

New records of marine algae from Tonga, Central Polynesia

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A total of 34 marine algae are reported for the first time based on historical herbarium collections from the marine shores of Tonga in the central South Pacific Ocean: eight Rhodophyta and 26 Chlorophyta. One species of Rhodophyta, i.e. Trichogloea requienii, and four species of Chlorophyta, i.e. Caulerpa plumulifera, Codium extricatum, Udotea glaucescens and Valoniopsis pachynema, represent the first records from central Polynesia. The red alga Titanophora pikeana has only been previously reported in this region from the adjacent western Melanesian islands of Fiji and the isolated Hawaiian Islands to the north. The other 28 algal species are widely distributed marine species around tropical and subtropical islands in the Pacific Ocean.

Keywords: central Polynesia, Chlorophyta, marine algae, Rhodophyta, Tonga

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INTRODUCTION

The recent literature checklist (Tsuda & Walsh, 2013) of the marine benthic algae in central Polynesia shows that previous algal floristics on the marine Rhodophyta (red algae), Phaeophyceae (brown algae) and Chlorophyta (green algae) in the contiguous South Pacific islands of Tonga (108 species), Niue (3 species) and Cook Islands (106 species) between 158° and 178°W longitude are wanting. The low algal species numbers (excluding Cyanobacteria) in these island groups are in contrast to the adjacent Samoan Archipelago (Samoa and American Samoa) to the north with 359 species (Skelton & South, 1999, 2004, 2007) and the adjacent Melanesian islands of Fiji to the west with 434 species (N'Yeurt *et al.*, 1996; South & Skelton, 2003). N'Yeurt & Payri (2006, 2007, 2010) include 309 taxa of brown, green and red algae in French Polynesia which lies east of the Cook Islands.

The expansive Tongan Archipelago (Figure 1) is the southernmost island group in central Polynesia and comprises some 170 islands scattered over 748,000 km²; some 36 islands are inhabited with a total population of about 102,000 (London Times, 1997; National Geographic Society, 2005). Previous records of 108 documented Tongan algal species and one Cyanobacteria species were reported in Harvey & Bailey (1851), Martens (1866), Grunow (1874, 1915), Bailey & Harvey (1874), Dickie (1876), Yamada (1930), Howe (1932), Hillis (1959), Taylor (1964, 1966), Ducker (1967), Papenfuss (1967), Skelton & South (2007) and N'Yeurt & Payri (2007). Aside from the few incidental records of Tongan algae in the latter two references on Samoa and

French Polynesia, respectively, the previous 12 references were published more than 46 years ago.

Seven additional species, with type specimens credited to the islands of Tonga, were not listed in Tsuda & Walsh (2013). The species include three Rhodophyta, i.e. *Callophycus seriatus* (Harvey ex Kützing) P.C. Silva, 1957, *Bostrychia radicans* (Montagne) Montagne, 1842a [= *Bostrychia bipinnata* Harvey ex J. Agardh, 1863] and *Bostrychia tenella* (J.V. Lamouroux) J. Agardh, 1863 [= *Bostrychia terrestris* (J. Agardh) Harvey ex Zanardini, 1872], and four Chlorophyta, i.e. *Bornetella capitata* (Harvey ex E. Wright) J. Agardh, 1887, *Bornetella nitida* Munier-Chalmas ex Sonder, 1880, *Caulerpa chemnitzia* (Esper) J.V. Lamouroux, 1809 [= *Caulerpa peltata* J.V. Lamouroux, 1809] and *Caulerpa nummularia* Harvey ex J. Agardh, 1873 [= *Caulerpa stellata* Harvey ex J. Agardh, 1873; = *Caulerpa peltata* var. *stellata* (Harvey) Weber-van Bosse 1898 (Belton *et al.*, 2014)].

In April and May 2005, the first co-author was invited and afforded the opportunity to examine 1,232 Pacific algal specimens from the British Natural History Museum (BM), London, of which 343 specimens, many unidentified, were collected from Tonga. The algal specimens comprised 64 species, i.e. 1 Cyanobacteria, 20 Rhodophyta, 5 Phaeophyceae and 38 Chlorophyta. A database search of Tongan algae at the Bishop Museum (BISH), Honolulu, by the second co-author and the examination of 43 algal specimens from Tonga, predominantly unidentified, yielded 30 species, i.e. 7 red algae, 4 brown algae and 19 green algae.

MATERIALS AND METHODS

This study is based on two sets of algal specimens identified independently by each of the two co-authors. The bulk of

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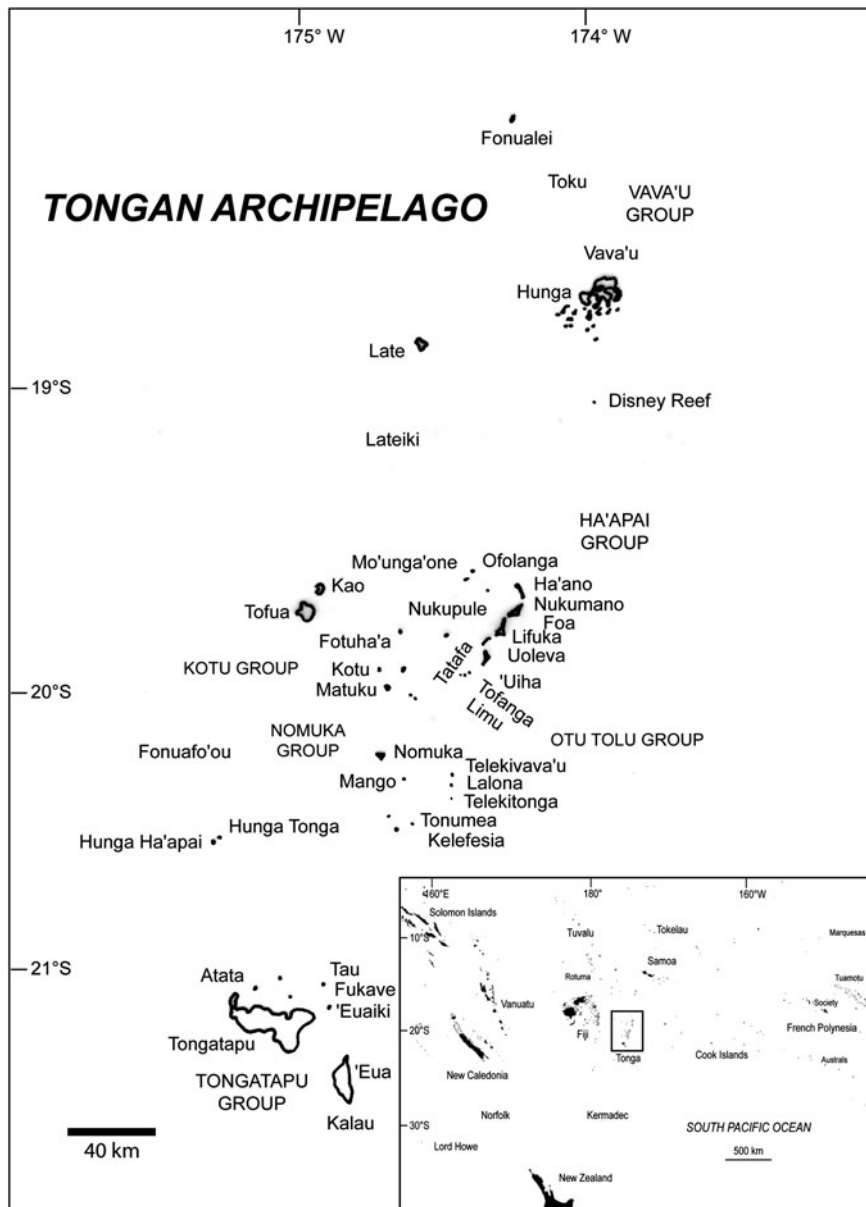


Fig. 1. Map of the Tongan Archipelago, showing the main island groups and localities.

the Tongan specimens deposited at the BM was collected predominantly by William H. Harvey in 1855 and 1874 during his voyage to the Pacific Ocean, and were much later identified by the first co-author in 2005. The second co-author identified the Tongan algal specimens deposited in BISH which were collected by Clyde T. Imada, Bishop Museum, in July 1988, by Winona P. Char in July 1995 and Timothy J. Motley in July 1995. Specimen numbers on few of the BISH specimens were preceded by 'IA' and represented specimen numbers of the late Isabella A. Abbott. Where synonyms of currently accepted names were previously used in references recording Tongan algae, these are given in brackets in the Results section. Silva *et al.* (1996) and Guiry & Guiry (2014) were used to identify references, higher algal classification and current species names. Island names for the Tonga Group follow those as listed in Motteler (2006), while the authors of plant names follow the guidelines of Brummit & Powell (1992).

RESULTS

Thirty-four new algal records for Tonga, i.e. 8 Rhodophyta and 26 Chlorophyta are presented below.

SYSTEMATICS
Phylum RHODOPHYTA
Class FLORIDEOPHYCEAE
Order NEMALIALES
Family GALAXAURACEAE

Dichotomaria obtusata (J. Ellis & Solander) Lamarck, 1816;
N'Yeurt & Payri, 2010

SPECIMENS EXAMINED

BM 841094, Tonga, coll. W.H. Harvey, 1855; BM 841098, Vava'u Group, Vava'u, coll. W.H. Harvey, 1855.

Family LIAGORACEAE
Liagora viscida (Forsskål) C. Agardh, 1822

SPECIMEN EXAMINED

BM 701498, Tonga, coll. and det. W.H. Harvey, 1855.

Trichogloea requienii (Montagne) Kützing, 1847;
N'Yeurt & Payri, 2010
(Figure 2A)

SPECIMENS EXAMINED

BM 841012, 841015 and 841016, Ha'apai Group, Uoleva, coll.
W.H. Harvey, coral reef pools, 1855.

Order CORALLINALES
Family CORALLINACEAE
Jania pumila J.V. Lamouroux, 1816;
Abbott, 1999

[= *Corallina pumila* (J.V. Lamouroux) Kützing, 1858]

SPECIMEN EXAMINED

BISH 529618. Tongatapu Group, 'Eua I., epiphytic on
Laurencia sp., reef flat off 'Ohomua Harbor, coll. C. Imada
(s.n.), 26 July 1988.

Order NEMASTOMATALES
Family SCHIZYMENIACEAE
Titanophora pikeana (Dickie) Feldmann, 1942;
Abbott, 1999
(Figure 2B)

SPECIMEN EXAMINED

BISH 692759. Vava'u Group, Pangaimotu Island, Lisa Bay,
coll. W. Char (IA 22494), 8 July 1995, det. I.A. Abbott, 11
November 2003.

REMARKS

This specimen represents the first record of *Titanophora pikeana* within central Polynesia outside of Hawaii (Abbott, 1999). The species is also reported from the neighbouring western Melanesian islands of Fiji (South & Skelton, 2003). A second species, *Titanophora weberae* Børgesen, was reported from Fiji by N'Yeurt *et al.* (1996), Upolu, Samoa by Skelton & South (2007) and from Tahiti, Society Islands by N'Yeurt & Payri (2010).

Order RHODYMENIALES
Family LOMENTARIACEAE
Ceratodictyon repens (Kützing) R.E. Norris, 1987

SPECIMEN EXAMINED

BM 840695, Vava'u Group, Vava'a, coll. W.H. Harvey 1855.

Order CERAMIALES
Family RHODOMELACEAE
Amansia rhodantha (Harvey) J. Agardh, 1841

SPECIMENS EXAMINED

BM 841369, 841371 and 841394, Ha'apai Group, Lifuka, coll.
W.H. Harvey, 1855.

Tolypocladia glomerulata (C. Agardh) F. Schmitz,
in Schmitz & Falkenberg, 1897

SPECIMENS EXAMINED

BM 841009, 841010 and 841011, Vava'u Group, Vava'u, coll.
W.H. Harvey, 1855.

Phylum CHLOROPHYTA
Class ULVOPHYCEAE
Order ULVALES
Family ULVACEAE
Ulva clathrata (Roth) C. Agardh, 1811;

N'Yeurt & Payri, 2007
[= *Enteromorpha clathrata* (Roth) Greville, 1830]

SPECIMEN EXAMINED

BISH 529619, Tongatapu Group, 'Eua I., reef flat off Ohonua
Harbor, coll. C. Imada (s.n.), 26 July 1988.

Ulva flexuosa Wulfen, 1803;
N'Yeurt & Payri, 2007
[*Enteromorpha flexuosa* (Wulfen) J. Agardh, 1883]

SPECIMEN EXAMINED

BISH 692762, Tongatapu Group, Tongatapu Island, south-
east side, Emeline Beach, coll. W. Char (IA 22513), 11 July
1995.

Ulva lactuca Linnaeus, 1753;
N'Yeurt & Payri, 2007

SPECIMENS EXAMINED

BM 770090, Tongatapu Group, Tongatapu Island, coll. W.H.
Harvey, date unknown; BISH 692784, Tongatapu Group,
Tongatapu Island, south-east side, Emeline Beach, coll. W.
Char (IA 22508), 11 July 1995.

Order BRYOPSIDALES
Family BRYOPSIDACEAE
Bryopsis pennata J.V. Lamouroux, 1809;
Abbott & Huisman, 2004

SPECIMENS EXAMINED

BISH 529620, Tongatapu Group, 'Eua I., reef flat off 'Ohonua
Harbor, coll. C. Imada (s.n.), 26 July 1988; BISH 692764,
Tongatapu Island, Emeline Beach, coll. W. Char (IA 22515),
11 July 1995; BISH 692769 and 692770, Vava'u Group,
Foilifuka Island, coll. T. Motley, 28 July 1995.

Family CAULERPACEAE
Caulerpa brachypus Harvey, 1860

SPECIMENS EXAMINED

BM 515866, 515867 and 515868, Ha'apai Group, Lifuka, coll.
W.H. Harvey, date unknown.

Caulerpa cupressoides (M. Vahl) C. Agardh, 1817;
Abbott & Huisman, 2004
[= *Caulerpa mamillosa* Montagne, 1842b]

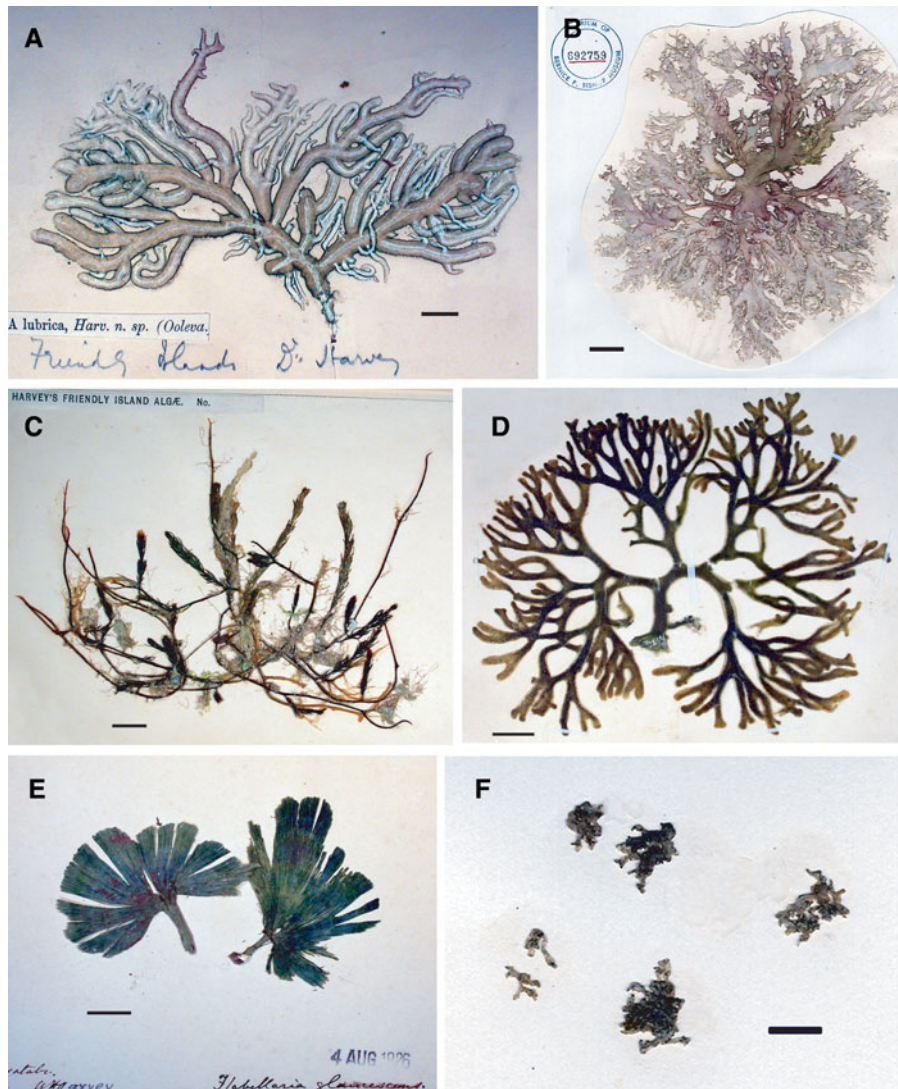


Fig. 2. New records of marine algae for Tonga: (A) *Trichogloea requienii* (Montagne) Kützing (BM 000841014); (B) *Titanophora pikeana* (Dickie) Feldmann (BISH 692759); (C) *Caulerpa plumulifera* Zanardini (BM 000841481); (D) *Codium extricatum* P.C. Silva (BM 000840921); (E) *Udotea glaucescens* Harvey ex J. Agardh (BM 840810); (F) *Valoniopsis pachynema* (G. Martens) Borgesen (BISH 550188). Scale bars: A, 10 mm; B, 20 mm; C–F, 10 mm.

SPECIMENS EXAMINED

BM 701588, 701589 and 701592, Vava'u Group, Vava'u, coll. W.H. Harvey, date unknown; BISH 692795 and 692796, Vava'u Group, specific island unknown, coll. W. Char (IA 22503), 10 July 1995; BISH 692797, Tongatapu Group, Tongatapu Island, Emeline Beach, coll. W. Char (IA 22507), 11 July 1995.

Caulerpa fastigiata Montagne, 1837

SPECIMENS EXAMINED

BM 515892, Vava'u Group, Vava'u, coll. W.H. Harvey, date unknown; BM 841587 and 841591, Tongatapu Group, Tongatapu Island, coll. H. Moseley, July 1874.

Caulerpa plumulifera Zanardini, 1878
(Figure 2C)

SPECIMENS EXAMINED

BM 841481, Ha'apai Group, Lifuka, coll. W.H. Harvey, 1855, det. A. Weber-van Bosse; BM 841487, Tongatapu Group, Tongatapu Island, coll. E. Graeffe, 1869; BM 841550, Ha'apai Group,

Lifuka, coll. W.H. Harvey, date unknown, det. A. Weber-van Bosse. This is a currently accepted name in *AlgaeBase*, and also reported from Sri Lanka in Silva *et al.* (1996). However it was not recollected from Tonga since the 19th Century, and new collections as well as a molecular study on this species would be desirable to ascertain its taxonomic status.

Caulerpa sertularioides (S.G. Gmelin) M. Howe, 1905;
Abbott & Huisman, 2004

SPECIMENS EXAMINED

BM 701530, 841473 and 841477, Vava'u Group, Vava'u, coll. W.H. Harvey, 1855; BISH 692793 and 692794, Vava'u Group, specific island unknown, coll. W. Char (IA 22500), 10 July 1995.

Caulerpa taxifolia (M. Vahl) C. Agardh, 1817

SPECIMENS EXAMINED

BM 701533, 701534 and 701535, Tonga, coll. W.H. Harvey, date unknown.

Caulerpa urvilleana Montagne, 1845

SPECIMENS EXAMINED

BM 701587, 701590 and 701591, Tonga, coll. W.H. Harvey, date unknown.

Caulerpa verticillata J. Agardh, 1847

SPECIMENS EXAMINED

BM 515895, 841524 and 841525, Tongatapu Group, Tongatapu Island, mangrove, coll. W.H. Harvey, 1855.

Caulerpa webbiana Montagne, 1837

SPECIMENS EXAMINED

BM 515896, 515897 and 515898, Ha'apai Group, Lifuka, coll. W.H. Harvey, 1855.

Family CODIACEAE

Codium arabicum Kützing, 1856

SPECIMENS EXAMINED

BM 659654 and 840916, Tonga, coll. W.H. Harvey, 1855.

Codium extricatum P.C. Silva, 1959
(Figure 2D)

SPECIMENS EXAMINED

BM 840910, Tongatapu Group, Tongatapu Island, coll. H. Moseley, ca. 1870; BM 840921, Tonga, coll. W.H. Harvey, 1855.

Codium geppiorum O.C. Schmidt, 1923;
N'Yeurt & Payri, 2007
[*Codium bulbopilum* Setchell, 1924]

SPECIMENS EXAMINED

BM 840911, Tongatapu Group, Tongatapu Island, fringing reef, coll. H. Moseley, July 1874, det P.C. Silva; BM 840913, Tongatapu Group, Tongatapu Island, coll. H. Moseley, July 1874, det. P.C. Silva as *Codium bulbopilum*. BM 840918, Tongatapu Group, Tongatapu Island, coll. E. Graeffe, date unknown, det. P.C. Silva; BM 840922, Tonga, coll. W.H. Harvey, 1855, det. P.C. Silva; BISH 692788, Tongatapu Group, Tongatapu Island, south-east side, Emeline Beach, coll. W. Char (IA 22520), 11 July 1995.

Family HALIMEDACEAE

Halimeda borneensis W.R. Taylor, 1975;
Kooistra *et al.*, 2002

SPECIMENS EXAMINED

BM 701496 and 841152, Tongatapu Group, Tongatapu Island, coll. H. Moseley, 1874; BM 841075, Tongatapu Group, Tongatapu Island, coll. H. Moseley, date unknown; BISH 753200, Vava'a Group, Hunga Island, coll. T. Motley, 12 July 1995.

REMARKS

Halimeda simulans in the Indo-Pacific region is now recognized as *Halimeda borneensis* (Kooistra *et al.*, 2002).

Halimeda discoidea Decaisne, 1842;
Hillis, 1959

SPECIMENS EXAMINED

BM 701508 and 840959, Tonga, coll. W.H. Harvey, 1855; BM 840951, Tongatapu Group, Tongatapu Island, coll. H. Moseley, 1874; BISH 692787, Tongatapu Group, Tongatapu Island, south-east side, W. Char (IA 22506), 11 July 1995.

Family UDOTACEAE

Udotea glaucescens Harvey ex J. Agardh, 1887
(Figure 2E)

SPECIMENS EXAMINED

BM 515944, 515945, 840806, 840807, 840809, 840810. Tongatapu Group, Tongatapu Island, coll. W.H. Harvey, 1855.

Order CLADOPHORALES

Family ANADYOMENACEAE

Microdictyon umbilicatum (Velley) Zanardini, 1862

SPECIMENS EXAMINED

BM 841210 and 841212, Tongatapu Group, Tongatapu Island, coll. H. Moseley, July 1874; BM 841209, Tonga, coll. W.H. Harvey, 1855

Family BOODLEACEAE

Boodlea composita (Harvey) F. Brand, 1904

SPECIMENS EXAMINED

BM 701628, Ha'apao Group, Lifuka, coll. W.H. Harvey, date unknown; BM 701629, Vava'u Group, Vava'u, coll. W.H. Harvey, date unknown; BM 840740, Tongatapu Group, Tongatapu Island, fringing reef, coll. H. Moseley, date unknown.

Family CLADOPHORACEAE

Chaetomorpha linum (O.F. Müller) Kützing, 1845

SPECIMEN EXAMINED

BM 841384, Tonga, collector and date unknown, in Herb. Dickie.

Family PITHOPHORACEAE

Dictyosphaeria versluisii Weber-van Bosse, 1905;
Skelton & South, 2007
[= *Dictyosphaeria australis* Setchell, 1926]

SPECIMEN EXAMINED

BISH 692778, Vava'u Group, Foilifuka Island, coll. T. Motley, 28 July 1995.

Family SIPHONOCLADACEAE

Boergesenia forbesii (Harvey) Feldmann, 1938;
Skelton & South, 2007

SPECIMENS EXAMINED

BM 637958, Tonga, coll. W.H. Harvey, date unknown, det. F. Leliaert (7 April 2002); BM 841679, Tonga, coll. W.H. Harvey, no date; BISH 692780, Tongatapu Group, Tongatapu Island,

south-east side, Emeline Beach, coll. W. Char (IA 22517), 11 July 1995.

Family VALONIACEAE

Valonia ventricosa J. Agardh, 1887;
Kraft, 2007

[= *Ventricaria ventricosa* (J. Agardh) Olsen & J.A. West,
1988]

SPECIMENS EXAMINED

BISH 529613. Tongatapu Group, 'Eua Island, reef flats off Ohonua Harbor, coll. C. Imada (s.n.), 26 July 1988, det. P. Skelton; BISH 692775, Vava'u Group, Foilifuka Island, coll. T. Motley, 28 July 1995.

Valoniopsis pachynema (G. Martens) Børgesen, 1934;
Kraft, 2007
(Figure 2F)

SPECIMEN EXAMINED

BISH 550188. Tongatapu Group, Tongatapu Island, Nukualofa Reef, coll. H.E. Parks and W.A. Setchell (UC Herb. 17103), early June 1926.

DISCUSSION

Eight species of Rhodophyta and 26 species of Chlorophyta are reported for the first time from the marine waters of Tonga in the central South Pacific Ocean. The 34 new species records from Tonga represent 26 (41%) of the 64 species from Tonga examined at BM and 15 (50%) of the 30 species of Tongan algae which were deposited at BISH. Seven species of the newly recorded Chlorophyta were present in both the BM and BISH collections.

One species of Rhodophyta, i.e. *Trichogloea requienii*, and four species of Chlorophyta, i.e. *Caulerpa plumulifera*, *Codium extricatum*, *Udotea glaucescens* and *Valoniopsis pachynema* represent the first records from central Polynesia. The Tongan Archipelago may thus be considered a 'stepping stone' area for the distribution of marine algae between eastern Melanesia (Fiji) and western Polynesia (the Cook Islands). The red alga *Titanophora pikeana* was only reported previously from the adjacent western Melanesian islands of Fiji (South & Skelton, 2003) and the isolated Hawaiian Islands to the north (Abbott, 1999). The other 28 algal species are widely distributed marine species around tropical and subtropical islands in the Pacific.

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