

New Species Records and Voucher Specimens of Marine Benthic Algae from Kaho‘olawe, Main Hawaiian Islands¹

ROY T. TSUDA² & ISABELLA A. ABBOTT^{2†}

Hawaii Biological Survey, Bernice P. Bishop Museum, 1525 Bernice Street, Honolulu, Hawai‘i 96817-2704 USA; email: roy.tsuda@bishop.museum.org

Kaho‘olawe is the smallest (18.0 km long and 9.7 km wide) of the eight main volcanic islands of the Hawaiian Islands, and is located 11 km SW of Maui. It is one of four islands (Maui, Moloka‘i, Lāna‘i, Kaho‘olawe) of the Maui Nui Complex (Price & Elliott-Fisk 2004), which was connected as a single landmass in the past (1.2 million years ago). The annual rainfall is less than 65 cm and the shortage of water contributes to the current lack of a permanent human population. The island was used as a live-fire training ground and bombing range by the U.S. Armed Forces from the early 1950s to 1990. In 1993, military controlled Kaho‘olawe was transferred to the jurisdiction of the State of Hawai‘i which established the Kaho‘olawe Island Reserve. The Kaho‘olawe Island Reserve Commission was established the following year by the Hawai‘i State Legislature to oversee the whole island and its surrounding waters (3 km radius from shore). Today, the island is unique in that commercial use on the island is prohibited and the Reserve is used only for native Hawaiian cultural, spiritual and subsistence purposes (Wikipedia 2018).

The written records of marine benthic algal species from Kaho‘olawe are recent. Dames & Moore (1997) listed 12 species of marine algae in the Kaho‘olawe Ocean Management Plan prepared for the Kaho‘olawe Island Reserve Commission, with no reference to where the listing originated. The following year, Coles *et al.* (1998) conducted a baseline survey and reported the marine algae and invertebrates observed in the intertidal and subtidal waters of Kaho‘olawe. The algal species were predominantly identified via observations in the field, and voucher specimens were not specified nor were the sites of specimen deposition, if any, identified. The study was mainly to identify non-indigenous and invasive species in the nearshore marine waters of the Kaho‘olawe Island Reserve. Eighty species of macroalgae, i.e., three Cyanobacteria (blue-green algae), 38 Rhodophyta (red algae), 16 Phaeophyceae (brown algae) and 23 Chlorophyta (green algae), were listed which included nine taxa identified only to genera. *Asparagopsis taxiformis* (Delile) R.Trevis. (gametophyte) and “*Falkenbergia hillebrandii*” (sporophyte) listed as two taxa are considered here as one species. None of the algae are considered invasive species.

Abbott (1999) and Abbott & Huisman (2004) documented 70 species of marine algae with voucher specimens from Kaho‘olawe which included 35 species of red algae, 13 species of brown algae and 22 species of green algae (see Appendix). Abbott (1999) stated “..., this volume contains the first comprehensive reports of marine algae from Kaho‘olawe, and we look forward to more collections from that island in the future.” Among the species, Abbott (1999) cited one specimen (IA 21063) of *Acanthophora spicifera*, an invasive species, from Kaho‘olawe. This single specimen, however, is not deposited in *BISH*. In their study of invasive algal species in Hawai‘i, Smith *et al.* (2002)

1. Contribution No. 2018-009 to the Hawaii Biological Survey.

2. Research Affiliate, Department of Natural Sciences, Bishop Museum, 1525 Bernice Street, Honolulu, Hawai‘i 96817-2704, USA.

examined the algal specimens at *BISH* but did not find any specimens of *A. spicifera* from Kaho‘olawe among the collection.

Shultz (2004) compared the intertidal and shallow subtidal (<4 m deep) marine algal communities at three sites at Kaho‘olawe and two sites at adjacent Maui. His Masters of Science thesis recorded 71 taxa, including 11 taxa identified only to genus, from Kaho‘olawe during the months of January, February, April, August and October during 2002 and 2003. Twenty nine specimens collected solely by Shultz from Kaho‘olawe were listed in the *BISH* algal database with all except one collected on 23 April 2002. The exception was *Padina meleleme* I.A. Abbott & Magruder, which was collected on 28 February 2002.

Alcohol preserved specimens of marine algae, representing six species collected during the Coles *et al.* (1998) study were recently found in November 2017 in the Invertebrate Collection of the Bishop Museum. The specimens were sorted, identified, mounted on herbarium paper, cataloged (BISH 769051 to 769056) in *Herbarium Pacificum*, and represent the only voucher algal specimens from that study in *BISH*. The species included three new records, two previously recorded species and one taxon identified only to genus.

Eighteen species of unreported marine benthic algal species from the island of Kaho‘olawe (1 blue-green alga, 12 red algae, 1 brown alga, and 4 green algae) were found in *Herbarium Pacificum* (*BISH*), reexamined, and reported here. An additional 21 species (1 blue-green alga, 10 red algae, 6 brown algae and 4 green algae) were also found in *Herbarium Pacificum* based on other collections from Kaho‘olawe. These specimens can serve as voucher specimens for selected species listed in Dames & Moore (1997), Coles *et al.* (1998) and Shultz (2004). The species distribution from the other seven main Hawaiian Islands (MHI) are also provided. All algal species had been previously reported from one or more of the MHI. The species distribution in the coastal waters of the 10 islands, atolls and shoals of the Papahānaumokuākea Marine National Monument (Northwestern Hawaiian Islands) (PMNM) are summarized in Tsuda (2014) and Tsuda *et al.* (2015). AlgaeBase (Guiry & Guiry 2018) was consulted for currently accepted algae names and synonyms. Pukui *et al.* (1974) was consulted for spelling of Hawaiian place names (collecting sites), when available, along the coast of Kaho‘olawe.

Phylum CYANOBACTERIA

Leptolyngbya crosbyana (Tilden)

Voucher specimen

Anagn. & Komárek

MHI distribution. O‘ahu (Tilden 1910; as *Phormidium crosbyanum* Tilden, Huisman *et al.* 2007); Kaho‘olawe (Coles *et al.* 1998).

Material examined. BISH 694018, E. Waikahalulu Bay, coll. S. Hau & F. Oishi, 09 Sep 1992 (IA 21001).

Symploca hydroides Kütz. ex Gomont

New island record

MHI distribution. Specific MHI not designated (Huisman *et al.* 2007).

Material examined. BISH 694015, Pu‘ukoa‘e, coll. S. Hau & F. Oishi, 09 Sep 1992 (IA 20878); BISH 694016, Lae o Kealaikahiki, coll. S. Hau, 20 Oct 1992 (IA 21016); BISH 694017, Kanapou Bay, 3.0–9.1 m deep, coll. G. Jeane II, 21 Dec 1992 (IA 21150).

Phylum RHODOPHYTA***Ahnfeltiopsis concinna* (J.Agardh)****Voucher specimen**

P.C.Silva & DeCew

MHI distribution. Kaua'i, O'ahu, Maui, Lāna'i, Hawai'i (Abbott 1999); Kaho'olawe (Dames & Moore 1997; as *Ahnfeltia concinna* J.Agardh).

Material examined. BISH 692541, coll. D. McGregor, 17 Sep 1993 (IA 21874).

***Amansia fimbriifolia* (R.E.Norris) L.E.Phillips** **New island record**

MHI distribution. Kaua'i, O'ahu (Abbott 1999; as *Melanamansia fimbriifolia* R.E.Norris).

Material examined. BISH 666878, Hakioawa Bay, 9.1–12.2 m deep, coll. R. Okano & K. Schultz, 16 Aug. 2000 (IA 24766), det. I.A. Abbott.

Amphiroa valonioides* Yendo*New island record**

MHI distribution. Kaua'i, O'ahu, Lānai (Abbott 1999).

Material examined. BISH 666880, Hakioawa Bay, 9.1–12.2 m deep, coll. R. Okano & K. Schultz, 17 Aug 2000 (IA 24772), det. I.A. Abbott.

Asparagopsis taxiformis* (Delile) R.Trevis.*Voucher specimen**

MHI distribution. Kaua'i, O'ahu, Moloka'i, Hawai'i (Abbott 1999); Kaho'olawe (Coles *et al.* 1998, Shultz 2004).

Material examined. BISH 693746, coll. D. McGregor, 17 Sep 1993 (IA 21876); BISH 771019 (slide), coll. R. Okano, 16 Aug 2000 (IA 24769), det. I.A. Abbott.

Caulacanthus ustulatus* (Mertens ex Turner)*New island record**

Kütz.

MHI distribution. Kaua'i, O'ahu, Moloka'i, Maui, Hawai'i (Abbott 1999).

Material examined. BISH 769053, NE Hakioawa Bay, coll. R. DeFelice, S. Coles & J. Smith, 12 Jan 1998 (*s.n.*).

Ceramium clarionense* Setch. & N.L.Gardner*Voucher specimen**

MHI distribution. O'ahu, Maui, Hawai'i (Abbott 1999); Kaho'olawe (Coles *et al.* 1998).

Material examined. BISH 771031 (slide), Hakioawa Bay, 1.5–6.1 m deep, coll. R. Okano, 16 Aug. 2000 (IA 24780b), det. I.A. Abbott.

Ceramium hanaense* R.E.Norris & I.A.Abbott*Voucher specimen**

MHI distribution. Maui, Hawai'i (Abbott 1999); Kaho'olawe (Coles *et al.* 1998).

Material examined. BISH 689402 (slide), Kūheia, coll. K. Shultz, 23 Apr 2002 (KS 06), det. J.R. Fisher.

***Ceratodictyon intricatum* (C.Agardh) R.E.Norris** **Voucher specimen**

MHI distribution. O'ahu, Maui (Abbott 1999; as *Gelidiopsis intricata* (C.Agardh) Vickers); Kaho'olawe (Coles *et al.* 1998).

Material examined. BISH 691878, W of Lae o Kākā, coll. S. Hau, 19 Oct 1992 (IA 21059); BISH 691879, Pu'ukoa'e, coll. S. Hau & F. Oishi, 09 Sep 1992 (IA 20884c); BISH 772655, Hakioawa Bay, 7.0–13.7 m deep, coll. S. Hau, 18 Jan 2001 (IA 28174), det. I.A. Abbott.

Champia parvula (C.Agardh) Harv.**Voucher specimen**

MHI distribution. Kaua'i, O'ahu, Moloka'i, Maui, Lāna'i (Abbott 1999); Kaho'olawe (Coles *et al.* 1998, Shultz 2004).

Material examined. BISH 771032 (slide), Hakioawa Bay, 1.5–6.1 m deep, coll. R. Okano, 16 Aug 2000 (IA 24780c), det. I.A. Abbott; BISH 689041, Kūheia, coll. K. Shultz, 23 Apr 2002 (KS 05), det. J.R. Fisher.

Chondria simpliciuscula Weber Bosse**New island record**

MHI distribution. O'ahu, Maui, Lāna'i, Hawai'i (Abbott 1999).

Material examined. BISH 689055 (slide), Kūheia, coll. K. Shultz, 23 Apr 2002 (KS 19), det. J.R. Fisher; BISH 769054, NE Hakioawa Bay, coll. R. DeFelice, S. Coles & J. Smith, 12 Jan 1998 (*s.n.*); BISH 771009 (slide), coll. R. Okano, 16 Aug 2000 (IA 24751).

Chondrophycus undulatus (Yamada)**New island record**

Garbury & J.T.Harper

MHI distribution. O'ahu, Maui (Abbott 1999; as *Laurencia undulata* Yamada).

Material examined. BISH 771029 (slide), Hakioawa Bay, coll. R. Okano, 16 Aug 2000 (IA 24780).

Corallophila itonoi (Ardré) R.E.Norris**Voucher specimen**

MHI distribution. O'ahu, Maui (Abbott 1999); Kaho'olawe (Shultz 2004).

Material examined. BISH 771017 (slide), Hakioawa Bay, coll. R. Okano, 16 Aug 2000 (IA 24759), det. I.A. Abbott.

Dasya anastomosans (Weber Bosse)**New island record**

M.J.Wynne

MHI distribution. Kaua'i, O'ahu, Hawai'i (Abbott 1999 as *Dasya pilosa* (Weber-van Bosse) Millar).

Material examined. BISH 689052 (slide), Kūheia, coll. K. Shultz, 23 Apr 2002 (KS 16).

Dichotomaria marginata (J.Ellis & Sol.) Lam.**Voucher specimen**

MHI distribution. O'ahu, Maui, Hawai'i (Abbott 1999; as *Galaxaura marginata* (J.Ellis & Sol.) J.V.Lamour.); Kaho'olawe (Coles *et al.* 1998; as *Galaxaura marginata*).

Material examined. BISH 680056, O'owapalua, 4.9–9.1 m deep, coll. S. Hau, 17 May 2000 (IA 24372); BISH 692288, Honukanaena, tidal shelf, <1 m deep, coll. M. LeGrande & K.R. Wood, 18 Jul 2001(*s.n.*); BISH 772929, W Hālonā, 9.4–16.8 m deep, coll. S. Hau, 17 May 2000 (IA 24865)

Dotyella hawaiiensis (Doty & Wainwr.)**New island record**

Womersley & Shepley

MHI distribution. Kaua'i, O'ahu, Maui (Abbott 1999).

Material examined. BISH 771027 (slide), coll. R. Okano, 16 Aug 2000 (IA 24777), det. I.A. Abbott.

Drouetia coalescens (Farlow) G.De Toni**New island record**

MHI distribution. Kaua'i, O'ahu, Maui (Abbott 1999; as *Halichrysis coalescens* (Farlow) R.E. Norris & Millar).

Material examined. BISH 691708, coll. S. Hau, Sep 1992 (IA 20844); BISH 771015 (slide), Hakioawa Bay, 1.5–6.1 m deep, coll. R. Okano, 16 Aug. 2000 (IA 24756).

Ganonema farinosum (J.V.Lamour.)

K.C.Fan & Yung C.Wang

New island record

MHI distribution. O'ahu, Maui, Hawai'i (Abbott 1999).

Material examined. BISH 700491, N of Keana Keiki, coll. S. Hau & F. Oishi, 21 Oct 1992 (IA 20871), det. I.A. Abbott.***Haloplegma duperreyi*** Mont.**Voucher specimen**MHI distribution. Kaua'i, O'ahu, Moloka'i, Maui, Hawai'i (Abbott 1999); Kaho'olawe (Coles *et al.* 1998, Shultz 2004).*Material examined.* BISH 691893, W. Kamōhio Bay, coll. S. Hau & F. Oishi, 09 Sep 1992 (IA 21027).***Hypoglossum minimum*** Yamada**New island record**

MHI distribution. O'ahu, Moloka'i (Abbott 1999).

Material examined. BISH 771012 (slide), Hakioawa Bay, 1.5–6.1 m deep, coll. R. Okano, 16 Aug 2000 (IA 24754), det. I.A. Abbott.***Nitophyllum adhaerens*** M.J.Wynne**New island record**

MHI distribution. Maui, Hawai'i (Abbott 1999).

Material examined. BISH 771024 (slide), Hakioawa Bay, 1.5–6.1 m deep, coll. R. Okano, 16 Aug 2000 (IA 24774), det. I.A. Abbott.***Polysiphonia foetidissima*** Cocks ex Bornet**New island record**[= *Neosiphonia tepida* (Hollenb.) S.M.Guim. & M.T.Fujii]MHI distribution. O'ahu, Moloka'i (Hollenberg 1968; as *Polysiphonia tepida* Hollenb.).*Material examined.* BISH 769056, epiphytic on *Chondria* sp., Hakioawa Bay, coll. R. DeFelice, S. Coles & J. Smith, 12 Jan 1998 (*s.n.*).***Portieria hornemannii*** (Lyngb.) P.C.Silva**Voucher specimen**MHI distribution. O'ahu, Maui, Hawai'i (Abbott 1999); Kaho'olawe (Coles *et al.* 1998).*Material examined.* BISH 666874, Hakioawa Bay, 9.1–12.2 m deep, coll. R. Okano & K. Schultz (IA 24760); BISH 680059, 'Oawapalua, 4.9–9.1 m deep, coll. S. Hau, 17 May 2000 (IA 24374), det. I.A. Abbott; BISH 693859, W of Lae o Kākā, coll. S. Hau, 19 Oct 1992 (IA 21056), det. I.A. Abbott; BISH 720282, Honukanaeae, tidal shelf, <1 m deep, coll. M. LeGrande & K.R. Wood, 18 Jul 2001 (*s.n.*), det. I.A. Abbott; BISH 772653, Hakioawa Bay, 7.0–13.7 m deep, coll. S. Hau, 18 Jan 2001 (IA 28176), det. I.A. Abbott.**Class PHAEOPHYCEAE*****Asteronema breviarticulatum*** (J.Agardh)

L.C.Ouriques & Z.L.Bouzon

Voucher specimenMHI distribution. Kaua'i, O'ahu, Hawai'i (Abbott & Huisman 2004); Kaho'olawe (Coles *et al.* 1998; as *Hincksia breviarticulata* (J.Agardh) P.C.Silva, Shultz 2004).*Material examined.* BISH 700699, E. Waikahalulu Bay, coll. S. Hau & F. Oishi, 09 Sep 1992 (IA 21004).***Feldmannia mitchelliae*** (Harv.) H.S.Kim**Voucher specimen**MHI distribution. O'ahu, Maui, Hawai'i (Abbott & Huisman 2004; as *Hincksia mitchelliae* (Harvey) P.C.Silva); Kaho'olawe (Shultz 2004; as *Hincksia mitchelliae*).*Material examined.* BISH 689038 (slide), Kūheia, coll. K. Shultz, 23 Apr 2002 (KS 02), det. I.A. Abbott.

Padina australis* Hauck*New island record**

MHI distribution. O'ahu, Maui (Abbott & Huisman 2004).

Material examined. BISH 700862, Keana Keiki to Honukanaeae, coll. D. McGregor, 17 Sep 1993 (IA 21792a), det. I.A. Abbott.

Sargassum aquifolium* (Turner) C.Agardh*Voucher specimen**

MHI distribution. O'ahu, Maui, Hawai'i (Abbott & Huisman 2004; as *Sargassum echinocarpum* J.Agardh); Kaho'olawe (Dames & Moore 1997 and Coles *et al.* 1998; as *Sargassum echinocarpum*).

Material examined. BISH 553879 (alcohol specimen), Hakioawa Bay, tidepool, coll. P.K. Higashino, Apr 1980 (*s.n.*); BISH 700789, Pu'ukoa'e, coll. S. Hau & F. Oishi, 09 Sep 1992 (IA 21120), receptacles; BISH 700796, E. Waikahalulu Bay, coll. S. Hau & F. Oishi, 09 Sep 1992 (IA 21007), filiform leaves with smooth branch.

Sargassum obtusifolium* J.Agardh*Voucher specimen**

MHI distribution. O'ahu, Moloka'i, Maui, Hawai'i (Abbott & Huisman 2004); Kaho'olawe (Coles *et al.* 1998, Shultz 2004).

Material examined. BISH 553876 (alcohol specimen), Hakioawa Bay, tidepool, coll. P.K. Higashino, Apr 1980 (*s.n.*).

Sphacelaria rigidula* Kütz.*Voucher specimen**

MHI distribution. Kaua'i, O'ahu, Moloka'i, Maui, Hawai'i (Abbott & Huisman 2004); Kaho'olawe (Coles *et al.* 1998).

Material examined. BISH 689044 (slide), coll. K. Shultz, 23 Apr 2002 (KS 08).

Turbinaria ornata* (Turner) J.Agardh*Voucher specimen**

MHI distribution. O'ahu, Maui, Hawai'i (Abbott & Huisman 2004); Kaho'olawe (Coles *et al.* 1998).

Material examined. BISH 700904, Kanapou Bay, 3.0–9.1 m deep, coll. G. Jeane II, 21 Dec 1992 (IA 21147).

Phylum CHLOROPHYTA***Bryopsis pennata* J.V.Lamour.****New island record**

MHI distribution. Kaua'i, O'ahu, Maui (Abbott & Huisman 2004).

Material examined. BISH 771016 (slide), Hakioawa Bay, 1.5–6.1 m deep, coll. R. Okano, 16 Aug 2000 (IA 24758), det. I.A. Abbott.

Codium arabicum* Kütz.*New island record**

MHI distribution. Kaua'i, O'ahu, Maui, Hawai'i (Abbott & Huisman 2004).

Material examined. BISH 553872 (alcohol specimen), Hakioawa Bay, tidepool, coll. P.K. Higashino, Apr 1980 (*s.n.*); BISH 711606, Kūheia, coll. K. Shultz, 23 Apr 2002 (KS 20, IA 30047a), det. I.A. Abbott.

Codium edule* P.C.Silva*Voucher specimen**

MHI distribution. O'ahu, Moloka'i, Maui, Hawai'i (Abbott & Huisman 2004); Kaho'olawe (Dames & Moore 1997, Coles *et al.* 1998, Shultz 2004).

Material examined. BISH 553871 (alcohol specimen), Hakioawa Bay, tidepool, coll. P.K. Higashino, Apr 1980 (*s.n.*).

Halimeda gracilis Harv. ex J.Agardh**New island record**

MHI distribution. O'ahu (Abbott & Huisman 2004).

Material examined. BISH 701153, Halona Pt., coll. S. Hau & F. Oishi, 10 Sep 1992 (IA 20990), det. L.M. Hodgson.

Halimeda kanaloana P.Vroom**New island record**

MHI distribution. Maui, Moloka'i (Abbott & Huisman 2004; as *Halimeda incrassata* (J.Ellis) J.V.Lamour).

Material examined. BISH 724259, Ku'ia Shoal via ROV (HURL), 50–95 m deep, coll. E.H. Chave, 21 Aug 2002 (IA 30048).

Siphonocladus tropicus (P.Crouan & H.Crouan) **Voucher specimen**

J.Agardh

MHI distribution. Kaua'i, O'ahu, Maui (Abbott & Huisman 2004); Kaho'olawe (Coles *et al.* 1998).

Material examined. BISH 553870 (alcohol specimen), Hakioawa Bay, tidepool, coll. P.K. Higashino, Apr 1980 (*s.n.*).

Ulva lactuca L.**Voucher specimen**

MHI distribution. Kaua'i, O'ahu, Moloka'i, Lāna'i, Maui (Abbott & Huisman 2004; as *Ulva fasciata* Delile); Kaho'olawe (Dames & Moore 1997, Shultz 2004; as *Ulva fasciata*).

Material examined. BISH 701696, Keana Keiki to Honukanaeae, coll. D. McGregor, 17 Sep 1993 (IA 21792c).

Valonia ventricosa J.Agardh**Voucher specimen**

MHI distribution. Kaua'i, O'ahu, Moloka'i, Lāna'i, Maui, Hawai'i (Abbott & Huisman 2004; as *Ventricaria ventricosa* (J.Agardh) Olsen & West); Kaho'olawe (Coles *et al.* 1998 and Shultz 2004; as *Ventricaria ventricosa*).

Material examined. BISH 666870, Hakioawa Bay, 1.5–6.1 m deep, coll. R. Okano & K. Schultz, 16 Aug 2000 (IA 24750), det. I.A. Abbott.

ACKNOWLEDGMENTS

Sincere appreciation to those individuals who collected the algal specimens from Kaho'olawe and donated the specimens to the Bishop Museum — E.H. Chave, S. Hau, P.K. Higashino, L.M. Hodgson, G. Jeane II, M. LeGrande, D. McGregor, F. Oishi, R. Okano, J.K.K. Shultz and K.R. Wood. Lynn M. Hodgson and the late Jack R. Fisher are acknowledged for initially identifying three of the specimens from Kaho'olawe. Acknowledgements to the BISH Collection Manager Barbara H. Kennedy for providing a listing of algal specimens previously collected from Kaho'olawe from its database and to Nicolas Walvoord (Bishop Museum) for locating and photocopying Coles *et al.* (1998) for this study. Gratitude to Steve L. Coles (Bishop Museum) and Celia M. Smith (University of Hawai'i at Mānoa) for their constructive comments on the manuscript.

LITERATURE CITED

Abbott, I.A. 1999. *Marine red algae of the Hawaiian Islands*. Bishop Museum Press, Honolulu. 477 pp.

- Abbott, I.A. & Huisman, J.M.** 2004. Marine green and brown algae of the Hawaiian Islands. *Bishop Museum Bulletin in Botany* **4**: xi + 259 pp.
- Coles, S.L., DeFelice, R.C., Smith, J.E., Muir, D. & Eldredge, L.G.** 1998. Determination of baseline conditions for introduced marine species in nearshore waters of the island of Kaho'olawe, Hawaii. Prepared for the Kaho'olawe Island Reserve Commission. *Bishop Museum Technical Report* **14**, 26 pp.
- Dames & Moore** [in association with Akala Products, Inc., Cultural Surveys Hawaii, Environmental Assessment Company, Mr. Robert Lu'uwai, Morgan & Associates, Native Hawaiian Legal Corporation]. 1997. Ola Ike Kaio Kanaloa, Kaho'olawe Ocean Management Plan. Prepared for Kaho'olawe Island Reserve Commission. xii + 70 pp.
- Guiry, M.D. & Guiry, G.M.** 2018. AlgaeBase. World-wide electronic publication. National University of Ireland, Galway. Available from: <http://www.algaebase.org>. (Last accessed 25 May 2018).
- Hollenberg, G.J.** 1968. 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, 3 figs.
- Huisman, J.M., Abbott, I.A. & Smith, C.M.** 2007. *Hawaiian reef plants*. University of Hawai'i Sea Grant College Program, Report No. UNIHI-SEAGRANT-BA-03-02, 264 pp.
- Price, J.P. & Elliott-Fisk, D.** 2004. Topographic history of the Maui Nui Complex, Hawai'i, and its implications for biogeography. *Pacific Science* **58**: 27–45.
- Pukui, M.K., Elbert, S.H. & Mookini, E.T.** 1974. *Place names of Hawaii*. University of Hawaii Press, Honolulu. 289 pp.
- Shultz, J.K.K.** 2004. Comparison of shallow marine algal communities among selected sites of Maui Nui, Hawai'i. Unpublished Master's Thesis, Botany Department, University of Hawai'i at Mānoa, Honolulu. 92 pp.
- Smith, J.E., Hunter, C.L. & Smith, C.M.** 2002. Distribution and reproductive characteristics of nonindigenous and invasive marine algae in the Hawaiian Islands. *Pacific Science* **56**: 299–315.
- 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 [Geological and Natural History Survey of Minnesota]. Botanical Series. VIII. Board of Regents, University of Minnesota, Minneapolis. 328 pp., 20 pls.
- Tsuda, R.T.** 2014. Bibliographic catalogue of the marine benthic algae in the Papahānaumokuākea Marine National Monument (Northwestern Hawaiian Islands). *Phytotaxa* **167**: 35–60. [<http://dx.doi.org/10.11646/phytotaxa.167.1.2>]
- Tsuda, R.T., Spalding, H.L. & Sherwood, A.R.** 2015. New species records of marine benthic algae in the Papahānaumokuākea Marine National Monument (Northwestern Hawaiian lands). In: Evenhuis, N.L. & S.E. Miller (eds.), Records of the Hawaii Biological Survey for 2014. Part I: Articles. *Bishop Museum Occasional Papers* **116**: 41–47.
- Wikipedia.** 2018. Kaho'olawe. Available from: <https://en.wikipedia.org/wiki/Kahoolawe>. (Last accessed: 17 May 2018).

APPENDIX

Previously Reported Marine Algae with Voucher Specimens from Kaho‘olawe
(Abbott 1999, Abbott & Huisman 2004)

[Species listed in Dames & Moore 1997 (+), Coles *et al.* 1998 (*) and Shultz 2004 (^)]

Phylum Rhodophyta

- **Acanthophora pacifica* (Setch.) Kraft
- Acanthophora spicifera* (Vahl) Børgesen
- Acrothamnion butleriae* (Collins) Kylin
- ^**Actinotrichia fragilis* (Forssk.) Børgesen
- ^**Amansia glomerata* C.Agardh [= *Melanamansia glomerata* (C. Agardh) R.E.Norris]
- Centroceras clavulatum* (C.Agardh) Mont.
- ^*Chondria polyrhiza* Collins & Hervey
- Chondrophyucus dotyi* (Y.Saito) K.W.Nam [= *Laurencia dotyi* Y.Saito]
- +*Chondrophyucus succisus* (A.B.Cribb) K.W.Nam [= *Laurencia succisa* A.B.Cribb]
- Crouania minutissima* Yamada
- ^**Dasya iridescens* (Schlech) A.Millar & I.A.Abbott
- Digenea cymatophila* (R.E.Norris) Diaz-Tapia & Maggs [= *Alsidium cymatophilum* R.E.Norris]
- Diplothamnion jolyi* C.Hoek
- Galaxaura divaricata* (L.) Huisman & R.A.Townsend [= *Galaxaura fasciculata* Kjellman]
- ^**Galaxaura rugosa* (J.Ellis & Sol.) J.V.Lamour.
- Gayliella flaccida* (Kütz.) T.O.Cho & L.McIvor [= *Ceramium flaccidum* (Kütz.) Ardissonne]
- ^**Gibsmithia hawaiiensis* Doty
- ^+*Gracilaria coronopifolia* J.Agardh
- Heterosiphonia crispella* (C.Agardh) M.J.Wynne
- Hypnea spinella* (C.Agardh) Kütz.
- Laurencia brachyclados* Pilger
- Laurencia dendroidea* J.Agardh [cited as *Laurencia majuscula* (Harv.) Lucas]
- Laurencia galtsoffii* M.Howe
- ^*Martensia fragilis* Harv.
- Melanthamnus apiculatus* (Hollenb.) Diaz-Tapia & Maggs [= *Neosiphonia apiculata* (Hollenb.) Masuda & Kogame, *Polysiphonia apiculata* Hollenb.]
- Peyssonnelia inamoena* Pilger
- Predaea weldii* Kraft & I.A.Abbott
- ^**Spyridia filamentosa* (Wulfen) Harv.
- Stylonema cornu-cervi* Reinsch
- ^**Taenioma perpusillum* (J.Agardh) J.Agardh
- ^*Tolypiocladia glomerulata* (C.Agardh) Schmitz
- **Tricleocarpa fragilis* (L.) Huisman & R.A.Townsend
- Trichogloeopsis mucosissima* (Yamada) I.A.Abbott & Doty
- Womersleyella pacifica* Hollenb.
- Womersleyella setacea* (Hollenb.) R.E.Norris [= *Polysiphonia setacea* Hollenb.]

Class Phaeophyceae

- ^**Chnoospora minima* (Hering) Papenf.
- ^**Dictyota acutiloba* J.Agardh
- **Dictyota ceylanica* Kütz. [also cited as *Dictyota divaricata* J.V.Lamour.]
- **Dictyota friabilis* Setch.
- Dictyota sandvicensis* Sond.
- Dictyota stolonifera* E.Y.Dawson
- Feldmannia indica* (Sond.) Womersley & A.Bailey [= *Hincksia indica* (Sond.) J.Tanaka]
- ^**Lobophora variegata* (J.V.Lamour.) Womersley ex Oliveira
- ^*Padina melemele* I.A.Abbott & Magruder
- Rosenvingeia orientalis* (J.Agardh) Børgesen
- **Sargassum polyphyllum* J.Agardh
- **Sphacelaria novae-hollandiae* Sond.
- ^*Sphacelaria tribuloides* Menegh.

Phylum Chlorophyta

- **Bornetella sphaerica* (Zanardini) Solms
- Caulerpa lentillifera* J.Agardh
- **Caulerpa serrulata* (Forssk.) J.Agardh
- **Caulerpa taxifolia* (Vahl) C.Agardh
- Caulerpa verticillata* J.Agardh
- ^**Caulerpa webbiana* Mont.
- Cladophora hawaiiiana* Tilden
- ^**Cladophora socialis* Kütz.
- ^*Cladophora vagabunda* (L.) C.Hoek
- Cladophoropsis fasciculata* (Kjellm.) Wille [= *Cladophoropsis sundanensis* Reinbold]
- **Cladophoropsis membranacea* (Hoffman Bang ex C.Agardh) Børgesen
- ^**Dictyosphaeria cavernosa* (Forssk.) Børgesen
- ^**Dictyosphaeria versluysii* Weber Bosse
- ^*Halimeda discoidea* Decaisne
- ^**Halimeda opuntia* (L.) J.V.Lamour.
- ^**Microdictyon setchellianum* M.Howe
- **Microdictyon umbilicatum* (Velley) Zanardini [also cited as *Microdictyon japonicum* Setch.]
- ^**Neomeris annulata* Dickie
- ^**Neomeris vanbosseae* M.Howe
- Parvocaulis clavatus* (Yamada) S.Berger, U.Fettweiss, S.Gleissberg, L.B.Liddle, U.Richter, H.Sawitzky & G.C.Zuccarello [= *Acetabularia clavata* Yamada]
- Ulva paradoxa* C.Agardh [= *Enteromorpha paradoxa* (J.Agardh) Kütz.]
- Valonia aegagropila* C.Agardh