

	Torrey Pines	Lake Miramar	US Gulf and East Coast	Aquitaine Basin, France	North-Central Europe	New Zealand
Pterothrissidae						
<i>Pterothrissus umbonatus</i>		1				
<i>Pterothrissus</i> sp.		2				
Albulidae						
<i>Albula hasbiana</i>	28	13				
<i>Huddlestonichthys profundicauda</i>	9	2				
Albuliformes incertae sedis						
<i>Genartina bambergi</i>	10					
Heterenchelyidae						
<i>Pythonichthys texanus</i>	4					
Ophichthidae						
<i>Eoplichthys ardathensis</i>	6	1				
<i>Eoplichthys gracilis</i>	11					
<i>Ipaimuraena californiensis</i>	3					
<i>Ipaimuraena fusiformis</i>	1					
<i>Ophichthys</i> sp.	1					
Muraenesocidae						
<i>Muraenesox websteri</i>	8	3				
Congridae (Bathymirinae)						
<i>Protanago brazosensis</i>	534	16				
<i>Protanago miramarensis</i>	1	94				
Congridae (Congrinae)						
<i>Acromycter gratus</i>	3					
<i>Gnathopbis frizzelli</i>	566	1014				
<i>Rhynchoconger eocenicus</i>	461					
<i>Uroconger priscus</i>		1				
Nettastomatidae						
<i>Hoplunnis diagonalis</i>	8					
Protanguillidae						
<i>Protanguilla? glaber</i>	4	1				
Clupeidae						
Clupeidae indet. frag.	21					
Ariidae						
<i>Arius? planus</i>	532	603				
Gonostomatidae						
<i>Prigonostoma torreyensis</i>	30					
Sternoptychidae						
<i>Platygonostoma gibbsi</i>	22					
<i>Polyipnus apicalis</i>	66					
Paraulopidae						
<i>Paraulopus</i> cf. <i>davisi</i>	1					
Aulopidae						
<i>Protaulopus pseudolestidiops</i>	7					
Sudidae						
<i>Sudidae</i> indet.	3					
Myctophidae (Eomyctophinae)						
<i>Eomyctophum cyrano</i>	55					
Myctophidae (Diaphinae)						
<i>Diaphus roederi</i>	106					
Bregmacerotidae						
<i>Bregmaceros? rappei</i>	2					
Ophidiidae (Carapinae)						
<i>Alienocarapus banana</i>	1	3				
<i>Encheliophis transversalis</i>	2					
<i>Paracarapus californiensis</i>	7					
<i>Paracarapus smithvillensis</i>	385					
Ophidiidae (Neobythitinae)						
<i>Amptheristus turgidus</i>	26					
<i>Baobythites pacificus</i>	95	6				
<i>Hoplobrotula panicula</i>	112	305				
<i>Hoplobrotula robusta</i>	2093					
<i>Pseudaequalobythites biplex</i>	457					
<i>Sirembola</i> sp.	1	1				
Ophidiidae (Brotulataeniinae)						
<i>Paucillibrotula dolinorum</i>	4					
Ophidiidae (Brotulinae)						
<i>Brotula aquitanica</i>	12					
<i>Sirembrotula mediator</i>	1					
Bythitidae						
<i>Calamopteryx? moelleri</i>	8					
<i>Eobidenichthys symmetricus</i>	88	6				
<i>Pseudobrotulina fitchi</i>	82					
<i>Saccogaster salebransus</i>	1					
Myripristidae						
<i>Weileria cajun</i>	58	1				
Trachichthyidae						
<i>Trachichthys melamphaoides</i>	2					

Diretmidae						
<i>Diretmus fidelis</i>	4					
Berycidae						
<i>Centroberyx eocenicus</i>	144					
<i>Centroberyx predorsalis</i>	1	76				
<i>Centroberyx pseudopulcher</i>	155	21				
Mugilidae						
<i>Avitamugil scrippsi</i>	19	6				
Citharidae						
<i>Rhombocitharus nanus</i>	50					
Paralichthyidae						
Paralichthyidae indet.	3	2				
Soleidae						
<i>Praeaciroolithus altus</i>	116	428				
<i>Praeaciroolithus confusus</i>	621	26				
Menidae						
<i>Mene</i> sp.		1				
Carangidae						
Carangidae indet.		1				
Stromateidae						
<i>Peprilus? muelleri</i>		1				
Nomeidae						
<i>Cubiceps lautus</i>	1					
Uranoscopidae						
<i>Uranoscopus? lini</i>	8					
Trichonotidae?						
<i>Protobembrops ascensus</i>	38	8				
<i>Protobembrops</i> sp.	5					
Ambassidae						
<i>Ambassis californiensis</i>	1101					
Lactariidae						
<i>Lactarius kokeni</i>	42	964				
Acropomatidae						
<i>Parascombrops fragilis</i>	60					
<i>Verilus lajollaensis</i>	155					
Scombroptidae						
<i>Scombroptus americanus</i>	3					
Serranidae						
<i>Torreichtys speciosus</i>	16					
<i>Pseudolabrax missionis</i>	1	13				
<i>Serranus? fongeri</i>	15	4				
<i>Serranus? moratus</i>	6	2				
<i>Serranus? strigosus</i>	7	7				
Haemulidae						
<i>Micropomadasys granulatus</i>	113					
<i>Protopomadasys fitchi</i>	1	20				
<i>Protopomadasys pacificus</i>	44	16				
<i>Strongylauris obliquus</i>	8	63				
Malacanthidae						
<i>Malacanthus? rugosus</i>	506					
Sparidae						
<i>Sparus? esseri</i>	1085					
<i>Sparus? sparsus</i>	31					
Antigoniidae						
<i>Antigonia transpacifici</i>	86					
Scorpaenidae						
<i>Scorpaenodes acronis</i>	72					
<i>Scorpaenodes huddlestoni</i>	179	661				
<i>Scorpaenodes starnesi</i>	32					
Cottidae						
Cottidae indet.						
Liparidae?						
<i>Liparomorphus gerringerae</i>	2					
Trigidae						
<i>Prionotus</i> sp.		2				
Labrisomidae						
<i>Labrisomus? eocenicus</i>		1				
Bathylupeiidae						
<i>Bathylupei arribautensis</i>	23					
incertae sedis						
<i>Electrolaps</i> sp.	1					
<i>Fitchichthys placidus</i>	21					
<i>Plesiolithus inornatus</i>	30					
<i>Porrolaps ornatissimus</i>	7					
Number of species (total = 96)	88	38				
Number of specimens (total = 15128)	10753	4375				
	Shared species (dark grey)		15	11	10	3
	Related species (light grey)		8	8	13	8

Table 1 - Species list of otolith taxa found in the Californian middle Eocene at Black's Beach and The Miramar Reservoir site and correlation with Eocene otolith-based faunas from the US Gulf and Atlantic coastal plains, the Aquitaine Basin in France, North and Central European basins and New Zealand. Data are collected from cited literature.

Family	Distribution of family			General climatic ranges			
	Freshwater	Brackish	Marine	Tropical	Subtropical	Temperate	Arctic
Albulidae ¹							
Congridae							
Ariidae							
Ophidiidae							
Bythitidae							
Berycidae							
Mugilidae							
Soleidae							
Trichonotidae?							
Lactariidae							
Serranidae							
Haemulidae ²							
Scorpaenidae							

Table 2 - Environmental and climatic preferences of otolith-based families of fishes represented in the Mission Valley Formation that constituted at least 0.1% of the total assemblage. Notes: Albulidae¹ = Rarely in freshwater and brackish. Haemulidae² = Chiefly marine and rarely freshwater.

Family	Distribution of family			General climatic ranges			
	Freshwater	Brackish	Marine	Tropical	Subtropical	Temperate	Arctic
Albulidae ¹	Red	Red	Red	Green			
Ophichthidae	Red	Red	Red	Green	Green	Green	
Congridae		Red	Red	Green	Green	Green	
Clupeidae	Red	Red	Red	Green	Green		
Ariidae	Red	Red	Red	Green	Green		
Gonostomatidae			Red	Green	Green	Green	
Sternoptychidae			Red	Green	Green	Green	
Myctophidae		Red	Red	Green	Green	Green	Green
Ophidiidae		Red	Red	Green	Green	Green	
Bythitidae	Red	Red	Red	Green	Green	Green	
Holocentridae			Red	Green			
Berycidae			Red	Green	Green	Green	
Mugilidae	Red	Red	Red	Green	Green	Green	
Citharidae			Red	Green	Green	Green	
Soleidae	Red	Red	Red	Green	Green	Green	
Trichonotidae?		Red	Red	Green	Green		
Ambassidae?	Red	Red	Red	Green	Green	Green	
Lactariidae		Red	Red	Green			
Acropomatidae			Red	Green	Green	Green	
Serranidae	Red	Red	Red	Green	Green	Green	
Haemulidae ²	Red	Red	Red	Green	Green	Green	
Malacanthidae			Red	Green	Green	Green	
Sparidae	Red	Red	Red	Green	Green	Green	
Scorpaenidae		Red	Red	Green	Green	Green	
Bathylupeiidae			Red	Green	Green		

Table 3 - Environmental and climatic preferences of otolith-based families of fishes represented in the Ardath Shale that constituted at least 0.1% of the total assemblage. Notes: Albulidae¹ = Rarely in freshwater and brackish. Haemulidae² = Chiefly marine and rarely freshwater.

Order	Taxon / Clade	Danian	Selandian	Thanetian	Ypresian	Lutetian	Bartonian	Priboonian	Rupelian	Chattian	Region of first deepwater occurrence (probable – confirmed)
Stomiiformes	all Stomiiformes	■	■	■	■	■	■	■	■	■	since late Cretaceous
	Gonostomatidae			■		■		■	■	■	Austria – New Zealand
	Sternoptychidae			■		■		■	■	■	Austria – New Zealand
	Phosichthyidae					■		■	■	■	SW France – Italy
Myctophiformes	Neoscopelidae		■	■		■		■	■	■	West Greenland
	Eomyctophinae			■		■		■	■	■	Australia – New Zealand
	Diaphinae					■		■	■	■	Denmark
Gadiformes	Bregmacerotidae				■	■		■	■	■	SW France – Denmark/New Zealand
	Bathygadidae					■		■	■	■	SW France – Italy
	Macrouridae		■			■		■	■	■	(Denmark) SW France – New Zealand
	Trachyrincidae					■		■	■	■	SW France – Italy
Ophidiiformes	extinct ophidiids					■		■	■	■	Denmark
	<i>Neobythites</i>					■		■	■	■	New Zealand
	<i>Glyptophidium</i>								■	■	Italy
	Bythitidae					■		■	■	■	SW France – New Zealand
Trachichthyiformes	Diretmidae			■	■	■		■	■	■	Austria – Italy
Beryciformes	Melamphaidae			■		■		■	■	■	(Austria) SW France – Italy
Zeiformes	Zeniontidae	■	■	■	■	■		■	■	■	Maastrichtian in Bavaria – Italy
(Bathyclupeidae)	Bathyclupeidae					■		■	■	■	California/SW France – Italy
confirmed (black) + probable (grey)		1+1	1+3	1+6	1+7	4+12	8+9	10+7	18+1	17+1	

Table 4 - First deep-water occurrences of selected clades based on otolith occurrences. Probably deep-water occurrence shown in grey, confirmed deep-water occurrences in black. Data are collected from cited literature.