# ARCHAEOLOGICAL EVIDENCE FOR THE ORIGIN OF THE PLANK CANOE IN NORTH AMERICA

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*Advanced maritime technology associated with long-distance exchange and intensified resource acquisition has been linked to the development of stratification and greater sociopolitical complexity in the Pacific Rim region. One such example is the emergence of hereditary chiefs among the Chumash Indians of southern California. Plank boats owned by an elite group of wealthy individuals and chiefs were an integral part of an elaborate economic system that was based on maritime exchange. An artifact assemblage associated with the construction, maintenance, and use of this watercraft was identified and analyzed. It included wooden planks, asphaltum plugs, asphaltum caulking, and chipped stone drills. Radiocarbon dates and other relative-dating techniques provide strong evidence that the plank canoe originated at least 1,300 years ago in southern California. This represents the earliest use of this type of watercraft in North America and probably in the New World. The timing of this innovation provides evidence that sociopolitical complexity developed in the region at least 500 years earlier than previously proposed.*

*La avanzada tecnología marítima asociada con intercambio de larga distancia y la intensificación de la adquisición de recursos ha sido asociada al desarrollo de estratificación y aumento de la complejidad socio-política en la región circum-Pacifica. Un ejemplo es la emergencia de jefes hereditarios dentro de los indios Chumash en California del sur. Botes de tabla pertenecientes a un grupo elite de individuos ricos y jefes fueron parte de un elaborado sistema económico basado en el intercambio marítimo. Una colección de artefactos que incluye tablas de madera, tapones y calafate de asfalto, y taladros de piedra asociada con la construcción, el mantenimiento y el uso de estos botes fue identificada y analizada.. Fechas de radiocarbono y otras técnicas de fechados relativo proveen evidencias de canoas de tabla que se originan al menos 1,300 años antes del presente en el sur de California, esto representa el uso mas temprano de este tipo de barcos en Norteamérica y probablemente en el Nuevo Mundo. El momento de esta innovación provee evidencia de que la complejidad socio-política en la región se desarrolló al menos 500 años antes de lo propuesto anteriormente.*

Advanced technological innovations, including irrigation, effective storage, and reliable transportation, have long been recognized as critical catalysts in the development of greater sociopolitical complexity throughout the world. Among groups that rely on maritime resources, reliable oceangoing boats are an essential technological innovation for the intensification of maritime resource acquisition and long-distance exchange (Arnold 1995; Kirch 1991; Yesner 1980). In regions where topography is precipitous and water transportation is feasible, boats are clearly the most efficient means of moving goods, people, and information. With a more substantial and reliable means of water transportation, exchange can be enhanced, allowing groups greater access to resources, including prestige goods, marriage partners, and knowledge.

Researchers have long noted the significance of water transport for exchange and acquisition of resources among maritime societies. Among Polynesian chiefdoms, Kirch (1984:242–243) viewed the development of canoes for long-distance voyages as a fundamental aspect of political consolidation in the region. According to Kirch, canoe technology in Tonga was essential to the control of prestige-good exchange. Among a maritime chiefdom such as the Tonga, the high rank of canoe builders and navigators reflected the importance with which specialists were regarded by those in political control (Kirch 1984:237). In western Melanesia, Kirch (1991:156) noted that prehistoric exchange was dominated by specialist traders who tended to maintain a monopoly of oceangoing canoes. Hayden (1993) observed a similar pattern among Polynesian chiefdoms. In an attempt to understand the early social characteristics

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of Lapita communities, Hayden (1993:127) suggested that oceangoing vessels "are the key for understanding stratification in Polynesia." Gladwin (1970) identified the significance of navigators in long-distance voyaging in Micronesia and documented that they received the greatest prestige and respect. Alkire (1982) further suggested that navigational knowledge in Micronesia was monopolized and an essential component in the evolution of centralized political systems and the development of stratification.

Other scholars (Arnold 1995, 2001; Arnold and Munns 1994; King 1982) have suggested that the plank canoe *(tomol)* played an important role in the development of sociopolitical complexity and in greater inequity of wealth and power among the Chumash. Arnold (1995) proposed that the development of seafaring boats was linked to increased sociopolitical complexity among the Chumash and that control of transportation and the distribution of goods was an important avenue for individuals to organize labor. Arnold (2001) more recently suggested that the control of exchange between the mainland and the Channel Islands by the canoe owners on both sides of the Santa Barbara Channel was a fundamental component in the rise of hereditary leadership among the Chumash. The California case differs from those in Oceania because open-sea voyaging was not known to have been practiced by the Chumash Indians. The northern Santa Barbara Channel Islands (Anacapa, Santa Cruz, Santa Rosa, and San Miguel) are situated between 32 and 71 km off the coast of California. On a clear day, all four of the islands can be seen from the mainland. It has been estimated that the east end of Santa Cruz Island could be reached in about a half a day from Point Mugu by canoe. Furthermore, ethnographic evidence indicates that the Chumash avoided being out to sea after dark (Hudson et al. 1978:137–139). Obviously, long-distance navigation was not as significant an issue in the Santa Barbara Channel as it was in much of Oceania, where some voyagers traveled hundreds of kilometers with no land in sight for days.

Early explorers described plank canoes in two regions of the New World: the southern coast of California where the Chumash and Tongva (Gabrielino) Indians lived, and in southern Chile around the Gulf of Coronado where the Cuncos lived (Heizer 1938). One goal of this research is to determine when the plank canoe first originated in southern California and its significance in the development of sociopolitical complexity.

The technological development of the plank canoe has long been recognized as a significant innovation in the elaboration of greater sociopolitical complexity among the Chumash Indians of southern California (Blackburn 1975; Hudson et al. 1978; King 1982). Nevertheless, researchers have disagreed over when simple chiefdoms first developed in the Chumash region; many have suggested that environmental change played a critical role in the development of sociopolitical complexity in the region (Arnold 1992; Johnson 2000; Kennett and Kennett 2000). Arnold (1992) has argued that social ranking among the Chumash developed around A.D. 1200–1300 and has explained its origin from the perspective of labor control in the context of environmental degradation, political opportunism, and the manipulation of labor by rising elites. She has proposed that Chumash chiefdoms developed in part from population-resource imbalances during an unfavorable warm water period in the Santa Barbara Channel that occurred between approximately A.D. 1150–1300 (Arnold 1992:69). More recently Arnold (2001) has elaborated on the factors that stimulated social ranking in the region, suggesting that the manipulation of labor was associated with technological innovation, and that a small group of leaders, including canoe owners and traders, seized opportunities that most likely resulted from resource imbalances to gain economic and political advantages. Kennett and Kennett (2000) have concurred with Arnold's concept that climatic change played an important role in the emergence of sociopolitical complexity but identified a period of extended terrestrial drought and high marine productivity between A.D. 450–1300. This climatic reconstruction departs significantly from that of Arnold. Kennett and Kennett (2000:392) proposed that "increased regional violence, the emergence of greater sedentism, more intensive fishing strategies, and greater trade" developed between A.D. 650 and 1300 as a result of this climate change. In contrast, King (1990) has not viewed climate change as a significant stimulus in the emergence of sociopolitical complexity in the region. Based on detailed analyses of burial associations and their changes through time, King has argued that a ranked society with a hereditary elite first appeared in the Santa Barbara Channel area about 2,600 years ago at the end of the Early period.

Although King recognized the innovation of the plank canoe as important, he suggested that social complexity preceded its use and viewed its development as a result of greater complexity rather than a stimulus to it.

Determination of when the plank canoe first was used by the Chumash is fundamental to understanding the development of sociopolitical complexity among them and is a principal goal of this research. Arnold (1995:737) has suggested that the plank canoe reached its "fully modified form by A.D. 1100–1150" and that social ranking developed around A.D. 1200–1300. If the plank canoe was fully developed much earlier than A.D. 1100–1150 and was significant in the development of social ranking as Arnold has suggested, then hierarchical status may have emerged earlier than Arnold hypothesized. Recent investigations of mortuary remains from the region indicate a ranked society emerged at least by A.D. 950–1150, earlier than has been argued by Arnold (Gamble et al. 2001). Despite the importance of the canoe in the relatively complex exchange system of the Chumash, no one has tried to determine exactly when the plank canoe first came into use by systematically examining all of the archaeological evidence.

In this paper, I present a methodologically integrative approach to determine the antiquity of the plank canoe in North America. This approach employs multiple lines of evidence, including a formal analysis of planks, asphaltum plugs, and chipped stone drills used in the manufacture of plank canoes. With the accurate identification of an artifact assemblage associated with the plank canoe, independent data sources are analyzed to determine the antiquity of this important watercraft among the Chumash. Wooden planks are the most direct evidence of the *tomol* and are perishable. The identification of an artifact assemblage that also includes inorganic items associated with the plank canoe allows a researcher to examine more durable evidence. This approach is appropriate when considering the antiquity of watercraft anywhere in the world.

## Ancient Watercraft in North America

Before examining evidence for the Chumash plank canoe, a brief overview of the types of boats that were used in North America at the time of historic contact is provided to support the claim that the plank canoe in southern California is the first of its kind in North America. Maritime archaeological finds of aboriginal boats in North America are rare (Gould 2000; Muckleroy 1978); therefore, most of the evidence presented here on maritime transportation is based on ethnohistoric and ethnographic information.

Hide or skin boats were the most common type of watercraft in the Arctic region (Driver and Massey 1957). To a lesser extent, they were also found in the Subarctic. Two forms were used prior to historic contact in the Arctic, the kayak and umiak (Adney and Chapelle 1964; Driver and Massey 1957; Gould 2000:95; Hornell 1970:155–168; Johnstone 1980). A third type of skin-covered boat was a circular tub-shaped craft known as a bull boat and was usually used to cross streams and rivers in the Plains area, the Great Lakes region, and parts of the southeastern United States (Adney and Chapell 1964:220; Driver and Massey 1957:289; Hornell 1970: 148–150; Roberts and Shackleton 1983:149–153).

Throughout much of temperate North America from Maine to central Alaska, bark canoes, which were used primarily in rivers and lakes, were the dominant form of watercraft (Adney and Chapell 1964; Driver and Massey 1957; Greenhill and Morrison 1995; Johnstone 1980:21–22; Reynolds 1978:103–104; Roberts and Shackleton 1983:156).

Boats *(balsas)* made from tule (*Scirpus* sp.) reeds were common in California and also reported for the Plateau, Lower California, and the mainland coast of the Gulf of California (Driver and Massey 1957:290–292; Heizer and Massey 1953; Johnstone 1980:44–45). Southeastern tribes in the United States used cane rafts. Similar in construction are log rafts, which have been found scattered throughout Canada, California, Mexico, and the Southwestern United States but, according to Driver and Massey (1957:292), "were nowhere of much consequence."

At the time of historic contact, dugout canoes were recorded along the Northwest coast, in the Plateau region, in the Southeastern United States, in the Great Lakes region, and in parts of California, Mexico, and the Caribbean (Driver and Massey 1957:290–291; Gould 2000:101–102; Roberts and Shackleton 1983:13–129). In regions where massive logs were readily available, such as the Northwest coast, large dugouts up to 60 feet in length with a capacity to carry six to eight tons proved especially seaworthy (De Laguna 1990:208). Johnstone (1980:50–51) suggests that planked boats devel-

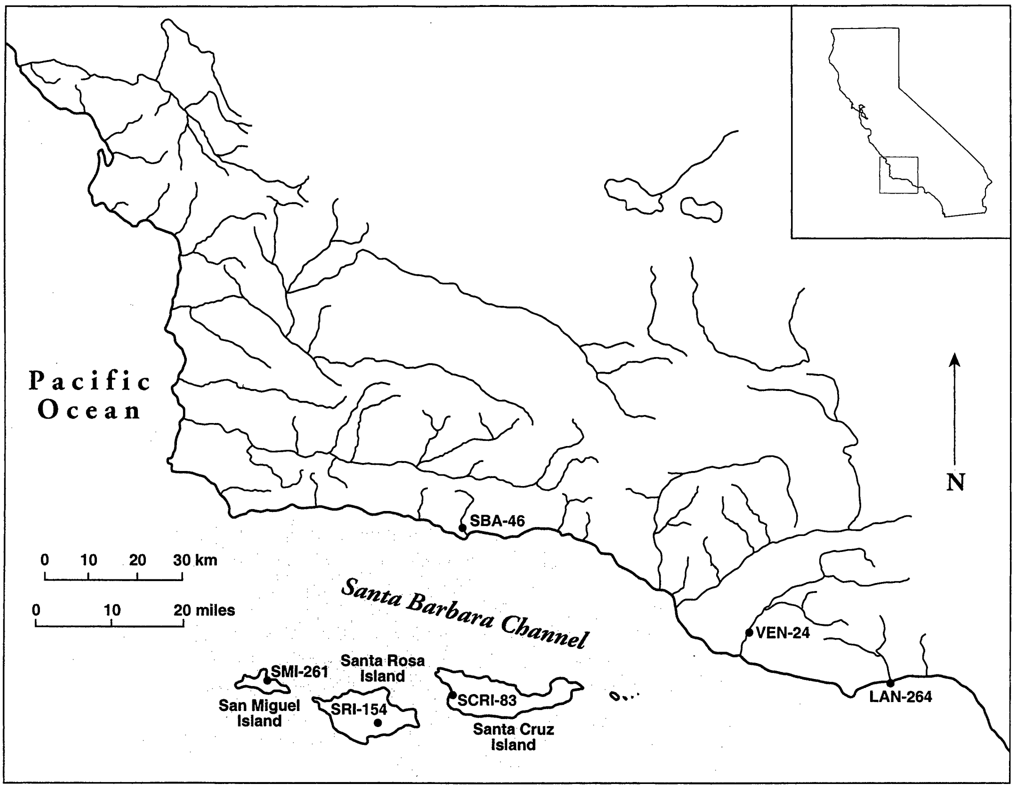


**Figure 1. Map of southern California with selected Chumash settlements.**

oped from dugouts. The Chumash and Tongva are the only North American Indian tribes that are known to have used the plank canoe prior to European contact.

## Ethnographic and Ethnohistoric Evidence of the Plank Canoe in Southern California

The plank canoe was known as the *tomol* by the Chumash, and by the Tongva, their neighbors and exchange partners, as the *ti'at*. The *tomol* and the *ti'at* were described by diarists on essentially every major excursion to the Santa Barbara Channel region (Figure 1), all of whom were clearly impressed by the watercraft, the distribution of which apparently did not extend to the north past Point Conception or to the south past Malibu, except for its appearance on Santa Catalina and San Clemente Islands (Brown 1967; Heizer 1938; Heizer and Massey 1953; Robinson 1942, 1943). Cabrillo provided the earliest mention of the plank canoe in 1542 when he observed many canoes, first at Santa Catalina Island and then throughout the Santa Barbara Channel region (Bolton 1976:23–39). Cabrillo estimated that the canoes carried approximately eight to 13 people, although others (Heizer 1938; Robinson 1942, 1943) suggest they more commonly carried three to five people. Most early diarists noted that plank boats were used for fishing and sea-mammal hunting in addition to transporting cargo and passengers. Several historic accounts furnish more explicit information about the plank canoe, including details on their size and construction (for a more thorough discussion, see Heizer 1938; Hudson et al. 1978; Robinson 1942, 1943; Woodward 1959).

It is believed that the Tongva acquired the plank canoe from the Chumash (Hudson et al. 1978:22). No historic sources mention that the plank boat was made in the Tongva area, despite the fact that plank canoes were observed historically on the Tongva-occupied southern Santa Barbara Channel Islands. The only historic account that contains a description of a settlement where plank canoes were manufactured is from the historic Chumash settlement at Carpinteria, where in 1769, Crespi noted that "it looked like a ship-yard" (Brown 1967:37–38).

A plank canoe was the most costly item a Chu-

**Figure 2: Plank canoe built in 1912 for J. P. Harrington.**

mash Indian owned—more expensive than a house—and its construction involved tremendous expertise and coordination (Hudson et al. 1978). Chiefs or wealthy individuals organized the labor necessary to build a canoe and paid for the materials and labor. Construction could often take up to six months and involved selective and guarded knowledge (Blackburn 1975:10). According to Fr. Pedro Font in 1776, owners of canoes were distinguished from other people by the bear-skin capes they wore (Bolton 1930).

The coastal Chumash lacked access to large trees suitable for seaworthy dugouts, and therefore primarily relied on driftwood from northern California as a source of planks for their boats. *Tomol*s varied in length between 3.5 and 9 m. Font described them as little boats without ribs with ends that were elevated and arched with a "V" opening (Bolton 1930:253). The gap at the prow and stern of the boat (Figure 2), also known as "ears," served a purpose in catching large fish.

Stone tools were used to drill holes in the planks, which were later sewn together with milkweed string. High-grade asphaltum from mainland tar seeps, mixed with pine pitch, provided the material used to fill the holes and caulk the seams where the planks were joined (Hudson et al. 1978). The material used to plug the holes and caulk the seams was a critical component of its seaworthiness (Heizer 1940:83; Landberg 1965:38).

Once plank canoes were built, chiefs and wealthy individuals who owned them exerted considerable control in their use (Hudson et al. 1978:130). In 1776, Font observed a canoe filled with fish that was carried to the house of the canoe captain by 10 or 12 fishermen upon arrival at the beach (Bolton 1930:259).

Historically, the Chumash operated two types of watercraft, the tule balsa and the plank canoe, and possibly a third—the dugout canoe. The tule balsa was primarily used for fishing along the coast and occasionally to access the Channel Islands in calm conditions (Hudson and Blackburn 1982:331), but was limited in terms of the amounts of goods it could transport. There is doubt among scholars as to whether the dugout was used by the Chumash (Heizer 1940), although Chumash small wooden or stone-boat effigies look like dugouts. Hudson et al. (1978:22) suggested that the earliest *tomols* were probably dugouts with a few boards added to the hull to make them more seaworthy. The dugout or the tule balsa may have been used when the offshore Channel Islands were settled approximately 10,000 years ago.

## Exchange in the Santa Barbara Channel Region

The Chumash had a highly developed economic system in which shell beads were used as money (King 1976). The production of shell beads as a standardized, portable medium of exchange was a complex industry. Inhabitants of villages on Santa Cruz Island and the other Channel Islands specialized in manufacturing goods such as bead money to gain access to resources not available on the islands (Arnold 2001; Kennett and Kennett 2000). In return for bead money, inhabitants of the mainland and interior of the Santa Barbara Coast region furnished subsistence and status items to the islanders. Seaworthy plank canoes provided the transportation for the efficient exchange of beads and other goods between the mainland and the islands.

In addition to shell beads, other items were manufactured on the Channel Islands and traded to the mainland Chumash, including mortars and pestles (Conlee 2000; Kennett 1998:346), large steatite ollas and comals (frying pans) (Howard 2000; Meighan 1959:384), and sea mammal parts (Walker 1997). Transportation of heavy items like steatite vessels, ground stone, and sea-mammal parts would have been greatly facilitated with seaworthy transportation such as the plank canoe.

Arnold (2001:288–296) has suggested significant organizational changes occurred among the Chumash about A.D. 1150–1300 that culminated in more intensive exchange of shell beads and other valuables that was controlled by elite canoe owners. Kennett and Kennett (2000:390) have indicated that intensification in exchange between the mainland and islands emerged at an earlier date (A.D. 650). Evidence includes increased detritus resulting from shell-bead manufacturing on eastern Santa Rosa Islands and western Santa Cruz Islands between A.D. 650–1300 and increased production of mortars and pestles on San Miguel Island. Conlee (2000) noted that the most active period of groundstone manufacture occurred during the late Middle period (A.D. 580–980) and could have been related to the development of the *tomol*.

## Archaeological Evidence of the Plank Canoe in California

Wooden planks, asphaltum canoe plugs, and asphaltum caulking impressions are the most direct archaeological evidence of plank canoes in southern California. Less-direct indications of plank canoes are large, trifacial stone drills and elaborate maritime technology associated with deep-sea fishing, such as harpoons. Small canoe models were also found among the Chumash and were apparently used as "charms" or *'atishwin* for good luck when out to sea (Hudson et al. 1978:126).

King (1990:85–86, Figure 3) has provided the best archaeological documentation of when the plank canoe first originated in the Chumash region. He suggested that evidence for the *tomol* appears between A.D. 400–1000. King noted, however, a number of uncertainties affecting his estimates, including the tentative identification of large drills as canoe drills and the questionable antiquity of a number of artifact types.

To better document when the plank canoe was first used, I examined five classes of relevant artifacts from seven repositories: 1) canoe planks, 2) asphaltum plugs, 3) asphaltum caulking, 4) large, trifacial stone drills, and 5) model canoes.

### *Canoe Planks*

Fragments of wooden planks are the most direct evidence of plank canoes. Almost all archaeological examples of portions of *tomols* in southern California have been found in mortuary contexts. Unfortunately, because of the Mediterranean-like climate in southern California, few are preserved, and when preserved, they are usually from historic or protohistoric sites. I examined canoe planks to determine if there were any from earlier contexts and to take some relevant measurements. The thickness of canoe planks and the diameter of the holes were considered pertinent to this research for an accurate identification of the drills used in the manufacture of plank canoes. If the production of canoes was specialized, I anticipated a tool kit with a standardized drill. Moreover, I assumed that the drills used to bore the wooden planks of the canoe would exhibit use-wear polish typical of wood, and that the distribution of this polish along the drill bit would be similar in length to the thickness of a canoe plank.

I examined 62 planks, 10 of which were complete. Because of the fragmentary nature of some planks, maximum thickness was measured on 47 of them (Table 1). The mean thickness of the canoe planks was 20.0 mm ($s = 4.3$), with most (64 percent) planks measuring between 15 and 22 mm thick. All of the

Table 1. Summary of Canoe Planks Used in the Analysis.

| Site | Thickness (mm) | Asphaltum (Presence)[a] | Beveled | No. of Holes[b] |
|---|---|---|---|---|
| LAN-52 | 21.83 | H,E,S | Side | 3 |
| LAN-52 | 25.00 | H,S | Side | 2 |
| S. Nicholas I. | 19.29 | H,E | None | 1 |
| S. Nicholas I. | 12.18 | H | None | 1 |
| S. Nicholas I. | 22.32 | H | None | 5 |
| S. Nicholas I. | 20.19 | H,E | Side | 5 |
| S. Nicholas I. | 29.11 | H,E,S | Side | 2 |
| S. Nicholas I. | 29.54 | H,S | None | 3 |
| S. Nicholas I. | 13.12 | H,S | Side | 1 |
| S. Nicholas I. | 20.01 | E | Side | 2 |
| S. Nicholas I. | 13.93 | E,S | None | 4 |
| S. Nicholas I. | 19.18 | H,E,S | None | 3 |
| S. Nicholas I. | 17.41 | None | None | 2 |
| S. Nicholas I. | 25.33 | H | None | 2 |
| SCRI-1 | 27.73 | H,E | None | 4 |
| SCRI-1 | 24.20 | None | None | 2 |
| SCRI-1 | 14.00 | H,E | None | ? |
| SCRI-1 | 17.79 | E,S | None | ? |
| SCRI-138 | 19.07 | H,E | None | 3 |
| SCRI-138 | 19.58 | S | None | 2 |
| SCRI-138 | 18.77 | None | None | ? |
| SCRI-138 | 17.03 | None | None | 1 |
| SCRI-138 | 18.72 | None | None | ? |
| SCRI-138 | 17.46 | None | None | ? |
| SCRI-138 | 14.40 | None | None | 1 |
| SCRI-257 | 18.00 | S | None | 2 |
| SCRI-257 | 19.30 | None | None | ? |
| SCRI-257 | 23.40 | None | None | 1 |
| SCRI-257 | 21.85 | H,S | None | 4 |
| SCRI-257 | 14.07 | None | None | ? |
| SCRI-257 | 24.00 | None | None | 3 |
| SCRI-257 | 21.74 | H,E,S | None | 6 |
| SCRI-257 | 18.60 | H | None | 2 |
| SCRI-257 | 24.00 | None | None | 1 |
| SCRI-83 | 19.12 | H,E,S | Side | 12 |
| SCRI-83 | 19.58 | H,E,S | Side | 9 |
| SCRI-83 | 20.30 | H,E,S | None | 13 |
| SCRI-83 | 18.65 | H,E,S | None | 14 |
| SCRI-83 | 21.04 | H,E,S | None | 9 |
| SCRI-83 | 19.63 | H,E,S | None | 8 |
| SCRI-83 | 20.55 | E | None | ? |
| SCRI-83 | 22.12 | None | None | 11 |
| SCRI-83 | 20.38 | S | None | ? |
| SMI-261 | 31.44 | H,E,S | End | 6 |
| SRI-40 | 16.39 | H,E,S | Side | 1 |
| SRI-40 | 15.26 | H,E,S | End | 1 |
| SRI-40 | 15.28 | None | End | ? |

[a] H = Hole, E = End, S = Side.
[b] ? = Number of holes is unclear because of fragmentary or eroded condition.

whole planks have traces of asphaltum plugs and caulking along their sides or at the ends. Twelve of the planks analyzed for this research display evidence of beveling (Table 1). One of the most complete and best-preserved archaeological examples of a plank canoe is from a mortuary context at Christies Beach (CA-SCRI-257) on Santa Cruz Island. A two-m-long segment of one side of a *tomol*, consisting of 10 planks, was recovered by Olson (Ms. 442, Original Field Notebooks and Photo Prints of Santa Barbara

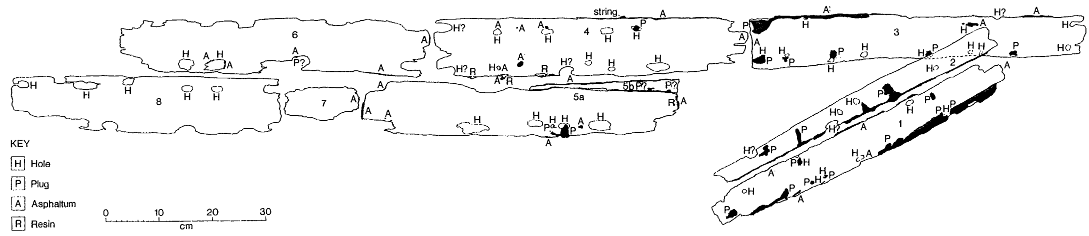


**Figure 3: An archaeological example of a portion of a plank canoe.**

Mainland and Santa Cruz Island Excavations, [by R. L. Olson, 1927–1928], Archaeological Archives of the Phoebe Hearst Museum of Anthropology, UC Berkeley). Olson carefully documented the spatial arrangement of the planks and numbered them as they were removed (Figure 3), but never published his find. Although various archaeological discoveries of portions of *tomol*s have been found in the Chumash region, none were recorded and removed in such a manner as to preserve their arrangement. If the remainder of the canoe consisted of the same size planks as those recovered by Olson, a total of 144 planks would have been required to make a boat 609 cm long (19.75 ft) and 92 cm high (3 ft). The planks Olson recovered exhibit 70 holes on seven planks, averaging 10 holes per plank. Three of the planks are too fragmentary to determine the number of holes or the length of the planks (Figure 3).

There are a number of other examples of planks as grave associations (King 1982:85), two of which are noted here. One is from the historic cemetery at Mescalitan Island, where a person was buried inside what appeared to be a whole canoe (Putnam 1879:39). Another is from the historic site of *Humaliwu*, where an individual was buried in a large portion of a canoe (Gamble et al. 2001:198).

One accelerator mass spectrometry (AMS) radiocarbon date was obtained on a portion of a plank canoe that represents one of the earliest, if not the earliest, dates for a plank canoe in the New World (Table 2). The plank, approximately 1,300 years old, was found in Daisy Cave (CA-SMI-261) on San Miguel Island. This cave is probably best known for its evidence of early occupation on the southern California coast, dating back to ca. 10,500 years ago (Erlandson et al. 1996; Rick et al. 2001). The wooden plank clearly was part of a plank canoe. The calibrated date (cal A.D. 625–700 at 95 percent probability) lies within Phase 3 of the Middle period according to King's chronology. Because this date was on probable driftwood, the "old-wood" effect may result in a date considerably older than the time period it was actually used; therefore, this date needs to be viewed conservatively. More recently, Jon Erlandson and René Vellanoweth (personal communication 2001) obtained a date on another piece of wood from Daisy Cave of about 2,300 years ago. This was a small, flat piece of wood that was covered with asphaltum. It may have been a portion of a plank canoe; however, because of its fragmentary nature, it is difficult to identify it as such with certainty. Erlandson and Vellanoweth caution that the old-wood effect or the asphaltum could exaggerate the age for the cultural use of the wood. Further evidence of canoe planks during this period is from the cemetery at the site of *Simo'mo* (CA-VEN-26), where a canoe plank was found with one of the burials. The cemetery is estimated to have been used

Table 2. Radiocarbon Dates of Artifacts Associated with the Plank Canoe.

| Site | Provenience | Laboratory Number (Beta-) | Material Dated | Uncorrected Radiocarbon Age | Calibrated Results[a] (2 Sigma, 95% Probability) |
|---|---|---|---|---|---|
| CA-SCRI-253 | Pit M, Sect 1, 27 in | 119070 (AMS) | wood | 400 ± 50 | cal A.D. 1425-1640 |
| CA-SMI-261 | G3, 6-12 in | 129776 (AMS) | wood | 1370 ± 40 | cal A.D. 625-700 |
| CA-SRI-3 | Cem. A, Burial 8 | 119068 (AMS) | *Lottia gigantea* | 4450 ± 60 | cal B.C. 2505-2185 |
| CA-SRI-3 | Cem. A, Burial 8 | 119069 (AMS) | *Haliotis chracherodii* | 4650 ± 70 | cal B.C. 2860-2425 |

[a] Calibrated at 2 sigma with the Pretoria Calibration Procedure program.

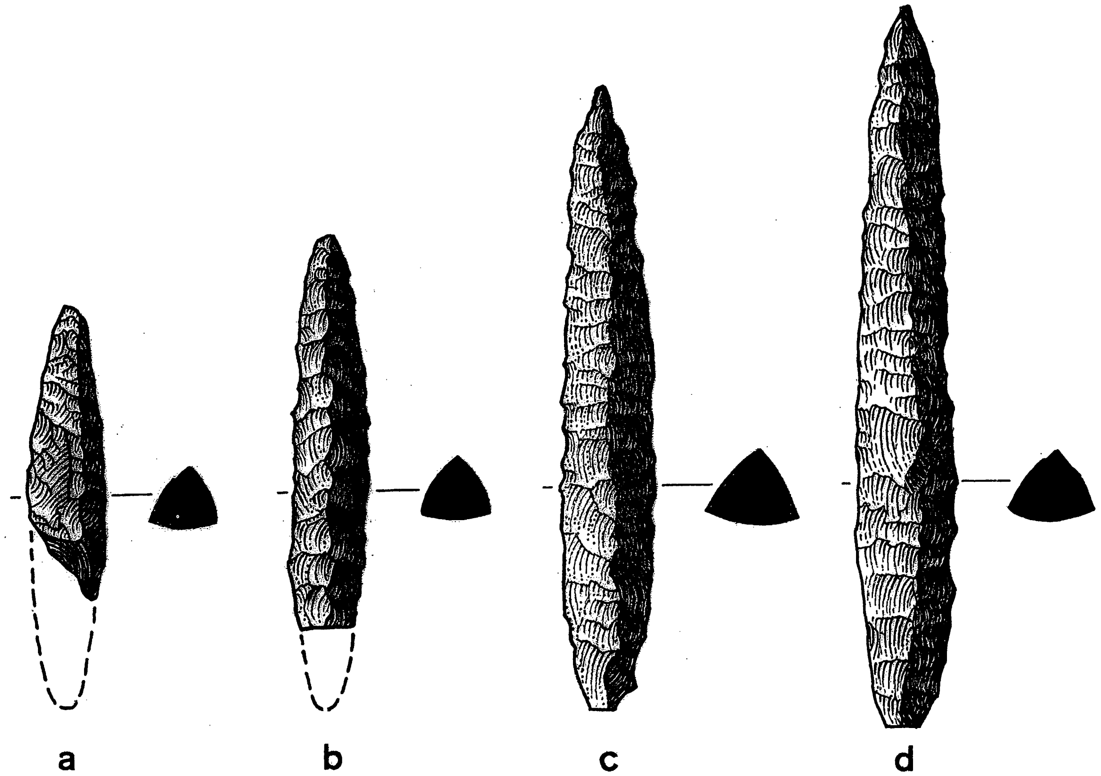


**Figure 4. Examples of canoe drills: (a) UCLA Catalog No. 565-929, Monterey chert drill from the Pitas Point site (CA-VEN-27); (b) UCLA Catalog No. 565-2523, Monterey chert drill from the Pitas Point site (CA-VEN-27); (c) LACMNH Catalog No. L-1433-32-831, Monterey chert drill from Simo'mo (CA-VEN-26); (d) LACMNH Catalog No. L-1433-32-832, Monterey chert drill from Simo'mo (CA-VEN-26).**

during Phase 4 of the Middle period (A.D. 700–900) (King 1990:xxii and Figure 3), and possibly earlier during Phase 3 (A.D. 400–700) (Martz 1984).

*Asphaltum Associated with the Plank Canoe*

Asphaltum was intensively used by the Chumash for thousands of years as general-purpose glue, sealant, decoration, and for many other purposes (Gamble 1991). It was also used to plug the holes of plank canoes, for caulking between the planks, and for decoration with inlaid beads or bits of shell on the exterior. Asphaltum canoe plugs, caulking, and decoration were examined as part of my research. Because the diameter of asphaltum plugs used in canoes is the most accurate measurement of hole sizes, diameters were measured on numerous plugs. The diameter of the holes in the planks was assumed relevant for an accurate identification of the drills. Forty-four whole asphaltum canoe plugs were measured. The range of diameters was between 8.7 and 17.8 mm, with a mean of 12.5 mm. The length of the canoe plugs varied between 12.4 and 30.9 mm, with the mean length of a plug about 23.4 mm. Asphaltum caulking was visible on the edges of most of the canoe planks examined. The earliest examples of asphaltum caulking and canoe plugs are from the Chumash Middle period site of *Simo'mo* (CA-VEN-26).

*Canoe Drills*

An important component in the production and maintenance of *tomols* is the drilling of the holes in each plank. Based on the estimate of the number of planks per canoe ($n = 144$) and the number of holes ($n = 10$) in each plank in the archaeological examples, one canoe might require 1,440 drilled holes. The drills used to produce these holes should be identifiable and standardized in form, and therefore should provide evidence for the origin of the plank canoe, particularly given the preservation qualities of stone. Examples identified as "canoe drills" are illustrated in Figure 4. The uniform, trifacial cross-section of

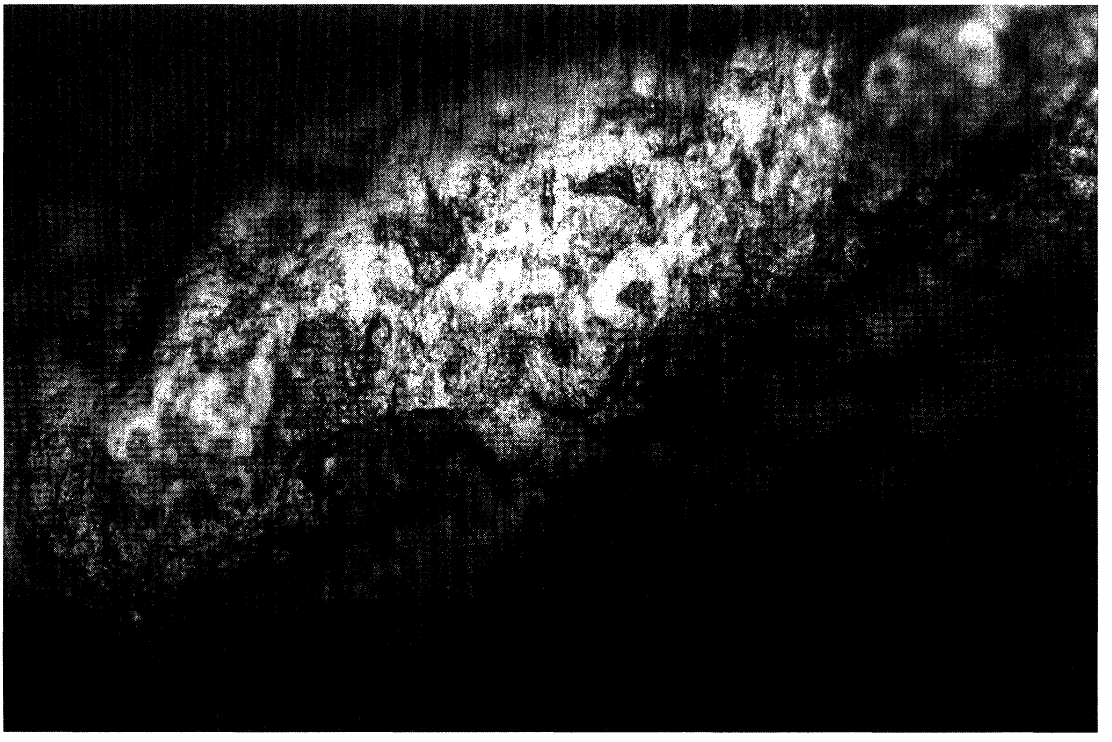

**Figure 5. Microscopic view of polish on Monterey chert drill from Santa Barbara Museum of Natural History: Catalog No. 1-60A/3275 (CA-SRI-60A). Approximate magnification 200×.**

these drills is markedly different than that of other drills found in the Chumash region. "Canoe drills" are found primarily in coastal sites, on the mainland, or the northern Channel Islands in the Santa Barbara Channel region. These drills have not been found in California outside of the Chumash and Tongva region and are rare in the Tongva region. Their distribution is significant as it corresponds with the distribution of the plank canoe (Heizer and Massey 1953) and is consistent with the hypothesis that this type of drill was used predominantly on canoe planks. One of the more interesting examples of one such drill was found with what was believed to be the burial of a chief inside a *tomol* at Mescalitan Island (SBA-46) (Gamble 1991).

I analyzed 68 drills, 36 from mainland Chumash sites and 32 from island sites. Of these 68, length was measured for 40 of the drills that were whole or almost whole. These ranged in length from 42.0 to 123.5 mm with a mean of 66.2 mm. Forty-two drills were selected from the whole sample for a more thorough analysis of edge damage and use-wear polish through high-powered microscopic analysis (see Keeley 1980). Most of the drills were made from chert, an ideal material for use-wear polish analysis. Nineteen of the 42 had evidence of use-wear polish. The motion of use on all 19 was identified as a drilling or reaming action. The type of polish could not be identified on 3 of the 19 drills. Of the remaining 15, 12 (75 percent) showed evidence of wood polish (Figure 5). Two of these also had evidence of shell polish on their bits. In summary, the majority of the drills exhibiting use wear appear to have been used to drill wood.

Other variables support the hypothesis that most of these drills were used in the construction of plank canoes. The mean diameter of the drills (12.8 mm) is almost identical to the mean diameter of the stems of asphaltum canoe plugs (12.5 mm). The mean length of polish on the drill bits was 19.6 mm long. This figure is very close to the mean thickness of a canoe plank, which is 20.0 mm. All of these data, including the geographic distribution of the drills, indicate that they were used primarily to drill planks in the construction and repair of the plank canoe, although some had multiple uses.

Recently, Arnold et al. (2001) conducted a study of macrodrills from Santa Cruz Island. In their study, they identified six drills ranging in length from 20–50 mm, that they claim are often labeled as "canoe drills" (their Type 3). They were able to distinguish microwear polish on three in their sample; two display wood polish. In their conclusion, however, they suggested that the term "canoe drill" be dropped from the regional typological vocabulary because "macrodrill morphology correlates poorly with the material drilled" (Arnold et al. 2001:131). The data presented on "canoe drills" in this paper provides compelling evidence that such drills can be identified accurately.

The earliest drills in my sample (illustrated in Figure 4, c and d), both with evidence of wood polish, are trifacial and from the site of *Simo'mo*. A third drill, similar in appearance to the type identified as canoe drills and from a much earlier context (Burial 8, Cemetery A, SRI-3), was examined. It was found in a lump of asphaltum that had been enclosed within a container composed of two shells, a *Haliotis chracherodii* and a *Lottia gigantea*. Microscopic observations of this drill were inconclusive. A radiocarbon date on a whole olivella shell from the same burial lot provided a conventional radiocarbon age of 4110 ± 70 B.P. (see Erlandson and Johnson in Breschini et al. 1996:97). Because it is possible that the olivella shell that was dated may not have actually been associated with the drill, two AMS dates for the shells most closely associated with the drill were also obtained. Both shells that surrounded the asphaltum were selected for dating. Care was taken to insure that the samples were not contaminated with asphaltum. Of these dates, the results (4450 ± 60 B.P. and 4650 ± 70 B.P.; Table 2) are relatively close in age to the previous date obtained by Erlandson and Johnson and indicate that the drill may be considerably older than other drills of this type. The only substantial difference between this drill and many of the others that were identified as canoe drills is that it was not as finely flaked. Because the three dates associated with the drill are similar, I doubt there is a problem with the radiocarbon dates. It is possible that this drill was used for some purpose other than drilling canoe planks, or that the drill was used to perforate wooden planks for a canoe and represents early boat technology. Many of the canoe drills reported here were assigned to relative time periods, and some are from inadequately documented collections or from sites where the chronological sequence is poorly understood. Therefore, it is possible that some of the other drills examined for this research are from earlier contexts. Future studies should resolve some of these issues.

### *Canoe Effigies*

The association of canoe effigies with plank canoes is tenuous, in part because these effigies cannot always be identified according to type of boat. Some show the ears that are typical of plank canoes, but many are more simple renditions of boats and might represent dugout canoes or tule boats, although the latter is unlikely. Despite the problems associated with these types of artifacts, the date at which these objects first enter the archaeological record may be relevant in determining the origin of the plank canoe.

Most canoe effigies found in an archaeological context are made from stone, although some are wood (Hudson and Blackburn 1986:171–226). Canoe effigies are found on the northern and southern Santa Barbara Channel Islands as well as on the mainland coast. The earliest examples of stone canoe effigies are two from a cave site on Santa Rosa Island (SRI-154) that Jones excavated in 1901. Artifacts associated with the effigies are from Phase 3 of the Middle period (A.D. 400–700) (King 1990). A wooden canoe effigy was found on Santa Rosa Island (SRI-6) at a depth of more than 2.5 m and may be from a very early context. Deposits from the upper layers of SRI-6 are estimated to be approximately 1,250 years old on the basis of a calibrated radiocarbon date from a mussel shell (Erlandson et al. 1999:Table 1). However, a calibrated radiocarbon date (7470 cal B.P.) on a red abalone shell from the lower levels of the site (3.65 m) indicates that the deposit where the canoe model was recovered may be quite early. None of the effigies just described have a prominent prow or stern that might suggest that they were representations of *tomols* instead of dugouts.

### *Other Artifacts Associated with the Plank Canoe*

The proliferation of the remains of large, deep-sea fish and harpoons probably reflects a greater reliance on more seaworthy boats. Widespread evidence of deep-sea fish such as tuna and swordfish appears in the archaeological record about 1,800 to 2,000 years ago (Davenport et al. 1993; King 1990:85). Harpoons were believed to have been used in the capture of large fish, and bone barbs attached to the harpoons appear in the archaeological record at about the same time as deep-sea fish remains appear (Davenport et al. 1993:261; King 1990). Rick and Glassow (1999) suggest that swordfish remains may have appeared in the archaeological record much earlier in the Santa Barbara Channel region at CA-SBA-53. They cite Harrison and Harrison (1966), who reported five swordfish vertebrae at the site that was occupied about 5,000 years ago. This is considerably earlier than the widespread use of swordfish remains reported by Davenport and his colleagues. Rick and Glassow (1999:253) note that these may have been obtained "by scavenging or intermittent capture on cross-channel voyages."

## Discussion and Conclusions

Recent discoveries provide evidence that the offshore northern Santa Barbara Channel Islands were occupied for at least the last 10,000 radiocarbon years B.P. (Erlandson et al. 1996). Erlandson and his colleagues propose that this initial colonization would have required a relatively seaworthy watercraft. Chumash emphasis on maritime resources for thousands of years confirms a heavy reliance on watercraft. Radiocarbon dating of a canoe plank indicates that the *tomol* was in use as early as A.D. 625–700. Between A.D. 400–900, canoe planks, drills, asphaltum caulking, and plugs appear in the cemetery at *Simo'mo* and provide ample evidence of the *tomol*. It is likely that the plank canoe was fully developed by about 1,400 years ago and had evolved from earlier technology over a period of hundreds or even thousands of years. If the date that Erlandson and Vellanoweth obtained on a plank was part of a *tomol*, it would suggest that the Chumash plank canoe was used over 2,000 years ago.

The *tomol* used by the Chumash represents the earliest documented example of sewn plank boats in North America and probably in the New World. The only other region in the New World that has yielded evidence of a sewn plank boat *(dalca)* is in southern Chile (Cooper 1917; Heizer 1966; Lothrop 1932). The *dalca* was first recorded off the southern coast of Chile in the Gulf of Coronado by Miguel de Goiçueta on the Cortés Hojea expedition of 1557–1558 (Edwards 1965:24), although it is believed that Goiçueta actually first observed *dalcas* in 1553. Most scholars agree that the early date of Goiçueta's account and other evidence indicate that the *dalca* was an aboriginal invention and not technology borrowed from the Spanish (Edwards 1965:90–92). Early reports indicate the *dalca* was approximately 9–12 m long and was made from only three planks, a bottom plank that projected out and was bent for the stern and the prow, and two others for the sides of the boat (Heizer 1966:24; Lothrop 1932:244). Plant material in the form of a roll of grass or the inner bark of the *maqui* tree *(Aristole maqui)* was used along the joints of the planks and in the holes (Lothrop 1932:245). The only archaeological example of a *dalca* was found by Junius Bird who observed one washing out of a bog in Chiloé in 1935 (Edwards 1965:130).

The significance of the canoe in the development of sociopolitical complexity among the Chumash cannot be underestimated. Johnson and Earle (2000) note that among hunter-gatherer-fisher societies in environments with rich resources, intensification through technological developments, such as special boats, is often associated with developments in the political economy. For example, political leaders in Eskimo Tareumiut society are boat owners who organize and coordinate voluntary associations of whale hunters in "the manufacture, use, and maintenance of whaling technology and the distribution of the massive catch" (Johnson and Earle 2000:178). These boat owners also play an important role in intervillage economic integration through the hosting of competitive feasting events.

Parallels can be seen among the Chumash; however, the intervillage economic integration appears to have been more formalized. Ethnographic evidence indicates that during the historic period men associated with the manufacture and use of plank canoes belonged to an elite craft guild known as the "Brotherhood of the Tomol." This organization crosscut localized kinship affiliation (Blackburn 1975:10; Hudson et al. 1978:154–155). The leader of the "Brotherhood of the Tomol" was often the canoe owner and frequently was a chief who gained considerable wealth and prestige through control of the intensified maritime economy, including subsistence and exchange. Membership in this organization served to integrate a number of settlements, suggesting that the development of the plank canoe was associated with a greater level of regional economic integration. Although not all Chumash chiefs were necessarily boat owners, the development of the canoe clearly provided a mechanism that increased and formalized differences in social status.

The Chumash findings are similar to those of Polynesia and Melanesia in the South Pacific, where even more elaborate maritime technologies and sociopolitical complexity arose. In both Oceania and southern California, exchange was an integral part of the sociopolitical systems. The high rank of canoe owners and canoe builders was similar in both regions, reflecting the significance of these individuals among the political elite. In the case of the Chumash, political leaders were apparently the same individuals that owned the canoes. The control of exchange through ownership of this highly developed form of maritime technology appears common to both regions. In the Chumash region, the emergence of hereditary chiefs was integrally linked to their advanced economic system. It may have been the demand for money and prestige goods among the elite who lived in the large, coastal mainland centers that fueled the development of craft specialization in the form of shell beads found on the northern Channel Islands.

One issue that I have not addressed is the possibility of culture-contact in the development of the plank canoe. The only regions in the Pacific where plank boats were used prehistorically were in Oceania and Chile (Hudson et al. 1978:22–23). It is unlikely that the Chumash were introduced to the idea of plank boats from Chile, as those apparently developed much later in time. In contrast, the highly efficient double-hulled and outrigger plank boats in Oceania are considered to have had a lengthy developmental history. The timing of the Chumash *tomol* is intriguing in that it coincided with a major phase of Polynesian long-distance voyaging and exploration that took inhabitants of Polynesia to the far eastern Pacific (Kirch 2000). Hather and Kirch (1991) provide solid archaeological evidence that the sweet potato *(Ipomoea batatas)* was on the island of Mangaia in eastern Polynesia by A.D. 1000, and possibly earlier. They suggest that this tuber, which was domesticated in South America, was probably transferred to Oceania by the seafaring Polynesians. Although there is no evidence for culture contact between Polynesians and North American Indians prehistorically, it is possible. Most scholars (Heizer 1966:34; Hudson et al. 1978:22; Robinson 1943:17–18) assume that the construction of *tomols* and Polynesian watercraft was so different that the Chumash canoe must have been an independent invention.

Solid evidence for the plank canoe by about 1,300 years ago indicates that this important maritime technology was fully developed earlier than Arnold (1995) suggests. If ownership of the plank canoe in the Chumash region reflects greater inequity of wealth and power as Arnold (1995), King (1982), and others have proposed, then the appearance of this type of watercraft in the archaeological record during the Middle period suggests that social hierarchy may have appeared 500–600 years earlier than Arnold (1992, 1995) has hypothesized. According to Kennett and Kennett (2000), this date is closer to the era that more intensive fishing strategies and exchange developed. Independent information based on mortuary data from a number of Middle period Chumash sites (Gamble et al. 2001; King 1990) supports the idea that social ranking emerged in the Chumash area at least 1,600 years ago.

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