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UPPER PLEISTOCENE MOLLUSCA FROM POTRERO CANYON, PACIFIC PALISADES, CALIFORNIA

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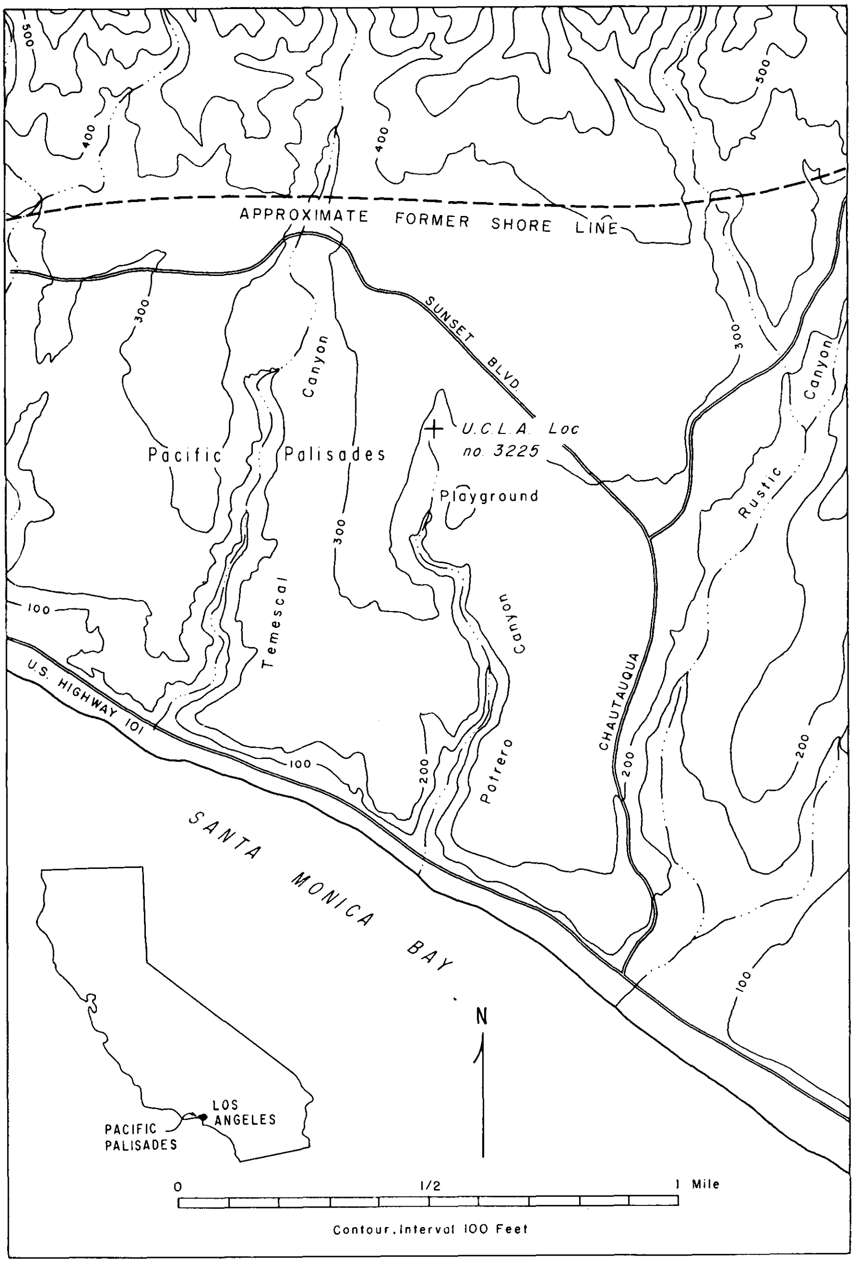

FIGURE 1. Index map of a portion of Pacific Palisades, California, showing the locality from which the Clark collection was recovered (UCLA Loc. no. 3225) and its relation to the shoreline during maximum sea stand on the Dume terrace platform.

UPPER PLEISTOCENE MOLLUSCA FROM POTRERO CANYON, PACIFIC PALISADES, CALIFORNIA

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INTRODUCTION

Fossiliferous marine terrace sands of Upper Pleistocene age are exposed near the head of Potrero Canyon, Pacific Palisades, California (figure 1). Tens of thousands of mollusks from this deposit, collected over a period of years by Dr. F. C. Clark, were acquired by the Department of Geology, University of California, Los Angeles, in January, 1943. The preparation of homesites and other construction in Potrero Canyon has caused removal or burial of the most fossiliferous portions of the terrace sands, so that Clark's original locality is destroyed, and his collection cannot now be duplicated. It is therefore desirable to record this large assemblage, which contains 128 species and varieties previously unreported from the Upper Pleistocene of Potrero Canyon.

PREVIOUS WORK

Ralph Arnold was apparently the first to assign strata at Potrero Canyon to the Upper Pleistocene; he referred to the soft, rudely stratified nonmarine deposits forming much of the Palisades at Potrero Canyon and southward as probable equivalents of the Upper San Pedro series, "from lithological and stratigraphical reasons" (1903, p. 56). This correlation cannot be validated at present, although it is likely that some of the nonmarine terrace cover is of Upper Pleistocene age.

Marine deposits that are now considered Upper Pleistocene were first reported from the Santa Monica Mountains in 1904 by Rivers, who mentions "Quaternary beach gravels" as capping strata that he called Pliocene. Rivers described two mollusks, *Cavolina telemus* var. *tricuspida* and *Strombiformis raymondi,* from the Upper Pleistocene. It is probable that these came from Potrero Canyon.

Following Rivers' paper, several records of species from Upper Pleistocene deposits at "Santa Monica" appear in the literature. These forms are with but one exception (*Anachis lineolata*) present in the Clark collection, and are presumed to be from Potrero Canyon. The earliest of these papers is by Raymond (1906), who recorded varieties of *Megasurcula carpenteriana* from the "Pleistocene of Santa Monica", attributing the collection to Rivers. Bartsch described *Alabina monicensis* from the "Upper San Pedro series at Santa Monica, California" in 1911, and in 1917 described a new species of *Balcis* (*monicensis*) and recorded three additional species of this genus (*micans, oldroydi,* and *rutila*) from the same locality. The first chitons were reported from "Pleistocene deposits of the Santa Monica Hills" by Chace (1917), who recorded 7 identified forms collected by Clark. More gastropods were described from the "Upper Pleistocene of Santa Monica" by T. S. Oldroyd in 1921 (*Anachis minuta* = *A. lineolata,* and *Epitonium clarki*), and a record of *Acteocina infrequens* by Dall (1922), from an unspecified locality in Santa Monica, may belong here.

The earliest specific reference to an Upper Pleistocene fossil locality in Potrero Canyon appears to have been made by Berry (1922, p. 412, as "Long Wharf Canyon"). Working with material supplied by Clark, he revised and expanded Chace's list of chitons to 9 species. It remained however for Hoots to locate accurately the Potrero Canyon exposures on a map (1931, pl. 16), accompanied by the most complete description of the fauna yet published (Woodring in Hoots, 1931, pp. 121-122). Woodring listed 121 forms, of which 89 were specifically identified. The fauna was interpreted as a warm-water assemblage, correlative with the Upper San Pedro of Deadman's Island (Palos Verdes sand). Differences between the San Pedro and Potrero Canyon Upper Pleistocene assemblages were ascribed to biofacies differences.

A considerable number of species from the Upper Pleistocene of "Santa Monica", presumably Potrero Canyon, were included among the Pleistocene records compiled in Grant and Gale's famous catalogue (1931). These records are based on specimens in the Oldroyd and Clark collections (now at Stanford University and the University of California, Los Angeles, respectively). More recently, Woodring has re-emphasized the southern aspect of the Potrero Canyon fauna while affirming his earlier correlations (in Woodring, Bramlette, and Kew, 1946, p. 106).

Present Work

Preparation and identification of the F. C. Clark collection at U.C.L.A. was begun by Mr. E. H. Quayle in 1944, but was put aside due to the press of other duties. This work was completed by the writer in 1955 during the course of studies of Pleistocene molluscan faunas. The material received from Dr. Clark included Pleistocene mollusks from localities other than Potrero Canyon, which had unfortunately become mixed with a few of the Potrero Canyon fossils. Material so contaminated had been preserved separately by the direction of Professor W. P. Popenoe. Attempts to identify the source of this mixed material proved fruitless, as much of it had been cleaned of matrix. It has accordingly been excluded from the present study.

There remain in the Clark collection 227 species and varieties of mollusks that are unquestionably from the Upper Pleistocene deposits in Potrero Canyon (U.C.L.A. Locality no. 3225). The fauna is herein listed, together with all known published records of fossils from the same locality. In listing previous records, the nomenclature has been revised to accord with present usage. The chitons were identified by Dr. S. Stillman Berry during the preparation of his monograph (Berry, 1922). A total of 262 molluscan species and varieties are now reported from Potrero Canyon Upper Pleistocene.

Species or varieties not previously reported as fossils are *Acteocina magdalenensis, Sulcoretusa xystrum* (plate 13, fig. 10), *Hanetia elegans* (plate 13, figs. 7, 8), *Odostomia farallonensis, Odostomia gravida, Alabina tenuisculpta* var. *phalacra,* and *Polinices draconis.*

Acknowledgments

Professors U. S. Grant and W. P. Popenoe, University of California, Los Angeles, and Dr. John T. McGill, Geologist, U. S. Geological Survey, aided the preparation of this paper by careful criticism and discussion. The Clark collection was made available to the writer through the courtesy of Mr. Takeo Susuki, Junior Research Geologist, University of California, Los Angeles. Dr. Leo G. Hertlein, California Academy of Sciences, kindly furnished comparative material and ecologic data on certain mollusks. The index map was drafted by Mr. Ronald H. Arntson, University of California, Los Angeles, and Mr. Armour C. Winslow, Louisiana State University, aided in the preparation of the plate.

STRATIGRAPHY OF THE TERRACE DEPOSITS

Remnants of a marine platform of abrasion, included by Davis in his Dume terrace (1931, p. 1098 ff.), are preserved beneath an alluvial cover in the Pacific Palisades region. The platform surface is eroded on tilted strata of considerable structural complexity, which range in age from Paleocene to Lower Pleistocene. Near the head of Potrero Canyon, about 0.1 mile south of U.C.L.A. Locality no. 3225 (figure 1), this surface is exposed in stream and road cuts. It is underlain here by gently tilted, gray-green, massive siltstones mapped as Pliocene by Hoots (1931, pl. 16), and overlain by 1 to 6 feet of essentially horizontal, iron-stained, crudely bedded, loosely consolidated, fine to medium grained, angular quartz sands. The sands, where exposed, are largely unfossiliferous; only a few scattered sponge spicules and small, badly worn shell fragments could be found. About 50 feet of alluvium overlie the sands.

The surface of the terrace platform is somewhat irregular, as is well shown in Davis' photographs (1933, pl. 55). In Potrero Canyon, at the locality mentioned above, a shallow depression in the platform surface is exposed on the east bank of the stream. Very fine, highly fossiliferous sand fills this depression; it is finer than the sands above but coarser than the underlying siltstones. The molluscan fauna is similar to that in the Clark collection; in addition, foraminifera, ostracodes, and the minute skeletal remains of various other groups of marine invertebrates are present.

Hoots reports that the locality from which the Clark collection was recovered (locality 61 of Hoots, 1931, p. 121) is in a fine white and brown sand resting directly upon the Pliocene siltstones. The matrix of the mollusks in the Clark collection agrees well texturally with the very fine fossiliferous sand exposed in the depression, and contains a similar microfauna. It seems likely therefore that the rich Upper Pleistocene fauna has come from a unit lying between the Dume platform surface and the barren, fine to medium grained sand exposed in Potrero Canyon today. The fossiliferous unit was apparently stripped off much of the terrace before the overlying sands were deposited.

Among the most abundant foraminifera from the fossiliferous unit are *Bolivina interjuncta* Cushman, *Uvigerina peregrina* Cushman, *s. l., Cassidulina californica* Cushman and Hughes, *Cassidulina translucens* Cushman and Hughes, and *Anomalina* cf. *A. schmitti* Cushman and Wickendon. With the exception of the *Anomalina,* all these species are reported from formations beveled by the terrace platform in the Pacific Palisades region (Goudkoff *et al.* in Hoots, 1931, pp. 117-118), and as they live today in depths much too great for waters on the Dume terrace (see below; Natland, 1933) they have doubtless been reworked from the underlying strata. The *Anomalina* may be conspecific with a form that is now abundant in protected shallow water off Catalina Island, but that lives in moderately deep water as well (Natland, 1933). It may or may not represent an Upper Pleistocene microfauna.

PALEOECOLOGY

HABITAT

A summary of the habitats of Recent representatives of Potrero Canyon species is given in table 1. Most data on the ecology of Pacific Coast Mollusca are recorded in rather general terms, and therefore broad habitat categories have been used. Some of these categories require definition.

Under "protected shallow water" are tallied species which live in embayments or in quiet water along protected outer coasts, and which are commonly found above 5 fathoms; most of them are subtidal, while many range also into shallow offshore waters. "Ubiquitous" forms are found in such a variety of environments that they cannot be used as ecologic indicators in this study; few of them range into moderately deep water, however. "Offshore, shallow water" forms live in waters at least as shallow as 20 fathoms, but are found below most heavy

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TABLE 1. Present habitats of species and varieties in the Potrero Canyon fauna.

Habitat	Species and Varieties	Per Cent
Protected shallow water	68	33.0
Ubiquitous	61	29.6
Offshore, shallow water	42	20.4
Exposed rocky shores	19	9.2
Offshore, moderately deep water	11	5.3
Exposed sandy shores	3	1.5
Pelagic; open ocean	2	1.0
Total for which data available	206	100.0

wave action; they are not recorded from very shallow, subtidal zones. The "offshore, moderately deep" category includes species known to be living only at depths greater than 20 fathoms.

From the table, it is clear that most of the species prefer quiet shallow waters. The habitats from which "ubiquitous" species were derived cannot be known, but if the same proportions hold for them as hold among the rest of the fauna, fully 76.4 per cent of the species tallied may represent shallow water habitats free from strong wave action. The great majority of individuals as well as of species have been drawn from these habitats. Of the 42 "superabundant"[1] species for which ecologic data are available, 23 live today in protected shallow water, 2 offshore in shallow water, and 1 each in rocky exposed shore and moderately deep water habitats. The remaining 15 are "ubiquitous".

TEMPERATURE

Using the present distribution of species and of water temperatures as a datum, it seems possible to estimate the approximate magnitude and range of water temperatures represented by the Potrero Canyon fauna. The present geographic ranges of about 75 per cent of the species includes the latitude of Potrero Canyon; all of the remaining 25 per cent (59 species) live today only south of the Potrero Canyon area. Northern end-points of the ranges of these species are found in the following areas: Santa Monica, 10 species; Redondo Beach, 11 species; San Pedro-Long Beach, 13 species; Newport Beach, 1 species; Catalina Island, 4 species; La Jolla-San Diego, 5 species; and Baja California, 15 species.

Thus, two-thirds of the south-ranging species have the northern end-points of their present ranges within 25 or 30 miles of Potrero Canyon, while one-third do not now live within 100 to 900 or more miles of the region. Among the most southerly species are *Trachycardium procerum* (Scammon's Lagoon to Peru), *Chione gnidia* (Cedros Island to Panama), *"Chione" picta* (Magdalena Bay to Panama), *Dosinia ponderosa* (Scammon's Lagoon to Peru), *Mulinia pallida* var. *modesta* (Baja California and the Gulf of California),

[1]Species listed as "superabundant" in the *Checklist of Species,* to follow, are represented by 256 or more specimens in the Clark collection.

Bivetopsia bullata (plate 13, figs. 1, 2; Cedros Island to Panama), *Hanetia elegans,* previously unreported fossil[2] (plate 13, figs. 7, 8; Cape San Lucas to Panama), *"Nassa" cerritensis* (Point Abreojos to Guaymas), *Centrifuga leeana* (Guadalupe Island to Cedros Island), *Tricolia variegata* (Magdalena Bay to Cape San Lucas), *and Ischnochiton acrior* (Cedros Island to Cape San Lucas).

Although no species are reported fossil at Potrero Canyon that live only to the north, several are essentially northward-ranging types. Among these are *Bornia retifera* (Monterey to the Santa Barbara Islands), *Mitromorpha interfossa* (Alaska to Catalina Island), *Ocinebra barbarensis* (British Columbia to San Pedro), and *Epitonium sawinae* (British Columbia to Catalina Island).

Mean annual near-shore sea-surface temperatures range from something below 61° F. in Santa Monica Bay to about 68° or 69° F. near Magdalena Bay and about 75° F. near Cape San Lucas (Hertlein and Grant, 1944, p. 72). Although northern and southern species in the Potrero Canyon assemblage may live today in waters warmer or cooler than mean annual temperatures can indicate, their present distribution strongly suggests that the range of water temperature off the Dume terrace coast was greater than at present. Waters no warmer than those in Santa Monica Bay today, together with waters perhaps, as a conservative guess, 8° F. warmer, seem to have been present contemporaneously, or perhaps in alternate seasons, during the sea-stand on the Dume terrace platform.

A mechanism which might account for this condition has recently been postulated (Valentine, 1955): shallow quiet waters were warmed at some time in the Upper Pleistocene either by increasing heat from the sun or by the introduction of warm southern water in countercurrents; at the same time, shallow waters in areas where upwelling occurred remained relatively cool. As it seems likely that the temperature of upwelling water was lower than at present during and shortly after glacial ages, relatively warm and cold water species may have been able to live in close proximity. Emerson (1956) has also discussed the effect of upwelling on molluscan faunas, and its significance in Pleistocene paleoecology.

[2]Gratitude is expressed to George P. Kanakoff, Los Angeles County Museum, for identification of this species. Mr. Kanakoff has discovered *Hanetia elegans* in Upper Pleistocene deposits at Playa Del Rey, California.

INFERRED DEPOSITIONAL ENVIRONMENT

The position of the shoreline at high sea stand on the Dume terrace, indicated in figure 1, is an approximation based on the slope of the platform surface as extrapolated from localities where it is exposed, and on such evidence as is afforded by the present topography. No exposure of the shoreline angle was found. Although the precise position and character of the Dume shore cannot be determined, this approximation will serve as a basis for limiting the depth at which the fossils could have been deposited; the difference in elevation between the fossil locality and the shoreline angle is judged to be no more than 30 feet.

Conditions at and near the site of deposition may be limited by combining the geographic and faunal evidence. The fossil locality lay no farther than ½ mile from shore and under a probable maximum of 5 fathoms of water. Silt and fine sand composed the substratum. These conditions seem to be reflected in the ecologic composition of the fossil fauna, for Recent representatives of most of the species prefer or tolerate such an environment. The waters near the fossil locality were probably fairly quiet, and not consistently disturbed by wave action while the assemblage lived. Perhaps an offshore bar or spit protected this part of the platform at times from most wave action; Davis (1933, p. 1103) mentions this possibility in another connection. Moderately deep water or open ocean types must have been swept inshore by occasional storm waves, while exposed sandy beach and rocky shore forms may have been transported offshore through the action of currents and gravity.

AGE AND FAUNAL AFFINITIES

As noted above, the Dume terrace bevels tilted strata of Lower Pleistocene age, and the marine terrace deposits at Potrero Canyon contain a fauna characterized by many species that live today along the nearby coast, together with several markedly southern forms. Similar faunas are commonly found in strata assigned to the Upper Pleistocene of Southern California. The Potrero Canyon fauna may therefore be considered as Upper Pleistocene on both stratigraphic and faunal grounds.

Similarities between the Upper Pleistocene fauna described by Willett from Playa Del Rey (1937) and the Potrero Canyon assemblage are striking, as Woodring has noted (in Hoots, 1931, p. 122, and in Woodring, Bramlette, and Kew, 1946, p. 106). The two faunas have 194 species and varieties in common, while 96 forms from Playa Del Rey are not reported at Potrero Canyon, and 68 of the Potrero Canyon forms are not known from Playa Del Rey. The Playa Del Rey assemblage is slightly the larger (290[8] *vs.* 262 species and varieties). Differences between the two faunas are much smaller than these figures indicate. Of the forms not found in both faunas, only 20 from Playa Del Rey and 17 from Potrero Canyon are represented by more than 10 specimens in the very large collections available from each locality. Relative abundances of species in each assemblage are remarkably alike. Several species common to the two localities are not reported elsewhere in the Pleistocene of Southern California. These include *Diacria trispinosa* (plate 13, figs. 3, 4), *Bivetopsia bullata* (plate 13, figs. 1, 2), *Engina strongi* (plate 13, fig. 9), *Hanetia elegans* (plate 13, figs. 7, 8), and *Calliostoma gloriosum* (plate 13, figs. 5, 6). Several species from Playa Del Rey that are unknown at Potrero Canyon are tidal marsh or mud flat forms, a biotope not represented at the latter locality. With this exception, both faunas have clearly been drawn from similar habitats within nearly the same range of ecologic conditions. Both faunas have essentially the same thermal significance as well.

The bearing of the Potrero Canyon assemblage on the age of the Rancho La Brea vertebrate fauna has been discussed by Grant and Sheppard (1939, p. 308), who point out that the Rancho La Brea deposits seem to be contained in the distal end of the Hollywood fan, one of a series of alluvial fans that blanket the northern margin of the Los Angeles basin. These fans appear to be roughly contemporaneous with nonmarine terrace cover at Pacific Palisades. The vertebrate fauna is thus probably Upper Pleistocene, and somewhat younger than the Potrero Canyon assemblage.

Precise correlation of the Dume terrace with individual terraces elsewhere in Southern California cannot yet be made, but the correlations suggested by Woodring (*loc. cit.*) are doubtless correct. That is, the Potrero Canyon assemblage belongs within a period of uncertain duration in the Upper Pleistocene that is characterized faunally by the presence of a prominent southern molluscan element in protected habitat biofacies; to this period of time also belong the lowest terrace in the Palos Verdes Hills and possibly several of the earlier terraces, the Playa Del Rey deposits, and their correlatives.

[8]The figures given for the Playa Del Rey assemblage differ slightly from Willett's, owing to the necessity for "splitting" or "lumping" a few forms in order to obtain uniform taxonomic treatment for both faunas.

CHECKLIST OF FOSSILS

KEY

Column 1, Clark collection:
- V—Very rare, less than 5 specimens.
- R—Rare, from 5 to 16 specimens.
- C—Common, from 17 to 64 specimens.
- A—Abundant, from 65 to 256 specimens.
- S—Superabundant, more than 256 specimens.

Column 2, Woodring in Hoots, 1941:
- X—Reported present.

Column 3, Grant and Gale, 1931:
- Clk—Attributed to the Clark collection.
- Old—Attributed to the Oldroyd collection.

Column 4, other authorities:
- B-1—Reported by Bartsch, 1911.
- B-2—Reported by Bartsch, 1917.
- Ber—Reported by Berry, 1922.
- Cha—Reported by Chace, 1917.
- Dal—Reported by Dall, 1922.
- Old—Reported by Oldroyd, 1921.
- Ray—Reported by Raymond, 1906.
- Riv—Reported by Rivers, 1904.
- Wdg—Reported by Woodring, 1946.

Column 5, present geographic distribution:
- P—Present range includes the latitude of Potrero Canyon.
- S—Known to be living only south of Potrero Canyon.
- E—Not known to be living.

SYSTEMATIC CHECKLIST

SPECIES AND VARIETIES	1 Clark Collection	2 Woodring in Hoots, 1931	3 Grant & Gale, 1931	4 Other Authority	5 Present Distribution
PELECYPODA					
Nucula suprastriata Arnold	S	X	Old		P
Nuculana taphria (Dall)	S	X			P
Yolida cooperi Gabb	S				P
Ostrea lurida Carpenter	S				P
Leptopecten latiauratus (Conrad)	S	X			P
Leptopecten latiauratus var. *monotimeris* (Conrad)	S				P

SYSTEMATIC CHECKLIST

SPECIES AND VARIETIES	1 Clark Collection	2 Woodring in Hoots, 1931	3 Grant & Gale, 1931	4 Other Authority	5 Present Distribution
Lima hemphilli Hertlein & Strong	V				P
Anomia peruviana d'Orbigny	C				S
Pododesmus macroschisma (Deshayes)	R	X			P
Modiolus fornicatus Carpenter	V				P
Lithophaga plumula (Hanley)	C				P
Periploma planiusculum Sowerby	C				P
Pandora punctata Conrad	C	X			P
Crassinella branneri (Arnold)	R				S
Crassinella nuculiformis Berry	V				E
Chama pellucida Broderip	C				P
Pseudochama exogyra (Conrad)	S	X			P
Epilucina californica (Conrad)	V				P
Here excavata (Carpenter)	C				S
Lucinisca nuttallii (Conrad)	S	X			P
Parvilucina tenuisculpta (Carpenter)	C	X			P
Diplodonta orbella (Gould)			Old		P
Kellia laperousii (Deshayes)	V				P
Aligena cerritensis Arnold	V				S
Mysella aleutica (Dall)	V				P
Bornia retifera Dall	V				P
Laevicardium elatum (Sowerby)	R	X			S
Trachycardium procerum (Sowerby)	C	X	Old		S
Trachycardium quadrigenarium (Conrad)	A	X			P
Trigoniocardia biangulata (Sowerby)	A				S
Chione gnidia (Broderip & Sowerby)				Wdg	S
Chione undatella (Sowerby)		X			P
Chione cf. *C. undatella* (Sowerby)	V				?
Chione undatella var. *simillima* (Sowerby)	A				S
G Willett "*Chione*" *picta* ~~Dall~~	R				S
Protothaca tenerrima (Carpenter)		X			P
Saxidomus nuttalli Conrad	A				P
Transenella tantilla (Gould)		X			P
Amiantis callosa (Conrad)	A	X			S
Dosinia ponderosa (Gray)	V			Wdg	S
Cooperella subdiaphana (Carpenter)	V				P
Tellina buttoni Dall	V	X			P
Tellina idae Dall	S	X			S
Apolymetis biangulata (Carpenter)	C				P
Macoma indentata Carpenter	S	X	Clk		P

SYSTEMATIC CHECKLIST

SPECIES AND VARIETIES	1 Clark Collection	2 Woodring in Hoots, 1931	3 Grant & Gale, 1931	4 Other Authority	5 Present Distribution
Macoma nasuta (Conrad)	S				P
Macoma secta (Conrad)	S		Old		P
Macoma yoldiformis Carpenter	V	X			P
Semele decisa (Conrad)	R				S
Semele rubropicta Dall	V				P
Donax gouldii Dall	V	X			P
Psammobia edentula (Gabb)	R				S
Tagelus subteres (Conrad)	V				P
Solen sicarius Gould	A	X			P
Siliqua lucida (Conrad)	R	X			P
Ensis californicus Dall	A	X			P
Mactra californica Conrad	A	X	Old		P
Spisula catilliformis Conrad	V				P
Spisula "dolabriformis Conrad"	R				P
Spisula hemphilli (Dall)	A	X			S
Mulinia pallida var. *modesta* Dall	V				S
Schizothaerus nuttallii (Conrad)	A	X			P
Platyodon cancellata (Conrad)	R				P
Cryptomya californica (Conrad)	S	X			P
"Corbula" luteola Carpenter	R	X	Clk		P
Panope generosa Gould	C				P
Hiatella arctica (Linnaeus)	V	X			P
Zirfaea pilsbryi Lowe	C	X			P
SCAPHOPODA					
Dentalium neohexagonum Sharp & Pilsbry	S	X			P
Cadulus fusiformis Pilsbry & Sharp	A	X			P
GASTROPODA					
Cavolina telemus var. *tricuspida* (Rivers)				Riv	P
Diacria trispinosa (Lesueur)	V				P
Acteon punctocaelatus (Carpenter)	C	X	Old		P
Acteon traski Stearns	R	X	Old		S
Acteocina culcitella (Gould)	S	X	Clk Old		P
Acteocina inculta (Gould)	S				P
Acteocina infrequens (C. B. Adams)				Dal	S
Acteocina magdalenensis Dall	V				S
Sulcoretusa xystrum (Dall)	V				S
Coleophysis carinata (Carpenter)			Old		P

SYSTEMATIC CHECKLIST

SPECIES AND VARIETIES	1 Clark Collection	2 Woodring in Hoots, 1931	3 Grant & Gale, 1931	4 Other Authority	5 Present Distribution
Coleophysis harpa (Dall)	S				P
Volvulella cylindrica (Carpenter)	S	X	Old		P
Cylichna attonsa Carpenter	S	X	Clk		P
Bulla cf. *B. punctulata* A. Adams	V				?
Williamia peltoides (Carpenter)	R		Old		P
Terebra pedroana Dall	S	X	Clk		P
Conus californicus Hinds	S	X			P
Megasurcula carpenteriana (Gabb)	R	X		Ray	P
Megasurcula carpenteriana var. *tryoniana* (Gabb)	A			Ray	P
Antiplanes perversa (Gabb)	V				P
Pseudomelatoma penicillata var. *semiinflata* Grant & Gale	A				E
Moniliopsis incisa (Carpenter)	?	X	?		P
Moniliopsis incisa var. *fancherae* (Dall)	S				P
Moniliopsis incisa var. *ophioderma* (Dall)	S				P
Clavus hemphilli (Stearns)	S	X	Clk		P
Kurtzia arteaga var. *roperi* (Dall)	C				P
"Mangelia" cetolaca Dall	S	X			E
"Mangelia" variegata Carpenter	S		Old		P
Mitromorpha cf. *M. interfossa* Carpenter		X			?
Bivetopsia bullata (Sowerby)	R				S
Olivella baetica Carpenter	S				P
Olivella biplicata (Sowerby)	S	X	Clk		P
Olivella pedroana (Conrad)		X			P
Hyalina californica (Tomlin)	R				S
Cystiscus regularis (Carpenter)		X			P
Cystiscus subtrigona (Carpenter)	V				P
Mitra fultoni Smith	R		Old		S
Mitra idae Melvill	R				P
"Fusinus" luteopictus Dall	C				P
Barbarofusus barbarensis (Trask)	R	X			P
Harfordia monksae (Dall)			Old		P
Kelletia kelletii (Forbes)	V				P
Engina strongi Pilsbry & Lowe	V			Wdg	S
Hanetia elegans Dall	V				S
"Nassa" cerritensis Arnold	C				S
"Nassa" delosi Woodring	S	X			E
"Nassa" fossata (Gould)	S	X			P

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SYSTEMATIC CHECKLIST

SPECIES AND VARIETIES	1 Clark Collection	2 Woodring in Hoots, 1931	3 Grant & Gale, 1931	4 Other Authority	5 Present Distribution
"*Nassa*" *mendica* Gould			Old		P
"*Nassa*" *mendica* var. *cooperi* Forbes	C		Clk		P
"*Nassa*" *perpinguis* (Hinds)	S	X	Clk		P
"*Nassa*" *tegula* Reeve	V				P
Anachis lineolata (Reeve)				Old	S
Mitrella carinata (Hinds)	A		Clk		P
Mitrella carinata var. *gausapata* (Gould)	S	X	Clk		P
			Old		
Mitrella gouldi (Carpenter)	V				P
Mitrella tuberosa (Carpenter)	C				P
Amphissa versicolor Dall	C	X			P
Pteropurpura trialatus (Sowerby)	R				P
Pterynotus petri (Dall)	C				P
Centrifuoa leeana (Dall)	C				S
Jaton festivus (Hinds)	S	X	Old		P
Maxwellia gemma (Sowerby)	A				P
Ocinebra barbarensis (Gabb)		X			P
Ocinebra circumtexta (Stearns)	V				P
Ocinebra foveolata (Hinds)	V				P
Ocinebra interfossa Carpenter	V				P
Ocinebra poulsoni Carpenter	S	X			P
Stramonita biserialis (Blainville)	A			Wdg	S
Nucella emarginata var. *ostrina* (Gould)	R				P
Acanthina lugubris (Sowerby)				Wdg	S
Acanthina paucilirata (Stearns)		X			S
Acanthina spirata (Blainville)	A				P
Boreotrophon stuarti (Smith)		X			P
Forreria belcheri (Hinds)	C				P
Epitonium bellastriatum (Carpenter)	A	X	Old		P
Epitonium clarki T. S. Oldroyd	S			Old	E
Epitonium cooperi Strong	A				P
Epitonium insculptum (Carpenter)	V				E
Epitonium sawinae Dall	A				P
Epitonium tinctum (Carpenter)		X			P
Balcis micans (Carpenter)	C		Clk	B-2	P
Balcis monicensis (Bartsch)	R			B-2	E
Balcis oldroydi (Bartsch)	V			B-2	P
Balcis rutila (Carpenter)	C			B-2	P
Balcis thersites (Carpenter)	R				P

SYSTEMATIC CHECKLIST

SPECIES AND VARIETIES	1 Clark Collection	2 Woodring in Hoots, 1931	3 Grant & Gale, 1931	4 Other Authority	5 Present Distribution
Strombiformis raymondi (Rivers)	R			Riv	S
Turbonilla almo Dall & Bartsch	A				P
Turbonilla asser Dall & Bartsch	R				P
Turbonilla canfieldi Dall & Bartsch	C				P
Turbonilla carpenteri Dall & Bartsch	V				S
Turbonilla keepi Dall & Bartsch	A				S
Turbonilla laminata (Carpenter)	R				S
Turbonilla lowei Dall & Bartsch	A				P
Turbonilla lowei var. *pedroana* Dall & Bartsch	C				P
Turbonilla pentalopha Dall & Bartsch	V				S
Turbonilla regina Dall & Bartsch	S				P
Turbonilla stylina (Carpenter)	R				P
Turbonilla tenuicula (Gould)	C				P
Turbonilla torquata (Gould)	R				P
Turbonilla tridentata (Carpenter)	R				P
Turbonilla weldi Dall & Bartsch	A				S
Odostomia cf. *O. californica* Dall & Bartsch	V				?
Odostomia donilla Dall & Bartsch	C				S
Odostomia eugena Dall & Bartsch	R				S
Odostomia farallonensis Dall & Bartsch	C				P
Odostomia gravida Gould	A				P
Odostomia helena Bartsch	C				P
Odostomia cf. *O. minutissima* Dall & Bartsch	A				?
Odostomia nemo Dall & Bartsch	S				S
Odostomia cf. *O. phanella* Dall & Bartsch	V				?
Bursa californica (Hinds)	A	X			P
Pusula californianus (Gray)	V		Old		P
Pusula solandri (Sowerby)			Old		S
Erato columbella Menke	V	X	Old		P
Alabina monicensis Bartsch				B-1	E
Alabina tenuisculpta var. *diegensis* Bartsch	V				S
Alabina tenuisculpta var. *phalacra* Bartsch	R				S
Bittium attenuatum Carpenter		X			P
Bittium rugatum Carpenter	V				S
Bittium cf. *B. rugatum* var. *giganteum* Bartsch		X			E
Bittium rugatum var. *larum* Bartsch	R				S

SYSTEMATIC CHECKLIST

SPECIES AND VARIETIES	1 Clark Collection	2 Woodring in Hoots, 1931	3 Grant & Gale, 1931	4 Other Authority	5 Present Distribution
Seila montereyensis Bartsch	R	X	Clk		S
Cerithiopsis antefilosa Bartsch	R				S
Cerithiopsis arnoldi var. *fossilis* Bartsch		X			E
Cerithiopsis cosmia Bartsch	R				P
Cerithiopsis pedroana (Bartsch)	R				S
Cerithiopsis pedroana var. *fatua* Bartsch		X			E
Triphora pedroana (Bartsch)	R				S
Metaxia diadema Bartsch			Clk		P
Alvania acutelirata (Carpenter)	V	X			S
Rissoina pleistocena Bartsch	C	X			E
Turritella cooperi Carpenter	A	X			P
Aletes squamigerus Carpenter	V		Clk		P
Spiroglyphus lituella (Morch)	R				P
Caecum californicum Dall	V	X			P
Micranellum crebricinctum (Carpenter)	S	X			P
Fartulum hemphilli Bartsch	R				S
Fartulum occidentale Bartsch	C				P
Littorina planaxis Philippi	V		Clk		P
Littorina scutulata Gould	C				P
Lacuna carinata Gould	V		Clk		P
Lacuna carinata var. *aurantiaca* Carpenter	R				P
Lacuna unifasciata Carpenter	S	X	Clk		P
Alaba catalinensis Bartsch	V				S
Alaba jeannettae Bartsch	V				S
Hipponix antiquatus (Linnaeus)			Clk		P
Hipponix tumens Carpenter	V		Clk		P
Crepidula adunca Sowerby		X	Clk		P
Crepidula excavata (Broderip)	S		Old		P
Crepidula nummaria Gould	C	X			P
Crepidula onyx Sowerby	A		Old		P
Crepipatella lingulata (Gould)	C	X			P
Crucibulum spinosum (Sowerby)	V		Clk		P
Calyptraea contorta Carpenter	C	X			P
Polinices draconis Dall	R				P
Neverita reclusiana (Deshayes)	A				P
Neverita reclusiana var. *alta* Arnold	S	X			P
Neverita reclusiana var. *imperforata* Dall	S				P
Euspira lewisii (Gould)	V				P
Sinum debile (Gould)			Clk		S
Sinum cf. *S. debile* (Gould)	V				?

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SYSTEMATIC CHECKLIST

SPECIES AND VARIETIES	1 Clark Collection	2 Woodring in Hoots, 1931	3 Grant & Gale, 1931	4 Other Authority	5 Present Distribution
Sinum scopulosum (Conrad)	S				P
Acmaea insessa (Hinds)		X			P
Tricolia compta (Gould)	C				P
Tricolia pulloides (Carpenter)	S	X			P
Tricolia variegata (Carpenter)		X			S
Pomaulax undosus (Wood)	A	X			P
Homalopoma carpenteri (Pilsbry)	C				P
Norrisia norrisi (Sowerby)	A				P
Tegula aureotincta (Forbes)	S	X			P
Tegula gallina (Forbes)	A				P
Tegula ligulata (Menke)	A	X			P
Calliostoma annulatum (Humphreys)		X			P
Calliostoma doliarium (Holten)	C				P
Calliostoma gemmulatum Carpenter	C				P
Calliostoma gloriosum Dall	V				P
Calliostoma cf. *C. splendens* Carpenter			Old		?
Calliostoma supragranosum Carpenter	V	X			P
Calliostoma tricolor Gabb	S				P
Turcica caffea Gabb	V				P
Pupillaria optabilis (Carpenter)	A	X			P
Vitrinella? sp.	V				S
Skenea californica (Bartsch)	V				P
Diodora aspera Eschscholtz			Old		P
Megatebennus bimaculatus (Dall)	V				P
AMPHINEURA					
Leptochiton clarki Berry				Ber	E
Mopalia acuta (Carpenter)	R			Ber	P
Acanthochitona avicula (Carpenter)				Ber	P
Ischnochiton acrior Carpenter	R			Ber Cha	S
Ischnochiton conspicuus Carpenter	V	X		Ber Cha	P
Ischnochiton pectinulatus Carpenter	R			Ber	P
Ischnochiton sanctaemonicae Berry	A			Ber Cha	E
Callistochiton crassicostatus Pilsbry	C			Ber Cha	P
Callistochiton palmulatus var. *mirabilis* Pilsbry	A			Ber Cha	P

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EXPLANATION OF PLATE 13

Figs. 1, 2. *Bivetopsia bullata* (Sowerby), approximately natural size. Hypotype, U.C.L.A. coll., no. 27480. Length, 45 mm., diameter of last whorl, 34 mm. U.C.L.A. Loc. no. 3225.

Figs. 3, 4. *Diacria trispinosa* (Lesueur), approximately X 5¼. Hypotype, U.C.L.A. coll., no. 27381. Length, incomplete, 7.6 mm., width, incomplete, 6.5 mm. U.C.L.A. Loc. no. 3225.

Figs. 5, 6. *Calliostoma gloriosum* Dall, approximately X 2. Hypotype, U.C.L.A. coll., no. 27482. Length, 17 mm., diameter of last whorl, 13 mm. U.C.L.A. Loc. no. 3225.

Figs. 7, 8. *Hanetia elegans* Dall, approximately natural size. Hypotype, U.C.L.A. coll., no. 27483. Length, 41 mm., diameter of last whorl, 26 mm. U.C.L.A. Loc. no. 3225.

Fig. 9. *Engina strongi* Pilsbry & Lowe, approximately X 2. Hypotype, U.C.L.A. coll., no. 27484. Length, 14 mm., diameter of last whorl, 8 mm. U.C.L.A. Loc. no. 3225.

Fig. 10. *Sulcoretusa xystrum* (Dall), approximately X 15½. Hypotype, U.C.L.A. coll., no. 27485. Length, 1.7 mm., greatest diameter, 0.8 mm. U.C.L.A. Loc. no. 3225.