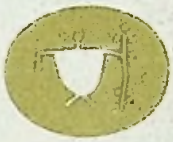
ARTS AND CRAFTS OF HAWAII

BY TE RANGI HIROA
(PETER H. BUCK)

VI
Canoes



or additions have been made. The author wrote them as autonomous sections, capable of standing alone, rather than as chapters. It is felt that this altered presentation will allow the contents to be used with greater ease and will allow as well for their broader distribution. It will also allow for expansion and revision through time by other students of Hawaiian material culture who will take their inspiration from Buck's pioneering efforts. Although the survey of Hawaiian arts and crafts is magnificently comprehensive and resulted from at least sixteen years of intensive work, Sir Peter would have been the last to claim that the treatment is complete. Had he lived longer, the contents would have been expanded, beyond a doubt.

Finally, it should be noted that the reprinting of any document as it appeared at a given point in time often does the author an injustice. Discoveries and developments subsequent to the time of the writing cannot be included and, for this reason, what may seem to be incompleteness and even some errors of fact may result. Dr. Buck's work endures the test of time remarkably well. A classic work, appreciated by professionals and lay readers alike, it stands as a lasting tribute to the passing cultures of Polynesia, provided by one of their own, possessed of rare scholarly eloquence.

ROLAND W. FORM

Bernice P. Bishop Museum
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CONTENTS

VI

CANOES

INTRODUCTION

Canoes (*wa'a*) were vital to the Hawaiians, not only for peaceful and warlike transport between the islands, but to enable them to harvest the rich food resources provided by the fertile sea. Kamakau states that the vessels of the early ancestors who came from Tahiti were made of planks but that in the time of Laka, they were made from single logs. Be that as it may, the double and single outrigger canoes at the time of European contact were dubbed out of solid tree trunks and the freeboard was increased by the addition of gunwale strakes. They were made in large numbers, for Ledyard (1783, p. 103) says that two of Cook's officers were ordered to make a count of the canoes surrounding the ships in Kealakekua Bay. Both counts exceeded 3,000 canoes; and though it is hard to see how such a large number could be accurately counted with the canoes moving about, the figures indicate the extraordinary number that assembled. It was estimated that the canoes carried at least 15,000 men, women, and children besides those swimming and on surfboards. On a later visit to Kealakekua Bay in 1779, Cook's ships found that there were "not fewer than a thousand [canoes] about the two ships, most of them crowded with people, and well laden with hogs and other productions of the islands." (See Cook, 1784, vol. 2, p. 458.) Thus, during the period of early contact the canoes were used in trading native produce for foreign goods.

The canoes of Hawaii have been described in detail by James Hornell in an authoritative work, "Canoes of Oceania," written in collaboration with A. C. Haddon and published by Bishop Museum in three volumes (Special Publications 27-29). Hornell was assisted in his compilation by access to material in Bishop Museum, particularly a manuscript on the double canoe written by Victor S. K. Houston of Honolulu. Houston's manuscript was ready for publication, but he unselfishly turned his material over to Hornell when he heard that Hornell and Haddon were engaged on the larger work. Much valuable information was also obtained from the accounts of early voyagers and from the monumental monograph by F. E. Paris, a French admiral. published in 1841.

I have used Hornell's work as well as Kamakau's collected articles in writing this report. However, some pieces of old canoes in the Museum collection have provided additional details on the Hawaiian technique of lashing the gunwale strake and end pieces.

RELIGIOUS CEREMONIES

Tutelary Deities

Canoe building (*'oihana wa'a*) was conducted by skilled craftsmen (*kahuna kalai wa'a*) who, in addition to being expert in designing and shaping the vessels, possessed a knowledge of the religious ceremonies to be observed at various stages of the work. The religious ritual consisted of offerings and chanted prayers addressed to the tutelary deities of the craft. The gods of the craft, as listed by Kamakau, were Kupulupulu and five other forms of Ku. It is probable that the six names enumerated various attributes of the one god, Ku. In most of the other parts of Polynesia, Ku (or Tu) was the god of war, and the god of forests and canoe building was Kane (Tane). It is therefore evident that the Hawaiian ancestors confused the functions of the two gods and erroneously transferred the functions of Kane to Ku. However a god by any name would perform the functions attributed to it by its worshipers. Lea, as the wife of one of the forms of Ku, was the female deity of the craft. Her visible representative, or incarnation, was the *alapaea* woodpecker [probably the *elepaio*]. When a tree was felled for a canoe hull, Lea, represented by the bird, kindly gave expert advice as to the soundness of the tree. If, when the bird appeared, it walked the whole length of the trunk without pausing, the wood was sound. On the other hand, if the bird stopped and pecked at the bark, the tree had a hollow or flaw at the spot pecked and was thus condemned by the higher authority. A variant to this form of diagnosis was the interpretation of a dream by a priest to whom the prospective owner reported that he had located a suitable tree. The priest slept beside the shrine in the men's house (*mua*); and if a naked man or woman appeared in a dream, the tree was condemned as having some hidden flaw and the canoe seeker had to find another tree. If the priest dreamed that he saw a well-clad man or woman, the tree was approved as sound.

Felling the tree

The head builder, the prospective canoe owner, and assistants took offerings of a pig, red *kumu* fish, coconuts, and *'awa* to the site of the selected tree in the evening. After the appropriate prayers had been recited, they slept the night near the tree. In the morning the pig was cooked and eaten and the other offerings disposed of. The felling of the tree was begun by the cutting of two scarfs about 3 feet apart and one above the other. The intervening wood was split off in the vertical grain of the wood. The scarfs were continued around the tree on the same level. When the intervening wood was removed all round. the scarfs were deep-

ened; and so the work proceeded, with the time necessary for felling the tree depending upon the number of expert craftsmen engaged in the work. When the tree began to crack and fall, all voices were lowered. The head builder, adz in hand, mounted the fallen trunk and, facing the stump, called to the gods, "Give us a canoe! Smite with the adz and hollow the canoe!" He faced about and, after girding on a ceremonial white loin cloth (*malo*), proceeded to strike along the trunk with his adz until he reached the place for cutting off the branched end. He tied a piece of *'ie'ie* vine around the part to be cut, and the other craftsmen proceeded to sever the end. When severed, the tapu which had invested the tree was automatically removed and all could share in the work.

CANOE VARIETIES

A number of names were applied to various forms of the canoe. The following list is recorded by Malo (1951, p. 131), but the definitions are amplified by me.

kaukahi: canoes with one hull; the outrigger canoe
- ko'okahi, ko'olua, ko'okolu, ko'owalu, etc.: canoes holding one (kahi) to eight (walu) persons
- kioloa: long narrow racing canoe
- pou: a short canoe
- lele'iwi: canoe with broad bow ornament (manu ihu)
- ihunui: broad bow made from butt end of log

kaulua: canoe with two equal hulls; the double canoe
- ku'e'e: double canoe with one hull shorter
- peleleu: large double war canoes made for Kamehameha I in 1796

pukolu: canoe with three hulls; an experiment which failed

THE HULL

PRELIMINARY SHAPING

The preliminary shaping of the log took place at the tree site to get rid of superfluous wood and thereby lighten it for hauling to the canoe shed near the beach. The log was tapered at each end for the pointed bow and stern. The sides were trimmed down and the bottom or *kuamo'o* [back bone of the canoe] rounded. The log was turned over and the upper side flattened (*hola*). The hollowing out of the hull was directly supervised by the head craftsman and he decided where the side projections or comb cleats (*pepeiao*) for the seats should be located. A neck (*maku'u*) was cut on the stern end for the attachment of the hauling lines. The stern end of the hull was deeper and wider than the bow end; thus it was always made at the butt end of the log, except in one form of canoe termed *ihunui* (large bow).

As the stone edges were soon blunted, a large number of adzes were used in the work. In addition to the skilled craftsmen who did the woodwork, there were

two sets of assistants who attended to the sharpening of the tools. One group undid the lashings of the blunted adzes and sharpened the edges. The second group took the sharpened adzes and lashed them to the handles. Thus a primitive production line speeded up the work by enabling the master craftsmen to devote full time to the more difficult part of production.

HAULING THE HULL

The head craftsman conducted a ceremony termed *puikawa'a*, in which he prayed that the gods would protect the canoe from damage until it was safely housed in the canoe shed. Men and women assembled for the hauling which was made into a festival, with pigs and other food. The best route was cleared of wood and stones, and marshy places were avoided. The hauling rope was attached to the *maku'u* neck, and the people hauled the canoe, stern foremost, over the prepared route. An expert guided the hull by pushing against the forward end to change direction. The head craftsman, or priest, followed some paces behind; and no one was allowed behind him, as that space was reserved for the ship-building gods who were present in spirit. Great care was exercised in lowering the hull over steep places or cliffs, and it was evidently this need for special help that led to inclusion of Kuhooholopali (Ku-the-guider-over-cliffs) among the various names of Ku. And so with hauling chants and general pleasure, the hull was safely conducted to its haven in the canoe house.

FINISHING THE HULL

The hull was finished off in the canoe shed. Work started on the upper part, which was trimmed and the upper edges of the gunwales shaved down to a fairly straight line without sheer. The sides were shaped further and smoothed down as far as possible with the stone adzes. The hull was then turned over and shaped to form a rounded bottom without a keel and adzed in a longitudinal curve with a sheer at each end. The hull was again turned over and the hollowing out of the interior (*kupele maloko*) completed. The diminishing width of the hold toward the bow and stern was too narrow for the free employment of ordinary adzes. This problem was solved in Hawaii, as in other parts of Polynesia, by the use of a special socketed adz termed *ko'i 'awili* or *kupa 'ai ke'e*. A special rounded socket, to which the stone adz was attached, could be turned in a groove on the foot of the haft. Thus the edge of the adz could be turned to any angle to lie more nearly in the longitudinal axis of the haft and function like an ax. The inner sides were trimmed fairly straight from the top down, until they curved inward at the bilge.

The method of shaping the hull was the same for the two hulls of a double canoe as for the single hull of an outrigger canoe. One of the finishing touches was the smoothing down of the outer surface of the hull before it was painted.

Stone Canoe Rubbers

Stone rubbers (*pohaku 'anai*) were used to smooth and polish the outer surface of the canoe hull. The term *pahe'e* (smooth, slippery) was sometimes included in the descriptive name as in *pohaku pahe'e 'anai.* Similar rubbers were used to smooth and polish wooden bowls (*'umeke la'au*) and rougher ones for rubbing off the singed hair of pigs (*pua'a*) before cooking. The particular function of the rubber was indicated by adding the name of the object. Thus the canoe rubber was *pohaku 'anai wa'a*; the bowl rubber, *pohaku 'anai 'umeke la'au*; and the pig rubber, *pohaku 'anai pua'a.* Still more detail was added by including the name of the kind of stone or substituting it for the general term *pohaku.*

J. S. Emerson's catalog (p. 18) enumerates six kinds of rubbers and the order in which they were used as follows: 1, *puna* "a fine coral"; 2, *pohaku 'eleku;* 3, *'ana;* 4, *'oahi;* 5, *ola'i;* and 6, *'o'io*, "the last and finest stone used." The definitions in the Andrews-Parker Hawaiian dictionary (1922) proved too vague and general to help in identifying the different kinds of rock. However, I checked several canoe rubbers from the Emerson collection against the numbers and names given in Emerson's catalog and concluded that the names used by him were obtained from the old Hawaiians from whom he got the rubbers. The rubbers given as *pohaku 'eleku* or simply *'eleku* are of vesicular basalt or lava crust with a coarse rubbing surface, the *'ana* specimens are large pieces of pumice, a well-made *'oahi* rubber is a dense coral reef rock, no labeled specimens of *ola'i* are present, and several well made *'o'io* rubbers are made of close-grained basalt. This is probably accurate as regards Emerson's terms, but some confusion occurs in the Museum catalog through the use of the same term for different kinds of stone.

The rubbers and polishers in the Museum collection number 350 pieces of various sizes, shapes, and kinds of rock. Of these, 160 are large enough to be used as canoe rubbers. No specimens of the *puna* close coral are included. They were probably large pieces of suitable coral used in the initial rubbing down process to remove the edges between the adz marks and must have been thrown away after they were worn down. Several specimens of the coarse vesicular basalt (*pohaku 'eleku*), also used in the early stage of rubbing, are found in the collection. These are mostly irregular pieces with one level surface and weigh about a pound or slightly more. An occasional piece is roughly shaped, as in figure 182, *a*. Pieces of lava crust less than an inch thick were also used. Though they were natural pieces broken off the crust, the under vesicular surface formed an excellent rasp. The next stage of smoothing was done with large pieces of pumice (*'ana*) of a natural, irregular shape. Such rubbers show one or sometimes two level surfaces due to rubbing (fig. 182, *b*).

Emerson's fourth (*'oahi*) stage is represented by a well-made rubber of close-grained coral reef rock of circular shape with a flat under surface and

the upper surface evenly convex (fig. 182, *c*). The fifth (*ola'i*) stage is here omitted for want of definite information. The sixth, or last (*'o'io*), polishing stage was definitely made with rubbers of close- or fine-grained basalt. Many consist of natural beach-worn stones, but all have a smooth, shiny rubbing surface. The majority, however, are well-shaped in various forms. The commonest and most attractive form is the circular plano-convex type similar to the *'oahi* specimen (fig. 182, *d*). They range in diameter from 3 to 6 inches, in maximum thickness from 1.5 to 3.3 inches, and in weight from 1 pound to 8 pounds. A few have a knob on the upper convex surface (fig. 182, *e*), and others have the convex upper surface slightly flattened. A few are disk-shaped, resembling throwing disks, but polished surfaces indicate their use. All the rubbers of close-grained basalt come under the name *'o'io*, which thus indicates the material and not the shape.

Of the whole series of 160 rubbers, about 100 are made of close-grained basalt. Some, of the attractive plano-convex form, are made of a grayish basalt. A few are made of material resembling silica. Coral, reef rock, and limestone rubbers are small, and were evidently used on wooden bowls.

FIGURE 182.—Canoe rubbers: a, of coarse basalt, roughly shaped; b, of pumice; c, of coral; d, e, of close-grained basalt.

PAINTING THE HULL

According to Malo (1951, p. 129), the outside of the hull was painted before such hull accessories as gunwale strakes and bow and stern pieces were fastened to it. N. B. Emerson, in a note to Malo's text (1951, pp. 133-134), states that the ingredients consisted of the juices of certain *Euphorbia* plants, the inner bark of *kukui* roots, and the buds of banana flowers. The liquid obtained by pounding in stone mortars with stone pestles was mixed with charcoal made by burning pandanus leaves. The black paint so formed was termed *pa'ele*, as was the process of painting. Various writers have listed other ingredients, and it is probable that craftsmen used their own formulas. A dressing of *kukui*-nut oil was applied to give finish to the painted surface. According to Emerson, the finish had almost the quality of lacquer.

The paint was applied with a brush made from a piece of pandanus aerial root, one end of which was beaten to free the fibers from the soft interfibrous material. The other, unbeaten, end formed the handle.

The hull or underbody completed, attention was devoted to the hull accessories, which consist of the gunwale strakes, the end pieces, the thwarts, and the U-shaped braces.

HULL ACCESSORIES

The dug-out hull, or underbody, was built up higher by the addition of side and end pieces to the upper edge of the underbody. In modern canoes, these parts are nailed, screwed, or bolted in position; and no complete Hawaiian canoe with the old technique has survived. Fortunately, some old pieces which had been concealed in caves in Lanai were discovered by Hector Munro; and these, with some discoveries made by Emory, are preserved in Bishop Museum. The individual side and end pieces have been described in detail by Emory (1924, pp. 89-92). They show that the lashing holes (*puka 'aha*) were made with a technique peculiar to Hawaii.

The interior of the hull was fitted with U-shaped spreaders and thwarts, the spreaders taking part in the lashing of the cross booms in double and outrigger canoes. Certain implements were also used in connection with making the lashing holes for the side and end pieces (p. 265).

Gunwale Strakes

For practical purposes, the length of the hull gunwale was divided into three unequal sections and the side planks, technically termed the gunwale strakes (*mo'o*), were fitted to the middle section on each side by a double scarf joint. The scarf joint was formed by recessing the lower edge of the strake plank on its inner side for about half its thickness and for a varying depth. The gunwale edge was treated in a similar manner on the outer side so that the two edges fitted neatly together. However, the gunwale strake was thicker than the gunwale edge and its lower edge projected outward beyond the outer side of the hull (fig. 183, *a*).

Gunwale strakes in modern canoes are 6 or more inches wide, but the salvaged fragments from seven old canoes are much narrower, with a range of 1.6 to 2.4 inches. A complete strake (B.7690) is 7 feet 3 inches long, 1.7 inches wide, and 0.8 inch thick. The inner recess at the lower edge is cut in for half the thickness, 0.4 inch, but the height is only 0.2 inch. The recess extends the full length of the strake, but the two ends are cut to form tenons which evidently fitted into mortices in the adjoining ends of the end pieces. This tenon and mortice join for the ends is not found in the other specimens, and was probably a later development due to the use of steel tools.

The lashing holes (*puka 'aha*) are peculiar in being remarkably narrow longitudinal slits, averaging 0.6 inch in length and 0.15 to 0.2 inch in width. They are made on the inner side of the strake about 0.2 inch above the edge of the recess and on its under edge to the outer side of the seam formed with

the hull. The two perforations connect with a larger rectangular hole cut into the upper angle of the recess. A rectangular hole was also made through the hull below the junction with the strake. In the complete strake described there are 10 sets of holes spaced 8.25 to 9 inches apart. Parts of the original lashing remain in the large middle hole in the strake, and the material is flat five-ply coir braid in three rounds to each set of holes.

Hornell (1936, p. 10) states that the braid used in the lashings was passed through the lower hull hole from the inside, passed up through the lower strake

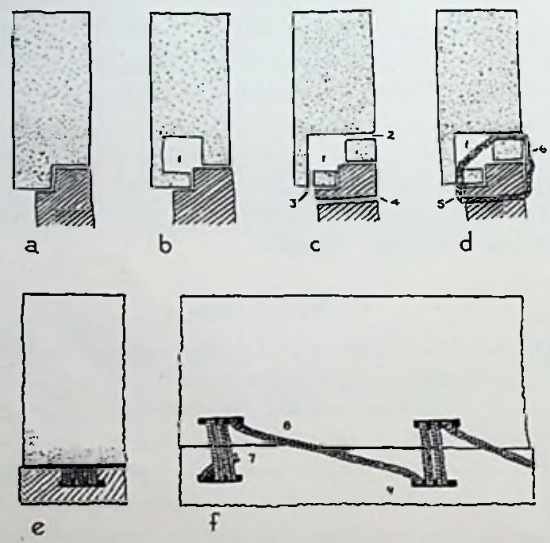

FIGURE 183.—Lashing gunwale strake (stippled) to hull (lined obliquely): a, double scarf join; b, rectangular hole (1) cut in from angle of recess; c, inner perforation (2) and lower perforation (3) connecting with rectangular hole (1) and straight hull hole (4); d, one round of lashing (5, 6); e, outer surface showing exposed course of lashing (*d*, 5); f, inner surface showing buried commencement end of braid (7), two rounds between upper and lower holes, the third round (8) passing on to lower hole (9) of next set.

hole, and on through the inner strake hole to the inside. After a number of rounds, the braid was carried from the upper strake hole on the inside to the lower hull hole in the next set and the turns repeated.

The stages of the peculiar hole and lashing technique are shown in figure 183.

END PIECES

End pieces were referred to generally as *na la'au* and more specifically as *kupe*. The somewhat vague term of *la'au* (wood) was rendered clearer by referring to the forward pieces as *la'au ihu* and the aft pieces as *la'au hope*.

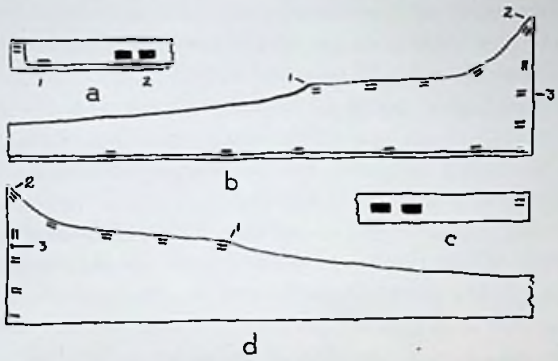

FIGURE 184.—Starboard stern piece: a, inner side of fore end, showing slit-perforations (1, 2) for lashings; b, inner side of wide aft part, showing continuation of lower edge recess, lashing slits, and (1) obtuse angle, (2) end point, and (3) aft end; c, outer side of *a*, showing end slits and lashing holes; d, outer side of *b*, showing angles (1-3) and lashing holes.

They consisted of specially designed planks for each side of the fore-and-aft sections of the hull not covered by the gunwale strakes. They combined the functions of gunwale strakes and end covers. In the four stern pieces and one bow piece available for study the length ranges from 7 feet 6 inches to 9 feet 1 inch. Though varying in size, gunwale strakes were all made on the same pattern. There was no distinction, except that the bow piece had extra holes along the upper edge for the lashing of an intermediate cover (*kaupo'i*) not present in the stern. The shape and details of a starboard stern piece (B.7687) from Lanai, 7 feet 6 inches long, are illustrated in figure 184 and described as follows.

The inner side of the fore end (*a*) is recessed 1.1 inches to form a reciprocal join with the aft end of the starboard gunwale strake, where two horizontal slits indicate the form of lashing. The strake end is 2.2 inches wide and 0.9 inch thick. The lower edge is recessed to half the thickness and a height of 0.5 inch. Two sets of slit perforations 0.6 or 0.7 inch long and 0.15 or 0.2 inch wide (1, 2) are for lashing to the hull. These are made in the same way as the strake holes (fig. 183). Above the second set of holes (2), two large rectangular holes, 0.9 inch long and 0.5 inch wide, which pass straight through the wood are for the boom lashing. The inner side of the wide aft part (*b*) shows the continuation of the lower edge recess and the lashing slits in 8- to 9-inch intervals. The plank gradually widens from 2.2 inches through 3 and 4 inches until, at a distance of 72.5 inches from the fore end, it widens to 6 inches and the upper edge thins to 0.5 inch. Here, an obtuse angle (1) is formed when the upper edge becomes more horizontal before it curves up sharply to the upper point of the stern. Besides rising upward, the plank curves inward and, from the obtuse angle (1), meets the opposite plank in the middle line, the two being lashed together through the paired slits along the upper edge up to the end point (2). The plank is 11.5 inches wide at the aft end (3), and the edge has paired slits for lashing to the similar edge of the other plank to form a sharp wedge-shaped edge to the stern. The outer side of *a* (*c*) shows the end slits and the holes for lashing the boom. The outer side of *b* (*d*) has paired slits along upper and end edges.

Remnants of two-ply coir cord lashings in the lower edge holes revealed the material used in the lashing. As they were narrower than braid, as many as five or six rounds were made with each lashing.

The slit perforations at the upper edge for joining with the other plank are unique in that they are made in pairs about 0.25 inch from the edge and parallel with it. They are similar in size to the lower edge perforations, averaging 0.6 inch in length and 0.2 inch in width. The narrow bar between each pair is 0.2 inch wide. The upper edge between the obtuse angle and the stern point (fig. 184, *b*, 1, 2) is plain and fits against the similar edge of the other plank, which also has opposite paired slits. The slits pass through the planks. Lashing remnants in the slits show that two-ply cord was used and that the lashing turns passed over the bars between the slits on the upper surface and therefore must have crossed underneath to the opposite pair of slits, where they, in turn, passed up over the slit bar and returned underneath to complete the lashing turns. This curious technique is illustrated in figure 185.

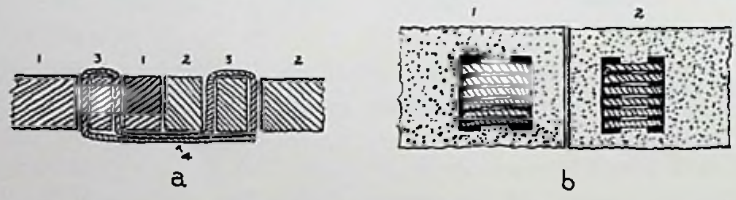

FIGURE 185.—Median join of end pieces: a, cross section through join, showing two planks (1, 2) with straight seam between and cord lashing (3) passing over bar between slits and passing underneath (4) to opposite slits; b, upper surface of planks (1, 2), showing cord turns with each pair of slits.

Besides the upward and inner curve of the wide part of the plank, the lower edge also curves inward with the hull gunwale so that the wide vertical edges at the aft end meet the edge of the plank on the other side. The vertical stern edge (fig. 184, *b*, 3) is also provided with paired slit perforations, of which the two upper pairs are vertical and the two lower pairs are horizontal. The direction, however, makes no difference to the lashing technique which is similar to that of the upper edges (fig. 184), the lashing turns crossing on the inside to similar paired holes on the other plank. The single slit at the lower end is for the end lashing with the hull gunwale. The lashings through the paired holes bind the two stern planks firmly together, forming the wedge-shaped stern end which is purposely made some inches short of the end of the hull underbody.

The bow planks were made in the same shape as the stern planks and they were lashed to the hull and to each other in the same way. A starboard bow plank (B.7689) from Lanai is 7 feet 10 inches long, 1.7 inches wide at the aft end where it joined the gunwale strake, and 8.5 inches wide at the bow end. The

width at the obtuse angle is 5.5 inches. The lower edge is recessed on the inner side and the external flange is so thin in one part that the lower lashing slits emerge on the outer surface. The vertical bow edge has five pairs of horizontal slits and the upper edge, in a length of 21.5 inches from bow point to obtuse angle has nine pairs of slits for joining with the other bow plank. Of these, the six aft pairs are alternately longitudinal and transverse and the other three pairs are longitudinal. The two planks had lateral convex expansions at the bow point and, when lashed together, formed an elliptical ornament termed *manu*. A similar ornament was formed at the stern. The gradual rise in width of the planks gave the upper edges, fore and aft, a sheer which was absent in the straight line of the hull gunwale.

Median Bow Cover

The median bow cover (*kaupo'i*) provided extra protection for the fore part of the hold by filling in the angular space between the two end pieces where they diverged from the end of their join at their obtuse angles. Unfortunately no fragment was preserved, but the bow end piece here described gives useful information regarding its lost companion. Stretching back from the obtuse angle for a length of 33 inches are nine single slit holes, 0.2 to 0.4 inch long and 0.15 to 0.2 inch wide, spaced along the upper edge. They are pierced downward through the upper slanting edge, which is 0.6 inch thick. The slits are obviously made for lashing to a bow cover, hence the cover must have been a little more

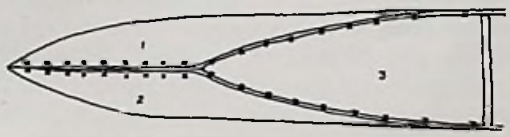

Figure 186.—Lashing bow cover to washstrakes, showing relation of bow cover (3) to the two bow pieces (1, 2).

than 33 inches long and provided with single slits along its corresponding side edge to correspond with those of the bow end piece. The remains of two-ply coir cords in the end piece slits show that two lashing turns were made with the short slits and three were made with the longer slits. As the slits are single, the lashing turns must have crossed the join on the outer surface and recrossed on the inner surface. The covers were triangular in shape, and the posterior free base was thick to provide a vertical transverse board to serve as a breakwater. The protection from the inrush of water was needed forward, and the stern received no coverage beyond that provided by the curved-in parts of the stern end pieces. The relation of the bow cover to the two bow pieces and their respective lashings are outlined in figure 186.

Thwarts

Thwarts, or canoe seats (*nohoana wa'a*), were boards fitted to the width of hull above the comb cleats (*pepeiao*) upon which they rested.

U-shaped Spreaders

Canoe spreaders (*wae wa'a*) were curved in a U-shape or at a more obtuse angle to fit against the sides of their respective canoes. On the outer side of each limb a notch was made at a distance corresponding to that from the comb cleats to the top edge of the gunwale strake. The outer sides of the limbs were trimmed flat from the notch to their ends. With the arch downward, the notches fitted against the comb cleats and the flat surfaces fitted against the inner sides of the gunwale strakes. The ends, which were level with the upper edges of the strakes, were cut off square; or at a slant, if the strakes had an outward inclination. Though the arch was rounded, the vertical diameter was usually 0.25 to 0.5 inch greater than the cross diameter. In four Museum specimens the vertical diameters range from 1.8 to 3.1 inches. The distances between the outer sides of the ends range from 15 to 18.5 inches, which is the inner width between the upper edges of the gunwale strakes. In longer canoes, the spreaders were more massive and were four-sided, the lateral surfaces greater than the upper and lower surfaces.

As the function of the spreaders was to assist in lashing the booms (*'iako*), they were adjusted to the comb cleats below the two holes (*puka 'iako*) in the gunwale strake for the boom lashing. Each comb cleat had two spaced holes, and the limbs of the spreader rested between them and the two strake holes. The spreader was lashed to the cleat by means of braid rounds passing through a cleat hole, over the spreader limb, and through the cleat hole on the other side. The rounds crossed each other diagonally over the spreader limb (fig. 187).

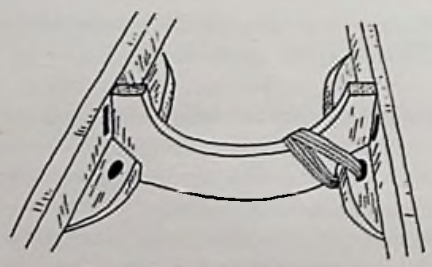

Figure 187.—U-shaped spreader.

Hornell (1936, p. 11) holds that the spreaders gave support to the sides of the canoe and probably represented true frames which had degenerated to serve a new purpose. However, there is no evidence to show that true frames were ever needed to strengthen the sides of a dug-out hull.

Builder's Implements

In addition to the larger adzes used in shaping the hull and accessories, a number of implements were used in connection with the attachment of the gunwale strake and the end pieces. These were chisels, hammers, clamps, and what appear to be caulking tools.

STONE CHISELS

Stone chisels (*pohaku pao*) with wooden handles (*kau*) were originally used to make the lashing holes in the gunwale strake and the hull gunwale. The holes formed were, therefore, rectangular or narrow slits. The rectangular holes and slits which passed straight through the wood were wider on the inner side and were evidently made from that side with an inward slant so that they were narrower on the outer side. The later chisels were made of steel, hence were termed *kila pao* (*kila,* steel). The canoe builders preferred them to the modern bit and brace because the rectangular holes better suited the form of lashing which had been developed.

STONE HAMMERS

Stone hammers (*pohaku kapili wa'a*) were used to tap the chisels in making the lashing holes. Most of them were ordinary hammer stones used for other purposes as well, but some were throwing disks (*'ulumaika*) which had been diverted from their original purpose. The disks gave a good grip for the finger, and some so used show signs of wear on the peripheral edge.

WOODEN CLAMPS

Wooden clamps (*puki'i wa'a* or *kaumo'o*) were used, according to Emerson's catalog in Bishop Museum, to bind down the gunwale strake (*mo'o*) while it was being secured to the canoe. The Museum collection contains six specimens, two consisting of two pieces united by a cord and four consisting of single pieces which have become detached. In one well-made pair (3594) the two pieces are 4.2 and 4.0 inches respectively. On their apposing sides they are flat for 3.3 and 3.1 inches, and the ends turn outward at sharply cut obtuse angles. On the outer sides they are evenly curved at the ends. In the middle they are 0.45 and 0.35 inch thick and 0.85 and 0.9 inch wide. Single holes are pierced through toward one end, and a two-ply *olona* cord with an overhand knot is passed through the two holes (fig. 188, *a*). In the second pair (3590) one piece is 3.3 inches long and perfectly straight, whereas the other piece, 6.1 inches long, has the ends turned outward. Both pieces are 0.5 inch thick, and their widths are a little greater. As in the first pair, each piece has a single hole toward one end and a two-ply cord 44.5 inches long, with a knotted end, passes through the two holes (fig. 188, *b*).

Of the four single pieces, three are perfectly straight and range in length from 3.4 to 4.7 inches. All have a single hole toward one end and all have two-

ply cords with a knotted end passed through the holes. The cords are 48, 54, and 64 inches long respectively. The remaining single piece, 5.7 inches long, has a double bend at one end and a hole toward the other (fig. 188, *c*).

Three single specimens in the Peabody Museum, Cambridge, have the double bend at one end, as in figure 188, *d*; and one has the other end turned up or out (fig. 188, *e*).

While the number of specimens proves that they were an established type, I have no information as to how they were applied. The most feasible explanation

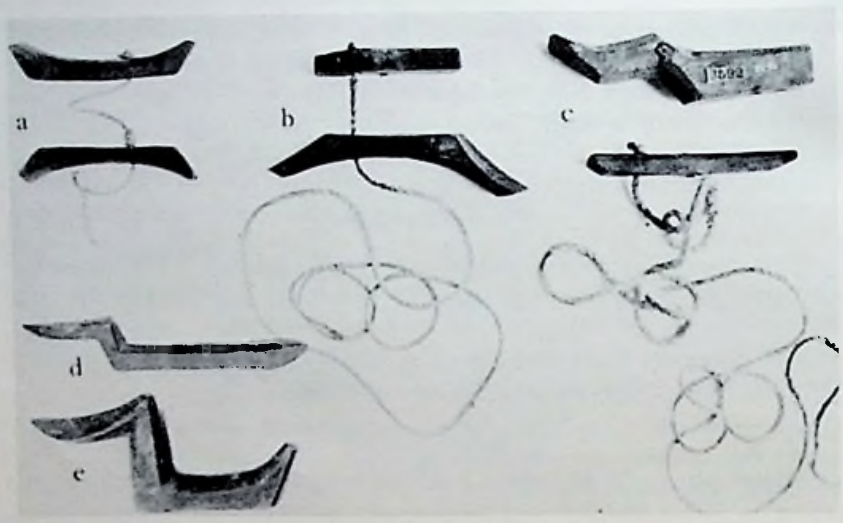

FIGURE 188.—a-c, wooden canoe clamps.

appears to be that when the gunwale strake was placed in position on the hull gunwale, several of these clamps were used to hold it in the correct position. The clamp piece without the knotted end was run off the cord and the piece with the knot was placed vertically on the outside of the lashing holes with the short end downward. The cord was then passed through the hull hole, the second clamp piece rethreaded on the cord, and the cord drawn vertically against the inside of the hull with its short end downward. The cord was drawn taut so that the upper ends of the clamp pressed against the sides of the gunwale strake. The long cord could then pass over the top edge of the gunwale strake and make outer and inner turns around the clamp pieces to retain the gunwale strake. When the permanent lashings were made the clamp was released at that particular set of holes to free the hull perforations for the lashing. The other clamps kept the gunwale strake in position and were released as the permanent lashings reached them.

CAULKING TOOLS

Five wooden implements in the Museum look like caulking tools. Though I do not see how caulking could be used in the double scarf joins, these implements are described here in order to place them on record. They are straight pieces with one end squared and the other trimmed to a rounded flat point. A cord drawn through a round hole toward the blunt end is stopped by an end overhand knot. Three implements range in length from 4.0 to 4.4 inches, and they are 0.8 inch wide by 0.4 to 0.8 inch thick. The cords range in length from 42 to 45.5 inches, with the free end thinned down. One cord starts and continues as a five-ply coir braid for 6 inches, then changes to a two-ply cord of *olona*. The other two cords are of two-ply *olona*. One of the specimens is described in Emerson's catalog (specimen 237) as a clamp (*pukiʻi waʻa*), and it is possible that the three with long cords are single members of paired clamps. However, the rounded flat points must have been made for some specific purpose.

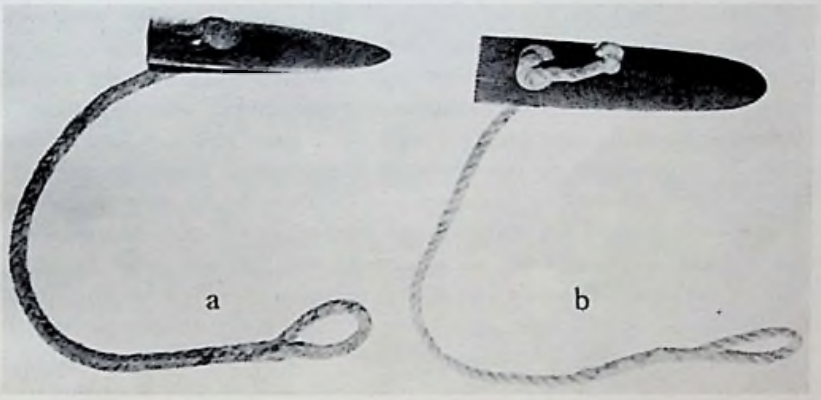

FIGURE 189.—a, b, caulking tools.

The other two implements, though of similar shape, are definitely complete single pieces, for they have short thick cords 16 inches long, including end loops 1.8 inches long when stretched. It is impossible for these loops to be passed through a hole in a paired piece, and the short length of the cord contrasts with the long cords of the clamps. One specimen (3595) is 4.5 inches long, 1.2 inches wide at the blunt end, and 0.5 inch thick. The rounded point has a short edge, and the cord is an eight-ply square braid of *olona* (fig. 189, *a*). The other specimen (B.6726) is 5.3 inches long, 1.45 inches wide at the base, and 0.5 inch thick. The rounded point is somewhat spatulate in shape, and a median edge is formed on each surface by trimming the sides to sharp edges (fig. 189, *b*).

DOUBLE CANOES

Double canoes (*wa'a kaulua*) are credited with being the vessels in which the Polynesians made their long sea voyages and in which the Hawaiian ancestors came from Tahiti. Their size not only accommodated more people and provisions than could single canoes, they were seaworthy. Kamehameha I built a large fleet of double canoes to transport his forces for the conquest of Oahu and the other islands. Malo (1951, p. 131) refers to them as *peleleu* and Emerson, in a note to Malo's text (p. 135), states that the *peleleu* were a fleet of very large war canoes which Kamehameha I began building in 1796 from *koa* trees felled in the forests back of Hilo, Hawaii. It was also during the time of Kamehameha I that an experiment was tried with a triple canoe (*wa'a pukolu*), but it evidently proved a failure. Double canoes were in common use at the time of the early voyagers, but the gradual increase in the number of foreign vessels displaced double canoes as a means of interisland transportation.

Double canoes had two parallel hulls, kept the required distance apart by cross booms (*'iako*), usually more than two in number. The hulls were formed by dugout underbodies, each made from a single tree trunk without any join for increased length. They were fitted with gunwale strakes, bow and stern end pieces, and median bow covers in the manner described in preceding pages. The interiors of the hulls were provided with comb cleats and U-shaped spreaders for the boom attachments. The bow ends of the canoes were distinguished by the breakwater; the median bow cover and the stern, by the short projection of the underbody beyond the wedge-shaped junction of the stern end pieces. The starboard hull was termed the *'akea;* and the port hull was called the *ama,* as it was on the same side as the *ama* float in outrigger canoes. When the available logs permitted, the two hulls were made of equal length; but when they had to be unequal, the shorter hull was placed on the port side. The same terms are used in central Polynesia, where the starboard hull is termed *katea* and the shorter port hull, the *ama.*

ACCESSORIES

Cross Booms

The cross booms (*'iako;* Polynesian, *kiato*) connecting the two hulls rested on the gunwale strakes and projected a short distance on the outboard side of each hull. According to Malo (1951, p. 130), the booms of double canoes in ancient times were straight though, in the time of Keawe, the curved boom was invented by Kanuha. Alexander (1891a, p. 46), however, says that Kanuha was the son of Keawe II and lived in the last quarter of the seventeenth century.

Curved booms were for the purpose of raising the height of the platform (*pola*) built upon them in the interval between the hulls and helped keep passengers and cargo dry. The booms had straight ends for fitting over the hulls,

with the curve in the middle. A curved boom preserved in Bishop Museum (fig. 190) is 7 feet long. The middle of the arch is 5 inches in diameter, and the diameters of the two straight ends are an inch less. The middle of the arch gives an additional elevation of 10 inches above the upper level of the gunwale strakes.

If one were to judge by small model canoes, the curved booms were easy to shape. But models give a false picture of actual details. In a Bishop Museum model canoe, the outboard ends of the booms are enlarged into rounded knobs, the booms rest directly on the underbodies, and the gunwale strakes are notched on the lower edge to fit over the booms. The booms are lashed to the U-shaped spreaders only on the inner side of the gunwale strakes and, consequently, there are no holes through the strakes and end pieces are in one piece instead of two. Thus the model is wrong in practically all details.

FIGURE 190.—Cross boom.

A small double canoe in Bishop Museum, 18.5 feet long, has single end pieces; but the boom lashings follow an old pattern (fig. 191). Two straight booms, 7 feet 2 inches long with a middle diameter of 4.5 inches, are laid over the gunwale strakes with short outboard projections. The U-shaped spreaders are lashed to the comb cleats, as in figure 187; but this lashing is omitted in figure 191 to avoid confusion with the turns of the boom lashings. In the rear view the far holes in the gunwale strakes are hidden by the limbs of the spreaders. The sennit braid, 0.4 inch wide and 0.2 inch thick, is of sufficient length to make the two lashings. The details, which are described below, are illustrated in figure 191.

In the first stage (*a*) the braid is doubled in the middle and the doubled end, loop upward, is laid against the rear side of the spreader (4) in the middle. The two ends (1′, 2′) pass under and over the spreader and through the loop to either side, the right part (2′) being left temporarily. The left braid (1′) passes obliquely outward through the left strake hole (2), under the boom on the left and over it to form the first outer round (3′). It crosses under the boom to pass through the far hole in the strake to the inside, whence it descends obliquely to pass under the spreader to the near side, then ascends vertically to form the first inner round (4′) over the boom. It descends vertically behind the boom and spreader (5′) to appear at the lower edge of the spreader on the right of its ascending part. This completes the first series of turns, which gives the key to the pattern.

In the next stage (*b*) the braid (5′) passes obliquely outward to go through the near strake hole, under and over the boom to form the second outer round (6′). It crosses under the boom, through the far strake hole to the inside, obliquely downward and inward on the far side of the spreader to its lower edge (7′) to the inner side of the first vertical turn over

the boom. It ascends vertically over the boom and descends on the far side (8′) to the lower edge of the spreader to complete the second inner round over the boom and complete the second series of turns.

Finally (c), a third series of turns follows the course of the second series, completing three outer turns around the boom and three vertical inner turns around boom and spreader. From the end of the third series (9′), the braid passes vertically upward in a fourth turn (10′) over the boom, descends behind the boom, and crosses obliquely downward and outward (11′) over the four vertical turns, passes behind them, and descends inward to be fixed with a slip overhand knot (12′) around the commencement part. The right half of the braid (2′) makes a series of turns similar to those on the left, and this completes the boom lashing on the right.

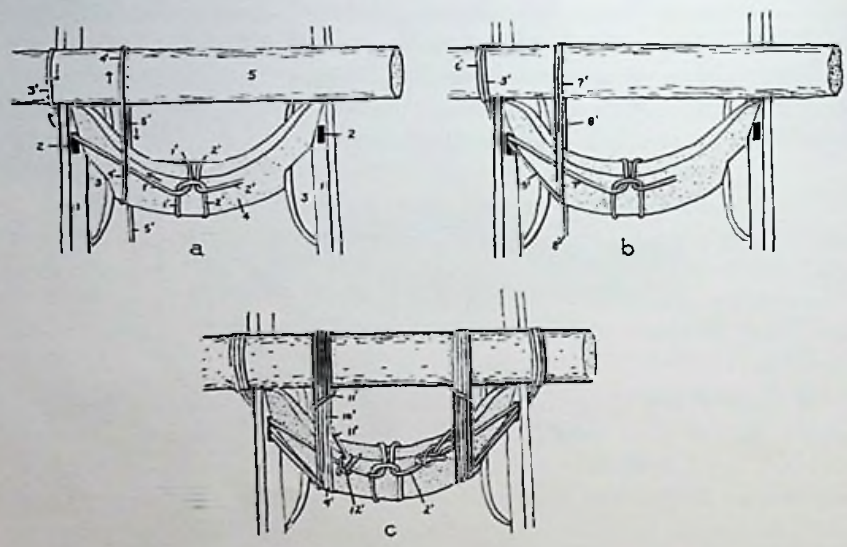

FIGURE 191.—Double canoe boom lashings. a, first series of turns, showing (1) strake, (2) strake hole. (3) comb cleat, (4) spreader, (5) boom: 1′, 2′, two ends; 3′, first outer round; 4′, first inner round; 5′, first turn around boom and spreader. b, second series of turns: 6′, second outer rounds; 7′, second inner round; 8′, second turn around boom and spreader. c, completion of third series: 9′, third turn; 10′, fourth turn; 11′, oblique turn over the four vertical inner turns; 12′, slip overhand knot.

PLATFORMS

A somewhat narrow platform (*pola*) was made of poles laid lengthwise over the booms and lashed to them. Another form consisted of a wide plank flanked by a pole on each side.

OUTRIGGER CANOES

More outrigger canoes (*wa'a kaukahi*) were made than double canoes because of their more general use and easier handling. The Reverend William Ellis (1827, p. 342) says that they were evidently calculated for speed and that one

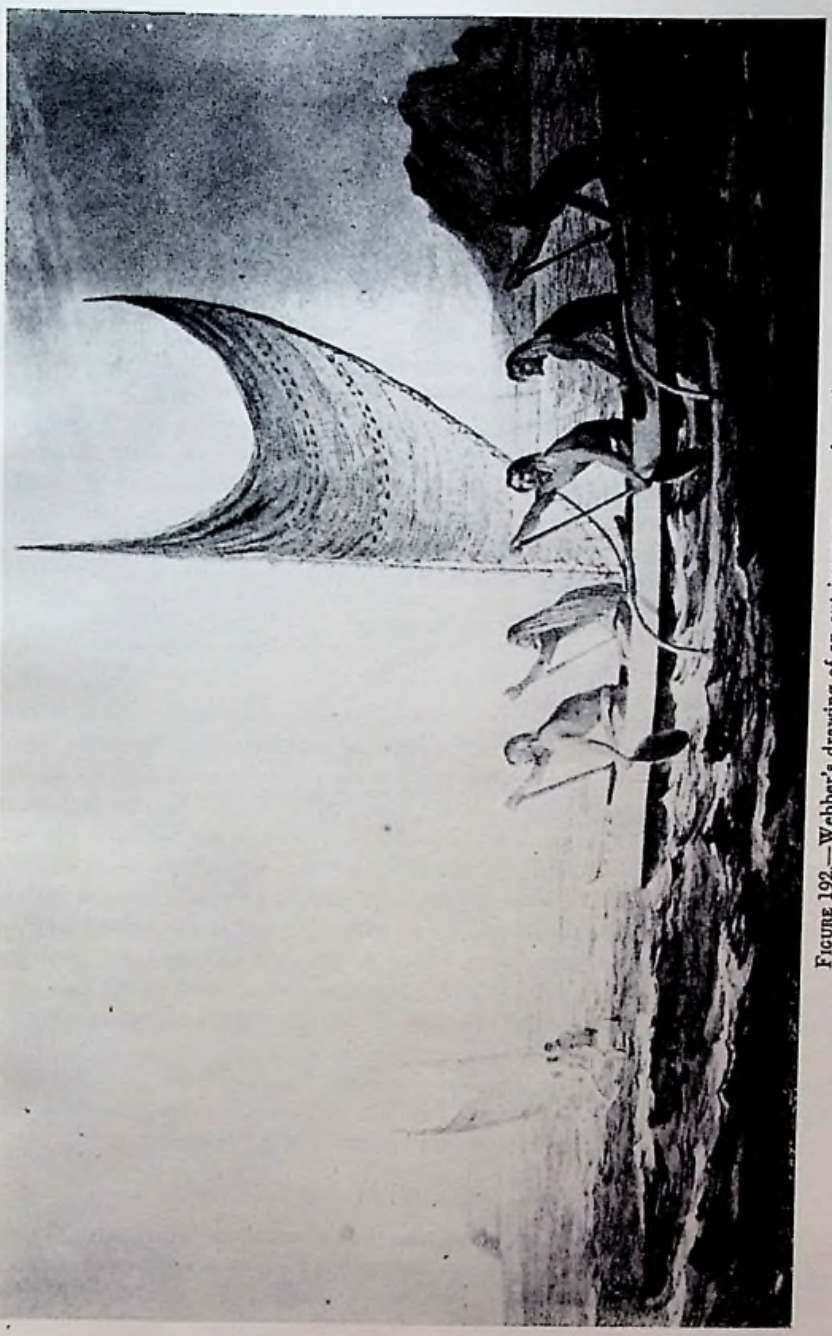

FIGURE 192.—Webber's drawing of an outrigger canoe under sail.

man could "paddle a single canoe faster than a boat's crew could row a whaleboat." The canoes were made of single tree trunks and were rarely more than 50 feet long, though exceptional ones were upward of 70 feet, 1 or 2 feet wide, and sometimes more than 3 feet deep. An occasional long log of Oregon pine floated ashore from the American coast, especially on Kauai, and such flotsam became the property of chiefs. Depth could be increased by one or more gunwale strakes; but length was restricted to the natural length of the available tree trunks in Hawaiian canoes. The method of joining for extra length observed in central Polynesia and New Zealand was not used by Hawaiian craftsmen. The hull and its accessory parts were built on the same plan as the hull of the double canoe. A drawing of an outrigger canoe by Webber is reproduced in figure 192.

The outrigger canoe survived longer than the double canoe because of its value in fishing. However, it underwent the changes brought about by steel tools and nails and screws. Furthermore, suitable *koa* trees became scarce. Today, the outrigger fishing canoe has been replaced by plank boats and motor launches. However, a few remain, and the Outrigger Canoe Club of Honolulu maintains a few for the entertainment of its members. One of the survivals, once owned by Kamehameha V, is on exhibition in Bishop Museum. It is 35.5 feet long, and the outside hull measurement is 20 inches wide and 26 inches deep.

ACCESSORIES

Outrigger Booms

Outrigger booms (*'iako*) have the same name as the double canoe booms had. They are two in number, as they are throughout the rest of Polynesia. Stout poles of *hau* wood were used in the natural state, but the parts that lay on the gunwale strakes were flattened on the under surface. The booms for larger canoes were adzed to four sides. The booms were always attached with the outboard long ends projecting on the port side, and they projected a short distance on the starboard side. The outer lengths were straight or curved upward slightly before they curved downward to connect with the float on the water line. The *kua 'iako,* or inboard parts, were lashed to the U-shaped spreaders and the gunwale strakes on each side. The aft boom was always closer to the stern end than the fore boom was to the bow end. In the Kamehameha canoe mentioned above the aft boom is 9 feet 9 inches from the stern and the fore boom is 12 feet 2 inches from the bow. The space between them is 13 feet 7 inches, thus adding up to the total length of 35.5 feet. The vertical diameter of the four-sided booms is 4.2 inches, and the horizontal diameter is 3.8 inches.

Boom and Hull Lashing

The boom lashings to the hull retained the old technique, and patterns varied according to the sequence of turns made around the boom and spreader and through the gunwale strake holes (*puka 'iako*). The simple form of vertical turns

described for the double canoe (fig. 191) is equally applicable to the outrigger canoe.

A pattern of oblique crossing turns is used in the Kamehameha canoe. The braid consists of three plies of two-ply twisted coir cords making a width of 0.4 inch by 0.2 inch thick. The commencement technique is by the loop method used in the double canoe (fig. 191, *a*). The sequence of turns, shown in figure 193, is as follows.

From the loop commencement shown in *a* (1′), the left braid (2′) is carried obliquely upward and outward behind the boom, over it, and obliquely downward (3′) to pass through the near hole in the strake. On the outside, it passes upward (4′) under the boom to the far side, crosses over it and descends obliquely inward (5′) to pass under the spreader near its junction with the comb cleat. It passes obliquely upward and outward on the far side of the spreader (not visible) in a long stretch similar to 5′ and appears on the upper side of the boom (6′) to the inner side of the previous turn, and crosses diagonally over it to the under side of the boom to pass through the far strake hole, whence it ascends obliquely inward on the far side of the boom to appear at its upper edge (7′) on the outer side of the first crossing of 3′. To avoid obscuring the loop commencement, the downward and inward oblique turn over the near side of the boom and parallel with 2′ to cross the near side of the spreader has not been made in the figure. However, it completes the first series of turns which sets the subsequent pattern.

In the second stage (*b*) the last turn (8′) of the first series is completed, which brings the braid down to the commencement point. It ascends obliquely upward and outward and completes two more full series of turns. When the third series is completed (9′), the braid repeats a fourth series (10′, 11′, 12′), but on rounding the lower edge of the spreader (13′), it ascends on the far side only as far as the crossing rounds.

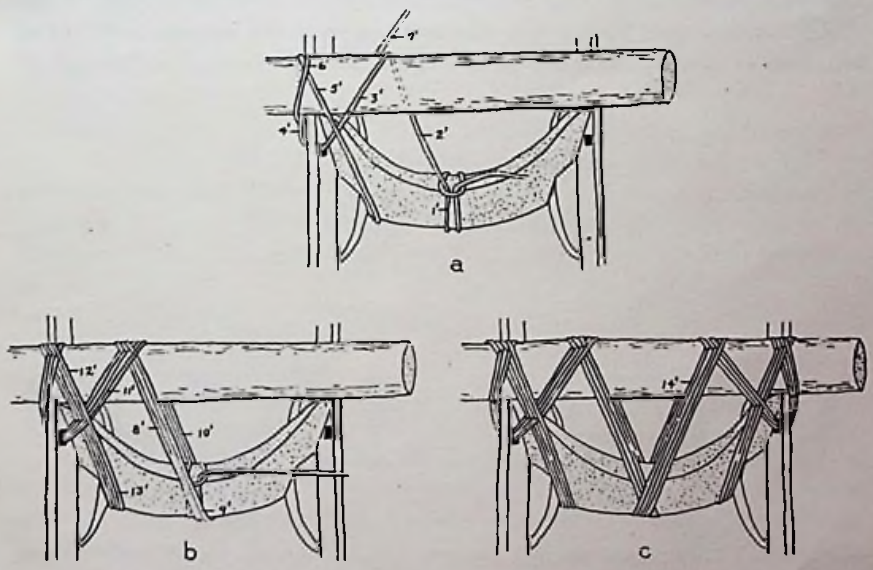

FIGURE 193.—a-c, boom and hull lashings, showing (3′-13′) the sequence of turns of left braid (2′) from the loop commencement (1′). The first oblique turn to the right is 14′.

In the third stage (c) the right end of the braid from the loop commencement proceeds to lash the right side of the boom, the first oblique turn (14′) being made over the near side of the boom instead of the far side. The same sequence of turns is made on the right, but the change in position of the first turn results in the opposite arrangement of the groups of threes and fours, as shown in the completed lashing with its attractive pattern.

The above-described lashing is very firm because the boom is lashed to the spreader in three places, the two sides and the middle. A line figure without the preliminary details is shown by Hornell (1936, p. 11, fig. 5, *b*) and also a photograph of the canoe of Kamehameha V (p. 22, fig. 12).

A lashing of a different pattern was made by a Hawaiian named Maunupau on an outrigger canoe at Kailua, Hawaii, and three stages of the technique were photographed by Emory. From the photographs and Emory's notes, the details have been worked out as shown in figure 194 and described below.

In the first stage (*a*) the knotted end (1′) of the lashing braid is laid against the middle of the back of the spreader at a slant and is crossed by two turns around the spreader to fix the commencement end. The braid (2′) is carried upward and outward to cross the boom. It descends on the far side to pass through the far hole in the left gunwale strake, crosses under and around (3′) the outboard side of the boom, passes inward through the near hole of the strake, ascends obliquely inward (4′) to pass over its previous course and over the boom. It descends obliquely inward from the far side of the boom (5′), and around the back of the spreader to appear at its lower edge (6′) near the starting point. This completes the first series of turns, which forms the key to the pattern. In *b* the first series of turns established in *a* is repeated four times, the outboard turns being on the outer side of the first turn (3′), the inboard turns on the inner side of the first turns (2′, 4′). A similar series of turns (c) is made on the right with the right half of the braid and completes the full lashing.

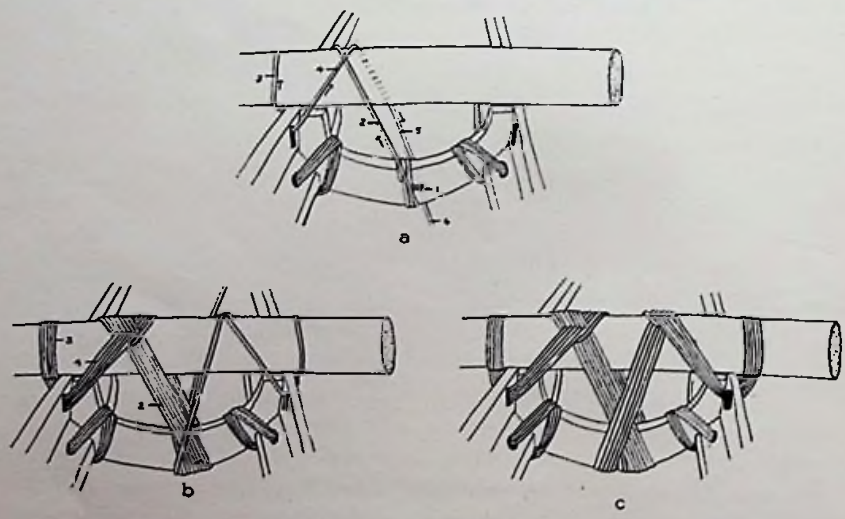

FIGURE 194.—a-c, boom and hull lashings, showing (1) knotted end and (2-6) sequence of turns.

The outer end of the boom for attachment to the float varies, as is shown in figure 195, *a-c*, which is copied from Hornell (1936, fig. 13, *a-c*). The downward sloping end was cut off square (fig. 195, *a*) or the under surface was grooved concavely to fit against the upper curve of the float (fig. 195, *b*). In some canoes the outer end was notched or formed an end knob as additional security against the lashing slipping (fig. 195, *c*). In a fragment from a cave in Lanikai (B. 4046), the outer knob is enlarged to 4 inches in length and 3 inches in height, and the upper surface is carved into a human face with the chin inward (fig. 195, *f*). Adjacent to the knob, the boom is 2.2 inches wide and 2.0 inches in vertical diameter. Farther inward, the diameters are 2.6 inches by 2.3 inches.

Float

The wood preferred for the float (*ama*) was *wiliwili* wood because of its lightness; but if it was not available, *hau* was used. The length of stout pole selected had a convex curve, which turned downward in the water and allowed the two ends to rise above the surface. The aft end (*kanaka*) was cut off square or trimmed above and below to form a horizontal edge. The fore end (*lupe*), as described by Hornell (1936, p. 23), had the sides cut away to form a thin vertical board. He quotes Freycinet as saying that it represented a conventionalized lizard's head, but the resemblance is not even faintly visible. The vertical board has a sloping fore edge like the bow of a canoe and looks more like a cutwater to lessen water resistance when the fore end was submerged. In the Kamehameha V canoe (p. 272), with a length of 35.5 feet, the float is 19 feet 3.5 inches long, and the distance from the middle of the canoe to the middle of the float is 10.7 feet.

The specialized shape of the fore end is peculiar to Hawaii, as is the curved form of the float. Hornell (1936, p. 23) quotes Paris as remarking that the curvature was originally more pronounced and that it created a compensatory effect by its action, for on entering and leaving the water progressively, the resistance offered was neither so great nor so sudden as it would be with a straight float.

Kamakau says that the *wiliwili* floats were trimmed into shape with wooden adzes made of *walahe'e* wood.

Boom and Float Lashings

According to Hornell (1936, p. 22), the boom is lashed to the upper side of the float by several turns of sennit around the float and the end of the boom, which is either upcurved or notched on the upper side to make the lashing more secure (fig. 195, *d*). In an alternate method, two holes are bored transversely in the float and several turns of lashing are passed through the holes and around the end of the boom (fig. 195, *e*), which is either upcurved or notched on the

upper side, or may be left plain with the underside cut and shaped to fit upon the surface of the float.

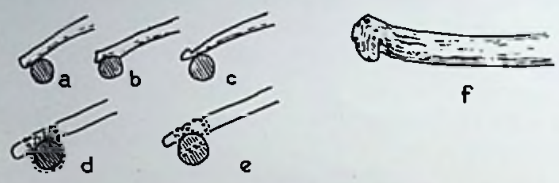

FIGURE 195.—Boom attachment to float: a-c, three forms of boom ends. d, e, two methods of attaching boom to float: *d*, by passing lashing around float; *e*, fastening boom to float by passing lashing through transverse perforation. f, fragment from Lanikai cave, showing end of boom carved to resemble a human face. (*a-e* after Hornell.)

FISH-SPEAR RACKS

Some of the fishing canoes had racks attached to the outboard part of the fore booms to hold fish spears and canoe poles. The common form was arched with a straight upper edge which was cut into three or four concave notches in which the spears rested. The lower ends were cut at a slant to rest lengthwise on the booms. The Museum's small double canoe with no *pola* platform has one arched rack on the fore boom. The lower ends of the rack are notched and the lashings are made over the notch and around the boom. Of seven specimens in the Museum collection, four are of the arched form with the lower ends perforated with rectangular holes through which the lashings passed. Two of this type are shown in figure 196, *a*, *b*. One of these has a small human figure perched on the lower end with the face looking outward. The figure on the other limb has been broken off.

Of the three other Museum specimens, one (3911) is a vertical board with three upper notches and two lower rectangular holes for the lashing (fig. 196, *c*). Each of the other two (3906, 3907) is ornamented at the upper ends with carved human heads (fig. 196, *d*, *e*). Hornell (1936, p. 24, fig. 16) figures the two carved racks and correctly labels them rod racks. Through some error, Brigham in a Bishop Museum Handbook (1915, pt. 1, p. 16) describes these same two racks as double-headed gods which "pious fishermen" placed in the bow of the canoe, and Hornell (1936, p. 25), after figuring them correctly, quotes Brigham's mistake.

The single rack on the fore boom was seen by Emory on two canoes when he was on Hawaii in 1924. These, with the single fore rack on the Museum double canoe, indicate that the racks were attached only to the fore boom, the other end of the spears and poles resting directly on the aft boom. No two of the seven Museum specimens are alike.

The Museum specimens are cataloged as *ihu wa'a*, which means "canoe

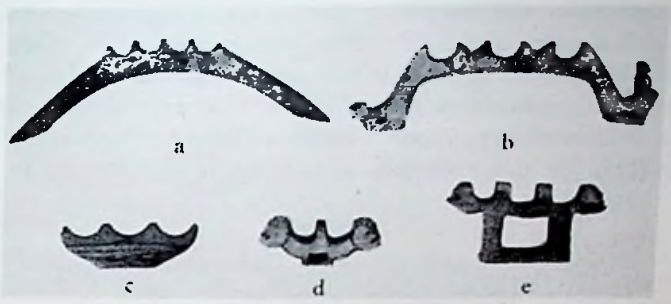

FIGURE 196.—Fish-spear racks: a, b, arched form; c, vertical form with two rectangular lashing holes; d, e, with carved human heads.

bow," and this name was accepted by Hornell in his work. However, the name seems singularly inappropriate for a rack attached to an outrigger boom, and Emory records in his field notes that the two he saw had the name of *haka*. The term *haka* is also the name for the racks from which water gourds and other household objects were suspended. Such racks consist of notched boards fixed horizontally to an upright stand. The evidence, therefore, indicates that *haka* was the correct term for notched racks, whether used in a house or on a canoe.

MAT COVER

According to Malo (1951, pp. 131, 135), a mat cover termed a *pa'u* was made to keep the water out of the hold of a canoe. The ordinary *pa'u* covered the waist of the craft, where the baggage and freight were stored. A larger *pa'u* was made to cover the hull opening from stem to stern as protection in stormy weather. Holes were made through which the paddlers thrust their heads and bodies. A number of holes were made along the upper edge of the canoe, and a line termed *'alihi pa'u* was lashed along the sides by small cords passing through the canoe holes. A line (*haunu*) was then crisscrossed from side to side through the loops of the *'alihi pa'u* to keep the mat *pa'u* in place.

PADDLES

Hawaiian paddles (*hoe*) are characterized by a straight thick shaft and a short wide blade, ovate in shape. In the Museum collection of 36 full-sized paddles, the total lengths range from 55 to 71 inches, with an average of 62 inches. The lengths of the blades (*laulau*) range from 19 to 26 inches, with an average of 23 inches. The blades' greatest widths range from 8.5 to 15 inches with an average of 12 inches. The greatest width is at approximately the middle of the blade or slightly above it; but in quite a few paddles it is slightly nearer the tip. The length of the shaft (*ku'au*) averages 39 inches, and its greatest diam-

eter in the middle is 1.6 inches with a fraction less at the end. The handle is not quite round in section but the differences in cross sections are slight. The long thick shaft with its short wide blade contrasts sharply with paddles from many parts of Polynesia, particularly New Zealand. This contrast is brought out by comparing the Hawaiian averages in inches with the measurements of a typical Maori paddle in my own collection.

	Hawaii	New Zealand
total length	62	58.5
shaft length	39	24
shaft thickness	1.6	1.3
blade length	23	34.5
blade width	12	5

The upper part of the blade forms an angular shoulder with the shaft, then makes a wide curve toward the sides. In a few paddles the blade runs out in a straight line for a short distance before the lateral curve starts. The thick shaft continues downward into the blade for a distance of 1 to 2 inches, depending upon the size of the paddle, and forms a short midrib like the short midrib of a leaf stalk. The shaft midrib is formed on both surfaces of the blade and gradually decreases in thickness until, at its end, it merges into the general surfaces of the blade. The sides of the midrib may run parallel or incline toward each other without meeting, or come together in a point. The three variations are about evenly divided as to number in the Museum series. The projection of the midrib is formed by trimming down the blade surfaces from a horizontal line at the end of the midrib to the upper edges of the blade, as shown in figure 197, *a*. The thickness of the blade edge near the shaft is about 0.3 inch but increases to 0.6 inch at the back of the horizontal line. From there the side edges decrease to about 0.2 inch. The thickness of the blade in the middle line at the end of the midrib is slightly more than an inch. This technique is described in detail because it is characteristic of Hawaiian paddles and helps to distinguish them from the short, broad-bladed paddles of Tonga and Fiji.

The blades of old paddles are flat on the back surface and slightly convex from side to side on the forward surface. In modern paddles both surfaces are evenly flat. The side edges average 0.2 inch in thickness and are rarely trimmed to a sharp edge.

A short rib, or thickening, termed *'upe* or *io* may extend upward from the tip of the paddle on the forward surface. Of 36 paddles in the Museum collection, 14 have the rib, always on the forward surface. This fact conflicts with Linton's statement (1923, p. 318) that the rib is present on either side. The rib varies considerably in length, width, and thickness. In an average paddle (307) the rib is 2.3 inches long, 0.3 inch wide, and 0.25 inch thick

from the blade surface. Hornell (1936, p. 17) refers to an affinity with the elongated tip of Micronesian paddles, thickened equally on each side. The same type of tip is found on paddles in the Polynesian atoll of Kapingamarangi (Buck, 1950, p. 207); but the affinity is vague, as compared with the old types of paddles from the Cook Islands wherein the rib extends upward on the forward surface only. Though modern paddles have changed, the rib is found in old paddles from Atiu, Aitutaki, and Mangaia (Buck, 1944a, figs. 126, 128, 129, 131).

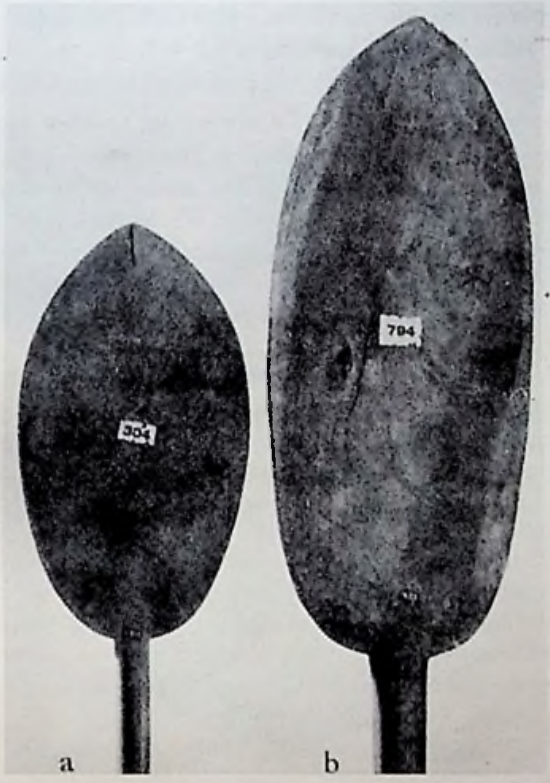

FIGURE 197.—Paddles: a, with midrib; b, steering paddle.

Hornell and Linton evidently shared the opinion that the ribs served no known useful purpose, but in the Cook Islands, the "known useful purpose" was to strengthen the tip of the paddle for the occasions when it was used in lieu of a canoe pole. In Mangaia the rib was lengthened, widened, and carved with geometrical patterns so that from being purely utilitarian, it became both useful and ornamental. The beak-shaped ends of the paddles of the Tuamotus,

Marquesas, and Mangareva originated in the purpose of combining the functions of a canoe pole and a paddle in one convenient implement. However, end results which may have been influenced by an affinity of purpose do not necessarily have to undergo similar evolutionary stages in construction.

Smaller paddles were made for women and children. Of four such specimens in the Museum, a typical one has the following measurements: length, 42.5 inches; handle length, 28.5 inches; handle thickness, 1.0 by 0.8 inch; blade length, 14 inches; and blade width, 7.75 inches. Of the four, two have the *'upe* rib at the blade tip. The paddles are well made and definitely not models. Women often assisted men in paddling when a large number of canoes was assembled to drive fish into nets in some forms of community fishing.

Steering paddles were made in the same form as other paddles but were larger. Hornell (1936, p. 17) says that they also differed in having a straight crutch-shaped hand grip, as figured by Choris and as is shown by a fine example in the British Museum. Bishop Museum has one steering paddle (794), which lacks the hand grip (fig. 197, *b*). Its dimensions are as follows: length, 88 inches; handle length, 50 inches; handle diameters, 2.7 by 2.0 inches; blade length, 38 inches; and blade width, 16 inches.

BAILERS

Canoe bailers (*ka wa'a*) of the general Polynesian pattern, a wooden scoop with a median handle projecting forward from the back, are lacking in the Museum collection. A single small specimen (C.3338) cataloged as a *ka wa'a* is made from a gourd cut lengthwise (fig. 198). Its length is 7.5 inches; its

FIGURE 198.—Gourd canoe bailer.

greatest width, 5 inches; and its greatest depth near the broad end, 2.75 inches. It is probable that some of the larger gourds cut lengthwise were used as bailers and not as food dishes. Though the original name of *ka* (Polynesian, *ta* or *tata*) was retained, the material and the form with the median handle was abandoned. It is also probable that the increased cultivation of the gourd offered more easily made substitutes and that the change in material involved the loss of the median handle.

ANCHORS AND CANOE BREAKERS

Stone anchors for canoes are termed *pohaku hekau* in the Andrews-Parker dictionary (1922). They were apparently not used much in fishing, as the fisherman kept his canoe in approximately the same place by using the paddle with his left hand while he held the fishing line with his right. Most of the specimens in the Museum are natural stones which weigh more than 10 pounds. However, one specimen (C.4478) is well shaped and has a hole drilled through the upper end for the anchor rope (fig. 199, *a*). It is eight inches high, 9.8 inches wide, 3.75 inches thick, and weighs 15 pounds 2 ounces. Another, elongated form (B.4070a) has a knob at the top with a constricted neck for the rope; it weighs 11.5 pounds (fig. 199, *b*).

FIGURE 199.—a, b, anchors; c, canoe breaker.

Stone canoe breakers called *pohaku ku'i wa'a* are said to have been used in naval engagements. Those in the Museum collection of four range in weight from 12.5 pounds to 20.75 pounds. The largest one (C.3180) is 7.1 inches high, 8.5 inches wide, and 5.4 inches thick (fig. 199, *c*). All have a wide, deep groove completely encircling the middle of the long width for the rope. Two are somewhat rectangular in shape with the corners rounded off, and the other two have the ends rounded to form an elliptical shape. They were hurled into the opposing canoe and hauled back with the rope to repeat the operation. Thus they formed a kind of primitive artillery. They could have been used equally well as anchors.

MAST AND SAIL

Double canoes under sail (*la*) and paddle are well depicted by Webber (Cook, 1784), who also illustrates an outrigger canoe under sail (figs. 200 and 192 respectively). However, details concerning the mast and the sail are scanty. Such information as is available has been assembled from the literature by Hornell (1936, p. 18).

The mast (*kia* or *pou*) was erected perpendicularly, though there is confusion regarding its exact position. Hornell concludes that "the mast was stepped in the starboard or weather hull in small double canoes without a *pola*, where a notched heel would enable it to fit upon the second *iako*, whereas in larger

canoes it was stepped in a socket or shoe upon the *pola* but immediately above the second *iako*." In Webber's picture of an outrigger canoe under sail (fig. 192), the mast is fixed beside the forward *'iako* (boom).

Sails were three-sided and made of pandanus leaf plaited in strips and sewed together horizontally between the mast edge and the outer edge, which was attached to a boom sprit. This technique of sewing plaited strips together was used in the lateen sails of Samoa (Buck, 1930, p. 411); and a similar technique was in vogue until recently in the Polynesian atoll of Kapingamarangi in the Carolines (Buck, 1950, p. 199). However, the Hawaiian sail followed the principle of the Oceanic sprit sail with the apex of the triangle down beside the mast. One side of the sail was tied at intervals to the mast, and the outer side was attached to a slender spar which functioned as a boom sprit. The lower end of the spar was tied to the mast near its foot, and the upper end was drawn in toward the mast by a cord. The drawing in of the cord caused the slender boom sprit to curve inward and gave the free upper margin of the sail a deeply crescentic curve which Hornell (1936, p. 18) likens to the crab-claw sails of Santa Cruz and New Guinea. Streamers of tapa were flown from the upper end of the boom sprit and sometimes from the masthead. The mast was kept in position by a back stay and a pair of shrouds on each side.

The Oceanic sprit sail was used throughout Polynesia, with the exceptions of Mangareva in the east and Samoa and Tonga in the west. In these islands the lateen sail was used. The theory that the lateen sail diffused from Micronesia to Fiji and thence to Samoa and Tonga is probably correct, but its presence in Mangareva remains a problem.

ORNAMENTATION

The elliptical-shaped expansions at the upper ends of the bow and stern end pieces termed *manu* were made for ornamentation. The bow ornament (*manu ihu*) was usually slightly larger than the stern ornament (*manu hope*). They were easy to make and for that reason, probably, were continued in the modern canoes. This form of ornament is peculiar to Hawaii and offers an accurate means of identification.

Carving in geometrical figures has not been recorded at all, and the carving of human figures or human heads was evidently confined to the spear racks and, more rarely, to the outer ends of the booms (*'iako*). Reference has been made to Brigham's error in describing two double-headed spear racks as double-headed gods placed in the bow by "pious fishermen." We have no evidence that double-headed gods were ever made by the Hawaiians and as the two double-headed images (fig. 196, *d*, *e*) are definitely recorded in the Museum catalog as spear racks, it is difficult to see how such a mistake could have been made. Samwell (Edge-Partington, 1899, p. 262) refers to small wooden images being carried in the stern of some canoes; and one of Webber's illustrations (Cook, 1784, Atlas,

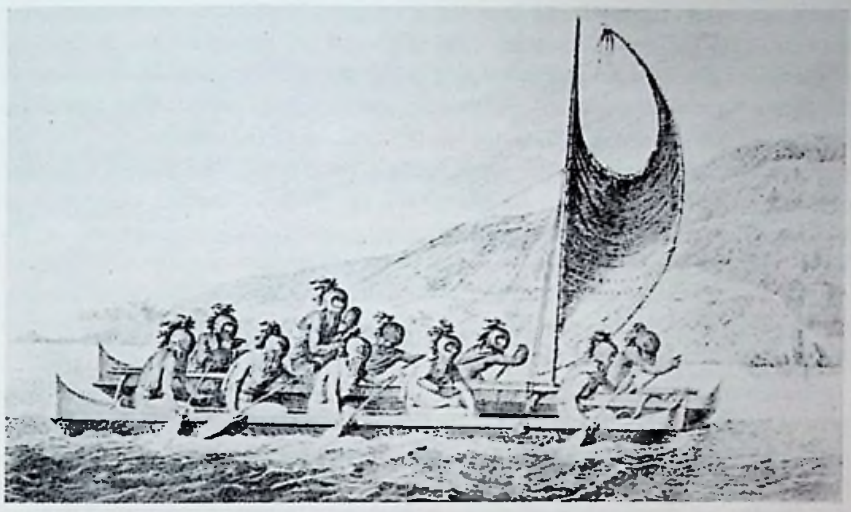

FIGURE 200.—Double canoe with sail, by Webber.

pl. 65) shows an image being held by a man on the platform of a double canoe (fig. 200). However, the carrying of images has nothing to do with the structural ornamentation of canoes.

NAVIGATION

For some time after the settlement of the Hawaiian Islands from Kahiki (Tahiti), voyages of communication were continued between the two groups. On one of these later voyages from Tahiti, the shark-skin drum (*pahu*) was introduced by Laamaikahiki. On a still later voyage, Paao introduced the red feather insignia of chieftainship and the marae form of religious structure, which was locally renamed *heiau*.

The point of departure for the south was the passage between Kahoolawe and Maui which was named Ke Ala i Kahiki (The Course to Tahiti). In a translation from Kamakau, Alexander (1891b) refers to the southern sailing directions. Hokupaa, the North Star, was left directly astern; and when Hokupaa sank below the northern horizon on reaching the Piko o Wakea (the Equator), Newe became the guiding star to the south. No sailing directions were given for the return voyage to the north.

A reconstruction theory was given by Admiral Hugh Rodman (1927) regarding the return voyage. He held that the navigators sailed north on the starboard tack against the southeast trade wind and so made to the east. When they crossed the equator and picked up the North Star, they knew they were well to the east of Hawaii. To correct their course, according to Rodman, they invented a "sacred calabash," sometimes referred to as the "magic calabash,"

which consisted of a bowl with four equally spaced holes at the same level below the rim of the calabash. When the calabash was filled with water up to the level of the holes and held so that the water would not spill through, observations of the North Star were made by applying an eye to a hole and looking across the far rim of the calabash. When the North Star appeared on the rim, the observer knew that it was at the same latitude as Hawaii. The course was then changed to due west and the islands picked up. Rodman further states that he had seen the calabash in the Bishop Museum and that the angle formed by the level of the water and the line from a hole to the far rim was one of 19 degrees. As the nineteenth degree of latitude north passed through the Hawaiian Islands, Rodman concluded that the Hawaiian navigators had invented a nautical instrument of mathematical accuracy.

However, the object illustrated by Rodman as the "sacred calabash" was proved by Stokes (1928) to be a deep wooden bowl used for carrying clothing and other valuables. The multiple holes below the rim were in groups of three for the lower ends of cords used to form the netting which kept the cover of the container in position, and none of the holes made an angle of 19 degrees with the far rim. Thus the "sacred calabash" proved to be a suitcase and not a primitive sextant. Furthermore, a search through the Museum's large collection of calabashes failed to locate one with four holes making angles of 19 degrees with an opposite point on the rim. And no references can be found in Hawaiian traditions as to observations on the North Star during the latter end of the homeward voyages.

The story of the "sacred calabash" has been given in some detail because it has encircled the globe and Bishop Museum has received many requests for a picture of this fabulous nautical instrument. Charitably, the "sacred calabash" may be regarded as an attempt to solve a navigational problem by a non-Polynesian navigator accustomed to using a sextant who, from scraps of legends and from seeing a calabash with holes below the rim, composed a wonderful story of what could have happened in theory. However, the lack of nautical instruments makes the successful voyages all the more remarkable, for the navigational problems were solved with the naked eye and the exercise of human judgment.

NOTE: The following "Literature Cited" refers to the entire book, as originally published in one volume.

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