PROCEEDINGS OF THE BIOLOGICAL SOCIETY OF WASHINGTON
120(2):214–226. 2007.

A newly documented species of *Madracis* (Scleractinia: Pocilloporidae) from the Caribbean

Jan M. Locke*, Ernesto Weil, and Kathryn A. Coates

(JML, EW) Department of Marine Sciences, University of Puerto Rico, Mayagüez, P.O. Box 908, Lajas, Puerto Rico 00667, e-mail: JML100@gmail.com, eweil@caribe.net;
(KAC) Department of Conservation Services, P.O. Box FL 588, Flatts, Bermuda FL BX, e-mail: kcoates@transact.bm

Abstract.—*Madracis auretenra*, new species, is described for a common, shallow-water, zooxanthellate coral species found throughout the wider Caribbean. This new species is distinguished from other species of the genus by a thin branched, dendritic morphology and depth distribution of 1–60 m. Other characteristics include: non-living basal branch portions; a fairly smooth coenosteum; a distinct line of coenosteal spines centrally located between adjacent corallites; no visible secondary septa in corallites; and closely spaced corallites. Individuals of this taxon have been incorrectly referred to *Madracis mirabilis* (Duchassaing & Michelotti 1860), which is a deep-water species and which is synonymous with *Madracis myriaster* (Milne-Edwards & Haime 1849), in several publications subsequent to 1973. Herein, a brief explanation of the taxonomic confusion surrounding *M. mirabilis* and the undescribed species is provided along with a complete description of this new species of *Madracis*. Records of the new species are confirmed for Puerto Rico, Curaçao, Grenada, and Bermuda. Authors of many recent studies on "*Madracis mirabilis* sensu Wells" will need to reconsider and reconfirm the identities of their study organisms.

Coral reef ecosystems are the current focus of many marine biologists and ecologists, including large research consortia, and are of great interest to the larger public that is extremely concerned about global climate change. Studies of scleractinian biodiversity, genetics, toxicology, and disease are providing valuable data that are informing preservation and conservation of these systems. Unfortunately, the importance of sound α-taxonomy (species determination) as the foundation of much of this research is not fully understood or appreciated. Accurate explanations of anthozoan biology and regional biodiversity patterns are highly dependent upon correct and consistent taxonomy (Daly & den Hartog 2004).

Scleractinian corals are considered to be taxonomically problematic in that species are difficult to distinguish if one attempts to adhere to a strict definition of a biological species (genetic independence) or rely on morphology alone (Willis 1990, Knowlton 2001). Morphological variation is exhibited within individuals and species and there is an overall lack of documentation of this intraspecific variability for widely accepted species. Veron (1995) suggested that some of the difficulties in recognizing morphological boundaries between species may stem from reticulate evolution (hybridization) among species. However, some taxonomic problems in this group, as well as in

* Corresponding author.

Table 1.—Statistical mean and standard deviation $\bar{X}$ (*SD*) reported for six morphological characters for the "type" of *S. mirabilis*, and specimens of *M. myriaster* and *M. auretenra*. The results of this preliminary study confirm statistically significant differences between *M. myriaster* and *M. auretenra* (*ANOVA*, $P < 0.001$). Results of Holm-Sidak pairwise comparisons are denoted by lowercase letters each of which indicates a statistically different group. Characters indicated with an asterisk distinguish the two species.

	Madracis myriaster			*Madracis auretenra*		
	MZUT 358	USNM 79719	USNM 79726	PR1	PR2	BDA1
Diameter (mm)*						
Corallite*	1.55(0.09)a	1.54(0.09)a	1.54(0.13)a	1.32(0.13)b	1.31(0.14)b	1.49(0.13)c
Columella*	0.8(0.10)a	0.85(0.07)a	0.76(0.11)a	0.64(0.14)b	0.56(0.15)b,c	0.51(0.09)c
Length (mm)						
Primary Septa	0.42(0.06)a	0.42(0.06)a	0.38(0.04)b	0.35(0.07)b	0.37(0.09)b	0.49(0.06)c
Neighbor Distance (mm)*						
Minimum*	1.2(0.29)a	1.24(0.26)a	1.15(0.23)a	0.73(0.18)b	0.46(0.13)c	0.38(0.22)c
Maximum*	5.10(1.32)a	4.54(1.26)a	3.65(0.86)b	1.51(0.28)c	1.51(0.22)c	0.94(0.24)d
Density (cm^{-2})*						
Corallite*	7.70(1.75)a	8.01(1.12)a	11.83(1.46)b	21.33(1.10)c	22.09(2.25)c	21.29(3.12)c

Note: PR1 = Paratype USNM 1098755; PR2 and BDA1 = other material.

other groups of invertebrates, have originated through simply failing to apply basic taxonomic practices, such as referring to original species descriptions and type material.

The current and common use and referral of the name *Madracis mirabilis* (Duchassaing & Michelotti 1860) (sensu Wells 1973a) to what is, in fact, an undescribed species is an instructive example of the importance of rigorous application of the best taxonomic methods. Type material of *M. mirabilis* has been confirmed to be *Madracis myriaster* (Milne-Edwards & Haime 1849) a deeper occurring azooxanthellate species (Cairns 1979; Table 1). The shallow-water, zooxanthellate, thin-branched coral that is widely distributed in the Caribbean region and that regularly is incorrectly referred to *M. mirabilis* (see Veron 2000 for example; note that the species authority for *M. mirabilis* cited in Veron is incorrect) has never been formally described or named. As it is nomenclaturally preoccupied, the name *M. mirabilis* is unavailable for this or any other species (ICZN 1999). Herein, one widely distributed, thin-branched, common, shallow-water species of *Madracis* is described and named, resolving at least some of the confusion between deep, azooxanthellate, and shallow, zooxanthellate, species of *Madracis* in the Caribbean.

Brief taxonomic review of *Madracis* and *M. mirabilis*

The original descriptions of two, indeed the same, genera of scleractinian coral, *Axhelia* and *Madracis*, were presented in a single publication of Milne-Edwards and Haime (1849). The type species of these genera were designated *Axhelia myriaster* and *Madracis asperula*, respectively. Pourtalès (1871) revised and synonymized the two genera, designating *Madracis* as the senior synonym; however, his later actions (Pourtalès 1874; mentioned below) with regard to *Stylophora mirabilis* suggest he subsequently reconsidered this decision. In accord with this possibility, Vaughan (1901) synonymized *Madracis* Milne-Edwards & Haime, 1849 with *Axhelia* Milne-Edwards & Haime, 1849 and transferred *M. asperula* to *Axhelia*. Vaughan & Wells (1943) returned both *A. myriaster* and *Axhelia asperula* to *Madracis* in a reversal of Vaughan's (1901) action, and *Axhelia* became, in practice, the junior synonym.

According to the current understanding of the genus, *Madracis* Milne-Edwards & Haime, 1849 is a common taxon in temperate and tropical waters from the Atlantic and Caribbean through the Pacific to the Indian Ocean and Red Sea (Cairns 1999, Veron 2000, Vermeij et al. 2003a). Excluding the new species described herein, there are currently 15 valid and extant azooxanthellate and zooxanthellate species of *Madracis* worldwide (Cairns 1999, Vermeij et al. 2003a). Ten of these species are reported as azooxanthellate; *Madracis pharensis* (Heller 1868) and *M. asperula* are reported both with and without zooxanthellae. The only zooxanthellate species from the Pacific and Indian Oceans is the laminar and encrusting *Madracis kirbyi* Veron & Pichon, 1976 (Cairns 1999). Within the wider Caribbean, seven extant zooxanthellate *Madracis* are recognized (Cairns 1999, Vermeij et al. 2003a, 2003b). Taxonomic debate continues within the genus regarding the species status of *Madracis decactis* (Lyman 1859), *M. pharensis*, and *Madracis formosa* Wells, 1973b (Fenner 1993, Diekmann et al. 2001; see Vermeij et al. 2003b).

Madracis mirabilis was first described from St. Thomas, Lesser Antilles, as *Stylophora mirabilis* Duchassaing & Michelotti, 1860, and a specimen, now considered by some as a paralectotype, was deposited at the Museo Zoologia Università, Turin, Italy. Rossi (1959) assigned holotype status to the specimen in Turin, believing it to be the only material deposited by the authors. Recently, it has been related that specimens or fragments of specimens from the Duchassaing & Michelotti collection were donated by Michelotti to the Museum of Florence. The specimen of *S. mirabilis* in Florence has catalogue number MZUF 63 and is accompanied by the notes ''St. Thomas'' and ''fragment of the specimen represented in the original plate.'' Accordingly, the curators in Florence have designated the specimen in Florence the lectotype and the specimen in Turin paralectotype (see Volpi & Benvenuti 2003). Additional information about the original specimen indicates that some fragments may also be located in museums in Florence, Paris, London, and at Harvard University. Neither the original description of the species, nor the information with the deposited specimens, included a collection depth.

In 1874, Pourtalès placed *S. mirabilis* within the genus *Axohelia* Milne-Edwards & Haime, 1849 (sic, misspelled for *Axhelia* Milne-Edwards & Haime, 1849); subsequently reporting it in 1880 from a depth range of 336–1572 ft. Vaughan (1901) synonymized the deep-water species *Axhelia schrammi* (Pourtalès, 1874) with *A. mirabilis*, and reported *A. mirabilis* from a depth of 258 ft. In the same year Verrill (1901) indicated that *A. schrammi* and *Axohelia myriaster* Milne-Edwards & Haime, 1849 were the same. The combination of these actions (Vaughan 1901, Verrill 1901) have the effect of synonymizing *A. mirabilis* with *A. myriaster*, with the latter being the senior synonym.

Vaughan & Wells (1943) reinvigorated use of the name *Madracis mirabilis*, unfortunately without discussion of the earlier history and events surrounding this taxon and without justifying their action (S. D. Cairns, pers. comm.). The record of *Madracis mirabilis* in Vaughan & Wells (1943) is of the specimen reported by Vaughan (1901) from 258 ft, and up to that time *M. mirabilis* had been reported only as a deep-water coral, occurring over a depth range of 258–1572 ft.

Subsequently, specimens of shallow-water *Madracis* were identified as the deep-water azooxanthellate taxa *M. mirabilis* and *M. asperula* (Goreau 1959, Lewis 1960, 1965; Roos 1964, also see Cairns 2000), possibly because these were the only existing descriptions of branching species of *Madracis*. These authors

did not provide descriptions of their material and based on the literature alone, it is not possible to determine what species they may have had. Goreau & Wells (1967) seem to be the first to specifically list *M. mirabilis* (= *M. myriaster*) as a shallow-water inhabitant. In this publication (Goreau & Wells 1967), *M. mirabilis* is reported as previously recorded from Jamaica as *M. asperula* from a depth range of 1–60 m (1–180 ft), and to be very common. Goreau & Wells (1967) provided no description of their material and did not substantiate their identification of it as *M. mirabilis* in any particular way, for example by comparison to the originally deposited specimen. *Madracis asperula* is a deep-water, azooxanthellate species (100 m) (Cairns 2000, Vermeij et al. 2003b), which has extremely slender branches (3 mm in Wells 1973a; 1.7 mm in Cairns 2000; and 1.7 mm, J. M. Locke, pers. obs., USNM specimens 99046, 99048 and 45507), so that it should be readily distinguished from the shallow-water, zooxanthellate, branching forms of the genus, even in the field.

Wells (1973a) presented an artificial key of *Madracis* species in which he keyed shallow-water, thick-branched (6–10 mm) *Madracis* specimens as *M. mirabilis*. Of the other keyed species in Wells (1973a), branch diameter is only reported for *M. asperula* (slender, 3 mm) and *M. formosa* (thick, 15 mm). Wells (1973a) also included *M. myriaster* (to which *M. mirabilis* is a junior synonym) in his key as a deep-water azooxanthellate species. Since this publication (Wells 1973a), most literature on Caribbean corals has referred the name *M. mirabilis* to common, branched, shallow-water (1–60 m) corals that monopolize large reef areas in some habitats. In fact, this species (or group of species—see Discussion) remains undescribed. Nonetheless, it has become a common experimental taxon for numerous coral reef-related studies and the name *M. mirabilis* has become deeply entrenched within the literature for shallow, thinly-branched zooxanthellate species of the genus.

Cairns (1979) raised the problems with the taxonomy and the use of the name *M. mirabilis* in his work on deep-water Scleractinia. He examined the type material of *M. mirabilis* held in Turin (MZUT 358) and found, in confirmation of Vaughan (1901), that it was the same morphological species as *M. myriaster*, a striate, deep-water, azooxanthellate species. [Note: this type specimen has been referred to as holotype (Cairns 1979:28, 29), syntype (Cairns 1979: plate 1, fig. 4) and now as paralectotype (Volpi & Benvenuti 2003: L. Levi, pers.comm.)]. Cairns (1979) considered *Stylophora mirabilis* a junior synonym of *M. myriaster* and also stated that the common, shallow-water nonstriate species, known today as *M. mirabilis* sensu Wells, 1973, required a new name. More than 25 years, and many specific studies later, *Madracis mirabilis* sensu Wells, 1973 remains undescribed and without a legitimate name.

Morphometric analysis of colony and corallite characters among a type specimen of *M. mirabilis, M. myriaster* material, and new material of a shallow-water zooxanthellate species that could be identified as *M. mirabilis* sensu Wells, 1973 (Appendix I) have corroborated Cairns' (1979) prediction. A new species is described herein, for this shallow-water, thin-branched form of *Madracis* that is found throughout the Caribbean region and in Bermuda.

Materials and Methods

An overall, general description of each freshly collected specimen was made; the specimens were bleached, rinsed with fresh water and dried, prior to morphometric measurements.

Material of other species examined were *Madracis myriaster* from the National Museum of Natural History, Smithsonian Institution (USNM), USNM 79719,

79726 and *Stylophora mirabilis* from the Museo Zoologia Università de Torino (MZUT) MZUT 358 (image provided by L. Levi).

All material was examined and photographed using an Olympus SZ410 stereomicroscope with analog camera and "Snappy 4.0" image capture. Images of individual corallites were taken using a Scopetronix "Max view Plus" system with a Canon S45 digital camera and captured with Canon ZoomBrowser® Ex 4.1 remote capture. Measurements were taken using SigmaScan Pro® 5.0.0 (SPSS Inc. 2002). Ten corallites were measured for each specimen and four characters were measured per corallite; corallite diameter; columella base diameter; length of primary septa; and width of primary septa. The distance from inside corallite wall to closest inside corallite wall; distance from wall to farthest neighboring corallite; and diameter of branches and density of corallites cm^{-2} were also recorded for each specimen. All measurements were taken at least 1 centimeter from branch tips. For each trait measured, the mean and standard deviation were calculated using SigmaStat® 3.0 (SPSS Inc. 2002; Table 1).

SigmaStat 3.0 (SPSS Inc. 2002) was used to confirm differences between *M. myriaster* and the new species described herein. A one-way analysis of variance (ANOVA) was done for specimens for six morphometric characters among *Stylophora mirabilis* MZUT 358, specimens of *M. myriaster* and specimens of the new species (Table 1). Statistically significant differences were further analyzed using Holm-Sidak *post hoc* tests for multiple pairwise comparisons. For distance from inside corallite wall to farthest neighboring corallite wall values were log transformed (Table 1).

Family Pocilloporidae Gray, 1842
Genus *Madracis* Milne Edwards & Haime, 1849

Diagnosis (after Cairns 1979, 1999).—Colonial, extratentacular budding producing massive or ramose coralla. Coenosteum costate or spinose. Septa arranged in groups of six, eight, or ten, but rarely in more than two cycles. Columella styliform. Paliform lobes often present on first cycle of septa.

Type species.—*Madracis asperula* Milne Edwards & Haime, 1849, by monotypy.

Remarks.—A synonymy of the genus is presented in Vaughan (1901) and Vaughan & Wells (1943). We know of no substantial revisions since these two.

Madracis auretenra, new species
Figs. 1–5

Madracis asperula.—Lewis, 1960:1133, 1139, 1140, figs. 9–11.—Roos, 1964:7, pls. 4b, 6b.

Madracis mirabilis.—Werding & Erhardt, 1976:49, pl. 4, fig. 1.—Colin, 1978:212 (color), 214, 215.—Cairns, 1982:274, fig. 120e.—Lewis & Snelgrove, 1990:268, figs. 1a–c.—Bruno & Edmunds, 1997:2179, figs. 1a, b.—Grotolli-Everett & Wellington, 1997:292, fig. 1.—Veron, 2000:20, 21 (color).—Humann & Deloach, 2002:103 (color).

Holotype.—Four branches from one colony, two of which are fused, USNM (1098754), dry skeletal specimen, collected Jan, 2006 by JML.

Type locality.—Media Luna SW fore reef of barrier reef, La Parguera, Puerto Rico. 17°56.086′N, 67°03.010′W. Colony 17 cm in height and 46 by 30 cm in diameter. Depth 11.5 m.

Paratypes.—Five colony branches, USNM 1098755 Cayo Laurel W, patch reef (3–5 m), La Parguera, Puerto Rico, 17°56.496′N, 67°04.034′W; USNM 1098756 near Chubb Head SW, patch reef (6 m), Bermuda 32° 15.074′N, 64°58.613′W; USNM 1098757 Aquarium reef, fringing reef (10–20 m), Curaçao 12°05.039′N, 68°53.693′W; USNM 1098758 Flamingo reef, fringing reef

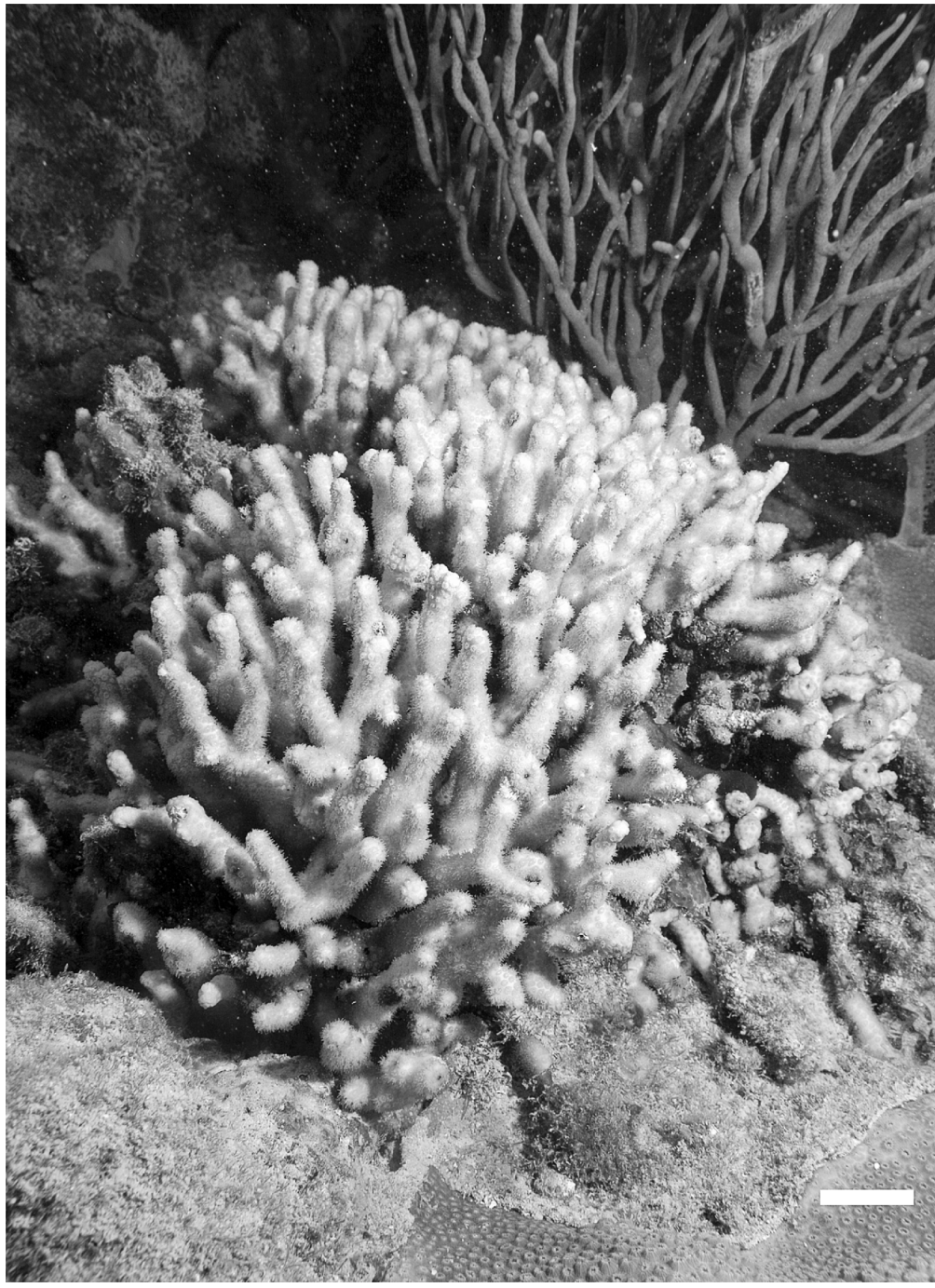

Fig. 1. Live solitary colony of *Madracis auretenra* holotype in situ at Media Luna SW Puerto Rico. Depth 11.5 m. Scale bar = 2 cm.

Fig. 2. *Madracis auretenra* holotype, from Media Luna SW, Puerto Rico, illustrating the normal branching morphology, strong secondary and short tertiary branches, and dead basal branch portions. Scale 2 bar = cm.

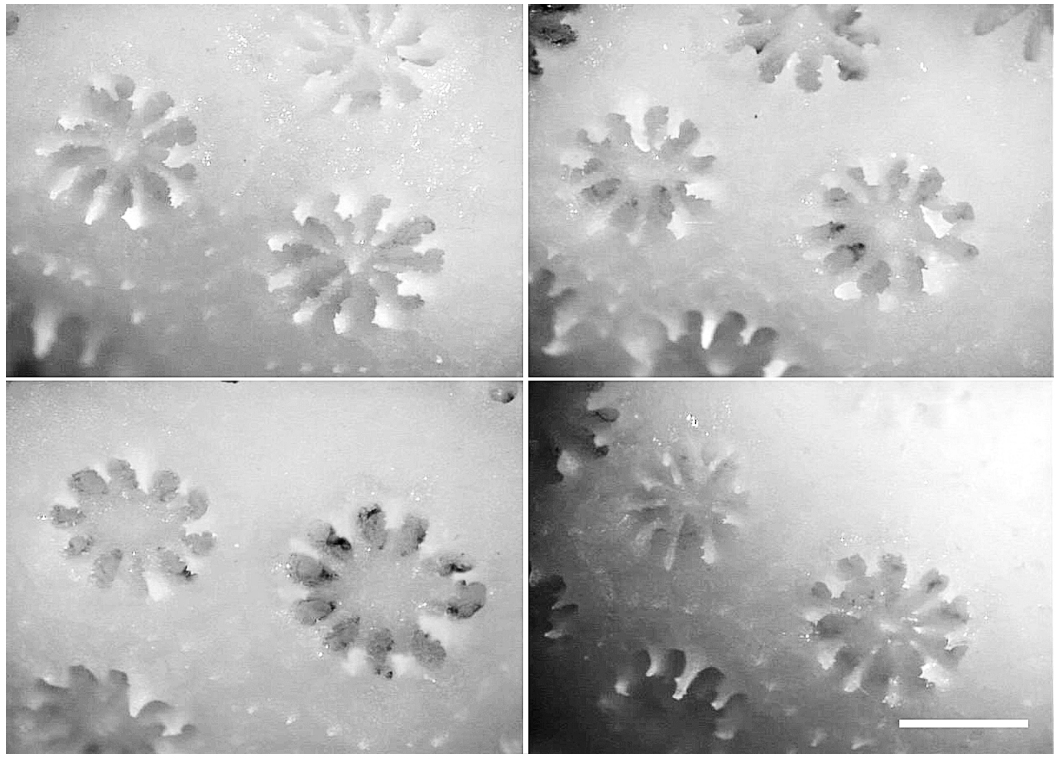

Fig. 3. Representation of intracolony corallite variation in one branch of the holotype. Note differing columella morphology and boundary spines between corallites. Scale bar = 1 mm.

(10 m), Grenada 12°05.517′N, 61°45.544′W; and Bermuda Aquarium Museum and Zoo, BAMZ 2006 251 016, Tynes Bay, patch reef (8 m), Bermuda 32°18.461′N, 64°46.569′W.

Other material examined.—Two branches from separate colonies from Cayo Laurel W, patch reef (3–5 m), La Parguera, Puerto Rico, 17°56.496′N, 67°04.034′W; one colony branch collected Tynes Bay, patch reef (7 m), Bermuda 32°18.461′N, 64°46.569′W, two colony branches from Aquarium reef, fringing reef (10–20 m), Curaçao and two colony branches from Flamingo reef, fringing reef (10 m), Grenada, coll. EW.

Description.—Colony of several separate, thin, short to elongate branches, originating centrally and radiating upward and outward (Fig. 1). Occasional fusion between branches. Basal portions of colony branches often dead (Fig. 2). Healthy colony color most often pale yellow to golden brown; zooxanthellate with Clade B zooxanthellae (Bermuda) (L. Holland 2006, pers. comm.). Branch length from dead basal skeleton to live tip from 2.0–6.1 cm ($n = 31$, $\bar{X} = 4.4$, $SD = 1.0$). Branches thin in comparison to other species of *Madracis*, diameters from 4.9–10.1 mm ($n = 60$, $\bar{X} = 7.4$, $SD = 1.3$). Branches circular in cross-section. Branches often bifurcate into secondary and rarely tertiary branches (Fig. 2). Corallites round to slightly oval (Fig. 3). Corallite diameter 0.9–2.3 mm ($n = 364$, $\bar{X} = 1.5$, $SD = 0.2$). Corallites with 10 prominent, primary septa; no secondary septa observed. Very rarely, larger corallites, diameters 1.6–2.3 mm ($n = 8$, $\bar{X} = 1.9$, $SD = 0.3$), with 16 septa. Length of primary septa 0.2–0.7 mm ($n = 262$, $\bar{X} = 0.4$, $SD = 0.08$). Width of primary septa 0.07–0.2 mm ($n = 262$, $\bar{X} = 0.1$, $SD =$

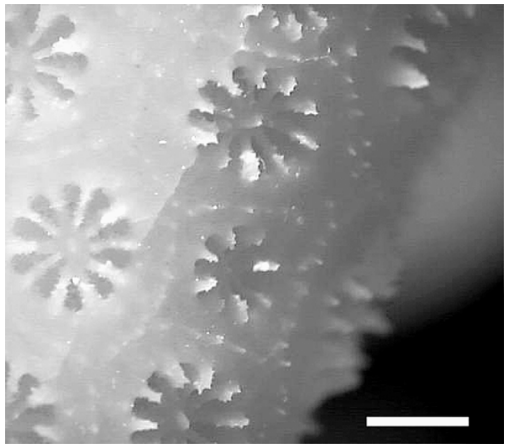

Fig. 4. Coenosteum of *Madracis auretenra* exhibiting boundary spines between corallites. Scale bar = 1 mm.

0.03). With intracolony variation in corallites. Septa connect to a central columella; columella flat, or with slight central bump sunken within corallite, or protruding to point matching height of extended septa (Fig. 3). No observed intracolony distribution pattern of columella type. Small spines on primary septa occasional. Distance from inside wall of corallite to nearest neighboring corallite inside wall 0.2–1.1 mm ($n = 130$, $\bar{X} = 0.6$, $SD = 0.15$) and distance to furthest neighboring corallite 0.7–2.6 mm ($n = 130$, $\bar{X} = 1.3$, $SD = 0.4$). Corallite density 16–36 corallites cm^{-2} ($n = 65$, $\bar{X} = 26$, $SD = 5$). Corallites flush with coenosteum or raised; often primary septa project above coenosteum. Coenosteum slightly granular, often with distinct lines of intercorallite spines; spines forming five-sided corallite boundaries (Figs. 3, 4).

Etymology.—The species is named from Latin to represent its thin, golden branched appearance, *aureus*, of the color of gold, *tenuis*, thin, *ramus*, branch.

Taxonomic remarks.—*Madracis auretenra* represents the seventh described, extant, species of the genus in the

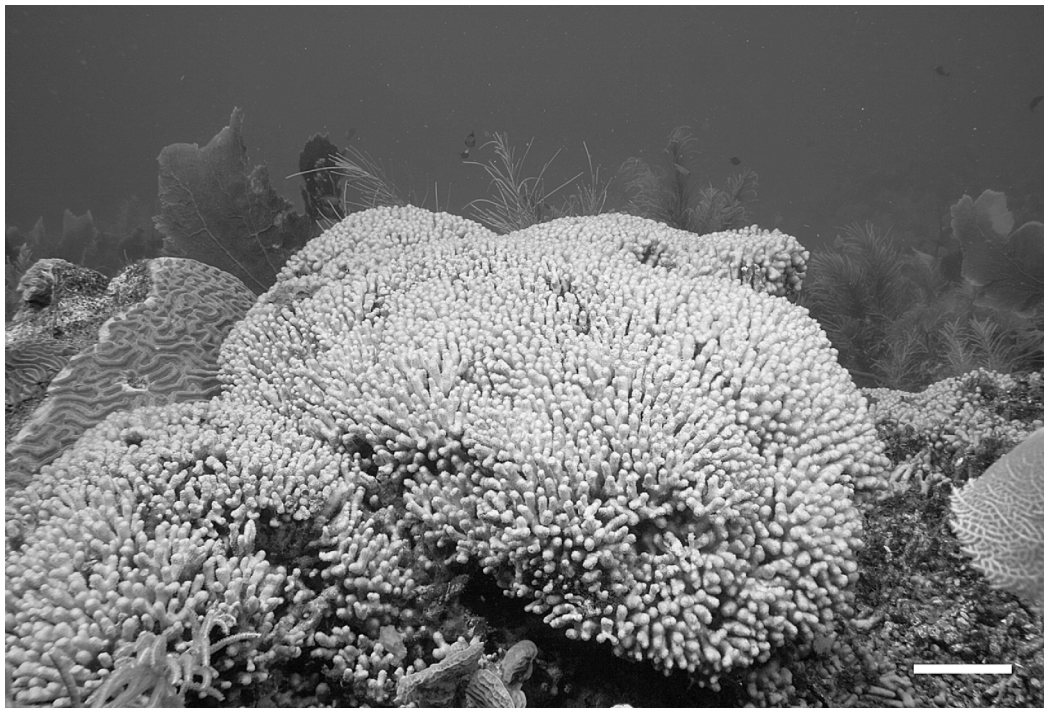

Fig. 5. Colonial field of *Madracis auretenra* located on the south side of Mona Island, Puerto Rico. Depth 20 m. Scale bar = 10 cm.

Table 2.—Zooxanthellate *Madracis* species with known distributions in the Atlantic (+ indicates species which may also be azooxanthellate). * Mistakenly called by the name *M. mirabilis*.

Species	Distribution
Madracis asperula+ Milne-Edwards & Haime, 1849	West and East Atlantic
Madracis decactis (Lyman, 1859)	West and East Atlantic
Madracis carmabi Vermeij, Diekmann & Bak, 2003	West Atlantic
Madracis formosa Wells, 1973a	West Atlantic
Madracis auretenra new species*	West Atlantic
Madracis pharensis+ (Heller, 1868)	West and East Atlantic
Madracis senaria Wells, 1973b	West Atlantic

Caribbean region (Table 2). It differs from known, extant *Madracis* species by a combination of the following characters: its thin (4.9–10.1 mm), usually elongate, branches; decamerally arranged septa; linear spines on the coenosteum; presence of zooxanthellae; and depth range. Other shallow-water, branching species of *Madracis* possessing zooxanthellae and corallites with ten septa are *M. decactis* and the more recently described *M. carmabi* Vermeij, Diekmann & Bak, 2003, but both of these have blunt or lobed branches of a wider diameter (12.5–26 mm) than found in *M. auretenra*. Similar species to *M. auretenra*, which also have thin branches, but occur in deeper water, are azooxanthellate *M. myriaster*, which possesses a striate coenosteum and widely-spaced corallites, and *M. asperula*, the colonies of which are small and delicate with extremely slender branches (1.7–3 mm). [Cairns (2000) stated the largest colony of *M. asperula* he examined was 4 cm in height with an attachment base of 3.5 cm.]

Habitat and distribution.—Inhabits mostly intermediate water depths (5–15 m) but can be found from 1–60 m. Known from Atlantic and wider Caribbean regions: Bermuda, Curaçao, Grenada and Puerto Rico.

Colonies of *M. auretenra* may be distributed as large fields or be solitary (Figs. 1, 5), possibly attributable to asexual or sexual modes of propagation, respectively.

Other remarks.—A partial 18S ribosomal RNA gene sequence is available for *M. auretenra*, (labeled as *M. mirabilis*) from GenBank under accession number AY950684.

Discussion

Madracis auretenra may continue to carry the common name applied to it, "yellow pencil coral," throughout the wider Caribbean region—which was not a name ever given to the true *M. mirabilis* (a junior synonym of *M. myriaster*). Following the synonymy of *M. mirabilis* with *M. myriaster*, this common name was, however, applied to *M. myriaster* in the species database of the Convention on International Trade in Endangered Species (CITES) (UNEP-WCMC 2006) [http://www.unep-wcmc.org/isdb/CITES/Taxonomy/tax-species-result.cfm?display-language=eng&Genus=Madracis&Species=myriaster&source=animals&Country=]. *Madracis myriaster* is commonly referred to as "striate finger coral" (Cairns 2000, Cairns et al. 2002).

The presence of a striate coenosteum in the paralectotype of *M. mirabilis*, which is absent in *M. auretenra*, and significant differences in five corallite characters (corallite diameter, columella base diameter, near and far distances between corallites and density of corallites cm^{-2}) provide evidence that the type of *M. mirabilis* is different from *M. auretenra* (Cairns 1979, Table 1). The corallite

character, primary septal length, was significantly different within each species but not between *M. myriaster* and *M. auretenra* (Table 1). The formalized synonymy of *M. mirabilis* with *M. myriaster* (Cairns, 1979) renders the name *M. mirabilis* unavailable for the zooxanthellate, shallow-water, thin-branched species of *Madracis* found in the Caribbean region.

Considering the numerous (>125) studies (pers. obs.) that have experimented with or referred to "*M. mirabilis* sensu Wells" as a shallow-water taxon, clarification of the taxonomy of this coral may be considered a nuisance to some who are considering issues of coral reef preservation and conservation. However, advocating and retaining this unsupported taxonomy—to suit individual and immediate needs—has many negative implications.

Increasing interest in deep-water, azooxanthellate species and in the differences in physiology between azooxanthellate and zooxanthellate groups is sure to bring attention to the true *M. mirabilis* (= *M. myriaster*). Thus, confusion of shallow and deep-water taxa is a looming problem.

As a result of Cairns' (1979) investigations, the only mention of *M. mirabilis* within the species database of the Convention on International Trade in Endangered Species (CITES) is as a synonym for *M. myriaster*. Thus, *M. auretenra*, which has previously been called "M. mirabilis," is not in that list, and not afforded any of the protection that being listed provides.

At this point it is not possible to have any confidence that the numerous studies referring to "*M. mirabilis*," as indicated above, have all considered one and the same species given that: previously there has been no detailed and specific reference for the identification of the species; and very few authors provide comprehensive descriptions of their specimens. Nonetheless, limited molecular and reproductive data (Diekmann et al. 2001; Vermeij et al. 2003b, 2004) suggest that within shallow coral reef habitats of the Caribbean, there is only one thin-branched *Madracis* taxon or "yellow pencil coral." Thus, studies subsequent to 1973 referring to the shallow-water, thin-branched *Madracis* species misidentified as *M. mirabilis*, have some probability (greater than 0) of having considered the newly described *M. auretenra*. However, the only way of confirming this is if voucher specimens from the original studies have been kept or recorded (as high resolution photographs, for example). The synonymy provided herein, lists only citations which include complete descriptions (none) or images that can be identified as the new species. We can only hope that some authors now will undertake to confirm their identifications and that they will consistently adopt the best practice of keeping and safely storing taxonomic reference materials. We also hope to encourage reference to primary taxonomic literature and taxonomic experts, and to discourage a total reliance on handbooks, guidebooks and brief keys. The last three are invaluable resources, but they are the starting—not end—points for a species identification.

Acknowledgments

Sincere appreciation is expressed to Stephen D. Cairns for his generous and patient correspondence. Gratitude is extended to Lisa Levi, Museo Regionale di Scienze Naturali, Torino for her detailed and very informed assistance and to Hector Ruiz for his in situ colony photography. Logistical support was provided by the University of Puerto Rico, Marine Science Department. Financial support was provided for JML by National Science Foundation Grant # EPS-0223152. This is contribution number 118 of the Bermuda Biodiversity Project of

the Bermuda Zoological Society and Bermuda Aquarium, Museum and Zoo.

Literature Cited

Bruno, J. F., & P. J. Edmunds. 1997. Clonal variation for phenotypic plasticity in the coral *Madracis mirabilis*.—Ecology 78:2177–2190.

Cairns, S. D. 1979. The deep-water Scleractinia of the Caribbean and adjacent waters.—Studies on the Fauna of Curaçao and other Caribbean Islands 57:1–341, 40 plates.

———. 1982. Stony corals (Cnidaria: Hydrozoa, Scleractinia) of Carrie Bow Cay, Belize.—Smithsonian Contributions to the Marine Sciences l2:271–302, pls. ll9–l33.

———. 1999. Species richness of recent Scleractinia.—Atoll Research Bulletin No. 459: 1–46.

———. 2000. A revision of the shallow-water azooxanthellate Scleractinia of the Western Atlantic.—The Natural History of the Caribbean Region 75:1–240, 215 figs.

———, et al. 2002. Common and Scientific Names of Aquatic Invertebrates from the United States and Canada: Cnidaria and Ctenophora. Second Edition. American Fisheries Society Special Publication 28, Bethesda, Maryland, 115 pp.

Colin, P. L. 1978. Caribbean Reef Invertebrates and Plants. T. F. H. Publications, Inc., Ltd., Hong Kong, 512 pp.

Daly, M., & J. C. den Hartog. 2004. Taxonomy, circumstance, and usage in *Anthopleura* (Cnidarian: Anthozoa: Actiniaria) from the Gulf of Mexico and Caribbean.—Bulletin of Marine Science 74:401–421.

Diekmann, O. E., R. P. M. Bak, W. T. Stam, & J. L. Olsen. 2001. Molecular genetic evidence for a probable reticulate speciation in the coral genus *Madracis* from a Caribbean fringing reef slope.—Marine Biology 139: 221–233.

Duchassaing, P., & J. Michelotti. 1860. Mémoire sur les coralliaires des Antilles.—Memoires of the Academy of Science, Torino 19:279–365, 10 plates.

Fenner, D. P. 1993. Species distinctions among several Caribbean stony corals.—Bulletin of Marine Science 53:1099–1116.

Goreau, T. F. 1959. The ecology of Jamaican coral reefs: I. Species composition and zonation.—Ecology 40:67–90.

———, & J. W. Wells. 1967. The shallow-water Scleractinia of Jamaica: revised list of species and their vertical distribution range.—Bulletin of Marine Science 17:442–453.

Gray, J. E. 1842. Northern Zoological Gallery, Room II, III, Radiated animals, Pp. 128–135, Synopsis of the Contents of the British Museum. London, 44th edition.

Grotolli-Everett, A. G., & G. M. Wellington. 1997. Fish predation on the scleractinian coral *Madracis mirabilis* controls its depth distribution in the Florida Keys, U.S.A.—Marine Ecology Progress Series 160:291–293.

Heller, C. 1868. Die Zoophyten und Echinodermen des Adriatischen Meeres.—Zoologische Botanische Verhandlungen Wien 18:1–88.

Holland, L. P. 2006. The molecular diversity of Symbiodinium (Seussiales: Dinoflagellata) within Alcyonacea of Bermuda and the Caribbean. M.Sc. thesis, Department of Zoology, University of Toronto, 213 pp.

Humann, P., & N. Deloach. 2002. Reef Coral Identification: Florida, Caribbean, Bahamas, including marine plants, Second Edition. New World Publications, Inc., Jacksonville, Florida, 278 pp.

International Commission on Zoological Nomenclature. 1999. International Code of Zoological Nomenclature. 29, 306 pp. International Trust for Zoological Nomenclature, London.

Knowlton, N. 2001. Who are the major players on coral reefs and does it matter? The importance of coral taxonomy for coral reef management.—Bulletin of Marine Science 69:305–308.

Lewis, J. B. 1960. The coral reefs and coral communities of Barbados, W.I.—Canadian Journal of Science 88:1133–1145.

———. 1965. A preliminary description of some marine benthic communities from Barbados, West Indies.—Canadian Journal of Zoology 43:1049–1074.

———, & P. V. R. Snelgrove. 1990. Corallum morphology and composition of crustacean cryptofauna of the hermatypic coral *Madracis mirabilis*.—Marine Biology 106:267–272.

Lyman, T. 1859. On a new species of coral (*Astrea decactis*).—Boston Society of Natural History, Proceedings 6:260–263.

Milne-Edwards, H., & J. Haime. 1849. Memoire sur las polypiers appartenant a la famille des oculinides, au groupe intermediaire des pseuastreides et a la famille des fongides.—Comptes Rendus 29:67–73.

Pourtalès, L. F. 1871. Deep-Sea corals.—Illustrated. Catalogue of the Museum of Comparative Zoology 4:1–93, 8 plates. (Memoires of the Museum of Comparative Zoology 2).

———. 1874. Zoological results of the Hassler expedition. Crinoids and Corals. Illustrated.—Catalogue of the Museum of Comparative Zoology 8:33–50, plates 6–9.

———. 1880. Reports on the results of dredging by the US Coast Survey steamer Blake. VI. Report on the corals and Antipatharia.—Bulletin of the Museum of Comparative Zoology 6:95–120, 3 plates.

Roos, P. J. 1964. The distribution of reef corals in Curaçao.—Studies of the Fauna of Curaçao 20:1–51.

Rossi, L. 1959. Catalogo dei tipi di Madreporari esistenti nel Museo Zoologico di Torino.—Bollettino dell'Istituto e Museo di Zoologia dell'Università di Torino 6:3–12.

SPSS, Inc. 2002. SigmaStat® 3.0. SYSTAT Software, Inc., Chicago, Illinois,

United Nations Environment Program-World Conservation Monitoring Center. 7 November, 2006. UNEP-WCMC Species Database: CITES-Listed Species.

Vaughan, T. W. 1901. The stony corals of the Porto Rican waters.—Bulletin of the United States Fish Commission 1900 20:290–320, 38 plates.

———, & J. W. Wells. 1943. Revision of the suborders, families and genera of the Scleractinia.— Geological Society of America, Special Papers, 44.

Vermeij, M. J. A., O. E. Diekmann, & R. P. M. Bak. 2003a. A new species of scleractinian coral (Cnidaria, Anthozoa), *Madracis carmabi* n.sp. from the Southern Caribbean.—Bulletin of Marine Science 73:679–684.

———, E. Sampayo, K. Bröker, & R. P. M. Bak. 2003b. Variation in planula release of closely related coral species.—Marine Ecology Progress Series 247:75–84.

———, ———, ———, & ———. 2004. The reproductive biology of closely related coral species: gametogenesis in *Madracis* from the southern Caribbean.—Coral Reefs 23:206–214.

Veron, J. E. N. 1995. Corals in space and time. Cornell University Press, Ithaca, 322 pp.

———. 2000. Corals of the World. Vol. 2. Australian Institute of Marine Science, Townsville, 429 pp.

———, & M. Pichon. 1976. Scleractinia of eastern Australia. Part 1, Families Thamnasteriidae, Astrocoeniidae, Pocilloporidae.—Australian Institute of Marine Science Monograph Series I, 86 pp.

Verrill, A. E. 1901. Variations and nomenclature of Bermudian, West Indian, and Brazilian coral reefs, with notes on various Indo-Pacific corals.—Transactions of the Connecticut Academy of Arts Science II: 63–168, plates 10–35.

Volpi, C., & D. Benvenuti. 2003. The Duchassaing & Michelotti collection of Caribbean corals: status of types and location of the specimens.—Atti Società Italiana Scienze. naturali Museo civico di Storia naturale di Milano 144:51–74.

Wells, J. W. 1973a. New and old Scleractinian corals from Jamaica.—Bulletin of Marine Science 23:16–55, 36 figs.

———. 1973b. Two new hermatypic corals from the West Indies.—Bulletin of Marine Science 23:925–932.

Werding, B., & H. Erhardt. 1976. Los corales de la Bahia Chengue en el Parque Nacional "Tairona" (Colombia).—Mitteilungen aus dem Instituto Colombo-Aleman de Investigacioes Cientificas 8:45–57, 4 plates.

Willis, B. 1990. Species concepts on extant scleractinian corals: Considerations based on reproductive biology and genotypic population structures.—Systematic Botany 15:136–149.

Associate Editor: Stephen D. Cairns