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MARINE ALGAE OF ST. MARTIN'S ISLAND, BANGLADESH. VIII. NEW RECORDS OF RED ALGAE (RHODOPHYCEAE)

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Key words: Seaweeds, Red algae, *Dudresnaya hawaiiensis*, St. Martin's Island, Bangladesh

Abstract

Ceramium brevizonatum var. *caraibica* Peter. *et* Børg., *Dasya corymbifera* J. Ag., *Dudresnaya hawaiiensis* R.K.S. Lee, *Chrysymenia agardhii* Harv. and *Hypnea boergesenii* Tanaka are recorded and described for the first time from the St. Martin's Island, Cox's Bazar, Bangladesh.

Introduction

Recently, four species of *Acrochaetium* including a new species *A. nurulislamii* A. Aziz *et* S. Islam 2009 have been reported. The authors on further examinations of the samples came across five taxa of red algae which on examination were found to be not recorded earlier from the Bangladesh territory. Thus, the total number of red algae reported from Bangladesh is 93 (Ahmed *et al.* 2009, Aziz and Islam 2009). These species are described and illustrated.

Materials and Methods

Several marine algae were collected from the littoral (exposed and knee-deep water below low tide mark) zone of the St. Martin's Island, Cox's Bazar district, Bangladesh on 6 January, 2006 by Dr. Abdullah Harun Chowdhury, University of Khulna. The algal materials were preserved with 4% formalin in marine water.

Results and Discussion

Ceramium brevizonatum var. *caraibica* Peter. *et* Børg., *Dasya corymbifera* J. Ag., *Hypnea boergesenii* Tanaka, *Chrysymenia agardhii* Harv. were found to be growing on exposed rocks, shells and stones collected from the coast of St. Martin's Island, Bangladesh. *Dudresnaya hawaiiensis* R.K.S. Lee, was found in a collection of drifted forms, a first report from Asia. The descriptions and illustrations of these taxa are given below.

Class: Rhodophyceae; Order: Ceramiales; Family: Ceramiaceae
Genus: *Ceramium* Roth

1. *Ceramium brevizonatum* var. *caraibica* Peter. *et* Børg. **(Fig. 1A-F)**

(Joly 1965, 192, Pl. 38, Fig. 498-501; Taylor 1960, 527, Pl. 67, Fig. 7-9)

Habit: Plants profusely branched forming dense tuft thallus, 4-7 cm tall.

Vegetative structures: Thalli dichotomously branched, apices forcipate and very strongly incurved. The nodes well separated, 28.56 - 35.70 µm long and 71.40 - 85.68 µm broad, composed of 2 - 3 rows of irregular cells, the cells of the upper row much smaller than those of the lower row. Lowest row of very large cells, 25.00 - 28.56 µm long, 21.42 - 35.70 µm broad basally and 14.28 -21.42 µm broad distally.

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Reproductive structures: Tetrasporangial sori secund, more than at one each node, ballon-like, tetraspores cruciate, 1 - 3 at each node, partially covered by short involucral branchlets at the base, 128.5 - 114.2 µm long and 57.12 - 71.40 µm broad.

Discussion: Presence of broadest nodal cells basally, smallest distally, formation of ovate tetrasporangia with cruciate tetraspores and single layered involucres resembles with *Ceramium brevizonatum* var. *caraibica* Peter. *et* Bøergesen. There are 113 accepted species of the genus *Ceramium* Roth in the species database at present.

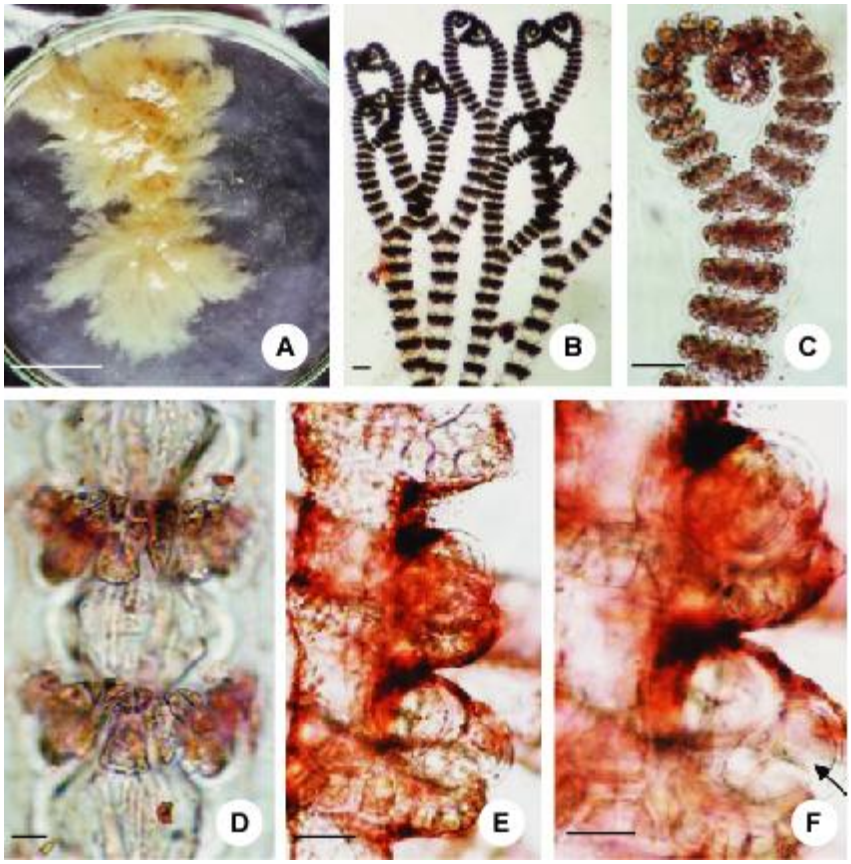

Fig. 1A-F: *Ceramium brevizonatum* var. *Caraibica* Peter. *et* Børg. A. Habit of a whole plant submerged in water. B. Upper part of a thallus showing dichotomous branching. C. Strongly incurved forcipate branch apex (enlarged). D. Enlarged portion of two nodes, showing three layers of cells in each node; internodes with longitudinal cytoplasmic strands but no cortications. E. Secund tetrasporangial sori developed from nodes with short involucral branchlets at the bottom. F. Enlarged tetrasporangia showing the cruciate tetraspores (arrow). (Bar A = 2 cm, B-F = 50 µm.)

Habitat and local distribution: The genus *Ceramium* is almost exclusively marine growing on rocks, widely distributed on most coasts, occurring from intertidal to deep-water situations under almost every ecological conditions. Collection No. 214; common.

Geographical distribution: Atlantic Island: Bermuda; North America: Florida, Mexico; Central America: Belize; South America: Brazil, Venezuela; Caribbean Islands: Barbados, Caribbean, Cuba, Dominican Republic, Hispaniola; Africa: Tanzania; Indian Ocean Islands: Seychelles.

Class: Rhodophyceae; Order: Ceramiales; Family: Ceramiaceae

Genus: *Dasya* C. Ag.

2. *Dasya corymbifera* J. Ag. **(Figs. 2A-E)**

(Taylor 1960, 559, Pl. 46, Figs. 4, 5)

Synonym: Callithamnion corymbiferum (Kütz.) Trev., *Dasya venusta* Harv.

Habit: Plants profusely branched, dark red, 5.0 - 8.0 cm high.

Vegetative structures: Thalli with spirally disposed branches on the main axes somewhat denuded below, axis 122 - 143 µm broad, with closely placed ramelli at distal ends; ramelli dichotomously to subdichotomously branched, on the upper portion of the axis partially corymbose; the lower cells of ramelli 50.00 - 78.54 (- 100) µm long and 71.40 µm broad, in the upper segments exceedingly delicate, 600 - 800 µm long and 40 - 50 µm broad, gradually tapering and strongly incurved, distal cells of basal ramelli produced into rhizoid like structure, tip cells blunt, the first dichotomy forms 90 - 180˚ angle.

Reproductive structures: Stichidia usually on one celled stalk, cone-shaped to lanceolate with acute apex, about 290 - 400 µm long and 100 - 110 µm broad; sporangia produced acropetally, 4 - 5 at each node.

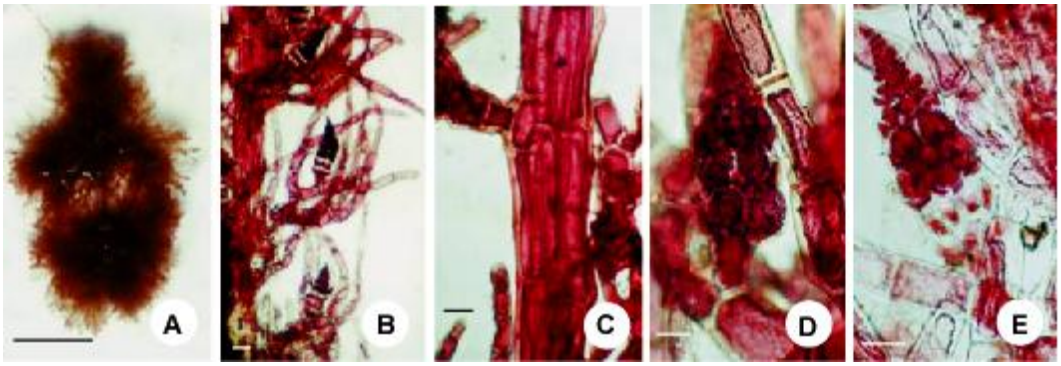

Fig. 2A-E: *Dasya corymbifera* J. Ag. A. Habit of a whole plant submerged in water. B. A portion of main axis with three branches and stichidia one in each. C. A portion of an axis showing polysiphonous nature and origin of branches. D-E. Stichidia at different stages of tetraspore formation and release; two empty lower rows in Fig. E of the stichidia. (Bar A = 2 cm, B-E = 50 µm)

Discussion: The structure, pattern and measurement of ramelli and shape and position of stichidia are very much close to *D. corymbifera* J. Ag. but differs only in pattern of branching and substantial cortication by rhizoids. There are 238 species names of *Dasya* C. Ag. in the species database at present, of which 80 have been flagged as currently accepted taxonomically.

Habitat and local distribution: The alga grows on rocks; it is an intertidal to deep subtidal genus of sub-polar to tropical waters, world-wide distribution. Collection no. 213; common.

Geographical distribution: Atlantic Island: Bermuda; North America: Florida; Caribbean Islands: Hispaniola, Virgin Island.

Class: Rhodophyceae; Order: Cryptonemiales; Family: Dumontiaceae
Genus: *Dudresnaya* Crouan & Crouan

3. *Dudresnaya hawaiiensis* R.K.S. Lee **(Figs. 3A-N)**
(Lee 1963, 315, Figs. 1-11; Robins and Kraft 1985, 15, Figs. 44-89)

Habit: Plants dull red to pink, mucilaginous distally; branched and can reach 6.0-8.0 cm high.

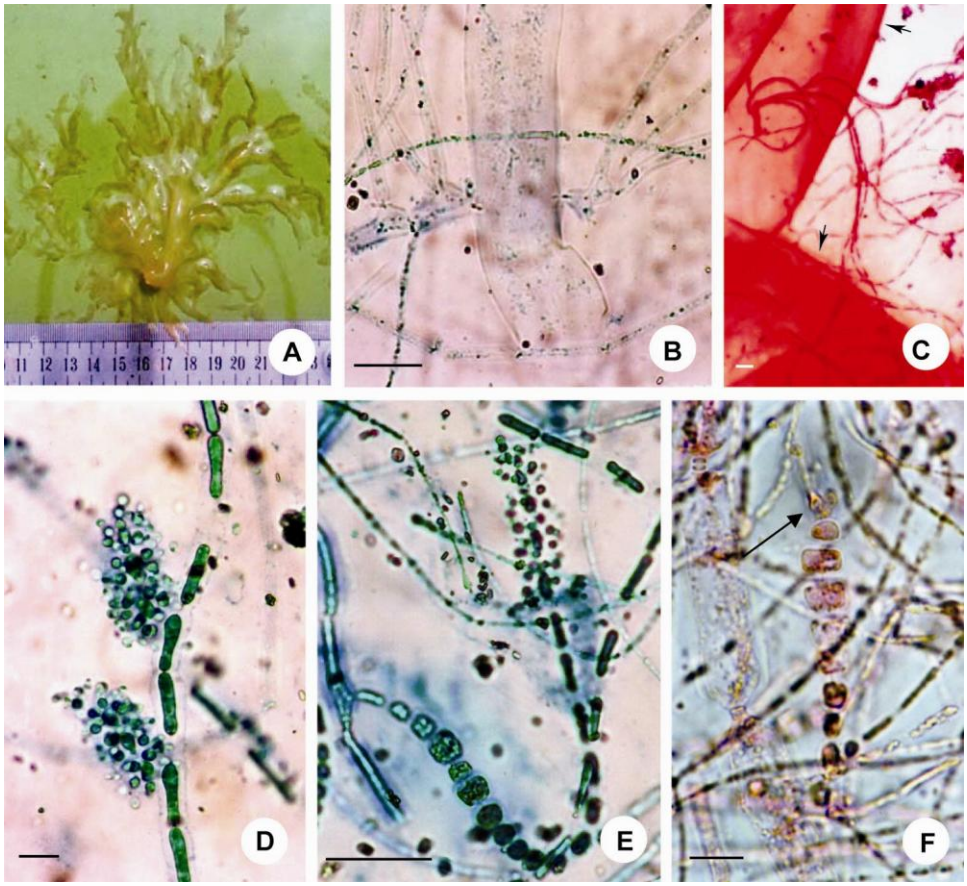

Fig. 3A-F: *Dudresnaya hawaiiensis* R.K S. Lee**.** A. A whole thallus, where some branches on the left is torn off. B. A portion of primary axis bearing opposite branches and rhizoidal filaments; C. Mucilage sheath surrounding cortical filaments (arrows) and a detached profusely branched cortical filament. D. Two spermatangial branches from two cells of a cortical filament. E. Auxiliary-cell filament whose terminal cells produced spermatangial sorus. F. A mature carpogonial filament, note the carpogonium (arrow). (Bar B = 5 mm, C = 100 µm, D-F = 50 µm)

Vegetative structures: Thalli composed of 1 - 3 orders of irregularly radial laterals, branches gradually narrowed, the main axis 7.00 - 10.00 mm broad. The higher-order branches are generally slightly compressed, rarely terete, and never annulate. Margins of the thallus poorly definite, and apices are bifurcate (Fig. 3A). Central (primary) axial cells produce whorls of 2 - 5 cortical laterals/assimilatory filaments that branch sub-alternately or pseudodichotomously at first but can later develop a distinct (secondary) axis with opposite branching. Outer cortical cells cylindrical,

63.50 - 83.82 µm long and 15.24 - 17.78 µm broad (Fig. 3B). The assimilatory filaments are surrounded by soft, thick mucilage (Fig. 3C).

Secondary axes grow towards the branch apex and may be almost indistinguishable from the primary axis. Normally, many secondary axes are produced, often obscuring the true central axial filament and giving the plant an almost multiaxial appearance. Neither primary nor secondary axes are obviously percurrent. Axial cells 117 - 140 µm long and 53.34 - 55.88 µm broad.

The basal cells of any cortical lateral (including reproductive filaments) may produce up to four rhizoidal down-growths that are simple or sparingly pseudodichotomous and do not produce cortical laterals. Rhizoids remain narrow, rarely exceeding 10.00 µm in diameter. In thick parts (basal) of the thallus, inner cortical cells may become rhizoidal in appearance (Fig. 3B).

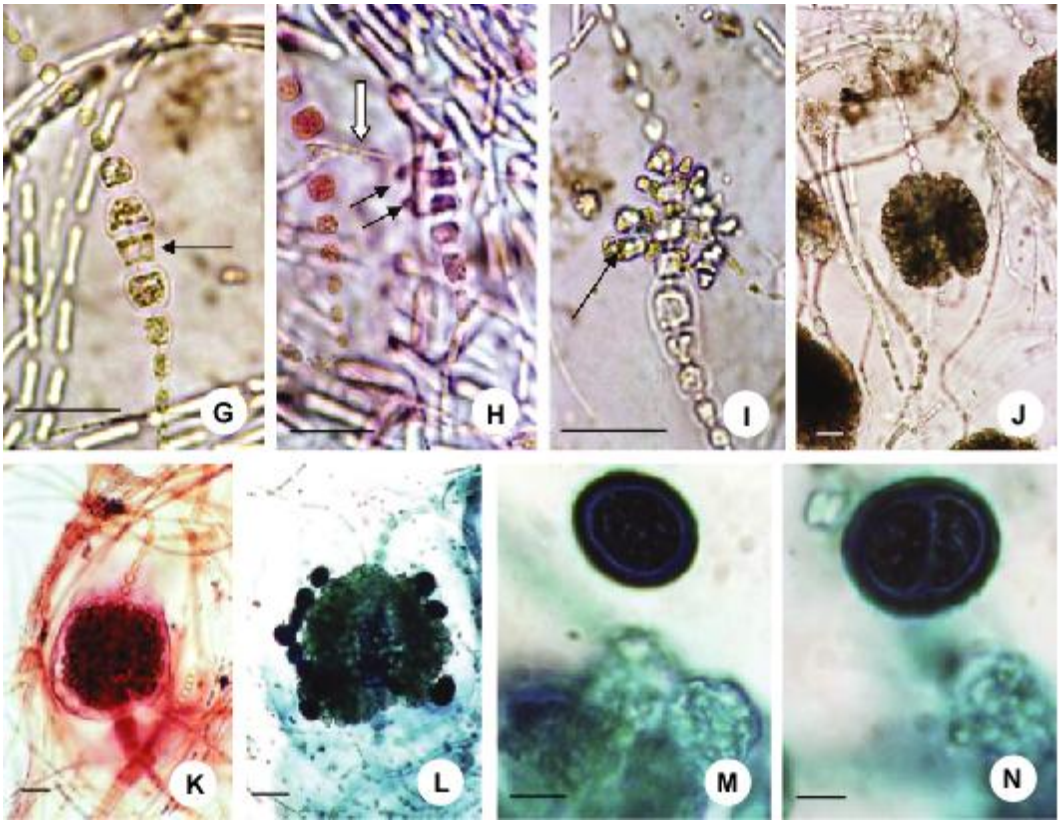

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Fig. 3G-N: *Dudresnaya hawaiiensis* R.K.S. Lee. G. A mature auxiliary-cell filament with a generative auxiliary cell (arrow) between large nutritive cells. H. A carpogonial filament on the right side with 3 - 4 fusion cells (arrows) and a primary connecting filament (block arrow) made contact with generative auxiliary cell of an auxiliary-cell filament on the left hand side. I. Diplodized generative auxiliary-cell producing gonimoblast initials (arrows). J. A mature cystocarp. K. A mature cystocarp surrounded by thick mucilage coat. L. Carpospores developed from gonimoblast filaments of the cystocarp. M. A mature carpospores. N. A divided carpospore. (Bar G-L = 50 µm, M-N = 10 µm)

Reproductive structures: Gametophytes monoecious, with spermatangia produced from cortical cells on spermatangial filaments which may arise anywhere in the cortex (Fig. 3D) and at times, on the sterile distal portion of auxiliary-cell filaments (Fig. 3E). Such 'special' filaments appear to be modified female reproductive filaments. Spermatangial mother cells are borne in double whorls of 3 - 4 cells around each fertile axial cell and give rise to three spermatangia.

Female reproductive filaments arise throughout the inner cortex, usually replacing nomal vegetative filaments. Young reproductive filaments appear as a single file of discoid or barrel-shaped cells, often in great profusion. Mature carpogonial filaments are composed of 5 - 15 cells (of which 3 - 10 are specialized) and are terminated by a carpo-gonium with a long flexuous trichogyne (Fig. 3F). The trichogyne is multicellular, in some cases appearing to revert to a vegetative cortical filament. After initiation of the trichogyne, the carpogonium may undergo a single oblique division; hypogynous cell is generally of greater diameter than the carpogonium, which is positioned obliquely on the inner side of the curved filament. Cells 3 and 5 of the carpogonial filament are generally somewhat inflated and darkly stained (Fig. 3G).

Auxiliary-cell filaments are composed of 3 - 20 cells, of which 8 or more are highly modified (discoid, inflated and darkly stained) and, together with other adjacent cells, becomes surrounded by a thick mucilage coat (Fig. 3K). The generative auxiliary cell (Fig. 3G) is flattened, rectangular, and smaller, often slightly wider (6.35 - 10.16 μm) at its distal end, and lies between two very darkly stained large cells (17.78 × 12.70 μm), which function as 'nutritive' cells. Mucilage is often especially thick around these 'nutritive' cells. The auxiliary-cell filament produces a long terminal file of normal outer cortical cells at its distal end, sometimes produce spermatangial sorus.

After fertilization, the trichogyne becomes plugged at its base and most of the carpogonial protoplasm goes into the production of a primary connecting filament. This connecting filament fuses with 1 - 3 nutritive auxiliary cells (any of cells 1 - 5 in the carpogonial filament), and secondary connecting filaments arise from the resulting fusion complex (Fig. 3H). In these cases, secondary gonimoblast cells developed directly from generative auxiliary cell.

Secondary connecting filaments fuse laterally with generative auxiliary-cells. The portion of connecting filament inflates laterally from the auxiliary cell, which remains distinct from this protrusion even after the carposores have been shed. Globular gonimoblast-initials (Fig. I) are formed successively, either in close aggregation or quite separately, from the swollen segment of fused connecting filament. The mature cystocarp can reach 203 μm in diameter (Fig. 3J, K) and is composed of compactly arranged, spherical to ovoid carposporangia (Fig. 3L). The carpospo-rangial mass normally maintains a narrow slit, only rarely encircling the auxiliary-cell filament completely. Carpospores thick walled, commonly germinate within the mother plant, producing a protonema from one or both products of an initial transverse division (Fig. 3M, N).

Discussion: Dudresnaya hawaiiensis is the anatomically variable of all *Dudresnaya* species. The holotype, with its many small ovate lateral branches (Lee 1963), is apparently atypical, as most of the Australian and Hawaiian material is considerably less compact. The broad range of plant habits and internal morphology reflects the extreme lability and often poor differentiation of reproductive and vegetative filaments and the seemingly unprogrammed interconversion of determinate and indeterminate filaments. Present material differs from Australian material having definite thalllus covered by thick mucilage coat, gradually narrowed into bifurcate apices and a spherical carposporophyte. But the Australian material with rather indefinite thallus surface due to the long exerted cortical filaments and apices are obtuse, and carposporophytes angular. The species is the first report from Asia. There are 30 species names of the genus *Dudresnaya* Crouan & Crouan in the species database at present, where 17 are correctly accepted taxonomically.

Habitat and local distribution: This is a subtidal genus of tropical, subtropical and warm temperate seas of the world, it can be epilithic, epiphytic or epizoic. Usually a (late winter-) spring-summer (-early fall) ephemeral. The genus is recorded for the first time from Bangladesh and Asia. The alga was collected as drifted form; collection no. 215.

Geographical distribution: The species is reported from Pacific islands, South Africa, Australia and New Zealand, thus a new record from Asia (Bangladsesh).

Class: Rhodophyceae; Order: Rhodymeniales; Family: Rhodymeniaceae
Genus: *Chrysymenia* J. Ag.

4. *Chrysymenia agardhii* Harvey **(Fig. 4A-C)**

(Kylin 1956, 331; Taylor 1960, 480, Pl. 63, Fig. 2, as *Cryptarachne agardhii* (Harvey) Kylin)

Synonym: Chryptarachne agardhii (Harv.) Kylin, (Ref. www.algaebase.org)

Habit: Plants foliaceous, palmately laciniate with short stipes up to 30 cm.

Vegetative structures: Thallus gelatinous-membranous, few large pores present in the thallus, rose-red, from a short stipe expanding through a cuneate base to a blade 10.00 - 24.50 cm long, palmately laciniate, where the lobes narrowly cuneate, approximate above the narrow axils, 2.00 - 2.50 cm broad, the margins commonly erose dentate, cortex three layered, outermost epidermal cells, cells ellipsoidal to oval 7.62 - 8.89 µm long and 3.81 - 5.08 µm broad, produced from three - four times larger ovoid cells (subepidermal cells) 10.16 - 12.70 µm long and 8.89 - 10.16 µm broad, below these cells lie sporangial mother cells, 17.78 - 20.32 µm long and 7.62 - 10.16 µm dia and cruciate tetrasporangia. Medullary area traversed by numerous rhizoidal filaments about 50.80 - 63.50 µm long and 5.08 -7.62 µm broad.

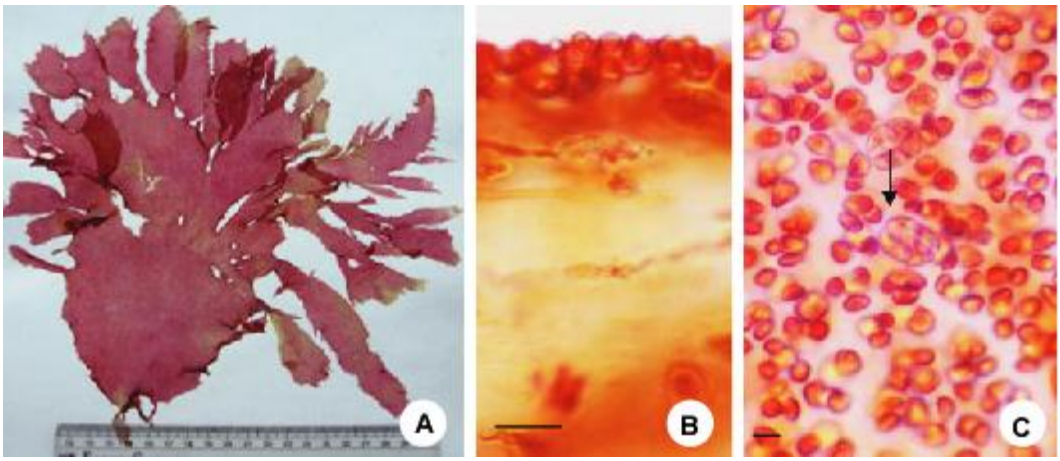

Fig. 4A-C: *Chrysymenia agardhii* (Harv.) Kylin. A. A herbarium of a whole thallus. B. Cross-section of a part of the thallus taken from the herbarium showing cortex and medulla with rhizoidal filaments. C. Surface view of a part of the thallus showing epidermal cells and cruciate tetrasporangia (arrow). (Bar B-C = 10 µm)

Reproductive structures: Tetrasporangia oval shaped on surface view, 10.16 × 16.51 µm and ellipsoidal on cross-section of the thallus 10.16 × 19.05 µm (Fig. 4B,C).

Discussion: This material is similar to *Halymenia agardhii* De Toni by internal structure and cruciate tetrasporangia, but the plant is highly branched, semicircular. There are 63 species names of the genus *Chrysymenia* J. Ag. in the species database at present, of which 19 have been flagged as currently accepted taxonomically.

Habitat and local distribution: The alga grows on rocks; collection no. 245; common as drifted form. This genus is distributed in tropical and subtropical zones of the world.

Geographical Distribution: Atlantic Island: Bermuda; North America: Florida, North Carolina; Caribbean Islands: Virgin Islands; South America: Colombia.

Class: Rhodophyceae; Order: Gigartinales; Family: Hypneaceae

Genus: *Hypnea* Kütz.

5. *Hypnea boergesenii* Tanaka **(Fig. 5A-G)**

(Pham-Hoang 1969, 191, Fig. 2.122; Prud'homme *et al.* 2002, 209, Figs. 1-8)

Synonym: Hypnea aspera Kütz.

Habit: Plants forming dense tufts, composed of irregular branches, 8-12 cm high.

Vegetative structures: Branches percurrent, terete, tapering towards the apices, 386 - 650 µm broad. Proliferous in upper portion, densely producing short, simple, acuminate lateral branchlets, 300 - 571 µm long, and longer compound lateral branchlets 443 - 600 µm long, bifurcate or beset with short spinose projections giving cone-shaped structure. Axes and branches in cross section composed of a small central cell surrounded by five to six larger pericentral cells (Fig. 5D), many other large medulla cells; medullary and pericentral cells often with lenticular thickenings; the outer cortex is a rather abrupt transition composed of much smaller cells, the epidermis is single layered cell with thick wall.

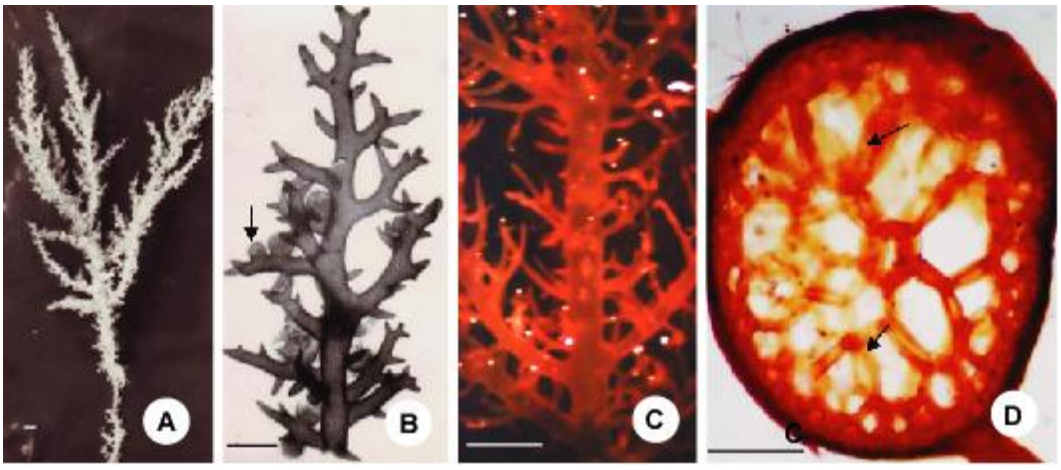

Fig. 5A-D: *Hypnea boergesenii* Tanaka. A. A plant with irregular branches and branchlets. B. Upper part of a branch enlarged showing cystocarps (arrow). C. Main axis of tetrasporic plant with short spinose projections, the tetrascrangial nemathecia. D. Cross-section of an axis, showing medullary cells with lenticular thickenings (arrows) in their cell walls. (Bar A-C = 1 mm, D = 100 µm)

Reproductive structures: Tetrasporangial branch 585 - 643 µm long and 243 - 250 µm broad, tetrasporangial sori develops on basal or middle parts of lateral and ultimate branchlets, tetrasporangia zonate, terminal on corticating filaments, forming nemathecia on swollen parts of

special short lateral branchlets, tetrasporangia 28.56 - 35.70 µm long and 17.80 - 18.50 µm broad, cystocarps spherical or hemispherical, covered with pore-less pericarp, almost, solitary or in small groups on branchlets, cystocarps 171 - 321 µm broad.

Discussion: Islam (1976) reported *Hypnea (?) boergesenii* Tanaka where he described crozier tips of branchlets, a characteristic feature of *Hypnea musciformis* (wulf.) Lamx., the present material do not possesses crozier tips and thus, the taxon has been described as *Hypnea boergesenii* Tanaka. There are 109 species names of the genus *Hypnea* Kütz. in the species database at present, of which 54 have been flagged as currently accepted taxonomically.

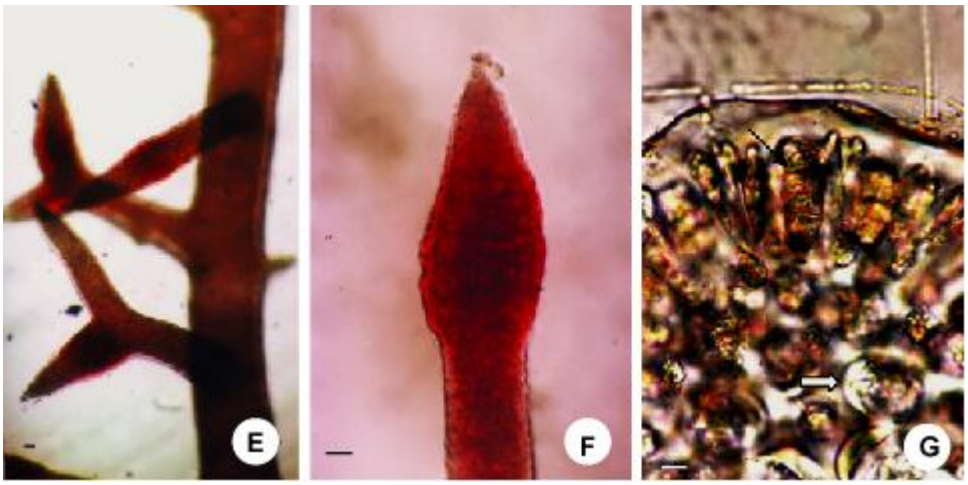

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Fig. 5E-G: *Hypnea boergesenii* Tanaka. E. Tetrasporangial nemathecia on branchlets. F. An enlarged tetrasporangial nemathcium. G. A portion of the cross-section enlarged showing zonate tetrasporangia in the periphery (narrow arrow) with paraphyses and lenticular thickenings (thick arrows) at the centre of the section. (Bar E-G = 50 µm)

Habitat and local distribution: The alga grows on rocks; collection nos. 9, 210, 211, 251; abundant. This genus is distributed worldwide.

Geographical distribution: Pacific Islands: New Caledonia; Africa: Kenya; South-West Asia: Indonesia, Philippines, Vietnam; Australia and New Zealand: New South Wales, Queens land, Western Australia.

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