

The Harappan "Port" at Lothal: Another View¹

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with a note by

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Excavations at one of the southern-most sites of the Harappan Culture have revealed a large artificial basin adjacent to the settlement area. This has been interpreted to be a mooring station for merchant vessels and the settlement itself has been considered an entrepôt for trade with Mesopotamia. In this article, the author argues that there is little substantive support for either of these claims. The settlement in general and the basin in particular do not, in the author's view, appear to meet the requirements of a port. As an alternative, he suggests that the basin could have served as an irrigation tank for a moderately-sized but still rural village.

TO anyone concerned with the study of the ancient Orient, the site of Lothal on India's western seaboard has considerable importance. Not only is it the southernmost outlier of the Harappan Civilization to have been thoroughly excavated, thus clearly demonstrating the vast extent of this civilization, but the claim that Lothal was a port settlement with direct trade relations with Mesopotamia has wide implications (Rao 1962 & 1963:179). Nearly half a century of research has unfortunately brought only rather scanty information on the nature of the Harappan economy and, particularly, its commerce. Until the excavation of Lothal, the direct evidence for Harappan maritime activity was limited to two depictions of boats (one on a pottery sherd, the other on a seal) from Mohenjo-daro, and likely as not these represent river craft rather than seaworthy vessels (Mackay 1937:II, plates LXIX:4, LXXXIX:A). Nonetheless, it has reasonably been thought that shipping did play a part in Harappan commerce, even if a doubt remains whether the Harappans themselves went to sea, or rather left the water transport of their merchandise to others (Piggott 1950:210; Wheeler 1960:65).

The recent explorations by Dales (1962) and the earlier researches of Stein (1931), which identified Harappan outposts along

the Makran coast, lend support to the likelihood of sea-trade, and it is in this context of strong presumption but lacking evidence that the discovery of a large basin, interpreted as a dock, at Lothal assumes more than local interest. If the structure can indeed be considered a dock, then the arguments that the *Meluhha*, or perhaps *Dilmun* of Sumerian texts, was Western India gain much in weight (Oppenheim 1954, Kramer 1963)². To some extent, the interpretation of Lothal as a port, and the basin structure as a dock, has already been accepted in archaeological literature (Wheeler 1966:65); and indeed, the excavator of Lothal has claimed to have presented "conclusive proof" that ships were berthed there (Rao 1962 & 1963, Government of India 1959/60:66). Such certainty is rare to archaeology, but this notwithstanding, doubts have been expressed³ so that it seems apposite to view closely the nature of the Lothal site and, more particularly, the basin structure called a "dockyard."

Lothal (from the Gujarati *loth* = dead, hence meaning the same as Mohenjo-daro) is situated near Saragwala village, about fifty miles southwest of Ahmedabad (see Figure 1). It lies in a level plain between the Bhogava and Sabarmati Rivers and at present is some twelve miles distant from the Gulf of Cambay coast. The siltation rate of the Sabarmati delta is known to be rapid, so that

¹Accepted for publication May 6, 1968.

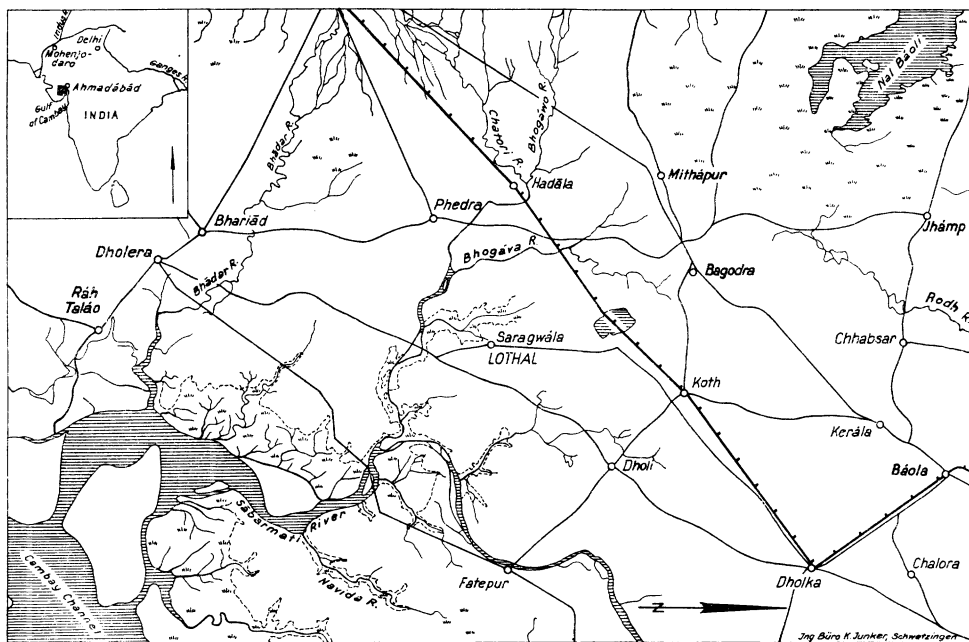


FIGURE 1

in former times the site may actually have been nearer the sea. Lothal today is not linked with the Gulf by a waterway, but to the west of the site the map shows a depression which, we may suppose, formerly provided such a connection. The settlement area (according to the published plan about 600 by 850 feet) (Rao 1962: Fig. B1) and parts of the surroundings were subjected to large-scale excavation in eight campaigns between 1954 and 1962. In addition to several general articles, brief interim reports on each campaign have been published although the final excavation report has not yet appeared.⁴ The excavator, S. R. Rao, has taken a particularly firm stand regarding the dock in these publications, and has thereby given the matter over to open discussion. I hope here to demonstrate that the basin at Lothal was not a dock at all, and to suggest some other possibilities for its functional interpretation.

The Harappan nature of the Lothal settlement is clearly established, with all the typical elements present, such as steatite seals bearing the characteristic script and designs, painted pottery, long chert blades, weights, some copper artifacts, architecture in burnt

brick, and an excellent drainage system. There is evidence that copper, semi-precious stones, and possibly shell and ivory were worked at Lothal, but claims that the governing authority was secular and that fire worship was practiced require the further amplification of the full excavation report. The identification of an elevated area above the main settlement, which contains among other structures the remnants of a granary invites comparison with the cities of the Indus Valley, especially Harappa itself. The field crops on which the Lothal agriculture was based are thought to have included wheat, rice, and cotton.

According to Rao, it is a "certainty that the Harappans came to Lothal for trade or colonizing in 2450 B.C." (1962:15) and that when their settlement was destroyed, along with the Indus Valley cities in the wake of a great deluge, they moved to Rangpur and Bhagatrav. This would have been sometime after 2000 B.C. (Rao 1962:17, 1962 & 1963:204). The *Völkerwanderung* that brought the Harappans to Lothal is conceived of as a sea passage from the Indus. In the main, this argument is based on the supposed absence of Harappan sites in the

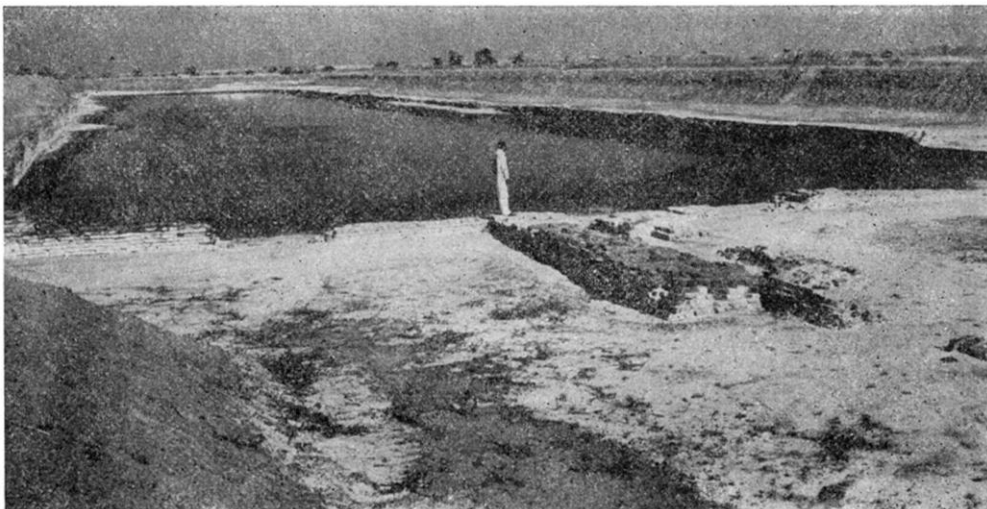


FIGURE 2. The recessed enclosure at Lothal. In foreground the water conduit, at extreme right, gap in eastern embankment.

tract between Sind and Lothal (i.e., in Kutch) and the establishment of a relative chronology that claims absolute priority in the region for the founding of Lothal (Rao 1956 & 1957:82, 1965:30). This dating is, however, itself questionable and exploration of the Kutch area has brought to light a number of Harappan sites there (Joshi 1966), so the arrival-by-sea theory will have to be reconsidered.

Walking through the excavated portion of Lothal one has the impression of being in the midst of a prosperous, not-quite-large village of the type still to be seen in Gujerat, excepting perhaps that the sanitary arrangements of four millennia ago were much superior to anything evidenced today. The extant size of the habitation appears rather too small to represent an "important metal working center and emporium for international trade" (Rao 1962:15), but it is thought that the original area of settlement was much greater (extending to a circumference of two miles), a large part having been later washed away by flooding. In trying to understand this development we are again handicapped by not having the full excavation report. Pending this however, the argument for a greater extension of the settlement is not quite convincing, for it depends upon the discovery of a brick-lined well

some 500 feet south of the village (which might well have been in the fields) and the unsupported assertion of an extension to the north (Government of India 1959/60:17). Moreover, the habitation area appears to be well defined by antiflood walls (Rao 1962:Fig. B1), so that for the present purpose we take the limits of occupation as given above.

Abutting the eastern side of the mound is the structure that is of main concern here: a large, sub-rectangular basin set into the ground and revetted with walls of burnt brick (see Figure 2). This is the structure called a dockyard, and upon it depends Lothal's identification as an international emporium, although it is interesting to note that Rao considered Lothal a port even before he discovered the basin (Government of India 1956/57:15). Yet, apart from the basin, there is very little about Lothal that would allow us to recognize it as a trading partner of Ur and Susa. The recovered objects of supposed foreign origin are very few indeed: they include one seal of the Persian Gulf type, a seal impression, some bun-shaped copper ingots, and sherds of a reserved-slip ware said to resemble one from Ur, Brak, and elsewhere (Rao 1965:35). But this ceramic type has now been recognized at several Kutch sites, among them in-

land locations, so that it cannot be accepted as evidence for unique Lothal contacts with the West (Joshi 1966:64).

Lacking any analogies from South Asia itself, in what frame of reference is one to conceive the nature of an Indian port of the third millennium B.C.? Granting that some trade between the Harappan and Mesopotamian peoples is established, and that both civilizations were part of an ancient Persian Gulf *oikoumene*, the Mesopotamian example should prove instructive. In Sumer, docks were not merely places where merchandise was transferred to and from vessels, but the actual centers of commercial activity as well. Goods were exchanged and sold at the quay, for which purpose merchants had permanent establishments, and tavern-keepers were as familiar to the waterfront scene then as they are in the ports of the world today. The harbor area was administered independently of the town proper and was separated physically from it. There the foreign traders also had their residences (Leemans 1960:1; Oppenheim 1964:78, 116). At Lothal, by comparison, nothing of this is evident; on the contrary, the basin is integrated into the settlement by its very proximity to the main residential area. That the Harappans otherwise divided their cities into sections is abundantly clear at Harappa, in the case of the workmen's quarters and also (as elsewhere) in the acropolis-lower town division. Unless, therefore, we suppose that foreigners were not encumbered with the same restrictions of residence as in Ur, their presence cannot be assumed, for there are no indications of such an enclave at Lothal. Neither are there any other remains, such as those of shops along the quay, that would bear comparison with the picture of the Sumerian harbor. At the least, it seems that the Harappan port had a different appearance from that of its Mesopotamian trading partner, but a likelier inference is that Lothal was not an emporium of the kind Rao envisages at all. (The granary, it is noted in passing, occurs as a fairly regular feature of Harappan settlements and is therefore not pertinent to the argument here.) In their turn, neither do the small finds encourage the view that Lothal was a center of international trade. The identifiable objects from overseas can be

counted on one's fingers. Conceivably this might be because Lothal imports consisted largely of perishables. Sumer did export textiles (Oppenheim 1954:6, 13), but whether to the cotton-growing Harappan peoples is questionable, and textual evidence for other perishable exports besides woolens and grains is lacking.

Rao suggests that besides the export of agricultural and marine (i.e., shell) products, ivory, and finished gemstones, Lothal imported rough stones and copper (1965:30, 35). The export of cotton appears a reasonable supposition, since its presence at Ur has been identified, but it is less so to think that grains were sent to Sumer, whose field crops were its main natural source of wealth. The rough gemstones probably came from Central India, as Rao suggests, but whether the origin of the Lothal copper ingots is traceable to Susa remains to be seen (Rao 1965:30, 35). Not far from Lothal in Rajasthan, we have evidence for the mining of copper ores at least by the middle of the second millennium B.C., if not earlier, and the two areas are in fact linked by a common ceramic that might imply close cultural association⁵. Moreover, there is reason to suppose (if the identification of Meluhha with India is accepted) that copper was an Indian *export*, not *import*, in Sargonid times. Also from Meluhha, Sumer received carnelian beads (Oppenheim 1954:14; Leemans 1960:10, 33) (sometimes in the characteristically Harappan kidney shape), which could have come from Lothal, but might as well have originated in the Indus Valley; Chanhudaro, for example, is also known to have been a bead-working center. One material found in Mesopotamia which is likely to have come from the region of Lothal is the chank shell (Hornell 1951:239), but this does not yet make Lothal a port. Seven terracotta models of boats recovered by the excavator are, unfortunately, too indistinguished to bear on the question.

On the whole, there is not much evidence for an extensive or regular overseas trade conducted by the Harappans, and it *would* be curious if the little there was lay in the hands of relatively minor settlements such as Lothal. In an age of cities, it is difficult to imagine a village as an international trade

center. Admittedly, arguments *ex silentio*, as are some of the above, do not bring one far, but apart from the basin, there is little else upon which the claim to Lothal's being an international port rests. To this basin I now turn.

Evidence for actual docks in the ancient world, against which the Lothal basin can be measured, is sharply opposed. On the one hand, in Mesopotamia, none at all are known, a fact which may mean either that none have yet been discovered, or that none existed, i.e. that mooring arrangements were of the simplest kind. The absence of any textual reference to them points to the latter alternative (Oppenheim 1967: personal communication). On the other hand, the complex harbor at Pharos (modern Alexandria) which dates back to c. 2000 B.C. was so skillfully constructed with breakwaters and jetties that an expert, Sir L. H. Savile, has called it the work of a genius, equal to the standard of a modern engineer (1941:210, 214). By contrast, the Lothal basin is a quite elementary structure, and if meant to function as a dock, then it was very poorly designed. Yet the excavated remains of Harappa and Mohenjo-daro leave us in no doubt that Harappan competence in civil engineering was the equal of any in the third millennium B.C.. Rao himself has pointed out that the Bronze Age knew no other port similar to the one at Lothal (1965:32), and though Lothal could be a unique instance, this observation requires a cautious approach to the interpretation of the structure.

As mentioned, it is a recessed basin, sub-rectangular with its long arms running east-west and measuring 710 feet. The southern end is 116 feet long, that at the north, 124 feet. It is revetted on all four sides with a continuous dry masonry burnt-brick wall, four courses wide, which at its greatest extant depth reaches to fourteen feet (Government of India 1958/59:13). The walls are vertical on all sides and there is no access to the basin in the form of steps. Towards the southern end of the eastern embankment there is a broad and relatively shallow gap. This, it has been supposed, was the inlet channel of the dock. Leading off from the southern wall is a narrow, brick water-passage, said to have functioned as a spill chan-

nel when fitted with a sluice-gate (Government of India 1958/59: plate XIV:B).

Originally, it had been suggested that ships were sluiced at high tide from the Gulf of Cambay to the dock through the inlet channel (probably via a creek to the east of the basin—see Fig. 3, sketch A) (Rao 1962:17). This explanation raised some difficulties, since it was not understandable why the inlet should be in such a position that entering ships would have to take a 90° turn in order to berth.⁶ Moreover, the topographic map (Fig. 1) indicates a depression (possibly a former river bed) to the west of the mound, that is, with the habitation area placed between the dock and the water source. Further study of the problem convinced Rao that ships entered the dock from the river to the west (not as first thought, to the east) by way of a navigation canal skirting the northern margin of the settlement (Fig. 3, sketch B) (Government of India 1962/63:7). This explanation satisfactorily accounted for the relative positions of river, habitation area, and dock, but suffered the disadvantage of compounding the awkwardness of the approach to the dock. In the most recent and complete discussion of the Lothal port, Rao (1965) has also sought to resolve this difficulty. We are told that the dock was used in two stages. During Stage I ships entered from a canal running east-west along the northern edge of the settlement (as in Fig. 3, sketch C) and opening into the northern embankment of the dock. This wall originally had a fifty-five foot wide gap in it (not previously reported), which would represent the inlet of Stage I. Eventually, an "unprecedented flood" blocked the mouth of the original flow channel, and brought about a shift in the river to the east of the settlement. Thus in Stage II, a new inlet channel was built into the eastern embankment to accord with the changed position of the water course (Fig. 3, sketch C). Rao explains that in Stage II, the inlet channel was too shallow and narrow to accommodate large ships, but initially (Stage I) the structure was designed "to sluice ships 18-20 meters long and 4-6 meters wide. At least two ships capable of plying the high seas would pass simultaneously and manoeuvre easily. In Stage II however, only flat bottoms could enter. At

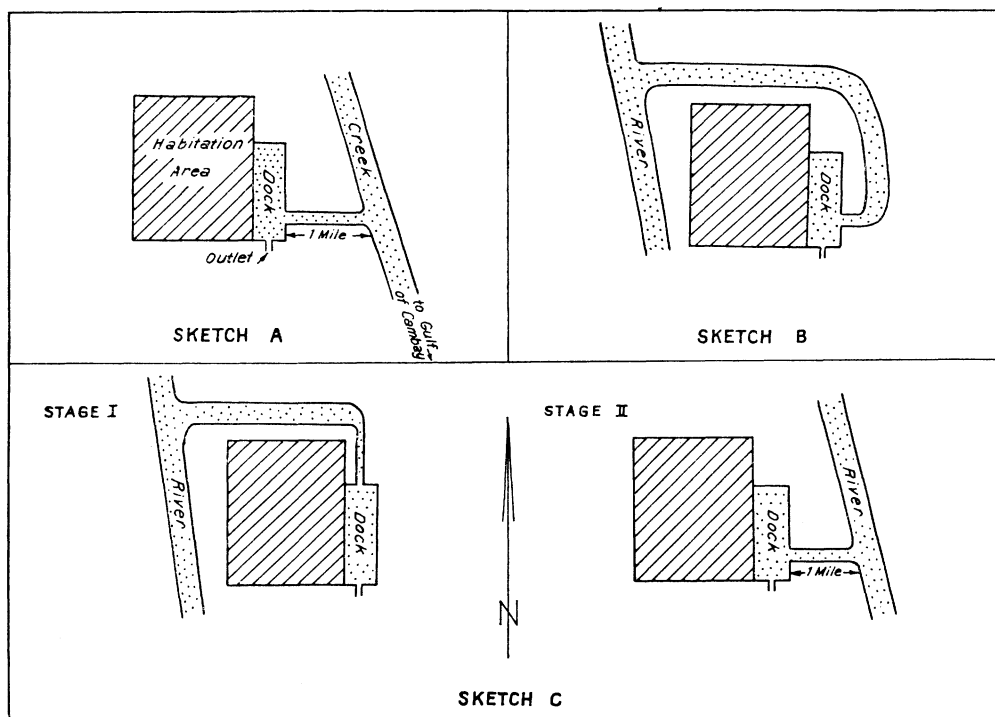


FIGURE 3

this period, the seafaring vessels would be berthed in deeper waters and their cargos trans-shipped by country craft" (1965:35). This most recent interpretation is hard to reconcile with previous ones, for prior to the report of the northern inlet, Rao wrote that the entrance of sea-going vessels through the eastern inlet, had been "established beyond doubt" (Government of India 1961/62:10). He does not tell us why he changed his mind, but one can guess the nature of the eastern gap had something to do with it. With hardly three feet separating the sill of the gap from the rim of the adjacent walls (Government of India 1958/59: plate XV:B), there is patently inadequate clearance for even a small fishing vessel of the type that today plies the coast, but is not seaworthy. Such boats, weighing about 100 tons, have a draft of some four feet. (It has been assumed by Rao that the basin's rim was at one time higher, yet he does not cite the relevant evidence [1965:32, 35]).

Now the point in having a completely enclosed dock with its water-level controlled

by a spill channel is to enable the flotation of ships when the tide is out. If this is not required, then a basin for arresting water becomes unnecessary, a simple open wharf sufficing for mooring arrangements. Hence in Stage II, the dockyard would be serving no purpose, if the sea-going vessels were left to fend in the pull of the tides. Rao has drawn attention to what he supposes to be a parallel to the Lothal dock in the present-day nearby dock at Ghogha (1962:18). The significant point about this other dock, it seems to me, is precisely that it is not an enclosed basin, but merely a quay alongside which ships are berthed. Evidently, the flotation of ships at ebb tide is not considered essential here, and as Rao mentions, they get stuck in the mud, which is apparently no particular disadvantage.

At this point, it would be well to look somewhat more closely at this basin. I am not able to comment on the reported inlet at the northern embankment since my efforts to locate it on the site itself were unsuccessful, and Rao unfortunately has not yet pub-

lished any illustration of it. The eastern inlet however is clearly depicted (Government of India 1958/59: plate XV:B). To be added to what has already been said about this is the observation that the jambs in either side of the gap show no evidence of being planned. They terminate in irregular, uneven steps, so that the opening looks to be much less the result of intent than a chance breach effected by brick robbers. The level of the sill is too high to be consistent with a navigable inlet, and there is no trace of any provision for affixing a sluice gate, especially one spanning twenty-three feet and sturdy enough to withstand an enormous internal water pressure at ebb tide.⁷ During the last-but-one excavation campaign, confirmation for the presence of an inlet channel at this point was sought by cutting across its suspected alignment some yards distant from the basin. The profile revealed a concavity now filled in with silt, and a photograph of this has been published (Government of India 1961/62: 10, plate XVII:A). In the photo, the depression appears quite shallow, probably too much so, again, to have permitted the passage of ships. Successive deposits of silt and fine sand as well as the presence of sea shells do not necessarily point to the flow of tidal waters, as maintained by Rao. At one time, the Nal Lake was still connected with the sea (Government of India 1879:16), this entire area would have been subjected to flooding, and deposits of the kind observed readily left in surface depressions.⁸

Leading off from the southern embankment is the presumed spill channel. The conduit, constructed of burnt brick, has been traced in its length for several yards. The water passage is about one yard wide and contains at the lower end, near the basin, a stepped descent that serves to decrease the water velocity. The orientation of the steps and the gradient of the conduit as a whole is *toward* the basin. Obviously, then, its purpose must have been just the reverse of an outlet and the staged passage affords another illustration of how thoroughly competent the Harappans were in the field of civil engineering. With the conduit serving as an inlet, the basin cannot have been a dock.

During the excavations seven "anchor"

stones were found, five of them coming from the basin area (Rao 1965:35). Six of the seven stones are discoid with central holes and another is pyramidal, with holes in the apex. The largest of the stones has a diameter of about sixteen inches, making it only doubtfully heavy enough to have served as an anchor by itself, while a series of them would have been unwieldy. Similar stones have been found in and around the Nal Lake, and have also passed into the local folklore as anchor stones though this does not, of course, assure their identification (Government of India 1879:16). Ringstones of this kind are further known from Harappa and Mohenjo-daro where they were thought to have been either architectural units, used in erecting pillars, or, in another view, cult objects recalling Yonis (Marshall 1931:I:61-63, II:473, III:plate CXXX:7,9). The collection of seventeen ringstones in a single place at Mohenjo-daro might point to some such function, but then only secondarily. At Lothal, we have a hint of their primary use by the occurrence of five of them in or near the basin. I would suggest that they served as counterweights for the arm of a *shaduf* (in India, called *lat*, or *piccotah*). The *shaduf* is a water-lifting device of considerable antiquity, consisting of two poles, one of which is stationary and erect, while the other, attached to it, moves in a vertical plane. A bucket is suspended from the latter at one end and counter-balancing weights are affixed to the other (see Fig. 4, after Buckley 1893:3). It is operated by a single man who pulls the empty bucket down into the water of a well, tank, or river, and then retrieves the full bucket with ease by letting the counterweight do the work of lifting. The *shaduf* is prominently featured in Egyptian rural scenes and was also used in Mesopotamia. In Mohenjo-daro there is a linear representation of a man using the *shaduf*, so that its presence is documented for the Harappan civilization as well (Marshall 1931:389). Marshall describes the Mohenjo-daro ringstones as having slots that were used to fasten the stones to something that passed through the central aperture. This could well have been the arm of a *shaduf*, to which the stone weights were lashed by rope or leather thongs. The *shaduf* is still employed near Lothal, although the

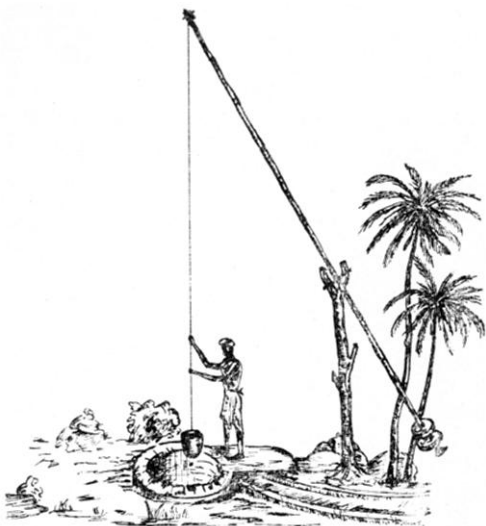


FIGURE 4

stones are no longer pierced, but simply secured with rope. Pierced stones continue however to be used in this way in Eastern India.⁹ At points along the embankment of the basin, Rao has identified post holes, which he has associated with mooring posts, but their use for the vertical arm of the shaduf would also be consistent with the opinion expressed here. Some further support may be lent to this by the observation that the shaduf does not usually lift water more than fifteen feet, and that the depth of the basin is in close accord with this simple physical limitation.

We have here then, a long, narrow, and relatively shallow enclosure, revetted in brick, with a single inlet channel and perhaps a line of shadufs standing along the embankments. To what use was it put? A single answer is likely to be only part of the story since the evident possibilities are not mutually exclusive. The character of the Lothal settlement was critically reviewed at mid-stage in its excavation by U. P. Shah, who expressed the opinion that the basin served as a reservoir for drinking water. Professor Shah particularly emphasized the present-day scarcity of potable water in the region (1960:312, fn. 9), and this is evident when one sees the saline efflorescences that blanket the wastelands in the area. (Only

two wells have been found at Lothal, one of these being beyond the habitation area. The supply of water from wells appears to have been quite limited.) As Professor Shah conceived it, the reservoir would have been solely rain fed, though now the identification of an inlet channel shows that water was also drawn from the river. Today, nearly every town and village in the region has its own reservoir, which is used soon after the rains, mainly for bathing and washing. But as wells and streams turn salty with the advance of the hot weather the reservoirs become the sole source of drinking water. Most of them, it is true, are mere ponds, although some do have brick wallings. These again usually have steps leading down to the water, and their absence at Lothal has been used as a decisive argument in rejecting the implied parallel (Rao 1962 & 1963:179). Steps are not, however, an invariable feature of the tanks; in 1879, the town of Dhan-dhuka, not far from Lothal, had a masonry tank that enclosed some 20 acres but was without steps (Government of India 1879:19). The absence of an entry to the Lothal tank might hinder its use for many purposes, but not, with the help of the shaduf, for the storage of drinking water. From all else that we know about the Harappans, it would not be surprising to learn that their notions of water pollution were clearer than those prevalent today.

The basin could have been, and probably was, used as a source of drinking water, but I believe its primary purpose was to store water for irrigation. If future research can substantiate this identification, in preference to the port theory, then the contribution of the Lothal excavations to our knowledge of ancient India is in no way diminished, for in losing a dock, we gain the first real insight into the Harappan agricultural system. To date, very little is known about the agrarian basis of this civilization, and the relationship the larger urban centers maintained with the rural hinterland.¹⁰ It is generally supposed that the people of the Indus Valley settlements practiced some kind of irrigation, although direct evidence has been lacking (Wheeler 1960:67; Drower 1958:522).¹¹ Lothal has perhaps now provided some.

Before the days of the great canalization projects in the Punjab and South India, in-

digenous irrigation was largely based on tanks, and still today large parts of the South are dependent upon it. Some writers have supposed that this method originated in India. "Tank" in the Indian usage refers to a reservoir that stores water either by damming a stream at a conveniently broad, high place, or by the diversion of its waters to some depression (Wilson 1903:153), either natural or artificial. (It is this latter type that is exemplified at Lothal.) The walls of these tanks are frequently only earthen but also sometimes of masonry. Some tanks are great in size, covering 9–10 square miles, while the storage capacity of others suffices only for limited local use (Buckley 1893:6).

As far back as Rigvedic times (in the latter half of the second millennium B.C.) tank irrigation was known, although well irrigation was perhaps more common. In the later days of ancient India, the construction of tanks came to be considered a meritorious deed and belonged to the list of royal duties. In the Mahabharata (II.5.77) a king is asked: "are large and swelling lakes excavated all over thy kingdom at proper intervals, without agriculture being in thy realm entirely dependent on the showers of heaven?" (Bose 1961:135). The earliest specific mention of an irrigation tank comes from Junagarh (in Kathiawad) and dates to about 300 B.C. (Venkayya 1906:202, A. L. Basham 1967: personal communication). But recently, it has been suggested that tank irrigation came to South India together with the megalithic mode of burial, and this would add perhaps a further 100 years to the age of tanks in India, though still making them 1500 years later than the Lothal example. The evidence for the temporal association of megaliths and tanks is however entirely circumstantial, resting on the coincidence that tanks are often found in the vicinity of the tombs (Banerjee 1956:23). Since there are, at one counting, over 40,000 tanks in South India (Burn 1908 (III):323), the association needs to be more firmly established before it can be accepted.

The region of Lothal is fertile, producing with consistency cotton, wheat, barley, and other crops, even under wasteful methods of cultivation (Government of India 1879:4). Annual rainfall amounts to some thirty

inches, which in *quantity* would suffice to meet the crop refinements. However the erratic *distribution* of the rains makes agriculture precarious without artificial means for regulating the distribution of moisture to the crops. In the last century, tank irrigation was resorted to mostly during the cold months of November and December, in order to bring the rice crops to maturity. A cultivator commonly hollowed a part of his field for a pond, and allowed this to fill with rain water. Then, if the later rains failed, he would carry the pond water to the rice beds by means of a channel or water lift (Government of India 1879:51).

In this light, the fact that Lothal is one of the two places in India (the other is Navda Toli) for which the early use of rice is attested assumes renewed significance. The presence of the granary at Lothal (and much else that we know of the Harappans) implies that agriculture was subject to some sort of centralized control that must have extended to the irrigation system. Given then (1) that rice was cultivated and that this required the use of stored water and (2) that agriculture was governmentally regulated, it would be an administratively sensible approach to irrigation to construct just such a tank as we have at Lothal. Throughout the ages, irrigation in the Orient has been a matter of governmental concern, and it is not likely to have been otherwise at Lothal.

In lieu of factual evidence, it might be supposed that the inlet channel was connected with the tank at one end and the river, which once flowed west of the mound, at the other. A weir thrown across the river would divert water to the inlet, the flow being controlled by staging and, finally, by a sluice gate. The fittings for such a gate have been identified at the basin end of the channel. One of the great difficulties with such tanks is that they retain all the silt of the stored water, and must either be periodically cleared, or abandoned. The use of the bricks at Lothal eased the cleaning task, provided for a long period of usage, and protected the basin from the erosive force of the water entering through the inlet. When required, the stored water was lifted out of the tank by shadufs and brought to the fields by an interconnecting canal system. Already well ac-

quainted with drainage canals in their settlements, the irrigation canals would have presented no special problem to the Harappans. The one well that was found beyond the settlement area might have supplemented the tank irrigation, a practice common in India (Burn 1908 (VIII):318).

In summary, the identification of Lothal as a port of international commerce seems questionable. The arguments favoring it are based on slender evidence, and ultimately, they rely upon the demonstration that the basin-like structure abutting the habitation area was a dock capable of receiving sea-going vessels. In my opinion, this has not been adequately shown, for the presumed opening for ships in the eastern embankment appears to be due more to the depredations of brick robbers than intentional design, and the conduit identified as a spill channel is more likely to have served as an inlet for water from the river. The alternative explanation I offer for the basin is that it served as an irrigation tank and, secondarily, as a source for drinking water.

Admittedly, this view also lacks the weight of decisive evidence, but it seems at least to be reasonably in keeping with the general rural character of the Lothal settlement as we know it. Rao's significant work has opened up several new lines of inquiry, the most important of which may lead to valuable insights into the Harappan agricultural system.

THE LOTHAL TANK AS AN IRRIGATION RESERVOIR

K. H. JUNGHANS

The question has been raised whether the basin at Lothal might not have served as an irrigation reservoir. It is true that the fields surrounding Lothal could have easily been irrigated by canals. Why then the necessity of leading water through a conduit into the basin, then raising it and again bringing it onto the fields along a canal system? The answer to this is coupled to another query: were technical facilities sufficiently advanced to enable large amounts of water to be lifted out of the basin in a short period, in order to fill the irrigation canals?

In this area of scanty rainfall, rivers and canals often run dry during the summer

months. The example mentioned above for Gujarat, where tanks are built prior to the monsoon rains for the storage of water to be used later, can be extended to many parts of India. In Orissa, the construction of such tanks is in fact part of an official famine prevention policy. It is, however, remarkable that the Lothal tank was brick-built and not simply made of earthen walls as is generally the case today in India. Besides facilitating cleaning and preventing erosion, as already suggested, the brick walls also reflect something of the irrigation techniques employed. If made of earth, the walls of a basin would have to be much sloped to prevent soil movement. Now if the fields to be irrigated lie lower than the tank, the outflow of water can easily be regulated by sluice gates. The sloped sides would be no hinderance in this case. However, if the fields are at the same height as the basin, then the water has to be mechanically raised. Today this is frequently done by pumps or Persian wheels, but formerly, the shaduf system prevailed. Difficulties arise however if shadufs are to be used over sloped walls. Hence today, where in use, the shadufs are primarily erected at wells that are masonry constructions. The brick walls of the Lothal basin would have been admirably suited for the use of shadufs at the water's edge, and we would adduce this fact in support of the opinion that this system was actually used at Lothal, as evidenced by the ringstones. We now turn to consider certain economic aspects of the problem.

It would be difficult to state with certainty just which crops would have been irrigated from the tank, and we can offer here only some suggestions. What is clear however, is that the size of the tank is sufficiently large to permit the use of a number of shadufs, operated perhaps by a social group that specialized in this work. Still today one finds, for example among the Mundas of eastern India, the shared use of irrigation works. Four to six families of a village dig a well on communal property and receive in return a plot near this water source. Shadufs are erected and each family draws water for its fields from the well. In a recent study of such a system near the Rourkela steel plant in Orissa, it was determined that an irrigated area of 0.3 to 0.6 acres of

vegetable land sufficed to employ a family fully.

The Lothal tank had a capacity of about 5,000 cubic meters, and the flow of the water into it was assured for about five to six months. This would have permitted refilling three to four times yearly, so that a total of 15,000 to 20,000 cubic meters of water was available for irrigation purposes. For vegetables, we assume an average growth period of some eighty days during which period the plants require 500 to 700 mm rainfall. Now, generally irrigated fields are capable of producing three vegetable harvests a year, thus requiring 1,500 to 1,800 mm of water. The actual rainfall in the Lothal region today is 700 to 800 mm, and we assume a similar precipitation in former times. The tank capacity would have sufficed to provide the deficit moisture for vegetable gardening. As we understand it, the tank had a dual function: (1) it provided the farmer with a kind of insurance in the event of a monsoon failure and (2) permitted vegetable gardening throughout the dry season. If the tank was filled four times yearly, providing 20,000 cubic meters of water, this together with the normal rainfall would have made eight to twelve acres available for vegetable gardening.

This area would give work to twenty or twenty-five families. Relatively small as the area is, the resulting vegetable harvest would represent an important culinary addition, not only balancing but also relieving the monotony of a grain diet.

Whether the irrigation system was also used to water grain fields is another matter. Grain cropping in earlier times required extensive areas, in relation to which the capacity of the Lothal tank seems small. But even if field crops were not solely dependent upon irrigation, it is certainly possible that the stored water was used as a hedge against dry periods later in the year, as already suggested above.

NOTES

¹ A concise version of this article was read at the 27th International Orientalist Congress at Ann Arbor in August 1967.

² For a summary of the arguments favoring the identification of Western India with Meluhha see Leemans (1960). See also two recent statements: Buchanan (1967) and Mallowan (1965).

³ Several Indian and European scholars have privately expressed to me doubts about the dock interpretation. To my knowledge, the sole other publication questioning it is by Professor U. P. Shah (1960).

⁴ Reports on the Lothal excavation will be found in *Government of India* (1954/55:12; 1955/56:6; 1956/57:15; 1957/58:12; 1958/59:13; 1959/60:16; 1961/62:10; 1962/63:7), and Rao (1956 & 1957:82-89; 1962:14-30; 1962 & 1963:4-207; 1963:96-99; 1965:30-37).

⁵ The ceramic is the Black and Red Ware found at many sites in Central India, but principally associated with Ahar, in Rajasthan, where copper was anciently worked (*Government of India* 1961/62:45).

⁶ This point was made by Mr. P. Oza, at the time Director of Ports in Ahmedabad, when he prepared a report on his observations at Lothal at the excavator's request. The present Director of Ports, Mr. Mehta, has kindly made Mr. Oza's report available to me, and in Baroda I had the opportunity of discussing it with him. Mr. Oza did not commit himself, either in the report or during our talk, to the view that the structure was a dock. In quoting him as being "definitely of [this] opinion," Rao is mistaken (1962:18). I wish here also to acknowledge the readiness with which Mr. Buddhbhatt, Executive Engineer in Ahmedabad, discussed the problem with me.

⁷ The small block of bricks abutting the exterior of the eastern wall near the gap is not with certainty associated with it.

⁸ There is also some doubt whether the shells recovered were actually those of salt and not fresh water species.

⁹ This information comes from Dr. K. H. Junghans of Heidelberg.

¹⁰ Some very interesting thoughts on such questions have recently been recorded by Fairervis (1967).

¹¹ For a somewhat different interpretation see Lambrick (1964:75).

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