THE CANAL OF XERXES: FACTS AND PROBLEMS

(PLATE 4)

When Xerxes prepared for the invasion of Greece, he could draw not only on the impressive wealth and manpower which his Empire afforded but also, where special problems required it, on the considerable expertise available to him. The construction of a bridge across the Hellespont, and the digging of a ship canal across the Mount Athos peninsula at its narrowest point involved the use of all these resources. The bridge has long gone, but traces of the canal can still be seen on the isthmus between Nea Roda on the northern and Tripiti on the southern shore, in the narrowest section of the Mount Athos peninsula. It represents not only the most impressive surviving monument of Persia's short-lived imperial presence in Europe, but also one of the most important pieces of ancient marine communication engineering anywhere. That it should have attracted the attention of classical writers from Herodotus onwards, and of scholars and travellers in more recent times, is not surprising. It is however remarkable that modern archaeological research has passed it by completely. Yet there are not many cases where a detailed technical report from ancient times could be so fruitfully linked with modern methods of investigation – providing, incidentally, a useful test case for the much discussed veracity of Herodotus.

To obtain information about the canal, three lines of evidence are available to us. There are, firstly, statements by classical writers, especially by Herodotus (VII, 22–24, 37, 122);[1] secondly, reports by more recent visitors, including the one by Col. Leake[2] who visited the site in 1806, and more in particular the description accompanied by a survey map, offered by Choiseul-Gouffier[3] (who discusses what he saw in 1766) and the detailed account and plan published by Spratt; this latter represents the state of things encountered by him in 1838, when he was detailed by Commander Graves of H.M.S. Beacon, in which he was then serving as a lieutenant, to measure across the isthmus of Mount Athos at the spot where the canal was cut by Xerxes.[4] Lastly, there is the testimony offered by ocular inspection now, and by air photos of various quality and date: detailed maps of the canal zone by the Greek authorities are in preparation but are not yet available.

The reasons which impelled Xerxes to order the digging of the canal was, we are told, his desire to avoid a repetition of the disaster which struck the Persian fleet led by Mardonius when it tried to round the Mount Athos headland in 492 B.C. Sailing around this headland has indeed remained a potentially dangerous operation for small craft, particularly since adverse winds and currents may prevail during considerable parts of the year. Both Choiseuil-Gouffier and Leake refer to this fact; indeed the latter reports that he

[1] For a list of classical and later authorities who have referred to our subject see E. Oberhummer in *RE* II (Stuttgart, 1896), col. 2067.

[2] W.M. Leake, *Travels in Greece* I–IV (London, 1835; reprinted Amsterdam, 1967).

[3] M.G.A.P. de Choiseul-Gouffier, *Voyage pittoresque en Grèce* I, II (Paris, 1782, 1809).

[4] T. Spratt, 'Remarks on the Isthmus of Mount Athos', *Journal of the Royal Geographical Society* 17 (1847), 145–50.

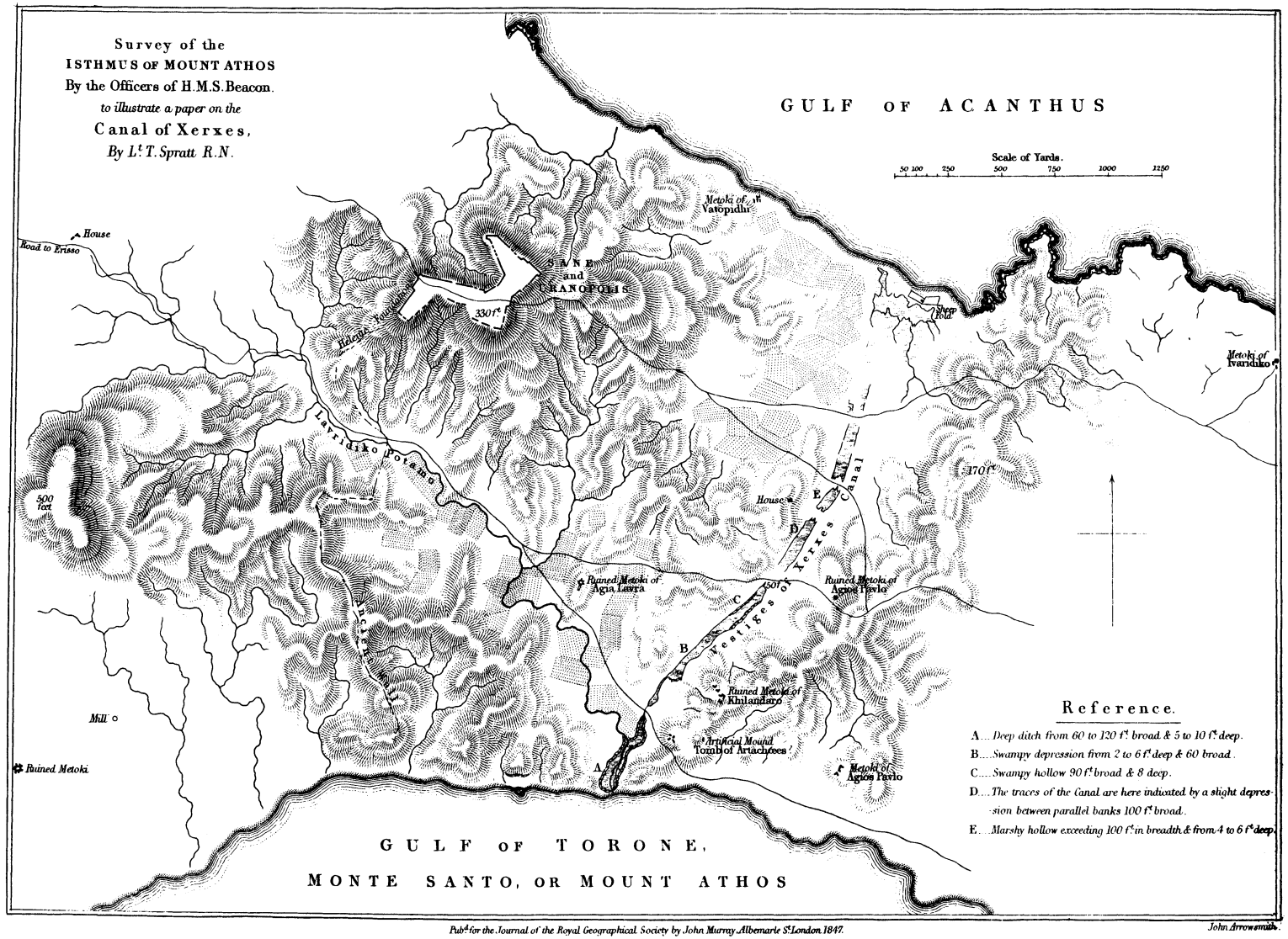

FIG. 1. Map of the Isthmus of Mount Athos accompanying T. Spratt's article (reproduced by kind permission of the Librarian of the Royal Geographical Society).

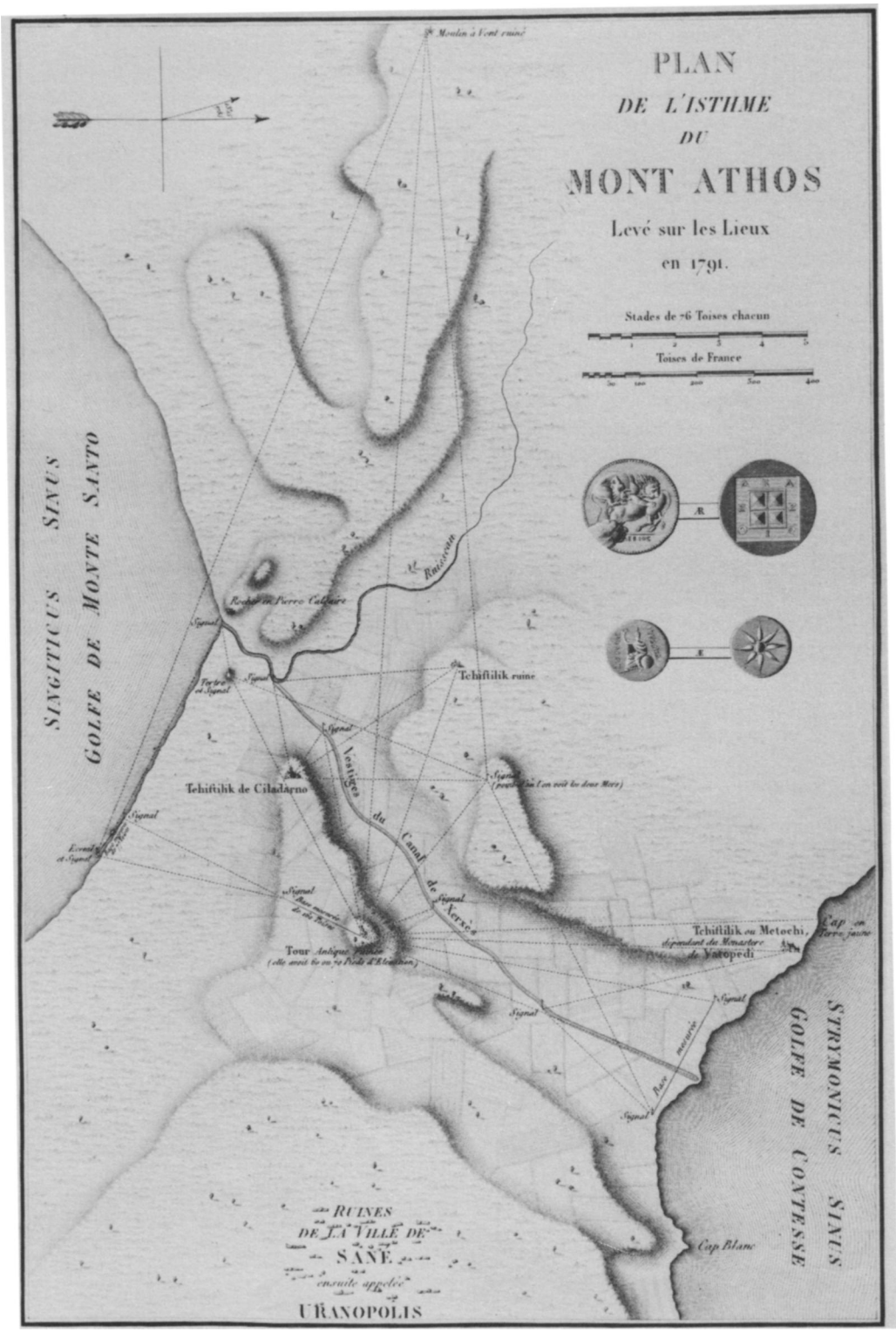

FIG. 2. Map of the Isthmus of Mount Athos included in Choiseul-Gouffier's *Voyage pittoresque en Grèce* (reproduced by courtesy of the Director and Librarian, the John Rylands University Library of Manchester).

could not prevail on any boat to carry him from the eastern side of the peninsula to the western, though he offered a high price.[5] The decision to construct the canal has indeed been questioned on technical grounds: Herodotus (VII, 24) thought the ships of the Persian fleet might just as well have been dragged across the Isthmus, and more recently it has been suggested by F. Montevecchi that the fleet could have rounded the cape in small groups, if captains had been allowed to choose times when conditions seemed, in their judgment, to be favourable.[6] Yet Choiseuil-Gouffier remarked long ago that dragging even single ships overland was a slow operation, and waiting for propitious weather conditions might have imposed very long delays: neither method was suitable, then, for the rapid movement of a large fleet working in a combined operation with the army – an operation which might, moreover, have had to be repeated.[7] The alleged striving by Xerxes to leave a permanent monument to his imperial glory, adduced as a motive by Herodotus and other classical writers, might indeed have been a factor in his decision; overawing the peoples in invaded regions by works of incredible scope and efficiency would have served as a useful tool of psychological warfare and imperial propaganda.

Concerning the course and dimensions of the canal, Herodotus – our main written source – offers some guidance. Its length was twelve *stadia* overall – ca. 2200–2300 m, depending on the *pous* underlying Herodotus' report.[8] Since the actual distance between the northern and southern shores of the isthmus is ca. 2000 m, and since the canal follows a somewhat oblique course and moreover curves somewhat, this estimate is not too far from the truth (larger figures given by other classical writers like Pliny (*Natural History* iv, 32) or by Skymnus (*Periegesis*, 648) are less correct: but the total length of eleven stadia, implied by Demetrius of Skepsis, preserved in Strabo's *Geography* (VII, fr. 35) may, on the other hand, represent a reasonable alternative reckoning. Herodotus gives no figure for the width of the canal, but he does state it was wide enough for two triremes to proceed along it side by side. Since, according to the recent reconstruction by Morrison and Coates a trireme with oars out occupies ca. 10 m of space laterally,[9] a width of water of ca. 30 m might just be sufficient for two triremes to be rowed side by side, though Montevecchi – a former naval captain – estimated at least 35 m would be needed.[10] If the width was less than 30 m the ships would almost certainly have had to be dragged along side by side with oars shipped (which would have required the existence of a tow path).[11] A direct statement concerning the width of the canal is however given by Demetrius of Skepsis as quoted in Strabo's *Geography* (VII, fr. 35). He mentions a width of one *plethron* (ca. 27–35 m, depending again on the length of the foot used).[12] Herodotus also does not say how deep the canal was, but some guidance may be extracted from his report, indirectly. He states (VII, 23) that men standing next to those who dug the canal bed handed on the loose earth to others positioned one step up on the canal side, and these in turn passed the soil to yet others placed one step higher still, from whom workmen standing on the original land

[5] W.M. Leake, *op. cit.* (n. 1), III, 145; cf. Choiseul-Gouffier, *op. cit.* (n. 2), II, 147.

[6] F. Montevecchi, 'A proposito di alcune burrasche e disastri navali avvenuti in Mediterranceo nell' antichità', in M. Sordi (ed.) *Fenomeni naturali e avvenimenti storici nell' antichità. Contributi dell' Istituto di storia anticha, XV. Università Cattolica del Sacro Cuore* (Milano, 1989), 22–34. esp. 24.

[7] Cf. Choiseul-Gouffier, *op. cit.*, II, 146–7 with reference to Herodotus VII, 22.

[8] *Der Kleine Pauly* V (München, 1976), 334–6 *s.v. Stadion* (O.W. Reinmuth).

[9] Cf. J.S. Morrison and J.F. Coates, *The Athenian Trireme* (Cambridge, 1987), 199, fig. 57.

[10] F. Montevecchi, *op. cit.* (n. 6), 25.

[11] Dragging is assumed by Choiseul-Gouffier, *op. cit.* II, 149.

[12] *Der Kleine Pauly* IV (München, 1982), 927 *s.v. Plethron* (H. Chantraine).

surface received the earth and carried it away. Since each lifting operation would probably involve a height of ca. 1–1.50 m – more would tire out the labourers after a time and thus be counterproductive – the total height of the canal bed would, by such a reckoning, have been ca. 3–4.50 m. One may also attack the problem from another direction, again on the basis of what Herodotus reports. According to him, in the section of the canal whose construction was assigned to the Phoenicians, the sides were made to slope in such a way that the width at the top was twice that at the bottom. If the top width was in the region of 30 m and that at the bottom accordingly something like 15 m, then, if slopes descending at an angle of ca. 45° are assumed,[13] the depth would have been no less than ca. 7.5 m. This seems rather much, but the sides may well have descended at a lesser angle. Some important recent canals have slope angles of ca. 20–30°, and the angle of the western down slope of the Phoenician built Cothon canal at Motya, near its junction with the basin where it is not flanked by quay walls, is only just 20°, with a ratio of base to height of ca. 3:1.[14] If the relation of the angles of slope in the canal of Xerxes were within anything like this range, then we should arrive at a height of 2.5–4.5 m, perhaps ca. 3–3.5 m. This is fairly similar to our first figure, and we shall in fact meet indications that the depth may have been near 3 m below. Other recent and older estimates are not far from this: Montevecchi assumes a total depth of 4 m (2 m above and 2 m below water);[15] Choiseul-Gouffier suggests the canal had a bottom width of 60 ft (ca. 20 m), sides sloping at 45° angle, a top width of 90 ft (ca. 30 m), the depth of water being 12 ft (ca. 4 m) with an additional height of 3 ft (ca. 1 m) above water level, thus making a total depth of 15 ft (ca. 5 m).[16]

There remains the question, raised by Demetrius of Skepsis and echoed by some classical and more recent writers, whether the canal was indeed dug right across the isthmus. Demetrius (whose statement apparently reflects some knowledge of local conditions) says that for a distance of ten stadia the soil was soft and workable, and here a canal had indeed been dug; but thereafter a rocky plateau one stadium in length made it impossible to dig a canal of the depth required by ships, right to the sea. We shall come back to this matter below.

We must next turn our attention to the more recent descriptions by Choiseul-Gouffier, Leake, and Spratt. The basic picture offered by them is that of a somewhat curved line of traces indicating the former presence of the canal bed, along a slight natural declivity filled with soft soil between hillocks, which extends across most of the Isthmus. In this reach, the ground rises only little above sea level – and digging the canal would have been easy, though the friable sandy and marly soil would also have had a tendency to cave in and to slip off the sides of any vertical cuts. This agrees with what we are told by Herodotus (VII, 23) concerning what happened in the sectors excavated by contingents of workmen drafted from various nations lacking the expertise of the Phoenicians who slanted their canal sides. The width of the canal was, according to Leake, no more than 60 ft (ca. 20 m); Spratt says the width varied from 60 to 90 ft (20–30 m) in a succession of swampy hollows from 2 to 8 ft (0.6–2.4 m) deep.[17]

[13] As by Choiseul-Gouffier, *op. cit.*, 150.

[14] Cf., in general, L.F. Vernon Hacourt, *A Treatise on Rivers and Canals* (Oxford, 1882), I, 153–201, *passim*; II, pl. 11, figs. 2, 3, 4; pl. 12, figs. 3, 4. On Motya see for the moment B.S.J. Isserlin, 'New Light on the Cothon at Motya', *Antiquity* 45 (1971), 178–86 and fig. 7. Fuller details are to appear in *Motya III* later.

[15] F. Montevecchi, *op. cit.*, 24.

[16] Choiseul-Gouffier, *op. cit.*, II, 150.

[17] W.M. Leake, *op. cit.* III, 144; T. Spratt, *op. cit.*, 147.

The northern and southern ends of the canal present special problems. To the north, traces of the canal are lost on Spratt's map where it enters a small plain, some 600 m from the coast, though its course, if prolonged, would have met the sea near the eastern limit of the present village of Nea Rodi (cf. FIG. 1). Choiseul-Gouffier's map, drawn by M. de Chanaleilles and M. Racord in 1791 does indeed indicate its presence thereabouts by two straight lines (cf. FIG. 2). However this presents a difficulty, for near the coast Spratt observed, and mapped, a marshy lagoon, which seemed to occupy the position of the mouth of the canal.[18] Leake likewise referred to it as a large pond, divided from the sea only by a narrow ridge of sand. He noticed on both sides of it foundations of what he called 'Hellenic walls', those to the west close to its edge and to the sea beach, but those to the east some little distance away; such walling was also traceable parallel to the beach for some distance northwestwards in the direction of Vatopedhino.[19] There is no trace of this feature on Choiseul-Gouffier's map. It seems unlikely it came into existence in the comparatively short time between his, and Leake's visit; more likely it was omitted from his map as unimportant. One may wonder how long this marshy lagoon had been there. It could be linked with a rise in sea level since antiquity, which would of course need to be established on other grounds. If it did exist earlier, it might represent the remains of a harbour basin or 'lay-by' which would have been very useful to ships awaiting their turn to go through the canal in sheltered conditions. The matter cannot be decided without archaeological investigation.

Conditions at the southern end of the canal likewise require some special observations. Here, for the last 200 m or so, the ground level is considerably higher, being part of a belt of raised ground which is dissected transversally by the entrenched valley of a small river descending from the neighbourhood of Ierissos. This river – whose bed was adapted to serve as the final stretch of the canal – ends, as Spratt noted[20] between two rocky hills, the eastern of which is ca. 155 ft (51 m) high, the other ca. 30 ft (10 m); it here forms a small pool in a ditch or water-course with steep clay banks 10 ft (ca. 3 m) deep and 120 ft (40 m) broad. This ditch, Spratt goes on, 'continues about 100 yards beyond the junction of the watercourse, towards a hollow or depression of the isthmus, through which the canal must have been cut, but there is nothing in this part that would lead a casual observer to suppose that the ditch was more than the natural result of winter torrents flowing from the neighbouring hills; and certainly it shows no connexion with an artificial cut.' Further on, however, the traces of the canal are distinguishable. The reference by Demetrius of Skepsis to high rocky ground into which a canal could not be dug may be related to this general picture, though he or his informant did not indicate the use made hereabouts of the river bed, and the absence of a clear linkage with the main canal excavation may even in his time have given rise to doubt its existence here. We should, however, note the small pool described by Spratt: it seems big enough to serve as a lay-by, like the pool at the northern end of the canal.

We must, finally, say something about the canal as it is now. Our impressions are mostly based on a visit in September, 1989, when the writer spent a week together with his wife viewing the situation, one full day being employed on a detailed study together with Dr R. Jones of the Fitch Laboratory in the British School at Athens. The writer has also

[18] Spratt, *op. cit.*, 147.
[19] Leake, *op. cit.*, III, 144.
[20] Spratt, *op. cit.*, 146–7.

viewed such air photos of the zone as he could: these latter do little except to confirm Spratt's map and statements, concerning the course of the canal.

At the northern end, the lagoon or pool, set in the small plain, seen by Leake and Spratt, has now been filled in, and we could not find the traces of ancient walls noted near it by Leake (cf. PLATE 4a). The chain of swampy hollows formerly marking the middle section of the canal has also vanished, but its former presence is indicated, over part of its course, by a slight depression ca. 30 m across carrying vegetation (including bushes and reeds) different from that found on the adjoining higher ground. (cf. PLATE 4b). We could not see any clear signs of spoil heaps along the canal sides: the earth deposited here will long have been washed back. Near the southern shore of the isthmus, where the course of the canal coincided with the bed of the little river running along a deep trench (cf. PLATE 4c), there are a number of interesting features. The pool noted by Spratt is still there, flanked on its western side by a rocky eminence on which we could not observe any traces of human activity above present water level; to the east, its boundary is lost in a thicket of vegetation (cf. PLATE 4d). The river is separated from the sea by a solid bank of shingle (indicated already on Spratt's map); this may hint at a rise in water level.[21] We could not test the depth of water (10 ft – ca. 3 m) given by Spratt, and it remains an open question whether it corresponds approximately to the original depth of the canal: Spratt seems to have assumed something of the sort, since he claims[22] that, the highest point of the isthmus being 51 ft above sea level, the greatest depth of soil to be cut through to make the canal could not have exceeded 60 ft (implying a depth of 9 ft below sea level). Since we did not have permission to cut our way through the dense vegetation which surrounds the river basin, we could not study the configuration of the ground in detail, including in particular the steep clay banks seen by Spratt. The latter might however repay investigation: if they are not natural, then they would represent a substantial piece of engineering of a kind sometimes employed in more recent times when canal banks need treatment.[23] The ground hereabous, moreover, appears to descend in a series of steps or terraces. These may involve the presence of built-up embankments: Dr Jones noticed a piece of ashlar lying below the path which fringes the river valley on its eastern side here. We did not observe any traces of possible embankment construction anywhere else along the canal.

Of the breakwaters or dykes mentioned by Herodotus (VII, 122) we found no signs either on land or, according to indications on air photos, in the sea, at either end. Whether the walling noticed along the northern shore by Clarke had anything to do with such, is unclear; at the southern end any surviving traces may be buried below the shingle.

Having surveyed, as far as possible, what is known about the canal we now turn to the technical questions raised by its construction, and what an enterprise of the kind and size concerned here may have required in terms of logistics. We may begin by the question approximately how much earth would have had to be dug and moved. Since we do not know the exact length of the canal – did it exclude the pool at its northern end – or its dimensions – were these the same everywhere, or were some parts left with vertical sides and others with sloping sides – only a rather imprecise indication of general magnitude can be given; but this may nevertheless be instructive.

[21] An assessment of possible changes in sea level since antiquity by a competent specialist would obviously be of great interest for our subject.

[22] Spratt, *op. cit.*, 147.

[23] For the application of clay to canal banks see the article by Sir Edward L. Williams in the *Encyclopaedia Britannica* (11th ed.), V (London, 1910), 169, *s.v. Canal*. Clay is here said to provide water proofing.

An estimate was made long ago by Choiseul-Gouffier, who calculated that the digging of the canal would have necessitated the removal of 31,250 cubic *toises*[24] (since a *toise* corresponds to a length of roughly 2 m, this would correspond to 8 × 31,250 = 250,000 cubic metres). Montevecchi, recently, suggested that a canal of a top width of 35 m (which he thought would be required to permit two triremes to be rowed side by side) would have required the removal of 300,000 cubic metres – an estimate not far removed from Choiseul-Gouffier's.[25] Regarding the work force required to achieve this, the latter thought that, since two men in a day could jointly dig one (cubic) *toise* of soil and even if required carry it off for some distance, 62,500 working days were implied: a labour force of 2000 men would then have been able to carry out the work in 30–40 days.[26] However these figures may need some correction. Firstly, Choiseul-Gouffier drew on the experience gained in the construction of the canal linking the Atlantic and the Mediterranean under the direction of P.P. de Riquet. It is not to be assumed that the pressed and unskilled labour force employed in the digging of the Xerxes' canal would have reached the daily output of ca. ½ cubic *toise* per man (ca. 4 cubic metres) achieved by de Riquet's labourers; it may well have been much less, perhaps only half. Digging the canal would have taken accordingly longer, perhaps 60–80 days. Nor would excavation and the removal of earth have been all that was required. The construction of the breakwaters mentioned by Herodotus, perhaps also the quay walls and the covering of the slopes with clay to secure them, and possibly of lay-by basins at the two ends would have been additional tasks requiring man hours. We should probably also assume a rather larger labour force than assumed by Choiseul-Gouffier: as we saw, Herodotus states (VII, 23) that for each man employed in digging there were four others occupied in lifting and carrying away the spoil. It would however probably be excessive to multiply the number of 2000 by five.

Yet even with this our calculations are not yet at an end: and here we come to what is perhaps the most interesting problem, but also the one where at present the picture is totally nebulous. We are talking of the necessary logistic support required to put the labour force to work, and to keep them there for many months on end. We have to think, not only of access roads from wherever the work force was lodged to their places of work, but also of their lodgings themselves. For we must remember that a whole social pyramid was involved: at the top there were two Persian noblemen, Boubares and Artachaies (no doubt with their retinues) directing the work (badly, Choiseul-Gouffier thought, since they did not standardise the canal profile.[27] Below them there must have been task masters, soldiers acting as guards, technicians, craftsmen, traders (we hear of a market) and camp followers. It is not to be assumed that the 'upper crust' would have been satisfied with tent accommodation over many months of sometimes very inclement weather; even for the labour force something more permanent might well have been desirable to prevent the reduction of its active strength through illness or death. One should thus look for remains of permanent or semi-permanent structures ranging from the luxurious to the spartan. None are known at present; possible clues on air photos may prove deceptive unless substantiated on the ground. Additionally, we must remember that, though supplies in grain or flour to feed this large multitude came from Asia, presumably by ship (Herodotus VII, 23), adverse weather was likely to interrupt supplies

[24] Choiseul-Gouffier, *op. cit.*, II, 150.
[25] Montevecchi, *op. cit.*, 25.
[26] Choiseul-Gouffier, *op. cit.*, II, 150.
[27] Choiseul-Gouffier, *op. cit.*, 148.

from time to time. Storage buildings or granaries to obviate crisis during such priods must have seemed desirable. Lastly, Artachaies is unlikely to have been the only person to have died while the canal was being made (Herodotus VII, 117): one must expect burials, and also, incidentally rubbish pits filled with the detritus produced by the living. None are known at present[28] and whether any, or indeed any other indications of the presence of the Persian labour force have survived remains to be discovered. They should be well worth looking for: evidence about workmen's villages from antiquity is scarce. All considered, the total canal enterprise may have taken rather longer to organise and carry through than the time needed for digging the canal bed alone, but the three year period which, Herodotus says, Xerxes took for his preparations seems on the ample side.

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[28] Information kindly provided by Dr Julia Vokotopoulou, the Director of the Museum in Thessalonica.

PLATE 4

(a)

(b)

(c)

(d)

THE CANAL OF XERXES : FACTS AND PROBLEMS

(a) View of the coastal plan near the northern end of the canal, looking east from near Nea Rodi; (b) Patch of vegetation marking the location of the canal bed in the central part of its course; (c) View of the little river at the southern end of the canal where it joins the sea. It is located in the trench fringed by dark vegetation running across the middle of the picture; (d) View of the pool marking the seaward end of the little river used by the canal at its southern end. Note the shingle in the foreground, and the rock marking the end of the western eminence, to the left.

Photographs taken by the author in 1989.