The species of Avrainvilleas hitherto found on the shores of the Danish West Indies.

By

Frederik Börgesen.

(With Tab. III.)

This paper is based upon material collected during my last visit to the islands in 1905—06. The specimens brought home have for the most part been dried but a good deal also have been preserved in spirit or formalin.

At first it had been my intention to work out all my material of the *Codiaceæ* but as Mrs. and Mr. Gepp in London have informed me that they are working out a monograph of this family I have preferred to put off my examination of this group until their paper has appeared.

I want to bring my best thanks to Mrs. and Mr. Gepp for valuable information as to the Avrainvilleas, received not only personally during a visit to London last autumn but also by letter later on.

I am also highly indebted to Dr. Ed. Bornet in Paris, who has most kindly sent to me original specimens of Crouan's Herb. to be found in Herb. Thuret.

The Genus *Avrainvillea* was founded by Decaisne on a specimen from Iles des Saintes, near Guadeloupe in his paper: "Sur les Corallines ou Polypiers calcifères" (Annales des sciences naturelles, Botanique, II. sér., tome 18, 1842, p. 108). He describes here the species *Avrainvillea nigricans*.

Later on, several species were described, partly really new partly also forms which had already been described. By reason of this and also from the fact that the same species has been referred to different genera, the nomenclature has been highly entangled and the attempts which have been made to correct this failure have for the most part been far from successful. In this connection I may mention the paper by Murray and Boodle: "A systematic and structural account of the genus Avrainvillea Decne." (Journal of Botany, Vol. 29, London 1889, p. 67), where not only the definition of species but also the nomenclature for the most part is highly unsatisfactory. Howe has in a recently published paper: "Phycological Studies — III. Further notes on Halimeda and Avrainvillea" (Bulletin of the Torrey Botanical Club, vol. 34, 1907, pag. 491) tried to bring clearness in this disorder. Even if his paper shows a great progress I cannot agree with him in all points. Later on I shall come back to this matter.

In the Danish West Indies I have only found this genus in deeper water, for the most part in about 20—30 meters, while in other places e. g. at Jamaica it also occurs in quite shallow water as I have myself seen.

Avrainvillea Decaisne.

Avrainvillea comosa (Bail. et Harv.) Murray et Boodle.

Murray, G. and L. A. Bodle, A systematic and structural account of the genus Avrainvillea Decne (Journal of Botany, vol. XXVII, 1889, p. 71). *Chlorodesmis comosa* Bail. et Harv. in Harvey, Nereis Boreali-Americana, Part III, 1858, p. 29.

Only one specimen was found which I refer, not without doubt, to this species, my plant being somewhat different from the specimens I have seen from the eastern hemisphere.

The plant had no stipe; it was of a dark yellow-green colour and consisted of a large tuft of intertwined filaments about 6—8 cm. high. It was of a very loose consistency, the filaments being for the most part free; it was fastened to the bottom by means of

rhizoids (Fig. 1 *f*) which grew out from the lowest part of the filaments and attached themselves to sand and gravel. The filaments were not very richly branched and above the dichotomy there was usually no constriction or it was only present in one of the filaments (cfr. Fig. 1 *a*, *b*, *c*, *d*, *e*). The thickness of the filaments was about 140 μ. The filaments were thin-walled; small spindle-shaped

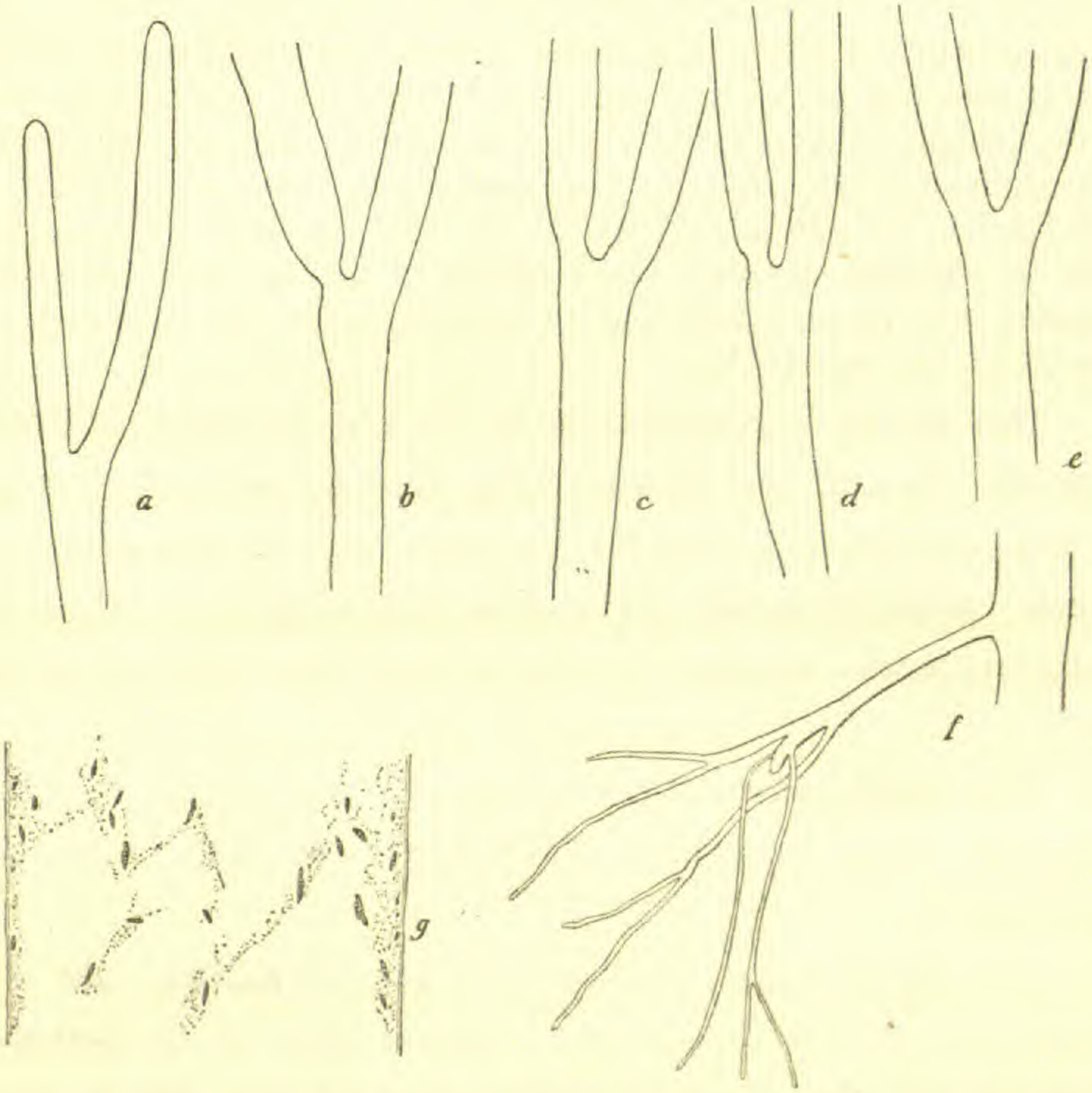

Fig. 1. *Avrainvillea comosa* (Bail. et Harv.) Murray et Boodle. Compare text. *a*—*f* about $^{20}/_{1}$; *g* about $^{170}/_{1}$.

chromatophores occurred in the wall-plasma (Fig. 1 *g*); in these I have not seen pyrenoids nor have I found amylum.

The plant was found: St. Jan, off America Hill in the sea to the west of Tatch Island near Tortola in about 30 meters of water.

My plant differs from specimens of the Eastern Hemisphere which I have seen by having lesser branched filaments, by having

the filaments only rather seldom constricted above the dichotomy and by its thin walls. But it seems to me that these differences may very possibly be ascribed to the rather great depth at which the plant was found.

Avrainvillea nigricans Decaisne.

Decaisne, Sur les Corallines etc. (l. c. p. 108). Howe, Phycological Studies III (l. c. p. 508). *Avr. nigricans* Decsne., Murray and Boodle l. c. p. 70, the specimens from "Iles des Saintes prope la Guadeloupe, d'Avrainville". *Avr. longicaulis* Murray and Boodle, l. c. excluding syn. *Rhipilia longicaulis* Kütz. *Avr. sordida* Murray and Boodle, l. c. at all events the Nr. 174 bis, which I have been able to examine through the kindness of Dr. Bornet and which contains only rather small, but to be sure, quite characteristic specimens of this species[1]).

This species is characterized by its very regularly moniliform filaments, those of the interior being thicker, more often varying to both sides of 50 μ (Fig. 2 *b*, *c*); while those of the surface grow thinner, about 30 μ and get shorter links (Fig. 2 *a*). These filaments are woven together forming a very loose and open cortical layer.

The chromatophores are spindleshaped and contain a pyrenoid (Fig. 2 *c*); much amylum is to be found, especially in the older filaments.

Avr. nigricans has a rather heterogeneous habitus. The stipe, which takes its rise from a terete rhizome lying on the bottom, is terete, though often flattened in the uppermost part, passing evenly into the flabellum; the stipe can be 10—15 cm. long and even more, or quite short. The shape of the flabellum also varies much. It can be transverse, oval or reniform, often with cordate or cuneiform base, with the margin entire, or more or less lacerated, or even lobed. Most commonly it is not at all zonate, but specimens also occur which are very clearly zonate.

On account of the very loose texture of the flabellum *Avr.*

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[1]) As Dr. A. Gepp most kindly informs me only the Nr. 30 of Mazé, Algues de Guadeloupe is the type of *Avr. sordida* Crn.

nigricans is rather easily recognized, as the light is seen through the leaf when kept against the window.

Avr. longicaulis is the most common species of the Avrainvilleas in the Danish West Indies, where it occurs in deeper water at a depth of about 20—30 meters.

It has been found hitherto: at St. Thomas in the sea west

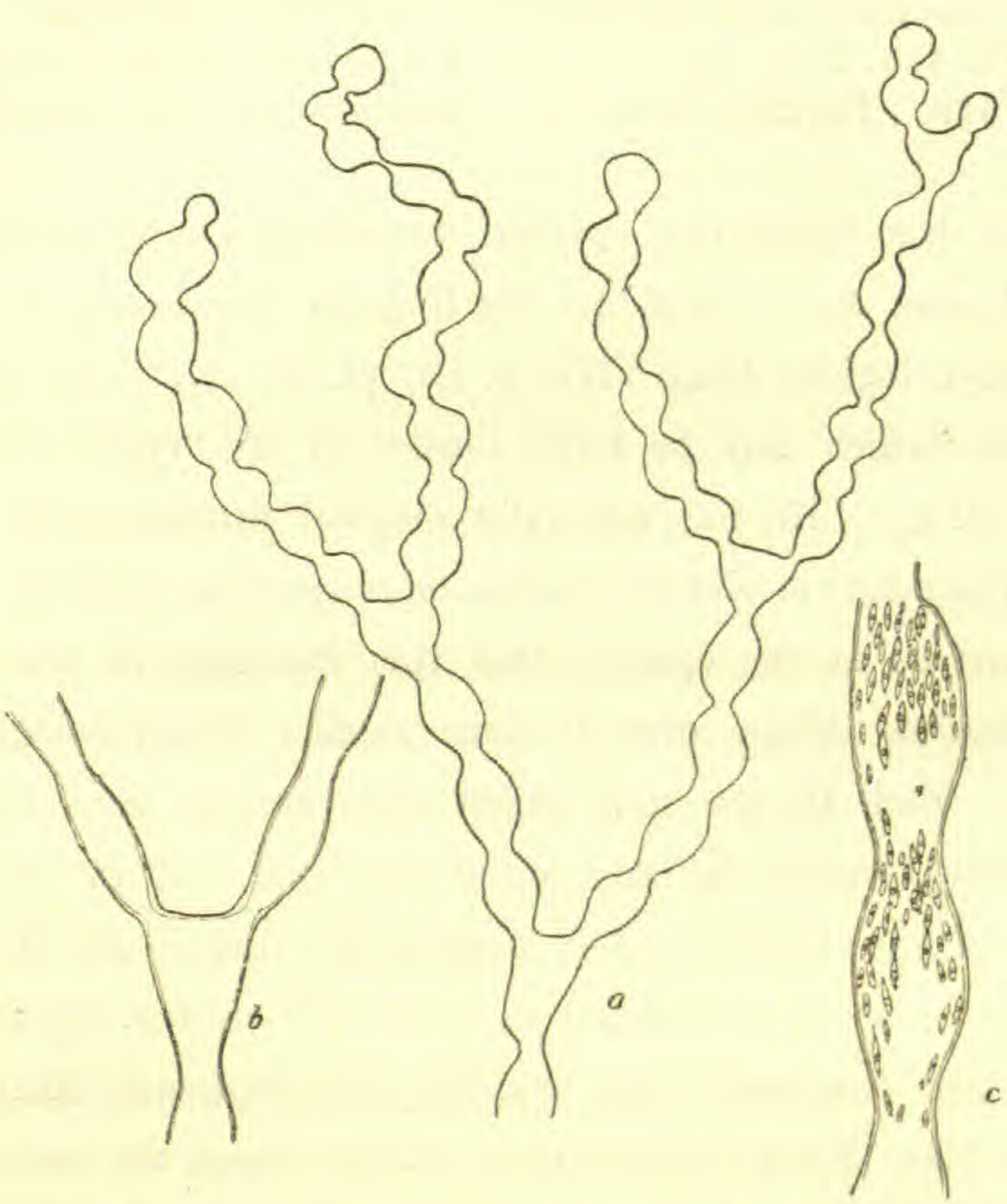


Fig. 2. *Avrainvillea nigricans* Decaisne.
Compare text. *a*, *b* about $^{70}/_{1}$; *c* about $^{170}/_{1}$.

of Water Island; St. Jan in the sound between St. Thomas and St. Jan off Christiansfort, and near the Gt. St. James Isle.

This species has already been found at St. Thomas by the Challenger-Expedition; Murray and Boodle have called it *Avr. longicaulis* (Murray and Boodle l. c. p. 70). At my request Mr. Gepp has kindly examined the specimen to be found in the British Museum and writes to me as follow: "The St. Thomas "Challenger" speci-

men of *Avr. longicaulis* Murray and Boodle has moniliform filaments measuring 30—70 μ in diameter which is M. A. Howe's definition of *Avr. nigricans* Decsn. It certainly is not *Avr. Rawsoni* M. A. Howe."

Avrainvillea Mazei Murray and Boodle.

G. Murray and L. A. Boodle, A systematic and structural account of the genus Avrainvillea Decsne (Journal of Botany, vol. 27, 1889, p. 70, tab. 288, fig. 6). *Avr. longicaulis* Howe, Phycological Studies — III. Further Notes on Halimeda and Avrainvillea (l. c. p. 509).

Howe has called this species *Avrainvillea longicaulis* (Kütz.) Murr. & Boodle, as he considers the *Rhipilia longicaulis* of Kützing (Tabulae phycologicae Band VIII, p. 13, pl. 28, fig. 2) as being this species and "which may be fairly considered the "type" of the new binomial" (l. c.). He has also (Phycological Studies — II, p. 586) examined fragments of Kützing's *Rhipilia longicaulis* in Herb. Sonder and has arrived at the opinion that this specimen is the same as the *Avrainvillea Mazei* even if some smaller disagreements are to be found. Had Howe now called this species *Avr. longicaulis* (Kütz.) Howe I might perhaps agree with him but in referring it to Murray's and Boodle's *Avr. longicaulis*, which, as Howe has pointed out, is to be considered as a mixture of *Avr. nigricans* (the diagnosis) and *longicaulis* (the syn. *Rhipilia longicaulis* Kütz.) I can not follow him. Howe writes (l. c. p. 510) about the matter: "The maintenance of the binomial *Avrainvillea longicaulis* for the present species and the crediting of the name to Murray and Boodle are both, we believe, technically correct, even though it may prove a source of some confusion for a time, in as much as Murray and Boodle evidently intended that another species — the true *A. nigricans* Decaisne — should bear Kützing's name *longicaulis*. But as Murray and Boodle, in proposing the new combination *Avrainvillea longicaulis* cited Kützing's *Rhipilia longicaulis* it cannot be denied that this new combination applies also to Kützing's species and that it applies to it in a peculiar and typical way."

In my opinion the confusion which Murray and Boodle have brought into the Avrainvilleas by this is made much more hopeless. It seems to me that neither the diagnosis of Kützing (l. c. p. 13) nor his figure may be said to give any particularly good characteristic of *Avr. longicaulis* in the sense of Howe. As on the other hand we have in the diagnosis of Murray and Boodle's new species *Avr. Mazei* a comparatively good description, in which they just point out the chief characteristic for this species viz: the cylindric filaments, and they further give a good figure

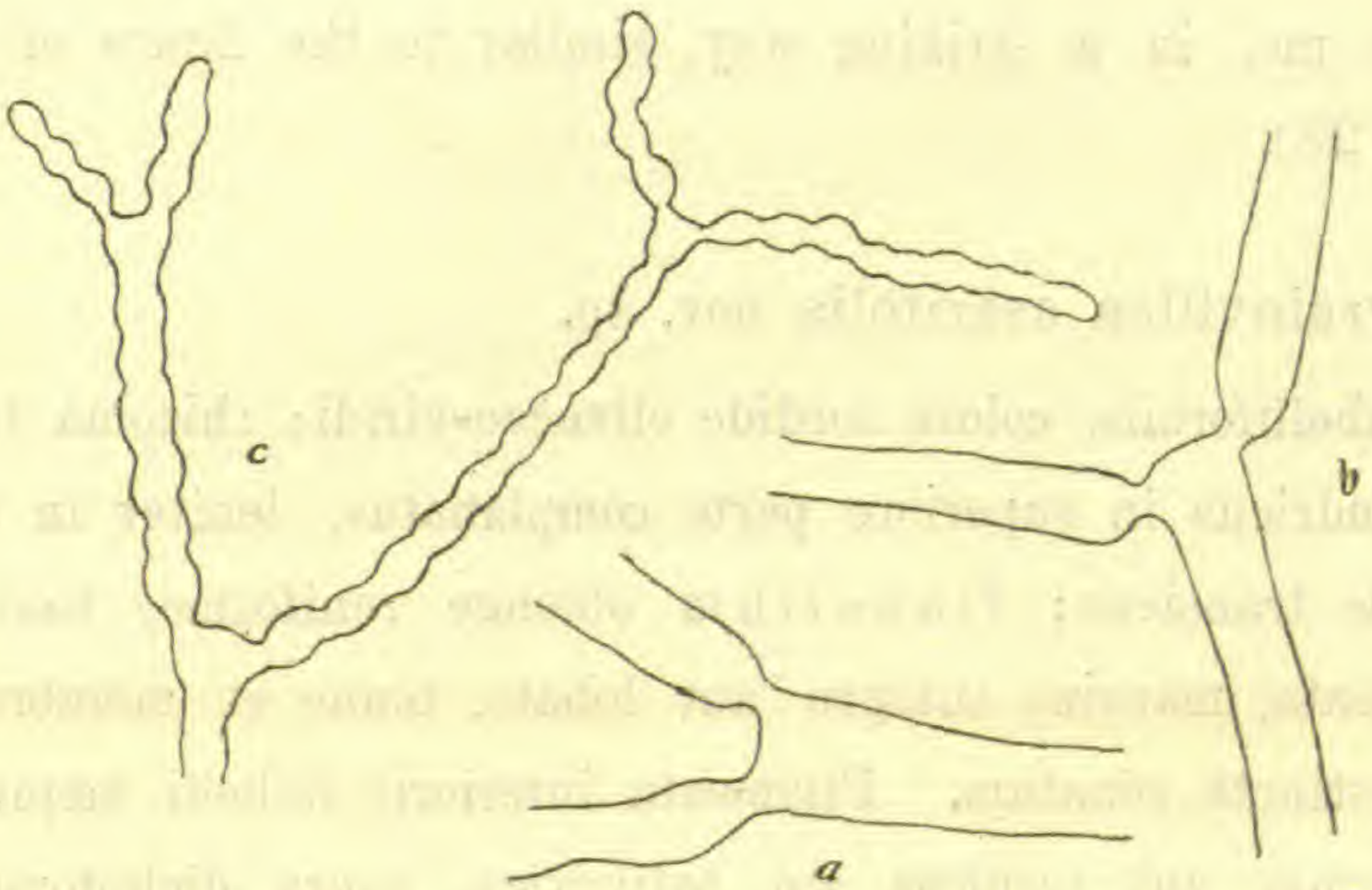


Fig. 3. *Avrainvillea Mazei* Murray and Boodle. Forma.
Compare text. *a*, *b*, *c* about $^{70}/_{1}$.

(l. c. tab. 288, fig. 6) of a part of a filament, it seems to me the only correct course to use their name of this species.

I shall also point out that I have been able through the kindness of Dr. Bornet to see the Nr. 65 of Mazé et Schramm's Algues of Guadeloupe quoted by Murray and Boodle and which is a well-developed specimen of this species.

On the shores of the Danish West Indies I have only found a single, small, but quite typical specimen of this species. The stipe is about 3 cm. long; the breadth of flabellum 7 cm. The filaments agree very well with the figure of Murray and Boodle and with Howe's description; they are about 50 μ thick, cylindric and strongly constricted above the dichotomy.

While this specimen as mentioned above is quite typical I have, yet with some doubt, referred another specimen (my collections Nr. 1106) to this species (Fig. 3). The specimen in question is large, the stipe being about 20 cm. long and the flabellum 8 cm. high and 11 cm. broad; the margin of the flabellum is irregularly lobed. The filaments of the interior of the flabellum are cylindric (Fig. 3 *a*, *b*), about 50 μ thick, those of the surface thin, about 20 μ and rather torulose or sometimes even moliniform (Fig. 3 *c*). Howe gives the diameter of the filaments as 28—70 μ and writes about the filaments: "rarely here and there subtorulose". This plant seems to me, in a striking way, similar to the figure of Kützing (l. c. pl. 28).

Avrainvillea asarifolia nov. sp.

Flabelliformis, colore sordide olivaceo-viridi; rhizoma teres, stipes cylindricus in superiore parte complanatus, leniter in flabellum terminale transiens; flabellum oblonge reniforme, basi cordata aut cuneata, margine integro aut lobato, tenue et membranaceum, satis distincte zonatum. Filamenta interioris flabelli sæpius paullo moniliformia aut torulosa aut cylindrica, supra dichotomiam constricta. Latitudo filamentorum 20—30 μ, sæpius 24—27 μ. Filamenta superficiei tenuiora, torulosiora magisque ramosa et inter se plexa, latitudo 8—10—13 μ, apice filamentorum interdum in pilum elongato [Tab. nostr. III].

Dark-olive-green or sometimes greyish when dried; most probably of a similar colour when living; rhizome terete; stipe cylindric, in the lower part more flattened, higher up 6—23 cm. long, about 7 mm. in diameter; flabellum oblong-reniform with cordate base or especially in older specimens with more or less cunate base until about 10 cm. high and 14 cm. broad, entire or lobed, thin and membranaceous, of a rather firm consistency, being for the most part rather clearly zonate; the surface subglabrous, under a lens fine granulated. Filaments in the interior of the flabellum cylindric or often slightly moniliform or torulose with a rather

strong constriction just above the dichotomy (Fig. 4 *a*, *b*). The diameter of the filaments about 20—30 μ, more often reaching only 24—27 μ. Near the surface the filaments grow gradually slender, becoming more and more torulose and more richly ramified (Fig. 4 *c*, *d*), woven together, forming a rather firm but yet open plectenchyma

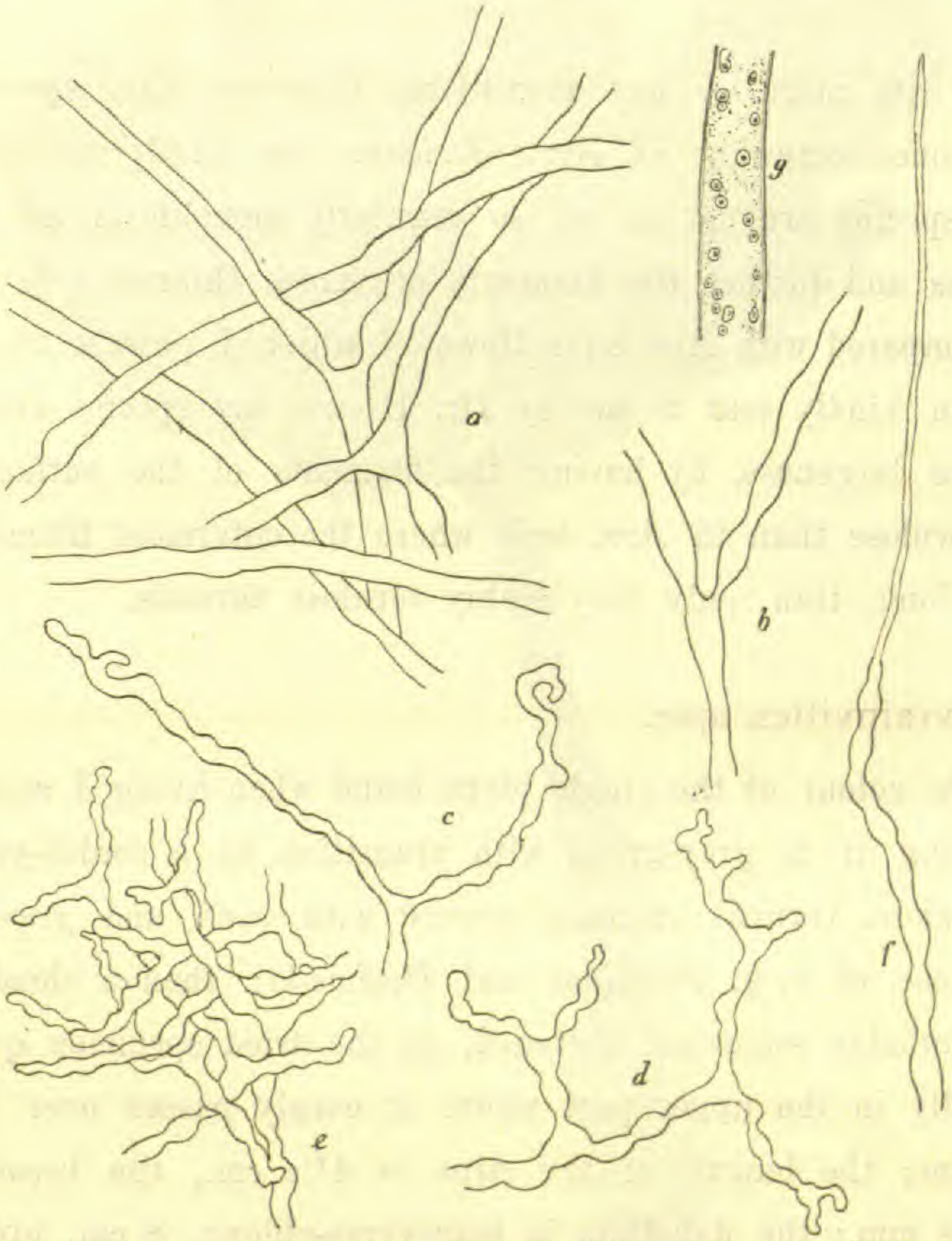


Fig. 4. *Avrainvillea asarifolia* nov. sp.
Compare text. *a*—*f* about $^{70}/_{1}$; *g* about $^{170}/_{1}$.

(Fig. 4 *e*); the diameter of the outermost filaments varies from 8—10—13 μ; the walls here in the outermost filaments are rather thick, thicker than those of the filaments in the middle of the flabellum. Sometimes the apex of the filaments runs out in long hairs (Fig. 4 *f*). (Tab. III).

The chromatophores are roundish or oblong and contain a

pyrenoid (Fig. 4 *g*); in older filaments especially quantities of amylum are to be found.

This species is found at St. Thomas: in the sea to the west of Water Island at a depth of about 20 meter; St. Jan: off Christiansfort in about 30 meter of water, and near the isle Gt. St. James in the sound between St. Thomas and St. Jan at the same depth.

By its more or less moniliform filaments this species may remind one somewhat of *Avr. nigricans*, but firstly the filaments in my species are not at all so regularly monoliform as in *Avr. nigricans* and further the filaments are much thinner.

Compared with *Avr. levis* Howe of which I possess an original specimen kindly sent to me by Dr. Howe my species differs, besides its largeness, by having the filaments of the surface much more torulose than in *Avr. levis* where the outermost filaments run out in long, thin, only very feebly torulose threads.

Avrainvillea spec.

The colour of the single plant found when living I cannot tell, on drying it is grey-green with transition to a sordid-yellow; it has a short vertical rhizome covered with sand and gravel quite like those of e. g. *Penicillus* and *Halimeda*; then a slender stipe most probably somewhat flattened, on the dried specimen quite flat, especially in the upper part where it evenly passes over into the flabellum; the length of the stipe is $4^1/_2$ cm., the breadth only about 4 mm.; the flabellum is transverse-oblong, 8 cm. broad, $5^1/_2$ high, thin, of a rather loose consistency with a more or less lacerated or lobed margin; the surface is somewhat uneven.

Filaments in the interior of the flabellum (Fig. 6 *a, b, c*) cylindric or only very little torulose, about 30 μ in average diameter, only just below the dichotomy reaching 40 μ or even more, rather strongly constricted above the dichotomy and above the constriction in the thicker filaments often a single monoliform swelling; near the surface the filaments grow thinner (Fig. 6 *d, e*) becoming irregularly

torulose and often strongly constricted; sometimes only one of the branches is developed (cfr. Fig. 6 *e*). The thickness of these filaments is about 14—17 μ; the uttermost part of them often growing

Fig. 5. *Avrainvillea* spec. $^1/_1$.

thicker (19—25 μ). The chromatophores are spindle-shaped and contain a pyrenoid (fig. 6 *f*).

Only a single specimen was found, viz: St. Jan, Maho Bay, where it was growing in a depth of about 16 meters of water.

This plant I had at first referred to *Avr. levis* Howe (Phycological studies — II, Bulletin Torrey bot. Club, Vol. 32, p. 565) and

Mrs. Gepp to whom I showed my plant during a visit to London in October 1907 then agreed with me; later on after having seen an original specimen of *Avr. levis* Howe, I have some doubt if my plant really could be referred to this species; but having only one specimen and therefore not being able to form any opinion as to its capability of variation I have preferred to let it be undetermined. The chief characteristic of my plant is that the main filaments in

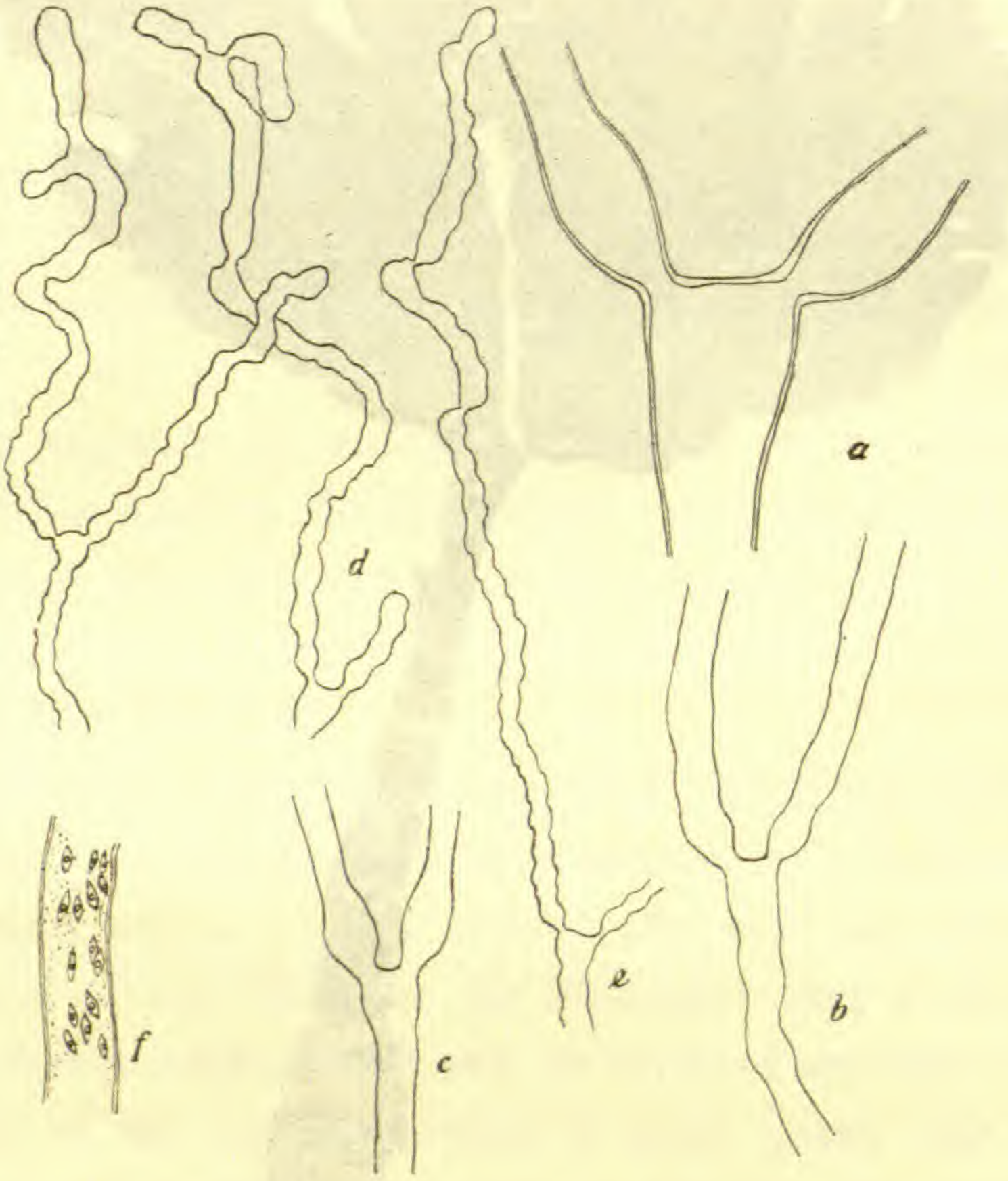


Fig. 6. *Avrainvillea* spec.
Compare text. *b*, *c*, *d*, *e* about $^{70}/_{1}$; *a* and *f* about $^{170}/_{1}$.

the middle of the flabellum are cylindric or only very little torulose; and further the increasing of the diameter of the outmost branches. Also the habitus of the plant is rather different from *A. levis*, my form being much larger, of a looser consistency and the flabellum with a lacerated and lobed margin.

In connection with the above-named species of Avrainvilleas I may also mention a peculiar plant which I first took for an *Avrainvillea* but later on have found may be like the *Flabellaria luteofusca* Crn., in Mazé et Schramm, Essai de Classification des Algues de la Guadeloupe, p. 88.

Through the great kindness of Dr. Bornet, in whose possession Herb. Thuret is and in which Herb. Crouan is incorporated, I have got for comparison with my plant the No. 1403 mentioned by Mazé et Schramm (l. c.) and which anatomically has shown itself quite to agree with my specimens. Murray (Catalogue of the marine Algæ of the West Indian Region, Journal of Botany vol. 27, p. 239) has referred this plant, though with a ?, to the genus *Udotea* and writes about it: "This very obscure form appears to me to be an imperfect state of an Udotea. Agardh, who had not seen a specimen (loc. cit. p. 76), says, "An potius *Avrainvillea* forma?" It is certainly not an *Avrainvillea* though it outwardly resembles one." Finally Howe in his latest paper: Phycological Studies — III p. 513, gives a description of this species, which in all essentials seems to agree well with my plant, even if it, in a few points, shows some differences.

I shall now firstly give a description of my plant. The single specimen found is preserved in formalin. Its colour is dark-green and most probably it has had nearly the same colour when living. The stipe (the rizome was wanting) is rather thin, about 4 mm. in diameter; it is cylindrical in the basal part, more flattened upward and passes evenly into the flabellum; the length of the stipe was in the present specimen 4 cm., between the stipe and the flabellum there was a broader flattened part on the side of which most probably side-branches have been present. The present flabellum is transversely suborbicular, 8 cm. broad and $5^1/_2$ cm. high, entire, only with a little lacerated margin rather thin and membranaceous, but of a rather thin texture reminding one of that in *Udotea*, the surface being rather dense and glabrous; it is distinctly zonate.

In the interior of the flabellum the filaments are cylindric or sometimes a little subtorulose, seldom even moniliform (Fig. 8 *a-d*); above the dichotomy, which is not so very typical, as one of the branches is most often somewhat thinner and placed to the side, just as sometimes filaments divided into three branches (Fig. 8 *e*)

Fig. 7. *Cladocephalus luteofuscus* (Crouan) Börgs. $^1/_1$.

occur, the filaments are less or not at all constricted; the thickness of these filaments varies from 60—70 μ or a little towards one of these. At the surface the filaments divide several times and grow here, rather suddenly, quite thin viz. 6—8 μ in diameter (Fig. 8 *f, g*). These thin, torulose, irregularly branched

and rhizoid-like ends of the filaments are rather firmly woven together and transformed to a dense and firm plectenchyma (Fig. 8 *h*),

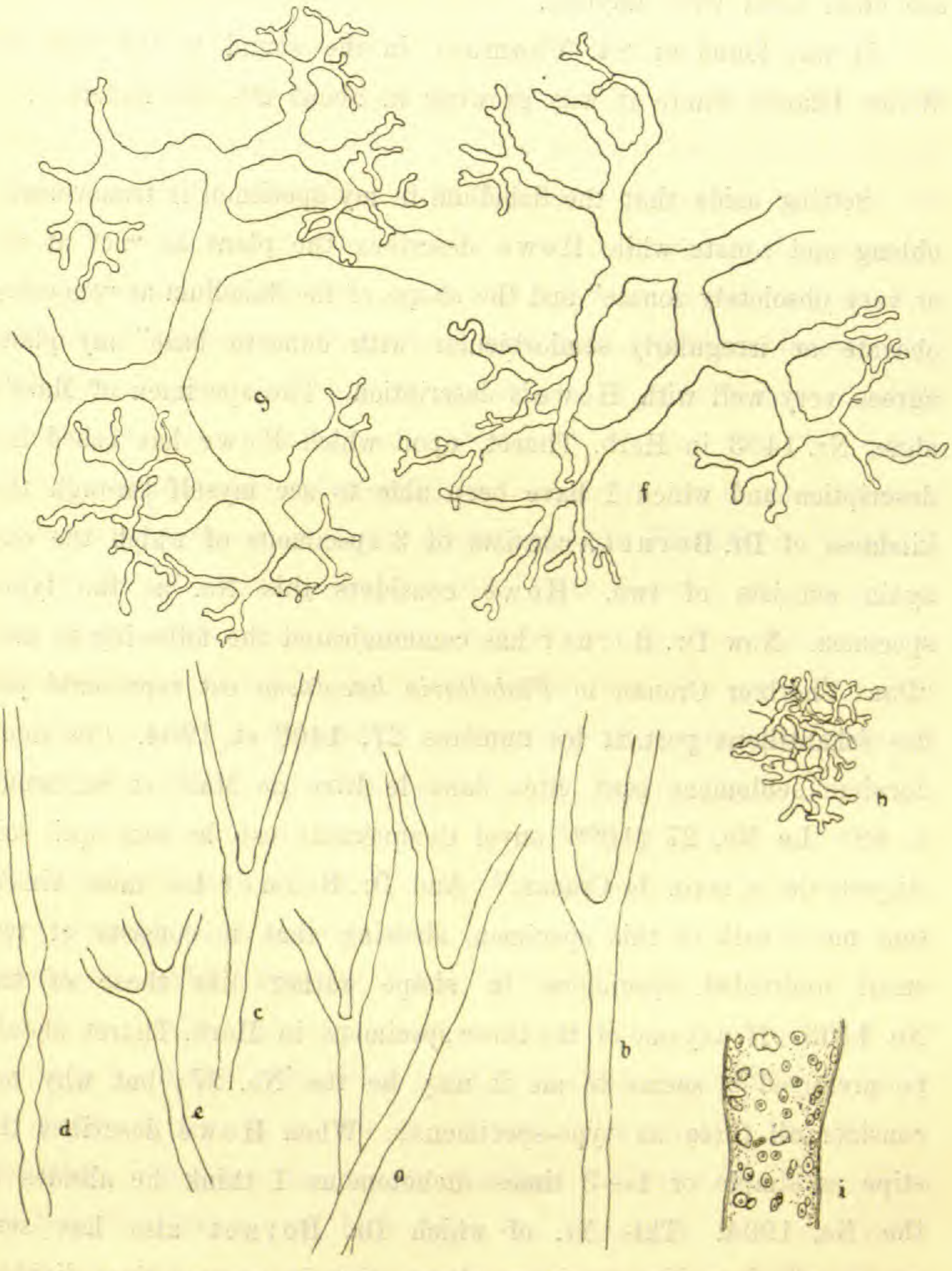


Fig. 8. *Cladocephalus luteofuscus* (Crouan) Börgs.
Compare text. *a*, *b*. *c*. *d*. *e* about $^{20}/_{1}$; *f*, *g*, *h* about $^{70}/_{1}$; *i* about $^{175}/_{1}$.

though not so dense but that numerous small openings are present between the filaments. The stipe has a very similar anatomy. The plant is uncalcified.

The chromatophores are roundish or oblong (Fig. 8 *i*), lying quite near the thin wall of the plant; they contain a pyrenoid and are often filled with amylum.

It was found at St. Thomas: in the sound to the west of Water Islands where it was growing in about 20—30 meters.

Setting aside that the flabellum in my specimen is transversely oblong and zonate while Howe describes the plant as "not at all or very obsoletely zonate" and the shape of the flabellum as "cuneate-obovate or irregularly semiorbicular with cuneate base" my plant agrees very well with Howe's description. The specimen of Mazé's algæ, Nr. 1403 in Herb. Thuret, upon which Howe has based his description and which I have been able to see myself through the kindness of Dr. Bornet, consists of 3 specimens of which the one again consists of two. Howe considers this No. as the type-specimen. Now Dr. Bornet has communicated the following to me: "Dans l'herbier Crouan le *Flabellaria luteofusca* est représenté par des échantillons portant les numéros 27, 1403 et 1904. Ces deux derniers seulement sont cités dans le livre de Mazé et Schramm, p. 88. Le No. 27 (10ème envoi Conquérant) est le seul qui soit étiqueté de la main de Crouan." And Dr. Bornet has most kindly sent me a calk of this specimen, showing that it consists of two small undivided specimens in shape rather like those of the No. 1403. If any one of the three specimens in Herb. Thuret should be preferred it seems to me it may be the No. 27; but why not consider all three as type-specimens? When Howe describes the stipe as simple or 1—3 times dichotomous I think he alludes to the No. 1904. This Nr. of which Dr. Bornet also has sent me a calk is a big specimen whose stipe is several time divided, bearing five flabella, these being nearly obovate with cuneate base and in the uppermost part more or less lacerated. In the British Museum another specimen of this number is present. Dr. A. Gepp has most kindly sent a calk to me; it consists of two plants which also have the stipes branched, the one with three

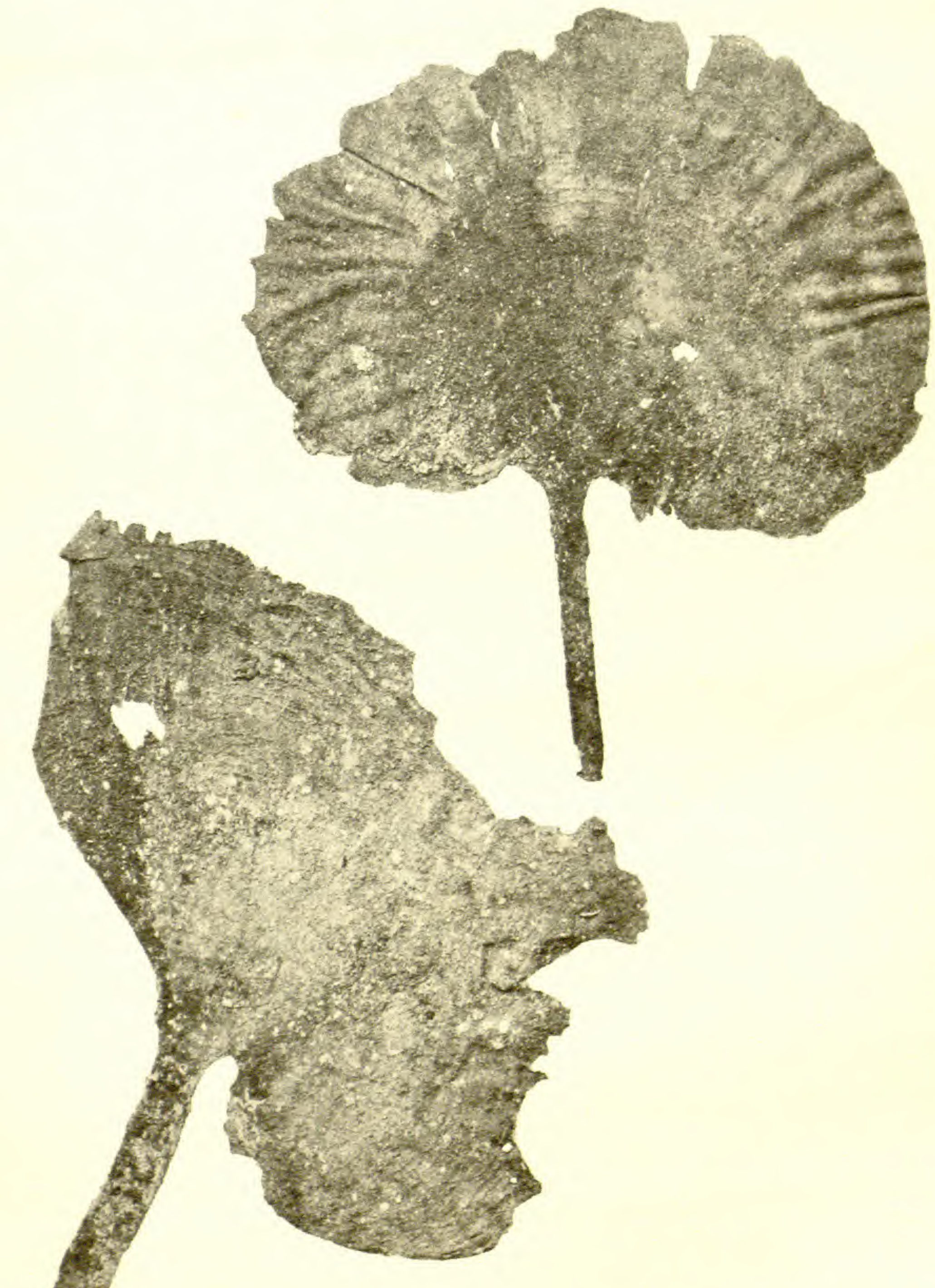
the other with five flabella. It follows from this that the plant is rather polymorph.

In the Bulletin of the Torrey Botanical Club, vol. 32, 1905, p. 569 Howe has described a new genus *Cladocephalus* represented by one species viz. *Cl. scoparius*. As to the related forms of this genus Howe writes as follows: "The genus *Cladocephalus*, though having a slight superficial resemblance to *Penicillus* in habit and form, is most nearly allied to *Avrainvillea*, being in some respects intermediate between that genus and *Udotea*. It differs from both genera in having a thamnioid or scopiform capitulum instead of a flabellum." Having examined specimens of this plant, of which Howe has most kindly sent specimens of his type No. 4079, I have found that *Cladocephalus scoparius* as to its anatomy competely agrees with my plant and with *Flabellaria luteofusca* Crouan at all events with Nr. 1403. It is therefore the habitus of the plant only which could maintain the generic difference of Howe's plant from Crouan's and mine, and the question arises if this really is justified. Ultimately this question may of course be settled by investigations in nature itself, to decide about this finally my material is too scanty. But referring to Howe's figure as well as to original specimens, it seems to me very probable that Howe's plant is only to be considered as a form developed under peculiar, most probably unfavourable external conditions of life. Howe writes namely as to the growing-place for his type No. 4079: "Rare and local in the Bahama Islands, on sandy or muddy bottom in 2—10 dm. of water (low-tide)." And further, he adds: "Besides the single specimen collected on the shores of New Providence, we have thus far met with this remarkable plant on only one occasion, when several hundreds were growing associated with two species of *Penicillus* in a small area in an inland pond which had been connected with the sea by an artificial canal." Ponds like these often occur also in the Danish West Indies, where the water is shallow, often dirty, and cloudy and more or less brackish. In such localities the algæ are often seen

above the surface of the sea when unusually low water occurs and such low water needs not to be of long duration in the tropics to cause the parts of the algæ which reach over the sea to be burnt and killed by the sun. And it is just under such conditions that I think Howe's plants have been living. If we suppose that the flabellum has been killed nearly down to the stipe, and the water has later been rippling over the plants, it seems to me very probable that the lowest part of the flabellum and the uppermost part of the stipe may have been shredded into more or less tatters and threads such as we find in *Cladocephalus scoparius*.

However this may be the question at all events arises what the name of my plant should be. As already pointed out, my plant has several points in common with the genus *Avrainvillea* but it agrees also very much with *Udotea*, though not in such a way that it may naturally be placed in any of these genera. The most natural thing would surely be to refer it to a special genus and as my plant, setting aside the outer habit, quite agrees with Howe's genus *Cladocephalus* I think it right to refer it to this genus; the species-name on the other hand may be *luteofusca* Crouan, my plant as mentioned above agreeing quite well with this species. The name of the plant must therefore in my opinion be *Cladocephalus luteofuscus* (Crouan) Börgs.

June 1908.



Avrainvillea asarifolia nov. spec. About $^{3}/_{4}$: 1.