



The black coral fauna (Cnidaria: Antipatharia) of Bermuda with new records

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Abstract

The black coral fauna of Bermudan waters is poorly known, in large part due to the logistical challenges of surveying deep-water (>50 m) environments where most species occur. In 2016, the Nekton Expedition sought to survey the deep-water biodiversity around Bermuda using manned submersibles and mixed-gas technical SCUBA. A total of 28 black coral specimens were collected, and these were examined based on skeletal spine morphology, polyp morphology, colony branching pattern and *in situ* photographs. The specimens were assigned to seven species in three families and four genera, including (1) *Antipathes atlantica* Gray, 1857, (2) *Antipathes furcata* Gray, 1857, (3) *Stichopathes pourtalesi* Brook, 1889, (4) *Stichopathes* sp., (5) *Distichopathes filix* (Pourtales, 1867), (6) *Tanacetipathes hirta* (Gray, 1857), and (7) *Tanacetipathes tanacetum* (Pourtales, 1867). Of these, three species (*Stichopathes* sp., *S. pourtalesi*, and *D. filix*), one genus (*Distichopathes*) and one family (Aphanipathidae) are reported from Bermudan waters for the first time, thereby increasing the known black coral diversity of Bermuda to twelve species, five genera and four families. The diagnostic characters of the taxa identified as part of this study are illustrated and described.

Key words: Antipathidae, Aphanipathidae, deep-sea coral, mesophotic coral ecosystem, Myriopathidae

Introduction

Antipatharians, commonly known as black corals, represent a taxonomic order within the anthozoan subclass Hexacorallia that currently encompasses ~250 described species (Brugler, *et al.*, 2013; France *et al.*, 2007). Black corals are characterized by (1) polyps with six unbranched tentacles that are non-retractile, (2) six primary mesenteries, (3) skeletons that are primarily proteinaceous and covered with spines, and (4) consisting entirely of colonial species (Brugler *et al.*, 2013; France *et al.*, 2007). Antipatharians occur worldwide in all oceans and have a wide bathymetric distribution ranging from 2–8600 m (reviewed by Wagner *et al.*, 2012). Despite this wide depth range, black corals are primarily found in deeper waters, with over 75% of described species being restricted to depths below 50 m (Cairns, 2007). At these depths, black corals are often dominant components of the benthic fauna (reviewed by Wagner *et al.*, 2012); however, they remain largely understudied in many locations, due to the logistical challenges of surveying deep-water environments, as well as the scarcity of taxonomic experts that work on this group (Cairns, 2007; Wagner *et al.*, 2012).

The deep-water fauna of Bermuda was first surveyed through deep-sea trawls conducted by the HMS *Challenger* Expedition in 1873–1874 (reviewed by Locke, Coates, & Bilewich, 2013). However, that expedition failed to document any black corals from Bermuda (Brook, 1889). Since then multiple more recent expeditions surveyed the deep-water coral fauna of Bermuda using manned submersibles, remotely operated vehicles, and mixed gas-technical SCUBA (reviewed by Locke *et al.*, 2013). Nine black coral species have been recorded as a result of these efforts (reviewed by Locke *et al.*, 2013), including (1) *Antipathes atlantica* Gray, 1857, (2) *Antipathes furcata* Gray, 1857, (3) *Antipathes gracilis* Gray, 1860, (4) *Stichopathes luetkeni* Brook, 1889, (5) *Stichopathes* cf. *spiessi* Opresko & Genin, 1990, (6) *Tanacetipathes hirta* (Gray, 1857), (7) *Tanacetipathes tanacetum* (Pourtales, 1880), (8) *Tanacetipathes thamnea* (Warner, 1981), and (9) *Parantipathes tetrasticha* (Pourtales, 1868). It is important to point out, however, that *A. gracilis* from Bermuda has been incorrectly synonymized with *Cupressopathes gracilis* (Locke *et al.*, 2013), a species that does not occur in Bermudan waters, and has to date only been recorded from the Indo-Pacific (Opresko, 2001).

In 2016, the Nekton Expedition sought to survey the deep-water biodiversity of Bermuda using manned submersibles and mixed-gas technical SCUBA diving. Several black coral specimens were collected as part of these surveys, including several new records. The purpose of this study was to provide taxonomic descriptions of black coral species collected by the Nekton Expedition using *in situ* observations, as well as morphological analyses of preserved specimens.

Materials and methods

A total of 28 specimens were examined, all of which were deposited in the invertebrate collections of the Bermuda Natural History Museum at the Bermuda Aquarium, Museum and Zoo (BAMZ; Table 1). Specimens were collected between July and August 2016 as part of the Nekton Expedition to the Northwest Atlantic Ocean and Bermuda using manned submersibles and mixed-gas technical SCUBA (Table 1). Morphometric measurements of polyps and skeletal spines were made from photographs of specimens that were preserved in 95% ethanol as described in Wagner *et al.* (2010). Additionally, samples were prepared for scanning electron microscopy (SEM) as described in Wagner *et al.* (2010), and viewed under a JEOL JSM5600LV SEM (JEOL USA Incorporated, Peabody, USA).

Results and discussion

Based on the overall morphology of colonies, polyps and skeletal spines, the 28 examined specimens belong to three families (Antipathidae, Aphanipathidae and Myriopathidae), four genera (*Antipathes*, *Stichopathes*, *Distichopathes*, *Tanacetipathes*) and seven species, three of which are recorded from Bermuda for the first time (Table 1). Examined specimens included some that were very similar to the type material described for (1) *Antipathes atlantica* Gray, 1857, (2) *Antipathes furcata* Gray, 1857, (3) *Stichopathes pourtalesi* Brook, 1889, (4) *Distichopathes filix* (Pourtales, 1867), (5) *Tanacetipathes hirta* (Gray, 1857), and (6) *Tanacetipathes tanacetum* (Pourtales, 1867), and were therefore assigned to those species. Furthermore, several examined specimens resembled a syntype of *S. pourtalesi* (Table 1), which has recently been reassigned to an undescribed species within the genus *Stichopathes* (Bo & Opresko, 2015). The diagnostic characters of the species identified as part of this study are discussed in the systematic section below and highlighted in Figures 1–7.

Family Antipathidae Ehrenberg, 1834

The family Antipathidae is characterized by polyps that (1) range from about 0.5 mm to more than 1 mm in transverse diameter, (2) are not elongated in the transverse plane, (3) possess six primary and four secondary mesenteries, and (4) have sagittal tentacles that are substantially longer than the lateral tentacles when fully expanded (Bo, 2008; Opresko, 2005; Opresko & Sanchez, 2005). However, the latter feature is frequently not apparent in preserved specimens. Historically, the Antipathidae has been considered a taxonomic dumping ground, and is the oldest and most species-rich antipatharian family (Bo, 2008; France *et al.*, 2007). As a result, colony and skeletal spine morphology is very heterogeneous within this family. While several taxa that formerly belonged to the Antipathidae have recently been transferred to new families (Opresko, 2006, 2004, 2003, 2002, 2001), the family is still considered polyphyletic and in need of further taxonomic revisions (Brugler *et al.*, 2013; France *et al.*, 2007). Two genera (*Antipathes* and *Stichopathes*) have previously been reported from the waters off Bermuda (Locke *et al.*, 2013), both which were recorded as part of this study (Table 1).

Genus *Antipathes* Pallas, 1766

Antipathes is the oldest black coral genus, and is distinguished by colonies that are branched, with branching patterns varying from fan-shaped to bushy (Opresko & Sanchez, 2005; Opresko, 1972). Like the family

Antipathidae, the genus *Antipathes* is considered a taxonomic dumping ground that includes highly heterogeneous forms (Opresko & Baron-Szabo, 2001). Even though many species have been removed from *Antipathes* and placed into new genera (Opresko, 2006, 2004, 2003, 2002, 2001; Opresko & Cairns, 1994), the genus still groups numerous species that are morphologically and phylogenetically heterogeneous, and is therefore in need of further revisions (Brugler *et al.*, 2013; Bo, 2008; France *et al.*, 2007). Two species have previously been reported from Bermuda (*A. atlantica* and *A. furcata*; Locke *et al.* 2013), both of which were recorded as part of this survey (Table 1).

TABLE 1. Black coral specimens examined as part of this study (BAMZ = Bermuda Aquarium, Museum and Zoo; NR = not reported; * = new record for Bermuda).

BAMZ catalogue number	Species	Collection date	Locality	Collection depth (m)	Latitude	Longitude
2016-337-002	<i>Antipathes atlantica</i>	July 25, 2016	Plantagenet	90	31°56.69'N	65°09.52'W
2016-337-014	<i>Antipathes atlantica</i>	August 3, 2016	Spittal	96	32°19.12'N	64°39.49'W
2016-337-023	<i>Antipathes atlantica</i>	August 7, 2016	Spittal	152	NR	NR
2016-337-015	<i>Antipathes atlantica</i>	August 7, 2016	Spittal	111	32°19.11'N	64°39.50'W
2016-337-010	<i>Antipathes atlantica</i>	August 7, 2016	Spittal	107	32°19.14'N	64°39.51'W
2016-337-008	<i>Antipathes atlantica</i>	August 9, 2016	Spittal	96	32°18.84'N	64°39.54'W
2016-337-017	<i>Antipathes atlantica</i>	August 11, 2016	Spittal	77	32°19.23'N	64°39.53'W
2016-337-028	<i>Antipathes atlantica</i>	August 7, 2016	Tiger	90	32°12.21'N	64°56.94'W
2016-337-024	<i>Antipathes atlantica</i>	August 7, 2016	Tiger	90	32°12.21'N	64°56.94'W
2016-337-004	<i>Antipathes atlantica</i>	August 9, 2016	Challenger	55-90	32°04.39'N	65°01.06'W
2016-337-003	<i>Antipathes atlantica</i>	August 9, 2016	Challenger	55-90	32°04.39'N	65°01.06'W
2016-337-012	<i>Antipathes furcata</i>	August 3, 2016	Spittal	104	32°19.15'N	64°39.49'W
2016-337-021	<i>Antipathes furcata</i>	August 3, 2016	Spittal	96	32°19.12'N	64°39.49'W
2016-337-001	<i>Stichopathes pourtalesi</i> *	July 23, 2016	NNE	146	32°30.14'N	64°37.17'W
2016-337-029	<i>Stichopathes pourtalesi</i> *	July 28, 2016	NNE	300	32°29.07'N	64°35.09'W
2016-337-009	<i>Stichopathes pourtalesi</i> *	August 9, 2016	Spittal	143	32°18.91'N	64°39.54'W
2016-337-020	<i>Stichopathes pourtalesi</i> *	August 9, 2016	Spittal	305	32°18.87'N	64°39.47'W
2016-337-019	<i>Stichopathes pourtalesi</i> *	August 9, 2016	Spittal	279	32°18.96'N	64°39.32'W
2016-337-026	<i>Stichopathes pourtalesi</i> *	August 12, 2016	Tiger	300	NR	NR
2016-337-022	<i>Stichopathes</i> sp.*	August 9, 2016	Spittal	279	32°18.96'N	64°39.32'W
2016-337-018	<i>Stichopathes</i> sp.*	August 9, 2016	Spittal	279	32°18.96'N	64°39.32'W
2016-337-027	<i>Stichopathes</i> sp.*	August 12, 2016	Tiger	304	32°10.92'N	64°58.91'W
2016-337-025	<i>Distichopathes filix</i> *	August 12, 2016	Tiger	304	32°10.92'N	64°58.91'W
2016-337-016	<i>Tanacetipathes hirta</i>	August 4, 2016	Spittal	125	32°18.66'N	64°39.64'W
2016-337-006	<i>Tanacetipathes hirta</i>	August 7, 2016	Spittal	152	NR	NR
2016-337-007	<i>Tanacetipathes hirta</i>	August 7, 2016	Spittal	122	32°19.22'N	64°39.44'W
2016-337-013	<i>Tanacetipathes tanacetum</i>	August 3, 2016	Spittal	96	32°19.12'N	64°39.49'W
2016-337-005	<i>Tanacetipathes tanacetum</i>	August 9, 2016	Challenger	55-90	32°04.39'N	65°01.06'W

Antipathes atlantica Gray, 1857

Antipathes atlantica forms large colonies that are 0.5 m in height or more, and are densely branched with most branches located in a single plane like a fan (Figure 1a–c). Adjacent branches are sometimes fused together to form a net-like pattern. The terminal branches are straight or slightly curved, and typically shorter than 1 cm without

becoming branched. The skeletal spines are smooth, triangular or slightly inclined distally, and are about the same width at their base as they are tall (Figure 1d–e). The spines are never bifurcated and are 40–100 μm in height. On smaller branches, the spines are arranged in axial rows with adjoining rows offset in a spiral pattern around the corallum (Figure 1d). Spine spacing is fairly even within each row, and ranges between 175–300 μm . The polyps are arranged on only one side of the corallum, are generally 0.5–1.1 mm in transverse diameter, and are spaced 1.1–1.7 mm apart (Figure 1c). All colonies observed as part of this study were grayish white *in situ* (Figure 1a), however, greenish colonies have also reported for this species in other locations (Opresko *et al.*, 2016; Opresko & Sanchez, 2005; Warner, 1981). *A. atlantica* has previously been reported from the Caribbean, Gulf of Mexico and Northwest Atlantic at depths ranging between 15–100 m (Cairns, Opresko *et al.*, 1993; Opresko, 2009; Opresko *et al.*, 2016; Opresko & Sanchez, 2005; Padilla & Lara, 2003; Sanchez, 1999; Sanchez *et al.*, 1998; Warner, 1981, 2005). Specimens examined as part of this study were collected at depths between 55–152 m (Table 1), thereby extending the known depth range of this species.

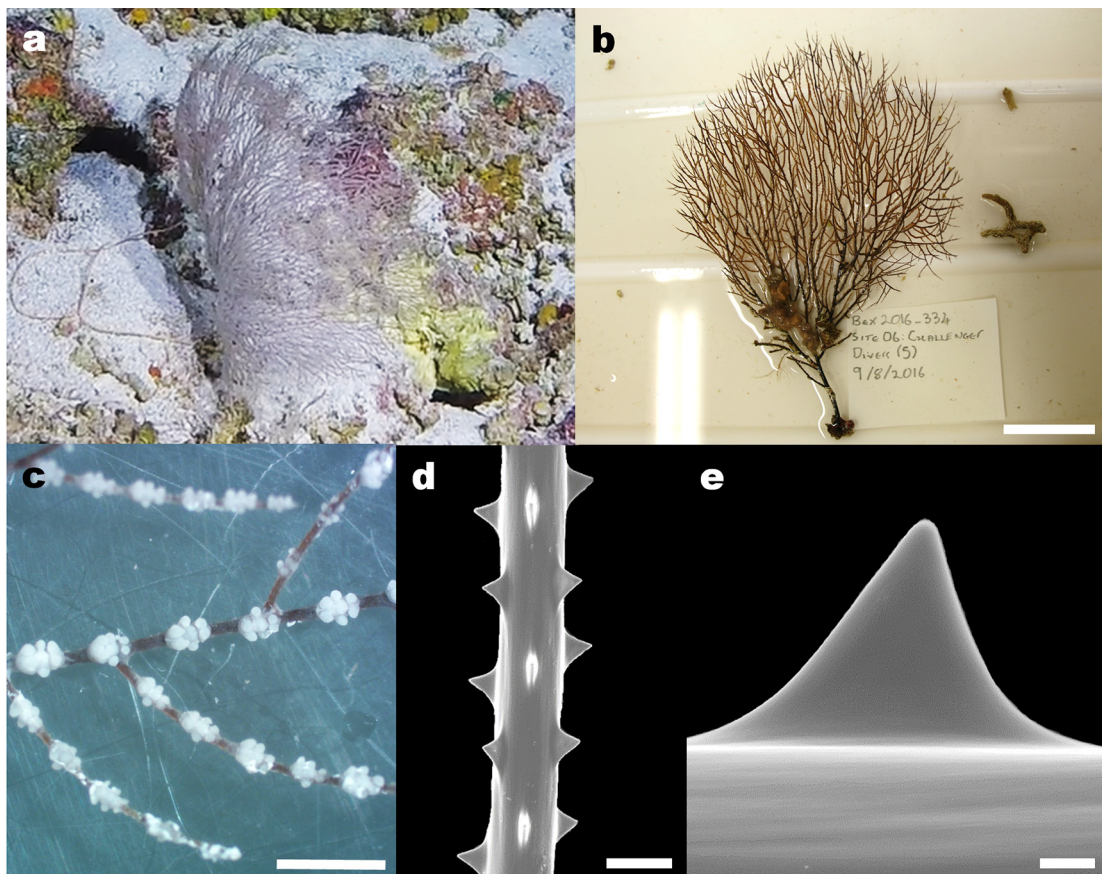


FIGURE 1. *Antipathes atlantica* from Bermuda showing (a) colony *in situ*, (b) preserved specimen (scale bar= 4 cm), (c) polyps on terminal branch under light microscopy (scale bar= 2 mm), (d) skeletal spines on terminal branch under SEM (scale bar= 100 μm), and (e) close-up of polypar spine under SEM (scale bar= 10 μm).

Antipathes furcata Gray, 1857

Antipathes furcata forms fan-shaped colonies that are typically less than 50 cm in height, with long branches that grow in narrow branch angles (Figure 2a–b). The terminal branches typically reach lengths of 5 cm or more without becoming branched. Skeletal spines are smooth, triangular or slightly inclined distally, and occasionally include some that are bifurcated towards their apex (Figure 2d). The spines are generally 30–70 μm in height and typically 50–70 μm in width at their base. On smaller branches, the spines are arranged in axial rows with adjoining rows offset in a spiral pattern around the corallum (Figure 2d). Spine spacing is fairly regular within each row, and typically ranges between 240–280 μm . The polyps are arranged on only one side of the branches, are generally 0.6–1.0 mm in transverse diameter, and are spaced 1.1–1.3 mm apart (Figure 2c). The coloration of living colonies

ranges between grayish brown to white. *A. furcata* has previously been reported from the Caribbean, Gulf of Mexico and North Atlantic at depths ranging between 15–340 m (Brito & Ocaña, 2004; Cairns *et al.*, 1993; Opresko, 2009; Opresko *et al.*, 2016; Opresko & Sanchez, 2005). Bermudan specimens examined as part of this study were collected at depths between 96–104 m (Table 1).

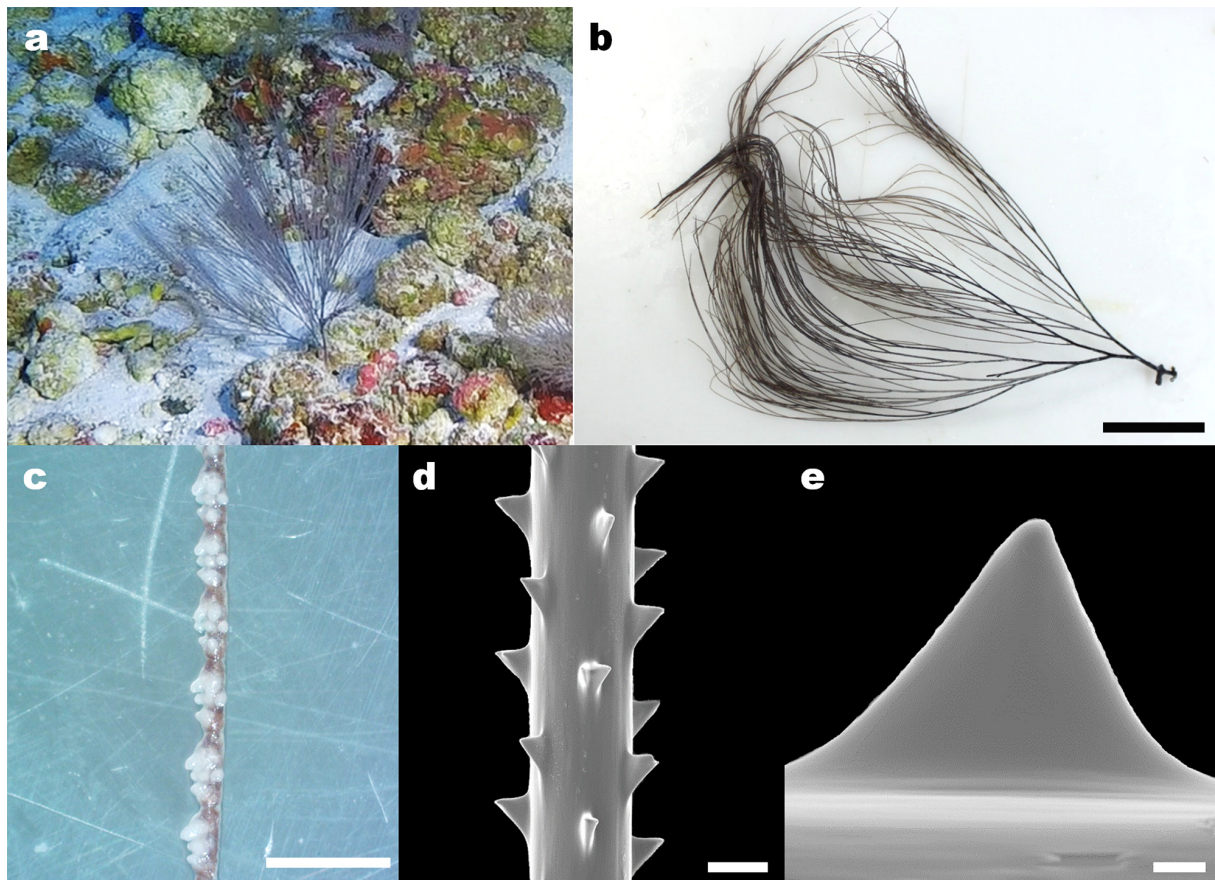


FIGURE 2. *Antipathes furcata* from Bermuda showing (a) colony *in situ*, (b) preserved specimen (scale bar= 4 cm), (c) polyps on terminal branch under light microscopy (scale bar= 2 mm), (d) skeletal spines on terminal branch under SEM (scale bar= 100 µm), and (e) close-up of polypar spine under SEM (scale bar= 10 µm).

Genus *Stichopathes* Brook, 1889

The genus *Stichopathes* is characterized by colonies that are unbranched, and polyps that are arranged in a single row on one side of the corallum (Brook, 1889). However, the validity of polyp arrangement as the main diagnostic character distinguishing amongst *Stichopathes* and the two other antipatharian genera with unbranched colonies (*Cirrhopathes* and *Pseudocirrhopathes*) has been questioned by numerous authors (Bo & Opresko, 2015; Bo *et al.*, 2012; Bo, 2008; Brugler & France, 2007; Pasternak, 1977; Pax, 1918; van Pesch, 1914). Two *Stichopathes* species have previously been reported from Bermuda (*S. lutkeni* and *S. cf. spiessi*; Locke *et al.* 2013). This study adds *S. pourtalesi* and an undescribed *Stichopathes* species to the known antipatharian fauna from Bermuda (Table 1).

Stichopathes pourtalesi Brook, 1889

Stichopathes pourtalesi forms unbranched colonies that are 1 m or more in height, and coiled distally forming multiple spirals (Figure 3a–b). The skeletal spines are conical and covered with elongated papillae towards their distal half (Figure 3d). On the lower part of the corallum, skeletal spines are often forked or have multiple lobes towards their apex. The polypar spines are generally 100–200 µm tall, whereas abpolypar spines are only 50–150 µm in height (Figure 3d–e). Skeletal spines are arranged in axial rows with adjoining rows offset in a spiral pattern around the corallum (Figure 3d). Spine spacing ranges between 300–750 µm in each row (Figure 3d). The polyps

are 0.8–1.7 mm in transverse diameter, and spaced 1.0–2.7 mm apart (Figure 3c). Living colonies are light brown or white in coloration (Figure 3a). Syntypes that were assigned to *S. pourtalesi* in the recent redescription of this species were collected from the Caribbean and Gulf of Mexico at depths ranging between 82–299 m (Bo & Opresko, 2015). All Bermudan specimens examined as part of this study were collected at depths between 143–305 m (Table 1).

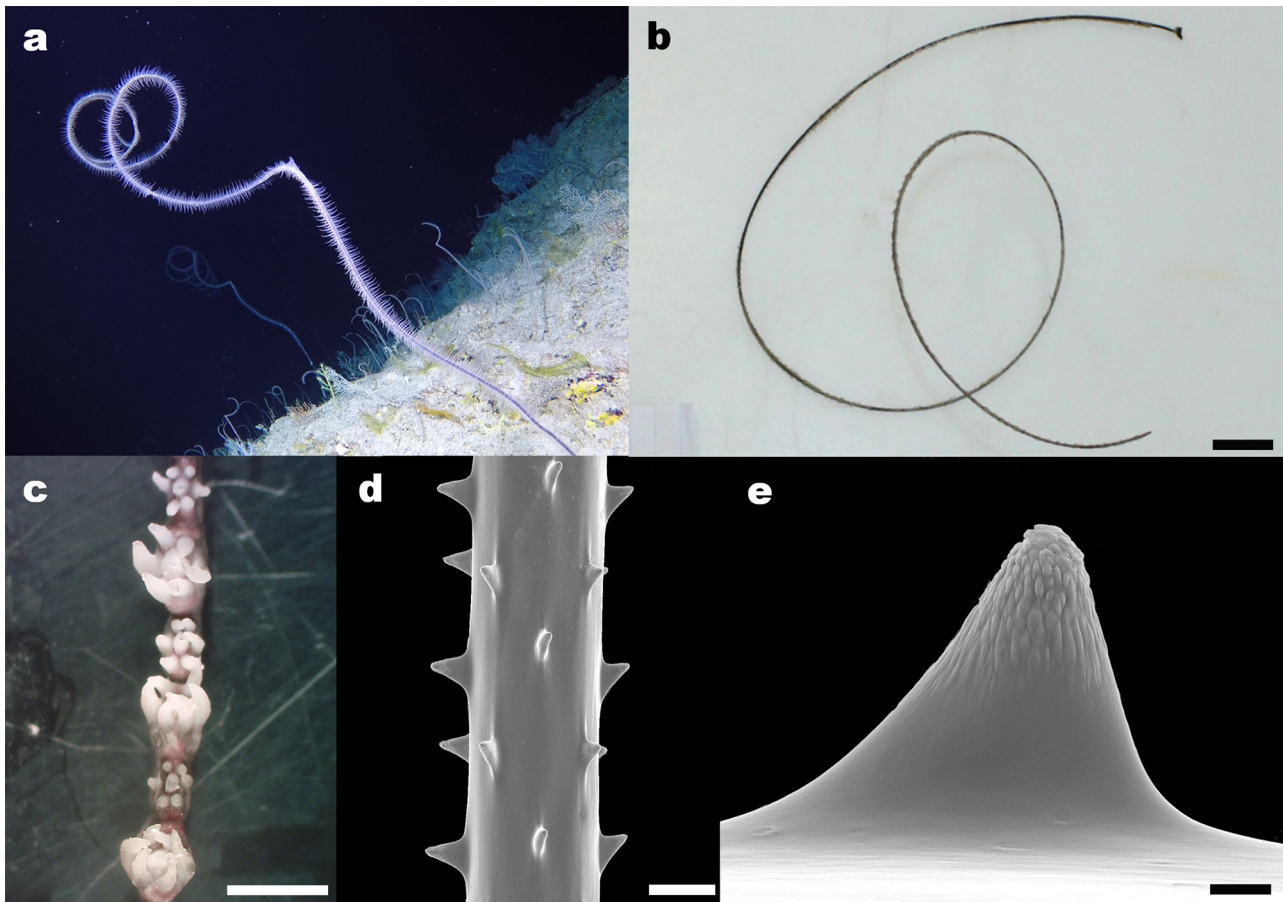


FIGURE 3. *Stichopathes pourtalesi* from Bermuda showing (a) colony *in situ*, (b) preserved specimen (scale bar= 2 cm), (c) polyps on terminal branch under light microscopy (scale bar= 2 mm), (d) skeletal spines on terminal branch under SEM (scale bar= 200 μ m), and (e) close-up of polypar spine under SEM (scale bar= 20 μ m).

Stichopathes sp.

Stichopathes sp. forms unbranched colonies that are up to 1 m in height or more and coiled distally (Figure 4a). The skeletal spines are subcylindrical and covered with distinct tubercles towards their distal third (Figure 4d–e). Polypar spines are generally 190–300 μ m in height, whereas abpolypar spines are only 150–240 μ m in height (Figure 4d–e). Skeletal spines are arranged in axial rows with adjoining rows offset in a spiral pattern around the corallum (Figure 4d). Spine spacing is fairly even within each row, and typically ranges between 400–575 μ m (Figure 4d). The polyps are up 1.0–1.5 mm in transverse diameter, and spaced 1.0–1.7 mm apart (Figure 4c). The coloration of living colonies was unfortunately not documented as part of this study. As noted earlier, the morphology of the spines of this species resembles a syntype of *S. pourtalesi* (MCZ 90362), which was collected at 232 m off Cuba, and recently reassigned to an undescribed species within the genus *Stichopathes* (Bo & Opresko, 2015). This reassignment was a result of the realization that the type series of *S. pourtalesi* contains multiple species (Bo & Opresko, 2015). Future studies will need to be undertaken in order to define the diagnostic characters of *Stichopathes* sp., as well as to document its biogeographical distribution. *Stichopathes* sp. specimens examined as part of this study were collected from Bermudan waters at depths ranging between 279–304 m (Table 1).

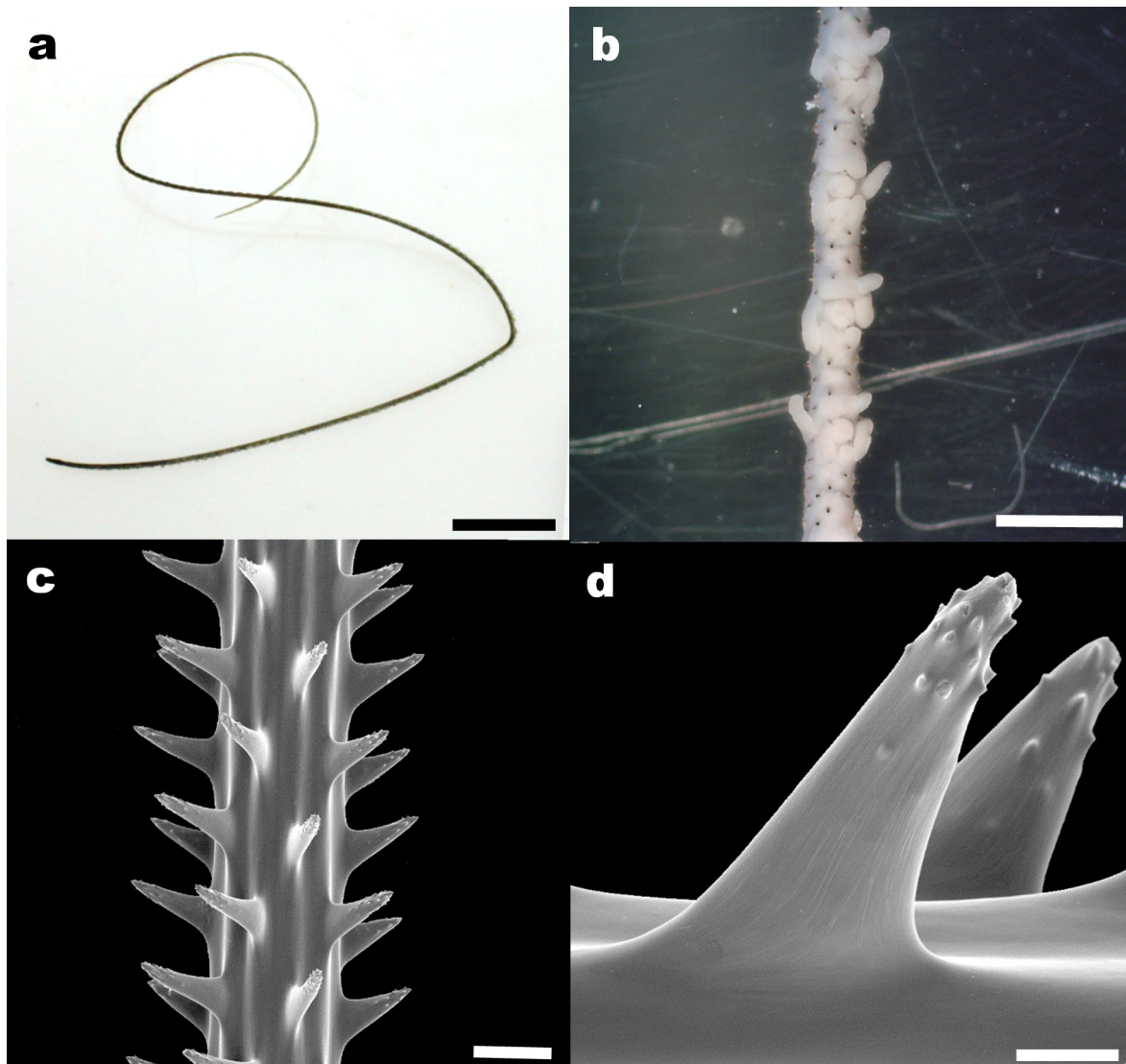


FIGURE 4. *Stipichopathes* sp. from Bermuda showing (a) preserved specimen (scale bar= 2 cm), (b) polyps on terminal branch under light microscopy (scale bar= 2 mm), (c) skeletal spines on terminal branch under SEM (scale bar= 200 μ m), and (d) close-up of polypar spine under SEM (scale bar= 50 μ m).

Family Aphanipathidae Opresko, 2004

The family Aphanipathidae is characterized by polyps with six primary and four secondary mesenteries, that are 0.5–1.3 mm in transverse diameter, and have tentacles that are all nearly of the same length when fully expanded (Bo, 2008; France *et al.*, 2007; Opresko & Sanchez, 2005; Opresko, 2004). Furthermore, the skeletal spines of the Aphanipathidae often penetrate through the soft tissues of polyps, have distinct tubercles, and are not usually bifurcated towards their apex (Bo, 2008; France *et al.*, 2007; Opresko & Sanchez, 2005; Opresko, 2004). The family Aphanipathidae has not been previously reported from Bermuda (Locke *et al.*, 2013), and is therefore documented here from Bermuda for the first time.

Genus *Distichopathes* Opresko, 2004

The genus *Distichopathes* is characterized by colonies that are monopodial or sparsely branched, with branching that tends to be planar (Opresko, 2004). The stem and branches are pinnulate, but not subpinnulate. The simple

pinnules are primarily arranged in two lateral rows. The pinnules in each lateral row alternate with those of the opposite row (Opresko, 2004). The genus *Distichopathes* has not been previously recorded from Bermudan waters (Locke *et al.*, 2013), and is thus here reported from Bermuda for the first time.

Distichopathes filix (Pourtales, 1867)

Distichopathes filix forms very sparsely-branched colonies that are branched in a single plane (Figure 5a–b). Pinnulation is bilateral, and the pinnules in each lateral row alternate with those of the opposite row (Figure 5b–c). Spines are needle-shaped and covered with distinct tubercles on the distal third of their surface (Figure 5d–e). On the side of the corallum opposite to the one bearing the polyps, the spines are uniform in height and typically range between 90–120 μm (Figure 5d). In contrast, the side of the corallum bearing the polyps contains skeletal spines of greatly varying heights (Figure 5d). The tallest spines are located in the area underneath the outer edges of polyps and reach heights of 200–250 μm , whereas the shortest spines are situated in the area underneath the oral cone, and typically reach heights of only 200 μm (Figure 5d). Polyps are 0.7–1.0 mm in transverse diameter, and spaced 1.1–1.2 mm apart (Figure 5c). The color of living colonies is bright yellow (Figure 5a). *D. filix* has previously been reported from the Caribbean Sea and the Gulf of Mexico at depths ranging between 51–695 m (Opresko, 2009; Cairns *et al.*, 1993; Opresko, 1972; Brook, 1889; Pourtales, 1871). The only Bermudan specimen examined as part of this study was collected at a depth of 304 m (Table 1).

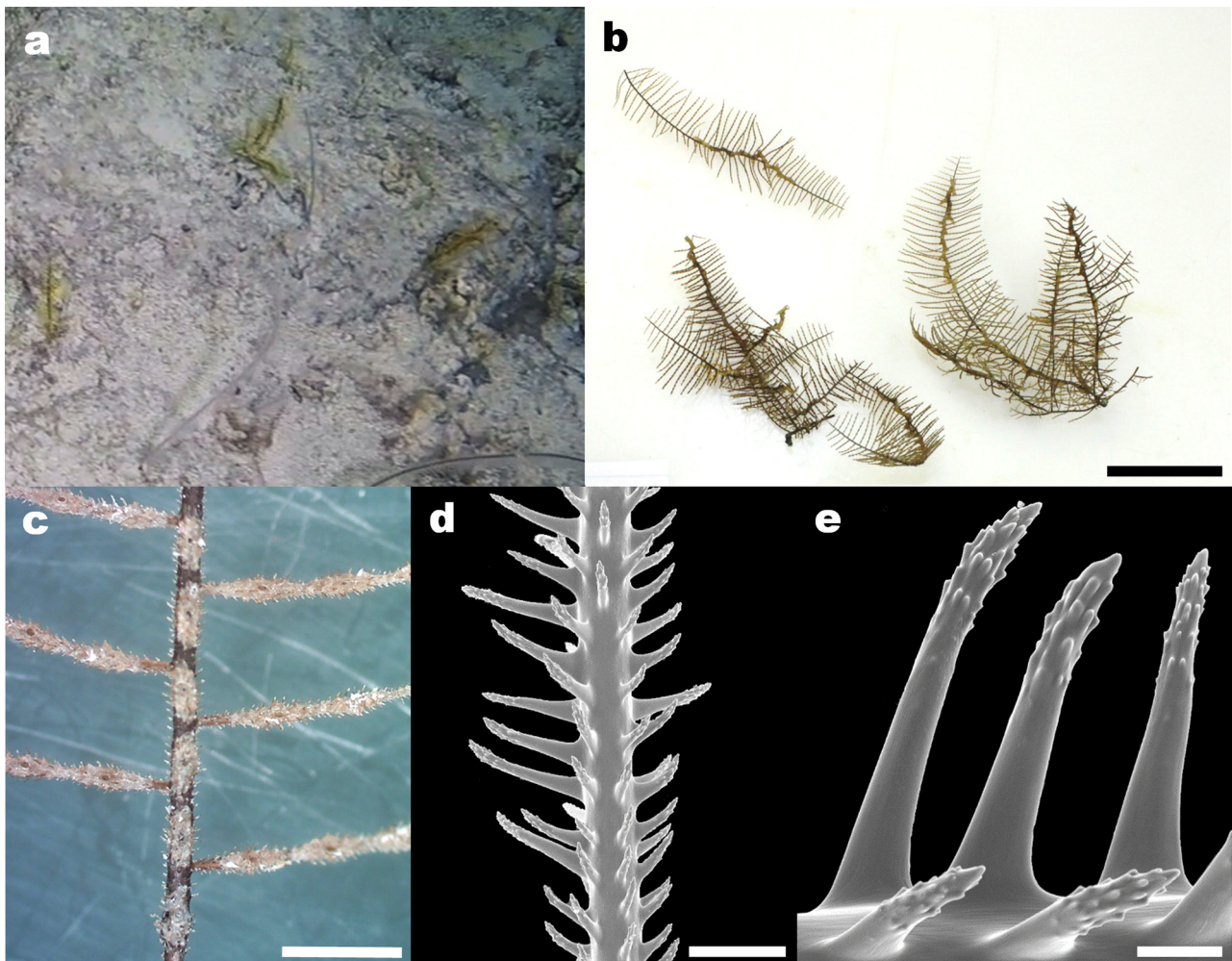


FIGURE 5. *Distichopathes filix* from Bermuda showing (a) colonies *in situ*, (b) preserved specimen (scale bar= 4 cm), (c) polyps on basal part of pinnules under light microscopy (scale bar= 2 mm), (d) skeletal spines on a primary pinnule under SEM (scale bar= 200 μm), and (e) close-up of polypar spine under SEM (scale bar= 50 μm).

Family Myriopathidae Opresko, 2001

The family Myriopathidae is characterized by polyps with six primary and four secondary mesenteries that are 0.5–1.0 mm in transverse diameter, and possess short tentacles with rounded tips. The skeletal spines of the Myriopathidae are usually needle-shaped on smaller branches, and frequently forked or antler-like on larger branches (Bo, 2008; France *et al.*, 2007; Opresko & Sanchez, 2005; Opresko, 2001;) Two genera, *Cupressopathes* and *Tanacetipathes*, have previously been reported from Bermuda (Locke *et al.*, 2013). However, *Cupressopathes* was incorrectly reported from Bermuda due to an incorrect synonymization between *Antipathes gracilis*, which occurs throughout the Western Atlantic (Opresko, 2009; Opresko & Sanchez, 2005; Warner, 2005; Padilla & Lara, 2003; Cairns *et al.*, 1993; Warner, 1981), and *Cupressopathes gracilis*, which is only known from the Indo-Pacific (Opresko, 2001). *Tanacetipathes* is the only genus within the family Myriopathidae that is currently known from Bermuda, and was documented as part of this study as well (Table 1).

Genus *Tanacetipathes* Opresko, 2001

The genus *Tanacetipathes* is characterized by colonies that are monopodial or branched, with the stem and branches being pinnulate like a bottle brush, to the 3rd–4th order (Opresko, 2001). The primary pinnules are arranged in 4–6 regular rows and in alternating biserial groups of 2–3 pinnules. Secondary pinnules are mostly restricted to the lateral sides of primary pinnules, and are usually developed more extensively on the abpolypar sides of the primary pinnules. At least one uniserial tertiary pinnule is found on the abpolypar side of the lowermost secondary pinnules, and quaternary pinnules may be present in some species within this genus (Opresko, 2001).

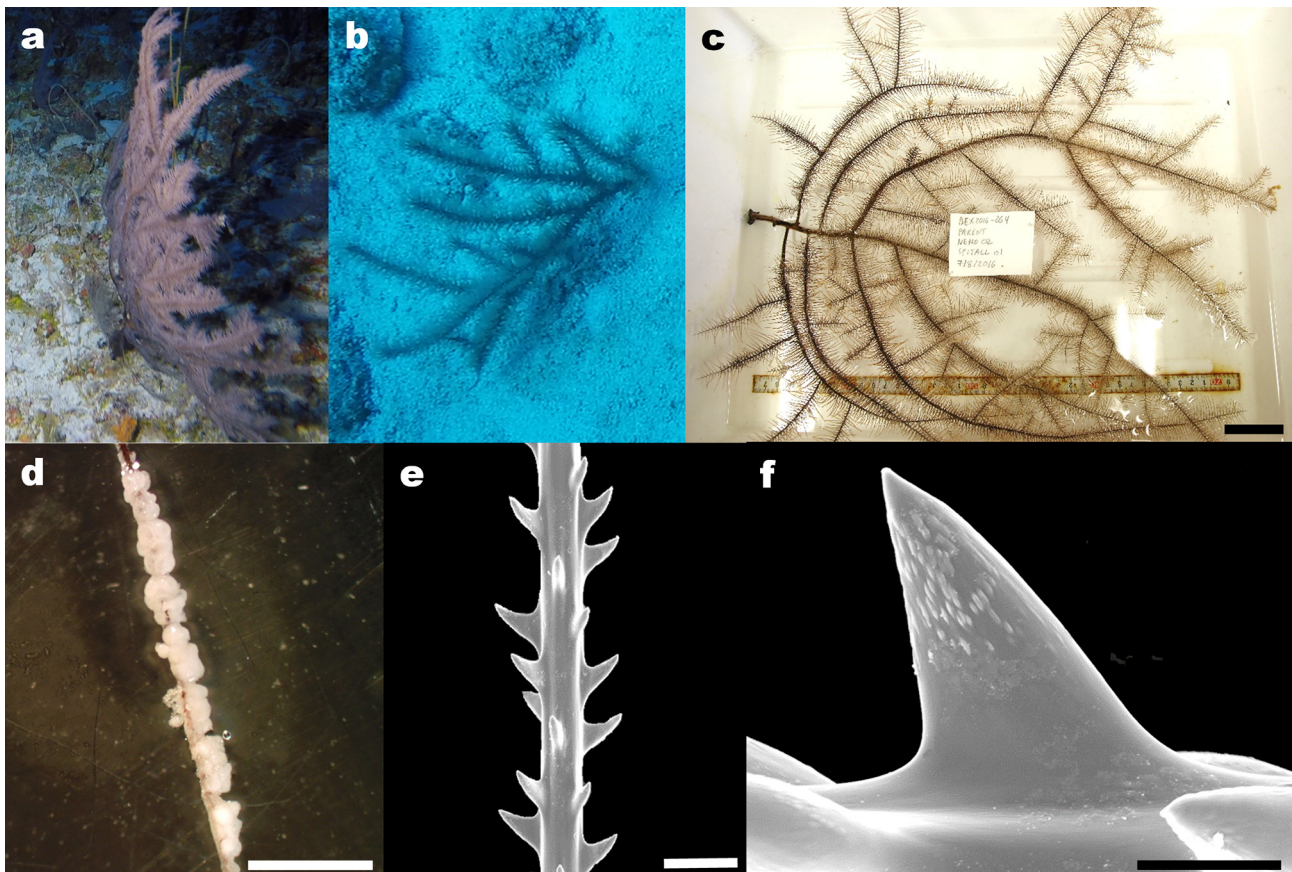


FIGURE 6. *Tanacetipathes hirta* from Bermuda showing (a-b) colonies *in situ*, (c) preserved specimen (scale bar= 5 cm), (d) polyps on a primary pinnule under light microscopy (scale bar= 2 mm), (e) skeletal spines on a primary pinnule under SEM (scale bar= 100 µm), and (f) close-up of polypar spine under SEM (scale bar= 50 µm).

***Tanacetipathes hirta* (Gray, 1857)**

Tanacetipathes hirta colonies are typically less than 50 cm in height and sparsely branched, with most branching tending to be in a single plane like a fan (Figure 6a–c). Colonies branch to the 3rd–4th order, with branches usually arising at close to right angles from the branching point. The stem and branches have 4–6 rows of primary pinnules, which are arranged biserially and in alternating groups of 2–3 along the length of the axis. The posterior primary pinnules are usually 2–3 cm long and considerably longer than the anterior primary pinnules. The secondary pinnules are usually confined to the abpolypar side of the basal section of primary pinnules. Few tertiary pinnules are present, which are restricted to the posterior side of the secondaries nearest the base of each primary pinnule. The skeletal spines are subcylindrical, inclined distally, and covered with faint papillae towards their distal half (Figure 6e–f). Polypar spines are typically 60–130 µm tall, whereas abpolypar spines are 50–100 µm in height (Figure 6e). The polyps range between 0.7–1.0 mm in transverse diameter, and are spaced 0.9–1.1 mm apart (Figure 6d). *In situ* colonies are grayish to light brown in coloration (Figure 6a–b). *T. hirta* has previously been reported from Brazil to Bermuda at depths ranging between 20–347 m (Opresko *et al.*, 2016; Locke *et al.*, 2013; Opresko, 2009; Opresko & Sanchez, 2005; Loiola & Castro, 2005; Padilla & Lara, 2003; Echeverria, 2002; Opresko, 1972; Warner, 1981). The Bermudan specimens examined as part of this study were collected at a depths ranging between 122–152 m (Table 1).

***Tanacetipathes tanacetum* (Pourtalès, 1880)**

Tanacetipathes tanacetum colonies consist of a single, bottle-brushed stalk (Figure 7a–b). The stem and branches form 4–6 rows of primary pinnules, which are arranged biserially and in alternating groups along the length of the axis. The posterior primary pinnules are generally 1.0–2.5 cm in length. The primary pinnules give rise to 2–3 orders of subpinnules, and the secondary pinnules are all mostly arranged uniserially on the abpolypar side of primaries. Tertiary pinnules occur uniserially on abpolypar sides of secondary pinnules, and quaternary pinnules are sometimes present. The skeletal spines are inclined distally and conical to subcylindrical in shape (Figure 7d–e). Spines are smooth or faintly papillose (Figure 7d–e). Polypar spines are 190–240 µm in height, whereas abpolypar spines are 120–180 µm in height (Figure 7d). The polyps are arranged on a single side of the axis, are typically 0.6–0.9 mm in transverse diameter, and are spaced 0.6–0.8 mm apart (Figure 7c). The color of living colonies ranges between brown to light orange (Figure 7a). Bermudan specimens resemble the lectotype of *T. tanacetum* (see Perez *et al.*, 2005) in terms of both colony branching pattern and skeletal spine morphology. However, the skeletal spines of Bermudan specimens are substantially larger (range=120–240 µm) than those of the lectotype of *T. tanacetum* (range=100–130 µm; Perez *et al.*, 2005). Specimens from other locations, including Brazil, the Caribbean and Gulf of Mexico, with skeletal spines that are up to 300 µm in height have also been assigned to this species (Opresko *et al.*, 2016; Perez *et al.*, 2005; Opresko & Sanchez, 2005; Loiola & Castro, 2005). Consistent with this, we here also assign the Bermudan species to *T. tanacetum*, despite of it having larger skeletal spines than the *T. tanacetum* lectotype. Future studies should be undertaken, particularly those that include molecular data, in order to determine whether the two forms with different skeletal spine sizes represent different species or intraspecific variability (Perez *et al.*, 2005). *T. tanacetum* has previously been reported from Brazil to the Northwest Atlantic at depths ranging between 20–1293 m (Opresko *et al.* 2016; Opresko, 2009; Perez *et al.*, 2005; Loiola & Castro, 2005; Padilla & Lara, 2003; Cairns *et al.*, 1993; Opresko, 1972). The Bermudan specimens examined as part of this study were collected at depths between 55–96 m (Table 1).

Conclusion

Based on the morphological examination of 28 specimens collected in Bermudan waters as part of the Nekton Expedition, this study reports seven black coral species. These species include three species (*Stichopathes* sp., *S. pourtalesi*, and *Distichopathes filix*), one genus (*Distichopathes*) and one family (Aphanipathidae) that were not previously known from Bermuda. These additions increase the known black coral diversity of Bermuda to twelve species, five genera and four families. Furthermore, this study documented *Stichopathes* sp. specimens that closely

resemble material that was previously collected off Cuba. Future studies will need to be undertaken to delineate the diagnostic characters of this species and to determine its biogeographical distribution.

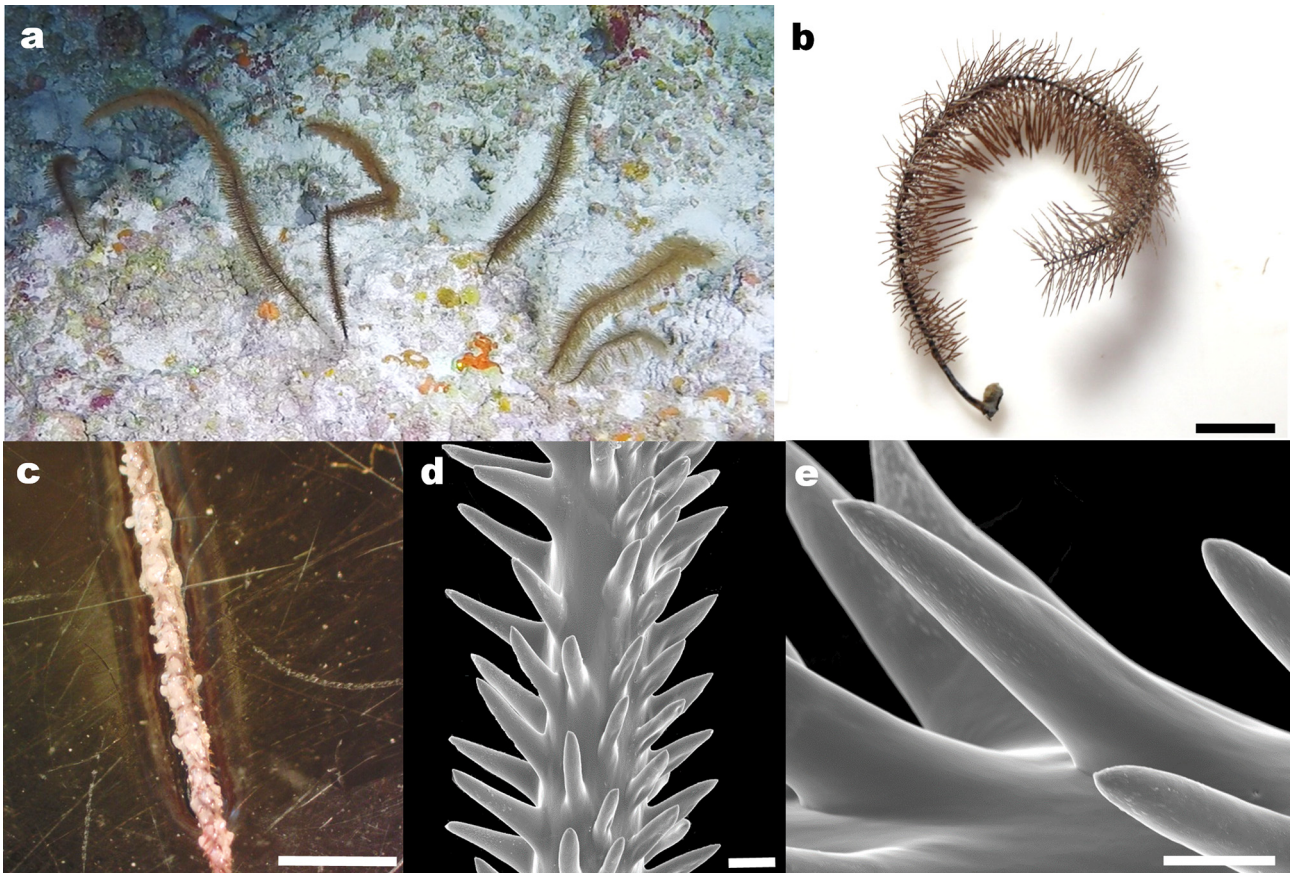


FIGURE 7. *Tanacetipathes tanacetum* from Bermuda showing (a) colonies *in situ*, (b) preserved specimen (scale bar= 2 cm), (c) polyps on distal part of primary pinnule under light microscopy (scale bar= 2 mm), (d) skeletal spines on distal part of primary pinnule under SEM (scale bar= 100 μ m), and (e) close-up of polyp spine under SEM (scale bar= 50 μ m).

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