming the context of the stipe are nearly hyaline and contain very little granular material.

Ceriomyces crassus, Form B

Plate 22, figure 11

The form referred to above as *C. crassus* Form B has been collected but once. The following description is based upon three mature or possibly slightly over-mature specimens collected in Muir Woods, Marin County, under madrone (*Arbutus Menziesii*) and Douglas fir (*Pseudotsuga taxifolia*). These plants are now filed in the herbarium of the University of California under No. 37.

The plants referred to as Form B are brown in color, almost indistinguishable from the dead madrone leaves among which they grow. The pileus is 12 to 14 cm. in diameter and quite thick and fleshy. The context is white, unchanging. The tubes are brown, with small (1–3 to a mm.) circular mouths. The spores are smooth, brown, 9 to 10 by 3.5 to 4.5μ. The stipe is 8 to 10 cm. in length, tapering toward the base. The upper part of the stipe is 4 to 5 cm. in diameter, while near the base it is 2 to 3 cm. in diameter. The upper part of the stipe is dark yellow-brown in color and reticulate, while the lower half is smooth and almost black. The context of the stipe is white, unchanging.

Form B differs from the plants referred to Form A in several respects. The surface of the pileus is brown, while in the case of Form A the surface is reddish. The pores are somewhat larger in diameter in these plants. The upper part of the stipe is reticulate and dark brown in color while the lower half of the stipe is smooth and almost black. In Form A the stipe is even or the lower part is slightly enlarged, but in Form B the stipe tapers toward the base.

Histology

The pileus is covered with long hairs 4 to 7μ in diameter and 160 to 220μ in length. Beneath the hairs we find a layer some 60μ in thickness consisting of hyphae 2 to 4μ in diameter densely felted together and surrounded by a jelly. The entire rind is yellow in color as seen under the microscope. It is very difficult to be certain of the structure since the material of these plants is very poor for microscopic study. However, so far as one can determine from this material, the surface layers appear to disintegrate after maturity is reached, since, in most cases, the surface is merely covered with a layer of nearly colorless jelly containing fragments of hyphae, spores, etc. Beneath the surface layer is the context, consisting of nearly hyaline hyphae 2 to 4μ in diameter and very much interwoven.

The structure of the hymenium is exactly similar to the hymenium of Form A described above.

The reticulated upper portion of the stipe presents a very characteristic appearance under the microscope. The reticulations appear as ridges, 200 to 350μ across at the base and rising 150 to 200μ above the surface of the stipe. The depressions between the ridges, of course, vary greatly in width, depending upon where the section was taken (often 750 to 900μ). The surface, both of the ridges and the depressions between the ridges, is covered with a differentiated layer 45 to 60μ in thickness, formed of swollen, club-shaped tips of hyphae 6 to 8μ in diameter, curved outward so that they stand in a position perpendicular to the surface at their point of origin. This layer is yellowish brown in color. Below the reticulations where the surface of the stipe is smooth, the surface rind is formed of the same sort of club-shaped hyphal tips as described above, but here they are not, of course, raised so as to form ridges.

The context of the stipe consists of interlaced hyaline hyphae 4 to 8μ in diameter (pl. 22, fig. 10).

It seems probable that in these plants the hymenium is decurrent on the stipe for some distance below the tubes, because basidia are sometimes found among the club-shaped cells on the reticulations. They seem to be typical basidia with four sterigmata, although spores were never observed attached to them.

Near the base, the stipe is covered with rind 200 to 250μ in thickness formed of reddish-brown hairs 4 to 8μ in diameter. These hairs are very loosely interwined and appear to the naked eye as black scales.

Ceriomyces auriflammeus (Berk. & Curt.) Murrill

A single specimen of *C. auriflammeus* contributed by Dr. W. A. Murrill is described here for purposes of comparison. Murrill describes this species as follows:

Pileus convex to expanded, 6–8 cm. broad, 1–2 cm. thick, surface dry, slightly viscid after a rain, tomentose, bright yellow, sometimes partially covered with a scarlet pulverulence; margin thin, entire, context white, unchanging, somewhat colored just beneath the pellicle, not bitter, tubes plane or convex, adnate, radially elongate near the stipe, decurrent, greenish-yellow; mouths angular, usually slightly scarlet when looked at sidewise, especially in dried plants, rarely conspicuously scarlet over most of the hymenium; spores pale yellow, smooth, oblong-ellipsoid, 9–11 by 3–4μ; stipe enlarged above, usually tapering below, but sometimes bulbous, very variable in size, 5–9 cm. long, 0.5–1 cm. thick, colored and clothed like the pileus, distinctly and beautifully reticulate, sometimes entirely to the base.

While not a Californian plant, the description of *C. auriflammeus* is placed here to increase the amount of material for comparison.

HISTOLOGY

The surface of the pileus is but very slightly differentiated in the single specimen examined. There is, however, a layer of densely compacted hyphae some 20μ in thickness. This layer is made up of brownish hyphae 3 to 5μ in diameter which are frequently branched and densely interwoven. The context of the pileus is formed of interwoven hyaline hyphae 6 to 10μ in diameter.

The hymenium resembles that of *Ceriomyces communis*, Form B, in every detail.

The rind of the stipe presents a very characteristic appearance in this plant. The surface is covered with a rind some 50 to 70μ in thickness. This rind is formed by the swollen tips of hyphae which curve outward until they lie in a position perpendicular to the surface. The individual hyphal tips vary greatly in their shape; usually, however, they are club-shaped, oval, or elongated. The are 8 to 12μ in diameter and contain a granular substance which is probably oil from its general appearance. The hyphae of the context of the stipe increase in diameter as the center of the stipe is approached. Those immediately beneath the rind are usually about 4 to 6μ in diameter, while at the center the hyphae may attain a diameter of 20 to 25μ. All the hyphae of the context are hyaline and lie in a position nearly parallel to each other and to the long axis of the stipe (pl. 24, fig. 25).

SUILLELLUS Murrill

Suillellus is a genus instituted by Murrill (*Mycologia*, Vol. 1, No. 1, January 1909) to include plants previously referred to the section "*Luridi*" of the genus *Boletus* of Fries and later writers. Unlike other genera instituted or adopted by Murrill, *Suillellus* is not characterized by any morphological character which can be determined in dried material. It differs from *Ceriomyces* only in one particular and that is that the mouths of the tubes are red, and this red color is not due to any permanent structure but simply to a red pigment which disappears on drying. Even this distinction breaks down in some cases, for certain plants referred to *Ceriomyces* sometimes have tubes with red mouths, for example *C. auriflammeus.*

Two distinct forms of *Suillellus* found in the Bay region of California have been referred to a single species (*S. Eastwoodeae* Murrill) by Dr. Murrill after an examination of dried material.

Suillellus Eastwoodeae Murrill

Taking Murrill's description as a basis, *S. Eastwoodeae* may be distinguished from other species referred to this genus chiefly by its size and the shape of the stipe. In *Suillellus Eastwoodeae* the stipe may be as much as 9 cm. long and 7 cm. thick at the much swollen center. The stipe is contracted at the apex and the base and is perfectly even and glabrous. The plants are solitary. The thick hemispheric pileus may be as much as 10 cm. in diameter. The surface is smooth and glabrous, shining, and not at all viscid. The surface of the pileus is very light brown in color, with an entire, slightly projecting margin. The tubes are adnate or, in old specimens, may separate from the stipe. The yellowish tubes are concave or plane in mass, with small angular pink mouths. The yellowish-brown, smooth, oblong-ellipsoidal spores are 11 to 12.5 by 4 to 5μ. The surface of the stipe is perfectly even and glabrous, concolorous with a rosy tint in certain parts and yellowish at the base. The context of the pileus is firm, white or light yellow in color, and changes to blue when wounded but later it returns to its original color. The context of the stipe is yellowish-white.

The small tubes with red mouths are very characteristic and cannot be readily mistaken in fresh material for any of our other species of Boletaceae, though in dried plants the red color at the mouths of the tubes disappears so that it is almost impossible to distinguish these plants from certain species of *Ceriomyces* except by the shape of the stipe.

Suillellus Eastwoodeae Form A

Plate 21, figure 7

The study of Form A was made upon a single dried specimen sent in from the vicinity of Point Reyes. This specimen agreed in every way with the published description of *S. Eastwoodeae*, at least in so far as can be determined from dried material.

Histology

Upon examination under the microscope the surface of the pileus is seen to be covered with a rind 20 to 25μ in thickness, formed of intertwined brownish hairs 4 to 6μ in diameter. Beneath the hairs there is a definite layer 60 to 70μ thick formed of hyphae which are very firmly packed together. This inner layer differs from the outer simply in the closer packing of the hyphae. Sometimes the surface of the pileus seems to be covered with a jelly-like substance without any hairs. This jelly is very likely formed by the breaking down of the walls of the hairs soon after the plants reach maturity. The context of the pileus is formed of intertwined hyaline hyphae ranging in diameter from 4 to 6μ up to even 10 to 12μ.

The hymenium consists of basidia and paraphyses only, no cystidia having been observed. The basidia when mature rise above the paraphyses a distance of about 2μ.

The rind of the stipe varies considerably in its thickness. In some places the rind is quite thick (40 to 80μ) but in other places it may be only 10 to 20μ in thickness. In either case the rind is formed of the same sort of hyphae. The hyphae forming the rind are 2 to 4μ in diameter, brown in color and very closely woven together. Beneath the rind is the context, made up of hyaline hyphae 4 to 6μ in diameter near the surface and increasing in diameter up to 16 to 18μ as the center of the stipe is approached. The hyphae of the context usually lie in a position generally parallel to the long axis of the stipe.

Suillellus Eastwoodeae, Form B

Plate 21, figure 6

The plants described below were determined by W. A. Murrill from dried material, as a form of *Suillellus Eastwoodeae*, but they differ from that species in so many respects that they might well be considered to belong to a distinct species. The description given below is based upon five specimens collected near Muir Woods, Marin County, on October 21, just after the first heavy rain of the season. The plants were growing in moist ground under the shade of a mixed forest of redwood (*Sequoia sempervirens*), Douglas fir (*Pseudotsuga taxifolia*), madrone (*Arbutus Menziesii*), live oak (*Quercus agrifolia*), and tan oak (*Pasania densiflora*). Dried specimens of this form are filed in the herbarium of the University of California under No. 239.

The following is a brief description of *Suillellus Eastwoodeae* Form B. Plants solitary on the ground: pileus thick, compact, hemispheric, 15–22 cm. broad, surface smooth, glabrous, not viscid, reddish brown, margin entire; slightly projecting context firm, white or light yellow changing quickly to blue when wounded and then slowly (or not at all) changing to yellow and finally to a dirty white. Tubes adnate, separating with age, about 1.5 to 2.0 cm. long, concave to plane in mass, yellow, mouths small, angular, red. Spores oblong-ellipsoidal, smooth, brownish, 8 to 9 by 4 to 5μ. Stipe bulbous at the base, reticulated above the swelling, the stipe above the bulb is red, the swollen base is brown. Stipe solid, context of stipe above bulbous base concolorous with the context of the pileus and undergoing the same color changes. The context of the bulbous portion of the stipe is brown, unchanging. The stipe is 10 to 14 cm. long, 6 to 7 cm. thick above the bulbous portion, which is 8 to 12 cm. thick.

The differences between these plants and *Suillellus Eastwoodeae* as described by Murrill and illustrated by Form A are as follows: In the first place the plants are very much larger in every way than are those of *S. Eastwoodeae* as described by Murrill. The color of the surface of the pileus is reddish in these plants, while in *S. Eastwoodeae* it is described as light brown by Murrill. Moreover, the color-changes differ somewhat. The tubes are considerably longer, being nearly twice as long in some individuals as are those of *S. Eastwoodeae*. The spores also differ slightly in size. When we come to consider the stipe, however, we find the greatest and most remarkable differences. Instead of being enlarged at the center as is described for *S. Eastwoodeae* and illustrated in Form A, it is decidedly bulbous at the base. The surface of the stipe of *S. Eastwoodeae* is described by Murrill as even and glabrous, while in these plants the stipe above the bulbous portion is decidedly reticulate.

Histology

Under the microscope the surface of the pileus is seen to be covered with long hairs, 1 to 2μ in diameter, and 80 to 100μ in length. These hairs are unbranched and have few septa. Below these hairs is a rind 40 to 50μ in thickness made up of brown, densely interwoven hyphae, 1 to 2μ in diameter and septate. The context is formed by interwoven hyaline hyphae 4 to 8μ in diameter (pl. 22, fig. 15).

The hymenium is made up of paraphyses and basidia and in this form the basidia do not stand out above the paraphyses. There were no cystidia observed. The tissue between the tubes consists of interwoven hyaline hyphae 4μ in diameter.

In neither Form A nor Form B was there noted any histological structure at the mouths of the tubes to which the red color might be ascribed. The red color is probably due to a red pigment in the protoplasm.

The stipe has a rind about 60μ in thickness formed by the greatly swollen tips of hyphae standing in a position nearly perpendicular to the surface of the stipe. These swollen hyphal tips are 16 to 20μ in diameter and 30 to 40μ in length. They are brownish-yellow in color. Beneath this outer rind there is a tissue (the context) formed of interwoven hyphae varying in diameter from 2 to 6μ. These hyphae gradually become greater in diameter and less densely interwoven as the center of the stipe is approached. At the center the hyphae are hyaline and 4 to 8μ in diameter (pl. 22, fig. 14).

From the above description of the histology of Form B and of Form A it can be seen that the plants referred to these two forms differ from each other not only in details of their morphology but also in the histology of both the surface of the pileus and the surface of the stipe.

Suillellus Frostii (Russell) Murrill

This is an Eastern species of *Suillellus* of which a dried specimen was contributed by Dr. Murrill. Its histology is described here for the purpose of comparison with the histology of our Californian species of *Suillellus*.

Suillellus Frostii is described by Murrill as follows: Pileus convex to plane, gregarious, 6–15 cm. broad; surface glabrous, shining, viscid in damp weather or when young, blood red, sometimes paler red with patches of yellow; context firm, juicy, white or yellowish, scarcely changing to greenish blue when wounded, taste mild; tubes adnate, subdecurrent, depressed, straw yellow within, changing slowly to greenish blue when injured, yellowish brown with age, mouths large, stuffed, edges blood red; spores oblong-ellipsoid, smooth, brownish yellow, with a greenish tinge when fresh, 12–15$\times$4–5μ. Stipe subventricose, tapering upward, blood red, sometimes with yellow stains, becoming bluish green when handled, deeply and beautifully alveolate-reticulate its entire length, solid, firm, yellowish within, 7–10$\times$2 cm.

While this is not a Californian species and I have had to rely upon dried material, an account of the histology is included here for purposes of comparison with that of our Californian forms referred to *S. Eastwoodeae*.

Histology

The pileus is covered with a rind 40 to 50μ in thickness, made up of dark brown hyphae densely matted together. Beneath this outer layer is a second, 160 to 170μ in thickness. This second layer is lighter in color than the outer and the hyphae composing it are not so closely matted together, though they are somewhat darker and more closely interwoven than are the hyphae of the context. Both layers of the rind and also the context are made up of hyphae 4 to 8μ in diameter. The structure of the hymenium is the same in every detail as that of *Suillellus Eastwoodeae*, Form A, previously described.

The surface of the stipe is protected by a rind 20 to 30μ in thickness, consisting of an almost solid tissue formed of very densely compacted dark-brown hyphae. The hyphae of the context lie nearly parallel to each other and to the long axis of the stipe. These hyphae, unlike those of most of the other plants I have investigated, are rather dark in color. The hyphae of the context increase from 4μ in diameter near the rind to as much as 12 to 16μ at the center of the stipe. The hyphae also become lighter in color as the center of the stipe is approached.

ROSTKOVITES P. Karst

This is a genus distinguished from *Ceriomyces* by the presence of granular dots on the stipe and in this connection it may be well to repeat that in *Ceriomyces communis*, Form B, structures are found on the stipe which resemble the "glands" found in *Rostkovites* rather closely. This fact would seem to indicate that the presence or absence of glandular dots is merely a matter of their relative size and abundance, rather than of their actual presence or absence. Certain species of other genera are described as glandular dotted but these genera are all distinguished from *Rostkovites* by the presence of an annulus. Moreover, we shall see when we consider *Boletus luteus* that in this species at least, which is described as possessing glandular dots on the stipe, these dots are quite different in their origin from those in *Rostkovites*.

Rostkovites is a small genus comprising four North American species. Of these four species two have been collected in California. Most of the species of *Rostkovites* grow in the vicinity of coniferous trees. One species, *R. granulatus*, is found in great abundance in the Bay region during a long season, coming up after the first rains in October and continuing to appear from time to time until about April.

According to Murrill's description, the genus *Rostkovites* is made up of forms having an annual terrestrial hymenophore and differing from other genera of Boletaceae with ochraceous or brown spores by the presence of glandular dots on the stipe, as well as in the absence of an annulus. The surface of the pileus is viscid, glabrous or hirtellous, and has a yellow context which does not change color when wounded. The yellow tubes are adnate and exude drops of a liquid which blackens upon drying. The smooth, oblong-ellipsoidal spores are yellowish brown. The stipe is solid, glandular-dotted, but not reticulate. In our Californian species the context of the stipe is yellowish and unchanging in color.

Rostkovites granulatus (L.) P. Karst

This is probably our most common species of the Boletaceae. It is usually found under Monterey pine (*Pinus radiata*), though the plants sometimes occur under other species of pine. The plants may be collected at almost any time after the first rains of the season until a hot, dry spell comes, usually some time in April.

Using Murrill's description as a basis, *Rostkovites granulatus* may be described as including plants with a convex or nearly plane pileus, the surface of which is very viscid or glutinous, with a surface cuticle or "skin" which can be readily peeled away, exposing the white or pale yellow context. The pileus varies in color from a light pinkish or gray to a reddish brown color, or is often livid or sometimes spotted, especially toward the center. The margin is sterile and usually incurved in young specimens. The context is thick and fleshy, white or light yellow, and does not change to blue when wounded. The taste is mild. The tubes are yellow, short (3 mm. or less), adnate or subdecurrent, and plane in mass. They do not change color when wounded. The large mouths are subcircular or angular, with black granules in old specimens or drops of a whitish liquid in the younger individuals. The spores are fusiform, varying in color from a light yellowish brown to dark brown, 7.5 to 9.5 by 2.5 to 3.5μ. The stipe is short, thick, subequal or enlarged below, white or pale yellow, dotted with pinkish-brown droplets which become darker on drying, solid, white within, 2.5 to 5 cm. long and 1.0 to 1.5 cm. thick. The pileus in our Californian plants is 4 to 12 cm. in diameter.

The Californian plants referred to *R. granulatus* agree very well with the above description and come well within the limits of the species as described above. The surface of the pileus in the plants of this region varies in color from a light gray to a very dark brown, and is always very viscid.

Histology

When examined under the microscope the surface of the pileus is seen to be covered with long hairs. These hairs are about 4μ in diameter and 250 to 300μ in length. The walls are very gelatinous and are embedded in a purplish jelly. In fresh material the hairs are very hard to distinguish, since they are almost concealed by the jelly. In dried material the hairs are brownish and are filled with certain peculiar black dots which are probably similar to the black dots formed by the drying of the liquid given off by the glands. The context is made up of tangled hyaline hyphae, 2 to 3μ in diameter. In dried material black masses or dots are found in the context. These masses are sometimes 10 to 12μ in diameter, irregular in shape and appear to be of the same material as the black dots found in the hairs (pl. 25, fig. 31).

In the hymenium the basidia and paraphyses are found along with certain peculiar cystidia or glandlike structures to be described below. These glands are most abundant near the mouths of the tubes but also occur some distance back of the mouths (pl. 25, fig. 28).

The term "glands" is used for certain peculiar structures especially characteristic of species of *Rostkovites*. These structures resemble cystidia rather closely and have been so designated by Levine, 1913. Similar structures have also been observed in *Ceriomyces communis*, Form B, on the stipe, as has been described. The glands appear under the microscope as clusters or nests of large, swollen, hyphal tips, dark in color and projecting some distance out into the tubes or above the surface of the stipe. The individual cells are club-shaped, 30 to 70μ in length and 5 to 8μ in their shorter diameter. They project 30 to 50μ above the level of the hymenium, or above the surface of the stipe as the case may be. The glands occur in clusters of from four or five up to several hundred. The larger clusters are 100 to 500μ in diameter and appear as black dots or granulations at the mouths of the tubes and on the stipe. The cells branch from the hyphae immediately below the hymenium or surface of the stipe and force their way up through the hyphae, or basidia as the case may be. The glands are usually dark brown in color, or hyaline if empty. They secrete or give off a milky juice which sometimes appears in drops at the mouths of the tubes or on the stipe. Under the microscope the liquid is seen to be made up of a fluid, colorless portion and numerous globular particles, 1 to 2μ in diameter, resembling conidia in some respects, but giving a red reaction with tincture of alkanna, indicating them to be of a resinous or oily nature. When this liquid dries it becomes a dark brown.

The stipe has a thin rind, 16 to 20μ in thickness, formed of the swollen tips of hyphae curved outward so that they stand in a position perpendicular to the surface. These swollen tips are 8 to 12μ in diameter. Clusters of glands similar to those found in the tubes also occur on the surface of the stipe. Some of these clusters are 280 to 350μ in diameter. The context of the stipe consists of hyphae 2 to 4μ in diameter and lying nearly parallel to each other and to the long axis of the stipe.

Rostkovites granulatus (Eastern)

A single dried specimen from the Eastern United States was contributed by Dr. W. A. Murrill. Its morphological characters, so far as could be determined from dried material, agreed in every respect with our Californian plants referred to this species. An examination of the histology of this plant was made for purposes of comparison with the histology of our Californian species.

Histology

The surface of the pileus is but very slightly differentiated. The hyphae are somewhat more densely intertwined and darker in color than are the hyphae of the context, but there is absolutely nothing like the long hairs found in the Californian plants referred to this species. The hyphae of both the surface and of the context of the pileus are 3 to 4μ in diameter (pl. 25, fig. 32).

The structure of the hymenium is the same in every respect as in that of the Californian form, except that the glands are less abundant.

The surface of the stipe is covered by a definite rind 50 to 60μ in thickness. The outer layer of this rind is formed of club-shaped, swollen ends of hyphae, 4 to 10μ in diameter. Below these swollen hyphae tips is a layer formed of densely interwoven hyphae, 2 to 3μ in diameter. The rind is dark brown in color. The hyphae making up the rind arise as branches from the hyphae of the context. The context is made up of hyaline hyphae, 4 to 8μ in diameter, which lie parallel to each other and to the long axis of the stipe. Glands like those previously described under the Californian form are found on the surface of the stipe (pl. 25, fig. 29).

Rostkovites californicus (Murrill)

Plate 21, figure 8

The plants referred to under this name were sent in by Mr. F. H. Bolster of Grass Valley, California, and were then referred to Dr. W. A. Murrill, by whom they were recognized to be a new species, which was described by him as *Rostkovites californicus* in *Mycologia*, Vol. VII, No. 1.

They were sent to Dr. Murrill in the dried condition, but the specimens were accompanied by notes made by myself from the living specimens. Specimens of *R. californicus* are filed in the University of California Herbarium under No. 251.

Rostkovites californicus may be described as follows. The pileus is 6 to 9 cm. broad, convex to plane, surface brown, smooth, subtomentose, viscid when fresh, margin even. The context is fleshy, light yellow, unchanging, taste mild. Tubes adnate, yellow, 4 to 6 mm. long. Mouths large, angular. Spores oblong-ellipsoidal, 7 to 8 by 3.5 to 4μ, brown and smooth. Stipe 3 to 6 cm. long and 1.5 to 2 cm. thick, equal or slightly enlarged at the base. Surface yellow with black dots or granulations. Context yellow, unchanging, somewhat fibrous at the base.

The plants referred to *R. californicus* differ from *R. granulatus* especially in the subtomentose surface of the pileus. The spores are also slightly smaller.

Histology

The surface of the pileus is covered with long hairs, 8 to 10μ in diameter and 200 to 250μ in length. These hairs are embedded in a purplish jelly which, with the hairs, forms a distinct cuticle or rind. Beneath the hairs is a tissue made up of densely intertwined hyphae, some 4μ in diameter. This layer, together with the hairs and jelly, form a definite surface "skin" which can be readily peeled away from the context. The context of the pileus consists of very densely intertwined hyphae, 8 to 12μ in diameter, with thick walls (1μ) and containing granular contents (pl. 24, fig. 23).

The structure of the hymenium and of the tissue between the tubes resembles the corresponding structures in *R. granulatus* except that the glands appear to be less numerous.

The surface of the stipe is nearly covered with "glands" similar in every respect to those of *R. granulatus.* Over the surface which is not occupied by glands there is a differentiated rind formed by slightly swollen tips of hyphae standing in a position perpendicular to the surface. These hyphae are rarely more than 1 or 2μ in diameter and are brownish in color. The hyphae of the context of the stipe are 8 to 12μ in diameter and lie in a position parallel to each other and to the long axis of the stipe. The hyphae increase in their diameter as they approach the center of the stipe, where they may attain a diameter of 16μ. The hyphae forming the context contain a granular substance (probably an oil). Drops of oil are visible among the hyphae in abundance.

BOLETUS (Dill.) L

The genus name *Boletus* has been retained by Murrill for the ochraceous or brown-spored species of the Boletaceae which possess an annulus and the top of whose pileus is smooth and viscid. *Boletus luteus* is the only species of the Boletaceae described by Linnaeus which has an annulus. This species is the type of the genus *Boletus* as limited by Murrill.

As limited by Murrill, the genus *Boletus* includes plants with an annulus and a smooth, viscid pileus. The hymenophore is annual and terrestrial. The context is white or yellowish. The small, angular yellowish tubes are adnate and are covered by a veil. The smooth, yellowish-brown spores are oblong-ellipsoidal or, rarely, globose. The solid stipe is central, often glandular, dotted and annulate.

Boletus luteus L

Plate 21, figure 9

Dried specimens of certain of our Californian plants were sent to Dr. Murrill, who referred them to *Boletus luteus.* Based upon the description by Murrill, *Boletus luteus* may be described as follows:

Plants having glandular dots upon the stipe whose surface is, however, not at all reticulate. Pileus convex or nearly plane with age, surface yellow, yellowish-brown, or reddish-brown or streaked. Surface smooth and quite viscid. Margin thin and entire. Tubes adnate or slightly decurrent, short (1.5 to 2.5 mm.), and somewhat depressed in mass. The tubes are dark yellow and unchanging. Mouths circular, large, 1 mm. in diameter. Spores smooth, yellowish-brown, oblong-fusiform, 6 to 9 by 2.5 to 4μ. Stipe solid, nearly equal or slightly tapering toward the base, light yellow or reddish-brown, with glandular dots both above and below the annulus. Context of the pileus pale yellow and unchanging when wounded or sometimes becoming darker with age. Context of the stipe yellowish and unchanging. Pileus 5 to 10 cm. broad, and stipe 3 to 6 cm. long and 1 to 2 cm. in diameter.

The Californian plants differ from the description given above in only a few minor details. The tubes change to a faint tan color when bruised and their mouths are angular. The spores are slightly larger (8 to 10 by 3 to 4.5μ). The stipe is nearly equal, with a context which changes to blue at the base where the plants are usually attacked by insects. The annulus is present at first but soon disappears, apparently deliquescing and leaving a brownish substance on the stipe which sometimes appears reticulate.

A considerable number of specimens of *Boletus luteus* have been collected in the vicinity of Muir Woods and Point Reyes, both localities being in Marin County but separated by a distance of about thirty miles. Dried specimens of these plants are filed in the Herbarium of the University of California under Nos. 236 and 243.

Boletus luteus occurs in this region in cool, moist, mixed woods. The plants grow on the ground under redwood (*Sequoia sempervirens*), Douglas fir (*Pseudotsuga taxifolia*), Bishop pine (*Pinus muricata*), Madrone (*Arbutus Menziesii*), coast live oak (*Quercus agrifolia*) and tan oak (*Pasania densiflora*). The plants appear after the first rains of the season, usually during the latter part of October, remain above ground only a short time and then are not found again until the following season.

No eastern material of this species was available for examination, and consequently I can describe the histology of the Californian plants only.

Histology

Under the microscope the surface of the pileus is seen to be covered with slender hairs 1 to 2μ in diameter and about 120μ in length. These hairs are dark brown in color and septate (pl. 25, fig. 27).

The context of the pileus is made up of hyaline, much branched hyphae 8 to 12μ in diameter.

The hymenium has a rather characteristic structure in *Boletus luteus.* The basidia project almost 12μ above the club-shaped paraphyses. There are also certain clusters of cystidia present. These cystidia are 6 to 8μ in diameter and project 25 to 30μ above the paraphyses. The cystidia often occur in groups of 2 or 3 and in such cases they often bear a striking resemblance to the "glands" found in species of *Rostkovites.*

The surface of the stipe also has a very characteristic structure in *Boletus luteus.* On the outside is seen a honeycomb-like material which is almost black in mass but of a brownish-yellow color in thin section. This mass is formed of hyphae 2 to 3μ in diameter. The openings in the honeycomb are 5 or 6 sided and about 40μ in diameter, with partitions 8μ in thickness between the openings. This layer is some 100μ in thickness but does not occur uniformly over the surface of the stipe. It is these patches of black "honeycomb" which appear to the naked eye as black dots or granules.

Beneath the "honeycomb" is a rind which extends uniformly over the surface but varies in thickness from 20 to 60μ. This rind is made up of densely interwoven hyphae, 4 to 6μ in diameter, which arise as branches from the hyphae of the context. The hyphae of the rind are light yellow in color, while those of the context are hyaline, 4 to 10μ in diameter just beneath the rind and increasing to 20μ in diameter near the center of the stipe. Near the periphery of the stipe the hyphae lie in a position nearly parallel to each other and to the long axis of the stipe, but toward the center there is an abundant branching and anastomosing of the hyphae which gives rise to a pseudo-parenchymatous tissue (pl. 25, fig. 30).

SUMMARY

The general purposes of the studies leading up to this paper, as outlined at the beginning, have been:

1. To extend so far as possible the knowledge of the species of Boletaceae growing in California, about which there existed at the beginning of the work very little, if any, certain information.

2. To make such a study of the histology of the various species of the Boletaceae as to assist in furthering our knowledge along the two following lines: (1) To determine, as accurately as possible, the details of the individual species; and (2) to compare the histology of different individuals of the same species as well as of individuals referred to different species.

3. To obtain, if possible, histological characters which might be applied to dried or living specimens to confirm, or to bring into question, determinations made according to general morphological characters.

The results of this investigation are briefly summarized below, although it has been found that a much more extensive examination of living material from more widely separated localities, as well as of the type specimens, will be necessary before the problems outlined above can bring forth accurate and explicable results.

First: we have seen that there were formerly attributed to California some sixteen species of Boletaceae, but not all of these are to be considered so definitely referred as to pass without challenge. In the attempt to extend the knowledge of Californian species of this family there have been fairly certainly found to be some six well-defined species as commonly considered and under three of these it has also been possible to separate out certain definite forms. From *Ceriomyces communis*, for instance, there have been separated out four forms, from *Ceriomyces crassus* two forms, and from *Suillellus Eastwoodiae* two forms, so that altogether we have eleven different forms, some of which, at least, appear to be entitled to consideration as separate entities. There are doubtless many other forms to be found in California, since Harkness and Moore credit the Bay region with some sixteen species, but it is impossible at present to verify their determinations.

In regard to the second object of the study, it has been possible to give, in fair detail, the histology of these different species and forms.

In the investigation of our Californian plants there have been found, as has been brought out in the detailed description, important differences in the histology as well as in the morphology of plants referred to the same species. These differences appear to be greater than can be explained merely by variations due to habitat, difference of season, or mere individual variation. In several of the forms considered, plants have been found from widely separated localities exhibiting the same morphological and histological differences and plainly to be referred to the same form.

In the comparison of our Californian plants with plants from the Eastern United States seemingly important differences in the histology and morphology have been observed. In this case, however, it is impossible to say how characteristic the structures seen in the plants from the Eastern United States may be, since in each case the material from the East was limited to a single individual.

In view of the limited amount of material observed in many of the Californian plants and in all the eastern plants, I have preferred to arrange the species and the forms under the species to the species to which they were referred by Dr. W. A. Murrill. It seems probable, however, that a more extensive investigation over a longer period and with more abundant material, both of individuals and of species and forms, Eastern and European as well as Californian, may indicate that certain of our Californian plants which have been discussed in this paper as forms should be elevated to specific rank. It is probable that some, if not all, of the Californian plants referred to, may differ sufficiently from the Eastern plants now referred to the same species, to cause their being placed ultimately under separate species.

There are several lines, as indicated above, along which future investigation may lead to valuable increase of our knowledge of the Boletaceae. As has been stated previously in this paper, a veil has been found in at least two forms of *Ceriomyces* referred to two different species. In both these species the presence of a veil has not been previously described. It is true that in both cases the veil is present only in the younger individuals, and later entirely disappears, being persistent neither as an annulus nor as a fringe on the margin of the pileus, but since in other species of *Ceriomyces*, cf. *C. Zelleri* (Zeller, 1914), there is no evidence of a veil at any time during the development of the sporophore, a very important line of cleavage is indicated in this genus. Those forms with a veil in the early stages lean toward such genera as *Boletus*, *Boletellus*, etc., while the gymnocarpous forms tend toward genera in which the annulus is wanting, as, for example, the genus *Rostkovites*. In regard to the absence of the veil in *Rostkovites* I may state here that, while I have made no such careful study as Zeller made of the young stages of *C. Zelleri*, I have had an abundance of material in very young stages and have not noticed the occurrence of a veil in any of this material. A veil rudiment may, of course, be present, but there is nothing comparable to the very marked veil found in individuals referred to *Ceriomyces communis* and *Ceriomyces crassus*.

Another fact which points toward the view that *Ceriomyces* is a genus of relatively undifferentiated forms is the occurrence of structures resembling "glands" on the stipe of certain plants referred to *Ceriomyces communis*. These "glands" attain their maximum development in species of *Rostkovites*. It is true that the stipe in certain other genera is described as glandular dotted, but, as has been previously explained, in the case of *Boletus luteus*, at least, the glandular dots are very different in their origin and structure from those found on the stipe of species of *Rostkovites*.

Again, when we consider *Suillellus*, we find certain species, or at least certain individuals, referred to *Ceriomyces* taking on something of the distinguishing characters of *Suillellus*, that is, the red mouths of the tubes. *Ceriomyces auriflammeus* has tubes with mouths which are red at least in a certain sense.

When we come to the third part of our problem, that of finding histological characters to aid in the determination of fresh or more especially of dried material, the results of this investigation must be said to be inconclusive so far as general and extensive recognition is concerned. For example, at the present stage of the investigation it would be impossible to construct a generic key or a specific key to the species, based upon histological characters alone. However, I do find it possible to determine, by their histology, the different forms under the species, both as to their identity and as to their separation from other forms referred to the same species. While at present I am not able to bring forward histological details to separate all the species, it seems probable that this might be possible if the series of species described as to their histology were sufficiently large.

Finally, it may be well to state that the results of this study have been to increase my own belief, at least, in the constancy of certain minor morphological characters as associated with certain definite and peculiar histological characters as criteria for the separation of the different species and forms.

I desire to express here my thanks and appreciation to Professor W. A. Setchell, to whom I am indebted for many helpful suggestions made from time to time during the progress of this investigation. He has most freely given me of his time and the benefit of his mature judgment in the preparation of material and as to the value of certain of the histological characters discussed in this paper.

Transmitted April 16, 1915.

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EXPLANATION OF PLATES

PLATE 21

Fig. 1. Longitudinal section of an individual of *Ceriomyces communis*, Form C, showing the long slender stipe and the cracked surface of the pileus (No. 240). × ½ diam.

Fig. 2. Longitudinal section of an individual of *Ceriomyces communis*, Form A (dried specimen contributed by Dr. W. A. Murrill). × ½ diam.

Fig. 3. Longitudinal section of an individual of *Ceriomyces communis*, Form E. (No. 241). × ½ diam.

Fig. 4. Longitudinal section of an individual of *Ceriomyces communis*, Form B, showing the short, thick fleshy stipe abruptly attenuate at the base. × ½ diam.

Fig. 5. Longitudinal section of an individual of *Ceriomyces communis*, Form D, showing the thick stipe enlarged below. (No. 238). × ½ diam.

Fig. 6. Longitudinal section of an individual of *Suillellus Eastwoodeae*, Form B, showing the thick, fleshy pileus and the large stout stipe with the lower portion decidedly bulbous. (No. 239). × ½ diam.

Fig. 7. Longitudinal section of an individual of *Suillellus Eastwoodeae*, Form A, showing the stipe swollen at the middle. (Reconstruction from dried material). × ½ diam.

Fig. 8. Longitudinal section of an individual of *Rostkovites californicus*. (No. 251, dried specimen). × ½ diam.

Fig. 9. Longitudinal section of an individual of *Boletus luteus* showing the annulus. (No. 236). × ½ diam.

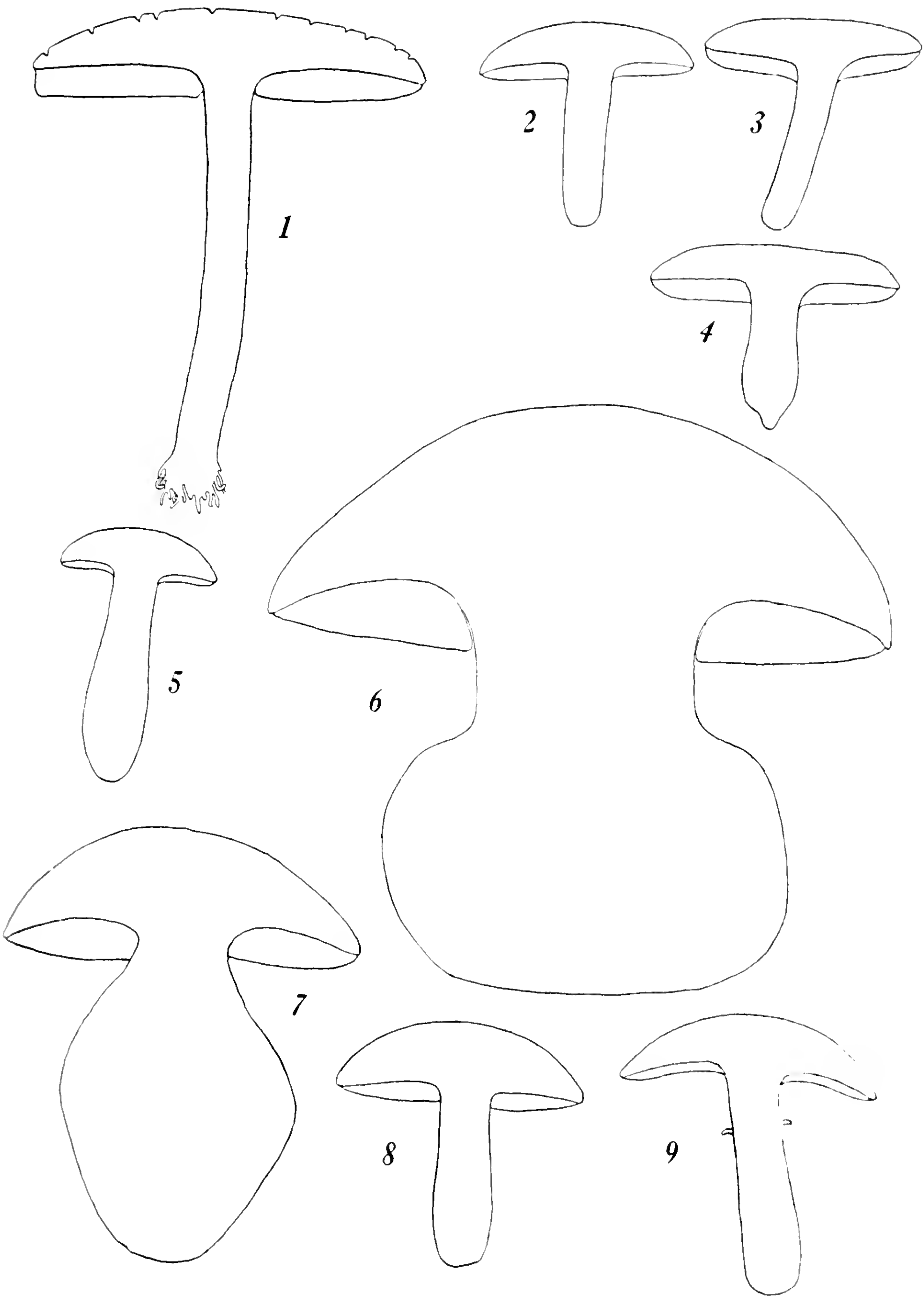
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PLATE 22

Fig. 10. *Ceriomyces crassus*, Form B. This is a section of the surface of the stipe and part of a reticulation and indicating something of the relative size and arrangement of the hyphae. (No. 37, from dried material). × 250 diam.

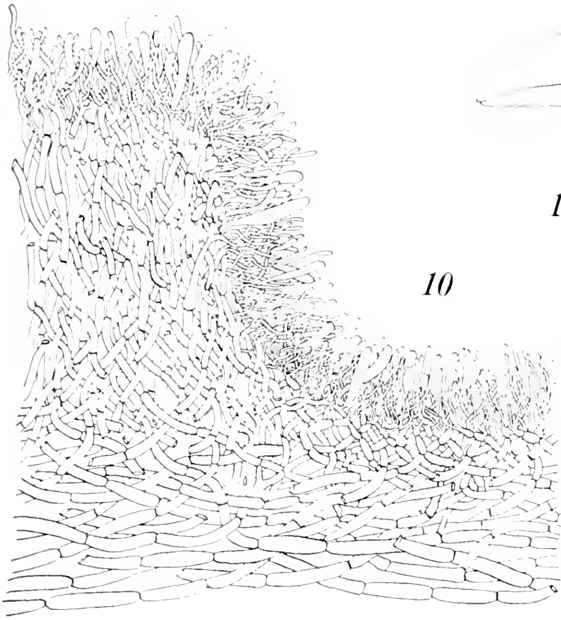
Fig. 11. *Ceriomyces crassus*, Form B. A longitudinal section of an individual showing the decided taper of the stipe toward the base. (No. 37). × ½ diam.

Fig. 12. *Ceriomyces crassus*, Form A, showing the stipe slightly enlarged toward the base. (No. 72). × ½ diam.

Fig. 13. *Ceriomyces crassus* var. *separans*. A section of the stipe showing the rind and a few hyphae of the context (dried material contributed by Dr. W. A. Murrill). × 250 diam.

Fig. 14. *Suillellus Eastwoodeae*, Form B. A section of the stipe showing the rind. (No. 239). × 250 diam.

Fig. 15. *Suillellus Eastwoodeae*, Form B. A section of the surface of the pileus showing the long hairs, the rind of interwoven hyphae and an indication of the structure of the context. (No. 239). × 250 diam.



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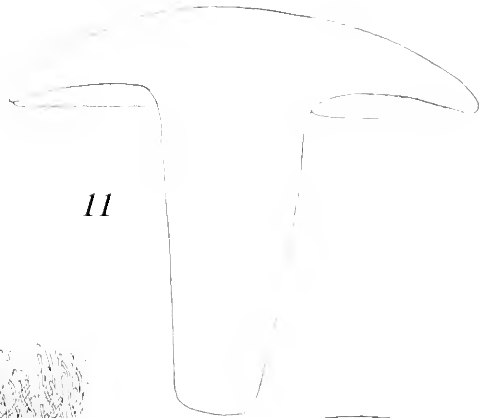

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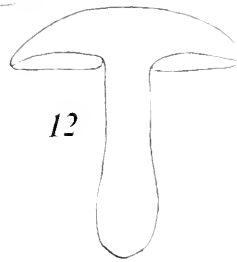

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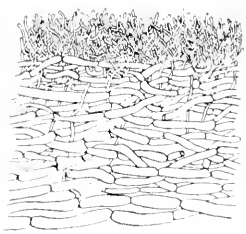

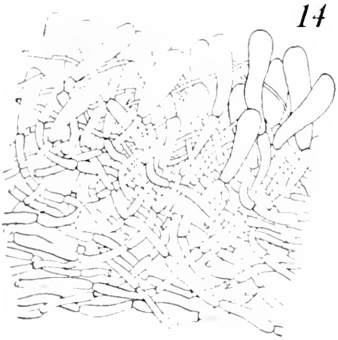

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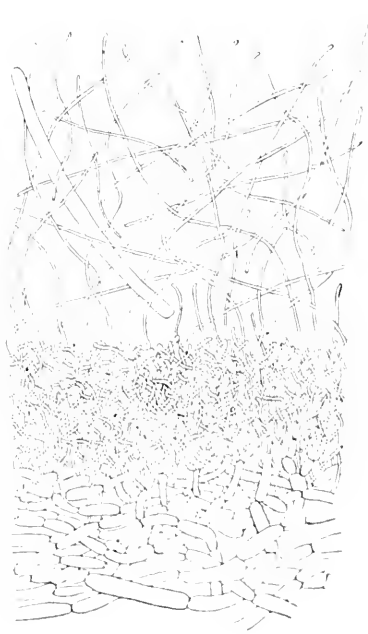

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PLATE 23

Fig. 16. *Ceriomyces communis*, Form E. A section of the surface of the pileus showing a rind formed of an outer layer of long hairs and an inner layer made up of densely interwoven hyphae. (No. 241). × 250 diam.

Fig. 17. *Ceriomyces communis*, Form B. A section of the pileus showing the general arrangement of the hairs on the surface. (No. 77). × 250 diam.

Fig. 18. *Ceriomyces communis*, Form B. A section of the surface of the pileus showing the arrangement of the hairs. (No. 77). × 250 diam.

Fig. 19. *Ceriomyces communis*, Form C. A section of the pileus showing the tufted appearance of the surface hairs and the tangled hyphae beneath the tufts. This section also shows a few of the hyphae of the context. (No. 240). × 250 diam.

Fig. 20. *Ceriomyces communis*, Form D. A section showing the hairs on the surface of the pileus. (No. 238). × 250 diam.


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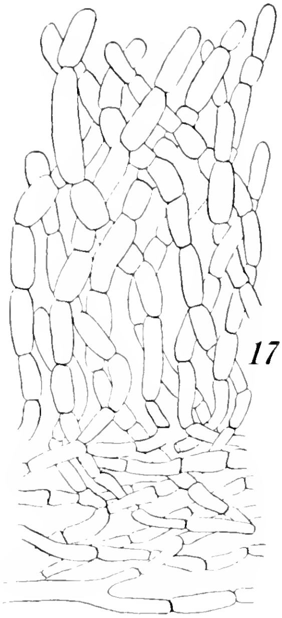
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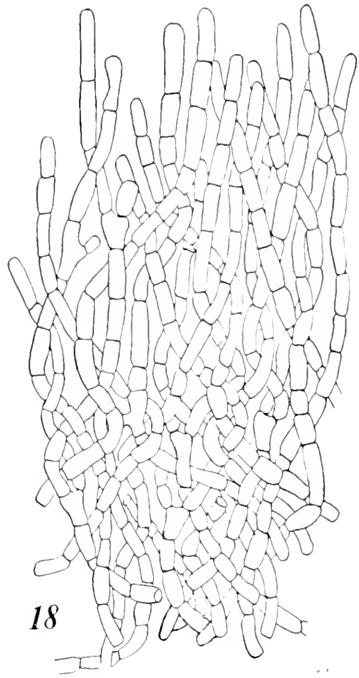
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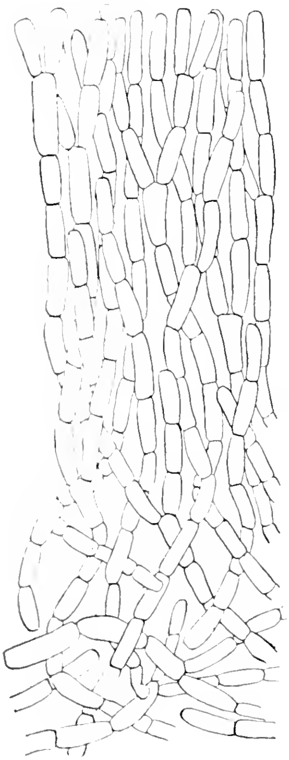
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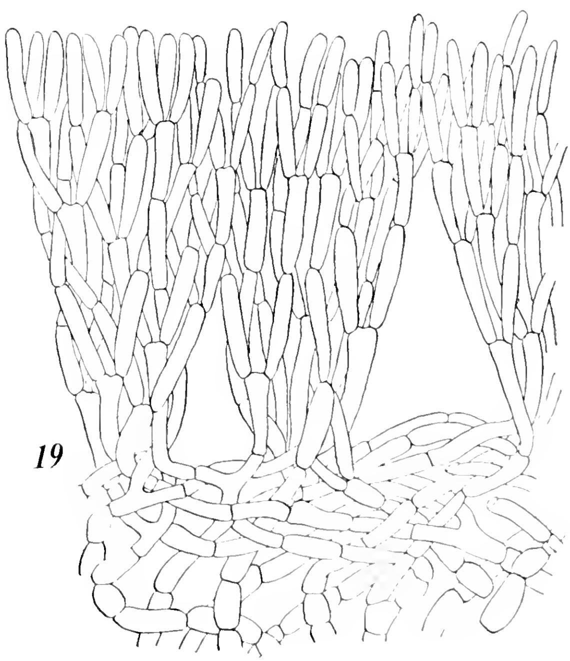
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PLATE 24

Fig. 21. *Ceriomyces crassus*, Form A. A section showing the hairs on the surface of the pileus and something of the structure of the context. (Dried material, No. 72). × 250 diam.

Fig. 22. *Ceriomyces communis*, Form A. A section showing the structure of the rind on the surface of the stipe. (Dried material contributed by Dr. W. A. Murrill). × 250 diam.

Fig. 23. *Rostkovites californicus*. A section of the pileus showing the hairs on the surface and something of the structure of the context. (Dried material, No. 251). × 250 diam.

Fig. 24. *Ceriomyces communis*, Form A. A section of the surface of the pileus showing the very slight differentiation of the rind. (Dried material contributed by Dr. W. A. Murrill). × 250 diam.

Fig. 25. A series of sections of *Ceriomyces auriflammeus* showing the structure of the stipe. (All from dried material contributed by Dr. W. A. Murrill). All × 250 diam.

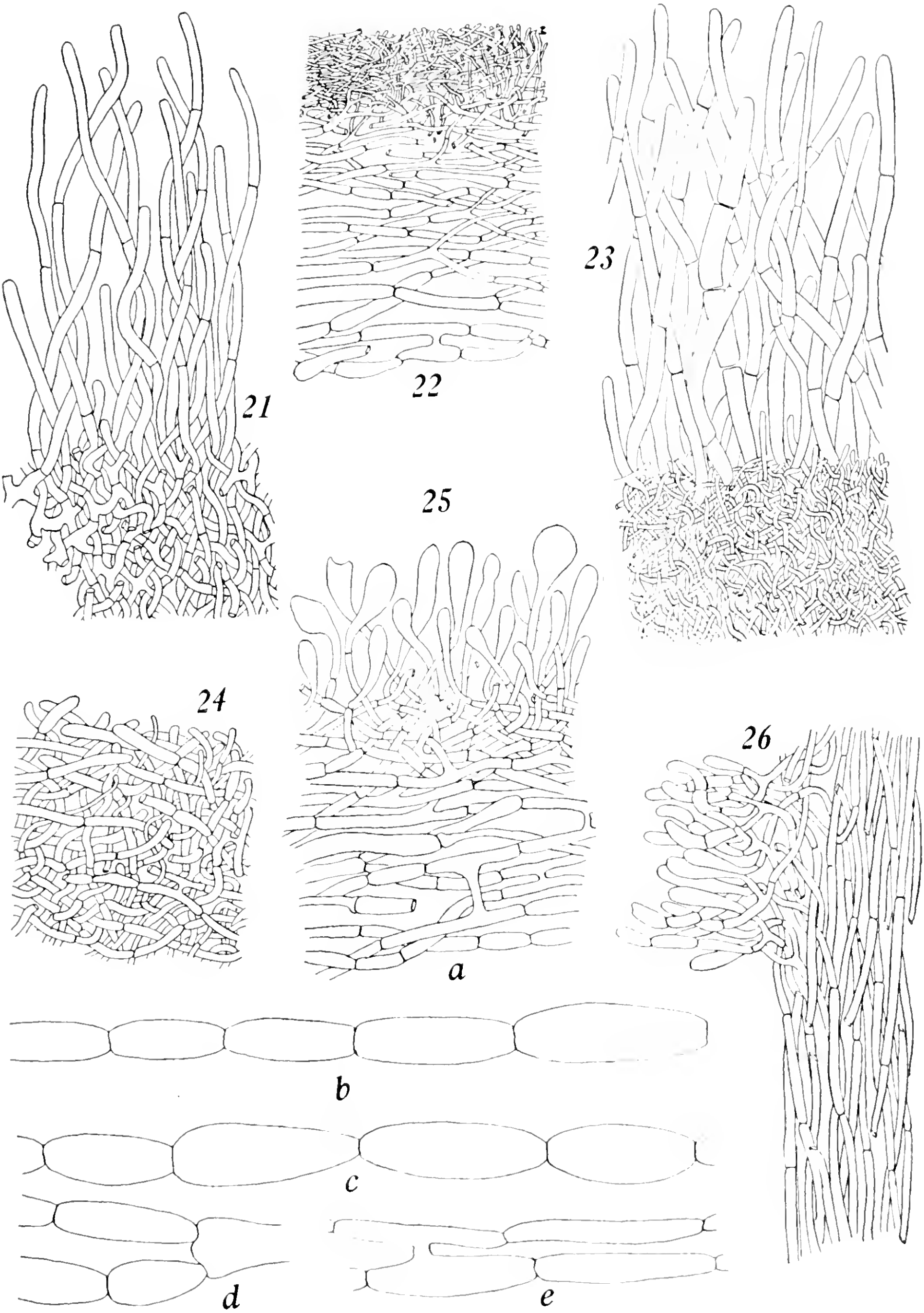
(*a*) A section showing the structure of the rind.

(*b*), (*c*) A single hypha from the context showing the relative length and diameter of the divisions.

(*d*) This figure shows the typical method of branching of the hyphae.

(*e*) This figure shows the union of two hyphae.

Fig. 26. *Ceriomyces communis*, Form B. A section showing the surface of the stipe with the hyphae lying parallel to the surface and a single tuft made up of gland-like hyphal tips. (No. 238). × 250 diam.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a
b
c
d
e

PLATE 25

Fig. 27. *Boletus luteus.* A section showing the hairs on the surface of the pileus. (No. 236). × 250 diam.

Fig. 28. *Rostkovites granulatus.* A longitudinal section of the hymenial layer showing the paraphyses, a basidium with spores, a cluster of glands, and the sub-hymenial layers. × 550 diam.

Fig. 29. *Rostkovites granulatus.* A longitudinal section of the stipe showing the structure of the rind. (Dried material contributed by Dr. W. A. Murrill). × 250 diam.

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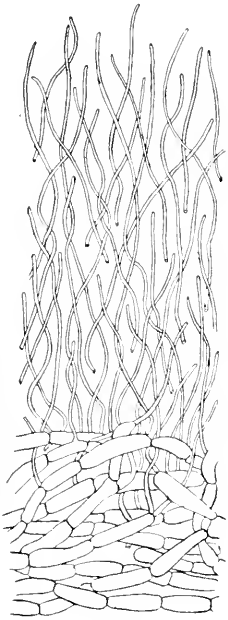
Fig. 32. *Rostkovites granulatus.* A section of the surface of the pileus showing the lack of differentiation in the structure of the rind. (Dried material contributed by Dr. W. A. Murrill). × 250 diam.



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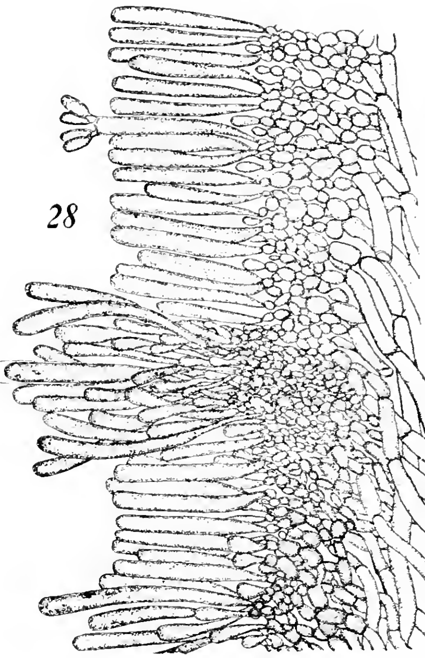

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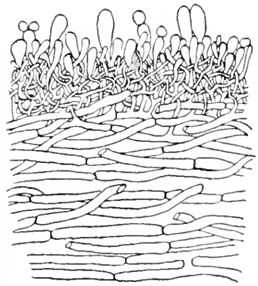

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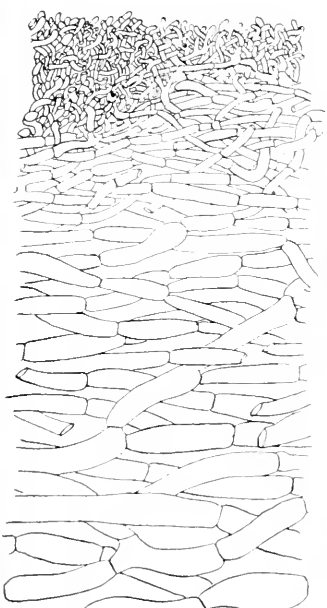

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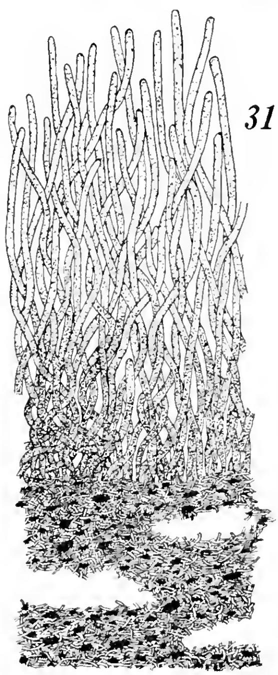

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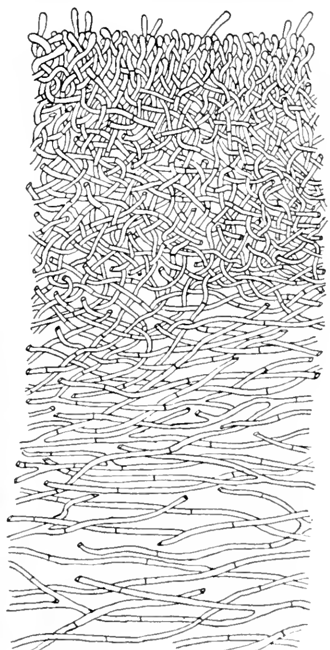

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A REVISION OF THE TUBERALES OF CALIFORNIA

BY
HELEN MARGARET GILKEY

CONTENTS

I. INTRODUCTION

Of all members of the vegetable kingdom, the longest, perhaps, to remain in absolute obscurity as to their manner of growth and methods of reproduction, were the truffles and their allies. Practically no study had been made of their life-history or relationships until the beginning of the nineteenth century, when four species were described by Persoon in his *Synopsis Fungorum*. Twenty years later, Fries added eight species distributed through four genera. But the first real critical study of these plants was made by Vittadini, who published in 1831 his *Monographia Tuberacearum* containing in thirteen genera seventy-three species. These pioneer workers were followed by Klotsch, Corda, and by the Tulasne brothers, whose *Fungi Hypogaei* with its twenty-one exquisite plates, appearing in 1851, is still one of the most valuable contributions which have been made to the subject. Within recent years, Professor Oreste Mattirolo of the University of Turin, Italy; Professor Edward Fischer of Bern, Switzerland; Fedor Bucholtz; Professor Th. M. Fries of the University of Upsala, Sweden, and others, have added to our knowledge of these plants.

All the studies mentioned, however, have been principally of European forms. In Fischer's review of the Tuberales for the *Pflanzenfamilien* in 1897, only one species was reported from North America; and except for the work of Spegazzini in Argentina, and Harkness in California, the hypogaeous fungi of the western hemisphere have been quite neglected. The fact that they are little known in comparison with those of Europe may be accounted for by the supposition that our hypogaeous flora is less rich than that of the other continent; but a more reasonable explanation at present is, perhaps, that attention has not been attracted to them by an overcrowded population necessitating the utilization of every possible natural resource. In any case, material is present in some quantity, for occasional specimens have been reported from New York, Pennsylvania, Louisiana, Minnesota, and Michigan, as well as California, and at least small collections are known to have been made in various other parts of the United States. Much of this material, however, has perhaps been picked up by accident, and no attempt, so far as known, has been made to assemble data for a systematic account of the hypogaei of America.

In 1899, a paper entitled "California Hypogaeous Fungi" was published in the *Proceedings* of the California Academy of Sciences by Dr. H. W. Harkness, a retired physician living at the time in San Francisco. He had long been interested in the neglected fungus flora of the west, and had published, with Justin P. Moore, nine years previously, a catalog of the Pacific Coast fungi. The results of his scientific labors appeared from time to time in *Grevillea*, the *Bulletins* and *Proceedings* of the California Academy of Sciences, and other journals.

Harkness' paper dealing with the hypogaei was received with considerable interest, since it was the first work of its kind in North America. Unfortunately, however, no keys are included, and the descriptions are so abbreviated that one who has not the privilege of access to the type material finds the paper of little value in the placing of unknown plants. In spite of this, much credit is due Dr. Harkness for his pioneer work carried out under various difficulties, in collecting and arranging the species so far as they were known at that time.

II. MATERIALS AND TECHNIQUE

The collection assembled during the twenty-five years that Dr. Harkness studied the fungi of the Pacific Coast is said to have aggregated ten thousand species. Some of these were acquired by purchase or exchange, but the most were native plants of California, the range of territory covered extending from Mount Shasta on the north to Fort Yuma on the south, and from the seashore to the eastern limits of the Sierras (Harkness, 1880, p. 1). Of this collection the greater part became the property of the California Academy of Sciences whose headquarters were in San Francisco. Unfortunately, the herbarium of the Academy was largely destroyed by the fire of 1906, the only specimens of fungi saved being those designated as types of new species, which were rescued with much difficulty and hardship by Miss Alice Eastwood, curator of the herbarium. However, before this time, but after the death of Dr. Harkness, the main collection of hypogaei came into the possession of Leland Stanford Junior University, at Palo Alto, so this portion escaped. Through the kindness of Professor Le Roy Abrams, curator of the herbarium at that institution, full facilities for the examination of the collection were enjoyed. Only three types of the ascomycetous hypogaei are missing. These are not noted on the list of numbers representing the fungi in the California Academy herbarium saved from the fire—for which list I am indebted to Mrs. Katherine Layne Brandegee of the University of California—so it is probable that they are not now in existence.

The Harkness collection consists of "approximately three hundred species," of which nearly one-third are ascomycetous. The specimens are preserved in 95 to 100 per cent alcohol, in bottles, and are labeled, usually, with both numbers and names, though in some cases neither is present. While most of the specimens are Californian, a few are from European herbaria. No data whatever are to be found for the unlabeled material, except a quotation from Dr. Gustav Eisen, the illustrator of the Harkness paper, who believed it to have been collected after the publication of the latter. Of many species little material is present, a number having only a portion of an ascocarp remaining.

In addition to the specimens, there is a large number of slides in the collection. Some of the sections were hand-cut and mounted in glycerine, while the remainder, which were made by microtome, were preserved in balsam. The latter, according to Dr. Eisen, were the ones used principally for his illustrations. All the slides are, however, at the present time almost worthless. Those in glycerine are unsealed, and consequently suffered seriously during shipment. Those in balsam were less injured, but little remains to be seen of the delicate, colorless fungal tissues. It has been necessary, therefore, with nearly every specimen, to make new sections; and in cases in which only a small part of a type remains, the matter of securing for sectioning a portion from the most desirable location without injuring the value of the remainder of the plant has been a delicate one. Some of the ascocarps are riddled by insect work, which is a particular disadvantage in cases of scanty material.

Another difficulty met in working over the collection has resulted from various confusing discrepancies of numbers and names. In several instances, one species is discovered to have been described under three or four different names; or a plant cited in the *Hypogaeous Fungi of California* as a particular species is found in a bottle bearing a different label. Two young specimens were published under different specific names from the mature plant, one even appearing in a separate genus. Sometimes two species are cited under the same number, and occasional bottles bear two numbers. The solution of such difficulties is rendered more difficult by the very meagre descriptions in the Harkness paper, and by the fact that when a plant was considered identical with a previously described species, the original description was quoted, generally in abridged form, and no critical notes added. The collection as a whole, however, has been found to be in good condition; of some species there is ample material, and it has been possible in most cases to obtain very satisfactory sections.

In addition to the Harkness collection, the hypogaei in the herbarium of the University of California have been available for study. This collection, made principally by Professors W. A. Setchell and N. L. Gardner, numbers at present about four hundred and fifty specimens, of which nearly one hundred are ascomycetous. As a provision against any possible accident or emergency, material of nearly every species is preserved both in dried form and in alcohol. The mistake was made at first of preserving the specimens in formalin, but it was soon discovered that these became too soft to section. Ninety-five per cent alcohol was substituted and the material so preserved retained its original firmness.

Besides the Californian species present in the University collection, there are two species of *Tuber* from Professor Kauffman of the University of Michigan, one from Professor F. Butters of the University of Minnesota, and specimens of a *Tuber* collected by Professor Gardner in Iowa. There has also been available for comparison European material received from Professors Mattirolo of Italy and Fischer of Switzerland. Unfortunately, however, it has been impossible to examine types of European material, and all classifications have depended of necessity upon published descriptions and illustrations.

In preparation for study, alcoholic material was soaked in water for some time, then sectioned by Professor Gardner's adaptation of the Osterhout freezing method of cutting (Osterhout, 1896, p. 195). Sections from 5 to 15μ were made, those of 10μ being found in nearly all cases most satisfactory. The material in formalin was similarly treated, but in every case was too soft to section successfully. The only stain employed was Fuchsin S (Grüblers) in acidified alcohol, which was sufficient clearly to contrast cell walls and contents.

III. DISTRIBUTION IN CALIFORNIA

Of the distribution of hypogaei in California much is yet to be known, for though the field thus far covered by collectors is comparatively broad, the work done has necessarily been more or less desultory. Dr. Harkness (1899, p. 242) bounds the region over which he collected

> on the north by the California State line, on the south by the Tehachapi range, by the sea-coast on the west, and the Valley of Donner lake upon the east—an area exceeding 400 miles from north to south, and some 300 miles from east to west, and within which are to be found the Coast Range mountains, with the dense forests of Sequoias, and the Sierra Nevada mountains rising to an elevation of 8,000 feet.

As to the seasons, he says (pp. 242–243):

> Many species may be found soon after the first autumnal rains, especially if the rain is followed by a period of sunshine and moderate heat. If these conditions continue during the entire rainy season, much material may be collected during the winters. The most productive season, however, is that of early spring, as it seldom fails during these months that there are warm rains followed by sunny days. If, as it sometimes happens, there is an abundant precipitation of moisture, good material may be found even late into the spring. After the close of the rainy season, but little is to be found, unless it be upon the banks of mountain rivulets, or in a few favored spots where there exists sufficient moisture combined with a suitable soil. . . . The earliest date at which we may hope to find *Tubers* (truffles, so-called) is about the first of January. At this time the cell structure of the gleba is in a perfect state, but

is still destitute of asci or spores, which makes the identification of species impossible. So far as I have seen, the spore does not arrive at maturity until April; much, however, depends upon the weather.

Professor Gardner's experience in regard to seasons differs somewhat from the preceding, for he has collected various species of *Tuber* which were fully developed in the early part of December. As Dr. Harkness has stated, however, much depends upon the weather, and the years of early *Tubers* correspond to those in which early and frequent rains are followed by warm sunshine.

The trees and shrubs which Dr. Harkness cites as associates of ascomycetous forms are: *Quercus*, *Pinus*, *Abies*, *Sequoia*, *Libocedrus*, *Ceanothus*, *Eucalyptus*, *Arctostaphylos*, and *Heteromeles*. Professor Gardner adds *Arbutus* and *Salix* to the list. In few cases was a fungus discovered always to be associated with the same kind of tree or shrub, some species even being found under various conifers as well as deciduous trees.

Many species, according to Professor Gardner, grow only under leaves, while some are truly hypogaeous and occur sometimes several inches under ground. The soil may be light and porous, or may be of heavy clay. The latter is evidently preferred by *Tuber candidum*, which is often found buried two or three inches deep. It is reported also, however, as growing in both leaf-mold and sand.

IV. ECONOMIC IMPORTANCE

Dr. Harkness states (1899, p. 244): "All of the Californian species are . . edible, and no doubt would be greatly esteemed as a luxury were it not for the fact that they are so rare as to practically prohibit their use as food." On the same page he refers to a species which a number of years ago was discovered in large quantities near Marysville and Sacramento. It was freely eaten and considered a great delicacy; and from its large size and its effect upon the surface of the ground above it, Dr. Harkness, who knew it only by report, believed it to be a species of *Terfezia*, a genus well known in Southern Europe and Western Asia for its edible qualities. Unfortunately, no further notes have been made, and whether or not a *Terfezia* exists in Cailfornia is still unknown.

Professor Gardner has found *Tuber candidum*, *T. californicum*, and *Geopora Harknessii* in comparative abundance, but no particular tests of their edibility have been made. At present writing, however, specimens of *Geopora magnifica*, a large species measuring from four to ten centimeters in diameter, have been sent in from Alameda, California, the discoverer, Mr. A. A. Baroteau, having for some time collected and eaten the plant and esteemed it as an article of food.

Of the true *Tubers* found in our state, none are closely related to the common edible truffles of Europe. *Tuber aestivum* of England, *T. brumale* of France, *T. magnatum* of Italy, and others, all so-called "black" or "queen" truffles, are dark brown or black, with the surface covered by large pyramidal or shield-shaped warts. The "white" truffles of Europe are lighter-colored, with a smooth, or at most a verrucose surface; and while some of these are eaten, they are in much less demand than the former. The *Tubers* thus far reported from California are all "white" truffles, but apparently even of these we have none of the European species. None of our species exhibits any marked odor, and since the truffle is used as a condiment and valued for its flavor rather than for any nutritive value it may possess, it is probable that ours will not prove of great economic importance.

V. MORPHOLOGY AND PHYLOGENY

Owing to the difficulties in the way of securing early stages in the life-history of hypogaeous fungi, the relationships of the various genera with each other and with other orders is still largely a matter of conjecture. The latest arrangements of the ascomycetous forms are those of Fischer (1897*a*, p. 279; 1908, pp. 142–161), and Bucholtz (1903, pp. 161–164). It will be seen from the text of all three that the arrangements have been based principally upon the structure of mature ascocarps rather than upon development. In a few species moderately young ascocarps were studied, *Tuber excavatum* and *T. puberulum* by Bucholtz (1903, pp. 154–158), and *Piersonia bispora* (the species at that time unnamed) by Fischer (1908, pp. 149–154). The latter also figures in Rabenhorst's *Kryptogamen-Flora von Deutschland* (V Abtheilung, p. 8) an immature ascocarp of *Genea sphaerica*. No statement is found concerning the age of the specimen from which the drawing was made, and the fact that no notes in regard to development accompany the illustration, except one refering to the width of the apical opening, would perhaps indicate that the ascocarp was too nearly mature to reveal much of value in the way of changes due to growth. Bucholtz makes the statement that ascocarp development in *Genea* is wholly unknown (1903, p. 163). Fischer quotes Mattirolo as saying that he has examined young material of *Balsamia* and has concluded that the latter is cleistocarpous in origin (Fischer, 1908, p. 159). I have not yet had an opportunity of consulting the original reference as to the extent of Mattirolo's study of this genus.

These observations, with those of De Bary and Solms-Laubach, represent practically all cases, so far as I have been able to discover, of inquiry into the development of the ascomycetous hypogaei. In no case have I found record of observations upon the entire life-history of any species.

In Engler and Prantl's *Die natürlichen Pflanzenfamilien*, Fischer included the ascomycetous hypogaei under two orders—Tuberineae Winter (Tuberales) and Plectascineae Schröter (Plectascales), basing the division upon the presence and absence, respectively, of definite hymenium, and the consequent massing in the latter case of the asci in definite areas. However, the distinction between the two orders, which were considered of different origin but of parallel development, is so obscure that Fischer has since transferred several genera from the Plectascales to the Tuberales, principally upon their resemblance, apparently, to newly-investigated genera which he considers undoubted Tuberales (Fischer, 1908, p. 160). In the opinion of various botanists the presence or absence of a defined hymenium is not sufficient basis for a separation into two orders, and the status of the Plectascales is at present somewhat uncertain.

The Tuberales in *Die natürlichen Pflanzenfamilien* were divided into two families, Eutuberaceae and Balsamiaceae, also considered of different origin but of parallel development. The Eutuberaceae, including all genera having openings from the hymenium to the exterior of the ascocarp, were placed in phylogenetic line with the gymnocarpous Helvellales; while the Balsamiaceae with closed ascocarps were considered descendants of the hemiangiocarpous Pezizales. Under Balsamiaceae were placed *Balsamia, Geopora,* and *Hydnocystis* (the latter two with some doubt); and the Eutuberaceae included *Genea, Pseudhydnotrya, Hydnotrya, Stephensia, Pachyphloeus,* and *Tuber*. In the *Botanische Zeitung* (1908) Fischer again published an opinion of the relationship of these plants, and his arrangement of the genera at this time, which was largely influenced by investigations of Californian forms, varied in several important points from the original. *Pseudhydnotrya* Fischer, which had formerly appeared under Eutuberaceae because external openings had been observed, was reduced, the genus being considered identical with Geopora, originally of the Balsamiaceae. The latter family was left with the single genus *Balsamia*, its relation to *Geopora* and *Hydnocystis* being questioned. To the Eutuberaceae were added the new genera *Gyrocratera*, *Pseudobalsamia*, *Piersonia* and *Myrmecocystis*, as well as the genera *Hydnobolites*, *Choiromyces*, and *Genabea*, which were earlier included with the Plectascales.

Fischer's arrangement for the Eutuberales, which is essentially, with some modifications and additions, that of Bucholtz, is represented in the following table:

$$\begin{tikzcd}
 & & & & \text{Hydnobolites, Pseudobalsamia} \\
\text{Sphaerosoma} \arrow[r] & \text{Gyrocratera} \arrow[r] \arrow[d, dashed, "?"] & \text{Hydnotrya} \arrow[r] \arrow[drr] & \text{Stephensia, Pachyphloeus} \arrow[r] & \text{Tuber} \arrow[u, dashed, "?"] \\
 & \text{Genea} \arrow[dr] & & & \text{Piersonia} \arrow[d, dashed, "?"] \\
 & & \text{Myrmecocystis} \arrow[r] & \text{Genabea} & \text{Choiromyces}
\end{tikzcd}$$

The Eutuberaceae are connected with the Helvellales by *Sphaerosoma*. The status of the latter genus has been discussed by Setchell (1910), who proves that *Sphaerosoma* Klotzsch belongs to the Pezizales rather than to the Helvellales. Fischer may have referred here to *Sphaerozone ostiolatum* (Tul.) Setchell, which was named *Sphaerosoma ostiolatum* by Tulasne, and which is probably a member of the Helvellales. Tulasne's figures of this species were used by Schröter in the Pflanzenfamilien (p. 172) under the name *Sphaerosoma fuscescens* Klotzsch.

In the diagrammatic table, plate 26, I have shown an outline of the relationships of the genera which I have had opportunity to observe, as I understand these relationships at the present time. It will be noticed that several genera mentioned by Fischer are absent. Of these *Gyrocratera* and *Genabea* have been omitted because no material has been at hand for study, while *Myrmecocystis* is included as a subgenus under *Genea*, the reasons for its reduction being found in the discussion of that genus. *Delastria* and *Terfezia* have been transferred from the Plectascales, tentatively, at least, for the presence or absence of definite hymenium does not seem sufficient to separate them so widely from the genera of the Tuberales which they resemble in general character, habit, and habitat, more closely than genera of any other order.

This arrangement, like all preceding arrangements, has been based principally upon a study of mature ascocarps. In only one case, that of *Tuber candidum*, were young plants available for investigation, but these served rather to strengthen than weaken the probability of the relationships indicated in plate 26.

In the following explanation of the table, it is hoped that the linking of the Tuberales with the Pezizales, and the further theory of relationships indicated, will be justified so far as justification of any arrangement is possible with our present imperfect knowledge of development in these plants.

Except for the absence of localized mycelium in *Hydnocystis*, there is little difference between this genus and *Peziza*, either in superficial characters or fundamental structure. The latter exists first as a completely closed body which opens during development as a result of more rapid internal than external growth, the hymenium for the first time becoming exposed. *Peziza*, then, is of angiocarpous origin. Both *Hydnocystis* and *Genea* also appear sometimes as closed bodies, and while the earliest stages are not known, it is not unreasonable to assume that these genera, too, are originally angiocarpous, the open forms representing cases of greater inequality of growth in cortical and subcortical tissues. An interesting point here, which may or may not be significant, is the presence in many genera of the Pezizales of branched paraphyses similar to those found in several species of *Genea*; and even the secondary cortex of the latter is, to an extent, duplicated in *Conida*, *Caldesia*, *Heteropatella*, and other members of the above-named order.

In plate 26, two main lines of development labeled respectively *A* and *B* are indicated, the ascocarps of the former differing from those of the latter in the possession of external openings from the hymenium. This condition is first observed in *Hydnocystis* in which, apparently, the subcortical growth has exceeded the cortical in certain forms. Others remain completely closed and give rise to the genera of line *B*. In *Geopora* the comparatively simple ascocarp form of *Hydnocystis* has become complicated by greater disparity of growth in the two tissues, causing infoldings of the entire wall, and inward-extending projections from the inner surface. In a few cases here also is found such great disparity of tissue development that the cortex has yielded to the pressure from within, and openings are formed. As the simple cavity of the ascocarp becomes filled with folds of tissue, it is dissected into canals of various form. These are first represented in *Geopora,* and continue through the line. These canals are generally lined with a palisade of asci and paraphyses, some of the latter at times developing into the canals and filling them with a mass of branched and tangled hyphae. Such canals are called *venae externae* and are seen in *Pseudobalsamia, Stephensia, Pachyphloeus, Tuber,* and *Piersonia.* In other cases the paraphyses all remain as palisade or are absent, and the passages are left free, as in *Geopora* and *Hydnotrya.*

As the ascocarp becomes more and more crowded with minute, irregular folds of tissue, these are fitted together until the hymenium loses all indication of order; and the asci are massed in apparently irregular form in areas separated by narrow veins, the latter representing the original folds or projections which were large enough to retain their identity. This is the condition found in *Tuber.* In *Piersonia* the internal folding has not been so great, but the hymenial areas are distinct, through the loss of asci for long distances upon the venae externae, and the consequent shrinkage of the latter, forming narrow canals.

Line *B* branches from the original with the definite appearance in *Balsamia* of closed chambers. These are first to be considered in *Geopora,* in which various folds coalesce, closing the passages. These chambers become complicated in *Hydnotryopsis* by infolding of their walls, producing a condition in each chamber similar to that of the original cavity of *Geopora.* In *Choiromyces* the open canals of *Hydnotryopsis* become filled with hyphae formed by development of paraphyses; and finally in *Terfezia* and *Delastria* all semblance of order in the hymenium is lost, as in *Tuber.*

These lines which were arranged merely upon ascocarp structure, were found to exhibit development in spore characters and numbers as well. For example, *Hydnocystis* has spores which are entirely smooth, and this character continues through the genera to *Pachyphloeus* of the one line and *Hydnotryopsis* of the other. In the offshoot *Genea,* however, sculptured spores are observed. The asci of all genera to *Tuber* and *Delastria* contain generally eight spores, from this point the number varying through one to four.

Several points of the preceding theoretical line of development of the Tuberales have been borne out to some extent in a study of these plants. (1) In *Geopora Harknessii* every stage was found between an almost simple ascocarp and one having the cavity dissected into complex canals with the walls more or less coalesced to form closed chambers. *G. magnifica* represented the highest development in this genus of the latter condition; and occasional openings, apparently due to growth, were found in both species. (2) The very close similarity of form and structure between *Balsamia* and *Pseudobalsamia*, described under the latter genus, seems to indicate a nearer relationship than that attributed to them by Fischer. (3) Fascicled paraphyses and occasional undeveloped asci in the sterile canals of *Piersonia* denote the possible disappearance, mentioned above, of asci from these parts, and the resultant closing together to form the very narrow channels leading to the hymenial areas. (4) The actual condition was found in young ascocarps of *Tuber candidum* in which folds of tissue of varying size and shape from the subcortex were projected into the cavity and became fitted so closely together that all trace of the original folds as such was lost. The walls were covered with a hymenial palisade of asci and paraphyses, which was perfectly regular except for a rare ascus which had apparently been too crowded in development and had not been able to parallel in position the other asci. At first the whole cavity of the ascocarp was apparently in communication, but as the various folds and projections of irregular form became fitted together, many of the paraphyses developed into the canals, filling them with tangled hyphae which became more or less compressed, and the original system was finally hidden in the mass of tissue, asci, and spores. The wider canals did not lose their identity but remained as venae externae. The venae internae in this case were clearly the original folds or projections, and not simply compressed layers of tissue taking the form of veins between developing asci, as they have generally been understood in other species.

The material was not sufficiently young to show the complete development of the external openings, but so far as observed the ascocarp did not appear to have the gymnocarpous origin which Bucholtz (1903, pp. 154–158) believed he had discovered for *Tuber*. Further studies of young ascocarps, however, are expected to throw more light upon this point.

VI. SYNOPSIS OF REVISION

The changes made in the arrangement of species found in the Harkness paper are indicated in the list which follows.

Species Cited by Harkness:	Referred to:
Balsamia alba	
filamentosa	
magnata	Pseudobalsamia magnata
platyspora	
polysperma	
vulgaris	
Balsamia nigrens	Pseudobalsamia magnata, var. nigrens
Choiromyces gangliformis	Pachyphloeus citrinus
Delastria rosea	Delastria rosea
Genea arenaria	Genea arenaria
compacta	compacta
hispidula	Harknessii
sphaerica	Gardnerii
verrucosa	Harknessii
Geopora brunneola	Geopora annulata
Cooperi	Not found
magnata	Not found
mesenterica	Not found
Hydnobolites excavatum	Piersonia alveolata
Hydnocystis compacta	Genea intermedia
Hydnotrya cerebriformis	Hydnotrya cerebriformis
Myrmecocystis candida	Myrmecocystis cerebriformis
Myrmecocystis cerebriformis	Myrmecocystis cerebriformis
Pachyphloeus carneus	Pachyphloeus citrinus
Pachyphloeus ligericus	Piersonia alveolata
Piersonia alveolata	Piersonia alveolata
scabrosa	Piersonia alveolata
Pseudhydnotrya carnea	
Harknessii	Geopora Harknessii
nigra	
Stephensia bombycina	Hydnotryopsis Setchellii
Terfezia spinosa	Terfezia spinosa
Zeynebiae	Zeynebiae
Terfeziopsis lignaria	Tuber lignarium
Tuber australe	australe
Borchii	levissimum
candidum	candidum
californicum	californicum
Caroli	candidum
citrinum	citrinum
Eisenii	candidum
excavatum	separans
gibbosum	gibbosum
Magnatum	californicum
monticolum	monticolum
olivaceum	candidum
puberulum	californicum

VII. SPECIAL MORPHOLOGY AND TAXONOMY

In the following pages the structure of each specimen examined is considered in detail. In certain cases descriptions are necessarily somewhat incomplete, through lack of sufficient data and material This is particularly true in several specimens of which little remains in the Harkness collection, for such characters in these cases as color, size, and shape cannot be determined with accuracy.

It will be found in the taxonomic arrangement which follows that a number of new names have been proposed, very few of our species being referred to European forms. Even the latter have been so referred with some doubt, for the specimens of the one and descriptions of the other do not entirely agree, and the inability to make comparisons with European material renders the matter still more uncertain. In general, particular species of the Tuberales do not seem to be represented in both the eastern and western hemispheres, though apparently closely related species are found.

Throughout the following descriptions, spore measurements in every case have included sculpturing. This has not been customary in certain genera, for example *Tuber*, but it was found impossible to measure the main body of most spores having a thick, deeply colored epispore. In order to avoid confusion, therefore, all measurements were made in the same way. However, in all possible cases in which such addition seems necessary, the thickness of the sculpturing is also cited.

Hydnocystis Tul.

Ascocarp even or somewhat lobed, hollow, subglobose, with or without external opening from hymenium, opening when present often more or less closed by dense hairs; surface verrucose, covered with short or long hairs; tissue of ascocarp wall partly or entirely pseudoparenchymatous; cavity of ascocarp lined with hymenium consisting of asci and paraphyses in palisade; asci cylindrical to long club-shaped, rounded at end; paraphyses slender, length of asci or projecting beyond them into interior of ascocarp; spores globose to globose-ellipsoid, smooth, colorless or of very light color.

The structure of the ascocarp in this genus is very similar to that in many of the Pezizales; and in the *Hydnocystis* species which open, the plant much resembles an inverted *Peziza*. Apparently there is no record of studies made of young forms in this genus, but it seems evident from mature ascocarps that, as in *Peziza*, the opening from the hymenium comes about as the result of development. Considering these resemblances, as well as those of *Hydnocystis* to *Geopora* and through the line to *Tuber* and *Piersonia*—described in the introduction to this paper—its arrangement as a connecting link between the Pezizales and the higher Tuberales seems justifiable.

Hydnocystis californica sp. nov.

Plate 29, fig. 9

Ascocarp 1 cm., subglobose, light to very dark brown, completely closed, enveloped in brown, septate, branched mycelium; surface divided into mostly hexagonal areas, 1.5 mm. in diam., forming bases of pyramidal projections; gleba white; tissue pseudoparenchymatous through verrucosities, cells 12–16μ in diam., walls of outer cells slightly thickened; occasional cells developing as septate hairs; pseudoparenchymatous tissue changing within to hyphae of same diam. as outer cells, these becoming much narrower toward hymenium; latter lining cavity of ascocarp and formed of regular palisade of asci and paraphyses; asci cylindrical, somewhat constricted between spores, narrowing to more or less definite stipe, 16–24 $\times$ 240μ; spores globose-ellipsoid, smooth, 18–20 $\times$ 22–24μ, 1-seriate; paraphyses slender, 4–6μ thick, generally length of asci but some projecting beyond at irregular distances; barely swollen at tip.

Odor of caramel.

"Under *Pinus*, in sand, Ingleside, San Francisco Co., Cal., May 2, 1903." No. 127, U. C. Col., *type*. N. L. Gardner.

The three species of *Hydnocystis* described in *Sylloge Fungorum*, vol. VIII, p. 876, are distinguished from our species as follows:

H. piligera by globose spores 32–35μ in diam.;

H. arenaria by an opening to hymenium, size of ascocarp (reaching the diameter of a chestnut), spore measurement (13–16 by 16–19μ), and unpronounced odor;

H. Thwaitesii by an opening to the hymenium, and spore shape and measurements (13–16 by 16–19μ).

There are other minor differences and all seem sufficient to separate the species.

H. Beccari, a later species founded by Mattirolo, apparently differs from ours in long-ellipsoid spores (24–27 by 15μ) and the presence of an opening to the hymenium, though full descriptions of this species could not be obtained.

Pseudobalsamia Fischer

Ascocarp subglobose to more or less depressed, somewhat lobed, infolded at apex, point of attachment of mycelial tuft at base more or less distinct; surface verrucose; outer cortical tissue pseudoparenchymatous; venae externae forming irregular canals filled with hyphae or open, converging toward apex and opening to surface at one point or several points; asci 8-spored, globose-ellipsoid, deformed by crowded spores, stipitate, irregularly arranged between veins; spores smooth, hyaline, ellipsoid, irregularly arranged in asci.

A mycelial tuft at the base is not always present, but when absent it has probably disappeared at maturity or upon collection, for a more or less definite point of original attachment is generally visible, usually with slightly elongated lobes of the ascocarp radiating from it.

Fischer, who described this genus from Californian material collected by Professor N. L. Gardner and sent by Professor W. A. Setchell, places *Balsamia* Vitt. and *Pseudobalsamia* in different lines of development, and bases this arrangement upon the presence in the latter of venae externae and the absence of conspicuous venae internae (1908, pp. 154–156). However, in the material of *Pseudobalsamia* which I have studied there is a layer of hyphal tissue below the pseudoparenchymatous cortex, which can be traced for a short distance into the gleba, parallel to the venae externae, and giving rise to the asci. In some plants this layer is much more definite than in others, but in all plants observed it can easily be found. It is not distinguishable throughout the gleba, as it is in an Italian specimen in the University of California herbarium, received from Mattirolo and labeled *B. vulgaris*, and the asci are therefore somewhat more irregularly placed, but in *Pseudobalsamia* the free ends of the asci lying nearest the canal are turned toward it as in Balsamia, showing a degree of the more or less definite arrangement found in the latter.

A little farther on in the article above mentioned (1908, pp. 154–156), in placing *Pseudobalsamia* in phylogenetic line with *Tuber*, Fischer makes the statement that the absence of "venae internae" is not so important as it might at first glance seem, for the reason that in several species of *Tuber* they are little developed. He quotes in this connection the following sentence from Bucholtz in regard to *T. puberulum* (Bucholtz, 1903, pp. 152–174): "Durch Bildung von Asci wird das ursprünglich lockere Geflecht im Innern des Fruchtkörpers zusammengedrückt und in die hier äusserst schwachen, manchmal gar nicht entwickelten Venae internae verwandelt." *Pseudobalsamia*, as I have seen it, agrees with Fischer's description of *Balsamia* (1897*a*, p. 62), in the following points: Ascocarp knob-like, fleshy, with or without basal mycelial tuft; penetrated by numerous labyrinthine chambers (open in *Pseudobalsamia*); peridium consisting of outer layer of pseudoparenchyma and inner layer of closely woven hyphae, this layer continuing into the chamber walls as trama (venae internae); chambers clothed with ascus-bearing zone consisting of paraphyses arranged in more or less distinct palisade; asci of more or less unlike form, often irregularly globose or ellipsoid, often long stipitate, 8-spored; spores ellipsoid or almost cylindrical with rounded ends, smooth, placed irregularly in ascus.

The asci do not appear to lie between the paraphyses as they are described for *Balsamia*, for the paraphyses are always developed above them, but, as previously stated, the fact that the outer layer of asci, *i.e.*, the ones nearest the venae externae, have their free ends turned toward the canal, would indicate a similar fundamental arrangement. In the genus *Hydnotrya* there is apparently as much irregularity in the arrangement of asci as in these two genera, for they are described by Fischer (1907, p. 26) as "palissadenförmig zwischen den Paraphysen stehend oder ausserdem noch unregelmässig in dem darunterliegenden Geflechte eingebettet."

The "hollow" chambers of *Balsamia* (Fischer, 1897*a*, p. 62) apparently do not hold for *B. platyspora* Berk. which is said (*ibid.*, p. 65) to possess "oft durch Hineinwachsen der Paraphysen ausgefüllten Kammern." The occasional presence, then, in the chambers of *Balsamia* of hyphal structure, and the occasional absence of the same in the chambers of *Pseudobalsamia* (see preceding description), show that no distinct point of difference can be found here.

Since *Pseudobalsamia*, as I have studied it, agrees with Fischer's description of *Balsamia* in practically every respect except the presence of venae externae and the absence of completely developed venae internae; and since, according to Fischer, the latter character is unimportant, a complete separation of the two into distinct phylogenetic lines seems unjustifiable without definite evidence that the differences are due to origin rather than development. *Hydnobolites*, near to which *Pseudobalsamia* belongs according to Fischer (1908, pp. 155–156), is distinguished from it by globose sculptured spores, pseudoparenchymatous lining of canals (the latter always hollow), and complete lack of venae internae. These would seem more nearly to approach fundamental differences than those separating *Balsamia* and *Pseudobalsamia*. A thorough study of young ascocarps, however, will be necessary to determine the actual relationships existing among these various genera.

Pseudobalsamia magnata (Hk.) comb. nov.

Pseudobalsamia Setchellii Fischer, Ber. deutsch. Bot, Gesell., 1907, p. 374; Bot. Zeit., 1908, pp. 154–156, pl Vi, figs. 11–13.

Balsamia magnata Hk., Proc. Cal. Acad. Sci., 3rd ser., vol. 1, No. 8 (1899), p. 264.

Balsamia alba Hk., Proc Cal. Acad. Sci., 3rd ser., vol. 1, no. 8, p. 264.

Balsamia filamentosa Hk., Proc. Cal. Acad. Sci., 3rd ser., vol. 1, no. 8, p. 265, pl. XLIII, figs. 13*a*–13*f*.

Balsamia vulgaris Hk. non Vitt., Proc. Cal. Acad. Sci., 3rd ser., vol. 1, no. 8, p. 265.

Balsamia platyspora Hk. non Berk., Proc. Cal. Acad. Sci., 3rd ser., vol. 1, no. 8, p. 265.

Balsamia polysperma Hk. non Vitt., Proc. Cal. Acad. Sci., 3rd ser., vol. 1, no. 8, p. 265.

Ascocarp orange to reddish brown, 1–2 cm. in diam., somewhat depressed globose, infolded at apex, with more or less persistent mycelial tuft at base; surface of ascocarp divided into distinct polygonal areas forming bases of more or less pointed verrucosities; tissue of latter pseudoparenchymatous, generally thick-walled throughout, cells becoming smaller and walls thinner, changing gradually to hyphal tissue below verrucosities; outer cells of cortex often extended to form simple hairs, particularly at openings of venae externae, hairs continuing inward, as elongations of paraphyses forming hyphal filling of canals; interior of ascocarp formed of closely crowded folds of tissue, often united, separating labyrinthine canals or sometimes apparently closed chambers; inner walls of these lined with asci and paraphyses; canals and chambers filled with hyphae (formed by elongation of paraphyses), or completely open; canals converging at one point or at several points, opening to exterior through infolded apex of ascocarp; asci irregularly arranged between canals with free ends of those lying nearest canals turned toward latter; asci generally short-stipitate, more or less globose-ellipsoid, but usually much deformed by irregular arrangement and crowding of spores, 25–35 by 50–70μ; spores smooth, colorless, varying in single plant from long cylindrical with rounded ends to globose-ellipsoid, 12 by 24 to 14 by 22μ, usually with three oil drops; paraphyses irregular in shape, 4 to 6μ wide, quite regularly arranged in palisade, some elongated and branched, forming loose hyphal tissue of canals.

"In forests, Auburn, Placer Co., Calif., May."
No. 185, Hk. Col. *Type.*
"Under oaks, Wire Bridge, Placer Co., Calif., Feb."
No. 129, Hk. Col. *Type* of *B. alba.*
"Under *Heteromeles arbutifolia*, Auburn, Placer Co., Calif., Feb."
No. 236, Hk. Col. *Type* of *B. filamentosa.*
"Among decaying vegetation in shrubby thickets, Auburn, Placer Co., Calif., Dec." No. 231, Hk. Col. Referred to *B. vulgaris.*
"Among shrubs under vegetable mold, Auburn, Placer Co., Calif., Dec." No. 222, Hk. Col. Referred to *B. platyspora.*
"Under shrubs in sandy soil, Auburn, Placer Co., Calif., Dec."
No. 220b, Hk. Col. Referred to *B. polysperma.*
"In soil under *Ceanothus*, Mill Valley, Marin Co., Calif., Dec. 28, 1902." No. 33, U. C. Col. W. A. Setchell and C. C. Dobie.
"Under *Pinus radiata*, U. C. Campus, Berkeley, Calif., Jan. 3, 1903." "Under *Pinus*, Apr. 1." "Under *Pinus radiata*, Mill Valley Calif., Jan. 23, 1904." No. 46, U. C. Col. N. L. Gardner.
"Hypogaeous under *Pinus radiata*, U. C. Campus, Berkeley, Calif., Nov. 19, 1904." "Under *Arbutus Menziesii*, Mill Valley, Calif., Mar. 8, 1905."
No. 212, U. C. Col. *Type* of *P. Setchellii*. N. L. Gardner.
"Under *Ceanothus sorediatus* in sand, near Golden Gate Park, San Francisco, Calif., Mar. 23, 1905."
No. 280, U. C. Col. N. L. Gardner.
"Ingleside, San Francisco Co., Calif., Feb. 13, 1915."
No. 404, U. C. Col. N. L. Gardner.

Very noticeable variation is found in this species in color; degree of verrucosity of surface; thickness of walls and extent of elongation of cortical cells; contrast between cortical and subcortical tissues; and spore size and shape. Yet none of these are sufficiently defined and constant to be used as specific characters. It was evidently upon these characters that Harkness based his various species, but they must be considered, I believe, merely individual differences; for every degree of variation, particularly in cell-form and in shape of spore, sometimes exists in a single plant. Colors range, according to Harkness, from dirty white through orange and brown to black. However, the plant in the Harkness collection labeled *Balsamia alba* is apparently immature, which may account for its absence of color; while the species *B. nigra* appears sufficiently distinct in structure to be considered a variety of *P. magnata*. This leaves the general range of color for the species extending through orange to reddish brown, a variation which is not uncommon in a single species of other genera.

Pseudobalsamia magnata, var. **nigrens** (Hk.) comb. nov.

Plate 30, fig. 33

Balsamia nigrens Hk., Proc. Cal. Acad. Sci., 3rd ser., vol. 1, no. 8 (1899), p. 264.

Ascocarp black, somewhat depressed globose, coarsely and sharply verrucose; pseudoparenchymatous cortical tissue divided into two distinct layers, outer cells dark and very thick-walled, inner lighter-colored and thinner-walled, strongly elongated toward center of ascocarp, becoming smaller below but changing rather abruptly to hyphal tissue of subcortex; venae externae narrow, closely filled with interwoven hyphae, opening to surface between verrucosities, the hyphae continuing outward as irregular simple hairs found only at external openings of veins.

"Beneath *Ceanothus*, Auburn, Placer Co., Calif., May."

No. 180, Hk. Col. *Type* of *B. nigrens*.

The color, sharply defined verrucosities, very much thickened walls of outer cortex, strongly elongated cells of inner cortex, and narrow completely filled venae externae, easily distinguish this variety from the type of the species. In the exceedingly variable specimens of *Pseudobalsamia magnata*, however, intermediate forms of all the above characters are found in greater or lesser degree, never so sharply defined as here but sufficiently marked to make a separation of a distinct species in this case unjustifiable.

Pachyphloeus, Tul.

Ascocarp subglobose, with conspicuous basal mycelial tuft; surface pseudoparenchymatous; venae internae originating from subcortical tissue, either at base of ascocarp and extending to various points of upper side, or at different points of periphery and converging at apex; venae internae separated by venae externae, latter opening at various points of upper side of ascocarp or (usually) at single point (generally at apex), in depression; venae externae lined with hymenium, composed of asci and paraphyses in irregular palisade; asci cylindrical or club-shaped, 8-spored; spores globose, acutely or obtusely spinose, regularly seriate or irregularly arranged in ascus.

Pachyphloeus citrinus Berk. et Broome

Plate 30, fig. 24

Ann. and Mag. of Nat. Hist., XVIII, 79.

Pachyphloeus carneus Hk., Proc. Cal. Acad. Sci., 3rd ser., vol. 1, no. 8, (1899), p. 268, pl. XLV, figs. 33*a*–33*b*.

Choiromyces gangliformis Hk. non Vitt., Proc. Cal. Acad. Sci., 3rd ser., vol 1, no. 8, p. 277.

Ascocarp bright orange, 1–3 cm. in diam., somewhat compressed, even, with large, round opening at apex; mycelial tuft at base; surface divided into somewhat elongated polygons 1.5–3 mm. in length, forming bases of low pyramidal verrucosities, each separated into several parts by fissures extending from apex to near periphery; venae externae originating at various points of interior of ascocarp, and converging at apical mouth; cortical tissue pseudoparenchymatous through verrucosities of surface; subcortex mostly hyphal but partly pseudoparenchymatous; venae internae large, little-branched, originating from subcortex and likewise both hyphal and pseudoparenchymatous; asci narrowly club-shaped to very broad, 32–36 by 60–160μ; spores generally irregularly arranged, rarely 1– or 2–seriate, globose 18–22μ; sculpturing somewhat variable, generally consisting of minute, low, comparatively broad, truncate papillae, thickened at tips; occasional spore with projections more or less needle-like; paraphyses 8–13μ thick, rounded and somewhat swollen at end, usually extending beyond asci.

"Beneath *Sequoias*, Mill Valley, Marin Co., Calif., July."
No. 253, Hk. Col. *Type* of *P. carneus*.
"Under *Arctostaphylos*, Calistoga, Napa Co., Calif., April."
No. 151, Hk. Col. Referred to *Choiromyces gangliformis*.
"U. C. Campus, Berkeley, Calif., Jan. 7, 1905." "Under *Arbutus Menziesii*, Mill Valley, Calif., Mar. 8, 1905." "Under *Quercus agrifolia*, Wild Cat Canyon, Berkeley, Calif., Apr. 1, 1905." "Under *Quercus agrifolia*. Berkeley, Calif., Apr. 29, 1905." "Under *Quercus agrifolia*, Berkeley, Calif., May 11, 1905."
No. 251, U. C. Col. N. L. Gardner.

This species is referred with some doubt to *Pachyphloeus citrinus*, for while in general it corresponds with the descriptions of the latter, even to the peculiar sculpturing of the spore, there are several points with which it does not agree. Our plants reach a larger size than that cited for *P. citrinus*, and while the European species is described as dark brown with yellow papillae, ours is a bright orange-color over the entire surface. However, Fischer, who compared a specimen of ours with the type of *P. citrinus*, pronounced the two identical (Letter of October 6, 1905).

In the different specimens of the considerable collection of these plants in the University of California herbarium, little variation is found in characters. Both specimens in the Harkness collection, however, *i.e.*, Nos. 253 and 151, exhibit in cross-section decided lateral compression of the cortical cells, which is not present in the former specimens. No. 151 is immature, with the spores not quite fully developed, and both of the Harkness plants seem somewhat more delicate in structure than those of the University of California collection.

The compression has perhaps occurred in the process of sectioning, as a result of thinner walls due perhaps to younger or less robust condition or to something connected with the method of collection or preservation. In any case, the plants appear identical in all other respects, and this single dissimilarity has not seemed of sufficient importance to separate them.

While a specimen of this species is found in the Harkness collection under No. 151 referred to *Choiromyces gangliformis* Vitt. (Hk. 1899, p. 277), it is probable that this is not the plant which Harkness had under consideration, for there is no possible means of reconciling it with the description he quotes of Vittadini's species, even through the first three adjectives: "Globosus, levis, fuscus." If the original and the present No. 151 are not identical, the locality quoted above for that number is probably incorrect. Here, as in all other such cases, critical notes added by Harkness would be of much value.

Genea Vitt.

Ascocarp verrucose, brown or black, globular or irregular in form, with a variously shaped opening at apex; cavernous, either with large simple hollow or with connected labyrinthine canals formed by infolding of, or inward extending projections from, wall; canals converging at apical opening. Asci and paraphyses arranged in palisade on inner side of wall. Hymenium rarely interrupted by strands of sterile tissue, or conspicuously divided by such strands into "pockets." Paraphyses slender, septate, uniting above asci to form secondary cortex, latter generally narrower and somewhat more finely verrucose than outer cortex, but similar in color and in pseudoparenchymatous structure. Asci more or less regularly cylindrical, 8-spored. Spores ellipsoid or globular, papillose, verrucose, or spinose. 1– or incompletely 2–seriate, colored or colorless.

The genus *Myrmecocystis* established by Harkness (1899, p. 269), and further described by Fischer (1908, pp. 144–149), was originally separated from *Genea* by the light color of the ascocarp; spore sculpturing, shape, and size; and division of the hymenium into definite areas. Several Californian species, however, show such distinctly intermediate forms of certain of these characters that their location under the original arrangement is impossible. *G. Gardnerii* and *G. Harknessii*, for example, exhibit as definite division of the hymenium as *Myrmecocystis cerebriformis*, while all other characters are typical of *Genea*. Again, the compact arrangement of asci and fascicled paraphyses, as well as the very large globose spores (36μ), of *G. intermedia* would place it under *Myrmecocystis;* but the color of the ascocarp, sculpturing of the spores, and grouping of the asci are intermediate between *Myrmecocystis* and *Genea.* The two genera agree in being verrucose, more or less irregular in form, cavernous with a variously shaped opening at apex, asci and paraphyses forming palisade on inner side of wall, with paraphyses extending beyond asci to form secondary cortex. The principal point of difference apparently is in the presence in *Genea* of a mycelial tuft at the base, and its absence in *Myrmecocystis;* but this difference is noticed among the species in other genera of the Tuberales, e.g., *Balsamia* (Fischer, 1897*a*, p. 62). Since the similarity of the two is so marked, and various intermediate forms exist, a separation of the genera not only seems unnecessary but is impossible upon the old basis: therefore, in order to accommodate the previously mentioned forms, the two genera have been united in this paper.

Eugenea subgen. nov. Spores ellipsoid; asci not crowded; hymenium rarely interrupted by strands of sterile tissue.

Spores 28 by 36μ, covered by large, irregular (in size and shape) papillae. .... *G. compacta.*

Spores 22 by 32μ, minutely and obtusely verrucose .... *G. arenaria.*

Heterogenea subgen. nov. Spores ellipsoid to nearly globose, asci not crowded; hymenium interrupted by strands of sterile tissue.

Spores 22 by 28μ, covered with papillae varying in size, regularity of outline, and number .... *G. Harknessii.*

Spores 28 by 32μ, coarsely papillose, papillae more or less covered by very minute papillae .... *G. Gardnerii.*

Myrmecocystis subgen. nov. Spores globose, 28–38μ, papillose or minutely spinose; asci crowded with paraphyses apparently fascicled between; hymenium interrupted by strands of sterile tissue.

Spores irregularly papillose .... *G. intermedia.*

Spores minutely and densely spinose, spines often coalescing into irregular groups .... *G. cerebriformis.*

Genea compacta Hk.

Plate 30, fig. 32

Proc. Cal. Acad. Sci., 3d ser., vol. 1, no. 8, 1899, p. 262, plate XLIII, figs. 10*a*–10*c*.

Ascocarp light brown; 7–10 cm. in diam., flattened, lobed, surface quite regularly divided into polygons, 5 mm. in diam., forming bases of irregular pointed or truncate pyramidal projections; outer cells of cortex mostly projecting and pointed, forming superficial layer of short, 1-celled hairs with somewhat thickened walls; cavity of ascocarp irregular, due to infolding of wall but without projections; inner surface of wall verrucose, verrucosities narrower and lower than those of outer; primary cortex of large-celled pseudoparenchymatous tissue to depth of verrucosities, below which tissue abruptly changes to hyphal; asci cylindrical, constricted between spores, rounded at apex, 30 by 240μ; spores 1–seriate, ellipsoid, 24–28 by 32–34μ, surface covered with large, irregular, more or less densely crowded, flattened or conical papillae rarely reaching 4μ in height and 7μ in width (generally 2 by 4); spores 1–seriate, placed irregularly in ascus; paraphyses delicate, 3–8μ wide (generally 4μ) arising from hyphal tissue of primary cortex, and broadening above asci to form secondary cortex.

"Found in forest, Mt. Tamalpais, Marin Co., Calif., April."

No. 86, Harkness Collection, *type*.

While the spore surface of this species is similar to that illustrated by Tulasne (Fungi Hypogaei, tab. XIII) for *G. Klotzschii*, and answers to the description by Fischer of the type specimen of Berkeley and Broome (1897*b*, p. 24), the spore and ascus measurements are too small, those given for *G. Klotzschii* being for the former 31–45 by 21–32μ and for the latter, 270–320 by 35–42μ. Also, the color of the Californian species is lighter, it does not have the decided folds from the base to the apex described by Fischer as usually present, while the hyphal character of the primary cortex which is very marked in this species has been found in no description of *G. Klotzschii*. In the herbarium of the University of California is an Italian specimen from Mattirolo labeled *G. Klotzschii* which differs from our species in a very much more minutely verrucose surface, darker color of ascocarp, the presence of occasional strands of sterile tissue in primary cortex, larger and more nearly globular spores, and in the sculpturing of the spore surface, which in this case consists of very irregular papillae, the larger usually truncate and measuring sometimes 7 by 8μ. The specimen from Mattirolo represents the variation from the type plant cited by Fischer from Mattirolo's herbarium (1897*b*, p. 24), but the notes would indicate that the variation is only in the spore and the differences in ascocarp characters therefore would separate our plant as a distinct species.

The spore is very similar to Tulasne's illustration of the spore of *G. hispidula*, and the spore and ascus measurements agree with those cited for this species, but the lack of hispid character of the ascocarp, the lighter brown color, irregular cavity and presence of hyphal tissue (which is not described for *G. hispidula* and, from Tulasne's illustration, is evidently not present) would separate the two species.

One and a half specimens of this species are now present in the Harkness collection, and it is from these that the descriptions have been made.

Genea arenaria Hk.

Pl. 30, fig. 34

Proc. Cal. Acad. Sci., 3d ser., vol. 1, no. 8 (1899), p. 263.

Ascocarp brown, 1–2.5 cm. in diam., irregular, coarsely lobed and folded; surface divided into polygonal areas 5 mm. or less in diam., forming bases of low pyramidal projections rounded at apex; surface more or less covered with long, brown, septate hairs; cavity of ascocarp irregular through infolding of wall; inner surface of wall more closely verrucose than outer; outer half of primary cortex of large thin-walled cells, forming pseudoparenchymatous tissue; inner half composed of small, variously shaped cells elongated laterally and lying in more or less definite rows (parallel to surface) with walls coalescing; asci cylindrical, sometimes somewhat constricted between spores, rounded at apex, 20–28 by 200–240μ; spores 1-seriate, ellipsoid, 16–24 by 22–28μ, epispore thin, covered with minute irregular cylindrical, usually truncate verrucosities rarely reaching height of 4μ, generally 2μ or less; paraphyses slender, 4μ or less thick, branched below secondary cortex.

"In sandy ground. No locality or date." No. 42, Hk. Col. *Type.*
"In clay soil under oaks, Claremont Canyon, Berkeley, Calif., Mar. 4, 1903." No. 81, U. C. Col. N. L. Gardner.
"Under oak, Piedmont Park, Oakland, Calif., April 4, 1903." No. 96, U. C. Col. N. L. Gardner.
"In clay soil under *Quercus agrifolia*, U. C. Campus, Berkeley, Calif., Nov. 26, 1901." No. 225, U. C. Col. N. L. Gardner.
"Under *Quercus agrifolia*, U. C. Campus, Berkeley, Calif., Jan. 7, 1905." No. 247, U. C. Col. N. L. Gardner.
"Under *Quercus agrifolia*, U. C. Campus, Berkeley, Calif., Jan. 7, 1905." No. 248, U. C. Col. N. L. Gardner.

This species evidently comes near *Genea verrucosa* Vitt. and *Genea pulchra* Corda, but it differs from descriptions of these species in several points mentioned below. The spores of the material studied under all the numbers cited above are identical in being very minutely verrucose, with the projections mostly slender cylindrical and truncate, instead of either semi-globose or conical as described for *G. verrucosa* and figured by Tulasne (1851, pls. XII and XIII). The specimens differ from material from Mattirolo in the University of California collection bearing the name of *G. verrucosa*, in lighter color, the presence of hairs upon the ascocarp, verrucosities of the spore more irregular and more slender, and narrower paraphyses (those of Mattirolo's specimen measuring 4–7μ in thickness). Descriptions of *G. pulchra* differ from this species in having the ascocarp even, without folds or inner projections, and in larger spores (21–25 by 28–31μ) covered with minute sharp-pointed needles.

While spore characters and all measurements are constant in different plants of this species, the characters of ascocarp surface and cortical tissue are quite variable. In No. 42, Hk. Col., Nos. 81 and 248, U. C. Col., very few hairs are found upon the surface of the ascocarp; while in other specimens they are comparatively plentiful. The structure of the cortex is also found to vary in different specimens. However, all of these variations are present to some extent in different plants of the same collection, and do not seem sufficient basis for specific separation, particularly since a single ascocarp occasionally exhibits striking variability in the characters mentioned above.

Genea Harknessii sp. nov,

Plate 29, figs. 10, 11, 12, 13

Genea hispidula Hk. non Berk., Proc. Cal. Acad Sci., 3d ser., vol. 1, no. 8 (1899), p. 263.

Genea verrucosa Hk. non Vitt., Proc. Cal. Acad Sci., p. 263.

Ascocarp dark brown to black, 2 cm. in diam., slightly flattened, somewhat lobed; surface divided into minute polygonal areas, forming bases of stout pyramidal projections; cavity of ascocarp much broken by irregular projections from wall; wall of cavity with verrucosities as wide as but lower than those of outer surface; primary cortex consisting of pseudoparenchymatous tissue of rapidly elongated, very large, dark, thick-walled cells extending to base of verrucosities; from here to asci, tissue becoming hyphal; hymenium often double from joining of inner projections of wall, divided into distinct "pockets" by strands of sterile hyphal tissue connecting cortices; asci cylindrical to somewhat club-shaped, not constricted between spores but covering spores loosely, stipitate, rounded at apex, 32 by 225μ; spores 1- or incompletely 2-seriate, 22–24 by 28μ, surface covered by semi-globose or truncate conical papillae, rarely reaching width and height of 4μ, usually variable in size, distribution, and shape on single spore; paraphyses 2–8μ in thickness, branched below secondary cortex.

"Strawberry Canyon, Berkeley, Calif., Mar. 27, 1915."
No. 429, U. C. Col. *Type*, N. L. Gardner.

"Among decaying leaves under trees, Santa Cruz, Santa Cruz Co., Calif., May." No. 70, Hk. Col. Referred to *G. verrucosa*.

"Beneath surface of ground under trees, San Rafael, Marin Co., Calif., May." "Under Oaks, Wire Bridge, Placer Co., Calif., April." No. 115, Hk. Col. Referred to *G. hispidula*.

No. 70 of this species is cited as *G. verrucosa* Vitt. by Harkness, while No. 115 is placed under *G. hispidula* Berk. The bottles in the Harkness collection bearing these numbers are both labeled *G. perlata*. The species differs from the description of *G. hispidula* (Fischer, 1897*b*, p. 20) in having smaller spores (the measurements cited for *G. hispidula* being 38–42 by 32μ) and in being glabrous. It also differs from descriptions of both *G. hispidula* and *G. verrucosa* (including *G. perlata* Corda) in having sometimes club-shaped asci, hyphal tissue in the primary cortex, branched paraphyses, and very conspicuously interrupted hymenium. In the University of California herbarium is an Italian specimen from Mattirolo which is labeled *G. verrucosa*, and which has somewhat larger spores than our plant, no apparent branching of the paraphyses, and no indication of interrupted hymenium. Bucholtz (1903) states that the hymenium of *G. verrucosa* is not continuous, but since this character is found mentioned in no descriptions it is apparently not conspicuous. The character of the hymenium of our species apparently excludes it from any described species, and seems sufficient basis, together with associated peculiarities of paraphyses and primary cortical tissue, for a distinct species.

Genea Gardnerii sp. nov.

Plate 28, figs. 7, 8

Genea sphaerica Hk. non Tul., Proc. Cal. Acad. Sci., 3d ser., vol. 1, no. 8 (1899), p. 263.

Ascocarp black, 1–1.5 cm. in diam., very much wrinkled and folded, surface minutely verrucose; cavity of ascocarp very irregular due to infolding of wall, but rarely to projections from wall; verrucosities of inner surface equal in size to those of outer; outer layer of both cortices pseudoparenchymatous, composed of coarse, dark, thick-walled cells, below verrucosities becoming small and thin-walled, colorless; cells of primary cortex gradually lengthening laterally, giving appearance of hyphae with united walls; hymenium conspicuously divided into "pockets" by sterile strands of tissue composed of united extensions from the two cortices, of pseudoparenchyma, or by such extensions joined by mass of paraphyses; asci cylindrical to more or less club-shaped, not constricted but loosely covering spores, rounded at apex, 34–42 by 280–425μ, tapering to stipe with latter sometimes much elongated; spores 1- or rarely incompletely 2-seriate, sometimes only 3 or 4 maturing in ascus, ellipsoid, 30–34 by 32–36μ; surface densely covered with broad (8μ) low, semi-globose papillae, these minutely and more or less evenly papillose; paraphyses irregular in shape with some cells long-cylindrical, others short and swollen; 3–9μ in width, branched.

"Under oak on top of ground beneath leaves, Piedmont Park, Oakland, Calif., Apr. 4, 1903." No. 97, U. C. Col. *Type.* N. L. Gardner.
"Hypogaeous under *Quercus agrifolia.* Leona Heights, east of Oakland, Calif., Mar. 4, 1905." "Under *Quercus agrifolia.* Berkeley, Calif., Apr. 29, 1905." No. 249, U. C. Col. N. L. Gardner.
"Beneath surface of ground under oaks, Contra Costa Co., Calif., May." No. 89, Hk. Coll. Referred to *G. sphaerica.*

Harkness quotes No. 89 under the name *Genea sphaerica* Tul. (Harkness, 1899, p. 263). The plants under this number in his collection, however, differ from the descriptions (Tulasne, 1851, p. 120, Fischer, 1897*a*, p. 24) of the above-named species in having much larger asci (those cited for *G. sphaerica* being 190–220 by 28–35μ); in the form of the ascocarp which in *G. sphaerica* is said to be more or less regularly globose with large anastomosing projections from the inner wall extending into the cavity; in the spores, those of the Californian plant being much more nearly globose than described for *G. sphaerica* and having much larger papillae bearing small secondary papillae which are not mentioned in descriptions of *G. sphaerica;* and finally in the interrupted hymenium, which character is so conspicuous in our species that it must certainly have been noticed and recorded if it were present in the European plants.

This species differs from *G. Harknessii* in the much more irregular ascocarp, absence of projections from inner wall, generally deeper color, lower verrucosities of surface, larger spores and asci, and in the shape and sculpturing of the spore, that of *G. Gardnerii* being nearly globose with more dense and much larger papillae. A hasty comparison of the ascocarps is insufficient, however, to distinguish between the two, for both are dark-colored and strongly verrucose, and may easily be mistaken for each other in the field. This evidently occurred in the case of the two citations given above under No. 249, for both species were found in the bottle bearing that number.

G. Gardnerii comes very near descriptions of *G. Klotzschii,* the spores of our species measuring a little smaller but of the same general type. However, while Bucholtz (1903, p. 162), in a comparison of the genera of the Tuberales, makes the statement that the hymenium of *G. Klotzschii* is not an uninterrupted layer, apparently this condition is not conspicuous, for I find no mention of it in any description of the species; neither do I find an account of branched paraphyses. In an Italian specimen from Mattirolo in the University of California herbarium, labeled *G. Klotzschii,* occasional strands of sterile tissue are found in the hymenium but the latter is not divided into the distinct "pockets" characteristic of our species. No branching of paraphyses can be discovered in the Italian plant. The spores of the latter differ from those of ours in having much higher papillae which are truncate, conical or cylindrical, much less crowded, and the surface between them closely covered with very minute papillae. The latter are also distributed over the larger papillae as in ours, but not so conspicuously.

Fischer (1897*a*, p. 23) describes the spores of the type of *G. Klotzschii*, which, he states, approach those of *G. verrucosa;* and he compares with these the spores of material from Mattirolo, the description of which corresponds with the preceding description of a specimen from the same herbarium. Apparently the differences in the two examples occur, however, only in the spore, and as intermediate forms are found and wide variation can be seen in single specimens, he does not consider these a sufficient basis for a new species. In the Californian material, on the other hand, the variation from the type as described lies not so much in the spore as in the distinct character of the hymenium and in the form of the paraphyses, and it seems best at present to consider this a separate species.

The material in the University of California collection is in much better condition than the Harkness specimens. For this reason, descriptions and illustrations were made from No. 97 of the former, this being selected as the type of the species.

Genea intermedia nom. nov.

Plate 29, fig. 14

Hydnocystis compacta Hk., Proc. Cal. Acad. Sci., 3d ser., vol. 1, no. 8, p. 262, pl. XLIII, figs. 11*a*–11*c*.

Ascocarp reddish brown, somewhat lobed, surface covered by rounded papillae varying in size, reaching 0.3 mm. in diam.; cavity of ascocarp apparently comparatively simple, inner wall following slight lobing of outer; outer wall more coarsely verrucose than inner; primary cortex only slightly thicker than secondary; both pseudoparenchymatous throughout, outer cells larger and somewhat thicker-walled than inner and all more or less compressed laterally; hymenium showing few "pockets;" asci cylindrical, sometimes constricted between spores, rounded at apex, 44 by 300μ; spores 1-seriate, globose, 36μ, smooth and hyaline when young, surface at maturity covered with semi-globose papillae varying in size on single spore from 5μ in height to very minute granules often coalescing in irregular groups; in dense crowding of spores, papillae often rubbed off from surface; paraphyses 4μ in width, compressed in groups between crowded asci.

"Under *Libocedrus*. Alta, Placer Co., Calif., May."
No. 98, Hk. Col. *Type*.

Only two small portions of a plant, each about 7 mm. in diam., are now present in the Harkness collection, and therefore such points as size, shape, the presence or absence of an external opening and of projections from the inner wall, cannot be determined with certainty. In the material studied, however, the wall of the ascocarp is comparatively even, there being only slight lobing; no indications are found of inner projections; and an external opening was apparently originally present. The latter character may have been overlooked by Harkness as it apparently was overlooked in his genus *Myrmecocystis*. However, plants which in all other respects answer perfectly to the description of *Genea* but which lack an opening are found in the University of California collection; and even the absence of this character, therefore, would not seem sufficient alone to debar the species from this genus. Its transference to *Genea* from *Hydnocystis*, where it was placed by Harkness, is justified by the presence of a secondary cortex formed by the paraphyses. Because of its spore shape and size and the densely crowded arrangement of the asci and paraphyses, however, it cannot be separated from *Myrmecocystis* upon the old basis of distinction between the latter and *Genea*, and must therefore be considered under *Genea* in the enlarged sense.

Since the specific name *compacta* has already been used by Harkness in connection with *Genea*, the name *intermedia* is proposed.

Genea cerebriformis (Hk.) comb. nov.

Myrmecocystis cerebriformis Hk., Proc. Cal. Acad. Sci., 3d ser., vol. 1, no. 8, p. 269, pl. XLV, figs. 28*a*–28*c*; Bot. Zeit., 1908, p. 145, pl. VI, figs. 1–3, Ed. Fischer.

Myrmecocystis candidum Hk., Proc. Cal. Acad. Sci., 3d ser., vol. 1, no. 8, p. 269, pl. XLV, figs. 29*a*–29*e*.

Pseudogenea californica Fischer, Ber. deutsch. Bot. Ges., 1907, p. 372.

Ascocarp creamy white, 1 cm. in diam., very irregular in form with conspicuous convolutions, these in turn being minutely convoluted; surface covered by minute mostly conical verrucosities; cavity of ascocarp dissected by infolding of and projections from wall into system of labyrinthine canals; inner wall more minutely verrucose than outer; cortices composed of large-celled pseudoparenchyma to somewhat below base of verrucosities, cells in more or less distinct radial rows and elongating toward center of ascocarp, this tissue becoming smaller-celled and, in primary cortex, changing to more or less connected hyphal tissue to bases of asci; hymenium sometimes double, partitioned into irregular, mostly bent "pockets" by strands of cortical tissue; asci crowded, separated by fascicled paraphyses; asci more or less deformed by pressure, cylindrical to somewhat club-shaped, normally 8-spored but some spores often not maturing, not constricted between spores, rounded at apex, 40 by 180–250μ; spores 1– or incompletely 2–seriate, globose, 28–40μ, smooth and hyaline when young, at maturity smoky yellow, densely covered by long, slender spines with enlarged bases, bases often coalescing in groups and making surface of spore appear irregularly rugose; paraphyses 4–6μ in width, difficult to distinguish separately because of dense crowding between asci.

"In sandy places under oaks, Wire Bridge, Placer Co., Calif., May." No. 25, Hk. Col. *Type.*

"In rich sandy soil under oaks, Alameda Co., Calif., June." No. 18, Hk. Col. *Type* of *M. candidum.*

"About 3 inches deep in soil under oak, Piedmont Park, Oakland, Calif., Apr. 4, 1903." No. 98, U. C. Col. N. L. Gardner.

"Hypogaeous under *Salix*, Sunset Park, Santa Clara Valley, Calif., May 17, 1903." No. 145, U. C. Col. N. L. Gardner.

"In gravel soil under *Quercus agrifolia*, Leona Heights, east of Oakland, Calif." "Under *Arbutus Menziesii*, Mar. 8, 1905." "Under *Quercus agrifolia*, hills by Lake Temescal, Oakland, Calif., Aug. 11, 1905." No. 272, U. C. Col. *Type* of *Pseudogenea californica* Fischer. N. L. Gardner.

"Under *Quercus agrifolia*, Dimond Canyon, East Oakland, Calif., Mar. 14, 1914." No. 401, U. C. Col. N. L. Gardner.

The plants found under No. 18 and labeled *Myrmecocystis candidum* are apparently young specimens of No. 25, Hk. Col. The spores, which are immature, are similar to undeveloped spores found in No. 25, and the form and structure of the ascocarps of the two are identical. The spores of this species are very peculiar in their sculpturing. The spines appear to be covered by a transparent membrane which holds them rigid, but where this has broken away leaving the ends free, they are seen to be long and flexible, tapering gradually from an enlarged base. The coalescing of these bases in groups of irregular lines gives the sculpturing a netted appearance, but the extent of such coalescence varies greatly in different spores of a single plant, and often every gradation is found between spores whose spines are entirely separate and those whose surfaces are completely covered by a network of connected bases. The ends of the spines are not united in any case. A similar coalescence of projections of spore surface is found in *G. intermedia* to a much less marked degree.

The form of the hymenium in this species seems to be a further development of that of the species under *Heterogenea* in which are likewise found, though less conspicuously, fascicled paraphyses and strands of cortical tissue between groups of asci. In *Genea cerebriformis* the "pockets" of the hymenium are described by Fischer as more or less strongly bent (1908, p. 145). This is due to the minute lobing, previously described, of the ascocarp, the hymenium naturally lying parallel with the surface. The partitions occur usually at the bases of the small convolutions; but there seems to be no definite relation of this kind, for in cases of larger convolutions, partitions are found distributed promiscuously through the arch.

Fischer states that the central hollow of the ascocarp opens to the surface at various points at the bases of folds (1908, p. 145). It is true that openings usually exist beneath several folds of a single ascocarp, but so far as I have observed they are all connected, the original single simple mouth described for *Genea* having here become exceedingly irregular by the very decided lobing of the ascocarp.

Hydnotrya Berk. et Broome emend.

Ascocarp subglobose, surface generally folded or with projections into exterior; gleba penetrated by hollow chambers or labyrinthine canals opening to surface usually between folds or into inward extending projections of surface; canals lined with hymenium; asci forming palisade with paraphyses or more or less irregularly imbedded in tissue below; asci cylindrical, club-shaped, or long-ovoid, 6–8-spored; spores globose or ellipsoid, minutely or very coarsely papillose; paraphyses more or less swollen at tips, at external openings of chambers continuing into surface of ascocarp as swollen-tipped hyphae.

No typical species of *Hydnotrya* have thus far been reported from California; but the two anomalous species referred to this genus differ as widely from each other as from the type, and consequently can be disposed of only by establishing two new genera or by enlarging the original genus. The latter method is chosen at present; first, because only one preserved specimen of each exists, so far as I have been able to discover; and, second, the dissimilar characters of the two in relation to the type species of the genus seem less important than the characters which are similar. Further collection and study of these plants, however, may make another arrangement necessary.

Ascocarp of loose folds, forming large chambers; paraphyses scarcely swollen; spores ellipsoid, minutely papillose. *H. ellipsospora.*

Ascocarp containing narrow labyrinthine canals; paraphyses conspicuously swollen; spores globose, minutely papillose. *H. cerebriformis.*

Hydnotrya ellipsospora sp. nov.

Plate 30, fig. 38

Ascocarp purplish brown, 1.5 cm. in diam., subglobose, composed of loose folds occasionally joined; surface of ascocarp minutely villose; interior of large, hollow, connected chambers opening without at various points; wall of ascocarp 1 mm. thick, lined with hymenium, the transition of hymenium to cortex at external openings plainly visible; hyphae of wall somewhat connected immediately below external surface; hyphae at surface distinctly separated, somewhat swollen at tips, 9–18μ thick, continuing into hymenium as slender paraphyses; asci cylindrical, not constricted between spores, 10 by 260μ, 8-spored; spores 1-seriate, ellipsoid, 10 by 14μ, minutely papillose; paraphyses not produced beyond asci, little swollen, 2–5μ thick.

"Under *Quercus agrifolia*, Pacific Grove, Calif., Dec. 1909."
No. 316, U. C. Col. *Type.* N. L. Gardner and M. B. Nichols.

This species differs from the descriptions of the genus *Hydnotrya* in having mostly large, open, connected chambers, regularly cylindrical, closely crowded asci, and ellipsoid, minutely papillose spores; rather than labyrinthine canals, mostly club-shaped or long-ovoid, 6–8-spored asci, and globose spores with very thick, coarsely papillose epispore, described for *Hydnotrya*. The spores are much smaller, also, than reported for any described species of which I have found record, those of *H. Tulasnei*, for instance, cited as 25–35μ and those of *H. jurana*, 30–40μ. However, the ascocarp is of the general structure of *Hydnotrya*, i.e., irregularly folded, forming empty cavities between, which open to the surface; the surface is covered with crowded separate hyphae, more or less swollen, which continue into the hymenium as paraphyses; and the structure between the hymenium and the outer surface of the wall is hyphal. It has seemed best at present, therefore, to extend the genus *Hydnotrya*, rather than to establish a new genus for this species.

Hydnotrya cerebriformis Hk.

Plate 30, fig. 27

Proc. Cal. Acad. Sci., 3d ser., vol. 1, no. 8 (1899), p. 266, pl. XLIV, figs. 19*a*–19*f*.

Ascocarp "salmon," 2.5 cm. in diam., subglobose, coarsely lobed, with several deep, close folds; surface minutely villose; gleba white or yellowish, penetrated by long, labyrinthine, connected, narrow canals, the walls lined with hymenium; canals hollow but often so narrow that tips of opposite rows of paraphyses are in contact; outer cortical tissue of tangled hyphae 10μ in thickness, with 3 or 4 terminal cells of each projecting, swollen, reaching thickness of 20μ; upon infolded surface these swollen hyphae larger, sometimes 36μ thick; hyphae toward hymenium becoming more compact but conspicuously tangled and interwoven; hymenial tissue similar, bearing palisade-like asci and paraphyses, latter a continuation of swollen hyphae of ascocarp surface; asci cylindrical, 8-spored, not constricted between spores, rounded or slightly pointed at tips, 28 by 220μ; spores brown, globose, 25–32μ, minutely papillose; paraphyses with terminal cell swollen, 12–16μ thick, swollen tips projecting beyond asci in fan-shaped clusters.

"Among fir trees, Donner Lake, Nevada Co., Calif., July."
No. 37, Hk. Col. *Type.*

While this species has very regularly cylindrical asci, conspicuously swollen hyphae, and minutely papillose spores, all more or less contrary to former descriptions of these parts in the genus *Hydnotrya*, yet its general structure and its other characters come so near that it seems best to refer it to this genus. With the addition of conspicuously swollen paraphyses to the generic characters, this species can be referred without difficulty to *Hydnotrya* as it is enlarged to include *H. ellipsospora*.

Only one specimen is found in the Harkness collection, and this has been cut in two. The preceding description, with the exception of color, has been made from the single plant. The color is quoted from Harkness. A discrepancy is noted between his description of the spore surface and that given above. This point is very difficult to determine, for the sculpturing is exceedingly minute; and very small regular foveolate or alveolate markings and closely and regularly placed papillae appear very similar under the microscope. However, from a study of the margin of sectioned spores, and of surfaces which have been separated from the body of the spore, it seems clear that the epispore is papillose rather than foveolate.

Tuber Mich.

Ascocarp regularly globose to very irregular, fleshy or cartilaginous; surface smooth, verrucose, or with coarse projections; cortical tissue often pseudoparenchymatous; subcortex of laterally extending hyphae, loosely arranged or more or less united; gleba penetrated by venae externae and venae internae (latter rarely wanting); venae externae filled with hyphae, opening at various points of surface, or converging more or less distinctly at one point or line or several points or lines; venae internae originating from subcortex, lying usually parallel with venae externae, composed of generally parallel hyphae, loosely arranged or more or less united, sometimes pseudoparenchymatous; hymenium lying between two vein systems, consisting of irregularly arranged asci separated by strands of tissue generally similar in structure to that of venae internae; asci usually numerous, pyriform, ellipsoid or nearly globose, with 1 to 4 or more spores, number varying in asci of single ascocarp, size of spore varying with number in ascus; spores ellipsoid or globose, alveolate or spiny, irregularly arranged in ascus.

The genus *Tuber* is generally divided into two subgenera: *Eutuber*, with the venae externae opening at various points of the surface, and the consistency of the ascocarp generally fleshy; and *Aschion*, with the venae externae converging and opening at the base of the ascocarp, the consistency of the latter being hard, horny, or woody. No plants of the true *Aschion* type have yet been reported from California, but it is approached by *Tuber candidum* and *T. lignarium*, both having a somewhat cartilaginous ascocarp with venae externae converging and opening to the surface along a definite line or point or several connected or separated lines or points. These lines are somewhat irregularly arranged, sometimes occurring singly on one side of the ascocarp, but often extending half the distance around it, and more or less branched, or joined by other lines.

Sometimes there are a number of short lines, or occasionally several of these are reduced to points, and in these cases there are as many "centers" of converging venae externae. There is no definite orientation of the plant in relation to these lines, for they may be found upon the upper surface or a side of the ascocarp as often as at the base.

According to the sculpturing and shape of the spores, *Tuber* species have been divided into four groups: *Eutuber*, including those with ellipsoid, alveolate spores; *Sphaerotuber*, with globose, alveolate spores; *Oögaster*, with ellipsoid, spinose spores; and *Sphaerogaster*, with globose, spinose spores. By far the greater number of Californian species that have been collected have alveolate spores; and of these species all but one must be included under *Eutuber*. No specimens of true *Sphaerogaster* have yet been reported, though *T. lignarium* comes very near. The same relationship evidently exists in Europe between globose and ellipsoid-spored species, the latter being far in the majority.

In the descriptions which follow, aside from the size, shape and surface characters of the ascocarp and spore, there have been considered the thickness of the peridium and the structure of the venae internae and the tissue lying between the asci. The two latter tissues originate from the subcortex and are generally similar in character; but occasional cases are found in which one has become modified without a corresponding modification of the others. The structure and arrangement of these three tissues are not always constant in a species, but generally they are little variable. In a number of cases these tissues are composed of long-celled hyphae, more or less regularly arranged, which have coalesced, forming practically a pseudoparenchymatous layer of somewhat elongated cells of various sizes. Sometimes, also, apparently true pseudoparenchyma exists in such tissues, the latter appearing in section as an even layer of equal, united, globular cells. Whether this is really pseudoparenchyma, or whether the effect is produced by a section across the long diameters of the united hyphae previously described has not yet been determined. An illustration of these two tissues will be found in the figure of *T. candidum*, plate 27.

Eutuber. Spores alveolate, ellipsoid.

A. Surface of ascocarp smooth.

a. Ascocarp lobed or convolute.

Ascocarp reaching 2 cm. in diam., yellow; asci 1–4-spored; spores 26–36 by 30–44μ; 7 by 8 alveoli across diameters .... *T. citrinum*.

Ascocarp reaching 1.5 cm., dirty white, lobed and wrinkled; asci 2–4-spored; spores round-ellipsoid, 28–34 by 32–40μ; 11–14 by 12–16 alveoli across diameters .... *T. monticolum*.

b. Ascocarp even.

Ascocarp reaching 2 cm., clay-brown; asci 1–4-spored; spores round-ellipsoid, 32–48 by 36–52μ; 3–10 by 4–13 alveoli across diameters.. .... *T. levissimum*.

B. Surface of ascocarp verrucose, scabrous, or minutely wrinkled.

a. Ascocarp lobed or convolute.

Ascocarp reaching 1.5 cm., cinnamon-brown, minutely scabrous; spores long-ellipsoid, pointed at both ends, 28–38 by 36–52μ; 6 by 7 alveoli across diameters .... *T. gibbosum*.

Ascocarp reaching 1.2 cm., lead-purple, minutely verrucose; asci 1–3-, rarely 4-spored; spores round-ellipsoid, 40–48 by 48–56μ; 5–10 by 7–11 alveoli across diameters .... *T. separans.*

Ascocarp reaching 1 cm., depressed globose, minutely verrucose with occasional more coarsely verrucose areas; asci 1–3- (generally 1–2-) spored; spores 36–48 by 40–56μ; 3–8 by 3–9 alveoli across diameters .... *T. irradians.*

Ascocarp reaching 1.5 cm., brown, finely convoluted, verrucose; asci 1–5- spored; spores 24–30 by 28–48μ; 3–11 by 5–14 alveoli across diameters .... *T. Gardnerii.*

Ascocarp 0.3 to 2.5 cm., silver white with occasional smooth areas of darker color; depressed, irregular, convolute and often finely wrinkled, more or less divided into minute areas by crossing of wrinkles, sometimes having short, blunt hairs; asci 1–4- (generally 1–2-) spored; spores 28–44 by 38–56μ; 8–9 by 9–10 alveoli across diameters .... *T. argenteum.*

b. Ascocarp even.

Spores greenish yellow, 7–11 by 8–12 alveoli across diameters.. *T. australe.*

SPHAEROTUBER. Spores alveolate, globose.

Ascocarp very uneven, pubescent; spores dark brown, 40–48μ in diameter .... *T. californicum.*

OOGASTER. Spores spinose, ellipsoid or ovoid.

Ascocarp minutely verrucose, at least about furrows; spores ovoid to long ovoid, 22–32 by 28–40μ, with straight spines.......... *T. candidum.*

Ascocarp entirely smooth; spores globose-ellipsoid to globose, 20–32μ, with spines having recurved tips .... *T. lignarium.*

EUTUBER

Tuber (Eutuber) citrinum Hk.

Plate 29, fig. 18

Proc. Cal. Acad. Sci., 3d ser., vol. 1, no. 8 (1899), p. 271, pl. XLV, figs. 30*a*–30*c*.

Ascocarp pale yellow, 2 cm. in diam., somewhat convolute, surface entirely smooth, gleba somewhat lighter yellow than cortex; veins inconspicuous; cortical tissue pseudoparenchymatous; cells nearly equal in size, outer walls not thickened; cells becoming gradually lengthened laterally and changing to laterally extending, more or less connected hyphae of subcortex; thickness of peridium, 520–540μ; venae internae and tissue between asci consisting of long-celled, loose, irregular, unconnected hyphae, scarcely branched, 5μ thick; venae externae filled with coarse, much-branched hyphae, 4–6μ thick, so regularly branched and openly arranged as to appear reticulate; asci somewhat long-stipitate, semi-globose, 64–78 by 72–96μ, 1–4-spored; spores ellipsoid, 26–36 by 30–44μ, alveolate, 7 by 8 alveoli across diameters.

"In forest, Tamalpais, Marin Co., Calif., May."

No. 123, Hk. Col. *Type.*

In general characters as shape of ascocarp, smooth surface and absence of pronounced base, this species seems to come near *Tuber foetidum* Vitt. and *T. australe* Speg. The former as described, however, differs in the reddish-brown gleba, longer spores in comparison to their width, larger and fewer alveoli, and probably in the very disagreeable odor. It is impossible to determine from alcoholic material the presence or absence of the latter character, but if it were as decided in the Harkness material as it is said to be in the European specimens of *T. foetidum*, it would doubtless have been mentioned by Harkness. *T. australe* is described as "dirty-white, gleba white becoming gray, asci at first 2–3- then 1–2-spored, spores 35–38 by 45–50μ" (Paoletti, 1889, p. 888), in all of these characters disagreeing with our species. Its color and thickness of peridium, as well as the distinct vein and spore characters, seem sufficiently important to keep it as a distinct species.

Tuber (Eutuber) monticolum Hk.

Plate 30, fig. 23

Proc. Cal. Acad. Sci., 3d ser., vol. 1, no. 8 (1899), p. 271.

Ascocarp dirty white, 1.5 cm. in diam., lobed and wrinkled, surface very minutely scabrous; gleba white, netted with many small veins; outer cortical tissue pseudoparenchymatous, cells varying little in size, walls not thickened, outer layer breaking away slightly in places, making surface of ascocarp minutely scabrous; pseudoparenchyma changing gradually to very loose, branched, irregular hyphae, bordered below by close, more or less connected hyphae, becoming pseudoparenchymatous in places; venae internae of similar structure to latter tissue; thickness of peridium variable, 280–640μ; asci semiglobose, 64–80μ, 2–4-spored; spores globose-ellipsoid, very minutely alveolate, 11–14 by 12–16 alveoli across diameters; spores 28–34 by 32–40μ.

"Among firs in dense woods in Sierra Nevada Mts., at Towle, Placer Co., Calif., July." No. 27, Hk. Col. *Type.*

In cross-section this species appears somewhat like *Tuber levissimum*, for the pseudoparenchymatous tissue of the cortex is very narrow, and the peridium (in places) is unusually thick; but the whole structure is more delicate, the subcortical tissue is more irregular and unconnected, the spores are much more minutely alveolate, and the general appearance of the ascocarp—as observed from the two descriptions—is very different.

Tuber (Eutuber) levissimum sp. nov.

Plate 30, fig. 31

Tuber Borchii Hk. non Vitt., Proc. Cal. Acad. Sci., 3d ser., vol. 1, no. 8 (1899), p. 272.

Ascocarp clay-brown, 2 cm. in diam., regular; surface smooth; gleba lighter brown than cortex; veins large, inconspicuous in color; cortical tissue barely pseudoparenchymatous, composed mostly of more or less closely coalesced irregular hyphae, becoming less connected toward hymenium; outer cells slightly broken away, making surface of ascocarp very minutely scabrous, this character visible only under compound microscope; thickness of peridium 840μ; venae internae and tissue between asci of compact, more or less closely coalesced parallel hyphae, 5–6μ thick; venae externae filled with similar hyphae loosely arranged, not parallel, unconnected; asci subglobose to globose, 50–80 by 70–100μ; 1–4-spored; spores globose-ellipsoid, 32–48 by 36–52μ, alveolate, alveoli irregular in size and number on spore, 3–10 by 4–13 across diameters; sculpturing 4μ thick.

"In rich, damp loam, about 9 in. below surface, May, 1912."
No. 338, U. C. Col. *Type*. C. F. Drew.

"Among decaying leaves of oak, Mt. Tamalpais, Marin Co., Calif., June."
No. 54, Hk. Col.

This species agrees very closely in shape and color of ascocarp; venation; and shape, size and sculpturing of the spores, with the descriptions of *Tuber Borchii* Vitt. The alveoli of the spores of the latter, however, are described as generally very regular in form. In the Californian material this is found to be the case in perhaps one-half of the spores of a plant. In the others irregularity in size and shape exist to a noticeable degree. No evidence of pubescence or spots of dark color on the surface of the ascocarp is found, but as these are both described as early characters in *T. Borchii* which disappear with maturity their absence is not necessarily important. No mention is made in descriptions of *T. Borchii* of the very thick peridium nor of the small amount of pseudoparenchyma in the cortex; and the description of the subcortical layer as composed of irregular, loose, interwoven hyphae does not agree with that layer in the Californian plants, in which it is a regularly arranged, generally compact tissue of more or less coalescing hyphae.

Of the Harkness material only three portions of specimens are now present in the collection, making impossible the determination of points such as size. The material in the University of California herbarium, being more ample in quantity and in much better condition, has been selected as the type.

Tuber (Eutuber) gibbosum Hk.

Plate 29, fig. 15

Proc. Cal. Acad. Sci., 3d ser., vol. 1, no. 8 (1899), p. 273.

Ascocarp "cinnamon-brown," 1.5 cm. in diam., convolute, surface minutely scabrous, gleba ochraceous; veins barely distinguishable; outer cortical cells forming branched, knotted hairs parallel with surface; inner cortical tissue pseudoparenchymatous, deeply colored, changing to colorless laterally extending hyphae of subcortex; thickness of peridium 200μ; venae internae of long, compactly arranged but unconnected hyphae; venae externae of loose, spongy tissue composed of branched, irregular hyphae, 4–5μ thick; venae externae opening in depressions of surface, depressions filled with parallel, irregular, colored hairs of surface of ascocarp; spores dark brown, long-ellipsoid, pointed at ends, 28–38 by 36–52μ (mostly 32 by 44μ) alveolate, mostly 6 by 7 alveoli across diameters, sculpturing 4μ thick.

"Under oaks, Mill Valley, Marin Co., Calif., April."

No. 162 Hk. Col. *Type.*

Of this species only one specimen is found in the Harkness collection, and from this a small section has been removed. The plant is infested with what appears to be an ascomycetous parasite which has nearly destroyed the tissue of the gleba, making a study of this structure difficult. However, occasional unaffected portions are to be found, and is possible from the material to describe all parts of the ascocarp except the asci, which have almost entirely disappeared, only occasional pieces of membrane remaining. The size and shape of the asci, therefore, and the number of spores they contain cannot be determined with accuracy. Through the venae internae, which in most cases are found to have more or less completely disintegrated, run long, coarse, branched hyphae, which apparently belong to the parasite.

This species seems to come nearest *T. oligosporum* as it is described by Vittadini who established it. Like the Harkness specimen, *T. oligosporum* is said to be lobed, with venae externae opening in depressions filled with hyphae. The surface is illustrated as conspicuously verrucose, however, the color of the ascocarp is described as reddish black, that of the gleba and spores as sooty white, and the spore shape is simply stated as oval. There are no measurements. A distinguishing point used by Vittadini is the odor, which cannot be determined in the alcoholic material The character of the surface and the colors cited do not agree with those of the Harkness material, as will be seen in a comparison of the two preceding descriptions, while the principal distinguishing characteristics of the spore of the latter plant, *i.e.*, long-ellipsoid with decidedly pointed ends, is not mentioned in Vittadini's description. Except for three views of the ascocarp in Vittadini's *Monographia Tuberacearum*, I have been unable to find illustrations of *T. oligosporum*. It is apparently rare, for Tulasne simply paraphrases the original description, noting at the end "non vidimus," while Fischer, in Rabenhorst's *Kryptogamen-Flora*, includes it under the heading "Ungenügend bekannte Arten."

While the differences in color and surface characters may not be sufficient to separate our specimen from *T. oligosporum*, yet so many points are at present doubtful that it seems best to keep them distinct until more data for both can be secured.

Tuber (Eutuber) separans sp. nov.

Plate 29, fig. 19

Tuber excavatum Hk. non Vitt., Proc. Cal. Acad. Sci., 3d ser., vol. 1, no. 8 (1899), p. 273.

Ascocarp lead-purple (preserved) 1 to 1.2 cm. in diam., semi-globose, convolute, surface very minutely verrucose; gleba similar in color to cortex; veins inconspicuous; cortex pseudoparenchymatous, cells becoming smaller within and changing to compact subcortical layer of unconnected hyphae; walls of outer cortical cells somewhat thickened; thickness of peridium 200–260μ; tissue between asci of mostly loose, unconnected not parallel hyphae, 4–6μ thick; venae internae very compact, hyphae parallel, often connected, sometimes becoming pseudoparenchymatous; venae externae filled with loose, tangled hyphae 4–6μ thick; asci short stipitate, semi-globose, 56–68 by 60–92μ, 1–3-, rarely 4-spored; spores brown, globose, ellipsoid, 40–48 by 48–56μ, alveolate, 5–10 by 7–11 alveoli across diameters.

"Beneath oaks in clayey soil, Laundry Farm, Alameda Co., Calif., April." No. 159, Hk. Col. *Type*.

The single specimen found under No. 159, which is listed by Harkness as *Tuber excavatum*, shows no indication whatever of the basal cavity which is described as characteristic of that species. The alveoli of the spore are smaller and more irregular in number and size than they are described for *T. excavatum*, and the venae internae are not composed of tangled hyphae. Instead of converging at the base as in the latter species, the venae externae open at various points of the surface. The species comes nearest *T. irradians* and *T. Gardnerii* but it differs from the former in its smaller, thicker-celled pseudoparenchymatous cortex, with the cells not in radial rows, more compact subcortical tissue, more compact venae internae sometimes becoming pseudoparenchymatous, asci never long-stipitate and alveoli generally smaller; while it is distinguished from *T. Gardnerii* by its exceedingly minutely verrucose surface, more compact subcortical layer and venae internae, asci 1–3-spored, spores shorter in comparison to width, and sculpturing less variable. The structure of the venae internae is particularly characteristic. It was difficult to secure complete sections of the material, for the hymenium fell away under the knife; but the dense tissue of the venae internae remained, in most cases, for long distances, forming the skeleton of the original gleba. In no other case was this marked difference in delicacy between the various tissues observed.

Tuber (Eutuber) irradians sp. nov.

Plate 29, figs. 16, 17

Ascocarp brown, 1 cm. in diam., depressed globose, somewhat lobed; surface minutely verrucose with occasional areas more coarsely verrucose; gleba at first white, becoming brown; veins few, little branched, white; cortical tissue pseudoparenchymatous, cells thin-walled, large (to 24μ), in more or less clearly distinct radial rows to depth of 140–160μ, changing abruptly to loose hyphal structure of subcortex; thickness of peridium 380μ; venae internae and tissue between asci of somewhat loosely arranged unconnected hyphae, 5μ and fewer thick; venae externae filled with loosely interwoven hyphae 5μ thick; asci sometimes long-stipitate, easily separable from hyphae, pyriform, elongated or subglobose, 44–64 by 76–92μ, 1–3-spored (generally 1 or 2); spores brown, ellipsoid, 36–48 by 40–56μ, alveolate, number of alveoli variable, 3 by 3 to 8 by 9 (usually 7 by 8) across diameters; sculpturing 4–6μ thick.

"Hypogaeous under *Quercus agrifolia*, Dimond Canyon, Alameda Co., Cal., Mar. 25, 1905." No. 281, U. C. Col. *Type*. N. L. Gardner.

The regular arrangement in radial rows of the pseudoparenchymatous cortical cells, in this species, together with the marked variability in number and size of alveoli upon the spore, distinguish it from related forms as they have been described. The possession of a pseudoparenchymatous cortex and of a verrucose surface separate it from descriptions of *T. maculatum* and *T. dryophilum*. It is probably most closely related to *T. Gardnerii* but differs in several points which are mentioned under that species.

Tuber (Eutuber) Gardnerii sp. nov.

Plate 30, fig. 30

Ascocarp brown, 1.5 cm. in diam., subglobose, with small convolutions; surface verrucose; gleba white in young specimens, light brown in mature plants; veins wide, conspicuous, white; outer cortical tissue somewhat coarsely pseudoparenchymatous, thin-walled, changing gradually to subcortical layer of unconnected hyphae; thickness from surface to hymenium 240–320μ; venae internae and hymenial tissue of mostly slender, unconnected hyphae, 2–4μ thick; venae externae of loosely arranged branching hyphae 2–4μ thick; asci not stipitate, semi-globose, rarely elongated, 56–68 by 80–88μ; 1–5-spored; spores light brown, globose-, or long-ellipsoid, 24–30 by 28–48μ, alveolate, number of alveoli varying from 3–11 by 5–14 across diameters; sculpturing 2–4μ in height.

"Hypogaeous under *Arbutus Menziesii*, Leona Heights, Alameda Co., Calif., Mar. 4, 1905." "Under *Quercus agrifolia*, U. C. Campus, Berkeley, Calif., Mar. 22, 1905." "Under *Quercus agrifolia*, U. C. Campus, Berkeley, Calif., Apr. 29, 1905."

No. 274, U. C. Col. *Type*. N. L. Gardner.

This species apparently resembles most closely *Tuber foetidum*, *T. dryophilum*, and *T. maculatum*. However, nothing is recorded in regard to its odor; and its most noticeable characteristic, i.e., the exceeding variation in number and size of alveoli upon a spore, is not mentioned in descriptions of *T. foetidum*, while Tulasne's figures (1851, pl. XVII, fig. VII) would indicate that they are uniform, at least in size. In *T. foetidum* the asci are described as ellipsoid and 1–2-, rarely 4-spored, these characters both differing from those of our specimens. The species differs from the original descriptions of *T. maculatum* and *T. dryophilum* and as they are described by Fischer (1897*b*, pp. 47 and 51 respectively) in its verrucose, unspotted surface, possession of pseudoparenchymatous cortex, smaller spores, and narrower alveoli, those of *T. maculatum* given as 7–10μ, and of *T. dryophilum*, 14 by 21μ, though the latter is said by Fischer (*ibid.*, p. 52) to have sometimes more finely alveolate spores occurring with the more common widely alveolate ones. In the Californian material, the variation in alveoli is very remarkable, occurring not only in a single plant, but even in a single ascus. It is often the case, probably usually, that two or three spores in an ascus differ widely in the size and number of alveoli. In one ascus, for example, three spores were present, the first measuring 28 by 32μ and having 3 by 4 alveoli across the diameters, averaging 8μ in width; the second was 24 by 28μ, having 7 by 9 alveoli.

averaging 3μ; and the third was 32 by 40μ, with 7 by 8 alveoli, averaging 5μ. Among the smaller spores, the number and size of alveoli do not appear to be directly related to spore size; but the largest spores, i.e., those occurring singly in an ascus, usually have the greatest number and the smallest alveoli.

This species differs from *T. irradians* (which shows the similar irregularity in spore sculpturing) in color, being darker; in the ascocarp, which is larger, much more uneven, and more conspicuously verrucose; in outer cortical cells which, while coarse, are not in rows, and merge more gradually into subcortical tissue; in spores, which are not so dark brown and are smaller.

Tuber (Eutuber) argenteum sp. nov.

Plate 30, fig. 28

Ascocarp silver-white with occasional smooth areas of darker color, horny; 3 mm.–2.5 cm. in diam., depressed, irregular, convolute and sometimes minutely wrinkled; surface smooth or in places divided into minute areas by crossing of wrinkles, more or less covered by slender, short, blunt, septate hairs; gleba brownish with white branching veins; cortical tissue pseudoparenchymatous or coarsely and loosely hyphal, outer cells often forming hairs; subcortical layer of very loose, irregularly placed hyphae; thickness of peridium 100–200μ; venae internae numerous, of loose, irregular structure similar to subcortex and tissue between asci, hyphae 5–7μ thick; venae externae fewer, filled with loose, irregularly interwoven, branched hyphae 5–7μ thick; both venae internae and venae externae much enlarged at junction with peripheral layer of ascocarp; asci with or without short stipe, semi-globose, 64–78 by 76–92μ, 1–4-spored (generally 1 to 2); spores dark brown, ellipsoid, sometimes one end acute, 28–44 by 38–56μ, regularly and mostly evenly alveolate, generally 8–9 by 9–10 alveoli across diameters, sculpturing 4μ thick.

"In sand among needles of *Pinus attenuata*, Ingleside, San Francisco Co., Calif., May 11, 1905."

No. 284, U. C. Col. *Type*. N. L. Gardner.

The generally smooth, somewhat spotted surface of the ascocarp of this species, together with the spore shape and size, seem to place it near *Tuber maculatum* Vitt. and *T. dryophilum* Tul. However, it differs from descriptions of both in having a pseudoparenchymatous cortex, and in color, that of *T. maculatum* described as first white, becoming spotted with yellow, finally entirely golden yellow, and that of *T. dryophilum* as brownish with reddish violet spots. The alveoli of the spore surface of *T. dryophilum* are said to measure 14 by 21μ, while those of *T. argenteum* are generally 6–8μ. The former is also recorded as having occasional more minutely alveolate spores occurring with those of coarser alveoli, but in the Californian species the number and size of alveoli vary little.

Tuber (Eutuber) australe Speg. (?)

Plate 30, fig. 29

Spegazzini, Ann. de Soc. Cien. Argentina, vol. 24 (1887), p. 122.
Harkness, Proc. Cal. Acad. Sci., 3d ser., vol. 1, no. 8 (1899), p. 272.

Ascocarp reddish brown (preserved), 1 cm. in diam., nearly globose, very even with few wrinkles, minutely verrucose; gleba yellow gray, of loose texture; veins not conspicuous in cut surface; pseudoparenchymatous layer of cortex thin, changing soon to compact tissue of coalescent hyphae of subcortex; thickness of peridium 480μ; venae internae and tissue separating asci of similar structure to subcortex, with hyphae somewhat less closely united; venae externae of loosely interwoven branched hyphae 5–6μ thick; asci more or less pyriform, 48–60 by 60–80μ, 1–2-spored; spores greenish yellow, nearly globose, 30–40 by 32–48μ, alveolate 7–11 by 8–12 alveoli across diameters.

"Among oaks in vegetable humus upon a well-drained hillside, Auburn, Placer Co., Calif., June." No. 203, Hk. Col.

It is difficult to decide whether or not this species is identical with *Tuber australe*, for descriptions of the latter species are meagre, and no illustration of it exists, so far as I have been able to determine. Also, only one specimen of the Harkness material is present in the collection, and Harkness made no critical notes upon this species. Which characters are variable in different plants, therefore, and which are modified by the preserving alcohol must remain in doubt. However, most characters of the alcoholic specimen agree in general with the descriptions of *T. australe*, the color of the ascocarp being the only serious point of disagreement. This, however, has probably changed since the specimen was preserved. The surface of the Harkness plant is also slightly verrucose rather than smooth as described for *T. australe*, but this amount of variation sometimes occurs in different plants of a species. It seems best, therefore, to leave this specimen under *T. australe* until more material may be available for study.

Tuber (Sphaerotuber) californicum Hk.

Plate 29. fig. 20

Tuber Magnatum Hk. non. Pico. Proc. Cal. Acad. Sci., 3d ser., vol. 1, no. 8 (1899), p. 272.

Tuber puberulum Hk. non B. et Br., Proc. Cal. Acad. Sci., 3d ser., vol. 1, no. 8, p. 273.

Ascocarp whitish to ochraceous, often caespitose, 1.5–2.5 cm. in diam., much lobed and wrinkled; surface unevenly pubescent; gleba brown, marbled with large, light-colored veins; cortical tissue pseudoparenchymatous, cells varying little in size, compressed laterally, occasional cells of surface layer developing into long septate hairs; outer wall of surface cells thickened; subcortical tissue of very loose, irregular, branched hyphae; thickness of peridium 200μ; venae externae very large, branching, irregular in width, filled with loose, branched hyphae; tissue between asci more compact than venae externae, but of coarse structure; venae internae wanting; asci short-stipitate, semiglobose to globose, 72–88 by $72–100\mu$, 1–4-spored; spores dark brown, globose, $40–48\mu$, coarsely alveolate, 3 to 9 (generally 6 or 7) alveoli across diameter; epispore $4–8\mu$ thick.

"Under oaks beneath vegetable humus upon a hillside, Laundry Farm, Alameda Co., Calif., March." No. 150, Hk. Col. *Type.*

"In oak forest, San Rafael, Marin Co., Calif., March." "Under oaks, Wire Bridge, Placer Co., Calif., March."
No. 62, Hk. Col. Referred to *T. Magnatum.*

"Growing amongst decaying pine bark in forest, Donner, summit of the Sierra Nevada mountains, 7,000 ft., July; under *Libocedrus*, Towles, Placer Co., Calif."
No. 36, Hk. Col. Referred to *T. puberulum.*

"U. C. Campus, Berkeley, Calif., Jan. 7, 1903."
No. 60, U. C. Col. N. L. Gardner.

"Under *Quercus agrifolia*, U. C. Campus, Berkeley, Calif., Dec. 12, 1904." No. 228, U. C. Col. N. L. Gardner.

"Under *Quercus agrifolia*, U. C. Campus, Berkeley, Calif., Dec. 29, 1904." No. 239, U. C. Col. N. L. Gardner.

"U. C. Campus, Berkeley, Calif., Mar. 20, 1915."
No. 426, U. C. Col. N. L. Gardner.

This species, which is found in the Harkness collection under three numbers, and referred respectively to *T. californicum*, *T. puberulum*, and *T. Magnatum*, differs so distinctly from the latter two and from all other described species of which record has been found, that it has been allowed to remain under the name of *T. californicum*. There is no indication, whatever, either in the fresh or preserved material examined, of the white flecks considered an important character of the surface of *T. puberulum;* the spores are regularly globular rather than from short-ellipsoid to globular, the reticulations are not regular in form, and the spores measure 8–20μ instead of 5–9μ in diameter.

T. californicum, so far as collected, differs from descriptions of *T. Magnatum* in size, our species rarely found as large as 2.5 cm., while *T. Magnatum* is said to reach 8 cm. and sometimes more. The asci of *T. Magnatum* are described as only 40–55 by 60–70μ; the spores as short ellipsoid instead of globular, the ascocarp with a distinct base which is absent in ours; and no mention is made of pubescence. The only pubescent *Sphaerotuber* (aside from *T. puberulum* which is sometimes so placed), listed in Saccardo's *Sylloge Fungorum*, is *T. Mougeotii*, which differs in its description from *T. californicum* in being tuberculate, having granulose gleba, 2–4-spored asci, and yellow spores measuring 30–40μ.

Tuber (Oogaster) candidum Hk.

Plate 27

Tuber candidum Hk., Proc. Cal. Acad. Sci., 3d ser., vol. 1, no. 8 (1899), p. 274, pl. XLV, figs. 32*a*–32*b*.

Tuber Caroli Hk., non Bonnet., Proc Cal. Acad. Sci., 3d ser., vol. 1, no. 8, p. 274.

Tuber Eisenii Hk., Proc. Cal. Acad. Sci., 3d ser., vol. 1, no. 8, p. 275.

Tuber olivaceum Hk., Proc Cal. Acad. Sci., 3d ser., vol. 1, no. 8, p. 275.

Ascocarp light brown to reddish brown, reaching 2 cm. in diam., semi-globose, nearly even, with one furrow, or several generally connected furrows, mostly on one side, furrows sometimes united into circles forming "eyes" of different color from general ascocarp surface, usually pink in young specimens; surface of ascocarp smooth with small papillae about furrows, or whole surface divided into minute low polygonal areas, occasional colorless septate hairs on surface, particularly at or near mouths of venae externae; veins mostly large, whitish, conspicuous, converging at furrows; cortical tissue minutely and compactly pseudoparenchymatous, outermost cells sometimes lengthened laterally and more or less separated, forming short, knotted, laterally extending hairs or loose network similar to tissue of venae externae; pseudoparenchymatous layer changing within to subcortical layer of laterally elongated hyphae 4–6μ thick; thickness of peridium 200–360μ; venae internae of loosely or more or less compactly arranged hyphae; tissue between asci generally similar, but in some cases becoming more or less pseudoparenchymatous; venae externae filled with loosely interwoven, branched hyphae, 4–6μ thick, opened into furrows of ascocarp surface; asci long or short stipitate, generally ovoid, easily separated from hymenial tissue, 44–52 by 64–80μ, 1–7-spored; spores brown, exceedingly variable in shape from globose-ovoid to long, generally more or less conspicuously pointed at one end, 22–32 by 28–40μ; surface covered with minute or somewhat coarse spines, 2–3μ in length.

"Under dense clusters of *Ceanothus*, Auburn, Placer Co., Calif., May."
No. 195, Hk. Col. *Type.*

"In clayey soil beneath oaks, Laundry Farm, Alameda Co., Calif., March; Howards, Marin Co., Calif., May."
No. 149, Hk. Col. Referred to *T. Caroli.*

"In sandy places beneath vegetable humus, Auburn, Placer Co., Calif., May." No. 196, Hk. Col. *Type* of *T. Eisenii.*

"Beneath vegetable humus, Auburn, Placer Co., Calif., May."
No. 197, Hk. Col. *Type* of *T. olivaceum.*

"Under Salix, 2–3 inches deep in leaf-covered soil, U. C. Campus, Berkeley, Calif., Jan. 3, 1903."
No. 45, U. C. Col. N. L. Gardner.

"In clay soil under *Salix*, *Quercus* and *Umbellularia*, U. C. Campus, Berkeley, Calif., Mar. 29, 1903. Under *Eucalyptus*, U. C. Campus, Apr. 1, 1903." No. 91, U. C. Col. N. L. Gardner.

"Same locality and date as preceding (immature)."
No. 92, U. C. Col. N. L. Gardner.

"Under oak in clay soil, Lake Temescal, Oakland, Calif., Apr. 11, 1903." No. 108, U. C. Col. N. L. Gardner.

"In loamy, clayey soil among rocks, Lake Temescal, Oakland, Calif., Apr. 11, 1903." No. 109, U. C. Col. N. L. Gardner.

"In clay soil under *Quercus agrifolia*, Leona Heights, Alameda Co., Calif., Mar. 4, 1905." No. 273, U. C. Col. N. L. Gardner.

"In soil under *Quercus agrifolia*, Thousand Oaks, Berkeley, Calif., Dec. 3, 1913." No. 425, U. C. Col. H. M. Gilkey.

"Under *Salix*, U. C. Campus, Berkeley, Calif., Mar. 27, 1913."
No. 442, U. C. Col. N. L. Gardner.

"Under *Quercus agrifolia*, U. C. Campus, Berkeley, Calif., Mar. 27, 1913." No. 443, U. C. Col. N. L. Gardner.

This is the most commonly collected *Tuber* of California, but it will be noticed from the localities cited above that the range of territory in which it has been found is not wide. In some characters it is exceedingly variable, particularly in spore shape and sculpturing, in the tissue of the gleba, and in the surface of the ascocarp. It was thought possible at first to separate at least two forms, but study of a larger amount of material has shown that there is no apparent definite interrelation of these characters, and that varying intermediate forms are found. For example, in No. 108 of the University of California collection a verrucose ascocarp is associated with very loose hyphal structure of the hymenium. No. 195 of the Harkness collection, on the other hand, is perfectly smooth except about the furrows, while the hyphae of the hymenium are more or less united, and in places the tissue becomes apparently pseudoparenchymatous. No. 109, however, has the smooth surface of No. 195 with the hymenial structure of No. 108. The character of the spore surface and the shape of the spores differ markedly in a single specimen. The spines in some cases are slender and very numerous and in others coarser and fewer; while the shape of the spores varies from very globose-ovoid to long-ovoid. In nearly every case, one end of the spore is noticeably pointed and the other rounded. This is particularly conspicuous in sectioned spores, a definite thin spot in the wall at the acute end seeming to be present. No. 425 of the University of California collection has regularly longer spores than the other specimens, though in the latter such long spores are not uncommon, and No. 425 also has many spores of the apparently typical globose-ovoid type. The number of spores in an ascus varies generally from one to four, but in several collections the number is found to reach as high as seven. All the specimens are alike in having one to several undeveloped spores in many of the asci.

The venae externae distinctly converge, not at one point at the base as in the *Aschion* type of the *Tubers* of Europe, but along the whole line of the furrows of the ascocarp. There may be three or four or more such lines of convergence in one specimen, for there are sometimes several separated furrows, occurring on one side or even on opposite sides of the ascocarp. Often, however, only a single, generally branched furrow is present, but this may extend over half the distance around the plant. There is no definite orientation of the ascocarp in the ground in relation to these furrows.

This species comes very near descriptions of *T. rufum* (Fischer, 1897*b*, p. 57) in size, color, converging venae externae, sometimes more than four spores in an ascus, several often remaining rudimentary in other asci, spore often pointed at one end, spore and asci measurements, and spore sculpturing. The surface of *T. rufum* is described, however, as early pubescent, becoming glabrous and covered with small, low, polygonal warts or areas, separated by rather sharply marked furrows. There is no indication in the young specimens of our plants of definite pubescence, though occasional hairs are found even upon the mature ascocarps. Some, however, as previously noted, show division of the surface into polygonal areas. The consistency of the ascocarp of *T. rufum* is described as cartilaginous, becoming horny upon drying. Our specimens, particularly those in alcohol, have the consistency of a pickled green olive. The principal difference, however, between *T. candidum* and *T. rufum* seems to lie in the arrangement of the venae externae. As described, those of the latter species converge at one point, or at several outward-opening hyphal strands at the base of the ascocarp. No mention is made of furrows, though Tulasne's figures (1851, pl. VI, fig. 2) would indicate that they are present, but if present there is evidently no relation between them and the external openings of the veins. Since the venae externae of our plants open into fissures which are strongly marked, and which may occur upon any part of the ascocarp, it seems best to retain *T. candidum* as a distinct species until more extended data for the European material can be secured.

Tuber (Oögaster) lignarium (Hk.) comb. nov.

Plate 30, fig. 25

Terfeziopsis lignaria Hk., Proc. Cal. Acad. Sci., 3d ser., vol. 1, no. 8 (1899), p. 279, pl. XLIV, figs. 23*a*–23*e*.

Ascocarp brown, 1.5 cm. in diam., subglobose, somewhat furrowed, surface smooth, gleba white, veins variable in size, conspicuous; cortical tissue pseudoparenchymatous, of very small, irregular, thick-walled cells, changing somewhat abruptly to subcortex of compact but mostly unconnected hyphae; thickness of peridium, 320–360μ; venae internae and tissue between asci compact, of generally unconnected hyphae, but latter tissue pseudoparenchymatous in places; hyphae 4–6μ; venae externae few, variable in size but generally very wide at opening and at various places in ascocarp, filled with loose, tangled, branching hyphae, these often breaking away, leaving long canals through interior of ascocarp; asci long-stipitate, semi-globose and more or less cylindrical, 40–52 by 60–72μ, 2-, 3-, or 4-spored, spores light brown, globose-ellipsoid to globose, 20–32μ, surface covered with slender spines with recurved tips, 46μ in length.

"Among oaks in sandy pasture, Auburn, Placer Co., Calif., June."
No. 206, Hk. Col. *Type*.

This is probably the species examined by Harkness and described under *Terfeziopsis lignaria*, the globose or ovoid spores with recurved spines being characteristic; but the measurements in the material which I examined do not agree with the recorded Harkness measurements, and venae externae, though few, are conspicuous. These perhaps open to the surface regularly in furrows, but so little material is available for study that this point cannot be accurately determined. Since venae externae are present, and all other characters are typically those of *Tuber*, the species has been placed under that genus.

This species differs from *T. candidum* principally in completely smooth surface, fewer venae externae, these much enlarged in places and becoming open, and in the globose or nearly globose spores with somewhat curved spines. There are other less tangible characters which are difficult to describe but which tend distinctly to separate the two species. The color of the ascocarp in the alcoholic specimen of *T. lignaria* is shining bluish black, with white gleba; while in all alcoholic material of *T. candidum*, both in the Harkness and University of California herbaria, the ascocarp surface is somewhat reddish brown with lighter brown gleba.

T. lignarium apparently does not come near any described form, its spore shape and character together with the smooth surface of the ascocarp and the few venae externae distinguishing it. Very few Sphaerogasters have been described, and most of these are apparently little known (Paoletti, 1889, p. 885); of described Oögasters, none were found with measurements cited as nearly globose as those of *T. lignarium*.

Piersonia Hk.

Ascocarp subglobose; gleba with wide or narrow strands of sterile tissue separating irregular chambers lined with hymenium, latter sometimes appearing as colored dots on cut surface, connected with exterior by narrow venae externae; latter short or forming long canals through gleba, lined with more or less conspicuous paraphyses, some developing into branched tangled hyphae filling veins: hymenial chambers variously shaped by inward projecting branches of interhymenial tissue; asci and paraphyses arranged in more or less regular palisade, crowded, asci often deformed from crowding, generally somewhat club-shaped, 1 to 4-spored, some spores often not maturing; paraphyses fascicled between asci, somewhat swollen at tips.

The genus *Piersonia* is distinguished from all other genera of the Tuberales in having the asci in chambers which open to the exterior of the ascocarp by long sterile canals. These canals are lined with paraphyses which continue into and throughout the hymenium; and are perhaps approximated or at least foreshadowed in the inward projecting portions of ascocarp surface in *Hydnotrya*, these sometimes extending for long distances into the gleba where they open to the hymenium, the swollen-tipped hyphae of the surface showing gradual transition into paraphyses. However, the fascicled paraphyses in the venae externae of *Piersonia bispora*, with the presence of occasional undeveloped asci, would indicate the possible origin of the sterile canals as formerly fertile canals which have lost their asci. The spores of the species belonging to *Piersonia* are characteristic, for though alveolate sculpturing is not unusual in the Tuberales, in this case the walls of the alveoli are sometimes as thick (generally one-half as thick) as the diameter of the alveolar cavity, making the epispore appear continuous, with regularly placed, generally hexagonal depressions. These are apparently arranged in definite concentric circles, the centers occurring upon two opposite sides of the spore.

Fischer described the genus *Piersonia* in the *Botanische Zeitung* (1908), Heft VIII and IX, pp. 149–154, from No. 126 (since named *P. bispora*), of the University of California cryptogamic herbarium. His illustrations, pl. VI, figs. 5–10, picture well the characteristics of that species. The conception of the genus as above described will be found to be practically that of Fischer.

Ascocarp 1–1.5 cm. in diam.; gleba showing orange-colored spots; sterile tissue of gleba forming veins, generally narrower than hymenial areas; asci 1–4- (generally 4-) spored .... *Piersonia alveolata.*

Ascocarp reaching 8 cm. (generally 6) in diam.; gleba without orange-colored spots; sterile tissue of gleba generally broader than hymenial areas, not forming distinct veins; asci 1–2- (rarely more) spored.............. .... *Piersonia bispora.*

Piersonia alveolata Hk.

Plate 28, figs. 1, 2, 3, 4

Proc. Cal. Acad. Sci., 3d ser., vol. 1, no. 8 (1899), p. 275.

Piersonia scabrosa Hk., Proc. Cal. Acad. Sci., 3d ser., vol. 1, no. 8, p. 275.

Hydnobolites excavatum Hk., Proc. Cal. Acad. Sci., 3d ser., vol. 1, no. 8, p. 266.

Pachyphloeus ligericus Hk. non Tul., Proc. Cal. Acad. Sci., 3d ser., vol. 1, no. 8, p. 269.

Ascocarp white, becoming yellow or brown, 1.3 cm. in diam. slightly lobed, surface scabrous, sometimes pubescent; gleba yellowish with orange-colored dots, separated by lighter-colored veins; outer cortical tissue of branched intertangled hyphae, often with more or less regular globose thickenings, sometimes so close and even as to make hyphal thread appear like string of beads; hyphae often projecting from surface, forming hairs; tissue beneath other hyphae becoming pseudoparenchymatous, of distinctly angled cells reaching 20μ in diameter, cells becoming smaller within, changing to subcortical tissue of compactly arranged, sometimes connected hyphae running parallel to surface of ascocarp; thickness of peridium, $220–600\mu$; venae externae generally short, lined with paraphyses, filled with loose, branched hyphae similar to outer cortical tissue, inner hyphae less thickened than outer; venae internae much branched, broadened at angles, varying in width but mostly slender, of compact hyphal structure similar to subcortex, becoming pseudoparenchymatous in places; asci borne in distinct large "nests," generally irregularly bent or variously shaped by inward extending branches of venae internae; asci generally long-stipitate, crowded, club-shaped, more or less deformed, 64–72 by 80–104μ, separated by fascicled, swollen-tipped paraphyses, 1–4-spored (generally 4-spored); spores globose, 22–36μ, yellow or brown, minutely alveolate, walls of alveoli half as wide as alveolar cavities, 10–14 across diam.; spores irregularly arranged in ascus.

"Beneath *Ceanothus*, Auburn, Placer Co., Calif., May."
No. 183, Hk. Col. *Type.*
"In forest, Auburn, Placer Co., Calif., June."
No. 201, Hk. Col. *Type P. scabrosa.*
"Under vegetable humus in sandy ground, Auburn, Placer Co., Calif., May." No. 189, Hk. Col. *Type Hydnobolites excavatum.*
"Under pine trees in sandy soil, Towles, Placer Co., Calif., May."
No. 44. Hk. Col. Referred to *Pachyphloeus ligericus.*

This species is characterized by very large areas of hymenium which cause the colored dots in the gleba mentioned by Harkness (1899, p. 275), by narrow venae internae, generally 4-spored ascus, and small ascocarp. Apparently, too, the venae externae of this species are much shorter than those of *P. bispora*, and do not form the long canals described by Fischer for that species (1908, pp. 149–154), though this point has not been determined satisfactorily for the reason that the Harkness material is more or less granular at the present time, and perfect sections have not been obtained.

Harkness separated his two species upon the characters of ascocarp color and spore measurement. Nothing in regard to the former can be determined from the alcoholic material, but in the specimens sectioned and examined, absolutely no difference can be found in spore size. In both, the size varies from 22–36μ, those from 30–36μ predominating. Evidently some error occurred in recording the Harkness measurements, for these do not agree with his. Under the numbers 189 and 44 of the Harkness collection, named respectively *Hydnobolites excavatum* and *Pachyphloeus ligericus* (Harkness, 1899, p. 266 and p. 269) were discovered material of *Piersonia*. It is impossible to tell from the descriptions of the two species mentioned whether or not the plants examined by Harkness are the ones now found under the same numbers. His description of *Hydnobolites excavatum* with cavernous gleba and eight-spored asci would indicate that another plant was under consideration. However, in the slide which he left of No. 189, the section is clearly of *Piersonia*. No slide of *Pachyphloeus ligericus*, so-called, is found, so whether the discrepancy here was simply a result of accidental shifting of labels or confusing of specimens, can not be determined. The fact that the date and the locality for the material under both of these names, as well as of the two Harkness *Piersonias*, are almost identical, may or may not be significant, as much of the Harkness collection was made in Placer County.

No. 44 exhibits all the characters of *Piersonia alveolata* as previously described, but the material of No. 189 is badly worm-eaten and the resulting stimulated growth of tissue, in the form of coarse, colored hyphae, has so obscured the structure that it is impossible to determine with certainty the relation of venae externae to the gleba, and the size of the venae internae. The asci, too, have for the most part, lost their spores, so that the number in an ascus is uncertain. Consequently it is difficult to place this species exactly, but the structure, so far as it can be made out, is like that of *P. alveolata*.

Piersonia bispora sp. nov.

Plate 28, fig. 5

Piersonia (unnamed), Bot. Zeit., 1908, Heft. VIII, IX, pp. 149–154, pl. VI, figs. 5–10.

Ascocarp reaching 8 cm. in diam. (generally about 6 cm.), "ferruginous with occasional white patches;" surface scabrous, sometimes somewhat pubescent; gleba white without dots; outer cortex coarsely and irregularly hyphal, irregularly thickened hyphae often projecting in form of hairs; hyphae of subcortex more slender than those of cortex, compactly arranged, more or less parallel; thickness of peridium, 360–600μ; venae externae forming long, more or less connected, winding canals through gleba, lined with fascicled, swollen-tipped paraphyses, some extending into canal and forming coarse, loose, branched hyphal structure similar to outer cortex; venae externae ending in small chambers lined with asci; main venae internae much broader than hymenial areas, composed of loosely or somewhat compactly arranged hyphae, rarely becoming pseudoparenchymatous; asci club-shaped, long-stipitate, 60–70 by 76–92μ, 1–2- (rarely more) spored, separated by fascicled, somewhat swollen tipped paraphyses; spores globose, yellow or brown, minutely alveolate, walls of alveoli as wide or one-half as wide as alveolar cavities, 10–11 alveoli across diameter; spores 28–30μ, irregularly arranged in ascus; paraphyses 6–8μ at tip. "Odor of plant at first resembling desiccated cocoanut, changing as plant dries, to that of strong cream cheese."

"Under *Pinus radiata*, in hard soil, about one-half exposed; U. C. Campus, Berkeley, Calif., Apr. 27, 1903."

No. 126, U. C. Col. *Type*. N. L. Gardner.

"Under *Pinus radiata*, U. C. Campus, Berkeley, Calif., May 24, 1903."

No. 152, U. C. Col. N. L. Gardner.

Material under No. 126 was sent to Fischer, who described and figured it without a name in the *Botanische Zeitung* (1908). This species differs from *Piersonia alveolata* Hk. in the smaller hymenial areas with thicker sterile structure between, somewhat smaller asci with fewer spores, much greater size of the ascocarp, and probably in the very long winding canals through the gleba, though the failure to secure perfect sections of *P. alveolata* leaves this point somewhat doubtful. The gleba, in cut surface, instead of appearing veined with large hymenial areas lying between, as in *P. alveolata*, presents the appearance of a compact structure occasionally interrupted by comparatively small ascus-bearing areas. The sterile tissue in places becomes narrow enough to be considered veins, but generally is wider than the fruiting tissue. The orange-colored dots described by Harkness in *P. alveolata* are absent in *P. bispora*. Since the "dots" are merely the "nests" of asci, the color being due to the crowded masses of spores, this difference in the two species can be explained by the smaller ascus-bearing areas with consequently fewer asci, and by the smaller number of spores maturing in an ascus, making the whole mass of spores much less conspicuous.

Through the long venae externae, the paraphyses which line the walls are found to be quite regularly fascicled, and what appear to be undeveloped asci are occasionally found. The explanation, then, of the peculiar grouping of the asci in distinct areas within the ascocarp, may be simply the loss of asci from the walls of the original folds, and the closing together of these walls to form narrow canals.

Geopora Hk.

Ascocarp tomentose, irregular in shape, varying from simply lobed to very complexly folded, folds loose and easily separable or more or less united; inner cavity originally single, but divided by infolding of wall or by projections from inner surface into narrow labyrinthine canals, continuous or partitioned into chambers by uniting of folds; asci and paraphyses arranged in palisade on inner side of folds, hymenium rarely opening to exterior of folds or ascocarp; asci cylindrical to club-shaped; spores ellipsoid, smooth, colorless, 1- or incompletely 2-seriate.

A. Asci cylindrical to club-shaped, not constricted nor annulate between spores.
 Ascocarp rarely exceeding 2.5 cm. in diam., whitish to brown, simply lobed to closely folded; paraphyses slightly longer than asci, terminal cells swollen, 2–6μ thick .... *G. Harknessii.*
 Ascocarp averaging 1.5 cm. in diam., dark brown, somewhat lobed, folded within; paraphyses equal in length to asci, terminal cells swollen, 5–8μ thick .... *G. Cooperi.*
 Ascocarp 4–10 cm. in diam., reddish brown; slightly lobed; closely folded within, generally enclosing tomentum-lined cavity; paraphyses a little shorter than asci, terminal cells slightly swollen, 6μ thick...... *G. magnifica.*
B. Asci cylindrical, constricted, with annulate thickenings between spores.
 Ascocarp 2–2.5 cm. in diam., much wrinkled; loosely folded within; paraphyses equal in length to asci; terminal cell not swollen, 4–5μ thick...... .... *G. annulata.*

Geopora Harknessii Fischer

Plate 30, fig. 37

Botanische Zeitung, 1908, p. 157.
Pseudhydnotrya Harknessii Fischer, in Engler und Prantl, Die natürlichen Pflanzenfamilien (1897), I Teil, Abteilung 1, p. 282.
Pseudhydnotrya carnea Hk., Proc. Cal. Sci., 3d ser., vol. 1, no. 8 (1899), p. 267, plate XLIII, figs. 16*a*–16*b*.
Pseudhydnotrya nigra Hk., Proc. Cal. Acad. Sci., 3d ser., vol. 1, no. 8, p. 267.

Ascocarp light to dark brown, without definite point of attachment of mycelium, whole ascocarp at first enclosed in dense mass of brown branched hyphae; 0.7–4 cm. in diam.; varying in shape from slightly lobed to much folded, folds often extending far into interior; surface more or less verrucose, tomentose, with long coarse hairs; interior chamber comparatively simple to exceedingly irregular and consisting of long, connected labyrinthine canals, due to infolding of or projections from wall; folds and projections mostly easily separable but sometimes more or less connected; surface hairs continuing on infolded cortex, making folds appear as if filled with loose hyphal tissue; folds sometimes so closely crowded that tips of two layers of paraphyses meet; tissue of external wall and folds more or less pseudoparenchymatous between hymenium and tomentum of surface; outer cells of cortex colored and larger than inner colorless cells; asci cylindrical to somewhat club-shaped, not constricted between spores, rounded or somewhat pointed at apex, 16–28 by 140–200μ; spores smooth, 1- or incompletely 2-seriate, globose-ellipsoid to long cylindrical with rounded ends, 10–16 by 18–22μ; paraphyses colorless, terminal cell swollen, 2–6μ thick, little longer than asci.

"Under shrubs among vegetable humus, Mill Valley, Marin Co., Calif., April." No. 1, Hk. Col. *Type?*
"Among shrubs, Auburn, Placer Co., Calif., May; under rocks, Mill Valley, Marin Co., Calif., April."
No. 181, Hk. Col. *Type* of *Pseudhydnotrya carnea*, Hk.

"Under shrubs in firm ground, Auburn, Placer Co., Calif., Nov. to Apr." No. 216, Hk. Col. *Type* of *Pseudhydnotrya nigra.*
"Under 3–8 inches of decaying pine needles, over sand, Golden Gate Park, San Francisco, Calif., Dec. 22, 1901."
No. 3, U. C. Col. W. A. Setchell and C. C. Dobie.
"Under *Pinus radiata*, U. C. Campus, Berkeley, Calif., Jan. 3, 1903."
No. 42, U. C. Col. N. L. Gardner.
"Under *Pinus radiata*, U. C. Campus, Berkeley, Calif., Jan. 3, 1903."
No. 43, U. C. Col. N. L. Gardner.
"Under *Pinus radiata*, U. C. Campus, Berkeley, Calif., Jan. 3, 1903."
No. 44, U. C. Col. N. L. Gardner.
"Under pines, Golden Gate Park, San Francisco, Calif., Dec. 24, 1902." No. 52, U. C. Col. N. L. Gardner.
"Under needles of *Pinus radiata* on top of ground, U. C. Campus, Berkeley, Calif., Feb. 25, 1903."
No. 80, U. C. Col. N. L. Gardner.
"Under *Pinus Pinaster*, Golden Gate Park, San Francisco, Calif., May 9, 1903." No. 142, U. C. Col. N. L. Gardner.
"Under *Pinus Pinaster*, Golden Gate Park, San Francisco, Calif., Nov. 6, 1903." No. 153, U. C. Col. N. L. Gardner.
"Under *Pinus Pinaster*, Golden Gate Park, San Francisco, Calif., Nov. 6, 1903." No. 154, U. C. Col. N. L. Gardner.
"In sand under *Pinus Pinaster*, Golden Gate Park, San Francisco, Calif., Oct. 15, 1904." No. 206, U. C. Col. N. L. Gardner.
"Under pines, Ingleside, San Francisco Co., Calif., Oct. 29, 1904."
No. 207, U. C. Col. N. L. Gardner.
"Ingleside, San Francisco Co., Calif., Feb. 13, 1915."
No. 414, U. C. Col. N. L. Gardner.

This seems to be the most common representative of the Tuberales about the San Francisco Bay region, and the comparative abundance in which material has been collected has made possible definite observations in regard to the constancy of its characters. The ascocarp is found to vary greatly in form, from almost even with a comparatively simple, closed, inner cavity somewhat similar to that of *Peziza* or *Hydnocystis*, to distinctly folded with the cavity apparently very complexly divided. The apparent partitions are discovered to be infoldings of the outer wall or projections from the inner wall, generally very irregularly lobed and often fitted closely together. They are rarely united at points, but usually are very easily separable; and the cavity is found to be composed of labyrinthine canals which, except rarely near the cortex, are all connected. All stages are found between the ascocarps with nearly simple cavities and those with the central hollow represented by labyrinthine canals. In some cases, one side of the ascocarp is simply infolded, the two walls of the fold not in contact; in others there may be several infoldings which become closer as the projections from the wall into the interior produce pressure from within. However compact the structure of the ascocarp seems to be, however, with the various projecting folds fitted closely together, a slit through one side of the cortex enables it to be opened, nearly all the folds separating easily from each other. In a very few cases, openings from the hymenium to the surface of the ascocarp were found. Whether these exist in the early stages or occur as a result of development has not yet been determined.

Other variable characters in this species are color, from very light to dark brown; surface, whether distinctly verrucose or smooth; size and shape of spores; and size and shape of paraphyses. The first three of these characters are found to vary in plants of the same collection, and the irregularity of spore shape and size is constant in all the plants studied. The variability of paraphyses, however, seems due to another cause. In the half-specimen labeled *Pseudhydnotrya Harknessii* in the Harkness collection, and which may be half of the type specimen of that species, though it is not so indicated, occasional clusters of paraphyses are discovered which have the three or four terminal cells enlarged (measuring 12–14μ) and colored. The paraphyses being so swollen are apparently fascicled between the asci, and some have elongated above the latter, forming coarse brown hairs. The hymenium and the surface of the ascocarp are apparently connected in places, though from the scanty material at hand it is impossible to determine definitely this point. Those which appear to be normal paraphyses are colorless, little longer than the asci and have only the terminal cell swollen, this measuring 2–6μ at the tip. In only two other cases have paraphyses been found which differ from the latter description. One is that of an ascocarp which has been attacked by insects, and the other of an ascocarp badly infested with *Nigrosphaeria Setchellii* (Hk.) Gardner (1905). In both these cases colored and much enlarged paraphyses occur in close proximity to the affected portion of the plant, while all others are small and colorless. It is possible in the specimen labeled *Pseudhydnotrya Harknessii* that both the external openings and the large paraphyses are the result of an abnormal condition in the ascocarp, although, as previously stated, it is impossible to determine this satisfactorily from the small amount of material available. The paraphyses of *Pseudhydnotrya Harknessii* were originally described as 7–14μ thick at the tip (Fischer, 1897*a*, p. 282), but since those measuring 2–6μ appear to be the normal ones, occuring in all the plants studied, while the larger ones are rare and found under apparently pathological conditions in parts of occasional plants, I have not mentioned the latter in the specific description.

It will be noticed that the spore measurements indicated in the preceding description of *Geopora Harknessii* do not agree with those given by Harkness for *Pseudhydnotrya Harknessii* (25–28 by 14–18μ), though they correspond closely to those cited for *P. carnea* (22 by 15). However, careful examination and measurements of the spores failed to reveal any differences in shape and size in the three species of *Pseudhydnotrya* cited by Harkness. Gardner in a study of *Nigrosphaeria Setchellii* (1905, p. 178) discovered in this species a similar discrepancy in spore sizes as he found them and as they were indicated by Harkness.

The specimens in the Harkness collection labeled *Pseudhydnotrya Harknessii*, *P. carnea*, and *P. nigra*, are found to differ in minor respects, but since such a wide variation exists in a single species, and since representatives of all the forms mentioned above have been discovered in one collection, it seems best to unite the three under one specific name.

Many of the ascocarps of *Geopora Harknessii* are found to be infested with *Nigrosphaeria Setchellii* (Hk.) Gardner (Gardner, 1905). The perithecia of the latter occur as minute black globose bodies closely dotting the surface of the interior folds of the ascocarps of the host. So far as known, the parasite does not occur upon any other host. The exact relation of the two plants has never been definitely determined, but the parasite apparently does little injury. Except for the few cases previously mentioned of stimulated growth of paraphyses about the perithecia of the parasite, no difference can be found in the tissues of infested and non-infested ascocarps of *Geopora Harknessii*.

Geopora Cooperi Hk. (?)

Plate 30, fig. 22

Bull. Cal. Acad. Sci., vol. 1, no. 3, p. 168, 1885.
Proc. Cal. Acad. Sci., 3d ser., vol. 1, no. 8 (1899), p. 270.

Ascocarp dark brown, 1.5 cm. in diam., somewhat lobed; surface verrucose, clothed with tangled, coarse, dark brown, septate hairs; cortex pseudoparenchymatous; outer cells large with slightly thickened walls; inner cells elongated toward center, changing abruptly to hyphal tissue; cavity of ascocarp dissected by large, loose, mostly easily separable folds and by projections from inner wall into connected labyrinthine canals; pseudoparenchymatous tissue and hairs of cortex running through center of folds; asci cylindrical to somewhat club-shaped, gradually tapering to long stipe; asci not constricted between spores, rounded at apex, 24–28 by 200–220μ; spores globose-ellipsoid, 17–21 by 20–24μ; paraphyses with terminal cell swollen, 5–8μ thick, about equal in length to asci.

"Under *Pinus radiata*, U. C. Campus, Berkeley, Calif., Dec. 12, 1904."
No. 231, U. C. Col. N. L. Gardner.

Material under this number was sent to Fischer who describes it in the *Botanische Zeitung*, 1908, pp. 157–158, and places it with *G. Cooperi*. The specimens he received were not quite mature, and he found the asci shorter (150–190μ) and the paraphyses narrower (5μ) than above described. The spores in the material studied differ in size from those of *G. Cooperi* as described by Harkness, his measurements being 20 by 28μ. However, this difference is no greater than that found in actual measurements of *Pseudhydnotrya carnea* and those cited by Harkness, and the discrepancy in both cases may simply be due to an error in recording. Such other characters as are mentioned in his description agree with those of our species, and it seems best to consider the two identical; though since the type of *G. Cooperi* cannot be found in the Harkness collection at Stanford University and apparently also does not exist in the California Academy of Sciences herbarium, there seems to be no means of definitely deciding this point.

Geopora magnifica, sp. nov.

Plate 30, fig. 35

Ascocarp reddish brown, subglobose, 4–10 cm. in diam., minutely verrucose, densely tomentose, particularly in wrinkles and depressions; comparatively even, with few low lobes and shallow depressions, but surface of cortex occasionally extending far into ascocarp (rarely entirely through) forming a large, clearly defined chamber generally unconnected with hymenium; walls of chamber much folded and covered with tomentose cortical tissue; gleba composed of complex closely folded tissue through center of which runs cortical tissue as two narrow layers of pseudoparenchyma bearing intertangled septate hairs, these two layers sometimes separating for short distances forming small chambers; very rarely openings from hymenium to chambers present; inner walls of folds covered with hymenium, with sometimes numerous short projections making surface appear thickly papillose; hymenium-lined cavity representing single hollow into which much convoluted walls extend, forming numerous labyrinthine canals, later occasionally becoming closed chambers through union of walls; larger folds easily separated, but smaller more or less compactly fitted together and sometimes united; asci cylindrical, not constricted between spores, 20 by 180μ; spores smooth, 1-seriate, ellipsoid, 14–18 by 24μ; paraphyses a little shorter than asci, slightly swollen, 6μ thick.

"Moraga Ridge, Alameda Co., Calif., Jan. 24, 1915."
No. 412, U. C. Col. *Type*. A. A. Baroteau.

The measurements of paraphyses and spores in this species do not agree with those of Harkness for any of his species of *Geopora*. Aside from the measurements, there is nothing to exclude this species from *G. Cooperi* as described by Harkness, but there are no characters there mentioned that are particularly characteristic of this species. It differs from *G. annulata* in size, comparatively even surface, very definite hollow opening to exterior, unconstricted asci, and broader paraphyses. It differs from the plants which I have referred with a question to *G. Cooperi*, in size, regularity of surface, central hollow, smaller asci, spores less globose-ellipsoid, and paraphyses with less conspicuously swollen tips.

This is the largest of the ascomycetous hypogaei reported from California, being approached in size only by *Piersonia bispora*, which sometimes reaches 8 cm. in diameter. The collector, A. A. Baroteau of Alameda, California, pronounces the plants edible and delicious.

Geopora annulata sp. nov.

Plate 28, fig. 6

Ascocarp reddish brown and black, 2–2.5 cm. in diam., much wrinkled, surface verrucose, densely tomentose particularly in wrinkles, tomentose cortex extending deeply into interior; outer cortical tissue pseudoparenchymatous with large cells; gleba of large, loose folds containing central layer of coarse hyphal tissue continuing from outer cortex, ends of folds free, enlarged; asci cylindrical, strongly constricted with annulate thickenings between spores, rounded at apex, 16–20 by 140–160μ; spores smooth, 1-seriate, globose-ellipsoid, 14–18 by 22–26μ; paraphyses not swollen at tip, 4–5μ thick.

Locality and date, No. 10*b*, Hk. Col. *Type*.
"In sandy ground, Golden Gate Park, San Francisco, Calif., April."
No. 102, Hk. Col.

This species is found in the Harkness collection under the numbers 10*b* and probably also under 102. The type of *G. Cooperi* is cited under the number 106 (Harkness, 1899, p. 270) and it is possible that 10*b* represents the type, the number 106 being a misprint. There is nothing in the description, which is very general, to exclude it except the spore and ascus measurements, which are larger than my findings (26 by 220μ for the asci, and 20 by 28μ for the spores). The measurements given by Harkness for No. 102 (12 by 80 for the asci and 12 by 18 for the spores) likewise debar this material from that species. There is no mention in the descriptions by Harkness of either *G. Cooperi* or *G. brunneola* (the type of the latter being cited under No. 102, Harkness, 1899, p. 270) of the peculiar characteristics of Nos. 10*b* and 102 as I found them; and therefore I feel justified in the supposition that in the various handling received by the Harkness material, labels have been shifted or specimens otherwise confused, and 102 probably does not represent the type of *G. brunneola*. The latter is known to us only in the brief description of it by Harkness (Proc. Calif. Acad. of Sci., 3d ser., vol. 1, no. 8, p. 270), and therefore its present status cannot be defined.

Under 10*b*, entire specimens are found; but under 102 the material is discovered to be in three or four pieces each measuring about 18 mm. in diameter. Whether these all belonged originally to a single specimen or to more cannot be decided with certainty, and therefore the size of the specimen cannot be definitely determined. The material under 102 also has been attacked by the larvae of some insect, and very little remains from which to determine the structure. However, as far as it can be made out, it resembles 10*b* very closely, the measurements are identical, and the peculiarly constricted internally annulate asci, found in no other species observed, are very conspicuous in both.

HYDNOTRYOPSIS, gen. nov.

Ascocarp subglobose, compact, more or less lobed and wrinkled, without external opening; cortex sometimes extending deeply into interior; gleba composed of minute, irregular folds, more or less joined, forming complex system of veins separating canals and chambers; hymenium of regular palisade of asci, lining walls of canals and chambers; asci cylindrical, 8-spored; spores ellipsoid, papillose.

This genus belongs, apparently, in phylogenetic line with the angiocarpous forms, *Geopora* and *Balsamia*, for very careful search has failed to reveal external openings from the hymenium. The exceedingly fine folding of the gleba and wrinkling of the surface made this point a difficult one to determine, but sufficient material was available to make sections of every portion of the ascocarp. The closest, most careful study possible was made of a large series of these, and in no case was there any indication of external communication from the hymenium.

A cross-section of the ascocarp suggests the structure of *Choiromyces*, but descriptions and illustrations show the hymenium of the latter to consist of long, irregularly bent bands, the halves running more or less parallel and the ends often joined, the space between the free tips of the two rows of palisade filled with hyphal tissue. The sterile veins separating the bands appear irregular in shape and generally much wider than the bands. In the Californian specimens, the whole ascocarp is made up internally of an elaborate system of very narrow folds densely covered with hymenium. The folds, which form the sterile veins, are remarkably regular in width. These are often fitted so closely together that the free ends of the two rows of asci are nearly or quite in contact, but in places the folds are less closely associated and leave comparatively wide, open chambers. Sometimes the folds are united at points, closing the chambers, but as a rule they are unconnected and can be separated for long distances through the ascocarp. The canals, when wide, are generally irregular in shape, due to inward projecting, short branches of the venae internae. The spores are smaller than for any described species of *Choiromyces*, and are globose-ellipsoid instead of globose, while the asci are cylindrical rather than club-shaped. The structure of the interior comes near that of *Geopora*, but the glabrous surface, sculptured spores, more minute and compact folding, uniform veins originating from the subcortical layer rather than from the infolding of the cortex as they are formed generally in *Geopora*, and the much more common presence of short chambers, seem sufficient basis for the separation of the two.

While *Hydnotryopsis* differs from *Hydnotrya* in the absence of venae externae and the presence of a conspicuous system of venae internae, the general arrangement of empty canals and chambers lined with hymenium in regular palisade, the walls of the canals apparently formed by more rapid internal than external growth of the ascocarp, is like that of *Hydnotrya;* and the two have apparently reached the same stage in parallel lines of development. Though little preserved material exists from which to describe the genus, it seems sufficiently distinct from all other genera of the Tuberales to justify its position. It is to be hoped, however, that further collections and data may be obtained.

Hydnotryopsis Setchellii gen. et sp. nov.

Plate 30, figs. 21, 36

Stephensia bombycina Hk. non Tul., Proc. Cal. Acad. Sci., 3d ser., vol. 1, no. 8 (1899), p. 268, pl. XLIV, figs. 18*a*–18*c*.

Ascocarp clay-yellow, subglobose, compact, without mycelial tuft at base, 1.5 cm. in diam., lobed, lobes minutely and deeply wrinkled, cortex occasionally extending so deeply into interior as almost to reach opposite side; surface minutely scabrous; gleba composed of very small, irregular folds, sometimes joined, forming complex system of narrow branching veins separating long, labyrinthine, more or less connected canals and chambers not opening externally, lined with hymenium formed of regular palisade of asci; outer cortical tissue pseudoparenchymatous, becoming hyphal within; veins hyphal, originating from inner cortical tissue; asci cylindrical, 8-spored, 12 by 40μ; globose-ellipsoid, regular in size, 10–11 by 12–13μ, very minutely papillose.

"Found in forests, March. No locality." No. 173, Hk. Col. *Type.*

This species is found in the Harkness collection under the number referred by Harkness to *Stephensia bombycina* (1899, p. 268). It will be seen from the preceding description, however, that it differs from *Stephensia*, as described, in the absence of venae externae; of regular, radial arrangement of the venae internae; of a basal cavity: and of smooth, globose spores.

Delastria Tul.

Ascocarp irregularly subglobose, sometimes lobed, scabrous or finely floccose; cortex distinct, extending into gleba as venae internae; latter anastomosing in reticulate form, separating gleba into rounded, hymenium-bearing areas; venae externae wanting; asci irregularly arranged in hymenial areas, often deformed, club-shaped or long ellipsoid, sometimes curved, 2- to 4-spored; spores globose, alveolate, with angles extended to form spines.

This genus differs from *Tuber* in its lack of venae externae and in the reticulate arrangement of the venae internae, forming well-marked rounded areas of hymenium. The first suggestion of such arrangement is found in *Heterogenea* of the genus *Genea*. Here the hymenium, which in *Hydnocystis* and *Eugenea* consists of an even uninterrupted layer of asci and paraphyses, is separated by strands of sterile tissue into distinct "pockets," in which, because of the rounded angles, the originally regularly placed asci and paraphyses become irregular and crowded. In *Genea cerebriformis* extreme lobing of the ascocarp causes more or less doubling of the hymenium, further complicating the arrangement, the highest development of which is perhaps found in *Delastria*. The spores of *Delastria*, with the sharply projecting angles of the alveoli, resemble somewhat those of *Hydnobolites*, but the two genera are easily separated by the absence and presence, respectively, of venae externae, and by the general characters of the ascocarp.

Delastria rosea Tul.

Tulasne, Ann. Sc. Nat., 2nd ser., vol. 19 (1843), p. 379.

Ascocarp 1–1.5 cm. in diam., subglobose, somewhat convolute, surface minutely scabrous, caused by irregularly projecting cortical cells; veins of gleba indistinct like water marks, dividing it into roundish areas; cortex hyphal to pseudoparenchymatous, compact, 80μ thick; sterile veins of irregular hyphae joined to form pseudoparenchymatous structure; cells sometimes reaching width of 20μ; asci semi-globose, 36–52 by 48–60μ, or very much elongated, reaching length of 120μ, width 40μ; spores globose, 22–30μ, alveolate and spiny, 2–7 alveoli across surface, spines somewhat blunt, thick, 5μ in height.

"Under shrubs among vegetable humus, Auburn, Placer Co., Calif., May." No. 182, Hk. Col.

While for this genus only one species is reported, a great amount of variation apparently exists. Fischer's illustration (1897*a*, p. 317) represents a plant whose veins are principally hyphal, whose spores have generally 6–7 alveoli across the diameter, the angles projecting as sharp-pointed needles, and whose cortex is more or less pseudoparenchymatous of somewhat elongated narrow cells. The spore diameter cited is 30–40μ. Tulasne's illustration (1851, pl. XVI, fig. 1) indicates, on the other hand, a much looser, irregular structure through the venae internae, which is also seen in an Italian specimen, in the University of California herbarium, from Mattirolo. The spores of the latter agree in size with the measurements given by Tulasne and Fischer (30–40μ). Our specimens have a compact structure through the cortex and outer veins similar to that of Fischer's figure, though the hyphae in ours are entirely unconnected through the cortex, becoming more or less united in the venae internae, in places even pseudoparenchymatous with large cells. The spores in ours, however, are smaller than of any of the above, measuring 22–30μ, and the number of alveoli across the diameter is more often 3–5 than more, though occasionally 7 are found. The spines are distinct (they are not figured by Tulasne) but are shorter, fewer, and more blunt than in the Mattirolo specimen and than illustrated by Fischer.

There is no indication now of rose-color in the cut surface of the Californian material, but at the time of collection, this, according to Harkness, was very conspicuous.

The differences between these plants and those of Europe do not seem sufficient for specific separation, but the Californian specimens may at least be considered a geographical variety until the extreme variation in the whole genus is worked out more thoroughly.

Hydnobolites Tul.

Ascocarp subglobose, generally lobed or folded; cortex pseudoparenchymatous, changing to hyphal tissue toward hymenium, or whole structure of ascocarp more or less pseudoparenchymatous; canals of ascocarp labyrinthine, penetrating deeply into gleba, lined with pseudoparenchyma; opening generally between folds of ascocarp surface; venae internae wanting; asci somewhat irregularly arranged between canals, ellipsoid to pyriform, 8-spored; spores globose, alveolate, angles of alveoli projecting outward as spines; spores irregularly arranged in ascus.

This genus, which Fischer (1897*a*) formerly placed under the family Terfeziaceae of the order Plectascales, he has since removed to the Tuberales and placed in phylogenetic line with *Tuber*. The spores of the species in this genus resemble those of *Delastria rosea* in having the angles of the alveoli projecting in the form of needles, but the asci are 8-spored rather than 4-spored. The pseudoparenchymatous structure of the canal walls as well as, occasionally, of the whole ascocarp tissue, is characteristic, but is approached in several Californian species of *Tuber* in which the venae internae become more or less pseudoparenchymatous.

Hydnobolites californicus Fischer

Plate 30, fig. 26

Ed. Fischer, in Fedde, Repertorium 7 (1909), p. 194.

Ascocarp of gristly consistency, at first dirty-white, becoming brownish at maturity; 0.5–3 cm. in diam.; slightly to very irregularly folded, canals opening to surface in folds; surface bearing occasional short septate hairs of 2 or 3 cells; pseudoparenchymatous cortex of ascocarp continuing as border of canals, 8μ thick; cells irregular in size, inner generally smaller than outer, changing somewhat gradually to hyphal tissue of interior; hyphae of latter coarse, 4–10μ thick; canals narrow, mostly long, more or less labyrinthine; asci scattered irregularly through hyphal tissue, irregularly globose-ellipsoid; spores yellowish at maturity, loosely and irregularly arranged in ascus, globose, 14–18μ, very coarsely alveolate, angles of alveoli projecting as thick, blunt spines 4μ long; 3–4 alveoli across diameter of spore.

"Under oak, Piedmont Park, Oakland, Calif., Apr. 4, 1903."
No. 106, U. C. Col. *Type*. N. L. Gardner.
"Mt. View Cemetery, Oakland, Calif., Jan., 1903."
No. 110, U. C. Col. N. L. Gardner.
"U. C. Campus, Berkeley, Calif., Feb., 1905; Leona Heights, north of Oakland, Calif., Feb., 1905; Berkeley Hills, Berkeley, Calif., Feb., 1905; Wild Cat Canyon, Berkeley, Calif., April 1, 1905."
No. 278, U. C. Col. N. L. Gardner.

Material under the three numbers mentioned above was examined by Fischer who pronounced Nos. 106 and 278 identical and evidently a new species, since they differed in larger ascocarp, smaller spores, and absence of mycelial tuft at base, from the three previously described species. No. 110, through its somewhat larger spores, approached *Hydnobolites cerebriformis* Tul. in his opinion, perhaps being identical with it (letters of October 11, 1905, and March 27, 1909). He suggested the name *H. californicus* for the first two, and this was later published by him in Fedde, *Repertorium* VII (1909), p. 194.

Study of various specimens of No. 110, and careful comparison with material under the Nos. 106 and 278, reveal the fact that while the spores of the former are at times larger than those of the two latter, this difference is not constant, and otherwise the plants of the three collections seem identical.

Aside from the characters mentioned by Fischer, our plants differ from *H. cerebriformis*, as it is described, in shape of asci and thickness of pseudoparenchymatous cortex, the former of this species being given as less globose-ellipsoid, and the latter measuring 100–120μ. *H. californicus* differs from descriptions of *H. Tulasnei* Hesse in color, narrower hyphae of internal tissue, shape and size of asci, and size of ascocarp and spore, *H. Tulasnei* being described in these points as follows: Surface of ascocarp rose-colored, changing to flesh color at maturity; hyphae 10–14μ; asci pear-shaped to egg-shaped, 70–100μ; ascocarp 1 cm. in diam.; spores 17–21μ. Our species is debarred from *H. fallax* Hesse, as described, by the absence of pseudoparenchymatous tissue in the interior of the ascocarp.

VIII. KEY TO GENERA

A. Ascocarp with distinct external openings from hymenium.
a. Cavity simple, empty.
Spores generally smooth .... *Hydnocystis.*
aa. Cavity dissected into labyrinthine canals.
1. Canals connected, filled with hyphae, converging at apex or base.
x. Canals converging at apex, spores smooth.................. *Pseudobalsamia.*
xx. Canals converging at apex, spores sculptured.............. *Pachyphloeus.*
2. Canals unconnected, empty or filled with hyphae.
x. Canals empty.
z. Paraphyses forming secondary cortex beyond asci, spores papillose or verrucose .... *Genea.*
zz. Paraphyses not forming secondary cortex beyond asci, spores papillose or verrucose .... *Hydnotrya.*
xx. Canals filled with hyphae.
z. Hymenial areas irregularly arranged between canals .... *Eutuber.* (*Tuber*).
zz. Hymenial areas formed by enlarged ends of canals ....*Piersonia.*

AA. Ascocarp without distinct external openings from hymenium.
a. Asci and paraphyses arranged in palisade.
1. Cavity simple, empty .... *Hydnocystis.*
2. Cavity dissected into empty chambers or canals.
x. Canals or chambers mostly connected, ascocarp tomentose, spores smooth .... *Geopora.*
xx. Unconnected chambers redissected into connected canals, ascocarp smooth, spores sculptured .... *Hydnotryopsis.*
aa. Fruiting areas irregular; cavity wanting.
Cavity wanting, ascocarp divided into irregular fruiting areas.
x. Ascocarp comparatively even; asci 4-spored .... *Delastria.*
xx. Ascocarp conspicuously lobed; asci 8-spored................ *Hydnobolites.*

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X. DIAGNOSES OF NEW GENUS AND NEW SPECIES

Hydnocystis californica

Ascomatibus 1 cm. in diam., subglobosis, dilute vel atro fuscis, perfecte clausis, mycelio brunneo septato ramoso cinctis, ad superficiem projectis pyramidatis basi 1.5 mm. diam. instructis; gleba alba; texto superficiali intus per gibbos pseudoparenchymatico, cellularum externarum parietibus lente incrassatis; cellulis externis passim in pilis septatis productis; texto pseudoparenchymatico intus in hyphas transformato et hyphis prorsus ad hymenium eximie angustatis; ascis cylindricis, inter sporas lente constrictis, ad stipitem plus minusve distinctam attenuatis, 16–24 × 240μ, 8-sporis; sporis globoso ellipsoideis, levibus, 18–20 × 22–24μ, 1-seriatis; paraphysibus gracilibus 4–6μ crassis, in longitudine ascos aequantibus aut aliquando ascos leviter irregulariterque superantibus, septatis, apice exigue tumefactis; odorem sacchari usti ostendentibus.

Genea Harknessii

Ascomatibus atro fuscis usque ad atris, 2 cm. diam. compressis, lente lobatis, superficialiter projectis pyramidalibus robustisque basi usque ad 1 mm. altis indutis; caverna ascomatis projectis irregularibus e pariete interne multo dissecta; textis corticis externi pseudoparenchymaticis prorsus ad hymenium hyphas ostendentibus, cellulis externis magnis, obscuris et parietibus crassis; hymenio frequenter duplici, e conjunctione projectorum internorum parietum, a fasciis textorum sterilium cortices conjugentium; ascis cylindricis aut lente clavatis, non inter sporas constrictis, stricte stipitatis, 32 × 225μ; sporis 1- aut imperfecte 2-seriatis, 22–24 × 28μ, superficialiter papillatis; papillis semi-globosis aut exigue truncatoconicis usque ad 4μ latis altisque, vulgo in crassitudine altitudine, et distributione usque in spora eadem variabilibus, paraphysibus 2–8μ diam., sub cortice secundario ramosis.

Genea Gardnerii

Ascomatibus nigris, 1–1.5 cm. diam., multo rugosis plicatisque, superficialiter minute verrucosis; caverna ascomatis valde irregulari ob implicationes sed non saepe ob projecturas parietum; textis corticis externi pseudoparenchymaticis intus in hyphas horizontales anastomosantesque transformatis; hymenio textis sterilibus interrupto; ascis cylindricis aut plus minusve clavatis, inter sporas non constrictis, ad stipitem saepe elongatam attenuatis, 34–42 × 280–425μ, sporis 1-, aut rare imperfecte 2-seriatis, aliquando tantum 3–4 maturantibus, globoso-ellipsoideis, 30–34 × 32–36μ, superficialiter papillis latis (8μ), humilibus et semiglobosis dense vestitis papillis ipsis plus minusve minute papillosis; paraphysibus facie irregularibus cum cellulis nonnullis elongatocylindricis aliis brevibus tumidisque, 3–9μ diam., ramosis.

Genea intermedia nom. nov.

Ascomatibus rubro-fuscis, lente lobatis, ad superficiem papillis rotundatis usque ad 0.3 mm. diam. indutis; caverna fere simplice, pariete interna lobos parvos externos parallelo sequente; corticibus primis et secundis prorsus pseudoparenchymaticis; hymenio raro fasciculis texti sterilis interrupto; ascis cylindricis aliquando inter sporas constrictis, $44 \times 300\mu$; sporis 1-seriatis, globosis, 36μ diam., juvenilibus levibus hyalinisque, maturis asperis papillis semiglobosis, e minutis ad 5μ altis usque in spora singula variantibus, saepe irregulariter anastomosantibus; paraphysibus 4μ crassis inter ascos stricte in fasciculis aggregatis.

Hydnotrya ellipsospora

Ascomatibus purpurascente-brunneis, 1.5 cm. in diam., subglobosis, plicis laxis compositis, superficie minute pilosis; glebae cavernis connectis, latis angustisve, ascis paraphysibusque valliformibus indutis; paraphysibus in hyphis apice paululum tumidis ad foramina distincte transformatis; ascis cylindricis inter sporas non constrictis, $10 \times 260\mu$; sporis 1-seriatis, ellipsoideis $10 \times 14\mu$, minute papillosis; paraphysibus ultra ascos non prominentibus, $2–5\mu$ latis.

Tuber (Eutuber) levissimum

Ascomatibus argillaceo-brunneis, 2 cm. diam., regularibus, superficie levibus; gleba dilute brunnea, venis magnis colore inconspicuis; textis corticis vix pseudoparenchymaticis, hyphis parallelis plus minusve coalescentibus ad hymenium laxe connectis compositis; venis internis compactis, structura ad textas corticis approximatis; ascis subglobosis vel globosis, $50–80 \times 70–100\mu$, 1–4 sporis; sporis dilute brunneis, globoso-ellipsoideis, $32–40 \times 36–52\mu$, alveolatis; alveolis magnitudine et numero in sporis variabilibus, $3–10 \times 4–13$ trans diam., sculptura 4μ crassa.

Tuber (Eutuber) separans

Ascomatibus plumbeo-purpureis, 1×1.2 cm., semiglobosis, convolutis, superficialiter minute verrucosis, venis inconspicuis; textis corticis externi pseudoparenchymaticis interne compacte hyphalibus gradatim transformantibus; venis internis compactis, hyphis parallelis, saepe anastomosantibus, aliquando pseudoparenchymaticis; ascis breviter stipitatis, semiglobosis, $56–68 \times 60–92\mu$, 1–3- (rare 4-) sporis; sporis alveolatis, alveolis $5–10 \times 7–11$ trans diam.

Tuber (Eutuber) irradians

Ascomatibus fuscis, 1.5 cm. diam., depresso-globosis, paululum lobatis, superficialiter minute verrucosis areolis sparsis crassiore verrucosis; gleba primo alba deinde brunnea; venis paucis parce ramosis, albis; textis corticis pseudoparenchymaticis cellulis ordinibus plus minusve distincte radiantibus ordinatis; textis subcorticis laxe hyphalibus; venis internis hyphis parallelis, separatis laxeque instructis;

ascis aliquando longe stipitatis pyriformibus, elongatis aut subglobosis, 44–64 × 76–92μ, 1–3- (vulgo 1–2-) sporis; sporis ellipsoideis, 36–48 × 40–56μ, alveolatis, alveolis 3–8 × 3–9 (vulgo 7 × 8) trans diam.; sculptura sporarum 4–6μ alta.

Tuber (Eutuber) Gardnerii

Ascomatibus fuscis 1.5 cm. diam., subglobosis leviter convolutis, superficialiter verrucosis; gleba primo alba deinde pallide fusca; venis latis conspicuis, albis; textis corticis crasse pseudoparenchymaticis; textis subcorticis hyphis separatis parallelisque; venis internis hyphis tenuibus, separatis et parallelis; ascis non stipitatis, semiglobosis, raro elongatis, 56–68 × 80–88μ, 1–5-sporis; sporis pallide brunneis, globosis aut elongato-ellipsoideis, 24–30 × 28–48μ, alveolatis, alveolis 3–11 × 5–14 trans diam.; sculptura sporarum 4–6μ alta.

Tuber (Eutuber) argentea

Ascomatibus corneis argenteo-albis areis sparsis colore obscurioribus, 3 mm.–2.5 cm. diam., depressis, irregulariter convolutis et saepe minute rugosis, superficialiter planis aut per trajectus rugarum in areas minutas dissectis, cum pilis brevibus septatis et obtusis; gleba subfusca venis albis ramosisque induta; textis corticis pseudoparenchymaticis aut crasse et laxe hyphalibus; textis subcorticis hyphis laxis et irregulariter positis compositis; venis internis in structura strato subcorticis similibus; venis externis internisque ad junctionem cum pericarpio valde dilatatis; ascis breviter stipitatis estipitatisve, semiglobosis, 64–78 × 76–92μ, 1–4- (vulgo 1–2-) sporis; sporis obscuro-fuscis, ellipsoideis, alveolatis, alveolis 8–9 × 9–10 trans diam.; sculptura sporarum 4μ alta.

Tuber (Oogaster) lignarium

Ascomatibus fuscis, 1.5 cm. diam., subglobosis, lente sulcatis, superficialiter levibus; gleba alba; venis magnitudine variabilibus, distinctis; textis corticis pseudoparenchymaticis cellulis parvis, irregularibus parietibus crassis compositis; textis subcorticis hyphis compactis, liberis, parallelisque compositis; structura venarum internarum texto subcorticis simili; textis sterilibus hymenii passim pseudoparenchymaticis; hyphis venarum externarum saepe diffringentibus fissuras longas, in interiorem ascomatum efficientibus; ascis longe stipitatis semiglobosis ad fere cylindricis, 40–52 × 60–72μ, 2–3-, aut 4-sporis; sporis dilute fuscis, globoso-ellipsoideis ad globosis, 20–32μ, spinosis, spinis tenuibus, apice recurvatis.

Piersonia bispora

Ascomatibus ad 8 cm. (vulgo 6 cm.) diam., subglobosis, ferruginosis interdum maculas albas ostendentibus, ad superficiem glabris, aliquando parce ciliatis; gleba alba areis coloratis destituta; cortice crasse irregulariterque hyphali, hyphis irregulariter densis saepe ut pilis ultra superficiem prominentibus; hyphis texti subcorticalis gracilibus, compactis, plus minusve parallelis; venis externis longis, labyrinthiformibus, angustis; venis internis plerumque quam areis hymenialibus latioribus, plerumque hyphalibus, raro pseudoparenchymatice transformatis; ascis clavatis, longe stipitatis, 60–79 × 76–92μ, 1–2-(raro 3–4-) sporis, a paraphysibus fasciculatis et apice tumidis separatis; sporis globosis, luteis aut brunneis dense alveolatis, alveolorum parietibus sicut latis aut dimidiis quam cavernis alveolorum, alveolis 10–11 trans diam., sporis 28–30μ; paraphysibus apice 6–8μ diam.; odore plantarum vivarum carnis dessicatae nucis palmae indicae, sed plantarum siccarum casei cremoris aetate provecti simili.

Geopora magnifica

Ascomatibus rubro-fuscis, fere globosis, 4–10 cm. diam., minute verrucosis, dense tomentosis comparative planis lobis paucibus humilibusque sed cortici aliquando in interiore longe (rarissime totaliter) penetrante cavernam magnam plerumque hymenio non continuam formante; parietibus cavernae valde plicatis et textis corticalibus tomentosis indutis; gleba compactis plicis aliquando anastomosantibus composita, plicis textis corticalibus tomentosis completis; ascis cylindricis, inter sporas non constrictis, 20 × 180μ; sporis levibus, 1-seriatis, ellipsoideis, 14–18 × 24μ; paraphysibus quam ascis paululum brevioribus, lente tumidis, 6μ crassis.

Geopora annulata

Ascomatibus rubro-fuscis et nigris, subglobosis aut paululum elongatis, 2–2.5 cm. longis, valde rugosis, superficialiter verrucosis, dense tomentosis, textis corticis externi crasse pseudoparenchymaticis; gleba plicis magnis laxis tenuibusque composita, plerumque textis hyphalibus e cortice descendentibus impleta; finibus plicarum liberis, dilatatis; ascis cylindricis, inter sporas valde constrictis et parietibus valde annulatimque incrassatis, 16–20 × 140–160μ; sporis levibus, 1-seriatis, globoso-ellipsoideis, 14–18 × 22–26μ; paraphysibus apice non tumidis 4–6μ crassis.

HYDNOTRYOPSIS

Ascomata subglobosa compacta, lobata, cortice nonnumquam in glebam profunde penetrante; gleba plicis minutis compactis, et irregularibus, nonnumquam anastomosantibus et fossas longas labyrinthiformesque et cubicula clausa separantibus composita, externe ascis et paraphysibus valliformibus vestita; asci cylindrici, 8-spori; spora globoso-ellipsoidea, minute papillosa.

Hydnotryopsis Setchellii

Ascomatibus argillaceo-luteis, compactis, puncto adjuncto mycelialo destitutis, 1.5 cm. diam., lobatis, minute et profunde rugosis, cortice passim in interiorem profunde penetrante, superficie minute scabrosis; gleba plicis minutis irregularibusque nonnumquam anastomosantibus, venas longas angustas et ramosas fossas labyrinthiformes et cubicula hymenio ascis paraphysibusque valliformibus vestita formantibus composita; textis corticis pseudoparenchymaticis; textis subcorticis venisque hyphalibus; ascis cylindricis, 8-sporis, 12 × 40μ; sporis globoso-ellipsoideis, in magnitudine uniformibus, 10–11 × 12–13μ, minute papillosis.

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PLATE 26

Diagram of phylogenetic relationships in the Tuberales.

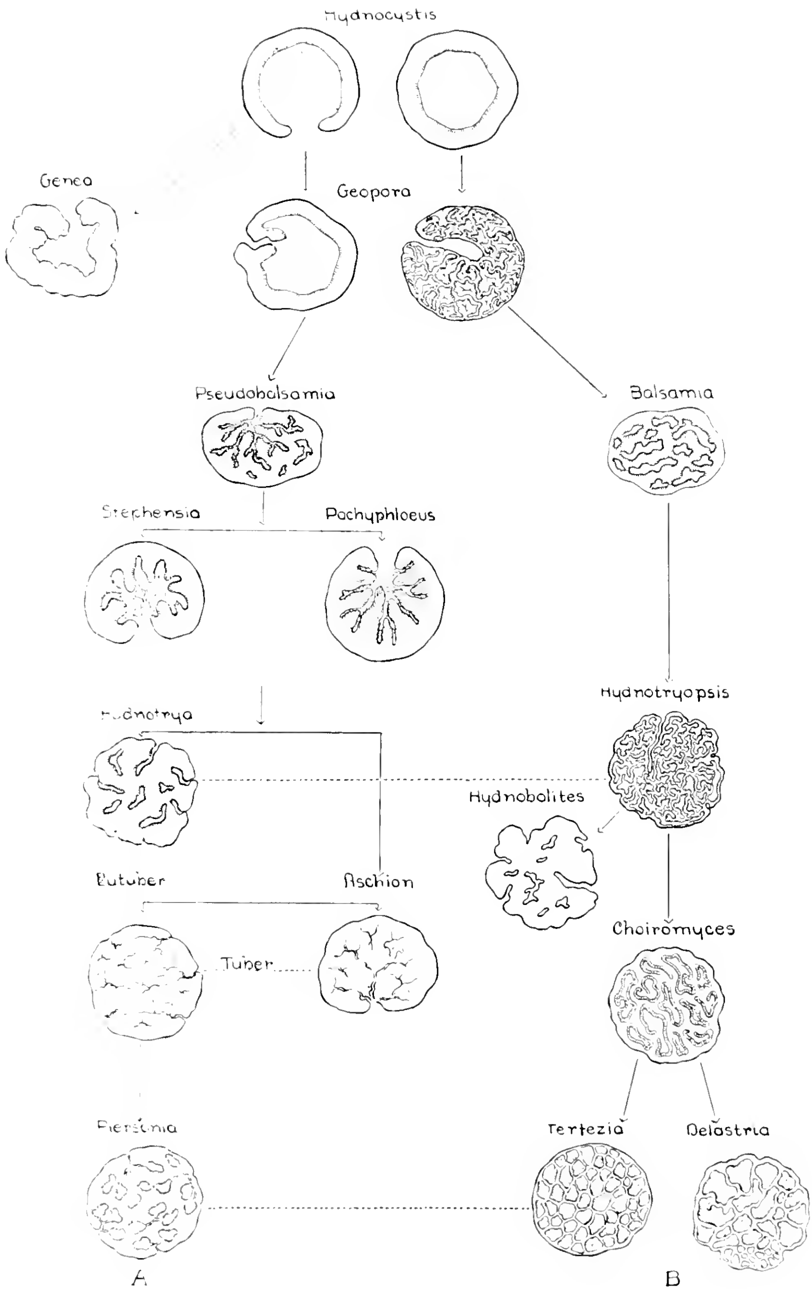
Hydnocystis
Genea
Geopora
Pseudobalsamia
Balsamia
Stephensia
Pachyphloeus
Hydnotryopsis
Hydnotrya
Hydnobolites
Eutuber
Aschion
Tuber
Choiromyces
Piersonia
Terfezia
Delastria
A
B

PLATE 27

Tuber candidum Hk.

Portion of ascocarp in section. × 500 diam.

a. Cortex.

b. Vena interna.

c. Vena externa.

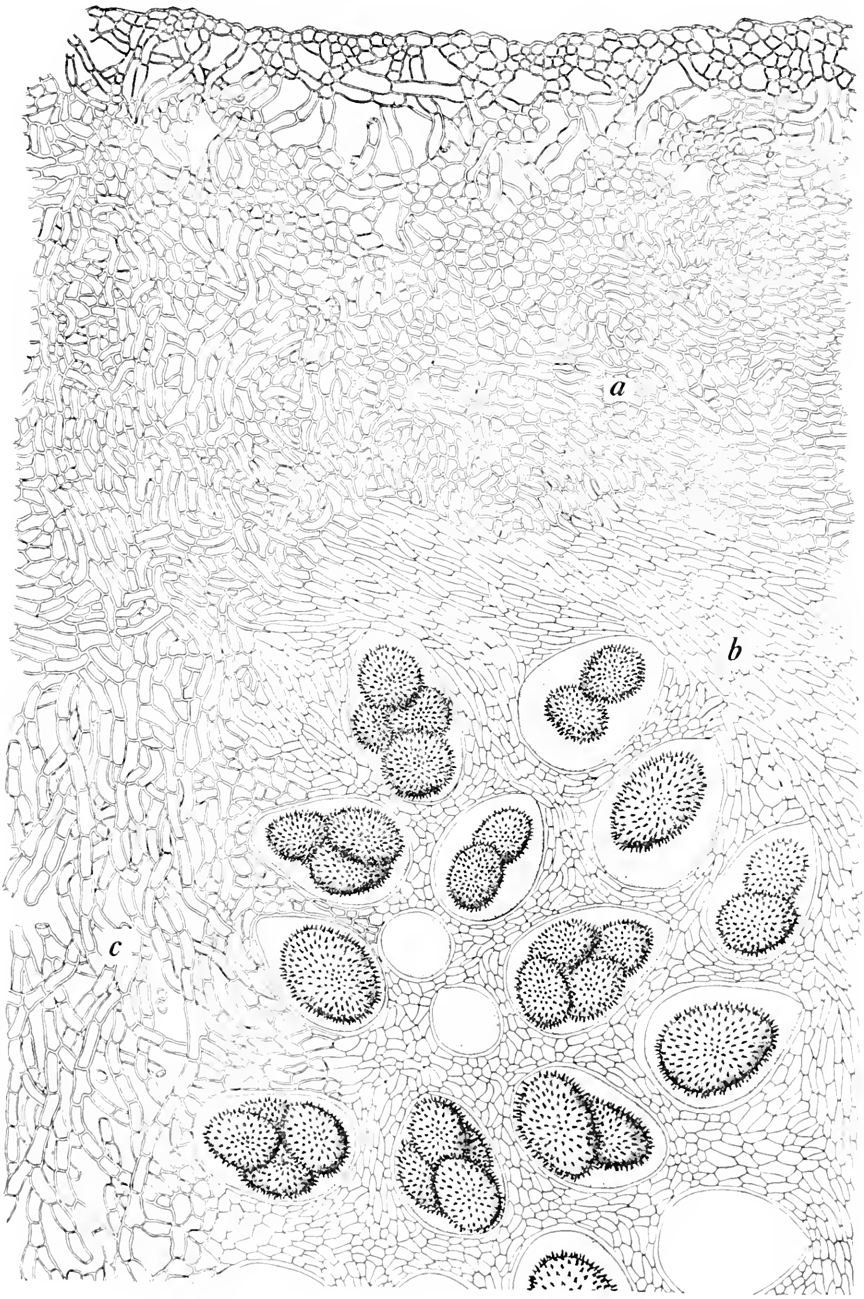
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PLATE 28

Fig. 1. Ascus and spores of *Piersonia alveolata*. × 500 diam.

Fig. 2. Ascus and spores of *Piersonia alveolata* (*Piersonia scabrosa* Hk.). × 500 diam.

Fig. 3. Ascus and spores of *Piersonia alveolata* (*Pachyphloeus ligericus* Hk.). × 500 diam.

Fig. 4. Spores of *Piersonia alveolata* (*Hydnobolites excavatum* Hk.). × 500 diam.

Fig. 5. Ascus and spores of *Piersonia bispora* sp. nov. × 500 diam.

Fig. 6. Ascus and spore of *Geopora annulata* sp. nov. × 350 diam.

Fig. 7. Ascus and spore of *Genea Gardnerii* sp. nov. × 400 diam.

Fig. 8. Paraphyses of *Genea Gardnerii*. × 400 diam.

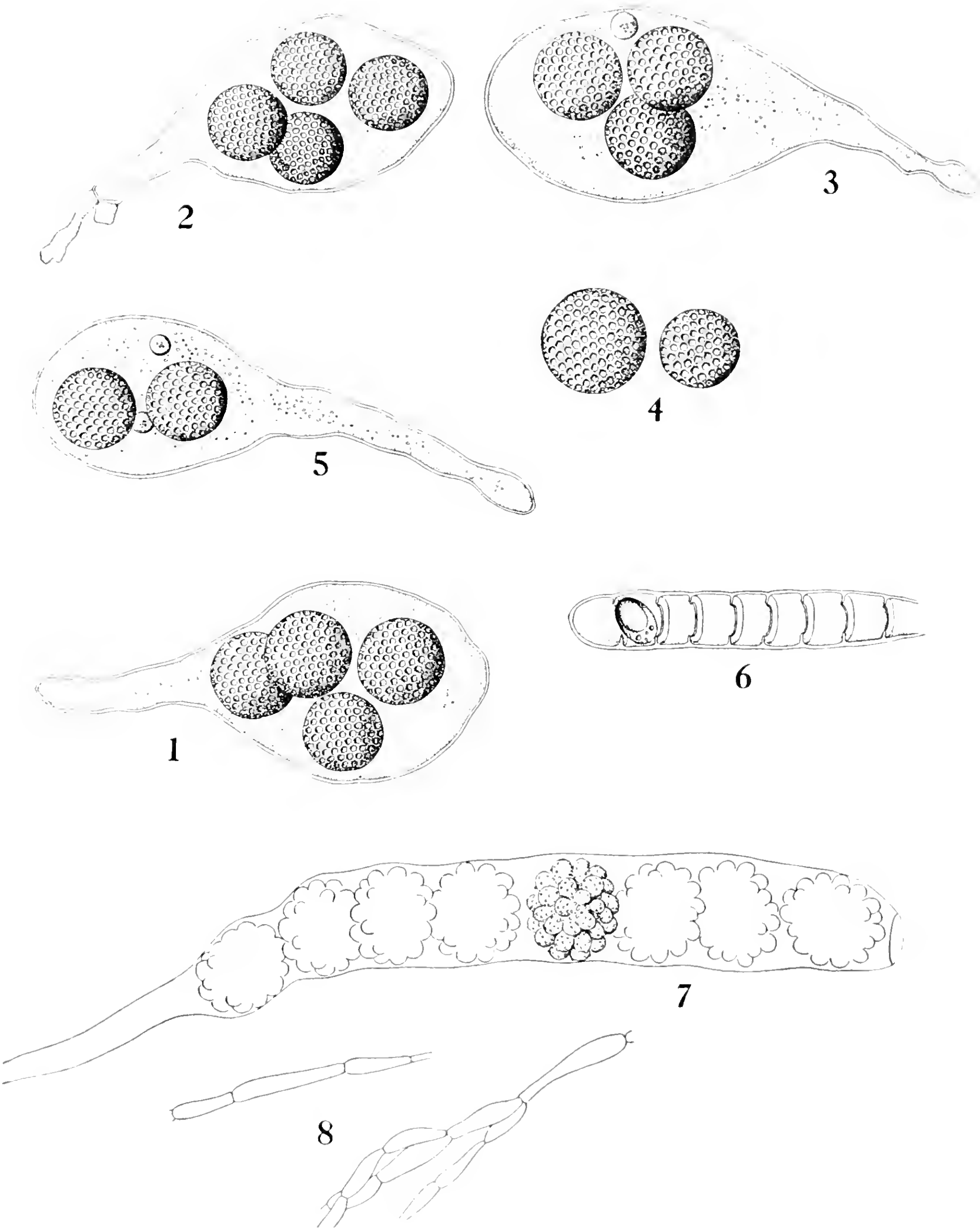

PLATE 29

Fig. 9. Portion of ascocarp of *Hydnocystis californica* sp. nov.

Fig. 10. Ascus and spore of *Genea Harknessii* sp nov. × 400 diam.

Fig. 11. Ascus of *Genea Harknessii.* × 400 diam.

Fig. 12. Spore of *Genea Harknessii.* × 400 diam.

Fig. 13. Paraphyses of *Genea Harknessii.* × 400 diam.

Fig. 14. Spore of *Genea intermedia* nom. nov. × 400 diam.

Fig. 15. Spore of *Tuber gibbosum.* × 350 diam.

Fig. 16. Spore of *Tuber irradians* sp. nov. × 400 diam.

Fig. 17. Spore of *Tuber irradians.* × 400 diam.

Fig. 18. Spore of *Tuber citrinum.* × 500 diam.

Fig. 19. Spore of *Tuber separans* sp. nov. × 400 diam.

Fig. 20. Spore of *Tuber californicum.* × 500 diam.

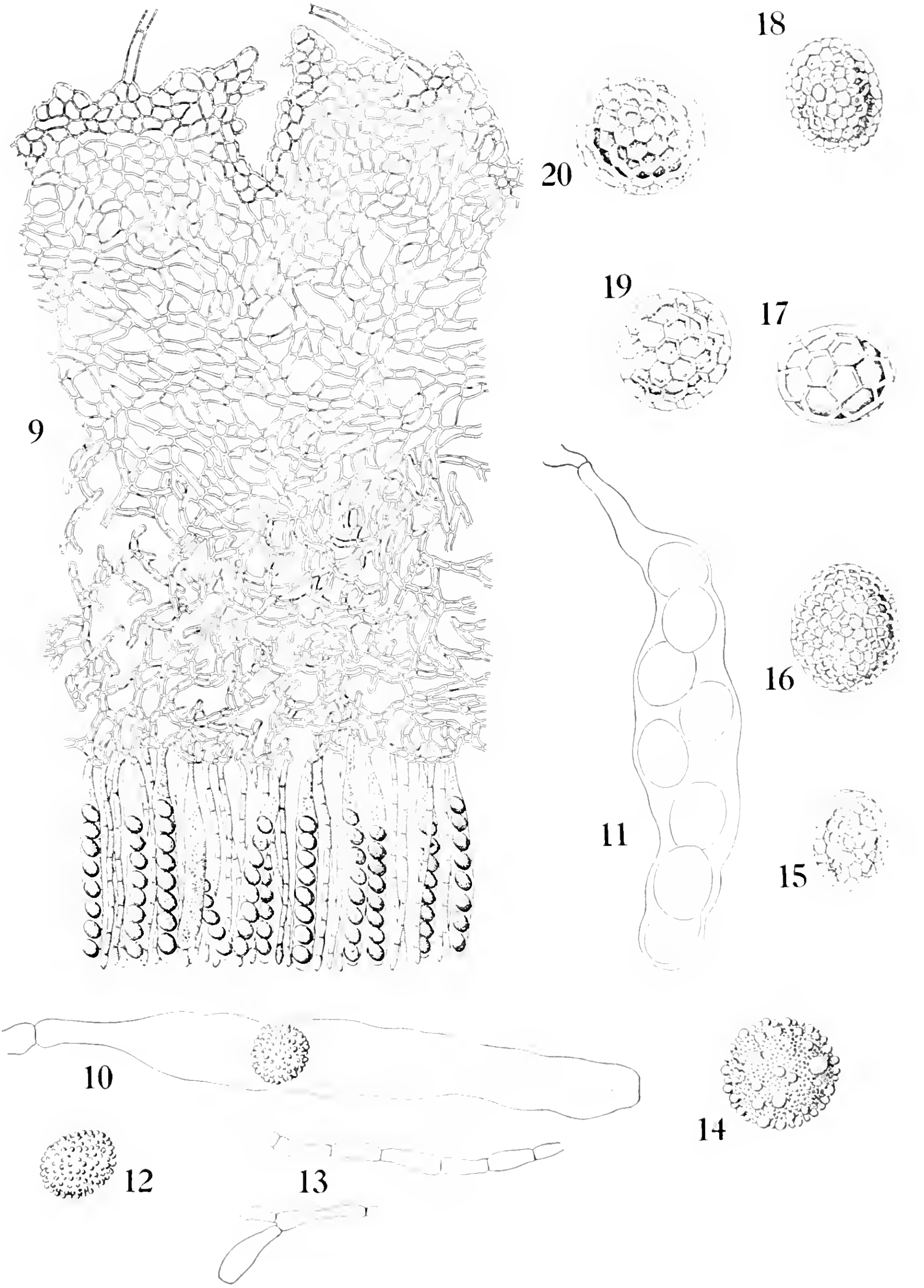
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PLATE 30

Fig. 21. Portion of ascocarp of *Hydnotryopsis Setchellii* gen. et sp. nov. × 250 diam.

Fig. 22. Spore of *Geopora Cooperi*. × 500 diam.

Fig. 23. Spore of *Tuber monticolum*. × 350 diam.

Fig. 24. Spore of *Pachyphloeus citrinus*. × 500 diam.

Fig. 25. Spore of *Tuber lignarium* comb. nov. × 500 diam.

Fig. 26. Spore of *Hydnobolites californicus*. × 500 diam.

Fig. 27. Spore of *Hydnotrya cerebriformis*. × 500 diam.

Fig. 28. Spore of *Tuber argenteum* sp. nov. × 500 diam.

Fig. 29. Spore of *Tuber australe*. × 500 diam.

Fig. 30. Spore of *Tuber Gardneri* sp. nov. × 500 diam.

Fig. 31. Spore of *Tuber levissimum* sp. nov. × 500 diam.

Fig. 32. Spore and paraphysis of *Genea compacta*. × 500 diam.

Fig. 33. Ascus and spores of *Pseudobalsamia magnata* var. nigrens comb. nov. × 350 diam.

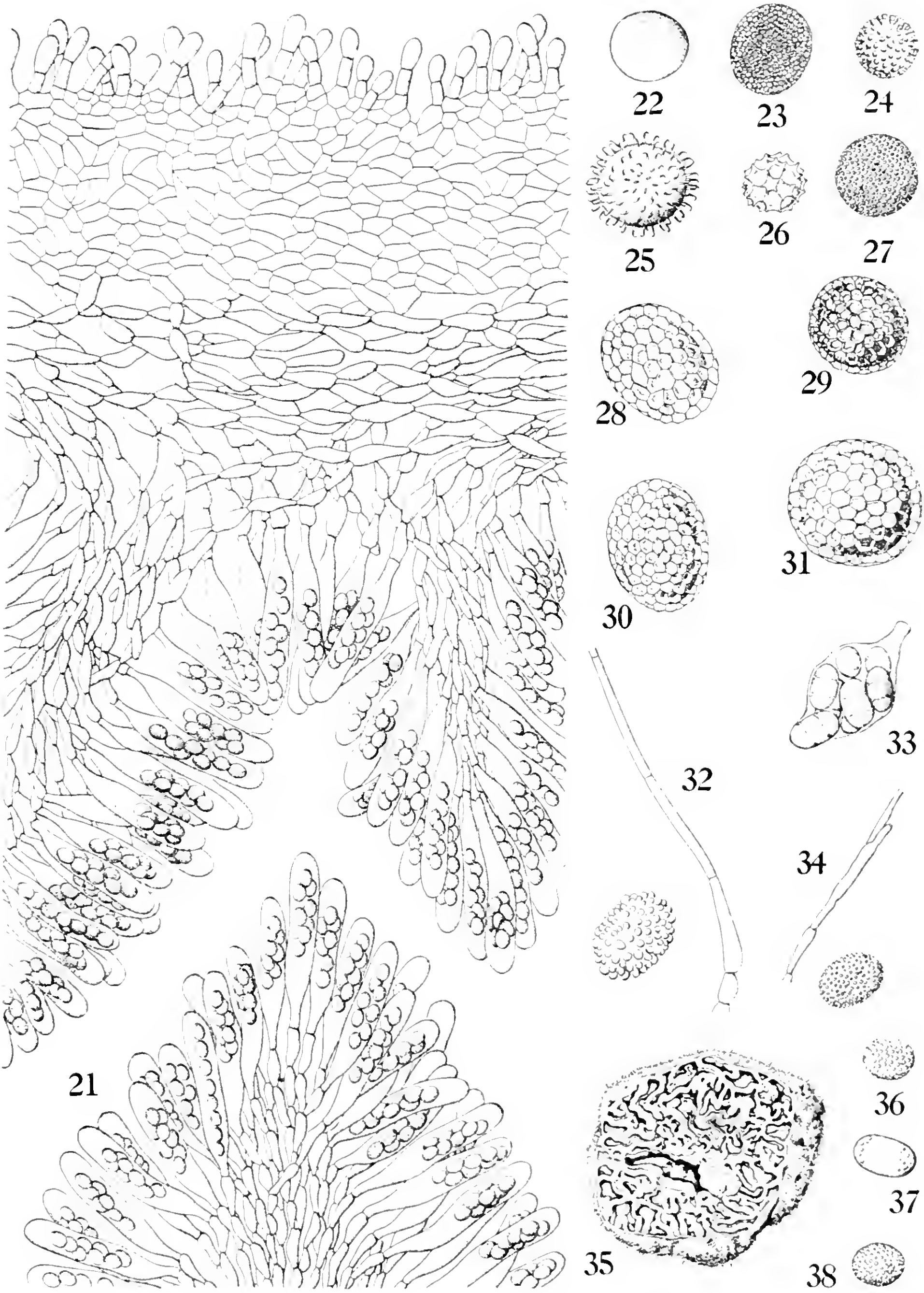
Fig. 34. Spore and paraphysis of *Genea arenaria*. × 500 diam.

Fig. 35. Section of *Geopora magnifica*. × $\frac{1}{2}$.

Fig. 36. Spore of *Hydnotryopsis Setchellii* gen. et sp. nov. × 500 diam.

Fig. 37. Spore of *Geopora Harknessii*. × 500 diam.

Fig. 38. Spore of *Hydnotrya ellipsospora* sp. nov. × 500 diam.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UNIVERSITY OF CALIFORNIA PUBLICATIONS
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SPECIES NOVAE VEL MINUS COGNITAE

BY

T. S. BRANDEGEE

Aristolochia (Gymnolobus) **monticola** sp. nov.

Pubescens: caulibus prostratis supra rupes vagantibus: foliis ovato-acutis ca. 12 cm. longis, 9 cm. latis auriculas magnas rotundatas includentibus, sinu ca. 2 cm. lato, 1.5 cm. alto; petiolis ca. 4 cm. longis: floribus solitariis axillaribus dense pubescentibus; pedunculo ca. 8 cm. longo bracteam ovatam cordatam gerenti; utriculo ovoideo ca. 6 mm. longo; tubo curvato intus processu breviter infundibuliformi praedito, ca. 1.5 cm. longo; labio cordato-ovato: columna stylina apice 5-lobata; antheris 5. Fructus deest.

Collected on Sierra de la Laguna, Baja California, by *T. S. Brandegee*, January 21, 1899. Type, Herb. Univ. Calif. No. 116656.

Aristolochia (Gymnolobus) **peninsularis** sp. nov.

Hirsuta: caulibus e radice valida lignosa adscendentibus, 2–3 dm. longis: foliis ovato-lanceolatis, 4–5 cm. longis, 2.5–4 cm. latis auriculas includentibus, sinu ca. 1 cm. lato, 5 mm. alto: petiolis ca. 1 cm. longis: floribus solitariis axillaribus; pedunculis 3–4 cm. longis medio bracteam ovatam acutam gerentibus; utriculo ovoidea ca. 1 cm. longo; tubo recurvato intus processu cylindrico praedito; limbo cordato-acuminato 1.5–2 cm. longo; columna stylina apice 5-loba; antheris 5. Fructus deest.

Collected by *T. S. Brandegee*, September 29, 1890, near San Jose del Cabo, Baja California, where it grows in sandy soil near the ocean. Type, Herb. Univ. Calif. No. 116657. Listed in Proc. Calif. Acad., ser. II, iii, 167, as *A. Karwinskii* D. C.?

Aristolochia (Gymnolobus) **sinaloae** sp. nov.

Prostrata puberula: caulibus tenuibus ca. 7 dm. longis: foliis sagittatis ca. 7 cm. longis, 2.5 cm. latis; petiolis ca. 1 cm. longis: floribus solitariis axillaribus; pedunculo ca. 1.2 cm. longo bracteam sagittatam gerenti; utriculo ovoideo ca. 8 mm. longo; tubo paulum curvato ca. 5 mm. longo intus processu breviter infundibuliformi praedito; labio unilabiato, labio basi breviter periphico, ovato-lanceolato ca. 2 cm. longo: columna stylina apice 5-lobato, lobis acuminatis; antheris 5. Fructus deest.

A prostrate delicate plant collected by *T. S. Brandegee*, November 5, 1904, on a grass-covered slope of Cerro Colorado near Culiacan, Sinaloa, Mexico. The basal lobes of the leaves are slightly obtuse. Type, Herb. Univ. Calif. No. 116580.

Sedum pinetorum sp. nov.

Glabrum caespitosum multicaule, e radicibus tubera gerentibus: caulibus brevibus, ca. 4 mm. altis, simplicibus apice unifloris: foliis dense imbricatis oppositis ovato-acutis vel obtusis sessilibus, costa valida, 2–3 mm. longis: pedunculo ca. 5 mm. longo, interdum bracteis parvis alternantibus praedito; floribus albis; calyce in lobos 5 late ovatis 2–3 mm. longis latisque fere ad basim sectis; petalis 5 ca. 3.5 mm. longis, ovato-lanceolatis prope basim connatis; staminibus 10, corollae affixis; folliculis liberis oligospermis; seminibus rubris.

A minute plant growing in dense clumps resembling superficially the cespitose depressed species of Phlox. Collected at deserted Pine City above Mammoth, Mono County, California, by *K. Brandegee*, July, 1913. Type, Herb. Univ. Calif. No. 185499.

Asclepias chapalensis sp. nov.

Erecta plus quam 3 dm. alta: caulibus pubescentibus crassis: foliis oblongis apice basique obtusis, ca. 2 dm. longis, 1 dm. latis, supra paululum hirsutis, subtus pubescentibus transverse et reticulatim venosis; petiolis ca. 1 cm. longis: umbellis multifloris, ca. 4, caules terminantibus, pedunculis usque ad 7 cm. longis dense tomentosis, pedicellis tomentosis ca. 6 mm. longis; calycis segmentis lanceolatis hirsutulis; corollae lobis late ovatis; columna brevissima, cucullis erectis superne acuminatis, complicatis, antheras superantibus, infra medium marginibus denticulatis, dorso crassis, processu interiori oblongo apice emarginato, membranaceo brevi. Fructus deest.

The interior appendage is an oblong membranous process arising from near the base of the hood and much shorter than it. Collected near Lake Chapala, Mexico, by *J. G. Lemmon*, 1905. Type, Herb. Univ. Calif. No. 105308.

Jatropha (Cnidoscolos) **maculata** sp. nov.

Multicaulis e radicibus tubera multa gerentibus, undique stimulosa: caulibus 3–5 cm. altis: petiolis 2–10 cm. longis, laminis usque ad 10 cm. longis latisque, basi cuneatis, ambitu orbicularibus, alte 3-vel subquinque lobatis, lobis grosse inciso-dentatis in setam longam terminantibus: cymis pedunculatis corymbiformibus floribus albis: sepalis ca. 8 mm. longis ultra medium in tubum connatis; disco annulari; columna staminali basi tomentosa; staminibus ca. 10 fere ad apicem columnae staminalis connatis: capsulis ca. 2.5 cm. longis: seminibus brunneis ca. 17 mm. longis; caruncula atro-brunnea.

The many-stemmed clumps of this plant with their mottled leaves are very attractive to the sight, but the stinging bristles discourage a close acquaintance. The seeds are pleasant to the taste and are eaten by the natives. The potato-like tubers are abundant. It resembles *J. acutidens* Müll. Arg., under which name it is listed in Proc. Calif. Acad. Sci., Ser. II, iii, 172. It differs in having white-blotched leaves with a cuneate base, larger fruit and all the stamens united so near the top of the staminal column that the free part of the filaments appear to spring from the same circle. It is common about San Jose del Cabo, Baja California. Collected by *T. S. Brandegee*, September 2, 1890. Type, Herb. Univ. Calif. No. 110145.

Lycium Cooperi Gray

The fruit of this species does not seem to have been examined. The flowers and seeds are as in *Lycium* proper; but the fruit is crustaceous, longer than broad, constricted at a point some distance below the top with the upper part hard, bony, and nearly solid. It never reddens so far as I know.

Lycium peninsulare sp. nov.

Frutex ramosus glaber: ramis in spinas terminantibus: foliis spathulatis ca. 2.2 cm. longis: floribus tetrameris axillaribus fasciculatis ca. 3 mm. longis; calyce campanulato ca. 2 mm. longo, lobis brevibus latis acutis: corolla late campanulata ca. 5 mm. longa, lobis latis reflexis; staminibus styloque exsertis, filamentis basi tomentosis: bacca ovoidea apice apiculata.

This *Lycium* is very floriferous. The stamens are exserted from the broad corolla, which by its reflexed lobes makes them very conspicuous. Collected by *T. S. Brandegee*, 1899, at San Jose del Cabo, Baja California. Type, Herb. Univ. Calif. No. 124646.

Galvezia rupicola sp. nov.

Caulibus ramosis villoso-hirsutis paulum glandulosis, erectis 1–3 dm. altis: foliis oppositis vel interdum ternatim verticillatis orbicularibus vel late ovatis, 1.5–2.5 cm. longis latisque; petiolis ca. 3 mm. longis: floribus axillaribus eis *G. junceae* Gray similibus.

Its habit is very different from that of *G. juncea* Gray and the broad persistent leaves are not found on that species, which also is not glandular. Collected by *T. S. Brandegee*, March 18, 1892, from the rocky promontory of Cabo San Lucas and at Saucito of the Cape Region of Baja California. The Saucito specimens have the larger leaves. Type, Herb. Univ. Calif. No. 103597.

Antirrhinum pusillum sp. nov.

Caulibus superne tenuiter viscoso-pubescentibus usque ad 15 cm. altis, interdum parce ramosis: foliis inferioribus oppositis, superioribus alternantibus, ovatis acutis basi cuneatis, ca. 15 mm. longis, 8 mm. latis; petiolis 3–6 mm. longis: floribus axillaribus solitariis; pedunculis ca. 5 mm. longis; calycis segmentis lanceolato-oblongis ca. 3 mm. longis corollam superantibus vel aequantibus: capsulis aequalibus ca. 5 mm. longis, stylo erecto: seminibus inordinate tuberculatis.

The flowers are very small. Slender axillary branches 5 to 20 mm. long, never tortile, bearing a few small leaves, are plentiful. Collected by *T. S. Brandegee*, 1897, on San Martin Island, on islands near Ensenada, all belonging to Baja California, and on Point Loma, near San Diego. Type, Herb. Univ. Calif. No. 139614.

The duplicates of my collecting were given to Mr. A. W. Anthony and numbered by him "225" of his list of plants distributed in that year.

Pentstemon Palmeri Gray var. **bicolor** var. nov.

Speciei similis sed corolla angustiori minus hiante, tubo paululum longiori.

The color of the flowers of different plants may be light yellow or purple. *P. Palmeri* Gray is variable in all its characters. Some plants have dark purple flowers and often corollas similar to those of the proposed variety are interspersed with typical ones of the species. Collected by *K. Brandegee*, May, 1915, at Good Springs, Nevada. Types, Herb. Univ. Calif. Nos. 178265 (yellow) and 178259 (purple).

Maximowiczia insularis sp. nov.

Seabra: caulibus brevibus glabris ca. 1 m. longis: foliis profunde lobatis, lobis lobatis lobulatis vel dentatis, utrinque setulosis; petiolis glabris ca. 2 cm. longis; floribus masculis racemosis; calycis dentibus triangularibus acutis; petalis oblongis obtusis extus intusque pubescentibus: fructibus ovalibus ca. 2 cm. longis quando maturis coccineis. Flores feminei desunt.

This proposed species has short stems and seabrous leaves. *M. sonorae* Watson as it grows in the Cape Region has stems 10 feet or more long climbing among bushes and the leaves are generally glabrous with a bluish tinge. *M. insularis* usually has a large root projecting from the ground nearly a foot, from the top of which the short stems hang, and when the scarlet fruit is mature becomes a handsome sight. The seeds are similar to those of *M. sonorae*. Collected by *T. S. Brandegee*, January 15, 1889, on Magdalena and Santa Margarita Islands, Baja California. Type, Herb. Univ. Calif. No. 102050.

Orobanche multicaulis sp. nov.

Multicaulis puberula parum viscosa laxiflora: caulibus ca. 2.5 dm. altis; bracteis ovato-acuminatis ca. 5 mm. longis: inflorescentia spicata; pedicellis inferioribus ca. 2.5 cm. longis, superioribus brevibus, medio vel sub calyce bibracteatis; calyce in lobos lanceolatos 5-partiti ca. 7 mm. longos: corolla ca. 2 cm. longa curvata, labio superiori bilobo, inferiori trilobo, lobis ovatis; filamentis filiformibus glabris, antheris glabris; stigmate bilobo, capsula quam calyce breviori.

The bilobed stigma separates this species from *O. Cooperi* Gray and other Californian species having crateriform or disciform stigmas. Collected by myself near Purisima in 1889, growing among loose rock; also at Calmalli by *Dr. C. A. Purpus*, both localities in Baja California. Type, Herb. Univ. Calif. No. 172754.

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PLANTAE MEXICANAE PURPUSIANAE, VIII

BY

TOWNSHEND STITH BRANDEGEE

Interruption of communication has prevented Dr. Purpus from collecting in Chiapas as he intended. Collecting about Zacuapan was continued and many species not in his previous collections as well as more complete ones of those previously distributed were found. Not having large collections to occupy my time, I have studied out plants of previous collections which were not found in sufficient quantity for distribution. Also are included a few Mexican species collected by myself.

Aristolochia (*Gymnolobus*) **racemosa** sp. nov.

Volubilis: caulibus elongatis paululum pubescentibus: foliis hastato-ovato-acuminatis viridibus, subtus glabris supra parum pubescentibus usque ad 10 cm. longis auriculas includentibus, 12 cm. latis, basi excisis sinu ca. 3 mm. profundo, 2 cm. lato, auriculas amplas interdum angulatas separante; petiolis 3–6 cm. longis: floribus in racemos axillares dispositis, pedicellis brevibus bracteam hastatam pubescentem gerentibus; ovario pubescenti; calyce ca. 3 cm. longo; labio parum curvato apice attenuato extus parum pubescenti ovato-cordato brunneo-purpureo basi flavidulo; tubo intus processu infundibuliformi instructo, superne ampliato; columna stylina fere sessili apice 5-lobata, lobis triangularibus; antheris 5. Fructum non vidi.

Collected near Zacuapan, Vera Cruz. No. 5333. Type, Herb. Univ. Calif. No. 156762. This locality is sometimes written Zacuapam.

Celosia chiapensis sp. nov.

Glabra siccatione atra: caulibus ca. 4 dm. altis: inflorescentia caules terminanti paniculam foliosam formanti: foliis ovato-lanceolatis acuminatis, basi in petiolum ca. 2 cm. longum attenuatis, usque ad 12 cm. longis, 4.5 cm. latis: perianthii segmentis ovatis acutis vel obtusis striato-venosis; filamentis superne filiformibus, basi in cupulam brevem ampliatis; stylo brevi stigmatibus 3; utriculo globoso perianthio exserto circumscisso, ca. 20-spermo.

Collected at Finca Irlanda, Chiapas. No. 7541. Type, Herb. Univ. Calif. No. 187780.

Polygala (*Hebecarpa*) **polyedra** sp. nov.

Suffruticulosa: caulibus validis erectis ramosis acute striato-angularibus indistincte puberulis, plus quam 3 dm. altis: foliis plerumque delapsis alternis, superioribus paucis persistentibus lineari-lanceolatis, ca. 5 mm. longis: racemis axillaribus vel ramos terminantibus densifloris, 2–3 cm. longis: petalis ovato-acuminatis glabris ca. 3 mm. longis; alis late ovatis glabris ochroleucis, ca. 5 mm. longis; carina petala oblonga superiora alasque paululum superanti; capsula ca. 7 mm. longa, 6 mm. lata, emarginata glabra, prope apicem paulo alata, pedicello ca. 1 mm. longo: semine piloso ca. 4 mm. longo, arillo ca. 2 mm. longo, 1.5 mm. lato, margine lacerato, umbone parvo piloso apiculato.

The specimens consist of a few *Russelia*-like stems sparingly branched with a few uppermost leaves persistent and several fruiting and flowering racemes. Collected at Mazatlan, Sinaloa. No. 7627. Type, Herb. Univ. Calif. No. 142753.

Polygala (*Hebecarpa*) **scopulorum** sp. nov.

E radice lignosa multicaulis: caulibus debilibus usque ad 3 dm. longis, glabris lignosis, ramis herbaceis vel frutescentibus dense puberulis pilis incurvis: foliis lineari-lanceolatis puberulis 1–1.5 cm. longis, ca. 1 mm. latis, basi in petiolum brevem attenuatis, inferioribus brevioribus: racemis ramos terminantibus ca. 4-floris, 2–6 cm. longis: sepalis ovato-lanceolatis breviter pubescentibus ciliatis, ca. 3 mm. longis; alis ca. 4.5 mm. longis, 3.5 mm. latis, ovatis acutis ciliatis, extus breviter pubescentibus; petalis superioribus oblongis, ca. 4 mm. longis; carina ca. 5 mm. longa; capsula glabra ciliata emarginata basi cuneata, ca. 7 mm. longa, 5 mm. lata; semine piloso ca. 4 mm. longo, arillo trilobo, lobo dorsali latiori, umbone magno piloso.

The acute wings and the long, woody, apparently trailing stems characterize this species. Collected on rocks near Peña, Coahuila. No. 1039. Type, Herb. Univ. Calif. No. 137737.

Polygala (*Hebecarpa*) **neurocarpa** sp. nov.

Caulibus frutescentibus ramosis erectis glabris, ca 3 dm. altis: foliis anguste oblongis acutis vel obtusis glabris, ca. 1.8 cm. longis, 2–4 mm. latis: racemis terminalibus laxifloris, ca. 7 cm. longis: sepalis lineari-lanceolatis minute ciliatis; alis ovatis basi cuneatis apice rotundatis, margine minute ciliatis quam sepalis paullo longioribus, ochroleucis; carina ca. 4 mm. longa alas paululum superanti, margine late atro-purpurea; petalis superioribus oblongis purpureis: capsulis ca. 9 mm. longis oblongo-orbicularibus reticulato-venosis margine breviter ciliatis, pedicellis ca. 3 mm. longis: seminibus pilosis ca. 3 mm. longis, arillis horizontalibus margine erosis umbonibus pilosis.

The reticulately veined capsules of this species are characteristic. Excepting the short-ciliate margins of the sepals, capsules and alae, it is entirely glabrous. Collected at Ixmiquilpan, Hidalgo. No. 1427. Type, Herb. Univ. Calif. No. 137871.

Polygala (*Hebecarpa*) parrasana sp. nov.

Multicaulis e radice lignosa valida, viridis: caulibus frutescentibus ca. 7 cm. longis, adscendentibus pubescentibus pilis patentibus, ramosis: foliis oblongo-ovatis utrinque pubescentibus, basi cuneatis, apice rotundatis mucronulatis, margine ciliatis, subtus valde nervosis, ca. 7 mm. longis, 2 mm. latis, fere sessilibus, superioribus quam inferioribus multo majoribus: racemis ramos terminantibus vel lateralibus, ca. 1.5 cm. longis, 1–5-floris, floribus plerumque terminalibus: sepalis ovato-lanceolatis pubescentibus ca. 3 mm. longis; alis ovatis ca. 4 mm. longis, 3 mm. latis, extus pubescentibus, margine ciliatis; petalis superioribus parte libera ca. 3 mm. longa, 2 mm. lata, apice rotundata; carina ca. 5 mm. longa alas superanti, circa apicem laete viridi; capsula immatura elliptica ca. 5 mm. longa, 3 mm. lata, emarginata puberula ciliata; semine ca. 4 mm. longo, piloso, arillo trilobo ca. 1.2 mm. longo, umbone corneo piloso.

Two specimens represent this species, one with many stems from a woody root, the other having lateral stems near the base, making it resemble a small bush. Collected on Sierra de Parras, Coahuila. No. 4627. Type, Herb. Univ. Calif. No. 144787.

Polygala (*Hebecarpa*) vagans sp. nov.

Caulibus teretibus tenuibus plus quam 7 dm. longis, puberulis, intricato-ramosis: foliis linearibus, apice acutis mucronatis, basi in petiolum ca. 1 mm. longum attenuatis, utrinque pilis paucis incurvis puberulis, ca. 2.8 cm. longis, 1 mm. latis: racemis caules ramosque terminantibus, ca. 3 cm. longis, laxe 3–7-floris: petalis anguste ovato-lanceolatis, ca. 2.5 mm. longis, puberulis ciliatis; alis ovatis, ca. 6 mm. longis, 4 mm. latis, sparsim hirsutis pilis brevibus incurvis: petalis superioribus oblongis obtusis quam carina paullo brevioribus; carina ochroleuca ca. 5 mm. longa; capsula ca. 9 mm. longa, 7 mm. lata, infra medium cuneata, emarginata sparsim puberula minute ciliata, pedicello ca. 6 mm. longo; semine ca. 5 mm. longo, piloso, arillo palliformi ca. 3 mm. longo, margine eroso, umbone corneo breviter piloso.

The long, almost filiform stems must have been prostrate or supported by other plants. The specimens lack the lower leaves. Collected in the state of Puebla. No. 7626. Type, Herb. Univ. Calif. No. 169525.

Polygala (*Hebecarpa*) **laeta** sp. nov.

E radice lignosa pluricaulis, viridis: caulibus diffusis adscendentibus ramosis, 1–1.5 dm. longis, puberulis pilis incurvis: foliis inferioribus anguste ovatis nunc obtusis nunc acutis, quam superioribus minoribus, superioribus ovato- vel oblongo-lanceolatis obtusis vel acuminatis mucronulatis, 1–2.5 cm. longis, 2–4 mm. latis, utrinque sparsim puberulis, petiolis brevibus: racemis caules ramosque terminantibus, 2–4 cm. longis, 2–10-floris, floribus ochroleucis: petalis ovato-lanceolatis puberulis ciliatis, ca. 4 mm. longis; alis ovatis basi angustatis, costa puberula, ca. 7 mm. longis, 4 mm. latis, carinam superantibus; petalis superioribus oblongis obtusis: capsula ca. 8 mm. longa, 6 mm. lata, basi cuneata, late emarginata, sparse puberula, pedicello ca. 3 mm. longo; semine paululum piloso ca. 4 mm. longo, arillo palliiformi ca. 2 mm. longo margine plus minusve lobato, umbone corneo magno pilosculo.

The diffuse stems often prostrate, the bright green foliage, the puberulent capsules with cuneate base and different seed, are some of the characters distinguishing this species from *P. brachyanthema* Blake. Collected at San Luis Tultitlanapa, Puebla, and at Las Naranjas, Oaxaca. No. 3500. Type, Herb. Univ. Calif. No. 137736.

Polygala (*Chamaebuxus*) **pycnophylla** sp. nov.

E radice lignosa pluricaulis: caulibus ramosis hispidis vel pilis incurvis puberulis, ca. 7 cm. longis, foliosis: foliis superioribus oblongo-lanceolatis, apice mucronatis, basi cuneatis, utrinque minutissime vel pilis incurvis puberulis, plus minusve nitidis, reticulatis, ca. 1.5 cm. longis, 2 mm. latis, imis obovatis vel oblongis obtusis, margine interdum ciliatis, 5–10 mm. longis: racemis geniculatis ramos caulesque terminantibus vel contra-axillaribus, ca. 7 mm. longis, 1–3-floris, floribus roseis: sepalis plus minusve roseis, glabris; superiore persistente ovato-lanceolato, ca. 3.5 mm. longo, inferioribus lanceolatis; alis ellipticis apice acutis, basi longe cuneatis, ca. 4.5 mm. longis, 2 mm. latis; petalis superioribus oblongis acutis carinam aequantibus; carina ca. 3.5 mm. longa, rostro ca. 0.5 mm. longo: capsula glabra emarginata striata, ca. 5 mm. longa, 3.5 mm. lata; semine piloso, ca. 3 mm. longo, arillo immaturo lobis lateralibus ca. 1 mm. longis, umbone corneo.

The characters of this species are variable. Most of the specimens have oblong-lanceolate, essentially glabrous leaves and erect stems; others have ovate-acuminate leaves and pubescent spreading stems, but there is no difference in the flowers. The sepals are either herbaceous and green or rose-colored and petaloid. Collected on Sierra de Parras, Coahuila. No. 4628. Type, Herb. Univ. Calif. No. 144786.

Euphorbia xeropoda sp. nov.

Verisimiliter annua, glabra: caule crasso erecto striato superne ramoso, 2–3 dm. alto: foliis obovatis acutis penniveniis, basi longe cuneatis, margine crenato-serratis, utrinque viridibus, usque ad 5.5 cm. longis, 3.5 cm. latis, infimis oppositis, superioribus parvis vel bracteiformibus, petiolis ca. 3 mm. longis: inflorescentia ad ramulos breves bracteoso-foliosos dissita; involucrorum campanulatorum pedicellis ca. 1 mm. longis, lobis fimbriatis, glandulis 4 stipitatis transverse ellipticis margine dactylis ca. 10 instructis; stylis integris: capsula glabra, seminibus tetragonis oblongis utrinque truncatis plus minusve rugulosis, ca. 4 mm. longis, lateribus ca. 1.5 mm. latis, caruncula magna stipitata, columella apice incrassata.

One specimen only was collected between Picacho and San Geronimo, Oaxaca, growing on a dry plain. No. 6901. Type, Herb. Univ. Calif. No. 172970.

Euphorbia (*Anisophyllum*) **pueblensis** sp. nov.

E radice lignosa multicaulis: caulibus diffusis tenuibus adscendentibus ramosis patenter pilosis: foliis breviter petiolatis ovato-acutis, basi valde inaequalibus, utrinque pubescentibus, internodiis brevioribus, ca. 6 mm. longis, 4 mm. latis; stipulis setaceis: involucris solitariis axillaribus pubescentibus breviter pedunculatis: glandulis 4–5, transverse ellipticis sulcatis, appendicibus eis latioribus nunc integris nunc bilobis aut inaequaliter trilobis, ca. 1 mm. longis: stylis usque ad medium bifidis: capsula pubescenti, seminibus turgidis obtuse tetragonis rugulosis, apice acutis.

The pubescence of this species is similar to that of *E. acuta* Engelm., but is less dense. The leaves are not apiculate, are unequal at the base and smaller, otherwise resembling those of that species. The stems are more slender and more diffuse; the seeds and appendages to the glands also differ. Collected at San Luis Tultitlanapa, Puebla. No. 3425. Type, Herb. Univ. Calif. No. 136667.

Euphorbia (*Anisophyllum*) **bicapitata** sp. nov.

Annua prostrata: caulibus breviter pubescentibus usque ad 1 dm. longis: foliis falcatis acutis serratis, basi obliquis, latere inferiori auriculatis, utrinque parum pubescentibus, ca. 11 mm. longis, 4 mm. latis; internodiis longis; petiolis brevissimis: cymis plerumque duabus caules terminantibus, pedunculis ca. 1 cm. longis: involucris parvis, lobis laceratis, glandulis cupulatis breviter stipitatis appendicibus nullis vel angustis margine integris vel inaequaliter bilobatis, albis; stylis breviter bifidis; capsula adpresse pubescente; coccis dorso subcarinatis; seminibus oblongo-acutis, valde quadrangulatis, faciebus transverse rugosis.

This species is related to *E. capitellata* Engelm. and *E. puberula* Fernald. Collected near San Luis Tultitlanapa, Puebla. No. 3428. Type, Herb. Univ. Calif. No. 136670.

Jatropha urens L. var. **longepedunculata** var. nov.

Petiolis deinde 2 dm. longis interdum parce stimulosis; laminis foliorum usque ad 15 cm. longis, 25 cm. latis, ultra medium 5-lobatis lobis oblongis profunde lobatis, utrinque glabris; pedunculis demum 2 dm. longis parce stimulosis; corymbis ca. 75-floris.

This seems to be a large glabrous form of *J. urens* L. The only differences are: its long peduncles, large leaves and perhaps the styles are not connate at base. Collected near Zacuapan, Vera Cruz. No. 7639. Type, Herb. Univ. Calif. No. 191126.

Hibiscus (*Bombycella*) **Purpusii** sp. nov.

Arboreus, dioicus: ramulis cinereis: foliis ovato-lanceolatis, basi trinerviis, margine crenato-serratis, subtus parum stellato-hirsutis venis prominentibus, 5–10 cm. longis, 2–4 cm. latis: petiolis ca. 7 mm. longis: floribus axillaribus fere sessilibus; calycis lobis ovato-acuminatis dorso parum pubescentibus glandulosisque; bracteolis ca. 5 lineari-lanceolatis usque ad 5 mm. longis: florum masculorum petalis ovato-acuminatis ca. 9 mm. longis calycem paululum superantibus, prope basim longe ciliatis, flavido-viridibus: stylo ovarioque nullo; columna staminea extrosum antherifera apice in ramos plus minus divisos secta; capsula subglobosa quam calyce breviori, loculicide 5-valva, stellato-hirsuta, seminibus in loculis 2 reniformibus lanatis. Flores feminei desunt.

The species is represented in the herbarium by two collections made in different years. The first consists of a few branches bearing fruiting capsules. The numerous flowers of the second are all staminate. The petals are similar to the calyx in color. Collected in the vicinity of Zacuapan, Vera Cruz. Nos. 7545 and 7546. Type, Herb. Univ. Calif. No. 138282, fruiting specimen, and No. 185410, flowering specimen.

Ayenia peninsularis sp. nov.

Fruticulus ramosus ca. 2.5 dm. altus: caulibus pubescentibus pilis reflexis: foliis ovato-acuminatis grosse serratis, basi rotundatis vel cuneatis, utrinque praecipue ad venas parce hirsutis, usque ad 4 cm. longis, 2.5 cm. latis; petiolis ca. 2 cm. longis, pubescentibus; pedicellis 1–3 axillaribus demum 1.3 cm. longis; sepalis teneris oblongo-acutis; petalorum laminis flabelliformibus basi acutis, dorso glandula clavaeformi auctis; antheris 2-locularibus. Fructus maturus ignotus.

This species has no stellate pubescence. Collected in Cañon San Bernado, Cape Region of Baja California, and at San Jose del Cabo by T. S. Brandegee. Type, Herb. Univ. Calif. No. 108705.

Ayenia reflexa sp. nov.

Multicaulis e radice valida lignosa: caulibus erectis plerumque glabris ca. 2 cm. altis, basi frutescentibus: foliis lanceolatis reflexis, ca. 3.5 cm. longis, 1–2 mm. latis, serratis utrinque glabris; petiolis ca. 2 cm. longis: pedicellis 2–3 axillaribus ca. 4 mm. longis: sepalis ovato-lanceolatis ca. 3 mm. longis; petalorum lamina oblonga, basi cuneata, utroque latere dentata, dorso glandula parva atra filiformi aucta: capsula muricata pedicello calycem aequanti; seminibus transverse rugosis.

One stem is very slightly pubescent and there are two or three broadly ovate leaves. The downwardly reflexed leaves give this species a very distinct appearance. Collected by T. S. Brandegee near Culiacan, Sinaloa. Type, Herb. Univ. Calif. No. 185715.

Ayenia cuneata sp. nov.

Frutescens: caulibus erectis ramosis pubescentibus, plus quam 4 dm. altis: foliis lanceolatis utrinque fere glabris, serratis basi cuneatis, ca. 4.5 cm. longis, 4–8 mm. latis: floribus 2–3 axillaribus, pedicellis 2–5 mm. longis; sepalis ovato-lanceolatis ca. 1.5 mm. longis, pubescentibus: petalorum lamina oblonga atro-purpurea, margine crenata, basi longe cuneata, dorso glandula clavaeformi aucta; ovario dense pubescenti; capsula muricata hirsuta, pedicello calycem paululo superanti; seminibus transverse rugosis.

This somewhat resembles *A. reflexa*. The leaves are broader and erect, the plant is more bush-like, the blade of the petals is darker colored and has a different shape and the base is long-cuneate into the claw. The other differences are shown by the description. Collected by T. S. Brandegee on Cerro Colorado, Sinaloa. Type, Herb. Univ. Calif. No. 108700.

Laetia glabra sp. nov.

Fruticulus: ramis verrucosis badiis: foliis oblongo-ovatis longe acuminatis pellucido-punctatis, margine crenato-serratis, usque ad 14 cm. longis, 5 cm. latis; petiolis ca. 2 cm. longis: petalis 0; sepalis 5, late ovatis ca. 5 mm. longis; staminibus ca. 20, antheris versatilibus: ovario ovato stylo capitato aequilongo: fructu solitario globoso diametro ca. 15 mm., uniloculari placentis 4 parietalibus, seminibus arillatis.

The leaves are thin in texture. The flowers of the specimens are very young or old. The sepals of the mature flowers are chartaceous and persist beneath the fruit. The species differs from the descriptions of the genus in having four parietal placentae instead of three. Collected on banks of arroyos near San Geronimo, Oaxaca. No. 7531. Type, Herb. Univ. Calif. No. 187791.

Sicyos sinaloae sp. nov.

Caulibus sulcatis glanduloso-puberulis: foliis leviter vel profunde 5-lobatis, lobis acuminatis margine denticulatis, supra puberulis, subtus puberulis simul ad nervos minute setosis, sinu basilari ambitu orbiculato diametro 1.5 cm. ca. 7 cm. longis, 9 cm. latis; petiolis ca. 1.7 cm. longis dense breviter glanduloso-pubescentibus: cirrhis 5-fidis: pedunculis florum masculorum ca. 3.5 cm. longis, glanduloso-puberulis; floribus minutis; corollis glanduloso-puberulis; pedunculis fructiferis ca. 1.5 cm. longis, dense breviter glanduloso-pubescentibus ca. 15 fructus in caput diametro ca. 2.5 cm. gerentibus; fructibus fere sessilibus, ca. 7 mm. longis, 4 mm. latis, utrinque acutis, primum setosis, demum glabris crasse reticulato-rugosis atro-fuscis.

This species has two leaf forms. One, collected at Cofradia, has the leaves very slightly lobed. The other, collected at Culiacan, has the leaves and the lobes narrowed at their base. Both forms have an orbicular, almost closed sinus. The fruit is finally nearly black and coarsely ridged. Collected in Sinaloa by T. S. Brandegee. Type, Herb. Univ. Calif. No. 160717.

Sicyos acerifolius sp. nov.

Caulibus striatis glanduloso-puberulis: foliis majoribus latioribus quam longis, ca. profunde 5-lobatis, lobis acuminatis margine denticulatis, utrinque puberulis simul sparse minuteque setosis, ca. 19 cm. latis, 12 cm. longis, basi sinu orbiculato vel ellipsoideo diametro ca. 4 cm.; petiolis glanduloso-puberulis 2.5–3 cm. longis; pedunculis masculis glanduloso-puberulis, ca. 18 cm. longis, prope ad apices umbellulis ca. 4 instructis; pedicellis umbellularum usque ad 2 cm. longis; pedicellis floriferis sterilibusque ca. 8, 5–7 mm. longis; calycis dentibus lanceolatis: corolla poculiformi glanduloso-puberula, lobis triangulo-acutis; disco ad basin filamentorum diametro ca. 1.5 mm., rugoso; antheris flexuosis congestis: pedunculis fructiferis glanduloso-puberulis, ca. 2 cm. longis; fructibus 12–15 compressis in caput diametro ca. 2 cm. congestis, dense setosis setis ca. 2 mm. longis: cirrhis indivisis. Flores feminei desunt.

Collected at Cofradia, Sinaloa, by T. S. Brandegee. Type, Herb. Univ. Calif. No. 160718.

Sicyos silvestris sp. nov.

Caulibus striatis fere glabris: foliis angulatis nunc obscure lobatis nunc margine integris, supra pustulatis interdum setis paucis instructis ad nervos minute hirsutis vel setosis, subtus punctatis ad nervos minute aculeatis, ovato-acuminatis vel late ovatis, usque ad 9 cm. longis, 8 cm. latis; petiolis 0.5–7.5 cm. longis, plerumque breviter setiferis: racemis femineis ca. 6-floris interdum flores masculos paucos gerentibus; corolla parva lobis acutis, stylo capitato; corolla mascula feminei simili, filamentis connatis, antheris 3 loculis fere rectis; pedunculis fructiferis ca. 8 mm. longis glabris, 2–3 fructus gerentibus: fructu obovato crasse tuberculato sine setis: cirrhis bifidis.

Collected in moist forests near Boca del Monte, a locality near the boundary line between Vera Cruz and Puebla. No. 5724. Type, Herb. Univ. Calif. No. 162978.

ECLIPTOSTELMA gen. nov. Asclepiadacearum

Calyx 5-partitus. Corolla subcampanulata, lobis angustissime dextrorsum obtegentibus, intus papilloso-puberulis. Corona O. Stamina prope basin tubi affixa, filamentis in tubum connatis; antherae membrana inflexa terminatae. Pollinia in quoque loculo solitaria, pendula. Stigma vertice rostratum. Folliculi ignoti. Suffrutex volubilis foliis magnis oppositis, caulibus crassis. Cymae in una axilla pedunculatae ramosissimae.

Ecliptostelma molle sp. nov.

Molliter pubescens: caulibus crassis teretibus diametro ca. 5 mm.: foliis ovato-acutis, basi obtusis vel subcordatis, usque ad 1 dm. latis, 1.6 dm. longis, petiolis 3–5 cm. longis: cymis ramosissimis diffusis multifloris ca. 1 dm. longis, 8 cm. latis, pedunculos ca. 3 dm. longos includentibus; calyce fere ad basim 5-secto ca. 3 mm. longo, lobis ovato-lanceolatis; corolla late campanulata ca. 5 mm. longa, 4 mm. lata, lobis oblongis apice rotundatis.

This species is a stout climbing vine with large leaves and a very diffuse cymose inflorescence. The flowers have the structure of those of *Astephanus*. Collected near Zacuapan, Vera Cruz. No. 7662. Type, Herb. Univ. Calif. No. 191107.

Asclepias polyphylla sp. nov.

Multifoliata: caulibus e radice simplicibus, ca. 4 dm. altis, superne bifariam pubescentibus: foliis oppositis lanceolatis, apice mucronulatis, basi obtusis vel cordatis, utrinque glabris, usque ad 13 cm. longis, 18 mm. latis, inferioribus minoribus; petiolis ca. 2 mm. longis: umbella multiflora terminali pedunculo quam foliis paululum breviori; pedicellis pubescentibus ca. 15 mm. longis; calycis segmentis lanceolatis; corollae lobis ovato-oblongis reflexis, ca. 9 mm. longis; columna brevi; cucullis lateribus complicatis dorso crassis late fornicatis gynostegium superantibus, processu membranaceo oblongo dorso cucullorum adnato superne acuminato supra stigmam breviter exserto. Fructus deest.

The mid-nerve of the leaf is very prominent and the leaves themselves are double the length of the internodes. Collected near Zacuapan, Vera Cruz, Mexico. Type, Herb. Univ. Calif. No. 141590.

Vincetoxicum (*Gonolobus*) **atrocoronatum** sp. nov.

Ramis vetustis cortice suberea puberula, junioribus hirsutis simul puberulis: foliis oblongo-ovatis acuminatis, basi sinu profundo cum auriculis fere tangentibus, utrinque pubescentibus, ca. 4 cm. longis, 1.5 cm. latis; petiolis puberulis parce hirsutisque ca. 2 cm. longis: pedunculis ca. 1.7 cm. longis, ca. 4-floris; pedicellis usque ad 1 cm. longis: calycis segmentis ovato-acutis hirsutis ciliatis, ca. 3 mm. longis; corolla ca. 1 cm. longa ochroleuca campanulata profunde lobata, lobis late lanceolatis reticulato-venosis; corona atro-fusca poculiformi basi tubi staminei adnata, stigma superanti, brevissime 5-secta, ad angulos fimbriata. Folliculi desunt.

The few specimens that were collected seem to be branches of a large plant. A noteworthy character is the large corona much exceeding the stigma and in the dried specimens enveloping it. Collected at Barranca de las Pilas, Puebla. No. 7540. Type, Univ. Calif. No. 141701.

Ipomoea sylvestris Brandg.

Univ. Calif. Publ. Bot., vi, 190.

Recent collections enable the description of this species to be made more complete: capsulis glabris ovato-acutis ca. 7 mm. longis, ab apice in valvas dehiscentibus: seminibus glabris basi sericeo-villosis pilis semen superantibus.

Ipomoea ursina Brandg.

Univ. Calif. Publ. Bot., iv, 382.

This species is very variable as to its pubescence and shape of leaves. Specimens from Zacuapan in fruit enable the description to be completed: capsulis glabris ovatis quam sepalis duplo longioribus, ab apice in valvas dehiscentibus: seminibus basi sericeo-villosis pilis semina multo superantibus.

Bassovia Purpusii sp. nov.

Glabra, ramosa: caulibus sulcatis: foliis ovato-acuminatis, basi in petiolum ca. 1.7 cm. longum attenuatis, margine integris, subtus nervis prominentibus, usque ad 14 cm. longis, 7 cm. latis: umbellis 5–10-floris, pedicellis ca. 13 mm. longis: calyce poculiformi deinde paululum aucto diametro 8 mm.: corolla ca. 2 cm. longo in lobos 5 profunde secta, aestivatione valvata: staminibus 5, antheris loculis parallelis in longitudinem dehiscentibus, filamentis complanatis quam antheris multo brevioribus: bacca globosa polysperma.

The type is No. 7502 from Zacuapan, Vera Cruz. Type, Herb. Univ. Calif. No. 178570. No. 7320 from Cerro del Boqueron seems to be the same species.

Bassovia foliosa sp. nov.

Fruticosa: caulibus glabris cinereis: foliis oblongo-ovatis acuminatis basi attenuatis margine integris, venis subtus prominentibus utrinquesecus ca. 7, supra glabris, subtus praecipue ad axillas venarum hirsutulis, geminis, altero ca. 12 cm. longo, 5 cm. lato, altero minore; petiolis ca. 7 mm. longis: umbellis oppositifoliis 5–7-floris: pedunculis ca. 1.5 cm. longis; pedicellis ca. 14 mm. longis: calyce cyathiformi breviter 5-lobo paululum pubescenti, ca. 5 mm. longo lurido: corolla alte 5-loba, lobis ovato-acutis apice intus hamatis; antheris 5 corollam aequantibus loculis in longitudinem dehiscentibus; filamentis brevibus complanatis; stylo brevi, capsula diametro ca. 4 mm. rubescente, coelata.

Collected near Zacuapan, Vera Cruz. No. 7565. Type, Herb. Univ. Calif. No. 187427.

Bassovia setosa sp. nov.

Fruticosa: caulibus 3–4 dm. altis, ramis juvenibus setosis: foliis interdum geminis, ovatis acutis basi in petiolum ca. 7 mm. longum attenuatis, utrinque hirsutis, usque ad 4.5 cm. longis, 2 cm. latis: floribus 1–5 lateralibus, pedicellis 5–12 mm. longis: calycis segmentis lanceolatis ca. 5 mm. longis, setosis: corollae tubo ca. 1 mm. longo, limbo anguste campanulato ca. 5 mm. longo, lobis valvatis ovato-lanceolatis extus setosis: staminibus tubi apici affixis, antherarum loculis in longitudinem dehiscentibus quam filamentis multo longioribus; stylo longo capitato: bacca glabra globosa diametro ca. 5 mm.

The calyx formed of distinct segments is very different from the usual cup-shaped one of other species of the genus. Collected near Zacuapan, Vera Cruz, in oak forests. No. 7509. Type, Herb. Univ. Calif. No. 178623.

Solanum (*Polymeris*) **sylvicola** sp. nov.

Fruticosum setoso-hirsutum: foliis praecipue ad venas dense setoso-hirsutis interdum geminis, altero ovato-acuminato basi inaequaliter cuneato 10–14 cm. longo, 2.5–4 cm. lato, petiolis ca. 5 mm. longis; altero ovato acuminato sessili ca. 7 mm. longo, 4 mm. lato: floribus 1–2 axillaribus: pedicellis 2–7 mm. longis; calyce turbinato ca. 3 mm. alto, appendicibus 10 corollam superantibus ca. 4 mm. longis instructo; corolla alte 5-fida, lobis lanceolatis quam tubo 8-plo longioribus, latitudine inaequalibus extus setuloso-hirsutis: staminibus aequalibus ovatis poris terminalibus dehiscentibus: Baccae desunt.

Collected in damp, rocky forests near Finca Irlanda, Chiapas. No. 7315. Type, Herb. Univ. Calif. No. 173378.

Solanum (*Polymeris*) stephanocalyx sp. nov.

Herbaceum, ramosum: caulibus 8–10 dm. altis puberulis: foliis geminatis ovato-acuminatis, subtus minute puberulis, basi in petiolum ca. 5 cm. longum attenuatis, altero usque ad 10 cm. longo, 5 cm. lato, altero multo minore: pedunculis axillaribus vel lateralibus solitariis unifloris, ca. 4.5 cm. longis; calyce turbinato margine lobis 10 lineari-lanceolatis ca. 4 mm. longis coronato; tubo corollae infundibuliformi quam lobis oblongis multo breviori; antheris magnis in tubum connatis, loculis poro terminali simul in rimam longitudinalem dehiscentibus; filamentis fere nullis. Bacca ignota.

The long filiform peduncles of the solitary flowers and the connivent anthers are important characters of this species. Collected near Zacuapan, Vera Cruz. No. 7519. Type, Herb. Univ. Calif. No. 178649.

Episcia aurea sp. nov.

Caulibus puberulis plus quam 3 dm. longis: foliis oppositis ovato-acuminatis, basi in petiolum ca. 1.8 cm. longum attenuatis, margine denticulatis, supra glabris, subtus pallidioribus ad nervos puberulis, ca. 12 cm. longis, 6 cm. latis: floribus axillaribus plerumque solitariis; pedicellis ca. 6.5 cm. longis; calycis lobis 5 late ovatis, acuminatis foliaceis, margine denticulatis, prope basin connatis, inaequalibus, usque ad 1 cm. longis, 7 mm. latis; corolla auri-colore, subbilabiata ca. 3.8 cm. longa, basi postice gibba, superne ampliata usque ad 2.5 cm. labio antico concavo quam labio postico emarginato multo majori; antheris 4 latioribus quam longis, cohaerentibus, loculis parallelibus; filamentis inter se liberis complanatis; stigmate dilato concavo; ovario supero; disci glandula postica emarginata; fructu globoso: placentae lamina facie interiore ovulifera.

In the peculiar shape of the corolla this species differs from the description of the genus. Collected on Cerro del Boqueron. Nos. 6850 and 7533. Type, Herb. Univ. Calif. No. 187784.

Crusea Chiapensis sp. nov.

Annua: caulibus debilibus teretibus, superne pubescentibus, inferne setosis, ca. 15 cm. altis: foliis ovato-lanceolatis, basi angustatis, sessilibus, utrinque paululum hirsutis, ca. 2 cm. longis, 5 mm. latis, quam bracteis capitulos involucrantibus paulo minoribus; stipulis setosis ciliatisque: capitulis caules terminantibus: calycis lobis 4, ovato-acuminatis longe setoso-ciliatis; corolla hypocraterimorpha, tubo ca. 7 mm. longo, styli ramis brevibus: fructibus breviter stipitatis.

This is a small species having weak stems sparingly branched and seemingly rose-colored flowers. A few specimens were collected in Chiapas. No. 7526. Type, Herb. Univ. Calif. No. 187693.

Aster spinosus Benth. var. **spinosissimus** var. nov.

Major rigidior: spinis numerosis validioribus ca. 3 cm. longis, quam internodiis longioribus, basi complanatis.

The appearance of this form, on account of its numerous rigid spines, is very different from that common in southern California. The type bears about a hundred stout spines and larger heads terminating short branches arising from the axils of the upper leaves. The species seems to develop its spines better in southern localities. A somewhat similar specimen, but having more slender spines, was collected at San Jose del Cabo. Collected at San Gregorio, Baja California, by T. S. Brandegee. Type, Herb. Univ. Calif. No. 87004.

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NEW PACIFIC COAST MARINE ALGAE I

BY

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Arthrospira maxima Setchell et Gardner sp. nov.

Plate 33, fig. 3

Natans, aeruginea, in algis aliis intermixta: trichomatibus 7–9μ diam., laxe et aperte spiralibus, 3–8 flexubus compositis, 40–60μ diam., aufractibus 70–80μ inter se distantibus, non torulosis; cellulis 5–7μ longis, dissepimentis distinctis; granulis numerosis, crassis, angulatis, refringentibusque et in dissepimentis frequenter dense aggregatis; cellula apicalibus rotundatis, membrana leviter incrassatis.

Trichomes 7–9μ diam., forming an open regular spiral of 3–8 turns 40–60μ diam., 70–80μ between the turns, slightly tapering at the ends; cells 5–7μ long, not constricted, with numerous, coarse, angular, refringent granules frequently crowded at the partitions; end walls of the terminal cells rounded, slightly thickened; color verdigris.

Floating in abundance among other species of Cyanophyceae in warm salt water. Key Route Power-house, Oakland, California. July, 1916.

The habitat of *Arthrospira maxima* is rather unusual. The salt water is pumped from San Francisco Bay into a series of ponds of considerable size. It is then pumped through the electric power-house for condensing steam; it there becomes heated to about 60° C, and is then allowed to run out where it is cooled again to the temperature of the air before being pumped back into the power-house. It thus appears that the plant is subjected to these rather unusual extremes of heat several times a day and yet thrives abundantly.

The genus *Spirulina* was established by Turpin in 1827 (Turpin, 1827, p. 309). He did not mention the transverse cell walls. These cell walls are quite obscure in the small forms of the genus, and this fact led later algologists to regard them as unicellular plants. In 1852, Stizenberger (1852, p. 32) founded the genus *Arthrospira* to receive a spirally twisted filamentous form whose transverse cell walls are plainly visible. Thus the only apparent morphological difference between the two genera is the stated difference regarding the transverse walls. This distinction is made use of by Gomont (1892, pp. 95–96), by Forti (1907, p. 145), and by Kirchner (1900, p. 63). By employing methods of differential staining, Professor W. A. Setchell and I have determined repeatedly that this distinction can no longer maintain. The small, tightly coiled forms are really multicellular, and hence no fundamental difference exists between the two genera. However, since the described species are few and there is not likely to be a very large number of new species added in the future, and since the forms thus far discovered fall rather naturally into two groups, those very small tightly coiled species with obscure cross-walls, and those rather loosely but regularly coiled species with conspicuous cross-walls, all of which are fairly well known, it seems wise, for the sake of convenience, to retain both genera, and emend the diagnosis of *Spirulina*. Certain species of *Phormidium* and *Oscillatoria* can scarcely be distinguished as to the principal generic character, the presence or absence of a sheath. All species of *Phormidium* are at times of active growth after formation of hormogonia without a sheath, and some well-recognized species of *Oscillatoria* may, under certain conditions, develop a sheath. I have observed this in *O. sancta*. The two genera are thus not absolutely distinct, but for convenience they are both kept up. Again, some of the small species of both genera have very obscure cross-walls. In this respect they bear the same relation to the larger species with definite cross-walls that *Spirulina* bears to *Arthrospira;* but in neither *Phormidium* nor *Oscillatoria* has this been considered sufficient to warrant generic distinction. The genus *Arthrospira* would doubtless never have been established if the real character of *Spirulina* had been known at the time.

A very close relationship exists between *Spirulina* and *Arthrospira*, on one hand, and a group of species of *Lyngbya* on the other, as regards the spirally twisting character. Moebius (1889, p. 312) described a new genus from Brazil which he called *Spirocoleus Lagerheimii*, concerning which he say "Diese Alge, für welche ich eine neue Gattung aufstellen muss, steht zu *Spirulina* in demselben Verhältniss wie *Lyngbya* Ag. zu *Oscillaria* Bosc., indem die schraubenförmig gedrehten Fäden mit einer deutlichen Scheide versehen sind." Gomont transferred Moebius' species to *Lyngbya*, and Forti (1907,

p. 287) retains it as such but also retains Moebius' *Spirocoleus* as a convenient subgenus or section of the genus *Lyngbya*, into which he assembles, along with *L. Lagerheimii*, six other species of small dimensions, all of which are more or less spirally twisted. *Arthrospira maxima* is not much unlike *Lyngbya spirulinoides* Gomont, differing generically in the absence of a sheath. However, the sheath of *L. spirulinoides* is said to be inconspicuous. In another instance Forti (1907, p. 207) has retained Rabenhorst's form *vaginata* with "filis subdistincte vaginatis" as belonging to the genus *Arthrospira*.

Spirulina Turp. emend.

Trichomata multicellaria, cylindrica, evaginata, laxe aut dense spiralia spiram laxam aut clausam efficientia; trichomatis apex vulgo aequalis, cellula apicalis rotundata, calyptra nulla; endochroma homogenea aut cum granulis instructa.

Trichomes multicellular, cylindrical, evaginate, loosely or tightly coiled into a more or less regular spiral; apex of trichome usually not tapering; terminal cell rounded, without calyptra; cell contents homogeneous or granular.

Chlorochytrium Porphyrae Setchell et Gardner sp. nov.

Plate 32, fig. 6

Viride; cellulis sphericis, 40–60μ diam., in gelina exteriori hospitis sub superficies geminas positis; chlorophoris singulis, primo parvis demum per plures ramos radiantes emittentes augescentibus et fine parietem cellularum tegentibus; pyrenoide singulo, magno, in chlorophora ad partem superiorem cellulae posito; parietibus cellularum 2–3μ diam., hyalinis, non laminatis; propagatione sexuali a gametibus biciliatis, 3–4μ diam., fusiformibus aut fere sphericis, per foramen ovatum in pariete externo (gametangii) evadentibus; propagatione asexuali a zoosporis aut a akinetibus ignota.

Cells spherical, 40–60μ diam., embedded within the host on both sides; chromatophore single, at first small, covering the upper part of the young plant, then increasing in size by sending out several radiating arms and finally covering the cell wall; pyrenoid single, large, embedded within the chromatophore toward the upper part of the cell; cell wall 2–3μ diam., hyaline, not laminated; color grass-green; sexual reproduction by biciliate gametes, 3–4μ diam., fusiform to almost spherical, escaping through the oval opening in the outer wall; asexual reproduction by zoospores and by akinetes unknown.

Growing completely embedded within the outer membrane of *Porphyra perforata* f. *segregata* Setchell and Hus, Lands End, San Francisco, California, April, 1916.

While collecting algae in the above-mentioned locality, I noticed groups of plants of *Porphyra* on rocks near high-tide limit which were considerably dwarfed and almost as green as the small *Ulva* growing in the same habitat. I suspected the color to be due to the death of the plants on account of their exposed condition, but a casual glance with a hand lens revealed the presence of myriads of small spherical cells of an endophytic unicellular green alga. Material was taken to the laboratory, sectioned and studied. It was found that myriads of these plants in all stages of development were inhabiting the thick gelatinous walls of the *Porphyra* cells. I began at once to search through the literature to determine first to what genus it seemed most closely allied, and second to determine whether it had previously been characterized specifically. The first task has proven to be by no means a simple one. The second one was fairly readily decided. Nothing, so far as I have been able to determine, has yet been discovered that is just like it. It seems certainly to belong to the Protococcaceae, and seems most closely related to the two genera *Chlorochytrium* Cohn and *Chlorocystis* Reinhardt. The limits of these two genera are not well defined, which makes it more or less presumptuous on the part of any one who attempts to ally, with much degree of certainty, a new species with either. Recently West (1916, p. 212) has gone so far as to reduce *Chlorocystis*, along with three other genera of Wille's group Endosphaereae to synonomy, retaining *Chlorochytrium*, it being the oldest, as sufficient to include the other three, which were founded upon characters which in his judgment are of minor importance, not cardinal enought to be ranked as generic. A brief résumé of some of the more important writings concerning these two genera may be of some value at this juncture. It is not intended to be complete by any means. Many other valuable papers bearing on the subject have been consulted. The chief points at variance between the two genera are, the method of formation of "gametes" and "zoospores," the matter of their conjugation, the number of their cilia, the shape of the chromatophores and the number of pyrenoids.

Chlorochytrium is the older of the two genera, and was established by Cohn in 1872 (1872, p. 87), based upon a form endophytic in the fronds of *Lemna trisulca*, which he named *C. Lemnae*. He says of the zoospore formation: "plasmate viride primum in segmenta majora diviso, dein secedente in zoosporas innumeras pyriformes virides processibus tubulosis extus emissas." This method of zoospore formation does not conform to that occurring in the plant under consideration in *Porphyra*. Wright (1879, p. 355) published a new species of *Chlorochytrium* which he dedicated to Professor Cohn.

The most essential difference, he says, between it and Cohn's *C. Lemnae* is the production of two kinds of zoospores, each kind having but a single cilium (concerning which he was very much in doubt), and in the method of their formation, of which he says, "On the cell arriving at an adult stage the whole of the green protoplasmic contents divides into a number of from ten to thirty, nearly circular, zoospores, which escape through the neck-shaped portion." He was not wholly satisfied that the form should be placed in the genus *Chlorochytrium* as diagnosed by Cohn, but placed it there more or less provisionally. One infers that these "zoospores" escape singly, and not simultaneously within a gelatinous utricle in the manner reported by later workers as occurring in the genus *Chlorochytrium*.

Kjellman (1883, p. 320) described *Chlorochytrium inclusum*, stating that it has a single chromatophore covering the entire wall. He states that a large number of "zoospores" are produced, but did not state the manner of their formation, the number of their cilia, nor their method of escape. De Toni (1889, vol. 1, p. 635) in diagnosing the genus says of the chromatophore "disciforme," and of the reproduction "zoospores sexualia vel neutra," that these reproductive bodies have two cilia and are formed by repeated cell division. Wille (1897, p. 65) diagnosed the genus as having a single parietal chromatophore with many pyrenoids, zoospores with four cilia, and gametes, both reproductive bodies formed by successive cell division, and that the gametes escape in a mass surrounded by a membrane in which they conjugate. He did not add any new features to the diagnosis in the *Nachträge* which he published in 1911. The diagnosis given by Collins (1909, p. 146) is very similar to that of Wille, but he states that each kind of reproductive body has two cilia.

The genus *Chlorocystis* was established by Reinhardt in 1885 based upon material collected near Odessa on the Black Sea, which he considered to be the same as that found by Wright on the coast of Ireland upon which he founded his species *Chlorochytrium Cohnii*. *Chlorocystis* was published in Russian and I have not access to the original paper, but I have seen and have made tracings of the drawings. Judging from the drawings and the reviews of Reinhardt's text, as compared with the drawings and descriptions of Wright, I find myself in accord with West (1916, p. 212). It seems to me that the differences between *Chlorochytrium Lemnae* of Cohn and the two collections of plants of Wright and Reinhardt, assuming that they are the same species hardly warrants the establishment of a new genus; that Wright's species, though perhaps incompletely diagnosed, should remain in the genus *Chlorochytrium* of Cohn, as pointed out by West, and that Reinhardt's species from the Black Sea should also be placed in the same genus but given different specific rank, and renamed. I therefore propose the name *Chlorochytrium Reinhardtii*. Moore (1900, p. 100) wrote concerning a plant found by him at Lynn, Massachusetts, growing on *Enteromorpha*, which he reluctantly referred to *Chlorocystis Cohnii*. The plant is well figured and carefully described. If compared with that which seems now to be the general concensus of latest opinions as to what are the most important characters that should constitute the genus *Chlorochytrium*, Moore's plant should be allied with that genus, but is unlike any described species of the genus. I propose the name *Chlorochytrium Mooreii* for the form. It has been distributed in Collins, Holden and Setchell, *Phycotheca Boreali-Americana* (Exsicc.), no. 565, as *Chlorocystis Cohnii* (Wright) Reinh.

There still remain several phases in the life-history of *Chlorochytrium Porphyrae* to be worked out. At the time of collecting the plant, the host, *Porphyra*, was nearing the end of its life-history, that is, the majority of the plants were in the fruiting condition. There are, however, a few plants of this species to be found at all seasons of the year, and the basal parts of the old plants remain for some time after the plant fruits. Probably the endophytic *C. Porphyrae* remains in these older parts over the season unfavorable for growth and infects the newer generations as they appear. The plants become completely embedded within the host and no tube is left behind through which the gametes escape. There is but a single chromatophore, at first covering only the posterior, outer part of the cell. This increases in size, at times thrusting out projections sometimes becoming a network but finally practically always covering the cell wall. In this earlier stage it resembles the chromatophore figured by Reinhardt, the principal character upon which he founded his genus *Chlorocystis*. *C. Porphyrae* differs radically in the method of gamete formation from that described by Reinhardt in his account of the Black Sea plant. The cell divides first into two equal parts, then successively into four, eight, sixteen, etc., up to five hundred or more, depending upon the size of the plant, which may be exceedingly variable; whereas in Reinhardt's plant the "zoospore" formation is by free cell division.

Miss Whitting's *Chlorocystis Sarcophyci* seems to follow the method outlined by Reinhardt in zoospore formation. She states, however, that the cells at times divide into several large sections prior to spore formation, but is unable to interpret the function of such division. It may possibly be that these are the earlier successive divisions which usually result in spore or gamete formation, but which for some reason have been arrested in development. Moore's plant follows the same method as that of *C. Porphyrae* in the matter of the formation of reproductive bodies. Wille and Moore report "zoospores" with four cilia. Concerning this point my observations are incomplete with reference to *C. Porphyrae.* The reproductive bodies formed in this species, so far as I have observed, are gametes. They have two cilia. I have observed them in great abundance, and have observed their conjugation. The gametes escape singly through the surface aperture, instead of the entire mass intact within a utricle as reported for certain species, e.g. that found by Moore.

There is but a single large pyrenoid in *C. Porphyrae*, agreeing in this respect with *C. Mooreii* and *C. Reinhardtii.* Wille characterizes the genus *Chlorochytrium* as having many pyrenoids, but West looks upon that character more as specific than as generic.

West (1916, p. 212) is of the opinion that the shape of a chromatophore can not ordinarily be considered of sufficient stability to be used as a primary basis of generic distinction. I am inclined to agree with him on this point. Both Moore and I have shown that in the forms upon which we have worked the shape of the chromatophore is extremely variable, at times possessing radiating, flattened lobes, only partly covering the cell wall, but usually at maturity covering the entire wall.

The four genera which West has merged into *Chlorochytrium* Cohn ('72) are *Endosphaera* Klebs ('81), *Scotinosphaera* Klebs ('81), *Chlorocystis* Reinhardt ('85), and *Stomatochytrium* Cunningham ('88). They all agree in being holophytic, unicellular, spherical or nearly so, wholly or partially endophytic plants with a single chromatophore, covering the wall more or less completely and containing one or more pyrenoids. Reproduction is by gametes or by zoosphores or by both. The plant which I have discovered and described above, growing in *Porphyra*, possesses these characters and I have consequently allied it with the genus *Chlorochytrium* in the larger sense of West.

Chlorochytrium Porphyrae differs principally from *Chlorochytrium Mooreii* in having only biciliate gametes, as far as known, instead of quadriciliate zoospores of two sizes, as stated by Moore; in being completely embedded within the host, making entrance without the formation of a tubelike projection characteristic of *C. Mooreii* in those instances in which it partially embeds itself; and in size, being 40–60μ diam. as compared with 16–26μ in *C. Mooreii*. It differs from *Chlorochytrium Reinhardtii* in size and in the shape of the chromatophore; *C. Reinhardtii* differs from *C. Cohnii* Wright in shape, size, characters of chromatophore, and reproductive bodies.

Gayella constricta Setchell et Gardner sp. nov.

Plate 33, figs. 5–9, and Plate 32, fig. 5

Filamentis, atro-viridibus, nanis, fasculatis, 1–4 mm. altis, basi 18–20μ, apice ad 175μ diam., cylindrico-clavatis, uncinatis, frequenter intervallisque constrictis, basi parce ramosis; cellulis discoideis, 10–15μ diam., primo et infero totaliter serie singulari, superne longitudinaliter in glomerulis et in duobus aut multioribus planitiebus divisis et diametron filamentorum augescentibus; filamentis plerumque cylindricis longe ad basem attenuatis, apice crassissimis, maturis passim (glomerulis aliquibus cellularum non dividentibus) lente constrictis; parietibus cellularum hyalinis, non stratosis, transversis valde tenuibus; chlorophora singula, cellulam totam fere occupantibus; pyrenoide obscura.

Filaments small, dark green, somewhat tufted, 1–4 mm. high, 18–20μ diam. at the base, up to 175μ at the apex, cylindrical-clavate, uncinate, constricted at frequent intervals, sparingly branched at the base; cells disk-shaped, 10–15μ diam., at first in a single series throughout, remaining so for some distance at the base, but dividing in groups longitudinally in two or more planes above, increasing the diameter of the filament and preserving its cylindrical form in general though gradually becoming larger, the terminal group of cells having the greatest diameter; at frequent intervals groups of 2–6 cells remain undivided vertically, giving a constricted appearance to the mature plants; cell walls hyaline, homogeneous; cross-walls very thin; chromatophore single, occupying nearly the entire cell; pyrenoid obscure.

Growing in depressions and crevices in rock, above high-tide level, kept moist by dashing salt spray. Tomales Point, at the mouth of Tomales Bay, Marin County, California.

This plant was found growing on exposed rocks in company with a species of *Prasiola*. It is a rather unusual coincidence that the only other known species of *Gayella*, viz. *G. polyrhiza*, is also frequently found associated with a species of *Prasiola*. This has led to the belief that *Gayella* is merely a stage in the life-history of *Prasiola*, and indeed Børgesen (1902, p. 482) states that he has found the transition stages between *Gayella polyrhiza* and *Prasiola crispa*. Collins (1909,

p. 222) has retained the two genera separate, however, stating that it is difficult to establish distinctions among *Gayella*, *Schizogonium* and *Prasiola*.

I have had *Gayella constricta* under observation for over eighteen months, having the material of it and the accompanying *Prasiola* growing in the laboratory for over eight months. In some areas on the rocks the two plants are intermingled, but in others they are entirely separate, and the two can be distinguished by size and color, the *Prasiola* being larger and the *Gayella* much deeper green. There has not yet appeared the slightest indications of a metamorphosis of one into the other, though many new plants have started. The evidence thus far at hand is that these two forms should be kept as distinct genera.

I have compared *Gayella constricta* with the material of *Gayella polyrhiza* Rosenvinge, as distributed in Collins, Holden and Setchell, *Phycotheca Boreali-Americana*, no. 914. This distribution, though to a large degree comparatively young, seems to be quite typical, agreeing very closely with the descriptions and figures by Rosenvinge (1893, pp. 936–939). It possesses abundance of rhizoids, which in this instance are mere prolongations of single cells remaining undivided. *G. constricta* differs from *G. polyrhiza* in having fewer rhizoids and these usually much longer and multicellular; in having deep constrictions in the mature filaments caused by failure of certain cells to divide vertically; and in the filaments being uncinate.

Myelophycus intestinalis f. **tenuis** Setchell et Gardner forma nov.

Caespitosus, inconspicue tortus, 1.5–2.5 cm. altus, 0.25–0.75 mm. diam.; sporangiis unilocularibus late ellipticis, 40–45μ longis, 30–35μ latis; singulis aliis ut in specie.

Plants caespitose, inconspicuously twisted, 1.5–2.5 cm. high, .25–.75 mm. diam.; unilocular sporangia broadly elliptical, 40–45μ long, 30–35μ wide; otherwise as the species.

Growing on rocks, usually in sheltered localities at high tide level or even above, where the spray dashes. Common on the central California coast, and known as far north as Coos Bay, Oregon. The type locality is Fort Point, San Francisco, California.

This form differs from the species chiefly in size and in habitat. When the coast between Coos Bay and Puget Sound is more thoroughly investigated forma *tenuis* will doubtless be found growing lower and lower down in the littoral belt as well as becoming larger and larger northward, merging into the Puget Sound form.

Pelvetia fastigiata f. **gracilis** Setchell et Gardner forma nov.

Profuse dichotomo-ramosa; ramis centralibus longioribus, externis curtioribus, plantam totam plus minusve sphericam efficientibus; ramellis curtis densisque ad basem frequenter orientibus; frondibus gracilibus, ramis terminalibus 1–3 mm. diam.

Plants profusely dichotomously branched, central branches becoming much longer than those on the outside of the mass, giving to the whole plant a more or less spherical outline; frequently branches arise from near the base and develop a mass of short branchlets; fronds slender, the terminal branchlets 1–3 mm. diam.; fruiting in the summer and autumn.

Growing in the middle of the littoral belt. Carmel Bay, Pacific Grove and Santa Catalina Island, California. In these localities plants grow in groups quite separate from the typical *P. fastigiata*. The type locality is Carmel Bay, California.

This form, though morphologically connected with the species by plants intermediate in size, seems to be sufficiently distinct to warrant a form name on account of its profuse and delicate branches, and different fruiting season. Plants of forma *gracilis* begin fruiting early in the summer and reach their climax in the late fall, whereas those of *P. fastigiata* reach their maturity two or three months later.

Sargassum dissectifolium Setchell et Gardner sp. nov.

Sargassum piluliferum (Turn.) Ag., Farlow, Anderson and Eaton, Alg. Exsicc. Amer.-Bor., no. 102; Collins, Holden and Setchell, Phyc. Bor.-Am. (Exsicc.), no. 537*a*, not *b*. Not C. Ag., Sp. Alg., 1823, p. 27. Not Yendo, Fucaceae Japan, 1907, p. 54. Not *Fucus pilulifer* Turn., Hist. Fus., vol. I, 1808, p. 145, pl. 65.

Perenne, dioicum; radice solida, rugosa, plus minusve discoidea; stipite tereti, usque ad 18 cm. longa, apice 2–5 ramos teretes alternosque post fructificationem dissolutos ferentibus; ramis primariis ramellos steriles (folia), alternos, frequenter dense congestos, dendroide et dichotomo in 15–25 segmentis parce complanatis, 2–3 cm. longis, costatis, dissectos, gerentibus; ramis vetustis oribus projectis curtis spinosis plus minusve ramosis indutis; ramis secondariis numerosis ex axillis superne curtioribus, inferne longioribus orientibus, folia depauperata eorum frondium principalium similia gerentibus vesiculas et receptacula in axillis producentibus; vesiculis vulgo solitariis, levibus sphaericis, 3.5–6 mm. diam., in apicibus pedicellorum diametron vesiculorum aequantorum; receptaculis in axillis segmentorum stirilium dense dendroide congestis, multo vesicula aut folio depauperato ornatis; frondibus fructiferis saepe nudis, foliis disintegrantibus; conceptaculis conspicuis; cryptostomatibus numerosis.

Frond arising from a solid, rugose, more or less disk-shaped holdfast, 4.5–7 dm. high; stipe terete, up to 18 cm. long, bearing 2–5 terete, alternate branches at its summit, distintegrating after fruiting;

the main fronds give rise to sterile segments (leaves) alternately arranged and often densely crowded, dendroidally and dichotomously dissected into 15–25 slightly flattened segments, 2–3 cm. long, with midrib; older branches covered with short, more or less branched, spinose projections; numerous lateral, terete, secondary branches arise in the axils of the leaves, longer below, shorter above; these bear reduced leaves similar to those on the main fronds, producing vesicles and the receptacles in their axils; vesicles usually solitary, smooth, spherical, 3.5–6 mm. diam., on the ends of the pedicels about as long as the diameter of the vesicles; receptacles in a dense dendroid group in the axils of the sterile segments, often with a vesicle or reduced leaf as a part of the group; the fruiting fronds often appear nude as the leaves wear away; conceptacles conspicuous; dioeceous; cryptostomata abundant; plants perennial.

Growing in the upper sublittoral belt. Abundant at Santa Catalina Island, and probably grows in similar habitats along the coast of the mainland of southern California, as it is frequently cast ashore there. Known also from Guadalupe Island, Lower California.

Sargassum dissectifolium has been known as *S. piluliferum* since its distribution in Farlow, Anderson and Eaton's *Algae Exsiccatae Americanae-Boreales*, no. 102. It was discovered by Dr. E. Palmer in 1875 at Guadalupe Island, Lower California. It seems quite evident from a comparison of the literature that two plants have been confused under this name. The material upon which Turner described his *Fucus pilulifer* was from Japan. C. Agardh transferred the species to the genus *Sargassum* in 1823, and J. Agardh retained the species in 1848, both referring to the Japanese plant as described by Turner. But when Agardh published his *Species Sargassorum Australiae* in 1889, the description which he rendered on page 55 is more nearly suited to our plant than to the Japanese plant; however, he refers to both and evidently considered them to be identical. Yendo (1907, p. 57) has called attention to the dissimilarity between the American and the Japanese species, after a careful comparison of the plant distributed from Guadalupe Island by Farlow, Anderson and Eaton, with the Japanese species. The plant in our waters differs from that in the Japanese waters chiefly in having a prominent terete stipe and terete branches instead of being compressed, or ancipitose and midribbed; and in having the leaf segments finer, more dissected, flattened slightly and midribbed. It also differs in other minor details. Considering all of these differences together, it seems quite desirable and necessary to separate the two and give our plant a new name.

There have been three other species of *Sargassum* detected in the waters of the Pacific Ocean on the coast of the United States and Mexico, viz. *S. Agardhianum* Farlow, *S. Liebmanni* J. Ag., and *S. paniculatum* J. Ag. *S. Agardhianum* is the best known of these. It was named by Farlow in 1876 (p. 706) based upon material collected at San Diego, California. The description was first published in J. Agardh's *Species Sargassorum Australiae* (1889, p. 93). It has been distributed in Farlow, Anderson and Eaton's *Alg. Exsicc. Amer.-Bor.*, no. 103, in Collins, Holden and Setchell's *Phyc. Bor.-Amer.* (*Exsicc.*), nos. 179 and CXVIII, and in Hauck and Richter's *Phykotheka Universalis* (*Exsicc.*), no. 667. Its geographical distribution, as at present known, extends from the vicinity of Los Angeles to Point Loma, southern California, and the adjacent islands. *S. Liebmanni* was first collected on the west coast of Mexico by Liebmann and specimens finally came into the hands of J. G. Agardh, who published it (1847, p. 8). We have no further record of its occurrence elsewhere. There is a single fragment of *S. paniculatum* J. Ag. collected by E. Palmer on Guadalupe Island off the coast of Mexico, and contributed by Professor W. G. Farlow to the herbarium of the University of California under herbarium number 170615. The determination rests upon the authority of Th. Reinbold. This species seems quite limited in distribution in our waters, Guadalupe Island being the only locality in which it is known to occur. T. S. Brandegee collected specimens of a form on the coast of Lower California which resembles *S. paniculatum* quite closely and should probably be referred to that species. Howe (1911, p. 496) mentions fragments of two species of *Sargassum* collected by G. J. Vives at La Paz, Mexico, but they were too fragmentary for identification with certainty.

Cystoseira neglecta Setchell et Gardner sp. nov.

Plates 35–36

Dilute fusca, siccitate atra, 4–7 dm. longa, stipite e radice irregulariter conica et fibrosa, flexibili, parce dichotoma, 5–15 cm. longa, 4–6 mm. diam., in sectione transversali triangulari, superne in ramis complanatis alternatim sub puncto vegetationis apicali positis producente; ramis complanatis coriaceis, flexibilibus, siccitate rigidis fragilibusque post fructificationem deciduis et cicatrices angulares persistentesque in stipite efficientibus, juvenis in lobis rotundatis alternisque sinubus rotundatis divisis, lobis mediis infernisque 2–3 pinnatifidis, supernis in ramulis cylindricis cum receptaculis numerosis terminalibus repetite divisis; vesculis aeriferis in ramis supernis cylindricis positis, solitariis aut paucis in seriebus, sed 1–3 mm. distantibus, sphaericis, levibus, 2–3 mm. diam.

Stipe arising from an irregular conical-shaped, somewhat fibrous holdfast, flexible, rather sparingly forked, 5–15 cm. long, 4–6 mm. diam., triangular in cross-section, giving rise to flattened branches alternately arranged just below the terminal growing point; flattened branches coriaceous, flexible, becoming rigid and brittle when dry, dying back after fruiting, leaving a permanent angular scar on the stipe, when young divided into rounded alternate lobes by a deep sinus rounded at the base; the lobes of the lower and middle portion of the branches become 2–3 times pinnatified, and the upper lobes become repeatedly divided into cylindrical branches terminating in numerous receptables; air vesicles develop in the filiform branches, solitary or a few in a series but separated 1–3 mm. from each other, spherical, smooth, 2–3 mm. diam.; whole plant 4–7 dm. long; color of living plant light brown, turning black when dry; perennial; dioecious.

Growing in the upper sublittoral belt at Avalon, Santa Catalina Island, California.

Type numbers are 188975 and 188976, herbarium of the University of California.

From time to time within the past few years, fragments of the upper part of a plant resembling *Cystoseira Osmundacea*, especially resembling the upper part of forma *expansa* of that species, have been collected along the coast of southern California. Until recently the plants had not been seen growing in position, the fragments found always having been cast ashore. On this account it was presumed that the species was a deep-sea form, as nobody had seen it growing in position. In a previous paper (1913, p. 336) I suggested that these fragments would probably be found to belong to an undescribed species as soon as the whole plant could be discovered. While visiting Santa Catalina Island, about twenty-five miles off the coast from San Pedro, California, I had the good fortune to discover the same species growing in position in the locality from which the fragments cast ashore on the mainland had probably come. Many fragments were seen floating in the vicinity. The plants grew in abundance in the harbor at Avalon, mostly in the upper sublittoral zone. The discovery was made in March, 1913.

On account of profuse branching in the upper parts of the fronds, when the water is quiet the plants present the appearance of clumps of densely branching shrubs about two feet high.

It is not a simple task to decide what to do with a new plant belonging to the cyst-bearing group of the Fucaceae. Since the establishment of the genera *Cystoseira* Ag. ('21), *Blossevillea* Dec'sne ('40), *Cystophora* J. Ag. ('41), and *Cystophyllum* J. Ag. ('48), so many different forms have been discovered and described that the limits of these genera have become poorly defined. As I pointed out in a previous paper (1913, p. 327), all of the well-defined species of *Cystophora* should be placed under the genus *Blossevillea* according to the Vienna rules governing priority. *Blossevillea* was created to receive a fairly well-defined group of Fusaceae growing in the southern hemisphere. The chief difficulty now remains—to understand and interpret the limits of the genera *Cystophyllum* and *Cystoseira*. Harvey points out that the distinction between these two genera lies in the fact that *Cystophyllum* has the cysts limited to the terminal ramuli, and only the receptacular ramuli lie beyond, terminating the branchlets, while the cysts in *Cystoseira* are not limited to the terminal ramuli. Kjellman (in Engler and Prantl) makes use of the same characters in separating the two genera, as has K. Yendo also (1907), but none of these authors have made any attempt to separate, according to the above-mentioned marks of distinction, the thirty-five or more species that are now listed under these two genera. It does not seem to the writer that these characters are of sufficient stability and importance to be made use of as generic distinctions, since one may find both conditions in the same species; and if a revision of the genera based upon them should be made, it would necessitate many transfers, some of which might not be desirable. *Cystoseira Osmundacea* would become *Cystophyllum Osmundaceum* because most of the cysts are in the terminal branches. But on account of the fact that some plants have a portion of the earliest formed cysts back among the vegetative branches, one may be justified in permitting the species to remain where it is, although on the border line if the position of the cysts only is taken into consideration.

With very rare exceptions the cysts of *C. neglecta* diagnosed above are in the terminal branches and only the receptacular branches are beyond, which would place it in the genus *Cystophyllum*, but the general aspect of the species, from the holdfast to the apex, throughout, is so similar to *Cystoseira Osmundacea* as to leave but little doubt as to its close affinity to that species. This conclusion is further strengthened by the fact that both grow in the same general locality. I am unable at present to make a critical revision of these two genera on account of the lack of adequate material for study. There is much need, however, of such a critical study, that a more satisfactory basis for distinction may be established. If such distinction can not be discovered the two genera should be combined.

Petrocelis franciscana Setchell et Gardner sp. nov.

Plate 33, fig. 1

Petrocelis Middendorffii (Rupr.) Kjellman, Collins, Holden and Setchell, Phycotheca Boreali-Americana, no. 900 (not Phyc. Bor.-Amer., no. 1548); Tilden, American Algae, no. 202. The *Petrocelis Middendorffii* (Rupr.) Kjellman mentioned in Setchell and Gardner (1903, p. 357) is probably correctly referred, although the material is sterile, making its determination somewhat uncertain.

Thallo cartilagineo-gelatinoso, plus minusve orbiculariter expanso, ad saxa arcte adhaerente, brunneo-rubro, siccitate nigro, 2–2.5 mm. crasso; strato basali cellulis maxime anastomosantibus composito, filamenta verticalia parallela, in zonis anastomosantia parce ramosa et parietibus crassis gelatinosisque induta producenti; protoplastis in filamentis verticalibus 3–5.5μ diam., quadratis aut 2.5– plo diametro longioribus; tetrasporangiis intercalaribus, zonam ab superficie externa 25 cellulis distantem occupantibus, singulis, sphericis ad anguste ellipticis, 25–40μ longis, 20–28μ latis; cystocarpis antheridiisque adhuc ignotis.

Thallus of firm gelatinous consistency, forming more or less circular expansions of indefinite size, closely adhering to rock, color, dark brownish red, black when dry, 2–2.5 mm. thick; thallus consists of a basal layer of profusely anastomosing cells from which arises a much thicker layer of perpendicular filaments parallel with each other, anastomosing in zones and slightly branched, having thick gelatinous walls; protoplast in the perpendicular filaments 3.5–5μ diam., quadrate to 2.5 times as long; tetrasporangia intercallary, occupying a zone about 25 cells from the outer surface, varying from spherical to narrowly elliptical, 25–40μ long, 20–28μ diam.; cystocarps and antheridia unknown; plants perennial.

Type specimen in the herbarium of the University of California, no. 188973. The type locality is Fort Point, San Francisco, California.

Common in the upper littoral belt along the California coast.

Petrocelis franciscana is probably the most abundant and most widely distributed of all the rock-incrusting algae on our coast. It has been known for many years under the name of *Petrocelis Middendorffii* (Rupr.) Kjellman, because of its general resemblance to the plant figured and described by Ruprecht in 1851 under *Cruoria Middendorffii.* The material of Ruprecht's *C. Middendorffii* was collected in the Ochotsk Sea. His figure indicates that the specimens from which he drew it were just beginning to form tetrasporangia, as none of these show the mature tetraspores formed. The base of the plant, as figured and described by Ruprecht, consists of rows of small, closely set parenchymatous cells, and the upper portion consists of filaments more loosely held together by gelatinous walls. These vegetative characters belong to the genus *Petrocelis* as now understood and Kjellman removed the species to that genus in 1883. Ruprecht, in discussing the relation of *C. Middendorffii* to *C. pellita*, says that the former has a much more highly developed basal tissue.

Kjellman in discussing a *Petrocelis* from the Arctic Sea states that he thinks it conforms to the description of the Ochotsk plant of Ruprecht, agreeing with him in his opinion as regards the difference between the Ochotsk plant and the European *Cruoria pellita*, and thus places the Arctic Sea plant under *P. Middendorffii,* stating that it differs from *P. cruenta* in having "a more strongly developed basal layer, by the vertical cell-rows being often branched, and, above all, by the different shape and position of the tetrasporangia."

I have examined a portion of the Arctic Sea plant in the Herbarium of the University of California from northern Norway marked *C. Middendorffii* by Kjellman, and the vegetative characters seem to agree with those of the Ochotsk plant as described by Ruprecht. The specimen, however, is sterile, and nothing can here be said definitely concerning the identity of the Arctic Sea specimen and the Ochotsk plant. Our Pacific Coast plant does not agree in structure with the Arctic Sea plant, and judging from the descriptions alone, as no specimens of the Ochotsk plants are available, our plant is sufficiently different from that to warrant a new description and new name.

Usually about one-fourth of the thallus of *P. franciscana* consists of a compact mass of cells which in the growing region around the margin are somewhat parenchymatous and which may remain so for some time in certain parts of the thallus, but which later increase considerably in size and join with each other profusely by short lateral projections of the protoplasts. The basal layer gives rise to the perpendicular filaments whose cells have thick gelatinous walls. Reproduction as at present known is wholly by intercalary tetrasporangia formed by the direct transformation of vegetative cells, one in a filament usually, with cruciate tetraspores. The tetrasporangia are 20–28μ wide, and up to 40μ long. These grow in great abundance in a zone usually about twenty-five cells from the outer surface. The tetrasporangial zone is about fifteen cells wide, one tetrasporangium in a filament but not all developing at the same level. There is considerable difference in the shape of the tetrasporangia. Age seems to be one of the governing factors in this respect. The first indication of their formation is seen to be the enlargement of a cell usually of equal dimensions. The cell remains square in section for some time, and then begins to enlarge, in some instances becoming spherical and in others narrowly ellipsoidal. Plants with these differences may be found growing close together on a rock, or different parts of the same specimen may possess them. I have not been able to discover any other constant difference to accompany this difference in size of tetrasporangia and hence am unable to separate species on spore characters alone.

Plants fruit during the months of December, January, and February. By the last of March practically all of the spores have been shed and all of the tissue from the sporangial zone has sloughed off. Prior to this time many of the cells in a zone just beneath the fruiting zone have anastomosed by sending out short tubes, thus binding the filaments together. Then the outer part of the thallus is regenerated by branches from some of the cells in the anastomosing zone. Thus the species is perennial, but the length of time the individual may persist has not been determined. Its chief competitor for rock area in this vicinity is the genus *Hildenbrandtia*. *Petrocelis* seems generally to override it.

In some instances in which the plants are abundant it is not an easy matter to determine the limits of the individuals since they become confluent, but individual plants have been observed that are ten inches across, and doubtless many may attain a much greater expansion. I have observed rock areas of many square feet completely covered by the plant.

P. franciscana differs from *P. Middendorffii* in having anastomosing cells at the base and in zones in the erect filaments, in having larger tetrasporangia, up to 28μ wide, while those of *P. Middendorffii* are but 9–9.5μ wide, and in being much larger in every way.

Hildenbrandtia occidentalis Setchell sp. nov.

Plate 33, fig. 4

Thallo saxicola, tenaciter adhaerenti, 1–2 mm. crasso, indefinite expanso, saturate purpureo rubro, siccitate in saxis nigro, filamentis minutis, compactis, parallelis et substrato perpendicularibus composito, firmo haud gelatinoso; cellulis filamentorum 3–4.5μ diam., quadratis aut 2–3 plo quam diametro longioribus; parietibus cellularum tenuibus firmisque; conceptaculis numerosis in thallo conspersis, cylindricis, 200–300μ profundis, ampullaeformibus, ad faucem constrictis, 100–150μ latis; tetrasporangiis zonatis 25–32μ longis, 9–10μ latis; parietibus tenuibus ad parietes internos conceptaculorum perpendicularibus; paraphysibus nullis.

Thallus firmly adhering to rock, 1–2 mm. thick, of indefinite expansion, consisting of small compact filaments of uniform diameter perpendicular to the rock and parallel to each other, firm, not gelatinous; color dark purplish red, black when dry on the rocks; cells of the filaments 3–4.5μ diam., quadrate or 2–3 times longer than the diameter; cell walls thin and firm; conceptacles numerous, generally distributed over the surface, 200–300μ deep and flask-shaped or up to 800μ deep and cylindrical, constricted at the opening, 100–150μ wide; tetrasporangia 25–32μ long, 9–10μ diam., thin walled, perpendicular to the inner wall of the conceptacle; tetraspores seriate; paraphyses absent; antheridia and cystocarps unknown.

Lands End, San Francisco, California, W. A. Setchell, Cypress Point and Pebble Beach, Monterey County, California, Fort Point, San Francisco, California, N. L. Gardner. The type is no. 188974, Herbarium, University of California, from Lands End.

In the month of December, 1913, while collecting algae in the vicinity of Pacific Grove, California, I came across extenisve areas of rock at Cypress Point covered with a more or less continuous layer of a red alga of the appearance of *Hildebrandtia*. A portion of the rock ledge there is composed of decaying granite and it was easy to remove specimens having a granular appearance. It was found that the plant had completely invested particles of granite that had become loosened, and the roughened appearance of the surface was due to those small inclosed particles rather than to cystocarps which I had hoped to find. The plants, however, proved to be in good tetrasporic condition. Since then, in December 1915, I have visited the same place and found the same plant in the usual abundance. On examining incrusted rocks in other localities I find that the same species is quite common along the California coast and when growing on firm, smooth rock becomes considerably thicker, smoother and darker colored, becoming almost black when dry. I collected fine tetrasporic material at Pebble Beach, Carmel Bay, and at Fort Point, San Francisco, and Professor Setchell has also collected material at Lands End, San Francisco. The material collected by Professor Setchell has the conceptacles up to 800μ, or nearly a millimeter deep and quite narrow and cylindrical. The material collected at Fort Point is in general a little thicker than the Lands End material, but the conceptacles average only about one-half as deep. Otherwise the plants around San Francisco are like the southern forms. The species usually grows in the upper half of the littoral belt, but in March, 1916, I found plants growing on rocks near the limit of mean low tide at Moss Beach, San Mateo County, California. These plants were of a brighter red color than those found growing higher up on the rocks. Further search and investigation will doubtless extend the range of the species much to the north and to the south of its present known limits.

Professor Setchell has suspected for several years that this form had not been described and some time ago gave it the provisional name *Hildenbrandtia occidentalis.* He had not been fortunate, however, in collecting it in its fruiting season and had thus not been able to verify his suspicions. Ample fruiting material having now been assembled, it can no longer remain in doubt that the form has not previously been described. The publication has been somewhat delayed on account of a recent discovery we have made which involves the relationship between the genera *Hildenbrandtia* and *Besa*, the latter of which was published by Professor Setchell (1912, p. 236), based on material collected at Lands End, San Francisco. The material was very limited in quantity, growing on a single rock. The diminutive papillae were looked upon as parasitic upon a broadly expanded rock-encrusting form which was considered at the time to be *Hildenbrandtia*, and although no tetraspores were found the structure made it appear to be the same as *H. occidentalis* which has since been found to grow in profusion in the same locality. Recently we have found abundance of material of *Besa* growing on the same rock on which it was originally discovered. Also I have found it growing in much greater abundance near Cypress Point, Monterey County, California, and have carefully prepared quantities of very thin sections by means of a freezing device. This has enabled us to determine what Professor Setchell suspected might prove to be the case, viz., that these papillae actually belong to the expanded basal thallus, being specialized developments to bear the carpogonia and the antheridia, the latter of which had not been seen until recently. The similarity of structure between the sterile thallus of *Hildenbrandtia* and *Besa* makes it appear as though they are merely the sexual and the nonsexual plants of the same genus. As the plants of the two genera grow at Lands End, there is a very slight difference in the size of the cells of the two genera, but the difference is not greater than is ordinarily allowed within the limits of variation in a species. Two conditions met with, however, seem to militate against the two forms belonging to the same species. At Cypress Point *Besa* grows in profusion, but I was not able to find any tetrasporic *Hildenbrandtia.* Material of *Hildenbrandtia* scraped from the rocks and placed either in sea water or in formaline immediately give up a bright orange-colored pigment, whereas plants of *Besa* collected in the same locality when treated likewise do not give up their pigment. It seems best at present to keep the two genera separate awaiting further evidence of connection or distinction. If tetraspores can be found on papillae of *Besa* the question of the distinctness of the two genera will be cleared up.

The only other species of *Hildenbrandtia* known on the Pacific coast of the United States with which *H. occidentalis* is at all likely to be confused is the one that has passed under the name of *H. prototypus* Nardo. The thallus of *H. prototypus* is very much thinner, of a rose-red color, the conceptacles shallower and the tetrasporangia cruciately or irregularly obliquely divided.

Hariot (1889, p. 81) has described a species, *Hildenbrandtia Le Cannellieri*, from the vicinity of Cape Horn, which is the same as *H. occidentalis* in the method of tetraspore formation, but is much thicker, up to 8 mm. thick, has broad, flasked-shaped conceptacles and has paraphyses. *H. occidentalis* has no paraphyses, but the conceptacles quite frequently have slender, branched fungal hyphae in them.

Coriophyllum Setchell et Gardner gen. nov.

Thallus tenuis, coriaceus, expansus, plus minusve orbicularis filamentis gracilibus dense intertextis sub plano medio thalli radianter expansis horizontalibusque, supra et infra medium filamentis dense aggregatis verticalibus et parce anastomosantibus in zonis compactis compositus; in crassitudine per divisionem cellularum filamentorum verticalium et in peripheria per divisionem cellularum strati medii ad margines augens; sporangia cruciate divisa in nematheciis vage effusa et in magnitudine variabilibus paraphysibus comitata, ad superficiem superam orienda; antheridia et cystocarpia adhuc ignota.

Thallus forming a thin, coriaceous expansion more or less circular in outline and consisting of a tissue of fine, closely interwoven anastomosing filaments extending radially through the thallus slightly below its median plane; this tissue gives rise to a zone of tissue above and below consisting of a compact mass of fine, perpendicular, slightly anastomosing filaments; increase in thickness is accomplished by division of cells of the perpendicular filaments and in circumference by division of cells of the median tissue at the periphery; tetrasporangia with cruciate tetraspores are developed among paraphyses forming nemathecia of indefinite shape and size on the upper surface; antheridia and cystocarps unknown.

Coriophyllum expansum Setchell et Gardner gen. et sp. nov.

Plate 33, fig. 2

Thallo purpureo-rubro, 500–800μ crasso, 5–8 cm. diam., ad saxa laxe et sine rhizoideis adhaerente; cellulis filamentorum verticalium 8–12μ longis, 4–6μ crassis; sporangiis anguste ellipticis, 60–70μ longis, 22–28μ latis, pedicello unicellulari suffultis; paraphysibus numerosis, leviter clavatis, 10–14 cellulis compositis, supra maxime ad centrum nematheciorum curvatis, infra 3μ diam., supra 4.5μ diam.

Thallus dark purplish red, 500–800μ thick, 5–8 cm. in diameter, adhering loosely without rhizoids to the rocks; cells of perpendicular filaments 8–12μ long, 4–6μ wide; sporangia narrowly elliptical, 60–70μ long, 22–28μ wide, on a one-celled pedicel; paraphyses numerous, slightly clavate, 10–14 celled, the upper part curved mostly toward the center of the nemathecia, 3μ in diameter below, 4.5μ above.

Growing near the high tide limit at Cypress Point, Monterey County, California, December, 1913 and 1915. The type is no. 188972, Herbarium of the University of California.

While collecting *Hildenbrandtia* material at Cypress Point, I noticed a few small areas of rock a little below high-water mark covered by a plant that seemed to be somewhat different from the surrounding incrusting forms. A little closer inspection led me to remove some of the material, which was of a more leathery consistency and more easily removed than the other forms. The material was only superficially examined at the time and then laid away for future study. Not until nearly two years after, when those incrusting forms were singled out for special study, was the structure of the plant revealed. It is found to conform to the description of no known genus and the name *Coriophyllum* is here proposed to receive the plant.

The systematic position of *Coriophyllum* will necessarily have to remain in doubt until the sexual plants are discovered. It is placed only provisionally in the squamariaceae. It is very closely related to *Rhododermis* in the manner of the formation of the tetrasporic nemathecia, but in its vegetative characters it is quite remote from that genus. The tetrasporangia are developed on short pedicels among numerous slender clavate paraphyses, which are quite markedly curved in the terminal portion. The differentiation of the thallus into a central horizontal layer and a cortical layer above and below (pl. 33, fig. 2) is suggestive of relationship with some of the membranaceous forms which are attached only at the base by a small holdfast. However, the thallus of *Coriophyllum* is not symmetrical with respect to the relation of upper and lower surfaces to the central layer. The upper surface is more highly developed than the lower, and bears the nemathecia.

Coriophyllum has some resemblances to *Ethelia*, a subgenus of *Peyssonnelia* established in 1913 by Mrs. A. Weber-von Bosse, to include certain forms from the Indian Ocean which differ from true *Peyssonnelia* in having a "mesothallus" instead of a basal or "hypothallus." As shown in her diagram, the cells of the mesothallus are compact and almost parenchymatous, and the plants are wholly sterile. *Coriophyllum* has a median tissue composed of very delicate anastomosing threads. The relationship to the Indian Ocean plant can not be established until more is known of the methods of reproduction in both, particularly in *Ethelia*.

This is the only known rock-incrusting form of uncalcified Rhodophyceae on our coast in which there is such a marked differentiation in the histological character of the thallus. The central layer of filaments give off numerous branches above and below, and these soon assume a perpendicular position and are unbranched, parallel and adnate to each other, thus forming a very compact cortex considerably thicker above than below. There are no rhizoids developed as in *Peyssonnelia*, and the thallus as found growing at Cypress Point is more or less raised up from the rock, particularly in the older parts. Careful observation will probably reveal the presence of this plant in other localities along our coast; its close resemblance to other incrusting forms have protected it from being observed.

Cumagloia Setchell et Gardner gen. nov.

Frons e radice solida discoidea oriens, vulgo teres, flaccida, gelatinosa, simplex aut parce furcata, ramellis numerosis, brevibus, patentibus multifariis, vage positis, simplicibus aut 1–2 ramosis induta; antheridia solitaria in apicibus filamentorum repetite 2–3 chotomo ramosorum corticalium posita; carpogonium in trichogynum longum rectum et gracile productum, in fronde profunde positum, ramellis 2–cellulari suffultum; filamenta gonimoblastii e carpogonio fructificato orienta, repetite ramosa primo horizontalia demum in exteriorem partem curvantia, cum filamentis corticalibus intertexta et carposporas numerosas immediate sub superficiem externam frondis formantia; cystocarpia vage limitata; tetrasporangia adhuc ignota.

Frond arising from a solid disk-shaped holdfast, usually terete, flaccid, gelatinous, main fronds simple or sparingly forked, producing at right angles numerous short branchlets from all sides without definate arrangement, some of which may be in turn once or twice branched; antheridia solitary on the ends of repeatedly dichotomously or trichotomously branched cortical filaments; carpogonium, with long, slender, straight, trichogyne, deep-seated, on a two-celled branch; gonimoblastic filaments arise directly from the fertilized carpogonium and intermingle with the cortical filaments, repeatedly branching, at first horizontally and later bending outward, producing numerous carpospores just beneath the surface of the frond; cystocarp not definitely delimited; tetrasporangia unknown.

Cumagloia Andersonii (Farlow) Setchell et Gardner

Plate 31, figs. 1–4, and Plate 32, figs. 1–4

Solitaria aut paucae e radice communi orientes atropurpurea, dioica; 15–20 cm. alta, 2–3 mm. diam.; frondibus solidis aut aetate provecta alequando saccatis.

Plants solitary or in small clusters arising from a common holdfast, solid or in age occasionally saccate, 15–20 cm. high, 2–3 mm. diam.; color dark purplish red; dioecious.

Growing on rocks in the upper littoral belt, even above high-tide limit when growing on rock ledges covered by surf. It has been collected at the following localities along the Pacific coast of the United States: La Jolla, Mrs. Mary S. Snyder and Miss Minnie Reed; San Pedro, Mrs. H. D. Johnston; Carmel Bay, W. A. Setchell and N. L. Gardner; Pacific Grove, D. A. Saunders, B. M. Davis and M. A. Howe; Moss Beach, San Mateo County, W. A. Setchell and N. L. Gardner; Lands End, San Francisco, R. E. Gibbs and W. A. Setchell, all of the above localities being on the coast of California; Seal Rocks, Oregon, A. R. Sweetser; Chehalis Bay, Washington, Ralph Emerson. Specimens from all the above mentioned localities are in the herbarium of the University of California.

Nemalion Andersonii Farlow, Proc. Amer. Acad., vol. XII, p. 240.

Cumagloia is quite similar to *Nemalion* in vegetative characters but differs in the method of origin and in the structure of the cystocarp. It was discovered by Dr. C. L. Anderson at Santa Cruz, California. Anderson sent material to Professor W. G. Farlow of Harvard University, for study and determination. The material not producing cystocarps, Farlow was unable at the time to place the plant with certainty in any known genus, but on account of its structure he felt that it was closely allied to, if not identical with, the genus *Nemalion*, but unlike any described form of that genus. He named it for the discovered and published a diagnosis in the Proceedings of the American Academy of Arts and Sciences, in 1877. The plant has been known in the literature ever since under that name. Some time ago, at the suggestion of Professor W. A. Setchell, I began the collection and study of material at different seasons and different localities along the California coast with the hope of being able to obtain material in condition to show the young stages in the development of the cystocarp. As a result, I am now able to give the following account of the genus.

Farlow remarked that his *Nemalion Andersonii* differs from other species of *Nemalion* in being dioecious, as he had only the antheridial plants or sterile ones from which to judge. I soon discovered that *Cumagloia Andersonii* is a dioecious plant; at least, all of the specimens thus far examined have been either antheridial or cystocarpic. Plants may be found in the future which are, however, monoecious. I make this reservation because I have found that *Nemalion lubricum* which grows along the California coast and to which *Cumagloia Andersonii* is closely related, is not constant in this respect, but is mostly dioecious, with an occasional well-developed normal monoecious plant. In an aggregation of matured plants consisting of both sexes, it is usually easy to segregate the sexes on morphological characters alone, the antheridial plants as a rule being larger, with longer branchlets, less profusely branched, and lighter in color.

Plants range in size from a few inches up to over two feet in length. Those which have come to us from the northern regions are the smallest. Those on the California coast average about six inches long. The diameter of the main fronds is about 2–3 mm. The holdfast is solid and disk-shaped. Frequently several fronds arise from the same holdfast (pl. 31, figs. 3–4), and possibly this may persist for more than one fruiting season. At least I have noticed small young fronds just arising by the side of mature plants on the same holdfast. The fronds are usually solid, but occasionally plants growing high up on rock ledges where they are exposed to the air a considerable portion of the time may become saccate (pl. 31, fig. 4).

The fronds are composed of a few slender, sparingly branched filaments with gelatinous walls extending lengthwise through the center, and connected here and there to other similar filaments extending lengthwise of the frond in a circle around the center. These latter filaments in particular are composed of alternating long cells and very irregularly shaped short, joint-like cells. These joint-like cells give rise to the cells which connect with neighboring filaments and particularly to the filaments which compose the cortex. The cortical filaments remain unbranched for two or three cells usually, then branch dichotomously or rarely trichotomously for three or four divisions, ending in more or less pear-shaped cells which form the compact surface layer. When the antheridia are to be developed, one and sometimes both of the dichotomies of the division next to the last one in forming the cortex remain short and divide several times, usually dichotomously, but not infrequently trichotomously, finally ending in very small cells in which the spermatia develop, one in each terminal or antheridial cell (pl. 32, fig. 1). The anteridia are usually distributed over the whole frond, except on the stipe-like portion.

The carpogonial branches arise close to the growing point, usually on the second cell from the joint-like cell. Each carpogonial branch is one of the dichotomy which seems to have been suppressed in growth while the cell which gave rise to it continues to grow. This in time makes the carpogonium seem to have arisen laterally. Usually the carpogonial branch becomes three-celled, the terminal cell becoming the carpogonium (pl. 32, fig. 3). Plants have been observed with three and even four sterile cells composing the carpogonial branch, but even on these plants the two-celled branch predominates. The carpogonium has a long, slender trichogyne which extends straight out beyond the surface of the plant (pl. 32, fig. 3).

The characteristic feature in the development of the cystocarp is the direct origin of the gonimoblastic filaments from the fertilized egg without its previous division several times as in *Nemalion*. Several of these arise successively from the carpogonium by a pushing out of its cell wall at definite points (pl. 32, fig. 2). The protoplasm in these young gonimoblasts is soon cut off from the mother cell by a cross-wall, after which they continue to grow out more or less horizontally or obliquely among the cortical filaments, becoming more or less contorted and frequently branched, the branches constantly tending obliquely outward and terminating about one cell beneath the surface of the plant. The end cells of the gonimoblasts become the carpospores, which are considerably larger than the neighboring cortical cells though very similar in shape. There is no sterile tissue surrounding the cystocarp and no carpostome, the spores escaping from the point of their origin. The cystocarps are thus more or less diffuse, irregular in outline, do not produce a protuberance and hence are inconspicuous (pl. 32, fig. 4). They are quite numerous and are developed both on the branches and on the main frond except near the base. After fertilization the two or three cells of the branch on which the carpogonium develops become much enlarged and the protoplasm very dense, staining deeply with acid fuchsin.

With this understanding of the structure of *Cumagloia Andersonii* as revealed by this investigation, it now becomes necessary to endeavor to point out its relationship to other members of the Rhodophyceae. After stating that a description of *Nemalion Andersonii* had been published in the Proceedings of the American Academy, Farlow remarks: "Since then I have received from Mr. C. C. Merriman a *Nemalion* from St. Kilda, Australia, which bears strong resemblance to the California alga and the question arises whether it may not be that both should be regarded as forms of *Nemalion ramulosum*, Harv., described from New Zealand." Through the courtesy of Professor Farlow to Professor Setchell I have been able to make a careful examination of a bit of a fruiting plant from the above mentioned material from Mr. Merriman designated as *N. ramulosum* Harv. I find the specimen to be monoecious, thus differing in this respect from *Cumagloia Andersonii*, and that the cystocarps are of the regular *Nemalion* type, the carpogonium dividing into several cells from which develop numerous slender gonimoblasts. The gonimoblasts grow compactly together in an erect fascicle, are 8–10 cells, or 70–80μ, long and branch above, so that a longitudinal section of the cystocarp appears fan-shaped. As the cystocarp grows the cortical filaments are pushed aside so that there is no intermingling of cortical and gonimoblastic filaments. The material examined is too old to reveal the early stages in the development of the carpogonium and of the cystocarp. It thus will be seen that this plant ascribed to *N. ramulosum* Harv. as well as other *Nemalions* differ from *Cumagloia Andersonii* essentially as regards the character and development of the cystocarp.

Another genus in Helminthocladiaceae to which *Cumagloia* seems to be closely related is *Dermonema*. The origin and shape of the carpogonium in each is very similar. The nature and ramification of the gonimoblastic filaments of *D. dichotomum* Harv., as figured by Schmitz, are similar to those of *Cumagloia Andersonii*, but the division of the fertilized carpogonium previous to the development of the gonimoblasts, as figured by Heydrich, is a character belonging to *Dermonema* and *Nemalion* rather than to *Cumagloia*.

It may be noticed at this juncture that there exists in the genus *Nemalion* an excellent series of species representing stages of complexity of development of the gonimoblastic filaments. *N. lubricum* and *N. multifidum* have the carpospores practically sessile on the mass of cells resulting from the division of the carpogonium. *N. Schrammi* (Crn.) Børg. and a new species from the Danish West Indies recently described by Børgesen, *N. longicalle*, have delicate gonimoblasts similar to those mentioned above for *N. ramulosum*, but not so numerous and long as those in that species. *Nemalion* is placed in the section Nemalieae of Helminthocladiaceae by Schmitz and Hauptfleisch, while *Dermonema* is placed in the Dermonemeae of the same family by the same authors. From the standpoint of the development of the gonimoblasts, *Dermonema dichotomum* might possibly be joined to the series of species of *Nemalion*. The gonimoblastic filaments in *D. dichotomum* arise after the fertilized carpogonium has divided several times as in the genus *Nemalion*, but instead of forming a compact mass they ramify horizontally among the cortical filaments for some distance and give off erect branches which bear the carpospores, making a diffuse cystocarp as in *Cumagloia Andersonii*. If it were not for the fact that the gonimoblasts in *Cumagloia* arise directly from the fertilized carpogonium it might well stand in the series between *Nemalion* and *Dermonema*, since the gonimoblasts are less diffuse than those of the latter and less compact than those of the former. We are now brought to the position, as we frequently are in the study of genetic relationships, from which we must choose one of two alternatives in our method of treatment of the subject. We must either amend and combine or segregate and describe anew. In the present instance it has seemed best to follow the general tendency and adopt the latter course.

Before leaving the subject it seems well to point out the similarity between *Cumagolia* and *Harveyella mirabilis* Schmitz and Reinke. *Cumagloia* agrees with *Harveyella* in not having the gonimoblasts compact and definitely set off from the surrounding sterile tissue, but in having the intermingling of gonimoblasts and cortical filaments. Schmitz assigned *Harveyella* to the family Gelidiaceae among the Nemalionales. This family is characterized by Schmitz in part as follows: "Die befruchtete Eizelle sprosst vielfach nach Fusion mit einer oder mehreren benachbarten Zellen zum Gonimoblasten aus." In Gigartinaceae, however, the fertilized egg fuses with a distinct auxiliary cell which has previously been formed. The auxiliary cell then gives rise to the gonimoblasts. Sturch found that *Harveyella mirabilis* shows fusion between the carpogonium and an auxiliary cell which had been formed previous to fertilization, and that the gonimoblasts arise from the auxiliary cell. He says, "The genus *Harveyella*, which possesses an auxiliary cell developed before fertilization, must therefore be removed from the Gelidiaceae and may be placed in the

Gigartinales." This discovery makes *Harveyella* a step farther away in its relationship to *Cumagloia Andersonii* than it formerly seemed to be.

Summarizing the characters of the cystocarps of *Nemalion*, *Cumagloia*, *Dermonema* and *Harveyella* we may arrange these genera in the following series. *Nemalion* possesses the simplest form of cystocarp, with very short gonimoblasts arising from the fertilized carpogonium after its division as exemplified by *N. lubricum*; or with longer gonimoblasts, more profusely branched, but still compact, arising in the same manner, as exemplified by *N. Schrammi*. *Cumagloia* has the gonimoblasts profusely branched, with the main branches mostly extending horizontally, intermingling with the cortical filaments, and giving rise to numerous branches growing obliquely and perpendicularly upward; but the gonimoblasts arise directly from the fertilized carpogonium. *Dermonema* has a more extensive system of gonimoblasts than *Cumagloia*, but of the same general type, arising however, as do those of *Nemalion*. Finally, *Harveyella* has a profuse mass of gonimoblastic filaments intermingling with the sterile filaments similar to the two preceding genera, but the gonimoblasts arise from the auxiliary cell after its fusion with the carpogonium.

In conclusion I wish to acknowledge my grateful appreciation for the many helpful suggestions and the discriminating criticisms of Professor W. A. Setchell, who also rendered the Latin diagnoses.

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EXPLANATION OF PLATES

The photographs of plate 31 were taken by Robert L. Pendleton, and the drawings were all made by Dr. Helen M. Gilkey, under the directions of the writer.

PLATE 31

Cumagloia Andersonii (Farlow) Setchell and Gardner

Fig. 1. A tetrasporic plant profusely branched and showing small disk-shaped holdfast.

Fig. 2. Cystocarpic plants without bases, a common form with short lateral branches.

Fig. 3. A group of plants all arising from the same holdfast.

Fig. 4. A group of small inflated plants, an abnormal condition.

The plants of this plate were all photographed from dried specimens and reduced one-half.

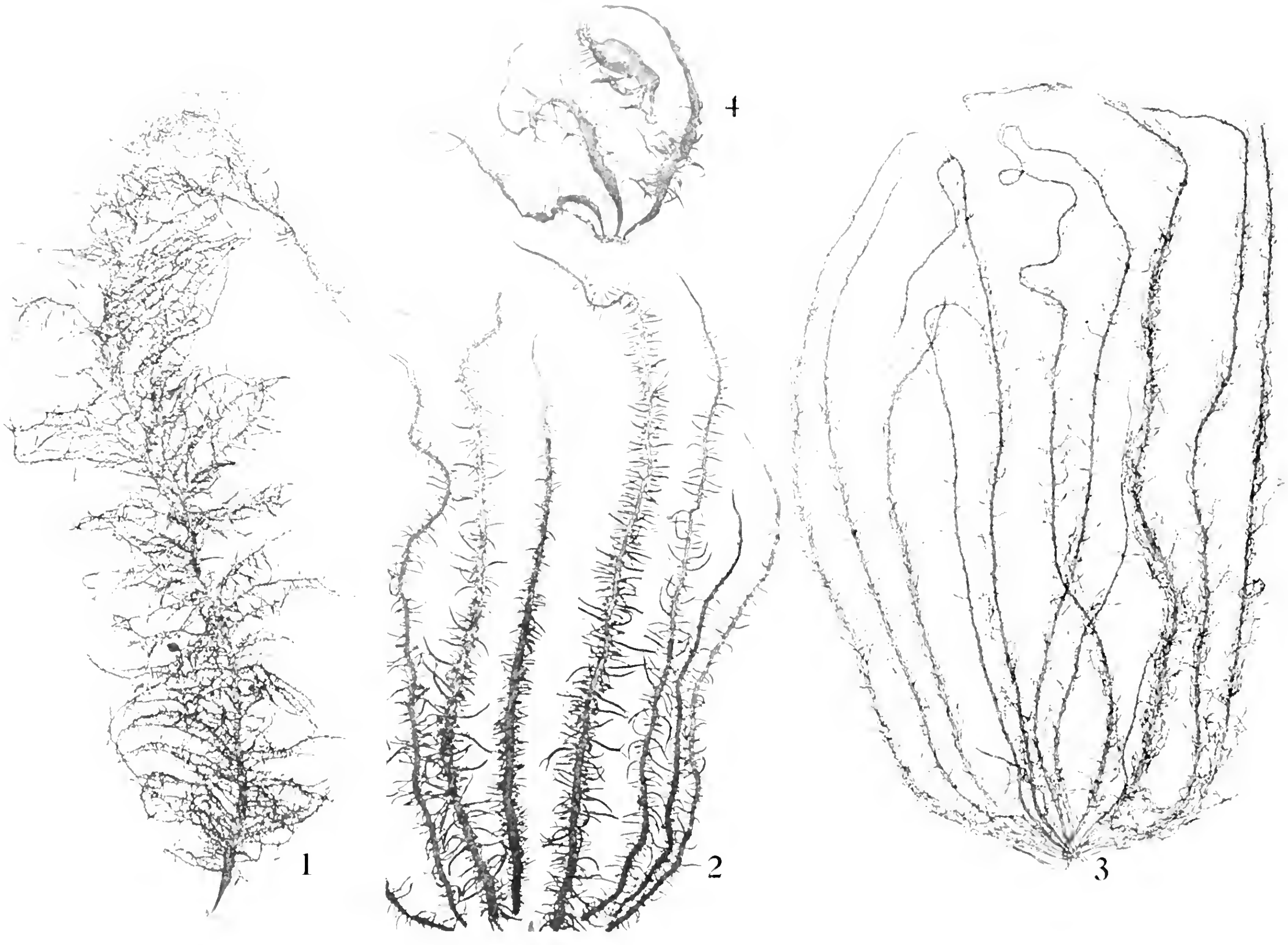

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PLATE 32

Cumagloia Andersonii (Farlow) Setchell and Gardner

Fig. 1. A portion of the cortex with antheridia.

Fig. 2. Carpogonial branch, showing the beginning of the development of gonimoblastic filaments directly from the fertilized carpogonium.

Fig. 3. A portion of the cortex with carpogenial branch and young carpogenium and attached sperms.

Fig. 4. A section through a small cystocarp.

Gayella constricta Setchell and Gardner

Fig. 5. A cross-section of a mature segment.

Chlorochytrium Porphyrae Setchell and Gardner

Fig. 6. Cross-section of *Porphyra perforata* f. *lanceolata* Setchell and Hus, showing *Chlorochytrium Porphyrae* in various stages of development in the mucilaginous walls.

Figures all highly magnified.

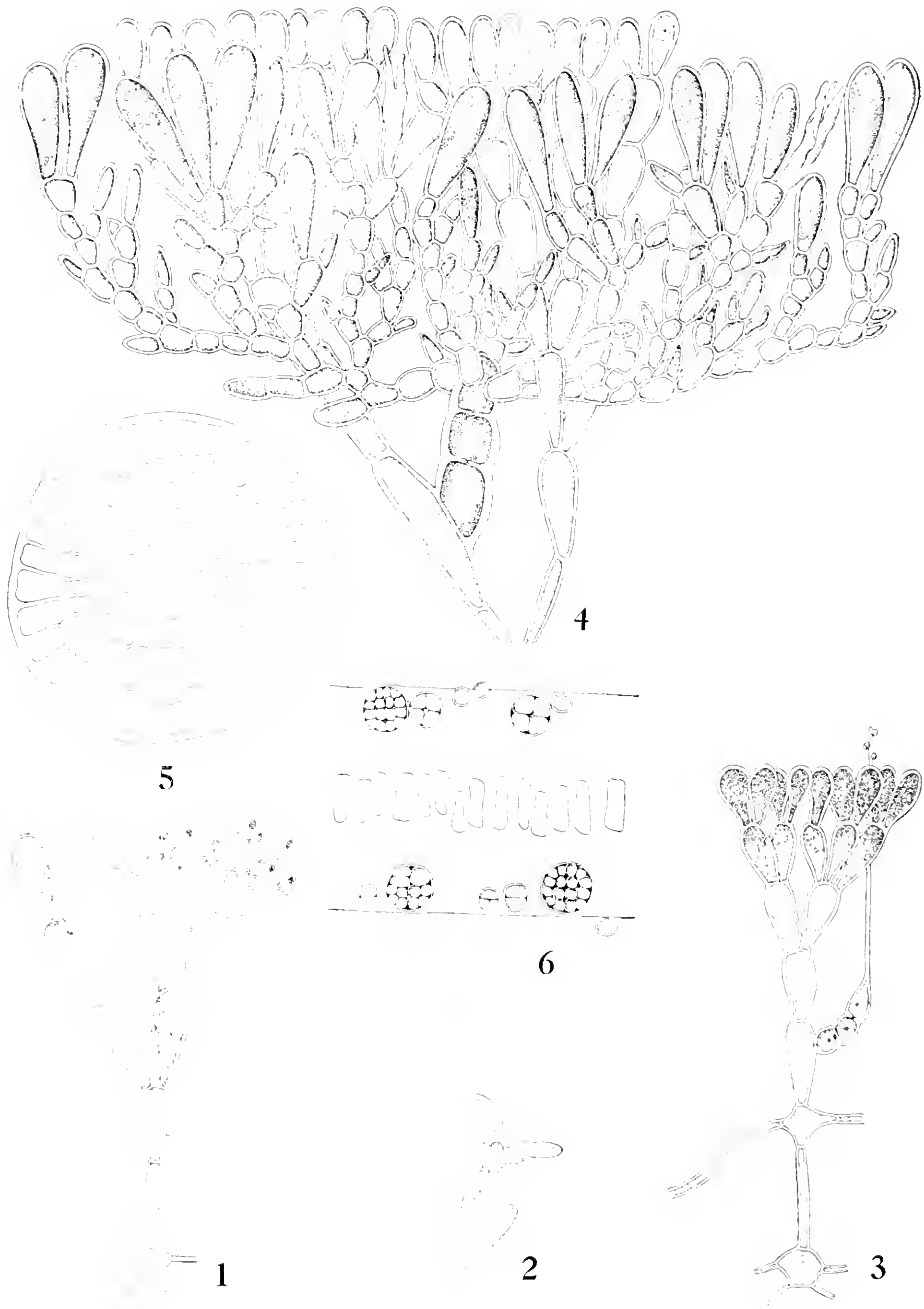
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PLATE 33

Petrocelis franciscana Setchell and Gardner

Fig. 1. Cross-section of mature thallus.

Coriophyllum expansum Setchell and Gardner

Fig. 2. Cross-section showing a portion of a nemathecium.

Arthrospira maxima Setchell and Gardner

Fig. 3. An entire mature plant.

Hildenbrandtia occidentalis Setchell

Fig. 4. A cross-section through the upper part of the thallus passing through the center of a conceptacle.

Gayella constricta Setchell and Gardner

Fig. 5. A mature plant.

Fig. 6. A median longitudinal section through a portion of a plant.

Figs. 7–8–9. Portions showing various conditions of branching.

Figures all highly magnified.

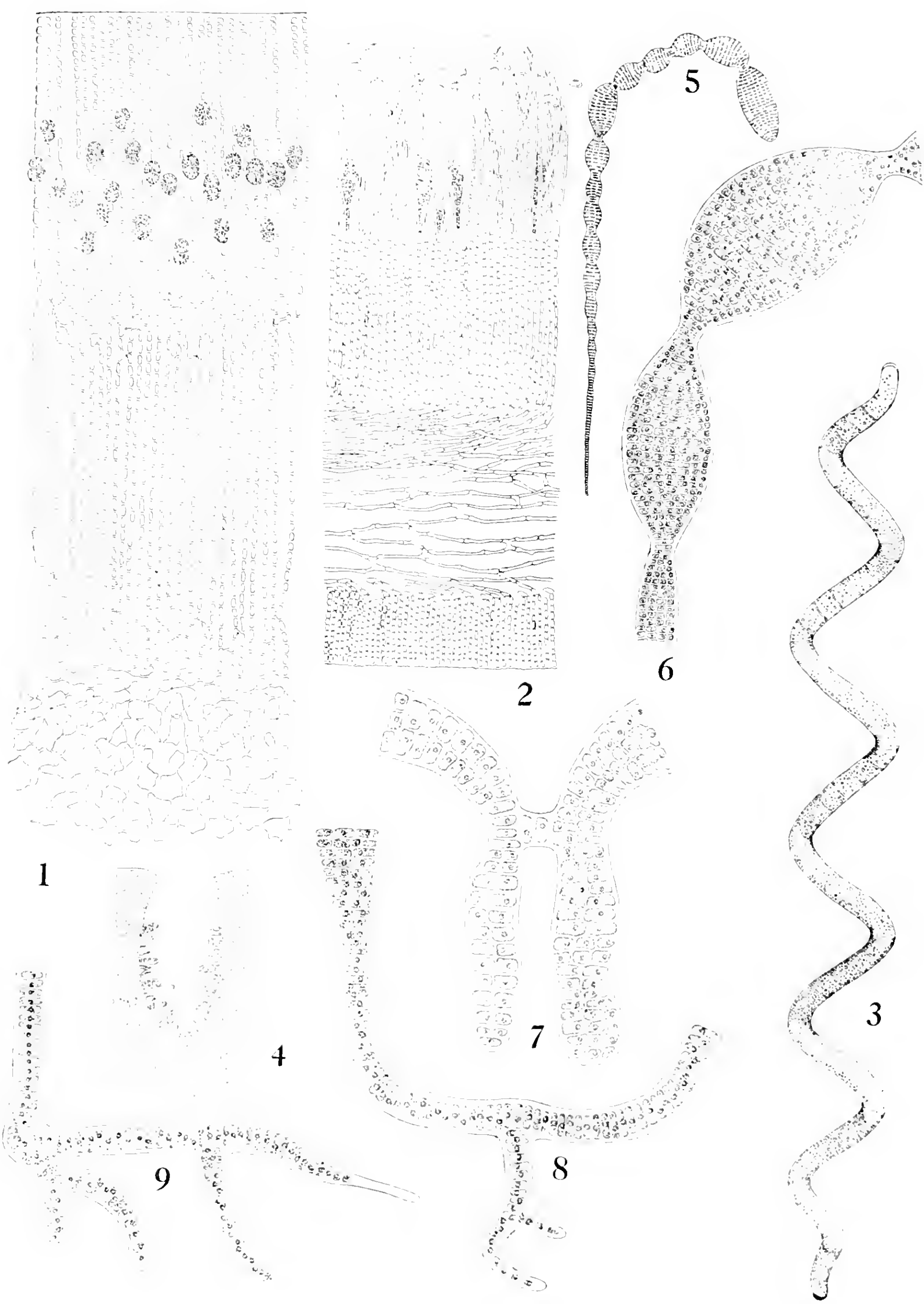
5
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PLATE 34

Cystoseira neglecta Setchell and Gardner

A mature plant, photographed from dried material.

PLATE 35

Cystoseira neglecta Setchell and Gardner

Branches of various shapes, sizes, and orders.

UNIVERSITY OF CALIFORNIA PUBLICATIONS
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AN ACCOUNT OF THE MODE OF FOLIAR ABSCISSION IN *CITRUS*

BY

ROBERT W. HODGSON

The study which is reported on here represents one phase of an investigation on the shedding of immature oranges of the Washington Navel variety, begun by Professor J. Eliot Coit and the writer in the spring of 1916, and reported on in part elsewhere (Hodgson, 1917). It developed that the young fruits drop from the trees while still alive and actively functioning; therefore the shedding is typical abscission in contrast with exfoliation which involves the cutting off of dead or dying plant parts as a result of the activity of a cork cambium. This latter phenomenon has been rather thoroughly investigated with a wide diversity of plant materials, but most of the studies on the former have hitherto had to do with herbaceous or shrubby plants in which the walls of the cells involved are relatively thin. In view of the economic importance of this process of abscission in the genus *Citrus*, causing as it does an annual loss of many thousands of dollars, and because of the thickness of the cell walls concerned, it has seemed desirable to make a rather intensive study of the abscission process in the leaves as well as in the young fruits. The study which constitutes the subject of this paper has to do with the former, a consideration of the process as it occurs in the fruits being reserved for presentation at a later time. A somewhat extensive histological and cytological study of the abscission zone, the separation layer, and the process itself as it takes place in the leaf has yielded results which have been so definite and striking that they are deemed worthy of presentation in a preliminary paper at this time.

The material used in this study consisted for the most part of leaves taken from trees of the Washington Navel variety *Citrus sinensis* and Eureka lemon variety *Citrus Limonia* grown in the greenhouses of the University of California. The mode of foliar abscission was found to be similar in both species. Practically all the histological and cytological work was done with the aid of fresh sections cut either with the table microtome or free-hand. Abscission was induced by placing cut shoots in large moist chambers kept in the laboratory at room temperature and was found to be consummated within 24 to 96 hours. Sections were cut at intervals from the time of insertion into the chambers until actual separation had occurred. After being placed in the moist chamber the most important factors in determining the time at which abscission was complete, named in the order of their importance, were found to be temperature and age of the material.

Series were also run in which illuminating gas and carbon dioxide were introduced in varying concentrations to ascertain their effect upon the time at which abscission was complete. This time was found to be substantially the same, no matter which of these gases was used or whether none was used. This is taken to indicate that in the case of citrus shoots placed in moist chambers or exposed to illuminating gas, carbon dioxide, or ordinary laboratory air the stimulus leading to abscission is probably not of an external nature, at least directly. Indeed, it seems more likely that it is internal and of the nature of a disturbance in the physiological equilibrium existing within the shoot. Preliminary studies on the relation between the time at which abscission occurs and the area of tissue distal to the abscission zone concerned have furnished some evidence that something of the nature of mass action is involved in the stimulus. Leaves which had been reduced in area by removal of a portion of the terminal leaflet were found to remain on the shoot longer than leaves not so treated and a general relation between the area removed and the time reaction was noted. This phase of the general abscission problem in *Citrus* as well as several others are reserved for discussion at a later time.

The Abscission Zone

The ordinary citrus leaf consists of a main terminal leaflet behind which is a somewhat elongated petiole bearing a narrow extension on either side. There is little doubt but that the whole represents a modified compound leaf, the two basal leaflets of which have been reduced to the vestigial structures known as the wings. Examination of abscission in the trifoliate orange *Citrus trifoliata*, which possesses a compound trifoliolate leaf, shows that separation occurs independently at the base of each leaflet, and also at the base of the petiole of the leaf itself. In the ordinary citrus leaf it occurs both at the base of the terminal leaflet and at the base of the petiole. Thus in either case the abscission zone is situated at or near the base of an internode, as is the case in most of the plants in which the process has been investigated (cf. Goodspeed and Kendall, 1916; Lloyd, 1916; Kendall, 1917).

The constriction which exists between the terminal leaflet and the wings gives rise to a conspicuous grooved ring. Such a groove also exists at the base of the petiole. These may be taken to represent the node or simply motor tissue. Inasmuch as abscission takes place at or near the base of the internode, and since such grooves are usually found in this vicinity, some investigators have been led to believe that they serve to delimit the location of the abscission zone. In the case of *Citrus*, at least, it has been impossible to establish any such relation (cf. Goodspeed and Kendall, 1916). Examination of very young leaves shows no such grooved ring present at the base of petiole, and leads to the conclusion that the grooves are formed because in the development of the petiole certain cells do not increase in size as fast as the neighboring cells on both proximal and distal sides. Since abscission occurs in young leaves where no groove is present, the conclusion is forced that the grooved rings are formed subsequent to the time at which the abscission zone becomes capable of activity. Indeed, abscission was found to occur in leaves which were just developing, a fact strongly indicating that the abscission zone is pre-formed and ready to function at any time.

In the case of the terminal leaflet, the abscission zone usually lies roughly opposite the grooved ring, but at the base of the petiole ordinarily occurs eight to ten layers of cells distal to the groove. In the latter case, however, considerable variation has been found in the position of the abscission zone with respect to the grooved ring. Thus it frequently happens that on the dorsal side the abscission zone and the groove coincide, whereas on the ventral side the abscission zone is located eight to ten tiers distal to the groove. The abscission zone extends in a plate completely around the cortex and across the pith both in the case of the terminal leaflet and at the base of the entire leaf.

In young material there is no histological distinction in the cells which would enable one to fix upon the ten to eighteen layers destined to function later as the abscission zone. The cells are of the same average size and appearance as those on both sides of the zone, and prior to the initiation of the process we have as yet no way of accurately determining its location. Evidence of a cytological nature will be submitted below to show that subsequent to the application of the stimulus which is to cause abscission changes occur in the cell walls of the abscission zone. These changes are such that they can be detected by optical and chemical means and constitute further proof that this zone is composed of cells physiologically different from those on either side.

In older material, both at the base of the terminal leaflet and at the base of the petiole, the cells in the abscission zone are smaller and differ in general appearance from those on either side. They are characterized by their small size, isodiametric shape and absence of visible vacuoles; they are darker in color, and, further, are somewhat collenchymatous in appearance. On both sides of the abscission zone the cells grade up in size, becoming lighter in color and more vacuolate until they are several times as large as the cells of the abscission zone proper. At the base of the terminal leaflet the cells of the abscission zone are somewhat smaller, thicker walled, and darker in color than those at the base of the petiole.

The Separation Layer

Actual separation occurs one or two tiers of cells proximal to the distal end of the abscission zone, that is, one or two layers below the upper end of this zone. Ordinarily only one or two layers of cells are involved in the separation process, but occasionally as many as four or five may take part. However, it is seldom that the cells of more than one tier actually complete the process. This is usually the uppermost tier, but the process also frequently includes a portion of the next lowest tier. Separation does not necessarily occur in a plane straight across the petiole at right angles to the main axis, but follows a more or less irregular path, undoubtedly depending somewhat on the mechanical resistance encountered in the older elements and vascular bundles. Indeed, in some cases the path is completely changed in direction, paralleling the vascular elements for a short distance before crossing them. The more or less jagged ends presented by the pieces cause them to hang together mechanically for some time after separation has been consummated. In testing for abscission time it is necessary to give the shoot a smart jar in order to cause those leaves in which the process has already been completed to drop. In the moist chamber this is subsequently accomplished automatically by the pressure developed in the further division of the cells of the abscission zone following separation.

Cytological Behavior Prior to Separation

Prior to the initiation of abscission, the tissues on both sides of the zone are plentifully supplied with starch which is either withdrawn or used before the process begins. At this time the cells of the abscission zone are gorged with starch while the tissues on both sides contain very little. Chlor-iodide of zinc and potassium iodide-iodine applied to sections cut just prior to the initiation of the process, delimit the zone and show it as a dark purple band. Examination at subsequent stages indicates that the starch content decreases as the process goes on, but even at complete separation the abscission cells contain notable quantities. Following separation, if moisture conditions are favorable, the cells constituting the abscission zone resume growth and active division and thus utilize the starch which is stored in them. The reason for the persistence of the starch in the abscission zone when it has disappeared elsewhere is not clear, but it is probable that soon after the application of the stimulus which is to result in abscission, changes occur in the cell walls of the abscission zone which prevent the translocation of the products of starch hydrolysis to adjacent cells.

The earliest indication of chemical alterations in the cell walls of the abscission zone is evidenced by a decreased power of taking up and holding stains. Thus at six to fifteen hours prior to abscission, when stained with iodine the cell walls of the abscission zone show a lighter color than those adjacent (cf. Lloyd, 1916).

When stained with strong potassium iodide-iodine the walls of the abscission cells take on a delicate greenish hue. On dilution with water this light green fades out and is replaced with a pale blue which is ultimately lost on further dilution. This change from green to blue occurs in all of the cells of the abscission zone and constitutes a very delicate test (cf. Lloyd, 1916). Just prior to abscission, the cells of the abscission zone when stained over night in dilute methylene blue, show a marked inability to hold the stain, appearing much lighter in color than the cell walls of adjacent tissues (cf. Jones, 1909).

The optical quality of these cell walls is markedly altered prior to abscission since quite different results are obtained using the open diaphragm on the abscission zone and on adjacent cells. The walls of the abscission cells are less highly refractive and appear lighter and more indefinite.

However, the most notable change lies in the fact that during abscission the walls of the abscission cells show a marked swelling and gelatinization which often reaches a magnitude of two to three times

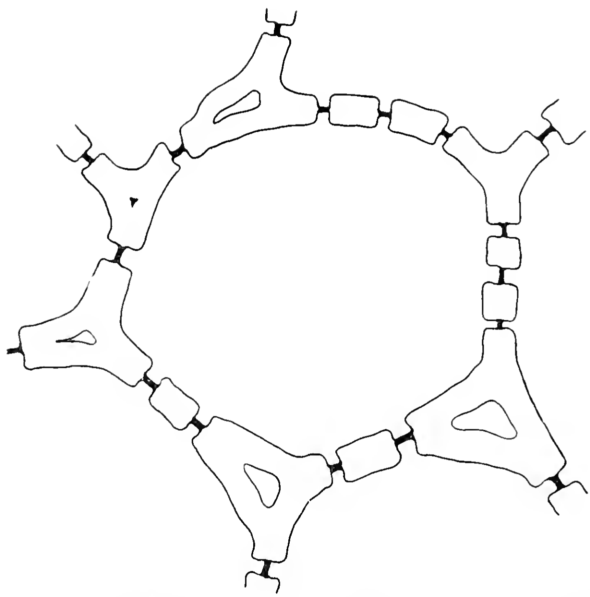

Fig. 1—Normal cortical cell from the abscission zone at the base of the petiole. Shows the relatively thick walls and simple pits. Taken prior to the application of the stimulus leading to abscission. Washington Navel orange.

the original thickness. This is particularly noticeable in the thick cell walls of the cortex although it occurs in all the living tissues. These cortical cells possess simple pits in considerable numbers (fig. 1). The portion of the wall constituting the pit membrane seems to be indurated or impregnated with some substance resisting this gelatinization, thus giving the cell wall a decidedly beaded appearance (fig. 2). This swelling occurs throughout the abscission zone and results in considerable pressure being applied to the protoplasts causing them to be crushed (fig. 3). This crushed appearance is particularly noticeable in the abscission zone at the base of the terminal leaflet.

As abscission nears completion these greatly swollen, gelatinous walls disappear, being apparently completely hydrolysed. This frees the indurated I-shaped portions of the pit membranes and on the slide these can be separated out as such (cf. Jones, 1909). As these are further attacked little club-shaped bars result (fig. 3) which ultimately are entirely hydrolysed. The dissolution of the gelatinized walls frees the abscission cells in the separation layer from one another, leaving them bounded by a very thin delicate tertiary membrane.

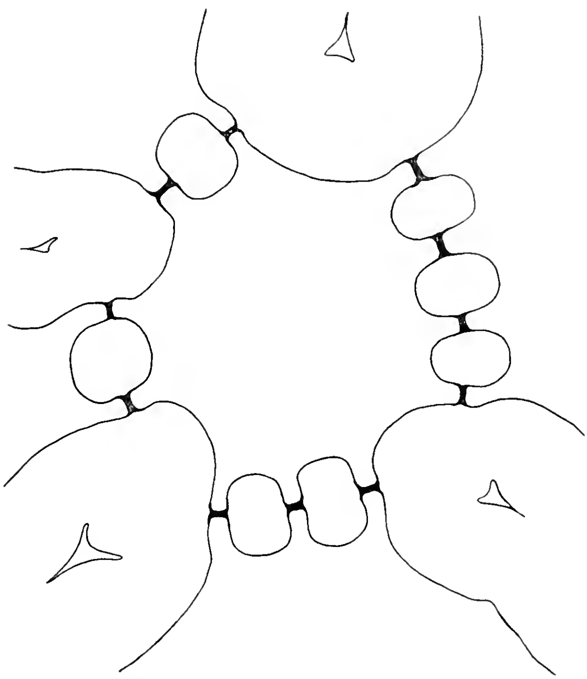

Fig. 2—An early stage of the abscission process. Shows the marked swelling and gelatinization of the cell wall. From the abscission zone at the base of the petiole. Washington Navel Orange.

That these cells are not degenerating or dead is proven by the fact that after separation they resume growth and active division with the result that a mass of loose tissue is produced.

The Process of Abscission

As to the nature of the preliminary changes in the cell walls prior to the swelling we can only speculate. There is considerable evidence to show that the swelling and ultimate dissolution of the cell walls in the separation layer is brought about by the chemical process of hydrolysis initiated by enzymes secreted in the abscission cells. In this separation process it is necessary to distinguish clearly two distinct stages. The first consists in the marked swelling and gelatinization noted above. The second stage is the dissolution of this gelatinized wall which results in the freeing of the cells concerned. These two clearly defined stages may be taken to indicate that there may be more than one reaction involved and more than one enzyme concerned.

In this connection it seems well to review briefly some of the more

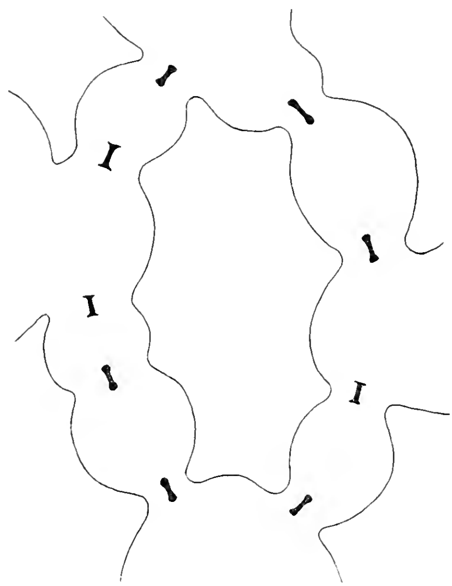

Fig. 3—A later stage in the abscission process showing separation of the tertiary lamellae from the pit membranes which remain free in the gelatinous matrix until subsequently hydrolyzed. The marked swelling of the walls, producing considerable pressure, results in the crushing of the protoplast. Taken from the abscission zone at the base of the terminal leaflet. Washington Navel Orange.

All of these drawings are semidiagrammatic.

recent literature on the origin and composition of middle and inner lamellae of the cell wall and their reactions with various enzymes. Until a few years ago it was generally understood that the walls of parenchymatous tissue of the kind under discussion were composed of cellulose. However, the last fifteen or twenty years have seen the development of the chemistry of cellulose and cellulose compounds and it is now accepted that "cellulose" includes a group of closely related substances. These have been divided into simple and compound celluloses. The more resistant to hydrolysis are known as the true celluloses, the less resistant simple celluloses being termed hemicelluloses. The compound celluloses have been further divided and we now have the pectose-celluloses or pectoses which are believed to constitute the middle lamella (cf. Atkins, 1916). Evidence tending to show that the middle lamella itself consists of calcium pectate and the inner lamellae of pectose has been advanced (Bertrand and Mallèvre, 1894, 1895; cf. Jones, 1909). In the case of *Citrus*, there is no evidence that separation is brought about by the dissolution of the middle lamella alone but rather by the hydrolysis of the entire wall with the exception of the delicate tertiary membranes (cf. Lloyd, 1916). It is probable that we have to do here with a mixture of calcium pectate and pectose.

A number of enzymes acting on pectic compounds have been isolated. In 1840 Fremy isolated an enzyme "pectase" from carrot roots which was capable of gelatinizing pectose and related compounds (Fremy, 1840). He supposed that the reaction involved was the conversion of the pectose into pectic acid. However, more recent researches have shown that the coagulum consists of calcium pectate and that in reality the reaction represents the coagulation of pectin in the presence of calcium salts (Bertrand and Mallèvre, 1894, 1895). Brown and Morris (1890) obtained from barley malt an enzyme of a cytolytic nature, in addition to diastase. It was found to function in the dissolution of the endosperm cell walls preceding the action of diastase upon the starch. The description of the process as given by them is very similar indeed to that which occurs in the separating cells in *Citrus* and in *Mirabilis* (cf. Lloyd, 1916). A number of other investigators have found evidence of the presence of enzymes of this character in germinating seeds. It remained for Bourquelot and Herissey (1898) to try the action of barley malt extract upon a solution of pectin. They obtained evidence of the presence of an enzyme which so changed the pectin that it could not thereafter be coagulated by the action of the enzyme pectase. This new enzyme they called pectinase. It was later shown that when the coagulum resulting from the action of pectase on pectin was treated with pectinase it was dissolved and coincidently traces of reducing sugars were found, showing that the process is a hydrolytic one (Bourquelot, 1899). Jones (1909) has isolated a cytolytic enzyme from *Bacillus carotovorus* which he calls pectinase. According to him this enzyme attacks the middle lamellae.

causing first a gelatinization followed by dissolution, resulting in separation of the cells in the tissue attacked. Atkins (1916) has recently reviewed the literature on the action of enzymes on pectic substances. He distinguishes three distinct enzymes causing as many different reactions. According to him, pectose is split up by pectosinase to form pectin which may be transformed into pectic acid by pectase. The pectic acid may in turn be converted into sugars by pectinase.

Whereas the literature on the subject is somewhat confusing and emphasizes our lack of definite knowledge regarding the composition of the inner and middle lamellae, there is little doubt but that enzymes capable of hydrolysing its various component parts have been isolated. In the case of *Citrus* the swelling is so pronounced as to indicate that something of the nature of gelatinization of the wall occurs, very similar to the reaction of pectase on pectic compounds. The subsequent dissolution of this wall resembles markedly the action of pectinase on pectic coagulums.

There is little or no evidence that turgor plays any prominent part in the abscission process, as Goodspeed and Kendall (1916) suggested might be the case in Nicotiana (cf. Kendall, 1917). Observation of the abscission process in very young leaves indicates how turgor might be taken as the causal agent. In such tissues the cell walls are quite thin and the swelling not at all conspicuous. Moreover, during separation the cells round up beautifully indicating considerable release of pressure.

The process apparently occurs simultaneously in the cortex and in the pith, all cells across the petiole in the region of the separation layer taking part except the tracheae. In young stems the epidermal cells and the wood parenchyma are seen to function very distinctly in the process. The only mechanical break occurs in the wood vessels and in the cuticle. No extenuation of the protoplasmic utricle of the separation cells during abscission has been observed (cf. Lloyd, 1916), and no evidences of cell divisions during the process have been found although immediately following separation new cross walls are frequently laid down in the cells of the separation zone. If moisture conditions are optimum following separation, all of the cells in the abscission zone may start to grow and divide resulting in groups of colorless, thin-walled, clavate cells held together in clusters by a portion of the undissolved gelatinized thick cell wall.

Studies on the time which intervenes between the application of the stimulus and the abscission process as well as the time involved in the process itself are now being carried on. Chemical studies as to the nature of the process, the character of the cell walls involved, the oxidations and reductions occurring, the enzymes present, and the nature of the propagation of the stimulus are now under way and will be reported on later.

Summary

1. The abscission zone arises at or near the base of an internode, abscission occurring at the base of the terminal leaflet and also at the base of the petiole.

2. The grooved ring present near the internode at the base of the petiole and at the base of the terminal leaflet does not bear any definite relation to the location of the abscission zone.

3. At the base of the terminal leaflet the abscission zone lies roughly opposite the grooved ring. At the base of the petiole it arises eight to ten tiers of cells distal to the groove.

4. The abscission zone is pre-formed and ready to function upon proper stimulation.

5. In the young material there are no visible histological differences delimiting the abscission zone from the tissues on both sides. In older material the cells of the abscission zone are smaller, isodiametric, and have denser contents than those of adjoining tissues.

6. The abscission zone consists of ten to eighteen layers of cells.

7. The separation layer is located at the upper end of the abscission zone.

8. The process of abscission conforms to the usual type, involving the separation of the cells along the plane of the middle lamellae.

9. No cell divisions or elongations of the tertiary membranes have been observed during the process.

10. All tissues across the petiole except the tracheae and the cuticle function in separation.

11. The first stage in cell separation consists in a marked swelling and gelatinization not only of the middle lamellae but of the entire wall with the exception of the tertiary membranes. This is followed by the dissolution of this gelatinized wall by hydrolysis.

12. There is little evidence that turgor plays any considerable rôle as a causal agent in separation.

13. All of the cells in the abscission zone show marked swelling and gelatinization and after separation resume growth and cell division

with the result that small clusters of clavate cells held together at their bases by a portion of the gelatinized wall are formed.

14. Prior to abscission starch in large quantities is stored in the abscission zone and later serves as a source of energy for growth following separation.

The writer wishes to acknowledge the obligation under which Professor F. E. Lloyd has placed him for his many helpful suggestions and interest in the investigation, and to express his appreciation to Professor Thomas H. Goodspeed for helpful criticisms.

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NEW PACIFIC COAST MARINE ALGAE II

BY
NATHANIEL LYON GARDNER

On various occasions in the recent past while collecting algae along this coast, I have come across specimens of marine Myxophyceae which I have set aside for future study. In this paper I am presenting thirteen species of them, new to science. They all very naturally conform to the order Coccogoneae as proposed by Thuret (1875) and amplified by Kirchner (1898). With the exception of two species of *Chlorogloea*, belonging presumably to the family Chroöcoccaceae of Naegeli (1849), they may readily be placed in the group Chamaesiphonaceae of Borzi (1882).

The chief difficulty which has been encountered in this study is the segregation of them into their proper genera. The genera which are particularly troublesome in this respect are *Dermocarpa* and *Xenococcus*, which in certain stages of their development are decidedly confusing; and *Hyella* and *Radaisia*, the limits of which have not been clearly defined.

Dermocarpa and *Xenococcus* growing apart from each other, and in their typical mature forms are not difficult to determine. The former genus has increase in the number of individuals by the formation of gonidia only, while the latter has increase by vegetative cell-division as well as by the formation of gonidia. But if species of these two genera happen to be intimately associated on the same host, it becomes a matter of considerable difficulty and uncertainty to state definitely to which genus a particular individual in a group belongs. One such instance has been encountered in the brief study the results of which I am presenting in this paper, that of *Dermocarpa pacifica* and *Xenococcus chaetomorphae*, as I have interpreted them, growing on *Chaetomorpha aerea*. The character of the host in this instance, as I shall point out later, seems to have had considerable influence upon the shapes that the cells of each species have assumed in the course of their development.

The genera, *Hyella* Bornet and Flahault (1888), and *Radaisia* Sauvageau (1895) as originally described, are not so clearly distinct as to make it a simple matter to assign new species to them with much degree of certainty. *Hyella caespitosa*, the type of the genus as described by Bornet and Flahault, has branched prostrate multicellular filaments, presumably arising from single cells on the surface of the host shell. The cells of these filaments, at least in part (*loc. cit.*, fig. 9), divide in all planes creating rows of cells within the original cell wall or sheath, similar to the formation of *Stigonema* filaments. From those prostrate filaments numerous erect filaments arise by divisions of certain cells of the prostrate filaments, or basal filaments as I shall call them. These erect filaments dissolve the shell and penetrate into it, and are very numerous. Gonidangia are formed near the surface of the shell on short branches arising from the cells of the basal filaments, and grow toward the interior of the shell or are sessile on the basal filament. Figures 2 and 3 of Bornet (*loc. cit.*) show that the filamentous nature of the basal filaments is nearly or quite destroyed when the erect filaments are nearly mature. They appear as separate groups of cells when viewed from above. Forti (1907) recognizes four other species of *Hyella*, all but one boring into calcareous material, *Hyella endophytica* Børgesen (1902) penetrating into *Chondrus crispus*. Recently Howe (1914) described *Hyella infestans* inhabiting *Leptocladia peruviana*. The descriptions of these five species fail to distinguish between the basal filaments and the erect filaments, also nothing seems to have been learned about the early stages of development. The superficial cells of *H. fontana*, *H. Balani* and *H. endophytica* may develop into gonidangia, in this respect differing from *H. caespitosa*. Howe did not observe any gonidangia in *H. infestans* and it is left indefinite as to which cells are transformed into gonidangia in *H. jurana*. Howe places his species in the genus *Hyella* on account of its close resemblance to *H. endophytica* of Børgesen. If basal filaments creeping at the surface of the host are to be deemed essential to the genus *Hyella*, as first diagnosed, it may yet be shown, when the early stages of development are made known, that none of the species subsequently described belong to that genus.

Howe and Børgesen are being followed in placing the species described in this paper, although the gonidangia have not been observed in two of the species, nor have the characteristic basal filaments been seen in any of them. More will be said concerning these under each species. In placing the species described in this paper the genus *Hyella* is being interpreted as having basal filaments which give rise to erect filaments penetrating the host, and as having gonidangia formed from special cells just within the host, or formed by the transformation of certain basal, surface cells at the basal ends of the erect filaments. It is also assumed that these conditions prevail in the species which are here presented although they have not been observed, judgment being based upon the resemblance of the plants as a whole to the original *H. caespitosa*.

Sauvageau (1895) founded the genus *Radaisia* on *R. Gomontiana*. He does not mention the basal layer or any of the early stages of development, either in the diagnosis or in the appended notes. The plant is represented as being composed of a mass of erect, nearly parallel rows of spherical cells or filaments embedded in a coherent jelly. The filaments are practically independent and are sparsely branched, thus producing a fan-shaped appearance in longitudinal section view. The gonidangia are terminal or intercalary, and the gonidia are formed by successive divisions of the cell contents. He separates this genus from *Entophysalis* because of the filamentous character of the cells in the colony, and particularly because of the presence of gonidangia. He places his *Entophysalis Cornuana* in *Radaisia* on account of its filamentous nature although gonidangia had not been observed.

Nothing being known of the method of the origin of a colony of *R. Gomontiana* or of *R. Cornuana*, one must remain somewhat in doubt when placing a species, whose early stages of development are known, in *Radaisia*. There are at least two possibilities as to the origin of the masses of perpendicular filaments of *R. Gomontiana* and *R. Cornuana*. The gonidia may escape in mass, come to rest on a substratum, and then spread out. Later, these gonidial cells by divisions in one horizontal plane would produce a new colony, each cell giving rise to a single chain of cells, or a filament. The colony would thus consist of a group of practically independent plants. Or on the contrary, the gonidia may escape and come to rest singly on the substratum, and each one after locating may produce a prostrate, or basal layer of cells by divisions in two or more planes, then by subsequent horizontal divisions of these cells produce the erect filaments. In the first case, the colony would consist of a number of practically independent plants, the descendants of the same number of individual cells—a simpler type. In the second case, the colony would consist of a single plant, all of whose cells would be the descendants of but a single cell—a more complex type. The plants which are here placed in the genus *Radaisia* follow the latter method of development.

The chief difference between the new species described here and the original species of the genus is the method of gonidia formation. In the type of the genus they are formed by successive divisions of the cell contents, while those proposed here are formed by simultaneous divisions of the contents of the gonidangium.

In segregating the plants of my collection the following characters have been used to distinguish the genera *Hyella* and *Radaisia*: Those forms with erect filaments, more or less branched and distorted, arising from basal filaments on the surface of the substratum and growing into it, and having gonidangia at their bases near the surface of the host, have been assigned to the genus *Hyella*. Those forms with erect filaments, simple or complex, closely compact, more or less parallel, not at all or only slightly branched, arising in the same manner as those mentioned above, but extending away from the host, and with gonidangia on the outer free ends, have been placed in the genus *Radaisia*.

Chlorogloea conferta (Kuetz.) Setchell et Gardner comb. nov.

Plate 36, fig. 6

Coloniis tuberculiformibus in magnitudine et in forma variabilibus; cellulis angularibus, 0.8–1.2μ diam., paululum longioribus quam crassis, in matrice densa, copiosa, gelatinosa et dilute flava immersis, inordinatis; contentu dilutissime caeruleo-viridi centro hyalino; multiplicatione vegetabili; partitionibus cellularum in directionibus omnibus.

Colonies forming tubercular masses of indefinite shape and size; cells angular, 0.8–1.2μ diam., slightly longer than the diameter, embedded in a dense, copious, gelatinous matrix of light yellow color, arranged in no definite manner; contents very pale blue-green with hyaline center; reproduction vegetative; cell divisions in all directions.

Growing on *Rhodochorton Rothii* in company with *Dermocarpa hemispherica* and *Dermocarpa suffulta* along high-tide level in shaded places. Moss Beach, San Mateo County, California.

Palmella conferta Kuetzing, Phyc. Germ., 1845, p. 149; Tab. Phyc., 1845–49, p. 12, pl. 16, fig. 4. *Pleurocapsa conferta* (Kuetz.) Setchell, Alg. nov., 1912, p. 229.

Chlorogloea conferta has been a subject of discussion among algologists for some time, and differences in opinions that have been expressed are probably due to different interpretations as to what plant Kuetzing had in mind when he described *Palmella conferta*, the description being brief and the type material being a mixture of small plants. I have been enabled to examine a small portion of his type material growing on "*Callithamnion Rothii*" through the courtesy of Professor W. A. Setchell who procured it from Kuetzing's herbarium through the courtesy of Mme. Weber-van Bosse. I find two species of Myxophyceae very intimately associated on the host plant. One consists of masses of very small cells embedded in a firm gelatinous matrix, varying much in shape and size, of a pale yellowish green color, wholly or only in part surrounding the filaments of the host plant. The other consists of cells, distributed either in small groups or singly, from 5–15μ in diameter, of bright blue-green color, and very frequently surrounded entirely by the preceding. It was no doubt one of these which Kuetzing took as the type of his *P. conferta*, and it remains to decide which one. Careful measurements of the specimens at hand compared with the measurements given by Keutzing "1/700‴ gross" leads to the conclusion that his measurements refer to the gelatinous, smaller celled form, whose cells I find to measure about 1μ in diameter, instead of the larger, more conspicuous form. This form seems to be very close, if not identical, with the plant commonly associated with the same host plant on both the Atlantic and the Pacific coasts of the United States. It is also usually accompanied by other species of Myxophyceae.

The genus *Palmella* as now restricted includes only forms of Chlorophyceae, hence it will be necessary to reject that name and adopt another for this widely distributed plant which seems to be on the border between the Bacteria and the Myxophyceae. Setchell (1912, p. 229), with special reference to the larger cells has referred the plant of Kuetzing to *Pleurocapsa*, but the smaller celled plant is not properly referred to that genus. Wille has created the genus *Chlorogloea* to receive a plant very similar to ours, and known as *Palmella ? tuberculosa* Hansgirg (1892, p. 240) and this generic name is here adopted.

Chlorogloea conferta differs from *C. tuberculosa* in the size of the cells, in their arrangement, and in the number of planes of cell divisions, *C. tuberculosa* dividing in but one plane according to Wille. The other species of Myxophyceae found on the material of Kuetzing's type seems to be a species of *Pleurocapsa*, though being immature it is not safe to attempt to place it. Possibly this is the plant which has been considered to be a form of *P. amethystea* Rosenvinge (1893, p. 967).

Chlorogloea lutea Setchell et Gardner sp. nov.

Plate 36, fig. 1

Coloniis in forma et in magnitudine maxime variabilibus, super superficiem hostis per partitione in planis duobus extendentibus, per partitione in plano tertio (horizontali) pulvinulum cellularum ad 100μ crassum formantibus, cellulis primo in seriebus verticalibus ordinatis, tardiore dispositionibus verticalibus per partitiones in planibus alteris evanescentibus, cellulis externis inordinatis; cellulis nonnullis lateris inferioris coloniae per partitiones horizontales in hostem penetrantibus et ramos tortuosos per incrementum apicalem in longitudine augentes formantibus, ramorum eorundem cellulis mox in planis alteris quam horizontalibus partientibus et cellularum greges, mox stipates et ultimo in greges solidas in centro coloniae coalescentes formantibus; cellulis 0.9–1.5μ diam., angularibus, proxime quadratis; cellulis apicalibus hostem penetrantibus ad 4μ longis; parietibus cellularum hyalinis; contentu cellularum luteo-viridi, homogeneo.

Colonies extremely variable in shape and size, spreading over the surface of the host by cell divisions in two planes, divisions in the third, horizontal plane forming a cushion of cells up to 100μ thick, the cells at first being arranged more or less in vertical rows, but the radial arrangement being soon destroyed by divisions in other planes, the outer portion of the colony having cells arranged in no definite order; by horizontal divisions certain cells from the lower side of the colony penetrate into the host, forming crooked branched filaments increasing in length by apical growth; cells of these filaments soon begin to divide in other planes than horizontal, producing masses of cells, encroaching upon one another, and finally coalescing into a solid mass in the central portion of the colony; cells 0.9–1.5μ diam., angular, nearly quadrate; terminal cells penetrating the host, up to 4μ long; cell walls hyaline; cell contents pale yellowish green, homogeneous.

Growing on the stipitate portion of *Iridaea minor* J. Ag. in the lower littoral belt. Carmel Bay, Monterey County, California. May, 1916.

Just where to align a plant like *Chlorogloea lutea* is a problem more or less perplexing. It starts to develop on the surface of the host plant, and if the cuticle of the host is sound in that particular place, it develops a dense mass of cells of considerable dimensions before penetrating into the interior. The plant at first spreads out over the host by cell divisions in two or more planes. It is impossible to state the size of a single plant or colony, for in some places on the host it is continuous for several millimeters. This, however, may be due to coalescence of several colonies. Later cell divisions in the horizontal plane increase the mass in thickness, up to 100μ or more. At first the cells are arranged in vertical rows, but soon this arrangement is destroyed by false branching or by divisions in other planes. The cells are mostly quadrate in this mass becoming somewhat spherical in its outer portion. Sooner or later at various points from the under side of the horizontal layer, certain cells are able to penetrate through the cuticle and make their way among the cortical filaments of the host. These penetrating filaments branch, and have a terminal cell two or more times as long as the other cells. Growth in length of these filaments is apical. Enlargement of the cells back of the growing points and divisions in other planes soon produce groups of cells which, encroaching on one another, form a solid mass, the cortical cells of the host at times completely disappearing from the area which they occupy. Plants penetrate to a depth of 200μ.

Chlorogloea lutea is very closely related in some ways, particularly in its method of development within the host, to *Hyella socialis* found growing with it, and also described in this paper. The method of behavior of both within the host is the same. I have not, however, seen *H. socialis* extending beyond the surface of the host as *C. lutea* does. *H. socialis* thus appears to be wholly endophytic, although on account of the absence of the gonidia, I consider the plants in this collection to be immature, and I am unable to say positively what might have developed later.

The habitat and method of development of *Hyella socialis* are so similar to those of *Hyella endophytica* Børgesen (1902, p. 525), which forms gonidangia near the surface of the host, that, notwithstanding the absence of gonidangia, there can be but little doubt that it belongs to the genus *Hyella*. On the other hand, the genus *Chlorogloea* never has gonidangia and the species *lutea* assigned to the genus here, is so assigned because of the absence of gonidangia and because of its resemblance to *C. tuberculosa* (Hansg.) Wille (1900), notwithstanding the close similarity in its method of development to *H. socialis* with which it is so intimately associated. The size, color, shape, and early arrangement of the cells in a colony very closely approximate to those of *Chlorogloea tuberculosa*, as described by Wille, but that species is wholly endophytic, and does not have radiating, branching filaments. Furthermore Wille states that cell division is in one plane, "nach einer Richtung des Raumes" (1900, p. 4, pl. 1, figs. 4–6). This method of the increase in the number of cells of the plant, or colony as it may be called, certainly is different from that of *Chlorogloea lutea*, which has cell division in three or more planes.

Howe (1914, p. 13) has described a plant which is very similar to *Chlorogloea lutea*. He placed it in the genus *Chlorogloea*, and its being wholly within the frond of the host, he called it *C. endophytica*, and stated that it was very close to *Chlorogloea tuberculosa* (Hansg.) Wille, differing however "in its endophytic habit, and in its less distinctly seriate arrangement of the cells, the softer gelatinous walls soon allowing the cells to become inordinate." He stated further that "cell divisions apparently occur in various planes." *Chlorogloea lutea* differs from *Chlorogloea endophytica* in being only partially endophytic, in having smaller cells, in building up larger colonies, and distinctly having cell divisions in all directions.

Xenococcus chaetomorphae Setchell et Gardner sp. nov.

Plate 36, figs. 2–4

Cellulis vegetativis in forma magnitudineque maxime variabilibus, aliis sphericis aliis maxime angularibus et in dimensionibus variis aequalibus, sed nonnullis longis angustisque, et utroque fine ut supra visis acute attenuatis, ad 25μ in diam. verticali, cellulis angustioribus ad 45μ longis; gonidangiis in forma ut cellulis vegetativis; gonidiis per partitiones repetitas contentus toti formatis; cellulis omnibus laete caeruleo-viridibus.

Vegetative cells extremely variable in shape and size, some spherical, some very angular and of nearly equal dimensions, and some long and narrow, tapering to sharp points at both ends as seen from above, up to 25μ in vertical diameter, the narrower cells up to 45μ long; gonidangia the same shapes as the vegetative cells; gonidia formed by successive divisions of the whole protoplast; color bright blue-green.

Growing on *Chaetomorpha aerea* in a pool near high tide limit. Cypress Point, Monterey County, California.

The first mention of the genus *Xenococcus* was that by Thuret in 1875 (Essai, p. 373). He did not, however, diagnose the genus nor mention a type species at that time. The genus was founded by him in 1880 (Bornet and Thuret, Notes algol., fasc. 2, pp. 73–75, pl. 26, figs. 1–2) based upon *Xenococcus Schousboei* Thuret, which is Schousboe's *Coleonema arenifera*, as the type species, but even in this publication he neglected to give a definite generic diagnosis. Gonidia were not discovered in the species by him, but from his statements and figures it is clear upon what vegetative characters he based the genus. In his notes on the species (*loc. cit.*, p. 75) he states distinctly that vegetative cell divisions occur perpendicular to the substratum and in that direction only, and hence colonies consisting of only one layer of cells can be produced in this genus. Examination of a part of the type material, *Coleonema arenifera*, reveals this condition to be correct. It is principally upon that character that the genus may be distinguished from *Pleurocapsa*, which has vegetative cell divisions in three planes, although Achille Forti says in his diagnosis of *Xenococcus* that it also divides vegetatively in three planes. (Forti, *in* De Toni, Syll. Alg., vol. 5, p. 133). Both *Xenococcus* and *Pleurocapsa* reproduce by gonidia, Batters having discovered them in *X. Schousboei* Thur. *X. chaetomorphae* conforms to the *Xenococus* method of vegetative growth rather than to that of *Pleurocapsa*, and hence is here placed in that genus.

This species was found associated with *Dermocarpa pacifica*, and it is somewhat difficult to distinguish the two species. Both species produce gonidia in great abundance, and plants of both species may be found in all stages of growth at the same time. They are very abundant, intermingled, and as seen from above are very angular on account of lateral pressure resulting from growth. There appears certainly to be vegetative growth in the *Xenococcus*, as the continuous areas covered by it, comprising many hundreds of cells, seem far too great to have arisen from a single group of gonidia, and should the gonidia escape singly they could never by chance become so uniformly and closely associated as they often are to be found. The cells of *Xenococcus* in all stages of growth are extremely angular and very variable in shape and size; sometimes being much crowded at the cross walls of the host plant, the tendency is to elongate vertically. Frequently groups of cells seem to have started to grow on the cell walls of young cells of the host between the cross walls, and as the host cell elongates the cells of the epiphyte seem to elongate abnormally in the direction of the long diameter of the host (pl. 36, fig. 3). There are no particular shapes or sizes of gonidangia, since any of the long narrow cells, small angular cells, or large spherical cells may be transformed into gonidangia. The gonidia are formed by successive divisions of the whole of the protoplast (pl. 36, fig. 4). On the whole it seems almost certain that we have two plants of different genera closely and intimately associated here, and it certainly is not possible to distinguish the individuals of the two in all stages of their development. I have previously referred to this difficulty in the introduction (p. 429).

Dermocarpa hemisphaerica Setchell et Gardner sp. nov.

Plate 37, fig. 21

Cellulis epiphyticis, solitariis, hemisphericis, a superficie plano adhaerentibus 18–21μ diam. basali, 10–13μ altis; contentu cellularum laete caeruleo-viridi, homogeneo; multiplicatione per partitiones continuas contentus toti gonidia spheriea 0.8–1.2μ formanti.

Cells epiphytic, solitary, hemispherical, attached by the flat plane surface, 18–21μ diam. at the base, 10–13μ high; contents of cell bright blue-green, homogeneous; cell wall hyaline, moderately thick, homogeneous; reproduction by successive divisions of the whole protoplast, forming spherical gonidia 0.8–1.2μ diam.

Growing on *Rhodochorton Rothii* in moist shaded places along high-tide level, or even above. Moss Beach, San Mateo County, California. The above locality is the one from which the type material has been obtained, but the plant has been observed growing on the same host at a number of different localities along the California coast.

Dermocarpa hemisphaerica is a somewhat aberrant plant. The individuals are small, mostly solitary, and multiplication is wholly by means of gonidia. In size and distribution on the host it resembles *Xenococcus* in the early stages of development of that genus, but differs from it in not having increase by means of vegetative cell divisions. In its solitary habit and method of reproduction it resembles *Cyanocystis*, but differs from that genus in its method of escape of gonidia, those of *D. hemisphaerica* escaping through a small opening at the apex of the gonidangia, and those of *Cyanocystis* escaping by means of a circumscissile splitting of the gonidangia. It seems more nearly to fulfil the requirements of the genus *Dermocarpa*, as now generally understood, than any other genus of Chamaesiphonaceae. It differs however from all of the species of that genus thus far described, so far as I know, in the method of the formation of gonidia. They are formed in this species by successive divisions of the contents of the gonidangia (pl. 37, fig. 21), those in the other species being formed by simultaneous division. In this respect it is like some species of *Pleurocapsa*.

Dermocarpa hemisphaerica is commonly associated with *Chlorogloea conferta* and *Dermocarpa suffulta* described in this paper. The early stages of the development of *D. hemisphaerica* and *D. suffulta* are very similar to each other, but they soon differentiate into their characteristic shapes, and at maturity are very readily distinguishable. *Chlorogloea conferta* is very frequently in such abundance as to completely cover up the other two species with which it is so frequently associated here; hence this condition along with the presence of diatoms and other foreign material, has made the separation of these forms somewhat difficult. The type material is comparatively free from foreign substances and the plants of *D. hemisphaerica* and *D. suffulta* are both fruiting, abundant, and comparatively free from *Chlorogloea*. This condition has made it possible to trace the life history of each of these three species, establishing beyond a doubt that they are not to be considered stages in the life history of a single form.

D. hemisphaerica seems closely related to *Pleurocapsa amethystea* Rosenvinge (1893, p. 967). This is especially true of the early vegetative stage and of the beginning of spore formation (*loc. cit.*, figs. C, D), p. 968). Later developments of *P. amethystea* depart from that of *D. hemisphaerica* (*loc. cit.*, figs. E, F, G).

Dermocarpa pacifica Setchell et Gardner sp. nov.

Plate 37, figs. 22–24

Cellulis in coloniis ad 200μ diam., in forma e fere sphericis, late ovatis aut pyriformibus ad anguste cuneatis variantibus, 30–45μ altis, 20–35μ diam.; parietibus cellularum crassis, hyalinis, homogeneis; contentu cellularum primo laete caeruleo-viridibus aut olvaceo-viridibus, aetate provecta, fuscescentibus; gonidiis numerosis, 2μ diam.

Cells aggregated into colonies up to 200μ diam., varying in shape from nearly spherical, broadly ovate or pear-shaped, to narrowly wedge-shaped, 30–45μ long, 20–35μ diam.; cell walls thick, hyaline, homogeneous; cell contents bright blue-green or olive-green when young, changing to brownish when old; gonidia numerous, 2μ diam.

Growing on *Chaetomorpha aerea* in a tide pool near high-tide limit. Cypress Point, Monterey County, California. January, 1917.

The plants of this species were found associated with *Xenococcus chaetomorphae* and the two species were so abundant as to give the host a very dark color. The shapes of the cells of *D. pacifica* are determined to a certain extent by their position on the host, and by their age. The young cells of *C. aerea* are cylindrical, but they become quite torulose at maturity. This change in the shape of the host cells modifies the form of certain cells of the epiphyte. If the gonidia of the *Dermocarpa* happen to locate at the cross walls when the host cells are young, increase in the size of the cells of both the host and the epiphyte causes the cells of the epiphyte to become much crowded and thus assume a narrow wedge shape (pl. 37, fig. 22). As the cells of the host plant mature and begin to disintegrate, the younger *Dermocarpa* cells that have had more room in which to expand, are liberated and these become broadly oval or even spherical (pl. 37, fig. 23). The cell contents become much darker and brownish at maturity, and when mounted in glycerine and acetic acid, change to purple. The contents of the whole gonidangium change into gonidia by simultaneous division.

Dermocarpa suffulta Setchell et Gardner sp. nov.

Plate 36, fig. 9

Cellulis solitariis aut in coloniis parvis laxe aggregatis, ovoideis, pyriformibus aut aliquando stipitatis, 17–20μ altis, in parte crassiore 10–14μ diam.; contentu laete caeruleo-viridi; parietibus cellularum hyalinis, homogeneis; gonidangiis e parte superiore cellulae formatis, parte infera ut pedicello sterili persistente; gonidiis 8–12 in gonidangio, 4–6μ diam.

Cells solitary or loosely associated into small groups, ovoid, pear-shaped or sometimes stipitate, 17–20μ long, 10–14μ diam. at the larger end; contents bright blue-green; cell wall hyaline; homogeneous; gonidangia formed from the upper part of the cell, leaving a cone-shaped, sterile, basal portion; gonidia 8–12 in a gonidangium, 4–6μ diam.

Growing on *Rhodochorton Rothii* near high-tide limit in shaded places on rock. Moss Beach, San Mateo County, California.

These plants were found growing in moderate abundance in company with *Dermocarpa hemisphaerica* and with *Chlorogloea conferta* described elsewhere in this paper. Of all the known species it seems most closely related to *Dermocarpa Leibleiniae* (Reinsch) Born. and Thur. It differs from that species in being narrower in general, in having fewer and larger gonidia, and in having a larger part of the cell changed into a gonidangium. Nearly half of *D. Leibleiniae* remains sterile. It is also closely related to *D. solitaria* very recently described by Collins and Hervey (1917, no. 2155 ms. and 1917*a*, p. 17) from Bermuda. Both species have the same habit of growth on the host, being mostly solitary instead of being aggregated into dense clusters as most species of *Dermocarpa* are. *D. solitaria* is much longer than *D. suffulta* being up to 75μ long.

Dermocarpa sphaeroidea Setchell et Gardner sp. nov.

Plate 36, fig. 7

Cellulis sphaeroideis aut lente obovatis, sub compressione parvo angularibus, solitariis, aut vulgo in coloniis parvulis aggregatis, ad 25μ diam.; parietibus cellularum hyalinis, homogeneis, tenuibus, 1.5μ crassis; contentu cellularum maturitate dilute caeruleo-viridi, subtiliter granulato; gonidangiis 18–25μ diam., contentu totaliter in gonidia partito.

Cells spheroidal or slightly obovate, somewhat angular when compressed, solitary or mostly grouped together in small clusters, up to 25μ diam.; cell wall hyaline, homogeneous, thin, 1.5μ thick; cell contents pale blue-green at maturity, finely granular; gonidangia 18–25μ diam., the whole cell contents dividing into small spherical gonidia.

Growing on *Porphyra perforata* forma *lanceolata*, along high-tide level. Lands End, San Francisco, California. April, 1917.

This species of *Dermocarpa* probably grows also on other hosts in the same locality. Groups of cells resembling those of this species have been observed intermixed with *Radaisia* and *Pleurocapsa* growing on small species of *Enteromorpha* and *Ulva*, but it is difficult to determine the separate members in such a mixture. The material found on Porphyra was free from other forms. It seems to occupy an intermediate position, as regards its gregarious habit, between *D. fucicola* and *D. suffulta*, the former growing in compact colonies and the latter almost always singly.

Hyella littorinae Setchell et Gardner sp. nov.

Plate 37, figs. 19–20

Filamentis erectis numerosis, rectis, parallelis, simplicibus aut sparse ramosis, 75–85μ longis, 10–14μ diam.; incremento longitudinali per partitiones cellularum apicalium; cellulis ad basim filamentorum angularibus 4–6μ diam.; partitionibus in directionibus omnibus; cellulis terminalibus filamentorum erectorum cylindricis, 20–30μ longis; contentu cellularum caeruleo-viridi, homogeneo; parietibus cellularum (aut vaginis) hyalinis, homogeneis, 2.5–3.5μ crassis; gonidangiis adhuc ignotis.

Erect filaments numerous, straight, parallel, simple, or sparsely branched, 75–85μ long, 10–14μ diam.; growth in length by division of apical cell; basal cells of filaments angular, 4–6μ diam., divisions in all planes; terminal cells of erect filaments cylindrical, 20–30μ long; cell contents blue-green, homogeneous; cell wall or sheath hyaline, homogeneous, 2.5–3.5μ thick, gonidangia unknown.

Growing on *Littorina planaxis* Nutt. along high-tide level on rocks. Common along the coast of California, but probably grows wherever this species of *Littorina* occurs from San Diego to Sitka. The type material is from Carmel, Monterey County, California.

For a discussion of the relation between the genera *Hyella* and *Radaisia* see page 430 of this paper.

Reproduction by gonidia has not been observed in this species, but the vegetative characters are so similar to those of *Hyella caespitosa* growing in the shells of oysters and other mollusks, as to leave room for little doubt as to its close affinity with that species. The prostrate filaments, characteristic of *Hyella caespitosa*, have not been observed. Gonidangia may not develop, and reproduction may be wholly vegetative in the same manner that vegetative reproduction is reported to occur in *H. caespitosa*. I base my opinion on the fact that I have examined shells at all seasons of the year and from different localities and have not found gonidia. The basal cells divide in several planes into numerous small angular cells, approximating gonidia. The filaments resulting from these divisions, resemble those figured by Bornet and Flahault (1889, fig. 2). These small, angular cells possibly escape and develop into new plants. They can scarcely be considered as having formed in gonidangia, because a few cells just above the basal cells divide likewise, though progressively to a less degree, forming clavate filaments at maturity (pl. 37, fig. 19).

Hyella linearis Setchell et Gardner sp. nov.

Plate 36, fig. 8

Thallis dense caeruleo-viridibus, in hostem penetrantibus, 350–450μ longis; cellulis finium filamentorum internorum minimis, 4–6μ diam., 3.5–4.5μ longis in magnitudine ad 12μ diam. supra superficiem externam hostis augentibus; parietibus cellularum tenuibus, hyalinis. partitionibus cellularum prima in directione una, filamenta plus minusve tortua et sparse ramosa formantibus; tardiore partitionibus cellulis in directionibus tribus, frequenter maxime obliquis, frequentissime ad superficiem hostis filamenta clavata formantibus; gonidangiis in superficie hostis sitis, 14–20μ diam.; gonidiis numerosis, 1μ diam.

Thalli dark blue-green, penetrating into the host, 350–450μ long; cells of the inner ends of the filaments smallest, 4–6μ diam., 3.5–4.5μ long, gradually increasing in size to 12μ in diam. toward the periphery of the host; cell walls thin, hyaline; cell divisions in one plane at first, building up more or less tortuous, rarely branched filaments; later, cell divisions in three planes, often decidedly oblique, most abundant toward the periphery of the host, building up clavate filaments; gonidangia at the surface of the host, 14–20μ diam.; gonidia numerous, 1μ diam.

Growing in *Prionitis* sp. Sunset Beach, near the mouth of Coos Bay, Oregon. May, 1914. This is the type locality and only one plant of *Prionitis* has been found infested by this species of Myxophyceae.

This species seems closely related in form to *Hyella socialis* of this paper, but differs principally in the size of the cells, and in having the filaments nearly straight and rarely branched. See the discussion on page 430 of this paper concerning other species of this genus touching on this point. I was led to the discovery of *Hyella linearis* by observing the presence of small warts, or excrescences growing on

Prionitis. *Hyella* was found to be uniformly associated with the warts only. I presume that the presence of the foreign plant stimulated the cells of *Prionitis* thus producing the abnormal growths at the point of infection. This rapid growth of the cells of *Prionitis* would have the effect of disturbing the horizontal layer of *Hyella* and of dispersing its erect filaments.

Hyella socialis Setchell et Gardner sp. nov.

Plate 36, fig. 5

Filamentis in hostem penetrantibus, 200–300μ longis, tortuis, dendroide ramosis, primo cellularum partitionibus in directione una, tardiore in directionibus tribus, greges cellularum in vagina originali producentibus, grege quoque e divisione cellulae singulae oriente, sicut libero, gregibus cellularum Gloeocapsae similibus, gregibus majoribus prope superficiem hostis sitis; cellulis maxime angularibus, in forma magnitedineque variabililbus, 4–6μ diam., cellula terminali 7–9μ longa, penetrante, maxime conica; parietibus cellularum hyalinis, mollibus; contentu cellularum laete caeruleo-viridi; gonidangiis adhuc ignotis.

Filaments penetrating into the host, 200–300μ long, tortuous, branching dendroidally, at first cell divisions only in one plane, later dividing in all directions, producing groups of cells within the original sheath; each group resulting from the divisions of a single cell in the filament, becoming practically independent, similar to groups of *Gloeocapsa* cells, the largest groups being nearest the surface of the host; cells very angular, irregular in shape and size, 4–6μ diam., terminal penetrating cell 7–9μ long, decidedly conical; cell walls hyaline, soft; cell contents bright blue-green; gonidangia unknown.

Growing on the stipitate portion of *Iridaea minor* J. Ag., in the lower littoral belt. Carmel Bay, Monterey County, California. May, 1916.

The basal filaments of the plant, if present at all, could not be thoroughly worked out with the material at hand. Further study will be required to elucidate this point. A discussion of the relation between the genera *Hyella* and *Radaisia*, in which the reasons are stated for placing these new species as arranged here, may be found on page 430 of this work.

The early stages of the development of this species are unknown. No gonidangia were present and the host plant was nearing maturity. It is possible that no gonidia were developed, and that the dissolution of the sheath of the groups of vegetative cells free them at the time that the host is beginning to disintegrate, and these vegetative cells locate on younger hosts.

This species is placed in the genus *Hyella* on account of its close similarity in some of its vegetative characters and its penetrating habit to those of *H. caespitosa* Bornet and Flahault (1888), the original species of the genus. They represent cell divisions as taking place in all directions at the base of the erect filaments. In surface view the cells arising from divisions of the cells in the basal filaments appear in more or less isolated groups in their illustrations. The few cells near the base of the erect filaments are less divided, and the terminal cells of the erect filaments remain undivided. The erect filaments thus become somewhat isolated, and clavate in form. The filaments of *H. socialis* appear to be formed in the same manner as those described and figured by Bornet and Flahault, although they are crooked and branched. In the absence of knowledge concerning the prostrate portion of the thallus, characteristic of typical *Hyella*, and in the absence of gonidangia, this species must remain in doubt as to its generic position.

Radaisia laminariae Setchell et Gardner sp. nov.

Plate 37, figs. 14–16

Thallo prostrato filamentis compactis radiantibusque, dichotome aut subdichotome ramosis, stricte compacto, orbiculari, ad 300μ diam.; cellulis filamentorum prostratorum quadratis, 4–4.5μ diam., per partitiones horizontales filamenta compacta erectaque producentibus; thallo adulto 30–40μ crasso; gonidangiis in filamentis erectis terminalibus, sphericis aut lente ovalibus, 8–9μ diam.; gonidiis 0.8μ diam., partitione simultanea; thallo laete caeruleo-viridi.

Prostrate portion of the plant consisting of compact, radiating filaments, dichotomously or subdichotomously branched, forming a closely compact thallus circular in outline, up to 300μ diam.; cells of prostrate filaments quadrate, 4–4.5μ diam., giving rise by horizontal divisions to closely compact, erect filaments; the whole thallus 30–40μ thick; gonidangia terminal on the erect filaments, spherical, or slightly oval, 8–9μ diam.; gonidia 0.8μ diam. formed by simultaneous division; color bright blue-green.

Growing on the terminal portion of the blades of *Laminaria Sinclairii*. Fort Point, San Francisco, California. This locality is, so far as I know, the only one in which this species has been observed. It probably has a much wider distribution. The host plant extends from the vicinity of Point Conception, California, to Vancouver Island.

I have presented a brief discussion in the introduction to this work, page 430, in regard to the relation between the general *Hyella* and *Radaisia*. *R. laminariae* I have taken to represent a typical species of the genus, having a single layer of cells for the base which gives rise to perpendicular, parallel, unbranched filaments extending away from the host and bearing each a single terminal gonidangium. The whole cushion or colony, is in reality a single plant resulting from the growth of a single gonidium.

The plants of this species start from a single cell, and by a few divisions a small group of cells is formed. Around the margin the cells soon begin to arrange themselves radially in rows and by divisions in two planes, radial and tangential, a circular disk, one layer of cells deep, is formed. The marginal cells enlarge tangentially and are cut into two cells by a radial wall, the resulting "filaments" are of equal growth, as a rule, and the forking thus becomes dichotomous (pl. 37, fig. 16). Plants often become so closely associated as to form a continuous layer over the surface of the host. Even under this condition they have no effect upon the host, so far as death and disintegration of the cells is concerned, and hence they are strictly epiphytic. The erect filaments result from the horizontal division of the prostrate or basal cells. They form very dense, compact masses, their cell walls adhering firmly (pl. 37, fig. 15). The gonidangia are numerous, spherical or slightly oval, being transformed terminal cells of the erect filaments (pl. 37, fig. 14).

Radaisia clavata Setchell et Gardner sp. nov.

Plate 37, figs. 17–18

Pulvinis in superficie hostis, minutis, dense caeruleo-viridibus, ad 100μ diam., in sectione media, plus minusve flabelliformibus; filamentis dense compactis, 70–100μ longis, ad fines externos sparse ramosis; cellulis 4–5μ diam. infero, supra 7–8μ, 3–4μ longis, partitionibus cellularum frequenter irregulariter obliquis; parietibus cellularum tenuibus, hyalinis; contentu cellularum homogeneo; gonidangiis 8–9μ diam., terminalibus, hemisphericis; gonidiis angularibus, 1–1.5μ diam., partitione simultanea.

Plants forming microscopic, deep blue-green cushions on the surface of the host, up to 100μ diam., more or less fan-shaped in median section; filaments very closely compact, 70–100μ long, sparsely branched near the outer ends. Cells 4–5μ diam., at the base, 7–8μ above, 3–4μ long, cell divisions often irregularly oblique, cell walls thin, hyaline; cell contents homogeneous; gonidangia 8–9μ diam., terminal, hemispherical; gonidia angular, 1–1.5μ diam., formed by simultaneous division.

Growing on *Gymnogongrus linearis*, in the lower littoral belt. Lands End, San Francisco, California. This is the only known locality in which this plant grows. The host plant is common along the California coast and extends as far north as the Strait of Juan de Fuca. It is not at all unlikely that it may be found on the same host in other localities.

R. clavata departs slightly from the previous species, *R. laminariae*, in having the filaments occasionally branched, and the cross cell divisions often decidedly irregularly oblique.

Radaisia subimmersa Setchell et Gardner sp. nov.

Plate 37, figs. 12–13

Thallis parvulis, inconspicuis, in linea exteriore in superificie hostis irregularibus, cuticulam aut cavernas externas parvasque incolentibus; thallo prostrato cellulis irregularibus irregulariter positis 3–5μ diam., primo verticalibus, tardiore ad fines liberos distantes divergentibus, 35–45μ longis, composito; partitione cellularum in superficie libera thalli in directione una intus in directionibus tribus, pondera ovalia formante; cellulis filamentorum erectorum 3–5μ longis, 1.5–2.5μ latis, vetustioribus frequenter pyriformibus; contentu homogeneo, caeruleo-viridi; gonidangiis terminalibus, sphaericis, 4–6μ diam., gonidiis 6–8, partitione simultanea.

Thalli small, inconspicuous, irregular in outline on the surface of the host, growing on the cuticle, or in small surface cavities; prostrate or basal layer composed of angular cells 3–5μ diam., arranged irregularly, giving rise to erect filaments, parallel at first, later spreading somewhat at the free distal ends, 35–45μ long; cell division on the free surface portion in one plane, within the host in three planes, building up oval masses; cells in erect filaments 3–5μ long, 1.5–2.5μ wide, older cells frequently becoming pear-shaped; contents homogeneous, blue-green; gonidangia terminal, spherical, 4–6μ diam., producing 6–8 gonidia by simultaneous division.

Growing on *Rhodymenia* sp. Carmel Bay, Monterey County, California.

The host plant, no. 3350, was collected by me. It is a *Rhodymenia* and possibly *R. palmetta,* at least belongs to the palmetta group. It was cast ashore and slightly faded thus making the *Radaisia* groups appear distinct which led to their discovery. The host is not uncommon along the California coast and the epiphyte is to be expected in other localities. This species of *Radaisia*, like others, seems to be epiphytic at least until the basal layer of cells is produced, as shown in plate 37, figure 13.

Plants start from a single cell on the cuticle of the host, at least numbers of them have been so observed. By repeated divisions, sometimes perpendicular to the longer diameter of the cell, but usually quite oblique, a single layer of cells of varying shapes and sizes is developed (pl. 37, fig. 13). The cell walls of this basal layer are transparent, seem to be gelatinous, so that the cells soon become more or less freed and independent of each other. Horizontal divisions begin and short filaments, 3–5 cells long, are formed above the surface of the host. Meanwhile it seems possible that the prostrate layer has begun to dissolve the cuticle and the underlying cortical cells, and division of the basal cells may have begun forming filaments which push into the host completely dissolving the host cells as they penetrate (pl. 37, fig. 12).

The plants upon which this species is founded are scarcely mature, the gonidangia being very rare. The depth to which they may penetrate the host is thus rather uncertain. It is not at all unlikely that they may penetrate to a much greater depth than that reported in the diagnosis above. It certainly seems that the whole of the cells of the host is actually absorbed, or at least destroyed, as far as the parasite travels.

Radaisia subimmersa may be looked upon as being on the border line between *Radaisia* and *Hyella* so far as its relation to the host is concerned, being partially internal and partially external, and possibly growing in both directions from the original basal layer. The filaments, however, being more or less parallel and having the gonidangia on the outer free ends, are characters which have led to its being placed in the genus *Radaisia*.

Radaisia epiphytica Setchell et Gardner sp. nov.

Plate 37, figs. 10–11

Thallis pulviniformibus in superficie hostis positis, in linea exteriori ut supra visis fere circularibus, 250–350μ diam., 50–60μ crassis; strato prostrato, aut infimo, per ramificatione dichotoma aut subdichotoma in margine formato; filamentis erectis laxe adhaerentibus, gregibus cellularum angularum 3–5μ diam., partione cellularum in directionibus tribus compositis; contentu cellularum homogeneo, caeruleo-viridi; cellulis terminalibus, subterminalibusque in gonidangiis magnitudine parvo majoribus transformatis; gonidiis angularibus, 1.8–2.4μ diam., partitionibus simultaneis.

Thalli forming cushions on the surface of the host, nearly circular in outline as seen from above, 250–350μ across, 50–60μ thick; prostrate or basal layer formed by dichotomous or subdichotomous branching around the margin; erect filaments loosely adherent, composed of groups of angular cells, 3–5μ diam., produced by cell divisions in three planes; contents homogeneous, blue-green; terminal and subterminal cells of the vertical groups transformed into gonidangia with slight increase in size; gonidia angular, 1.8–2.4μ diam., formed by simultaneous division of the contents.

Growing on *Iridaea minor,* in the lower littoral belt. Carmel, Monterey County, California.

Only a single antheridial plant of *Iridaea* has been observed with this epiphyte growing upon it, but doubtless it is common and probably grows on other sexes of the same species. *Iridaea minor* is usually rather dark colored which makes the presence of *Radaisia* somewhat obscure and this condition may account for its not having been previously observed.

The gonidangia of *R. epiphytica* depart somewhat from the typical form of the genus. Since the erect filaments are complex in each sheath resulting from vertical as well as horizontal divisions, often irregular and oblique, the gonidangia are also complex consisting of a group of transformed terminal cells instead of a single terminal cell as is usually the case. The original cell wall or sheath persists as the erect filaments elongate and become complex. Likewise when the terminal cells metamorphose into gonidangia the original sheath of a group of cells persists, and a compound gonidangium is the result.

In conclusion I wish to acknowledge a debt of gratitude which I owe to Professor W. A. Setchell who collaborates with me in presenting the new species of algae of this paper, and who has kindly prepared the Latin diagnoses.

EMENDATION

Since publishing New Pacific coast marine algae I, June, 1917, Professor Farlow has called our attention to the publication of *Sargassum Palmeri* Grunow (Verh. zool.-bot. Ges., Vienna, 1915, vol. 65, p. 338) based upon the plant distributed in Farlow, Anderson and Eaton, Algae Exsiccatae Amer.-Bor., no. 102. This plant was referred by Setchell and Gardner to *S. dissectifolium* (Gardner, *loc. cit.*, p. 386). The type of *S. dissectifolium*, however, is a plant collected at Santa Catalina Island, southern California, and deposited in the Herbarium of the University of California as no. 99,540. The copy of the above publication, 1915, has not as yet reached the University of California, presumably on account of the war.

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EXPLANATION OF PLATES

The illustrations have all been drawn by Dr. Helen M. Gilkey under the direction of the writer.

PLATE 36

Chlorogloea lutea Setchell and Gardner

Fig. 1. A section through the host plant showing the general character of the endophyte. × 500.

Xenococcus chaetomorphae Setchell and Gardner

Fig. 2. A few elongated vegetative cells with interspersed gonidangia. × 125.

Fig. 3. Vegetative cells on different parts of the cells of the host, *Chaetomorpha*. × 125.

Fig. 4. A group of cells near the cross wall of the host plant showing the formation of gonidia. × 250.

Xenococcus chaetomorphae Setchell and Gardner

Fig. 5. A section of the host plant showing the habit of growth of the endophyte. × 250.

Chlorogloea conferta (Kuetz.) Setchell and Gardner

Fig. 6. Habit sketch of a colony growing on *Rhodochorton Rothii*. × 500.

Dermocarpa sphaeroidea Setchell and Gardner

Fig. 7. Habit sketch of vegetative cells and two gonidangia showing shapes and relative sizes. × 250.

Hyella linearis Setchell and Gardner

Fig. 8. Section of the host *Prionitis*—diagrammatic—showing an affected portion inhabited by the endophyte which is shown as radiating groups of cells, and with two gonidangia on the surface. × 125.

Dermocarpa suffulta Setchell and Gardner

Fig. 9. Plants selected to show variations in shapes and sizes. The two empty cells are vegetative, the other three are gonidangia, one showing all of the contents changed into gonidia, the exceptional condition. × 500.

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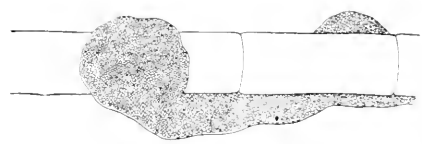

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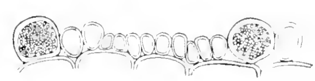

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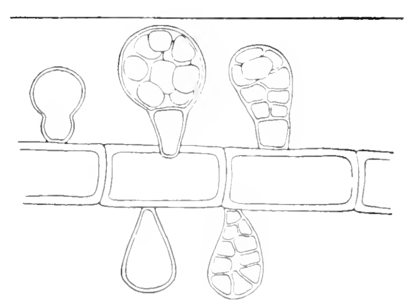

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PLATE 37

Radaisia epiphytica Setchell and Gardner

Fig. 10. A portion of the basal layer of a plant, as seen from above, showing a few rows of cells one layer deep at the right and beginning to develop erect filaments at the left. × 250.

Fig. 11. A few erect filaments showing complex gonidangia at the outer ends. × 250.

Radaisia subimmersa Setchell and Gardner

Fig. 12. A section through the host perpendicular to the flat surface, showing various stages of development of *Radaisia* on the surface at the left, and variously embedded groups to the right. × 250.

Fig. 13. Various stages in the development of the basal layer. × 250.

Radaisia laminariae Setchell and Gardner

Fig. 14. A few highly magnified erect filaments, three of them bearing terminal gonidangia. × 500.

Fig. 15. The same as figure 14, but less magnified, showing the margin of the colony at the left. × 250.

Fig. 16. A portion of the basal layer showing the method of its development. × 375.

Radaisia clavata Setchell and Gardner

Fig. 17. A perpendicular section through a plant showing the character of the erect filaments and one gonidangium. × 250.

Fig. 18. A portion of the basal layer. × 250.

Hyella littorinae Setchell and Gardner

Fig. 19. Showing a few forms assumed by the erect filaments, the upper portions representing the outer ends. × 250.

Fig. 20. A few groups of cells as seen from above, representing the outer ends of the filaments. × 250.

Dermocarpa hemisphaerica Setchell and Gardner

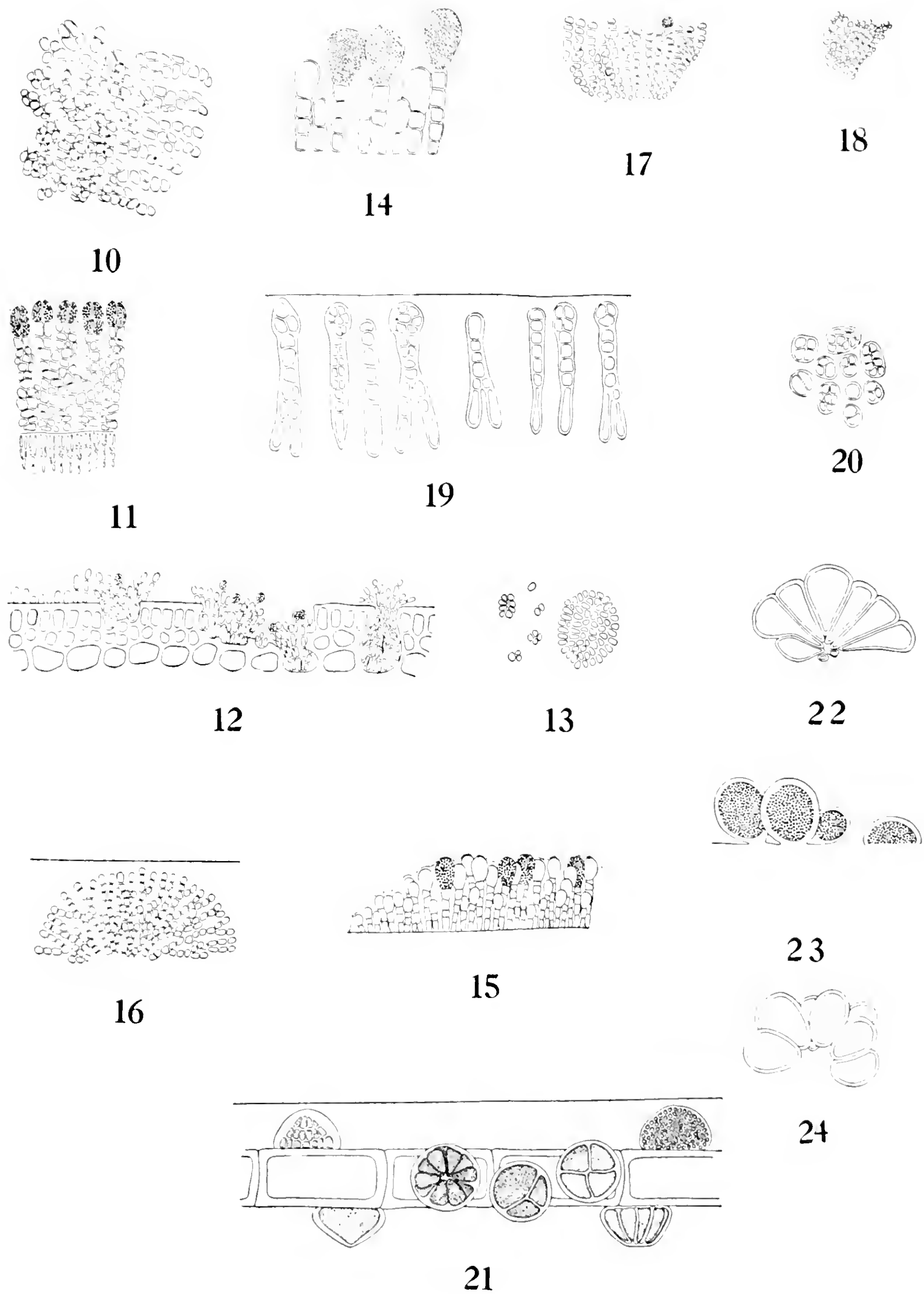
Fig. 21. Showing one cell in the lower left-hand corner representing the vegetative condition, and the others in various stages of gonidia formation. × 500.

Dermocarpa pacifica Setchell and Gardner

Fig. 22. A group of cells at the cross wall of the host, a common wedge-shaped form. × 250.

Fig. 23. A group of spherical gonidangia. × 250.

Fig. 24. A group of vegetative cells from the dead portion of the host. × 250.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NEW PACIFIC COAST MARINE ALGAE III

BY

NATHANIEL LYON GARDNER

Anacystis elabens (Kuetz.) Setchell et Gardner comb. nov.

Plate 38, figs. 6, 7

Young colonies globose, later becoming much flattened and irregularly lobed, 60–100μ diam.; cells oblong, 3–4.5μ diam., 7μ long, cell wall thin, protoplast aeruginous or olive-green, tegument moderately thin and firm.

Growing among other algae in tide pools. Pacific Beach, near San Diego, California. Collected by Mrs. M. S. Snyder.

Polycystis elabens Kuetzing, Sp. Alg., 1849, p. 210.

This is the only species of the genus growing either in fresh or in salt water that has been discovered on the Pacific coast of North America, and the above collection is from the only known locality from which it has been reported.

The cells of the colonies appear to separate into groups when they are nearing the stage of maturity (pl. 38, fig. 6), but our material does not show the groups with a distinct envelope as Kuetzing figures for the species. (Kuetz., Tab. Phyc., vol. 1, pl. 8.)

The genus *Anacystis* was published by Meneghini in 1837 and has generally been subordinated to *Microcystis* of Kuetzing published in 1833, but which is clearly a synonym of *Euglena* of Ehrenberg (1832?). Later it has been subordinated to *Polycystis* Kuetzing, proposed about 1845 and consequently distinctly later than the genus of Meneghini. It seems, therefore, necessary to adopt the name of *Anacystis* for the genus and to refer to it this species long ago described.

Placoma violacea Setchell et Gardner sp. nov.

Plate 38, figs. 1–3

Thallo microscopico, 175–250μ diam., irregulari ad leviter sphaerico, verrucoso; tegumentis dilute violaceis; cellulis 3.5–4μ diam., binis ad octonis frequentissime quaternis, ad superficiem radiate positis sed intus sine ordine aggregatis; juvenis angulatis demum sphaericis; cytioplasmate homogeneo, dilute coeruleo-viridi.

Thallus microscopic, 175–250μ diam., irregular to somewhat spherical, verrucose, tegument pale violet; cells 3.5–4μ diam., in groups of 2–8, mostly 4, arranged radially toward the periphery but mostly without order in the interior, angular when young, later becoming spherical; protoplast homogeneous, pale blue-green.

Growing on logs in company with other species of Myxophyceae, along high-tide level. Cape Flattery, Washington. Type no. 3829, Gardner.

This species is similar to *Placoma africanum* Wille (1903, p. 90), a fresh-water species collected in South Africa, but it differs from that species in having a different habitat, viz., salt water, in having larger cells aggregated into larger colonies, and in having a violet colored tegument.

Dermocarpa protea Setchell et Gardner sp. nov.

Plate 38, figs. 4, 5

Cellulis forma magnitudineque maxime variabilibus, late pyriformibus ad anguste cuneatis, 40–120μ longis, prope apicem 6–40μ diam., ad basim 3–7μ diam.; parietibus hyalinis, 2–3μ crassis; cytioplasmate homogeneo, dilute coeruleo-viridi; gonidiis 3–3.5μ diam., divisionibus iteratis formatis.

Cells extremely variable in shape and size, broadly pyriform to narrowly cuneate, 40–120μ long, 6–40μ diam. at the apex, 3–7μ at the base; cell wall hyaline, 2–3μ thick; protoplast homogeneous, light blue-green; gonidia 3–3.5μ diam. formed by successive divisions of protoplast.

Growing on *Spongomorpha* sp. West coast of Whidbey Island, Washington. Type no. 467, Gardner.

A single specimen of this species of *Spongomorpha* with the above epiphyte growing upon it has thus far been collected. The terminal portions were so thickly clothed with the epiphyte as to give it a very decidedly dark appearance. Microscopic examination showed that the colonies were unusually variable in shape and in size, some capping the filaments, others completely surrounding and obscuring them for some distance, and still others small and widely separated. Material scraped from the filaments and magnified revealed a surprising variation in the shape and size of the vegetative cells, as well as of the gonidangia. Among the collection one could select cells in both vegetative and reproductive conditions which would conform to the description, in shape and in size, of each of several well-known species, but since there is such perfect gradation in lengths and in widths, both in the purely vegetative cells and in the gonidangia, ranging in size of mature cells from 6μ to 40μ wide in the upper parts, and from 40μ to 120μ long, it is impossible to segregate them into species. Considered as a species, *D. protea* represents the largest known species of *Dermocarpa*, and has the greatest range of variation in size and in shape of the cells. Plate 38, fig. 4, represents some of these found among the gonidangia.

Dermocarpa protea is an excellent example of the formation of gonidia by successive and progressive divisions of the gonidangia to form gonidia (pl. 38, fig. 5). This method is represented in the gonidangia irrespective of shapes and sizes, and is another evidence in support of their all belonging to a single species.

Kirchner (1898, p. 58), in his key to the genera, places *Dermocarpa* in the group which produces the gonidia by simultaneous division of the protoplast. In my Cytological Studies in Cyanophyceae (1906, p. 281), I expressed the opinion that *Dermocarpa fucicola* Saunders produces gonidia in this manner. I have since examined authentic material of that species and, although the gonidangia are very sparse, it appears to form them by simultaneous division, but having examined other collections from our coast which seem to be of the same species, judging from the shape and size of the cells, which clearly show that the formation of gonidia is by successive divisions of the protoplast, some doubt may still be entertained as to which method *D. fucicola* follows. This subject must have more careful study and may prove to be a more stable character than shapes and sizes of cells upon which to establish species.

Dermocarpa sphaerica Setchell et Gardner sp. nov.

Plate 39, fig. 14

Cellulis solitariis aut contiguis, sphaericis, 8–16μ diam., dilute coeruleo-viridibus; parietibus tenuibus, hyalinis; cytioplasmate minute granulato; gonidangiis sphaericis 8–16μ diam.; gonidiis primo angulatis demum maturitate sphaericis 2–5.3μ diam., divisionibus simultaneis formatis, dissolutione parietis gonidangii totii liberatis.

Cells solitary or contiguous, spherical, 8–16μ diam., pale blue-green; cell wall thin, hyaline; protoplast finely granular; gonidangia spherical, 8–16μ diam.; gonidia angular at first, becoming spherical at maturity, 2.5–3μ diam., formed by simultaneous division of the protoplast, escaping by dissolution of the entire gonidangial wall.

Growing on various species of algae in the littoral belt, frequently in salt marshes. Ranging from Whidbey Island, Washington, to central California. The type material was found growing on a species of *Lyngbya*. Lands End, San Francisco, California. Type no. 1906, Gardner.

Xenococcus Schousboei Setchell and Gardner, Alg. N. W. Amer., 1903, p. 180; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 554 (not Thuret, *in* Bornet and Thuret, 1880, p. 73–77, pl. 26, fig. 1–2).

Dermocarpa sphaerica is the plant that has commonly passed for *Xenococcus Schousboei* on the Pacific coast of North America. Examination of a bit of the type material of Schousboe's *Coleonema arenifera*, upon which Thuret founded the genus, shows that the Pacific coast plant belongs to a different genus. *Xenococcus Schousboei*, as described and figured by Thuret, has increase in the number of individuals by means of vegetative cell divisions. This is the condition in which Schousboe found the type material; the plants being young the gonidial stage had not yet appeared. Our plant, which has passed under the name of *X. Schousboei*, does not divide vegetatively, and hence belongs to the group, of which *Dermocarpa* may be taken as a type, in which there is increase only by the formation of gonidia, instead of the group, of which *Pleurocapsa* may be taken as a type, in which there is increase by both vegetative cell divisions and by gonidia.

Kirchner (1898, p. 58) and Forti (1907, pp. 119, 120) recognize five genera of Chamaesiphonaceae which have no vegetative cell divisions and which reproduce exclusively by gonidial formation. These are *Cyanocystis* Borzi (1882, p. 314), *Dermocarpa* Crouan (1858, p. 70), *Clastidium* Kirchner (1880, p. 195), *Chamaesiphon* A. Br. & Grun. (1865, p. 148), and *Godlewskia* Jancz. (1883, p. 227). Kirchner separates the first three genera from the last two because of the simultaneous division of the whole protoplast of the gonidangium into gonidia, whereas in the last two genera the gonidia are abstricted successively from the apex of the gonidangium, the basal portion always remaining sterile. Forti adopts this entire arrangement except the statement of the simultaneous division of the protoplast.

It is necessary to modify Kirchner's statement in regard to the simultaneous division of the protoplast in *Dermocarpa* since I have found in several species that the gonidia result from successive divisions in different planes. This condition is notably true of *D. protea* of this paper. A further exception to the statement of Kirchner must be made in *D. Leibleiniae* (Reinsch) Born. and Thur. and *D. suffulta* Setchell and Gardner (*in* Gardner, 1918, p. 440), in that only a portion of the protoplast of the gonidangium is converted into gonidia, the basal portion in each species uniformly remaining sterile. There is but little likelihood of confusing *Dermocarpa* with either *Chamaesiphon* or *Godlewskia*, on account of their cylindrical shape and method of formation and liberation of gonidia, or even with *Clastidium*, which is narrow and cylindrical and possesses a setum at the outer end; but in attempting to place a species like *D. sphaericia*, or *D. Sphaeroidea* Setchell and Gardner (*in* Gardner, 1918, p. 440) the question arises as to which genus, *Dermocarpa* or *Cyanocystis*, if both of these are to be considered valid genera, should receive them. The method of escape of gonidia in *D. sphaeroidea* has not been determined, but in *D. sphaerica* the whole wall of the gonidangium dissolves and the group of gonidia are left free in position (pl. 39, fig. 14). The only distinction between *Cyanocystis* and *Dermocarpa*, as brought out by both Kirchner and Forti, is that of the method of escape of gonidia. In the former they escape by a circumscissile rupture and in the latter by a dissolution of the apex of the gonidangium. If the method of escape of the gonidia is to be taken as sufficient for generic distinction, it will be necessary to create another genus for *D. sphaerica* which does not conform to either of the above methods. It seems preferable in this case to refrain from extending the number of genera but rather to reduce it, and since *Dermocarpa* is the older genus, adopt that to receive our species and reduce *Cyanocystis*, in case further study makes it necessary or desirable.

Xenococcus acervatus Setchell et Gardner sp. nov.

Plate 39, fig. 13

Cellulis omnino epiphyticis, in directionibus duobus ad hospitem perpendicularibus divisis, colonias primo unistratosas demum acervatas confusas et indefinitas formantibus; cellulis primo angulatis, mox sphaericis aut pyriformibus, 3–6μ diam., parietibus tenuibus, hyalinis; cytioplasmate homogeneo, dilute coeruleo-viridi; gonidangiis ad huc ignotis.

Cells wholly epiphytic, dividing in two planes perpendicular to the host, building colonies at first one cell deep, later confusedly heaped up, of indefinite extent; cells angular at first, soon becoming spherical or pear-shaped, 3–6μ diam., cell wall thin, hyaline; protoplast homogeneous, pale blue-green; gonidangia unknown.

Growing in great profusion on *Enteromorpha* sp. in salt marsh pools. San Francisco Bay, California. Type no. 1580, Gardner.

Pleurocapsa amethystea var. *Schmidtii* Collins, *in* Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 1704. nomen novo.

The first publication of the name *P. amethystea* var. was by Børgesen (Mar. Alg. Faer., 1902, p. 524), Johs. Schmidt having identified one of Børgesen's species from the Faeröes as belonging there. Børgesen stated that Schmidt would comment on the species later in Helgi Jónsson's paper. Jónsson's paper appeared in 1903 but Schmidt mentions only a plant from Iceland under the above name (*P. amethystea* var.). Collins (*loc. cit.*) considers our plant to be of the same variety as the Iceland plant and gives it a varietal name without further comment.

In the absence of gonidangia it is not at present possible to give a complete comparison of our plant with the description of the Greenland plant, *P. amethystea*, of Rosenvinge (1893, p. 968), nor with the variety of that species growing in Iceland, determined by Schmidt (1903, p. 378). There are no specimens available to me at present for comparison. Rosenvinge's figures and description of *P. amethystea* show plainly that the cells divide in three planes, which allies it with the genus *Pleurocapsa*. Schmidt states that the Iceland plant differs from the the Greenland plant only in color, but forbears naming it on that character alone. The Iceland plant is thus a *Pleurocapsa*. Our plant divides vegetatively in but two planes, and, accepting Thuret's understanding of his genus *Xenococcus*, it belongs to that genus rather than to *Pleurocapsa*. A brief discussion of the structure and relation of these two genera was given in my paper (New Pac. Coast Mar. Alg. II, 1918, p. 429).

Xenococcus acervatus differs from *P. amethystea* in the number of planes of vegetative cell divisions, in the shape and size of the cells and in their color, the color of the latter being "sordide violacea," and of the former pale blue-green. None of the seven illustrations of Rosenvinge (*loc. cit.*) resembles very clearly any phases of the development of our plant except "A," the surface view of a group of vegetative cells.

At times the cells as viewed in the median plane of the host plant are piled up several cells deep, as though they had arisen by horizontal divisions. If this were the case our plant would properly belong to the genus *Pleurocapsa*. This does not seem to be the case, however, as the cells above the surface layer are very generally spherical, apparently independent, and very variable in size. They appear rather to be gonidia in various stages of development, that have come to rest on the surface layer, or in some cases seem to have grown in position where they were formed. The cell walls are quite gelatinous, which is conducive to holding the colonies together.

Xenococcus Cladophorae (Tilden) Setchell et Gardner comb. nov.

Plate 38, fig. 8

Strato nunc plus minusve continuo, unistratoso, nunc in grege parvo consociatis cellulis forma variabilibus, angulatis, prismaticis sphaeroideis aut pyriformibus, 8–15μ, usque ad 22μ diam.; parietibus conspicuis, hyalinis, homogeneis, saepe diffluentibus; cytioplasmate homogeneo, dilute coeruleo-viridi; gonidangiis cellulis vegetativis in forma magnitudineque similibus; gonidiis divisionibus iteratis formatis, 1.5–2μ diam.

Plants forming a more or less continuous layer one cell deep, or occasionally associated in small groups; cells variously shaped, angular, prismatic, spheroidal or pyriform, 8–15μ, occasionally 22μ diam.; cell walls prominent, hyaline, homogeneous, often diffluent: protoplast pale blue-green, homogeneous; gonidangia the same shape and size as the vegetative cells; gonidia formed by successive divisions of the protoplast, 1.5–2μ diam.

Growing on *Cladophora* sp. in tide pool, Baird Point, Strait of Juan de Fuca, British Columbia.

Pringsheimia scutata f. *Cladophorae* Tilden, Amer. Alg. (Exsicc.), no. 382, type. *Chlorogloea tuberculosa* Setchell and Gardner, Algae N. W. Amer., 1903, p. 182 (in part); Tilden, Minn. Alg., 1910, vol. 1, p. 46 (in part).

So far as I am able to discover on the available specimens of *Cladophora* distributed by Miss Josephine Tilden under no. 382 of her American Algae, there are no epiphytes present belonging to the Chlorophyceae. On the contrary there is a mixture of species belonging to the Myxophyceae.

One of these, a very small-celled form, very sparse in the distribution belonging to Professor Setchell, as suggested by Setchell and Gardner (1903, p. 182), seems to be closely related to *Chlorogloea tuberculosa* (Hansg.) Wille. The material is too sparse and scattered to admit of a very positive determination as to what species it really may be. There are also groups of well defined vegetative cells of a species of *Pleurocapsa*. Judging from its present vegetative stage it seems to be undescribed. There are, however, no gonidangia that I have been able to discover, and as the material is very scanty I for-bear naming it at present. Howe (1914, p. 12) states that he is unable to find in Miss Tilden's distribution, mentioned above, any member of the Chlorophyceae that he could interpret as being her *Pringsheimia scutata* forma *Cladophorae*, under which name no. 382 was distributed, but suggested that possibly the species referred to was that of a *Dermocarpa*, thus indicating that genus as being present in the material he examined. By far the most abundant species present in Professor Setchell's material is no one of these but is the plant described above. Some specimens of the host are much contorted by its presence. This species seems most likely to be the one upon which was based *Pringsheimia scutata* forma *Cladophorae*, and is the plant, in part at least, later described and figured as *Chlorogloea tuberculosa* by Miss Tilden (Minn. Alg., 1910, p. 46, pl. 2, fig. 42).

Xenococcus Gilkeyae Setchell et Gardner sp. nov.

Plate 39, fig. 11

Cellulis solitariis aut in colonias parvas consociatis, solitariis, sphaericis, sed in coloniis angulatis et plus minusve elongatis, 4–7μ raro 9μ diam.; parietibus inconspicuis, hyalinis; cytioplasmate dilute coeruleo-viridi; gonidangiis cellulis vegetativis forma magnitudineque similibus; gonidiis 0.8–1μ diam., divisionibus iteratis formatis.

Cells solitary or aggregated into small colonies, spherical when solitary, angular and more or less elongated in colonies, 4–7μ, rarely 9μ diam.; cell wall inconspicuous, hyaline; protoplast light blue-green; gonidangia of the same shape and size as the cells; gonidia 0.8–1μ diam., formed by successive divisions of the protoplast.

Growing on the filaments of *Elachistea* sp. which is epiphytic on *Fucus* sp. Lower littoral belt. Sitka, Alaska. Type no. 3962*a*. Gardner.

Having vegetative cell divisions in but two planes perpendicular to the substratum, *Xenococcus Gilkeyae* is a typical *Xenococcus*. It is an exceedingly delicate species but the type material being in excellent vegetative and reproductive conditions is clearly definable. The gonidia appear to be the results of two lines of development of the vegetative cells. Some gonidia seem not to divide vegetatively after coming to rest, but continue to increase in size until maturity is reached, then by a few successive internal divisions the whole protoplast is progressively converted into gonidia. In some cases the first division takes place horizontally, cutting off a small portion of the base of the protoplast, which in some instances seems to remain sterile, at least the whole upper part is converted into gonidia before the basal portion is (pl. 39, fig. 11*a*). In other cases the first division is through the center of the cell. Other gonidia develop for a time after coming to rest, then divide vegetatively several times, generating small colonies before advancing to the gonidial stage (pl. 39, fig. 11*b*).

This species is named in honor of Dr. Helen M. Gilkey, the artist who drew the accompanying illustrations and who discovered it while drawing the host plant upon which it grew.

Xenococcus pyriformis Setchell et Gardner sp. nov.

Plate 39, fig. 12

Coloniis parvis, nunc solitariis nunc confluentibus; cellulis juvenis paululum angulatis, maturitate pyriformibus usque ad subsphaeroideis, 10–15μ diam., 12–20μ longis; cytioplasmate laete coeruleo-viridi; parietibus conspicuis, densis, hyalinis; gonidangiis cellulis vegetativis forma magnitudineque similibus; gonidiis 2.8–3.5μ diam., divisionibus iteratis formatis.

Colonies small, single or occasionally confluent, young cells somewhat angular, pyriform to subspherical at maturity, 10–15μ diam., 12–20μ long; protoplast bright blue-green, cell wall conspicuous, dense, hyaline, gonidangia the same shape and size as the cells; gonidia 2.8–3.5μ diam., formed by successive divisions of the protoplast.

Growing on *Rhodochorton Rothii* on rock ledge along high-tide level and above. Cape Arago, at the entrance to Coos Bay, Oregon. Type no. 2756, Gardner.

This species having cell divisions in only two planes perpendicular to the substratum, thus forming colonies only one cell deep, is allied with *Xenococcus* rather than with *Pleurocapsa*, and while its pyriform cells suggest species of *Dermocarpa*, it differs from members of that genus in having vegetative cell division. In size and shape of cells it differs from the other members of *Xenococcus* so far as yet described.

Pleurocapsa entophysaloides Setchell et Gardner sp. nov.

Plate 41, fig. 30

Strato umbrino, pulverulento, plus minusve mucilagineo, 1–4 mm. crasso; cellulis sphaericis 8–10μ diam., in coloniis maxime angulatis, colonias sphaericas aut varie lobatas frequenter entophysaloideas, 40–60μ, usque ad 200μ diam., divisionibus iteratis sine ruptione tegumenti communis formantibus; tegumentis leviter mucosis, luteo-fuscis, 2μ crassis; cytioplasmate homogeneo, dilute coeruleo-viridi; gonidiis in cellulis vegetativis immutatis formatis aut in coloniis parvis aut in magnis, 3–3.5μ diam.

Plants forming a dark colored, pulverulent, somewhat mucilaginous stratum, 1–4 mm. thick; single cells spherical, 8–10 μ diam., in colonies very angular, 4–8μ diam., forming spherical or variously lobed, frequently entophysaloid colonies, 40–60μ, up to 200μ diam., by cell divisions without rupturing the original tegument; teguments firm, slightly mucilaginous on the surface, yellowish brown, 2μ thick; protoplast homogeneous, light blue-green; gonidia formed in unchanged vegetative cells of either the small or the large colonies, 3–3.5 diam.

Growing on rocks in the upper littoral belt. Carmel Bay, Monterey County, California. Type no. 3219, W. A. Setchell.

Pleurocapsa fuliginosa Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 704 (not of Hauck).

Pleurocapsa entophysaloides is closely related to *P. fuliginosa* Hauck (1885, p. 515, fig. 231) but differs from it in having slightly larger colonies which are often entophysaloid (pl. 41, fig. 30), in having a blue-green protoplast, a yellowish brown tegument, in having slightly larger vegetative cells and in having gonidia develop in the small vegetative cells. In this last statement concerning the size of the cells, I am assuming that Hauck intended to include the large spherical cells which he figures and which would ordinarily be considered gonidangia, in his measurement "Zellen 5–20μ dick." I have examined a bit of the type material of his *P. fuliginosa* and find that the vegetative cells of our species are slightly larger than the cells which I consider to be the vegetative cells of the type. Hauck does not mention gonidangia but he figures, in addition to groups of two, four, to many cells, four large spherical cells, one of which is filled with undoubted gonidia. The presence of these two forms and sizes of cells brings up the question as to whether or not we are dealing with a single species or with two species, and if the latter, the two species probably belong to different genera. I have been puzzled with several similar mixtures collected on our coast. I am of the opinion that we have to reckon with two species in these cases and in the case of *P. fuliginosa*. Now that we have discovered gonidia in these colonies of small vegetative cells in at least two species of *Pleurocapsa*, viz., *P. entophysaloides*, and *P. gloeocapsoides*, the evidence in favor of considering that such mixtures as mentioned above belong to two species is stronger. Either we may take this view of the matter or we may note that we have two lines of development in a single species. One starting with a single cell, e.g., a gonidium, and, after enlarging to mature size, divides in three planes successively more or less at right angles to each other, the process continuing until a smaller or larger colony is built up, according to the species, the cells all remaining within a common tegument. Then at maturity each small cell of the colony divides into a few gonidia, the whole mass of cell walls dissolves thus setting free the gonidia. The other line of development starts likewise with a single cell. This continues to increase in size without division until maturity is reached when it is many times larger than the vegetative cells in the other method of development, after which the whole protoplast divides into gonidia, either by successive or by simultaneous divisions. These questions need further observation and study before any decision of value can be made concerning them.

Pleurocapsa gloeocapsoides Setchell et Gardner sp. nov.

Plate 39, figs. 15–17

Strato molli, nitido, gelatinoso, sordido, 1–2 mm. crasso; divisionibus cellularum regulariter in directionibus tribus; cellulis singulis globosis, in coloniis sub pressione angulatis; cytioplasmate 4–8μ diam., homogeneo, dilute coeruleo-viridi; parietibus propriis conspicuis, fuscescentibus; coloniis 2–8-cellularibus tegumento amplo, homogeneo, hyalino, molli, gelatinoso indutis; gonidiis 2–4 in cellulis vegetativis ordinariis formatis, 2.5–3.5μ diam.

Colonies associated into soft, glistening, gelatinous masses, 1–2 mm. thick; cell divisions regularly in three planes; cells globose when single, angular from mutual pressure in colonies; protoplast 4–8μ diam., homogeneous, pale blue-green; cell wall conspicuous, brownish; colonies of 2–8 cells enclosed in an ample, homogeneous, hyaline, soft, gelatinous tegument; gonidia 2–4 formed in unchanged vegetative cells, 2.5–3.5μ diam.

Growing on a water-soaked log, at the margin of a salt marsh. Alameda, California. Type no. 4119, Gardner.

Gloeocapsa crepidinum Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 1151 (not of Thuret).

The material of the above mentioned distribution was collected in 1913 in the same locality in which the type material of *P. gloeocapsoides* was collected in October, 1917. The gonidia, if present in the original collection, were overlooked, and the close resemblance of the species in the vegetative stage of Thuret's *Gloeocapsa crepidinum*, so well and amply figured in Bornet and Thuret (Notes Algol. I, 1876, pl. 1), led the authors of the above mentioned exsiccatae to place it in that species. Now that well formed, typical gonidia are found in great abundance it seems best to remove it from the Chroococcaceae and place it in the Chamaesiphonaceae, if we are to adhere to the well recognized distinction between these two families. The formation of gonidia is not unique in this species. It is similar to that reported in this paper as taking place in *Pleurocapsa entophysaloides*, and in other undescribed species which I have observed. In all of these species the contents of all of the cells of a colony seem to divide simultaneously. Any and all of the vegetative cells may produce gonidia without change in size. This is true also of all species of *Dermocarpa*, *Gomphosphaeria*, etc. The cell being small, the number of gonidia from a cell is small, viz., 2–4, and it has not been determined positively whether the two divisions necessary to form four gonidia take place successively or simultaneously. In most of the species in other genera which I have studied, the divisions take place successively, and this method may possibly be the one followed by all species. Wille (1906, p. 21) has described and figured what appears to be the same method of gonidial formation in the European *Gloeocapsa crepidinum* Thur., which he finds near the biological station at Drontheim. He does not look upon this stage in the life-history as being the gonidial stage comparable to that of the Chamaesiphonaceae, but speaks of it as the "*Aphanocapsa*-Stadium." He concludes that these small cells float away, finally lodge in tide pools, and become the so-called marine species of *Aphanocapsa*, e.g., *A. marina* Hansg. The facts as we find them here seem hardly sufficient to warrant such conclusions concerning our species.

There are certain difficulties in the way of a satisfactory placing of this form that have led to the disposition of it as a new species of *Pleurocapsa*. Were it not for the presence of gonidia, it might be placed fairly satisfactorily under *Gloeocapsa crepidinum* Thuret. The discovery of similar gonidia in what Wille refers to *Gloeocapsa crepidinum* in Norway, strengthens this position. There are, however, possibilities that Wille's plant may not be the same as that of Thuret and that ours may be different from both. Possibly all *Gloeocapsa* species may be found ultimately to form gonidia, but it does not seem very probable. In view of the various uncertainties, it seems best for the present, at least, to describe the California plant as new and to refer it to *Pleurocapsa*.

Arthrospira breviarticulata Setchell et Gardner sp. nov.

Plate 39, fig. 18 and plate 41, fig. 26

Trichomatibus in spiram plus minusve regularem laxissime contortis, maxime et varie plus minusve dense implicatis, 14.5–16μ diam., comparate brevibus, leviter, torulosis, non ad terminos attenuatis;

cellulis 2.5–3.5μ longis; cytioplasmate dilute chalybeo, granulas leviter angulatas, paucas et late disseminatas praebente; parietibus tenuibus, distinctis; cellula terminali maxime convexa, membrana superne non incrassata.

Trichomes very loosely twisted into a more or less regular spiral, and much knotted and contorted, 14.5–16μ diam., comparatively short, slightly torulose, not tapering at the apices; cells 2.5–3.5μ long; protoplast pale steel-blue, with few scattered, somewhat angular granules; cell walls thin, distinct, terminal cell very convex, outer wall not thickened.

Growing on rocks and among *Cladophora trichotoma* (Ag.) Kuetz. in tide pools along high-tide level. Lands End, San Francisco, California. Type no. 1634, Gardner.

Arthrospira breviarticulata is distinguished from all other species of the genus by its much greater length, and greater diameter, by its being loosely coiled, and by its relatively much shorter cells.

Phormidium hormoides Setchell et Gardner sp. nov.

Plate 40, fig. 23

Strato indefinito tenui, expanso, gelatinoso; trichomatibus brevibus, leviter flexuosis, moniliformibus, 2.4–2.7μ diam.; vaginis hyalinis, amplis, gelatinosis, diffluentibus; cellulis quadratis aut subquadratis, maxime ad dissepimenta constrictis, cellula apicali majori, subsphaerica, membrana superne non incrassata.

Filaments forming a thin, expanded, gelatinous stratum; trichomes short, somewhat flexuose, moniliform, 2.4–2.7μ diam.; sheaths hyaline, ample, gelatinous, confluent; cells quadrate or subquadrate, extremely constricted at the dissepiments, terminal cell larger, subspherical, end wall not thickened.

Forming thin strata on glass aquaria of salt water from the Pacific Ocean. Physiological Laboratory, University of California, Berkeley, California, 1905. Type no. 1535, Gardner.

Phormidium hormoides is very closely related to *P. foveolarum* (Mont.) Gomont, which was found growing in small pits in calcareous rock on the coast of France, and from which it differs in habitat, in the size of the filament and in the shape of the terminal cell. The filaments as viewed under the microscope are not uniformly distributed in the stratum but seem to have a tendency to aggregate into fascicles which anastomose freely, giving the stratum somewhat the appearance of a very delicate net, although many short filaments crawl out into the interstices.

In the specimen collected *Phormidium hormoides* is mixed with another undetermined filamentous species of Myxophyceae, about

0.8μ diam., with cylindrical cells longer than the diameter and with conspicuous cross walls.

P. hormoides has some resemblance to the young filaments of a very delicate species of *Anabaena* on account of the pronounced moniliform filaments, but there is no indication of heterocysts or spores.

Lyngbya Willei Setchell et Gardner nom. nov.

Filaments epiphytic on larger algae, either attached at one end with the other end free or attached in the middle with both ends free, solitary or aggregated into small caespitose masses; sheath very delicate, hyaline, adhering closely; trichomes pale blue-green or grayish green, torulose, 1.5–2μ diam.; cells quadrate or one-half the diameter long; apices not attenuate, capitate nor calyptrate; terminal cell wall convex, not thickened; protoplasm homogeneous.

Growing on *Rhizoclonium riparium* var. *polyrhizum* Rosenv. Near the mouth of Tomales Bay, Marin County, California. August, 1916. No. 3440, Gardner.

Lyngbya epiphytica Wille, Algol. Notizen, XXII–XXIV, *in* Nyt Magazin for Natur., vol. 51, part 1, 1913, pp. 22–25, pl. 1, figs. 14–17 (not Hieronymus, 1898, p. 67).

The type, *Lyngbya epiphytica* Wille, was discovered on the coast of Norway at Trondhjem, growing on *Rhizoclonium hieroglyphicum* (Ag.) Kuetz. What seems to be exactly the same plant has been detected on the coast of California growing on *Rhizoclonium riparium* var. *polyrhizum* Rosenv. The latter species was distributed by me under no. 2238*a* of the Phycotheca Boreali-Americana of Collins, Holden and Setchell. The epiphyte is rather sparsely represented on our material of *Rhizoclonium*. The identification was made after the distribution of the *Rhizoclonium* and hence is not known to be represented in all of the specimens of the distribution.

The specific name, *epiphytica*, having already been occupied by Hieronymus (1898, p. 67) to designate a very small unique species coiling around the filaments of larger Myxophyceae, it becomes necessary to rename the species of the *Leibleinia* type found later by Wille, and the species is consequently dedicated to him. It may also be mentioned that very abundant, and apparently typical *L. epiphytica* Hieron, has also been discovered on the central California coast, and has been distributed in Collins, Holden and Setchell, Phycotheca Boreali-Americana (Exsicc.) no. 2206.

Symploca funicularis Setchell et Gardner sp. nov.

Plate 41, fig. 29

Filis minute funiculato-fasciculatis, contortis, 3–4 mm. altis; trichomatibus aeruginosis, leviter torulosis, 4.5–5.5μ diam.; cellulis quadratis aut ad duplo longioribus, 5–8μ longis; vaginis hyalinis, gelatinosis et in fasciculis diffluentibus; cellula apicali leviter longiori calyptram depresso-convexam praebente.

Filaments twisted into fine anastomosing ropelike fascicles 3–4 mm. high; trichomes aeruginous, slightly torulose, 4.5–5.5μ diam., cells quadrate or up to two times as long as the diameter, 5–8μ long; sheath hyaline, gelatinous and diffluent in the fascicles; terminal cell slightly longer, convex, with small convex calyptra.

Growing on moist soil and on other plants in a salt marsh. Bay Farm Island, near Alameda, California. Type no. 1598, Gardner.

Symploca atlantica Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 1356 (not of Gomont).

S. funicularis differs from *S. atlantica* in having a diffluent sheath, in having the filaments often tightly twisted into ropelike threads, in having smaller trichomes, less torulose, and with slightly longer cells; and particularly in the character of the terminal cell, having a small, depressed, convex calyptra covering only about one-third of the end cell, instead of being "depressed conical," as is the case of *S. atlantica* as described and figured by Gomont (1892, p. 109, 129 Repr., pl. 2, fig. 5).

Symploca aeruginosa Setchell et Gardner sp. nov.

Strato expanso, aeruginoso, parce fasciculos 1 mm. altos ostendentibus; filis 4–4.5μ diam., laxe intricatis; trichomatibus maxime torulosis, 3–3.5μ diam.; cellulis quadratis, cellula terminali rotundata nec capitata nec calyptrata; cytioplasmate homogeneo, dilute aerugineo; dissepimentis obscuris; vaginis tenuibus, hyalinis, strictis, primo levibus demum exteriore asperis.

Filaments 4–4.5μ diam., forming an aeruginous stratum of erect, loose fascicles, 1 mm. high; trichomes decidedly torulose, 3–3.5μ diam.; cells quadrate, terminal cell much rounded, neither capitate nor calyptrate; protoplast homogeneous, pale aeruginous, dissepiments obscure; sheath very thin, colorless, close, at first smooth, later becoming roughened on the outside.

Growing on mud-covered rocks, near the upper tide limit. St. Michael, Alaska. Type no. 5248*x*, W. A. Setchell.

Symploca lacteviridis Setchell and Gardner, Alg. N. W. Amer., 1903, p. 188 (not of Gomont).

In the Algae of Northwestern America (1903, p. 188), the plant described above as new was referred to *Symploca lacteviridis* Gomont with the statement that "it certainly seems strange to find a plant, hitherto known only from the tropical locality of Key West, so far north.'' Since then we have been able, through the kindness of Professor W. G. Farlow, to examine an authentic specimen of Gomont's species. It is heavily incrusted with lime, has a decidedly conical apical cell, while the cells of the trichome are almost always decidedly longer than broad. The diameter of the cells is 1.5–2μ and the dissepiments are comparatively broad and transparent. In all of these respects it differs from our Alaskan plant although that comes within the limits of thickness assigned by Gomont to his species. The Alaskan plant is more slender than *Symploca atlantica* Gomont, with less distinct sheath, and more rounded terminal cell which is not at all thickened above. It differs also in having inconspicuous dissepiments. On account of these various differences, it seems justifiable to describe the Alaskan plant as new.

Microcoleus Weeksii Setchell et Gardner sp. nov.

Plate 40, fig. 24

Vaginis tenuibus, gelatinosis, in ambitu indistinctis; trichomatibus in vaginis 20–40, laxe intricatis, aeruginosis, non torulosis, 7–8μ diam., ad apices attenuatis; cytioplasmate homogeneo; cellulis 1.8–2.5μ longis; cellula apicali acute conica nec capitata nec calyptrata.

Sheath thin, hyaline, gelatinous, irregular; trichomes 20–40 in a sheath, loosely intertwined, aeruginous, not torulose, 7–8μ diam., ends attenuated; protoplast homogeneous; cells 1.8–2.5μ long; end cell acutely conical, not capitate nor calyptrate.

Growing on *Griffithsia* sp. in the lower littoral belt. Near Pacific Grove, California. Collected by Mrs. J. M. Weeks, February 1, 1896. Type no. 100560, Herbarium of the University of California.

In 1896, Mrs. J. M. Weeks sent some specimens of *Griffithsia* to Professor Setchell for determination, and in making a microscopic examination of the material he detected specimens of a *Microcoleus* which he concluded to be undescribed. The material being scanty was not named and described at that time, but incorporated into the Herbarium awaiting further investigation, and with the hope that more material might be discovered. Since then, unfortunately, no more material has been reported, and it seems desirable at present to name and describe the species.

M. Weeksii is a species which seems at present to have its nearest affinities with *M. chthonoplastes* (Mert.) Thuret, on the one hand, and *M. acutirostris* (Crouan) Gomont, on the other. It differs from the first in the character of the sheath, being very much more indefinite, gelatinous and amorphous, in having fewer trichomes within the sheath, and in the trichomes being larger and the cells much shorter. From the latter it differs in having smaller trichomes with shorter cells, in not having the ends long attenuated and very acute-conical as has that species according to the figures and descriptions given by Crouan. The trichomes in *M. Weeksii* begin to taper about 6 to 10 cells back of the apex.

Microcoleus confluens Setchell et Gardner sp. nov.

Plate 40, fig. 25

Filis erectis, strata coeruleo-viridia, compacta, spongiosa ad saxa indefinite expansa formantibus; vaginis gelatinosis, moderate amplis, superficie irregularibus, hyalinis, homogeneis, primo distinctis aut demum diffluentibus; trichomatibus in vaginis 1–8, distinctis aut laxe intricatis; levissime ad dissepimenta constrictis, 4–4.5μ diam., rectis et ad apices non attenuatis; cellulis 2–4-plo brevioribus, cytioplasmate homogeneo; cellula apicali moderate rotundata, membrana apicali leviter incrassata.

Filaments erect, forming a blue-green, compact, spongy stratum of indefinite expansion on rocks; sheath gelatinous, moderately ample, irregular on the surface, hyaline, homogeneous, distinct at first or later diffluent; trichomes 1–8 in a sheath, separate or loosely entwined, very slightly constricted at the dissepiments, 4–4.5μ diam., straight and not attenuated at the apices; cells 2–4 times shorter than the diameter, protoplast homogeneous; apical cell moderately rounded, end wall slightly thickened.

Forming a spongy stratum in company with other species of Myxophyceae on rocks in the upper part of the littoral belt. Lands End, San Francisco, California. Type no. 1641, Gardner.

The species of the genera *Microcoleus* and *Hydrocoleum* intergrade. *Microcoleus* is the older of the two genera having been established by Desmazières in 1823, based upon *Conferva chthonoplastes* Mertens (*in* Hornemann, Flora Danica, 1818, tab. 1485). Kuetzing established *Hydrocoleum* in 1843 (p. 196), and transferred to the genus his *Vaginaria saxicola* and *V. racomitrii*. The forms upon which each genus were originally founded are quite distinct. Typical *Microcoleus* includes forms with numerous tightly entwined trichomes within firm, fairly regular unbranched sheaths. The trichomes are usually small, more or less pointed at the ends, mostly ranging below 7μ in diameter, except *M. subtorulosus* which is 6–10μ in diameter, and the cells are generally longer than the diameter.

The majority of the species which have thus far been placed in *Hydrocoleum* have fewer trichomes in a sheath, which is often more or less branched and which is commonly less firm and in some cases even wholly diffluent. The trichomes are large, as a rule, with cells shorter than the diameter, the end cells usually blunt with thickened end cell walls. Borzi, however, has placed a species from New Guinea in this genus although it is but 2μ in diameter.

Microcoleus confluens does not conform wholly to the characters of either of the two above mentioned genera. It has the few trichomes and diffluent sheath of a typical *Hydrocoleum* but has the small trichomes of a typical *Microcoleus*.

Calothrix rectangularis Setchell et Gardner sp. nov.

Plate 40, fig. 21

Filis simplicibus aut interdum parce pseudoramosis, basim algis variis affixis, juvenis prostratis, mox erectis, 400–500μ altis, ad basim 24–28μ diam.; trichomatibus basim 16–18μ diam., superne usque ad sub apicem longe attenuatis deinde in pilo brevi abeuntibus: cellulis 2–4μ longis, cytioplasmate tenui granulato, dilute coeruleo-viridi; vaginis juvenis hyalinis, aetate provecta dilute luteis, ad apices strictis; heterocystis basilaribus et intercalaribus, basilaribus sphaericis aut subconicis, intercalaribus plus minusve elongato-cylindricis pro parte majori singulis et prope basim trichomatis, 18–25μ longis et 16–18μ diam.

Filaments simple or occasionally sparsely branched, attached at the base to various other algae, prostrate when young, soon becoming erect, 400–500μ long, 24–28μ diam. at the base; trichomes 16–18μ diam. at the base, tapering gradually upward nearly to the apex, then rather abruptly ending in a short hair; cells 2–4μ long, protoplasm finely granular, pale blue-green; sheath hyaline when young, changing to light yellow with age, strict at the apex; heterocysts basal and intercalary, the basal spherical to subconical, the intercalary cylindrical, usually single, near the base of the trichome, 18–25μ long, the same diameter as the trichome.

Epiphytic on various species of marine algae, near low-tide level. East Sound, Orcas Island, Washington. Type no. 2365. Gardner.

This species comes within the range of measurements stated by Bornet and Flahault (Rev. I, 1886, p. 359) for the diameter of the filaments of *C. crustacea* Thuret with which it seems to be most closely related; the filaments are, however, much shorter than the measurements given for that species. The small size, the habit of growth on other algae, the presence of cylindrical, intercalary heterocysts always near the base of the trichomes, the infrequency of branching, and the strict sheath seem sufficient to separate this species from any of the forms of *C. crustacea*. The cylindrical heterocysts above mentioned, appearing rectangular to the view, are sufficiently striking to suggest the specific name.

Calothrix robusta Setchell et Gardner sp. nov.

Plate 40, fig. 22

Filis caespitosis, aut basim ad saxa affixis, et erectis aut medio affixis et utroque fine erectis, leviter flexuosis, cylindricis, 1–2 mm. altis, 30–40μ diam.; trichomatibus prope cylindricis sed ad apicem abrupte attenuatis, raro pseudo-ramosis, non torulosis, 16–20μ diam., laete coeruleo-viridibus; cellulis 2–3μ longis, minute et uniformiter granulatis; vaginis hyalinis aut aetate provecta dilute luteis, lamellosis, 7–8μ crassis, ad apicem juvenis clausis; heterocystis basilaribus multo compressis, 1–4 seriatis.

Filaments caespitose, attached at the base and erect, or attached at the middle and both ends erect, somewhat flexuose, cylindrical, 1–2 mm. long, 30–40μ diam.; trichomes nearly cylindrical throughout, very abruptly pointed at the apex, rarely branching, not torulose, 16–20μ diam., bright blue-green, cells 2–3μ long, finely and uniformly granular; sheaths hyaline or slightly yellowish with age, lamellose, 7–8μ thick, closed at the apex when young; heterocysts basal, much compressed, 1–4 seriate.

Forming a caespitose layer on rocks in small tide pools near high-tide level. Cypress Point, Monterey County, California. Type no. 3397, Gardner.

The material of this species shows but few heterocysts and these are all basal, and usually much compressed, and occasionally 2–4 seriate. It has a thick firm sheath and this remains closed at the apex for some time. The branching, so far as observed, is through a rupture either on the side of the sheath apparently caused by rapid growth of the trichome in that part, the closed sheath at the apex not expanding as rapidly as the trichome elongated, or more commonly a breaking through the sheath at the base of procumbent filaments.

Dichothrix seriata Setchell et Gardner sp. nov.

Plate 40, fig. 20

Strato caespitoso, 1–1.5 mm. alto, filis erectis, 25–35μ diam. erectis, repetite et plus minusve fasciculato-pseudo-ramosis, ramulis ultimis plerumque strictis, acuminatis; vaginis homogeneis, amplis, inferne hyalinis, superne luteo-fuscis, strictis non aut leviter ocreatis; trichomatibus aeruginosis, 9–11μ diam., prope cylindricis apicibus abrupte acuminatis non piliferis; pseudoramis fasciculatis in vagina communi deorsum longe inclusis; cellulis 2.5–3.5μ longis; heterocystis basilaribus, 2–6 seriatis, in magnitudine inferne in seriebus diminuendis, subsphaericis ad discoideis.

Filaments forming a caespitose stratum on rocks, 1–1.5 mm. high, 25–35μ diam., erect, repeatedly more or less fasciculately pseudo-branched, ultimate branches mostly strict, acuminate; sheath homogenous, ample, hyaline below, yellowish brown above, strict, not ocreate or only slightly so; trichomes aeruginous, 9–11μ diam., almost cylindrical, with acuminate apices; branches long included in the common sheath; cells 2.5–3.5μ long; heterocysts basal, 2–6 seriate, diminishing in size downward, subspherical to disk-shaped.

Growing on rocks interspersed with *Rhodochorton Rothii* (Turt.) Naeg., in sheltered localities along high-tide level. Cape Flattery, Washington. Type no. 3832, Gardner.

Of all the known forms of *Dichothrix*, *D. seriata* seems most closely related to *D. rupicola* Collins (1901, p. 290), from which it differs in having longer filaments with greater diameters which are more strict at the apices, in having seriate intercalary heterocysts as well as basal, and in the sheaths not being ocreate.

Dichothrix minima Setchell et Gardner sp. nov.

Caespitibus microscopicis, densis, 80–140μ altis; trichomatibus paucis, 2–5, fere in vagina communi inclusis, dilute aerugineis, repetite et dichotomo pseudoramosis, e heterocystis superne lente attenuatis, leviter torulosis, in pilis hyalinis longis abeuntibus; cellulis basilaribus 4–5μ diam., quadratis aut paululum longioribus, homogeneis; cellulis pilorum, 0.8–1μ diam.; heterocystis basilaribus, singulis, sphaericis aut subconicis, quam cellulis trichomatis paululum majoribus; vaginiis strictis, primo hyalinis, mox fuscescentibus et distinctis.

Filaments forming small, dense clusters 80–140μ high; trichomes few, 2–5, and almost wholly included within the common sheath, pale aeruginous, tapering gradually upward from the heterocyst, slightly torulose, ending in a long hyaline hair; basal cells 4–5μ diam., quadrate or slightly longer, homogeneous; hair cells 0.8–1μ diam.; heterocysts basal, single, spherical or subconical, slightly larger than the trichomes; sheath strict, at first hyaline, soon becoming brown and distinct.

Growing in small tufts on *Enteromorpha* sp. along high-tide level and above. Chuckanut Quarry, near Bellingham, Washington. Type no. 544, Gardner.

The type material of *Dichothrix minima* was collected in July, 1899, and sent to Professor W. A. Setchell. There was a very small quantity and it was placed in the Herbarium of the University of California under no. 100341, awaiting the accumulation of other material. We have not had an opportunity of visiting the locality since and other material has not been reported from elsewhere. It is hoped the appearance of its description here may stimulate further search for it.

Rivularia mamillata Setchell et Gardner sp. nov.

Plate 40, fig. 19

Thallis 0.5–1 mm. diam., laete coeruleo-viridibus aut fuscescentibus, sphaericis aut difformibus, plus minusve confluentibus, strata congesta et pulverulenta formantibus aut Myxophyceis aliis sparse immixtis; fiilis repetite pseudoramosis, superne late divergentibus; vaginis inferne hyalinis, superne luteo-fuscis, inferne distinctis superne tenuibus, ocreatis; trichomatibus e basi superne lente et longe attenuatis, in pilis hyalinis longisque abeuntibus, basim 4–5μ diam., leviter torulosis; cellulis 2–5μ longis, coeruleo-viridibus, distincte granulatis; heterocystis sphaericis ad truncato-conicis, 5.5–8μ diam.

Thallus 0.5–1 mm. diam., bright blue-green or brownish, spherical or irregular in outline, more or less confluent, forming congested, pulverulent layers, or scattered among other Myxophyceae; filaments repeatedly false-branched, spreading widely above; sheath hyaline below, yellowish brown above, distinct below but very thin above, ocreate, trichomes tapering gradually from the base upward, terminating in a long hyaline hair, 4–5μ diam. at base; cells 2–5μ long, slightly torulose, blue-green, decidedly granular; heterocysts spherical to bluntly conical, 5.5–8μ diam.

Growing on decaying logs along high-tide level in somewhat shaded localities. Cape Flattery, Washington. Type no. 3829, Gardner.

This species is closely related to *R. nitida* Ag. but has more distinct, ocreate sheaths, larger trichomes with shorter cells, and a less ample thallus.

Brachytrichia affinis Setchell et Gardner sp. nov.

Plate 41, figs. 27, 28

Thallis parvis, 0.5–2 cm. diam., profunde plicatis, bullatis, cavernosis, cartilagineis, dilute caeruleo-viridibus aut aetate provecta fuscescentibus; filis intricatis, inferne laxe intertextis, superne densissime stipatis parallelisque et in pilis tenuibus abeuntibus; cellulis filorum interiorum inferiorum leviter ventricosis, 4–5μ diam., 1.5–2-plo longioribus; cellulis infernis filorum erectorum sphaericis aut doliiformibus, 7–9μ diam.; supernis 1μ diam.; heterocystis sphaericis aut leviter depresso-sphaericis.

Thallus small, 0.5–2 cm. diam., deeply plicate, bullate, cavernous, cartilaginous, light blue-green or brownish with age; filaments intricate, loosely intertwined below, very densely crowded and parallel above and tapering gradually into delicate hairs; cells of the lower interior filaments slightly ventricose, 4–5μ diam., 1.5–2 times as long as broad; cells of the erect filaments spherical or doliform toward the base, 7–9μ diam., terminal cells 1μ diam.; heterocysts spherical or slightly compressed.

Growing in rock pools in the middle littoral belt. Laguna Beach, Orange County, California.

Brachytrichia Quoyi Guernsey, Notes on Mar. Alg., 1912, p. 195; Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 2106, type (not of Bornet and Flahault).

Brachytrichia Quoyi was accredited to our coast by Bornet and Flauhault (Rev. II, 1886, p. 373) on the authority of Grunow. It has not been possible in this study to compare our plant with the type of Agardh's *Nostoc Quoyi* from the Mariana Islands, nor with Zanardini's *Brachytrichia rivularioides* from Sarawak, Borneo, but comparison has been made with *B. Quoyi* from Woods Hole, Massachusetts, which, as has been suggested by Collins, probably was introduced some years ago from some of the southern islands through the instrumentality of guano ships or other human agencies. It has also been compared with material of the same species from the Philippine Islands.

Our plant is much smaller than those of *B. Quoyi* from Woods Hole and from the Philippines, the specimens at Woods Hole sometimes measuring up to 7 cm. in diameter. The largest specimen yet seen of *B. affinis* measures about 2 cm. in diameter, the greater majority being less than 1 cm. It is also much more firm and cartilaginous, more profusely lobed and saccate. The cells are in general slightly larger and the filaments more profusely branched.

The branching of filaments in *Brachytrichia* is unique. The filaments at first are more or less horizontal. At certain points in them lateral loops, sometimes only a few cells long, at other times many cells long, are formed (pl. 41, fig. 27). One cell at the end of the loop divides lengthwise cutting off a cell which becomes the basal cell of a branch which develops toward the surface of the frond, giving the appearance of dichotomous branching, although virtually a single filament gives rise to a single lateral branch at certain intervals. Occasionally after the cortical portion of the thallus becomes dense, branches develop without the formation of loops (pl. 41, fig. 28). This is in reality true branching, for the erect filament is connately joined to the parent filament. Soon a heterocyst is formed near the base of the erect branch and eventually the upper part develops into a *Calothrix*-like filament tapering to a very delicate hairlike point. Other intercalary heterocysts may appear. These masses of erect parallel filaments form the cortical portion of the thallus.

The genus *Brachytrichia* has hitherto been placed among the Rivulariaceae, on account of the erect, tapering trichomes which occasionally may become detached from the parent trichomes and thus resemble very closely those of a simple *Calothrix* or a *Rivularia*. The nature of the branching of *Brachytrichia* does not seem to have been thoroughly explained previously, or perhaps not sufficiently weighed when its phylogenetic position was first determined. In the group with non-tapering, cylindrical trichomes the family Stigonemaceae was created to receive those heterocysted species which have true branching, while in the group with tapering trichomes the family Rivulariaceae was created for those heterocysted forms with false branching. The character of true branching, that is, branches connately joined, is thus to be weighed as against tapering trichomes in determining the phylogenetic position of *Brachytrichia*. In our opinion the former outweighs the latter and it is here proposed to remove it from among the Rivulariaceae and place it among the Stigonemaceae where its relationship seems to be closest to *Mastigocoleus*.

In conclusion, it gives me pleasure to acknowledge the many helpful suggestions of Professor W. A. Setchell in the preparation of this paper. He concurs with me in proposing the new species and has furnished their Latin diagnoses.

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EXPLANATION OF PLATES

All of the drawings except figure 30 of plate 41 were made by Dr. Helen M. Gilkey under the direction of the writer. Figure 30 of plate 41 was drawn by Mr. H. N. Bagley under the direction of Professor W. A. Setchell.

PLATE 38

Placoma violacea Setchell and Gardner

Fig. 1. Habit sketch of the thallus.

Fig. 2. Perpendicular section through young confluent thallus showing the more or less radial arrangement of the cells.

Fig. 3. Surface view of a group of cells.

Dermocarpa protea Setchell and Gardner

Fig. 4. A series of gonidangia illustrating different shapes and sizes. × 250.

Fig. 5. A group of cells showing various stages of gonidial formation. × 250.

Anacystis elabens (Kuetz.) Setchell and Gardner

Fig. 6. Surface view of a colony, showing tendency to break up into groups of cells. × 125.

Fig. 7. A single group of cells from the colony. × 500.

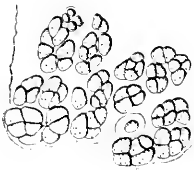
Xenococcus Cladophorae (Tilden) Setchell and Gardner

Fig. 8. A group of vegetative cells in various stages of growth and interspersed gonidangia. × 250.

Pleurocapsa entophysaloides Setchell and Gardner

Fig. 9*a-g*. A series of vegetative cells in various stages of development. *h-i*, two gonidangia. × 250.

Fig. 10. Section view through a large colony showing the somewhat entophysaloid arrangement of groups of cells. × 250.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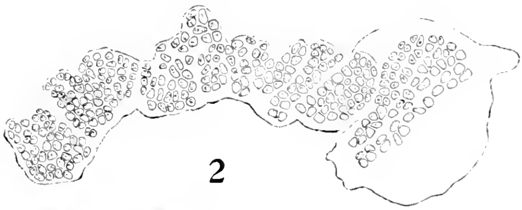
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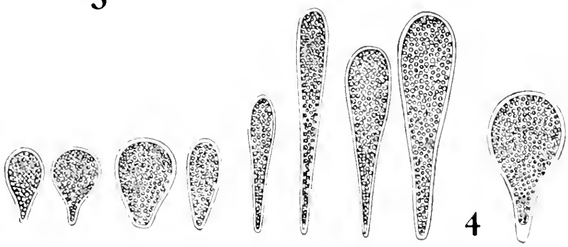
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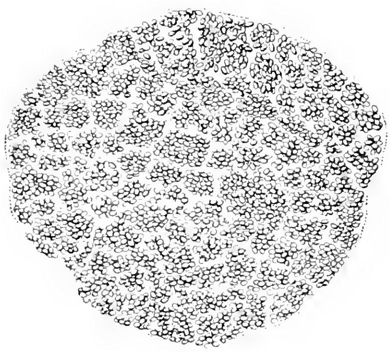
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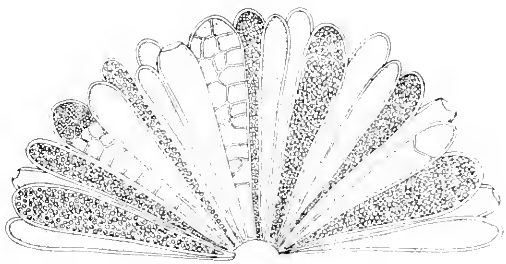
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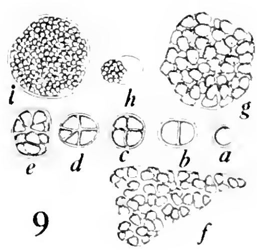

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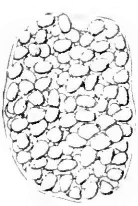
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PLATE 39

Xenococcus Gilkeyae Setchell and Gardner

Fig. 11. Group of vegetative cells and gonidangia in various stages of development. *a*. Gonidangium with sterile base; *b*. group of young vegetative cells. × 500.

Xenococcus pyriformis Setchell and Gardner

Fig. 12. Groups of vegetative cells as viewed from different angles, and three gonidangia. × 500.

Xenococcus acervatus Setchell and Gardner

Fig. 13. Vegetative cells, some showing cell divisions, others showing a heaped-up condition as seen in median plane view of the host. × 500.

Dermocarpa sphaerica Setchell and Gardner

Fig. 14. Vegetative cells and gonidangia: *a-b*, with the wall still in position; and *c-d*, showing where the walls have dissolved in position. × 500.

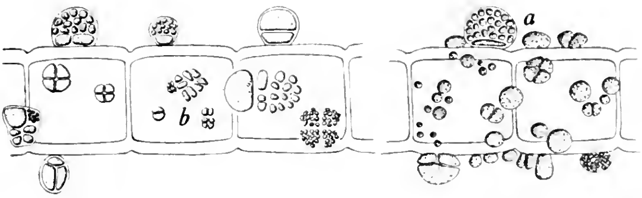
Pleurocapsa gloeocapsoides Setchell and Gardner

Figs. 15–16. Groups of vegetative cells in various stages of development. × 500.

Fig. 17. Showing formation of gonidia. × 500.

Arthrospira breviarticulata Setchell and Gardner

Fig. 18. An individual showing the loose spiral, doubled and entwined upon itself.



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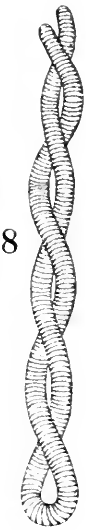

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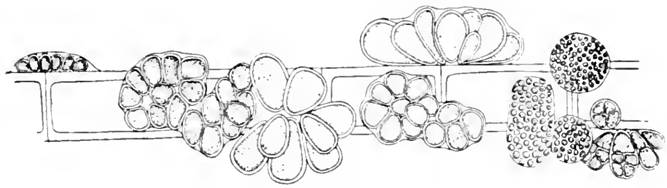

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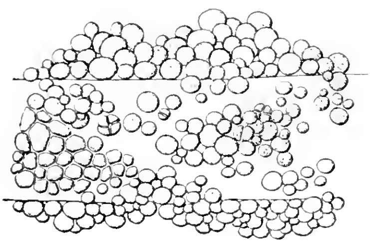

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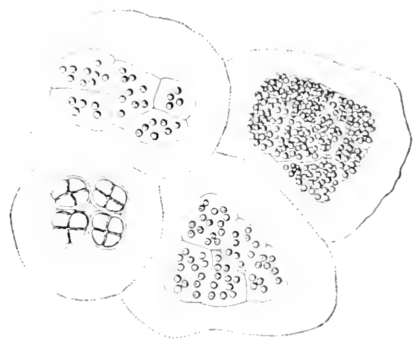

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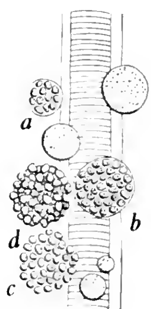

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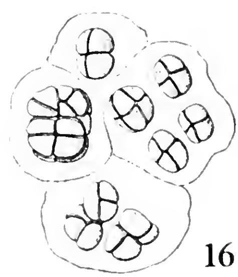

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PLATE 40

Fig. 19. *Rivularia mamillata* Setchell and Gardner. × 250.
Fig. 20. *Dichothrix seriata* Setchell and Gardner. × 125.
Fig. 21. *Calothrix rectangularis* Setchell and Gardner. × 125.
Fig. 22. *Calothrix robusta* Setchell and Gardner. × 125.
Fig. 23. *Phormidium hormoides* Setchell and Gardner. × 500.
Fig. 24. *Microcoleus Weeksii* Setchell and Gardner. × 500.
Fig. 25. *Microcoleus confluens* Setchell and Gardner. × 500.

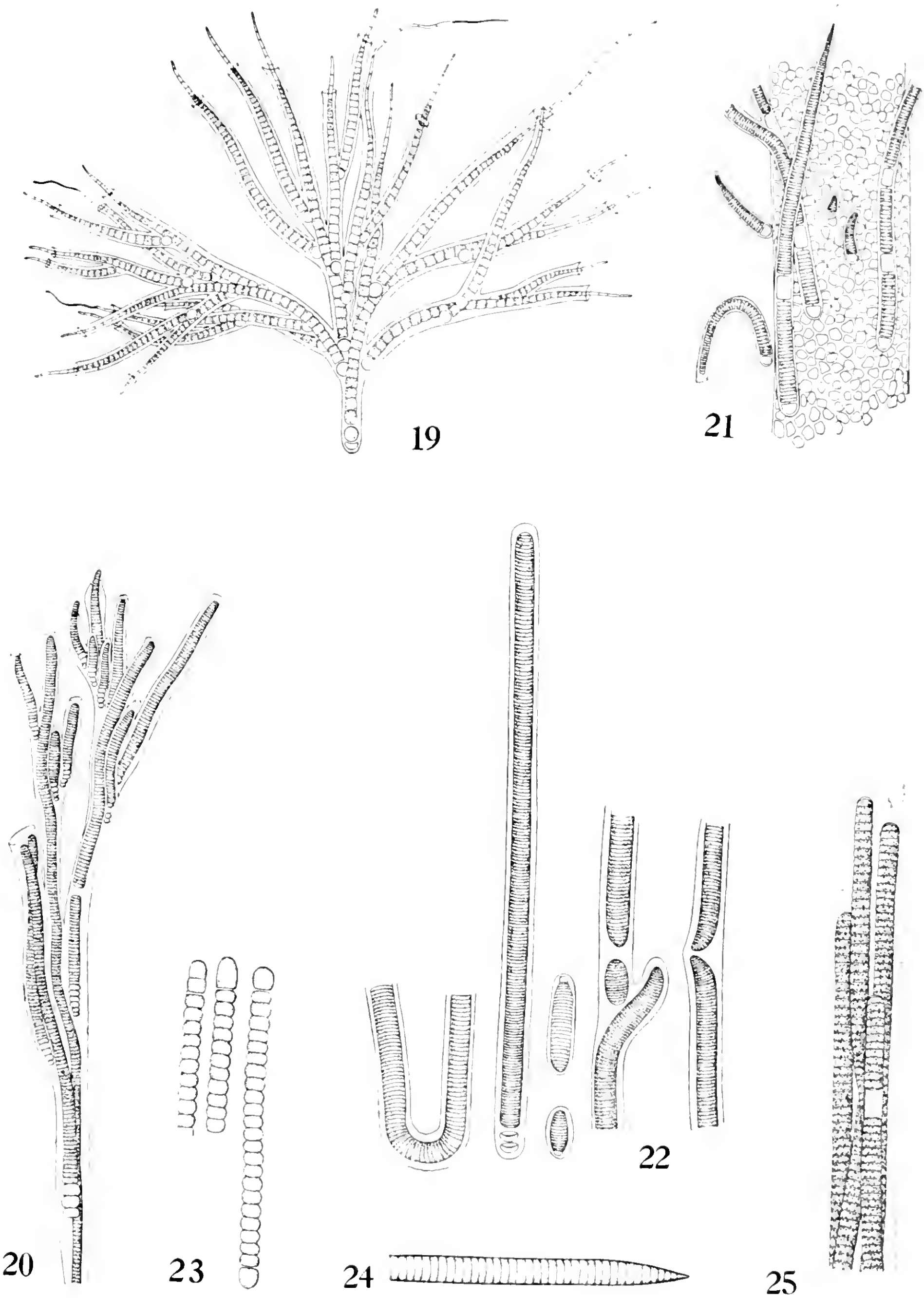
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PLATE 41

Arthrospira breviarticulata Setchell and Gardner

Fig. 26. An individual showing the general characters of a plant taken at random.

Brachytrichia affinis Setchell and Gardner

Fig. 27. A section view through the cortex of a young thallus showing the characteristic method of branching, and young hairs. × 330.

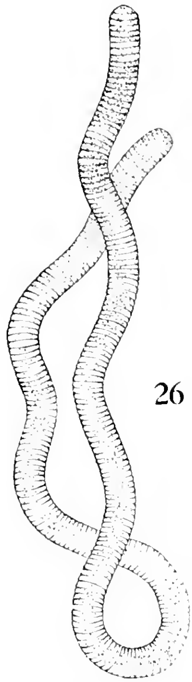
Fig. 28. A section view through an old thallus showing true branches springing directly from the main filaments without the formation of loops. × 330.

Symploca funicularis Setchell and Gardner

Fig. 29. Portion of a single filament showing the characters particularly of the terminal cell. × 330.

Pleurocapsa entophysaloides Setchell and Gardner.

Fig. 30. Showing the characteristic manner in which the groups of colonies arrange themselves in the stratum, after the manner of *Entophysalis*.



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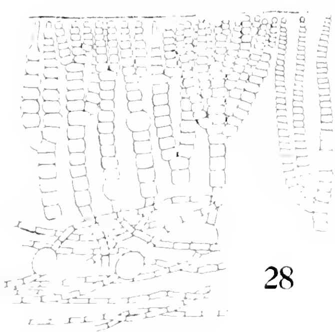

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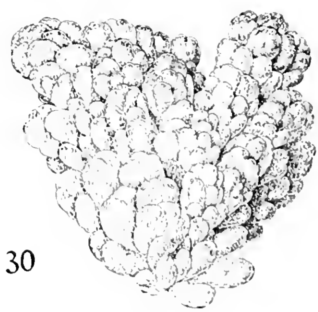

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UNIVERSITY OF CALIFORNIA PUBLICATIONS
IN
BOTANY

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NEW PACIFIC COAST MARINE ALGAE IV

BY
NATHANIEL LYON GARDNER

Anabaena propinqua Setchell et Gardner sp. nov.

Plate 42, fig. 1

Strato tenuissimo, laete coeruleo-viridi; trichomatibus flexuosis, 2.6–3μ diam., vaginis distinctis; cellulis subquadratis, 1.8–3μ longis, cylindricis, ad dissepimenta conspicua leviter constrictis; cellulis terminalibus obtusis aut acute conicis; heterocystis subsphaericis aut cylindricis, 3.5–4.5μ crassis, 5–7μ longis; sporis subsphaericis aut late ellipticis, 5.5–7μ crassis, 7–9μ longis, catenatis, ab heterocystis remotis evolutione centrifuga, membrana externa levi, hyalina.

Stratum very thin, light blue-green; trichomes flexuous, 2.6–3μ diam., with a distinct sheath; cells subquadrate, 1.8–3μ long, cylindrical, slightly constricted at the dissepiments which are very distinct; terminal cells varying from blunt to acute conical; heterocysts subspherical to cylindrical, 3.5–4.5μ diam., 5–7μ long; spores subspherical to broadly ellipsoidal, 5.5–7μ diam., 7–9μ long, catenate, remote from the heterocysts, developing centrifugally, membrane smooth, hyaline.

Forming a thin stratum, more or less continuous, on *Ruppia maritima*. In pools in a salt marsh, West Berkeley, California. Type no. 1423, Gardner.

Anabaena variabilis Collins, Holden & Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 1209.

Anabaena propinqua appears to be closely related to *A. variabilis* Kuetz., but comparison with authentic material of that species from the herbarium of Thuret contributed by Dr. Bornet (Herb. Univ. Calif. no. 100300) shows sufficient differences to warrant the establishment of a new species to receive our plant. It differs from *A. variabilis* Kuetz. in the smaller dimensions of all parts of the plant, vegetative cells, heterocysts and spores, which are also more nearly spherical than in *A. variabilis* and have hyaline walls instead of brown as in that species.

Ulothrix pseudoflacca f. maxima Setchell et Gardner forma nov.

Plate 42, fig. 6

Filis brevibus, plus minusve contortis, lubricis, atroviridibus, 16–36μ, vulgo 28–32μ diam.; cellulis brevibus, 4–8μ longis; parietibus cellularum 4–5μ crassis, homogeneis hyalinisque; chromatophoris incomplete annulatis parietes externos cellularum totaliter investientibus sed unilateraliter anguste fissis; pyrenoideis conspicuis; cellulis generativis non moniliformibus.

Filaments short, somewhat contorted, lubricous, dark green, 16–32μ, mostly 28–32μ diam.; cells short, 4–8μ long; cell wall 4–5μ thick, homogeneous and hyaline; chromatophore broken slightly on one side, but filling the length of the cell; pyrenoid conspicuous, reproductive cells not moniliform.

Growing on rocks and on various other small algae, along high-tide level or even above. Lands End, San Francisco, California. Type no. 4125, Gardner, November, 1917.

This is the only locality in which this species of *Ulothrix* has been observed. It is quite inconspicuous, often being located on the shaded portions of rocks, or obscured by the presence of other small algae, *Bangia, Enteromorpha, Ulva, etc.* It may grow in small tufts or, more often, evenly, but rather sparsely, distributed. They are rarely one centimeter long and are mostly only three to five millimeters long.

This form seems scarcely to be distinguished from *U. pseudoflacca* f. *major* (cf. Wille, 1901, p. 22, pl. 2, figs. 64–81). It agrees almost perfectly with Wille's description and figures, excepting in the size. The filaments are from 16–36μ in diameter, and the majority are of the larger diameters, 28–32μ. The diameters given for *U. pseudoflacca* f. *minor* are 8–16μ, and for f. *major* are 10–22μ.

The gametangia are formed in any of the cells without increase in their diameter, however the length may be greater than in the vegetative cells. This is particularly noticeable in cells that have been belated in forming gametes. The gametangia may become almost spherical.

Ulothrix pseudoflacca f. *maxima* is closely related to *U. flacca* (Dillw.) Thur. That species is said to have a much greater range of variation in the diameter of the filaments, and is a much longer plant. The diameter as given by Collins (1909, p. 185) is 10–25μ, and finally in the reproductive stage becomes 50μ in diameter. Farlow (1881, p. 45) says that the filaments of *U. flacca* become monoliform.

Codium Setchellii sp. nov.

Plate 42, figs. 10, 11

Thallo applanato, pulvinato, compacto, spongioso, 6–10 mm. usque ad 15 mm. crasso, ad saxa arcte adhaerente, atroviridi; filis medullaribus 12–30μ diam.; utriculis forma variabilibus, clavatis, cylindricis aut nunc sub apicem constrictis, superne truncatis aut leviter rotundatis, 65–75μ latis, parietibus juvenis ubique tenuibus, aetate provecta parietes apicales 6–16μ crassos, lamellosos et leves ostendentibus; gametangiis cylindricis aut lente fusiformibus, 300–330μ longis, 45–55μ crassis, in utriculis singulis; trichomatibus nullis.

Thallus forming dense, compact, spongy, irregular cushions, 6–10 mm., up to 15 mm. thick, adhering firmly to rocks; color dark glossy green; medullary filaments 12–30μ diam.; utricles variable in shape, clavate, cylindrical, or sometimes constricted below the apex, truncate or slightly rounded above, 65–75μ wide, walls thin throughout when young, the outer ends 6–16μ thick, smooth, and lamellose when older; gametangia cylindrical or slightly fusiform, 300–330μ long, 45–55μ diam., growing singly on the utricles; trichomes wanting.

Growing on rocks in the lower littoral belt. Central California. The type is no. 97655 in the Herbarium of the University of California, collected at Pacific Grove, California, by Mrs. J. M. Weeks, in February, 1897. Cotypes were distributed in Collins, Holden & Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 523.

Codium adhaerens Anderson, List of Calif. Mar. Alg., 1891, p. 217; Howe, A month on the shores of Monterey Bay, 1893, p. 63; McClatchie, Seedless Plants, 1897, p. 351; Saunders, Four Siphon. Alg., 1899, p. 2, pl. 350, figs. 3 *a–c*, Alg. Harriman Exped., 1901, p. 416; Setchell & Gardner, Alg. N. W. Amer., 1903, p. 231; Collins, Green Alg. N. A., 1909, p. 387 (not of Agardh). *Codium dimorphum* Hurd, Pug. Sound Mar. Sta. Publ., 1916, vol. 1, pp. 211–217, pl. 38, figs. 1–13; Collins, Green Alg. N. A., Supp. 2, June, 1918 (not of Svedelius).

The first publication of the occurrence of this incrusting species of *Codium* on the Pacific Coast of North America was that of C. L. Anderson (1891, p. 218) under *C. adhaerens* Ag. referring to material collected at Santa Cruz, California. The determination rests upon the authority of W. G. Farlow. Under the same name it next appeared in an article by M. A. Howe (1893, p. 67), the material having been studied at Monterey Bay, California. J. A. McClatchie (1897, p. 351) reported it from San Pedro, California. It was distributed in Collins, Holden and Setchell, *Phycotheca Boreali-Americana* no. 523, in 1898, from Pacific Grove, California. D. A. Saunders (1899, p. 2, pl. 350, fig. 3) described it and figured the utricles, based upon material collected at Point Pinos, Monterey Bay, California, and at Point Carmel, about ten miles south of Point Pinos. N. Svedelius (1900, p. 304) speaks of it in a discussion of its relation to his *C. dimorphum* in which he says, "Eine möglicherweise nahestehenden Form ist vielleicht Saunders *Codium adhaerens* von der nordamerikanischen Westküste (Saunders, Siphon. Alg.), deren Schläuche wenigstens einigermassen in der Spitze verdickt zu sein scheinen 'slightly thickened at the distal end.' Indessen bemerkt Saunders nicht über einen etwaigen Dimorphismus in der Schlauchwanderdickung, die offenbar sehr unbedeutend ist." Saunders again (1901, p. 416) reports a *C. adhaerens* as having been "dredged at Kadiak, at 15 meters depth (350)." The only comment he makes in this connection follows: "This species usually grows between tide marks and its occurrence at this depth is exceptional." If this is indeed the same species that grows on the coast of Central California, it is a considerably greater range in latitude, considering the marked differences in temperature of the waters of the two localities, than the great majority of algae are known to thrive in normally. Since Saunders reported it in the north, *Codium Ritteri* Setchell & Gardner has been published (1903, p. 231), based upon a single specimen collected by W. E. Ritter in two or three fathoms of water at Berg Bay, Alaska. Later Josephine E. Tilden found *C. Ritteri* in considerable abundance at Port Renfrew, on the west coast of Vancouver Island, and distributed it in her *American Algae* as no. 370, under *C. adhaerens*. Still later both T. C. Frye and G. B. Rigg of the University of Washington have collected *C. Ritteri* in Alaska, growing in the sublittoral belt. It probably is rather generally distributed from Vancouver Island northward, possibly to the Bering Sea. I have not seen the Saunders' specimen of *C. adhaerens* from Kadiak (*loc. cit.*), but in view of its incrusting habit, and its habitat in the sublittoral belt, it is to be suspected that his *C. adhaerens* should be referred to *C. Ritteri*. Setchell and Gardner (1903, p. 231) referred to the report of Saunders' Kadiak specimens of *C. adhaerens* and added to the list of localities a collection of my own from the west coast of Whidbey Island, Washington, and in July, 1917, I collected it at Sitka, Alaska. F. S. Collins (1909, p. 387) describes *C. adhaerens* and gives its range as "Vancouver to California," and again (1913, p. 105) listed it from Vancouver Island.

Recently Annie M. Hurd has published the most extensive account of the plants that have passed for *C. adhaerens* in the vicinity of the Puget Sound Marine Station at Friday Harbor, San Juan Island, Washington (Hurd, 1916, pp. 211–219, pl. 37). Through the courtesy of Svedelius she secured a portion of the type material in liquid of his *Codium dimorphum* from West Patagonia, and after comparison came to the conclusion that the plants from Patagonia and those from Puget Sound are identical, and refers the Puget Sound material to *C. dimorphum*. F. S. Collins, in a recent publication (1918, p. 88), has accepted Miss Hurd's interpretation, and, in addition, has referred all of the previously reported *C. adhaerens* of the Pacific Coast of North America to *C. dimorphum*. After having studied material of the so-called *C. adhaerens* from a number of localities ranging from Sitka, Alaska, to Laguna Beach, Southern California, and also having had an opportunity, through the courtesy of Miss Hurd, of examining a bit of the type material of Svedelius's *C. dimorphum*, I do not find myself in accord with the published views of either Miss Hurd or Mr. Collins, as to the identity of these two groups of plants. After having also compared our Pacific Coast "*C. adhaerens*" with the material of that species from Italy, it seems quite certain that no true *C. adhaerens* has been found on our coast, a conclusion at which Collins has also arrived. The most of the material which I have examined seems more closely related to the Patagonian species than to the European, but sufficiently different from the Patagonian *C. dimorphum* to warrant the establishment of a new species, for which I am proposing the name *Setchellii*.

From the various collections mentioned above, I have selected as the type a specimen collected in February, 1897, at Pacific Grove, California, by Mrs. J. M. Weeks. The cotypes were distributed as cited above. The material is in full fruit and seems to be typical of the species as it grows on the coast of Central California. All of the other material which I have examined from the Pacific Coast is sterile and represents considerable variation in the vegetative characters, particularly in the shapes and sizes of the utricles, from the type material. However, I am provisionally referring them all to *C. Setchellii*, awaiting further careful comparison and extended study, particularly of the plants growing in the northern portion of the range, and during the fruiting season, which seems to be mostly in the winter, when a final and more satisfactory disposition of them may be made.

The chief differences between *C. Setchellii* and *C. dimorphum* are in the characters of the utricles and in the method of growth of the fronds. The utricles of *C. dimorphum*, as described and figured by Svedelius, and as shown in the material which I have examined, are of two modifications, those with thin end walls and those with thick and lamellate end walls. The former are 5–7μ thick, and the latter are up to 80μ thick. The thickened utricles on the material at my disposal are in the margin, and especially in the underside of the thallus, and those on the underside of the thallus are not fruiting. Another characteristic feature of the thick walled utricles, which has not been mentioned either by Svedelius or by Miss Hurd, is the papillate thickenings on the outer surface of the thickened portion (pl. 42, fig. 8). This character does not appear at all in any of the specimens which I have referred to *C. Setchellii*. The first notice published of such modifications of the end walls of *Codium* utricles is that of Howe (1914, pp. 45, 46) as occurring in his *C. foveolatum*. Some years ago Professor Setchell noticed similar markings on the utricles of a *Codium* from Hawaii, probably undescribed. In this connection, I may mention a modification of the end walls of a specimen labelled *C. adhaerens* collected by M. A. Howe (no. 2055, Herb. Univ. Calif. no. 77292), from Porto Rico, differing from all of the above mentioned modifications in being on the inside surface of the wall (pl. 42, fig. 9). Similar modifications may have previously been overlooked on other described species, but in those in which it occurs it seems of sufficient diagnostic value as to be useful in making specific distinctions.

The fronds of *C. dimorphum*, as described and figured by Svedelius, are variously separated more or less into small lobes and are 5 mm. thick. Those of *C. Setchellii* are widely expanded, at times more or less lacerated, and are up to 15 mm. thick.

C. Setchellii differs from *C. difforme* Kuetz. as figured by Vickers (1908, pl. 25) in having the utricles less branched and with thicker end walls, and in having the sporangia much longer and narrower than in that species.

Rhizoclonium lubricum Setchell et Gardner sp. nov.

Plate 42, fig. 5

Filis flaccidis, lubricis, totaliter cylindricis, 3–4.5 dm. longis, laete viridibus; segmentis 35–50μ, vulgo 40μ, diam., quiescentibus 4–6 plo diam., post divisionem 1–2 plo diam., longis; chromatophoris parietalibus laxe reticulatis; pyrenoideis parvis, numerosis, in segmentis quiescentibus, 40–50; parietibus 2μ crassis, homogeneis; ramis rhizoideis curtis non septatis, cum cellulis generantibus continuis, sparsis; zoosporis gametibusque ignotis.

Filaments flaccid, lubricous, straight, cylindrical throughout, 3–4.5 dm. long, pale green; segments 35–50μ, mostly 40μ diam., resting segments 4–6 diam. long, after division segments 1–2 diam. long; chromatophore a coarse, parietal network; pyrenoids small, numerous, 40–50 in resting segments; wall 2μ thick, homogeneous; rhizoids short, mere prolongations of cells, non septate, rare; zoospores and gametes unknown.

Growing attached in mud, or floating on mud flats between tides. Roche Harbor, Washington, and Berkeley and Alameda, on the shores of San Francisco Bay, California.

This form closely resembles *R. riparium* f. *validum* Foslie, but is practically free from rhizoids, has thinner walls and larger and longer segments. From *R. implexum* it differs in having broader, straighter filaments of very different consistency, as well as usually longer segments. Unlike other species of *Rhizoclonium*, it is very lubricous, in mass, having the consistency of a *Spirogyra*.

Hormiscia sphaerulifera Setchell et Gardner sp. nov.

Plate 42, fig. 2

Filis maxime lubricis, laete viridibus, corpore protoplasmatico siccitate atro viridi, 4–6 cm. longis, usque ad 700μ diam., ad basim abrupte attenuatis, superne diametro uniformibus; rhizoideis intramatricalibus e 15–20 segmentis oriendis affixis; segmentis 0.5–2-plo diametro longioribus, juvenis cylindricis, maturitate sphaericis; chromatophoris taeniatis annulatis parietalibus juvenis tenuibus fenestratisque, aetate provecta solidis imperforatisque; pyrenoideis parvis, numerosis.

Filaments very lubricous, bright green, protoplast becoming dark when dry, 4–6 cm. long, up to 700μ diam., tapering abruptly at the base, of nearly uniform diameter above, attached by intramatrical rhizoids, from 15–20 segments; segments 0.5–2 times as long as the diameter and cylindrical when young, becoming almost spherical at maturity; chromatophore a thin fenestrate band when young, becoming solid when nearing the reproductive stage, pyrenoids small, numerous.

Growing on boulders in the extreme lower littoral belt. West Coast of Whidbey Island, Washington. Type no. 671 (Herb. Univ. Calif. no. 98547), Gardner.

Urospora Wormskioldii Setchell & Gardner, Alg. N. W. Amer., 1903, p. 221 (in part). No. 234, Gardner (Herb. Univ. Calif. no. 98545) and Collins, Holden and Setchell, Phyc. Bor.-Amer. (Exsicc.), no. 915, sub *Urospora Wormskioldii* (Mertens) Rosenv. seems to be of the same species, the plants in general being more mature but in less typical condition, the material not having been mounted when fresh.

Hormiscia vancouveriana (Tilden) Setchell et Gardner comb. nov.

Urospora Wormskioldii Setchell & Gardner, Alg. N. W. Amer., 1903, p. 221 (in part). *Hormiscia Wormskjoldii* Collins, Green Alg. N. A., 1909, p. 368 (in part). *Urospora Wormskjoldii* f. *vancouveriana* Tilden, Amer. Alg. (Exsicc.) no. 381.

Comparison of Miss Tilden's plant with material of *Urospora Wormskioldii* (Mert.) Rosenv., collected by J. Vahl in May, 1831, at Godthaab, Greenland, the type locality, has convinced us that her Vancouver Island plant is a distinct species, based chiefly upon the following differences: (1) much larger segments, up to 3 mm. in diameter; (2) a much more dense chromatophore with smaller openings; and (3) the mature segments much more nearly spherical.

Hormiscia grandis (Kylin) Setchell et Gardner comb. nov.

Plate 42, fig. 3

Growing on rocks in the upper littoral belt. West shore of Amaknak Island, Bay of Unalaska, Alaska. No. 3279 (Herb. Univ. Calif. no. 98535), Setchell.

Urospora peniciliiformis Setchell & Gardner, Alg. N. W. Amer., 1903, p. 220 (in part). *Urospora grandis* Kylin, Studien ueber Algenflora, etc., 1907, p. 18, fig. 3.

Number 514 (Herb. Univ. Calif. no. 98533), Gardner, collected in May, 1899, at Esquimalt, British Columbia, seems also to belong to this species. The segments are mostly shorter than the measurements given by Kylin, and also shorter than the Alaska specimen quoted above. The segment walls are also thinner. The material is young, which may very probably account for the differences.

The author is indebted to Professor W. A. Setchell for his critical examination of this paper and for the Latin diagnoses.

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EXPLANATION OF PLATE

PLATE 42

Figures 1, 2, 5, 6, 7, 8, 10, and 11 were drawn by Dr. Helen M. Gilkey, and the others by Miss Almeda H. Nordyke, under the direction of the author.

Anabaena propinqua Setchell & Gardner

Fig. 1. A group of plants. *A*, Young plants, the others are fruiting plants, showing extremes in the variation in shapes of spores. × 500.

Hormiscia sphaerulifera Setchell & Gardner

Fig. 2. *A*, Basal portion of filament showing intramatrical rhizoids. *B*, Vegetative cells in the median portion of the filament. *C*, An empty sporangium. × 25.

Hormiscia grandis (Kylin) Setchell & Gardner

Fig. 3. *A*, Basal portion of filament showing numerous intramatrical rhizoids. *B*, Two zoosporangia of moderate size. *C*, A long typical zoosporangium, empty. *D*, Moderate sized vegetative segments. × 80.

Hormiscia penicilliformis (Roth) Fries

Fig. 4. *A*, Sporeling with rhizoid penetrating a filament of *Ulothrix flacca*. *B*, Basal portion of a young filament, showing a few intramatrical rhizoids. *C*, Characteristic zoosporangia. *D*, Young vegetative segments. No description is given of this species. × 80.

Rhizoclonium lubricum Setchell & Gardner

Fig. 5. *A*, Terminal portion of a young filament with short segments. *B*, Terminal portion of a filament with long, ''resting'' segments. × 160.

Ulothrix pseudoflacca f. *maxima* Setchell & Gardner

Fig. 6. *A*, *B*, Vegetative filaments. *C*, Sporangia. × 250.

Codium dimorphum Svedelius

Fig. 7. A young utricle with an empty sporangium. × 80.

Fig. 8. A terminal portion of a utricle, showing the extremely thick, lamellate and tuberculate end wall. × 100.

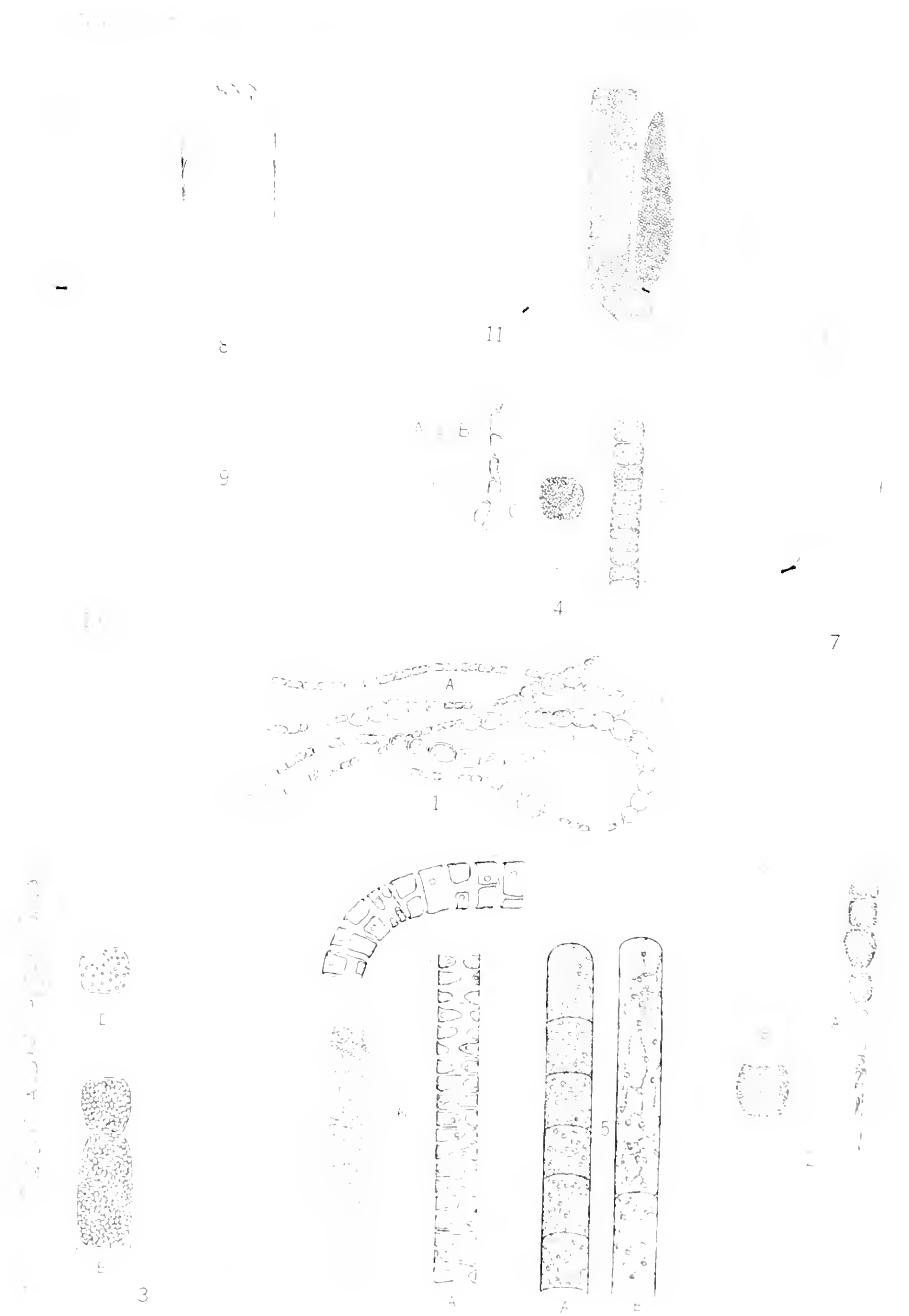
Codium adhaerens M. A. Howe

Fig. 9. Portion of the end wall of a utricle, showing internal modifications. × 100.

Codium Setchellii Gardner

Fig. 10. Typical utricle and sporangium, showing also the scars of three pervious sporangia. × 80.

Fig. 11. Showing different forms of utricles and sporangia.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UNIVERSITY OF CALIFORNIA PUBLICATIONS
IN
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Vol. 6, No. 19, pp. 497-504 November 3, 1919

PLANTAE MEXICANAE PURPUSIANAE, IX

BY

TOWNSHEND STITH BRANDEGEE

Acrodiclidium mexicanum, sp. nov.

Arbor parva: ramis fusco-pubescentibus: foliis alternis anguste ovatis, supra nitentibus glabris, subtus pubescentibus venis prominulis, apice obtusis vel acutis, ca. 12 cm. longis, 4 cm. latis, petiolis ca. 6 mm. longis, pubescentibus: paniculis axillaribus quam foliis multo brevioribus, pedunculis ca. 3 cm. longis, pedicellis 1–3 mm. longis; perianthii segmentis late ovatis, parvis luteolis; fructu aucto perianthii tubo paululum exserto, perianthio aucto ruguloso margine duplici.

Only very immature flowers were collected. The genus heretofore has been found only in the West Indies and South America. Dr. Purpus has also found about Zacuapan *Zuelania*, a genus belonging to the West Indies. Collected at Tlacoquistla, near Zacuapan. No. 8081. Type, Herb. Univ. Calif. No. 200978.

Acrodiclidium misantlae, sp. nov.

Arbor parva glabra: ramis badiis: foliis alternis ellipticis basi cuneatis apice acutis, 6–10 cm. longis, 3–4 cm. latis; petiolis ca. 1.4 cm. longis: paniculis laxis, floribus parvis: perianthii tubo aucto ruguloso: margine interiori parum exserta rugulosa.

This species is well marked by the rugulose margin of the slightly exserted inner perianth. A more complete description can not be written without more perfect specimens. Collected at Misantla, Vera Cruz. No. 8145. Type, Herb. Univ. Calif. No. 200935.

Acrodiclidium glabrum, sp. nov.

Arbor parva glabra: ramis cinereis: foliis ovato-lanceolatis apice acutis usque ad 18 cm. longis, 7 cm. latis; petiolis 1.7 cm. longis: bacca 2.5 cm. longa, tubo perianthii semi-exserta: perianthii tubo aucto ruguloso cupulato margine duplici cincto. Flores desunt.

This species is easily separated from *A. mexicanum* Brandg. by its larger glabrous leaves and large fruit. All three species bear acorn-like fruit with the berry semiexserted from the double-margined tuberculate perianth. Collected at Zacuapan, Vera Cruz. Nos. 8143 and 8096. No. 2068 distributed as *Nectandra ?* is this species. Type, Herb. Univ. Calif. No. 200937.

Sedum falconis, sp. nov.

Suffruticosum erectum e radice valida lignosa: caulibus ramosis glabris ca. 2 dm. altis: foliis alternis spatulatis paululum furfuraceo-puberulis, deorsum productis, apice rotundatis, usque ad 10 mm. longis, 5 mm. latis: paniculis caules ramosque terminantibus; floribus aggregatis breviter pedicellatis, pentameris; sepalis anguste oblongis obtusis furfuraceis, ca. 2 mm. longis; petalis liberis lanceolatis purpureo-lineatis, ca. 7 mm. longis; carpellis erectis, stylis longe subulatis divergentibus coronatis.

Collected on Cerro del Gavilan, near San Luis Tultitlanapa, Puebla. No. 4227. Type, Herb. Univ. Calif. No. 136828.

Sedum monticola, sp. nov.

Glabrum: caulibus plus quam 6 cm. altis, crassis: foliis obovatis vel spatulatis apice apiculatis usque ad 3.5 cm. longis, 8 mm. latis: inflorescentia cymoso-paniculata ramos laterales ca. 3 cm. longos terminanti; floribus aggregatis breviter pedicellatis; sepalis oblongis acutis ca. 4 mm. longis; petalis albis, liberis, late lanceolatis latitudine inaequalibus ca. 5 mm. longis; squamellis rotundatis; carpellis late divergentibus, stylis subulatis coronatis.

A species with apparently low, thick stems and short lateral branches bearing crowded flowers. Collected on Ixtaccihuatl. No. 7690. Type, Herb. Univ. Calif. No. 115361.

Rubus scolocaulon, sp. nov.

Caulibus glabris badiis, spinis numerosis validis ca. 6 mm. longis recurvatis compressis instructis: foliis juvenibus pubescentibus deinde glabris, petiolis usque ad 11 cm. longis: foliis plerumque 5-digitatis ovatis acuminatis basi rotundatis, margine serratis, venis utrinquesecus 7–10; foliolo terminali usque ad 8 cm. longo, 6.5 cm. lato, petiolulo ca. 4.5 cm. longo; foliolis lateralibus similibus paululum minoribus, petiolulis usque ad 3 cm. longis: foliolis inferioribus multo minoribus, petiolulis ca. 8 mm. longis; foliis ramorum floriferorum 3-digitatis: stipulis ca. 7 mm. longis lineari-lanceolatis: sepalis oblongo-ovatis utrinque tomentosis abrupte longe mucronatis: petalis albis ca. 1.5 mm. longis quam sepalis duplo longioribus. Fructus maturus deest.

This plant is very distinct from the Alta California species and resembles some of the Mexican forms. A slight pubescence can be found on the petioles and petiolules which are armed with numerous stout recurved spines. Collected on the Sierra de la Laguna of the Cape Region of Baja California by T. S. Brandegee, where it is not found in abundance. Type, Herb. Univ. Calif. No. 114643.

Indigofera Purpusii, sp. nov.

Suffrutescens erecta: caule pubescenti plus quam 5 dm. alto: foliis ca. 1 dm. longis; foliolis ca. 30, oblongis apice obtusis mucronulatis, basi rotundatis vel cuneatis, utrinque pilis adpressis instructis, ca. 1.5 cm. longis, 5 mm. latis; stipulis setaceis basi ampliatis: inflorescentia ferrugineo-pubescenti multiflora: racemis 5–10 cm. longis: calycis dentibus breviter lateque deltoideis; vexillo ca. 7 mm. longo, alis glabris, staminibus ca. 7 mm. longis; legumine immaturo arcuato reflexo, longe acuminato ferrugineo-pubescenti, ca. 10-spermo.

Collected on rocks in Barranca de Tenampa, Vera Cruz. No. 8167. Type, Herb. Univ. Calif. No. 200645.

HESPEROTHAMNUS, gen. nov. Leguminosarum

Calycis lobi inaequilongi, 2 superiores connati; petala subaequilonga, unguiculata; vexillum orbiculatum; alae oblongae, falcatae, liberae; carina incurva, obtusa. Stamen vexillare demum liberum, cetera in vaginam connata; antherae uniformes. Ovarium pubescens, sessile, multi-ovulatum; stylus incurvus, subulatus, imberbis, stigmate parvo terminali. Legumen oblongum, plano-compressum, 2-valve, valvis coriaceis. Semina orbiculata, estrophiolata, funiculo lato, radicula curvata, longa, cotyledonibus foliaceis accumbente. Frutex. Folia imparipinnata, foliolis integerrimis. Flores violacei in racemos terminales dispositi.

Hesperothamnus littoralis, nom. nov.

Lonchocarpus littoralis, Brandg. Zoe, vol. 5, p. 157. This species is found in cañons along the west side of the Cape Region of Baja California. In the description of *Lonchocarpus littoralis* the legume is incorrectly described as indehiscent. Additional collections show that it finally separates into two valves, which become somewhat contorted. The leaves and legume suggest *Brongniartia*, but the terminal racemes, the estrophiolate seed and long accumbent radicle do not belong to that genus. Type, Herb. Univ. Calif. No. 83370.

Clitoria monticola, sp. nov.

Suffruticosa: caule erecto, ramulis juvenibus paululum pubescentibus: foliis trifoliolatis, foliolis oblongo-lanceolatis basi rotundatis apice costa excurrenti mucronulatis, ca. 9 cm. longis, 2.5 cm. latis, supra glabris, subtus praecipue ad venas pubescentibus; petiolis pubescentibus 3–6 cm. longis: racemis 3–8-floris, 3–4 cm. longis: calyce tubuloso ca. 1.5 cm. longo, dentibus ca. 4 mm. longis; corolla ca. 2.8 cm. longa; ovario pubescente 3–5-ovulato; legumine usque ad 4.5 cm. longo glabro; seminibus globosis.

Collected by T. S. Brandegee at El Taste and Sierra de San Francisquito, high mountains of the Cape Region of Baja California. Type, Herb. Univ. Calif. No. 83907. This species is listed in Proc. Cal. Acad. of Sci., (2), vol. 3, p. 129, as *Clitoria Mariana* L., from which it is very distinct.

Lonchocarpus Purpusii, sp. nov.

Arbor parva, 5–6 m. alta, ramis lenticellatis: foliis 10–15 cm. longis, foliolis 5–7, glabris ovatis, apice acuminatis, basi cuneatis, pellucido-punctatis, 5–6 cm. longis, 2–4 cm. latis: paniculis plerumque axillaribus 7–9 cm. longis: pedicellis saepe bifloris; calyce cupulato margine undulato: petalis atropurpureis sub lente paululum pubescentibus; vexillo orbiculato emarginato ca. 1 cm. longo alas aequanti; carinae petalis medio parum adhaerentibus; stamine vexillari basi libero; ovario 2–3-ovulato paululum pubescenti.

A handsome species bearing an abundance of dark purple flowers. Collected near Zacuapan, Vera Cruz. No. 7849. Type, Herb. Univ. Calif. No. 198247.

Machaerium riparium, sp. nov.

Ramis vetustis badiis striatis, juvenibus ferrugineo-hirsutis: foliis 5–9-foliolatis, petiolo communi ca. 5 cm. longo, stipulis spinescentibus curvatis; foliolis ellipticis vel oblongis utrinque glabris apice basique obtusis ca. 3 cm. longis, 1.4 cm. latis; floribus in paniculis axillaribus ferrugineo-pubescentibus; bracteolis sub calyce late ovatis badiis pubescentibus; calyce breviter 5-lobato, lobis semi orbiculatis: corolla extus ferrugineo-sericea; ovario ferrugineo-hirsuto stipitato 1-ovulato; legumine glabro 5.8 cm. longo, ala 1.8 cm. lata apice rotundata.

Collected near Zacuapan, Vera Cruz, growing in rocky soil along brooks. No. 8166. Type, Herb. Univ. Calif. No. 200644.

Dalbergia Purpusii sp. nov.

Frutex scandens ramis juvenibus fusco-puberulis: foliis 7–9-foliolatis ca. 5 cm. longis; foliolis petiolulatis discoloribus oblongo-ovatis vel cuneatis apice retusis ca. 1.8 cm. longis, 1 cm. latis: inflorescentia cymoso-paniculata axillari quam foliis breviori; calyce 5-dentato dente inferiori multo longiori; vexillo apice retuso; staminibus 9 aut 10; legumine plano recto 2–5 cm. longo, ca. 1 cm. lato apice acuminato, basi in stipitem brevem angustato, 1–2-spermo.

Collected near Zacuapan, Vera Cruz. No. 7742. Type, Herb. Univ. Calif. No. 187843.

Mascagnia rupicola, sp. nov.

Frutex rupes praeruptas ca. 15 m. altas scandens: caulibus fuscis juvenibus tomentosis: foliis ellipticis basi obtusis vel cuneatis, apice mucronatis interdum emarginatis utrinque glabris margine tomentoso-ciliatis, ca. 3.5 cm. longis, 1.8 cm. latis: racemis lateralibus, ca. 5-floris 2.5–3.5 cm. longis; pedicellis ca. 1.5 cm. longis; calycis glandulis magnis; petali limbo oblongo ca. 6 mm. longo basi aurito margine eroso: fructu alas laterales confluentes flabelliformes includenti, ca. 1.9 cm. lato; ala dorsali deficienti.

The specimens bear vestiges only of the flowers and mature fruit. According to the collector's notes, this plant was found crawling up steep rocks to the height of 50 or 60 feet after the manner of *Ficus repens,* and consequently making it difficult to obtain specimens. Collected near Zacuapan, Vera Cruz. No. 7759. Type, Herb. Univ. Calif. No. 198188.

Gouania viridis, sp. nov.

Frutex ramis tenuibus sursum pubescentibus: foliis oblongo-ovatis, basi rotundatis vel subcordatis, apice acuminatis margine glanduloso-serratis, subtus ad venas minute pubescentibus, 5–8.5 cm. longis, 2–3.5 cm. latis, stipulis lanceolatis ca. 2 mm. longis; petiolis ca. 4 mm. longis: racemis usque ad 14 cm. longis, rhachi pubescenti haud cirrifera. Fructus deest.

This is a bright green plant nearly glabrous and quite distinct from other Mexican species. Collected near Zacuapan, Vera Cruz, growing on rocky banks of barrancas. No. 8032. Type, Herb. Univ. Calif. No. 198428.

✓ **Centradenia chiapensis,** sp. nov.

Caulibus glabris tetragonis ca. 3 dm. altis: foliis inaequali-ovato-acuminatis basi cuneatis, discoloribus in eodem jugo disparibus, altero usque ad 13 cm. longo, 4 cm. lato, altero minori interdum minimo, supra dissite hirtellis subtus ad venas pilosis, margine piloso-hirtello-ciliatis; petiolis ca. 4 mm. longis: floribus in cymas corymbiformes caules terminantes dispositis, bracteis cito deciduis chartaceis late lanceolatis margine piloso-ciliatis ca. 6 mm. longis instructas; calycibus glabris ca. 6 mm. longis, lobis ovato-acutis ca. 2 mm. longis; petalis late ovatis ca. 4 mm. longis; connectivo staminum majorum in appendicem brevem compressam producto, staminum minorum in appendicem glanduliformem terminanti; ovario apice dentato undique glandulis stipitatis obsito. Fructus deest.

Collected on Cerro del Boqueron, Chiapas. No. 6978. Type, Herb. Univ. Calif. No. 172787.

Ecliptostelma molle, Brandg. Univ. Calif. Publ. Bot., vol. 6, p. 371. Dr. Purpus has collected fruit of this high-climbing asclepiad and its description may be completed as follows: Folliculi crassi anguste ovoidei striati, striis pubescentibus, ca. 7.5 cm. longi, 3 cm. lati.

Cordia limicola, sp. nov.

Frutex ramis parce hirsutis: foliis ovatis acuminatis basi in petiolum marginatum cuneatis, margine superne crenato-dentatis, utrinque parce hirsutis, venis paululum excurrentibus, 5–8 cm. longis, 3–5 cm. latis: floribus in capitulo globoso pedunculum 6–9 cm. longum terminantibus: calyce ca. 8 mm. longo, lobis 5 lineari-lanceolatis ca. 3 mm. longis, hirsuto: corolla ca. 1.5 cm. longa infundibuliformi cito decidua: drupa calyce inclusa, putamine osseo tuberculato.

Collected at Corral de Piedras, near Zacuapan, Vera Cruz, growing in moist soil. No. 8017. Type, Herb. Univ. Calif. No. 198413.

Centaurium peninsulare, sp. nov.

Annuum, 12–20 cm. altum glabrum: foliis inferioribus ovatis basi in petiolum cuneatis, usque ad 2 cm. longis, 1 cm. latis; superioribus minoribus ovato-lanceolatis: floribus ramulos axillares 3–4.5 cm. longos vel caules terminantibus; pedicellis plerumque duobus 3–4 cm. longis; calycis lobis 5 linearibus ca. 6 mm. longis corollae tubo paululum brevioribus; corollae lobis 4 roseis ca. 4 mm. longis, late ovatis, obtusis; stigmate flabelliformi; antheris oblongis.

An erect few-flowered species. The axillary branches or peduncles are two-bracted at the top and usually bear two flowers on long pedicels. The dried flowers are rose-colored or pink. Collected by T. S. Brandegee on Sierra de San Francisquito, a high mountain of the Cape Region of Baja California. Type, Herb. Univ. Calif. No. 177313.

Peritylo incompta, sp. nov.

Herbacea: parte superiori puberula; caulibus parce ramosis plus quam 4 dm. altis, striatis; foliis oblongis, longe lanceolato-dentatis, superioribus parvis sessilibus; capitulis laxe corymbosis, pedunculis 2–3 cm. longis; bracteis involucri oblanceolatis ca. 4 mm. longis; receptaculo convexo; radiis albis 5 mm. longis apice 3-dentatis, disci floribus ca. 3 mm. longis puberulis, tubo faucibus fere aequanti, styli ramis tenuibus obtusis puberulis; achaeniis oblongis compressis margine ciliatis, ca. 2.5 mm. longis, pappo breviter cupulato lacero coronatis, aristulis nullis.

Collected by Walter E. Bryant at Los Dolores, a locality a short distance north from La Paz, Baja California. The specimens are not complete, lacking the lower part of the stem. They evidently represent a tall species having nearly glabrous stems and leaves dentate with narrow long teeth and with slender puberulent obtuse style branches. Type, Herb. Univ. Calif. No. 90513.

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* Univ. Calif. Publ. Bot., Vol. 6.

UNIVERSITY OF CALIFORNIA PUBLICATIONS
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Vol. 6, No. 1, pp. 1-34, pls. 1-6 Issued April 18, 1914

PARASITIC FLORIDEAE, I

BY

WILLIAM ALBERT SETCHELL

UNIVERSITY OF CALIFORNIA PRESS
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Vol. 6, No. 2, pp. 35-40, plate 7 Issued April 11, 1914

PHYTOMORULA REGULARIS, A SYMMETRICAL PROTOPHYTE RELATED TO *COELASTRUM*

BY

CHARLES ATWOOD KOFOID

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VARIATION IN *OENOTHERA OVATA*

BY

KATHARINE LAYNE BRANDEGEE

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PLANTAE MEXICANAE PURPUSIANAE, VI

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BY

HARVEY MONROE HALL

UNIVERSITY OF CALIFORNIA PRESS
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PLANTAE MEXICANAE PURPUSIANAE VII

BY

TOWNSHEND STITH BRANDEGEE

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PLANTAE MEXICANAE PURPUSIANAE, VIII

BY

TOWNSHEND STITH BRANDEGEE

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BY

NATHANIEL LYON GARDNER

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BY

ROBERT W. HODGSON

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PLANTAE MEXICANAE PURPUSIANAE, IX

BY
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