

Anchors from Goa waters, Central West Coast of India: Remains of Goa's overseas trade contacts with Arabian countries and Portugal

Sila Tripathi, A. S. Gaur and Sundaresh

Marine Archaeology Centre, National Institute of Oceanography, DONA PAULA, Goa 403 004 (India)

Email: sila@darya.nio.org

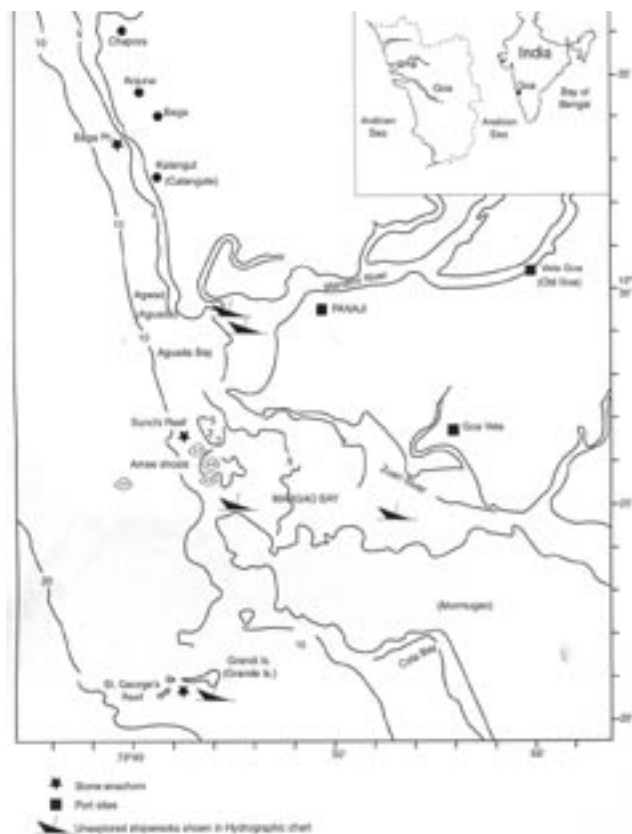


Figure 1. Figure showing the finding sites of stone anchors and port sites of Goa. (Drawing: S. Chitari).

Introduction

It is well known that a number of ships have been wrecked off Goa, India, due to submerged rocks, reefs, sand-bars and storms. Marine and other related records kept in the Goa State Archives at Panaji and India House in Lisbon document some of them. Marine archaeological explorations have been carried out in Sunchi Reef, Grande Island and Aguada waters since 1997 with the main objective to locate shipwrecks (Fig. 1). Stone and iron anchors have been retrieved from the sea-bed of Goa ever since underwater survey was commenced by the National Institute of Oceanography, Goa. In addition to stone and iron anchors, the exploration at Sunchi Reef has also yielded elephant tusks, hippopotamus teeth, guns, iron gunshot, a metal handle, Martaban pottery and dressed granite blocks from an early 17th-century shipwreck of the Portuguese period (Sila Tripathi, *et al.*,



Figure 2. Indo-Arabian type of stone anchor from Sunchi Reef, Goa. (Scale: 25 cm with 5 cm division) (Photograph: S.N. Bandodker.)

2001). Similarly, a stone anchor has been retrieved from Baga waters (Thakkar, 1990). The majority of the ships in Goa waters have been wrecked in shallow waters—a high-energy zone, which is not conducive to the preservation of remains of shipwrecks. Hence, only heavier and larger artefacts, such as guns and iron anchors have been found from the wreck sites. Anchors provide critical clues on the ancient maritime activities of the country. Initially, dead weight stone anchors were used and later wooden-fluke stone anchors replaced them. Subsequently, the iron anchors replaced stone anchors during the later period. Ancient stone anchors are worth studying because they provide information on maritime trade and contacts, which is unobtainable from any other source. In view of the varieties of anchors found in Goa waters, this paper describes their relevance and importance to the maritime archaeology of Goa.

Methodology

At each site a large area of about 50 to 100 m radius was covered in free swimline search. Sometimes local divers were contacted to obtain more information on these sites. The details of all the stone and iron anchors are given in Tables 1 and 2. A comparative study has been made between the stone anchors off Goa with similar stone anchors reported from other parts of India and the world. Further, wood samples were collected from the wooden stock of the iron anchor of Aguada waters. These were sent for radiocarbon dating to determine the age of the wood and anatomical analysis to identify the species of the wood. Infrared spectroscopy of the coating material was carried out to determine whether or not any organic materials had been mixed in the preservative coating

Sl. No	Location	Raw material	Length	Width	Lower holes	Upper hole	State	Weight in kg	Estimated weight in kg
1	Sunchi Reef	Laterite	114	34	10 x 9	—	Brittle	100	—
2	Grande Island	Sandstone	110	36	8 x 7 9 x 7	5	Good	113	113.44
3	Grande Island	Quartzite sandstone	123	25	11 x 8 11 x 8	—	Good	130	106
4	Baga	Tremolite schist	53	24	6 x 5 5 x 4.5	—	Good	51	—

Table 1. Dimensions of stone anchors found in Goa waters, (all in cm).

Sl No	Location	Length of shank	Length of fluke	Type of anchor	Remarks
1	Sunchi Reef	310	110x110	Admiralty long Shanked	Good condition
2	Aguada Bar	265	110x113	Admiralty long Shanked	Good condition
3	Aguada Bar	370	145x140	Admiralty long Shanked	Prows are corroded
4	Aguada Bar	270	110x110	Admiralty long Shanked	Prows are corroded
5	Aguada Bar	235	205	Pering’s improved anchor	Good condition
6	Aguada Bar	250	235	Pering’s improved anchor	Good condition
7	Unknown	335	130x135	Admiralty long Shanked	Shank and prows are corroded
8	Unknown	315	106x126	Admiralty long Shanked	Shank and prows are corroded

Table 2. Iron anchors found in Goa waters, (all in cm).

applied to the anchor.

Stone anchor of Sunchi Reef

Exploration on the eastern side of guns brought to light an Indo-Arabian type of stone anchor, which was trapped in between lateritic outcrops. There is a distinct crack at the upper side of the anchor. The anchor is made out of porous laterite and has an uneven surface; oyster shell growth is also present on it. It has only one lower square hole, which is highly abraded, and the other square lower hole is broken (Fig. 2). The stone anchor does not have the upper hole meant for a cable, and it is in a fragile state. The anchor is so brittle that while lifting it broke at the other lower hole. Its present length is 114 cm, weight 100 kg, but the original length could have been considerably longer than it is now. We have reconstructed the morphology of the anchor to arrive at its original shape and dimension (Fig. 3).

Iron anchor of Sunchi Reef

An iron anchor with 3.10 m long shank having two flukes was found lying in between the outcrop of lateritic boulders. The shank has a hole meant for a metal ring, however the ring is missing. The length of the each fluke

is 1.10 m. One fluke is exposed and the other is inside the crevices of the laterite hence it is very difficult to document the same. A thick layer of marine growth is also present on the anchor. There is a small projection

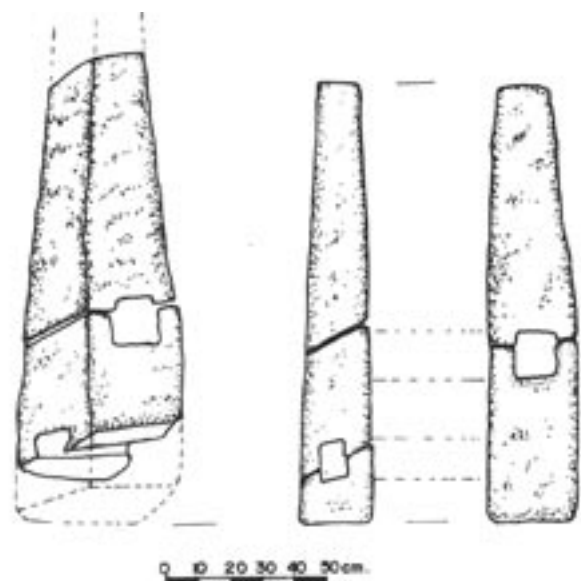


Figure 3. Stone anchor from Sunchi Reef, Goa. (Drawing: S. Chitari.)

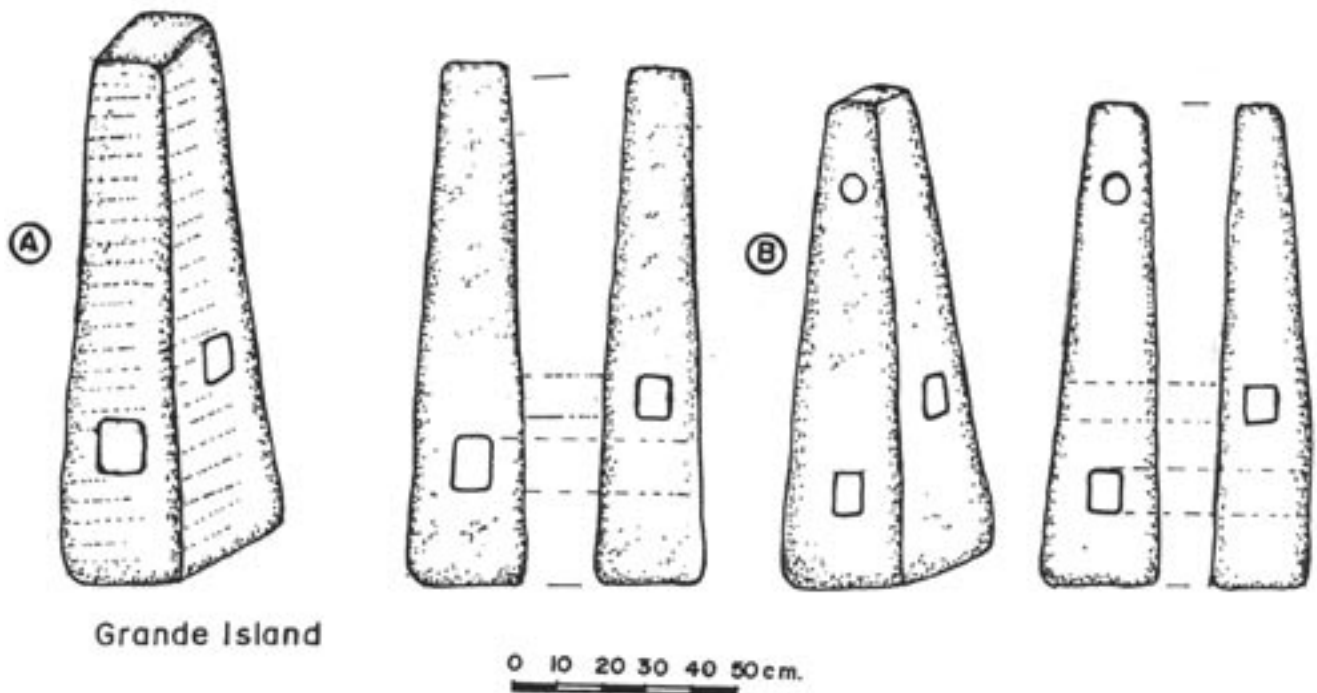


Figure 4. Stone anchors from Grande Island, Goa. (Drawing: S. Chitari.)

on the shank to locate the wooden stock but the wooden stock is not present. It appears that the stock might have disintegrated.

Stone anchors of Grande Island

Two Indo-Arabian type of stone anchors (Fig. 4) have been retrieved off the Grande Island one of which is housed in the Marine Archaeology Centre, Goa. This anchor was found in 1997 approximately 300 m away from the Grande Island jetty, in 7 m water depth. The constituent material of the anchor is sandstone and it weighs 113 kg. Deep and distinct chisel marks can also be seen on it (Fig. 5). The apex of the anchor is round instead of square and tapers upwards after the upper square hole. The size of the holes are smaller in comparison with the size of the anchor. Coral (*Favites abdita*) growth is also seen on one surface between the lower square hole and upper square hole, besides other marine growth is also noticed on its surface.

The other stone anchor was found in 2001 in 4 m water depth around 1.9 km north of the earlier one. It does not have the upper hole, however the lower two holes are present. The anchor tapers upward, although it is square in section and some portion of the apex is worn out. The anchor weighs 130 kg and is composed of quartzite sandstone. At one side of the base of the anchor, a big piece has been chipped out whereas the other three sides are uniform in size. The surface of the stone anchor has been neatly trimmed by chisel leaving parallel lines running all around the anchor. However, the holes are chiselled smoothly without parallel lines (Fig. 6). Oyster shell growth is noticed

on it. Both the anchors are different in shape and size, and the nature of chiselling shows these anchors were not used extensively and, therefore, their edges are sharp.

Stone anchor of Baga

Exploration in 3 to 6 m water depth off Baga, within a radius of 100 m, led to the recovery of a stone anchor having two rectangular holes, with a rectangular cutting on the apex. At first glance, the anchor stone looks like an Indo-Arabian type of stone anchor, the broader side is trapezoidal in shape and the narrower side is nearly rectangular. This stone artefact appears like a pyramidal stone anchor (Fig. 7). There are some worn-out marks on the anchor surface. No other artefacts have been found along with this stone anchor. The length of the stone anchor is 53 cm, weight 51 kg and it is made out of tremolite-schist. Hard wood or molten lead must have been inserted in the apex cutting to fix the metal hook. Sometimes, for easy retrieval, cords were passed through to fasten both the protruding parts of the wooden bars at the sides and knotted together (Sila Tripathi, 2002). There is no connection between the rectangular cutting at the apex and the upper hole, which is generally noticed on other pyramidal anchor stones (Frost, 1989; Tzalas 1999).

Iron anchors of Aguada Bar

The Archival records kept in the Goa State Archives at Panaji and India House in Lisbon mention that a number of ships have been wrecked at Aguada Bar. The bar has been referred in the Portuguese hydrographic charts as *Barra de Agoada* and the water depth at the bar is less than 3 m. A 2.65 m long



Figure 5. Indo-Arabian type of stone anchor from Grande Island, Goa, housed in Marine Archaeology Centre. (Scale: 25 cm with 5 cm division). (Photograph: Sila Tripati.)

iron shank anchor with a 2.53 m long nailed wooden stock (Fig. 8) was found at Aguada Bar at the location popularly known as ‘*Satbahu*’ (where the water depth is 14 m) and the information collected from local fishermen shows that fishing nets get entangled in this region.

In India, this is the first iron anchor with a wooden stock of its kind reported so far (Sila Tripati, 1999). Radiocarbon dating of the wood (sample No: 1712) belonging to the anchor stock suggests that the wood is 2500 ± 410 years BP, its calibrated age range is 2950–1950 years BP. The anatomical analysis of the wood shows that it belongs to the *Tectona grandis* species for which the trade name is teak. The radiocarbon date of the wood indirectly indicates that older wood was used for the construction of ships, and other related purposes, that could withstand adverse sea conditions. Half of the portion of the wooden stock is highly affected by wood borers while the other half is intact. It appears that the intact portion was buried in the sea-bed.

Nine nails have been used to join the stock together keeping the stock at the centre, out of which four nails



Figure 6. Indo-Arabian type of stone anchor from Grande Island, Goa. (Scale: 25 cm with 5 cm division). (Photograph: Sila Tripati.)

have been used around the anchor shank to keep it firm and the remaining five on the other part of the stock (Fig. 9). Among these five nails, four nails are on the intact portion of the wooden stock and only one is visible on the wood-borer side. There is no uniform distance



Figure 7. Stone anchor found during underwater exploration off Baga, Goa. (Scale: 20 cm with 5 cm division). (Photograph: S. N. Bandodker.)



Figure 8. Iron anchor with wooden stock from Aguada Bar, Goa. (Scale: 50 cm with 5 cm division). (Photograph: S. N. Bandodker.)

between the nails. However, no iron bands have been provided for fastening the wooden stock. The anchor has an iron ring, which is corroded. Further, a thick coat of yellowish cement has been applied to the surface of the anchor and stock to protect them from corrosion in the marine environment. No coating has been applied to the ring. The microscopy observation of the coating material shows a buff colour, comprising of fine sediment of mica and shell material. The hardness of the coating may be due to the presence of both magnesium and calcium which is insoluble in sea water and also acts as a good preservative for the anchor. The Infrared spectrum (KBr pellet method) analysis (Fig. 10) of the coating material, carried out using Shimadzu FTIR model 8201PC, indicates the presence of some organic material, which could be the marine organisms deposited on the stock during the later period. Since there is a coating on the anchor no marks can be seen on it.

Similarly, the Captain of Ports, Government of Goa, had carried out dredging at Aguada Bar for the movement of ships in 1977–82 (Fig. 11). In the course of dredging in a 50 m radius, four iron anchors and some timber pieces of 1–2 m length were retrieved from the site. Presently, these anchors are housed in the Goa State Museum, Panaji (Fig. 12).

Iron anchor A: The iron anchor is datable to the 16th–18th century with a 3.70 m long shank and without a wooden stock. In these types of anchor the wooden stock was fixed on the shank. It appears that the stock of the anchor might have decomposed. The ring meant for the hawser is present. The palms are corroded. No preservation coat is visible on the anchor surface (Fig. 13).

Iron anchor B: This iron anchor is datable to the 16th–18th century with a 2.70 m long shank having a hole at the end of the shank meant for a ring, however the ring is missing. The state of preservation of the anchor is good but the palms are slightly corroded. This anchor is similar to anchor 'A' in shape.

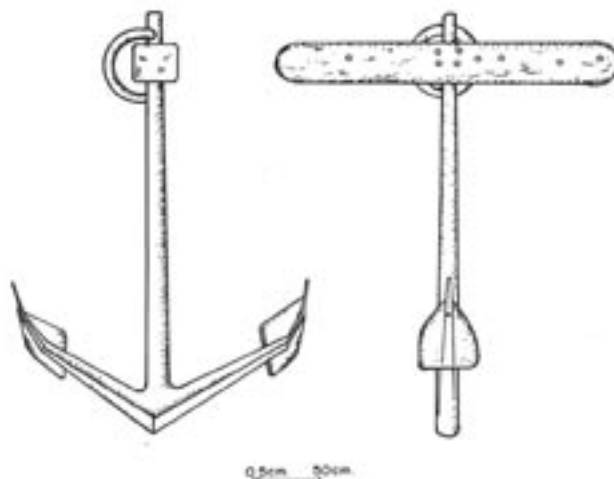


Figure 9. Iron anchor with wooden stock from Aguada Bar, Goa. (Drawing: S. Chitari.)

Iron anchor C: The length of the shank is 2.35 m and the state of the anchor is good. The ring is corroded. In this anchor a flexible iron stock is provided instead of a wooden stock; the length of the stock and shank is similar.

Iron anchor D: The length of the shank is 2.50 m and is bigger than anchor 'C'. The iron stock and one prow of this anchor are missing. Anchor 'C' and 'D' are similar in shape and datable to the 18th–19th century. From the shape and size of all these anchors it appears that anchors 'A' and 'B' belong to one period whereas anchors 'C' and 'D' belong to another. Further, these anchors appear to belong to different ships, because archival records mention that numerous ships have been wrecked in this region. The weight marks are also not visible on these anchors.

Iron anchors of Old Goa

Two iron anchors have been displayed in the

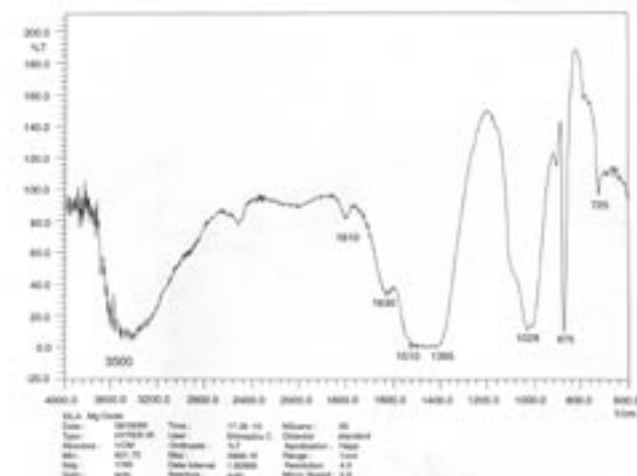


Figure 10. Infrared spectrum of the coating material on the wooden stock of anchor.

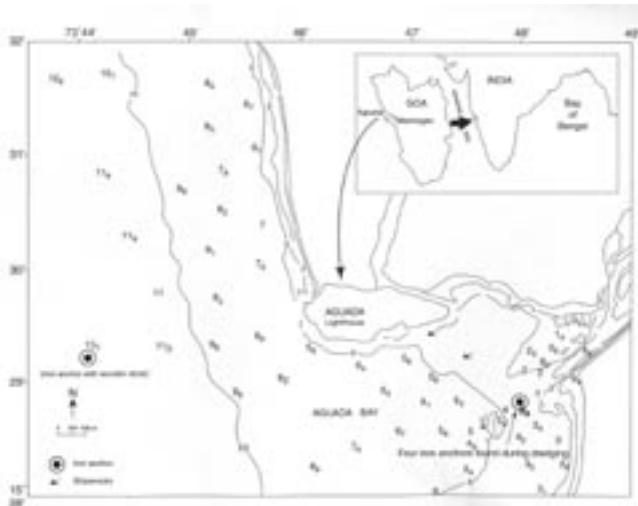


Figure 11. Figure showing location of iron anchors from Aguada Bar. (Drawing: S. Chitari.)

Archaeological Museum, Old Goa (Fig. 14). Earlier, these anchors were kept in the Institute of Menezes Braganza Hall, Panaji, and later shifted to St Cajetan Convent of Old Goa, then to Bom Jesus Church and at last housed in the Archaeological Museum in Old Goa. The finding place and other related information on these anchors is enigmatic. Both the anchors are similar in shape and size and datable to the 17th–18th century.

Iron anchor E: The length of the shank is 3.35 m, roundish in shape and larger than the other anchors but the palm and a little portion of the shank are corroded. The ring of the anchor is present (Fig. 15). The state of preservation of the anchor is better than the anchor F.

Iron anchor F: It is smaller than the previous one (E) and the length of its shank is 3.15 m, it is square in shape and the rope ring is missing. About 1 m of the shank is worn out, one palm is missing and other one is highly corroded. Due to extensive use, the hole meant for the ring is also worn out. Preservative coating has not been applied to anchors E and F, however 1 cm ‘nuts’ noticed on both of them were probably meant to provide a better grip to the wooden stock. The wooden stocks of both the anchors E and F are missing.

Association of anchors with maritime history of Goa

While anchors are proxies to maritime connections with other countries, the history of trade contacts provides background information. Archaeological explorations and literature sources indicate that the maritime history of Goa dates from the Early Historic Period. The Shilaharas (AD 750–1010) and the Kadambas (AD 1008–1300) dynasties were great maritime powers and maintained trade contacts with the countries of West Asia and East Africa (Gune, 1990). The excavations of Chandrapura, the oldest port of Goa yielded remains of the Satavahana period (2nd century BC) which include pottery and bricks (Herat, 1932). Due to siltation of the

river, the port town was shifted from Chandrapura to Gopakapattana during the Kadamba period (10th–11th century). Vallipattana and Revatidwipa (present Redi in Maharashtra) were flourishing ports and ships sailed up to the African and Arabian coasts. Cotton goods, diamonds, precious stones, spices, and perfumes were exported from here (Shirodkar, 1990). Subsequently, Malik Kafur, the General of Alaudin Khiliji overran the whole of Goa and destroyed its capital Gopakapattana on the river bank of Zuari. The Bahmanis succeeded in conquering Goa in AD 1472, and they had trade relations with Arabia, Africa and Persia. Yusuf Adil Shahi of Bijapur conquered Goa in AD 1490 and developed the port of Ela, which soon became an important emporium of the Indian Ocean trade. Before the arrival of the Portuguese in Indian waters, the Arabs were the dominating power in the Indian Ocean region and controlled maritime trade from the 8th–9th century onwards till the 16th century AD. Even, the Red Sea and African coast were under their control over the centuries and after the 9th century AD they could reach up to the coast of China (Hourani, 1975). The Indo-Arabian sea trade continued to flourish throughout the medieval period until the Portuguese, with superior western maritime technology, challenged it.

The merchants of Arabia, Persia and Ormuz brought horses, perfumes, and Chinese pottery to Goa and in turn they took rice, betel, spices, textile, sugar and fine muslin. Goa was the main centre for traffic of imported horses, which were essential for maintaining the military strength of the empires around the Goa region (Kamat, 2000). There were frequent battles between Bijapur and Vijayanagar dynasties for supremacy, hence Arab horses were in great demand. The Arabs knew Goa as Sandabur or Sindabur, whereas some had identified it as Shadashivagad (Nainar, 1942) and others had identified it as Chandrapura and Gopakapattana (Costa, 2002). Gopakapattana was the entry point for these traders to go to Bijapur and Vijayanagar dynasties. Even during later periods the Arabs had settled down in Chimbél, Pernem and Valpoi of Goa. The Arabs were very good navigators so much so that the Kadamba king Jayakesi I had appointed an Arab sailor as ‘*Maha pradhan*’ in his navy due to his experience in sea trade and navigation. During the later period, the Vijayanagar dynasty signed a treaty with the Portuguese to provide facilities to buy horses from the ports of Goa. Ismail Adil Shah of Bijapur had also requested Afonso de Albuquerque to permit the purchase of horses at Goa. During the Portuguese period, Old Goa became the commercial city. The hinterland region of Goa was connected by the land and riverine routes from the various port sites. Merchants from Arabia, Mozambique, Java, Sri Lanka, the Maldives and China visited Goa for trade.

Discussion

The evolution and development of anchors were closely related with the history of civilisation of the world. The

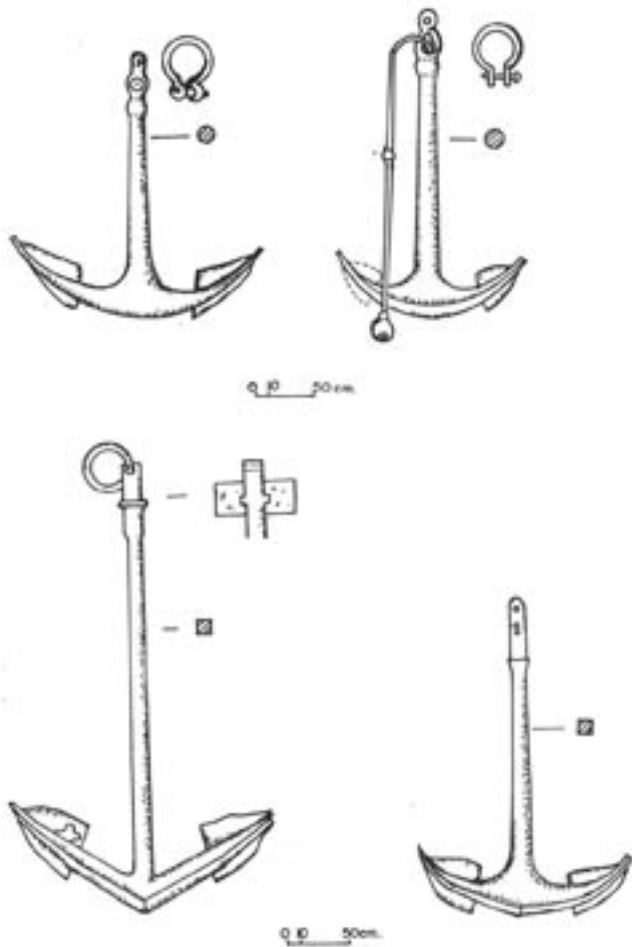


Figure 12. Iron anchors found during dredging in Aguada Bar, Goa. (Drawing: S. Chitari.)



Figure 13. Iron anchor from Aguada Bar, Goa. (Scale: 50 cm with 5 cm division). (Photograph: Sila Tripati.)

study of anchors shows that each of the anchors (stone, lead or iron) has its special features, origin and development. With the change in size of ships there was change in the shape and size of anchors as well as from stone to iron. In the beginning, dead weight anchors were used followed by the hook and movable stock anchors (Puech, 1984).

Explorations along the coast of India (Fig. 16) have brought to light a number of stone anchors:
 Dwarka—triangular 34, Indo-Arabian 63, ring stone 24;
 Bet Dwarka—triangular 13, Indo-Arabian 7, ring stone



Figure 14. Iron anchors displayed at archaeological museum, Old Goa. (Drawing: S. Chitari.)



Figure 15. Iron anchor displayed at archaeological museum, Old Goa. (Scale: 50 cm with 10 cm division) (Photograph: Archaeological Survey of India.)

1;
 Somnath—triangular 6, Indo-Arabian 2, ring stone 35;
 Aramda—triangular 2, Indo-Arabian 1, (Gaur, *et al.*, 2001;
 Sundaresh, *et al.*, 1999);
 Sindhudurg Fort—triangular 3, Indo-Arabian 5,
 Padmagad—Indo-Arabian 1, (Sila Tripati & Gaur,
 1997);



Figure 16. Figure showing stone anchor finding sites in India.

Vijayadurg—triangular 1, Indo-Arabian 23, (Sila Tripathi, *et al.*, 1998);

Minicoy Island—Indo-Arabian 1, (Kapitan, 1994); and
Tamil Nadu—Indo-Arabian 4, (Athyaman, 2001).

The common feature of the Indo-Arabian stone anchor is two rectangular or square holes at the lower side for fixing flukes and a circular hole at the apex meant for a hawser. These stone anchors are heavier and larger than the composite type of stone anchors.

They have been variously termed ‘Arabo-Indian’ (Souter, 1998), ‘Arabic or Protograpnel’ (Frost, 1985), ‘Arabo-Indian grapnel’ (Raban, 2002). However, in India we propose the term ‘Indo-Arabian’ to these stone anchors because they are similar in shape.

Of the three stone anchors found in Goa, two do not have apex holes hence their use is obscure. Similar kinds of stone anchors, without an upper hole, have also been reported from Dwarka, Bet Dwarka, Tamil Nadu coast, Kilwa Kisiwani, Oman and Mogadishu on the east African coast. These stone anchors may be unfinished or reworked after breaking at the apex end; even the nature of chiselling is similar with one stone anchor from Grande Island and with the ones kept at Mogadishu Museum and Tamil University Museum, Thanjavur.

It appears that the boats employed by merchants of Persia and Arabia to bring their horses for trade in India used these stone anchors. They have been reported wherever Arab boats called along the western Indian Ocean and the Red Sea coast. Those mariners introduced the Indo-Arabian type of stone anchors to the Indian coast. These anchors were in use until the introduction of iron anchors by the Portuguese in India. The discovery of several stone anchors indicates that there was an increase in the volume of maritime trade during the medieval period.

Similarly, an Indo-Arabian type of stone anchor has been found in the Red Sea on the Lone Mushroom wreck

datable to the 13th–14th century AD. It has grooves at the base, probably meant for retrieving the anchor in case it got trapped in between rock or it could be a maker’s mark (Raban, 1990). Stone anchors having such type of grooves have not been reported so far along the Indian coast. The excavation at Siraf (Whitehouse, 1970) on the Persian Gulf has brought to light two fragmentary stone anchors from the stratified layers that are datable to the 8th–11th century AD. Further, Indo-Arabian stone anchors have been reported from Dhofar, Dibba, Qalhat and Oman (Vosmer, 1999) and Kilwa Kisiwani and Mogadishu on the East African coast (Chittick, 1980). The Indo-Arabian stone anchors with the remains of wooden flukes have been reported from Galle Harbour, Sri Lanka. The radiocarbon dating of the wood shows that the wood is 430 ± 80 years BP (Souter, 1998).

The reported stone anchors from Goa waters have not been found at any harbour sites of Goa or a datable context. It appears that the mariners had dropped these anchors during rough weather or in an emergency; whence they became trapped in the rocks and the mariners left them behind. So far, none of the Indo-Arabian anchors that have been found date prior to the 8th–11th century AD anywhere in the world and the stone anchors of Sunchi Reef and Grande Island could be dated to the medieval period.

The use of iron anchors started in India after the 16th–17th century and iron anchors were introduced in India by the Portuguese mariners. It appears that the use of stone anchors might have continued for some years for maritime trade. Local fishermen or sailors who were navigating in regional waters might have used the left-over stone anchors for some duration and, subsequently, these anchors were used as lintels of parapet walls, paving and moorings (Sila Tripathi, *et al.*, 1998). Similarly, a broken stone anchor has also been used as an architectural feature in the city of Qalhat and is datable to the 10th–16th century AD.

In the beginning of the 18th century, Europeans started using long shank iron anchors. The iron anchors of the Dutch, Danes and Swedes were five percent longer than the French (Rubin, 1971). However, the English started using ‘Old Plan Long Shanked’ or Admiralty Long Shanked anchors which were five percent shorter than the French and had straight arms (Fig. 17). There were some minor differences but they looked alike. These anchors had wooden stocks, which were nailed or tightened by metal brackets (Rubin, 1971).

Wooden stocks were added to iron anchors to provide flotation and buoyancy and to prevent the anchor from damage when the anchor hit a rocky bottom. It appears that the length of the wooden stock and the shank is equal in some anchors. These were also used to turn the anchor square to the sea-bed. While the wooden stocks remained unchanged in use in wooden-hulled vessels, the iron stocks were adopted in iron and steel-hulled vessels (Upham, 1983). The wooden stocks of the iron anchors help one of the flukes to sink into the sea-bed, which helps

to bring the ship under control; these wooden stocks are transverse beams. In these types of anchors one of the flukes will sink into the sea-bed under any circumstance and the stock will remain on the sea-bed in a horizontal position (Kimpton, 1992). Wooden stocks were also 'softer' on the copper sheathing used on late 18th, 19th and early 20th century wooden-hulled ships.

The function of a removable iron stock is different from a wooden stock. However, iron stock anchors came into the limelight in the late 18th century (Upham, 1983). It was noticed that iron anchors were frequently broken because of weight, poor quality of welding, straight arms and inferior quality of iron used for manufacturing the anchors. During subsequent years, Richard Pering introduced the improved long shank anchor in 1815 and recommended the use of good quality of iron. The arms were curved slightly instead of being straight. The form of the shank was slightly flattened at the sides instead of being round, and the arms were oval. The length of the shanks and arms of the anchors were changed and these anchors were known as 'Pering's Improved anchors' (Cotsell, 1856). Generally ships carry five to eight types of anchors depending on the size of the ship. The Sheet or the best Bower anchor is used only in emergency. The sheet anchor was carried on the aft of starboard and it was used when bower anchors failed or were dragged on the sea floor. Besides this, ships carry smaller anchors which were about one third of the weight of the Sheet and Bower anchor (Evans & Nutely, 1991).

From their shape and size it appears that the iron anchors of Sunchi Reef, both the anchors at the Archaeological Museum, Old Goa, the anchor with a wooden stock, and first and second anchors of Aguada bar, belong to the 'Admiralty Long Shanked' anchor. Anchors 'C' and 'D' of Aguada bar belong to the Pering's improved anchor group from their shape and size. During the Portuguese regime Old Goa was the capital, port city and main trade centre. All the Portuguese ships called at the Old Goa port. The Aguada sand-bar has caused many wrecks. The iron anchors, which were found in Aguada waters, belonged to the Portuguese vessels. Another iron anchor having a similar shape and size with a 3.50 m long shank has been found from the dockyard of Vijaydurg and is presently kept in the Lal Bahadur Shastri Nautical and Engineering College, Mumbai.

Conclusion

The stone anchors found during the marine archaeological explorations along the coast of India, were associated with the Arab mariners. Whether the anchors reported from the Indian waters had any direct relation with those early Arab traders or not is yet to be ascertained. In subsequent years, Indian mariners found these Indo-Arabian stone anchors suitable for use in the Indian Ocean region. Hence, they might have copied them and used them in Indian waters for centuries. Further, these anchors provide evidence for maritime trade contacts between the

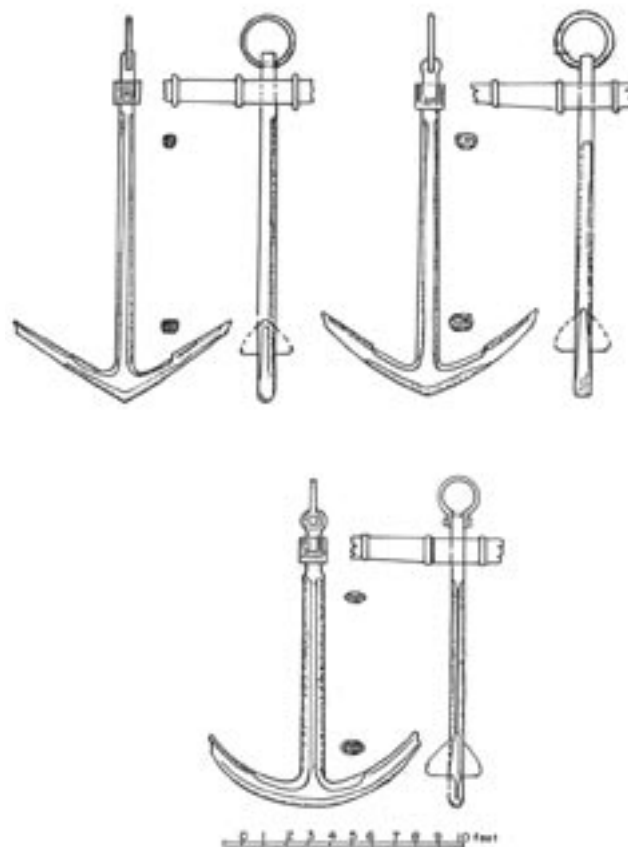


Figure 17. Pering's iron anchors, (After Cotsell 1856).

Arabians, Red Sea and East African coast countries. The finding of iron anchors confirms the loss of Portuguese ships in Aguada waters and statements made in the marine records emphasize this fact. For the first time in India, Aguada water has yielded a number of iron anchors. However, finding the remains of shipwrecks in Aguada waters would throw more light on the types of ships that were carrying these kind of iron anchors. The finding of stone and iron anchors in Goa waters relate to this transition period i.e. from old technology an adaptation of new technology. These types of iron anchors were in use between the beginning of the 15th century and remained typologically unchanged until the 19th century.

Acknowledgements

The authors express their deep sense of gratitude to Dr E. Desa, Director of the National Institute of Oceanography, and Shri K.H. Vora, Scientist-in-Charge, Marine Archaeology Centre for their encouragement in this field. The authors are indebted to Jeremy Green and Myra Stanbury, Western Australian Maritime Museum; A. Raban, Haifa University, Israel; Comdr. Somasiri Devendra, Sri Lanka; for providing information on anchors. The authors thank Dr R.V. Rao, Institute of Wood Science and Technology, Bangalore for anatomical analysis; Dr G. Rajagopalan, Birbal Sahni Institute of Palaeobotany, Lucknow, for radiocarbon dating of wooden stock of

iron anchor and the Archaeological Survey of India and Goa State Museum for providing the photographs of the iron anchors. We also acknowledge Dr P.S. Parameswaran, scientist of NIO, who carried out IR analysis of the samples; Shri S.N. Bandodker for photographs; Shri S.B. Chitari for drawings and Shri Anthony Estrocia sports diver of Goa for donating a stone anchor to NIO.

References

- Athiyaman, N., 2001, Stone anchors from east coast of India a precursor for marine archaeology of Tamil Nadu coast. *IHC: Proceedings, 61st (Millennium) Session*, 2001: 1293–1310.
- Chittick, H.N., 1980, Stone anchor shanks in the Western Indian Ocean. *International Journal of Nautical Archaeology*, **9.1**: 73–76.
- Costa, C.J., 2002, *The Heritage of Govapuri: A study on the artefacts in and around the Pilar seminary Museum*, Goa.
- Cotsell, G., 1856, *Treatise on ships' anchors*. London.
- Evans, V., and Nutely, D., 1991, Hooked on anchors. *Bulletin of the Australian Institute for Maritime Archaeology*, **15.2**: 41–44.
- Frost, H., 1989, "Pyramidal" stone anchors: An inquiry. *Tropics*, **1**: 97–114.
- Frost, H., 1985, Stone anchors; Criteria for a Corpus. *Thracia Pontica*, **III**: 352–369.
- Gaur, A.S., Sundaresh, Sila Tripathi, Gudigar, P., Vora, K.H., and Bandodker, S.N., 2001, A Group of 20 Stone anchors from the waters of Dwarka on the Gujarat Coast, India. *International Journal of Nautical Archaeology*, **30.1**: 95–108.
- Gune, V.T., 1990, Goa's coastal and overseas trade. In: de Souza, T. R., (ed.), *Goa through the Ages – II*. New Delhi, 117–135.
- Heras, H., 1932, Pre-Portuguese remains in Portuguese India. *Journal of Bombay Historical Society*, **4.2**: 1–56.
- Hourani, G.F., 1975, *Arab Seafaring in the Indian Ocean in Ancient and Early Medieval Times*. New York.
- Kamat, V., 2000, Trade and commerce under Yusuf Adil Shah (1489–1510 AD). In: Mhamai, S.K., (ed.), *Goa: trade and commerce through the ages*. Panaji, 43–55.
- Kapitan, G., 1994, Stone shank anchors of the Arab-Indian trade period—were they mooring anchors? *Bulletin of the Australian Institute for Maritime Archaeology*, **18.2**: 1–6.
- Kimpton, G., 1992, Construction of replica anchor stocks and a carronade carriage for display of artefacts from HMS *Sirius* (1790). *Bulletin of the Australian Institute for Maritime Archaeology*, **16.2**: 31–38.
- Nainar, S.M.H., 1942, *Arab geographers knowledge of Southern India*. Madras.
- Puech, A., 1984, *The use of anchors in offshore petroleum operations*. Huston.
- Raban, A., 2000, Three-hole composite stone anchors from a medieval context at Caesarea Maritima, Israel. *International Journal of Nautical Archaeology*, **29.2**: 260–272.
- Raban, A., 1990, Medieval anchors from the Red Sea. *International Journal of Nautical Archaeology*, **19.4**: 299–306.
- Rubin, N., 1971, The Anchor. *Nautical Research Journal*, **18.4**: 230–250.
- Shirodkar, P.P., 1990, Survey of the ancient Silahara-Kadamba port of Gopakapattana. *Journal Marine Archaeology*, **1**: 52–54.
- Sila Tripathi, 2002, Pyramidal anchor stone from Baga waters of Goa, west coast of India, *The Mariner's Mirror*, **88.1**: 6–13.
- Sila Tripathi, Gaur, A.S., Sundaresh and Bandodker, S.N., 2001, Exploration for Shipwrecks off Sunchi Reef, Goa, West Coast of India. *World Archaeology, (Shipwrecks)*, **32.3**: 355–367.
- Sila Tripathi, 1999, Exploration and excavation of shipwrecks in Goa waters. Technical Report No: NIO/TR-1/99, NIO, Goa, 1–35.
- Sila Tripathi, Gaur, A.S., Sundaresh and Bandodker, S.N., 1998, Historical period Stone anchors from Vijaydurg on the west coast of India. *Bulletin of the Australian Institute for Maritime Archaeology*, **22**: 1–8.
- Sila Tripathi, Saxena, M.K., Sundaresh, Gudigar, P., and Bandodkar, S.N., 1998, Marine archaeological exploration and excavation of Vijaydurg—a naval base of the Maratha Period, Maharashtra, on the west coast of India. *International Journal of Nautical Archaeology*, **27.1**: 51–63.
- Sila Tripathi, and Gaur, A.S., 1997, Stone anchors from Sindhudurg Fort on the west coast of India. *International Journal of Nautical Archaeology*, **26.1**: 51–57.
- Souter, C., 1998, Stone anchors near Black Fort, Galle, Sri Lanka. *International Journal of Nautical Archaeology*, **27.4**: 331–342.
- Sundaresh, Gaur, A.S., Gudigar, P., Sila Tripathi, Vora, K.H., and Bandodker, S.N., 1999, Stone anchors from the Okhamandala Region, Gujarat Coast, India. *International Journal of Nautical Archaeology*, **28.3**: 229–252.
- Thakkar, M., 1991, Search for shipwrecks in Goa water. In: Rao, S.R. (ed.), *Recent Advances in Marine Archaeology*. National Institute of Oceanography, Goa, 195–197.
- Tzalas, H., 1999, Were the "Pyramidal stone weights" of Zea used as anchors? *Tropics*, **V**: 429–447.
- Upham, N.E., 1983, *Anchors*. Shire Publications Ltd, Aylesbury, UK.
- Vosmer, T., 1999, Indo-Arabian stone anchors in the western Indian Ocean and Arabian Sea. *Arabian Archaeology and Epigraphy*, **10**: 248–263.
- Whitehouse, D., 1970, Excavations at Siraf. Third Interim Report. *Iran*, **VIII**: 1–17.