Four new Vetigastropoda (Anatomidae, Seguenziidae) from the northeastern Pacific

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ABSTRACT

Four new species of small to minute Vetigastropoda from two families are described: in the Anatomidae, *Anatoma georgii* new species from the intertidal of Alaska, with its radula illustrated; in the Seguenziidae, *Carenzia golikovi* new species, *Asthelys careyi* new species, and *Seguenzia macleani* new species, all from abyssal depth of the northeastern Pacific.

INTRODUCTION

Anatomidae was recently globally revised by Geiger (2012), with subsequent select additions and corrections by Pimenta and Geiger (2015) and Micali and Geiger (2015). The family comprises 83 valid species. There is generally less material available from higher latitudes, which in part explains that new taxa from relatively shallow waters can still be discovered. Thus far, five species are known from the northeastern Pacific: *Anatoma concinna* (A. Adams, 1962), *A. disciformis* (Golikov and Sirenko, 1980), *A. janetae* Geiger, 2006, *A. kelseyi* (Dall, 1905), and *A. lyra* (Berry, 1947).

Seguenziidae is a relatively small family with some 190 valid species listed in the World Register of Marine Species (Bouchet, 2010). It is generally a deep-water group, with relatively little material available. The most significant contributions have been those of Marshall (1983, 1991), Quinn (1983a; 1983b; 1987; 1997), and Poppe et al. (2006). While the group once was considered a deep divergence within archaeogastropods, in the suborder Seguenziina (Salvini-Plawen and Haszpurnar, 1987), it is now recognized as a specialized off-shoot within the larger Trochoidea (Kano, 2008; Geiger, 2012). Studies of the northeastern Pacific molluscan fauna have had sporadic contributions by Dall (1908; 1919), Rokop (1972), Quinn (1983a; 1983b), and McLean (1985); the number of valid species is subject to ongoing revisionary work.

The present contribution is part of the ongoing faunal revision of the northeastern Pacific gastropods. The project was initiated by the late James H. McLean (1936–2016), and is continued by D.L. Geiger, L. Groves, and J. Vendetti (editors; see www.nepacific.org).

MATERIALS AND METHODS

Standard methods for scanning electron microscopy (SEM) were used as detailed in Geiger et al. (2007) and Geiger (2012). Terminology for Anatomidae follows Geiger (2012), while no specialized terminology was necessary for Seguenziidae. Unless specified, measurements refer to maximum dimension. Institutional abbreviations used are: LACM: Natural History Museum of Los Angeles County, Los Angeles, California, USA; SBMNH: Santa Barbara Museum of Natural History, California, USA.

SYSTEMATICS

Anatomidae McLean, 1989

Anatoma Woodward, 1859

Type Species: *Anatoma crispata* Fleming, 1828 (subsequent designation Geiger, 2012: 734).

Anatoma georgii new species
(Figures 1–18)

Misidentification: *Anatoma lyra* (Berry, 1947): Geiger, 2012 (in part): fig. 784A (it is *A. georgii* new species).

Description: Shell small (1.36 mm, holotype 1.17 mm), trochiform depressed. Protoconch of 3/4 whorl, no apertural varix, apertural margin slightly sinusoid, flocculent sculpture. Teleoconch I of 2/3 whorl, finest growth lines only. Teleoconch II of up to 1 1/8 whorls. Shoulder slightly convex, with finest growth lines (Figure 12), last 1/8 whorls with about a dozen finest spiral threads. Suture impressed, sutsel about as wide as selenizone. Base biconvex, with distinct ridge at mid point, without constriction below selenizone, same sculpture of finest spiral threads as on shoulder, periumbilical cord

distinct, no funiculus. Umbilicus moderately wide. Aperture subquadratic. Selenizone at periphery, rather narrow for genus, keels low, slit open with parallel margins.

Animal with eyes. Radula rhipidoglossate, radular interlock moderate (Figures 14–15). Rachidian tooth triangular, cusp with central denticle largest, 4–5 smaller ones on each side (Figure 15). Lateral teeth 1–4 similar, cusp with 3–4 denticles, apicalmost largest (Figure 15). Lateral tooth 5 enlarged, approximately six denticles along inner edge of cusp, 2–3 along outer edge (Figure 16). Marginal teeth without food groove (Figure 17); inner marginal teeth with triangular cusp with 2–4 denticles on each side; outer marginal teeth with spoon-shaped cusp, many fine denticles (Figure 18).

Type Material: **Holotype** SBMNH 472248, dry shell with animal; **paratypes** SBMNH 469832 (1, in 70% ethanol, probably formalin fixed), SBMNH 469836 (1 in 70% ethanol, probably formalin fixed, 2 dry, radula on stub), SBMNH 469837 (2 in 70% ethanol, probably formalin fixed). All from type locality.

Type Locality: Hawk Inlet, Sakagway-Hoonah-Angoon County, Alaska, USA, 58.1237° N, 134.7553° W, intertidal.

Etymology: Named for naturalist and *viola d'amore* virtuoso, scholar, and teacher Thomas (Tom) Georgi for his masterful and nuanced interpretation of early music, particularly his tasteful gestures and ornamentation (Georgi, 2000; 2006; 2007; 2008), and for generously sharing his wealth of knowledge with players around the world, including the author.

Distribution: Alaska mainland to Aleutian Islands, USA.

Remarks: The northeastern Pacific *Anatoma* species differ from *A. georgii* as follows. *Anatoma concinna* has an overall globular shape (not lenticular) and has strong axial and spiral cords on shoulder and base. *Anatoma disciformis* shares the lenticular overall shape, but has distinct axial and spiral sculpture on shoulder and base of the teleoconch. *Anatoma janetae* grows much larger (3.8 mm); the early teleoconch has distinct axial cords in conjunction with the finer spiral lines. *Anatoma keenae* is overall more turreted, and has strong axial and spiral cords on shoulder and base. *Anatoma lyra* is proportionally taller and has axial sculpture of variable strength and a spiral cord in the position of the selenizone.

One specimen illustrated by Geiger (2012: fig. 784A) as a small specimen of *A. lyra* in fact is *A. georgii*. The specimen was also collected in very shallow water (7 m) on Attu Island, Alaska (LACM 79-71). It is a further example that multiple specimens of a new species help in its recognition. Early whorls of true *A. lyra* all have distinct axial sculpture, have a spiral cord in the position of the selenizone, and also have a proportionally wider selenizone. Accordingly, specimens of the new species are not juveniles of *A. lyra*, but the previously figured specimen was not recognized as being distinct.

Most *Anatoma* species are found between 100–1000 m depth; only a few are known from very shallow, and even intertidal waters, such as *A. parageia* Geiger and Sasaki, 2009, from southern Japan. Both species are among the smaller members of the genus *Anatoma*.

Other species with some shallow water records (<5 m/all records) include *A. amydra* Geiger and Marshall, 2012 (1/135 records), *A. aspera* (Philippi, 1844) (4/273 records), *A. conica* (d'Orbigny, 1841) (1/25 records), *A. crispata* (Fleming, 1828) (2/145 records), *A. flemingi* (Marshall, 2002) (1/32 records), *A. janusa* Geiger, 2012 (4/10 records), *A. orbiculata* Geiger, 2012 (1/3 records), *A. philippinica* (Bandel, 1998) (2/47 records), *A. pseudoequatoria* (Kay, 1979) (5/76 records), and *A. rapaensis* Geiger, 2008 (1/62 records). For those species with low frequency of shallow water occurrences, the records are rather an indication of post-mortem transport rather than extensive bathymetric range. The true bathymetric occurrence of the above species is impossible to determine based on empty shells alone. The frequency of records given above is taken as an uncertain proxy to the true range.

The illustrated shells still have some sediment attached to them. Because all material had been stored in fluid, it is extraordinarily fragile. The customary cleaning in an ultrasonic bath would most likely have shattered the specimens. Accordingly, the specimens were not further cleaned. Fortunately, all characters are sufficiently clear to permit an unambiguous assessment. Note that the aperture appears detached in the illustrated paratypes (Figure 5–11), and the sutsel appears wider than the width of the selenizone, contrary to the description. Those apparent discrepancies are artifacts due to the broken nature of the paratypes, as seen in the apical views.

The radula has no special attributes. It is the most common configuration in Anatomidae; see Geiger (2012) for extensive illustrations.

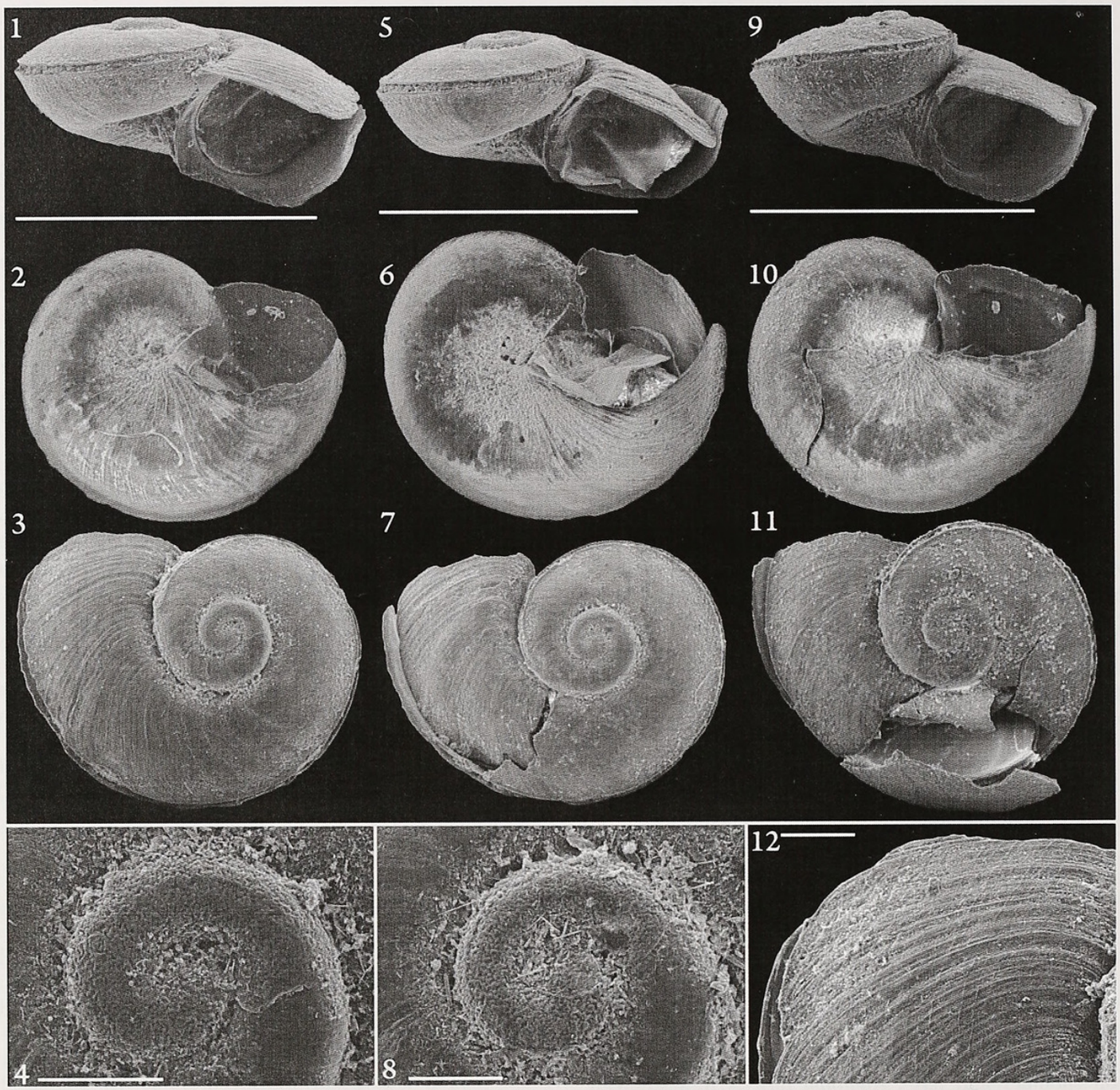
Seguenziidae Verrill, 1884

Remarks: The subfamilies and tribes introduced by Marshall (1991) lack unique diagnostic characters, and the cited character states vary widely within the taxa and overlap significantly among taxa. Marshall (1991: 46) noted the gradual changes amongst character states, and indicated that his tribes should rather be viewed as "informal groupings". The acceptance of a higher taxon by other authors does not mitigate the underlying issue of overlapping character states. Accordingly, none of those names are used here. A multivariate morphospace or phylogenetic analysis may clarify the validity of those higher taxa. The most detailed phylogenetic analysis only contains four seguenziids (Kano, 2008).

Carenzia Quinn, 1983

Type Species: *Seguenzia carinata* Jeffreys, 1877 (original designation).

Description: Shell conical, smooth, periphery carinate, mid-whorl carination more or less distinct; base convex, umbilicus narrow; apertural sinuses at periphery and base indistinct.



Figures 1–12. Shells of ***Anatoma georgii* new species. 1–4.** Holotype SBMNH 473348. **5–11.** Paratypes SBMNH 472236. Hawk Inlet, Sakagway-Hoonah-Angoon County, Alaska, USA, 58.1237 ° N, 134.7553° W, intertidal. Scale bars: shells = 1 mm; protoconch = 100 μm. **12.** Enlargement of apertural margin of holotype showing finest spiral threads. Scale bar = 100 μm.

***Carenzia golikovi* new species**
(Figures 19–22)

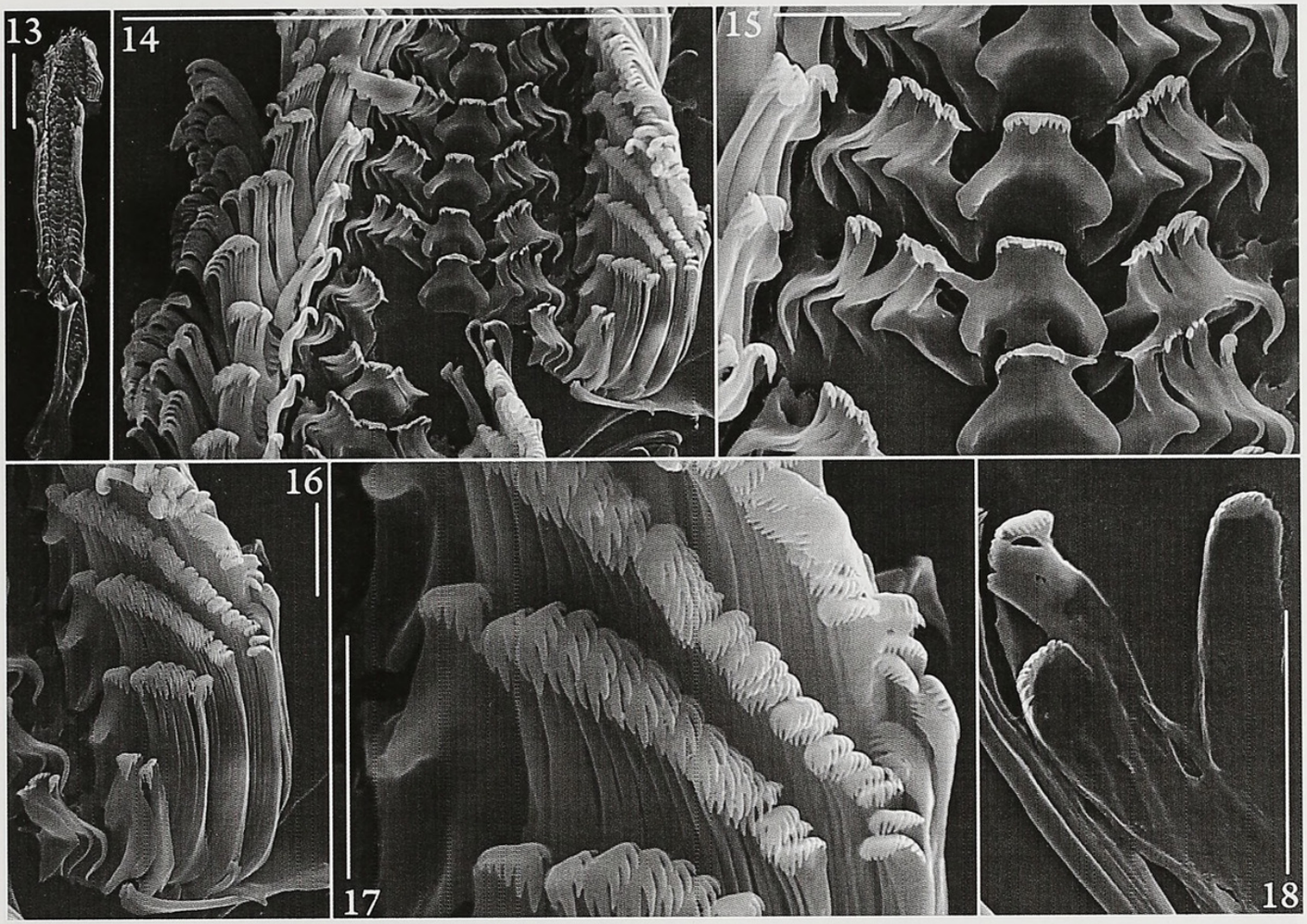
Description: Shell to 5 mm, trochiform; whorls five, rounded; carination on mid shoulder; base convex, good dozen irregularly spaced, spiral lines of variable strength; aperture subquadratic, umbilicus narrow, with indistinct funiculus; axial growth lines indistinct.

Type Material: Holotype LACM 3317, Oregon State University, R/V Wecoma (BMT 535), 19 August 1976; **paratypes** (2) LACM 3318, 5100 m, Aleutian Trench (near western end of chain), 52°12′ N, 175°44′ E, Roman Egorov, via Roger Clark and Ross Mayhew.

Type Locality: Abyssal plain W of Oregon, S of Gulf of Alaska, 5180 m, 45°00′ N, 153°47.7′ W to 45°02.3′ N, 153°55.9′ W.

Distribution: Aleutian Trench, 52° N, 176° W, to S Gulf of Alaska, 45° N, 154° W, 5100 m.

Etymology: Named for Russian malacologist Aleksandr Nikolaevich Golikov (1931–2010).



Figures 13–18. Radula of ***Anatoma georgii* new species. 13.** Entire radula. **14.** Full width of radula. **15.** Central field enlarged. **16.** Lateral tooth 5 and marginal teeth. **17.** Cusps of marginal teeth. **18.** Outermost marginal teeth. Scale bars: Figures 13–14 = 100 μm; Figures 15–18 = 10 μm.

Remarks: The overall shell morphology and the thin nacreous lining of the shell suggests placement in Seguenziidae. The closest genus is *Carenzia*, with the absence of strong axial sculpture and the spiral keels at the periphery and on the shoulder of the shell. In *C. golikovi*, however, only the keel on the mid-shoulder is present, while the keel at the periphery is not visible. It is notable that the spiral sculpture on the base starts right at the periphery, for which reason one could consider the uppermost spiral a reduced peripheral keel.

The most similar species in the northeastern Pacific include *C. inermis* Quinn, 1983, with a more basal carination and more inflated whorls. *Carenzia nitens* Marshall, 1991 from New Caledonia shares the smooth surface of the whorls, which, however, are biangulated.

Asthelys Quinn, 1987

Type Species: *Basilissa munda* Watson, 1879 (original designation).

Description: Shell small, biconical, bicarinate whorls macroscopically smooth, aperture trapezoidal.

Asthelys careyi new species

(Figures 23–24)

Description: To 7 mm, white; whorls five, smooth, slightly inflated; suture weakly impressed, base convex, smooth; basal angulation slightly projecting, with small channel above, resulting in weakly bicarinate configuration; aperture trapezoidal, umbilicus represented by narrow chink; bordered by narrowed columellar wall.

Type Material: **Holotype** LACM 3320, Oregon State University, R/V Wecoma (BMT 535), 19 August 1976.

Type Locality: Abyssal plain W of Oregon, S of Gulf of Alaska, 5180 m, 45° 00′ N, 153° 47.7′ W to 45° 02.3′ N, 153° 55.9′ W.

Distribution: Only known from holotype.

Etymology: Named for Professor Andrew Carey of Oregon State University, Corvallis.

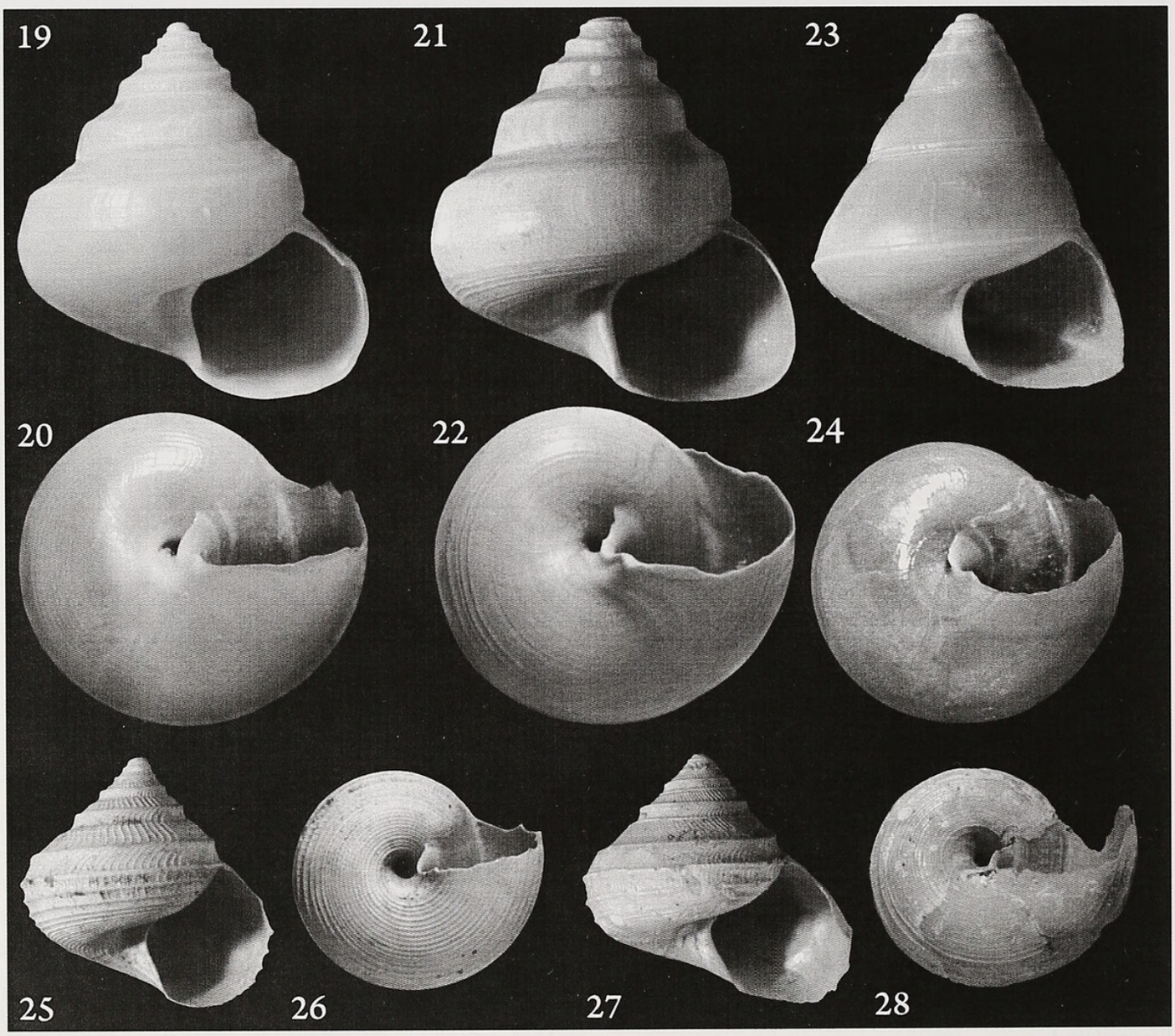
Remarks: The species is placed in the genus *Asthelys* for its conical overall shape and the diagnostic biangulate whorls (Quinn, 1987). That biangulation, though, is very subtle in *A. careyi*, amounting to not much more than a pair of parallel spiral ridges. It is the first representative of the genus from the northern Pacific. The other congeners are known from the Atlantic Ocean and New Caledonia.

The most similar species in the northeastern Pacific is *Carenzia inermis* (Quinn, 1983), which has a more trochiform overall shell shape, more inflated whorls, a rounded aperture, and a narrow yet distinct umbilicus.

***Seguenzia* Jeffreys, 1876**

Type Species: *Seguenzia formosa* Jeffreys, 1876 (monotypy).

Description: Shell to 10 mm, thin, fragile, umbilicate or anomphalous, external and internal surfaces with nacreous luster. Apertural lip bordering the three labral sinuses often flaring in mature shells. Columella curved, ending abruptly. Sculpture of narrow spiral carinae and basal cords, fine spiral threads and sharp axial riblets curving parallel to the labral sinuses.



Figures 19–28. New species of Seguenziidae. **19–22. *Carenzia golikovi* new species. 19–20.** Holotype LACM 3317, abyssal plain W of Oregon, S of Gulf of Alaska, 5180 m, approximately 45° N, 153.8° W, height 5.3 mm. **21–22.** Paratypes LACM 3318, Aleutian Trench (near western end of chain), 5100 m, 52°12′ N, 175°44′ E. **23–24. *Asthelys careyi* new species.** Holotype LACM 3320, abyssal plain W of Oregon, S of Gulf of Alaska, 5180 m, approximately 45° N, 153.8° W, height = 7.0 mm. **25–28. *Seguenzia macleani* new species. 25–26.** Holotype, LACM 3321, Aleutian Trench, 5100 m, 175° 44′ E, ~55° 30′ N, height = 8.7 mm. **27–28.** Paratype LACM 3486, abyssal plain W of Oregon, S of Gulf of Alaska, approximately 45° N, 153.8° W, height = 9.6 mm. Photos by James H. McLean.

***Seguenzia macleani* new species**
(Figures 25–28)

Description: Shell 9.6 mm (holotype), 8.7 mm (paratype), trochiform; whorls four, inflated, suture little impressed; spiral cords decreasing in strength from shoulder to base, one on shoulder, one at suture, approximately a dozen on base with stronger spirals randomly interspersed amongst the fine ones; crossed by axial lines decreasing in strength from suture to umbilicus: fewer stronger ones (holotype) or more numerous finer ones (paratype); aperture rounded; umbilicus wide, no funiculus; columella not thickened.

Type Material: **Holotype** LACM 3321 (Figs 25–26), Roman Egorov, via Roger Clark and Ross Mayhew; **paratype** LACM 3485 from type locality; **paratype** LACM 3486 (Figures 27–28), abyssal plain W of Oregon, S of Gulf of Alaska, 5180 m, 45° 00′ N, 153° 47.7′ W to 45° 02.3′ N, 153° 55.9′ W, Oregon State University, R/V WECOMA (BMT 535), 19 August 1976.

Type Locality: Aleutian Trench (near western end of chain), 5100 m, 175° 44′ E, ~55° 30′ N.

Distribution: Abyssal plain off Alaska and Oregon, 45° N, 5100–5180 m.

Etymology: The species honors James H. McLean, who first recognized this new species.

Remarks: The most similar species is *S. cerveola* Dall, 1919, which differs from *S. macleani* by the thickened columella and the columellar chink partially covering the umbilicus. This distinction cannot be explained by size, because the larger *S. macleani* lacks the thickening. Additionally, the spiral sculpture is stronger in *S. cerveola*.

DISCUSSION

The present contribution adds additional taxa of micromollusks to the northeastern Pacific malacofauna. The diversity of Anatomidae, now with six recognized species, is at the lower end in relation to those of other temperate regions. Difficulty to reach the deep-water habitats of most Seguenziidae makes an assessment of their true diversity very challenging, because of limited availability of samples from >200 m, with abyssal plain habits being particularly understudied. The less than one dozen species diversity in the northeastern Pacific is similar to that of six species known from Japan (Okutani, 2017).

The specimens of *A. georgii* were found in voucher material from an ecological study deposited at SBMNH and identified as "*Scissurella* sp." This is an instance that confirms the paradigm that new fieldwork is not necessarily required for the discovery of new taxa. The backlog of unprocessed material in natural history collections represents a highly valuable and readily accessible source for additional material. Given the ever more restrictive permitting requirements and import-export complications, working up backlog material is an excellent and cost-effective strategy for discovering new taxa.

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LITERATURE CITED

Bouchet, P. 2010. Seguenziidae. In: MolluscaBase (2017). Accessed through: World Register of Marine Species at http://www.marinespecies.org/aphia.php?p=taxdetails&id=23116 on 2017/11/14.

Dall, W.H. 1908. Reports on the dredging operations off the west coast of Central America to the Galapagos, to the west coast of Mexico, and in the Gulf of California XIV. The Mollusca and Brachiopoda. Bulletin of the Museum of Comparative Zoology, Harvard 43: 205–487, pls. 1–22.

Dall, W.H. 1919. Description of new species of Mollusca from the North Pacific Ocean in the collection of the United States National Museum. Proceedings of the United States National Museum 56: 293–371.

Geiger, D.L. 2012. Monograph of the Little Slit Shells. Santa Barbara Museum of Natural History, 1291 pp., 1042 figs., 5 color plates, 11 identification cards.

Geiger, D.L., B. Marshall, W.F. Ponder, T. Sasaki, and A. Warén. 2007. Techniques for collecting, handling, and preparing small molluscan specimens. Molluscan Research 27 (Special Issue): 1–50.

Georgi, T. 2000. Many Strings Attached. Eighteenth Century Music for Viola d'amore. Georgi, Toronto.

Georgi, T. 2006. Attilio Ariosti, The Stockholm Sonatas I. Lessons and Sonatas for Viola d'amore. BIS-CD-1535, Åkersberga.

Georgi, T. 2007. Attilio Ariosti, The Stockholm Sonatas II. Recueil de Pièces pour la Viola d'amour, part 1. BIS-CD-1555, Åkersberga.

Georgi, T. 2008. Attilio Ariosti, The Stockholm Sonatas III. Recueil de Pièces pour la Viola d'amour, part 2. Pur alfin gentil viola. BIS-CD-1675, Åkersberga.

Kano, Y. 2008. Vetigastropod phylogeny and a new concept of Seguenzioidea: independent evolution of copulatory organs in the deep-sea habitats. Zoologica Scripta 37: 1–21.

McLean, J.H. 1985. Two new northeastern Pacific gastropods of the families Lepetidae and Seguenziidae. The Veliger 27: 336–338.

Marshall, B.A. 1983. Recent and Tertiary Seguenziidae (Mollusca: Gastropoda) from the New Zealand Region. New Zealand Journal of Zoology 10: 235–262.

Marshall, B.A. 1991. Seguenziide from New Caldedonia and the Loyalty Islands. Résultats de Campagnes MUSORSTOM 7, Mémoires du Muséum national d'Histoire naturelle (A) 150: 41–109.

Micali P. and D.L. Geiger. 2015. Additions and corrections to the Scissurellidae and Anatomidae (Gastropoda Vetigastropoda) of the Mediterranean Sea, with first record of *Sinezona semicostata* Burnay and Rolán, 1990. Biodiversity Journal 6: 703–708.

Okutani, T. 2017. Family Seguenziidae. In T. Okutani (ed.). Marine Mollusca in Japan, second edition. Tokai University Press, Kanagawa, p. 767, pl. 37.

Pimenta, A.D. and D.L. Geiger. 2015. Taxonomic revision of the Anatomidae (Mollusca: Gastropoda: Vetigastropoda) from

Brazil, with description of four new species. Malacologia 59: 135–175.

Poppe, G.T., S.P. Tagaro, and H. Dekker. 2006. The Seguenziidae, Chilodontidae, Trochidae, Calliostomatidae and Solariellidae of the Philippine Islands. Visaya Supplement 2: 1–228.

Quinn, J.F., Jr. 1983a. *Carenzia*, a new genus of Seguenziacea (Gastropoda: Prosobranchia) with the description of a new species. Proceedings of the Biological Society of Washington 96: 355–364.

Quinn, J.F., Jr. 1983b. A revision of the Seguenziacea Verrill, 1884 (Gastropoda: Prosobranchia). I. Summary and evaluation of the superfamily. Proceedings of the Biological Society of Washington 96: 725–757.

Quinn, J.F., Jr. 1987. A revision of the Seguenziacea Verrill, 1884 (Gastropoda: Prosobranchia). II. The new genera *Hadroconus*, *Rotellenzia*, and *Asthelys*. The Nautilus 101: 59–68.

Quinn, J.F. 1991. Systematic position of *Basilissopsis* and *Guttula*, and a discussion of the phylogeny of the Seguenzoidea (Gastropoda: Prosobranchia). Bulletin of Marine Sciences 49: 575–598.

Rokop, F.J. 1972. Notes on abyssal gastropods of the eastern Pacific, with descriptions of three new species. The Veliger 15: 15–19, 2 pls.

Salvini-Plawen, L.v. and Haszprunar, G. 1987. The Vetigastropoda and the systematics of streptoneurous Gastropoda (Mollusca). Journal of Zoology 211: 747–770.