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Two New Species of Nudibranch Mollusks From the Coast of California

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Two new species of nudibranchs are described from the coast of California. *Okenia felis*, from Monterey County, is white with six pairs of lateral appendages and a single medial papilla inserted into the notum on a broad base. This species is similar in appearance to *Okenia japonica* Baba, 1949, but it differs in consistent features of external, radular, and reproductive anatomy. *Flabellina goddardi*, from the intertidal zone of Santa Barbara County, is externally most similar to *F. pricei* (MacFarland, 1966) and *F. pellucida* (Alder and Hancock, 1843), all of which have ceratal rows that are inserted in elevated peduncles. However, both *F. pricei* and *F. pellucida* have smooth lateral teeth, while *F. goddardi* entirely lacks lateral teeth. The species is compared to the other 15 *Flabellina* that have been recorded from the Pacific coast of North America.

Key Words: California, Goniodorididae, Flabellinidae, *Okenia, Flabellina,* new species

The nudibranch fauna of the coast of California is diverse and varied. Behrens and Hermosillo (2005) listed 122 species of nudibranchs known from California, including two presently undescribed species. Gosliner (1996) also documented two new species of nudibranchs from deep water off the coast of southern California. Recently, two additional species have been collected from the California coast. The first taxon, a new species of *Okenia,* has been found from 37-40 m off Carmel, California. The species of eastern Pacific *Okenia* have been recently reviewed (Gosliner 1996; Camacho-García and Gosliner 2004; Gosliner & Bertsch, 2004). Nine species are known to occur from British Columbia to Costa Rica.

Millen and Hermosillo (2007) reviewed the fifteen species of *Flabellina* recorded from the eastern Pacific. A new species of *Flabellina* from the intertidal zone of Carpinteria, California that is clearly distinct from all other members of the Flabellinidae has recently been discovered.

The present paper describes these two new taxa and compares them to other known members of *Okenia* and *Flabellina*.

Species Descriptions

Family Goniodorididae Bergh, 1891

Genus *Okenia* Alder and Hancock, 1855

***Okenia felis* Gosliner sp. nov.**
Figures 1A-B, 2A-D, 3A

Type material.— Holotype: CASIZ 174174, dissected, Pt. Lobos, Monterey County, California, 22 March 2009, 37–40 meter depth, collected by Robert and Alison Lee. Paratype: CASIZ

174175, one specimen, dissected, Pt. Lobos, Monterey County, California, 22 March 2009, 37–40 meter depth, collected by Robert and Alison Lee.

ETYMOLOGY.— *Okenia felis* is a noun from the Latin for cat indicating the appendages on notum that appear like cat whiskers. Also the collecting team that discovered this species, consisting of Robert and Allison Lee, John Heimann, and Clinton Bauder are known as "Team Kitty".

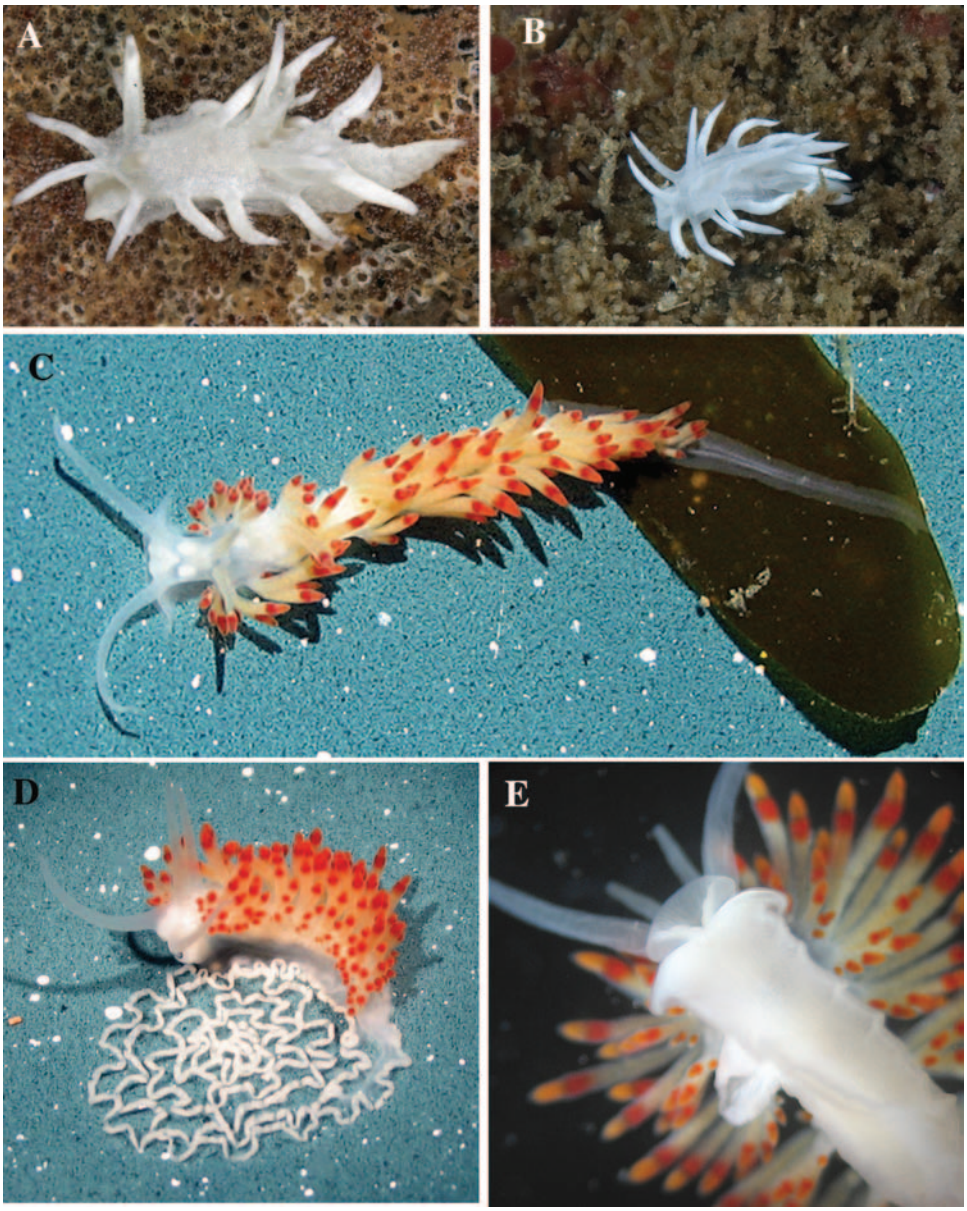

FIGURE 1. Living animals. A. *Okenia felis* sp. nov., Pt Lobos, Carmel, California. (Photo by Gary McDonald.) B. *Okenia felis* sp. nov., Pt Lobos, Carmel, California, *in situ*. (Photo by Rob Lee.) C. *Flabellina goddardi* sp. nov., whole animal, Carpinteria, California. (Photo by Jeff Goddard.) D. *Flabellina goddardi* sp. nov., animal with egg mass, Carpinteria, California. (Photo by Jeff Goddard.) E. *Flabellina goddardi* sp. nov., ventral view, Carpinteria, California. (Photo by Jeff Goddard.)

DISTRIBUTION.— Known only from the type locality, Pt. Lobos, Carmel, California.

EXTERNAL MORPHOLOGY.— The living animals (Fig. 1A, B) are relatively small, reaching a maximum length of about 7–8 mm. The body is white with granules of opaque white scattered over the surface but more concentrated on the rhinophores and notal append-ages. The body is wide with a strong notal edge. Along the edges of the notum are six pairs of elongate notal papillae, each with a relatively acutely pointed apex. Just anterior to the gill is a single elongate, acutely pointed papilla that extends from an elongate thin membrane (Fig. 2B) that begins between the rhinophores and continues to the region immediately anterior to the gill. This base is elongate and sail-shaped. The rhinophores (Fig. 2A) are elongate with 21–23 lamellae on the posterior portion of the rhinophore. The lamellae begin at the base of the rhinophore and continue to the upper two-thirds of the rhinophore, leaving the apical third devoid of lamellae. The apex is elongate and rounded. The gill plume is opaque white, with 3 bipinnate branches. The foot is thickened anteriorly and there is pair of short, rounded tentacles on either side of the mouth.

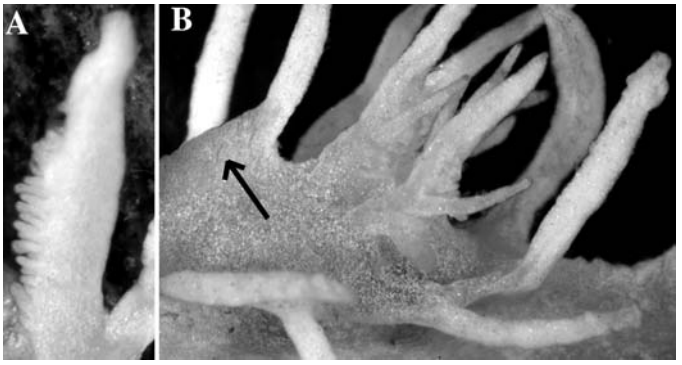

FIGURE 2. *Okenia* sp. nov. A. Detail of rhinophore. B. Detail of central papilla with base. (Photos by Gary McDonald.)

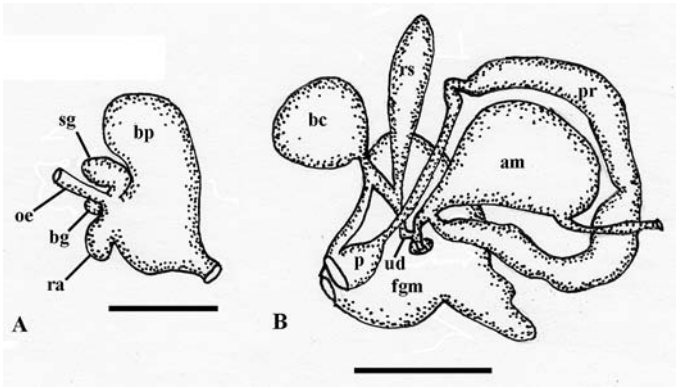

FIGURE 3. *Okenia felis* sp. nov. A. Oral tube, bg=buccal ganglion, bp=buccal pump, oe=oesophagus, ra=radular sac, sg=salivary gland, scale = 0.5 mm. B. Reproductive system, am=ampulla, bc=bursa copulatrix, fgm=female gland mass, p=penis, pr=prostate, rs=rectaculum seminis, ud=uterine duct, scale = 0.7 mm.

BUCCAL ARMATURE.— The buccal mass is thick and muscular (Fig. 3A) with a rounded buccal pump directed posteriorly. Small, inconspicuous, oral glands are present at the opening of the buccal mass into the mouth. The radular sac is short and extends ventrally from the buccal mass. The esophagus is thin and elongate and inserts into the buccal mass immediately ventral to the buccal pump. A rounded, lobate salivary gland is present on either side of the buccal mass anterior to the junction of the esophagus with the buccal mass. A labial cuticle surrounds the lips at the opening of the mouth. No obvious polygonal plates were visible (Fig. 4A). The cuticle expands as it enters the buccal pump. The radular formula is 20 × 1.1.0.1.1., in the holotype (Fig. 4B). The radula of the paratype was lost during preparation. The inner lateral teeth (Fig. 4C, E) are wide basally with an elongate acute cusp. The masticatory margin of the inner lateral bears about 19–23 triangular denticles that increase in size in the direction of the outer margin. The outer laterals are small and reduced (Fig. 4D) with a short cusp along the outer edge.

REPRODUCTIVE SYSTEM.— (Fig. 3B) The preampullary duct is elongate and thin and expands

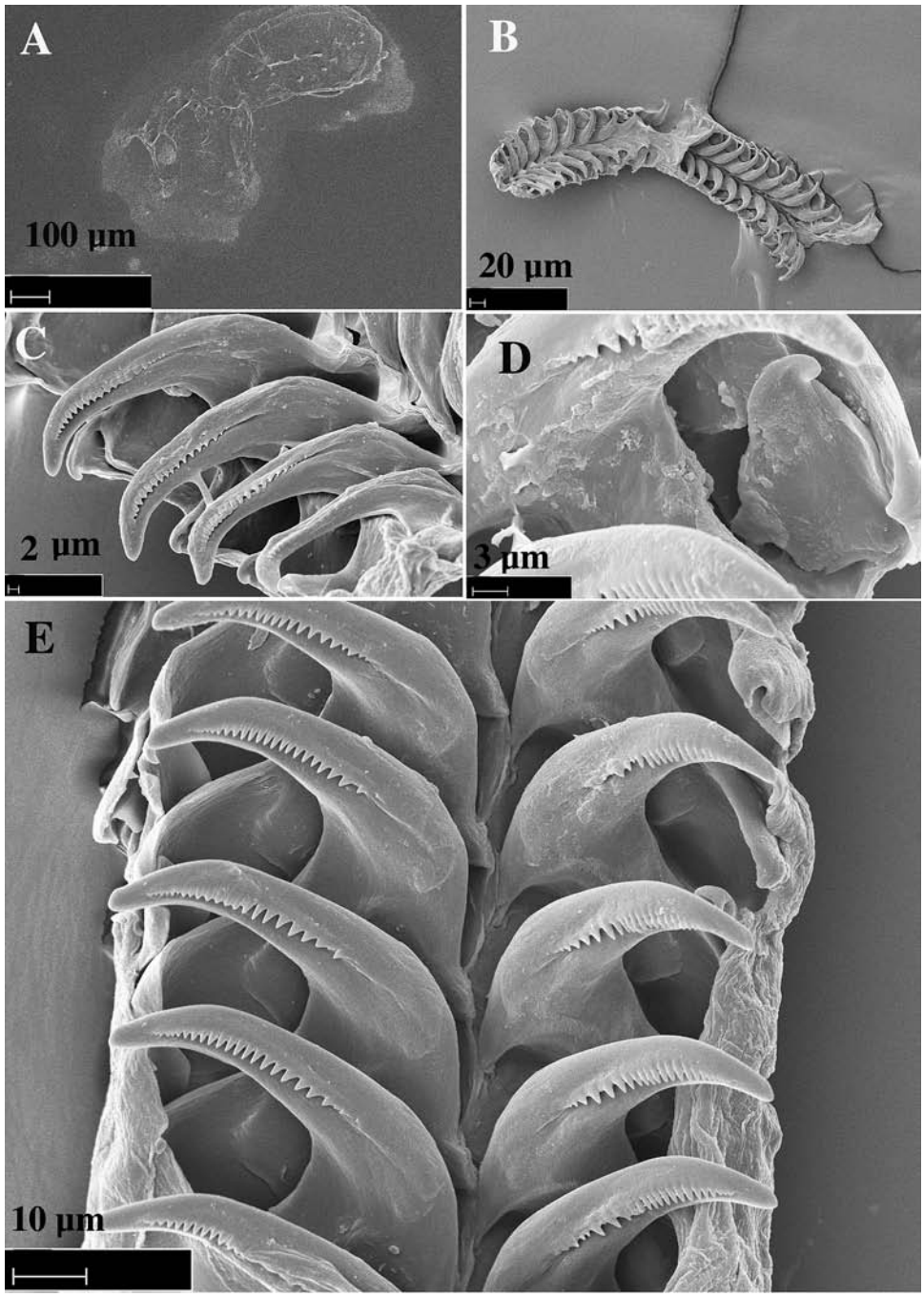

FIGURE 4. *Okenia felis* sp. nov. Scanning electron micrographs. A. Labial cuticle B. Entire radula. C. Inner lateral teeth. D. Outer lateral teeth. E. Half row of radular teeth.

into a globose ampulla. The ampulla divides into a short, narrow oviduct and the wider prostatic portion of the vas deferens. The oviduct enters the lobate female gland mass that consists of a small albumen gland, a lobed membrane gland and a larger, smooth mucous gland. These nidamental glands exit ventrally to the vagina and penis. The prostatic portion of the vas deferens is wide and consists of a single, undivided portion that surrounds the ampulla. The distal end of the prostatic segment narrows into an elongate, straight ejaculatory portion that terminates near at the distal end of the wide, short penis. There is no distinct penial papilla. Inside the distal end of the penis are penial spines. The vagina exits adjacent to the penis. It is narrow throughout its length. It connects directly to the spherical bursa copulatrix. The longer, club-shaped receptaculum seminis enters the uterine duct near the middle of the duct and then joins the short oviduct near its entrance to the albumen gland.

Natural history.— *Okenia felis* was observed to be locally abundant on a brown ctenostomatous bryozoan in deep water (37 to 40 meters) at Pt. Lobos, Carmel, California.

Discussion.— The present species is most similar to *Okenia japonica* Baba, 1949, in that both species have a white body color with elongate lateral papillae along either side of the body and a single mid-dorsal papilla. There are some consistent differences between the species, which are summarized in Table 1. The most notable external difference is that *O. felis* has fewer pairs of lateral papillae than *O. japonica* and the central papilla of *O. felis* has a markedly wider base than that of *O. japonica*. Also, the rhinophoral lamellae are situated more basally in *O. felis* and are located more apically in *O. japonica*. Internally, the most pronounced differences are in the shape of the inner lateral teeth, where *O. felis* lacks the thick inner margin of the inner lateral teeth that is present in *O. japonica* (Gosliner 2004, fig. 7). Additionally, the receptaculum seminis of *O. felis* is elongate and club-shaped and inserts near the middle of the uterine duct as opposed to being rounded and inserting near the base of the bursa copulatrix in *O. japonica*. The vagina of *O. felis* is narrow throughout its length. The penis of *O. japonica* (Gosliner 2004, fig. 6C) is elongate and club-shaped and is separate from the rest of the vas deferens. In *O. felis*, the penis is short and wide and is situated at the terminal end of the vas deferens rather than adjacent to it.

Okenia academica Camacho-Garcia and Gosliner, 2004, from the tropical eastern Pacific also has a white body color, but has a much wider body and lacks the central dorsal papilla that is present in *O. felis*. It also has much shorter notal papillae and has reddish brown pigment on the body.

Table 1: Comparative data between *Okenia felis* and *O. japonica.*

	Okenia felis sp. nov	*Okenia japonica* Baba, 1949
Number of pairs of lateral papillae	6 per side	7–9 per side
Central notal papilla	With wide anterior base	With narrow base
Papillae apices	Acutely pointed	Rounded
Labial cuticle elements	Not readily visible	Large, prominent
Inner margin of inner lateral tooth	Not thickened	With thick margin
Receptaculum seminis size and shape	Elongate, club-shaped	Rounded, pyriform
Receptaculum insertion	Inserts near middle of uterine duct	Inserts at base of bursa copulatix
Vagina	Thin, short	Wide basally, elongate
Penis	Short, wide, terminal	Elongate, club-shaped, adjacent to vas deferens

There are also numerous other internal differences in the shape of the radular teeth and the arrangement of the reproductive organs. Another undescribed, deep-water species of *Okenia* was documented from the Santa Maria Basin of southern California (Gosliner 1996). This species has only 3-4 notal papillae on either side of the body and lacks a central papilla. It also has more elongate inner and outer lateral radular teeth.

Family Flabellinidae Bergh, 1889

Genus *Flabellina* Voigt, 1834

***Flabellina goddardi* Gosliner sp. nov.**
Figures 1D-E, 5- 7

Type material.— Holotype: CASIZ 182590, dissected, , Carpinteria State Park, Santa Barbara County, California, 8 May 2008, rocky intertidal, collected by Jeff Goddard.

Etymology.— *Flabellina goddardi* is named for friend and colleague, Jeff Goddard who found the only specimen of this distinctive species. Jeff is the consummate naturalist with superb powers of observation.

Distribution.— Known only from the type locality, Carpinteria State Park, Santa Barbara County, California.

External morphology.— The living animal (Fig. 1C–E, 5) is relatively small, reaching a length of about 15 mm. The body is a translucent white, with salmon-colored digestive gland within the cerata. The ceratal apices are bright yellowish orange with a subapical purple-orange band. The rhinophores are smooth, elongate and about 2/3 the length of the oral tentacles. The oral tentacles are thin and elongate, and taper to a thin apex. The anterior end of the head is notched and the anterior foot cornes are tentacular with apices directed laterally. The cerata are elongate and cylindrical throughout most of their length with a somewhat thinner base. The cnidosac is elongate and rounded (Fig. 5D). The cerata are arranged in distinct groups, which are on cushions elevated from the notum (Fig. 5B). There are 4 rows of cerata in the anterior, precardiac cluster with 4-9 cerata per row. The postcardiac cerata are arranged in seven distinct rows, with 1–10 cerata per row. The gonopore is situated on the right side of body, ventral to third and fourth ceratal rows. There is a large fleshy genital flap surrounding the gonopore (Fig. 5C). The pleuroproctic anus is situated in the middle of interhepatic space (Fig. 5A) and the nephroproct is immediately dorsal to the anus.

Buccal Armature.— The buccal mass is thick and muscular. On either side of the anterolateral portion of the buccal mass is a rounded, lobate oral gland (Fig. 6A) There is a pair of brown, coriaceous jaws (Fig. 7A). The masticatory border of each jaw bears a single row of about 12 triangular denticles that were visible under light microscopy but were not evident in the scanning electron micrograph (Fig. 7B). The uniseriate radula has a formula is $30 \times 0.1.0$, in the holotype. The rachidian teeth (Figs. 7C, D) are broad with a wide central cusp that is longer than the adjacent denticles. On either side of the central cusp are 7-8 elongate lateral denticles.

Reproductive system.— (Fig. 6B) The preampullary duct is elongate and thin and expands into curved ampulla. The ampulla divides into a short, narrow oviduct and the wider prostatic portion of the vas deferens. At this junction the large, pyriform receptaculum joins the common insertion via a long duct. The short oviduct enters the lobate female gland mass that consists of a small albumen gland, a lobed membrane gland and a larger, smooth mucous gland. The oviduct exits adjacent to the curved bursa copulatrix. The bursa exits via a wide duct that has an even wider atrium. The prostatic portion of the vas deferens is wide and consists of a single, undivided portion

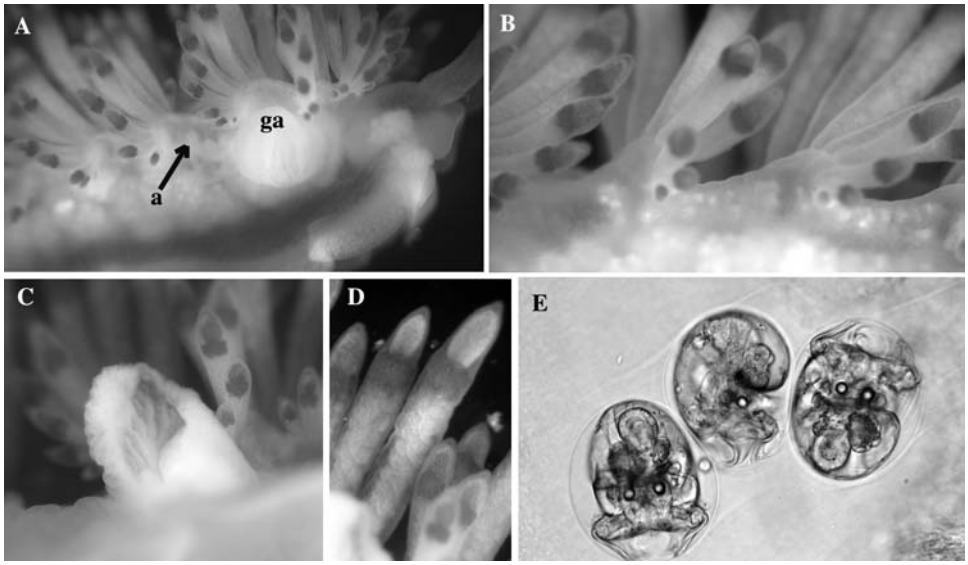

FIGURE 5. *Flabellina goddardi* sp. nov. A. Right lateral view of animal showing genital atrium and position of anus. B. View of ceratal clusters showing elevated peduncles. C. Genital atrium. D. Cerata showing digestive gland and cniosacs. E. Newly hatched veliger larvae. (Photos by Jeff Goddard.)

that is sausage-shaped. From the proximal end of the prostatic segment the narrow, short ejaculatory portion terminates near at the distal end of the wider, elongate penis. Thepenial papilla is conical and unarmed. Adjacent to the penial sac is a penial gland that is glandular throughout and is bifid at its distal end.

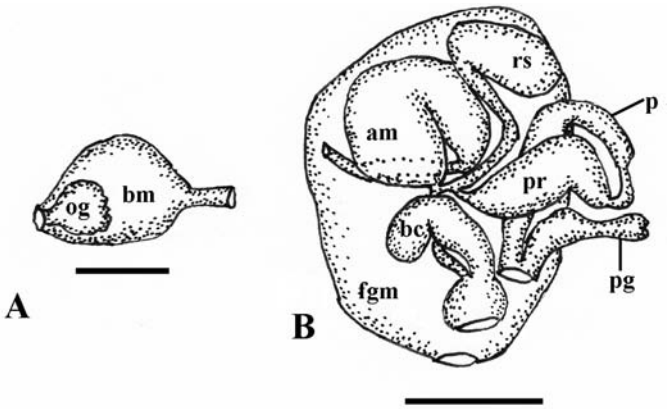

FIGURE 6. *Flabellina goddardi* sp. nov. A. Oral tube, bm= buccal mass, og=oral gland, scale = 0.4 mm. B. Reproductive system, am=ampulla, bc=bursa copulatrix, fgm=female gland mass, p=penis, pg=penial gland, pr=prostate, rs=rectaculum seminis, scale = 0.7 mm.

NATURAL HISTORY.— Little is known about the biology of this species. The single specimen was found in a tide pool at Carpinteria State Beach, Santa Barbara County, California. The single specimen produced a highly convoluted egg mass (Fig. 1D). From the egg mass, planktotrophic veliger larvae (Fig. 5E) emerged that possess a type 1 larval shell.

DISCUSSION.— The color pattern of *Flabellina goddardi* is unique among members of *Flabellina*. It is one of the only species that has orange and red-orange ceratal apices and subapical bands. The only other species that have a subapical purple band are *Flabellina marcusorum* Gosliner and Kuzirian, 1990, *F. rubrolineata* (O'Donoghue 1929), *F. exoptata* Gosliner and Willan, 1991, *F. delicata* Gosliner and Willan, 1991 and *F. riwo* Gosliner and Willan, 1991. The first four of these species have rhinophores with papillae on the posterior surface while *F. riwo* has perfoliate rhinophores. In contrast, *F. goddardi* has smooth rhinophores. All of the species mentioned above

have highly digitate oral glands that extend into the notum, while *F. goddardi* has a pair of simple lobate glands located on the anterior portion of the buccal mass.

Flabellina goddardi bears some external resemblance to two previously described species, *Flabellina pellucida* (Alder and Hancock, 1843) and *F. pricei* (MacFarland, 1966), in that they have ceratal rows inserted on elevated cushions. *Flabellina pricei* has annulate rhinophores, while both *F. goddardi* and *F. pellucida* have smooth ones. The cerata of *F. pellucida* are more numerous and highly congested than in *F. goddardi*. Both *F. pricei* and *F. pellucida* have a radula with smooth lateral teeth (MacFarland 1966, pl. 65, fig. 13; Kuzirian 1979, fig. 7) while *F. goddardi* entirely lacks lateral teeth. The reproductive system of *F. pellucida* has not been described. The reproductive system of *F. pricei* (MacFarland 1966, pl. 66, fig. 8), differs from that of *F. goddardi* in that it lacks a receptaculum seminis or a penial gland.

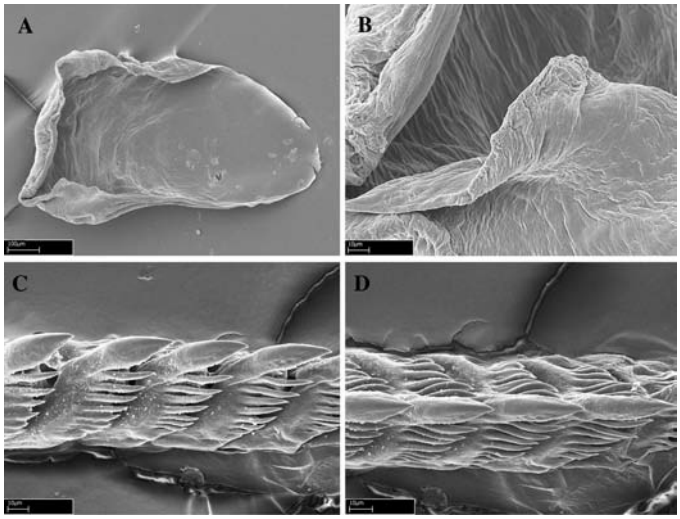

FIGURE 7. Flabellina goddardi sp. nov. A. Entire jaw. B. Masticatory margin. C. Lateral view of radular teeth. D. Dorsal view of radular teeth.

In a description of a new species of *Flabellina* from Mexico, Millen and Hermosillo (2007) reviewed the systematics of the 15 species of *Flabellina* known from the Pacific coast of North America. Of these 15 species, only two species, *Flabellina amabilis* Hirano and Kuzirian, 1991, and *F. bertschi* Gosliner and Kuzirian, 1990, have smooth rhinophores as in *F. goddardi*. Both of these species have a triseriate radula with a lateral tooth on either side of the rachidian tooth, while the radula of *F. goddardi* is uniseriate. No other described species of *Flabellina* has a uniseriate radula. This derived feature raises questions as to whether this species should be placed in *Flabellina*. *Flabellina goddardi* shares several features with other flabellinids including the prescence of a pleuroproctic anus, presence of cerata on elevated cushions and a head with an anterior notch. In a preliminary molecular phylogeny based on the examination of the H3 nuclear gene and COI and 16S mitochondrial genes, *F. goddardi* was basal to a clade of *Flabellina* species but clearly distinct from the sympatric congeners, *F. iodinea* (Cooper, 1863), *F. trilineata* (O'Donoghue, 1921) and *F. pricei* (MacFarland, 1966). These data strongly suggest that *F. goddardi*, despite having a uniseriate radula, is most closely related to other species of *Flabellina*. Future molecular systematic studies of a wide range of *Flabellina* species are necessary to understand more precisely the systematic relationships and membership of the Flabellinidae.

ACKNOWLEDGMENTS

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tographically documented additional aspects of the biology and morphology of this species. Jeff Goddard found the single specimen of *Flabellina goddardi* and carefully documented aspects of its external morphology and reproductive biology that made possible a more complete description of this distinct species. Michele Aldrich kindly reviewed the final version of the paper for grammatical oversights. To all of these individuals I am grateful.

Literature Cited

Behrens, D.W., and A. Hermosillo. 2005. *Eastern Pacific Nudibranchs — A Guide to the Opisthobranchs from Alaska to Central America*. Sea Challengers Publishing. Monterey, CA. vi + 137 pp.

Camacho-García, Y.E., and T.M. Gosliner. 2004. A new species of *Okenia* (Gastropoda: Nudibranchia) from the Pacific coast of Costa Rica. *Proceedings of the California Academy of Sciences*, ser. 4, 55: 431–438.

Gosliner, T.M. 1996. *The Opisthobranchia*. Pages 1–52 *in* J. Scott, J. Blake, and A. Lissner, eds, *Taxonomic Atlas of the Santa Maria Basin and Western Santa Barbara Channel, Mollusca,* Part 2.

Gosliner, T.M. 2004. Phylogenetic Systematics of *Okenia, Sakishimaia, Hopkinsiella* and *Hopkinsia* (Nudibranchia: Goniodorididae) with descriptions of new species from the tropical Indo-Pacific. *Proceedings of the California Academy of Sciences*, ser. 4, 55:125–161.

Gosliner, T.M., and H. Bertsch. 2004. Systematics of *Okenia* from the Pacific Coast of North America (Nudibranchia: Goniodorididae) with Descriptions of Three New Species. *Proceedings of the California Academy of Sciences*, ser. 4, 55:414–430.

Kuzirian, A. 1979. Taxonomy and biology of four New England coryphellid nudibranchs (Gastropoda: Opisthobranchia). *Journal of Molluscan Studies* 45:239–261.

MacFarland, F. 1966. *Studies of Opisthobranchiate Molllusks of the Pacific Coast of North America*. Memoirs of the California Academy of Sciences, No. 6. California Academy of Sciences, San Francisco, California, USA. 546 pp.

Millen, S., and A. Hermosillo. 2007. The genus *Flabellina* Voight, 1834 (Mollusca: Opisthobranchia) from Bahía de Banderas (Pacific Coast of Mexico) with ecological observations, the description of a new species, and the redescription of *Flabellina cynara*. *Proceedings of the California Academy of Sciences*, ser. 4, 58(26): 543–556.