LESSONS FROM THE TRIALS OF OLYMPIAS

When I submitted a summary of this paper I was intending to discuss a number of lessons which might be drawn from the Greek and British Trials of *Olympias* in 1987 and 1988. But, as the Mock Turtle in *Alice in Wonderland* observed, lessons are so called because they lessen every day. And so it has turned out.

It seems now to be accepted by nearly everyone that the trieres as reconstructed in *Olympias* is no Adventure Playground toy, as the 1987 article review in the *Mariner's Mirror* suggested it was, but a serious essay in experimental archaeology, an oared ship which works satisfactorily but not perfectly. And in the BAR International Series Report 486 (May 1989) we have made abundantly clear where the imperfections lie.

The 1987 *MM* reviewer made two reservations which may be briefly mentioned. The first was that we had assumed the length of the ship from the length of the Zea shipsheds whose lower end had not been properly surveyed. That is not the case. The length of the Zea shipsheds is a good rough guide, but the true length of the ship is determined by the length of the "engine room" ie. the fore-and-aft files of oarsmen, the longest of which is the thranite file of thirty-one oarsmen, and the basic unit of the file is the distance between one tholepin and the next, the "room" or *interscalmium* which I shall discuss later.

The second reservation which the reviewer made was that the oars were wrongly assumed to be of the same length in any one part of the ship. He argued that the oars are shown by epigraphical evidence to be distinguishable by sight, and that this must mean by length. The argument is plainly unacceptable, since there are several other ways by which they could be distinguished, e.g. marking, colour, and the shape of the blade. The last is actually required on practical grounds.

The most powerful, and at the same time the most elementary, argument for the oars of the trieres to be, where possible, of the same length is that the aim of the designer of the trieres must have been in antiquity, as it is now, to produce a ship which would make optimal use of the manpower available. Consequently the naval architect would take, at the outset of his design, oars of a length which fitted the physique of the average contemporary oarsman, and only depart from the length for very good reason. In the 4th century BC 9½ cubits seems to have been adjudged the optimal length and all the oars were made of that length except those at bow and stern where there was a good reason, the converging hull, for a small reduction of the loom (for which in fact Aristotle and Galen provide evidence).

If we had had no epigraphical or literary evidence, we should have reached the same conclusion, starting with the oars of length suitable for the average human physique and only departing from that length in the parts of the ship where shorter looms were necessary.

More cogent perhaps than both the theoretical arguments for the oarsystem adopted in *Olympias* is the sight of her in action under oar, as the video will remind you. There is still a lot of fine tuning to be done if the high speeds and endurance attested in antiquity are to be achieved. But I do not think that there can be any doubt that the system itself, embodying equality of oarlength in any one part of the ship, is the one used (in the reviewer's words) by "the trireme that was the glory of Athens".

Two things are needed before a trieres reconstructed on the design of Olympias can reach the higher levels of performance attested in antiquity, both acceleration in battle conditions and endurance at a high average speed on voyage. They are:

1 lighter oars of an improved design and

2 a longer stroke. The former is achievable when funds are avilable, the latter needs further investigation to which I shall devote the rest of this paper, since it now appears to be the most important point to have emerged from the trials.

The long stroke, on which speed, and probably endurance as well, has in the trials been seen to depend, was there inhibited by various factors, in particular by the thalamians' lack of room between the thwart at the back of their heads as they lean backwards in the stroke and the thwart in front of their foreheads as they lean forward. The stroke of the other oarsmen can plainly be no longer than the stroke of the thalamians. So that this inhibition affects the stroke as a whole.

There seems to be no obvious remedy for this state of affairs. The thalamians' seats cannot be set more than a very little lower. The thwarts (*zuga*) cannot be removed or reduced in thickness since they are vital to the structure of a hull which has no real deck. Further, the zygians' seats are on them (hence the name), so that they cannot be set significantly higher without upsetting the oarsystem and disturbing the equilibrium of the ship.

The distance between one thwart and the next, the shortness of which causes the trouble, is determined by the passage in Vitruvius. He wrote in Latin on architecture at the beginning of the last quarter of the first century BC in Rome. He says (1 2 4): [In] ships the working-out of harmonius designs (*symmetriarum ratiocinatio*) is found to derive [from] the *interscalmium* [i.e. the space between the tholepins (Gk. *skalmoi*)] which is called +*dipheciaca*+. In the same way the working out of the design of other manufactured things (*opera*) is found to depend on certain parts (*membra*).

In this passage the words (in) and (from) have to be supplied since the text is corrupt; and *dipheciaca* has been recognised as a corruption of a Greek word in Latin form which does not occur elsewhere, *dipechiaca* (Gk. *dipechiake* fem.sing. or *dipechiaka* neuter plural), with the meaning of "something (singular or plural) two cubits long". ("*Dipechus*" (of two cubits) occurs in Herodotus). Similar words of nautical slang are *thalamax, stuppax* in Aristophanes, and *ta biacha,* "the works" i.e. the ram, in Polybius.

That *interscalmium,* itself a mixture of Latin and Greek, should have a Greek equivalent is not surprising in view of the contemporary bilingual label of the Alba Fucentia graffito, *navis tetreris longa*. Most of Rome's *socii navales,* who manned her fleet, were probably Greek speaking, but the Greek word *dipechiake* is likely to derive not from them but from the shipbuilders, Sicilian or mainland Greek, from whom the Romans learnt how to build their oared warships. If that is the case, it is not surprising that the word does not turn up in Greek literature (the ship Odysseus is described as building in the Odyssey was a broad merchantman), since the shipbuilding tradition is otherwise entirely oral, and shipbuilding does not feature in comedy, our best source of maritime slang.

If *dipechiake* then belongs to the oral shipbuilding tradition, it may go back a very long way. There is no reason to connect it with triereis only, still less with the bigger ships the Romans used. It may originate with the first oared warships which had files of oarsmen one behind the other on each side of the ship, at the moment when the power/weight ratio became important with the development of the ram, and the minimum possible distance between one oarsman and the next began to be recognised as the crucial design feature and be given a name declaring that minimum distance...

This consideration suggests that we must look for the length in modern terms of the *dipechiake,* not in Rome or in Athens of the classical period but in archaic Greece, when the ships depicted on Geometric pottery and on the Dipylon vases, with their fore-and-aft files of oarsmen, were being built.

The length, in modern terms, of the cubit (1 ½ ft) is derived from excavation of buildings of various periods and from stadia. Doerpfeld's excavations on the Acropolis at Athens in the last century revealed the foundations of the earlier temple of Athena which epigraphy showed to have been called the Hecatompedon (i.e. the Hundred Foot Temple), and when the Parthenon was built the name was transferred to its eastern cella. The former was measured as accurately as possible and the length of 33 m established, while the latter measures 32.8 m. The foot accordingly at the early period is to be taken as measuring 33 cm (the Old Attic foot) and slightly less later. The cubit, which is always 1 ½ ft, was accordingly 49.5-49.2 cm. The Old Attic foot is the same as that which lies at the basis of the Aeginetan (and Peloponnesian), and is identical with the Babylonian, measurements of length. From the stadion at Olympia (600 ft) is derived a foot of 32 cm and a cubit of 48 cm and from a stadion at Samos a longer foot of 35 cm and a cubit of 52.5 cm. it is an interesting fact that in the tables attributed to the Alexandrian mathematician Hero the Ionian cubit (52.5 cm) is called "the stonemason's or wood sawyer's cubit", (*lithikos*, *xylopristikos pechus*), indicating the sort of connection with a craft tradition which we have suggested that the term *dipechiake* had with the craft of ship-building.

There seem then to be two candidates for the cubit of the *dipechiake* either the Old Attic cubit of 49.5 cm or the Ionian, wood-sawyer's cubit of 52.5 cm. The first would give our cramped *thalamians* 10 cm, and the second give them 16.2 cm, more room. They would be grateful for either. A longer *dipechiake* would of course bring with it a longer "engine room" and hence a longer ship. In the case of the Old Attic cubit the additional length would be 3.1 m and in the case of the Ionian cubit 5.2 m. The overall length of a reconstruction on the lines of Olympias in the former case would increase to about 40 m, making longitudinal bending strength an even more critical matter. In the latter case the length would increase by another two metres making it a more doubtful possibility both from a practical point of view (viz. the trieres' length) and in view of the Zea shipsheds).

The trials seem to have directed attention to a point no one would have been likely to think of without the direct experience of rowing *Olympias.* The logic is cogent. The ship cannot achieve her proper speed without a longer stroke at all levels, but that is not possible unless the thalamians are given room to swing their bodies a few inches further back and further forward. This additional room could only be provided by evaluating the two cubit "room" more generously. There is some ground for thinking that the term, *dipechiake*, expressing the basic element in the design of oared warships, may go back to the period of warship construction when the Old Attic foot was in use. Employment of the Old Attic foot would increase the "room" by 100 mm and the total length of the ship by about 3 m. The thalamians stroke would be 10 cm longer at the cost of making the longitudinal bending strength of the ship more critical. The measurements recorded there would have been certainly in the cubits employed in contemporary Athens. The uncertainty as to the precise length of the slipway of the Zea shipsherds removes any objection on their account to 3m of additional length for the ships they were built to house.

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