

PORTAGE OF SHIPS ACROSS THE ISTHMUS

Whether or not the ancients hauled merchant ships (ὀλκάδες)¹ over the Isthmus is a question that probably never will be answered satisfactorily. A note published by R. M. Cook puts the evidence succinctly in line. Among the more important points Cook makes are that the *Diolkos* was used primarily for commercial traffic, that Strabo's πορθμεῖα may have been particular types of transportable vessel, that the *Diolkos* was probably not a commercial success, that potential of damage from stress prohibited transport of loaded vessels and that vessels, if carried, would have moved separately from their cargo. Most importantly, Cook observes that a ship's weight was the critical factor.² In another note, B. R. MacDonald doubts that ships were carried at all and that the *Diolkos* was used for the heaviest cargoes, namely marble and timber.³ Cook's latest thoughts concentrate on the cost of transport and the advantages of a paved track over an earthen road.⁴ Although I cannot concur with all of Cook's conjectures, I will try to elaborate on his discussion.

The Isthmus is a narrow neck of land, about 6 kms. across between the Greek mainland and the Peloponnese and rises to a minimum of 80 m. above sea level at its crest. The *Diolkos*, the paved road way which in antiquity described a serpentine path as it exploited the shallowest grade over the Isthmus, cannot have been longer than 8 kms and its average grade, therefore, was in the range of 1:38 (2.7%) to 1:50 (2%). Excavated portions of the *Diolkos* reveal it to have been built early in the 6th century and plausibly the work of the tyrant Periander. The width of the built surface ranges, along the 450 m. excavated, between 3.6 and 6.0 m. It is scored by the wheels of transport vehicles whose wheelbase averaged 1.5 m. across. On either side of the paved portion were earthen roads.⁵

Historical sources mention five successful and one unsuccessful attempt, by naval forces, to portage warships over the Isthmus between 428 and 30 B.C.⁶ Niketas Oryphas, revealing his familiarity with ancient literature, effected a sixth crossing in A.D. 881.⁷ The question that arises is: were the admirals commemorated by historians for their enterprise or for their achievement of the commonplace? The answer, surely, is both. The admirals accomplished a manoeuvre infrequently performed but of great military advantage. On the other hand, small vessels were regularly treated in this fashion for profit by a large group of Corinthian minor entrepreneurs: ox drivers and small shipowners.

In considering the question whether ships were moved across the *Diolkos*, Aristophanes' use, as a simile, of the Corinthians' frequent portage of ships should not be neglected;⁸ for if ships were only rarely or never transported, there would be no humour in his lines. Still less should the explicit testimony of Pliny and Strabo be ignored.⁹ If Strabo's use of *υπερνεωλκουσιν* refers to merchant ships (*ολκας*) or trolleys used for moving ships (*ολκουσιν*), the conclusion that vessels were regularly moved on the *Diolkos* is inescapable. It is evident that these vessels were not large and that weight, as Cook rightly observes, must have been the overriding consideration.

A recent reconstruction of a replica of a trireme, a vessel designed to be beached or hauled up shipways, and occasionally carried over great distances, permits us to estimate the upper weight level that on five attested occasions was transported over the *Diolkos*. The trireme *Olympias*, reconstructed by J. S. Morrison and J. F. Coates, measures 37 by 5.5 m. Her displacement in the water, fully equipped and manned, is in the range of 45 tonnes and when beached and stripped of crew and equipment, but still carrying ballast, she weighs 26 tonnes.¹⁰ If in 217 B.C. Philip's slightly larger vessels were sent around Cape Malia because they were too large to be portaged, then the triremes were close to the upper level to weight tolerance.¹¹

A number of Greek and Roman trading ships have been recovered by archaeological means. The excavated remains suggest that merchant vessels were deep and broad in relation to their length and resembled the modern *perama*.¹² Archaeological and epigraphic data show that the largest cargo ships rarely exceeded 1000 tonnes capacity, that the average ship carried only about 130 tonnes and that ships up to 200 to 350 tons were unremarkable. A second class of vessel is represented by a find on the shore of the sea of Galilee. The 1st century a.C. Kinnaret boat is not only smaller in all respects, but is flat bottomed and tapers towards the stern, unlike the larger merchantmen. The boat had no deck and is considered to have been a fishing vessel, but is of a size and shape used in the Late Medieval period for transport and trade on internal waterways and for short-haul sea ventures.¹³ A better idea of size and weight of various small cargo ships can be gained from the following table:¹⁴

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Ship	L (Metres)	W	Total	Load (Tonnes)	Weight
WAR					
Olympias	37	5.5	45	19	26
CARGO					
Antikythira	30?	10?	130?	100?	30
Yassi Ada	20	5	72	52	20
Serce Liman	15	5	43	28	15
Kyrenia	15	4.5	41?	26?	15?
SMALLER VESSELS					
Kinnaret	9	2.5	20	10	10

The unloaded weight of the smaller cargo vessels in most cases is well within the limits for hauling suggested above; conceivably vessels the size of the Yassi Ada wreck and smaller could have been transported empty with little difficulty. Large fully laden cargo ships cannot have been transported, for all except the very smallest were too heavy. The stresses, not only on the walls of the vessel but also on the trolley carrying it would have been massive. Furthermore, any attempt to move a broad vessel (5-10m.), on a narrow cart (1.5 m.) would result in a top-heavy load courting a potentially expensive disaster. On the other hand, small, simply-rigged coasters of the size of the Kinnaret boat, which were perfectly suited to short haul Aegean voyages, fall well within the transportable range even when carrying a full cargo. The Kinnaret boat has a beam dimension (2.5 m.) that would have fit neatly on a trolley with a 1.5 m. wheelbase. Its estimated loaded weight (20 tons) manageable on the *Diolkos* if carefully laden to avoid structural damage. Strabo's πορθμεῖα may well have been barges or boats of similar size and weight to the Kinnaret boat.

Let us digress to consider land transport of goods. Most if not all commercial loads were hauled on a waggon by oxen or carried in panniers by mules or donkeys. Pulling a load, oxen could work for 5 hours a day covering between 7 and 11 miles.¹⁵ Traditional wisdom considers the ancient ox to have been smaller than the modern and that on a level earth road a yoke could pull in the range of 0.6 tonnes. On a paved road, the friction was considerably reduced permitting a corresponding increase in load; it is estimated that the load drawn by a team of horses increases from between 0.6 tonnes on an unimproved road to 2 tonnes

on a metallised surface. Reasonably, a pair of oxen on the hard surface of the *Diolkos* could be expected to haul a comparable load.¹⁶ The Olympias would therefore have required as few as 13 yokes of oxen when empty, the Yassi Ada 10 yokes and the Kinnaret 5 yokes.

Except in dead calm, unloading at the termini of the *Diolkos* would, at best, have been awkward in a light swell and impossible in a heavy sea. No trace of breakwaters, which would have mitigated this process, have been found at either end of the *Diolkos*. As has already been observed by a number of commentators, cargoes were unloaded at Lechaeum and Kenchreai. Merchandise due for inland markets within the hinterland of the port were taken off by ox-cart and pack animal, probably in loads of less than one tonne. However, it is difficult to envisage whole cargoes being transported by road to the port on the other gulf. On an earth road, a 52 tonne cargo of wine amphoras would involve in the region of 90 cartloads. If taken from Lechaeum to Kenchreai, this train would first have to move southwards until it arrived at the coast road near the walls of Corinth before turning east. The trip takes almost three hours on foot, by loaded waggon the journey would be closer to five; a full day's work for the animals which would then need food, water and stabling. If the ports of Corinth were as busy as one suspects, the transshipment by this means would have involved hundreds of carts and oxen and add considerably to the cost of a cargo, especially given the expense of land relative to sea transport.¹⁷

A pair of alternate solutions present themselves: the cargo could be transferred at one of the major ports to lighters or barges of the size of the Kinnaret vessel which would then sail to the *Diolkos*, be hauled across and from there either proceed to the opposite shore and be reloaded or act as the carrier to the cargo's ultimate destination or smaller ships could be unloaded at the terminus of the *Diolkos* on a calm day and be hauled separately from their cargo. In the first instance, the haulage, on a low friction surface, of the same cargo of 52 tonnes of wine would perhaps require as few as 50 yokes of oxen which would take only about two hours for the job and have more than enough time for a return trip. In the second case, the requirement would be fewer yokes still, involving only about 35 yokes for cargo and ship.

The financial advantage of the *Diolkos* is easily demonstrated. If one assumes, as does Cook, a set charge of 1.5 Drs per ton per mile,¹⁸ then the tariff for haulage over the 4.34 miles of the Isthmus would be little over half that to take it between Lechaeum and Kenchreai. If the charge was set at so much per yoke per day,¹⁹ the efficiency differential of low over high friction roads would increase the ratio

to nearly 1:6. This advantage would be of great benefit to the traders in bulky but low priced commodities like timber, but less so those dealing in small but expensive items like truffles or perfume.

In conclusion, it is possible to envisage transport of smaller vessels and their cargoes over the Isthmus on a regular basis making the haulage business at Corinth a profitable one. The *Diolkos* was certainly used enough to be repaired and maintained; the western terminus was rebuilt early in the 4th century and the paved surface shows areas patched with spolia perhaps from the sanctuary at Isthmia.²⁰ The only constraint, however, is the size of vessel.

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NOTES

1. Ὀλκός, -άδος, ἡ. see Hdt. 3.135, 7.25, 137; Thuc. 6.44, 7.7; Xen. *Ath.* 1.20.
2. R. M. Cook, *JHS* xcix (1979) 152-3.
3. B. R. MacDonald, *JHS* cvi (1986) 191-5.
4. R. M. Cook, "A Further Note on the Diolkos", in *Studies in Honour of T. B. L. Webster, I* 1986 65-7.
5. N. M. Verdelis, *Ath. Mitt.*, lxxi (1956) 51-59; *idem. Ath. Mitt.* lxxiii (1958); *idem. Praktika* (1962) 136-141; *idem. Praktika* (1962) 48-50; *idem. ILN* ccxxxi (19 Oct. 1957) 650; J. Wiseman, *The Land of the Ancient Corinthians* (Göteborg 1978) 45-6. The road was excavated by Verdelis who uncovered two stretches at its westward end. On the south side of the canal a docking area, now much eroded, was found along with about 250 m. of paved road. On the north side, within the army camp, a further 200 m. was excavated. The road varies in width from 3.6 to 6.0 m. Traffic on the paved portion was clearly one-way, but counter flow traffic could occupy the earthen road on either side.
6. Thuc. viii 7-8; Polybios iv 19.77-9; Polybios v 101.4; Corinth viii 2 31; Dio Cassio Li 5.2.
7. George Phrantzes 1.33.
8. Aristophanes, *Thesm* 647-8. "ἰσθμόν τιν' ἔχεις, ὠνθοροπ' ἄνω τε καὶ κάτω τὸ πέος διέλκεις πυκνότερον Κορινθίων".
9. Strabo 8.2.1 "ὁ δ' ἰσθμός κατὰ τὸν δίοικον δι' οὗ τὰ πορθμεῖα ὑπερνεωλοῦσιν ἀπὸ τῆς ἐτέρας εἰς τὴν ἐτέραν θάλατταν". Pliny, *NH* IV.10 "Corinthiacus hinc, illinc Saronicus appellatur sinus, Leceae hinc, Cenchreae illinc angustiarum termini, longo et ancipiti navium ambitu quas magnitudo plaustris transvehi prohibet.
10. J. S. Morrison and J. F. Coates, *An Athenian Trireme Reconstructed*, 1989, 20, 68.
11. Cook, *JHS* n. 16.
12. P. Throckmorton, "Romans on the Sea" in G. Bass ed. *A History of Seafaring*, London 1972, 65-86.
13. M. Bonino, "Lanteen Rigged Medieval Ships. New Evidence from Wrecks in the Po Delta (Italy) and Notes on Pictorial and Other Documents" *IJNA* 7 (1978) 9-28 for the Logonovo boat;

14. J. S. Morrison; Kyrenia; P. Throckmorton for the Antikythera ship; J. R. Steffy "Reconstruction of the 11th century Serce Liman Vessel" *JNA* 11 (1982) 13-24 this ship is estimated to have weighed 15 tonnes without cargo; *idem*. "The Kinneret Boat Project II. Notes on the Construction of the Kinneret Boat", *JNA* 16 (1987) 325-9; G. F. Bass and F. H. von Doorninck, *Yassi Ada I* 1982 p. 86.
15. A. Burford, "Heavy Transport in Classical Antiquity", *Economic History Review* 13 (1960) p. 9.
16. A. W. Skempton, "Canals and River Navigation before 1750" in Singer, G. *et. al. A History of Technology* 1957, 438-470; P. S. Bagwell, *The Transport Revolution from 1770*, 1974, p. 13. These figures are similar to those cited by Cooks' advisors, R. M. Cook, "A Further Note" n. 13.
17. R. Duncan Jones, *The Economy of the Roman Empire*, 1982, 366-9 puts the relative cost at 28:1.
18. Cook takes his charges from Burford p. 15.
19. See Burford, p. 14 for a table of charges based on *IG* ii2 1673.
20. Wiseman, pp. 45-6.