

“First” abyssal record of *Stenosemus exaratus* (G.O. Sars, 1878) (Mollusca, Polyplacophora) in the North-Atlantic Ocean

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Abstract

The first proven abyssal record of *Stenosemus exaratus* (G.O. Sars, 1878) is presented on the basis of an ROV study in the Irish Sea. For the first time *in situ* images of the species and data on the environmental parameters are provided.

Keywords

Deep-sea, Irish Sea, canyon systems

Introduction

Polyplacophoran molluscs are a group of exclusively benthic organisms distributed worldwide that are found from the splash zone down to hadal depths (Schwabe 2008).

According to Schwabe (2008) the maximum depth in which *Stenosemus exaratus* (G.O. Sars, 1878) has been collected is 2580 m. Schwabe (2008) cited depth ranges for this species cited by Kaas and Van Belle (1990), but confirmed localities where the species was collected in abyssal depths could not be traced. Thus proof for the occurrence of *S. exaratus* below the continental rise *sensu* Gage and Tyler (1991) is still lacking. The only abyssal records of chitons in the North Atlantic (excluding the Caribbean Sea) are restricted to a handful of records from off Galicia and the Bay of Biscay and all refer

to *Leptochiton alveolus* (M. Sars MS, Lovén, 1846). Kaas and Van Belle (1994) were apparently also aware of abyssal records for *Placiphorella atlantica* (Verrill & S. I. Smith in Verrill, 1882), but subsequent research again failed to trace these (Schwabe 2008). Thus *Leptochiton alveolus* is so far the only “true” abyssal Northern Atlantic species for which precise occurrence records are available.

During an expedition exploring canyon systems to the southeast of the Rockall Trough on the shelf edge of Ireland, one of us (LA) was able to collect three specimens of *S. exaratus* by means of an ROV (remotely operated vehicle). Still and high-definition video camera systems provide for the first time an insight into the species’ habitat. In addition, data are presented on relevant environmental parameters.

Material and methods

The chitons recorded here were collected during survey CE10004 of RV Celtic Explorer. This cruise, entitled ‘*Species at the Margins*’ sampled an unnamed canyon system at the edge of the continental margin, north of the Porcupine Bank, using the Irish deep-water ROV Holland I. ROV Holland I is a Quasar work class ROV rated to 3000 m. It is equipped with several video camera systems including a Kongsberg OE14-502a high definition colour zoom and a Kongsberg OE14-208 digital stills camera, and has two robotic arms and a slurp sampler. Laser sights are positioned 10 cm apart to facilitate size estimates. Samples from the slurp sampler are maintained in an enclosed system for the duration of the dive. Fauna collected with the robotic arms are stored in extendable storage boxes. Once samples arrived on deck, they were hand-picked from the ROV boxes and sediment was sieved through a 500 µm mesh. The chitons were deposited and identified at the Bavarian State collection of Zoology (ZSM Mol 20110215) (by ES). Environmental parameters were obtained using a 24-rosette conductivity-temperature-depth (CTD) data logger from the nearest locality and by visual inspection of the sediment. According to the available video sequences the species was collected at 2:06 pm. The position of the ROV was determined using a global acoustic positioning system, which incorporates inertial navigation systems and global positioning using ultra-short baseline beacons. At these depths, position data can be intermittent. We obtained position data approximately 10 minutes after the chiton was collected. As the ROV was climbing a vertical wall during this period, only the depth value is slightly inaccurate, the actual collection depth being slightly (approximately 20 meters as estimated from video footage) deeper than the nearest datum point.

Data resources

The data underpinning the analysis reported in this paper are deposited in the Dryad Data Repository at doi: 10.5061/dryad.h261h.

Results

During station 96 of cruise CE1004, an ROV dive to 3000 m depth, three full grown specimens of *Stenosemus exaratus* (G.O. Sars, 1878) were collected on a steep wall of an unnamed canyon southeast of the Rockall Trough (Fig. 1) at 54.2172°N, 12.6598°W. One specimen was sighted and taken just below the nearest recorded depth of 2733 m. Two additional specimens were taken blind by the slurp sampler, from wall sediment during the course of the dive. The wall extends vertically from approximately 2800 to 2650 m and consists of chalk, but is covered all over by a very fine greenish-grey silt layer. Despite a remarkably high number of scars and micro cavities the only other obvious macrobenthic fauna close to the sighted chiton was a glass sponge approximately 30 cm in length. No feeding tracks or "home" marks were visible around the chiton.

Data from the CTD at station 93 (54.217°N, 12.661°W, depth 2733 m) reveals the following abiotic parameters: salinity 34.925, temperature 2.85°C, pressure 2775.87 db and oxygen 235 $\mu\text{mol/kg}$ (this corresponds to a saturation of about 72–73%). These data indicate that the Bay of Biscay area is influenced by cold oxygen-rich Labrador Sea Water (e.g., McGrath et al. 2012)

Discussion

Abyssal records of chitons are scarce and few species are known to inhabit depths below the continental slope (see Schwabe 2008). Schwabe (2008) also showed that eurybathy occurs very rarely in polyplacophorans. Among the few species exhibiting eurybathy is *Stenosemus exaratus* reported herein. The present finding represents its deepest record (Fig. 2, circle), but it also occurs rather shallowly in fjord systems, including the Chilean Fjord region, where Schwabe and Sellanes (2010) recorded the shallowest occurrence at 23 m.

A similar situation was revealed for the other North Atlantic abyssal species, *Leptochiton alveolus* (Fig. 2, triangles). While its abyssal records to date are restricted to the canyon regions of the Bay of Biscay, we found it at 1380 m during cruise CE11006 of RV Celtic Explorer during a dive of ROV Holland I under a *Lophelia pertusa* bank in the Whittard Canyon. This coral species was also recorded at 1350 m in the Whittard Canyon system by Huvenne et al. (2011).

Mortensen and Fossa (2006, as *Lepidochitona* [sic] *alveolus*) reported *L. alveolus* from living cold-water coral *Lophelia pertusa* reefs in the Midfjord (Norway) in depths between 150–160 m. The previous deep-water findings of *Leptochiton alveolus* in the Bay of Biscay (Fig. 2) region lack accompanying data and it remains unclear, if the species is somehow related to the occurrence of *Lophelia pertusa*. However, hypothetically this would be possible, as Davies and Guinotte (2011: figs 4, 5) demonstrated that a co-occurrence of both species is possible. Jensen and Frederiksen (1992), however, did not record a single chiton from *Lophelia* associated communities.

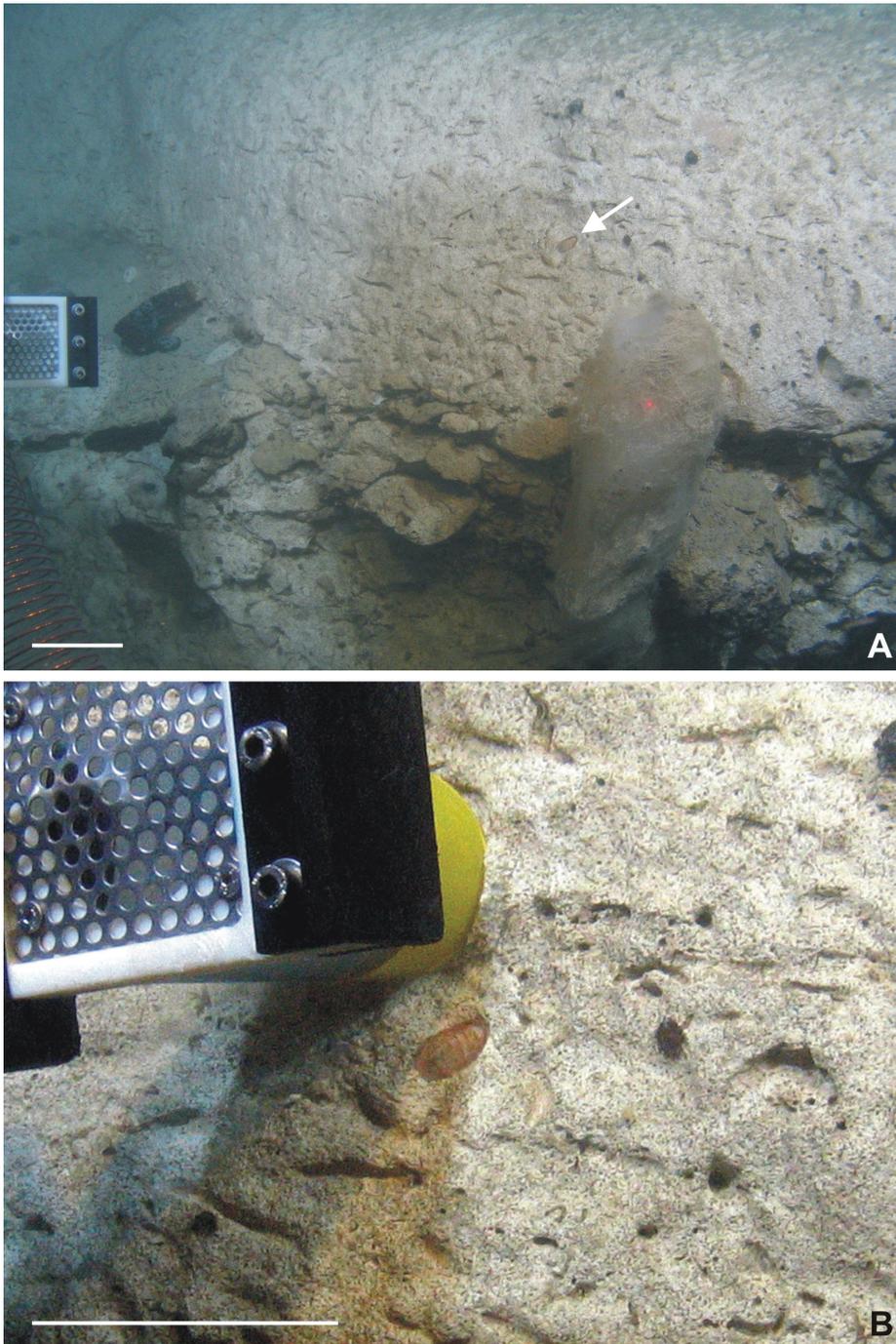


Figure 1. Rockall Trough at station 96 at 54.2172°N, 12.6598°W in 2733 m. The camera system of ROV “Holland I” detects *Stenosemus exaratus* (G.O. Sars, 1878) in its natural environment for the first time. A - Macrofauna-poor impression of the steep canyon wall; foreground contains a 30 cm long glass sponge and the chiton (indicated by an arrow). B - The ROV slurp sampler attempts to remove the chiton. Scale bars 10 cm.

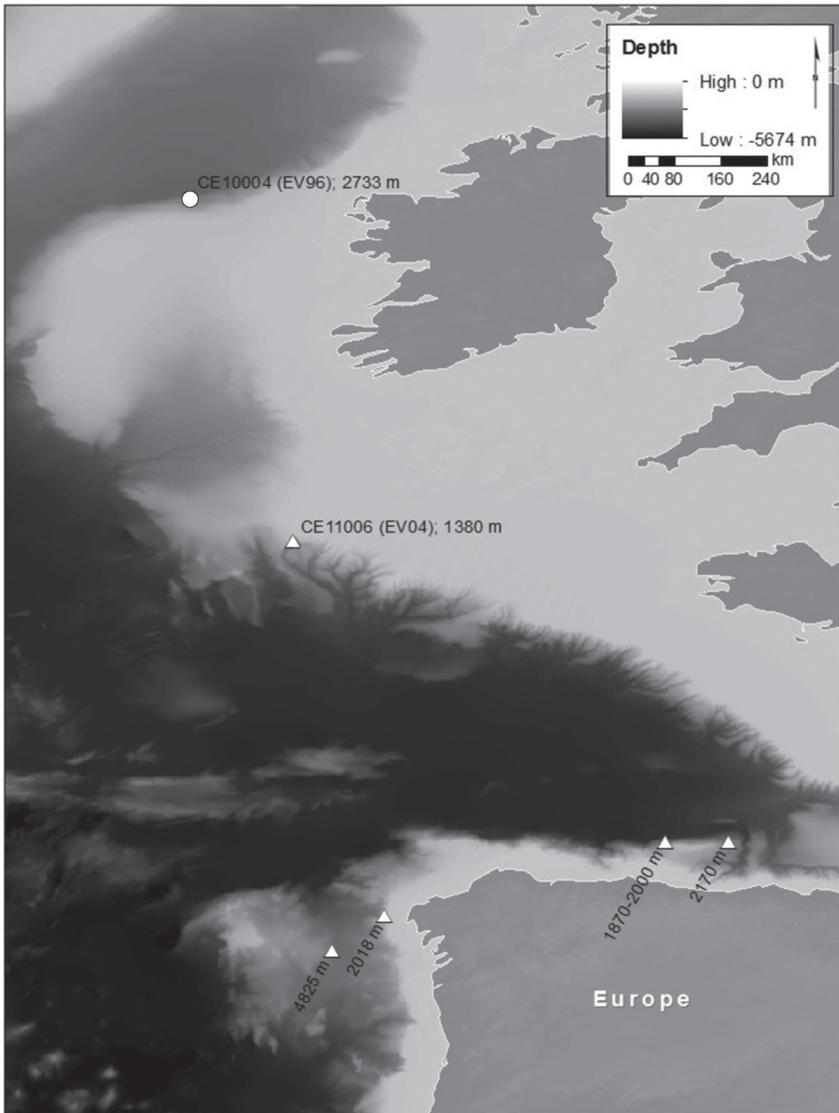


Figure 2. Locality map for the deep-water records of *Stenosemus exaratus* (G.O. Sars, 1878) (circle, herein) and *Leptochiton alveolus* (M. Sars MS, Lovén, 1846) (triangles) in the North Atlantic. “CE” localities refer to our expeditions on board the RV *Celtic Explorer*, remaining data extracted from Schwabe (2008).

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Bellisotoma, a new genus of Isotomidae from North America (Hexapoda, Collembola)

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Abstract

A new genus of Isotomidae, *Bellisotoma* **gen. n.**, is described. The new genus is a member of the *Proisotoma* genus complex and is characterized by a combination of having a bidentate mucro with wide dorsal lamellae that join clearly before the end of mucronal axis without forming a tooth and one strong ventral rib with basal notch that articulates with dens; having abundant chaetotaxy on both faces of dens; and abundant tergal sensilla. *Bellisotoma* **gen. n.** shows a furcula adapted to a neustonic mode of life, and may be a *Isotopenola*-like derivative adapted to neustonic habitats. *Subisotoma joycei* Soto-Adames & Giordano, 2011 and *Ballistura ewingi* James, 1933 are transferred to the new genus.

Keywords

Lectotype, Acidic sandy soil, Vermont, Quebec, Mississippi

Introduction

In the process of reviewing new North American species described since the last edition of the Collembola of North America (Christiansen and Bellinger 1998), it became evident that the recently described *Subisotoma joycei* Soto-Adames & Giordano displays a

combination of characters that excludes it from any and all currently accepted genera of Isotomidae. Retention of *S. joycei* in *Subisotoma* Stach would further expand the morphological diversity of species assigned to an already morphological heterogeneous genus. In this contribution, we describe the new genus, add some comments to the original description of *S. joycei* and transfer *Ballistura ewingi* James to the new genus.

Results

***Bellisotoma* Soto-Adames, Giordano & Christiansen, gen. n.**

urn:lsid:zoobank.org:act:AFA4345E-D38F-4D33-8FC4-881181109D23

<http://species-id.net/wiki/Bellisotoma>

Type species. *Subisotoma joycei* Soto-Adames & Giordano, 2011.

Etymology. The new genus is dedicated to Ross and Joyce Bell, in celebration of their contributions to the study of the entomological fauna of Vermont.

Description. General body shape short and stout, with sudden bend between abdominal segments 4–5 as in *Folsomides*. Cuticle smooth, granular complex formed by single light granules surrounded by 4–7 darker granules (Fig. 1), granular complexes irregular. Basal microsensilla on antennal segments 3–4 not differentiated; second antennal segment with 3 basal microsensilla; first antennal segment with 17–18 setae, 2 basal microsensilla, 3 basal ventral sensilla and 2 other distal sensilla. Prelabral setae 2; outer maxillary lobe with apical seta simple, sublobal plate with four appendages; labial palp with three proximal setae, all papilla present, guard seta e7 absent. Tergal microsensilla formula 10//101; number of tergal sensilla variable, but adults always with more than eight sensilla on each segment; medial abdominal sensilla inserted either on or just anterior to posterior row (Figs 7–8). Ventral thoracic setae absent. Sterna of second abdominal segment without isolated field of setae. All legs with more than 21 setae; legs with 1–3 weakly capitate or acuminate tenent hairs; setae B4 and B5 present, B5 longer than B4; adult males with setae B5 and x modified. Manubrium without ventral setae. Dens smooth, cylindrical, and shorter than manubrium; dorsal setae long and abundant, distributed throughout dens length; ventral setae few and restricted to distal half of dens. Mucro bidentate (Fig. 2), about half as long as dens, fused to dens dorsally, articulated ventrally; with wide dorsal lamellae that join clearly before the end of mucronal axis without forming a tooth (Fig. 3), and a ventral rib with basal notch that articulates with dens (Fig. 4).

Remarks. *Bellisotoma* gen. n. belongs to the *Isotopenola-Subisotoma* genera complex, but unlike these genera, the new genus shows a furcula adapted to a neustonic mode of life, as evidenced by the thick polychaetotic dens and lamellate mucro. *Bellisotoma* gen. n. differs from all other genera by the combination of having a mucro with lamellae that join subapically without forming a tooth, by the presence of a large number of dorsal setae on dens, presence of sensillar polychaetosis, smooth cuticle and second abdominal sternum segment without isolated setae field. The new genus is similar *Isotopenola* Potapov, Babenko, Fjellberg and Greenslade and *Subisotoma*, as

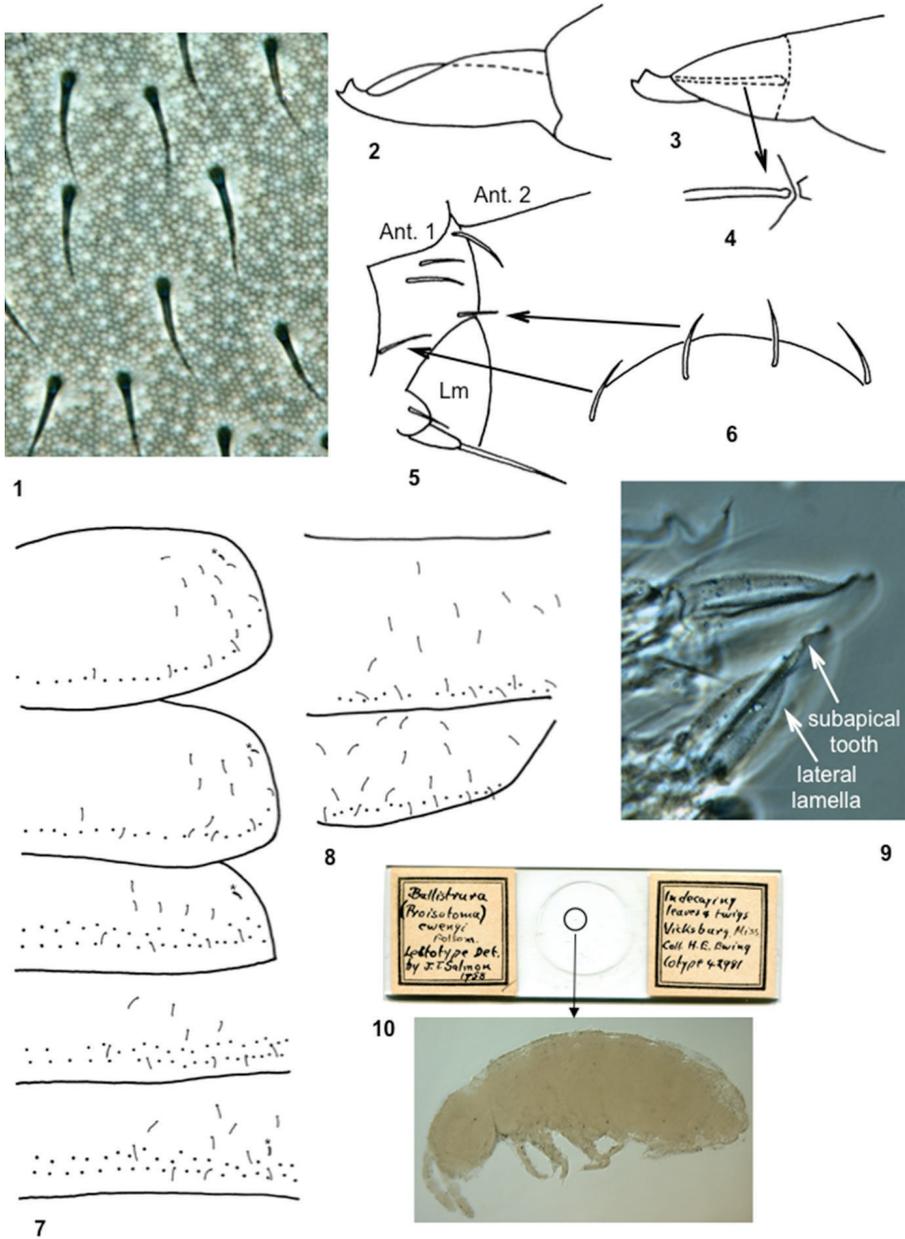


Figure 1–10. *Bellisotoma joycei*. **1** Ornamentation of dorsal cuticle of head **2** Lateral view of mucro, holotype **3** Oblique view of mucro, specimen from Quebec, hatched lines represent ventral rib and mucronal articulation **4** Ventral mucronal rib and articulation **5** Lateral view of fronto-clipeal region (Ant. 1-2 are 1st and 2nd antennal segments) and labrum (Lm) showing relative placement of prelabral setae **6** Dorsal view of prelabral region, only the inner setae are inserted just basal to labral suture, arrows point at corresponding seta on lateral view of head **7** Chaetotaxy of thorax 2- abdomen 3, asterisks identify microsensilla **8** Chaetotaxy of abdomen 4-5 (from Soto-Adames and Giordano 2011). *Bellisotoma ewingi*, lectotype **9** Structure of mucro (phase/contrast), dorsal and lateral views **10** Scan of lectotype slide and detail of habitus (DIC) showing general condition of specimen.

circumscribed by Potapov et al. (2009), in having reduced number of prelabral setae, simple outer maxillary palp, reduced number of guard setae on labial papilla E, reduced microsensillar chaetotaxy, absence of tibiotarsal seta B4/5 and smooth dens (Table 1). The three main characters given above distinguish the new genus from *Subisotoma*, whereas the new genus additionally differs from *Isotopenola* in the number of guard setae on labial papilla E (6 in *Bellisotoma*, 4–5 in *Isotopenola*). *Bellisotoma joycei* keys out to *Ballistura* in Potapov (2001), but the two genera are clearly distinguished by maxillary palp structure, sensillar and microsensillar formulae, absence of tibiotarsal seta B4/5 and dens sculpturing. Additional differences between the new genus and other genera in the *Proisotoma* complex (Potapov 2001, Fjellberg 2007, Potapov et al. 2006, 2009) are listed in Table 1. One other North American species, *Ballistura ewingi* (see below), belongs in the new genus.

Members of the new genus may be either psammophilous and/or acidophilus. The individuals of *B. joycei* from Vermont were collected on sandy shores of Lake Champlain and the individuals from Quebec on acidic sandy soils (pH 3.75; Therrien et al. 1996) in a sugar maple grove ≈28Km east of the St. Lawrence River. The exact topotypical locality of *B. ewingi* is not clear, but the soils around Vicksburg, Mississippi are also acidic, sometimes sandy.

***Bellisotoma joycei* (Soto-Adames & Giordano), 2011 comb. n.**

http://species-id.net/wiki/Bellisotoma_joycei

Material examined. Holotype (Illinois Natural History Survey [INHS] Insect Collection accession number 551,608) and 3 paratypes (INHS Insect Collection accession numbers 551, 610; 551,611; 551, 621): USA, Vermont, Grand Isle Co., South Hero, White's Beach, N44.62189, W73.32273, sand and thick layer of aquatic plant debris, October 2005. 2 paratypes (INHS Insect Collection accession numbers 551,609 and 551,612): Vermont, Grand Isle Co., Grand Isle, Pearl Bay, west of intersection of East Shore North Rd. and Hide Point West Rd., N44.73078 W73.26401, sand with sparse remains of aquatic plant debris, October 2005. CANADA, Quebec, 9115 (1994), St. Jude, sugar maple leaf litter near N45.78333, W72.93334, Berlese MO-SJ-2, identified as *Proisotoma (Ballistura) ewingi* on the label (this slide contains 7 specimens and is deposited in the A.J. Cook Arthropod Research Collection at Michigan State University).

Remarks. The specimens from Quebec were originally identified as *Ballistura ewingi*, but in the key character that separate *B. joycei* from *B. ewingi* (number of distal setae on the colophore) they are identical to *B. joycei*. All specimens from Quebec are small, the largest measuring only 0.78 mm. Two of the seven individuals from Canada are males. In the largest male the genital plate is well developed, but it appears to be closed, and neither males has modified metatibiotarsal setae. These males are either subadults of adults in reproductive quiescence.

In the specimens from Vermont the number and size of eyes varies, and one individual is blind (Soto-Adames and Giordano, 2011). In the individuals from Quebec

Table 1. Diagnostic characters for selected genera in the *Proisotoma* genera complex in comparison with *Bellisotoma* gen. n. Characters based on Potapov (2001) or Potapov et al. (2006, 2009). Modified from Soto-Adames and Giordano (2011).

Character	Genus	<i>Scutisotoma</i>	<i>Proisotoma</i>	<i>Folsomides</i>	<i>Ballistura</i>	<i>Isotopenola</i>	<i>Subisotoma</i>	<i>Bellisotoma</i> gen. n.
Prelabral Seta		4	3	2	2	2	2	2
Outer Maxillary Palp/ Sublobular Appendages		bifurcate/4	simple/4	simple bifurcate/3	bifurcate/3	simple/4	simple/4	simple/4
Number Guard Setae on Labial Papilla E		7	5	7	6	4-5	6	6
Tergal Microsensillar Formula		11//111	10//000 00//000	10//000 to 11//111	11//111	10//101 11//111	10//000, 10//100, 10//001, 10//101	10//101 ^a
Position Medial Sensilla Abd. 3		medial row	posterior row	medial row	just anterior to posterior row	subposterior row	posterior row or just anterior to posterior row	posterior row or just anterior to posterior row
Sternal Thoracic Setae		present absent	present absent	absent	absent	absent	absent present	absent
Mesotibiotarsal Setae B4/5		absent	absent	present	present	absent	absent	absent
Ventral Manubrial Setae		1+1 0	1+1	0	0	0	0	0
Dorsal/Ventral Dental Setae		variable	3-7/4-6	2-6/0-3	variable	3-8/1	<4/1	18-20/4-6
Tergal Sensilla Polychaetosis		absent present	absent	absent	absent	absent present	absent	present
Dental Sculpturing		crenulate tuberculate granulate	crenulate	smooth	tuberculate	smooth	smooth	smooth
Mucronal Lamellae		absent	absent	absent	present	absent	absent	present

the number of eyes is constant, except for one specimen in which eye G is missing on one side of the head. Dorsal views of the prelabral region suggest the presence of 4 prelabral setae (Fig. 6), but a lateral view of the head (Fig. 5) clearly shows that the outer setae are displaced posteriorly, away from the labral suture, and are not prelabral in the usual sense. One individual from Quebec has only one prelabral seta. The number of microsensilla is somewhat variable. Most individuals have 10//10100 microsensilla, but one specimen from Vermont has one microsensillum on the metathorax, and the two males from Quebec have 2 microsensilla on the first abdominal segment.

The shape of the tenent hairs is difficult to ascertain in the specimens from Canada. In the two smallest individuals (0.69 mm) all tenent hairs seem acuminate, whereas in the larger specimens there are 111 capitate and 011 acuminate tenent hairs. Most individuals have 3 tenacular teeth, but two have 3+4 and one has 2+3.

***Bellisotoma ewingi* (James), 1933 comb. n.**

http://species-id.net/wiki/Bellisotoma_ewingi

Material examined. Mississippi, Vicksburg; in decaying leaves and twigs, October 2, H.E. Ewing, coll.; Lectotype, designated by J.T. Salmon, 1958; original US National Museum of Natural History catalog number 42981; current catalog number 9026.

Remarks. The description provided by Folsom (1937) suggests that *Ballistura ewingi* and *Bellisotoma joycei* are very similar, sharing characters such as cuticle ornamentation, presence of 3 guard sensilla on the third antennal segment, distal tibiotarsal subsegmentation, and general eye, claw and furcula structure. Of the three main characters used to diagnose *Bellisotoma*, *B. ewingi* has the large number of dental setae and the general lamellate structure of the mucro. The only diagnostic character remaining to be scored for *B. ewingi* is the sensillar polychaetosis.

We studied the lectotype of *B. ewingi*, but the specimen is in such poor condition (Fig. 10) that most characters could not be scored. The few characters we were able to observe are: tergal sensilla present, although clearly seen only on Abd. 4; tibiotarsal setae B4 and B5 present; tenent hair apparently 1,2,2, and acuminate; tenaculum with 3 teeth; dens ventrally with 4 setae; mucro with two lamellae as in Fig. 9.

The tenent hairs and tenacular teeth in the lectotype of *B. ewingi* are as in *B. joycei*, and differ from the numbers reported by Folsom (1937) (2,2,2 or 3,3,3 hairs; 2 teeth). This leaves only the number of distal setae on the colophore to distinguish *B. joycei* (11 setae) from *B. ewingi* (4 setae), and it is possible that James species is a senior synonym of *B. joycei*. However, the condition of the lectotype is such that we prefer to await the study of fresh material from Mississippi before proposing a definite change in nomenclature. In any case, the similarities between *ewingi* and *joycei* listed above, justify the transfer of *ewingi* to the genus *Bellisotoma*.

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New taxa and revisionary systematics of alcyonacean octocorals from the Pacific coast of North America (Cnidaria, Anthozoa)

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Abstract

A taxonomic assessment of four species of octocorals from the northeastern Pacific Ocean (British Columbia to California) is provided. Included here are a new species of clavulariid stoloniferan *Cryptophyton*, a new species of the nephtheid soft coral *Gersemia*, an undetermined species of soft coral in the genus *Alcyonium* that has been referred in the literature by several other names, and a new genus is named for a plexaurid sea fan originally described in the Indo-Pacific genus *Euplexaura*. Discussions are included that compare the species to related taxa, or provide revisionary assessments.

Keywords

Alcyonium, *Cryptophyton*, *Gersemia*, Octocorallia, northeastern Pacific, plexaurid gorgonian, soft corals, taxonomy

Introduction

Bayer (1981a: 7–9) reviewed the present status of knowledge of octocorals in the major geographical regions of the world and established four categories representing broad levels of taxonomic knowledge – essentially complete, moderately well-known, poorly

known, and minimally known. He regarded the geographic region of the western coast of the Americas south to the Gulf of Panama as, “Moderately well-known: where there is extensive literature, but many more species remain to be described and taxonomic problems to be solved, and the major patterns of distribution must yet be worked out. Much descriptive work remains to be done before ecological and experimental studies can proceed at an effective level.” In spite of this, he lists a paucity of works in the literature – only five articles that treat the fauna, three of which cover tropical Central America (from the Gulf of California to Panama), while only two treat California – Nutting (1909) and Kükenthal (1913). The coasts of Oregon, Washington, and British Columbia are for the most part absent from the taxonomic literature. The calcaxonian octocorals of the eastern Pacific were treated by Cairns (2007) and the book chapter of Williams (2007) dealing with shallow water octocorals of the region, were added subsequently. These four works taken together, amount to the most inclusive taxonomic treatment to date of the west coast North American octocorals.

Recently collected material from British Columbia and California has allowed for the examination and taxonomic assessment of several shallow-water soft corals (inter-tidal to 20 meters in depth), as well as a plexaurid gorgonian (32–85 m).

Materials and methods

All material examined is housed in the marine invertebrate collections of the California Academy of Sciences, preserved in 95% ethanol, and acquired from various sources. Scanning electron micrographs were made using a LEO 1450 VP SEM.

Material used for comparative purposes: *Euplexaura* sp., CAS 107595, Western Pacific Ocean, Palau, Neco Channel, 28 September 1996, 24 m depth, coll. Gary C. Williams, one whole specimen.

Abbreviation used in the text: **CAS** (California Academy of Sciences, San Francisco).

Systematic account

Order Alcyonacea Lamouroux, 1816

Family Clavulariidae Hickson, 1894

Genus *Cryptophyton* Williams, 2000

***Cryptophyton jedsmithi* sp. n.**

urn:lsid:zoobank.org:act:482B9A4A-2E2E-4A4A-A319-5CC211242B45

http://species-id.net/wiki/Cryptophyton_jedsmithi

Figures 1–4, 19

Species diagnosis. Stolons ribbon-like to somewhat broadened in some areas. Anthosteles hemispherical, arise directly from basal stolons, elevated stolon bars or

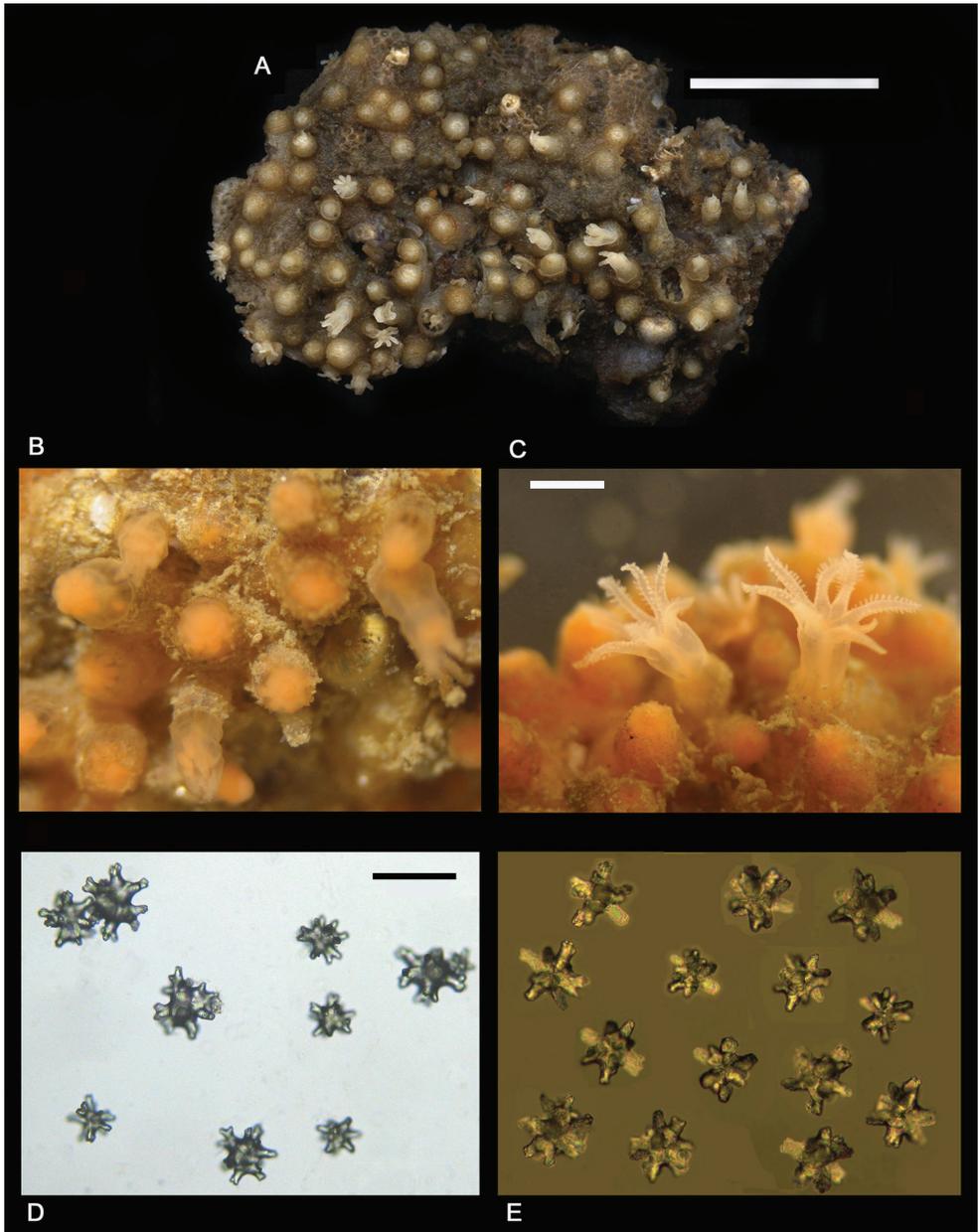


Figure 1. *Cryptophyton jedsmithi* sp. n. **A** Wet preserved holotype (CAS 177194); scale bar = 10 mm. **B–C** Living holotype, details of polyps; photos courtesy of Jeff Goddard; scale bar for both = 1.5 mm. **D–E** Light micrographs of coenenchymal sclerites; scale bar for both = 0.10 mm.

transverse platforms absent. Anthocodial armature absent. Sclerites of stolons and anthosteles 0.06–0.10 mm in diameter, mostly spiny balls or stellate bodies with projecting processes in three dimensions.

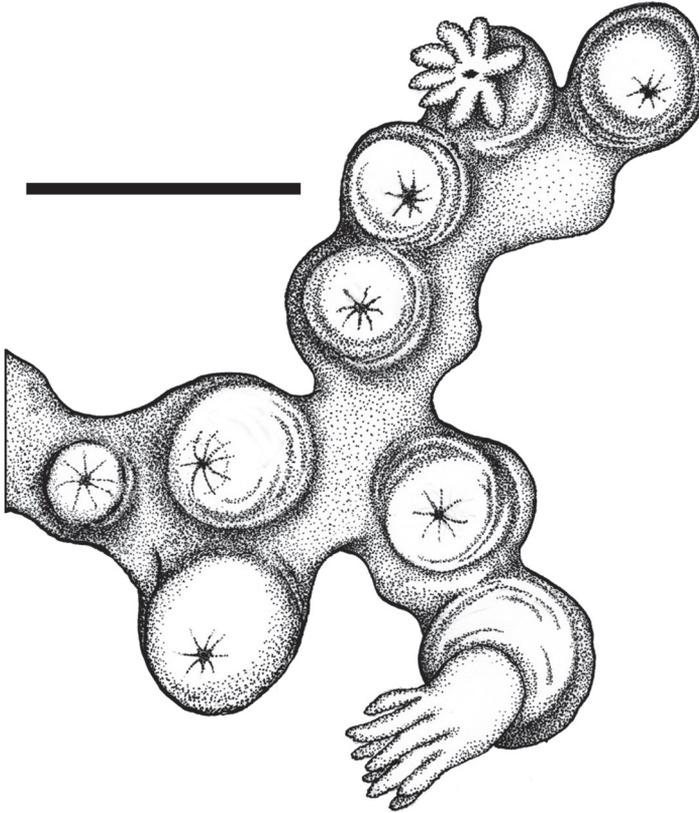


Figure 2. *Cryptophyton jedsmithi* sp. n. A portion of the holotype, showing arrangement of nine polyps on a membranous stolon; scale bar = 3.0 mm.

Type material. Holotype. CAS 177194. North America, U.S.A., California, San Diego County, San Diego, Point Loma, 32°42'N, 117°15'20"W, 12 February 2006, collector: Jeff Goddard, one specimen wet-preserved in 95% ethanol.

Habitat and distribution (Figure 19): Under a boulder in the low rocky intertidal zone at the type locality.

Etymology. The species is named for Jedediah Strong Smith, American trailblazer and cartographer, who explored vast regions of western North America between 1822 and 1831, and along the Pacific Coast, including San Diego in December of 1826 (Brooks 1977) – the area of the type locality of the new species.

Description. *Colonial morphology* (Figures 1A, 2). The holotype consists of approximately eighty-five polyps arising from flattened basal stolons. The stolons encrust a piece of dead cheilostomatid bryozoan, 32 mm long by 20 mm wide. The surface of the bryozoan is interspersed with several calcareous tubes of a serpulid polychaete.

Polyps (Figures 1B–C). Anthosteles are moundlike, rounded, hemispherical to subcylindrical. Anthocodiae are mostly retracted within the anthosteles, although a

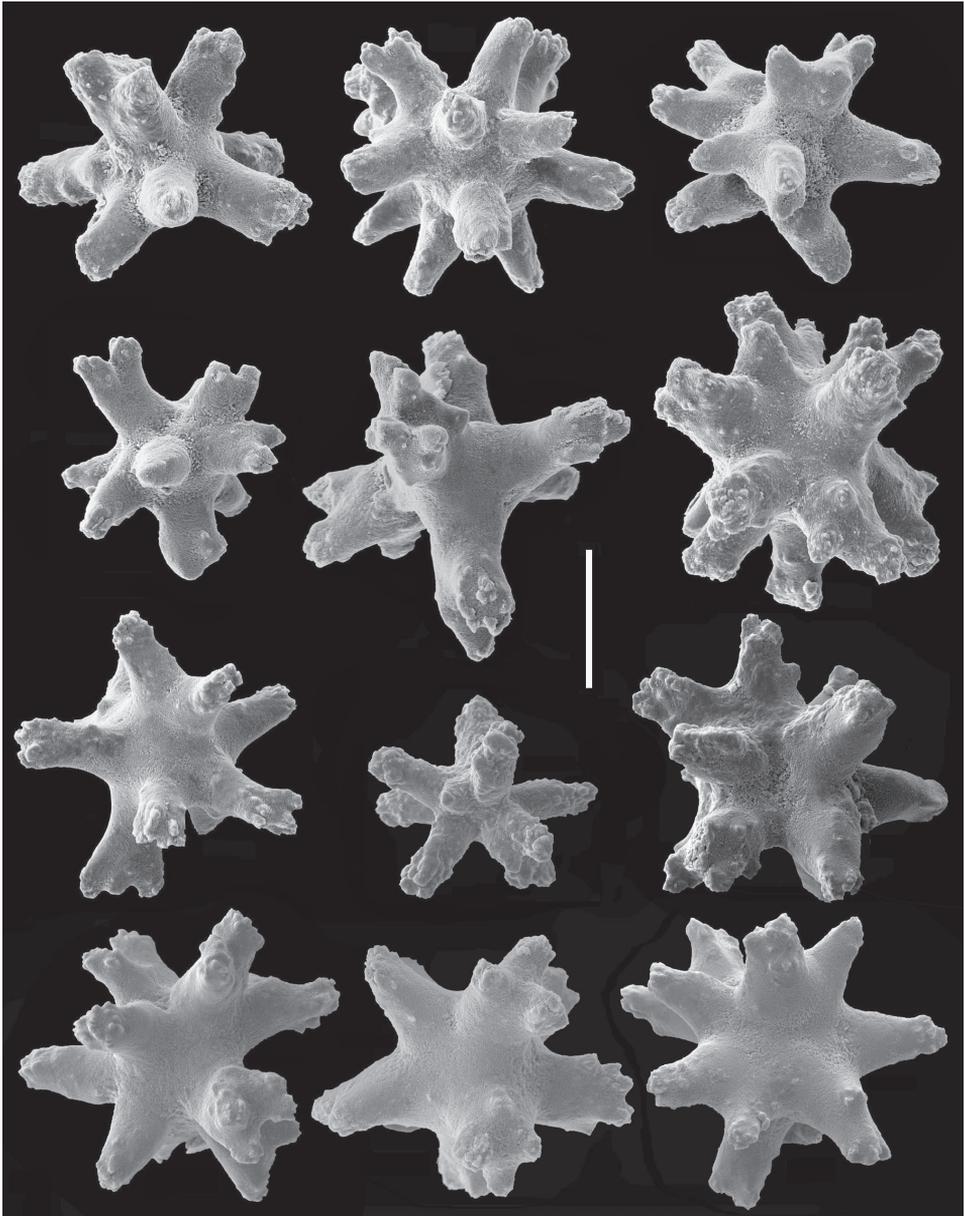


Figure 3. *Cryptophyton jedsmithi* sp. n. Scanning electron micrographs of coenenchymal sclerites from the holotype. Scale bar = 0.03 mm.

few are emergent. The anthosteles are approximately equal in height and diameter, mostly 1–1.4 mm.

Sclerites (Figures 1D–E, 3, 4). Sclerites of the coenecyeme and anthosteles resemble spiny balls or stellate bodies with projecting processes in three dimensions; 0.05 – 0.10 mm long. Sclerites are absent from the anthocodiae and polyp bodies.

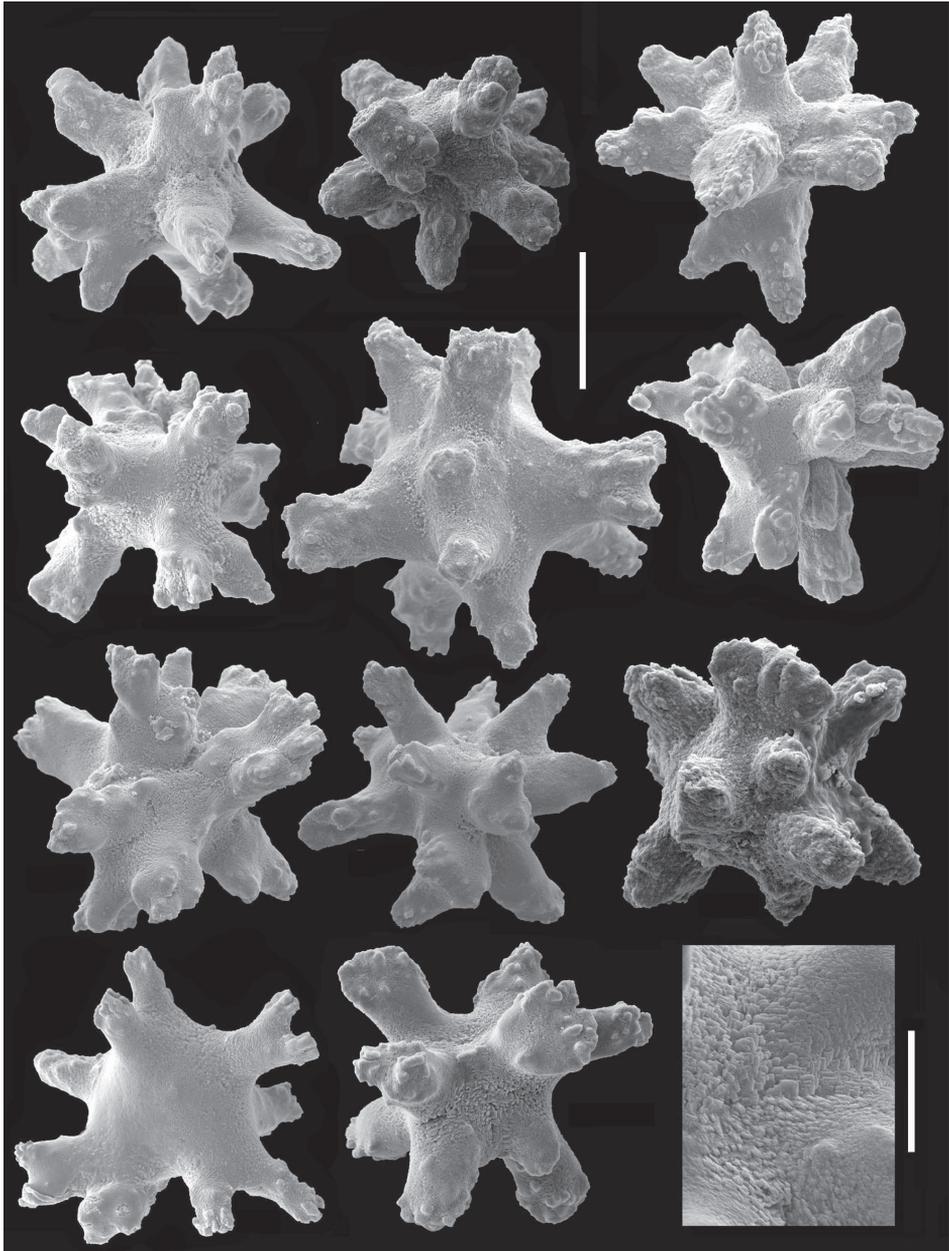


Figure 4. *Cryptophyton jedsmithi* sp. n. Scanning electron micrographs of coenenchymal sclerites from the holotype; scale bar = 0.03 mm. Lower right, ultrastructural detail from center of the sclerite to the adjacent left; scale bar = 0.01mm.

Color (Figures 1A–C). Color in life: the anthosteles are pale orange and the anthocodiae are white. Wet-preserved holotype: stolons and anthosteles light grayish white, while the emergent anthocodiae are white.

Differential diagnosis. Two species of the genus *Cryptophyton* are known, *Cryptophyton goddardi* Williams, 2000 and *C. jedsmithi* sp. n. The two species differ in sclerite shape. Those of *C. goddardi* are irregularly-shaped radiates, tuberculated rods, and shuttles (Williams 2000: 337), while those of *C. jedsmithi* sp. n. mostly resemble spiny balls or stellate bodies (Figures 1D–E, 3–4).

The geographic range of *Cryptophyton goddardi* was originally known only from the type locality of central Oregon on the Pacific Coast of the United States, but has recently been extended southwards to southern California, and has been collected at seven locations (Figure 19), while *C. jedsmithi* sp. n. is known only from the type locality – San Diego, California (Figure 19).

Key to the species of *Cryptophyton*

- 1a Anthosteles (polyp mounds) cylindrical, up to 2.8 mm in height and 1.8 mm in diameter. Sclerites are irregularly-shaped radiates, irregular sclerites presumably derived from radiates, tuberculate rods, and shuttles; 0.06–0.18 mm long..... ***Cryptophyton goddardi***
- 1b Anthosteles (polyp mounds) hemispherical, approximately equal in height and diameter, mostly 1–1.4 mm. Sclerites resemble spiny balls or stellate bodies with projecting processes in three dimensions; 0.05–0.10 mm long...
..... ***Cryptophyton jedsmithi* sp. n.**

Family Alcyoniidae Lamouroux, 1812

Genus *Alcyonium* Linnaeus, 1758

***Alcyonium* sp. indet.**

Figures 5–6

Synonymy. *Alcyonium* sp. Williams (2007: 184-185, 188); Williams and Lundsten (2009: 1078).

Material examined. CAS 179450, Canada, British Columbia, Weynton Passage, Plumper Group of islands, Plumper Island, (50°35.501'N, 126°47.997'W), 20 m depth, 10 November 2009, collector: N. McDaniel, one whole colony. CAS 173217, Canada, British Columbia, Strait of Juan de Fuca, Swordfish Island (48°18'36.4"N, 123°34'58.4"W), 6 m depth, 28 September 2009, collectors: C. Blondeau, T. Hill, R. Van Hall, one whole colony, abundant in underwater tunnel with dynamic surge. CAS 029138, U.S.A., Alaska, Arctic Ocean, near Point Barrow, 44 m depth, 29 July 1951, collector: J. Bohlke on R/V "Ivik", two whole colonies.

Taxonomic assessment. *Alcyonium* sp. indet. is known from the west coast of North America from Alaska south to British Columbia and California, and has been referred to as *Gersemia rubiformis*, *Capnella rubiformis*, or *Eunephthya rubiformis* in numerous publications (examples: Madsen 1944; Ofwegen 2012). These binomens are

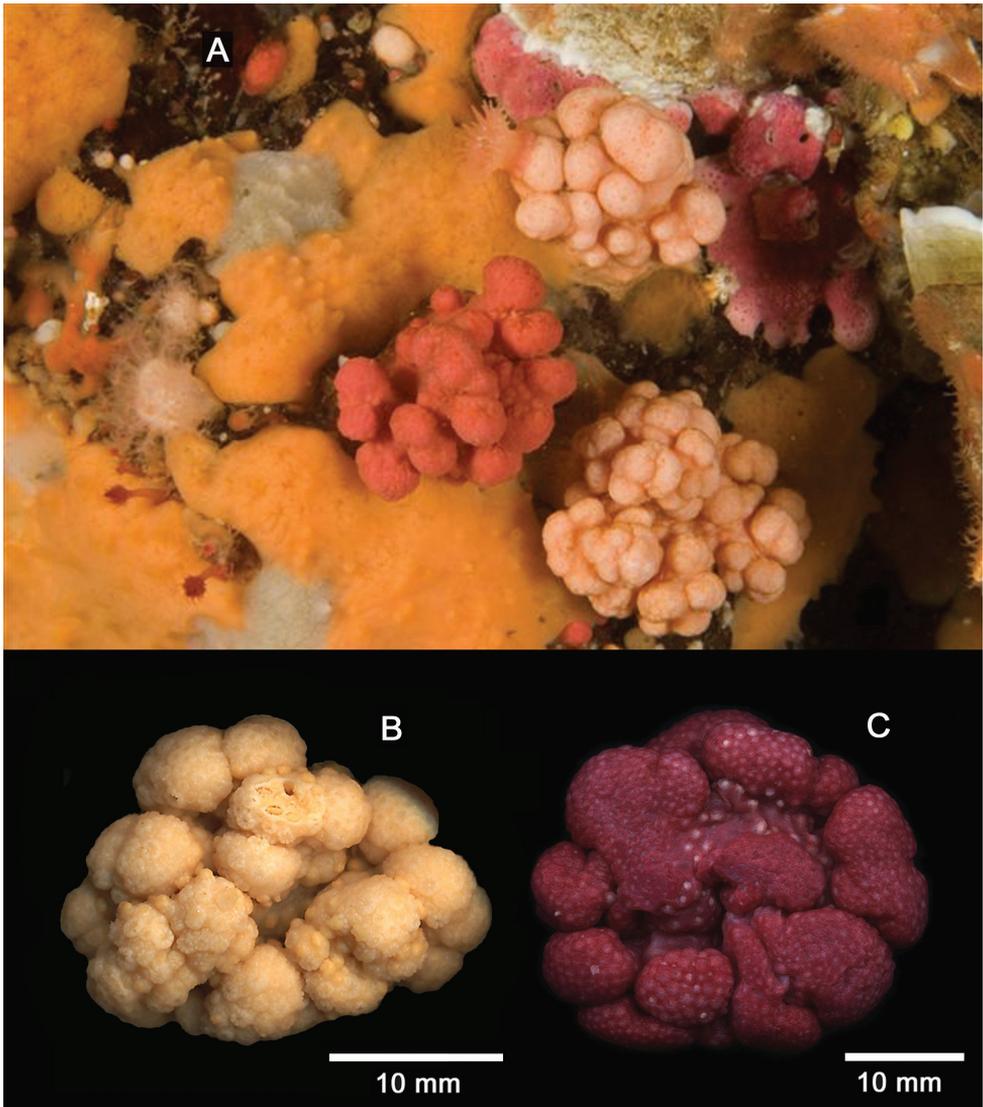


Figure 5. *Alcyonium* sp. indet. **A** Underwater photograph of orange and pale orange colonies, November 10, 2009, at Plumper Rock, Plumper Group of islands, Weynton Passage, British Columbia, Canada, GPS coordinates 50 35.495N × 126 47.998W., 20 m depth. Photo by Neil McDaniel **B** Wet-preserved white specimen (CAS 179450) **C** Wet-preserved red specimen (CAS 173217); scale bars for **B** and **C** =10 mm.

based on the entry *Lobularia rubiformis* by Ehrenberg (1834: 282). All previous references that referred to the original author of the species have noted Ehrenberg (1834) as the original source. However, on page 282 of this work, he notes that Pallas was the original author. This fact apparently has eluded the attention of subsequent authors, both in print and in electronic sources as well. Ehrenberg does not identify the date of Pallas's description, but it is known that Peter Simon Pallas published works on

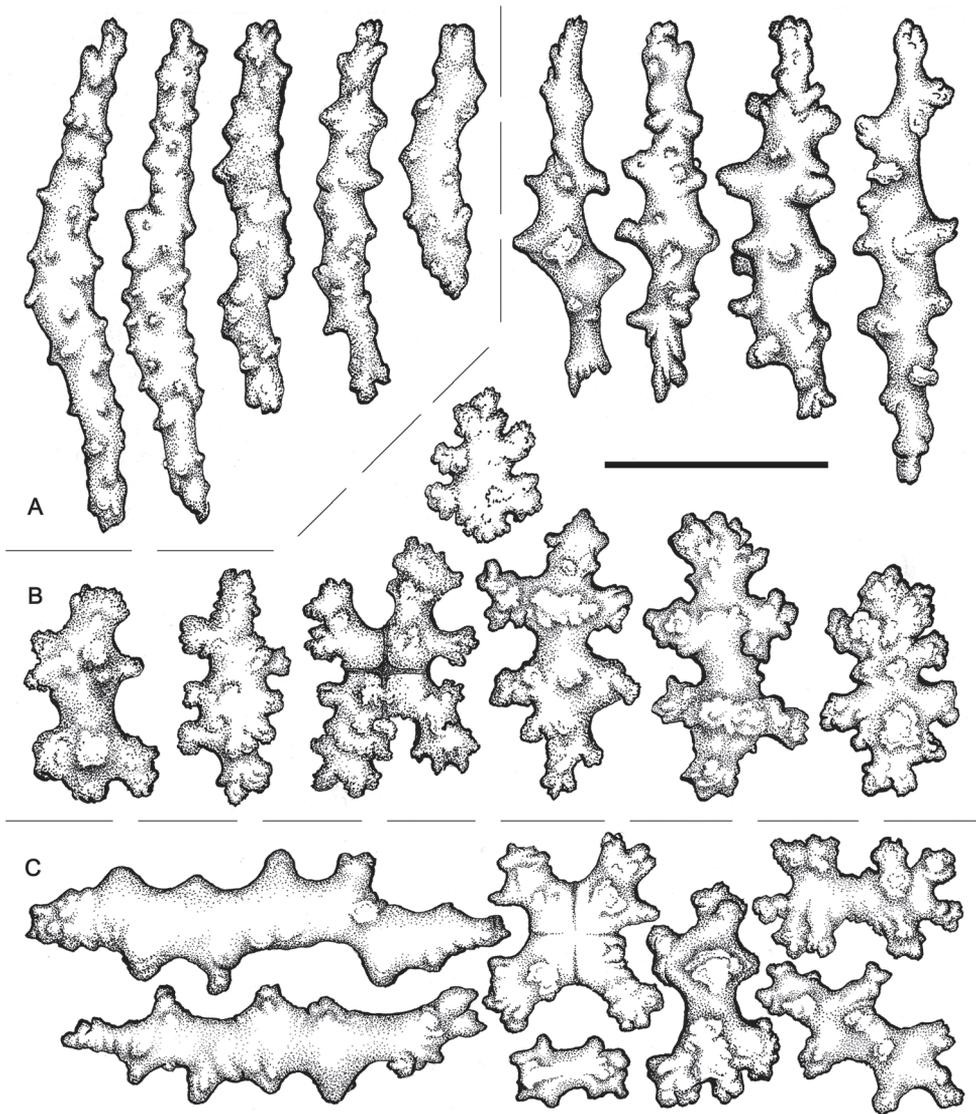


Figure 6. *Alcyonium* sp. indet. (CAS 029138). **A** Polyp sclerites **B** Coenenchymal sclerites of the polyp **C** Coenenchymal sclerites of the stalk. Scale bar = 0.10 mm.

zoophytes and corals between 1766 and 1798 (Bayer 1981a). Ehrenberg also notes the locality of *Lobularia rubiformis* as “Mari septentrionali” (= Northern Sea). Needless-to-say, this is ambiguous and could serve to describe the North Atlantic, the Arctic Ocean, or all northern seas including the North Pacific. The name *Gersemia rubiformis* has been applied to a species of soft coral that is reported to occur in polar to temperate regions of the Arctic Ocean and the northwest Atlantic Ocean from the eastern Canada south to North Carolina (Ofwegen 2012b). It has also been reported from the

North Pacific Ocean from Alaska south to California and west to Russia (Williams et al. 1987; Ofwegen 2012b).

In addition, there are other ambiguous details that are relevant here. Ehrenberg's 1834 paper is dedicated to the corals of the Red Sea, but he lists *Lobularia rubiformis* as inhabiting the "Mari septentrionali." The genus *Lobularia* is a synonym of *Cladiella*, a zooxanthellate Indo-Pacific genus that is distributed in the Red Sea as well as much of the Indo-West Pacific (Fabricius and Alderslade 2001). The genera to which this species has been identified in the literature represent two different soft coral families, the Alcyoniidae and the Nephtheidae. My examination of western North American material reveals that the species has small, completely retractile polyps and a polyp arrangement that is lobate rather than catkin-like (even though there may be few to no polyps on the lower parts of the expanded lobes). In addition, the northeastern Pacific material (Figure 5) exhibits morphological similarities to other species of *Alcyonium*, as previously described and illustrated (Verseveldt and Ofwegen 1992; Casas et al. 1997; Ofwegen et al. 2007). The general appearance of the sclerites of *Alcyonium* sp. indet. (Figure 6) are consistent with other species of the genus as well. I therefore here align the species to the Alcyoniidae, rather than the Nephtheidae.

Recent molecular phylogenetic evidence shows that there are two species included in *Gersemia* that nest in the genus *Alcyonium*, rather than with other nephtheids (Breedy et al. 2012: 357). In light of this, future research may show that other species previously allocated to *Gersemia* may in fact belong to *Alcyonium*. It is not known if a type specimen of *Lobularia rubiformis* was ever designated. From the aforementioned, it is here considered that the Pacific coast material cannot justifiably be ascribed to *Gersemia rubiformis* and the validity of that species cannot be determined at present. Because of this, the Pacific coast species is considered as an unidentified species of the genus *Alcyonium* (Williams 2007: 184–185, 188; Williams and Lundsten 2009: 1078). It is evident that a taxonomic revision and determination of the validity of *Gersemia rubiformis* is necessary, and that molecular studies of samples from various populations in the Atlantic, Arctic, and Pacific Oceans may provide a clearer understanding regarding taxonomic status.

Family Nephtheidae Gray, 1862

Genus *Gersemia* Marenzeller, 1878

Gersemia lambi sp. n.

urn:lsid:zoobank.org:act:C2BFCF41-3F55-43FA-9858-9FFC2543E0ED

http://species-id.net/wiki/Gersemia_lambi

Figures 7–11, 19

Species diagnosis. Polyps clustered in groups on short lobes, emanating from short stalk above holdfast. Polyps tubular, curved, non-retractile, relatively large. Sclerites primarily radiates with variable ornamentation and modification of tuberculation; rod-like forms also present. Colonies pink in life, white preserved.

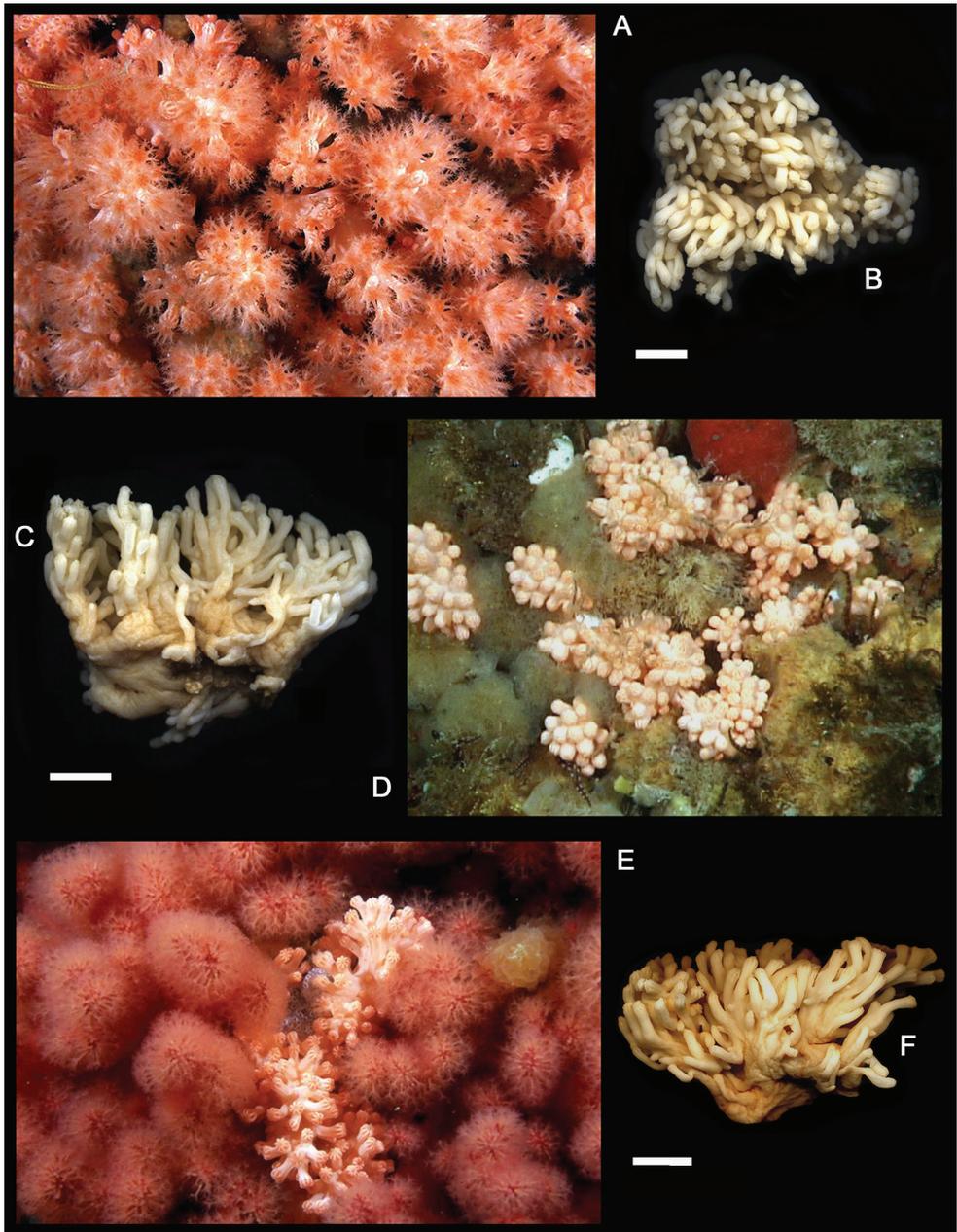


Figure 7. *Gersemia lambi* sp. n. **A** Underwater photograph of colonies with polyps fully expanded; photo courtesy Marc Chamberlain **B** Wet-preserved holotype, dorsal view; scale bar = 10 mm **C** Wet-preserved holotype, lateral view; scale bar = 10 mm **D** Underwater photograph of colonies with polyps retracted; photo courtesy Neil McDaniel **E** Underwater photograph of colonies with polyps retracted (center); photo courtesy Marc Chamberlain **F** Wet-preserved paratype, lateral view (CAS 171941); scale bar = 10 mm.

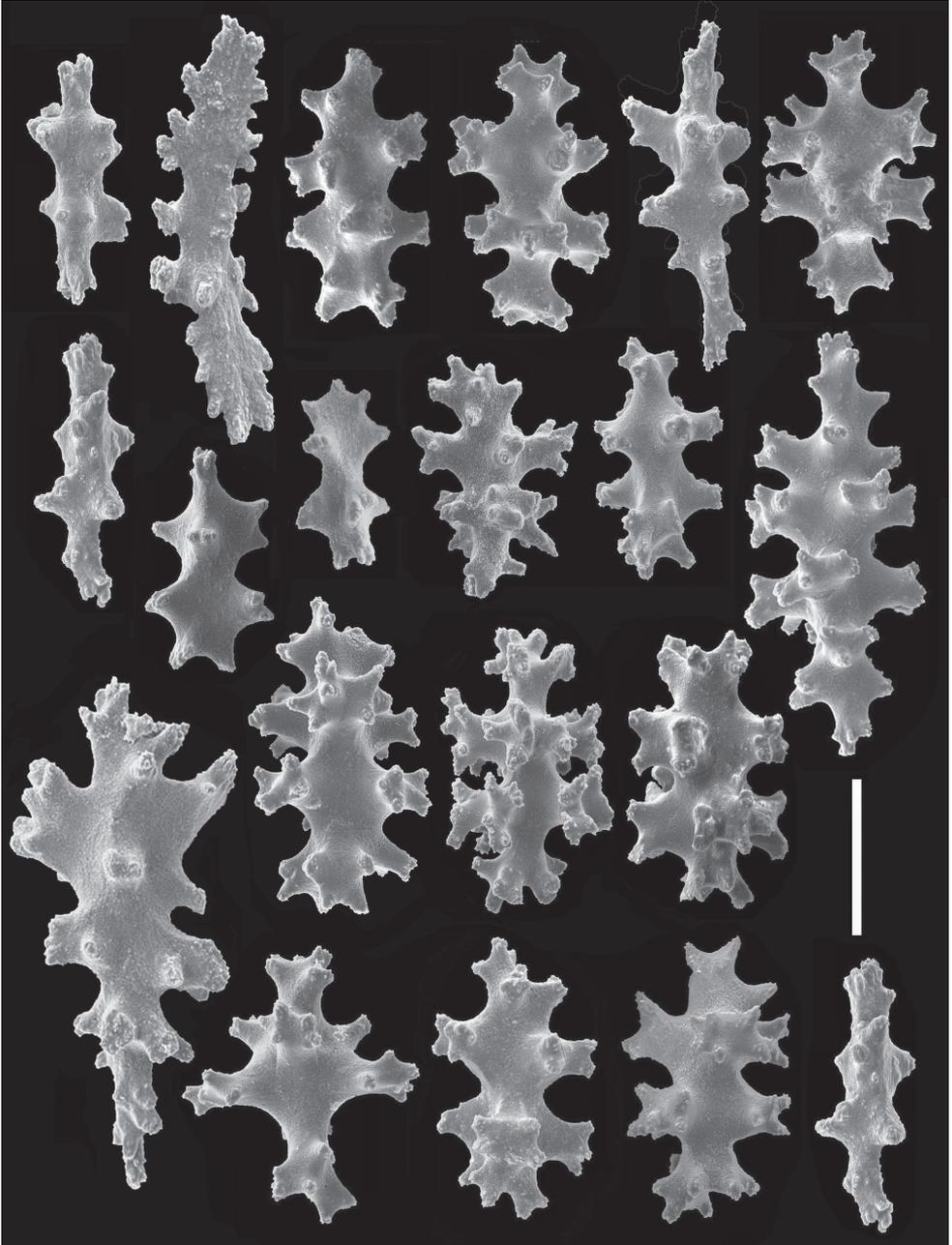


Figure 8. *Gersemia lambi* sp. n. Scanning electron micrographs of polyp sclerites. Scale bar = 0.04 mm.

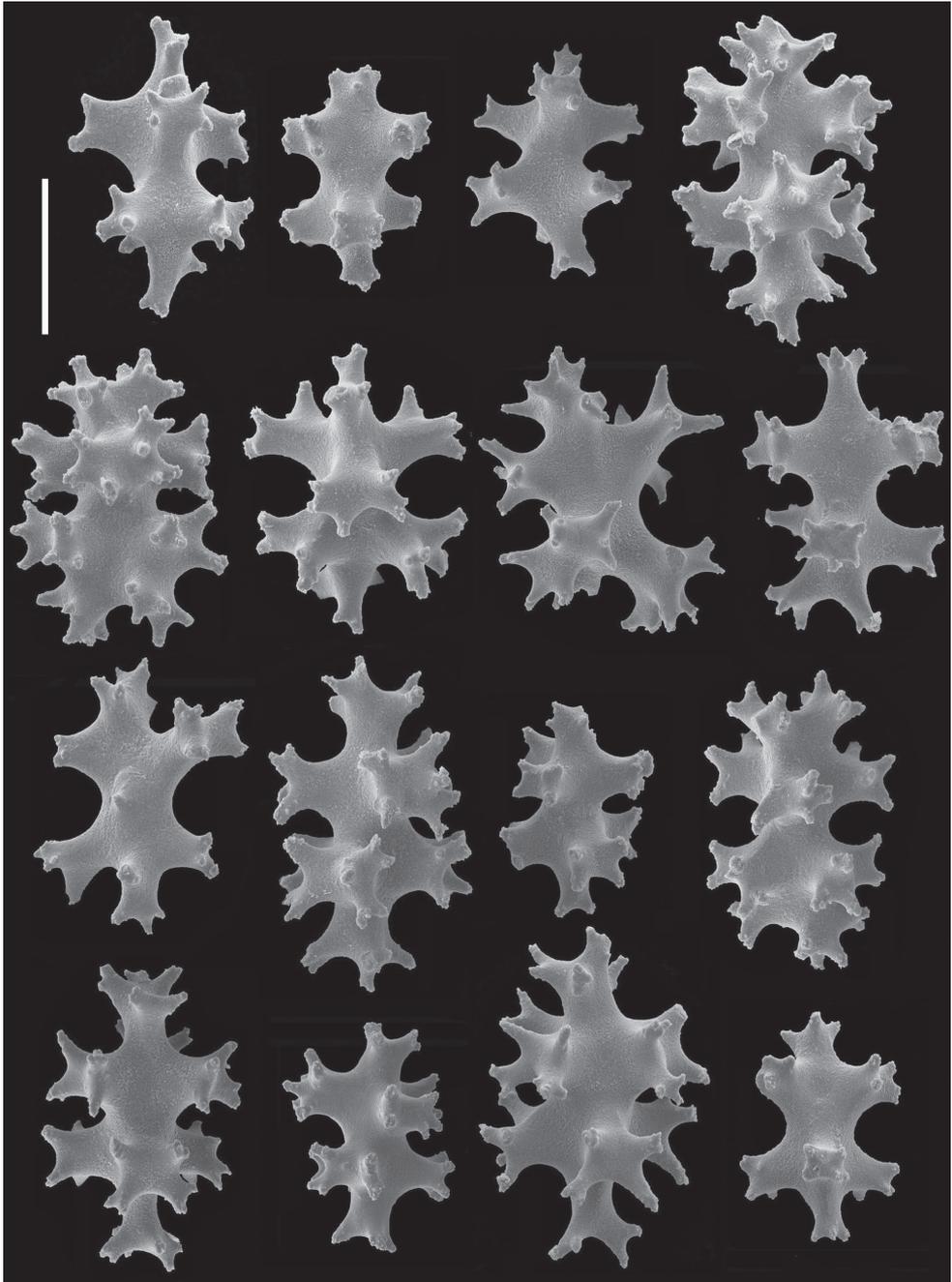


Figure 9. *Gersemia lambi* sp. n. Scanning electron micrographs of sclerites of the polypary coenenchyme. Scale bar = 0.04 mm.

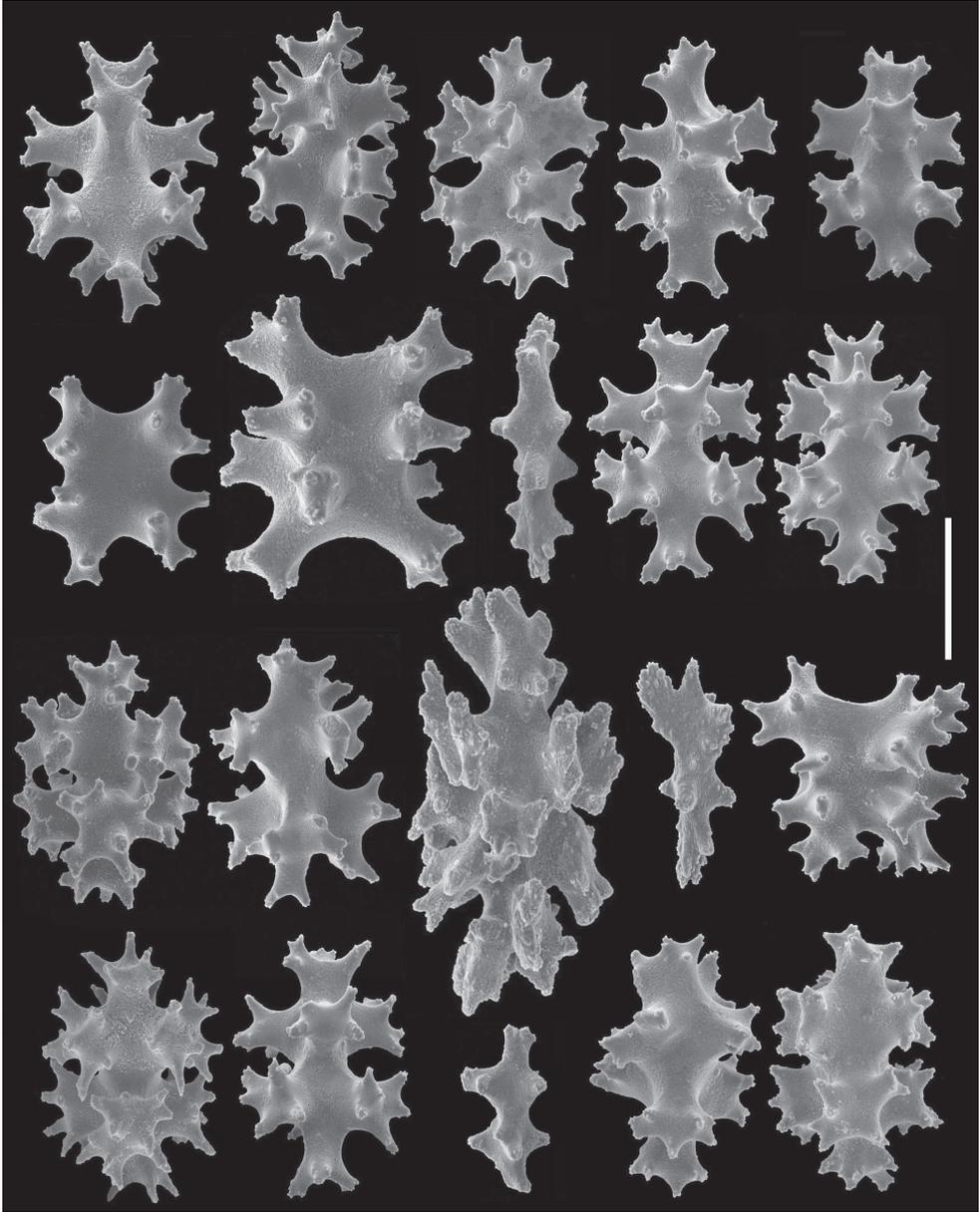


Figure 10. *Gersemia lambi* sp. n. Scanning electron micrographs of stalk sclerites. Scale bar = 0.04 mm.

Type material. Holotype. CAS 171939, Canada, British Columbia, Langara Island; 26 June 2004; 12 m depth, collected by Andy Lamb; one specimen. Paratypes. CAS 171940, same data as holotype, one specimen. CAS 171940, same data as holotype, one specimen.

Additional material. CAS 179449, same data as holotype, 11 specimens. CAS 173218. Canada, British Columbia, east side of Kerouard Island, off south end of

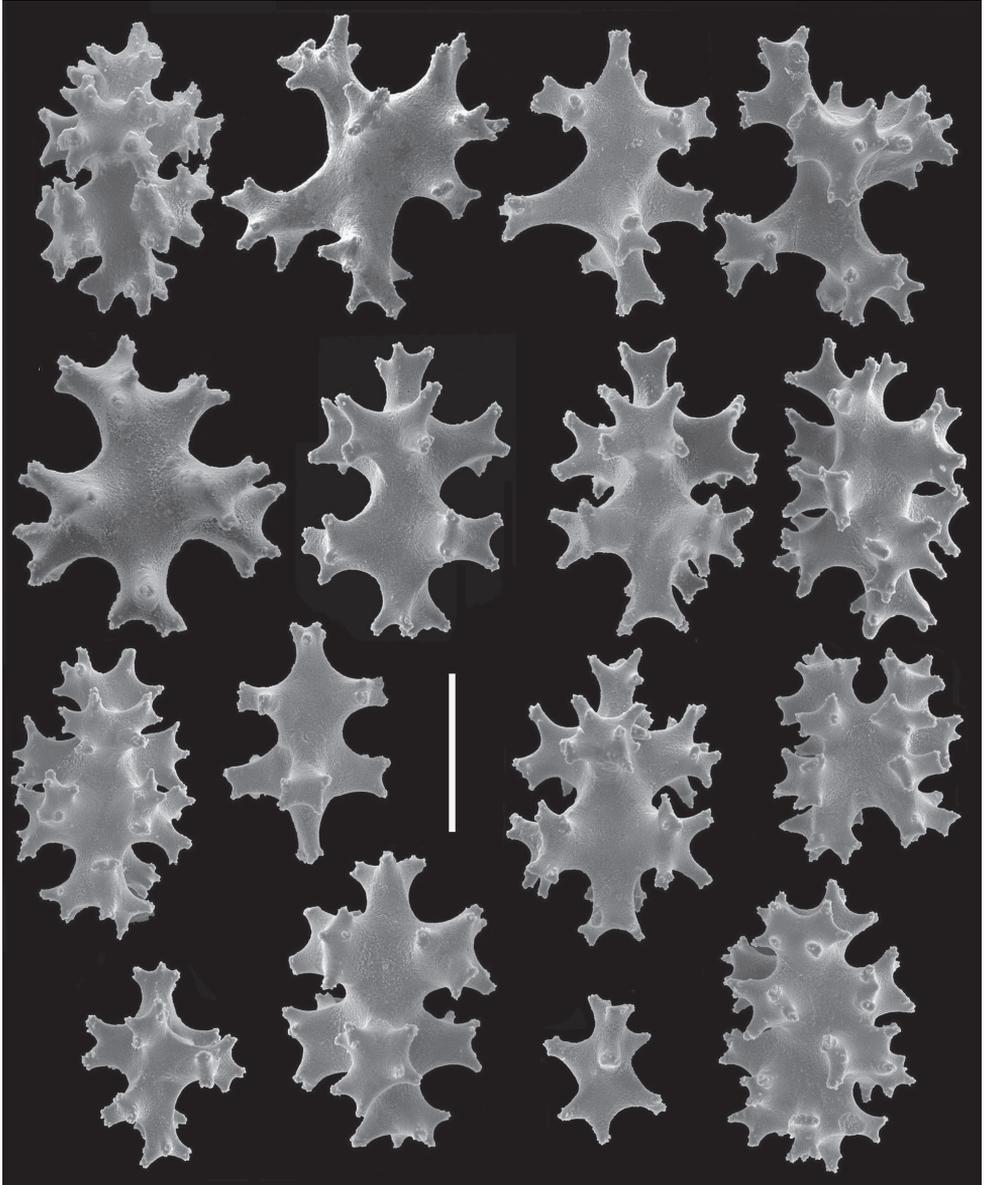


Figure 11. *Gersemia lambi* sp. n. Scanning electron micrographs of stalk sclerites. Scale bar = 0.04 mm.

Queen Charlotte Island; 9 m depth, 51°54.624'N, 130°58.635'W; 7 August 2003; 20 m depth; collected by Doug Swanston; one specimen. CAS 173219. Canada, British Columbia, Queen Charlotte Islands, Kunghit Island, west side of Cape St. James; 21 May 2002; 9 m depth; collected by Danny Kent; one specimen.

Habitat and distribution (Figure 19). Shallow subtidal region from Cape Omaney, southeast Alaska, USA (according to Neil McDaniel, pers. comm.), to central British Columbia, Canada; 9–20 m depth.

Etymology. This species is named for marine naturalist and educator Andy Lamb (Vancouver, British Columbia), who collected the type material.

Description. *Colonial morphology* (Figures 7B-C). The holotype measures 55 mm in length, 39 mm in width, and 35 mm in height. It is composed of dense concentrations of autozooids distributed in isolated clusters on several lobes that emanate from the stalk, which arises immediately above the basal holdfast. Each cluster usually contains approximately 5 and 15 polyps.

Polyps (Figures 7B–C,F). The polyps are monomorphic, non-retractile, tubular in shape, and vary in length and width (4.0–7.0 mm in length and 1.5–2.0 mm in width). The width of the polyps is greatest at the distal extremities. The polyps are erect and often curve upward from their bases.

Sclerites (Figures 8–11). Coenenchymal sclerites of the polypary are primarily sharply-tuberculated radiates, 0.03–0.11 mm. Coenenchymal sclerites of the stalk are mostly variously-ornamented radiates and modified radiates, 0.03–0.12 mm long. Polyp wall sclerites abundant, uniformly and densely-distributed, 0.03–0.13 mm in length, mostly variably-shaped radiates and rods with a few irregularly-shaped elongate forms and crosses. Tentacle sclerites densely and uniformly distributed (not arranged *en chevron*), mostly radiates and rods, although a few club-shaped or approach torch-like forms are also present.

Color (Figures 7A–D,E). Colony color is pink to reddish in life, often with orange oral discs. Colonies are uniformly cream-white in color when preserved in ethanol.

Differential diagnosis. The only other species known in the genus *Gersemia* from the Pacific Coast of North America is *Gersemia juliepackardae* Williams & Lundsten, 2009. Although coenenchymal sclerites of the two species are predominantly eight radiates, *G. juliepackardae* and *G. lambi* sp. n. differ markedly in surface feature characters. Those of *G. juliepackardae* are narrow with slender medial waists and relatively rounded tubercle tips (Williams and Lundsten 2009), while those of *G. lambi* sp. n. are broad with wide medial waists and more acute tubercle apices (Figures 8–11).

This species is distributed from Washington to southern California, while *G. lambi* is known from southern Alaska to British Columbia. The two species differ markedly in their bathymetric distributions. Collected material of *Gersemia juliepackardae* is recorded between 888 to 1600 meters in depth, although video images record the species from 520–2034 meters (Williams and Lundsten 2009). *Gersemia lambi* sp. n., on the other hand, is known at present only from a depth range of 9-20 meters.

Key to the species of *Gersemia* from the west coast of North America

- 1a Alcohol-preserved polyps cylindrical, straight, 4.5–5.5 mm long by 1.2–1.5 mm wide. Sclerites of the distal half of polyps are red, all other sclerites colorless. Color of preserved colonies white with pink distal regions of polyps..... *Gersemia juliepackardae*
- 1b Alcohol-preserved polyps tubular in shape, often curved, 4.5-8.0 mm long by 1.5–2.0 mm wide. All sclerites are colorless. Color of preserved colonies is white throughout..... *Gersemia lambi* sp. n.

Family Plexauridae Gray, 1859

Genus *Chromoplexaura* gen. n.

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<http://species-id.net/wiki/Chromoplexaura>

Figures 12–17, 19

Generic diagnosis. Plexaurid gorgonians. Colonies tall, erect, planar. Branching lateral from single basal stem. Upper branches relatively sparse, slender, elongate, mostly slightly curved. Retracted polyps as numerous low rounded protuberances all round surfaces of branches and stem. Sclerites mostly robust spindles and radiates, some ellipsoid to sub-spherical in shape.

Type species. *Euplexaura marki* Kükenthal, 1913.

Etymology. The generic name is derived from the Greek *chroma* (color), and the gorgonian generic name *Plexaura*, in reference to the vivid color of the colonies.

Systematics and phylogenetic assessment. The genus *Euplexaura* (Figures 12D, 18) is an Indo-Pacific genus (eastern Africa to the central Pacific) of 37 named species (Ofwegen 2012a), with the number of valid species not determined. The surface coenenchyme contains numerous robust ovoid to subspherical sclerites (Fabricius and Alderslade 2001). All sclerites are colorless. Since *E. marki* differs in these several respects to the genus to which it was originally described, a new genus is here named to accommodate it.

A comparison is also warranted between *Chromoplexaura* and two plexaurid genera that share some superficial similarities – *Thesea* with 31 described species from the Atlantic Ocean (Deichmann 1936: 110; Humann and DeLoach 2002: 78; Ofwegen 2012d), and *Swiftia* with 14 described species from the Atlantic and eastern Pacific (Deichmann 1936: 185; Goldberg 2001: 100; Humann and DeLoach 2002: 65; Ofwegen 2012c). It is yet to be determined if the Pacific species presently allocated to *Swiftia* do indeed belong to that genus or another one. The polyps of *Swiftia* emanate from calyx-like protuberances, and both *Thesea* and *Swiftia* have a preponderance of narrow/elongate to robust spindles. The sclerite complements of both genera are composed mostly of spindles with few to no radiates present. On the other hand, the sclerite complement of *Chromoplexaura* is comprised primarily of radiates and variably-shaped spindles.

Forty five genera of the holaxonian family Plexauridae are currently considered valid (Williams and Cairns 2011). Molecular phylogenetic studies have shown that the resolution necessary to produce a molecular phylogeny of the octocorals is lacking at present, due to slow rate of mitochondrial gene changes and a paucity of markers necessary to distinguish some taxa. Regarding future research, it is anticipated that ITS2 sequence data will produce improvements regarding better resolution and more credible results (McFadden et al. 2006, McFadden et al. 2010, Wirshing et al. 2005).

Currently, the evidence based on molecular data does not support the family as being a monophyletic one, but rather has shown many genera dispersed throughout



Figure 12. Plexaurid gorgonians, entire colonies. **A, C** *Chromoplexaura marki* (CAS 173222) **B, F, G** *Chromoplexaura marki* (CAS 096746) **D** *Euplexaura* sp. (CAS 107595.) **E** *Chromoplexaura marki* (CAS 168895). Scale bars = 50 mm.

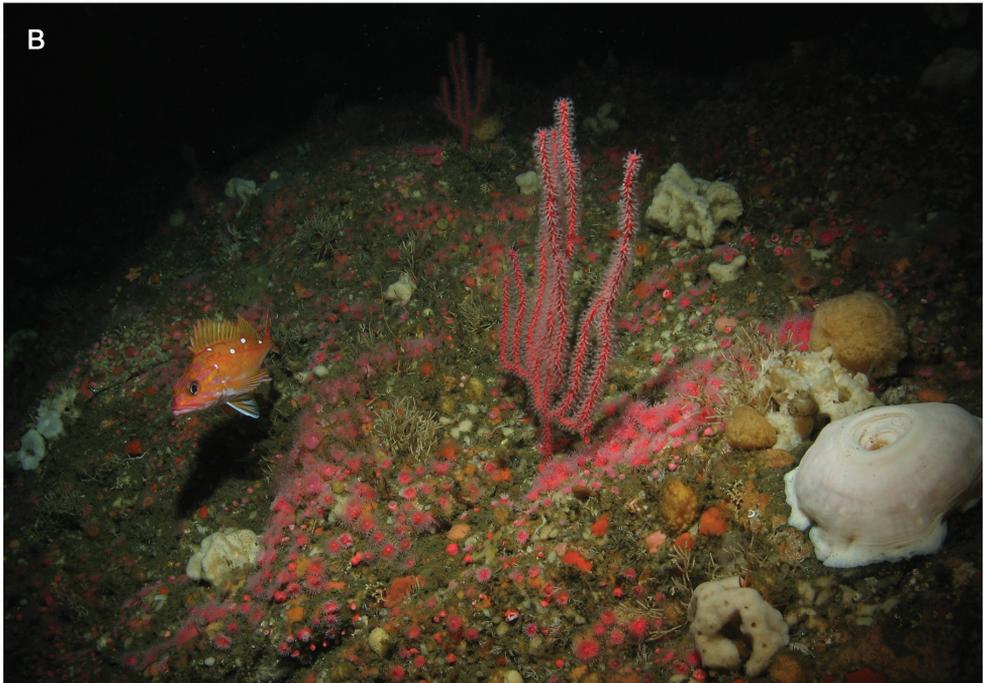
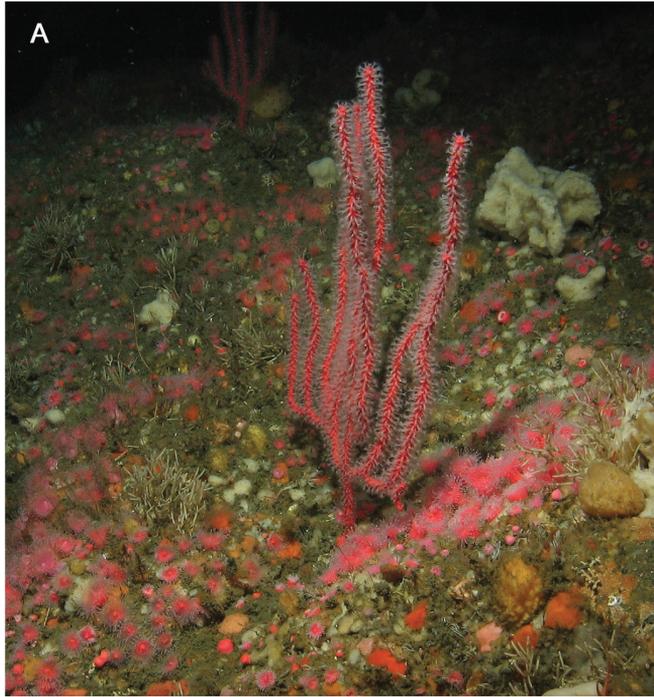


Figure 13. *Chromoplexaura marki*, two living colonies *in situ*. **A** Detail of two gorgonians **B** Wide angle view showing the area inhabited by the colonies. Rittenburg Bank, Gulf of the Farallones National Marine Sanctuary, California, 83 m depth. Photo courtesy: NOAA (National Oceanic and Atmospheric Administration).

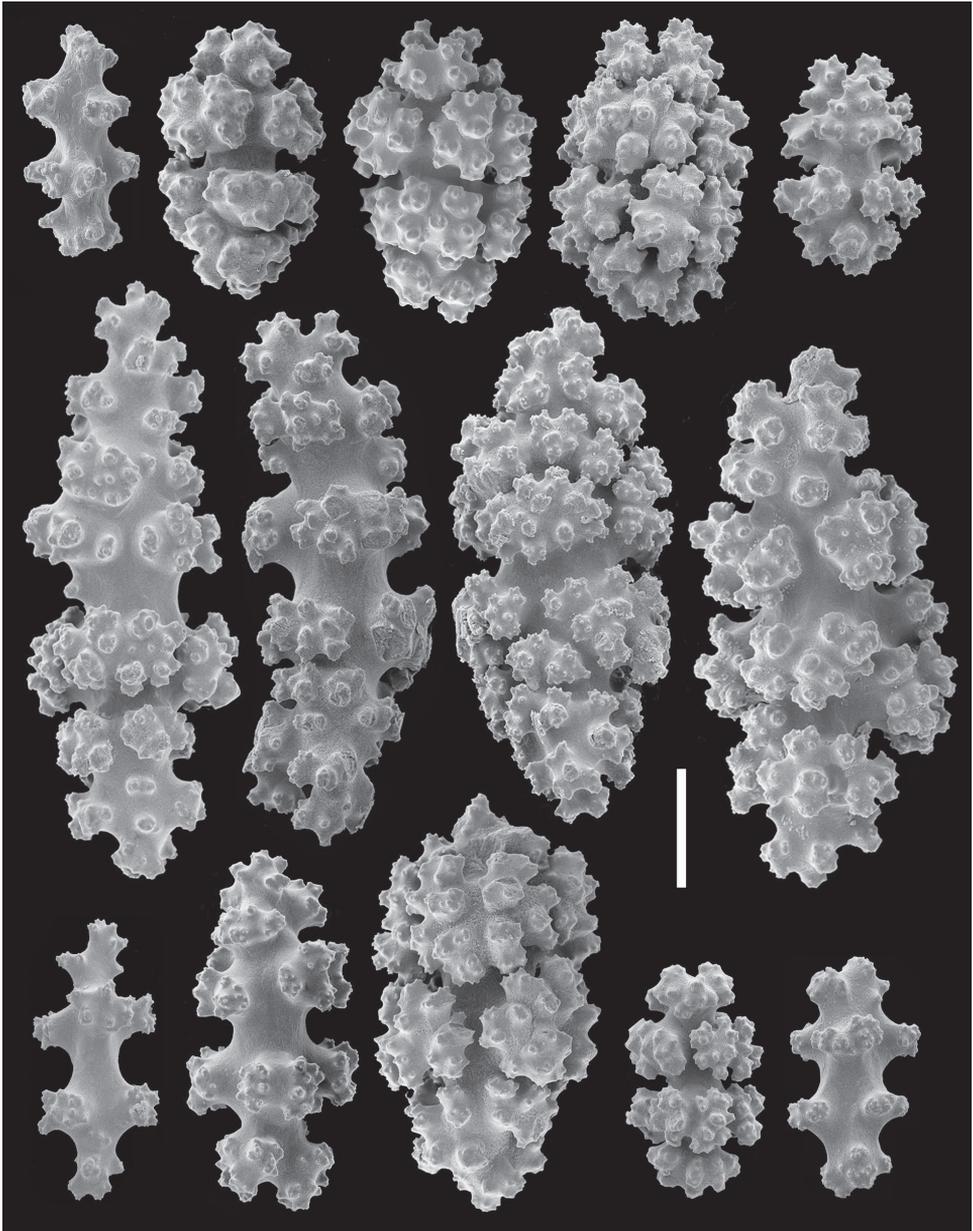


Figure 14. *Chromoplexaura marki* (CAS 096746). Scanning electron micrographs of coenenchymal sclerites. Scale bar = 0.04 mm.

richly-populated phylogenetic trees, and do not exhibit close affinities as a group. In some cases, plexaurid genera have even appeared associated with genera in other families (McFadden et al. 2006; Wirshing et al. 2005). At present, it is therefore not possible to produce a plausible topology of phylogenetic relationships for such genera as *Euplexaura*, *Swiftia*, *Thesea* and *Chromoplexaura* gen. n.

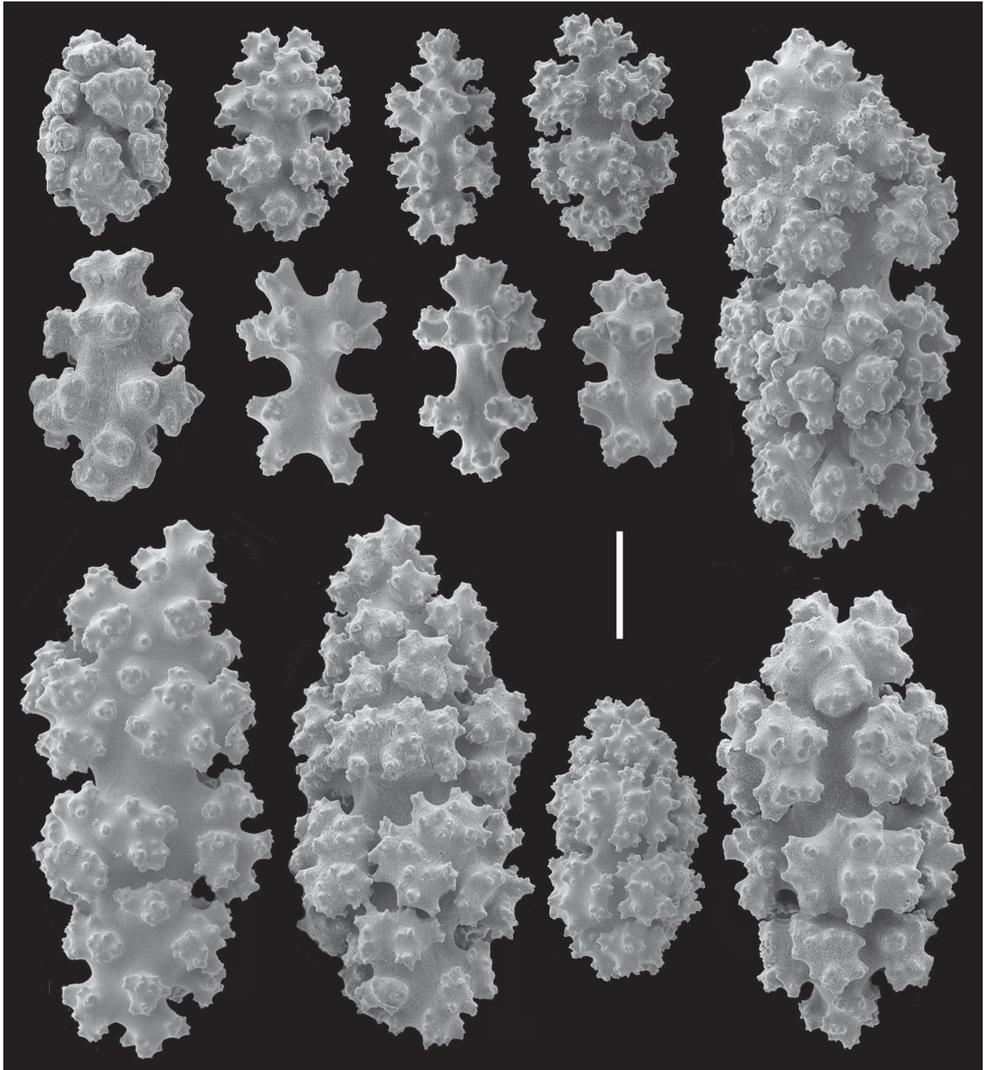


Figure 15. *Chromoplexaura marki* (CAS 096746). Scanning electron micrographs of coenenchymal sclerites. Scale bar = 0.04 mm.

Key to the genera *Chromoplexaura* and *Euplexaura*

- 1a Colony color red, formed by permanent red coloration of sclerites. Sclerites are mostly radiates and spindles, <math><0.10\text{--}0.25\text{ mm}</math> long. One species, temperate Eastern Pacific (California to Oregon).....*Chromoplexaura*
- 1b Colony color highly variable, often formed by alcohol-soluble pigments, sclerites colorless. Sclerites are robust ovals to subspheroids and plump spindles, $\geq 0.10\text{--}0.30\text{ mm}$ long. Approximately 36 described species, tropical Indo-West Pacific (East Africa to Western Pacific)*Euplexaura*

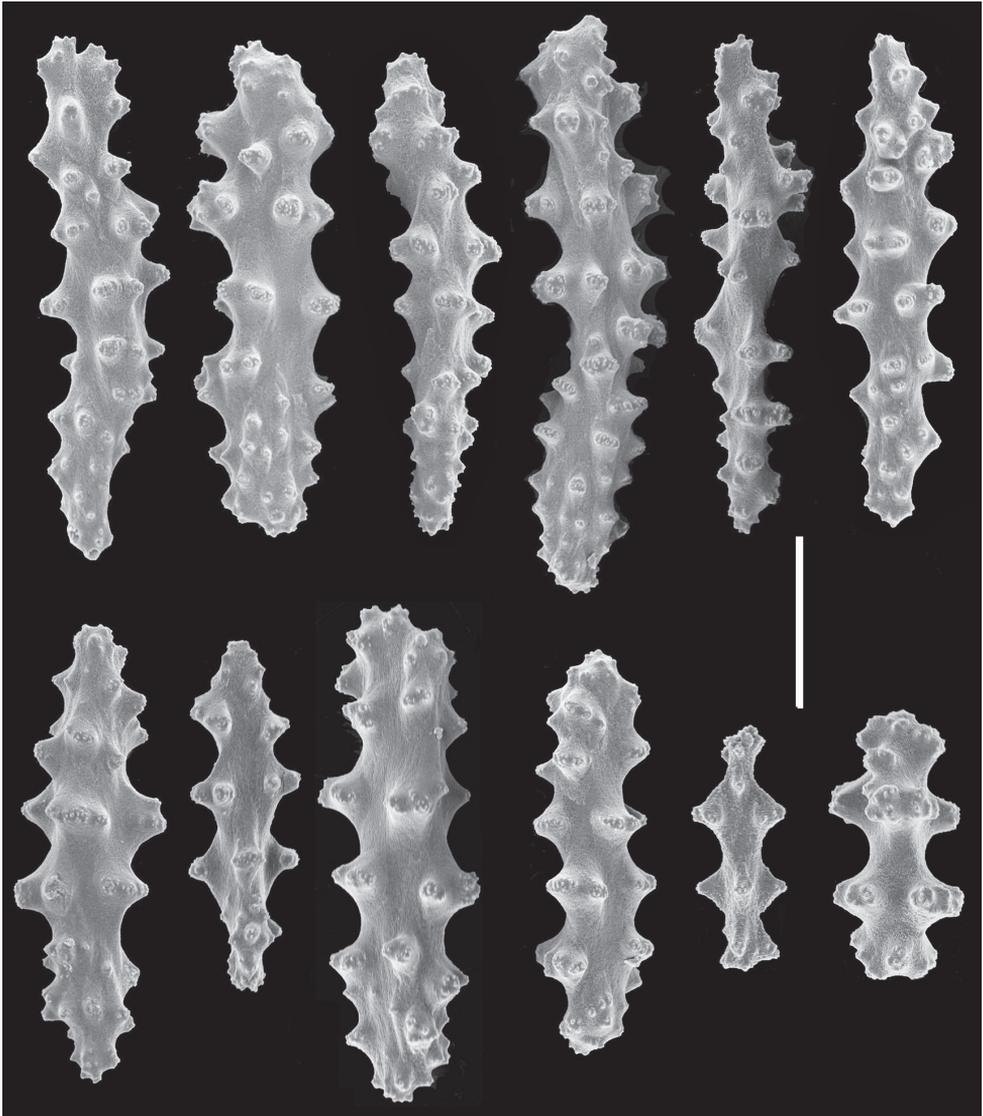


Figure 16. *Chromoplexaura marki* (CAS 168895). Scanning electron micrographs of the polyp sclerites. Scale bar = 0.04 mm.

***Chromoplexaura marki* (Kükenthal, 1913)**

http://species-id.net/wiki/Chromoplexaura_marki

Figures 12–17

Synonymy. *Euplexaura marki* Kükenthal 1913: 266; Kükenthal 1924: 93–94; Ofwegen 2012a.

Material examined. CAS 096746, California, Monterey Carmel Bay off San Jose Creek Beach (Monastery Beach), 38 m depth, 20 May 1962, coll. Dennis Sullivan, five

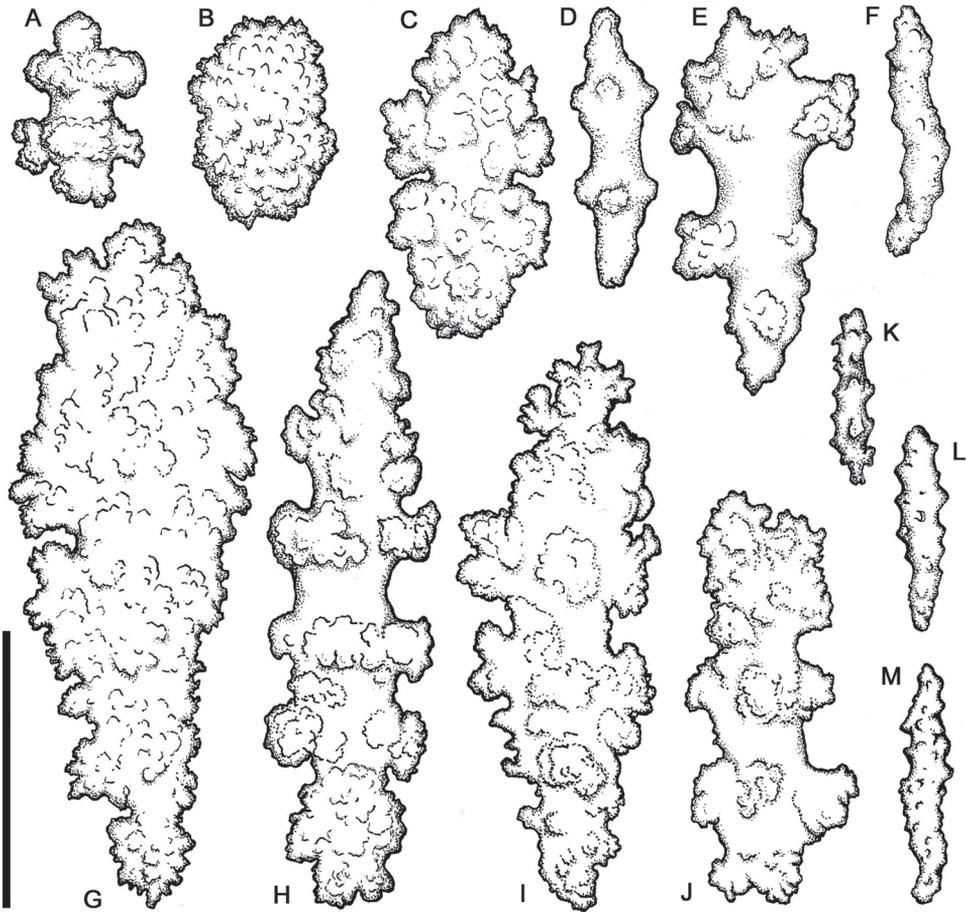


Figure 17. *Chromoplexaura marki*. Variation in sclerite form. **A, B, D, E, F, H, L, M** (CAS 096766) **C, G, I, J, K** (CAS 173222). Scale bar = 0.10 mm.

whole colonies. CAS 173222, California, Monterey Bay, Carmel Bay (Monterey Bay Marine Sanctuary), 32 m depth, 22 September 2010, coll. Karen Grimmer, two whole colonies. CAS 168895, California, (Gulf of the Farallones National Marine Sanctuary, Rittenburg Bank), 85 m depth, 8 October 2012, coll. National Oceanic and Atmospheric Administration, one whole colony.

Description. *Colonial morphology* (Figures 12–13): The predominantly proteinaeous central axis has a hollow core. The main stem above the holdfast varies from 50–120 mm in length. The ultimate branches measure 10–115 mm in length by 2.5–4.0 mm wide. The distal extremities are acute to rounded and often slightly swollen compared to the uniform width of the rest of the branches.

Polyps (Figures 12–13). Most of the polyps are fully retractile and form low rounded to hemispherical protuberances that are distributed on all sides of the branches. Some polyps are partially exserted and are <1.0 mm in width. Autozoid walls with

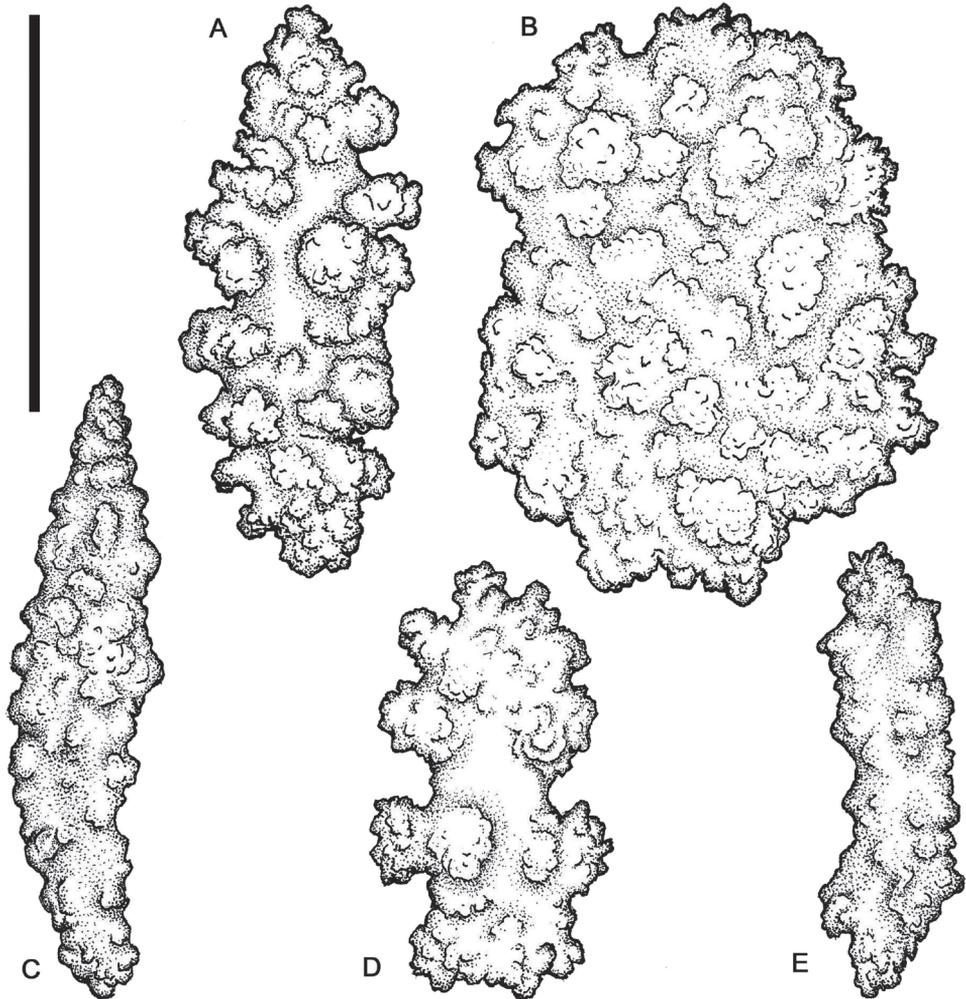


Figure 18. *Euplexaura* sp. (CAS 107595). **A, B, D** Coenenchymal sclerites **C, E** Polyp sclerites. Scale bar = 0.10 mm.

eight longitudinal rows of densely-set, more-or-less *en chevron* sclerites that give rise to narrow points in the middle of each tentacle.

Sclerites (Figures 14–17). The coenenchymal sclerites are radiates, robust spindles, and ovoid forms with highly variable tuberculation, 0.06–0.24 mm in length (Figures 14, 15, 17A–E, G–J). Some are robust and subspherical to ellipsoid with numerous and less well-pronounced tubercles. The sclerites of the polyp wall and points are heavily tuberculated spindles and rods, 0.04 mm–0.09 mm in length (Figures 16; 17F, K, L, M).

Color (Figures 12–13). The color of the colonies is similar in life or preserved, the coenenchyme is uniformly-colored orange-red to vivid red, while the exsert polyps are

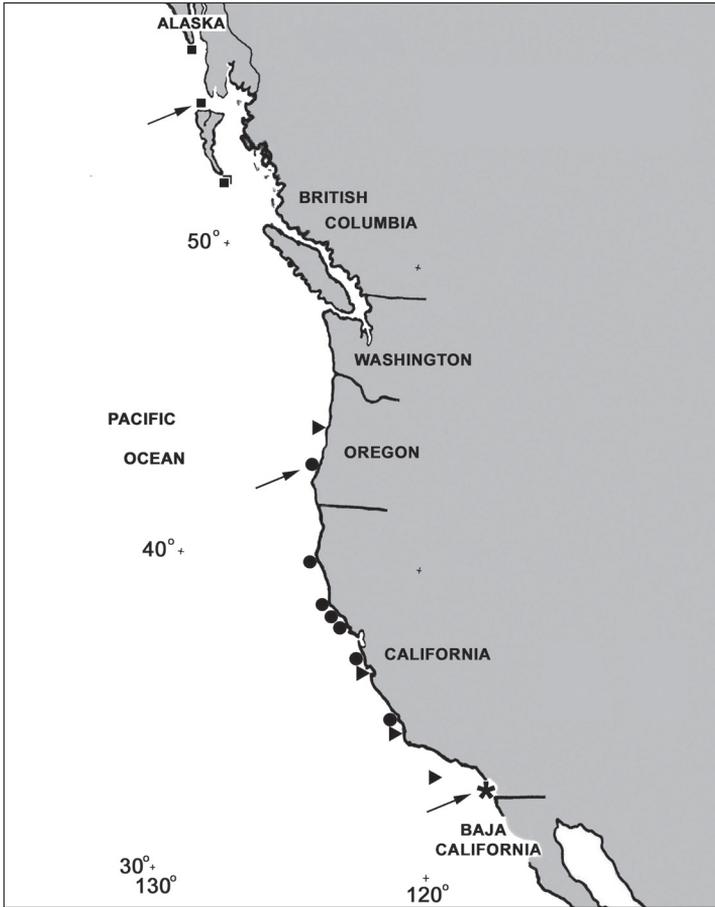


Figure 19. Map of the North American Pacific coast showing collecting localities for *Cryptophyton jed-smithi* sp. n. (*), *Cryptophyton goddardi* (●), *Chromoplexaura marki* (▲), and *Gersemia lambi* sp. n. (■). Arrows designate type localities.

white (Figure 11E). The coenenchymal sclerites are red-orange, while the polyp wall and points sclerites are colorless.

Distribution (Figure 19): Central Oregon to southern California; 9 to at least 90 m depth.

Biology and associated species. Several of the colonies in lot 096746, have enlargements on the branches that resemble gall-like growths, which contain epizoid barnacles of the genus *Conopea* (pers. comm., R. Van Syoc, California Academy of Sciences).

Discussion and conclusion

In spite of the fact that the marine fauna of the west coast of the United States is relatively well known with a plethora of marine laboratories dotting the coast, as well as an

abundance of well known and excellent manuals and field guides describing the fauna (Morris et al. 1980; Ricketts and Calvin 1985; Niesen 1994; Carlton 2007; Gotshall 2005; Lamb and Hanby 2005), the octocoral fauna is still largely only minimally studied. Perhaps the main factor responsible for this is that although a number of species have been described since the late 19th and early 20th centuries, the essential revisionary systematics necessary for ascertaining valid taxa, has been unfortunately ignored. As an example, the generic designation (*Euplexaura*) for a common plexaurid gorgonian from California and Oregon has been misapplied for the past century (1913–2013). The new genus *Chromoplexaura* is here named to provide a valid designation for the binomen *C. marki*.

In addition, two new species of octocorals are here described from recently collected material in the intertidal zone of southern California and in shallow subtidal regions of British Columbia and southern Alaska.

Acknowledgements

I am grateful to Jeff Goddard, Neil McDaniel, Andy Lamb, Marc Chamberlain, Doug Swanston, Danny Kent, and Pauline Ridings for their observations, and for providing photographic images and octocoral material. I thank Jei-Ying Chen (California Academy of Sciences, San Francisco) for help in the preparation of scanning electron micrographs.

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A new species of *Megachile* Latreille subgenus *Megachiloides* (Hymenoptera, Megachilidae)

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Abstract

A new species of leafcutter bee, *Megachile* (*Megachiloides*) *chomskyi*, is described from Texas, United States. *Megachile chomskyi* is one of the four known species of the *oenotherae* species group of *Megachiloides*, all members sharing the long tongue, and is most similar to *M. (Megachiloides) amica* Cresson. Like other members of the *oenotherae* species group, this species probably shows oligolecty with Onagraceae (Evening-Primrose Family). A diagnosis, full description of both sexes and a key to the species of the *oenotherae* species group are provided.

Keywords

Apoidea, Anthophila, Megachilinae, Onagraceae, Texas, *Megachile chomskyi*

Introduction

The subgenus *Megachiloides* Mitchell is the largest in North American *Megachile* Latreille, with just under 60 described species (Michener 2007; with recent synonymies in Sheffield et al. 2011) ranging from southern Canada (Saskatchewan to British Columbia) to northern Mexico. Originally, Mitchell (1924) proposed the genus *Megachiloides* to include one species, *M. oenotherae* Mitchell, which was morphologically distinct in possessing an extremely elongate tongue (i.e. glossum and labial palpus) (Figures 1 and 3f), and by the characteristic 3-dentate mandible of the female, with a small

additional tooth that is scarcely distinguishable from the second within the elongate interspace (Figures 2b); Michener (2000, 2007) considers this a 4-dentate condition. Subsequently, the similar (Figure 2c), albeit larger species *M. umatillensis* Mitchell, was added to *Megachiloides* (Mitchell 1927). Mitchell (1934) later reduced *Megachiloides* to a subgenus of *Megachile*, and added *M. amica* Cresson, a species which also has a relatively elongate tongue (Figures 3d) and the characteristic mandibular structure, and five additional species known at the time only from the female and possessing 3-dentate mandibles without the small tooth in the second interspace (Figure 2a), but with tongues more typical to *Megachile* (Figure 3b). Mitchell (1934) also proposed the subgenus *Xeromegachile* to include similar species with females with 4-dentate mandibles (Figure 2d) and short tongues (Figure 3c). Two years later, Mitchell (1936) proposed the subgenus *Derotropis* to separate the species with females with 3-dentate mandibles (Figure 2a) and short tongues (Figure 3b), and added several additional species, though only a few with males described and/or associated with females.

Subsequently, Mitchell (1980) reinstated *Megachiloides* to genus level; along with the subgenera *Megachiloides*, *Derotropis*, and *Xeromegachile*, he added *Argyropile* Mitchell and *Phaenosarus* Mitchell. This larger grouping thus contained all North American *Megachile* with the carina of T6 of the male being entire, excluding, at that time, members of *Argyropile* (see Mitchell 1980), though males of a few species also share this character (see Gonzalez and Griswold 2007). This broader classification thus also included females possessing 3-, 4-, and 5-dentate mandibles (Mitchell 1980). Michener (2000), not accepting Mitchell's broad partitioning of *Megachile* (i.e. Mitchell 1980), reinstated *Megachiloides* to subgenus level and made *Derotropis* and *Xeromegachile* junior synonyms; *Argyropile* recognized again as a subgenus, and *Phaenosarus* newly synonymized under subgenus *Xanthosarus* Robertson. Thus, the subgenus *Megachiloides s. l.* contains females which are slightly less variable in mandible shape, *Megachiloides s. str.* (i.e. the *oenotherae* species group) considered an intermediate between the 3-dentate *Derotropis* (Figure 2a) and the 4-dentate *Xeromegachile* (Figure 2d), with all males with the carina of T6 entire (Michener 2000).

The objective here is to describe a new species of *Megachile* from Texas, United States, and provide a diagnosis of this species and a key to distinguish it from other members of the *oenotherae* species group in North America. This work ultimately forms a contribution to an ongoing revision and phylogeny of *Megachiloides s. l.*

Methods

As part of previous work on *Megachile* in North America (Sheffield and Westby 2007, Sheffield et al. 2011), an ongoing revision and phylogeny of the subgenus *Megachiloides s. l.* (*sensu* Michener 2000), and a larger campaign to collect DNA barcodes from all bees (Bee-BOL; Packer et al. 2009), representatives of many species of *Megachile* were collected throughout North America and/or borrowed from other institutions. These include the Canadian Nation Collection of Insects, Arachnids and

Nematodes (Ottawa, ON), the Packer Collection at York University (Toronto, ON), the Royal Saskatchewan Museum (Regina, SK), University of Alberta (Edmonton, AB) the Royal Alberta Museum (Edmonton, AB), Simon Fraser University (Vancouver, BC), USDA Bee Biology and Systematics Laboratory (Logan, UT), University of Kansas (Lawrence, KS), American Museum of Natural History (New York, NY), Central Texas Melittological Institute (Austin, TX), North Carolina State University Insect Museum (Raleigh, NC), Entomology Research Museum, University of California Riverside (Riverside, CA), and the USGS Patuxent Wildlife Research Center (Beltsville, MD).

Photomicrography was undertaken with a Canon EOS 5D Mark II digital camera with an MP-E 65 mm 1:2.8 1–5× macro lens. Measurements were made with an ocular micrometer on a Nikon SMZ1000 stereomicroscope. Head length was measured from the lower margin of the clypeus to vertex in facial view; tongue length was measured from the base of the prementum to the tip of the glossum. The following abbreviations are used in the descriptions: F, flagellomere; S, metasomal sternum; T, metasomal tergum; OD, median ocellar diameter; i=interspace; pd, puncture diameter. Morphological terminology generally follows Mitchell (1980) and Michener (2007).

Systematics

Genus *Megachile* Latreille

Subgenus *Megachiloides* Mitchell

Megachiloides Mitchell, 1924: 154. Type species: *Megachiloides oenotherae* Mitchell, 1924, by original designation.

Megachile (*Xeromegachile*) Mitchell, 1934: 302, 309. Type species: *Megachile integra* Cresson, by original designation.

Megachile (*Derotropis*) Mitchell, 1936: 156. Type species: *Megachile pascoensis* Mitchell, 1934, by original designation.

Megachile (*Megachiloides*) *chomskyi* Sheffield, sp. n.

urn:lsid:zoobank.org:act:3A56D34A-E6FE-453E-BC9E-29A19613F75D

http://species-id.net/wiki/Megachile_chomskyi

Specimen data at doi: 10.5886/txsd3at3

Figures 3e, 4, 5a, 6a, 7, 8, 9a

Holotype. ♂ (Figure 4), 29707 // TEXAS: Winkler Co., 13.2 mi. E of 18 on rd 404, 31.767°N, 102.824° W, 15-vi-2005, J. Neff & A. Hook // on flowers of *Calylophus hartwegii* // *Megachile amica* Cresson ♂, det J.L. Neff 2005 // BeeBOL, CCDB-03768 A03, BEECE003-10 [DNA barcode accession #s] // RSKM_ENT_E-0100327; deposited in the Royal Saskatchewan Museum, Regina, Saskatchewan, Canada.



Figure 1. Lateral habitus of female *Megachile oenotherae* (Mitchell) (paratype); type species of *Megachiloides* Mitchell.

Allotype. ♀, 29701 // TEXAS: Winkler Co., 13.2 mi. E of 18 on rd 404, 31.767°N, 102.824°W, 15-vi-2005, J. Neff & A. Hook // on flowers of *Calylophus hartweggii* // *Megachile amica* Cresson ♀, det J.L. Neff 2005 // BeeBOL, CCDB-03768 A02, BEECE002-10 [DNA barcode accession #s] // RSKM_ENT_E-0100328; deposited in the Royal Saskatchewan Museum, Regina, Saskatchewan, Canada.

Paratypes. ♂ TEXAS: Ward Co., Monahans Sandhills State Park, campground area, 31°38'12"N, 102°49'01"W 13 June 1998, C.R. Nelson #6733 & class // *Megachile amica* ♂, det. J. Neff 2005 // UTIC // RSKM_ENT_E-0100589; ♀, 31173 // TEXAS: Ward Co., Monahans Sandhill S. P., 31.640°N, 102.819°W, J.L. Neff, 20-v-2006 // on flowers of *Calylophus hartweggii* // *Megachile amica* Cresson ♀, det J.L. Neff 2006 // BeeBOL, CCDB-03768 A04, BEECE004-10 [DNA barcode accession #s] // RSKM_ENT_E-0100591; 2♀, 29812, 29813 // TEXAS: Ward Co., Monahans Sandhill S. P., 31.640°N, 102.819°W, 16-vi-2005, J. Neff & A. Hook // on flowers of *Calylophus hartweggii* // *Megachile amica* Cresson ♀, det J.L. Neff 2005 // RSKM_ENT_E-0100592, RSKM_ENT_E-0100593; ♀, TEXAS: Ward Co., Monahans Sandhill S. P., N31.640 W102.818, 16.VI.2005, elev 829m, A.W. Hook, J.L. Neff // *Megachile amica* Cresson ♀, det J.L. Neff 2005 // UTIC // RSKM_ENT_E-0100590; ♀, 29703 // TEXAS: Winkler Co., 13.2 mi. E of 18 on rd 404, 31.767°N, 102.824°W, 15-vi-2005, J. Neff & A. Hook // on flowers of *Calylophus hartweggii* // *Megachile amica* Cresson ♀, det J.L. Neff 2005 // BeeBOL, CCDB-03768 A01, BEECE001-10 [DNA barcode accession #s] // RSKM_ENT_E-0100579; 9♀'s, 29694-29700, 29704-

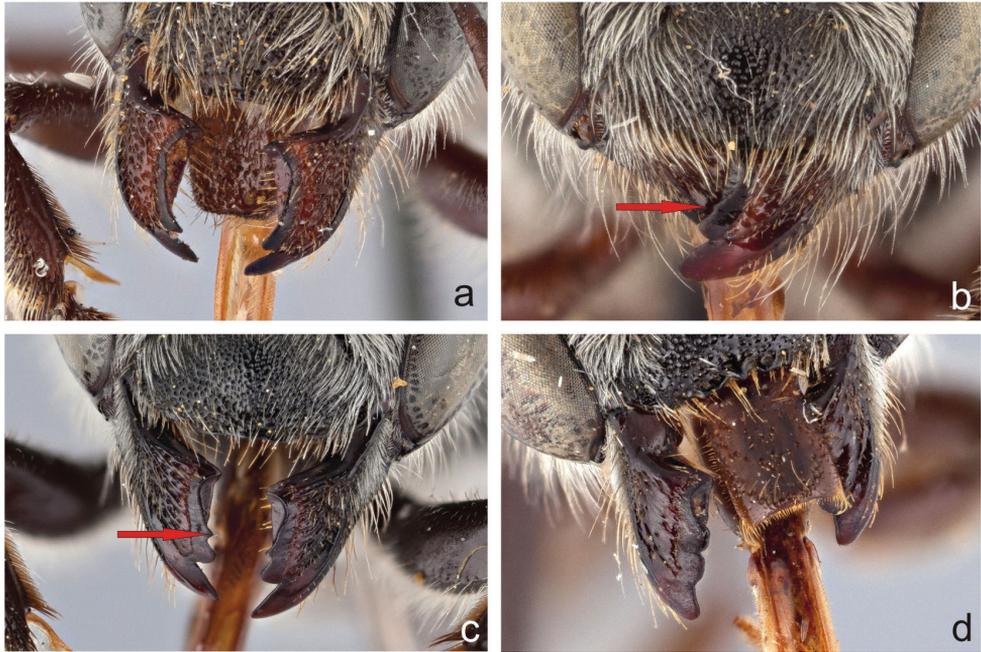


Figure 2. Mandibles of female *Megachile* subgenus *Megachiloides* s. l.; **a** *Megachile pascoensis* Mitchell (type species of *Derotropis* Mitchell **b** *Megachile oenotherae* (Mitchell), type species of *Megachiloides* Mitchell **c** *Megachile (Megachiloides) umatillensis* (Mitchell) **d** *Megachile integra* Mitchell, type species of the *Xeromegachile* Mitchell. Red arrows show the position of the “third” tooth in *Megachiloides* s. str.

29705 // TEXAS: Winkler Co., 13.2 mi. E of 18 on rd 404, 31.767° N; 102.824° W, 15-vi-2005, J. Neff & A. Hook // on flowers of *Calylophus hartweggii* // *Megachile amica* Cresson ♀, det J.L. Neff 2005 // RSKM_ENT_E-0100580-588; ♀, 21454 // TEXAS: Kleberg Co., Sarita, 3 mi. N, 27°82.94"N, 97°47.92"W, 22-iv-2001, J.L. Neff // on flowers of *Oenothera drummondii* // *Megachile amica* Cresson ♀, det J.L. Neff // RSKM_ENT_E-0100594; ♀, May, Austin, Texas // *Megachile amica* Cresson ♀, det J.L. Neff 01 // UTIC // RSKM_ENT_E-0100595. Paratypes deposited in the Royal Saskatchewan Museum, the Central Texas Melittological Institute, the University of Kansas, the USDA Bee Biology and Systematics Laboratory, and the American Museum of Natural History.

Diagnosis. The male of *M. chomskyi* can be distinguished by the combination of the long glossum, the carina a T6 being entire and triangular, the pale somewhat expanded front basitarsus with a row of elongate black densely plumose hairs beneath the white fringe of hairs (Figure 5a), the shallowly emarginate clypeal margin with a small, subapical median tubercle (Figure 6a), the body with pubescence entirely pale, the dense white tomentum of T3-T5 (Figure 4c), and S5 with postgradular area narrowly and deeply incised medially, almost separated into two halves (Figure 7c). It is most similar to other *Megachiloides* s. str. (*Megachile amica*, *M. oenotherae*, and *M. umatillensis*; i.e. the *oenotherae* species group) which all lack the pronounced median tubercle

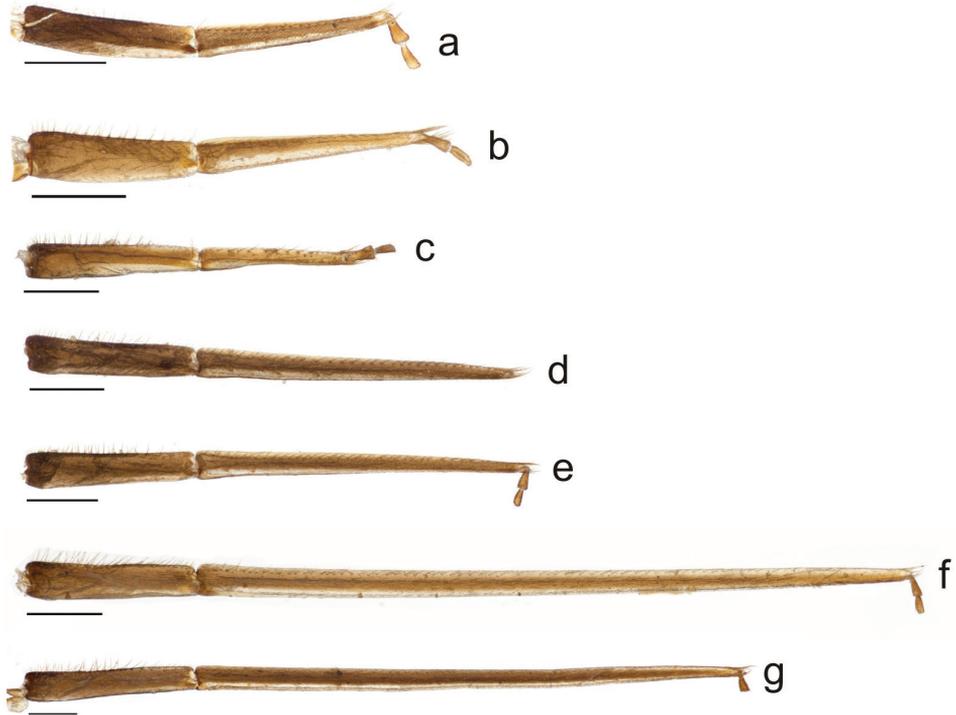


Figure 3. Labial palpi of *Megachile* subgenera *Megachile* (a) and *Megachiloides* s. l. (b–g), size of images adjusted to have basal palpomere of standardized length; a *Megachile centuncularis* (Linnaeus) (type species of *Megachile* Latreille) b *Megachile pascoensis* Mitchell (type species of *Derotropis* Mitchell) c *Megachile integra* Mitchell, type species of the *Xeromegachile* Mitchell d *Megachile amica* Cresson e *Megachile chomskyi*, new species f *Megachile oenotherae* (Mitchell), type species of *Megachiloides* Mitchell g *Megachile umatillensis* (Mitchell). Scale bar = 0.5 mm.

on the clypeal margin (Figure 6b). Male *M. amica* are typically smaller (10–12 mm), and have the carina of T6 less produced, with much dark pubescence on the apical terga, and S5 with postgradular area widely separated medially in basal half; males of *M. oenotherae* and *M. umatillensis* lack the black plumose hairs on the front basitarsis (Figure 5b), *M. oenotherae* has darker front tarsi, and much dark pubescence on the mesoscutum and mesoscutellum.

In addition to also possessing a relatively long tongue with the second labial palpomere at least 1.7× the length of the first (Figure 3e), the female of *M. chomskyi* can be distinguished by the 3-dentate mandible, with a small vestige of a tooth just posterior to the middle one, thus approaching a 4-tooth condition (Figure 8c), the relatively large size (13.5 mm), and the uniformly short dark hairs on T2–T4. It is also most similar to *M. amica*, *M. oenotherae*, and *M. umatillensis*. Females of *M. amica* are typically smaller (9–10 mm), and have dark hairs of varying length on T2–T4; females of *M. oenotherae* and *M. umatillensis* have an even longer tongue, the second labial palpomere at least 3× the length of the first (Figures 3f and g).



Figure 4. Male *Megachile* (*Megachiloides*) *chomskyi*, new species (holotype). **a** lateral habitus **b** face **c** dorsal view of terga 4–6.

Description. *Male:* Body length 13 mm, forewing length 10 mm. Head width 4.3 mm; head length 3.9 mm (Figure 4b). Tongue length 7.2 mm, first (i.e. basal) labial palpomere 0.55× length of second (Figure 3e). Intertegular distance 3.7 mm; distance between outer margins of tegulae 4.8 mm.

Structure. Compound eyes subparallel to slightly convergent below (Figure 4b). Lateral ocelli slightly nearer to compound eye than to edge of vertex (5:6). Mandibles 3-dentate, lower process of mandible slender, acute, subbasal in position. Clypeal margin narrowly shiny and impunctate, broadly and shallowly emarginate with a distinct median tubercle (Figure 6a). Gena as wide as compound eye in profile. F1 as long as broad, subequal in length to pedicel, slightly shorter than F2, F2 quadrate to very slightly longer than broad, F3–F8 longer than broad (2.5:2), apical segments



Figure 5. Front tarsi of male **a** *Megachile (Megachiloides) chomskyi*, new species, and **b** *Megachile (Megachiloides) oenotherae* (Mitchell).

more so (3:2), apical flagellomere more elongate, about twice as long as broad. Front coxal spine short, distinct, longer than broad, subacute with short dense patch of pale pubescence at tip, ventral surface otherwise bare, with small patch of reddish-brown subappressed bristles at base. T2 with shallow but distinct basal groove apical to gradulus, graduli of T3–T4 more distinct with carinate rims, basal grooves of T5 and T6 very deep, graduli with hyaline carinate rims. Apical margins of T2 and T3 slightly depressed, T4 and T5 very much so. T6 with carina entire, evenly triangular in dorsal view (Figure 4c), apical 1/3 slightly curved downward, median carinate teeth of apical margin very large and broadly rounded, closer to lateral teeth than to each other (2:3). T7 visible, triangular, pointed tip about as broad as long, gradulus deeply emarginated medially, triangular. S4 with apical margin very slightly emarginate medially with wide (1 OD) hyaline apical rim. S5 with pregradular area very thin medially, postgradular

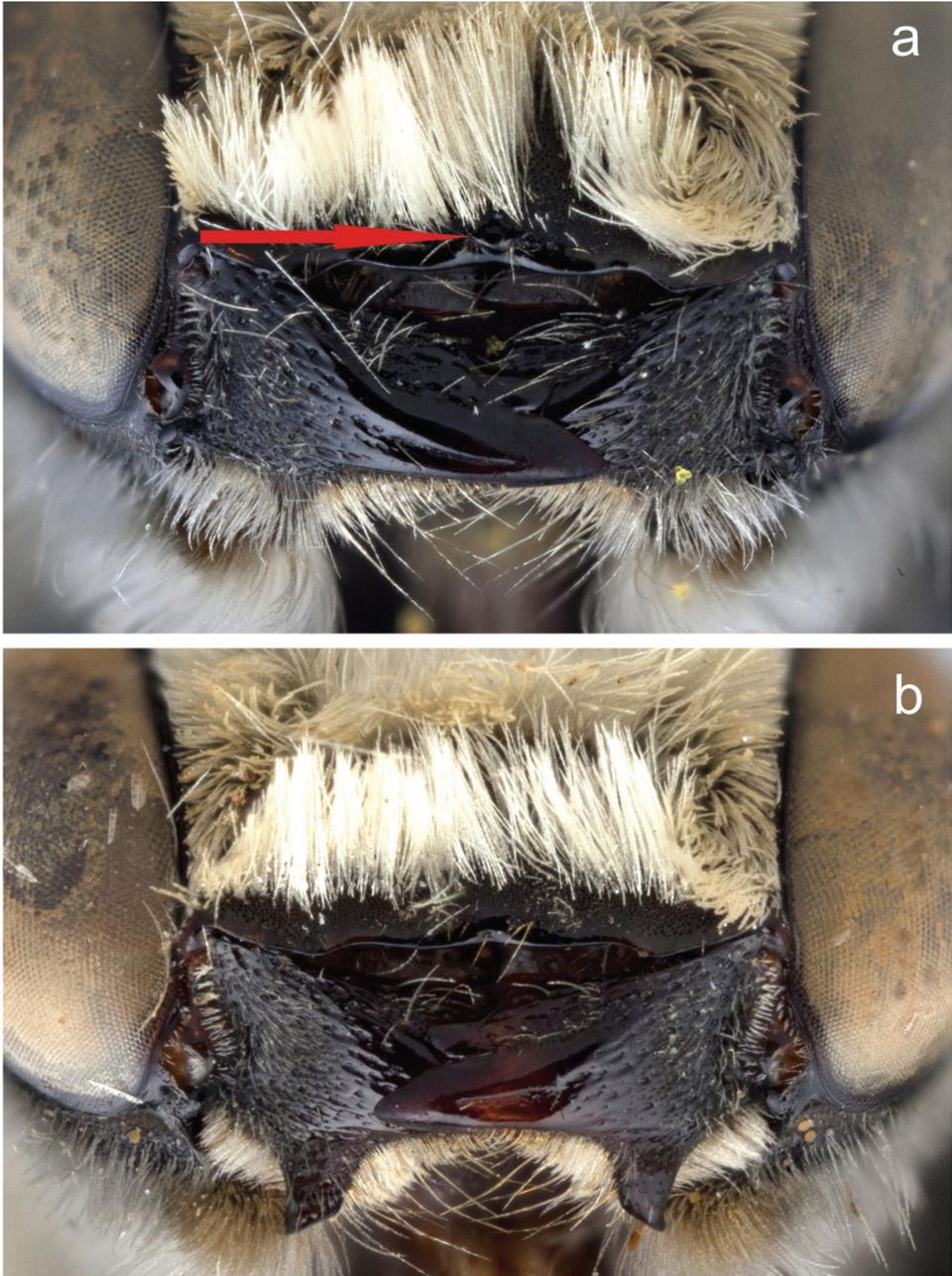


Figure 6. Apical edge of clypeus of male **a** *Megachile (Megachiloides) chomskyi*, new species (holotype), and **b** *Megachile (Megachiloides) amica* Cresson. Red arrow shows median tubercle.

area narrow, deeply incised medially, almost separated into two halves, apical rim laterally produced with median hair tuft (Figure 7c). S6 with apical lobe emarginate medially, with lateral edges broadly angulate ($\sim 90^\circ$), postgradular area heavily sclerotized,

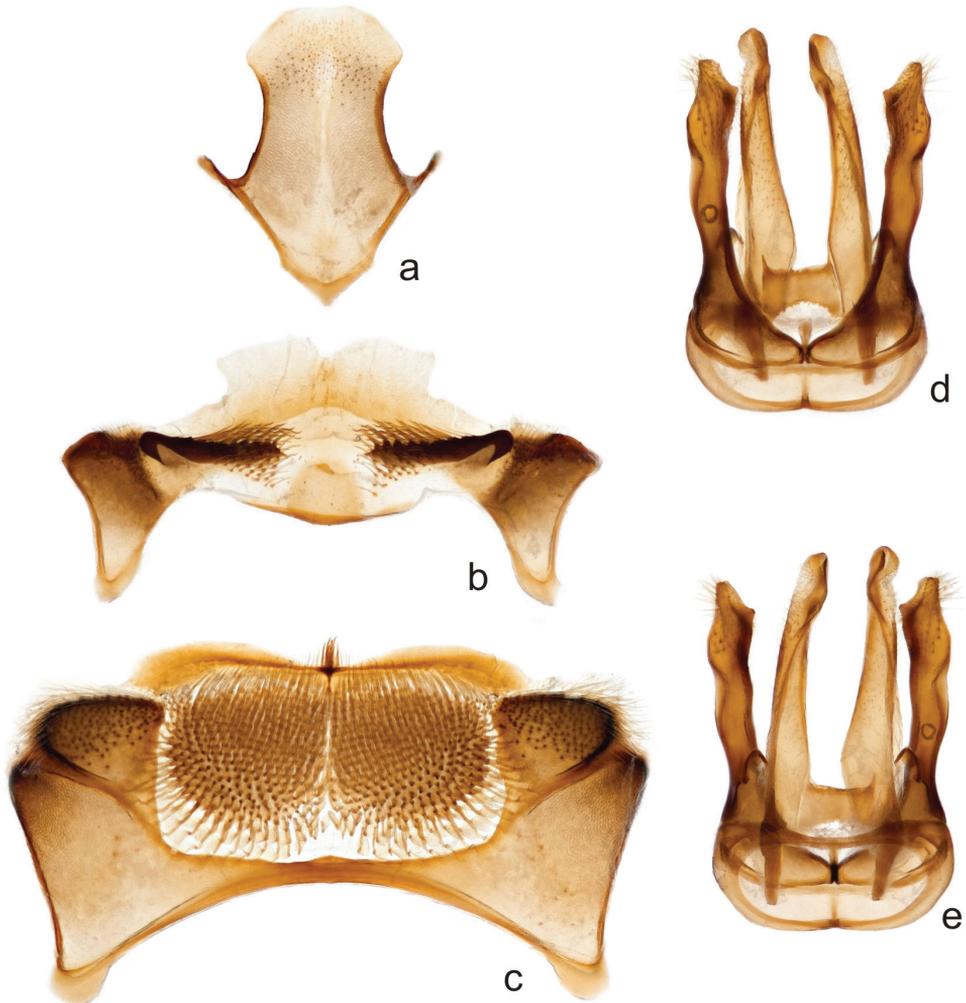


Figure 7. Male *Megachile (Megachiloides) chomskyi*, new species (holotype); **a** sternum 8 **b** sternum 6 **c** sternum 5, and genitalia in dorsal (**d**) and ventral (**e**) view.

setal patches rather widely divided, base of pregradular area slightly re-curved ventrally (several mites were found in the resulting cavity) (Figure 7b). S8 with lateral edges concave, apex rounded (Figure 7a). Gonocoxite sinuate in lateral view, with distinct ventral angle in basal third, narrowed basal to gonostylus region, ventral apical angle produced into small angular projection, dorsal apical surface covered with elongate hairs; penis valve relatively straight, slightly curved at tip and exceeding gonocoxite in length (Figures 7d and 7e).

Colour and pubescence. Integument black, tegula and apical tarsomere dark brown, front femur yellowish-brown ventrally, basitarsus yellow on outer surface, becoming light brown along edges, reddish brown ventrally, tibial spurs yellowish-brown, T6 with me-

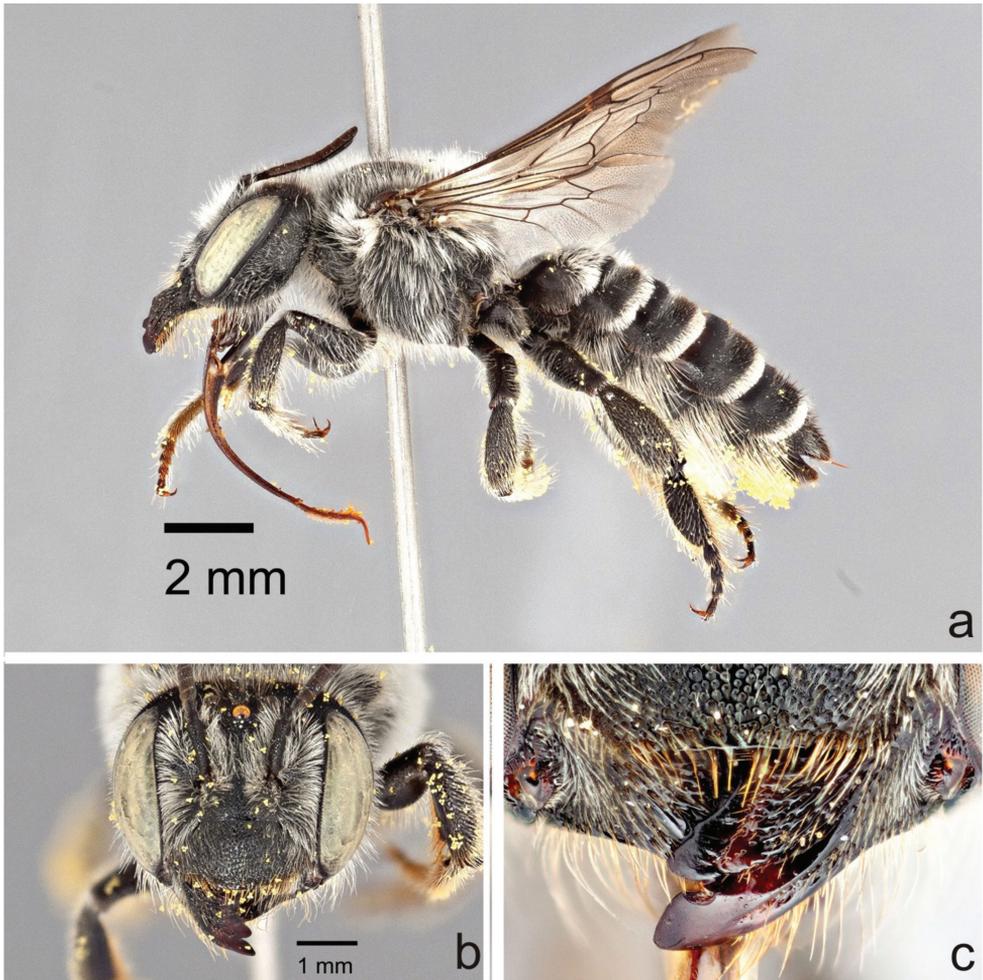


Figure 8. Female *Megachile* (*Megachiloides*) *chomskyi*, new species (paratype). **a** lateral habitus **b** face **c** mandible.

dian apical teeth reddish brown, apical edge of S4 broadly (i.e. 1.5 OD) hyaline. Wings clear, faintly hyaline apically beyond veins, veins dark brown. Pubescence entirely pale yellowish-white on body, becoming somewhat paler to white on mesosoma ventrally, dense and entirely pale yellow on face below level of median ocellus, mesoscutum rather sparsely but uniformly pubescent, becoming slightly longer and denser at periphery and on scutellum, terga with mostly pale yellowish-white pubescence, long and rather dense on T1, sparser but long and suberect on T2, erect hairs becoming sparser on T3-T5, basal groove of T3 and T4 with narrow band of white tomentum, more extensive on T5 (Figure 4c), T6 thinly pale pubescent above carina, with elongate plumose hairs laterally and below carina, T2-T5 with dense white apical fascia; front basitarsus with row of elongate black densely plumose hairs beneath white fringe of hairs (Figure 5a).



Figure 9. Metasomal terga of female **a** *Megachile (Megachiloides) chomskyi*, new species (paratype), and **b** *Megachile (Megachiloides) amica* Cresson.

Surface sculpture. Punctures fine and close on face, somewhat shallow but distinct on gena, becoming deeper but rather fine and close (<1pd) on vertex medially, more irregular sized but still close on vertex laterally, fine and very close on clypeus and on

supraclypeal area, apical edge of clypeus narrowly shiny and impunctate, mesoscutum and mesoscutellum with punctures shallow but distinct, rather fine and uniformly close, surface dull, punctures becoming deeper on pleura below, tegula finely and closely punctate throughout, propodeum with shallow, fine punctures with $i=0.5-1pd$, triangle dull, smooth and impunctate, punctures fine over most of dorsal surface of metasoma, minute and very close on T2, larger but still close ($i<1pd$) on T3, larger on T4 with shiny $i=1pd$, larger and somewhat elongate on apical 1/3 of T5, fine and densely crowded on T6, coarse and close ($i=1pd$) on S1-S2, becoming sparser ($i=3-4pd$) in apical half of S3-S4.

Female: Body length 13–13.5 mm, forewing length 8.5 mm. Head width 4.0 mm; head length 3.3 mm (Figure 8b). Tongue length 7.2 mm, first (i.e. basal) labial palp $0.55\times$ length of second (Figure 3e). Intertegular distance 3.3 mm; distance between outer margins of tegulae 4.2 mm.

Structure. Compound eyes very slightly convergent below (Figure 8b). Lateral ocelli as near to compound eye as to edge of vertex. Mandible 3-dentate, two apical teeth approximate, with small angle interrupting long cutting edge between 2nd and inner teeth (Figure 8c). Clypeal margin smooth, very slightly produced in median third. Gena as wide as compound eye in profile. F1 as long as broad, and subequal in length to pedicel, longer than F2, F2 broader than long (1.5: 1.2), F3-F9 quadrate to slightly longer than broad, apical flagellomere more elongate (2.5:1.5). T2-T5 with shallow but distinct grooves across base, graduli carinate, apical margins slightly depressed, laterally only on T2. T6 very slightly concave in profile.

Colour and pubescence. Integument black, flagellum and tegula dark brown, tibial spurs yellow-brown. Wings clear, faintly hyaline apically beyond veins, veins dark brown. Pubescence mostly white on body, a few short dark hairs on vertex laterally, in apical half of T2 (basal to fasciae), more extensive on T3, occupying almost entire surface of T4 and T5 (Figure 9a), T6 with short, thick, black pubescence interspersed with thin, pale, longer hairs. S2-S5 with scopa white, black on S6, pale hairs sparse on clypeus and supraclypeal area, becoming denser and longer on face around bases of antennae, mesoscutum sparsely pubescent, with short erect hairs, more dense at periphery, more elongate on mesoscutellum and pleura.

Surface sculpture. Punctures fine and close on face, rather shallow on gena with surface shiny, deeper but rather fine and very close on vertex medially, slightly larger but still close on vertex laterally, quite coarse on clypeus in apical half, with $i\leq 1pd$ and reaching apical edge, closer laterally, much finer and closer in basal 1/3 and on supraclypeal area; mesoscutum and mesoscutellum with punctures shallow but distinct, rather fine and uniformly close, surface dull, punctures becoming deeper and slightly more separated on pleura below, tegula finely and closely punctate throughout, propodeum with shallow, fine punctures with $i=0.5-1pd$, triangle dull, smooth and impunctate; punctures fine over most of metasoma, minute and very close on T1 (dorsal surface) and T2, similar apically on T3 and T4, though interspaces larger in basal half ($i=1-2pd$), more coarse but still close ($i\leq 1pd$) on T5, coarse and densely crowded to finely subrugose on T6, coarse and close on basal sterna, becoming slightly more separated on apically sterna, quite sparse on S6 ($i=2pd$).

Etymology. It is my pleasure to name this species after Professor Noam Chomsky, Department of Linguistics & Philosophy at the Massachusetts Institute of Technology (MIT) for his many academic achievements and contributions as a linguist, philosopher, cognitive scientist, historian, political critic, activist and global champion of human rights and freedoms.

Distribution. *Megachile chomskyi* is known from the state of Texas, United States.

Discussion

Megachile chomskyi is morphologically very similar to *M. amica*, but differs from that species not only in a series of structural characters, but also in COI similarity by 7.8%; intraspecific variation for each species averaging less than 0.8% (n=3) (unpublished). The subgenus *Megachiloides* still remains one of the most problematic *Megachile* groups in North America, due in part to the large proportion of species described from one sex (Sheffield and Westby 2007), outdated keys and descriptions which are poorly illustrated. Sheffield et al. (2011) associated some of the sexes, and with the assistance of DNA barcoding, discovered that several of the species occur as melanistic forms previous recognized as valid species known only from the female. The relationship of *Megachiloides* with other subgenera is also still not resolved (Gonzalez 2008), though a phylogeny and full revision of the subgenus are forthcoming.

As is suspected for other members of the *oenotherae* species group of *Megachiloides*, *M. chomskyi* may be a floral specialist of Onagraceae (Evening-Primrose Family). Most of the specimens examined were collected on *Calylophus hartwegii* (Benth.) P.H. Raven., which also occurs in Arizona, Colorado, Kansas, New Mexico, and Oklahoma, and *Oenothera drummondii* Hook., which occurs in Texas, Florida, Louisiana, North and South Carolina. Therefore, it is possible that some specimens presently identified as *M. amica*, which ranges from Arizona, north to Kansas and southeast to Texas, are actually this species. In Texas, *M. chomskyi* has been collected from late April to June.

Key to the *oenotherae* species group of *Megachiloides*

Females

- 1 Tongue relatively short, extended length of glossum not reaching beyond mid length of metasoma (Figure 8a), second labial palpomere less than twice the length of the basal palpomere (Figures 3d and 3e) **2**
- Tongue long, extended length reaching almost to tip of metasoma (Figure 1), second labial palpomere at least three times the length of basal palpomere (Figures 3f and 3g)..... **3**

- 2 Larger (13.5 mm), dark pubescence of T2 and T3 uniformly short and dense, maximum length less than half of width of pale apical fascia (Figure 9a)..... *M. chomskyi* sp. n.
- Smaller (≤ 11 mm), dark pubescence of T2 and T3 of intermixed length, length of longer, coarser dark hairs approaching width of apical fascia (Figure 9b)..... *M. amica* Cresson
- 3 Larger (≥ 13 mm); pubescence on mesonotum entirely pale *M. umatillensis* (Mitchell)
- Smaller (11 mm); pubescence on mesoscutum and mesoscutellum with much black pubescence *M. oenotherae* (Mitchell)

Males

- 1 Fringe of front basitarsus with distinct ventral row of elongate, black densely plumose hairs (Figure 5a)..... 2
- Fringe of front basitarsus entirely white, lacking black hairs (Figure 5b) 3
- 2 Larger (13 mm); clypeal margin shallowly emarginate, with small median tubercle (Figure 6a); carina of tergum 6 more produced, narrowly triangular; apical terga with pubescence almost entirely pale, tergum 5 with rather dense pale tomentum in basal half (Figure 4c)..... *M. chomskyi* sp. n.
- Smaller (10–12 mm); clypeal margin straight, lacking median tubercle (Figure 6b); carina of tergum 6 broadly rounded; apical terga with much black pubescence, tergum 5 lacking pale tomentum..... *M. amica* Cresson
- 3 Larger (> 13 mm); front basitarsus pale..... *M. umatillensis* (Mitchell)
- Smaller (9–10 mm); front basitarsus mostly dark.... *M. oenotherae* (Mitchell)

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The extinct Baltic amber genus *Propelma* Trjapitzin, a valid genus of Neanastatinae (Hymenoptera, Eupelmidae)

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Abstract

The extinct Eocene Baltic amber genus *Propelma* Trjapitzin 1963 is removed from synonymy under *Eupelmus* Dalman 1820 (Hymenoptera, Eupelmidae, Eupelminae) and treated as a valid genus within Neanastatinae Kalina 1984 based on examination of the holotype female of *P. rohdendorfi* Trjapitzin. *Propelma rohdendorfi* is redescribed, illustrated by photomicrographs, and compared to other described extant and extinct genera of Neanastatinae. Taxonomic, morphological and geological diversity of Neanastatinae relative to Eupelminae and Calosotinae is also discussed relative to potential age of the subfamily.

Keywords

Eocene, fossil, Dominican amber

Introduction

Trjapitzin (1963) established *Propelma* based on *Propelma rohdendorfi* (Hymenoptera: Eupelmidae), which he described from a single female in Eocene Baltic amber. Gibson (1995) later synonymized *Propelma* under *Eupelmus* Dalman 1820 in a revision of the world genera of Eupelminae Walker 1833. The synonymy was based primarily on the lateral habitus drawing of *P. rohdendorfi* given by Trjapitzin (1963, fig. 1) without examining the holotype.

When Trjapitzin described *Propelma* he stated that it was similar to *Metapelma* Westwood 1835 in general habitus and size of the body, head shape, antennal structure, thorax, and presence of a long ovipositor. *Metapelma* is one of seven genera currently classified in Neanastatinae Kalina 1984, which along with Calosotinae Bouček 1958 and Eupelminae comprise the three recognized subfamilies of Eupelmidae. Of the seven neanastatine genera, four are extant, including *Eopelma* Gibson 1989, *Lambdobrema* Gibson 1989, *Metapelma* and *Neanastatus* Girault 1913. The other three genera, *Aspidopleura*, *Brevivula* and *Neanaperiallus*, were all described by Gibson (1999) from Baltic amber inclusions and are extinct. Description of the three extinct genera greatly expanded morphological limits of Neanastatinae and the new knowledge led me to re-examine Trjapitzin's (1963) illustration of *P. rohdendorfi* and question the validity of synonymizing *Propelma* under *Eupelmus*. Resulting study of the amber holotype of *P. rohdendorfi* subsequently showed that Trjapitzin (1963) was correct in comparing *Propelma* with *Metapelma* relative to subfamilial affinities, and that *Propelma* represents a fourth, extinct, valid genus of Neanastatinae from Baltic amber. The purpose of this paper is to correct my erroneous synonymy and redescribe and illustrate *P. rohdendorfi* so that its classification is better established in Eupelmidae.

Methods

The description and photomicrographs are based on the holotype female of *P. rohdendorfi* [Holotype no. 364/360, Orlov Museum of Paleontology (formerly, Paleontological Institute of Russian Academy of Sciences), Moscow, Russia]. The holotype is in a mostly dark orange-colored block of amber (Fig 1). It is complete except that an unknown length of the ovipositor sheaths are missing, as is most of the femur and tibia of the left hind leg and the apices of the femora and bases of the tibiae of the right middle and hind legs. The missing parts are because these projected beyond the sides of the polished amber block. The right side of the specimen, in particular, is clearly visible (Fig. 1), but artefacts prevent a direct ventral view of the mesosoma or the dorsal surface of the body beyond about the posterior angles of the axillae, and thickness of the amber prevents clear observation of the face. Images were taken with a Leica DFC 425C, 5 megapixel digital camera attached to a Leica Z16 APO macroscope. Serial images were combined using Zerene Stacker and digitally manipulated using Camera Raw and Adobe Photoshop 4 to enhance clarity. Images taken of the right side of the holotype for the plates of illustrations were flipped so that they face in the normal direction for specimen observation. All images except for Fig. 1, which illustrates color of the amber, are published in greyscale because this better facilitates differentiation of structures.

Terminology follows Gibson (1989, 1995) except terms used for the metanotum follow Heraty et al. (2013). Abbreviations used on the plates to indicate morphological features are: **acs** = acropleural sulcus; **amd** = anterolateral mesoscutal depression; **ams** = anterior, transverse region of mesoscutum; **car** = carina; **cer** = cercus; **cl₁₋₃** = first, second, third clavomere; **fu_{1,8}** = first, eighth funicular; **gsp** = gastral spiracle;

map = mesotibial apical pegs; **mbl** = membranous lobe; **mdr** = depressed triangular region of mesopectus; **mlp** = lateral panel of metanotum; **msh** = mesotibial spur; **Mt₈** = eighth metasomal tergite; **mtp** = mesotarsal pegs; **mts** = mesotarsal setal line; **mtsa** = metanotal scutellar arm; **mtt** = metanotal trough; **pre** = lateral panel of prepectus; **psp** = propodeal spiracle; **ptl** = petiole; **sc₂h** = mesoscutellar hook; **sc₃** = metascutellum; **sp₂** = mesothoracic spiracle; **syn** = syntergum (Mt₈ + Mt₉); **tgl** = tegula. Measurements of the antennomeres, fore wing venation, and metasomal tergites were all taken at the same magnification; measurements between square brackets are repeated from the original description.

Results

Neanastatinae

Propelma Trjapitzin, stat. rev.

Propelma Trjapitzin, 1963: 89–91. Type species: *P. rhodendorfi* Trjapitzin, by original designation and monotypy. Synonymy under *Eupelmus* Dalman by Gibson (1995: 198).

Propelma rhodendorfi Trjapitzin, resurrected combination

http://species-id.net/wiki/Propelma_rhodendorfi

Figs 1–13

Propelma rhodendorfi Trjapitzin, 1963: 91–94. Holotype: female in Baltic amber. Label data: “Eupelmidae 364/360, *Propelma rohdendorphi*, Trjapitsyn 1963, Holotypus”. *Eupelmus rhodendorfi* Trjapitzin; Gibson, 1995. New combination by inference through synonymy of *Propelma* under *Eupelmus*.

Redescription. Female (Fig. 1). Length (anterior margin of head to posterior margin of syntergum in lateral view) = 7.9 mm [7.5]. Body mostly bright shiny orange (a reflection artefact, original color apparently mostly or entirely dark based on some regions of the body such as part of tegula (Fig. 6: tgl) and gastral tergites (Figs 12, 13)).

Head in frontal view almost as wide as high, with ventral margin of torulus in line with lower orbits and with convex, dorsally tapered interantennal region separating distinct scrobes over at least ventral half of scrobal depression (Fig. 2); scrobal depression inverted U-shaped with minimum distance between lateral margin and inner orbit about 0.4× maximum diameter of anterior ocellus, abruptly margined dorsolaterally to within about one maximum diameter of anterior ocellus where slight change in curvature differentiates more obscure dorsal margin from bare, similarly finely coriaceous, slightly concave region below anterior ocellus (Fig. 2) such that under some angles of view scrobal depression superficially appears to extend to ocellus; upper parascrobal re-

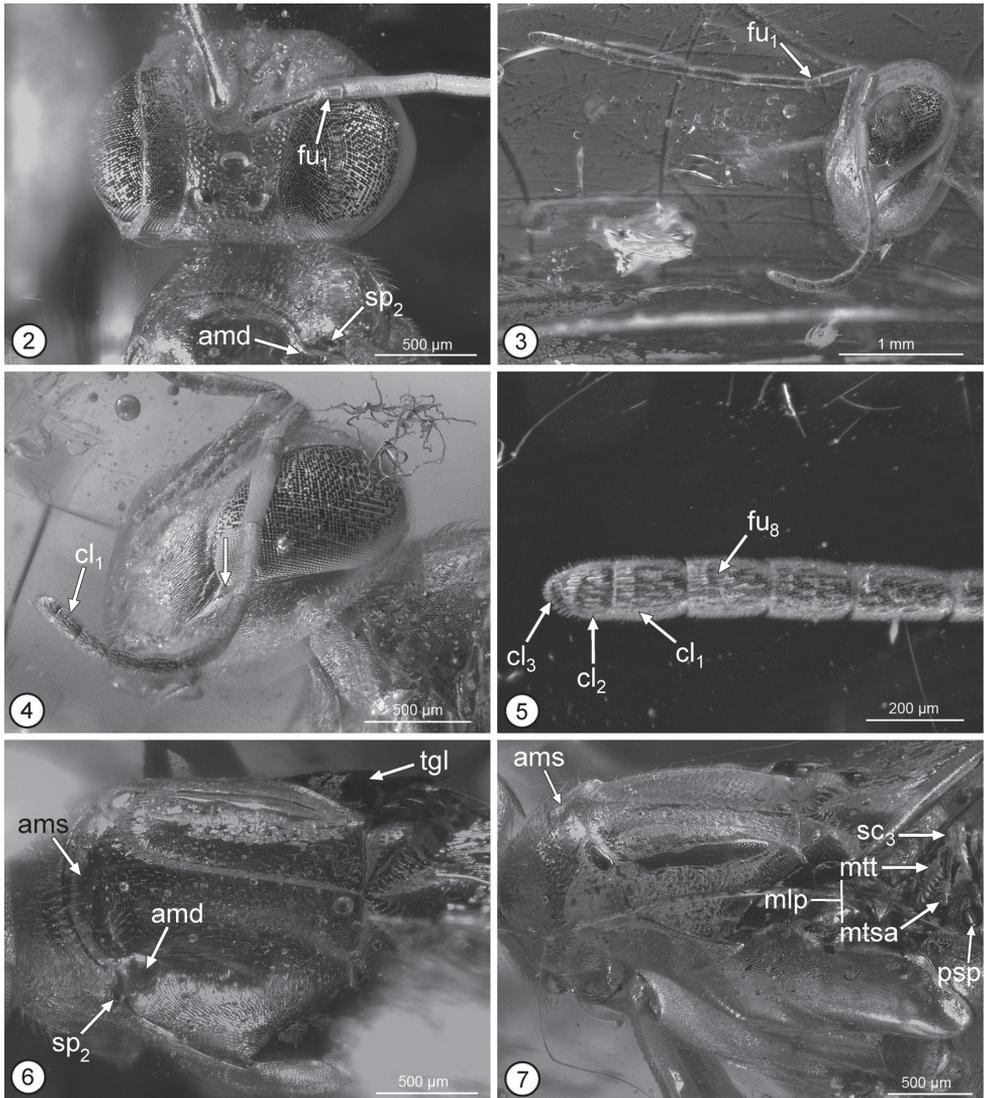


Figure 1. *Propelma rhodendorfi*, amber block bearing holotype female.

gion and frontovertex minutely coriaceous-granular with minute setiferous punctures; lower parascrobal region and gena more vertically coriaceous-alutaceous with short white setae similar to upper parascrobal region, frontovertex and interantennal region. Head in lateral view (Fig. 4) with vertex smoothly rounded into occiput; almost twice as high as maximum length at level of toruli; malar sulcus appearing bifurcate near lower orbit, delineating small triangular region below posteroventral orbit (Fig. 4: arrow) (see discussion); eye about 1.6× as high as wide, superficially bare, but with very short, sparse setae. Head in dorsal view with minimum distance between inner orbits about 0.3× width of head; anterior ocellus slightly transverse, with maximum diameter equal to distance between its outer margin and inner orbit, and slightly greater than maximum diameter of posterior ocellus (Fig. 2); POL: LOL: OOL: maximum diameter of anterior ocellus = 1.0: 0.8: 0.3: 1.0. Antenna (Figs 3, 4) with scape slightly widened distally, ventral margin straight; length of pedicel plus flagellum about 1.7× width of head; flagellum and clava slender, of similar width throughout (Fig. 3); length of scape = 4.0 (approximate); length of pedicel = 2.0; funicle 8-segmented, with fu_1 longer than wide, but much shorter than pedicel or fu_2 (Figs 2, 3), relative lengths of funiculars = 0.7: 2.7: 2.2: 1.6: 1.1: 1.0: 0.9: 0.9; clava 3-segmented (Fig. 5), length = 1.5, basal clavomere slightly longer than cl_2+cl_3 , separated from cl_2 by distinct transverse suture (Figs 4, 5), but cl_3 as tiny apical micropilose sensory region delineated by extremely fine, sinuate suture such that under some angles clava superficially 2-seg-

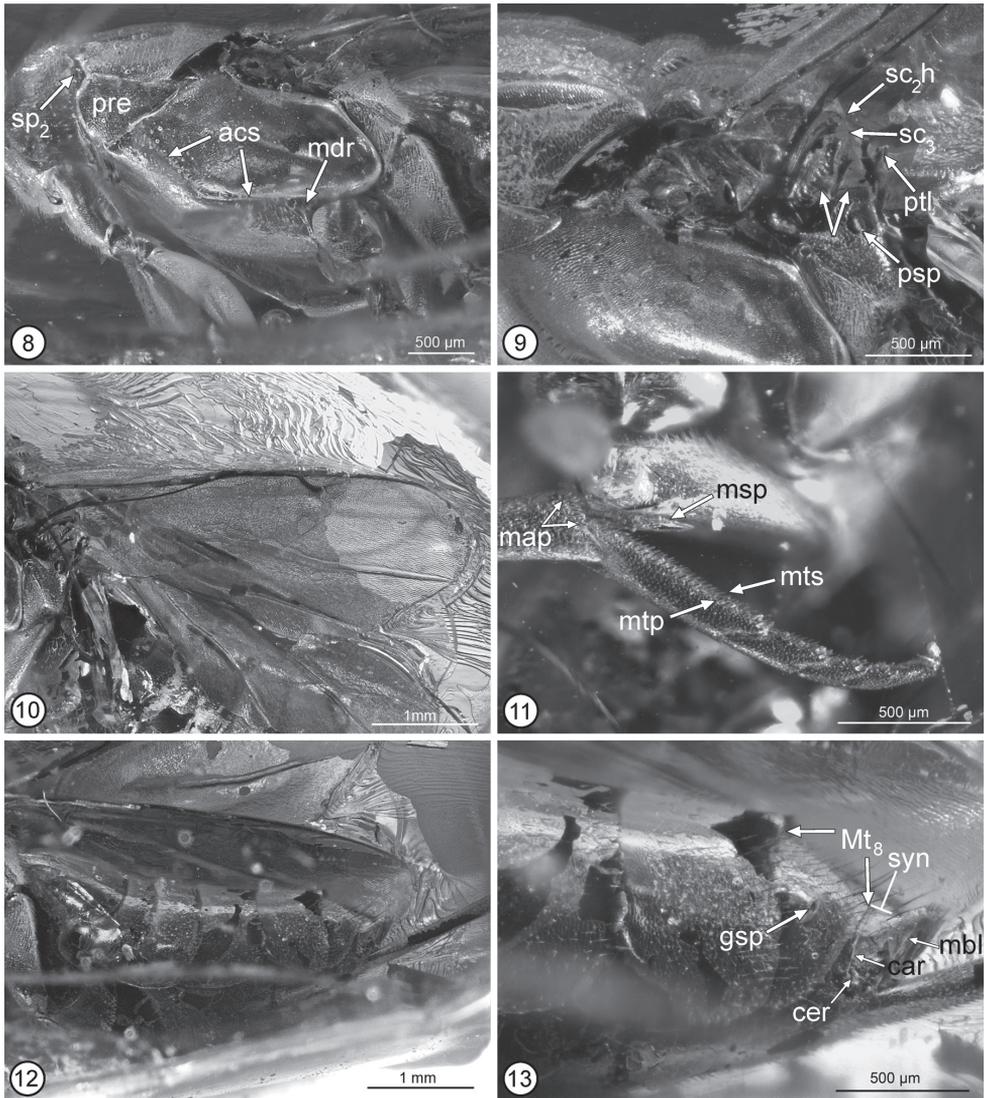
mented (Fig. 4) (relative length of clavomeres = 8:5:2); [length:width ratios of pedicel to clava = 30:9, 10:7, 40:8, 33:8, 23:8, 16:7, 15:8, 12:9, 12:9, 22:9]; flagellum with numerous multiporous plate sensilla in multiple rows per flagellomere and with very short, inconspicuous setae (Figs 4, 5).

Pronotum uniformly sclerotized, dorsally convex in transverse plane and flat mediolongitudinally, hence without differentiated collar and neck (Fig. 7); more or less bell-shaped, sinuately narrowed anteriorly, with incurved posterior margin (Figs 2, 6) (holotype with pronotum rotated anteroventrally such that dorsal surface at obtuse angle relative to mesonotum (Fig. 7) and exposing convex, asetose, transverse anterior part of mesoscutum (Figs 6, 7: ams) between short lateral depression (Figs 2, 6: amd) posterior to each mesothoracic spiracle (Figs 2, 6: sp₂), which accept dorsolateral angles of pronotum when this rotated horizontally in same plane as mesoscutum); finely coriaceous-granular to coriaceous-alutaceous with short black setae except for a line of longer setae along posterior margin. Mesoscutum slightly wider than long, with ridge-like medial elevation extending between exposed transverse anterior portion and transscutal articulation (Figs 6, 7), and with lateral lobes evenly convex; finely coriaceous, with short dark setae similar to pronotum. Mesoscutellar-axillar complex (Figs 6, 7, 9) with axillae transverse-triangular with contiguous inner angles, convex with abruptly angled, oblique, strongly crenulate posterior surfaces forming scutoscutellar sutures; mesoscutellum similarly convex as axillae, teardrop-shaped (cf. Gibson 2009, fig. 13), posteriorly tapered with apex curved down as short hook-like medial protrusion (Fig. 9: sc₂h) over metascutellum (Fig. 9: sc₃), apparently uniformly setose; axillula with dorsal margin carinate. Tegula (Fig. 6: tgl) triangular with almost truncate posterior margin. Prepectus (Fig. 8: pre) with lateral panel flat, anteriorly not protruding anterior of level of mesothoracic spiracle (Fig. 8: sp₂), triangular, 1.4× as long as high basally, with dorsal and ventral margins convergent to narrowly rounded posterior angle; finely coriaceous, bare. Acropleuron (Figs 7–9) extended posteriorly to metapleuron and anteroventral margin of metacoxa between meso- and metacoxa, without exposed mesepimeron; acropleural sulcus (Fig. 8: acs) horizontal ventrally to level about equal with apex of tegula, where curved dorsally as shallower, oblique groove to level of about middle of prepectus, bare, minutely meshlike coriaceous-reticulate within about anterior quarter but more minutely meshlike coriaceous mesally, finely meshlike coriaceous posteriorly, and more elongate striate-coriaceous posterodorsally (Figs 8, 9). Mesopectus (Fig. 8) uniformly setose below acropleural sulcus; posteriorly with small, depressed, triangular region (Fig. 8: mdr) between its posterodorsal margin, acropleural sulcus, and anterolateral margin of mesocoxa; ventrally with posterior margin transverse, abutting anterior margins of mesocoxae, with sulcate discrimen but without transepisternal sulcus. Metanotum (Figs 7, 9) composed of median, slightly raised, flat, strongly transverse metascutellum (Figs 7, 9: sc₃) and metanotal lateral panels (Fig. 7: mlp), each lateral panel broadened laterally and differentiated by transverse crenulate groove into anterior metanotal trough (Fig. 7: mtt) and posterior metanotal scutellar arm (Fig. 7: mtsa); metascutellar arm with about inner half developed as carinate ridge along posterior margin of lateral panel, and with what appears as a fine, obliquely longitudinal



Figures 2–7. *Propelma rhodendorfi*: **2** head, frontodorsal view **3** head and antennae, lateral view **4** head and right antenna, lateral view **5** apical three funiculars and clava **6** mesoscutum, dorsal view **7** mesosoma, dorsolateral view. See Methods for abbreviations for structural features (arrow on Fig. 4 points to triangular region differentiated by putatively bifurcate malar sulcus).

sulcus (Fig. 9: left arrow) near middle of outer broadened part; posterior margin of metanotum between lateral panels raised slightly above anterior margin of propodeum. Metapleuron (Fig. 8, 9) elongate-triangular with posterior margin straight and anterior margin slightly sinuate, uniformly setose with white setae similar to callus. Fore wing (Fig. 10) hyaline, uniformly setose with dark setae, without speculum or linea calva; cc: mv: stv: pmv = 9.4: 3.9: 1.1: 6.2 [smv/mv/stv/pmv = 13/5.5/one-third mv/8.0]; stigmal



Figures 8–13. *Propelma rhodendorfi*: **8** mesosoma, lateral view **9** mesoscutellar-axillar complex to base of metasoma, lateral view **10** fore wing **11** apex of mesotibia and mesotarsus **12** gaster, lateral view **13** Mt6 to apex of metasoma, lateral view. See Methods for abbreviations for structural features (arrows on Fig. 9 point to sulci on propodeal callus and metanotal scutellar arm).

vein apically curved, tapered into short uncus without differentiated stigma. Middle leg in holotype with mesocoxa rotated slightly anteriorly (Fig. 8), its posterior margin separated from anteroventral margin of metacoxa, with outer surface finely, obliquely striate, bare; mesotibia with row of at least eight short, black pegs anteroapically (Fig. 11: map) and with robust mesotibial spur (Fig. 11: msp) about 1.7× as long as apical width of tibia; mesotarsus with line of setae (Fig. 11: mts) along posterior margin and

line of short black pegs (Fig. 11: mtp) along anterior margin of basal four tarsomeres, and basitarsus in lateral view with maximum length slightly greater than combined length of remaining four tarsomeres (about 5:4). Hind leg with exterior surface of coxa completely, densely setose similar to metapleuron; tibia and tarsus not compressed. Propodeum (Fig. 9) with posterior margin broadly, shallowly incurved, with what appears as a fine longitudinal sulcus (Fig. 9: right arrow) mesad propodeal spiracle (Fig. 9: psp) in line with sulcus on metanotal scutellar arm, the putative sulcus (see discussion) thus differentiating medial plical region from callus; plical region strongly transverse, flat, asetose, and apparently very finely coriaceous; callus (Figs 8, 9) anteriorly setose to level of inner margin of propodeal spiracle and posteriorly setose to outer margin of spiracle, with white setae; spiracle (Figs 7, 9: psp) large, transverse-oval, with distance between anterior margin of spiracular rim and anterior margin of propodeum almost 3× distance between posterior margin of rim and propodeum.

Metasoma (Fig. 12) about 0.9× combined length of mesosoma and head; petiole (Fig. 9: ptl) a strongly transverse dorsal strip; in lateral view medial length of tergites from petiole to syntergum = 0.3: 5.2: 1.5: 2.0: 2.8: 3.1: 2.3: 0.8 [Mt₂–syntergum = 43: 11: 16: 23: 29: 18: 3+4]; Mt₂ to basal half of Mt₆ comparatively sparsely setose with dark setae, but Mt₇ and apical half of Mt₆ (Fig. 13) more densely setose with longer dark setae, the setae longest in apical half of Mt₇, and tergites dorsally very finely meshlike coriaceous; Mt₇ with gastral spiracle (Fig. 13: gsp) cone-like protuberant anterolaterally; Mt₈+Mt₉ fused into syntergum (Fig. 13), but with transverse carina (Fig. 13: car) extending at least partly between cerci, the carina continuous along anterior and outer margins of cercus (Fig. 13: cer), with cercus at about mid-length of syntergum, and syntergum sparsely setose but with a few longer, more conspicuous dark setae along posteromesal margin; triangular membranous lobe (Fig. 13: mbl) extending from posterior margin of syntergum, but not extended into anal filament. Ovipositor sheaths tubular, conspicuously exerted, but of unknown length.

Discussion

Propelma is assigned to Neanastatinae based on pronotal structure, mesopectus posteroventrally abutting the mesocoxal bases without a membranous region anterior to each coxa, and mesotarsal peg pattern, all of which are diagnostic of the subfamily (Gibson 1989, 2009). The scutoscutellar suture is also crenulate similar to extant and extinct species of *Metapelma* (Gibson 2009, fig. 13) and some species of *Lambdobrema* (Gibson 2009, fig. 15) (extant) as well as *Aspidopleura* (Gibson 2009, fig. 49) and *Brevivula* (Gibson 2009, fig. 39) (extinct), and the scutellum apically is curved ventrally into a small hook-like process over the metanotum similar to extant species of *Lambdobrema* (Gibson 2009, figs 15, 16) and *Neanastatus* (Gibson 2009, fig. 21) as well as *Brevivula* (Gibson 2009, fig. 40).

Propelma keys to couplet 6 (*Brevivula* and *Lambdobrema*) using the key to genera of Neanastatinae in Gibson (2009). It differs from both genera in having the fore wing

uniformly setose (Fig.10) rather than with a linea calva (cf. Gibson 2009, figs 6, 42) and by having the prepectus as an isosceles triangle, only about 1.3× as long as high with the dorsal and ventral margins convergent to a narrowly rounded apex (Fig. 8: pre), rather than being conspicuously elongate-triangular and tapered into an acute angle (cf. Gibson 2009, figs 21, 41). It also differs from *Lambdobregma* by the absence of a transepisternal sulcus (Fig. 8; cf. Gibson 1989, fig. 92), and from *Brevivula* by having the mesoscutal lateral lobes evenly convex (Figs 6, 7) rather than carinately margined (cf. Gibson 2009, fig. 39).

Trjapitzin (1963) interpreted Mt_8 and Mt_9 as separate tergites in *P. rohdendorfi*, but these are certainly fused into a syntergum (Fig. 13: syn). He also interpreted the bare triangular region at the apex of the syntergum as Mt_{10} . However, comparison with extant taxa suggests that this region is a membranous lobe (Fig. 13: mbl) homologous with the anal filament of some extant chalcidoids with comparatively long ovipositor sheaths (cf. Gibson 1989, figs 148, 153). Trjapitzin (1963) also noted that the malar sulcus appears bifurcate in the holotype (Fig. 4), though this and what appears like a continuous sulcus across the propodeum and metanotum (Fig. 9: arrows) may more likely represent artefacts of preservation rather than real structures.

The recognition of *Propelma* as a valid genus of *Neanastatinae* results in four extinct genera described from Baltic amber (*Aspidopleura*, *Brevivula*, *Neanaperiallus* and *Propelma*) and four extant genera, of which one (*Lambdobregma*) is restricted to the New World, one (*Eopelma*) is restricted to the Oriental region, one (*Neanastatus*) is Old World in distribution, and one (*Metapelma*) is more widely distributed throughout both the Old and New World. *Metapelma* is also the only extant genus with a described extinct species, *M. archetypon* Gibson (2009), from Baltic amber. Pike (1995) and Perrichot et al. (2010) both questionably recorded a species of Eupelmidae from Grassy Lake Canadian Cretaceous and Charentese French Cretaceous amber, respectively. I have been unable to obtain these inclusions for examination, but the earliest known verifiable eupelmids are all *Neanastatinae* from Baltic amber. Extant *Neanastatinae* is far less diverse, measured either by number of described species (82) or genera (4), than either Calosotinae (152/8) or Eupelminae (729/33) (Noyes 2012). It is unknown whether the absence of Eupelminae and Calosotinae from Baltic amber is because these two clades diversified more recently than the Eocene age (55–34 mya) of Baltic amber (Weitschat and Wichard 2010) or because some biological factor such as host taxon, host stage or host habitat favoured fossilization of *Neanastatinae* over the other two groups in Baltic amber resin. Eupelminae are recorded from Dominican amber (20–30 mya), including one taxon identified as the extant genus *Zaischnopsis* Ashmead (Wu 1997, Poinar and Poinar 1999), but the diversity of eupelmids in Dominican amber has yet to be described or analyzed. Eupelminae have extremely diverse host biologies (Gibson 1997), though relatively few, including *Zaischnopsis* (Gibson 1995), are parasitoids of wood-boring beetles. Most Calosotinae are parasitoids of wood-boring Coleoptera, which might be thought to favour fossilization of individuals in amber unless the amber producing trees in Baltic forests lacked suitable hosts. Members of *Metapelma* are also parasitoids of wood-boring Coleoptera and, as noted

above, one species has been described from Baltic amber. Members of *Neanastatus* are primary or secondary parasitoids of Cecidomyiidae (Diptera), and at least some members of *Lambdobregea* could be egg parasitoids based on a single putative rearing of *L. schwarzii* (Ashmead) from cricket eggs (Orthoptera: Grylloidea) (Gibson 1989). Such a diverse host range among so few extant genera and the greater morphological diversity encompassed by the extinct and extant genera (Gibson 2009) compared to Calosotinae and Eupelminae could indicate Neanastatinae is a comparatively old lineage. Munro et al. (2011, Fig. 1) retrieved Neanastatinae as a relatively basal clade of Chalcidoidea with no close relationships to Calosotinae or Eupelminae using strictly molecular evidence. Using combined molecular and morphological evidence, Heraty et al. (2013) either retrieved Neanastatinae + Calosotinae as the sister-group of Eupelminae (likelihood analysis, fig. 10) or as a paraphyletic assemblage relative to Cynipencyrtidae and Tanaostigmatidae (parsimony analysis, fig. 9).

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