QUATERNARY AND RECENT MOLLUSCAN FAUNAS OF THE WEST COAST OF LOWER CALIFORNIA

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INTRODUCTION

The Quaternary and Recent life of the West Coast of North America offers peculiar advantages for the study of climatic and faunal relations. Not only is the representation of species very large in each horizon, but the division into distinct faunas, mainly dependent upon conditions of temperature, is pronounced and sharp. The relations between the Recent and Quaternary of Upper California have been made well known through the works of Ralph Arnold, James Perrin Smith, William Healey Dall, and many others. Smith* has recently published a general summary of the subject. To lower California, however, no such intensive study has been given. Smith, in the above cited paper, included a brief discussion of Lower Californian faunas, and listed a few species from one of the Quaternary localities here discussed. Papers by Carpenter, Dall, Stearns, Bartsch, and others, contain descriptions of living shells taken here and there along the coast, and Dall** has recently recorded species from the Quaternary at Magdalena Bay and San Quentin Bay. Yet our present knowledge of the recent and extinct life of the west coast of the peninsula is not at all comparable to that of the region farther North, although the problems in Lower California are of no less interest and significance. Furthermore, when our acquaintance with the West American Recent, Quaternary and Tertiary is complete, we shall probably discover them to offer one of the finest laboratories existing for the study of the development of species and of their adaptations to changing environment, and, again, the principles of highly refined correlation here developed will hold for Cenozoic stratigraphic work in any region.

The present paper is intended as a contribution toward the general end; it comprises notes on three marine deposits of Quaternary age on the west coast of Lower California, including an attempt at correlation with the already defined horizons of Upper California, also a list, based upon the Henry Hemphill and other collections now at Stanford University, of extensions in range,

*Climatic Relations of the Tertiary and Quaternary Faunas of the Californian Region. Proc. Calif. Acad. Sci., 4th Series, Vol. IX, 1919, pp. 123-173.

**Magdalena Bay, Nautilus, Vol. XXXII, 1918, pp. 23-26.
San Quentin Bay, West American Scientists, Vol. XIX, 1921, pp. 17-23.

previously unreported, of numerous Lower Californian Mollusks. It is to be hoped that we shall soon know the entire living fauna of Lower California, with the full distribution of all of the species, for it is only through such accurate knowledge that the relations between the recent and fossil faunas become clear. As yet, however, much remains to be done in the way of extensive and careful collecting.

I make grateful acknowledgment of the help given by Dr. James Perrin Smith, who first interested me in this study, also to Mrs. Ida Shephard Oldroyd, for frequent aid in the determination of species, and for continued assistance in other ways. Finally, I am indebted to Dr. William Healey Dall and Dr. Paul Bartsch, who have very kindly determined a number of difficult species, as later indicated.

The marine life of the west coast of North America may be divided into several distinct faunas, each consisting of an assemblage of species of which a large number are confined to a certain definite region. It is true that there are many forms not so confined, some even ranging from the tropics northward into the cool temperate zone. But each fauna as a whole reveals a decidedly characteristic aspect, and many of the component species exist successfully only under the climatic conditions prevailing in the particular faunal zone. Species so limited thus become diagnostic. In any assemblage of species, the presence of many such, even with the inevitably large number of forms of unconfined range, indicates the fauna and faunal zone, and consequently, the climatic conditions under which the assemblage lived.

Two distinct faunas exist on the west coast of Lower California. The Southern Californian now ranges southward from Point Conception to Cedros Island in Lower California. It probably extends a little farther around the great bend at Cedros, and reaches perhaps to San Hipolito Point. Beyond this general limit the characteristic species are rapidly eliminated. The fauna of the Gulf of California ranges to the north on the west coast of the peninsula approximately to Scammon's Lagoon, which is a little farther up than Cedros Island. Thus, north of Scammon's Lagoon we find living only the species of the Southern Californian fauna; between Scammon's Lagoon and the neighborhood of San Hipolito Point there is an overlapping of the Southern Californian and the Gulf faunas, both probably existing almost complete, and in about equal numbers, together, on Cedros Island. South of San Hipolito Point, or, at most, south of San Ignacio Lagoon, we find living under present climatic conditions only the warmer-water types of the Gulf of California, with none of the characteristic northern species of the Southern Californian fauna. Species of unconfined range, of course, are to be considered common to both faunas, and characteristic of neither.

Arnold* has recognized two distinct horizons in the Quaternary of Southern California. The Lower San Pedro series carries a cool water fauna marked particularly by *Pecten islandicus* Mull., *Pecten caurinus* Gld., *Venericardia barbarensis* Stearns, *Cardium corbis* Mart., *Saxidomus giganteus* Desh., *Trophon multicostata* Esch., *Natica clausa* Brod. and Sby., and other northern species. There are very few truly southern types in the assemblage. Thus the climate of the Lower San Pedro was distinctly less warm than the present, and a southward displacement of the isotherms brought a northern fauna down into the San Pedro region, where, however, it now no longer exists. Above, and in general unconformity with the Lower San Pedro, lie the Upper San Pedro beds. In these the distinctly northern forms of the older horizon are practically absent, and the fauna closely resembles that now living in Southern California, though with a small but evident influx of warmer water types from the Gulf. *Pecten subnodosus* Sby., *Pecten dentatus* Sby., *Cardium procerum* Sby., *Chione gnidia* Sby., *Dosinia ponderosa* Gray, *Euplcura muriciformis* Brod., *Mellita longifissa* Mich., etc., are characteristic species. It accordingly becomes evident that the Upper San Pedro was a warm time, a little more tropical than the present.

In the Southern Californian Quaternary, therefore, we find beds of two distinct horizons, deposited under quite different climatic conditions, as indicated by comparison of the fossil faunas with the recent. Further, we may reasonably expect that along the Lower Californian coast to the South of San Pedro, there existed in Quaternary time similar conditions of deposition and of climatic change, and we may well look there for two distinct quaternary horizons, one with a fauna of cooler-water aspect than that of the region at present, the other similar to the living fauna, or perhaps of a slightly more tropical character. These differences should become less sharp as one goes south, for faunal zones are broad and ill-defined in the tropics, but the displacement should be more or less apparent for a considerable distance beyond San Pedro.

LOWER QUATERNARY OF MAGDALENA BAY

At Stanford University we have collections made by E. Call Brown and Richard C. McGregor from the Quaternary at Magdalena Bay. Unfortunately, no notes accompany the collections, and no locality more definite than "Magdalena Bay," is given. It is sure, however, that most of the material came from the same place, and quite probable that it is all out of the same horizon, although of the latter fact one cannot be entirely certain. The general conclusions as to the relations of the fauna would, nevertheless, not be greatly altered by the presence in the list of a few forms not properly belonging with the others.

*The Paleontology and Stratigraphy of the Marine Pliocene and Pleistocene of San Pedro, California. Mem. Calif. Acad. Sci., Vol. III, 1903.

I give below a list of the species obtained, accompanied by the living range of each as far as it is known. These ranges are important to the extent that they locate the species in one fauna or the other, or indicate a position common to both. They should, however, not be taken to be of greater significance, for they are undoubtedly incomplete. Those species belonging only to one or the other fauna are designated by a letter after the name. N (northward) shows that they are characteristic of the Southern Californian fauna; S., that they belong only to the Gulf fauna. Others apparently non-diagnostic are unmarked. Species determined by Dr. Dall are indicated by the asterisk (*); the imperfect specimen of *Bittium larum* was doubtfully named by Dr. Bartsch.

List of Species from the Lower Quaternary at Magdalena Bay

ECHINODERMATA

SPECIES	LIVING RANGE
Encope grandis Agassiz S	Magdalena Bay, to Gulf of California.
Encope micropora Agassiz S	Magdalena Bay, to Gulf of California.

PELECYPODA

Leda taphria Dall N	Bodega Bay, California to Lower California.
Leda penderi Dall N	Queen Charlotte Islands, B. C. to Santa Barbara Islands.
Leda* sp. aff. callimene Dall (young)	
Arca* solida Broderip and Sowerby	San Pedro, to Paita, Peru.
Arca tuberculosa Sowerby S	Ballenas Lagoon, L. Cal., to Peru.
Ostrea palmula Carpenter	San Diego to Gulf.
Pecten subnodosus Sowerby S	Scammon's Lagoon, L. Cal. to Guayaquil, Ecuador.
Pecten latiauritus Conrad N	Monterey to L. Cal.
Pecten circularis Sowerby	Monterey to Paita.
Hinnites giganteus Gray N	Aleutian Islands to Magdalena Bay.
Pododesmus macroschismus Deshayes N	Alaska to L. Cal.
Septifer bifurcatus (Conrad) Reeve	Crescent City, Calif. to Gulf.
Modiolus fornicatus Carpenter N	Trinidad, Cal., to Cortez Bank, off San Diego.
Cardita subquadrata Carpenter N	Queen Charlotte Islands to Pt. Santo Tomas, L. Cal.
Chama pellucida Sowerby	Oregon to Chile.
Diplodonta orbella Gould	Alaska to Gulf.
Diplodonta sericata Reeve	Santa Catalina Island to Panama.
Phacoides *cancellaris Philippi S	Cedros Island, to Panama.
Phacoides *lamprus Dall S	Gulf of Cal.
Phacoides approximatus Dall	Monterey to Panama.
Phacoides nuttallii Carpenter	Santa Barbara to Mazatlan.
Phacoides *mazatlanicus Carpenter	Mazatlan.
Phacoides richthofeni Gabb	San Pedro to Cape San Lucas.
Divaricella perparvula Dall S	Cape San Lucas to Ecuador.
Kellia laperousii Deshayes N	Bering Sea to Pt. Santo Tomas, L. Cal.
Cardium substriatum Conrad	Santa Catalina Island to Acapulco.
Cardium consors Sowerby S	Gulf to Guayaquil.
Cardium procerum Sowerby S	Scammon's Lagoon, L. Cal. to Peru.
Cardium biangulatum Sowerby	San Pedro to Guayaquil.
Cardium elatum Sowerby	San Pedro to Panama.
Cardium graniferum Sowerby S	Gulf to Guayaquil.
Tivela stultorum Mawe N	Halfmoon Bay, Cal. to Socorro Island, off West Coast of Mexico.
Macrocallista squalida Sowerby S	Scammon's Lagoon to Peru.
Macrocallista aurantiaca Sowerby S	Gulf to Guayaquil.
Saxidomus nuttallii Conrad N	Humboldt Bay to San Diego.
Chione fluctifragra Sowerby	San Pedro to Gulf.
Chione mariae Orbigny S	Gulf to Guayaquil.
Chione undatella Sowerby	San Pedro to Guayaquil.
Chione succincta Valenciennes	San Pedro to Panama.
Paphia staminea Conrad N	Alaska to Soccorro Island.
Paphia grata Say S	Turtle Bay, L. Cal. to Antofagasta, Chile.

SPECIES	LIVING RANGE
Tellina bodegensis Hinds	Queen Charlotte Islands to Gulf.
Tellina carpenteri Dall	Forrester Island, Alaska to Gulf.
Tellina rubescens Hanley S	Scammon's Lagoon to Tumbes, Peru.
Metis alta Conrad N	Santa Barbara to San Diego.
Macoma nausta Conrad N	Alaska to Scammon's Lagoon.
Macoma secta Conrad	Vancouver, B. C. to Gulf.
Semele rubropicta Dall N	Forrester Island to Tia Juana, L. Calif.
Donax punctatostriata Hanley	San Pedro to Paita.
Donax conradi Deshayes	San Pedro to Central America.
Tagelus californianus Conrad	Santa Barbara to Gulf of Techuantepec.
Solen sicarius Gould N	Vancouver Island to San Quentin Bay, L. Cal.
Mulinia *coloradoensis Dall	
Cryptomya californica Conrad	Alaska to Topolobampo, Mexico.
Corbula porcella Dall	Santa Rosa Island to Panama.

SCAPHOPODA

Dentalium neohexagonum Sharp and Pilsbry	Monterey to Guacomayo, Central America.

GASTROPODA

*Acteocina culcitella Gould N	Alaska to Manuel's Lagoon, L. Cal.
Terebra larvaeformis Hinds S	Gulf to Panama.
Tereba robusta Hinds S	Gulf to Panama.
Terebra specillata Hinds	San Pedro to San Blas, Mexico.
Terebra variegata Gray S	Scammon's Lagoon to Galapagos Islands.
Conus *puncticulatus Hwass S	Gulf to Costa Rica.
Conus *tornatus Broderip S	Cedros Island to Ecuador
Conus *interruptus Broderip S	Magdalena Bay to Panama
Conus californicus Hinds N	Farallones Islands, Calif. to Ballenas Lagoon, L. Cal.
Conus purpurascens Broderip S	Magdalena Bay to Paita
Turricula *burragei Bartsch	
Cryptoconus carpenterianus Gabb N	Bodega Bay to San Pedro
Clathrodrillia ophioderma Dall N	Bolinas Bay to Ballenas Lagoon, L. Cal.
Oliva angulata Linnaeus S	Magdalena Bay to Peru
Olivella biplicata Sowerby	Vancouver Island to Central America.
Olivella dama Mawe S	Gulf
Olivella porteri Dall	Redondo, Calif. to Magdalena Bay.
Kellettia kellettii Forbes N	Santa Barbara to San Quentin Bay
Macron aethiops Reeve	San Quentin Bay to Gulf
Solenosteira pallida Broderip and Sowerby S	San Ignacio Lagoon to Panama
Cantharus elegans Gray S	Pt. Abreojos to Peru
Alectrion mendica Gould N	Alaska to Magdalena Bay
Alectrion cerritensis Arnold	Long Beach to Gulf
Alectrion tegula Reeve	San Francisco to Mazatlan
Alectrion perpinguis Hinds N	Puget Sound to Cedros Island
Alectrion fossata Gould N	Puget Sound to San Ignacio Lagoon
Alectrion californiana Conrad N	Coast of Oregon to Magdalena Bay
Columbella strombiformis Lamarack S	Cape San Lazaro, L. Cal. to Paita
Columbella carinata Hinds	San Francisco Bay to Cape San Lucas
Nitidella ocellata Gmelin S	Magdalena Bay to Guayaquil
Triremis festiva Hinds N	Santa Barbara to San Ignacio Lagoon
Thais biserialis Blainville	La Jolla to Peru
Acanthina lugubris Sowerby	San Diego to Galapagos Islands
Bursa californica Hinds N	Monterey to Cedros Island
Ficus decussatus Wood S	Gulf to Ecuador
Strombus gracilior Gray S	Gulf to Manta Ecuador
Strombus granulatus Gray S	Gulf to Guayaquil
Cerithium gemmatum Hinds S	Gulf to Panama
Cerithium ocellatum Bruguiere S	Magdalena Bay to Galapagos Islands
Cerithium adustum Kiener S	Magdalena Bay to Galapagos Islands
Bittium larum (?) Bartsch N	San Pedro to San Bartolome Bay, L. Cal.
Cerithidea californica Haldeman N	Bolinas Bay to San Ignacio Lagoon
Cerithidea montagnei Orbigny S	San Ignacio Lagoon to Chile
Turritella goniostoma Valenciennes S	Scammon's Lagoon to Peru
Turritella cooperi Carpenter N	Monterey to San Diego
Hipponix tumens Carpenter N	Crescent City to San Diego
Crepidula *lingulata Gould	Bering Sea to Panama
Crepidula onyx Sowerby	Monterey to Panama
Crucibulum spinosum Sowerby	Trinidad to Chile
Crucibulum imbricatum Sowerby	La Jolla to Peru

SPECIES	LIVING RANGE
Polinices lewisii Gould N	British Columbia to San Pedro
Polinices recluziana Deshayes	Crescent City to Tres Marias Islands
Lottia gigantea Gray N	Crescent City to Cedros Island
Turbo fluctuosus Wood S	Cedros Island to Peru
Astraea undosa Wood N	Laguna Beach, Cal. to Cedros Island
Norrisia norrisii Sowerby N	Monterey to Cedros Island, L. Cal.
Tegula aureotincta Forbes	Santa Barbara Island to Magdalena Bay, L. Cal.
Tegula ligulata Menke	Monterey to Acapulco
Calliostoma gloriosum Dall N	San Francisco to San Diego
Calliostoma *eximium Reeve	Santa Catalina Island to Mazatlan
Calliostoma tricolor Gabb N	Santa Cruz, Cal. to Magdalena Bay
Megathura crenulata Sowerby N	Monterey to Cedros Island
Lucapinella callomarginata (Carpenter) Dall N	Bodega Bay to Magdalena Bay
Ischnochiton conspicuus Carpenter	Monterey to Gulf

Resumé

Pelecypoda	57
Scaphopoda	1
Gastropoda	66
Total Species	124
Species characteristic of Gulf of California Fauna	37
Species characteristic of Southern California Fauna	38
Species not characteristic of either Fauna	49

The above resumé clearly shows the character of the assemblage. Excluding those forms of wide range not particularly characteristic of any fauna, the others are about equally divided between species characteristic of the Gulf fauna and those of the Southern Californian. This condition prevails at present about Cedros Island, where the two faunas overlap, with large representation of each. It is not the condition now prevalent in the latitude of Magdalena Bay, for, as previously stated, practically all of the characteristic cooler water types are eliminated some distance north of the Bay and the Gulf fauna alone exists there.

It thus appears that when these quaternary beds were laid down there was a southward displacement of the isotherms sufficient to carry the conditions today prevailing at Cedros down as far as the latitude of Magdalena Bay. This was not a large displacement, and it would be most surprising to find any such violent changes in temterature here, approaching the tropics, as occurred in the San Pedro region, but the indication of a somewhat cooler period is certainly strong. Again, if we assume the displacement, the beds at Magdalena should be correlated in a general way with the Lower San Pedro Series of Upper California, which belonged to the cool time of the Quaternary. Not, of course, that these deposits are to be put into the San Pedro series proper, for here, far to the south, we have a fauna quite different from that of the Lower San Pedro, but an equivalence in time is certainly indicated.

Out of the foregoing list the following species may be selected as most suggestive of the cooler conditions: **Leda taphria** Dall, **Modiolus fornicatus** Cpr., **Saxidomus nuttallii** Conr., **Paphia staminea** Conr., **Solen sicarius** Gld., **Cryptoconus carpenterianus** Gabb, **Kellettia kelletii** Forbes, and **Polinices lewisii** Gld.

UPPER QUATERNARY OF MAGDALENA BAY

The Quaternary fossils reported from Magdalena Bay by Dall were collected on Magdalena Island. Sixty-five species, in all, were recognized by him—not a great number but surely enough to indicate in a general way the character of the fauna. Dall concludes that "on the whole the assembly has a more tropical aspect than that of the recent fauna." It is at least certain that these species lived under conditions no cooler than those now obtaining at Magdalena, and the assemblage appears quite different from that collected by

Brown and McGregor. Dall's list contains only two or three species characteristic of the Southern Californian fauna; the remainder are all either of wide distribution, or are distinctly Gulf of Californian, of which latter type the percentage is very large. It therefore seems that the beds in question should be correlated with the warm Upper San Pedro, or Upper Quaternary,—again not as the same formation, but as one of similar age.

It is hoped that with farther field work the presence of two distinct Quaternary formations in the Magdalena Bay region may be verified. More extensive collecting, with coincident study of the geologic relations would settle the question. There is always an element of doubt entering into conclusions such as these when the field conditions are imperfectly known.

UPPER QUATERNARY OF SAN IGNACIO LAGOON

A small collection was made by C. R. Swarts and T. J. Cullen from Quaternary deposits near San Ignacio Lagoon. According to a note accompanying the material, it came from a raised beach some five to seven miles inland. The following are recognized:

PELECYPODA

SPECIES	LIVING RANGE
Glycimeris giganteus Reeve S	Gulf of Cal. to Peru
Ostrea palmula Carpenter	San Diego to Gulf.
Pecten circularis Sowerby	Monterey to Paita.
Phacoides nuttallii Conrad	Santa Barbara to Mazatlan.
Cardium procerum Sowerby S	Scammon's Lagoon to Peru.
Cardium substriatum Conrad	Santa Catalina Island to Acapulco
Chione succincta Valenciennes	San Pedro to Panama.
Chione gnidia Broderip and Sowerby S	Cedros Island to Paita.
Tellina modesta Carpenter N	Vancouver Island to L. Cal.
Tellina reclusa Dall S	San Ignacio Lagoon, L. Cal. to Gulf.
Macoma inquinata Deshayes N	Alaska to San Pedro.
Macoma yoldiformis Carpenter N	Puget Sound to San Diego.
Anatina undulata Gould	San Pedro to Panama.
Mactra californica Conrad N	Coast of Washington to Manuel's Lagoon, L. Cal.
Corbula luteola Carpenter	Monterey to Acapulco.

SCAPHOPODA

Dentalium pretiosum Sowerby N	Forrester Island, Alaska to San Diego.

GASTROPODA

*Turricula burragei Bartsch S	Gulf.
Olivella pedroana Conrad	Puget Sound to Cape San Lucas.
Olivella dama Mawe S	Gulf.
Olivella inconspicua C. B. Adams S	Gulf to Panama.
Oliva angulata Linnaeus S	Magdalena Bay to Peru.
Oliva spicata Bolten S	San Ignacio Lagoon to Peru.
Fusinus dupetithouarsii Kiener S	La Paz, L. Cal. to Galapagos Islands.
Nitidella ocellata, Gmelin S	Magdalena Bay to Guayaquil.
Phyllonotus bicolor Valenciennes S	Guaymas to Paita.
Phyllonotus radix Lamarck S	Scammon's Lagoon to Paita.
Eupleura muriciformis Broderip S	Gulf to Colombia.
Strombus graoilior Sowerby S	Gulf of Cal. to Manta, Ecuador.
Cerithium ocellatum Sowerby S	Magdalena Bay to Galapagos Islands.
Cerithidea californica Haldeman N	Bolinas Bay to Scammon's Lagoon.
Polinices recluziana Deshayes	Crescent City to Tres Marias Islands.
Calliostoma tricolor Gabb	Santa Cruz to Magdalena Bay.

Resumé

Pelecypoda	15
Scaphopoda	1
Gastropoda	16
Total species	32
Species Characteristic of Gulf of Californian Fauna	16
Species Characteristic of Southern Californian Fauna	6
Species not Characteristic of either Fauna	10

The above list is rather short to serve as a basis for any definite conclusions. San Ignacio Lagoon lies north of Magdalena Bay, and is at present about the southern limit of the Southern Californian faunal zone. Taking the list for what it may be worth, however, the assemblage appears very like what would be expected in the Recent fauna of the Lagoon. There is no excess of northern species over those now living in the region, and there is little doubt that the beds are younger than the cold Lower Quaternary. Lacking fuller knowledge of the fauna, the correlation seems to be with the upper beds of Magdalena Island.

UPPER QUATERNARY OF SCAMMON'S LAGOON

In 1921, B. F. Hake collected the following Quaternary fossils from raised beaches near Scammon's Lagoon:

PELECYPODA

SPECIES	LIVING RANGE
Arca pacifica Sowerby S	Scammon's Lagoon to Paita.
Pecten circularis Sowerby	Monterey to Paita.
Phacoides nuttallii Conrad	Santa Barbara to Mazatlan, Mexico.
Cardium procerum Sowerby S	Scammon's Lagoon to Peru.
Macrocallista squalida Sowerby S	Scammon's Lagoon to Peru.
Chione succincta Valenciennes	San Pedro to Panama.
Chione fluctifragra Sowerby	San Pedro to Gulf.
Tagelus californianus Conrad	Santa Barbara to Gulf of Tehuantepec.
Mactra californica Conrad N	Coast of Washington to Manuel's Lagoon.

GASTROPODA

Bullaria punctulata A. Adams S	Gulf to Peru.
Turricula maculosa Sowerby S	Gulf to Guayaquil.
Olivella dama Mawe S	Gulf.
Macron aethiops Reeve	San Quentin Bay to Gulf.
Columbella strombiformis Lamarck S	Cape San Lazaro, L. Cal. to Paita.
Murex recurvirostris Broderip S	Scammon's Lagoon to Ecuador.
Phyllonotus radix Gmelin S	Scammon's Lagoon to Paita.
Phyllonotus bicolor Sowerby S	Guaymas to Paita.
Cerithium ocellatum Bruguiére S	Magdalena Bay to Galapagos Islands.
Cerithidea californica Haldeman N	Bolinas Bay to San Ignacio Lagoon.
Turritella goniostoma Valenciennes S	Scammon's Lagoon, L. Cal. to Peru.
Crucibulum imbricatum Sowerby	La Jolla to Peru.
Polinices recluziana Deshayes	Crescent City to Tres Marias Islands.
Modulus cerodes A. Adams S	Gulf to Galapagos Islands.
Turbo fluctuosus Wood S	Cedros Island to Peru.

Resumé

Pelecypoda	9
Gastropoda	15
Total Species	24
Species Characteristic of Gulf of Californian Fauna	14
Species Characteristic of Southern Calfiornian Fauna	2
Species not Characteristic of either Fauna	8

This list is very short; the Gulf of Californian aspect is nevertheless most striking. With but two exceptions, indeed, the characteristic species are all of the south, yet Scammon's Lagoon is well within the present range of the Southern Californian fauna, and it is somewhere near there that the Gulf fauna is now extinguished. While no definite conclusions can be based on this small number of species, what we have would indicate conditions warmer than the present, and would provisionally correlate the deposits with the Upper San Pedro and with the beds of Magdalena Island.

EXTENSIONS IN RANGE OF LOWER CALIFORNIAN MOLLUSKS

The remainder of this paper comprises a list of ranges of some Lower Californian mollusks as extended by previously unreported localities from material at Stanford University mainly obtained from Mr. Henry Hemphill who made considerable collections at various points on the West Coast of the peninsula. While many of Hemphill's localities have been recorded in one way or another, no general

report was ever made. His material and notes more or less extend the known range of some one hundred and fifty species, as given below together with a few records based on various small lots from different sources. The other extreme of the range as far as known is given for each species. In every case the name of the collector appears with the new locality. An attempt has been made to keep in accord with the latest accepted nomenclature, though where a species is not listed in any of Dall's recent papers, this has in some cases been found difficult. Species from the Hemphill collection are marked H.

PELECYPODA

SPECIES	LIVING RANGE
Arca labiosa Sowerby	Scammon's Lagoon (H) to Tumbes, Peru.
Arca reeviana Orbigny	Manuel's Lagoon (H) to Tumbes, Peru.
Arca pacifica Sowerby	Scammon's Lagoon, L. Cal. (H) to Tumbes, Peru.
Arca reticulata Gmelin	San Pedro, Calif. (O) to Ecuador.
Pinna rugosa Sowerby	Manuel's Lagoon, L. Cal. (H) to Panama.
Melina chemnitziana Orbigny	San Ignacio Lagoon, L. Cal. (H) to Panama.
Margaritiphora sterna Gould	San Diego, Cal. *(Kelsey) Scammon's Lagoon, L. Cal. (H) to Panama.
Ostrea amara Carpenter	San Diego, Cal.*
Ostrea conchaphila Carpenter	San Diego, Calif.* (K) San Ignacio Lagoon, L. Cal. (H) to Mazatlan.
Pecten subnodosus Sowerby	Scammon's Lagoon, L. Cal. (H) to Guayaquil.
Lima pacifica Orbigny	Lower California (C) to Guayaquil.
Spondylus crassisquama Lamarck	Scammon's Lagoon, L. Cal. (H) to Guayaquil.
Modiolus modiolus Linnaeus	San Ignacio Lagoon, L. Cal. (H) to Bering Sea.
Modiolus mutabilis Carpenter	San Ignacio Lagoon, L. Cal. (H) to Ecuador.
Thracia curta Conrad	San Hipolito Pt., L. Cal. (H) to Ecuador.

*The localities of San Diego in Kelsey's collection may be open to question.

Lyonsia californica Conrad	Manuel's Lagoon, L. Cal. (H) to Bering Sea.
Mytilimeria nuttallii Conrad	Round Island, L. Cal. (H) to Vancouver Island.
Crassatellites margarita Carpenter	Santa Catalina Island, Cal. (H), San Hipolito Pt., L. Cal. (H) to Mazatlan.
Cardita affinis Sowerby	Pequeña Bay, L. Cal. (H) to Panama.
Cardita subquadrata Carpenter	Pt. Santo Tomas, L. Cal. (H) to Queen Charlotte Island.
Kellia laperousii Deshayes	Pt. Santo Tomas, L. Cal. (H) to Bering Sea.
Rochefortia tumida Carpenter	Scammon's Lagoon, L. Cal. (H) to Shumargin Island, Alaska.
Serridens oblonga Carpenter	San Hipolito Pt. L. Cal. (H) to San Pedro, Calif.
Cardium procerum Sowerby	Scammon's Lagoon, L. Cal. (H) to Lobos Islands, Peru.
Cardium aspersum Sowerby	Manuel's Lagoon, L. Cal. (H) to Guayaquil.
Tivela byronensis Gray	Lagoon Heads, L. Cal., (H) to Guayaquil, Ecuador.
Tivela planulata Broderip and Sowerby	Magdalena Bay, L. Cal. (H) to Coquimbo, Chile.
Transennella tantilla Gould	San Hipolito Pt., L. Cal. (H) to Sitka.
Macrocallista squalida Sowerby	Scammon's Lagoon, L. Cal. (H) to Peru.
Cyclinella singleyi Dall	Scammon's Lagoon, L. Cal. (H) to Gulf of California.
Chione kellettii Hinds	Todos Santos Bay, L. Cal. (U. S. N. M.) to Panama.
Paphia grata Say	Turtle Bay, L. Cal., (H) to Antofagasta, Chile.
Petricola cognata C. B. Adams	Scammon's Lagoon, L. Cal. (H) to Panama.
Petricola tenuis A. Adams	San Ignacio Lagoon, L. Cal. (H) to Panama.
Petricola robusta Sowerby	Cape San Lucas, L. Cal. (C) to Guayaquil.

SPECIES	LIVING RANGE
Tellina crystallina Wood	Scammon's Lagoon, L. Cal., (H) to Guayaquil.
Tellina ochracea Carpenter	San Ignacio Lagoon (H) to Gulf of California.
Tellina rubescens Hanley	Scammon's Lagoon, L. Cal., (H) to Tumbes, Peru.
Macoma indentata Carpenter	Scammon's Lagoon, L. Cal. (H) to Puget Sound.
Semele decisa Conrad	Pt. Abreojos, L. Cal. (H) to San Pedro.
Semele flavescens Gould	San Pedro (Oldroyd) Scammon's Lagoon, L. Cal. (H) to Callao, Peru.
Semele venusta A. Adams	Scammon's Lagoon, L. Cal. (H) to West Colombia.
Mactra californica Conrad	Neah Bay, Washington to Manuel's Lagoon, L. Cal. (H).
Spisula hemphilli Dall	Todos Santos Bay, L. Cal. (H) to San Pedro.
Spisula falcata Gould	Manuel's Lagoon, L. Cal. (H) to Puget Sound.
Schizothaerus nuttallii Conrad	Scammon's Lagoon, L. Cal. (H) to Wrangel, Alaska.
Panopea generosa Gould	Scammon's Lagoon, L. Cal. (H) to Puget Sound.
Corbula luteola Carpenter	Acapulco, Mexico (Arnold) to Monterey.
Gastrochaena ovata Sowerby	Scammon's Lagoon, L. Cal. (H) to La Plata Island, Ecuador.
Barnea pacifica Stearns	Scammon's Lagoon, L. Cal. (H) San Francisco Bay.
Zirfaea gabbi Tryon	Scammon's Lagoon, L. Cal. (H) to Bering Sea.
Pholadidea penita Conrad	Pt. Abreojos, L. Cal. (H) to Alaska.
GASTROPODA	
Acteocina culcitella Gould	San Ignacio Lagoon, L. Cal. (H) to San Pedro.
Williamia vernalis Dall	Galapagos Islands.
Terebra variegata Gray	Manuel's Lagoon, L. Cal. (H) to Kodiak Island, Alaska.
Terebra pedroanum Dall	City, Calif.
Terebra larvaeformis Hinds	San Hipolito Pt., L. Cal. (H) Crescent Scammon's Lagoon, L. Cal. (H) to Guayaquil .
Conus fergusoni Sowerby	Magdalena Bay, L. Cal. (H) to Galapagos Islands.
Conus scalaris Valenciennes	Scammon's Lagoon, L. Cal. (H) to Gulf of California.
Conus regularis Sowerby	Scammon's Lagoon, L. Cal. (H) to Panama.
Cymatosyrinx pudica Hinds	Scammon's Lagoon, L. Cal. (H) to Central America.
Pseudomelatoma torosa Carpenter	San Ignacio Lagoon, L. Cal. (H) to Monterey.
Pseudomelatoma moesta Carpenter	Pt. Abreojos, L. Cal. (H) to Monterey.
Philbertia sculpta Hinds	Scammon's Lagoon, L. Cal. (H) to Panama.
Mangilia hamata Carpenter	San Diego, Calif. (Gripp) Pt. Abrejos, L. Cal. (H) to Panama.
Cancellaria obesa Sowerby	Pt. Abreojos, L. Cal. (H) to Guayaquil, Ecuador.
Cancellaria goniostoma Sowerby	Pt. Abreojos, L. Cal. (H) to Central America.
Oliva spicata Bolten	Pt. Abreojos, L. Cal. (H) to Guayaquil.
Olivella anazora Duclos	Pequeña Bay, L. Cal. (H) to Xipixapi, Colombia.
Olivella volutella Lamarck	Magdalena Bay, L. Cal. (H) to Palta.
Harpa crenata Swainson	Margarita Island, L. Cal. (Johnson) to Panama.
Marginella jewettii Carpenter	San Hipolito Pt., L. Cal. (H) to Monterey.
Marginella subtrigona Carpenter	Pt. Abreojos, L. Cal. (H) to Monterey.
Cypraeolina margaritula Carpenter	San Hipolito Pt., L. Cal. (H) to Mazatlan.
Macron lividus A. Adams	Pt. Abreojos, L. Cal. (H) to Farallones Islands, Cal.
Galeodes patulus Broderip	San Ignacio Lagoon, L. Cal. (H) to Ecuador.
Solenosteira anomala Reeve	Magdalena Bay, L. Cal. (H) Ecuador (Stanley Herold) to Mazatlan.
Cantharus lugubris C. B. Adams	Scammon's Lagoon, L. Cal. (H) to Panama.

SPECIES	LIVING RANGE
Cantharus elegans Gray	Pt. Abreojos, L. Cal. (H) to Paita.
Sistrum ferrugineum Reeve	Pt. Abreojos, L. Cal. (H) to Gulf of California.
Alectrion californianum Conrad	Magdalena Bay, L. Cal. (H) to Coast of Oregon.
Alectrion fossatum Gould	San Ignacio Lagoon, L. Cal. (H) to Puget Sound.
Alectrion tegula Reeve	San Ignacio Lagoon, L. Cal. (H) to San Francisco.
Anachis coronata Sowerby	Scammon's Lagoon, L. Cal. (H) to Panama.
Anachis fuscostrigata Carpenter	San Hipolito Pt., L. Cal. (H) to Cape San Lucas.
Anachis gaskoinii Carpenter	San Hipolito Pt., L. Cal. (H) to Mazatlan.
Anachis humerosa Carpenter	San Hipolito Pt., L. Cal. (H) to Acapulco.
Anachis subturrita Carpenter	Pt. Abreojos, L. Cal. (H) to San Pedro.
Anachis tincta Carpenter	San Hipolito Pt., L. Cal. (H) to Cape San Lucas.
Anachis pulchrior C. B. Adams	San Hipolito Pt., L. Cal. (H) to Panama.
Anachis fluctuata Sowerby	San Ignacio Lagoon, L. Cal. (H) to Paita.
Columbella gausapata Gould	San Hipolito Pt., L. Cal. (H) to Port Etches, Alaska.
Columbella strombiformis Lamarck	Cape San Lazaro, L. Cal. (H) to Paita.
Aesopus hemphilli Stearns	San Diego, Cal. (H) to Pt. Abreojos, L. Cal. (H).
Nitidella gouldii Carpenter	Manuel's Lagoon, L. Cal. (H) to Kodiak Island.
Nitidella ocellata Gmelin	Magdalena Bay, L. Cal. (H) to Guayaquil.
Strombina recurva Sowerby	San Ignacio Lagoon, L. Cal. (H) to Guayaquil.
Murex recurvirostris Broderip	Scammon's Lagoon, L. Cal. (H) to Ecuador.
Murex elenensis Dall	Scammon's Lagoon, L. Cal. (H) to Guayaquil.
Murex trialatus Sowerby	San Ignacio Lagoon, L. Cal. (H) to Bodega Bay, Calif.
Murex leeanus Dall	Scammon's Lagoon, L. Cal. (H) to Cedros Island.
Triremis gemma Dall	San Hipolito Pt., L. Cal. (H) to Santa Barbara.
Triremis festiva Hinds	San Ignacio Lagoon, L. Cal. (H) to Santa Barbara.
Phyllonotus radix Lamarck	Scammon's Lagoon, L. Cal. (H) to Paita.
Tritonalia hamata Hinds	San Ignacio Lagoon, L. Cal. (H) to Paita.
Tritonalia interfossa Carpenter	Pt. Santo Tomas, L. Cal. (H) to Semidi Islands, Alaska.
Purpura nuttallii Conrad	San Ignacio Lagoon, L. Cal. (H) to Monterey.
Thais patula Linnaeus	Pt. Abreojos, L. Cal. (H) to Galapagos Islands.
Thais triangularis Blainville	Margarita Island, L. Cal. (H) to Paita.
Acanthina lugubris Sowerby	San Diego, Calif. (Ritchie) Todos Santos Bay, L. Cal. (H) to Galapagos Islands.
Epitonium acapulcanum Dall	Pt. Abreojos, L. Cal. (H) to Acapulco.
Epitonium propehexagonum Dall	San Hipolito Pt., L. Cal. (H) to Mazatlan.
Melanella abreojosensis Bartsch	San Hipolito Pt., L. Cal. (H) to Pt. Abreojos, L. Cal. (H).
Melanella baldra Bartsch	Pt. Abreojos, L. Cal. (H) to San Hipolito Pt., L. Cal.
Turbonilla castanea Keep	San Hipolito Pt., L. Cal. (H) to San Pedro.
Turbonilla paramoea Dall and Bartsch	San Ignacio Lagoon, L. Cal. (H) to Panama.
Turbonilla cora Orbigny	San Hipolito Pt., L. Cal. (H) to Paita.
Turbonilla panamensis C. B. Adams	Round Island, L. Cal. (H) to Panama.
Odostomia astricta Dall and Bartsch	San Hipolito Pt., L. Cal. (H) to Monterey.
Odostomia grammatospira Dall and Bartsch	San Hipolito Pt., L. Cal. (H) to Cape San Lucas.
Odostomia navisa Dall and Bartsch	Pt. Abreojos, L. Cal. (H) to San Pedro.

SPECIES	LIVING RANGE
Odostomia aequisculpta Carpenter	San Diego, Calif. (H) to Cape San Lucas
Odostomia communis C. B. Adams	Pt. Abreojos, L. Cal. (H) to Panama
Odostomia inflata Carpenter	Monterey, Cal. (H) San Hipolito Pt., L. Cal. (H) to Neah Bay, Wash.
Cymatium wiegmanni Anton	San Ignacio Lagoon, L. Cal. (H) to Paita
Cypraea annettae Dall	Pt. Abreojos, L. Cal. (H) to Sechura Bay, Peru.
Cypraea arabicula Lamarck	San Hipolito Pt., L. Cal. (H) to Paita.
Erato vitellina Hinds	Pt. Santo Tomas, L. Cal. (H) to Bodega Bay.
Malea ringens Swainson	San Ignacio Lagoon, L. Cal. (H) to Paita.
Cyphoma emarginata Sowerby	Magdalena Bay, L. Cal. (H) to Guayaquil.
Cerithiopsis antefilosa Bartsch	San Hipolito Pt., L. Cal. (H) to San Pedro.
Cerithiopsis berryi Bartsch	Pt. Abreojos, L. Cal. (H) to Monterey, California.
Cerithiopsis gloriosa Bartsch	Pt. Abreojos, L. Cal. (H) to San Diego.
Cerithiopsis neglecta C. B. Adams	Pt. Abreojos, L. Cal. (H) to Panama.
Cerithiopsis pupiformis Carpenter	Pt. Abreojos, L. Cal. (H) to Mazatlan.
Metaxia diadema Bartsch	Pt. Abreojos, L. Cal. (H) to Monterey.
Cerithium adustum Kiener	Magdalena Bay, L. Cal. (H) to Galapagos Islands.
Cerithium interruptum Menke	Pt. Abreojos, L. Cal. (H) to Manta, Ecuador.
Cerithium ocellatum Bruguiére	Magdalena Bay, L. Cal. (H) to Galapagos Islands.
Alabina diomedeae Bartsch	Scammon's Lagoon, L. Cal. (H) to Gulf of Cal.
Bittium asperum Gabb	Ballenas Bay, L. Cal. (H) to Santa Catalina Island.
Bittium rugatum Carpenter	Santa Barbara, Cal. to Todos Santos Bay, L. Cal. (H).
Bittium interfossa Carpenter	Todos Santos Bay, L. Cal. (H) to Monterey.
Cerithidea californica Haldeman	San Ignacio Lagoon, L. Cal. (H) to Bolinas Bay.
Cerithidea montagnei Orbigny	San Ignacio Lagoon, L. Cal. (H) to Chile.
Vermiculum anellum Mörch	San Hipolito Point, L. Cal. (H) to Monterey.
Turritella goniostoma Valenciennes	Scammon's Lagoon, L. Cal. (H) to Lobos Islands, Peru.
Turritellopsis stimpsoni Dall	San Ignacio Lagoon, L. Cal. (H) to Nunivak Island, Alaska.
Littorina cognata Hemphill	Manuel s Lagoon, L. Cal. (H) to San Hipolito Pt. (H).
Littorina varia Sowerby	Magdalena Bay, L. Cal. (H) to Casma, Peru.
Littorina aspera Philippi	San Hipolito Pt., L. Cal. (H) to Panama.
Modulus disculus Philippi	Magdalena Bay, L. Cal. (H) to Acapulco.
Diala acuta Carpenter	San Hipolito Pt., L. Cal. (H) to Monterey.
Cingula kelseyi Dall	Pt. Abreojos, L. Cal. (H) to San Diego.
Rissoina firmata C. B. Adams	San Hipolito Pt. L. Cal. (H) to Panama.
Natica unifasciata Lamarck	San Ignacio Lagoon, L. Cal. (H) to Panama
Polinices uber Valenciennes	San Ignacio Lagoon, L. Cal. (H) to Callao, Peru.
Acmaea depicta Hinds	San Hipolito Pt., L. Cal. (H) to Santa Barbara.
Nerita scabricostata Lamarck	San Ignacio Lagoon, L. Cal. (H) to Ecuador.
Neritina picta Sowerby	Soledad, L. Cal. (H) to Panama.
Margarites parcipicta Carpenter	Todos Santos Bay, L. Cal. (H) to Sitka, Alaska.
Calliostoma supragranosum Carpenter.	Pequeña Bay, L. Cal. (H) to San Pedro.
Calliostoma tricolor Gabb.	Magdalena Bay, L. Cal. (H) to Santa Cruz.
Cyclostremella californica Dall and Bartsch	Pt. Abreojos, L. Cal. (H) to San Pedro.
Ischnochiton corrugatus Carpenter	Magdalena Bay, L. Cal. (H) to Santa Catalina.