

Marine Benthic Algae from Seamounts along the Mariana Islands, Western Pacific¹

ROY T. TSUDA

¹ Botany – Herbarium Pacificum, Department of Natural Sciences,
Bishop Museum, 1525 Bernice Street, Honolulu, Hawaii 96817, USA.
roy.tsuda@bishopmuseum.org

Peter S. Vroom², Kimberly N. Page-Albins³

NOAA-National Marine Fisheries Service, Pacific Islands Fisheries Science Center
Coral Reef Ecosystem Division, 1845 Wasp Blvd., Bldg. #176, Honolulu, Hawaii 96818, USA.

LOUISE GIUSEFFI

NOAA-National Marine Fisheries Service, Pacific Islands Fisheries Science Center,
Science Operations, 1845 Wasp Blvd., Bldg. #176, Honolulu, Hawaii 96818, USA.

Abstract— The marine benthic algae from six seamounts, i.e., isolated submerged reefs, banks and shoals, along the Mariana Islands were identified and recorded based on SCUBA collections obtained during the August-September 2003 and the September 2005 cruises by the U.S. National Oceanic and Atmospheric Administration (NOAA). The algae represented the first collections obtained from Supply Reef, Zealandia Bank and Tatsumi Reef within the Mariana Arc and from Stingray Shoal, Pathfinder Reef, and Arakane Reef within the West Mariana Ridge. A total of 67 species were documented, i.e., 8 species of blue-green algae, 30 species of red algae, 5 species of brown algae, and 24 species of green algae. Thirty-one algal species were collected only from seamounts within the West Mariana Ridge, and 5 algal species were collected only from seamounts (including Santa Rosa Reef reported previously) within the Mariana Arc. The remaining 31 algal species were recorded from seamounts along both the West Mariana Ridge and Mariana Arc. Aside from 5 taxa identified only to genus, 4 species of red algae (*Antithamnion decipiens*, *Ceramium isogonum*, *Chondria bullata* and *Gayliella transversalis*) were new records for Micronesia (including Mariana Islands). Ten additional species of red algae (*Caulacanthus ustulatus*, *Ceramium affine*, *Ceramium codii*, *Chondria simpliciuscula*, *Dasya* cf. *corymbifera*, *Jania pumila*, *Jania rubens*, *Lomentaria hakodatensis*, *Polysiphonia dotyi* and *Polysiphonia sertularioides*) were new records for the Mariana Islands.

Introduction

Approximately 20 isolated submerged banks, reefs, and shoals are located along the Mariana Arc and the West Mariana Ridge within the Mariana Islands in the Western Pacific. Most of these features could be identified as “seamounts” and would fall under the one inclusive umbrella definition proposed by Staudigel et al. (2010), i.e., “any geographically isolated topographic feature

¹ Citation: Tsuda, R.T., P.S. Vroom, K.N. Page-Albins & L. Giuseffi. 2015. Marine Benthic Algae from Seamounts along the Mariana Islands, Western Pacific, *Micronesica* 2015-04, 19 pp. Published online 22 January 2016. <http://micronesica.org/volumes/2015>
Open access; Creative Commons Attribution-NonCommercial-NoDerivs License.

² Present address: San Diego Public Utilities, Environmental Monitoring and Technical Services Division, 2392 Kincaid Road, San Diego, California 92101, USA.

³ Present address: NOAA Marine Debris Program/Genwest, NOAA Gulf of Mexico Disaster Response Center, 7344 Zeigler Blvd., Mobile, Alabama 36608, USA.

on the seafloor taller than 100 m, including ones whose summit regions may temporarily emerge above sea level, but not including features that are located on continental shelves or that are part of other major landmasses.” These submerged features can be biologically diverse due to its isolation and the steep slopes which allow nutrient-rich waters to be carried upwards from the depths and, in turn, contribute to the presence of a unique biota (Littler et al. 1986) and, at times, a high percent of endemism (Shank 2010). These seamounts also can serve as stepping stones which allow marine organisms (Hubbs 1959, Parker & Tunnicliffe 1994) to naturally disperse to new geographic locations.

Santa Rosa Reef, the southernmost isolated submerged reef in the Mariana Arc, was the site of the first algal study (Tsuda et al. 2012) of a seamount in the Mariana Islands. The specimens were collected during the same August-September 2003 and September-October 2005 cruises to the Mariana Islands by the U.S. National Oceanic and Atmospheric Administration (NOAA) Pacific Islands Fisheries Science Center (PIFSC) Coral Reef Ecosystem Division (CRED) discussed here. Thirty-two algal species were recorded from Santa Rosa Reef, including the predominantly Caribbean species *Dasycladus vermicularis* (Scopoli) Krasser (i.e., new Polynesian and Micronesian record) and *Cutleria irregularis* I.A. Abbott & Huisman (i.e., new Micronesian record). Six other species (*Dasya iyengarii* Børgesen, *Polysiphonia delicatula* Hollenberg, *Polysiphonia homoia* Setchell & N.L. Gardner, *Neomeris mucosa* M. Howe, *Rhipilia micronesica* Yamada, and *Udotea palmetta* Decaisne) represented new records for the Mariana Islands.

During the same 2003 and 2005 cruises to the Mariana Islands, algae were collected for the first time from six other isolated reefs, banks and shoals, i.e., Supply Reef, Zealandia Bank and Tatsumi Reef within the Marianas Arc, and Stingray Shoal, Pathfinder Reef and Arakane Reef within the West Mariana Ridge. Most of the algae were sorted, preliminarily identified, and held at the Bishop Museum in Hawaii. The uniqueness of this collection became evident when NOAA discontinued making algal collections from these and other isolated submerged features in the Mariana Islands and also due to the interesting algal findings obtained from Santa Rosa Reef.

The Mariana Islands are located between 12° and 21° N latitude, and 142° and 147° E longitude, and extend in a north-south orientation midway between Honshu (Japan) and Papua New Guinea in the western Pacific. The islands (PIFSC 2010) include nine mostly uninhabited, small volcanic islands to the north, i.e., Uracas (Farallon de Pajaros), Maug, Asuncion, Agrihan, Pagan, Alamagan, Guguan, Sarigan, and Anatahan, and six volcanic-carbonate islands to the south. Except for Aguijan and Farallon de Medinilla, four of the six southern islands (Saipan, Tinian, Rota and Guam) are inhabited. The three northernmost Mariana Islands (Uracas, Maug and Asuncion) represent the island component, and Stingray Shoal and Zealandia Bank are part of the submerged volcanic component of the Mariana Trench Marine National Monument (Mariana Trench MNM) established by U.S. Presidential Proclamation on 6 January 2009. The island of Guam, the largest and most populated southernmost island of the Mariana Islands, is a separate U.S. Territory and not politically part of the U.S. Commonwealth of the Northern Mariana Islands (CNMI).

Except for the 90 species (Tsuda & Tobias 1977a, 1977b) reported from the small volcanic islands to the north, previously published algal studies were restricted to the larger and more accessible southern islands of the Mariana Islands. Marine algal studies were initially conducted by Japanese phycologists (Okamura 1904, 1916, Yamada 1931, 1940, 1941, Tokida 1939). Taxonomic and floristic studies on Mariana benthic algae (excluding diatoms) included studies on *Laurencia* (Yamada 1931), *Caulerpa* (Yamada 1940, Taylor 1977), *Halimeda* (Yamada 1941, Moul 1964), crustose corallines (Johnson 1957, 1964, Gordon et al. 1976), *Turbinaria* (Taylor 1964), *Chlorodesmis* (Ducker 1967), *Herposiphonia* (Hollenberg 1968c), Phaeophyta from Guam (Tsuda 1972a), *Sargassum* (Tsuda 1972b, 1988, Soe-Htun & Yoshida 1986), *Rhipilia* (Gilbert 1978, Verbruggen & Schils 2012), *Bostrychia* (Kumano 1979), *Galaxaura* (Itono 1980), *Chamaedoris* and *Stenopeltis* (Itono & Tsuda 1980a), *Titanophora* (Itono & Tsuda 1980b), *Ulva*

(Tsuda 1982), *Gracilaria* (Tsuda 1985, Meneses & Abbott 1987, Abbott et al. 1991), *Avrainvillea* (Olsen-Stojkovich 1985), *Dictyota* (Potter 1986, Tsuda 2004), *Chondrophyllum* (Nam & Saito 1991), and *Dasyphila* (Kraft & Wilson 1997). Tribollet & Vroom (2007) provided a temporal and spatial comparison of macroalgal genera across the Mariana Islands. See Lobban & Tsuda (2003) for the listing of Guam algal species and Tsuda (2003) for listing of marine benthic algal species previously reported from individual islands within the Mariana Islands.

The objective of this study was to document baseline algal species diversity from the six other seamounts within the Mariana Islands. The last known algal collection made on any submerged features in the Mariana Islands was on 24 September 2005.

Materials and Methods

The algal specimens were haphazardly collected via SCUBA by two divers, i.e., PSV in August and September 2003 and KNP in September 2005 while aboard the NOAA research vessel *Oscar Elton Sette*. The algae were collected between the surface (one pinnacle of Zealandia Bank) and a depth of 36.6 m. Algae collected from five of six seamounts (except Zealandia Bank, ZEA-02-05) were in water shallower than the mesophotic depth (32 to 78 m deep) depicted by Wagner et al. (2014) at Johnston Atoll where nine species of macroalgae (non-turf or epiphytes) were recorded.

Algae were placed in plastic bags, labelled, and frozen immediately after each dive. Prior to examination, the frozen algae in plastic bags from each station were thawed in tap water. The thawed seawater was poured carefully out of the bags and replaced with 4% formalin in seawater to prevent the decomposition of delicate epiphytes. The collections were examined under the dissecting microscope, and epiphytes and turf were separated. The majority of the small specimens were mounted on glass slides, i.e., the specimens were decalcified with 10% hydrochloric acid, stained with either aniline blue or iodine, and mounted with 30% corn syrup (Karo) with phenol. Larger specimens were mounted on herbarium paper; two specimens were preserved in vials with 4% formalin in seawater. All specimens were databased and archived in *Herbarium Pacificum* (BISH) at the Bishop Museum, Honolulu.

Collecting Stations

The six seamounts in the Mariana Islands (Figure 1) are listed from north to south within the Mariana Arc and the West Mariana Ridge. NOAA stations are designated by a code which includes the first three letters of the seamount's place name (STI) for Stingray Shoals, followed by the station number (01), and terminating in the year collection was made (03) for year 2003, e.g., STI-01-03. Descriptions of the seamounts below were extracted from Brainard et al. (2012). Features of Zealandia Bank, Pathfinder Reef, and Arakane Reef are shown in Figures 2–5.

MARIANA ARC

Supply Reef, located 25 km north of Maug, is a steep-sided, conical stratovolcano (summit 300 m in diameter) and possesses ridges on all flanks, with a minimum depth of approximately 9 m. SUP-01-03, 20° 08.404' N, 145° 05.897' E, small shallow reef, strong current (> 2 knots), 12.2–19.8 m deep, coll. P. S. Vroom, 01 September 2003.

Zealandia Bank, located 25 km northeast of Sarigan, is an elongated stratovolcano formed by two adjacent volcanic pinnacles 1 km apart (Figure 2). During low tides, one of the two pinnacles is 1 m above sea level. ZEA-01-03, 16° 53.855' N, 145° 51.176' E, vertical walls of 46 m high pinnacles, 14.6 m deep, coll. P. S. Vroom, 25 August 2003. ZEA-02-03, 16° 53.692' N, 145° 50.964' E, vertical walls of 46 m high pinnacles, 15.8 m deep, coll. P. S. Vroom, 25 August 2003. ZEA-02-05, 16° 53.692' N, 145° 50.964' E, vertical wall of second pinnacle, 0–36.6 m deep, coll. K. N. Page, 17 September 2005.

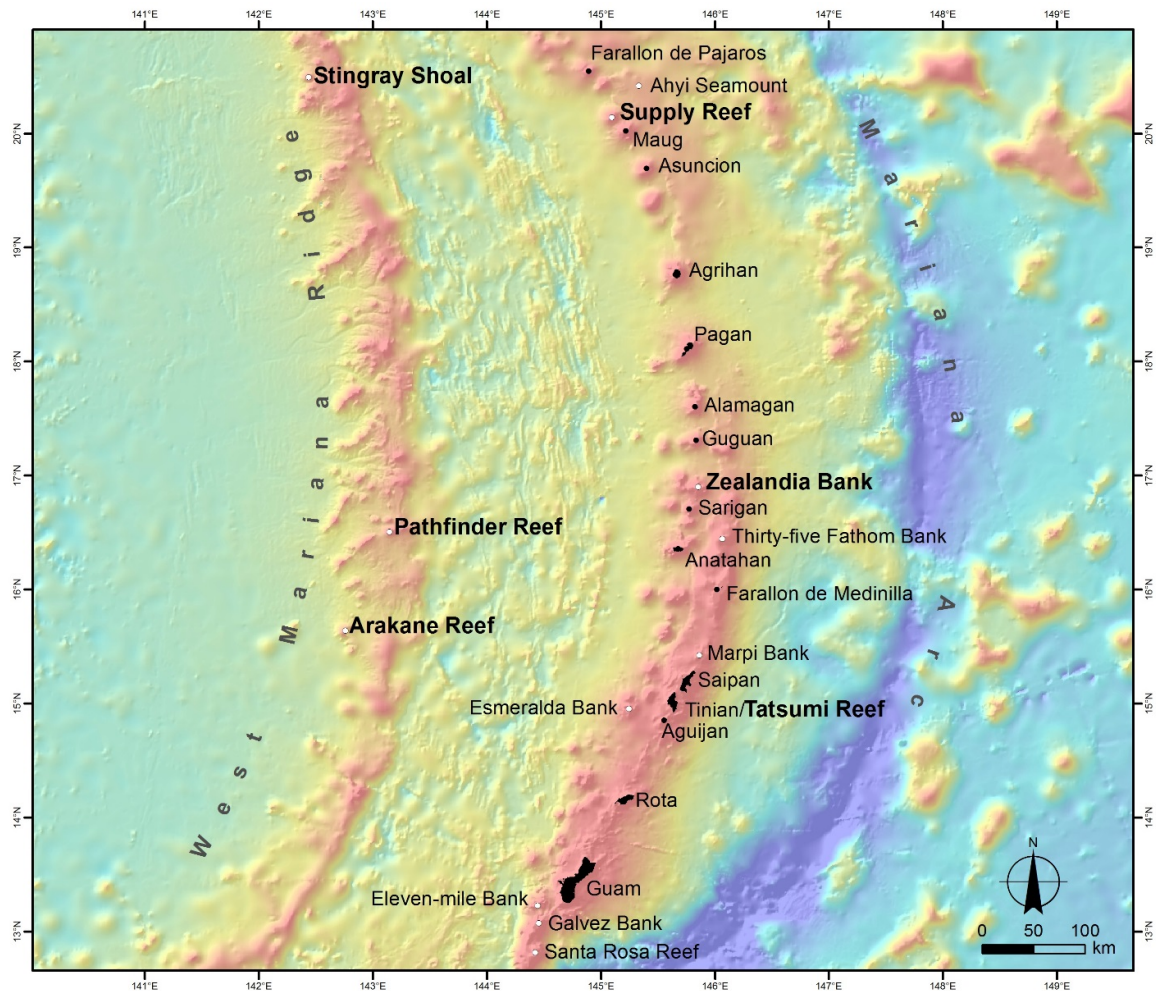


Figure 1. Map of the islands, reefs, banks and shoals within the Mariana Islands. Map provided by NOAA PIFSC CRED (2015).

Tatsumi Reef, located 2 km south of Tinian, possesses a flat top (5.5 x 2 km) with a minimum depth of 6 m. It was presumably formed by uplifted limestone overlying an older volcanic core. TAT-01-03, 14° 54.111' N, 146° 39.466' E, 30.9 m deep, reef located midway between Tinian and Aguijan, coll. fish towed-diver survey team J. Laughlin and B. Zgliczynski, 17 September 2003.

WEST MARIANA RIDGE

Stingray Shoal, located on the northern end of the West Mariana Ridge, is a conical remnant volcanic seamount with an estimated minimum depth of 13 m. STI-01-03, 20° 29.662' N, 142° 26.341' E, shallow bank with well-developed coral reef and sand patches, 18.3–24.4 m deep, coll. P. S. Vroom, 29 August 2003. STI-02-03, 20° 29.669' N, 142° 26.300' E, shallow bank with well-developed coral reef and sand patches, 18.3–24.4 m deep, coll. P. S. Vroom, 29 August 2003.

Pathfinder Reef, located 150 km west of Saipan, is a remnant volcanic submerged ridge with spur and groove reef structure and a minimum depth of 10 m (Figure 3). PAT-01-03, 16° 30.228' N, 143° 08.928' E, carbonate pavement on reef slope separated by deeper sand channels, 18.0 m deep, coll. P. S. Vroom, 14 September 2003. PAT-02-03, 16° 30.144' N, 143° 08.721' E, carbonate pavement on reef slope separated by deeper sand channels, 20.7 m deep, coll. P. S. Vroom, 14 September 2003. PAT-01-05, 16° 30.228' N, 143° 8.956' E, northeast side of bank, flat with little relief and high surge, 13.7–16.2 m deep, coll. K. N. Page, 24 September 2005. PAT-02-05, 16°

30.145' N, 143° 8.717' E, southwest side of bank, flat with little relief and high surge, 18.9–20.4 m deep, coll. K. N. Page, 24 September 2005.

Arakane Reef, located 110 km southwest of Tinian, is a small (i.e., 1.8 x 1 km) shallow bank with a minimum depth of approximately 10 m (Figures 4 and 5). ARA-01-03, 15° 38.045' N, 142° 45.558' E, broad patches of reef with small sand channels, 13.7–21.3 m deep, coll. P. S. Vroom, 15 September 2003. ARA-02-03, 15° 38.194' N, 142° 45.595' E, broad patches of reef with small sand channels, 13.7–21.3 m deep, coll. P. S. Vroom, 15 September 2003. ARA-01-05, 15° 38.624' N, 142° 45.529' E, strong current and surge, 15.2–16.5 m deep, coll. K. N. Page, 25 September 2005. ARA-02-05, 15° 38.167' N, 142° 45.567' E, strong current and surge, 19.2–19.8 m deep, coll. K. N. Page, 25 September 2005.

Floristic Account

Sixty-seven species of marine benthic algae were recorded from the six seamounts in the Mariana Islands. Four species of red algae represented new records for Micronesia and are preceded by two asterisks (**). Ten additional species of red algae represented new records for the Mariana Islands (part of Micronesia) and are preceded by one asterisk (*).

PHYLUM CYANOBACTERIA

Class Cyanophyceae

ORDER OSCILLATORIALES

FAMILY OSCILLATORIACEAE

Lyngbya confervoides C. Agardh ex Gomont; Desikachary 1959: 315, pl. 49 (fig. 8), pl. 52 (fig. 1).
Trichomes are 14–18 µm diam and 4–6 µm long with rounded apices.

Specimens examined. ZEALANDIA BANK: ZEA-01-03 (BISH 722338), ZEA-02-03 (BISH 720938). PATHFINDER REEF: PAT-01-03 (BISH 722359), PAT-02-03 (BISH 722386), PAT-01-05 (BISH 743254). ARAKANE REEF: ARA-01-05 (BISH 763250, 763258), ARA-02-05 (BISH 763276).

Lyngbya sordida Gomont; Tilden 1910: 118, pl. 5 (fig. 37); Engene et al. 2010: 593, figs. 1A, 1D.

[= *Lyngbya polychroa* (Meneghini) Rabenhorst]

Specimens examined. ZEALANDIA BANK: ZEA-01-03 (BISH 722345). PATHFINDER REEF: PAT-02-03 (BISH 722379), PAT-02-05 (BISH 743264).

Moorea bouillonii (L. R. Hoffman & Demoulin) Engene, Rottacker, Kastovsky, Byrum, Hy. Choi, Ellisman, Komárek & Gerwick; Lobban & Tsuda 2003: 57, fig. 2 as *Lyngbya bouillonii*.

[= *Lyngbya bouillonii* L. R. Hoffman & Demoulin]

Specimens examined. SUPPLY REEF: SUP-01-03 (BISH 720889). ARAKANE REEF: ARA-01-03 (BISH 722396).

FAMILY PHORMIDIACEAE

Phormidium sp.

Specimens appear as maroon-green clumps. Cells are 5–8 µm diam, 4–20 µm long and slightly separated from each other within the thin colorless sheath.

Specimens examined. ARAKANE REEF: ARA-01-05 (BISH 763244, 763247, 763252, 763262), ARA-02-05 (BISH 763270, 763279, 763286).

FAMILY SCHIZOTRICHACEAE

Schizothrix calcicola (C. Agardh) Gomont ex Gomont; Littler & Littler 2000: 464.

Specimens examined. STINGRAY SHOALS: STI-02-03 (BISH 720879). SUPPLY REEF: SUP-01-03 (BISH 720890).

ORDER NOSTOCALES
FAMILY RIVULARIACEAE

Calothrix confervicola C. Agardh ex Bornet & Flahault; Fan 1956: 169, fig. 6.

Trichomes are 10 µm diam at base.

Specimens examined. PATHFINDER REEF: PAT-01-05 (BISH 743246 on *Dictyota ceylanica* and *Chlorodesmis caespitosa*). ARAKANE REEF: ARA-01-05, epiphytic on *Microdictyon okamurae*, BISH 763242.

Rivularia polyotis (J. Agardh) Hauck; Tilden 1910: 286, fig. 20 (figs. 5 and 6).

Trichomes are 8–12 µm diam and constricted.

Specimens examined. PATHFINDER REEF: PAT-01-03 (BISH 722365), PAT-02-03 (BISH 722384), PAT-02-05 (BISH 743260). ARAKANE REEF: ARA-02-03 (BISH 722415). TATSUMI REEF: TAT-01-03 (BISH 722641 on *Halimeda taenicola*).

Scytonematopsis pilosa (Harvey ex Bornet & Flahault) I. Umezaki & M. Watanabe; Humm & Wicks 1980: 152.

[= *Calothrix pilosa* Harvey]

Trichomes are 12–16 µm diam with intercalary heterocysts.

Specimens examined. PATHFINDER REEF: PAT-01-05 (BISH 743249).

PHYLUM RHODOPHYTA

Class Florideophyceae

ORDER NEMALIALES

FAMILY LIAGORACEAE

Ganonema farinosum (J.V. Lamouroux) K. C. Fan & Yung C. Wang; Abbott 1999: 77, figs. 11A–G.

Specimens examined. TATSUMI REEF: TAT-01-03 (BISH 722642).

ORDER BONNEMAISONIALES

FAMILY BONNEMAISONIACEAE

Asparagopsis taxiformis (Delile) Trevisan de Saint-Léon; Abbott 1999: 174, figs. 43C–D.

Specimens on slide are a mixture of *Polysiphonia* spp. and the sporophyte phase of *Asparagopsis taxiformis* characterized by three pericentral cells.

Specimens examined. STINGRAY SHOALS: STI-02-03 (BISH 720885).

ORDER CORALLINALES

FAMILY CORALLINACEAE

****Jania pumila*** J. V. Lamouroux; N'Yeurt & Payri 2010: 56, fig. 98.

Decalcified specimens are 52–88 µm diam.

Specimens examined. PATHFINDER REEF: PAT-01-03 (BISH 722371), PAT-02-05 (BISH 743263). ARAKANE REEF: ARA-01-05 (BISH 763246), ARA-02-05 (BISH 763289). TATSUMI REEF: TAT-01-03 (BISH 722643).

****Jania rubens*** J. V. Lamouroux; Taylor 1950: 133.

The specimen is 3 mm long and up to 60 µm diam with terminal tips distinctly acute.

Specimens examined. PATHFINDER REEF: PAT-01-05 (BISH 743241).

ORDER PEYSSONNELIALES

FAMILY PEYSSONNELIACEAE

Peyssonnelia sp.

The collection consists of two small blades (1 cm diam). The dorsal surface shows lines of round cells (ca. 8 µm diam) in parallel rows from the apical margin. Branched unicellular rhizoids arise from the ventral basal sector of the thin crust.

Specimens examined. PATHFINDER REEF: PAT-02-03 (BISH 722385).

ORDER GIGARTINALES

FAMILY CAULACANTHACEAE

**Caulacanthus ustulatus* (Turner) Kützing; Abbott 1999: 104, figs. 20D-F.

Morphology of specimen is similar to *Hypnea spinella*; however, this specimen possesses polygonal cortical cells, 6–12 µm diam.

Specimens examined. ARAKANE REEF. ARA-02-05 (BISH 763283).

FAMILY CYSTOCLONIACEAE

Hypnea spinella (C. Agardh) Kützing; Abbott 1999: 117, figs. 25B–E.

Specimens are 240–320 µm diam and possess slightly elongated cortical cells.

Specimens examined. ZEALANDIA BANK: ZEA-01-03 (BISH 722343 on a *Halimeda* segment). PATHFINDER REEF: PAT-01-03 (BISH 722370), PAT-02-03 (BISH 722383), PAT-02-05 (BISH 743268). ARAKANE REEF: ARA-01-03 (BISH 722390), ARA-02-03 (BISH 722418).

ORDER RHODYMENIALES

FAMILY CHAMPIACEAE

Champia parvula (C. Agardh) Harvey; Skelton & South 2007: 68, figs. 126–133.

Specimens examined. PATHFINDER REEF: PAT-02-03 (BISH 722387).

FAMILY LOMENTARIACEAE

**Lomentaria hakodatensis* Yendo; Abbott 1999: 224, figs. 62A–D.

Specimens examined. ZEALANDIA BANK: ZEA-02-05 (BISH 743238). PATHFINDER REEF: PAT-01-03 (BISH 722373), PAT-02-03 (BISH 722381). ARAKANE REEF: ARA-01-03 (BISH 722393), ARA-02-03 (BISH 722406).

ORDER CERAMIALES

FAMILY CERAMIACEAE

***Antithamnion decipiens* (J. Agardh) Athanasiadis; Abbott 1999: 250, figs. 69C–D.

Specimens examined. ARAKANE REEF: ARA-01-03 (BISH 722397).

Antithamnionella breviramosa (E. Y. Dawson) E. M. Wollaston; Skelton & South 2007: 86, figs. 181–185.

Specimens examined. ZEALANDIA BANK: ZEA-02-03 (BISH 722352). PATHFINDER REEF: PAT-01-03 (BISH 722360).

Antithamnionella graeffei (Grunow) Athanasiadis; Skelton & South 2007: 87, figs. 186–188.

Specimens examined. STINGRAY SHOALS: STI-02-03 (BISH 720884 on *Chondria* sp. fragment).

**Ceramium affine* Setchell & N. L. Gardner; South & Skelton 2000: 54, figs. 1–10.

Specimens examined. PATHFINDER REEF: PAT-02-03 (BISH 722380). ARAKANE REEF: ARA-02-03 (BISH 722412).

**Ceramium codii* (H. Richards) Mazoyer; Cho & Fredericq 2006: 496, figs. 24–55.

Specimens examined. TATSUMI REEF: TAT-01-03 (BISH 722644 on *Ganonema farinosum*).

***Ceramium isogonum* Harvey; Skelton & South 2007: 98, figs. 240–245.

Filaments are up to 120 µm diam, with slightly elongated vertical cells formed acropetally and basipetally at node, and with forcipate apices. Tetrasporangia lack involucre and divide tetrahedrally.

Specimens examined. ARAKANE REEF: ARA-01-03 (BISH 722398).

Ceramium macilentum J. Agardh; South & Skelton 2000: 71, figs. 52–62; Skelton & South 2007: 103, figs. 246–250.

Specimens possess 6 periaxial cells which produce cells acropetally at node. The specimens are 60–74 µm diam which is less than half the diameter reported by Skelton & South (2007). Apices are distinctly forcipate or circinate.

Specimens examined. STINGRAY SHOALS: STI-02-03 (BISH 720886 on *Chondria* sp. fragment). ZEALANDIA BANK: ZEA-02-05 (BISH 743236, fragment). ARAKANE REEF: ARA-02-05 (BISH 763275).

Corallophila kleiwegii Weber-van Bosse; N'Yeurt & Payri 2010: 114, fig. 227.

[= *Corallophila apiculata* (Yamada) R. Norris]

Specimens examined. ZEALANDIA BANK: ZEA-01-03 (BISH 722341). PATHFINDER REEF: PAT-01-03 (BISH 722366), PAT-01-05 (BISH 743240), PAT-02-05 (BISH 743271).

*****Gayliella transversalis*** (Collins & Hervey) T. O. Cho & Fredericq; Cho & Fredericq 2006: 727, figs. 5a–n; N'Yeurt & Payri 2010: 117, figs. 228 and 229.

We follow N'Yeurt & Payri (2010) in using *G. transversalis* instead of *G. flaccida* (Kützing) T. O. Cho & L. McIvor for the Pacific specimens.

Specimens examined. ZEALANDIA BANK: ZEA-01-03 (BISH 722339).

FAMILY DASYACEAE

****Dasya* cf. *corymbifera*** J. Agardh; Abbott 1999: 320, figs. 90A–C.

Specimens are 5–13 mm long and appear to fall within the circumscription of *D. corymbifera*.

Specimens examined. ZEALANDIA BANK: ZEA-01-03 (BISH 722342). PATHFINDER REEF: PAT-02-05 (BISH 743265).

Dasya iyengarii Børgesen; N'Yeurt & Payri 2010: 127, figs. 258–261.

Non-corticated specimens possess prominent round basal cell in side branches and terminal incurved tips.

Specimens examined. ZEALANDIA BANK: ZEA-02-03 (BISH 722353). PATHFINDER REEF: PAT-01-03 (BISH 722361), PAT-02-03 (BISH 722377), PAT-01-05 (BISH 743242), PAT-02-05 (BISH 743266). ARAKANE REEF: ARA-01-03 (BISH 722395), ARA-02-03 (BISH 722408), ARA-01-05 (BISH 763245), ARA-02-05 (BISH 763266, 763274, 763285).

FAMILY RHODOMELACEAE

Chondria polyrhiza Collins & Hervey; Abbott 1999: 360, figs. 103G–H.

Specimens examined. SUPPLY REEF: SUP-01-03 (BISH 720896). ZEALANDIA BANK: ZEA-02-03 (BISH 722354). PATHFINDER REEF: PAT-01-03 (BISH 722368), PAT-02-03 (BISH 722375). ARAKANE REEF: ARA-01-03 (BISH 722391).

*****Chondria bullata*** N'Yeurt & Payri, N'Yeurt & Payri 2010: 140, figs. 292–294.

Specimens examined. STINGRAY SHOALS: STI-01-03 (BISH 723219), STI-02-03 (BISH 720887). PATHFINDER REEF: PAT-01-03 (BISH 722364).

****Chondria simpliciuscula*** Weber-van Bosse; N'Yeurt & Payri 2010: 143, fig. 304.

Specimens examined. PATHFINDER REEF: PAT-01-05 (BISH 743256). ARAKANE REEF: ARA-01-03 (BISH 722399), ARA-02-03 (BISH 722417), ARA-02-05 (BISH 763267, 763272, 763288).

Leveillea jungermannioides (Hering & Martens) Harvey; Abbott 1999: 396, figs. 116A–D.

Specimens examined. PATHFINDER REEF: PAT-01-05 (BISH 743250).

****Polysiphonia dotyi*** Hollenberg; Hollenberg 1968b: 198, figs. 1A, 1B, 4 and 5.

Pericentral cells (> 7) which appear swollen are arranged in offset positions in successive segments. Rhizoids are attached to pericentral cell in open connection.

Specimens examined. ARAKANE REEF. ARA-01-05 (BISH 763260 on *Halimeda opuntia*).

Polysiphonia homoia Setchell & N. L. Gardner; Hollenberg 1968b: 201, fig. 2B.

Specimens examined. STINGRAY SHOALS: STI-02-03 (BISH 719820).

**Polysiphonia sertularioides* (Grateloup) J. Agardh; Abbott 1999: 414, figs. 121A–D as *Polysiphonia flaccidissima* Hollenberg.

[= *Neosiphonia flaccidissima* (Hollenberg) M. S. Kim & I. K. Lee]

Specimens examined. ZEALANDIA BANK: ZEA-01-03 (BISH 722344). ARAKANE REEF: ARA-01-03 (BISH 722394), ARA-02-03 (BISH 722409).

Polysiphonia upolensis (Grunow) Hollenberg; Hollenberg 1968a: 94, figs. 6D, 6E, 29, 35, 42.

Specimens are 15 mm long with erect branches 100 µm diam at mid-height. Thallus possesses four pericentral cells and unicellular rhizoids are cut from pericentral cells.

Specimens examined. ZEALANDIA BANK: ZEA-02-05 (BISH 743237). PATHFINDER REEF: PAT-01-05 (BISH 743245).

Polysiphonia sp.

The entire collection is preserved on three slides. Prostrate branches are 80–120 µm diam and possess 4–7 pericentral cells with each pericentral cell about 16–25 µm wide and 1–2 times long. Erect branches, up to 2 mm high and 90 µm diam, are usually unbranched and at times possess only a single branch. The erect branches appear to possess 4 or 5 pericentral cells. Trichoblasts are rudimentary; however, scar cells are large, 16–20 µm diam, and arranged spirally similar to the tetrasporangia. Rhizoids are up to 112 µm long, cut from pericentral cell and form digitate tips. Gametophytic materials need to be examined before the specimens can be considered a new species.

Specimens examined. ZEALANDIA BANK: ZEA-01-03 (BISH 722346). PATHFINDER REEF: PAT-01-03 (BISH 722367).

FAMILY WRANGELIACEAE

Anotrichium tenue (C. Agardh) Nägeli; Abbott 1999: 247, fig. 68D.

Specimens are 100–120 (160) µm diam.

Specimens examined. PATHFINDER REEF: PAT-01-03 (BISH 722372), PAT-02-03 (BISH 722382).

PHYLUM OCROPHYTA

Class Phaeophyceae

ORDER DICTYOTALES

FAMILY DICTYOTACEAE

Dictyopteris repens (Okamura) Børgesen; Tsuda 1972a: 94, pl. 3 (fig. 1).

Specimens examined. STINGRAY SHOALS: STI-02-03 (BISH 720881 on *Chondria* sp. fragment). ZEALANDIA BANK: ZEA-01-03 (BISH 722340). PATHFINDER REEF: PAT-01-03 (BISH 722363), PAT-02-03 (BISH 722376), PAT-02-05 (BISH 743262). ARAKANE REEF: ARA-01-03 (BISH 722403), ARA-02-03 (BISH 722407).

Dictyota bartayresiana J. V. Lamouroux; Tsuda 1972a: 95, pl. 3 (figs. 2–3).

All specimens were fragments less than 1 cm long.

Specimens examined. SUPPLY REEF: SUP-01-03 (BISH 720894). PATHFINDER REEF: PAT-01-05 (BISH 743244).

Dictyota ceylanica Kützinger; Tsuda 1972a: 96, pl. 4 (fig. 2) as *Dictyota divaricata* J. V. Lamouroux.

The largest specimen is 1.5 cm long. All specimens possess narrow flattened acute apices.

Specimens examined. PATHFINDER REEF: PAT-01-05 (BISH 743243), PAT-02-05 (BISH 743261). ARAKANE REEF: ARA-02-03 (BISH 722414), ARA-01-05 (BISH 763251, 763254, 763256), ARA-02-05 (BISH 763277, 763280, 763290).

Dictyota friabilis Setchell; Tsuda 1972a: 96, pl. 4 (fig. 3).

The single specimen is 4 mm long and possesses a single dichotomous broad terminal branch.

Specimens examined: ARAKANE REEF: ARA-01-03 (BISH 722401).

***Lobophora* sp.**

The present specimens were exposed to formalin and would best be left under their generic name until further specimens are obtained for molecular analyses based on the recent study by Vieira et al. (2014) on *Lobophora* in New Caledonia.

Specimens examined. STINGRAY SHOALS: STI-01-03 (BISH 723218), STI-02-03 (BISH 720883). SUPPLY REEF: SUP-01-03 (BISH 720895, 724051). PATHFINDER REEF: PAT-01-03 (BISH 722369). ARAKANE REEF: ARA-02-03 (BISH 722410).

PHYLUM CHLOROPHYTA

Class Ulvophyceae

ORDER BYOPSIDALES

FAMILY BRYOPSIDACEAE

Bryopsis hypnoides J. V. Lamouroux; Abbott & Huisman 2004: 96, fig. 33A.

Specimens examined. PATHFINDER REEF: PAT-01-05 (BISH 743255).

FAMILY CAULERPACEAE

Caulerpa ambigua Okamura; Eubank 1946: 410, pl. 22, figs. 2a and 2b; Draisma et al. 2014: 1031.

Specimens examined. STINGRAY SHOALS: STI-01-03 (BISH 720880 on *Chondria* sp. fragment), STI-02-03 (BISH 720888 on *Chondria* sp. fragment).

Caulerpa chemnitzia (Esper) J. V. Lamouroux; Kraft 2007: 171, figs. 64A–C as *Caulerpa peltata*.
[=*Caulerpa peltata* J.V. Lamouroux, see Belton et al. 2014]

Specimens examined. PATHFINDER REEF: PAT-01-03 (BISH 722358), PAT-01-05 (BISH 743253).

Caulerpa racemosa (Forsskål) J. Agardh; Eubank 1946: 419.

Specimen is a peltate form of *C. racemosa*.

Specimens examined. PATHFINDER REEF: PAT-01-05 (BISH 743251).

Caulerpa webbiana Montagne; Eubank 1946: 415, figs. 1a–f, 2c.

Specimen consists of 4 mm high whorled uprights from a prostrate rhizome. Draisma et al. (2014) showed that *Caulerpa elongata* Weber-van Bosse and *C. webbiana* are clearly not conspecific.

Specimens examined. PATHFINDER REEF: PAT-01-05 (BISH 743252). ARAKANE REEF: ARA-01-05 (BISH 763261).

FAMILY DICHOTOMOSIPHONACEAE

Avrainvillea lacerata J. Agardh; Olsen-Stojkovich 1985: 33, fig. 18, pl. 6b.

Specimens examined. ZEALANDIA BANK: ZEA-01-03 (BISH 722347).

FAMILY HALIMEDACEAE

Halimeda fragilis W. R. Taylor; Taylor 1950: 88, pl. 48 (fig. 2).

Specimens appear chalky with nodal medullary filaments unfused.

Specimens examined. PATHFINDER REEF: PAT-02-05 (BISH 743267).

Halimeda gracilis Harvey ex J. Agardh; Taylor 1950: 144, fig. 44.

Specimens examined. ARAKANE REEF: ARA-01-03 (BISH 722405), ARA-02-03 (BISH 722422).

Halimeda opuntia (Linnaeus) J. V. Lamouroux; Hillis-Colinvaux 1980: 110, figs. 17, 20.

Specimens examined. ZEALANDIA BANK: ZEA-01-03 (BISH 722337), ZEA-02-03 (BISH 722348). ZEA-02-05 (BISH 743234, 743235). ARAKANE REEF: ARA-01-05 (BISH 763243, 763263), ARA-02-05 (BISH 763264).

Halimeda taenicola W. R. Taylor; Taylor 1950: 86, pl. 46 (fig. 1).

Specimens examined. ZEALANDIA BANK: ZEA-01-03 (BISH 722336), ZEA-02-03 (BISH 722349). PATHFINDER REEF: PAT-01-03 (BISH 722355), PAT-02-03 (BISH 722374, 722388), PAT-01-05 (BISH 743239), PAT-02-05 (BISH 743258). ARAKANE REEF: ARA-01-03 (BISH 722404), ARA-02-03 (BISH 722420), ARA-02-05 (BISH 763282).

Halimeda cf. tuna (J. Ellis & Solander) J. V. Lamouroux; Hillis-Colinvaux 1980: 122, figs. 17, 20, 34.

Although the distribution of *Halimeda tuna* seems to be restricted to the Mediterranean Sea and the Atlantic Ocean (Verbruggen et al. 2005), this single specimen has been tentatively placed under *H. tuna* since morphological and anatomical characters are similar to characters noted by Taylor (1950) and Hillis-Colinvaux (1980). The morphology of BISH 763271 differs from *H. cuneata* Hering where Kojima et al. (2015) relegated previously identified specimens of *H. tuna* in Japanese waters. Molecular analysis of more Pacific “*H. tuna*” should be undertaken to resolve this situation; Pacific “*H. tuna*” may be a cryptic new species.

Specimens examined. ARAKANE REEF. ARA-02-05 (BISH 763271).

FAMILY RHIPILIACEAE

Rhipilia orientalis A. Gepp & E. Gepp; Taylor 1950: 72, pl. 36 (fig. 1).

Specimens examined. ARAKANE REEF: ARA-02-03 (BISH 722419).

FAMILY UDOTACEAE

Chlorodesmis caespitosa J. Agardh; Ducker 1967: 157, pls. 3, 12, 13, 14 and 19.

Specimens examined. PATHFINDER REEF: PAT-01-03 (BISH 722362), PAT-02-03 (BISH 722378), PAT-02-05 (BISH 743248, 743269).

Rhipidosiphon javensis Montagne; Abbott & Huisman 2004: 140, figs. 52C–D.

Morphologically, the specimens resemble the flabellate form of *Tydemania expeditionis* Weber-van Bosse. The siphons which comprise the blades of *R. javensis* are, however, unequally constricted above each dichotomy.

Specimens examined. PATHFINDER REEF: PAT-01-05 (BISH 743247), PAT-02-05 (BISH 743259). ARAKANE REEF: ARA-02-05 (BISH 763284, 763287, 764138).

ORDER CLADOPHORALES

FAMILY ANADYOMENACEAE

Microdictyon okamurae Setchell; N’Yeurt & Payri 2007: 11, figs. 10–12.

Specimen consists of cells 460–540 µm diam and 400–1100 µm long with crenulate apical attachment sites. BISH 763242 was covered with *Calothrix confervicola*.

Specimens examined. ARAKANE REEF: ARA-01-03 (BISH 722400), ARA-02-03 (BISH 722413), ARA-01-05 (BISH 763242), ARA-02-05 (BISH 763281).

***Microdictyon* sp.**

Stellate branching patterns are present in few areas. Cells are mostly oblong, 880 µm long and 320–400 µm diam. Branch attachment is by annular wall thickening. The specimens may represent a new species of *Microdictyon*.

Specimens examined. ARAKANE REEF: ARA-01-05 (BISH 763248, 763259), ARA-02-05 (BISH 763269, 763273).

FAMILY BOODLEACEAE

Boodlea composita (Harvey) F. Brand; N’Yeurt & Payri 2007: 23, figs. 31–34.

Specimen is 3 mm long with main branch up to 200 µm diam and branches up to 96 µm diam.

Specimens examined. ARAKANE REEF: ARA-01-05 (BISH 763257).

Boodlea vanbosseae Reinbold; Dawson 1956: 29, fig. 6.

BISH 720891 is a young filament which is 1 cm long and 96–120 µm diam with conspicuous rhizoids, up to 240 µm long with fimbriate terminal apices.

Specimens examined. SUPPLY REEF: SUP-01-03 (BISH 720891 on *Lobophora* sp.).

Phyllocladon anastomosans (Harvey) Kraft & M. J. Wynne; Abbott & Huisman 2004: 63, figs. 16A–B.

Specimen is immature but possesses opposite branching pattern.

Specimens examined. ARAKANE REEF: ARA-02-05 (BISH 763291).

FAMILY CLADOPHORACEAE

Cladophora* cf. *flexuosa (O. F. Müller) Kützinger; Abbott & Huisman 2004: 72, fig. 20C.

Specimen is 2 mm long and resembles the basal filament of *C. flexuosa*.

Specimens examined. ARAKANE REEF: ARA-02-05 (BISH 763278).

Cladophora* cf. *vagabunda (Linnaeus) C. Hoek; Abbott & Huisman 2004: 79, figs. 24A–D.

Filaments are up to 10 mm tall and represent immature specimens.

Specimens examined. ARAKANE REEF: ARA-01-03 (BISH 722402), ARA-02-03 (BISH 722411).

FAMILY PITHOPHORACEAE

Dictyosphaeria cavernosa (Forsskål) Børgesen; Egerod 1952: 350, figs. 1b–f, 2f, 2g.

Specimens examined. SUPPLY REEF: SUP-01-03 (BISH 720892). PATHFINDER REEF: PAT-01-05 (BISH 743257). ARAKANE REEF: ARA-02-03 (BISH 722421), ARA-01-05 (BISH 763249), ARA-02-05 (BISH 763265, 764136).

Dictyosphaeria versluysii Weber-van Bosse; Egerod 1952, 351, figs. 1a, 2h–k.

Specimens examined. ZEALANDIA BANK: ZEA-01-03 (BISH 722335), ZEA-02-03 (BISH 722351). PATHFINDER REEF: PAT-01-03 (BISH 722356).

FAMILY VALONIACEAE

Valonia ventricosa J. Agardh; Kraft 2007: 121, figs. 51A–D.

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

Specimens examined. SUPPLY REEF: SUP-01-03 (BISH 720893). ZEALANDIA BANK: ZEA-01-03 (BISH 722334), ZEA-02-03 (BISH 722350). PATHFINDER REEF: PAT-01-03 (BISH 722357), PAT-02-03 (BISH 722389), PAT-02-05 (BISH 743270). ARAKANE REEF: ARA-02-03 (BISH 722416).

Discussion

The 67 algal species included 8 blue-green algae, 30 red algae, 5 brown algae and 24 green algae. Four species of red algae (*Antithamnion decipiens*, *Ceramium isogonum*, *Chondria bullata* and *Gayliella transversalis*) represented new records for Micronesia (includes Mariana Islands). An additional 10 species of red algae represented new records for the Mariana Islands which included *Caulacanthus ustulatus*, *Ceramium affine*, *Ceramium codii*, *Chondria simpliciuscula*, *Dasya* cf. *corymbifera*, *Jania pumila*, *Jania rubens*, *Lomentaria hakodatensis*, *Polysiphonia dotyi* and *Polysiphonia sertularioides*. The fact that all of the new records were species of red algae is not surprising since the red algae were the least studied within the Mariana Islands.

Five algal species were identified only to the generic level. The red-colored Cyanobacteria *Phormidium* sp. was abundant and characterized Arakane Reef in September 2005 at both sites, especially at ARA-01-05. This blue-green alga, however, was not collected from Arakane Reef during the same month in 2003. The brown alga which one would normally identify as *Lobophora variegata* (J. V. Lamouroux) Womersley ex E. C. Oliveira was listed as *Lobophora* sp. based on the findings of Vieira et al. (2014) of 14 species of *Lobophora* in New Caledonia. Our specimens which were collected in 2003 and 2005 were previously preserved in formalin and could not be

subjected to molecular analysis. The morphology of the Mariana seamount specimens of *Peyssonnelia* sp. did not typify widely distributed species around Pacific islands. The specimens of *Polysiphonia* sp. were unique in that they possessed 4–7 pericentral cells in the prostrate branches and 4–5 pericentral cells in the erect branches. The variable numbers of pericentral cells in the erect and prostrate branches differ from *Polysiphonia tsudana* Hollenberg which possesses 4 and 6–9 pericentral cells in the prostrate and erect branches, respectively. The fifth unidentified species, *Microdictyon* sp., possessed oblong cells with fine mesh with branch attachments by annular thickening. The specimens were only collected in September 2005 from Arakane Reef from both sites, ARA-01-05 and ARA-02-05, and differed morphologically from other species of *Microdictyon* reported around Pacific islands.

Fourteen (44%) of the 32 species of algae recorded by Tsuda et al. (2012) from Santa Rosa Reef (Mariana Arc) were also present among the 67 species recorded here. The species included 3 blue-green algae (*Calothrix confervicola*, *Lyngbya sordida*, *Scytonematopsis pilosa*), 3 red algae (*Dasya iyengarii*, *Hypnea spinella*, *Polysiphonia homoia*), 1 brown alga (*Dictyota ceylanica*) and 7 green algae (*Dictyosphaeria cavernosa*, *Dictyosphaeria versluysii*, *Halimeda fragilis*, *Halimeda opuntia*, *Halimeda taenicola*, *Halimeda* cf. *tuna*, and *Microdictyon okamurae*).

Of the 67 algal species recorded in 2003 and 2005, 31 species were collected only from seamounts within the submerged West Mariana Ridge, and 5 species were collected only from seamounts (including Santa Rosa Reef reported previously by Tsuda et al. 2012) within the Mariana Arc. One would have expected the greater number of species to be associated with the Mariana Arc which includes 14 islands lying in a north-south orientation adjacent to the seamounts. The remaining 31 algal species were present on seamounts along both the West Mariana Ridge and the Mariana Arc.

Acknowledgements

The NOAA Coral Reef Conservation Program provided funds to the Pacific Islands Fisheries Science Center's Coral Reef Ecosystem Division (PIFSC-CRED) which enabled PSV and KNP-A to participate in the scientific expeditions to the Mariana Islands. Appreciation to Fran Castro (CMNI Department of Environmental Quality), Shawn Wusstig (Guam Division of Aquatic and Wildlife Resources), and Elizabeth Keenan (PIFSC-CRED) for assistance in collecting algae and field data, and to all other members of the benthic team. Special thanks to Captain Ken Barton, the benthic coxswains Bruce Mokiao and Ariana Lynn, and the rest of the crew of the *Oscar Elton Sette*. We extend our appreciation to the late Jack R. Fisher and Lauren M. Russman, Bishop Museum, for sorting the bulk of the algal collections and preparing the slides, and to Annette DesRochers (PIFSC-CRED) for the map of the Mariana Islands. Our appreciation is also extended to Jill Coyle (NOAA-PIFSC), Christopher S. Lobban (University of Guam) and Antoine D. R. N'Yeurt (University of the South Pacific) for their constructive comments on the manuscript. This paper is Contribution 2015-005 of the Pacific Biological Survey, Bishop Museum.

References

- Abbott, I. A. 1999. Marine red algae of the Hawaiian Islands. Bishop Museum Press, Honolulu.
- Abbott, I. A. & J. M. Huisman. 2004. Marine green and brown algae of the Hawaiian Islands. Bishop Museum Press, Honolulu.
- Abbott, I. A., J. Zhang & B. Xia. 1991. *Gracilaria mixta*, sp. nov. and other western Pacific species of the genus (Rhodophyta: Gracilariaceae). *Pacific Science* 45: 12–27.
- Belton, G. S., W. F. Prud'homme van Reine, J. M. Huisman, S. G. A. Draisma & C. F. D. Gurgel. 2014. Resolving phenotypic plasticity and species designation in the morphologically challenging *Caulerpa racemose-peltata* complex (Caulerpacaeae, Chlorophyta). *Journal of Phycology* 50: 32–54.

- Brainard, R. E., J. Asher, V. Blyth-Skyrme, E. F. Coccagna, K. Dennis, M. K. Donovan, J. M. Gove, J. Kenyon, E. E. Looney, J. E. Miller, M. A. Timmers, B. Vargas-Angel, P. S. Vroom, O. Vetter, B. Zgliczynski, T. Acoba, A. DesRochers, M. J. Dunlap, E. C. Franklin, P. I. Fisher-Pool, C. L. Braun, B. L. Richards, S. A. Schopmeyer, R. E. Schroeder, A. Toperoff, M. Weijerman, I. Williams & R. D. Withall. 2012. Coral reef ecosystem monitoring report of the Mariana Archipelago: 2003–2007. Pacific Islands Fisheries Science Center, PIFSC Special Publication, SP-12-01, 1019 pp.
- Cho, T. O. & S. Fredericq. 2006. Two creeping *Ceramium* species (Ceramiaceae, Rhodophyta) from the Florida Keys: *C. reptans* sp. nov. and recircumscription of *C. codii* (Richards) Mazoyer. *Phycologia* 45: 495–504.
- Dawson, E. Y. 1956. Some marine algae of the southern Marshall Islands. *Pacific Science* 10: 25–66.
- Desikachary, T. V. 1959. Cyanophyta. Indian Council of Agricultural Research, New Delhi.
- Draisma, S. G. A., W. F. Prud'homme van Reine, T. Sauvage, G. S. Belton, C. F. D. Gurgel, P. E. Lim & S. M. Phang. 2014. A re-assessment of the infra-generic classification of the genus *Caulerpa* (Caulerpaceae, Chlorophyta) inferred from a time-calibrated molecular phylogeny. *Journal of Phycology* 50: 1020–1034.
- Ducker, S. C. 1967. The genus *Chlorodesmis* (Chlorophyta) in the Indo-Pacific region. *Nova Hedwigia* 13: 145–182.
- Egerod, L. E. 1952. An analysis of the siphonous Chlorophycophyta with special reference to the Siphonocladales, Siphonales, and Dasycladales of Hawaii. University of California Publication in Botany 25(5): 325–454.
- Engene, N., R. C. Coates & W. H. Gerwick. 2010. 16S rRNA gene heterogeneity in the filamentous marine cyanobacteria genus *Lyngbya*. *Journal of Phycology* 46: 591 – 601.
- Eubank, L. L. 1946. Hawaiian representatives of the genus *Caulerpa*. University of California Publication in Botany 18(18): 409–432.
- Fan, K. C. 1956. Revision of *Calothrix* Ag. *Revue Algologique* 3: 154–178.
- Gilbert, W. J. 1978. *Rhipilia sinuosa* sp. nov. (Chlorophyta, Siphonales) from Micronesia. *Phycologia* 17: 311–313.
- Gordon, G. D., T. Masaki & H. Akioka. 1976. Floristic and distributional account of the common crustose coralline algae on Guam. *Micronesica* 12: 247–277.
- Hillis-Colinvaux, L. 1980. Ecology and taxonomy of *Halimeda*: Primary producer of coral reefs. *Advances in Marine Biology* 17: 1–327.
- Hollenberg, G. J. 1968a. An account of the species of *Polysiphonia* of the central and western tropical Pacific Ocean. I. *Oligosiphonia*. *Pacific Science* 22: 56–98.
- Hollenberg, G. J. 1968b. An account of the species of the red alga *Polysiphonia* of the central and western tropical Pacific Ocean. II. *Polysiphonia*. *Pacific Science* 22: 198–207.
- Hollenberg, G. J. 1968c. An account of the species of the red alga *Herposiphonia* occurring in the central and western tropical Pacific Ocean. *Pacific Science* 22: 536–559.
- Hubbs, C. L. 1959. Initial discoveries of fish fauna on seamounts and offshore banks in the Eastern Pacific. *Pacific Science* 13: 311–316.
- Humm, H. J. & S. R. Wicks. 1980. Introduction and guide to the marine bluegreen algae. John Wiley and Sons, New York.
- Itono, H. 1980. The genus *Galaxaura* (Rhodophyta) in Micronesia. *Micronesica* 16: 1–19.
- Itono, H. & R.T. Tsuda. 1980a. New algal genera and species records from Micronesia: *Chamaedoris orientalis* (Chlorophyta) and *Rhodopeltis gracilis* (Rhodophyta). *Micronesica* 16: 21–27.
- Itono, H. & R. T. Tsuda. 1980b *Titanophora marianensis* sp. nov. (Nemastomataceae, Rhodophyta) from Guam. *Pacific Science* 34: 21–24.

- Johnson, J. H. 1957. Geology of Saipan, Mariana Islands. Part 3. Calcareous algae. U.S. Geological Survey, Professional Paper 280-E: 209–246.
- Johnson, J. H. 1964. Fossil and recent calcareous algae from Guam. U.S. Geological Survey, Professional Paper 403-G: 1–40.
- Kojima, R., T. Hanyuda & H. Kawai. 2015. Taxonomic re-examination of Japanese *Halimeda* species using genetic markers, and proposal of a new species *Halimeda ryukyuensis* (Bryopsidales, Chlorophyta). *Phycological Research* 63: 178–188.
- Kraft, G. T. 2007. Algae of Australia: Marine benthic algae of Lord Howe Island and the southern Great Barrier Reef, 1: Green Algae. ABRIS, Canberra, CSIRO publishing, Melbourne.
- Kraft, G. T. & S. M. Wilson. 1997. The taxonomy of *Dasyphila plumarioides* (Ceramiaceae, Rhodophyta). *Phycologia* 36: 138–149.
- Kumano, S. 1979. Morphological study of nine taxa of *Bostrychia* (Rhodophyta) from southwestern Japan, Hong Kong and Guam. *Micronesica* 15: 13–33.
- Littler, D. S. & M. M. Littler. 2000. Caribbean reef plants, an identification guide to the reef plants of the Caribbean, Bahamas, Florida and Gulf of Mexico. Offshore Graphics Inc., Washington D.C.
- Littler, M. M., D. S. Littler, S. M. Blair & J. N. Norris. 1986. Deep-water plant communities from an uncharted seamount off San Salvador Island, Bahamas: Distribution, abundance, and primary productivity. *Deep-Sea Research* 33: 881–892.
- Lobban, C. S. & R. T. Tsuda. 2003. Revised checklist of benthic marine macroalgae and seagrasses of Guam and Micronesia. *Micronesica* 35-36: 54–99.
- Meneses, I. & I. A. Abbott. 1987. *Gracilaria* and *Polycavernosa* (Rhodophyta) from Micronesia. *Micronesica* 20: 187–200.
- Moul, E. T. 1964. New records of *Halimeda* and *Udotea* for the Pacific area. *Atoll Research Bulletin* 106: 1–10.
- Nam, K. W. & Y. Saito. 1991. Anatomical characteristics of *Laurencia papillosa* (Rhodomelaceae, Rhodophyta) from Guam and Palau. *Micronesica* 24:87–94.
- National Oceanic and Atmospheric Administration, Pacific Islands Fisheries Science Center's Coral Reef Ecosystem Division (NOAA PIFSC CRED). 2015. Mariana Archipelago. 1:4,500,000.
- N'Yeurt, A. D. R. & C. E. Payri. 2007. Marine algal flora of French Polynesia. II. Chlorophyceae. *Cryptogamie, Algologie* 28: 3–88.
- N'Yeurt, A. D. R. & C. E. Payri. 2010. Marine algal flora of French Polynesia. III. Rhodophyta, with additions to the Phaeophyceae and Chlorophyta. *Cryptogamie, Algologie* 31: 1–205.
- Okamura, K. 1904. List of marine algae collected in Caroline Islands and Australia. *Botanical Magazine (Tokyo)* 18: 77–96.
- Okamura, K. 1916. List of marine algae collected in Caroline Islands and Mariana Islands, 1915. *Botanical Magazine (Tokyo)* 30: 1–14.
- Olsen-Stojkovich, J. 1985. A systematic study of the genus *Avrainvillea* Decaisne (Chlorophyta, Udoteaceae). *Nova Hedwigia* 41: 1–68.
- Pacific Islands Fisheries Science Center (PIFSC). 2010. Coral reef ecosystems of the Mariana Archipelago: A 2003–2007 overview. PIFSC Special Publication, SP-10-002, 38 pp.
- Parker, T. & V. Tunnicliffe. 1994. Dispersal strategies of the biota on an oceanic seamount: Implications for ecology and biogeography. *The Biological Bulletin* 187: 336–345.
- Potter, T. S. 1986. Effects of different habitats on morphological variation within natural populations of three reported species of *Dictyota* (Phaeophyta). University of Guam M.S. Thesis in Biology, 33 pp.
- Shank, T. M. 2010. Seamounts, deep-ocean laboratories of faunal connectivity, evolution, and endemism. *Oceanography* 23: 108–122.

- Skelton, P. A. & G. R. South. 2007. The benthic marine algae of the Samoan Archipelago, South Pacific, with emphasis on the Apia District. *Nova Hedwigia* 132: 1–350.
- Soe-Htun, U. & T. Yoshida. 1986. Studies on morphological variations in *Sargassum cristaefolium* C. Agardh (Phaeophyta, Fucales). *Japanese Journal of Phycology* 34: 275–281.
- South, G. R. and P. A. Skelton P.A. (2000) A review of *Ceramium* (Rhodophyceae, Ceramiales) from Fiji and Samoa, South Pacific. *Micronesica* 33: 45–98.
- Staudigel, H., A. A. P. Koppers, J. W. Lavell, T. J. Pitcher & T. M. Shank. 2010. Defining the word “seamount.” *Oceanography* 23: 20–21.
- Taylor, W. R. 1950. Plants of Bikini and other northern Marshall Islands. University of Michigan Press, Ann Arbor.
- Taylor, W. R. 1964. The genus *Turbinaria* in eastern seas. *Journal of the Linnean Society (Botany)* 58: 475–490.
- Taylor, W. R. 1977. Notes on plants of the genus *Caulerpa* in the Herbarium of Maxwell S. Doty at the University of Hawaii. *Atoll Research Bulletin* 208: 1–17.
- Tilden, J. 1910. Minnesota algae, Volume 1. The Myxophyceae of North America and adjacent regions including Central America, Greenland, Bermuda, the West Indies and Hawaii. Report of the Survey, Botanical Series, VIII, Minneapolis.
- Tokida, S. 1939. A list of marine algae from Micronesia. *Kagaku Nanyo* 2(1): 16–26.
- Tribollet, A. D. & P. S. Vroom. 2007. Temporal and spatial comparison of the relative abundance of macroalgae across the Mariana Archipelago between 2003 and 2005. *Phycologia* 46: 187–197.
- Tsuda, R. T. 1972a. Marine benthic algae of Guam. I. Phaeophyta. *Micronesica* 8: 87–115.
- Tsuda, R. T. 1972b. Morphological, zonal and seasonal studies on two species of *Sargassum* on the reefs of Guam. pp. 40–44. Proceedings of the Seventh International Seaweed Symposium (Sapporo), University of Tokyo Press.
- Tsuda, R. T. 1982. Further records of *Ulva* (Chlorophyta) in Micronesia. *Micronesica* 18: 193–194.
- Tsuda, R. T. 1985. *Gracilaria* from Micronesia: Key, list and distribution of the species. In I.A. Abbott & J.N. Norris (eds), *Taxonomy of Economic Seaweeds*. pp. 91–92. California Sea Grant Program, University of California, La Jolla.
- Tsuda, R. T. 1988. *Sargassum* from Micronesia. In I.A. Abbott (ed), *Taxonomy of Economic Seaweeds, Volume II*. pp. 59–63. California Sea Grant Program, University of California, La Jolla.
- Tsuda, R. T. 2003. Checklist and bibliography of the marine benthic algae from the Mariana Islands (Guam and CNMI). University of Guam Marine Laboratory, Technical Report No. 107, 49 pp.
- Tsuda, R. T. 2004. *Dictyota* (Phaeophyceae) from Micronesia. In I.A. Abbott & K.J. McDermid (eds.), *Taxonomy of Economic Seaweeds with Reference to the Pacific and Other Locations, Volume IX*. pp. 41–55. Hawaii Sea Grant College Program, University of Hawaii, Honolulu.
- Tsuda, R. T. & W. J. Tobias. 1977a. Marine benthic algae from the Northern Mariana Islands, Chlorophyta and Phaeophyta. *Bulletin of the Japanese Society of Phycology* 25: 19–24.
- Tsuda, R. T. & W. J. Tobias. 1977b. Marine benthic algae from the Northern Mariana Islands, Cyanophyta and Rhodophyta. *Bulletin of the Japanese Society of Phycology* 25: 155–158.
- Tsuda R. T., P. S. Vroom & K. N. Page-Albins. 2012. New marine algal records from the Polynesia – Micronesia region of the Pacific Ocean. *Marine Biodiversity Records* 5(e18): 1–7. doi: 10.1017/S1755267212000024.
- Verbruggen H. & T. Schils. 2012. *Rhipilia copejansii*, a new coral reef-associated species from Guam (Bryopsidales, Chlorophyta). *Journal of Phycology* 48: 1090–1098.
- Verbruggen H., O. De Clerck, T. Schils, W. H. C. F. Kooistra & E. Coppejans. 2005. Evolution and phylogeography of *Halimeda* section *Halimeda* (Bryopsidales, Chlorophyta). *Molecular Phylogenetics and Evolution* 37: 789–803.

- Vieira C., S. D'hondt, O. De Clerck & C. P. Payri. 2014. Toward an inordinate fondness for stars, beetles and *Lobophora*? Species diversity of the genus *Lobophora* (Dictyotales, Phaeophyceae) in New Caledonia. *Journal of Phycology* 50: 1101–1119.
- Wagner, D., R. K. Kosaki, H. L. Spalding, R. K. Whitton, R. L. Pyle, A. R. Sherwood, R. T. Tsuda and B. Calcinaï. 2014. Mesophotic surveys of the flora and fauna at Johnston Atoll, Central Pacific Ocean. *Marine Biodiversity Records* 7(e68): 1–10. doi:10.1017/S1755267214000785.
- Yamada Y. 1931. Notes on *Laurencia* with special reference to Japanese species. *University of California Publications in Botany* 16: 185–310.
- Yamada Y. 1940. *Caulerpa* in Micronesia. *Kagaku Nanyo* 3(2): 11–23.
- Yamada Y. 1941. *Halimeda* from Micronesia. *Kagaku Nanyo* 4(2): 12–25.

Received 20 Nov. 2015, revised 09 Dec. 2015.

Figures 2–5.

Figure 2. Vertical wall at one of two pinnacles at Zealandia Bank. Figure 3. In-situ image of *Halimeda taenicola* at Pathfinder Reef. Figure 4. In-situ image of *Caulerpa webbiana* at Arakane Reef. Figure 5. Arakane Reef, strong surge and currents, characterized by a high abundance of soft coral *Lobophytum* sp. and the red pigmented Cyanobacteria *Phormidium* sp. All photos by KNP.

