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SOME PLEISTOCENE AND PLIOCENE FRESHWATER MOLLUSCA FROM CALIFORNIA AND OREGON

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INTRODUCTION

Collections of well preserved fossil freshwater mollusks have been made during recent years from several lake basins of California. The identification and illustration of the various species found in the Pleistocene of Searles and Panamint basins have been attempted in the following pages. Also there is included the description of a Pliocene species from the basin of Mono Lake. An opportunity is furnished to illustrate the holotypes of two species described many years ago from southern Oregon.

Rainfall east of the Sierra Nevada during the Pleistocene was so great that very large basins became occupied by huge lakes. One of these was the well known Lake Lahontan of Nevada and California. It is generally believed that this great body of water overflowed into successively lower basins to the south and that Searles Lake and Panamint Lake were a part of this system.

The first extensive study of the lake sediments of the Lahontan basin was made by Russell (1885) and he has been followed by a long succession of students who have worked on various phases of the Pleistocene problem.

A recent discussion of the Pleistocene lakes of the area has been presented by Blanc and Cleveland (1961). No attempt has been made in the present study to review the literature on the subject except for those papers that pertain to the mollusks which lived in the lake system. However, it is believed that the references cited contain information and bibliographies which will lead the student to other phases of the problem.

Lake Beds of Searles Basin

When full, Searles Lake occupied several hundred square miles and it is especially noteworthy because of the two layers of saline minerals which are buried in the basin. The upper layer is 71 feet in average thickness and the lower layer is 35 feet thick; the two are separated by a layer of impervious clay which is 10 to 15 feet thick (Blanc and Cleveland, 1961).

These beds of saline minerals, covering approximately 20 square miles, have considerably complicated the problem of unravelling the history of the lake. If this great mass of soluble salts was in solution at the time the lake was full, it hardly seems possible that the water would furnish a habitat for a large molluscan fauna which is otherwise known to live only in waters of near purity. This strongly suggests that the salt beds belong to an earlier period than that in which the mollusks lived, with only a small amount of the salts being redissolved during the latest flooding of the basin.

The first information I had regarding the presence of freshwater shells in the sediments of the Searles Lake basin came from the well known geologist F. M. Anderson, about 30 years ago. He had noted the shells on a visit there many years earlier. His small collection, which is preserved as no. 25792 California Academy of Sciences (Geology Department), contains six species including *Lymnaea palustris* which has not been detected in any other collection. In 1953, Joseph R. Slevin and I located the fossil-bearing strata and made a small collection. In March, 1960, Charles W. Chesterman, Margaret M. Hanna, and I made a large collection from limited exposures, and in December, 1960, much more area was covered by the latter two collectors. Although these collections contain many thousands of specimens and represent the most common species, it is probable that additional rare forms could be obtained by further search.

The fossil-bearing strata are found in the southwestern part of the Searles basin. The highway between China Lake and Trona passes through the narrow canyon of Salt Wells Creek which is cut in basement rocks for about one-half mile. Beyond this, light-colored lacustrine sediments lie on both sides of the road, but the best exposures are found on the south side where near-vertical cliffs are approximately 25 feet high. The topmost layer is a light-colored, blocky clay, when dry, with scattered pebbles of many rock types covering the surface. This is underlain by a layer up to six feet thick of un-

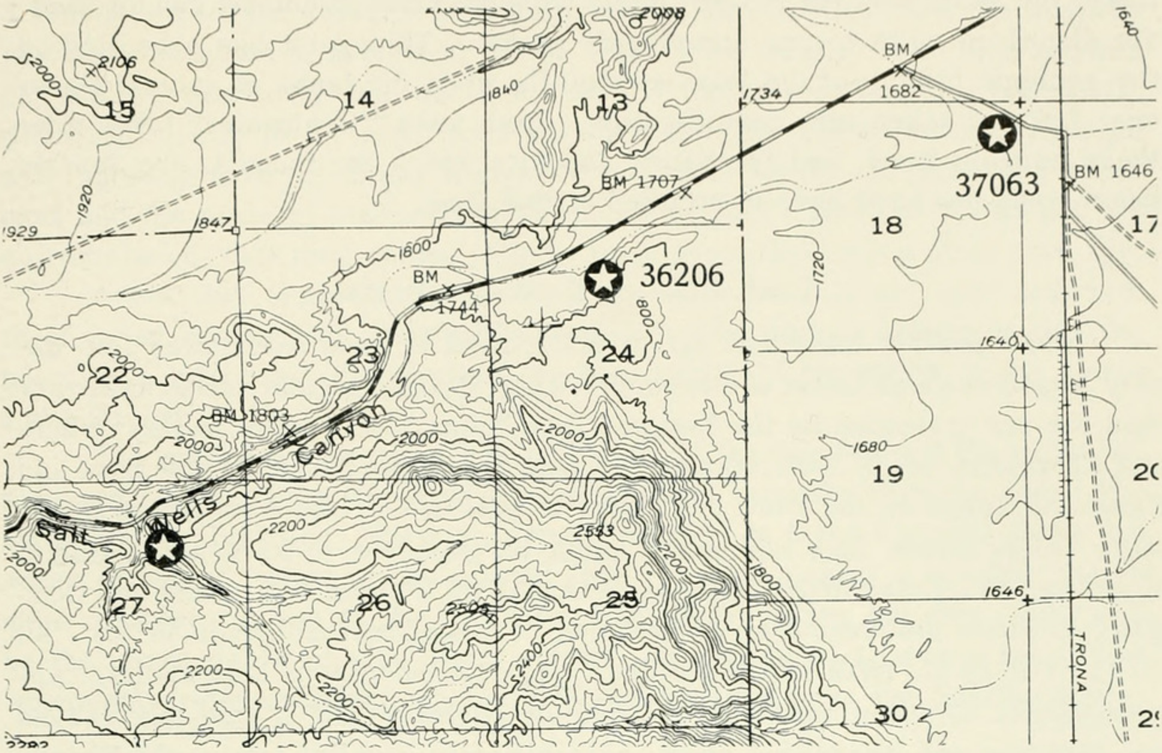


Figure 1. A portion of U. S. Geological Survey Topographic Map, Searles Lake, California, Quadrangle, edition of 1950, showing California Academy of Sciences fossil collection localities nos. 36206 and 37063 in Searles Lake basin.

consolidated granitic sand, and this in turn is underlain by a clay layer of undetermined thickness. It is in the sandy layer that most of the shells were found. The elevation of the locality is 1800 feet or 120 feet above the valley floor, and the locality is approximately 7.4 highway miles from the railroad-highway crossing at Trona (U.S.Geological Survey, Searles Lake, 15-minute quadrangle). The collecting site has received California Academy of Sciences locality no. 36806, and it is located in Secs. 23, 24, and 27, T. 26 S., R. 42 E., MDM. At 5.6 highway miles from the same crossing a dirt road branches off to the southeast toward and through a great group of tufa pinnacles. Beyond Salt Wells Creek, this road skirts the eastern limits of the sediments which form locality no. 36806. The sediments, which here are highly folded, are well exposed in a low cut bank 60 feet above the valley floor. Samples were collected from this site, which is in Sec. 18, T. 26 S., R. 43 E., MDM, and it has received California Academy of Sciences locality no. 37063. Most of the scattered shells were taken from the more sandy layers. No fossil diatoms were found in the numerous samples of clay that were examined from this locality.

Notes are presented below on the various species of mollusks found with an interpretation of their probable geographic distribution. It will at once be apparent to students of freshwater forms that when this fauna lived in Searles

Lake, the water was necessarily fresh because such organisms cannot tolerate dissolved salts to any appreciable extent. This point has a bearing on the geologic history of the lake, especially when the fauna of ancient Panamint Lake is taken into consideration. Both were "freshwater" lakes when these animals lived, and the saline deposits which are found in the Searles basin could not have been in solution at that time.

Lake Beds of Panamint Basin

When Searles Lake was full it is reported to have overflowed into the very large enclosed basin of Panamint Valley through a pass somewhat lower than the one traversed by the highway from Trona to Panamint Valley (Blanc and Cleveland, 1961). Detrital material from the Argus Range on the west and Panamint Range on the east, has covered most of the likely places in Panamint Valley where lake sediments might be expected to have accumulated. However, Mr. Frank Wiedenbenner of American Potash and Chemical Company at Trona discovered an outcropping of lacustrine sediments in Sec. 20, T. 21 S., R. 43 E., MDM which yielded a great abundance of lake shells. Approximately 17 miles northeast of Trona on Highway 178, a side road leaves the highway and trends due north, approximately parallel to the old Nadeau Stage Road. The collecting site, which has been given California Academy of

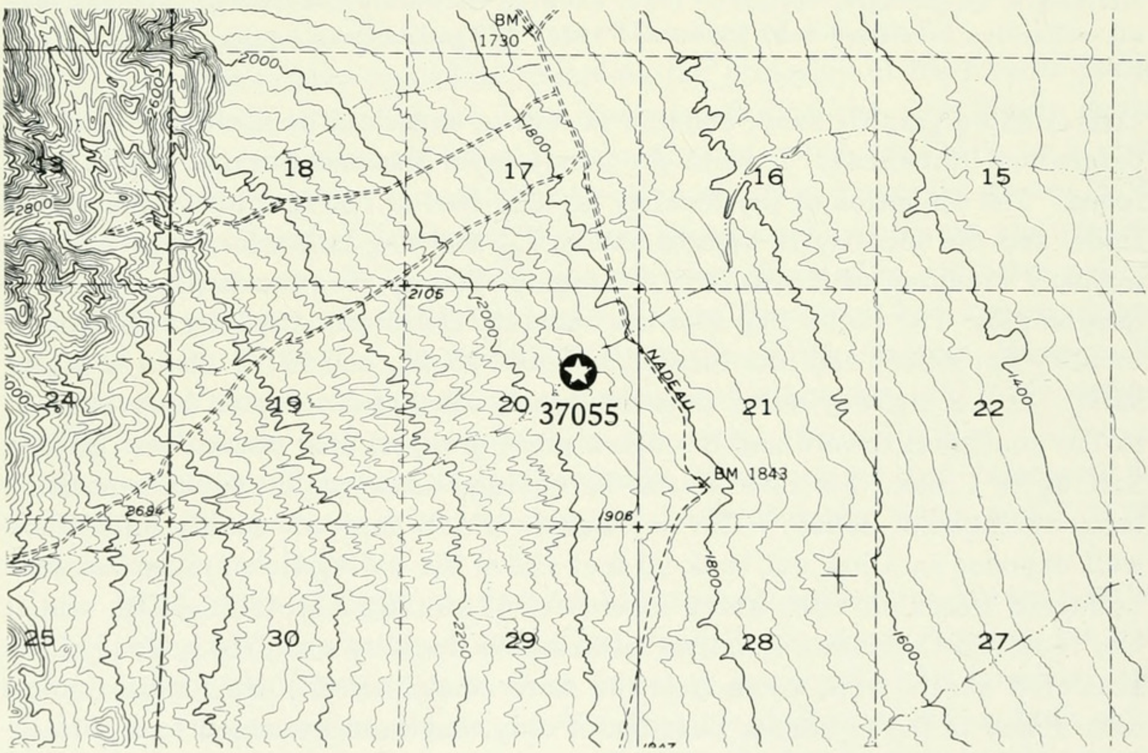


Figure 2. A portion of U. S. Geological Survey Topographic Map, Maturango Peak, California, Quadrangle, edition of 1951, showing California Academy of Sciences fossil collection locality no. 37055 in Panamint Lake basin.

Sciences locality no. 37055, is approximately seven miles from the highway junction and about ¼ mile west of the road. The locality is at an elevation of 1840 feet and is 800 feet above the floor of the valley. The lake sediments, which dip gently to the east, form low hills that are almost entirely covered with outwash from the Argus Range. Freshwater shells are extremely abundant and the state of preservation is nearly perfect. Many of the shells are so translucent that they appear to have been deposited only a short time ago.

About 200 yards south of the place where shells are best exposed, there is an outcropping of impure diatomite. The diatom fossils in this deposit give additional evidence of the near purity of the water of the former Lake Panamint.

The molluscan faunas of the lake beds of the Searles and Panamint basins are so nearly identical as to species that separate lists for these two areas are not justified. However, any differences in fauna between these two areas are noted below in the general list. In some cases, a species may be more abundant at one of the localities than at the other, but this could well be the result of the chance of collection. For example, *Lymnaea kingii* was apparently more abundant in the Panamint basin than in the Searles basin.

Lymnaea kingii Meek.

(Plate 2, figures 15-21.)

Limnaea (Polyrhytis) kingii MEEK, U. S. Geol. Surv. Terr., vol. 9, p. 532, 1876; U.S. Geol. Surv. 40th Parallel, vol. 4, 1877, p. 192, figs. 6, 7.

Polyrhytis kingii Meek, BAKER, Chicago Acad. Sci. Sp. Publ. no. 3, 1911, p. 102, pl. 17, figs. 1, 2.

Stagnicola kingii (Meek), CHAMBERLAIN, Nautilus, vol. 46, 1933, pp. 97-100.

Lymnaea kingii Meek, HENDERSON, Geol. Soc. America, Spec. Pprs. no. 3; 1935, p. 237.

Radix ampla var. *utahensis* CALL, U. S. Geol. Surv. Bull. no. 11, 1884, pp. 373, 379, 381, 401, pl. 6, figs. 7-9, Utah Lake, Utah, living.

Galba utahensis (Call), BAKER, Chicago Acad. Sci., Spec. Publ. no. 3, 1911, pp. 458-460, pl. 22, figs. 9-11; pl. 24, figs. 22-27.

This species is exceedingly abundant at locality no. 37055 (CAS) in Panamint basin. Thousands of well preserved shells may be collected in a short time. Size, shape, and ribbing vary approximately as Baker's illustrations of *R. a. utahensis* show. There can be little if any doubt regarding the identity of the latter with *L. kingii* as Chamberlain has indicated (1933).

The deposit from which *L. kingii* was originally collected has often been referred to the Pliocene and Chamberlain suggests that this species has lived continuously in the Utah-Idaho region since that time. He also showed that the ribbing was not due to a progressively more alkaline habitat but was actually a genetic character.

Lymnaea palustris (Müller).

(Plate 3, figure 4.)

Buccinum palustris MÜLLER, Verm. Terr. II, 1774, p. 131.
Limnophysa palustris (Müller), CALL, U. S. Geol. Survey, [vol. 2], Bull. 11, 1884, p. 17 [371].
Galba palustris (Müller), BAKER, Chicago Acad. Sci. Sp. Publ. no. 3, 1911, pp. 298-322, pl. 26, figs. 17-37; pl. 33, figs. 1-25, pl. 34, fig. 20.

A few specimens of this very widely distributed living species were among the fossils collected by F. M. Anderson many years ago at the western end of Searles Lake basin, locality no. 25792 (CAS). The exact location was not recorded but the matrix adhering to some of the shells does not differ noticeably from that where the more recent collections were made. It is noteworthy, however, that this form did not occur with the latter unless some of the young individuals supposed to be *L. kingii* are misidentified. In the adult stage the two species are readily distinguishable because *L. palustris* is a more slender shell and does not have the more or less conspicuous longitudinal ridges of *L. kingii.*

In 1884, Call recorded the abundance of *L. palustris* in Great Basin lake deposits including Lake Lahontan. It is therefore reasonable to expect it to be in the overflow basins of that lake.

Physa humerosa Gould.

(Plate 2, figure 2.)

Physa humerosa GOULD, Proc. Boston, Soc. Nat. Hist., vol. 5, 1855, p. 128; GOULD, Pacific Railroad Reports, vol. 5, 1856, p. 331, pl. 11, figs. 1-5. "Colorado Desert."

I know of no way to satisfactorily distinguish the many presumed species of *Physa* described from the United States. In the present case, many shells of Searles and Panamint lake beds do not differ greatly from those which we have collected in abundance from many temporary ponds, watering troughs, and other ephemeral bodies of water in California. Quite obviously this species has found means of distribution which enable it to get quickly from one body of water to another. It is convenient to call it *Physa humerosa* Gould, the type locality of which is the Colorado Desert, Lake Coahuila beds, Pleistocene.

Parapholyx effusa (Lea).

(Plate 2, figures 3-6.)

Pompholyx effusa LEA, Proc. Acad. Nat. Sci. Philadelphia, vol. 8, 1856, p. 80. BINNEY, Smithsonian Misc. Coll. no. 143, 1865, p. 74, fig. 119.

Pompholyx var. *solida* DALL, Ann. Lyceum Nat. Hist., vol. 9, 1870, p. 335, pl. 2, fig. 7a. HENDERSON, Nautilus, vol. 47, 1934, p. 90, pl. 9, fig. 5; [as *Parapholyx*]; locality corrected to White Pine, Nevada.

Pompholyx costata HEMPHILL (in Call), Bull. U. S. Geol. Surv. no. 11, 1884, p. 19. STEARNS, Proc. U. S. Nat. Mus., vol. 24, 1901, p. 291; The Dalles, Oregon.

Pompholyx leana H. & A. ADAMS, Proc. Zool. Soc. London, 1863, p. 434. "West Columbia."

Parapholyx mailliardi HANNA, Proc. Calif. Acad. Sci. ser. 4, vol. 13, 1924, p. 134, pl. 1, figs. 10-24; "Eagle Lake, California."

Parapholyx effusa diagonalis HENDERSON, Nautilus, vol. 42, 1929, p. 82. "Crater Lake, Oregon."

Parapholyx effusa nevadensis HENDERSON, Nautilus, vol. 47, 1934, pp. 90-91, pl. 9, figs. 6, 7. "Winnemucca and Pyramid Lakes, Nevada."

Parapholyx solida optima PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, vol. 86, 1934 [1935], p. 52. "Lake Bigler, Nevada." BAKER, Moll. Family Planorbidae, 1945, p. 476, pl. 120, fig. 32.

Parapholyx effusa klamathensis BAKER, Nautilus, vol. 55, no. 1, 1941, p. 16, fig. 1, "Klamath Lake, Oregon."

Parapholyx effusa dalli BAKER, Moll. Family Planorbidae, 1945, p. 227, pl. 115, figs. 27-30. "Klamath Falls, Oregon."

Parapholyx effusa sinitsini BAKER, Moll. Family Planorbidae, 1945, p. 228, pl. 123, figs. 2-10. "Barcley Spring, 14 miles north of Klamath Falls, Oregon."

Parapholyx pusilla BAKER, Moll. Family Planorbidae, 1945, p. 229, pl. 117, figs. 1-6. "Six miles west of Pyramid Lake, Washoe County, Nevada. Pleistocene."

Parapholyx effusa neretoides (Hemphill) BAKER, Moll. Family Planorbidae, 1945, p. 468, pl. 116, figs. 7-11. "The Dalles, Oregon.

Parapholyx effusa costata (Hemphill) HENDERSON, Nautilus, vol. 42, 1929, p. 81. "The Dalles, Oregon." BAKER, Moll. Family Planorbidae, 1945, p. 468, pl. 116, figs. 12-14. "The Dalles, Oregon."

The type locality of *Pompholyx effusa* Lea was given by Binney (1865) as "Pitt River," [California], and his figure of the "type" specimen, shows what appears to be a somewhat malleated shell.

We now have very large series of specimens of *Parapholyx* from many localities, both living and fossil. Variation is so great that it seems to be an appropriate time to reduce many of the named forms to synonymy because there are no constant shell characters to distinguish them. Ribbing has been used as a reason for naming at several times, but this character has no constancy; in every large series that we have studied, the shells vary from smooth (except for growth lines) to those with many longitudinal ribs and it is easy to find specimens of some which are ribbed in part only.

The size of the different specimens varies greatly. Some of the largest specimens, as well as the smallest (adult), are from Klamath Lake. Abundance

PLATE 1

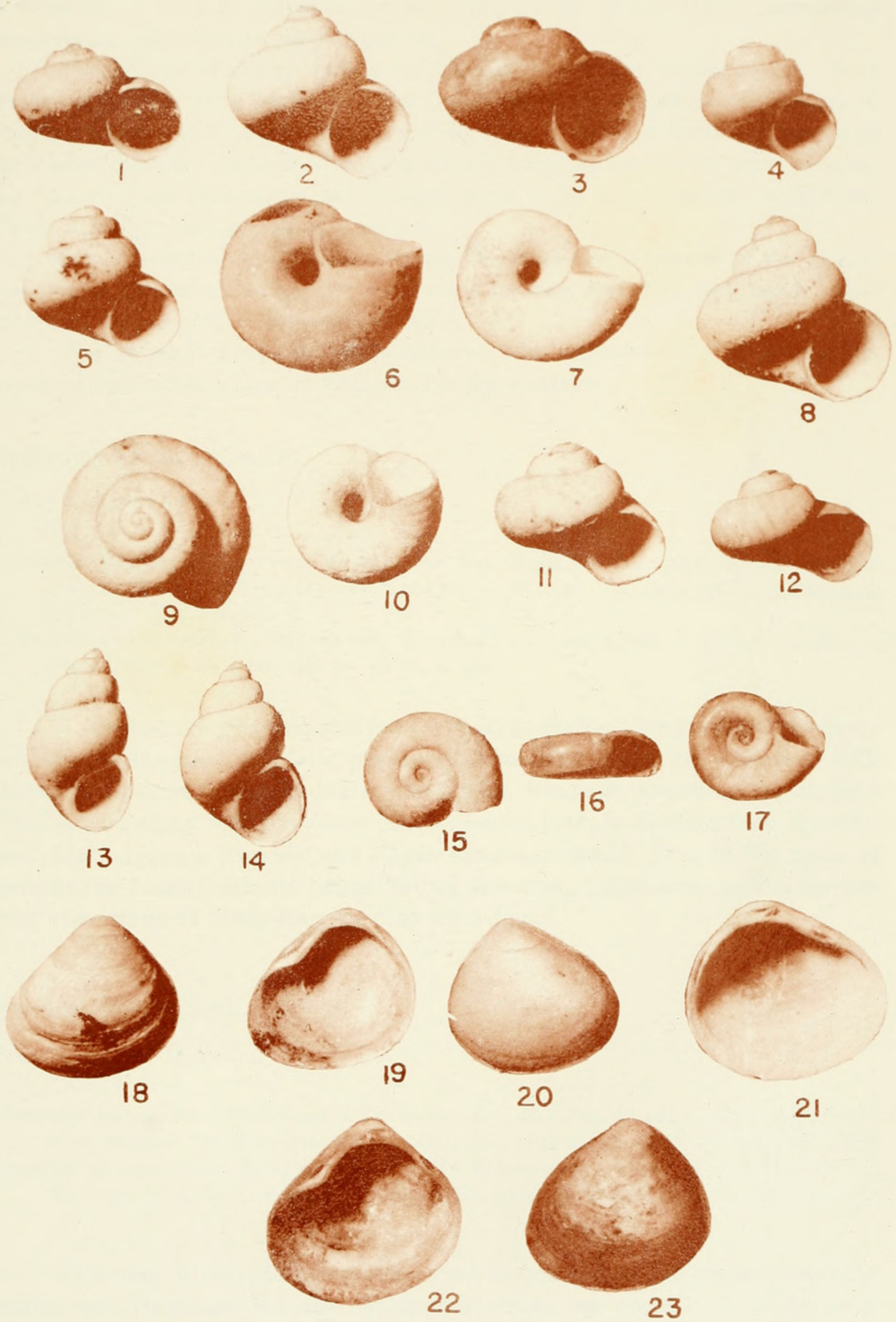
Figures 1-6. *Valvata humeralis* Say. Hypotypes nos. 12477-12482 (Calif. Acad. Sci., Dept. Geol. Type Coll.) locality no. 37055 (CAS), Panamint Lake beds, Inyo County, California. Measurements: Fig. 1, diameter, 3.8 mm.; height, 2.6 mm. Fig. 2, diameter, 4.2 mm.; height, 3.8 mm. Fig. 3, diameter, 4.5 mm.; height 3.6 mm. Fig. 4, diameter, 2.9 mm.; height, 2.9 mm. Fig. 5, diameter, 3.4 mm.; height, 3.6 mm. Fig. 6, diameter, 4.5 mm.; height, 4.3 mm.

Figures 7-12. *Valvata humeralis* Say. Hypotypes nos. 12483-12488 (Calif. Acad. Sci., Dept. Geol. Type Coll.) locality no. 36806 (CAS), Searles Lake beds, San Bernardino County, California. Measurements: Fig. 7, diameter, 4.1 mm.; height, 3.0 mm. Fig. 8, diameter, 4.5 mm.; height, 4.0 mm. Fig. 9, diameter, 4.3 mm.; height, 3.6 mm. Fig. 10, diameter, 3.7 mm.; height, 3.5 mm. Fig. 11, diameter, 4.0 mm.; height, 3.1 mm. Fig. 12, diameter, 3.6 mm.; height, 2.4 mm.

Figures 13 - 14. *Amnicola longinqua* Gould. Hypotypes nos. 12489-12490 (Calif. Acad. Sci., Dept. Geol. Type Coll.) locality no. 37055 (CAS), Panamint Lake beds, Inyo County, California. Measurements: Fig. 13, diameter, 2.7 mm.; height, 4.5 mm. Fig. 14, diameter, 3.2 mm.; height, 4.4 mm.

Figures 15 - 17. *Gyraulus parvus* (Say). Hypotypes nos. 12491 - 12493 (Calif. Acad. Sci., Dept. Geol. Type Coll.) locality no. 37055 (CAS), Panamint Lake beds, Inyo County, California. Measurements: Fig. 15, diameter, 3.5 mm.; height, 1.2 mm. Fig. 16, diameter, 3.5 mm.; height, 1.2 mm. Fig. 17, diameter, 3.3 mm. height, 1.2 mm.

Figures 18 - 23. *Pisidium* sp. Hypotypes nos. 12494 - 12499 (Calif. Acad. Sci., Dept. Geol. Type Coll.) locality no. 37055 (CAS), Panamint Lake beds, Inyo County, California. Measurements: Fig. 18, length, 4.9 mm.; height, 4.5 mm. Fig. 19, length, 4.2 mm.; height, 4.1 mm. Fig. 20, length, 4.1 mm.; height, 3.8 mm. Fig. 21, length, 4.2 mm.; height, 3.9 mm. Fig. 21, length, 4.2 mm.; height, 3.9 mm. Fig. 22, length, 4.9 mm.; height, 4.6 mm. Fig. 23, length, 4.5 mm.; height, 4.2 mm.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or scarcity of food is probably a controlling factor. Call (1884), considered temperature and salinity also important.

Parapholyx effusa is widely distributed in western United States. It is living at present from Idaho and the Columbia River, south to tributaries of Feather River and to Lake Tahoe, California. It has not been reported from the coast ranges. As a Pleistocene fossil the distribution is even greater, but Searles and Panamint lake basins seem to be southernmost localities. There it is the most abundant species.

It is interesting to note that during the Pliocene, members of the genus *Parapholyx* (or an allied genus) were much heavier and grew to a much larger size than living and Pleistocene forms.

The original genus name *Pompholyx* was replaced by *Parapholyx* because of an earlier usage of *Phompholyx* for a rotifer.

Helisoma ammon (Gould).

(Plate 3, figure 5.)

Planorbis ammon GOULD, Proc. Boston Soc. Nat. Hist., vol. 5, 1855, p. 129. GOULD, Pacific Railroad Reports, vol. 5, 1856, p. 331, pl. 11, figs. 12-18. "Colorado Desert," [California].

Helisoma ammon (Gould), HENDERSON, Nautilus, vol. 47, 1934, p. 89, pl. 9, fig. 4. HENDERSON, Nautilus, vol. 50, 1936, p. 41.

A few partially broken shells of this large *Helisoma* were found in Searles lake sediments. The best preserved have been critically compared with adequate material from near Indio, California, where it occurs on the surface of the desert along with *Anodonta californiensis* Lea, *Hydrobia protea* (Gould), *Amnicola longinqua* (Gould), and *Physa humerosa* Gould. This is the basin of Pleistocene Lake Coahuila of the Salton Sea area, California, where the original specimens of these four species were found.

Gyraulus parvus (Say).

(Plate 1, figures 15-17.)

Planorbis parvus SAY, Nicholson's Encyclopedia, pl. i, fig. 5, 1817, 1818, 1819. [Ref. from Binney, Smithsonian Misc. Coll., no. 194, pt. 2, 1869, p. 133, fig. 224].

Gryaulus parvus (Say), BAKER, Moll. Family Planorbidae, 1945, pl. 77, figs. 4 - 6. TAYLOR, U. S. Geol. Surv. Prof. Ppr. 337, 1960, p. 58, pl. 4, figs. 1-13, 17, 18.

This very widely distributed species is common in the deposits of both Searles and Panamint basins. If identifications are correct, it is the most common small planorbid in California, living or fossil.

Carinifex newberryi (Lea).

(Plate 2, figures 10-14.)

Planorbis newberryi LEA, Proc. Acad. Nat. Sci. Philadelphia, vol. 10, 1858, p. 41. "Klamath Lake and Canoe Creek, California." LEA, Journ. Acad. Nat. Sci. Philadelphia, N.S. vol. 6, 1866, [Sept. 1867], p. 153, pl. 23, fig. 68.

Carinifex newberryi (Lea), BINNEY, Smith, Inst. Syn. of air-breathing mollusks of North America. [Misc. checklist], Dec. 9, 1863, p. 11. BINNEY, Amer. Journ. Conch., vol. 1, Feb. 25, 1865, p. 50, pl. 7, figs. 6, 7. [Clear Lake added to Lea's localities]. PILSBRY, Science, n.s. vol. 64, 1926, pp. 248-249. BAKER, the molluscan family Planorbidae, 1945, pp. 154-159, [many illustrations].

We found *Carinifex* to be very common in the lake sediments of both Searles and Panamint basins. As usual it is extremely variable in shape; therefore, only a few of the available forms were chosen for illustration. After studying members of the genus for many years, both living and fossil, the conclusion has been reached that too many names have been given to individual variations. Many of these so-called species may be found in most large series of specimens from one locality. Others may deserve no better than subspecific rank. In the present case fully 90 per cent of our shells fall well within the range of variation of *C. newberryi* from the type locality. It would be beyond the scope of this paper to go to the depths of the taxonomic problems involving *Carinifex* and its many species names.

Amnicola longinqua Gould.

(Plate 1, figures 13 and 14.)

Amnicola longinqua GOULD, Proc. Boston Soc. Nat. Hist., vol. 4, 1855, p. 130. GOULD, Pacific Railroad Reports, vol. 5, 1855, pp. 235, 333, pl. 11, figs. 10, 11. PILSBRY, Proc. Acad. Nat. Sci., vol. 86, 1934 [1935], pp. 5, 58, pl. 22, figs. 2 *a-f*. Kettleman Hills, California, Pliocene.

The species was present in the material from both Searles and Panamint lake beds but was more abundant in the latter. The shells are not distinguishable from material from the type locality in the Salton Sea area, where it was very abundant when that basin was filled with fresh water. Curiously the species is much less variable in the present collections than others with which it is associated.

Valvata humeralis Say.

(Plate 1, figures 1-12.)

Valvata humeralis SAY, New Harmony Disseminator of Useful Knowledge, August 12, 1829, vol. 22, p. 244, "Inhabits Mexico". HANNIBAL in Keep, West Coast Shells, Revised Edition, 1911, p. 316, pl. 2, fig. 6. PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, 1903 [1904], p. 778, pl. 52, figs. 9, 12, 12a; notes on Say's type.
Valvata humeralis californica PILSBRY, Nautilus, vol. 22, 1908, p. 82. "Bear Lake, San Bernardino Mts., California." PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, Vol. 86, 1934 [1935], p. 556, pl. 21, figs. 11, 11a. "Tulare formation [Pliocene] Kettleman Hills, California."
Valvata humeralis densestriata PILSBRY, Nautilus, vol. 48, 1934, p. 16. PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, vol. 86, 1934 [1935], p. 566, pl. 21, figs. 12, 12a. From a well core, depth 772-792 feet, Tulare formation, Boston Land Co., Well C, Sec. 27, T. 19 S., R. 16 E., MDB&M., about 23 miles southwest of Hanford, Kings County, California.
Valvata humeralis pilsbryi VON MARTENS, Biologica Centrali Americana, 1899, p. 427. PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, 1903, p. 779, pl. 52, figs. 5, 5a. "Lake Patzcuaro, Michoacan, Mexico."
Valvata humeralis patzcuarensis PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, 1899, p. 302.

This rather smooth form of *Valvata* is very common in both Searles and Panamint lake basins. Some of the shells, as with most of the other species, are still translucent suggesting that they had lived a very short time ago. In only a very few specimens is there a trace of spiral ridges such as may be seen in material from Eagle Lake, California (Hanna, 1924, p.135).

The species has been recorded from many places in western America from Washington to Mexico and is also found in the Pleistocene from many widely distributed localities. In one case it was recorded from the marine Pleistocene of Newport Bay, California (Kanakoff and Emerson, 1959, p. 31). In many literature citations the species is recorded under the subspecific name "*californica*" but as Pilsbry has stated: "The distinction between typical *humeralis* of lakes in the valley of Mexico and our widely spread race *californica* is rather finely drawn ...." (Pilsbry, 1935, p. 567).

This species is extremely variable as is usual in *Valvata.* Among hundreds of specimens there are present many which can be placed readily in any of the "varieties" cited above. The width of the umbilicus varies within wide limits as does the strength of the sculpture. The height of the spire and flattening of the whorls adjacent to the suture are not consistent characters. There is a tendency among the shells from the Searles Lake locality to have two carinae, one bordering the umbilicus and the other subsutural. Rarely are these well developed. They are believed to represent extreme variation at this particular locality.

There are several additional names which have a bearing on the identity of the collections from the Searles and Panamint basins. Except for the

PLATE 2

Figure 1. *Succinea rusticana* Gould. Hypotype no. 12500 (Calif. Acad. Sci., Dept. Geol. Type Coll.) locality no. 36806 (CAS), Searles Lake beds, San Bernardino County, California. Diameter, 5.2 mm.; height, 9.0 mm.

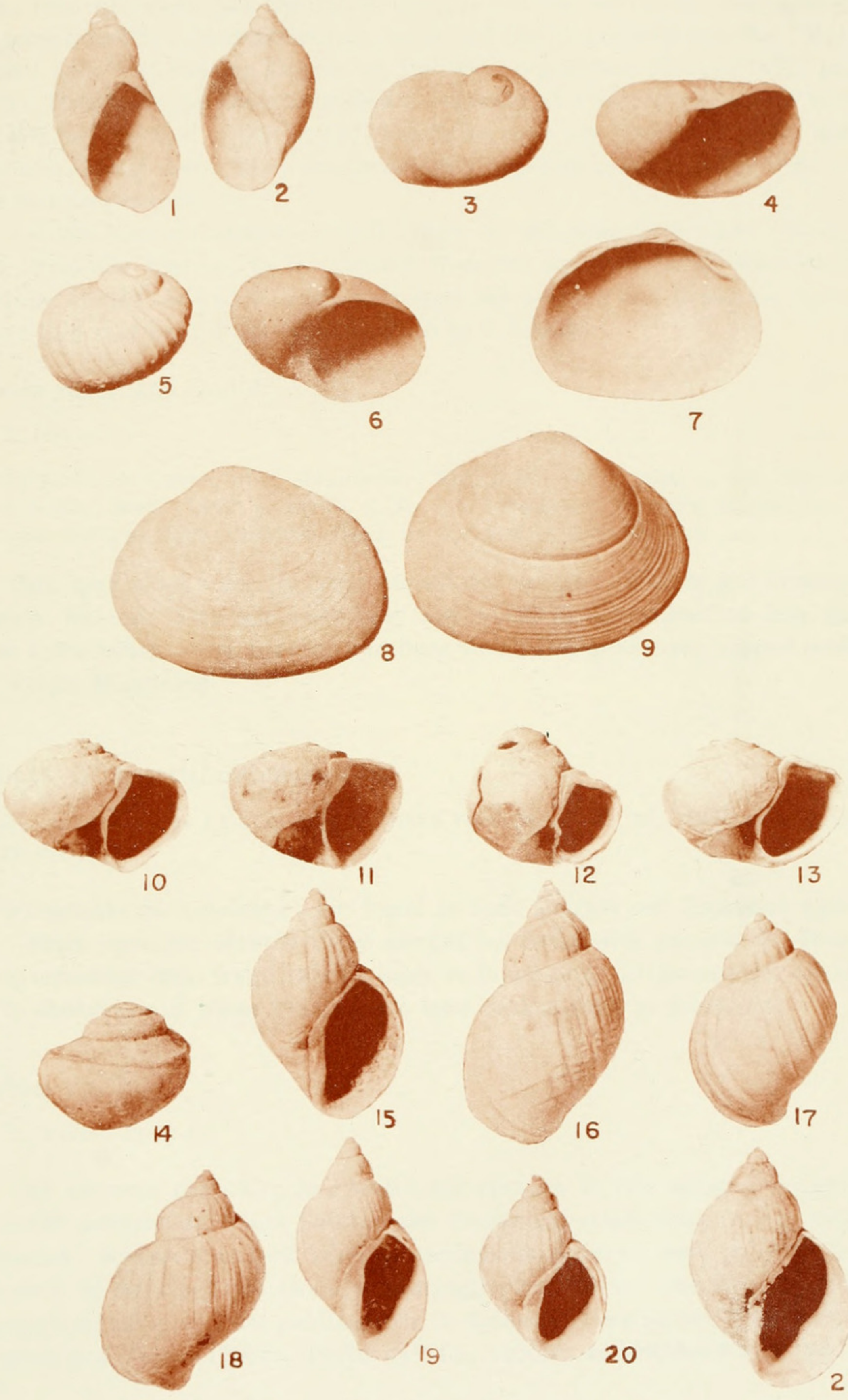
Figure 2. *Physa humerosa* Gould. Hypotype no. 12501 (Calif. Acad. Sci., Dept. Geol. Type Coll.) locality no. 37055 (CAS), Panamint Lake beds, Inyo County, California. Diameter, 8.3 mm.; height, 7.8 mm.

Figures 3 - 6. *Parapholyx effusa* (Lea). Hypotypes nos. 12502 - 12505 (Calif. Acad. Sci., Dept. Geol. Type Coll.) locality no. 37055 (CAS), Panamint Lake beds, Inyo County, California. Measurements: Fig. 3, diameter, 8.7 mm.; height, 7.1 mm. Fig. 4, diameter, 8.6 mm.; height, 6.7 mm. Fig. 5, diameter, 7.1 mm.; height, 5.2 mm. Fig. 6, diameter, 8.0 mm.; height, 6.1 mm.

Figures 7 - 9. *Sphaerium* cf. *S. striatinum* (Lamarck). Hypotypes nos. 12506 - 12508 (Calif. Acad. Sci., Dept. Geol. Type Coll.) locality no. 37063 (CAS), Searles Lake beds, San Bernardino County, California. Measurements: Fig. 7, length, 9.9 mm.; height, 7.4 mm. Fig. 8, length, 12.2 mm.; height, 9.4 mm. Fig. 9, length, 12.4 mm.; height, 9.8 mm.

Figures 10 - 14. *Carinifex newberryi* (Lea). Hypotypes nos. 12509 - 12513 (Calif. Acad. Sci., Dept. Geol. Type Coll.) locality no. 37055 (CAS), Panamint Lake beds, Inyo County, California. Measurements: Fig. 10, diameter, 12.9 mm.; height, 10.0 mm. Fig. 11, diameter, 12.4 mm.; height, 9.5 mm. Fig. 12, diameter, 10.7 mm.; height, 10.3 mm. Fig. 13, diameter, 12.5 mm.; height, 8.1 mm. Fig. 14, diameter, 11.2 mm.; height, 9.7 mm.

Figures 15 - 17. *Lymnaea kingii* Meek, Hypotypes nos. 12514 - 12520 (Calif. Acad. Sci., Dept. Geol. Type Coll.) locality no. 37055 (CAS), Panamint Lake beds, Inyo County, California. Measurements: Fig. 15, diameter, 11.8 mm.; height, 16.2 mm. Fig. 16, diameter, 11.4 mm.; height, 18.4 mm. Fig. 17, diameter, 10.2 mm.; height, 15.2 mm. Fig. 18, diameter, 11.3 mm.; height, 15.8 mm. Fig. 19, diameter, 9.3 mm.; height, 15.7 mm. Fig. 20, diameter, 8.6 mm.; height, 13.0 mm. Fig. 21, diameter, 14.0 mm.; height, 17.2 mm.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smaller size of those from the latter area, all of the variations are present which were found in a large collection described and illustrated from the "Warner Lake beds" of eastern Oregon as *Valvata oregonensis* Hanna (1922, pp. 11, 12). This form had been described previously as *Valvata whitei* and *Valvata calli* by Hannibal (1910, p. 107) but these were not illustrated. It is now my opinion that if these three names actually apply to a distinct species, *V. whitei* has precedence.

Valvata sincera utahensis Call (1884, p. 44) from Utah Lake (living) seems, from the figures, to be distinct from the material being discussed. Henderson (1935) omitted *V. utahensis* from his catalog and it may be inferred from this that he did not consider it to be a fossil.

Succinea rusticana Gould.

(Plate 2, figure 1.)

Succinea rusticana GOULD, Proc. Boston Soc. Nat. Hist., vol. 2, 1846, p. 187. GOULD, U.S. Exp. Moll., 1852, p. 28, pl. 2, fig. 29. "Oregon." PILSBRY, Monog. no. 3, Land Moll. of North America, vol. 2, pt. 2, 1948, p. 824, fig. 446.

This land snail normally lives around the margins of lakes and streams in a moist habitat. One specimen only was found in the collection from the Searles Lake basin. The species has been found living in many places west of the Rocky Mountains.

Anodonta cf. A. californiensis Lea.

Anodonta californiensis LEA, Trans. American Phil. Soc., vol. 10, 1852, p. 286, pl. 25, fig. 47.

Fragments of *Anodonta* were found in both Searles and Panamint Lake beds. While specific identification cannot be made with assurance, these seem to represent thin, fragile shells such as those of *A. californiensis*, which lived in abundance in other Pleistocene lake basins such as Coahuila.

Pisidium sp.

(Plate 1, figures 18-23.)

The extreme difficulty in identifying species in this group is encountered in the material from both Searles and Panamint basins where one or more are present. Rather than risk false determination it seems best to await the appearance of the final decisions of Herrington and Taylor who have studied the group extensively; their publications to date are: Herrington (1954, 1962), Herrington and Taylor (1958), Taylor (1960a, 1960b), and Hibbard and Taylor (1960).

Sphaerium cf. S. striatinum (Lamarck).

(Plate 2, figures 7, 8, 9.)

Shells comparable to those of this species, as illustrated by Hibbard, and Taylor (1960), were found in both Searles and Panamint lake beds. In most places this species was not as abundant as *Pisidium* but there was no difficulty in securing an adequate supply. The identification as *S. striatinum* is doubtful, but the shape is similar to the figures cited. The literature cited under *Pisidium* may be consulted if the material should be studied further.

A new species of freshwater Mollusk from Mono Lake basin, California

In 1959 Charles W. Chesterman and G. C. Gester discovered a deposit of hard, calcite-cemented sandstone in the Mono Lake basin which contained a single gastropod species in great abundance. With more time available for reconnoitering, the locality was again visited by Mr. Chesterman accompanied by C. H. Gray and the writer on October 19, 1960. The outcrop may be described as follows:

Loc. 36730, Calif. Acad. Sci. Geol. Coll., NW. corner, SW. ¼, Sec. 3, T. 2N., R29E., MDB&M, Trench Canyon Quadrangle, U.S. Geological Survey, Mono County, California. This is on an unimproved road connecting the "Pole Line

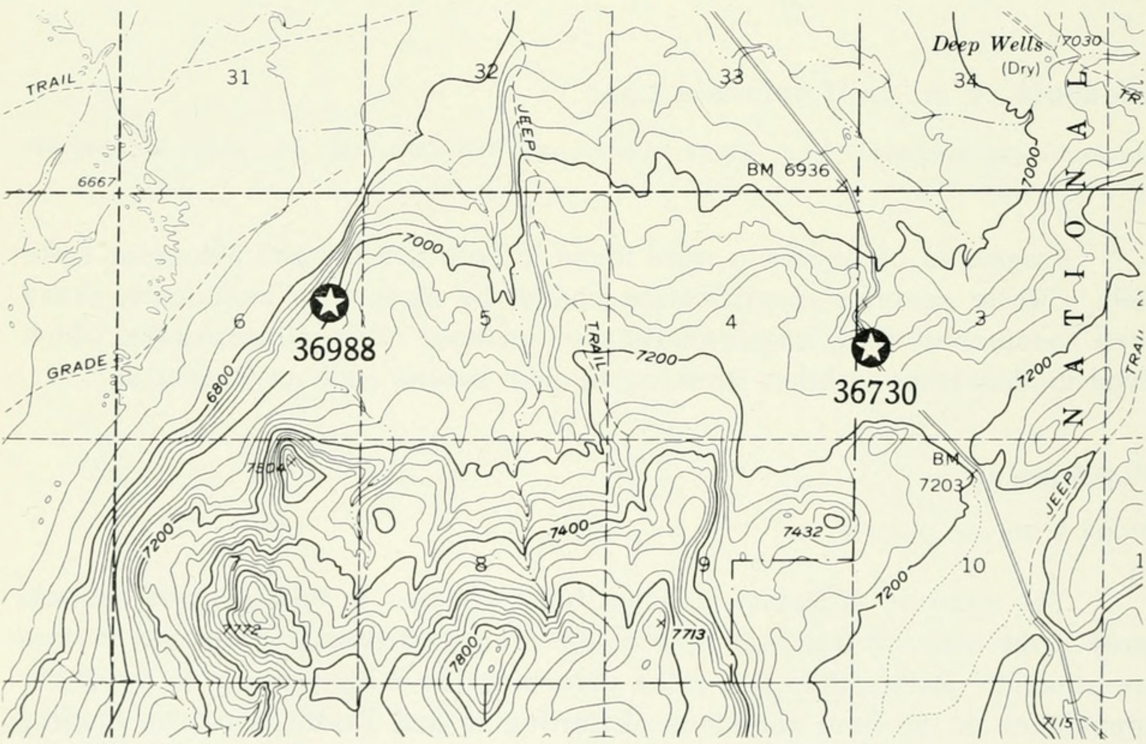

Figure 3. A portion of U. S. Geological Survey Topographic Map, Trench Canyon, California-Nevada, Quadrangle, showing California Academy of Sciences fossil localities nos. 36730 and 36988 in Mono Lake basin.

Road" (Leevining to Bodie), and the Leevining to Benton Station Road, across the Mono basin to the east of the lake. The lake beds are exposed in cuts on the road which passes from Mono Basin to the top of the plateau. They are apparently underlain by volcanic rocks and a lava flow immediately to the west seems to overlie the sediments exposed in the cut. In a few favorable locations the shells are weathered out and in good condition. The elevation of the outcrop is 7120 feet above sea level or 718 feet above the water level of Mono Lake in November, 1958. The fossils are believed to be of Pliocene age.

On the same day another deposit was discovered in the bluff about two miles to the west; this may be described as follows:

Loc. 36988, Calif. Acad. Sci. Geol. Coll., NE.-¼, Sec.6, T.2N., R. 29E., MDB&M, Trench Canyon Quadrangle, U. S. Geological Survey Mono County, California. Charles W. Chesterman, C. H. Gray, and G Dallas Hanna, collectors, October 19, 1960. The southeast boundary of Mono basin at this point is a volcanic cliff which includes an interbedded lake deposit. This lake deposit contains many shells, some of giant size, but all believed to belong to the following species. The lake beds are cut off to the east by a north-trending fault, which have dropped this locality 180 feet below the preceding locality. Many of the shells are represented only by molds.

Parapholyx gesteri Hanna, new species.

(Plate 3, figures 1-3, 6.)

Shell large and heavy, consisting of a little over four rapidly enlarging whorls; growth lines irregular, becoming low rounded ridges toward the aperture; umbilicus open but narrow; outer margin of aperture thin and not expanded unsymmetrically; rarely is there a trace of ribbing.

Holotype no. 12521 (Calif. Acad. Sci. Geol. Dept. Type Coll.), from Loc. no. 36730, Mono Lake Basin, Mono County, California, Pliocene. Diameter 16.5 mm.; height 16.1 mm.

Paratypes nos. 12522 - 12524 (Calif. Acad. Sci. Geol. Dept. Type Coll.).

The most striking character of this species is its large size. The following table of measurements in millimeters illustrates this.

LOCALITY 36730			LOCALITY 36988	
Diameter	*Height*		*Diameter*	*Height*
16.5	16.1	Holotype	25.2	19.5
18.3	15.3	Paratype	22.1	19.0
14.2	12.3	Paratype	24.3	?
9.7	8.8	Paratype	19.1	16.0
13.7	13.6		24.5	?
15.7	13.7			

PLATE 3

Figure 1. *Parapholyx gesteri* Hanna, new species. Holotype no. 12521 (Calif. Acad. Sci., Dept. Geol. Type Coll.) locality no. 36730 (CAS), Mono Lake basin, Mono County, California. Pliocene. Diameter, 16.5 mm.; height, 16.1 mm.

Figure 2. *Parapholyx gesteri* Hanna, new species. Paratype no. 12522 (Calif. Acad. Sci., Dept. Geol. Type Coll.) from same locality as figure 1. Diameter, 18.3 mm.; height, 15.3 mm.

Figure 3. *Parapholyx gesteri* Hanna, new species. Paratype no. 12523 (Calif. Acad. Sci., Dept. Geol. Type Coll.) from same locality as figure 1. Diameter, 14.2 mm.; height, 12.3 mm.

Figure 4. *Lymnaea palustris* (Müller), Hypotype no. 12525 (Calif. Acad. Sci., Dept. Geol. Type Coll.) locality no. 25792 (CAS), "southwest border of Searles Lake, F. M. Anderson, coll., Pleistocene. Diameter, 8.7 mm.; length, 17.8 mm.

Figure 5. *Helisoma ammon* (Gould). Hypotype no. 12526 (Calif. Acad. Sci., Dept. Geol. Type Coll.) locality no. 36806 (CAS), Searles Lake beds, San Bernardino County, California. Pleistocene. Diameter, 25.1 mm.; height, 11.6 mm.

Figure 6. *Parapholyx gesteri* Hanna, new species. Paratype no. 12524 (Calif. Acad. Sci., Dept. Geol. Type Coll.), from same locality as figure 1. Diameter, 9.7 mm.; height, 8.8 mm.

Figure 7. *Valvata calli* Hannibal. Holotype no. 472,(Stanford University Paleo. Type Coll.) from Summer Lake beds, Oregon. Pliocene. Diameter, 5.6 mm.; height, 4.5 mm.

Figure 8. *Valvata whitei* Hannibal. Holotype no. 473 (Stanford University Type Coll.) from Summer Lake beds, Oregon. Pliocene. Diameter, 5.8 mm.; height, 3.0 mm.

Figure 9. *Valvata calli* Hannibal. Holotype no. 472 (Stanford University Paleo Type Coll.) from Summer Lake beds, Oregon. Diameter, 5.6 mm.; height, 4.5 mm.

Figure 10. *Valvata whitei* Hannibal. Holotype no. 473 (Stanford University Paleo. Type Coll.) from Summer Lake beds, Oregon. Diameter, 5.8 mm.; height 3.0 mm.