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**MARINE PLEISTOCENE MOLLUSKS FROM THE**  
**GALAPAGOS ISLANDS\***

**BY**

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During the expedition of the California Academy of Sciences to the Galapagos Islands<sup>1</sup> in 1905-1906, Mr. W. H. Ochsner collected some marine mollusks from a raised beach on Albemarle (Isabela) Island, about 12 to 15 meters above sea level. Dall and Ochsner<sup>2</sup> considered these beds to be Pleistocene in age. Smith<sup>3</sup>, remarking on the climatic significance of this fauna, stated that no displacement of the isotherms was indicated in comparison to present day conditions.

During the G. Allan Hancock Expedition of the California Academy of Sciences to the Galapagos Islands in 1931-1932, Mr. George Stone, photographer on Captain Hancock's exploration cruiser

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<sup>1</sup> J. R. Slevin. Log of the Schooner "Academy" on a Voyage of Scientific Research to the Galapagos Islands, 1905-1906. Occ. Pap. Calif. Acad. Sci., No. 17, 162 pp., 17 pls., Feb. 14, 1931.

See also: Galapagos Islands. Handbooks prepared under the direction of the Historical Section of the Foreign Office, (London), **22**, no. 140: 60 pp., 1920.—L. W. Chubb, The St. George Scientific Expedition. Geol. Mag., **62**: 369-373, 1925.—L. W. Chubb, Geology of Galapagos, Cocos and Easter Islands. Bernice P. Bishop Mus., Bull. no. 110, 1933, 44 pp., 5 pls. Petrology of the Galapagos Islands by C. Richardson, pp. 45-64. Bibliography, pp. 65-66.

<sup>2</sup> W. H. Dall and W. H. Ochsner. Tertiary and Pleistocene Mollusca from the Galapagos Islands. Proc. Calif. Acad. Sci., (4), **17**, no. 4: 89-185, pls. 2-7, 5 text figs., June 22, 1928. See especially pp. 91-92, 96-97.

<sup>3</sup> J. P. Smith, Proc. Calif. Acad. Sci., (4), **9**, no. 4: 135, 1919.



*Velero III*, called the attention of the senior author to a raised beach at James Bay on James (San Salvador) Island. This ancient strand line extends along the coast for possibly a kilometer, at an elevation of about five to ten meters. Where not hidden by later lava flows this raised beach is on a lava platform which is covered by a thin veneer, or, in places, pockets of sand, fine sediment and some scattered boulders. A collection was made of the fossil marine shells which occur scattered about.

A study of the fossils of this beach leads to many interesting considerations. The Galapagos Islands lie on the equator about 960 kilometers (600 miles) west of Ecuador. On the lower slopes the islands are dry and warm, but the cool Humboldt current which sweeps up from the Peruvian coast, makes the climate along the shores unusually cool despite their equatorial position. A comparison of the fossil mollusks with those of the present known Galapagan fauna, and with those of the adjacent mainland, casts some light on the origin of the islands and the derivation of the fauna.

Dall and Ochsner regarded many of the Pliocene and Pleistocene mollusks to be related to those of the Panamic province, and the Gulf of California, and some affinities were noticed with the Caribbean region. With this conclusion the present writers are in accord.

Pilsbry<sup>4</sup> pointed out that the land snails are essentially Central American and Mexican in affinities. Furthermore the basaltic rocks of the Galapagos Islands are essentially Central and North American types. A study of the birds of the Galapagos Islands convinced Swarth<sup>5</sup> of the Caribbean affinities of much of the avifauna. A map by Dacqué<sup>6</sup> showing the trend of the Tertiary mountain ranges in the Central American region is very illuminating in regard to this study. The Tertiary mountain axes formed a bend to the east, thus including, west of the main mountain chain, a considerable portion of the present Caribbean region. Faunal evidence indicates that the Central American land barrier was open, at least during a part of the Miocene.

A small faunule was collected by the senior author from hard sand-

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<sup>4</sup> H. A. Pilsbry. Notes on the Galapagos, pp. 117-122, in "To the South Seas," by Gifford Pinchot, Philadelphia, 1930, (John C. Winston Co.).

<sup>5</sup> H. S. Swarth. The Avifauna of the Galapagos Islands. Occ. Papers Calif. Acad. Sci., No. 18, 1931, pp. 1-299, 1 pl. (map), 57 text figs. — The Bird fauna of the Galapagos Islands in relation to species formation. Biol. Reviews, 9, 2: 213-234, 3 figs., April, 1934. — See also, A. Gulick, Quart. Rev. Biol., 7, no. 4: 416-417, 1932.

<sup>6</sup> E. Dacqué. Grundlagen und Methoden der Paläogeographie. Jena, 1915. [See map.]

See also Charles Schuchert, Historical Geology of the Antillean-Caribbean Region. New York, 1935, (John Wiley and Sons.), I-XXVI, pp. 1-811. 16 pls. (Paleogeographic Maps); 107 figs., 1 frontispiece.

Lecointre (Mem. Soc. Sci. Nat. Maroc., No. 14: 86-90, 134-135, 1926), has recorded the occurrence of "*Calyptrea* (*Trochatella*) *trochiformis* Gmelin" and "*Purpura* (*Acanthina*) *crassilabrum* Lamarck" in the Marine Quaternary of Anfa, Morocco. These are known Recent off Chile and Peru and the former is recorded by Lecointre from the Cape Verde Islands off Western Africa. He suggested that these species might have made their way around Cape Horn when conditions were warmer than at present, and then reached western Africa by following a landmass or a chain of islands or by attachment to floating objects.

Assuming the identity of the Chilean and African species, there appears as yet no evidence of any considerable migration of species between these two regions, during any late geologic period.



stone beds, at sea level on South Seymour Island. The species from that locality are all living in the waters about the Galapagos Islands. Mr. J. R. Slevin, in 1927, during the voyage of Captain G. Allan Hancock's ship, *Oaxaca*, collected a few species from Albemarle (Isabela) Island in beds reported to be somewhat similar to those just mentioned on South Seymour Island. Two species were collected on the Templeton Crocker Expedition to the Galapagos Islands, from beds exposed on the shore on Jervis (Rabida) Island. The species are all Recent. The shells from all the localities retain color markings, or traces of such markings, in many cases.

The shells from James Bay are assigned to the late Pleistocene. Those from South Seymour and Jervis (Rabida) Island are regarded as probably the same age. Those from Albemarle might perhaps be regarded as late Pleistocene or possibly subfossil.

The writers wish to express their acknowledgments to: Captain G. Allan Hancock, whose generosity made it possible to secure the collection on which this paper is based; to Dr. G. Dallas Hanna, Curator of the Department of Paleontology of the California Academy of Sciences, for the line drawings of *Transennella galapagana* illustrated in the present paper, and for helpful suggestions. Acknowledgment is also due the late Mr. H. S. Swarth, and to Mrs. M. E. Davidson, formerly of the Department of Ornithology of the same institution, for criticism of the manuscript; and to Mr. E. H. Quayle who kindly identified the coral.

Loc. 27255 (C. A. S.). Raised beach 5 to 10 meters above sea level at James Bay, James (San Salvador) Island, Galapagos Islands; L. G. Hertlein, collector; January 11, 1932. Late Pleistocene.

*Astropsammia pedersenii* Verrill  
*Antigona isocardia* Verrill  
*Antigona multicostata* Sowerby  
*Arca* (*Acar*) *gradata* Broderip and Sowerby  
*Arca* (*Acar*) *pusilla* Sowerby  
*Arca* (*Barbatia*) *reeveana* d'Orbigny  
*Arca* (*Fossularca*) *solida* Sowerby  
*Chama frondosa* Broderip<sup>7</sup>  
*Chione undatella* Sowerby  
*Codakia galapagana* Dall  
*Kellia suborbicularis* Montagu

*Acanthina grande* Gray  
*Acanthina muricata* Broderip  
*Acmaea* sp.  
*Agathotoma* cf. *camarina* Dall  
*Alaba supralirata* Carpenter  
*Aletes squamigerus* Carpenter  
*Alvania lara* Bartsch

*Lima pacifica* d'Orbigny  
*Lithophaga aristata* Dillwyn  
*Mytilus adamsianus* Dunker  
*Ostrea fisheri* Dall [juvenile]  
*Pecten* (*Lyropecten*) *magnificus* Sowerby  
*Pedalion chemnitzianum* d'Orbigny  
*Semele punctata* Sowerby  
*Semele rupium* Sowerby  
*Transennella galapagana* Hertlein and Strong, n. sp.  
*Venericardia megastropa* Gray (*V. flamea* Michelin)

*Alvania veleronis* Hertlein and Strong, n. sp.  
*Anachis incerta* Stearns  
*Anachis* sp.  
*Aspella erosa* Broderip  
*Aspella pyramidalis* Broderip  
*Bullus punctulatus* A. Adams

<sup>7</sup> A specimen of this species was also collected by Mr. H. S. Swarth, at Loc. 27545 (C. A. S.), James Bay. It was attached to lava at an elevation stated to have been about 90 to 100 meters, and perhaps 300 meters inland from the shore, about midway between the "red butte," which is surrounded by lava, and the houses at the north end of James Bay.





- Caducifer thaleia* Pilsbry and Lowe  
*Calliostoma* sp.  
*Cancellaria haemastoma* Sowerby  
*Cantharus sanguinolentus* Duclos  
*Cerithiopsis anaitis* Bartsch  
*Cerithiopsis curtata* Bartsch  
*Cerithium adustum* Kiener  
*Cerithium uncinatum* Gmelin  
*Cheilea equestris* Linnaeus  
*Clathurella trichodes* Dall  
*Colubraria lucasensis* Strong and Hertle  
 in  
*Conus brunneus* Wood  
*Conus nux* Broderip  
*Conus purpurascens* Broderip  
*Conus tiaratus* Broderip  
*Craspedotriton scalariformis* Broderip  
*Crepidula aculeata* Gmelin  
*Crepidula arenata* Broderip  
*Cymatium wiegmanni* Anton  
*Cypraea nigropunctata* Gray  
*Cypraeassis tenuis* Wood  
*Cypraeolina margaritula* Carpenter  
*Daphnella* sp.  
*Diodora alta* C. B. Adams  
*Diodora inaequalis* Sowerby  
*Engina reeviana* C. B. Adams  
*Epitonium (Asperoscala)* cf. *emydoneus*  
 Dall  
*Epitonium* sp.  
*Erato marginata galapagensis* Schilder  
*Fossarus angiostoma* C. B. Adams  
*Fossarus atratus* C. B. Adams  
*Fossarus* sp.  
*Fossarus* sp.  
*Gadinia peruviana* Sowerby  
*Heliacus* cf. *planispira* Pilsbry and Lowe  
*Hipponix barbatus* Sowerby  
*Latirus tuberculatus* Broderip  
*Latirus varicosus* Reeve  
 "Mangelia" *hancocki* Hertlein and  
 Strong, n. sp.  
 "Mangelia" sp.  
*Marginella minor* C. B. Adams  
*Melanella falcata* Carpenter  
*Melanella* cf. *hastata* Sowerby  
*Metaxia convexa* Carpenter  
*Microcitharia uncinata* Sowerby  
*Mitra funiculata* Reeve  
*Mitra* cf. *lens* Wood  
*Mitra solitaria* C. B. Adams  
*Mitra (Strigatella) tristis* Broderip  
*Mitra* sp.  
*Mitrella ocellata* Gmelin  
*Modulus cerodes* A. Adams  
*Morum tuberculosum* Sowerby  
*Muricopsis dubia* Sowerby  
*Nassarius versicolor* C. B. Adams  
*Odostomia (Miralda) incantata* Hertlein  
 and Strong, n. sp.  
*Odostomia (Ividella) orariana* Dall and  
 Bartsch  
*Odostomia (Chrysallida) paupercula* C. B.  
 Adams  
*Odostomia* sp.  
*Olivella gracilis* Broderip and Sowerby  
*Pedipes angulatus* C. B. Adams  
*Phasianella (Tricolia) perforata* Philippi  
 "Philbertia" *stonei* Hertlein and Strong,  
 n. sp.  
*Phyllonotus princeps* Broderip  
*Phyllonotus regius* Wood  
*Pleurobranchus* sp.  
*Polinices uber* Valenciennes  
*Pyrene haemastoma* Sowerby  
*Rissoina dina* Bartsch  
*Rissoina* cf. *laurae* de Folin  
*Rissoina signae* Bartsch  
*Seila assimillata* C. B. Adams  
*Tectarius galapagensis* Stearns  
*Tegula cooksoni* E. A. Smith  
*Tegula snodgrassi* Pilsbry and Vanatta  
*Terebra strigata* Sowerby  
*Terebra* sp.  
*Thais callaoensis* Gray  
*Thais crassa* Blainville  
*Thais patula* Linnaeus  
*Thais planospira* Lamarck  
*Triphora alternata* C. B. Adams  
*Triphora chathamensis* Bartsch  
*Triphora galapagensis* Bartsch  
*Triphora inconspicua* C. B. Adams  
*Tritonalia parva* E. A. Smith  
*Trivia galapagensis* Melvill  
*Trivia pacifica* Gray  
*Turbonilla (?Strioturbonilla)* sp.  
*Turrid* sp.  
*Vermicularia eburnea* Reeve  
*Williamia galapagana* Dall

This list contains 106 definitely identified species, with six additional ones, the identity of which is not positive; these latter are compared to previously described species.

In this ancient beach fauna, only two species, "*Mangelia*" *hancocki* Hertlein and Strong, n. sp., and "*Philbertia*" *stonei* Hertlein and Strong, n. sp., are not known in either the Recent West Ameri-



can, or Galapagan fauna. Eighteen of the species have not been recorded living in the waters of the Galapagos Islands. Of course the Recent fauna of the Galapagos Islands is not completely known. It is likely, however, that a considerable part of the common shore and shallow water forms have been collected there,<sup>8</sup> but it is not improbable that all or nearly all of the species cited in the foregoing list may ultimately be found, should intensive collecting be undertaken in the Archipelago.

The ranges of the species in the present fauna, serve to emphasize the predominant Panamic character of the assemblage with, to a lesser degree, some Caribbean affinities. Only a few species show close affinities with the Polynesian or Indo-Pacific faunas, such as the tritons which are wide ranging forms.

Many of the shells retain color markings, or traces of such markings. The fauna is considered to be of a late Pleistocene age.

The following species, included in the preceding list, have not been reported living in the waters of the Galapagos Islands.

<i>Species</i>	<i>Range</i>
<i>Astropsammia pedersenii</i> Verrill.....	Gulf of California
<i>Antigona isocardia</i> Verrill.....	Gulf of California; Tres Marias Islands
<i>Kellia suborbicularis</i> Montagu.....	England (type locality); Antilles; British Columbia to Peru (Dall)
<i>Alaba supralirata</i> Carpenter.....	Gulf of California (?) to Panama
<i>Alvania veleronis</i> Hertlein and Strong, n. sp.....	Taboga Island, Panama
<i>Aspella erosa</i> Broderip.....	Mazatlan to Panama
<i>Cerithiopsis anaitis</i> Bartsch.....	Panama
<i>Fossarus atratus</i> C. B. Adams.....	Panama
<i>Gadinia peruviana</i> Sowerby.....	Gulf of California to Chile (Dall)
" <i>Mangelia</i> " <i>hancocki</i> Hertlein and Strong, n. sp.....	Not known Recent
<i>Microcitharia uncinata</i> Sowerby.....	Tres Marias Islands; Acapulco, Mexico, to Panama
<i>Mitra funiculata</i> Reeve.....	Off Lower California, in Lat. 24°14' to 24°18'N.; Gulf of California to Panama
<i>Muricopsis dubia</i> Sowerby.....	Gulf of California to Panama
<i>Odostomia (Miralda) incantata</i> Hertlein and Strong, n. sp.....	Bahia Honda, Panama; Taboga Island, Panama
<i>Odostomia orariana</i> Dall and Bartsch.....	Panama
<i>Odostomia paupercula</i> C. B. Adams.....	Panama
" <i>Philbertia</i> " <i>stonei</i> Hertlein and Strong, n. sp.....	Not known Recent

<sup>8</sup> A. Wimmer. Zur Conchylien-Fauna der Galapagos-Inseln. Sitz. k. k. Akad. Wiss. Wien, **80**, 5: 465-514, (Jahrg. 1879), 1880. — R. E. C. Stearns, Proc. U. S. Nat. Mus., **14**, 854; 307-335, 1891; **16**, 942: 353-450, 1 pl. (Moll.), 1 pl. (map), 1893. — H. A. Pilsbry and E. G. Vanatta. Proc. Washington Acad. Sci., **4**: 549-559, pl. 34, 1902. — T. Soot-Ryen, Pelecypods from Floreana (Sancta Maria) Galapagos Islands. Medd. Zool. Mus. Oslo, No. 27, (Saertrykk Nyt. Mag. Naturvid., **70**): 313-324, 2 pls., 1932.—A. M. Strong and L. G. Hertlein. Marine Mollusks of the Galapagos Islands, unpublished manuscript.



Species	Range
<i>Pleurobranchus</i> sp. ....	The genus has been recorded from western America, in the Gulf of California, and from the coast of Chile. It also occurs in the West Indies and on the Atlantic coast of Patagonia; also Indo-Pacific
<i>Triphora inconspicua</i> C. B. Adams. ....	Panama

Loc. 27250 (C. A. S.). Reddish sandstone beds probably about one and one half meters thick, on beach, on NW. part of the western side of South Seymour Island, Galapagos Islands; L. G. Hertlein, collector; January 2, 1932. Late Pleistocene.

<i>Eucidaris thouarsii galapagensis</i> Döderlein	<i>Engina reeviana</i> C. B. Adams
<i>Arca gradata</i> Broderip and Sowerby	<i>Fissurella rugosa</i> Sowerby
<i>Arca reeveana</i> d'Orbigny	<i>Hipponix antiquatus</i> Linnaeus
<i>Arca solida</i> Sowerby	<i>Hipponix barbatus</i> Sowerby
<i>Chama</i> sp.	<i>Hipponix grayanus</i> Menke
<i>Codakia galapagana</i> Dall	" <i>Mangelia</i> " sp.
<i>Alvania veleroana</i> Hertlein and Strong, n. sp.	<i>Marginella</i> cf. <i>phrygia</i> Sowerby
<i>Anachis</i> cf. <i>atrametaria</i> Sowerby	<i>Mitra</i> ? <i>solitaria</i> C. B. Adams
<i>Cancellaria haemastoma</i> Sowerby	<i>Mitra</i> ( <i>Strigatella</i> ) <i>tristis</i> Swainson
? <i>Cantharus</i> sp.	<i>Morum tuberculosum</i> Sowerby
<i>Cerithium adustum</i> Kiener	<i>Pyrene fuscata</i> Sowerby
<i>Cheilea equestris</i> Linnaeus	<i>Pyrene haemastoma</i> Sowerby
<i>Crepidula aculeata</i> Gmelin	<i>Rissoina dina</i> Bartsch
<i>Cypraea nigropunctata</i> Gray	<i>Tegula snodgrassi</i> Pilsbry and Vanatta
<i>Diodora inaequalis</i> Sowerby	<i>Thais patula</i> Linnaeus
<i>Engina maura</i> Sowerby	<i>Trivia pacifica</i> Gray
	<i>Trivia</i> cf. <i>pulla</i> Gaskoin

The 26 definitely identified species in the foregoing list have all been recorded living in Galapagan waters. The specimens retain partial color markings in many cases. These fossils were collected from very hard reddish sandy beds containing many fragments of volcanic material. The beds outcrop on the beach and dip at a low angle into the water. This portion of the island is a down faulted block, as shown on Ochsner's map. Recent beach sand occurs on and around the beds thus covering the exact contact of the sediments with the underlying lava.

From a consideration of the facts it would seem best to suggest a late Pleistocene age for the mollusks obtained at this locality.

Loc. 1306 (C. A. S.). On beach about two miles north of Tagus Cove, Albemarle (Isabela) Island; sandstone rocks on beach covered at high tide; J. R. Slevin collector; December 12, 1927. Late Pleistocene or subfossil.



*Bullus punctulatus* A. Adams  
*Conus purpurascens* Broderip  
*Cypraea nigropunctata* Gray  
*Hipponix grayanus* Menke  
*Morum tuberculosum* Sowerby

*Nassarius nodicinctus* A. Adams  
*Ostrea palmula* Carpenter  
*Pyrene castanea* Sowerby  
*Pyrene fuscata* Sowerby  
*Trivia pacifica* Gray

All of the species in this list have been recorded living in the waters about the Galapagos Islands. Many of the specimens retain much of their original color; others seem to indicate that they have been embedded in sediment.

From the specimens alone, it would seem unwise to venture an opinion as to their antiquity other than that they are probably late Pleistocene in age, or possibly subfossil.

Loc. 27547 (C. A. S.). Below high tide embedded in scoriaceous material at foot of a nine meter cliff on the southeastern shore of Jervis (Rabida) Island, Galapagos Islands; H. W. Clark, collector, Templeton Crocker Expedition; July 6, 1932. Probably Pleistocene.

*Cerithium adustum* Kiener  
*Conus purpurascens* Broderip

These two species were found with bones of a mammal (?), embedded in lava fragments. From the evidence of the shells alone, a Pleistocene age is suggested.

### ***Alvania veleronis* Hertlein and Strong, new species**

Plate 32, figure 18

Shell small, ovate, yellowish white; nuclear whorls two, apparently smooth (more or less eroded in all the specimens); postnuclear whorls 5, slightly rounded, narrowly shouldered at the summit, strongly contracted at the base, sutures deep; spiral sculpture on the second and third whorls of four tuberculate cords, on the last whorl there are 10 equally spaced cords, extending from the suture to the umbilical region, of which the first two are strongly nodulous, the third only slightly so, and the rest at most slightly undulated; axial sculpture of slender, wide spaced, nearly vertical ribs connecting the nodules of the spiral cords; of the axial ribs 16 appear on the third whorl and 18 on the penultimate whorl, where they fade out before reaching the fourth spiral cord; the spaces inclosed by the spiral cords and axial ribs are rectangular pits having their long axes parallel to the spiral sculpture; periphery of the last whorl well rounded; base produced anteriorly, slightly rounded; aperture nearly circular, outer lip thick; inner lip short, thick, continued as a thick callus over the body to a junction with the outer lip. The type measures: length, 2.6 mm.; diameter 1.2 mm.

*Holotype*, No. 700 Calif. Acad. Sci. Paleo. Type Coll., from Loc. 27228 (C. A. S.), dredged in from 3 to 9 fathoms off **Taboga Island, Panama**; Recent; L. G. Hertlein, collector. Seventy additional specimens were dredged at the same locality. This species also occurs at Loc. 27255 (C. A. S.), on a raised beach 5 to 10 meters above sea level, at James Bay, James (San Salvador) Island, Galapagos Islands, Pleistocene, where it was collected by the senior author.



In the key to the west coast species in the genus <sup>9</sup>*Alvania* this would follow *galapagensis* from which it differs decidedly in the details of the sculpture. It is probably nearest to *A. clarionensis* Bartsch<sup>10</sup> from which it differs principally in the fewer and stronger spiral cords.

This species is named for the exploration cruiser *Velero III*, owned by Captain G. Allan Hancock.

**Odostomia (Miralda) incantata** Hertlein and Strong, new species

Plate 32, figure 19

Shell minute, elongate-conic; white nuclear whorls two and a half, with the axis at right angles to that of the following whorls, in the first of which they are about one-half immersed; postnuclear whorls six, sutures deeply channeled; on the first whorl the sculpture consists of a nodulous spiral cord at the summit and a second smooth one of about equal strength on the middle of the whorl; on the following whorls the nodules of the upper cord become gradually elongated axially and on about the third whorl begin to be divided by a fine, incised, spiral line, this line becomes gradually stronger until on the penultimate whorl there are two spiral lines of nodules separated by a narrow groove, the smooth cord remaining about the same strength and relative position throughout; interspaces between the spiral cords and the lower cord and the suture marked with faint axial riblets corresponding in position to that of the nodules; periphery of the last whorl marked by a smooth spiral cord about equal to that on the spire, below which the base is marked by two similar but smaller spiral cords; aperture oval, the edge of the outer lip broken in the type; columella very short, twisted, the two lower basal cords extending into the aperture. The type measures: length, 2.1 mm.; diameter, 1.0 mm.

*Holotype*, No. 735 Calif. Acad. Sci. Paleo. Type Coll., from Loc. 27228 (C. A. S.), dredged in from 3 to 9 fathoms in **Bahia Honda, Veragua, Panama**; Recent; L. G. Hertlein, collector. Nine additional specimens were dredged at the same locality and three off Taboga Island, Panama.

This species also occurs at Loc. 27255 (C. A. S.), on a raised beach 5 to 10 meters above sea level, at James Bay, James (San Salvador) Island, Galapagos Islands; Pleistocene.

This differs from all the other west coast species in the subgenus *Miralda* in the doubling of the upper nodulous spiral cord on the lower whorls, a character noted on all of the specimens collected.

<sup>9</sup> Proc. U. S. Nat. Mus., 41: 334-336, 1912.

<sup>10</sup> Proc. U. S. Nat. Mus., 41: 356, pl. 32, fig. 4, 1912. "dredged by the United States Bureau of Fisheries steamer *Albatross* off Clarion Island, Mexico, in one of the five hauls — 2991 to 2995, the depths of which ranged from 31 to 460 fathoms."



**"Mangelia" hancocki** Hertlein and Strong, new species

Plate 32, figure 9

Shell small, slender, with three and a half smooth nuclear whorls and five strongly sculptured normal whorls; axial sculpture of fourteen, low rounded, nearly vertical ribs; spiral sculpture of two, strong, rounded cords on the lower portion of the whorls which rise to elongated tubercles where they cross over the axial ribs; above these there are on the second whorl one, on the third whorl two, and the fourth whorl three, smaller spiral cords which ride over the axial ribs but with less tendency to form tubercles; the periphery of the last whorl marked by a sulcus about as wide as the space between the two major spiral cords; below this is a nodulous spiral cord similar to the two major spiral cords on the upper whorls; base and canal with six spiral cords similar to those on the upper portion of the whorls; outer lip thickened; with a small, rounded, unarmed anal sinus close to the suture, bounded on the inside of the outer lip by a strong denticle, immediately below which there are two smaller denticles; canal short, slightly recurved. The shell is white with irregularly disposed patches of brown, darker in the interspaces between the spiral cords. The type measures: length, 4.0 mm.; diameter, 1.5 mm.

*Holotype*, No. 4693 Calif. Acad. Sci. Paleo. Type Coll., from Loc. 27255 (C. A. S.), raised beach, 5 to 10 meters above sea level, at **James Bay, James (San Salvador) Island, Galapagos Islands**; L. G. Hertlein, collector. Pleistocene.

In size, shape and general appearance this shell is quite similar to "*Mangelia*" (*Steironepion*) *melanosticta* Pilsbry and Lowe<sup>12</sup> but differs in the greater number of spiral cords and in the color pattern. The apparently smooth nuclear whorls are somewhat worn and in fresh specimens may show the spiral keel of *Steironepion*.

This species is named for Captain G. Allan Hancock, owner and captain of the exploration cruiser *Velero III*, through whose courtesy the senior author was privileged to accompany the expedition to the Galapagos Islands in 1931-1932.

**"Philbertia" stonei** Hertlein and Strong, new species

Plate 32, figure 8

Shell, small, slender, white, the extreme tip broken but the remaining one and a half nuclear whorls smooth; normal whorls four, strongly sculptured with axial ribs and spiral cords which are nodulous at the intersections; axial ribs on the last whorl eight; spiral cords on the spire two; periphery of the body whorl marked by a spiral cord equaling the other spiral cords in strength and partly exposed in the sutures of the upper whorls; base and canal with four similar spiral cords; outer lip greatly thickened, the outer edge scalloped by the ends of the spiral cords, the inner edge without denticles; anal sinus small, rounded, deep, close to the suture, without armature; canal short. The nearly square interspaces between the axial ribs and spiral cords are covered with close, microscopic, axial striations which may be due to the weathered condition. Length, 4.0 mm.; diameter, 1.8 mm.

<sup>12</sup> Proc. Acad. Nat. Sci. Philadelphia, **84**: 56, pl. 3, fig. 9, 1932. "San Juan del Sur, Nicaragua."



*Holotype*, No. 4694, Calif. Acad. Sci. Paleo. Type Coll., from Loc. 27255 (C. A. S.), raised beach, 5 to 10 meters above sea level, **James Bay, James (San Salvador) Island, Galapagos Islands**; L. G. Hertlein, collector. Pleistocene.

This species belongs in the group placed by Dall in the genus *Philbertia* but that name does not seem available, and much further study will be required before the various species can be arranged in proper genera and subgenera. In many ways the species resembles "*Philbertia*" *trichodes* Dall (*Pleurotoma hirsutum* de Folin)<sup>13</sup> from the same fauna. It differs in the lack of the peculiar projection of the nodules in that species.

This species is named for Mr. George Stone, photographer on the *Velero III*, who called the senior author's attention to the raised beach, from which the type specimen was later collected.

### Transennella Dall

*Transennella* DALL, Proc. U. S. Nat. Mus., **6**: 340, 341, 1883. Type (by monotypy): *Cytherea* (*Transennella*?) *conradiana* DALL, 1883: 340. "Rare at Cedar Keys, in mud between tides."—Figured by DALL, U. S. Nat. Mus., Bull. 37, 2nd ed., pl. 90, fig. 6, 1903; also Proc. U. S. Nat. Mus., **26**, pl. 13, fig. 6, 1903. [Not fig. 5 as cited on explanation to plate 13.]—VAN WINKLE PALMER, Palaeontogr. Amer., **1**, 5: 91, text fig. 10 and pl. 16, figs. 4, 8, 10, 1929.—See also Grant and Gale, Mem. San Diego Soc. Nat. Hist., **1**: 338, 1931.

*Transennella* is reported to range from Miocene to Recent. In the California Tertiary, *T. joaquinensis* Anderson and Martin,<sup>14</sup> has been recorded from the lower or middle Miocene of Kern County; and Arnold<sup>15</sup> has recorded *Transennella californica* Arnold, from the Pliocene of the south end of Kettleman Hills, San Joaquin Valley, California. *T. tantilla* Gould has been recorded from Pleistocene and Recent. *Transennella herviderana* Spieker<sup>16</sup> has been described from the Miocene of Peru. Other species have been recorded from Miocene to Recent in eastern North America.

During the work of identification of a small species referred to *Transennella*, collected both as a living shell and as a fossil in the Galapagos Islands, it was necessary to review all the west coast species belonging to the genus. For many years the only species placed therein was "*Venus tantillus* Gould."<sup>17</sup> This is a well known

<sup>13</sup> See Proc. U. S. Nat. Mus., **56**: 62, pl. 13, fig. 1, 1919. "Panama Bay."

<sup>14</sup> Proc. Calif. Acad. Sci., (4), **4**: 60, pl. 3, figs. 6a, 6b, 6c, 1914. "On west bank of a small canyon 1 1/4 miles northeast of Barker's ranch house, Kern County, California." Miocene.

<sup>15</sup> U. S. Geol. Surv., Bull. 396: 72, pl. 26, figs. 7, 7a, 1909. "South end of Kettleman Hills, Sec. 10, T. 25 S., R. 19E." Pliocene.

<sup>16</sup> *Transennella herviderana* Spieker, Johns Hopkins Univ. Studies in Geol., No. 3: 143, pl. 9, figs. 1, 2, 1922. "Lower Zorritos. Hervideras." — Olsson, Bull. Amer. Paleo., **19**, (Bull. No. 68): 121, pl. 10, fig. 2, 1932. "Lower Zorritos of Hervideras (Spieker), Zorritos of Que. Cardalitos."

<sup>17</sup> Boston Jour. Nat. Hist., **6**: 406, pl. 15, fig. 10, 1853. "Inhabits Santa Barbara. Col. Jewett."



shell ranging from Sitka, Alaska, to San Martin Island, Lower California. It was described as a white shell with "the posterior third stained deep slaty blue outside and in." While this color pattern is not uncommon, it is lacking in many specimens and nearly all show on the outside more or less distinct, tent-shaped brown lines. There are three cardinal teeth in each valve and a short, strong, left lateral fitting into a socket with raised edges in the right valve. On the inner basal margin of the valves there are a few rather indistinct, oblique grooves. On account of these grooves and the hinge formula Dall placed the species in the genus *Transennella*.

Carpenter described<sup>18</sup> a "*Callista* (? *pannosa*, var.) *puella*" from Cape San Lucas. Of this, in another place he said,<sup>19</sup> "The name *puella* given to the Cape San Lucas specimens was intended as varietal; although Mr. Cuming regards the Peruvian and Peninsular forms as distinct. It is not known along the Central American coast." Dall<sup>20</sup> considered *puella* to be a distinct species and placed both in the genus *Macrocallista*, quoting the range for *M. pannosa* Sowerby<sup>21</sup> as from the Gulf of California to Chile.

Pilsbry and Lowe<sup>22</sup> stated regarding *puella*, that it has the "oblique grooves in the ventral edges of the valves, and should, we believe, be transferred to *Transennella*." So far as we have discovered, *Transennella puella* Carpenter has not been illustrated heretofore. *Transennella sorocula* Pilsbry and Lowe,<sup>23</sup> from Nicaragua, is decidedly a larger species with more distinct, concentric sculpture. A specimen of *T. sorocula* from Loc. 27584 (C. A. S.), Lat. 23°03' to 23°06' N., Long. 109°31' to 109°36' W., in 20-200 fathoms, measures 35 mm. in length and 31.8 mm. in height.

A comparison of specimens of *tantilla* from California with the large series of *puella* from Cape San Lucas in the collections of the California Academy of Sciences, and with specimens of *pannosa* from Chile in the collection of Mr. H. N. Lowe, shows them to have almost identical hinge characters and similar grooves on the ventral margin of the valves. In all three the color is variable with the lighter colors predominating in the colder water and the darker forms in the warmer water. The tent shaped brown lines are nearly always present. The principal differences are in size and in the angle at which the dorsal margins meet at the beaks, resulting in small differences in the outline of the shell. *T. tantilla* Gould is a fairly

<sup>18</sup> Ann. and Mag. Nat. Hist., (3), 12: 313, 1864.

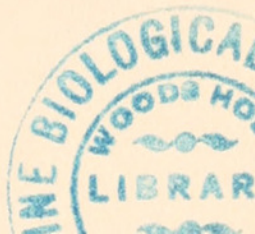
<sup>19</sup> Suppl. Rept. Brit. Assoc. Adv. Sci. for 1863 (issued 1864), p. 572.

<sup>20</sup> Proc. U. S. Nat. Mus., 26: 387, 1902.

<sup>21</sup> *Cytherea pannosa* Sowerby, Proc. Zool. Soc. London, 1835: 47. "Hab. ad oras Chilenses (Coquimbo)." "Found in sandy mud at low water. — G. B. S." — Sowerby, Thes. Conch., 2, *Cytherea*, 635, pl. 133, figs. 140, 141, 142, 1851; pl. 163, figs. 202, 203, 1853. "Coquimbo; in sandy mud at low water. Cuming." — See also Reeve, Conch. Icon., 14, *Dione*, October, 1863, sp. 62, pl. 12, figs. 62a, 62b, 62c. "Hab. Chili, Peru, Mazatlan." — Dall, Proc. U. S. Nat. Mus., 37: p. 266, 1909, (as *Macrocallista pannosa*). "Gulf of California south to Valparaiso, Chile."

<sup>22</sup> Proc. Acad. Nat. Sci. Philadelphia, 84: 102, 1932.

<sup>23</sup> Proc. Acad. Nat. Sci. Philadelphia, 84: 102, 1932.





thick shell reaching a maximum length of about 10 mm. and the angle at the beaks is approximately  $90^{\circ}$ . *T. puella* Carpenter reaches a length of about 16 mm. and is a thinner shell with the angle at the beaks wider, about  $120^{\circ}$ ; *T. pannosa* Sowerby is a still larger and heavier shell, reaching a length of about 30 mm. The angle at the beaks is about  $90^{\circ}$ . The record of *T. pannosa* Sowerby from the Gulf of California is probably based on the consideration that *T. puella* Carpenter is a variety. The record "*Macrocallista pannosa*" from Guadalupe Island, cited by Strong and Hanna,<sup>24</sup> can be referred to *T. puella* Carpenter, a species commonly found in the Gulf of California. We can locate no specimen or definite record of *T. pannosa* north of Peru. The specimens recorded by Pilsbry and Lowe, as *Macrocallista pannosa* dredged in 20 fathoms at San Juan del Sur, Nicaragua, could better be referred to *T. puella* Carpenter. We now add a fourth species to this closely related group.

***Transennella galapagana* Hertlein and Strong, new species**

Plate 32, figures 1, 2, 3, 6, 7

This shell has the same hinge as *T. tantilla* Gould, *T. puella* Carpenter and *T. pannosa* Sowerby, and similar oblique lines on the ventral margins of the valves. The color pattern is also quite similar and equally variable, ranging from white to purple brown, with tent shaped brown lines on the somewhat polished, smooth surface. The surface in some specimens is ornamented by fine microscopic concentric striae. It is much the smallest of the group but comparatively thick, and of slightly different outline, with the angle at the beaks about  $110^{\circ}$ . The small size of the tent shaped markings near the beaks show that this is a fully adult shell. Length of type, 5.9 mm.; height, 4.0 mm.; thickness of the two valves, 3.0 mm.

*Holotype*, No. 6904, and paratypes 6905-6909 Calif. Acad. Sci. Paleo. Type Coll., from Loc. 27232 (C. A. S.), on the beach in shallow water, **Conway Bay, Indefatigable (Santa Cruz) Island, Galapagos Islands**; Recent; L. G. Hertlein, collector. About 150 additional living specimens and several hundred empty valves were secured at the same place. This species also occurs fossil at Loc. 27255 (C. A. S.), on raised beach, 5 to 10 meters above sea level, at James Bay, James (San Salvador) Island, Galapagos Islands; Pleistocene.

<sup>24</sup> Proc. Calif. Acad. Sci., (4), 19, 1: 1-6, 1930.



## PLATE 32

Fig. 1. *Transennella galapagana* Hertlein and Strong, new species; holotype No. 6904, C. A. S. Paleo. type coll.; altitude 4.0 mm., length 5.9 mm.; from Loc. 27232 (C. A. S.), on the beach in shallow water, Conway Bay, Indefatigable (Santa Cruz) Island, Galapagos Islands; Recent. This species also occurs at Loc. 27255 (C.A.S.), raised beach, 5 to 10 meters above sea level at James Bay, James (San Salvador) Island, Galapagos Islands; Pleistocene. P. 378.

Fig. 2. *Transennella galapagana* Hertlein and Strong, new species; paratype left valve, No. 6905, C. A. S. Paleo. type coll.; altitude 4.8 mm., length 5.9 mm.; from the same locality as the holotype shown in figure 1. P. 378.

Fig. 3. *Transennella galapagana* Hertlein and Strong, new species; paratype right valve, No. 6906, C. A. S. Paleo. type coll.; altitude 3.8 mm., length 5.3 mm.; from the same locality as the holotype shown in figure 1. P. 378.

Fig. 4. *Tritonalia parva* E. A. Smith; hypotype No. 6957, C. A. S. Paleo. type coll.; length 13.9 mm., diameter approximately 9.1 mm.; from Loc. 27255 (C. A. S.), raised beach 5 to 10 meters above sea level at James Bay, James (San Salvador) Island, Galapagos Islands. Pleistocene. P. 370.

Fig. 5. *Colubraria lucasensis* Strong and Hertlein; hypotype No. 4695, C. A. S. Paleo. type coll.; length 40 mm., diameter 13.9 mm.; from the same locality as the specimen shown in figure 4; Pleistocene. P. 370.

Fig. 6. *Transennella galapagana* Hertlein and Strong, new species; a drawing showing the dorsal view of the holotype shown in figure 1. P. 378.

Fig. 7. *Transennella galapagana* Hertlein and Strong, new species; a drawing showing the characters of the interior of the specimen shown in figure 2. P. 378.

Fig. 8. "*Philbertia*" *stonei* Hertlein and Strong, new species; holotype No. 4694, C. A. S. Paleo. type coll.; length 4.0 mm., diameter 1.8 mm.; from the same locality as the specimen shown in figure 4; Pleistocene. P. 375.

Fig. 9. "*Mangelia*" *hancocki* Hertlein and Strong, new species; holotype No. 4693, C. A. S. Paleo. type coll.; length 4.0 mm., diameter 1.5 mm.; from the same locality as the specimen shown in figure 4; Pleistocene. P. 375.

Fig. 10. *Aspella pyramidalis* Broderip; hypotype No. 6958, C. A. S. Paleo. type coll.; length (incomplete), 10.5 mm., diameter 5.2 mm.; from the same locality as the specimen shown in figure 4; Pleistocene. P. 369.

Fig. 11. *Transennella sorocula* Pilsbry and Lowe; hypotype left valve No. 6960, C. A. S. Paleo. type coll.; length 35 mm., height 31.8 mm.; from Loc. 27584 (C. A. S.), Lat. 23°03' to 23°06' N., Long. 109°31' to 109°36' W., dredged from 20 to 220 fathoms. About 10 miles due east of San Jose del Cabo, Lower California: Recent; Templeton Crocker Expedition. View of the interior of the left valve. P. 377.

Fig. 12. *Transennella sorocula* Pilsbry and Lowe; hypotype right valve No. 6960a, C. A. S. Paleo. type coll.; exterior view of the right valve of the specimen shown in figure 11. P. 377.

Fig. 13. *Aspella pyramidalis* Broderip; hypotype No. 6959, C. A. S. Paleo. type coll.; length approximately 7.6 mm., diameter approximately 3.6 mm.; from the same locality as the specimen shown in figure 4; Pleistocene. P. 369.

(Concluded on next page)



## PLATE 32—(Concluded)

Fig. 14. *Transennella puella* Carpenter; hypotype right valve No. 6961, C. A. S. Paleo. type coll.; length 14.8 mm., height 11.2 mm.; from Loc. 24062 (C. A. S.), Cape San Lucas, Lower California; Recent; E. C. Johnson coll. Interior view of right valve. P. 377.

Fig. 15. *Transennella puella* Carpenter; hypotype left valve No. 6961a, C. A. S. Paleo. type coll.; view of the interior of the left valve of the specimen shown in figure 14. P. 377.

Fig. 16. *Transennella puella* Carpenter; hypotype right valve No. 6962, C. A. S. Paleo. type coll.; length 14.2 mm., height 11.6 mm.; from Loc. 27587 (C. A. S.), dredged off Cape San Lucas, Lower California in 20 to 220 fathoms; Recent; Templeton Crocker Expedition. View of the exterior of the right valve showing the tent shaped markings. P. 377.

Fig. 17. *Caducifer thaleia* Pilsbry and Lowe; hypotype No. 4696, C. A. S. Paleo. type coll.; length 31.6 mm., diameter 9.6 mm.; from the same locality as the specimen shown in figure 4; Pleistocene. P. 370.

Fig. 18. *Alvania veleronis* Hertlein and Strong, new species; holotype No. 700, C. A. S. Paleo. type coll.; length 2.6 mm., diameter 1.2 mm.; from Loc. 27228 (C. A. S.), dredged in from 3 to 9 fathoms off Taboga Island, Panama; Recent. This species also occurs at Loc. 27255 (C. A. S.), on a raised beach, 5 to 10 meters above sea level at James Bay, James (San Salvador) Island, Galapagos Islands; Pleistocene. P. 373.

Fig. 19. *Odostomia (Miralda) incantata* Hertlein and Strong, new species; holotype No. 735, C. A. S. Paleo. type coll.; length 2.1 mm., diameter 1.0 mm.; from Loc. 27229 (C. A. S.), dredged in from 3 to 9 fathoms at Bahia Honda, Vera-gua, Panama; Recent. This species also occurs at Loc. 27255 (C. A. S.), raised beach at James Bay, James (San Salvador) Island, Galapagos Islands; Pleistocene. P. 374.

Fig. 20. *Engina reeviana* C. B. Adams; hypotype No. 6963, C. A. S. Paleo. type coll.; length 16.8 mm., diameter approximately 11.1 mm.; from the same locality as the specimen shown in figure 4; Pleistocene. P. 370.

Fig. 21. *Cancellaria haemastoma* Sowerby; hypotype No. 6964, C. A. S. Paleo. type coll.; length 19.8 mm., diameter 14.4 mm.; from the same locality as the specimen shown in figure 4; Pleistocene. P. 370.

Fig. 22. *Craspedotriton scalariformis* Broderip; hypotype No. 6965, C. A. S. Paleo. type coll.; length (incomplete), 37.3 mm., diameter approximately 18 mm.; from the same locality as the specimen shown in figure 4; Pleistocene. P. 370.





Hertlein, Leo George and Strong, A M. 1939. "Marine Pleistocene Mollusks from the Galapagos Islands." *Proceedings of the California Academy of Sciences, 4th series* 23, 367–380.

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