## 7.16 Genus *Galaxea* (Family Oculinidae)

### 7.16.1 *Galaxea astreata* Lamarck, 1816

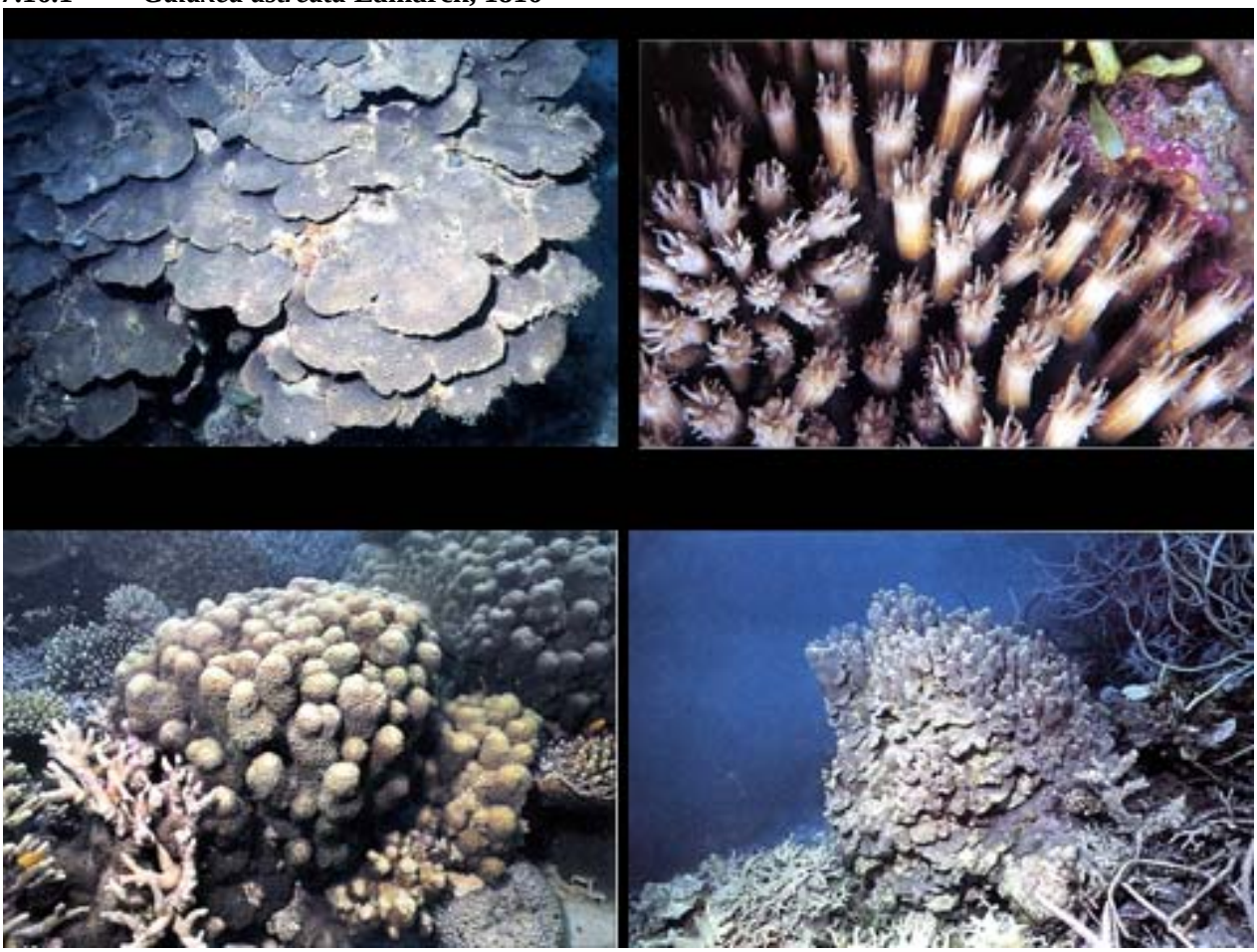

Figure 7.16.1. *Galaxea astreata* photos from Veron (2000).

### Characteristics

*Galaxea astreata* can vary considerably in colony morphology from (upper left photo above) tiered plates to (lower left photo above) columnar to (lower right above) combinations of tiered plates and columns. The (upper right photo) corallites typically appear tall and even compared to other species of *Galaxea*, and the corallites are less than half the diameter of the common *Galaxea fascicularis*. The colonies can be more than 2 m across (Veron, 2000) and can dominate areas. Colonies are usually grey in color with brown, green, or sometimes pink (Veron, 2000).

### Taxonomy

**Taxonomic issues**: None.

**Family:** Oculinidae.

**Evolutionary and geologic history**: The genus *Galaxea* originated in the Miocene (23 Ma–5.3 Ma). It became extinct in the Atlantic (Budd et al., 1994) but continues to be extraordinarily widespread throughout the Indo-Pacific.

## Global Distribution

*Galaxea astreata* has a very broad range, extending from the Red Sea and east Africa to Fiji, Kiribati and American Samoa (east-central Pacific Ocean). It extends latitudinally from Japanese waters in the northern hemisphere across the Great Barrier Reef and southern Africa in the southern hemisphere.

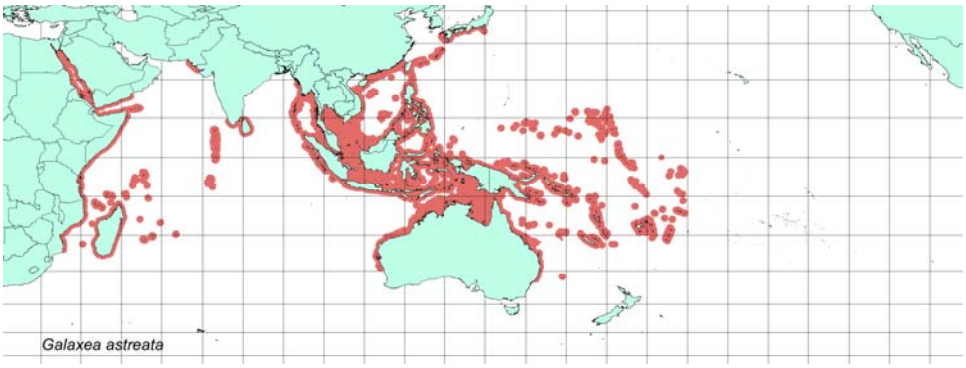


Figure 7.16.2. *Galaxea astreata* distribution from IUCN copied from http://www.iucnredlist.org.

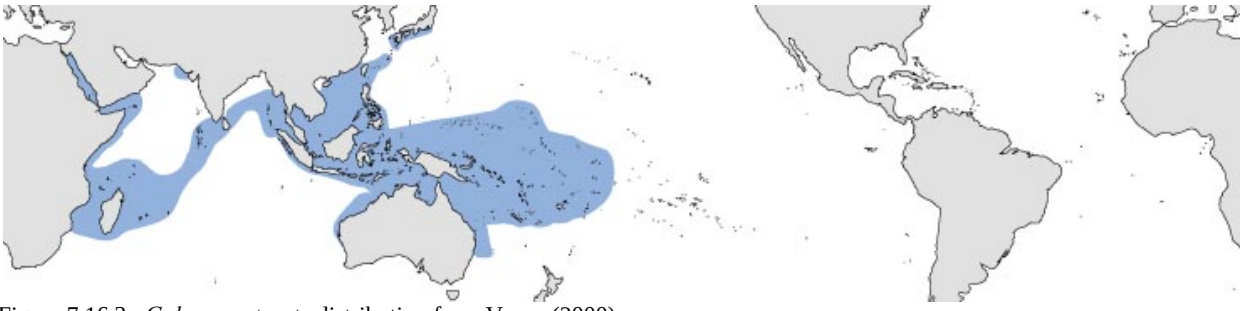

Figure 7.16.3. *Galaxea astreata* distribution from Veron (2000).

## U.S. Distribution

According to both the IUCN Species Account and the CITES species database, *Galaxea astreata* occurs in American Samoa. The IUCN Species Account also lists it for the U.S. minor outlying islands and the CITES database lists it for the Northern Mariana Islands.

A search of published and unpublished records of occurrence in U.S. waters indicates *Galaxea astreata* has been reported from Tutuila, Ofu-Olosega, and Ta′u in American Samoa (Birkeland, unpubl. data; Coles et al., 2003; CRED, unpubl. data; Fisk and Birkeland, 2002; Lovell and McLardy, 2008; Maragos et al., 1994; Mundy, 1996; National Park Service, 2009). In Veron (Veron, 2000) (Volume 2, page 111) the distribution map for this species includes a photo taken by Gustav Paulay labeled "Guam." However, Paulay (pers. comm. to J. Kenyon via email 2/28/2010) indicates a number of photos submitted by him to Veron from Palau, the Cook Islands, and other locations in the Pacific were mistakenly attributed to Guam (similar to the *errata* later acknowledged by Veron (Veron, 2002)) for *Acanthastrea regularis* and *Porites napopora*). Consequently, there are no substantiated records of its occurrence in the Mariana Archipelago. No published or unpublished records of occurrence in the U.S. minor outlying islands could be identified.

Within federally protected waters, *Galaxea astreata* has been recorded from the following areas:

- National Park of American Samoa, Ofu Island unit

## Habitat

**Habitat**: *Galaxea astreata* generally lives in areas protected from strong wave action. It can live in turbid waters (Titlyanov and Latypov, 1991) and can survive on reefs heavily influenced by terrestrial runoff.

**Depth range**: *Galaxea astreata* lives from low tide to at least 20 m, but typically range from water depths of 5 to 10 m.

## Abundance

*Galaxea astreata c*an be abundant and can even dominate some areas.

## Life History

*Galaxea astreata* is a hermaphroditic broadcast spawner (Babcock et al., 1986; Dai et al., 1992; Harrison et al., 1984). The sexual pattern of *Galaxea astreata* has been described as "pseudo-gynodioecious" on the Great Barrier Reef (Harrison, 1988) and in Singapore (Guest et al., 2005b). Populations are composed of female colonies that produce red eggs and colonies that produce sperm and lipid-filled white eggs. In this system, hermaphroditic colonies function as males, and the populations function as a gonochoristic breeding system. The minimum size and estimated age of first reproduction has not been determined for this species, but for the congener *Galaxea fascicularis*, the minimum size at first reproduction is 4 cm–5 cm (Yamazato and Minei, 1986).

## Threats

**Thermal stress:** On the genus level, *Galaxea* seems to be relatively bleaching resistant across regions (McClanahan et al., 2004a). *Galaxea* was one of the least susceptible to bleaching of scleractinian genera in the western Indian Ocean (McClanahan et al., 2007). The genus had low bleaching at the Great Barrier Reef (Marshall and Baird, 2000) during the 1997-1998 mass bleaching event, but *Galaxea astreata* had severe bleaching and total mortality in Africa (Obura, 2001) and Palau (Bruno et al., 2001) in the same event. *Galaxea astreata* in Australia host Clade C zooxanthellae, whereas *Galaxea fasicularis* hosts both C and the stress-resistant Clade D (LaJeunesse et al., 2004a); this could confer differences in bleaching resistance that would be difficult to detect when bleaching is often reported at the genus level. Bleaching may not pose a substantial risk to this genus, but it may have severe effects on this particular species.

**Acidification:** Acidification appears to be a potential risk for this species. When held under reduced pH conditions, *Galaxea astreata* produced abnormal skeletal septae. *Galaxea fascicularis* reduces calcification by 12% to 56% when $pCO_2$ is increased 2 times the preindustrial revolution levels and by 18% to 83% when $pCO_2$ is increased 3 times the preindustrial revolution levels (Kleypas et al., 2006). This agrees with the general pattern that acidification impairs growth (Langdon and Atkinson, 2005; Manzello, 2010) and, in the case of *Acropora palmata*, acidification impairs fertilization and settlement success (Albright et al., 2010), and acidification is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). Interestingly, Hii et al. (2009) report that *Galaxea fasucularis* expel their zoozanthellae and increased their calcification under elevated $pCO_2$ conditions. While ocean acidification has not been demonstrated to have caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

**Disease:** Susceptibility and impacts of disease on *Galaxea astreata* are not known. However, ample evidence indicate that diseases can have devastating regional impacts on individual coral species (e.g., Aronson and Precht, 2001; Bruckner and Hill, 2009) and evidence show that these impacts are occurring in more taxa and at a broader geographic scale (Green and Bruckner, 2000; Sutherland et al., 2004).

**Predation:** *Galaxea astreata* became one of the dominant corals in Zanzibar after crown-of-thorns seastar (*Acanthaster planci*) outbreaks removed Acroporid corals in the 1990s (Muhando and Lanshammar, 2008). *Drupella cornus* will feed on *Galaxea astreata* (probably synonymous with *Galaxea clavus*) (McClanahan et al., 2004b).

**Land-based sources of pollution (LBSP):** Sedimentation appears to be a minimal threat to *Galaxea astreata*. The species can live in turbid waters (Titlyanov and Latypov, 1991) and persist in areas under terrigenous influence (Van Woesik et al., 1999), while its congener *Galaxea fasicularis* is a relatively efficient sediment-rejecter (Stafford-Smith, 1993; Stafford-Smith and Ormond, 1992). Effects of nutrients and contaminants are unknkown.

LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

C**ollection/Trade:** In Singapore, overcollecting and trampling was a major concern for *Galaxea*. In 2005 alone, 20,000 pieces were exported. *Galaxea astreata* is also involved in trade from Fiji, Tonga, and Malaysia but on a small scale (<

500) pieces per year between 2000 and 2008), whereas from Indonesia it was reported that exports were between 4000 and 8000 pieces per year in the same time period (CITES, 2010).

## Risk Assessment

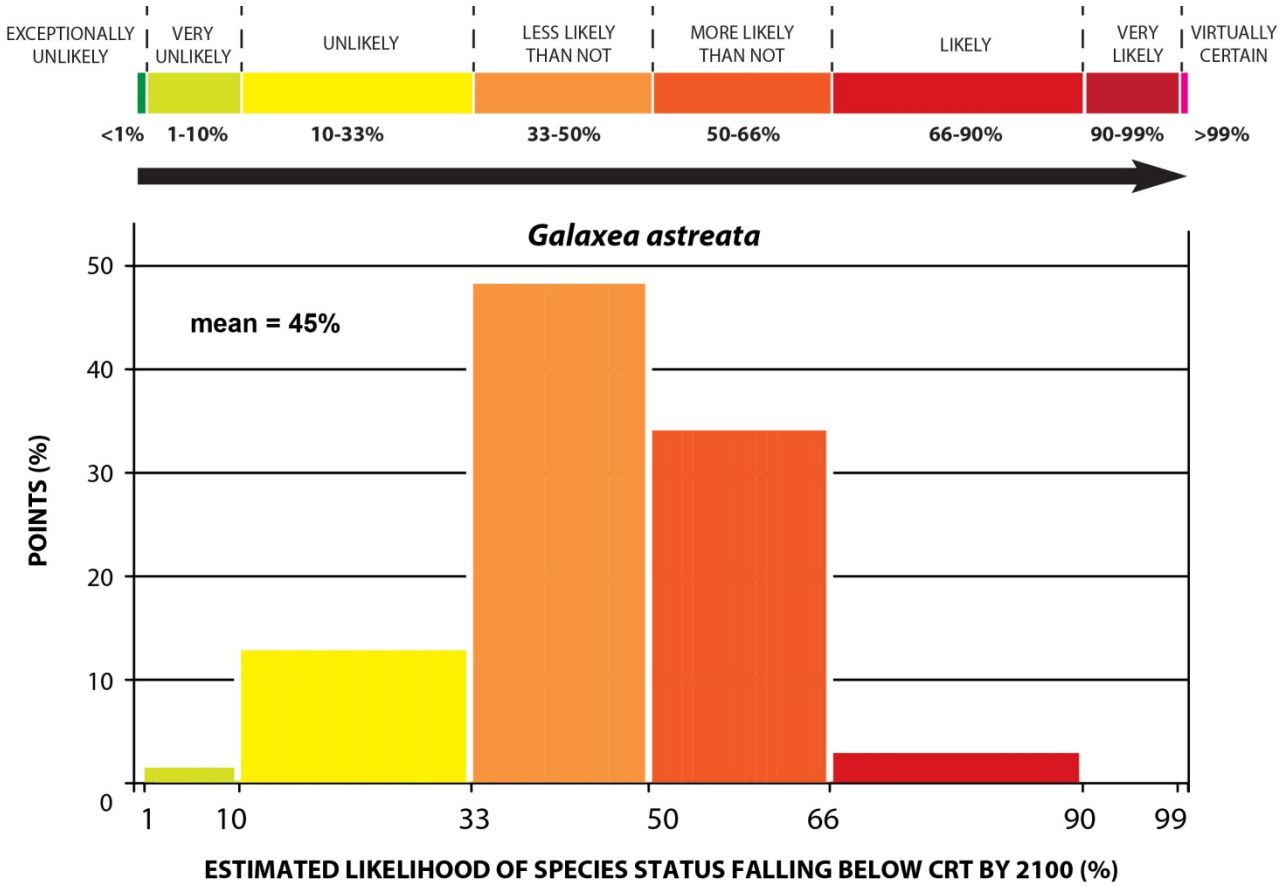


Figure 7.16.4. Distribution of points to estimate the likelihood that the status of *Galaxea astreata* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Galaxea astreata* include susceptibility to thermal stress, seawater acidification, and harvesting. Factors that reduce potential extinction risk (decrease the likelihood of falling below the Critical Risk Threshold) for *Galaxea astreata* are that this species can be dominant in turbid waters, are remarkably tolerant to terrestrial runoff and sedimentation, are generally not favored by corallivores such as *Acanthaster planci*, and are broadly distributed both latitudinally and longitudinally in the Indo-Pacific. Wide distribution is considered to lower extinction risk by making it more likely a species will be able to escape the impacts of threats and catastrophes in at least some locations.

The overall likelihood that *Galaxea astreata* will fall below the Critical Risk Threshold by 2100 was estimated to be in the "less likely than not" risk category with a mean likelihood of 45% and a standard error (SE) of 8% (Fig. 7.16.4). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 1%–90% (Fig. 7.16.4) and the average range of likelihood estimates of the seven BRT voters (52%). The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for *Galaxea astreata*.

## 7.17 Genus *Pectinia* (Family Pectiniidae)

### 7.17.1 *Pectinia alcicornis* Saville-Kent, 1871

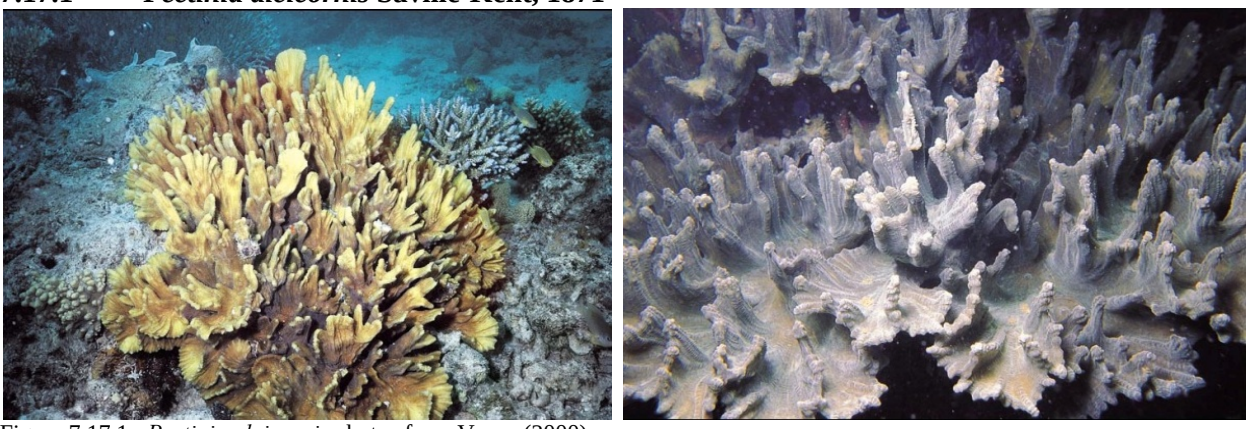

Figure 7.17.1. *Pectinia alcicornis* photos from Veron (2000).

### Characteristics

Colonies of *Pectinia alcicornis* are irregular clusters with flat fluted laminae and tall, upward-projecting spires that can dominate the morphology. Costae are toothed, exsert, and project upward with projecting spires and short walls. Colonies are green, yellow, brown, or mixtures of colors. Central portions of colonies are usually darker than colony edges (Veron, 2000).

### Taxonomy

**Taxonomic issues**: None. *Pectinia alcicornis* is similar to *Pectinia paeonia* (Veron, 2000).

**Family:** Pectiniidae.

**Evolutionary and geologic history:** The genus is known in the Pacific from the Pleistocene Era (Veron, 1995).

### Global Distribution

*Pectinia alcicornis* is broadly distributed in the Indo-Pacific, including Australia, Fiji, Indonesia, Japan, the Philippines, and India.

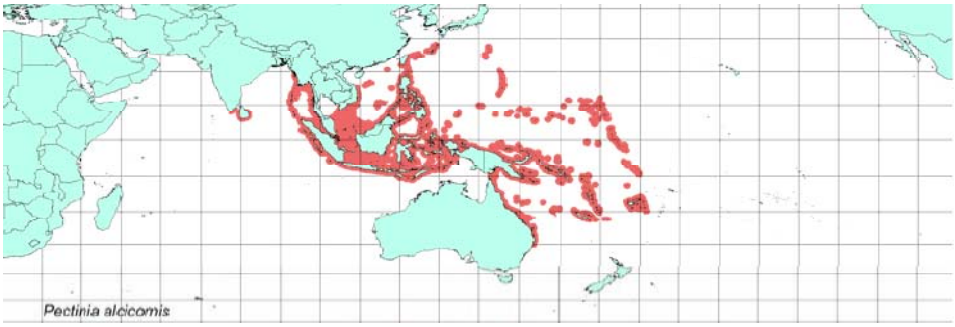


Figure 7.17.2. *Pectinia alcicornis* distribution from IUCN copied from http://www.iucnredlist.org.

Figure 7.17.3. *Pectinia alcicornis* distribution from Veron (2000).

## U.S. Distribution

The CITES database does not list *Pectinia alcicornis* as occurring in U.S. waters. The IUCN lists this species in the Mariana Islands, but no supporting record is given. Veron (2000) also lists *Pectinia alcicornis* in the Marianas; however, the Marianas record may be based on geographic errors of photographic records (Kenyon et al., 2010b). Paulay (pers. comm., 28 February 2010) indicates a number of photos submitted by him to Veron from Palau, and the Cook Islands, and other locations in the Pacific were mistakenly attributed to Guam (similar to the *errata* later acknowledged by Veron (2002) for *Acanthastrea regularis* and *Porites napopora*).

No other published or unpublished data sources indicate the occurrence of *Pectinia alcicornis* elsewhere in U.S. waters.

## Habitat

**Habitat:** *Pectinia alcicornis* inhabits turbid water, often on horizontal substrates (Veron, 2000). It is found in most reef habitats, both shallow and deep (Wood, 1983). The species has been reported to be found in caves on the Great Barrier Reef (Dinesen, 1983).

**Depth range**: *Pectinia alcicornis has been reported in water depths ranging from* 5 m to 25 m (Carpenter et al., 2008).

## Abundance

Abundance of *Pectinia alcicornis* has been reported as usually uncommon (Veron, 2000).

## Life History

*Pectinia alcicornis* is a hermaphroditic broadcast spawner (Babcock et al., 1986; Babcock and Heyward, 1986; Penland et al., 2004; Willis et al., 1985). The minimum size and estimated age of first reproduction have not been determined for any members of the family Pectiniidae (Harrison and Wallace, 1990). Although specific larval descriptions have not been published for this species, the larvae of the single *Pectinia* species studied do not contain zooxanthellae that can supplement maternal provisioning with energy sources provided by their photosynthesis (Baird et al., 2009), i.e., they are lecithotrophic. Larval longevity has not been determined for this species, but the maximum larval longevity for the congener *Pectinia paeonia* studied in laboratory cultures was 209 days (Graham et al., 2008).

## Threats

**Thermal stress:** As a genus, *Pectinia* were among the most highly susceptible to bleaching on the Great Barrier Reef in 1998 (Marshall and Baird, 2000), although *Pectinia alcicornis* showed very little mortality on the GBR in the 2001-2002 mass bleaching event (Done et al., 2003). Congener *Pectinia paeonia* was among the most susceptible species in Palau during the 1998 event (Bruno et al., 2001). *Pectinia alcicornis* harbors Clade C zooxanthellae in Okinawa (LaJeunesse et al., 2004a) and the South China Sea (Dong et al., 2009), but contained Clade D zooxanthellae in Palau after the 2001mass bleaching event (Fabricius et al., 2004).

**Acidification:** *Pectinia alcicornis* is one of many species that has been raised in the Waikiki Aquarium, which is characterized by high-nutrient, low-pH waters (Atkinson et al., 1995). This may imply that to some degree this species can tolerate acidified water, but the impact of acidification on growth has not been quantified. However, in most corals studied (Table 3.2.2), acidification impairs growth (Langdon and Atkinson, 2005; Manzello, 2010) and, in the case of *Acropora palmata*, impairs fertilization and settlement success (Albright et al., 2010) and is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). While ocean acidification has not been demonstrated to have caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

**Disease:** Susceptibility and impacts of disease on *Pectinia alcicornis* are not known. Congener *Pectinia lactuca* was observed to lack tissue lesions in American Samoa but did have parasitic crustaceans in its mesoglea (Work and Rameyer, 2005). *Pectinia* were among those genera not infected by the ciliate disease skeletal eroding band in the Red Sea (Winkler et al., 2004). However, ample evidence indicate that diseases can have devastating regional impacts on individual coral species (e.g., Aronson and Precht, 2001; Bruckner and Hill, 2009) and evidence show that these impacts are occurring in more taxa and at a broader geographic scale (Green and Bruckner, 2000; Sutherland et al., 2004).

**Predation:** Pectinid corals belong to a coral family highly susceptible to crown-of-thorns seastar (Keesing, 1990). However, little is known about the potential population-level impacts for *Pectinia alcicornis*.

**Land-based sources of pollution (LBSP):** Although it is generally a sediment-tolerant genus (Dikou and van Woesik, 2006), *Pectinia alcicornis* decreased along a deteriorating water quality gradient on the Great Barrier Reef (Fabricius, 2005). *Pectinia alcicornis* is one of many species that has been raised in the Waikiki Aquarium, which is characterized by high-nutrient, low-pH waters (Atkinson et al., 1995). This implies that the species may tolerate eutrophic conditions to some degree. Congener *Pectinia lactuca* showed no reduction in photosynthetic capacity when exposed to sediment (Philipp and Fabricius, 2003).

LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited ranges) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

**Collection/Trade:** This genus is heavily exported—several thousand specimens are exported annually, primarily from the Philippines, Indonesia, and the Solomon Islands. *Pectinia alcicornis* exports were reported at the species level only for 2000–2003, with a total of 133 specimens reported (CITES, 2010).

## Risk Assessment

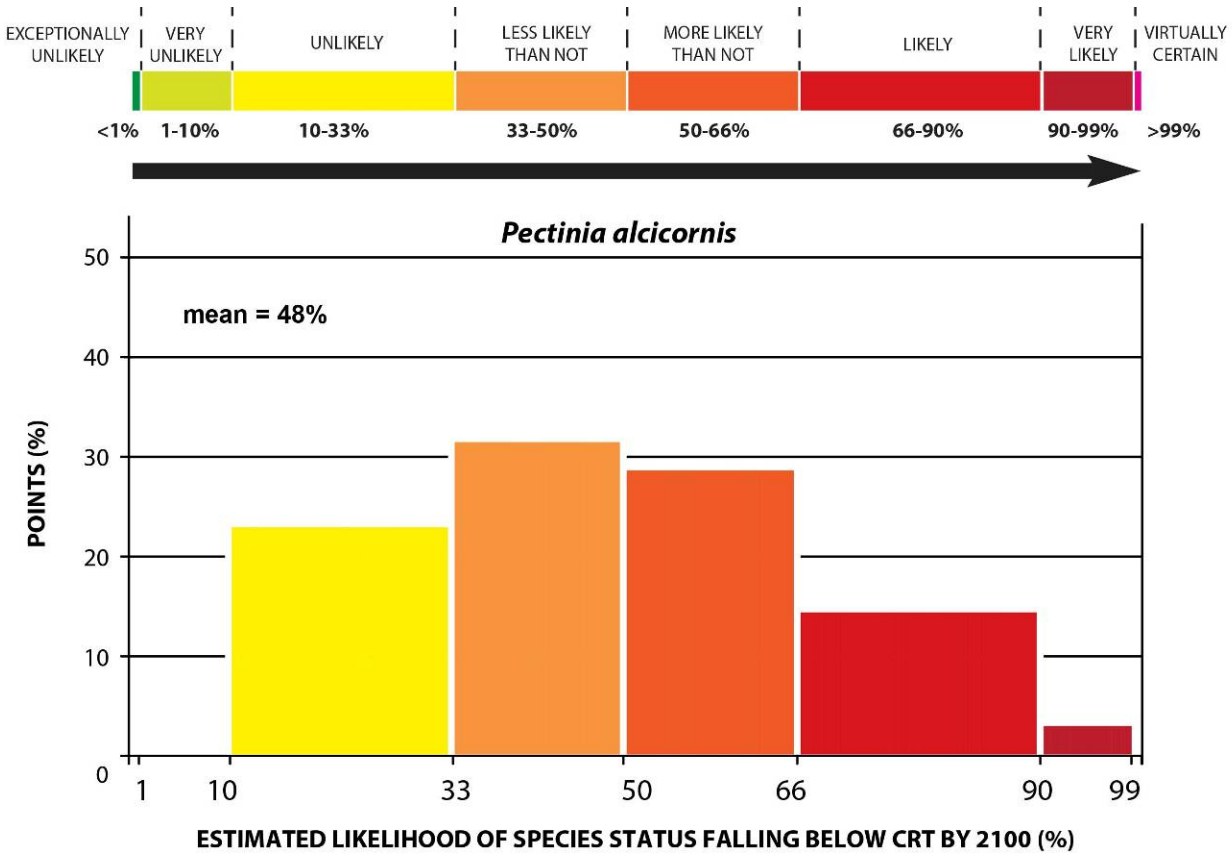


Figure 7.17.4. Distribution of points to estimate the likelihood that the status of *Pectinia alcicornis* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Pectinia alcicornis* include susceptibility to bleaching, predation, and harvesting. The high bleaching rate is the primary threat of extinction for *Pectinia*, although *Pectinia alcicornis* may be relatively resistant in some areas. Heavy use of this genus in the aquarium trade implies the potential for local extirpation if this usually uncommon species is heavily harvested.. Factors that reduce potential extinction risk (decrease the likelihood of falling below the Critical Risk Threshold) are that *Pectinia alcicornis* occupies a variety of habitat types and is broadly distributed both latitudinally and longitudinally in the Indo-Pacific. Wide distribution is considered to lower extinction risk by making it more likely a species will be able to escape the impacts of threats and catastrophes in at least some locations.

The overall likelihood that *Pectinia alcicornis* will fall below the Critical Risk Threshold by 2100 was estimated to be in the "less likely than not" risk category with a mean likelihood of 48% and a standard error (SE) of 16% (Fig. 7.17.4). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 10%–99% (Fig. 7.17.4) and the average range of likelihood estimates of the seven BRT voters (59%). The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for *Pectinia alcicornis*.

## 7.18 Genus *Acanthastrea* (Family Mussidae)

### 7.18.1 *Acanthastrea brevis* Milne Edwards and Haime, 1849

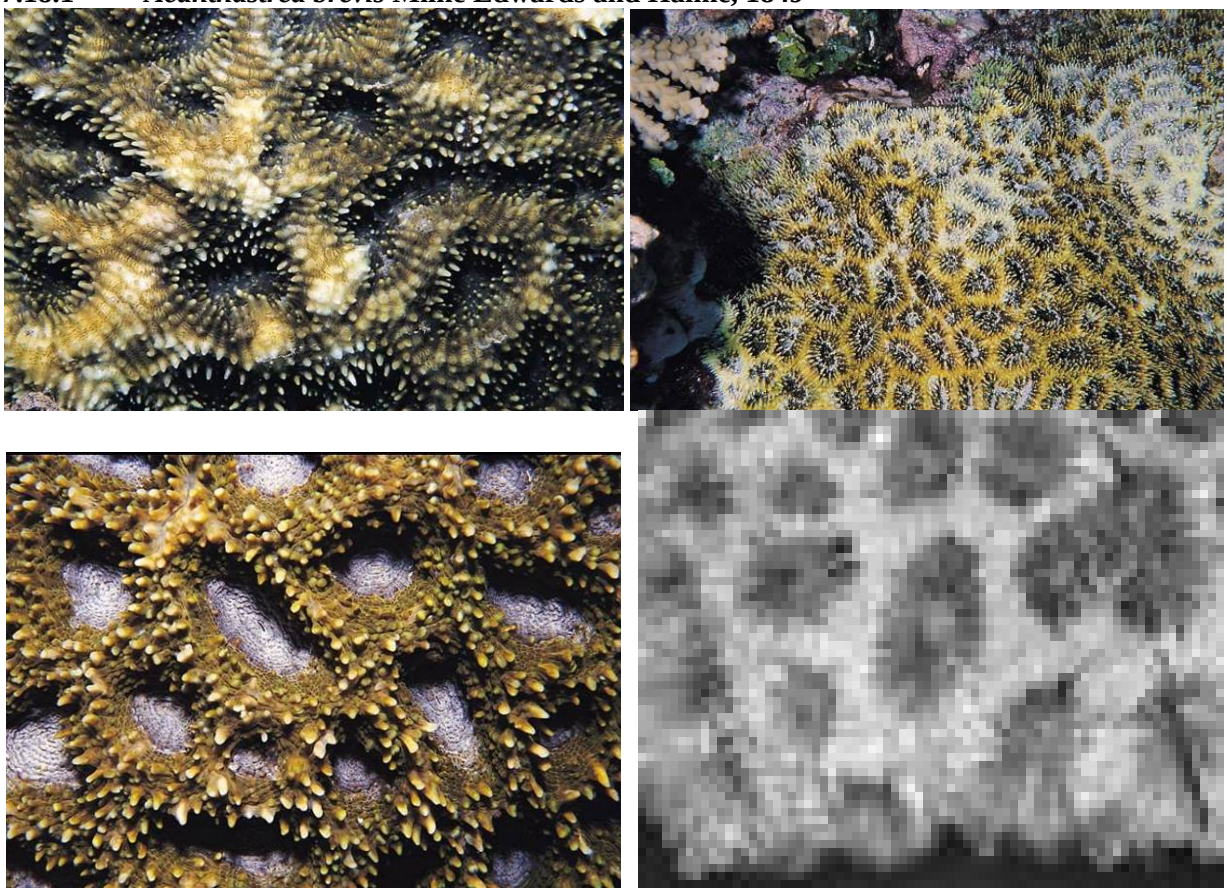

Figure 7.18.1. *Acanthastrea brevis* photos and corallite plan from Veron (2000).

### Characteristics

Colonies of *Acanthastrea brevis* are attached and colonial. Colonies are mostly submassive. Corallites are cerioid to subplocoid with moderately thin walls. Septa are thin and widely spaced. Larger septa have very long upwardly projecting teeth giving colonies a spiny appearance. Colonies are usually not fleshy. Uniform or mottled brown, yellow or green in color (Veron, 2000).

### Taxonomy

**Taxonomic issues**: None. *Acanthastrea brevis* is similar to *Acanthastrea echinata* which has relatively fleshy corallites with thicker walls and less elongate septal teeth. These two species may be difficult to distinguish unless they occur together.

**Family:** Mussidae.

**Evolutionary and geologic history**: The genus is known in the Indo-Pacific from the Miocene Era (Wells and Moore, 1956).

### Global Distribution

Wide distribution ranging from the Red Sea, Gulf of Aden, southwest Indian Ocean, and northern Indian Ocean to central Indo-Pacific, west Pacific, Great Barrier Reef, and Fiji (IUCN Species Account). In addition, Doug Fenner has identified this species from Fiji, Eastern Australia, New Caledonia, Papua New Guinea, Rodrigues, American Samoa (D.

Fenner, Dept. Marine and Wildlife Resources, Tutuila, pers. comm., April 2010). Veron (2000) describes its distribution range from the Indian Ocean, Red Sea and Gulf of Aden to the Indo and west Pacific (Veron, 2000).

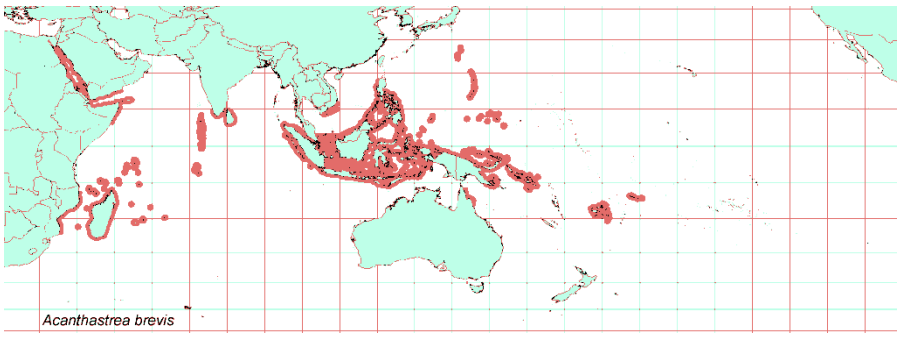


Figure 7.18.2. *Acanthastrea brevis* distribution from IUCN copied from http://www.iucnredlist.org.

Figure 7.18.3. *Acanthastrea brevis* distribution from (Veron, 2000).

## U.S. Distribution

According to the IUCN Species Account, *Acanthastrea brevis* occurs in American Samoa and in the Commonwealth of the Northern Mariana Islands. The references for the record in American Samoa are given as Fenner (2006, 2007), but those references pertain to Fiji, not to American Samoa. No supporting reference is given in the IUCN Species Account for the stated record of occurrence in the Northern Mariana Islands.

The CITES species database does not include any record of occurrence in U.S. waters. *Acanthastrea brevis* is not listed as occurring in American Samoa in Lovell and McLardy (2008). In Veron (2000) (Volume 3, page 17), the distribution map for this species includes the Mariana Archipelago, with a photo taken by Gustav Paulay labeled "Guam." However, G. Paulay (pers. comm., 28 February 2010) indicates a number of photos submitted by him to Veron from Palau, and the Cook Islands, and other locations in the Pacific were mistakenly attributed to Guam (similar to the *errata* later acknowledged by Veron (2002) for *Acanthastrea regularis* and *Porites napopora*). Further email communications of J. Kenyon with G. Paulay (3/2/2010) and J. Veron (4/23/2010) confirm this species has not been observed in the Mariana Archipelago. There are no other substantiated records of its occurrence in the Mariana Archipelago.

Fenner reports *Acanthastrea brevis* in American Samoa at Tutuila, Ofu-Olosega, Ta′u, and Rose Atoll (CRED, unpubl. data), with photographic support of visual identification at multiple sites. No other published or unpublished data sources indicate the occurrence of *Acanthastrea brevis* elsewhere in U.S. waters.

Within federally protected waters, *Acanthastrea brevis* has been recorded from the following areas:

- Rose Atoll Marine National Monument

## Habitat

**Habitat:** *Acanthastrea brevis* has been reported to occupy shallow reef environments (Veron, 2000), all types of reef habitats (Carpenter et al., 2008).

**Depth range**: *Acanthastrea brevis* has been reported at water depths ranging from 1 m to 20 m (Carpenter et al., 2008).

## Abundance

Abundance of *Acanthastrea brevis* has been reported as uncommon but conspicuous (Veron, 2000).

## Life History

Reproductive characteristics of *Acanthastrea brevis* have not been determined (Baird et al., 2009). However, the congeners *Acanthastrea echinata* and *Acanthastrea hillae* on the Great Barrier Reef are hermaphroditic broadcast spawners that participate in multispecies spawning events (Babcock et al., 1986; Willis et al., 1985). The minimum size and age of first reproduction has not been determined for any members of the family Mussidae (Harrison and Wallace, 1990). Although specific larval descriptions have not been published for this species, the larvae of three other *Acanthastrea* species studied do not contain zooxanthellae that can supplement maternal provisioning with energy sources provided by their photosynthesis (Baird et al., 2009), i.e., they are lecithotrophic. The maximum larval longevity for the congener *Acanthastrea lordhowensis* in laboratory cultures was 78 days (Wilson and Harrison, 1998).

## Threats

**Temperature stress**: The genus *Acanthastrea* has been reported to be highly susceptibility to bleaching in Austrailia (Marshall and Baird, 2000) and in the western Indian Ocean (McClanahan et al., 2007). The genus sustained moderate bleaching in Palau in 1994 (Paulay and Benayahu, 1999) and several *Acanthastrea* species were relatively unaffected during the 2002 event on the Great Barrier Reef (Done et al., 2003).

**Acidification:** Unknown for the genus *Acanthastrea*. However, in most corals studied, (Table 3.2.2), acidification impairs growth (Langdon and Atkinson, 2005; Manzello, 2010) and, in the case of *Acropora palmata,* impairs fertilization and settlement success (Albright et al., 2010) and is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). While ocean acidification has not been demonstrated to have caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

**Disease:** Susceptibility and impacts of disease on *Acanthastrea brevis* are not known. However, ample evidence indicate that diseases can have devastating regional impacts on individual coral species (e.g., Aronson and Precht, 2001; Bruckner and Hill, 2009) and evidence show that these impacts are occurring in more taxa and at a broader geographic scale (Green and Bruckner, 2000; Sutherland et al., 2004). Relatively few disease reports for the genus *Acanthastrea* have been documented in the global disease database (UNEP, 2010).

**Predation**: Unknown.

**Land-based sources of pollution (LBSP):** The effects of LBSP on *Acanthastrea brevis* are largely unknown. Congener *Acanthastrea echinata* has lower sediment rejection efficiency than many other corals, in part, because sediment becomes trapped between the calices when the polyps expand. However, it still clears most sediment within 24 h and is equally efficient in removing coarse and fine particles (Stafford-Smith, 1993). LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

**Collection/Trade:** Although no exports of *Acanthastrea* were reported from 2000 through 2009, 1000 *Acanthastrea* pieces were exported from Indonesia in 2010 (CITES, 2010). Hence, collection/trade is not considered to be a significant threat to this species.

## Risk Assessment

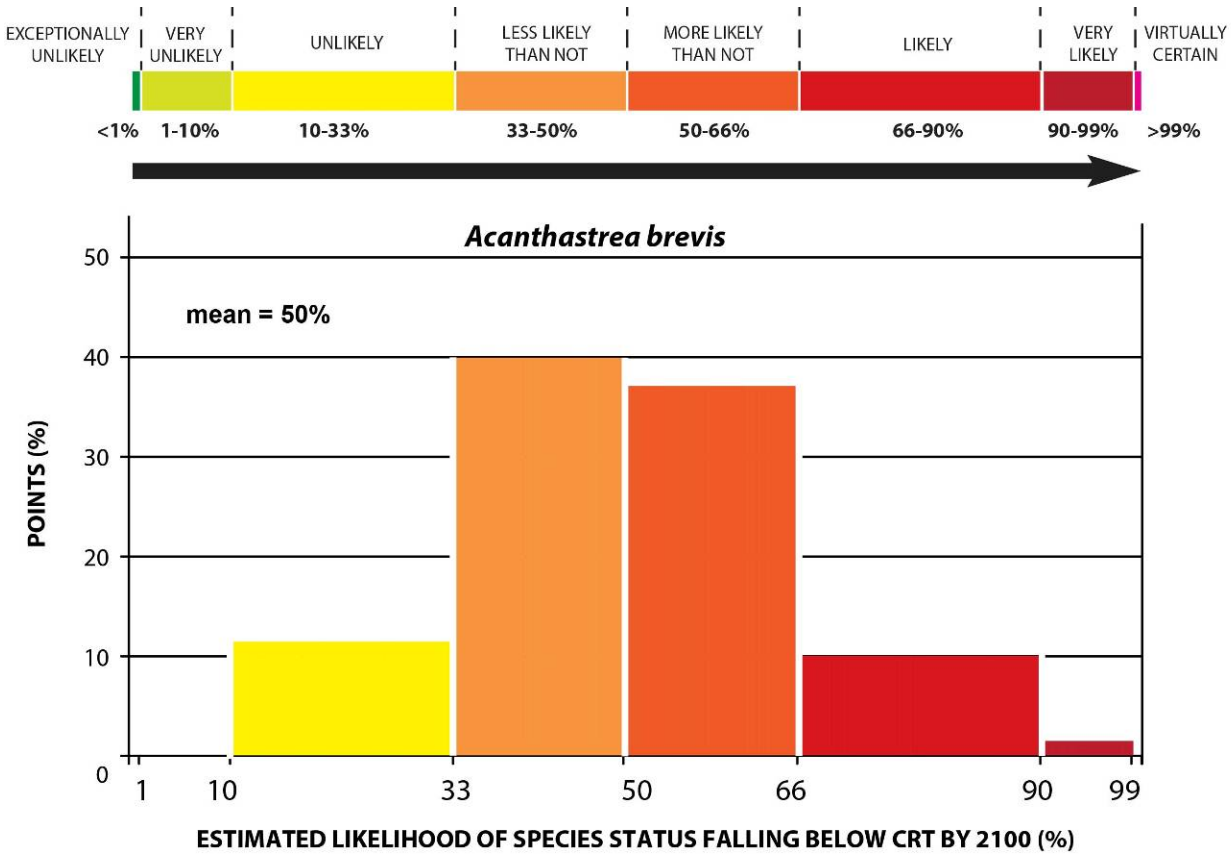


Figure 7.18.4. Distribution of points to estimate the likelihood that the status of *Acanthastrea brevis* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

The high susceptibility to bleaching is the primary factor that increases the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Acanthastrea brevis.* Factors that reduce potential extinction risk (decrease the likelihood of falling below the Critical Risk Threshold) for *Acanthastrea brevis* are that it occupies a variety of habitat types and is broadly distributed both latitudinally and longitudinally in the Indo-Pacific. Wide distribution range is considered to lower extinction risk by making it more likely a species will be able to escape the impacts of threats and catastrophes in at least some locations.

The overall likelihood that *Acanthastrea brevis* will fall below the Critical Risk Threshold by 2100 was estimated to be split between the "more likely than not" and "less likely than not" risk categories with a mean likelihood of 50% and a standard error (SE) of 9% (Fig. 7.18.4). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 10%–99% (Fig. 7.18.4) and the average range of likelihood estimates of the seven BRT voters (59%). The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for *Acanthastrea brevis*.

### 7.18.2 *Acanthastrea hemprichii* Ehrenberg, 1834

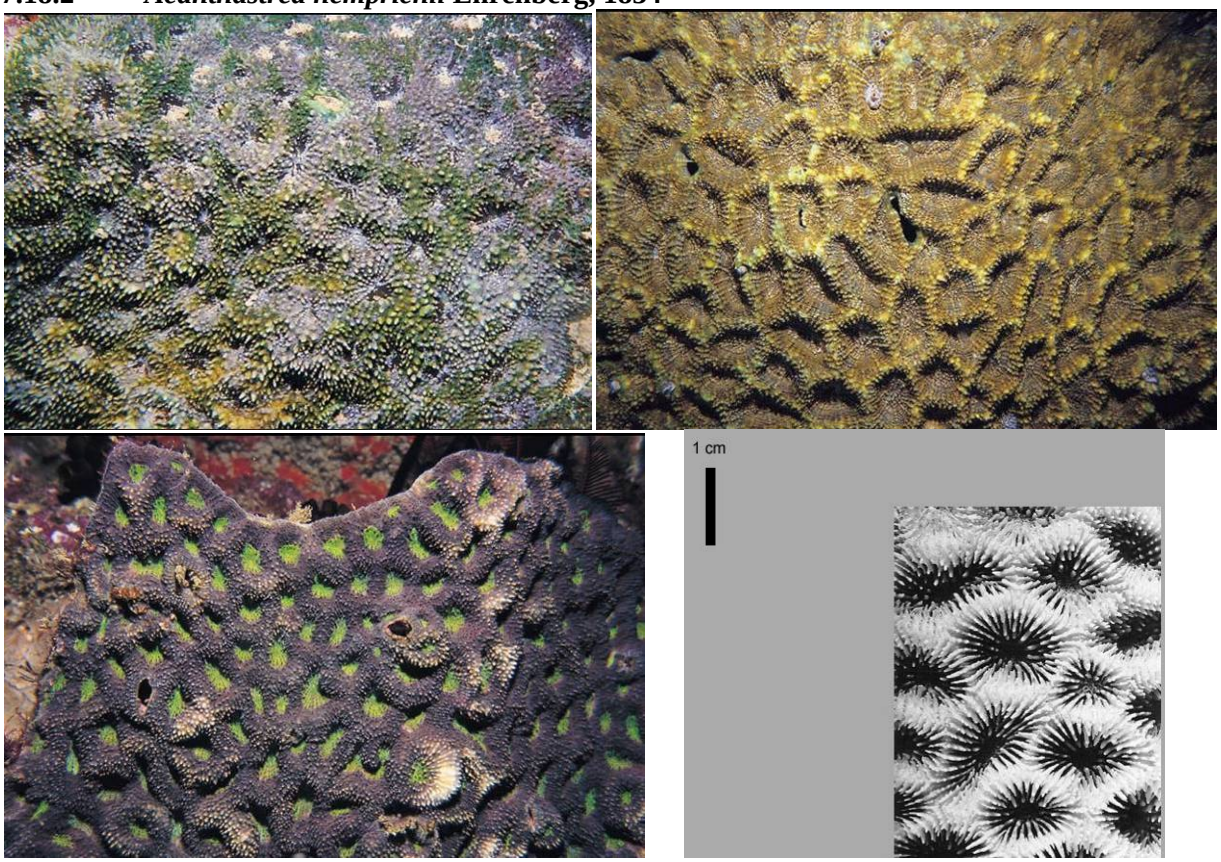


Figure 7.18.5. *Acanthastrea hemprichii* photos and corallite plan copied from Veron and Stafford-Smith (2002).

## Characteristics

Colonies of *Acanthastrea hemprichii* are encrusting to massive and frequently over 1 m across. Corallites are cerioid. Septa have exsert teeth. Colonies have fleshy tissue over the skeleton, but this is not thick enough to mask underlying skeletal structures. Colonies are mottled browns and greens in color, commonly with brown walls and green oral discs (Veron, 2000).

## Taxonomy

**Taxonomic issues**: None. *Acanthastrea hemprichii* is similar to *Acanthastrea echinata*, which has more widely-spaced, fleshy, less-cerioid corallites. It is also similar to *Acanthastrea bowerbanki*, which usually has a central corallite and more angular peripheral corallites and *Acanthastrea hillae*, which has larger and fleshier corallites (Veron, 2000).

**Family:** Mussidae.

**Evolutionary and geologic**: The genus *Acanthastrea* is known in the Indo-Pacific from the Miocene Epoch (Wells and Moore, 1956).

## Global Distribution

Wide geographic distribution including Red Sea, Gulf of Aden, southwest Indian Ocean, Indo- and west Pacific, and Great Barrier Reef (Veron, 2000). Range is not restricted or highly fragmented.

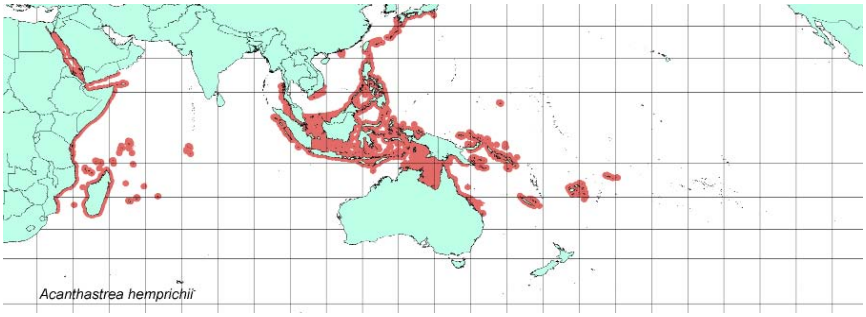

Figure 7.18.6. *Acanthastrea hemprichii* distribution from IUCN copied from http://www.iucnredlist.org.

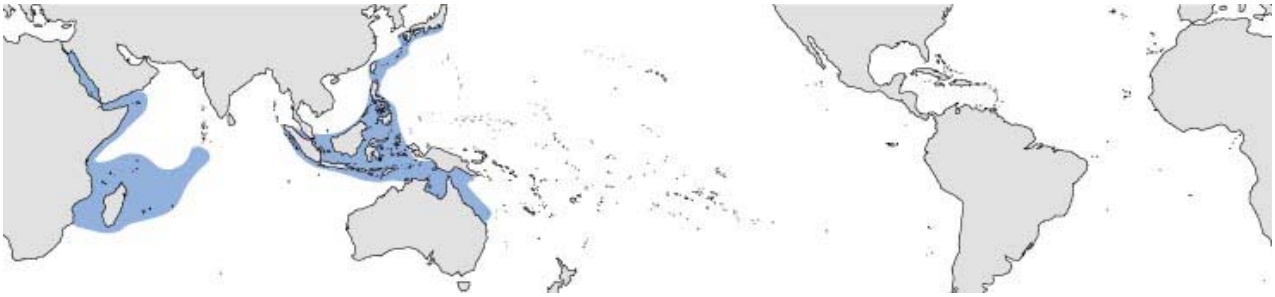
Figure 7.18.7. *Acanthastrea hemprichii* distribution from Veron (2000).

## U.S. Distribution

According to the IUCN Species Account, *Acanthastrea hemprichii* occurs in American Samoa, with the supporting reference given as "Fenner (pers. comm.)." The CITES species database does not include any record of occurrence in U.S. waters. *Acanthastrea hemprichii* is not listed as occurring in American Samoa in Lovell and McLardy (2008).

Fenner reports *Acanthastrea hemprichii* in American Samoa at Tutuila (CRED, unpubl. data). Visual identifications are supported by photographs (3). This species was found at only Lee Lee Point, Tutuila, where it was rare. The three photographs were taken of two colonies. These photographs provide a secure identification, although no sample has yet been collected. The species is relatively easily identified by the shared walls between corallites, and the common yellow-brown color often with lighter color patches. Thus, although the identification is secure, it is a very rare species in American Samoa.

This species was not observed elsewhere in American Samoa (CRED unpubl. data) during dedicated surveys conducted at 38 sites off Ofu-Olosega, Ta′u, Rose Atoll, Swains, and South Bank in March 2010. No other published or unpublished data sources indicate the occurrence of *Acanthastrea hemprichii* elsewhere in U.S. waters.

*Acanthastrea hemprichii* has not been recorded from federally protected waters.

## Habitat

**Habitat:** *Acanthastrea hemprichii* has been reported to occupy most reef environments (Carpenter et al., 2008; Veron, 2000).

**Depth range**: *Acanthastrea hemprichii* has been reported in water depths ranging from 2 m to 20 m (Carpenter et al., 2008).

## Abundance

Abundance of *Acanthastrea hemprichii* has been reported as uncommon (Veron, 2000).

## Life History

Reproductive characteristics of *Acanthastrea hemprichii* have not been determined (Baird et al., 2009). However, the congeners *Acanthastrea echinata and Acanthastrea hillae* on the Great Barrier Reef are hermaphroditic broadcast spawners that participate in multispecies spawning events (Babcock et al., 1986; Willis et al., 1985). The minimum size and age of first reproduction has not been determined for any members of the family Mussidae (Harrison and Wallace, 1990). Although specific larval descriptions have not been published for this species, the larvae of three other *Acanthastrea* species studied do not contain zooxanthellae that can supplement maternal provisioning with energy sources provided by their photosynthesis (Baird et al., 2009), i.e., they are lecithotrophic. The maximum larval longevity for the congener *Acanthastrea lordhowensis* in laboratory cultures was 78 days (Wilson and Harrison, 1998).

## Threats

**Temperature stress**: The genus *Acanthastrea* has been reported to be highly susceptible to bleaching in Australia (Marshall and Baird, 2000) and in the western Indian Ocean (McClanahan et al., 2007). The genus sustained moderate bleaching in Palau in 1994 (Paulay and Benayahu, 1999) and several *Acanthastrea* species (including *Acanthastrea hemprichii*) were relatively unaffected during the 2002 bleaching event on the Great Barrier Reef (Done et al., 2003).

**Acidification:** Unknown for the genus *Acanthastrea*. However, in most corals studied (Table 3.2.2), acidification impairs growth (Langdon and Atkinson, 2005; Manzello, 2010) and, in the case of *Acropora palmata*, impairs fertilization and settlement success (Albright et al., 2010) and is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). While ocean acidification has not been demonstrated to have caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

**Disease:** Susceptibility and impacts of disease on *Acanthastrea hemprichii* are not known. However, ample evidence indicate that diseases can have devastating regional impacts on individual coral species (e.g., Aronson and Precht, 2001; Bruckner and Hill, 2009), and some evidence show that these impacts are occurring on a trend of increasing taxonomic and geographic scale (Green and Bruckner, 2000; Sutherland et al., 2004). Few disease reports for the genus *Acanthastrea* appear in the global database (UNEP, 2010).

**Predation**: Unknown.

**Land-based sources of pollution (LBSP):** The effects of LBSP on *Acanthastrea hemprichii* are largely unknown. Congener *Acanthastrea echinata* has lower sediment rejection efficiency than many other corals, in part because sediment becomes trapped between the calices when the polyps expand. However, it still clears most sediment within 24 h and is equally efficient in removing coarse and fine particles (Stafford-Smith, 1993). LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

**Collection/Trade:** Although no exports of *Acanthastrea* were reported from 2000 through 2009, 1000 pieces of *Acanthastrea* were exported from Indonesia in 2010 (CITES, 2010). Hence, collection/trade is not considered to be a significant threat to *Acanthastrea hemprichii*.

## Risk Assessment

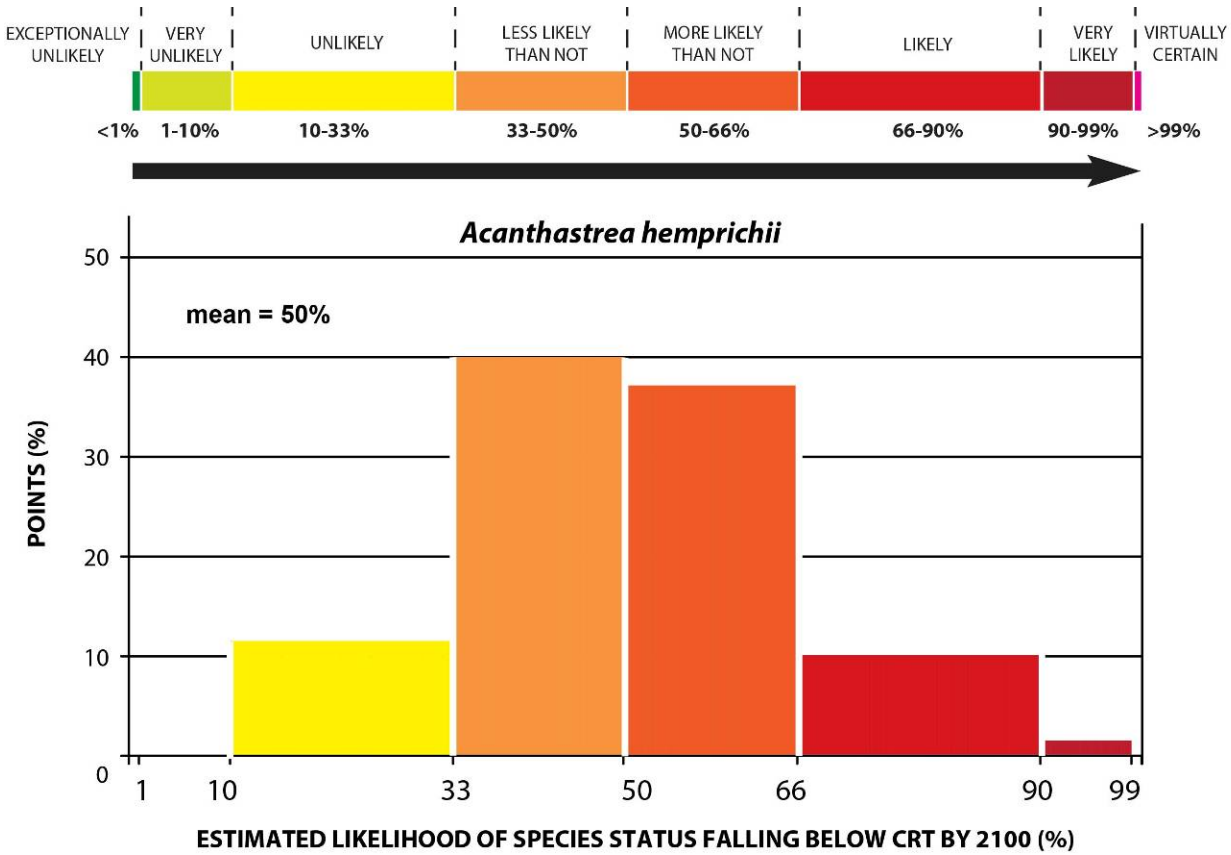


Figure 7.18.8. Distribution of points to estimate the likelihood that the status of *Acanthastrea hemprichii* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

The high susceptibility to bleaching is the primary factor that increases the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Acanthastrea hemprichii.* Factors that reduce potential extinction risk (decrease the likelihood of falling below the Critical Risk Threshold) for *Acanthastrea hemprichii* are that it occupies a variety of habitat types and is broadly distributed both latitudinally and longitudinally in the Indo-Pacific. Wide distribution range is considered to lower extinction risk by making it more likely a species will be able to escape the impacts of threats and catastrophes in at least some locations.

The overall likelihood that *Acanthastrea hemprichii* will fall below the Critical Risk Threshold by 2100 was estimated to straddle the "more likely than not" and "less likely than not" risk categories with a mean likelihood of 50% and a standard error (SE) of 9% (Fig. 7.18.8). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 10%–99% (Fig. 7.18.8) and the average range of likelihood estimates of the seven BRT voters (57%). The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for *Acanthastrea hemprichii*.

### 7.18.3 *Acanthastrea ishigakiensis* Veron, 1990

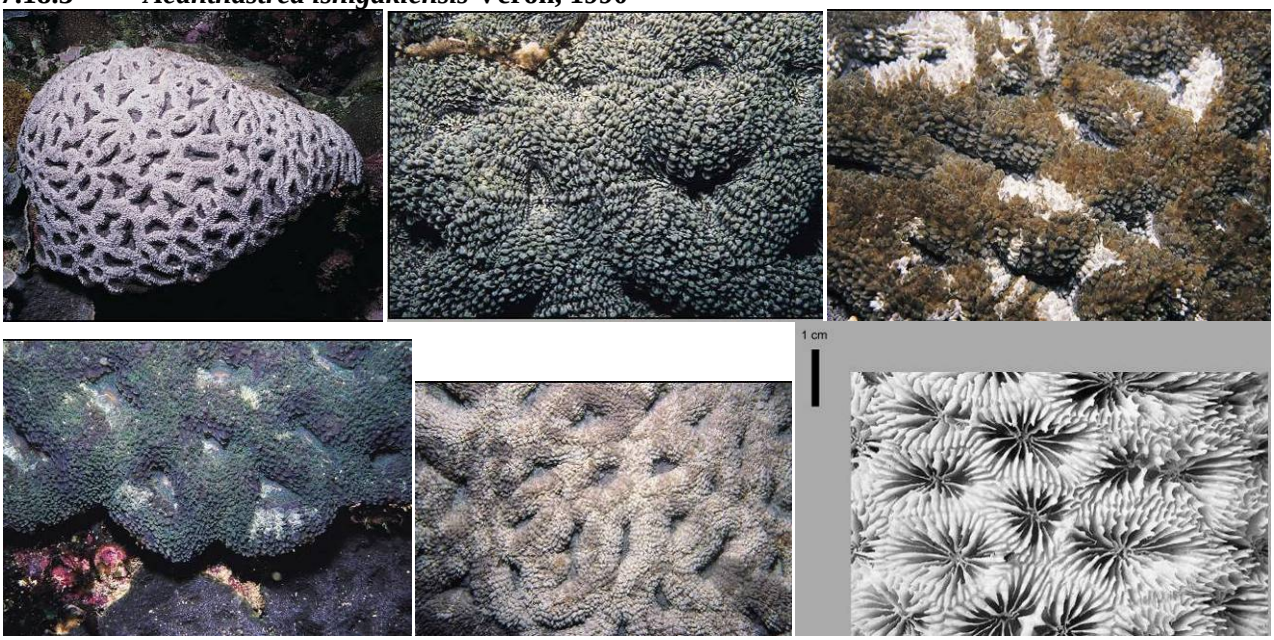


Figure 7.18.9. *Acanthastrea ishigakiensis* photos and corallite plan copied from Veron and Stafford-Smith (2002).

## Characteristics

Colonies of *Acanthastrea ishigakiensis* are massive, usually hemispherical and often more than 0.5 m across. Corallites are up to 25 mm in diameter and cerioid, becoming plocoid on the colony sides. Septa are mostly uniform, with large teeth. Colonies have thick fleshy tissue over the skeleton. Colonies are uniform blue-grey or mixtures of grey, brown, cream and green in color, usually with mouth, oral disc and walls of contrasting colors (Veron, 2000).

## Taxonomy

**Taxonomic issues**: None. *Acanthastrea ishigakiensis* is similar to *Acanthastrea hillae*, which has smaller corallites with a tendency to form valleys. It resembles *Symphyllia erythraea* underwater (Veron, 2000).

**Family:** Mussidae.

**Evolutionary and geologic history**: The genus *Acanthastrea is* known in the Indo-Pacific from the Miocene Epoch (Wells and Moore, 1956).

## Global Distribution

*Acanthastrea ishigakiensis* has a broad range; it stretches from the Red Sea, Gulf of Aden, and southern Africa to the central Pacific Ocean as far as Samoa but not including Australia.

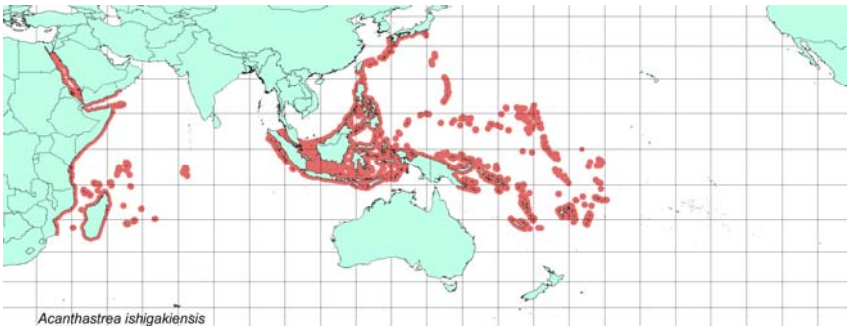


Figure 7.18.10. *Acanthastrea ishigakiensis* distribution from IUCN copied from http://www.iucnredlist.org.

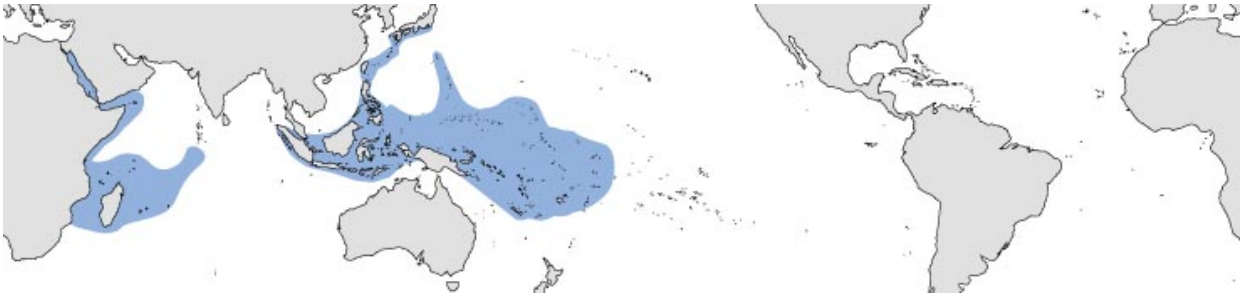

Figure 7.18.11. *Acanthastrea ishigakiensis* distribution from Veron (2000).

## U.S. Distribution

According to the IUCN Species Account, *Acanthastrea ishigakiensis* occurs in American Samoa and the Northern Mariana Islands, but no supporting reference is given for the record of occurrence in either of these areas in the IUCN Species Account.

The CITES species database does not include any record of occurrence in U.S. waters. *Acanthastrea ishigakiensis* is not listed as occurring in American Samoa in Lovell and McLardy (2008). In Veron (2000) (Volume 3, page 17), the distribution map for this species includes the Mariana Archipelago, with a photo taken by Gustav Paulay labeled "Guam." However, G. Paulay (pers. comm. to J. Kenyon via email 2/28/2010) indicates a number of photos submitted by him to Veron from Palau and the Cook Islands, and other locations in the Pacific were mistakenly attributed to Guam (similar to the *errata* later acknowledged by Veron (2002) for *Acanthastrea regularis* and *Porites napopora*). No substantiated records of its occurrence in the Mariana Archipelago are documented (J. Veron pers. comm. to J. Kenyon via email 4/23/2010).

Fenner reports a single colony of *Acanthastrea ishigakiensis* in American Samoa at Tutuila (CRED, unpubl. data). Visual identifications are supported by photographs (3), but no voucher sample was collected. The colony was photographed at Matuu, Tutuila. The species is relatively easy to identify, as it has large corallites, which are often pinched sideways, and it forms massive colonies unlike *Acanthastrea hillae* which forms encrusting colonies.

This species was not observed elsewhere in American Samoa by Fenner during dedicated surveys conducted at 38 sites off Ofu-Olosega, Ta′u, Rose Atoll, Swains, and South Bank in March 2010 (CRED, unpubl.data). No other published or unpublished data sources indicate the occurrence of *Acanthastrea ishigakiensis* elsewhere in U.S. waters.

*Acanthastrea ishigakiensis* has not been recorded from federally protected waters.

## Habitat

**Habitat:** *Acanthastrea ishigakiensis* has been reported to occupy shallow protected reef environments (Veron, 2000).

**Depth range**: *Acanthastrea ishigakiensis* has been reported in water depths ranging from 1 m to 15 m (Carpenter et al., 2008).

## Abundance

Abundance of *Acanthastrea ishigakiensis* has been reported as uncommon but conspicuous (Veron, 2000).

## Life History

Reproductive characteristics of *Acanthastrea ishigakiensis* have not been determined (Baird et al., 2009). However, the congeners *Acanthastrea echinata and Acanthastrea hillae* on the Great Barrier Reef are hermaphroditic broadcast spawners that participate in multispecies spawning events (Babcock et al., 1986; Willis et al., 1985). The minimum size and age of first reproduction has not been determined for any members of the family Mussidae (Harrison and Wallace, 1990).

Although specific larval descriptions have not been published for this species, the larvae of three other *Acanthastrea* species studied do not contain zooxanthellae that can supplement maternal provisioning with energy sources provided by their photosynthesis (Baird et al., 2009), i.e., they are lecithotrophic. The maximum larval longevity for the congener *Acanthastrea lordhowensis* in laboratory cultures was 78 days (Wilson and Harrison, 1998).

## Threats

**Temperature stress**: The genus *Acanthastrea* has been reported to be highly susceptible to bleaching in Australia (Marshall and Baird, 2000) and in the western Indian Ocean (McClanahan et al., 2007). The genus sustained moderate bleaching in Palau in 1994 (Paulay and Benayahu, 1999) and several *Acanthastrea* species were relatively unaffected during the 2002 bleaching event on the Great Barrier Reef (Done et al., 2003).

**Acidification:** Unknown for the genus *Acanthastrea*. However, in most corals studied (Table 3.2.2), acidification impairs growth (Langdon and Atkinson, 2005; Manzello, 2010) and, in the case of *Acropora palmata*, impairs fertilization and settlement success (Albright et al., 2010) and is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). While ocean acidification has not been demonstrated to have caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

**Disease:** Susceptibility and effects of disease on *Acanthastrea ishigakiensis* are not known. However, ample evidence indicate that diseases can have devastating regional impacts on individual coral species (e.g., Aronson and Precht, 2001; Bruckner and Hill, 2009) and evidence show that these impacts are occurring in more taxa and at a broader geographic scale (Green and Bruckner, 2000; Sutherland et al., 2004). Relatively few disease reports for the genus *Acanthastrea* were found in the global disease database (UNEP, 2010).

**Predation**: Unknown.

**Land-based sources of pollution (LBSP):** The effects of LBSP on *Acanthastrea ishigakiensis* are largely unknown. Congener *Acanthastrea echinata* has lower sediment rejection efficiency than many other corals, in part, because sediment becomes trapped between the calices when the polyps expand. However, it still clears most sediment within 24 h and is equally efficient in removing coarse and fine particles (Stafford-Smith, 1993). LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually, and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

**Collection/Trade:** Although no exports of *Acanthastrea* were reported from 2000 through 2009, 1000 pieces of *Acanthastrea* were exported from Indonesia in 2010 (CITES, 2010). Hence, collection/trade is not considered to be a significant threat to *Acanthastrea ishigakiensis*.

## Risk Assessment

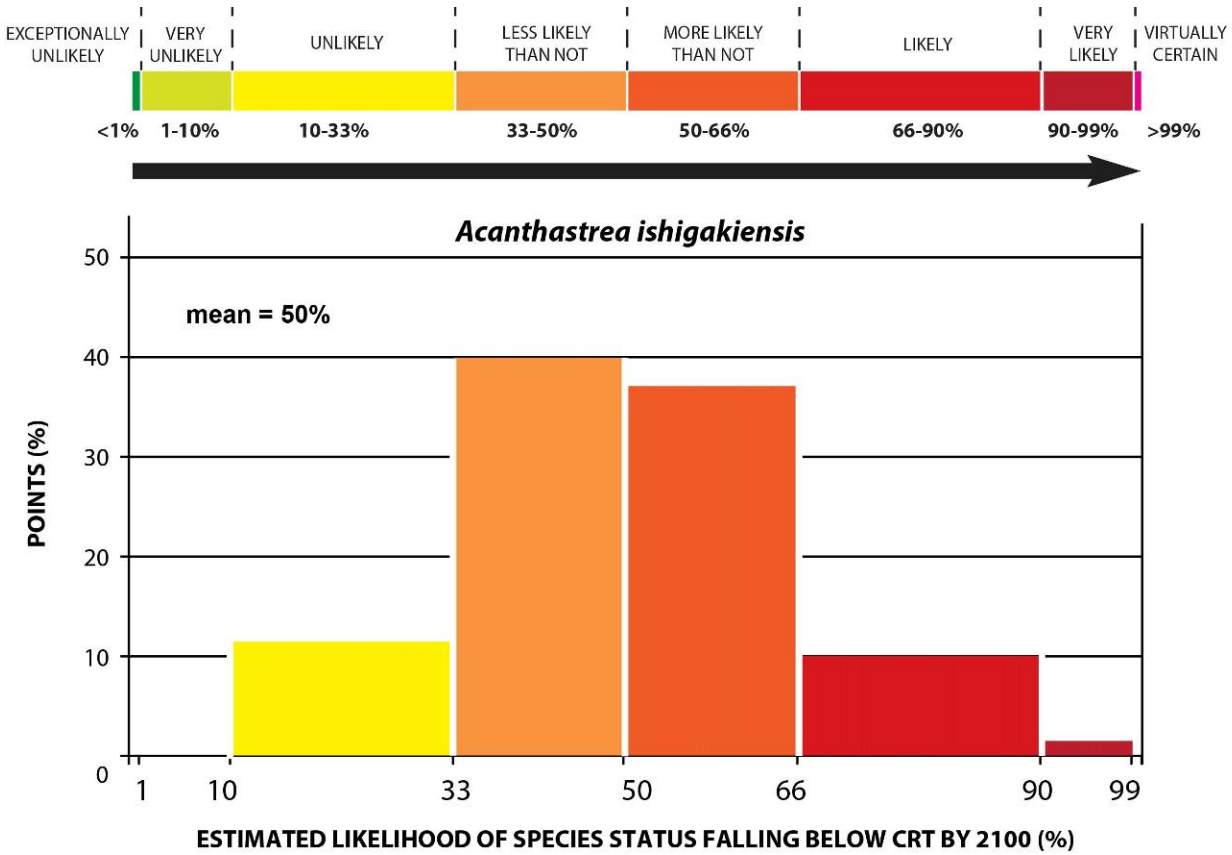


Figure 7.18.12. Distribution of points to estimate the likelihood that the status of *Acanthastrea ishigakiensis* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

The high susceptibility to bleaching is the primary factor that increases the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Acanthastrea ishigakiensis*. Factors that reduce potential extinction risk (decrease the likelihood of falling below the Critical Risk Threshold) are that *Acanthastrea ishigakiensis* is broadly distributed both latitudinally and longitudinally in the Indo-Pacific, making it more likely the species will be able to escape the impacts of threats and catastrophes in at least some locations.

The overall likelihood that *Acanthastrea ishigakiensis* will fall below the Critical Risk Threshold by 2100 was estimated to be in the "less likely than not" risk category with a mean likelihood of 50% and a standard error (SE) of 7% (Fig. 7.18.12). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 10%–99% (Fig. 7.18.12) and the average range of likelihood estimates of the seven BRT voters (59%). The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for *Acanthastrea ishigakiensis*.

### 7.18.4 *Acanthastrea regularis* Veron, 2000

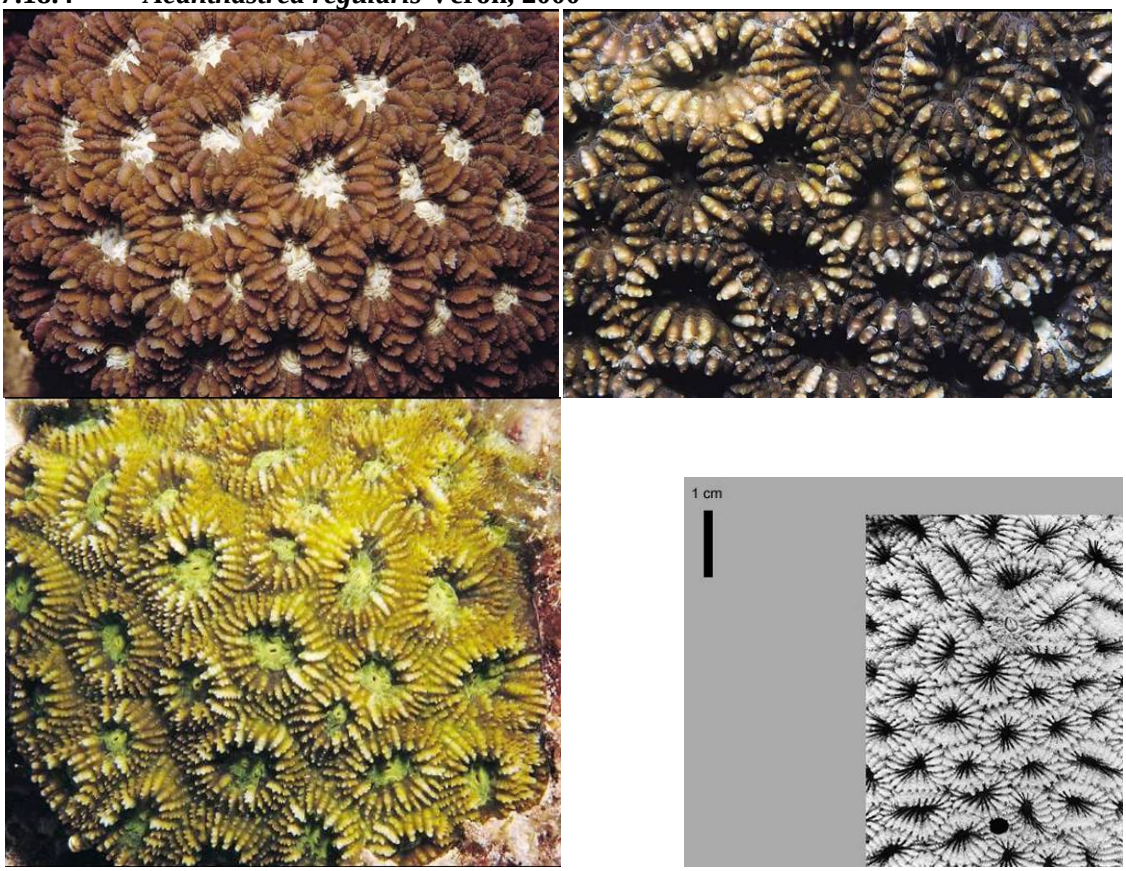


Figure 7.18.13. *Acanthastrea regularis* photos and corallite plan copied from Veron and Stafford (2002).

## Characteristics

Colonies of *Acanthastrea regularis* are massive and subplocoid. Septa are uniformly spaced with 8–10 evenly spaced, rounded teeth. Teeth on adjacent septa are often aligned, forming concentric circles. Some septa are more prominent than others. Columellae are weakly developed. Colonies do not have thick tissue over the skeleton and are variable brown and yellow-brown in color, usually with contrasting corallite walls and centers (Veron, 2000).

## Taxonomy

**Taxonomic issues**: None. *Acanthastrea regularis* may resemble the faviids *Montastraea* and *Favia* species more than other *Acanthastrea* underwater (Veron, 2000).

**Family:** Mussidae.

**Evolutionary and geologic history**: The genus *Acanthastrea* is known in the Indo-Pacific from the Miocene Epoch (Wells and Moore, 1956).

## Global Distribution

Distribution is fairly restricted both longitudinally as latitudinally. It is highly centered in the Coral Triangle but also found around some of the islands in the west Pacific and Australia's Great Barrier Reef (Veron, 2000).

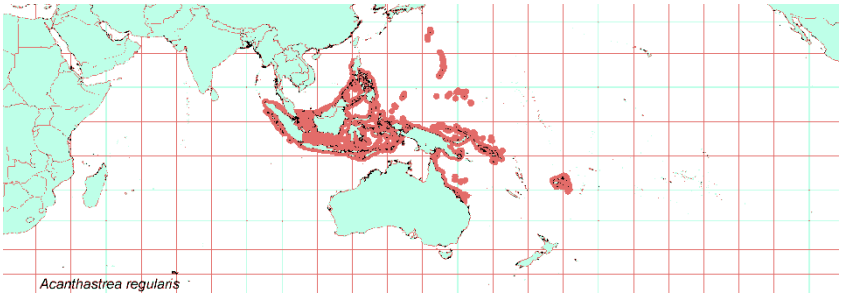

Figure 7.18.14. *Acanthastrea regularis* distribution from IUCN copied from http://www.iucnredlist.org.

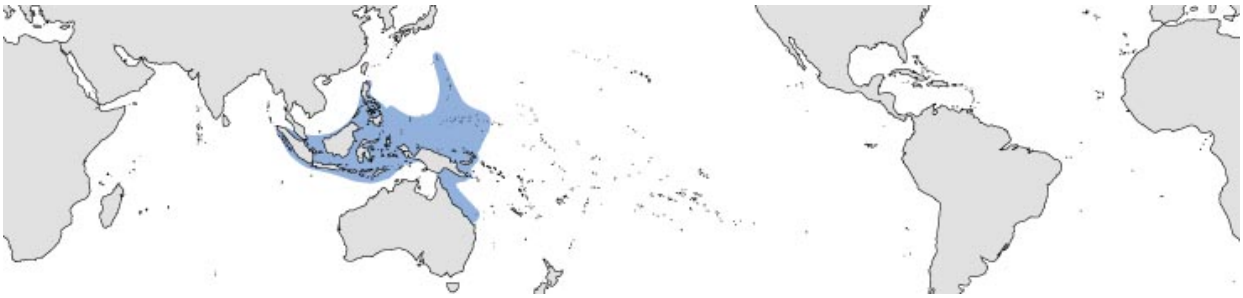
Figure 7.18.15. *Acanthastrea regularis* distribution from Veron (2000).

## U.S. Distribution

According to the IUCN Species Account, *Acanthastrea regularis* occurs in the Northern Mariana Islands, but no supporting reference is given. The CITES species database does not include any record of occurrence in U.S. waters.

In Veron (2000) (Volume 3, page 16), the distribution map includes the Mariana Archipelago, with a photo taken by Gustav Paulay labeled "Guam." However, Veron (2002) indicates "erratum: photograph was taken at Palau, not Guam" (page 130). G. Paulay (University of Florida, Gainesville, FL. pers. comm. to J. Kenyon via email 2/28/2010) indicates photos submitted by him to Veron from Palau, the Cook Islands, and other locations were mistakenly attributed to Guam. Further email communications of J. Kenyon with G. Paulay (3/2/2010) confirm this species has not been observed by G. Paulay in the Mariana Archipelago. There are no other substantiated records of its occurrence in the Mariana Archipelago.

No other published or unpublished data sources indicate the occurrence of *Acanthastrea regularis* elsewhere in U.S. waters.

## Habitat

**Habitat:** *Acanthastrea regularis* has been reported to occupy shallow reef environments (Veron, 2000).

**Depth range**: *Acanthastrea regularis* has been reported from water depths ranging from 2 m to 20 m (Carpenter et al., 2008).

## Abundance

Abundance of *Acanthastrea regularis* has been reported as uncommon (Veron, 2000).

## Life History

Reproductive characteristics of *Acanthastrea regularis* have not been determined (Baird et al., 2009). However, the congeners *Acanthastrea echinata and Acanthastrea hillae* on the Great Barrier Reef are hermaphroditic broadcast spawners that participate in multispecies spawning events (Willis et al., 1985; Babcock et al., 1986). The minimum size and age of first reproduction has not been determined for any members of the family Mussidae (Harrison and Wallace, 1990).

Although specific larval descriptions have not been published for this species, the larvae of three other *Acanthastrea* species studied do not contain zooxanthellae that can supplement maternal provisioning with energy sources provided by their photosynthesis (Baird et al., 2009), i.e., they are lecithotrophic. The maximum larval longevity for the congener *Acanthastrea lordhowensis* in laboratory cultures was 78 days (Wilson and Harrison, 1998).

## Threats

**Temperature stress**: The genus *Acanthastrea* has been reported to be highly susceptible to bleaching in Australia (Marshall and Baird, 2000) and in the western Indian Ocean (McClanahan et al., 2007). The genus sustained moderate bleaching in Palau in 1994 (Paulay and Benayahu, 1999) and several *Acanthastrea* species were relatively unaffected during the 2002 bleaching event on the Great Barrier Reef (Done et al., 2003).

**Acidification:** Unknown for this genus. However, in most corals studied (Table 3.2.2), acidification impairs growth (Langdon and Atkinson, 2005; Manzello, 2010) and, in the case of *Acropora palmata*, impairs fertilization and settlement success (Albright et al., 2010) and is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). While ocean acidification has not been demonstrated to have caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

**Disease:** Susceptibility and impacts of disease on *Acanthastrea regularis* are not known. However, ample evidence indicate that diseases can have devastating regional impacts on individual coral species (e.g., Aronson and Precht, 2001; Bruckner and Hill, 2009) and some evidence show that these impacts are occurring on a trend of increasing taxonomic and geographic scale (Green and Bruckner, 2000; Sutherland et al., 2004). A few disease reports for the genus *Acanthastrea* are documented in the global disease database (UNEP, 2010).

**Predation**: Unknown.

**Land-based sources of pollution (LBSP):** The effects of LBSP on *Acanthastrea regularis* are largely unknown. Congener *Acanthastrea echinata* has lower sediment rejection efficiency than many other corals, in part, because sediment becomes trapped between the calices when the polyps expand. However, it still clears most sediment within 24 h and is equally efficient in removing coarse and fine particles (Stafford-Smith, 1993). LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually, and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

**Collection/Trade:** Although no exports of *Acanthastrea* were reported from 2000 through 2009, 1000 pieces of *Acanthastrea* were exported from Indonesia in 2010 (CITES, 2010). Hence, collection/trade is not considered to be a significant threat to *Acanthastrea regularis*.

## Risk Assessment

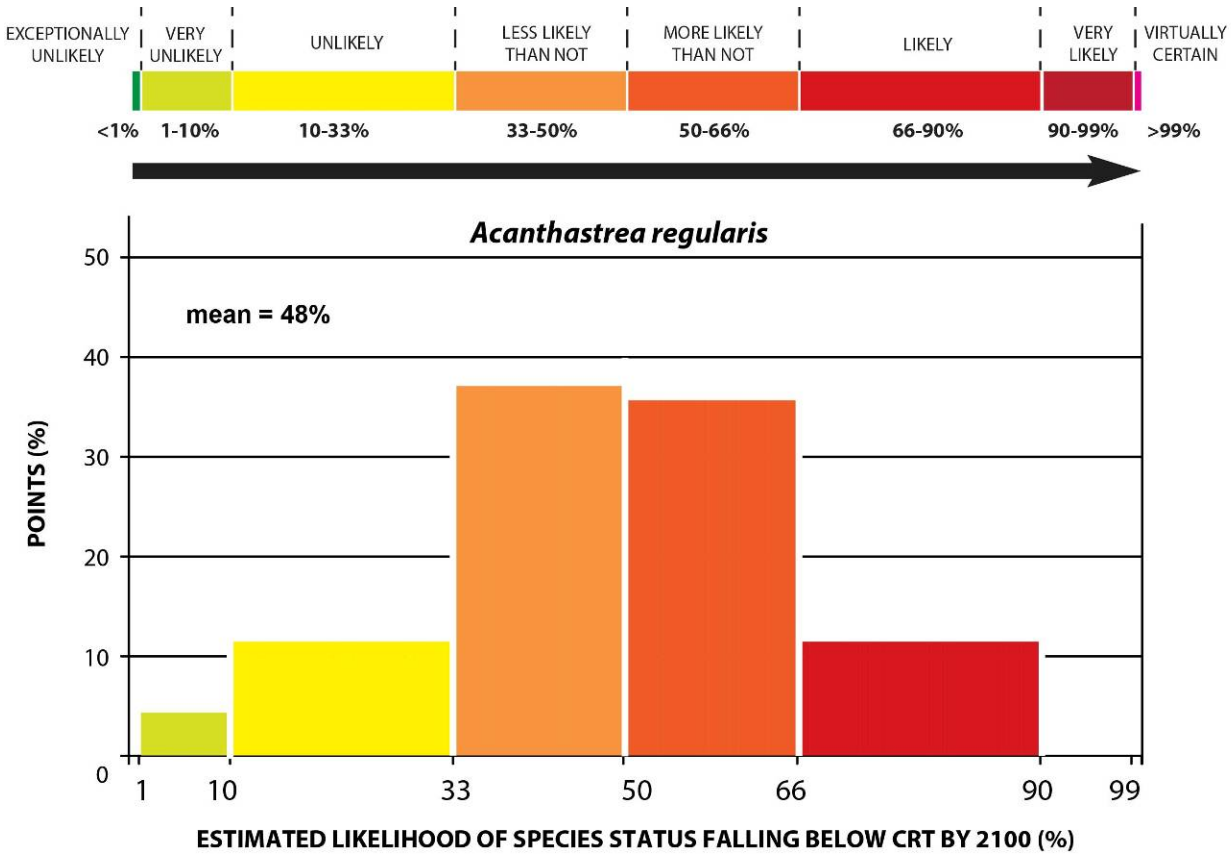


Figure 7.18.16. Distribution of points to estimate the likelihood that the status of *Acanthastrea regularis* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

The high susceptibility to bleaching is the primary factor that increases the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Acanthastrea regularis*. *Acanthastrea regularis* occupies a variety of habitat types and is broadly distributed both latitudinally and longitudinally in the Indo-Pacific which are factors that reduce potential extinction risk (decrease the likelihood of falling below the Critical Risk Threshold).

The overall likelihood that *Acanthastrea regularis* will fall below the Critical Risk Threshold by 2100 was estimated to be in the "less likely than not" risk category with a mean of 48% likelihood and a standard error (SE) of 15% (Fig. 7.18.16). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 1%–90% (Fig. 7.18.16) and the average range of likelihood estimates of the seven BRT voters (46%). The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for *Acanthastrea regularis*.

## 7.19 Genus *Barabattoia* (Family Faviidae)

### 7.19.1 *Barabattoia laddi* Wells, 1954

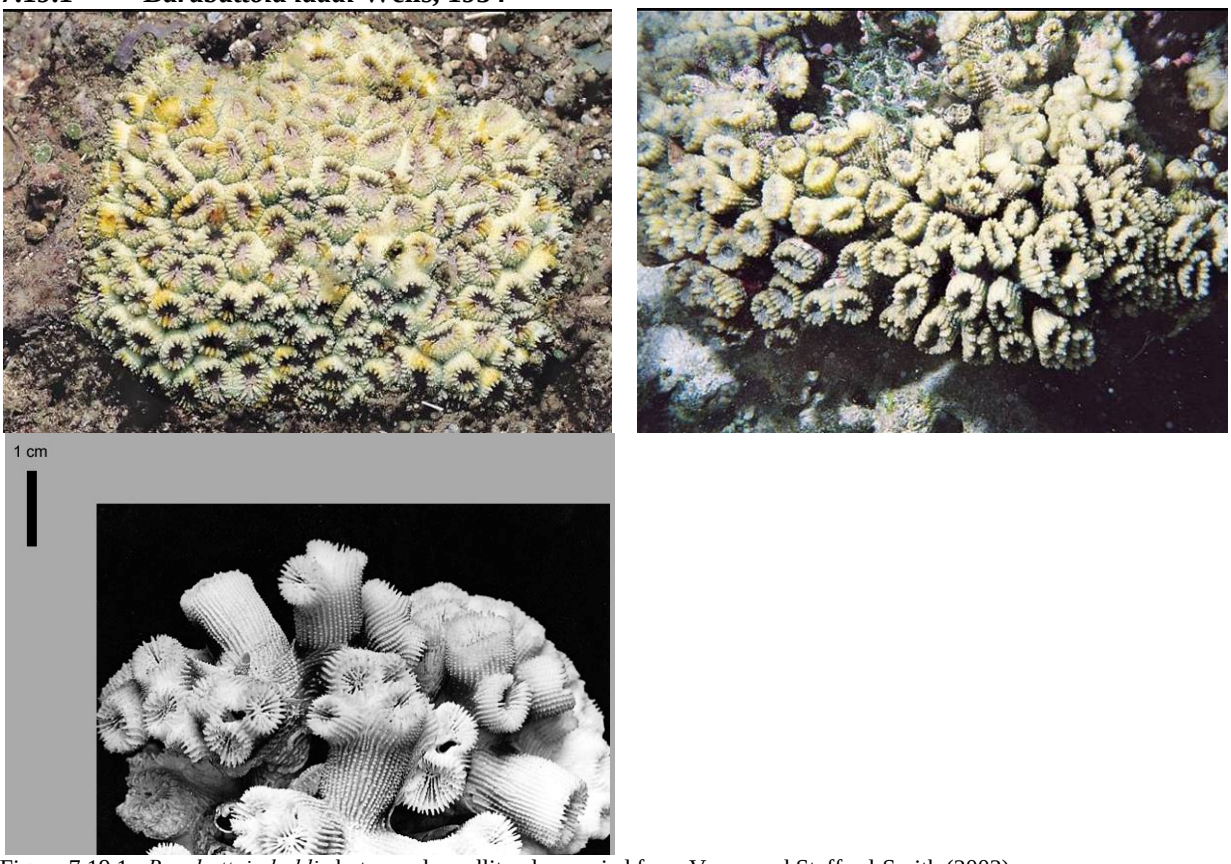


Figure 7.19.1. *Barabattoia laddi* photos and corallite plan copied from Veron and Stafford-Smith (2002).

### Characteristics

Colonies of *Barabattoia laddi* are clusters of tubular corallites. Budding is extratentacular. Corallites bifurcate at approximately 10 mm intervals and frequently join. Costae are in two alternating orders and are strongly beaded. Colonies are pale brown in color (Veron, 2000).

### Taxonomy

**Taxonomic issues**: None. *Barabattoia laddi* is similar to *Barabattoia amicorum* and *Montastraea* spp. (Veron, 2000).

**Family**: Faviidae.

**Evolutionary and geologic history**: *Barabattoia* is a recent Pacific genus with no known fossil record (Veron, 2000).

### Global Distribution

The range of *Barabattoia laddi* is somewhat restricted, latitudinally. It is highly centered in the Coral Triangle but also found around some of the islands in the western Pacific, central South Pacific, and Australia's Great Barrier Reef (Veron, 2000).

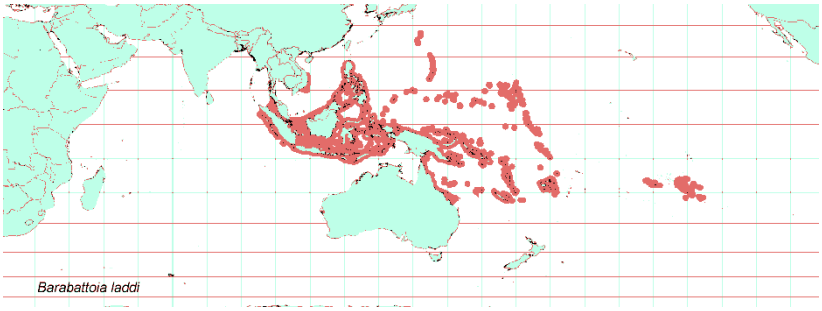

Figure 7.19.2. *Barabattoia laddi* distribution from IUCN copied from http://www.iucnredlist.org.

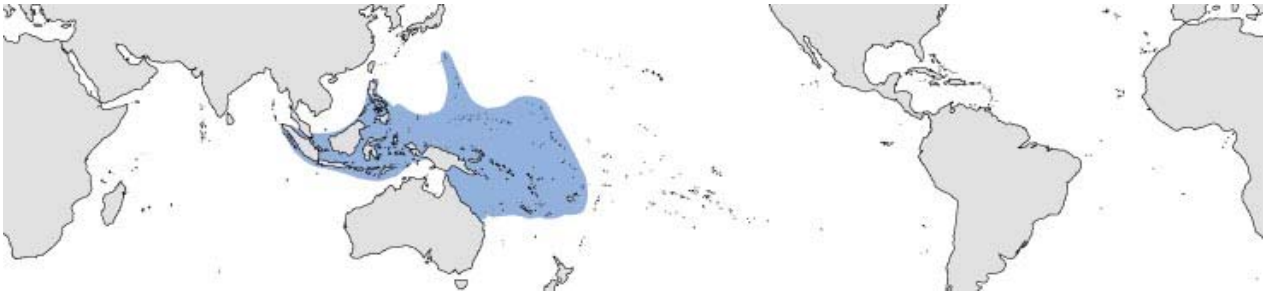
Figure 7.19.3. *Barabattoia laddi* distribution from Veron (2000).

## U.S. Distribution

According to both the IUCN Species Account and the CITES species database, *Barabattoia laddi* occurs in the Northern Mariana Islands.

A search of published and unpublished records of occurrence in U.S. waters indicates *Barabattoia laddi* has been reported from Rose Atoll in American Samoa (Kenyon et al., 2010a) and Guam (Veron, 2000).

Within federally protected waters, *Barabattoia laddi* has been recorded from the following areas:

- Rose Atoll Marine National Monument

## Habitat

**Habitat**: *Barabattoia laddi* has been recorded only from shallow lagoons (Veron, 2000).

**Depth range**: *Barabattoia laddi* has been reported in water depths ranging from 0 m to 10 m (Carpenter et al., 2008).

## Abundance

Abundance of *Barabattoia laddi* has been reported to be rare (Veron, 2000).

## Life History

The reproductive characteristics of *Barabattoia laddi* have not been determined (Baird et al., 2009). The congener *Barabattoia amoricum* is a hermaphroditic broadcast spawner that participated in multispecies spawning events at Magnetic Island and Orpheus Island on the Great Barrier Reef (Babcock et al., 1986). The minimum size and age of first reproduction have not been determined for this genus. Although specific larval descriptions have not been published for this species, the larvae of the single *Barabattoia* species studied do not contain zooxanthellae that might supplement maternal provisioning with energy from photosynthesis (Baird et al., 2009), i.e., they are lecithotrophic and azooxanthellate. Larval longevity has not been determined in this genus, but maximum longevity in 9 other species in the family Faviidae ranges from 56 to 244 days (Graham et al., 2008).

## Threats

**Temperature stress**: Unknown for this species but *Barabattoia amicorum* has low-to-moderate bleaching susceptibility with an unknown degree of resultant mortality (Bruno et al., 2001).

**Acidification**: Unknown for the genus *Barabattoia*. However, in most of the corals that have been studied to date, acidification impairs growth (Langdon and Atkinson, 2005; Manzello, 2010) and, in the case of *Acropora palmata*, impairs fertilization and settlement success (Albright et al., 2010) and likely will contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). While ocean acidification has not been demonstrated to have caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

**Disease**: Susceptibility to and effects of disease on *Barabattoia laddi* are not known. However, ample evidence indicate that diseases can have devastating regional impacts on individual coral species (e.g., Aronson and Precht, 2001; Bruckner and Hill, 2009), and evidence show that these impacts are occurring in more taxa and at a broader geographic scale (Green and Bruckner, 2000; Sutherland et al., 2004).

**Predation**: Susceptibility to predation is unknown for *Barabattoia laddi*.

**Land-based sources of pollution (LBSP)**: The effects of LBSP on *Barabattoia laddi* are largely unknown. LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually, and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

**Collection/Trade**: No trade information for *Barabattoia laddi* was listed in the CITES Trade Database, UNEP World Conservation Monitoring Centre (CITES, 2010).

## Risk Assessment

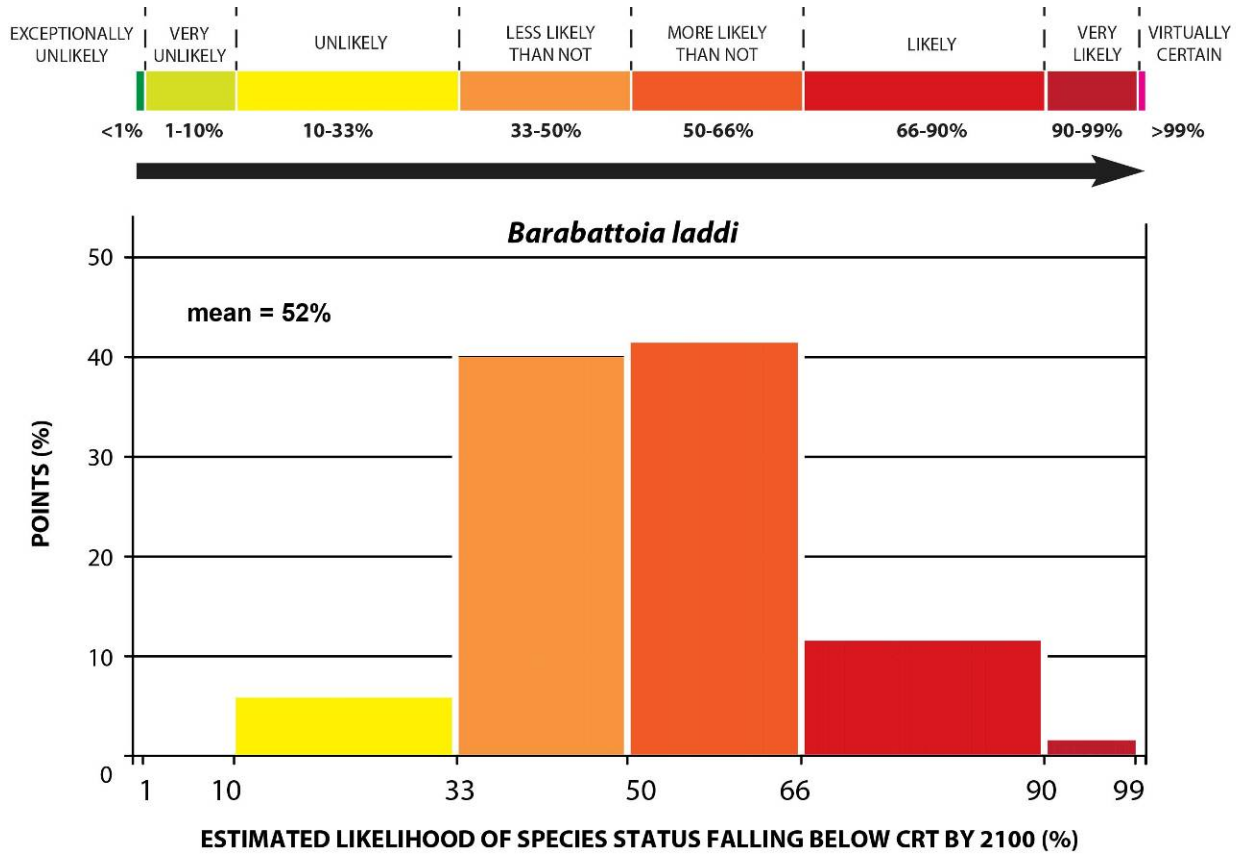


Figure 7.19.4. Distribution of points to estimate the likelihood that the status of *Barabattoia laddi* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (increase the likelihood of falling below the Critical Risk Threshold) are the species' limited western Pacific distribution, its occurrence in shallow lagoons and its rare abundance. However, very little information is available on *Barabattoia laddi*.

The overall likelihood that *Barabattoia laddi* will fall below the Critical Risk Threshold by 2100 was estimated to be in the "more likely than not" risk category with a mean likelihood of 52% and a standard error (SE) of 13%. (Fig. 7.19.4). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 10%–99% (Fig. 7.19.4) and the average range of likelihood estimates of the seven BRT voters (51%). The overall wide range of votes reflects the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for *Barabattoia laddi*.

## 7.20 Genus *Caulastrea*

### 7.20.1 *Caulastrea echinulata* Milne Edwards and Haime, 1849

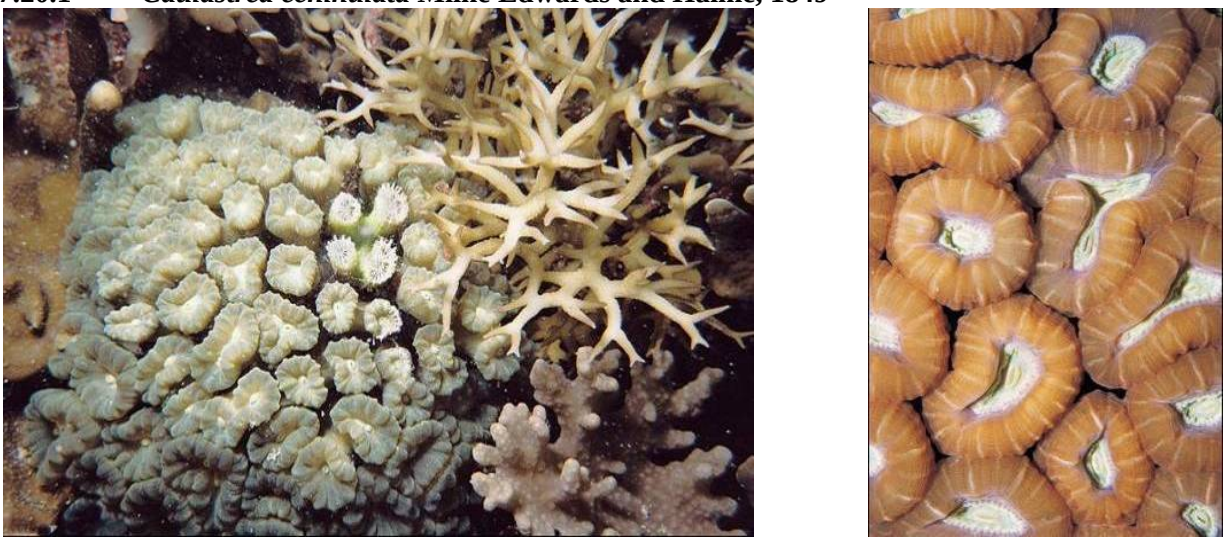

Figure 7.20.1. *Caulastrea echinulata* photos from Veron and Stafford-Smith (2002).

### Characteristics

Colonies of *Caulastrea echinulata* are phaceloid with closely compacted corallites (< 10 mm diameter). Septa are exsert, irregular, and uniform in width. The colonies have fleshy polyps that conceal characteristics of the septae (Veron, 2000). The genus is usually less than 30 cm diameter (Wood, 1983), although the maximum size of this species may reach 100 cm (Veron, 1986). Colonies are tan or dark brown in color, with pale oral discs (Veron, 2000).

### Taxonomy

**Taxonomic issues:** None. *Caulastrea echinulata* is similar to *Caulastrea furcata*, which has less compact corallites. Superficially resembles *Blastomussa wellsi* (Veron, 2000).

**Family:** Faviidae.

**Evolutionary and geologic history:** The genus is known from the Oligocene Age from the Caribbean and the Eocene Epoch in the Tethys Sea but is extinct in those locations (Wells and Moore, 1956).

### Global Distribution

*Caulastrea echinulata* is known primarily from Australia, Fiji, Indonesia, and Japan, although it does extend to the Philippines, New Caledonia, and the Solomon Islands.

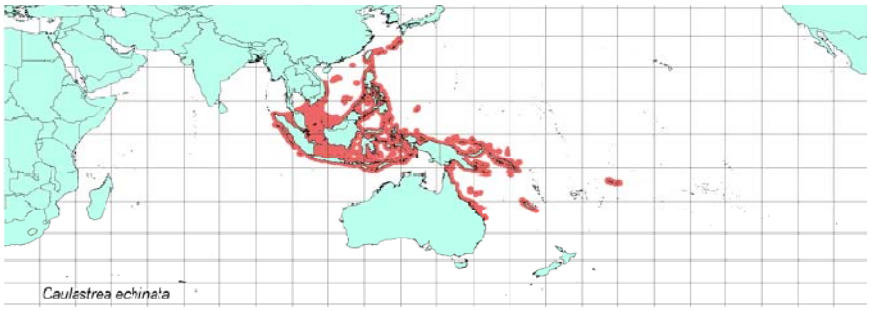


Figure 7.20.2. *Caulastrea echinulata* distribution from IUCN copied from http://www.iucnredlist.org.

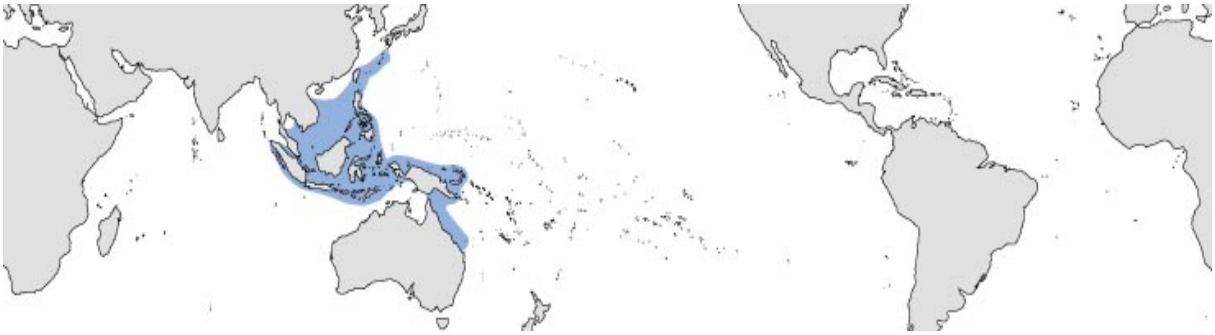

Figure 7.20.3. *Caulastrea echinulata* distribution from Veron (2000).

## U.S. Distribution

According to the IUCN Species Account, *Caulastrea echinulata* occurs in American Samoa, with the supporting reference given as "Fenner (pers. comm.)." The CITES species database (which treats this genus as *Caulastraea*) does not include any record of occurrence in U.S. waters.

*Caulastrea echinulata* and *Caulastrea furcata* are not easily separated. Veron, Pichon and Wijman-Best (UNESCO, 1985) and Veron (1986; 2000) have changed those photos that are presented under these names. Fenner has examined samples of these two species in the Veron collection at AIMS and was unable to see the differences between these species indicated in Veron et al. (1977).

Fenner reports tentative identification of *Caulastrea echinulata* at Tutuila, with four photographs but no voucher sample. *Caulastrea echinulata* is not listed as occurring in American Samoa (Lovell and McLardy, 2008). This species was not observed elsewhere in American Samoa by Fenner during dedicated surveys conducted at 38 sites off Ofu-Olosega, Ta′u, Rose Atoll, Swains, and South Bank in March 2010, nor was any other species of *Caulastrea*.

The occurrence of *Caulastrea echinulata* in American Samoa remains uncertain. No other published or unpublished data sources indicate the occurrence of *Caulastrea echinulata* elsewhere in U.S. waters.

Within federally protected waters, *Caulastrea echinulata* may have possibly been recorded from the following areas:

- National Park of American Samoa (Ofu unit; uncertain ID)

## Habitat

**Habitat:** *Caulastrea echinulata* has been reported to occupy horizontal substrates protected from wave action and with turbid water (Veron, 2000).

**Depth range**: *Caulastrea echinulata* has been reported in water depths ranging from 1 m to 20 m (Carpenter et al., 2008).

## Abundance

Abundance of *Caulastrea echinulata* has been reported to be uncommon (Veron, 2000).

## Life History

The reproductive characteristics of *Caulastrea echinulata* have not been determined (Baird et al., 2009). The congener *Caulastrea furcata* is a hermaphroditic broadcast spawner (Willis et al., 1985). The minimum size and age of first reproduction have not been determined for this genus. Although observations of larvae have not been published for this species, *Caulastrea furcata* larvae do not contain zooxanthellae that can supplement maternal provisioning with energy sources provided by their photosynthesis (Baird et al., 2009), i.e., they are lecithotrophic. Larval longevity has not been determined in this genus, but maximum longevity in nine other species in the family Faviidae ranges from 56 to 244 days (Graham et al., 2008).

## Threats

**Thermal stress:** Unknown, but other Faviid corals are often at moderate to low bleaching risk on the Great Barrier Reef (Marshall and Baird, 2000) and western Indian Ocean (McClanahan et al., 2007) (though see (Done et al., 2003) as an example of the range of bleaching response in that family). *Caulastrea furcata* was not observed to bleach in 1998 in Palau (Bruno et al., 2001).

**Acidification:** Unknown for the genus *Caulastrea*. However, in most corals studied (Table 3.2.2), acidification impairs growth (Langdon and Atkinson, 2005; Manzello, 2010) and, in the case of *Acropora palmata*, impairs fertilization and settlement success (Albright et al., 2010) and is likely to contribute to reef destruction in the future (Hoegh-Guldberg et al., 2007; Silverman et al., 2009). While ocean acidification has not been demonstrated to have caused appreciable declines in coral populations so far, the BRT considers it to be a significant threat to corals by 2100.

**Disease:** Susceptibility and impacts of disease on *Caulastrea echinulata* are not known. However, ample evidence indicate that diseases can have devastating regional impacts on individual coral species (e.g., Aronson and Precht, 2001; Bruckner and Hill, 2009), and evidence show that these impacts are occurring in more taxa and at a broader geographic scale (Green and Bruckner, 2000; Sutherland et al., 2004).

**Predation**: Unknown for *Caulastrea echinulata*.

**Land-based sources of pollution (LBSP):** The effects of LBSP on *Caulastrea echinulata* are largely unknown. LBSP-related stresses (nutrients, sediment, toxins, and salinity) often act in concert rather than individually and are influenced by other biological (e.g., herbivory) and hydrological factors. Collectively, LBSP stresses are unlikely to produce extinction at a global scale; however, they may pose significant threats at local scales (particularly important for species with limited range) and reduce the resilience of corals to bleaching (Carilli et al., 2009a; Wooldridge, 2009b).

**Collection/Trade:** Trade in *Caulastrea echinulata* is heavy. From 1999 to 2009 gross exports averaged 8713 specimens annually, with the vast majority originating in Indonesia (CITES, 2010). Take quotas over that same period increased from 9000 in 1999 to 10,670 in 2010.

## Risk Assessment

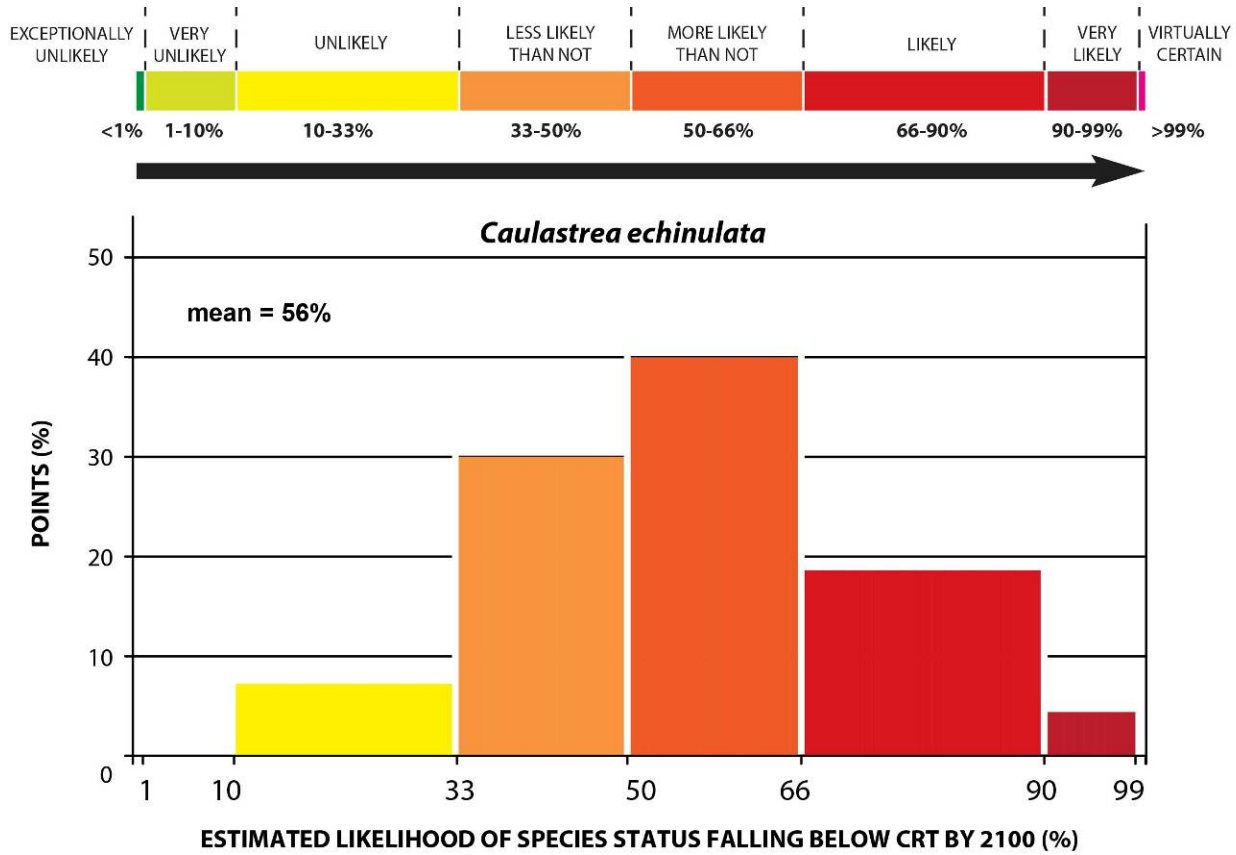


Figure 7.20.4. Distribution of points to estimate the likelihood that the status of *Caulastrea echinulata* falls below the Critical Risk Threshold (the species is of such low abundance, or so spatially fragmented, or at such reduced diversity that extinction is extremely likely) by 2100.

Factors that increase the potential extinction risk (higher likelihood of falling below the Critical Risk Threshold) for *Caulastrea echinulata* is uncommon but heavily traded. Factors that reduce potential extinction risk (decrease the likelihood of falling below the Critical Risk Threshold) are that the species distribution is broad latitudinally, and that its preferred habitat type (turbid conditions) may provide some refuge from global threats such as bleaching (to which it may have relatively low susceptibility).

The overall likelihood that *Caulastrea echinulata* will fall below the Critical Risk Threshold by 2100 was estimated to be in the "more likely than not" risk category with a mean likelihood of 56% and a standard error (SE) of 10% (Fig. 7.20.4). This SE was calculated by taking the standard deviation of the seven mean voting scores of the BRT members and shows the coherence among the BRT. The uncertainty of the BRT is reflected in the range of votes of 10%–99% (Fig. 7.20.4) and the average range of likelihood estimates of the seven BRT voters (63%). That average range is the second highest for any species (Table 8.1), reflecting the uncertainty among BRT members inherent in the lack of adequate ecological and demographic information for *Caulastrea echinulata*.