## MOLLUSCA OF THE SOUTHWESTERN STATES, XI—FROM THE TUCSON RANGE TO AJO, AND MOUNTAIN RANGES BETWEEN THE SAN PEDRO AND SANTA CRUZ RIVERS, ARIZONA.

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We continue here the examination of mollusks of the desert mountains of the southwest carried on in former papers of this series. The accumulation of data on more or less similar faunas of the many mountain ranges of this region is, from the nature of the task, somewhat monotonous; yet such work is absolutely essential to an understanding of the problems of distribution and evolution. A study of the distribution and migrations of such desert genera as *Sonorella*, which we have under way, cannot be made until reasonably full local data are available.

The records following relate almost wholly to the faunas of Pima County and the western border of Cochise County, Arizona. The explorations were made by one of us (J. H. F.) in 1917–18, continued in company with the late Mr. A. A. Hinkley, in 1919.

Types of the new species and subspecies are in the museum of the Academy. Paratypes of all are in the Ferriss collection.

I. List of stations and of mollusks collected from the Tucson Range west to Ajo.
II. List of stations and of mollusks collected in the Empire, Whetstone, Mustang, Huachuca, Santa Rita, Patagonia, San Cayento, Tumacacori and Pajaritos Ranges.
III. Notes and descriptions of *Sonorella*, *Oreohelix*, *Bulimulus* and *Holospira*.
IV. On *Micrarionta rowelli* (Newc.) and *M. newcombi*, new species.

### I. List of Stations and of Mollusks Collected from the Tucson Range to Ajo.

To the eastern man, Tucson seems to be upon the rim of the world, more so than San Diego. At Tucson it is Ajo, 150 miles westward, that is the land's end and thus fascinating to explorers and miners. Contemplating the journey to Ajo, a little run was made out in that direction to the Tucson range about Christmas time, 1917, to try a new machine and to take a look at the road. Camp was made that afternoon at Pictured Rocks, a pass about the middle of the range, an hour from the city. The next day, Christmas, Frank Cole, our guide, hunter, cook and boss, brought in a wild pig, and *Sonorella* bones were found. The pig was baked with

sweet potatoes, and there were hot biscuits, jam and peaches on Christmas day.

The next day living Sonorellas were found at four stations. A diamond rattler, mountain sheep, black-tailed deer and small game were in evidence, here under the shadow of the chief city of the state, more than in any range visited in 1917–18.

The Christmas reconnoiter was satisfactory. A few days were needed to finish up the Tucson hills and again we camped there. This programme was repeated a number of times, and the west side of the range during the months of January and February was well explored from Catt mountain on the south end to Relitto village on the north, about 35 miles.

During the last week of February the newly paved county road was taken to Ajo. The machine ran as though on air. Some twenty-two miles west of the city, on the Robles ranch, small buttes of limestone capped by lava appear, not over 100 or 150 feet above the desert floor; but we turned aside for a couple of miles and investigated. Sonorellas were very plentiful and alive. Heretofore the highest peaks of Arizona, at least from 8,000 to 10,000 feet, have been our idea of snail prosperity. The species is a small form of *S. ambigua*, here at the eastern limit of its range.

This discovery caused a deflection to the nearby Roskruge range where further good fortune awaited us, *Sonorella berryi*, and others; and it was the 7th of March before we were again on the road to Ajo. These mountains are on the right of the county road, but the Coyote range on the left seemed much higher than when viewed from the Baboquivari peaks. Thus another deflection, and our tents were pitched in the main canyon, or cove of the Coyotes facing eastward. Here was a half section or more of level land, well-forested with mesquite and paloverde, long known for its ranch houses, mines, and good water. Four domes of granite tower on the southwest. There are thick groves of oak, and a wealth of snails and ferns, one of the most pleasing places in this region (see maps, Text-figs. 5 and 6).

*Sonorella ambigua* grows larger in the Coyotes than elsewhere. It is also the prevalent Sonorella in Bobb's Butte and the southern Roskruges, where *S. berryi* and an interesting small race of *S. tumamocensis* were taken in single colonies.

On the 22nd of March the Coyotes, Kitt's Peak and a spur of the Baboquivaris were left behind. Water was taken on at Indian

Oasis, where the National Government, a Presbyterian mission, and the traders have a beautiful village. All west of the Tucson Range to the western limit of Pima county belongs to the Papago Indians, a tribe rich in horses and cattle, and in good health. It is the desert proper, but well covered with mesquite, paloverde and the giant cactus. Columns of the latter run up fifty to sixty feet occasionally, and the ribs are largely used by Indians and Mexicans in fencing and house building. The forests of giant cacti are sometimes thirty miles wide. The desert trees made good firewood and fencing but do not grow larger in this region than apple trees of the east. Little real timber is seen west of Kitt's Peak.

Low parts of the desert are selected for farming, and the Indians have many acres of corn and wheat under cultivation. If the rains come they get a fair crop. There were not as many species of native plants westward of Tucson as eastward, but there were changes and new societies, hour after hour. The organ cactus (*Cereus thurberi*), here near its northern limit, we saw for the first time, also the crucifix tree and another species of the paloverde group. The organ cactus grows only fifteen or twenty feet high and branches freely, or rather, the stems spread at the surface of the soil. It is only about eight inches in diameter, but has the same rib construction as the giant cactus.

The hills and low mountains of the region west of the Tucson range, as well as a large part of the Tucson range itself, are capped with eruptive rock, "malpais" and basalt. This gray volcanic rock is oxidized by the weather, polished by the sand blast, thus the hills take on a dark bronze color. Among the broken fragments or blocks of this flow a prehistoric people left trenches and fortresses, plainly constructed for defensive purposes. Thus trench warfare is not as new as some may believe, for the Indians now living here do not know who built these fortifications. The graves of this people were also on the hillsides, built above-ground of lava blocks and timbered, and in this climate much of the wood is still sound. On top, the level spaces had squares and circles cleared in the lava for dwellings. In picture-writings their stories are recorded upon the larger volcanic blocks and cliffs.

Sonorellas in every hill was the rule until near the Big Ajo range. Then a light-colored powder appeared on the lava, and a week passed without finding a shell, except a few of the small fry found in drift. One hundred and one miles west of Tucson the fine desert Son-

orella, *S. ambigua*, was found in the low hills, but not beyond there. It is one of the wide-ranging snails, found also far southward, on the Mexican boundary, and extending west of any other *Sonorella*.

Sonorellas were the only large species obtained from Tucson to Ajo. *Chaenaxis* and *Thysanophora hornii* were common, but other small shells few in number. Desert Sonorellas, large as they are, give the pursuer a hard race. In dry weather they retire to the deepest regions of their talus world, and to the farthest corners, and stay there in cool weather, wet or dry. Only a steady downpour on a warm day awakens long sleep and the attachment to smooth stones. But in numerous instances *Sonorella* has been surprised in the world above, in rainy weather, wandering among the fresh vegetation and fallen leaves. There again they are discovered with much difficulty. In the egg-laying periods they often gather plentifully among stones near fresh vegetation at the lower edge of the slide. In some instances they seemed to herd their young. Perhaps but a few times in their history do they partake of a square meal. And, where is their harvest field, in the stone pile, or in the vegetation above?

Ajo is now one of the great mining centers of Arizona, and at the time of our visit was but a little over a year old in this reputation, though an old camp in the history of the state. The prospect of novelty and entertainment was pleasing, but the snailing proved disheartening. Later, information was gathered that a colony of shells had been seen in the Big Ajo Mountains southward, at a walnut grove and spring. Also that there were shells in the Mesquite Range on the Mexican border. The large Growler Range west of Ajo city looked promising from a distance, but the Mexican bandits were active at that time along the western boundary.

There were also hills of promise on the road back. The Pisenomo route Tucsonward was taken, and shells found in the south end of the Quijotoa Range, and in the southern foot hills of the Cababi Range. Again *Sonorella ambigua;* also *Chœnaxis*, and various Pupillidæ.

Sonorellas have a wide range in station, from decaying logs in the deep moist woods of the Catalinas, to the hot side of dry desert hills. At our camp near the Palo Alto Cattle Company's ranch house, at the foot of Kitt's Peak, a small desert hill not over fifty feet high sheltered a colony of Sonorellas. Near the summit of Kitt's peak a colony of small Sonorellas, *S. xanthenes*, had chosen

heavy shade and a deep forest cover; in similar situations *Polygyra albolabris, palliata* and *thyroidus* are found in the east.

April 8th, our expedition to Ajo was again under roof at Tucson. Many may make that journey in quicker time, but few will see as much between the two cities. In interest every day was filled to its full capacity.[1]

Collections were made at the following stations in 1917–1918:

(*1-11. Baboquivari Range.* See map, Text-fig. 8, on page 83.)

1. Sycamore canyon, east bank of north fork, 100 yards above the fork, in stratified porphyry.
2. 100 yards above station 1, west bank of north fork, in a slide.
3. Half mile above station 2 on same fork; large slide opposite caverns.
5. South slope of small hill north of camp, in a small pile of porphyry.
6. High peak west of north from camp, slope overlooking Otero canyon.
7. Tumble of porphyry cliffs, head of ridge.
8. Near Station 7.
9. Head of Otero canyon.
10. High mountain 4 miles west of Station 9.
11. Opposite Station 3.

(Stations 12 to 45 and 48, in the Santa Catalina, Rincon, Galiuro and Tortillita Ranges, have been enumerated in these PROCEEDINGS for 1918, pp. 307, 308.)

46. Silver Bell Range: slides on a quartzite hill northeast of the mine headquarters.
47. Sierrita Range: largest canyon on the northeast, in bank of gulch and porphyry slides above.

(*53-90. Tucson Range*)

53. Half a mile northwest of Pictured Rocks.
54. About 4 miles north of Station 53, one of several slides facing west, on the west side of the Range.
55. Slide facing west, on the next mountain north.
56. Slide facing south, same mountain.
57. Table mountain, half a mile east of Station 54.
58. About 3 miles south of Pictured Rocks, opposite Yuma mine ("Mountain Sheep Camp").
59. About 5 miles north of Mt. Sheep Camp, in a quartzite outlier west of the range, and a twin outlier of lime butte.

[1] Besides the well-known works of Lumholz and MacDougal, upon the Papago country, there has recently been issued a valuable paper by Kirk Bryan, "Erosion and sedimentation in the Papago country, Arizona, with a sketch of the geology." U. S. Geol. Survey, Bulletin 730-B. 1922.

60. Half a mile above Station 58, porphyry slide.
61. Slide west of 60, across the gulch and higher.
62. Old miners' camp at foot of hill whereon are Stations 58, 60, 61.
63. (This and the following up to 85, are in and about the amphitheater, p. 71, diagram, Text fig. 4). Small slide at point of mountain at southwest point of amphitheater, about 3 miles south of Silver Bell road gap (Nelson's ranch).
64. North slope of same in boulders of gulch, foot of peak.
65. Bed of dry wash below 65.
66. Near top of range, above 64.
67. Between two highest peaks, in gulch boulders at a low level.
68. A short distance further up than 67.
69. Silver Bell Pass, north side of the highway, reddish quartzite.
70. South side of the same.
71. Northwest side of quartzite butte, opposite Station 59.
72. North end of the range opposite Rillito village 1 mile, north side of peak.
73. 200 yards east of the same (bones very abundant).
74. Base of mountain, below Station 66, in a gulch bank slide.
75. 200 yards up same gulch.
76. Foot of next peak east.
77. Below 76, in boulders.
78. South side of the peak at the north end of the range, opposite Stations 72, 73.
79. Quarter mile east of same.
80. Mountain at northwest point of amphitheater, near top, in a quartzite slide on the south side.
81. Cliffs above Station 68. &c.
82. Dry wash at Twin Cacti camp.
83. West point of amphitheater, south side, in boulders.
84. Higher up, under shoulder of the peak, cliffs.
85. Southeast end of flat-topped mountain, in a slide.
86. Catt Mountain, northwest side, above spring and herder's cabin.
87. North side of a mountain on south side of the amphitheater (Limekiln Camp).
89. 2 miles southeast of Mile-wide Copper Co. camp.
90. Southwest slope of same mountain as No. 87.

(*Robles Hills, an eastern outlier of the Roskruge Range*).

91, 92. At the dolomite quarry.
93. Northeast side of the same hill, the malpais slide.
94. North side of middle hill.
95. East side same hill; in malpais.

(*Roskruge Range*).

96. Small spur running north and south, west of Little Robles ranch house.

97. Boulder bank in a mountain 1½ miles east of ranch house, main range, in a wash on the north side of the first high peak.

98. Rocky cliff, higher and further east.

99. Half mile further east, higher (Raining; 58 Sonorellas alive) This is 2 miles east of Little Robles ranch house.

100. Half mile further east.

101. Little Robles spur, a small knob between the two peaks. furthest north.

102. Next to the last peak north, slide on the north side.

103. Malpais slides, small hill near forks of the road on the north side, east side of the range.

104. Black table-top mountain on east side of the range, south side.

105. East side of the same, overlooking Indian village of Cocoraque.

106. South end of range: Bobb's Butte, a high peak north of the Ajo road, in a malpais slide on the east side, in the north side of a wash.

107. South side of a talus field ¼ mile long, 100 yards wide, further up.

108. Half way up the slide.

109. Near middle of the slide, which is divided by a strip of creosote bushes.

110. Small black hill three miles east of north of Bobb's Butte, in malpais slide.

(*Coyote Mountains.* See Text-figs. 5, 6.)

111. Near head of piped springs, in cliffs.

112. Boulder walls of gulches about the mining camp.

113. Wall, northeast of canyon.

114. Cliffs in rincon between Baboquivari and Coyote ranges and Kitt's Peak at spring of Chief Pablo la Jaro.

115. North wall of main canyon, near 113.

116. Mining camp, below Station 112.

117. Cliffs of creek near former Sycamore Forest Ranger Station, now a cattle camp, rincon of Chief Pablo.

118. Foot of the middle dome, southwestern rim of main canyon.

119. Santa Rosa Ranch, in the valley between the Roskruge and Comobabi Ranges; in bank of wash west of the ranch house.

(*120–124, 147. Kitt's Peak, at the North End of the Baboquivaris and West of the Coyotes, and its Environs.*)

120. Base of small outlier northwest of Kitt's Peak.

121. Kitt's Peak, middle one of three large canyons on the north side, in boulders near foot of mountain.

122. About a mile further up, on a stream of living water.
123. Foot of cliffs near the head of the above stream, about 1,500 ft. from summit, under scattered rocks among oak brush, sticks and leaves.
124. In a low hill north of road to the ranch house.

(*125–131. Along the Comovo Route to Ajo.*)

125. Small hills south of the road, about 12 miles west of Indian Oasis.
126. Small hills south of the road, about 3 miles west of Comovo Church.
127. Small group of hills 10 miles from Wall's Wells, 101 miles from Tucson. Indian pictographs in the point near the road.
128. Wash at Wall's Wells, Ajo Mountains.
129. South of Station 127.
130. Between 127 and 129.
131. On the desert midway between Wall's Wells and Quijotoa Range.

(*132–136. Quijotoa Mountains.*)

132. Midway between Poso Blanco and Covered Wells.
133. East side and south end of Rangeold mines (Logan), in gulch slides.
134. South mountain east side, near base, bank of gulch.
135. Foot of slide higher up mountain, in dark malpais.
136. Half mile north in deep gulch, slide of light-gray malpais.

(*137–146. Cababi Hills.* See map, Text-fig. 7, on page 81.)

137. Southwestern foothills: a small hill on the plain in the west side of the group.
138. West side of eastern hill of group.
139. A small hill near the wash.
140. East side of eastern hill; the locality where Frank Cole collected in 1914.
141. A large hill south of the Indian village, east of the road.
142. Two outlying hills west of the road to the village.
143. North side of the eastern hill.
144. North of wash at our camp.
145, 146. West and east sides of a valley southwest of camp, southern foothills.
147. Small granitic hill, about 50 ft. high, half mile west of Palo Alto cow camp, near Kitt's Peak.

TUSCON RANGE. The following are species or localities additional to those reported in these PROCEEDINGS for 1915, pp. 399, 400:

*Sonorella tumamocensis* P. & F. Stations 86, 87, 90.
*Sonorella sabinoensis tucsonica* P. & F. Generally distributed.
*Sonorella sabinoensis deflecta* P. & F. Station 59.
*Sonorella baboquivariensis depressa* P. & F. Stations 58, 60, 61.

*Thysanophora hornii* (Gabb). Stations 53, 62, 87, 89.
*Gonyodiscus cronkhitei* (Nc.) Tumamoc Hill.
*Helicodiscus arizonensis* P. & F. Station 53.
*Pupoides marginatus* (Say). Stations 65, 82.
*Chaenaxis tuba* (Pils.). Stations 53, 62, 82.
*Chaenaxis intuscostata* (Clapp). Stations 87, 89.
*Gastrocopta bilamellata* (St. & Clapp). Stations 82, 87.

We have not succeeded in tracing *Sonorella arizonensis* Dall, based on a unique bleached shell found in the Santa Cruz River, Tucson.

SIERRITAS AND SILVER BELL RANGE WEST TO AJO yielded the following species:

*Sonorella ambigua* P. & F. Coyotes and Robles Hills to 101 miles west of Tucson. Nariz Mts. on the Mexican Boundary.
*Sonorella xanthenes* P. & F. Kitt's Peak.
*Sonorella baboquivariensis depressa* P. & F. Sierritas, Baboquivaris.
*Sonorella berryi* P. & F. Station 103, Roskruge Mts.
*Sonorella sitiens comobabiensis* P. & F. Cababi Mts., near Indian Oasis, south end Quijotoa Mts.
*Sonorella tumamocensis* var. Silver Bell Mts., Station 46; Roskruges, Station 110.
*Thysanophora hornii* (Gabb). Station 136, Quijotoas, and 132, Covered Wells.
*Pupoides marginatus* (Say). Station 128, Wall's Wells, Ajo Range; 132, Covered Wells.
*Chœnaxis intuscostata* (Clapp). Station 136, Quijotoa Range.
*Chœnaxis tuba* (Pils.). Station 92, Robles Hills.
*Gastrocopta pellucida hordeacella* (Pils.). Station 128, Wall's Wells, Ajo Range.
*Gastrocopta bilamellata* (S. & C.). Station 128, Wall's Wells, Ajo Range; 132, Covered Wells.
*Gastrocopta perversa* (St.). Station 203, south side Sierritas.
*Gastrocopta ashmuni* (St.). Station 203, south side Sierritas.
*Succinea avara* Say. Station 128, Wall's Wells, Ajo Range, and Station 131, plain between Ajo and Quijotoa Mts.

## II. LIST OF STATIONS AND OF MOLLUSKS COLLECTED IN THE EMPIRE, WHETSTONE, MUSTANG, HUACHUCA, SANTA RITA, PATAGONIA, SAN CAYENTO, TUMACACORI AND PAJARITOS RANGES.

A general account of the winter and spring campaign of 1919, by one of us (J. H. F.), may be found in *The Nautilus*, XXXIII, pp. 37–44. Descriptions of some of the species taken are given in the same volume, pp. 19–21.

COLLECTING STATIONS, 1918. (J. H. F.)

*(149–152. Empire Range.)*

149. North side of large peak 1½ miles north of Total Wreck mine. Limestone.

150. Road to Forty-nine mining camp, north slope of mountain ½ mile south of camp, in a gulch running north.

151. Gulch west, starting west then turning north. Limestone and porphyry.

152. Southwest side of largest peak, 2 miles north of Forty-nine mining camp, north of road; at foot of 300 ft. cliff.

*(153–159. Mustang Range.)*

153. North side tower, east peak.

154. West end range on north side south hill, 3d peak from west.

155. Same ridge higher up the mountain.

156. Next slide north of 155.

157. North side of 4th peak.

158. East side of tower, east peak.

159. Top and northwest side of east peak.

STATIONS OF 1918. (J. H. F. AND A. A. HINKLEY.)

200. Southerland ranch, Santa Catalinas.

201. South side of Black Mt., San Xavier del Bac.

202. Sierrita Mts., canyon facing east, about 4500 ft. Same as Station 47 (1917–18).

203. Sierritas: road to Harris ranch, south side.

204. Sierritas, south side, about 6500 ft. Dead *Sonorella* only.

204½. Tumacácori Mts., amphitheater facing east immediately south of Tumacácori Peak, about 4000 ft., in tailings of an old mine, 3 miles west of old mission.

205. Santa Cruz River (*Physa*).

206. Allen Mts. in Josephine canyon (southwestern foothills of the Santa Ritas).

207. East of the largest peaks of the San Cayetano range (in the southwestern foothills of the Santa Ritas ending at Calabasas).

208. Northeast side Tumacácori Peak about half way up, in south banks of the arroyo.

209. North bank of the same.

210. South bank of same, just below north peak of canyon.

211. Same amphitheatre as Station 204½ near the head of stream.

212. Next to canyon wall at the head of same.

213. The lowest of the prominent knobs leading down the next slope of the main peak of the S. Cayetanos. Stations 213 to 217 are in the northwest side of the S. Cayetanos.

214. North end highest peak of S. Cayetanos.

215. Near the preceding.

216. North slope of same peak in slide of white porphyry. (Same slide as Station 207, but higher.)
217. South side same ridge.
218. Half a mile south of the above.
219. Near the preceding.
220. Pajaritos Range: Calabasas canyon, Garcia National Forest, about a mile above Oro Blanco road.
221. A short distance further up canyon on west side.
222. Larger slides near 221.
223. Pina Blanca canyon ½ mile above Oro Blanco road, slide on east bank.
224–229. Successively further up the stream.
230. Same vicinity as 229.
231. Quarter mile east of Cassin's gate on Oro Blanco road, in the Tumacácori Mts.
232. Montana Peak.
233. Montana mine reservoir (*Physa*).
234. Tumacácori Mts., 5 miles north of Pina Blanca, in a small canyon running east and west, opposite main gulch from Tumacácori Mts. (living *Bulimulus* in slide).
235. Large slide, same hill.
236. Slide ½ mile below camp in Pina Blanca.
238. Bear canyon, Pajaritos Mts., mile below Oro Blanco road.
239. Cassin's reservoir (*Physa*).
240. Opposite 236.
241. Creek 2 miles north of Nogales-Tucson road (*Physa*).
242. Northwest branch of Pina Blanca canyon.
243. Southern peak of San Cayetano Mts., 2 miles above Calabasas, west bank of Sonoita Creek.
244. South side of a small knob, in porphyry.
245. Further north. Albino *Sonorella* in this and the preceding colonies.
246. Further north.
247. The furthest south of the larger peaks.
248. Near 247.
249. Edge of the mountain. Stations 243–249 are on the south side of the Cayetano Range.
250. Northwest slope of mountain, in mass of loose rock about 40 acres in extent. This station is about 2 miles from Station 217, both well over towards the west side of the S. Cayetano Range.
251. Small hill east side of Sonoita Creek.

(*252—264. Patagonia Mountains.*)

252. West side of Mt. Washington, Patagonia Mts., in hills west of main canyon and of the road to Duquesne.
253. Boulder island of the main canyon running west on Mt. Washington; about 4500 ft.
254. Half mile above, among boulders.

255. Half mile below peak.
256. Hills east of peak.
257. Red Mountain, Patagonia Mts., north side (Red Mountain Copper Co.).
258. North side of Duquesne road near summit of pass, in a long porphyry slide.
259. South side of road and ravine.
260. 2 miles east of Duquesne road to Mexico in ravine bank, large rocks.
261. Branch of ravine running east from Bald Mt., near Duquesne.
262. On the road, above bridge over perhaps the same stream.
263. Base of the top rock of Bald Mountain, south side.
264. Near foot of Bald Mt., south side.
265. Mouth of cave on Bald Mt. (Pupillidæ).
266. Crevices, Bald Mt. peak, sloping eastward (Pupillidæ).
267. Near cave, west side Bald Mountain, (Pupillidæ, etc.).
268. Manila mine, northwest end of Huachuca Range, (Type locality of *Holospira ferrissi*).
269. Peak east of the cave (Pupillidæ).
270. Hill southeast of cave in the red rock.
271. Deep canyon, 1 mile north of the Manila mine hill, dolomite cliff facing northwest.
272. Cliff facing south.
273. North of 272, cliff of granite facing northwest.
274. In cliffs on the south side of the canyon.
275. Peak of foot-hill one mile east of the camp.
276. Large peak in the Canelo hills, east of the Huachuca-Duquesne road.
277. Smaller hill, north.
278. Stream near Canelo P.O. (*Lymnæa* and *Physa*).
279. Lyle canyon, south side Huachuca Range, near the head, about 7,000 ft.
280. Near the mouth of Lyle canyon, about 6,000 ft.
281. High hill two and one-half miles southwest of Manila camp.
282. West side of same peak.
283. Piatt's reservoir (once known as Igo's), quarter mile from Manila camp (Pisidium, etc.).
284. Dan Mathew's ranch, Mustang Mountains, slope of limestone peak facing south, in the heart of the range.
285. Slope of lime facing east.
286. High cliff facing north (Station 153 of 1918).
287. Limestone hill east of 286.
288. North side of hill north of the Mustang Range (*Chænaxis*).
289. Limestone hills west of the Duquesne road, Canelo Hills, four stations, numbers 289–292, commencing nearest the road.
292. Three miles west of the road, the last station of this series.

293. Whetstone Range, two miles north of Two-Peak mining camp, in a long, porphyry slide facing east.
294. Near 270 in the Huachucas.
295. Tombstone reservoir in Carr canyon, Huachucas, slide east of stream.
296. West side of the stream.
297. Heart of Garden canyon.
298. Cliffs of Brown canyon, south of concentrator.
299. Cliffs farther west.
300. Lime ridge forming NW. boundary of Carr canyon.
301. Second gulch east and south side of Miller canyon above Tombstone water-works dwelling.
302. North slope of divide overlooking Ramsey canyon.
303. North slope of next peak NW. of Station 293, Whetstone Range.
304. Peak north of 303, facing north, and the highest cleft peak.
304½. Same peak as 293, slope facing north.
305. Steep northern slope of trail to above stations, mile from camp.
306. Western dome of the Mustangs.
307. Western gulch of Carr canyon, Huachucas, near the cliffs.
308. Spring near marble quarry in Ash canyon (*Pisidium*, etc.).
309. East fork of double gulch southeast of spring, on Ash Mountain.
310. Same gulch near top of the mountain.
311. West fork of same gulch.
312. South of Foot's cabin, in limestone ridge, Montezuma canyon.
313. Farthest eastern peak, south side of canyon near Ed. Ratcliff ranch, small cliff on side hill.
314. Slides near the cliffs.
315. Gulch west of 314.
316. Copper canyon, a mile above ranger station.
317. Ida canyon, a mile from Happy Jack cave.
318. Copper canyon, a half mile above Station 316.
319. Small mountain in forks of Copper canyon, near the mines.
320. Mountain north of State of Texas mine camp, in Montezuma canyon.
321. Northwest side of mountain west of this camp.
322. On lime hill in pass to Copper canyon, slide of porphyry.
323. Slide of porphyry southeast of pass.
324. Mountain slide north of Ed. Ratcliff ranch, near spring.
325. East side of peak northeast of State of Texas mining camp.
326. Gulch southwest of camp, in lime, Ash canyon.
327. Deep double gulch, west of last rock-fronted mountain on south side of Montezuma canyon.
328. Large conglomerate precipice one mile southwest of camp.
329. North side of canyon from camp.

330. Opposite side of mountain from Station 229 (the Ash canyon side).
331. Third mountain south of marble quarry in Carr canyon.
332. Largest mountain west of Dan Mathew's ranch house in the Mustangs; main gulch of north slope.
333. Next gulch eastward.
334. Small hill in the pass to Elgin.

SANTA RITA MOUNTAINS.—Late in December, 1917, Rosemont and Greaterville, on the eastern slope, were found to be dry collecting. Miners have removed much of the timber. Living Sonorellas were rare, and the dead ones very dead. This is in the oak, walnut and sycamore zone. A couple of miles south of Rosemont a crossing was made westward on a spur of porphyry, looking down upon Helvetia. Slides were numerous, large and deep. Dead Sonorellas of two species were found, and one alive.

At Greaterville a limestone ridge south of the placer diggings, four miles south of the village, was given a hard half-day's work. Mr. Cole, our guide, in his mining days was a superintendent here, knew the ridges and led the way. Under large blocks of stone and deep in the earth we found a few "bones" of *Sonorella*, but none alive. The short list follows:

*Sonorella walkeri aguacalientensis* P. & F. Allen Mts., in Josephine canyon, Station 206 (1919).
*Sonorella linearis* P. & F. Station 49, 50 (1917).
*Sonorella hesterna* P. & F. (?). Station 49–52 (1917).
*Thysanophora hornii* (Gabb). Station 48 (1917), Rosemont.
*Polita indentata umbilicata* (Ckll.). Station 48 (1917), Rosemont.
*Gastrocopta ashmuni* (Sterki). Station 48 (1917), Rosemont.

THE EMPIRE MOUNTAINS are small, the highest peak about 5500 ft., lying in eastern Pima Co. between the Whetstones and the northern end of the Santa Rita Range. They are mapped on the Patagonia Quadrangle. Camping on this range, across the valley from the Santa Ritas, *Sonorella* and *Holospira* were located in a high peak at the north end of the range, about two miles north of the Total Wreck mine. Again they were found in peaks on the south side of a branch road to the Forty-Nine mining camp. Also north of this road a mile or more, at the foot of a prominent precipice. Very few were alive.

*Sonorella binneyi imperialis* P. & F. Station 151; a few bones at 150.
*Sonorella tryoniana* P. & F. Stations 149, 152.

*Thysanophora hornii* (Gabb). Stations 149, 150.
*Holospira whetstonensis* P. & F., small form. Station 149.
*Polita indentata umbilicata* (Ckll.) Stations 150, 151.
*Chaenaxis tuba* (Pils.). Station 149.
*Chaenaxis intuscostata* (Clapp). Station 150.
*Gastrocopta perversa* (Sterki). Station 149.

THE WHETSTONE MOUNTAINS form a short range on the boundary between Pima and Cochise counties, north of the Huachucas, connected therewith by the 4500 ft. contour. The highest peak reaches 7684 ft. The range forms part of the Coronado Forest Reserve, and is mapped on the Benson Quadrangle, U. S. G. S. topographic maps.

A brief visit was made by one of us (J. H. F.) in 1914, and a few shells of *Sonorella cotis* were obtained. In the spring of 1919, with A. A. Hinkley, two trips were made from our Huachuca camp without finding a shell. On the third trip, a long slide facing east was discovered,[2] containing many dead Sonorellas. Shells were subsequently found in the following stations:

*Sonorella cotis* P. & F. Stations 3 (1914), 293, 304, 304½ (1919).
*Sonorella insignis* P. & F. Stations 304, 304½, 305.
*Oreohelix concentrata huachucana* (Pils.). Stations 286, 303, 304, 304½.
*Holospira whetstonensis* P. & F. Stations 293, 304, 305.
*Gastrocopta ashmuni* (Sterki). Station 293.
*Gastrocopta a. minor* (Sterki). Station 303.
*Gastrocopta dalliana* (Sterki). Stations 303, 293.
*Gastrocopta pilsbryana* (Sterki). Station 293.
*Gastrocopta pellucida hordeacella* (Pils.) Stations 293, 303.
*Vallonia perspectiva* Sterki. Station 303.

The MUSTANG MOUNTAINS are a small group, only about 4 miles long, between the Huachucas and Whetstones, within the eastern border of Pima Co. The highest peak is 6315 ft. elevation. Mapped on the Benson Quadrangle. The prevalence of limestone makes these mountains particularly favorable for *Holospira*.

First visited by J. H. F. in 1918, going down from the Empire Range. Across a beautiful prairie country settled up by dry farmers, twenty miles or more southeast the highway to Patagonia and Fort Huachuca passes between the Whetstone and the Mustang Mountains. Here was limestone again in both ranges. Sonorellas and Holospiras were plentiful at the Dome of the Mustangs (Sta-

[2] Nautilus, XXXIII, p. 42.

tion 159) and two hills to the west, all that we investigated; but the limestone of the Whetstones was hard, sharp pointed, and had no snails, large or small. Subfossil *Oreohelix* were found in the clay banks of the Mustang gulches. Like the Empire Range, the Mustangs have a few stunted oaks and an abundance of foot-hill shrubs.

*Sonorella mustang* P.& F. Commonly distributed.
*Oreohelix concentrata huachucana* (Pils.). Fossil only.
*Holospira arizonensis mustang* P. & F.
*Holospira ferrissi monoptyx* P. & F. Station 285.
*Holospira whetstonensis arata* P. & F. Stations 159 and 153 (1918).
*Polita indentata umbilicata* (Ckll.). (Station 153 (1918).
*Pupilla syngenes* (Pils.). Station 286.
*Chænaxis tuba* (P. & F.). Stations 288, 306.
*Gastrocopta perversa* (St.). Station 286.
*Gastrocopta p. sana* (Pils.). Station 306.
*Gastrocopta ashmuni* (St.). Stations 288, 306, 332.
*Gastrocopta a. minor* (St.). Station 288.
*Gastrocopta a. imperfecta* P. & F. Station 286.
*Gastrocopta dalliana* (St.). Stations 286, 332.
*Gastrocopta pellucida hordeacella* (Pils.). Stations 286, 288, 306, 323.

HUACHUCA MOUNTIANS.—Our former work on this range[3] was supplemented in the spring of 1919 by an examination of Montezuma and Copper canyons, at the southeastern end of the range, and further collections in other parts by J. H. F. and A. A. Hinkley.

*Ashmunella varicifera* (Anc.). Montezuma canyon, Stations 314, 321, 327 (1919). Limestone hill in pass to Copper canyon, Station 322. Copper canyon, Station 316. Ash Mountain, Stations 310, 311.
*Ashmunella levettei heterodonta* Pils. Ida canyon, Station 317.
*Ashmunella levettei angigyra* Pils. Station 270, hill southeast of cave, Bald Mt. Station 280, near mouth of Lyle canyon.
*Sonorella* (see section III of this paper).
*Holospira ferrissi* Pils. Northwestern end. See below.
*Zonitoides minuscula* (Binn.) Station 295, Carr canyon.
*Striatura milium meridionalis* P. & F. Stations 295, Carr canyon, and 323, Montezuma canyon.
*Pupilla syngenes* (Pils.) Station 299, western cliffs of Brown canyon.
*Chaenaxis intuscostata brevicostata* Pils. Station 300, limestone ridge, northwest boundary of Carr canyon.
*Gastrocopta pellucida hordeacella* (Pils.) Stations 268, 294, 300.
*Gastrocopta perversa* (St.). Stations 269, 270, 294, 300, 311, 268.

[3] Proc. A. N. S. Phila., 1909, pp. 495–516.

*Gastrocopta perversa sana* Pils. Stations 269, 270, 326.
*Gastrocopta ashmuni* (St.). Stations 270, 297, 323.
*Gastrocopta ashmuni minor* (St.). Stations 294, 297.
*Gastrocopta ashmuni imperfecta*, n. subsp. Stations 270, 297, 303 and 311. The columellar lamella is simply curved within, and outwardly remains horizontal, as in *G. cochisensis*, not passing into the position of an infraparietal lamella. The free peristome, very large angulo-parietal lamella and the very deeply immersed lower-palatal fold remain as in *G. ashmuni*.
*Gastrocopta cochisensis* (P. & F.). Station 299, Brown canyon.
*Gastrocopta dalliana* (St.). Stations 270, 294, 297, 311.
*Gastrocopta pilsbryana* (St.). Stations 295, 297, 299.
*Vertigo coloradensis inserta* Pils. Stations 295, 296, rare.
*Vertigo hinkleyi* Pils. Station 296 *e*, Carr canyon.

The CANELO HILLS are a long range with the higher crests up to about 5900 ft. They lie between the northern ends of the Huachuca and Patagonia ranges, united with both by the 5000 ft. contour, and more deeply separated from the southeastern Santa Ritas by the valley of Sonoita Creek. They are mapped on the Patagonia and Nogales Quadrangles.

*Sonorella elizabethæ* P. & F. Station 276.
*Holospira ferrissi caneloensis* P. & F. Stations 289–292.
*Gastrocopta ashmuni minor* (St.). Station 289.
*Gastrocopta dalliana* (St.). Station 289.
*Gastrocopta pellucida hordeacella* (Pils.). Station 289.

The PATAGONIA RANGE is about 15 miles long, running up to over 7000 ft. The southern foothills extend across the Mexican boundary. Mapped on the Nogales Quadrangle. Visited by J. H. F. and A. A. Hinkley in midwinter, 1919, when there was considerable snow, hence not many species were taken. J. H. F. and E. H. Ashmun had collected a few shells in the northwestern foothills and at Sanford many years ago.

*Sonorella patagonica* P. & L. Southern part, about Washington.
*Sonorella tryoniana* P. & F. Northern end.
*Gastrocopta perversa* (Sterki). Station 265.
*Gastrocopta dalliana* (Sterki). Station 265.

The SAN CAYETANO MOUNTAINS lie east of the Santa Cruz River and north of Sonoita Creek, near the southern end of the Santa Ritas. Collection made by J. H. F. and A. A. Hinkley, 1919.

*Sonorella hinkleyi* P. & F. Mainly in the southern part.
*Sonorella hinkleyi cayetanensis* P. & F. Northern part.

The TUMACACORI MOUNTAINS are west of the Santa Cruz River, and pass southward into the Pajaritos. Visited by J. H. F. and A. A. Hinkley in 1919.

*Sonorella hinkleyi tumacacori* P. & F. Tumacácori Peak and next mountain southward.
*Zonitoides minuscula alachuana* (Dall). Station 205.
*Zonitoides singleyana* (Pils.).
*Gastrocopta ashmuni* (Sterki). Station 235.
*Gastrocopta dalliana* (Sterki). Station 235, 236.
*Gastrocopta cristata* (P. & V.). Station 205, Santa Cruz, River drift.
*Gastrocopta pellucida hordeacella* (Pils.). Station 205, Santa Cruz River drift.

PAJARITOS MOUNTAINS.—These rolling hills extend across the Mexican boundary west of Nogales. Visited by J. H. F. and A. A. Hinkley early in 1919. It is the only known locality in Arizona for *Bulimulus*.

*Sonorella walkeri montana* P. & F. Stations 231, 232, 238.
*Sonorella sitiens* P. & F. Numerous stations.
*Bulimulus nigromontanus* Dall. Pina Blanca canyon, and 5 miles north in the Tumacácori Range.
*Gastrocopta dalliana* (Sterki). Station 237.

## III. NOTES AND DESCRIPTIONS OF SONORELLA, OREOHELIX, BULIMULUS AND HOLOSPIRA.

### HELICIDAE

The species of *Sonorella* may be grouped as follows:

$a^1$. Length of penis decidedly exceeding the diameter of the shell.
  $b^1$. Penis-papilla long, thick-walled, perforated by a minute duct; epiphallus shorter than the penis.
    $c^1$. Penis large, simply bent or but little folded in preserved examples, the stout papilla from about half to nearly as long as penis. Group of *S. virilis*.
    $c^2$. Penis slender, both it and the vagina disposed in folds. Group of *S. rinconensis*.
  $b^2$. Penis-papilla short (contained 4½–5 times in penis), hollow, with an enclosed tube; epiphallus longer than penis. Group of *S. dalli*.
$a^2$. Length of the penis less than the diameter of the shell.
  $b^1$. Penis-papilla usually stout and cylindric, or enlarging toward the blunt or conic distal end.
    $c^1$. Vagina much longer than the penis. Group of *S. granulatissima*.

$c^2$. Vagina not much longer than the penis, often shorter. Group of *S. ambigua.*

$b^2$. Penis slender, the papilla slender, gradually tapering to the distal end. Group of *S. hachitana.*

*Group of S. hachitana.*

**Sonorella hachitana** (Dall)

A series of 21 specimens in the National Museum, no. 130005, is from the top of two peaks of the Carrizalillo Hills, near Carrizalillo Spring, New Mexico, collected by Dr. Mearns when on the International Boundary Survey. They have the deeply descending last whorl of *hachitana,* and differ from that species in little except the smaller size, from 18.5 to 21 mm. diameter. It is apparently a small local form of *hachitana,* and of interest because it is at the eastern limit of the genus as now known.

**Sonorella elizabethæ** Pils. & Ferr. Plate I, fig. 1; plate IV, figs. 1, 1a.
Nantilus vol. 33, July 1919, p. 20.

Canelo Hills: Station 276, a large peak east of the Huachuca-Duquesne road. Type no. A. N. S. P.

Closely related to *S. hachitana,* but the shell is constantly smaller and the male organs longer. The penis is decidedly over one-third the diameter of shell and longer than the vagina (in *hachitana* between one-third and one-fourth the diameter of shell, and shorter than vagina). It is very slender, with a short, stout basal sheath. Penis-papilla slender, tapering, over half the length of penis. Flagellum minute. The organs in two specimens from Station 276 measure.

| | |
|---|---|
| Penis.....8.0 mm. | Epiphallus....5.5 and 6 mm. |
| Penis-papilla.....5.0 mm. | Vagina.....6.0 mm. |

The shells vary in diameter from 16.7 to 20.7 mm.

**Sonorella mustang** Pils. & Ferr. Plate I, figs. 2; plate IV, figs. 5.
Nautilus vol. 33, July, 1919, p. 20.

Mustang Mountains, on the Pima-Cochise Co. line, at Stations 153, 155–159 (1918), and 284, 286, 332–334, 336 (1919). Type from Station 332 (1919).

The shell resembles *S. hachitana* closely, differing by being slightly less depressed, the umbilicus somewhat smaller, the last whorl descending less in front, and the aperture larger.

It is glossy, light pinkish cinnamon, fading to whitish around the umbilicus and on both sides of the chestnut-brown band above the periphery, which is visible above the suture on 1½ to 2 whorls. The first whorl has minute, irregular, radial wrinkles partly anas-

tomosing on the first half whorl, then very fine, forwardly-descending threads over them, about as in *S. hachitana.*

Height 15.3, diam. 26.5 mm.; barely 5 whorls. Station 332. Type.
" 15.5 " 25.7 " 5 whorls. Station 153.
" 14 " 25 " Station 153.
" 13 " " " $4\frac{2}{3}$ whorls. Station 153.

Genitalia (Plate IV, fig. 5) of the *hachitana* type, but characterized by the much greater length of all of the male organs, which are decidedly longer than in *S. h. flora,* which has a shell at least as large as *S. mustang.*

The penis is slender, having a sheath which is thick and muscular near the base. Its papilla is about two-thirds the length of penis, tapering and slender. The flagellum is unusually long; beyond the flagellum the vas deferens is somewhat enlarged, as in the related forms. The lengths of the organs are as follows:

Penis 15.5 mm., Penial retractor 11.5 mm., Penis-papilla 10.5 mm., Epiphallus 8.0 mm., Flagellum 2.0 mm., Vagina 13.5 mm., Museum No. 44048. Station 286.

The jaw has 6 strong ribs.

Though not much differentiated from *S. hachitana* in the shell, this form appears to be specifically distinct by the genitalia. The penis is about three times as long as in *S. cotis,* while the epiphallus is about the same as in that species.

Common throughout the Mustang range. It was taken alive in abundance at Stations 153, 155, 156 (1918) and Station 332 (1919). At Station 336 (1919) only a few fossil examples were found. Fossil or "subfossil" shells were abundant at Station 153 (1918). These shells are rather small, between 19 and 22 mm. in diameter, with 4 to $4\frac{3}{4}$ whorls.

A few beautiful albino shells were taken at Station 284.

**Sonorella cotis** Pils. & Ferr. Plate I, figs. 5, 6; plate IV, figs. 3, 9.
Nautilus vol. 33, July, 1919, p. 20.

Whetstone Range. Type 130994 from Station 3 (1914).

The typical small form only was taken in 1914, the type locality being station 3 (1914), a mile up from the Ranger Station. The diameter is from 20 to 22 mm. In the genitalia (Plate IV, fig. 9, paratype) this form resembles *S. sabinoensis occidentalis.* The penis is small, slender, becoming abruptly swollen near the base, the swollen part containing several large pilasters. The papilla is very slender, with slight traces of annulation. Vas deferens is enlarged in the lower part, as in *S. walkeri.* The organs measure:

| | | | |
|---|---|---|---|
| Penis | 4.8 mm. | Flagellum | 0.5 mm. |
| Penis-papilla | 3.0 " | Vagina | 10.5 " |
| Epiphallus | 7.0 " | Museum No. | 119038. |

The pallial region (Plate IV, fig. 3) shows a kidney more than half as long as the lung the proportion being 15 to 26 mm. The pericardium is 4.5 mm. long. The veins of the anterior portion of the lung are sparsely bordered with brown dots.

In 1919 it was collected at Stations 293, 304 and 304½. While some typical *S. cotis* were taken, most of the shells are larger, up to 25 mm. diam., and not definitely distinguishable from *S. mustang;* also very close to *S. walkeri.* No animals were preserved, so that we cannot compare the genitalia of this large form, which is temporarily left with *S. cotis,* as there seems to be some intergradation in size.

**Sonorella patagonica** Pils. & Ferr. Plate I, figs. 7–10; plate IV, figs. 2, 4, 6, 7, 8.
*Sonorella patagonica* P. & F., Nautilus vol. 33, July, 1919, p. 20.

Patagonia Mountains, in the southern part, Stations 253, 254, 255, 258, 259 to 262, 264, the type from Station 254.

The shell is very similar to *S. papagorum,* but in the type and many other specimens (but not in all) there are *impressed spiral lines* on the last whorl below the suture. The embryonic shell shows forwardly-descending threads, *hachitana* pattern, characters not observed in *S. papagorum.*

Height 12.8, diam. 22 mm.; 4¾ whorls. Type, No. 43722.
" 11.7 " 19 " 4½ " No. 43719.

Genitalia similar to those organs in *S. papagorum,* but the organs are somewhat longer; flagellum generally better developed, and the vas deferens is somewhat enlarged near the flagellum. Penial papilla is slender, tapering, corrugated (but in one example, No. 43719, from Station 260, it is smooth). Measurements of the organs in mm. follow.

| Museum No. | 43721 | 43722 | 43720 | 4715 | 43718 | 43733 | 43719 |
|---|---|---|---|---|---|---|---|
| Penis | 9.3 | 8.7 | 8.5 | 7.0 | 7.0 | 6.5 | 6.5 |
| Penis-papilla | 6.3 | 6.0 | ... | 5.0 | 5.5 | ... | 5.5 |
| Epiphallus | 7.8 | 8.0 | ... | 8.5 | ... | 6.5 | 5.7 |
| Flagellum | 0.5 | 0.5 | 1.0 | minute | ... | 0.7 | 1.0 |
| Vagina | 11.0 | 9.0 | 8.5 | 8.0 | 8.0 | 8.0 | 7.5 |
| Station | 258 | 254 | 252 | 253 | 255 | 260 | 260 |

While this form has considerable resemblance to *S. hachitana* in genitalia, the shell differs, being less depressed, with the last whorl descending less.

The size is rather variable. Thus one lot, no. 43720, from Station 252, includes specimens measuring from height 11.5, diam. 18.3 mm., to 15 × 23.7 mm., together with intergrading sizes.

**Sonorella walkeri aguacalientensis** P. & F.

Allen Mountains, Station 206 (1919), a small group of hills in Josephine canyon, in the southwestern foothills of the Santa Ritas, towards the Cayetano Mountains.


Fig. 1 — *Sonorella walkeri montana*. 43724. *p.* penis, *pr.* penial retractor, *sp.d.* duct of spermatheca.

Fine, large specimens, about 25.5 mm. in diameter, were taken. The reproductive organs measure in length:

| | |
|---|---|
| Penis | 2.5 mm. |
| Penis-papilla | 1.3 " |
| Epiphallus | 5.0 " |
| Penial retractor | long. |
| Flagellum | vestigial |
| Vagina | 12 mm. |
| Museum No | 43729. |

**Sonorella walkeri montana** Pils. & Ferr. Plate. I, fig. 11.
*Sonorella montana* P. & F., Nautilus vol. 33, July, 1919, p. 19.

The shell in this handsome form is not distinguishable from that of *S. walkeri:* but *montana* differs somewhat by the still smaller male organs. The penis is extremely small, having a short, stout basal sheath and long retractor muscle. The flagellum is reduced to a mere bud; beyond it the vas deferens is enlarged. The base of the vagina is enlarged. Specimens from Stations 232 and 238 agree. Measurements of the organs follow:

| | |
|---|---|
| Penis | 2.5 mm. |
| Penis-papilla | 1.3 " |
| Epiphallus | 5.0 " |
| Vagina | 9.4 mm. |
| Museum No. 43724. | Station 232. |

The preserved animal is nearly white.

Pajaritos range at Station 232, Montana Peak, near the mine; 238, Bear canyon in Bear Valley; and 231, half mile northeast of Cassin's gate in the pass, highway to Oro Blanco.

**Sonorella linearis** n. sp. Plate I, fig. 12.

Northern end of the Santa Rita Range, the type from Station 50 (1917), on the western side of the saddle, overlooking Helvetia. Also Rosemont, Stations 48 and 49, abundant at the latter. At Stations 49 and 50 it was associated with *S. hesterna.*

The shell is umbilicate (the umbilicus contained about seven times in the diameter), dilute cinnamon, the base whitish, with a

chestnut-brown band with very indistinct pale borders, somewhat glossy, with fine, weak growth lines, and below the suture on the last whorl *a group of incised spiral lines* (weak on some specimens, but probably always present). Whorls increase rather slowly, the last slowly descending in front. The peristome is very slightly expanded.

Height 11, diam. 17.3, umbilicus 2.5 mm.; 4½ whorls. Type.
" 10, " 17.5 mm. Station 49.
" 9, " 15 " " "

Soft anatomy unknown.

*S. clappi* in the Santa Ritas has some resemblance to this species, but the last whorl is wider and the surface granulose. It appears distinct from known species of other ranges by the size, small umbilicus and especially the sculpture. Numerous dead specimens, part of them in good condition, were taken at Station 49.

Until specimens can be dissected the position of this species in the genus cannot be determined.

**Sonorella sabinoensis tucsonica** n. subsp.

Tucson Range, the commonest species, generally distributed. Stations 63, 64, 66, 74, 75, 77, 80–83 in one valley, "wild pig amphitheatre"; 72, 73, 79 are the small form from the northwest end of the range. Also at Stations 54, 56, 57.

The shell is similar to *S. sabinoensis* except that the umbilicus is a little larger in specimens of equal size; as in that species, the last whorl, seen from above, is quite wide. It differs from *S. papagorum* by the sculpture of the embryonic whorls, which is distinct, as in *sabinoensis*, while in *papagorum* it is extremely weak, the surface appearing more polished. The color is distinctly darker than *papagorum*, wood-brown or almost fawn color, with a usually broad chestnut-brown band with pale borders. The last whorl descends very little in front.

Height 15.7, diam. 27 mm., 4½ whorls. Type. Station 81.
" 15 " 25.4 " " " Station 57.
" 12.3 " 20.5 " " " " 64.

The genitalia are similar to *S. sabinoensis*, characterized by a rather long penis, in those measured from slightly over ⅓ to nearly ½ the diameter of shell. The slender, slightly tapering penis-papilla is also long, generally wrinkled somewhat, but in one specimen (Station 64) it was smooth. The flagellum is small, or in a specimen from Station 57, wanting. The penis and vagina are longer than in *S. papagorum*, but of the same type. Measurements follow:

| No. | 118070 | 118047 | 118063 | 118046 |
|---|---|---|---|---|
| Penis | 9.5 | 10 | 9 | 9.5 |
| Penis-papilla | 6 | 7 | 8 | 7.5 |
| Epiphallus | 6 | 8 | 7.5 | .. |
| Flagellum | small | very small | 1 | wanting |
| Vagina | 7 | 11 | 9.5 | .... |
| Diam. of shell | 27 | 23.5 | 21 | 25 |
| Station | 81 | 54 | 64 | 57 |

In No. 118070 and 118047 the basal sheath of penis is but little larger than the distal part of the penis. In 118063, 118067 and 118049 it is quite thick, as in *S. sabinoensis occidentalis*.

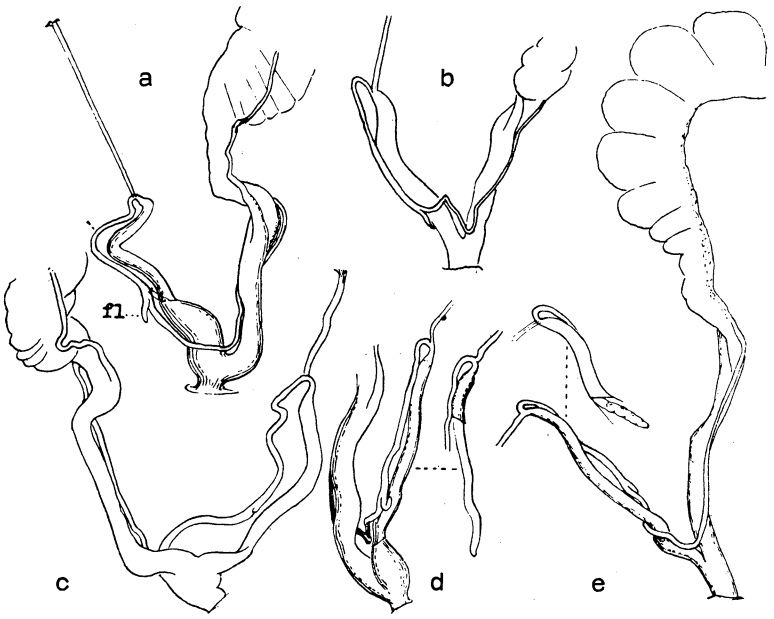



Fig. 2.—*Sonorella sabinoensis tucsonica*. Lower ducts of the genitalia, a, No. 118067, station 72. b, *S. s. deflecta*, No. 118050, station 59. c. *S. s. tucsonica*, No. 118047, station 54. d, 118063, station 64. e, 118070, station 81. *fl.*, flagellum. All in the Tucson Range.

The shell is highly variable in size and in degree of depression of the spire. The largest specimens, from Station 81, were found less than half a mile from the smallest measured above, Station 64, in the same valley.

At the north end of the Tucson Range, Stations 72, 73, 79, all of the specimens are small and dark, diam. 20 to 21.5 mm. In the

genitalia they do not differ from the smaller examples from "Wild Pig Amphitheatre" (fig. 4). Measurements follow.

| Museum No. | 118067 | 118049 | 118050 (*deflecta*). |
|---|---|---|---|
| Penis | 9 | 7.5 | 7 mm. |
| Penis-papilla | 6 | 4 | 4.5 |
| Epiphallus | 7 | 4 | 6.5 |
| Flagellum | 1 | ... | 1 |
| Penial retractor | 7.5 | ... | ... |
| Vagina | 6 | 5 | 5.5 |
| Station | 72 | 79 | 59 |

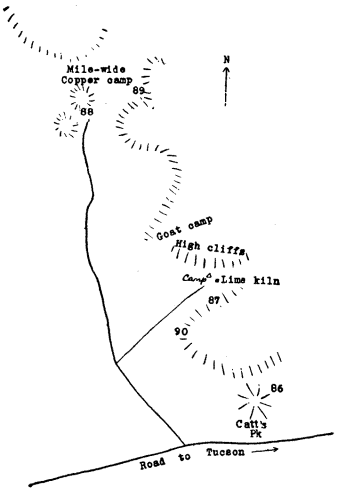



Fig. 3.—Southern end of the Tucson Range.

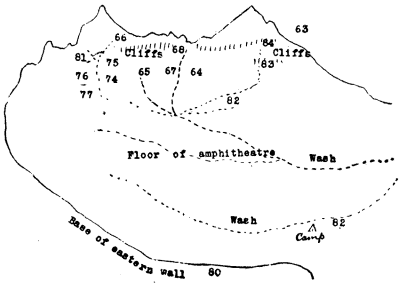



Fig. 4.—Diagram of "Wild Pig Amphitheatre," Tucson Range, looking south, showing approximate locations of collecting stations 63 to 85. Length about 1 mile.

**Sonorella sabinoensis deflecta** n. subsp.

An equally small form was taken at station 59, about 5 miles north of Sheep camp, in a quartzite outlier of the range westward and a twin outlier of Lime Butte. In form these shells are more depressed than *S. s. tucsonica*, the whorls are smaller in caliber, the aperture smaller. *The last whorl descends rather deeply in front*, while in *tucsonica* it descends but little. The color is paler than in the small *tucsonica* from the northern end of the Tucson Range. The genitalia (fig. 2*b*) appear not to differ. Measurements given above under No. 118050.

Height 12, diam. 19.6 mm.; $4\frac{1}{2}$ whorls.

Type no. 118050*a*, from Station 59 (1918). One specimen in the long series seen lacks the dark shoulder band.

**Sonorella xanthenes** n. sp. Plate I, fig. 13; plate VII, fig. 11.

Kitts Peak, near the top, Station 123, at foot of cliffs near the head of stream, under scattered rocks among sticks and leaves in oak brush. Type no. 118094 A.N.S.P. collected by J. H. Ferriss, 1918. Paratypes in coll. Ferriss.

The shell is rather thin, has a moderately raised spire and rather small umbilicus contained about $8\frac{1}{2}$ times in the diameter; it is dull cinnamon-buff, paler on the base, with a narrow chestnut-brown band above the periphery. Surface smooth except for light growth lines, having little gloss. The last whorl descends moderately in front. The peristome is thin, narrowly expanded, dilated at the columellar insertion and impinging slightly on the umbilicus. Parietal callus very thin.

Height 8.4, diam. 13. mm.; $4\frac{1}{3}$ whorls. Type.
" 9 " 14.6 " " " Largest.
" 7.5, " 13 mm. Smallest.

The penis contains a relatively long, smooth, slightly tapering papilla, acute at the end. The epiphallus is very slender, much longer than the penis, is a little swollen near the end and bears no flagellum. The penial retractor inserts on the epiphallus some distance from the penis. The vagina is decidedly shorter than the penis.

Length of penis .....4.7 mm. Length of epiphallus 8 mm.
" " papilla 3 " " " vagina 2 "

This is one of the smallest species of Sonorella, about the size of the smallest specimens of *S. coloradoensis*. It differs from the latter in the slender, acute penis-papilla and long epiphallus, among other characters.

*Group of Sonorella ambigua.*

This group comprises a number of minor sections or series, such as (1) the series of *S. binneyi*, in which the last whorl is very wide, with *S. binneyi*, *S. bowiensis*, *S. tryoniana*, *S. baboquivariensis*; and (2) the series of forms with spirally grooved penis-papilla, comprising *S. tumamocensis*, *S. eremita*, *S. hinkleyi* and *S. hesterna*.

**Sonorella ambigua** P. & F. Plate 2, figs. 1–4; plate V, figs. 1–10, 12; plate VI, figs. 1–5.
*Sonorella ashmuni ambigua* P. & F., Proc. A. N. S. Phila., 1915, p. 411.

Abundant in the Cababi Hills, Stations 137–141, 143–146 (1918). Station 143, north side of the eastern hill of the group, is the type locality, being Cole's original station.

The large series does not show much variation, all being between 20.5 and 24 mm. in diameter. It is a handsome, glossy form, light

ochraceous buff with a slight cinnamon cast, whitish on the base, very little or not whitish alongside of the chestnut-brown band. There is generally no spiral striation, but sometimes the faintest traces may be seen below the last suture. The last whorl is wide and descends somewhat abruptly in front. The peristome expands, and in fully adult shells there is a slight thickening within. Parietal callus is very thin. Growth lines weak. The tip of the apex is smooth, followed by a few radial wrinkles, then some small papillæ near the suture. The rest of the embryonic shell has but little sculpture; small radial wrinkles below the suture are more or less noticeable, but no protractive or retractive threads.

The genitalia were examined in specimens from stations 137, 138, 146. The large penis is long, half the diameter of the shell or slightly more, sheathed at the base, and contains a large papilla, which is between half and two-thirds as long as penis, truncate or rounded at the end, where it is generally a little enlarged, and more or less wrinkled and dented. The penial retractor is less than half as long as penis, inserted on the epiphallus where the latter enlarges basally.[4] There is a very small flagellum. Measurements follow.

| Museum No. | 118108 | 118103 | 108099 | 118100 |
|---|---|---|---|---|
| Length of penis | 12.5 | 12. | 11.5 | .... |
| " " papilla | 8 | 8.5 | 6 | 7 |
| " " epiphallus | 9 | 9 | .... | .... |
| " " retractor | 5 | 5 | .... | .... |
| " " vagina | 12 | .... | .... | .... |
| " " sp. and duct | .... | .... | .... | .... |
| Station | 146 | 146 | 138 | 137 |
| Pl. V, fig. | 1 | 2 | .... | 3 |

The form described and figured as *S. ashmuni capax* P. & F., taken by Frank Cole in the Cababi Hills, 1915, was not rediscovered in 1918. It is larger than any of the long series of *ambigua* taken, and the embryonic shell distinctly shows many protractive threads, of which we see no trace in *S. ambigua*. It is probably specifically distinct from the latter.

The rather large caliber of the long penis and of the blunt papilla, generally larger at the end than further up, the penis longer than the epiphallus, are diagnostic of *S. ambigua*. The wrinkling of the papilla, doubtless due to contraction in alcohol, still in some degree depends upon its structure, and it varies to a certain extent in specimens from different mountain ranges. Unfortunately, no

[4] In measuring penis and epiphallus, care must be taken not to include the thick basal part of the latter, below the insertion of the retractor, as part of the penis. The latter terminates at the root of the papilla, even when there is no distinct contraction above that point.

fresh specimens have been dissected. It must be remembered that all of the figures and descriptions are from alcoholic preparations.

Besides the typical form of *S. ambigua*, from the southern hills of the Cababi group, we recognize this species in various forms from the Roskruge and Coyote Ranges, their outliers, and several ranges westward.

ROSKRUGE RANGE FORMS.—The shell characters vary from typical to forms with stronger parietal callus. The penis-papilla, while typical in shape, is not much wrinkled, generally showing some longitudinal or irregular and but slightly raised wrinkles towards the distal end (Plate V, figs. 5–7). Measurements of the organs follow:

| Museum No. | 118081 | | 118077 | 118079 | 118078 |
|---|---|---|---|---|---|
| Length of penis | 11 | 14 | 10.5 | 14 | 14.5 |
| " " papilla | 5 | 7 | 9 | 11.5 | 10 |
| " " epiphallus | 10 | 7 | 11.5 | 8 | 12 |
| " " vagina | 9 | .. | .... | 7 | 10.5 |
| Spermatheca and duct | 20 | .. | .... | .... | .... |
| Station | | 99 | 100 | 101 | 106 |
| Plate V, fig. | 7 | | 5 | 6 | |

Bobb's Butte, at the south end of the range, north of the Ajo road, different places in a malpais slide on the east side, Stations 106–109 (1918). The size is more variable than in the Cababi Hills, 19.5 to 25 mm. diam. in one lot, Station 107. Some examples are quite typical in form, but there is often a tendency towards depression of the spire, which is sometimes nearly flat. The parietal callus is generally thicker than in the typical locality, often with a thickened edge.

The genitalia of a specimen from Station 106 (Plate V, fig. 4) are are as in *ambigua* except that the penis-papilla shows only a few pale, slightly raised wrinkles near the distal end.

East side of the Roskruge Range in the neighborhood of Little Robles Ranch, Stations 96–102. The species was taken in abundance at some stations, such as 99 and 102. The specimens vary from completely typical in shell characters to forms with a moderate or heavy parietal callus, as noted above for Bobb's Butte. Size variable, the largest and smallest in several lots measuring:—

| | | | | | |
|---|---|---|---|---|---|
| Height | 15.3, | diam. | 25.5 mm. | Station | 98. |
| " | 13 | " | 21.5 " | " | 98. |
| " | 13.4, | " | 22.4 " | " | 102. |
| " | 11.7 | " | 19.5 " | " | 102. |

Height 14.6 diam. 24.3 mm. Station 104.
" 12.3 " 21 " " 104.

At Station 99, a half mile west of 98 and higher, 2 miles east of Little Robles Ranch house, the diameter runs from 19 to 22.3 mm., and the penis-papilla is shorter than usual and smooth, Plate V, fig. 7.

Specimens from the Black Table-top mountain in the eastern edge of the Roskruge Range, Station 104 on the south side and Station 105, east side, overlooking the Indian village of Cocorague are typical in form, running from 21 to 24 mm. diameter.

ROBLES HILLS, outliers of the Roskruge Range eastward. Stations 91–95, at the dolomite quarry and northeast side of same hill, and north and east sides of middle hill, all in malpais. Shells rather small, compact, rather solid, the parietal callus generally thickened with a thickened edge.

Height 11.8, diam. 20 mm., $4\frac{1}{2}$ whorls. Station 92.
" 11.5, " 18.7 " Station 92.
" 13.3, " 22.3 " " 93.

Genitalia (Plate V, fig. 10, Station 93) typical except that the penis-papilla is deeply wrinkle-pitted, as in Coyote group forms. Measurements follow:

| | | |
|---|---|---|
| Museum No. | 118080 | 118084 |
| Length of penis | 11.5 mm. | 12.3 mm. |
| " " papilla | 8.5 " | 7 " |
| " " epiphallus | 8 " | 8 " |
| " " penial retractor | .. | 6 " |
| " " vagina | 9 " | 9.5 " |
| " " spermatheca and duct | .. | 22 " |
| Station | 93 | 104 |
| Plate V, fig. | 10 | 12 |

COYOTE RANGE.—Collections were made in the main canyon opening east, bounded on three sides by high granite walls and four dome-like peaks on the southwestern wall. At the western head there are springs, piped to the abandoned Zechendorf ranch. The Cavalla mining camp is at the west spring. Stations 111–113, 115, 116, 118, and the Rehn and Lutz station, are in this canyon. Stations 114 and 117 are in the rincon between the Baboquivari and Coyote mountains and Kitt's Peak, as shown on the sketches, figs. 5 and 6.

The special characteristics of Coyote specimens of *S. ambigua* are the large size of the shell and, in alcoholic specimens, the deeply,

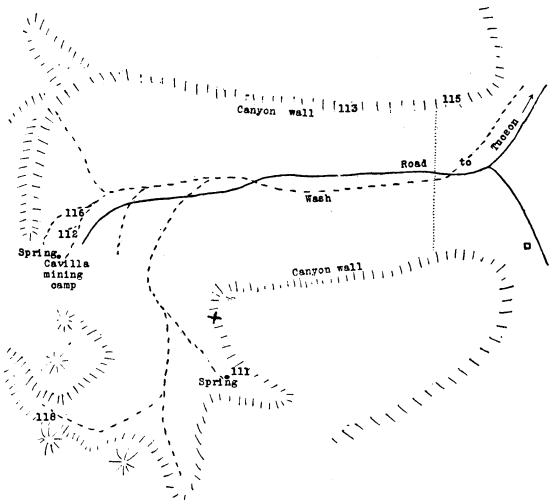



Fig. 5.—Main canyon of the Coyote mountains.

copiously, wrinkle-pitted penis-papilla, abruptly terminated and about ¾ as long as the penis, as shown in Plate. VI, fig. 3. The organs in two large specimens measure:

| | | |
|---|---|---|
| Museum No. | 118093 | 118054 |
| Length of penis | 18 mm. | 17.5 mm. |
| " " papilla | 14 " | 13 " |
| " " epiphallus | 14 " | 10 " |
| " " retractor | 10 " | .... |
| " " vagina | 14 " | 16.5 " |
| " " spermatheca and duct | | 19 " |
| Plate. VI, fig. | 3, 4 | 1 |

At Stations 114, 118, 119 the shells are rather thin, very large, glossy, last whorl of unusual width, parietal callus thin. Height 16.3, diam. 27.3 mm., 4½ whorls (Plate. II. figs. 1, 2, Station 118). Others from the same station are not more than 25.5 mm. diameter. These large shells closely resemble *S. a. capax* except in the embryonic shell, which is that of *S. ambigua.*

In other Stations, 112, 113, 115, 116, the shells are smaller, often somewhat more solid. Often the spire is much depressed, as noted in Bobb's Butte specimens. Height 15, diam. 26.5 mm., Station 112. Height 12, diam. 21 mm., Station 112. It is these smaller shells which form a perfect series connecting the large forms with typical *S. ambigua.*

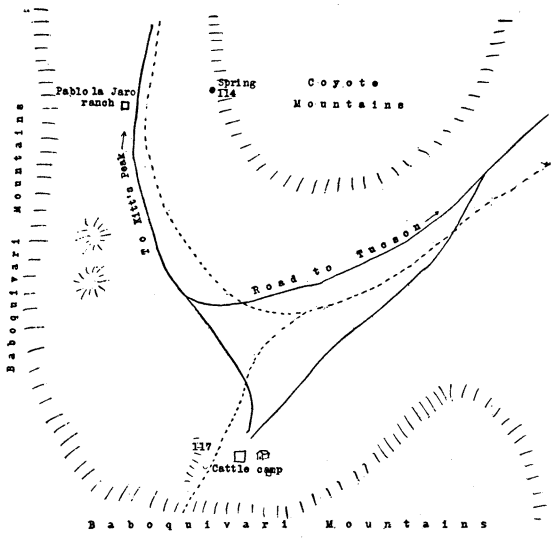



Fig. 6.—Rincon between the Baboquivari and Coyote mountains.

This species appears to have been first taken in the Coyotes by E. A. Goldman of the Biological Survey, whose specimens are 215129 U. S. N. M., 4 dead shells, one in good condition. It was next found by J. A. G. Rehn, who took numerous examples in the main canyon of the Coyotes at between 3600 and 3750 ft., on August 5, 1916, in company with F. E. Lutz. His station is marked X in fig. 5.

KITT'S PEAK AND ENVIRONS.—Stations 120–124, 147 for this species are in this region, located as follows:

120. Base of a small outlier northwest of Kitt's Peak.
121. Middle one of three large canyons on the north side, among bowlders near foot of the mountain.
122. About a mile up the canyon from 121, on a stream of living water.
123. Near head of the stream at foot of cliffs, at about 5500 ft. elevation, under scattered rocks in oak brush, sticks and leaves. The type station for *S. xanthenes*.
124. In a low hill, north of road, foot of Kitt's Peak.
147. Small hill about 50 ft. high, near Palo Alto cow camp.

At Station 122 some individuals reach a large size, 23 to 26.5 mm. diam. Small ones only were found at 123, the highest station, 18.5 to 22 mm. diam. The few taken at 147 are similar. At the

other stations the sizes are intermediate. Altogether, they resemble closely the Coyote group specimens.

In 1916, Rehn and Lutz took specimens in rocky foothills, 3700–3725 ft. elevation, 2 miles north by east of Kitt's Peak.

A specimen from Station 120 has the penis of *S. ambigua*, but the papilla appears smooth (Plate V, figs. 8, 9). Flagellum wanting or very minute.

| | | | |
|---|---|---|---|
| Length of penis | 11.5 mm. | Length of epiphallus | 9 mm. |
| " " papilla | 9 " | " " retractor | 4.5 " |

The shells are typical *ambigua*. Elevated and depressed examples are figured, pl. II, figs. 3, 4.

Comovo Road to Ajo.—The last Sonorella station westward, in the expedition of 1918, was at a small group of hills where the signboard reads "Tucson 101 miles." Beyond that the basaltic rocks were covered with white dust, perhaps alkali, or the granite faces were sharp and dry.[5] Station 127, small hills with Indian pictographs on the point nearest the road; 129 is back of the pictured rocks, west side, and south of 127. Station 130 was made between the preceding hills and the Quijotoa Range.

Specimens from Stations 127 and 130 are typical *S. ambigua* in shell characters, but they average rather large, the range being from 21 to 26 mm. diameter.

The penis-papilla is rounded at the end, not slightly enlarged distally as usual in *ambigua*. It is slightly wrinkled or smooth. The flagellum is short or rather long, 1.8 mm. in one example.

| Museum No. | 118097 | 118089 | 118096 (*cyclostoma*) |
|---|---|---|---|
| Length of penis | 14.5 | 7.5 | 12.5 mm. |
| " " papilla | 11 | 6 | 9 " |
| " " epiphallus | 13 | 8 | 10.5 " |
| " " vagina | 9 | .... | 9.5 " |
| Station | 130 | 127 | 126 |
| Plate. VI, fig. | 5 | 2 | 6 |

Nariz Mountains.—At Monument 163 of the International Boundary, at the summit of the mountain, Dr. Mearns took two dead specimens agreeing perfectly with *S. ambigua*. They measure 20.5 and 21.1 mm. diameter. No. 187479 U. S. N. M.

**Sonorella ambigua cyclostoma** n. subsp. Plate 2, figs. 5–7.

Station 126 (1918). Small hills south of Comovo road to Ajo about 3 miles west of Comovo Church. Type no. 118096*a*.

[5] Nautilus XXII, 3–9.

Specimens from Station 126 are a peculiar form in which the caliber of the whorls is somewhat reduced and the aperture is less oval, nearly round. The lip margins converge more than in *ambigua*, and are united by a callus in old individuals. Umbilicus rather large, contained 6 times in the diameter. Embryonic shell as in *S. ambigua*. The peristome is well expanded and somewhat thickened within. Height 12, diam. 21 mm.; $4\frac{1}{2}$ whorls.

Genitalia (Plate. VI, fig. 6) as in some specimens of *S. ambigua*, the penis-papilla smooth. Measurements are given on p. 78. The animal, in alcohol, is light brownish vinaceous, duskier on the back, as in *S. ambigua*.

**Sonorella sitiens** Pils. & Ferr. Plate VI, figs. 7, 9.
Proc. A. N. S. Phila. 1915,p. 407.

This species, originally described from Las Gijas, further north and west, was found everywhere in Pina Blanca canyon, Pajaritos Range. This canyon is above Oro Blanco, and heads over the border in Mexico. Stations 223, 224, 225, 229, 230, 236, 240, 242 (1919). Also in Clark's mine canyon, Station 237.

Three specimens from Stations 224 and 229 were dissected. They have the essential features of the Gija range type,—a very short, thick cylindric penial papilla and no flagellum; but in these examples the papilla is not corrugated, probably a condition of preservation. It is apparently less contracted, being the fraction of a millimeter longer. In a specimen from Clark's mine canyon it is 2 mm. long. The organs of 3 specimens measure in length as follows:

| Museum No. | 43740 | 43734 | 43723 |
|---|---|---|---|
| Length of penis | 4.5 | 6 | 5 mm. |
| " " papilla | 1.3 | 1.4 | 2 " |
| " " epiphallus | 7 | 5 | 7 " |
| " " vagina | 4 | 5 | 6 " |
| Station No. | 224 | 229 | 237 |
| Pl. VI, fig. | 9 | — | 7 |

Specimens of the shell from Station 237 measure: Height 10.7, diam. 18.5 mm.; height 13, diam. 20.7 mm.

**Sonorella sitiens montezuma** Pils. & Ferr. Plate II, fig., 8; pl. VI, fig. 10.
*Sonorella montezuma* P. & F., Nautilus, vol. 33, July 1919, p. 20.

Huachuca range in Montezuma canyon and the pass into Copper canyon, often abundant, Stations 312–315, 320, 321, 323–325, 327, all of 1919. Type no. 130583 from Station 327.

The shell is rather narrowly umbilicate, dilute cinnamon tinted, fading to whitish around the umbilicus and on both sides of the chestnut-brown band. Surface somewhat glossy, with sculpture of weak growth lines only. Embryonic shell, after the initial smooth tip, minutely wrinkled radially, the wrinkles irregular, becoming interrupted and weaker after the first half whorl. Last whorl wide, rounded peripherally, moderately descending in front. Aperture rounded, nearly as high as wide, the peristome sharp, very slightly expanded, having a distinct thickening within.

Height 9, diam. 15 mm.; $4\frac{1}{2}$ whorls. Type, Station 327.

Diam. 14 to 17 mm. Station 324.

The penis is longer than the vagina, has a sheath nearly half its length, and contains a very short, thick, cylindric papilla with shortly conic end. The epiphallus is enlarged where it enters penis. A very short flagellum is present. Lengths of the organs follow.

| Museum No. | 130628 | 130698 |
|---|---|---|
| Penis | 6.0 | 5.5 |
| Penis-papilla | 2.5 | 2.3 |
| Epiphallus | 6.0 | .. |
| Vagina | 6.0 | 3.7 |
| Spermatheca and duct | 16.0 | .. |

By the shape of the penis-papilla, the sculpture of the embryonic shell, etc., this race closely resembles *S. sitiens;* but the male organs are larger than in that, though the shell is much smaller. It differs from *S. parva* by the more rounded periphery and the very different genitalia.

**Sonorella sitiens comobabiensis** P. & F. Plate VI, fig. 11.

Originally described from the Comobabi Range; also reported from the Cababi Hills. The specimens we formerly referred to *S. vespertina*, from the Qui-i-tomoc Hills, appear on reexamination to be rather large *S. s. comobabiensis.* All of these were collected by the botanist J. C. Blumer.

In 1918, it was taken at Station 125, a small hill south of the Ajo road, 12 miles west of Indian Oasis; and at Stations 133, 134, 135 and 136, in the southern end of the Quijotoa Range.

Specimens from Station 133 dissected show the peculiarly short, thick penis-papilla characteristic of *S. sitiens* alone; but both penis and papilla are longer than in typical *sitiens*, and the penial retractor muscle is inserted on the summit of the penis, not as in typical *sitiens* and *S. s. montezuma,* distinctly on the epiphallus.

Length of penis 10, of papilla 2 mm. (Plate VI, fig. 11).

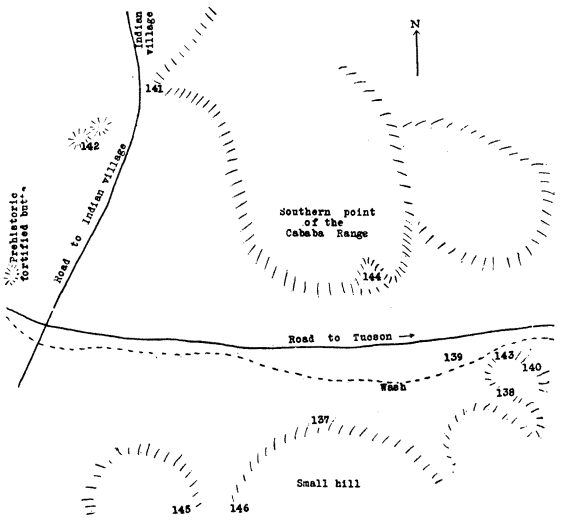



Fig. 7.—Southern end of the Cababi Range.

It was also taken at Stations 141 and 142, Cababi Hills, in a large hill south of the Indian village, east of the road, and in two outliers west of the road from the Indian village.

Localities of this group lie 50 to 75 miles northwest of the type locality of *S. sitiens*.

**Sonorella baboquivariensis** P. & F. Plate II, figs. 9, 10.

Specimens dissected in 1915, were from intermediate stations in the range of the species as then mapped. In order to test the constancy of the character then emphasized, the enlarged, acorn-shaped end of the penis-papilla, several others have been opened, from extreme points explored in our first visit, Stations 21 and 27.[6] Both show the peculiar papilla; in those from Station 27, "Sycamore" canyon, it is strongly developed, Plate VII, fig. 2; in two from Station 21, Mt. Mildred, Plate VII, fig. 3, it is blunter but still characteristic. Measurements of the organs in No. 111557, Station 27, follow:

| | | | |
|---|---|---|---|
| Length of penis | 7 mm. | Vagina | 7 mm. |
| " " papilla | 2.7 " | Flagellum | 1 " |
| " " epiphallus | 10 " | | |

[6] These stations are marked on the map, Proc. A. N. S. Phila., 1915, p. 413.

A week in October, 1917, camp was pitched upon the same spot in Sycamore canyon in the Baboquivaris occupied by us in 1910. A. W. Roberts, of much assistance to us at that time, feeling the need of venison, was the host, and thus it was designed as a hunting party; but the collections were good. The Forest Reserve has been vacated by the U. S. Government, and Frank Cole, the ranger, withdrawn. Much of the timber seen in 1910 has disappeared, and the streams have less water, yet the snails seemed more plentiful than before. Perhaps the rodents have departed; very few were seen. On no other range were so many snails found alive. Fifteen to sixty was the rule at every station.

A form of *S. baboquivariensis* was taken at Station 117 (1918), in the rincon of Chief Pablo, in the cliffs of the creek near a cow camp, formerly the Sycamore Forest Ranger station (marked on map, fig. 6, p. 77). The shells vary in size from 16.4 to 20.3 mm. diam. The umbilicus is generally slightly wider than in typical *S. baboquivariensis*, but there is no constant difference.

The genitalia (Plate VII, figs. 12, 13) differ chiefly by the absence of an enlargement of the end of the penis-papilla, which is rather thick as in *baboquivariensis*, but slightly longer. The papilla is shaped as in *S. b. depressa* but is much larger, especially thicker. The epiphallus is very slender and long, but was not gotten out entire, the specimens being very hard. Vagina is short. Three specimens of no. 118085 were dissected. The organs of two measure:

| | | |
|---|---|---|
| Penis | 6.2 mm. | 6 mm. |
| Papilla | 4.3 " | 4 " |
| Vagina | 3.7 " | 5 " |

On account of the difference in the papilla, this should be segregated as a race if the character proves constant.

**Sonorella baboquivariensis depressa** P. & F. Plate II, fig. 11; pl. VII, figs. 5–7, 9, 10.

In October, 1917, one of us (J. H. F.) visited the last canyon northward of those shown in our sketch map of 1915, p. 413, known as "Sycamore" or "Brown's" canyon The stations of this visit are plotted in text fig. 8, representing a northward extension of the former map.

The shells vary from the typical *baboquivariensis* form (Station 2) to smaller forms with the umbilicus somewhat less covered, and either narrow, as in *baboquivariensis*, or much wider, as in the form called *S. b. depressa*. Two from Station 5 measure:

Plate II, fig. 9. Height 11.8, diam. 19.2 mm., umbilicus 2.5 mm.
Plate II, fig. 10. Height 10, diam. 16.2 mm., umbilicus 1.8 mm.

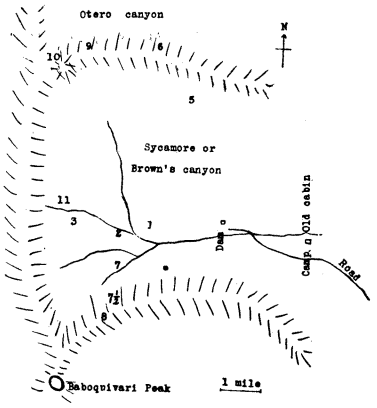



Fig. 8.—Sketch map of a section of the Baboquivari Range, showing collecting stations, 1917.

Specimens from Stations 3, 5–11 are similar.

In all of these lots dissected (Stations 2, 5, 10) the penis-papilla differs from that of typical *baboquivariensis* by its far *more slender* shape, with a bluntly tapering end, *not at all enlarged* and glandiform as it is in *baboquivariensis*. This may indicate that the form defined as *depressa* is specifically distinct; yet as the shell characters appear to intergrade, we leave this Sycamore canyon form as a subspecies. It inhabits the region immediately north of *baboquivariensis*.

Measurements of the genitalia follow:

| Museum No. | 117527 | 117527 | 117522 | 117519 |
|---|---|---|---|---|
| Penis | 7 | 6 | 5 | 8 |
| Papilla | 3.3 | 3 | 2 | 3.5 |
| Epiphallus | 7 | 7.3 | 6 | 9 |
| Flagellum | long | 2 | .. | 1 |
| Vagina | 8 | 6.5 | 5 | .. |
| Stations (1917) | 5 | 5 | 10 | 2 |
| Pl. VII, fig. | 7 | 9 | 10 | 5 |

In the Sierrita Mountains collections were made at Station 47 (1917) and 202 (1919), in a canyon facing east, at about 4500 ft., and at Station 204 (1919), on the south side of a mountain facing Harris ranch, at about 6000 ft. more or less. The shells resemble closely those from Sycamore canyon, and the genitalia, particularly the form of the slender penis-papilla, are identical with that race, in two dissected from Station 202. Length of penis 6.3, papilla 1.7, epiphallus 8, flagellum 1, vagina 7 mm.

In the Tucson Range, specimens were taken at Stations 58, 60 and 61. As the original account of *depressa* was quite short, a fuller description is here given of a specimen from Station 58, pl. II, fig. 11.

The shell is very thin, depressed, with a narrow umbilicus contained 9–10 times in the diameter. Between cinnamon-buff and light pinkish-cinnamon color, fading towards whitish on the base, with a chestnut-brown band above the periphery and more or less showing on the penult whorl, and having very indistinct, narrow pale borders. The surface is glossy, the last 2 whorls marked with fine smooth, growth lines under a lens; next earlier whorl having the lines irregular; after the nearly smooth first half whorl the embryonic whorls are minutely, closely but weakly rugose radially, and in the most perfect examples there are rather widely spaced protractive threads, as in *S. binneyi*. The spire is rather low; last whorl is *very wide*, viewed from above; it descends slowly and but little in front. The *aperture is unusually large*, peristome thin, distinctly but very narrowly expanded throughout, dilated at the columellar insertion, where it overhangs a small part of the umbilicus. Parietal callus arches forward somewhat, and bounded by a light raised line.

Height 11.5, diam. 19.3, diam. umbilicus 2 mm., $4\frac{1}{2}$ whorls.
" 10, " 17.0 mm.
" 11.7, " 17.5 "

Genitalia (Plate VII, figs. 4, 5, 8) characterized by the rather slender penis with stout basal sheath, and containing a rather short, smooth, slender, blunt-ended papilla, contained 3 times, more or less, in the length of penis. Flagellum short. The vagina is slightly shorter than the penis in specimens dissected (Stations 59 and 61). Dimensions follow:

| Museum No. | 118059 | 118061 | |
|---|---|---|---|
| Penis | 7.3 | 8 | mm. |
| Penis-papilla | 2 | 3 | " |
| Epiphallus | 8 | 7.5 | " |
| Vagina | 6.7 | 5 | " |
| Station | 61 | 58 | |

It differs from *S. binneyi* by the more fragile shell and slightly larger aperture.

We at first thought that this might be *S. arizonensis* Dall, but that species, well figured by Bartsch, has not so large an aperture, a decidedly higher spire and less depressed body-whorl, and it is said to have "rather well-marked incremental lines and microscopic vermicular markings"; the latter are certainly wanting in the present form, but may perhaps be due to the dead condition of the single specimen of *arizonensis* found.

**Sonorella binneyi imperialis** n. subsp. Plate 2, fig. 12; pl. VII, fig. 1.

Empire Range, Station 151 (1918); a few "bones" at Station 150.

The shell is decidedly more depressed than *S. binneyi*, rather narrowly umbilicate (umbilicus about one-ninth to one-tenth the diameter), thin, dilute cinnamon above, shading into white beneath, with a chestnut-brown band rather indistinctly whitish-bordered. There are some narrow whitish growth-arrest streaks. Surface glossy, with light, fine growth lines. Embryonic shell, after the smooth initial part, radially anastomosing-crinkled, then with slowly protractive threads over fine radial crinkling, and on the last part of the first whorl, retractive threads. The spire is small. The last whorl increases very rapidly and is unusually wide, as viewed from above. In front it descends a little and slowly. The aperture is large, its width decidedly more than half the diameter. Lip thin, very slightly expanded, outwardly and basally, dilated at the columellar insertion, partly covering the umbilicus.

Height 11.3, diam. 19.5 mm.; $4\frac{1}{2}$ whorls.

By its large aperture, texture, lip and apical sculpture this species resembles *S. baboquivariensis* P. & F., but in that species the aperture is even larger and the umbilicus more covered; moreover, the penis papilla is noticeably different, though otherwise the genitalia are rather similar. It differs from the typical Chiricahuan *S. binneyi* chiefly by being more depressed. The genitalia of this species show affinity to *S. bowiensis* and *S. bartschi*—species in which the umbilicus is decidedly larger.

The few living ones and numerous "bones" show very little variation in size, nearly all being from 19 to 20 mm. in diameter.

*S. binneyi*, while it has a remarkably wide range for a *Sonorella*, appears everywhere to be very local. In the Chiricahuas it is known from a single canyon in the southern part of the range. The form we called *franciscana* has a very limited area, separated from the Chiricahuan locality by valleys and by ranges where we know that *binneyi* does not occur. *S. b. franciscana* differs from the original lot by having a somewhat longer epiphallus, a difference of no great weight, and perhaps it is not really distinguishable from typical *S. binneyi*. The Empire Range form, *S. b. imperialis*, lives about 90 miles northwest of the type locality, several intervening ranges which we have explored being without the species. It has a more depressed shell than typical *binneyi*, and the penis-papilla is thicker. Finally in the Tucson Range, still further west, we have an allied form, *S. baboquivariensis depressa*, in which the penis-papilla is very slender.

**Sonorella tryoniana** n. n.

*Sonorella rowelli* (Newc.), Pilsbry, Proc. A. N. S. Phila., 1902, p. 511; Nautilus XVI, p. 32. Pilsbry & Ferriss, Proc. A. N. S. Phila., 1905, p. 261, pl. 18, figs. 33–35; pl. 20, figs. 13, 14, 20. Not *Helix rowelli* Newcomb.

Sanfords, Pima Co., on the bank of Sonoita creek under leaves and logs, near the water, J. H. Ferriss, type and paratype No. 83273 A. N. S. P. Also a short distance eastward in the northern end of the Patagonia mountains, J. H. F., 1902, and E. H. Ashmun, 1898. Empire mountains at Stations 149 and 152 (1918), J. H. Ferriss.

This small species, related to the Chiricahuan *S. bowiensis* and *S. binneyi*, was long thought to be Newcomb's *H. rowelli*. That species, however, proves to be a *Micrarionta* (*Eremarionta*), from southwestern Arizona.

*S. tryoniana* is much like *S. bowiensis*, but in that species the margins of the lip converge more, leaving a shorter parietal callus.

At Sanfords this species was found on the bank of the creek near the water under leaves and logs.

The specimens from far northward, in the Empire Mountains, appear to be practically typical *tryoniana*. Among the species of these mountains, this shell resembles *S. binneyi imperialis* in color and texture, but it is smaller, the last whorl is not so wide, the umbilicus is decidedly larger (contained between $6\frac{1}{2}$ and 7 times in the diameter), and the aperture is relatively smaller, though of similar shape. Surface very glossy, lightly striate, without spiral lines or granulation. Height 9.4, diam. 15.7, umbilicus 2.3 mm.; $4\frac{1}{2}$ whorls.

Living examples were taken at Station 149, but those preserved unfortunately became dry, and the sketch, Plate VIII, fig. 6, and the measurements obtained by soaking it up, are given for what they may be worth. The penis-papilla is cylindric with a blunt, rounded end.

Length of penis 3.5 mm.; papilla 1.5 mm.; vagina 4 mm.

**Sonorella berryi** n. sp. Plate II, fig. 13.

Station 103 (1918), in malpais slides on a small hill north of the road near the forks, on the east side of the Roskruge Range. Type no. 131001 A. N. S. P.

The shell is depressed-globose, thin, narrowly and half-covered umbilicate, translucent, white, with a chestnut-brown band above the periphery and narrowly showing on the penult whorl, and a pinkish-buff band below the suture, spreading about half way to

the chestnut band. Surface rather glossy, smooth except for very fine growth lines. Embryonic shell smooth at the tip, then finely radially rugose towards the end of the first whorl (showing a few widely spaced protractive threads in some, especially young, examples). The last whorl is very wide and descends a little and slowly in front. The aperture is very large. Peristome thin, expanded, reflected half over the umbilicus. Parietal callus thin. Height 12.3, diam. 18.3 mm.; $4\frac{1}{2}$ whorls. Type. Height 12, diam. 18.7 mm. Height 11.5, diam. 17.3 mm.

Genitalia (Plate V, fig. 11) about as in *S. binneyi* P. & F., so far as can be judged from a dried specimen, soaked up.

About 60 living specimens of this handsome little Sonorella were taken. While it is related to *baboquivariensis depressa*, of the Baboquivari, Sierrita and Tucson Ranges, it differs by the smaller, more covered umbilicus, the still larger aperture, the less depressed shape, and in coloration, which is uniform in the long series taken.

In the genitalia it resembles *S. binneyi franciscana* in having the epiphallus longer than in Tuscon Range specimens of *depressa*. Unfortunately the single animal saved became dry and had to be soaked up, hence the following measurements may require some revision when fresh ones are obtained.

Length of penis 6.7 mm.; length of papilla 2.5 mm.; length of vagina 7.5 mm.

Named for S. Stillman Berry, who has done good work on the Californian desert snails.

**Sonorella odorata** P. & F. Plate VI, fig. 8.

Genitalia of a specimen from Station 22 (1917), in the aspen zone, Spud Rock Ranger Station, Rincon Mts., are here figured to show variation in form of the penis-papilla, which is somewhat enlarged distally.

| | |
|---|---|
| Length of penis .....6 mm. | Length of epiphallus. 10 mm. |
| " " papilla ....3 " | " " vagina.... 7 |

**Sonorella hinkleyi** P. & F. Plate III, figs. 1, 4.

Nautilus vol. 33, July 1919, p. 19.

San Cayetano Mountains, in the southern part, at Stations 243 to 251 (1919), the types from Station 243, the southernmost peak of the Cayetano foothills 2 miles above Calabasas, on the western branch of Sonoita Creek. The highest stations at about 7500 ft. elevation.

The shell is small, moderately solid, depressed, the umbilicus contained about 5 times in the diameter; between light pinkish-

cinnamon and pinkish-buff, the base paler, a chestnut-brown band above the periphery. The surface is slightly glossy. Embryonic whorls radially crinkled, the second with very irregular tangential (protractive) threads on its peripheral half; subsequent whorls with weak lines of growth only. The spire is low, whorls convex, the last wide, descending a little in front. The aperture is rounded, peristome slightly expanded.

Alt. 8, diam. 15.7 mm.; $4\frac{1}{3}$ whorls. Type, station $243\frac{1}{2}$. Alt. 10, diam. 17 mm. Station 243.

The penis is rather long with a basal sheath nearly a third of its length; the papilla cylindric with conic end and weak spiral plication. Epiphallus about as long as penis, the long penial retractor inserted upon it. No flagellum. The vagina is longer than the penis, and at the distal third there is an annular swelling, the wall there being thickened and muscular, with an internal annular ridge. Above this the internal wall has fine, irregular, longitudinal threads. Measurements of the organs in mm. follow.

| | | |
|---|---|---|
| Museum No. | 43735 | 43726 |
| Penis | 10.5 mm. | 10 mm. |
| Penis-papilla | 4 " | 3.3 " |
| Epiphallus | 10 " | 9.5 " |
| Vagina | 13 " | 11 " |
| Station | 243 | 244 |

A small, depressed nearly smooth species. At Station 244, in a porphyry slide on a small knob, southern side of the southern peak of the Cayetanos, most of the specimens taken are albinos, the shell white throughout. There were 452 albinos to 24 banded specimens (Plate III, fig. 4).

**Sonorella hinkleyi cayetanensis** Pils. & Ferr. Plate III, fig. 5.

*Sonorella cayetanensis* P. & F., Nautilus vol. 33, July 1919, p. 19.

Cayetano Mountains: Station 216, in a slide of white porphyry on north side of double peak, near the top, type loc. Also Stations 207, 212, 215, 217, from the foothills up.

The shell is thin, light, umbilicus contained about 8 times in the diameter, dilute cinnamon, fading to whitish around the umbilicus and on both sides of the chestnut-brown supraperipheral band. The latter shows only narrowly on the penult whorl. Surface glossy, lightly striate. Faint traces of protractive and retractive threads are visible on the latter part of the embryonic shell in young examples. The whorls increase rather slowly to the last, which is about double the width of the penult and descends very little in front. The thin peristome is narrowly expanded, insertions of the margins rather widely apart. Height 11.7, diam. 21 mm.; nearly $4\frac{3}{4}$ whorls.

Genitalia much as in *S. hinkleyi*. The long penis contains a spirally plicate papilla somewhat over one-third the total length, its end conic. The equally long epiphallus terminates in a very short flagellum. The vagina is longer than the penis, and has an annular muscular swelling at its distal fourth. The organs measure in length:

| | | | |
|---|---|---|---|
| Penis | 13.5 mm. | Vagina | 20 mm. |
| Penis-papilla | 5.0 " | Museum No. | 43737. |
| Epiphallus | 13.5 " | Station | 216. |

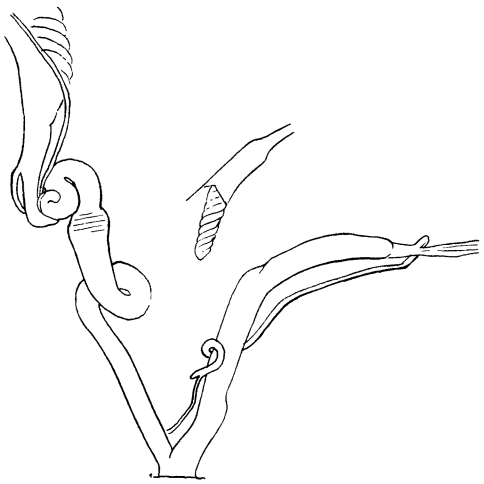


Fig. 9.—*Sonorella h. cayetanensis*, No. 43737, Station 216.

This form from the northern end of the Cayetano range is anatomically very close to *S. hinkleyi*, which inhabits the southern end of the same range, and is distinguished by the smaller size and more solid texture of the shell. However, there are some specimens, such as those from Station 219 (1919) which appear intermediate, and we therefore reduce *cayetanensis* to subspecific rank.

**Sonorella hinkleyi tumacacori.** Plate III, fig. 2; pl. VIII, figs. 4, 5.

*Sonorella tumacácori* P. &. F., Nautilus vol. 33, July, 1919, p. 19.

Tumacácori Mountains, Stations 204½, 208, 209, 210, 211, 212, all on Tumacácori Peak and the next mountain southward.

Except by the somewhat greater length of the reproductive organs, the decidedly stronger node or swelling on the vagina, the short penial retractor and less closely twisted penis papilla, this form differs very little from *S. hinkleyi*, of which we now consider

it a local race. The localities of species and race are separated by the Santa Cruz river valley.

The shell varies in size. Height 9, diam. 17 mm., $4\frac{1}{2}$ whorls. Station 210. Height 11, diam. 18.5 mm., $4\frac{1}{2}$ whorls. Station $204\frac{1}{2}$.

The long penis has a sheath about one-third its length. The papilla is weakly spirally plicate, cylindric with long conic end. There is an extremely short flagellum. The penial retractor is very short, inserted near the base of the epiphallus. The vagina is much longer than the penis, and has a strong muscular annular swelling near its upper end, where it is folded upon itself.

| | | | | |
|---|---|---|---|---|
| Penis | 14. mm. | 13.0 | 13. | 11.8 |
| Penis-papilla | 5. " | 4.2 | 5. | 4.2 |
| Epiphallus | 15. " | 11.5 | .. | 11.5 |
| Flagellum | minute | minute | minute | minute |
| Vagina | 16 mm. | 17 | .. | 14 |
| Spermatheca and duct | 21 " | | | |
| No. | 43731 | 43738 | 43732 | 43739 |

**Sonorella hesterna** P. & F. Plate VIII, figs. 8, 9.

Northern end of the Santa Rita Mountains: Station 49 (1917), near Rosemont; 50, west side saddle of Santa Ritas, overlooking Helvetia; 51, Helvetia; 52, Greaterville; all in the eastern part of Pima County.

We provisionally refer a series of specimens from the northern and eastern Santa Ritas to this species from the southern foothills of the Rincons, which was described without anatomical characterization.

It is very closely related to *S. hinkleyi* and particularly to *S. h. cayetanensis*, the genitalia being of the same general character, but the shell is more solid. The penis-papilla is strongly plicate spirally, with a conic end. There is a muscular swelling or node on the vagina. Flagellum minute, vestigial. The organs measure in length:

| | | | |
|---|---|---|---|
| Penis | 13.0 mm. | Vagina | 17 mm. |
| Penis-papilla | 3.7 " | Museum No. | 118058. |
| Epiphallus | 15.0 " | Station | 50. |

It remains to be seen whether *S. hesterna* from the type locality has the same anatomical features; it may possibly prove to be more like *hachitana* or *walkeri*.

**Sonorella tumamocensis** Pils. & Ferr. Plate VII, fig. 14.

Tucson Range, Stations 86, Cat Mountain, 87, 90, Limekiln camp. Silver Bell mining camp (north of the Roskruge Range).

Malpais slides in a small black hill 3 miles east of north of Bobb's Butte, southern end of the Roskruge Range, Station 110.

A specimen from near the Desert Laboratory, Tumamoc Hill, was dissected and the penis is drawn in Plate VII, fig. 14. It agrees well with the original lot, except that the spiral grooves of the penis-papilla are less closely wound. The penis and epiphallus are each 9 mm. long, papilla 4 mm., in a shell 8.5 × 15.7 mm. There is no flagellum.

At Station 87 the specimens vary from 18 to 20.5 mm. diameter, becoming larger than any from the type locality. None have been dissected from the Tucson Range proper, west of Tumamoc Hill, or from the Silver Bell, but except in attaining larger size they appear to be identical.

At Station 110, southern foothills of the Roskruge Range, the specimens are much like the smallest examples of typical *S. tumamocensis*, diam. 14 to 16.2 mm. They are more depressed than the larger Tucson Range shells, somewhat translucent. The animals had been dried, but by the use of potash one was soaked up. The genitalia (Plate VII, fig. 15) do not differ materially from *tumamocensis*, except that the papilla appears to be *smooth* and shaped as in *S. binneyi*, not tapering and spirally grooved as in *tumamocensis*. There is a very small flagellum.

| | | | |
|---|---|---|---|
| Length of penis | 12 mm. | Length of epiphallus | 7.5 mm. |
| " " papilla | 3.5 " | " " vagina | 8 |

Little stress can be attached to such details in a specimen so poorly preserved. Evidently a further investigation of the anatomy of these several forms referred to *tumamocensis* must be made.

The shells at station 110 show considerable variation in size of the umbilicus:

| | | | | | |
|---|---|---|---|---|---|
| Height | 8, | diam. | 16.2, | width umbilicus | 2.5 mm. |
| " | 8 | " | 14.2 | " " | 2.1 " |
| " | 7.6, | " | 13.9, | " " | 2.7 " |

Similar variation occurs in the type locality, where also most specimens are larger.

These specimens from Station 110 are very much like *S. ferrissi*, but the last whorl is more depressed in the latter.

HUACHUCAN SONORELLAS.—The Huachucas have a more varied fauna of Sonorellas than any other range yet explored, the five species known anatomically belonging to four of the groups founded

on anatomical structure. The shells are greatly varied in size and form, and two species *S. dalli* and *S. parva*, possess rudimentary "teeth." We here figure a specimen of the former having these teeth well developed (Text-fig. 10).

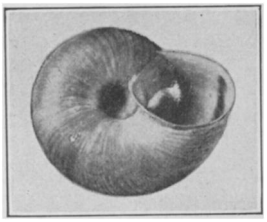


Fig. 10.—*Sonorella dalli* showing parietal teeth.

Besides these species, there are two others not yet dissected. *S. huachucana* was taken in 1904. It was originally described as a subspecies of the Chiricahuan *S. virilis*. Somewhat faded bones of another species of about 20 mm. diameter, with smooth (not granulose) surface was taken in 1919 at Station 270, at the northern end of the range. As it belongs to a group of very weakly differentiated species, we do not attempt to name these specimens, which certainly differ specifically from any described Huachucan species.

*Key to Huachucan Sonorellas by Characters of the Genitalia.*

*a*. Penis long (about 40 mm. in a shell 27 mm. diam.), containing a short papilla (about $\frac{1}{5}$ length of penis); epiphallus long (49–60 mm.); flagellum present. *S. dalli* Bartsch.

*a*$^1$. Penis long (about 20–25 mm. in a shell of about 16 mm. diam.), containing a long, longitudinally costulate papilla; epiphallus shorter than penis; no flagellum. *S. parva* Pils.

*a*$^2$. Penis shorter, about equalling the diameter of shell or much less, containing a thick, cylindric papilla.

*b*. Papilla less than half the length of penis; vagina shorter than penis; epiphallus thickened where it passes into penis. *S. sitiens montezuma* P. & F.

*b*$^1$. Papilla more than half the length of penis; epiphallus not enlarging where it enters penis; vagina much longer than the penis.

*c*. Upper part of vagina muscular, swollen, usually fusiform; penis 5 to 7.5 mm., papilla 3.3 to 5 mm. long. *S. granulatissima* Pils.

*c*$^1$. Vagina rather slender throughout, with a small fleshy node midway or at the upper third; penis 12 to 19 mm., papilla 9 to 13 mm. long. *S. danielsi* P. & F.

**Sonorella danielsi** P. & F.

This is a common shell in Ash canyon, Stations 310, 311, 330 (1919), Montezuma and Copper canyons, no. 314, 316, 318-320, 322–324, 327–329, all 1919. Its known range is thus extended considerably.

The color is not yellow as in the types, but a brown tint. In the soft anatomy, specimens from stations 310, 311, 314 agree fully with the typical form. One from 319 dissected has the vagina like *granulatissima* (P.A.N.S. 1909, pl. 21, fig. 4), but the penis and papilla are long, as in *danielsi*. Measurements of the organs follow.

| Museum No. | 44043 | 44041 | 44035 |
|---|---|---|---|
| Penis | 10 | 10 | 11.5 |
| Penis-papilla | | 7 | 8.5 |
| Epiphallus | 10 | .. | .. |
| Penial retractor | 9 | .. | .. |
| Vagina | 16 | 13 | 18 |
| Station | 314 | 311 | 319 |

The large, club-shaped, abruptly truncate penis-papilla has a wrinkled-areolate surface, not very well shown in the figures published in 1909, but best in Plate 21, fig. 7.

Specimens of *S. danielsi* in the National Museum, No. 124479*a*, are labelled "Tucson, Arizona, Cox, Lea Collection." We have noticed the Huachucan *Ashmunella* from the same source in these PROCEEDINGS for 1909, p. 496. It is a form, *A. varicifera*, which inhabits the southern Huachucas, the habitat also of *S. danielsi*. The latter is known from over 25 stations in this region, but neither species has been taken by us further northwest in the Huachucas, or in any other range. There can therefore be little doubt that the Cox specimens of *Ashmunella* and *Sonorella* labelled "Tucson" came from somewhere in the neighborhood of Ash canyon, Huachucas.

**Sonorella parva** Pils. Plate VIII, figs. 2, 3.

*Sonorella granulatissima parva* Pils., Proc. A. N. S. Phila., 1905, p. 264, pl. 18, figs. 45–47; 1909, p. 501, pl. 19, figs. 10–12.

The exact locality of the original lot was not noted; they were picked up between Fort Huachuca and the Manila mine, near the latter, and agree perfectly with those taken at Station 274 (1919). It was found also at Stations 270 and 281 (1919). All of these are in the western foothills of the northwestern end of the Huachuca range.

Sculpture: after the smooth apex, there are some radial wrinkles to the end of the initial half whorl; the whorl following is very minutely, densely, evenly reticulate-pitted; in oblique light in certain places faint traces of fine, close oblique lines may sometimes be made out. The following neanic whorls are microscopically densely granulose, as in *S. granulatissima*, but on the last whorl this granulation becomes very weak or almost disappears.

The last whorl is bluntly subangular in front, or at least somewhat compressed there; it descends rather deeply to the aperture.

Aperture is strongly oblique, rounded, somewhat wider than high, the margins approaching. There is sometimes a very low, oblique callus pad or "tooth" on the parietal wall, further in and nearer the periphery than is usual in helices. This tooth is visible in all adult shells from station 281, but seems to be only occasional in other lots. It is present but excessively weak in the figured type, but is well developed in a paratype.

The soft anatomy, examined in specimens from Stations 270, 274 and 281, shows that this form is not nearly related to *S. granulatissima*. The animal is plumbeous black above; sole with a wide isabella colored central area, sharply defined, and dusky side areas. Genital organs are relatively large. The penis is long with a short sheath, thin-walled, containing a long fleshy papilla having numerous slender longitudinal ridges, the end abruptly truncate. Penial retractor short, on the epiphallus, which is twisted around the retractor, the basal part thickened. No flagellum. The vagina is long.

| Museum No. | 44054 | 44037 |
|---|---|---|
| Penis | 20 mm. | 25 |
| Penis-papilla | 14 " | 12 |
| Epiphallus | 12 " | .. |
| Penial retractor | 8 " | 8 |
| Vagina | 16 " | 21 |

The peculiar sculpture of the penis-papilla is unique in the genus. The "tooth" on the parietal wall is a very unusual feature in *Sonorella*, but occurs also, and more strongly developed, in *S. dalli*.

**Sonorella insignis** Pils. & Ferr. Plate III, fig. 3.
Nautilus, vol. 33, July 1919, p. 21.

Whetstone Mountains, Stations 304, 304½ and 305 (1919). Living specimens were taken only at the type Station 304.

The shell is much depressed, openly umbilicate (the umbilicus about one-fifth the total diameter), solid, opaque, whitish stained with light pinkish-cinnamon above and in places on the base, banded with chestnut-brown, the band broad, situated well above the periphery. Surface with little gloss, having coarse, unevenly developed, very low plications in the direction of growth lines, and mainly confined to the last whorl; under the microscope traces of rather coarse, well separated spiral impressed lines may be deciphered in some places on the upper surface. No protractive threads are visible on the embryonic shell in the adult or nearly adult shells. The last whorl descends rather deeply to the aperture, which is oval with converging margins, very slightly expanded.

Height 9.5, diam. 20.5 mm.; 4½ whorls. Type.
" 8.8, " 19 " Topotype.
" 10.3 " 21.7 " "

Genitalia (Plate VIII, fig. 1, type) characterized by the long male organs. The large penis papilla is ¾ the length of the penis, with a bluntly conic end. The penis is slender basally, enclosed in a short sheath. Flagellum very small but distinct. Vagina shorter than penis. Lengths of organs as follows:

| | | | |
|---|---|---|---|
| Penis | 16.5 mm. | Epiphallus | 24 mm. |
| Penis papilla | 12.0 " | Vagina | 10 " |
| Penial retractor | 8.5 " | Spermatheca and duct | 25 " |

The jaw has 4 or 5 ribs.

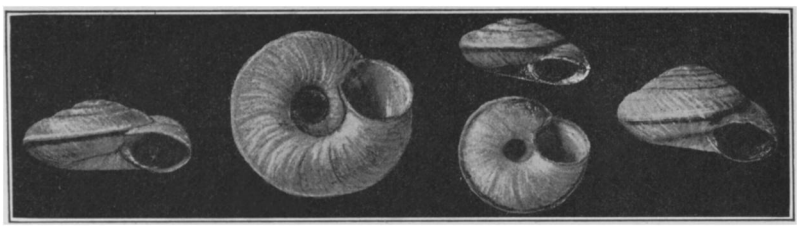
This species is readily known by its depressed shape and coarse sculpture. It is not closely related to any described form, but by the very large penis and papilla appears to belong to the group of *S. virilis*.

A very old specimen has a distinctly calloused parietal wall, much as in some Oreohelices.

**Oreohelix concentrata huachucana** Pils.

Whetstone Mountains, Stations 286, 303, 304, 304½ (1919).

The Whetstone form is generally more depressed and more widely umbilicate than is usual in the Huachucas, but some Huachucan



A B C D

Fig. 11.—*Oreohelix concentrata huachucana*. Whetstone mountains, *a*, *b*, *c*, station 304½; *d*, station 286.

examples are entirely similar, and some from the Whetstones are elevated. They are always angular or keeled in front or throughout. Fully adult specimens measure:

| | | | |
|---|---|---|---|
| Height 13.3, | diam. 22 mm. | Station | 286. |
| " 10.3 | " 18 " | " | " |
| " 13.3, | " 25 " | " | 303. |
| " 12.3, | " 24.5 " | " | 304½. |
| " 12.5 | " 22.7 " | " | " |
| " 9.3 | " 20.4 " | " | " |
| " 8.7 | " 17.3 " | " | " |

In the Mustang Mountains only fossil specimens were found. Those from Station 157 (1918) measure 20–22 mm. diameter, have a moderately raised spire, and are practically typical of the subspecies. At Station 153 (1918) the shells are smaller, 15 to 19 mm. diameter.

**BULIMULIDÆ.**

**Bulimulus nigromontanus** Dall. Plate I, figs. 3, 4.

Pajaritos Mountains in Pina Blanca canyon, Stations 225, 236. Also 5 miles north of Moor Ranger Station, Pina Blanca, in a small canyon running east, opposite the main gulch from the Tumacácori Mountains, in a slide on the north slope of a hill of crumbling porphyry, Ferriss and Hinkley, 1919.

Except in having a somewhat smaller umbilicus, these specimens appear to agree with the description of *B. nigromontanus*, which came from Black Mountain, 12 miles south of Monument 77 of the International Boundary, on the right bank of the San Bernardino River, in Sonora. The localities now recorded carry the species about 130 miles further west. It is a species new to the United States list.

**UROCOPTIDÆ.**

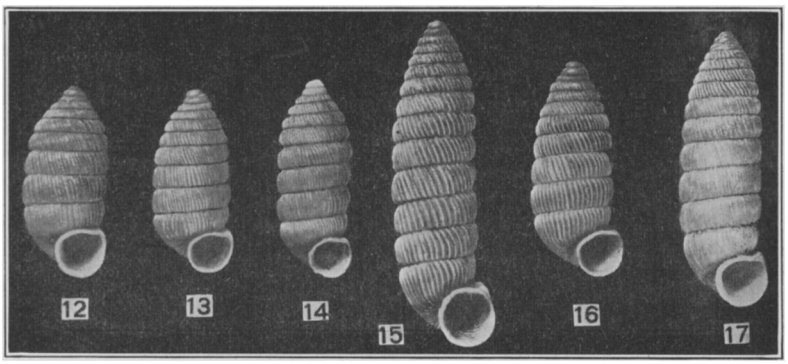



Fig. 12.—*Holospira ferrissi caneloensis.* Fig. 13.—*H. f. monoptyx.* Fig. 14.—*H. p. fluctivaga,* Fig. 15.—*H. whetstonensis.* Fig. 16—*H. w. arata.* Fig. 17.—*H. arizonensis mustang.* In each case the type is figured.

**Holospira ferrissi** Pils.

This was taken at Station 268, Manila mine, at the northwest end of the Huachucas, the type locality. Also Station 275, foothill a mile east. Many, but not all, specimens have 3 internal lamellæ, and the whorls are ribbed throughout. Ten topotypes opened have lamellæ as follows:

Axial lamella only.....5 specimens
Axial and basal.....2 "
Axial, basal and parietal.....3 "

Form 2.—At Station 271, a deep canyon 1 mile north of the Manila mine hill, at a dolomite cliff facing northwest, two lots were obtained. These generally have the riblets weak on the penult or on two whorls, and the lamellæ within are reduced. 15 opened from one lot and 11 from another have lamellæ thus:

| | No. of specimens | No. of specimens |
|---|---|---|
| Axial only..... | 10 | 10 |
| Axial and basal..... | 4 | . |
| Axial, basal and parietal | 1 | 1 |

These specimens average somewhat larger than the typical lot of *ferrissi*.

An identical form was taken at Station 306 on the western dome of the Mustangs. Most of the specimens opened had a columellar lamella only, but one had 3 lamellæ.

**Holospira ferrissi caneloensis** n. subsp. Text-fig. 12.

Canelo Hills: limestone hills west of the Duquesne road at Stations 289 to 292, the latter three miles west of the road and the furthest from it. Type 131010 A. N. S. and paratypes in Ferriss collection from Station 289.

The shell has the short contour and small size of typical *ferrissi*, but the sculpture is slightly finer, and becomes *obsolete* on the antepenult to last whorls, strengthened again on the last half whorl. The three internal lamellæ are strongly developed.

| | | | | | | |
|---|---|---|---|---|---|---|
| Length | 8, | diam. | 3.5 | mm., 10 | whorls. | Type. |
| " | 7.2, | " | 3 | " 10 | " | Station 290. |
| " | 9.8, | " | 3.5 | " $11\frac{1}{2}$ | " | " " |

Three internal lamellæ are present in all opened of the type lot, but at Station 292 some of the apparently quite adult shells had only the axial lamella.

**Holospira ferrissi monoptyx** n. subsp. Text-fig. 13.

Mustang Mountains, in a limestone slope facing east, near Dan Mathew's ranch. Type No. 131009 A. N. S., paratypes in coll. Ferriss.

The shell has the short, compact shape of *ferrissi*, but differs by having the costulation weaker on the penult and face of last whorl, and in numerous specimens opened there is but one lamella, a strong axial.

Length 8 diam. 3.3 mm., $10\frac{1}{2}$ whorls. Type.
" 7.2 " 3.25 " $9\frac{1}{2}$ "
" 8.7 " 3 " 11 "

This form resembles *H. f. caneloensis*, and certain specimens are not distinguishable; but in numerous examples opened, none had any lamellæ other than the axial.

**Holospira ferrissi fluctivaga** n. subsp. Text-fig. 14.

Debris of the San Pedro River near Mammoth, Pinal Co., Ferriss, 1917. Type 131008.

The shell is cylindric with a short, conic, somewhat mucronate summit; much like *H. ferrissi*, from which it differs by having the later whorls decidedly more convex. There are about 8 riblets in 1 mm. on the penult whorl. In the back and right side of the penult whorl there is a very strong and long parietal lamella, a strong, blunt axial, and a rather low basal fold.

Length 8.3, diam. 3.15 mm.; $10\frac{3}{4}$ whorls.

It stands close to *H. f. sanctæcrucis*, but differs by the greater convexity of the whorls of the cylindric portion of the shell.

A broken specimen of this species was in the shell debris collected by Pilsbry on the San Pedro, near Benson, in 1910. It measures, length 7.3, diam. 2.8 mm., $10\frac{1}{4}$ whorls.

**Holospira arizonensis mustang** n. subsp. Text-fig 17.

Mustang Range, Pima Co., Arizona: north side of tower, eastern peak, Station 153 (1918); also the following Stations of 1919: 286, the same as 153 of 1918; 287, a limestone hill east of 286; 332, main gulch of north slope of the largest mountains west of Dan Mathew's ranch house, and 333, the next gulch eastward. Type No. 131003 A. N. S. P., and paratype in Ferriss coll. from Station 153.

Related to *H. arizonensis mularis*, but more slender; summit usually somewhat more slowly tapering; back of the last whorl more coarsely and more irregularly ribbed. Axis having a stout, blunt lamella. Smaller than typical *H. arizonensis*.

Length 12, diam. 3.5 mm.; $13\frac{1}{2}$ whorls. Type.

**Holospira whetstonensis** n. sp. Text-fig. 15.

Whetstone Mountains at Stations 293, 304, 305. Type 131007.

The shell is imperforate, long, cylindric with a rather tapering terminal cone about one-fourth the total length; light flesh colored. Sculpture of strong riblets throughout after the two smooth apical whorls; riblets narrower than the intervals, 40 on the penult whorl in the type specimen. The whorls of the cone are strongly convex,

later whorls moderately so, with a well impressed suture. The last whorl is flattened laterally, sloping to the base, is contracted and very shortly free in front. The small aperture is rounded with part of the upper margin straightened. Internally there are one to three lamellæ. The type having an axial lamella only.

Length 14.2, diam. 3.7 mm., 14½ whorls. Type.
" 11.5 " 3.6 " 13 "

This species resembles *H. cionella* and *H. chiricahuana*. The latter has a longer terminal taper, passing imperceptibly into the cylindric part. *H. cionella* is a smaller species with finer sculpture. Out of 7 specimens from the type locality opened, 2 have an axial lamella only, 4 have axial and basal, and one has axial, basal and parietal. Several opened from the other two stations have the axial lamella alone.

The specimens from Station 293 are similar to those from 304, the type station; but at 305 the shells are smaller, extremes measuring:

Length 11.3, diam. 3.7 mm., 12½ whorls.
" 9.5, " 3.6 " 10½ "

A few opened have a axial lamella only.

Also taken in the Empire Mountains, Station 149 (1918), on the north side of a large limestone peak 1½ miles northwest of the Total Wreck mine. Specimens small, about as at Station 293, above; only an axial lamella.

**Holospira whetstonensis arata** n. subsp. Text-fig. 16.

Mustang Mountains, Stations 159 (1918), type loc., and 153 (1918), both on the eastern dome of the range. Type 131005.

The shell is smaller, especially shorter than *whetstonensis*, with a shorter neck, but having similar strongly cut riblets, coarser than in *H. ferrissi;* the terminal cone longer than in *ferrissi*. There is an axial lamella lateral in position.

| | | | | | |
|---|---|---|---|---|---|
| Length | 9.3, | diam. | 3.5 mm., | 11½ whorls. | Type. |
| " | 9.8 | " | 3.3 " | Topotype. | |
| " | 8.5 | " | 3.2 " | " | |
| " | 10.9 | " | 3.2 " | 12 whorls. | Station 153. |
| " | 9.4 | " | 3.7 " | 10½ " | " " |

## IV. On Micrarionta rowelli (Newc.) and M. newcombi, n. sp.

**Micrarionta rowelli** (Newc.). Plate III, figs. 7 (type), 6.

*Helix rowelli* Newcomb, Proc. California Acad. Sci. III, 1865, p. 181. Binney and Bland, Land and Fresh-water Shells of N. A., I, p. 185, upper fig. 326; not the description or lower figure.

This species was, we believe, the first land snail described from Arizona. Newcomb's type appears to have come from Frick, or at least he is given as authority for the locality "Arizona." Whether Frick was a fortyniner who reached California by the Old Yuma Trail through Mexico and Arizona, we do not know. We know that he lived in Oahu for some years, and collected shells there; but no details of his life could be obtained.

Binney, in 1869, confused Newcomb's shell with *Helix lohrii* Gabb, a very different shell. His description appears to be composite, and only his upper figure is certainly identifiable as *rowelli*. The lower figure differs in lacking the parietal callus and in being larger. Fischer and Crosse followed Binney in this mistake.

In 1882, Henry Prime reported "*Ampelita*" *rowelli* from the Salt River Mountains, 7 miles south of Phoenix, Arizona, "determined by Dr. Newcomb." We have seen some of these shells, which have a general resemblance to *M. rowelli*, but are really bleached Sonorella "bones" of an undescribed species. In 1905, one of us (H. A. P.) thought to recognize Newcomb's species in certain small Sonorellas from Sanfords and the adjacent foothills of the Patagonia Mountains, Arizona. On comparison with the type specimen, it is seen that these shells are different, and the new name *Sonorella tryoniana* has been proposed for them.

The type-specimen of *M. rowelli*, No. 27517 of the Newcomb collection, Cornell University, is represented in Plate III, fig. 7. It is bleached white, but shows a narrow gray band above the periphery. The surface is glossy, finely, weakly striate. On the antepenult whorl the striæ are slightly irregular, indistinctly broken into long granules. The apex is now broken, but the last part of the embryonic shell remains. It shows a sculpture entirely similar to that of *M. wolcottiana*, *M. hutsoni* and others,—granules lengthened in a spiral direction. The whorls are rather strongly convex, the last one very wide, and descending rather deeply in front. Aperture is very shortly oval, nearly as high as wide, the peristome expanded, a little thickened within, the margins connected by a strong parietal callus. Height 8.8, diam. 16; diam. umbilicus 2.8 mm. Aperture 8 mm. high, 9 wide.

In the U. S. National Museum there are two examples (one much broken) of a *Micrarionta* (Plate III, fig. 6), No. 187478, labelled as collected at Tinajas Altas by Maj. E. A. Mearns, Feb. 21, 1894. They agree so fully with Newcomb's type of *M. rowelli* that we

believe that the habitat of that species can now be fixed. Mearns was in camp at Tinajas Altas, at the east base of the Gila Mountains, from February 14 to 23, 1894, and made a careful exploration.[7] These famous natural rock tanks, which furnish an almost unfailing supply of good water, were an important camping place on the old Yuma Trail to California,[8] and probably are where Frick obtained the type of *Helix rowelli*. In the absence of other information, we propose that Tinajas Altas be considered the type locality.

*M. rowelli* stands close to *M. hutsoni*, but the aperture is more rounded, less oval, and the parietal callus is decidedly longer.

The Mearns example measures: height 8, diam. 16.3 mm., and is figured on Plate III, fig. 6. The parietal callus is not so heavy as in Newcomb's type, which is evidently an old shell.

**Micrarionta newcombi** n. sp. Plate III, fig. 8.

The shell is strongly depressed, openly umbilicate (the umbilicus contained 4 times in the diameter), thin, whitish (dead), with a narrow brown band above the periphery. Surface smoothish, with faint growth striæ only. Embryonic whorls showing no sculpture (somewhat worn). Whorls convex, rather slowly increasing. Aperture rounded-lunate. Peristome sharp, the specimen not fully mature.

Height 8, diam. 15.5, width of umbilicus 3.9 mm., $4\frac{1}{2}$ whorls.

A single specimen of this species was in the Newcomb collection with the type of *M. rowelli;* presumably from the same locality. It is not fully mature, yet should be easily recognized by the strongly depressed shape and large umbilicus, unlike any other known species of the region. It is more depressed and more openly umbilicate than *M. rixfordi*, which appears to be related.

Type in the Newcomb collection, Cornell University.

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[7] Mammals of the Mexican Boundary of the United States, Bull. 56 U. S. N. M., 1907, pp. 21, 122, pl. 13, fig. 1.

[8] The Old Yuma Trail. National Geographic Magazine, XII, 1901, pp. 129–143, map on p. 132.

## Explanation of Plates I–VIII.

Plate I.—Fig. 1.—*Sonorella elizabethae* P. & F. Station 276, Canelo Hills, Arizona. Type. No. 130991.
2. *Sonorella mustang* P. & F. Station 153, Mustang Range. Type. No. 130992.
3, 4. *Bulimulus nigromontanus* Dall. Station 225, Pina Blanca canyon, Arizona. No. 43748.
5. *Sonorella cotis* P. & F. Whetstone Range. Type. No. 130994.
6. *Sonorella cotis* P. & F. Station 293, Whetstone Range. No. 130995.
7. *Sonorella patagonica* P. & F. Station 260, Patagonia Mts., Arizona. No. 43719.
8. *Sonorella patagonica* P. & F. Station 254, Patagonia Mts. Type. No. 43722.
9, 10. *Sonorella patagonica* P. & F. Station 252, Patagonia Mts. No. 43720.
11. *Sonorella walkeri montana* P. & F. Type. No. 43724.
12. *Sonorella linearis* P. & F. Type. No. 130996.
13. *Sonorella xanthenes* P. & F. Type. No. 118095.

Plate II—Fig. 1–2.—*Sonorella ambigua* P. & F. Station 118, Coyote Mts. No. 130997.
2, 4. *Sonorella ambigua* P. & F. Station 120, outlier of Kitt's Peak. No. 130998.
5–7. *Sonorella ambigua cyclostoma* P. & F. Type (fig. 6) and paratypes. No. 118096*a*.
8. *Sonorella sitiens montezuma* P. & F. Type. No. 130583.
9, 10. *Sonorella baboquivariensis* P. & F. Bases of two specimens from station 5, Sycamore canyon, Baboquivari Mts.
11. *Sonorella baboquivariensis depressa* P. & F. Station 58, Tucson Range. No. 130999.
12. *Sonorella binneyi imperialis* P. & F. Type. No. 131000.
13. *Sonorella berryi* P. & F. Type. No. 131001.

Plate III.—Fig. 1.—*Sonorella hinkleyi* P. & F. Type. No. 43735.
2. *Sonorella hinkleyi tumacacori* P. & F. Type. No. 131002.
3. *Sonorella insignis* P. & F. Type. No. 44040.
4. *Sonorella hinkleyi* P. & F. Albino from Station 244. No. 43726.
5. *Sonorella cayetanensis* P. & F. Type. No. 43737.
6. *Micrarionta rowelli* (Newc.). Enlarged views of specimen from Tinajas Altas. No. 187478 U. S. N. M.
7. *Micrarionta rowelli* (Newc.). Type. Natural size and enlarged. No. 27517 Cornell Univ. Coll.
8. *Micrarionta newcombi* P. & F. Type. Enlarged. Cornell Univ. Coll.

Plate IV.—Fig. 1–1a.—*Sonorella elizabethae* P. & F. No. 130577. Station 276, Canelo Hills.
2. *Sonorella patagonica* P. & F. No. 43721. Station 258, Patagonia Mts.
3. *Sonorella cotis* P. & F. No. 119038. Station 3 (1914), Whetstone Mts.
4. *Sonorella patagonica* P. &.F. No. 43715. Station 253, Mt. Washington.
5. *Sonorella mustang* P. & F. No. 44048. Station 286, Mustang Mts.
6. *Sonorella patagonica* P. & F. No. 43719. Station 260, Patagonia Mts.
7. *Sonorella patagonica* P. & F. No. 43719. Station 260, Patagonia Mts.
8. *Sonorella patagonica* P. & F. No. 43722. Type. Station 254, Washington Mt., Patagonias.

9. *Sonorella cotis* P. & F. No. 119038. Station 3 (1914). Whetstone Mts.

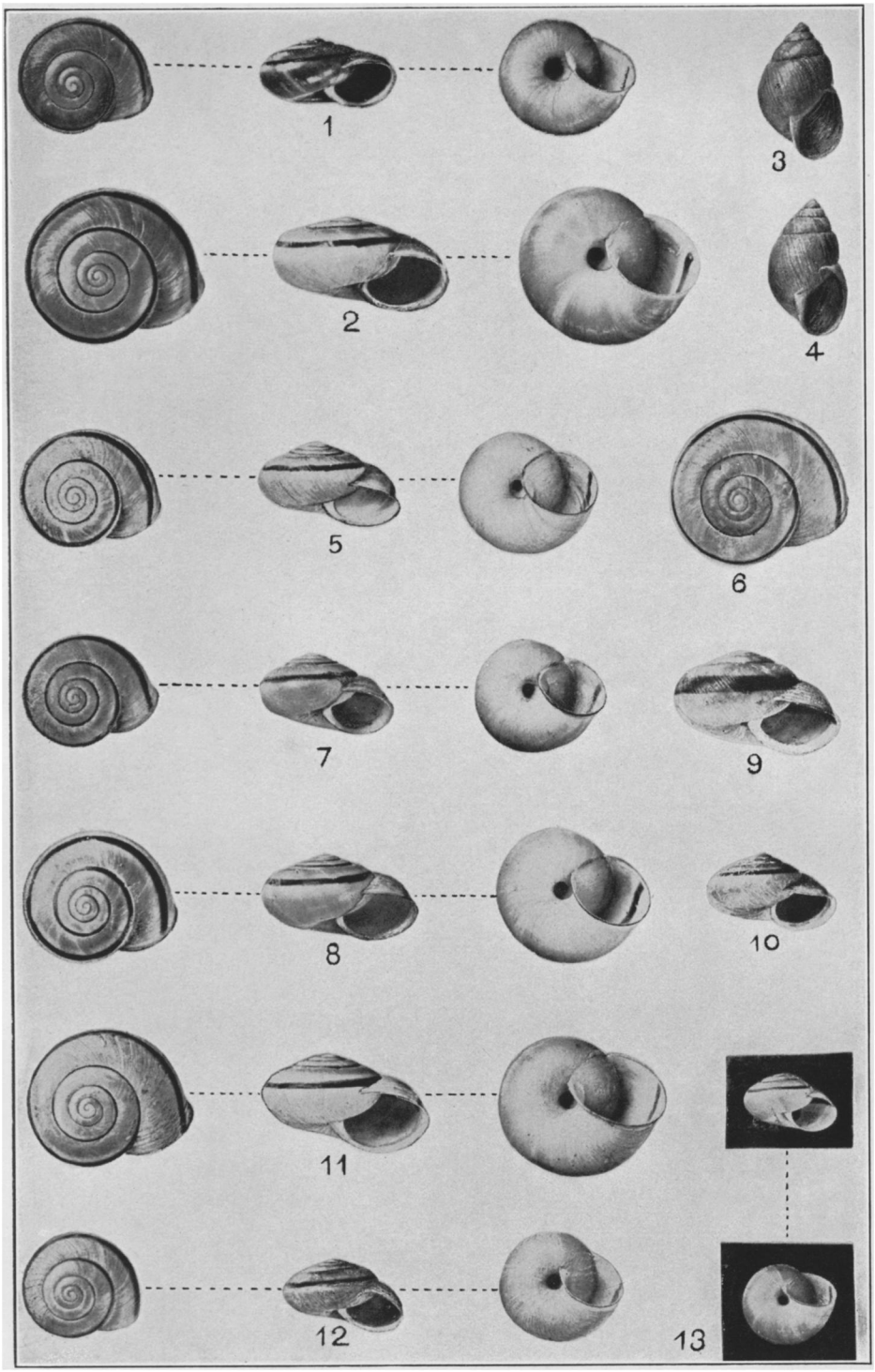
PLATE V.—Fig. 1.—*Sonorella ambigua* P. & F. No. 118108. Station 146, Cababi Hills.
2. *Sonorella ambigua* P. & F. No. 118103. Station 146, Cababi Hills.
3. *Sonorella ambigua* P. & F. No. 118100. Station 137, Cababi Hills.
4. *Sonorella ambigua* P. & F. No. 118078. Station 106. Bobb's Butte.
5. *Sonorella ambigua* P. & F. No. 118077. Station 100, Roskruge Range.
6. *Sonorella ambigua* P. & F. No. 118079. Station 101, Roskruge Range.
7. *Sonorella ambigua* P. & F. No. 118081. Station 99, Roskruge Range.
8, 9. *Sonorella ambigua* P. & F. No. 118098. Station 120, outlier, N.-W. of Kitt's Peak. Penis and the same opened showing papilla.
10. *Sonorella ambigua* P. & F. No. 118080. Station 93, Robles Hills.
11. *Sonorella berryi* P. & F. No. 118086. Station 103, Roskruge Range. From a dry specimen, soaked up.
12. *Sonorella ambigua* P. & F. No. 118084. Station 104, Table Top Mts., Roskruge Range.

PLATE VI.—Fig. 1.—*Sonorella ambigua* P. & F. No. 118054.
2. *Sonorella ambigua* P. & F. No. 118089. Station 127, Pictured rocks, 101 miles west of Tucson.
3–4. *Sonorella ambigua* P. & F. No. 118093. Station 118, Coyote Mts.
5. *Sonorella ambigua* P. & F. No. 118097. Station 130, Pictured rocks.
6. *Sonorella ambigua cyclostoma* P. & F. No. 118096. Station 126, 3 miles west of Comovo church.
7. *Sonorella sitiens* P. & F. No. 43723. Station 237, Clark's mine canyon, Pajaritos.
8. *Sonorella odorata* P. & F. No. 130844. Station 22 (1917), Spud Rock Ranger Station, east side Rincon Mts.
9. *Sonorella sitiens* P. & F. No. 43740. Station 224. Pina Blanca canyon.
10. *Sonorella sitiens montezuma* P. & F. No. 130628. Station 323.
11. *Sonorella sitiens comobabiensis* P. & F. No. 118102. Station 133, S. end E. side of Quijotoa Range.

PLATE VII.—Fig. 1.—*Sonorella binneyi imperialis* P. & F. No. 118111. Station 151, Empire Mts.
2. *Sonorella baboquivariensis* P. & F. No. 111557. Station 27 (1910), Baboquivari Mts.
3. *Sonorella baboquivariensis* P. & F. No. 111551. Station 21 (1910), Baboquivari Mts.
4. *Sonorella b. depressa* P. & F. No. 118059. Station 61, Tucson Range.
5. *Sonorella baboquivarienis depressa* P. & F. No. 117519. Station 2, Baboquivari Mts.
6. *Sonorella baboquivariensis* P. & F. No. 117528. Station 3.
7. *Sonorella b. depressa* P. & F. No. 117527. Station 5, Baboquivari Mts.
8. *Sonorella b. depressa* P. & F. No. 118061. Station 58, Tucson Range.
9. *Sonorella b. depressa* P. & F. No. 117527. Station 5, Baboquivari Mts.
10. *Sonorella b. depressa* P. & F. No. 117522. Station 10, Baboquivari Mts.
11. *Sonorella xanthenes* P. & F. No. 118095. Kitt's Peak.
12. *Sonorella baboquivariensis* var. 118085. Station 117 (1918), rincon of chief Pablo.

13. *Sonorella baboquivariensis* var. No. 118085. Station 117 (1918).
14. *Sonorella tumamocensis* P. & F. No. 117524. Desert Laboratory, Tucson.
15. *Sonorella tumamocensis* P. &. F. variety. No. 118090. Station 110, Roskruge Range.

PLATE VIII.—Fig. 1.—*Sonorella insignis* P. & F. No. 44040. Station 304. Whetstone Mts.
2-3. *Sonorella parva* (Pils). No. 44054. Station 270, Huachuca Range.
4. *Sonorella hinkleyi tumacacori* P. & F. No. 43731. Station 209, Tumacácori Mts.
5. *Sonorella hinkleyi* P. & F. No. 43726. Station 244, Cayetano Range.
6. *Sonorella tryoniana* P. & F. No. 118104. Station 149, Empire Range.
7. *Sonorella hinkleyi* P. & F. No. 43735. Station 243½, S. peak Cayetano Mts.
8. *Sonorella hesterna* P. & F. No. 118058. Station 50, N. end Santa Rita Range.
9. *Sonorella hesterna* P. & F. penis papilla. The direction of coil was inadvertently reversed by the camera lucida.

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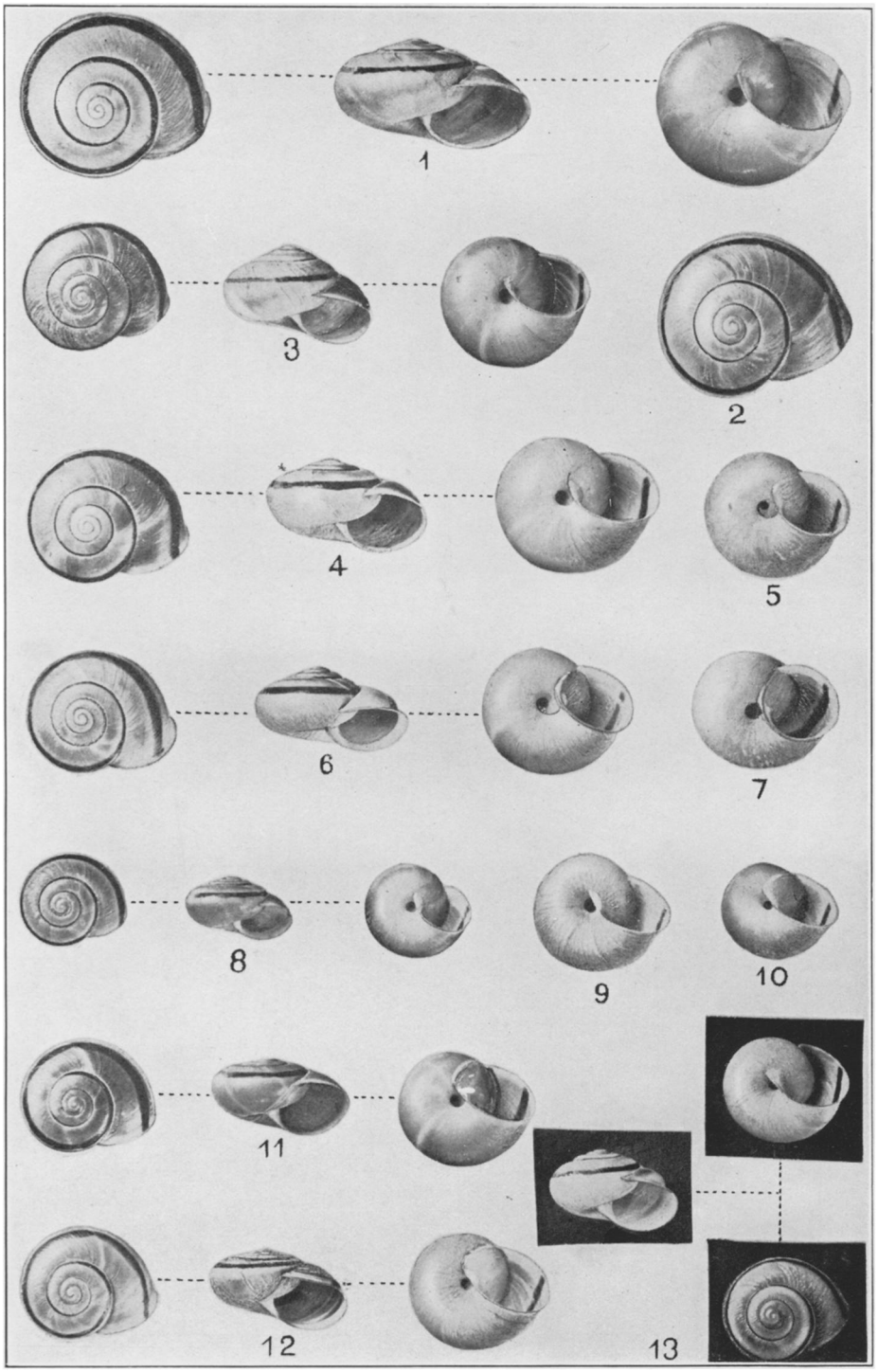


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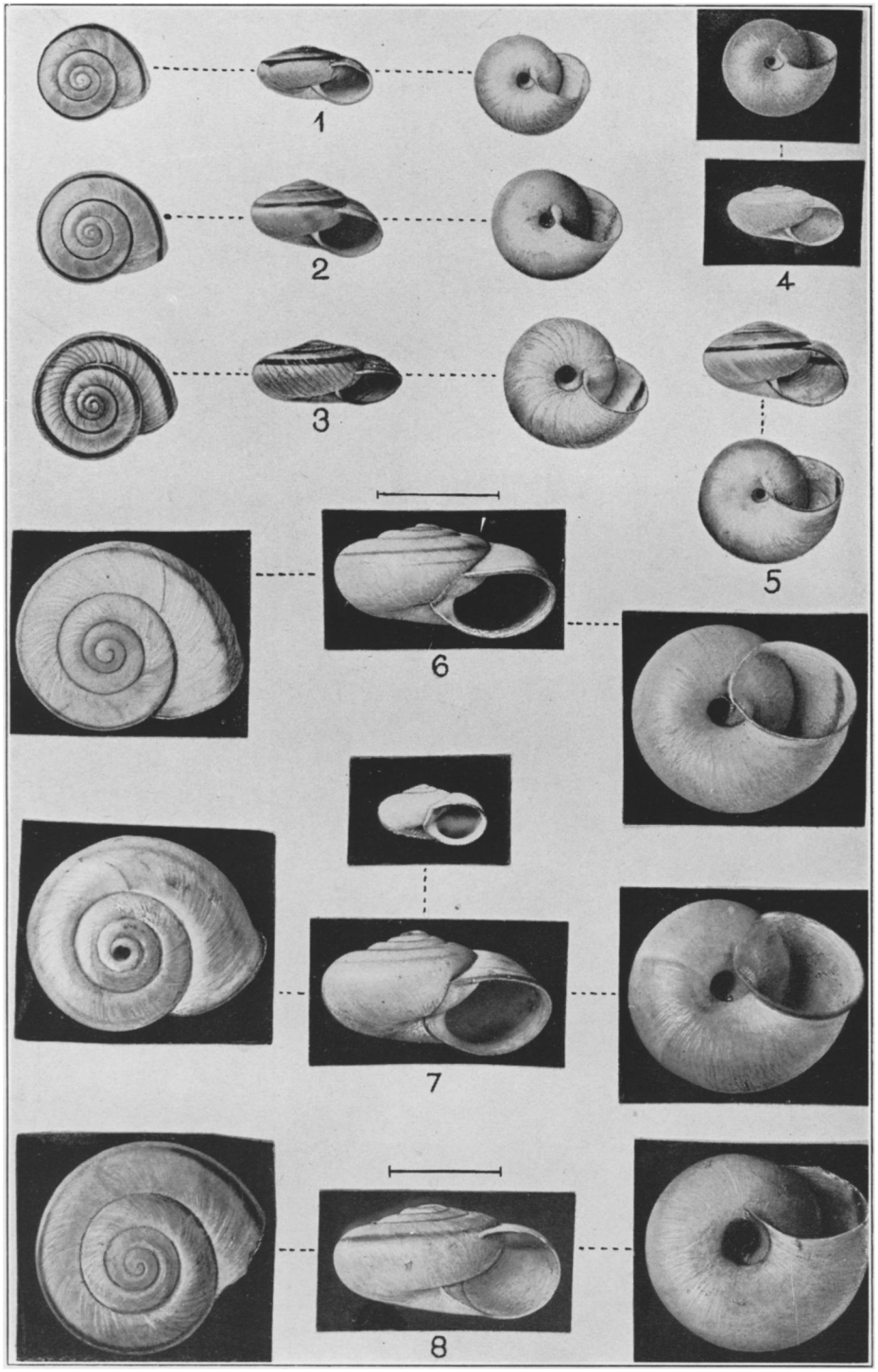


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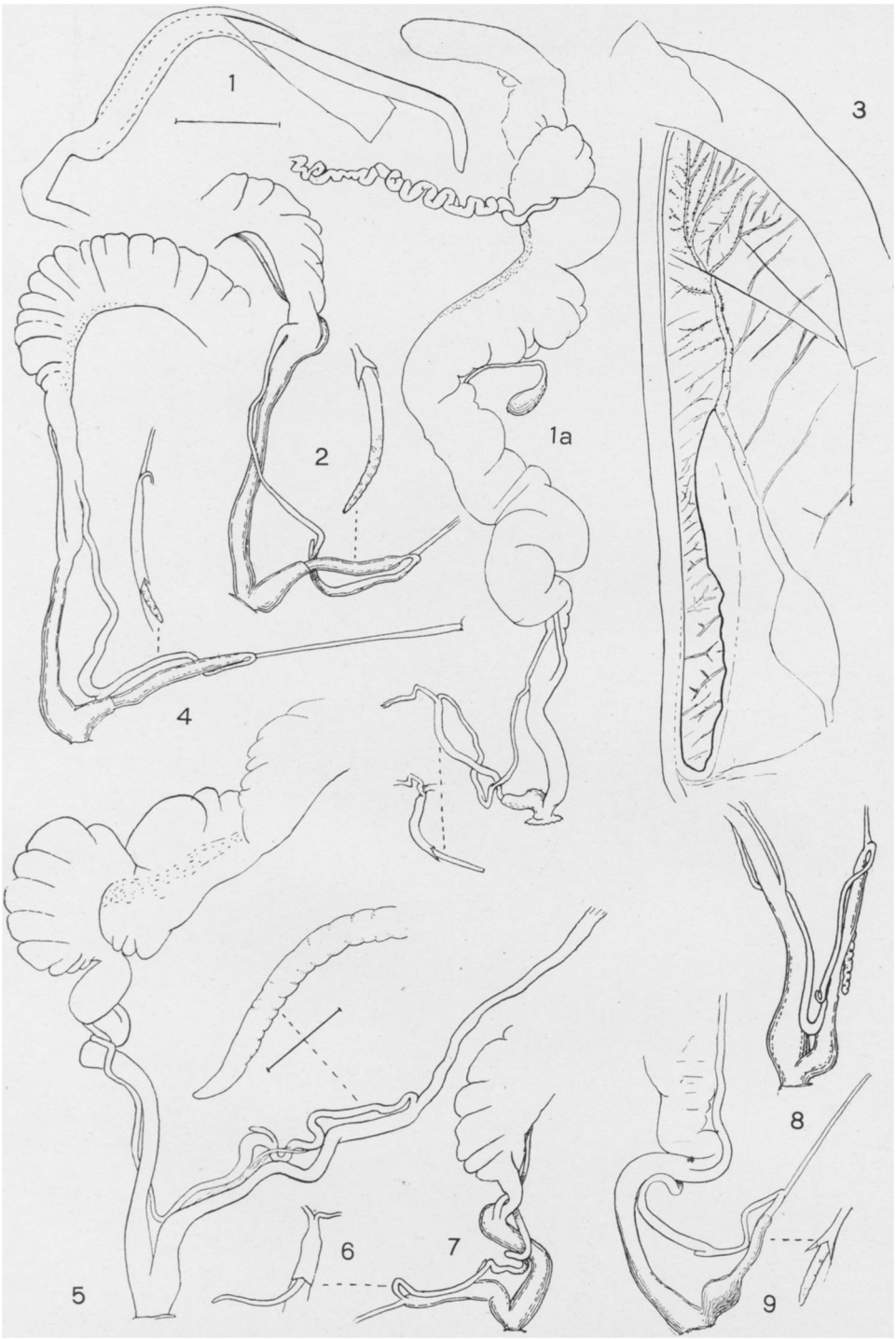


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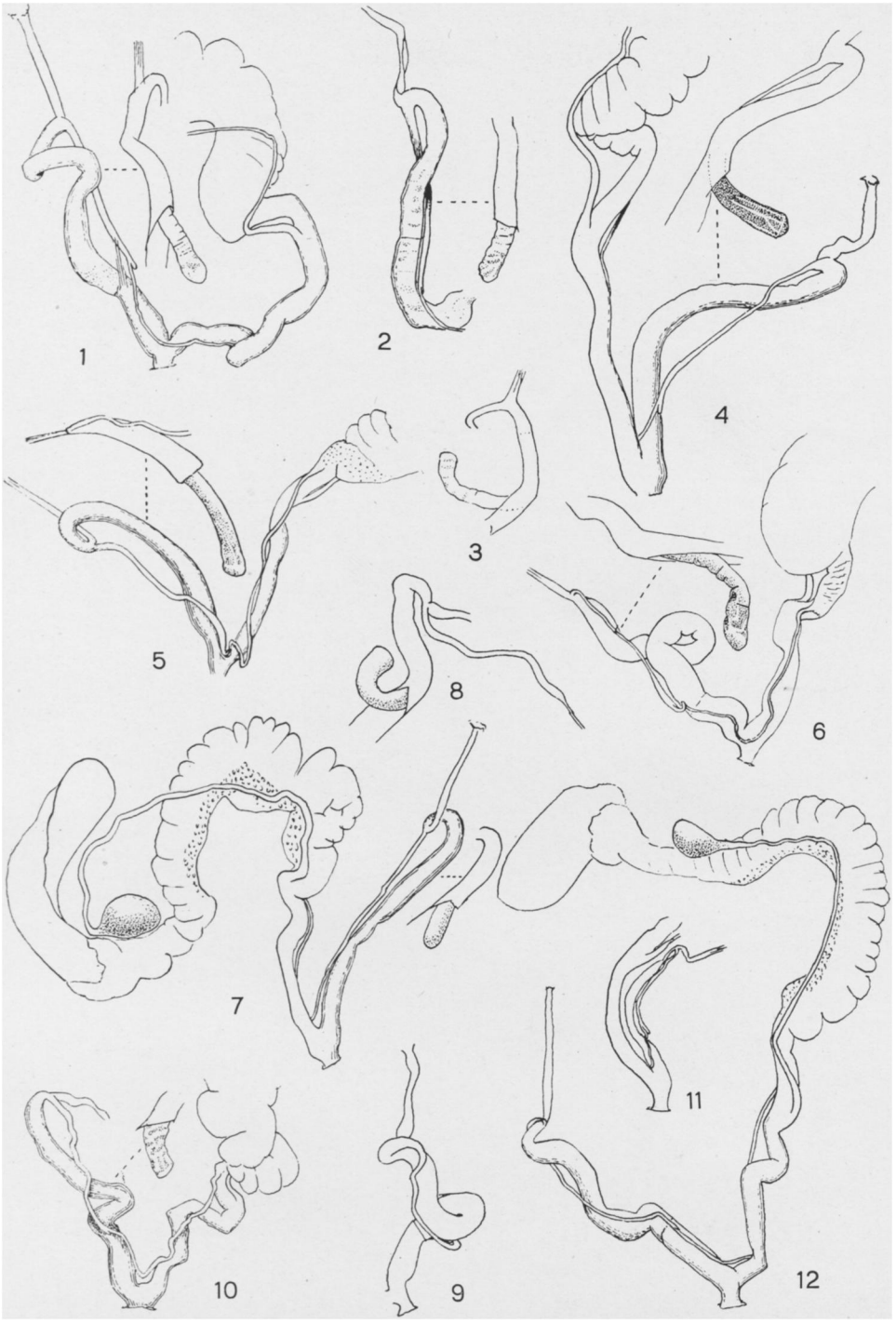


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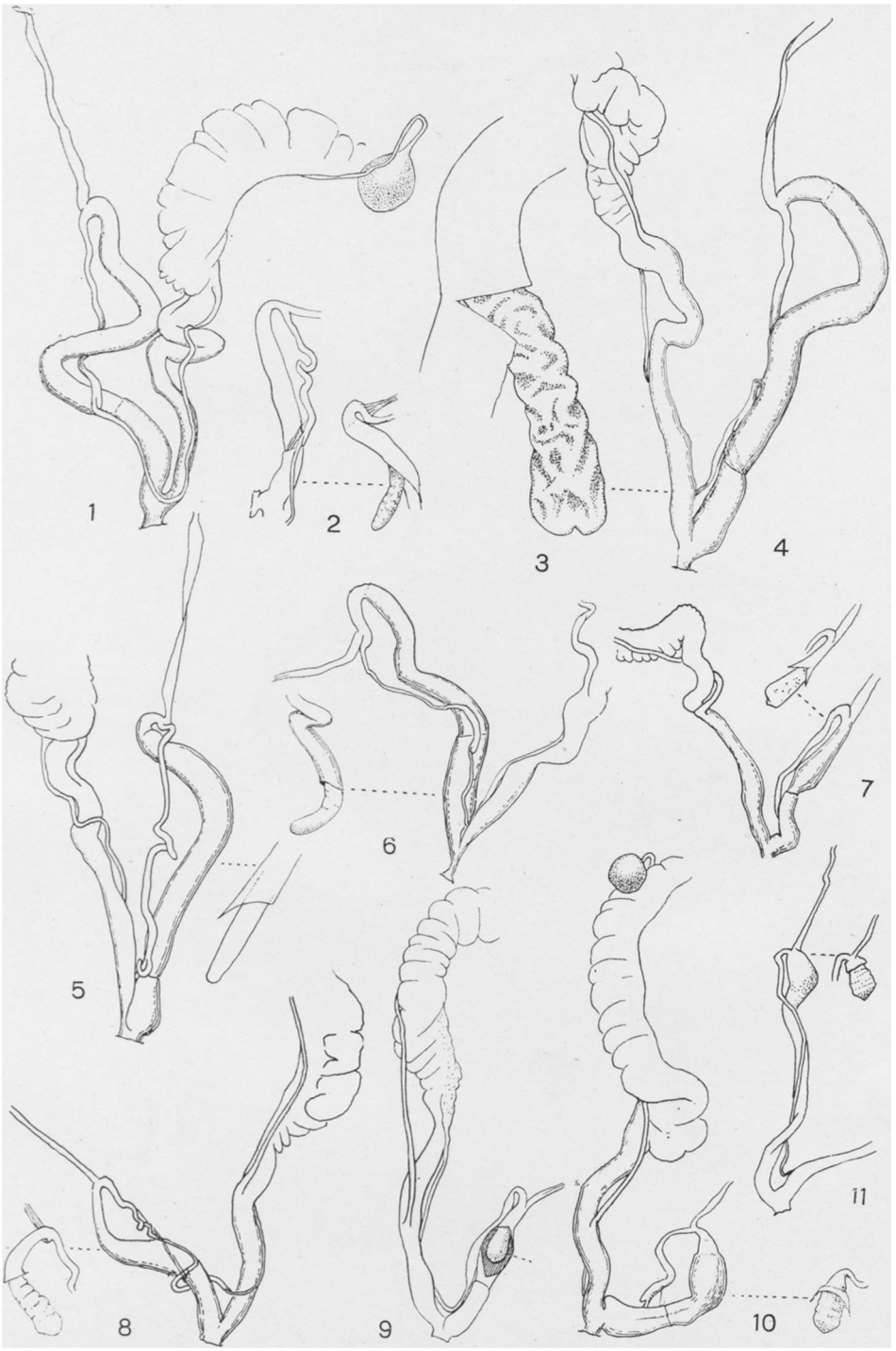


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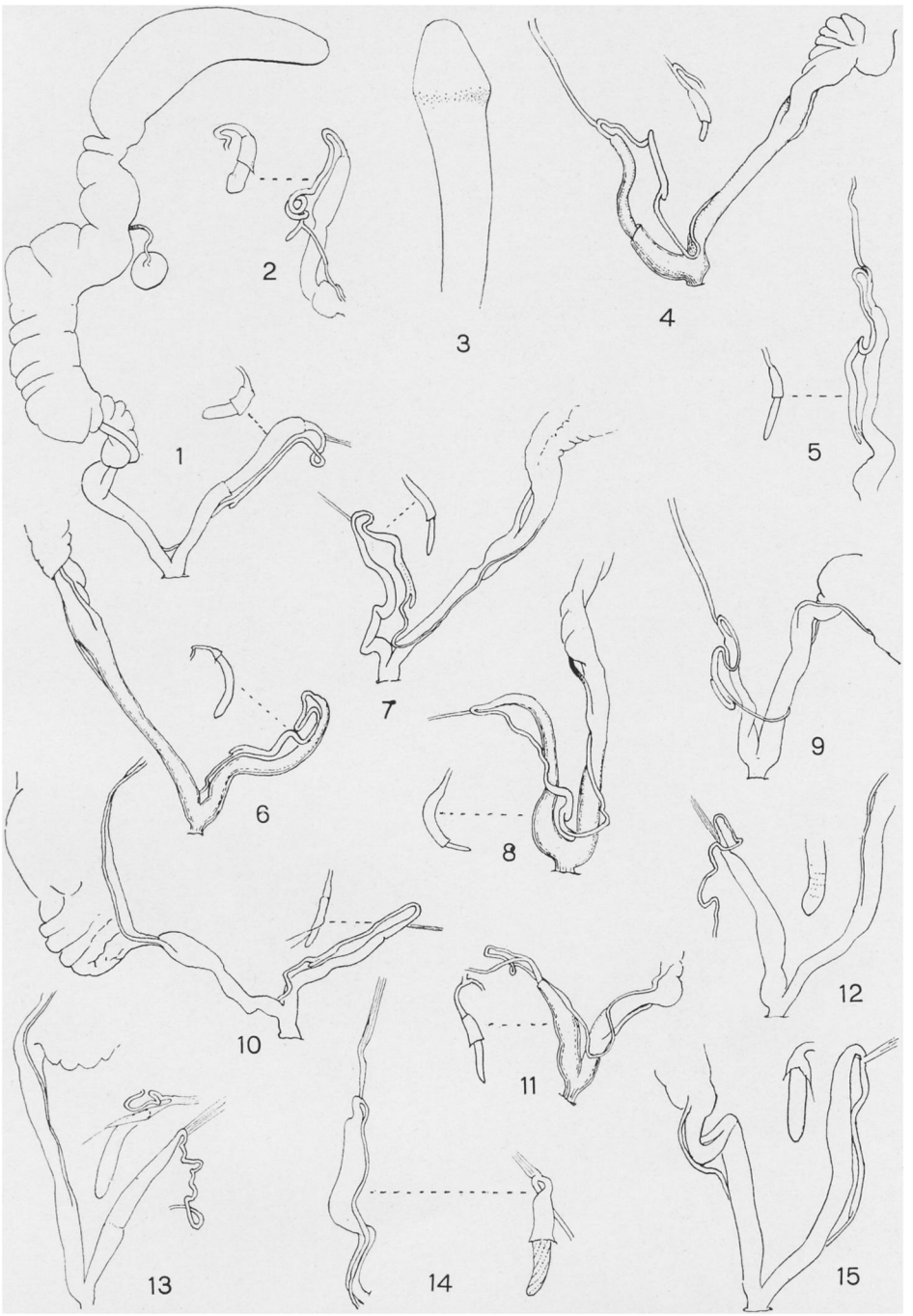


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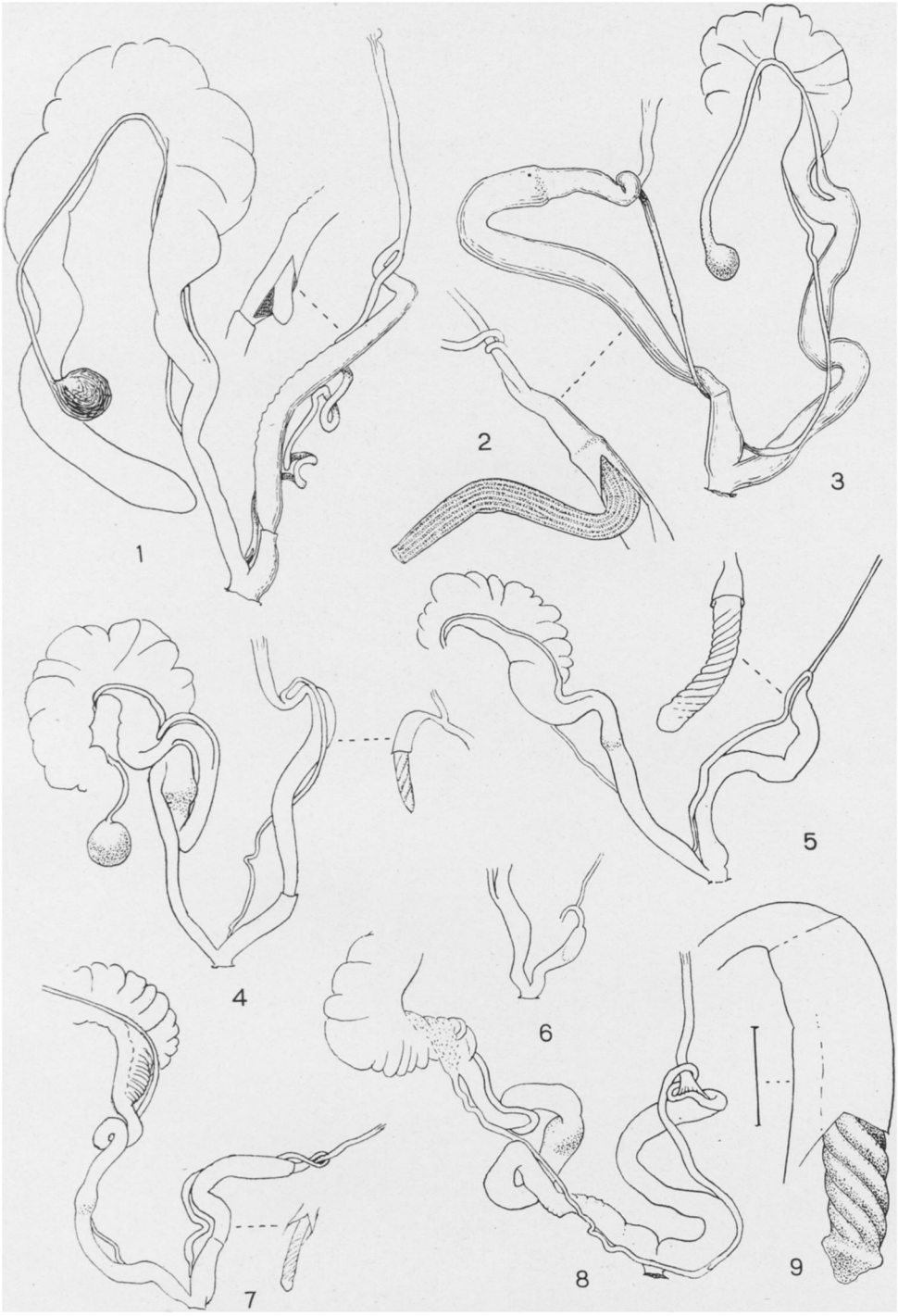


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