

THE STRUCTURE AND REPRODUCTION OF *DUDRESNAYA LUBRICA* SP. NOV. (RHODOPHYTA, DUMONTIACEAE)

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Dudresnaya lubrica sp. nov. is described from Oahu Island and constitutes the second species of the genus reported from the Hawaiian Islands. *D. lubrica* differs from other species of the genus by its vegetative and reproductive morphology. The internal and external structure of the male and female vegetative thalli, spermatangial, carpogonial and auxiliary-cell branches and the corresponding post-fertilisation stages of the carposporophyte are discussed and compared with those of other species of *Dudresnaya*.

Lee (1963) contrasted the salient structural and reproductive features of the nine previously described species of *Dudresnaya* and the reader is referred also to that paper for information concerning their geographic distribution. *D. lubrica* constitutes the second record of the genus from the Hawaiian Islands, the first being *D. hawaiiensis* Lee, previously known only from two specimens taken from Kaneohe Bay, Oahu Island (Lee, 1963).

DUDRESNAYA LUBRICA sp. nov.

DIAGNOSIS

Thallus pallide ruber, 2.5-7.5 cm alt., lubricosusque; frondes cylindricae angustaeque (1 mm diam.), dense irregulariterque ramosae, cellulis terminalibus rotundatis; cellulae axiales usque ad $550 \times 100 \mu\text{m}$, ramificatione verticillata; cellulae corticantes usque ad $110 \times 12 \mu\text{m}$; plantae dioeciae; ramus carpogonialis e 6-10 cellulis compositus, cellulae alimentariae a duabus cellulis parvis a carpogonio seiunctae; ramus cellulae auxiliaris e 10-16 cellulis, quarum 4-6 amplificatis, compositus, cellula auxiliari secunda cellularum amplificatarum ab extremitate proximali; cystocarpi usque ad $430 \mu\text{m}$ diam; spermatia in ramis lateralibus thallorum masculorum terminalia. Locus typi: locus Makua Beach, Oahu Island, Hawaii. Exemplum typicum: M. Littler No. 618 (Fig. 1), in Herbario Maxwell S. Doty depositum.

Thallus pale red, from 2.5 to 7.5 cm tall, lubricous in texture; fronds cylindrical and narrow (1 mm in diameter), densely and irregularly branched; distal vegetative cells rounded; axial cells to $550 \times 100 \mu\text{m}$ with verticillate branching; corticating cells to $110 \times 12 \mu\text{m}$; dioecious; carpogonial branch of 6-10 cells, nutritive cells separated by 2 small cells from the carpogonium; auxiliary cell branch with 10-16 cells of which 4-6 are enlarged, auxiliary cell the second of the enlarged cells from the proximal end; cystocarps to $430 \mu\text{m}$ in diameter; spermatia terminal on lateral branches of male thalli. The type locality is Makua Beach, Oahu Island, Hawaii. Specimen ML618 (Fig. 1) is the type specimen and is deposited in the Maxwell S. Doty Herbarium.

MATERIAL AND METHODS

Material referable to the genus *Dudresnaya*, but not to any of the described species, was first encountered by myself in April 1969 during SCUBA studies of crustose Corallinales. The alga was abundantly present on dead-coral rubble at a depth of 7 m off Makua Beach, leeward Oahu Island. It was collected (collections ML609, ML613 and ML 618) on three subsequent dives in the same area, whereupon it abruptly disappeared during June 1969. Attempts to re-collect this alga were unsuccessful even though numerous trips were made to the same area throughout the following year. Pressed and wet-preserved specimens, in addition to those in my

collection, are on deposit in the G. M. Smith Herbarium of the Hopkins Marine Station and in the private herbaria of Maxwell S. Doty and Peter S. Dixon. Materials examined for each population included living specimens, some preserved in 10% formalin and others res soaked from pressed sheets. Comparisons between species populations were made using parallel pre-treatment methods to control against possible artifacts of preservation or microtechnique. These comparisons showed the collected materials to be an undescribed species.

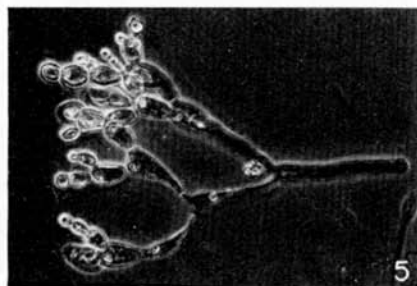
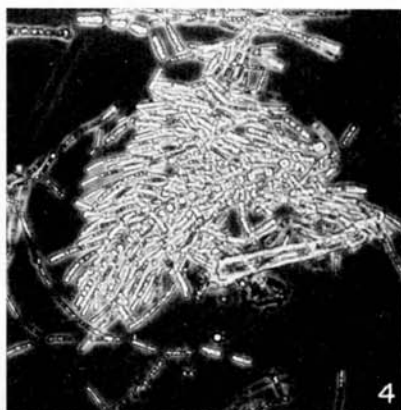
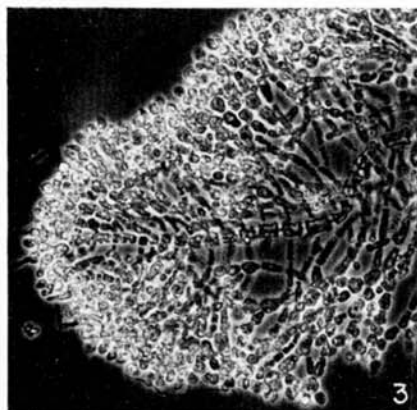
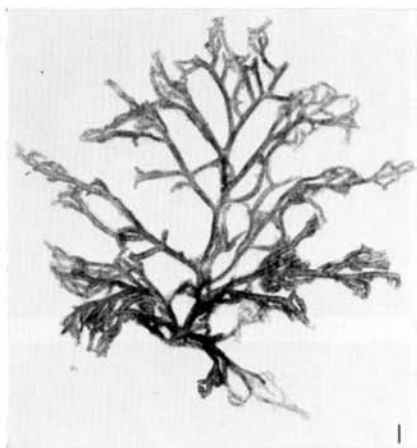
OBSERVATIONS AND DISCUSSION

External characteristics of the thallus are taxonomic criteria traditionally used to delimit the species of *Dudresnaya*. On the basis of external morphology, *D. lubrica* (Fig. 1) differs from all other species of the genus (see Lee, 1963) except *D. verticillata* (Withering) Le Jolis (Fig. 2). However, a critical microscopic examination of material representing seven English and four French populations of *D. verticillata* indicated consistent and obvious differences in the internal morphology with respect to the Hawaiian population of *D. lubrica*. The use here of internal vs. external characteristics poses no special problem as the utility of similar criteria has been demonstrated in the taxonomic delimitation of many species of Rhodophyta.

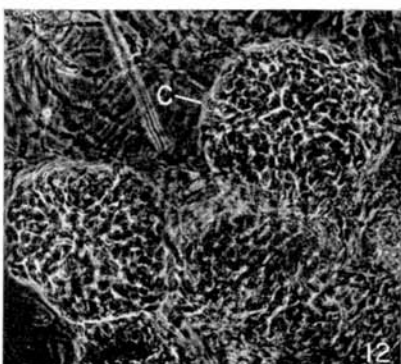
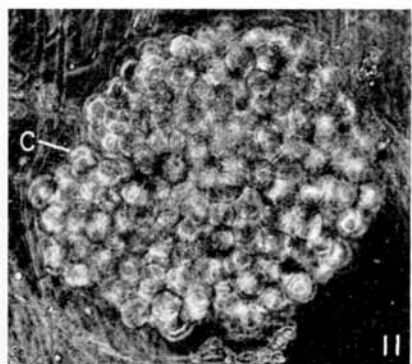
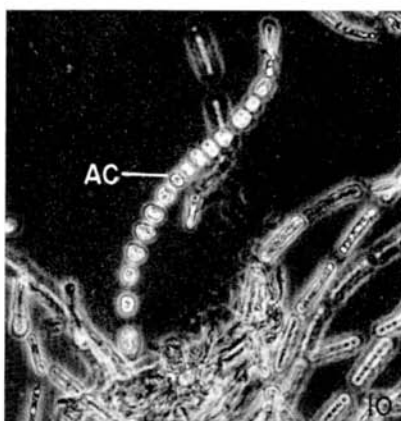
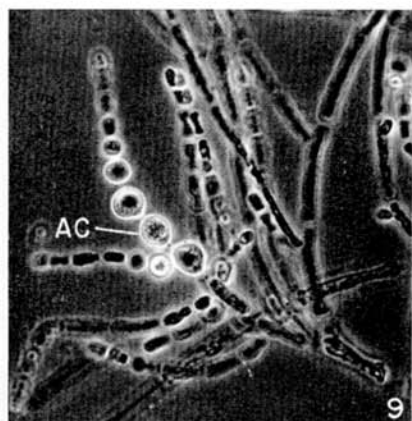
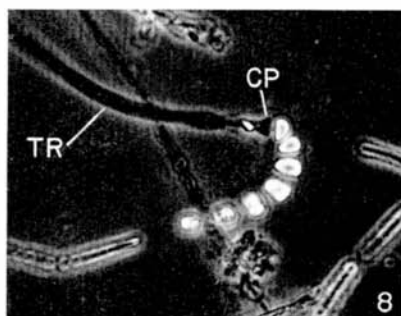
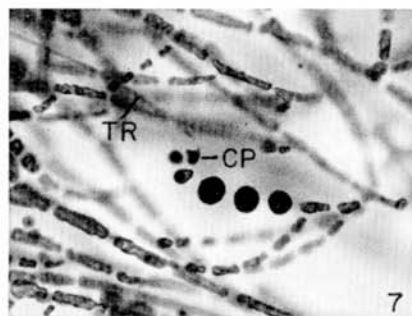
Paired sets of illustrations (Figs 3–12) have been prepared to contrast the internal differences between *D. lubrica* and *D. verticillata*. *D. lubrica* differs in that the apical vegetative cells (and their immediate derivatives) of the branch axes (Fig. 3) and laterals (Fig. 5) are swollen and rounded while those of *D. verticillata* (Figs 4, 6; see also Kylin, 1928, 1956) are cylindrical.

The carpogonial branch of *D. lubrica* (Fig. 7) is a characteristic and well-defined 6–10 celled structure, the terminal cell consisting of the carpogonium with long trichogyne. The two cells immediately below the carpogonium are relatively small (6.0 μm) and stain deeply with aniline blue. The next two cells (nutritive cells) in sequence are round and large (12.0 μm) and are also darkly stained by aniline blue. The fifth cell from the carpogonium is rounded and stains densely but is considerably smaller (8.0 μm) than the third and fourth cells but larger than the first and second cells. Sterile laterals occasionally develop from the unspecialised lower cells of the carpogonial branch as is also the case for *D. verticillata* (Fig. 8; Kylin, 1928).

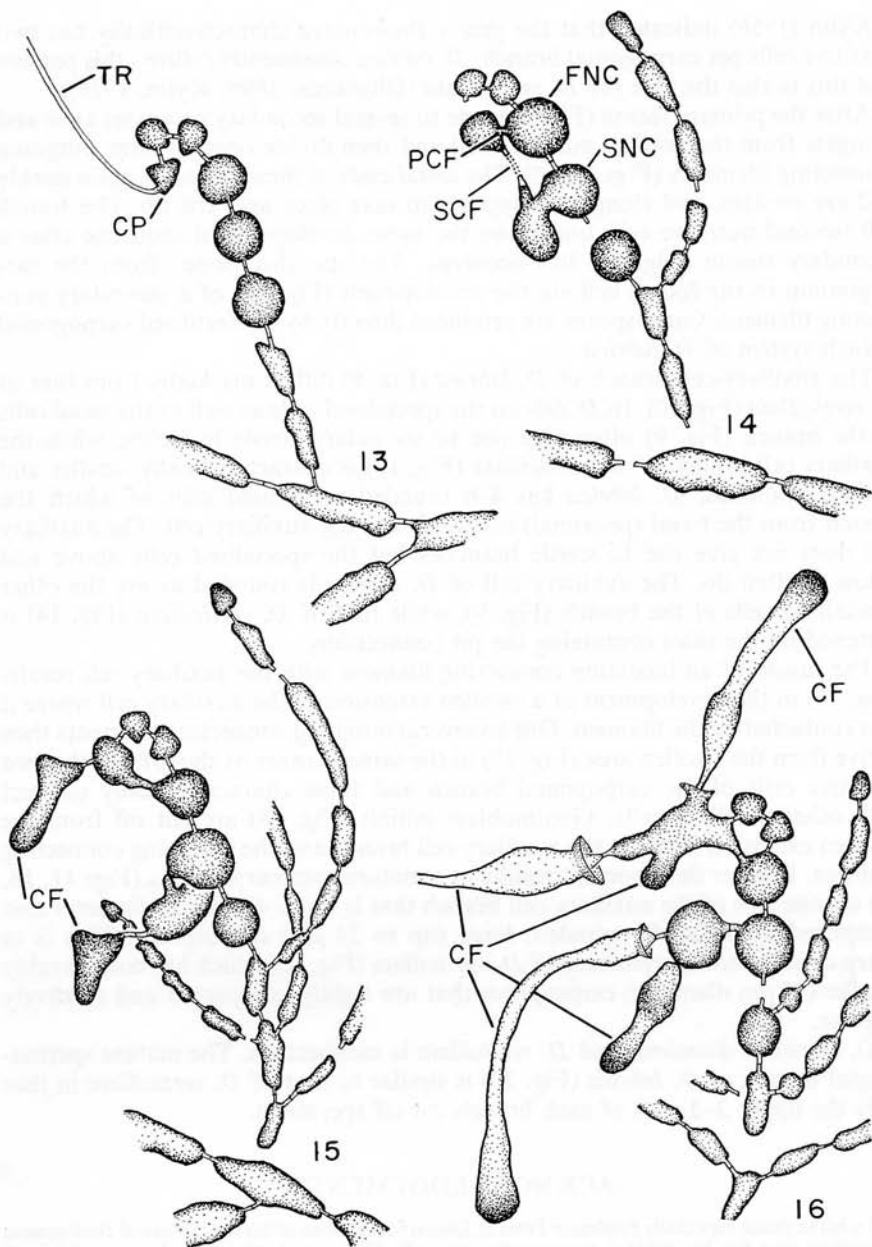
The carpogonium loses its typical appearance following fertilisation and the ensuing post-fertilisation stages (Figs 13–16) closely approximate to those illustrated by Kawashima (1959) for *D. minima* Okamura. The cytoplasmic contents probably contribute toward the partial development of connecting filaments because the trichogyne, but not the carpogonium, becomes withered and degenerates (Fig. 16). The tip of the carpogonial branch is curved (Figs 7, 13) so that the carpogonium and the third cell below it (the first nutritive cell) are juxtaposed. Hence a connection between the primary connecting filament and this nutritive cell is made (Fig. 14) by only a minimal elongation of the filament. Fusion of the carpogonium to the third cell below (nutritive cell) occurs in this direct and consistent manner in contrast with all but *D. minima*. In *D. verticillata* (Oltmanns, 1898; Kylin, 1928), the primary connecting filament also is typically two-celled. Fritsch (1945) attributed the two-celled primary connecting filament to all species of *Dudresnaya*. This is not always the case in *D. minima* (Kawashima, 1959), *D. hawaiiensis* (Lee, 1963) and *D. crassa* Howe (Taylor, 1950) and was never observed in *D. lubrica*.



FIGS 1-6. Light micrographs. Fig. 1. Pressed type specimen (No. ML618) of *Dudresnaya lubrica*. $\times 0.9$. Fig. 2. Pressed specimen of *D. verticillata* from Galway, Ireland. $\times 0.9$. Fig. 3. Branch axis of *D. lubrica*. $\times 100$. Fig. 4. Branch axis of *D. verticillata*. $\times 125$. Fig. 5. Branch lateral of *D. lubrica*. $\times 200$. Fig. 6. Branch lateral of *D. verticillata*. $\times 200$.



FIGS 7-12. Light micrographs. Fig. 7. Carpogonial branch of *Dudresnaya lubrica*. TR, trichogyne; CP, carpogonium. $\times 175$. Fig. 8. Carpogonial branch of *D. verticillata*. $\times 400$. Fig. 9. Auxiliary cell (AC) branch of *D. lubrica*. $\times 190$. Fig. 10. Auxiliary cell branch of *D. verticillata*. $\times 190$. Fig. 11. Cystocarp of *D. lubrica*. C, carpospore. $\times 200$. Fig. 12. Cystocarp of *D. verticillata* showing smaller size and angular nature of carpospores (C). $\times 200$.



FIGS 13–16. Camera lucida drawings of *Dudresnaya lubrica* from formalin-preserved material. Post-fertilisation stages of carpegonial branch. Fig. 13. Carpegonial branch. TR, trichogyne; CP, carpegonium. $\times 335$. Fig. 14. Fusion of primary connecting filament (PCF) with first nutritive cell (FNC) and secondary connecting filament (SCF) with second nutritive cell (SNC). $\times 335$. Fig. 15. Initiation of additional connecting filaments (CF) that may fuse with an auxiliary cell. $\times 335$. Fig. 16. Later developmental stage showing additional connecting filaments. $\times 335$.

Kylin (1956) indicated that the genus *Dudresnaya* characteristically has two nutritive cells per carpogonial branch. *D. lubrica* consistently follows this pattern and this is also the case for *D. verticillata* (Oltmanns, 1898; Kylin, 1928).

After the primary fusion (Fig. 14), one to several secondary processes arise and elongate from the swollen nutritive cell and then divide once to form outgoing connecting filaments (Figs 15, 16). The distal ends of these filaments stain darkly and are swollen, and elongation appears to take place near the tip. The fourth cell (second nutritive cell) undergoes the same developmental sequence after a secondary fusion (Fig. 14) has occurred. The stimulus passes from the carpogonium to the fourth cell via the development (Fig. 14) of a secondary connecting filament. Carpospores are produced directly by the fertilised carpogonial branch system of *D. lubrica*.

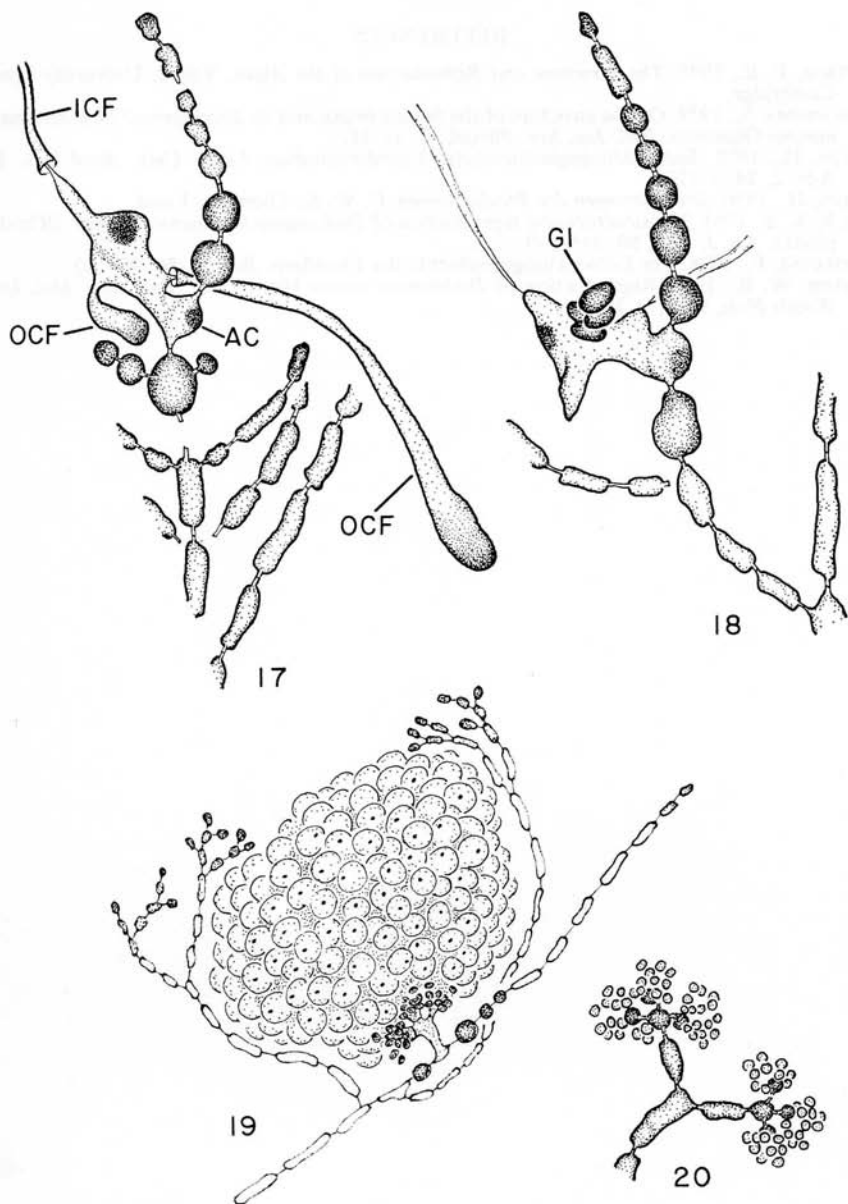
The auxiliary-cell branch of *D. lubrica* (Fig. 9) differs markedly from that of *D. verticillata* (Fig. 10). In *D. lubrica* the specialised cells as well as the basal cells of the branch (Fig. 9) often give rise to secondary sterile branches, while the auxiliary cell branch of *D. verticillata* (Fig. 10) is characteristically smaller and seldom branched. *D. lubrica* has 4–6 rounded specialised cells of which the second from the basal (proximal) end is always the auxiliary cell. The auxiliary cell does not give rise to sterile branches but the specialised cells above and below it often do. The auxiliary cell of *D. lubrica* is rounded as are the other specialised cells of the branch (Fig. 9), while that of *D. verticillata* (Fig. 14) is flattened on the sides containing the pit connections.

The fusion of an incoming connecting filament with the auxiliary cell results (Fig. 17) in the development of a swollen extension of the auxiliary cell where it was contacted by the filament. One to several outgoing connecting filaments then derive from the swollen area (Fig. 17) in the same manner as those from the two nutritive cells of the carpogonial branch and these characteristically connect with other auxiliary cells. Gonimoblast initials (Fig. 18) are cut off from the swollen extension between the auxiliary cell branch and the incoming connecting filament. Further development results in a mature cystocarpic mass (Figs 11, 18, 19) on one side of the auxiliary cell branch that is up to 430 μm in diameter and comprised of distinctly rounded, large (up to 24 μm) carpospores. This is in sharp contrast to the cystocarp of *D. verticillata* (Fig. 12) which has considerably smaller (11 μm diameter) carpospores that are tightly compacted and relatively angular.

D. lubrica is dioecious and *D. verticillata* is monoecious. The mature spermatangial branch of *D. lubrica* (Fig. 20) is similar to that of *D. verticillata* in that only the upper 2–3 cells of each branch cut off spermatia.

ACKNOWLEDGEMENTS

I wish to thank especially Professor Peter S. Dixon for the loan of his specimens of *Dudresnaya verticillata* and for his helpful suggestions, my wife Diane S. Littler for photographic and illustrative work, and Mrs L. M. Irvine for providing critical young material of *D. verticillata*.



FIGS 17–20. Camera lucida drawings of *D. lubrica* from formalin-preserved material. Figs 17–19. Post-fertilisation stages of auxiliary cell branch. Fig. 17. Incoming connecting filament (ICF) fused to an auxiliary cell (AC), and the formation of an outgoing connecting filament (OCF) that may fuse with another auxiliary cell. $\times 335$. Fig. 18. Gonimoblast initials (GI). $\times 335$. Fig. 19. Mature cystocarp. $\times 170$. Fig. 20. Spermatangial branch. $\times 335$.

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