Αρχαιομετρικές Μελέτες για την Ελληνική Προϊστορία και Αρχαιότητα

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ΝΕΟΛΙΘΙΚΑ ΣΚΑΦΗ: ΜΑΡΤΥΡΙΕΣ ΓΙΑ ΤΟΥΣ ΤΥΠΟΥΣ ΚΑΙ ΤΙΣ ΧΡΗΣΕΙΣ ΤΟΥΣ

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ΠΕΡΙΛΗΨΗ

Με βάση εθνολογικές μαρτυρίες, φαίνεται πιθανό ότι στις προσπάθειες μετακίνησης του ανθρώπου πάνω στο νερό πριν από τη Νεολιθική εποχή είχαν χρησιμοποιηθεί πρώιμες μορφές πλωτήρων και άλλων πλωτών κατασκευών από διαθέσιμες πρώτες ύλες, όπως είναι οι κορμοί δένδρων, το δέρμα των ζώων ή τα δεμάτια καλαμιών. Όπως σε κάθε εποχή, και στη Νεολιθική η τεχνολογία επηρεάζει φυσικά την επεξεργασία των υλών αυτών και συνεπώς τις δυνατότητες κατασκευής σκαφών. Οι πιθανοί τρόποι χρήσης τους περιλαμβάνουν το ψάρεμα, τη μεταφορά υλικού μεγάλου όγκου ή βάρους, καθώς και ανθρώπων και ζώων.

Οι μαρτυρίες για τους τύπους πλωτών μέσων στη Νεολιθική εποχή προέρχονται από έμμεσες πηγές, όπως είναι το συγκριτικό εθνολογικό υλικό ή οι παραστάσεις σκαφών, καθώς και από σωζόμενα μονόξυλα. Στην ανακοίνωση αυτή γίνεται ανασκόπηση των δεδομένων που αφορούν στους δυνατούς τύπους νεολιθικών σκαφών και τις ενδεχόμενες χρήσεις τους, σε συνάρτηση με τις περιβαλλοντικές συνθήκες.

ΛΕΞΕΙΣ-ΚΛΕΙΔΙΑ: *ΑΙΓΑΙΟ, ΝΕΟΛΙΘΙΚΗ ΕΠΟΧΗ, ΝΑΥΣΙΠΛΟΪΑ, ΣΚΑΦΗ, ΔΕΡΜΑΤΙΝΑ ΣΚΑΦΗ, ΣΚΑΦΗ ΑΠΟ ΚΑΛΑΜΙΑ, ΜΟΝΟΞΥΛΑ, ΔΙΠΛΑ ΜΟΝΟΞΥΛΑ*

NEOLITHIC CRAFT: EVIDENCE ABOUT BOAT TYPES AND USES

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ABSTRACT

According to ethnological evidence, in first attempts for aquatic mobility of man, preceding the Neolithic period, primitive forms of floats and other floating devices could have been used, which were made from available raw materials, such as tree trunks, animal skin or reed bundles. As in every period, in the Neolithic technology certainly influences the work of these materials and consequently the possibilities of watercraft construction. Probable uses of water craft include fishing, conveying of bulky or heavy material, man and animal transport.

Evidence about types of craft in the Neolithic comes from indirect sources, such as comparative ethnological material or boat representations, as well as from preserved dugouts. This paper reviews data concerning possible Neolithic boat types and their possible uses, considered in connection with environmental conditions.

KEYWORDS: *AEGEAN, NEOLITHIC, NAVIGATION, WATERCRAFT, HIDE BOAT, REED-BUNDLE BOAT, DUGOUTS, PAIRED LOGBOATS.*

INTRODUCTION

Aquatic mobility by means of floats (Hornell 1942) or floating structures, rafts and boats (McGrail 1987), has always presented important advantages to man for communication, transport, or food acquisition. Floats (inflated skins, logs, empty containers or reed bundles) are "personal aids to flotation with man partly immersed in water" (McGrail 1985, p.294). Buoyancy is necessary to remain afloat and satisfactory for floats. Buoyancy of rafts, mainly combined floats, is derived from their individual elements, their raw material being lighter than water, and they are not intended to be watertight (McGrail 1985, p.294, Greenhill 1995, p.74, 78), in contrast to boats. A raft may be made from logs, inflated skins, or reed bundles (Greenhill 1995, fig.62, 63, 64, 68). Construction of log rafts would have been technologically possible since the Upper Palaeolithic (McGrail 1987, p.53). Rafts of course offer more space than floats and can be used for the transportation of people, animals and goods, but the cargo is not protected from the water, continuously liable to break over it. Boats, on the contrary, are watertight and their buoyancy derives from the whole vessel, that is, from the enclosed air (McGrail 1985, p.296, fig.1, Greenhill 1995, p.78). Passengers and cargo are then sheltered from the waves.

Besides coastal sites and islands, prehistoric settlements neighbouring waterways, located on the banks of lakes or rivers and thus situated at the borders of various biotopes, are privileged, since they may exploit both aquatic and land resources. Fishing, mollusk collecting and water-fowl hunting are added to agricultural and stock-breeding activities (Marangou 1990 with references).

When floating devices are discovered, in order to cross the water surface, since bridges do not exist, they can be used to convey not only men, but also animals and goods, and naturally communication with the opposite bank as well as down- and upstream is facilitated. Heavy or bulky cargoes, such as wooden beams, stones or reeds for the construction and equipment of houses, but also exchanged goods may be transported easier by inland waterways than by land. There results an enhanced reciprocal influence in the economic, technological and cultural sectors with other settlements.

The importance of communication in prehistoric times needs hardly to be stressed (cf. this volume, theme session *Technology and trade of lithic materials and metals in the Eastern Mediterranean during Prehistory).* Moreover, presence of water lets us assume the possibility or necessity of aquatic mobility. The latter is naturally presumed for settlements with easy access to the sea and confirmed by the colonization of islands (Cherry 1985) and imports of items across the sea (sea for example, Perlès 1990). When the landscape has changed since the Neolithic, the discovery of dugouts, among other evidence, in proximity to continental prehistoric settlements attests a former aquatic environment, such as, the presence of a lake or river.

Besides buoyancy, stability is necessary for a watercraft. Its centre of gravity has to be located directly above its centre of buoyancy. If the water is not still, these centres change and the hull becomes unstable (Steffy 1996, p.8-10). The craft must continuously recover stability in different positions during travel. The weight of the cargo complicates things even more. At sea, in rough weather, a boat is subjected to even more complex hydrodynamic and aerodynamic forces (McGrail 1987, p.16). This is why, besides available materials, technological knowledge and intended use, not to speak of social determinants, the type of waterway (river, lake or sea) determines the form of a hull (Steffy 1996, p.12). Traditional craft is normally adapted to the local environmental conditions.

A boat may be propelled by water power (current), without real control of direction, muscle power (paddles, poles, oars, or tow), and wind power (sails). Combination of two means of propulsion on the same boat is generally possible and sometimes propulsion may be combined with steering (McGrail 1987, p.204). The sail is first represented in the Aegean iconography in the Middle Bronze Age, more precisely on a seal-stone from Platanos (Evans 1921, fig.138). Its use in the Neolithic can therefore not be assumed, at least for the moment.

In inland waters, a flat-bottomed craft with elementary stability and control of direction, propelled by paddles (rather than oars), poles or man- or animal traction is sufficient. Sometimes merely wind and current may be used for propulsion satisfactorily to cross a river.

On the contrary, at sea there is a need for greater lateral stability and dirigibility. If a craft may be flat-bottomed in sheltered waters, a sea-going boat must have the necessary qualities to stand the waves and winds in the large. The boat has primarily to be seaworthy and to be able to move towards a chosen direction. An adequate means of propulsion other than the wind and currents and a steering device are indispensable.

Floating devices were thus invented as an answer to environment and as a consequence of specific needs. They certainly depended on technological progress, while it is not excluded that other factors which can not be traced in the archaeological record may also have influenced their construction and morphology.

Most present direct evidence about Mesolithic and Neolithic craft comes from preserved dugouts. Nevertheless, hollowed stems do not constitute the only solution: reed bundles, unworked logs or animal skin may have been used for the construction of primitive rafts and boats (McGrail 1987, p.163-190). Bark boats of basic types from suitable tree-trunks could be built since the Mesolithic in North West Europe, although moulded ones might not have been possible before the Bronze Age (McGrail 1987, p.96, Tables 7.5, 7.6 and 7.7). Moreover, bark boats are used in particular latitudes: in North America -bark boats are particularly associated to Native Americans (Greenhill 1995, p.97-100)-, Siberia, Sweden, Chile, Australia and South East Africa (McGrail 1987, p.88, Table 7.1). Simple types were widely used on rivers, for example in Siberia and in Australia (McGrall 1987, p.88).

Therefore, hide-, reed-bundle boats and dugouts would constitute convincing Neolithic precursors of Early Bronze Age Aegean vessels.

HIDE BOATS

According to later written sources about the beginnings of navigation, in particular ancient texts (Diodorus, Lycophron, Scholia to Iliad etc.), animal skin was used for the first attempts to cross the sea, after the flood, on floats or rafts. Ethnological parallels also show the constructive simplicity of the more unpretentious types of craft. The materials needed for a skin raft or boat are sewn animal hides and a light wooden or bone framework. These were easily available in the Neolithic, in contrast to trees with a stem suitable for the construction of a dugout, which would not always be close at hand. Adequate stone and bone tools for wood working and sewing, such as the ones included in the Neolithic tool kit, would certainly have been necessary.

Hide boats had probably been used already in the Upper Palaeolithic and Epipalaeolithic (Arnold 1996, p.36). The palaeolithic tool kit and available materials permit this assumption (McGrail 1987, p.185,186, Tables 10.6, 10.7 and 10.8), while large trees, adequate for the construction of dugouts, would only be available from the Mesolithic onwards, at least in North West Europe (McGrail 1987, p.53). Skin boats did not survive, they were besides short-lived structures, because of the material used. Nevertheless, it has been suggested (Ellmers 1986, p.30; Hôckmann 1985, p.9; Hôckmann 1996, p.25, against this identification: McGrail 1987, p.185) that a shaped fragment of reindeer antler dating from 9000 BC from the North Sea coast (Schleswig-Holstein, Husum) could have belonged to the frame of a skin boat (replica: Hôckmann 1988, fig.3, 1; Hôckmann 1996, p.26, fig.1,2). A piece of wood from a burial mound in Ireland dating from the 10th century AD could also have been part of the gunwale of a skin boat (Greenhill 1995:92, *cf.* McGrail 1987, p.186). A wooden mesolithic paddle found in a lake-side settlement at Star Can· (Yorkshire) and dating from approximately 7000 BC (Clark 1954) could have belonged to a hide boat, as evidence showed that animal bodies were not used only for food (Marsden 1995, p.167).

Some Neolithic and Bronze Age boat representations on rocks from Skandinavia might show originals from animal hide (Greenhill 1995, p.93, fig.83). Occasionally, some clay models have been interpreted as representing *curraghs*. These date already from the Hungarian Early Neolithic (Hôckmann 1988, fig.3, 2-3 and personal communication, letter 12.09.1991; Hôckmann 1996, p.37, fig.9), as well as from Bronze and Iron Age Ireland and Wales (Ellmers 1986, fig. on p.31, McGrail 1987, p.186, 187, fig.10.9, Greenhill 1995, p.96, fig.85-86). Furthermore, on a Late Neolithic incised sherd from the Grabak cave (island of Hvar, Lésina) in Dalmatia (Novak 1955, p.320, p.194) (Fig. 1) a boat might be represented,

possibly a light structure covered by hides (Bonino 1983, p.66, fig.7B), but its interpretation is not easy (could it rather be a plank boat? Hôckmann 1985, p.37; Bonino 1983, p.66). A Late Neolithic incised ceramic bowl with an applied animal (?) head and a series of dots around the rim from Dikili Tash (Eastern Macedonia) could also represent a simple hide craft (Theocharis 1973, p.199, possible identification by L. Basch, oral communication). To this we might compare the model fragment from Otzaki Magoula in Thessaly which also presents an animal head modelled in relief on the preserved end (Milojcic 1983, pl.23, nr.10, Marangou 1990, pl.IIb).

It would seem that skin boats have been marginal to the development of wooden boat types, although they may have influenced the improvement of some techniques of plank-built boats in some areas (Greenhill 1995, p.93). Till recently, simple craft like *curraghs* and *coracles* (McGrail 1987, p.179, fig.10.3, 180, fig.10.4, Greenhill 1995, fig.56, 80, 81), rounded and respectively long narrow structures, consisting of an animal hide covering and a simple wooden frame, have been used in Wales or Ireland for example. Eskimo hide boats, *kayaks* and *umiaqs,* are, on the contrary, very specialized boats (McGrail 1987, p.179, fig.10.6, Greenhill 1995, p.91) attesting an advanced knowledge of naval architecture.

If the distances of open sea in the Aegean Palaeolithic were relatively short and the cargo restricted, given the small quantities of obsidian found at Franchthi (Jacobsen 1993 with references), then a simple hide craft could be adequate for these crossings; its use could naturally continue in the Mesolithic and the Neolithic, as it did in inshore or inland navigation in later periods.

REED BUNDLE AND BASKET BOATS

Basket boats, with a skin or fabric covering, made watertight with tar or clay and reed bundle boats, possibly with a light framework and water-proofed with bitumen are occasionally attested in ethnology (Greenhill 1995, p.75 and fig.59, 60).

Numerous boat representations from Predynastic Egypt (mostly 4th millenium BC) are engraved on rocks or painted on pottery. Several of them depict *papyrus* boats (Basch 1987:33-34, fig.65-66; 49, fig.76; 50, fig.78), used for fluvial navigation and attesting rather african origin. Later pharaonic boats may show similar shapes or decorations, but their use in the Mediterranean certainly imposed different construction methods. A boat model from Eridu (5200 BC), constructed from clay coils, probably represented a bundled reed boat; it is coated with bitumen inside and out and the sides are curved inward near the gunwales. Later iconographic evidence shows crescent-shaped craft, either reed boats or wooden boats imitating the reed craft form (Vosmer 1996:225).

Very recent discoveries attest the possibility of use of basket or bundled reed boats in the sea around the middle of the 3d millenium BC, in the Arabian gulf and western Indian Ocean region (Ra's Al Jinns in Oman; Vosmer 1996). The evidence consists of pieces of bitumen with impressions of bundled reeds lashed together, basket weave and wooden planks lashed, stitched or sewn together. Because of the remains of barnacles preserved sometimes on the surfaces opposite the reed or wood impressions, it is concluded that these surfaces were immersed in seawater and consequently that the bitumen had coated the hulls of sea-going vessels.

Besides ethnological, iconographic and distant parallels, experimental archaeology attests a possible early use of reeds for boat construction in the Aegean Sea.

The Hellenic Institute for the Preservation of Nautical Tradition constructed recently a double-ended *papyrella* reed-boat and succeeded in crossing the sea from Central Greece to Melos (Tzalas 1989a, *idem* 1989b, Tzamtzis 1987) (Fig. 2). The objective of this archaeological experiment was to test the feasability of this travel for the acquisition of obsidian at Mesolithic Franchthi in the Argolid. As a matter of fact, in the later Mesolithic (9000 b.p. uncalibrated), the quantity of Melian obsidian as a raw material became important at Franchthi, while, at the same time, tuna fishing was an important activity (Jacobsen 1993).

The necessary techniques and tools in order to build a reed boat or raft are attested since the Mesolithic (McGrail 1987, p.172, Table 9.4). As a matter of fact, reeds were the principal material worked with flint tools at Mesolithic Franchthi (Jacobsen 1993 with

references). Simple reed bundle crafts have been used till recently in shallow waters off Corfu; these are called 'rafts' by McGrail (1987, p.164). The flat craft of the experiment, which could be considered as a longitudinal extension of the simple *papyrella* (McGrail 1987, p.169-170) consisted moreover of a wooden (cypress) frame, on which bundles of *Scirpus lacustris L. ssp. Lacustris* were fastened with lashings of vegetal fibre rope. It was propelled by a crew of five or six paddlers. Its buoyancy was excellent and its stability very good, but the frame was too heavy and rigid and the thickness of the transversal planks reduced the hull speed and increased the craft's drift. Leather strips would moreover have been more resistant than vegetal fibre rope when damp (Tzalas 1989, p.445-446, 453-454, 456, note 8).

The sea crossing distances in the Aegean were greater in the Mesolithic than in the preceding periods (Jacobsen 1993). The problem of the return travel of reed bundle crafts and of the availability of raw material, therefore of the possibility of repairs at the final destination (Melos) makes some scholars doubt and propose hide instead for the construction of these early boats, or, alternatively, log rafts (Basch 1987, p.76). Of course, the parallel use of reed-bundle craft in inland waterways or inshore is plausible.

THE DUGOUT

The adequate tools as well as suitable logs for the construction of dugouts existed from the Mesolithic onwards (McGrail 1987, p.64, 86). Several suitable species, such as oak, pine, poplar, chestnut, or beech, existed in Neolithic Thessaly; oak and pine are attested at Nea Nikomedeia, Servia and several Thessalian sites, sometimes since the Early Neolithic (Zohary *et al.* 1988, p.71-72, 191). Basic dugout types remained similar since the Mesolithic, which results to dating difficulties. Simple crafts have been used in parallel to advanced forms. Similarities of construction and typology persisted from the Mesolithic through the Bronze Age, the Galloroman period and the Middle Ages. Even later plank boats for inland waters may have a dugout shape (Arnold 1995, fig. on p.178, p.180-181) (cf. Fig. 5).

Types of dugouts may vary regarding the transverse section of the hull, that depends primarily on the use of a whole log or a half-log, the shape of the ends and, in more developed types, the fittings. Variety is attested quite early. Moreover, different types of dugouts, eventually of boats in general, may be used simultaneously on a site. Their uses may be specialized: for example, transport, fishing, crossing.

Mesolithic dugouts have been found in France, Germany, the Netherlands and Denmark, and some contemporaneous artefacts interpreted as paddles on several north-European sites, particularly in Denmark (Andersen 1987; Arnold 1995, p.25-27, 35). In the Neolithic, numerous examples of dugouts have been found in Northern Europe (for an overview, see Arnold 1995, p.33-55, cf. Cornaggia Castiglioni 1967 for Italian prehistoric examples). Because of the similarities, it is not useful to distinguish between European Mesolithic and Neolithic dugouts (Arnold 1995, p.25).

A series of Neolithic clay models may represent dugouts. Since the scale is unknown, and the shape of other wooden artefacts, such as troughs, is similar, their identification is often uncertain. Even real remains of hollowed log or half-log artefacts may be difficult to interpret, and the possibility of secondary use of real dugouts is not excluded (McGrail 1987, p.56). Identified clay models of dugouts date from the Middle and Late Neolithic of the Balkans and Greece (Marangou 1990 and *idem* 1991 with references): Middle Neolithic clay models of dugouts belong to the Vinca culture (Fig. 3); Late Neolithic ones come from the Karanovo, Gumelnita, Bakamo-Gummo and Vinca cultures, from Thessaly (Marangou 1990 and *idem* 1991) and from Western Greek Macedonia, in particular Dispilio by the lake of Kastoria (excavations by prof. Georges Hourmouziadis, University of Thessaloniki) (Marangou 1996). Several examples dating mostly of the 3rd millennium, come from Mesopotamia (Göttlicher 1978, in particular with perforated ends: pl.1,4; 2,14; 4,35; 5,75; 6,81 and 93; 7,94). Even among models, variety of types is astonishing. They may be asymmetrical or symmetrical, have ellipsoid or approximately quadrangular transversal and longitudinal sections, and even comprise fitted transoms.

Recently the identification of these models as boat representations has been confirmed by the discovery of the preserved outlines of Late or final Neolithic craft at the settlement of

Dispilio (lake of Kastoria, excavations Hourmouziadis) (Hourmouziadis 1996, p.43, fig.12, Marangou 1993, 1996) (Fig. 4). The distance of the site of Dispilio from the opposite bank of the lake of Kastoria is short, and, till recently, crossing was preferred to going round the lake (Tsolakis 1992). Wooden plank boats, flat *manoxyla* (sic) or *monoxyla* of comparable to the Neolithic outlines' dimensions are still used in the area of Dispilio; according to their name, they have a dugout hull shape, they are particularly well adapted to the environment and mainly used for fishing (Fig. 5) (Tsamisis 1949, Tsolakis 1992, Marangou 1993, Rouskas 1996, p.29). The Neolithic ones could also be useful for conveying large beams and reeds for houses and structures, as the architectural remains on the site show (Hourmouziadis 1996, p.34, fig.7a and 35, fig.7b).

The basic principle for the design of a dugout is simple. Nevertheless, the actual construction demands, besides the suitable tree-stem, a great investment in time, a know-how of wood-working technology and the adapted tools. Suitable trees must first be available near the water. Oak seems to have been preferred, but also ash, elm, chestnut, alder, beech, lime, willow, fir and pine have been used in logboat-building (McGrail 1987, p.60; Arnold 1995, p.40-41). Controlled fire may be used in order to hollow the stem: embers are laid down on the upper surface, the charred parts are scraped away with a wooden stick or shells (Arnold 1995, p.32) and the work is completed with stone tools. Stone axes and adzes have been used for dugout construction in the Neolithic (McGrail 1987, p.60-63, Arnold 1995, p.29). Woodworking tools are very common at Dispilio (Hourmouziadis 1996, p.30, fig.5b), but also in Thessaly and at Nea Nikomedeia, where large posts (diameter: 30 cm) were used already in the Early Neolithic for the construction of buildings.

Ethnographic evidence suggests that the logboat construction was a communal effort; sometimes, somebody is in charge of the work, even with a priestly function (McGrail 1987, p.64). Making a logboat is a considerable, specialized and time-consuming undertaking. This time investment requires a sufficient surplus of food production to enable the dugout makers to work. Sufficiently efficient tools are of course necessary, that is, a certain stage of technical development must have been achieved (Greenhill 1995, p.101-102). It may be no coincidence that dugouts become common from the Neolithic onwards.

The main disadvantage of flat-bottomed craft, having a low gunwale, if it were to travel in the open sea, would be the lack of sufficient stability and dirigibility. It is evident that limits for the construction of a dugout are imposed by the dimensions of the log. The basic logboat may nevertheless attain improved performances by expansion (alteration of the sides by heat, increasing effective beam at waterline), pairing (joining two or more logboats) and extension (increasing depth, therefore improving freeboard, by addition of elements) (McGrail 1987, p.56,66, cf. Kapitän 1987, p.228-229). Expansion is usually attested in Skandinavia and in particular Finland, where the trees used for expanded logboats are often poplar or aspen (McGrail 1987, p.60, Table 6.1). Expansion would have been technologically possible since the Bronze Age (McGrail 1987, p.86, Table 6.5). Combination of expansion and extension is possible. Extension is much more frequent, while examples of paired logboats are attested all over the world, although their number is limited. Paired logboats are attested since at least the Bronze Age (see further) and extension may have been possible since the Neolithic at least (McGrail 1987, p.87, Table 6.6) (see further).

The tradition of the basic dugout has been continuous through all periods but there is parallel evidence about an evolution to more complex types. In the Early Bronze Age, for instance, clay models of basic dugouts, inland craft, come from Troy (Figs. 10-11), while a more or less contemporary clay model from Thermi (Lesbos island) represents a much more sophisticated type of watercraft, probably an extended dugout, apparently sea-worthy (Marangou 1991, fig.4-7,10) (Figs. 12-13) (see further).

PAIRED LOGBOATS

Extension of a basic logboat in order to improve transverse stability and increase transport capacity may be achieved by pairing (McGrail 1987, p.56,70), by joining two or more similar logboats together bow to bow and stem to stem. Double dugouts are attested in inland waters since the Bronze Age in an Italian lake (Cornaggia-Castiglioni 1967, fig.1,1; Bonino 1983,

p.56, 58, fig.2F (reconstruction)). Ethnological records attest their use for transporting animals across rivers in Albania in the beginning of the 20th century. They were propelled by means of paddles or poles (Traeger 1904, p.27-28, fig.6-7) (Fig. 6). Paired logboats are particularly well adapted for the transport of bulky cargoes and especially river navigation (Bonino 1983, p.56, 60).

Late Neolithic clay models possibly representing double dugouts have been found in Romania, Pelagonia (Vucedol, Bitola) and Albania (Maliq: PRENDI 1982, pl. IX, nr. 10-11) (Marangou 1990 with references). It is interesting to note that, not only communication among sites located in the Pelagonian closed river valley is easy (Simoska and Sanev 1975), and close cultural contacts exist between the latter two regions (group Bakamo-Gummo-Suplevec-Gmobuki), but also boat types are similar.

Besides their use in inland waters, double dugouts have been also used at sea by monks of the Mount Athos in the end of the 16th century A.D. The monks assembled two hollowed trunks with wooden pegs and used this craft as far in the open Aegean sea as possible for fishing (Belon 1588, p.80-81). Because of their improved qualities, paired logboats could be seaworthy, especially in a calm sea.

EXTENDED DUGOUTS

The hollowed log is susceptible to almost limitless development while the very nature of the structure and materials used in rafts, skin boats and bark boats restricts their development in varying degrees (Greenhill 1995, p.101). This explains why, even if a basic dugout is not stable enough for the sea, however evidence suggests that Bronze Age sea-going vessels were descendants of extended dugouts.

The basic logboat determines the shape of the final boat, but a logboat base can be easily converted into a keel plank and thus a round-hulled, plank-built boat evolves (Greenhill 1995, p.106). Logboats were built in three parts in Japan, in the 14th century: a central hollowed-out log with two or more hollowed logs joined to it, one at each end, and set at an angle to the basic log to give a sheer to the whole structure (Greenhill 1995, p.106). Similar suggestions of assembling several elements have been made about the construction method of the originals represented by an Eneolithic boat model from Osikovo (Bulgaria) (three longitudinal elements; Frey 1991, p.196, 197, fig.2 and 199 fig.4) and a Neolithic one from Tsangli (Thessaly) (combination of longitudinal and transversal elements; Höckmann 1996, p.29-30, fig.4,2) (see further).

External fittings fastened to the sides of logboats enhance initial transverse stability at waterline; above the waterline they may protect from wear and damage, reduce the amount of water entering the boat, or stabilise the boat if it is loaded beyond normal draft, increase large angle stability and give longitudinal strength to the boat (McGrail 1987, p.71).

There is evidence about extended dugouts already in the Neolithic. Recently an eleven metres long oak dugout was found in a Neolithic settlement ("La Marmotta", 7500 BC) in the lake of Bracciano (Italy), while numerous clay boat models come from the settlement area. One of the sides of the dugout had been partly raised with the addition of a wooden plank(?)-element, while a series of transversal ribs were saved in the interior during the construction, in order to reinforce the structure *(L'Archeologo subacqueo* 1,3, September-December 1995, p.3). The Neolithic dugout of Verup I, St. Amose (Denmark) had also been extended by addition of longitudinal strakes, secured by means of a series of holes preserved along both gunwales (Christensen 1990, fig.11-12).

A unique Middle Neolithic clay model of what seems to be a sea-worthy craft comes from Tsangli in Thessaly (Marangou 1990, pl. IV, VIIb-IXd; *idem* 1991, fig.2-3) (Figs. 7-8). Although it has several caracteristics of the dugout, its keel-like device could be understood if it were an extended logboat, while the shape of its hydrodynamic prow attests of advanced nautical knowledge, and its stability would be sufficient to confront the open sea. Its very large breadth in relation to its length is striking; it could be explained by a construction assembling longitudinal elements of several stems (cf. Höckmann 1996, p.29-30, fig.4,2), as it seems too early for a plank construction. One should not forget, though, that a model may exaggerate some features of the original such as a boat's breadth or even add nonexistent ones

(for example, decoration).

The Tsangli model is divided in two compartments by means of an element apparently either representing a bulkhead left in the solid during construction, or suggesting a fitted transom (a vertical board fitted into a transverse slot), which may divide the inner space or close the ends of real logboats. Its inner division and large breadth may suggest that the boat was well adapted as a cargo.

Partitioning even of basic logboats is often a method of securing the load or separating functional spaces on board, such as for the fisherman or the helmsman, or the location of the fish, the fishing gear, the catch or the carried goods. It would also be useful for separating conveyed animals (cf. above, paired logboats) and for providing seats. A Neolithic dugout with inner division into compartments was found at the German lake-side of Federsee (Paret 1930, p.79, fig.2) (Fig. 9). A Middle Neolithic decorated clay artefact, divided into compartments, from Knossos, could possibly represent a dugout with inner compartmentation (Theocharis 1973, p.198, identification: Hôckmann 1988, fig.6; idem 1996, p.32, fig.5,3).

If reed-boats were satisfactory for the Mesolithic, they would not provide sufficient space for the large-scale trade of goods and the island colonization in the Neolithic (Jacobsen 1993 with references). If the Tsangli model represents a Neolithic cargo, we could reasonably presume that considerable quantity of heavy items, such as obsidian, marble or andésite millstones could have been transported by means of boats of similar types.

Early Bronze Age sea-going boat types have probably resulted from a long tradition of these extended dugouts. This has been suggested about Early Cycladic boats (Basch 1987, p.77). Kapitän (1987 and 1989) considers more probable the origin of later plank boats from rafts and not logboats (cf. Greenhill 1995, p.80). An early example of these sea-going vessels constitutes an Early Bronze Age clay model from Thermi (Lesvos island) (Fig. 12-13): a probable descendant of the extended dugout, it has a distinct keel and asymmetrical ends, reminding types mostly known from bi-dimensional representations of vessels depicted on cycladic frying-pans or the Ðorak daggers (the authenticity of the latter has, however, been questioned) (Marangou 1991, p.279 with references).

CONCLUSIONS

A variety of types of watercraft from the point of view of the raw materials, of the complexity of construction, of performances and of uses, were possible in the Aegean Sea in the Neolithic period. It is not excluded that different types were used simultaneously on the same site, or that similar types were used both in inland waters and for coastal navigation.

These types were a response to specific needs, eventually of a specialization of uses. Often they may have been cargoes, for the transport of livestock or humans, or for conveying material, such as wood, reeds and stones, or crossing to the opposite bank. They may also have been a means for the acquisition of subsistence resources, fishing and water-bird fowling.

Evidence about the craft used for offshore navigation and, consequently, for trade or transport of lithic materials overseas in the Neolithic Aegean remains scanty. Nevertheless, in this period, if not before, developed boat types certainly appeared, a glimpse of which is given by the Tsangli model, as well as from more or less distant in time or space parallels and experimental archaeology. The clearly sea-worthy craft which crossed the Aegean sea after the Stone Age had followed a long tradition in shipbuilding and navigation.

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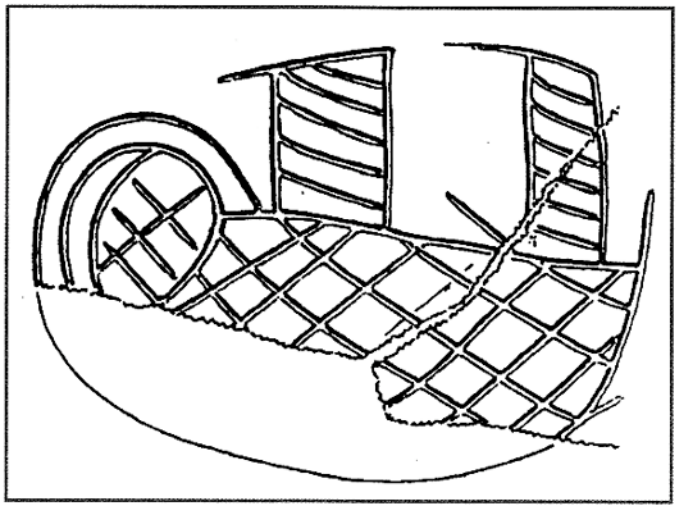

Fig. 1: Incised Late Neolithic sherd from Hvar (after Höckmann 1985: 38, fig. 3).

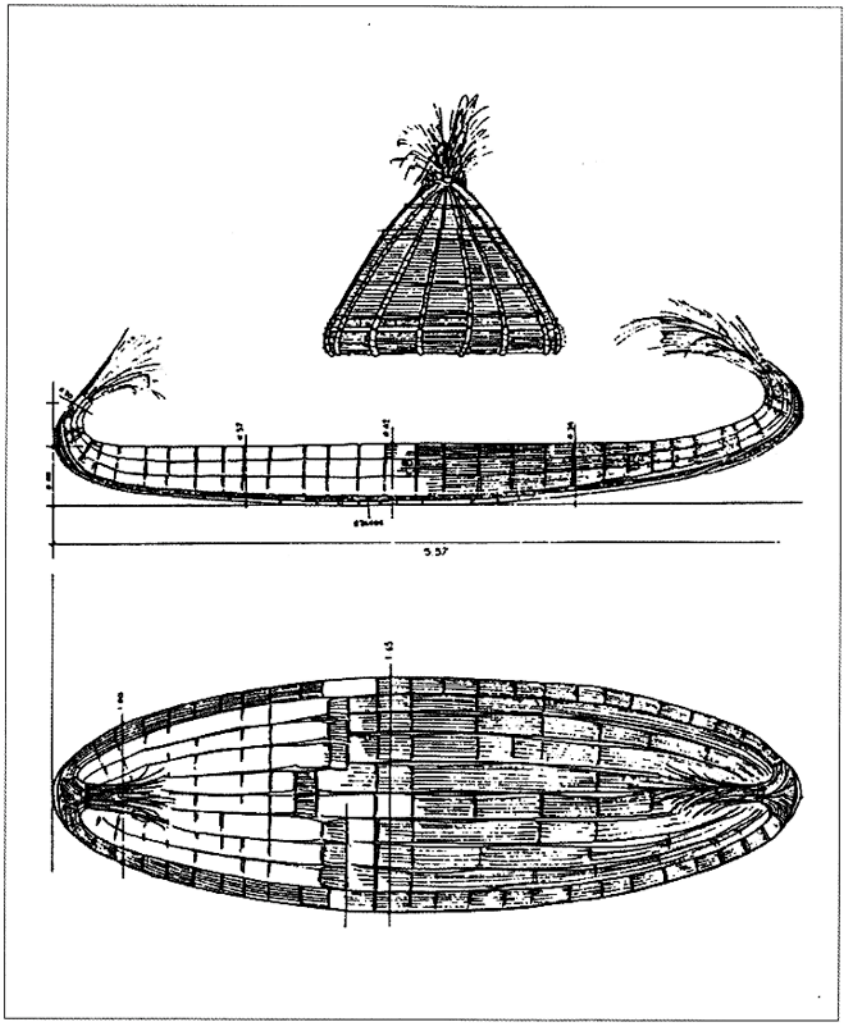

Fig. 2: The double *papyrella* used for the experimental travel to Melos by the Institute for the Preservation of Nautical Tradition (after TZALAS 1989b: 463, fig. 1).

Fig. 3: Middle Neolithic clay model from Selevac (after TRINGHAM *et al.* 1990, pi. 10.5).

Fig. 4: Late/Final Neolithic outline of a watercraft from Dhispilio (photograph kindly provided by Professor G. Hourmouziadis).

Fig. 5: Modem *manoxyla* moored at Dhispilio (photograph by the author, 1993).

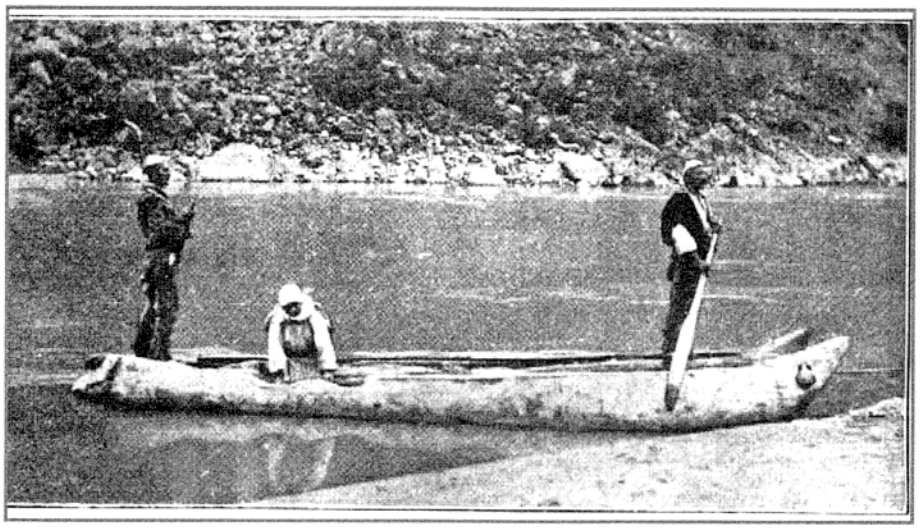

Fig. 6: Paired logs used on an Albanian river in the beginning of the 20th century (after TRAEGER 1904, fig. 6. photograph kindly provided by the Bochum Library; *cf.* Marangou 1990, pi. VI, b).

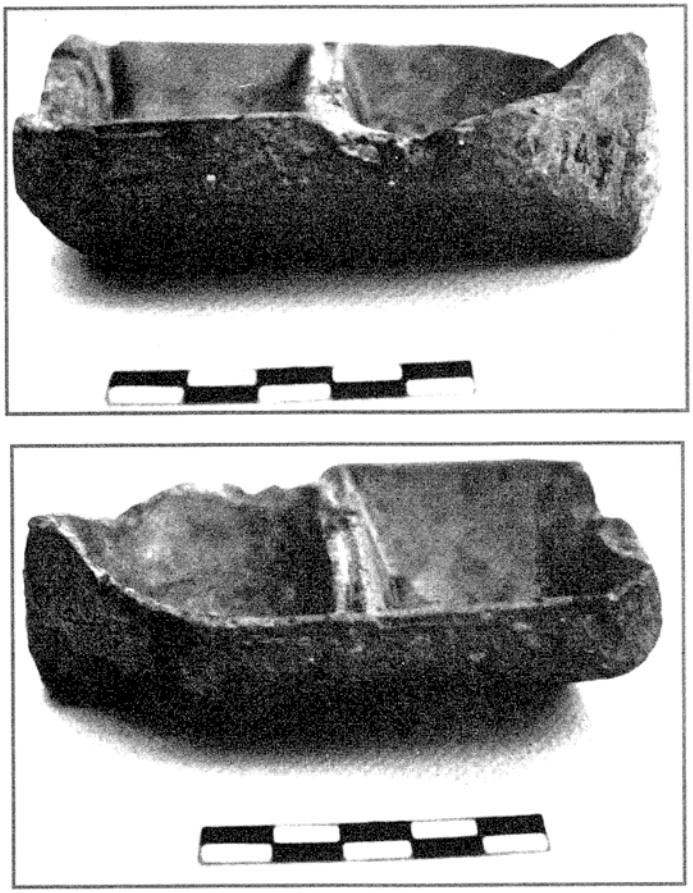

Fig. 7-8: Middle Neolithic Tsangli boat model: starboard- and port-side (photographs by the author).

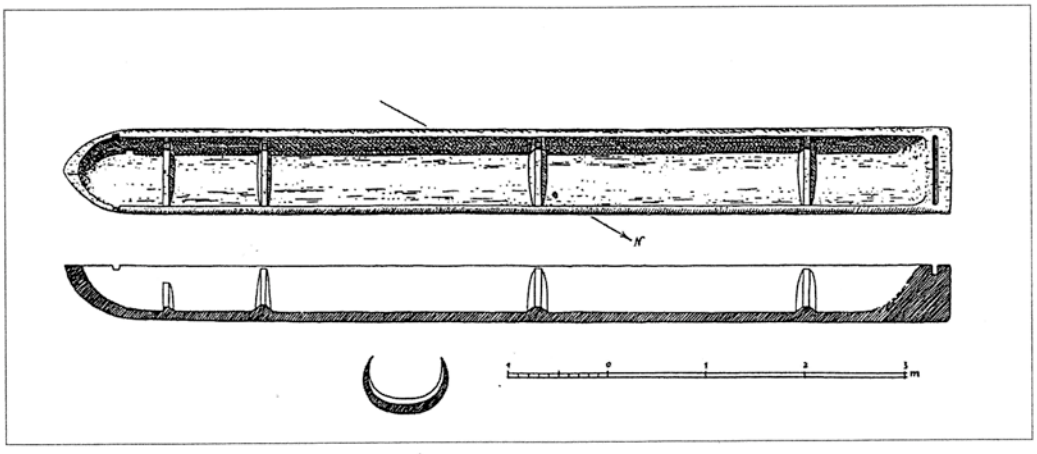

Fig. 9: Neolithic dugout with inner partition from Federsee (after PARET 1930: 79, fig. 2).

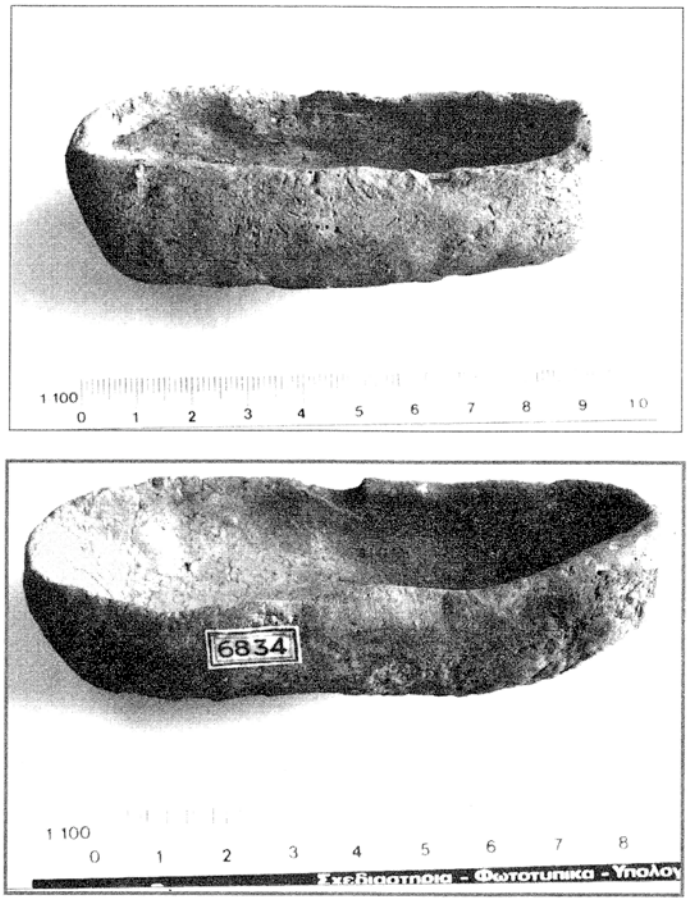

Fig. 10-11: Early Bronze Age clay dugout models from Troy (Berlin, Museum fuer Vor- und Fruehgeschichte; photographs by the author).

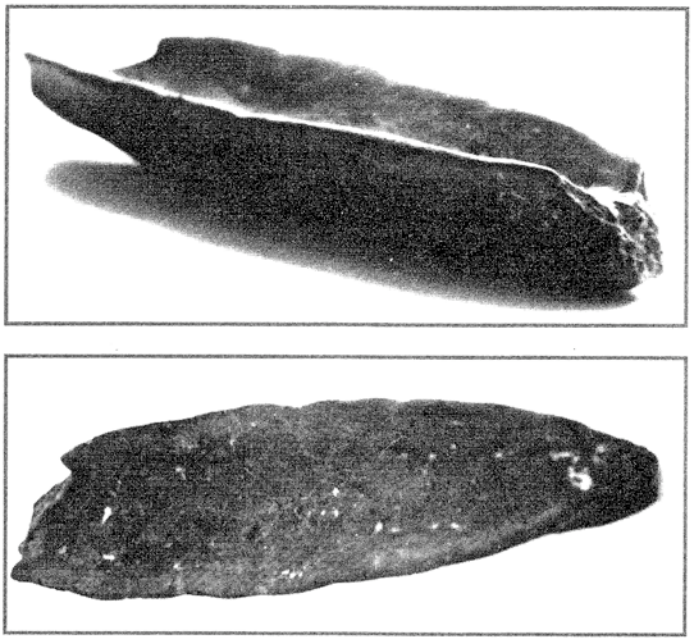

Fig. 12-13: Early Bronze Age complex boat type from Thermi (Lesbos) (Mytilini Museum; photographs by the author).