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GEOLOGIC RANGE OF MIOCENE INVERTEBRATE
FOSSILS OF CALIFORNIA

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April 2, 1912

FAUNAL ZONES IN THE MIOCENE OF CALIFORNIA.

When Conrad described the Tertiary fossils of California in the Reports of the Pacific Railroad Survey, he assigned some species to the Miocene on account of a vague resemblance to Miocene species from Virginia and Maryland; but he had no positive criterion for distinguishing the various faunas. When, in 1868, Gabb wrote his monograph on the Tertiary of California, he, too, had little opportunity of distinguishing the separate faunas that make up the beautiful succession, as we know it, on the West Coast. Where the rock beds were much disturbed and hardened, he called them Miocene; and where they were little disturbed, and not lithified to any extent, he called them Pliocene. This criterion was usually right, but not always; for there are Miocene beds in California that are unconsolidated, and Pliocene beds that are turned up on edge and hardened into real rocks. In fact, the principal disturbance in the Tertiary beds of the Coast Ranges came in the mountain-making epoch at the end of Monterey, in the middle Miocene time, and, after this, several thousand feet of sandstones were laid down still containing Miocene fossils in abundance.

Later writers—Fairbanks, F. M. Anderson, Merriam, Lawson, and Arnold—have introduced a much more elaborate classification of the Neocene of California, and a large number of formation-names. But these so-called formations, however useful they may be for areal mapping and for economic geology, do not always correspond to the faunal divisions. Some of them are merely different facies of the same thing. The formations have been subdivided much more minutely than the faunas warrant.

Instead of the numerous subdivisions recognized by most stratigraphers, there are, in fact, only two major faunal units in the Miocene of California: a lower, including all the faunas up through the Monterey; and an upper, including the San Pablo, Santa Margarita, and Etchegoin faunas. The division line between them corresponds to the period of orogenic activity that came on at the end of the Monterey epoch. This marks not only a great change in the physiography of the West

Coast, but also the extinction of many of the older Miocene types, and the introduction of new forms, many of which have survived until the present time. This brings us back almost to the standpoint of Lawson and Merriam, who have proposed to call all the lower Miocene "Monterey," and all the upper Miocene "San Pablo."

The beds containing the Vaqueros, Temblor, and Monterey faunas were uplifted and somewhat hardened in the Coast Range uplift; and on the eroded flanks of this range were laid down the younger Miocene strata containing the Santa Margarita, San Pablo, and Etchegoin faunas. They too have been upturned by later disturbances, but not hardened to such a degree as were the older beds.

The fossils in these later Miocene beds not only have a much more recent appearance than those of the lower Miocene, but also the number of species still living is much greater among them. The number of these living species increases gradually as the top of the Miocene is approached, and the faunas grade over imperceptibly into the Pliocene. There is no natural boundary between Miocene and Pliocene in California, and the line is drawn between the Etchegoin and Purisima as a matter of convenience. In fact the two faunas overlap; and the formations may well do so. The Etchegoin has been called the Pliocene by F. M. Anderson, and upper Miocene by Arnold. The overlying Purisima has been called transitional by Ashley, Pliocene by Arnold, and upper Miocene by Dall. And since all these writers had good reasons for their opinions, it is safe to conclude that the line between Miocene and Pliocene should be drawn somewhere near the boundary line between the two formations.

One of the most striking characteristics of the Tertiary of California is the orderly advance toward modern life, with a constantly increasing number of modern species, and a constantly increasing number of species closely allied to recent forms. Step by step each succeeding fauna becomes more like the present life of the California coast than the preceding. This gradual change finds its explanation in the physiography of the region. All through the Tertiary the coast line of California was nearly the same as at present; for while the orogenic

disturbances during that age have been profound and far-reaching, they were longitudinal. There was here, as elsewhere in the northern hemisphere, a gradual drop from the subtropical warmth of the Eocene to the cool climate of the Pliocene, the chill of the Glacial Epoch, and then a fluctuating rise to the genial climate of the present. This has been recorded in the successive marine faunas, but the changes were so gradual that during the Neocene there was no catastrophic destruction of the inhabitants of the sea. From each geologic formation many species live on into the next. It would have delighted Lyell to see such a complete illustration of the principle he adopted for the subdivision of the Tertiary, for here we have a gradation from the Eocene with no living species, through the Miocene and Pliocene with gradually increasing number of modern forms, the Quaternary with about 90 per cent of recent species, to the present, where in the same region, out of a marine fauna of somewhere near a thousand species, over four hundred extend back into the Quaternary, and nearly a hundred extend back into the Tertiary.

TABLE OF MIOCENE FAUNAS OF CALIFORNIA.

MIOCENE	UPPER	ETCHEGOIN fauna, of the Coalinga region, of the Salinas and the San Benito valleys.
		SAN PABLO-SANTA MARGARITA faunas, of the Mt. Diablo region, Salinas valley, and the Coalinga region.
	LOWER	MONTEREY-TEMBLOR faunas, of the Contra Costa hills, Mt. Hamilton Range, Black Mountain, Santa Lucia Range, Coalinga region, Bakersfield region, Santa Ynez and Santa Monica mountains, and Santa Ana Range.
		VAQUEROS fauna, of the Santa Lucia Range, Black Mountain, the Santa Monica and Santa Ynez mountains.

As shown in the table, there are only two major faunal divisions of the Miocene: a lower, including the Vaqueros and the Monterey-Temblor faunas; and an upper, including the San Pablo-Santa Margarita and the Etchegoin faunas.

The entire Miocene fauna consists of about 300 species described, and of these about 220 are confined to the Miocene.

The entire lower Miocene, as known as present, consists of about 173 species, of which 116 are confined to lower Miocene, 25 range into upper Miocene; 11 range into Pliocene; 1 ranges

into Quaternary; and 20 persist into the Recent fauna. The percentage of Recent species in the lower Miocene fauna taken as a whole is 11 per cent.

The Vaqueros fauna consists of 56 species, of which 10 are confined to the Vaqueros, or to this and the San Lorenzo Oligocene faunas; 25 range into the Monterey-Temblor faunas; 10 range into upper Miocene; 3 into Pliocene; 1 into Quaternary; and 6 range into the Recent fauna, giving 10 per cent of living species.

The Monterey-Temblor faunas contain a total of about 154 species, of which 25 range up from Vaqueros; about 70 are confined to Monterey-Temblor; 26 range into upper Miocene; 11 into Pliocene; 1 ranges into Quaternary; and 20 persist into the Recent fauna, giving 13 per cent of Recent species.

The following characteristic species are confined to the Vaqueros fauna:

Modiolus inezanus Arnold
Pecten magnolia Conrad
Pecten vanvlecki Arnold
Pecten vaughani Arnold
Turritella inezana Conrad

Turritella inezana var. *sespeensis* Arnold
Purpura vaquerosensis Arnold
Natica inezana Conrad
Scutella fairbanksi Arnold
Terebratalia kennedyi Arnold

This lowest horizon of the Miocene has been called by Merriam¹ the zone of *Turritella hoffmanni* (= *Turritella inezana*); it may eventually be found to be the inshore equivalent of the deep-water San Lorenzo Oligocene, with which it has a few species in common. Of this fauna only six species are known to have persisted to the present, namely, *Terebratalia occidentalis*, *Balanus concavus*, *Hinnites giganteus*, *Macoma nasuta*, *Phacoides richthofeni*, and *Psammobia edentula*; and of these *Macoma nasuta* appeared in the San Lorenzo Oligocene.

The following characteristic species are confined to the Vaqueros and Monterey-Temblor faunas:

Arca montereyana Osmont
Cardium vaquerosense Arnold
Chione conradiana Anderson
Chione mathewsoni Gabb
Dosinia conradi Gabb
Dosinia mathewsoni Gabb
Glycimeris branneri Arnold
Pecten branneri Arnold
Pecten lompocensis Arnold
Pecten miguelensis Arnold

Pecten nevadanus Conrad
Pecten peckhami Gabb
Pecten perrini Arnold
Pecten sanctaecruzensis Arnold
Pecten sespeensis Arnold
Agasoma barkerianum Cooper
Agasoma gravidum Gabb
Cuma biplicata Gabb
Trochita costellata Gabb

¹ Bull. Dept. Geol. Univ. Calif., vol. 3 (1904), p. 380.

The following characteristic species are confined to the Monterey-Temblor fauna :

<i>Scutella breweriana</i> Remond	<i>Cancellaria condoni</i> Anderson
<i>Scutella merriami</i> Anderson	<i>Conus hayesi</i> Arnold
<i>Corbicula dumblei</i> Anderson	<i>Conus owenianus</i> Anderson
<i>Glycimeris barbarensis</i> Conrad	<i>Ficus kernianus</i> Cooper
<i>Pecten hamlini</i> Arnold	<i>Ficus nodiferus</i> Gabb
<i>Pecten propatulus</i> Conrad	<i>Ficus pyriformis</i> Gabb
<i>Tellina congesta</i> Conrad	<i>Ficus stanfordensis</i> Arnold
<i>Yoldia impressa</i> Conrad	<i>Oliva californica</i> Anderson
<i>Yoldia oregona</i> Shumard	<i>Terebra cooperi</i> Anderson
<i>Agasoma santacruzianum</i> Arnold	<i>Trophon gabbianus</i> Anderson
<i>Bathytoma keepi</i> Arnold	<i>Turritella ocoyana</i> Conrad
<i>Bullia anglonana</i> Anderson	<i>Turritella variata</i> Conrad

In addition to the six species enumerated under the Vaqueros, the following species persist from the Monterey-Temblor fauna into the present :

<i>Cardium quadrigenarium</i> Conrad	<i>Panopaea generosa</i> Gould
<i>Dosinia ponderosa</i> Gabb	<i>Phacoides annulatus</i> Reeve
<i>Leda taphria</i> Dall	<i>Saxidomus nuttalli</i> Conrad
<i>Macoma calcarea</i> Gmelin	<i>Solen sicarius</i> Gould
<i>Macoma secta</i> Conrad	<i>Tellina idae</i> Dall
<i>Mactra catilliformis</i> Conrad	<i>Lunatia lewisii</i> Gould
<i>Metis alta</i> Conrad	<i>Olivella pedroana</i> Conrad

The entire upper Miocene fauna consists of about 182 species known at present. Of these 26 range up from lower Miocene, and become extinct in the San Pablo-Santa Margarita and Etchegoin faunas; about 77 are confined to the upper Miocene; 26 range into Pliocene, and become extinct in the Purisima or San Diego horizon; 2 range into Quaternary; and 50 persist into the Recent fauna.

The lower division of the upper Miocene consists of the San Pablo-Santa Margarita-Jacalitos faunas, which are a unit, or nearly so—the Jacalitos being merely the upper division of the Santa Margarita, and both together being the approximate equivalent of San Pablo. The aggregate fauna of this division amounts to 117 species, of which 38 are still living, giving 32 per cent of Recent forms.

In the Etchegoin fauna there are known 111 species, with 20 additional that existed both before and after that time, making 131 species. Of these 51 are still living, giving 38 per cent of Recent species in the Etchegoin fauna.

The following common and characteristic species range up from the lower Miocene, and become extinct in the San Pablo-Santa Margarita fauna:

<i>Arca microdonta</i> Conrad	<i>Panopaea estrellana</i> Conrad
<i>Arca obispoana</i> Conrad	<i>Pecten andersoni</i> Arnold
<i>Chione temblorensis</i> Anderson	<i>Pecten crassicardo</i> Conrad
<i>Cytherea diabloensis</i> Anderson	<i>Pecten discus</i> Conrad
<i>Modiolus multiradiatus</i> Gabb	<i>Pecten estrellanus</i> Conrad
<i>Ostrea titan</i> Conrad	<i>Trophon carisaensis</i> Anderson

The following characteristic species are confined to the San Pablo-Etchegoin fauna:

<i>Pecten pabloensis</i> Conrad	<i>Astrodapsis whitneyi</i> Remond
<i>Astrodapsis antiselli</i> Conrad	<i>Tamiosoma gregaria</i> Conrad
<i>Astrodapsis tumidus</i> Remond	

The following species lived over from the lower Miocene, and became extinct in the Etchegoin:

<i>Mulinia densata</i> Conrad	<i>Zirphea dentata</i> Conrad
<i>Sigaretus scopulosus</i> Conrad	<i>Trophon ponderosus</i> Gabb

The following characteristic upper Miocene species became extinct in the Etchegoin:

<i>Diplodonta harfordi</i> Anderson	<i>Ostrea atwoodi</i> Gabb
<i>Diplodonta parilis</i> Conrad	<i>Pecten coalingaensis</i> Arnold
<i>Glycimeris coalingaensis</i> Arnold	<i>Placuanomia californica</i> Arnold
<i>Modiolus directus</i> Dall	<i>Thais kettlemanensis</i> Arnold
<i>Mytilus coalingaensis</i> Arnold	<i>Turritella vanvlecki</i> Arnold
<i>Ostrea vespertina</i> Conrad	

The following characteristic species range up from lower Miocene, and become extinct in the lower Pliocene, Purisima-San Diego fauna:

<i>Scutella gibbsi</i> Gabb	<i>Phacoides sanctaecrucis</i> Arnold
<i>Arca trilineata</i> Conrad	<i>Thracia trapezoidea</i> Conrad
<i>Chione securis</i> Shumard	<i>Venus pertenuis</i> Gabb
<i>Trochita filosa</i> Gabb	<i>Chione staleyii</i> Gabb
<i>Mactra albaria</i> Conrad	<i>Trochita inornata</i> Gabb
<i>Marcia oregonensis</i> Conrad	

The following characteristic upper Miocene species range over into lower Pliocene, and become extinct in the Purisima-San Diego fauna:

<i>Astrodapsis perrini</i> Weaver	<i>Pecten cerrosensis</i> var. <i>menden-</i>
<i>Scutella gibbsi</i> Gabb var. <i>ashleyi</i>	<i>halli</i> Arnold
Arnold	<i>Pecten nutteri</i> Arnold
<i>Arca canalis</i> Conrad	<i>Pecten oweni</i> Arnold
<i>Cryptomya ovalis</i> Conrad	<i>Pecten wattsi</i> Arnold
<i>Cardium coosense</i> Dall	<i>Schizothoerus pajaroanus</i> Conrad
<i>Cardium meekanum</i> Gabb	<i>Chrysodomus imperialis</i> Dall
<i>Macoma astori</i> Dall	<i>Chrysodomus portolaensis</i> Arnold
<i>Ostrea veatchi</i> Gabb	<i>Miopleioma oregonensis</i> Dall
<i>Pecten cerrosensis</i> Gabb	

Crepidula princeps Conrad persists from lower Miocene into Quaternary, and *Pisania fortis* Carpenter persists from upper Miocene into Quaternary before becoming extinct.

Throughout the Miocene, into the Pliocene, and up to the present, little evolution of forms is seen. Species appear with all their characteristics distinctly marked, run their course, and disappear from our ken, without any appreciable change. The geologist, looking over collections from the lowest Miocene to the Recent fauna, rarely sees the evolution of marine invertebrates. He sees only the sudden appearance of forms, and equally sudden disappearance of the same, without knowing whence they came, or how they disappeared.

This could be used as an argument for saltatory or spasmodic evolution. But it could be used equally well as an argument for special creation. In fact, the paleontologist does not see here any spasmodic evolution; he sees only sudden appearance. The species appear before us in the rocks, without any previous record or credentials as to their history—presumably as immigrants, having been evolved somewhere else. They live on a while, and disappear a few at a time.

In the few cases where there is even a suggestion of evolution of species, this is not spasmodic, but slow and regular. In the Venus shells there is a probable genetic series, from *Chione temblorensis* in the lower Miocene, through *Chione securis* in the middle and upper part of the Miocene, to the group of *Chione succincta* of the Pliocene, Quaternary, and Recent faunas.

An equally good genetic series is seen in the development of *Pecten andersoni* of the lower Miocene into *Pecten discus* and *Pecten pabloensis* of the upper Miocene.

Another probable genetic series is that of the group of "Janira"; namely, *Pecten sanctaecruzensis* of the lower Miocene, *Pecten bellus* of the Pliocene, and *Pecten excavatus* of the Quaternary and Recent faunas. In this case there was a gradual retreat southward as the climate grew cooler, and the modern representatives are almost entirely confined to warmer waters. In addition to these, nearly fifty other species in the Recent fauna can be traced somewhat doubtfully into Miocene ancestors.

The tables of the occurrence and range of the Miocene species of California are based on a critical study of all the literature, and a critical examination of extensive collections from all the Miocene localities in California. Of course the list is not complete, for there are many undescribed species in the collections of the U. S. National Museum, of the University of California, of the California Academy of Sciences, and of Stanford University. Also some species that are now put together may not be synonyms, and very certainly some that are now treated separately will eventually be merged.

Further examination of better material will probably show that some of the Miocene species, now considered as identical with Recent forms, are different. And further collection will probably bring to light more Recent species in the Miocene faunas. But none of this will change materially the figures and percentages given. The numbers are too large, and the collections already made are too extensive for that to be the case.

It is hoped that this list will be of use to students of Californian stratigraphy, for whom it was prepared. Each one can do something towards completing it, by adding new species as they are described, checking the occurrence of old species, correcting the synonymy, and inserting names that have been omitted.

In the check-list the Temblor and Monterey faunas are entered separately as a matter of record, although they are certainly synchronous. The lower Pliocene faunas are merged under the name *San Diego-Purisima* for convenience of reference; and the upper Pliocene is recorded under the name *Santa Barbara*, because it is by no means certain that the name *Merced*, which has been used for the upper Pliocene, is applicable in southern California. The name *Fernando*, which has been extensively used in listing the faunas of southern California, is not applicable, for it has included faunas from lowest Pliocene to middle Quaternary in age.

CHECK-LIST OF MIOCENE INVERTEBRATES OF CALIFORNIA

GENERA AND SPECIES	OLIGOCENE		MIOCENE					PLIOCENE		QUATERNARY	RECENT
	San Lorenzo	Vaqueros	Lower			Upper	San Diego-Purisima	Sta. Barbara			
			Temblor	Monterey	San Pablo-Sta. Margarita	Etchegoin					
									Lower		
<i>Astrangia coalingensis</i> Vaughan.....							X				
<i>Favia merriami</i> Vaughan.....							X				
<i>Stephanocoenia fairbanksi</i> Vaughan .							X				
<i>Amphiura sanctaecrucis</i> Arnold						X					
<i>Asterias remondi</i> Gabb.....						X					
<i>Astrodapsis antiselli</i> Conrad						X					
<i>Astrodapsis antiselli</i> , var. <i>arnoldi</i> Pack						X					
<i>Astrodapsis jacalitosanus</i> Arnold....						X					
<i>Astrodapsis fernandoensis</i> Pack.....				X		X					
<i>Astrodapsis tumidus</i> Remond.....						X					
<i>Astrodapsis whitneyi</i> Remond.....						X					
<i>Scutaster andersoni</i> Pack.....						X					
<i>Scutella fairbanksi</i> Arnold.....		X									
<i>Scutella merriami</i> Anderson			X								
<i>Scutella perrini</i> Weaver.....		X					X	X			
<i>Scutella norrisi</i> Pack		X									
<i>Scutella breweriana</i> Remond.....				X							
<i>Scutella gibbsi</i> Remond.....				X		X	X	X			
<i>Scutella gibbsi</i> , var. <i>ashleyi</i> Arnold..				X		X	X	X			
<i>Clypeaster bowersi</i> Weaver.....						X					
<i>Clypeaster gabbi</i> Remond.....						X					
<i>Linthia californica</i> Weaver.....			X								
<i>Terebratalia kennedyi</i> Dall.....		X									
<i>Terebratalia occidentalis</i> Dall		X				X	X	X			X
<i>Terebratalia Smithi</i> Arnold.....						X	X	X	X		
<i>Discinisca oregonensis</i> Dall			X	X		X	X	X	X	X	X
<i>Balanus concavus</i> Brown		X				X	X	X	X		
<i>Balanus estrellanus</i> Conrad.....						X	X				
<i>Tamiosoma gregaria</i> Conrad.....				?		X					
<i>Anomia subcostata</i> Conrad.....							X				
<i>Arca canalis</i> Conrad.....						X		X	X		
<i>Arca microdonta</i> Conrad.....		X	X	X		X					
<i>Arca montereyana</i> Osmont.....			X	X		X					
<i>Arca obispoana</i> Conrad			X	X		X					
<i>Arca osmonti</i> Dall.....			X								
<i>Arca trilineata</i> Conrad.....			X			X	X	X	X		
<i>Arca schizotoma</i> Dall.....						X	X	X	X		
<i>Arcopagia unda</i> Conrad.....						X					
<i>Cardium coosense</i> Dall.....						X	X	X	X		
<i>Cardium meekanum</i> Gabb.....						X	X	X	X		

CHECK-LIST OF MIOCENE INVERTEBRATES OF CALIFORNIA—
Continued.

GENERA AND SPECIES	OLIGOCENE		MIOCENE					PLIOCENE		QUATERNARY	RECENT
	San Lorenzo	Lower			Upper		Lower	Upper			
		Vaqueros	Temblor	Monterey	San Pablo- Sta. Margarita	Etchegoin					
<i>Cardium quadrigenarium</i> Conrad....			X	X	X			X	X	X	
<i>Cardium vaquerosense</i> Arnold.....		X	X								
<i>Chama pellucida</i> Sowerby.....					X			X	X	X	
<i>Chione conradiana</i> Anderson		X	X								
<i>Chione mathewsoni</i> Gabb.....		X	X	X							
<i>Chione securis</i> Shumard			X	X	X	X	X				
<i>Chione staleyi</i> Gabb.....			X	X	X	X	X				
<i>Chione temblorensis</i> Anderson		X	X	X	X	X	X				
<i>Clidiophora punctata</i> Conrad.....					X	X	X		X	X	
<i>Corbicula dumblei</i> Anderson			X								
<i>Cryptomya ovalis</i> Conrad					X	X	X				
<i>Cryptomya quadrata</i> Arnold.....						X	X	X			
<i>Cumingia californica</i> Conrad						X	X	X	X	X	
<i>Cyrena californica</i> Gabb.....					X						
<i>Cytherea diabloensis</i> Anderson.....			X	?	X	X					
<i>Diplodonta harfordi</i> Anderson.....					X	X					
<i>Diplodonta parilis</i> Conrad.....					X	X					
<i>Dosinia jacalitosana</i> Arnold.....					X						
<i>Dosinia ? longula</i> Conrad					?						
<i>Dosinia mathewsoni</i> Gabb.....		X	X	X							
<i>Dosinia montana</i> Conrad.....					?						
<i>Dosinia ponderosa</i> Gabb.....			X	X	X	X	X		X	X	
<i>Dosinia subobliqua</i> Conrad.....					?						
<i>Dosinia conradi</i> Gabb.....		X									
<i>Gari alata</i> Gabb.....					X						
<i>Glycimeris barbarensis</i> Conrad			X								
<i>Glycimeris branneri</i> Arnold		X	X								
<i>Glycimeris coalingaensis</i> Arnold.....					X	X					
<i>Glycimeris septentrionalis</i> Midd.....						X			X	X	
<i>Hemimactra lenticularis</i> Gabb.....			X								
<i>Hinnites crassus</i> Conrad					X						
<i>Hinnites giganteus</i> Gray.....		X	X		X	X			X	X	
<i>Lucina estrellana</i> Conrad.....					X						
<i>Macoma calcarea</i> Gmelin.....			X	X		X	X	X	X	X	
<i>Macoma inquinata</i> Deshayes				X		X	X	X	X	X	
<i>Macoma astori</i> Dall.....						X	X				
<i>Macoma jacalitosana</i> Arnold.....					X						
<i>Macoma nasuta</i> Conrad.....	X	X	X	X	X	X	X	X	X	X	
<i>Macoma piercei</i> Arnold			X								
<i>Macoma secta</i> Conrad.....			X		X	X	X		X	X	
<i>Macoma vanvlecki</i> Arnold.....				X	X						

CHECK-LIST OF MIOCENE INVERTEBRATES OF CALIFORNIA—
Continued.

GENERA AND SPECIES	OLIGOCENE		MIOCENE					PLIOCENE		QUATERNARY	RECENT
	San Lorenzo	Vaqueros	Lower		Upper		San Diego-Purisima	Sta. Barbara			
			Temblor	Monterey	San Pablo-Sta. Margarita	Etchegoin					
									Lower	Upper	
<i>Macoma ocoyana</i> Conrad.....			X								
<i>Mactra albaria</i> Conrad.....			X	X	X			X			
<i>Mactra catilliformis</i> Conrad.....			X	X				X		X	X
<i>Mactra coalingaensis</i> Arnold.....						X					
<i>Mactra montereyana</i> Arnold.....				X							
<i>Marcia oregonensis</i> Conrad.....	X		X		X			X			
<i>Meretrix uniomeris</i> Conrad.....						?					
<i>Meretrix traski</i> Conrad.....				X							
<i>Meretrix decisa</i> Conrad.....			X								
<i>Metis alta</i> Conrad.....			X		X	X		X		X	X
<i>Modiolus capax</i> Conrad.....					X	X		X			X
<i>Modiolus directus</i> Dall.....						X					
<i>Modiolus multiradiatus</i> Gabb.....				X	X	X					
<i>Modiolus rectus</i> Conrad.....					X	X		X	X	X	X
<i>Modiolus ynezanus</i> Arnold.....	X	X				X		X			
<i>Monia macroschisma</i> Deshayes.....					X	X					X
<i>Mulinia densata</i> Conrad.....			X		X	X					
<i>Mulinia</i> , var. <i>minor</i> Arnold.....			X								
<i>Mya japonica</i> Jay.....						X					X
<i>Mytilus coalingaensis</i> Arnold.....					X	X					
<i>Mytilus inezensis</i> Conrad.....		?									
<i>Mytilus mathewsoni</i> Gabb.....		X	X	X	X						
<i>Mytilus mathewsoni</i> , var. <i>expansa</i> Arnold.....		X	X								
<i>Nucula castrensis</i> Hinds.....					X	X		X	X	X	X
<i>Nucula conradi</i> Meek.....			X								
<i>Ostrea atwoodi</i> Gabb.....					X	X					
<i>Ostrea bourgeoisi</i> Gabb.....					X						
<i>Ostrea eldridgei</i> Arnold.....	X	X									
<i>Ostrea heermanni</i> Conrad.....						X					
<i>Ostrea panzana</i> Conrad.....					X						
<i>Ostrea lurida</i> Carpenter.....						X			X	X	
<i>Ostrea tayloriana</i> Gabb.....			?								
<i>Ostrea titan</i> Conrad.....	X	X	X	X							
<i>Ostrea veatchii</i> Gabb.....						X	X				
<i>Ostrea vespertina</i> Conrad.....						X					
<i>Ostrea vespertina</i> , var. <i>sequens</i> Arnold.....						X					
<i>Leda cahillensis</i> Arnold.....			X								
<i>Leda taphria</i> Dall.....			X	X			X		X	X	
<i>Pandora scapha</i> Gabb.....			X								

CHECK-LIST OF MIOCENE INVERTEBRATES OF CALIFORNIA—
Continued.

GENERA AND SPECIES	OLIGOCENE		MIOCENE					PLIOCENE		QUATERNARY	RECENT
	San Lorenzo	Lower			Upper		San Diego-Purisima	Sta. Barbara			
		Vaqueros	Temblor	Monterey	San Pablo-Sta. Margarita	Etchegoin					
									Lower		
<i>Panopaea generosa</i> Gould.....			X	X	X	X	X		X	X	
<i>Panopaea estrellana</i> Conrad.....		X	X		X	X	X				
<i>Paphia jacalitosana</i> Arnold.....					X	X	X				
<i>Paphia tenerrima</i> Carpenter.....					X	X	X		X	X	
<i>Paphia staminea</i> Carpenter.....					X	X	X		X	X	
<i>Paphia truncata</i> Gabb.....					X	X	X				
<i>Pecten andersoni</i> Arnold.....			X	X	X						
<i>Pecten branneri</i> Arnold.....	X	X	X								
<i>Pecten carrizoensis</i> Arnold.....						X					
<i>Pecten cerrosensis</i> Gabb.....						X	X	X			
<i>Pecten cerrosensis</i> , var. <i>mendenhalli</i> Arnold.....						X					
<i>Pecten coalingaensis</i> Arnold.....						X					
<i>Pecten crasscardo</i> Conrad.....		X	X	X	X						
<i>Pecten crasscardo</i> , var. <i>hamiltoni</i> Arnold.....			X								
<i>Pecten deserti</i> Conrad.....						X					
<i>Pecten discus</i> Conrad.....				X	X						
<i>Pecten eldridgei</i> Arnold.....					X	X					
<i>Pecten estrellanus</i> Conrad.....		X	X		X						
<i>Pecten estrellanus</i> var. <i>catalinae</i> Arnold.....					X						
<i>Pecten estrellanus</i> var. <i>terminus</i> Arnold.....					X						
<i>Pecten etchegoini</i> Anderson.....						X					
<i>Pecten hamlini</i> Arnold.....			X			X					
<i>Pecten hastatus</i> Sowerby.....						X	X	X	X	X	
<i>Pecten keepi</i> Arnold.....						X					
<i>Pecten lompocensis</i> Arnold.....		X	X								
<i>Pecten magnolia</i> Conrad.....		X	X								
<i>Pecten miguelensis</i> Arnold.....		X	X								
<i>Pecten nevadanus</i> Conrad.....		X	X								
<i>Pecten nuttteri</i> Arnold.....						X	X				
<i>Pecten oweni</i> Arnold.....					X	X	X				
<i>Pecten pabloensis</i> Conrad.....					X						
<i>Pecten peckhami</i> Gabb.....		X		X							
<i>Pecten perrini</i> Arnold.....		X	X								
<i>Pecten propatulus</i> Conrad.....		X	X								
<i>Pecten sanctaecruzensis</i> Arnold.....	X	X	X								
<i>Pecten sespeensis</i> Arnold.....		X	X								
<i>Pecten sespeensis</i> , var. <i>Hydei</i> Arnold.....		X	X								
<i>Pecten stanfordensis</i> Arnold.....				X							

CHECK-LIST OF MIOCENE INVERTEBRATES OF CALIFORNIA—
Continued.

GENERA AND SPECIES	OLIGOCENE		MIOCENE					PLIOCENE		QUATERNARY	RECENT
	San Lorenzo	Vaqueros	Lower			Upper	San Diego-Purisima	Sta. Barbara			
			Temblor	Monterey	San Pablo-Sta. Margarita	Etchegoin					
<i>Pecten vanvlecki</i> Arnold.....		X									
<i>Pecten vaughani</i> Arnold.....		X									
<i>Pecten veatchi</i> Gabb.....							X				
<i>Pecten wattsi</i> Arnold.....							X	X			
<i>Periploma sanctaecrucis</i> Arnold.....				X							
<i>Phacoides acutilineatus</i> Conrad.....		X	X	X		X	X				
<i>Phacoides annulatus</i> Reeve.....					X		X	X	X		
<i>Phacoides richthofeni</i> Gabb.....		X	X	X				X		X	X
<i>Phacoides sanctaecrucis</i> Arnold.....		X	X	X				X			
<i>Pholadidea ovoidea</i> Gould.....							X				X
<i>Placuanomia californica</i> Arnold.....					X		X				
<i>Pinna alamedensis</i> Yates.....			X		X						
<i>Psammobia edentula</i> Gabb.....		X	X			X	X	X		X	X
<i>Saxidomus nuttalli</i> Conrad.....			X			X	X		X	X	X
<i>Saxidomus vaquerosensis</i> Arnold....			X								
<i>Semele rubropicta</i> Dall.....						X					X
<i>Schizodesma abscissa</i> Gabb.....					X	X					
<i>Schizothoerus pajaroanus</i> Conrad....					X	X	X	X			
<i>Septifer coalingaensis</i> Arnold.....			X								
<i>Siliqua nuttalli</i> Conrad.....					X	X	X	X	X	X	X
<i>Solen sicarius</i> Gould.....			X	X	X			X			X
<i>Tapes inezensis</i> Conrad.....		?									
<i>Tellina aragonia</i> Dall.....					X						
<i>Tellina congesta</i> Conrad.....				X							
<i>Tellina idae</i> Dall.....			X						X	X	X
<i>Tellina oregonensis</i> Conrad.....			X								
<i>Tivela inezana</i> Conrad.....		X	X		X						
<i>Thracia jacialitosana</i> Arnold.....					X						
<i>Thracia mactropsis</i> Conrad.....				X			X	X			
<i>Thracia trapezoidea</i> Conrad.....			X				X	X	X		
<i>Transenella californica</i> Arnold.....											
<i>Venus pertenuis</i> Gabb.....		X	X		X			X			
<i>Venericardia montereyana</i> Arnold...				X							
<i>Venericardia ventricosa</i> Gould.....						X		X	X	X	X
<i>Yoldia cooperi</i> Gabb.....					X			X		X	X
<i>Yoldia impressa</i> Conrad.....	X		X								
<i>Yoldia oregona</i> Shumard.....			X								
<i>Yoldia submontereyensis</i> Arnold.....			X								
<i>Yoldia supramontereyensis</i> Arnold..				X							
<i>Zirphea dentata</i> Gabb.....			X		X						
<i>Zirphea gabbi</i> Tryon.....					X	X	X	X		X	X
<i>Agasoma barkerianum</i> Cooper.....		X	X	X							

CHECK-LIST OF MIOCENE INVERTEBRATES OF CALIFORNIA—
Continued.

GENERA AND SPECIES	OLIGOCENE		MIOCENE					PLIOCENE		QUATERNARY	RECENT
	San Lorenzo	Vaqueros	Lower		Upper		San Diego-Purisima	Sta. Barbara			
			Temblor	Monterey	San Pablo-Sta. Margarita	Etchegoin					
									Lower	Upper	
<i>Agasoma gravidum</i> Gabb		X	X								
<i>Agasoma santacruzianum</i> Arnold			X								
<i>Agasoma sinuatum</i> Gabb.....				X							
<i>Ancillaria fishii</i> Gabb			X								
<i>Astyris richthofeni</i> Gabb.....							X				
<i>Bathytoma carpenteriana</i> Gabb.....							X	X		X	X
<i>Bathytoma carpenteriana</i> , var. <i>fernandoensis</i> Arnold							X	X			
<i>Bathytoma coalingaensis</i> Arnold.....							X				
<i>Bathytoma keepi</i> Arnold.....			X								
<i>Bathytoma piercei</i> Arnold.....			X								
<i>Bittium asperum</i> Gabb.....					X				X	X	X
<i>Bullia anglonana</i> Anderson.....			X								
<i>Calliostoma coalingaense</i> Arnold							X				
<i>Calliostoma kerri</i> Arnold.....							X				
<i>Cancellaria altispira</i> Gabb				X							
<i>Cancellaria andersoni</i> Arnold.....			X								
<i>Cancellaria condoni</i> Anderson.....			X								
<i>Cancellaria joaquinensis</i> Anderson ..			X								
<i>Cancellaria dalliana</i> Anderson.....			X								
<i>Cancellaria pacifica</i> Anderson			X								
<i>Cancellaria simplex</i> Anderson.....			X								
<i>Cancellaria tritonidea</i> Gabb						X	X	X	X	X	
<i>Cancellaria vespertina</i> Anderson.....					X						
<i>Cancellaria vetusta</i> Gabb.....			X								
<i>Cerithium topangensis</i> Arnold.....			X								
<i>Chrysodomus imperialis</i> Dall.....					X	X	X	X			
<i>Chrysodomus portolaensis</i> Arnold ...					X	X	X	X			
<i>Conus owenianus</i> Anderson			X								
<i>Conus hayesi</i> Arnold.....			X								
<i>Crepidula onyx</i> Sowerby.....					X		X		X	X	X
<i>Crepidula praerupta</i> Conrad.....			X		X						
<i>Crepidula princeps</i> Conrad.....	X	X	X		X	X	X	X	X	X	
<i>Cuma biplicata</i> Gabb.....	X	X	X								
<i>Cylichna petrosa</i> Conrad.....				X							
<i>Dentalium conradi</i> Dall.....			X								
<i>Ficus kernianus</i> Cooper.....	X	X	X	X							
<i>Ficus nodiferus</i> Gabb.....			X	X							
<i>Ficus ocoyanus</i> Conrad			X								
<i>Ficus pyriformis</i> Gabb.....			X	X							
<i>Ficus stanfordensis</i> Arnold.....			X	X							
<i>Fusus portolaensis</i> Arnold.....						X	X				

CHECK-LIST OF MIOCENE INVERTEBRATES OF CALIFORNIA—
Continued.

GENERA AND SPECIES	OLIGOCENE		MIOCENE					PLIOCENE		QUATERNARY	RECENT
	San Lorenzo	Lower			Upper		Lower	Upper			
		Vaqueros	Temblor	Monterey	San Pablo- Sta. Margarita	Etchegoin					
<i>Fusus stanfordensis</i> Arnold			X	X							
<i>Goniobasis kettlemanensis</i> Arnold ...			X				X				
<i>Hemifusus wilkeseanus</i> Anderson....			X								
<i>Littorina mariana</i> Arnold							X				
<i>Littorina planaxis</i> Phill.....						X					X
<i>Littorina remondi</i> Gabb.....						X					
<i>Lunatia lewisii</i> Gould.....				X		X	X	X	X	X	X
<i>Macron merriami</i> Arnold			X								
<i>Margarita johnsoni</i> Arnold						X					
<i>Metula remondi</i> Gabb			X								
<i>Mioleptonia oregonensis</i> Dall.....							X	X			
<i>Monoceros engonatum</i> Conrad						X					X
<i>Nassa arnoldi</i> Anderson			X								
<i>Nassa californiana</i> Conrad						X	X	X		?	X
<i>Nassa californiana</i> , var. <i>coalingaensis</i> Arnold ..							X				
<i>Natica geniculata</i> Conrad.....			X								
<i>Natica inezana</i> Conrad.....		X									
<i>Neptunea recurva</i> Gabb.....						X					
<i>Neverita callosa</i> Gabb.....		X	X			?					
<i>Neverita reclusiana</i> Petit.....						X	X	X	X	X	X
<i>Ocenebra topangensis</i> Arnold.....			X								
<i>Ocenebra lurida</i> Midd.....						X	X	X		X	X
<i>Oliva californica</i> Anderson.....			X								
<i>Oliva futhyana</i> Anderson			X								
<i>Olivella biplicata</i> Sowerby.....							X	X	X	X	X
<i>Olivella pedroana</i> Conrad			X			X	X		X	X	X
<i>Pachypoma biangulata</i> Gabb.....		X	X			X					
<i>Pisania fortis</i> , var. <i>angulata</i> Arnold..							X				
<i>Pleurotoma transmontana</i> Conrad ...			X								
<i>Purpura vaquerosensis</i> Arnold		X									
<i>Ranella mathewsoni</i> Gabb.....			X								
<i>Scaphander jugularis</i> Conrad.....			X								
<i>Sigaretus scopulosus</i> Conrad.....	X		X				X				
<i>Sigaretus perrini</i> Arnold.....			X								
<i>Terebra cooperi</i> Anderson.....			X								
<i>Thais canaliculata</i> Ducl.....						X			X	X	X
<i>Thais crispata</i> Chem						X	X	X		X	X
<i>Thais edmondi</i> Arnold.....			X								
<i>Thais etchegoinensis</i> Arnold.....						X	X				
<i>Thais kettlemanensis</i> Arnold.....						X	X				
<i>Trochita costellata</i> Conrad.....		X	X	X							

CHECK-LIST OF MIOCENE INVERTEBRATES OF CALIFORNIA—
Continued.

GENERA AND SPECIES	OLIGOCENE		MIOCENE					PLIOCENE		QUATERNARY	RECENT
	San Lorenzo	Vaqueros	Lower			Upper	Lower	Upper			
			Temblor	Monterey	San Pablo- Sta. Margarita	Etchegoin					
									San Diego- Purisima		
<i>Trochita diegoana</i> Conrad.....						?					
<i>Trochita filosa</i> Gabb.....			X			X		X			
<i>Trochita inornata</i> Gabb.....				X		X		X			
<i>Trophon bartoni</i> Arnold.....			X			X					
<i>Trophon carisaensis</i> Anderson.....				X		X					
<i>Trophon coalingaensis</i> Arnold.....							X				
<i>Trophon gabbianus</i> Anderson.....			X								
<i>Trophon gabbianus</i> , var. <i>cancellarioides</i> Arnold.....			X								
<i>Trophon kernensis</i> Anderson.....			X								
<i>Trophon ponderosus</i> Gabb.....				X		X	X				
<i>Trophon stuarti</i> Smith.....							X		X	X	
<i>Turbo topangensis</i> Arnold.....			X								
<i>Turritella inezana</i> Conrad.....		X									
<i>Turritella inezana</i> , var. <i>sespeensis</i> Arnold.....		X									
<i>Turritella ocoyana</i> Conrad.....			X								
<i>Turritella vanvlecki</i> Arnold.....						X	X				
<i>Turritella variata</i> Conrad.....			X								
<i>Vanikoro diegoana</i> Conrad.....							?				
<i>Triptera clavata</i> Gabb.....			X								

SPECIES CONFINED TO THE LOWER MIOCENE—VAQUEROS,
TEMBLOR, AND MONTEREY FAUNAS

GENERA AND SPECIES	San Lorenzo	Vaqueros	Temblor	Monterey
<i>Linthia californica</i> Weaver.....			X	
<i>Astrodapsis fernandoensis</i> Pack.....				X
<i>Scutella fairbanksi</i> Arnold.....		X		
<i>Scutella merriami</i> Anderson.....			X	
<i>Scutella norrisi</i> Pack.....		X		
<i>Scutella breweriana</i> Gabb.....				X
<i>Terebratalia kennedyi</i> Dall.....		X		

SPECIES CONFINED TO THE LOWER MIOCENE—Continued

GENERA AND SPECIES	San Lorenzo	Vaqueros	Temblor	Monterey
<i>Arca montereyana</i> Osmont.....			X	X
<i>Arca obispoana</i> Conrad.....			X	X
<i>Arca osmonti</i> Dall.....			X	
<i>Cardium vaquerosense</i> Arnold.....		X	X	
<i>Chione conradiana</i> Anderson.....		X	X	
<i>Chione mathewsoni</i> Gabb.....		X	X	X
<i>Corbicula dumblei</i> Anderson.....			X	
<i>Dosinia conradi</i> Gabb.....		X	X	
<i>Dosinia mathewsoni</i> Gabb.....		X	X	X
<i>Glycimeris barbarensis</i> Conrad.....			X	
<i>Glycimeris branneri</i> Arnold.....		X	X	
<i>Hemimactra lenticularis</i> Gabb.....			X	
<i>Leda cahillensis</i> Arnold.....			X	
<i>Macoma piercei</i> Arnold.....			X	
<i>Macoma ocoyana</i> Conrad.....			X	
<i>Macra montereyana</i> Arnold.....				X
<i>Meretrix decisa</i> Conrad.....			X	
<i>Modiolus ynezanus</i> Arnold.....	X	X		
<i>Mytilus inezensis</i> Conrad.....		X		
<i>Mytilus mathewsoni</i> Gabb, var. <i>expansa</i> Arnold.....		X	X	
<i>Nucula conradi</i> Meek.....		X	X	
<i>Ostrea eldridgei</i> Arnold.....		X	X	
<i>Pandora scapha</i> Gabb.....			X	
<i>Periploma sanctaecrucis</i> Arnold.....				X
<i>Pecten branneri</i> Arnold.....	X	X	X	
<i>Pecten hamlini</i> Arnold.....		X	X	
<i>Pecten lomdocensis</i> Arnold.....		X	X	
<i>Pecten magnolia</i> Conrad.....		X	X	
<i>Pecten nevadanus</i> Conrad.....		X	X	
<i>Pecten peckhami</i> Gabb.....	X	X	X	X
<i>Pecten perrini</i> Arnold.....		X	X	
<i>Pecten propatulus</i> Conrad.....			X	
<i>Pecten sanctaacruzensis</i> Arnold.....	X		X	
<i>Pecten sespeensis</i> Arnold.....		X	X	
<i>Pecten sespeensis</i> , var. <i>hydei</i> Arnold.....		X	X	X
<i>Pecten stanfordensis</i> Arnold.....				
<i>Pecten vanvlecki</i> Arnold.....		X		
<i>Pecten vauhani</i> Arnold.....		X		
<i>Saxidomus vaquerosensis</i> Arnold.....			X	
<i>Septifer coalingaensis</i> Arnold.....			X	
<i>Tapes inezensis</i> Conrad.....		?		
<i>Tellina congesta</i> Conrad.....				X
<i>Tellina oregonensis</i> Conrad.....			X	
<i>Yoldia impressa</i> Conrad.....	X		X	
<i>Yoldia oregona</i> Shumard.....			X	
<i>Yoldia submontereyensis</i> Arnold.....			X	
<i>Yoldia supramontereyensis</i> Arnold.....			X	X
<i>Agasoma barkerianum</i> Cooper.....		X	X	X
<i>Agasoma gravidum</i> Gabb.....			X	
<i>Agasoma santacruzianum</i> Arnold.....			X	
<i>Agasoma sinuatum</i> Gabb.....				X

SPECIES CONFINED TO THE LOWER MIOCENE—*Continued*

GENERA AND SPECIES	San Lorenzo	Vaqueros	Temblor	Monterey
<i>Ancillaria fishii</i> Gabb.....			X	
<i>Bathytoma keepi</i> Arnold.....			X	
<i>Bathytoma piercei</i> Arnold.....			X	
<i>Bullia anglonana</i> Anderson.....			X	
<i>Cancellaria altispira</i> Gabb.....				X
<i>Cancellaria andersoni</i> Arnold.....			X	
<i>Cancellaria condoni</i> Anderson.....			X	
<i>Cancellaria dalliana</i> Anderson.....			X	
<i>Cancellaria joaquinensis</i> Anderson.....			X	
<i>Cancellaria pacifica</i> Anderson.....			X	
<i>Cancellaria simplex</i> Anderson.....			X	
<i>Cancellaria vetusta</i> Gabb.....			X	
<i>Cerithium topangensis</i> Arnold.....			X	
<i>Conus hayesi</i> Arnold.....			X	
<i>Conus owenianus</i> Anderson.....			X	
<i>Cuma biplicata</i> Gabb.....		X	X	
<i>Cylichna petrosa</i> Conrad.....				X
<i>Dentalium conradi</i> Dall.....			X	
<i>Ficus kernianus</i> Cooper.....		X	X	X
<i>Ficus nodiferus</i> Gabb.....			X	X
<i>Ficus ocoyanus</i> Conrad.....			X	
<i>Ficus pyriformis</i> Gabb.....			X	X
<i>Ficus stanfordensis</i> Arnold.....			X	X
<i>Fusus stanfordensis</i> Arnold.....				X
<i>Hemifusus wilkesanus</i> Anderson.....			X	
<i>Metula remondi</i> Gabb.....			X	
<i>Macron merriami</i> Arnold.....			X	
<i>Nassa arnoldi</i> Anderson.....			X	
<i>Natica geniculata</i> Conrad.....			X	
<i>Natica inezana</i> Conrad.....		X		
<i>Ocenebra topangensis</i> Arnold.....			X	
<i>Oliva californica</i> Anderson.....			X	
<i>Oliva futehiana</i> Anderson.....			X	
<i>Pleurotoma transmontana</i> Conrad.....			X	
<i>Pupura vaquerosensis</i> Arnold.....		X		
<i>Ranella mathewsoni</i> Gabb.....			X	
<i>Scaphander jugularis</i> Conrad.....			X	
<i>Sigaretus perrini</i> Arnold.....			X	
<i>Terebra cooperi</i> Anderson.....			X	
<i>Thais edmondi</i> Arnold.....			X	
<i>Trochita castellata</i> Conrad.....		X	X	X
<i>Trophon bartoni</i> Arnold.....			X	
<i>Trophon gabbianus</i> Anderson.....			X	
<i>Trophon gabbianus</i> , var. <i>cancellarioides</i> Arnold.....			X	
<i>Trophon kernensis</i> Anderson.....			X	
<i>Turbo topangensis</i> Arnold.....			X	
<i>Turritella inezana</i> Conrad.....		X		
<i>Turritella inezana</i> , var. <i>sespeensis</i> Arnold.....		X		
<i>Turritella ocoyana</i> Conrad.....			X	
<i>Turritella variata</i> Conrad.....			X	
<i>Triptera clavata</i> Gabb.....			X	

SPECIES CONFINED TO THE UPPER MIOCENE IN CALIFORNIA—
SANTA MARGARITA, JACALITOS, SAN PABLO AND ETCHEGOIN FAUNAS

GENERA AND SPECIES	Santa Margarita	Etchegoin
<i>Astrangia coalingaensis</i> Vaughan.....		X
<i>Favia merriami</i> Vaughan.....		X
<i>Stephanocoenia fairbanksi</i> Vaughan.....		X
<i>Amphiura sanctaecrucis</i> Arnold.....	X	
<i>Asterias remondi</i> Gabb.....	X	
<i>Astrodapsis antiselli</i> Conrad.....	X	
<i>Astrodapsis tumidus</i> Remond.....	X	
<i>Astrodapsis whitneyi</i> Remond.....	X	
<i>Clypeaster bowersi</i> Weaver.....		X
<i>Clypeaster gabbi</i> Remond.....	X	
<i>Anomia subcostata</i> Conrad.....		X
<i>Arcopagia unda</i> Conrad.....	X	
<i>Cyrena californica</i> Gabb.....	X	
<i>Diplodonta harfordi</i> Anderson.....	X	X
<i>Diplodonta parilis</i> Conrad.....	X	X
<i>Dosinia jacalitosana</i> Arnold.....	X	
<i>Gari alata</i> Gabb.....	X	
<i>Glycimeris coalingaensis</i> Arnold.....	X	X
<i>Hinnites crassus</i> Conrad.....	X	
<i>Lucina estrellana</i> Conrad.....	X	
<i>Macoma jacalitosana</i> Arnold.....	X	
<i>Mactra coalingaensis</i> Arnold.....		X
<i>Meretrix uniomeris</i> Conrad.....		?
<i>Modiolus directus</i> Dall.....		X
<i>Mya japonica</i> Jay.....		X
<i>Mytilus coalingaensis</i> Arnold.....	X	X
<i>Ostrea atwoodi</i> Gabb.....	X	X
<i>Ostrea bourgeoisi</i> Gabb.....	X	
<i>Ostrea heermanni</i> Conrad.....		X
<i>Ostrea panzana</i> Conrad.....	X	
<i>Ostrea vespertina</i> Conrad.....		X
<i>Ostrea vespertina</i> , var. <i>sequens</i> Arnold.....		X
<i>Paphia jacalitosana</i> Arnold.....	X	
<i>Paphia truncata</i> Gabb.....	X	
<i>Pecten carrizoensis</i> Arnold.....		X
<i>Pecten deserti</i> Conrad.....		X
<i>Pecten eldridgei</i> Arnold.....	X	
<i>Pecten etchegoini</i> Anderson.....		X
<i>Pecten keepi</i> Arnold.....		X
<i>Pecten pabloensis</i> Conrad.....	X	
<i>Pecten veatchi</i> Gabb.....	X	
<i>Placuanomia californica</i> Arnold.....	X	X
<i>Schizodesma abscissa</i> Gabb.....	X	X
<i>Siliqua nuttalli</i> Conrad.....		X
<i>Tellina aragonia</i> Dall.....	X	
<i>Thracia jacalitosana</i> Arnold.....	X	
<i>Transenella californica</i> Arnold.....		X

SPECIES CONFINED TO THE UPPER MIOCENE IN CALIFORNIA—
SANTA MARGARITA, JACALITOS, SAN PABLO AND ETCHEGOIN FAUNAS—*Continued*

GENERA AND SPECIES	Santa Margarita	Etchegoin
<i>Astyris richthofeni</i> Gabb.....		X
<i>Bathytoma coalingaensis</i> Arnold.....		X
<i>Calliostoma coalingaense</i> Arnold.....		X
<i>Calliostoma kerri</i> Arnold.....		X
<i>Cancellaria vespertina</i> Anderson.....	X	
<i>Goniobasis kettlemanensis</i> Arnold.....		X
<i>Littorina remondi</i> Gabb.....	X	
<i>Littorina mariana</i> Arnold.....		X
<i>Margarita johnsoni</i> Arnold.....	X	
<i>Nassa californiana</i> , var. <i>coalingaensis</i> Arnold.....		X
<i>Neptunea recurva</i> Gabb.....	X	
<i>Pisania fortis</i> , var. <i>angulata</i> Arnold.....		X
<i>Thais etchegoinensis</i> Arnold.....		X
<i>Thais kettlemanensis</i> Arnold.....	X	X
<i>Turritella vanvlecki</i> Arnold.....	X	X
<i>Trophon coalingaensis</i> Arnold.....		X

LIST OF MIOCENE SPECIES THAT ARE STILL LIVING

GENERA AND SPECIES	San Lorenzo	Vaqueros	Temblor	Monterey	Santa Margarita	Etchegoin	San Diego- Purisima	Santa Barbara	Quaternary	Living
<i>Terebratalia occidentalis</i> Dall.....		X			X	X	X			X
<i>Balanus concavus</i> Brown.....		X			X	X	X			X
<i>Cardium quadrigenarium</i> Conrad....			X	X	X	X		X	X	X
<i>Chama pellucida</i> Sowerby.....					X	X		X		X
<i>Clidiophora punctata</i> Conrad.....					X	X			X	X
<i>Cumingia californica</i> Conrad.....					X	X	X		X	X
<i>Dosinia ponderosa</i> Gabb.....			X	X	X	X	X	X		X
<i>Glycimeris septentrionalis</i> Midd.....					X	X	X		X	X
<i>Hinnites giganteus</i> Gray.....		X	X		X	X			X	X
<i>Macoma calcarea</i> Gmelin.....			X	X		X	X	X	X	X
<i>Macoma inquinata</i> Deshayes.....						X	X	X	X	X
<i>Macoma secta</i> Conrad.....			X	X	X	X	X	X	X	X
<i>Macoma nasuta</i> Conrad.....		X	X	X	X	X	X	X	X	X
<i>Mactra catilliformis</i> Conrad.....	X		X	X	X	X	X	X	X	X
<i>Metis alta</i> Conrad.....			X		X		X		X	X
<i>Modiolus capax</i> Conrad.....					X	X	X		X	X
<i>Modiolus rectus</i> Conrad.....					X	X	X		X	X
<i>Monia macroschisma</i> Deshayes.....					X	X	X	X	X	X
<i>Mya japonica</i> Jay.....						X		X		X

LIST OF MIOCENE SPECIES THAT ARE STILL LIVING—
Continued

GENERA AND SPECIES	San Lorenzo	Vaqueros	Temblor	Monterey	Santa Margarita	Etchegoin	San Diego-Purisima	Santa Barbara	Quaternary	Living
<i>Nucula castrensis</i> Hinds.....					X	X	X	X	X	X
<i>Ostrea lurida</i> Carpenter.....						X	X		X	X
<i>Leda taphria</i> Dall.....			X	X			X		X	X
<i>Panopaea generosa</i> Gould.....			X	X	X	X	X	X	X	X
<i>Paphia tenerrima</i> Carpenter.....					X	X	X		X	X
<i>Paphia staminea</i> Carpenter.....					X	X	X	X	X	X
<i>Pecten hastatus</i> Sowerby.....						X	X	X	X	X
<i>Phacoides annulatus</i> Reeve.....				X	X	X	X	X	X	X
<i>Psammobia edentula</i> Gabb.....		X	X	X			X		X	X
<i>Phacoides richthofeni</i> Gabb.....		X	X				X			X
<i>Pholadidea ovoidea</i> Gould.....						X	X			X
<i>Tellina idae</i> Dall.....			X					X	X	X
<i>Saxidomus nuttalli</i> Conrad.....			X		X	X	X	X	X	X
<i>Semele rubropicta</i> Dall.....						X			X	X
<i>Siliqua nuttalli</i> Conrad.....					X		X		X	X
<i>Solen sicarius</i> Gould.....			X	X	X		X	X	X	X
<i>Venericardia ventricosa</i> Gould.....					X	X	X	X	X	X
<i>Yoldia cooperi</i> Gabb.....					X	X	X		X	X
<i>Zirphea gabbi</i> Tryon.....					X	X	X		X	X
<i>Bathytoma carpenteriana</i> Gabb.....						X	X		X	X
<i>Bittium asperum</i> Gabb.....					X			X	X	X
<i>Crepidula onyx</i> Sowerby.....					X		X		X	X
<i>Littorina planaxis</i> Phill.....					X				X	X
<i>Lunatia lewisii</i> Gould.....				X	X	X	X	X	X	X
<i>Nassa californiana</i> Conrad.....					X	X		?	?	?
<i>Neverita reclusiana</i> Petit.....					X	X	X	X	X	X
<i>Ocenebra lurida</i> Midd.....					X	X	X	X	X	X
<i>Olivella biplicata</i> Sowerby.....						X	X	X	X	X
<i>Olivella pedroana</i> Conrad.....			X		X	X		X	X	X
<i>Thais canaliculata</i> Ducl.....					X		X		X	X
<i>Thais crispata</i> Chem.....					X	X	X		X	X
<i>Trophon stuarti</i> Smith.....						X		X	X	X



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