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STUDIES ON THE MARINE ALGAE OF SOUTHERN AUSTRALIA

INTRODUCTION AND
No. 1 THE GENERA ISACTIS AND RIVULARIA (MYXOPHYCEAE)

By H. B. S. WOMERSLEY, Department of Botany, University of Adelaide

[*From "Transactions of the Royal Society of South Australia," vol. 70, (2) 1946*]

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[Read 9 May 1946]

INTRODUCTION

The history of Phycology in Australia is one of an enthusiastic beginning during the years 1840-1890, when numerous collections from the Southern Australian region (including Tasmania) were sent to Europe and described by workers of that time. During this period a considerable proportion of the Australian species was described, chiefly by W. H. Harvey, J. G. Agardh, W. Sonder, T. Reinbold and others, and it is on the work of these men that present-day phycology in Australia is based. A. H. S. Lucas, who was the only Australian worker between 1910 and 1936, has given a more detailed survey of the early work (Seaweeds of South Australia, Pt. I), as also has V. May (Journal of the C.S.I.R., **18**, No. 1, 62).

For Australian students taking up the study of marine algae this history has certain unfortunate results. The type specimens of most of the species described before 1900 are in Europe (with the exception of those of W. H. Harvey, of which numerous cotypes are present in the Melbourne and Sydney National Herbaria), and not available to Australian workers. This means that determination of species must, in many instances, be based on descriptions alone. Apart from the works of W. H. Harvey, which were usually well illustrated, most authors gave no figures; descriptions were usually inadequate and only in Latin, resulting in the utmost care being necessary to establish an identification today.

Since 1900, practically the only worker on Australian marine algae was A. H. S. Lucas, who published several papers in the Linnean Society of New South Wales, and wrote Part I and the first half of Part II of "The Seaweeds of South Australia." Since 1938 keys and notes on New South Wales algae have been published by V. May, and Part II of "The Seaweeds of South Australia" should be available by July 1946.

It is evident that at present scarcely a single species from Australian waters does not require a thorough study, and each genus needs detailed revision. In the past details of locality and occurrence have been generally inadequately given.

Although taxonomic studies are of first importance, extensive ecological surveys are needed, for it is such work that brings to light variations in form of many species and indicates how reliable certain taxonomic criteria may be. It is during such ecological studies that associations of economically important species are likely to be found.

This paper is the first of a series on marine algae from the Southern Australian coasts and deals with two genera of the Myxophyceae, family Rivulariaceae, which are common on rocky or tidal flat regions. The Myxophyceae as a whole have been left severely alone by previous workers, although many species are to be found around our coasts.

No. 1 THE GENERA ISACTIS AND RIVULARIA

These two genera belong to the family Rivulariaceae of the blue-green algae. The family is a natural one, distinguished by a combination of false branching and terminal hairs to the trichomes, and usually with heterocysts at the base of the filaments. Both freshwater and marine representatives of the family are common, and several marine species of *Calothrix* and *Lyngbya* occur in South Australian waters.

Genus Isactis Thuret 1875

Thuret, Essai Class. Nost., 1875, 376, 382; Bornet and Flahault, Rev. 1, 1886, 343; De Toni, Sylloge Algarum, 5, 646; Rabenhorst, Kryptogamen Flora, 14, 656; Setchell and Gardner, Marine Algae of Pacific Coast of N. America, 104; Newton, Handbook of British Seaweeds, 35.

Filaments erect, parallel, densely crowded and coalescent into a compact layer attached to the substratum, simple or sparsely branched; heterocysts basal; reproduction by spores unknown.

Isactis is a genus differing from *Rivularia* in its more simple trichomes which are crowded and parallel. This gives rise to flattened, more or less orbicular layers instead of hemispherical or more or less convex and lobed expansions.

Isactis plana (Harv.) Thuret

(Fig. 1, A)

Rivularia plana Harvey in Hooker, Brit. Fl., 1833, 2, (1), 394; *Isactis plana* (Harv.) Thuret in Essai, 1875, 382; Bornet and Thuret, Notes Algal. II, 1880, 163, pl. xl; Bornet and Flahault, Rev. II, 344; De Toni, Sylloge Algarum, 5, 646; Rabenhorst, Kryptogamen Flora, 14, 656; Setchell and Gardner, Marine Algae of Pacific coast of N. America, 104; Newton, British Seaweeds, 35.

Fronds 0·4 to 0·9 mm. thick, spread out indefinitely on the surface of rocks, but usually less than 2 cm. across, dark green; filaments densely crowded, mostly simple; trichomes 7-9·5 μ diameter, light blue-green, tapering into a delicate hair above when young; cells not to fairly deeply incised at cross walls, $\frac{1}{2}$ to 1 times as long as broad.

South Australian specimens seem to belong to the var. *plana* B. and F. in which the layer is not zonate, filaments unbranched or nearly so, cohering together.

Hog Bay (on rocks in littoral), Vivonne Bay (edge of rock pools, on mollusc *Cellana*), and Pennington Bay (on reef surface) on Kangaroo Island; Port Noarlunga (on reef in littoral); Port Willunga (on reef in upper littoral).

Atlantic, Mediterranean, coasts of Europe, North America. Apparently not previously recorded from Southern Hemisphere. Probably to be found anywhere in the Southern Australian region, at all times of the year.

The only noticeable difference from descriptions of Northern Hemisphere specimens is in the greater thickness of the frond (0·9 mm. against 0·5 mm).

Genus Rivularia C. Agardh 1812

C. Agardh, Disp. Alg. Suec., 1812, 43, Syn, Alg. Scand., 1817, p. xxxviii, 130-131; Syst. Alg., 1824, 19; Roth, Neue Beitr. z. Bot., 1803, 261; Cat. Bot., 3, 1806, 332; Bornet and Flahault, Rev. Nost. Het. I, 1886, 345; DeToni, Sylloge Algarum, 5, 648; Rabenhorst, Kryptogamen Flora, 14, 643; Setchell and Gardner, Marine Algae of Pacific coasts of N. America, 105; Newton, British Seaweeds, 38.

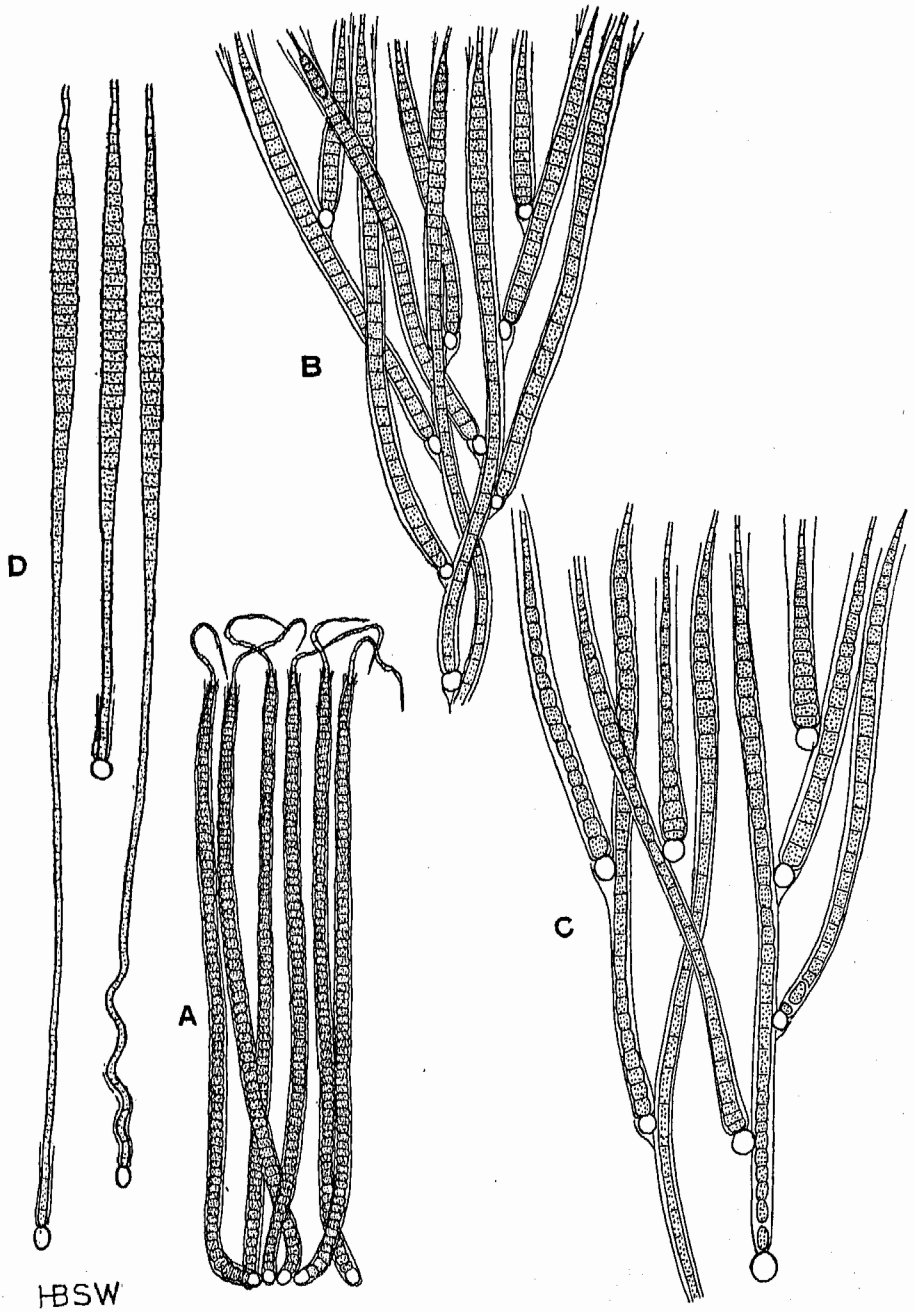

Fig. 1

A, *Isactis plana*, group of trichomes; B, *Rivularia atra*, group of trichomes with two hormogonia; C, *Rivularia nitida*, group of trichomes; D, *Rivularia australis*, three typical trichomes from one of Harvey's specimens.

Thallus hemispherical, globose or irregularly lobed, light to dark green, softly or firmly gelatinous, at times hollow, or confluent into a solid expanded stratum; filaments radiating from the centre or from the base, repeatedly false-branched;

heterocysts basal (or rarely intercalary), some species (sub-genus *Gloeotrichia*) producing cylindrical spores contiguous to the heterocyst.

In view of the presence of intercalary heterocysts, as described below in *R. firma, R. polyotis* and *R. australis,* the generic description must be modified slightly, as has been done above.

The species of *Rivularia* are far from satisfactory taxonomically, as considerable variations may be shown in different habitats. In placing any particular specimen, attention should be focussed on all the features used in separating the species rather than any single one. Five species can now be recorded from Southern Australia, of which one is described as new; the other four are considered specifically identical with widespread Northern Hemisphere forms which are probably cosmopolitan.

Staining with gentian violet is often necessary to distinguish details of the sheath. Sometimes if a firm colony is broken up a layer of mucilage may cling to the trichome and appear very similar to an individual sheath, staining faintly blue.

KEY TO THE SOUTHERN AUSTRALIAN SPECIES OF *Rivularia*

1	Intercalary heterocysts abundant, thallus very firm.	*R. firma* n. sp.	
1′	Intercalary heterocysts absent or rare, thallus either small or large and soft.		2
2	Thallus solid, hemispherical, less than 4 mm. across.	*R. atra*	
2′	Thallus hollow, expanded, globose or plicate corrugate.		3
3	Thallus dark olive green, plicate corrugate, usually less than 1 cm. across.	*R. nitida*	
3′	Thallus light green, hollow, soft.		4
4	Trichomes 5-7·5 μ thick, sheath thin.	*R. australis*	
4′	Trichomes 9-14 μ thick, sheath usually wide, lamellate.	*R. polyotis*	

Rivularia firma n. sp.

(Fig. 2, A and B)

Thallus caeruleus, hemisphericis, solidus, firmissime gelatinus, 2 cm. latus, copiae 5 cm. latae; corpus qui produci potest, lentus. Trichomatibus confertis, pressione non secendentibus, 2-3 μ latis inferne, superne 6-8·5 μ latis, in pilum attenuatis; vaginis angustis, hyalinis, superne indistinctis, totus in gelatinam amorpham confluens; cellulis superne diam. $\frac{1}{3}$-1 brevioribus, ad genicula contractis, cellulis inferioribus elongatis. Heterocystis basibus et intercalaribus; basis globosa, 10-18 μ diam.; intercalaribus usitatus copiosis, ovatis aut longis linearis, cum crasso muro, 4-8 μ latis, diam. 2-20 brevioribus; basibus heterocystis in concentrica zona dispositis.

Thallus dark blue-green, hemispherical, solid, very firmly gelatinous; individual plants to 2 cm. across, masses formed by union of several to 5 cm. across; substance elastic, not easily torn. Trichomes crowded, not separable by pressure, 2-3 μ thick near basal heterocyst, expanding upwards to 6 to 8·5 μ thick in meristematic region, then tapering to a long narrow hair; sheath thin, hyaline, vanishing above, but the whole in a very firm gelatinous matrix; cells in meristematic region $\frac{1}{8}$ to 1 times as long as broad, slightly to moderately incised at cross walls, lengthening below to 3-6 times as long as broad. Heterocysts basal and intercalary; basal approximately spherical, 10-18 μ diameter; intercalary ones usually abundant, ovoid to elongate linear, thick-walled, 4-8 μ wide, 2 to 20 times as long as wide, rarely causing any bulging of filaments; basal heterocysts usually produced in roughly concentric bands causing a faint zonation in transverse section of the thallus.

Granite Island and Petrel Cove, near Victor Harbour (on rocks, particularly in roughest places, in upper littoral and spray zones). Antechamber Bay, Cape

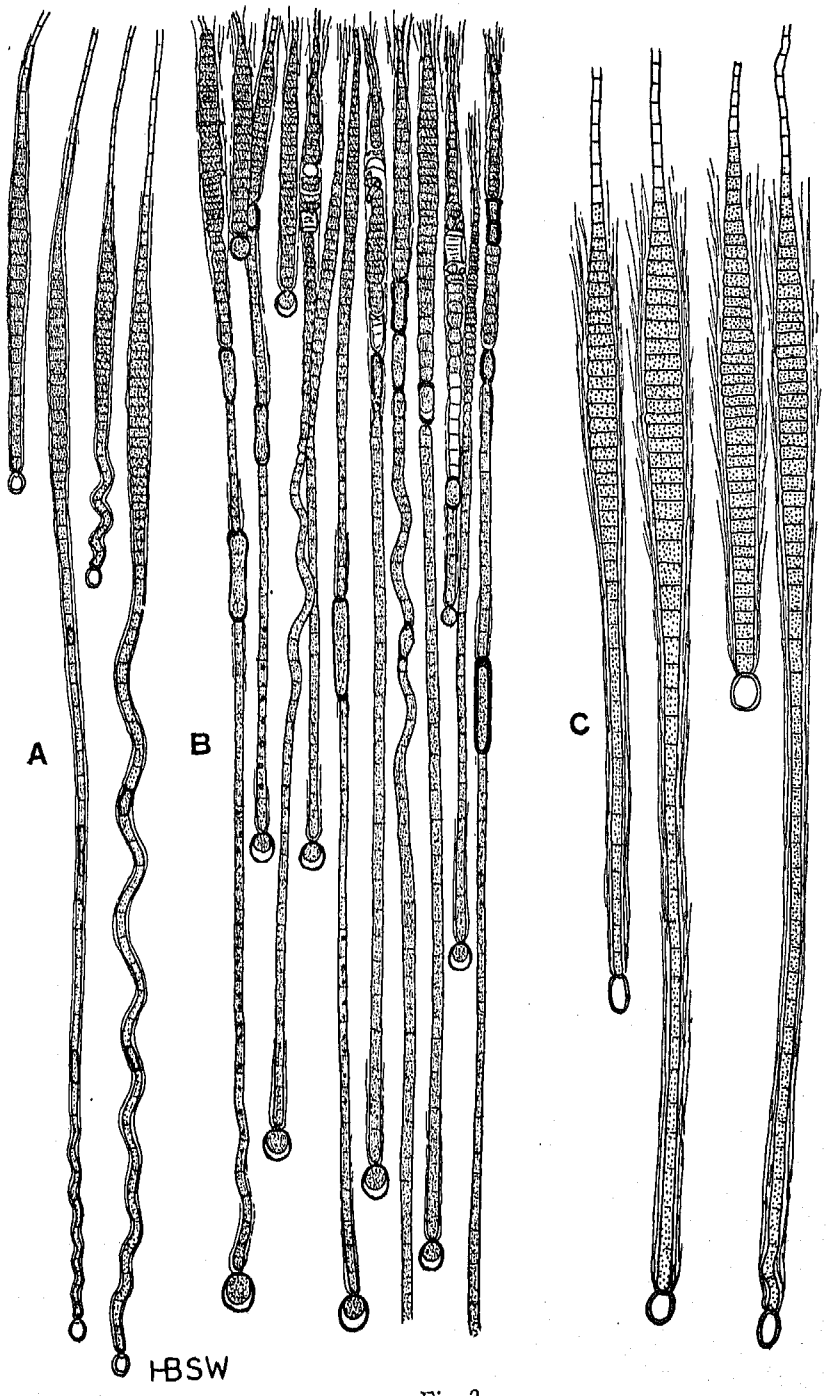

Fig. 2

A and B, *Rivularia firma* n.sp; A, trichomes from young thallus; B, trichomes from older thallus showing intercalary heterocysts and cell arrangement; C, *Rivularia polyotis*, trichomes with wide lamellate sheaths.

Willoughby, Pennington Bay, Vivonne Bay, on Kangaroo Island (in upper littoral, probably all along east, south and west coasts).

Occurring throughout the year, but usually better developed in winter.

In general, *R. firma* forms a zone in the upper littoral on exposed rocky coasts, frequently occurring on otherwise bare rocks and in situations where it is often exposed to desiccation for several hours daily. The firmly gelatinous thallus enables it to withstand considerable exposure.

The presence of abundant intercalary heterocysts distinguishes this species from any previously described. They are usually much elongated, 2 to 20 times as long as broad, lying within the trichome sheath. When much elongated each is often slightly wider at the ends where the walls are somewhat thicker than in the centre, with finely granular colourless contents (see fig. 2, B). Intercalary heterocysts such as these have apparently not been described in any other species. Occasionally, however, they occur in both *R. australis* and *R. polyotis,* though only very rarely.

The very firm and solid nature of the thallus is also a distinctive characteristic.

Hormogonia develop beneath the superficial layers of the thallus, and because of their confinement within the very firm gelatinous matrix often develop into ovoid or elongated masses of compressed, often polygonal, cells instead of the usual cylindrical trichomes. This type of hormogonia development is particularly characteristic of species of *Rivularia* with a firm thallus.

Specimens collected from the south side of Granite Island, Victor Harbour, in December 1943, were brownish, with pitted surfaces, particularly distorted hormogonia, and unusual abundance of intercalary heterocysts. This is attributed to a heat wave and low tides shortly before collection, the specimens probably being dead and atypical when collected.

Type and cotype specimens are catalogued under numbers A 2205 (K.I. 5) and A 2,204 (K.I. 4) respectively, in the Algal Herbarium, Department of Botany, University of Adelaide.

Rivularia atra Roth
(Fig. 1, B)

Roth, Cat. Bot., 3, 1806, 340; Bornet and Flahault, Rev. II, 1886, 353; Harvey Phyc. Britt. t. 239; De Toni, Sylloge Algarum, 5, 664; Rabenhorst, Kryptogamen Flora 14, 645; Setchell and Gardner, Marine Algae . . . . 107; Newton, British Seaweeds, 38.

Thallus solitary or confluent, hemispherical or flattened, up to 4 mm. in diameter. Filaments radiating from the centre, densely compacted, abundantly false-branched. Trichomes 2·5-5 μ thick below, expanding slightly to 5-6·2 μ thick above, then tapering to a narrow hair; cells yellowish-green, shorter than broad above, lengthening below to 3-6 times as long as broad, not or very slightly incised at cross walls; cross walls very indistinct below; sheath hyaline, inconspicuous, but often fairly thick. Heterocysts basal, spherical to ovoid, 7-10 μ diameter. Older specimens may show faint zonation of heterocysts in section of the thallus. Hormogonia forming towards ends of outer trichomes.

Port Noarlunga (on reef, littoral); Marino, Moana (on rocks); Port Willunga (on reef, littoral); Vivonne Bay, Kangaroo Island (around edges of littoral pools, south side of Ellen Point). Occurring throughout the year.

Europe, North America, Japan, Australia (previously recorded by Nordstedt). Cosmopolitan.

Two varieties of *Rivularia atra* have been distinguished; var. *hemispherica* (Kütz.) B. and F., with hemispherical colonies, very dark green, and var. *confluens* (Kütz.) Bornet, in which the thallus is a flat confluent mass, deep blue-

green, trichomes 5-7 μ wide. Both varieties seem to be present in South Australia, although many gradations between the two are shown.

The main differences from descriptions of Northern Hemisphere species lie in (a) trichomes expanding slightly to up to 6·2 μ thick. Setchell and Gardner, however, record a width of 5-7 μ for trichomes in var. *confluens* (Kütz.) Bornet. Young outer trichomes, in our specimens, taper evenly from the base, being 5-6·2 μ thick; (b) sheath often quite thick in our specimens, whereas it is given as "thin" in all descriptions.

Rivularia nitida Ag.

(Fig. 1, C)

C. Agardh, Disp. 44, 1812; Bornet and Flahault, Rev. II, 1886, 357; De Toni Sylloge Algarum, **5**, 661; Rabenhorst, Kryptogamen Flora, **14**, 646; Setchell and Gardner, Marine Algae . . . 108; Newton, British Seaweeds, 38; *R. plicata* Carm. in Hooker's Brit. Fl. Crypt., 392; Harvey, Phyc. Brit. t, 215; Phyc. Aus. Syn. No. 787.

Thallus usually hollow, variable in outline, expanded and plicate-corrugate, to 2 cm. across, dark olive green in colour. Filaments crowded, usually tapering from the base to a long narrow hair, from 3·5 to 6·3 μ thick below, occasionally to 8·5 μ thick next to heterocyst, tapering evenly to 2 μ thick in the hair, or sometimes expanded slightly upwards; cells olive green, mostly $\frac{1}{2}$-1 times as long as broad, often longer below, not or slightly incised at cross walls. Sheath usually prominent and distinct, hyaline or yellowish-brown. Heterocysts basal, ovoid to spherical, 6 to 12 μ across.

Pelican Lagoon, American River, Kangaroo Island (on flat rock in littoral). Collected during January 1946, but probably present throughout the year. Specimens from this locality are identical with Harvey's No. 591 B (as *R. plicata* Carm.) from King George Sound, Western Australia.

Britain, North Europe, Mediterranean, Nova Scotia, Alaska.

Only apparent difference from Northern Hemisphere specimens lies in the somewhat thicker trichome (to 6·3 μ thick as against 2-5 μ in descriptions).

Rivularia australis Harvey

(Fig. 1, D)

Harvey, Some Acc. Marine Bot. of W. Aust., 566, 1854; Phyc. Aus. Syn., n. 786; Sonder, Alg. Austral. hact. cognitae, 42, n. 1,047; Bornet and Flahault, Rev. II, 362; De Toni, Sylloge Algarum, **5**, 658; Newton, British Seaweeds, 40; Rabenhorst, Kryptogamen Flora, **14**, 646.

Thallus irregularly globose, soft, always hollow, to 8 cm. across, usually a metallic blue-green in colour; occasionally growing as masses of smaller irregularly united hollow thalli. Trichomes easily separated by pressure, long, almost parallel, expanding in width from 1-3 μ near heterocyst to 5-7·5 μ in meristematic region, then tapering to a fine hair; cells in meristematic region $\frac{1}{3}$ to 1 times as long as broad, slightly to moderately incised at cross walls, becoming longer below. Sheath very thin, hyaline, usually only detectable near heterocyst. Filaments below straight or slightly undulating. Heterocysts ovoid to spherical, 10-13 μ by 7-11 μ; intercalary heterocysts very rare, ovoid to oblong, similar to those in *R. firma*.

The very soft thallus, trichome width and absence of a sheath distinguish this species reasonably well.

South Australia: Port Willunga (on reef, littoral). Victoria: Port Lonsdale (January 1941); Phillip Island (January 1946); Brighton (January 1853);

Frankston (January 1903) [1]; San Remo (February 1929).[1] New South Wales. Eden (January 1910).[1] Tasmania: Tamar Heads (December 1864); Low Head (February 1935) [1]; East Beach, Low Head (February 1927 [1] and March 1932). Western Australia: Cape Riche (Harvey's 592 C).

Most of these records are during the months of January and February, but the species probably occurs during all months of the year.

Atlantic, Europe, England.

Specimens of Harvey's *R. nitida* Ag., No. 593 I, recorded by Harvey from Brighton, Port Phillip and Georgetown, Tasmania, have been examined and found to belong to *R. australis* Harv. According to De Toni, Sylloge Algarum, **5**, 660, *R. nitida* Ag. as figured by Harvey in Phyc. Brit. t. 68, is a synonym for *R. bullata* (Poir) Berkeley, and Harvey's and Sonder's Australian specimens are referred to the latter species. The only difference in the specimens placed by Harvey under the two species, *R. australis* and *R. nitida* Ag., lies in the external appearance of the thallus. Harvey's *R. australis* was slightly smaller and firmer than his *R. nitida*, but both show trichomes expanding upwards to 5-7·5 μ thick, with the cells $\frac{1}{3}$-1 times as long as broad, slightly to moderately incised at the cross walls. The sheaths in both are scarcely detectable, very thin and hyaline. Heterocysts are spherical to ovoid, 7-9 μ by 7-11 μ. Intercalary heterocysts are rare, but present, in Harvey's 592 C.

Harvey's *R. nitida* Ag. (*R. bullata* (Poir) Berkeley) must then without any doubt be referred to his own species, *R. australis*. He records *R. australis* as growing on rocks near low water at Cape Riche. Possibly his specimens of *R. nitida* were growing in more sheltered conditions, and this would account for the slight differences in the external thallus structure.

A specimen in the Melbourne National Herbarium, named as *R. nitida* var. *bullata* Kütz., from rocks at Port Phillip, is probably also referable to *R. australis* Harvey. Sonder's specimens of *R. bullata* from "Adelaide" (according to De Toni) may also be referable to *R. australis* Harv.

It appears then that the true *R. bullata* cannot as yet be recorded from Australia.

It should be noted, however, that *R. australis* Harv. and *R. bullata* (Poir) Berkeley are closely related. From descriptions, it appears that the main differences lie in the firm thallus and slightly wider trichomes (to 8·5 or 10 μ) of *R. bullata* compared with the very soft thallus and trichomes to 7·5 μ wide of *R. australis* Harv.

Rivularia polyotis (Ag.) Bornet and Flahault
(Fig. 2 C)

Bornet and Flahault, Rev. II, 360; De Toni, Sylloge Algarum, **5**, 659; Rabenhorst, Kryptogamen Flora, **14**, 647. *R. plicata* Harv. Australian Alg. (1857); Sonder, Algae Austral., 42 (see De Toni, **5**, 659).

Thallus light to dark green (darker when young), very soft, hollow except when young, irregularly globose, to 8 cm. across. Trichomes easily separated by pressure, expanding in width upwards from 2-5 μ near heterocyst to 9-14 μ in meristematic region, then tapering to a moderately thick hair; cells in meristematic region $\frac{1}{3}$ to 1 times as long as broad, not or slightly incised at cross walls, becoming longer below. Sheath usually prominent, thick, hyaline, lamellate, expanding above. Heterocysts basal, ovoid to spherical, 10-18 μ by 10-14 μ. Intercalary heterocysts very rare, ovoid to oblong-cylindrical, similar to those in *R. firma*.

[1] These specimens had been identified by A. H. S. Lucas as *Leathesia difformis* (L.) Aresch., and one specimen from Tasmania, Low Head, as *Codium pomoides* J. Ag.

American River, Kangaroo Island (on *Posidonia, Zostera* and algae on tidal flats, often detached and floating. Common throughout the year. West Beach, Port Adelaide River, Port Noarlunga, Port Willunga (on *Hormosira Banksii* Dcne. and on reef, littoral). Typically occurring under calm sheltered conditions, such as on tidal flats and inlets.

Europe, Atlantic, Mediterranean, Southern Australia.

The combination of soft, hollow thallus, thick trichome and wide lamellate sheath distinguishes this species. Occasionally, however, a few specimens of an otherwise uniform series from the one locality have failed to show any noticeable sheath.

The records of this species given by De Toni (**5**, 659) as under "*R. plicata* Harv. Aus. Alg. (1857), Sond. Algae Austral., 42, non Carmichael, *nec* Lloyd," cannot be discussed as none of these specimens are available for examination.

Ecological Notes on the South Australian Species of *Rivularia*

The South Australian species of *Isactis* and *Rivularia* are found in the upper littoral or spray zone on rocky coasts, or in littoral regions in tidal inlets, where they are often floating. Although records are still very fragmentary, except for Kangaroo Island, there are probably few places on the coast of Southern Australia where one or more of the above species do not occur.

Rivularia polyotis is characteristic of tidal inlets such as American River and the Port River, where conditions are very calm. This species is usually epiphytic, particularly on *Posidonia australis* Hooker and *Zostera Muelleri* Irmish (American River), or on *Hormosira Banksii* Dcne. (Port Willunga); young specimens occur on the reef itself at Port Willunga, and may be solid. *R. polyotis* is often cast up on the beaches of Holdfast Bay during winter months.

Rivularia australis probably favours somewhat similar habitats. Only one specimen of this species has been found in South Australia, but from records available it appears to be common in Port Phillip Bay, Victoria, and the Tamar in Tasmania.

On the rocky exposed south coast of Kangaroo Island, and similar places on the mainland (Granite Island, Petrel Cove), the dark green, very firm blobs of *Rivularia firma* are usually found. This species is confined to the upper littoral and spray zones, where it may have to withstand exposure for several hours each day.

The small blobs of *Rivularia atra* and *Isactis plana* occur usually in littoral situations where they may have to withstand some exposure, but appear to be less hardy than *Rivularia firma.* At Pennington Bay *Isactis plana* occurs in areas of scattered small patches almost anywhere on the reef surface, but invariably where it is always covered with water.

Rivularia nitida occurs on flat rock in the littoral zone at Pelican Lagoon, American River. Here it is subject to severe drying and desiccation during low tide on hot days, for no water is retained near it. It appears to suffer little damage from this.

The Southern Australian species of *Rivularia* and *Isactis* then are typically littoral algae; *R. firma* flourishes under the roughest of conditions, while *R. polyotis, R. australis* and *R. nitida* favour calm sheltered places. *R. atra* and *Isactis plana* occur in intermediate conditions. All these species seem to occur throughout the year.

From the literature available, it appears that *Isactis plana* has not been previously recorded from the Southern Hemisphere.

SUMMARY

One species of *Isactis* and five of *Rivularia* (Myxophyceae) are now known from Southern Australia, including one species, *R. firma,* here described as new. The presence of abundant intercalary heterocysts in *R. firma* is considered as distinguishing this species from all others of the genus.

An examination of W. H. Harvey's specimens of *R. australis* and *R. plicata* Carm. (*R. nitida* Ag.) has shown that they are specifically identical, and his *R. plicata* Carm. must be referred to *R. australis* Harv. It appears that records of *R. bullata* (Poir.) Berkeley may be incorrect, the specimens actually being of *R. australis* Harv.

ACKNOWLEDGMENTS

I am indebted to Dr. Francis Drouet, Chicago Museum of Natural History, for confirmation of *Rivularia firma* as being previously undescribed. Specimens of *Rivularia* from the Lucas collection, Division of Plant Industry, C. S. & I. R., Canberra, and the National Herbarium, Melbourne, were examined through the kindness of Mr. W. H. Hartley and Mr. A. W. Jessep respectively. Dr. E. McLennon, Department of Botany, University of Melbourne, also kindly forwarded specimens for examination.

With the Author's Compliments

STUDIES ON THE MARINE ALGAE OF SOUTHERN AUSTRALIA

No. 2 A NEW SPECIES OF DASYOPSIS (FAMILY DASYACEAE) FROM KANGAROO ISLAND

By H. B. S. Womersley, Department of Botany, University of Adelaide

[*From "Transactions of the Royal Society of South Australia," vol. 70, (2) 1946*]

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By H. B. S. Womersley, Department of Botany, University of Adelaide

[Read 9 May 1946]

Plate XXVII

Previous to this communication the genus *Dasyopsis* has been known only from the Northern Hemisphere, where seven species have been described. Five species occur in the European and Mediterranean regions, and two on the western coast of the United States of America. (De Toni, 1,177; Smith, 356).

The family Dasyaceae comprises a natural grouping of members of the Ceramiales showing sympodial growth of the axis, while *Dasyopsis* is distinguished from other genera of the family by the apparent absence of pericentral cells surrounding the central axis or siphon of the stem. This apparent absence, however, is actually due to separation of the pericentral cells from each other and from the central siphon by corticating cells which penetrate between them. This will be discussed more fully later.

The species described as new in this paper agrees with *Dasyopsis* in all essential aspects, but shows several distinctive differences, as far as can be ascertained from descriptions alone, from all other described species. An alga such as this, being so far removed from other species of the genus in its geographical distribution, forms a most interesting record. It is worth noting, however, that the closely related genus *Dasya* shows a strong Australasian distribution of its species, 25 of 46 described species occurring in the Southern Australian and Tasmanian regions. Other genera of the Dasyaceae are also well represented in these regions.

The range in external form is remarkable in this species (see fig. 1, A and B, pl. xxvii). When first collected only the extreme forms (pl. xxvii) were known and the existence of two species was suspected. A complete range of form between the two extremes has now been found, and the form in any particular habitat appears to be correlated with the roughness and severity of wave action in that habitat.

This alga has been collected during ecological studies on the marine algae of Kangaroo Island. In later papers it is hoped to survey the ecology of the south coast of the island, particularly the Pennington Bay and Vivonne Bay regions.

Dasyopsis clavigera n. sp.

Named after the clavate (club-shaped) form of the branches.

Occurrence and Habit

The only known occurrences as yet are on the southern and western coasts of Kangaroo Island. Serial numbers of the specimens deposited in the Algal Herbarium, Department of Botany, University of Adelaide, are given below.

Pennington Bay, 20 and 25 May 1945—Cast up and growing in the *Cystophora*-coralline association in the south-east corner of the main reef. (This reef is the largest of many similar ones in the Pennington Bay region, and is also the most accessible.) Sometimes epiphytic on *Cystophora sub-*

farcinata (Mert.) J. Ag., or with *Ceramium nobile* J. Ag. epiphytic on it. No. A 2,727 (K.I. 527).

15 January 1946—In the *Cystophora*-coralline association and along the eastern edge of reef and to one foot down the vertical side. Often with a heavy epiphytic growth of *Jania* sp. Tetrasporangial, spermatangial and cystocarpic plants present. Nos. A 3,049 (K.I. 849), A 2,845 (K.I. 645).

A 2,845a has been selected as the type specimen (fig. 3, A).

Vivonne Bay, 23 May 1945—On rocks just above the *Cystophora* zone, on the south side of Ellen Point. Only tetrasporangial plants found. No. A 2,726 (K.I. 526).

31 December 1945. From just inside Ellen Point, extending around the point and at least half a mile west, in a region just above the *Cystophora* zone (lower littoral). Plants mainly tetrasporangial. No. A 2,997 (K.I. 797).

West Bay, 6 January 1946—Cast up; epiphytic on *Sargassum* sp. and with *Plocamium* sp. and *Nitophyllum* sp. epiphytic on it. Plants tetrasporangial or sterile. Nos. A 3,199 (K.I. 999), A 3,251 (K.I. 1,051), A 3,253 (K.I. 1,053), A 3,265 (K.I. 1,065).

It seems probable that *Dasyopsis clavigera* occurs generally along the south and west coasts of Kangaroo Island, usually in regions where it is subject to considerable or very heavy wave action. All the habitats in which it has so far been found correspond to the lower littoral or the upper margin of the sub-littoral.

The extreme forms of this variable alga are illustrated in pl. xxvii, A and B. The type specimen, A, from Pennington Bay is the largest found, being 20 cm. high and consisting of numerous erect terete stems from a common base, the main stems being rarely branched but all closely set with short lateral branches 1 to 3 cm. long, giving each frond a narrowly pyramidal outline.

The specimens in pl. xxvii, B, from Vivonne Bay (May 1945) are quite typical of those collected at this time. Each consists of one to five clavate, simple or occasionally branched, stems from a common base, the whole forming a tuft 2 to 5 cm. high.

During January 1946 specimens collected from the end and about half a mile to the west along the south side of Ellen Point, Vivonne Bay, showed all degrees of variation between the specimens shown in pl. xxvii, B, and smaller specimens of the form shown in pl. xxvii, A.

The plants in all cases consist of a terete stem or branch densely clothed with branched, filamentous pseudolaterals, giving the frond a woolly appearance, but usually becoming shrubbier and finally denuded near the base.

The form of this alga shows adaption to the extremely rough conditions under which it grows. At Vivonne Bay, particularly in the habitat where the smaller unbranched specimens grew, waves are continually breaking directly on to the rocks, and the short, stout, terete fronds, with a common adhesive base and little branching, together with the close occurrence of the plants, offer minimum resistance to the breakers. In somewhat less exposed places more branched plants occur, showing gradation to the forms met with on the Pennington Bay reef.

On the reef studied at Pennington Bay, *D. clavigera* occurs in the south-east corner (*Cystophora*-coralline association) and along the eastern edge of the reef. All the plants in these regions show profuse laterals, but vary from one to

numerous main stems from the common base. Owing to the very flat and horizontal nature of the reef, and the sudden vertical drop into deep water at the edge, the breakers tend to surge over the edge and along the side of the reef, rather than breaking onto it. These conditions are clearly less violent than at Vivonne Bay, and allow greater development in size and lateral branching of the alga. A dense covering of other algae on the reef also affords mutual protection for each.

Branched forms of *D. clavigera* are uniformly of a yellowish-brown colour, with the extreme tips often a rose red. The Vivonne Bay plants of May 1945 (pl. xxvii, B), however, were all deep rose red in colour. It seems that with greater development only the youngest parts retain the red colour.

The forms of *D. clavigera* met with so far in different localities, therefore, appear to be closely related to the forces of wave action which they have to withstand. The importance of physical factors in determining the form of an alga is quite clear in this case; such criteria as degree of branching, and particularly size, are of little value taxonomically, and it is more than likely that forms previously separated on such criteria will have to be united when their full range of form becomes evident.

Vegetative Structure

Dasyopsis clavigera shows the sympodial type of growth that is characteristic of all the Dasyaceae. The growing region, illustrated in fig. 1 D, shows clearly the development of pseudolaterals. A lateral, arising from the base of the previous generation, continues the growth of the axis, while the upper parts, which become displaced, form the successive units of the sympodium (3, 2, 1 in fig. 1 D) and develop as branched, apparent laterals (pseudolaterals). These pseudolaterals develop in spiral sequence, densely covering the stem and branches except for the lower parts and base which usually become denuded. The stem between the pseudolaterals is bare, and where they are not too dense the spiral arrangements can be readily distinguished. Fritsch (p. 572), however, refers to the pseudolaterals in other species of *Dasyopsis* as being distichously arranged, although they are spiral in the genus *Dasya*.

The genus *Dasyopsis* differs from *Dasya* essentially in that the pericentral cells become separated from the central siphon by large corticating cells which penetrate between the original pericentrals. The presence of pericentral cells has often been denied, but Fritsch (p. 574) points out that their apparent absence is due to intermixture with cortical cells and separation from the central siphon.

Fig. 1 D illustrates the method of cortication of the main axis. At the bases of the pseudolaterals which have just been displaced small elongate cells develop and rapidly form a thick cortex to the stem. Fritsch (p. 572) records five pericentral cells generally for *Dasyopsis*, but in this species no definite number could be distinguished. At the base of each apical tuft of the filaments the structure is clearly polysiphonous, but cortication commences so early, with the corticating cells penetrating between the original ones, that a cross section just below the apex shows a ring of cells, some of which may be larger than others, surrounding a large central siphon (see fig. 1 E). The cortex rapidly becomes many cells thick, but often in the younger parts four to six cells are larger and stand out from the others (fig. 1 F). In older stems no distinctive cells are apparent, though the central siphon is always evident, being several times larger than any other cells in the stem. It may well be that the number of pericentrals is five, but this could not be established in any of the plants examined. The adult stem is 1-2 mm. thick, and the cells have rather thick walls.

Fritsch (p. 572) refers to the pseudolaterals of *Dasyopsis* as uniseriate, though noting that in *Heterosiphonia* the three basal segments of the pseudolaterals

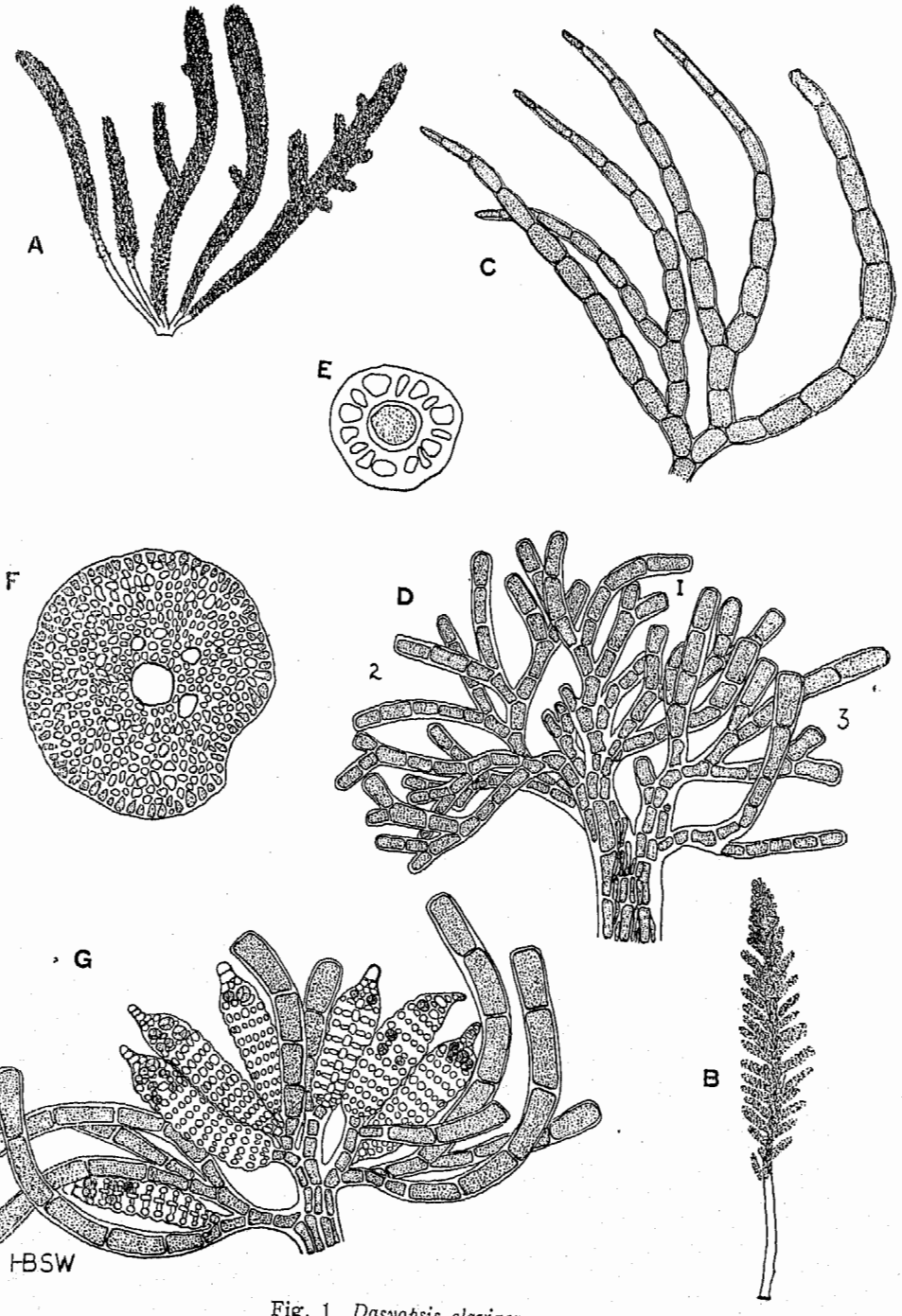

Fig. 1 *Dasyopsis clavigera* n. sp.
A, form of specimen from Vivonne Bay; B, form of small specimen from Pennington Bay; C, tuft of hairs from near apex; D, the growing point, showing sympodial growth; E, cross section of stem just below growing point. F, cross section of stem lower down; G, pseudolateral tuft bearing stichidia. A x 1½, B x ⅔.

become polysiphonous, while according to Falkenberg (p. 169) the basal segment may also become polysiphonous in *Dasya*.

In this species the base of each pseudolateral is clearly polysiphonous (fig. 1, D, G), and divided by successive dichotomies into a number of monosiphonous filaments, all curved upwards and in towards the stem above. All the filaments lie in essentially the same curved plane.

After being displaced from the growing point each pseudolateral develops into a small dense tuft. Further development, however, into lateral branches up to 2 cm. long, may occur, such as in the branched forms from Vivonne and Pennington Bays; *i.e.*, the pseudolaterals retain the power of further growth, the extent to which this occurs being determined by the conditions under which the plant grows.

The form of the filaments is illustrated in fig. 1 C, D, G. At or close to the apex of the stem or branch the filaments taper uniformly in the upper half. As they become larger, and further from the growing point, the upper tapering part invariably becomes broken off, leaving the filaments terminating at the largest cell, the end of which is squarely cut off. Apparently the rough conditions under which the alga grows allow only the strongest basal part of the filament to remain. No trace of the breakage is left, however. Further from the apex the pseudolateral tufts become stubbier, until the stem is finally denuded, although scars in the positions of the old tufts often remain.

Filament dimensions: near growing points, 38-60 μ thick, 47-115 μ thick when fully developed. Cells at base of filaments 1½-2 times as long as broad, 2-5 times in widest region, 6-8 times towards the ends. Cells in all parts with a distinct firm gelatinous sheath, wider towards the base. Pseudolateral tufts 1-2 mm. long, giving the fronds a thickness of 2-4 mm.

Attachment to the rock substratum is by means of an adhesive disc. At Pennington Bay the plants are often epiphytic on *Cystophora subfarcinata* (Mert.) J. Ag., and may be heavily epiphytised themselves with *Jania* sp., *Ceramium nobile* J. Ag., *Polysiphonia dasyoides* Zan. and other algae.

The filaments of the pseudolateral tufts comprise the main photosynthetic organs of the alga. Each cell contains numerous rose-red laminate chromatophores, usually irregularly polygonal in outline, though in occasional cells spindle-shaped. They are confined to the peripheral cytoplasm of the cells, the colourless spaces left between them giving the whole cell a reticulate appearance in face view. The outer layer of cells of the stem usually contains similar chromatophores.

Development of Stichidia and Tetrasporangia

Plants bearing tetrasporangia and cystocarps have been collected during both May and January, so it is likely that fruiting material may be found at any time of the year.

A stichidium originates as one branch of a dichotomy of the pseudolateral filaments, very close to the growing point. An initial row of cells each cuts off, from below upwards, six pericentral cells (fig. 2 B). Each of these pericentrals then divides transversely to the length of the stichidium to form an upper cell which develops into the tetrasporangium, the lower cell remaining as a basal supporting cell. This basal cell then cuts off two cover cells on the outside (fig. 2 B, C), and all from one layer of pericentrals lie in the same plane, slightly below and outside each tetrasporangium (fig. 2 A).

The central row of cells elongates slightly at this stage and as the tetrasporangia mature they become almost completely exposed (fig. 1 G, 2 A, C).

Mature stichidia comprise 10 to 13 series of pericentrals, but usually only four tetrasporangia form in each row of six. At an early stage the young stichidium has a wide base and tapers to the apex (fig. 2 A). Development occurs from the base upwards, and by the time the stichidium is mature most of the tetraspores in the lower part have escaped (fig. 1 G).

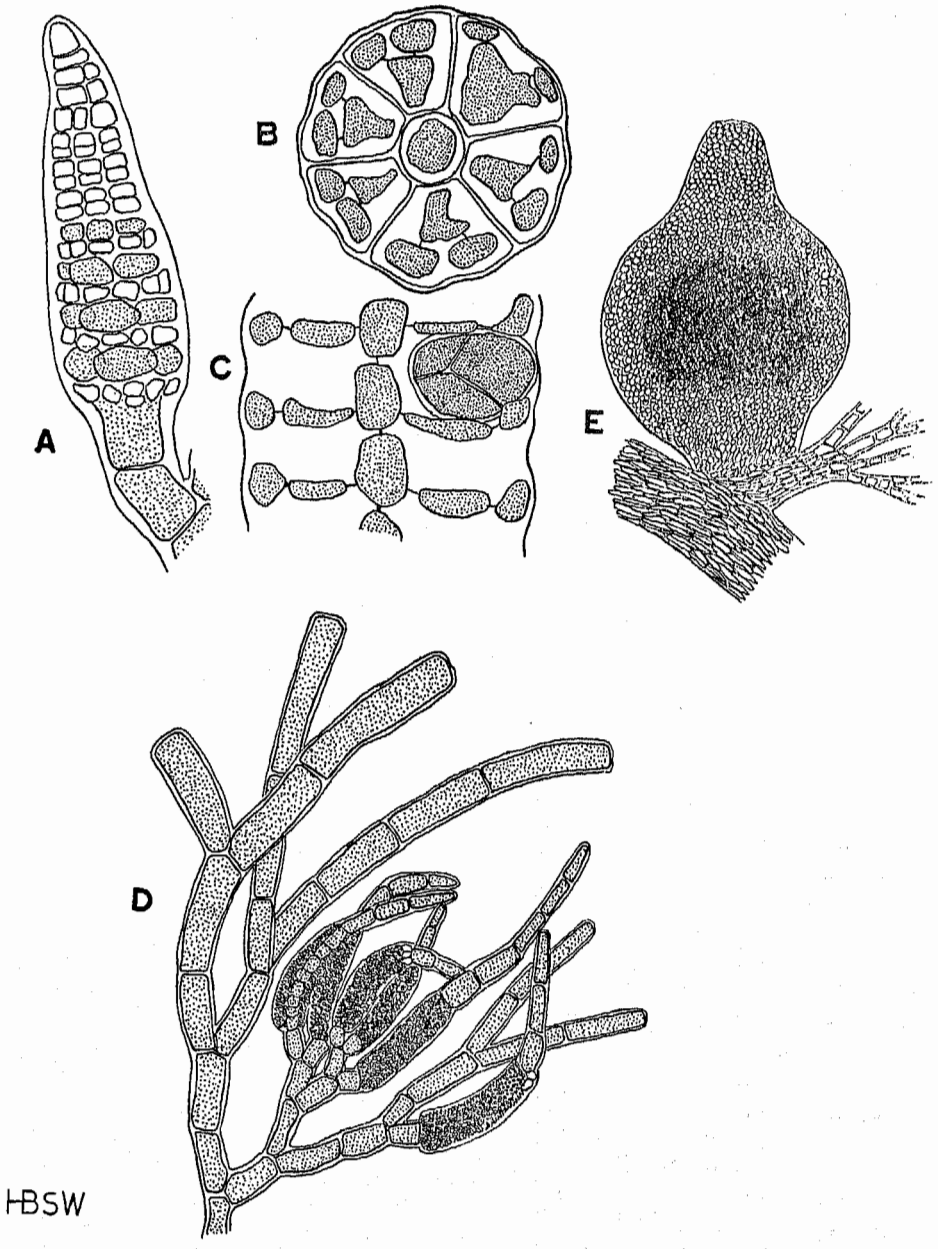

Fig. 2 *Dasyopsis clavigera* n. sp.
A, young stichidium; B and C, transverse and longitudinal section respectively of mature stichidium; D, pseudolateral tuft bearing spermatangia; E, cystocarp.

Mature stichidia are borne profusely on the pseudolaterals, each on a short monosiphonous pedicel of 1-3 cells. Each is oblong cylindrical in shape, narrowing at the top to a uniseriate beak of up to five cells (fig. 1 G). Length 310-450 μ, width 80-110 μ. Tetrasporangia tetrahedrally divided, rose-red in colour, 24-25 μ in diameter.

Development of Spermatangia

Spermatangia develop on filaments of the pseudolateral tufts, in a similar position to the stichidia. Often 70 to 80% of the filaments bear spermatangia.

A row of 6 to 10, but usually about 8, almost quadrate cells forms in place of one of the filaments, and beyond this row of cells the filament develops normally though much less extensively, forming a chain of only 3 to 5 small cells (fig. 2 D). Each of these quadrate cells cuts off two rows, one above the other, of 8 pericentral cells; later more may be formed, giving up to 16, and these become the spermatangial mother cells. Each of these gives rise to 1 to 3 (usually 2) spermatangia, resulting in a horizontal row of from 16 to 32 spermatangia. At the apex of the spermatangial mass a group of 2 to 4 larger cells, surrounding the axial cells, is usually left. Development occurs from the base up, but most spermatangia form almost simultaneously. Spermatangial masses 75-120 μ long, 30-50 μ wide, the whole encased in a gelatinous matrix (see fig. 2 D).

This is in general agreement with spermatangial development for *Dasyopsis* (also *Polysiphonia*) as recorded by Fritsch. It will be noticed also that many similarities are shown with development of tetrasporangia as previously discussed.

Cystocarp Structure

Cystocarpic plants of *D. clavigera* were found during both May and January.

Cystocarps occur in the axils of pseudolateral tufts, the pericarp being attached at maturity to both the base of the pseudolateral and the main branch, but more so to the latter (fig. 2 E). Fritsch (711) states that as a general rule only one cystocarp matures on each branch, but in this species up to six were found on one lateral branch. They often occur on otherwise almost denuded branches. Each cystocarp is large, spherical, with a prominent apical beak surrounding the osteole, the whole just showing through the crowded pseudolaterals when mature. Length when mature 0·8-1·2 mm., width 0·6-0·85 mm. Pericarp of three layers of cells, containing a large mass of dark-red carpospores. Carpospores irregularly ovoid to spherical, 9-18 μ long.

Early stages of cystocarp development have, as yet, not been found.

Relation to other Species of *Dasyopsis*

D. clavigera appears most closely related to *D. cervicornis* (see Falkenberg, 664, De Toni, 1,178), differing in the terete stem compared with the angular stem and winged branch insertion of the latter. Other species also appear to possess distichously arranged pseudolaterals, these also being monosiphonous, whereas in *D. clavigera* they are polysiphonous at the base and spirally arranged.

D. clavigera appears to be the only species of *Dasyopsis* known from the Southern Hemisphere, thus establishing considerable geographic discontinuity within this genus.

Taxonomic Description

Frondes cum caulibus unus aut plures, erecti teretes, ex uno base, principes caules parce ramosi, plerumque tecti cum brevibus ramulis quoquoversum egredientibus; frons in forma angusti pyramidis, 4-20 cm. altus, ramuli 1-2·5 cm. longi. Caules et ramuli tecti cum brevibus floccis pseudolateralibus ramellis, nudis ad basem. Pseudolaterales polysiphonii ad basem, aliter monosiphonii et

decomposites-dichotome. Cellulae pericentrales nullae, axi cortice rhizoideo immediate cincto, 1-2 mm. latae. Cystocarpia globosa, osteolata, cum rostro in apice, 0·8-1·2 mm. longa, 0·6-0·85 mm. lata, cum copia rubidorum carposporum. Spermatia in ramellis pseudolateralum, 70-120 μ longa, 30-50 μ lata. Stichidia in ramellis pseudolateralum, oblonga, rostrata, 310-450 μ longa, 80-110 μ lata, in pedicello monosiphonio 1-3 cellulorum. Color fulvus, juvenis sanguineus. Specimina exsiccatione chartae adherent.

Fronds comprising one to several upright terete stems from a common base, main stems rarely branched, but usually closely set with short laterals, spreading on all sides, giving a narrowly pyramidal outline; frond 4 to 20 cm. high, laterals 1-2·5 cm. long. Stems and branches covered with short tufts of pseudolateral filaments, denuded near base. Pseudolaterals polysiphonous at base, otherwise monosiphonous and dichotomously branched. Stem with a single central siphon, pericentrals obscured, 1-2 mm. thick. Cystocarps globose, osteolate, with a prominent beak, 0·8-1·2 mm. long by 0·6-0·85 mm. wide, containing a mass of dark red carpospores. Spermatangia borne on filaments of pseudolaterals, masses 70-120 μ long, 30-50 μ wide. Stichidia replacing filaments of pseudolaterals, oblong cylindrical, apiculate, 310-450 μ by 80-110 μ, borne on a monosiphonous pedicel of 1-3 cells. Colour yellowish-brown, rose red at branch tips or in young plants. Adheres to paper.

Loc.—Pennington Bay, Vivonne Bay and West Bay, Kangaroo Island, South Australia. In lower littoral or sub-littoral fringe, on rocks.

Type (No. A 2,845a) and cotype specimens have been deposited in the Algal Herbarium of the Botany School, University of Adelaide. Cotypes have also been sent to the National Herbaria of Melbourne and Sydney.

SUMMARY

A new species of the genus *Dasyopsis, D. clavigera,* from the south coast of Kangaroo Island, is described. The range of form in relation to its habitat is discussed, and the development of vegetative organs, stichidia and spermatangia outlined.

It is considered that in finding the range of form and variation of a species an ecological approach is necessary. The geographical discontinuity between this species and others of the genus (from Europe and west coast of the United States) proves this to be a most interesting record.

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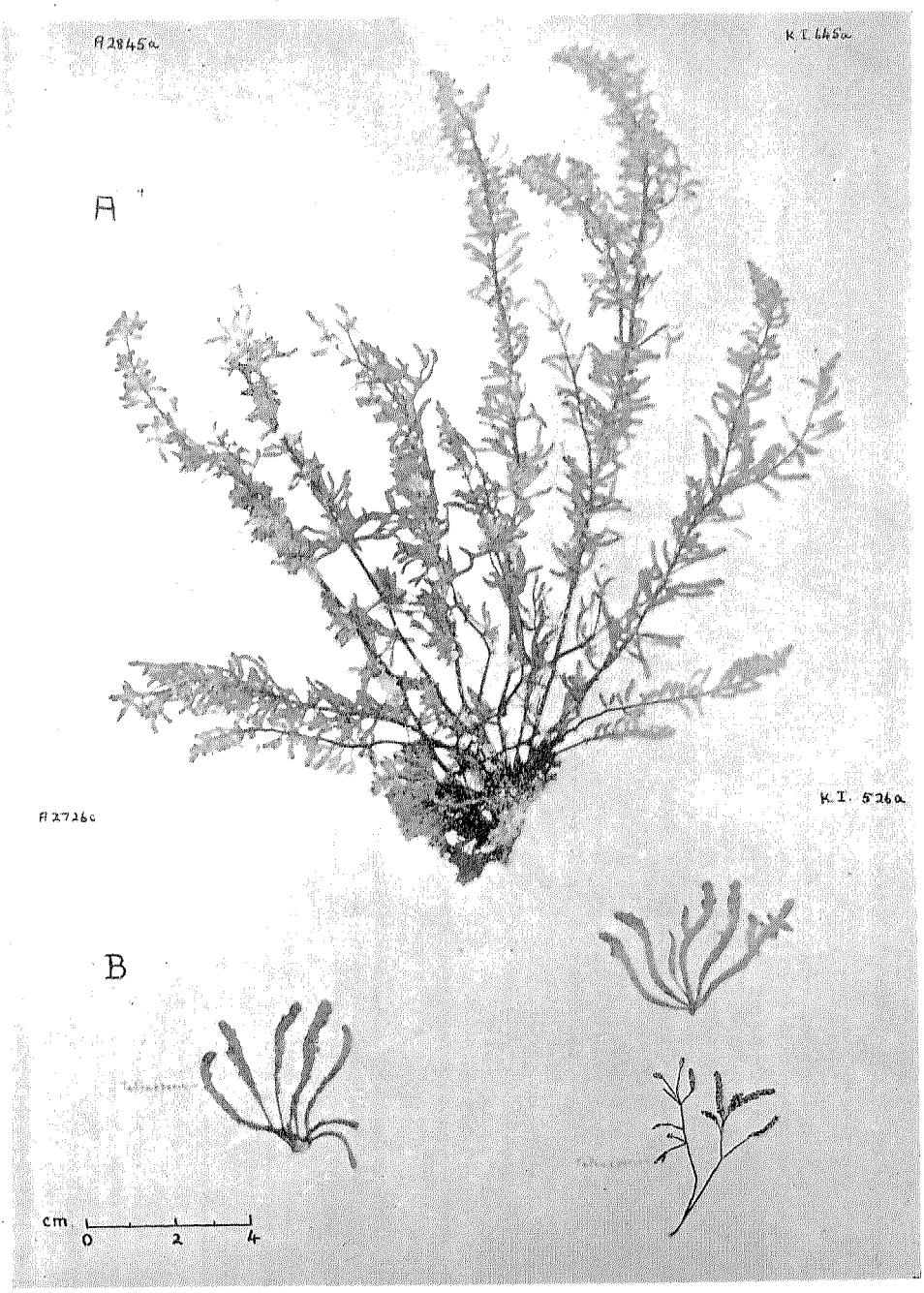

Dasyopsis clavigera n. sp.
Type specimens: A, from Pennington Bay; B, from Vivonne Bay.

STUDIES ON THE MARINE ALGAE OF SOUTHERN AUSTRALIA
No. 3 NOTES ON DICTYOPTERIS LAMOUROUX

By H. B. S. WOMERSLEY

Department of Botany, University of Adelaide

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No. 3 NOTES ON DICTYOPTERIS LAMOUROUX

By H. B. S. Womersley

[Read 10 November 1949]

Dictyopteris Lamouroux 1809 has been referred to in Australian algal literature as *Haliseris* Targioni-Tozzetti 1819 (Lucas 1936, p. 89, and previous authors) or *Neurocarpus* Weber and Mohr 1805 (May 1939, p. 200) but was included in the list of "Nomina Generica Conservanda" of the 1935 International Botanical Congress.

DICTYOPTERIS AUSTRALIS Sonder 1852 and D. PARDALIS (Harvey 1854) May

Dictyopteris pardalis is supposed to differ from *D. australis* in the absence of fine lateral veins running from the midrib to the margin. Sonder (1871, p. 47) first regarded *D. pardalis* as only a "variety with small thallus" of his *D. australis*, and he was followed by Askenasy (1888, p. 30) and Borgesen (1930, p. 173). Lucas (1936, p. 89) however considered them distinct species.

The type specimen of *D. australis*, collected at Lefevre Peninsula, South Australia, by F. von Mueller on 16 December 1847, and with Sonder's ms. description on the sheet, is in Melbourne National Herbarium. This specimen, though rather battered, is specifically identical with cotype specimens of Harvey's of *D. pardalis* in Melbourne and Sydney National Herbaria, which also show fine lateral veins from midrib to margin. There is also no significant difference in thallus width between the specimens, and the spores in both (though almost denuded in the type of *D. australis*) are arranged in recurved arches.

An examination of all the specimens available in Australian Herbaria of these species shows that the presence, and prominence, of lateral veins is a very variable character. Some specimens show veins in only some parts, others all over the thallus; often lateral veins occur on one side of the midrib and not the other side. All specimens, however, show some veins, though often extremely fine.

D. pardalis (Harv.) May must therefore be relegated to synonomy of *D. australis* Sonder, with the following references:

Dictyopteris australis Sonder herb. Askenasy 1888, p. 30. Borgesen 1930, p. 173. *Haliseris australis* Sonder 1852, p. 664; 1871, p. 47. Kützing 1859, pl. 54. De Toni 1895, p. 257. Lucas 1936, p. 89. *Haliseris pardalis* Harvey 1854, p. 535; 1858, pl. 29. Kützing 1859, pl. 59, II. De Toni 1895, p. 258. Lucas 1935, p. 209; 1936, p 89. *Dictyopteris pardalis* (Harvey) May 1946, p. 274.

Distribution Records—Herbarium abbreviations used below are: Botany Department, University of Western Australia — W; Botany Department, University of Adelaide — A; Melbourne National Herbarium — M; Sydney National Herbarium — S.

Western Australia—Dongarra (A. Baird, April 1930; G. Smith, February 1944—in holes on reefs — W.). Cottesloe (G. Smith, January 1945, 1946—as bushy tufts on rocks in 10 feet of water — A., W.). Fremantle (Harvey, No. 86 A, as *H. pardalis*, M. and S.). Point Peron (G. Smith, June 1949, W.). Bunbury (M.). Champion Bay (M.).

* Department of Botany, University of Adelaide.

SOUTH AUSTRALIA — Lefevre Peninsula (F. v. Mueller, December 1847, M.). Port Noarlunga (E. Macklin, 1924, A.). Spencer's Gulf (A.).

QUEENSLAND—Caloundra (G. McKeon, August 1948, A.). Moreton Bay (Askenasy). Peel Island (J. Marshall, May 1949, A.). Margate (V. May, December 1943 (as *D. pardalis*). Redcliffe (A. Cribb, July 1949, A; G. McKeon, September 1948, A.). Port Denison (F. Kilner in Sonder). Cape Upstart (M.).

EXTRA AUSTRALIA—Lord Howe Island (F. Perrin and A. Lucas, June 1933, S. — as *H. crassinervia*—see later; also Lind and Fullagar, M.). INDIA—Dwarka, Okla Port (Borgesen), Karachi (Harvey).

Most of the Australian specimens, except those of Smith from Dongarra and Cottesloe, were probably collected from the drift. D. *australis* probably occurs in deep pools on reefs and the sublittoral.

DICTYOPTERIS CRASSINERVIA (Zanardini) Schmitz

Schmitz 1937, p. 219. *Haliseris crassinervia* Zan. 1874, p. 487. De Toni 1895, p. 258.

In the Melbourne National Herbarium is a sheet (see pl. xxii, fig. 1) labelled, in O. W. Sonder's writing, *Halyseris Mulleri* Sonder

Halyseris crassinervia Zanard.

The specimens were collected by Fullagar at Lord Howe Island, and probably received by Sonder from F. von Mueller, then Government Botanist at Melbourne. Mr. A. W. Jessep, Director of the Melbourne Herbarium, informs me that "Fullagar and Lind were together on Lord Howe Island for nearly a year, about 1873, and collected extensively for Baron von Mueller." He also states that Mueller apparently submitted the Lord Howe algal collections to Sonder.

Zanardini described a number of species from Lord Howe Island, and this specimen in the Melbourne Herbarium agrees very well with his description of *H. crassinervia*, and is sterile. It seems probable that this is an authentic, probably a cotype specimen of *H. crassinervia*. Sonder apparently (from the label) had doubts as to whether it was distinct from his *H. muelleri*, but although closely related it differs in the much darker, wider and more robust thallus.

In Melbourne Herbarium is also a specimen of *H. australis* collected by Fullagar and Lind on Lord Howe Island, which was not however recorded by Zanardini.

Lucas (1935, pp. 209-210, pl. vii, fig. 1) describes and figures what he considered to be *H. crassinervia*. Lucas' specimens (in Sydney and his own herbaria) are clearly *H. australis*, as is shown also by his description, and are quite distinct from the authentic specimen of *H. crassinervia* in Melbourne Herbarium. Apparently Lucas did not collect true *H. crassinervia* on Lord Howe Island, but presumed his specimens must be this species as it was the only one recorded from the island.

D. crassinervia hence is still only known from the sterile Fullagar collection, and Lucas' comments apply to *D. australis*, as do those of May 1946, p. 274.

The other Australian species of *Dictyopteris* are as follows:

D. acrostichoides (J. Agardh) Borgesen from Victoria, Tasmania, Queensland, New South Wales.

D. muelleri (Sonder) Schmitz from Western Australia, South Australia, Victoria, Tasmania.

D. woodwardii (Brown) Schmitz from North Queensland.

In addition the following species from Kangaroo Island is now described.

Dictyopteris nigricans n. sp.

(Fig. 1, pl. xxii, fig. 2)

Thallus 5-20 cm. altus, ramis subdichotomis et parce lateralibus 2-5 mm. latis, adfixus basi rhizoidibus; apices interdum proliferi; costa prominens infra, venis nullis; cumulus paraphysium sparsus in una linea ab utroque latere costae; sporae sparsae in thallo cum angusta et sterili margine; color thalli fuscus.

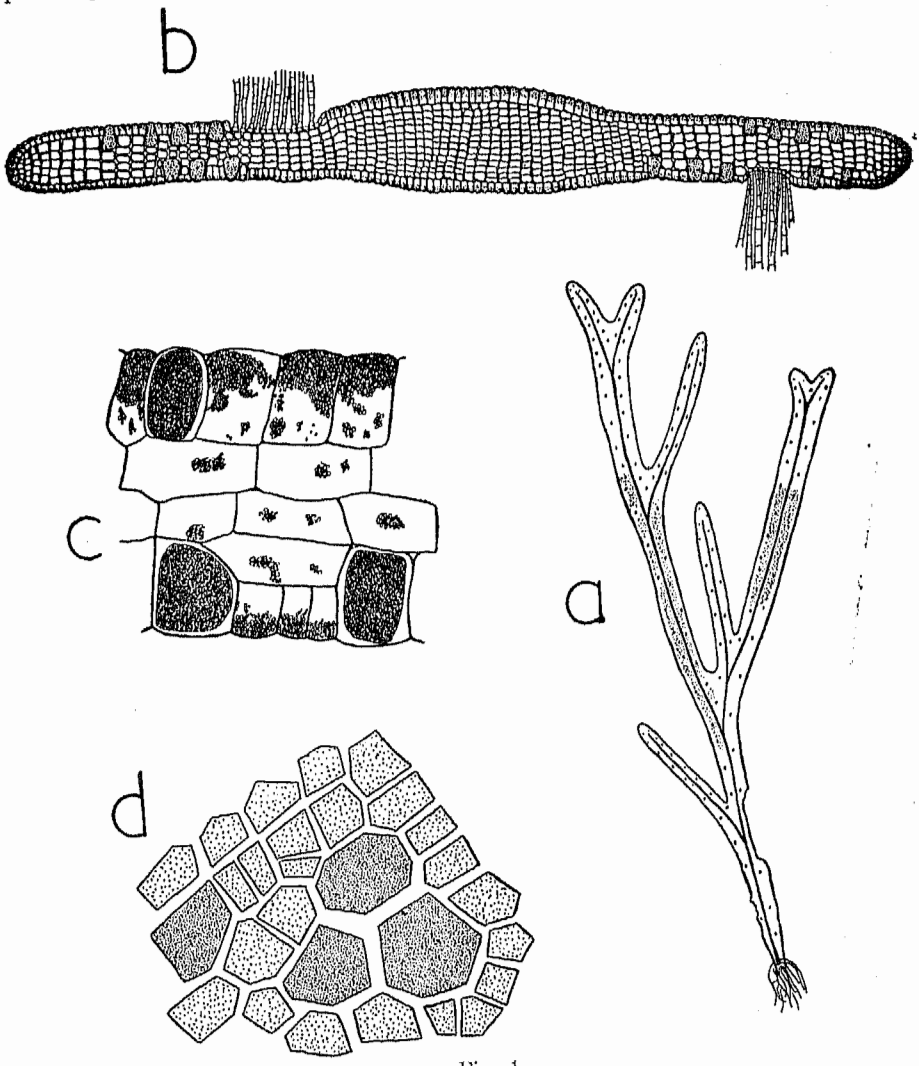

Fig. 1

Dictyopteris nigricans n. sp.: a, Habit, showing hair groups and patches of spores; b, Transverse section of thallus, showing hair groups and spores; c, Section of thallus on a larger scale; d, Surface view of thallus, with spores.

Thallus 5-20 cm. high, usually in tufted masses, subdichotomous with some lateral branches, 2-5 mm. wide, attached at the base by rhizoids; branch tips sometimes proliferous; axils rounded. Midrib conspicuous, lateral veins absent. Hair groups in a single irregular line on each side of midrib. Spores scattered, not on midrib and with a narrow sterile margin at edge of thallus. Colour very dark brown.

LOCALITIES—On Kangaroo Island, South Australia:

Pennington Bay: in deeper pools on reefs, all seasons.

Vivonne Bay: in pools on reefs in the bay, January 1948; drift, January 1949.

West Bay: drift, January 1946.

D. nigricans probably occurs in deeper pools on reefs and in the upper sublittoral along the south and west coasts of Kangaroo Island. The type specimen is A 2296 in the Algal Herbarium of the Botany Department, University of Adelaide.

D. nigricans resembles *D. muelleri* in possessing scattered spores, but differs in the much narrower and darker coloured thallus, with hair groups in a single irregular series on each side of the midrib It resembles *D. acrostichoides* in the spores tending to be in a band on each side of the midrib, with a narrow sterile margin; the thallus of *D. acrostichoides* however is wider and the hair groups tend to occur in recurved arches.

Only 3 or 4 fertile plants of *D. nigricans* have been found in several hundred examined, and the spores in these may not be fully developed as they consist only of large cells with much darker, denser contents, scattered among the epidermal cells, and they do not protrude above the surface (fig. 1, b, c, d).

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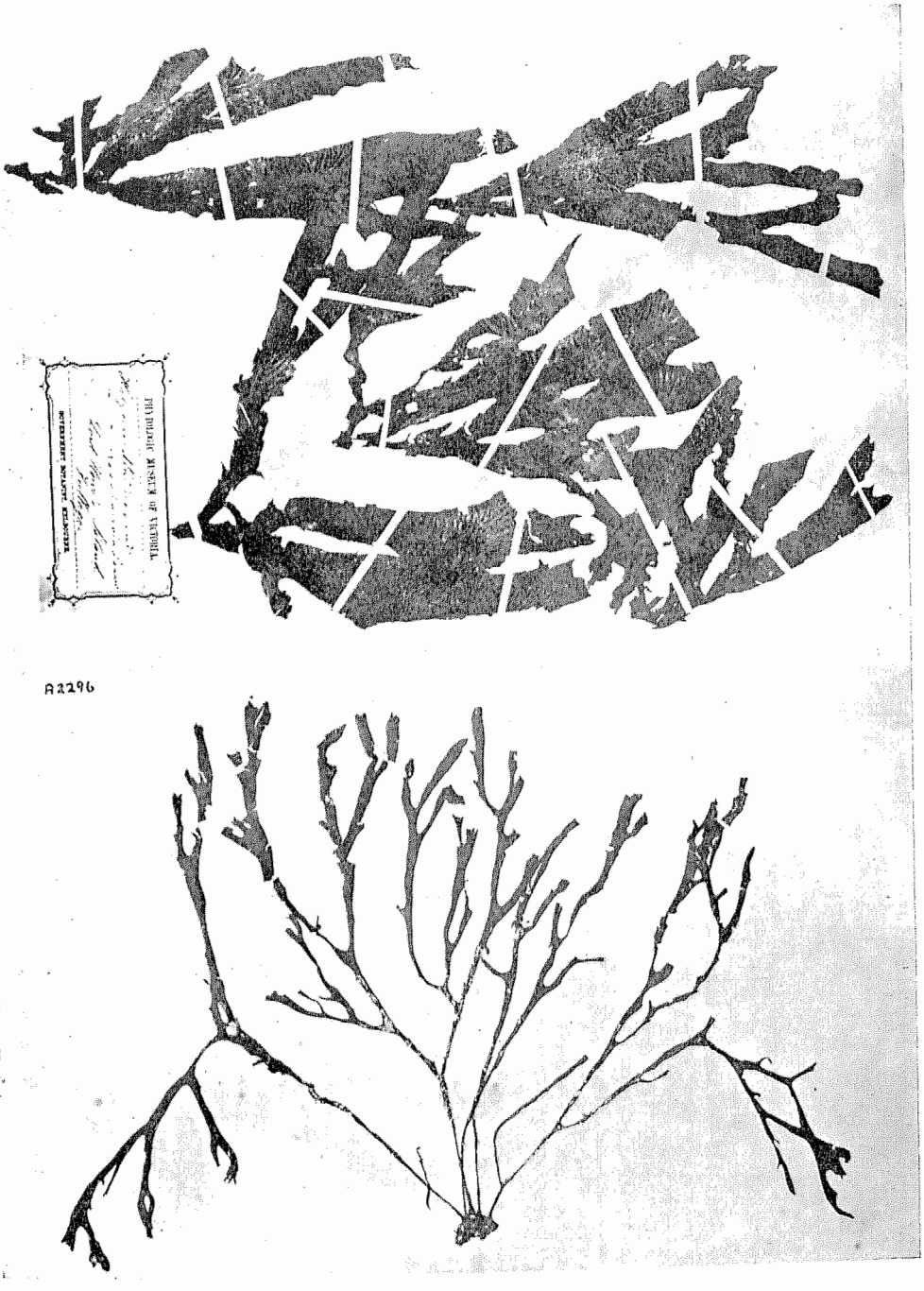

Fig. 1 (above)—An authentic specimen of *D. crassinervia* in Melbourne National Herbarium (x $\frac{1}{3}$).

Fig. 2 (below)—The type specimen of **D. nigricans** (x $\frac{2}{3}$).