# ONE OLD JUNK IS EVERYONE'S TREASURE:

# THE EXCAVATION, ANALYSIS, AND INTERPRETATION OF A CHINESE SHRIMP JUNK AT CHINA CAMP STATE PARK

by

John C. Muir

A thesis submitted to

Sonoma State University

in partial fulfillment of the requirement for the degree of

MASTER OF ARTS

in

Cultural Resources Management

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Dr. Margaret Purser, Chair

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# CHAPTER I. INTRODUCTION

China Camp State Park in San Rafael, California, located at the site of one of the major historic 19th-century Chinese shrimp fishing villages in the San Francisco Bay, preserves and interprets the history and material culture of these unique immigrant communities. Much of the interpretation at the Park, however, focuses on the land-based shrimp-processing operations and daily life of the camps. Although the nature of the fishery and some of the fishing gear used in it is discussed in the Park's exhibits, the central element to the fishery and the community as a whole - the fishing junks - play only a peripheral role in the Park's interpretive scheme. The de-emphasis of this key element of the Chinese camps' material culture reflects the fragmented nature of the historical and physical records of these unique vessels. The 1977 discovery of the remains of two shrimp junks buried in the mud flats of Rat Rock Cove on Park lands, however, created for the Park a unique opportunity to study these vessels first hand. Unfortunately, limited field time in 1977 prevented the thorough documentation of this important cultural resource. This thesis seeks to advance the level of documentation of the Rat Rock Cove junks through limited archaeological survey. It also seeks to explore the ways in which the material evidence can both illuminate and be illuminated by the historic photographs, written documents, and ethnographic information. The resulting analysis, by expanding our understanding of both the junks and the culture that created them, also expands the interpretive potential of the Rat Rock Cove site. The final chapter explores this potential by suggesting avenues for the public interpretation of this unique and valuable cultural resource.

Historical Background of the Chinese Shrimp Fisheries 1870-1913

The task of setting the historical context of the San Francisco shrimp junks, and of the Rat Rock Cove junks in particular, is simplified by the fine work of California Department of Parks and Recreation historian Marvin Brienes. In his capacity as Interpreter in DPR's Office of Interpretive Planning, Dr. Brienes in 1983 produced a comprehensive document entitled *China Camp and the San Francisco Bay Shrimp Fishery,* which was intended to serve as a reference for interpretive program at the newly founded China Camp State Park. The below section is drawn entirely from this work, unless otherwise noted.

China Camp State Park is located on the site of one the largest and most prosperous of the many Chinese shrimp fishing villages of 19th- and early 20th-century San Francisco Bay Area. Located near prime shrimping areas, where shallow, estuarine mud flats rich in nutrients supplied ample food for a variety of fish, the villages could be found crowded around the isolated shores of San Francisco and San Pablo Bays, from the mouth of Gallinas Creek to the north, down to the southern sloughs of Redwood City. Commonly referred to as "camps," they were collections of roughly built, redwood-planked work sheds, storage buildings, and boarding houses. Many of these structures were raised up on pilings over the water's edge. Long, narrow wharves led out to the junks and sampans used in the pursuit of shrimp, the *modus vivandi* that defined the life of the villages' inhabitants.

Though many early 20th-century observers noted their picturesque quality, the camps were essentially factories, whose central focus was the procure-

ment and processing of shrimp.The shrimp were caught using triangular shaped bag-like nets, which were staked into the muddy bottom of shallow-water areas in long rows. With the mouth of the nets open and facing into the rush of the tide, the fine mesh of the nets acted like a filter, sifting out the shrimp, and many other varieties of small fish. Before the full six-hour run of a San Francisco tide, and near as possible to slack current, the nets were hauled up into junks and sampans, where the catch was released from the purse of the nets into wicker baskets. Shrimp intended for live sale, if any were so intended, were separated and quickly sent off to market. The rest of the catch was brought ashore to be sorted and processed.

In the first stages of processing, the freshly caught shrimp were boiled in salted water for a short period, usually around ten minutes. Then, after being drained and cooled, the shrimps were graded for size, with the larger ones being set aside for prompt shipment to the markets and restaurants of San Francisco, and the smaller ones being spread out to dry on the drying grounds. These were either open clearings on the hillsides behind the camps, or raised wooden platforms. The catch was left to dry for several days, and required regular turning over,a task that was performed using a wooden rake. Drying shrimp, of course, required dry and sunny weather, and restricted shrimp operations to temperate seasons. Finally, as soon as the shrimp were adequately dry, they were gently crushed, either under bare feet or by using the more efficient weight of a two-handled, slatted roller. This device loosened the heads and the shells from the shrimp meat. These were finally separated by the use of a winnowing machine, an ancient Chinese agricultural machine used to separate the grain from chaff in the processing of grain and rice harvests. Once separated, the dried shrimp meat, and the heads and shells, mixed together to be sold as fertilizer, were

bagged in large burlap sacks, and stored until shipment to San Francisco, and markets further abroad.

The shrimping industry, during the period under discussion, was both prolific and profitable. In some years of the 1890s, the shrimp catch was worth as much as $250,000. In 1896, it was one of the three most valuable catches in the state of California. While a small amount of the catch was locally sold live or "freshly cooked," as much as 90% of the catch was dried and sold as meal or dried shrimp meat. Though a small proportion of these products were also sold to Chinese communities around the Bay Area, and to some in other places of the United States, the bulk of the industry's profits were generated through their export to the markets of China and other regions overseas, where they were valued as a dietary staple. In the prosperous year of 1892 alone, the Chinese exported almost 1,000,000 lbs. of dried shrimp, and almost 3,000,000 lbs. of shrimp meal. At an average price of roughly 10 cents per lb. This represents a very substantial output, and indicates the high value of the industry.

The profitability of the shrimp industry supported the growth of shrimp camps between 1870 and 1890. The historical record of the camps in this period, and particularly of the camps around Pt. San Pedro, chronicle their rapid development from simple, all-male work camps into diverse, budding communities. The earliest accounts of a Chinese shrimping village describe a small settlement of 66 Chinese fishermen, living in 15 dwellings and working out of as many boats, around Pt. San Pedro near the town of San Rafael, in or near the area now known as China Camp State Park. By 1880, this settlement had grown to support almost 500 people in over 80 dwellings, including 19 women and 31 children. It could also boast of a diversity of occupations, including two gardeners, a barber,

a school teacher, a physician, a marine supplies dealer, a dealer in junks, and three general stores.

A large percentage of the inhabitants of the camps around Pt. San Pedro in 1880 were Chinese-born immigrants, and, like most 19th-century immigrants to the San Francisco Area, had come from five different districts in the vicinity of the Pearl River Region of Guangdong Province. Many had originally come to California to seek gold in the storied hills of the Sierras, or to build the new railroads of the Western United States. As these endeavors waned, many Chinese found a new opportunity in the shrimp fisheries of San Francisco Bay. Isolated from and ignored by most of the surrounding Caucasian communities of the Bay Area, the people of Pt. San Pedro recreated where possible a life of customs and cultural practices brought with them from their native China. They prayed in shrines, ate traditional Chinese foods, and passed on the Chinese language to their children. Even the equipment they used in the fishery was brought from China, where shrimp fishing on estuarine mud flats had long been practiced.

Unfortunately, the flourishing of a diverse and permanent community at Pt. San Pedro was brought to a stop by the growing pressures against the Chinese shrimp fishery, and California's Chinese community as a whole. The groundswell of anti-Chinese sentiments in California, responding to the flood of Chinese labor released by the completion of the railroad projects which had occupied them in earlier years, forced the passage of the Chinese Exclusion Act of 1882, which denied citizenship to all Chinese immigrants. This racist legislation, and further immigration restrictions imposed in the early 1890s, greatly impaired the villages' growth. Women were prevented from joining their hus-

bands in the camps, and nuclear families became rare again. Many of the inhabitants, longing to see their families, forfeited their residency in California and chose to return to China. By 1900, the population at the Pt. San Pedro camps had declined to 122, with only 79 fishermen. Only two of these were married couples, and only one of these had children. The barber and the junk dealers remained, but the gardeners, the physician, and the schoolteacher had gone. Indeed, the prospects of a permanent and flourishing community in 1900 were quite dim, and growing dimmer. Curiously, even in 1900, while the village community was showing signs of instability and impermanence, the profitability of the shrimp fishery endured.

In the next decade, a combination of social pressures would further seal the fate of the shrimp communities, and bring the first period of the Chinese-dominated shrimp fishery's prosperity to a close. Competition from other fishing groups, a growing conservation movement, and the rising tide of anti-Chinese sentiment in California combined to force the passage of legislation directed at the restriction of Chinese fishing practices, and ultimately the ruin of the Chinese shrimp fishery. The dramatic rise in the immigration of Italian fishermen led to a sharp increase in competition for the increasingly limited resources, and for the increasingly lucrative shrimp market, of the San Francisco Bay. Ignoring other possible causes for the decline of the fisheries of the region, such as overfishing, water redirection, and siltation from hydraulic mining upstream on the tributaries of the Sacramento River, the Italian fishermen blamed Chinese fishing practices for an increasingly meager shrimp catch. They complained that the Chinese bag nets caught and killed too many other species of fish, and deprived the food chain of the Bay of critical, smaller bait fish.

While complaints against the Chinese may have been based on competitive motives, and even, perhaps, on some degree of factual observation, they were certainly also supported by the strong anti-Chinese sentiment prevalent in California at this time. Indeed, largely because they competed with white labor, the Chinese of California suffered intense racial prejudice. They were charged special taxes aimed at keeping them out of profitable businesses, refused citizenship, and denied the legal protections and rights available to all other members of the population. The complaints of the increasingly influential Italians, voiced in such a politically charged climate, brought the investigations of both federal and state government fishery agencies. These had been established in the later decades of the nineteenth century to study, assess, and regulate the fisheries of the United States, and were the product of a growing national consciousness about their fragility, as well as their value.

The California Fish Commission sent the naturalist Norman B. Scofield in 1897, and again in 1910, to assess whether the claims of the competing fishermen had any scientific bases. His reports and observations, which comprise a large part of the historical record of the camps, basically agreed with the complaints, and were used to justify the passage of strict regulatory legislation by the State Of California. The first of the new regulating laws, passed in 1901, prohibited fishing for shrimp between the months of May and August, the peak season of the Chinese fisheries. In 1905, the closed season was dropped, but in that same year a far more damaging law prohibited the export of dried shrimp. In 1909, the closed season was reinstituted, though only for three months. Finally, in 1911, following Scofield's 1910 investigation, the final nail in the coffin of the traditional Chinese fisheries was driven home. The possession of dried shrimp was outlawed altogether, as was any use of the Chinese bag net.

Although restrictions on the use of the bag net in the South Bay were lifted four years later, and a modicum of traditional shrimp fishing was resumed there using powered vessels, the effect of the 1911 laws was, for the most part, immediate and lasting. Over three-quarters of the camps disappeared altogether, while the few remaining were largely abandoned. The camps around Rat Rock cove were abandoned shortly after 1911. In August of 1913, a fire leveled the buildings, wharfs, and at least two junks lying idle in the cove. Some portion of these junks, however, sank before being completely destroyed by the fire, and were buried by the gathering silt of the cove. These remains, which are the subject of this study, remained in the mud until their discovery in 1977.

## San Francisco Shrimp Junks in the Historic Record

The historic record of the junks is largely comprised of observations made by government surveyors from state and federal fish commissions, as well as both written and oral testimony from contemporary fishermen and sailors. While the bulk of their work centers on the fishing gear, the shrimp catch, and the methods used in processing it, it also provides some limited descriptions of the vessels' general features. Unfortunately, these and other contemporary accounts of the junks are skewed by the prevalent disdain for the Chinese in California, and almost universally exhibit a general disregard for the Chinese watercraft. As, J. Porter Shaw, the ubiquitous observer of the 19th-century San Francisco maritime scene noted, "No one paid any attention to them...they were roughly built...."(Shaw, cited in Moore 1992:5). Those that did pay heed to the Chinese watercraft, often intermixed factual observation with culturally biased perception. One observer described the Chinese watercraft as "long, unwieldy,

clumsily constructed craft, with heavy, ill-shaped oars" (Rathbun 1883:151). Despite such unhelpful and obviously biased descriptions, some important construction details of the shrimping junks were factually recorded in the historical record, and help us to better understand these unique watercraft.

The Chinese shrimp fisheries featured a variety of watercraft as a part of its fishing fleet. These included vessels ranging from small, undecked sampans of not much more than 10 ft., to larger, two-masted junks, over 60 ft. in length, used for carrying cargo to the markets of San Francisco. While this variety did seem to exist throughout the camps' short histories, the historical record seems to indicate a gradual shift towards larger watercraft. Though not precisely pinpointed in the historical record, this shift may have been a response to the waning flow of manpower to the camps, and a resulting need for more efficiency in the fishing operations (Brienes 1983: 59). The anti-Chinese sentiment, and the growing body of legislation that followed it, could not have but made the various fishing companies anxious to increase efficiency, and make the most of the fishing opportunity while it lasted.

The predominant larger fishing vessel was the single-masted junk, which is the subject of this study. These were the workhorses of the Chinese shrimp fisheries during the period of its flourish, and up until its demise in 1911. Historic photographs of village waterfronts depict fleets of these vessels lining the narrow wharves in the 1880s and 1890s (Figure 1). The number of these vessels on San Francisco Bay reached a peak during this time, and was estimated in 1892 to be 42 (Weaver, 1892:151). The eventual onslaught of restrictive legislation, however, reduced these numbers by 1906 to 17 (CCF, as cited in Brienes 1983: 59), where, judging from a 1910 count of 19 (Scofield 1919: 4), it leveled off until the fishery's demise a year later.

The average overall length of these junks ranged from between 40 and 50 ft., again, with the larger vessels more common later in the 1870-1913 period. (Nash 1973:261, Scofield 1919:5). The hull was round-bottomed, and keelless, and featured a sharp bow with a square stern. A single mast, stepped approximately one-third of the vessel length aft from the bow, supported a traditional Chinese batten lug-sail (Scofield 1919:5). Vessel steerage was achieved using a stern rudder which, when lowered, extended below the vessel's bottom, and could be raised completely out of the water when in shallows, or at anchor.

Bulkheads divided the vessels into several sections. Starting aft, these were the living quarters, where the fishermen cooked, ate and slept; the catch hold, where the baskets of shrimp and fish were kept; the net hold, and, finaly, a hold for other gear further forward. The lengths of the various compartments on the later vessels were roughly estimated by Scofield. The length of deck covering the living quarters hold, estimated at 14 ft., was slightly longer than the next two forward, which Scofield assigned lengths of 12 ft. Next to the bulkhead in between the net hold and the living quarters was set a horizontal windlass, constructed of a tenoned, central drum, and four projecting wooden spokes, which were turned by the hands and the feet of the operator. The line from the windlass ran through a notch in the bow post, or stem, and over into the water, where it was used to pull up the fishing nets and to weigh anchor (Scofield 1919:5).

The junks, like most of the other vessels in the Chinese fisheries, were planked in redwood (Jordan 1887:612). Planks in the bow, where curvature was required, were bent into place by heating the oil-smeared planking timber

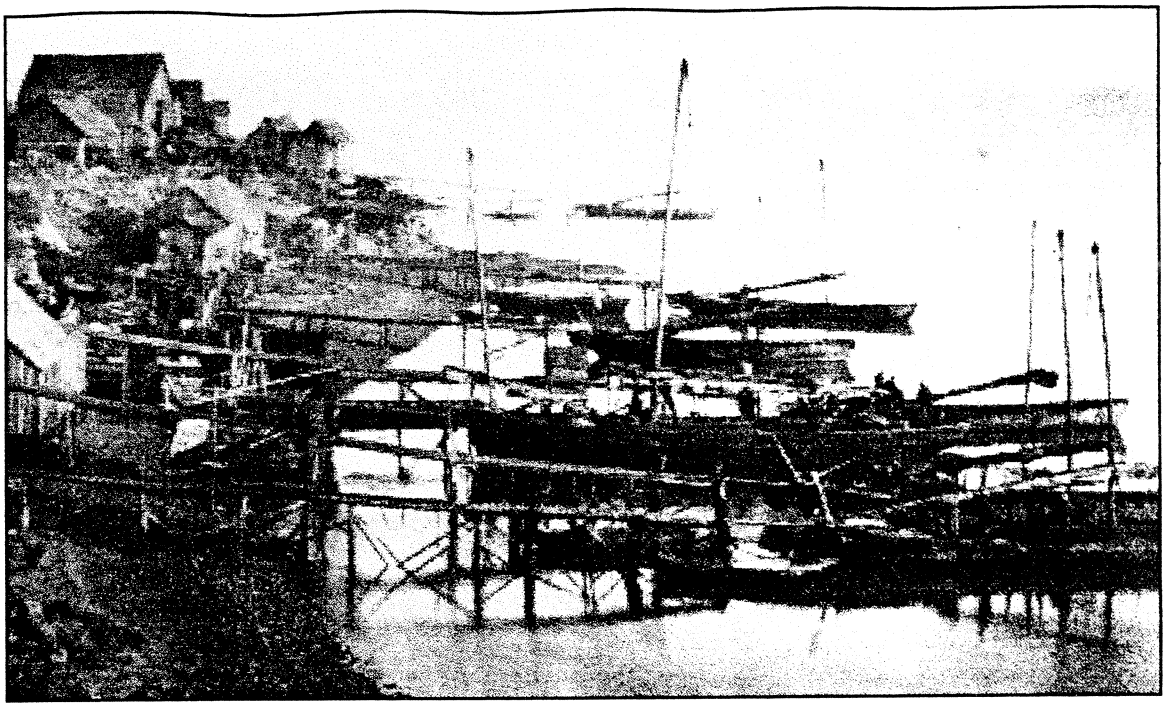


Figure 1. Shrimp Fishing Camp at Pt. San Pablo,1885, showing five of the larger single-masted junks,the workhorses of the fishery, a larger two-masted junk used for the delivery of shrimp to market, and some smaller sampans. C.H. Townsend, photographer. Photo courtesy of San Francisco Maritime NHP.

directly over an open fire until the proper shape was achieved (Wetton 1984: 20). In addition to being nailed onto frame and floor timbers, planks were nailed together during the building process using a technique of edge-nailing. After planks were fit into place, nails were driven into triangular notches carved along the plank's seam, effectively fastening the notched plank to the one below. (Wetton 1984: 20). The nail heads, and the remaining notch, were then covered with the same putty used to caulk the planking of the hulls. The finished vessels were unpainted (*San Francisco Call,* 1892: 8), though they were often coated with a thinned-out mixture of tar (Shaw, as cited in Moore 1992:5).

Aside from a few exceptions late in the fishery's history, the single-masted shrimp junks were constructed on the beaches of the camps (Jordan 1887:619; Nash, 1973:274; Scofield 1897:5; Wetton 1984: 20). The last recorded date for the construction of these vessels comes from Scofield's fieldnotes for July 18, 1897,

in which he reports that a shipbuilder at Rat Rock Cove was building "a large boat to go to San Francisco." Nine days later, Scofield reports that "at the farther village [Rat Rock Cove] the new boat is ready to launch." (Scofield, 1897:5,8). This very well could represent one of the vessels investigated in this study.

The sailing performance of the junks was noted in several accounts, and was usually favorable (Collins 1892: 46; Chappelle 1976: 301). The most famous of these was written by Jack London in *Tales of the Fish Patrol,* his fictional account of the enforcement adventures of the California Fish Commission. Though it is only fiction, the passage communicates a palpable respect for the junks' capabilities, as well as the celebrated ability of the Chinese batten-lug sail to outpoint a gaff rig:

> I was now alone in the REINDEER, seeking feverishly to capture a third prize. The first junk I took after was a clean miss, for it trimmed its sheets, and shot away surprisingly into the wind. By fully half a point it outpointed the REINDEER, and I began to feel respect of the clumsy craft (London 1982: 17).

While the historic record does indeed record a number of the junks' important features, the limited detail and scope of these accounts leaves much to be desired. Recent work has used historic photographs of the junks, many of which were taken by the state and federal fishery agencies, to further elaborate on the configuration of these unique craft. (Nash 1973; Brienes 1983). Features such as rudder fenestrations, or diamond-shaped holes cut into the blade of the rudder, have been derived. Aspects of the sail configuration, such as the number of battens (5-6), and the humped leech, have been noted, and help to further describe the junks. The same studies have found explanations for many of these features in sources for boatbuilding traditions in China.

The body of every visible rudder in the photographs (Figure 2), for example, is pierced with two or three rows of diamond-shaped holes. This feature, though not described in the historic record of the San Francisco junks, is discussed in Needham's classic treatise on Chinese nautical technology, *Science and Civilization in China.* Its purpose, Needham explains, is to "ease the steering by reducing the pressure against which the tiller has to act, and minimize the drag on the ship caused by the turbulence in the hydrodynamic flow past the rudder. As the water is a viscous medium the efficiency of the rudder is very little impaired" (Needham 1971: 656).

The work of Needham, and the other master of Chinese shipbuilding traditions, G.R.G. Worcester, have also been used to explain the presence of the fenestrated rudder, as well as the humped leech of the batten-lug sail, in the San Francisco Bay. Both features are characteristic of vessels plying the waters of the Guangdong province, the place of origin of the bulk of San Francisco immigrants (Worcester 1966: 89; Needham 1971: 656). By tracing these features to their place of origin, the historical studies of Nash and Brienes have been able to stress the importance of cultural traditions in the design and construction of the junks (Nash 1973: 254; Brienes 1983:56).

Unfortunately, both of the aforementioned studies are restricted by the limited scope of their analysis of the historic photographs, as well as the broad, general nature of the work of both Needham and Worcester, especially with regards to the inshore watercraft of the southern provinces. Nevertheless, they do suggest the potential of both sources for the analysis of the archaeological data reviewed by this thesis. They also demonstrate the potential of a structure

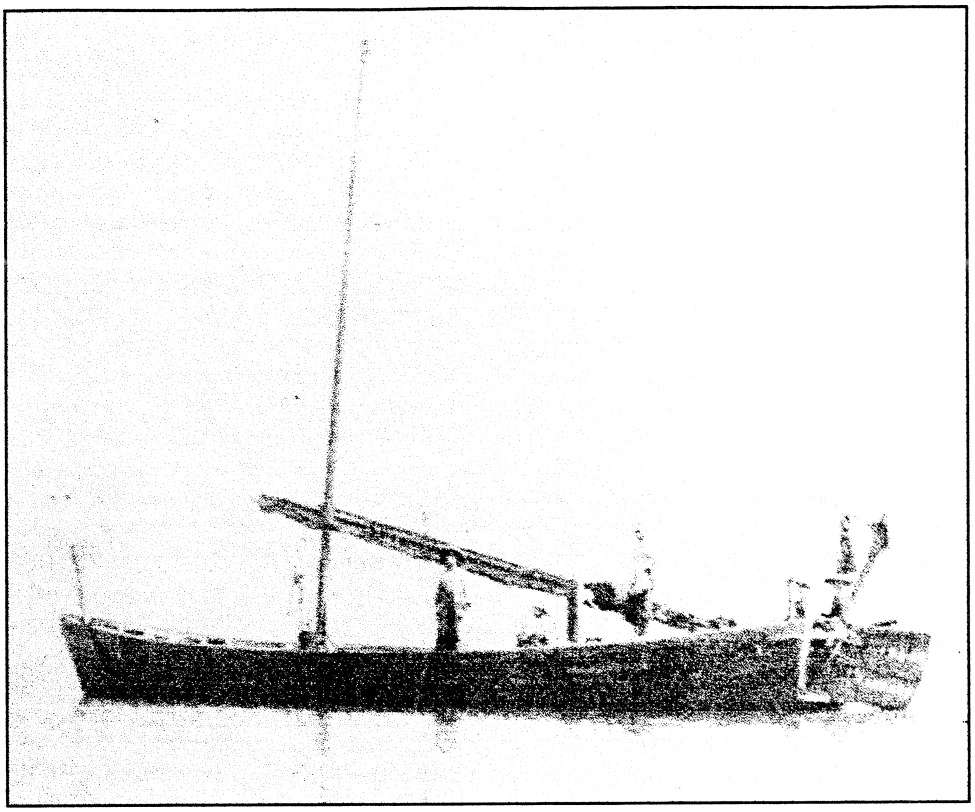


Figure 2. 1887 image of San Francisco shrimp junk showing fenestrated rudder raised while at anchor. Photograph from the Oliver collection, Bancroft Library, UCB.

of analysis which compares the San Francisco junks to those of China, as well as the importance of data that supports this comparison. This structure contributed to the generation of research questions guiding thesis, and will also be applied to the analysis of the data collected for its support.

Although the historic record provides a general understanding of the Chinese shrimp fishing junks of San Francisco Bay, much detail is wanting. The material record of the Rat Rock Cove junks offers a great chance to closely observe and document key construction details. It also serves to test the accuracy of the historic record and of recent historical work, as well as the applicability of observations made from Chinese watercraft traditions. While research questions generated from our current understanding of the historical context of the junks can guide the investigation of their material record, the converse is also true: the

material record of the junks offers us the opportunity to both investigate and expand our understanding of their historical context.

## Research Questions

The research questions guiding this thesis can be divided into three different groups. The first seeks to describe the form and the quality of the San Francisco shrimp junks, and to understand these as a product of specific construction processes. Quite simply, they all address the general question, "How were these junks built?" The generation of these questions was informed both by traditional Western and traditional Chinese boatbuilding practices, and are ordered according to the traditional stages of both junk and ship construction. In addition to a long list of questions addressing the construction of specific vessel components, these questions also include:

What is the quality of the craftsmanship used in the construction of the junks? Is there evidence of errors? To what degree do these vessels reflect the work of skilled craftsman drawing from a life immersed in native boatbuilding traditions? Is there evidence of mishandling of the craft, or of its normal use in fishery operations? What is the overall impression created by these vessels? To what degree does it, as well as the craftsmanship and the construction details of the junks, reflect a sojourning ethic?

The answers to this first set of primarily descriptive questions can also be used to test the accuracy of the historic record, as well assumptions inherent in the use of historic photographs to interpret the material record of the Rat Rock Cove junks. It follows, then that they can also be used to test the data, and some of the conclusions, used in recent historical work.

The next group of research questions seeks to move beyond the mere description of the features of shrimp junks towards an understanding of their origin. These questions assess the degree to which the Chinese fishermen held to their native watercraft traditions, and the degree to which they abandoned these to adapt to new conditions, and a new society, in California. These questions include: How do the San Francisco junks' features compare with those of vessels in the sources, both ethnographic and secondary, describing watercraft traditions in the Pearl River Delta region of China? Is it possible to determine a specific region of origin within the Pearl River Delta area for the San Francisco shrimp junks, and for the Rat Rock Cove junks in particular? If so, what features express this regional identity? Once identified, can these features be seen to vary in the historic record, and particularly in historic photographs? Might this variation reflect the variation in regional demographics from camp to camp?

Are there features of the San Francisco junks that are modified Chinese traditions? Are there some that don't fall within traditional Chinese watercraft traditions at all? If so, why might these innovations have been adopted? To what degree did factors such as economic necessity, material availability, and environmental conditions dictate these innovations? How much did the internal organization of the shrimp camps , and of the shrimp industry, influence these factors?

How do the junks' features compare with those in Western boatbuilding traditions, and specifically with those prevalent in contemporary San Francisco watercraft? To what degree did the fishermen adopt Western technology to the construction of their watercraft? Is the assertion that the Chinese resisted Western culture supported by the material record and its interpretation? To what

degree is a sojourning ethic reflected in the form of the junks? How might societal factors such as racism, cultural isolation, economic competition, and restrictive legislation have contributed to the pressure to innovate, or, for that matter to resist innovation?

Were the innovations successful, or did they contribute to the demise of the Chinese shrimp fishery? How might they have effected the way of life in the shrimp camps, and how might they have effected the relationship of the shrimp fishery and its inhabitants to the contemporary Caucasian society of San Francisco Bay ?

These research questions served to guide both the collection and the analysis of data pertaining to the San Francisco shrimp junks. Throughout each of these often interrelated processes, old questions became irrelevant, while new questions arose. Many questions in both of these categories, unfortunately, fell outside of this thesis' scope. Most of these are articulated in the "Directions For Further Research" component of this thesis' final chapter.

## Data Requirements and Method of Analysis

The biggest obstacle to the analysis and interpretation of the Chinese shrimping junks is the incoherence of the data pertaining to them. Not one of these once ubiquitous vessels remains intact today, and every category of information about them, including archaeological data, provides only a partial idea about their design, construction, and use. While the examination of each of these individual categories of data can, potentially, answer a number of important questions, their combination can form the basis for a more holistic description

of the vessels. This, in turn, facilitates a more expansive analysis of the vessels, and permits a broader understanding of their historical context. The interpretation of the archaeological data of the junks in Rat Rock Cove, then, will be expanded by the review of historic photographs of the San Francisco shrimp junks. Ethnographic information gathered by the author in the Pearl River Delta region in 1999, and secondary sources describing the boatbuilding traditions of the Guangdong Province, will also assist in the interpretation process. This thesis draws these disparate sources of data together by reconstructing the likely form of the San Francisco shrimp junks in an attempt to understand the origins of the watercraft's features, and the context in which they functioned.

Though this thesis will expend much effort to describe and explain the material evidence pertaining to the Rat Rock Cove junks, its goal will be to move away from description, and to use the increased understanding of the artifact to illuminate the context in which it was used. Analysis will center inquiry on the how, who and why of these vessels, using a decidedly materialistic approach to attempt to understand the choices made in their construction and use as products of a number of variables. Chief among these is the adherence to traditional boatbuilding practices. A structure of analysis that compares the junks' construction details with those of vessels typical to Chinese and Western boatbuilding traditions will identify choices made from conservative allegiance to the former, and by radical adoption of the latter. Where a Western technology has been adopted, and even more where a construction detail cannot be traced to either tradition, other variables influencing the builder's choice may be identified and investigated.

Potential influences in the design and construction of the junks include the availability of materials and tools, and the suitability of these to the desired

function of the vessel; the environmental conditions and the equipment requirements of the California shrimp fishery; the organization and goals of the fishing community itself; and, finally, the restrictions of the the larger society of the San Francisco Bay area. Each of these factors will have to be individually assessed for the degree of influence they might have exerted upon the builders of the junks and the decision making processes of their construction and use. In this way, the material evidence of the junks in Rat Rock Cove provides an important blueprint for exploring and expanding our understanding of the historic context of the shrimp fishing community in which it functioned.

# CHAPTER II. THE ARCHAEOLOGY OF THE RAT ROCK COVE JUNKS

Given the incomplete historic record of the San Francisco shrimp junk, the archaeological remains of two of these unique vessels, buried in the mud flats of Rat Rock Cove at China Camp State Park in San Rafael, constitute an invaluable source of data. The usefulness of this data, however, depends on the level of its documentation, and other than a brief effort in 1977, limited funding, ephemeral expertise, and the protected nature of the site precluded progress towards this end. In the Fall of 1998, a field team led by the author conducted a limited excavation and survey of portions of both vessels with the intention of broadening the Park's understanding of the resource, and of completing its documentation. Fieldwork was designed to minimize impact to the resource, while maximizing the collection of information about hull form, construction details, and boat-building techniques. These, it was hoped, would support a material culture analysis capable of broadening our understanding of Chinese shrimp villages, and of enhancing the interpretive mission of China Camp State Park.

## 1977 Documentation Effort

The archaeological remains of the two junks in Rat Rock Cove were first discovered in 1977 by the California Department of Parks and Recreation during the last days of an archaeological survey of the environs of China Camp State Park. The heavy scouring action of the winter runoff out of the Sacramento and San Joaquin River Delta that year carried away enough of the fine silt in Rat

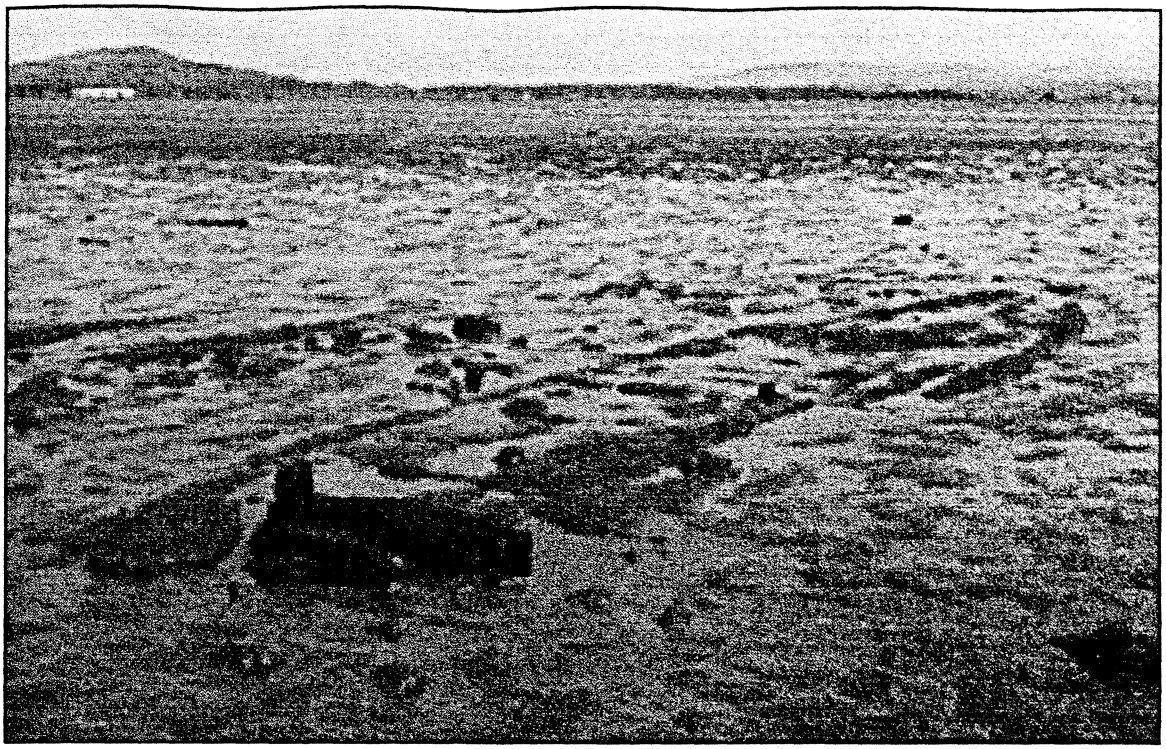


Figure 3. 1977 photograph showing exposed portion of the junk remains in Rat Rock Cove. Note the definition of cross timbers as well as hull outline. California DPR photograph.

Rock Cove to expose the upper extremities of the junk remains (Figure 3). Despite the surprise appearance of these remains, and the limited time available to record them (limited even further by the tidal cycle), Park archaeologists were able to mount a documentation effort that produced roughly scaled sketches of the exposed portions of the western most of the two vessels. Little excavation was pursued during this effort, though a rough sketch of the section between frames 11 and 12 indicates that at least one frame bay was partially cleared.

Unfortunately, the sketch drawings produced by the work in 1977 were never developed into a coherent, finished scale drawings. Much of the detail in the field sketches was faded, smudged, or simply illegible, leaving gaps in the record (Figure 4). The use of conflicting nautical terminology, as well as contradicting systems of measurement, made the ex-post-facto translation of the sketch

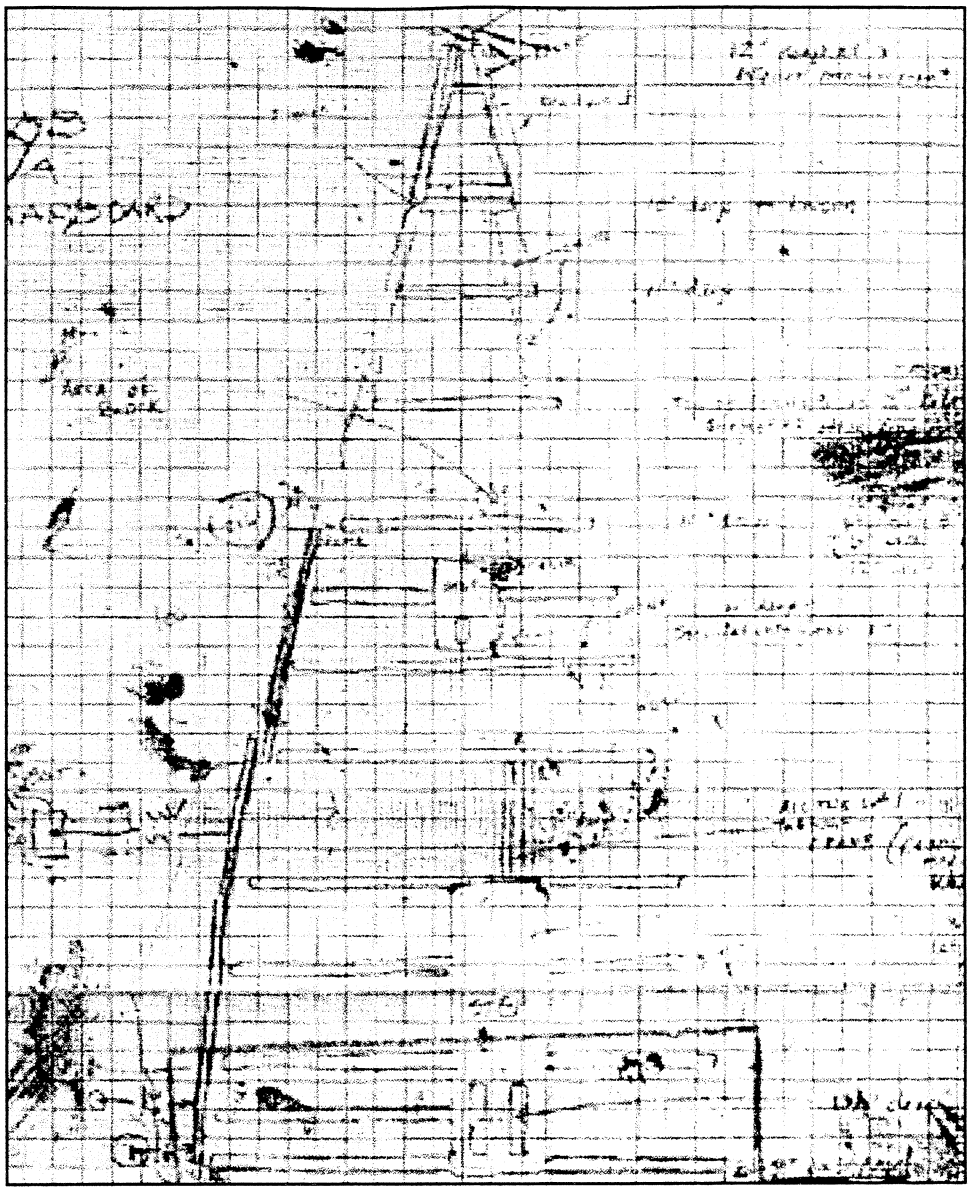


Figure 4. Detail of sketch map produced from 1977 field documentation. Despite some problems, the sketch contains much useful information, including scale measurements of frame widths and spacing. Reproduced courtesy of California DPR.

difficult, if not impossible. Moreover, much information about critical construction details was unrecorded, presumably due to the lack of excavation during the fieldwork. Measurements of the aft third of the vessel were not converted into the overall sketch, and details of the stern section were recorded only by a simple, out-of-scale diagram. Finally, no documentation of the eastern junk was recorded, and no map clearly indicating the location of either of the vessels was

produced, placing the long-term management of this important resource at risk. Clearly, the 1977 field documentation of the Rat Rock Cove junk left room for further efforts.

Despite the shortcomings of the 1977 documentation of the exposed junk remains, much valuable information was contained in the sketches produced. First, the overall length of the vessel could be teased out of the data recorded, and helped to indicate its probable identity as one of the larger shrimp junks. Second, the spacing and width of the floors, which were apparently visible at the surface of the mud, were accurately measured and centered on a centerline. This established the general plan of the vessel, and defined the forward two-thirds of its outline. Third, the location of seven deteriorated pilings along the port side of the junk were recorded. This information assisted both with the generation of a site map, and with the later identification of the probable owner's of the junk. Finally, and perhaps most importantly, the general size and the relative location of many key construction details were accurately mapped into the site sketch. Essentially, then, the sketches produced during the 1977 fieldwork provided a skeletal map of the westernmost Rat Rock Cove junk, andwhich could be used to more tightly choreograph future efforts at a more detailed documentation. This proved to be an important advantage in the 1998 fieldwork.

## 1998 Fieldwork Design

Fieldwork in 1998 sought to expand the documentation of the western Rat Rock Cove junk, and to produce both an overall site plan and a site map of both junks that would be useful in the management of the site as a cultural resource. One of the principle concerns of John Foster, Senior Archaeologist for the

California Department of Parks and Recreation, who was consulted throughout the design stages of the fieldwork, was that impact to the resource be kept to an absolute minimum. This concern is in keeping with the current philosophy of the archaeological field in general, and of public agency cultural resource management in particular, which dictates that archaeological sites be disturbed only when impact is imminent, or when the information they contain is deemed critical to the mission of the protecting agency.

The junks at Rat Rock Cove were under no immediate threat, lying as they were under a layer of preservative anaerobic silt in a protected mud flat within park boundaries. The perceived threat, given both the gradual siltation of Rat Rock Cove, and the attrition of informants able to remember the location of the junks, was the imprecise knowledge of the scale and location of the site. Furthermore, the lack of documentation as to the nature of the resource was seen to prevent the assessment of its value, both as a depository of scientific information, and as an interpretive resource. Such an assessment is critical to the long-term protection of a cultural resource. Given these threats, then, an effort to further document the junks of Rat Rock Cove was approved, with the caveat that the fieldwork would not endanger the resource, which had effectively been protected by nature, and by the establishment of park boundaries, since 1913. In order to facilitate the development of such a plan, the mud flats of Rat Rock Cove were reconnoitered in August of 1998.

Working from the oral testimony of Frank Quan, a long-time resident and shrimp fishermen at China Camp State Park, and Peter Schulz, an archaeologist for the California Department of Parks and Recreation, a preliminary field reconnaissance using steel probes located the remains of the westernmost Rat

Rock Cove junk (henceforward to be referred to as the West Junk). The upper extremities of the vessel were found to be lying under approximately 10 inches of fine silt at its bow, and under a thin covering of about four inches at the stern. After both the stern and the bow were staked, the general north-south orientation of the vessel was noted, and compass bearings to key landscape features taken. A small test excavation conducted at the bow of the vessel confirmed the accuracy of the floor spacing recorded in the 1977 sketch, proving its suitability as a guide for the selective excavation of key construction details.

The accuracy of the 1977 sketches was a critical factor influencing the decision to further document the West Junk in Rat Rock Cove, allowing as it did for an efficient placement of a minimum number of test excavations. By measuring back from the bow, key construction details outlined in the 1977 sketches could be quickly located, and excavating teams could drop down through the mud at their precise location. This would save valuable time in the field, which was greatly curtailed by the fact that the site was submerged for a little less than half of the thirteen-hour tidal cycle. This limited window of opportunity was further restricted by the fact that the low tides of the excavation days fell at the end of the day, and so were cut short by the arrival of sunset. In all, each of the three field sessions lasted a little more than three hours. Efficiency in the field, therefore, was critical.

The choice of location for excavations was guided partly by the 1977 sketches, but principally through the reconstruction of the stages of vessel construction. This is a common tool in the design of nautical archaeology field plans, and has been used in numerous well-documented projects (Crisman 1993:308; Steffy 1994:236). A detailed list of questions was developed that attempted to fill

in every detail necessary to every stage of reconstructing a junk. Knowledge of these stages was drawn both from the author's experience as a boatbuilder, and from historic sources outlining Chinese boatbuilding traditions. Questions that could be answered definitively by the 1977 data were struck from the list, while those that remained were grouped according to the location where they might be answered.

In total, five different locations on the West Junk were selected for inquiry (Figure 5). At each position, measurements were to be taken of planking widths, floor and frame timber dimensions, and hull shape. The first position was planned to involve the complete excavation of the bow back to the second floor timber, and would allow the documentation of stem construction and keel dimensions if a keel was found to exist. The second position was located a few floors further aft, and was aimed at understanding the nature of the forward step and the "centerboard well," as well as investigating what appeared to be a plank scarf, in the 1977 drawings. The third position sought to uncover the forward end of the mast step, as well as the entire section between the mast step's aft bulkhead and the floors just aft of it. This position appeared be the beamiest in the 1977 drawings, and was intended to give a count of existing bottom planks, as well as a good idea of the hull shape at this important bulkhead.

The fourth excavation position was to be located another 100" aft of the third position, where the 1977 drawings noted both the next doubled floor timber, which presumably represented a major bulkhead, and what appeared to be a rare remnant of a frame. Only the port side of this section was slated for excavation. The fifth position called for the excavation of the aftmost portion of the existing vessel. Critical here was the determination of whether or not the end of

the archaeological remnant represented the true stern of the vessel. Also, any evidence of stern components, such as the transom, the aftermost floor timbers, or the rudder gudgeon shelves, would be documented in the hopes of better understanding this unique Chinese construction detail. Finally, it was hoped that excavation in this position would help to determine the identity of the metal concretion noted both in the 1977 drawings and during the probing phase of the 1998 preliminary reconnaissance session.

In addition to the excavation at the five positions, the fieldwork design also included the documentation of the West Junk's rocker (the up and down curvature of the vessel bottom), which was to be measured by probing at six-inch intervals down the centerline of the boat. Depth measurements would be recorded by noting where a level line stretched between the bow and the stern ran across a measured tape attached to the shaft of the probe. The fieldwork was also planned to include the measurement of the overall length of both vessels, as well as the delineation of their plan outlines. These goals were to be accomplished by probing and staking at regular intervals along the perimeter of both vessels, and by mapping the resulting shape. Compass bearings of the centerlines of both vessels were to be taken at this stage, as were compass bearings from the each bow stake to key landmark positions.

The field plan also allowed for the a brief survey of the East Junk, provided enough time was available. This survey intended to verify whether or not the East Junk was the same type of vessel, and was dependent on the results of overall length and hull outline measurements. If these two sets of data were found to correspond with those of the West Junk, a brief excavation at the bow was planned to verify the scantlings and the arrangement of the stem, keel, planking,

and floor timbers. A small test excavation was also planned along the centerline at a distance aft from the stem which corresponded to the distance between the stem and the mast step of the West Junk. Given the apparent uniformity of mast placement in these vessels, this was thought to be a good initial test of the similarity between junks.

The plan for the 1998 documentation of the Rat Rock Cove junks, then, called for the excavation of roughly one-fifth of the surface area of the West Junk, and only a fraction of that of the East Junk. Furthermore, the excavations would expose each area excavated for a maximum period of less than three hours, as all units would be refilled at the end of each session. Moreover, all field workers were instructed remain outside of the vessel, or at least off of its wood, whenever possible, and to use the utmost care in the removal of mud from its surface. Finally, absolutely no collection of artifacts was planned, and all objects found were to be recorded and left in their place. These precautions, and the limited nature of the planned excavations, were deemed sufficient to safeguard the resource against negative impacts, and the field plan was given the go ahead by John Foster and the managing staff at China Camp State Park.

## Field Techniques and the Challenges of Mud Flat Excavation

The environmental conditions of Rat Rock Cove mud flats posed a number of challenges to the field excavation of the junks buried there. As mentioned earlier, on a normal tide these mud flats are exposed for roughly five hours of the normal thirteen-hour tidal cycle of the San Francisco Bay. Fieldwork, then, had to be planned carefully for days which featured a minus-tide during reasonable daylight hours. Unfortunately, during the fall, these days are relatively

irregular, and options were slim. This left us at the mercy of late fall and early winter weather, and at least one field date had to be postponed. On the third and final day of excavation, a sudden rainstorm proved to be challenging to the comfort of fieldworkers. Furthermore, mud is wet, a condition which was worsened by the creation of footprint impressions, which captured water before it could leave on the outgoing tide. Despite the very temperate conditions of the first two field days, staff were quickly soaked, and, by the end of the field days, many workers were shivering with cold. By the third session, however, the ideal mud-working suit of rain-slicker pants and many layers of undergarments were found to work wonders, even in the face of a late afternoon squall.

Perhaps the most substantial challenge to the fieldwork was presented by the mud itself. Located in a quiet cove protected from the high energy sediment transport of the major currents in the bay, the mud in Rat Rock Cove consists of very fine clay, which is both very deep (more than four feet near the site) and very sticky. Needless to say, it is not easy to move across it, and harder still to dig in. The former problem was addressed through the use of snowshoes, rented from an unsuspecting mountain sports outlet in the Bay Area. Each of the fieldworkers was presented with a pair, and after a brief period of practice, was able to move across the mud flats at a comfortable pace. Problems arose, however, after arrival to the site, when the heavy work of mud excavation began. The longer a worker remained in one place, the deeper he or she sank into the mud. The relatively large surface of the snowshoe, once buried, created an enormous amount of suction, and made freeing it for a simple step a great burden, and a risky feat of balance. The problem was compounded by the hinged nature of the snowshoe bindings, and many of the heavier workers found themselves expending an unsafe amount of energy simply to move a single step. It was finally

decided that snowshoes could be removed and work carefully continued in boots from inside of the vessel.

While a combination of snowshoes and boots facilitated the movement around the site, no solution could be found for the difficulty of digging in the sticky, heavy, moisture-laden mud. Shovels and trowels were used, though many found the use of plastic dustpans to be the best, allowing as they did for a two-handed bulldozing action that circumvented the suction effect of the mud by not actually requiring its complete removal. The difficulty was compounded by the tendency of the water to collect in footprints around an excavation area, and to come gushing in at inopportune moments. Plywood coffer dams were setup around each hole, and eventually fieldworkers developed the art of diversion channels, which moved water away from excavation areas.

The mud also made measurement of the site difficult, obscuring the various measurement instruments with a thin film of dark clay. With similarly coated hands, excavators found themselves unable to adequately clear the instruments in order to read them. Many measuring devices were lost altogether after being dropped into the mud below. Eventually, a bucket of water, sponges, and extra towels were kept near each unit, and lanyards were fastened to rulers and tape measures. To avoid dirtying data, one person in each of the three three-person excavation teams was assigned the sole duty of recording and drawing the data, and was given a strict mandate to avoid touching anything except their pencil, paper, and clipboard. The other two were delegated the muddy duties, such as digging, measuring, and moving excavation equipment. A clean and a dirty work table were constructed of plywood fastened to milk crates, and helped keep muddy items, such as shovels, tape measures, trowels and buckets

from contaminating cameras, compasses, pencils, and, most importantly, data. A photographer handled all photographic duties, while the author supervised the overall proceedings.

Another challenge to the successful documentation of the junks in Rat Rock Cove resulted from the nature of the object being documented, the level of expertise of the field excavators, and the author's over-preparation of the field plan. The successful deciphering and recording of watercraft features requires an adequate knowledge of nautical terminology, and a familiarity with their basic construction details. Knowing that many of the volunteer field excavators had little experience with nautical technology, and fearing the limited time for excavation, the author prepared a set of questions for each group that simplified the terminology and outlined the scope inquiry at each excavation position. These were intended to guide the measurement process, and to insure that the essential data was collected. In effect, however, the questions in more than one case narrowed the focus of the field teams, and limited their inquiry. As a result, many unforeseen surprises that did not fit within the list of questions received less attention than warranted, while questions made inconsequential by these surprises were answered in overabundant detail. What should have been stressed instead of verbal questions was the measurement and graphic illustration of each unit completely enough to allow for its accurate reconstruction at a later date. Fortunately, most of the recorders in each field unit were very gifted graphically, and created excellent illustrations of their portion of the vessel (Figure 8, p. 37), despite the author's best preparations. Furthermore, the fine work of the field photographer insured against the loss of critical details.

## Field Results

Despite the many challenges of mud flat excavation, the three field sessions at Rat Rock Cove in the Fall of 1998 yielded very successful results. All five positions on the West Junk were investigated thoroughly, and at each field teams documented new and surprising construction details. Measurements of the West Junk's rocker also yielded useful information, as did the recording of the location and the outline of both junks. Time was also found to be available to dig three test excavations on the East Junk, which allowed for an initial comparison between the two vessels. As a result of less than twelve hours of excavation, a detailed plan of the West Junk (Figure 5), a general site plan of both vessels (Figure 6),an overall site map (Figure 6a) and detailed sectional drawings at each of the five positions were generated (Figure 7). These products should prove useful to both the management of the junks as a cultural resource, and to their interpretation to the general public.

Each of the five planned excavation units yielded both the expected range of information and new surprises in construction detail. The field team at position 1 on the West Junk, which encompassed the bow portion of the vessel, uncovered a stem area that included a gently curving, two-piece, or "false" stem, a stem knee of what appeared to be straight-grained timber, and a strip of half-oval screwed into the leading edge and wrapping around to the bottom of the keel (Figure 8). The outside portion of the false stem was found to extend down below the joint where the inner stem landed on top of the keel. Aft of the stem knee, a black, gritty concrete mixture smelling of tar filled the area between the knee and the first visible frame bay, presumably to both seal the rabbet and to facilitate the draining of bilge water aft, where it could be accessed and bailed.

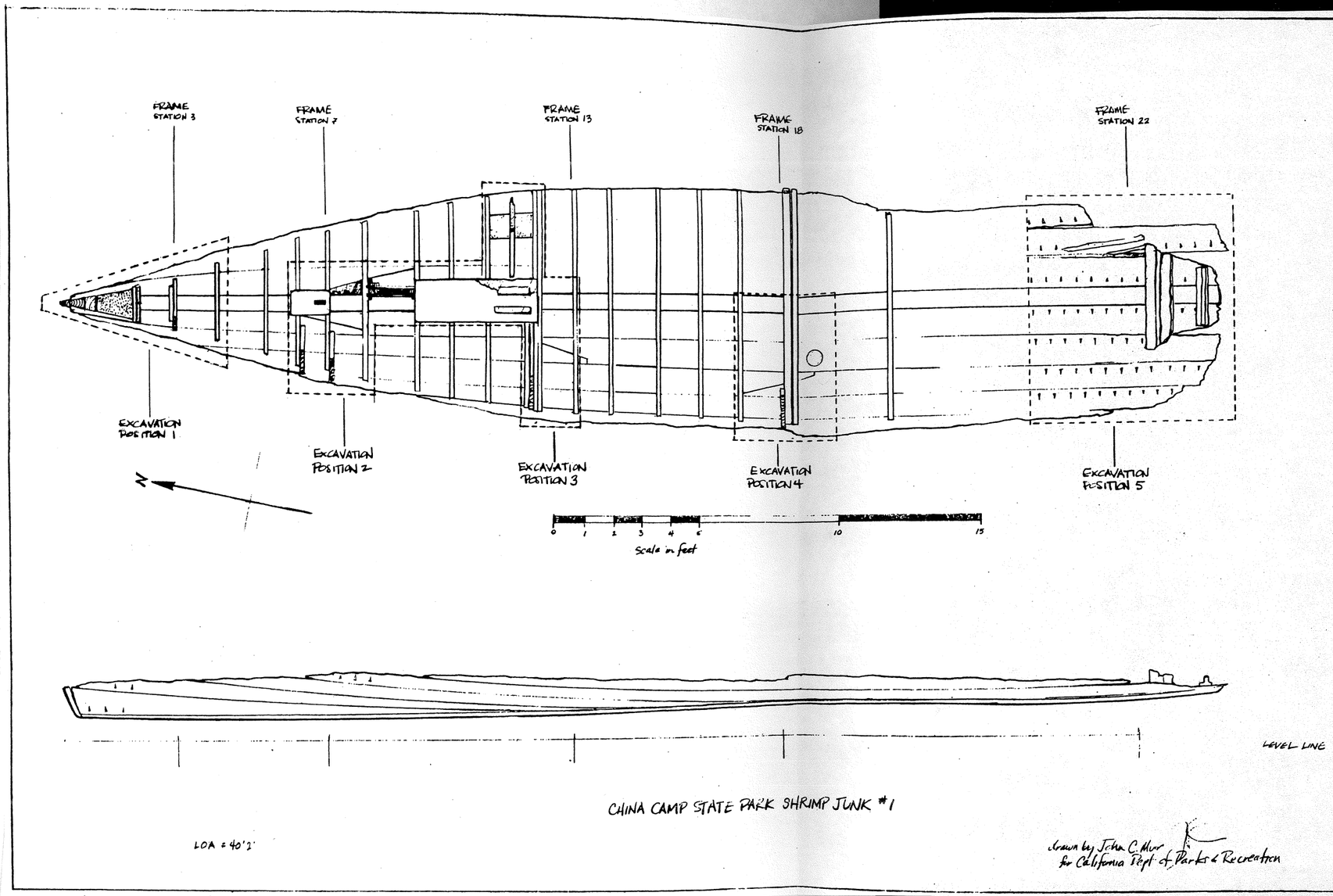



Figure 5. Plan and profile of West Junk compiled from 1998 excavation data and 1977 documentation. The areas within the dotted lines represent 1998 excavation areas. Hull outline outside of these areas determined through probing. Frame timber positions and width outside these areas determined from 1977 documentation. Edge-nailing shown in Excavaton Position 5 area also typical in Excavation Positions 3 and 4. At Excavation Positions 1 and 2, some edge-nailing was noted on outside of hull. Drawing by John Muir.

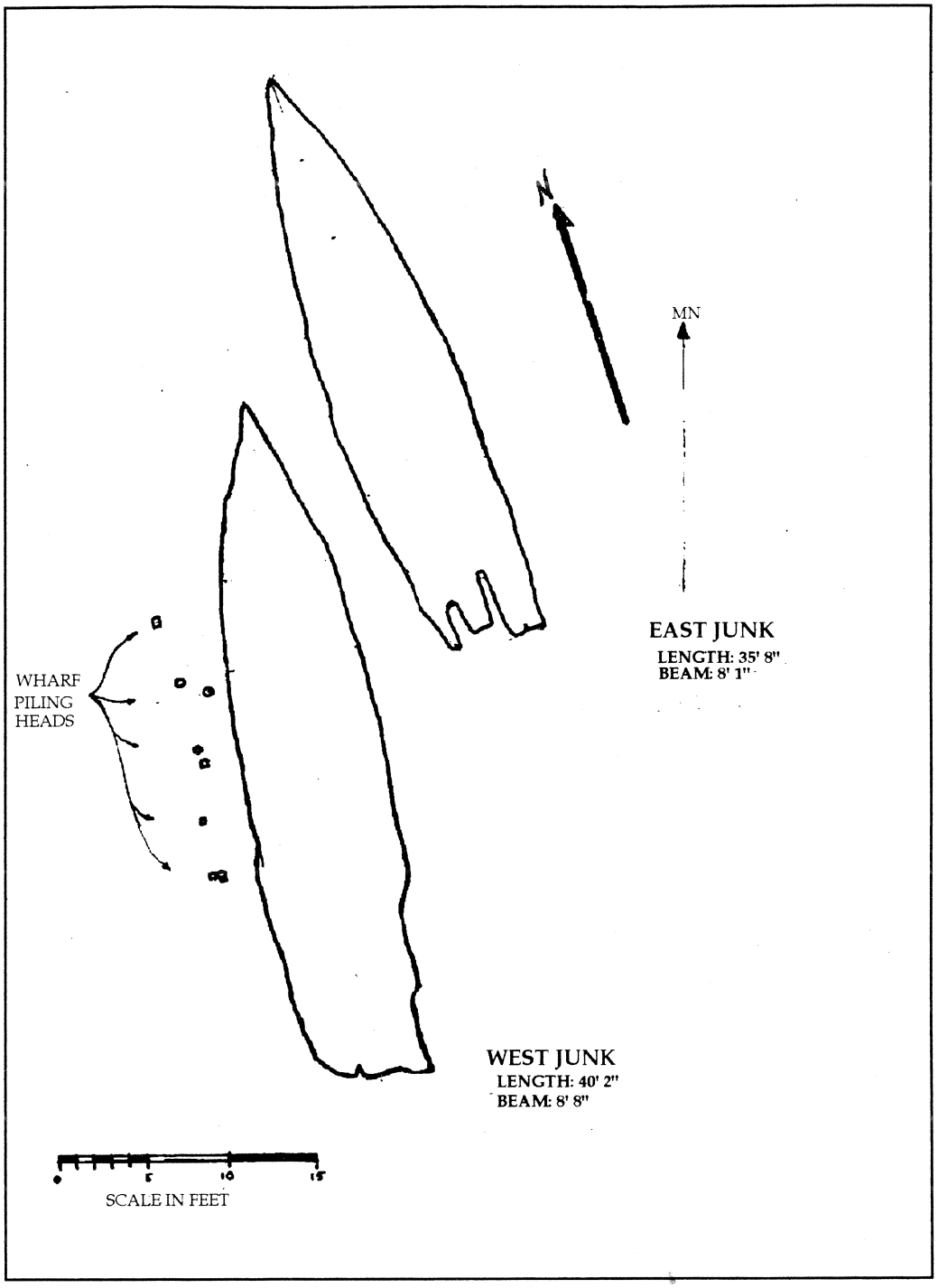



Figure 6. General plan of Rat Rock Cove site, including the West Junk and the East Junk, as well as piling heads recorded in 1977 and confirmed in 1998. Hull outlines of both vessels determined by probing.

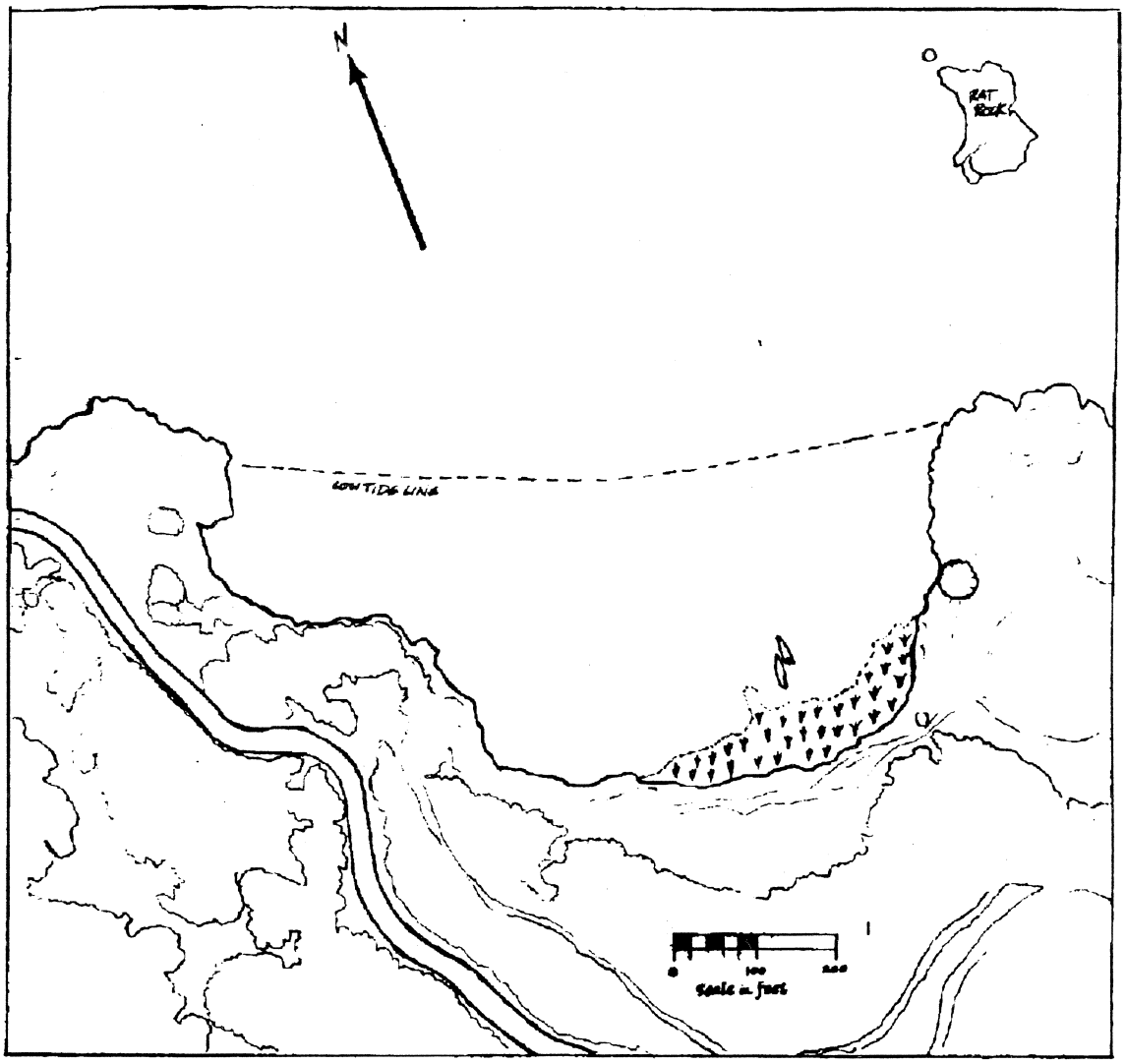



Figure 6a. Site Map of Rat Rock Cove mud flats, showing the relationship of the junks to the surrounding features. Note how the orientation of the junks closely matches that of the outcrop of land in the center of the cove. Map by John Muir.

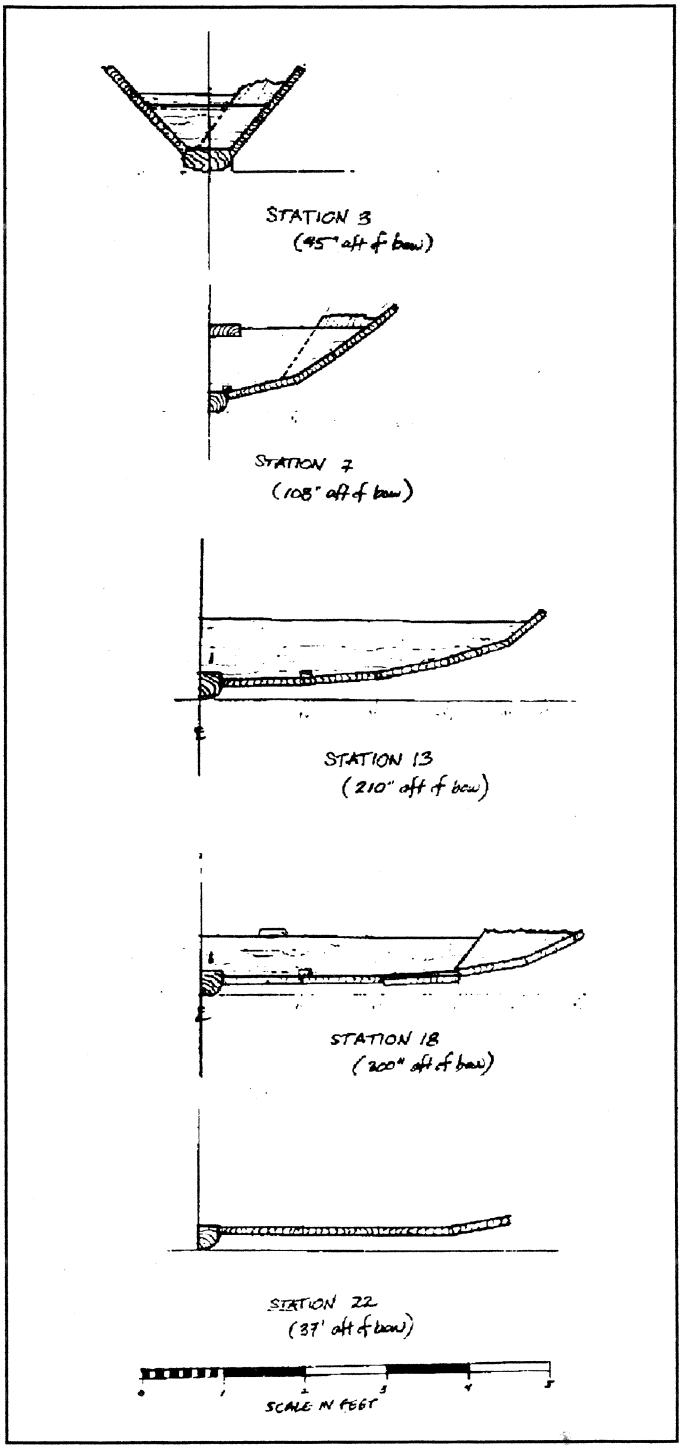



Figure 7. Sectional Drawings of Frame Stations of West Junk (Junk #1). All views looking aft. Note how in the last three aft frame stations (13,18, 22) the turn of the bilge begins at the fourth plank out from the keel. Keel thickness is conjecture based on measurements at stern and bow of vessel Frame Station 3 shows cross timber used to brace port-side frame. Drawing by John Muir.

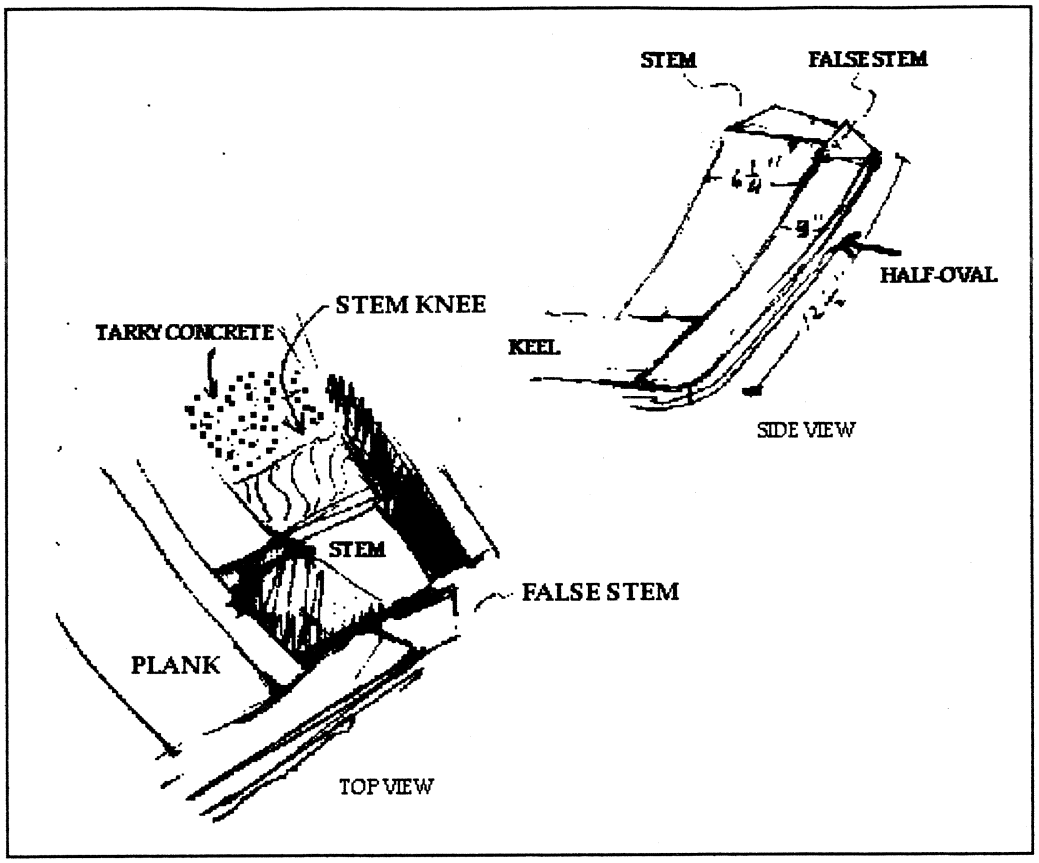



Figure 8. Detail from field sketches at Excavation Position 1, showing false stem, keel joint, stem knee, tarry concrete mixture, and half-oval strip at bow. The sketch also shows sprung hood ends of garboard planks, as well as thickness of keel below rabbet seam. Drawing by Amy Hosa.

This first frame bay consisted only of frame ends, while the second featured a short, athwartships floor and aft of it only a port-side frame braced with small timber between it and the starboard planking.

The garboard plank on either side at the stem was sprung slightly, which allowed the excavators to document both the width of the planking there, and the nature of the joint between the plank and the components of the stem. On the starboard side, a patch of copper covered the lower edge of the rabbet at the stem, presumably to stop leakage there. Regularly spaced edge-nailing notches were noted along the bottom outside of the two planks visible at Excavation Position 1. Each of the triangular edge-nailing notches here was filled with a

hardened putty, which presumably is the chunam mixture common to Chinese boatbuilding practices. This substance was found to fill edge-nailing notches wherever they were observed on the vessel. Additionally, despite the deteriorated nature of the plank edges, it was found that the garboard tapered to a square edge at its hood end, but was beveled along its bottom edge to mirror the bevel along the top corner of the keel. This method of joining the garboard to the keel is in striking contrast to the Western method of carving a rabbet, and is reflected in ethnographic record discussed in Chapter IV. The implications of this method are further discussed in the material culture analysis of the junk in Chapter V.

The field team at Excavation Position 2 uncovered a number of its own surprises. The forward step was found to be notched into both the fifth and sixth floors, and elevated almost one foot above the keel (Figure 9). Furthermore, under the rectangular hole in the aft half of the step, the crew documented a series of grooves etched into the keel. The pattern of wear seemed to indicate that whatever had been inserted into the hole extended all the way down to the keel, and moved about while in position. Both garboards at Position 2 featured sloping edge scarfs that spanned the distance of two frames. These were unusual scarfs, differing as they did from the traditional Western scarfs, which commonly involve either the joining together of the sloped faces of two planks, or the use of a butt block as a backing piece at the place where the square-ends of the two planks meet. On the starboard side, the nib end of the aft half of the scarf was broken off and provided a good opportunity to gauge the thickness of both the keel and the planking there, as well as the bevel along the edge of the keel.

The group excavating at Position 2 also managed to closely inspect and document the construction of the daggerboard well two floors aft of the forward

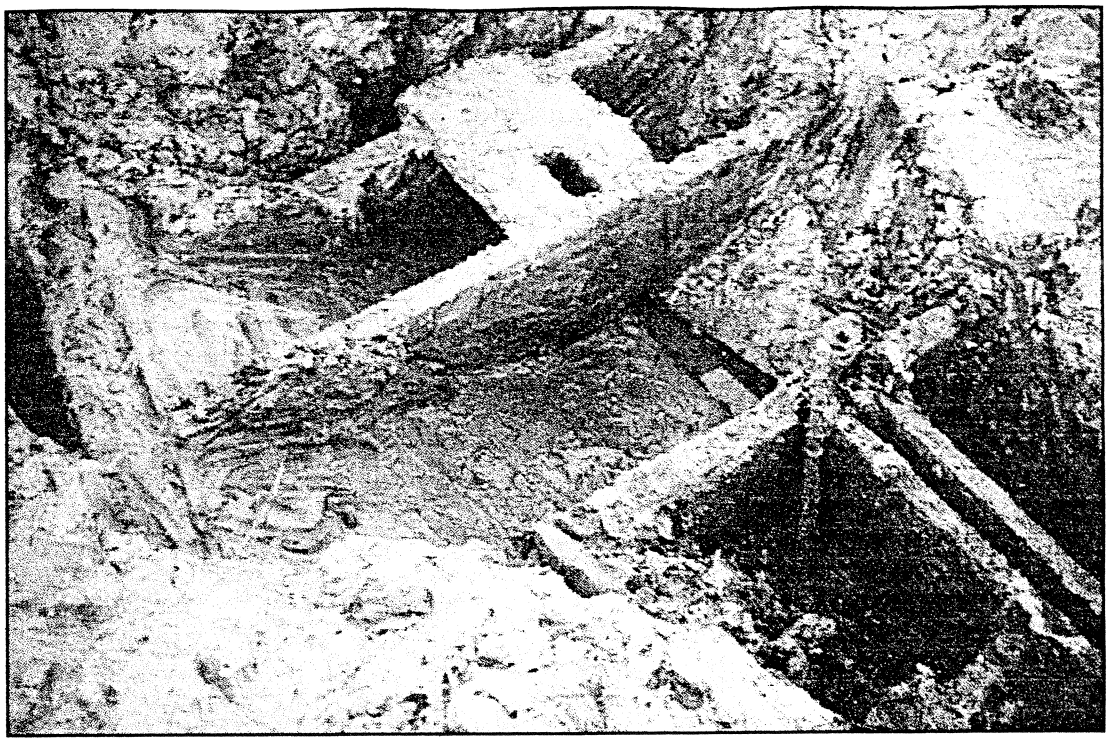


Figure 9. Excavation Position 2, showing the elevated forward step, daggerboard box, and starboard- side planking void. Outline of the void describes shape of scarf in garboard. Note also frame ends at stations 3 and 4. Paul Sanchez photograph.

step. This turned out to be a heavily constructed box, the forward and after sides of which were constructed from narrow posts nailed into the floor timbers on either end, and the sides of which were made from planks with a thickness of 1 in. The forward edges of these side planks were let into the forward floor timber, and a bracing piece or cleat was nailed alongside the starboard side, presumably either to reinforce or to seal a leaking daggerboard box seam. The bottom of the well was, of course, open, and the slot for the daggerboard was let through the starboard garboard, with the inboard edge of the slot being formed by the starboard edge of the keel. This offsetting of the daggerboard kept it from penetrating the keel, and preserved the strength of this important timber.

Excavation Position 2 was also the place where the group first confirmed the round-bottomed hull shape of the West Junk. Indeed, despite a partly legible

reference to a kelson in the 1977 sketches, there was no definite indication anywhere that these were round-bottomed, featuring a central keel and a planked sides. In fact, the field team began the excavation expecting to see a largely flat-bottomed vessel with a hard chine forming the principal turn of its bilge. At Excavation Position 2, the existence of the keel, and the gradually curving sides indicated otherwise, and many of the planned research questions concerning the documentation of a hard chine vessel had to be scrapped. The round hull shape was even further confirmed at Excavation Position 3.

Some edge-nailing was also documented in places along the inside seams of the higher planks at Position 3, though the regular pattern noted elsewhere in the vessel was not recognized. This is hard to understand, and may indicate that edge-nailing at this position occurred outside of the vessel. Indeed, some regularly spaced edge-nailing triangles were documented along the highest seam at the outside edge of the planks on the port side. Finally, the bottom ends of the frames on the port side of the 6th and 7th floor timbers were found to be intact, and their shape was carefully documented. These were two of only three frame remnants documented, and, as we shall see in Chapter V, will prove very valuable to later efforts at reconstructing hull shape.

At Excavation Position 3, excavating teams were able to successfully clear the mud from around the mainmast step, and were able to measure and document its peculiar configuration (Figure 10). It featured two identical, rectangular notches carved into the aft end of the long, heavy plank forming the step. The step itself was let into the heavy floors at either end of it, as well as the more normal-sized floors supporting its middle. The floor at the forward end was doubled, with the forwardmost timber likely forming a bulkhead at this station.

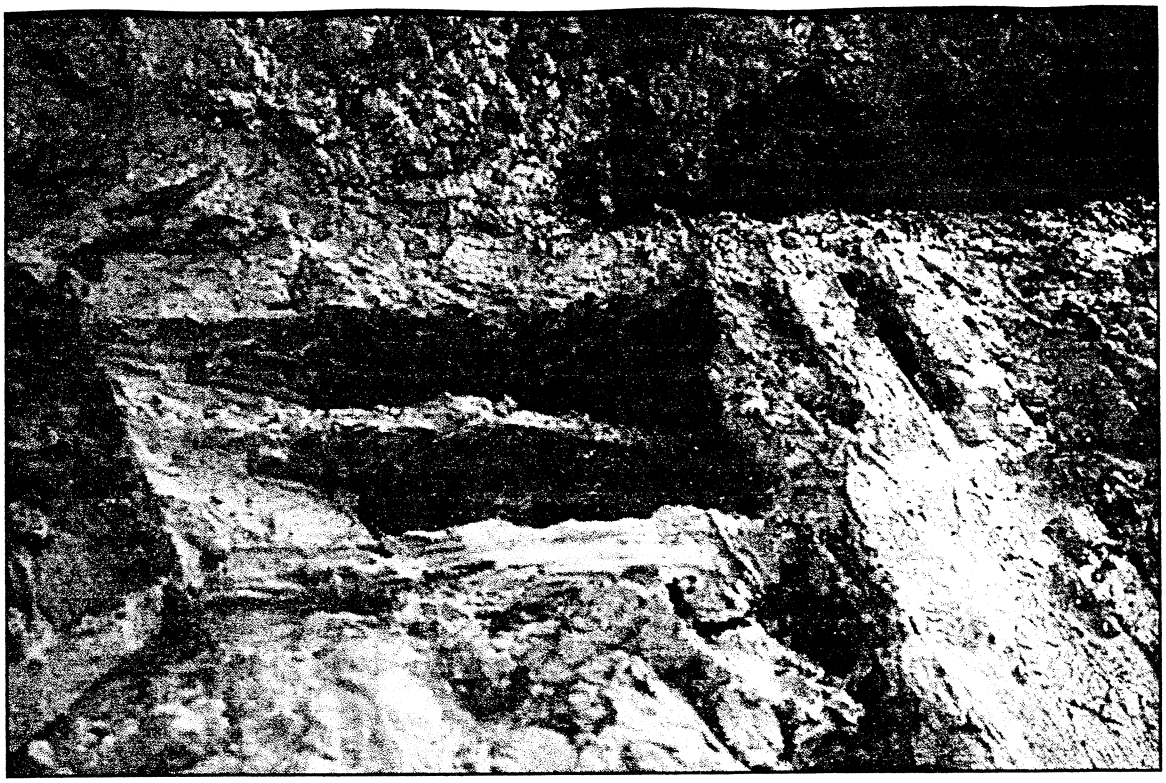


Figure 10. Excavation Position 3, looking aft, showing starboard side of unit, including mast step, planking void, repair frame, and doubled floors of bulkhead. Note two notches in mast step, and how the aft end of the mast step is let into the forward floor. Paul Sanchez photograph.

Surprisingly, few of the floors supporting the mast step did not actually land on the keel, bearing instead on the hull planking. This may have been a construction error, and may also explain the numerous randomly placed floors and half-floors documented on either side of the mast step. Apparently, there had been some trouble sufficiently supporting the planking there, and numerous repairs were necessary. On the starboard side, the third plank up from the keel was also found to be broken, or missing between the 11th and the 12th frame stations, where a half-floor had been nailed to reinforce it.

Some construction details recorded in other positions were confirmed in the clearing away of the bay between frame stations 12 and 13 (Excavation Position 3). Regular edge-nailing was recorded along the seams visible there, as

was another angular edge scarf in the broadstrake, or second plank up from the keel, on the port side. The keel was also found to be 1 in. proud of the garboards at this position, indicating that the edge-nailed planks were sprung slightly downwards during the construction process. Finally, five planks were counted at this position, and the shape they formed was carefully recorded. The fifth plank was found to interrupt an otherwise fair hull curve, and was presumed to represent the plank where the turn of the bilge begins.

Excavation Position 4, which was excavated on the third and final day of fieldwork, benefited from the perfection of excavation techniques and the preparedness of the returning members of the field crew. As a result, it was the most completely and cleanly excavated of the units, permitting a very fine level of detail to be documented (Figure 11). It was at this position, for instance, that all the floor timbers and planking were carefully and sufficiently scraped to determine the type of wood used in their construction. This had also been pursued in the other units, but only a few of the timbers could be positively identified. This included the mast step, the forward step, and the planking at Excavaton Position 1. All of these turned out to be made from redwood. The aftermost floor at Position 4, however, appeared to be of a much lighter color, which seemed to indicate Douglas fir. This contradicts the assertions in the historical record that the junks were made entirely of redwood, although it must be noted that every other initial test seemed to confirm them.

Excavation Position 4 also offered the opportunity to view fastening patterns around a sloping edge scarf, as well those of a floor at a major bulkhead position. In fact, edge-nailing triangles followed all edges of the scarf, and a few on the forward plank were driven from the inboard direction. Two large edge-

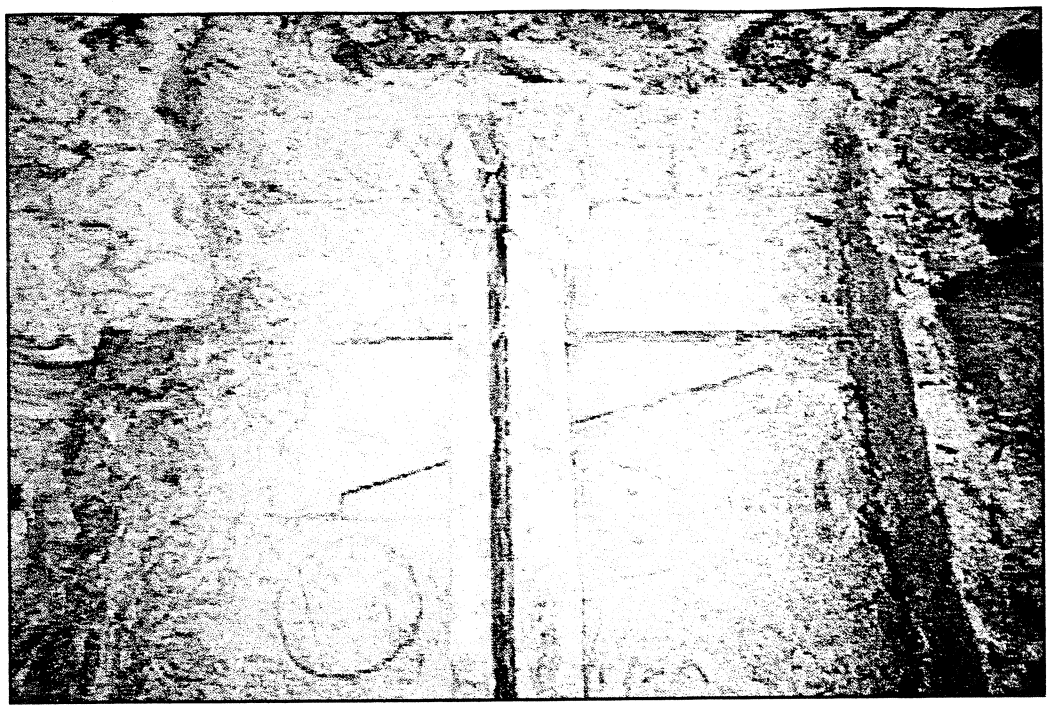


Figure 11. Excavation Position 4, showing heavy bulkhead of station 18, the longitudinal scarf in the third plank up from the keel, the circular disc of wood believed to be the bottom of a bucket, and the frame end on the forward face of the forward floor of station 18.

nailing triangles were also noted in the aft face of the forwardmost floors at this position, indicating that floors were probably first attached to the keel in this manner, and later nailed into from the outside through the planking. A large remnant of a frame timber was also documented in this position, and again offered a rare glimpse of these important components. Preserved in this particular frame was the angle of its inside edge, which, as we shall see later, will prove very helpful in the reconstruction of the sectional hull shape at this position. Finally, Excavation Position 4 also presented the only artifact of the entire excavation. Lying on the port side broadstrake aft of frame station 18 was a small, thin (3/8 in. thick), circular piece of wood, with a beveled edge and a diameter of 7 1/4 in. This was documented and left in its place. The current theory is that this represented the bottom of a wooden bailing bucket, or perhaps some other type of wooden container.

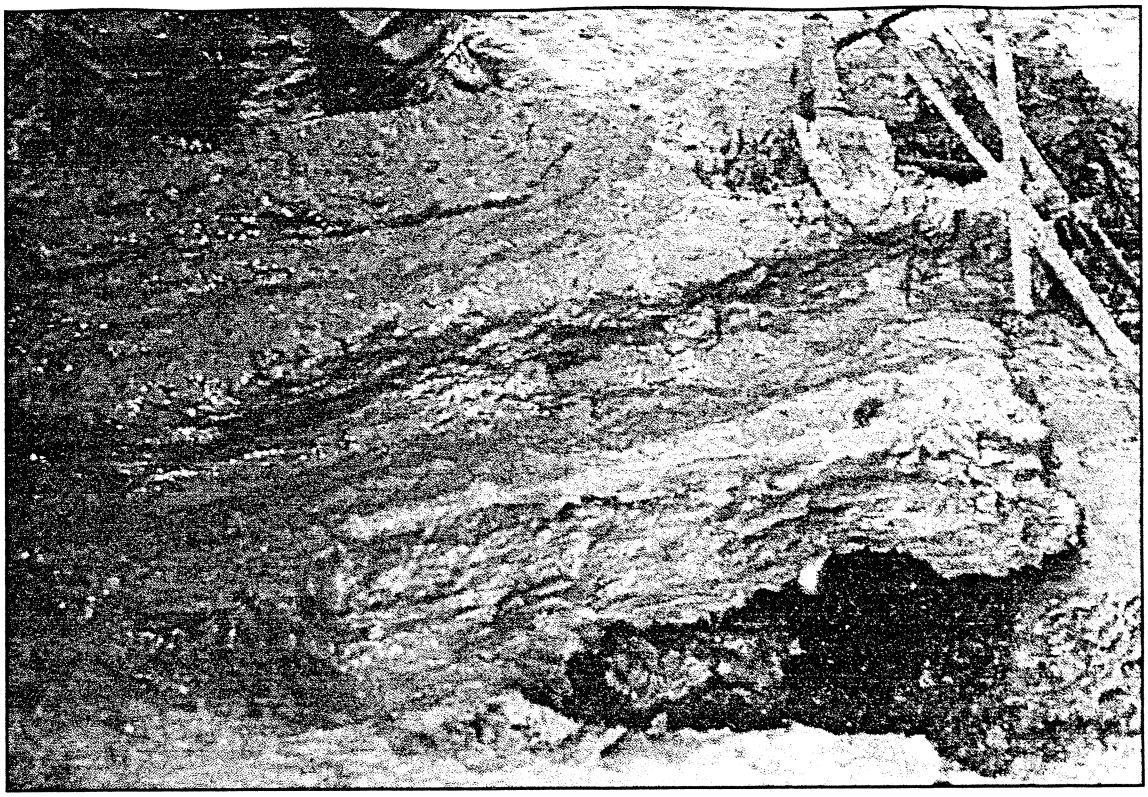


Figure 12. Excavation Position 5, showing aft edge of the West Junk, and deteriorated end of the keel below. Also visible are the two pieces of metal concretion. Paul Sanchez photograph.

The excavation efforts at Excavation Position 5 yielded important information about the keel, which was exposed by digging under the vessel from its stern edge (Figure 12). This was facilitated by the fact that at this point, the vessel was lying on a hard gravel and sand surface, which was black and smelled of tar. This may represent the original surface of the shoreline of Rat Rock Cove. This seems probable in light of the vessel's close proximity even today to the mean high tide waterline of the cove. In any event, the exposed end of the keel was drawn and measured. It revealed a keel 3 in. thick and 6 in. wide, with rounded bottom corners and no rabbet to receive the garboard planking. The keel also appeared to made of redwood, although the saturated nature of the timber made positive identification difficult. Like the planking edge-nailed into

it, the keel's end was broken in a reverse angle, suggesting that the now missing portion was once suspended above ground and had split off, possibly under its own weight. The aft edge of the center planking exhibited a similar type of breakage, although it was less apparent in the planking further away from the center of the vessel. Interestingly, the breakage pattern in the planking and the keel was preserved by the wood's apparent absorption of the decaying iron and steel particles from the rusting metal concretion just forward of it.

Other than the evident breakage at the center of the vessel, the line of deterioration aft followed a gently sloping curve that abruptly turns toward the center of the vessel in the last foot or two of the hull remains. The shape of this curve appears to mimic the shape of a waterline on a flat-bottomed vessel with substantial rocker aft. Furthermore, it is interesting to note that the line of deterioration throughout the vessel does not follow plank lines. In fact, the process of drawing the profile view of the hull remains revealed that the deterioration line appears to follow a level line. This may indicate that the vessel burned to its level waterline and then sank, to be buried and preserved by the accumulating silt of the cove. Alternatively, the level line of deterioration may indicate that the vessel sank, for whatever reason, to rest on the bottom at its present angle, to be eroded along a level line that corresponded to the action of the water in the cove. Further analysis of these hypotheses will be pursued in Chapter III with the aid of historic photographs.

Unfortunately, aside from some enigmatic, diagonal-lying timbers at the forward end of the Excavation Position 5, no evidence of sternmost floor timbers, frame timbers, or transom were found to help shed light on the construction of the vessel's stern. The deteriorated aft edge of the vessel appears to indicate that

the stern was located further aft, and did not survive the vessel's demise. This may help to explain the location of the mysterious metal concretion documented little more than six inches from the aft end of the surviving hull remains. If the stern of the intact vessel was located some few feet further aft, this would place the concretion within the living compartment of the vessel. This compartment, as we know from historic sources and historic photographs, was usually decked over, and featured space for cooking, eating, and, in the event of a night-long fishing excursion, sleeping. Perhaps, then, the metal concretion is the decayed remains of a stove. Certainly, the deterioration of the physical evidence makes any identification of this metal concretion difficult. It is comprised of at least two separate pieces. The aft most is a piece of heavy angle iron about 2 ft. long, while the larger, forward section is a stepped chunk of rusted iron almost 4 ft. long in its athwartships dimension, and about 1 in. wide in its fore-and-aft dimension. The object stands about 10 in. high, and appears to consist of a number of columnar sections lying athwartships. Both components of the object are centered over the keel, and are fastened sturdily to the hull. Indeed, this concretion presents a difficult puzzle whose solution awaits further research.

The shape of the hull at Excavation Position 5 was also carefully recorded. It was found to be almost perfectly flat, except for the fourth and fifth plank up from the keel on the port side. The bevel measured here confirmed the findings at positions 3 and 4 that the fifth plank seemed to begin the turn of the bilge. This evidence, when considered along with maximum beams for junks recorded in historic records, as well evidence from historic photographs, indicates that the hardest bevel between plank edges, and the sharpest turn of the bilge for the after half of the boats, probably occurred between the fifth and the sixth planks up from the keel.

The measurement of the rocker of the West Junk revealed both the fore-and-aft shape of the keel and the slope at which it rests (see profile drawing in Figure 5, p. 33). The keel itself exhibits a very gently curving rocker in its forward half. About amidships, this curve steepens, and then, curiously, reverses, creating a slight hollow, or keel hog, for about ten feet. This curve then levels, and about five feet forward of the stern, begins an abrupt curve upwards. The keel hog amidships may have existed prior to the demise of the west junk. The fact that the stern edge of the vessel was found to be lying on a hard gravel ground that most likely represents the shore at the time of the vessel's demise, seems to preclude the idea that the hollow in the keel resulted from sag occurring after the vessel sank. Indeed, keel hog is a condition common to aging wooden vessels, and results from the gradual weakening of the fore-and-aft strength of a vessel's structural integrity. Unfortunately, however, a definitive investigation of the stresses and the structural strength of the California shrimp junks is dependent upon their reconstruction, and is beyond the scope of this thesis. The tendency of these vessels to develop keel hog, then, should be noted as a question for future analysis.

Meanwhile, it may be concluded that the keel of the West Junk in Rat Rock Cove exhibited a gentle amount of bottom rocker through most of its hull, increasing significantly as it approached the final ten feet of the stern. This last bit of sweep in the rocker will be further corroborated through the analysis of historic photographs in Chapter III. Bottom rocker information is central to the reconstruction of the vessel's hull shape, and its successful recovery through the low-impact technique of probing represents an important success.

Probing also helped to confirm and clarify the outline of the remains of both the East and the West Junks (Figure 6). In the case of the West Junk, the outlining process confirmed many of the width measurements of the 1977 sketches where excavations were not performed, and also added clarity to the previously undocumented aft section of the vessel. Moreover, the outline of the East Junk revealed a vessel of a similar length-beam ratio, as well as a very similar shape. The compass bearings of the centerlines of both vessels were within a few degrees of each other, and the East Junk was found to be lying more than half a boat's length forward of the West Junk. The relationship between the two positions seem to indicate that the vessels were both laying against the same pier at the time of their demise. The confirmation of the deteriorated piling heads obliquely noted in the 1977 sketches, and the corroboration of their compass bearing with that of the two vessels, seems also to support this hypothesis. Chapter V will further explore the implications of this information by bringing historic photographs, maps, and written records to bear on the archaeological evidence.

A comparison of the outlines of the East and West Junk hulls revealed that the length of the East Junk's hull remains were 5 ft. shorter. Anxious to further understand this difference, and also hoping to discover some stern construction details where the West Junk failed to provide any, it was decided on the second day of fieldwork to attempt a test excavation at the stern of the East Junk. Unfortunately, footprints from the previous days work had captured a significant amount of water, and prevented the adequate clearing away of mud. Nevertheless, the patient exploration of the vessel's aft features through groping revealed a very disturbed and broken integrity in this portion of the vessel. This deteriorated condition may help to explain the East Junk's shorter length.

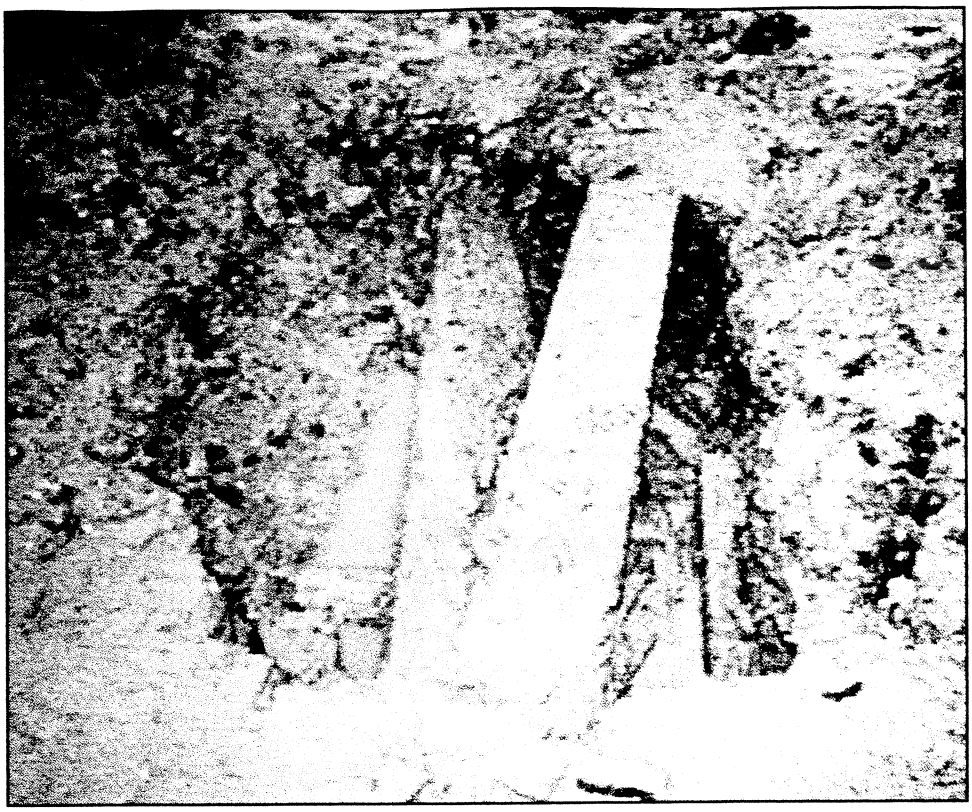


Figure 13. East Junk Excavation Unit 2, 100" aft of bow. This area was checked for similarity to the comparative area in West Junk, but disturbed nature of unit prevented positive identification of components.

The two other test excavations of the East Junk confirmed the disturbed integrity of the vessel remains. Excavation at its bow, while revealing component scantlings similar to those of the West Junk, also failed to locate many important features there. The stem was entirely missing, as was the stem knee and the second floor station, despite markings indicating its existence. The excavation 200 in. aft of the bow revealed even more disturbance, and the observed jumble of timbers proved extremely difficult to decipher (Figure 13). The confused nature of both positions, and the expiration of field time due to the incoming tide, made the documentation of these test excavations impossible, save for a few photographs snapped by the field photographer. The further excavation of the East Junk awaits future efforts.

Products of Field Research

The data collected during the three field sessions allowed for the production of a number of valuable management documents. These include a site map of the entire Rat Rock Cove, a general site plan of both vessels and the wharf pilings, the detailed plan and profile view of the West Junk, and the sectional drawings created from measurements at the five different excavation positions of the West Junk. Each of these embody information critical both to the management of this cultural resource, and its interpretation as an artifact of material culture. As such, each deserves a few words concerning the assumptions inherent in their production.

The site map of Rat Rock Cove (Figure 6a, p. 35) was produced by overlaying clear acetate onto a blown-up color Xerox of an aerial photograph of a larger area of China Camp State Park. Distortion is likely in this process, and so an exact level of scale and proportion should not be assumed for it. Furthermore, the scale for this map was derived from measurements of Rat Rock Cove land features from the U.S.G.S. 7.5 minute topographic map of the Petaluma Point quadrangle, (1959, pr 1980). The representation of Rat Rock Cove features therein are small and roughly defined, and their use in determining the scale of the blown-up portion of the aerial photograph may also have introduced some degree of error.

The general site plan featuring the outlines of the both junks (Figure 6, p. 34), as well as the position of the pilings, is a relatively imprecise rendering, and

is intended primarily to express the positional relationship between the three features. The bow and stern points of both vessels, as well as the location of the piling heads, are accurately drawn. The outline of the vessels in this drawing, however, was determined through probing at 2 1/2 ft. intervals along the perimeter of each.

The detailed construction plan of the West Junk (Figure 5, p. 33) was drawn from the combination of data from the 1998 excavations and the sketches from the 1977 documentation session. The outlined areas of the drawing represent the extent of the 1998 excavations. The hull outline in places outside of these areas was determined both through probing and from the 1977 sketches. Planking lines, which were not featured in the 1977 sketches, were extended on the port side from within excavation areas, as well as from within the starboard side bow area, where they were recorded. Their extension assumes that, in fact, plank lines necessarily were continuous on the vessel. As we shall see from the ethnographic record in Chapter IV, this may be a questionable assumption. Regular edge-nailing is drawn only in the stern area of Excavation Position 5, and the outside of planking in the bow, but was typical for Excavation Positions 2, 3 and 4 as well. Edge-nailing was not drawn in these regions to facilitate the clear illustration of other construction details there.

## Impacts to the Resource

Despite the numerous precautions taken, the field teams in the 1998 excavations were unable to completely avoid negatively impacting the archaeological remains of the junks in Rat Rock Cove. Noting these impacts is useful both to future research at the site, and for future reference in mud flat work elsewhere. The decision to work from within the vessel, which was made in response to the

difficulties confronted with snowshoes, resulted in the minor breakage of a few components. In particular, the port side planking at the stern, and the fourth floor timber at Excavation Position 1 were cracked under the weight of excavators.

A number of impacts occurred either because of the excavators' lack of experience or accidental clumsiness resulting from exhaustion. The false stem at the bow of the West Junk was accidentally broken off, and later returned to its place. The bucket bottom was also cracked in half in the process of photographing it. The diagonal timbers lying on the forward starboard side at position five were lifted out of their original place, and in the process they were broken free of what appeared to be fastenings holding them there. The forward post of the daggerboard well was broken free during exploration of its construction, as was one of the cleats sealing its starboard side. Indeed, even with strict instructions and the best intentions to be careful, the excavators impacted, at least partially, the integrity of the site.

It seems likely that the exposure of the vessel to oxygen and water through its excavation will also have some impact to its level of preservation. Despite the fact that the areas of excavation were refilled within three hours of the original exposure, it became clear that the level of compaction of the refilled areas was considerably less dense than it was previous to excavation. This means that both water and oxygen that had been introduced during exposure were likely to remain for some time. A slow rate of siltation and settling for the mud flats was indicated by the fact that footprints from the excavation season were still visible on the surface of the mud as many as three months later. While the anaerobic protection of the vessel remains may have been disturbed by the 1998 field

session, consolation may be taken in the fact that most of the remains were found to be made from very well-preserved redwood, and most of the fastenings were sealed under a layer of hardened chunam. Hopefully, these preservative qualities will continue to protect the resource against degradation.

It is clear, then, that despite the limited nature of field excavations, and the care taken to avoid impacting the resource buried in the mud flats, that some negative impact did occur. Future excavations at the site would certainly benefit from the construction of scaffolding over and around the site, or any other method of working that avoids the placement of workers directly onto the vessels. The use of a dredge by divers floating above the wreck while the site is submerged may offer a solution, though is likely also to create problems of its own. The exposure of the vessel to oxygen may be avoided altogether through remote sensing operations. All of these alternatives, unfortunately, were beyond the scale and scope, as well as the budget, of the 1998 field season. Hopefully, they will be considered in future work. In any case, it is hoped that the value of the information retrieved during the 1998 research will weigh favorably against the negative impacts it inflicted.

## Conclusions

The 1998 fieldwork at Rat Rock Cove successfully achieved most of the goals of its ambitious field plan. In addition to recording the location and the extent of the nautical archaeological site buried there, a number of key construction details of the West Junk were recorded in situ. Much information not recorded in the 1977 documentation effort was recovered through both excavation and probing, and should greatly assist the answering of research questions guiding this thesis.

Our understanding of how the junks were built was greatly advanced. The construction of the stem was clearly deciphered, as was the nature of the forward step, the main mast step, and the daggerboard box. Key measurements of component scantlings were made, including those of the keel, the planking , and the floor timbers. Preliminary examination of the wood used identified redwood in most of the components, but found at least one important timber to made of Douglas fir. In addition to these specific construction details, evidence of construction techniques was documented throughout the vessel. Edge-nailing, scarfing, and the method of fitting the garboard planks to the keel were documented, and should help us to reconstruct the process of junk construction.

Key information about the shape of the original hull was also obtained during the 1998 excavations. Five sections of the hull shape were documented at evenly spaced increments along the hull. This should greatly assist in the hypothetical reconstruction of the original vessel, as will the information about bottom rocker gained through probing. The documentation of the line of deterioration allow us to reconstruct the demise of the junks in Rat Rock Cove by providing clues to the formation processes involved in the archaeological record. The confirmation of the location of the wharf pilings alongside the wrecks also assists with this, as does the correlation between their compass bearing and those of both the East and the West Junks.

If the 1998 field excavations answered many of the questions about the nature of the junks buried in Rat Rock Cove, it also created many new ones. For example, the identity of the metal concretion at the stern of the vessel, remains unknown. So does the method of constructing the unique stern barely visible in

historic photographs of the junks. Moreover, many construction details recorded, though well documented, defy explanation when viewed from a Western boatbuilding perspective. The mainmast step, for example, with its two long rectangular notches, differs greatly from the standard Western pattern of a single, centered notch. The forward step also remains enigmatic, as the few double-masted junks captured in historic images clearly place their foremast well forward of this step's location. The location of the daggerboard well also raises some doubts as to its true identity, as Western nautical traditions rarely, if ever, place daggerboards forward of the mainmast. The method of beveling the keel and the bottom edge of the garboard plank also greatly defies Western boatbuilding traditions of rabbeting the keel, and needs further explanation.

Indeed, many of the construction details recorded in the archaeological record are hard to explain based on the measured data alone. The understanding of these and other mysteries recorded by the 1998 field excavations require the additional perspectives provided by historic photographs and ethnographic information. These are also critical to establishing a comparative basis for developing our understanding of the cultural traditions that construction details recorded in the archaeological record represent. The following two chapters will review these additional bodies of data, and will seek to provide support for their analysis in Chapter VI. This analysis will attempt to expand our understanding of the material record to a clearer understanding of the culture and history of the people that produced it.

# CHAPTER III. HISTORIC PHOTOGRAPHS

The interpretive potential of the archaeological resource at China Camp State Park can be greatly extended through the study of historic photographs of the San Francisco Bay fishing junks. Both qualitative and quantitative methods of analysis can be used to help answer the same research questions guiding the archaeological investigation of Rat Rock Cove. In addition to general observations, useful in describing construction details as well as general design features, techniques using direct measurements can estimate the size, scale, and shape of important vessel characteristics. A method of overlaying historic images onto present-day landscapes can help to identify and interpret the context in which these vessels were used.

## The Photographic Record

To date, the author has been able to examine twenty-six historic images of the San Francisco shrimp fishing junks. These range from extremely detailed, professionally-produced black and white images printed from glass plate negatives, to tiny, heavily obscured second-generation photostatic copies taken from personal photo albums. The large majority of these images are curated in institutional archives, and have been appropriately catalogued, though there are a few exceptions. The principal institutions housing these images are the Bancroft Library at the University of California, Berkeley; San Francisco Maritime National Historical Park; and the California Department of Parks and

Recreation. Most of the images discussed in this paper are available for public study, and can be reproduced for a nominal fee.

The bulk of the photographic record of the Chinese fishing junks was, like the historical record, generated by the state and federal fishery agencies that chronicled the fishery operations in the late nineteenth and early twentieth century. Charles H. Townsend was an official photographer of the United States Bureau of Fisheries, and accompanied the federal surveys of the shrimp fishing camps around the San Francisco Bay Area in the late 1880s. His is the most comprehensive oeuvre of images, chronicling vessels under way, at pier-side, as well as the layout of the camps themselves. The images of H.B. Nidever, the photographer accompanying the California Fish Commission investigator Scofield in his 1910 survey of the shrimp-fishing camps, focus on the junks almost exclusively, and feature a few rare shots from on board the vessels. The bulk of these are archived by the California Department of Parks and Recreation, although a few are only available as screened images from the 1919 publication of the journal *California Fish and Game.*

Some of the historic images of San Francisco Bay junks were taken by amateur photographers, the best of which was William Oliver, whose collection is housed at the Bancroft Library, at the University of California, Berkeley. Oliver's images feature almost exclusively vessels under way or at anchor, and were shot from Oliver's own yacht. Most of his images are crystal clear, and attest to the skill of this important chronicler of the San Francisco Bay watercraft scene.

A few words of caution are in order concerning the use of historic photographs to extrapolate the characteristics of the Rat Rock Cove vessels. There is,

after all, no way of confirming that any of the vessels in the photographs are the same ones excavated at China Camp State Park. Most of the Oliver collection was photographed between 1885 and 1895, while Townsend's photographs were taken no later than 1892. Considering the large numbers of vessels on the Bay between the early 1880s and the 1913 date of the fire at Rat Rock Cove, the chances are fairly remote that any of these vessels are the same as those documented in the mud. The fact that these vessels are slightly different in each image further warns against their use as a standard model of construction applicable to the vessels in use as much as twenty years later. At best, the junks in these images can be used to hypothesize about the construction of aspects of the Rat Rock Cove junks. They should not be used to arrive at any hard and fast conclusions about the vessels.

Of the 26 historic images reviewed in this study, those photographed by Nidever stand the fairest chance of featuring the Rat Rock Cove junks. As deputies of the California Fish and Game, Nidever and Scofield were engaged directly with the vessels operating out of Rat Rock Cove on numerous occasions in the camp's final years. In fact, according to Scofield's notebooks from this period, on October 26, 1910, Scofield and Nidever arrested and towed in two vessels from the companies of Quong Sing Lung and Quong Lee Chong, the latter operating vessels out of Rat Rock Cove. It could be that the image of the fish patrol launch *Quinnat* towing two Chinese junks depicts this very incident (Figure 14). In any event, the photographs taken by Nidever could conceivably be images of the hulls found and documented in the mud in Rat Rock Cove in 1998. At the very least, Nidever's images are of vessels contemporary to the Rat Rock cove wrecks, and are perhaps the best candidates for photographic analysis that seeks to better understand the Rat Rock Cove vessels.

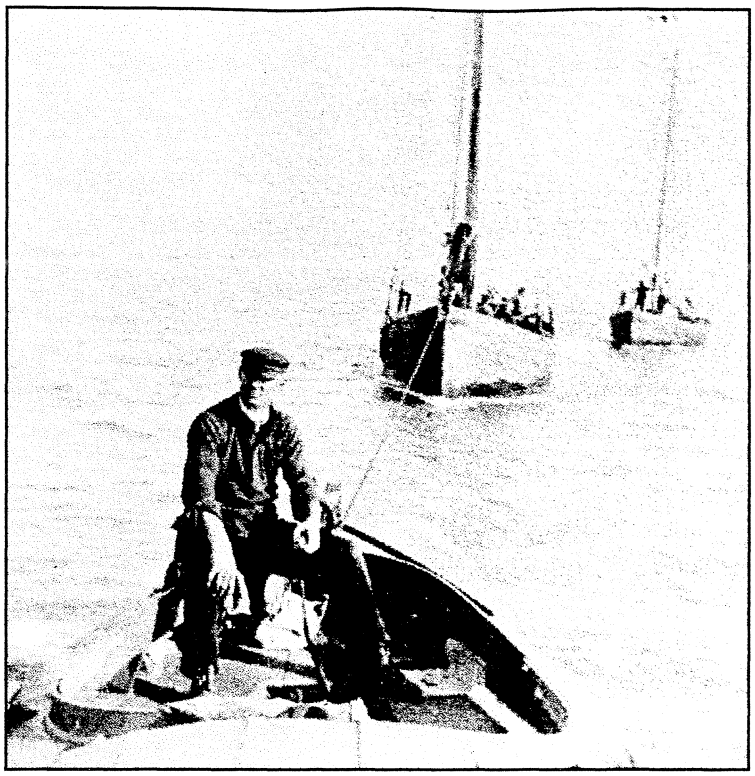


Figure 14. Deputies of California Fish Commission towing junks.This may be an image of either Scofield or Nidever steering the launch *Quinnat* during their October 1910 arrest of two shrimp fishing companies for possession of small fish. California DPR Photo Archives.

## General Observations

Historic photographs of the San Francisco shrimp fishing junks pick up where the archaeological record leaves off: at the waterline. In a happy coincidence, the photographic record, though incomplete, features almost everything above the waterline, while the archaeological record at Rat Rock Cove documents almost everything below it. This symbiotic coverage is convenient, and permits the observation in one record of numerous construction details absent in the other. The construction of the stern, rudder, and the layout of the deck mast partner, and windlasses, are items missing in the archaeological record that are documented, if sometimes only partially, in historic photos.

The construction of the stern section is one of the most elusive details of the Chinese fishing junks in California. As we have seen, neither of the junks in the mud at China Camp featured stern components, instead ending aft with a line of deterioration and breakage apparently forward of the transom. We have also seen that the historic record also fails to adequately describe this portion of the vessels. Fortunately, five historic photographs feature some limited information that can serve to further our understanding of the construction of the stern. Either because the photograph was shot at an oblique angle to the stern or because of unfavorable light, none of the photographs by themselves completely describe the stern. What necessarily follows, then, is a composite image formed from information in all five photos.

The best photograph of the stern section of the Chinese vessels was taken by H.B. Nidever from almost directly aft of a vessel at anchor (Figure 15). Though the stern is largely left in the shadows, it is possible to make out the outlines of the principle components forming the aft frames, rudder gudgeons, rudder, and transom. These form a typical Chinese stern area on a vessel with an axial rudder. The transom is inset from the end of the planking, with its topmost edge ending below the sheer line of the planking. Along this edge runs a transverse shelf, featuring at its center an aperture through which is slotted the rudder post. Some timbers can be seen around this aperture, and probably serve to reinforce it. It is worth noting that in this image the upper gudgeon shelf does not penetrate through the hull planking. The lower gudgeon for the rudder is constructed of a similar scantling material as the upper shelf, and runs across about six to ten inches above the bottom planking of the vessel. It is apparently fastened both into the transom and into the aftermost frame timbers just abaft it. These frames are nailed into the aft edge of the planking and rake aft with it

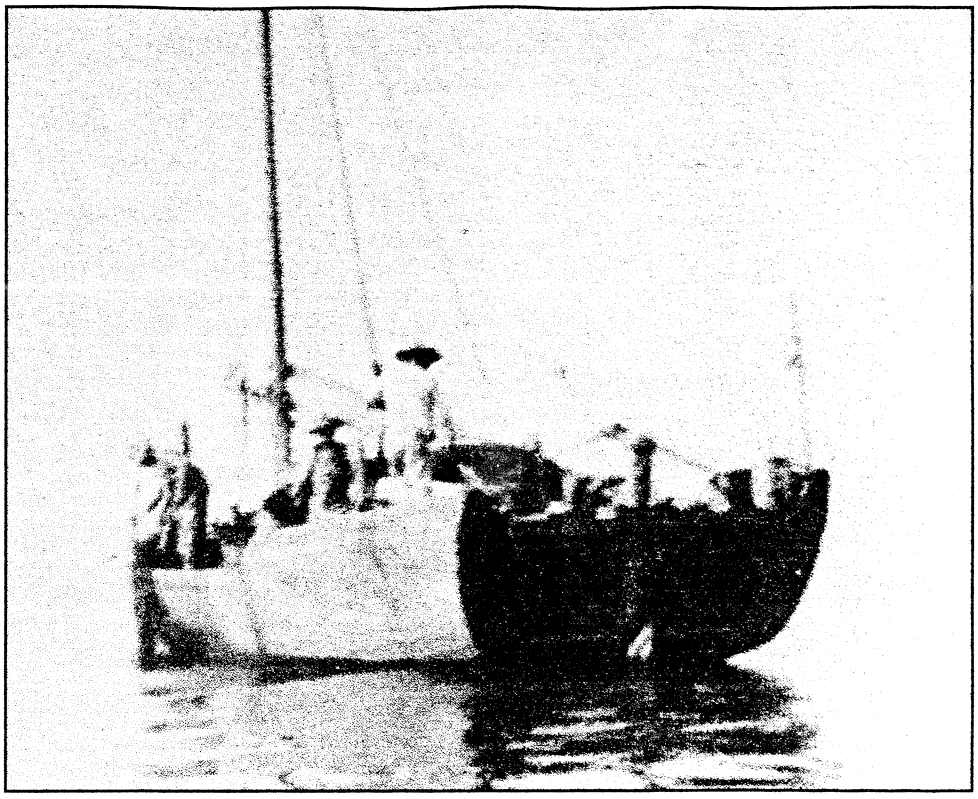


Figure 15. Stern view of shrimp junk, 1910. Though difficult to see, note cross timbers acting as gudgeons to hold the rudder post. Also note aft-most frames are aft of gudgeon shelf, and rake down to transom. Nidever Photograph, California DPR Archives.

from the nibs of the bottom planking up to the sheer. The rudder in this image is fully slotted through the gudgeon apertures in operational mode, with its top and aft corner just protruding above the surface of the water. The tiller is lashed to the center of the boat by a line running to either side of it, obviously holding it steady during work at anchor.

The stern construction described above is also apparent in another Nidever image (Figure 16) of a junk taken from a point off of its port stern quarter. In fact, it is very likely that these photographs represent the same vessel. The oblique angle of the photo permits the additional observation of small timbers fastened around the lower gudgeon aperture, also presumably to strengthen

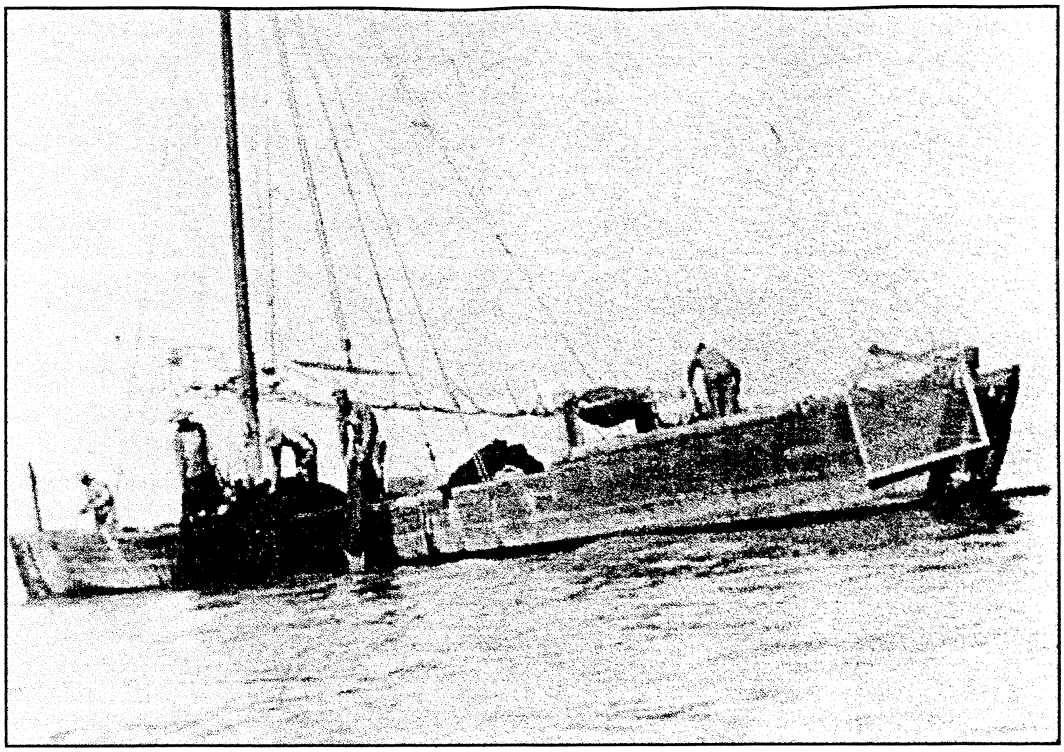


Figure 16. Port Stern-Quarter View of Junk Crew Working Nets. Note gudgeon shelves at stern, and fore-and- aft cleats reinforcing rudder post hole. Square frame hanging from the aft of the vessel is a screen used to separate shrimp from fish. Nidever photograph. Cal. DPR Archives.

this heavily stressed portion of the stern. The stern construction described in an Oliver image (Figure 2, p. 14) also confirms this basic form of construction, but features a variation in the upper gudgeon shelf. On this vessel, the shelf penetrates the hull planking, landing on the upper edge of a notch cut out in the plank below the sheer. A similar arrangement can be seen in heavily obscured image of a vessel wharfside on the mud (Figure 17). Close inspection reveals, however, that the transverse timber penetrating the hull planking here is not, in fact, the upper gudgeon shelf but another transverse timber even further aft. This probably served to reinforce the entire stern structure, and perhaps to provide a platform from which to hoist the large rudder in shallow water. Despite these minor variations, however, the vessels followed a pattern of stern construction described above. This pattern appears to represent "typical" stern con-

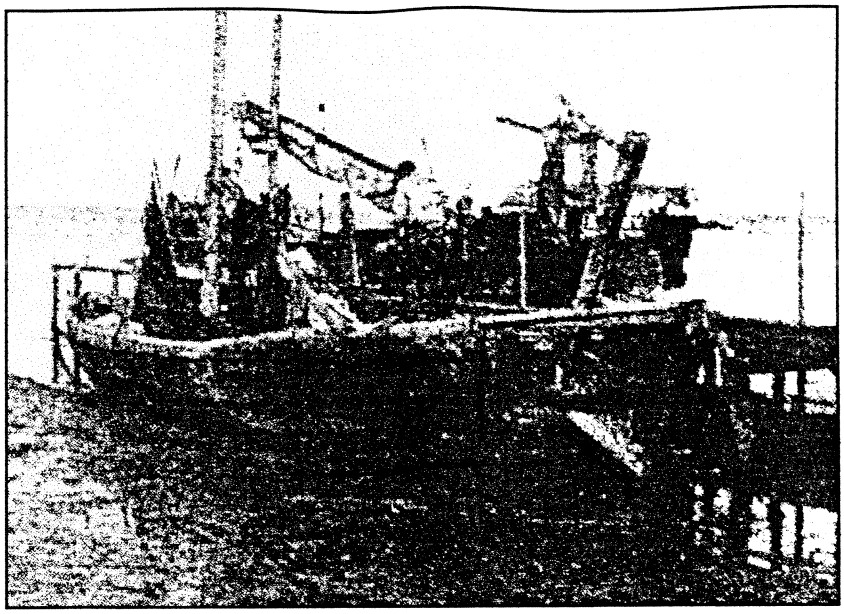


Figure 17. Wharfside Junk High and Dry on the Mud. Though heavily obscured, this photocopied image features a rare close-up view of a shipped rudder and stern section. Also visible is the aft sweep of the keel rocker. Location of original photograph unknown. Photocopy on file at California DPR Archives.

struction, and may serve to guide the reconstruction of the vessels in the mud in Rat Rock Cove at China Camp State Park.

The configuration of the axial rudder (see Appendix, p. 177) common to the San Francisco junks is also visible in a number of historic images. Figures 2 and 18 picture rudders pulled up out of the water, either because the vessels are aground wharfside, or because they are at anchor. In both images, the basic construction is the same. A long, thick, column of wood, which appears to be substantially longer than the height of the men on board, forms the rudder post. The tiller is also mortised into the top of the rudder post, and extends forward perpendicular to it. The distance between the bottom of the tiller and the top of the rudder blade is necessarily larger than the distance between the upper and lower gudgeon shelves, as in order for the rudder to work its blade must be clear of

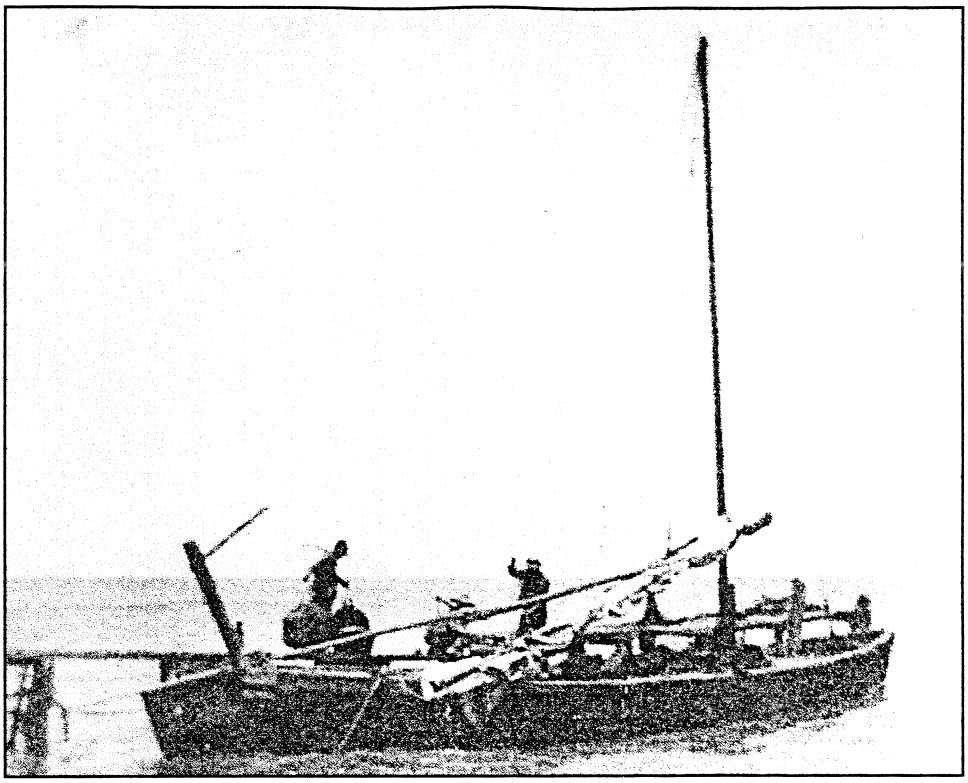


Figure 18. Junk at Pt. San Pedro Pier, 1910, Off-loading Catch.This image offers an excellent view of the characteristic rudder. Note also the raised dagger-board forward of the mast. Nidever photograph. California DPR Archives.

the lower shelf, while the tiller must be clear above the upper one. The blade of the rudder is formed by a vertical row of boards, which themselves are cleated together by three horizontal timbers, the forward ends of which are tenoned into mortises in the lower half of the rudder post. The angle between the top edge of the rudder body and the rudder post is approximately 80°, while the bottom edge is slightly less acute. Into the boards forming the rudder blade are cut diamond-shaped holes, or fenestrations. These vary in number from vessel to vessel, a fact which may point to the feature as an expression of identity.

The rake, or lean, of the planking at the stern, and by extension the rake of the aftermost frames, is also described in a number of images, and most accurately by three photographs taken from almost directly abeam a junk (Figures 19, 20, 21). The simple application of a protractor to measure the angle between the

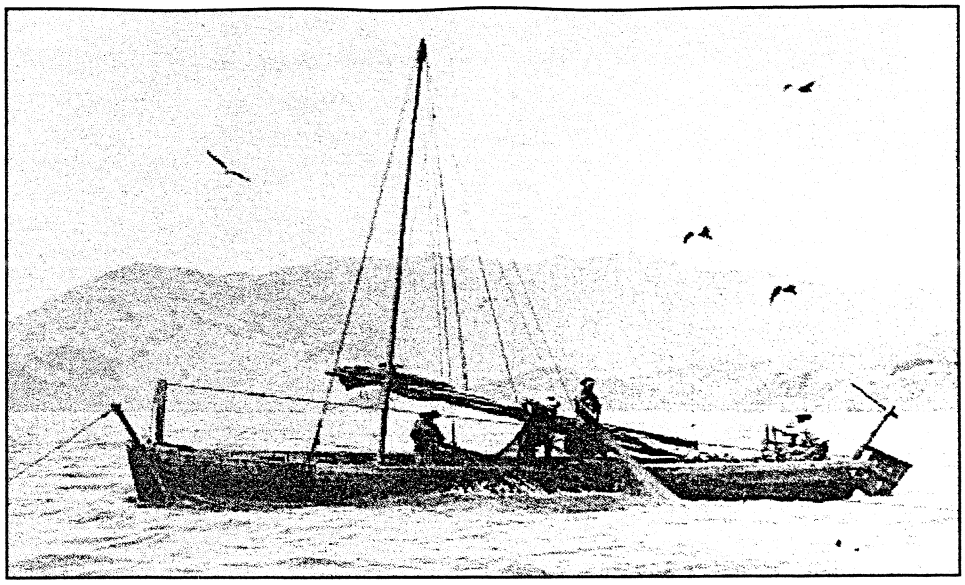


Figure 19. Shrimp Junk at Anchor, Hauling Nets. Stern rake is clearly visible, as is bow rake, and mast height. This rare broadside-view photograph permits the direct measurement of many features of the vessel. Oliver Collection. Bancroft Library, UCB.

waterline and the aft edge of the planking reveals a strikingly narrow range of variation between the four vessels. The three images measure 119° (Figure 21), 12° (Figure 19), and 121° again (Figure 20), giving an average rake of 120.33°. This figure can be assumed to be typical, and thus can provide a key template in the reconstruction, either hypothetical or real, of a San Francisco shrimp fishing junk.

Valuable insights into the layout and placement of deck features can also be gleaned from historic photographs of San Francisco shrimp fishing junks. The absence of any cabin superstructure is not at all typical of vessels in China (Needham 1971, Worcester 1971),but becomes immediately apparent in any review of existing historic images of San Francisco junks. The one exception to this rule (Figure 22), shows a box-like structure offset to the starboard side of the rear deck. This appears too small to serve as a shelter, however, and may instead be a trunk or storage. In any case, it may safely be asserted that as a rule, no cabin superstructure existed on the junks.

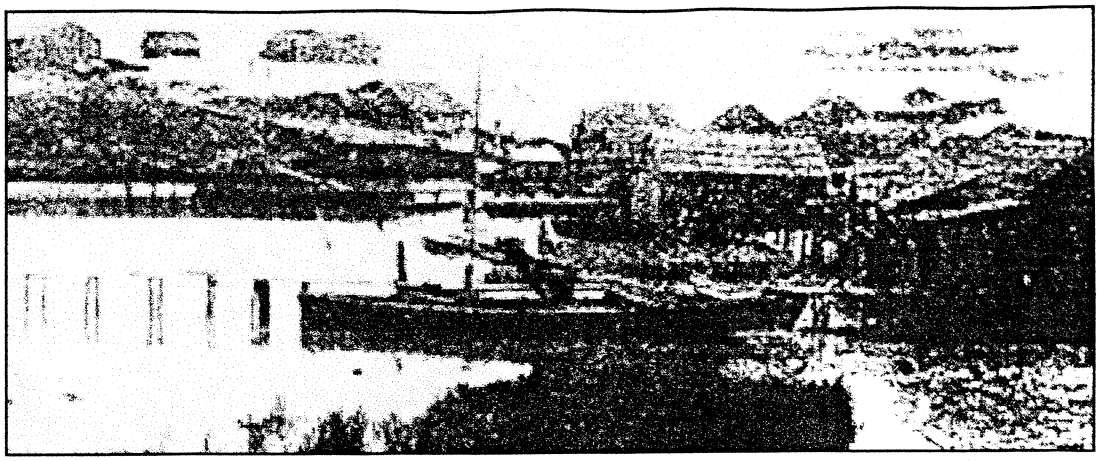


Figure 20. (above)East-Looking View of Rat Rock Cove, providing the opportunity to see stern and stem rakes, as well as rocker of the keel aft, and a shipped rudder.This is an important image, and hopefully the original photographs will be found. This photocopy on file at California DPR archives.

Figure 21. (below) Broadside View of a Junk Under Sail. This image also provides the opportunity to measure the stem and stern rake, as well as mast height. Photocopy of Nidever screened image featured in Scofield's 1919 *California Fish and Game* article.

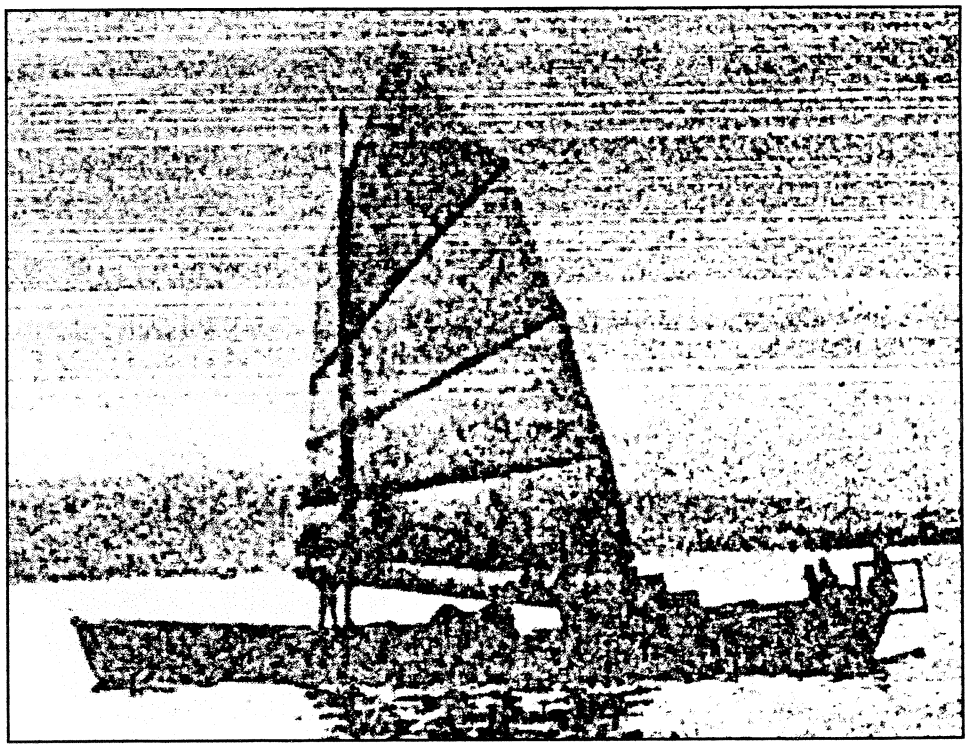


Figure 22. Shrimp Junk Sailing Along San Francisco Waterfront, 1887. Note small box-like structure aft, which could represent a rare cabin superstructure. Note also forward windlass, and daggerboard raised for downwind reach. Photo courtesy SF Maritime NHP.

Two rare photographs taken on board two different junks (Figures 23 and 24) constitute a treasure trove of information concerning deck features, as well as rigging and fishing gear, absent in the archaeological record. Two of the images were taken by Nidever, and provide an excellent if slightly fuzzy record of on-board fishing operations. In the left side of Figure 25, four of the six-man crew of the junk are wrestling with the leading edge of their shrimp net off their star-board bow quarter while a fifth man holds fast the aftermost edge of the net over the port rail. Presumably, the sixth man is aft of the camera, working the aft windlass. We get a chance to see him, as well as a member of the fish patrol, possibly Scofield himself), in the right side of the image. Here, under the watch-

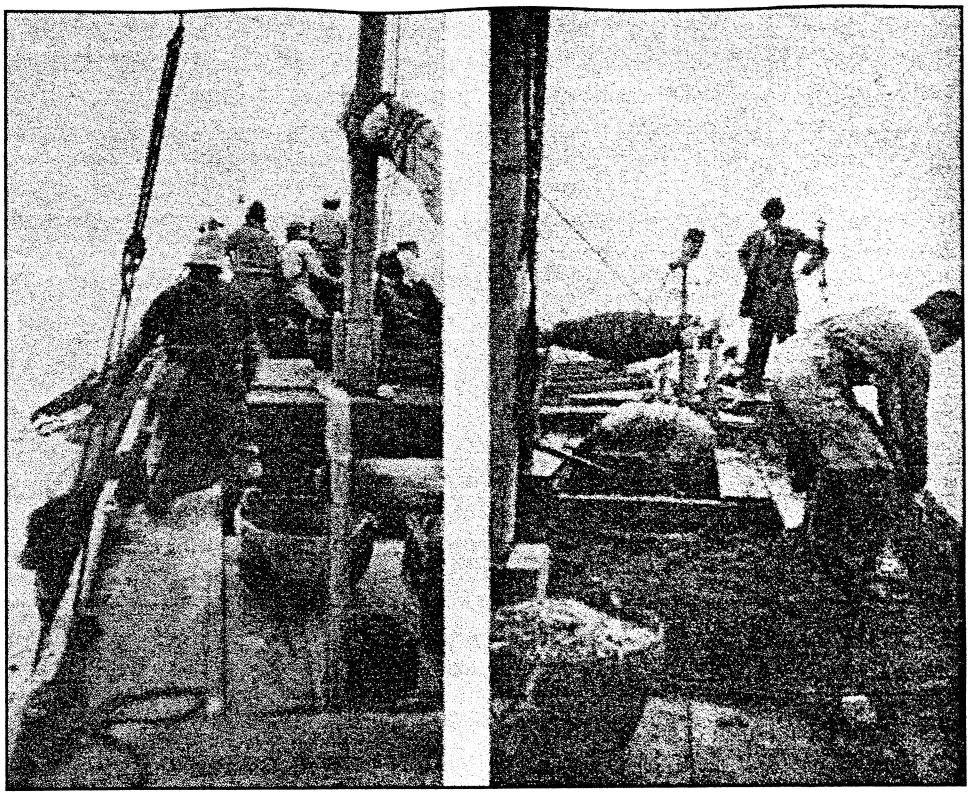


Figure 23. On Board Junk As Nets Are Being Pulled, 1910. The image on left was probably taken before the one on the right, as the latter features a windlass full of line, a hold full of nets and a basket full of shrimp. Note windlass in both images, as well as thole pins and deck planking. A California Fish Commission official, probably Scofield,observes shrimping operations. Nidever photograph, taken from Scofield's 1919 article in *California Fish and Game.*

ful eye of a member of the fish patrol, the sixth man is hauling on the hand windlass, which is winding a taut line that runs aft from the bow, while another man rummages around inside the hold just forward of him. A different man is now tending the aft edge of the net over the port rail. It appears that the second image, or the aft view, was taken after the first, or forward view, as the shrimp baskets on deck in the former are empty, while the one in the latter is brimming with live shrimp. The windlass spool is also empty in the forward view, while in the after view it is loaded with line.

In both of these wonderful images, we can see critical construction details of the forward two-thirds of the vessel, with the exception of the bow, which is crowded with men. The division of the vessel by bulkheads is clearly

seen here, and we can distinguish five different compartments. The pattern of deck planking, which lays on top of the bulkheads, can also be observed. It includes long side planks running fore and aft from the aftermost bulkhead to the fourth bulkhead forward of the mast. These are notched around the frames. Removable fore and aft planks span the first and the second bulkheads inside of the long side plank, and probably also the fourth and fifth bulkheads, though these are only partially visible. Athwartships planks run along the top edge of the first and third bulkheads from aft, but not the second. The athwartships plank along the top edge of the third bulkhead serves as the forward half of the mast partner. An aperture cut into it and strengthened on either side by two fore-and-aft timbers holds the mast, which is wedged snugly by two rectangular timbers.

The athwartships plank on top of the first bulkhead, and the bulkhead itself, serve another critical strengthening function by lending support to the feet of the windlass, which are slotted through the removable deck planking just forward of them. This is a rare close-up view of this uniquely Chinese machinery, or at least part of it, and provides useful clues to its construction. The legs of the windlass are made from heavy rectangular timbers, and are rounded at the top. The short small nib ends of the windlass axle are slotted in to an aperture below the shaped portion of the windlass legs, and appear to be pinned to prevent the shaft from working its way out. Inside of the legs, the diameter of the windlass axle widens to almost three times the thickness of the windlass leg timbers. A few inches in on the axle are slotted offset windlass handles about one and one-half inches in length. This is a unique example of Chinese technology, and we are fortunate to have it so closely recorded.

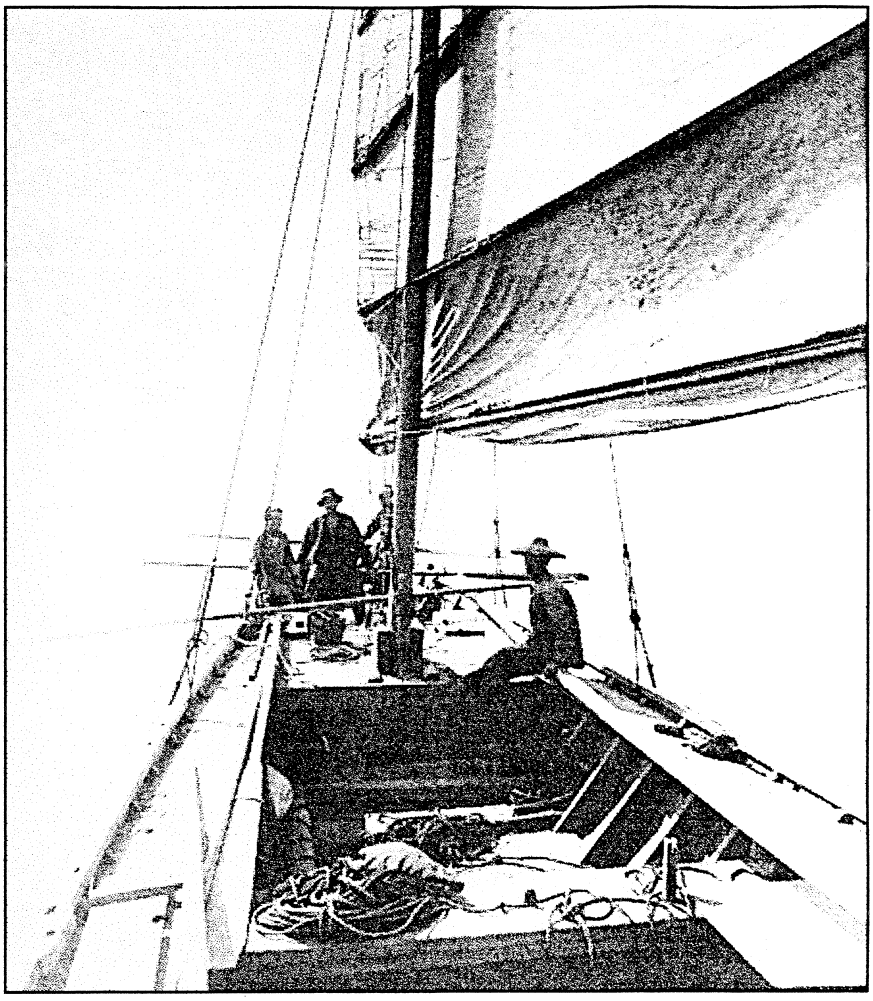


Figure 24. The Forward Interior of a Junk, Under Way. This image shows the workmen at rest, and smiling. Note deck planking arrangements, mast wedges,sweeps, thole pins, and dislodged windlass laid in net hold.Also note the notched pads up forward for receiving windlass legs. Note also the daggerboard forward of mast slightly raised for downwind stretch. Photo courtesy of SF Maritime NHP.

The other, equally striking photograph of an interior of a San Francisco shrimp junk (Figure 24) confirms most of the details of the Nidever photographs, but also adds a few of its own. This image, presumably taken by a photographer from the Taber photographic studios in San Francisco, credited at the bottom of the image, is crystal clear, and was taken from the stern of the vessel looking forward. The junk in the image is under sail, and the fishermen on board are relaxing at the bow. Again, the middle hold is clearly pictured, complete with floor

planking, oars and grommets, and empty shrimp baskets. Interestingly, the inside edge of the frames can also be seen, and are straight, indicating that the frames were shaped from straight-grained planks, and not grown timbers. At the side of the vessel, we get a clear picture of the gunwale construction, which is comprised of both an inwale and rubrail. Into the former on the port side are nailed two thole blocks. The forwardmost of these thole blocks houses a traditional Chinese thole pin, around which a grommetted oar can be fit for use in rowing.

The two images of the Chinese junk interiors illustrate another key function of the historical photograph by providing clues to some of the more enigmatic features observed in the archaeological record. For example, the mast partner configuration pictured in each helps to explain the puzzling form of the mainmast step uncovered in China Camp State Park. Western mast steps commonly feature a single central notch carved into the wood block of the mast step which then receives a tenon on the foot of the mast. The mast step at Rat Rock Cove, however, featured two notches on either side of center, measuring 2 11/16" wide by almost 11" long. This seemed to indicate that three grooves were cut into the foot of the mast. Such an approach would be both uneconomical in terms of the labor required, and unwise, as the two tenons would tend to crack because of their proximity to the outside grain on the mast. The notches, then, without the benefit of historic photographs, baffled analysis, and appeared to point to an unusually inefficient and mysterious construction technique.

The twin notches in the mast step of the junk at Rat Rock Cove may be explained by the rectangular wedges on either side of the masts pictured in the both the Nidever and the Taber photographs. These wedges do appear to taper

slightly towards the center of the mast, and may extend down all the way to the mast step below, where they socket into the notches on either side of the center of the mast. This way, the mast is secured against movement from side to side. Chocks of wood wedged between the heel of the mast and the bulkheads forward and aft of it would serve to secure it against falling forward or backwards, while still allowing easy stepping and unstepping of the mast. Such an arrangement, described in native Chinese craft by Worcester (1971: 75), would also explain why the mast step extends so far forward of the notches. By running to the next bulkhead forward, it provides both a solid landing for stepping and unstepping the mast, and a base upon which to land the foreword chock. Essentially, then, the mast step notches, wedges, chocks, thwarts and bulkheads, together form a unique, removable tabernacle, which serves both to secure the mast when under way and to facilitate its speedy removal and replacement when necessary.

The Taber photograph (Figure 24, p. 70) helps to substantiate another surprising feature recorded in the archaeological investigation at Rat Rock Cove: the daggerboard- well forward of the mast. This fascinating feature, unrecorded in historic records of San Francisco junks, is barely visible in the image just to the left of the mast. About one foot of the daggerboard extends above the top of the well, which itself ends flush with the thwart at the forward edge of the bulkhead just forward of the mast. The top edge of the daggerboard is sandwiched between two pieces of wood, while a small timber appears to wedge the daggerboard against the starboard side of the well, presumably to keep it from rattling or vibrating when under way. It is important to note that the daggerboard well on this vessel is slotted to the port side of the keel, unlike the starboard-side daggerboard well of the Rat Rock Cove junk. This indicates, of course, that they are

not the same vessel. It is also interesting to note that the daggerboard detail in the Taber photograph would likely not have been noticed, much less understood, had it not been for the discovery of a daggerboard well in the archaeological record. The daggerboard in two other images would likely also have remained unidentified. The junk in Figure 22 (p. 67) is sailing before the wind and has its daggerboard up all the way, as does the wharfside junk in Figure 18 (p.64 ). The daggerboard in both photographs is a non-descript, flat board, and both escaped identification by the author prior to his review of the archaeological notes of the 1977 Rat Rock Cove survey and the 1998 excavation there. Now, however, the function of these boards is clear. Moreover, both of these images now give an idea of the length of the daggerboard, and begin also to indicate it widespread usage.

Historic photographs of the San Francisco junks also help to solve the puzzle of the forward step on the Rat Rock Cove West Junk. Because its appearance is more similar to single-notched Western mast steps, it was initially thought that this may represent a mast step as well. Its placement, however, is somewhat puzzling, as most Chinese two-masted vessels, and the few pictured in historic photographs, place their foremast close to the stem at the bow. This step, however, is positioned halfway between the stem and the main mast step. A review of historic photographs reveals that six of the junks pictured featured a windlass at this position. Most show a line running from the windlass spool out to an anchor at the bow. Furthermore, at least two of these appear to land one of the windlass legs down at the center of the boat, presumably to allow for clear and easy passage around the windlass. The step of the Rat Rock Cove West Junk may represent a step for landing such a windlass leg. Figure 24 (p. 70), the Taber image of the junk interior, reinforces this hypothesis by showing the method for

partnering windlass legs. At either side of the thwart forward of the mainmast, one can distinguish a large, square pad landed on the thwart's forward edge. Into the aft and inboard corner of the pad is notched a rectangular aperture. This is the hole through which the removable legs of a windlass are slotted, and is very similar to the hole recorded in the forward step of the Rat Rock Cove West Junk..

Historic photographs also help to confirm another feature recorded in the archaeological record. The measurements taken of the rocker of the Rat Rock cove vessel revealed a relatively flat keel that curves somewhat abruptly upward back aft, about five to ten feet from the stern. In two poor-quality images featuring junks aground on mud flats, Figure 17 (p. 63) and Figure 20 (p.66), a very similar bottom shape is discernible, with the stern lifting off of the ground at what appears to be about the same point in the hull. This shape helps to explain why, in an number of photographs (see especially Figure 15, p. 61) , the entire stern is visible above the water. Such a feature may serve the function of permitting easy access to the lower rudder gudgeon, which plays such a central role in the steerage of the vessel.

The same images showing the stern of the junks lifting out of the water help to confirm the archaeological record by illustrating that the normal waterline back aft ran out before the stern on an extremely oblique surface of the hull. The resulting waterline, commonly seen on the after portion of flat-bottomed hulls, closely mimics the line of deterioration at the stern of the West Junk at Rat Rock Cove. As discussed in the previous chapter, the fact that the vessel's line of deterioration does not follow plank lines in the forward portion of the hull further indicates that the surviving remains of the West Junk probably represent

the hull below and up to the waterline. This corroborates the theory that the vessel burnt to its waterline, sank, and was buried in the slowly accumulating silt. Whatever the conclusion, it is clear that historic photographs can offer important testimony to the original form of the vessels.

If historic images help to confirm the hull form of the Rat Rock Cove junks, they may also assist in its derivation above the waterline. Although the reconstruction of the complete hull form of the San Francisco junks is beyond the scope of this thesis, a few points may be made to illustrate the importance of historic photographs in this process. Returning again to the Taber image of the junk interior (Figure 24, p. 70), we recall that the interior edges of the frames pictured therein are straight, and run from just below the floors of the vessel up to the sheer line. With this in mind, if the inside edges of the frame remnants recorded in the archaeological record are projected up a straight line, we have defined the minimum beam of the vessel at the given station at any height along that projected line. This is, of course, possible only at frame stations 7 and 18, where the remains of frames were observed and recorded (Figure 7, p.36).

The further derivation of the complete hull shape at these stations will necessarily involve the estimation of the height of the sheer, as well as the length of the line describing the outside of the hull. A count of the planks visible above the waterline in historic photographs, when combined with the count and measurement of planks present in the archaeological remnants at individual stations, should help to inform such an estimate. For example, in Figure 14 (p. 59), the vessel at the front of the tow features seven planks visible above the waterline at the bow. If we allow that the vessel is likely squatting in the bow under the force of the tow, and if we assume that the number of planks present below the water-

line in the Rat Rock Cove junk also applies to the one pictured, then we may assume that between eight to ten planks form the hull of the vessel. This range is affirmed also in Figure 16 (p. 62) and Figure 19 (p. 65). These images also affirm that at approximately the halfway point between the mast and the stem, which is roughly the position of Frame Station 7, five planks tend to be visible above the waterline. We may therefore, for the purposes of hypothetical reconstruction, assume that Frame Station 7 of the Rat Rock Cove West Junk (Figure 7, p. 36) would require five more plank widths and possibly six, to complete its hull shape. If we also assume that none of the above water planks would be likely to be wider than those below the water, and we assume also they are close to the same dimension of the uppermost existing full plank, we may therefore posit an estimated range of length for the reconstructed side of the hull.

The length of the hull surface above the waterline at Frame Station 7 cannot alone describe the curvature of the hull there. The measurement will only describe the length of a hypothetical batten, which extends from the edge of the existing planking, and which must be bent to match a fair curve that lands on the line projecting up from the existing frame. The curve chosen can be informed by a number of photographs, taken from oblique angles to the hull, which capture the silhouetted hull curvature at various sections of the boat. For example, the shape at Frame Station 7, or roughly thereabouts, is described by the starboard side of the second boat under tow in Figure 14 (p. 59), and by the port side of the vessel in Figure 17 (p. 63). The curves described by these images can serve as guides for the bending of the batten to meet the projected line of the frame at Station 7. When a suitable and pleasing curve has been found, the line may be drawn to represent the hull shape.

In the reconstruction of the hull form of the San Francisco shrimp fishing junks, the station shapes will have to be unified into a cohesive lines plan. This phase, too can be assisted by a close review of historic photographs. The relationships between stem and stern heights, as well as the curvature of the sheer line (or the upper edge of the top hull plank) are recorded to some degree in a number of historic photographs, and will prove useful in properly lining up the derived stations. The next section of this chapter reviews a technique for overlaying historic images on existing structures that may further assist in the development of a cohesive reconstruction of a typical San Francisco junk.

## Direct Measurements of Historic Photographs

It has been shown that numerous general observations can be made that both confirm the features recorded in the archaeological record and fill in information missing from it. These observations, though extremely useful, have been primarily descriptive, and have offered little in the way of concrete, measurement-based information. Despite problems of parallax introduced by lens distortion, there are two techniques involving the direct measurement of historic photographs that expand their capacity to inform the reconstruction of material culture. The first of these measure the relative sizes of key features of the junks, and transposes these proportions on the archaeological record to derive the probable lengths of various components there. The second employs a method of photographic overlay that enables direct measurement of the landscape surrounding the junks at Rat Rock Cove, and confirmation of the archaeological site's placement there. This last technique may also facilitate the verification of any three-dimensional reconstructions of the San Francisco junks.

Proportional Measurements

In historic photographs the San Francisco junks, the location of the masts in relation to the length of the vessel hull is remarkably uniform. Such uniformity is common in watercraft traditions, as mast placement greatly effects the balance of the sailing rig particular to a vessel and so largely determines its sailing performance. If mast and sail are placed too far forward, the vessel tends to fall away from the wind too easily. If they are placed too far aft, the vessel tends to round up into the wind. Either condition is unsuitable, creating undesirable steering work for the helmsman. It is therefore not surprising that a uniformity of placement is noticeable for the San Francisco junks. It is possible to confirm this appearance of uniformity by measuring the ratio between the distance of the mast step from the bow and the overall length of the keel in a series of images. In order to limit the distorting effects of parallax, it is, of course, important to measure vessels whose image was taken from a point perpendicular to the vessel hull. Unfortunately, only five images of six different vessels shot from such an angle are known to exist (Fig. 1, p.11; Fig. 19, p. 66; Fig. 20, p. 67; Fig. 21, p. 67; and Fig. 25, below). Even within this small sample, the range of the mast step to keel length ratio varied by about four percent, with the highest percentage being .367, and the lowest being .326. Three of the vessels varied by little more than a single percent, measuring .343, .355, and .356. The average for the entire group was .345. These figures mean that normally, the Chinese junks featured masts stepped at a point approximately 34.5%, or roughly a little more than a third of the length of the keel aft from the bow.

By expressing the relationship between the location of the mast step and the length of the keel in terms of a percentage, we are able to apply it to the archaeological record, and estimate a range for the both the length of the keel

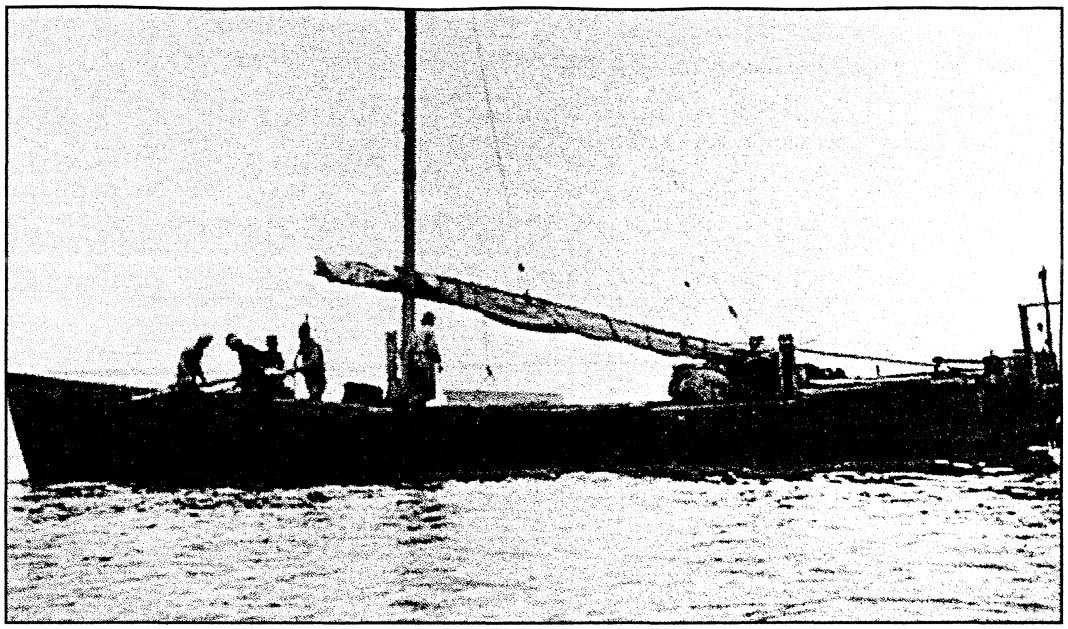


Figure 25. Junk at anchor, with crew working a pole-like implement( possibly a sweep). This 1910 image was taken from a point almost exactly abeam of the vessel, and allows for the proportional measurement of the distances between the bow and the keel, the mast step, and the stern of the keel. These may be used to approximate a length of keel for the West Junk. Nidever photograph, courtesy of California DPR archives.

and the overall length of the Rat Rock Cove vessel. The mast step of the Rat Rock Cove junk was measured at 15 ft., 1 in. aft from where the stem lands on the keel. Using the figures measured in the historic photographs, that gives a range of between 41 ft., 3 in. (.367) and 46 ft., 4 in. (.326), with a middle figure, derived from the average, of 43 ft., 9 in. for the length of the keel of the Rat Rock Cove vessel. If we estimate the normal length of the stem and sterns from historic photographs, and then adjust the keel length figures to account for their rake, we may then arrive at a range for the overall length of a reconstructed vessel. The close proximity of human figures to the bow profile in Figure 19 (p. 65) and Figure 26 (below) allow for a rough estimate of 5.5 ft. for the stem length, while the same images allow for an estimate of around 4 ft. for the stern. If we project these lengths up and rake them according to the stem rake recorded on the Rat Rock Cove vessel, and the average stern rake of 119.25°, we arrive at an adjustment of roughly 4 ft. to the length of the keel. This gives a range of

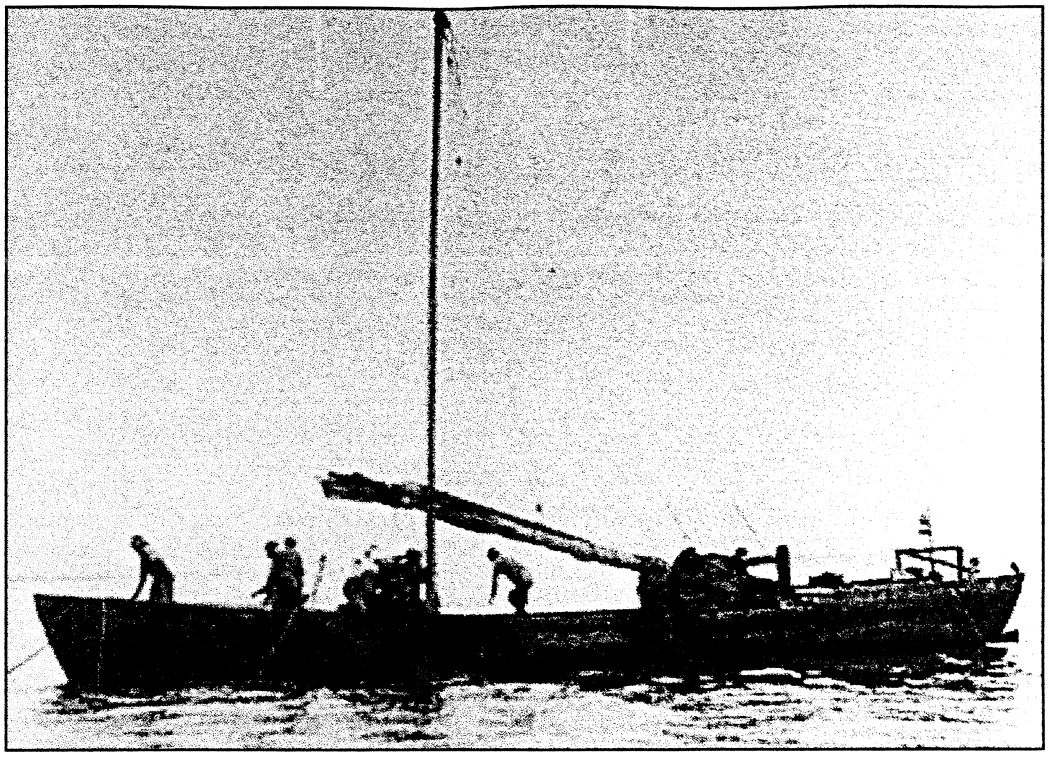


Figure 26. Junk at anchor, 1910, showing full height of mast. This image is also useful for proportional measurements, including the mast height to keel length, and mast step to bow and stern ends of the keel. Stem and stern heights can also be determined as proportions of keel length. Nidever photograph, California DPR archives.

between 45 ft., 3 in. and 50 ft., 4 in. with a middle figure of 47 ft., 10 in. for the overall length of the Rat Rock Cove West Junk. It is comforting to note that these estimates fall also within the range of vessel lengths documented in the historic record during the later period of junk use.

Proportional measurements can estimate the size of other vessel components as well. The proportion of mast heights to keel lengths are also relatively uniform, and are even less subject to the distortion of parallax or foreshortening because of their relatively insubstantial width and their round cross-section. In the same six vessels used to measure the relationship of keel length to mast step placement, the mast height expressed as a percentage of keel length produced an average percentage of .75, with a range between .73 and .80. If we use the middle keel length of 43 ft., 9 in. derived earlier for the Rat Rock Cove vessel, we

end up with a mast measuring between 31 ft., 9 in. and 35 ft., with a middle figure of 33 ft., 1 in.

While admittedly rough and inexact, figures derived from proportional measurements of historic photographs can nevertheless assist efforts at reconstructing the San Francisco shrimp junks in general, and the junk recorded in Rat Rock Cove in particular. Other features, such as stem and stern height, rudders size, and sail area may also benefit from such analysis. It must be noted, however, that the smaller the size of the component being analyzed the less accurate the result will be. Furthermore, the effects of foreshortening and parallax wreak havoc on the technique's accuracy, and greatly limit its application.

Prince's Principle of Historic Image Overlay

Another technique that uses historic photographs to better understand the material culture of the past has been developed by Gene Prince, formerly of the R.H. Lowie Museum of Anthropology at the University of California, Berkeley (Prince 1988). This surprisingly simple technique involves the superimposition of an historic photograph on the same present-day landscape, and allows the researcher to accurately relocate, map, and measure items that have long since disappeared. After first placing a slide of the historic image on the view finding screen of a 35mm camera, the researcher looks through the camera lens and gradually moves around to line up the landscape features of the semi-transparent historic image now visible in the camera screen with the same landscape features present today. Once this is accomplished, the camera is set into a tripod, and features in the historic image such as buildings are flagged, measured, and mapped. This is, of course, a simplified version of the technique, and there are a

number of procedural details that determine the success of the technique. A full review of Gene Prince's article (Prince 1988) is strongly recommended prior to the application of the technique. Nevertheless, the potential of Prince's Principle for accurately locating archaeological sites is clear, and encouraged its application to an historic photograph of Rat Rock Cove.

Only two images exist depicting the waterfront of the Chinese shrimp camps in Rat Rock Cove. One of these consists of only a photocopy of the original image (Fig 20, p .66), while the other (Figure 27) was taken from a somewhat distant point on the eastern slope behind the buildings lining the cove. As this latter image is clearer, and features well-defined outlines of the mountains and hills to the west of the cove, it was chosen as the first subject for the application of Prince's Principle. Of particular interest to the effort was the location of the wharves visible in the center of the image, as well as the junk alongside the westernmost one. It was hoped that one of these wharves might correspond to the pier remnants recorded in the archaeological record, thus verifying which pier, and potentially which company, the Rat Rock Cove junks belonged to.

The location of the point from which the historic photograph was taken was achieved quickly and satisfactorily using the 50 mm. focal length. The water level of the shore (the tides were picked to match the level in the historic image), the shape of the western point of the cove, the outline of the slope in the foreground, the outline of the hill forming the western side of the cove, and finally the silhouette of the distant mountains above it were the key landscape features that facilitated the rapid discovery of the original camera point. Interestingly, the elevation of this point proved to be only 22 inches above ground, presumably either because the original cameraman rested his camera at a similar elevation

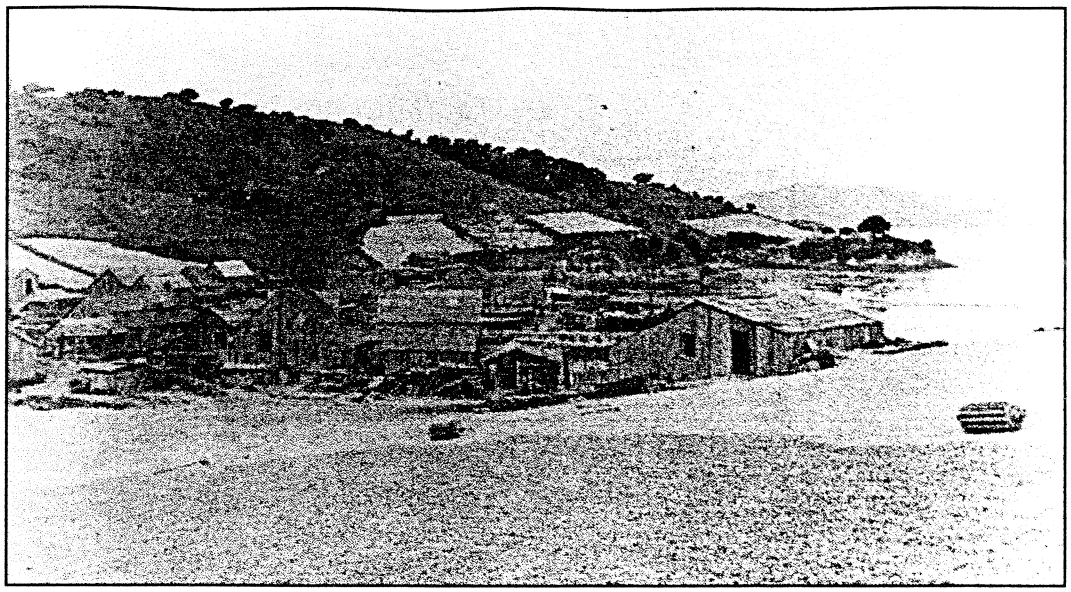


Figure 27. West looking view of Rat Rock Cove, taken from up on the bluff. After using Prince's Principle to find the exact location of where the image was taken, key features such as pilings in the piers pictured were flagged on present-day mud flats. Location of these flags were found to correspond exactly with existing piling heads recorded in archaeological work. Photo courtesy of SF Maritime NHP.

above ground, or because the elevation of the ground at that point had increased since.

After placing the camera on the tripod, the research team proceeded to flag the three visible corner points of the building in the right side, or northern edge, of the historic image. The flaggers were directed by the person viewing the building through the camera, and were excited to discover that they were guided almost exactly to the corner points of a two-level, square depression in the earth. These points presumably marked the remaining outline of the original site of the building. Their position relative to each other and to the camera position were measured and mapped. These measurements will facilitate not only their relocation and mapping, but also the application of a perspective grid, similar to the one used in Montague's photographic analysis, to the historic image. This grid, when applied throughout the image, will allow the consequent measure-

ment of other features pictured, and, eventually, for the production of a planimetric map of the structures in the cove. For a more detailed description of this process, please refer to the sources listed at the end of this chapter. The application of this process to the Rat Rock Cove image is, unfortunately, beyond the scope of this thesis, and awaits future efforts.

After adequately measuring and mapping in the north building, flaggers were sent out into the mud flats of the cove below, and were guided to points describing the pilings comprising the first two piers pictured. Flags were placed at visible pier clusters, as well as the stern of the vessel pictured. Once again, the technique provided immediate gratification, as the flags describing the location of the second, more western pier, landed directly on top of existing pier heads lying just below the surface of the mud. This line of piers runs along the stony, elevated outcrop that juts out into the mud and is visible at low tide. The flags describing the first, easternmost pier, after an adjustment estimated to compensate for the incomplete view of them in the historic image, aligned almost perfectly with the line of piers recorded in the archaeology of the Rat Rock Cove vessel. This alignment was further confirmed when the position of the flags, which were recorded using a transit and stadia rod, were mapped onto the archaeological site map produced from the 1998 fieldwork.

It may be concluded from the evidence acquired through the application of the Prince's Principle to the historic images of the Rat Rock Cove, that the junks excavated in 1998 were, at the time of their demise, lying alongside the easternmost pier pictured in the image, which probably represents the easternmost pier of the cove. Unfortunately, no date for the image exists, and it is thus

difficult to know definitely which company this pier belonged to. The possible extrapolations from this data depend on the close analysis of historic information, and are pursued in Chapter V. In any event, it is clear that the application of Prince's Principle can greatly enhance the contribution that historic images can make to the study of the San Francisco junks, and of material culture in general.

In addition to relocating missing structures, and to verifying the location of archaeological sites, Prince's Principle may be usefully applied both to the interpretation of the cultural resources, and to the verification of three-dimensional reconstructions of material culture. Both of these applications are briefly investigated in Chapter VI of this thesis.

## Conclusions

This chapter has shown the importance of historic photographs in the study of the San Francisco shrimp junks. These rare and valuable images complement the archaeological record by both filling in missing information and explaining features recorded there. Without the detail of historic images, features of the junks such as the stern construction, the rudder, stern rake, deck windlasses, mast partners, and bulkheads would remain unknown. Enigmatic features recorded in the archaeological record such as the mast step, the forward windlass step, and the daggerboard well would remain mysterious, while aspects of the hull shape, such as the bottom rocker, stem rake, and waterline, would remain unconfirmed.

The absence of historic images would also greatly cripple efforts to

understand the shape, size and scale of the San Francisco shrimp junks, and of the Rat Rock Cove junk in particular. We have seen how historic photographs can be combined with archaeological data to derive the sectional shape of the Rat Rock Cove hull. We have also seen how proportional measurements of profile photographs can be combined with archaeological measurements to estimate the length of the Rat Rock Cove junk's keel, as well as its overall length and its mast height. Moreover, the field application of Prince's Principle has demonstrated how historic photographs can confirm the location of the Rat Rock Cove junks, and also identify the pier alongside of which they are buried. Indeed, historic photographs are clearly data-rich, and play an integral role in furthering our understanding of the Rat Rock Cove junks. This role is expanded in Chapter V's analysis.

# CHAPTER IV. THE ETHNOGRAPHY OF PEARL RIVER DELTA BOATBUILDING

The research questions that guided the archaeological investigation of the junk wrecks at China Camp State Park may be further illuminated by the consideration of ethnographic data collected from China in January of 1999. Though subject to a number of limitations, field research in the Pearl River Delta region clarifiies the archaeological dat recorded at Rat Rock Cove. Observations of traditional boatbuilding techniques, as well as observations of specific watercraft features, should also help in the reconstruction of a San Francisco fishing junk. Finally, by identifying and illustrating Chinese traditional boatbuilding practices, ethnographic data provides a more developed basis from which to ask the comparative research questions guiding this study.

## Field Research Itinerary

The January 1999 trip to the Pearl River Delta was conceived with the goal of seeing what, if any, traditional boatbuilding, and traditional fishing vessels, still remained in the area from which the bulk of San Francisco immigrants had originated. Comprising about one hundred square miles, this region is fairly well defined by the knowledge of the district associations of the San Francisco immigrants at the turn of the century. These associations served as immigrant organizations in 19th-century San Francisco area. Like many immigrant associa-

tions, each focused its economic activities in particular areas, though rarely completely controlled any one. These areas have been documented in a number of studies (Chinn, ed., 1973). The retail fishing industry in the city, for the most part, was dominated by the Cheungshan association, whose native region extends from below the Guangzhou area to the tip of the peninsula extending south from there to Macau.

The regional makeup of the shrimp industry, and of the shrimp camps specifically, appears to have been less homogenous. According to the 1880 census for San Pedro (Brienes 1982: 90), the camps at Pt. San Pedro (the China Camp region) were comprised of immigrants from the Sam Yup districts (Punyu, Shuntak, and Namhoi), the Toishan (Sunning) region of the Sze Yup, as well as the Cheungshan regions. The geographical origins of these groups basically covers the area surrounding Guangzhou south to Macau, the riverine area between Guangzhou and Humen on the eastern shore of the delta, and the coastal and riverine area extending westward from Macao to Guanghai (Figure 28). These regions were given high priority in the original itinerary of the trip, and port towns were selected within each for visiting.

In fact, because of a number extenuating circumstances, the Sam Yup region comprised the bulk of the data collected on this trip. The village of Tanzhou lies within the Shuntak region of the of the Sam Yup district, while the village of Xinwan lies at the southern tip of the Punyu region of the Sam Yup district. The village of Coloane, at the southern tip of Macau, lies at the southern extremity of the traditional Cheungshan district. Efforts to reach villages in the Sze Yup district regions of Sunning and Sunwui were thwarted by a lack of time, money, and availability of interpreter assistance. Fortunately, the village of

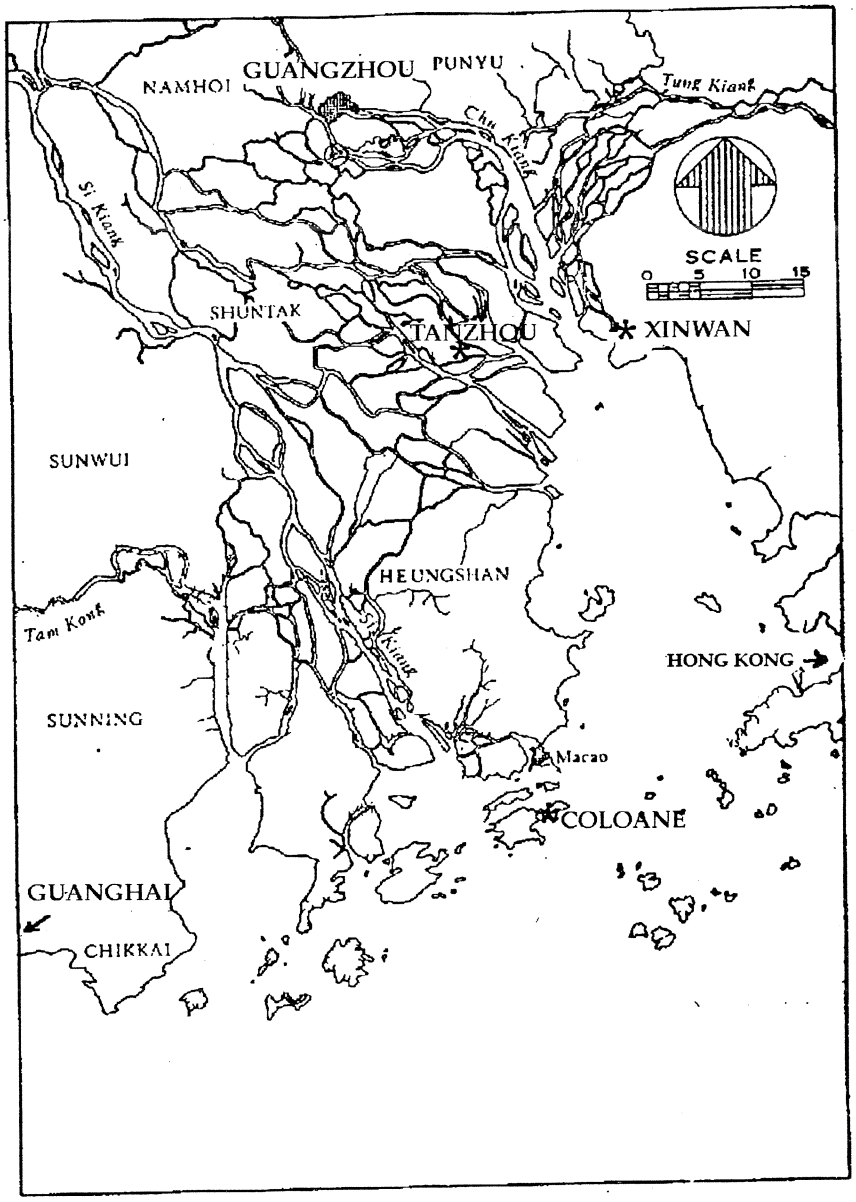



Figure 28. Map of Pearl River Delta Region, showing villages visited during1998 field research, and regional districts. Sunning and Sunwui are Sze Yup districts, while Punyu and Shuntak, and Namhoi are Sam Yup districts. Heungshan, which includes Macau, is also referred to as Cheungshan. Map reprinted from Nash 1973.

Guanghai in the Sunning region district was documented by J. Baldwin in 1982 (Baldwin 1982), and some of his observations of the boatbuilding there have been incorporated into this study.

Although the Hong Kong area was not cited in historical records as the origin of the San Francisco immigrants involved in the shrimp fishing industry of San Francisco, Aberdeen, on Hong Kong Island, and Cheung Chau, an island lying a few miles to the west, were included in the study. Reports of pollution and industrial development in the Pearl River region encouraged their inclusion, as it seemed possible that the fisheries of the more northern regions would have moved further downstream of the industrial developments around Guangzhou, towards the regularly flushed open water areas to the south near Hong Kong. Furthermore, these were villages reported by both popular guidebooks and by travelers to the region as being active fishing fleets with some modicum of boat-building and repair operations happening in their harbors. It was hoped that observations at Aberdeen and Cheung Chau might provide a comparative basis for defining differences between mainland boatbuilding traditions and those of the Hong Kong area. Failing the observation of traditional boatbuilding on mainland China, it was hoped that observations at both of these locations, would at least provide some general sense of Chinese boatbuilding traditions in a more generally-defined Pearl River Delta area.

## Research Questions

At each location visited, inquiry was guided by a set of research questions similar to those posed in the archaeological investigation of the San Francisco shrimp fishing junks at China Camp State Park. The first set of questions can be grouped the larger question, "How are these boats built?" General construction techniques, including fastening, caulking, and fire-bending were documented. The use of patterns, tools, and construction materials was taken note of, as were stages of construction.

The construction and design of specific components of the vessels were also documented. Vessel attributes missing in the San Francisco record were paid particular attention to. Bulkhead, stern, frame, and rudder construction were carefully observed. Vessel attributes which had proved puzzling or surprising in the archaeological investigation at China Camp State Park were also investigated. Planking and scarfing patterns, stem construction, and keel rabbeting were noted whenever possible.

All construction details were documented with the intention of better understanding the material remains found in the archaeological record at China Camp State Park, and the construction process they represent. They were also aimed at better defining the boatbuilding traditions of the regions of the Pearl River Delta where San Francisco immigrants originated. It was hoped that a better definition of native cultural traditions would assist the analysis of the material and historical record of the San Francisco Junks by providing a comparative perspective from which to examine how they differed from the watercraft traditions of China, as well as those of the Western Europeans. Answers to these questions form a major component of the material culture analysis of Chapter V.

## Level of Documentation

Observations made during field research were documented primarily through photographs and written notes. The time and scope of the research trip did not facilitate extensive field measurements. In most cases, much effort was required at each site to put the boatbuilders at ease, and it was generally felt that direct measurements would cause discomfort and at least a general sense of alarm. As a result, observations made during fieldwork are solely descriptive.

One of the most visible construction techniques observed was the practice of edge-nailing. This is a technique of fastening boards edge to edge, and involves the driving of nails through a series of triangular notches carved along the seam of the boards being fastened. The nails penetrated the edge of the plank below, and serve to pin the two boards together. Usually, nails are spaced at regular intervals, depending on the particular use of the component of the boat. Edge-nailing is most commonly used to fasten planking, bulkhead boards, and deck coamings. It is also widely used in repairs to broken or split planks, wherever they appear on the vessel.

The technique for fastening an edge-nailed plank was observed in the construction of a yacht at Coloane Island near Macau, and at two different boatyards in Tanzhou (Figures 29-33, below). After a plank was clamp-fit to its position on the vessel, it was removed for the carving of the triangular notches. These were created, usually at regular intervals of about a hand's width, by first carving the vertical sides of the triangle with a series of alternating blows, and then finishing with the an authoritative blow of the chisel to form the bottom ledge. The plank was then clamped back into its position on the boat using both standard c-clamps, which hold the plank against the frames, and large iron staples, which serve to edge-set the plank by spiking into the hull below and bearing down on wedges at its top edge. Next, a long, tapered drill bit chocked into an electric drill is used to pre-drill nail holes into the triangular notches and the plank below. Square, hand-forged steel nails are set into the holes and pounded in using a triangular shaped nail set and a large ball peen hammer. Well over half the length of the nails usually penetrate the plank below. Edge-nailing is followed by hammering larger, bent-head spikes, perpendicular to the hull, into

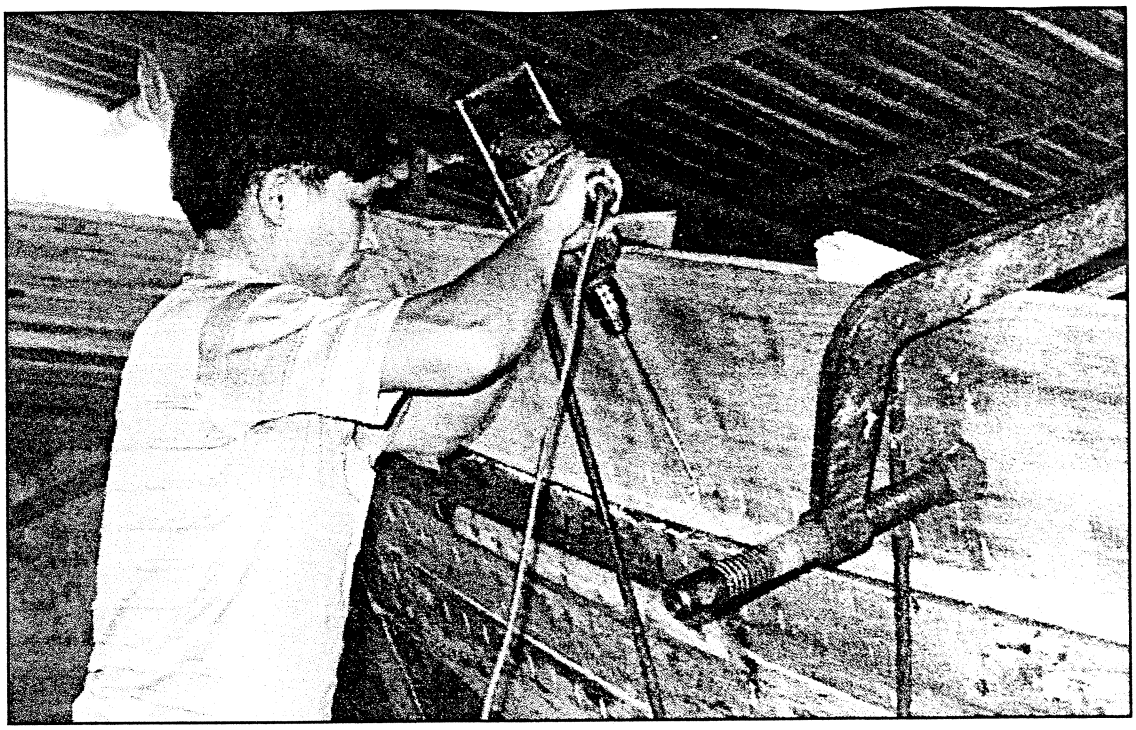
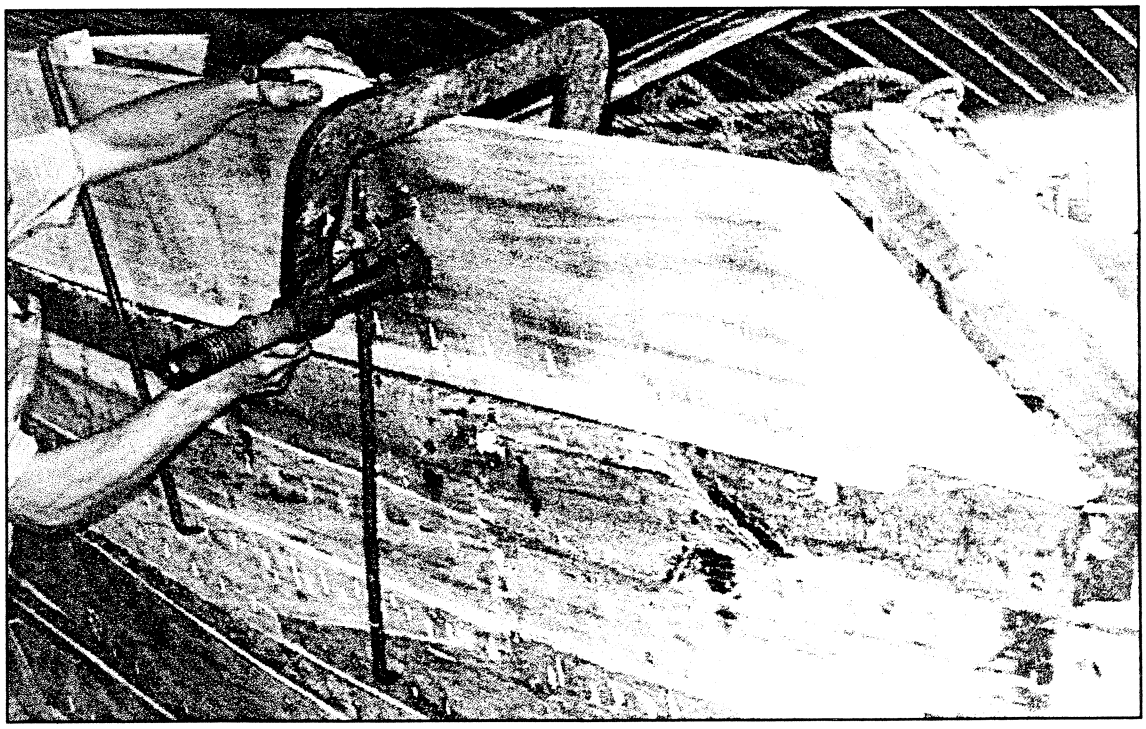


Figure 29 (above). Tanzhou Boatbuilder prepares to fasten a repair plank. After carving row of triangular notches along seam, the plank is fit to the boat, clamped into position using c-clamps, large iron staples and wedges. Holes are pre-drilled into the notches using a long tapered bit and an electric drill.

Figure 30 (below). Next, the builder sets tapered square nails into the notches. The nails are four inches long, headless, steel, and hand-forged in the shop. Note iron staple and wedge system used to edge set the plank into place.

Figure 31 (above). The builder next drives home the nails using a long, triangular shaped nail set, until the nail ends just disappear into the wood of the triangular notch.

Figure 32 (below). Long steel spikes with a hooked head are driven perpendicular to the plank into the frames behind. Though holes are predrilled for these spikes, no notches are carved. The builder then returns to complete the edge-nailing on the remainder of the plank. Note also scarf at bottom of nearest edge-clamping staple.



the frames of the vessel. Together, the two nailing systems ensure a sturdily-fastened craft.

After observing over a dozen vessels, a normal pattern of edge-nailing began to emerge. Regardless of the vessel component, edge-nailing was never observed on both sides of a plank or board, except in the case of an extremely dilapidated vessel that required emergency fortification along the plank seams. In almost every instance, edge-nailing was used in planking on whichever side it could be most conveniently applied. Plank seams that were difficult to access from the outside were edge-nailed from the inside of the vessel, and vice versa. For example, in most of the vessels observed, the first two planks up from the keel, the garboard and the broadstrake, were edge-nailed on the inside of the vessel back aft where the hull was flat. Towards the bow, where these two planks usually twisted to a more vertical orientation, becoming more accessible from the outside, and less so from the inside, edge-nailing was observed on the outside of the vessel along the plank seams, especially along the rabbet (the seam between the garboard and the keel).

Accessibility was not the only factor controlling the location of edge-nailing on hull planking. In many of the vessels constructed of high-cost materials, edge-nailing was generally confined, where possible, to the inside of the hull planking. This was observed in the large teak fishing vessel under construction at Tanzhou, as well as the large trawler and the yacht under construction at Coloane island. In most of the teak sampans in the wealthier harbors of Cheung Chau and Aberdeen, edge-nailing on the outside of planking was confined to below the waterline, while above the waterline only nails driven into the frames could be observed. By contrast, on the more rugged, working craft built from

pine wood, like the market barges at Tanzhou and Songgan, as well as the sampans under construction at Tanzhou and Xinwan, planks, both above water and below, were edge-nailed on the outside of the hull.

How do we explain the difference in approaches to the edge-nailing of planking? While it could be explained as a simple preference of the craftsman, it seems likely that the almost perfect division of techniques along wood lines is more than just a coincidence. It is possible that edge-nailing, with its line of closely spaced triangular notches filled with hardened gray-green putty, is considered a crime against the beauty of teak wood, and is generally avoided on the outside of a teak hull whenever possible. A hull of pine wood, on the other hand, is considered less valuable, and holds less aesthetic appeal to begin with, and so the more convenient method of edge-nailing on the outside of the hull is more acceptable. To be sure, the color of hardened putty blends well with the color of work-worn pine, while it remains highly visible against the reddish hue of teak.

Unfortunately, the observation at Tanzhou of one freshly constructed, medium-sized trawler of pine, featuring inside edge-nailing casts some doubt on the universal applicability of this explanation. This pine trawler, however, was an expensive vessel compared with the other pine vessels visited. It may be, then, that inside edge-nailing, by minimizing the exposure of the nails to moisture, is seen as a measure of protection whose preservative potential is valued when the investment in a vessel is great. Or it may be that inside edge-nailing is seen as a status symbol, or as a measure of expertise. While the definitive explanation awaits further ethnographic research, it may at least be observed that inside edge-nailing appears to more prevalent on vessels of greater value, and certainly on vessels constructed of teak.

Edge-nailing is an important component of Chinese boatbuilding technique, and is fundamental to the Chinese approach to many stages of construction. Confidence in the effectiveness of the process allows for a number of repair and construction techniques that are different from Western boatbuilding approaches to the same problems. Often these approaches require a minimum of material. Planks are scarfed , or spliced together, by joining their edges in a long angular fore-and-aft joint, that is nailed along the edges using the process. Repairs to planking are made in the same way. Rather than requiring complicated inlays (called "dutchman") or face-to-face scarfs normal to Western boatbuilding, Chinese plank repairs simply involve replacing the damaged section of the plank with the repair piece, and nailing along its edges. In most cases, triangular notches were carved and nailed into all four edges of the repair piece, insuring the tightness of the repair. Both scarfs and repairs regularly landed between frames and floors, further indicating the Chinese confidence in the effectiveness of edge-nailing.

Chinese bulkhead construction also depends on edge-nailing. Bulkheads (athwartships partitions of a vessel) are built up with planks stacked and nailed edge-to-edge, and also into the sides of frames, without the use of any additional framing structure. This has the certain advantage of requiring the minimum amount of wood, while at the same time insuring the watertight nature of the bulkheads.

Interestingly, the edge-nailing of bulkheads gives rise to another uniquely Chinese, or at least Asian, watercraft feature. In order to protect the upper edge of the bulkhead, which at the center of the boat is somewhat fragile due to a lack

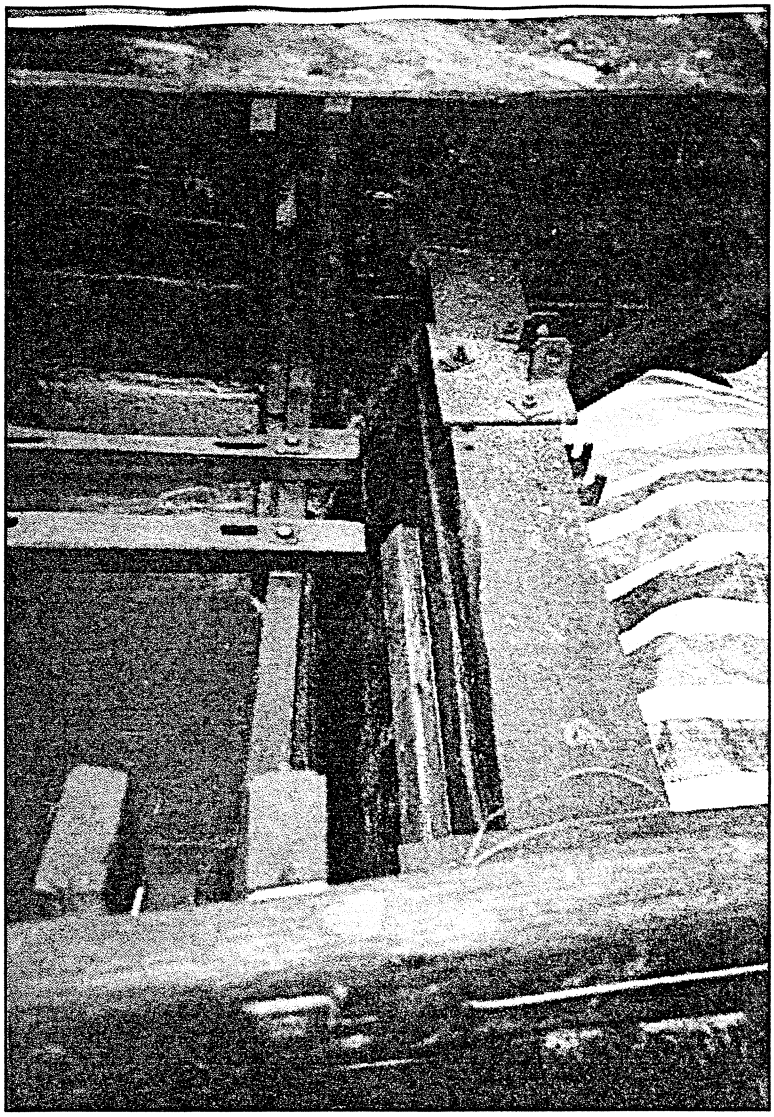


Figure 33. Penetrating Thwart, running along the top edge of the transom and through the side planking of a small boat in Xinwan. This configuration protects the upper edge of the bulkheads, gives rigidity to the thwart, and strengthens the vessel as a whole.

of supporting structure, Chinese boatbuilders land an athwartships plank face down along the top edge (Figure 33). This plank itself is supported by inserting both of its ends through the hull planking. In some vessels, the ends of this thwart extend beyond the outer surface of the hull and serve as support for something like exterior scaffolding, commonly used to work nets, or as a gangplank around a wide cabin structure. In most of the vessels observed at Tanzhou, however, these thwarts were cut flush to the hull. According to one builder, this

technique not only made it possible to work on the top edge of the bulkheads, but also served to strengthen the entire vessel by locking together its various components.

Edge-nailing can be seen to fundamentally influence the stages of Chinese vessel construction. Mastery of the edge-nailing process gives the Chinese boatbuilder the option of either plank-first or frame-first construction. Both approaches were observed in the construction of larger vessels, while plank-first construction was observed in all small boat (sampan) construction. As discussed above, in plank-first construction, the first couple of planks are fastened by edge-nailing to the keel without the benefit of any interior structure. Such an approach has the advantage of allowing the planks to determine how they will lay, and relieves the builder both of having to torture the plank to fit its interior structure, and of having to accurately guess how to shape the floors and frames prior to planking. Moreover, in both plank-first and frame-first construction, edge-nailing provides the builder an additional tool with which to edge-set, or bend edge-wise, his plank into an appropriate fit. Such a tool can greatly extend the efficiency of the planking operation.

Finally, in the case of hard chines (sharp, angular edge-wise turns in the bilge of the vessel), edge-nailing sufficed to secure the plank edges at this precarious point of construction. In Western hard-chine construction, a longitudinal piece, running the length of the vessel on the inside, is often required as a backing piece into which the planks forming the chine can be nailed. The Chinese, armed with edge-nailing, are able to do without this component in even the sharpest of chines. This reliance on edge-nailing in hard-chine construction is yet another Chinese vote of confidence in the technique.

Stages of Construction

As mentioned above, both of the fundamentally different patterns of frame-first and plank-first construction were observed in the field. Most of the larger vessels under construction used a frame-first technique, while the smaller vessels, of about 20 ft. and under, employed a plank-first technique. In most cases, the frames and floors in the frame-first technique are derived from patterns cut from thin stock. These could be seen hanging from the rafters in the shops at Coloane and Tanzhou, and are used to trace out the shape of both the floors and the frames, which are nailed or bolted together. In some cases, a makeshift bulkhead of only a few planks is constructed across each of these floor and frame units to provide additional strength. These units were then spiked or bolted into the keel, and held upright via longitudinal stringers, which in many cases remained in the boat. After these are in place, a couple of bulkheads at key positions in the vessel are constructed, at least partially, in order to insure strength during the planking process. The inclusion of bulkheads at this stage of construction is perhaps is the only substantial difference, in terms of the order of construction, between Western and Chinese frame-first construction techniques.

The plank-first technique, being rare in the Western boatbuilding traditions, was particularly interesting to observe. In fact, in every case, the process alternated between the addition of planks and the addition of framing structure. At Tanzhou, three different builders built sampans by first edge-nailing into place the two planks on either side of the keel (Figure 34), and then fitting the floor timbers. The top edge of the floors ran between the top edge of the second planks already bent to shape (see "Fire-Bending Wood" section below). After

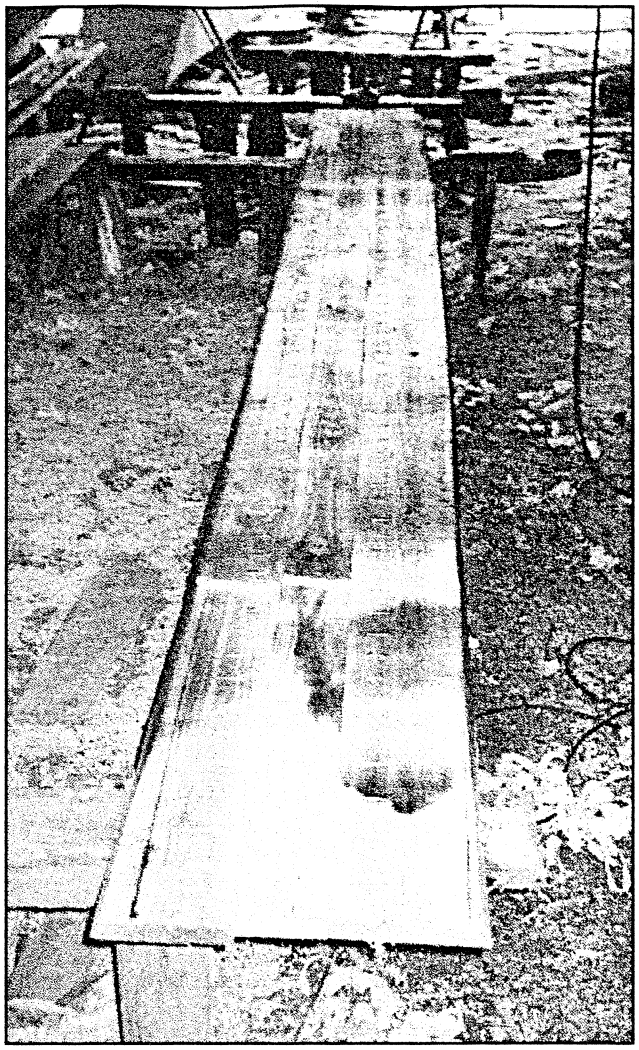


Figure 34. Small boat in Tanzhou being constructed planking first. Note edge-nailing along seams of planks. Charcoal can also still be seen on planks where fire was applied to induce a bend onto the planks. Note also the sawhorse arrangement, with the legs spiked down into the dirt floor for stability and adjustability.

these were nailed into place, usually from the outside of the planking up and into the floors, the remaining two planks were edge-nailed into place (Figure 35). Next, frame timbers were fit, overlapping the floors by at least one plank width at their bottom extreme, and running up to the sheer line at their top. Frames were nailed through the outside of the planking. Bulkheads (see Appendix, p. 174) were then constructed, usually by edge-nailing planks into already existing floors, and into the sides of already existing frames. Patterns

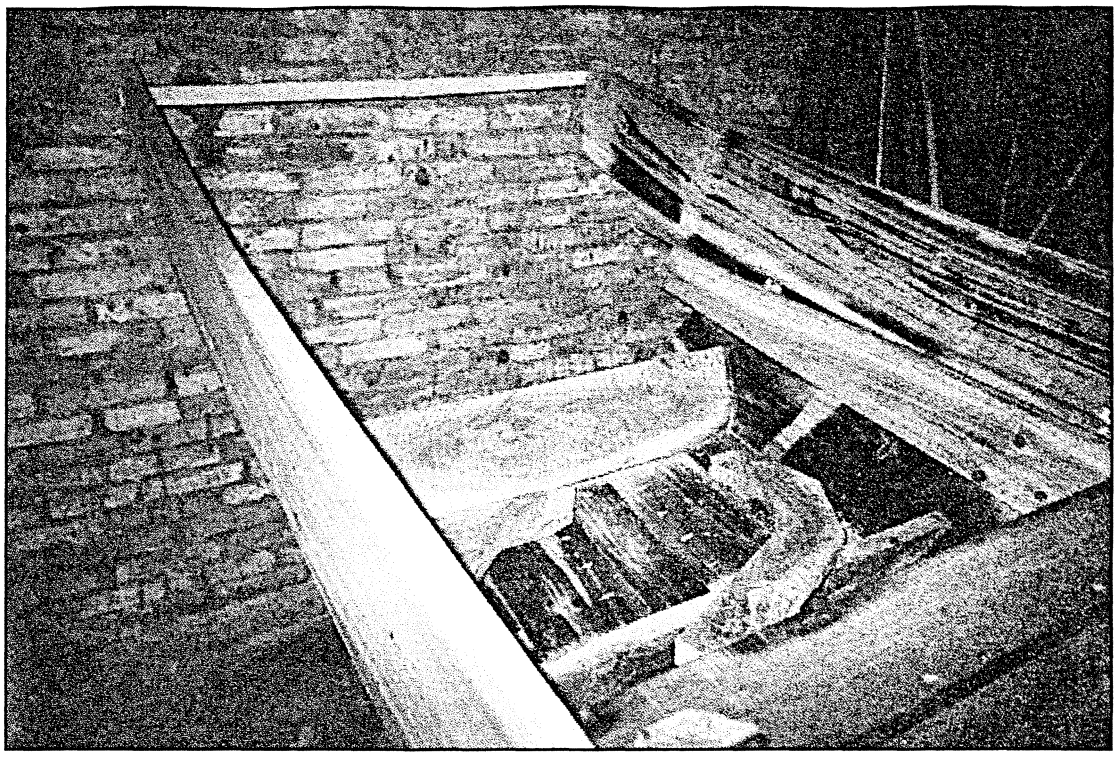


Figure 35. Stern section of sampan at Tanzhou in third stage of plank-first construction, after bottom planks, floor timber, and side planks are nailed, but before frames and remaining transom planks are nailed. Note the confidence in the ability of edge-nailing to hold side planking. Also note the grown timber lying in bilge to be used as a frame.

were not generally used in the construction of the smaller vessels, although one builder did use a drawing of a midships station, worked out between himself and his customer on a square of plywood. From this drawing, the builder took bevels, and transferred them to the boat during the planking process. The rest of the framing stations were worked out according to the way the plank naturally wanted to make the transition between the transom and the midships station.

While the use of the two different techniques of construction did in fact seem to generally depend on the length of the vessel, each builder claimed that they occasionally built boats using the other technique. It remains difficult to explain, then, why and under what conditions one technique is used instead of the other. One builder using the frame-first technique explained that while

planking first is sometimes used as an option, using patterns and the frame-first technique allowed him to more precisely and more cost-effectively meet the specific orders of a customer. Interestingly, another builder of smaller craft used much the same defense for a plank-first technique, claiming that the technique allowed him greater flexibility in meeting the specific needs and desires of a customer.

## Caulking

Caulking, or the filling of plank seams to prevent the entry of water, was observed at each location. In the case of larger vessels, such as the trawler at Coloane and the all-teak fishing vessel at Tanzhou, caulking involved a five-stage process. First, the outside corners of the seams to be caulked were very slightly broken, or bevelled, to allow for the easier and crack-free insertion of the caulking fiber. Second, a thin layer of caulking putty, commonly called "chu'nam" (Worcester 1977: 32), was spread into the open seam. Third, a strand of frayed bamboo fiber was stuffed by hand into the seam. Fourth, the fiber was driven into the seam using a wide, flat caulking chisel (Figure 36). Finally, the seams were filled flush with more of the putty. The putty received further protection with the application of a wood oil, probably tung oil, as a final finish for the entire outside of the hull.

The ingredients of the putty were generally the same from place to place. These were crushed shell, linseed or tung oil, and a number of thickener and filler ingredients, like sand and asphalt, and crushed bamboo fiber. Pre-mixed putty could be store-bought in large tins, though in some yards some effort was expended further mixing the stuff. Some of the larger vessels apparently chose a

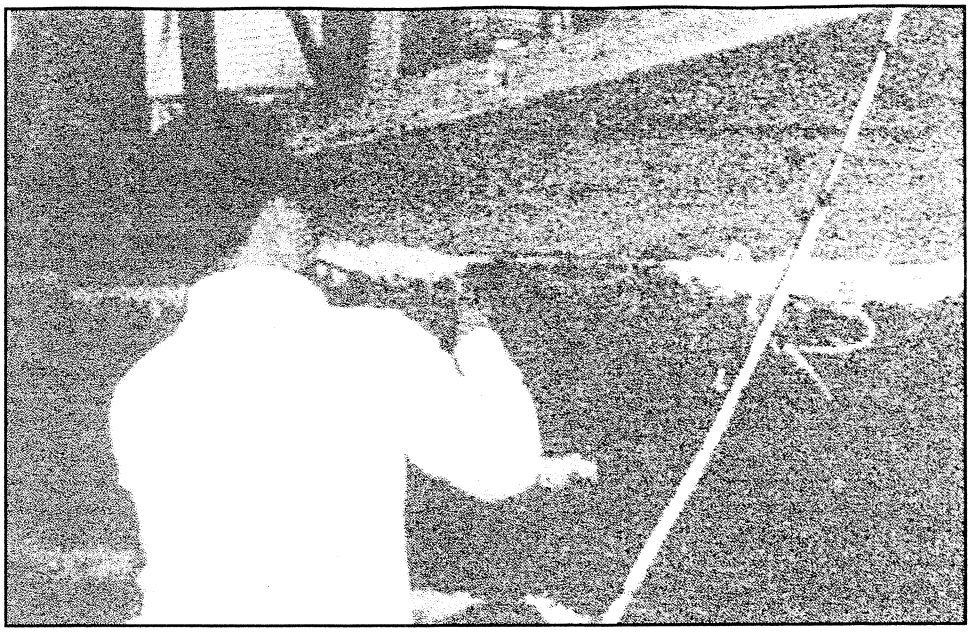


Figure 36. Caulking at Coloane, Macau. A Coloane village shipyard worker presses frayed bamboo fibers into plank seams that have already been beveled and spread with a thin layer of caulking putty. After about ten feet of seams are filled, the caulker will chink the bamboo tightly into the seams, and then fill over this with more of the putty.

more concrete-like mixture. All of the putties apparently hardened after a short time, though the lime and linseed oil mixture remained softer longer.

J. Baldwin, during his 1982 trip to a boatyard in Guanghai, a small city in the western region of the Pearl River Delta, observed a rather different mixture used for caulking. He described the putty as "a witches brew consisting of water buffalo hair, tallow, clay, asphalt and ash made up into an unspeakable texture and consistency" (Baldwin 1982: 109). This is a considerable departure from what was observed during the 1999 field research and is difficult to explain. It may point to a regional variation, a general flexibility in ingredient use, or the practices of a time now passed. These possibilities are discussed more fully later in this chapter.

## Fire-Bending Wood

One of the most unique Chinese boatbuilding techniques is the bending of wood through the direct application of fire. This technique, evidence of which was observed in the field at Xinwan, Coloane island, and Tanzhou, differs dramatically from the traditional Western technique of bending through the application of steam or boiled water. While the actual process was not witnessed during field research, oral interviews, and the 1982 report of fire-bending at Coloane island (Moodie 1982), allow us to recreate the stages of the procedure.

The fire-bending process is applied almost exclusively to hull planking, as frames in all cases were sawn from grown timbers and not bent to fit. At Tanzhou, one builder had just finished applying fire to two planks that were being fit to the bottom of a small sampan under construction. Fire is applied to the planks away from the vessels under construction, and is often applied repeatedly until the desired bend is achieved. After setting one end of the planks into a fixed clamping rig, weight in the form of rocks or tension in the form of clamps or rope, is attached to the other, suspended end (Figure 37). In between, at the desired bending location, a small fire is lit, and the planks are exposed directly to the flame. Apparently, the wood used for planking is freshly cut, and in many cases, has just come from soaking in water, so the tongues of flame do not cause significant damage. If the bend is extreme, or the scantling of the wood is large enough to require a longer exposure to the flame, water is periodically splashed onto the plank to prevent excessive charring. A bucket of water is kept nearby at all times for this purpose. If the bend or twist desired runs a long length of the plank, as is often the case with a garboard, the plank's position in the fixed clamping rig is simply shifted appropriately.

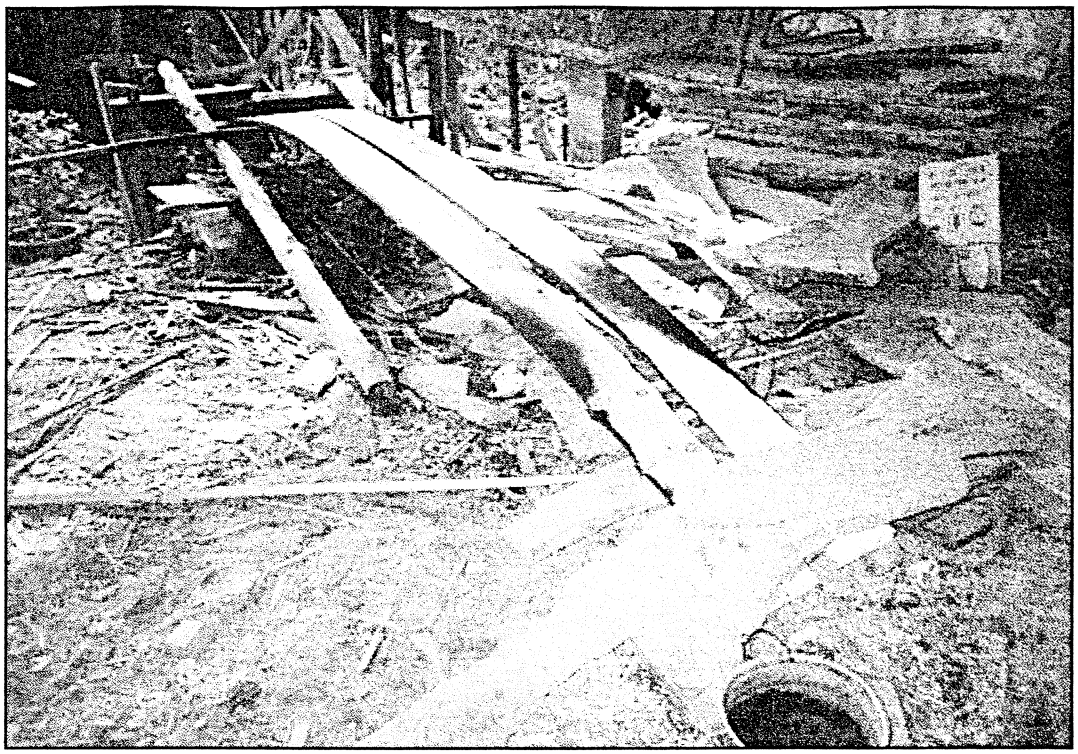


Figure 37. Fire-bending rig at sampan shop in Tanzhou. The far end of the both the port and starboard planks are chocked into a sawhorses, while the near end is weighted to induce a bend. Beneath the planks will be lit a fire. Note the bucket of water in the foreground, kept nearby in case the planks begins to burn too much. Note also charred areas where plank had been exposed to the flame.

The charcoal smudge left on the planks by fire-bending could be seen on many of the vessels observed. Most commonly, these were at points near the bow and the stern of the vessels, where vessel planking curves and twists most dramatically. The charcoal remaining on the surface of the planks on the outside of a vessel are usually removed with a plane, or painted over with bottom paint. On the inside of a vessel, however, most of the charcoal patches created in the construction process could be observed, leaving a good indication of the extent to which the process is used.

Use of Timber

Though the names of individual types of timber used were not always successfully translated from spoken Chinese to the written English, some general observations about the patterns of wood use were made. Of particular concern was the degree of specialization, or the use of specific wood types for specific vessel components, as well as the use of grown versus sawn timbers.

In fact, as in most boatbuilding traditions of the world, the Chinese boat-builders tended to specialize in wood usage, preferring teak, mahogany, and pine-like woods for planking; a reddish, locally grown hardwood for frames, floors and thwarts; and, in the case of larger vessels, Malaysian hardwoods such as yacal for keel, stem, and gunwales. Planking woods varied according to the value, and expense, of the vessel, with teak and mahogany being common on the larger, higher priced vessels, and pine being most commonly seen on smaller, cheaper, and more roughly-built working craft. On some vessels, specialization even extended to the same component. On a few vessels observed, a different wood was used on the planking above the waterline. The trawler under construction at Coloane island, for example, featured a light red, softer wood (probably mahogany) below the waterline, and a harder, darker wood (probably teak) above.

The locally-grown wood used universally for frames, knees, floors and thwarts in all the different sizes and types of vessels is a naturally curving tree, the name of which the author failed to learn. It produces "grown" timbers, the grain of which curves with the timber's shape, maximizing its strength (Figure 38). The hue of this wood is a dark reddish brown, and resembles in color a light

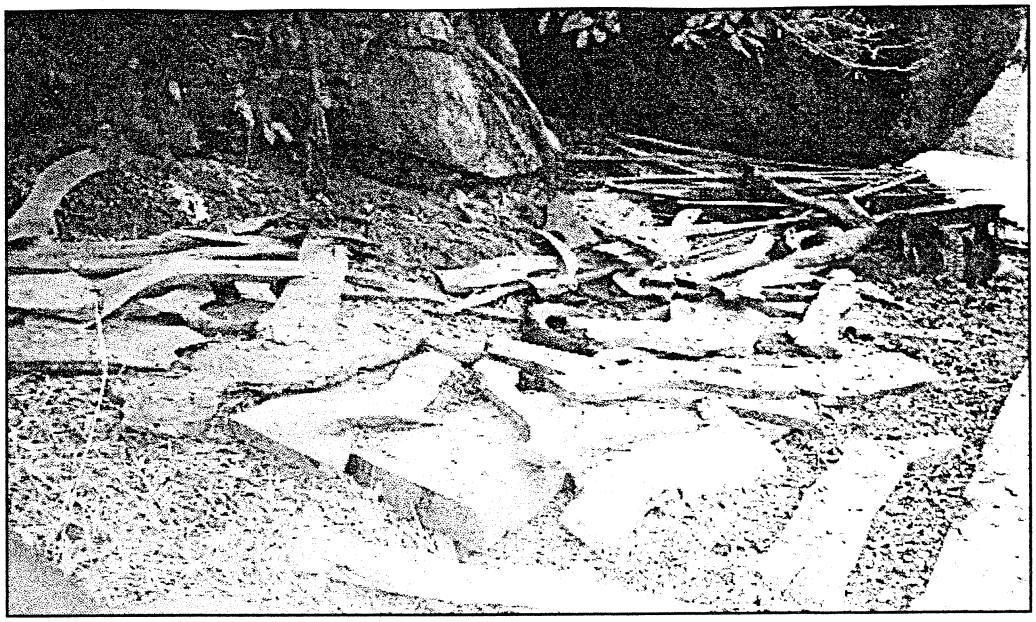


Figure 38. Curved, Grown Timbers at Tanzhou Air-drying in preparation for their use as frames.

rosewood. The pine used for planking in smaller vessels and consistently for bulkheads tends to be a light yellow and gray, and features a considerable amount of knots. It appears likely, however, that more than one variety of pine-like woods were used in this capacity. Similarly, a wide variety of hardwoods were used for gunwales, stem, keel, and deadwood, and were probably chosen according to availability and price at the time of construction.

The degree of wood specialization observed throughout the study region contrasts rather sharply with the use in San Francisco, as documented in the historical and archaeological record, of one type of wood for most of the components of the shrimp junks. This assumes, of course, that the historical record of the San Francisco junks is accurate, and that the very limited sample of the archaeological record is sufficient to represent the general trend in the San Francisco Bay Area. Chapter V of this thesis discusses the possible meanings of this difference in approaches to the use of wood.

## Planking

At many of the boatyards visited, a couple of unique approaches to planking were observed. While the bulk of the hull planking ran the full length of the vessels, often there was one or two that ran out to a thin nib before reaching either the stem or the transom. Some planks failed to make it to either end, and instead were deftly scarfed into the planks, much like stealers in traditional Western shipbuilding, and gradually expanded in thickness to blend into the rest of the hull planking. This practice allows the builder flexibility in the planking process, and limits the burden of having to shape the vessel planks to fit uniformly around the changing vessel shape. It also allows for the constant correction of problems encountered in the building process, such as cracking and lack of appropriate timber, by permitting the easy replacement of problem areas with a plank of suitable shape or size. Such a practice is facilitated, again, by the process of edge-nailing, which permits the attachment of planks at a desired location regardless of its relationship to interior structure.

In many vessels, plank lines also regularly could be observed to be asymmetrical on either side of the keel. This was especially true of lower value working craft, though not in all of them. The practice was also observed in some of the more expensive large teak fishing vessels. It probably reflects an attempt to conserve wood and minimize waste, adapting planking shapes to the existing shapes of wood instead of cutting planks to more favorable shapes.

## Construction of Specific Vessel Components

In addition to general construction techniques, the Chinese approach to the construction of specific watercraft components was observed and, where

possible, documented. Of particular interest were the components which had been documented during the archaeological investigation of the San Francisco shrimp junks in Rat Rock Cove at China Camp State Park, and which stood out as unusual or different from Western boatbuilding traditions. Chief among these were the Chinese approach to the rabbeting of vessel stems and the lining off of planks. Also of interest were the components that were missing from the San Francisco junks, such as stern sections, and bulkheads.

## Stem and Keel Rabbets and the Attachment of Plank Hood Ends

One of the principle enigmas of the archaeological record at China Camp State Park was the way in which the stem and keel were joined, and carved to receive the garboard plank. Due to deterioration and difficulty of access, the investigation of the shrimp junks at China Camp was unable to determine definitively whether the keel was rabbeted to receive a square-edged plank, as is the case in Western boatbuilding, or if it was simply beveled to receive a beveled plank. For this reason, this particular junction was carefully observed at every opportunity during field research in China, with the hopes of discovering the normal Chinese approach to its construction.

In fact, in every instance of similar construction (stem instead of bow transom), the keel was beveled to receive the beveled lower edge of the garboard plank, while the stem was always fully rabbeted. Often, along the areas of the seam between the keel and the garboard, a thin strip of wood was bedded in chu'nam and nailed along its length in order to give extra strength to this precariously joined but very important area. In many vessels observed, the lower edge of the garboard was left proud, indicating perhaps a hesitancy on the part of the

builders to bring the bevel on the garboard all the way out to the outside corner, thus leaving a fine edge prone to cracking during both the nailing process and the rigors of the vessel's normal working life. In instances where the garboard hood end remained proud at the stem, it was commonly planed until it was flush with the surface of the stem. Such a practice may help to explain the very thin beveled garboard hood end documented on the junk at China Camp State Park.

The joining of the garboard to the keel and stem with a beveled joint may be yet another construction technique that is an extension of the builders' confidence in edge-nailing, as its success depends on a downward pressure against the joint between the edge of the beveled garboard plank and the beveled upper edge of the keel. Most Western builders, lacking the tradition of edge-nailing, would be very hesitant to attempt such a joint at such a critical area. A bevel-to-bevel joint similar to that used between the garboard and the keel was observed in the construction of a hard chine yacht at Coloane island, and further suggests the Chinese confidence in such a practice. This joint was used at the transition from a hard chine joint, which featured a topsides plank landing onto the face of a bottom plank, to the edge to edge seam between two planks as they entered the stem rabbet. The transition necessarily involves a bevel-to-bevel joint, and requires a masterfully carved changing bevel on both planks involved, as well as a sensitive fastening scheme. Most Western builders only attempt such a joint when it is coupled with a longitudinal backing strip on the inside of the vessel, called a chine strip. A chine strip both reinforces the joint by providing something to nail the planks into, and seals the joint by covering the seam. The builders at Coloane did not use a chine strip, and chose to rely solely on the tightness of their fit, and the efficiency of edge-nailing.

Let us return to the Chinese approach to stem construction. Interestingly, the pattern of the joint between the keel and the stem varied from place to place, though not necessarily from region to region. In most vessels featuring a stem at the bow, the stem was joined to the keel with a bevel, and backed by a bolted knee of a grown hardwood. On two different vessels in Tanzhou, the stem extended down to the bottom of the joint, and the keel ended against the inside face of the stem. In not one case was the stem seen to land squarely on the keel, as was the case with the San Francisco shrimp junks. It is also important to note that not a single false stem (see Appendix, p. 174), was observed in the field. This also contrasts with the archaeological record at China Camp State Park, and will be further discussed in Chapter V of this thesis.

Stern Construction

Unfortunately, the observation of the traditional construction of the transom and rudder gudgeon structure was made difficult by the apparent demise of working sail, and by the widespread use of small metal rudders fastened with through-bolted metal straps. Interestingly, even the ubiquitous, mass-produced metal rudders featured the traditional rows of diamond-shaped holes cut into them. Their tenacity in the material record, even in the face of their mild condemnation by Western naval architectural science, is unusual, and suggests either a strong belief in their efficiency, or a strong cultural connection to the practice.

Fortunately, wooden rudders, and wooden gudgeons, were observed on three older vessels in Xinwan (Figure 39), Macau, and Hong Kong. In all three cases, the lower gudgeon was formed with an athwartships plank, side-nailed on its forward edge through the transom, and fit around the aftermost frames. In

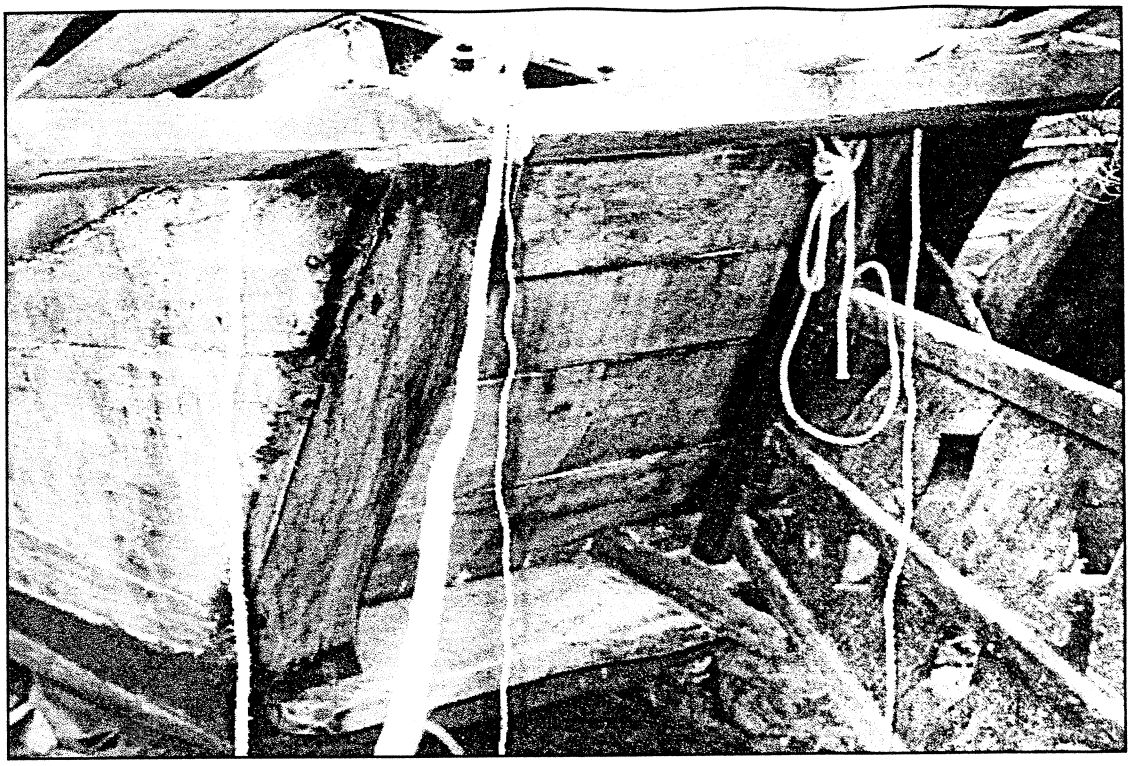


Figure 39. Stern section of older sampan at Xinwan, showing lower gudgeon shelf and upper penetrating thwart, which does not appear to house a gudgeon keyhole. Supporting fore-and-aft cleats for rudder post hole. Note also construction of fenestrated rudder. Stern details closely parallel those visible in record of San Francisco junks.

the Hong Kong vessel, this lower gudgeon plank landed on a knee, which itself was landed on the nibs of bottom planking protruding beyond the bottom edge of the transom. At Xinwan and Macau, the gudgeon plank was left floating above the bottom of the vessel planking, depending for its strength on the fastenings into the transom and the aftermost knees. In all three cases, the keyhole-shaped gudgeon aperture that accepts the rudder was cut into the center of the plank where it widened to clear the nibs or the knee below. The aperture was strengthened by small pieces of wood nailed along the sides of the aperture.

The construction of the upper gudgeon was more variable, though followed basically the same pattern. It was usually formed by two small fore and aft pieces of wood nailed into the transom on their forward ends, and at their aft ends into a thwart suspended above the water at the sternmost extremity of the

vessel. This particular construction, it may be noted, essentially prevents the complete removal of the rudder. It should also be noted that this differs from the gudgeon construction evident in the historic photos of the San Francisco junks and sampans, which indicates the use of an aperture similar to that seen on the lower gudgeons in the ethnographic record.

The construction of the stern in most of the vessels observed followed a general pattern, within which were observed numerous minor variations. The sternmost thwart in most cases lands on the hull planking extending beyond the transom, often penetrating entirely through the hull. The thwart was nailed both into the planking and the aftmost frames. These raked aft from the transom at their lower end, and ended up either aft, forward, or directly under the stern-most thwart. As with penetrating thwarts described earlier, this locks together and strengthens the stern components of the hull. Where the aftmost thwart penetrated the hull planking and ran out beyond the outside of the hull, the protruding nib was used either to help form a platform for working outside the hull, or as a landing for a thole pin, onto which a steering oar can be grommeted. Often, a penetrating thwart also ran along the top edge of the transom and was used either as a gudgeon plank, a landing for engine machinery, or as a joist for landing decking. In many cases, decking was laid across both of these penetrating thwarts, forming a small stern deck, or the after portion of a wheelhouse floor.

The use of penetrating thwarts at the stern may help to explain the almost universal absence of knees at the transom. The penetrating thwarts in the stern construction help to lock in the transom at the top, while the bottom ends of the aftmost frames help to secure the transom at the bottom. Together, they render a stern knee unnecessary.

## Hull Forms

In addition to construction techniques and specific watercraft components, field research sought to document watercraft hull forms. It was hoped that the location of a hull form closely resembling that of the San Francisco junks would more precisely indicate their region of origin, and the specific boatbuilding tradition influencing their design. While no exact duplicate of the San Francisco vessels was located, some similarities were noted in vessels in the harbors of Macau and Xinwan (Figure 40). The stem rake and the general size of the San Francisco shrimp junks were echoed by medium-sized vessels in both places. Their length-beam ratio also appeared very similar, though the ethnographic vessels appeared a little beamier back aft. The draft of these vessels also appeared to be similarly shallow, although none were viewed out of the water.

Despite these similarities, many differences were also observed. All vessels within the size range of the San Francisco junks feature a considerably larger amount of freeboard, or the height of the top edge of the side of the vessel above the surface of the water. They also almost universally feature more elaborate superstructures, especially in the after section of the vessels. These usually included an enclosed wheelhouse, as well as accommodations for the fishermen and his family or crew, most of whom were living on board. The sheer line of these vessels also sweeps more dramatically from a higher stem forward aft to the higher superstructure. Indeed, the match with the San Francisco hull forms is hardly perfect.

Many of these differences in hull form may be explained by the universal acceptance of the marine engine, and the now absolute demise of working sail in

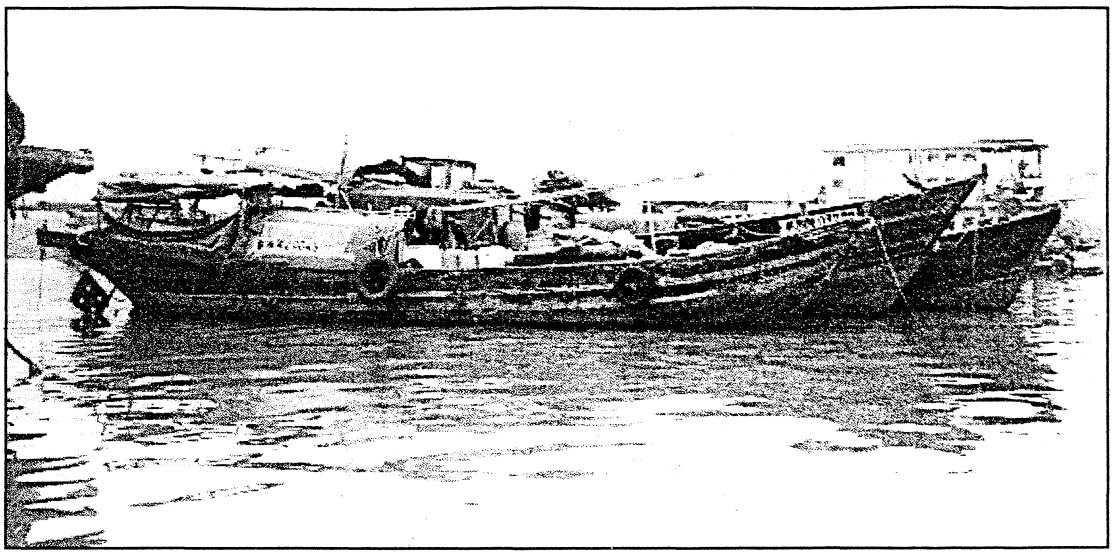


Figure 40. Junks at Xinwan harbor. These and other similar vessels at Macau were the hull forms most closely matching those of the San Francisco shrimp junks. Note sharp, gently-curving stem and raked stern. Note also key differences: high freeboard, high stem, extensive cabin accommodations.

the region. The shift from sail to engine power in a traditional watercraft often entails the broadening of the stern section of a vessel in order to accommodate both the weight of the engine and the squatting induced by its drive. The bow is often heightened in order to counter the effects of the bow being driven into waves by the power of the engine. The increase in the height of the stem may also be the indirect product of increasing the typical range of the fishing vessel induced by the advent of the marine engine. Fishing trips to deeper waters, and larger waves, are made faster and more convenient. This increased range may also explain the higher freeboard, and the enclosed wheelhouse, as both of these features also would become more necessary in deeper, rougher waters. Despite these possible explanations, the differences between the San Francisco shrimp junks and the vessels observed at Macau and Xinwan remain substantial enough to make the identification of the precise origin of the former difficult to ascertain.

If locating the precise origin of the San Francisco shrimp junks was made difficult by the dearth of vessels matching its hull form, the task was further

complicated by the remarkable complexity of the watercraft assemblages throughout the Pearl River Delta Region. Every harbor visited featured a wide array of watercraft types and sizes, ranging from small, double-transom, harbor punts to large, 100-ton, ocean-going trawlers. Indeed, the sheer number and variety of the vessels in the general region makes the assessment of regional variation a truly daunting task, and one that certainly exceeds the scope of this study. Nevertheless, a few initial observations may serve to begin the process, and to suggest an approach for future efforts.

In general, watercraft variation increased as vessel length decreased. Many of the same types of larger vessels, deep-water beam trawlers, were seen in every port visited that had enough water to anchor them. The same large vessels were noted around the harbors of Hong Kong, Aberdeen, and Cheung Chau as were those in the harbors of Macau and Xinwan. Small craft, however, differed greatly between these regions. The beamy, round, high-sided, double-transomed, diesel-powered sampans around Hong Kong, Aberdeen and Cheung Chau (Figure 41) are strikingly dissimilar to the ubiquitous outboard-driven, taxi sampans of Macau, the shrimp fishing sampans at Xinwan, and livery sampans of the Tanzhou area. The differences noted between the vessels of the Hong Kong area may be explained by the predominance of the Tongka peoples in that area. The Tongka, boat people traditionally from the coastline further north and east of Hong Kong, have in the last century, gradually come to fill the fishing niche around the Hong Kong area. This niche was left increasingly vacant by people native to the area due to the modernization of the region and the rise of economic opportunity in other fields (Rogers 1999). Whatever the explanation for the differences between small craft in the Pearl River region, it is clear that they express regional identity more dramatically than larger vessels.

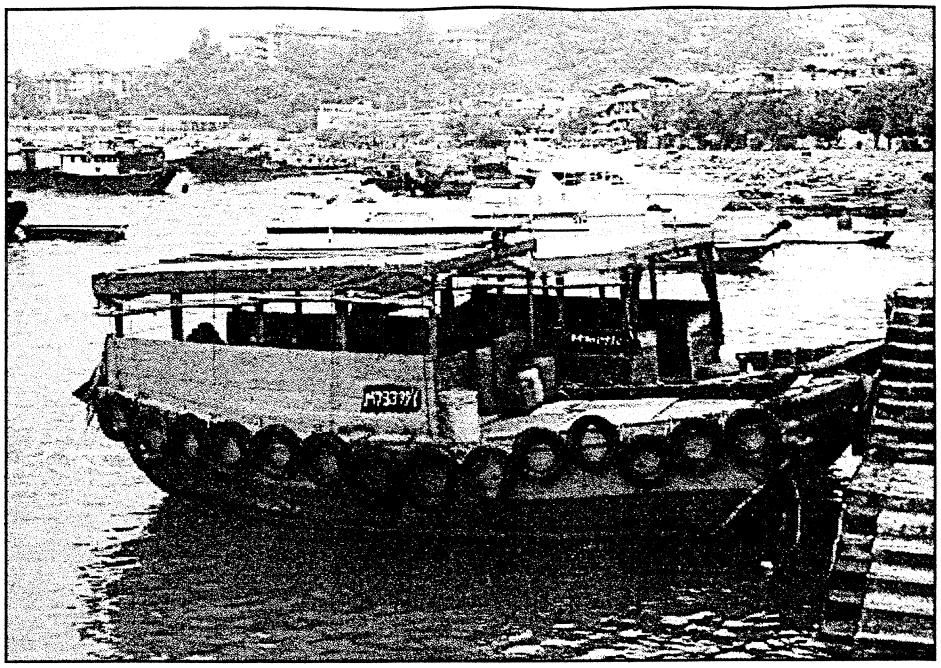


Figure 41. Sampans at Cheung Chau Harbor. Their high freeboard, double-transomed, beamy hull form is typical of sampans in the Hong Kong region, and comes from watercraft traditions of the Tongka peoples.

Some other initial observations about regional variation of watercraft may also be made based on the 1999 field research. In general, the smaller the vessel, the more simple its superstructure and interior furnishings. While many sampans and small junks did feature living accommodations and wheelhouses, many used in inshore and shallow water fishing were open, and very simply outfitted. This was rarely true of vessels exceeding 30 ft. Also generally speaking, the further inshore and upriver, the lower the freeboard of the watercraft observed. This general tendency was well illustrated by both the small fishing sampans observed in inland stretches of the Pearl River, and especially the barges plying the waterways around Guangzhou. While neither of these observations permit the precise regional identity for the San Francisco junks, they do seem to indicate an inshore origin for their hull forms.

Historic Photographs of the Pearl River Delta

The review of over four thousand historic photographs in the collection of Hong Kong Museum of History during the 1999 field research trip sheds some interesting light on both the ethnographic record and the origins of the San Francisco shrimp junks. Out of over three hundred images of watercraft examined, only one featured vessels resembling the San Francisco shrimp junks. In fact, most of the medium-sized (40 - 50 ft long), single-masted, sailing vessels documented in the photographs also featured more elaborate superstructures, a greater amount of beam and sheer, and more freeboard than the San Francisco junks. While this does seem to contradict the theory that these qualities in the ethnographic record are a product of the advent of the marine engine, it may also at least partially be explained by the fact that the scope of the photographic collection at the museum is certainly biased towards the Hong Kong waterfront, as well as that of Guangzhou, with most of the 19th-century images having been taken by British expatriates living or visiting there. The images of Hong Kong vessels are largely of deeper water vessels, more commonly engaged in trawling, and requiring a more ocean-going form, much like their modern counterparts. The Guangzhou images, by contrast, chronicle urban livery vessels, most of which are without sail, and whose principle line of trade is carrying cargo between inland farms and riverside centers of commerce. The inshore fishing vessels of the regions between Guangzhou and Hong Kong, then, remain virtually unchronicled by the photographic record, with the exception of one image discovered in the collection.

The one Hong Kong Museum of History image of sailing vessels closely resembling the San Francisco shrimp junks (Figure 42), unfortunately, has no

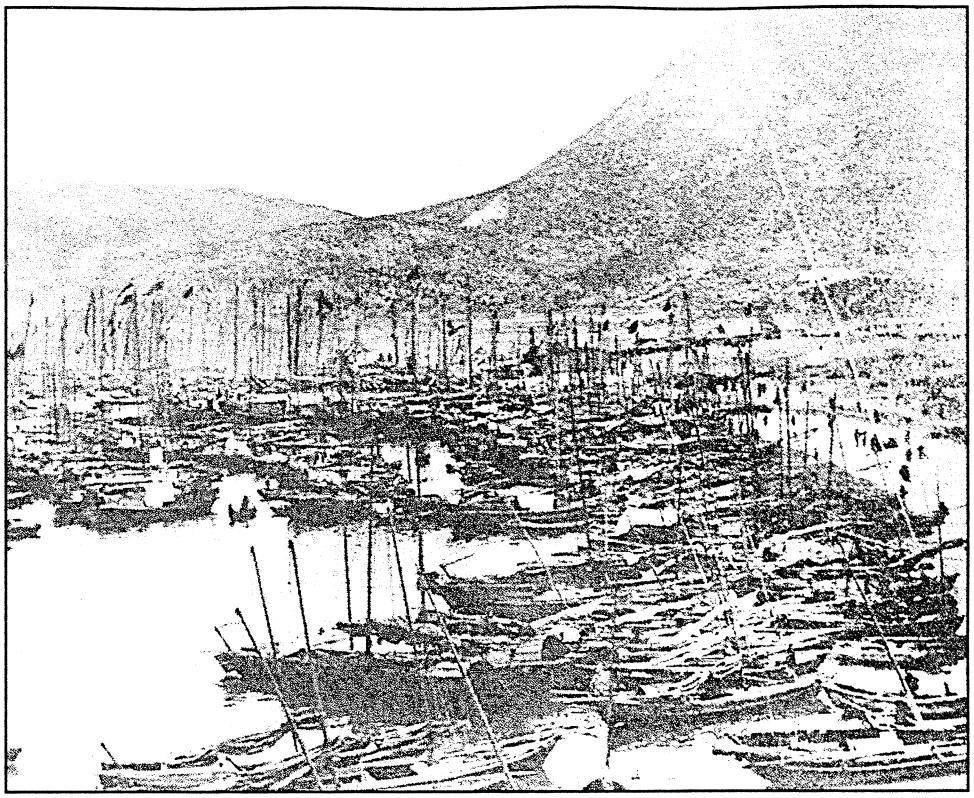


Figure 42. Unidentified Harbor of Pearl River Delta Region, ca. 1900, showing numerous vessels closely resembling the San Francisco shrimp junks. Note the shipped, fenestrated rudders, the placement of the masts, and the lack of superstructure. Photo courtesy of Hong Kong Museum of History.

location attributed to it. It is probably a Guangdong province harbor, as most of the vessels have the fenestrated rudders indicative of that general region. It also appears to be a relatively shallow-water, inshore region, with extensive mud flats and marshes visible in the background. The proximity of the steep hills in the background to the shallow water harbor pictured may indicate the coastline to the west of Macau, which happens also to be the southern portion of the Sze Yup region of Sunning, a place where many of the San Francisco immigrants originated. While the exact provenience of these boats is unknown, it is clear that they are closely related to the San Francisco junks. The very simple deck, the limited amount of sheer, the low freeboard, the mast stepped roughly a third of the way aft, and the raising rudder of these vessels indicate a link to the San Francisco junks. Nevertheless, a few key differences are visible. Almost all of the

vessels in the Guangdong image feature a bamboo cabin, even if it is somewhat simple. The stem rake also appears to be more extreme. Finally, the vessels are on the whole and considerably shorter than the San Francisco junks, and appear to average approximately thirty feet on average. Despite these differences, this rare image confirms an inshore, shallow water origin for the hull form of the San Francisco shrimp junks.

## Conclusions

The 1999 field research trip to the Pearl River Delta region in China provided numerous insights into the boatbuilding traditions of the area. Construction techniques such as edge-nailing, fire-bending, caulking, and plank-first construction, all of which are recorded in the historic record of the San Francisco shrimp junks, were observed first hand. Edge-nailing in particular emerged as a fundamental construction technique that defines much of the form of the Pearl River vessels, and explains many of their construction details. The specialized use of timber, as well as the use of asymmetrical planking lines was documented during field research. This valuable information should greatly help both in the reconstruction of the San Francisco junks, and in the assessment of the degree to which they reflect Chinese boatbuilding traditions.

The reconstruction and analysis of the San Francisco junks will also be assisted by the ethnographic data collected describing the construction of vessel components not present in the archaeological record. The Pearl River Delta approach to the construction of the stern, rudder gudgeons, thwarts and bulkheads were revealed during field research. Moreover, many enigmatic construction features noted in the archaeological record were confirmed and illustrated in

by field observations. The construction of the stem and the techniques for rabbeting the keel recorded in many boatyards of the Pearl River Delta region reflected the construction of the same components recorded in the Rat Rock Cove West Junk. This confirmation reinforces our understanding of the archaeological record, and permits a more accurate reconstruction of the processes involved in the building of the San Francisco shrimp junks.

Finally, although the limited scope of the field research, the dearth of identical watercraft forms, and the complexity of the watercraft assemblages in China prevented the identification of a specific region of origin for the San Francisco shrimp junks, the ethnographic record does seem to indicate a more inshore, shallow water ancestry for their hull form. The Hong Kong region, as well as that immediately surrounding the city of Guangzhou, appear to be excluded from the possible places of origin, while the regions around Macau, Xinwan and Tanzhou remain possible candidates. Historic photographs of the region further confirm these conclusions. The closest match to the San Francisco junks form, though smaller in size, appears to be from the Sze Yup region to the west of Macau. The analysis of Chapter V will investigate the implications of these observations for the interpretation of the San Francisco shrimp junks.

# CHAPTER V. ANALYSIS

The material record of the junks in Rat Rock Cove at China Camp State Park, when combined with a review of both historic accounts and historic photographs, greatly enhances our understanding of these unique watercraft. Numerous construction details come into a much clearer focus, as does the overall hull form of the junks. Techniques of junk construction are also described by the material record, and are further illuminated by the ethnographic record of boatbuilding techniques in the contemporary Pearl River region. When taken together, these disparate bodies of data support the detailed reconstruction of the Rat Rock Cove junk, the process of its construction, and some of the patterns of its use. These, in turn, provide a coherent basis for a material culture analysis which seeks to understand the features of the Rat Rock Cove junks as products of the cultural, environmental, and socio-economic forces that shaped the Chinese shrimp fishing industry, and the communities it supported.

The previous four chapters have reviewed contributions that available sources of data can make to our understanding of the San Francisco shrimp junks. While each of these bodies of data are intelligible in their own right, a higher level of coherence between them may be achieved by organizing their contributions according to the process of construction. By following the progression from the initial laying of the keel through the final stages of outfitting the vessel, it is possible to form a clearer picture of the junks as a whole, and to assess the degree to which the various data has completed that picture.

The Rat Rock Cove West Junk Reconstructed

The historic record indicates that the Rat Rock Cove West Junk, like most of the San Francisco shrimp junks, was probably constructed on the beach at the water's edge. Heavy cross timbers serving as saw horses were spaced along the planned length of the vessel and fixed with legs driven into the ground below (ethnographic record). These supported the keel, and the rest of the boat, throughout the building process. The keel, consisting of one, possibly two, timbers of 3 in. x 6 in. redwood totaling over 40 ft. in length, was probably subjected to fire in order to coax rocker into its after end, and then sprung down and fastened onto fixed sawhorses below. At this stage, the gently curving stem may have been carved out of a large, thick stock of redwood, and landed onto the forward end of the keel. It was probably supported with braces, and strengthened in place by the addition of a stem knee.

Planking, cut from wide redwood planks of over one inch in thickness, was probably begun next, and required the carving of edge-nailing notches along their inboard seam, the fitting of the inboard edge of the plank snugly to the edge of the keel, and the driving home of forged black iron nails to secure the plank in place. Holes may have been pre-drilled into the notches by the use of a bow-drills or perhaps a bit brace, but the practice is only documented in the ethnographic record. The planks towards the bow, where they were required to twist and curve from the flat shape of the bilges amidships to the vertical stem forward, were bent over the open fire as well, probably using a bending system similar to the ones recorded in the ethnographic record. Floors were set into place up toward the bow at the early stages of planking, in order to support the

bend of the planks as they were forced into their final fit, and to provide additional structure for nailing them into place. Edge-nailing on the outside of the planks also helps to secure the bend. The stem bevel, and probably the keel taper, were carved as the bow planks were brought into the stem and nailed home.

Where planking ran out, long scarfs spanning the length of two floors were cut, and secured together using both edge-nailing and by nailing into frames. Floor positions, as well as bulkhead locations, were probably marked out early in the planking process in order to facilitate the proper location of scarfs. After the fourth plank was fastened, a more extreme bevel was carved along its top edge, and the bilges began their turn in the middle and aft sections of the hull. At this point, the floors back aft, and any remaining unfastened forward, were fitted and nailed into place. The floors at the major bulkhead positions were made from thicker, 3 in. stock of redwood. Into most of the floors were notched scuppers to permit the communication of water in the bilges, although the floor forming the bulkheads aft were fit very tightly and formed a watertight seal against the planking and the keel.

With floors fit and landed, the planking resumed, completing the turn of the bilges, and filling out the rest of the hull shape to the sheer plank. Edge-nailing on the outside of the hull secured the planking until frames, fashioned from straight, wide, redwood boards, were fit and nailed into the floors. Planking was nailed into the frames to further strengthen the hull. The proud hood ends at the bow were cut flush with the forward edge of the stem and a full length false stem was fastened at the bow. A half-oval strap was nailed into place to further protect the leading edge of the junk.

Bulkheads were built up by edge-nailing lighter bulkhead planks into the floor timbers below, and by driving nails into the adjoining frames. Back aft, the transom was formed in much the same way, with the bottom transom planks landing on the aft end of the keel and raking aft, where its top edge was inset from the aft end of the hull planking. The upper gudgeon shelf was slotted through a notch in the sheer plank and landed on to the top edge of the transom, and a keyhole-shaped hole was cut into its center to accept the rudder. The aftermost frames were fit into place, raking aft sharply from the bottom of the transom to frame in the upper gudgeon shelf. The lower gudgeon shelf was fit in between the transom and the aft frames about one foot up from the keel, and also received a keyhole-shaped hole for the rudder stock. Supporting cleats were nailed alongside of these holes to further strengthen them against the inevitable stress of bearing the rudder.

As the other major bulkheads were completed, heavy thwarts were landed across their top edge, and were further secured onto fore and aft cleats and stringers nailed into frames. With the planking, floors, frames, and bulkheads finished, the builders of the junks began to outfit the interior with its key features. The mainmast step was landed into the floors, and the partner notch was cut into the heavy thwart running across the top of the bulkhead just aft of it. The forward windlass step was landed, and partners for it cut and landed appropriately. The hole for the daggerboard was cut into the starboard garboard, and the box to house the daggerboard was built up along the forward edge of the forward bulkhead. A tarry concrete was poured into the frame bays at the very bow to allow water to work its way aft. Floorboards were fit and nailed, as were the long side deck planks and the removable hatch planking. Rubrails were

cut, sprung into shape around the outside of the hull, and spiked into place. The tips of the frames were cut, and an inwale was fit along the top of the sheer plank. Thole blocks were shaped and fit along the inwale, and holes were drilled beneath it to receive the stays of the rig. A long, aft bulwark plank was fit and nailed into place, supported by stanchions.

The large, trapezoidal, fenestrated rudder was made and fit, as were the daggerboard, windlasses, sweeps, and thole pins. The triangular notches throughout the hull were filled with chunam, as were the planking seams. Linseed oil, mixed with some thinned tar, is spread over the outside and some of the inside of the hull. After the hull was launched, the mast of Oregon pine was stepped, and secured with the mast wedges and a fore-and-aft brace running between the forward bulkhead and the forward edge of the mast. The huge, six-battened, humped leech sail was bent on, and the movable stays were secured around the gunwales. The sheets were run, the halyards made fast, and the newly built junk was ready for a life of hard work.

## Analysis of the Reconstructed Junk as Material Culture

The San Francisco shrimp junks, it appears, are very Chinese watercraft. Almost all of the characteristics of the Rat Rock Cove West Junk recorded in the material record, and those reconstructed from historic photographs, written accounts, and ethnographic information, can be traced to boatbuilding traditions in China. Evidence of Western boatbuilding traditions is almost entirely absent in the junks, and in almost every stage of the construction process, the builders of the Rat Rock Cove junk chose a distinctly Chinese approach, and employed a distinctly Chinese technique or material. From the skegless keel to the use of wooden rudder gudgeons, from edge-nailing to fire-bending, the San Francisco

shrimp junks were clearly the products of their builders' devotion to the ways of their homeland.

It is useful to remember that boatbuilding is a problem-solving operation, and that there is a universal set of problems common to all boatbuilders, regardless of their culture. Keeping water from coming in through the planking, giving the vessel enough the structural strength to endure the stresses of sailing, and shaping the vessel so that it moves easily through the water are some of the more obvious of these problems. Creating adequate steerage, fastening timbers securely, scarfing planks together, balancing sails appropriately, and preserving wood effectively are some of other, less obvious ones. At every stage of the construction process outlined in the previous section, and in almost every feature of the reconstructed Rat Rock Cove junk, it is possible to identify a non-Western solution to the problem of watercraft construction. In most cases, the solution instead can be identified as belonging to a Chinese repertoire of solutions.

To begin with, the lack of a skeg, or stern fin, on the keel of the junks, is uncommon to most Western vessels of comparable size. The method of beveling the keel and the plank at the bow, and the use of support cleats along the seam, instead of carving a rabbet into the keel, is a dramatically different approach to this critical area. The placement of the daggerboard forward of the mast is exceedingly rare in Western traditions, as is the use of removable wooden windlasses. The two notches of the mast step, and their placement at the step's aft end, as well as the method of reinforcing the mast with a two long wedges on either side and a spacer block between the mast and the forward bulkhead, are all unseen in Western approaches to stepping and securing a mainmast. The raising, fenestrated rudder, which when under use extends down far below the

hull, is dramatically different in form from Western methods of steerage, as is the method of securing it with wooden gudgeons, an inset transom, and a penetrating thwart.

Perhaps the feature of the Rat Rock Cove junk that most dramatically distinguishes it from Western watercraft is the use of edge-nailing in its construction. As we have seen in the ethnographic record, the edge-nailing technique does not just help to seal the vessel, but fundamentally influences its construction process, as well as the form of many of its features. It gives the builders the ability to attach planks first, and gives them an extra advantage if edge-setting is required. It allows the builder to use edge-joined scarfs that can be placed independent of the location of floors and frame, and it relieves him of the need to rabbet the keel, saving time in the construction of the bow. It also allows the builder to closely fit floors and frames at will during any stage of the junk's construction, and to securely fasten bulkhead planks together using a minimum of structure. Chine strips, stringers, and knees, common in Western practices, are rendered unnecessary by the rigidity-inducing edge-nailing, as are butt blocks, dutchmen, and other complicated Western methods of plank repair. Indeed, by retaining the technique of edge-nailing, the builder of the Rat Rock Cove junk ensured the overwhelmingly Chinese nature of its features and its form.

Some of the clearly Chinese features of the shrimp junks can also be traced to a more specific region of origin within China. The shape of the sail and rudder, the fenestrations in the rudder, and the use of daggerboard forward of the mainmast indicate a distinctly Guangdong Province and even Pearl River Delta identity for the vessels, and, by extension, for their builders (Needham 1971: 596, 618, 656, Worcester 1968:88 ). Moreover, based on observations from

ethnographic data, the shape and rake of the stem, and the average length-beam ratios, as well as the shallow draft of the junks, may further narrow the place of the vessels origin. These characteristic seem to indicate an inshore origin, and were most closely replicated in the ethnographic record around Macau, and in the southern Sam Yup regions around Tanzhou and Xinwan. Admittedly, however, neither the historic nor the ethnographic record as yet provide enough detail to more precisely identify the origin of the San Francisco junks. Indeed, even if a more detailed record of regional variations did exist, the task would probably still be complicated by the incredible variety and uniqueness of each watercraft in the Pearl River Delta region. As Worcester writes,"In other parts of China the boatbuilders are most conservative...in the Kwangtung [Guangdong] area, however, there are seldom to be found two junks even of the same type exactly alike" (Worcester 1966:89).

The identification of the regional origins in the San Francisco junks, and of the Rat Rock Cove junk in particular, may be assisted by the identification of the regional affiliations of the shrimp fishing camps and the fishermen that worked in them. An unusually careful census enumerator in 1880 recorded not only the Chinese nationality of the camp residents, but also their district affiliations. While the majority of the fisherman at Pt. San Pedro were from the Sze Yup regions, a large number of those occupying the more northerly areas of the camp, and possibly Rat Rock Cove, came from the Sam Yup regions. It must be remembered, however, that the fishermen may not have been the builders of the junks. The one "Junk Dealer" listed in this census is listed as coming from Yong Wo, yet another Sze Yup region. It seems likely, then, that if the junks were to express regional origins, they would probably indicate either a Sam Yup or a Sze Yup affiliation. Unfortunately, the 1900 census enumeration for the Pt. San Pedro fisheries do not indicate regional affiliation, and so do not help to identify the regional origin of the Rat Rock Cove junk's characteristics.

One other possible avenue for identifying the regional origins of the Rat Rock Cove junk may have been created by the 1998 application of Prince's Principle. The identification of the cove's easternmost pier as the location of the junks at the time of their demise may be correlated with the knowledge of company ownership. In 1910, Norman Scofield identified the easternmost pier as that belonging to the Quong Sing Lung company. Furthermore, on October 26, 1910, Scofield reports arresting five members of the Quong Sing Lung Rat Rock Cove camp on their junk for the possession of 30% fish. He lists their names as Fook Chow; Lee Kun; Kai Young; Loy Chu; and Tau Low. Two days later, he again arrests Sing Lung Company fishermen. The names of these unfortunate fellows are different from their arrested comrades from the two days earlier, and may indicate that the company owned and operated more than one junk out of each pier (Scofield 1910: 30-31). This may explain the existence of two junks along the same pier in the archaeological record. In any event, it may be possible, with further research, to identify the regional affiliation of this company, and perhaps that of its fishermen, and thereby identify a possible regional affiliation of the junks themselves. Again, however, it is important to remember that the men that built the shrimp junks did not necessarily share the same regional affiliation as the fishermen that used them, or the company members that paid for their construction.

While it may be difficult to narrow the identification of the San Francisco shrimp junks' region of origin beyond the inshore Sam Yup and Sze Yup regions of the general Pearl River Delta area, it may at least be asserted with certainty that the San Francisco shrimp junks were almost entirely the products of Chinese boatbuilding traditions, and that the builders of the junks were uninfluenced by

the Western boatbuilding traditions prevalent in the other vessels of the San Francisco Bay. The perseverance of the Chinese traditions this late in the San Francisco shrimp fishing junk culture may be explained by a number of factors. First among these is the strength of traditional knowledge, and the universally conservative nature of the boatbuilding craft in general. Traditional boatbuilders around the world have been shown to be very resistant to change in design, preferring to stay with known techniques and features that have successfully stood the test of time. In the case of fishing vessels, the consequences of failed experimentation are costly, resulting in the loss of livelihood, or of life itself. Furthermore, if change happens to a boatbuilding tradition, unless it is a response to a drastic change, it usually happens slowly, and often across generations. It is conceivable, even likely, that the junkbuilder at Rat Rock Cove at the turn of the century was a first generation immigrant, who learned his craft in China. The likelihood of him deviating from his native training is indeed slim, as is that of his customers and fellow fishermen encouraging such a departure.

The resistance of the San Francisco junkbuilders to change may also be justified by the suitability of the Chinese traditions to the new environment, and to the shrimp fishery, of the San Francisco Bay. The shallow estuarine environment of the Pearl River Delta which gave rise to many of the junk's features is closely matched by the environment of the San Francisco Bay. An image of the San Francisco Bay, with its steep, rugged hills dropping to the wide flat water of the bay and river banks can easily be mistaken for an image of the Pearl River. The shallow draft of the fishing junks, the lack of a skeg, the daggerboard, and the adjustable rudder are as perfectly suited to shrimp fishing on the mud flats of San Francisco Bay as they were to shrimp fishing in China, and their persistence in the new environment makes perfect sense.

Another possible explanation for the persistence of Chinese features in the shrimp junks is the evident isolation of the builders and residents of the camps. Even if the Chinese builders were not conservative and the traditions were not suited to the new environment, exposure to alternative solutions and methods was minimal because of cultural and physical separateness from the surrounding Caucasian communities. Most of the camps were located far from places where Western boatbuilders plied their trade, and most of the camps were rarely visited by Western vessels. Western boats in general were probably avoided on the open water, out of fear of recrimination and legal persecution. Indeed, the growing hostility against the Chinese must have made friendly exchange with competing fishermen increasingly rare in the latter days of the fishery.

Even if there was a friendly atmosphere of open idea exchange between the Chinese and Western boatbuilders, the vessels of the Western fishermen offered few, if any, advantages over the Chinese design. No western vessels combined the qualities of ruggedness, shallow draft, open workspace, and nimbleness that the junks exhibited. The sail rig was clearly superior to the predominant gaff and sprit rigs of Western vessels, and the raising rudder and daggerboard made for a mobility and maneuverability that far surpassed western vessels of similar draft. Indeed, in view of the options afforded them, it is no surprise that the Chinese builders chose not to adopt Western boatbuilding traditions.

Another factor that may explain the conservatism evident in the construction details of the San Francisco junks may be the growing sense of impermanence that must have pervaded life in the shrimp fishing camps in these latter days. If most of the inhabitants and fishermen of the camps had only intended a

brief sojourn in the United States to begin with, decades of harassment and discriminatory legislation against Chinese in general and the shrimp fishery in particular must have made it particularly clear by the turn of the century that their days in the United States were numbered. The knowledge of an imminent return to the traditions of the homeland may have encouraged the adherence to those traditions. Furthermore, the isolation and strangeness of the sojourning experience was made endurable by the preservation of cultural traditions and the recreation as closely as possible of life as it was in China. This atmosphere of nostalgia and cultural continuity must certainly have reinforced the conservatism of the junkbuilders, and encouraged them not to deviate from Chinese boatbuilding traditions.

## Departures from Chinese Boatbuilding Traditions

If the predominantly Chinese features of the San Francisco shrimp fishing junks may be easily explained by cultural conservatism, a sojourning ethic, and technical advantages, an explanation for the few construction details that don't fall within either Western or Chinese boatbuilding traditions require somewhat more careful consideration. The identification of these deviations is made possible by the well-focused view of the San Francisco junks afforded by the archaeological and photographic record, as well as the comparative body of information gleaned from ethnographic and historical sources. The pattern of wood use, the materials used in caulking and sail-making, the quality of construction, and the general size and shape of the junks, appear to differ from the traditions of China in general, and of the Pearl River Delta in particular.

The junks' most dramatic deviation from the Chinese traditional boatbuilding is the almost universal use of redwood (*Sequoia sempervirens*) for the

many features of the vessels. While the archaeological record does reveal that sometimes other woods were used, it also confirmed that a large percentage of the features were made of this straight, finely grained timber. The Rat Rock Cove junk's frame timbers, stem, keel, planks, floor timbers, bulkheads, and mast steps were all comprised of redwood, with the exception of at least one Douglas fir floor. As discussed in Chapter IV, the ethnographic record reveals that this non-specialized use of wood in watercraft construction differs from the practices of the Pearl River Delta region. Historic sources also report the use of at least three different woods in typical Chinese vessel construction (Worcester 1971:34). Indeed, such non-specialization is rare in boatbuilding traditions everywhere, with the normal pattern being the use of a hardwood for keel and frame construction, and the use of lighter, more flexible, straight-grained softwood for planking and decking. Moreover, other than its vernacular use in some small, backwater duck hunting skiffs, redwood was widely spurned by contemporary Western boatbuilders along the Pacific Coast, primarily because of its brittleness and its tendency to check, or shrink, when dried by the sun. How, then, do we explain its universal use in the shrimp junks?

The use of redwood in the construction of the junks is customarily explained by the cost-efficiency of the wood. Redwood, after all, was widely available in the Bay Area, and presumably, very inexpensive. A review of retail lumber prices in the mid-1880s on file at the Bancroft Library at UC Berkeley , however, reveals that redwood was sold for the same price as both pine and Douglas fir, species of wood more closely matching those used for boatbuilding in China. The availability of all three of these woods was also roughly the same in San Francisco. Indeed, San Francisco south of Market Street and along the wharves near China Basin was teeming with lumber companies dealing in every

type of timber (Olmsted 1988:29). Certainly a good planking pine, and a decent framing hardwood, and perhaps even a tropical timber for keels, would have been available for purchase there. If we remember, however, that the shrimp camps at Pt. San Pedro were a long day's sail from the lumber wharves of San Francisco, and that most of the shrimp camp inhabitants were not in the habit of making frequent trips to San Francisco, or in engaging in a free and open trade there, the price and availability of lumber in San Francisco becomes less important.

In fact, the camps at Pt. San Pedro didn't need to go to San Francisco to get wood. They were, effectively, located right along a veritable wood transport highway. A steady stream of scow schooners plying the waters between San Francisco and Petaluma passed close by Pt. San Pedro. These carried hay, basalt paving stones, and produce from the valleys of Sonoma County to the markets of the city, and returned with shipments of redwood for the construction of wharves and buildings in the burgeoning inland port town of Petaluma (Olmsted 1988: 30). These scows could easily have stopped to take orders and sell product to the Chinese junkbuilders. They also could have dealt with them through Captain Bullis, the American farmer who lived at Pt. San Pedro, or McNear, the landlord and operator of the brickyards there, both of whom maintained their own piers, as well as their own vessels. In fact, Bullis himself supplied the camps with weekly shipments of firewood brought up by him in his sloop from Redwood City in South San Francisco Bay (Brienes 1982: 82). In any event, it is clear that redwood was, in fact, the more available of California woods to the junkbuilders at Rat Rock Cove and Pt. San Pedro, and that availability, at least as much as price, played a principle factor in its predominant use in the construction of the junks.

While the availability of redwood may have first determined its use in junk construction, a number of other factors probably reinforced this practice. First, redwood is resistant to rot, a feature very attractive for watercraft that are exposed incessantly to marine conditions. Second, redwood at this time was available in exceptionally wide and long dimensions, translating well to the size and shape of the junks. The flatness of the junks' hulls, induced at least partly by the shallow draft requirements of mud flat fishing, also required a relatively small amount of bending, and were less effected by the brittleness of redwood. The tight grain of the predominantly old growth redwood being harvested and sold at this time would have minimized its resistance to bending, and would also have made it acceptably strong for use in structural members such as floors, frames, stem, and keel. Perhaps most importantly, the technique of edge-nailing would have minimized the redwood planking's propensity for shrinkage, and rendered the principle complaint against its use in boatbuilding all but moot. Even in the unlikely event of shrinkage or checking, edge-nailing, and the application of the Chinese caulking putty, would have provided an effective and easily applied means of correcting the problem. Indeed, redwood, in addition to being readily available to the junkbuilders at Rat Rock Cove, was also well suited to the Chinese boatbuilding traditions.

The choice to use redwood in the construction of the junk may also have determined some of its features not found in the record of Chinese boatbuilding traditions. As a straight-grained timber, its use in frames required that their inside edges be also straight in order to provide width and insure strength throughout these critical components. In China , the use of curved-grain, grown hardwoods permits the use of much narrower, curving timbers, and allows the

frames to take up much less room in the vessel. The use of redwood may also explain the false stem recorded for the Rat Rock Cove West Junk. Redwood, as a softwood, even with relatively fine grain, does not carve exceptionally well, and may have rendered the common Chinese (and Western) practice of carving a rabbet into a one-piece stem difficult. A false stem is a clever and efficient substitute for this practice, and does not require the rigidity and carvability of a hardwood.

Availability of materials may also have determined the San Francisco junkbuilders' change from traditional practices of caulking. The use of ground bamboo fibers for caulking, noted in the ethnographic record, would have been difficult in San Francisco due to its limited availability there. Indeed, although very occasionally imported from China, bamboo was not a regular staple of the overseas trade, and the critical, almost everyday need for a suitable caulking material certainly would have forced the use of an alternative material. Hemp was a product grown in the Bay Area, and its use for the caulking of Western ships was well-known. In fact, the use of hemp for caulking in China has also been documented for hundreds of years, both as an initial filling strand, and, in its crushed form, as an additive to the chunam, the Chinese caulking putty (Worcester 1971: 34). Its ready adoption in San Francisco, then, is not so surprising. Indeed, it may be that the use of bamboo fibers in contemporary China is a relatively new practice, and is itself a response to changes in availability there.

While the availability of materials may explain some of the unusual characteristics of the San Francisco junks, it does not explain their apparently rough construction. Indeed, a number of details recorded in the archaeological record indicate some inadequacies in the Rat Rock Cove junk's original structure. The

use of a cross member to brace a solitary frame at the bow; the copper patch at the rabbet near the bow; the use of a wedge to fit the bow planks to the forward-most floor; the use of small chine strips at the bow and along the daggerboard trunk to prevent leaking; the existence of a number of half frames and doubled floors amidships; and the failure to land key structural floors aft of the mast onto the keel; all of these features indicate weakness in the integrity of the vessel. Moreover, none of these features were seen in the ethnographic record. While they may well represent repairs to damages inflicted by the daily rigors of the shrimp fishery, they may also result from the gradual decline of boatbuilding expertise in the shrimp camps. Given the 1913 date of its demise, and the average 10-year lifespan of a working wooden vessel, the Rat Rock Cove junk is likely to have been built close to the turn of the century, almost twenty years after the Chinese Exclusion Act of 1882. The population at the camps had, by then, begun its rapid decline, and the pool of boat-building talent at Pt. San Pedro must certainly have been diminished. In the 1900 census, out of the 86 residents listed, only one 48 year-old man and his sixteen year-old, American born son were registered as junk men, indicating that the trade was hardly flourishing. Indeed, the lack of competition, as well as the lack of a guidance and exchange of skills among fellow tradesmen, may have weakened the quality of craftsmanship at Pt. San Pedro. Norman Scofield, in his 1897 fieldnotes, noted the inferior quality of the Pt. San Pedro vessels compared to those of the South Bay camps (Brienes 1982: 115). It seems possible that the Rat Rock Cove junk suffered from the lack of boatbuilding expertise at Pt. San Pedro, a lack largely determined by the restrictive action of the Chinese Exclusion Act.

The structural imperfections noted in the Rat Rock Cove junk may also have resulted from the sojourning ethic that pervaded the camps in these later years. The lack of permanent residency history at the Pt. San Pedro camps (Nash

1973: 185), which was certainly encouraged by the restrictions of immigration legislation, must have by the turn of the century lent a palpable sense of impermanence to the endeavors there. Incentives to construct exceptionally durable vessels that could last many years must have been weakened. This sense of impermanence may also have quashed the desire, so evident in Italian boatbuilders, to construct boats celebrating the prowess and skill of their cultural traditions, as well as the validity of their presence on San Francisco Bay (Gumina 1979: 68). Admittedly, this last assertion is difficult to prove using only the material record, and must be taken only as one hypothesis for the rough nature of the Rat Rock Cove West Junk's construction.

While the quality of junk construction at the Pt. San Pedro camps may have been impacted by a diminishing pool of boatbuilding talent and the predominance of a sojourning ethic, the increasingly corporate nature of the shrimp fishery may also have exerted some influence on the junkbuilders there. By 1900, "owner-operator" nature of the shrimp companies, in which the same persons that owned the vessels and the other capital goods did the fishing, was largely a thing of the past, being replaced by two different systems of ownership. One of these was a "owner-lessor" - "lessee-operator" relationship, in which a marketing organization based in San Francisco invested capital in gear, including vessels, and sublet both the campsite and the equipment to an operator, which itself was often a partnership consisting of more than one individual. The other arrangement involved the camp owner's hiring of employees to fish and do the processing (Brienes 1982: 80; Nash 1973: 158). Both arrangements, and especially the "owner-lessor" - "operator-lessee" relationship, meant a change in the fishermen's relationship to the junks. No longer were they the property of the operator, and no longer were the upkeep and quality of construction of the junks their

sole concern, or financial responsibility. Moreover, the corporate owner is further removed from the object, both physically and practically, and is perhaps less concerned with minor details of construction and repair than with bottom line profitability of the investment. Certainly the corporate nature of the shrimp fishery by 1900, and the international scale of its profits and its operations, made it a much more pressurized industry than the small-scale partnership endeavors of twenty years before. The owners of these extractive industries, like capitalists everywhere, were much more susceptible to broader market pressures, and no doubt felt more pressure to make capital investments pay, and less pressure to make a junk as proudly and beautifully crafted as possible. It is conceivable, then, that profit-motivated, corner-cutting decisions about junk construction, made from afar, and born from the new corporate nature of the shrimp companies, also negatively impacted the quality of the Rat Rock Cove junk's construction.

The corporate nature of the shrimp fishery and the subsequent increase in pressure to make a profit may also explain the unique hull form of the San Francisco junks. We have already seen how the shrimp fishery opted for larger and more uniform vessels as time progressed. If measured by the number of nets used and the manpower required, this change from sampans to junks increased the efficiency of fishing operations by a factor of twelve (Brienes 1982: 60). It is interesting to note that this 1880s move towards increased efficiency in such a critical phase of the fishery coincides with not only the passage of the Chinese Exclusion Act and the ensuing shortage of manpower, but also with the move away from "owner-operator" relationships towards more corporate nature of ownership. It also coincides with falling prices in the local market during the area's lean economic times in the 1880s and 1890s, as well as a unstable overseas market in rebellion-ravaged China of the same period. While it may be true that,

as Brienes writes, "the switchover to junks was a boon to a fishery that may otherwise have been in serious trouble in the hard times of the 1890s," it may also be that the move towards a more corporate structure of fishery operations, by increasing its sensitivity to a wider variety of economic pressures, and making substantial capital investment easier, simultaneously required and facilitated the "switchover" to the larger vessels.

While economic forces, manpower shortage, and a corporate structure may have inspired the move towards a larger shrimp fishing vessel, there were a number of factors that probably limited their size. The 1892 extension of the Chinese Exclusion Act subjected non-citizens using vessels between 5 and 15 tons of burden within 200 miles of United States shores to taxes and penalties as foreign vessels (Collins 1892 cited in Moore 1992:53). This aspect of the legislation was directed primarily at destroying the Chinese offshore fishing operations near San Diego, which was conducted in larger, two-masted fishing junks. However, it also served not only to exclude the San Francisco Chinese from prosperous large-vessel industries such as cargo transport, but to define the upper limits of their shrimp fishing vessel size. Indeed, the reports of the average catch per fishing voyage of the San Francisco junks indicate that these vessels came close to, but remained below, the 5-ton burden limit.

Other factors probably also limited the size of the San Francisco junks. The shallow water nature of the shrimp fishery, as well as the tidal mud flat location of its bases of operations, required a minimum of vessel depth, or draft. The operation of a vessel in strong currents and shallow estuarine waters also required a significant amount of manoeuvrability, a trait facilitated by a smaller size. The aforementioned shortage of manpower also probably limited the size of

the vessels by limiting the number of available crew. Finally, the nature of fishing operations, which required the hauling and setting of complicated nets over the side of the vessels further restricted the size of the junks by requiring low free-board.

Some of the same factors limiting the size of the junks may also help to explain the unusually simple nature of their deck layout and superstructure. The hauling and setting of a large number of nets required open space, and probably discouraged the addition of bulwark planks, exterior scaffolding, and cabin superstructures so prevalent in the vessels noted in the both ethnographic and historic record of China. The corporate, extractive nature of the shrimp fishery in California probably also kept the deck and the superstructure needs of the junks to a minimum, as both the location and the processing operation of the nearby camps meant that the fishermen were not living on the junks, but simply using them as equipment serving one phase in a larger process. This differs from the predominant Chinese pattern of commercial fishing from vessels of comparable length which, because they also serve as homes for the fishermen and their families, require more amenities, such as a cabin superstructure and a poop deck. Furthermore, vessels as large as 50 ft. in China tended (and still tend) to be used as trawlers, and fished more in deeper, open waters, requiring more freeboard, while shallow water shrimp fishing was done more from smaller open decked sampans, much as it was in the earlier days of the San Francisco shrimp fishery.

The shape and size of the late-period San Francisco shrimp junks like the ones buried in Rat Rock Cove, then, may be seen as developing in response to a

number of factors unique to the context of the shrimp fisheries of the San Francisco Bay. A corporate structure of ownership and the international scope of its operations, as well as restrictive immigration legislation, made efficiency critical, and spurred the construction of larger junks. Legislation restricting vessel size, the technical requirements of the fishing operations, as well as those of the camps onshore, worked against this impetus to restrain both the size and the complexity of the vessels. The resulting hull form was larger than traditional shrimp fishing sampans, but more simple in shape and furnishings than traditional fishing junks. Until a junk of similar form is located in the historical record of watercraft in China, the size and shape of the San Francisco junks must be added to the use of redwood as a unique adaptation to the shrimp fishing in the San Francisco Bay.

## Conclusions

The material record of the Chinese shrimp junks buried in the mud of Rat Rock Cove, when combined with a review of historic and ethnographic data, reveals an immigrant watercraft built largely in the native traditions of the Pearl River Region of China. Most of the West Junk's traditional Chinese construction details, and the boatbuilding techniques that created them, translated well from shallow estuarine environmental conditions of the Pearl River Delta to those of the San Francisco Bay shrimp fishery. They were also reinforced by the conservatism universal to traditional boatbuilders, as well as the cultural and geographic insularity of the shrimp fishing communities. The sojourning ethic that pervaded these communities, heightened by legislative restrictions and racist persecution, also probably kept the junkbuilders loyal to the Chinese boatbuilding traditions they knew so well. The junkbuilders, then, were both reinforced

by the enclave in which they worked, and by building traditional Chinese vessels, reinforced its strongly Chinese identity.

Many of the same factors reinforcing the Chinese character of the shrimp junks also effected some changes to their traditional form. The geographical remoteness of the communities of the fishing camps restricted the availability of materials, and made the use of a single type of wood for the junks both more economic and more convenient. This use in turn effected changes to the design of the vessel. Restrictive legislation depleted the labor pool and adversely effected the quality of craftsmanship. Craftsmanship in the construction of the junks was also probably also weakened by the change in ownership structure of the camps, which itself was necessitated by restrictive legislation and increasing economic pressures in the industry. The same pressures made efficiency critical to the success of the industry, a requirement which was largely met by the construction of larger junks that still retained the open, sparsely outfitted qualities of their smaller predecessors. The resulting vessels, therefore, while constructed largely by traditional Chinese techniques, and featuring predominantly Chinese attributes, were uniquely adapted to the context of the 19th- and early 20th-century Chinese shrimp fisheries of San Francisco Bay.

The material record of the Rat Rock Cove West Junk, then, closely recorded and carefully reviewed, can be seen to reveal and reflect the context and the culture in which it was used. As an artifact of material culture, it can serve to unify a disparate historic record, and illustrate the history of its makers and users. Moreover, material culture artifacts, and the fruits of their analysis, translate well into the realm of public interpretation and cultural resource manage-

ment. The next chapter investigates the interpretive potential of the Rat Rock Cove junks at China Camp State Park, and suggest some directions for future research.

# CHAPTER VI. THE INTERPRETATION OF THE RAT ROCK COVE JUNKS

Historic watercraft, when treated as artifacts of material culture, can facilitate valuable insights into the historical context in which they were used. The detailed analysis of the material record of the Chinese shrimp junks buried in Rat Rock Cove has illustrated how the environmental, social, and economic conditions of the 19th- and early 20th-century San Francisco Bay area impacted the lives of the Chinese shrimp fishing community. The elaboration of historic context afforded by the material culture analysis of historic watercraft becomes especially valuable to the task of public interpretation. By expanding beyond mere technological description to include the human processes and cultural conditions effecting and effected by the artifact, a material culture interpretation of the artifact allows the public audience to draw important and powerful connections between the human past and its own human present. These connections can be intensified by the three-dimensional nature of material culture. In the case of the Rat Rock Cove shrimp junk, where the artifact cannot be displayed, the meticulous recording of physical construction details required by its material culture analysis lends itself well to its reconstruction in three-dimensions. While such efforts can intensify the power and potential of the interpretive mission at China Camp State Park, they also can provide important opportunities for further research about the junks and the people that used them.

## Junks and the Interpretive Program at China Camp State Park

The prospects for the public interpretation of the Rat Rock Cove junk, and of the San Francisco shrimp junks in general, are greatly enhanced by the existing interpretive facilities at China Camp State Park. The park setting itself is a virtual living museum, set on the scene of the middle cluster of shrimp fishing camps, to the south and east of Rat Rock Cove, at Pt. San Pedro. Reconstructions of a number of original buildings and structures combine with some surviving structures (including watercraft) from the later period of shrimp fishing to recreate some of the ambiance of the working life there. A small, redwood, board-and-batten museum building, set onto pilings and perched over the water, is itself a replica of a shrimp camp structure. Inside, it features a scene of a shrimp warehouse interior, recreated from historic photographs. It also features fine replicas of some of the shrimp processing tools, such as the rollers used to crush the shells, and the rake used to spread the shrimp over the drying grounds. A three-quarter scale reproduction of a sampan, constructed by the author from historic photographs of the Monterey squid fishing sampans, occupies a central place in the structure, and serves to interpret some of the fundamental features typical of California Chinese small watercraft. Archaeological artifacts such as potsherds, broken pipes, and porcelain are also featured on display, and are used to tell both the story of everyday life in the camps and the story of the archaeological inquiry that helped to recreate it.

While the artifacts and the setting are important to the success of China Camp State Park's museum, the interpretive text, by exploring a number of important and socially relevant themes, are key to their evocative power. Indeed, a number of the research questions explored in this thesis were inspired by the

insight and articulation of the interpretive program there. The isolation of the communities, the traditional Chinese character of life there, the sojourning nature of their intentions, and the devastating effects of the difficulties with the surrounding Caucasian community are themes running throughout the exhibit. By setting them into the context of human endeavor, the interpretive story gives life to the artifacts exhibited, and adds resonance and power to the quiet solitude of the Park's setting. Visitors to the museum, enveloped in the ambiance of the camps, are encouraged to empathize with the fishermen that toiled there, and to draw parallels between their aspirations and difficulties and the aspirations and the difficulties of their own lives.

The analysis of the shrimp fishing junks as artifacts of material culture explored in this thesis, then, could translate well to their interpretation at China Camp State Park. The existing description of the junks could be expanded to a much greater level of detail. The Chinese character of the junks' features, as well as the processes used in their construction, could be more exhaustively interpreted to reflect the tenacity of Chinese traditions in the shrimp camps, and the sojourning nature of the endeavors there. The isolation of the camps could be reflected in a discussion of the use of redwood, while the size and simplicity of the vessels could be easily folded into the exhibit's discussion about the need for efficiency in the face of economic and political difficulty. Indeed, most of the major points of the analysis of Chapter V, having been inspired by the interpretive themes at China Camp State Park, can be used to support both a more detailed interpretation of the shrimp junks and the larger contextual themes explored in the exhibits there.

The interpretation of the shrimp junks at China Camp State Park can also be assisted by the historic materials reviewed and data generated in this thesis.

The historic photographs collected from a wide range of archives for analysis could provide additional images to the interpretive exhibit, and reinforce the intensified interpretation of the junks. The 1999 images of contemporary boat-building practices in the Pearl River Delta area could more clearly illustrate the techniques of construction used to build the San Francisco junks, while images of the geography of the Pearl River area could help to communicate the similarities between the immigrants' old and new environments. The archaeological photographs of the Rat Rock Cove excavations could also help to render the unique features and the scale of the shrimp junks, as could the drawings of the West Junk.

The archaeological data generated by the 1998 excavations in Rat Rock Cove could also strengthen the interpretation of archaeological inquiry at the China Camp State Park museum. Indeed, the archaeology of shipwrecks is a proven attraction, and is capable of sparking the imagination of young and old alike. The simplicity of the field plan for the Rat Rock Cove excavations, and the easily interpreted nature of the subject being excavated, make the story of the junk's excavation a perfect subject for interpretation. Furthermore, the numerous photographs of the archaeological fieldwork on the mud flats chronicle the unique and almost humorously difficult nature of the fieldwork, while the diverse composition of the field teams should help to increase the appeal of the story. Perhaps most importantly, the drawings of the West Junk, and of the site as a whole, could illustrate the origin of the knowledge communicated by the exhibit. This is important, as it allows the visitor to become a more explicit part of the process of "reading history" in material culture that is fundamental to the museum experience (Summers 1998:15).

The archaeological data generated by this thesis may also serve another function in the park's interpretive program. The current exhibits, including the historic structures, neglect to tell the story of Rat Rock Cove, once a major part of the fishery operations. Aside from a few deteriorated piling heads, pot shards, porcelain fragments, and nondescript foundation mounds, all traces of this once active fishing cove have disappeared. While the restoration of the cove to its natural state of marsh grasses, lush hillside vegetation, and active animal life is a welcome and valued component of the park, the almost complete erasure of its historical phase runs counter to its interpretive mission. A sense of the large, thriving scale of the fishery operations at Pt. San Pedro is largely diminished by the exclusion of Rat Rock Cove in the interpretive process, and the visitor is left with the impression of the much tinier, less significant settlement as a whole. The telling of the story of the archaeological excavations in Rat Rock Cove, however, could serve to remember the presence of the fishery activities there, as well as the extent of the original settlements at China Camp State Park.

Prince's Principle offers an evocative way of interpreting the history and archaeology of Rat Rock Cove in situ without impacting the environmental integrity there. The placement of an opaque image of the historic photograph of Rat Rock cove at the precise location from which it was originally shot could provide a powerful vehicle for remembering the past there. The empty environment of Rat Rock cove could suddenly be peopled with ghostly buildings, wharves, fishermen, and boats of the shrimp camps. The method has been used in other parks and museums around the United States, and has shown great success in transporting the visitor back in time and place (Deetz 1993; Prince 1984:112). These efforts have included the use of a camera housed in a weatherproof housing, as well as the use of a transparency mounted on a durable inter-

pretive exhibit panel. Either of these could be easily mounted in the appropriate location in the clearing adjacent to the upper parking lot at China Camp State Park, and either could expand its current use as a picnic spot to one of historical interpretation. Prince's Principle could also be used there to set the stage for the interpretation of the archaeology of the Rat Rock Cove junks. Images taken from the picnic area that show the general scene of the fieldwork, and especially the images showing the flagged and taped outline of the two junks there, could be easily translated to Prince's Principle. The archaeological site could thus be deftly located on the now placed and unmarked mud flats of the cove without impacting the purity and integrity of this important marine environment. The issue of cultural resource protection should be addressed prior to this interpretive effort, however, as the disclosure of the wreck location could lead to vandalism of the site, despite the difficulty of access posed by the mud in which it is buried. Nevertheless, it is clear that the use of Prince's Principle, which served the research purposes of this thesis, might also serve the interpretive mission of China Camp State Park.

## Junk Reconstructions and the Power of Three Dimensions

The data generated by the material culture analysis of the Rat Rock Cove junks might also intensify the interpretive program at China Camp State Park by supporting their three-dimensional reconstruction. The level of detail recorded in the archaeology of the West Junk, as well as that gleaned through the review of historical accounts, historic photographs, and ethnographic field observations, should allow for a relatively accurate and thorough reconstruction of almost every major vessel component. Reconstruction of the junks could help to unify the disparate data reviewed in this thesis into a coherent summary, and to

convey the unique character of the vessels. The power of three-dimensional representations is already well-confirmed by the numerous replicas in the museum at the Park, and the unique and dramatic form of the reconstructed San Francisco shrimp junks could greatly enhance the story of these unique watercraft.

Three dimensional reconstruction of the San Francisco shrimp junks may be most easily and cheaply achieved through the production of a scale model. The cost of materials and the time of construction would be minimized in the construction of a scale model, while its small size would facilitate its display and curation in the limited space of the museum building. The use of redwood and original finishing materials, as well as the meticulous attention to dimensions and construction techniques outlined in this thesis should counter the drawbacks of diminished scale, allowing for the illustration, and interpretation, of the junks' essential characteristics. The concurrent and even side-by-side exhibit of a scale model of the archaeological remains of the West Junk could illuminate both the archaeological investigation in Rat Rock Cove and the process of reconstruction. This would allow for the important discussion of the assumptions involved in reconstruction, and the implications of these assumptions have for the interpretation of the junks and the fishing camps as a whole.

While the scale-model of the Rat Rock Cove junks would provide a cheap but effective interpretive tool, the addition of realistic scale to a reconstruction would dramatically increase its contributions. Indeed, the interpretive power of three dimensions is fully realized in full-scale watercraft reproductions. The ability of full-scale replicas of historic watercraft to convey the essential qualities of the craft is well documented in numerous successful reconstructions

in public institutions around the world. Size, mass, quality of construction, and the division of space that are communicated by such replicas are invaluable to the interpretation of the history of their use. When afloat or under way, full-scale reproductions can come alive, providing the visitor with a powerful and moving sense of connection to the vessels and the people that used them. Moreover, a working reproduction can serve as traveling ambassador of history, visiting the waterfronts of towns and cities during historical celebrations and special events, carrying the interpretive mission wherever it goes. The sight of the humped leech sail and the oiled redwood hulls of the junks sailing along the waterfronts of the San Francisco Bay would certainly provide a powerful promotional image for the mission of the Park, and for the history of Bay Area Chinese immigrants.

The process of constructing a full-scale replica can itself provide numerous invaluable interpretive opportunities. If staged in a public space, the use of traditional boatbuilding techniques and materials offer a graphic illustration of the unique traditions of its builders, and renders the vessels as products of human effort.The use of fire-bending and edge-nailing, as well as the making of chunam caulking putty would make fascinating interpretive demonstrations. The interpretive and educational value of such demonstrations can be further intensified through participation of the public in the construction process. Furthermore, the experience gained in construction techniques used in building a replica may be later used to support ongoing, hands-on demonstrations of the techniques even after the completion of the vessel. Finally, the documentation of the reconstruction process can provide additional interpretive materials, such as photographs, videos, and drawings that could prove useful to the interpretation of the reproduction.

China Camp State Park is well-suited to the construction and of a full-scale reproduction. Ample space along its beaches, as well as the existence of a working carpenter shop, make the reconstruction of a junk in its original outdoors shoreside setting possible. The construction site itself would greatly add to the ambiance of the park, and would also provide a public setting conducive both to educational and promotional programs. The Park also features a working pier, alongside which the finished reproduction could be moored, and displayed during the clement seasons. Interpretation of the junk could include sail-raising and rudder-lowering demonstrations, as well as periodic sails and net-setting demonstrations. The historic marine railways alongside the museum building, which is currently used to haul out the park's Monterey fishing boat, could also be used to haul the junk for regular maintenance, and winter storage along the beach. Indeed, even beached, the junk would serve to recreate the ambiance of its original context, as numerous historic images attest to the vessels regular beaching.

While the interpretive benefits of a reproducing a San Francisco shrimp junk escalates dramatically with the addition of scale, so, too, does the expense of the project. Nevertheless, the materials of the junks are still readily accessible and, though they are somewhat more expensive than they were in 1890, they are not outrageously so. The non-profit nature of the endeavor might also induce a reduced price, if not outright donations, for many of the materials. A number of small redwood lumber mills in Northern California offered just such a reduction during the author's reconstruction of the Monterey sampan on display at China Camp, and would probably be even more inclined to do so given the larger size of the lumber order. Creative solutions for the conscription of labor to construct the junks might also be found through cooperative agreements with other agen-

cies and institutions possessing expertise in such endeavors. San Francisco Maritime National Historic Park, which features numerous maritime craftsman skilled in historic reproductions, as well as an active cadre of boatbuilding volunteers, has expressed interest in the construction of California shrimp junk, and may be a source of labor and expertise. Other maritime museums, as well as community educational programs, may also be able to provide assistance with the construction process.

The most formidable challenge to the reconstruction of the California shrimp junks is the long-term curation and maintenance of the completed vessel. Watercraft require regular and attentive maintenance, as well as periodic repair. Moorings and dock lines also have to be carefully monitored and maintained. The beaching and winterization of the replica will be necessary to avoid damage to the vessel likely to be inflicted by the heavy northerly winter weather endemic to San Pablo Bay and the coves of China Camp State Park. Any plan for the ongoing interpretation of a full-scale junk reproduction will have to consider these challenges, and assign both funding and personnel to see that they are properly addressed. Again, cooperative agreements with other public and private institutions may facilitate a solution. Certainly the interpretive potential of a full-scale reproduction of the Chinese junks warrants efforts to resolve the challenges its curation poses.

## The Research Potential of Junk Reconstruction

While the full-scale reproduction of a San Francisco shrimp junk at China Camp State Park would benefit the interpretive mission of the park, the project would also provide valuable opportunities for furthering research about the

design, construction and use of the vessels. In fact, research has motivated the construction of most of the full-scale watercraft replicas around the world. From the reconstruction of bronze age trading vessel in Turkey to that of an ancient Greek trireme, such projects have been used to test hypothetical construction techniques and materials, check the suitability of reconstructed hull forms, and to gauge the performance and handling requirements of the vessels under way (Throckmorton 198; McGrail 1977; Steffy 1994). All of these areas of inquiry could be applied to answer a number of questions remaining about the San Francisco shrimp junks.

A number of the Chinese construction techniques examined in this thesis could be tested in the construction of a full-scale reconstruction of a San Francisco junk. The process of edge-nailing could be fully examined, and the degree to which it influences the strength of the vessel structure, the order of construction, as well as the form of many of its components, could be assessed. Fire-bending and its effects on green redwood could be examined, and the extent to which the process was necessary to obtain the hull shape of the shrimp junks could be assessed. The feasibility of plank-first construction in the building of the San Francisco shrimp junks could be tested, as could the process of bulkhead construction and the insertion of a penetrating thwart for an upper gudgeon shelf back aft. The carving of a changing bevel along the keel and bottom edge of the garboard could be experimented with, and assessed for difficulty and efficiency. The suitability of redwood to the construction and design as whole, and the limitations it opposes on both could be explored, and could be used test some of the hypotheses in this thesis. The use of traditional tools such as bow drills, Chinese hand planes, frame saws, and caulking chisels could be examined, and the marks left by their use, as well as the nature of the work they produce, could be documented for future reference and interpretation.

In addition to the examination and testing of construction techniques and boatbuilding technology, the process of construction would offer the opportunity to answer some more general questions about the process, and to offer insights into its context. These questions include: What is the level of skill required to simulate the quality of construction documented in the archaeological remains of the West Junk, and how does this support allegations of a diminished level of craftsmanship? How many people were required to build a junk, and how long might it have taken in man-hours? How much material is required to build a typical junk, and what might the cost have been? How much space was required for the process, and how does this narrow the possible historic locations for junk construction?

Questions about the engineering of some of the junk components left unanswered by this thesis might also be addressed by a full-scale reconstruction. The mechanics of raising and lowering the rudder, as well as the support and specific design of gudgeon shelves could be tested, and probable solutions could be worked out. The configuration of the mast step area and it tabernacle-like function could be experimented with and refined, while the arrangement of rigging to support the mast could experimented with. Perhaps most importantly, reconstructions of the junks' hull shape could be tested, though the bulk of the experimentation should probably be completed on a scale model prior to the commencement of full-scale reconstruction. The testing of the scale model's hull shape could be assisted by the application of Prince's Principle, with the model being shifted in front of an opaque images of the junks under way or at anchor until a match is arrived at. The dimensions of the developed scale model could then be enlarged appropriately and used to form the shape of key sections in the full-scale reproduction.

Another set of research questions could be addressed by the launching and use of the reproduced junk. Questions pertaining to performance could be examined. These could include: How well does the junk point into the wind, and how fast does she sail? How does this compare to the sailing performance of historic vessels and replicas of Western boat traditions that were contemporary with the junks? Does it support or refute the historic assessments of their performance? How might this performance have effected the ability of the fishermen to avoid contact with regulatory officials and competing fishermen? How many people are required to sail the junks, and how much skill is required to do so effectively? How well does the junk handle the strong currents, shallow waters, and prevalent winds of the area, and how might this have effected the location of the fishing grounds and the rhythm of the fishery? How difficult is it to row the junks, and how might this have effected the ability to combat flukey winds and doldrums regular to the evenings on San Pablo Bay? How difficult is it to handle the junks during the working of the shrimp nets, and how do features such as low freeboard, clear deck space, and windlasses facilitate the work? What is the carrying capacity of the junk? Does it exceed five tons? How does an increased cargo effect her performance and stability? Indeed, the number of research questions that could be addressed by launching and using the full-scale reproduction of the San Francisco shrimp junks is impressive indeed, and would certainly render the effort required to do so worthwhile.

In addition to questions of performance, the in-water use of the full-scale replica could also offer the opportunity to study the patterns of wear and tear on the vessel, as well as the natural patterns of deterioration. The effectiveness of chunam caulking could be assessed, as could the holding power of the forged

iron nails and edge-fastening techniques. The ability of edge-nailed redwood to withstand the stresses induced by the sailing of the vessel, as well as the shrinkage and expansion of the planking induced by the alternating exposure to sun and water, could be observed first hand. The degree to which the vessels tend to hog, develop leaks, and spring planks could also be tested. In this way, the formation processes, or processes effecting the observed state of the archaeological record of the West Junk, could be investigated. This would not only test this thesis' assumptions about the skill level of its builders, but could also provide insights into the junk's moment of demise.

Indeed, the full-scale reproduction of a San Francisco shrimp junk would yield invaluable research opportunities, and would permit the further refinement of our understanding of these unique watercraft. It would also provide a wealth of interpretive possibilities, from hands-on construction demonstrations to the first-hand experience of sailing a shrimp junk. Additionally, the completed vessel could serve as a powerful promotional tool, as well as a traveling ambassador to carry its interpretive mission outside Park boundaries. While the organization, funding, and curation of such a reconstruction presents some formidable challenges, its rewards, outlined above, clearly merit a whole-hearted effort. Moreover, the thorough nature of the documentation of the West Junk in Rat Rock Cove, and the wealth of ethnographic and historic information reviewed in this thesis, increases the likelihood of an accurate reconstruction, while the inherent simplicity of the junks' design all but insures its successful completion.

## Other Directions for Further Research

While the reconstruction of the San Francisco shrimp junks would offer a wealth of research opportunities, there also remain a number of other avenues

for further research. Further archaeological work, in Rat Rock Cove and at other former sites of Chinese villages, could both expand and elaborate some of the research questions addressed by this thesis. A more exhaustive review of the historical record of the shrimp fishery could help to better understand the changing structure of the endeavor, as well as the nature of its later manifestation. Finally, the expansion of the ethnographic research, both in California and China, could help to illuminate the origins and the nature of life in the shrimp fishing camps.

While the 1998 archaeological investigation of the junk remains in Rat Rock Cove yielded much important information, the brief duration and limited scope of the fieldwork left much of the site uncovered and undocumented. Although two small test trenches were excavated on the East junk, little of the vessel was documented. Judging from the extent of the remains observed during these brief exposures, the survival of components not documented on the West Junk seems considerable, and may merit further excavation there. The full documentation of the East Junk could help to identify the degree of uniformity in junk construction. It might also allow for a more refined assessment of the quality of construction in the West Junk. A more thorough excavation of the area of the site may reveal more parts and artifacts associated with the junks, as probing throughout the area in 1998 seemed to indicate that the boundaries of the site extended beyond the surviving hulls. Any future attempts at excavation should consider the use of scaffolding and coffer dams to both avoid negative impacts to the site and facilitate excavation in the difficult mud.

In addition to the further archaeological investigation of Rat Rock Cove, there remain numerous former sites of Chinese fishing camps that may yield information pertaining to the junks. Much of the area of mud flats just to the

south of Pt. San Pedro, where Captain Wakeman first noted the early development of the Chinese shrimp fishery, has yet to be investigated. Other sites off of South San Francisco and Redwood city appear to be relatively untouched by the destructive impacts of dredging and landfill. All of these sites could be surveyed using remote sensing devices such as ground penetrating radar and magnetometers. Any of these technologies could be tested for their effectiveness n the Rat Rock Cove site, and the data signatures recorded there could help to guide the analysis of data generated in surveys elsewhere. If junks are found at these other potential sites, their excavation may provide the opportunity to compare the junks of different camps. Differences may indicate the expression of regional identities in each of the camps. They may also indicate different stages in the evolution of the junk design and construction, which in turn may reflect the different social and economic forces shaping their form and use. Many of the fishing camps of the South Bay were revitalized a few years after the facilities in Rat Rock Cove were razed by fire, and the junks and fishing equipment continued to evolve. The archaeological excavation of one of these later forms of the shrimp fishing junks would offer the opportunity for the comparison between the material records of these different phases of the shrimp fishery, and would likely afford some valuable insights into the ways that the fishermen and boatbuilders in this later era continued to innovate and adapt to the socioeconomic and environmental challenges they faced.

The later period of the shrimp fishery, which employed primarily motor-powered junks and Monterey trawlers, still begs further historical research as well. The more thorough examination of the business records of the shrimp companies from this period, as well as those of the companies operating in the earlier phases of the fishery, may help to refine our picture of the fishery as a corporate

venture. This would provide a critical perspective from which to gauge the industry's responsiveness to the larger economic and social events of its time, and should help us to understand how the junks both influenced and were influenced by the industry's economic needs. The wholesale operations and retail markets to which the local fresh catch were sold also remains to be more fully examined, and may provide another missing piece in our picture of the forces acting on the fishing camps, and on the junkbuilders in particular. Shipping records of scow schooners and other cargo carrying vessels of the 19th and early 20th century might be reviewed for records of transactions with the fishing camps, affording the chance to assess the availability and price of many of the materials required for the construction of the junks.

Further efforts to expand the ethnographic record of the Chinese involved in the California shrimp fishery could provide valuable information about every aspect of the industry. While the chances of finding someone involved in the earlier, sail-powered days of the fishery are admittedly very slim, informants involved in the later period of South Bay shrimp fishing should be sought after and interviewed. In addition to illustrating the lifeways of the late-period shrimp fishermen, these interviews would allow the comparison between the South Bay shrimp fishing experience and that of Frank Quan and the other contemporary North Bay shrimp fishermen. Such a comparison may help to identify the ways in which a different set of fishing equipment, a different type of corporate organization, and a different set of environmental factors may have influenced the nature and the success of the shrimp fishing endeavors in both regions.

More extensive ethnographic work in the Pearl River Region of China might also benefit the analysis and interpretation of the San Francisco shrimp

junks and the California shrimp fishery as a whole. A longer fieldwork session, which uses the full-time services of an interpreter, and visits to a larger area of the Sze Yup regions, may help to identify a more precise region of origin for the San Francisco types by locating vessels that share more of their essential characteristics. More extensive documentation of the vessels observed might also allow for the identification of vessel attributes that express regional identity. This would help to more clearly gauge the extent of such expressions in the archaeological and historical record of the San Francisco junks, and may also allow for an assessment of the changing demographics of the camps based on the material record alone. More time in the field observing traditional boatbuilding in China would increase our understanding of boatbuilders' decisions about the order of construction, the use of materials, and the survival of traditional techniques. A refined picture of expertise, and the ways in which boatbuilding knowledge is passed on, might also be recorded during future fieldwork in China. Finally, a more thorough assessment of social and economic factors influencing the design, construction and use of the watercraft of the region might help to better assess the impact these factors had in San Francisco one hundred years ago.

## Conclusion

While many avenues for research about the San Francisco shrimp junks remain, it is hoped that this thesis has contributed significantly to our understanding of these important watercraft. It is also hoped that this thesis has been able to show how the material culture analysis of historic watercraft reconstructed from archaeological, historic, and ethnographic information can yield important insights into the historical context in which the vessels were used. These insights, and the three-dimensional nature of the material record, translate well

into an interpretive mission of cultural resource agencies like the California Department of Parks and Recreation, and indicate the extensive contributions historic watercraft can make to the interpretation and preservation of public history.

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# APPENDIX

## Glossary of Nautical Terms

# GLOSSARY OF NAUTICAL TERMS

Athwartships. Across a vessel from side to side, perpendicular to the keel.

Batten. A small spar, usually of bamboo in Chinese traditions, secured to, and lying across, a sail so as to extend the leech or trailing edge. In San Francisco shrimp junks, battens appear to have been made from a local wood such as fir, spruce, redwood, or pine. The word also refers to a thin plank or strip of wood used to determine hull curvatures in the drafting of plans and in boat construction.

Beam. The breadth of a vessel at its broadest part.

Bevel. A measured angle. Also an angled surface created by slicing the edge of a timber. The San Francisco shrimp junks featured bevelled plank edges, as well as bevelled frames, floors, stem, and transom.

Bilge. The area of the hull's bottom on which it would rest if grounded, usually where the side of the vessel meets the bottom, and often described as "slack" or "hard" depending on the curvature. In the plural, it refers to the cavities between floors and frames where bilge water tends to collect.

Broadstrake. The second hull plank up from the keel.

Bulkhead. A partition built up in a vessel to separate various portions below deck and give extra strength to the vessel structure.

Butt block. A block of wood used to back up seams between plank ends in Western boatbuilding.

Caulking. A fibrous material, such as cotton, oakum, ground bamboo, or animal hair, which is driven into the planking seams of a vessel in order to make them watertight. Often a putty of paste is smeared onto the fibrous material n the seams in order to both further seal the seam and to preserve the fibrous caulking material.

Chine. The line of intersection between the sides and bottom of a flat or V-bottom vessel.

Chine strip or Chine log. Longitudinal timber connecting frames at the chine, to which side and bottom planking are fastened.

Chinese batten-lug sail. (Figure 43) The typical sail arrangement of vessels in China and of Chinese vessels in California, consisting of a roughly rectangular sail with full-width battens running from luff to leech at intervals along the

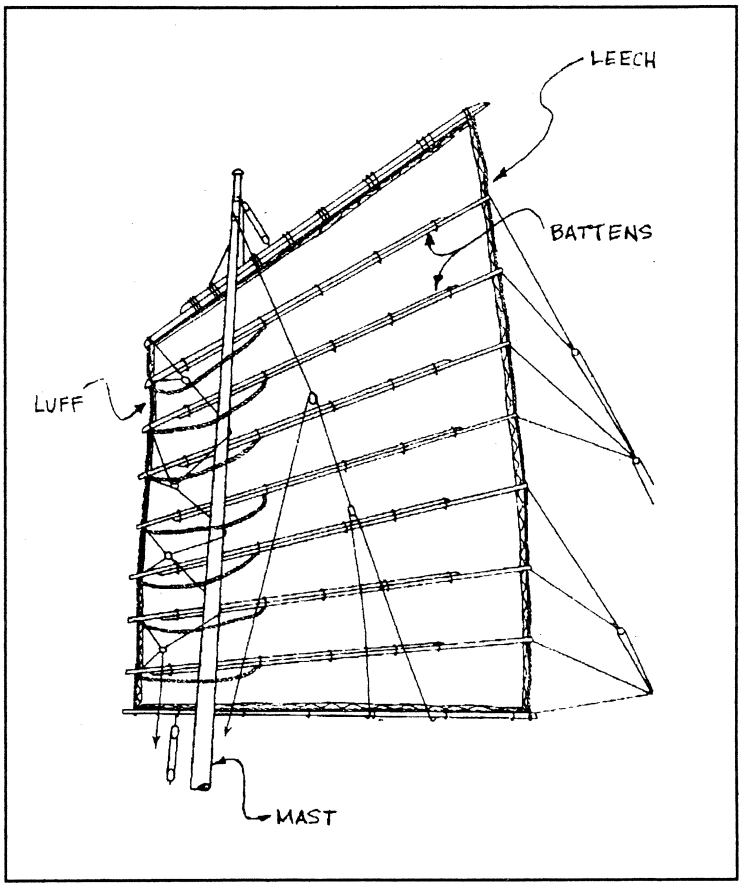


Figure 43. Traditional Chinese Batten-lug Sail. From Worcester, *The Junks and Sampans of the Yangtze*, p.77. San Francisco shrimp junks generally featured fewer battens, and more curvature in the leech.

length of the sail, and fastened to the mast at the battens somewhere in between the luff and the leech.

Chock. Block or wedge of wood, often used to fill out or separate area between timbers. Also often used to guide running rigging or handling lines.

Chunam. Traditional Chinese caulking paste, usually consisting of lime and some form of wood oil, such as T'ung oil, and some other thickening agent, such as ground hemp fibers, ground bamboo, or animal hair.

Cleat. A piece of wood fastened into a vessel to support or fasten something else, such as the gudgeon cleats often seen in Chinese vessels to support the gudgeon holes carved into the gudgeon shelves at the transom.

Daggerboard. A plank of wood which slides upward or downward through its box and slot, extending down below the bottom of the keel, providing resistance to lateral motion in sailing. A daggerboard comes completely out of its box when not in use, and can thus be distinguished from a centerboard, which stays in an enclosed box and pivots on a pin in the keel.

Edge-nailing. (Figure 44) The method of fastening the components of a vessel by nailing at regular intervals through carved triangular notches across the longitudinal seams of timbers.

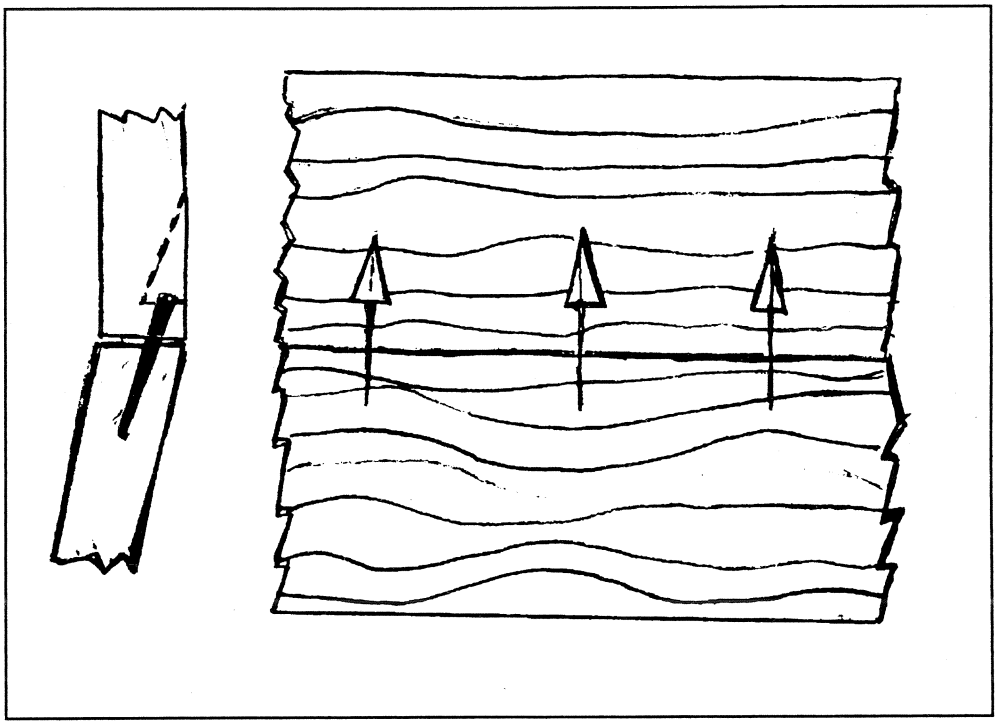

Figure 44. Sketch showing two views of triangular edge-nailing notches and angle of nail penetration across seam between planks.

False stem. An outer timber fixed to the forward surface of the stem to strengthen or protect it and the ends of planking.

Floor, Floor timber (Figure 45). A frame timber that crosses the keel and spans the bottom; the central piece of a compound frame.

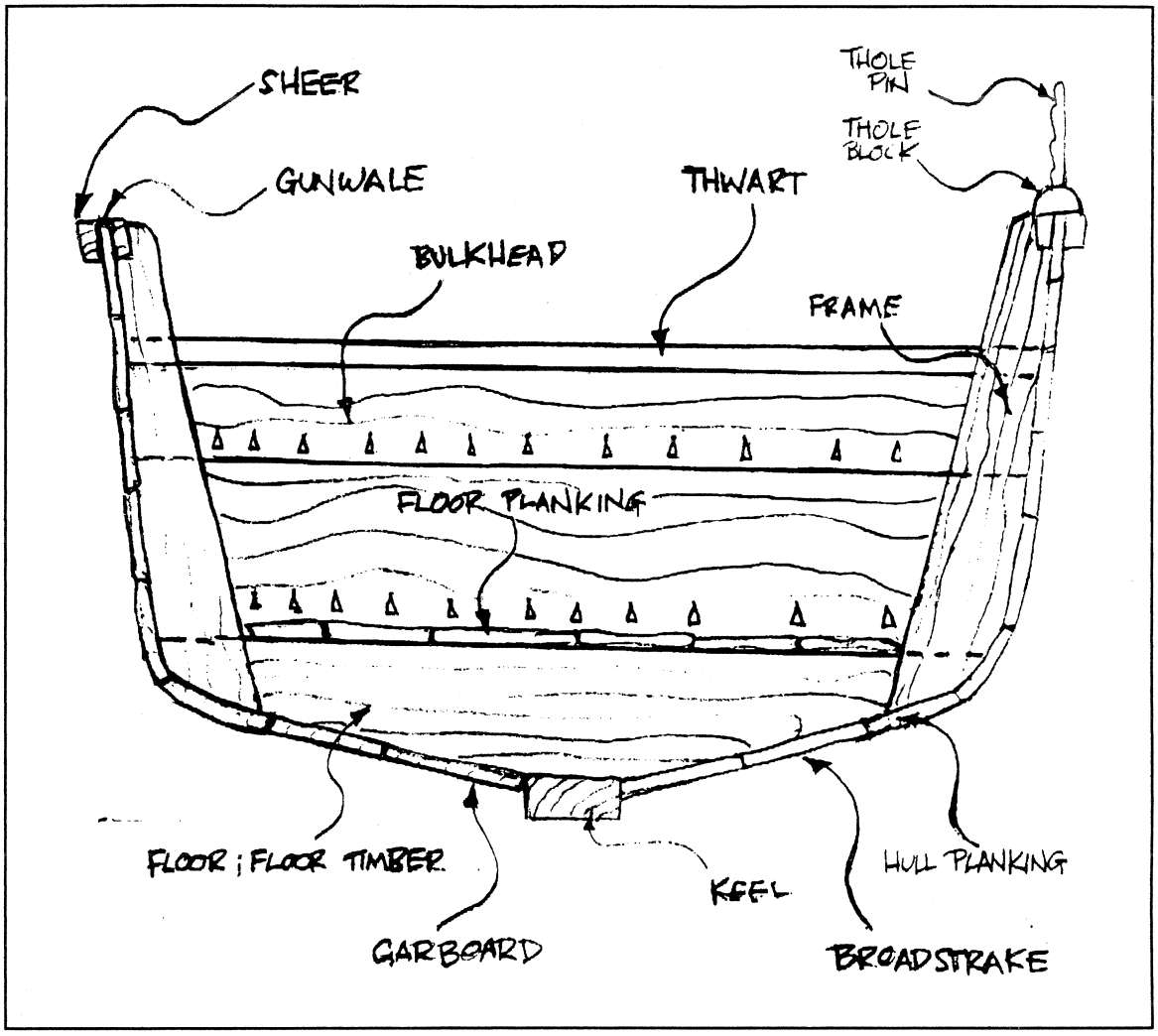


Figure 45. Cross section of typical San Francisco shrimp junk showing major components.

Floor planking. (Figure 45) The longitudinal planks nailed onto the top edges of floor timbers to form a decking or flooring in a hold.

Frame, Frame timber. (Figure 45) A transverse structural timber, defining the cross-sectional shape of a vessel hull, into which the longitudinal hull planking is fastened. *

Freeboard. The amount of a vessel's side that is above the water, normally, or under a given load. Also defined as the distance between the waterline and the upper deck of a vessel.

Gaff rig. A sail rig in which the main sail is four-sided, with the forward (vertical) edge attached to the mast (usually by hoops) and the upper (slanting ) edge to a spar called the gaff.

Garboard. The hull plank next to the keel or bottom board; the lowest hull plank. in a vessel.

Grommet. A ring of rope, usually used in Chinese traditions to fasten oars or sweeps to a thole pin.

Gudgeon. (Figure 46) The female part of a rudder hinge. In San Francisco shrimp junks and in many areas of China, rudder gudgeons were formed by key-hole shaped holes in athwartships planks fastened into the transom. Into these gudgeons was slid the rudder post and rudder.

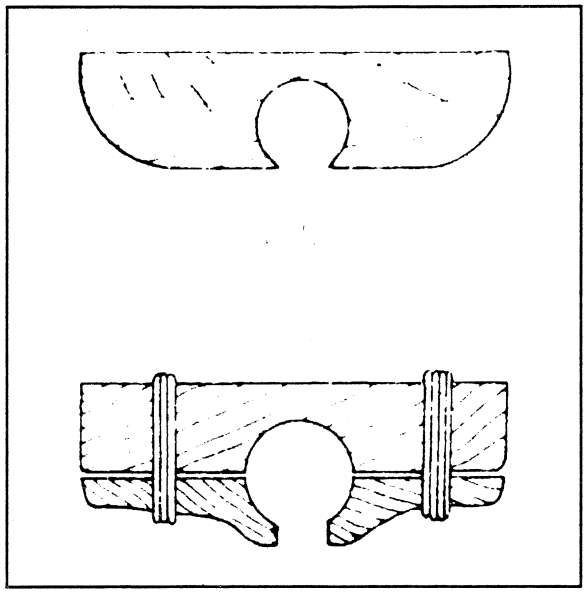

Figure 46. Two gudgeons common in China and especially in Guangdong Province. The top gudgeon style was typical of San Francsico shrimp junks. From Worcester, *The Junks and Sampans of the Yangzte,* p. 98.

Gunwale. (Figure 45, p. 174) The upper edge of a vessel's side, often including an inner part (inwale, and outer part (outwale or rubrail) and a top part (gunwale cap).

Hold. The interior of vessel hull. The word is often used to refer to cargo or equipment compartments of a merchant or fishing vessel.

Hood end. The ends of hull planks that fit into rabbets at the stem and sternpost.

Hull. The body of a vessel exclusive of its hardware, equipment, and sail rig.

Junk. Generally used to describe a decked Chinese watercraft over 40 feet in length.

Keel. The main center-line longitudinal structural timber of most hulls, upon which the frames and ends of the hull are mounted; the backbone of the hull. A keel often project down below the planking of a vessel.

Leech. (Figure 43, p. 172) The after edge of a fore-and-aft sail.

Luff. (FIgure 43, p. 172) The forward edge of a fore-and-aft sail.

Mast. A vertical pole that supports a sail rig.

Mast partner. The timber surrounding the deck opening for a mast, intended to provide important support for the upright position of the mast. Often wedges are driven between the partner and the mast in order to further secure the mast at this point.

Mast step. A large timber usually laid fore-and-aft across floor timbers and mortised to receive a tenon on the foot of the mast. The mast step of the Rat Rock Cove West Junk featured two mortises, presumably to receive either two tenons on the foot of the mast or more likely the ends of the wedges driven down through the mast partner.

Mortise. A rectangular notch carved into a timber, usually to receive a tenoned component.

Nib. The practice of squaring hull and deck plank ends to avoid fine, sharply angled ends prone to distortion and splitting.

Planking. The outer lining, or shell, of a hull. The word is also applied to timbers covering the decks of a vessel, in which case it is called "deck planking."

Port. The left side of a vessel when facing forward.

Rabbet. A groove or cut made on a piece of timber in such a way that the edges of another piece can be fit into it to make a tight joint. Generally, the term refers to the grooves cut into the sides of the keel, stem, and sternpost into which the garboards and hood ends of the outer plank are seated.

Rocker. The intentional fore-and-aft curvature of the bottom of the keel or bottom board.

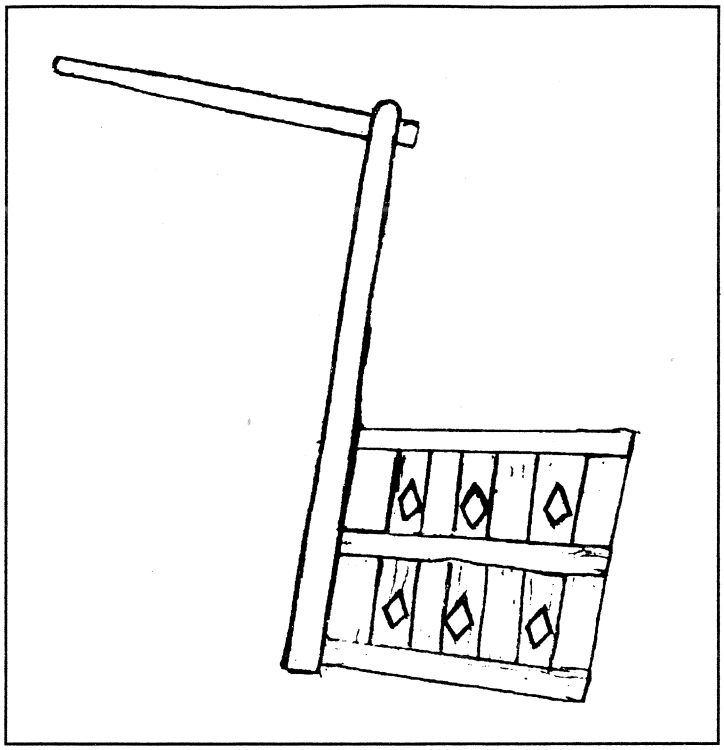

Figure 47. Sketch of a typical rudder used on San Francsico shrimp junks, as derived from historic photographs.

Rudder. (FIgure 47) A timber, or assembly of timbers, that can be rotated about an axis to control the direction of a vessel under way. The typical rudder of Guangdong province and also of the San Francisco shrimp junks featured a long, heavy post, through which was slotted three horizontal timbers forming the frame of the rudder blade. Onto this frame was nailed vertical timbers, into which were carved diamond-shaped holes, or fenestrations. Into the top of the rudder post was slotted a long tiller. The rudder was mounted by slotting the rudder post down through the keyhole-shaped apertures carved into the gudgeon shelves at the transom.

Sampan. Literally, meaning three planks, but generally applied to all Chinese open, or half-decked boats of 40 feet or less.

Scantlings. Specifications for the width and thickness of the principal timbers of a vessel, particularly the frames, floors, planks, and keel.

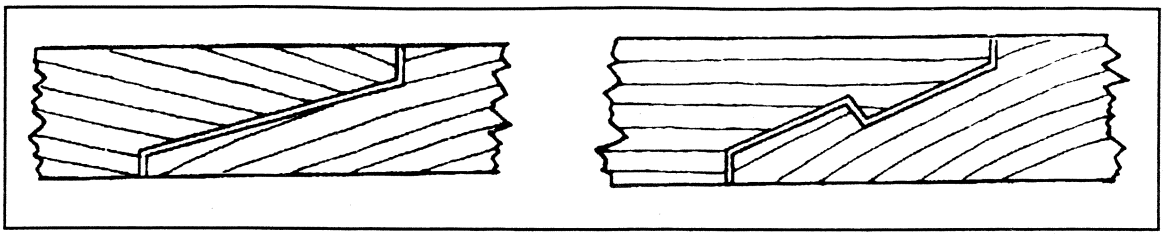

Figure 48. Two Chinese methods of scarfing. The method on the left was noted in the archaeological record of the Rat Rock Cove West Junk, as well as in the ethnographic record of the Pearl River Delta. in 1999.

Scarf. (Figure 48) A joint by which two timbers are connected longitudinally into a continuous piece, the ends being halved, notched, or cut away so as to fit into each other with mutual overlapping.

Sheer. The top line of a hull as seen in profile; also, the amount of curvature in this line, or the difference in height between the ends and the middle of the hull.

Spar. The poles in a sail rig used for booms, gaffs, and masts.

Starboard. The right side of a vessel when looking forward.

Stanchions. An upright supporting post, including supports for deck beams, bulkheads, coamings, and gunwales.

Stem. The upright structural member forming the pointed end or ends of a vessel, to which the ends of hull planking are fastened.

Stern. The after or back end of a vessel.

Sweeps. Large oars used to propel and sometimes steer a vessel through the water.

Tabernacle. A timber assembly or housing that supports a hinged mast and facilitates its raising and lowering.

Tenon. A wooden projection cut from the end of a timber or a separate wooden piece that was shaped to fit into a corresponding mortise.

Thole pin. (Figure 45, p. 174) A pin, or one of a pair of pins, set vertically into a gunwale to serve as a fulcrum for a sweep or an oar. Chinese thole pins generally feature a number of grooves which allow the rower to adjust the height at which the grommet fastening the oar to the thole pin hangs. This adjustment presumably allows the rower to adjust to the changing height of the hold according

to the amount of cargo or equipment being stored there, as well as a changing amount of freeboard.

Thole block. (Figure 45, p. 174) A block of wood fastened onto a gunwale to house a thole pin or a pair of thole pins.

Thwart. (FIgure 45, p. 174) A transverse plank in a vessel, often used to seat rowers and sailors, support masts, or provide lateral stiffness.

Topsides. The outside part of a hull above the waterline.

Transom. The aftermost athwartships bulkhead giving shape to and supporting the stern.

Windlass. A horizontal cylinder used to haul anchors and fishing line. In Chinese traditions, and in the San Francisco shrimp junks, these were tenoned into two posts which themselves were partnered at the deck level and presumably stepped into timbers lying across floors. The windlasses were turned by hand and feet using long handles inserted into the body of the cylinder. The windlasses in the San Francisco vessels could apparently be removed at will.