The *Fucus cordatus* of Turner (*Fuci, 2, 118, 119, pl. 116 (1809)) has been a much misunderstood plant and its various misinterpretations have been responsible for other misconceptions. The species was described from specimens collected by Mr. Menzies at "Banks' Isles" on the northwest coast of North America on the second voyage of Vancouver. "Banks' Isles," now generally known as Banks Island, lies on the east side of Hecate Strait in British Columbia and at about 50° lat. N. and 130° long. W. The total distribution of this species, according to one or another author, extends from the northeastern coasts of Asia, around through the type locality, along the west Pacific Coast of North America to (or almost to) the southern boundary of the United States, the coasts of Chile to the Antarctic continent and up along the eastern coast of South America to (and including) the Falkland Islands (cf. particularly Gain, "Deux. Exp. Antarct. française," 1908-1910, "La Flore Algologique," 54-58, 1912) and even to South Africa. Such a range even among the Red Algae is almost unparalleled, but from the point of view of moderate polymorphism did not, until very recently, seem beyond plausibility.

*Fucus cordatus* was referred by Bory (*Dict. Class., 9, 16 (Feb., 1826)) to his proposed new genus *Iridea* as *Iridea cordata* and was the first of the binomials coined by him under this genus, although he mentioned the *Delesseria edulis* of Lamouroux first of all the species belonging to *Iridea*, but without coining a proper binomial for it. In Bory's time, fixing a type for a genus was not customary. Greville, however, in 1830 (*Alg. Britt., 136*) definitely designates *Fucus edulis* Stackhouse as the type of the genus, as he had a perfect right to do. Later the name *Iridea* (or *Iridaea*) was more and more restricted to plants of the general type of *Fucus cordatus* and in 1847 J. G. Agardh (*Kongl. Vet. Akad., Handl., 82*) in discussing the various types of South African plants still referred to *Iridea*, in his turn, formally designated *Fucus cordatus* Turner as the type of the genus, following the seeming usage of Bory in his latest account (*Voy. Cog., Bot., 2, 103-114 (Feb., 1828)) and of Kuetzing, who (*Phycol. gen., 395 (1843*)) places *Fucus cordatus* first in the enumeration and in his illustration (loc. cit., pl. 77, II, not truly of *Fucus cordatus* Turner) of the genus, although he includes *I. edulis* (Stackh.) Grev. and others which J. G. Agardh (loc. cit.) finally excluded from his conception of *Iridaea*.

When the late Professor Nathaniel Lyon Gardner and myself, after somewhat over thirty years of collecting and study, issued our preliminary
We may presume that such of Dawson Turner's Algae as are to be found in the "Hooker Herbarium" were preserved through the meticulous care of his son-in-law, Sir William Jackson Hooker, who is responsible for so many of the excellent drawings of Turner's "Fuci."

While there seemed to be no doubt from our previous studies that *Fucus cordatus* Turn. was not among the *Iridophycus* species known from the Southern Hemisphere, the question as to its exact characters became acute as Gardner and myself attempted to unravel the complex of the species of the coasts of western North America and northeastern Asia. Following out a suggestion of one of our fellow botanists (Dr. Ivan M. Johnston of the Gray Herbarium) that some of the plants collected by Archibald Menzies were to be found at the Royal Botanic Gardens at Edinburgh, a letter was addressed to the Regius Keeper, Sir William Wright Smith, with the result that a sheet of two specimens of "*Fucus cordatus*" collected by "A. M., Banks' Isles, N. W. Coasts of America" were found in the "Menzies Herbarium" and generously forwarded to us for study. The lower specimen answers so very closely to Turner's figure of the plant (*Fuci, 2*, pl. 118) that it seems possible that it may be the very specimen from which the drawing was made. It is, moreover, just one-half the diameter of the figure of Turner, who says, however, that it "contracts to little more than half its original size" in drying. It seems, therefore, since in all its characters it corresponds to Turner's description, that here we have the type material, or if any doubt remains, at least duplicate type
material, and it is possible to study the cystocarpic type in all essential detail.

*Fucus cordatus* Turner, both as described by Turner and as represented by the Menzies specimens in Herb. Edinb. is a plant of the size of the series of larger species of *Iridophycus* (cf. Setchell and Gardner, *Proc. Nat. Acad. Sci.*, 23, 174 (Mar., 1937)). Turner describes it as about a foot long and 6 inches wide, which corresponds to the larger of the two specimens in the Menzies Herbarium, after allowing about half diameter for shrinkage during drying. The fronds, according to Turner, arise from "a largish, expanded, callous disk" and "the fronds are numerous from the same base." There is a distinct stipe, about 1.2 cm. long ("6 lines," according to Turner) which is flattened, narrow below and expanding above into a narrow cuneate apophysis, distinctly set off from the stipe below and the broad flaring base of the lamina (or blade) above and about 1 cm. long and 0.6–1 cm. broad. The color of the whole plant from basal disc to apex is described by Turner as "livid-brown, not without a tinge of purple, transparent, darker when dry, and then looking almost black unless held up to the light," with "substance" described as between "coriaceous and fleshy, thick and full of moisture."

The blade is broadly ovate-oblong, with broad, shallow, cordate base, more or less unsymmetrical, narrowing in the upper third to a broad and obtuse point. The margins are devoid of projections or lobes, "quite entire" is Turner's description, but are broadly undulate, with the very small cystocarps of extraordinarily uniform size, scattered over the entire blade with the exception of a crescentic zone just above the apophysis. Turner says: "in the lower and narrowed part of the frond the margins are remarkably elevated and incurved and this part consequently looks not only like a stem, but a channeled one." This shows also in the Menzies specimens and indicates that the species has a very definite apophysis set off from both the blade above and the short stipe below.

The cystocarps are described by Turner (loc. cit., p. 118) as being "spherical tubercles, smaller than a pin's head, of a tawny color, scattered without order all over the frond, and immersed in the middle of its substance, containing a number of minute, oblong, red seeds, together with pellucid jointed fibers." While the general morphology of *Fucus cordatus* is almost sufficient to stamp it as a very well defined species among those of *Iridophycus*, the uniformity of the cystocarps together with their comparatively small size, add to the other indications that it is most distinct and, as will be indicated later, evidently restricted to a small region in northwestern North America.

Transverse sections of the plant of Menzies are from about 186 to 245 μ thick in the sterile portions (when only moderately swollen up, to about what seems normal when fresh (i.e., cut by freezing method in 70 parts
of glacial acetic acid and 30 parts of water, mounted in "Karo") while the cystocarpic portions are up to 375 μ thick or even somewhat thicker. That portion of the blade (see figure 1) which is not cystocarp-bearing shows a medullary layer occupying about three-sevenths of the diameter of the section and consisting in very thin section of about 4 more or less parallel slender and loosely placed filaments, about 3–4 μ diam. The segments of the hyphae are commonly elongated (up to 28 μ long). In thin sections cut about 15 μ thick and treated so as to prevent undue swelling, the filaments of the medulla show practically parallel (as in figure 1), but in thick sections (or crushed fragments) the hyphal segments form an irregular but close reticulum often with elongated meshes and with many free ends, enough to disturb the regularity of the reticulum. In thicker or more swollen sections the irregular network is definitely apparent but never approaches the regular reticulum of the Iridaea cordata of Kuetzing (Phyc. Gen., 395, pl. 77, II (1843), Tab. Phyc., 17, pl. 6, fig. b (1867)) from Valparaiso, which is obviously not Turner's species but Iridophycus Boryanum Setch. et Gard. (Proc. Nat. Acad. Sci., 22, 470 (1936)).

The cortex of the sterile portions of the frond is indistinctly double (as in most species of the genus), divided into an outer and an inner. The outer cortex consists of closely packed anticlinal rows (or anticlinal groups) of cells, 6–8 in number (vertical to the surface). These cells form a perfectly distinct layer of about 6 cells from the surface, the lower larger and rounded or slightly flattened, the upper 3 (or 4) slightly elongated vertical to the surface. The outermost, commonly single, may be globular to cartridge-shaped. Occasionally the outermost cells arise by twos from the cell below and are decidedly elongated as indicated by Kylin (Lund Univ. Årsskr., n. f., Avd. 2, 24, 47, fig. 25 (1928)).

The lower portion of the outer cortex is not, in cystocarpic and antheridial plants, sharply delimited, but between it and the medulla there is a tissue, undefined on outer and inner sides, of several layers of distant, horizontally elongated cells, short to fairly long in horizontal diameter (parallel to the surface of the frond) which exists in all species of Iridophycus and which, because of its augmentation in the tetrasporic plants of the genus, may be distinguished as an inner cortex. This undefined inner cortex equals approximately the thickness of the outer cortex. The comparatively slight development in the inner cortex in sterile, antheridial and cystocarpic individuals of species of Iridophycus as compared with tetrasporic individuals makes for the extreme increase in thickness found in the last and is to be emphasized here in the case of the type of Fucus cordatus since search for the proper tetrasporic type is utterly complicated as to thickness and complexity of structure.

The cystocarps in Turner's plant (cf. figure 2) measure up to about 500 μ
*Iridophycus cordatum* (Turn.) S. et G.

Fig. 1 (above). Portion of a transverse section of a sterile portion of the blade of the "type" specimen. $\times 400$ diam.

Fig. 2 (below). Portion of a similar section showing the upper segment of a cystocarp $\times 400$.

(Drawn by Roy W. Donley under direction of the author)
in horizontal diameter and about 315 µ in vertical diameter. The spores are in definite groups, separated by slender "nutritive" filaments, and the whole cystocarp is enclosed within a distinct and fairly thick (60–65 µ) layer of concentrically disposed filaments, the "pericarpium proprium," from whose filaments radiating "nutritive" filaments pass into the groups of spores (from gonimoblastic lobes) and join the nutritive filaments surrounding each of them (see figure 2). The pericarpium proprium arises from the inner cortex. The cystocarps form rather to one surface or the other of the frond, enlarging to become almost central at maturity and causing the surfaces of the frond to bulge out slightly and almost equally on both surfaces. The large, densely filled auxiliary cells ("Tragzelfen") are shown in many of the immature cystocarps of the sections from the type material and in very characteristic fashion (cf. Kylin, "Anat. d. Rhodophyc.," figure 210A (1937)).

The cystocarpic type of *Iridophycus cordatum* (Turner) Setchell et Gardner (*Proc. Nat. Acad. Sci.,* 23, 170 (Mar., 1937)) seems clearly established from the Menzies specimens in the Herbarium of the Royal Botanic Garden of Edinburgh. Its salient points are the distinct stipe, equally distinct broadly cuneate apophysis, the flaring, more or less shallow cordate base of the ovate blade with smooth but undulate margins, and the regularly and thickly scattered small cystocarps of uniform and small diameter. Added to this, the blade is only moderately thick and of a brownish purple color, becoming opaque and blackish on drying. Examining sections of dried material (cut by the freezing method in 70 parts of glacial acetic acid to 30 of water and mounted in "Karo," so as to prevent undue swelling), the medullary layer shows 3–4 (?) moderately slender filaments with usually a parallel course although anastomosing into an elongated and irregular reticulum with many free endings as seen in the thicker sections or on crushing. If only a little more water is added the sections enlarge very considerably and even become disorganized, as is the case with other species of the genus and even with most Gigartineae. The cortices are also reasonably distinctive, consisting of a few layers of larger, widely separated cells of the inner cortex and an outer cortex of about 6 cells in each anticlinal row. The cystocarpic portions of the fronds bulge slightly on both surfaces and the flattened, bluntly lenticular cystocarp has a distinct pericarpium proprium.

Studies of various plants, particularly those collected from the general Puget Sound region and northward, for occurrences of *Fucus cordatus* have been made with the following results: (1) no specimens from south of Cape Flattery; (2) a number of specimens from the west coast of Whidbey Island, Wash., collected by N. L. Gardner, which agree within fair limits; (3) some young specimens from Table and Calvert Islands, B. C., collected by T. T. and E. R. McCabe, which are in the general distribu-
tional area of Banks Island, B. C.; and (4) two specimens collected by John Macoun on Vancouver Island, B. C., without special data, but judging from Macoun's correspondence, probably in the neighborhood of Ucluelet on the west coast area about May, 1909. None of these various specimens is mature cystocarpic, but several are young or mature tetrasporic, while some may possibly be young antheridial. The lack of additional mature cystocarpic specimens (the type specimen being cystocarpic) for exact comparison and since tetrasporic plants of species of *Iridophycus* differ from cystocarpic especially in details of thickness and difference of histologic details due to the usually prominent tetrasporogenic layer, make the lack of any additional specimens from the exact type locality unfortunate.

Since both cystocarpic and tetrasporic plants are necessary to understand a species, it has seemed reasonable to assume that the tetrasporic generation is represented by such plants as were included by N. L. Gardner under his No. 58, cast ashore on the western shores of Whidbey Island, Wash. (Herb. Univ. Calif. Nos. 464012, 547647, 547648). Another mature tetrasporic plant is No. 72 of John Macoun, probably collected at or near Ucluelet, on the west or ocean side of Vancouver Island in 1909. All of these plants agree in general habit with the type specimen (cystocarpic) but differ in minor details of gross and naturally, of microscopic anatomy. They vary up to about twice the length of the type and in one at least the blade is very broad. The blade varies from a moderate flare above the apophysis to shallow cordate, while the tip is shallowly to fairly deeply and broadly lobed into two to three divisions. None is cleft to (or through) the apophysis. The color of the mature fruited plants is deep claret to almost black in the dried specimens.

The stipe is comparatively long (1.2–1.5 cm.) and about 1.5 mm. thick, cylindrical at the very base, compressed above. The apophysis is distinct, broad cuneate, 1–2 cm. long and about 2 cm. broad above. The blade flares suddenly and with a shallow cordate to reniform base. A similar habit, to a certain degree at least, is to be found in *I. coriaceum* S. et G., *I. splendens* S. et G., *I. lineare* S. et G., *I. whidbeyanum* S. et G., *I. fulgens* S. et G. and *I. sinicola* S. et G., but the coarse, crowded, short and irregular segments of the medulla of the blades of these species easily distinguish them, as well as minor differences in stipe, apophysis and blade. The nearest approach to *I. cordatum* (Turn.) S. et G. is *I. flaccidum* S. et G., but there are differences in color, stipe, apophysis, thickness and medullary structure sufficient to separate characteristic plants of this species although, at times, there may be difficulty in placing young or sterile specimens.

Tetrasori in the plants selected as typical (N. L. Gardner No. 58, as indicated above) are very thickly and regularly scattered over the whole
blade (at maturity) except that portion of it immediately above the apophysis. In more translucent dried specimens they appear as fairly uniform, small, dark, circular to elongated-oblont patches, on both surfaces, each of which is slightly elevated above such sori as occur directly beneath it. The mature sori are separated from one another by intervals less than that of their own diameters. In cross-section the tetrasporic plants show the same type and thickness of medulla as found in the cystocarp type plant, but differ, as do all the tetrasporic plants of the genus *Iridophycus*, in details of the outer and inner cortices. The outer cortex of the tetrasporic plant differs from that of the cystocarpic plant in having the terminal cells of the anticlinal rows more regularly in pairs and somewhat to very considerably elongated, a matter of only occasional occurrence in cystocarpic plants, and giving their cortices a decidedly different aspect. The most modifying difference between cystocarpic and tetrasporic plants, however, is in the voluminous development of the tissue between the medulla (proper) and the outer cortex (proper), since as in all the species of *Iridophycus*, this “inner cortex,” not very distinctly set off from the “outer cortex” in the sterile, antheridal and cystocarpic plants, increases in thickness, and through the multiplication of cells forming a complex of elongated and connecting filaments between the medullary segments on the one side and the anticlinal rows of the cortex on the other, a definite sporogenic tissue is formed up to about 100 μ to 150 μ in thickness (on each side). In this tetrasporogenic plexus, the intercalary cells enlarge, multiply, pull away from one another and form finally the tetrasporangial mother cells, from which by division at right angles the tetraspores are formed. The tetrasporangia are thus intercalary or interstitial as to origin, but are “accessory” in the sense that they occur as a multiplication of cells of the inner cortex (not of the outer cortex or of the medulla) into a distinct tetrasporogenic tissue.

As may be understood from the statement of the intercalation of a distinct and relatively thick tetrasporogenic tissue on each side of the medulla, the thickness of a fertile (or even immature) tetrasporic plant will greatly exceed that of the sterile portions of the cystocarpic plant. While the sterile portions of a tetrasporic plant may be little over 250 μ as in the cystocarpic plant, the thickness of the greater part of a tetrasporic plant (according to stages toward maturity) may increase up to 685 μ or less. In such a section the medulla accounts for about 63 μ of the thickness and each of the outer cortices for about the same, while each tetrasporogenic tissue, in sterile portions of the blade only about 20–25 μ as an inner cortex, has become 150–200 μ thick, according to its maturity. The tetrasporogenic layers are not absolutely continuous, but slight breaks may occur in them.

The sori are distinct, flattened spheroid, usually about 60–65 μ in
vertical diameter at maturity and vary in their horizontal diameter from about the same up to 625 µ and (exceptionally) even up to 1000 µ. They impinge upon the true medulla inwardly and upon the outer cortex outwardly, and cause bulges, above each, of the outer cortex. The tetrasporangia are somewhat variable in size, elongated ellipsoid, about 28 X 14 µ divided cruciately into the 4 tetraspores.

Summary.—It has seemed best to consider the Fucus cordatus Turn. in sufficient detail to make clear its nature, since it has been regarded as:

1. The morphological and even the taxonomic type of the genus Iridaea of Bory;
2. The species of widest distribution through Pacific North and South America and even South Africa;
3. A species whose type specimen had been lost, until the discovery of the Menzies specimen in Herb. Edinburgh.

With the discovery of that type and the realization that there were somewhere about 30 species of Iridophycus segregated in at least 4 distinct sections (or subgenera?), the necessity for some exact knowledge of the nature and distribution of Fucus cordatus Turn. became imperative. There results from this study, not only of the cystocarpic type specimen but also of the tetrasporic plants seemingly undoubtedly to be referred to it, the following:

1. That it has a distinct, relatively long stipe;
2. That its apophysis is broad cuneiform, distinctly set off from both the stipe below and the blade above;
3. That the blade is rather broadly cordate, with some variation as to flare at the base;
4. That the tip is broadly and obtusely pointed, either entire or 2–3-lobed;
5. That it belongs to the group of larger species of Iridophycus;
6. That its medullary tissue is of slender filaments, anastomosing into an irregular reticulum, and to be distinguished by this from species of similar aspect whose medullary filaments are coarse, short articulate and not forming apparent reticula;
7. That the tetrasporogenic inner cortex is highly developed in the tetrasporic plant, as in other species of Iridophycus where this tissue is continuous;
8. That both the mature and the immature cystocarps are typical of Iridophycus;
9. That its distribution is most probably confined to the shores of northwestern North America, not having been found south of the Straits of Juan de Fuca, and certainly bearing no relation to the South American or South African species earlier considered identical with it.