An underwater photograph of a coral reef. The water is a deep, clear green. In the foreground, there are large, rounded, greenish-brown structures, likely coral or algae. The background shows more of the reef structure, with some darker, more complex shapes. The lighting is soft and diffused, typical of an underwater environment.

ReefWatcher's Field Guide to

Alien and Native Hawaiian Marine Algae

This booklet and workshop materials have been funded by
the Hawaii Community Foundation and University of Hawaii Sea Grant
College Program, School of Ocean Engineering, Science and Technology

Introduction

The Hawaiian Islands are the most distant from any other land mass on earth. Because of this geography, their flora and fauna have evolved in isolation and are unique: about 25% of Hawaii's reef fish, coral, and algae species occur nowhere else. Their isolated evolution, combined with human alteration of near-shore habitats, has made Hawaii's marine habitats, especially coral reefs, particularly vulnerable to alien invasions.

Four species of alien algae have become invasive in Hawaii: *Acanthophora spicifera*, *Hypnea musciformis*, *Kappaphycus spp.*, and *Gracilaria salicornia*. *Acanthophora spicifera* arrived as an accidental "visitor" on the bottom of a shipping barge in 1950; the latter three species were intentionally introduced on Oahu and Molokai in the 1970's for experimental aquaculture for the agar industry. These "weedy" species have now spread from their initial sites of introduction and are competing with native marine flora and fauna.

Most alien algae populations are currently confined to discreet areas and may still be able to be controlled by removal and/or enhancement of native grazer populations. Other areas, particularly coral reefs, remain at risk from the spread of aliens from these sites.

This field guide is designed to help ReefWatchers protect Hawaii's reefs. It includes information about invasive alien algae, native seaweeds (so important in the reef food web, as well as for cultural usage), and native algae that may become invasive in altered habitats (e.g. from nutrient pollution or overfishing).

Algae are major contributors to our coral reefs. Just as plants are on land, algae are the primary producers in the ocean. Algae exist in many forms: as the larger, more-recognizable macroalgae in this guide, as well as lesser known encrusting coralline, turf, and filamentous forms. Even the corals are photosynthetic factories, infused with zooxanthellae, a microscopic alga.

How to Use the Field Guide

Organization: The first section of this guide portrays an alien alga positioned next to the native alga with which it is most likely to be confused. Later pages alphabetically list natives species commonly found in the same habitats on the Big Island.

Colored Bands: The algal names are located in a color band which specifies whether the algae is alien, native or of unknown origin (see legend below).

What's in a name?: Most of our Hawaiian algae do not have common names, except for the edibles that have Hawaiian names. The latin name is comprised of two parts: the genus name groups related algae while the species name is unique to that particular plant.

Example: (genus) *Halimeda opuntia* (species)

Group Classifications: The alien and native macroalgae included in this guide are from 3 major groups of marine algae. The group classifications are based upon photosynthetic pigments and give the algae their characteristic colors: the Rhodophyta (red algae), Chlorophyta (green algae), and Phaeophyta (brown algae).

Features: Key features of each alga are listed next to its picture, providing a quick reference for identification in the field. Unique or defining characteristics, color and habitat are noted.

Additional references: For more information refer to:

"Marine Red Algae of the Hawaiian Islands" by Dr. I.A. Abbott, Bishop Museum Press, Honolulu, Hawaii, 1999.

Invasive Algae of Hawaii Guide: <http://www.hawaii.edu/reefalgae/>

Alien and Invasive Algae website: <http://www.botany.hawaii.edu/GradStud/smith/websites/ALIEN-HOME.htm>

Legend	
	Alien
	Native
	Unknown origin

Acanthophora spicifera

Rhodophyta

Description: Solid, cylindrical branches covered with many distinctive small spinelike branches, branched sparingly to repeatedly. Grows to 20 cm high. Color varies from red, brown to dark green but turns yellow in bright sunlight.

Habitat: *Acanthophora spicifera* is abundant on calm, shallow reef flats, tidepools, and on rocky intertidal benches. This alga attaches to hard substrates such as rocks, basalt ledges, or dead coral heads. It may also be found free-floating, due to its brittle, easily-broken nature.

Ecology: *Acanthophora spicifera* is the most widespread and successful alien alga in Hawai'i. *A. spicifera* is often found in communities with common native and alien intertidal species, such as *Hypnea* and *Laurencia* spp. The brittle nature of the branches often results in fragmentation, which contributes to frequent, large free-floating populations and its widespread distribution. *A. spicifera* was first found in Pearl Harbor and Waikiki in the early 1950's, most likely entering Oahu on a barge from Guam. The alga's adaptability has enabled it to spread throughout the state: it is found in brackish water ponds, salty tidepools, on basalt ledges and in sandy bottomed habitats attached to coral rubble. It is now found on all of the main Hawaiian Islands and is a common component of the intertidal environment throughout the state.

Competition between *A. spicifera* and native algae and invertebrates is likely, but impacts on community structure and diversity have not yet been extensively quantified.

Laurencia spp. (*limu mane'one'o*)

Rhodophyta

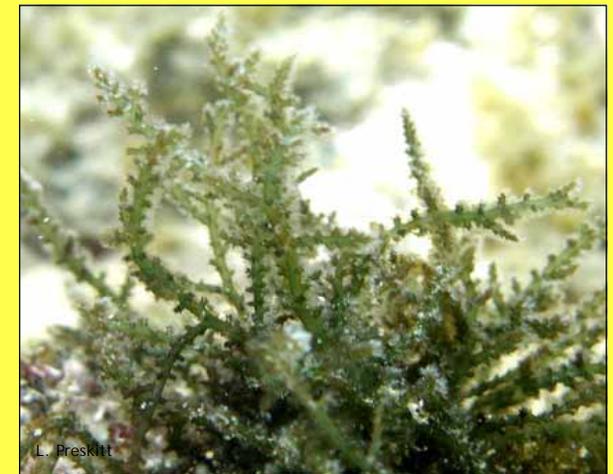
Description: There over 16 species of *Laurencia* in Hawai'i. Plants are usually erect and fleshy with variable branching patterns, each order of branching shorter than the preceding. Most *Laurencia* species have cylindrical branches, but a few intertidal species are compressed. Branch tips club-shaped with pits in the tips. Plants usually range in size from a few cm to 20 cm, and are pink-purple to red but can have yellow and even green portions.

Habitat: *Laurencia* spp. are found in clumps or as components of turfs attached to eroded coral or basalt rocks intertidally to subtidally, and are often associated with *Acanthophora spicifera*.

Some *Laurencia* spp. are used as condiments by Hawaiians.

Features:

- Spinelike branches
- Red, brown to yellow in bright sunlight
- Intertidal, shallow reef flats
- Most successful alien



Features:

- Pits in end of branches
- Pink-purple to red or green



Hypnea musciformis

Rhodophyta

Description: Rounded main branches, 1-3 mm diameter, with short, pointed side branches. Tips of branches are flattened and have characteristic "hooks" or tendril-like projections. Length from 3-30 cm. Bright yellow in sun to dark red in shaded areas.

Habitat: *Hypnea musciformis* is common on calm intertidal and shallow subtidal reef flats, tidepools and on rocky intertidal benches. Most often found low intertidal to shallow subtidal reef flats, attached to sandy flat rocks. In bloom stage, may be found free-floating.

Ecology: *H. musciformis* was introduced to Kane'ohe Bay in 1974 for kappa-carageenan mariculture. The alga is often found as an epiphyte on reef algae such as *Sargassum* spp. and *Acanthophora spicifera*. *H. musciformis* forms large, odiferous unialgal mats, and during the winter can represent 2/3 of the biomass of drift algae on windward and leeward beaches on Maui. In peak blooms, thousands of pounds wash up on Maui beaches. This species has been collected from all the main Hawaiian Islands except Hawai'i and Kaho'olawe. Samples have also been collected from lobster traps in deep water off Maro Reef and Necker Island in the Northwestern Hawaiian Islands.

The success of this alga in Hawai'i is likely due to a rapid growth rate, ability to epiphytize other algae and easy fragmentation. Dispersal may well have been enhanced via interisland travel on fouled boat hulls.

Soon after its introduction, it was identified as a food source for the green sea turtle, *Chelonia mydas*. *H. musciformis* can make up a significant part of their diet, sometimes representing 99-100% of the seaweed mass found in their stomachs.

Pterocliadiella capillacea

Rhodophyta

Description: Plants firm, wiry, to 7 cm high. Flattened branches taper near tips and branchlets are constricted at base. Branching patterns often regular and opposite but may be highly variable in response to environmental factors. Dark, reddish brown to light green.

Habitat: *Pterocliadiella capillacea* and other *Pterocliadiella* spp. are very common on nearshore intertidal reef flats, tidepools and subtidally, attached to basalt and other hard substrates in areas of high wave exposure. May form extensive unialgal masses seasonally, with peak growth in Hawai'i in December.

Features:

- Tips flattened, with "hooks"
- Short, pointed side branches
- Yellow to dark red
- Calm, intertidal and shallow reef flats
- Large floating blooms in west Maui



Features:

- Strap-shaped blades
- Opposite branching, pinched at base
- Dark red to green
- Unialgal mats



Gracilaria salicornia

Rhodophyta

Description: Plants brittle, cylindrical, 2-5 cm in diameter. Branching irregular, often forked at tips and constricted at base of forks. Tips bluntly rounded. Varies in color from a bright yellow at the tips to orange or green and then even dark brown at the base.

Habitat: *Gracilaria salicornia* is found in tidepools, on reef flats, and intertidal to subtidal 4 meters deep, attached to limestone and basalt substrates. This alga grows in three-dimensional mats tightly adherent to hard substrata up to 40 cm in thickness. In calm environments it can also grow in an upright and more openly branching form.

Ecology: *G. salicornia*'s three dimensional growth form allows it to grow over the top of other benthic organisms (native algae, corals and other invertebrates), thus becoming particularly disruptive and ecologically dominant in some habitats.

G. salicornia has been present for several decades inside and outside the break wall and in Kapoho Bay in the Hilo area on the Big Island of Hawai'i; the origin of these populations is unknown. *G. salicornia* was intentionally transported from Hawai'i to Kane'ohe Bay and Waikiki in O'ahu in the 1970's and later to near Pukoo, Moloka'i, where it was planted in open reef cultures for experimental aquaculture and research. Evidence suggests that *G. salicornia* has significantly altered benthic community structure and species diversity where it has spread throughout much of Waikiki, and reports suggest that it is now common on much of Molokai's south shore from Kamalo to Kaunakakai.

Features:

- Brittle, easily fragments
- Short, pointed side branches
- Yellow to dark red
- Calm, intertidal and shallow reef flats
- Large floating blooms in west Maui



Codium edule (limu wawae'iole)

Chlorophyta

Description: Fleshy, felt-like, dark green plants, 1-2 cm diameter. Soft, spongy to touch. Branches repeatedly forked. Branches lie prostrate and attach to anything on the substrate, forming mats incorporating bits of coral rubble, rocks and shells.

Habitat: *Codium edule* is common throughout the islands and is found intertidally to subtidally, 2-4 m deep, but most commonly subtidally.

C. edule is a popular edible seaweed sold in markets in Hawai'i. Its Hawaiian name means rat's foot, after the appearance of the thin, cylindrical branches.

Features:

- Soft, spongy to touch
- Forked branches
- Dark green
- Lies prostrate, frequently attached to substrate and rubble



Avrainvillea amadelpha

Chlorophyta

Description: Plant consists of wedge shaped blades that are thin, diaphanous, 1-4 cm wide, and 1-3 cm tall. Each blade is attached by stalk to a compact basal holdfast, forming dense clusters. Blades are asymmetrical, surfaces felt-like, edges smooth to lacerated. Green to green-gray. Clumps are often covered with silty sand, appearing muddy brown.

Habitat: *Avarainvillea amadelpha* is abundant in habitats of shallow, sandy bottoms with low water motion, 1-10 meters deep. Forms dense clumps often covered with silt and sand. In larger, more mature communities, other macroalgae will be found attached to blades.

Ecology: In Hawai'i, *A. amadelpha* can be found in abundance on the shallow reef flats on Oahu's south shore where it has disturbed and replaced native seagrass beds, and specimens have been collected from deeper water up to 90 m depth. At this time it is not known if this alga has been introduced or is a native. It is possible that *A. amadelpha* is a natural component of the deep-water community in Hawai'i and is now emerging in shallow water.

Cladophora sericea

Chlorophyta

Description: Very fine, filamentous, has a very soft appearance and is heavily branched. Light to bright green. Has main axis that may branch, with lateral branches arranged opposite of one another. Variable; feather-like, or may form highly branched filaments that tangle together forming large clumps of bright green wisps.

Habitat: *Cladophora sericea* occurs in small amounts with other algae or in abundant loose strands attached to coral, basalt substrate, and other hard surfaces on reef flats low intertidal to 8 m deep.

Ecology: *Cladophora sericea* is native to Hawai'i and is found on most reefs. This green alga is usually a small part of the biomass of the diverse, highly competitive intertidal community.

C. sericea has demonstrated weedy characteristics in Hawai'i. Approximately 10 years ago the alga became exceedingly abundant on leeward reefs in Maui and large blooms now occur regularly. During the blooms, large masses of the alga drift in the water column, snagging on coral and rock outcroppings, smothering organisms beneath. Rotting algae on the beaches and extensive amounts of algae drifting in the nearshore environment prevent people from enjoying ocean-related activities.

Features:

- Wedge-shaped, loosely woven spongy blades
- Densely clustered blades
- Green to gray-green
- Calm, sandy bottoms



Features:

- Very fine, delicate
- Wispy, feather-like
- Bright green
- Low intertidal to subtidal
- Forms large blooms in west Maui



Ahnfeltiopsis coccina (limu aki'aki)

Rhodophyta

Description: Plants thick, erect, 2-60 cm tall. Branches cylindrical, to 3 mm in diameter, forked branching. Forms thick clumps. Color variable; yellow in sun to dark reddish brown in shade.

Habitat: Forms bands at high, intertidal zone in locations with heavy wave exposure. Attaches to to basalt rock; can form thick mats or may only be found in cracks and crevices. Abundant where found, common on Hawai'i, Maui, Kauai, but rare on Oahu.

Edible seaweed.



Features:

- Thick erect, cylindrical blades
- Thick clumps attached to basalt
- Bright yellow in sun to dark brown in shade
- High wave exposure



Caulerpa racemosa

Chlorophyta

Description: Upright branches 1-15 cm high, covered in small, bead-like branchlets 2-4 cm diameter. Light to bright green in color. Attaches to substrate by creeping runners that are often branched. Looks like small bunches of grapes; forms mats up to 4 cm thick.

Habitat: *C. racemosa* forms intertwined mats in tidepools and on reef flats. Horizontal runners tightly anchor mats to rocks and sand and in calm to moderately heavy surf areas.



Features:

- "Grape-like"-spherical branchlets
- Thick clusters
- Light green
- Tidepools and reef flats



Dictyosphaeria sp.

Chlorophyta

Description: *Dictyosphaeria cavernosa* is referred to as the "Green Bubble Alga" due to its large round cells. It forms hollow spheres when small; when larger spheres burst becoming convoluted and cup-shaped, forming large mats. *D. versluysii* also has bubble-like cells but is completely solid and remains rounded, 1-5 cm wide. Grass green to bluish in color.

Habitat: *Dictyosphaeria* spp. is found attached to rocks or coral rubble on shallow, calm reef flats and in tidepools. Older *D. cavernosa* plants can form large convoluted mats, 1-10 cm thick, that may cover large subtidal areas to 59 meters deep. In Kane'oh'e Bay it overgrows and kills finger coral. *D. versluysii* does not show weedy tendencies; it forms small clusters of solid "bubbles" scattered among turfs on hard substrates.

Dictyosphaeria cavernosa



- Hollow cup-shaped "bubbles"
- Convoluted masses

Dictyosphaeria versluysii



- Solid, rounded masses

Galaxaura marginata

Rhodophyta

Description: Plants to 12 cm tall, distinctly flattened, pink to wine red, more or less dichotomous (forked) branching. Blades strap shaped, flat and smooth, 1-2.5 cm wide with margins of blades slightly raised. Chalky appearance due to calcification. Often forms large clumps attached by single holdfast.

Habitat: *Galaxaura marginata* is found in shaded areas of tidepools, and low intertidal to subtidal, where it grows among coral fingers and over rubble. *G. marginata* is more common subtidally on open coasts.

Halimeda opuntia

Chlorophyta

Description: Blades are kidney-shaped calcified thick segments, 0.5-2 cm wide, with midrib down middle of segment. Plants are large and spreading, to 30 cm, attached to substrate frequently with rhizoids (small filamentous root-like structures). Green to chalky white.

Habitat: *Halimeda opuntia* is found attached to hard substrates subtidally between rocks or under coral overhangs. *H. opuntia* is the most widespread species of *Halimeda* and is the major producer of carbonate sands in many tropical reef areas.



Liagora spp.

Rhodophyta

Description: *Liagora* spp. can often be recognized by their cylindrical, forked branches and white, calcified appearance. Otherwise, they are highly variable. The amount of calcification can vary from chalky to slippery, and structure from limp to stiff. Can be up to 45 cm tall, and color often tan to pink to brown. Plants moderately to highly branched, attached to substrate by single holdfast.

Habitat: Commonly found in tidepools, low intertidal habitats and on reef flats. Attaches to rock and eroded coral. Some species may be annuals, appearing seasonally.

Features:

- Flattened, calcified blades with raised margin
- Chalky pink to red
- Intertidal to subtidally



J. Smith

Features:

- Thick kidney-shaped blades
- Calcified
- Green to chalky white
- Large spreading plants subtidally



L. Preskill

Features:

- Calcified, often soft and slippery
- Forked branching
- Tan to pink to brown
- Intertidal to subtidal



L. Preskill

Martensia fragilis

Rhodophyta

Description: Plant has very delicate flat blades, iridescent pink, purple or blue colors. Blades may be whole or branched in a semi-forked pattern. Blades have solid blade and gauze-like mesh portions that are very delicate and may contain holes from being torn. 1-8 cm tall.

Habitat: *Martensia fragilis* form small to large clumps attached to coral rubble or other algae. It is common in intertidal pools and low intertidal to shallow subtidal crevices.

*(Melan) Amansia glomerata**

Rhodophyta

Description: Plants have semi-transparent, strap-shaped blades arranged in rosettes at top of tough, stem-like stalks, giving plant top-heavy look. Stalk bare below rosettes, may branch several times. Blades less than 1 cm long, with midribs, edges serrated to smooth, and tips rounded. Plant averages 6 cm tall. Dark maroon red.

Habitat: *Melanamansia glomerata* grows on rock and coral rubble, and is often found in low light habitats such as crevices or among coral fingers. *M. glomerata* is often covered with epiphytic crustose coralline seaweeds, giving it a pink appearance.

*Name under revision; currently *Melanamansia*

Padina spp.

Phaeophyta

Description: *Padina* spp. have flat calcified brown blades that may be rolled into a circle or flat and broad. Attaches to substrate with a small holdfast. Degree of calcification can vary between species but is often visible in horizontal circular rings, upper surface is usually more calcified than the lower. Size varies from a few cm to greater than 20-30 cm tall. Chalky white to light yellow-brown.

Habitat: This genus is common in Hawai'i and can be found in both intertidal and subtidal zones. *P. japonica* (right) is common in tide pools and on basalt benches. Other species can be found in silty disturbed areas.

Features:

- Delicate, flat blade
- Alternating blade and mesh portions
- Iridescent pink or blue
- Low intertidal to subtidal



Features:

- Semi-transparent blades in rosettes
- Blades with midribs, serrated edges
- Tough, stem-like stalk
- Dark maroon red
- High wave exposure



Features:

- Flat calcified blade with rings
- Chalky white to light yellow-brown
- Bright yellow in sun to dark brown in shade
- Intertidal and subtidal



Sargassum echinocarpum

Phaeophyta

Description: Blades very thick and stiff, margins with spiny projections. Plants 5-70 cm tall with blades 0.3-2 cm wide. Golden to dark brown holly leaf-like blades with mid rib and flattened stems. Gas bladders (small round hollow beads) attached to stalks.

Habitat: *Sargassum echinocarpum* is commonly found on wave-swept rocky intertidal benches, in tidepools, and on reef flats. Often associated with *Turbinaria ornata* and turfs in intertidal bench communities.



Features:

- Thick, spiny blades
- Gas bladders
- Golden to dark brown
- Intertidal, wave exposure



L. Preskitt

Turbinaria ornata

Phaeophyta

Description: Stiff erect seaweed with distinctive angular turban-like blades and a central stalk with a row of stiff spines around blade margin. Light yellow brown color and grows 2-20 cm tall.

Habitat: Very common. Found in tidepools and on reef flats and crests on rocky intertidal coastlines, mid-intertidal to 30 m deep. Plant often isolated or in small groups, but occasionally forms large, low mats in high intertidal. Shows seasonal tendencies in upper intertidal.



Features:

- Stiff, erect turban-like blades with spines
- Light yellow brown
- Very common
- High intertidal to subtidal



L. Preskitt

Ulva fasciata (limu palahalaha)

Chlorophyta

Description: Large, flat twisted blade, 1-10 cm wide and 5-100 cm long. Blades broadened at base, upper portions may be divided deeply into many ribbon-like segments; margins smooth, often wavy. Plants thin, sheet-like, up to 1 meter long, consisting of wide blades attached to substrate with a small holdfast. Grass green in color.

Habitat: *Ulva fasciata*, also known as sea lettuce, is very common. Found on intertidal rocks, in tide pools, and on reef flats. Abundant in high nutrient water, near stream mouths and run-off pipes.



L. Preskitt

Features:

- Flat, thin, sheet-like
- Thick clumps attached to basalt
- Bright green
- Intertidal and reef flats, areas of high wave exposure



L. Preskitt

Acknowledgements

As a volunteer ReefWatcher, your astute observation of intertidal and reef areas you know best will provide valuable information on the seasonality of native algal communities as well as provide an early detection system for the appearance of, or possible take-over by, an aggressive native or alien species.



This booklet is the product of collaborative efforts of Dr. Cindy Hunter, Dr. Isabella Abbott, Dr. Karla McDermid, and Jen Smith, all dedicated to the understanding and preservation of Hawai'i's reef ecosystems. The main author, photographer and designer is Linda Preskitt, with contributions of text from Dr. Cindy Hunter, Jen Smith and Sara Peck.

This booklet and workshop materials have been funded by the Hawaii Community Foundation and University of Hawaii Sea Grant College Program, School of Ocean Engineering, Science and Technology.

ReefWatchers is a volunteer organization affiliated with University of Hawaii Sea Grant College Program, School of Ocean Engineering, Science and Technology.

For information contact Sara Peck,
U.H. Sea Grant Extension Service West Hawai'i,
808-329-2861
peck@hawaii.edu

Sponsored by:

