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Paleoecologic Analysis and Age of a Late Pleistocene Fossil Assemblage from Upper Newport Bay, Newport Beach, Orange County, California

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Abstract. A new fossil site containing abundant late Pleistocene marine invertebrates was exposed during grading activities near the northeastern end of Upper Newport Bay, in the city of Newport Beach, Orange County, southern California. The site has since been destroyed but yielded an assemblage of at least 103 species, represented by 98 species of mollusks (54 bivalves, 43 gastropods, and one scaphopod), at least three species of arthropods (barnacles and crabs), and two echinoids from six spot collections. The composite assemblage from the Fletcher Jones site (Orange County Paleontological Collections [OCPC] localities 2601 through 2606) represents a mixed thanatocoenosis, including representatives from protected bay, sandy-bottom and rocky-bottom, protected to open coasts, and offshore environments. The percentage (12.6%) of extralimital southern species indicates warmer-water temperatures than presently exist along the Orange County coast. The age of the fauna (~120,000 yr) is inferred from correlation with similar, U-series dated faunas from the same marine terrace around Upper Newport Bay. Correlative faunas from nearby localities contain extralimital southern species, and date to marine oxygen-isotope ($\delta\ ^{18}O$) substage 5e. *Turritella mariana* Dall is reported as a fossil for the first time.

INTRODUCTION AND GEOLOGIC SETTING

During 1996 and 1997, grading operations for a new car dealership (Fletcher Jones Motor Cars) (Figure 1) exposed a Pleistocene marine terrace platform overlain by marine sediments containing a diverse marine invertebrate fauna. The Fletcher Jones site (now destroyed) was a roughly triangular area of about eight acres, between Jamboree Road, Bristol Drive and San Diego Creek, at the northeast end of Upper Newport Bay, in the city of Newport Beach, Orange County, southern California (Figure 1). The Fletcher Jones site and Upper Newport Bay occupy an erosional water gap between the tectonically rising San Joaquin Hills and Newport Mesa. Emergent marine terraces in the northern San Joaquin Hills have been dated by $^{234}U/^{230}Th$ analysis of solitary corals (Grant et al., 1999) and other methods (Barrie et al., 1992). The marine terrace at the Fletcher Jones site is mapped as correlative with the second emergent marine terrace (terrace 2) around the San Joaquin Hills (Grant et al., 1999).

Upper Pleistocene marine deposits and assorted invertebrate faunas are well known around Newport Bay (see Watts, 1900; Arnold, 1903; Bruff, 1946; Hoskins, 1957; Kanakoff and Emerson, 1959; Mount, 1981; Peska, 1975, 1976, 1984; Powell, 2001). Most of these reports deal with the warm-water fauna from the second terrace (Watts, 1900 [in part]; Arnold, 1903; Bruff, 1946 [in part]; Hoskins, 1957; Kanakoff and Emerson, 1959; Mount, 1981; Peska, 1975, 1976, 1984), whereas only a few deal with the cooler-water fauna from the lower and younger first terrace (Watts, 1900 [in part]; Bruff, 1946 [in part]; Powell, 2001). The Fletcher Jones site lies on the higher, older terrace and contains a warm-water fauna.

A composite stratigraphic section (Figure 2) consists of a basal marine siltstone unit questionably referred to as the Niguel Formation (unit Tn) (Morton & Miller, 1981) or the Tertiary Unnamed sandstone (Tus) of Vedder and others (1957), overlain by upper Pleistocene marine deposits, fluvial channel deposits, and Holocene (?) alluvium. The contact between the Niguel Formation (?) and marine terrace sediments is an erosional unconformity, interpreted as a wave-cut platform, at an elevation of about 7 m (22.5′) above sea level. The overlying sediment consists of a marine terrace deposit (Qt) that grades from a silty mudstone near the base to a cross-bedded, moderately well sorted, unconsolidated sand near the top. A bryozoan biorudite and shell lenses are present in this unit between 7.4 m and 9.5 m elevation (24–31′). The marine terrace sediments (Qt) are overlain and cut into by fluvial channel deposits (unit Qc) consisting of unconsolidated silty sand, with associated overbank deposits (Qob) composed of unconsolidated muddy silt and sand.

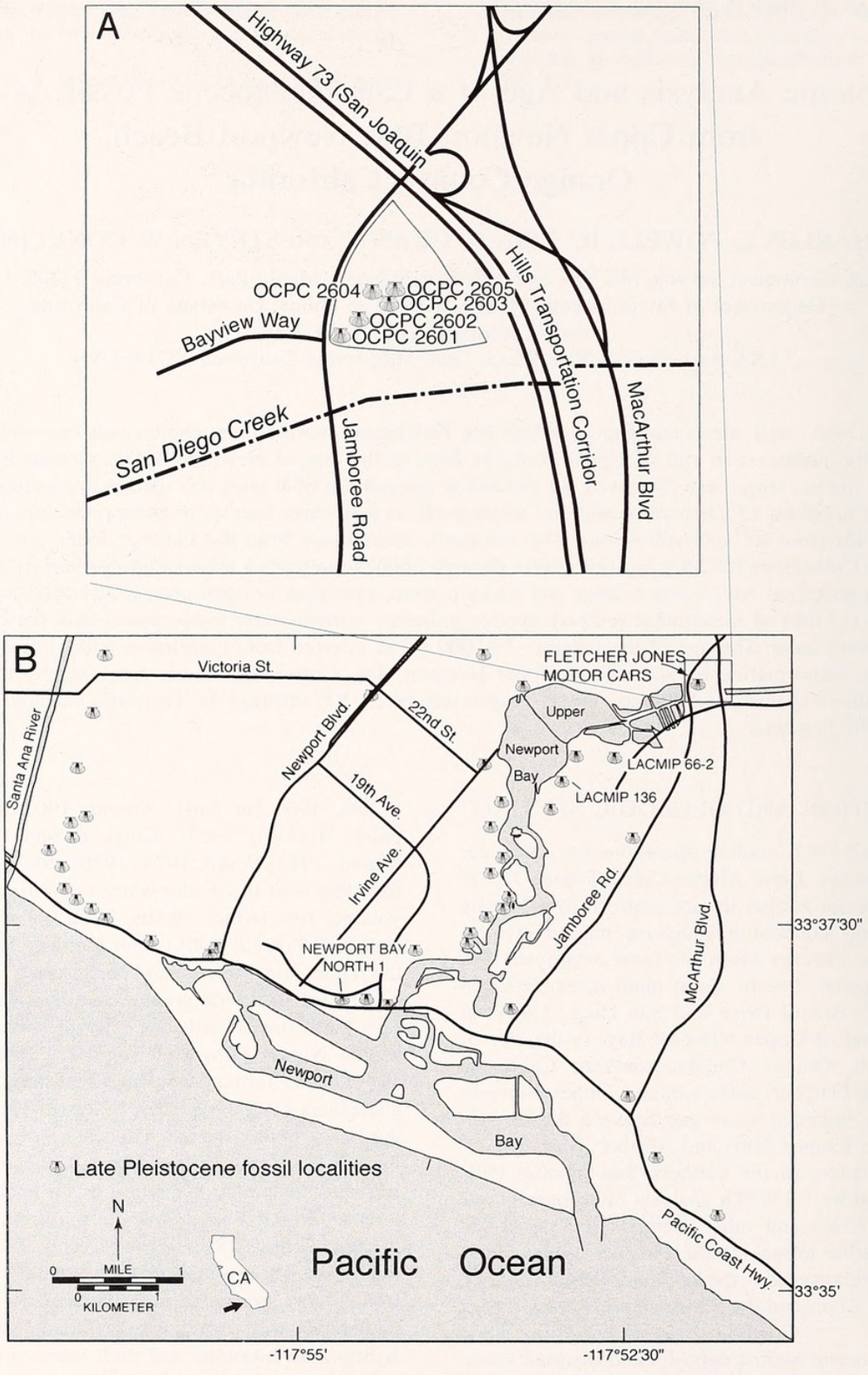

Figure 1. A. Locality map showing location of the eight-acre parcel developed for Fletcher Jones Motors Cars. This parcel is bounded on the west by Jamboree Road, on the northeast by the San Joaquin Hills Transportation Corridor (Highway 73), and on the south by where Bayview Way would project if it extended past Jamboree Road, north of San Diego Creek (covered), in the city of Newport Beach near the northeast end of Upper Newport Bay, and the approximate position of OCPC localities 2601 through 2606 (Table 1) in the parcel. B. Shows the general location of the Fletcher Jones site in relation to other late Pleistocene fossil localities in the Newport Bay area (indicated by small pectens). Other fossil localities mentioned in text are named.

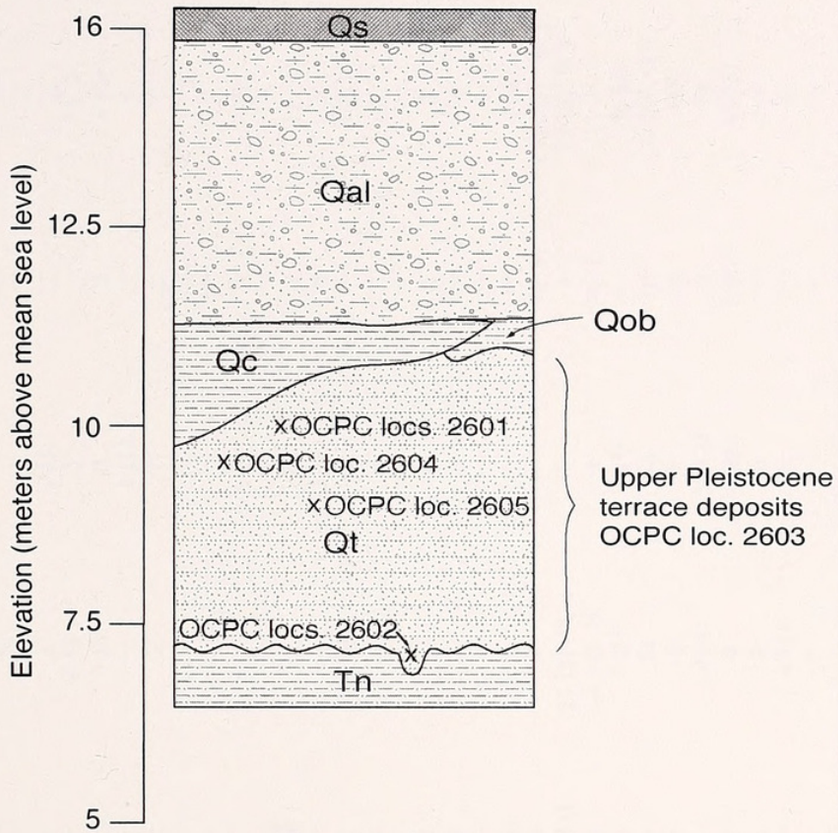

Figure 2. Composite stratigraphic section of the Fletcher Jones site. Abbreviations are: Tn—Silty mudstone, questionably referred to the Pliocene "Niguel" Formation (see text); Qt—marine terrace bay deposit, Pleistocene; Qc—fluvial channel, Pleistocene?; Qob—overbank deposits, Pleistocene?; Qal—alluvium, Holocene; Qs—topsoil, Holocene. OCPC locality 2603 includes the entire unit Qt. OCPC localities 2604 and 2605 refer to separate shelly lag deposits within unit Qt. The scale is meters above mean sea level and starts at the lowest exposure.

Both Qc and Qob are overlain by colluvium and alluvium (unit Qal) to an elevation of about 16.5 m (54 ft), on which a soil (unit Qs) has developed.

PALEONTOLOGIC DISCUSSION

Fauna

A fauna of at least 103 invertebrate species represented by 98 species of mollusks (54 bivalves, 43 gastropods, and one scaphopod), at least three species of arthropods (crabs and barnacles), and two echinoids were recovered. The species represent a mixed thanatocoenosis derived from several nearshore marine habitats. Most of the bivalves are represented by single valves, many with attached epibionts, although some specimens were articulated.

With the exception of the bulk sediment sample from OCPC locality 2601, all collections from the Fletcher Jones site are dominated by large, well-preserved, high-graded shells recovered during paleo-salvage operations. Most of the smaller species obtained are from a bulk sediment sample (OCPC locality 2601) from the major shell bed in unit Qt. This sample yielded a significant number of smaller species not recovered elsewhere. Because most of the collections were high-graded during collection and are from the same deposit, we combine all the collections for paleoenvironmental analysis, although the collections are listed separately in Table 1.

Of note at the Fletcher Jones site are a few particularly large specimens of the venerid bivalves *Chione cortezi* Carpenter to 84.3 mm and *C. gnidia* Broderip & Sowerby to 129.7 mm. The largest specimens here are larger than the maximum size for these species reported by Keen (1971). A single broken specimen of *Turritella mariana* about 75.5 mm long compares well with modern specimens at the California Academy of Sciences. This specimen, if correctly identified, is the first fossil record of this species.

Paleoenvironment Reconstruction

Species from four broad habitats are present from the Fletcher Jones site: (1) sandy, intertidal to shallow-subtidal, bay; (2) sandy, intertidal to shallow-subtidal, coast; (3) rocky, intertidal to shallow-subtidal, coast; and (4) muddy to sandy, deeper subtidal, coast. Molluscan species characteristic of the sandy, intertidal to shallow-sub-

Table 1

List of species collected from the Fletcher Jones site (localities OCPC loc. 2601 through 2606). In paleoecologic discussion the fauna is not divided into distinct localities but is here. Numbers are the number of specimens collected; numbers in parentheses ( ) are incomplete specimens and (or) fragments, brackets [ ] indicate articulated bivalve (number refers to individual valves, not articulated individuals). Names with an asterisk (*) are extralimital southern species; names with a superscript (1) are represented by internal molds.

Species/Locality	OCPC loc. 2601	OCPC loc. 2602	OCPC loc. 2603	OCPC loc. 2604	OCPC loc. 2605	OCPC loc. 2606
Mollusca: Bivalvia						
Amiantis callosa (Conrad, 1837)	—	—	4 (1)	—	—	1
Anadara perlabiata (Grant and Gale, 1931)*	2	—	5	7	—	—
Anomia peruviana Orbigny, 1846	43 (8)	4	5	5	5	12 (9)
Argopecten ventricosus (Sowerby, 1842)	4 (5)	1	113	20 (5)	4	14
Chama arcana Bernard, 1976	1	—	2	—	2	(1)
Chione californiensis (Broderip, 1835)	—	1	11	15	—	25 [4], cf.1
Chione cortezi (Carpenter, 1864)*	—	2	7	—		20 [4]
Chione fluctifraga (Sowerby, 1853)	—	5	2	1	cf. 1	1
Chione gnidia (Broderip & Sowerby, 1829)*	(4)	13 [2]	22 [2], cf. 1	—	1	23 [2], cf.1
Chione undatella (Sowerby, 1835)	—	1	—	—	cf. 4	4 [cf. 2], cf. 3
Chione sp., indeterminate	4 (5)	4	5	—	—	1 (8)
Crassadoma gigantea (Gray, 1825)	—	—	1	—	—	—
Crassinella nuculiformis Berry, 1940*	58 [2]	1	1	2	—	1
Crassinella pacifica (Adams, 1852)	6	2	—	—	2	2
Cryptomya californica (Conrad, 1837)	1	—	1	3	—	—
Cyclocardia ventricosa (Gould, 1850)	—	—	—	1	—	—
Diplodonta sericata (Reeve, 1850)	23 (7)	3	26	1	—	15 (1)
Donax californicus (Conrad, 1837)	54 (8)	—	5	7 (3)	4	3
Donax gouldii Dall, 1921	28 (1)	2, sp.1	9	12	5	11 (5)
Dosinia ponderosa (Gray, 1838)*	—	—	2	—	—	1
Epilucina californica (Conrad, 1837)	—	—	—	?1	1	—
Euvola vogdesi (Arnold, 1906)*	—	—	2	—	—	2
Juliacorbula luteola (Carpenter, 1864)	8	—	2	1	[2]	—
Laevicardium substriatum (Conrad, 1837)	5 (2)	—	2	—	—	—
Leptopecten latiauratus (Conrad, 1837)	1	—	—	1 (1)	—	1
Lucinisca nuttalli (Conrad, 1837)	2 (1)	—	9 (3)	9	3	5 [2]
Macoma carlottensis (Whiteaves, 1880)	2, cf.1	—	6, cf.1	2	—	cf. 2
Macoma nasuta (Conrad, 1837)	—	—	3	(1)	—	—
Macoma sp., indeterminate	—	—	1 (1)	1	—	—
Mactromeris sp., cf. *M. catilliformis* (Conrad, 1867)	—	—	(1)	—	—	—
Mactromeris hemphill (Dall, 1894)	—	—	—	—	(2)	—
Mactridae, indeterminate	—	—	—	(1)	—	(1)
Megapitaria squalida (Sowerby, 1831)*	—	—	1	1	—	1
Modiolus sp., cf. *M. carpenteri* Soot-Ryen, 1963	—	—	1	—	—	—
Mytilus sp., inderminate	—	—	—	(1)	—	—
Nuttallia nuttallii (Conrad, 1837)	—	—	4 (4)	—	—	—
Nucula exigua Sowerby, 1833	2	1	1	—	—	—
Ostrea conchaphila Carpenter, 1857	8	—	9	20	15	6

Table 1

Continued

Species/Locality	OCPC loc. 2601	OCPC loc. 2602	OCPC loc. 2603	OCPC loc. 2604	OCPC loc. 2605	OCPC loc. 2606
Petricolaria cognata (Adams, 1852)*	(14)	[2]	4 (1)	2 (4)	cf. (1)	[2]
Pitar newcombianus (Gabb, 1865)	—	—	2	2	—	—
Platyodon cancellatus (Conrad, 1837)	—	—	(1)	—	—	—
Pseudochama exogyra (Conrad, 1837)	—	—	—	3 (1)	—	2, sp. 1
Semele sp., cf. *S. pulchra* (Sowerby, 1832)	(1)	—	—	—	—	—
Semele venusta (Reeve, 1853)	2, (cf. 1)	—	3	—	—	1
Septifer bifurcatus (Conrad, 1837)	—	—	—	1	—	—
Simomactra falcata (Gould, 1850)?	—	—	—	(1)	—	—
Tagelus californianus (Conrad)	—	—	—	—	—	3 [2]
Tagelus affinis (Sowerby, 1852)	—	—	cf. 8 (5)			—
Tagelus sp. indeterminate	1 (5)		1	5 (1)		[2][1]
Tellina meropsis Dall, 1900	—	1 sp.	—	2		—
Tivela stultorum (Mawe, 1823)	—	—	1	—	—	—
Trachycardium sp., cf. *T. panamense* (Sowerby, 1833)*	—	4	5	7	3	7 (1)
Veneridae, indeterminate	—	—	—	(1)	—	—
Zirfaea pilsbryi Lowe, 1931	—	—	(3, sp. 1)	—	—	—
Mollusca: Gastropoda						
Acanthinucella spirata (Blainville, 1832)	—	—	(1)		—	—
Acanthinucella sp., indeterminate	—	—	1	—	—	—
Acteocina sp., indeterminate	4	—	—	—	—	—
Aesopus chrysalloides (Carpenter, 1864)	—	—	3	—	—	—
Alia carinata (Hinds, 1844)	—	—	—	1	—	—
Astraea undosa (Wood, 1828)	—	—	2 (sp. 1)	—	—	—
Bulla gouldiana Pilsbry, 1893	—	—	1 (1)	3 (4)	—	(1) sp.
Calliostoma gemmulatum Carpenter, 1864	—	—	2	2	(1)	—
Calliostoma tricolor Gabb, 1865	—	—	—	1	—	—
Ceratostoma nuttalli (Conrad, 1837)	—	—	(3)	—	—	—
Cerithidea californica (Haldeman, 1840)	1 (4)	—	6	17 (1)	3 (1)	2
"Collisella" scabra (Gould, 1846)	—	—	2	—	—	—
Conus californicus Reeve, 1844	—	—	1	3	—	1
Crepidula sp., cf. *C. coei* Berry, 1950	—	—	4	—	—	—
Crepidula onyx Sowerby, 1824	—	—	—	1	—	—
Crossata californica (Hinds, 1843)	—	—	(8)	2	—	(1)
Crucibulum spinosum (Sowerby, 1824)	9 (2)	—	4 (3)	4	3	7
Diodora arnoldi McLean, 1966	—	—	2	6	—	—
Epitonium sp., indetermiante	—	—	5 (1)	1	—	—
Eupleura muriciformis (Broderip, 1833)*	(2)	—	4	3 (3)	—	—
Fissurella volcano Reeve, 1849	—	—	3	2	—	—
Forreria belcheri (Hinds, 1944)	—	—	—	(1)	—	—

Table 1

Continued

Species/Locality	OCPC loc. 2601	OCPC loc. 2602	OCPC loc. 2603	OCPC loc. 2604	OCPC loc. 2605	OCPC loc. 2606
Hipponix craniodes Carpenter, 1864	—	—	1	—	—	—
Lirobittium? sp., indeterminate	1	—	—	—	—	—
Melampus olivaceus Carpenter, 1857	1	—	3 (1)	5	2	—
Nassarius cerritensis (Arnold, 1903)*	(sp. 1)	—	3	—	—	—
Nassarius perpinguis (Hinds, 1844)	—	—	1	2	—	—
Nassarius tegula (Reeve, 1853)	1	—	3	5	4	—
Naticidae, indeterminate	—	1	(1)	—	—	(2)
Neverita reclusiana (Deshayes, 1839)	—	(1)	5 (cf. 1)	4	2	11 (2)
Norrisia norrisi (Sowerby, 1838)	—	—	—	—	—	(1)
Ocenebra circumtexta Stearns, 1871	—	—	1	—	—	—
Olivella baetica Carpenter, 1864	3	—	6	6	2	—
Olivella biplicata (Sowerby, 1825)	—	—	2	2	—	—
Ophiodermella inermis (Reeve, 1843)	—	—	1	(cf. 2)	—	—
Pusula solandri (Sowerby, 1832)	—	—	1	—	—	—
Pteropurpura festiva (Hinds, 1844)	—	—	1	(1)	—	—
Sinum scopulosum (Conrad, 1849)	—	—	1	—	—	—
Stramonita biserialis (Blainville, 1832)*	—	—	(3)	sp. 1	(1)	—
Tegula aureotincta (Forbes, 1852)	—	—	2	sp. 1	—	—
Tegula eiseni Jordan, 1936	(1)	—	7 (2)	8 (3)	—	1
Tegula gallina (Forbes, 1852)	—	—	(6)	(8)	(1)	(3)
Terebra danai Berry, 1958	—	—	(sp. 2)	(1)	—	—
Turritella mariana Dall, 1908*	—	—	1	—	—	—
Zonaria spadicea (Swainson, 1823)	—	—	(2)	—	—	—
Mollusca: Scaphopoda						
Dentalium neohexagonum Sharp & Pilsbry, 1897	—	—	7	6	—	—
Arthropoda: Crustacea						
Balanus? sp., indeterminate	(1)	1	12	8 (3)	6	12
Coronula? sp., indeterminate	—	—	1	—	—	—
Decapoda, indeterminate	—	—	5	14	—	10
Echinodermata: Echinoidea						
Dendraster excentricus (Eschscholtz, 1831)	3 (1)	1	18 (5, sp. 1)	39 (13)	7 (2)	(5)
Echinoidea, indeterminate	—	—	—	1	—	—

tidal bays include the bivalve *Ostrea conchaphila* Carpenter, which attaches to hard substrates, *Donax californica* Conrad, and the gastropods *Bulla gouldiana* Pilsbry, *Cerithidea californica* Conrad, *Crucibulum spinosum* (Sowerby), and *Nassarius tegula* (Reeve). These species are common in protected bays from the high intertidal zone [*Cerithidea californica*] to shallow subtidal water depths. Mollusks characteristic of sandy, intertidal to shallow subtidal coasts include the bivalves *Amiantis callosa* (Conrad), *Donax gouldii* Dall, and the gastropods *Conus californicus* Reeve, and *Olivella* spp. Overlapping depth ranges suggest water depths no deeper than 20 m [*Amiantis callosa* (Conrad)] and possibly shallower. Mollusks that represent rock, intertidal to shallow-subtidal coasts include the bivalves *Crassadoma gigantea* (Gray), *Pseudochama exogyra* (Conrad), and the gastropods *Acanthinucella spirata* (Blainville), "*Collisella*" *scabra* (Gould), *Astraea undosa* (Wood), *Zonaria spadicea* (Swainson), and *Tegula* spp. These species are commonly found together at intertidal to shallow subtidal water depths. Lastly, mollusks characteristic of the deeper water depths include the bivalves *Dosinia ponderosa* (Schumacher), *Nucula exigua* Sowerby, *Tellina meropsis* Dall, and the scaphopod *Dentalium neohexagonum* Sharp and Pilsbry, which together suggest water depths between 10 and 50 m on an open coast.

Judging from the abundance of specific taxa and the sediments in which the fauna was preserved, deposition most likely took place in a semi-protected, shallow (≤5 m), sandy environment adjacent to, or within a bay, similar to Outer Newport Bay today. Rocky-shore and deeper-water species were probably washed in by storm waves.

CORRELATION AND AGE

Dating Quaternary faunas may be difficult because of their modern aspect and similar zoogeographic aspects of faunas of different ages. Because all the species in the Fletcher Jones fauna are extant, they probably indicate a middle to late Pleistocene age. In addition, the Fletcher Jones site contains 12.6% southern extralimital species, which indicates correlation with an interglacial sea-level highstand deposit. Highstand deposits in southern California date to 80,000–85,000 yr (oxygen isotope ($\delta^{18}O$) substage 5a), 100,000–105,000 yr (substage 5c), 120,000–130,000 yr (substage 5e), 200,000–220,000 yr (stage 7), ~320,000 yr (stage 9) and older (Lajoie et al., 1991; Ponti et al., 1991). Los Angeles Basin highstand deposits younger than those of substage 5e do not contain extralimital southern species, but typically contain an element of extralimital northern species indicative of cooler-water paleoclimate conditions that are found today off the adjacent coast (Kennedy et al., 1982; Kennedy, 2000; Powell et al., 2000). Therefore, the Fletcher Jones fauna is inferred to be older than or equal to substage 5e (≥125,000 yr), probably younger than early Pleistocene (<730,000 yr), and was deposited during an interglacial sea-level highstand deposit.

Kanakoff and Emerson (1959) described a large fauna (n = 427 species of mollusks) nearby along Upper Newport Bay (Natural History Museum of Los Angeles County, Invertebrate Paleontology [LACMIP] locality 66-2) that contains 9.6% extralimital southern species. The percentage of southern extralimital species from LACMIP loc. 66-2 is similar to that from the Fletcher Jones site (12.6%) and both correspond to the typical 10%–15% southern extralimital species from deposits attributed to substage 5e (G. Kennedy, written communication, 2003). In addition, all of the species reported here (Table 1), with the exception of *Turitella mariana* Dall, have also been reported by Kanakoff and Emerson (1959) from LACMIP loc. 66-2. The similar faunas further supports correlation of the two sites originally suggested by Grant et al. (1999) on geomorphic grounds.

Among the deeper water species in the southern extralimital bivalve *Dosinia ponterosa,* whose modern depth range is from 50 to 80 m (Bernard, 1983). This occurrence indicates warmer water temperatures offshore and not restricted to protected environments as has been suggested for similar southern extralimital species in the southern California Pleistocene (i.e., Grant & Gale, 1931). Similar faunas showing species from several environments, including some deeper water, southern extralimital species, have been recognized at Bixby Slough in Torrance, Los Angeles County (Powell, unpublished data) and from the second (?) terrace in San Pedro (Chace, 1966).

The difference in the elevation of the marine terrace platform at LACMIP loc. 66-2 [20 m (Kanakoff and Emerson, 1959)] and the Fletcher Jones site (approx. 7 m) may be explained by their distance form the original shorelines, tectonic uplift of the San Joaquin Hills, and/or anticlinal folding along a northwest trending fold axis (Stevenson & Emery, 1958; Grant et al., 1999). The platform of terrace 2 slopes away from the San Joaquin Hills and approximately toward the Fletcher Jones site (Grant, unpublished data) similar to those of other terrace platforms in the area (Barrie et al., 1992). If this is because of the original position of the two sites with respect to the Pleistocene shoreline or tectonic uplift, or both, is unclear. But in both cases the platform elevation at LACMIP 66-2 should be higher than at the Fletcher Jones site. In addition, late Pleistocene faulting near the head of Upper Newport Bay (Grant et al., 2000) may also have displaced the terrace platform and contributed to the difference in elevations.

LACMIP loc. 66-2 has been correlated with the Fletcher Jones site (above) and is approximately 1 km northeast of, and is probably correlative with, LACMIP loc. 136 and loc. FP-28 of Peska (1984) based on similar faunas and elevations. Grant et al. (1999) report a Uranium series

age of 122,000 yrs for a specimen of the solitary coral *Paracyathus pedroensis* from loc. FP-28 (Peska, 1984). Therefore, the best estimate of the age of the Fletcher Jones fauna is approximately 120,000–125,000 yr, correlative with marine oxygen isotope (δ ^{18}O) substage 5e.

Powell (2001) described a fauna ("Newport Bay North 1" on Figure 1B) along the southern margin of Newport Mesa across Pacific Coast Highway from the Lido Isle Reach of Newport Bay, at about an elevation of 7 m. This elevation is nearly identical to the elevation of the marine platform at the Fletcher Jones site (approx. 7 m). However, Newport Bay North 1 was assigned to the first emergent terrace in the San Joaquin Hills by Grant et al. (1999), based on its geomorphic position below terrace 2 and the surface of Newport Mesa. In addition, the Newport Bay North 1 fauna contains several extralimital northern species (Powell, 2001). The cool-water northern extralimital species and geomorphic position suggest correlation with highstand deposits younger than substage 5e (Kennedy et al., 1982; Kennedy, 2000; Powell, 2001), and younger than the Fletcher Jones fauna.

The Fletcher Jones fauna is similar to other faunas from southern California based on the mutual presence of southern extralimital species. Unfortunately, the occurrence of extralimital southern species alone does not allow precise correlation. Warmer-than-present faunas exist in outcrops correlated to marine oxygen–isotope stages 11, 9, possibly 7, and 5e (about 350,000–125,000 yr) (Kennedy et al., 1982; Kennedy, 2000; Powell et al., 2000), and therefore correlation based on the zoogeographic character alone is not precise. But coupled with geomorphic data the Fletcher Jones site is correlated with other fossil localities around Upper Newport Bay that are dated to substage 5e (about 125,000 yr).

CONCLUSION

A late Pleistocene fauna from the Fletcher Jones site near the northeastern end of Upper Newport Bay, Newport Beach, Orange County, southern California, yielded an assemblage of at least 103 species consisting of 98 species of mollusks, at least three species of arthropods, and two echinoids from six spot collections. The composite fauna represents a mixed thanatocoenosis, with representatives from protected bay, sandy- and rocky-bottom, protected to open coasts, and offshore environments. The fauna includes 12.6% extralimital southern species, indicating warmer-water temperatures than present. All of the extralimital southern species are common in shallow bays, where warmer water conditions might exist, except the bivalve *Dosinia ponderosa. Dosinia ponderosa* is reported living offshore (Keen, 1971; Bernard, 1983), and occurrence of well-preserved specimens suggests warmer-water conditions offshore also. Of interest from the Fletcher Jones fauna is *Turritella mariana,* which is reported as a fossil for the first time, and a few venerid bivalves attaining a large size; in particularly *Chione cortezi* to 84.3 mm and *C. gnidia* to 129.7 mm.

The age of the Fletcher Jones fauna can be inferred from correlation with that from LACMIP loc. 136, which also contains extralimital southern species and is dated to about 125,000 yr, corresponding with marine oxygen-isotope (δ ^{18}O) substage 5e.

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APPENDIX—LOCALITY DESCRIPTIONS

The specimens used in this study are deposited at the Orange County paleontology curation facility (OCPC), currently located at 1119 East Chestnut Street, Santa Ana, California 92701.

OCPC 2601. Sample from shelly layer approximately 12′ (3.7 m) below the top of the geomorphic terrace, which may have been disturbed by grading prior to sampling. the shelly sand layer is at an elevation of approximately 32–33 feet (~10 m) in a graded cut on the southwest side of an eight-acre parcel being developed for Fletcher Jones Motors Cars. this parcel is bounded on the west by Jamboree Road, on the northeast by the San Joaquin Hills Transportation Corridor (Highway 73), and on the south by where Bayview Way would project if it extended past Jamboree Road, north of San Diego Creek (covered), in the city of Newport Beach near the northeast end of Upper Newport Bay, Orange County, California. Collected by Lisa B. Grant, 14 December 1995, field no. LG-95-12-14C.

OCPC 2602. Samples collected from coarse sand with highly compacted, olive to brown, mottled, mud, rip-up clasts at the contact between the "Niguel" Formation and overlying Pleistocene deposits. This locality is at an elevation of about 22.5′ (7 m), and is located about 160′ (49 m) east of Jamboree Road, north of the intersection of Jamboree Road and Bayview Way, city of Newport Beach near the northeast end of Upper Newport Bay, Orange County, California. Collected by S. E. Clay [field no. SEC-FJ-04-10-96-01 (Bed 01)]; L. L. Sample, and D. Alexander, 10 April 1996; and P. H. Dorsey on 5 August 1996 [field no. PHD-8-5-96-1].

OCPC 2603. Samples from locally cross-bedded, loosely compacted, white to gray, sand bed extending from 22.5′ (6.8 m) to 37′ (11.2 m) above sea level and contains concentrated shells lenses up to 2′ (0.6 m) thick. Entire bed generally composed of locally cross-bedded, loosely compacted, white to gray sand. This locality is located about 260′ (79 m) east of Jamboree Road, north of the intersection of Jamboree Road and Bayview Way and slightly northwest of OCPC 2602, city of Newport Beach near the northeast end of Upper Newport Bay, Orange County, California. Collected by L. L. Sample [field no. LLS-FJ-02-27-96-04 (Bed 04)], S. E. Clay, S. W. Conkling, D. Alexander, G. King, and P. H. Dorsey, 25 March 1996; and P. Dorsey [field no. PHD-10-24-96?-5] 24 October 1996.

OCPC 2604. Sample from massive, loosely compacted, white sand at 31′ (9.5 m) elevation about 240′ (73 m) east of Jamboree Road, north of the intersection of Jamboree Road and Bayview Way and slightly northeast of OCPC 2603, city of Newport Beach near the northeast end of Upper Newport Bay, Orange County, California. Collected by L. L. Sample [field no. LLS-FJ-02-27-96-04A (Bed 4A)], S. W. Conkling, S. E. Clay, and D. Alexander, 27 February 1996.

OCPC 2605. Sample from fine-grained, loosely compacted, white to gray, sand at an elevation of 29.5′ (9 m) located about 280′ (85 m) east of Jamboree Road, north of the intersection of Jamboree Road and Bayview Way and east of OCPC 2604, city of Newport Beach near the northeast end of Upper Newport Bay, Orange County, California. Collected by L. L. Sample [field no. LLS-FJ-02-30-96-4B (Bed 4B)], S. E. Clay, and S. W. Conkling, 30 February 1996.

OCPC 2606. Float collected in an eight-acre parcel de-

veloped for Fletcher Jones Motors Cars. This parcel is bounded on the west by Jamboree Road, on the northeast by the San Joaquin Hills Transportation Corridor (Highway 73), and on the south by where Bayview Way would project if it extended past Jamboree Road, north of San Diego Creek (covered), in the city of Newport Beach near the northeast end of Upper Newport Bay, Orange County, California. collected by S. E. Clay [field nos. SEC-FJ-01-29-96-01 and SEC-FJ-07-08-96-01], L. L. Sample and P. H. Dorsey.