8
DESIGN

What tree is best for the big canoe.
And the canoe shaped with the adze of Lono the God
Shaped by strong men and the Kahuna
Shaped so long and narrow . . .

"We can divide the Sandwich Island canoes into two types . . . the single and the double canoes. The former have an outrigger, while the latter do not, and are nothing more than two single canoes, held together by cross booms that leave a space between the two hulls . . . The length of the double canoes varies from thirty-five up to seventy-five feet, and the single canoe is between twelve to fifty feet long." Indeed, the hulls making up a double canoe, except for the extra *wae* and sets of *ʻiako* lashing holes, were no different from the hull of a single outrigger canoe.

What were the adaptations, the features that made the pre-contact Hawaiian canoe so different from most other Polynesian and Oceanic canoe forms? The question is best addressed by identifying primary design features common to all traditional Hawaiian canoes, together with the secondary design features that were not always present.

Primary Design Features

1) Pre-contact Hawaiian canoes had one-piece wooden hulls, as opposed to hulls built of planks. They were made primarily from *Acacia koa,* although other native woods and occasionally non-native driftlogs were also used.

2) Canoes were of two kinds—the outrigger canoe, consisting of a hull with two *ʻiako* lashed to a stabilizing *ama,* and the double canoe, consisting of two hulls joined by two or more *ʻiako.* There were no design differences between the hulls of a double or single canoe and they could be used interchangeably.

3) The hull bottom could always be characterized as being generally rounded or "U" shaped.

4) All hull curves in contact with the water, both longitudinal (length-wise) and transverse (cross-section) were convex. In cases of a hull with an extreme "calabash" shape, that is, when the lower part of the hull bulged out considerably and the upper part of the hull tucked in concavely, a very slight concave curve, *never part of the wetted surface area,* could sometimes be seen.

5) All canoe hulls had continuous rocker—convex fore and aft curvature of the bottom of the hull. In some cases the hull approached a nearly straight bottom.

6) The bow and stern portions as seen in the profile and plan views presented a narrow, tapered, and generally rounded entry and exit.

7) The hull in transverse section, especially at the ends of the canoe, was characterized by "slack," or gently rounded curves.

8) All canoes were deepest and widest to the rear of the midship section. A rare exception, according to Malo, is the *ihu-nui* (big-bowed canoe).

9) All canoes, whether rigged double or single, had these component parts: the seats, gunnels, *ʻiako, kaupoʻi, manu,* and *wae.* All these parts were of the forms described in Chapter 6, that are today considered traditional.

10) All rigging and lashing consisted of traditional coconut sennit or other vegetable fiber lashings.

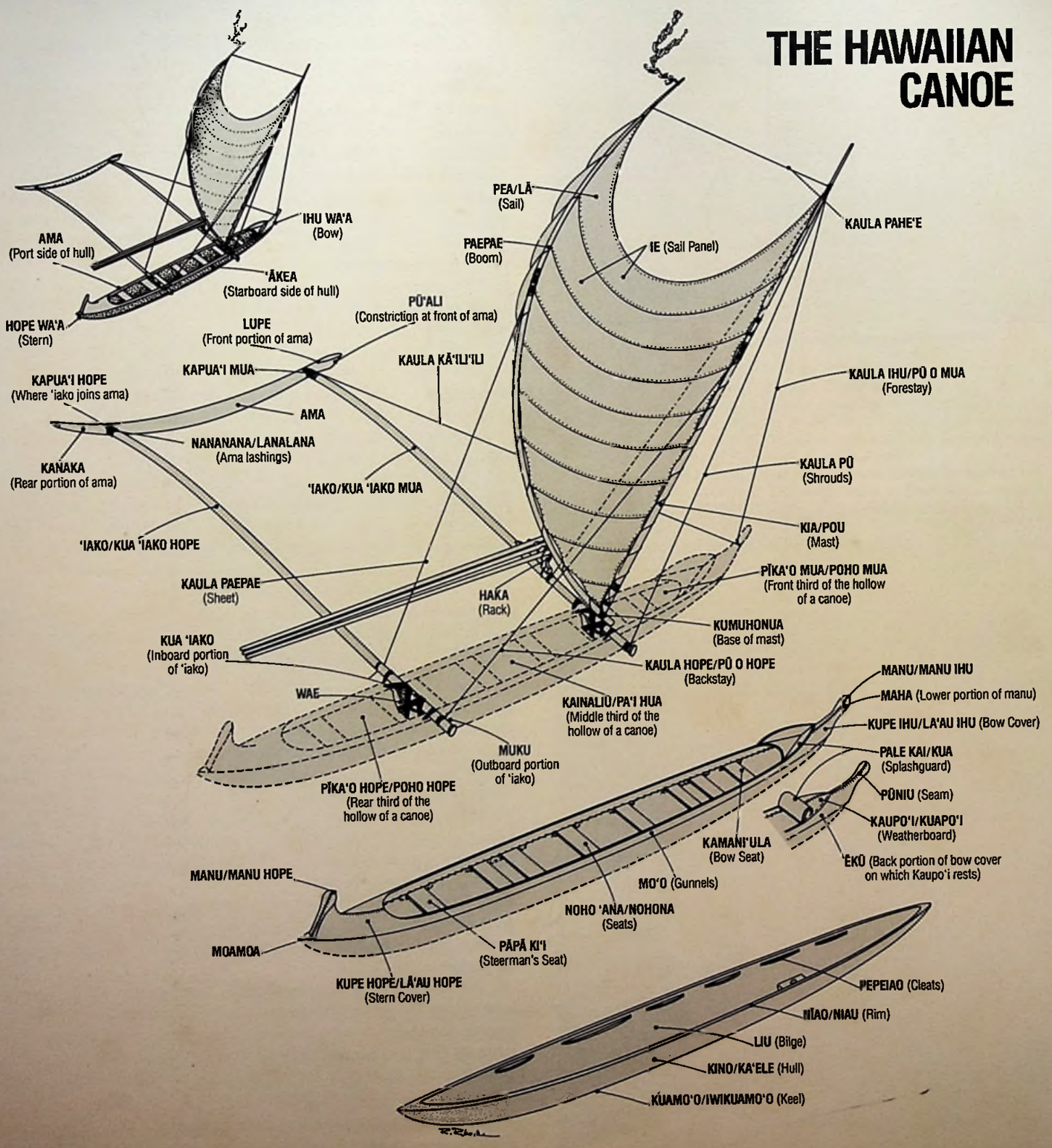
Secondary Design Features

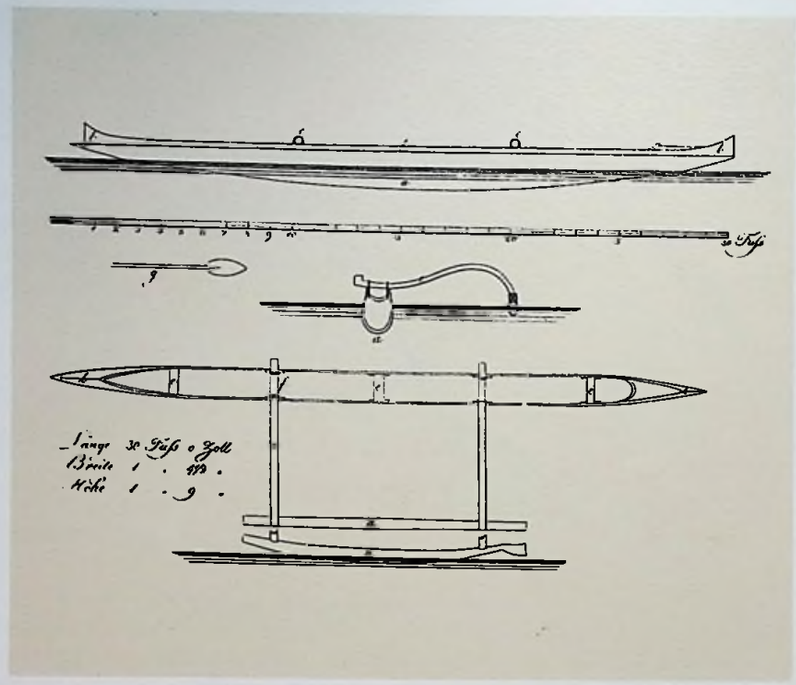
Secondary design features are those traditional features that may be found in some but not all canoes, producing a specialized canoe or one for specialized use. Such features still must fall within the range of what is regarded as being of traditional Hawaiian design.

1) A subtle keel or a medial ridge is sometimes found at the bow and stern and may have even run the whole length of the hull bottom as is seen in some old canoes. This subtle keel or medial ridge has erroneously been called a rounded or semi-"V", terms that are properly used to describe much more distinctly "V"-shaped hulls. When in evidence, the medial ridge is more like a slight ridge typically seen in the bow and less often in the stern. The medial ridge is so subtle as to almost immediately blend into the overwhelming roundedness of the hull. As far as is known, the medial ridge never went much beyond the very subtle forms seen in the accompanying diagrams of the Herbert Dowsett canoe and the canoe made of breadfruit wood, and in diagrams of the *ʻA* and the *Malia* seen in Chapter 14. Never did a medial ridge ever approach the degree of "V" entry or bottom seen in Tahitian and many other Pacific island canoes.

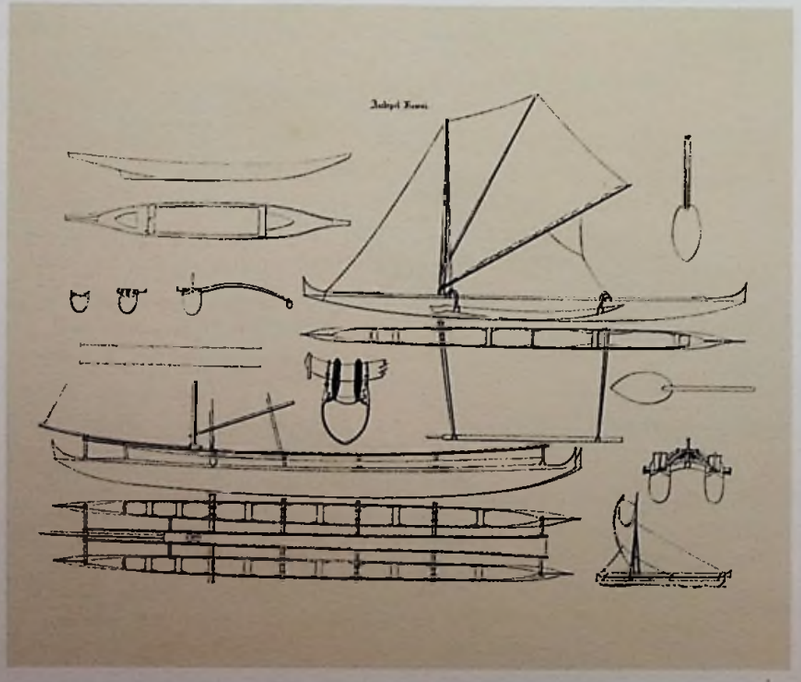
A bow and stern with a distinct medial ridge will assist the canoe's entry and exit more efficiently than a rounded hull by respectively cleaving or breaking the adhesion effect of the water to the hull. A medial ridge in a hull will also induce the canoe to "track" (rather than side slip or wander), in certain conditions a desirable feature for a paddling racing hull. However, such a feature will render the canoe less maneuverable and responsive than a round-bottomed hull, especially in large following seas. A canoe

THE HAWAIIAN CANOE





The earliest schematic drawing *of a single canoe* (above) *was done by Langsdorff in 1804. About 35 years later, Paris prepared well-known drawings of single and double canoes* (below). *Although both sets of drawings contain a few minor inaccuracies, they nevertheless provide useful information on early canoe design.*



with a true "V" bottom, as seen in the typical Tahitian canoe, would in wild Hawaiian waters have "tracked" itself into extinction, constantly broaching, flipping or causing a hull or outrigger to bury. When buffeted by contrary swells the Hawaiian canoe will at a critical point "give ground," momentarily integrating itself with the particular surface condition. A rounded-bottom Hawaiian hull will deftly contour, slide, and side slip its way through heavy seas. A "V" hull of any kind is definitely not a desirable feature for surfing hulls.

As seen in the accompanying drawings, two completely different types of canoes, the Dowsett two-man racing-type canoe and the capacious breadfruit fishing canoe, display two different ridge or keel configurations running the whole length of the hull bottom. The Dowsett canoe, reportedly about one hundred and twenty years old, displays a sharply rounded bottom coming off a deadrise, which is a flattening of the bottom curve in the lower portion of the hull. The breadfruit canoe, a very wide and chunky fishing canoe built in Waipi'o Valley about one hundred years ago, has a distinct ridge running the length of the hull bottom. In both canoes it would appear as though the ridge and the deadrise were transitional features, whims of the individual post-contact canoe builder. None of the numerous canoes used for burial purposes which are discussed in a later chapter reportedly display even a suggestion of a "V" or a medial ridge in any part of the hull. The earliest known schematic drawing of a typical Hawaiian canoe, by George Langsdorff in 1804, portrays a hull rounded in all aspects. Admiral Paris, in his drawings of an outrigger and double canoe, indicates the presence of a medial ridge in at least part of the double canoe hull; this was most likely a transitional feature.

All this is mentioned because it is not absolutely certain whether pre-contact canoes in fact had a subtle keel or medial ridge. It is not seen in any of the old canoe models, nor figured by any of the early European visitors in either their written descriptions or drawings. And there is good reason to believe that a subtle keel or medial ridge might have been the one design feature that distinguished the post-contact from pre-contact canoes. Visiting islanders from Tahiti and other Pacific island groups, where a "V" element in a canoe's hull was standard, might have added their influence as might have the European boat builders, who very soon after contact were working alongside the native Hawaiians, building various types of craft including the hybrid *peleleu* or war canoe.

2) The bow and stern sections varied markedly from canoe to canoe. Some of the lighter and faster canoes had relatively narrow and fine entries—the bow rocker tapering and curving up very gradually as seen in the drawings of the *Malia* and Herbert Dowsett canoes. This is in contrast to the typical fishing and cargo canoes, which were characterized by a much broader entry and exit section, and a much more abruptly curving rocker in the ends of the canoe. Much as with a distinct medial ridge, the finer the entry, the easier the canoe will break the water, and most importantly the less the resistance. Typical fishing canoes with very full and blunt bows, as shown in the two drawings, push a lot more water than their cousins having finer entries. However, the finer, smaller-bowed canoes have far less carrying capacity than the wide and full-bowed fishing canoes. For the most part, the narrower and sharper the entry, the faster the canoe.

Similarly, a narrower and gently tapering stern will release from the water more efficiently and create less drag than a full, abrupt stern. It was usually the canoes that were designed more for speed than high carrying capacity that got the daintier and finer 'ōkole (sterns). As a rule, canoes with deep and full bows and sterns had more wetted surface area, which added to the drag and resistance.

3) The sides of a canoe varied considerably, from an almost straight-sided drop from the gunnels that curved into an almost perfect "U"-bottom, to sides that were sometimes nearly concave just below the gunnels bulging out considerably—calabash style—at the lower part of the hull.

The incorporation of the calabash shape in a hull increased the carrying capacity of a canoe tremendously, making such vessels excellent for carrying heavy loads of men or freight. A canoe with a calabash hull would ride quite high in the water even when heavily loaded, due to its large-displacement hull design. A canoe of the same general dimensions but with straight sides and no calabash would, given the same load, ride much lower in the water. This translated into higher freeboard for the calabash-shaped hull even when loaded, an important feature in rough water.

The degree of calabash—how accentuated the bulge—and its location, whether near the bottom of the hull or higher up the sides, directly affected the canoe's handling, performance and carrying capacity, especially in different sea conditions.

4) Most Hawaiian canoes displayed an element of sheer—the fore and aft curve of the hull at the top edge of the gunnel. While in some instances sheer was absent, a reverse sheer was never found.

5) "Rocker" or "banana" similarly refer to the convex fore and aft curvature of the canoe hull bottom when viewed from the side. The degree of rocker in a hull varied markedly from canoe to canoe and played a large part in determining the performance and use of the canoe. In some canoes the rocker was a continuous convex curve from the tip of the bow to the tip tip of the stern, a classic "banana" shape.

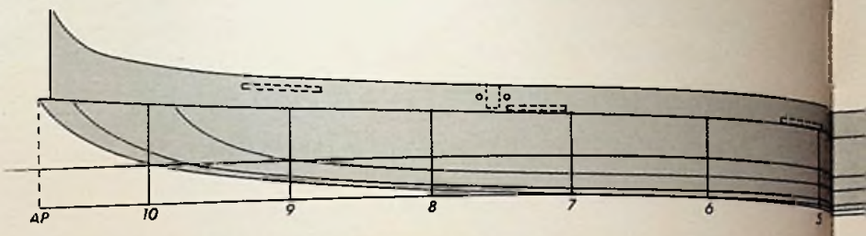
The more pronounced the rocker in the hull's bottom line, the more likely there was to be added sheer in that hull's gunnel. A heavily rockered canoe had high freeboard at the ends, making a very functional rough-water designed hull. As a general rule a canoe with pronounced rocker rode high and buoyantly over the waves, a favored design for handling in heavy seas and steep boarding swells. Such a canoe also usually made a good surfing hull, having much less of a tendency to "pearl dive"—bury its bow under water—than a relatively straight-bottomed canoe with minimal rocker.

Other Hawaiian canoes displayed minimal rocker with pronounced curvature only in the bow and stern sections, and with the mid-section of the hull bottom nearly straight. Few, if any, Hawaiian canoes had a perfectly flat bottom although some were fairly straight and had transverse curves so subtle as to appear flat. The stern, and less frequently the bow, on a canoe with little rocker usually graduated abruptly, resulting in a halved sausage look. Hardly streamlined in appearance, such hulls had high carrying capacity and were often seen in certain types of fishing canoes. The drawings seen in this chapter and in Chapter 14 illustrate the wide range of rocker seen in different types of Hawaiian canoes.

Beyond the gross design of a Hawaiian canoe, its various dimensions and how they related to each other determined canoe type and use. Two canoes of the same length might vary so greatly in depth and width and the relationship of these features that they were two radically different craft. One might be a light, sleek, narrow and low-freeboarded racing canoe and the other a heavy, deep, wide-hulled freight or rough-water canoe.

A canoe's speed, and to a lesser extent its performance, were functions of its weight. Light-weight canoes made fast paddling or sailing canoes. The type of wood used for the canoe hull, whether a heavy, medium or light-density *koa,* pine or *wiliwili,* had an obvious relationship to the canoe's weight. The next determinant of a canoe's weight, and thus quite often its intended use, was the thickness of the hull. Two canoes of the same general form and dimensions could vary considerably in weight if one were a thick, massive-hulled *'ōpelu*-type fishing canoe and the other a thin-hulled all-purpose canoe. *'Ōpelu*-type canoes were sometimes three to five inches thick on the bottom and two to three inches thick on the sides. This contrasts to the comparable-sized utility canoes which might

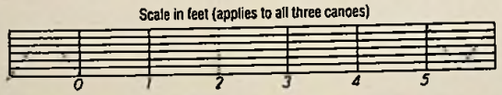
Two contemporaneous engravings *from the late 18th century, one* (above) *based upon drawings by Webber and the other* (below) *on sketches by Ellis, illustrate the transformation that such works underwent at the hands of European engravers. While Webber's field sketches were generally faithfully reproduced, those of Ellis were stylized almost beyond recognition.*

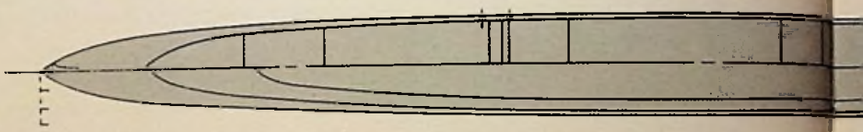


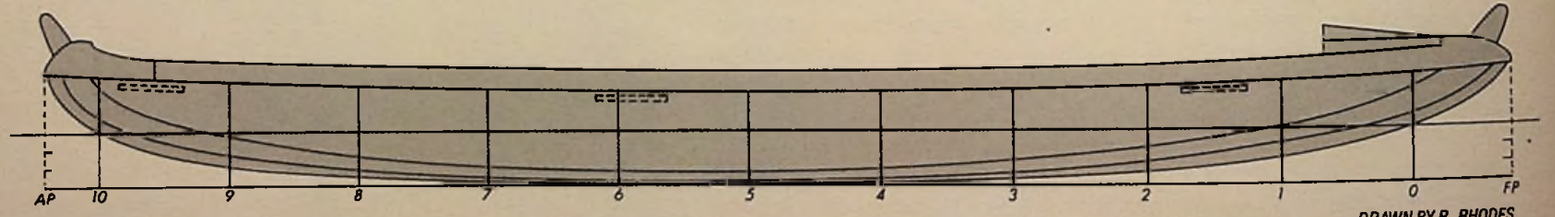
DOWSETT CANOE

REPUTEDLY A TWO-MAN RACING CANOE
BUILT IN KONA, HAWAI'I CIRCA 1850

LOA 23'-7⅞"
LWL 19'-6"
BEAM 1'-4¾"
DRAFT 6½"





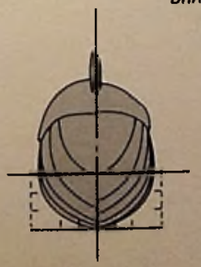


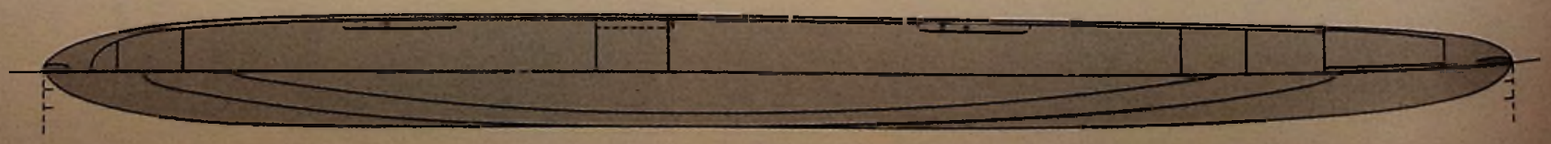
DRAWN BY R. RHODES

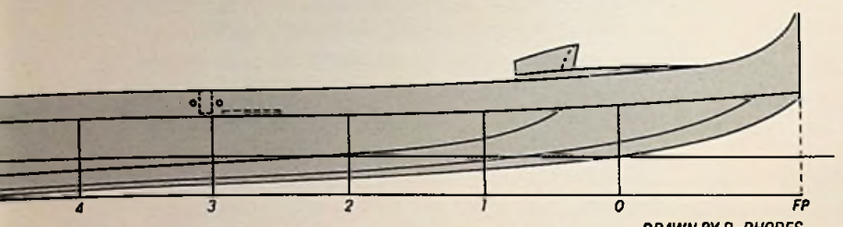
BREADFRUIT CANOE

BUILT IN 1890 IN WAIPI'O VALLEY, HAWAI'I
BY GREAT-GRANDFATHER OF
JAMES MAWAI OF MOLOKA'I

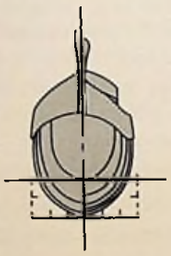
LOA 20'-10"
LWL 18'-7"
BEAM 1'-7"
DRAFT 9"

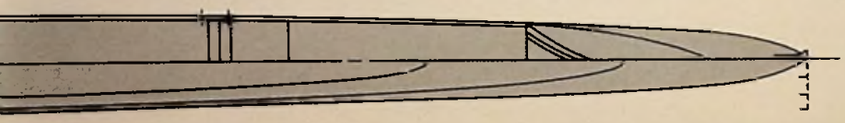


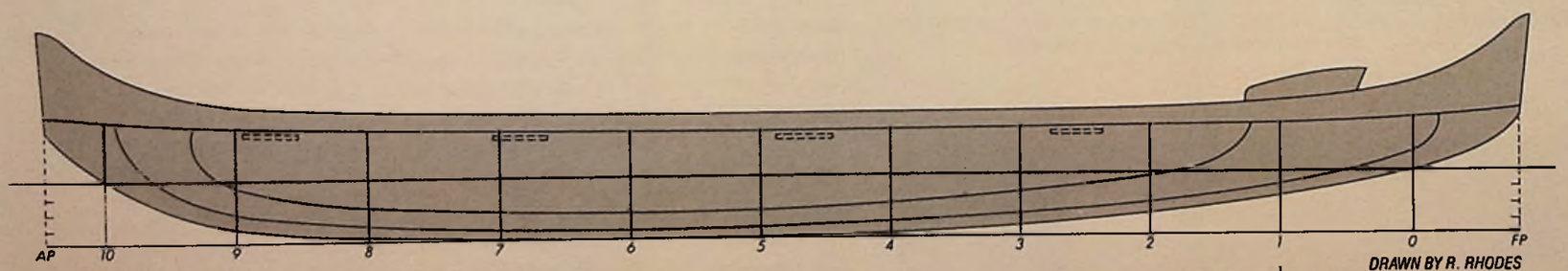




DRAWN BY R. RHODES





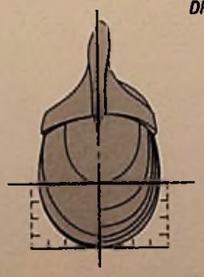


DRAWN BY R. RHODES

ʻŌPELU TYPE FISHING CANOE

ʻŌPELU CANOE IS A CONTEMPORARY GENERIC TERM
GIVEN TO 18'–25' LONG HEAVILY CONSTRUCTED,
DEEP AND WIDE KOA FISHING CANOES IN USE
DURING THE 19TH AND 20TH CENTURY

LOA 22'-5½"
LWL 19'-11"
BEAM 1'-10"
DRAFT 11⅜"



have been one to one-and-a-half inches on the bottom and one quarter to one inch on its sides. The weight differential for these two canoes could easily have exceeded several hundred pounds. The lightweight canoe was faster and more maneuverable, while the heavier canoe combined high carrying capacity with durability.

Endless tradeoffs and infinite combinations of characteristics—speed, carrying capacity, windward sailing ability, surfing ability, seakindliness, rough water capability, safety, light construction, durability—all were important, especially for certain functions in certain waters. Secondary design features generally determined the type of canoe, the range of its use and its activities. John Whitman, writing in 1813, remarks that "their canoes are of various lengths adapted to the purposes of war, fishing and playing in the surf."

Ultimately, the unruly and unmerciful sea dictated the primary design features common to all Hawaiian hulls that ensured survival in her capricious domain. Hawaiian canoes, for all their variability in secondary design features, displayed an amazing degree of homogeneity.

Each canoe was a special edition, a signature model. There were no molds, no templates and no sophisticated tools that made for production of duplicates, even if desired. Each builder had his own personal style and preferences, just as each log had its own distinct personality and quirks.

Canoe Forms

Hawaiian canoes were named according to their various forms and/or uses; a list of these names and when known, a description, follows.

Canoe Types

ʻakea	the starboard or outer hull of a double canoe
ama	the port hull of a double canoe; also *iama*
ʻauwaʻa hoʻāpipi	two single canoes hastily joined to do service as a double canoe; also *mau hoʻāpipi, waʻa hoʻāpipi*
ekea	same as *ʻākea*
iama	same as *ama*
ihu nui	canoe with a broad bow; made from the butt end of a log
hoʻomo	single or double *aku* fishing canoe
kāpili	fishing canoe
kaukāhi	canoe with one hull; outrigger canoe; also *waʻa kaukāhi*
kaulua	canoe with two or more or less equal hulls; also *waʻa kaulua*
kialoa	long, light and swift canoe; used for display and racing; also *kioloa*
kiapā	swift sailing canoe
kiapoho	canoe with a deep curving hull
kiapoko	short canoe with a rounded hull; nearshore fishing canoe
kioloa	long, narrow canoe; also *kialoa*
koʻokāhi, koʻolua, etc.	canoe holding or carrying one person, two persons, etc., up to eight persons *(koʻowalu)*
kūʻēʻē	double canoe with hulls of unequal length
kupeʻulu	old, worn-out canoe without sail or other conveniences; canoe with a large bow
lēʻiwi	canoe with a very flat *manu* or none at all
leleiwi	canoe with an unusually broad and decorative *manu*
loloniu	canoe made from coconut tree trunk; a rare type
malau	large canoe capable of carrying much freight; somewhat like a *peleleu*
manua	fishing canoe
mau hoʻāpipi	two canoes coupled together; also *waʻa hoʻāpipi*
mumuku	canoe with one end cut off and boarded up; canoe cut in two at the middle; possibly a burial canoe
ʻōpelu	present-day term for a short, thick-hulled, wide-bodied, heavy fishing canoe
panipani	fishing canoe
peleleu	extremely large (deep and wide), unique type of war canoe commissioned by Kamehameha I in the 1790's to aid him in his conquest of the Hawaiian Islands; very large canoe, sometimes a double canoe; fishing canoe of the largest size; short canoe
pou	short canoe, broad for its length, thick and blunt at the ends; used for baggage
pukahi	fishing canoe
pūkolu	canoe with three hulls; an experiment which failed
waʻa ʻākea	starboard hull of a double canoe; also *ʻākea, waʻa kea*
waʻa ʻaki	canoe with a rather sharp bow and stern
waʻa akua	sacred canoe for a specialized purpose (no other data)
waʻa ʻāpulu	old, worn-out canoe
waʻa ʻauhau	tribute or tax canoe; basket filled with food and set adrift during the *Makahiki* ceremonies; represented the canoe in which Lono returned to Tahiti
waʻa aukāhi	canoe whose wood is all of one color
waʻa hoʻāpipi	two single canoes hastily joined to do temporary service as a double canoe; also *ʻauwaʻa hoʻāpipi, mau hoʻāpipi*
waʻa honua	wide canoe
waʻa humu	sewn canoe; built up of planks sewn together with sennit
waʻa kae	slow canoe
waʻa kailike	canoe with little sheer
waʻa kaka	canoe with a good deal of sheer
waʻa kakaka	long, clean-built clipper canoe
waʻa kaua	war canoe; fleet of canoes about to enter into battle
waʻa kauhī	*aku* fishing canoe
waʻa kaukāhi	canoe with one hull; outrigger canoe; also *kaukāhi*
waʻa kaulua	canoe with two more or less equal hulls; also *kaulua*
waʻa kea	unpainted canoe set to sea after *kapu* were lifted during the *Makahiki;* another term for *waʻa ʻakea*
waʻa kome	bulrush canoe
waʻa kūpāhoa	long, thin canoe; clipper-built canoe; also *waʻa pāhoa*
waʻa lawaiʻa	narrow and deep fishing canoe with sides straight up-and-down
waʻa naku	bulrush canoe; possibly a search canoe
waʻa pā	canoe constructed of boards; rowboat
waʻa pāhoa	narrow and deep fishing canoe with sides straight up-and-down; longish canoe with straight sides of equal width all the way; also *waʻa kūpāhoa, waʻa lawaiʻa*
waʻa paulua	large or double canoe with three *ʻiako*
waʻa pū maiʻa	canoe with rather full and round in the waist, short at either end; good working canoe; canoe in which some of the sap-wood still remained
waʻa puhi	small canoe, slim and higher in the middle; used by chiefs in surfing
waʻa ʻula o ke aliʻi	canoe for display, to show kingly state; typically colored red; a chief's canoe with red sails