The Eastern Pacific Cowries

BY

CRAWFORD N. CATE

12719 San Vicente Boulevard, Los Angeles, California 90049

(Plates 11 to 15; 3 Maps)

INTRODUCTION

THE PURPOSE OF THIS PAPER is to provide a checklist of the cowrie species known from the Eastern Pacific Region of the Americas, including such islands and island groups as the Galápagos, Clipperton, Cocos, Revillagigedos and Guadalupe. All of these offshore localities share a similar molluscan fauna. It seems pertinent, therefore, to mention a few facts regarding these islands.

First in geographical importance are the Galápagos Islands, which provide a home for many cowrie species including both eastern and western forms. The archipelago consists of 10 major islands, the largest of which is Isabella (Albemarle). Other more important islands, with their earlier names are: Santa Cruz (Indefatigable), San Cristobal (Chatham), San Salvador (James), Fernandina (Narborough), Santa Maria (Charles), and Española (Hood). The collecting localities at these islands are, for the most part, horizontal strata, lava outcroppings, boulder strewn extensions of black basaltic lava with attached algae, and a minimum of sandy beaches.

Clipperton Island appears to be the crossroads for the eastern and western cowries, as here the two faunas come together. This former atoll is located on the western perimeter of the Eastern Pacific cowrie region and seems to provide a bridge that has enabled some of the more western species to migrate to the American mainland. Clipperton Island is roughly 2 square miles of irregular atoll land area; it is uninhabited and is about 670 miles southwest of Mexico. With a diameter of about 2½ miles, it encloses a rocky projection of about 85 feet in height, the highest point on the atoll. The shore area appears to be ideal for cypraeids with its sandy beaches, some of which are strewn with rock and coral rubble, and the adjacent coral and algae reef-flats.

Luria isabellamexicana (STEARNS, 1893) seems to be the native cowrie species, considering the east and west extremes of its range. It appears to reproduce in greatest abundance at Clipperton Island, whence its range extends eastward to the west Mexican-Central American intertidal waters. Westward the species emerges again in Hawaiian subtidal waters as *L. isabella controversa* (GRAY, 1824). This range determination becomes more valid when one considers that *L. isabella atriceps* SCHILDER & SCHILDER, 1938, a clearly distinguishable subspecies, can be observed to commence its West-Central Pacific range in the Hawaiian Islands, a fact that should not have been ignored in CATE (1965). A study of a series of these subspecies shows little or no intergrading between them, even though they share overlapping habitats.

Cocos Island, Costa Rica, is an uninhabited island of approximately 18 square miles, situated southwesterly from the mainland. Not much field work has been undertaken at this presently inaccessible locality, and, therefore there is not much known of its cowrie fauna.

The Revillagigedos Islands lie about 420 miles west of the Mexican mainland and, nearly 240 miles south of Cape San Lucas, Baja California del Sur. These islands belong to Mexico, and consist mainly of Clarion and Socorro Islands; Roca Partida Island is the westernmost of this group (see HERTLEIN & HANNA, 1930). Some field work has been accomplished at these islands, resulting in a somewhat better knowledge of the cowries there. However, isolation and inaccessibility still limit the field work in this area.

The Tres Marias Islands, Mexico, on the other hand, are only about 50 miles off the mainland coast of the State of Nayarit, and some 200 miles southeast of Cape San Lucas (STRONG & HANNA, 1930). Several collecting expeditions to these islands have fairly well explored the fauna, so that we have an adequately complete knowledge of the cowrie species occurring in these islands.

The Pacific coast of Central America represents the connecting link, or land bridge, between North and South America; it extends officially from the southern boundary of Mexico to the northwest boundary of Colombia. This coastline includes numerous bays, islets, cliff-bound shores, and rocky projections into the sea; coral tables at the

ocean surface, coral reefs, and extensive sandy beaches. Mangroves line areas of quiet backwaters; to all of this is added a tropical water temperature. There are at least 5 of the Eastern Pacific cowrie species living within this warm-water range. The northern coast of Pacific South America provides for at least 2 more, with the remainder confined to the Gulf of California-West America, and the listed islands.

The Gulf of California, an arm of the Pacific Ocean, extends northwest into the mainland of North America. It is bounded on the East by mainland Mexico, and on the West by the peninsula of Baja California. It is interesting to note that most of the cowrie species in this province thrive within the confines of the Gulf as well as along the open shoreline. The one exception is *Zonaria annettae annettae* (DALL, 1909), which appears to be completely restricted to the waters of the Gulf.

The west coast of North America from Monterey, California in the North to the proximity of Cedros Island, West Baja California, in the South, provides another delimited range for cowries. Perhaps the most notable factor in the living conditions in this area are the cold water upwellings, a condition not generally found in the other areas included in this discussion. *Zonaria (Neobernaya) spadicea* (SWAINSON, 1823) may be collected at nearly any point in this range that provides suitable ecological conditions for cowries; this includes all of the islands such as the southern Guadalupe Island.

Guadalupe Island, a Mexican island possession, is situated about 275 miles west of El Rosario, Baja California del Norte, and about 185 miles southwest of San Diego, California. The island is surrounded by very deep water, up to 2000 fathoms; it is of volcanic origin. It is said to possess much the same marine ecological conditions as those observed on the California coast and Californian islands (STRONG & HANNA, 1930; CHACE, 1958).

No provision is made here to include a report on the possibility of cypraeids occurring at the remote, southern Chilean islands of San Felix (20°20′S Lat.; 80°10′W Long.); San Ambrosio (26°40′S Lat;80°00′W Long.); and Juan Fernandez (33°30′S Lat.; 79°00′W Long.).

Special interest attaches to the discovery of two cowrie species from the western Pacific on the beaches of Baja California del Sur by Mrs. Helen DuShane, Whittier, California. On July 6, 1956 she found a dead, decorticated specimen, though with some color and fresh markings, of *Erronea caurica* (LINNAEUS, 1758) (Plate 14, Figure 23) at Rancho Eureka, Punta Arena. The morphological details of this specimen are: (42.6 23.0 18.5 18 16). On July 7 Mrs. DuShane found a specimen of *Staphylaea staphylaea* (LINNAEUS, 1758) (Plate 14, Figure 24) at Los Chilenos, a locality 4 miles beyond Rancho El Tule, but before reaching Cabo San Lucas. The shell was in excellent condition, imbedded in a clump of fresh sea weed deposited on the beach. The details of this shell are: (20.0 12.0 10.0 24 20).

The largest and smallest shells available to me for this study are listed to provide an estimate of size variation found in the species. The 5 figures given are, in the following order: length, width, height (all in millimeters), number of teeth on outer lip, number of teeth on columellar lip.

ACKNOWLEDGMENTS

There are many people to whom I wish to express my sincere thanks, in addition to those mentioned elsewhere in this paper, for their contributions of material, field information, and literature references; they are: the late Conrad Limbaugh, Emery Chace, Mrs. Helen DuShane, Mr. and Mrs. Ben Purdy, Mrs. Twila Bratcher, Glen Bickford, John Fitch, Lawrence Thomas, Gale Sphon, Mr. and Mrs. Michael O'Brien, Mrs. Emily Reid (for the maps), Dr. Takeo Susuki (for special processing of the photographs) and, finally, Jean Cate for helpful suggestions and continued encouragement of my work as well as for the photography for the plate illustrations.

LOCALITY INDEX

Many of the localities listed here were obtained from handwritten labels in various collections. Every effort has been made to verify the spellings, but in some instances certain place-names were not found on any map or atlas available to me; it is regretted if any discrepancies occur.

1. Acapulco, Guerrero, Mexico
2. Agua Chale (approx. 24 mi S of San Felipe), E Baja California del Norte, Mexico
3. ibid. (subfossil, Indian kitchen midden)
4. Albemarle Island, Galápagos Islands, Ecuador
5. ibid. (Banks Bay)
6. ibid., (Tagus Cove) (HERTLEIN, 1939; Pleistocene)
7. Algodones (Bahía), Sonora, Mexico (Tesora Exped.) March 1966
8. Almejas (Playa), W Baja California del Norte, Mexico (adjacent to Magdalena Bay)
9. Angel de la Guarda Island, Gulf of California
10. Anacapa Island, off Santa Barbara, California
11. Audencia (Bahía de), Colima, Mexico; Churea Expedition January 1962
12. Bahía Honda, Panama

13. Bahía Salahua, 3 mi. N of Manzanillo, Colima, Mexico (Las Hondas Hotel area)
14. Bahía Tenacatita (60 mi. N of Manzanillo, Colima)
15. Balboa Bay, Orange County, California
16. Balboa, Canal Zone, Panama
17. see no. 5, above
18. Barra de Navidad (30 mi N of Manzanillo), Jalisco, Mexico
19. ibid., first Churea Expedition, 7 - 11 January 1962
20. ibid., second Churea Expedition, February 1963
21. Bat Island, Costa Rica
22. Bacochibampo Bay, 1 mi N of Guaymas, Sonora
23. Bomber Beach, Puertecitos, E Baja California del Norte, Mexico
24. Buena Vista, Las Palmas Bay (23°35′N Lat.; 109° 40′W Long.), East Baja California del Sur
25. Cabo San Lorenzo, Ecuador

25a. Cabo San Lucas, Baja California del Sur

26. Cabrillo Beach, San Pedro, California
27. Caleta de Campo, Guerrero, Mexico; just N of Acapulco
28. Cambria, California (subtidal rocks)
29. Cambria Radar Station, California (1½ mi. offshore, 67 - 70 feet of water)
30. Cape San Lucas, S tip of Baja California del Sur
31. Caracol (Playa) near Bahía San Carlos, Sonora, Mexico; Tesora Expedition, 29 March 1966
32. Cardalitos, Peru
33. Carmen Island, Marques Bay (off-shore from Loreto), Baja California del Sur
34. Carmen Island, Salinas Bay, Baja California del Sur
35. Catalina Island, California
36. Cerralvo Island, Gulf of La Paz, E Baja California del Sur
37. Changame Island, Panama Bay, Panama
38. Charles Island, Galápagos Islands
39. Chatham Island, Galápagos Islands
40. Chatham Bay, Cocos Island, Costa Rica
41. Cholla Bay, Puerto Peñasco, Sonora, Mexico
42. Clarion Island (Revillagigedos Islands), Mexico
43. Cleofas Island, Tres Marias Islands, Mexico
44. ibid., (Yellow Bluff)
45. Coaloil Point, Goleta, California (20 feet of water)
46. Clipperton Island (11°00′N; 109°20′W); 1958
47. ibid., (Hertlein, 1937)
48. Cocos Island (5°32′N; 86°59′W), Costa Rica
49. ibid., (Ingram, 1951)
50. ibid., Chatham Bay
51. Concepcíon Bay, East Baja California del Sur
52. Corinto, Nicaragua
53. Corona del Mar, Orange County, California
54. Coronado Island, W Baja California del Norte
55. Coyote Lagoon (Bahía), Concepcíon Bay, E Baja California del Sur
56. Creston Island, Mazatlán, Sinaloa; 22 Dec. 1960
57. ibid., under rocks, 25 feet of water, January 1964
58. Dana Point, Orange County, California
59. Desemboque (Playa), Sonora, Mexico
60. Enchura Bay, Peru
61. El Coyote Bay, within Concepcíon Bay, E Baja California del Sur
62. El Tule (Rancho), approx. 9 mi E of Cabo San Lucas, Baja California del Sur, 22 February 1963
63. Elwood Beach, Santa Barbara County, California

63a. Empalme (approx. 10 mi. S of Guaymas), Sonora

64. Ensenada, W Baja California del Norte
65. Espiritu Santo Island, E Baja California del Sur
66. Flamenco Island, Panama Bay, Panama (under rocks at minus tide; December 1960)
67. Galápagos Islands (00°01′S; 90°30′W); Ecuador
68. ibid., Hertlein, 1939 (Pleistocene)
69. Gaviota Point, Mazatlán, Sinaloa; second Churea Expedition, 22 January 1963
70. Geronimo Island, off Punta Baja, W Baja California del Norte
71. Goleta, Santa Barbara County, California
72. ibid., Coaloil Point, on rocks, minus tide
73. ibid., Cookout Beach, University of California at Santa Barbara
74. ibid., reef off Devereau School, N Goleta

74a. Guadalupe Island, Mexico (29°00′N; 120°00′W)

75. Guanacaste, Costa Rica
76. Guaymas, Sonora, Mexico

76a. Gulf of Fonseca, Costa Rica-Nicaragua

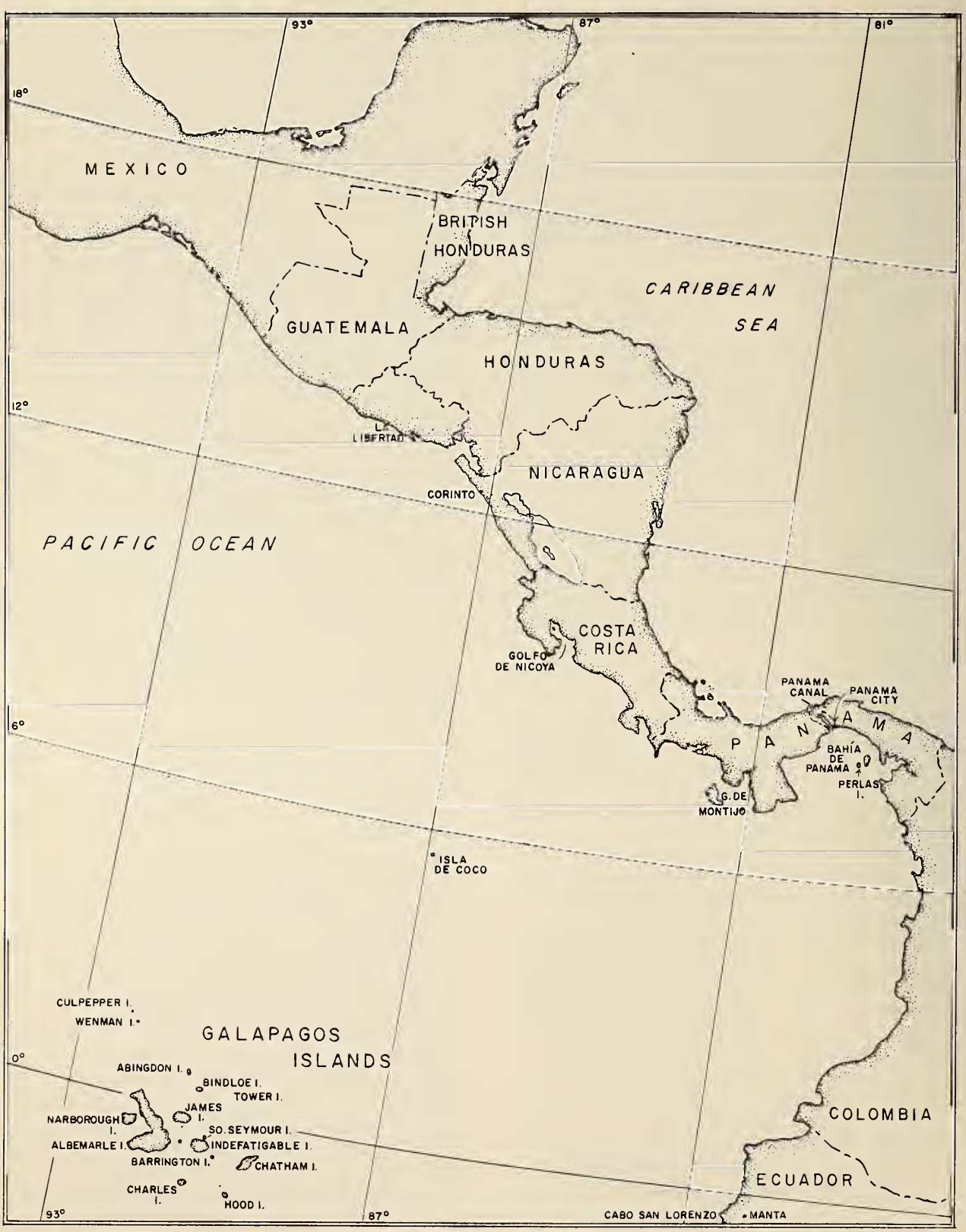
77. Gulf of Nicoya, Costa Rica
78. Gulf of Montijo, Panama
79. Hood Island, Galápagos Islands
80. Indefatigable Island, Galápagos Islands
81. ibid., Academy Bay
82. Isabel Island, Galápagos Islands

82a. Isla Angel de la Guarda, Gulf of California

83. Isla de Malpelo, Colombia
84. Isla San Benito (Bahía de Sebastian Vizcaino), W Baja California del Norte
85. Isla San Luis, E Baja California del Norte
86. Isla Santa Cruz, Galápagos Islands
87. James Island, Galápagos Islands
88. ibid., Sulivan Bay

88a. ibid., Hertlein, 1939 (Pleistocene)

89. Kino Bay, Sonora (approx. 75 mi. N of Guaymas)
90. Kobbee Beach, Canal Zone, Pacific Panama
91. La Jolla, San Diego County, California
93. La Libertad, San Salvador
94. La Paz, SE Baja California del Sur


93°
87°
81°
18°
MEXICO
BRITISH
HONDURAS
CARIBBEAN
SEA
GUATEMALA
HONDURAS
12°
LA
LIBERTAD
NICARAGUA
CORINTO
PACIFIC OCEAN
COSTA
RICA
GOLFO
DE NICOYA
PANAMA
CANAL
PANAMA
CITY
PANAMA
BAHÍA
DE
PANAMA
PERLAS
I.
G. DE
MONTIJO
6°
ISLA
DE COCO
CULPEPPER I.
WENMAN I.
GALAPAGOS
ISLANDS
0°
ABINGDON I.
BINDLOE I.
TOWER I.
JAMES
I.
NARBOROUGH
I.
SO. SEYMOUR I.
ALBEMARLE I.
INDEFATIGABLE I.
BARRINGTON I.
CHATHAM I.
CHARLES
I.
HOOD I.
COLOMBIA
ECUADOR
93°
87°
CABO SAN LORENZO
MANTA

95. La Penita, Nayarit (between Compostella and Puerto Vallarta)
96. Las Animas (Bahía) mainland, W of Isla Angel de la Guarda, E Baja California del Norte
97. Las Gaviotas Beach, Mazatlán, Sinaloa
98. Las Varas, Nayarit (out of Tepíc, via Compostella)
99. Lobitos, Peru
100. Loreto, E Baja California del Sur
101. ibid., (very small shells).
102. Los Angeles Bay (shore W of Isla Angel de la Guarda) E Baja California del Norte
103. Los Chilenos (8 mi. E of Cabo San Lucas), Baja California del Sur
104. Magdalena Bay, W Baja California del Sur
105. Manta, Ecuador
106. Manacora, Peru
107. Manzanello (Boca Chamela) = Manzanillo, Colima
108. Manzanillo, Colima
109. ibid., Boca Chamela
110. ibid., 20 miles W of -
111. ibid., 100 miles S of -
112. Margarita Bay, La Paz, E Baja California del Sur
113. Maria Madre Island, Tres Marias Islands, Nayarit
114. ibid., Emerson & Old, 1963 (dredge, off Arroyo Honcho)
115. ibid., Puerto Balleto
116. Maria Magdalena Island, Tres Marias Islands
117. Mazatlán, Sinaloa, Mexico
118. ibid., Yacht Club
119. ibid., 100 miles S of -
120. ibid., Venado Island
121. Melique, Jalisco, Mexico
122. Mendia, Sinaloa, Mexico
123. Miramar Beach, Guaymas, Sonora
124. Mission Bay, San Diego County, California
125. Modesto, Sinaloa
126. Monserrate Island, E Baja California del Sur (approx. 50 mi. S of Loreto)
127. Monterey Bay, California
128. Montijo, Gulf of Montijo, Pacific Panama
129. Morro Bay, California
130. ibid., Point Buchon
131. Narborough Island, Galápagos Islands
132. Negritos (Parinas), Peru
133. Newport Bay, Orange County, California
134. Newport Beach, Orange County, California
135. Norse Beach (Cholla Bay), Punto Peñasco, Sonora
135a. Paita, Peru
136. Paitilla Point, Panama
137. Palmito del Verde (approx. 50 mi. S of Mazatlán)
138. Palo Seco Beach, Canal Zone, Pacific Panama
139. Palos Verdes Peninsula, California
140. ibid., Palos Verdes Point
141. Panama, Pacific Central America
142. ibid., Panama Bay
143. ibid., Panama Canal (cement wall within Pacific entrance)
144. Pelican Point, Puerto Peñasco, Sonora
145. Perlas Island, Panama Bay, Pacific Panama
146. Playa Almejas (adjacent Magdalena Bay), W Baja California
147. see no. 31
148. see no. 59
149. Playa Santa Maria (Cabo San Quintín), W Baja California
150. see no. 130
151. Point Conception, California
152. Point Fermin, San Pedro, California
153. Point Loma, San Diego, Calif. (lower lighthouse)
154. Point San Telmo (mainland landfall W of Isla Santa Cruz), E Baja California del Sur
155. Point Vicente, Palos Verdes Peninsula, California
156. Portuguese Bend, Palos Verdes Peninsula, California
157. Puertecitos (approx. 180 mi S of California-Mexico border), E Baja California del Norte
158. ibid., 24 mi N of -
159. ibid., 28 mi S of -
160. see no. 115
161. Puerto Chileno (8 mi E of Cabo San Lucas), Baja California del Sur
162. Puerto Escondido (approx. 11 mi S of Loreto), E Baja California del Sur
163. ibid., under rocks in the lagoon
164. Puerto Grande, San Salvador Island, Galápagos Islands
164a. Puerto Libertad (approx. 60 mi N of Guaymas), Sonora, Mexico
165. Puerto Madre, Chiapas, Mexico
166. Puerto Peñasco, Sonora, Mexico
167. Puerto Vallarta (17 mi N of -), Jalisco, Mexico
168. ibid., small specimens from deep water
169. Pulmo Reef, (approx. 70 m S of La Paz), E Baja California del Sur
170. Pulperia Reef, Panama Bay, Pacific Panama
171. Pulpito Point (approx. 40 mi S ofLoreto), E Baja California del Sur
172. Punta Arena (approx. 70 mi N of Cabo Pulmo, E Baja California del Sur
173. Punta Baja (approx. 15 mi S of El Rosario), E Baja California del Norte
174. Punta Banda (approx. 15 mi S of Ensenada), W Baja California del Norte
175. ibid., Cape (Todos Santos Bay)
176. Punta Canoas (approx. 55 mi S of El Rosario), W

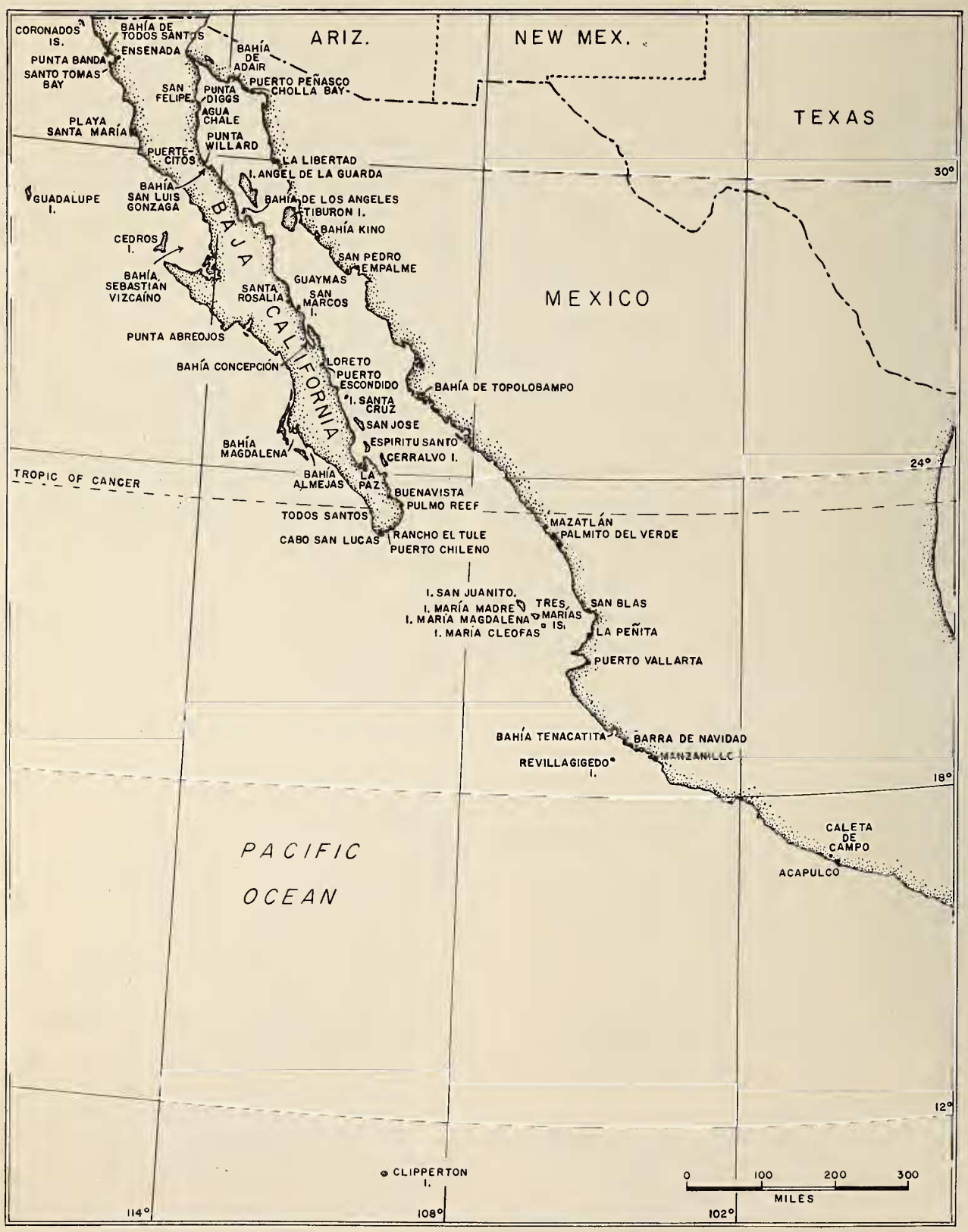

CORONADOS IS.
BAHÍA DE TODOS SANTOS
ENSENADA
PUNTA BANDA
SANTO TOMAS BAY
BAHÍA DE ADAIR
PUERTO PEÑASCO
CHOLLA BAY
ARIZ.
NEW MEX.
TEXAS
SAN FELIPE
PUNTA DIGGS
AGUA CHALE
PLAYA SANTA MARÍA
PUNTA WILLARD
PUERTECITOS
LA LIBERTAD
I. ANGEL DE LA GUARDA
30°
GUADALUPE I.
BAHÍA SAN LUIS GONZAGA
BAHÍA DE LOS ANGELES
TIBURON I.
BAHÍA KINO
CEDROS I.
SAN PEDRO
EMPALME
BAHÍA SEBASTIAN VIZCAÍNO
SANTA ROSALIA
GUAYMAS
SAN MARCOS I.
MEXICO
BAJA CALIFORNIA
PUNTA ABREOJOS
BAHÍA CONCEPCIÓN
LORETO
PUERTO ESCONDIDO
BAHÍA DE TOPOLOBAMPO
I. SANTA CRUZ
SAN JOSE
ESPIRITU SANTO
CERRALVO I.
BAHÍA MAGDALENA
24°
TROPIC OF CANCER
BAHÍA ALMEJAS
LA PAZ
BUENAVISTA
PULMO REEF
TODOS SANTOS
MAZATLÁN
PALMITO DEL VERDE
CABO SAN LUCAS
RANCHO EL TULE
PUERTO CHILENO
I. SAN JUANITO
I. MARÍA MADRE
I. MARÍA MAGDALENA
I. MARÍA CLEOFAS
TRES MARÍAS IS.
SAN BLAS
LA PEÑITA
PUERTO VALLARTA
BAHÍA TENACATITA
BARRA DE NAVIDAD
MANZANILLO
REVILLAGIGEDO I.
18°
CALETA DE CAMPO
ACAPULCO
PACIFIC OCEAN
12°
CLIPPERTON I.
0 100 200 300
MILES
114°
108°
102°

Figure 1

Macrocypraea cervus cervinetta (KIENER, 1843)
Galápagos Islands × ¾

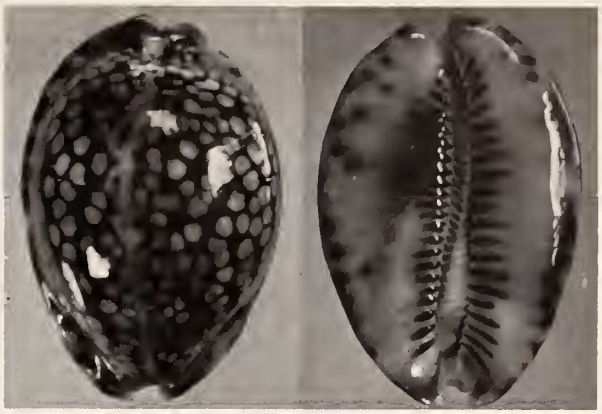


Figure 2

Mauritia maculifera SCHILDER, 1932
Clipperton Island × 1

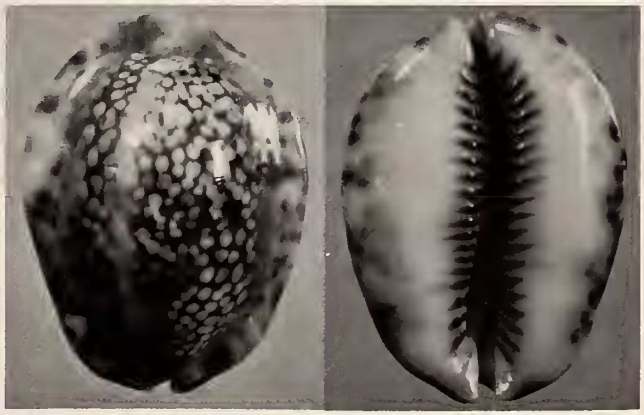


Figure 3

Mauritia depressa (GRAY, 1824)
Clipperton Island × 1¼

Figure 4

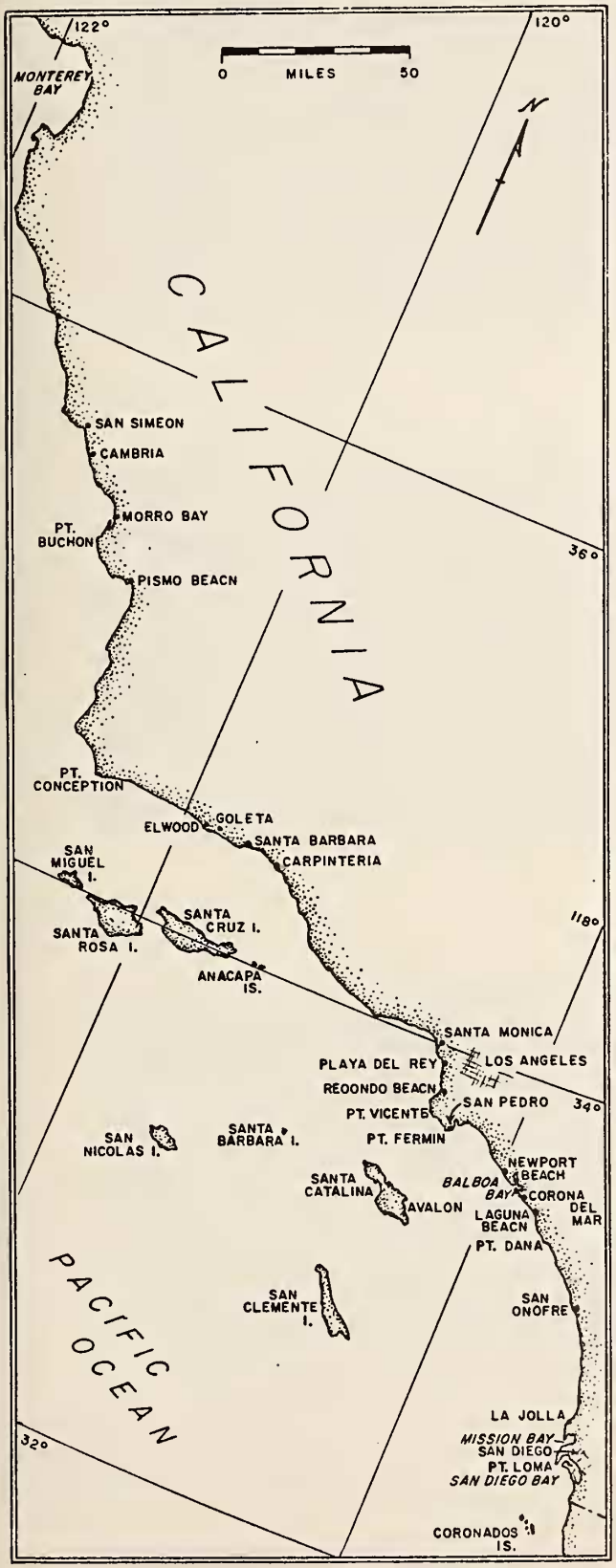
Mauritia scurra retifer (MENKE, 1829)
Clipperton Island × 1⅓

Figure 5

Lyncina vitellus polynesiae
SCHILDER & SCHILDER, 1939
Clipperton Island × ⅔

Figure 6

Lyncina schilderorum IREDALE, 1939
Clipperton Island × 2



176a. Punta Catedral, Costa Rica
177. Punto Colorado, Guaymas, Sonora
178. ibid., 1 mi S of -
179. Punta Diggs (6 mi S of Mazatlán), Sinaloa
180. Punta Dominical, Costa Rica
181. Punta Estrella (approx. 5 mi S of San Felipe), E Baja California del Norte
182. Punta Final (S point of San Luis Gonzaga Bay), E Baja California del Norte
183. Punta Parinas, Peru
184. Punta San Carlos (approx. 60 mi S of El Rosario), W Baja California del Norte
185. Punta San Miguel (6 mi N of Ensenada), W Baja California del Norte
185a. Punta San Roque (approx. 85 mi S of Cedros Island), Baja California del Sur
186. Rancho Buena Vista (approx. 8 mi S of Santa Rosalia), E Baja California del Sur
187. Rancho El Tule (approx. 9 mi E of Cabo San Lucas), Baja California del Sur
188. ibid., just E of -
189. Rancho La Cuevas (Popotle) (20 mi S of Tijuana), W Baja California del Norte
190. Revillagigedo Island (off Mazatlán), Sinaloa
191. Salaverry, Peru
192. see no. 34
193. Salinas, Ecuador
194. Saladita Bay (near Guaymas), Sonora
195. Salsepuedes Island (near Tiburon Island), Gulf of California
196. San Blas (Topolobampo), Nayarit, Mexico
196a. San Carlos Bay, near Guaymas, Sonora (approx. 8 mi N of -)
197. ibid., 7 mi NW of -
198. San Clemente Island, California (32°51′N; 118°30′W)
199. San Felipe, E Baja California del Norte
200. ibid., 45 mi S of -
201. ibid., 50 mi S of -
202. San Francisco (Playa), near Guaymas, Sonora
203. San José Island (50 mi N of La Paz), E Baja California del Sur
203a. ibid., Amortajarado Bay
204. San Jaunito Island, Tres Marias Islands, Nayarit
204. San Juanito Island, Tres Marias Islands, Nayarit
205. San Luis Gonzaga (approx. 85 mi S of San Felipe), E Baja California del Norte
206. ibid., on the reef
207. San Luis Island (approx. 70 mi S of San Felipe), E Baja California del Norte
208. San Marcos Island (approx. 20 mi S of Santa Rosalia), E Baja California del Sur
209. San Miguel Island, California, 34°05′N; 119°30′W
210. San Lorenzo Island, just S of Isla Angel de la Guarda
211. San Nicolas Island, California, 33°15′N; 119°30′W

212. San Pedro Bay, Sonora, Mexico
213. San Pedro Breakwater, San Pedro, California
214. San Roque, Baja California
215. San Salvador Island, Galápagos Islands,
216. San Simeon, California
217. San Simeon, Chiapas, Mexico (20 - 30 fathoms, July 1961)
218. Santa Barbara Island, California (33°28′N; 119°02′W)
219. Santa Catarina Landing (35 mi S of El Rosario), W Baja California del Norte
220. Santa Cruz, Nayarit (10 mi. S of San Blas)
221. ibid., S end of Bahía Matanchen
222. ibid., Churea Expedition, 16 January 1962
223. Santa Cruz Island, California, 34°01′N; 119°50′W
224. Santa Cruz Island, E Baja California del Sur, Mexico (24°30′N; 110°45′W)
225. Santa Cruz Island, Galápagos Islands, Ecuador
226. Santa Monica Breakwater, Santa Monica, California
227. Santa Rosalia, E Baja California del Sur
228. Santo Tomas Bay, W Baja California del Norte
228a. Santa Ynez Bay (approx. 30 mi S of Santa Rosalia), E Baja California del Sur
229. Sechura Bay, Peru
230. Seymour Island, Galápagos Islands
231. ibid., South - (HERTLEIN, 1959; Pleistocene)
232. Socorro Island, Revillagigedos Islands, Colima
233. Soldado Bay, N of Guaymas, Sonora; Paisano Expedition, 30 April 1964
234. see no. 231 (except: 1939)
235. Taboga Island, Honda Bay (12 mi SW of Panama)
236. Tangola Tangola, Oaxaca, Mexico
237. Tagus Cove, Albemarle Island, Galápagos Islands
238. Tenacatita Bay, Jalisco; second Churea Expedition, 5 - 8 February, 1963
239. Tetas de Cabra (near Guaymas), Sonora
240. Three Arches Beach, Newport, California
241. Tiburon Island, Gulf of California
242. Topolobampo Bay, Sinaloa; second Churea Expedition; 19 January 1963
243. Trailer Park, San Carlos Bay, Sonora; Tesora Expedition, March 1966
244. Tres Marias Islands, Nayarit; Tesora Expedition, March 1966
245. Turtle Beach (12 mi S of Puertecitos), Okie's Landing), E Baja California del Norte
246. Valma Beach (2 mi S of Santa Barbara Pier), Santa Barbara, California
247. Venado Island, Panama Bay, Pacific Panama
248. Venado Island (off Mazatlán), Sinaloa; Churea Expedition, 21 December 1961
249. Vera Cruz, Panama
250. Vique Point, Panama Bay, Panama
251. Wenman Island, Galápagos Islands
252. White's Point, San Pedro, California
253. Willard Bay (just N of Bahía San Luis Gonzaga), E Baja California del Norte
254. ibid., Willard Point
255. see no. 118
256. Zoritos, Peru

SPECIES INDEX

1. *Macrocypraea cervus cervinetta* (KIENER, 1843)

Spéc. Icon. Coq., *Cypraea*, p. 72; plt. 2, fig. 1; plt. 3, fig. 2

(Plate 11, Figure 1)

Localities: 4 32 36 38 43 52 67 76 78 79 82 87 90 94 99 104 105 106 112 113 116 117 120 122 135a 138 142 143 145 162 168 169 170 176a 193 197 220 222 225 230 235 241 250 253 254 255 256

Largest shell:	97.1	48.8	35.4	36	33
Smallest shell:	42.4	20.5	16.1	30	25

Shell variable in size, tending to be large; elongate ovate, narrow for its length, strong, lightweight; humped adapically, sloping in front, sub-cylindrical; aperture wide, broadening sharply abapically; left margin rounded, right

Figure 7

Luria isabellamexicana (STEARNS, 1893)
La Paz, Mexico × 1¼

Figure 8

Luria isabellamexicana (STEARNS, 1893)
Clipperton Island × 1¼

Figure 9

Zonaria a. annettae (DALL, 1909)
Puerto Escondido, Mexico × 1

Figure 10

Zonaria a. annettae (DALL, 1909)
with *Crepidula incurva* (BRODERIP, 1834)
Puertecitos, Mexico × 1½

Figure 11

Zonaria a. annettae (DALL, 1909), variant
Puerto Escondido, Mexico × 2

Figure 12

Zonaria annettae aequinoctialis SCHILDER, 1933
Cabo San Lorenzo, Ecuador × 1

margin bluntly angled, neither more than noticeably calloused; teeth long, strong, heavier on outer lip, extending adaxially well onto columella from margin to base; base convex, broadened outer lip flattened; fossula short, crossed with teeth, shallow or almost lacking; terminals heavy, produced, openings wide, exaggeratedly so in front; primary shell color light grey, exposed through final covering of light brownish-yellow as grey ocellae of various sizes; a somewhat broadened light grey mantle line on right dorsum; interior of shell light grey; terminals, base, lip, and interstices bright brownish-grey; teeth dark brown; semi-obscure small brown spots in base coloring.

This subspecies is associated with the Gulf of Mexico-Caribbean Sea species *Macrocypraea cervus cervus* (Linnaeus, 1758). The Gulf of Panama seems to be the locality of greatest abundance for these animals. *Macrocypraea cervus cervinetta* may have been separated from the original stock and isolated by the Pliocene emergence of the narrow land-bridge now connecting the Americas. Study shows the two shell forms to be very close in growth, size, color, and the living requirements of the animals themselves. Adult shells of subspecies range in size from quite small to extremely large.

These animals appear to be algae feeders, living in coral pockets and on ledges and on rocks and basalt substrates. The species is fairly common, particularly in the Gulf of Panama. Fossil records for the subspecies consist, so far as I have been able to determine, of a single specimen from the Pliocene at Seymour Island, Galápagos Islands (Dall & Ochsner, 1928).

2. *Mauritia (Arabica) maculifera* Schilder, 1932

Zool. Anz. **100** (7/8): 165

(Plate 11, Figure 2)

Localities: 46 47

Largest shell:	52.3	37.8	28.0	26	24
Smallest shell:	49.2	31.3	25.2	28	22

The shell description is omitted here, as the specimens agree in color and morphological characters with the Hawaiian form (see Cate, 1965); the shells are beach-worn and a description would not correctly represent the species. The shells I have seen from Clipperton Island seem to be slightly smaller than the norm.

This animal has a broad living range that extends from one side of the Pacific Ocean to the other without quite attaining the American or Asian mainlands. With Clipperton Island the eastern anchor, it ranges to the Philippine Island-Ryukyu Island-Japanese Islands axis in the west; and north to south from the Bonin Islands possibly to the Gilbert Islands just below the equator.

The 2 specimens listed above were collected by Conrad Limbaugh in 1959. Other specimens of this species are recorded in the literature (see Hertlein & Allison, 1960).

3. *Mauritia (Arabica) depressa depressa* (Gray, 1824)

Zool. Journ. **1**: 77

(Plate 11, Figure 3)

Locality: 46

Shell data:	40.8	30.9	20.7	24	19

Shell fairly large for the species, short, wide, having a flattened appearance, solid, heavy; terminals do not protrude beyond periphery of marginal outline; margins heavily, thickly calloused, angled and upswept, semi-shouldered; base and outer lip of nearly equal breadth, convex; aperture narrow, fairly straight, terminal openings narrow; teeth of medium size and length, prominent; primary shell-color off-white, overlaid with light chestnut-brown, thickly ocellate, and divided the length of the right dorsum with wide off-white mantle line; upper sides and terminals light grey; margins and base off-white, with sides, margins, and a narrow area of the base and outer lip spotted with large, medium brown spots that become obscure on the base; base, interstices, terminal interiors off-white, teeth brown.

The specimen listed here is a live-collected animal taken at the low water line under a large rock just inside the outer reef. Several dead shells were also collected among the rocks on the beach at the same time (coll. Conrad Limbaugh, 1959; pers. commun.). This species is fairly well established in the islands extending across the northern half of the Pacific Ocean, but has yet to be found in the Hawaiian group. Reports of the species there have proven to be *Mauritia (Arabica) maculifera* Schilder, 1932. The addition of Clipperton Island extends the range eastward from heretofore known localities.

4. *Mauritia (Arabica) scurra retifer* (Menke, 1829)

Verz. Conch. Samml. Malsburg, p. 76

(Plate 11, Figure 4)

Localities: 46 47

Shell large, long, narrow, cylindrical, solidly formed; terminals protruding, well developed; margins barely thickened, rounded; base roundly convex; aperture long, narrow, straight; teeth numerous, small, fine, not crossing recessed columella; fossula broad, deep, a third the length of columella, weakly dentate; primary shell color light grey to grey-beige, dorsum overlaid with ocellate, light chestnut-brown color which is bisected by a wide mantle

line the length of the dorsum; terminals blotched with black on either side; sides, margins, and most of base and outer lip grey brown to smoky-brown, except for bright, lighter coloring on center of base; sides, margins, and upper part of base marked with large dark brown spots; remainder of base, outer lip, and interstices brownish-beige; interior of shell, fossula, and columella off-white; teeth dark brown.

Although small specimens are found occasionally, the larger form seems to predominate. The live animals are only fairly common; they are found living on rocks in a very rocky area with active water flow. Dead shells on the rocky beaches are in greater abundance. This species appears not yet to have reached the American mainland or its off-shore islands.

5. *Lyncina vitellus polynesiae* SCHILDER & SCHILDER, 1939

Proc. Malacol. Soc. London **23** (4): 187

(Plate 11; Figure 5)

Locality: 46

Shell data:	68.0	42.1	36.0	28	25

The single specimen listed here is a dead, subfossil shell collected on the beach at Clipperton Island by Conrad Limbaugh in 1959. Although it is in fair condition, it does not reflect the true aspect or color of a live-collected animal. However, the shell is large for the species, is typically formed, and, in this case, has the familiar golden, glossy color of a subfossil shell; large white spots show faintly through the dorsal golden color; sides, margins, base, teeth, interstices, and interior of shell bright white; teeth large, short and thick on outer lip; more numerous, finer, not extending onto base, but longer adaxially, crossing over columella and fossula; fossula broad, long, and shallow; shell pyriform in outline.

This species is listed in the literature (HERTLEIN & ALLISON, 1960) as a single specimen found on a beach-flat at the north side of the island. It would seem the species is uncommon.

6. *Lyncina schilderorum* IREDALE, 1939

Austral. Zool. 9 (3): 303

Syn.: *Cypraea arenosa* GRAY, 1824

(Plate 11, Figure 6)

Locality: 46

Shell data:	29.3	22.5	16.6	28	24

This specimen, very badly worn and decorticated from beach rolling, was discovered in a bag of equally worn *Erosaria caputserpentis caputophidii* SCHILDER, 1927, from Clipperton Island. It was an exciting discovery and substantiates the report of this species at Clipperton Island by HERTLEIN & ALLISON (1960). No shell description is offered here because of the condition of the specimen; a jagged hole penetrates the right dorsum abapically; the measurements and dentition given above are only approximate. The species is undoubtedly rare at Clipperton Island, but for that matter, it is not at all common anywhere.

7. *Luria isabellamexicana* (STEARNS, 1893)

Proc. U. S. Nat. Mus. **16**: 384; plt. 50, figs. 3, 4

(Plate 12, Figures 7, 8)

Localities: 4 14 18 27 30 36 42 43 46 48 50 76 79 94 95 98 108 109 110 111 113 117 160 169 172 190 204 232 244

Largest shell:	51.5	27.0	22.4	37	32
Smallest shell:	18.4	9.8	7.8	29	25

Shell cylindrically ovate, solid, strongly formed; dorsum flattened centrally, humped adapically, sloping sharply in front; base noticeably flattened adaxially, outer lip likewise; aperture fairly straight, narrow; teeth numerous on both lips, columella very fine, almost obscure, rudimentary, short, lengthening somewhat onto central base, not extending adaxially onto columella; lip teeth short, weakly formed; fossula long, narrow, concavely shallow, ribbed weakly with teeth (approximately 7 on adaxial rim of fossula); terminals well developed, but only barely protruding; margins thickened, barely angled; primary shell color light grey, overlaid with light grey-brown in 3 wide, transverse bands, upon which are overlaid numerous irregularly formed, broken narrow lateral black lines; upper margins medium brownish-grey, fading into white; base, teeth, interstices white; terminals bright, orange-red; 4 dark brown spots superimposed on the orange-red terminals in adult shells; sometimes the quadrimaculation becomes a continuous brown band over the terminal collars.

These animals are found living intertidally in coral formations and on loose coral rubble at Clipperton Island; on the West Mexican - South Baja California shores they occur on coral reefs; and at the Galápagos Islands in crevices and under lava rocks.

A large population of this species has recently been discovered at La Penita, Nayarit, Mexico; the shells, however, are very small on an average at this locality. Every indication seems to point to Clipperton Island as being the locality of greatest abundance of *Luria isabellamexicana.*

Most of the subspecies of *Luria isabella isabella* (LINNAEUS, 1758) develop shells of a moderate size, seldom

Figure 13

Zonaria robertsi (HIDALGO, 1906)
Kobbee Beach, Panama × 2

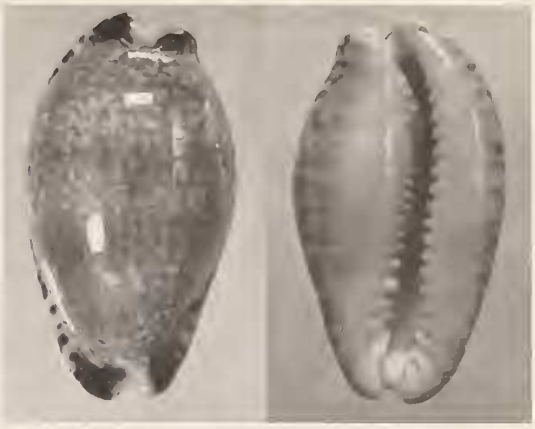


Figure 14

Zonaria nigropunctata (GRAY, 1828)
Galápagos Islands × $1\frac{1}{2}$

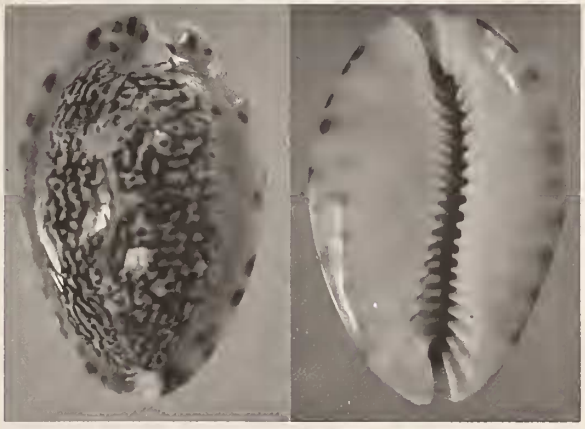


Figure 15

Zonaria arabicula (LAMARCK, 1810)
Mazatlán, Mexico × $1\frac{1}{2}$

Figure 16

Zonaria spadicea (SWAINSON, 1823)
Point Vicente, California × $\frac{3}{4}$

Figure 17

Bistolida r. rashleighana (MELVILL, 1888)
Clipperton Island × $2\frac{2}{3}$

Figure 18

Bistolida t. teres (GMELIN, 1791)
Clipperton Island × 2

attaining the size of this eastern related species. The morphological differences are outstanding, becoming initially apparent in the eastern islands of Polynesia, especially at the Hawaiian Islands where it is recognized as *L. i. controversa* (Gray, 1824).

As stated above, at La Penita a population of 203 (or, possibly, more) animals of *Luria isabellamexicana* were discovered in the autumn of 1966 by Sergio Verboonen. I examined 75 of these shells; all but a dozen were exceedingly small for the species; the largest shells range in length from 30 to 36 mm, the remainder only from 18 to 22 mm.

8. *Zonaria (Zonaria) annettae annettae* (Dall, 1909)

Nautilus **22:** 125
Syn.: *Cypraea sowerbyi* Kiener, 1845
Cypraea ferruginosa Kiener, 1843

(Plate 12, Figures 9 to 11)

Localities: 2 3 18 22 33 36 41 51 61 63a 65 76 82a 89 96 101 102 126 157 158 159 162 163 164a 166 169 172 181 194 195 196a 199 203 203a 205 206 207 208 210 228a 241 254

Largest shell:	44.0	24.0	19.4	26	19
Smallest shell:	21.4	18.5	10.9	19	14

Shell usually medium large, solidly formed, pyriform, humped in back, sloping to the front; terminals produced, semi-beaked, strong, well formed; margins thickened, noticeably angled on left, weakly angled on right; aperture fairly straight, wide, flaring somewhat abapically; teeth short, well developed, finer on the columellar base; base bulbously convex centrally, outer lip rounded; primary shell color (observed in bulla stage) light grey, overlaid by overlapping patterns of nearly solid chestnut-brown; margins, terminals, base, and interstices medium chocolate brown, with numerous irregularly sized dark brown spots; teeth off-white.

This is a common species in the Gulf. The range for this animal appears exclusively confined to the protected waters of the Gulf of California; it seems not to occur on the exposed southwest coast of Baja California. Its habitat seems to be shallow water with algae covered rocks and coral strata. The range of this species can be outlined rather accurately by a line drawn across the Gulf from Empalme (just S of Guaymas, Sonora) to a point roughly midway between La Paz and Cape San Lucas (Baja California del Sur), thence northward along the eastern shore to San Felipe (Baja California del Norte) and across the Gulf to Puerto Peñasco; and finally south along the coast back to Empalme. *Zonaria annettae annettae* is somewhat rare at San Felipe (Dr. Shasky, personal communication), becoming more plentiful at Agua Chale and southward. I have examined specimens from practically all the offshore islands and can confirm them at the localities also (see Cate, 1961).

Pairs of animals have been observed on several occasions protecting clutches of small, amber-colored, gelatinous egg masses laid on rock or coral slab surfaces. As noticed in other cowrie species, the larger of the two animals present had its widely spread foot in contact with the upper surface of the egg mass, while the smaller remained immobile near by.

Schilder (1967) published a report of the Calyptraeidae found living attached to the shells of *Zonaria annettae annettae*. This commensal relationship (see Plate 12, Figure 10) between the cowrie and a *Crepidula* is, as far as I can ascertain, unique in the Cypraeidae. I noted this phenomenon while collecting at Puerto Peñasco where I collected this species from under coral slabs with at least one specimen of *Crepidula incurva* (Broderip, 1834), and sometimes two, attached. A report (Mrs. Helen DuShane, personal communication) tells of 9 specimens living on a single cowrie shell.

A subfossil specimen of *Zonaria a. annettae* I removed from an Indian kitchen midden exhibits a 19.5 mm long *Crepidula* scar in the dorsal surface.

It seems worth noting that the presence of *Crepidula incurva* on *Zonaria a. annettae* seems restricted more or less to the animals living within the triangle bounded by Puertecitos, San Felipe, and Puerto Peñasco; it does occur also, but infrequently, on shells found at Guaymas and Bacochibampo.

9. *Zonaria (Zonaria) annettae aequinoctialis* Schilder, 1933

Zool. Anz. 101: 193

(Plate 12, Figure 12)

Localities: 25 60 83 99 106 132 143 183 229 256

Largest shell:	46.2	29.3	23.4	18	13
Smallest shell:	40.9	26.4	21.5	17	12

Shell large, heavy, solid, widely ovate, subpyriform, humped; terminals barely produced, strong, thickly formed; margins thickly layered with nacre, rounded on the left, subangled on the right; base bulbously convex, outer lip rounded; aperture wide, curving left adapically; teeth short, interstices wide on outer lip and columella, longer on the latter, crossing adaxially over columella and fossula; fossula shallow, barely evident; basic shell color light grey, dorsum overlaid almost solidly with ir-