CATAMARANS

A.Y.R.S. PUBLICATION

No. 1

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The Amateur Yacht Research Society

(*Founded June*, 1955)

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EDITORIAL

The Amateur Yacht Research Society was formed in 1955 and has since produced many publications, details of which will be found on the last page of this issue which is a third edition of No. 1.

We are a Society whose object is to help individual yachtsmen to experiment with and develop sailing boats. However, we will also undertake group research into the power of sails and the efficiency of sailing hulls. It is our belief that there is a vast inventive ability in the yachting public which, by our help, will produce a more rapid development of sailing yachts into efficient mechanisms.

Essentially, we want to produce new ideas. The easiest way to do this is to put before a group of people a complete account of some field of human endeavour. If the presentation has been good enough, many of the group will quickly appreciate the basic principles of the field and will be able to suggest other aspects which have not been explored. This booklet and some of the others we have produced, describe many ways in which the Outrigger principle has been applied to sailing craft and suggest several others. As a result of these accounts, we feel sure that many of our readers will be able to devise useful Outrigger sailing craft. For example, the Micronesian sailing canoe is undoubtedly the most efficient conception of a sailing craft which has ever appeared. Every part of it is made to get the utmost from the wind and water forces which appear around it. But it has some faults which do not allow it be acceptable to yachtsmen. However, should only one of the readers of this journal devise a method to correct these faults, these craft might become common in our waters and a lot of people might be able to get a great deal of pleasure from them.

The A.Y.R.S. members are to be found all over the world. We are very happy about this because we feel that yachting can be most quickly advanced only by the free and unfettered exchange of ideas between yachtsmen everywhere. It is felt that every effort should be made by the A.Y.R.S. Secretaries to widen the International basis of the Society still further and get articles from all parts of the world for the publications.

THE AMATEUR YACHT RESEARCH SOCIETY

At the first Annual General Meeting in December, 1955, the following objectives for the Society were decided upon :

1. To make full sized and reduced models of all types of outrigger craft to see if a cheap, fast, sailing craft could be produced for yachtsmen.

2. To make hydrofoil craft which are lifted clear of the water by structures running beneath the surface to achieve the greatest possible sailing speeds.

3. To produce a safe, comfortable, fast and cheap cruising boat.

4. To experiment with sails, sail rigs and, if practical, aerofoils to see if any of them are likely to be an improvement on present rigs.

5. To examine new developments in yachting as they occur.

6. To build up a pool of technical information available to members on request.

7. To produce publications every two months. These will describe our experiments and any others of which we learn and also the method of the development of craft and sails from all over the world in their evolution. We also hope to show how new ideas can be achieved and expressed in any aspect of yachting.

From all these objectives and it will be seen that we are simply concerned with helping amateur yachtsmen. Most of the members are amateurs but it has been found necessary to have professionals to advise us and help us make things. We obviously must have yacht designers amongst us who, though they may now be amateurs, at least hope to earn their living from their art in the future. Also, because we want to encourage members to invent things and design new boats, we must logically be prepared to advise on patents and protect the copyright of designs.

A.Y.R.S. PROPERTY

1. One of Prouts' standard SHEARWATER II hulls with mast, rigging and sails for it.

2. Floats and seats for this as described in the last article in this publication.

3. A 12′ 3″ dural step ladder and two planing floats for item No. 1 which are 4 feet long, 1′ 6″ in beam and 8″ deep.

4. The A.Y.R.S. wind tunnel which would be suitable for testing models with a 6′ mast.

5. A 1″ to the foot model of the A.Y.R.S. hull with a slot arrangement forward of the mast so that different hydrofoils or floats can be attached for testing.

6. 7 hydrofoil configurations and one pair of floats for No. 5.

7. A Fijian model of a single outrigger canoe presented by Owen Dumpleton.

8. A model of a double hulled cruising catamaran made and presented by Owen Dumpleton.

9. A hull with automatically operating hydrofoil stabilisers.

10. A crank operated dynamo presented by Owen Dumpleton.

11. A wind or water operated pressure gauge presented by Harold Wiggins.

12. A model of Sandy Watson's Micronesian, backwards-forwards canoe.

13. A model of a refined version of item No. 12 with rounded sections and a special type of Bermudian rig.

14. One display board.

A.Y.R.S. ACCOMPLISHMENTS AND PLANS

Most of the work we have done so far has been the accumulation of information and its publication. Even the amount which we have already done, however, seems to have influenced quite a number of people, we hope to the advantage of the craft they are now building.

In 1955, our first year, we sailed the A.Y.R.S. Catamaran with the two types of floats mentioned in items 1, 2 and 3 above. We learned quite a lot from these tests though a sense of urgency prevented us from trying out each type as well as we should have done. We hope not to repeat this mistake.

Sandy Watson made his Micronesian canoe which sails with either end as the bow but always has the same side to windward. A description of this craft is to be found in OUTRIGGERS. This craft sailed but it was slow, due to its weight and our home made sails.

Various members did individual work in 1955 for which the A.Y.R.S. was not responsible. The Prout Brothers continued their development of the double-hulled catamaran with SHEARWATER II.

PLANS FOR 1956. The A.Y.R.S. hull and sails will be fitted with a hydrofoil configuration which looks better than that of the Baker Company in the U.S. to me. We hope for success.

Experiments will continue with Sandy Watson's Micronesian canoe.

Bill O'Brien is going to launch a nicely designed, chined, double-hulled catamaran.

Bob Harris is launching what Victor Tchetchet described as a " Beautifully built " doubled hulled catamaran with semicircular underwater sections.

The Prouts are selling a newly designed 16′ 6″ double-hulled catamaran in large numbers for £150 each ($450).

PLANS FOR 1957. We are going to spend a lot of thought and time making models and working out ideas for both hull and sail testing apparatus this year. We also hope to work out a complete testing programme. It is hoped that this programme will be put into operation next year, though " Pilot " tests to study our apparatus may be made this year.

THE A.Y.R.S. TWO-HOUR ARMCHAIR YACHT-DESIGNING METHOD

This method will let you draw the lines of a yacht in two hours or less. The materials needed are a pencil, a rubber and some graph paper. To test it, a fourteen year old friend of mine, Sandy Watson, was asked to design his own idea of a sailing yacht. In one hour and three quarters he produced the lines which are shown here. He had never even thought of designing a yacht before I talked him into doing it and, though the lines may perhaps lack several qualities which we may look for in a design, I think you will agree that they are very passable for a first attempt.

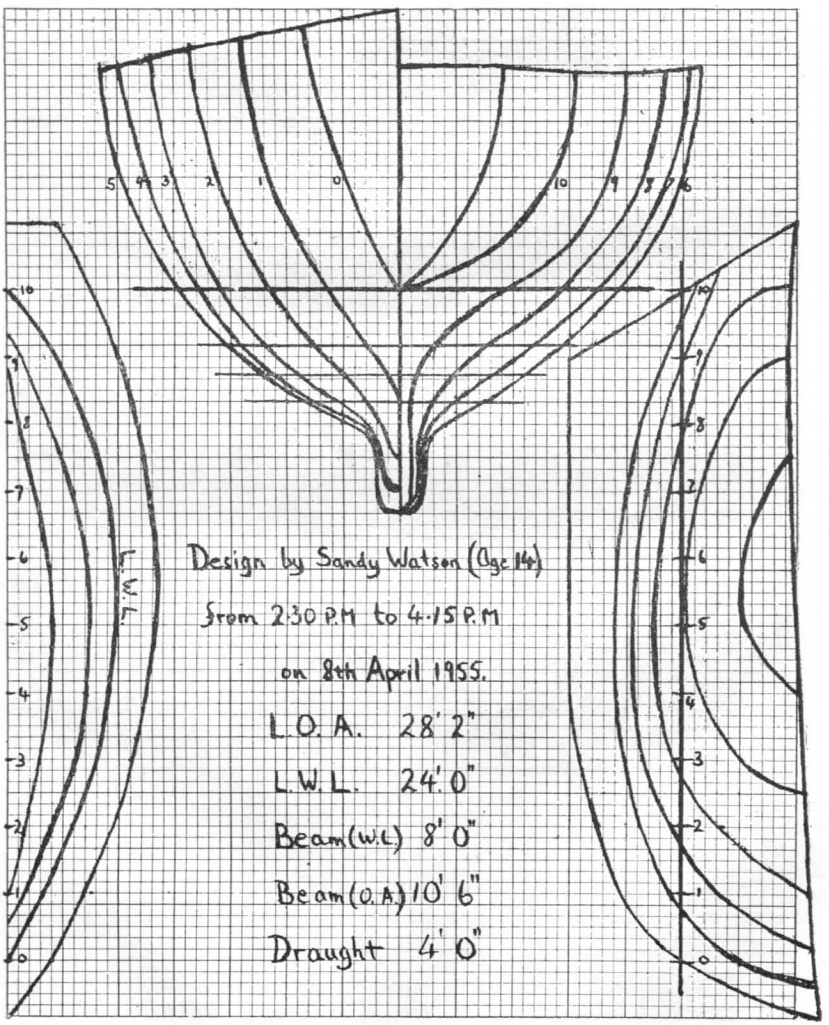
The method depends for its simplicity on the use of a set of areas for the underwater sections of the yacht. In other words, the waterline of the boat is divided into ten, and the part of the yacht underwater at each of the divisions is given an area which, for our purposes, is in a fixed ratio to the area of the midship section underwater part. If the fore and aft ends of the waterline are sections 0 and 10, respectively, the sectional areas can be in the following ratios :—

Section	0	1	2	3	4	5	6	7	8	9	10
Area of section	0	1.1	2.5	5.0	8.2	10.0	9.9	8.2	5.0	2.0	0

This " Curve of areas " as it is called is the average of the curves of

areas of several successful yachts whose curves of areas have been published. Any curve of areas may, of course, be used in its place. In fact, quite large liberties can, apparently, be taken with the curve of areas and the yacht can be fast.

Process 1. Draw the midship section (section 5) on the graph paper according to your own wishes, using any convenient scale such



as 1″ to the foot. Count the number of the smallest of the squares of the graph paper which are below the waterline.

Process 2. Using the ratios of the curve of areas selected such as that one given above, and the number of small squares which have been counted for the midship section, find the area of each section in small graph paper squares.

Process 3. Draw in all the sections so that their underwater areas are those calculated in process 2. It is useful to remember in this process that where the sectional lines meet the sheer, a regular lessening of the distance between them will produce a convex gunwale and, if the gunwale distance between any adjacent two sections is the same, the gunwale will be straight there. The section at the after end of the waterline may be a little hard to estimate. A reference to some published set of lines will give an approximate idea of its shape relative to the section 5 which has been drawn.

Process 4. Using the heavier vertical lines of the graph paper, take off the eleven points of each section which cut each one and draw the buttock lines on a separate piece of graph paper. It is recommended that the horizontal scale of the boat be reduced so that these lines become almost circular in shape because that is an easier curve to fair up with the eye. However, that is only a matter of personal preference.

Process 5. " Fairing up." The buttock lines which have been produced will probably be uneven with hollows and bumps on them. These should now be smoothed out where possible and the points on the sections altered accordingly.

Process 6. The waterlines may now be drawn from the sections using the heavier horizontal lines of the graph paper. A deck line may be drawn if the sheer is absolutely flat or its average, if it is not. This will allow the buttock lines to be continued upward to deck level.

Process 7. " Fairing up." Both buttocks and waterlines must be fair curves. Any uneven parts of them must be altered to achieve this, and where such an alteration is made in one of them, the other set of lines and the sections must also be altered because what has happened is that the hull has been designed with a hump or a hollow on it and if this is smoothed out all three sets of curves will be affected.

Process 8. If the buttocks and waterlines have been reduced in scale as recommended, the yacht must be restored to scale, a sheer drawn if wanted, and the lines are complete.

This is the art of the yacht designer expressed in its most simple and easy form. To the naval architect, however, it is only the beginning

of his work unless he is in the fortunate position of having others to do it for him. The displacement must be calculated. The internal accommodation with the weight of every item must be worked out so that the yacht will float on her designed waterline. The sail plan must be selected and placed in its proper position relative to the centre of lateral resistance. In some cases, the lines which have been drawn will be tested for balance or the tendency of the hull which is built from them to gripe when the yacht heels. This fault in yachts is partially due to having broad quarters and a fine entry. When the boat heels, the broad quarters cause the stern to be raised up more than the bow and the lateral resistance moves forward so as to cause griping. Another calculation for the heeled yacht will give the knowledge of its ability to run a straight course with the rudder amidships. Yet another (which is seldom done) will give the amount of righting force at every angle of heel. All these things are simple enough in themselves, though they involve a good deal of tedious work. A useful theoretical account of yacht design is No. 5 publication by Charles Satterthwaite.

CATAMARANS

The word Catamaran takes its origin in India where it is the English version of the native words meaning " Tied logs." It is therefore a better word to describe the craft which will be described here than " Bi-scarf " or " Tri-scarf " which mean double ship and treble ship respectively, and also better than " Trimaran "—a mixed Greek and Tamil word.

There are five main types of catamaran which are 1. The double hulled ; 2. The Polynesian single outrigger ; 3. The Indonesian with outrigger floats on either side ; 4. The Micronesian and Melanesian which sail with the single outrigger always to windward and thus have to be able to sail as well backwards as forwards ; 5. The Balance board sailing canoe.

The Double-Hulled Type.

The linking together of two logs whether hollowed out or not by cross beams above them is probably a very ancient concept in the Pacific. It was found in most of the more remote islands and among the more primitive peoples when Europeans arrived there. There is also evidence that it was more widespread previously in some of the religious symbols of the Micronesians. Whether or not it was the very first concept of a mechanism to get more stability from a log craft is a

matter of doubt, but it is a fact that its use was getting less among the Pacific peoples even before the arrival of the European and it has now practically disappeared. It is strange, therefore, that yachtsmen have seized upon this type for development instead of the single outrigger craft which is a much more seaworthy and efficient mechanism. Its main use among the Pacific people was as a cargo-carrying and war-making craft. This was because of its large surface area and stability. Its main fault is that there are large wringing strains between the two hulls which must often have caused them to break apart.

It is more than likely that many craft of this kind have been made by Western peoples since the discovery of the Pacific. The first known to the writer was by Sir William Petty in the reign of Charles II. A large double hulled craft called " The Experiment " was made by him and sent on a cruise to the West Indies. It disappeared in the Bay of Biscay however, with all hands, so the type came into a good deal of disrepute which it has retained to the present day. It is thought that it ran into a storm, which was reported to be there at the time, and broke up.

N. G. Herreshoff took up the type in the United States about 1870 and designed 5 or 7 of them. His hulls were about 30 feet long by about 1 foot 6 inches in beam and spaced about 15 feet from each other. He also worked out a method of holding the two hulls parallel to each other and still allowing them to pitch in a fore and aft direction freely which abolished the wringing strains. At least two of N. G. Herreshoff's craft ran their bows under and capsized stern over bows which must have been a little terrifying for their crews. He is reported as having said "It is my belief that a single hulled sailing machine can be developed that will have a higher average speed than the multihulled craft." This was in reference to the slowness of the double-hulled type in light winds where its wetted surface is greater than that of normal yachts.

The type enjoyed a limited popularity in America for some years because Mott lists 10 of the type in service in the 1890's, but it then died out more or less till recently. When marine plywood came on the market, several of the type appeared with deep slicing hulls and the Bermudian rig. These craft proved to be fast downwind but were slow to windward and were very hard to put about. Their slowness to windward was, in my opinion, due to their relatively great wetted surface. There might also have been a tendency to sail them rather closer to the wind than was correct for this type of craft. After all, the people sailing them were used to conventional craft and it is quite possible that the course to steer to get this craft to windward might be

quite different. The slowness in stays was due to the great grip which the long, deep hulls had on the water. Also, when turning, the lee hull has to be pulled around in a larger arc than the weather hull. These craft were so light that the force of the wind often stopped all the way on the boat before she was head to wind. Having the hulls closer together makes putting about easier but decreases the stability and sail-carrying power.

As far as I know, the first thoroughly successful double hulled catamaran was made by Prout's of Canvey Island in 1954, though two others must be mentioned. These are the Lear Cat, originally an American design, and Ebb and Flow, a large craft with 40 foot planing hulls designed by Tothill.

Roland Prout is a very successful canoeist and, with his brother, runs a firm making kayaks of resin-bonded plywood among other craft, Now the best way to find the shape of hull with the least resistance is to design hulls for manpower in races. Roland Prout was able to show that what mattered most under these conditions was the wetted surface of the hulls and designed his racing kayaks with an almost semi-circular underwater section which is the shape with the least wetted surface for a given displacement and length.

When his interest turned to double hulled catamarans, Roland merely made two hulls from his racing kayak mould and joined them with a flying cockpit. A centreboard and Bermudian rig completed the craft.

The Prout's catamaran is extremely fast downwind. It has been timed at 20 land miles per hour. Close hauled, it is rather faster than most centreboard dinghys of the same length. In strong winds, it does not appear that the centreboard is necessary, though when the wind is light, it must be used. It is still slower in stays than other boats, especially, in light winds and if the centreboard is not used in strong winds. When I was sailing in her, we always got about without losing way. In my opinion, the spacing of the hulls was about right because in the puffs of wind we just lifted the weather hull off the water.

In some of the Pacific single outrigger canoes, the float is not parallel to the main axis of the hull, its after end being nearer the hull than the forward end. It is quite possible that the hulls of double canoes should be similarly placed. What is needed is a sailing skeleton of two hulls, sails and rudder all adjustable to each other to find the perfect combination. Many further details of these craft are to be found in OUTRIGGERS, OUTRIGGER CRAFT AND OUTRIGGER CONSTRUCTION.

The Polynesian Single Outrigger Type.

The Polynesian single outrigger canoe is a simple machine. The ordinary fisherman's craft consists of a dugout hull about 20 feet long with washstrakes along the gunwales. Two poles are placed athwartships across the washstrakes and stretch as a rule out to port for 6 to 8 feet. At the ends of these poles, the float is attached, either through holes in the float, by pegs driven into the float or where there is Melanesian influence, sticks may be stuck into the float and lashed to the poles at the other end thus allowing the poles to be horizontal and not curved. The dugout hull has a bow and stern.

When this canoe is being sailed, the float is sometimes to windward and sometimes to leeward. When it is to windward, the float acts as a counterpoise to the weight of the wind and a member of the crew may be sent out on to it to increase this. When it is to leeward, the float acts as buoyancy on the lee side and again keeps the craft upright. In this state, it is bad for the float to dig into the water too deeply, not only because it increases the resistance but because the lift which the float can give is limited and it can be driven under the water and cause a capsize. To avoid this, the poles across the canoe stretch out for some distance on the opposite side to the float and a crew member can be sent out to windward to balance the wind forces. In Samoa, the upper side of the float at the front is pared down into a curve like the leading edge of an aeroplane wing, and it is likely that this is done because it has been found that this shape kept the float from burying itself so deeply as does the ordinary shape of bow entrance like that of the canoe hull.

This type of canoe would be very suitable for a paddling canoe for us. A light kayak hull with an outrigger float could very easily be carried up a beach by a child. It could be decked and even made inhabitable for one person with a berth and a cockpit cover made of perspex like the hood of some aeroplanes. As such, it would be quite safe and free from any danger of capsize in any ordinary sea.

If it were wished to sail this type of craft, certain additions would be necessary to make it reasonably safe. The weight of the float would have to be suitable for the sail area carried when it was being used as a counterpoise. Its lifting power would have to be as great as its weight so that it could be used as fully on the other tack.

Only one attempt to use this type of stabilizing mechanism by Western people is known to the writer and that is the recent account of an attempt by a French engineer and his wife to cruise in a small dinghy from France to Australia.

The Indonesian Double Outrigger Canoe.

This craft consists of a dugout hull with (usually) two athwartships poles with floats at either end. The floats just lap the water on either side when at rest. If they were to be raised much above the water, the craft would bang on its floats when there was anything of a sea.

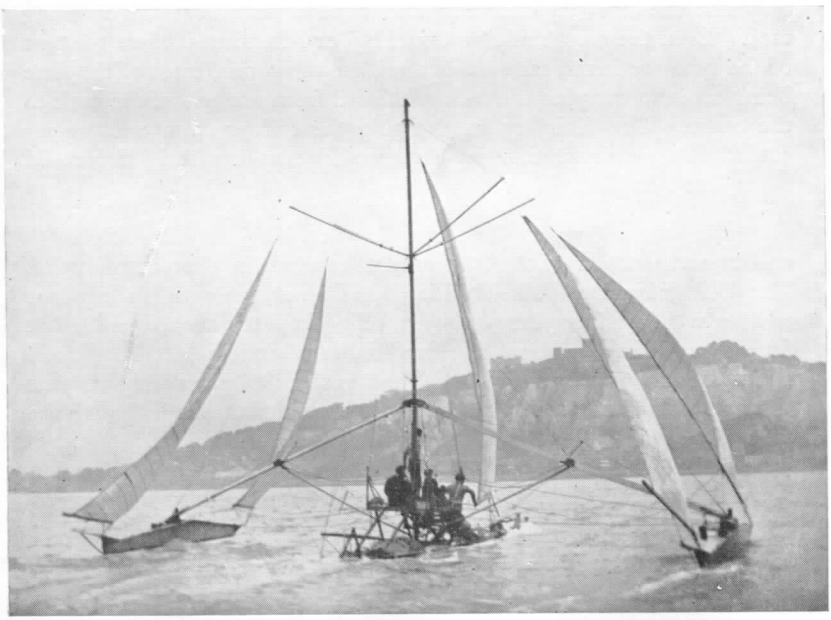
Judging from photographs, the way in which these craft are sailed is for the crew to go out along the weather outrigger pole till the weather float is pressing more deeply into the water than that of the lee side. In a steady wind, they seem to be perfectly satisfactory craft but when there is much of a sea, it appears that the floats have a tendency to break their supporting poles.

In the summer of last year, I had the good fortune to have a sail in the double outrigger which had been built by Commander Fawcett. It was undoubtedly fast but it was not very manoeuvreable.

Victor Tchetchet in the U.S. is experimenting with this type of craft which he calls "Trimarans." An account of his successful craft EGG NOG will be published in a future issue.

The Micronesian and Melanesian Sailing Canoes.

These canoes are similar in their basic layout to the Polynesian single outrigger canoes. The Micronesian canoe is more advanced



Commander Fawcett's outrigger craft

and its main hull is a plank-built boat which may be as much as 60 feet long. The single outrigger float is attached to it by many poles and connectives so as to give an immensely strong structure. The main difference from the Polynesian canoe is in the way the craft is used. The outrigger is always to windward so that the craft sails with one end as the bow on one tack and the other end as the bow on the other tack. To go from one tack to the other, the craft is stopped, the tack of the lateen sail is carried from that end of the boat which has been the bow to the end which will now become the bow, the steersman carries his paddle from one end to the other, the sheet is pulled in and the craft sails off in the opposite direction.

Because the hull has one side always to leeward and the other side always to windward, it need not be symmetrical about a fore and aft axis and, in fact, is not so. The leeside is flat and the weather side is curved so that the hull resembles a narrow, double ended boat like a whaleboat cut along the middle with a flat wall of planking instead of one of the halves. When looked at from above, it is rather like the shape of the section of an aeroplane wing and, by its motion through the water, creates a force acting to windward. The lateen sail is efficient on all courses of sailing being almost as good as the Bermudian rig.

The one difficulty of this type of canoe is the difficulty in changing tack. Even the most skilled crew in Fiji or Micronesia where the best of the type are found take about a minute to do this, most of the time being taken in carrying the tack of the sail from one end of the craft to the other. The difficulty in changing the rudder from end to end could be very easily rectified by having rudders at each end which could be lowered on changing tack.

The basic conception of this type of craft is so difficult for us to understand that few of the type have been made in western countries. The U.S. magazine " The Rudder " had an article with photographs of a large " Proa," as these craft are called in Micronesia, in 1898 but little more is known about it. Sir William Acland in 1938 launched a craft of this type and has been good enough to give me full details about it. The hull and float were in the normal native style though the construction of the hull was of three skins in the way in which dinghys are made. The lateen sail differed from native practice, however, in that the mast slung the yard from its exact centre so that in changing tack, the peak of the sail could become the tack on the opposite course. The masts of all these craft must rake towards the bow to get the sail forward of the centre of lateral resistance so they are only stayed to the midline of the hull athwartships and can fall towards either end. Run-

ning stays to each end allow them to be kept under control. Both mast and the sprit which holds it to leeward are in sockets to allow the movements.

The tack changing drill adopted by Sir William was as follows :— 1. Let fly mainsheet ; 2. Let fly tack ; 2. Tauten vang. At this stage, the yard is more or less horizontal and the sail is flying to leeward like a flag. 4. Aft the mast ; 5. Haul down new tack by what was the vang. 6. Haul in sheet. The time taken to go from full speed ahead to having

Sir William Acland's Micronesian canoe

the sail full and drawing going " astern " was only 15 seconds which shows that the modification to the sail was a great improvement.

Sir William's " Proa " was faster than a six meter and could sail closer to the wind than a cruiser though not as close as a six. With the paddle steering he used, not enough leverage was present to control the craft as easily as is customary. The craft only capsized once when the helmsman (not Sir William) " put about " by mistake and brought the float to leeward where it was immediately driven under.

The Balance Board Sailing Canoe.

In the Palk strait between India and Ceylon is found a canoe used for fishing which may be up to 40 feet long with a beam of as little as 4 feet. It carries a large sail area and depends for its stability on a plank which stretches across it and the weight of up to four of the crew perched out at its windward end. The mast stays are attached to the plank. From the presence of another plank or pole stretched across the canoe at its after end but which is not used for stability, it is possible to guess that this craft took its origin from a double outrigger craft with the floats removed.

It is known that for nearly three thousand years the Sinhalese, as the people of Ceylon are called, have been trading with Indonesia and it is possible that through this trade the double outrigger was introduced into Ceylon and the neighbouring parts of India and the modern balance board sailing canoe as well as the single outrigger canoes are its descendants.

The International sliding seat sailing canoe is the modern version of this craft.

Modern Outrigger Compromises.

L. Francis Herreshoff in his book " The Common Sense of Yacht Design " suggests a compromise between the single outrigger and the double outrigger which allows the use of a fixed rudder and the Bermudian rig. He suggests that the thwartships poles of a double outrigger be made so that they can be slid from side to side. By this means, the weather outrigger only can be kept in use as a counterpoise to the weight of the wind. On putting about in the normal way, the outrigger apparatus is slid over to windward and will perform as well on that tack as the previous one. The crew can add their weight to that of the weather float on either side.

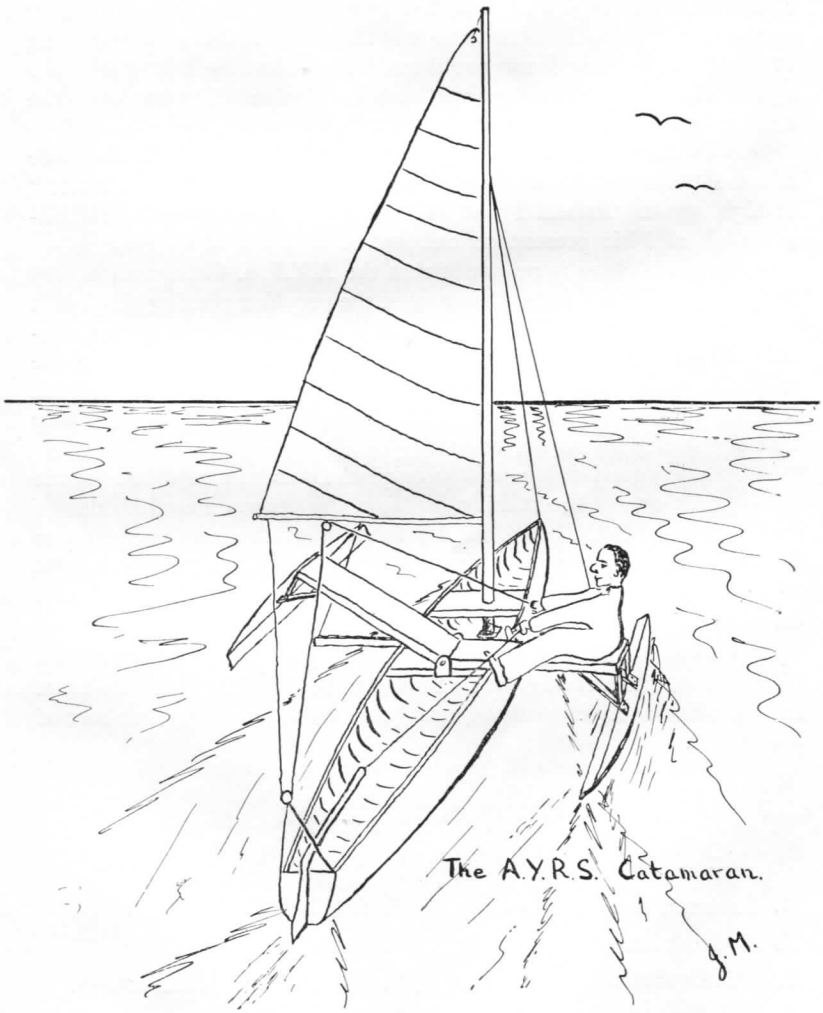
THE A.Y.R.S. CATAMARAN

The accompanying sketch shows my first idea of a single hulled double floated Catamaran. From my study of the native canoes in the Pacific, I had come to the conclusion that it was not desirable to use lift from the lee float, but that it was better to use the weight of the crew as a counterpoise on the weather side.

This craft was made by Prouts of Canvey Island exactly as shown, using one of their stock SHEARWATER II hulls, in 1955.

On the first sailing trials, it was found that lift *could* be used from the lee side perfectly well, a fact which has been well confirmed by

Victor Tchetchet and others. Unfortunately, I had not given enough support to the float because the working of the waves caused the plywood itself to tear. These floats were then temporarily discarded and two planing floats were made by the Dover Yacht Company and fixed to the ends of a light alloy step ladder by a single bolt so that they could pitch freely. The ladder was so arranged that it could be slid across



the hull from side to side in the manner suggested by L. Francis Herreshoff. This sliding arrangement has not, however, found favour with anyone sailing the craft and it it is not, in fact, used.

The Catamaran was then taken down to Weston, near Southampton for the speed trials and placed in the able hands of Ivan Morris for their duration. The first fault found was that the floats tended to dig their bows under, which was probably due to having too bluff an entry and not enough V. Ivan then put a second bolt from the ladder ends to the floats to fix them firmly and then noticed that when travelling at great speeds, the floats could suddenly submerge but would rise again quickly when the sheet was eased. This may also be due to the bluff entry.

Extra lateral resistance was necessary and a leeboard was made of a well seasoned piece of pine but this snapped off " like a carrot " at high speed. Roland Prout had the same difficulty with SHEARWATER and his present centreboard is 2" thick at its greatest.

Speeds. There is no doubt that the A.Y.R.S. Catamaran is very fast, certainly much faster than any of the very fast planing dinghys at Weston. Unfortunately, the winds at the speed trials were not suitable for great speeds but Ivan was sure that, in one strong gust, she was doing 15 kts. Compared to Prout's SHEARWATER, there seems to be very little between them for speed, though it would appear that she is slightly slower as yet.

On one occasion, one of the original floats was tried out on one side against one of the planing floats on the other. Paced by one of Bill O'Brien's DARINGS, it was found that the planing float was faster but the trial was not quite fair as the original float was designed to go in the water on the *weather* side, and on this trial, it was being used on the lee side.

It has been noted in all our trials that it seems to make little or no difference to the steering which float is in the water. Control always stays positive and easy and she is as quick in stays as any other boat of her length.

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We have a wind tunnel where members can improve their sailing skill. Discussion Meetings are now being held in London and Sailing Meetings are being arranged.

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