

A redescription of *Facelina stearnsi* Cockerell, 1901 (Nudibranchia: Aeolidacea: Facelinidae) with a reassignment of its generic placement

Jamie M. Chan and Terrence M. Gosliner

Department of Invertebrate Zoology and Geology, California Academy of Sciences
875 Howard Street, San Francisco, California 94103, USA

Abstract – *Facelina stearnsi* Cockerell, 1901 is known from Santa Cruz (Nelson 1986) to La Jolla, California (Behrens 1991). Several preserved specimens are examined and compared with the original description and other species in the genus *Austraolis* Burn, 1962. The coloration, reproductive and radular morphology are described in detail for the first time using SEM, compound microscopy and photographs of live specimens. Observation of several new morphological and anatomical characters suggests a reassignment of *Facelina stearnsi* to the genus *Austraolis* Burn, 1962.

INTRODUCTION

According to Miller (1974) the Facelinidae is divided into subfamilies based on the ceratal arrangement. Genera are further divided on the basis of penial morphology. Cockerell (1901) described *Facelina stearnsi* from a specimen collected in San Pedro, California. Cockerell's description consisted of observations of the external and radular morphology. No details were given for any of the internal organ anatomy. There were no plates or drawings in the original description. The type material has not been located in any American museum and a neotype is here designated. Additional records of this species have been published by Eliot (1907), O'Donoghue (1926), Steinberg (1961), Marcus and Marcus (1967), and Nelson (1986) but only two publications, O'Donoghue (1927) and McDonald (1983), included line drawings of radular teeth and one jaw part. The present study examines several specimens of *Facelina stearnsi* and compares them to previous descriptions.

MATERIAL AND METHODS

Material was obtained from the Department of Invertebrate Zoology and Geology, California Academy of Sciences, San Francisco (CASIZ). The specimens were dissected by ventral or dorsal incision. Their internal features were examined and drawn under a dissecting microscope with a camera lucida. Systematically important soft parts were critical point dried for SEM. Special attention was paid to the morphology of the reproductive system, digestive system and central nervous system. The penial hooks and jaw plates were prepared for examination by SEM. Radulae were extracted and examined using SEM or compound microscopy.

Features of living animals were recorded from photographs or notes of collectors.

Austraolis stearnsi (Cockerell, 1901)

Facelina stearnsi Cockerell, 1901: 86. Behrens, 1991:97 Fig. 206.

Phidiana stearnsi McDonald, 1983: 203–204 figure 111.

Austraolis stearnsi (Cockerell) comb. nov.

Material examined

Neotype: CASIZ 171165, one specimen 2 cm in length. CASIZ 89095 fifteen preserved specimens, three dissected, Morro Bay, San Luis Obispo County, California, United States of America, 12 m depth, 17 July 1993, Mike Behrens, lengths 2.5 cm, 3 cm, 2cm (preserved dissected specimens).

Distribution

This species is known from Santa Cruz (Nelson, 1986) to La Jolla, California (Behrens, 1991).

Etymology

This species was named after Dr. Robert Edward Carter Stearns.

External Morphology

The body is elongate and slender, with a trailing posterior end of the foot (Figure 1). The anterior margin of the foot and tentaculiform foot corners are bilabiate and slightly notched. Body color can range from translucent clear to a pink or purple cast. The moderately long cerata are cylindrical and taper distally. The tightly grouped cerata are arranged in eight arches on each side of the body



Figure 1 Photograph of living specimen of *Australaelis stearnsi* (Cockerell, 1901) photo by T. Gosliner.

(Figure 2A). The largest arch is the most anterior on each side and consists of 28–30 cerata. The cerata are translucent from the base terminating with a broad band of orange/vermillion to yellow and tipped with white. The rhinophores are annulate and have 10–15 annulae each. The upper half of the rhinophores transition from yellow to orange/vermillion, with a white tip. Both the oral tentacles and the tentacular anterior foot corners have an orange mid-region and an opaque white tip. The long tapering oral tentacles also have a white or cream line that runs along the dorsal side and then across the head to the base of the rhinophores. The line is often orange/yellow toward the base of the rhinophore. There are irregular spots of orange/vermillion behind the rhinophores and between each group of cerata. A white to orange line runs dorsally from the posterior cerata cluster to the tip of the foot. The anus is located ventral and within the second cluster of cerata. The genital aperture is

located below the anterior limb of the first ceratal arch.

Anatomy

The radula formula is 24–25x0.1.0 (Figure 3A) for three examined specimens. The rachidian tooth consists of a single large incurved hook-like tooth flanked by 4–6 smaller denticles on each side (Figure 3A, 3B). The jaws have a tan-brown hue to them (Figure 2B, 3C). There is a thickened tooth-like projection at the anterior corner of each jaw. There are 18–20 denticles on the masticatory edge of each jaw. Some of the larger denticles have distinct papillae on the top (Figure 3D).

The ampulla is long and curved (Figure 2C). The ampulla bifurcates to the oviduct and the vas deferens. The oviduct is one quarter the length of ampulla and leads to a large spherical receptaculum seminis. The receptaculum seminis connects to the female gland mass via a thin duct half the size of the oviduct. The female gland mass is composed of a large mucous gland, a small albumen gland and a convoluted membrane gland. The vas deferens is thick, twice diameter and half the length of the ampulla. The vas deferens curves into a fibrous penial sheath. The penis is armed with a ring of 20 spines (Figure 2D, 3E, 3F). The spines are papillate in shape.

Discussion

Cockerell (1901) described the radula of *Facelina stearnsi* as being very similar to *Hermisenda crassicornis* (Eschscholtz, 1831), but *Facelina stearnsi* can be distinguished from *H. crassicornis* by the absence of minute denticles lining the ventral side of the primary cusp of the rachidian tooth. The rachidian tooth of *H. crassicornis* is more concave than *Facelina stearnsi*. Cockerell made no observation of the jaws or reproductive system.

Eliot (1907) described a *Facelina* sp. from a preserved specimen collected in Dunedin Harbour, New Zealand. Eliot described the *Facelina* sp. as having a similar radula and jaw morphology to *Facelina stearnsi*. The ceratal arrangement of this species was not described. No observation was made of the reproductive system other than the presence of penial armature. Data were not collected about the color and appearance of the specimen in its living state. The reported range of *Facelina stearnsi* is from Santa Cruz to La Jolla, California (Behrens, 1991). It is unlikely that Eliot's *Facelina* sp. is *Facelina stearnsi* based on the collection locality and the biogeographical distinctions of California and New Zealand marine biotas.

O'Donoghue (1927) described a preserved specimen of *Facelina stearnsi* from Laguna Beach, California. The external morphology and radula described agree with the description by Cockerell. O'Donoghue observed that the jaw had a

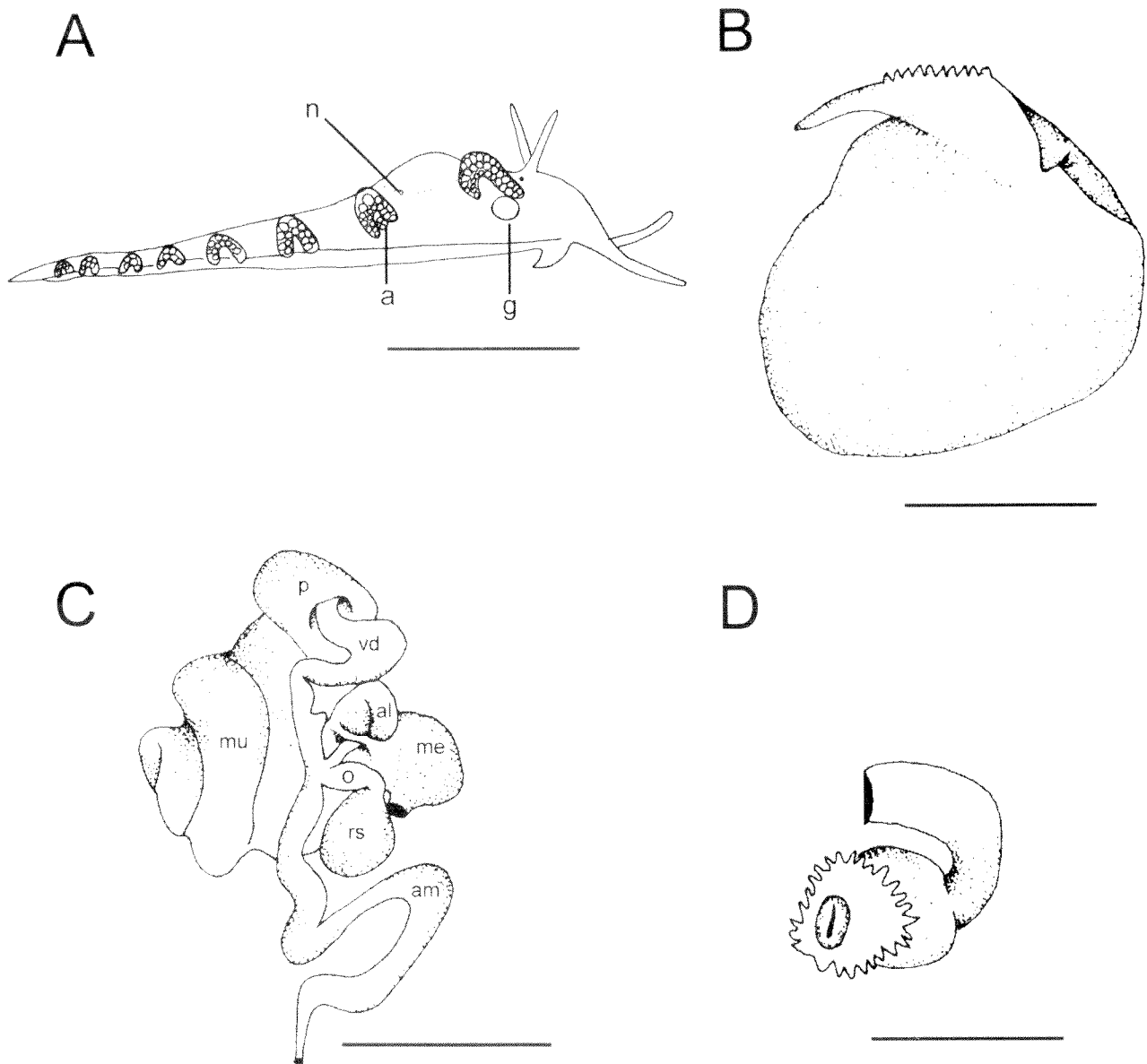


Figure 2 Anatomical drawings of *Austracolis stearnsi* (Cockerell, 1901). A, Body with cerata arrangement, abbreviations: a = anus, g = genital aperture, n = nephroproct, scale bar = 10 mm; B, Jaw plate, scale bar = 1mm; C, Reproductive system, abbreviations: am, ampulla; al, albumen gland; me, membrane gland; mu, mucus gland; o, oviduct; p, penis; rs, receptaculum seminis; vd, vas deferens, scale bar = 1mm; D, Penis, scale bar = 0.40 mm.

'...thickened tooth like process at their anterior corner. The masticatory edge is well developed, thickened and runs downwards as a denticulate projection attached to the main mass by a wide flange.' This observation is similar to the jaws of the three specimens dissected in the current study. Data were not collected about the specimen in its living state other than the observation that its "appendages" were colored.

McDonald (1983) described *Facelina stearnsi* from a preserved specimen collected in Santa Barbara, California. Observations were only made of the external and radular morphology. McDonald observed the distinctive 'longitudinal band of brilliant vermilion to scarlet orange on either side of the head'. Little is known about the ecology of

this species. It is usually seen on or near hydroid colonies.

All previous records of *Facelina stearnsi* report the cerata arranged in eight regular rows. The cerata are arranged in 7-8 arches on all specimens observed in this study. According to Miller's (1974) diagnosis of the Facelinidae (=Glaucidae sensu 1974) the morphological and anatomical characteristics we observed place *Facelina stearnsi* in the Favorininae. The Favorininae are distinguished by the arrangement of cerata in arches. Miller described the Favorininae as being 'Cleioproctic, one or several rows of cerata in arches, both pre- and post-cardiac groups, as are the digestive ducts.' The Facelininae in contrast, have cerata arranged in linear rows.

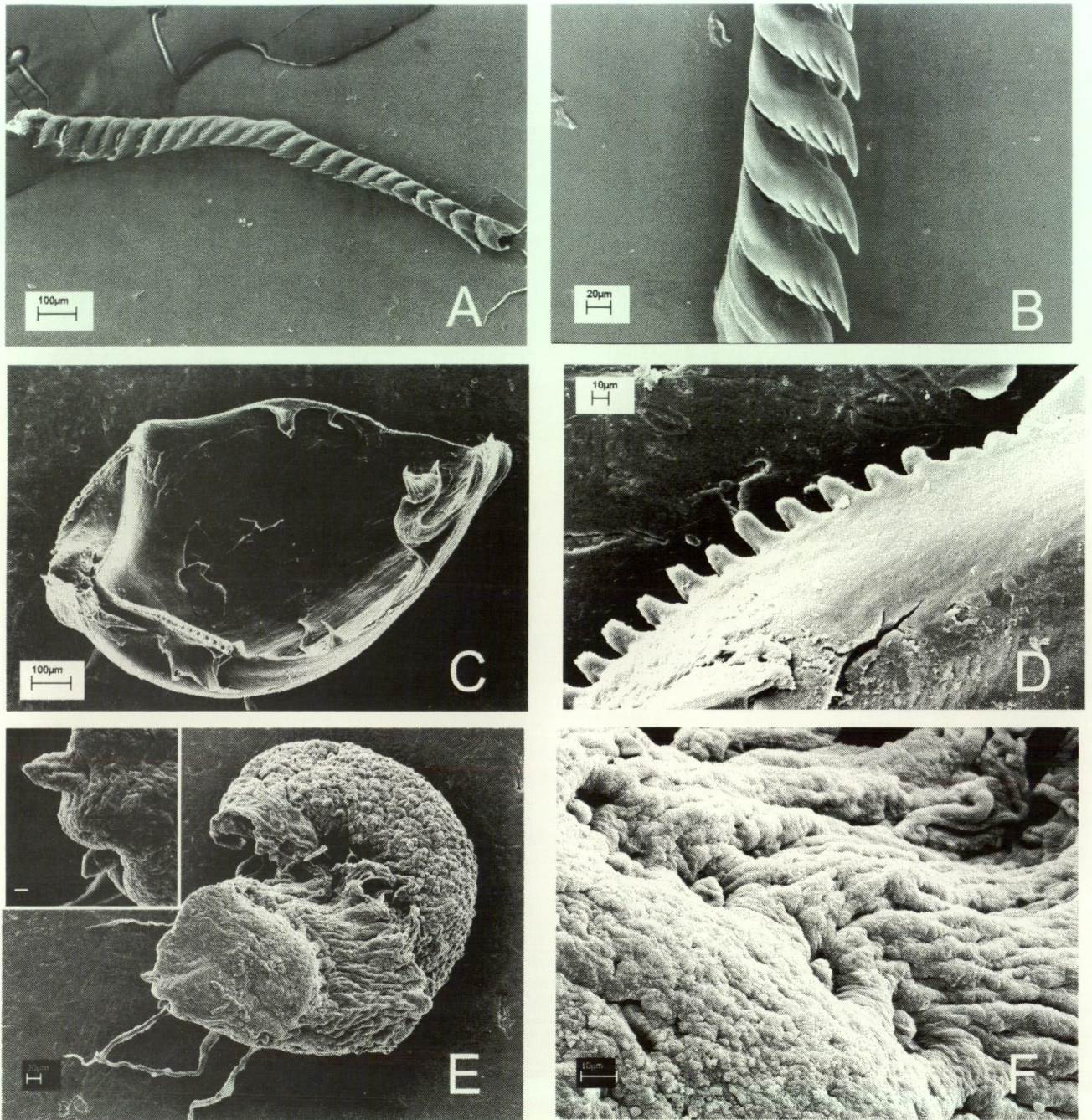


Figure 3 Scanning Electron Micrographs of *Austraeolis stearnsi* (Cockerell, 1901) (CASIZ 89095). A, Radula, scale bar = 100µm; B, Radula close up, scale bar = 20µm; C, Jaw, scale bar = 100µm; D, Jaw close up, scale bar = 10µm; E, Penis and detail of penial papillae, scale bar = 20µm, Insert scale bar = 3µm; F, Detail of penial papillae, scale bar = 10µm.

Based on Miller's diagnosis and original generic descriptions the penis of *Facelina stearnsi* is most similar to the Favorininae genera *Amanda* (Macnae 1954) and *Austraeolis* Burn 1962 (Table 1). *Amanda armata* is described as having a penis with a sub-apical circle of tiny hooks. The rhinophores are annulate with 3–4 incomplete rings compared to 10–15 annulae in *Facelina stearnsi*. The radula is uniserate with denticles and the jaw is denticulate. The description of the reproductive system of *A. armata*, the type species, indicates penial spines that

are very incurved and terminate in a fine point. The penial spines of *Facelina stearnsi* are shorter and more papillate in shape. Other differences include dramatically different color pattern and more sparsely arranged cerata in *Facelina armata*.

The genus *Shinanoeolis* Baba, 1965 is described as having a more similar penial shape and armature to *Facelina stearnsi*. Based on the original type description *Cuthona emurai* (Baba 1937) for *Shinanoeolis* the external features and radula do not agree with the current description of *Facelina*

Table 1 A comparison of the anatomical characteristics of *Amanda armata* Macnae, 1954, *Austraeolis ornata* Angas, 1864, and *Austraeolis stearnsi* (Cockerell, 1901).

Specie/Genus	<i>Amanda armata</i> (Macnae, 1954)	<i>Austraeolis benthicola</i> (Burn, 1966)	<i>Austraeolis catina</i> (Marcus & Marcus, 1964)	<i>Austraeolis ornata</i> (Angas, 1864)	<i>Austraeolis westeralis</i> (Burn, 1966)	<i>Facelina stearnsi</i> (Present study)
Rhinophores	Annulate Rhinophores	Annulate with 5 annulae each	Annulate and have up to 12 annulae each	Annulate Rhinophores	Annulate with 12 or more annulae each	Annulate and have 10-15 annulae each
Jaw	16 denticles on the masticatory edge of each jaw	Ovate jaw, with 30 irregularly rounded denticles	30 conical, knobbed denticles on the masticatory edge of each jaw	20 denticles on the masticatory edge of each jaw	Subovate jaw with 20 large conical denticles on the lower edge of each jaw and numerous small serrations above 18-20 denticles on the masticatory edge of each jaw	
Radula	16-17x0.1.0 Radula uniserate with prominent cusp and strong lateral denticles	28x0.1.0 Long slender teeth with a large tapering cusp and 2-3 denticles each side	23x0.1.0 The cusp of the tooth is prominent, flanked by 4-6 slightly curved denticles	20-22x0.1.0 Prominent central cusp with 4-5 lateral denticles	23x0.1.0 A tapering cusp with 4-5 denticles each side	24-25x0.1.0 Single large incurved hook-like tooth flanked by 4-6 smaller denticles on each side
Penis	sub-apical circle of tiny hooks	conical and short, tip with a shallow rim on one side that forms a lip from which the vas deferens opens	cylindrical and curved upward. Ends in a disc whose edge is beset with 10 broad warts, each bearing a tiny spine. Two further warts on the surface of the disc also with spines.	finger-like and curved forward, transversely demarked by muscular ridges; glans beset with a circlet of six minute fleshy filaments, without any trace of chitonous or spicular hooks	Similar to <i>Austraeolis ornata</i> but is shorter and broader	armed with a ring of 20 spines. The spines are papillate in shape

stearnsi. Distinctive differences such as smooth rhinophores, color pattern and a rachidian tooth bearing numerous small indistinct denticles suggest its synonymy with *Hermisenda crassicornis* (Eschscholtz, 1831).

The penis, radula, and jaw structure of *Facelina stearnsi* agree most closely with species in the genus *Austraeolis* Burn 1962. *Austraeolis* is described as having a conical penis with a fleshy lobe (sometimes papillate) or short fleshy processes or warts, a rachidian with 4–5 lateral denticles on each side, and a denticulate jaw. There are five described species of *Austraeolis*; *A. ornata* Burn, 1962, *A. fucia* Burn, 1962, *A. benthicola*, Burn 1966, *A. westeralis*, Burn, 1966 and *A. catina* Marcus and Marcus, 1967. *Austraeolis ornata*, *A. fucia*, *A. benthicola* and *A. westeralis* are known from Australia. *Austraeolis catina* is found in the Caribbean.

Burn made observations of the external, internal, radular and penial morphology of *A. ornata*. The penis is described as '.....finger-like and curved forward, transversely demarcated by muscular ridges; glans beset with a cirlet of six minute fleshy filaments, without any trace of chitonous or spicular hooks.' This is in contrast to the more than 20 spines present in *Facelina stearnsi*. The radula formula is 20–22x0.1.0. The jaw has a denticulate masticatory border. The body color can range in color from a pale translucent yellow to an intense bright orange. There are usually white patches and spots on the body often bluish or iridescent. The rhinophores have some prominent folds or ridges and are usually tipped with white rather than the well developed annulae found in *Facelina stearnsi*. The digestive gland within the cerata ranges in color from a pale yellow to a dark brown. (Rudman, 2000).

Austraeolis fucia is described from a single specimen collected in Queenscliff, Australia. Observations were made of the external and radular morphology. There are no illustrations of the internal anatomy. The radula formula is 19x0.1.0. Burn noted that the morphology of *Austraeolis fucia* is distinct from *A. ornata* by 'having fewer annulae on the rhinophores'. The body color is creamy-white, the cerata are transparent, with the inner digestive gland a creamy-white color. In 1966, Burn noted that *Austraeolis fucia* is most likely a specimen of *Facelina hartleyi* Burn, 1962.

Austraeolis benthicola is described from a single specimen collected in New South Wales. *Austraeolis benthicola* has a conical and short penis, at its tip is a shallow rim on one side that forms a lip from which the vas deferens opens. The radula formula is 28x0.1.0. *Austraeolis benthicola* is unique from all other *Austraeolis* species in having wide foot margins, ovate jaws, slender radular teeth and an apical rim of the penis. It is the first deep-water aeolid recorded from Australia.

Austraeolis westralis is described from seven specimens collected in Western Australia. *Austraeolis westralis* has an internal and external anatomy similar to *A. ornata*. *Austraeolis westralis* differs from *A. ornata* in possessing a narrower coiled prostatic vas deferens, larger outer vas deferens, shorter, broader penis with numerous denticle-like fleshy serrations at the tip and a more elongate spermatheca. Due to the lack of knowledge on opisthobranch fauna in southern Australia, Burn considers that *Austraeolis westralis* might be an extreme form of *A. ornata*.

Austraeolis catina is described from two preserved species. Observations were made of the external and radular morphology. *Austraeolis catina* differs from the other species by the absence of cuticular hooks on the six filaments of the penis, 9 rhinophoral rings, 20 denticles on the masticatory border of the jaw and a radular formula of 20–22x0.1.0. Body color is described as 'transparent greyish .. with brown marks on side of head and middle of rhinophores' and with white speckling on skin, concentrated in some parts such as middle of head and tentacles'. *Facelina stearnsi* can be distinguished from other species of *Austraeolis* by its external and penial morphology.

Based on this study, the following characteristics appear to be consistent for all *Facelina stearnsi* specimens:

1. Oral tentacles have a white or cream line that runs along the dorsal side and then across the head to the base of the rhinophores. The line is often orange/yellow toward the base of the rhinophore.
2. Irregular spots of orange/vermillion behind the rhinophores and between each group of cerata.
3. Cerata arranged in eight arches
3. Anus is located ventral and anterior to the second cluster of cerata.
4. The genital aperture is located below the anterior limb of the first ceratal arch.
5. The penis is armed with a ring of papillate spines.

In conclusion, we suggest that *Facelina stearnsi* is more properly placed in the genus *Austraeolis* due to the arrangement of cerata and its penial armature. A thorough study of the Facelinidae is necessary to establish phylogenetic relationships and determine monophyletic clades.

ACKNOWLEDGEMENTS

This research was supported by the California Academy of Sciences, the NSF PEET grant #0329054 and a UNITAS Student Travel Grant that permitted the senior author to attend the World Congress of Malacology in Perth, Australia July, 2004.

REFERENCES

- Angas, G.F. (1864). Description d'espèces nouvelles appartenant à plusieurs genres de Mollusques Nudibranches des environs de Port-Jackson (Nouvelles-Galles du Sud), accompagnée de dessins faits d'après nature. *Journal de Conchyliologie* 12: 43-70.
- Baba, K. (1937). Opisthobranchia of Japan (II). *Journal of the Department of Agriculture* 5: 289-344.
- Baba, K. and Hamatani I. (1965). The anatomy of *Sakuraeolis enosimensis* (Baba, 1930), N.G. (= *Hervia ceylonica* (?) Eliot, 1913) (Nudibranchia-Eolidoidea). *Publications of the Seto Marine Biological Laboratory*, (8) 2:103-113
- Behrens, D.W. (1991). *Pacific coast nudibranchs: a guide to the opisthobranchs Alaska to Baja California*. Sea Challengers, Monterey, California.
- Burn, R. (1962). Descriptions of Victorian nudibranchiate Mollusca, with a comprehensive review of the Eolidacea. *Memoirs of the National Museum of Victoria*, 25: 95-128.
- Burn, R. (1966). Descriptions of Australian Eolidacea (Mollusca: Opisthobranchia), *Journal of the Malacological Society of Australia* 1(9): 25-35
- Cockerell, T.D. (1901). Three nudibranchs from California. *Journal of Malacology* 8: 85-87.
- Eliot, C. (1907). Nudibranchs from New Zealand and the Falkland Islands. *Proceedings of the Malacological Society of London* 7: 327-361.
- Marcus E. and Marcus E. (1967) *American Opisthobranch Mollusks*. University of Miami, Institute of Marine Sciences.
- McDonald, G.R. (1983). A review of the nudibranchs of the California Coast. *Malacologia* 24: 114-276.
- Macnae, W. (1954). On some eolidacean nudibranchiate molluscs from South Africa. *Annals of the Natal Museum* 8: 1-50.
- Miller, M.C. (1974). Aeolid nudibranchs (Gastropoda: Opisthobranchia) of the family Glaucididae from New Zealand waters. *Zoological Journal of the Linnean Society* 54: 31-61.
- Nelson, L. (1986). A range extension of *Phidiana stearnsi* (Cockerell, 1901) (Gastropoda, Nudibranchia). *The Veliger* 2: 240-243.
- O'Donoghue, C. (1926). A list of the nudibranchiate Mollusca recorded from the Pacific coast of North America, with notes on their distribution. *Transactions of the Royal Canadian Institute* 15: 199-247.
- O'Donoghue, C. (1927). Notes on a collection of nudibranchs from Laguna Beach, California. *Journal of Entomology and Zoology, Pomona College, Claremont, California* 19: 77-119.
- Rudman, W.B. (2000) *Austraeolis ornata* (Angas, 1864). [In] *Sea Slug Forum*. Australian Museum, Sydney.
- Steinberg, J.E. (1961). Notes on the opisthobranchs of the west coast of North America. I Nomenclatural changes in the order Nudibranchia (Southern California). *The Veliger* 4: 57-63.