



## Calliostomatidae of the northeast Pacific

PAUL M. TUSKES

3808 Sioux Ave., San Diego, California, 92117, USA. E-mail: [tuskes@AOL.com](mailto:tuskes@AOL.com)

### Abstract

Four genera of Calliostomatidae are known from the northeast Pacific, *Akoya*, *Calliostoma*, *Otukaia*, and *Xeniostoma*. Fifteen holotypes and all species are illustrated and diagnostic information presented. Approximately one third of the species occur most commonly below 100 m, some species have been collected in excess of 1,000 m. *Akoya titanium* (McLean, 1984) and *A. bernardi* (McLean, 1984) are recognized as synonyms of *A. platinum* (Dall, 1890). Confirmed diet of the species, which are known, includes primarily sessile invertebrates and diatoms.

**Key Words:** Calliostomatidae, *Calliostoma*, *Otukaia*, *Xeniostoma*, *Akoya* northeast Pacific

### Introduction

Although morphological and dietary differences between calliostomids and Trochidae were previously known (Hickman & McLean 1990, Perron 1975), it was not until DNA data indicated the group was distinct, that Calliostomatidae Thiele (1924) was widely accepted (Bouchet & Rocroi 2005, Williams *et al.* 2010). Members of Calliostomatidae occur nearly worldwide, exhibiting physical and habitat diversity. Comments regarding diet, reproduction, habitat and shell appearance are specific to those species of the northeast Pacific.

The northeast Pacific spans multiple marine provinces (MP) including, the Arctic, Oregonian-Alaskan, and Californian, which collectively encompasses coastal Alaska (USA), British Columbia (Canada), Washington, Oregon, California (USA), and Baja California (Mexico).

Four genera of Calliostomatidae are currently recognized from the northeast Pacific:

*Akoya* Habe, 1961. White shelled species occurring in moderately deep water from Alaska to southern California, with conical shape, low cords and threads beaded/not beaded.

*Calliostoma* Swainson, 1840. Species with variegated patterns with threads/cords often beaded, shells cream brown, gray, soft yellow, often with multi colored peripheral band, flammules or blotches.

*Otukaia* Ikebe, 1942. White shelled species occurring in moderately deep water in the Bering Sea, with large strongly keeled cords may lack beading.

*Xeniostoma* McLean, 2012. Small species with a white shell lacking threads, cords, or carination, umbilicus open, from moderately deep water off Alaska.

The goal of this contribution is to facilitate the identification of Calliostomatidae from the northeast Pacific and to compile past and current literature relevant to their identity. Distinctive shell characteristics are provided to aid in identification and are not re-descriptions of named taxa. Approximately one-third of the calliostomids in the northeast Pacific occur most frequently below 75–100 m, the remainder may be found intertidally or while SCUBA diving. As deep-water surveys continue, it is expected that the known range of numerous species will be expanded. Many species prevalent in the Oregonian MP and further north are less abundant in the Californian MP and often at greater depths where the water is cooler. The temperate Californian MP also contains some tropical species typical of the Panamic MP. *Otukaia* and *Xeniostoma* are both deep-water genera. At present, *Xeniostoma* is a monotypic genus.

## Materials and Methods

The collection of the San Diego Natural History Museum (SDMNH), Natural History Museum of Los Angeles County (LACM), Santa Barbara Museum of Natural History (SBMNH), the Benthic Collection at Scripps Institute of Oceanography (SIO), City of San Diego Ocean Monitoring Program (CSDOMP), Carnegie Museum of Natural History (CMNH), National Museum of Natural History, Smithsonian (USNM) were visited and various private collections examined. The computerized collection database of the California Academy of Science (CAS, CASIZ), Academy of Natural Sciences, Philadelphia (ANSP), and the Natural History Museum of London (NHMUK), were also reviewed. In addition, the author has SCUBA-dived and studied *Calliostoma* in the Oregonian, Californian, and Panamic marine provinces.

## Abbreviations

H/W        Height and width measurements  
MP        Marine Province

## Systematics

### *Calliostoma* Swainson, 1840

*Calliostoma* Swainson, 1840: 218, 351. Type species (SD Herrmannsen 1846: 154): *Trochus conulus* Linnaeus, 1758. Europe.

**Description.** Shell moderately high-spired, whorls flat-sided or rounded; final lip not thickened. Peristome incomplete, columella lacking folds or denticles, somewhat thickened, truncate toward base, often with external oblique columella scar or sulcus. Early sculpture beaded spiral threads/cords, beading persisting or lost in later growth stages. Protoconch with reticulate sculpture, rounded pits. Color patterns often variegated; interior iridescent, exterior surface may show metallic luster. *Calliostoma* of northeast Pacific without open umbilicus or sulcus, but rather slight scar-like shallow depression.

**Remarks.** *Calliostoma* of the northeast Pacific are opportunistic feeders on a range of soft bodied sessile invertebrates and are occasional scavengers, allowing them to occur in varied habitats and depths compared to the Eastern Pacific Trochidae that consume algae. Prey species include bryozoans, hydrozoans, sponges, diatoms, and various cnidarians including the anemone *Corynactis californica* (Carlgren, 1936), hydrocoral *Stylaster californica* (Verrill, 1866), and gorgonians (Perron 1975, Keen 1975, Harbo 2007, Morris *et al.* 1990, Stone *et al.* 2014, Tuskes & Tuskes 2019). Three species [*C. annulatum* (Lightfoot, 1786), *C. canaliculatum* (Lightfoot, 1786), *C. ligatum* (Gould, 1849)], may be found on large brown kelp and consume the fauna that lives on the fronds and periodically the fronds or reproductive growth. See Tuskes & Tuskes (2019) for additional details regarding the diet of specific species and other biological information. The reproductive biology of *C. ligatum*, as a broadcast spawner is similar to *Tegula* in the family Trochidae; for details on development see Holyoak (1988).

**Species Excluded.** A single specimen of *Calliostoma antonii* (Koch, 1843), USNM 206116, is labeled San Diego, California “Cooper”. That record is doubtful as no other California material has been found, and McLean (1971) gave the distribution of *C. antonii* as El Salvador to Peru.

### *Calliostoma annulatum* (Lightfoot, 1786)

(Figure 1)

*Trochus annulatus* “Martyn,” Lightfoot, 1786: 101. Type whereabouts not known. Type locality not designated.

*Trochus annulatus* Martyn, 1784: pl. 33 [unavailable]. ICZN (1957: opinion 456).

*Trochus virgineus* Chemnitz, 1788: 10: 289, pl. 165, figs 1581, 1582 [unavailable]. ICZN (1954: direction 1).

*Trochus rubiginosus* Valenciennes, 1846: pl. 4, figs 1, 1a, 1b. Type whereabouts unknown. Type locality not designated.

**Description.** Shell relatively thin, height 20–35 mm. Ground color golden yellow, apex purple; whorls

slightly convex; threads golden-yellow, lightly beaded; cords golden-yellow, bead color alternating light yellow, red/brown; peripheral band bright purple; base rounded, basal threads 7–10 beaded, purple, band extends from lip, wraps around columella into shell; columella scar iridescent silver.

**Distribution.** The northern record for this species is east of Afognak Island, Alaska, 58°18.13'N, 151°09.93'W (Clark 2018). The southern record is currently San Geronimo Island, Baja California (30° N). Found on rocky bottoms, *Macrocystis* kelp and other large kelp species. Locally common north of Point Conception, Santa Barbara County, California, uncommon south of Point Conception. Lower intertidal to 45 m.

**Remarks.** Old museum material fades such that the purple band and beading becomes drab yellow-brown. Small faded shells appear similar to faded *C. variegatum*. The whorls of *C. annulatum* are convex and beads are uniform in size; whorls of *C. variegatum* are flat, threads have smaller beads than those on cords.

### ***Calliostoma canaliculatum* (Lightfoot, 1786)**

(Figure 2)

*Trochus canaliculatus* “Martyn” Lightfoot, 1786: 101. Type whereabouts unknown. Type locality not designated.

*Trochus canaliculatus* Martyn, 1784: pl. 42 [unavailable]. ICZN (1957: opinion 456).

*Trochus doliarius* Chemnitz, 1788: 10: 288, pl. 165, figs 1579, 1580 [unavailable]. ICZN (1954: direction 1).

**Description.** Shell relatively thin, height 20–45 mm. Ground color tan; whorls flat-sided, spiral cords prominent, color off-white, smooth, beading vestigial if present; interspace tan–brown; flammules when present brown; base angulate, basal cords 5–6 smooth, threads 4–5 smooth, columella scar iridescent purple-gray.

**Distribution.** Sitka, southeastern Alaska (57°N), to San Benito Island (28°N), Baja California. Locally common north of Point Conception, Santa Barbara County, California, lower intertidal to 90 m, found on kelp fronds and hard structure. Uncommon south of Point Conception.

**Remarks.** The largest *Calliostoma* species in the northeast Pacific. Both *C. canaliculatum* and *C. ligatum* have strong smooth cords. The whorls of *C. ligatum* are bulbous, and the base is rounded, while whorls of *C. canaliculatum* are nearly flat, and the base angulate.

### ***Calliostoma eximium* (Reeve, 1842)**

(Figure 3)

*Trochus eximius* Reeve, 1842a: 185; Reeve (1842b: pl. 118, fig. 12). Holotype: Museum Cuming: not at NHMUK. Payanum, Panama Bay, Panama, muddy sand, 10 fm (18.3 m).

*Trochus versicolor* Menke, 1850: 172–173. Holotype whereabouts unknown. Mazatlan.

**Description.** Shell sturdy, height 20–27 mm. Ground color gray-yellow to light yellow; whorls concave above, shoulder convex; periphery flat, shoulder sloping tabulate; threads low, beaded, dark brown dashes form broken lines; body whorl flammules, when present, gray-brown, vary in intensity; base rounded, basal threads shallow/alternating light brown-orange spots, columella/scar metallic silver.

**Distribution.** Cedros Island (28°N), Baja California, Gulf of California, south to Peru (10°S). Specimens have been collected intertidally on muddy sand and to depths of 50–60 m. Locally common.

**Remarks.** Both Dall (1921) and Oldroyd (1927) listed Santa Catalina Island off southern California as the northern extent of the range. Reeve (1842a, 1842b) was not the source, as he only mentions the type locality in Panama. One dubious specimen is in the SDNHM from La Jolla (San Diego), but the data card with the same number as the shell lacked both date and collector and was for a series of *C. tricolor*.

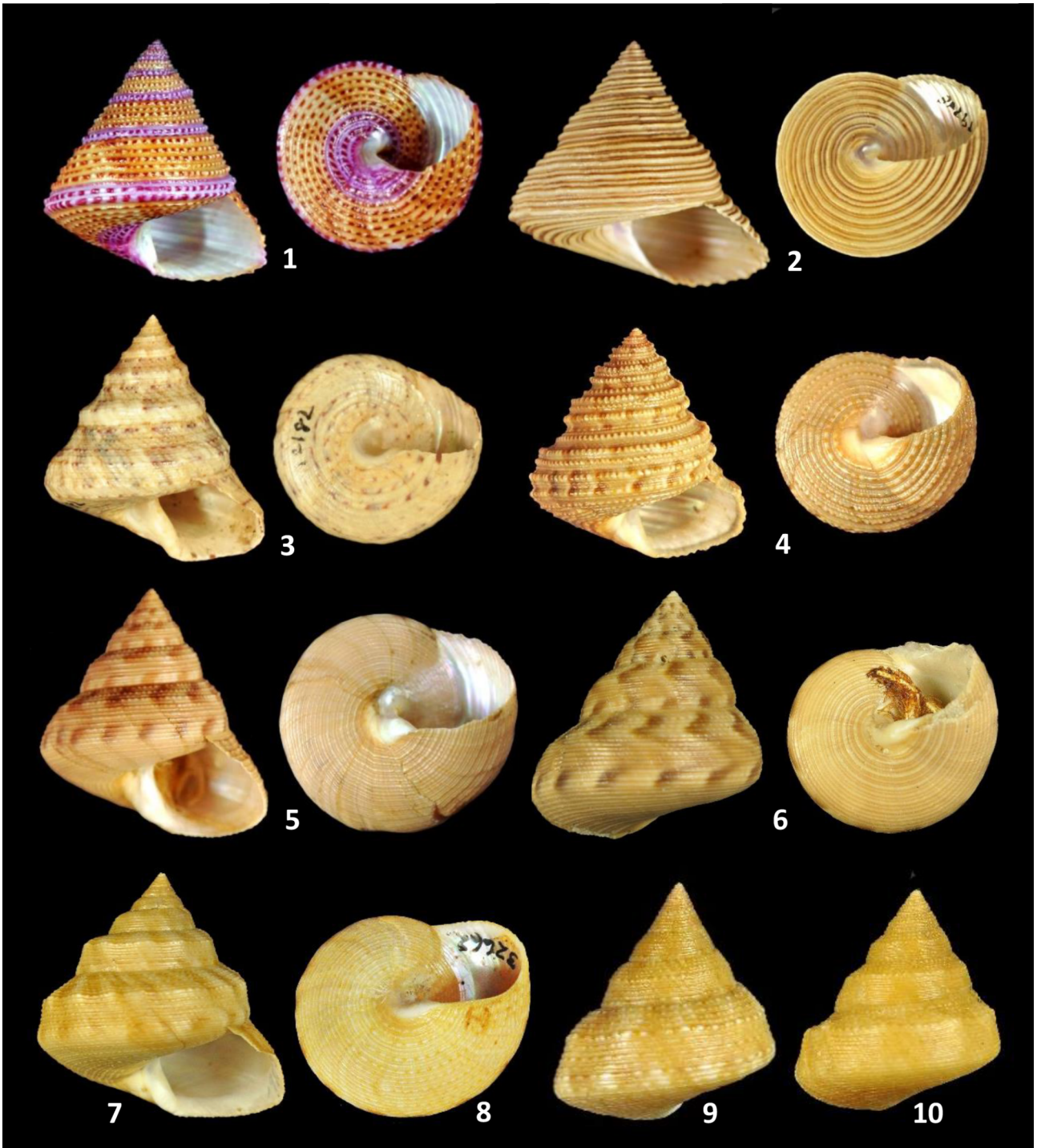
### ***Calliostoma gemmulatum* Carpenter, 1864**

(Figures 4, 26)

*Calliostoma formosum* Carpenter, 1864b: 156. Holotype USNM 16261. San Pedro, California. (unavailable, non McAndrew & Forbes, 1847)

*Calliostoma gemmulatum* Carpenter, 1864a: 215 [new name for *C. formosum* Carpenter].

*Margarites kepi* Smith & Gordon, 1948: 228–229, pl. 4, figs 5–7. Holotype CAS Paleo 8557. Monterey Bay, 25 fm.



**FIGURES 1–10.** 1. *Calliostoma annulatum* 27.1 mm, Monterey Bay, Monterey County, California, (LACM 181622). 2. *Calliostoma canaliculatum* 37.2 mm, on floating kelp, Monterey Bay, Monterey County, California (LACM 19748). 3. *Calliostoma eximium* 26.7 mm, Scammons Lagoon, Baja California (SDMNH 2903). 4. *Calliostoma gemmulatum* 17.6 mm, San Pedro, Los Angeles County, California (LACM 23418). 5. *Calliostoma gloriosum* 28.4 mm, San Pedro, Los Angeles County, California, (LACM 57752). 6. *Calliostoma gloriosum* 21.2 mm, Sacramento Reef, south of Geronimo Island, Baja California (LACM 3640). 7. *Calliostoma guerreroensis* holotype (LACM 3640), 32.4 mm, off Magdalena Bay, Baja California. 8–9. *Calliostoma guerreroensis* paratypes, off Laguna Guerrero Negro, Baja California (SBMNH 132662). 8. 23.6 mm. 9. 15.9 mm. 10. *Calliostoma guerreroensis* paratype. 14.9 mm, subadult, off Natividad Island, Baja California, (LACM 71-165.10).

**Description.** Shell thin, height 13–21 mm. Ground color brown, vertical streaks/blotches brown/olive; whorls convex, suture deeply impressed; body whorl, three cords strongly beaded, interspaced low beaded thread 2–3, shoulder multiple fine threads, minutely beaded; base angular, basal cords 10–12, alternating light brown-orange spots; beading absent/weak, columella scar metallic white.

**Distribution.** San Simeon (CM 142913), San Luis Obispo County, California (35°N), to San Juanico Bay (26°N), Baja California Sur. Intertidal to 100 m. Rocky habitats along the open coast and rocky entries to bays. Often not collected for intervals of several years. Uncommon.

**Remarks.** *Margarites keepi* was based upon a juvenile shell 2 mm in height taken in Monterey Bay, California (38°N); mature specimens have not been collected that far north.

### ***Calliostoma gloriosum* Dall, 1871**

(Figures 5–6, 27)

*Calliostoma gloriosum* Dall, 1871: 127. Holotype USNM 206134. Monterey Bay, California.

**Description.** Shell sturdy, height 20–35 mm. Ground color dull orange, tan, to gray-brown; whorls lightly convex, body whorl, threads finely beaded below suture, peripheral threads not beaded; flammules light/dark brown or orange-brown; base angular; basal threads fine, not beaded; columella scar silver-white.

**Distribution.** *Calliostoma gloriosum* occurs from San Francisco, California (38°N), to at least San Benito Island, (27°N), Baja California. Common north of Point Conception, Santa Barbara County, California, occurring from the lower rocky intertidal to 100 m. Uncommon south of Point Conception, California, 5–100 m.

**Remarks.** A small percentage of shells have notably bulbous whorls. *Calliostoma gloriosum* has been confused with *Calliostoma guerreroensis*, see below.

### ***Calliostoma guerreroensis* Tuskes & Tuskes, 2019**

(Figures 7–10)

*Calliostoma guerreroensis* Tuskes & Tuskes, 2019: 11, figs 7–10. Holotype LACM 3640. 24–27 m, 5.45 mi. 230° T, from Punta Entrada, Bahía Magdalena, Baja California Sur, Mexico (24°37.2'N, 112° 01.00'W). Leg. R/V *Velero IV* 1971-50 (LACM 50-41).

**Description.** Shell sturdy, height 25–35 mm; ground color light yellow-brown (straw). Bodywhorl, shoulder with 5–6 beaded cords, lightly beaded thread between cord; distinctive axial ridges, diagonal flammules alternating brown/cream, raised/not raised; below last prominent cord of shoulder angle abruptly changing from approximately 35 degrees to approximately 80–90 degrees; lateral surface with 3–4 beaded cords alternating cream/straw, threads between cords smooth/low profile straw beads; peripheral band, three cords, alternating brown square with larger cream rectangular markings, cords beaded, alternating cream/straw; base with 16–18 shallow straw cords with/without low beading, interspace threads, cords proximal to columella broader, numerous cords with alternating cream/straw spots present; columella white, shallow columellar scar white to lustrous.

**Distribution.** From Cedros Island, Baja California to Magdalena Bay, Baja California Sur. Depth 27–55m. Uncommon.

**Remarks.** The unique axial ridges on body whorls 6–7 are not present on smaller shells. The intensity of the peripheral bands is variable and may not be notable in juveniles. The ground color may be slightly darker among juveniles. The number of basal cords with alternating cream/light brown spots is variable but always present. Juvenile shells typically lack the distinct pattern of mature shells. Shells of subadults have the shape and markings of adults, but lack bulk. This species is easily distinguished by its stepped profile and alternating cream/light brown spots on basal cords; *C. gloriosum* (Figs 5–6) lacks these characteristics and has a rounded profile.

### ***Calliostoma keenae* McLean, 1970**

(Figure 11)

*Calliostoma keenae* McLean, 1970: 424, pl. 62, figs 13, 14. Holotype LACM 1272. Off Laguna Beach, Orange County, California, 106–109 m.

**Description.** Shell thin, height 10–15 mm. Ground color drab yellow; whorls convex, shoulder sloping tabulate, threads below suture beaded, threads immediately above, below periphery band, typically smooth; flammules light brown; peripheral band alternating dark brown/white. Base rounded, basal threads nearly smooth; columella scar light brown. Shell coloration fades with age.

**Distribution.** Laguna Beach, Orange County, California (34°N), to Cape San Lucas, Baja California Sur, south to Clarion Island (18°N) in the Revillagigedo group. Skoglund & Koch (1993) reported this species in the Gulf of California, as far north as Los Angeles Bay, depth 45–110 m. Rare.

### *Calliostoma ligatum* (Gould, 1849)

(Figures 12, 28)

*Trochus ligatus* Gould, 1849: 91; 1856: pl. 12, fig. 207. Holotype USNM 5608. Puget Sound, Washington.

*Trochus costatus* Martyn, 1784: pl. 34 [unavailable ICZN (1957: opinion 456), not *T. costatus* Gmelin, 1791]. Holotype whereabouts unknown. No type locality designated.

*Trochus filiosus* Wood, 1828: 17, 56 [not Helbling, 1779]. Holotype whereabouts unknown. Type locality not designated.

*Trochus modestus* Middendorff, 1849: 413, pl. 10, figs 16–18 [not Reeve, 1842, nor Koch, 1845]. Holotype whereabouts unknown. Sitka Island, Alaska.

*Trochus middendorffii* Philippi, 1851: 337 [new name for *T. modestus* Middendorff].

*Trochus castaneus* “Nuttall,” Forbes, 1852: 271. Holotype whereabouts unknown. Upper California.

*Calliostoma costatum caeruleum* Dall, 1919: 359. Syntype USNM 59808. Monterey, Monterey County, California.

*Calliostoma costatum pictum* Dall, 1919: 359. Syntype USNM 12612a. Neah Bay, Clallam County, Washington.

**Description.** Shell sturdy, height 17–30 mm. Ground color brown-light brown; whorls bulbous; early spiral cords smooth/rarely lightly-beaded; lower whorls, cords unbeaded, light brown-off white; interspaces broader than cords, brown-light brown; base rounded, basal cords smooth (8–12) light brown; columella scar metallic white.

**Distribution.** Afognak Island, Alaska (58°N), to San Benito Island, Baja California (28°N). Locally common in rocky intertidal to 30 m. South of Point Conception, Santa Barbara County, California, found at 20–95 m on hard substrate. Scarce.

**Remarks.** There are two color forms, *caeruleum* has a sub-sutural purple band and form *pictum* has brown flammules. The purple band of *C. ligatum* often fades completely within 1–2 years after collection. Purple-ringed *C. ligatum* are easily separated from *C. annulatum*, by examining the cords, *C. ligatum* has smooth cords while those of *C. annulatum* are strongly beaded. Also see *C. canaliculatum*.

### *Calliostoma nepheloide* Dall, 1913

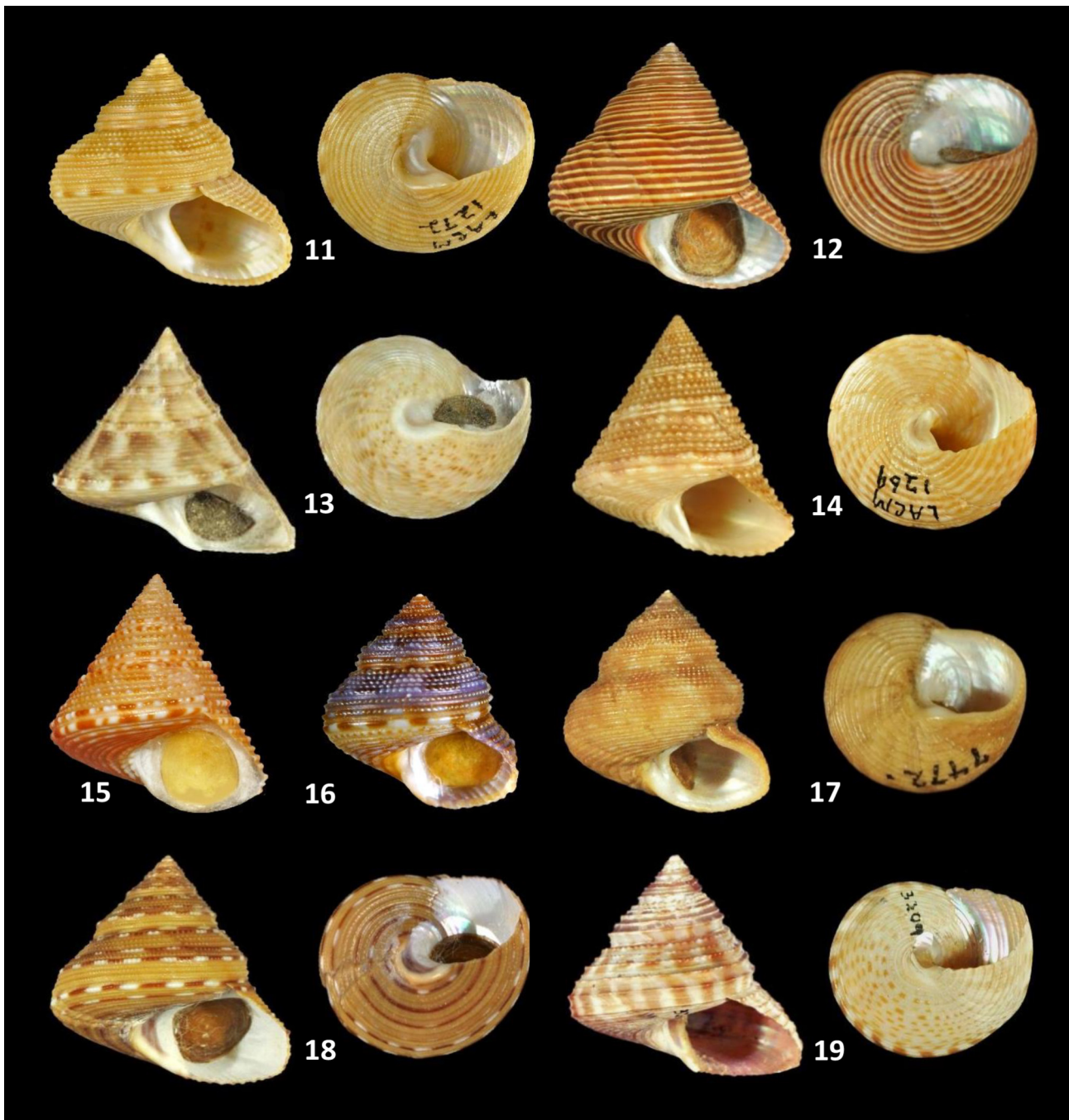
(Figures 13, 29)

*Calliostoma nepheloide* Dall, 1913: 592. Two syntype USNM 96637. Panama Bay, Panama, 86 m.

**Description.** Shell thin, height 15–28 mm. Ground color olive-brown to yellow-brown; whorls flat; two prominent beaded peripheral cords; threads numerous, shallow, beaded lightly, interspace metallic copper/light brown; flammules dark purple-brown/absent; peripheral band alternating white/brown; base angulate, basal threads 17–22 shallow, beaded; columella scar metallic white/silver.

**Distribution.** Point Abreojos (27°N), Baja California Sur, to Panama (18°N). McLean (1971) gave a depth of 73–120 m, which is consistent with data on museum material. Houston (1980) indicated the species was common in Baja California Sur in both estuaries and mangroves stands with sandy-mud bottoms and found intertidally; although contrary to museum records it may represent a previously unidentified aspect of its biology.

**Remarks.** This species has been taken in deep water in the northern transition zone between the Californian and Panamic MP and is included because there is a reasonable possibility that it will be found within the geographic scope of this publication series.



**FIGURES 11–19.** 11. *Calliostoma keenae* holotype (LACM 1272), 15.6 mm, Laguna Beach, Los Angeles County, California. 12. *Calliostoma ligatum* 26.2 mm, Morro Bay, San Luis Obispo County, California (LACM 181023). 13. *Calliostoma nepheloide* 15.6 mm, Chiriqui, Golfo de Chiriqui, Panama (SBNHM 157918). 14. *Calliostoma sanjaimense* holotype (LACM 1263), 20.0 mm. San Jaime Bank off Cape San Lucas, Baja California 15. *Calliostoma sanjaimense* 16 mm, Nine Mile Bank off San Diego, San Diego County, California (LaGrange collection). 16. *Calliostoma supragranosum* 8 mm, Mission Bay Jetty, San Diego, San Diego County, California (Tuskes collection). 17. *Calliostoma supragrenosum* 12.9 mm, San Pedro Bay, Los Angeles County, California (SBMNH 7772). 18. *Calliostoma tricolor* 21.5 mm, White Point, Los Angeles County, California (SBMNH 16907). 19. *Calliostoma turbinum* 17.3 mm, La Jolla, San Diego County, California, 183 m (SBMNH 103209).

***Calliostoma sanjaimense* McLean, 1970**

(Figures 14–15)

*Calliostoma sanjaimense* McLean, 1970: 423, pl. 62, fig. 11. Holotype LACM 1269. San Jaime Bank, Baja California Sur, 137 m.

**Description.** Shell small; height 10–16 mm. Ground color dark yellow; whorls flat; texture rough; two peripheral cords strongly developed, beaded, alternately marked white/orange-brown; threads dark yellow, beaded dark yellow/brown; base angulate, 9–11 cords nearly smooth; columella metallic white.

**Distribution.** A deep-water species from San Diego (33°N), 140–160 m (LaGrange 1992), south to Cape San Lucas (23°N), Baja California Sur. Rare.

**Remarks.** The holotype has faded.

***Calliostoma supragranosum* Carpenter, 1864c**

(Figures 16–17, 30)

*Calliostoma supragranosum* Carpenter, 1864c: 653. Holotype USNM 14925 (Palmer 1958: pl. 17, figs 14, 15). San Diego, California.

*Calliostoma splendens* Carpenter, 1864b: 156. Syntype USNM 16278 (Palmer 1958: pl. 17, figs 11, 12). Santa Catalina Island, California.

**Description.** Shell thin, height 8–14 mm. Ground color reddish-brown whorls convex; body whorl threads beaded above periphery, beading light/absent below periphery, flammules present/absent darker than ground color; peripheral band alternating brown, white patches, weak/strong; base rounded, basal cords 7–8 smooth; columella scar metallic white-green-blue.

**Distribution.** Cordell Bank, off Point Reyes, Marin County, California (38°N), to Asuncion Island (27°N), Baja California Sur. Occurs in rocky subtidal habitats to 30 m. Uncommon.

**Remarks.** The purple-blue phenotype is rare. Both specimens illustrated have undulations on the inner lip, but are only obvious on the blue specimen because of the contrasting colors. *Calliostoma splendens* has been treated as a synonym since McLean (1969). For details and past usage see Tuskes & Tuskes (2019). Most specimens taken in recent years average 10 mm or less in height, old collections contain specimens to 14 mm.

***Calliostoma tricolor* Gabb, 1865**

(Figure 18)

*Calliostoma tricolor* Gabb, 1865: 186. Syntype ANSP 38184. San Pedro, California.

**Description.** Shell solid, height 15–22 mm. Ground color dull yellow-orange; whorls slightly bulbous, slightly concave, rounded periphery, suture impressed; threads beaded, color variable: yellow, alternately white/dark brown, alternating yellow-white; base angulate, basal threads 8–11 lightly beaded/unbeaded; columella scar slightly depressed, gray-blue distal, metallic silver proximal.

**Distribution.** Half Moon Bay, San Mateo County, California (38°N), to Tortugas Bay, (28°N), Baja California Sur, Mexico. North of Point Conception, Santa Barbara County, California this species may be found intertidally, but occurs below the thermocline in southern California, 25–70 m. Locally common north of Point Conception, uncommon to south.

**Remarks.** Gabb (1865) did not designate a holotype in the original description. Coan & Bogen (1988) located a syntype in the ANSP collection. After reviewing various photos of that specimen and discussions with the collection manager, I believe it is likely the post Pliocene specimen, which Gabb mentioned in the original description along with other recently collected material from California. The syntype is eroded and lacks many of the diagnostic features, but the written description of *C. tricolor* is appropriate for current material.



### ***Calliostoma turbinum* Dall, 1896**

(Figures 19, 31)

*Calliostoma turbinum* Dall, 1896: 8. Holotype USNM 122578. R/V *Albatross* Station 2906, Santa Barbara Channel, Point Conception, Santa Barbara County, California, 183 m.

**Description.** Shell thin, height 15–20 mm. Ground color metallic silver-gray: whorls lightly convex; spiral threads beaded, interspace iridescent metallic copper; flammules narrow, elongated, numerous, iridescent copper, lower peripheral flammules extend to basal margin; base rounded, basal threads/cords heavily marked, 10–12 copper spots; columella scar iridescent white proximally, faint gray-blue distally. When rotated under light the colors change, iridescent copper may become brown.

**Distribution.** Point Conception, Santa Barbara County, California (34°N), to San Benito Island, Baja California (28°N). Depth usually 90–180 m, rarely as shallow as 26 m. Scarce.

### ***Calliostoma variegatum* Carpenter, 1865**

(Figure 20, 32)

*Calliostoma variegatum* Carpenter, 1865: 61. Holotype USNM 4201 (Palmer 1958: pl. 17, figs 9, 10). Puget Sound, Washington.

**Description.** Shell sturdy, height 18–29 mm. Ground color light yellow to light yellow-tan, apex rose, whorls flat, suture slightly impressed, threads heavy beaded, alternating yellow/orange/brown; base angular, basal cords 7–8, beaded, alternating cream and light orange spots, simple threads between some cords, ground color; columella scar pearl; aperture crenulate.

**Distribution.** East of Afognak Island, Alaska, 58°18.13' N, 151°09.93' W (Clark 2018), south to Cedros Island, Baja California (28°N). Taken by SCUBA divers in the northern portion of range on soft bottoms, southern portion of the range found at 70–230 m. Scarce.

**Remarks.** The shell may fade to a uniform dull yellow and may be mistaken for small faded *C. annulatum*. Whorls of *C. annulatum* are convex and beads are uniform in size; whorls of *C. variegatum* are flat and threads have smaller beads than those on cords. Semi-alba shells are known, white with rose apex.

### ***Akoya* Habe, 1961**

*Akoya* Habe, 1961: 10. Type species (OD): *Calliostoma akoya* Kuroda in Ikebe, 1942.

**Description.** Shell thin, height 30–37 mm; ground color white or iridescent silvery-white; periostracum semitransparent gray-brown; whorls convex; spiral beaded cords usually present on early teleoconch; whorls with spiral cords/threads beaded/unbeaded, becoming frequent/obsolete on later whorls; columella and scar white.

**Remarks.** The status of *Akoya* has fluctuated. It is treated here as a genus, acknowledging a wide-ranging group of deep-water white shells with the general conformation of both *Calliostoma* and *Otukaia* characteristics. At the moment, the lineage of deep-water white shells is elusive. As methods of genetic evaluation become both more sophisticated and comprehensive our understanding of clades may definitively address evolutionary trends and better define genera. Ikebe (1942) was the author of a journal article in which Kuroda described *Calliostoma akoya*. As such, Ikebe is the author of the publication while Kuroda in Ikebe is the taxon authority.

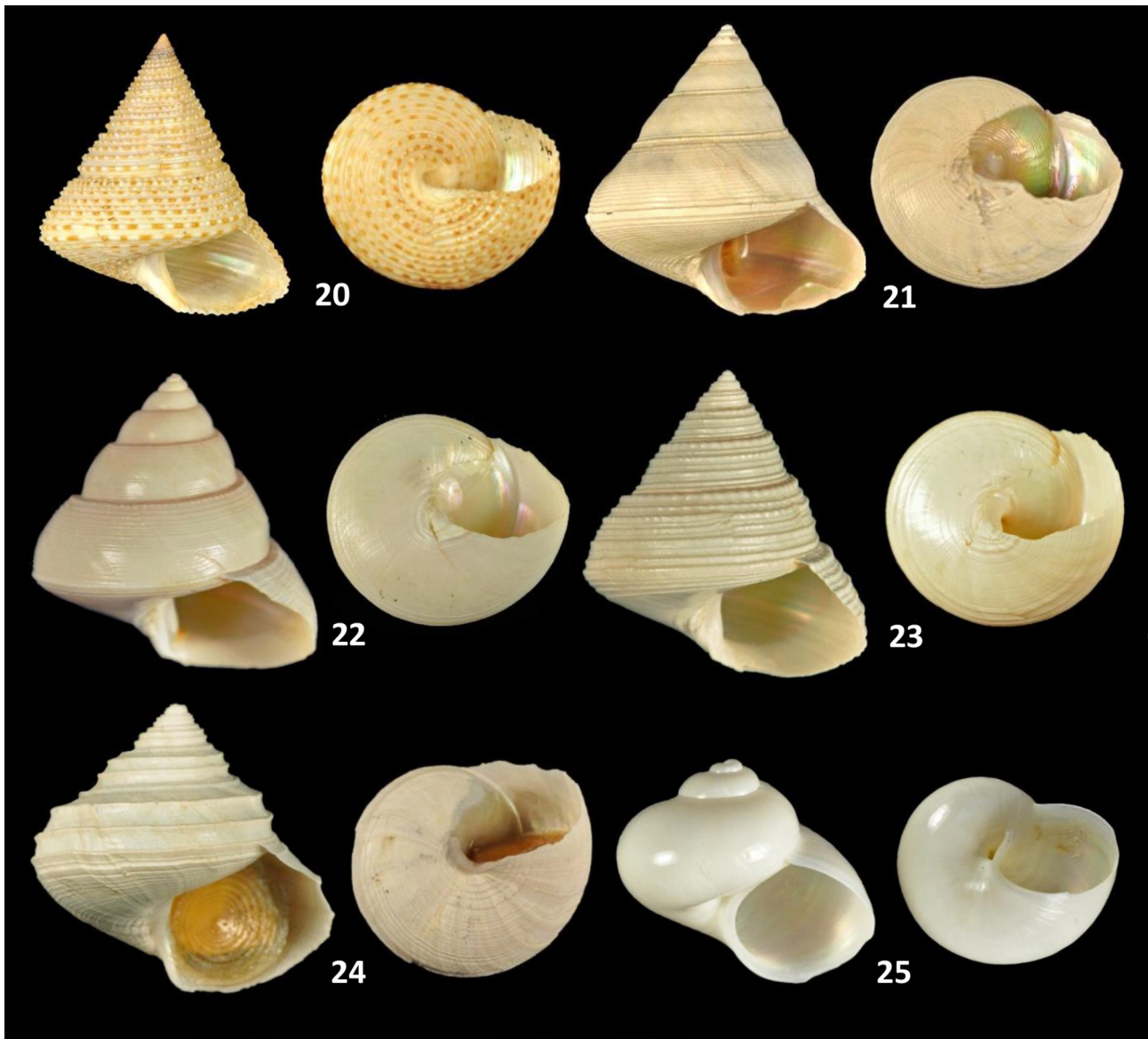
### ***Akoya platinum* (Dall, 1890)**

(Figures 22–24, 33)

*Calliostoma platinum* Dall, 1890: 343, pl. 7, fig. 7. Holotype USNM 96558. R/V *Albatross* Station 2839, near Santa Barbara Island, California, 756 m.

*Calliostoma titanium* McLean, 1984: 236, fig. 4. Holotype LACM 1995. R/V *Velero* 1027-39 8.3 km SE of Santa Catalina Island, California, 256–274 m.

*Calliostoma bernardi* McLean, 1984: 236, figs 5, 6. Holotype: LACM 1996. R/V *Velero* 1152-40SE end of Santa Catalina Island, California, 241–271 m.



**FIGURES 19–25.** 20. *Calliostoma variegatum* 25.9 mm, Forrester Island, Prince of Whales County, Alaska (LACM 163523). 21. *Akoya platinum* 29 mm, lip damaged. Tanaga Island, Bering Sea, Aleutians West County, Alaska, 1,247 m (LACM 179493). 22. *Calliostoma titanium* holotype (LACM 1995) 32.2 mm, 8.3 km SE of Santa Catalina Island, California, 256–274 m. 23. *Calliostoma bernardi* holotype (LACM 1996) 26.6 mm, SE end of Santa Catalina Island, California, 241–271 m. 24. *Otukaia beringensis* holotype (LACM 3514) 26.5 mm, west central Aleutian Islands, Alaska, 1,247 m. 25. *Xeniostoma inexpectans* holotype (LACM 2471) 8.7 mm. 272 miles west of Kiska Island, Rat Islands, Aleutian Islands, Alaska, 219–384 m.

**Description.** Shell thin, height 25–37 mm. Ground color white (periostracum removed); whorls convex; teleoconch 2–3 unbeaded threads; whorls, subsutural threads 0–5 weak/absent, threads smooth rarely lightly beaded; peripheral cords 1–3 smooth; threads immediate above/below, absent/microscopic; base angular, basal threads 35+ absent/minute; columella scar pearl-silver; notable carina present/absent adjacent to columella.

**Distribution.** From Icy Bay, Gulf of Alaska (59°17.61'N, 141°56.04'W: Clark 2018), south to San Diego (33°N), California. 180–700 m. *Akoya platinum* undoubtedly occurs south of San Diego, California, at appropriate depth along the northern Baja California peninsula. Scarce.

**Remarks.** The shells illustrated represent the ideal phenotypes for *A. platinum*, form *titanium* and form *bernardi*. Variation in color (gray/gray-brown vs white results from the presence or absence of the

periostracum. Tuskes & Tuskes (2019) illustrated the intermediate forms and provide additional quantitative results. Forms *titanium* and *bernardi* have progressively increasing number of cords/threads and beading.

### ***Otukaia* Ikebe, 1942**

*Otukaia* Ikebe, 1942: 277. Type species (OD): *Calliostoma kiheiziebisu* Otsuka, 1939. Japan.

**Description.** Shell moderate to large; ground color silky-white to light tan, shell thin; two or more spiral cords present on early teleoconch whorls, becoming obsolete on later whorls of some species, retained in others; spiral cords beaded in some species, smooth, broad/angular in others.

**Remarks.** This group had been considered to be broadly distributed in moderately deep water, but many species have since been transferred into other genera of Calliostomatidae. The type species from Japan was figured by Sasaki (2000). In addition to Japan, *O. kiheiziebisu* has been found at 1,200 m off Hawaii (Severns 2011).

### ***Otukaia beringensis* Tuskes & Clark, 2018**

(Figure 24)

*Otukaia beringensis* Tuskes & Clark, 2018: 236, figs 1–2. LACM 3514. Central Aleutian Islands, 52°52'N, 178°17'W, Alaska, 1247 m.

**Description.** Shell thin, height 25–35 mm. Ground color white; body whorl, two projecting keeled cords, above peripheral; one secondary keeled cord below suture, peripheral cord slightly keeled, sub-peripheral cord low, broadly rounded; base, 25+ finely spaced shallow threads, proximal to columella broadly flattened, centrally narrow, distally slightly raised, some incomplete; columella/basal scar dull white; umbilicus closed aperture oval; operculum circular, light brown,

**Distribution.** All specimens are from the Eastern Bering Sea. It is not known if the Aleutian Basin or the Aleutian Trench, which are deeper than the current known locations, affect their distribution.

**Remarks.** This is the first species of *Otukaia* to be collected in the northeast Pacific. The current known depth range is 818 to 1,247 m, with additional sampling, both depth and distribution will be better defined. The holotype was photographed by Robert Stone during his research via an ROV. The animal was feeding on the gorgonian *Calcigorgia beringi* (Nutting, 1912) (R. Stone pers. comm.) and a paratype was associated with bamboo coral *Isidella* sp., which is also a gorgonian.

### ***Xeniostoma* McLean, 2012**

*Xeniostoma* McLean, 2012: 89. Type species (OD) *Xeniostoma inexpectans*. Aleutian Islands, Alaska.

**Description.** Shell small to moderate, rounded, smooth lacking spiral threads or cords, height 8–12 mm; protoconch smooth and large, nearly 1 mm.

**Remarks.** Currently it is a monotypic genus. The lack of enlarged inner marginal teeth distinguishes this subfamily (Xeniostomatinae) from typical members of the subfamily Calliostomatinae. The lack of any spiral sculpture, the lack of jaws, and the lack of the pseudoproboscis are further differences from Calliostomatinae. Other recent or fossil material awaiting discovery will further define the characters of this recently described genus and subfamily.

### ***Xeniostoma inexpectans* McLean, 2012**

(Figure 25)

*Xeniostoma inexpectans* McLean, 2012: 89, figs 1–6. Holotype LACM 2471. West of Kiska Island, Rat Islands, Aleutian Islands, Alaska (51°54.31'N, 176°35.89'E). 272 m.

**Description.** Shell thin, height 8–12 mm. Ground color white interior strongly iridescent; shell slightly broader than high; texture smooth lacking spiral or axial sculpture; base rounded; umbilicus open; columella and scar white.

**Distribution.** The species is known from the eastern portion of the Rat Islands. This group of around 15

islands is in the western portions of the Aleutian Island chain of Alaska. The species has been taken at depths of 219–384 m. A large sample of live specimens were collected off south central Oregon coast (43° 27' 0" N, 124° 52' 34" W) in 1974 by Oregon State University (SBMNH 470508) at a depth of 630 m. The disjunct distribution is likely due to lack of adequate sampling. Scarce.

**Remarks.** This species is found associated with a vase shaped hexactinellid sponge in the family Rossellidae. The lack of jaws and the unique radula suggest it consumes detritus that collects in the bowl of the sponge. There is no indication it feeds on the tissue of the sponge (McLean 2012).



**FIGURES 26–33.** All type images provided by USNM. 26. *Calliostoma formosum* holotype (USNM 16261) 11.7 mm, San Pedro, Los Angeles County, California. 27. *Calliostoma gloriosum* holotype (USNM 206134) 27.5 mm, Monterey Bay, Monterey County, California. 28. *Trochus ligatus* holotype (USNM 5608) 18.7 mm, Puget Sound, Washington. 29. *Calliostoma nepheloide* syntype (USNM 96637) 25 mm, Panama Bay, Panama. 30. *Calliostoma supragranosum* holotype 14925, 8.4 mm, San Diego, San Diego County, California. 31. *Calliostoma turbinum* holotype (USNM 122578) 12 mm, Santa Barbara Channel, Point Conception, Santa Barbara County, California, 183 m. 32. *Calliostoma variegatum* holotype (USNM 4201) ca. 6 mm, Puget Sound, Washington. 33. *Akoya platinum* holotype (USNM 96558) 32 mm, near Santa Barbara Island, Santa Barbara County, California, 756 m.

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