



## Two New Species of *Chrysopathes* (Cnidaria: Anthozoa: Antipatharia) from the Western Atlantic

D. M. OPRESKO<sup>1</sup> & L. de LAIA LOIOLA<sup>2</sup>

<sup>1</sup>Environmental Sciences Division, Oak Ridge National Laboratory, 1060 Commerce Park, Oak Ridge, TN 37830, USA.

E-mail: opreskodm@ornl.gov

<sup>2</sup>Projeto Coral Vivo, Arraial d'Ajuda Eco Parque, Estrada da Balsa, km 4,5, Arraial d'Ajuda, Porto Seguro, BA, Brazil. 45816000.

E-mail: livialoiola@hotmail.com

### Abstract

Two new species of *Chrysopathes* are described, *C. oligocrada* from Yucatan and Brazil, and *C. micracantha* from the southeastern coast of the U.S. and Brazil. *Chrysopathes oligocrada* is characterized by lateral pinnules mostly 7–8 mm long (to 2 cm); 18–21 primary pinnules per cm; anterior-most primary pinnules with no more than one secondary pinnule (absent on some); some posterior primaries with a single secondary pinnule; lateral primary pinnules usually simple, rarely with a single subpinnule; tertiary pinnules absent; pinnular spines to 0.07 mm. This species is similar to *C. formosa* Opresko 2003 from the Pacific; the latter species differing in density of pinnulation (15–18 per cm) and size of the spines (to 0.16 mm). *Chrysopathes micracantha* is characterized by lateral pinnules mostly 5–6 mm long (to 2 cm); 24–33 primary pinnules per cm; anterior and posterior primary pinnules with as many as two subopposite secondary pinnules; lateral primary pinnules usually simple but with subpinnules on the thicker branches and stem; tertiary pinnules rarely present; pinnular spines to 0.1 mm. *Chrysopathes micracantha* is similar to *C. speciosa* Opresko 2003 from the Pacific, the latter species differing in a greater number of secondary pinnules per primary (three or more) and in size of the spines (to 0.18 mm).

**Key words:** Cladopathidae, *Chrysopathes oligocrada*, *Chrysopathes micracantha*, Yucatan, Mexico, United States, Brazil

### Introduction

The genus *Chrysopathes* was established by Opresko (2003) on the basis of material collected in the northeast Pacific. The genus is differentiated from others in the family Cladopathidae by the occurrence of the primary pinnules in six rows. Specimens of this genus were collected by RSMAS in 1968 in waters off the Yucatan Peninsula. Since then, additional material has been found off the southeastern coast of the U.S. and also off the coast of Brazil. Two undescribed species are represented in these collections. These new species are described herein and are compared to closely related species from the northeastern Pacific. The Brazilian specimens discussed in this paper were previously described (but not named) by one of the coauthors at the 3<sup>rd</sup> International Symposium on Deep-Sea Corals, held in Miami, Florida, Nov. 28 to Dec. 2, 2005 (de Laia Loiola 2007).

The genus *Chrysopathes* is placed in the family Cladopathidae, one of seven families recognized in the order Antipatharia. It is the only family in which the polyps have only primary mesenteries and no secondary mesenteries. In the Antipathidae, Myriopathidae (see Opresko 2001), Aphanipathidae (see Opresko 2004), Schizopathidae (see Opresko 2002), and Stylopathidae (see Opresko 2006) the polyps have six primary and

four secondary mesenteries. In the family Leioopathidae the polyps possess six primary and six secondary mesenteries.

### List of abbreviations and acronyms

NOAA:	National Oceanographic and Atmospheric Administration
MNRJ:	Museu Nacional do Rio de Janeiro, Rio de Janeiro, Brazil
REVIZEE:	Recursos Vivos da Zona Econômica Exclusiva
RSMAS:	Rosenstiel School of Marine and Atmospheric Science, U. of Miami
SCDNR:	South Carolina Department of Natural Resources
UMML:	University of Miami Marine Lab (= RSMAS)
USNM:	U.S. National Museum (= U.S. National Museum of Natural History, Smithsonian Institution)

### Material and methods

Specimens discussed in this paper were obtained from several sources including: 1) the deep-sea biology program of the RSMAS (R/V *Pillsbury*); 2) the NOAA Ocean Explorer project “Estuary to Abyss,” conducted by the SCDNR, 3) surveys of the U. S. Bureau of Commercial Fisheries (R/V *Oregon*); 4) the REVIZEE Program conducted in 1996–2002 by the Brazilian government to survey the living resources off the coast Brazil; and 5) the Campos Basin Deep Sea Environmental Project/PETROBRAS, an oil industry sponsored survey of the Campos Basin, Brazil.

The microscopic skeletal features of the specimens were examined using an AMRAY 1810 scanning electron microscope (SEM) at the USNM. Measurements were made using an optical dissecting microscope equipped with an ocular micrometer as well as from SEM photomicrographs.

Holotypes are deposited in the USNM. Paratypes are deposited at RSMAS, at Marine Resources Research Institute, SCDNR, and at the MNRJ.

### Systematic description

#### Cladopathidae Kinoshita 1910

**Diagnosis.** Polyps with six primary mesenteries and no secondary mesenteries. Actinopharynx may be present or absent. Polyps elongated in direction of skeletal axis, 1.5–6 mm in transverse diameter. Corallum monopodial or branched, and pinnulate. Pinnules simple or with subpinnules.

**Remarks.** The subfamily Cladopathinae Kinoshita was first given family-level status by Schultze (1896).

#### Cladopathinae Kinoshita 1910

**Diagnosis.** Actinopharynx present. Polyps 1.5–3.3 mm in transverse diameter. Corallum branched and pinnulate. Pinnules simple or subpinnulate. Subpinnules present on some or all primary pinnules.

**Remarks.** The subfamily name Cladopathinae was proposed by Kinoshita as a replacement name for Hexamerota Schultze 1896, according to the Zoological Codex.

## *Chrysopathes* Opresko 2003

**Diagnosis.** Primary pinnules arranged in six rows and also in alternating biserial groups of three pinnules each. In each group of three, lateral pinnule more distal than anterior or posterior pinnule. Subpinnules confined to anterior primary pinnules or present on lateral and posterior primaries as well. Subpinnules arranged irregularly, alternately, or in subopposite pairs. Secondary pinnules usually shorter than primary pinnules.

**Type species.** *Chrysopathes formosa* Opresko 2003.

**Remarks.** Although the younger parts of colonies may have only four rows of primary pinnules, the typical condition in this genus is six rows. The primary pinnules in the anterior-most rows (corresponding to the side of the corallum on which the polyps occur) are usually those showing the greatest subpinnulation, although in some species subpinnules also occur on the other primaries.

**Species assigned to *Chrysopathes*.** Five species: *C. formosa* Opresko 2003, *C. speciosa* Opresko 2003, *C. gracilis* Opresko 2005, *C. oligocrada* new species and *C. micracantha* new species.

**Distribution.** Three species of this genus are known from the Pacific (*C. formosa*, *C. speciosa*, and *C. gracilis*), and two from the western Atlantic (*C. oligocrada* and *C. micracantha*).

### *Chrysopathes oligocrada* new species (Figs. 1–2)

*Chrysopathes* sp. Opresko, 2005; de Laia Loiola, 2007 (in part).

**Holotype.** USNM 1104648, Gulf of Mexico, off the Yucatan Peninsula, 21°17' N, 86°15' W, 225–250 fm (411–457 m), March 14, 1968, R/V *Pillsbury* sta. 587.

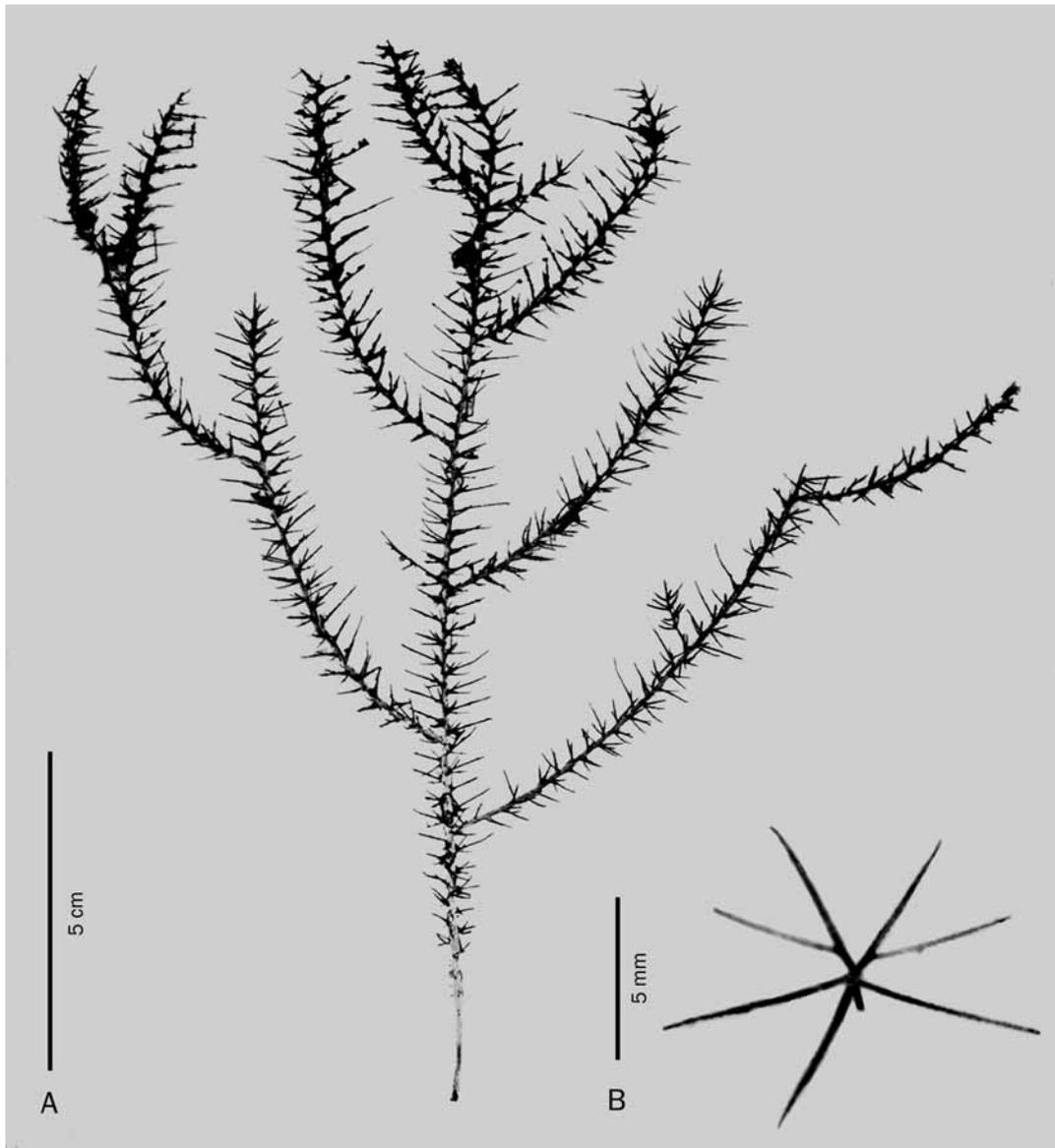
**Other material.** Paratypes (USNM 1104649), same locality data as holotype (4 specimens). Paratypes (UMML 7.1157), same locality data as holotype (27 specimens). Paratype, (MNRJ 4627), Brazil, off Salvador, 13°23'S, 38°37'W, 761 m, REVIZEE Bahia-2 sta. E0499 (1 specimen).

**Diagnosis.** Corallum branched primarily in single plane; usually only one or two orders of branching (three orders in some colonies). Arrangement of primary pinnules as described for genus; density 18–21 per cm. Lateral pinnules mostly 7–8 mm long (to 2 cm); slightly to distinctly longer than anterior and posterior pinnules. Anteriormost primary pinnules usually with one secondary pinnule arising near base, and only on outer side. Posterior primary pinnules occasionally with single secondary pinnule. Lateral primary pinnules usually simple, very rarely with single subpinnule. Tertiary pinnules absent.

Spines simple, smooth,  $\leq 0.07$  mm. Spines on middle and lower parts of pinnules conical and slightly inclined distally in side view; those on distal part of pinnules appearing more strongly inclined distally and with abaxial side extending basally down axis. Abaxial side of distal spines generally 2–4 times longer than adaxial side. Polyps 1.6 to 2.4 mm in transverse diameter; in single row with about three polyps per centimeter.

**Description of holotype.** Height 16.5 cm high, width 15 cm (Fig. 1A); lower end of stem about 1.2 mm in diameter; unpinnulated part of stem 4 cm; basal plate missing. Corallum mostly with first and second order branching (one third order branch); overall branching planar with branches arising from outer sides of lower order branches. Stem extending to top of corallum; with eight branches, mostly 1.5–2 cm apart (eight per 10 cm). Largest branch 8 cm long (broken at distal end); basal diameter 0.9 mm. Branches extend upward and outward slightly (distal angle 60–70°), but curve vertically.

Primary pinnules about 3 mm apart in each row, resulting in four pinnules per centimeter in each row. Total of 21 primary pinnules per cm (18 per cm on stem and some larger branches). Lateral primary pinnules (Fig. 1B) usually 7–8 mm long (to 12 mm); maximum diameter 0.2 mm near base. Anterior and posterior primary pinnules to 6 mm long. Pinnules thin and very narrow walled. Distal angle of primary pinnules and branch 60–70°.

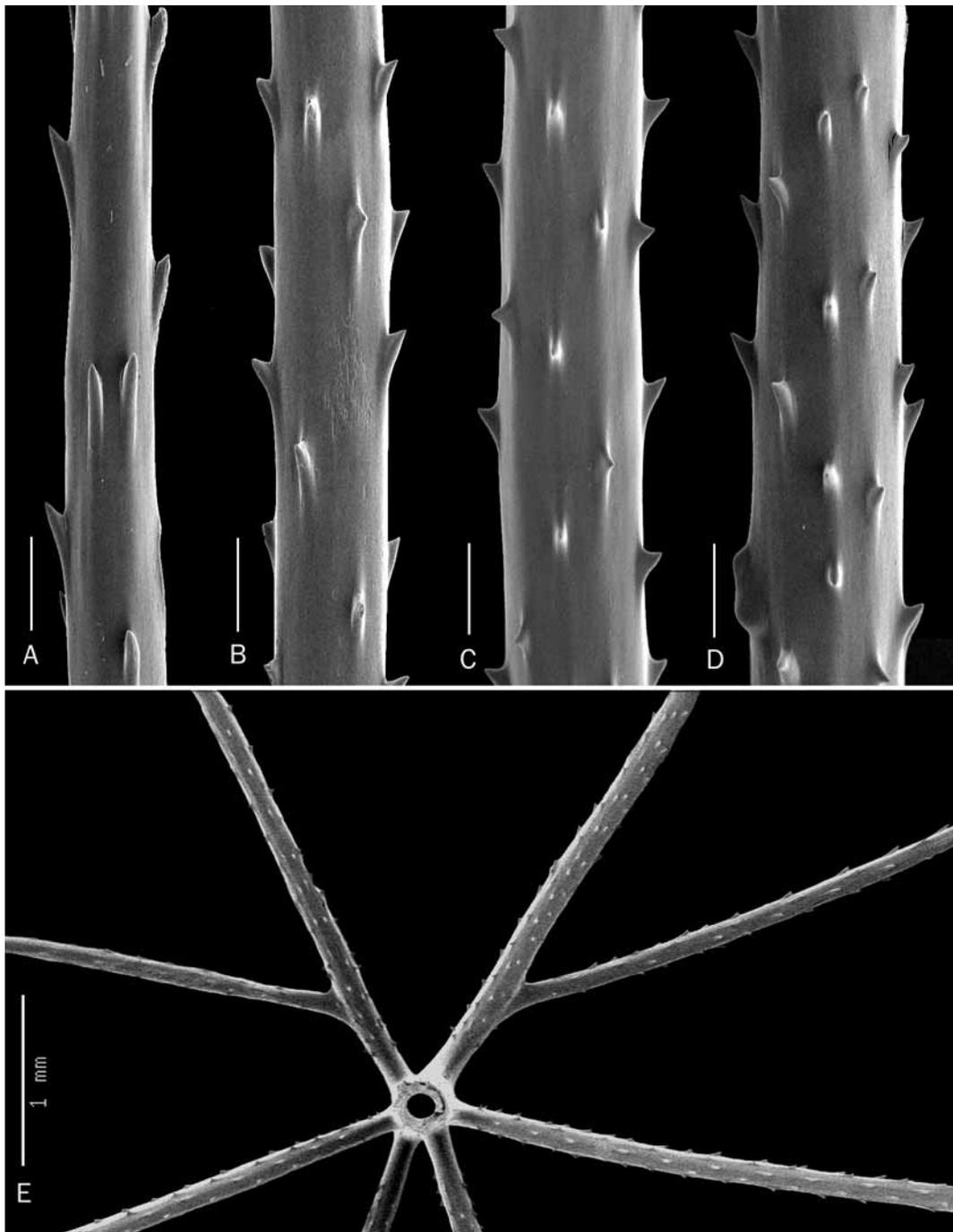


**FIGURE 1.** *Chrysopathes oligocrada*, new species, holotype, USNM 1104648: A, entire corallum; B, cross section of branch showing pinnules and subpinnules.

Single secondary pinnule on one or both anterior primary pinnules (Figs. 1B and 2E), usually absent on lateral or posterior primary pinnules except on stem. Secondary pinnules arise about 0.5 mm from base of anterior primary on outer side and extend laterally or slightly basally; secondaries on anterior primaries of opposite rows directed away from each other; secondaries on posterior primaries, when present, follow similar pattern. Secondary pinnules mostly 3–4 mm long, but some slightly longer than anterior pinnules.

Spines conical in lateral view and inclined distally on middle and lower parts of pinnules (Figs. 2B–D); increasingly more inclined distally towards tip of pinnule with abaxial edge flared out basally (Fig. 2A); abaxial edge of distal spines to four times longer than adaxial edge (e.g., 0.1 mm vs. 0.025 mm). Height of pinnular spines (from midpoint of base to apex) 0.05–0.07 mm on distal sections and 0.03–0.04 mm on middle and basal sections. Spines generally subequal in size around circumference of axis. Spines on stem and larger branches 0.03 mm. Number of rows of spines (visible in lateral view) increasing from three to four near tip to five or six along lower sections of pinnules. Distance between spines in the same row 0.15–0.3 mm. Number of rows and density of spines on larger branches and stem similar to that on pinnules.

Polyps present on some branches but in poor condition; mostly 1.6–2.0 mm in transverse diameter (to 2.4 mm) as measured from distal edge of distal lateral tentacles to proximal edge of proximal lateral tentacles. Polyp density three per centimeter. Polyps on primary pinnules arranged in single row on upper, lateral, or rarely on lower side of pinnule relative to direction of branch. Polyps on subpinnules commonly found on side facing distal section of anterior primary pinnule; thus, polyps on subpinnules in opposite rows face in same general direction.



**FIGURE 2.** *Chrysopathes oligocrada* new species, holotype, USNM 1104648: A–D, spines on sections of pinnules, scale bars 0.1 mm; E, cross section of branch showing arrangement of pinnules and subpinnules

**Description of paratypes.** Other specimens from *Pillsbury* sta. 587 similar to holotype in planar growth form of corallum; height to 20 cm, width to 15 cm, basal stem diameter to 1 mm; usually with two orders of branches. Subpinnulation typically consisting of single secondary pinnule on each anterior primary pinnule; single secondary pinnule on some posterior primaries but usually only on larger branches and stem; secondary pinnules rarely present on lateral primaries. Density of primary pinnules 18–21 per cm. Lateral primary pinnules usually only slightly longer than anterior and posterior ones; but to three or four times longer (to 2 cm). Spines on distal section of pinnules to 0.07 mm tall; 0.16–0.25 mm apart in each row; with three or four rows visible in lateral view. Polyps in poor condition; mostly 1.6 to 2.0 mm in transverse diameter.

Paratype from Brazil (MNRJ 4627) with similar pinnular density (18–21 per cm) and with only one subpinnule per primary. Colony 10.0 cm by 4.0 cm; unpinnulated section of stem 2.0 cm, basal stem diameter 0.5 mm. Lateral primary pinnules 11–17 mm long and 1.8–3.0 mm apart in each row; anterior and posterior primaries 4–9 mm; secondaries 3.0–8.0 mm long; tertiary pinnules not present. Distal pinnular spines 0.04–0.05 mm; middle and basal ones 0.02–0.03 mm; spines on stem and larger branches rarely more than 0.02 mm. Five or six irregular rows of spines visible in lateral view. Distance between spines in one row 0.12–0.27 mm; three to four spines per millimeter in each row. Polyps absent.

**Comparisons.** The species is similar to *Chrysopathes formosa* Opresko 2003 in the overall growth form of the corallum, and in the small number of secondary pinnules, but differs from that species in several ways. In *C. formosa* the pinnules in general are slightly longer and are spaced somewhat further apart (15–18 per cm for all rows) than in *C. oligocrada*. The most significant difference, however, is in the size of the spines. In *C. formosa* the pinnular spines are mostly 0.08–0.12 mm (to 0.16 mm tall), whereas those in *C. oligocrada* are not more than 0.07 mm and often less.

**Etymology.** The specific name is derived from the Greek *oligo* (few) and *crada* (twig), in reference to the scarcity of subpinnulation.

**Distribution.** The species is known from off the coast of Yucatan, Mexico at a depth of 411–457 m and from off the coast of Brazil at a depth of 761 m.

### ***Chrysopathes micracantha* new species (Figs. 3–5)**

*Chrysopathes* sp. Opresko, 2005; de Laia Loiola, 2007 (in part).

**Holotype.** USNM 1097219, Northwest Atlantic, off Florida, Reed Peak #160, 29°50.9726'N, 79°37.5976'W, 2448–2857 ft (746–871 m), *Johnson Sea Link*, Dive 4912, spec. 2-009, November 9, 2005, coll. S. Brooke and C. Messing.

**Other material.** Paratype (USNM 77111), off Georgia, E. of Brunswick, 30°52' N, 79°34'W, 658 m, January 21, 1972, RV *Oregon II*, sta. 11717 (1 specimen). Paratype (USNM 1086635), off Jacksonville Beach, Florida, 30°16.56' N, 79°20.38'W, Aug. 30, 2004, 836 m, *Johnson Sea Link* Dive 3470, collection No. T10041060 (part of specimen deposited in the Marine Resources Research Institute, SCDNR, Accession No. 2004-0543, Catalog No. S2332). Paratype (MNRJ 5150), Brazil, off Campos, 22°24.655' S, 39°55.413'W, 1130 m, BC-Sul-CENPES/UFRJ (1 specimen).

**Diagnosis.** Corallum planar to somewhat bushy with overlapping branches; branched to fifth order. Stem and branches pinnulate and subpinnulate. Arrangement of primary pinnules as described for genus; 24–33 primary pinnules per cm. Anterior and posterior primary pinnules on smallest branches with one or two (subopposite) secondary pinnules; lateral primary pinnules usually simple or rarely with single subpinnule. Subpinnules more abundant on primary pinnules on thickest branches and stem; one subopposite pair per primary in some cases. Tertiary pinnules present on some secondaries but not common.

Spines on pinnules simple, smooth, often very distinctly inclined distally; usually not more than 0.06 mm tall (from middle of base to apex) but to 0.10 mm at tips of pinnules. Abaxial side of spines three to seven times longer than adaxial side. Spines on middle and lower parts of pinnules becoming more triangular and less distally inclined. Polyps 2.2–2.8 mm in transverse diameter; arranged in a single row on upper or lateral side of pinnules.

**Description of holotype.** Height about 30 cm, width 20 cm, basal stem diameter 3 mm; unpinnulated part of stem 3.5 cm long. Corallum (Fig. 3A) branched to fifth order; planar with some overlapping branches (possibly due to preservation in small jar). Stem extends to top of corallum and has 12 branches of varying sizes along its length. Branches of corallum not evenly distributed; most 2–4 cm apart. Largest branch about 18 cm long; basal diameter about 2 mm. Branches extend outward at point of insertion (distal branch angle 40–50°) and then curve upward to become parallel to lower order branch (or stem) from which they arise. Width across branchlets mostly 8–10 mm.

Primary pinnules generally straight and stiff (Figs. 3B and 4A) and inclined distally (distal angle about 70°). Each group of three primary pinnules occupies distance of 0.8–1.0 mm; distance between groups 0.4–0.5 mm; one cycle of six pinnules covers about 2.5 mm of axis. Pinnules mostly 2.5 mm apart in each row, resulting in five pinnules per centimeter in each row; total of 24–27 primary pinnules per cm for all rows. Primary pinnules generally 5–6 mm long (to 1.0 cm) and 0.2–0.25 mm in diameter near base, with laterals slightly longer than anterior and posterior primaries. One or two single secondary pinnules on anterior primary pinnules on higher order branches (Figs. 3B and 4A), less commonly one or two on posterior primaries. Paired secondary pinnules arranged suboppositely (Fig. 4B). No secondaries on lateral primary pinnules. Secondary pinnules arise about 0.5 mm from base of primaries on lateral or towards lower side of primary and extend distally (distal angle about 45°) relative to direction of primary. Secondary pinnules 3–4 mm long. Secondary pinnules on thicker branches and stem often found on all primaries and usually in subopposite pairs.

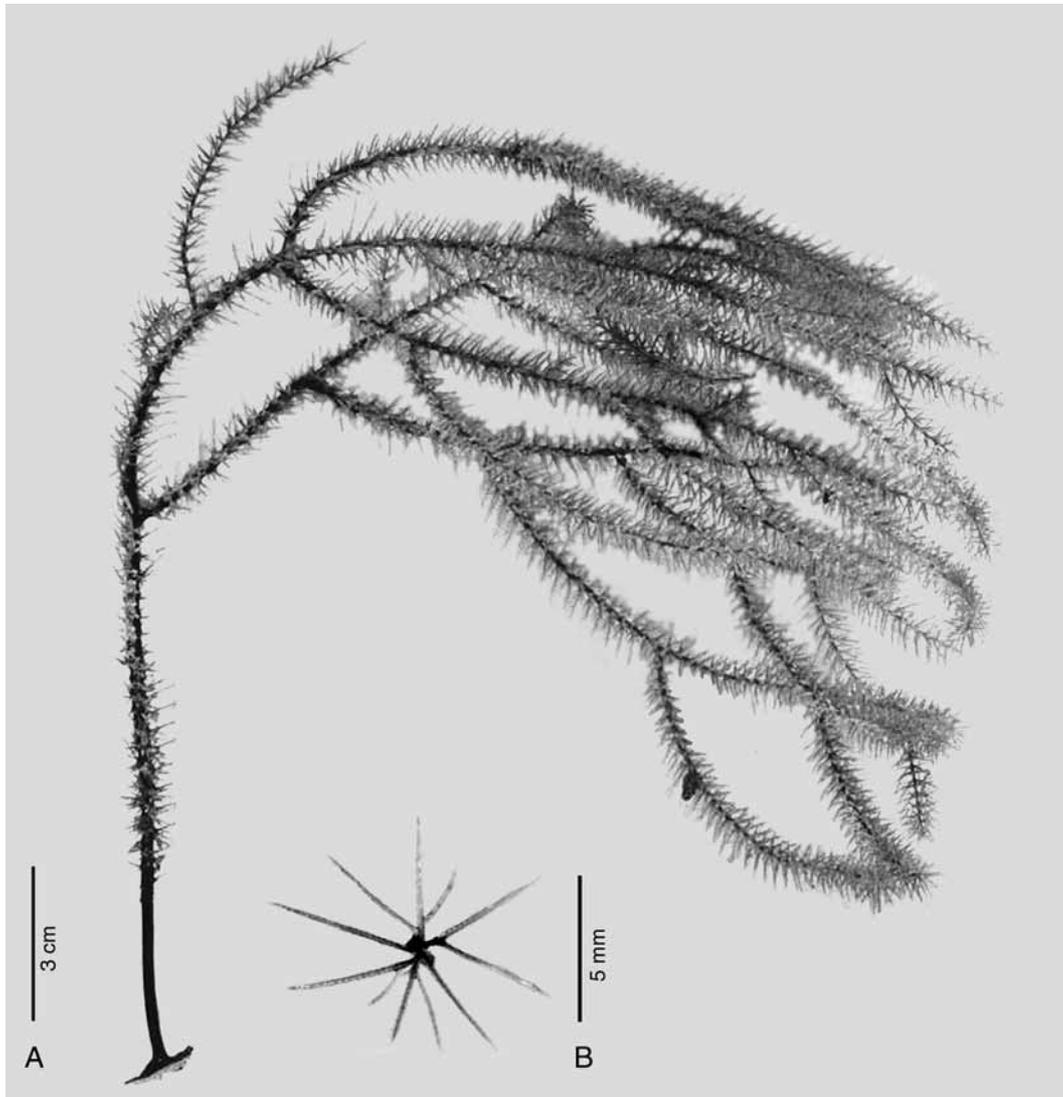
Spines (Fig. 5) on distal section of pinnules distally inclined; abaxial edge to 0.14 mm and adaxial edge to 0.02 mm; height to 0.1 mm (measured from tip to middle of base). Spines along middle section of pinnules less distally inclined (i.e., proximal edge only 0.07 mm), and height generally no more than 0.06 mm). Spines on lower part of pinnules triangular and conical in lateral view with proximal and distal edges about equal in length; height about 0.03 mm. Spines generally subequal in size around circumference of axis; arranged in rows, four of which visible in lateral view. Distance between adjacent spines in each row about 0.2 mm. Spines on branches similar in size, shape and density as those on lower section of pinnules; 0.03–0.04 mm tall with about four rows visible in lateral view.

Polyps present on some branches and pinnules; mostly 2.2–2.8 mm in transverse diameter (from distal edge of distal lateral tentacles to proximal edge of proximal lateral tentacles). Density of polyps could not be determined due to poor condition. Polyps arranged in single row on pinnules; however, relative position varies somewhat from pinnule to pinnule with most located on upper side (relative to direction of branch), others occur laterally.

**Description of paratypes.** All have two secondary pinnules on at least some primary pinnules. Secondaries on younger branchlets most commonly found on anterior primaries. Secondaries present on some posterior primaries on lower parts of branches and stem. Lateral primaries generally without subpinnules on younger portions of branches, but may have one or two (usually subopposite) secondaries on older branches. Branching of corallum varies from planar with relatively short branchlets (USNM 77111) to more bushy (USNM 1086635) with more elongate and somewhat overlapping branches. Density of primary pinnules ranges from 24–33 per centimeter. Length of primary pinnules also variable, usually less than 1 cm (to 2 cm). In USNM 77111 maximum width of some branchlets 1.5 cm. Spines on USNM 77111 and USNM 1086635 mostly 0.05–0.08 mm tall (to 0.1 mm) and 0.2–0.3 mm apart. Three or four rows of spines visible in lateral view.

Paratype from Brazil (MNRJ 5150) planar, 19.5 cm high and 15.0 cm wide: unpinnulated part of stem 3.3 cm, basal stem diameter 1 mm. Corallum branched to second order; distal branch angles about 45°. Lateral

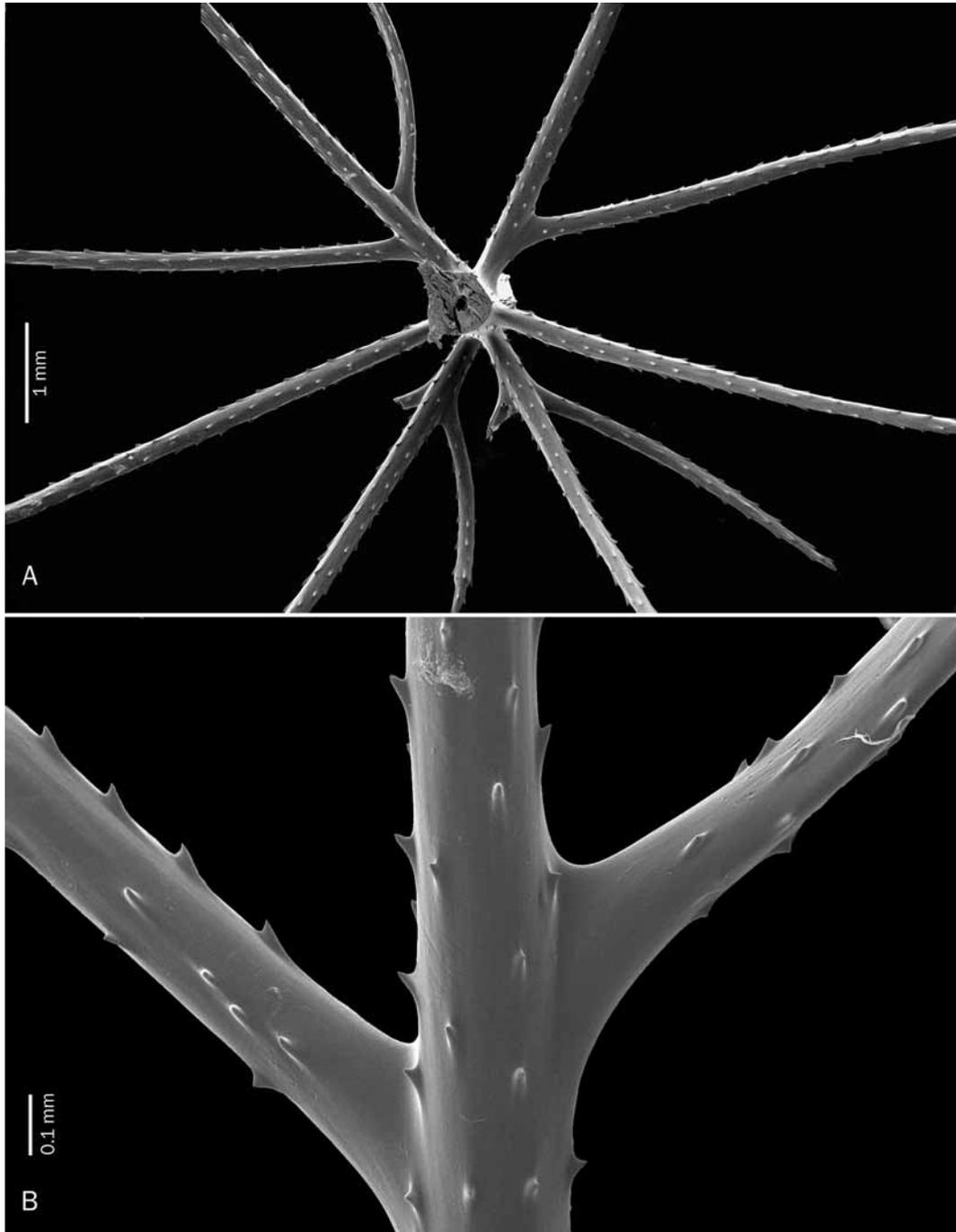
primary pinnules 6–11 mm long; anterior and posterior primary pinnules usually not more than 4–6 mm long. Pinnules 2.5–3.0 mm apart in each row (four or five per centimeter) with 24–30 pinnules per cm total for all rows. One or two (subopposite) secondary pinnules, 2–6 mm long, on anterior, lateral and posterior primary pinnules. Subopposite secondary pinnules not very common; confined to branches in middle of corallum. Tertiary pinnules rarely present on anterior or posterior secondaries; maximum size 2.0 mm. Spines on distal portion of pinnules 0.07–0.09 mm tall; spines on lower portions of pinnules 0.04–0.06 mm. Six rows of spines visible in lateral view. Distance between spines in one row 0.17–0.3 mm; five or six spines per millimeter in each row. Polyps absent.



**FIGURE 3.** *Chrysopathes micracantha* new species, holotype, USNM 1097219: A, entire corallum; B, cross section of branch showing pinnules and subpinnules.

**Comparisons.** *Chrysopathes micracantha* is differentiated from *C. oligocrada* primarily on the basis of the number of secondary pinnules present on the primary pinnules. In *C. micracantha* there are as many as two secondaries per primary, and these occur in subopposite pairs, whereas in *C. oligocrada* there is only one secondary per primary. Also, in *C. micracantha* the pinnules are spaced closer together (24–33 per cm) compared to *C. oligocrada* (usually 18–21 per cm). In *C. micracantha* the spines tend to be more appressed to the axis, especially those near the tips of the pinnules, and the polyps are slightly larger (2.2–2.8 mm in transverse diameter) than those in *C. oligocrada* (1.6–2.4 mm).

A species found in the Pacific, *C. speciosa* Opresko 2003, is very similar to *C. micracantha* in having more than one subpinnule on the primaries. In *C. micracantha* the subpinnules are more regularly in subopposite pairs. Furthermore, *C. speciosa* may have more than two secondaries on a primary, and tertiary pinnules. These species can also be differentiated by the size of the spines. In *C. speciosa* the pinnular spines are mostly 0.06–0.12 mm (maximum 0.18 mm) and stand out from the axis, whereas those in *C. micracantha* are generally not more than 0.06 mm (maximum 0.1 mm), and are more appressed to the axial surface.



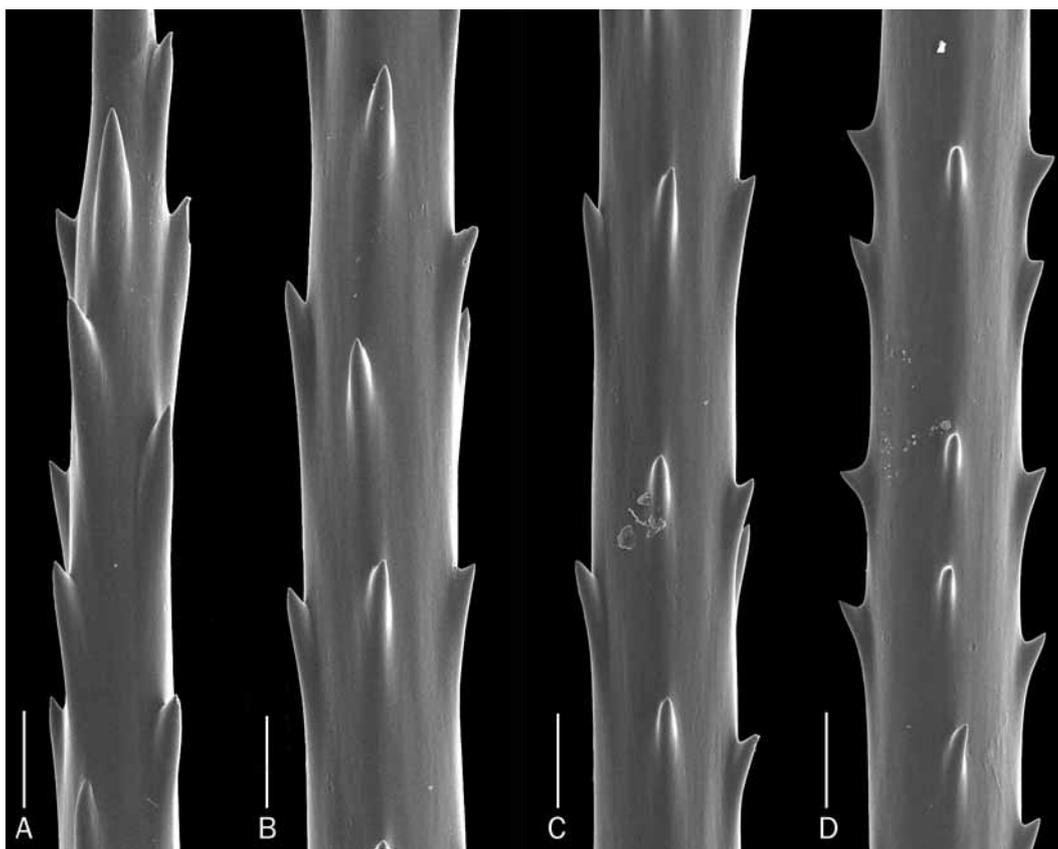
**FIGURE 4.** *Chrysopathes micracantha* new species, holotype, USNM 1097219: A, cross section of branch showing arrangement of pinnules and subpinnules: B, close-up view of basal portion of subopposite secondary pinnules.

**Remarks.** Another specimen found in the RSMAS collection (from RV *Pillsbury* sta. 741, 1052–1066 m, off Venezuela, 11°47.8'N, 66°06.8'W to 11°52.4'N, 66°14.0'W) may represent a third species of *Chryso-*

*pathes* in the Atlantic. This specimen has more extensive subpinnulation than *C. micracantha*. Subpinnules occur on all primaries, although they are less common on the laterals. There are as many as three secondaries per primary. Where there are two or more secondaries they occur in a subopposite pair or in a cluster of three. Tertiary pinnules are present and these appear to be confined to the secondaries on the anterior primaries (polyps are not present on the specimen; therefore, the anterior/posterior orientation of the pinnules is difficult to discern). The primary pinnules are generally not more than 7 mm in length and there are 24–27 primary pinnules per cm. The spines are about 0.04 mm tall. The poor condition of the specimen and the fact that only one specimen is available for study precludes establishing a new taxon at this time.

**Etymology.** The specific name is derived from the Latin *micro* (small) and *acantha* (spine).

**Distribution.** The species has been collected in the western Atlantic, from Brazil north to off the southeastern coast of the U.S. at depths ranging from 658 to 1130 m.



**FIGURE 5.** *Chrysopathes micracantha*, new species, holotype, USNM 1097219: A–D, spines on pinnules, scale bars 0.1 mm.

### Acknowledgments

The authors wish to thank S. Cairns of the USNM; N. Voss of the RSMAS; S. deVictor of the Regional Taxonomic Center of the SCDNR; G. Sedberry, currently Superintendent of Gray's Reef National Marine Sanctuary; S. Brooke of the Oregon Institute of Marine Biology, University of Oregon; C. Messing of Nova University; the NOAA Office of Ocean Exploration (Project: "Exploration of Deep-water Coral Ecosystems off the Coast of Florida: Mapping and Habitat Characterization"); the Campos Basin Deep Sea Environmental Project/PETROBRAS and REVIZEE Program for providing material for study; and C. Castro (Museu Nacional do Rio de Janeiro) for providing one of the coauthors (LLL) research space in the MNRJ. Also much appreciated by the authors is the careful and thorough review of the manuscript by T. Molodtsova and an

anonymous reviewer, and the very helpful editorial comments of D. Fautin. The photomicrographs were prepared in the Scanning Electron Microscopy Laboratory of the USNM; S. D. Whittaker of the USNM kindly assisted in the SEM analysis.

D.M. Opresko is a Research Associate of the USNM, and gratefully acknowledges that affiliation. This work was supported in part by Oak Ridge National Laboratory, Oak Ridge TN.

## References

- de Laia Loiola, L. (2007) Black corals (Cnidaria: Antipatharia) from Brazil: an overview. *In*: George, R.Y. & Cairns, S.D. (Eds.), Conservation and Adaptive Management of Seamounts and Deep-Sea Coral Ecosystems. Rosenstiel School of Marine and Atmospheric Science, University of Miami, Miami, FL.
- Kinoshita, K. (1910) On a new antipatharian *Hexapathes heterosticha* n. gen. and n. sp. *Annotationes Zoologicae Japonenses*, 7, 231–234.
- Opresko, D.M. (2001) Revision of the Antipatharia (Cnidaria: Anthozoa). Part I. Establishment of a new family, Myriopathidae. *Zoologische Mededelingen, Leiden*, 75, 347–374.
- Opresko, D.M. (2002) Revision of the Antipatharia (Cnidaria: Anthozoa). Part II. Schizopathidae. *Zoologische Mededelingen, Leiden*, 76, 411–442.
- Opresko, D.M. (2003) Revision of the Antipatharia (Cnidaria: Anthozoa). Part III. Cladopathidae. *Zoologische Mededelingen, Leiden*, 77, 495–536.
- Opresko, D.M. (2004) Revision of the Antipatharia (Cnidaria: Anthozoa). Part IV. Establishment of a new family, Aphanipathidae. *Zoologische Mededelingen, Leiden*, 78, 209–240.
- Opresko, D.M. (2005) New genera and species of antipatharian corals (Cnidaria: Anthozoa) from the North Pacific. *Zoologische Mededelingen, Leiden*, 78, 129–165.
- Opresko, D.M. (2006) Revision of the Antipatharia (Cnidaria: Anthozoa). Part V. Establishment of a new family, Stylopathidae. *Zoologische Mededelingen, Leiden*, 80, 109–138.
- Schultze, L.S. (1896) Beitrag zur Systematik der Antipatharien. *Abhandlungen der Senckenbergischen naturforschenden Gesellschaft*, 23, 1–40.