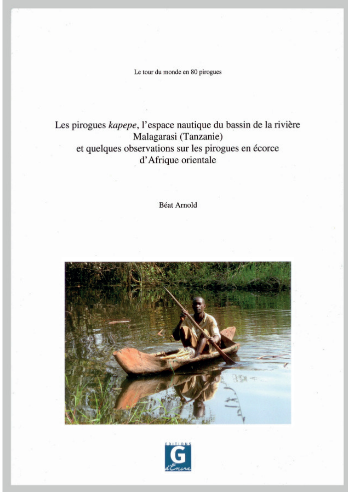
Kapepe canoes, the nautical space of the Malagarasi River Basin (Tanzania) and some observations on the bark-canoes of East Africa

(English text without illustrations)



Béat Arnold

Le tour du monde en 80 pirogues
Part One

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Foreword

"Around the world in 80 canoes"

This series of fascicules is the logical extension of my expedition notes relating to traditional craft. These are completed in the month after my return home and have not been reworked. They have remained as originally written, in their raw state and with all of the imperfections that travel entails, but it must be remembered that they are only notes. The idea of accompanying photographs from my expeditions with a commentary first came about in 2000. The first notes were thus often written in the evening, after returning from an excursion, during the interminable periods of waiting in airports or on planes.

The evolution of the modern world, the accelerated disappearance of ancestral traditions, the inexorable deforestation of the planet and the resultant destruction of the large trees normally used to make logboats and the fact that they are now consequently beyond the budget of fishermen, the development of outboard motors and composite materials – all of these parameters mean that my expedition notes may be of interest in the future, and thus disseminating them has ultimately become a deliberate action. The series of notes produced between 2000 and 2010 has thus been transformed into four volumes, published in the form of a CD-ROM in 2011:

"Holiday memories:
around the world in 80 canoes and a handful of traditional craft (2000-2010)".

As a logical extension of this work, some of these notes and original observations have undergone later expansion which has also involved a certain amount of synthesis and comparison with other works. The large number of illustrations, for example relating to the construction of some craft, make the publication of this work problematic in specialised journals, where only a summary presented by a few photographs can be published, meaning that the work thus loses much of its interest. The idea of an independent publication was thus born.

For the production of this fascicule, I would like to thank in particular Patrice Pomey, Eric Rieth and Danièle Tissot for their critical reading of the manuscript, and Maeva Arnold for vectorising my hand drawn illustrations.

Béat Arnold

07
Introduction

The Malagarasi River Basin is characterised by the great diversity of craft used, some of which are made from bark. This river basin is located in the north-west of Tanzania, and more specifically in the region of Kigoma. The upstream section constitutes the frontier with Burundi, then the river flows exclusively inside Tanzania, where it describes a wide loop towards the west around Nyaka Kangaga. Here it is supplemented by a number of more modest rivers such as the Kimila. It then runs towards the south, bordering the Moyowosi Game Reserve, and flows into Lake Nyagamoma. It then continues to flow towards the west, passing close to the village of Malagarasi, swelling with the addition of the Ugalla River and skirting the village of Uvinza, before ending in Lake Tanganyika. The waters of Lake Sagara, located only 20 km to the south of Nyagamoma, are collected by the Ugalla River shortly before it enters the Malagarasi River.

The region is still locally covered by extensive wooded areas and remains lightly populated. The area is crossed by few roads, and the main ones are not asphalted: Kasulu-Nyaka Kangaga towards the north-east (road B8), Kasulu-Uvinza at right angles to the former, and finally Uvinza-Nguruka, which runs east-west.

The latter will soon be replaced by a kind of motorway linking Kigoma to Tabora. Finally, Nguruka is a small village located halfway between lakes Nyagamoma and Sagara.

Having provided the broader context, we will now examine the areas occupied by the different types of canoe (see map below). The existence of bark-canoes in this basin was indicated to us by Wayne Hendry, who has travelled extensively in this region and who we would like to thank for his invaluable information which has supplemented our own.

The bark-canoes are called ***kapepe*** by the fishermen who we have encountered on the Kimila River, which can be literally translated as "very very light"[1]. The construction methods of these canoes will be examined in detail later (p. 28). It is worth noting, for example, the presence of a framework in this canoe, which is used on the calm water in the loop around Nyaka Kangaga.

1) We would like to thank Kassim Govola Mbingo for his extensive information and invaluable assistance when he was our guide in 2013. He has worked for 25 years at the Livingstone Museum in Kigoma. Without his extensive knowledge of the hinterland of Kigoma and his numerous personal contacts, it would have been impossible for us to gain access to the most remote areas of this region.
For Mozambique and Malawi, Mike Makwakwa was our guide and driver on several occasions (2012-2013).

Fig. p. 7. The nautical water system of the Malagarasi River Basin (Tanzania)
1) *Ubwato*, hardwood logboats
2) *Migoma*, palm tree canoes
3) *Kapepe*, bark-canoes
4) Bark-canoes in the region of Ugalla

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On the Ugalla River, to the west of the village of the same name, we observe the presence of less complex bark-canoes, the form of which is exclusively maintained by an upper structural support. Between these two zones, lakes Nyagamoma and Sagara are only crossed by canoes made from African Palmyra palm trees, while at the emissary and on Lake Tanganyika, we see the presence of logboats.

Despite a relatively small overall area, the basin of the Malagarasi River thus presents an extremely marked juxtaposition of different regions from a nautical point of view. We are not in a position to specify whether these are the result of population movements resulting from large-scale slave trading, colonial wars, postcolonial wars or genocides. However, we believe that the diversity of the successive natural environments and the different drainage patterns have played an essential role in this spatial division. Finally, this division may have been emphasised by the fact that this region is still relatively little populated and that terrestrial communication routes do not form a comprehensive network. This situation has also enabled the creation of large natural reserves, in particular the game reserves of Moyowosi, Kigosi and Ugalla River. The vegetation in these preserved areas extends a little beyond the administrative borders, with wooded and marshy areas. Upstream, the waters of the Malagarasi are sometimes very turbulent, which is largely incompatible with the development of a localised tradition of navigation. However, on the small tributary rivers, natural areas of calm water sometimes produce areas which favour the use of small fishing canoes (area 3, for example). As for the large marshy areas or the wide humid belts surrounding the regional lakes, they have facilitated the development of African Palmyra palm trees and their exploitation (area 2). Finally, in its lower section, the Malagarasi River becomes wide and serene, providing a calm space between the two highly wooded banks that can only be linked together by means of water borne craft, which are also used for fishing. This area ends in Lake Tanganyika, where the use of robust boats – in other words logboats possessing good nautical qualities – becomes preponderant.

The *migoma* (or *mihama*) canoes of lakes Nyagamoma and Sagara

In the central area of the basin, particularly in lakes Nyagamoma and Sagara, the basic canoe consists of a logboat made from a specific palm tree, the African Palmyra palm (*Borassus aethiopium*), which is characterised by a sizeable bulge in its upper part. These canoes are around 4 m long and are called ***migoma*** or more rarely ***mihama*** by the indigenous inhabitants. They have a lifetime of 3-4 years. We have not observed the presence of any other canoe or logboats made from any other tree species.

The palm trees cost nothing to collect and are freely available to the indigenous inhabitants. The trunks are then cut into one or two sections according to the diameter of the trunk. The upper part, characterised as we have mentioned by a sizeable bulge, constitutes the most interesting part of the palm tree when creating large canoes. The central part is also often used: it enables the production of canoes which are not very wide and with parallel sides. However, the lower part, marked by a considerable localised bulge, is rarely used[2]. The fishermen transport the sections of tree by bicycle to the space where the canoes are stored; in other words by land, never by water.

The outer part is one centimetre thick. It consists of the base of the leaves. It is relatively compact, unlike the rest of the trunk which is formed by an agglomeration of stems surrounded by spongy tissue. This part thus constitutes almost the whole of the trunk and includes a slightly more homogeneous 5 cm wide ring in contact with the outer part. The outer part is carefully retained, thus forming the external surface of all of these canoes.

The central part of the ends is the most fragile and has a tendency to wear away over time. The resulting hole is then plugged by a handful of grasses, compacted and consolidated with clay. The outer part of the trunk thus plays a supplementary role in containing the pressure exercised by the material used to fill the repaired ends. This operation is also now carried out on many canoes by means of an additional piece cut from a plastic container.

In other regions, such as on the Pungwe River (Mozambique; cf. map p. 41), a different technique is employed to solve this problem. This consists of retaining a large mass at each end which often then has a vertical form. This poses no problem in the shaping stage, even with lithic tools, because the wood is so soft.

2) A single case has been identified, which can be recognised through its egg-shaped stern and a prow which is narrow but notably wider than that of the *donga* that we observed in Bangladesh. See, for example, HORNELL 1924 (p. 177-178), who also mentions the use of the Asian Palmyra palm (*Borassus flabellifer*, formerly *flabelliformis*), the trunk of which does not have an excrescence at the top and which is very narrow above its wide base.

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As a result of its specific structure, the central part of the palm tree is less dense. In consequence, it is extremely soft. The marks left by the work of hollowing are indicated by the exceptional size of the removed wood. The removed chips of wood, about the size of a hand, are characteristic of the use of an adze with an exceptionally broad iron blade (14-15 cm) working in very soft wood. Unlike the normal blades in the region which consist of a flat triangular blade, directly inserted into a handle fitted with a distal bulge, the adzes used to hollow out palm trees end in a cylindrical loop into which the handle is fitted. For these particular adzes this is due to the use of a standard hoe blade, purchased from an ironmonger and shortened in order to obtain a particularly wide and slightly oval blade. The marks left by the final adjustments in the thickness of the sides clearly demonstrate the generalised use of such a tool (fig. p. 12/6).

When it is employed by a fisherman, the blade buries itself in the wood as though in damp sand, producing a soft sound, then the chip of wood is torn away as the fisherman pulls the handle towards himself. It is not surprising, in this context, that the time taken to shape such a canoe is only three or four days.

Observed half-finished canoe: top part of a large African Palmyra palm tree (*Borassus aethiopium*). Length of removed section 4.2 m; width in the centre 0.73 m; depth 0.30 m. The lower, or rather central, part brought to the site is still in the natural state; it is 4.1 m long (p. 10-11).

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Fig. p. 10/3. The canoes are only paddled from a seated position once past the reeds edging the lake (Katale).

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Fig. p. 12/4. A small channel gives access to Lake Sagara.

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The *ubwato* (or *mtumbwi*) of Ilagala and Lake Tanganyika

In the lower section of the basin, shortly before the Malagarasi River empties into Lake Tanganyika, another type of craft is used (map p. 7). This is a logboat made from trees such as the *myovo*, *msufi* (*Rhodognaphalon schumannianum*; the kapok tree) and *mkamba* (*Mangifera indica*; mango tree)[3]. These are called ***mtumbwi***, as on the coast of Tanzania, but are also locally known as ***ubwato***, a term that we will employ here in order to avoid any confusion with the logboats used on the Indian Ocean coast. As for the term ***bwato***, it is used to refer to the numerous canoes on Lake Malawi (or Nyassa), which are characterised by the presence of a narrow slit that constitutes the longitudinal opening of the canoe (ARNOLD, in prep.).

The *ubwato* vary between 4.5 and 5 m. They are sometimes as little as 4 m in length if the trunk of the tree is too short. They are usually 0.60 m wide and 0.30 m deep, and there is not normally any particular internal arrangement. Propulsion is provided by a paddle.

The logboats on Lake Tanganyika have a bench towards the stern and a thwart pierced with a circular mortice towards the front which enables the insertion of a small mast carrying a triangular sail. No outriggers are present. Given the pressure exercised on the sail by the wind, the stability of the canoe is ensured by the fisherman, who moves his own centre of gravity accordingly. Directly beneath the thwart, a mass of wood is left in place during the hollowing process. It is pierced by a mortice in order to act as a mast step. This type of canoe is disappearing on the lake. I have been informed that there is only one elderly artisan remaining who is capable of producing logboats; a man who we encountered in Ilagala. It takes him around ten days to complete such a craft.

These logboats are now being replaced by similar forms obtained by means of planks held together with clamps. The chine consists of a narrow piece of wood in the form of a gutter, nailed to the bottom and the corresponding side. A similar element is also present in the large craft propelled by outboard motors used for night fishing, or even the large transport vessels called *dhows*. However, the latter have nothing in common with the craft of the same name in use for sea-based transport. The bottom is flat and forms a single unit. It is assembled on a framework consisting of a set of small horizontal beams, each attached to two piles sunk into the sand. The edge of the base is bordered and maintained in place by a set of narrow boards, inserted vertically into the sand and higher than the top of the bottom. The side planks are nailed to a number of L-shaped active frames, the foot of which is screwed to the bottom. The chine has the form of a gutter and is only fitted later once the narrow boards have been removed from the ground. It is attached by tangential nailing to the edging of the bottom and the first plank forming the side. It does not need to be stated that this narrow chine, rendered fragile by double nailing into two other assemblies (the bottom and one side), is particularly vulnerable, and that numerous craft lie on the beach awaiting the replacement of this element.

3) Where possible, we have systematically added the Latin name of the tree species used by the indigenous inhabitants. For the conversion between the vernacular and scientific names, see, for example, the following reference, which should be used with caution (as it contains several names for a single tree and several trees with the same name): http://www.fpl.fs.fed.us/documnts/TechSheets/Chudnoff/African/htmlDocs_africa/brachystegia.html (USDA Forest Service), http://www.thewoodexplorer.com/maindata/we180.html (the Wood Explorer) etc.
For the identification of the tree species whose bark has been used in canoes, we have employed the monograph written by COATES PALGRAVE 1977.

Fig. p. 13. Recently completed *ubwato* at the mouth of the Malagarasi River.

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Fig. p. 14/1. *Ubwato* on the Malagarasi River near the Ilagala ferry.

Fig. p. 14/2. *Ubwato* propelled by paddles on Lake Tanganyika.

Fig. p. 14/3. *Ubwato* under sail on Lake Tanganyika.

Fig. p. 14/4. Stump of felled mango tree and half-finished *ubwato* (Ilagala).

Fig. p. 14/5. Half-finished *ubwato*, near Ilagala.

Fig. p. 14/6. Recently completed *ubwato* (Ilagala, July 2012).

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Fig. p. 15/1. *Ubwato* on the banks at Ujiji (near Kigoma).

Fig. p. 15/2. *Ubwato* with its cross beam, which acts as a mast step (Ujiji).

Fig. p. 15/3. *Ubwato* with significant repairs (Ujiji).

Fig. p. 15/4. Large fishing boats in the port south-southwest of Kigoma.

Fig. p. 15/5. A chine undergoing repair (port south-southwest of Kigoma).

Fig. p. 15/6. The chines of this "dhow" have not yet been inserted in this phase of construction (Kibirizi, near Kigoma).

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The *kapepe* bark-canoes of the Kimila River

The fishing camp that we visited on the small Kimila River (see map, p. 7), which flows into the Malagarasi, is located half an hour's drive (on tracks which are barely visible) from the main B8 beaten earth road, which we left shortly after Nyaka Kangaga. This modest camp was then occupied by eight people and dominated the river by around 4 m. The current was almost imperceptible, unlike that of the Malagarasi River, which was dotted by numerous small rapids. The basic equipment for each fisherman consists of an elevated rack (around 0.80 m) beneath which a small fire is lit.

On his return from fishing, the prow of the canoe is drawn upon to the bank and the craft is tied with a rope to the pointed end of the handle of the paddle, which is inserted into the ground. The initial process consists of spreading the fish on the racks and adding a little more wood to the fire. In bad weather, some fishermen add a small roof over their rack. The fish are covered by a sheet of bark – the universal material for these fishermen – from a bark-canoe that is no longer in use. They then each consume the meal that they have prepared; an unchanging rhythm that nothing disrupts.

Their canoes, which they call ***kapepe***, are made from bark coming from two trees, the *mtundu* and *mtwana*; the whole being reinforced by a number of poles, both longitudinal (gunwale poles) and transverse (stretchers)[4]. The length of the former varies between 3.5 and 4.2 m. The example manufactured as we watched was one of the largest specimens, being 4.24 m in length. The cost of these canoes, insofar as they have one, is estimated by the fishermen at 15,000 TZS, or the equivalent of 10 USD; but in fact they buy nothing. They find all of the materials in the forest. Analysing the structure of such a canoe while it is in use is rather difficult, because many parts are not tied in place and have a tendency to move and be lost over time without the user seeking to replace them – with the exception of the two stretchers and the tie which ensure or control the separation of the top of the sides. It is therefore only during the construction phase that it is really possible to observe the standard parameters employed by the fishermen. The craft appear very rustic, but this is very far from being the case.

Manufacturing such a canoe takes four days. The first is spent finding a suitable piece of bark in the forest, which undoubtedly constitutes the most extensive aspect of the work, both in time and effort; it takes three men to carry out this operation.

The *mtundu* corresponds to the *Brachystegia spiciformis* of the savannah forests of Tanzania (where it is also called *mundu*, *myombo* or *mtondo*), Zambia (*muputu* or *umuputu*) and Mozambique. In the latter country it is called *messassa*, and as we discovered the same term is used to denominate the bark-canoes of the Vanduzi and Muarèdzi tributaries of the Pungwe River. The identification of the *mtwana* (*Brachystegia boehmii*), with its very characteristic leaves, could be carried out using a tree identification key[5].

4) Bark-canoes are light constructions, and the nautical terms used for wooden plank craft often assume the presence of a large sample. We have therefore preferred to use specific terms enabling an understanding of the descriptions. The longitudinal pole to which the top of the bark sheet is sewn is called the gunwale pole (*longeron*; EMPERAIRE 1955, p. 179, 181); where other poles are added at this point to reinforce longitudinal rigidity these are called respectively internal and external longitudinal reinforcement poles. This assemblage is sometimes covered by a wooden overlay, the whole then constituting the gunwale.
The transverse poles which ensure the separation of the sides (functioning in compression) are known as stretchers (*traverses*; GUY 1977, p. 57). Where these are formed of small planks, they are identified as cross beams. Conversely, we talk of ties (generally associated with a transverse rope), if their function is to contain the sides by traction.
The combination of these elements (gunwale poles, stretchers and ties) constitutes the upper structural support.
We use the term of stringer for the longitudinal poles placed on the framework, which is often very slender (frame stick), and lashed to the latter in order to stabilise it.
5) COATES PALGRAVE 1977, p. 271.

Fig. p. 16. Fisherman in his *kapepe*, on the Kimila River.

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Fig. p. 17/1. Leaves of *mtwana* (*Brachystegia boehmii*).

Fig. p. 17/2. Leaves of *mtundu* (*Brachystegia spiciformis*).

Fig. p. 17/3. Two *kapepe* on the bank, one large and one small.

Fig. p. 17/4. Canoe secured by a strap attached to the paddle.

Fig. p. 17/5. A *kapepe* with significantly raised ends from which the excess bark has not been removed (Kimila).

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Fig. p. 18/1. Bailers made from calabashes.

Fig. p. 18/2. Basic tools: knife, awl, adze and axe.

Fig. p. 18/3. Spare straps, temporarily removed from the river.

Fig. p. 18/4. The day's catch.

Fig. p. 18/5. The fish are smoked on a rack.

Fig. p. 18/6. The camp on the Kimila River.

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Fig. p. 19/1. Kimila River: plan of a *kapepe* in use; the prow is to the left (scale 1/25).
In grey: removed part of the phloem sheet.
Part of the bottom near the prow has been deformed at a later date, leading to an enlargement of the sides. A number of ribs seem not to be in their initial position.
A wooden block which serves as a bench is placed on a recycled sheet of bark from an older canoe. The sheet is thus placed on two ribs which stabilise the block.
Length of the canoe 4.09 m; width 0.73 m; depth in the centre 0.22 m.

Fig. p. 19/2. In the background, the *kapepe* used for the plan drawing once its various elements had been removed.

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The removal of bark to produce *kapepe* canoes

Once the catch has been left to dry on the rack, and the fishermen have eaten, three men enter the forest; one with an axe, one with an adze, all of them equipped with a large, pointed and well sharpened knife. Finally, one of them pushes a bicycle. Their progress is easy in the primary forest, where undergrowth is almost completely absent. We encounter the trail of a number of herds of zebu, which leads to the river. After 40 minutes' walking, we arrive in an area of interest, where the two tree species grow which have usable bark; the *mtundu* and the *mtwana*. Many have already had bark removed from them, and the trees die 3 to 6 months later. Some of them are still standing; others have been cut down at a later date. However, there are no longer any suitable trees – in other words, presenting the correct diameter – and we continue walking for a further 20 minutes. Here we reach a new area where the trees sought grow. One of the fishermen moves away from the group a little in order to expand the search area. When a suitable tree is found, its diameter is evaluated by a fisherman who presses one of his shoulders against the trunk and attempts to encircle it with his arm. An external diameter of 30-35 cm is considered optimal. Then, in the decisive phase, a section of bark 10 x 10 cm is removed at the base of the tree using an axe or adze depending on the tool carried by the fisherman. If significant humidity is not present between the bark and the wood, giving this area a viscous texture, the tree is not suitable for the purpose. The bark will adhere too strongly for it to be possible to remove it from the trunk. The fishermen tell me that here there is no specific season (sap rising) for removing bark, and there must simply be sufficient humidity between the bark and the wood.

A tree with a number of small branches scarcely 10 cm long emerging from the trunk is also considered unfit for use. This is because the fishermen do not know how to repair a hull, and the smallest defect or accident means that the canoe will be no longer watertight and thus no longer usable. This lack of knowledge of such a procedure constitutes an essential parameter in the process of manufacturing a *kapepe*. It is only after 20 minutes of searching that a suitable *mtwana* is finally discovered. The opening of a "window" at the base of the trunk reveals the presence of sufficient humidity, and the work can begin.

Fig. p. 20/1. Setting off into the forest in search of a suitable tree.

Fig. p. 20/2. Opening a "window" to check the humidity.

Fig. p. 20/3. Evaluating the diameter of the trunk: the only bodily measurement observed.

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The "window" is extended around the base of the trunk and a ring of bark 10 cm high is removed. This width is necessary to facilitate the end of the removal process. An axe is used to cut a vertical slit in the bark up to head height. Where the ring of removed bark and the slit meet, the axe blade is introduced between bark and wood and traction is applied perpendicular to the blade in order to locally peel off the bark so as to evaluate how difficult the final removal process will be.

Meanwhile, the two other fishermen have manufactured a "ladder" in order to reach the upper part of the bark being removed. A small tree, with two main branches of similar length starting from the same point, is cut down. The branches are cut 1.5 m from their base. Wedged diagonally against the bark to be removed, the remaining length of these two branches serves as a kind of work platform enabling access to the entire circumference of the tree. One fisherman climbs the inclined surface of the small tree and uses his adze or that of a colleague to cut a circular notch, the position of which is estimated by eye, thus defining the length of the section of bark to be removed. A vertical slit the width of the adze blade is then cut downwards, removing the outer cracked part of the bark to a depth of 0.5 to 1.0 cm, until a smooth pinkish layer appears (the phloem).

A vertical line is then traced using a knife point in order to reach the wood beneath. The forked "work platform" is then lowered by one metre and the slit and the line traced with the knife are extended. The process continues in this way until the lower vertical slit created with the axe is reached. Prior to this, one of the fishermen prepares three levers – three strong branches with a blunted, bevelled end.

The base of the bark is removed from the trunk using an axe blade slipped between bark and trunk and employed as a wedge enabling the bevelled part of the first lever to be inserted under pressure. As it is pulled away from the trunk, the bark separates from the wood and the second and third levers can be brought into action. The effort involved is considerable. The levers are introduced further and further up, then diagonally. The same procedure is then followed for the other side of the bark. The work then begins again a little higher up on the first side. However, the working height of the levers never exceeds 2 m. The separation of the bark is more and more pronounced. Suddenly, a loud "bang" resounds through the forest.

Fig. p. 21/1. Removal of the ring from the base of the selected *mtwana*.

Fig. p. 21/2. Lower part of the vertical slit.

Fig. p. 21/3. Ring of bark from the base of the *mtwana*. The bark is 12 mm thick, of which 10 mm is phloem.

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Fig. p. 22/1. Setting up the "ladder" cut for the operation.

Fig. p. 22/2. One fisherman climbs up to the top of the work space.

Fig. p. 22/3. Platform consisting of two main branches.

Fig. p. 22/4. Cutting the upper ring with an adze.

Fig. p. 22/5. Preparing the upper part of the slit.

Fig. p. 22/6. Final incision of the bark with a knife, down to the wood.

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Fig. p. 23/1. The upper part of the incision meets the lower part.

Fig. p. 23/2. The bark is prepared for removal with an axe.

Fig. p. 23/3. The bevelled ends of the levers are blunted to avoid damaging the interior face of the bark.

Fig. p. 23/4. Finally, the bark is prised away from the wood using the three levers.

Fig. p. 23/5. The same procedure is followed for the other side of the bark.

Fig. p. 23/6. Force is then applied to the upper part of the bark.

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The remainder of the bark has separated from the wood all at once, and the cylinder of bark slides down to the base of the ring that was initially removed. A branch is placed on the ground opposite the vertical slit, and the men open the base of the bark with the levers until it no longer surrounds the trunk. They then pull it away from the tree, sliding it on the branch placed on the ground. The bark continues to slide over the branch and the lips of the top edge of the bark separate more and more, until the angle with a trunk is such that the top of the bark can no longer encircle it. After an hour and a half's work, the bark is placed carefully on the ground, forming a hollow cylinder 4.45 m long. At 4.24 m long, the canoe being manufactured will, as we have already mentioned, be one of the largest specimens.

Two men use axe and adze to remove the outer cracked part of the bark to reveal a smooth pink layer. Only the phloem itself is retained. The bark is reduced from a thickness of 12 mm to one of

9-10 mm. The traces of this reduction can still be seen on the exterior of these canoes, here and on the specimens which we were able to observe in Mozambique, at Chocas (see fig. p. 47/2 and 48/1) [6].

6) All of these photographs (p. 9-55) date from 2012-2013.

Fig. p. 24/1. The bark is pushed away from the tree, sliding on a branch placed on the ground.

Fig. p. 24/2. The base of the bark is pushed further and further away from the tree.

Fig. p. 24/3. The bark is almost released from the trunk.

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Fig. p. 25/1. A bark cylinder.

Fig. p. 25/2. The cracked outer part of the bark is removed.

Fig. p. 25/3. Next stage in the reduction of the bark. The initial form is retained in order to facilitate the work.

Fig. p. 25/4. The cylinder now consists only of the phloem.

Fig. p. 25/5. The cylinder of phloem is flattened.

Fig. p. 25/6. Meanwhile, a stock of bark straps is manufactured (foreground).

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Finally, the cylinder is flattened out by one, then two of the fishermen pushing the edges with their feet then their hands. The material is then turned over and the process of flattening is continued by stamping with the feet. The sheet of phloem is then turned over once again, and three straps of bark are placed longitudinally and partially beneath one of the ends. Finally, it is rolled up along a transverse axis, then maintained in position with the three straps. The roll is then attached to the bicycle. 30 minutes have passed since the bark first touched the ground.

While two fishermen remove the outer part of the bark, the third prepares a set of bark straps removed from a smaller example of the same type of tree. These elements will constitute the raw material for the straps. No humidity check is carried out. A horizontal slit encircling the small tree is cut at a metre from the ground and supplemented by two or three relatively short vertical notches. The start of each band is then held firmly in the hand, then with a few successive hard tugs the fisherman peels the tree in strips reaching up to the top of the trunk, thus obtaining long straps. The external, cracked part of the bark is also removed at this stage. In fact, it is actually the phloem which is removed, with the cracked part being maintained on the ground with one foot. Then the edges of the phloem are neatened using a knife.

One thing is clear: removing the bark in order to manufacture a canoe is not possible by this method if the tree has been felled, because it would not present sufficient resistance to the action of the levers employed to remove the bark.

The party then returns to the camp, where the roll of bark is immersed in the river for two days. The first phase of the operation has therefore taken 4 hours and 20 minutes, including the time taken to move through the forest.

Mtwana tree used (*Brachystegia boehmii*):
Ø upper part: interior 0.24 m; exterior 0.27 m.
Ø base: interior ~ 0.34 m; exterior 0.37 m.
Length of bark removed: 4.45 m.
Width of bark sheet: 0.78 m at the top and 0.95 m at the base.
Finished canoe: length 4.24 m; a small portion (0.20 m) of the distal part has been cut at the end of the construction process; width: 0.70 m; depth: 0.25 m.
Weight of the reduced bark (before removal of the top of the tips, fig. p. 32/2 and 33/5): 36 kg.

Tools used: axe, adze, large pointed knife; to which can be added, for the construction phase, a rectangular section awl.

Fig. p. 26/1. The sheet of phloem is rolled up.

Fig. p. 26/2. Setting off for the Kimila River fishing camp.

Fig. p. 26/3. The cylinder is submerged for two and a half days.

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Fig. p. 27/1. The base of the strap is cut free with the axe.

Fig. p. 27/2. With one sharp tug the bark detaches up to the crown.

Fig. p. 27/3. The central part, the phloem, is removed.

Fig. p. 27/4. The edges of the phloem strips are trimmed.

Fig. p. 27/5. Long straps ready for use.

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Manufacture of a *kapepe*

On the fourth day, the roll of bark is removed from the river, as are a series of bark straps. On the previous day, rods of two different sizes have been cut from the forest. These are a large series of small rods (Ø ~ 3 cm), which have been gradually whittled on a single face only, with a final thickness of one third of their initial diameter. These will constitute the ribs of the canoe; nine of which will ultimately be inserted. Other, thicker poles (Ø ~ 3.5 cm), rectilinear and much longer, will be used to create the upper structural support placed inside the canoe.

This work is also carried out by three fishermen. The bark is unrolled in a shaded area, as it is midday. It is left to dry for 30 minutes before the work begins. A knife is used to remove the irregularities of the longitudinal edges and the scattered fibres lifted or broken when the levers were inserted at the start of the bark removal process. The bark is then allowed to take on its initial cylindrical form. The interior face of the bark will constitute the interior of the canoe. The thickness of the edges is reduced using an axe on the external face over a depth of 5 cm. The thickness of the phloem is thus reduced from 9-10 mm to 6 mm. The top of the sides will thus be easier to pierce with an awl at a later stage.

Two fishermen then sit face-to-face on either side of the base of the bark which will form the stern of the canoe. The work begins with this end. They press together the two edges of the bark sheet with their hands, while using their feet to push at the rounded face in contact with the ground until a flat, vertical element is obtained. An initial lashing is carried out at the top of the edges where they are pressed against each other (stage 1, fig. p. 37). The position of this is strategically important, because it corresponds on one hand to the length of the terminal part of the prow and on the other to the position where the two edges will later separate to constitute the top of each side. This lashing also corresponds to the point of articulation which will enable the stern to be raised at a later stage.

To carry out the lashing/sewing[7], a new tool is employed: this is an awl of rectangular section, a form ideally suited for piercing holes through the bark sheet. These rectangular holes will be used for the passage of the bark straps. The latter are used in an untreated state and must be kept humid so that they retain their flexibility while they are being used. Unusually, five loops are created at the position of the first lashing. With each passage, the previous hole is enlarged slightly or, more often, a new one is pierced to one side or beneath.

7) Sewing: assembly of two similar pieces (for example two planks, two pieces of bark, two skins etc.) or different pieces (for example fabric and rope or a pole), using a thread running continuously from one stitch to another and piercing at least one of the pieces with each stitch.
Lashing: assemblage of two pieces, for example beams, using a rope partially or wholly surrounding them. For a succession of lashings, corresponding to a non-continuous series of stitches, we talk of a lashed assemblage.

Fig. p. 28/1. The bark is unrolled in the shade and dried.

Fig. p. 28/2. The edges are reduced using an axe, facilitating penetration by an awl.

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Fig. p. 29/1. The fishermen press the stern into a blade shape with their feet.

Fig. p. 29/2. Key phase: the first lashing (stage 1).

Fig. p. 29/3. The strap is inserted through the hole made with the awl.

Fig. p. 29/4. First lashing, preparation of the fifth loop.

Fig. p. 29/5. Tying off the first lashing.

Fig. p. 29/6. Reducing the tips of the base of the stern in order to facilitate and maintain the significant curve at this position.

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Finally, the sides of the two joined faces in contact with the ground are reduced using an axe. This operation makes it easier to maintain the strong curve given to the bark in this position.

The second strategic phase involves adjusting the position from which each gunwale pole will begin (see note 4) in relation to the first lashing. This pole will initially be lashed to the top of the edge of the bark sheet, then sewn in place. The dimension of the depth between the top of the lashing and the pinched base of the bark opposite is horizontally represented by means of a strip on top of each side. This is in order to determine more exactly the symmetrical position of the start of each of these gunwale poles, which will be attached by an initial lashing (stage 2). The general position of each gunwale pole is then checked so that the edge of the bark always reaches the same level as the top of the gunwale pole. Where necessary, a knife is used to remove the few centimetres of bark which the poles locally protrude beyond. Two additional lashings are carried out on each side (stage 3). This initial phase takes 30 minutes.

Next comes the process of sewing the two gunwale poles, systematically and at regular intervals. The stitches are opposite each other (stage 4). A rectangular hole is first pierced in the bark level with the lower face of the gunwale pole, and a bark rope tightly encircles the two elements. Three loops are carried out, and the rectangular holes are pierced or enlarged three times, then the strap follows the exterior side of the bark up to the following stitch, and so on.

Fig. p. 30/1. Measuring the position for the start of the gunwale poles.

Fig. p. 30/2. Checking the position of the gunwale poles in relation to the first knot.

Fig. p. 30/3. The edge of the bark is trimmed locally with a knife.

Fig. p. 30/4. Initial phase: a single lashing, then a double one (stages 2 and 3).

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Fig. p. 31/1. Rectangular hole made with an awl.

Fig. p. 31/2. Each loop is tightened carefully.

Fig. p. 31/3. Three loops, with three holes, are made for the following stitch.

Fig. p. 31/4. The stitches on each edge are opposite each other.

Fig. p. 31/5. From the fourth stitch, the strap runs from one stitch to another (sewing).

Fig. p. 31/6. Continuous sewing (stage 4), along the exterior face, for the gunwale poles edging and supporting the top of the bark from the inside.

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When the strap becomes too short, it is extended with a new piece attached to the previous one. After 50 minutes' work, a final stitch with four loops is carried out on each side (stage 5). The excess length of the gunwale poles is then cut. These are now 2.6 m long.

The partially constructed canoe is dragged a few metres into the shade, as the sun has moved while the work has been going on. The men take a short break before returning to their work on the stern. The central axis of the bark currently still describes a horizontal line. The end that will become the stern is then raised by a fisherman (stage 6), and the sides automatically separate at gunwale pole height in relation to the first lashing carried out. The length of an initial stretcher is then adjusted; this transverse piece will thus maintain the inclined shape of the stem and will be inserted between and beneath the two gunwale poles (stage 7). The longer this stretcher, the more the stern will be raised. The first lashing of each gunwale pole is now doubled by a new one (stage 8), located at a distance corresponding to the diameter of the stretcher, in order to give it a firmer purchase against the bark.

The upper part of the pinched end of the stern is removed with a knife (stage 9) to prevent it from greatly exceeding the height of the main part of the canoe (for the opposite situation, see fig. p. 17/5). Stitches then link the trimmed top of the two pinched sides of the bark; a position which is thus not watertight. In this way, once the canoe has been completed, it is merely necessary to slightly raise one of the ends for all of the water taken on to run out of the top of the other end, which thus plays the role of a spout. By sufficiently raising the end, the area where the two sides joined will be located above the line of flotation and no work will be required to make it watertight.

The work then moves to the prow, where the two faces of the bark beyond the gunwale poles are pressed against each other by two fishermen sitting face to face in the same way as for the stern. A major lashing thus also maintains the parts which are pressed against each other, at a distance evaluated by eye (stage 10). The end is raised (stage 11), the edges separate and a second stretcher is cut and inserted (stage 12). The top of the two sides of the bark sheet which have been pressed against each other now rise up too far above the body of the canoe. The basic lashing of the prow is thus repeated a little lower and the excess bark is removed using a knife (stage 13). Finally, the two sides are sewn together. It has thus taken 50 minutes of additional work to achieve this stage. It takes a further 30 minutes for the canoe to be completely finished.

Fig. p. 32/1. The stern is raised (6) and maintained in place by a stretcher (7).

Fig. p. 32/2. Shaping the end of the stern (stage 9).

Fig. p. 32/3. Reinforcing the first stretcher by means of a lashing (right) (stage 8).

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Fig. p. 33/1. Stitching on the top of the stern.

Fig. p. 33/2. Shaping the prow.

Fig. p. 33/3. Lashing the prow (10), then insertion of the second stretcher (12). This latter is not sufficiently wide and will be replaced.

Fig. p. 33/4. Using a knife to adjust the profile of the prow.

Fig. p. 33/5. The excess bark is removed using a knife (stage 13).

Fig. p. 33/6. Sewing the top of the prow and reducing the tips.

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The stern stretcher is first removed, then the small rods – the thickness of which has been reduced – are bent and inserted under pressure (stage 14). The flat, reduced face is held with the foot against the bottom of the canoe while the fisherman uses both hands to bend the other end in the opposite direction in order to slide it beneath the second gunwale pole. This takes place at the position of the stitching located opposite that under which the first end of the rib has been wedged. If this location had not been selected, the rib would have slipped between the gunwale pole and the bark. Once the first third of the ribs has been inserted, the stretcher at the prow end is removed in turn and the remaining ribs are inserted. Finally, the two stretchers are put back into place.

The last operation involves adjusting the separation of the sides of the central area of the canoe using a tie. A pole is cut to the correct length and notched at each end (stage 15). A strap then connects the two gunwale poles, which are gradually moved towards each other, in order to control the central width of the canoe. At the third passage of the bark strap, it breaks on several occasions as a result of being too thin or too dry. A nylon cord is immediately employed to resolve this problem, because otherwise it would be necessary for one of the men to go back to the river to collect a new strap stored in the water[8].

After 2 hours and 40 minutes of work, the canoe is completed, then transported to the river running below. A seat in the form of a wooden block is simply placed in the rear of the *kapepe*, sometimes on a reused piece of bark resting on two or three ribs. The first fisherman embarks immediately in order to test out the new craft.

In conclusion we can state that these canoes, which are extremely rustic in appearance, in fact result from a relatively well-developed process that can easily be underestimated with a superficial examination, and requiring a knowledge of the specific properties of certain trees and their bark, the techniques employed in removing the bark and in particular in working on an unfelled tree, the presence of sufficient humidity between the phloem and the wood, the strategies required to ensure that no opening or hole is present below the flotation line – in other words finding a system for ensuring that the sewn part of the ends is located significantly above the water level, the stabilisation of the edges of the bark with lashings, the sewing of the gunwale poles, and the general maintenance of the form by means of stretchers, a tie and a light framework.

8) For convenience, nylon threads now often replace bark strips even though manufacturing the latter does not take very long.

Fig. p. 34/1. Preparing the ribs.

Fig. p. 34/2. Inserting the ribs following the removal of the first stretcher (14).

Fig. p. 34/3. Cutting a rib to the correct length.

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Fig. p. 35/1. Adjusting a rib to the correct length.

Fig. p. 35/2. Inserting a rib under pressure.

Fig. p. 35/3. The rib rests on a stitch.

Fig. p. 35/4. Inserting the central tie to adjust the width (15).

Fig. p. 35/5. Securing the lashings associated with the tie.

Fig. p. 35/6. The *kapepe* is now complete.

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Fig. p. 36/1. The *kapepe* is transported to the river.

Fig. p. 36/2. First contact with the Kimila River.

Fig. p. 36/3. Installation of the standard bench.

Fig. p. 36/4. The canoe is immediately tested by one of the canoe builders.

Fig. p. 36/5. The first paddle strokes of another canoe builder.

Fig. p. 36/6. The canoe builders have fun too.

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Fig. p. 37. Kimila River: plan of a *kapepe* just after construction; the prow is to the right (scale 1/25).
Numbering of successive sequences. In grey: removed part of the phloem sheet.
The flotation line corresponds to that of the canoe with a man sitting on the wooden block that serves as a bench.
Weight of the canoe when completed; in other words with bark that is still damp: 38 kg (of which 30 kg represents the bark). As it dries, the bark will harden and the canoe will become a little lighter.
Dimensions of the completed *kapepe*: length 4.24 m; width 0.70 m; central depth 0.25 m.

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Fig. p. 38. The *kapepe* whose construction we have witnessed now lies on the bank of the Kimila River.

39

Some comments on the bark-canoes of East Africa

According to the photographs by Wayne Henry, the bark-canoes of the Ugalla River (map p. 7), have a more rustic structure than the *kapepe*, characterised by the absence of a framework, which is replaced only by an upper structural support. This support consists of two gunwale poles sewn along the top of the bark, two stretchers and a tie. The stretchers exercise a force separating the sides, based on the initial lashing of the top of the bark, which marks the starting point of each end on the inside of the craft. The tie, together with a rope connecting the two sides, enable the sides to be pulled together, thereby controlling the central width of the canoe. Sometimes one or two ribs can be observed. The end seam is also raised above the line of flotation. With the exception of this latter point, this type of canoe is present on many rivers in East Africa, and in particular in the central and northern part of Mozambique, as we have been able to observe.

Fig. p. 39/1. Bark-canoe with upper structural support from the Ugalla River (W. Henry).

Fig. p. 39/2. Bark-canoe from the Ugalla River (W. Henry).

Fig. p. 39/3. Ugalla: a canoe without a framework (W. Henry).

Fig. p. 39/4. Ugalla: a few ribs are sometimes present (W. Henry).

In his work on the typology of traditional craft and their distribution across the world, H. SUDER (1930, p. 107-108) classifies bark-canoes in the group of "Hautboote"; in other words canoes with an envelope in bark, skin or basketry. They are manufactured using large sheets of bark sewn together; the simplest form consists only of a single piece, requiring only a few additional elements[9]. He notes the presence of bark-canoes in five main areas: the woody savannahs of the southern hemisphere in Africa, the northern part of North America[10], north-east Asia[11], the Amazon Basin (and the south of Guyana)[12] and the northern and eastern parts of Australia[13]. To these areas can be added less extensive spaces such as Tierra del Fuego[12] and Borneo[14], to mention only two examples.

The woody savannahs of the southern hemisphere in Africa, bordered to the north by tropical forest, thus constitute one of the spaces in which the indigenous inhabitants employed bark-canoes (SUDER 1930, p. 109, pl. 13/4, 5, 11). This area thus extends from the Atlantic coast with the Cunene River (its lower reaches forming the border between Angola and Namibia), to the coast of the Indian Ocean with the basin of the Pungwe River (Mozambique; for example including the Muarèdzi and Vanduzi rivers), via the basins of the Okavango (Cubango and Cuito rivers), the Zambezi (Cuando River and upper stretches of the Kafne) and the southern extremity of the Congo Basin, specifically the Loange River[15] and the region of the Great Lakes (basin of the Malagarasi River, Wami River[16], lakes Edward [17] and Kyoga[18]).

Canoes with an upper structural support: the *nikhula* of the Lúrio River

Other than the basin of the Malagarasi River (which flows into Lake Tanganyika), which we have examined by means of the canoes of the Kimila and Ugalla rivers, we have been able to observe a number of bark-canoes known as ***nikhula*** on the Lúrio River, located to the south of Pemba (north of Mozambique). The function of these canoes is primarily to ensure passage from one bank to another. They are also used for fishing.

The lengths measured vary between 2.55 and 3.27 m. The indigenous inhabitants estimate one day's work to produce such a canoe, which seems a little short, as the trees employed grow in a location which is now rather distant from the village. Their duration of use is estimated to be four years. Finally, the larger specimens can accommodate three to five people. Although the lengths are relatively short, the widths vary between 0.88 and 0.92 m.

The tree species preferentially used is the *mmpila*[19]. The bark is removed as for the *kapepe*; in other words by the removal of a ring at the base and a ring at the top of the trunk, the two being connected by a vertical slit, with the work being carried out without felling the tree.

The external face of the *nikhula* from the Lúrio River is not reduced in thickness; i.e. the outer layer of the bark is not removed. The two sides of each end of the bark cylinder are also pressed against each other and sealing material is inserted in the form of scraps of dried fibres from the outer part of a banana tree trunk.

9) See in particular the illustrations and references presented in the context of the typological analysis (p. 56-63); HORNELL 1940.
10) ADNEY and CHAPELLE 1964, JENNINGS 2002, KENT 1997, RITZENTHALER 1950, ROBERTS and SHACKLETON 1983.
11) ANTROPOVA 1961, LEVIN and POTAPOV 1964, MIDDENDORF 1875.
12) EMPERAIRE 1955, p. 178-182; LOTHROP 1932, p. 251-252; VAIRO 2002.
13) EDWARDS 1972, DAVIDSON 1935, ROTH 1910, SMYTH 1878, THOMSON 1952.
14) ROTH 1896, p. 254; NEYRET 1974, t. 1, p. 92, t. 2, p. 185.
15) On 24 March 1854, D. LIVINGSTONE (1858, p. 383-384) used a bark-canoe with stretchers and sewn ends to cross the Chikápa River, at the end of the Loange River Basin.
16) A single bark-canoe was observed by F. STUHLMANN (1910, p. 34) on the Wami River (to the north of Dar es-Salaam). This type of canoe disappeared many years ago: we would like to thank Halima Kiwango (Saadani National Park), the author of a detailed study of the Wami River Basin carried out in 2008, for this invaluable information.

17) As regards Lake Edward, J. HUXLEY (1931, p. 370) mentions the use of canoes consisting of pieces of wood *or* bark, assembled by sewing. The photograph published opposite page 373 shows a canoe in which the visible end does not contradict the use of bark.
18) For Lake Kyoga in Uganda, see VIVIAN 2012, p. 166; http://www.cherini.eu/etnografia/AF/slides/af_0112.html.
19) Which corresponds to *Pterocarpus angolensis*; Allan Schwarz, pers. comm.

Fig. p. 40. Distribution map for bark-canoes (SUDER 1930, pl. 13).

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To sew these two parts together, the bark is not submerged in water, but each end is placed between two stakes inserted obliquely into the ground, the tops of which are gradually moved together, the bark being locally softened over a small fire built on each side of each end.

The gunwale poles of the upper structural support are not formed of a bamboo stem, but consist of a number of elements issued from split stems, making it possible to give the top of the sides a very pronounced S-shape (fig. p. 42/2).

Fig. p. 41. Southern and eastern Africa: locations mentioned in the text (associated with bark-canoes) and indication of the area across which they are distributed as suggested by H. SUDER (1930, pl. 13).

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They are initially fixed to each side of the top of the bark envelope using ropes around 4 mm thick (fig. p. 44/4-5), obtained by longitudinal tearing of the leaflets of palm tree leaves. This lashing technique (fig. p. 44/4-5) has now been replaced by the use of coconut fibre – and above all nylon – cords, by spiral sewing (fig. p. 42/3).

We have also occasionally observed the presence of splits repaired using a roll of plant fibres sewn over the defective part both on the interior and exterior. The hole through which the thread passes is sealed using small plugs inserted from the inside. This is a technique probably resulting from maritime influences; a theme that we will examine with the *muterere*. In this context, we should also mention the presence, in the delta of the Lúrio River, of numerous logboats of a type usually used for sea fishing but here employed as ferries linking the two banks.

Two stretchers and a tie are generally present, maintaining and controlling the separation of the sides. The first example of the *nikhula* which was presented to us, stored in the Lúrio River by a fisherman during the dry season (in fact so that it was not stolen), had lost its transverse elements but could nevertheless be used (fig. p. 45/1-3). The same applied to the example that we were able to observe as we travelled up the Lúrio delta (fig. p. 44/4). Superficial observation would inevitably have led to the interpretation of these two canoes as particularly rustic, without any element to control the separation of the sides; however, this was not the case.

This comment does not imply that canoes consisting essentially of a single bark sheet, without transverse elements, do not exist, but their presence has not yet been established in this region. Finally, we can note that the lashing/sewing of the gunwale poles automatically requires the insertion of transverse elements.

A type of canoe similar to the *nikhula* exists on the Pungwe or Púnguè River, which flows into the Indian Ocean near Beira. D. SHROPSHIRE (1935) mentions here the presence of ***ngarawa***[20], equipped with a simple upper structural support, unusually reinforced by two poles placed diagonally across this support.

20) This name is abundantly used on the Tanzania coast to designate outrigger canoes, the floats of which consist of a plank deviating slightly from the vertical; see also PARRY 2000.

Fig. p. 42/1. A *nikhula* canoe in storage during the dry season (near Namapa).

Fig. p. 42/2. Upper structural support, bent at one end.

Fig. p. 42/3. *Nikhula* used to produce a plan (near Namapa).

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Fig. p. 43/1. Lúrio River, near Namapa: adjusted plan (based on the stretchers) of a *nikhula* with a repaired slit (scale 1/25). Length 2.82 m; width 0.92 m; depth in the centre 0.19 m.

Fig. p. 43/2. Explanation, with demonstration, of the construction method.

Fig. p. 43/3. The *nikhula* have no internal framework (near Namapa).

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Fig. p. 44/1. Double stitching of one of the ends (Lúrio, near Namapa).

Fig. p. 44/2. Sewn prow of a *nikhula*.

Fig. p. 44/3. Repaired slit associated with small caulking plugs inserted from the inside and sewn gunwale.

Fig. p. 44/4. An abandoned *nikhula* and temporary shelter on the bed of the delta.

Fig. p. 44/5. Upper structural support maintained in place by plant lashings.

Fig. p. 44/6. Palm leaves used to make the lashings.

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On recent photographs, we have been able to observe similar canoes used on the Muarèdzi River, a tributary of the Pungwe, with a simple structural support but without diagonal poles. These are known as ***messassa*** and are made from the bark of the *Brachystegia spiciformis*, the local vernacular name of which[21] is the same as that of the canoe. The bark is removed using two grooves surrounding the tree connected by a vertical slit. Similar canoes also exist on the neighbouring Vanduzi River.

In the basin of the Okavango, complementary data emphasise the fact that, once felled, the bark of the tree, a *houtbosch* (in other words a *Berlinia baumii* or *Julbernardia paniculata*) is removed using a fire lit beneath it, and the lashings/stitches are made waterproof using wax (BAUM 1903, p. 36-37).

On the upper waters of the Kafue River (in the Zambezi Basin in north-east Zambia), the bark of the *umuptu* (*Brachystegia spiciformis*) is removed in the same fashion as for the *nikhula*; in other words from an unfelled tree, and the ends are also softened using a localised fire. The length of the bark cylinder is around 3.65 m. A number of stretchers are inserted to maintain the opening of this canoe, known as an ***ichikondo***, and the slits present are blocked using "clay" (DOKE 1931, p. 119, fig. 51).

Nikhula, *ngarawa*, *messassa*, *ichikondo*: all of these local names refer to the same type of canoe.

21) Like the majority of the trees mentioned in our text, *Brachystegia spiciformis* possesses a considerable number of vernacular names as a result of the numerous idioms spoken (for example, more than 30 terms for *B. spiciformis* in http://www.thewoodexplorer.com/maindata/we180.html).

Fig. p. 45/1. A *nikhula* is removed from the Lúrio River (near Namapa).

Fig. p. 45/2. The external part of the bark has not been removed (Namapa).

Fig. p. 45/3. As soon as it has been removed from the riverbed, the canoe can be used without its stretchers.

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Major axial sheet bark-canoes

H. SUDER (1930, p. 109, pl. 13/11), and above all J. HORNELL (1935) have drawn attention to the presence of a bark-canoe with a lenticular form constituted by the assembly of several sheets of bark. The detailed description of such a canoe observed by J. Hornell in 1926 on the island of Mozambique, supplemented by two photographs, has been mentioned by a number of authors[22]. The analysis by F. von LUSCHAN (1907), however, is much less well-known even though accompanied by an accurate plan and transverse section. In his study of the traditional craft of Mozambique, A. MOURA (1988, p. 365, 367, pl. 18) published a photograph of such a canoe, named ***muterere***. We have ourselves been able to observe, in 2013, the existence of two canoes of this type still in use for sea fishing, at Chocas. There is, in fact, a further specimen in this region, but in a location which is difficult to access. These canoes are still called *muterere* by the indigenous inhabitants. Another example was observed in the courtyard of the Museum of the Palace São Paulo on the island of Mozambique. This latter is older than the specimens at Chocas, as indicated by the sewing, which has been carried out using plant fibres and not with nylon cord.

On the other hand, the ***untoro*** seen by A. MOURA a little further to the south (1988, p. 367-368, pl. 20) at Quinga have not been made "for a long time" according to the people questioned. The method used for the assembly of the different sheets of bark constituting the hull is here difficult to analyse using the published photograph, in particular in terms of the extent of their respective overlap and the waterproofing system employed.

The framework is characterised by a very small sample, like the *muterere*, but denser. However, clear similarities exist between these two types of bark-canoe, which we can describe as major axial sheet canoes.

The major axial sheet canoes known as *muterere*

According to the information provided to us by two old fishermen and *muterere* users, it takes one day for one person to remove the bark; the fisherman who will be the user of the craft. Here too, the tree is unfelled during the process of removal of the bark, which is carried out in the same manner as we have observed for the *kapepe*. The outer cracked part of the bark is also carefully removed (fig. p. 47/2 and 48/1). The bark is then immersed in sea or freshwater – either will suffice – for five days. It then takes five to seven days for one person to manufacture the canoe itself, the length of which varies between 3.30 and 3.42 m[23]. As we have mentioned, the owners were two old fishermen. The fact that the manufacture of these canoes is a solitary process, associated with the disinterest of the young fishermen, who use only small logboats with a blade-shaped stern (suitable for attaching a rudder), will inevitably lead to a loss of knowledge and to their disappearance in the near future.

The ends of the *muterere* consist of two sides of the main bark sheet sewn together, forming on one side the prow and on the other the stern. The edges pressed against each other are made waterproof through the insertion of a mass of coconut fibres which protrude into the interior, and the form of the assemblage is maintained by a vertical seam.

22) For example, QUIRKE 1952, p. 87-88; NEYRET 1974, t. 2, p. 239 (with an attempt at a plan reconstruction); VAIRO 2002, p. 110-112 etc.

23) Measured lengths: 3.30, 3.31 and 3.42 m; J. HORNELL (1935) indicates 4.3 m for the specimen that he observed. For example, for the specimen he purchased in 1905, F. von LUSCHAN (1907) gives a length of 5 m. The length of 6 m mentioned in PARRY 2000, for the *muterere* located to the north of Angoche, is perhaps a little overestimated, or corresponds to an exceptional example.

Fig. p. 46. *Untoro* from Namevil, Quinga Bay; a model which is no longer in use (MOURA 1988, pl. 20).

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Fig. p. 47/1. Large *muterere* acquired in 1905, for the Museum für Völkerkunde in Berlin, by F. von LUSCHAN (1907, p. 17-18). This canoe has a floor consisting of two bark sheets placed lengthwise and sewn together, reminiscent of *muterere* no. 1. We can note that two defective areas of the bottom have been repaired. The top of the axial section is cut four times at the top of each edge. Length 5.0 m; width 1.05 m; depth 0.33 m (Scale 1/40).

Fig. p. 47/2. Sewn end and outer part of the removed bark (*muterere* no. 2; Chocas).

Fig. p. 47/3. *Muterere* no. 1 on the beach at Chocas alongside a logboat, the most frequently used boat in this area.

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In order to keep the base of the main bark sheet horizontal (in particular at the ends), two relatively short vertical slits are made in the edge of the main sheet around 0.8 m from the ends (fig. p. 51). These enable the superimposition of the lips of the slit (fig. p. 50/3) and, indirectly, result in the formation of ogival ends.

The edges of the bottom or main bark sheet, which are too low, must clearly be supplemented and raised on each side by the addition of a large sheet of bark which significantly overlaps the bottom piece. The majority of the waterproofing is in fact provided by a bundle of fibres on the inside, placed on the step where the bottom bark becomes that of the side (fig. p. 52/6).

The holes created for the passage of the sewing cords are sealed with small pegs inserted from the interior. The cords are sometimes made of nylon and create an N-shape in the interior and vertical lines on the exterior. This system is reversed on the example exhibited in the Museum of the Palace São Paulo (fig. p. 54/3 and 6).

Finally, the bark that constitutes each side of the canoe is extended by small triangular bark sheets; these are sewn pieces recovered during the disassembly of an old canoe and do not require the systematic application of any waterproofing technique. On one of the examples observed, (no. 1), one of the ends does not consist of the large axial sheet (which was probably too short or defective) but of an additional piece (fig. p. 49/5).

Regarding the rigidification elements[24], we see on the inside of each side a bamboo gunwale pole running from stem to stern against which is sewn the top of the bark envelope. This gunwale pole is then supplemented by two longitudinal reinforcing poles, also in bamboo, placed against the inside of each side. These are maintained in place by a number of relatively weak lashing points. Finally, an additional piece of bamboo, often from a split pole, runs along the exterior of the side. This is maintained in place by a new small series of ropes which also surrounds the three bamboo elements previously attached. As for the robust ropes maintaining the benches in place, they do not surround the bark, but only the assemblage of three bamboo elements on the inside of each side.

24) For this aspect, we can also refer to the extremely accurate description published by J. HORNELL (1935).

Fig. p. 48/1. Bottom surface where only the phloem is present (*muterere* no. 2).

Fig. p. 48/2. Section of the elements successively sewn (*a*), then lashed (*b-c-d*) at the gunwales of the *muterere* observed in 2013.

Fig. p. 48/3. Section of a *muterere* purchased in 1905 (von LUSCHAN 1907, fig. 6).

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Fig. p. 49/1. Photomontage of *muterere* no. 1. Length 3.30 m; width 0.93 m; depth 0.30 m.

Fig. p. 49/2. *Muterere* no. 1 on the beach at Chocas.

Fig. p. 49/3. View of the interior structure of *muterere* no. 1.

Fig. p. 49/4. Frame sticks of *muterere* no. 1.

Fig. p. 49/5. Additional end piece of *muterere* no. 1.

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The first bamboo piece (in other words, the gunwale pole) thus serves to stabilise the edge of the bark envelope. The two latter reinforce the form of the canoe. As for the fourth element, its function most likely consists of protecting the ropes visible on the outside of the top of the canoe.

The framework consists of a series of rods of small diameter (Ø ~ 1 cm). These are numerous (38 on the example examined, 35 on the other and 38 on the specimen preserved in the museum on the island of Mozambique) and sometimes inserted in pairs. They are inserted once the various bark sheets have been sewn together. These fine rods, taken from bushes rather than bamboo groves, are maintained on each side of the base by a long rod or stringer of the same diameter. The two stringers are separated in this position by a piece of wood which we can term a stretcher (and also as a mast step). These long poles are often replaced by bamboo pieces of greater diameter, as we have observed on one of the canoes present on the beach at Chocas, in the Museum of the Palace São Paulo and on the photographs by J. Hornell, where they were even present in pairs (Ø ~ 2-3 cm). These pieces clearly reinforce the longitudinal rigidity of the bottom of this craft, and are systematically lashed to the rods constituting the framework. Another longitudinal pole, similar to those arranged in the bottom, is present halfway up each side, and a new series of lashing points maintains this very light frame stick in place.

Fig. p. 50/1. The *muterere* are particularly light canoes (*muterere* no. 2).

Fig. p. 50/2. Area of overlap of the three sheets of bark (no. 2).

Fig. p. 50/3. Bottom sheet: overlap of the lips of the cut area (no. 2).

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Fig. p. 51/1. Plan of a *muterere* (no. 2), on the beach at Chocas; the prow is to the left (scale 1/25). Length 3.31 m; width 0.90 m; depth 0.33 m.

Fig. p. 51/2. Photomontage of *muterere* no. 2, before removal of the palm leaves which prevent the fish from escaping.

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Fig. p. 52/1. Frame sticks of *muterere* no. 2.

Fig. p. 52/2. Longitudinal poles (stringers) maintaining the framework.

Fig. p. 52/3. Continuous lashing of longitudinal poles.

Fig. p. 52/4. Watertight bundle (behind the framework) and "mast step" stretcher.

Fig. p. 52/5. Watertight bundle with N-shaped stitches (no. 2).

Fig. p. 52/6. Watertight bundle over the overlap between the bark sheets (which can be seen again to the right).

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The lashing of the framework to each of the stringers is carried out using a single cord running from one rib to another, and a single cord is also used to fix the edges of the bark to the gunwale pole and for sewing the watertight bundles.

On all of the *muterere* observed, it can be noted that the sewing of the bark forming the envelope constitutes the first stage, as the watertight bundles are covered by the frame stick associated with the longitudinal reinforcement poles. It is also at this stage that the edge of the bark envelope is then lashed to the gunwale poles. It has not been possible for us to determine if the two additional bamboo pieces reinforcing each side are sewn in place next, followed by the insertion of the rods of the framework, or if the reverse is the case. As for the stringers, their primary function is to stabilise the frame stick and not necessarily to reinforce the longitudinal rigidity provided by the upper structural support. Finally, the separation of the top of the sides, and thus the stability of the forms, is ensured by four small pieces of plank (or cross beams) and no longer by thin stretchers. These are suspended and lashed from two points on each side, and more specifically, as we have mentioned, from the upper structural support which consists of the three first pieces of bamboo. Finally, the second cross beam is pierced by a hole enabling the insertion of a mast bearing a small triangular sail (von LUSCHAN 1907, fig. 7), the stretcher also acting as the support for the base of the mast.

Fig. p. 53/1. The two methods for sewing the bark sheets: with the N internally (*muterere* nos. 1 and 2) or externally as here on the *muterere* from the Museum of the Palace São Paulo.

Fig. p. 53/2. Photomontage of the *muterere* preserved in the Museum of the Palace São Paulo (island of Mozambique). The prow is on the right. Near the stern, a large oval sheet of bark has been sewn over a defective area, like the *muterere* from 1905. Length 3.42 m; width 0.92 m; depth 0.38 m.

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Fig. p. 54/1. *Muterere* from the Museum of the Palace São Paulo, island of Mozambique.

Fig. p. 54/2. External N-shaped stitches, which form parallel lines on the inside.

Fig. p. 54/3. Bottom: overlap of the lips of the cut area of the bottom sheet.

Fig. p. 54/4. Stitches on the various bark sheets of the envelope.

Fig. p. 54/5. Interior structure of the stern.

Fig. p. 54/6. The watertightness of the seams is ensured by small plugs inserted from the inside.

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A strategic issue: making the stitches watertight

In terms of their technological complexity, the *kapepe* are undoubtedly situated between the canoes with upper structural supports and the *muterere*. The fundamental difference with the latter can ultimately be found in the lack of awareness of the fisherman of the Malagarasi River of procedures to waterproof the slits that may be present in the hull. The impossibility of assembling in a watertight manner the different bark sheets further emphasises the major constraints introduced by the form of the raw material. We find ourselves faced with a similar problem to that present in the shift from the logboat to the boat consisting of an assembly of planks. Given a lack of familiarity with caulking techniques, the opportunities for developing canoe forms remain very limited.

The use of sewn watertight bundles is geographically highly localised and probably derives, as noted by H. Suder and J. Hornell, from a transfer of knowledge resulting from the presence of maritime craft in one of the major commercial centres, or hubs, of the western coast of the Indian Ocean, such as the small island of Mozambique.

The *kapepe* should thus be associated with an assemblage close to the canoes with upper structural supports, thereby constituting a group that we can describe as canoes with developed upper structural supports. This first assemblage of canoes is therefore characterised by the possibility of manufacturing and shaping them without necessarily having to waterproof any joints.

Our examination of the construction of *kapepe* has led us to consider more closely the basic structure of craft with bark envelopes. The comparison made by J. HORNELL (1935) with the *curragh*, although legitimate when his article on the bark-canoes of the island of Mozambique was written, has later supported numerous authors in a sometimes problematic approach to the structural concept of bark-canoes. The *curragh* and *umiak* (to mention only two examples) have an unformed exterior envelope consisting of skins. The craft only exist by means of the wooden groundwork over which the skins are stretched, the envelope here playing no structural role; these craft should therefore instead be grouped in an assemblage that we could term *craft with a frame-groundwork*.

With bark envelopes, the situation is therefore significantly different, as we have discovered through this assemblage of bark-canoes from East Africa, which contain both simple and complex specimens. The bark removed is present in the form of a large self-supporting cylinder, even when it has been softened by brief immersion in water. The simple forms, such as the *nikhula*, or those which are more complex, like the *kapepe*, demonstrate that once the two sides of each end of the bark have been assembled by means of stitching, the geometry of the ends is directly dependent on the width of the first stretcher present in the relevant distal part. The insertion of a framework is not essential, and when it is present it is above all employed to consolidate the regular form of the bottom.

In summary, the bark is not fundamentally dependent on a strong interior structure, but possesses its own structural resistance. In this context, bark-canoes are particularly similar to the logboats characterised by a process of removal of material (ARNOLD, in prep.). In the case of bark-canoes, all of the wood has in fact been removed at once. It is only secondarily that a framework is sometimes inserted into these canoes, such as the *kapepe*, but above all in those where the hull consists of bark sheets assembled together as in the *muterere*, and which thus gradually become independent of some of the constraints imposed by the initial form of the raw material.

Fig. p. 55. A self-supporting cylinder consisting of the bark of a *mtwana*.

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Towards a typology of bark-canoes

Our examination of the bark-canoes present in East Africa, where very simple forms coexist with complex canoes, has led us to approach the problem on a wider scale[25]. Enlarging our examination to the scale of the world involves developing a typology based on a significant common denominator – one not too subject to influence by man – and it is the characteristics of the raw material itself which ultimately constitute the key element.

Bark intended for the construction of canoes must possess specific properties, presented by a number of trees distributed across the continents. Firstly, it is necessary that the bark can be removed from the wood itself. The removal method thus has an impact on the typology; in any case on the simplest canoes, the least highly developed: lenticular[26] and cylindrical pieces of bark are removed from the tree. In the former case, the shape of the canoe is literally cut into the bark over part of a large trunk, usually characterised by the presence of very thick bark, and the tree generally survives.

In the second, all of the bark from a trunk with a more modest diameter is removed up to a certain height, giving the removed bark a cylindrical form and leading to the death of the tree in the very short term. For specimens with a larger section, obtaining such a sheet is not necessary, and a rectangular piece is obtained by cutting the desired shape. We will describe this as a half-cylinder, as the concept is fundamentally similar to the cylindrical removal method but adapted to very large trees.

We have already emphasised that bark possesses its own structural resistance. The stronger this is, the more difficult it is to shape the bark unless it is significantly reduced by removing the outer cracked part of the bark, retaining only the phloem, or even only a part of the latter. In parallel, techniques for softening the bark are also employed, whether by immersing it for a few days in water or heating it locally over a moderate fire, or even by combining the two.

Finally, the longitudinal fibres of the phloem are not cut and give a homogeneous product with a relatively small thickness (in the order of one centimetre) which is therefore very light. This produces small canoes whose length varies often between 3 and 6 m. A structural support is generally lashed or sewn to the top in order to maintain an open form when the bark dries; a process which makes the bark much more compact and resistant. This structure must be supplemented by the insertion of an increasingly stronger framework as the dimensions increase, and in which the hull is composed of the assemblage of a number of bark sheets. The self-supporting capacity of the material disappears completely when shaping the sides of some very complex canoes, where the edges of the bark sheets are deeply notched in a number of places in order to give the canoe a highly developed lenticular form.

25) As we have indicated, SUDER's 1930 monograph (p. 107-115, pl. 13) undoubtedly constitutes an interesting point of departure for such an approach. The same applies to the article by HORNELL 1940, referring to Australia (included without alteration in his 1946 monograph, p. 181-189), although we do not agree with his conclusions, in particular when he considers that the logboat "is not the *fons et origo* of the series", but that the latter derives from bark-canoes.
26) Numerous photographs illustrating the current state of such trees are present in EDWARDS 1972. The use of several types of eucalyptus is mentioned by those authors having studied bark-canoes in Australia. EDWARDS 1972 (p. 7) refers to the use of two types of bark. The first is thus removed in the form of large rigid sheets due to the thickness of the bark (3 cm). These are the red gum (*Eucalyptus camaldulensis*; synonym *E. rostrata*; SMYTH 1878, p. 407). In the Northern Territory, *E. tetradonta* is used for equivalent properties (THOMSON 1952, p. 1 and 3). The second type consists of species with a thinner bark (*E. obliqua*), removed in the form of a cylinder.

Fig. p. 56/1. Removal of a lenticular piece of bark from a eucalyptus tree by Australian aborigines (SMYTH 1878, fig. 241).

Fig. p. 56/2. Removal of a half-cylinder of bark in the Oyapock Basin, Guyana (CREVAUX 1883, fig. p. 216).

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For the large examples which can transport heavy loads, we can sometimes observe the employment of a floor made of long planks placed on the bark in order to reinforce the bottom of the canoe and the sides, covered and maintained in place by the ribs. Naturally, these planks are very thin in order to preserve the lightness of the craft. The same is true for the framework, when it is present, which is then composed either of an assemblage of thin rods (frame sticks), as is the case in the *muterere*, or of broad, curved pieces of sheathing, as in the bark-canoes of the North American Indians. However, the maximum dimensions are limited, even if several sheets sewn together, because it is impossible to make the envelope thicker while still maintaining its uniformity.

If we exclude the simplest forms, usually confined to interior waters, the construction of bark craft requires the implementation of highly developed concepts and techniques, including knowledge of tree species (the bark of only a few trees is suitable for large-scale removal), the optimal time for removal, techniques for the softening of the bark and watertight assemblage of a number of sheets, and the employment of a structural support during removal and sometimes even during the first stages of the construction.

In comparison with the manufacture of logboats, the construction of bark-canoes is therefore no easier. The duration of use is, however, generally much shorter than that of logboats, and while bark-canoes have continued to be used across large areas this is certainly due to their lightness – making it possible to easily carry them from one river to another or circumvent an obstacle by means of portage –

but also to the rapidity of construction. In this context, the canoes of the North American Indians constitute a particular case (Type 6, see p. 62-63).

The bark raft.

While this is not a canoe as such, but rather a floating craft using the individual buoyancy of each of its constituent multiple elements lashed in bundles, and thus not possessing an envelope delimiting a space separated from the water, we should mention the existence of a type of raft in which the buoyancy results entirely from the water displaced by the volume of the bark, assembled by a network of ropes. This is the *catimarron*[27], discovered in 1802 on the east coast of Tasmania by the expedition led by F. Péron[28], and which had disappeared as early as the middle of the 19th century. The central bundle of one example was measured at 4.55 m long and 1.05 m wide. It was topped on each side by a small bundle 3.90 m long and 0.22 m wide.

In Arnhem Land, D. THOMSON (1952, p. 4, pl. Ab) mentions the use of small, makeshift rafts (*tjutu*) pushed by swimmers. These consisted of superimposed bark sheets fixed together by short stems inserted obliquely.

27) These should not be confused with the more highly developed rafts used on the southern coast of India (SWAMY 2012, p. 27-43).
28) LA BILLARDIÈRE 1799-1800, atlas pl. 44; LESUEUR and PETIT 1811, pl. XIV; ROTH 1899, p. 154-156, fig. p. 156; SUDER 1930, p. 99, pl. 11.

Fig. p. 57. *Catimarron* from coastal Tasmania (LA BILLARDIÈRE 1799-1800, atlas pl. 44).

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Type 1 bark-canoe: natural lenticular sheet.

The aborigines of the Murray River Basin east of Adelaide cut the particularly thick bark of large eucalyptus trees into a lenticular form, with the pointed parts becoming the ends of the canoe. They preferentially choose trees with curved trunks (SMYTH 1878, p. 410-412, fig. 241; see fig. p. 56). The edges are sometimes regularised, and the insertion of three stretchers prevents the bark from folding transversally on itself as it dries (EDWARDS 1972, fig. p. 28, 34, 55).

As another example, the Xingu Indians of the Amazon Basin cut the sheet into a point at the top, which becomes the prow of the *igat* or *jatobá*, and the base is truncated[29]. A rope retains the bark, which is almost half-cylindrical, so that it does not fall heavily to the ground. The length can reach 7.30 m, as the bark has an exceptional thickness of 3 cm (of which 2 cm is the phloem). However, the ends are nevertheless roughly raised by softening them using a fire, as is done for the sides, which thus become a little more curved (VAIRO 2002, p. 117-121).

Each assemblage proposed can be subdivided into a number of sub-groups, but we then risk losing the essential characteristics which we wish to highlight.

Type 2 bark-canoe: cylindrical, non-incised sheet with raised ends.

The most widespread technique consists of removing a cylinder of bark using a circular groove at the base of the tree, another in the upper part of the trunk at a height corresponding to the length of the canoe, and then connecting these two rings by a vertical slit, as we have seen in the manufacture of the *kapepe*. The tree is generally left unfelled in order to offer sufficient mechanical resistance to counteract the forces exercised on the levers during removal of the bark.

Normally, a gunwale pole is lashed or sewn against the top of each longitudinal edge of the bark sheet. These elements are necessarily supplemented by the insertion of two or three stretchers (associated with one or two lashings connecting the top of the two sides), the whole constituting an upper structural support enabling the separation of the sides and permitting their shape to be maintained and controlled. In exceptional cases where the bark is thick, the gunwale poles are not present (for example, the canoes of the Araras Indians).

29) FRIEDERICI 1907, p. 40-41; PARRY 2000, p. 291; VAIRO 2002, p. 117-121.

Fig. p. 58/1. Type 1 bark-canoe on the Murray River, with only three stretchers (EDWARDS 1972, fig. p. 55).

Fig. p. 58/2. The *igat* or *jatobá* from Amazonia can be classified as Type 1 (PARRY 2000, fig. p. 291).

Fig. p. 58/3. Bark-canoe (Type 2) constructed by the Araras or Caripunas Indians, without gunwale poles (near Mamoré/Guajarà, Brazil/Bolivia; KELLER-LEUZINGER 1874, fig. p. 408).

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The ends are raised and closed by sewing or lashing. It is therefore not necessary to employ waterproofing techniques. Sewing can maintain the tips of the sheet pressed to each other, unless the bark is sufficiently flexible at this point for the end to be closed by a single lashing located above the flotation line, by crumpling the bark in some way[30]. The presence is sometimes observed of a light framework to help maintain the form of the hull, as is the case in the *kapepe*.

Type 3 bark-canoe: cylindrical, non-incised sheet with non-raised ends.

A canoe similar to that of Type 2, with an upper structural support, but here the ends are not raised and waterproofing must be employed when the tips of the ends are sewn together, as in the *nikhula* of the Lúrio River (fig. p. 43). This is probably the least frequently observed model. As for the constraints represented by the raw material, these are so great that they constitute a fundamental obstacle, leading to the implementation of similar solutions in a number of locations.

Type 4 bark-canoe: cylindrical sheet with a number of incisions on the end of the sides and rectilinear edges.

The following phase consists of making an incision at the top of each side towards one or both ends. By overlapping the lips produced by each incision, it is easier to create the raised ends, the elevated section of which is triangular in the case of the *attamanmad*[31] and rectangular in the *yachip*[32]. Naturally, waterproofing techniques are usually employed in these positions. This type of canoe is also found in Australia, in particular on the coasts of the Northern Territory and Gulf of Carpentaria (THOMSON 1952, map in appendix).

Type 5 bark-canoe: major axial sheet with limited incisions and generally lenticular form.

A few incisions at the top of the sides enable this canoe to be given a lenticular form and to enlarge the central part of the hull, with a consequent lowering of the height of the sides. These are generally topped by a long additional sheet, sewn against each side. The axial base remains self-supporting during the construction, but the canoe requires the presence of an upper structural support to ensure rigidity and the secondary insertion of a light frame stick to support the envelope, which has a slender appearance. Clearly, the *muterere* belong to this assemblage.

There have been no specialised studies relating to the construction of bark-canoes in eastern Siberia (in particular in the region of the Amur River); we have finally classified these canoes as Type 5. The use has been mentioned of a large sheet of bark and the presence of notches (ANTROPOVA 1961, fig. p. 127) or of three birch bark sheets (THIELE 1984, p. 172), but these latter are in fact assembled as a sandwich.

30) LESUEUR and PETIT 1811, pl. XXIII. See also DURHAM 1960, p. 46-47, and STEWART 1995, p. 119-121, who examine makeshift/rescue craft used during floods, for example. For the implementation of craft intended for such purposes cf. ADNEY and CHAPELLE 1964, p. 212-219.

31) FARABEE 1918, p. 74-76, fig. 8; ROTH 1929, p. 99-100, fig. 90.
32) NISHIMURA 1931, p. 204-205, fig. 47.

Fig. p. 59/1. *Attamanmad*, a Type 4 canoe (north of Amazonia and south of Guyana; FARABEE 1918, fig. 8).

Fig. p. 59/2. *Yachip*, model of a Type 4 canoe (craft once used by the Ainu; NISHIMURA 1931, fig. 47).

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The first is placed flat on the ground and constitutes the envelope per se, each longitudinal edge being bordered (temporarily?) by a long pole. Still with the bark lying flat on the ground, other sheets of bark are placed inside the first and covering the network of longitudinal and transverse poles[33].

The sides are raised and temporarily maintained in place by ropes running transversely around the hull on the outside[34]. It appears that the incisions in the top of the sheet are made at this stage, first at one end and then at the other. The aim is to give the end an ogival form. Simultaneously, the insertion of long pieces of wood with proximal ends having a pronounced C-shape enables the end of the canoe to be finished in the form of a more or less raised sturgeon-nose.

33) LEVIN and POTAPO (ed.) 1964, p. 704; in THIELE 1984, fig. 6. LEVIN and POTAPO (ed.) 1956, fig. p. 795.
34) LEVIN and POTAPO (ed.) 1956, fig. p. 795/3. Incisions can also be observed in SCHRENCK 1891, pl. 38/5; ANTROPOVA 1961, fig. p. 127/5-6 and in MIDDENDORFF 1875, p. 1357. The latter author mentions the use of bark from three birches for a canoe, but does not describe how this was done.

Fig. p. 60/1. Evenk canoe with incised sides (Tungusic peoples). Plan drawn up in 1843-1844 (MIDDENDORFF 1875, p. 1357).

Fig. p. 60/2. Construction of canoes in eastern Siberia (Type 5), on the Amur River, with superimposed layers of bark. The craft is shaped using ropes surrounding the bark (LEVIN and POTAPO (ed.) 1956, p. 795 and 1964, p. 704; ANTROPOVA 1961, p. 127).

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The canoes of the Kutenai Indians, in particular those inhabiting the State of Washington, but also of the Salish (living a little further to the south), also have sturgeon-nose ends (RITZENTHALER 1950, p. 59, fig. 1; ROBERTS and SHACKLETON 1988, p. 166 and 216). The ribs of these canoes (in certain specimens) cross the top of the main bark sheet, unusually sourced from a Western white pine (*Pinus monticola*) – the bark of which is much thicker – and not from a paper birch (the latter being at the southern limit of its area of distribution). Finally, the internal part of the bark constitutes the external face of the canoe, which is called *ac-so-molth*. Here too, this unusual arrangement apparently demonstrates that the envelope has not been placed on a groundwork, but that the ribs have been inserted secondarily, one by one, into the hull in order to consolidate its general form. However, we do not know the number of incisions made in this bark in order to obtain the form sought (MASON and HILL 1901, p. 527-531, fig. 2-3, pl. 2). Apparently, these are very few, if not non-existent[35]. If this latter case corresponds to the basic principle, we must classify these canoes as Type 4.

35) Unfortunately, we do not know the exact sequences for the construction of this type of canoe (ADNEY and CHAPELLE 1964, p. 173). However, if we take as a starting point the drawings of WAUGH 1919 (pl. 1 and 2), where the seams are clearly drawn, or the photograph published in WIPPER 1999 (p. 225), we conclude that the main sheet of pine bark has no incisions, and that it is topped by a narrow additional strip of bark.

Fig. p. 61/1. Large scale model of an *ac-so-molth* canoe used by the Kutenai Indians of Washington State (MASON and HILL 1901, fig. 3).

Fig. p. 61/2. The many incisions in the edges of the bark sheet (Type 6) enable a particularly slender form to be given to the bark boats and canoes of the North American Indians, and require the use of temporary support elements (ADNEY and CHAPELLE 1964, fig. 18).

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Type 6 bark-canoe: major axial sheet with multiple deep incisions and generally lenticular form.

The multiple incisions carried out on the top of the sides mean that the axial sheet is no longer self-supporting, but they enable the hull to be given a very slender form. This essentially involves the bark-canoes of the North American Indian tribes, generally made from paper birch bark (*Betula papyrifera*), which is not too thick and has a particularly watertight texture.

We can also note that the particularly flexible and durable nature of this bark has favoured the development of an unusual type of canoe (Type 6), differentiating it significantly from those made from the bark of pine, eucalyptus or *Brachystegia*.

The construction of these canoes usually begins with the temporary creation of a framework in the middle of the bark sheet, weighed down by large pebbles[36]. This is installed on a bed of sand or a prepared surface. This framework demarcates the limit of the extensive multiple lateral incisions[37]. In order to be raised, the sides must be supported by numerous stakes inserted in the ground along the framework before the lips are sewn together. With the exception of small canoes, each side is topped by an additional bark sheet. The watertightness of the lips and added sheets is ensured by the application of mastic consisting of a type of pitch made less fluid with the addition of grease, and sometimes coloured black by the presence of crushed charcoal. A floor, composed of thin longitudinal planks, protects the inside of the bark envelope while reinforcing its longitudinal rigidity. Finally, a more robust frame stick is inserted, consisting of wide, thin, curved pieces of sheathing. Hot water and steam are often used to soften the bark and the wooden elements. The heat of the fire is sometimes used to facilitate the removal of the bark from the trunk.

These canoes are the result of considerable work and their expected lifetime is clearly several decades. We also note the large diversity of elements required for the construction of such a canoe[38]: a large sheet of bark from the paper birch (*Betula papyrifera*), roots from the Jack pine (*Pinus banksiana*) for the ropes, white cedar wood (*Thuja occidentalis*) to be split into the wooden elements (bent ribs, poles, gunwale elements), pine resin (*Pinus strobus* and *resinosa*; *Picea mariana* and *glauca*). We thus note that two thirds of the two weeks necessary for the construction of such a craft are spent collecting and preparing the materials (see also note 37).

36) Framework present in the form of a template (RITZENTHALER 1950, fig. 10 and 12), or sometimes of an element which is raised secondarily, forming the interior of the upper structural support.

37) WAUGH 1919, ADNEY and CHAPELLE 1964; the construction sequences of these canoes have been the subject of detailed observations during the period in which they were disappearing (RITZENTHALER 1950, GUY 1977, GIDMARK 1988 and 1989). We thus observe an initial replacement of the bark by canvas (TAYLOR 1980).

38) The tree species mentioned here are present only as examples of those most often encountered in the publications, since for each use we always observe the employment of a number of tree species according to the available natural resources and the customs of the constructors.

Fig. p. 62. General form of the bark-canoes of the North American Indians and the region in which the paper birch is present (RITZENTHALER 1950, fig. 1).

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Type 7 bark-canoe: multi-sheet canoes.

With the canoes of this type, we abandon the concept of the initial cylindrical sheet, even those modified with incisions and with raised ends. This type of canoe involves the use of a transversally flattened sheet of bark to constitute the bottom and raised areas, or at least a part of the latter (EDWARDS 1965, p. 21-25), and each side consists of another sheet attached by spiral sewing to the central piece at the chine. Also usually present is an upper structural support and a light framework. The latter is generally necessary to maintain the form of the whole and, in the case of the *yeni* canoes of the Alacaluf from Tierra del Fuego, is covered by bark strips acting as a floor (all of the bark used by this people is that of *Nothofagus betuloides*; EMPERAIRE 1955, p. 179-180; VAIRO 2002). The longitudinal sheets can also be more numerous, for example five or more (LOTHROP 1932, p. 252).

Several of the Aborigine canoes used in Queensland are also of this type (von LUSCHAN 1907, p. 50-52, fig. 14-15; DAVIDSON 1935, p. 84, 137-138, fig. 9, 13), and the same is true for the Gulf of Carpentaria (HORNELL 1946, p. 184). With these canoes, we gradually converge upon the construction methods and structures employed in wooden plank boats.

Type 8 bark-canoe: canoe with groundwork.

This type of canoe has not yet been fully identified[39]. It fundamentally consists of an internal frame-groundwork, like that of the *curragh* and *umiak* where the unformed external envelope consists of skins (see p. 55). In the current case, this would involve small fragments of bark assembled by sewing, constituting a whole which would be arranged over a wooden groundwork, or an exceptionally flexible bark similar to skin or leather.

Structurally, such a canoe – as for the rafts – would not have the same relationships with the bark-canoes analysed above, the latter being characterised by the mechanical properties resulting from the raw material employed. In the current case, a groundwork constructed in advance would define the form of the canoe.

39) Contrary to what is suggested by S. MCGRAIL 1987 (p. 9/C8). However, he does raise the problem posed by the reliability of certain early observations (p. 92-93).

Fig. p. 63. *Yeni* canoe used by the Alacaluf people, with bark sheets (Type 7), Musée d'Histoire de Berne (photograph: Musée d'Histoire de Berne).

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Fig. p. 64. The *kapepe*: a Type 2 bark-canoe used on the Kimila River, which forms part of the basin of the Malagarasi River.

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In conclusion

Bark-canoes constitute a homogeneous assemblage, closer to logboats and craft with monoxylous bases than to craft with flexible envelopes which exist only due to the frame-groundwork over which the envelope is stretched. Bark possesses an inherent structural resistance (albeit with some limitations for the paper birch), but it also presents major geometrical constraints which are much more extensive than in the case of the monoxylous craft (where the raw material permits an endless variation of sculptural forms). These constraints are partially compensated for by the presence of a material that is relatively flexible due to its reduced thickness and to the fact that the longitudinal fibres of the phloem are not cut.

For the two assemblages, overcoming the restrictions imposed by the raw material involves the addition of extra pieces in order to raise the bottom; an operation associated with the insertion of elements enabling the form to be stabilised. We also note the frequent use of fire (together with immersion in water for a number of days) to soften the material and give it new forms. In short, the parallels between the development of monoxylous craft and bark-canoes show numerous similarities, apparent above all in the simple forms. The shift to the more complicated, larger specimens necessitates finding solutions to similar problems, such as that of maintaining watertightness between the different parts of the envelope, assembling the pieces constituting the hull and inserting elements which ensure the rigidity of the forms. While these elements may be attached directly to the hull of the wooden craft this is not the case with bark-canoes, where the attachment points are systematically located in the upper structural support.

However, the major difference is found in the thickness of the hull, where, in the case of the wooden craft, the planks may become thicker and thicker, while the thickness of the envelope may not be increased for the bark craft (the addition of thin longitudinal planks in the bottom of the craft is only a partial response), thereby limiting the maximum dimensions of this type of craft, whose major interest lies in its lightness and the rapidity of its construction, at least for the basic forms.

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