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Naming the Bonaire banded box jelly, *Tamoya ohboya*, n. sp. (Cnidaria: Cubozoa: Carybdeida: Tamoyidae)

ALLEN G. COLLINS[1], BASTIAN BENTLAGE[1,2], WILLIAM (BUD) GILLAN[3], TARA H. LYNN[1], ANDRÉ C. MORANDINI[4] & ANTONIO C. MARQUES[4]

[1]*National Systematics Laboratory of NOAA's National Marine Fisheries Service and the National Museum of Natural History, MRC-153, Smithsonian Institution, PO Box 37012, Washington, DC 20013-7012, USA. E-mail: collinsa@si.edu; thtinlynn@gmail.com*
[2]*Department of Ecology and Evolutionary Biology, The University of Kansas, 1200 Sunnyside Avenue, Lawrence, KS 66045, USA. E-mail: bentlage@ku.edu*
[3]*AP and Honors Biology Teacher, Palm Beach County (FL) Schools, Boynton Beach Community High School, 4975 Park Ridge Boulevard, Boynton Beach, FL, 33426, USA. E-mail: gillanw@palmbeach.k12.fl.us*
[4]*Departamento de Zoologia, Instituto de Biociências, Universidade de São Paulo, Rua do Matão trav. 14, n. 101, São Paulo, SP, 05508-090, BRAZIL. E-mail: acmorand@usp.br; marques@ib.usp.br*

Abstract

A new species of cubozoan jellyfish has been discovered in shallow waters of Bonaire, Netherlands (Dutch Caribbean). Thus far, approximately 50 sightings of the species, known commonly as the Bonaire banded box jelly, are recorded, and three specimens have been collected. Three physical encounters between humans and the species have been reported. Available evidence suggests that a serious sting is inflicted by this medusa. To increase awareness of the scientific disciplines of systematics and taxonomy, the public has been involved in naming this new species. The Bonaire banded box jelly, *Tamoya ohboya*, **n. sp.**, can be distinguished from its close relatives *T. haplonema* from Brazil and *T.* sp. from the southeastern United States by differences in tentacle coloration, cnidome, and mitochondrial gene sequences. *Tamoya ohboya* **n. sp.** possesses striking dark brown to reddish-orange banded tentacles, nematocyst warts that densely cover the animal, and a deep stomach. We provide a detailed comparison of nematocyst data from *Tamoya ohboya* **n. sp.**, *T. haplonema* from Brazil, and *T.* sp. from the Gulf of Mexico.

Key words: nematocysts, cnidome, stings, citizen science, taxonomic impediment

Introduction

Marine scientists and other ocean enthusiasts generally understand that we have yet to recognize, name, and describe a vast number of species inhabiting Earth's oceanic realm (Tittensor *et al*. 2010). Given that marine ecosystems are under stress from a host of widespread human activities (from fishing, to development, to burning fossil fuels, etc.), lack of marine biodiversity knowledge is an urgent issue (Wilson 1985). It appears, however, that the general public is less aware of our considerable lack of understanding of marine biodiversity. Discoveries of new species, which are common events, occasionally make headlines in popular media outlets. In one sense, this is good news for systematists for it tells us that our science is interesting enough to capture the attention and imagination of some significant portion of the public. A society that is curious about marine biodiversity has the potential to support studying it. Nevertheless, lack of public awareness for the scope of the work involved in documenting marine biodiversity is at least partly responsible for the relatively impoverished state of resources allocated for taxonomy and the natural history museums that house valuable marine biodiversity collections (Wheeler *et al*. 2004, Winston 2007). Without significantly increased support, the resulting taxonomic impediment (Hoagland 1996, Evenhuis 2007) is likely to persist.

In 2001, one of us (WG) became aware of a remarkable jellyfish captured on video in Bonaire, Netherlands (at the time, Netherlands Antilles). The video shows a lone, strong swimming, elongated (estimated bell height roughly 15 cm) cuboidal jellyfish with four banded tentacles, each extending from a single pedalium at each corner

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of the bell. The species is immediately recognizable as a box jellyfish (class Cubozoa) of the order Carybdeida. The banding pattern of the tentacles is prominent and distinctive (Fig. 1). Striped tentacles are unusual in Cubozoa and it was suspected that the video featured a species that might be new to science.

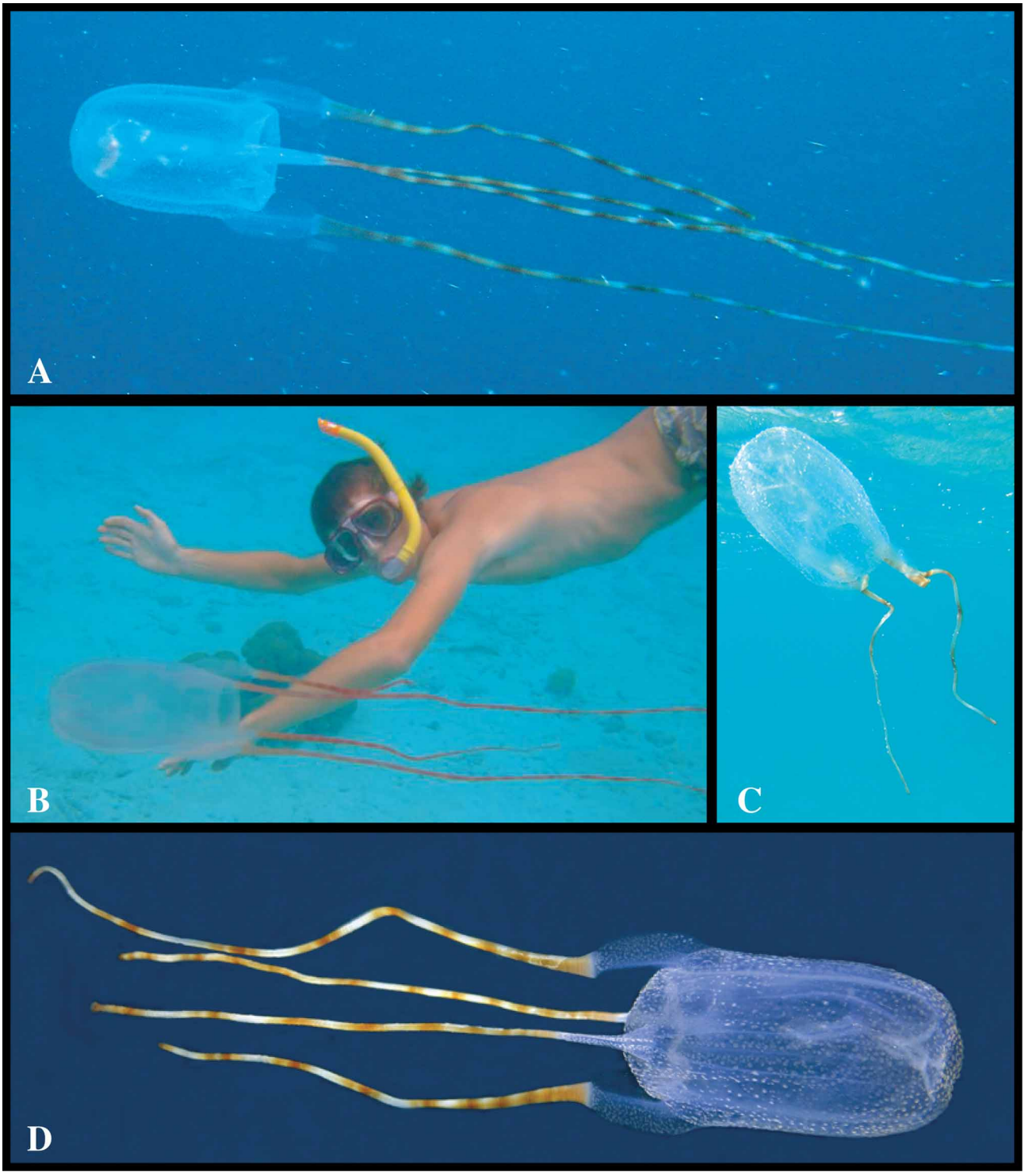

FIGURE 1. In situ photographs of *Tamoya ohboya* **n. sp.** A. St. Lucia, 1–2 m, 20 May 2007, photo by Tim Lowry and used with his permission. Note the deep stomach and long manubrium. B. Divi Divi, Bonaire, 0–5 m, 17 July 2008, photo by Marijke Wilhelmus and used with her permission. C. Bonaire, 1–2 m, 30 December 2006, photo by John Crum and used with his permission. Note flattening of tentacles proximal to pedalia. D. St. Vincent, August 8, 2008, photo by Ned Deloach and used with his permission. Note nematocyst warts on bell and pedalia.

It is rare that a marine species is given a common name prior to having a formal name and description, but this animal quickly became known as the Bonaire banded box jelly. Since 2001, in an example of citizen science, one of us (WG) has tabulated documentation of 50 sightings of the Bonaire banded box jelly, mainly in Bonaire, but also from widespread localities across the Caribbean Basin -- specifically St. Lucia (2), St. Vincent (1), Cozumel, Mexico (1) and Utila, Honduras (1). This documentation includes three human stings that have had relatively serious health consequences. These observations are particularly relevant because Cubozoa contains several species that are highly venomous.

When providing a scientific name and formal description for a species, properly preserved specimens should be placed in an archival museum collection so they can be used as reference points for future study. Securing permits to collect marine animals from Bonaire is no simple matter, as the government is rightfully interested in protecting its marine resources. By appealing to the authorities with information indicating that the Bonaire banded box jelly is likely new to science, we (WG and AGC) were able to secure a permit to collect the Bonaire banded box jelly in 2007. However, the jellyfish is rarely encountered and thus far nearly all sightings have been of solitary, fast swimming individuals and were made by people unaware of the scientific need to have the specimens collected. Thus, it was not until July 2008 that the first specimen was captured, preserved in ethanol, and sent to the Smithsonian's National Museum of Natural History (NMNH). Museum and the National Oceanographic and Atmospheric Association's (NOAA) National Systematics Laboratory (NSL) staff members have registered and cataloged specimens, and have extracted DNA and derived molecular sequence data from them. A PhD student (BB) and an intern between undergraduate and graduate degrees (TL) have documented the gross anatomy and nematocyst morphology of the banded box jelly and a close relative from the southeastern United States, at the direction of an established cnidarian biologist (AGC). Brazilian colleagues (ACMa and ACMo) from the Institute of Biosciences at the University of São Paulo (IB-USP) documented similar genetic and morphological data derived from *T. haplonema* from the type region in Brazil. Together, we have engaged in the scholarship and writing necessary to provide the Bonaire banded box jelly with a scientific name and description, in order to make it formally known and available for science. Specimens have also been used in outreach activities (by AGC and BB) for Smithsonian Sant Ocean Hall visitors and teacher workshop participants.

Reports of new species in the media most often do not correspond to the actual naming and description of the species in question. In fact, it is unknown what percentage of new species reported in recent years have actually been recognized formally in scientific publications. Available evidence suggests that the percentage is small (Evenhuis 2007). Indeed, a Florida TV station has already reported the discovery of the new species described in this paper. It would seem that the public is largely unaware that after discovery, much interesting work goes into describing and naming a species. To increase awareness of what is actually involved in naming and describing a species, we have engaged the public in establishing a species name for the Bonaire banded box jelly (see below). This endeavor was conceived by Jennifer Collins of the Coalition on the Public Understanding of Science (COPUS; http://www.copusproject.org/) and was featured as part of the 2009 Year of Science (http://yearofscience2009.org/jellyfish) celebration. Involving public participation in naming the Bonaire banded box jelly is one small effort to increase awareness of marine biodiversity and the importance of documenting it.

Material and methods

Three specimens of the Bonaire banded box jelly have been captured, collected, and deposited at the Smithsonian National Museum of Natural History. The first specimen to be examined was captured by Johan van Blerk near the water surface off Klein Bonaire, Netherlands, on 29 July 2008. Aware of our interest in describing the species, it was preserved in ethanol and shipped to NMNH. Visual examination of the specimen indicated that it likely represents a close relative of the box jellyfish species *Tamoya haplonema* Müller, 1859. Because of its preservation in ethanol, the specimen was stiff and somewhat difficult to examine. A subsample of tentacle was excised for DNA extraction. In an effort to make the specimen more supple, it was placed in a solution of ~15% glycerol and dish soap in water, and left to soak for approximately five days. Subsequently, the specimen was transferred into 10% buffered formalin. In addition to this initial specimen (USNM 1124022), two additional specimens have been collected. One was collected after it stung a young girl (envenomation described below) in 2006, but this was lost and not delivered to the Smithsonian until June, 2009 (USNM 1146084). Recently, a third specimen was collected

(USNM 1146080). A subsample of tentacle tissue was preserved in 95% ethanol and the rest of the specimen in 10% buffered formalin. Because of the quality of its preservation, it has been designated the holotype of the species described herein. Observations on the gross anatomy of the specimens were made using a Nikon SMZ 1500 stereoscope. Images were taken with the SPOT Insight 14.2 Color Mosaic Camera (Diagnostic Instruments Inc., MI).

Nematocysts were sampled from several anatomical parts of two specimens: proximal and distal ends of the longest tentacle, tip of mouth lip, gastric cirri from opposite ends of the stomach, nematocyst warts from pedalia, nematocyst warts from exumbrella (half way between velarial turnover and apex), and nematocyst warts from apex. For comparison, nematocysts were sampled in the same manner from a specimen of *Tamoya* sp., an undescribed species from the Gulf of Mexico (USNM 1114657) as well as *Tamoya haplonema* (MZUSP 494, referred to as the neotype of *T. haplonema* in Gershwin, 2006) from São Sebastião, southeastern Brazil.

Pieces of tissue were excised and placed on microscope slides, immersed in distilled water, cut into smaller pieces, and covered with a cover slip. Subsequently, the cover slip was pressed down to separate nematocysts from the tissue. Nematocysts were examined using a Nikon Eclipse 80i compound microscope. Images were taken with the SPOT Insight 14.2 Color Mosaic Camera (Diagnostic Instruments Inc., MI). Maximum length and width of nematocyst capsules were measured from images in SPOT Imaging Software Basic (ver. 4.2) using the implemented measurement calibration tool.

Nematocysts were identified using Mariscal (1974), Östman (2000), and Gershwin (2006). Primarily, we relied on Mariscal's (1974) key for the classification of nematocysts. Nematocysts were classified only to the level that we could confidently identify using light microscopy. In accordance with Östman (2000) and Gershwin (2006), nematocysts with lancets in undischarged shafts displaying a v-shaped notch at their base (see Figs. 4A, C, J; 5A, B; 6A, E, H) were classified as "p-".

Nematocyst nomenclature. Shape: club-shaped = elongated cylinder that thickens on one end; lemon-shaped = oval with 2 distinct bulges at opposite ends of its longest axis; spherical = capsule almost or completely round in shape. Shaft and tubule morphology: holotrichous = spines of equal size along the entire length of tubule; microbasic = shaft length ≤ capsule length; macrobasic = shaft length > capsule length (following Gershwin 2006). Note that distinction between microbasic and macrobasic can only reliably be made from discharged nematocysts. Lancet: a pointed, dart-like structure within the shaft (after Yanagihara *et al*. 2002).

Genomic DNA was extracted from tentacle subsamples of USNM 1124022 and USNM 1146080. DNA "barcodes", mitochondrial 16S and cytochrome oxidase I (COI), were PCR amplified and sequenced using primers from Cunningham and Buss (1993) and Dawson and Jacobs (2001), respectively, for both samples. Mitochondrial 16S was also derived from three samples of *Tamoya haplonema* from southeastern Brazil and one sample of *Tamoya* sp. from the southeastern United States. In addition, mitochondrial COI was derived from two samples of *Tamoya haplonema* from southeastern Brazil. All of these sequences have been deposited in GenBank (GQ150263-164; HQ824526-532) in association with this description. Near complete genes for the large and small subunits of the nuclear ribosome, LSU and SSU, respectively, were also derived from USNM 1124022 and published as part of a molecular phylogenetic study of Cubozoa (Bentlage *et al*. 2010).

Systematic account

Phylum Cnidaria Verrill, 1865

Subphylum Medusozoa Petersen, 1979

Class Cubozoa Werner, 1973

Order Carybdeida Gegenbaur, 1857

Family Tamoyidae Haeckel, 1880

Valid genera: *Tamoya* Müller, 1859

Diagnosis (following Bentlage *et al*. 2010): Carybdeida with medusae that possess frown-shaped rhopaliar niche ostia lacking rhopaliar horns (Fig. 2A).

Genus *Tamoya* Müller, 1859
Figures 2A, C–E

Valid species: *Tamoya haplonema* Müller, 1859; *Tamoya ohboya*, **n. sp.**, described herein.

Insufficiently known to be considered valid species: *Tamoya bursaria* (Lesson, 1829 as *Bursarius cythereae*); *Tamoya gargantua* (Lesson, 1829); *Tamoya haeckeli* Southcott, 1967 = *Tamoya gargantua*.

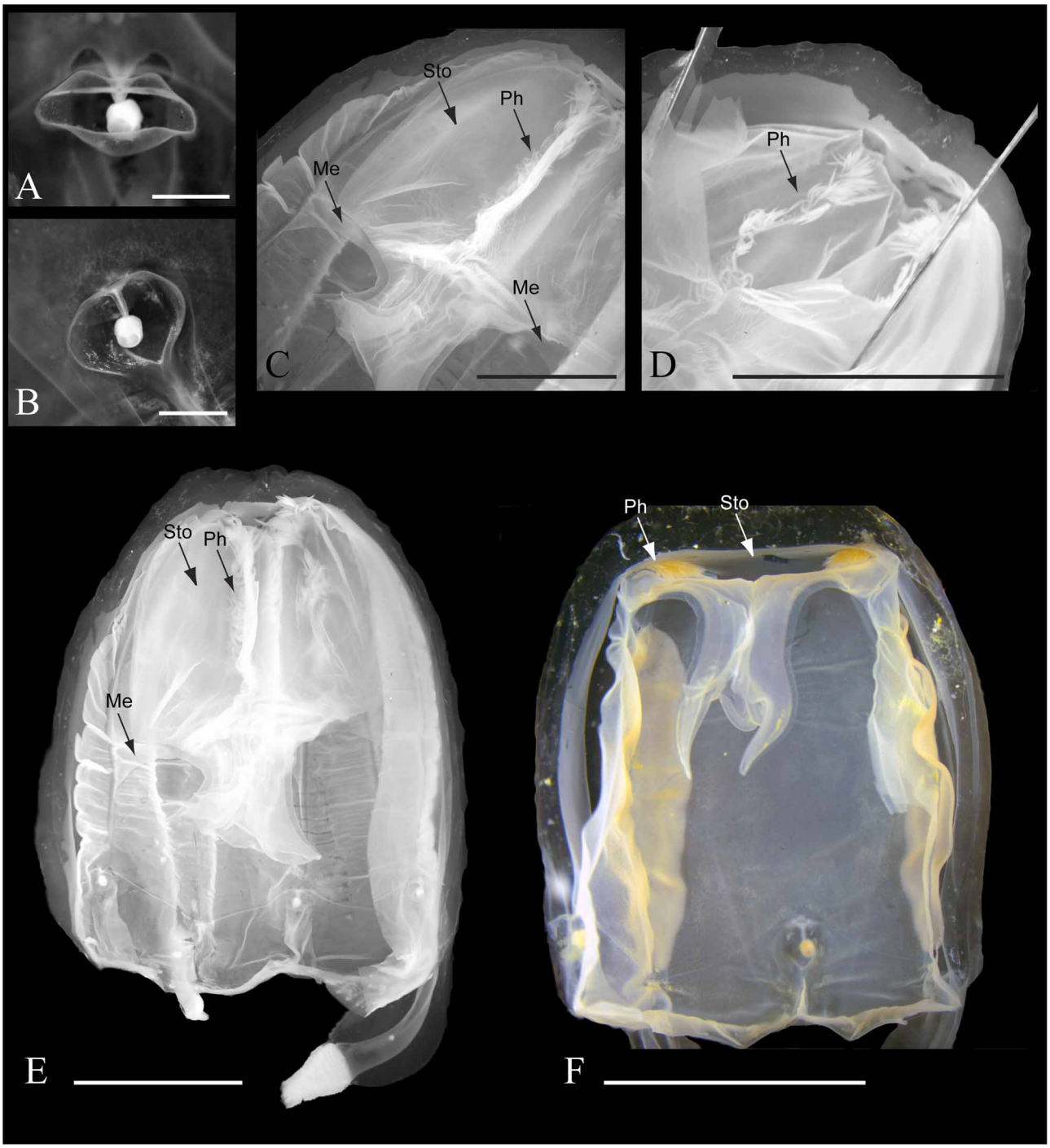

FIGURE 2. Comparison among characters of *Tamoya* sp. (USNM 1114657) and *Carybdea rastonii* Haacke, 1887 (USNM 88365). A. Frown-shaped rhopaliar niche ostium of *T.* sp. B. Heart-shaped rhopaliar niche ostium (only a single upper covering scale present) of *C. rastonii*. C. Stomach of *T.* sp. with mesenteries and vertically arranged gastric phacellae. D. Gastric phacellae of *T.* sp.; note that individual gastric cirri are simple and unbranched. E. Whole specimen of *T.* sp. cut in half longitudinally. F. Longitudinal cut specimen of *C. rastonii* with epaulette-like gastric phacellae visible in corners of the shallow stomach. Me = mesentery; Ph = gastric phacellae; Sto = stomach. Scale bars: 10 mm (F & E), 5 mm (C & D), 1 mm (A & B).

Other named species: *Tamoya prismatica* Haeckel, 1880 = *Tamoya haplonema* (see Mayer 1910); *Tamoya quadrumana* Müller, 1859 = *Chiropsalmus quadrumanus* (see Agassiz 1862); *Tamoya virulenta* Kishinouye, 1910, known in Japan as "Hikurage", is considered valid, but is a species of *Morbakka* in the newly erected family Carukiidae (Bentlage *et al*. 2010).

Diagnosis (following Haeckel 1880): Tamoyidae with deep stomach connected to the subumbrella with 4 prominent perradial mesenteries. Vertical phacellae in the interradii.

Type species: *Tamoya haplonema* Müller, 1859, by subsequent designation by Haeckel (1880).

Remarks: Müller (1859) erected the genus *Tamoya* for two cubozoan species from Santa Catarina state (southern Brazil), *Tamoya haplonema* and *Tamoya quadrumana* (= *Chiropsalmus quadrumanus*), which today we recognize as representatives of separate orders. At the time, however, Müller believed that the two were so similar that he could provide just a single description, pointing out the specific differences throughout his manuscript. He distinguished *Tamoya* from *Carybdea* Péron & Lesueur, 1810, the only other cubozoan genus described at the time, based on the morphology of the bell margin, stomach extensions, origination of the tentacle bases, presence or absence of a sphincter, whether the gastric cirri pointed towards the stomach or the bell, and whether or not the cirri were hollow. These characters are somewhat nebulous and have been widely disregarded by subsequent workers (e.g., Claus 1878, Haeckel 1880, Maas 1903, Mayer 1910, Kramp 1961, Gershwin & Alderslade 2005). Claus (1878) discussed the generic diagnosis presented by Müller (1859) in detail and considered that the characters invoked either do not differ substantially from those of *Carybdea* or are uninterpretable, and thus concluded that the designation of a new genus for the specimens from Brazil was not warranted. However, Claus (1878) did not actually inspect the specimens studied by Müller (1859), but simply relied on Müller's description, which arguably contains several shortcomings regarding erection of the genus *Tamoya*.

Clearly, *Tamoya quadrumana* is a chirodropid (a clade of cubozoans not recognized at the time of Müller's description) and so distinct from any carybdeid that it was soon moved into its own genus, *Chiropsalmus*, by Agassiz (1862: 174; as *Chiropsalmus quadrumanus*). Subsequently, Haeckel (1880: 445–446) established the order Chirodropida (family Chirodropidae at the time) to accommodate *Chiropsalmus* and his new genus *Chirodropus*. Haeckel (1880: 442–443), in disagreement with Claus (1878), also modified the diagnosis of *Tamoya* to contain all those species that possess a stomach that protrudes deep into the subumbrellar cavity and is connected to the subumbrella by mesenterial bands (Fig. 2C & E). Furthermore, the gastric cirri of *Tamoya* sensu Haeckel (1880) are arranged in four interradial bands running along the stomach walls from the upper portion of the stomach down towards the manubrium (Fig. 2C, D & E). As Haeckel (1880) pointed out, the stomach of *Tamoya* differs so strongly from the stomach of *Carybdea* that taxonomic distinction is warranted. For comparison, the stomach of *Carybdea* is shallow, the gastric phacellae cluster in the corners of the stomach, and mesenteries are absent (Fig. 2F). Mayer (1910: 512) considered both *Tamoya* and *Carybdea* to be valid, though he posited that the distinction between the two may be based on intergrading characters. Following Haeckel (1880), the genus *Tamoya* persists, is in widespread use, and is consistent with molecular phylogenetic analyses (Bentlage *et al*., 2010).

***Tamoya ohboya*, n. sp.**
Figures 1, 3, 4, 5

Tamoya cf. *haplonema*: Bentlage *et al*., 2010: 495.

Material examined. Holotype: USNM 1146080, sex undetermined, 61 mm BH (bell height; measured from velarial turn-over to top of bell), 29 mm IRW (interradial bell width), collected 30 June 2010 at Divi Flamingo, Bonaire, Netherlands (~12°8.61" N, 68°16.60) by W. Gillan and M. Wilhemus. Paratype: USNM 1146084, sex undetermined, 67 mm BH, 32 mm IRW, collected 15 August 2006 at Windsock, Bonaire, Netherlands (~12°8.03" N, 68°16.98) by J. Richter, T. Dace and P. Keyes. Paratype: USNM 1124022, mature male, 63 mm BH, 30 IRW, collected 29 July 2008 mid-afternoon, at or close to surface a few meters from shore at No Name Beach, Klein Bonaire, Netherlands (~12°10.03' N, 68°18.03' W) by Johan van Blerk.

Type locality. Divi Flamingo, Bonaire, Netherlands (Dutch Caribbean).

Etymology. The specific name, *ohboya*, has been chosen by the public through the following process. Individuals were permitted to submit potential names and reasons for them via the Internet between 14 May and 14 June 2009 (see http://www.yearofscience2009.org/jellyfish). Seven potential epithets were then selected from all sub-

mitted names (n=309) by the authors of this paper. Choice among these seven names was then tabulated with an Internet poll of more than 830 votes cast from 18–26 June, 2009. The winning entry, *ohboya*, was submitted by Lisa Peck, a high school marine biology teacher who provided the following reason for submitting the name:

"I bet "Oh Boy" is the first thing said when a biologist or layman encounters the Bonaire Banded Box Jellyfish. It is not often that a new amazing species is discovered, especially one so beautiful. I am confident that Bud Gillan exclaimed "Oh Boy" when he saw tourist Vicki Carr's video of the Bonaire Banded Box Jellyfish (a never before seen species of jellyfish). Vicki probably exclaimed "Oh Boy" when Bud called her to tell her the news of her amazing discovery. I am sure that "Oh Boy" was uttered by the three people who were stung by the Bonaire Banded Box Jellyfish. In addition, I bet that "Oh Boy" was spoken by the doctors when they saw the wounds inflicted by the nematocysts of the Bonaire Banded Box Jellyfish. Later, the doctors probably uttered "Oh Boy" when they were confident that these 3 people would survive their encounter with the Bonaire Banded Box Jellyfish. And finally, when I saw the website Year of Science: Species naming contest of the Bonaire Banded Box Jellyfish I loudly exclaimed "Oh Boy"!! Therefore I am suggesting the scientific name Tamoya ohboya be given to this amazing creature."

Diagnosis. *Tamoya* with distinctly dark brown to reddish-orange banded tentacles. *Tamoya* with lemon-shaped, microbasic birhopaloids and small, oval isorhizas present in cnidome of tentacles.

Description. Morphology & Anatomy: Bell translucent, densely covered in conspicuously raised nematocyst warts (Fig. 1 & 3A). Pedalia covered with nematocyst warts, both on outer keel and inner wing; pedalial wing scalpel-shaped as in *Tamoya haplonema*. Pedalial canal bend with prominent spike (Fig. 3B). Tentacles with characteristic bands, red or orange to brown (Fig. 1); tentacles flared at their bases, round in cross section (pictures indicate that in life tentacles are flattened when extended). Perradial gonads as leaf-like sheets. Stomach extending to about 1/3 of bell height into subumbrellar cavity (Fig. 3C); stomach attached to subumbrella with four well-developed mesenterial bands (Fig. 3D) extending about half-way between apex and velarial turn-over. Manubrium cruciform, without nematocyst warts; lips of square shape with nematocyst warts and smooth edges (Fig. 3C). Rhopaliar niche opening raised, frown-shaped, with single upper and lower covering scales; rhopaliar horns lacking (Fig. 3E). Rhopalia with two median lens eyes and four lateral eyespots, two pit and two slit (Fig. 3I & J); statolith oval (Fig. 3J). Velarium broad; numerous canals per octant, growing close to each other with diverticula mainly at distal ends of canals (Fig. 3F). Velarium sprinkled on exumbrellar side with many white nematocyst warts (Fig. 3F). Frenulae four, each consisting of two sheets bracing the right-angle connection from tip of rhopalial niche to about 3/4 distance between velarial turnover and its margin (Fig. 3G); perradial lappets absent. Gastric phacellae forming four bands, one in each perradius, running vertically from top of stomach down to sphincter of stomach (Fig. 3H). Gastric cirri numerous with branches arising tree-like from each stalk (Fig. 3K).

Cnidome: The following types of nematocysts are present in *T. ohboya* **n. sp.**: club-shaped macrobasic p-euryteles; lemon-shaped microbasic birhopaloids; small oval isorhizas; spherical holotrichous isorhizas; and small, oval amastigophores. Small oval isorhizas are found in all body parts except phacellae; spherical holotrichous isorhizas in all parts but apex warts. Birhopaloids are located in tentacles, manubrium and phacellae and all of them probably belong to the same type (i.e., p-birhopaloid); v-shaped notch was indiscernible in tentacles (due to image resolution) and phacellae (all nematocysts discharged) but otherwise all birhopaloids appear morphologically very similar under light microscopy. Macrobasic p-euryteles in the tentacle tip are of two types (A and B) differing in shape and size of the lancet (Fig. 4A, C). Spherical holotrichous isorhizas in the tentacle tip belong to two distinct size classes (i.e., L and S), but do not appear to differ in morphology (Fig. 4G–l). The size ranges and distribution of nematocyst types across different regions of *T. ohboya* **n. sp.** are presented in Table 1.

Genetic Data: No variation in mitochondrial 16S is observed between the holotype (USNM 1146080) and paratype (USNM 1124022) of *T. ohboya* **n. sp.** Mitochondrial 16S from *T. ohboya* **n. sp.** differs from that of *T. haplonema* from Brazil by 2.1–2.5% and *T.* sp. from the southeastern USA by 10.7–10.9%. Mitochondrial COI from the two samples of *T. ohboya* **n. sp.** differ by 0.4%, whereas they differ from COI from *T. haplonema* from Brazil by 4.4–4.5%.

Differential diagnosis. *Tamoya ohboya* **n. sp.** is very similar to both *T. haplonema* from Brazil and *T.* sp. from the southeastern USA in gross morphology. All three species possess a deep stomach that reaches far into the subumbrellar cavity and is connected to the subumbrella by four mesenterial filaments. All three also share the arrangement of the gastric cirri as vertical bands along the stomach walls and similar frown-shaped rhopaliar niche ostia that lack the rhopaliar horns characteristic of the genera that used to be classified within Tamoyidae (sensu Gershwin & Alderslade 2005; *Carukia*, *Malo*, *Gerongia*, and *Morbakka*). These latter taxa have recently been

united in the family Carukiidae (Bentlage *et al*. 2010). *Tamoya ohboya* **n. sp.** can most readily be distinguished from other species of *Tamoya* by the distinctive red to orange banded tentacles (but see remarks below).

The overall cnidome of *Tamoya ohboya* **n. sp.** is also similar to those of *T. haplonema* from Brazil and *T.* sp. from the southeastern USA. However, the distribution of nematocyst types differs among the three species and *T. ohboya* **n. sp.** possesses more nematocyst types and displays more variation across all body parts (Table 1; Figs. 4–6). The absence of small oval amastigophores appears to differentiate *T. haplonema* from Brazil from other species of *Tamoya*, whereas small oval isorhizas were not observed in *T.* sp. from the Gulf of Mexico. *Tamoya ohboya* **n. sp.** appears to be the only known species of *Tamoya* to possess lemon-shaped microbasic birhopaloids and small oval isorhizas in its tentacles. In contrast to *T. haplonema* from Brazil, no lemon-shaped microbasic birhopaloids are present in its pedalial warts. No such warts were observed in *T.* sp. from the Gulf of Mexico so it is unknown if this character can differentiate the two species.

Distribution. Confirmed sightings have been made in shallow (<10 m) near-shore waters off Bonaire (Netherlands Antilles), St. Lucia (Lesser Antilles), St. Vincent (Lesser Antilles), Cozumel (Mexico) and Utila (Honduras), suggesting that the species has a widespread distribution across the Caribbean Sea. A picture taken from Fernando de Noronha archipelago suggests that its range may extend to northern Brazil. Of the 50 tabulated sightings of *T. ohboya* **n.sp.**, 45 have been on the western margin of Bonaire.

Remarks. One of us (WG) has been accumulating sightings of *Tamoya ohboya* since 2001 and has also had an opportunity to swim with the species in nature. Roughly 50 confirmed sightings, mostly by amateur naturalists, of the species between 1989 and the present have been recorded. Of the 50 tabulated sightings, 26 (including collection of the holotype and two paratypes) involve pictures or videos of the specimen that clearly show the body shape and banded tentacles. Many of these have been accumulated on the online photo sharing service Flickr (http://www.flickr.com/photos/tesserazoa/tags/bonairebandedboxjelly/). The rest were confirmed by description and by having individuals that reported encounters examine available pictures presumed to be *T. ohboya* **n. sp.** The most distinctive feature that can be observed in photos is the prominent banding pattern of the tentacles. Occasional specimens identified as *T. haplonema* in Brazil also display similar tentacle bands. It is unclear if specimens of true *T. haplonema* sometimes have banded tentacles or whether *T. haplonema* and *T. ohboya* **n. sp.** have overlapping ranges in Brazil. Further remarks are limited to information garnered from the tabulated 50 sightings.

Very little is known about the ecology of *Tamoya ohboya* **n. sp.**, but it appears to be solitary since it has most often been encountered alone (49 of 50). The species may forage for prey during the day, given that nearly all sightings (49 of 50) have been during the day. Nevertheless, more people are in the water during this time and so it would be premature to conclude from these limited observations that *T. ohboya* **n. sp.** is a daytime predator. We also know little about the ecology of its congener, *Tamoya haplonema*, but the information gathered thus far suggests that it feeds during the night (Nogueira Jr. & Haddad 2008). Several *Tamoya ohboya* **n. sp.** individuals have been observed swimming back and forth between the surface and the bottom in shallow water, but the significance of this behavior remains unstudied. Specimens are reported to be fast swimmers. The vast majority of the 50 occurrences have been reported during July, August, and September (8, 14, and 9, respectively), though the species has been seen in all months of the year.

Tamoya ohboya **n. sp.** is believed to cause serious envenomations to humans, although just three putative stings have been documented. The best-documented envenomation occurred 13 August 2006, when a 13- to 15-year-old girl was stung at Bachelor's Beach, Bonaire. Identity of *T. ohboya* **n. sp.** as the stinger was easily confirmed because the girl's father threw the jellyfish onto a nearby jetty after which it was photographed and collected (under the permit referred to in the introduction above; http://blog.richterscale.org/index.php/weblog/unknown_box_jellyfish_species/). This specimen was preserved and an attempt was made to bring it to the US for study, but it was lost for some time and not delivered to the Smithsonian until June, 2009 (USNM 1146084; kindly provided by Ned Deloach). The envenomation resulted in pain and agitation, and the girl received hospitalization involving compression wrap and antibiotic/analgesic cream. However, the condition of the patient worsened resulting in medical evacuation to Curaçao. Two other stings have been attributed to the Bonaire banded box jelly. One was in Bonaire and involved the daughter of an individual who is familiar with the species. This envenomation resulted in severe pain and skin damage. The victim was treated with StingThing (Remedy Marketing, Inc.) with proteolytic enzymes, and hospitalization was not needed. The third sting attributed to *T. ohboya* **n. sp.** took place on St. Lucia. The victim described the banding pattern of the tentacles and confirmed identity by viewing pictures of the species. We know little about the severity of this sting.

TABLE 1. Cnidome comparison of *Tamoya* specimens. L, W denote capsule lengths and widths, respectively, in µ. ? indicates uncertainty of identification.

		T. ohboya (USNM 1124022)				*T. ohboya* (USNM1146084)				*T. haplonema* (MZUSP 494)				*T.* sp. (USNM 1114657)			
Tentacle Tip		Mean	Range	StDev	N	Mean	Range	StDev	N	Mean	Range	StDev	N	Mean	Range	StDev	N
Club-shaped, macrobasic p-eurytele (A)	L	39.2	35.2–49.4	3.0	40	47.2	39.8–60.0	4.2	23	39.8	34.3–50.9	5.4	10	46.1	36.2–52	3.4	20
	W	12.6	10.8–13.9	0.7	40	17.2	14.9–21.7	1.7	23	13.0	11.7–14.7	0.8	10	16.5	13.9–19.1	1.7	20
Club-shaped, macrobasic p-eurytele (B)	L	33.2	32.4–34.0	---	3												
	W	12.0	10.7–14.1	---	3												
Lemon-shaped, microbasic birhopaloid	L	25.4	24.0–28.1	1.3	11	23.8	23.1–24.4	---	2								
	W	15.9	15.0–17.2	0.9	11	17.9	17.5–18.3	---	2								
Small, oval isorhiza	L	10.5	8.6–12.9	0.9	20	10.0	6.1–12.5	2.1	7								
	W	6.5	5.7–7.2	0.5	20	7.2	5.1–7.9	1.0	7								
Spherical, holotrichous isorhiza (larger)	L	31.2	28.9–32.7	1.4	10	32.4	28.6–35.3	1.7	10					30.0	26.8–32	2.3	5
	W	26.5	23.3–27.9	1.5	10	26.4	24.8–29.0	1.4	10					23.7	22.3–25.6	1.4	5
Spherical, holotrichous isorhiza (smaller)	L	23.1	19.8–25.9	2.1	16	22.5	---	---	1								
	W	18.8	15.8–21.2	1.6	16	14.2	---	---	1								
Small, oval amastigophore	L													12.7	9.8–14.1	1.6	10
	W													7.3	6.4–8.6	0.8	10
Tentacle Base																	
Club-shaped, macrobasic p-eurytele	L	47.8	44.1–52.1	2.0	40	56.0	51.9–59.9	2.3	10	55.0	50.9–56.8	1.7	10	47.1	40.2–53.6	2.9	20
	W	14.8	12.8–19.0	1.3	40	17.4	15.7–19.6	1.4	10	17.0	15.6–18.6	0.8	10	14.6	13.4–15.8	0.7	20
Lemon-shaped microbasic birhopaloid	L	26.5	---	---	1												
	W	18.3	---	---	1												
Small, oval isorhiza	L	11.0	8.3–14.2	1.4	20	7.6	5.9–9.1	1.3	4								
	W	7.2	6.5–7.6	0.4	20	6.4	5.3–7.2	0.8	4								
Spherical, holotrichous isorhiza	L	28.0	26.1–30.0	1.2	20	35.1	28.5–40.3	3.7	10	34.3	31.3–36.2	1.2	10	31.5	26.8–33.9	2.2	9
	W	23.5	21.8–25.2	0.9	20	29.8	25.7–32.7	2.4	10	27.6	25.4–29.4	1.0	10	25.6	21.5–27.8	2.1	9
Small, oval amastigophore	L													11.6	9.4–13.2	1.6	5
	W													7.6	6.9–8.6	0.7	5
Club-shaped, macrobasic p-eurytele	L	56.1	45.2–67.4	10.6	4	54.2	50.2–56.2	1.7	10	53.9	---	---	1				
	W	18.1	14.5–22.6	3.4	4	16.9	14.8–19.1	1.4	10	14.7	---	---	1				
Lemon-shaped, microbasic p-birhopaloid	L	24.7	19.9–28.1	1.8	40	25.4	23.7–27.8	1.5	9	26.4	---	---	1	24.4	20.7–27.7	1.5	20
	W	17.3	13.3–19.9	1.6	40	18.1	16–19.6	1.1	9	17.6	---	---	1	16.8	14.8–18.6	1.1	20
Small, oval isorhiza	L	11.4	9.6–13.5	1.0	20	9.7	---	---	1	10.6	9.8–11.7	0.8	6				
	W	8.4	7.6–9.2	0.3	20	8.2	---	---	1	7.0	6.8–7.8	0.3	6				
Spherical, holotrichous isorhiza	L	30.1	27.1–32.8	1.5	20	29.5	26.6–33.1	2.2	10	30.0	29.4–31.3	0.7	10	28.2	23.6–30.4	2.5	6
	W	25.9	22.8–28.8	1.9	20	25.0	21.7–27.6	1.9	10	24.8	23.5–26.4	0.7	10	24.6	21.7–26.5	1.7	6
Small, oval amastigophore	L	10.7	10.0–12.0	0.7	6	11.5	10.7–11.8	0.4	8					12.3	10.2–14.4	1.3	10
	W	7.2	6–7.9	0.7	6	8.1	7.4–8.8	0.5	8					8.3	6.8–9.7	0.9	10
Lower Phacellae																	
Lemon-shaped, microbasic p-birhopaloid	L	23.4	21.9–24.7	0.8	20					19.8	18.6–20.5	0.8	4				
	W	15.7	14.4–17.1	0.7	20					14.7	13.7–17.6	0.7	4				

continued next page

TABLE 1. (continued)

		T. ohboya (USNM 1124022)				*T. ohboya* (USNM1146084)				*T. haplonema* (MZUSP 494)				*T.* sp. (USNM 1114657)			
Club-shaped, macrobasic p-eurytele	L					53.6	---	---	1								
	W					17.6	---	---	1								
Upper Phacellae																	
Spherical, holotrichous isorhiza	L	44.0	---	---	1					15.6	---	---	2				
	W	37.8	---	---	1					14.7	---	---	2				
Unidentified	L	17.9	---	---	2									15.8	13.5–17.5	1.8	4
	W	14.4	---	---	2									13.3	12.7–13.9	0.5	4
Pedalial Warts																	
Spherical, holotrichous isorhiza	L	34.0	29.1–36.4	2.3	11	32.3	26.6–40.2	3.7	10	33.9	33.2–35.2	0.8	10				
	W	31.9	28.2–35.4	2.1	11	28.5	25.5–31.6	1.8	10	27.7	25.4–31.3	1.6	10				
Small, oval isorhiza	L	10.7	8.8–12.6	0.9	20	12.2	10.5–15.6	1.6	9	10.6	9.8–11.7	0.5	10	No warts found			
	W	8.1	6.3–9.3	0.6	20	8.4	6.5–10.1	0.9	9	6.6	5.8–6.8	0.3	10				
Lemon-shaped, microbasic p-birhopaloid	L									22.8	19.6–24.5	1.7	10				
	W									15.3	13.7–16.6	0.7	10				
Bell Warts		Mean	Range	StDev	N	Mean	Range	StDev	N	Mean	Range	StDev	N	Mean	Range	StDev	N
Spherical, holotrichous isorhiza	L	34.6	28.4–37	1.8	20	32.6	28.3–36.2	2.6	10	30.2	29.4–32.3	1.1	6	35.0	32.9–37.1	1.2	20
	W	31.2	26–33.9	1.9	20	30.1	25.6–35.5	3.3	10	26.1	25.7–27.4	0.7	6	29.8	28.5–31.1	0.7	20
Small, oval isorhiza	L	11.0	9.3–12.6	1.0	27	11.9	9.9–12.9	0.9	10	11.0	9.8–12.7	1.1	8				
	W	8.7	7.3–10.6	0.7	27	8.5	7.8–9.1	0.5	10	6.3	4.9–6.8	0.8	8				
?Club-shaped, macrobasic p-eurytele	L	43.9	---	---	1					37.2	---	---	2				
	W	17.3	---	---	1					11.2	---	---	2				
Small, oval amastigophore	L													12.9	11.6–14.6	1.0	20
	W													9.0	7.5–10.8	0.8	20
Apex Warts																	
Small, oval isorhiza	L	12.1	11–13.7	0.7	20	11.3	10.3–12.2	0.7	8	11.3	9.8–12.7	0.8	10				
	W	9.2	8.1–10.1	0.6	20	8.1	7.4–8.6	0.4	8	6.6	5.8–6.8	0.3	10	No warts found			
Spherical, holotrichous isorhiza	L					32.1	25.4–41.6	7.3	4	30.5	27.4–33.3	2.0	10				
	W					29.4	22.8–37.2	6.9	4	25.9	23.5–28.4	1.4	10				

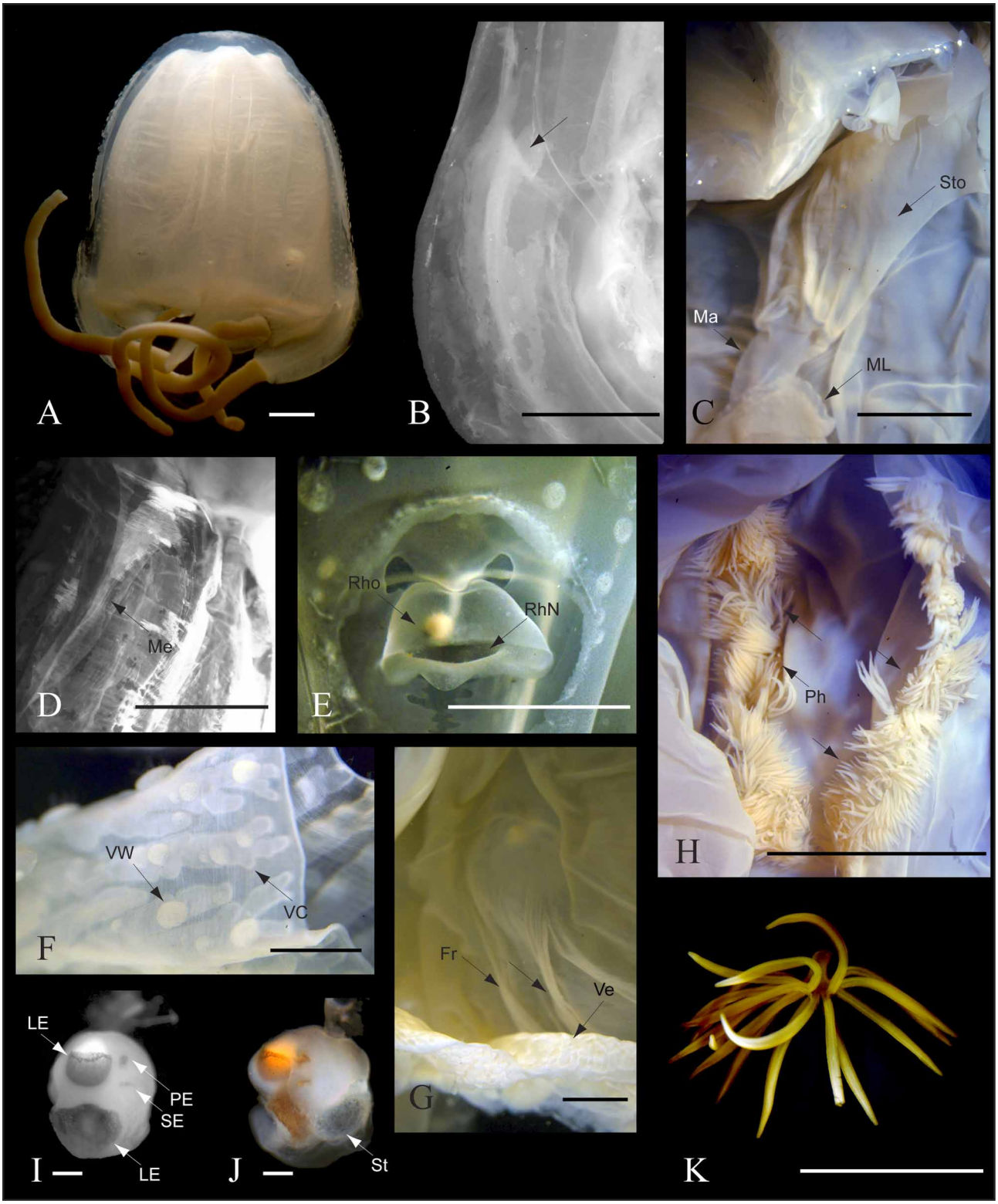

FIGURE 3. *Tamoya ohboya* **n. sp.**, type series. A. Whole animal; holotype, USNM 1146080. B. Pedalial canal bend (arrow); paratype USNM 1124022. C. Deep stomach, manubrium, and mouth lips; paratype USNM 1124022. D. Mesentery attaching stomach to subumbrella; paratype USNM 1124022. E. Rhopaliar niche ostium; holotype, USNM 1146080. F. Velarium with velarial canals and velarial warts; holotype, USNM 1146080. G. Frenulum consisting of two sheets (arrows); paratype USNM 1124022. H. Gastric phacellae (arrows); paratype USNM 11240221124022. I. & J. Rhopalium; paratype USNM 1124022. K. gastric cirrus; paratype USNM 1124022. Abbreviations: Fr = frenulum; LE = lens eye; Ma = manubrium; Me = mesentery; ML = mouth lips; PE = pit eye; Ph = phacellae; Rho = rhopalium; RhN = rhopaliar niche ostium; SE = slit eye; St = statolith; Sto = stomach; Ve = velarium; VC = velarial canal. VW = velarial wart. Scale bars: 10 mm (A, C, H), 5 mm (B, D, E), 2 mm (F, G, K), 0.1 mm (I. & J.).

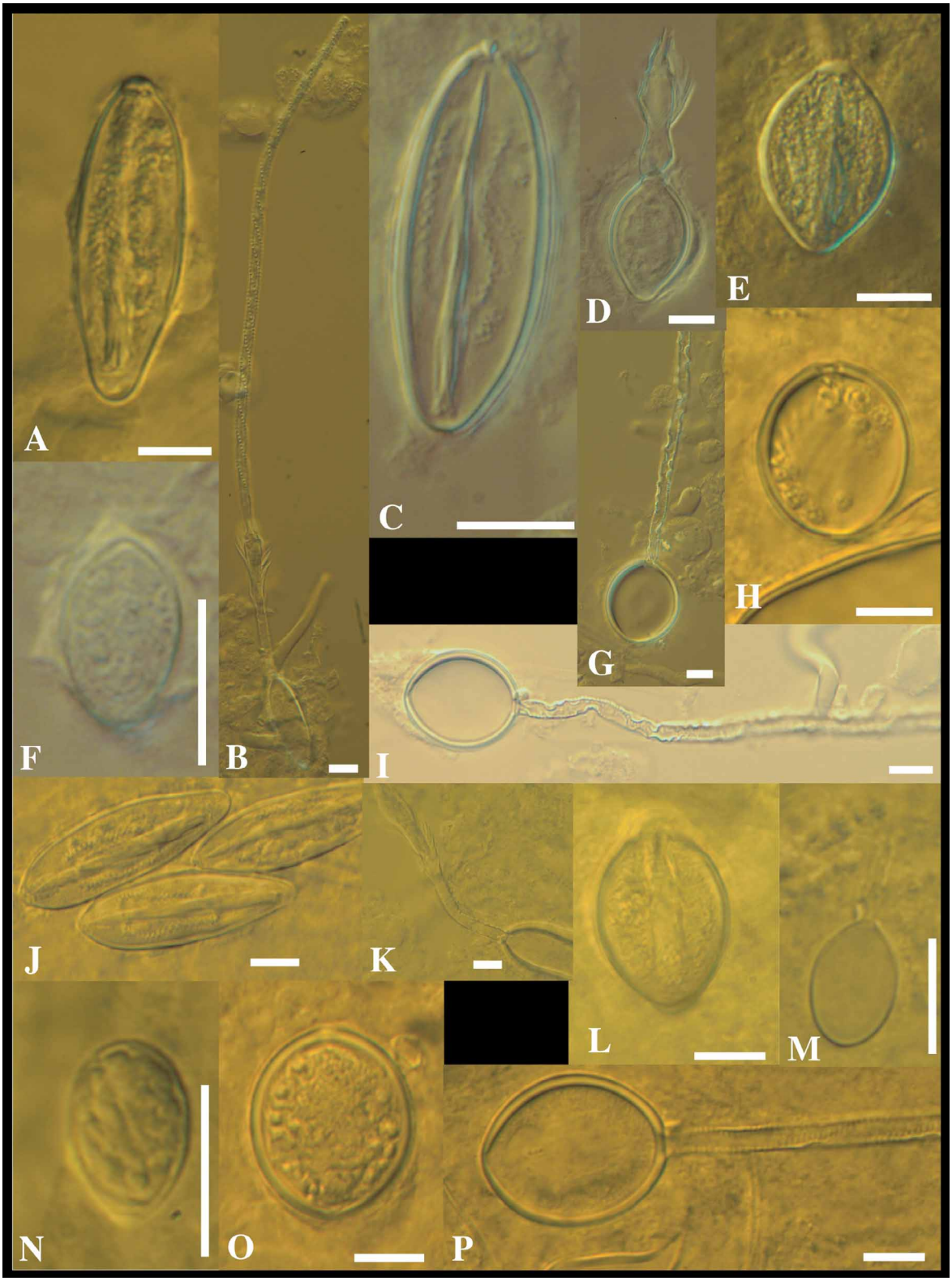

FIGURE 4. Part one of the cnidome of *Tamoya ohboya* **n. sp.** A–I. Tentacle tip. J–P. Tentacle base. A and B. Club-shaped macrobasic p-eurytele^{A}. C. Club-shaped macrobasic p-eurytele^{B}. D and E. Lemon-shaped microbasic birhopaloid. F. Small oval isorhiza. G. Spherical holotrichous isorhiza^{L}. H and I. Spherical holotrichous isorhiza^{S}. J and K. Club-shaped macrobasic p-eurytele. L. Lemon-shaped microbasic birhopaloid. M and N. Small oval isorhiza. O and P. Spherical holotrichous isorhiza. All images from paratype USNM 1124022. All scale bars represent 10 μ.

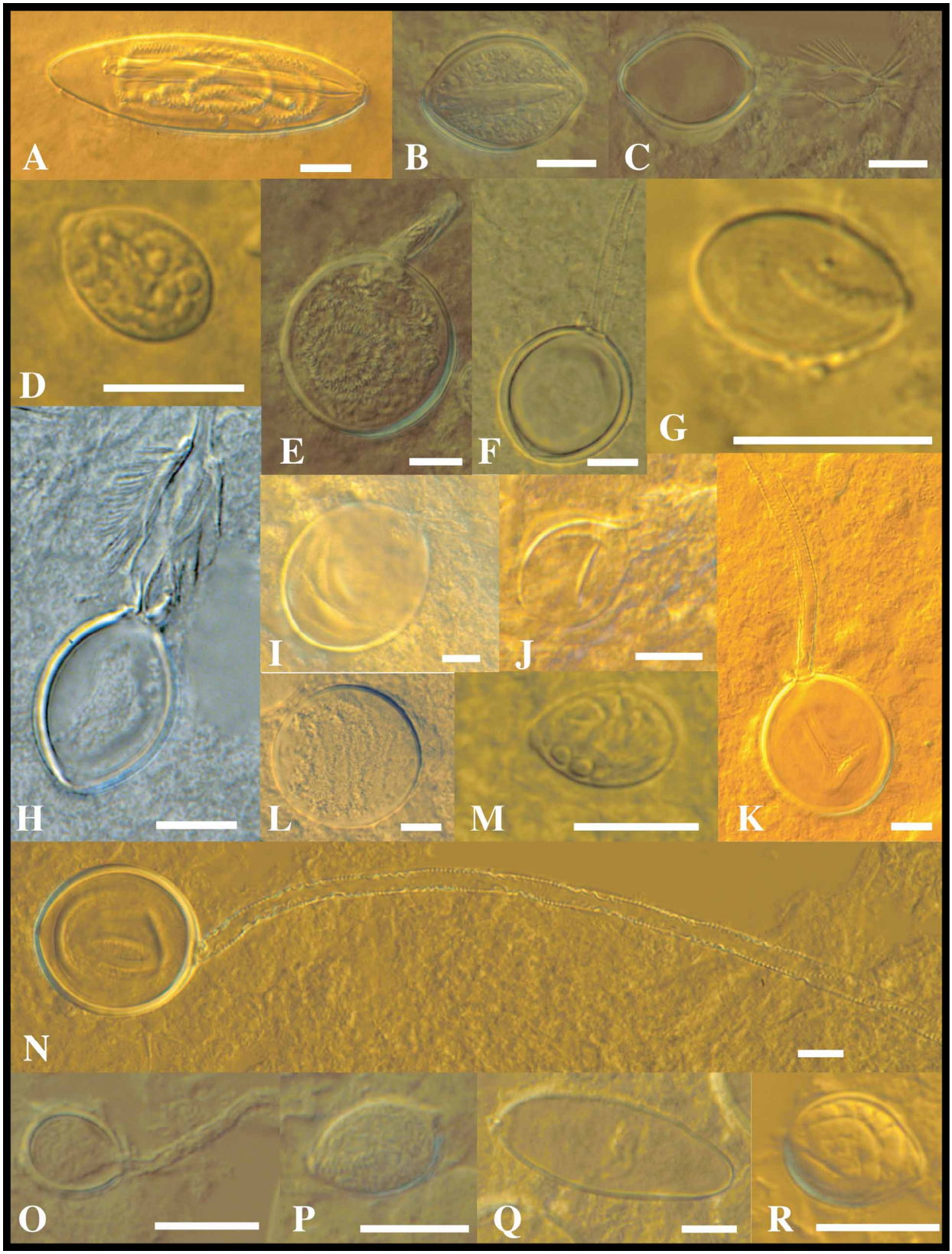

FIGURE 5. Part two of the cnidome of *Tamoya ohboya* **n. sp.** A–G. Manubrium. H–J. Phacellae. K–M. Pedalial warts. N–Q. Bell warts. R. Apex warts. A. Club-shaped macrobasic p-eurytele. B and C. Lemon-shaped microbasic p-birhopaloid. D. Small oval isorhiza. E and F. Spherical holotrichous isorhiza. G. Small oval amastigophore. H. Lemon-shaped microbasic birhopaloid. I. Spherical holotrichous isorhiza. J. Unidentified nematocyst. K and L. Spherical holotrichous isorhiza. M. Small oval isorhiza. N. Spherical holotrichous isorhiza. O and P. Small oval isorhiza. Q. ?Club-shaped macrobasic p-eurytele. R. Small oval isorhiza. All images from paratype USNM 1124022. All scale bars represent 10 µ.

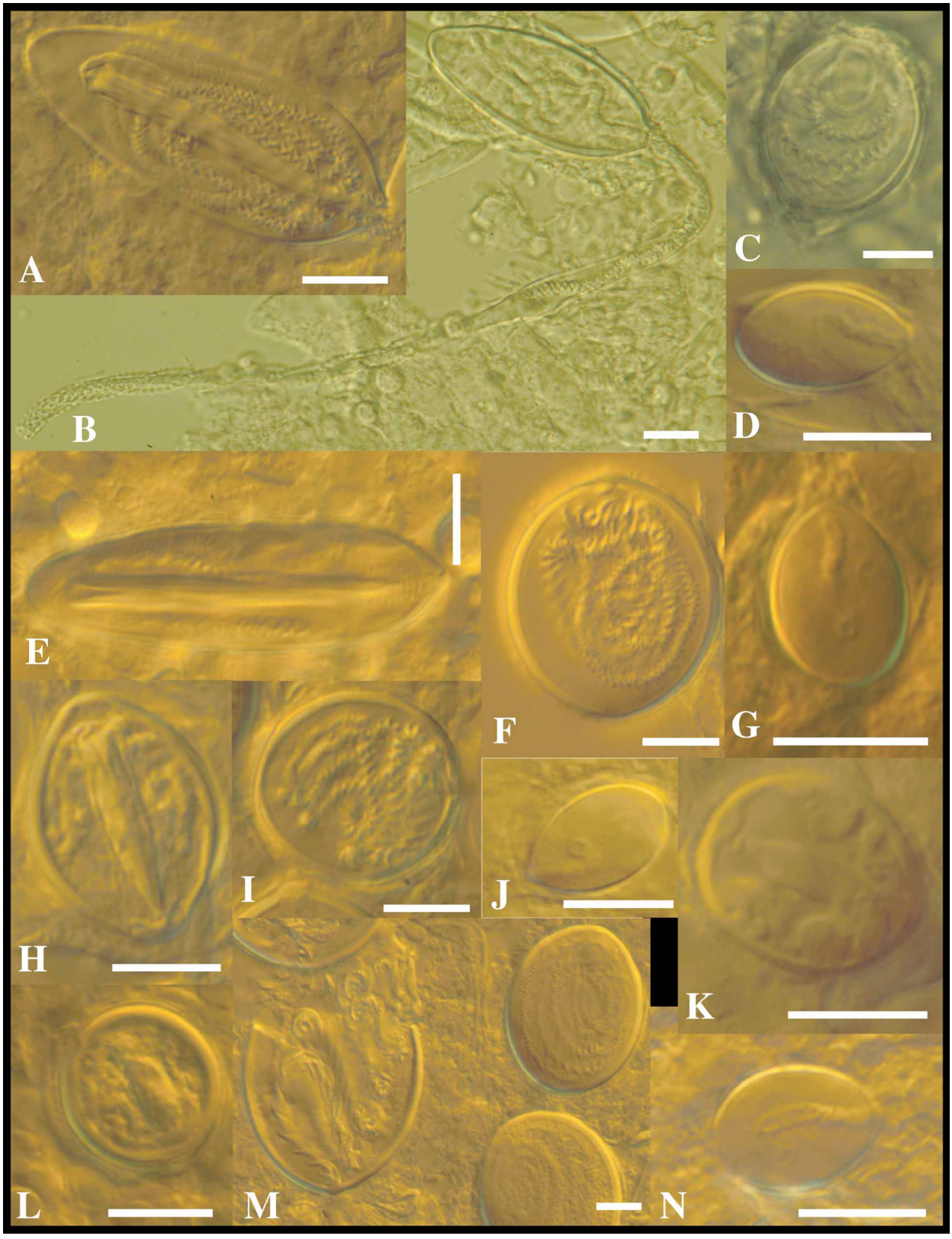

FIGURE 6. Cnidome of *T.* sp. (USNM 1114657) from Gulf of Mexico. A–D. Tentacle tip. E–G. Tentacle base. H–J. Manubrium. K–L. Phacellae. M–N. Bell warts. A and B. Club-shaped macrobasic p-eurytele. In B, note the tubule is only partly everted and visible inside the shaft and capsule. C. Spherical holotrichous isorhiza. D. Small oval amastigophore. E. Club-shaped macrobasic p-eurytele. F. Spherical holotrichous isorhiza. G. Small oval amastigophore. H. Lemon-shaped microbasic p-birhopaloid. I. Spherical holotrichous isorhiza. J. Small oval amastigophore. K. Unidentified nematocyst 1. L. Unidentified nematocyst 2. M. Spherical holotrichous isorhiza. N. Small oval amastigophore. All scale bars represent 10 µ.

That *Tamoya ohboya* **n. sp.** has a potent sting is not surprising given that its close relative, *T. haplonema*, is known to inflict a serious sting. Morandini and Marques (1997) reported that envenomation caused by body and tentacles of *T. haplonema* to an adult male victim in southeastern Brazil caused intense burning, necrosis, and permanent scarring of the affected skin. The victim was hospitalized and sedated, and burning and itching persisted for one week. This is similar to what is known as Morbakka syndrome, caused by *Morbakka fenneri* Gershwin, 2008 of Australia, though this also involves cough, backache, and tightness of the throat (Fenner *et al.* 1985). Additional observations are needed to determine the severity and variance of symptoms caused by *T. ohboya* **n. sp.** envenomations, but caution is advised when dealing with this species.

This new species brings the total number of accepted species of Cubozoa to 39 (Daly *et al.* 2007; WoRMS 2010). All purported records of "*Tamoya*" from the Indo-Pacific are either questionable or refer to animals that are species of *Morbakka* Gershwin 2008, *Alatina* Gershwin, 2005, or *Carybdea*. Thus, known species of *Tamoya* are exclusively Atlantic. While mostly reported from the western Atlantic, *Tamoya* (as *T. haplonema*) has occasionally been reported from the eastern Atlantic (six specimens from the Gulf of Guinea clearly fit the description of *Tamoya*; Stiasny 1934). Whereas *T. ohboya* **n. sp.** is thus far known only from the Caribbean, and perhaps northern Brazil, specimens usually identified as *T. haplonema* range from approximately as far south as Buenos Aires, Argentina (Pastorino 2001) during episodic strong activity of the Current of Brazil southwards to as far north as Long Island on the east coast of the United States (e.g., Mayer 1910). Our documentation raises the hypothesis that *Tamoya* from the Gulf of Mexico and southeastern United States is an undescribed species.

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