Building upon Honor Frost's Anchor-Stone Foundations

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Synthesis of the evidence and theories of Honor Frost and colleagues regarding stone-based anchors of the prehistoric Near East, substantiated by statistical analysis of a corpus of anchor object finds, illuminates elements of the early history of the tool. In the Near East pierced stone anchors were employed by seagoing sailors from at least the 3rd millennium BC. Stone-frame staked anchors likely first appeared around the 15th century BC on Cyprus and were possibly the primary tradition employed by Cypriot sailors until the close of the Bronze Age. However, pierced stone anchors continued to be employed by Levantine sailors into the 1st millennium BC, with their dominance ending only with the invention of the stock-anchor.

Keywords: Pierced stone anchor, planar stone-frame staked anchor, Prehistory, Cyprus, Levant, Egypt.

While Honor Frost's pioneering investigations into harbours and ships are influential, her greatest efforts were arguably with anchors and particularly prehistoric pierced anchor-stones. This paper is an overview and substantiation of Frost and her colleagues' work from the Mediterranean and Near East concerning the design and reconstruction of these anchors and their nautical contexts. It also addresses the reasons for the contemporaneous presence of two distinct types of anchor in the Near Eastern Late Bronze Age: the stone anchor and stone-frame staked anchor. This investigation is facilitated by employment of a diachronic, spatial, and object-characteristic database populated with published information from the Mediterranean and Near East, compiled by the author in a manner that Frost promoted (1973; 1986; 1997; see Appendix and Fig. 1).

In order to approach this topic and related complex questions, it is necessary to define chronological and geographical boundaries. As an expedient, the term 'prehistoric' refers here to the period prior to the 5th century BC, while 'historic' is

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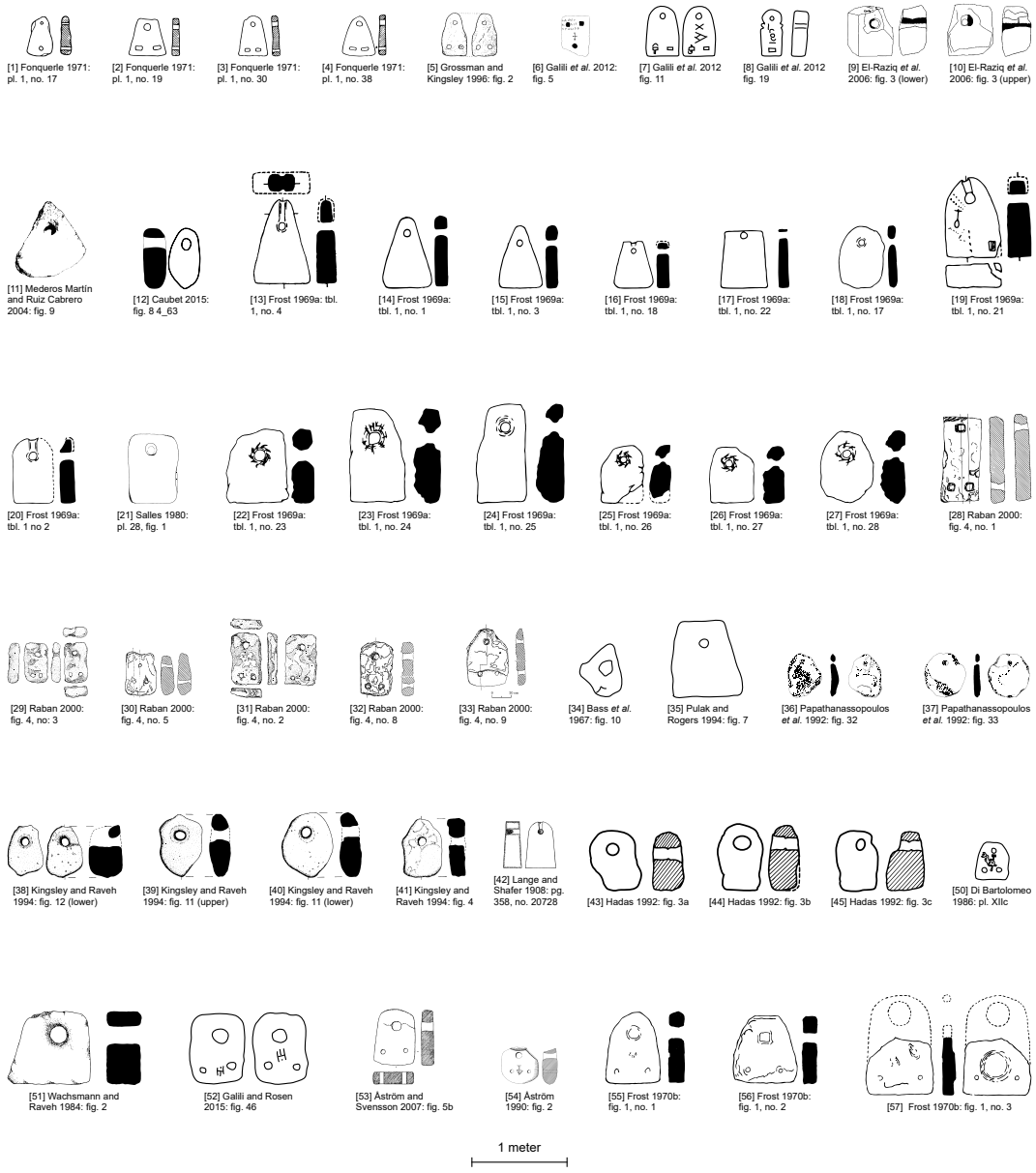

Figure 1. Tracings of anchor-stone illustrations. For full references see Appendix. (G. Votruba).

used for the 5th century BC and later. Because prehistoric finds are in focus here, the discussion and statistics presented relate to those objects with date ranges confined to 500 BC or earlier. Only those historical dating or ethnographically recorded finds that aid in hypothesis development for the prehistoric period are incorporated where relevant. Specifically, later-dating items are used to provide information about the organic superstructure for prehistoric reconstruction hypotheses and to contribute to setting the prehistoric finds in their diachronic economic nautical context. Contextual dating such as stratigraphic is considered, while several examples are also dated by

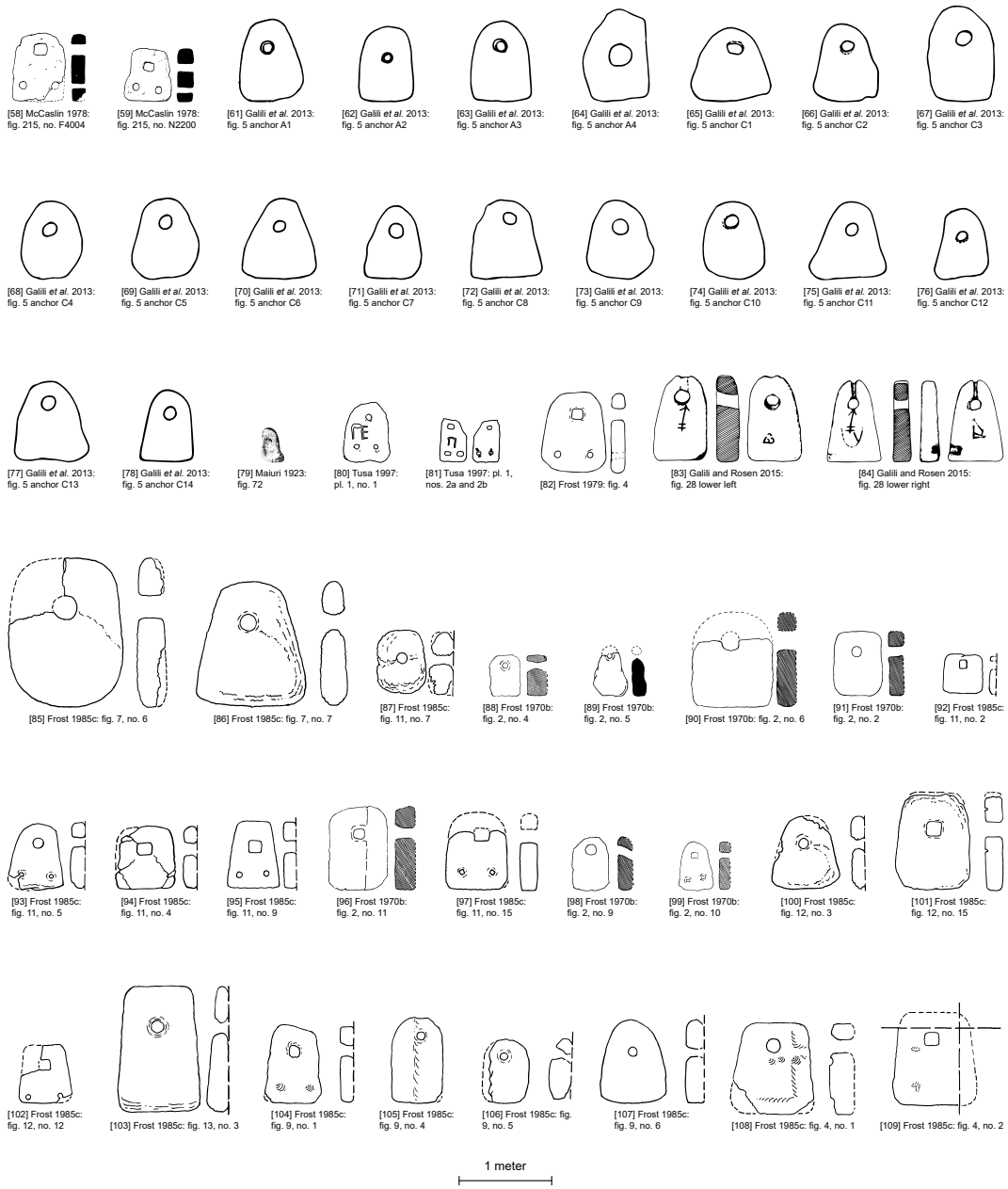

Figure 1. Continued.

object-specific features, or scientific analysis (inscriptions, C14 dating, etc.); the dates as published for each artefact are used here.

The 263 objects discussed are each identified by a catalogue number (in square brackets in the text). The catalogue consists of citations for each object and the scaled tracings of published illustrations, ideally line drawings, with at least frontal view and precise scale (Fig. 1). Because the publications related to these objects vary greatly in nature, quality, and comprehensiveness, and not all are illustrated to these

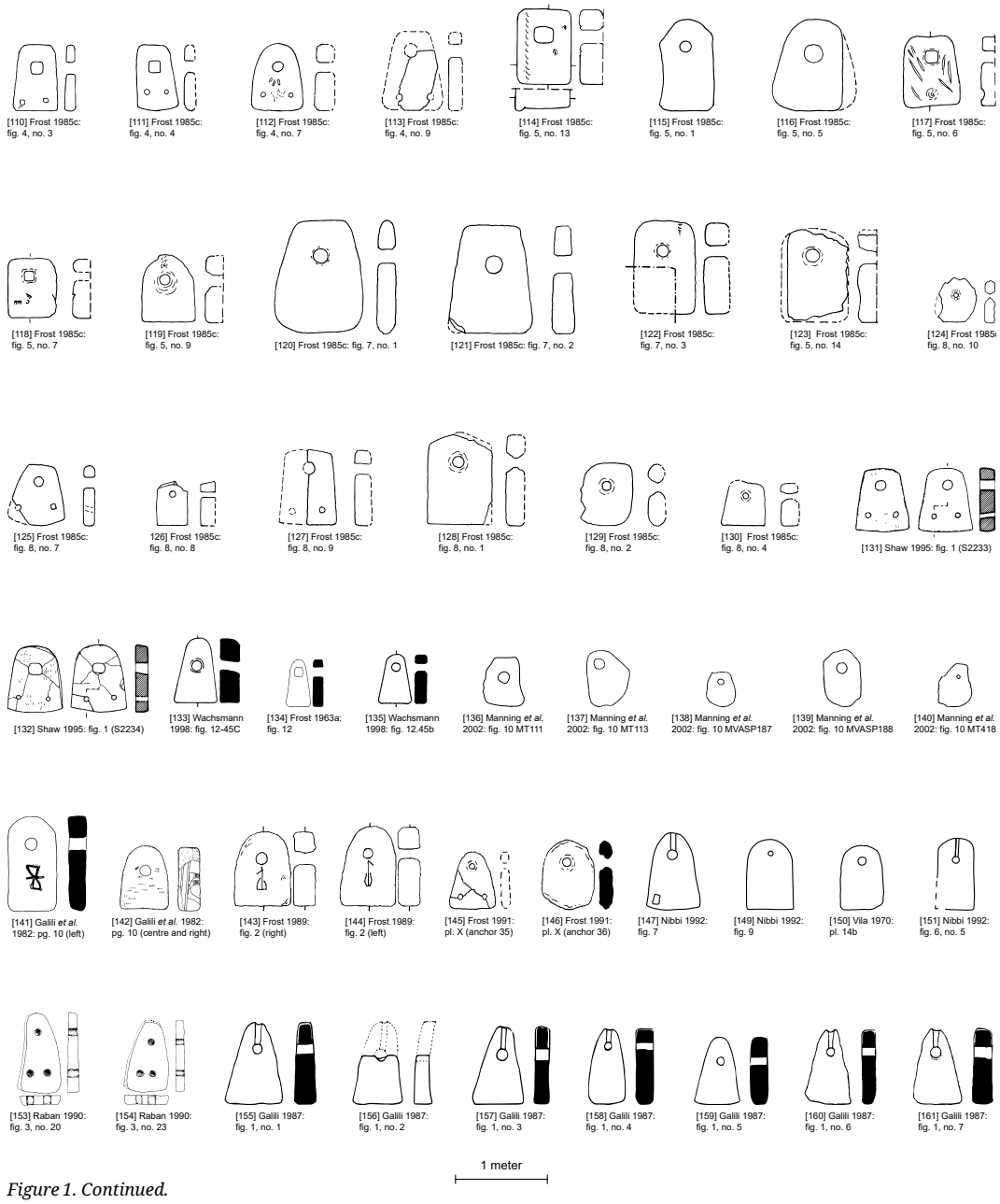

Figure 1. Continued.

specifications, the illustrations are not exhaustive. In the absence of an established typological sequence, dating based on similarity in overall form is avoided here.[1] Only those finds published and uncontested as anchor objects are considered. This study

1 The sole exception to this limitation is the wreck assemblage of the Neve Yam C which lacked datable associated finds. The importance of this assemblage renders a typological comparison necessary, fortunately displaying clear Middle Bronze Age dating parallels (Galili, 1985: 147 and 149; Wachsmann, 1998: 272-273).

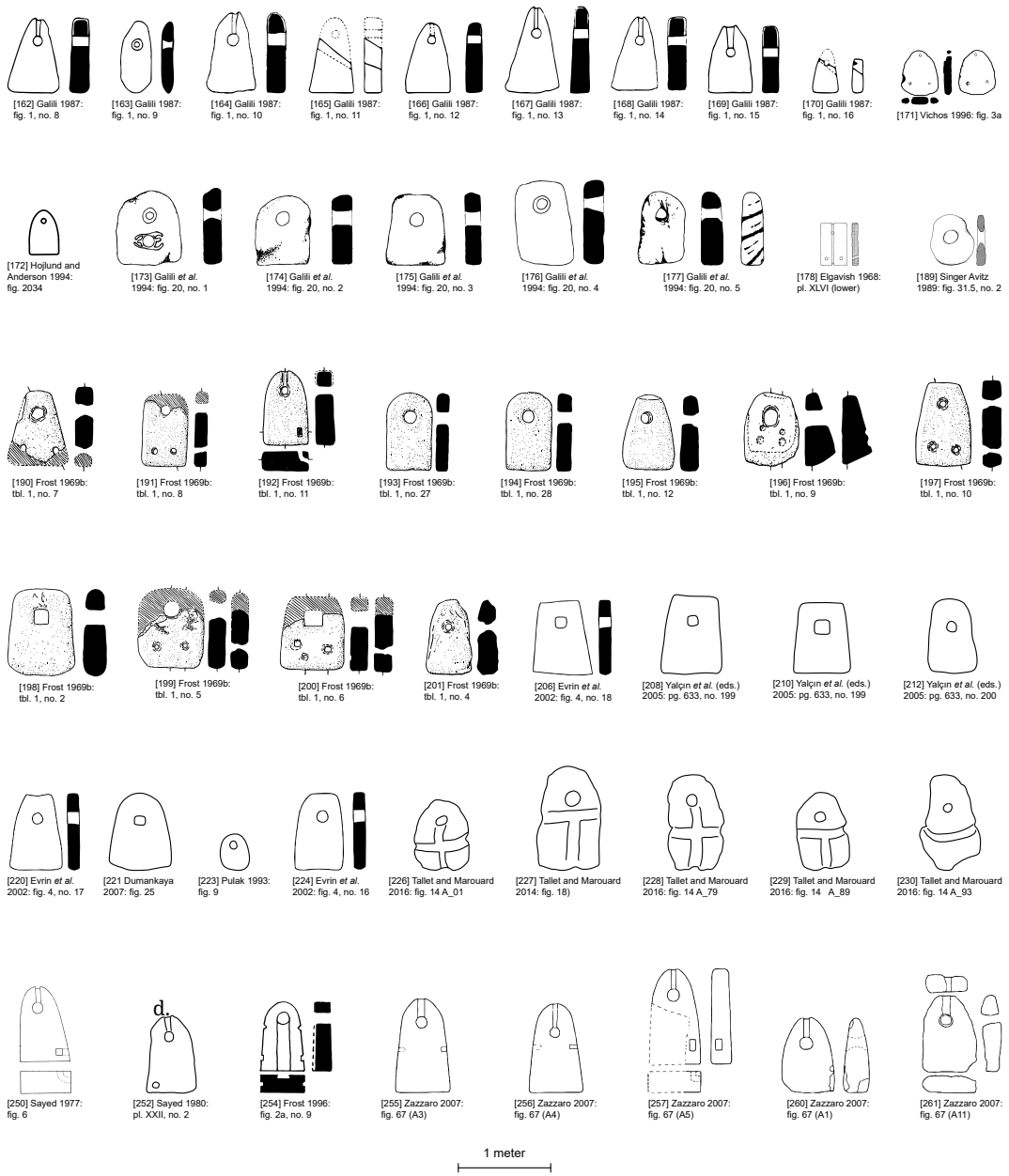

Figure 1. Continued.

focuses on three primary regions represented by uniquely large numbers of finds in datable contexts: the Egyptian Red Sea, the Levantine coast, and the island of Cyprus.

To simplify discussion, it is necessary to establish a system of acronym nomenclature (Fig. 2). A refined approach to the terminology of 'stone anchors' is taken here. The term 'anchor' refers to an object attached to the ship's (or other floating object's) cable as a tool to increase resistance opposite to the ship's momentum, regularly to hold it in a position. The only anchors that are here considered 'stone anchors' are those that consisted solely of stone when employed. These can be a 'pierced stone anchor' (PSA),

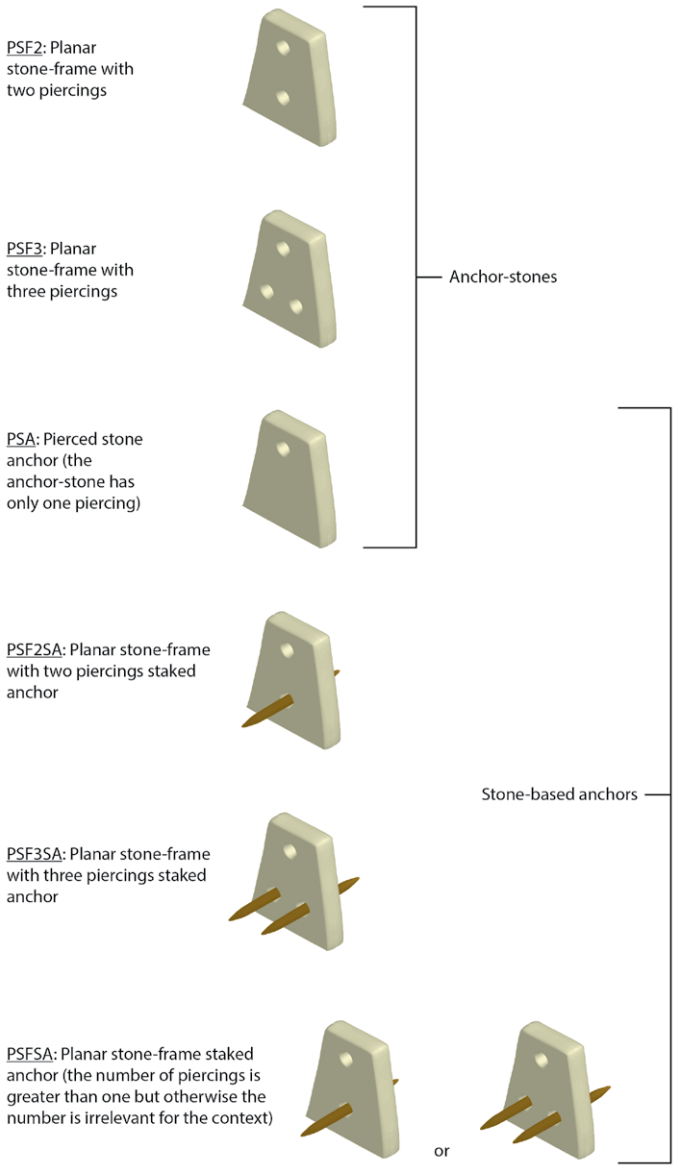

Figure 2. General terminology, acronym definitions and clarifying illustrations. (G. Votruba).

with a single piercing ('eye'; Fig. 3), intended to be run through by the cable directly or, rather, accommodate an eye-loop, or a waisted or grooved anchor, carved to allow the attachment of the cable. An unworked stone skilfully wrapped on all faces with a rope (or directly by the cable) would be termed a 'stropstone' (van Nouhuys, 1951: 20-21). There is no evidence for the use of 'stropstones' in the ancient Mediterranean, but this may be because of the difficulty in identifying them once the rope has disintegrated.

Those finds with pierced holes that would have held stakes, in addition to the eye, are here considered stone frames for anchors (henceforth 'stone-frames'). A rigged example would be rather a 'staked anchor' or, more precisely, a 'stone-frame staked anchor'. The elongated frustum-like variety known from medieval, primarily Indian

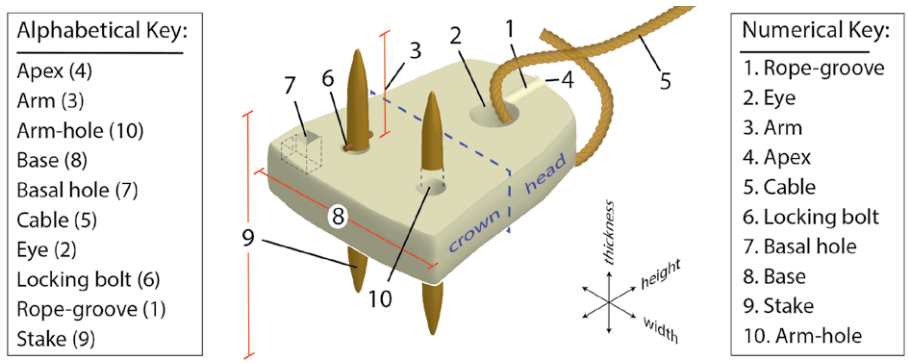

Figure 3. Generic illustration of pierced stone anchor (PSA) and planar stone-frame staked anchor (PSFSA) terminology. (G. Votruba).

Ocean contexts (see for example Gaur *et al.,* 2004), with the arm-holes running at right angles to each other, should be distinguished from this planar, broadly flat, prismatic variety with the arm-holes pierced through the same face. These are termed 'planar stone-frame', or 'planar stone-frame staked anchor' (PSFSA) in reconstruction. Where there is more than one piercing, the number (including the eye) is present within this acronym (PSF2SA or PSF3SA). Stone-frames with four or more piercings are absent from both the archaeological (cf. Frost, 1993: 452) and ethnographic anchor record. Stone-frame examples attributed to the prehistoric period are (currently) only of the three-hole type.[2] Possibly two arms engaged were understood to be better than one, both because of increased anchor resistance and also because two stakes would prohibit rotation, which would cause destructive abrasion of the arm.

It should be clarified that several prehistoric PSA also have an additional piercing called a 'basal hole', since they are located near the base (see Fig. 3, Table 3). The holes, which are roughly angular or L-shaped, exiting on adjacent faces, would not be fitted with stakes but were subsidiary rope attachment points for a location-marking buoy or trip-rope to remove an anchor when stuck (Wachsmann, 1998: 259; Frost, 2004: 329). Due to this distinct function, basal holes do not change the identity of the anchor-stone from a PSA to a stone-frame. Besides PSA and PSF3SA, only stock-type anchors have been positively identified for the prehistoric period, and then only in its final century. Stock-anchors are treated here only in relation to their significance to the prehistoric PSA and PSF3SA narrative.

This paper follows a micro to macroscale progression. It first discusses the design and reconstruction of these tools, independent of what they originally would have been anchoring (fishing apparatus, a ship etc.). Subsequently, the substantial evidence for their nautical employment is addressed. Finally, hypotheses are proposed regarding the distinct employment of prehistoric PSA and PSF3SA chronologically and spatially in the eastern Mediterranean.

2 Two illustrated pierced stones that have been interpreted as PSF2 from Pantelleria are the only such dated to the prehistoric period (Orsi, 1899: 463-464 and figs 13 and 14); however, each having a long-side broken edge and residential-terrestrial context, renders their identification problematic.

Design of prehistoric PSA and PSF3SA

Most prehistoric-dating PSA and PSF3 are reported to be made of limestone with sandstone being the second most common material (Table 1). These stones allowed for a functional hardness and weight but could still be worked with a chisel. The relative absence of igneous stones is feasibly the result of their excessive hardness, particularly considering the commonality of accessible basalts in Lebanon and Syria (Mascle, 1991: 373).

The eye is regularly pierced near the apex of the stones so that the distance between them was not so close as to be friable but still close enough to easily bend the cable to the anchor. This also created a centre of gravity distant from the eye so that, when suspended (or being dragged laterally), the anchor would orient itself head-up (or broadly shipward), and generally limit the rotation of the stone, which would have contributed to cable/eye-loop chafing. For the prehistoric period, eyes regularly appear large enough to insert a wooden beam sufficiently strong to act as a lever to carry the stone (cf. Wachsmann, 1998: 290), and to fit a durable, robust cable portion or eye-loop. Feasibly a large hole would also allow a second anchor to be attached to the same cable when needed, which might require the hole to be of a diameter greater than twice that of the cable. A slack portion of the cable already being employed (with one end attached to the first anchor, the other to a bit, for example) could be bighted and pushed through the eye of a second anchor to be reattached to itself with a lashing.

Due to the PSA/PSF3SA's suspended orientation, often the head of the PSA or PSF3 was rounded (Fig. 4 a), the overall frontal shape was generally triangular (or isosceles trapezoidal, Fig. 4 b) or at least the corners of a flatish head are rounded or angular (Table 2). These expedients benefited the raising of the anchor, whether from the hold or retrieval to the ship, so that its head portion did not catch, minimizing any potential damage to the hull. The profiles of PSA and PSF3 were typically flat or slab-like (planar; with a profile thickness ratio measured at the eye and at the base between 0.8 and 1.2), which would facilitate stacking and stowage. This would have been particularly the case

	Number	Catalogue Nos
Limestone	144	12, 13, 14, 15, 16, 17, 19, 20, 22, 23, 24, 25, 26, 27, 36, 37, 42, 53, 54, 55, 56, 57, 58, 59, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 82, 83, 84, 85, 88, 89, 91, 95, 96, 97, 98, 99, 102, 104, 105, 106, 108, 109, 110, 111, 112, 114, 124, 126, 128, 129, 131, 132, 141, 142, 143, 144, 145, 146, 147, 149, 151, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 173, 174, 175, 176, 177, 189, 190, 192, 198, 200, 201, 204, 223, 226, 228, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 255, 256, 257, 258, 259, 261. 'chalk' – 191, 193, 194
Sandstone	47	18, 35, 52, 81, 92, 94, 100, 101, 116, 117, 118, 119, 120, 121, 122, 127, 133, 134, 135, 148, 150, 152, 196, 202, 203, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 224, 225, 227, 229
Granite	2	21, 260
Basalt	2	195, 197
Conglomerate	7	86, 87, 90, 107, 125, 171, 199
Gneiss	1	220

Table 1. Published geology of anchor-stones.

for stone-frames, which were required to be narrow to enable piercing the arm-holes. A fairly flat-cut base is also common. This would have allowed for some temporary stability when stood upright, which would help when tying the cable through the eye and rigging the stakes through the arm-holes of PSF3 prior to deployment, for instance.

Since practically no organic fittings of prehistoric PSA and PSF3SA anchors have been preserved, their original form and rigging must be interpolated from parallels. Both ethnographic and historical evidence of PSFSA demonstrate the fitting of stake(s) within the arm-hole(s) accompanying the eye. The sole PSF3SA in the ethnographic record derives from Spain or its vicinity and has two wooden stakes fitted into the two

	Number	Catalogue Nos
Rounded head	86	10, 19, 20, 42, 55, 56, 58, 62, 63, 66, 67, 71, 72, 76, 77, 78, 83, 84, 88, 93, 94, 96, 97, 98, 105, 106, 112, 115, 119, 126, 127, 131, 132, 141, 142, 143, 144, 147, 148, 149, 150, 151, 172, 173, 174, 175, 177, 192, 193, 194, 196, 209, 212, 215, 218, 221, 225, 226, 227, 228, 229, 232, 233, 234, 236, 237, 238, 240, 241, 242, 243, 244, 245, 246, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 260, 261
Approximately triangular face	87	13, 14, 15, 16, 35, 42, 56, 59, 61, 63, 65, 66, 69, 70, 71, 72, 75, 76, 77, 81, 82, 86, 89, 93, 95, 99, 100, 101, 102, 104, 107, 108, 110, 116, 120, 121, 125, 131, 132, 133, 134, 135, 144, 145, 147, 148, 155, 157, 158, 159, 160, 161, 162, 164, 166, 167, 168, 169, 195, 197, 201, 203, 205, 206, 207, 208, 209, 210, 212, 215, 216, 218, 219, 220, 221, 224, 225, 231, 235, 240, 244, 246, 255, 256, 257, 260, 261
Rounded/ angled corners at the head	17	21, 22, 23, 24, 25, 26, 51, 52, 53, 92, 111, 117, 122, 128, 130, 183, 198
Flat/slab-like (profile thickness ratio between 1.2 and 0.8)	87	9, 10, 11, 12, 13, 14, 15, 20, 26, 27, 35, 51, 52, 53, 54, 55, 75, 76, 78, 80, 81, 83, 84, 85, 86, 87, 88, 90, 91, 93, 94, 95, 96, 97, 98, 99, 100, 101, 104, 106, 107, 108, 110, 111, 112, 113, 114, 120, 121, 122, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 140, 143, 144, 145, 146, 172, 173, 174, 175, 176, 177, 178, 189, 206, 208, 210, 212, 220, 224, 250, 251, 252, 254, 255, 256, 257, 261
Wide base (profile thickness ratio between 0.8 and 0.56)*	23	22, 23, 24, 25, 36, 37, 42, 62, 63, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 77, 89, 171, 260
Flat(ish) base	185	10, 13, 14, 15, 16, 17, 19, 20, 21, 22, 23, 24, 25, 26, 35, 42, 51, 52, 53, 55, 56, 57, 58, 59, 61, 62, 63, 64, 65, 66, 67, 69, 70, 71, 72, 75, 76, 77, 78, 81, 82, 83, 84, 86, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 125, 126, 127, 128, 130, 131, 132, 133, 134, 135, 141, 142, 143, 144, 145, 147, 148, 149, 150, 151, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 172, 173, 174, 175, 176, 177, 179, 183, 186, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 212, 213, 215, 216, 218, 219, 220, 221, 224, 225, 226, 227, 228, 229, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 260, 261
Base not flat or ambiguous	40	9, 11, 12, 18, 27, 34, 36, 37, 46, 47, 48, 49, 54, 73, 74, 79, 85, 87, 123, 124, 129, 136, 137, 138, 139, 140, 146, 152, 171, 180, 181, 182, 189, 211, 214, 217, 222, 223, 230, 247

Table 2: Diagnostic features of illustrated anchor-stones.
** These are primarily represented by two groups. One with a median date prior to the 3rd millennium BC, as possibly indication of early indifference. The second is more anomalously the Late Bronze Age Hishuley Carmel wreck assemblage.*

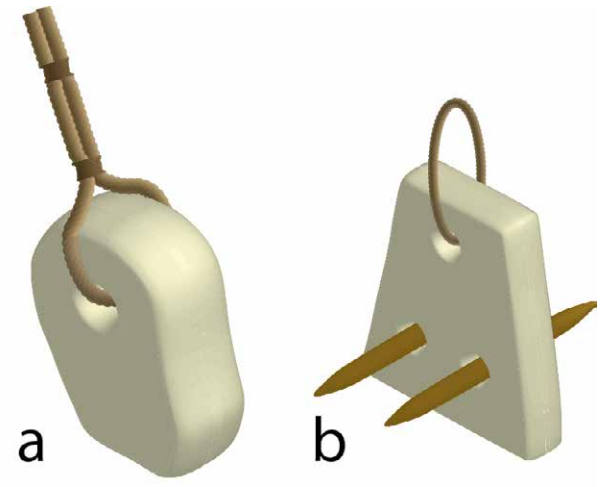

Figure 4. PSA (a) and PSF3SA (b) as recorded with associated organic portions. The PSA is based on two Hellenistic dating finds from the Dead Sea ([43] and [45]). The PSF3SA derives from the record of expendable fishing-vessel anchors from Spain or its vicinity (Rodríguez Santamaría (1923: 665-667). (G. Votruba).

arm-holes pierced crownward from the eye (Fig. 4b), while an eye-loop runs through the eye. Correspondingly, only single stakes are seen with PSF2SA,[3] the eyes of which can either be fitted with an eye-loop or accommodate the cable directly.[4] An incompletely excavated stone-frame staked anchor [60] from the Nile Delta silt, with a date range that could include the prehistoric period, has a wooden stake in the one exposed arm-hole (Rodríguez Santamaría, 1923: fig. 479). One Byzantine find from Yenikapı, Turkey, has two wooden stakes through the crown and a fragment of its binding rope running through the eye [262], while detail of another also has a rope fragment through the eye [263]. To this, several other ancient PSF3 ([81] 6th century BC), [5] 12/13th century AD) or undated stone-frames (PSF3: [2], [3], [4], [6] and PSF2: [1]) have been found with fragments of wood preserved only in the crownward piercings. Similarly indicative are concretions derived from iron locking bolts originally run perpendicularly through the arm and projecting at both sides flush with the stone-frame, used to hold the stake in place ([81] 6th century BC, [50] 'Roman'; [7] 6th to 7th century AD; [6] Roman or later: all PSF3). These also are of relatively later date. If such fastening mechanisms were used in the Bronze Age, they could have been made of wood, which would not have left a trace (Fig. 3, No 6). Only one side of the stake would need to be bolt-locked because it would be shaped to taper, or had a projecting step that would keep the stake from sliding further than necessary. Alternatively, carefully inserted wedges tight between the stake and arm-hole edge may have been an option.

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3 Rodríguez Santamaría (1923: fig. 479) illustrates a PSF2SA with only the crownward piercing accommodating a wooden stake. Only single-stakes are also reported from PSF2SA from the Middle East: Persian Gulf (Dickson, 1959: 482 (a); Bowen, 1957: 289-290; Frost, 1994: fig. 6); Syria (Frost, 1993: 453 and fig. 3; and 1995: 170, figs. 5 and 6).

4 Bowen claims that the eye of PSF2SA could be fitted with either a chain loop or the cable itself (1957: 289-90); while an example illustrated by Frost has a chain-loop (1994: fig. 6). The PSF2SA example from Syria has the looped-cable directly run through the eye and subsequently run through its loop. It may be relevant that all those ethnographically reported from the Persian Gulf have the eye running transversely, *i.e.* through the narrow edges; a logical expedient for avoiding rope abrasion, but one not seen dated to the prehistoric period.

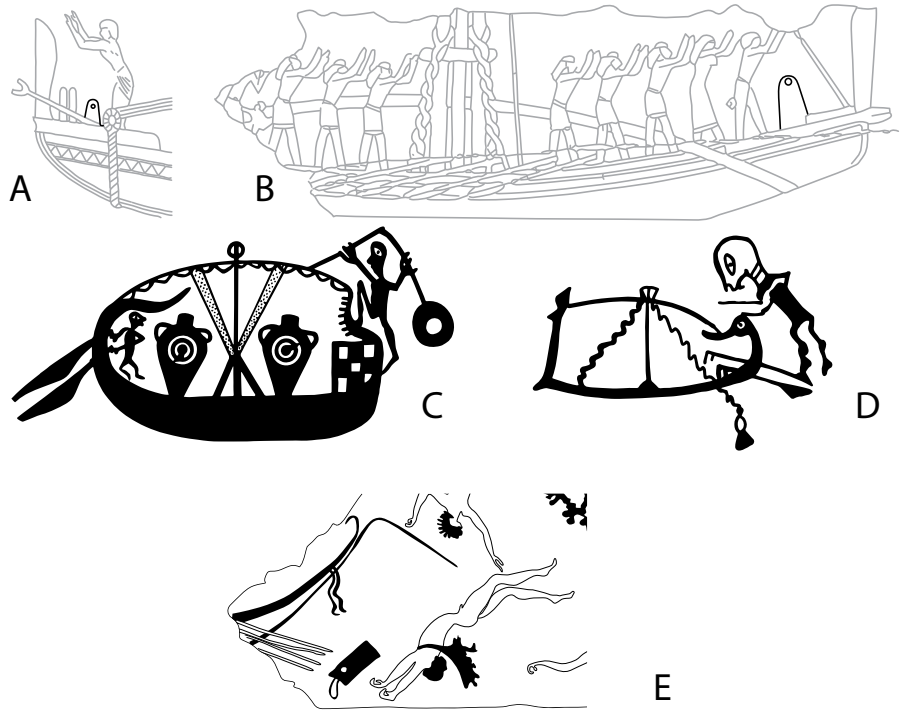

Figure 5. Prehistoric iconography illustrating PSA. a) Stone relief of one of the ships in the funerary complex of Pharaoh Sahure. (5th dynasty; c.2500 BC; Frost, 1985 a: fig. 1; Basch, 1987: fig. 72); b) stone relief of a ship of the pyramid of the Pharaoh Ounas. (5th dynasty, c.2400 BC; Hassan, 1955: fig. 2; Frost, 1979: pl. 1); c) painting on a c.7th century BC Cypriot 'Bichrome IV' jug. (Karageorghis & Des Gagniers, 1974: 122); d) painting on a c.7th century BC Cypriot 'White Painted IV' jug. (Karageorghis & Des Gagniers, 1974: 123); e) detail of a violent naval scene fresco fragment from the destruction of Thera of the mid-2nd millennium BC. (Marinatos, 1974: pl. 7; Papò, 2008: 59 and fig. 44).

The form of the wooden arms can be straight and whittled to fine ends, according to the Nile Delta [60] and Yenikapı [262] examples. In neither case is arm length precisely measurable, but these and a Spanish ethnographic PSF3SA sketch (Rodrígues Santamaría, 1923: fig. 521) suggest that arms could project a significantly greater distance (several lengths greater than the thickness of the stone-frame) than the stubby ethnographic examples illustrated from the Levant and Persian Gulf. As the frontal form of stone-frames generally narrow towards the head, the crownward placement of the arm-hole(s) would ensure that the stake(s) was located at a relatively ballasted position for greater seafloor friction, while also sufficiently distant from the eye, base, and sides to minimize stone-frame fragility.

Regarding PSA, two historically dated examples from the Dead Sea were found with the cable run through the eye and continuing through to be tied to itself some 1.40 m back ([43], [45] 3/2nd century BC; Fig. 4a). The portion where the rope ran parallel to itself was bound by a fine lashing near to the PSAs' apex and at several other locations along the rope's length. This technique would have thickened the leading portion of the cable, which was particularly susceptible to chafing on the seafloor. The PSA depictions on

	Number	Catalogue numbers
With a basal hole	12	19, 84, 147, 192, 250, 251, 252, 253, 255, 257, 258, 259
Eye shape round	162	9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 34, 35, 36, 37, 42, 46, 47, 51, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 83, 84, 85, 86, 87, 88, 89, 91, 98, 100, 105, 106, 107, 108, 115, 116, 119, 120, 121, 122, 123, 124, 126, 128, 129, 130, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 146, 147, 148, 149, 150, 151, 152, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 166, 167, 168, 169, 170, 172, 173, 174, 175, 176, 177, 179, 180, 183, 184, 189, 192, 193, 194, 195, 196, 201, 203, 204, 206, 209, 211, 212, 215, 218, 220, 222, 224, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 249, 250, 251, 252, 253, 254, 255, 256, 257, 260, 261
Eye shape polygonal	22	90, 92, 94, 96, 101, 109, 114, 117, 118, 198, 202, 205, 207, 208, 210, 213, 214, 216, 217, 219, 221, 225
With rope-groove		13, 16, 19, 20, 42, 83, 84, 147, 148, 150, 151, 155, 157, 158, 160, 161, 162, 164, 166, 167, 168, 169, 192, 250, 251, 252, 253, 255, 256, 257, 260, 261

Table 3. PSA features.

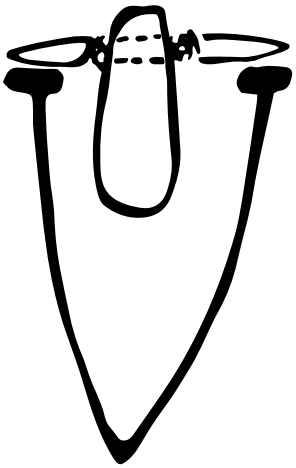

Figure 6. Sketch of a single-hole pierced stone with a stake placed through the eye from the Gilbert Islands (after Grimble, 1924: fig. 18 upper right). Originally accompanied by the handwritten text: 'Anchor stone pierced by "palm" of wood slung in place across gunwales'.

the Thera fresco (Fig. 5e) and a 7th-century-BC Cypriot jug (Fig. 5d) seem, like Rodríguez Santamaría's PSF3SA record, to have an eye-loop.

A stake placed through the eye, producing two arms, would conceivably have increased the potential anchor-holding friction (Kapitän, 2001); however, whether a stake was also inserted through the eye, along with the cable (or cable-loop), is not clear. An example of such an anchor has been sketched from the Gilbert Islands in profile (Grimble, 1924: fig. 18 upper right) (Fig. 6). It indicates that the bind to the ship is made by tying the cable to both projecting arms rather than running the rope through the eye along with the stake. Nikolaou and Catling (1968: 229) have suggested that the polygonal (square) eye, occasionally seen on both PSA (*c.*12%) and PSF3, would better accommodate a wooden beam (Table 3). However, as Frost expounded (1986: 358-359; 1991: 362; 1996: 883), the difference between a polygonal and round hole may merely be that between employing a chisel or a drill. Several prehistoric finds have rope stabilizing and protecting rope-grooves running around the apex and

carefully chiselled until the eye, giving the impression that the cable (or eye-loop) would have run through the hole. However, such grooves conceivably would also have been beneficial for a bind similar to that indicated from the Gilbert Islands example mentioned above.

It might, however, be emphasized that the Gilbert Islands example may be exceptional. Ethnographically, in its neighbouring broader island region bound by the continent of Asia and Australia, PSA and stropstones are widespread and far better represented (Van Nouhuys, 1926: 272-273; Sarasin, 1938: 11-28). Correspondingly, only PSA (without arms) are apparent within the five known examples of prehistoric iconography (Fig. 5). Additionally, the only ancient (Hellenistic) single-holed stone examples found in conditions allowing organic preservation were PSA [43] and [45]. PSA's absence of projecting portions would facilitate stowage as clearly relevant for the ships that held numerous examples such as the Neve Yam C (16; Galili, 1985, 1987; Marcus, 2007: 156, n. 55), Uluburun (24; Wachsmann, 1998: 281-283; Pulak, 2008: 210-211, 299, 306-307) and Hishuley Carmel (18; Galili *et al.*, 2013: 4-6), while any conceivable relative inefficiency resulting from the armless form would be accommodated by deploying more PSA as conditions dictated.[5] Nevertheless, in contrast to the robust ethnographic and historical period evidence that two- and three-holed stone-frames would only have been fitted with stakes in the crownward holes, the evidence is less substantial for one-hole stones.[6] Therefore, while the bulk of the evidence suggests that single-pierced anchor-stones were likely PSA (that is, accommodating only the cable's attachment – or eye-loop – in the single piercing ('eye'), resulting in the preference here to identify them as such, it cannot be confidently concluded that a ground-resisting stake was never fitted through the eye.

In summary, it is most likely that the eyes of prehistoric PSA and PSF3 would have been left for the cable-bind only, be it with an eye-loop or run through with the cable directly. Stones with two or more piercings would have wooden stakes through the arm-hole(s) located at the wider portion of the face, near the base. It appears that prehistoric PSA would produce holding resistance deriving primarily from their weight in conjunction with whatever surface friction they produced (as examined by WAREP, see Votruba and Erkurt, 2017). If PSA were less efficient in holding power, they would have had the added benefit of being readily stackable and better distributable as ballast when inboard. They could also more effectively be employed to slow the momentum of the ship, when approaching shore for example, just as pierced stones (λίθος τετρημένος) were employed at the stern for Nilotic vessels travelling downstream, as observed by Herodotus (*II*, 96).

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5 The suggestion of multiple PSA/PSF3SA regularly deployed together and attached in a chainlike manner by Wallace (1964) and Green *et al.* (1973: 173) is feasible. However, as Frost clarified (1982 a: 263-265), we lack clear oriented lines of pierced stones of sizes typical of prehistoric anchors on the seafloor.

6 One might suspect that the form of the piercings of the objects could help identify the intended fittings within them. For example, perhaps bi-cupular holes would be more suited to rope, whereas straight holes support stakes more easily. Presumably, three-holed stones would be most clear in this regard having both holes for rope and stakes. However, as illustrated, all examples of three-holed stones seem to have a single hole shape, be it bi-cupular, straight, or something in between.

Nautical contexts

Frost was the first to synthesize the evidence that heavy pierced stones found terrestrially and on the seafloor in the eastern Mediterranean were originally prehistoric PSA or PSF3 for anchoring ships (1963 a, 1963 b).[7] Later discoveries have largely demonstrated the validity of this nautical attribution despite their illogical design in comparison to modern anchors. Several PSA of the Old Kingdom period were found in position where ships had been anchored within a Red Sea harbour, at Wadi al-Jarf, protected by a breakwater (Tallet *et al.,* 2012: 422-423 and n. 88, 90, 93, figs 9, 30, tbl. 2; Tallet and Marouard, 2012: 5 and 2016: 141, fig. 4 upper; Tallet, 2013: fig. 7, 2015 b: 63 and 2015 a). A similarly early Red Sea Egyptian PSA find [9], excavated at Ayn Soukhna, had a preserved painted hieroglyph including a portion meaning 'ship' (Tallet, 2006: 27). These are testimony to Frost's attribution of 5th Dynasty murals illustrating pierced anchors in position for use from the bows of seagoing ships (Fig. 5a and b).[8]

Regarding ships themselves, PSA have been found among the 2nd millennium BC shipwreck assemblages of the Neve Yam C, Uluburun, Hishuley Carmel; and, likely, Cape Gelidonya A (Bass, 1967: 45; 1999: 23; Pulak and Rogers, 1994: 20). The large number of anchors found on the first three of these sites suggests that many would regularly have been employed as anchors but also as ballast when stowed (Erkurt, 2005: 328). Large marine PSA and stone-frame concentrations that have been found off the 2nd-millennium-BC Cypriot sites at Kouklia-Achni (Howitt-Marshall, 2012) and Maroni (Manning *et al.,* 2002), have been interpreted as indicating anchorage activities.[9]

For the final three centuries of the prehistoric period, multiple PSA have been identified in the 8th-century-BC Phoenician Tanit and Elissa wreck assemblages in the open sea, off Ashkelon (Ballard *et al.,* 2002). These wrecks are paralleled by two 7th-century-BC Cypriot jug depictions displaying PSA cast from ships, one manipulated by a sailor at the bow (Fig. 5c), and another of a ship in distress likely overseen by a protecting deity (Fig. 5d). Frost (1982 b) suggests this ship was identifiably in distress because of the zig-zag form of the cable and what she perceived to be a protecting deity, along with a nearby swastika, which she considers a distress symbol based on nautical Dipylon painted scenes. A PSA was found at Bamboula/Kition in a 7th/6th-century-BC context, which was accompanied in an immediately subsequent stratigraphic layer by a stone-stock in the same sacred area (Caubet, 1984: 112, 115-117, 144-146, 285; figs 8.4, 63; Frost, 1982 a; Brody, 1998: 51-52, n. 64).[10] As Frost highlighted, this is illustrative of the change in anchor design occurring *c.*600 BC with the appearance of the stock-anchor.

As at Bamboula, it is particularly characteristic for Frost to highlight the anchor finds made terrestrially, demonstrating that they are often in the vicinity of sacred areas. At Byblos, several PSA are said to have been found in sacred contexts at the end of the Early Bronze Age 'Tower-Temple' and Middle Bronze Age 'Temple of the Obelisks'

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7 Dunand was identifying PSA as such from excavated prehistoric levels at Byblos as early as 1954.

8 cf. Moll (1918: 357); For conclusion to debate regarding the small triangular objects at the bows of Nile-going vessels, that they are dedicatory bread loaves rather than anchors, see Doyle (2002: 313-317) and bibliography there.

9 The practice of permanent moorings appears to be a modern phenomenon (Rose, 2003), while for Mediterranean seagoing-ships habitual beaching was atypical at best (Votruba, 2017).

10 For stone stocks generally and the probable 7th/6th century BC appearance of the stock-anchor see Gianfrotta (1977) and Kapitän (1982).

precincts (Frost, 1969 a)(see Francis-Allouche & Grimal, this volume); the latter, Aaron Brody proposes, was attributed to a divine patron of sailors connected with Melqart (1998: 44-45, n. 26). Supplementing these, there are numerous finds in sacred contexts or in the vicinity of temple structures at Kition (Frost, 1985 c). Several of these temples have depictions of ships inscribed on their masonry (Basch & Artzy, 1985; Brody, 1998: 50). In the courtyard of one, a PSA-like object (treated as one here, [124]) was found standing upright on a mudbrick plinth surrounded by horns and cranium fragments of animals. For Ugarit, Frost demonstrated that PSA and PSF3 are clustered around the temple of the storm god Ba'al, as opposed to the nearby land god Dagon's temple (Frost, 1991). Therefore, these are feasibly *ex-voto* dedications to deities. The Cypriot jug with a ship in distress and 'deity' (Frost, 1982 b) could be Ba'al himself, overlooking a ship that has deployed a PSA in the hope of slowing its storm-tossed progress. Frost further highlighted the textual testimony for sacred anchor dedication of Apollonius of Rhodes (*Argonautica*, *I*, 955-960), Arrian (*Periplus Maris Euxini*, X) and Pausanias (*Description of Greece*, 1.4.5; *e.g.* Frost, 1970 c: 56-57, cf. Brody, 1998: 76). Therefore, the commonly sacred terrestrial context of many of the finds is reasonably a reflection of the sailors dedicating them after believing they had been protected while sailing (or also possibly in veneration prior to a daunting journey), and as further evidence for a nautical connection.

While the evidence for nautical employment of these stones is robust, other uses cannot be excluded, particularly for fishing and oil-pressing industries. While employment within fishing industries, as net anchors or other fishing purposes, must be considered, ethnographic evidence for the use of stones employed in the Mediterranean suggests that these stones would have been significantly smaller. Frost reports that stones weighing about 10 kg (1984: 125) are employed with contemporary fishing apparatus, while those of 2-7 kg were used for fixed-line fishing (1985 b: 170; 1991: 365; cf. De La Blanchère, 1868: 121-124). Wachsmann illustrates a cobble with a maximum length of *c.*15 cm serving as a weight for a contemporary fishing net at Acco, Israel. The stone was attached to the net by a small hole (1998: 273 and fig. 12.35), and a similar net on a boat in Lebanon is published by Frost (1985 b: fig. 79a). Regarding ancient evidence, Frost highlights an Egyptian Old Kingdom image of a fishing net with apparently modest, waisted, stone-like objects attached (1985 b: 170). For the Roman period, Oppian, within his substantial discourse on fishing techniques, describes a τρητὸν λίθον 'pierced stone' anchoring a wickerwork fish trap supported by cork, used for an unidentified flat fish (*Hal. 3.371-375*). Recorded free-diving stones appear similarly light (Frost 1969 a: fig. 10, pl. 4 upper; 1982 c: fig. 1). Van Nouhuys (1926) cites a 17th-century text describing pierced stones used for diving weighing *c.*25 kg, while a descriptive poster of the occupation by an E.L. Ettman and Co. dated 1897, informs us that they weigh *c.*18 kg. Ultimately the evidence for employing stones for fishing suggests they would weigh under 30 kg.

Similarly, it is easy to recognize the usefulness of many single-pierced stones found terrestrially as press weights, most commonly for olive-oil production, but for fish oils and other pressed products as well. However, while oil weight stones are regularly as heavy as ship's anchors, they are commonly designed differently (Hadjisavvas, 1992; Callot, 1987 a). They have large, wide bases so that they are stable when standing upright (and for pressing the olive baskets), or otherwise display considerable asymmetry to precisely fit the contours of the pressing vat (Frost, 2001 a: 199).

	Type	Catalogue Numbers
Anchor-stones with illustrations and published weights		7, 9, 10, 28, 29, 30, 31, 32, 33, 36, 37, 38, 39, 43, 44, 45, 52, 55, 80, 81, 83, 84, 88, 99, 131, 132, 143, 144, 146, 153, 154, 171, 174, 175, 176, 206, 208, 210, 212, 220, 224
Anchor-stones with directly calculated volumes	PSA	9, 10, 11, 12, 13, 14, 15, 20, 22, 23, 24, 25, 26, 27, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 51, 62, 63, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 85, 86, 87, 88, 91, 94, 96, 98, 100, 101, 107, 114, 120, 121, 122, 126, 129, 130, 133, 134, 135, 136, 137, 138, 139, 143, 144, 146, 172, 173, 174, 175, 176, 177, 189, 206, 208, 210, 212, 220, 224, 250, 251, 252, 254, 255, 256, 257, 260, 261
	PSF3	5, 7, 28, 29, 30, 31, 32, 33, 52, 53, 54, 55, 80, 81, 95, 99, 110, 111, 112, 125, 131, 132, 145, 153, 154, 171, 178
	PSF2	8
Anchor-stones with volume estimated by recorded weight	PSA	35, 202, 203, 204, 205, 207, 209, 211, 213, 214, 215, 216, 217, 218, 219, 221, 222, 223, 225

Table 4. 'Informative' anchor-stones (See Fig. 7).

A further possible approach to recognizing stones used as anchors is to examine their dimensions and weights in detail – specifically, examining the diachronic pattern of change in the volumes of identified PSA and stone-frames (a relative approximation of stone weight)(Fig. 7). Volumes have been calculated primarily using published dimensions (Fig. 8, Table 4).[11] Their weights are derived from the density trend produced from illustrated anchors whose weights have also been published. In absence of published drawings, the volumes of Uluburun and Cape Gelidonya A PSAs, and PSF2 or PSF2SA ethnographically testified by Bowen for the Persian Gulf (1957: 289-90) are based on their published weights in relation to this density trend. Using this information, the size of anchor-stones from the 1st millennium BC appear noticeably small compared to those typical of the two previous millennia, and sparser, although detailed data from the first few centuries of the 1st millennium BC are unfortunately lacking (Fig. 7). A closer examination reveals a further historical pattern of gradual decline in the size of anchor-stones. It seems that seagoing ships, at least those from *c.*600 BC, were abandoning pierced stone-based anchors for the new stock-anchor design. The gradual decline indicates the slower adoption of stock-anchors by provincial vessels: increasingly, only smaller vessels were employing PSA or PSFSA[12]. Conversely the pattern of known shipwrecks demonstrates a remarkable increase in both seafaring and the size of the largest ships from the 6th century BC into the Roman period (Parker,

11 Calculation of volume for PSA see Fig. 8: (([A] x (([B]+[D]+[E]+[F])/2) x (([J]+[I]+[G])/3))-(((((π) x (((([C]+[D])/2)/2) x ((([C]+[D])/2)/2))) x [I])+(((π) x (([H]/2) x ([H]/2)))) x [I])/2). For PSF3: ([A] x (([B]+[D]+[E]+[F])/2) x (([J]+[I]+[G])/3))-(((((π) x (((([C]+[D])/2)/2) x ((([C]+[D])/2)/2))) x [I])+(((π) x (([H]/2) x ([H]/2)))) x [I])/2)-(((((π) x (((([K]+[L])/2)/2) x ((([K]+[L])/2)/2))) x [M])+(((π) x (([N]/2) x ([N]/2)))) x [M])/2)-(((((π) x (((([P]+[Q])/2)/2) x ((([P]+[Q])/2)/2))) x [M])+(((π) x (([O]/2) x ([O]/2)))) x [M])/2).

12 Bowen (1957: 290) ethnographically records that PSF2SA anchors were 'used only on smaller craft and are favoured by fishermen and pearlers… The smaller anchors run around 50 lb (23 kg), while the larger ones may weigh over 100 lb (45 kg)'. Frost gives comparable weights to those she observed in use in the Mediterranean '*i.e.* 20-30 kg' (1982 c: 281), and '… in the order of 20kg' (1995: 170). These weight ranges are compatible with the general pattern of decrease in stone-frame (and PSA) size seen from the 1st millennium BC (Fig. 7).

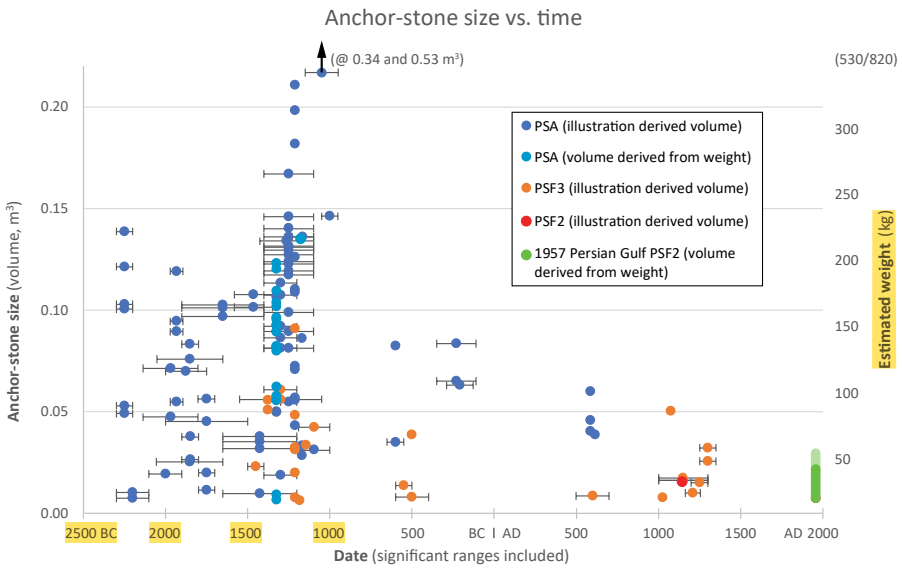

Figure 7. A synthesis chart of 'informative' anchor-stones from the Near East. 'Informative' is defined here as those published finds that have been dated with an accuracy of five centuries or less and well enough illustrated or otherwise described for their volumes to be broadly calculated (see Table 4).

1992; Wilson, 2009: 219-229). This increase would have been reflected in an increase in anchor-stone frequency and size if PSA and staked anchors had continued to be primary types employed on seagoing ships. Ultimately, it can be hypothesized with reasonable confidence that pierced stones weighing 30 kg or more discovered on the seafloor or in sacred terrestrial contexts, with the forms and characteristics described above, were originally anchors (PSA), or were parts of an anchor (stone-frame), for a boat or ship.

There remains, however, the issue of how such heavy and dangerous objects would have been stowed and manipulated. Considering deployment, the Cypriot jug with the ship in distress depiction, described above, seems to display a PSA being deployed with its cable running through the masthead and back down to the hull. This would be a logical means of retrieving them since the masthead is already designed to raise and lower the sail and boom (Ballard *et al.*, 2002: 164). The stone might be kept away from the hull on retrieval, for instance, by running the seaward cable through a fitting at the end of the boom or perhaps by employing a separate mast-derrick (Frost, 1995: 168-172).

Regarding stowage, a remarkable pattern is the several prehistoric PSF3 twins, closely matched in size and shape, that have been found together terrestrially at Kommos ([131], [132]) and Kition ([110], [111]), allowing the impression that the two anchors could have been employed together in the sea. This theory is substantiated by the PSA distribution found on the Neve Yam C, Uluburun, and Hishuley Carmel wreck assemblages in which two (possibly four for the Uluburun) PSA are interpreted to have been situated on the foredeck separated from the main cluster(s) that would have been in the bottom of the hull (Galili, 1985; Pulak, 2008: 306-307; Galili *et al.*, 2013: 17). The position of such anchors in the bow is also substantiated by three iconographic documents (Fig. 5 a-c). Additionally, twin PSA from the seafloor at Megadim ([143], [144]; Steiglitz, 1972: 75), each with opposite facing rudder hieroglyphs, have been interpreted

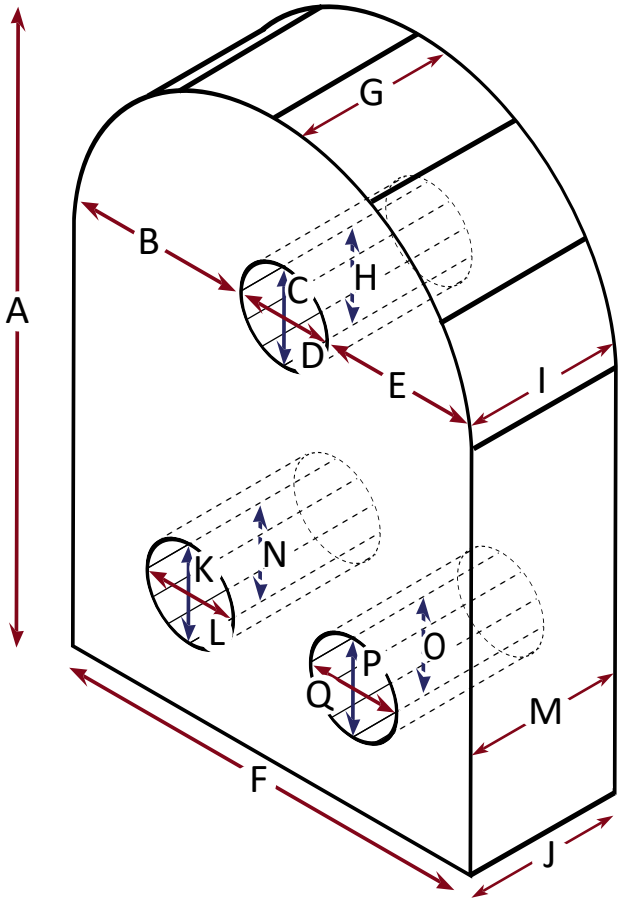

Figure 8. An isometric sketch of a generic PSF3 (also PSA) illustrating the measurements taken for the anchor-stone calculations employed.

as indicating port and starboard. Two other PSA ([83], [84]) from Kfar Samir also have practically identical prehistoric inscriptions. It seems that a pair (or more) of anchors would have been prepared for employment on each side of the bow from where they could be cast by manhandling over the side, while, at least for ships carrying PSA, a reserve group would be available in the hold distributed as ballast. These latter could be raised when needed, employing the mast for leverage.

Distinct employment of PSA and PSF3SA

While Frost's overall identification of these pierced stones as remains of anchors for ships is well-supported by a variety of evidence, there is an important aspect of her theory that requires reconsideration. Frost outlined that the two distinct designs were a factor of the type of seafloor on which the anchor would be employed (Frost, 1963 a: 7-9; 1963 b: 49-50; 1993: 449-451; 2004: 329). Specifically, PSA were for rocky seafloors while PSFSA were intended primarily for use on sandy seafloors. Frost reasonably considered that an anchor with arms would produce greater friction within sand than

a PSA of the same weight, while the projecting arms would get problematically stuck in the gaps in a rocky substrate.[13]

While the idea that sailors used different anchor designs for different types of seafloor is reasonable and possible to an unmeasurable extent, patterns in the archaeological record suggest that there were other important factors involved. Firstly, all seven prehistoric shipwreck assemblages found with two or more anchors have only PSA: Dhokós [36], [37]; Neve Yam C (Galili, 1985; 1987; Marcus, 2007: 156, n. 55), Uluburun (Pulak, 2008: 210-211, 299, 306-307; Wachsmann, 1998: 281-283 and citations there), Hishuley Carmel (Galili *et al.*, 2013: 4-6), Cape Gelidonya A (Bass, 1967: 45; 1999: 23; Pulak and Roger, 1994: 20), Tanit and Elissa (Ballard *et al.*, 2002). Feasibly, additional PSFSA could originally have been part of the complement for all of these ships but were lost during the voyage prior to the wreck event but, at least for those assemblages with numerous anchors, this seems to be unlikely. Frost rectified the discrepancy in her theory with the Uluburun's wholly PSA assemblage by hypothesizing that it planned a route where anchoring would only have been necessary upon a rocky substrate (1991: 368). Rather, in absence of mixed complements, it is likely that these ships were employing their PSA independent of the consistency of seafloor.

It appears, furthermore, that there is a chronological distinction in the first use of PSA and PSF3 in the archaeological record (Figs 7 and 9). Through the middle of the 2nd millennium BC, PSA were the sole anchor design employed with seagoing ships in the Near East. The earliest certain date for the use of PSA being the first half of the 3rd millennium BC in the Red Sea ([226], [227], [228], [229], [230], [231], [232], [233], [234], [235], [236], [237], [238], [239], [240], [241], [242], [243], [244], [245], [246], [247], [248], [249]), providing the earliest 'late-dates' of their date ranges), while the earliest certain dating from the Mediterranean is the second half of the 3rd millennium BC at Byblos, along with the Dhokós wreck assemblage ([22], [23], [24], [25], [26], [27], [36], [37]). However, for the PSF3SA, both the earliest certain dating of PSF3, as well as its date-probability histogram pattern, indicate a 15th-century-BC appearance (Fig. 9). It seems that Near Eastern sailors were employing PSA for a millennium or more prior to the invention of the PSFSA.

However, the appearance of the PSF3SA should not be interpreted as an indication of linear evolution of anchoring technology since subsequent to the 15th century BC, PSA remain the dominant type as far as the quantity of dated finds indicates (87 of the anchor-stones dating within the period of between the 14th and 11th centuries BC are PSA, while only 19 are PSF3, see Table 5). Furthermore, PSA may also be the sole form to continue into the 1st millennium BC, whereas PSF3SA feasibly go out of use in the 2nd millennium, by the early 12th century BC (Fig. 9). This would explain why in the first half of the 1st millennium BC in the Near East only the PSA stone-based anchor design is attested both physically and iconographically. We should therefore see the appearance of the PSF3SA in the later 2nd millennium BC rather as a diversification of anchoring culture, and possibly even a limited one, lasting only about two or three centuries, with its statistical floret being in the 13th and 12th centuries (Fig. 9).

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13 However, Dickson reports the Arabian '*sinn*' (PSF2SA) to be of particular use on rocky bottoms (1959: 482, a), while Bowen purports to its functionality on 'flat muddy bottoms' (1957: 290).

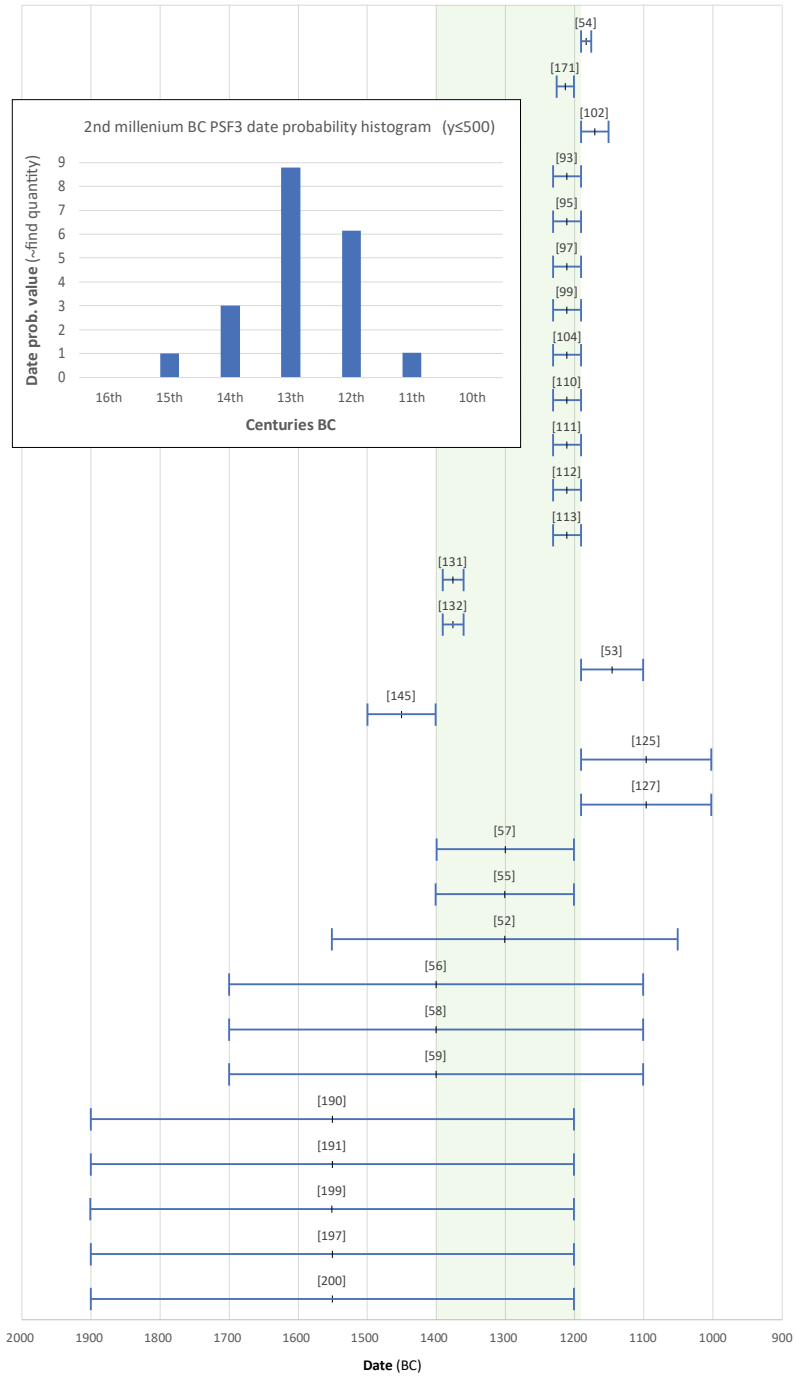

Figure 9. Date distributions of 2nd millennium BC PSF3 dated finds along with their date-probability histogram (inset, illustrating statistical floret), the latter only including those objects with maximum five centuries or less date ranges. The green highlight represents the period of statistical certainty of the existence of PSF3 (the late 15th to the early 12th century BC) defined by the find with the earliest late-date of its date range [145] and those with the latest early-dates of their date ranges ([53], [54], [102], [125] and [127]).

	Number	Catalogue Nos
PSA	83	34, 35, 51, 61, 62, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 87, 88, 89, 90, 81, 94, 103, 247, 248, 249, 250, 273, 275, 276, 289, 109, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 126, 128, 129, 130, 146, 173, 174, 175, 176, 177, 183, 189, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225
PSF3	17	53, 54, 57, 93, 95, 97, 99, 102, 112, 111, 113, 110, 125, 127, 131, 132, 171

Table 5. Anchor-stones dating 14-11th centuries BC.

Furthermore, temporal distinction of PSA and PSF3SA may also be matched by geographic variation. Particularly, the number of PSF3 dated to the 2nd millennium BC is significantly higher west of the Levant (73%):[14] suggesting that there is a 'west of the Levant' connection.[15] Particularly remarkable is the number found at Cyprus, specifically 2/3 of the whole assemblage. To this a PSF3 from Israel is inscribed with a Cypro-Minoan symbol ([52]; no. 102 of Masson's classification, 1974: fig. 4).[16] Correspondingly, McCaslin (1980: 47) and Raban (1988: 287) also connect the markings of a PSF3 from Ugarit [199] to Cypro-Minoan script.[17] Basch argued that the form of another PSF3 example [82] from Egypt matched well with a find from Hala Sultan Tekke and another example from a sacred dedication context at Kition (1978: 120-121). Ultimately, three-quarters of the 2nd-millennium-BC datable PSF3 are either found on Cyprus or arguably attributable to the island.[18] The remaining finds all derive from Ugarit or its out-port Minet-al Baida, sites known to have uniquely strong connections

14 22 (Cyprus [53], [54], [55], [56], [57], [58], [59], [93], [95], [97], [99], [102], [104], [110], [111], [112], [113], [125], [127]; Greece [131], [132], [171]) vs eight (Egypt [82]; Israel [52]; Syria [145], [190], [191], [197], [199], [200]).

15 Raban had previously proposed that the PSFSA was an innovation brought with the Sea Peoples in the 13th century BC (1988: 284-288 and 293). However, Shaw (1995: n. 12) argues that the Sea Peoples may not be the agents of PSFSA importation since there are eastern Mediterranean PSF3 finds dating prior to the 13th century BC (see Fig. 9, taking the normative notion that the Sea Peoples have an Aegean origin). Additionally, in context of the near absence of stone-frames and PSA in the second half of the 2nd millennium BC Aegean, Wachsmann's suggestion that anchoring culture there was based on a largely wooden anchor type, with a ballast stone that is as yet unidentified in the archaeological record, is viable at least for the 2nd half of the 2nd millennium BC (1998: 275, 279; 2000: 815-820). Toth's suggestion (2002: 86, 92) that the staked anchor can be traced to Harappan India lacks a demonstrated supporting example.

16 Cypro-Minoan text is regularly identified with Cypriots specifically (*i.e.* Nikolaou & Catling, 1968: 229; Wachsmann, 1998: 61).

17 Specifically, these authors cite a small pierced stone from Enkomi with similar markings that had been identified by Dikaios as such (1969: 205; cf. Frost, 1991: 366 and 377). Frost (1991: 377) further reports a personally communicated comment by Dr Olivier Masson that the sign might be Aegean in origin.

18 Several investigations have been made on stone samples, primarily at Kition and Ugarit, in an attempt to provenance them. While provenancing sedimentary stones remains speculative, the great majority have been compatible with nearby sources (Mascle, 1985: 320-321; 1991: 373-374). Frost, accordingly, proposed that terrestrially dedicated PSA and PSF3 would regularly have been made on site, rather than transporting them from the ship (1991: 371-372). The geologic analysis from the two PSF3 found at Kommos ([131], [132]), Crete, suggested a provenance in Malta or east of Crete. That they were found with Cypriot and Levantine sherds, along with an absence of ancient stone-frames from Malta, supports the latter option (Shaw, 1995).

with Cyprus. It can therefore be postulated that Cyprus in the second half of the 2nd millennium BC, particularly, is connected to the PSF3SA.

It is possible to further isolate this phenomenon by limiting the data sample used to those anchors with date ranges wholly within the statistically certain period in which the PSF3SA existed: the late 15th through to the early 12th centuries BC (Fig. 9). These examples suggest that PSA continued to be the primary design employed along the Levantine coast during this period. Terrestrially, only PSA have been exposed (Tel Abu Hawam ([184], [185], [186], [187], [188]), Tel Michal [189] and Minet el-Beida [146]). Added to this, the Uluburun ship, with its PSA, is believed to have originated just north of the Carmel coast (Pulak, 2008: 299 and 303). The PSA identifying the Kfar Samir ship assemblage were found nearby.[19] In comparison, all the PSF3 of this same chronological limitation are found on Cyprus (Hala Sultan Tekke [54], [55], [57]) and Kition ([93], [95], [97], [99], [104], [110], [111], [112], [113]) or further west at Kommos, Crete ([131], [132]); while the only relevant shipwreck, the Point Iria, identified as Aegean, albeit with an important portion of its cargo being Cypriot, carried a PSF3 ([171]).[20] In this light it is also compatible that all six relevant anchor-stones identified with Cypro-Minoan symbols are PSF3 ([52], [54], [55], [57], [112], [199]), and none PSA. One PSF3 from Cyprus had the eye completed while the two arm-holes were incomplete [104] suggesting that at least the arm-holes were being drilled on the island. Ultimately, for the Bronze Age broadly, it appears that the culture of PSA use is attributable to the continental Near East, while the Late Bronze Age PSF3SA use is attributable specifically to Cyprus.

However, complicating this pattern are 24 PSA examples found on Cyprus within this date range, incidentally all terrestrially at Kition ([90], [91], [92], [94], [96], [100], [105], [106], [107], [108], [109], [114], [115], [116], [117], [118], [119], [120], [121], [122], [123], [128], [129], [130]). This is a significant number considering that only 12 PSF3 are known from this date range on Cyprus ([54], [55], [57], [93], [95], [97], [99], [104], [110], [111], [112], [113]). One factor for this discrepancy may be that PSA may be more likely than PSF3 to be exposed on land due to being more conspicuously functional as secondary building stone (that is a stone with three piercings is likely more fragile than a stone with only one). Another possibility is that PSA were indeed commonly employed also by Cypriot sailors. Perhaps Cypriots employed both types in their anchor complements, in a manner such as Frost suggested, and we merely lack a supporting Cypriot wreck assemblage to demonstrate this. Alternatively, one might consider that the Late Bronze Age Levantine sailors would have had particular incentive to sail to Cyprus, not least for its copper resources. Since it was a difficult, uniquely open-sea voyage, they were particularly pleased to arrive safely and therefore likely to dedicate

19 Although potentially dating a generation later than the confined dating considered here, two PSA ([34], [35]) from the Cape Gelidonya A assemblage deserve note, being a mainland Levantine derived vessel that took on cargo in Cyprus before wrecking upon the Anatolian coast.

20 This PSF3's small size and uniquely symmetrical form is remarkable. See note 15 for suggestion that anchoring culture in the Aegean at this time was rather based on an as yet unidentified (and therefore distinct) form, so that the remains of the ship's anchors – apart from the PSF3 example – were not recognizable during excavation. In this regard, three stones found close to the Point Iria PSF3 separated from the main ceramic assemblage are intriguing but unfortunately not illustrated (Vichos, 1999: 78).

an anchor in veneration. It is therefore also conceivable that the PSA found at Kition were made and originally dedicated by specifically Levantine sailors.

In conclusion, throughout the 2nd millennium BC, PSA remained the anchor type preferred by Levantine sailors. Cyprus, on the other hand was relatively economically isolated from the mainland through the first half of the 2nd millennium. For the second half, even contemporary material culture of well-published and well-connected Kition and Ugarit display profound distinctions (Brody, 1998: 50). While Cypriot anchor-stone anchoring culture was logically influenced by the neighbouring Levantine PSA tradition, its relative isolation proved fertile ground for the development of their own variation, one incorporating additional piercings and stakes. This is not to say that PSA could not regularly have been employed by Cypriot sailors in the late 2nd millennium. At least it seems that the PSF3SA played a more important role on Cyprus than in the Levant during its period of use, possibly limited to the 15th through to the 12th centuries BC. Conversely, there is no specific detail among the robust Levantine anchor evidence that Late Bronze Age Levantines ever adopted the staked anchor, so the anchor tradition distinction could well have been absolute. The implications for our understanding of Late Bronze Age Cypriot and Levantine interconnections is that they were rare enough to promote conspicuous distinction in anchoring tradition. These regions were, after all, separated by a formidable open-sea voyage.

Between an 11th/10th-century-BC dated PSA [101] from Kition and the early 8th-century-BC Tanit and Elissa wrecks we have a lacuna of anchor evidence,[21] and can merely interpolate that only PSA continued in regular use by both Levantine and Cypriot sailors into the 6th/7th century BC. It is conceivable that the Iron Age PSA usage in Cyprus was influenced by the inhabitant Phoenicians, a culture that developed in the Levant. By the time the Phoenicians established themselves on the island, the Cypriot PSF3SA culture may long have disappeared, coinciding with the general decline of the Bronze Age economy. Alternatively, the Phoenician establishment on Cyprus may itself have been the cause of the loss of the staked anchor-stone tradition there. Whatever the case, the archaeological reappearance of the PSF3 by *c.*500 BC[22] could testify to a reinvention of the PSFSA at a time when the stock-anchor was also novel.

21 A PSA [103] from broadly dated 'Phoenician' context at Kition must also be mentioned, particularly considering that its large size (*c.*0.2 m^3) is uncharacteristic for the historic period (Fig. 8).

22 The 6th century BC at Isola delle Femine [81] and/or 5th century [80], and another [178] encompassing these dates from Shiqmona… and feasibly contemporary to Atlit. The several stone-frames and PSA recovered from within Atlit's harbour basin (McCaslin, 1980: 39-44; Raban, 1988: 288 and 1996: 504-506) are more likely to be from the later centuries of the harbour's employment (active between the 9th/8th through the 4th century BC, Haggi, 2006: 54) due to the absence of sealing stratigraphy along this high-energy sandy coast, and heavy recovery activity occurring in active harbours generally.

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