

# The Characeae of Fiji<sup>1</sup>

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IN JUNE AND JULY, 1961, the writer made a concentrated search for Characeae in Fiji. Whereas these plants had previously been known only from outlying islands of Ovalau and Macuata-i-wai, they were found to be fairly common on the main islands as well and to include five species. The present systematic treatment is based upon the writer's collections and upon the few specimens available from other herbaria.

Earlier published records of Characeae report only two species from three collections. The first-known collection was made by the U. S. Exploring Expedition under Wilkes (1845:230 ff.) on Muthuate Island (= Macuata-i-wai), and it was described as *Nitella muthnatae* by T. F. Allen (1887:211). Later collections by Naumann in 1875 and Weber in 1882, both on Ovalau Is., were reported by Nordstedt (1888a:188) as *Chara australis* var. *vieillardii* f. *vitiensis*. These taxa are treated here as *Nitella pseudoflabelata* and *Chara corallina* (dioecious strain), respectively.

The Fiji Islands straddle the International Date Line (180° long.) at about 17° 30' S and lie approximately 1,300 miles south of the equator. They are one of a series of archipelagoes which lie in a stepwise chain extending eastward from Australia at intervals of approximately 800 miles. Samoa lies to the east and New Caledonia lies to the west. The geology and weather have been described by Freeman (1951) and Derrick (1957). Fiji includes some 300 separate islands, but the major portion (6,180 sq miles) of the total land surface (7,055 sq miles) consists of the two main islands of Viti Levu and Vanua Levu. The larger islands are of the continental type, and are generally mountainous. Lying as

they do in the southeast trade winds, the islands receive regular precipitation (ca. 120 inches/year at Suva) on the eastward, or windward, side but are fairly dry on the leeward side in the rain shadow of the mountains. On the dry, or lee, sides rainfall (40–60 inches/year) is largely restricted to the five wet months of December through April.

Available aquatic habitats are numerous and include rugged mountain streams, meandering rivers, waterfall pools, coastal lagoons and marshes, a high mountain lake (Tavenui), and man-made habitats including rice fields, canals, ditches, lily pools, and taro patches.

The Characeae, instead of being rare as seemed indicated by the sparse previous collections, occur widely throughout the islands visited by the writer. In fact, they were found in 19% of the habitats visited. They seemed to be especially frequent in the drier parts of the islands. The most frequently inhabited sites were the flooded rice fields and pools in fields or open woods. Such habitats supported Characeae in more than 50% of the cases. Somewhat less frequently occupied sites were lily ponds, canals, and ditch ponds. By contrast, Characeae were very rarely found in rivers or small streams, natural marshes or taro patches.

It was surprising to find three species of *Nitella* abundant beneath a dense cover of water lilies (pools on the plain below the Adi Cakobou School near Sawani), almost invariably absent from the coastal marshes with the large fern *Acrostichum aureum* L., and totally absent from the mountain lake. *A. aureum*, according to Merrill (1945:52), grows in areas occasionally swept by sea water; the salinity doubtless excludes the Characeae. The one lake, Crater Lake on Tavenui, was found by Koroiveibau in 1961 to have deeply stained water and to be largely covered with a [sedge ?] mat. Characeae were also absent from roadside ditches, frequently a fertile habitat in Australia.

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Collecting was done from June 5 to July 30, 1961; and, as described earlier (Wood, 1962*b*), herbarium specimens, formalin-preserved samples, and selected bits fixed in Carnoy's (3:1) solution for cytological analysis were prepared. The main excursions were by car and on Viti Levu included two circuits on the island, as well as short trips from Korovau to the Wainamala River, from Suva to Sawani, and from Sigatoka up the Sigatoka River; on Vanua Levu, from Labasa westward to Seaqaqa and Macuata, and from Dalana near Savusavu Point some 15 miles eastward along the southern coast; and on Ovalau, from Levuka southward around the end of the island to Bureta. On Macuata-i-wai (just off the north central coast of Vanua Levu), the group went on foot from the Chief's koro on the northeast tip of the island around the east shore and about one-fourth the way to the south end of the island.

The classification and nomenclature follow the writer's revision (MS) and approximate his prior report (1962*a*). Place names are spelled according to Fijian practice; the conventions as summarized by Capell (1957) are used with *b* for the sound of *mb*, *d* for *nd*, *g* for *ng* (as in singer), *c* for *th*, *q* for *ng-g* (as in finger). Certain of the more frequently cited and easily misinterpreted names are Bola (pronounced Mbola), Cakobou (Thakombau), Cakaudrove (Thakaundrove), Colo (Tholo), Cuvu (Thuvu), Galoa (Ngaloa), Labasa (Lambasa), Macuata (Mathuata), Nabukavesi (Nambukavesi), Nacobo (Nathombo), Nadi (Nandi), Nadona (Nandona), Nadroga (Nandronga), Naibasiri (Naimbasiri), Seaqaqa (Seang-gang-ga), and Sigatoka (Singatoka). In addition, Nordstedt's (1888*a*:188) "Leruka" and "Oralau" are here revised to Levuka and Ovalau. Both had been followed by Zaneveld (1940:129). Also, T. F. Allen's (1887:211) Muthnate Island is corrected to Mathuata (as Macuata in Fijian conventions).

Herbarium abbreviations follow Lanjouw and Stafleu (1959) except for the writer's personal collection (RDW). Duplicates have been distributed to BA, BM, L, LE, MEL, SUVA, and US; and remaining duplicates will be distributed to other herbaria.

## ACKNOWLEDGMENTS

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REVISED CLASSIFICATION OF CHARACEAE  
(Wood, 1962*a*)

The closest known occurrences of non-Fijian taxa are indicated in parentheses.

Division CHLOROPHYTA  
Class CHAROPHYCEAE  
Family CHARACEAE

## I. Tribe Chareae

## 1. Subtribe Charinae

1. Genus *Chara*

1. Subgen. *Chara* (Diplostephanae)—none (nearest: Australia, New Caledonia)

2. Subgen. *Charopsis* (Haplostephanae)

1. Sect. *Charopsis*

1. *C. corallina* Kl. ex Willd.

2. Sect. *Agardhia*

2. *C. fibrosa* Ag. ex Bruz.

2. Genus *Lamprothamnium*—none (nearest: New Caledonia; New Zealand)

3. Genus *Lychnothamnus*—none (nearest: Australia)

## 2. Subtribe Nitellopsinae

4. Genus *Nitellopsis*—none (nearest: Malaya)

## II. Tribe Nitelleae

5. Genus *Nitella*

1. Subgen. *Nitella* (Anarthrodactylae)

1. Sect. *Nitella*—none (nearest: Asia)

2. Sect. *Rajia*

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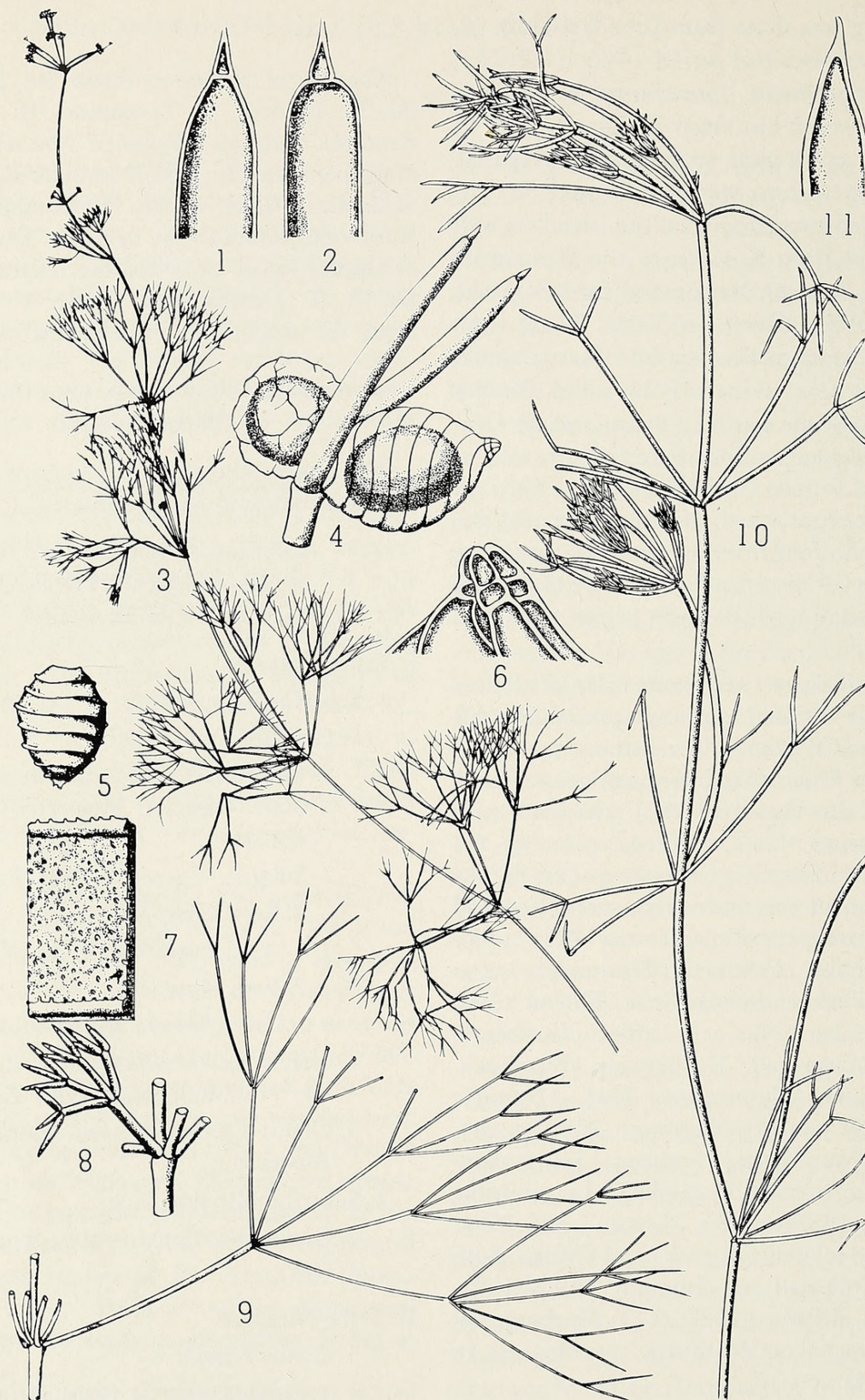


FIG. 1. Two common *Nitellas* of Fiji. 1-9, *Nitella pseudoflabellata*: 1-2, Apices of 2-celled dactyls,  $\times 90$ . 3, Habit,  $\times 1$ . 4, Terminal branchlet furcation with antheridium (at left) and oogonium,  $\times 44$ . 5, Oospore,  $\times 44$ . 6, Distal end of oogonium with coronula,  $\times 178$ . 7, Granular-papillate membrane in fossa between two adjacent ridges of oospore,  $\times 490$ . 8, Two-furcate, reduced branchlet (2-) 3-furcate,  $\times 4$ . 9, Sterile branchlet (2-) 3-furcate,  $\times 4$ . 10-11, *Nitella acuminata*: 10, Habit,  $\times 1$ . 11, Apex of 1-celled dactyls,  $\times 90$ . (1-9 From spec. k; 10-11 from spec. f.)



- 3. *N. acuminata* A. Br. ex Wallm.
- 3. Sect. *Knighitia*—none (nearest: Africa)
- 4. Sect. *Brownia*—none (nearest: N. & S. America)
- 5. Sect. *Riddellia*—none (nearest: N. & S. America)
- 6. Sect. *Palia*—none (nearest: Japan; Australia)
- 2. Subgen. *Hyella* (Pluricellulatae, pp. [allantoid])—none (nearest: New Caledonia; New Zealand; Australia)
- 3. Subgen. *Tieffallenia* (Arthrodactylae)
  - 1. Sect. *Tieffallenia* (Mucronatae)
    - 4. *N. furcata* (Roxb. ex Bruz.) Ag.<sup>4</sup>
  - 2. Sect. *Gioallenia*
    - 5. *N. pseudoflabellata* A. Br.<sup>5</sup>
  - 3. Sect. *Decandollea*—none (nearest: New Caledonia; New Zealand)
  - 4. Sect. *Earthya*—none (nearest: Africa)
  - 5. Sect. *Muelleria*—none (nearest: Australia)
  - 6. Sect. *Vogania*—none (nearest: Australia)
  - 7. Sect. *Persoonia*—none (nearest: Australia; Japan; New Caledonia; New Zealand)
  - 8. Sect. *Migularia*—none (nearest: Australia)
- 6. Genus *Tolypella*
  - 1. Sect. *Tolypella*—none (nearest: Australia)
  - 2. Sect. *Rothia*—none (nearest: Asia)

KEY TO CHARACEAE OF FIJI

- 1a. Branchlets not furcate.....*Chara*
- 2a. Totally ecorticate.....1. *Chara corallina*<sup>6</sup>

<sup>4</sup> as *N. mucronata* by Wood (1962a:17).  
<sup>5</sup> includes *N. muhnatae* T.F.A.  
<sup>6</sup> *C. braunii*, known from Hawaii and New Zealand, is monoecious with strongly developed stipulodes and bract-cells.  
<sup>7</sup> *C. zeylanica*, known to occur as near as New Caledonia and Hawaii, is diplostephanous (two tiers of stipulodes) and has branchlets more or less corticated but with the basal branchlet segment regularly ecorticate.

- 2b. Axes corticated.....2. *Chara fibrosa*<sup>7</sup>
- 1b. Branchlets (at least fertile ones) furcate.....*Nitella*
- 3a. Anarthrodactylous (dactyls 1-celled)....  
.....3. *Nitella acuminata*
- 3b. Arthrodactylous (dactyls 2-more-celled)
  - 4a. Brachydactylous (some of the dactyls tiny).....4. *Nitella furcata*
  - 4b. Macrodactylous (dactyls not tiny)  
.....5. *Nitella pseudoflabellata*<sup>8</sup>

I. Tribe CHAREAE

1. *Chara* L.

2. Subgenus *Charopsis* (Kütz.) Leonh.

1. Section *Charopsis*

- 1. *Chara corallina* Kl. ex Willd., em. R.D.W.—  
*Chara corallina* Klein ex Willdenow (1805: 89); *C. australis* R. Brown (1810:346); em. Wood (1962a:12), em. Wood (1962a:12).

Figs. 2, 3

REFERENCES FOR FIJI: *Chara australis* var. *vieillardii* f. *vitiensis* Nordst.: Nordstedt (1888a: 188; 1888b:8); and Zaneveld (1940:128); *C. corallina* var. *corallina*: Wood (1962a:12).

DESCRIPTION OF FIJI MATERIAL: *Plants* dioecious, 10–30 cm high, with dull finish when dry. *Axes* 500–980  $\mu$  in diameter, slender to moderately stout; internodes 2–8 cm long, 1–2 times as long as the branchlets; cortex none; nodes of axes commonly swollen and congested with a white material. *Stipulodes* in 1 tier, 2 per branchlet, 0–1 $\frac{3}{4}$  times as long as the axis diameter, slender, commonly up to 600  $\mu$  long and 60  $\mu$  wide and stiffly spreading; widely variable, and obscure or absent in some collections. *Branchlets*, *sterile*, 5–7 in a whorl, 1–3.5 (–6) cm long, undivided, spreading and fairly straight; segments 3, the end segment generally 2-celled with the end cell a conical mucro which is variable in length, commonly 350  $\mu$  long by 120  $\mu$  wide; *fertile*, same as sterile or reduced, where reduced may form into terminal or lateral heads (especially in  $\delta$ ). *Bract-cells* 0–4 at a node, commonly absent, where present  $\frac{3}{4}$ –1 $\frac{1}{4}$  times as

<sup>8</sup> *N. tenuissima*, reported from Palau, has a strongly reticulate oospore membrane and forms no heads or mucus.



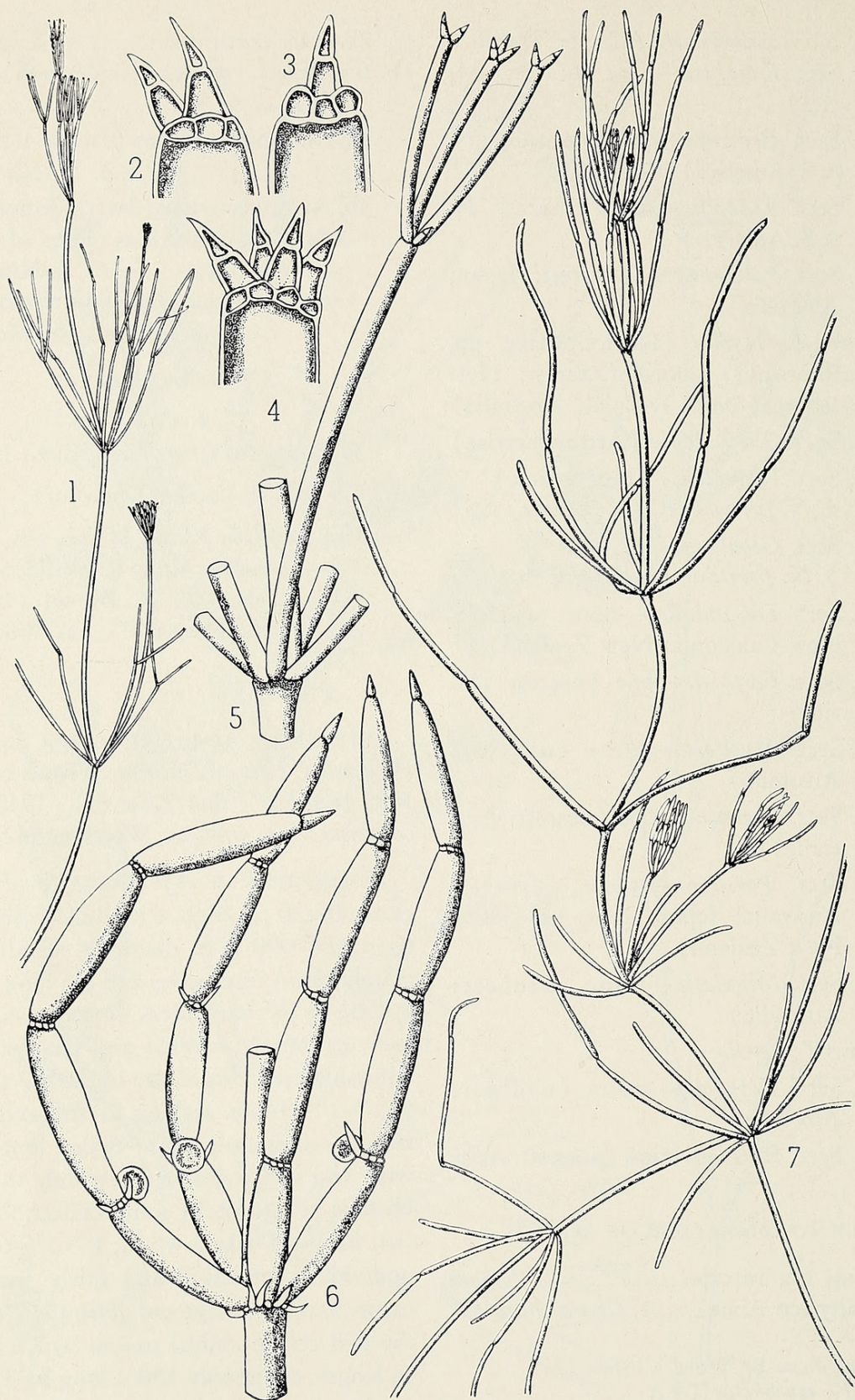


FIG. 2. A rare *Nitella* and a common *Chara* of Fiji. 1-5, *Nitella furcata*. 1, Habit,  $\times 1$ . 2-4, Apices of sterile branchlets showing ultimate furcation into 2-celled dactyls (there being variously 2, 1, and 4 dactyls shown) subtended by peripheral nodal cells; 2 and 3  $\times 130$ , 4  $\times 86$ . 5, Two-furcate sterile branchlet with a short 2-celled dactyl at the 1st furcation and abbreviated terminal dactyls,  $\times 12$ . 6-7, *Chara corallina* (dioecious strain, earlier *C. australis*). 6, Branchlet whorl of  $\delta$  thallus, showing well-developed stipulodes and the bract-cells at the lowest and 2nd (in center two branchlets) nodes,  $\times 10$ . 7, Habit of sterile thallus,  $\times 1$ . (1-5 From spec. a; 6-7 from spec. j.)



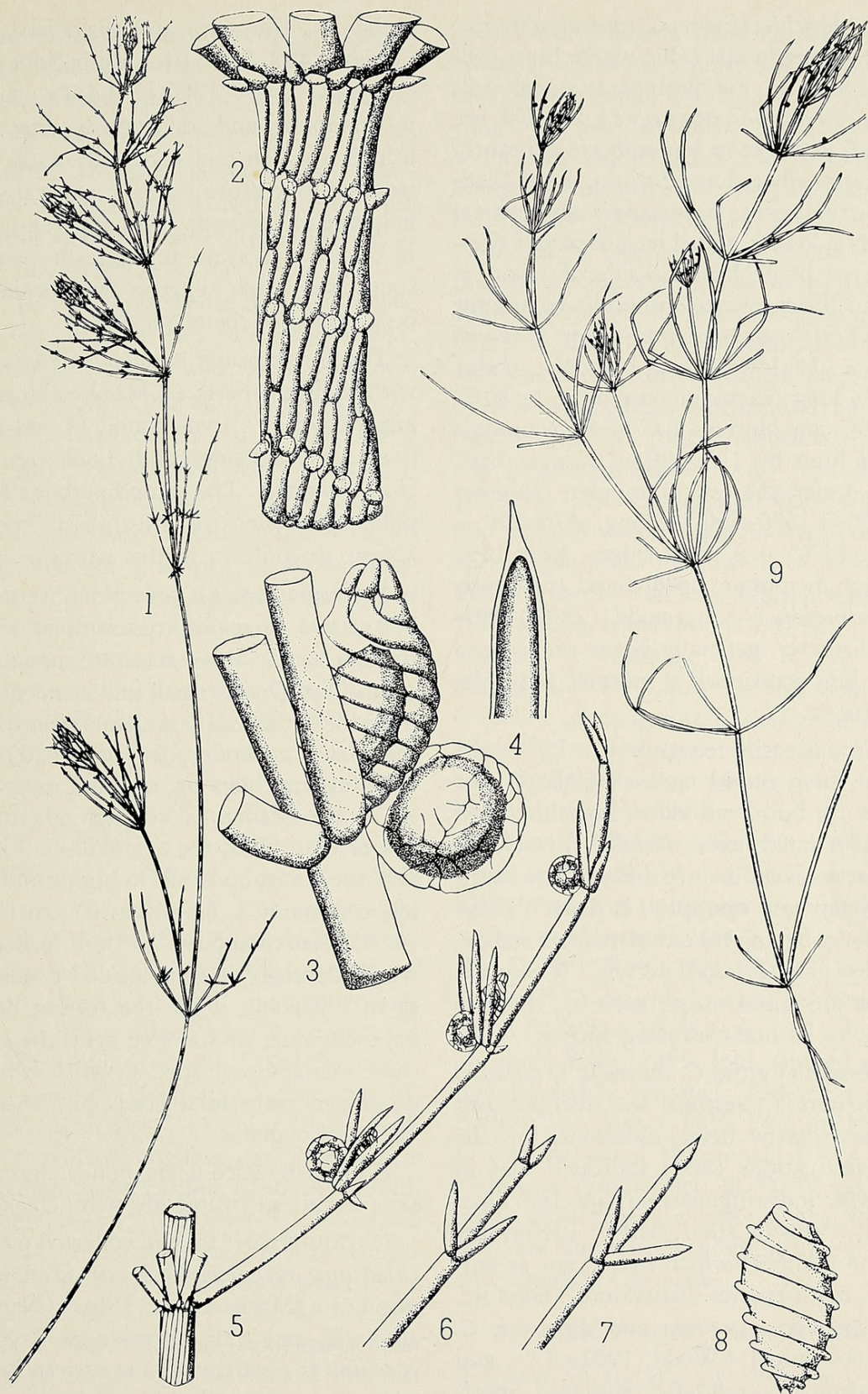


FIG. 3. The two common Charas of Fiji. 1-8, *Chara fibrosa*. 1, Habit,  $\times 1$ . 2, Portion of axis and node showing short alternating stipulodes (large ones have been lost) and the 2-corticated axis,  $\times 44$ . 3, Fertile branchlet node with oogonium above antheridium and two large bracteoles,  $\times 44$ . 4, Apex of bract-cell,  $\times 89$ . 5, Axial node and one branchlet with 5 segments and 3 fertile nodes, the two lowest having conjoined gametangia,  $\times 17$ . 6, Apex of branchlet showing bract-cells,  $\times 1$ . 7, Apex of branchlet with end cell apparently without node,  $\times 16$ . 8, Oospore with 7 broadly flanged striae and the basal spurs,  $\times 44$ . 9, *Chara coralina*, a  $\delta$  thallus with numerous antheridia,  $\times 1$ . (1-8 From spec. h; 9 from spec. m.)



long as the branchlet diameter, separated by two obvious peripheral nodal cells; where bract-cells are not developed, the peripheral nodal cells form a ring. *Bracteoles*, none noted. *Bractlet*, not noted. *Heads* uncommon, but antheridial branchlets are occasionally reduced forming loose heads 3–5 mm in diameter. *Gametangia* on separate plants, at 1–2 lowest branchlet nodes and occasionally 1 per branchlet on inside of whorl at base of branchlets; mature antheridia commonly on small whorls congested into heads. *Oogonia* (1–) 2–3 at the lowest 1–2 branchlet nodes, 780–1080  $\mu$  long (excluding coronula) by 610–680  $\mu$  wide; convolutions 6–7 (–8); coronula 100–105  $\mu$  high by 140–180  $\mu$  wide at base, 5-celled in 1 tier, the cells triangular. *Oospores* black, (560–) 600–660  $\mu$  long, 470–580  $\mu$  wide; striae of (5–) 6 broad ridges; fossa 105–130  $\mu$  across; membrane opaque and apparently smooth. *Antheridia* 2–3 at a node, (280–) 480–580  $\mu$  in diameter, generally borne on reduced branchlets but occasional at normal branchlet nodes; 8-scutate.

*C. corallina* is easily recognized in Fiji in the field by the crisp turgid nature and large size, and by having both undivided branchlets and totally uncorticated axes. *Nitella furcata*, although sometimes difficult to differentiate in the field in depauperate examples, is generally distinguishable by having forked branchlets and the tiny 2-celled, abbreviated dactyls. When the two species are mixed (e.g., spec. t), the two may appear to be one confusing species.

This is essentially the *C. australis* f. *vitiensis* of earlier writers. *C. australis* was distinguished from *C. corallina* by being dioecious; but the writer's investigations (MSS) indicated that in two otherwise indistinguishable "species" dioeciousness is a genetic state (half of the normal chromosome number) which may occur at random and is not a species distinction. Therefore, the monoecious *C. corallina* and dioecious *C. australis* were united (Wood, 1962a:12), and the oldest name, *C. corallina*, is employed. Specimens exhibiting the dioecious condition are here designated as "dioecious strains."

The Fiji specimens seem fairly unusual because of the small stature, slender structure, and occurrence of two rather than one stipulodes per

branchlet. They also appear to have small antheridia (480–580  $\mu$ ) for a dioecious strain (see Queensland, 800–1000  $\mu$ , and Tasmanian, 1250  $\mu$ , examples), and to have the axial nodes unusually swollen and congested with white material. It may prove to merit varietal status. The holotype of f. *vitiensis* was apparently destroyed in Berlin; and, as no duplicates have as yet been found, the writer suggests that specimen r (US) be accepted as the NEOTYPE.

The chromosome number of 14 is consistent with earlier reports of Macdonald and Hotchkiss (1956:277) who found 14 and 28, respectively, for dioecious and monoecious material from Australia. The second author's further unpublished counts of Australian "species" also appear to conform to this pattern.

Variations among collections were not great, but at two extremes are examples which seem to depend for their structure upon ecological conditions. One is small and slender with short branchlets, the axis less than 580  $\mu$  in diameter, the plants generally 12 (rarely 20) cm high, and the branchlets up to 2 cm long (see spec. e–i). The second is stouter, taller, and with longer branchlets, the axis 650–980  $\mu$  in diameter, the plants up to 30 cm high, and the branchlets commonly 3 (rarely to 6) cm long (spec. r). The latter appears to be a lush expression which develops in rich, shaded conditions such as in lily pools, while the former develops in exposed water of wet rice fields. In addition to these extremes, see spec. k which exhibits well-developed antheridial heads, and spec. f which has basal oogonia.

**HABITATS:** Rice fields, ponds, drainage ditch, pool by bridge, water lily pool, creek, river.

**DISTRIBUTION:** In Fiji, collected on Viti Levu (Nadroga, Naitasiri, Tailevu), Ovalau, and Vanua Levu (Macuata near Labasa, Natua, Macuata-i-wai, and Cakaudrove near Savusavu). *C. corallina* is restricted to the eastern hemisphere, where it is widely distributed in the tropics and extends into the temperate regions (especially of the southern hemisphere). It is reported from Africa, Mauritius, India, Ceylon, Burma, Thailand, Japan, Philippines, Indonesia, Australia (including Tasmania), New Caledonia, New



Zealand, and Fiji. Monoecious strains are known from Africa, Mauritius, Asia, and Australia, and the dioecious strains occur in Asia, Australia, and on the islands of the South Pacific.

SPECIMENS: OVALAU ISLAND—(a) *Nau-mann*. Nov. 1875. Levuka (as "Leruka") (B, destroyed, not seen; ref. Zaneveld, 1940:129, as f. *vitiensis*, HOLOTYPE);—(b) *Weber* [573 ?]. June 1882. In the marshes near Bureta "Oralau" (B, destroyed, not seen; ref. Nordstedt, 1888a: 188, 1888b:8, as No. 573 and var. *β vieillardii*, and Zaneveld, 1940:129, as f. *vitiensis*, ♂); VANUA LEVU: Cakaudrove: (c) *R. D. Wood* 61-7-1-1. July 1, 1961. Abundant in 1-2 ft of fairly clear water, mud bottom, large pool ca. 100 ft SE of Loa Road at culvert L 284 ca. 26 miles E of Savusavu airstrip, Cakaudrove Peninsula (CYT F 20, n = 14; slender, oogonia  $920 \times 640 \mu$ , convolutions 7, oospore black,  $660 \times 380 \mu$ , striae 6, fossa ca.  $130 \mu$  across, antheridia  $580 \mu$  in diam, 2-3 at a node, axis  $750 \mu$  in diam); Macuata: (d) *A. C. Smith* 6698. Nov. 25-Dec. 8, 1947. In flowing water of Korovuli River, Seaqaqa Plateau [vicinity of Natua, alt 100-200 m] (L, US, as *C. corallina*, det. F. K. Daily) (dioecious);—(e) *R. D. Wood and Vakuru Waibuta* 61-6-29-2. June 29, 1961. Abundant in ca. 6 inches of clear water, mud bottom, pool in dry ricefield W of Nakoroutari Road, ca. 2 miles S of Nakama Road turnoff, ca. 5 miles S of Labasa (♂, small and slender, axis  $550-600 \mu$  in diam; mixed with *N. pseudoflabellata*) (e<sup>1</sup>) [ibid. 61-6-29-1. See *C. fibrosa*, mixed with some *C. corallina* on which CYT 16, n = 14 was counted];—(f) ibid. 61-6-29-4. Ibid. (with some basal oogonia, slender with axis ca.  $590 \mu$  in diam);—(g) ibid. 61-6-29-5. Ibid. (formal. only);—(h) ibid. 61-6-29-6. Ibid. (CYT F 17, n = 14; slender, ca.  $500 \mu$  in diam);—(i) ibid. 61-6-29-7. Ibid. (heavily fertile ♂, axis  $550 \mu$  in diam);—(j) ibid. 61-6-29-9. Sparse in ca. 1 ft of still water, sandy mud, small embayment on SE shore of Nakama River, just N of ford ca.  $\frac{1}{8}$  mile SW of Labasa (RDW 1536, Fig. 2) (nodes swollen, nodes and stipulodes with white deposit, axes ca.  $700 \mu$  in diam);—(k) ibid. 61-6-29-10. Ibid. (axes ca.  $700 \mu$  in diam);—(l) ibid. 61-6-29-11. In ca. 3 inches of dark water, mud bottom, long ditch

pool W of Nakama Road ca. 200 yards N of Nakama school ca. 3 miles SW of Labasa (axes ca.  $650 \mu$  in diam);—(m) ibid. 61-6-30-10. June 30, 1961. Abundant in ca. 1 ft of clear water, silty sandy-mud bottom, pool called "Nalioniga" W of road ca. 1 mile past Seaqaqa Agric. Farm (RDW 1534, Fig. 3);—(n) ibid. 61-6-30-11. Ibid. (formal. only; ♂ and ♀);—(o) ibid. 61-6-30-12A. Sparse in ca. 10 inches of clear water, ibid. (formal. only; oogonia  $560-930 \mu \times 380-700 \mu$ , coronula  $105 \times 140 \mu$ , ♂  $480 \mu$  and on reduced branchlets);—(p) ibid. 61-6-30-12C. Ibid. (formal. only; a few scraps mixed with *N. pseudoflabellata*); Macuata-iwai [Mathuata Island]: (q) ibid. 61-6-30-1. June 30, 1961. Common at water's edge in ca. 10 inches of water, sandy bottom, pool in creek at place known as "Vuniwesi" ca.  $\frac{1}{4}$  way around island to south from koro (formal. only; oogonia  $1000 \mu$  long, convolutions 7 (-8), ♂ and ♀); VITI LEVU: Nadroga: (r) *R. D. Wood and Family*, 61-7-9-1. July 9, 1961. Common in ca. 6 inches of clear water, silty mud bottom, N edge of pool with water lilies, Burns Point at E end of Sigatoka Bay (nodes with hard white deposit (negative for lime with dil.  $\text{HNO}_3$  and starch with IKI), stipulodes 2 per branchlet in a firm ring; axes  $750 \mu$  in diam, branchlets 6 cm long) (spec. in US suggested as NEOTYPE of f. *vitiensis*); Naitasiri: (s) *S. Pillay and A. Vuailili, Suva*, 12498. July 12, 1961. Abundant, Sawani R., 1 chain below bridge, N shore [Waimanu R. at Sawani ?] (axis  $650 \mu$  in diam);—(t) ibid., *Suva* 12499. Ibid. (mixed with specimen labeled *N. furcata*); Tailevu: (u) *B. E. V. Parham* 742. Aug. 1, 1937. Forming large patches in shallow water, Wainimalo River, alt 700 ft (SUVA, as *Nitella*, det. R. D. Wood) [there is only a small region where the river touches Tailevu, but the writer visited the area in July 1961 and found no Characeae].

## 2. Section *Agardhia* R.D.W.

2. *Chara fibrosa* Ag. ex Bruz., em. R.D.W.—*Chara fibrosa* Agardh ex Bruzelius (1824: 21); *C. flaccida* Braun (1849:296); *C. gymnopitys* Braun (1852:708); *C. Benthami* Braun (1867:799); *C. gymnopitys* var. *Benthamii* (A. Br.) J. Groves (1924: 373) (orth. mut. to "Benthamii"); *C. fi-*



*brosea* subsp. *gymnopitys* (A. Br.) Zaneveld (1940:158); *C. fibrosa* subsp. *flaccida* (A. Br.) Zaneveld (1940:162); em. Wood (1962a:13).

Fig. 3

REFERENCES FOR FIJI: none.

DESCRIPTION OF FIJI MATERIAL: *Plants* monoecious, 10–20 (–35) cm high, occasionally incrusting. *Axes* moderately slender, ca. 300  $\mu$  in diameter; internodes 1–1½ times as long as the branchlets; cortex 2-corticated, occasionally slightly overlapping, aequistriate to slightly tylacanthous; spine cells sparse, tiny, conical, 20–80  $\mu$  high and ca. 80  $\mu$  wide. *Stipulodes* in 1 tier, 1–2 at each branchlet, generally elongate, 1–3 times longer than the axis diameter, cylindrical with acute tips; very deciduous and apparently replaced by short conical stipulodes. *Branchlets*, all similar and potentially fertile, 8–10 in a whorl, 1–2 (–2.5) cm long, segments (2–) 3 (rarely –4), end segment generally 2-celled with a reduced end cell. *Bract-cells* generally 3, verticillate, short, 1/10–1½ as long as the branchlet diameter, commonly 150–500  $\mu$  long and ca. 100  $\mu$  wide (highly variable). *Bracteoles* 2, longer than the bract-cells, ½–1½ times oogonium in length. *Bractlet*, none. *Gametangia* conjoined at lowest 2 (rarely 3) branchlet nodes. *Oogonia* 1 at a node, ca. 700  $\mu$  long (excluding coronula) and ca. 450  $\mu$  wide; convolutions ca. 9; coronula conical, ca. 70  $\mu$  high and 300  $\mu$  wide. *Oospores* dark brown (slightly immature), ca. 450  $\mu$  long and ca. 250  $\mu$  wide; striae of 7–8 prominent ridges, possibly prolonged into short basal spines; fossa ca. (72–) 84  $\mu$  across; membrane smooth, brown. *Antheridia* 320–480  $\mu$  in diameter; 8-scutate.

This species is the only local charad with cortication. The longitudinal lines on the axis can just be seen by holding the plant up against the sunlight, and they can be easily made out with the aid of a hand lens. Another corticated species, *C. zeylanica*, occurs as near as New Caledonia and may turn up in Fiji. It could readily be distinguished by having two distinct rows of stipulodes, whereas there is only one row in *C. fibrosa*.

Although commonly treated as *C. gymnopitys*, the older name of *C. fibrosa* has priority, and

Zaneveld (1940:153) re-established this as the correct name. The present writer (1962a:13) included both *C. gymnopitys* and *C. benthamii* in the type variety of *C. fibrosa*.

The chromosome number of 28 agrees with Hotchkiss' unpublished data on Australian examples of *C. fibrosa*.

Variation in gross appearance is slight, but there are considerable differences in details. Some specimens exhibit only short, conical stipulodes (spec. i), while others have the elongate ones (spec. k). Between these two extremes are a number which have few to many elongated stipulodes (spec. h), but where they are missing the gap is filled with the short ones. It would appear that the long stipulodes abscise, perhaps at an early stage of development, and are replaced by the short ones. Where two stipulodes occur, they arise one at each side of each branchlet; but, where only one stipulode remains, it may appear to be alternately inserted. Other features to be noted are a spiny appearance due to large bract-cells (spec. a), smooth appearance when bract-cells are small (spec. h), and an appearance intermediate between these two (spec. j). None of the features seems consistent. The peculiar irregularity of the stipulodes, their large size, and the tendency for the number to vary from 1 to 2 per branchlet agree with these characteristics of the forms previously designated as *C. benthamii*.

HABITATS: Rice fields, ponds, pool by bridge, pool in ditch.

DISTRIBUTION: In Fiji, collected from Viti Levu (Tailevu near Sawani and Natovi; Nadroga near Sigatoka and Cuvu) and Vanua Levu (Macuata and Macuata-i-wai). *C. fibrosa* is widely distributed throughout the tropic and temperate world, Europe being the only temperate continent from which it is unknown. In the western Pacific, it is also reported from Japan, the Philippine Islands, Indonesia, Australia (including Tasmania), New Caledonia, New Zealand, and Guam.

SPECIMENS: VANUA LEVU: Macuata: (a) R. D. Wood and Vakuru Waibuta 61–6–29–1. June 29, 1961. In ca. 3 inches of clear water, mud bottom, pool in drained rice field W of Nakoroutari Road ca. 150 ft W of culvert marker



K 33, ca. 5 miles S of Labasa; mature ♀, 2-cort., slightly tylacanthous, stipulodes 1–2 per branchlet, oospore fossae 72–84  $\mu$  across, [contains traces of *C. corallina* on which CYT F 16 was counted]; Macuata-i-wai [Mathuata Island]: (b) *ibid.* 61–6–30–1. June 30, 1961. Common at water's edge, in ca. 10 inches of clear water, sandy bottom, pool in creek at place known as "Vuniwesi" in a valley ca.  $\frac{1}{4}$  way around island to S from koro at E end (some stipulodes  $1\frac{1}{2}$  times axis diam in length);—(c) *ibid.* 61–6–30–2. *Ibid.* (formal. only; mixed with *N. pseudoflabellata*);—(d) *ibid.* 61–6–30–3. *Ibid.* (formal. only; sparse, mixed with *N. pseudoflabellata*);—(e) *ibid.* 61–6–30–4. *Ibid.* (formal. only; mixed with *N. pseudoflabellata*);—(f) *ibid.* 61–6–30–6A. *Ibid.* (formal. only; mixed with *N. pseudoflabellata*); VITI LEVU: Nadroga: (g) *W. Greenwood* 104. Sept. 12, 1920. In water in drain side of rock cutting, Sigatoka (K, as *Chara* sp., annotated *C. flaccida* by J. Groves);—(h) *R. D. Wood* 61–6–9–1. June 9, 1961. In ca. 6 inches of fairly clear water, mud bottom, pond in marsh N of Queen's Road ca. 1 mile W of Sigatoka Hotel (RDW 1564, Fig. 3) (incrusted throughout, stipulodes deciduous, first long then short);—(i) *ibid.* 61–6–11–2. June 11, 1961. In ca. 12 inches of clear water, mud bottom, drained rice paddy E of Queen's Road ca. 14 miles N of Cuvu (unusual, bracteoles 4,  $1-2 \times$  oogonium length, 2 (–3)-cort., nearly aequistriate, stipulodes small);—(j) *ibid.* 61–6–11–3. In ca. 12 inches of clear water, drained rice paddy W of Queen's Road ca. 23 miles N of Cuvu (cortex 2-cort., somewhat overlapping);—(k) *ibid.* 61–6–11–4. *Ibid.*, but in 3 inches of water (large, 28 cm high, stipulodes largely lost and the few remaining ones are long); Tailevu: (l) *ibid.* 61–6–28–1. June 28, 1961. In ca. 6 inches of clear fresh water, black muck bottom, small pool in ditch W of Natovi-Korovou Road ca. 13 miles N of Korovou (CYT F 15,  $n = 28$ );—(m) *ibid.* 61–6–28–2. *Ibid.*

## II. Tribe NITELLEAE

### 2. *Nitella* Ag. em. A. Br.

1. Subgenus *Nitella* (= Anarthrodactylae)
2. Section *Rajia* R.D.W. (= Acuminatae)

3. *Nitella acuminata* A. Br. ex Wallm., em. R.D.W.—*Nitella acuminata* Braun ex Wallman (1853:35, and 1854:263) (including "*N. acuminata*" var. *Bellangeri* Braun, 1849:292); em. Wood (1962a:16).

Figs. 1, 4

REFERENCES FOR FIJI: none.

DESCRIPTION OF FIJI MATERIAL: *Plants* monoecious, (5–) 15–20 (–35) cm high, moderately slender to stout, with or without a dendroid central stalk and with or without fertile heads. *Axes* moderately stout, 600–1200  $\mu$  in diameter; internodes 1–2 times longer than the branchlets, 1–7 cm long. *Branchlets*, *fertile*, 6–7 in a whorl, 1–4 (–5) cm long but sometimes reduced, 1-furcate into 2–3 secondaries (dactyls in this case); primaries  $\frac{2}{5}$ – $\frac{4}{5}$  of branchlet length; *sterile* similar to fertile, not reduced. *Dactyls*, *fertile*, 2 (–3), (1/10–)  $\frac{1}{5}$ – $\frac{3}{5}$  of branchlet length, 0.3–3 cm long, 1-celled, tapering to an elongate acute or acuminate tip; *sterile* similar to fertile, but not reduced. *Heads* uncommon, but upper whorls occasionally somewhat compacted into loose clusters 1–10 mm across; without mucus. *Gametangia* conjoined at branchlet nodes, but where reduced whorls occur the gametangia are nearly completely restricted to these heads; generally 1 antheridium and 1–2 (–3) lateral oogonia at a node. *Oogonia* 1–2 (–3) at a node, 350–390  $\mu$  long (excluding coronula) by 295–320  $\mu$  wide; convolutions 8–9; coronula (28–) 30–35  $\mu$  high and 42–50 (–64)  $\mu$  wide, persistent, upper cells slightly longer than lower. *Oospores* dark brown, 248–280  $\mu$  long and (210–) 225–240  $\mu$  wide; striae of 5–6 (–7) flanged ridges; fossa regular and 40–50  $\mu$  across or variable and 37–50  $\mu$  across; membrane pale brown, smooth or loosely tuberculate with 15–18 (–30) figures across fossa, 1–3 diameters apart (spec. a). *Antheridia* 224–280  $\mu$  in diameter; 8-scutate.

This is the only Fijian charad which is ecorticated and which has routinely 1-furcate branchlets. *N. furcata*, which usually has branchlets 2-more furcate, may appear 1-furcate at times and resemble *N. acuminata*; but a close examination will reveal small terminal, 2-celled dactyls, whereas the entire dactyl is 1-celled in *N. acuminata*.



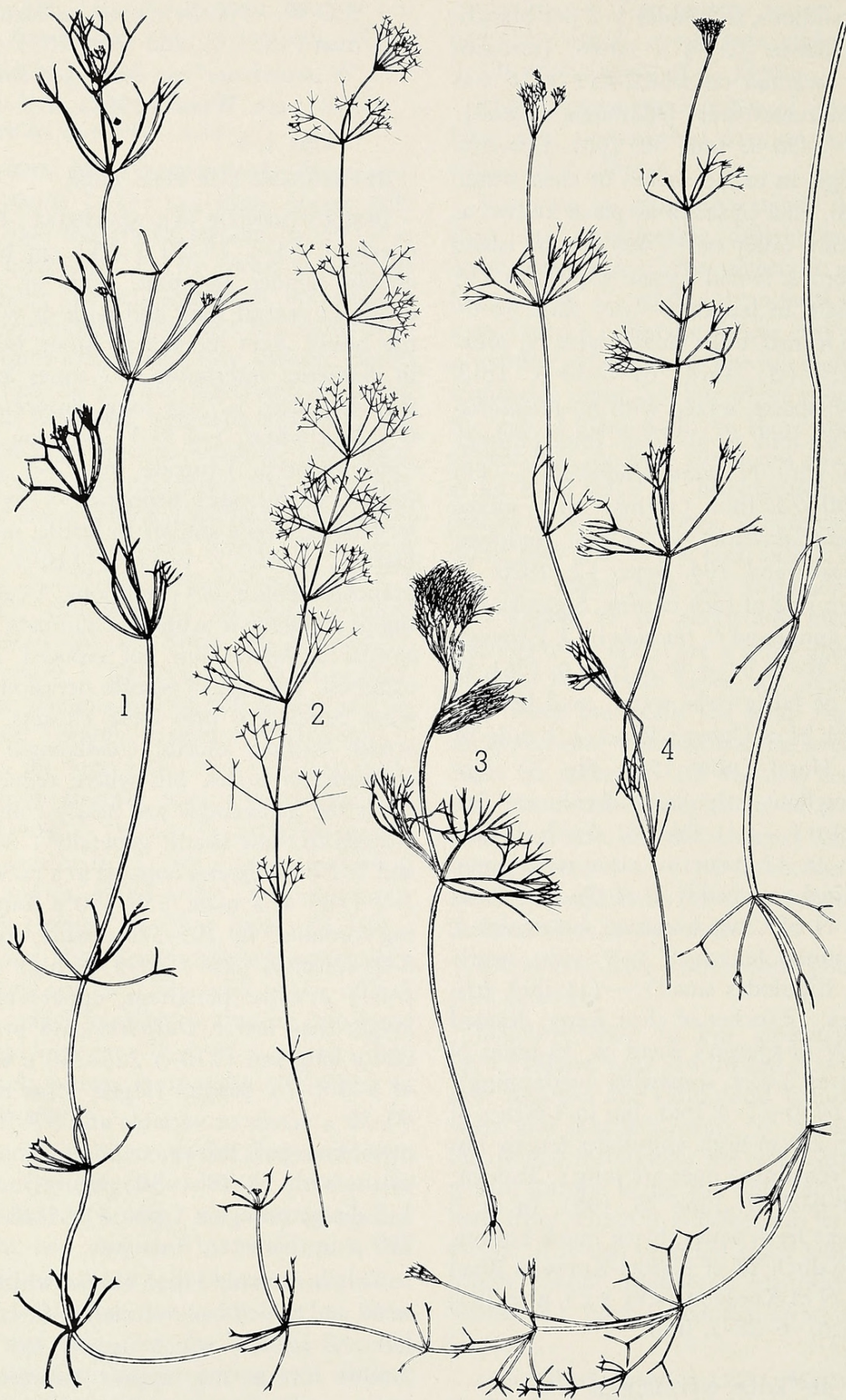


FIG. 4. Variations in *Nitellas* of Fiji. 1, *Nitella acuminata*, an elongate, lax specimen,  $\times 1$ . 2-4, *Nitella pseudoflabellata*. 2, Bushy form,  $\times 3$ . 3, Diffuse form,  $\times 1$ . 4, Mathuate form,  $\times 1$  (= *N. muthnatae* T.F.A.). (1 From spec. a; 2 from spec. af; 3 from spec. a; 4 from spec. p.)



The type variety, var. *acuminata*, is here broadened to include both the early sense, var. *Belangeri* Braun (1849:292), and that of the more diffuse forms, var. *diffusa* R.D.W. (Wood, 1962a:16).

The chromosome number of 18 agrees with Hotchkiss' (1958:15) earlier findings for North American material.

Variations are relatively minor and intergrade into one another; however, one extreme predominates in rice paddies and the other in pools. They appear to be ecologically induced fluctuations. One extreme is dendroid with an elongated lower axial internode which resembles a stalk and gives the plant a treelike habit. The plants also tend to be stouter throughout and to form distinctive heads (spec. d, f, g, j). The lax extreme has fairly uniform whorls evenly distributed along the axis, the plants tending to be more slender and not to form heads (spec. a, b, h). In addition to the above variations, it should be noted that some specimens exhibit unusual tuberculate rather than smooth oospore membranes. Otherwise they agree with *N. acuminata* (spec. d, f, h), and are not here separated on the membrane feature alone. Hotchkiss (in press) noted no differences in the chromosomes of these variants.

**HABITATS:** Rice fields, pools by bridge, pool by waterfall, lily pool, beach pool, creek, river. It apparently tolerates some salinity, as it occurred (spec. h) in a marsh which also had *Acrostichum aureum* L. The latter prefers "shallow brackish swamps" (Merrill, 1945:52). The apparent tolerance of *N. acuminata* to some trace of salt water in Fiji agrees with the observation of Wood and Muenscher (1956:11), who reported it from tidal mud flats of the Hudson River, New York.

**DISTRIBUTION:** In Fiji, collected only on Viti Levu (Naitasiri near Sawani; and Serua near Galoa and Navua). *N. acuminata* is widespread throughout the world, and absent from only one temperate continent, Europe. It is commonly reported from islands, and in the Pacific is known from Indonesia, the Philippine Islands, Formosa, and Japan.

**SPECIMENS:** VITI LEVU: Naitasiri: (a) R. D.

Wood and S. Pillay 61-6-26-2. June 26, 1961. In ca. 12 inches of fairly turbid water, mud bottom, amid water lilies in the [more] western of the two large lily ponds on the plain below the Adi Cakobou School, Sawani, ca. 18 miles N of Suva (RDW 1551, Fig. 4);—(b) *ibid.* 61-6-26-3. *Ibid.* (CYT F 14,  $n = 18$ ; primary rays 2-3 times dactyls in length); Serua: (c) R. D. Wood 61-6-8-1. June 8, 1961. In ca. 2 inches of clear water, muck bottom, old rice paddy ca. 6 miles E of Galoa, ca. 32 miles E of Korolevu Hotel (small fertile heads);—(d) *ibid.* 61-6-8-2. *Ibid.*;—(e) *ibid.* 61-6-25-1. June 25, 1961. In 3-4 inches of clear water, mud bottom, wet field N of road, ca.  $\frac{1}{4}$  miles N of Navua Hotel, ca. 28 miles W of Suva (CYT F 10,  $n = 18$ ; with some short dactyls 2-3 mm long);—(f) *ibid.* 61-6-25-2. In ca. 2 inches of clear water, mud bottom, rice paddy N of road, ca.  $1\frac{1}{2}$  miles W of Naitonitoni, ca. 29 miles W of Suva (RDW 1558; Fig. 1) (with some reduced dactyls and some small whorls);—(g) *ibid.* 61-6-25-3. In ca. 1 inch of clear water, mud bottom, tips of the *Nitella* projecting ca. 1 inch above water surface [water receding], rice paddy S of road, ca. 1 mile W of Naitonitoni, ca. 30 miles W of Suva;—(h) *ibid.* 61-6-25-5. In ca. 8 inches of clear fresh water, fairly firm mud bottom, pool ca. 50 ft behind beach, ca. 500 yards S of jetty at end of road, Naitonitoni, ca. 31 miles W of Suva; some *Acrostichum* in the adjacent marsh (mature ♀);—(i) *ibid.* 61-6-25-6. *Ibid.* (formal. only, mixed with and labelled *N. pseudoflabellata*);—(j) *ibid.* 61-6-25-9. In 2-4 inches of fairly clear water, mud bottom, rice paddy N of Queen's Road 1 mile E of "Coronation Triangle" at Navua, ca. 26 miles W of Suva.

## 2. Subgenus *Tieffallenia* R.D.W.

(= Arthrodactylae, pro parte)

### 1. Section *Tieffallenia* (= Mucronatae)

4. *Nitella furcata* (Roxb. ex Bruz.) Ag., em. R.D.W.—*Chara furcata* Roxburgh ex Bruzelius (1824:22); *Nitella furcata* (Roxb. ex Bruz.) Agardh (1824:124); em. Wood (1962a:17).



var. *sieberi* (A. Br.) R.D.W.—*Chara mucronata* [var.] *Sieberi* Braun (1835:52); *Nitella polyglochis* var. *microcarpa* (A. Br.) T. F. Allen (1871:9); *N. microcarpa* var. *microglochis* (A. Br.) Zaneveld (1940:103); *N. mucronata* subsp. *furcata* var. *microcarpa* (A. Br.) Wood (1962a:18); *N. furcata* var. *sieberi* (A. Br.) Wood (1963:227).

Fig. 2

REFERENCES FOR FIJI: none.

DESCRIPTION OF FIJI MATERIAL: *Plants* monoecious, 15–30 (–more ?) cm high, varying considerably in habit from diffuse to strict; specimens depauperate. *Axes* moderately stout, 400–480  $\mu$  in diameter; internodes 1–4 times as long as the branchlets. *Branchlets*, fertile (not known, but probably not distinctive); sterile (5–) 6–8 in a whorl, 0.5–3 cm long, spreading at 40–60° angle from axis, irregularly (1–) 2 (–3)-furcate into (2–) 3 (–5) secondaries, and where present also into 1–3 tertiaries; primaries  $\frac{1}{2}$ – $\frac{2}{3}$  (–most) of total branchlet length, secondaries tiny in some cases or up to  $\frac{1}{4}$  of branchlet length. *Dactyls*, sterile, 2–3, generally reduced and tiny, 2-celled, penultimate cell rounded distally and wider than base of end cell; dactyls occasionally not reduced. *Heads* (not known, probably not developed). *Gametangia* absent (see Wood, 1963, for details from comparable Samoan material). (See Zaneveld, 1940:88, and Imahori, 1954: 105 and pl. XXIV, for descriptions of *N. furcata* (sens. strict.)).

This species is readily recognizable in Fiji as the only ecorticated charad which appears coarse and which has branchlets 2-more times furcate. Further, it has tiny 2-celled abbreviated dactyls. These are visible under a hand lens (see *C. corallina*).

As recently noted by the author (Wood, 1963), the names *N. furcata* and var. *sieberi* have priority and thus replace *N. mucronata* and var. *microcarpa* he had listed (1962a:17).

Unfortunately, no useful cytological material of this species was found in Fiji; but suitable stages were obtained in Western Samoa of a strain similar in all observable respects. The chromosome count of 18 (Wood, 1963:228) was obtained, which agrees with Gillet's (1959: 231) report of 18 in European *N. mucronata*

(= *N. furcata* subsp. *mucronata* in the present writer's revision).

Variations among the specimens were considerable, there being two extremes; but unfortunately no well-developed fertile material was obtained of either variant. A lax example has long branchlets up to 3 cm in length, and superficially resembles a lax *N. flexilis* in habit (spec. a). The other extreme is strict, has short branchlets up to 1 cm long, is dark gray green, and is long and slender in habit (spec. b). The lax variant occurred in a waterfall pool, and the strict material occurred in a river.

HABITATS: Pool below waterfall, in river.

DISTRIBUTION: In Fiji, collected only on Viti Levu (Naitasiri near Sawani). *N. furcata*, in the broad sense used here, is distributed throughout the world, and is known from the western Pacific in Indonesia, New Guinea, Australia (Queensland), the Philippine Islands, and Japan. The writer also found it in Western Samoa, but not in New Caledonia.

SPECIMENS: VITI LEVU: Naitasiri: (a) R. D. Wood and S. Pillay 61–6–26–4. June 26, 1961. In ca. 4 inches of rather turbid water, mud bottom, small pool on plain below Adi Cakobou School, ca.  $\frac{1}{3}$  way from lily pools to bridge, Sawani, ca. 18 miles N of Suva (RDW 1549, Fig. 2);—(b) S. Pillay and A. Vualili, Suva 12499. July 12, 1961. Abundant in Sawani River [Waimanu R. at Sawani?], 1 chain below bridge (a confusing mixture of glossy specimens of *N. furcata* and dull specimens of *C. corallina*, at first thought by the writer to be *Nitellopsis* because the furcations of the *Nitella* resemble the long bract-cells of *Nitellopsis*);—(c) *ibid.*, Suva 12500. Abundant in Sawani River [Waimanu R. at Sawani?], below bridge on N side.

## 2. Section *Gioallenia* R.D.W.

5. *Nitella pseudoflabellata* A. Br. in A. Br. & Nordst., em. R.D.W.—*Nitella pseudoflabellata* Braun in Braun and Nordstedt (1882:54); em. Wood (1962a:19).

Figs. 1, 4, 5

REFERENCES FOR FIJI: *Nitella muthnatae* T.F.A.: T. F. Allen (1887:211), Zaneveld (1940:72), Wood (1952:352, nom. tant.), Wood and Imahori (1959:178); *N. gracilis* subsp. *leptosoma* var. *mathuatae* (T.F.A.) Wood



(1962a:20) (orth. mut.).—"nom. ined., '*N. Gibbsiae*' J. Gr. (herb. K)."

**DESCRIPTION OF FIJI MATERIAL:** *Plants* monoecious, (4-) 9-18 cm high, moderate in size, slender, light to dark green. *Axes* slender, (170-) 250 (-465) (570)\*  $\mu$  in diameter; internodes (1/2-) 1-2 times as long as the branchlets, 1-4 cm long. *Branchlets*, *fertile*, (6-)\* 7-8 in a whorl, of normal size or reduced (0.6-1.2 cm long), (1-) 2-3 (-4)-furcate into (4-) 5-6 (-8) secondaries one of which is generally central and similar to the laterals, (3-) 4-5 tertiaries and (3-) 4-5 quaternaries; primaries  $2/5$ - $3/5$  of the total branchlet length; *sterile* similar to unreduced fertile branchlets. *Dactyls*, *fertile* and *sterile* similar, 3-4, 2-celled, (600-) 800-2000  $\mu$  long, (50-) 120  $\mu$  wide, basal cell tapering sharply to base of end cell or occasionally rounded distally, end cell conical and acute, 50-110  $\mu$  long, 30-35  $\mu$  wide, occasionally somewhat mucronate. *Heads* not well formed, but young (uppermost 1-2 internodes) fertile axes commonly elongate while their branchlets are still immature giving the appearance of terminal or lateral inflorescences, rarely compact and headlike. *Gametangia* conjoined at (1st-) 2nd (-3d) lower branchlet nodes, generally absent from lowest; protandrous, antheridia early deciduous. *Oogonia* 1 (-2) at a node, (360-380-)\* 420-495  $\mu$  long (excluding coronula) and (270-)\* 340-355  $\mu$  wide; convolutions 8-9 (-10), the cells unwinding slightly at maturity beneath the coronula; coronula (20-) 45-50  $\mu$  high and (20-) 35-50 (-56)\*  $\mu$  wide, upper cells  $1\frac{1}{2}$ -2 (-3) times longer than the lowers. *Oospores* dull brown (slightly immature), (265-)\* 315-340  $\mu$  long, 230-245 (-255)  $\mu$  wide, 190  $\mu$  thick; striae of 5-7 (-8) slightly flanged ridges; fossa 42-52  $\mu$  across; membrane granular papillate, possibly appearing somewhat reticulate when pressed under a coverslip, 10-12 (-16) papillae across fossa, 2-3 diameters apart and ca. 2  $\mu$  high. *Antheridia* 1 at a node, 170-258 (-270)\*  $\mu$  in diameter, slightly wider than high, apparently 8-scutate.

This species is easily recognized in Fiji because of the delicate structure and tendency for repeatedly divided branchlets. Extreme examples which are more stout and have branchlets only 1-2-furcate can be checked under the microscope for the 2-celled dactyls.

The identity of the Fijian *Nitella* had been a matter of concern to the writer for some time. The existence of an endemic on an isolated mid-ocean island, apparently unrelated to species of adjacent continents, seemed remarkable. The present collections include complete sexual material and permit identification as *N. pseudoflabellata*. There is wide variation among the Fiji specimens, and the original type of *N. mathuatae* represents but one expression—a stout form with 1-2-furcate branchlets and occasional inflorescence-like apices. Based on original collections alone, Zaneveld (1940:72) had thought it might be *N. bipartita*, and the writer (1962a:20) had referred it to *N. gracilis* var. *leptosoma*.

The chromosome number of 18 differs from the only known prior reports of 24 from Japan (Imahori & Kato, 1961) and New Zealand (Hotchkiss, in press). It suggests the possibility of a polyploid series. By contrast, numbers for the similar *N. gracilis* were reported as 17 by Lindenbein (1927) and 34 by Karling (1926).

The local variants of *N. pseudoflabellata* form about six more or less distinctive categories, all of which appear to blend into one another. These include ones which are (1) glomerate, larger, denser upper whorls (spec. ad); (2) diffuse but uniform branching throughout (spec. a, h, x, aa, ac); (3) inflorescence-producing upper whorls reduced and isolated along an elongated axis, also coupled with branchlets being only 2-furcate (spec. k, p, r, v, w)—var. *mathuatae*<sup>9</sup> (*N. muthnatae* T.F.A.); (4) elongate, intermediate between 1 and 2, but with fewer furcations (spec. z); (5) bushy with very uniform, regular branchlets, with mature oogonia at central tip of each branchlet (spec. l, m, q, af); and (6) very small, 2-4 cm high, slender and delicate,

<sup>9</sup> *N. pseudoflabellata* var. *mathuatae* (T.F.A.) R.D.W., *comb. nov.* (basonym: *N. muthnatae* T. F. Allen (1887:211)).

\* Wood (in press).



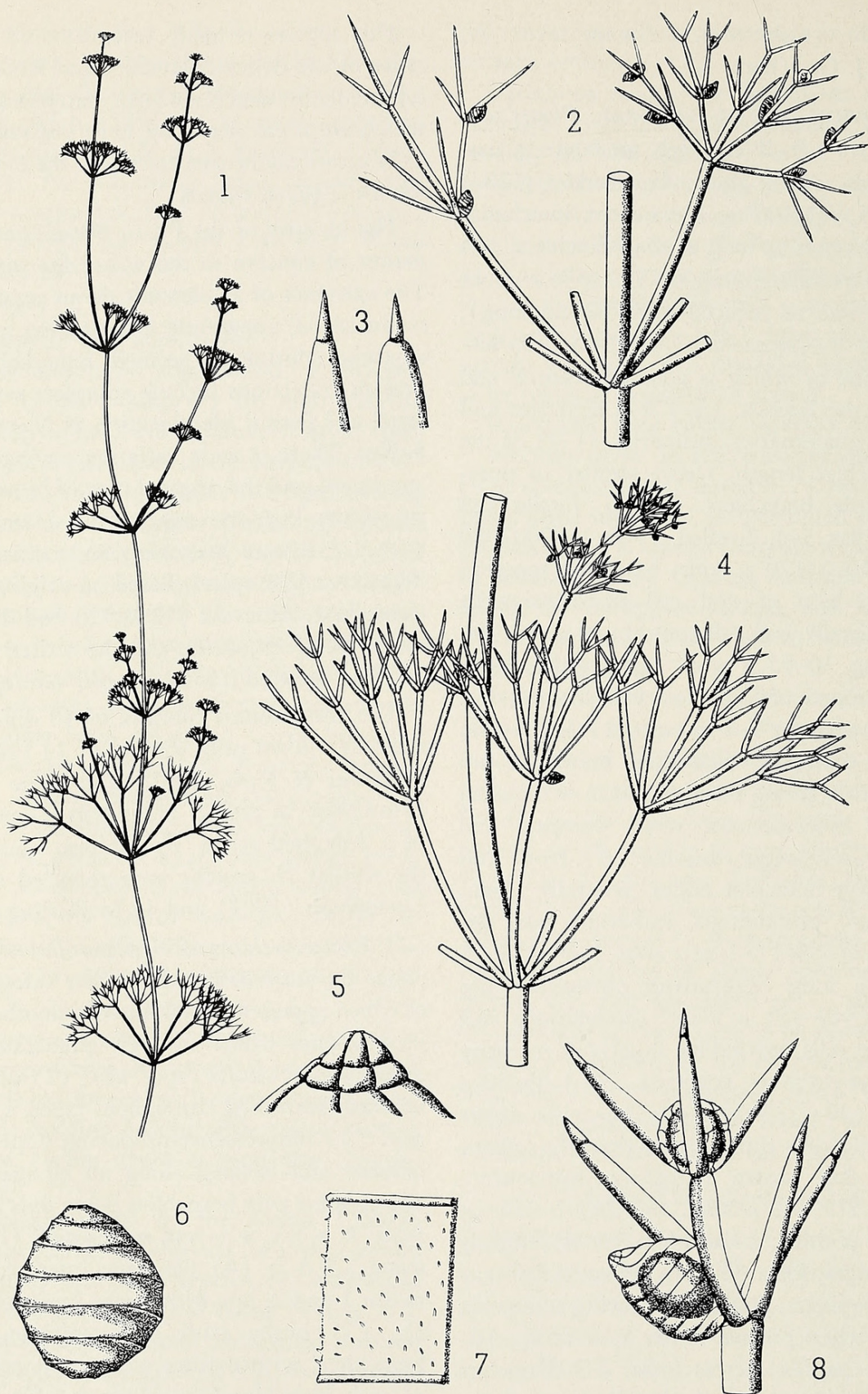


FIG. 5. Type of *Nitella muthnatae*, here designated as *N. pseudoflabellata* var. *mathuatae* (from Wood and Imahori, *Iconograph of the Characeae* (in press). Cramer. Weinheim (ICON 325)). 1, Habit,  $\times 1$ . 2, Axial node with (1-) 2-3-furcate fertile branchlets,  $\times 12$ . 3, End cells of dactyls,  $\times 90$ . 4, Lower axial node with 2-3-furcate branchlets and an accessory branch produced at the 1st node,  $\times 5$ . 5, Coronula,  $\times 390$ . 6, Oospore,  $\times 90$ . 7, Oospore membrane,  $\times 500$ . 8, Branchlet node with gametangia and dactyls,  $\times 40$ .



2-furcate (spec. e, t, u)—(*"N. Gibbsiae"* J. Gr., ined.). For convenience, these could be designated by such descriptive names as f. *glomerata*, *diffusa*, *mathuatae*, *elongata*, *fruticosa*, *minima*.

The original collections of *N. mathuatae* (as *"N. muthnatae"*) were distributed from the U. S. National Herbarium under the label of the United States Exploring Expedition and, aside from giving the location as "Muthnate Island" and the year as 1838–42, no data were added. Wilkes reported (1845:225, 234) that the ships anchored at "Muthuata Village" (Macuata) on June 19 and departed July 2, 1840. The entry concerning "Muthuata Island" (Macuata-i-wai) (*loc. cit.*, p. 230, 231) makes no mention of plant collecting. Thus, it is not clear when or by whom *"N. muthnatae"* was gathered; but, as the specimens were well mounted and the ship was in Macuata for a limited time, it is here arbitrarily assumed that they were done by the botanists, Rich and Brackenridge, in June 1840. The exact location is not specified, but Macuata-i-wai is a small island less than a mile long, and in 1961 was said by the natives to have four creeks with standing-water holes. Concerning Macuata, it is curious that Derrick (1957) described it as deserted, rocky, and dense with *Casuarina* trees; that Wilkes (1845) described it as uninhabited and used for burials; whereas, in 1961, it had remnants of an extensive village, was reported as the stronghold of paramount chiefs, and had grassy upland with a coastal belt of coconut trees. Could there have been another Macuata just off Vanua Levu?

**HABITATS:** Rice fields, taro patch, drainage ditch, pool by bridge, pool below waterfall, pool behind beach, streams, and creeks.

**DISTRIBUTION:** In Fiji, collected on Viti Levu (Colo North, Lautoka, Nadroga, Naitasiri, Rewa, and Serua), Ovalau, and Vanua Levu (Macuata and Macuata-i-wai). *N. pseudoflabellata* is widespread in the eastern hemisphere and is known from Madagascar, India, Ceylon, Burma, China, Japan, Malaysia, New Caledonia, New Zealand, and Fiji.

**SPECIMENS:** OVALAU ISLAND: (a) *R. D. Wood and Bernard Vunibobo* 61–6–13–1. June

13, 1961. In ca. 3 inches of clear, flowing water, drainage ditch on village green, Nacobo Koro, ca. 6.4 miles along road S from Levuka (RDW 1567, Fig. 4) (CYT F 2,  $n = 18$ ; delicate, 3-furcate into 5–6 secondaries one of which is central, 4 tertiaries, 3 quaternaries); VANUA LEVU: Macuata: (b) *R. D. Wood and Vakuru Waibuta* 61–6–29–2A. June 29, 1961. In ca. 6 inches of water, mud bottom, ricefield W of Nakoroutari Road, ca. 2 miles S of Nakama Road, ca. 5 miles S of Labasa (oospores  $300 \times 210 \mu$ , striae 5, flanged, fossa  $63 \mu$  across, membrane granular-papillate, ca. 10 papillae across fossa; mixed with *C. corallina*);—(c) *ibid.* 61–6–29–3. *Ibid.* (antheridia ca.  $224 \mu$  in diam);—(d) *ibid.* 61–6–29–5. *Ibid.* (formal. only; mixed with *C. corallina*);—(e) *ibid.* 61–6–29–6A. *Ibid.* (formal. only; mixed with *C. corallina*) (*"N. gibbsiae"* J. Gr., CYT F 17,  $n = 18$ ; tiny, with dense terminal heads);—(f) *ibid.* 61–6–29–7. *Ibid.* (formal. only; mixed with *C. corallina*; gelatinous heads, ca.  $2 \times 1.5 \text{ mm}$ );—(g) *ibid.* 61–6–29–7A. *Ibid.* (crumbled to fragments);—(h) *ibid.* 61–6–29–8. *Ibid.* (nodes frequently swollen, branchlets stiff and straight, CYT F 18,  $n = 18$ );—(i) *ibid.* 61–6–30–10. June 30, 1961. Abundant in ca. 1 ft of clear water, silty-sandy-mud bottom, pool known as "Nalioniga" W of road ca. 1 mile past Seaqaqa Agric. farm (mixed with and labeled *C. corallina*);—(j) *ibid.* 61–6–30–11. *Ibid.* (formal. only; mixed with *C. corallina*);—(k) *ibid.* 61–6–30–12. *Ibid.*, but common in 10 inches of water (RDW 1544, Fig. 1) (exhibits inflorescence-like upper axial whorls);—(l) *ibid.* 61–6–30–12A. *Ibid.* (formal. only; no heads nor mucus, mature ♀ and ♂); Macuata-i-wai [Mathuata Island]: (m) *ibid.* 61–6–30–2. Common at margin in ca. 10 inches of clear water, sandy bottom, pool in creek [on hill side] at place known locally as "Vuniwesi" in shallow valley ca.  $\frac{1}{4}$  the way around S edge of island from koro [at NE point] (soft and delicate branchlets, fossae ca.  $42 \mu$  across);—(n) *ibid.* 61–6–30–3. *Ibid.* (formal. only; mucus heads, variable branchlets (some simple), oogonium  $440 \times 354 \mu$ , convolutions 9, coronula  $20 \times 50 \mu$  wide, upper cells slightly longer than lower, oospore brown, fossa ca.  $46 \mu$  across, membrane



loosely papillate, ca. 10 papillae across fossa and 2–3 diameters apart on roughened background); —(o) *ibid.* 61–6–30–4. *Ibid.* (formal. only; mixed with and labeled *C. fibrosa*) (typical f. *mathuatae*) TOPOTYPE; —(p) *ibid.* 61–6–30–5. Abundant, in ca. 3 inches of clear water, sandy mud bottom, at outflow from pool [location as above] (RDW 1541, Fig. 4) (CYT F 20x, n = 18; formal. specimen with heads ca. 5 mm in diam, antheridia 160–280  $\mu$  in diam, dactyls unequal, secondary and tertiary rays occasionally simple, typical f. *mathuatae*) TOPOTYPE; —(q) *ibid.* 61–6–30–6. *Ibid.*, but in ca. 10 inches of clear water; —(r) [*? W. Rich and J. D. Brackenridge*] s.n. June, 1840. In small pool in creek. Muthuate Island, Feejee. (as U. S. South Pacific Expl. Expedition under Command of Capt. Wilkes. 1838–1842). (US, HOLOTYPE; NY, ISOTYPE, Fig. 5). Note: the script is easily misinterpreted to read "Muthnate," as apparently was done by T. F. Allen (1887: 211); VITI LEVU: Colo North: (s) *L. S. Gibbs* 762. July 10, 1909 (Sept. 1907). In stream, Mt. Waikubakuba [–] Tabua Rd., 500 ft alt, Nadarivatu (K, as *Nitella gracilis*, det. ?; poor wadded specimen); LAUTOKA: (t) *W. Greenwood* 102. Aug. 29, 1920. In water in taro plantation, Mt. Lautoka (K, as *Nitella* sp., annotated "*N. Gibbsiae*, J. Groves ms"); —(u) *ibid.* 103. *Ibid.* (K, *ibid.*); NADROGA: (v) *R. D. Wood* 61–6–11–1. June 11, 1961. In ca. 12 inches of clear water, mud bottom, drained rice paddy, ca. 14 miles N of Cuvu on Queen's Road; Naitasiri: (w) *R. D. Wood and S. Pillay* 61–6–26–1. June 26, 1961. In ca. 6 inches of rather turbid water, mud bottom, small pool ca. 200 ft SE of S end of bridge at Sawani, ca. 18 miles N of Suva; —(x) *S. Pillay and A. Vualili*, *Suva* 12501. July 12, 1961. Scarce, muddy water, in pool at base of waterfall, Sawani; Rewa: (y) *B. Vunibobo*, *Suva* 12502. June 25, 1961. Standing water, ricefield at Dreketi midway between Vunisinu and Nadona village (glomerate variant); —(z) *R. D. Wood* 61–7–5–1. July 5, 1961. Sparse in ca. 6 inches of turbid water, mud bottom, field pool ca. 50 ft S of King's Road, between road and Rewa River, ca. 2 miles NW of Nausori; Serua: (aa) *I. Bola*, *Suva* 12503. July 17, 1961. Wairoro Creek, Nabukavesi; —(ab) *ibid.*, *Suva* 12504. *Ibid.*—

(ac) *ibid.*, *Suva* 12505. July 18, 1961. Scarce, Nabukavesi Creek; —(ad) *ibid.*, *Suva* 12506. July 19, 1961. *Ibid.*; —(ae) *R. D. Wood* 61–6–25–5A. June 25, 1961. In ca. 8 inches of clear, fresh water, fairly firm mud bottom, pool ca. 50 ft behind beach, ca. 500 yards S of jetty at end of Naitonitoni Road, ca. 31 miles W of Suva; —(af) *ibid.* 61–6–25–6. *Ibid.* (RDW 1554, Fig. 4) (CYT F 11, n = 18).

#### CONCLUSIONS

1. Intensive collecting of Characeae on four islands of the Fiji group was done in June–July, 1961, and two genera and five distinct species, including *Chara corallina*, *C. fibrosa*, *Nitella acuminata*, *N. furcata*, and *N. pseudoflabellata*, were found.

2. The two earlier reports were of *Chara australis* and *Nitella mathuatae* (as *muthnatae*); but, through revision, these are included as synonyms of *C. corallina* and *N. pseudoflabellata*, respectively.

3. The chromosome numbers were found to be: *C. corallina* (dioecious state) 14, *C. fibrosa* 28, *N. acuminata* 18, and *N. pseudoflabellata* 18. No counts were made of *N. furcata* on Fiji, but the same species in Samoa had 18.

4. The chromosome numbers are, with the exception of *N. pseudoflabellata*, consistent with findings for the species in other countries, and add confirmation to the writer's new classification system.

5. Certain of the habitats in which Characeae occur in Fiji are also found in the Society Islands; and thus the absence of these plants from Tahiti is probably not due entirely to lack of suitable environments.

6. *Nitella* is somewhat more common than *Chara* in number of habitats occupied (56.2% of the habitats with Characeae had *Nitella* and 43.8% had *Chara*).

7. Characeae occurred in 19% of the habitats examined, predominating in rice fields and in ponds in fields and open woods. They were rare in taro patches, streams, and rivers.

8. *Nitella mathuatae* T.F.A. is transferred to *N. pseudoflabellata* var. *mathuatae* (T.F.A.) R.D.W., comb. nov.



## COLLECTORS AND COLLECTORS' NUMBERS

Species number and specimen letter as they appear in the text are cited in parentheses.

BOLA: 12503 (5aa), 12504 (5ab), 12505 (5ac), 12506 (5ad)—GIBBS: 762 (5s)—GREENWOOD: 102 (5t), 103 (5u), 104 (2g)—NAUMANN: s.n. (1a)—PARHAM: 742 (1u)—PILLAY and VUALILI: 12498 (1s), 12499 (1t, 4b), 12500 (4c), 12501 (5x)—PILLAY and WOOD: (see Wood and Pillay)—RICH and BRACKENRIDGE: s.n. (5r)—SMITH: 6698 (1d)—U. S. SOUTH PACIFIC EXPLORING EXPEDITION (see Rich and Brackenridge)—VUALILI (see Pillay and Vualili)—VUNIBOBO: 12502 (5y) (also see Wood and Vunibobo)—WAIBUTA (see Wood and Waibuta)—WEBER: 573 (1b)—WOOD: 61611 (1c), 616111 (5v), 616112 (2i), 616113 (2j), 616114 (2k), 616251 (3e), 616252 (3f), 616253 (3g), 616255 (3h), 616255A (5ae), 616256 (5af), 616259 (3j), 616266 (5af), 616281 (2l), 616282 (2m), 616751 (5z), 61681 (3c), 61682 (3d), 61691 (2h), 61711 (1c), 61751 (5z)—WOOD and FAMILY: 61791 (1r)—WOOD and PILLAY: 616261 (5w), 616262 (3a), 616263 (3b), 616264 (4a)—WOOD and VUNIBOBO: 616131 (5a)—WOOD and WAIBUTA: 616291 (1e, 2a), 616292 (1e), 616292A (5b), 616293 (5c), 616294 (1f), 616295 (1g, 5d), 616296 (1h), 616296A (5e), 616297 (1i, 5f), 616297A (5g), 616298 (5h), 616299 (1j), 6162910 (1k), 6162911 (1l), 616301 (2b, 1q), 616302 (2c, 5m), 616303 (2d, 5n), 616304 (2e, 5o), 616305 (5p), 616306 (5q), 616306A (2f), 6163010 (5i, 1m), 6163011 (1n, 5j), 6163012 (5k), 6163012A (1o, 5d), 6163012C (1p).

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