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Lenormandiopsis (Rhodomelaceae), newly recorded from Africa, with a description of *L. nozawae* sp. nov. and comparison with other species

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NORRIS, R.E. 1987 *Lenormandiopsis* (Rhodomelaceae, Rhodophyceae), newly recorded from Africa, with a description of *L. nozawae* sp. nov. Jap. J. Phycol. **35**: 81–90.

A rare genus in Japan, Indonesia and along the south and west coasts of Australia, *Lenormandiopsis* Papenfuss has been found in drift and by diving on the northern coast of Natal. The genus is distinctive in the Rhodomelaceae in producing broad blades up to 20 cm long and forming tetrasporangial stichidia in clusters on both surfaces of the blades. Gametophytes have not been found in our collections in Natal. Structure of the plants from one Natalian collection relate them with *L. lorentzii*, a species previously known from Indonesia. Plants in the second collection are a new species named for Mrs. Y. NOZAWA.

Key Index Words: Amansia Group; Aneuria; Lenormandiopsis; *marine algae*; *Natal*; *red algae*; *Rhodomelaceae*; *Rhodophyceae*; *South Africa*.

The *Amansia*-group of the Rhodomelaceae, the largest of the red algal families, is characterized by having dorsiventral thalli of large blades, usually branching and producing reproductive structures in surface-borne branchlets often termed stichidia, at least for male and tetrasporangiate branchlets. The genus *Lenormandiopsis* PAPENFUSS (1967) has the broadest blades in the group (up to 15 cm) and the plants often attain a length of two or more decimeters. The blades may be lobed or proliferous on the margins, where the thallus has been torn or otherwise damaged, but they do not produce regularly formed branches. The size and form of the plants are remarkable, especially when one considers the method of apical growth and the precise formation of tissues in the Rhodomelaceae.

Two species are recognized in *Lenormandiopsis*, *L. latifolia* (Harvey et Greville) PAPENFUSS (1967) and *L. lorentzii* (WEBER-VAN BOSSE) PAPENFUSS (1967). KYLIN (1956) attributed only a single species, *L. lorentzii*, to the genus (known by him as *Aneuria* WEBER-VAN BOSSE, a name that has an older homonym) but PAPENFUSS (1967) corrected this impression and pointed out that the second species, *L. latifolia*, should be recognized as the type species of the genus. Few studies of *Lenormandiopsis* have been published, the most informative being those of WEBER-VAN BOSSE (1923), OKAMURA (1929) and NOZAWA (1965). Tetrasporophytes were described by the first two authors and NOZAWA was the first to describe female reproduction and cystocarps in the genus. Male reproductive structures for *Lenormandiopsis* remain undescribed.

The discovery of specimens of *Lenormandiopsis* from two collections in Natal is especially noteworthy because heretofore the genus has not been recorded in South Africa (SEAGRIEF 1984) and known to occur only in Australia [*L. lorentzii* & *L. latifolia* (MAY 1965)], Indonesia [*L. lorentzii*

(WEBER-VAN BOSSE (1923)] and Japan [*L. lorentzii* (OKAMURA 1929 & NOZAWA 1965)]. There are relatively few specimens described from these localities so information gained from the Natalian specimens may contribute to a better understanding of the genus and its position in the Rhodomelaceae.

Materials and Methods

Specimens used in this study that are in the Herbarium, University of Natal, Pietermaritzburg, are: *L. latifolia* [NU 4102 (female), NU 1779 (tetrasporophyte), Drift, Flinders Bay, Augusta, Western Australia, 19–III–1959 (R.E. NORRIS 3250 a); NU 6450 (tetrasporophyte) Drift, Cowaramup Bay, Yallingup, Western Australia, 17–III–1959 (R.E. NORRIS 2146); NU 2514 (tetrasporophyte) Drift, Robe, South Australia, 16–IV–1959 (R.E. NORRIS 3800)]; *L. lorentzii* [NU 3101 (tetrasporophyte), Drift, Cape Vidal, Natal, 14–VI–1980 (S.R. MEYER)]; *L. nozawae* [NU 9134, NU 9135 (both tetrasporangiate) off Jesser Pt., Sodwana, Natal, by Scuba diving to 47 m, 6–V–1985 (by J.S. Dench, Nat 3210)]. Slides and formalin preserved parts of thalli of *L. nozawae* are also maintained in the collection and slides prepared from dried specimens of all species are also in our collection. Slides were prepared by a method in which the stain, aniline blue, is incorporated into a corn syrup mounting medium (MIN-THEIN and WOMERSLEY 1976).

Results

The Natal specimens come from two collections, one specimen in the drift at Cape Vidal and several specimens obtained from diving at Sodwana, both localities in tropical to sub-tropical regions. The specimen from Cape Vidal (Fig. 10) was from drift material and has characteristics different from the Sodwana specimens (Fig. 1) and two species are present on the coast of Natal. The Sodwana specimens have thalli that are only slightly lobed unbranched blades with coarsely crenulate margins and distal proliferations. The broad blades taper proximally to a narrow (1 mm) stipe up to 1.5 cm long and are attached to a discoid holdfast. A midrib may be present extending from the stipe into the blade for up to 1 cm. The blades have a light red to dark purplish-red colour and often have coatings of bryozoa. The specimen from Cape Vidal is brownish- to blackish-red, lobed distally and with a few coarse crenulate marginal lobes. The blade tapers abruptly proximally to a segment of the thallus that is narrow (0.5 cm) and is broken from the holdfast which is not present. No midrib is present in this specimen and the thallus has no encrusting organisms.

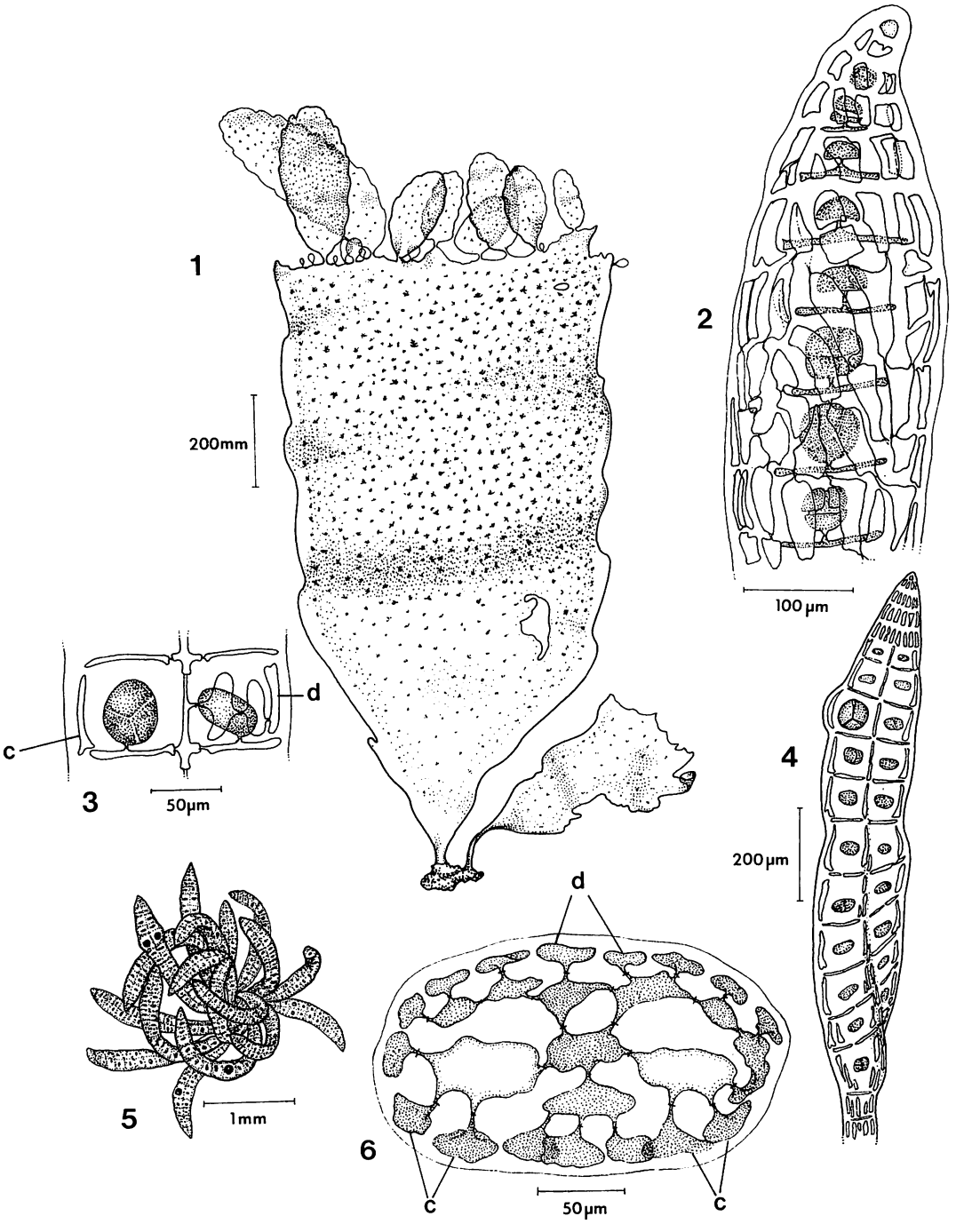
All specimens in the Natal collections are tetrasporophytes. Tetrasporangia are borne in stichidia occurring in clusters on the blade that are clearly positioned in rows in young thalli representing branch axes. In older thalli clusters of tetrasporangial stichidia occur in more irregular patterns over both surfaces of the blade. Tetrasporangial stichidia on the Sodwana specimens' blades are long and slender (1–2 mm × 150 μm) (Fig. 4) whereas the stichidia on the Cape Vidal specimen are shorter (400 × 150 μm) (Fig. 11).

A study was made comparing specimens of the type species of *Lenormandiopsis, L. latifolia* (Harvey et Greville *ex* Harvey) PAPENFUSS (originally described as *Lenormandia latifolia* Harvey et Greville *in* Harvey 1847), from South Australia and Western Australia, with the Natalian plants (Table 1). *Lenormandiopsis latifolia* has large unbranched thalli and the margins are entire with little lobing or crenation (Fig. 12). The blade of *L. latifolia* is thick (up to 400 μm near the stipe) and the cortex thickens secondarily forming up to four cell layers in this proximal region. Thalli of the Natal plants from both collections do not form secondary thickening in the blade in the specimens at hand but the thalli are also up to 400 μm thick (the Cape Vidal

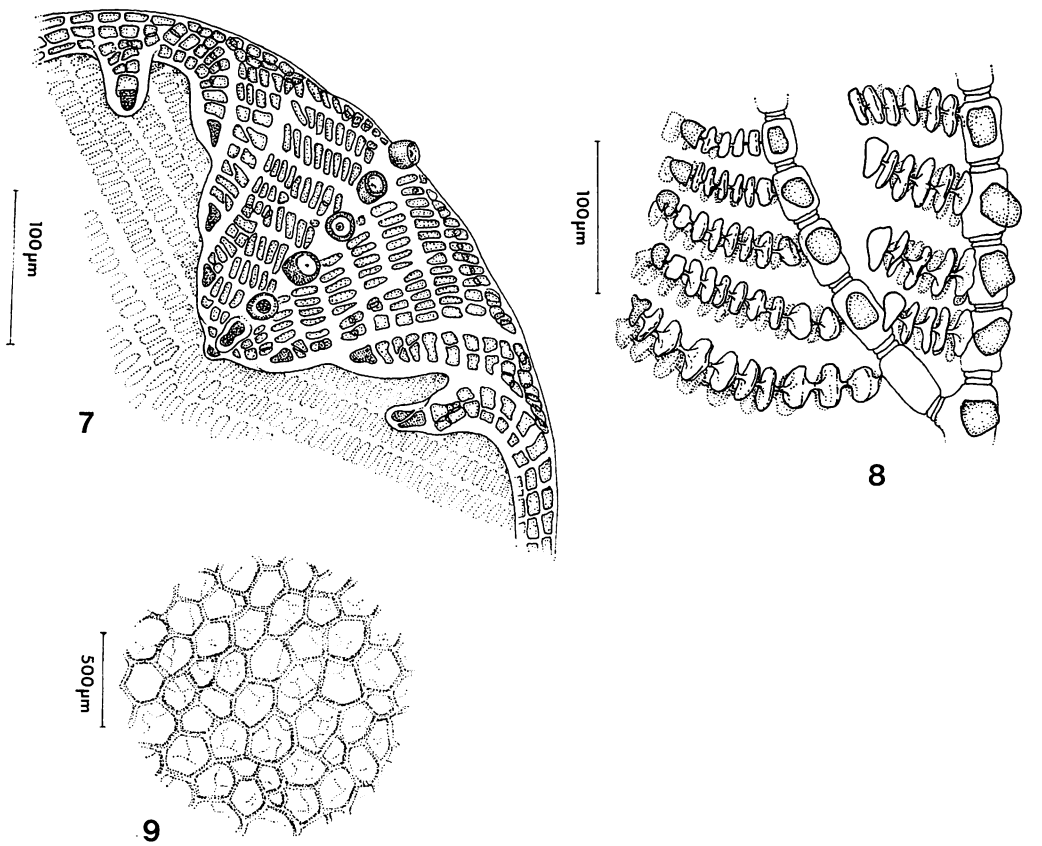
plant was slightly thinner than the Sodwana plants). Dorsiventrality was reflected in the sections of thalli near the stipe in *L. latifolia* in that the dorsal cortex was one to two layers of cells thicker than the ventral (four cell layers on the ventral side and six layers on the dorsal). Thickness of the outer cortical cells is different between the species (those in both Natalian species being 40 μm whereas those of *L. latifolia* are 20 μm) probably because of the secondarily formed ones being smaller due to their probable division without much subsequent growth. Surface cortical cells of *L. latifolia*, 2 cm from the thallus apex, measure up to 50 μm but those of the Natal specimens usually are somewhat smaller, up to 20 μm in the Sodwana plants and up to 25 μm in the plants from Cape Vidal. Medullary cell size is different between the thalli studied. The type species has medullary cells up to 400 μm in their longest dimension whereas this measurement in the Cape Vidal specimen is up to 1000 μm and up to 500 μm in the Sodwana specimens. Lower regions of thalli, when examined with low magnification, reveal a reticulate pattern caused by pericentarl cells, and their derivatives, outlining the larger medullary cells. The pattern in *L. latifolia* is distinctly and regularly rhombic (Fig. 13) whereas in the other two species the reticulum is irregularly polygonal (Fig. 9). The number of these units along the long axis in one millimeter in *L. latifolia* is approximately 6 whereas in the other two species approximately 3–4 units are present in the same space.

Tetrasporangial stichidia are approximately the same size in the Australian and Cape Vidal plants but they are much longer and more slender in the specimens from Sodwana. The Sodwana stichidia have a regular width for most of their length whereas in the Australain and Cape Vidal plants the stichidia are ovoid. Mature tetrasporangia often cause a swelling on the side of the stichidium in the Sodwana specimens sometimes becoming directly exposed, but the sporangia of the other taxa usually remain embedded in the stichidia and the cover cells often become stretched and slender (Figs 11, 15). A reflection of stichidial size is the number of sporangial-bearing segments, up to 12 in the type species, up to 8 in the Cape Vidal plant and up to 29 in the Sodwana specimens. Stichidia are often attached on a raised cushion of filaments in *L. latifolia* but such a structure was not present or less conspicuous in the Natal plants. Cover cells in the Sodwana stichidia are large and distinct, covering the young tetrasporangia. In *L. latifolia* as well as in the Cape Vidal specimen the cover cells are hardly recognizable even at an early stage because they become stretched and displaced in the stichidium. Tetrasporangia of *L. latifolia* are conspicuously smaller (up to 80 μm diameter) than those of the South African plants (up to 120 μm diameter in the specimen from Cape Vidal and up to 90 μm in the Sodwana plants). [A female, cystocarpic, plant of *L. latifollia* in my collection from Flinders Bay, Western Australia, has cystocarps on short polysiphonous branchlets on the thallus surface (Fig. 14). Apparently this is the first report of a cystocarpic plant for the type species of *Lenormandiopsis*.]

These differences between *L. latifolia* and the Natalian plants, therefore, suggest that our species are not the same as the type species and, furthermore, that there are two species occurring in Natal. The deeply lobed thallus illustrated by WEBER-VAN BOSSE (1923) for *L. lorentzii* gives the immediate impression that the Natal specimens are not the same. A similarity between *L. lorentzii* and the Natal plants exists in the characteristic coarse (almost lobed) crenulated margin in the Natal plants, a character that may be distinctive, and such crenulations are present on the Indonesian plant where they are even more prominent but they are not as clear on the figures given by OAKMURA (1929). Tetrasporangia in the illustration provided by WEBER-VAN BOSSE are up to 60 μm in diameter, a size similar to those for *L. latifolia*



Figs. 1–6. *Lenormandiopsis nozawae* R.E. NORRIS *sp. nov.* 1. Holotype specimen, tetrasporangiate, drawn before drying for the Herbarium. Note the tetrasporangial stichidia in clusters on the thallus surface. 2. Terminal region of a tetrasporangial stichidium. Note the torsion in the rows of sterile external cells. 3. Optical section of a stichidium showing a pair of bearing pericentral cells and their tetrasporangia in one segment. One cover cell (c) is shown and a single dorsal pericentral cell and its derivatives (d). 4. A single tetrasporangial stichidium showing its elongate form and many segments. 5. A cluster of tetrasporangial stichidia. 6. Cross section of a tetrasporangial stichidium showing five pericentral cells attached to the axial



Figs. 7–9. *Lenormandiopsis nozawae* R.E. NORRIS sp. nov. 7. Inrolled apex of thallus showing laterally fused branch tips and scar cells on primary axial cells that are derived from bases of deciduous single-celled trichoblasts. 8. A small part of the thallus near thallus apex before secondary thickening is initiated showing 2 branch axes each bearing a pair of branches unilaterally and dorsal and ventral (not shown) pericentral cells. 9. Surface configuration of thallus near the stipe showing polygonal units representing cortical thickening between medullary cells. (This configuration is also characteristic of *L. lorentzii*).

rather than *L. lorentzii*.

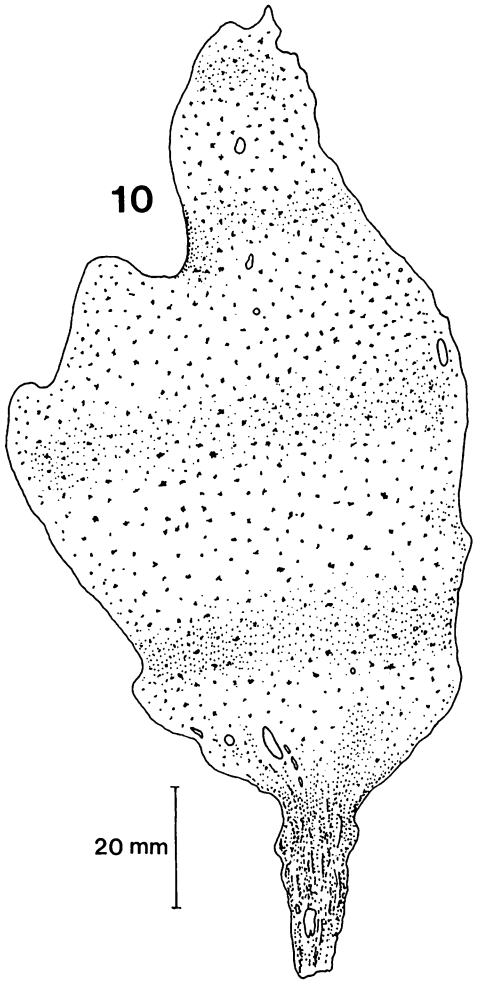
OKAMURA (1929) gave good illustrations of Japanese specimens that he assigned to *L. lorentzii*, but his specimens were not as highly branched as the specimen illustrated by WEBER-VAN BOSSE (1923), a type of plant that he did not find in Japan. NOZAWA (1965), however, described a specimen from deep water collected by Dr. Tanaka from Yoron Island, Japan, that was large and with many branches, and she tentatively identified her specimens as *L. lorentzii*. Mrs. NOZAWA gave additional information on the Japanese plants, describing female reproductive structures and cystocarps for the genus for the first time, pointing out that midribs can be observed in her specimens, although they are often indistinct, and showing that tetrasporangial stichidia have 4–5 sporangial chamber pairs (up to 8 were described for *L. lorentzii* by WEBER-VAN BOSSE).

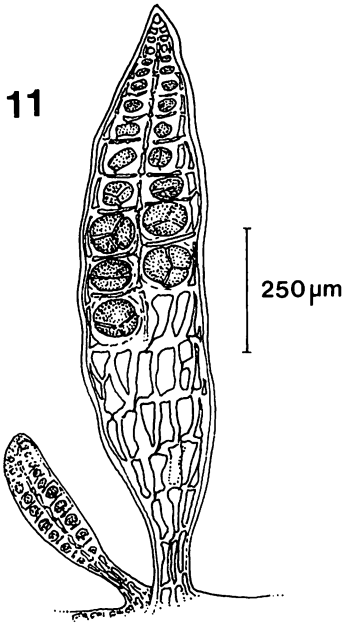
The Cape Vidal plant undoubtedly is different from the specimens collected at

cell. The two opposite larger pericentrals are the bearing cells each with 2 cover cells and secondary pit connections to derivatives of the two dorsal pericentrals (upper). These and other derivatives of the dorsal pericentrals (d) form an extensive cover on that side of the stichidium. Derivatives on the single ventral pericentral cell (lower) form a less extensive tissue.

Sodwana and the plants in both Natal collections are different from the type species, *L. latifolia*. The lobed thallus of the Cape Vidal plant, its anatomy and tetrasporangial stichidia suggest that it may be close to *L. lorentzii*, especially considering the expanded description of the species from the Japanese investigators. At the present time, therefore, I consider this specimen to be tentatively assigned to *L. lorentzii* and it is hoped that more specimens may soon be found in Natal that can bring the identity into a clearer focus.

The specimens collected in deep water at Sodwana, however, have characters that set it well apart from both the type species and the specimen from Cape Vidal. The thallus habit does not have a tendency to branching except for distal proliferations on older blades and the extremely long and slender tetrasporangial stichidia are very different from those on the Cape Vidal plant. Specimens from this collection are considered to be an undescribed species and it is hereby given the name *Lenormandiopsis nozawae* sp. nov. in honor of the late Mrs. Y. NOZAWA of Kagoshima, Japan the person who most recently added to our knowl-





Figs. 10, 11. *Lenormandiopsis lorentzii* (Weber-van Bosse) Papenfuss. 10. Habit of thallus collected at Cape Vidal in Natal. Note lobes on thallus margin and clusters of tetrasporangial stichidia. 11. Two tetrasporangial stichidia.

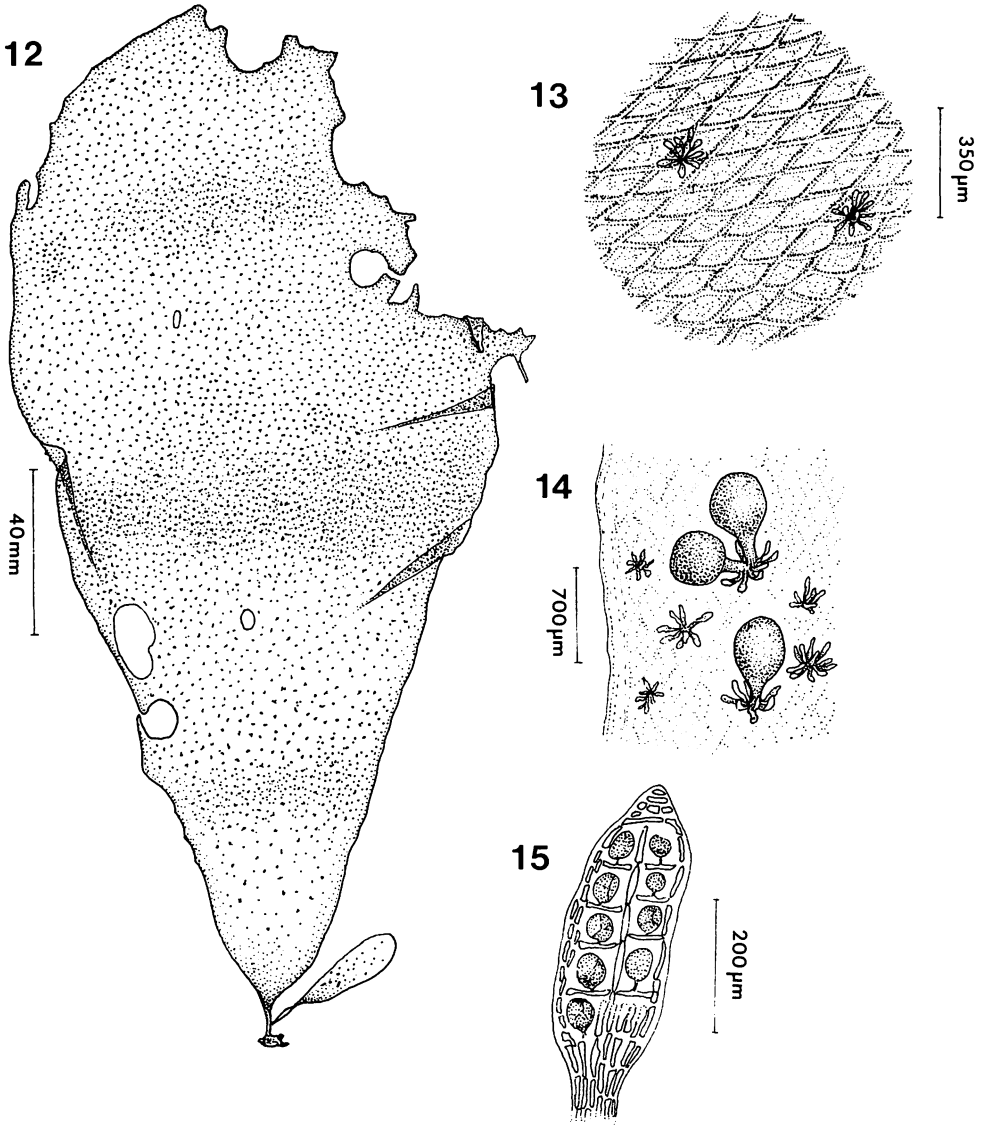
edge of the genus.

Diagnosis

Lenormandiopsis nozawae R.E. Norris sp. nov.

Thalli usque ad 20 cm alt., 7 cm lat., saxicoli, elaminis singulis per hapteron discoideum affixis constituti; laminae el-

lipticae ad lineares, interdum cuneiformes factae post noxam apicalem; proximaliter attenuatae ad stipitem brevem usque ad 1.5 cm long.; costa brevis ad stipitem contigua interdum visa; margo grosse crenatus, plerumque sine proliferationibus, thalli post noxam, autem, multae laminas proliferas distaliter saepe efficientes; cellula apicalis ad cacumen sectionis thalli paululum in-



Figs. 12–15. *Lenormandiopsis latifolia* (Harvey et Greville) Papenfuss. 12. Habit of a tetrasporangial thallus. 13. Rhombic pattern of units formed by cortical thickening outlining the medullary cells near the stipe of a tetrasporangial thallus. 14. Surface view of a small segment of a female thallus showing clusters of branchlets, some bearing cystocarps. 15. A tetrasporangial stichidium.

volutae ramos primarios lateraliter efficiens, his ramis cum parte axiali principali, crescentia alarum bilateralum coalitarum in axibus et axis principalis et eius ramorum, semper coniunctis; rami in thallo auctu excrescentiarum crassarum crenulatarum, omni cellula apicale terminata, visi. Stichidia tetrasporangialia utro in latere effecta axium secondarium in ordinibus in thallis iuvenibus manifestis. Thalli venustiores fertiles habent stichidia ut videntur sparsa sine ordinatione, relinquent, autem, in lamina marginem sterilem. Stichidia tetrasporangialia acerosa tetrasporangia bina nata, usque ad 29 segmenta facientia habentia; cellulae obtegentes magnae rectangularesque per longitudinem segmenti extensae; omnis cellula axialis stichidiorum quinque cellulas pericentrales ferens, duabus sporangia ferentibus, quae maxim proximalia in segmento et tribus cellulis sterilibus pericentralibus, magis distaliter positis, una in latere ventrali atque duabus in latere dorsali ferentes; omnis cellula pericentralis fertilis, duas cellulas obtegentes, quae plerumque semper non divisae, efficit, hae, autem, postea interdum se subdividunt; steriles cellulae pericentrales aliquot cellulas corticatentes externales faciunt; numerosiares cellulae corticantes dorsali in latere, procreatae frugibus duarum cellularum pericentralium sterilium, stichidium illo in latere convexum fieri efficiunt et structura ventraliter flectere efficunt.

Nomen huius algae dominam demortuam Y. NOZAWA loci Kagoshima City dicti honorat.

Specimen typicum NU 9135, specimen A (tetrasporophyta) isotypi adsunt in eadum paginam et NU 9134.

Thalli to 20 cm high, 7 cm broad, saxicolous, single blades attached by a discoid holdfast; blades elliptical to linear, sometimes becoming cuneiform if apically injured (Fig. 1); tapered proximally to a short stipe up to 1.5 cm long; a short midrib sometimes evident adjacent to the stipe; margin coarsely crenate, usually without proliferations but injured thalli often having many proliferous blades produced distally; apical cell at the tip of a slightly inrolled section of the thallus, producing primary branches laterally that remain united to the main axial part by development of fused bilateral wings on axes of both the main axis and its branches; branches evident in thallus by development of coarse crenulate outgrowths each terminated by an apical cell and together forming a sinuate margin. Tetrasporangial stichidia (Figs 2–5) produced on both sides of secondary axes in rows evident in young thalli. Older fertile thalli have stichidia that appear to be scattered without a pattern but leaving a sterile margin on the blade. Tetrasporangial stichidia acerosate (Figs 4, 5), having tetrasporangia borne in pairs (Fig. 3) forming up to 29 segments (Fig. 4); cover cells large and rectangular (Fig. 2), extending the length of the segment; each axial cell of stichidia bearing five pericentral cells (Fig. 6), two bearing sporangia, that are most proximal in the segment (Fig. 3), and three more distally placed sterile pericentral cells, one on the ventral side and two on the dorsal side (Fig. 6); each fertile pericentral cell produces two cover cells that usually remain undivided but may, in later stages of development, subdivide; sterile pericentral cells from several external corticating cells; the more numerous corticating cells on the dorsal side (Fig. 6), derived from two sterile pericentral cells, causing the stichidium to be convex on that side and the structure to bend ventrally.

Named in honor of the late Mrs. Y. NOZAWA of Kagoshima City.

Type specimen (Holotype) NU 9135, specimen A (a tetrasporophyte). Isotypes present on the same sheet and NU 9134.

Type locality: Natal, Ubombo Distr., Sodwana, off Jesser Point. Coral and sand substrate, depth 46–47 m. (6–V–1985) coll. by J.S. Dench.

Additional Observations on L. nozawae

Structure of the thallus apex has been studied to determine some aspects of development of the vegetative system. The inrolled tip of the plant (Fig. 7) encloses an apical system that is typical for the Amansiae, having secund regularly formed branches (Fig. 8) that remain fused together developing a winged axis that is not heavily corticated but a midrib visible to the unaided eye is usually not present. Axial branches also are formed but they are not discernible because they and their branches are incorporated into the single large blade that is the thallus of this species. Lateral axial branch tips often terminate in a short polysiphonous axis that develops from a trichoblast and the branch sometimes develops into a tetrasporangial stichidium. The apical region of each axial branch (Fig. 7) forms a small lobe on the margin that gives the thallus a coarsely crenate or sinuate aspect. Axial cells each form five pericentral cells, two dorsally, two larger ones laterally and a single smaller ventral pericentral cell. Division of pericentral cells occurs giving the thallus a single, sometimes two layers of cortication in most regions. Trichoblasts occur on most every segment of the axis in apical regions, the trichoblast being reduced to a single protuberant cell and a stalk cell that becomes a scar cell in later stages when the trichoblast degenerates (Fig. 7). Scar cells are easily recognized on the dorsal side of the axis by the thick protuberant wall that surrounds the base of the trichoblast, the structure being maintained and recognizable even in considerably older parts of the axis.

Clusters of branched trichoblasts develop on both surfaces of the thallus and seem to at first be restricted to lines representing the branch axes, excluding the midrib, but older parts of thalli develop them in less regular patterns. The trichoblasts become polysiphonous basipetally forming small branched trichoblasts on the polysiphonous segments. The trichoblasts are deciduous leaving scar cells similar in structure to those described for the thallus axis. The polysiphonous sections continue growth to form a stalk and eventually a long cylindrical tetrasporangial stichidium that is typical for this species. Development of the stichidium is described above and is formed in a dorsiventral manner similar to the thallus apex.

Acknowledgements

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Richard E. NORRIS：アフリカ新産のスジナシグサ *Lenormandiopsis* 属（紅藻，フジマツモ科）の新種 *L. nozawae* sp nov. の記載，及び他種との比較

日本，インドネシア，及びオーストラリア南，西海岸に稀産する *Lenormandiopsis* 属の2種がアフリカ，ナタールの北岸で発見された。20 cm 以上になる幅広い葉状体を持ち，葉状体の両面に四分胞子をつけるスティキジアを房状に形成する点で，本属はフジマツモ科の中でも顕著な属である。ナタールのコレクション中に配偶体は見出されなかった。今回報告した第1の種はインドネシアなどから知られているスジナシグサ *L. lorentzii* と考えられ，第2の種を新種として *L. nozawae* と命名した。(Department of Botany, University of Natal)

新 刊 紹 介

Croasdale, H & E. Flint Flora of New Zealand Desmids-Volume 1.

Government Printing Office, Publishing Warehouse, PO Box 14-277, Kilbirnie, Wellington, New Zealand

美しい雪山を背景とした湖水から浮び迫ってくるデスミッドの水彩画をカバーにしたこの書物は，単細胞ながら美しくも多様に形態分化した数多くの種類を含む鼓藻類とニュージーランドの自然の魅力を漂わせたユニークな存在である。第一巻 *Cylindrocystis*, *Mesotaenium*, *Netrium*, *Roya*, *Spirotaenia*, *Closterium*, *Euastrum*, *Genicularia*, *Gonatozygon*, *Micrasterias*, *Penium*, *Pleurotaenium*, *Tetmemorus*, *Triploceras*, 第二巻（予定）*Actinotaenium*, *Cosmarium*, *Cosmocladium*, *Spinocosmarium*, *Xanthidium*, 第三巻(予定) *Staurastrum*, *Staurodesmus*, *Arthrodesmus* の3部作の最初の巻であり，14属218分類群が含まれている。序文（vii-xii）に続く本文は，地図2葉を含む植生や水質等の環境条件を附記した採集地のリスト（1～27頁），属及び種の検索表及び属の解説を含む分類群の記述（29～110頁），用語の説明（111と112頁），文献表（113-125頁）及び索引（127～132頁）から構成されており，その後に左頁に種名，右頁にスケッチ図を配した見開きの27プレートが続き，終っている。他に9葉のカラー写真の5頁が挿入されており，未だ彼地に足を踏み入れたことのない読者の臨場感を誘っている。世界的な2人の才媛の長年の努力の結晶のひとつが誕生したことを喜ぶとともに続く2作のできるだけ早い刊行を祈りたい。著者の1人のハンナ・クロアスダールは80歳を過ぎてもなおデスミッドの魅力に憑れ，精力的に仕事を続けられていると聞いていたが真に感慨深いものである。（東大・応微研　市村輝宜）