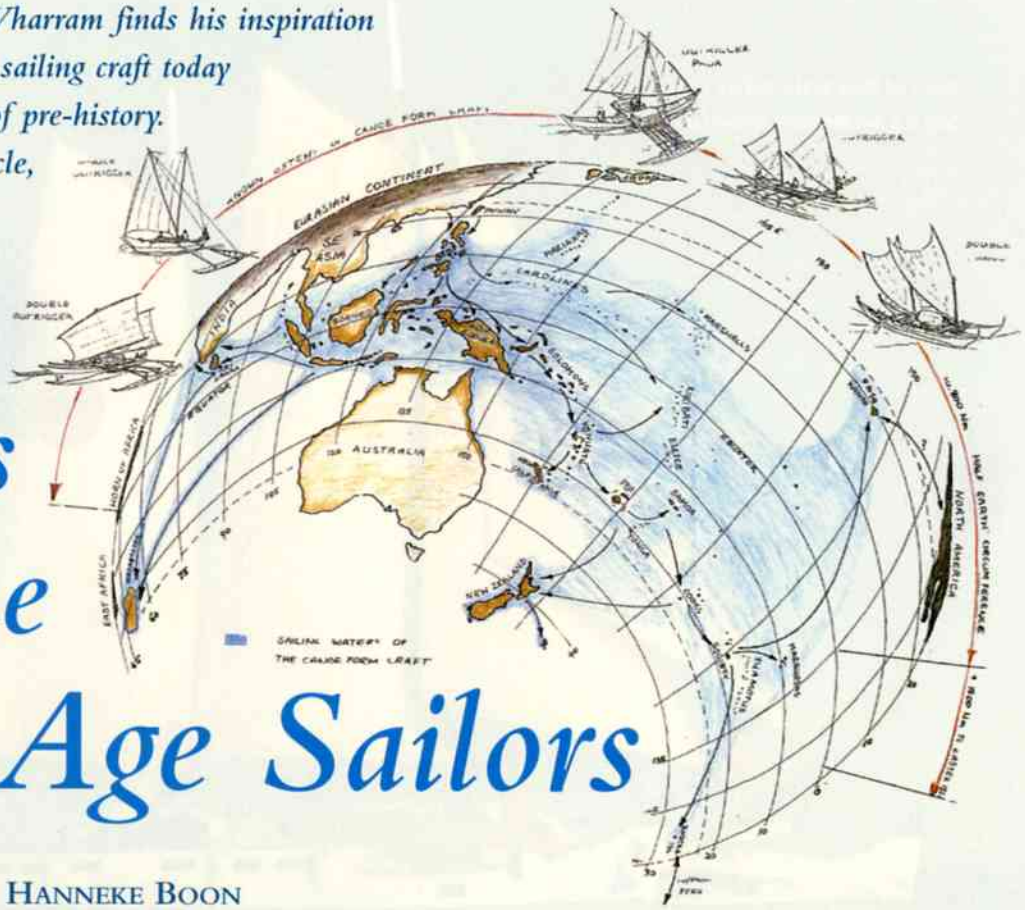
Multihull designer James Wharram finds his inspiration for affordable and practical sailing craft today in the ocean-going vessels of pre-history. In the first of a 2-part article, he considers:



Lessons from the Stone Age Sailors

WITH ILLUSTRATIONS BY HANNEKE BOON

James with villagers in Vamuata, measuring a canoe.

In February 1998, an interesting public debate was held at the Royal Lymington Yacht Club with the motion: "This house believes that the future of cruising yachts will be fast, light displacement boats that are fun to sail and are seaworthy."

The two sides of British yacht design were represented: the extreme 'modern' and the more traditional approach. The term 'Light Displacement Boats' meant the highly expensive modern monohulls with deep fin keels and tall, high-tension masts and the rider "that are seaworthy" showed the proposers considered some modern light displacement boats lack seaworthiness.

In general, the phrasing of the motion implied a disappointing lack of knowledge of the world's sailing craft for seaworthy light displacement cruising craft, coastal and ocean, have been around for thousands of years and have been – and are being – adapted for present day sailors.

The Viking ship was a light displacement craft and modern descendants of the type, like the Norwegian Femboring fishing boats or some of Iain Oughtred's excellent double-enders, are both "fun to sail" and very seaworthy.

Long before the Viking ships of 800-1100 AD – long, long before that, about 10,000 years ago at the end of the Ice Age – fast light displacement canoe-form craft started migrating out from areas around Taiwan, long before Chinese settlement and continued from Indonesia across oceans against the prevailing winds to eventually settle

Spirit of Gaia in the Indian Ocean.
She is a modernised ancient double canoe.

Hawaii, New Zealand and across the Indian Ocean to Sri Lanka, South India and Madagascar – see Fig 1.

This ocean wide settlement of over half the world's circumference took about 8,000 years; 8,000 years during which the principles of the Canoe-form light displacement sailing ship evolved not by 'Regulations' but in the organic way of a living creature, like a seal or dolphin; their evolution speeded up by the minds and wishes of practical sailors.

The First Sailors

This school of practical sailing design has existed longer than most people realize. The latest palaeo-anthropological studies of the evolution of humans show that the island of Flores in Indonesia was settled 800,000 years ago. Flores has always been an island and the settlers must have travelled by watercraft to get there. However, though disputed by some, the majority opinion of anthropologists is that Man, Homo Sapiens, has only evolved out of Africa in the last 100,000 years! Therefore, watercraft of some sea survivable type were being used by what has so far been popularly presented as the semi animal-pre human Homo Erectus some 700,000 years *before* the Homo Sapiens species developed.

Sewn boat in Oman, a typical example of sewn boats all around the Indian Ocean.

There is a less arguable later date of the settlement of Lombok from Bali 250,000 years ago but again 150,000 years before our ancestors walked out of Africa. The evidence again shows seagoing watercraft existed before Man existed. Homo Sapiens only settled Australia by watercraft 60,000 years ago.

Archaeological evidence shows the next wave of modern Man spreading and migrating out of the Eurasian continent from the end of the Ice Age 10,000 years ago, not by foot but by sea-going craft.

Small boat sailing is so old, it is a deep, instinctive part of our behaviour pattern like throwing a stone – inherent in cricket, football, tennis and other ball sports – wishing to light fires or find

peace in the quiet sound of moving water. Perhaps our ancient sailing history explains the instinctive feeling of some people today that something has got lost in recent sailing craft and sailing attitudes.

The Canoe-form Craft

For four years, my partner Hanneke Boon and I, with a number of interested sailors, have been sailing in the Pacific and Indian Oceans aboard our double canoe/catamaran, the 63' (19.2m) *Spirit of Gaia,* studying the last surviving light displacement canoe-form vessels, descendants of the canoe ships which explored those oceans in the great first chapter of Man's sailing history.

I have a replica collection of stone hand axes, available to Man 60,000 years ago which look like crude broken stones with sharp edges. However, with them you can cut bamboos or reeds to make a sturdy, seaworthy raft, or you can skin the bark of a large tree to make a short lived, delicate, bark skin canoe. But the Dugout Canoe-form Craft demands better woodworking tools.

By 30,000 years ago, Man had a kit of stone tools that could duplicate the work of the steel tools of this century. A stone adze, which I saw in use in New Zealand, was sending the chips flying at the speed of a modern steel adze.

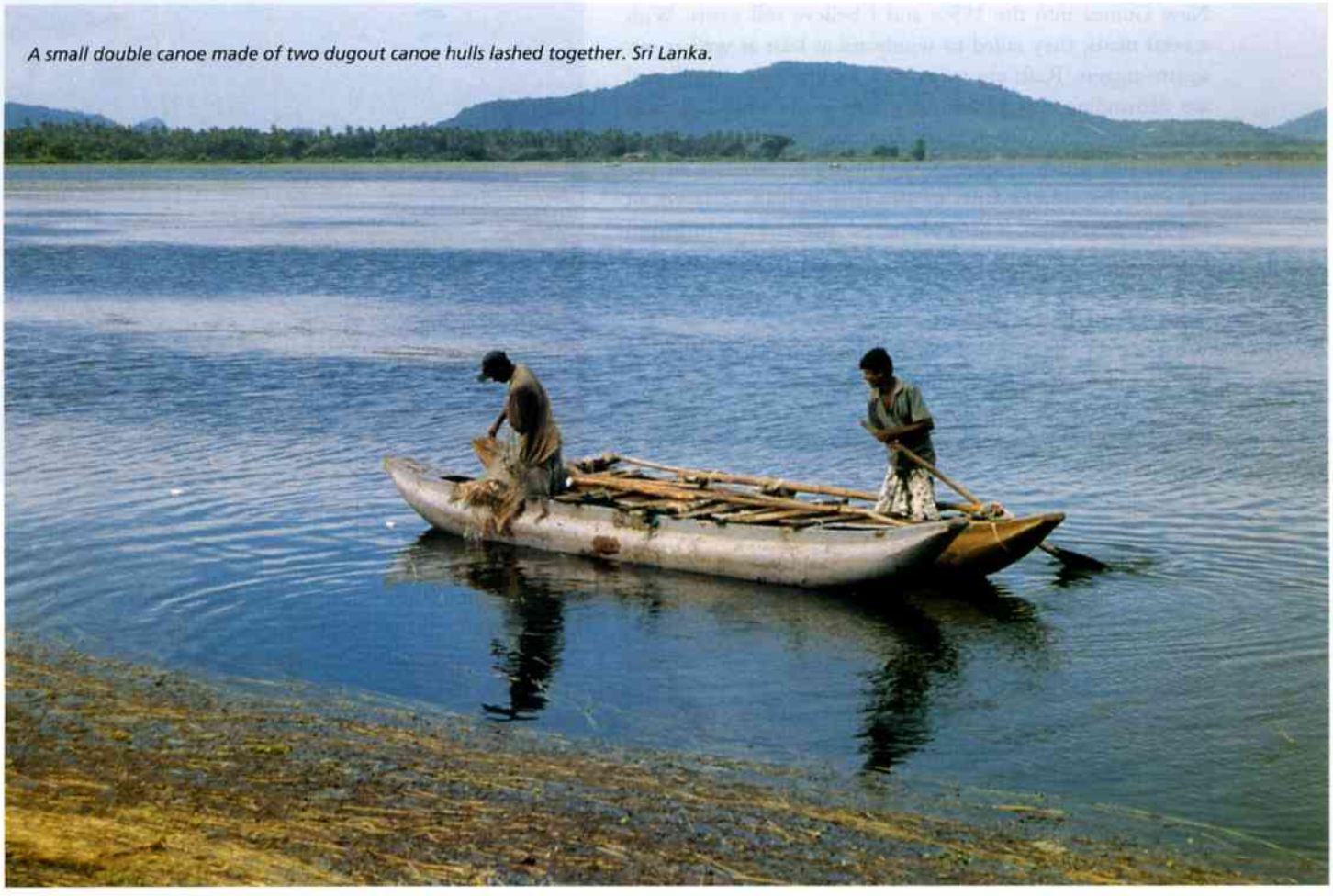
The Dugout was a natural progression from the bark canoe and is often wrongly seen as the crudest form of boat built. A natural tree log is an ideal structural material that can be subtly shaped and is free from leaking, unless you find a bad log. Some modern boatbuilders are gluing hundreds of strips of wood together to get the quality of wood construction inherent in developed carved dugout hulls.

When big trees are not available, you have to develop planked canoe hulls. Sewn or lashed together, planked hulls were used all over the world. The sewn boats which have survived in the Pacific and Indian Oceans until today show the strength and durability of this plank joining method and its suitability for hard long distance sailing, though like all planked boats they can leak.

Dugout hulls have the rigidity to crash land on a beach and be hauled out. Sewn boats have the elasticity to do the same. Modern light displacement yachts require very expensive wheeled boat hoisting vehicles to lift them and their slender fin keels out of the water for repair, painting or stowage! And if they should go aground...!

Single canoe form vessels up to 60' (19m) long, with a hull length/beam ratio of between 12:1 and 20:1, are ideal for river use. Jungle and heavily wooded country is easier to move through by river than hacking your way over land. For sea use, with their narrow beam they need to be stabilized to resist capsizing by wave and sail.

The slower, heavier, beamier rafts with a length/beam ratio of 3:1-5:1 have always existed along with the canoe. It does not take much thinking for practical sailors to combine 2,3,4 or 5 canoes into a stable load-carrying raft.



A small double canoe made of two dugout canoe hulls lashed together. Sri Lanka.

Gathering of Double Canoes in Raiaeta, 1995. Replica canoes arrived from Hawaii, New Zealand, Cook Islands, Tahiti and ... UK.

A canoe raft of this type, the Lakatoi, existed in Papua New Guinea into the 1950s and I believe still exists. With several masts, they sailed to windward at least as well as our square-riggers. Rafts are seaworthy. Increasingly, 'regulators' are demanding that yachts carry rafts – the small inflatable kind – for safety. When these first canoe rafts began sailing we do not know. Papua New Guineans, builders of the Lakatoi, are descendants of the first human seafarers of 60,000 years ago who colonized the then combined Australia-New Guinea continent.

The Double Canoe

What we do know is that when Europeans began sailing in the Pacific in the 17th century, over a wide area they met

Fig. 2
Double Canoe

Cook Island double canoe Te Au O Tonga.
70' replica built in ply and epoxy.

Double Canoe Rafts – as in Fig 2 – known to Polynesians as *Vaka* or *Pahi* and to Western sailors who call its modern version a 'Catamaran'.

Purists, like myself, have argued that the ancient and modern double canoes should not be called catamarans because catamaran comes from the Tamil word *katta-maran*, meaning tied logs. Perhaps, on reflection, the word catamaran, even though of the wrong language, is the right word to describe past and modern double-hulled Raft vessels. I have been sailing them offshore for nearly 45 years

and this experience informs me that it is realistic to describe them as Rafts: their stability calculations are the same as for the raft and their 'feel' when sailing is comparable to a speeded up raft.

Double Canoe Sailing Rafts sail without heeling or rolling. Their large deck areas allow space to build fair sized deck cabins either in bamboo and mats as in the ancient canoes or elaborate GRP houses as on the modern catamarans.

The minimum wave drag and wetted surface of the two canoe hulls give the stable raft shape a good speed potential. These inherent qualities have made the modern catamaran, developed over the last 40 years out of the ancient Pacific craft, a successful part of the modern sailing scene.

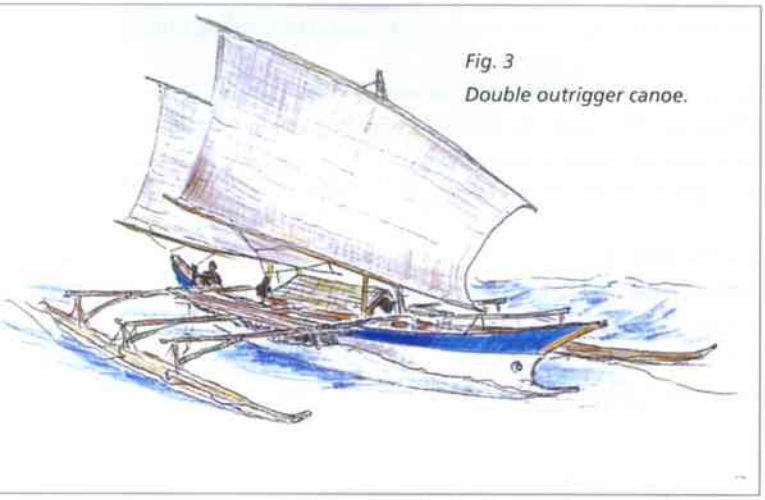
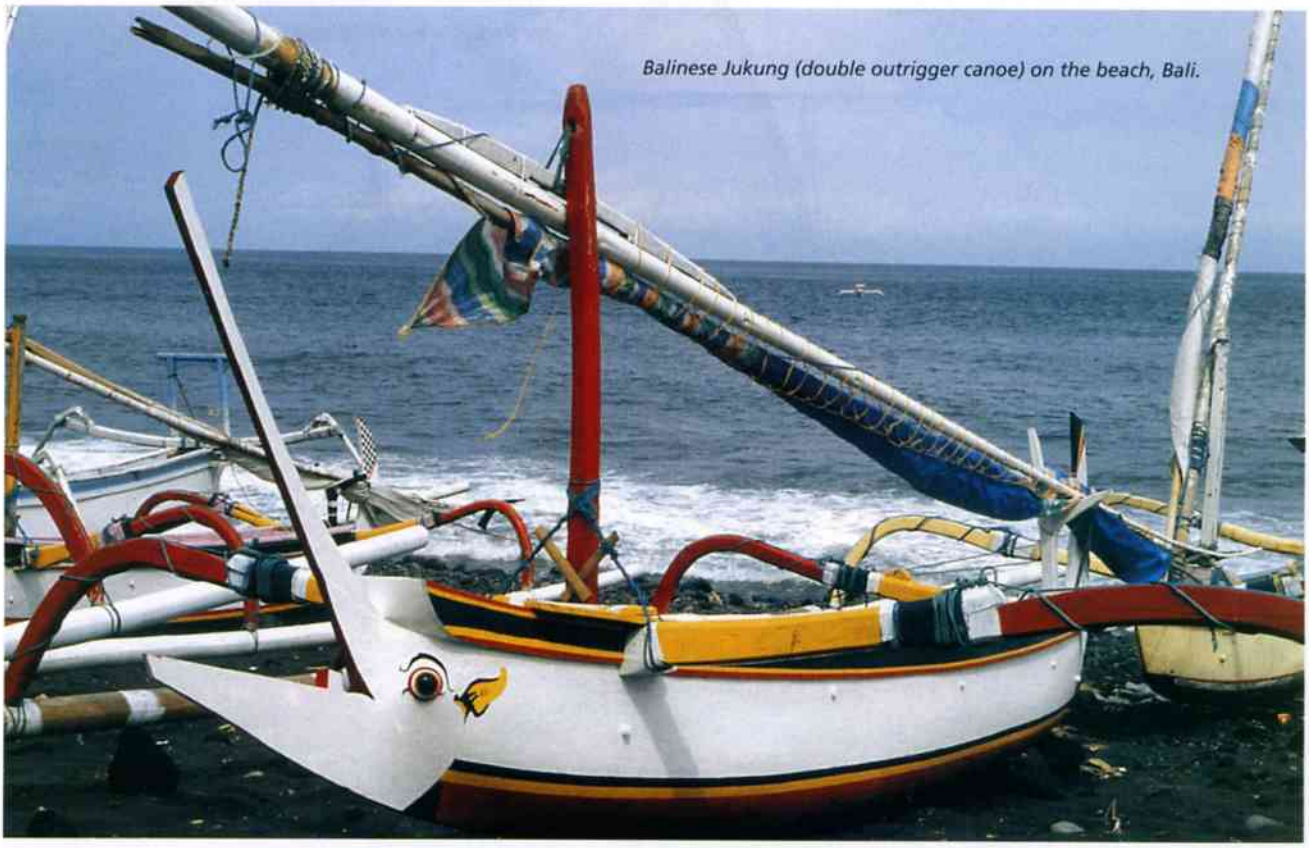


Fig. 3
Double outrigger canoe.

This canoe is being sailed by the most basic of sails, ie four palm leaves lashed together to make a downwind rig.

The Double Outrigger Canoe

Another modern craft developed out of the ancient canoe form is the Trimaran, a word I dislike. It is a mixture of the Greek *Tri*, meaning three, and the Tamil *maran*. It signifies the mixed up Western modern design approach to the Double Outrigger. Fig 3 shows a Double Outrigger of the type used in the settlement of Madagascar from Indonesia about 2,000 years ago. Today, the Double Outrigger Canoe type is sailed from the Philippines – where, when used for smuggling with 4 big outboards, they can outrun many high



Balinese Jukung (double outrigger canoe) on the beach, Bali.

Jukung in Darwin Museum.

speed Naval patrol craft – through Indonesia, to Madagascar.

The present day Balinese *Jukung* is one of the most beautiful of these double outrigger craft. To see them ride white crested waves, their floats balancing the main hull like gentle hands or swooping up to crunch land on the beach, is to observe a kinetic art form. Technically, the hulls are superbly shaped dugouts, semi-circular in cross section with greater buoyancy aft of the hull mid-section. An important part of the design is its outrigger floats, made of special thick bamboo, which are 33% longer than the main hull, projecting equally forward and aft of it and have 30% of the buoyancy of the underwater section of the main hull.

From our studies of Canoe-form designs in the Pacific and Indian Oceans, we believe that the basic sailing hull of the ancient Pacific sailing canoes is still ahead of the modern multihull in subtlety of underwater hull shape. Improvements in the performance of today's multihulls, as indeed much 'improvement' of yachts in recent years, have less to do with designers' hull shaping skills and more with improvements in modern sail fabric. Synthetic sailcloth allows you to sail closer to the wind, with more drive than the matting sail of the Pacific, the leather of the Roman sails, the wool of the Viking sails or the flax of the Channel lugger sails.

The development of modern catamarans and trimarans is an important pointer to the vast treasure house of design knowledge, experience and ideas that exist not on the screen of a computer but in the traditional small craft still sailing and found in ship museums or books of historic sailing craft.

In our September/October issue, on sale 24 August, James Wharram will examine the less well-known single outrigger craft of the Pacific and Indian Oceans which could be suitable for development for present day sailors.

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Wharram designed double canoe, Tehini, *rigged with Polynesian Crabclaw sails used for trading around Madagaskar.*

Multihull designer James Wharram continues his study of the ancient canoe-form craft of the Pacific

Lessons from the Stone Age Sailors Part 2

WITH ILLUSTRATIONS BY HANNEKE BOON

One reason for the expense of modern yachts, multihulls or mono, is that they are increasingly designed to accommodate the body comfort and mental attitudes of soft Urban Man – and as Urban Man is in debt slavery to a lifetime mortgage to buy a house, modern yachts that cost as much as their home are no longer affordable to a large number of would-be sailors.

Some rare souls like Frank and Margaret Dye adapted themselves to the sea and with minimal expense have sailed their 16' (4.9m) camping Wayfarer around Europe through fine weather and foul to experience the joy of becoming 'People of the Sea'. Much of the success of French sailors is based on the training of the Glenans Sailing School which taught the same approach in the 1970s and 80s. In 1997, Rory McDougall completed a round the world voyage on a Wharram 21' (6.4m) Tiki and he too adapted himself to the sea.

The ancient Canoe-form Craft that explored half of the world's circumference offer to people inspired by such real sailors, 'Light Displacement Fun Boats' – see the previous article in W21 – that are economical to build and own. On many oceanic archipelagos in the ancient Canoe-form world, suitable stone for tools was in short supply and suitable boat material either hard to work or again short in supply. However, with determination, these past Sea People developed with minimum materials and tools, craft that could sail fast, ride out ocean storms and land, when necessary, on open beaches. Their minimalist craft is the Outrigger Canoe: one main Canoe-form hull stabilized by an outrigger float. Today in the area of Indonesia and the Pacific Ocean, they survive in sizes from 12' to 30' (3.6-9.1m), made out of carved logs, planks of wood or plywood and in the case of modern expensive racing team paddling canoes, GRP and carbon fibres.

In the Melanesian areas of the Pacific, like Vanuatu – the former New Hebrides – and the Solomons, the small canoes are as common as bicycles in the Netherlands. They are used for personal transport, fishing and as small trucks to carry produce from main island gardens to the smaller offshore dormitory islands.

Sailing outrigger canoes are sailed with two distinct techniques. The first type, which has a distinct bow and stern, tacks like a Western craft with the bow going through the wind. On one tack the float is to windward and has less stress on it. On the other tack, the float is to leeward and is pressed into the sea. To prevent the float submerging, a balance board is added on which the crew can sit or stand as moving ballast

The second type of Outrigger Canoe, usually called the proa, always has the float to windward. To tack, you turn the forward bow away from the wind and when beam on, change the sail and mast positions, then turn what was the stern into the wind, tighten up the sheets and away you go

Fig. 1

on a new tack. For this technique, called shunting by Western writers, you need a specially designed hull profile with a symmetrical fore and aft keel line and with a similar bow at each end.

Fig. 2

During our 4 years of seasonal sailing in the Pacific and Indian Ocean, we had much experience of both types of sailing outrigger canoes. Both have advantages and disadvantages in building and sailing and are capable of sailing in turbulent coastal waters or offshore with a chance of meeting storms.

The Outrigger Canoe

In 1996, studying Melanesian sailing craft, we sailed into Lelepa Island, Vanuatu. Two small sailing canoes were launched off the beach to guide us five miles into the anchorage. Our pilots were keen sailors and sailed hard keeping ahead of us. Our speed log showed 6 knots. Later, we measured these canoes: they were about 16' (4.9m) long, so using the speed/length ratio formula, these simple outrigger canoes with crude sails were sailing at a speed/length ratio

Ancient Oru in Sri Lanka.

equalling that of displacement racing monohulls: 1.5 x √LWL.

The chief canoe builder could carve such a dugout hull out of a local softwood in two days and unpainted, it would have a working life of at least four years. Nor were the experienced builders blindly following tradition; they understood the why and how of hull design. Sailing aboard our 63' (19m) Double Canoe, one old canoe builder hung his head over the bow carefully studying our Vee-d hull entry wave pattern and then said that he was going to modify his special Racing Canoes to have a similar entry. As he had no Recreational Craft Directive official to consult, he could achieve design development in just two days.

Left: *Bow of Tikopian Canoe in Auckland War Memorial Museum.*

Above: *Dinghy in Galle Harbour, Sri Lanka, with outrigger added 'for safety'.*

On one island in the Maskelyns, Vanuatu, we met the people of a village which had run short of softwood trees. They wanted to build in plywood and asked us for advice. For them, we designed the 16' (4.9m) Melanesia outrigger canoe made out of two sheets of plywood – see W14. Since then, it has been of great interest to Western sailors. From sailing studies of the Melanesia, it does seem that a major factor in sailing outrigger design is flexibility in the structure, crossbeam attachment, float attachment to the crossbeam, mast and sail. When sailing, the craft seems to 'wriggle' its way to windward and this flexibility, particularly of crossbeam, mast and sail, seem to add to stability. When the float is to leeward, there is less drag than we expected.

Seen here is a 30' (9m) outrigger canoe from Tikopia – a 'Polynesian' island in the Solomon Islands, which are part of Melanesia – which I discovered 1995 in the Imperial War Museum in Auckland, New Zealand, half hidden in the small crowded hall of Pacific Canoes. It had been in the museum for 80 years, a Sacred Canoe presented to the museum when the island was 'missionised'. It was probably built nearly 100 years ago and is a genuine hull form from the Pacific sailing past.

The keel profile is a graceful curve and its long overhangs would gently lift in rough seas or ride through surf. The cross section of the hull is an exquisite rounded Vee. The question was how would this canoe – or a larger, say 45' (13.7m), ocean cruising version – sail? During the winter of 1996, out of curiosity, we laid a scaled transparency of the 30' (9m) Tikopian canoe lines on the lines of our 63' (19m) Spirit of Gaia. The keel lines and cross sections practically matched; it was an inspiring and humbling moment.

In our 1996 sailing season, we made the effort of sailing to the lonely island of Tikopia, to meet the Chief whose great-grandfather had presented the craft to the museum. I knew the roughness of the seas they sailed and of the regular 150-200 mile voyages they made to the Melanesian Vanuatu group. I also know from our similar hull form that theirs has sufficient lateral resistance to sail 45° off the apparent wind without making leeway.

On a waterline of 36' (11m), from our hull form experience the canoe can be expected to attain average speeds of between 1x √LWL to 1.5 x √LWL, between 6 to 9 knots. Therefore, this Tikopian outrigger craft would be able to average through rough seas 150-200 miles a day; in 6-7 days in a Force 4 wind one could plan to sail 1,000 miles.

Sea-going canoes of this type and size were recorded all over the Polynesian Pacific, from Samoa to Tahiti and up to Hawaii though unfortunately, the use of these craft was abandoned in most islands with the coming of the missionaries – who objected to the 'fun' with the vahines that went on at the beginning and end of the voyages – and little concrete data remains. We do know that they were sailed on 1000 mile journeys. However, we do not know how often they used the balance board or how difficult it was to use it when the float was on the leeside.

TACKING SEQUENCE OF MICRONESIAN PROA (MARSHALLESE WALLAP)

Sailing on port tack, bearing away from the wind.

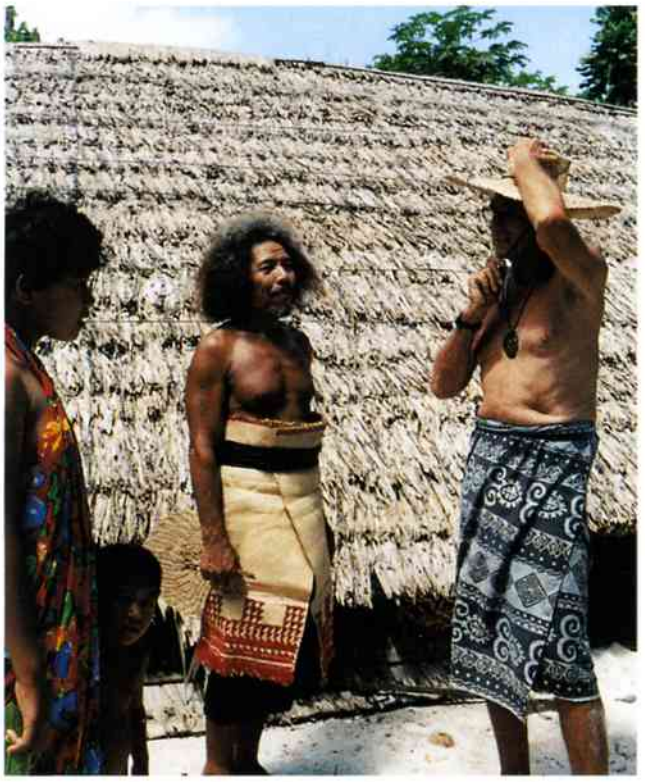
Tack of sail is disconnected...

... and carried aft, while the crew at the stern pull on the stay to cant the mast upright

The Micronesian Proa

The solution to the design problem of the float burying in the sea when on the leeside is the major difference between the outrigger canoe and the Proa.

In the vast area of the Canoe-form sailing world, there is one area, Micronesia in the NW Pacific, that consists of a few chains of small islands and atolls spread over thousands of square miles of ocean. As late as the 1950s, there were sailors there who would sail 500 miles for a few packets of tobacco.



James with Tikopean Chief Taumako, whose great grandfather donated the sacred canoe to Auckland Museum.

There is a report of a 27-30' (8-9m) proa on such a voyage being 'rescued' in a storm by a steamship. The crew of the steamship then observed, that these Micronesians did not perceive themselves as being rescued but as being 'given a lift'!

Their proa was the outrigger craft that always sails with the float to windward. The name Proa, I think, comes from the Indonesian boat name Prahu. It has come to mean the distinctive end for end, or bow for bow, tacking technique.

Also shown is a Marshall Island voyaging proa of the beginning of this century. Notice the small but comfortable deck cabins giving shelter from sun and rain. The Walap, the local name for such a craft, no longer sails the seas. However, in 1992, for the Pacific Arts and Crafts Festival in Rarotonga, the Marshall islanders built for the first time in 20 years a slimmer, faster 52' x 28' (16 x 8.5m) version of the Walap, the type known as the Flying Proa because it lifts its float out of the sea. It is a craft that has been recorded 'flying' at 20 knots. After the Festival, it was loaned to the Auckland Maritime Museum in New Zealand where, re-launched in 1995 for the Vaka Moana Symposium, being a planked boat, it had dried out and kept sinking. We had it hanging off the stern of our Double Canoe until it 'took up'. While there we made a close study of its construction. Hanneke also had the opportunity to sail on 'him' – canoes in the Marshalls are male!

All Pacific canoe form craft steer like a sailboard by moving the centre of effort of the sails. Tilt the mast and sail forward and the craft turns away from the wind. Tilting the mast and sail backwards, the craft goes into the wind. The steerboard/paddle is mainly a trimming device. On the Double Canoe, the Double Outrigger and the Tikopia Single Outrigger, sail and mast movement is minimal. With the end-for-end proa, to get steering balance when tacking there is a considerable movement of mast and sail, requiring strength, agility and careful teamwork. The photo sequence shows the 'shunting' of this racing Walap proa, using four strong experienced men. Get it wrong and you risk bruised fingers, strained muscles and the odd hernia.

On sailing aboard the proa, Hanneke noticed another problem. Get too close to fluky winds and you can go aback; with minimal or no mast staying on the normal leeward side, the mast and sail can collapse over the beam platform and float. From our observation of the shunting proa in Auckland, we favoured the outrigger canoe as being easier to handle.

The Sri Lankan Proa

In making that assessment we were wrong. An easier way of tacking a Proa has been observed by Westerners for 300 years. Holiday brochures of Sri Lanka in the Indian Ocean invariably show the Sri Lankan outrigger sailing craft, called the Oru. But the Oru was seen as a vessel of the Indian Ocean, not the Pacific and therefore not thought of as a Proa. Of course to

Mast is upright and sail is passed round on the lee side.

As sail moves on, the mast cants through further.

The tack of the sail is attached to the new bow...

... she luffs up and sails off on SB tack.

the ancient Canoe-form World, it was all one sailing area.

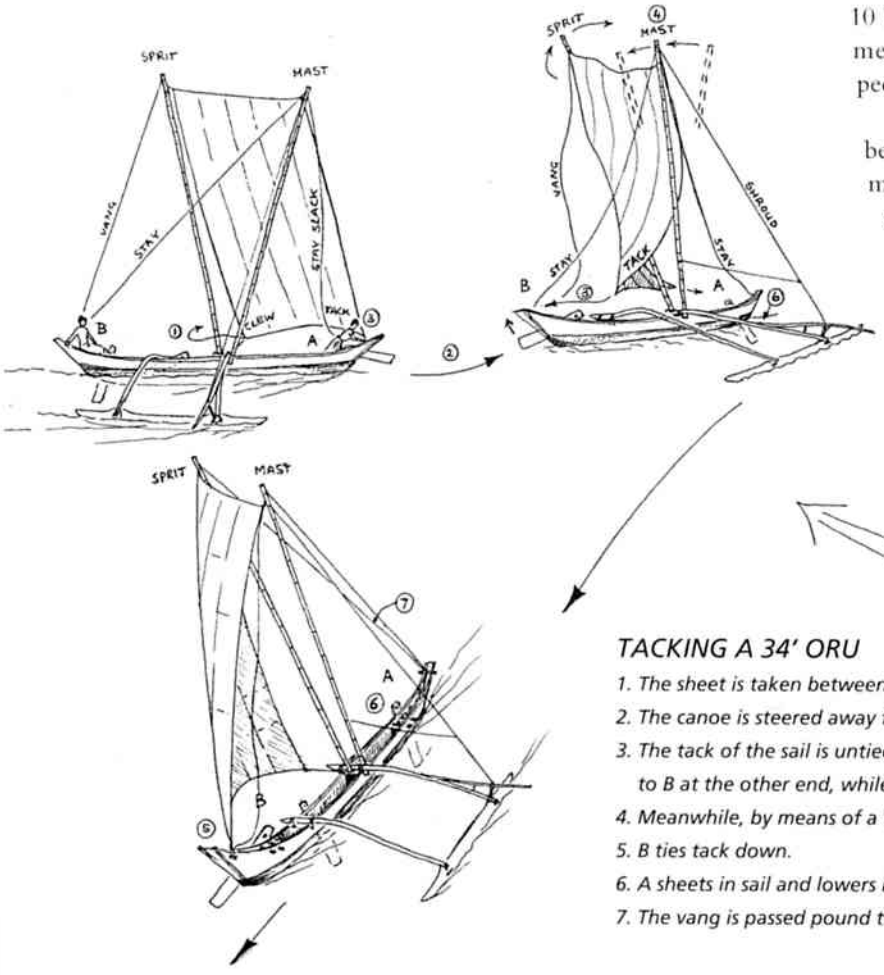
The Oru tacks end for end like the Micronesian Proa. Hundreds of fishing Orus still sail the Sri Lankan coast. The Sri Lankan government has encouraged the building of Orus with GRP main hulls, and certain fishing is restricted to sailing outriggers only. So closely is the concept of safety at sea connected to outriggers, that a small harbour fishing craft made out of a Western yacht dinghy has an outrigger added 'for safety'!

The Sri Lanka Oru would not win any Boats on Show competition for elegance of form or finish. The first one we measured loomed over my head like an archaic sea animal, its long dugout hull pitted with age and mended with stitched on tingles. It was 50 years old and its built up single plank topsides were sewn on.

Compared to the light woodwork elegance of the Micronesian Walap, it was brutally strong and easily repairable. The flat plank overhanging bows could not only ride the surf on beaching but also lift over stormy seas. I had the opportunity to sail one of these craft, not in such conditions but in the lightest of winds.

Six of us pushed the 1.25 tons craft into the water and even in the glassy calm, she was moving out to sea. When the first wind ripples began showing on the surface, the absurd rectangular sail filled like a spinnaker and the craft was moving at 3-4 knots 45° off the apparent wind. Light weather sailing ability is as important as that of withstanding strong winds and this archaic looking craft moved well in the lightest airs. From the crews' description of the locations of their offshore fishing areas and the time they took to get there, this craft could average 7 knots. Others reported 10 knots averages in what they describe as 1,2,3 or 4 men winds, meaning attained with the number of people out on the outrigger beam to add stability.

Once we had a good way on, I said: "Tack". After bearing away bringing the float into the wind, the two-man crew eased a few ropes and well... the drawing shows what happened. This Proa rig, compared to the Proa of Micronesia, needed no big men for heavy lifting when tacking. It is a rig that could be developed to be used by Western sailors.



TACKING A 34' ORU

1. The sheet is taken between the mast and the spirit by man A and belayed, while...

2. The canoe is steered away from the wind by man B.

3. The tack of the sail is untied by A from the "bow" and passed between the spars to B at the other end, while the canoe lies beam on to the wind. B raises his rudder.

4. Meanwhile, by means of a tug on the stay, the mast starts to cant to the other end.

5. B ties tack down.

6. A sheets in sail and lowers his rudder.

7. The vang is passed pound the leeside and tightened at the "stern" by A.

Modern yachts are defined by mathematical formulae: sail area/displacement ratio; displacement/length ratio; sail area/wetted surface ratio. There is an accepted scale of comparison, defining a yacht as heavy displacement, medium displacement or light displacement. Unfortunately, as I explained in W22, the assumption is made that the fast light displacement boat is a modern concept. We applied these defining formulae to the crude looking, low cost Oru and discovered that by modern mathematical definition, the Oru is a high performance, light displacement sailing craft! The 15:1 main hull length/beam ratio and float length/beam ratio equals modern high-speed multihulls. The blunt ends of the dugout log Oru give a high prismatic coefficient, again considered an important aspect of current multihull design. Their semi-circular cross sections give minimum wetted surface for maximum speed.

The only negative – to me a serious negative – of the performance orientated light displacement Oru is its calculated stability, which is similar to that used in three modern cruising catamarans which capsized with injuries and loss of life! Others may differ but I do not recommend cruising for 'fun' with such a low stability factor. However, from our observations, it does seem that vital extra stability is gained from flexibility in the outrigger and rigging. If one reduced the amount of sail to achieve a sail area/wetted surface ratio of 2:1, the Oru would have stability equal to many proven stable multihulls.

The outrigger craft of the Pacific are 'Light displacement cruising craft that can be fun to sail'. For the modern would-be sailor who can do without creature comforts, these ancient craft offer the inspiration for sparkling sailing boats that can be easily built at affordable prices.

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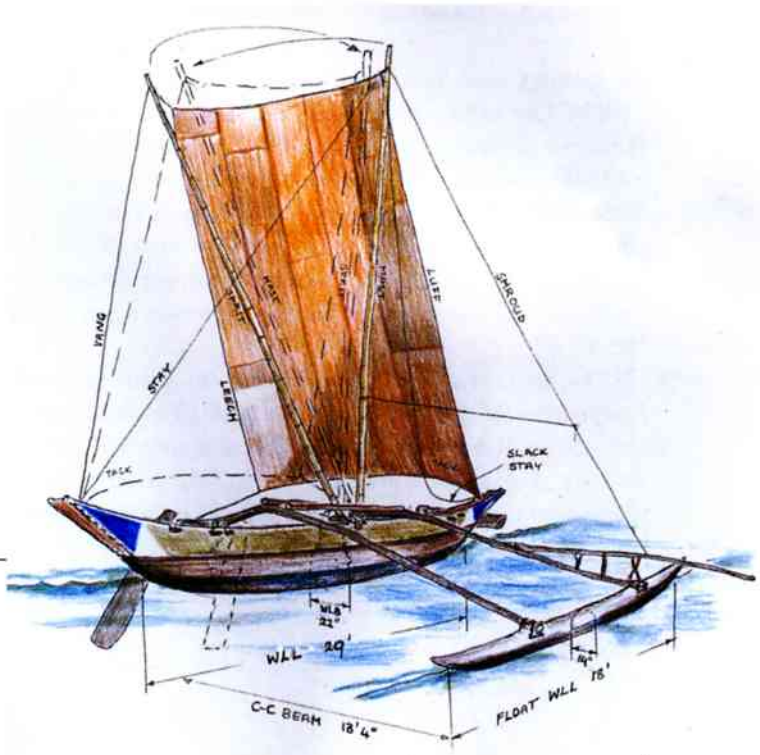

ORU DESIGN ANALYSIS

L.O.A.	34'	
W.L.L.	29'	
FLOAT LENGTH	19'	
BEAM C-C	13'4"	
WEIGHT ALL UP	1.25 TON (2760 lbs)	FLOAT = APPROX 30% CANOE HULL WEIGHT
WEIGHT FLOAT	290 kg (638 lbs)	

	ESTIMATED	REDUCED
SAIL AREA	345 ft²	280 ft²
RATIOS:		
SA / WETTED SURFACE	3.1	2.6
SA / DISPLACEMENT	28	22.8
DISPL. / LENGTH	51.2	
SPEED / LENGTH @ 7 kn	1.3 $\sqrt{WLL}$	
@ 10 kn	1.85 $\sqrt{WLL}$	
HULL LENGTH / BEAM	15 : 1	

COMPARISONS:

- 2.6 IS EXCELLENT GHOSTER
- 20 – 22 RACING MONOHULLS
- 22+ VERY HIGH PERFORM. HONOS.
- 25 – 30 HIGH PERFORMANCE MULTIHULLS
- 50 – 120 ULTRA LIGHT MONOHULLS
- 1.5 $\sqrt{WLL}$ IS MAX. SPEED FOR HIGH PERFORMANCE MONOHULL
- 15 : 1 + HIGH PERFORM. RACING. CATS

SA/WETTED SURFACE : $\frac{SA\ (ft^2)}{WS\ (ft^2)}$

SA/DISPL. $\frac{SA\ (ft^2)}{DISPL.\ (ft^3)^{2/3}}$

DISPL./LENGTH : $\frac{DISPL.\ (TONS)}{\left(\frac{WLL\ (ft)}{100}\right)^3}$