

Evidence of net fishing in Phoenician Punic Ibiza. Study of some lead net weights found on the island

Abstract

The study of four groups of net weights made of lead and preserved in the Archaeological Museum of Ibiza and Formentera allows us to consider the use of different types of mesh tackle for fishing in Ibiza during the Phoenician-Punic era. We have distinguished seine trawl and seine gear for fishing in the open sea, as well as barrier meshes for shallow fishing on the coastal platform. This implies different capture strategies, different work organization and also different productivity.

Keywords: lead net weights, net fishing, seine gear, barrier net, island of Ibiza, Phoenician Punic period

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Introduction

The research on fishing and fishing gear in Antiquity has experienced remarkable progress, specially in the last two decades^{1, 1-13}. However, the study of Phoenician-Punic fishing techniques and their tackle and gear is still one of the pending subjects, since present knowledge is still poor. This is an investigation that encounters serious difficulties, having to confront a notable scarcity of archaeological evidence¹⁴ and where the gear presents very little typological variety over the centuries.¹⁵ There is also a scarce supply of literary sources, where most of the texts referring to the Phoenician-Punic sphere come from Greek and Latin authors.^{16,14} The iconography is neither abundant nor explicit,¹⁴ being reduced to representations of fish and less frequently crabs, octopuses, etc, especially on stelae,¹⁷ also on coins,^{18,19} and sometimes in rings²⁰⁻²⁴ and amulets,²¹ as well as in some molds and plates,^{25,20} shaped modelled cups,²⁰ ceramic containers and, exceptionally, in a “shaving razor”²⁶.

Net fishing was, in ancient times as in the present, the main system for supplying fish to different human groups. But we can directly know the ancient nets only in those extraordinary occasions in which, due to having been deposited in anaerobic environments -as in Albufereta and *Caesaraugusta* in Hispania,²⁷ or in others of great dryness -as in Myos Hornos (Quseir al-Qadim), on the Egyptian coast of the Red Sea, some parts of nets have been preserved. In the rest of the cases are the weights to sink the mesh -material, morphological and morphometric characteristics, quantity, spatial distribution, etc that can provide arguments to try to identify the type of gear to which they belonged.

This work is focused on net fishing along the Phoenician-Punic era in the island of Ibiza, situated in the Western Mediterranean, Southwest Mallorca and in front of the Levantine Spanish coast (Figure 1a and 1b). On this island, the study of sea resources exploitation,^{28,29} and of fishing in particular, is still in a very initial stage.³⁰ The use of nets is attested by the existence of shuttles or needles for sewing nets topped with forks at both ends², as well as by 21 net weights, which are the object of this study.

¹For a history of fishing research during Antiquity in Spain and Portugal, see Vargas 2020.³¹

²Which are not included in this work since they will be the matter of another study.



Figure 1 a) Situation of Ibiza Island in the Western Mediterranean. b) In the archipelago of Balearic Islands. c) Map of the Pityusai Islands (Ibiza and Formentera), with indication of some sites mentioned in the text: 1 Sa Caleta; 2 Cala Olivera; 3 Es Culleram; 4 Puig des Molins.

Materials

Net weights found in Ibiza

All net weights in Ibiza, until now safely identified as such, are made of lead. They have been found in three sites that, despite their small number, together nearly cover the entire Phoenician-Punic period on the island. They are Sa Caleta,³² Cala Olivera^{33,34} and Es Culleram.³⁵ There is a fourth group, preserved in the MAEF collection, but without any reference to its place of discovery, although it is very possible -but not certain- that this was the great urban necropolis of Puig des Molins.²⁵

Sa Caleta (Sant Josep de sa Talaia)

This archaic Phoenician settlement on the SW coast of the island presents a single occupation phase dating from the 7th century BC. The excavations directed by Joan Ramon Torres between 1986 and 1998,³² produced the discovery of just three net weights:

SC1**Inv. MAEF³:** 10416/104**Description:** Net weight, formed by a rectangular lead sheet rolled into a cylindrical shape.**Length:** 4.4 cm**Maximum width:** 1.4 cm**Sheet thickness:** 0.4 cm**Maximum inner diameter:** 0.5 cm / minimum: 0.45 cm**Weight:** 46.24 g.**Location:** Sondage E.bg of the Central District³²**SC2****Inv. MAEF:** 10412/26**Description:** Net weight, formed by a rectangular lead sheet rolled into a cylindrical shape. Opaque white patina.**Length:** 1.8 cm**Maximum width:** 0.95 cm**Sheet thickness:** 0.3 cm**Maximum inner diameter:** 0.35 cm / minimum: 0.3 cm**Weight:** 6.96 g**Location:** Sondage E.n of Southern Quarter³²**SC3****Inv. MAEF:** 10413/95**Description:** Sheet of lead, approximately rectangular in shape, with a notch in its central part, probably due to a blow, and a slight curvature at one end. opaque white patina**Length:** 1.8 cm**Maximum width:** It cannot be determined being the weight completely open.**Sheet thickness:** 0.4 cm.**Internal diameter:** It cannot be determined being the weight completely open.**Weight:** 27.39g.**Location:** Sondage E.n of the Southern Quarter.³²**Remarks:** This piece has been published as an unrolled net weight. This seems plausible, given the physical characteristics of the sheet, which presents a slight curvature at one end, probably the result of having been rolled in a circular fashion. However, at some point, after its amortization as a net weight, one of its ends was hammered to lengthen it, with an indeterminate purpose. We know a parallel of one piece unrolled, or only partially rolled, in the sanctuary of La Algaida.³¹ The author assumes that the piece was not completely rolled up to be transformed into a complete net weight by cooling the lead, which in our opinion is not the same case as that of the piece studied here (Figure 2).**Figure 2** Sa Caleta net weights. From left to right, SC1, SC2 and SC3 (foto B. Costa, MAEF files).

The first thing that stands out about this Phoenician settlement of Sa Caleta is that fishing is very little represented in its archaeological record. The findings are reduced to nine hooks and these three net weights, which, in the case of a maritime establishment, seems like a very small number. Especially when some archaeo-ichthyofaunistic analyzes show that at least since the 7th century BC, if not before, fishing in the western Phoenician area appears as a diversified and organized economic sector, and not as a simple opportunistic predation.³⁶ Therefore, this poorness of fishing items in the site seems to us an abnormal situation, for which we do not have any satisfactory explanation, for the moment. Anyway, with the present evidence, we should admit that use of the hook-and-line method would be much more extended than the net one.

Cala Olivera (Santa Eulària des Riu)

Cala Olivera is a wide cove on the eastern coast of the island of Ibiza, open at midday and formed by the confluence of the mouths of the s'Olivar and sa Roca Llisa torrents. The mouth of the s'Olivar torrent has formed a small sandy beach. The deposit is located on top of the rocky point that closes this little beach on the west side. It is a shell mound of about 8x4 m, which is located about 6-7 m above sea level, in a kind of shelter in the rock, where in the past there would have been a small cave or shelter, whose vault collapsed in antiquity. The excavation of this site, carried out in the summer of 2005 by a team led by C. Alfaro and B. Costa, allowed us to document a short but interesting stratigraphic sequence.^{33,34} Seven net weights, made of lead and cylindrical in shape, appeared in the S.U. 9, a blackish-colored stratum with a very organic appearance, very rich in archaeological materials that allow us to place this S.U. 9 chronologically in a period between the 3rd century BC and the first half of the 1st century AD, in the Julio Claudian era. Above that S.U. 9, other SS.UU. corresponding to a shell dumping place, with a predominance of muricidae, evidencing the subsequent existence in the place of a low-imperial workshop for the elaboration of purple, although with the presence of many other non-purple species,^{33,34} which implies diversified activities and management of malacological resources.²⁹

CO1**Inv. MAEF:** 21543/UE9-D4/20**Description:** Rectangular and thick sheet of lead, rolled into a cylindrical shape. Flattened face due to wear, probably due to continuous rubbing on the bottom.**Length:** 4 cm.**Maximum width:** 3.4 cm.³Museu Arqueològic d'Eivissa i Formentera

Sheet thickness: 1 cm

Maximum inner diameter: 2.1 cm / minimum: 1.4 cm.

Weight: 187.71 g.^{34,27}

CO2

Inv. MAEF: 21543/UE9-D4/21

Description: Rectangular and thick sheet of lead, rolled into a cylindrical shape.

Length: 3.5 cm

Maximum Width: 3.5 cm

Sheet thickness: 1.2 cm

Maximum inside diameter: 1.9 cm / 1.2 minimum: cm

Weight: 174.8^{34,27}

CO3

Inv. MAEF: 21543/UE9-D4/22

Description: Rectangular and thick sheet of lead, rolled into a cylindrical shape.

Length: 4.1cm

Maximum width: 3.6 cm

Sheet thickness: 0.9 cm

Maximum inner diameter: 2.1 cm / minimum: 1.4 cm

Weight: 182.1g.^{34,27}

CO4

Inv. MAEF: 21543/UE9-D4/23

Description: Weight formed by a thick rectangular sheet of lead, rolled into a cylindrical shape.

Length: 3.5 cm

Maximum width: 3.5 cm

Sheet thickness: 0.8 cm

Maximum inside diameter: 2.5 cm / minimum: 1.5 cm

Weight: 183.3g^{34,27}

CO5

Inv. MAEF: 21543/UE9-D4/24

Description: Rectangular and thick sheet of lead, rolled into a cylindrical shape. It is open, with the sides of the sheet separated.

Length: 3.7cm

Maximum width: 3.8 cm (the measurement is not reliable because the weight is intentionally open).

Sheet thickness: 1.1 cm

Maximum / minimum internal diameter: These measurements are not computable because the weight is intentionally open.

Weight: 168.4g.^{34,27}

CO6

Inv. MAEF: 21543/UE9-D4/25

Description: Rectangular and thick sheet of lead, smaller than the rest, rolled into a cylindrical shape, but intentionally open longitudinally, separating both sides.

Length: 3.2cm

Maximum width: 2.5 cm (the measurement is not reliable because the weight is intentionally open).

Sheet thickness: 0.7 cm

Maximum/minimum inside diameter: These measurements are not computable because the weight is intentionally open.

Weight: 72.1g.^{34,27}

CO7

Inv. MAEF: 21543/UE9-C5/6

Description: Rectangular and thick sheet of lead, rolled into a cylindrical shape, but intentionally open longitudinally, separating both sides.

Length: 3.5cm

Maximum width: 4.1 cm (the measurement is not reliable because the weight is intentionally open).

Sheet thickness: 1 cm

Maximum/minimum inside diameter: These measurements are not computable because the weight is intentionally open.

Weight: 143.2^{34,27}

The discovery of these seven net weights is congruent in a stratum that has been interpreted as a dumping place, where the fishermen who worked in the cove throw their waste. Six of the weights appeared, if not grouped, then relatively close to each other, in square D-4. The other was recovered in the neighboring square C-5. This surely indicates that they were thrown into the landfill on the same occasion and thus they would probably form part of the same gear (Figure 3).



Figure 3 Lead net weights from Cala Olivera (Photo B. Costa, MAEF files).

Es Culleram (Sant Joan de Labritja)

In this partially built up and partially inside a cave sanctuary dedicated to the cult of the goddess Tinnit,³⁵ excavations in 1967 recovered seven net weights, made of a thin sheet of lead, in addition to a conical sinker for a line and hook rig.³⁷ However, these elements did not receive proper attention until recent time (Costa 2022).

EC 1

Inv. MAEF: 6756/1

Description: Sheet of lead folded longitudinally in half. Sides slightly open. Well preserved. Whitish patina

Length: 5.60 cm

Maximum width: 1.1 cm

Sheet thickness: 0.21 cm

Maximum inner diameter: 0.39 cm / minimum: 0.31 cm

Weight: 23.3 g.³⁰

EC 2

Inv. MAEF: 6756/2

Description: Sheet of lead folded longitudinally in half. Intentionally open, except at one end. Blow, possibly with a cutting instrument, in its central part. Whitish patina.

Length: 5.90 cm

Maximum width: 0.75 cm / 1.4 cm (distorted because it is open)

Sheet thickness: 0.19 cm

Maximum internal diameter: 1.1 cm (distorted because it is open) / minimum: 0.40 cm

Weight: 23.3 grams.³⁰

EC 3

Inv. MAEF: 6756/3

Description: Sheet of lead folded longitudinally in half. Blow with a blunt instrument in its central part. One of its ends with the sheet folded on itself by hammering to close the central hole. Whitish patina.

Length: 5.35cm

Maximum width: 1.25 cm

Sheet thickness: 0.12 cm

Maximum inner diameter: 0.40 cm / minimum: 0.21 cm

Weight: 22.2 grams.³⁰

EC 4

Inv. MAEF: 6756/4

Description: Sheet of lead folded longitudinally in half. closed sides. Small blow with a sharp instrument in its upper part. Well preserved. whitish patina.

Length: 5.65cm

Maximum width: 0.75 cm

Sheet thickness: 0.21 cm

Maximum inner diameter: 0.45 cm / minimum: 0.15 cm

Weight: 26.1 grams.³⁰

EC 5

Inv. MAEF: 6756/5

Description: Sheet of lead folded longitudinally in half. Laterally struck in one of its halves with a blunt instrument, which has left an impression in its central part. Whitish patina.

Length: 5.90cm

Maximum width: 0.85 cm

Sheet thickness: 0.15 cm

Maximum inside diameter: 0.48 cm / minimum: 0.25 cm

Weight: 18.8 g.³⁰

EC 6

Inv. MAEF: 5756/6

Description: Remarkably thin sheet of lead, folded longitudinally in the middle and folded back on itself at one end. A fragment is missing at the other end, which is deformed. Corrosion hole on one side. Badly preserved. Whitish patina.

Length: 5.49 cm

Maximum width: 0.75 cm

Sheet thickness: 0.1 cm

Maximum inner diameter: 0.35 cm / minimum: 0.25 cm

Weight: 11.2 g.³⁰

EC 7

Inv. MAEF: 5756/7

Description: Sheet of lead of considerable thickness, folded longitudinally in the middle. Sides well closed. Traces of tapping on its lower part, and possibly on one side, with a small blunt instrument to close it. Well preserved. Whitish patina

Length: 5.79cm

Maximum width: 8.8 cm

Sheet thickness: 0.25 cm

Maximum inside diameter: 0.32 cm / minimum: 0.22 cm

Weight: 40g.³⁰

The offering of fishing gear in various Mediterranean sanctuaries is a well-attested fact, both in the Greek and Phoenician-Punic cultural spheres.^{27,31,30} For this reason, in our opinion, the discovery of these pieces in a cultic context is not a merely anecdotal fact, but their appearance in a sanctuary must respond to a premeditated act, of a pious nature and with undeniable symbolic values. All this allows us to hypothesize that they are offerings of fishing gear by fishermen, who would go to the sanctuary demanding the favor of the divinity, to avoid the dangers of the sea and obtain good catches, or as thanks for have got them. In the case of Es Culleram, it would be offerings to Tanit, probably in her role as "Goddess of Good Fortune". We could be, therefore, a testimony in Ibiza of a fishermen cult to Tinnit to favor fishing campaigns (Figure 4).³⁰



Figure 4 Lead net weights from Es Culleram (Photo H. Jiménez, MAEF file).

Unknown provenance

Four weights are preserved in the Museum funds, probably they must have been found in some old excavation, perhaps from the 40s or 50s years of the 20th century. At the moment, we have not been able to find any reference to its discovery or to its entry into the museum. So, they are from an unknown provenance.

UP 1

Inv. MAEF: 21457/1

Description: Very elongated rectangular sheet of lead, rolled into a cylindrical shape. Well preserved.

Length: 7.5 cm

Maximum width: 1.4 cm

Sheet thickness: 0.2 cm

Maximum inner diameter: 0.7 cm / minimum: 0.4 cm

Weight: 66.3 g

UP 2

Inv. MAEF: 21457/2

Description: Very elongated rectangular lead sheet, rolled into a cylindrical shape, but intentionally open in its central part.

Length: 8.6 cm

Maximum width: 1.5 cm (measured on the non-deformed part)

Sheet thickness: 0.3 cm

Maximum inside diameter: 0.9 cm / minimum: 0.55 cm

Weight: 83.9 g

UP 3

Inv. MAEF: 21457/3

Description: Very elongated rectangular lead sheet, rolled into a cylindrical shape, but intentionally open in its central part, and with bumps at the ends

Length: 8.8 cm

Maximum width: The deformations of the part do not allow this measurement to be taken reliably.

Sheet thickness: 0.4 cm

Maximum internal diameter: The deformations of the piece do not allow these measurements to be taken reliably.

Weight: 77.6 g

UP 4

Inv. MAEF: 21457/4

Description: Very elongated rectangular lead sheet, rolled into a cylindrical shape, but intentionally open in its central part.

Length: 7.5 cm

Maximum width: 1.2 cm

Sheet thickness: 0.3 cm

Maximum inner diameter: 0.7 cm / minimum: 0.5 cm

Weight: 79.4 g

Although, as it has been said, these items are from unknown provenance and, therefore, we do not have any criteria to date them, its characteristics are so homogeneous (appearance, dimensions, patina, etc.) that we have no doubt that they come from a single find in a specific place (Figure 5).



Figure 5 Group of pieces from the Museum collection and unknown provenance (Photo B. Costa, MAEF files). From left to right, UP1, UP2, UP3 & UP4.

Typology

The four sets of net sinkers found in Ibiza are included in the weights made from a sheet of lead that is adhered around the dragrope (lower rope in which the weights are attached), to ballast the net in order to sink it as quick as possible. Its design was clearly aimed at limiting potential net entanglement.³⁸ The main difference is:

- 1) The sheet has been rolled up on itself, forming a cylinder around the rope. They are classified in type L2.2 by Galili, Rosen and Sharvit⁹ an also in type PLI12 by Bernal.³⁹
- 2) The sheet has simply been folded in half, although in the latter case the fold was usually done on a finer headrope. They are classified in type L.2.3 by Galili, Rosen and Sharvit, defined as Lead fishing sinkers (L), final processing by bending (L.2), folded rectangular.⁹ They can also be included in the PLIX2 type of Bernal Casasola.³⁹ Among this class of folded weights, it can also be distinguished that the sheet with which they are made is square (Bernal's subtype PLIX1) or rectangular (PLIX2 subtype), and that the lateral ends are closed or open, in the latter case they can be in section in U or V.⁴⁰ However, it should be noted that the open ones must have been a posteriori; that is to say, not when they were used in the net, but at the time of their amortization to unseat them from the cord or rope to which they had been attached.

The three pieces from Sa Caleta, at least the two that have retained their original shape, are classified as type L.2.2. by Galili, Rosen, and Sharvit. Also, the four weights of unknown origin, although larger and heavier, fit into the same typology. In contrast, the seven weights at Es Culleram correspond to the simplest type of net weight: rectangular sheets of lead folded lengthwise in half. They therefore fit into the type that Galili, Rosen and Sharvit⁹ defined as L.2.3 and Bernal Casasola as PLIX2.

The very elementary morphological characteristics of these models mean that they are very widely extended types, both in time and space. They appear at the end of the Bronze Age, being present in the wrecks of Ulu Burun, where one hundred and seven specimens of different formats appeared, and Cape Gelidonya, where eighteen were found, among other places.⁴¹ Since then, the list of known parallels, from the beginning of the Iron Age to the middle ages, is endless.

Without any intention of being exhaustive, and merely by way of example, we will cite as parallels of the coiled sheet weights (type L.2.2 by Galili, Rosen and Sharvit = PLI2 by Bernal), the specimens of the archaic wreck from the island of Giglio.^{42,40} In Sicily, a specimen from the Vendicari fish processing and processing facility.⁴³ In the Iberian Peninsula, we can cite a group of specimens from the Tartessian palace-sanctuary of Cancho Roano (Zalamea de la Serena, Badajoz), dated to the 5th century BC,⁴⁴ while in room O-1, another group of lead net weights appeared along with other various offerings.^{31,45} Other similar specimens are the nine found in the Phoenician-Punic sanctuary of La Algaída, although almost all of them are small.⁴⁶ Let us also cite the specimens of funerary provenance found in the 2005-2006 excavations on the site of the City of the Justice in Cádiz.⁴⁶ Without leaving the Iberian Peninsula, in the Iberian cultural sphere we also know similar specimens both in coastal sites, such as La Albufera, where a group of 28 specimens from the 4th century BC were found,³⁴ as well as in inland fluvial settlements, such as Castellones de Ceal, in the upper Guadalquivir, where 44 weights were found in the form of rolled sheets, in addition to the remains of another 20 partially melted.⁴⁴ In the Near East, in the underwater site of Mount Carmel, net weights of different varieties appeared, among them the tubular one using a rolled sheet, as well as weights in the form of rings and folded sheets.⁹ Also, an important set of net weights in Yavneh Yam, a fishing establishment that was the main commercial port between Sinai and Jaffa.⁴⁷ In the river port of ancient *Moguntiacum* (Mainz), a specimen of rolled sheet appeared along with others made of flat or slightly flat-convex sheets, with a hole at its upper end.⁴⁸ Likewise, in Northern Europe, in Roman times this type of tubular weights were widely used, as demonstrated by the findings of the Oudenburg castellum (Belgium), the Woerden castellum (Holland), the *Hunerberg cannabae legionis* (Nijmegen) and a long etcetera.^{4,49}

Regarding folded sheet weights, Bernal Casasola considers that his PLIX2 type (= Galili, Rosen and Sharvit type L.2.3) is the most common in Spain and probably also in the Greco-Roman Mediterranean. From the Phoenician-Punic period, we will begin by citing the two specimens from the Algaída sanctuary,¹³ as well as those from Plaza Asdrúbal in Cádiz.⁶ In Greece, for example, in Oropos, in the southern Gulf of Euboea, lead weights in the form of bent sheets have also appeared,²⁷ in addition to numerous finds of bronze hooks, lead weights of different lengths and thicknesses, and a large number of seashells in the Central and Western neighborhoods, dated to the Geometric and Archaic periods.⁵⁰ Among the numerous finds at this site, we will highlight the specimens from the building at

⁴For a list of findings in the Netherlands and Belgium, see Table 1 of this publication.

Skala Oropou, which suggest the presence of one or more networks.⁵¹ Also in the sanctuary of Poseidon of Kalaureia, on the island of Poros, some specimens of folded sheet have appeared, very similar to those of Oropos and Mount Carmel.²⁷ In the Near East, in addition to the folded specimens from Mount Carmel,⁹ we will also mention three specimens from a peasant establishment in Atlit (Israel), dated between the V-III centuries BC.⁵² In the Red Sea, we will point to Roman-era specimens from Myos Hornos in Egypt.³⁸ Similarly, from Roman times, in the Iberian Peninsula, we will mention the specimens from the *macellum* of Baelo Claudia.⁶ And still, advancing in time, we could add various finds from the Byzantine period, among which we can highlight the examples of the Yassi Ada, some with geometric decoration^{53,40} and by Serçe Limani, wrecks where the distribution of the weights allows us to suggest the existence of four fishing nets, a significant part of whose weights are decorated with rosettes, dots and concentric circles, and even inscriptions.⁵⁴

But it is in systematically excavated nuclei with long stratigraphic sequences where the appearance and continuity of this type of weight throughout Antiquity can be documented. Let us take the example of the port city of Lattes, the ancient *Lattara*, on the *Narbonense* coast. There, its stratigraphies illustrate the appearance of these types of net weights in the second half of the 5th century BC, and its uninterrupted duration for seven and a half centuries, until the end of the 3rd century AD. It should be noted, however, that the leads made using a rolled sheet in a cylindrical shape are the oldest, while those made using a folded sheet did not appear until the end of the 4th century BC. Lasting during the Hellenistic period and the Roman period.³⁰

As for the most robust specimens from Cala Olivera,^{33,34} they are small rectangular sheets of lead, short and thick, around 3.5 cm both length as width, with an average weight of 159.44 g. These, by means of hammering, were rolled up on a rope to give them the final shape, sometimes with the sides in close contact and other times with one side mounting on the other. The weights are, therefore, cylindrical in shape, although only two of these pieces keep their original shape intact (CO1 and CO2), since the others are more or less deformed, either due to lack of care when fixing them to the net (CO3 and CO4) and, above all, due to the intentional opening, separating the sides, at the time of their amortization (CO5, CO6 and CO7). They are classified, therefore, in the L.2.2 type by Galili, Rosen and Sharvit and in the PLI2 by Bernal. Similar pieces have been found in various Hispanic sites, such as the Punic factory of Puerto 19 (P-19), where a specimen similar to ours dated from the 4th century BC appeared.⁵⁵ Others already come from Hispano-Roman sites, such as *Traducta* and *Baelo Claudia*.

Methodology

The study of the weights of fishing nets is still in an embryonic state, due to the complexity of address this issue, something that should be related with the complex identification of these artifacts, poorly characterized archaeologically, and sometimes wrongly identified.^{6,31}

In order to try to deduce what kind of rig the groups of weights studied here could have been part of, we will analyze several variables. In the first place, three closely related dimensions: the length and thickness of the sheet, which will determine the third magnitude, which is the total weight of the piece. Later, we will analyze the internal diameters to be able to find out the thickness of the line to which they were attached.

Length

It is an important variable, because it depends on whether there is a greater or lesser rate of pieces in the weights rope.

The pieces from Sa Caleta are the most irregular, varying in length from 4.4 cm to 1.8 cm. This means that, with the exception of the two smaller ones (SC 2 and 3) that have the same length (1.8 cm), there is too great a difference with the longest one (2.6 cm), which implies that they respond to patterns different and to different types of gear.

The sinkers of Cala Olivera do not offer great differences, as they measure between 3.5 and 4.1 cm, with an average of 3.8 cm, except for a smaller specimen (CO6) that measures 3.2 cm (0.9 cm of variation). This means that this last piece could come from a different network. However, it should be borne in mind that fishermen of all ages have recovered and reused leads from amortized tackle to make new nets. This allows us do not rule out the hypothesis that, despite the differences in size and weight, all these weights, found in the same archaeological context and spatially very close to each other, could be used in the same network (Figure 6).

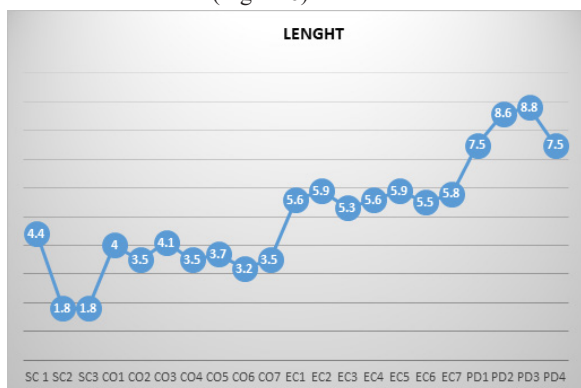


Figure 6 Graphic showing the differences among the length of the pieces under study.

The weights of Es Culleram are fairly regular, since the maximum (5.9 cm) and minimum (5.35 cm) magnitudes are within the interval of the same centimeter, with the mean being 5.66 cm. This means that the artisans who made these weights possibly followed a certain length pattern that was around 5.5 cm. However, as it is a manual production, there are slight differences between one piece and another that can mean a few millimeters of difference (generally less than 1 cm) from one piece to another.

Lastly, the four pieces of unknown provenance show a little more variation (1.3 cm). Here two patterns are observed with a slight difference: one of 7.5 cm (UP1 and 4) and another of 8.7 cm on average (UP2 and 3).

Sheet thickness

This variable will allow us to know the type of sheet used to make the net weight.

The weights of Sa Caleta are relatively regular, as they are between 0.3 and 0.4 cm.

Those of Cala Olivera are the thickest, presenting a slight variation between 0.8 and 1.2 cm, with the average being 0.95 cm. This is three times the thickness of Sa Caleta and nearly five times the thickness of the pieces found at Es Culleram

If we analyze the thicknesses of the Es Culleram sheet, all the values move in the interval between a minimum of 0.1 cm and a

maximum of 0.25 cm, with 0.17 cm being the average. This means a very thin sheet, nine times thinner than Cala Olivera ones.

Finally, the weights of unknown origin show a variation of just 2 mm, between 0.2 and 0.4 cm, similar to those of Sa Caleta pieces (Figure 7).

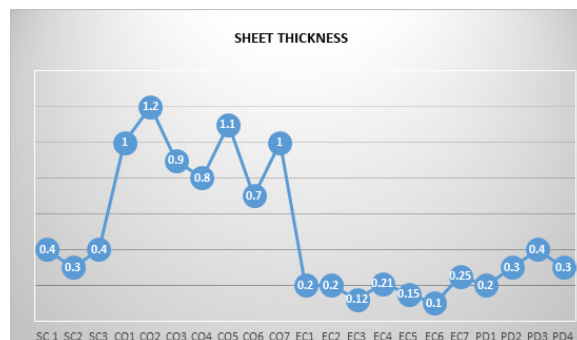


Figure 7 Graphic showing the differences among the sheet thickness of the pieces under study.

Weight

It is a fundamental variable in a net weight, since it depends on it to adequately fulfill its function. The greater or lesser weight will depend, above all, on the type of net and the depth at which it has to fish. To do this, in each case net weights of different sizes and weights will be used.

The biggest differences are in the pieces from Sa Caleta, which range from 46.24 g (SC1), 27.39 g (SC3) and, finally, 6.96 g (SC2). This diversity of weights should correspond to weights of different gears.

In the Cala Olivera complex, several of the pieces (CO1 to CO5) range from 187.71 g to 168.4 g, while two others (CO6 and CO7) deviate from these measurements, with 72.1 g and 148, 2 g. This, in principle, could make us think of at least two different nets, although it is worth remembering what we have already said about the reuse of weights from different gears in the same net.

In the Es Culleram weights, we see that marked differences also occur in this variable, since the maximum value amounts to 40 g (EC7), while the minimum is only 11.2 g (EC6), with the maximum oscillation being of 28.2 g and the mean value 23.55 g.

In the pieces of unknown provenance, the weights range from 66.3 g (UP1) to 83.9 g (UP2), with the maximum oscillation being 17.6 g and the average of all of them 76.8 g (Figure 8).

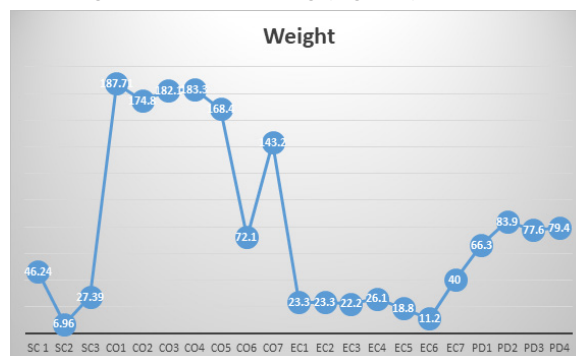


Figure 8 Graphic showing the differences among the weights of the pieces under study.

Inner diameter

It is determined by the thickness of the rope to which the weight has been attached. This is the data that can demonstrate whether weights found in the same context, despite their differences in size and weight, have been able to go together in a single net. For this reason, we must also take into account the internal diameter of the sinkers as a computable variable in our study.

We have taken the maximum and minimum diameter of each piece, between which there may be certain differences. However, the former is usually distorted because it is the consequence of deformations often attributable to the intentional opening of the plumb line to disengage it from the dragrope on which it was mounted. When the weight has been fully opened, completely deforming the original piece, we have not computed the value of those pieces because the originals are lost. For this reason, we consider the minimum diameter more reliable for our objective, even though this may also be somewhat distorted because when hammering the metal weight on a fairly soft fiber rope, the minimum diameter of the weight may be less than the thickness of the rope itself.

The two pieces from Sa Caleta in which we have been able to compute this variable show a very small variation between them, of only 0.15 and 0.05 cm. They would be subject to lines of approximately 0.45 cm (SC1) in one case and 0.30 cm in the other (SC2).

On the other hand, the weights of Cala Olivera where the two dimensions could have been computed, show important differences between the maximum and minimum diameters. Three of the weights (CO1, CO2 and CO3) show the same difference between one and the other diameter: 0.7 cm. While the CO4 weight shows a difference of 1 cm between maximum and the minimum. This means that they were probably attached to a dragrope a little less than 2 cm thick (Figure 9).

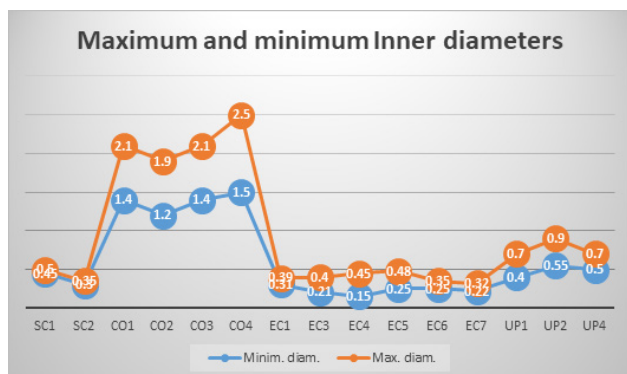


Figure 9 Graphic showing the oscillations between the maximum and minimum internal diameter of each piece.

The internal diameter of the pieces from Es Culleram shows, once again, considerable variability. A first group, with minimum diameters of 0.25 to 0.31 cm, would include pieces EC1, EC5 and EC6, while a second group would be made up of pieces EC3, EC4 and EC7, with minimum diameters of 0.15 to 0.22 cm. These results would allow us to suggest that these plumb lines could belong to at least two different networks. However, the raw material and the handmade nature of these ropes would explain that they could have certain variations in thickness, especially considering that the hammering with which the weights were adjusted to the rope could compress it, and these variations would be reflected in the internal diameters of the lead sinkers. If so, it would be considered that the seven pieces could have belonged to the same net, especially considering that the maximum difference is 0.23 cm. If this were the case, after all that

we have seen, we would have to conclude that the weight rope of said net had been made by reusing, at least in part, sinkers from other previous nets, as revealed by the different weights of each net sinkers. However, we would also have to conclude that this had not been done completely randomly, but that the fisherman who made the net took this difference in weight of each one very much into account, since the evident decrease compared to the average that show the weight of the pieces EC5 and EC6 -and therefore their lower sinking force-, was compensated with the higher weight -and greater sinking force- of the EC7.

As for the four pieces of unknown provenance, they show few variations, both in the minimum diameter, between 0.4 and 0.55 cm, and in the maximum, between 0.7 and 0.9 cm.

Results

Net fishing suppress allows much larger catches than hook and line fishing. Because the different mesh gears, whether purse seine, barrier or trawl, make possible captures in different ecosystems, so that both sedentary benthic species and even practically complete shoals during migratory flows, can be trapped between their meshes.⁵⁶ The discovery of weights, whether lead, ceramic or lithic, is the only reliable evidence of the existence of one or more networks in the investigated site, whether marine or terrestrial.⁵¹ In ancient times, nets used to be made of natural fibers, such as flax, since this fiber is invisible to fish, although it has the drawback of its short duration.⁵⁷ Possibly, this fact led to the search for alternative materials. This seems to indicate that the analysis of two samples from the Serçe Limani wreck confirms that they were animal hair fibers, which have been identified as belonging to goats.

The pieces from Sa Caleta, the oldest since they date back to the 7th century BC, are completely uneven. This implies, to the extent that the three pieces are representative of the fishing activity of the enclave, a lack of standardized pattern for the manufacture of this type of weights. The typological characteristics of the SC1 piece, and in particular its notable weight (46.24 g), make us consider it a true net sinker, attached to a dragrope of circa 0,5 cm thick. However, the low weight of piece SC2, which does not reach 7 g, leads us to discard it as a net weight, inclining ourselves to consider that, more probably, it was used as sinker in a hook and line rig for fishing shoreline, a fishing rod or a simple line with lead sinker and hook. As for the SC3 piece, with an intermediate weight between the two previous pieces (27.39 g), although it is somewhat higher than the Es Culleram pieces, its small dimensions, before being deformed, lead us to consider that it was probably used also as a weight for a hook and line rig, although for fishing deeper than the SC2, given its superior sinking force.

The set of seven pieces from Cala Olivera, although with some variations in its weight and size, shows a remarkable typological homogeneity. They are small almost square sheets of lead, around 3.5 cm, both in length and width, with an average weight of 159.44 g, which were rolled by hammering until they were given the final shape, on a rope slightly less than 2 cm in diameter.

The pieces from Es Culleram are also typologically homogeneous, as they consist of seven weights made from sheets folded in half, with an average length of 5.62 cm and an average weight of 23.55 g, which were mounted on a headrope very fine, 0.3-0.4 cm.

As for the set of four weights of unknown origin, the homogeneity of their physical appearance and their dimensions would corroborate that they are weights from the same net and, therefore, from the same origin. These are larger pieces than those of Es Culleram and much

narrower and longer than those of Cala Olivera. They are made of a rectangular sheet rolled up on itself, which would be mounted on a rope of approximately 0.6 cm and which at the time of its amortization three of them were completely open in its central part.

Discussion

How can we find out what kinds of gear art the Phoenicians and Punic handled? Given the lack of own Phoenician-Punic texts, together with the poverty of information sources that we have described at the beginning, the recourse to the dissection of the written sources and comparative ethnography is imposed, contrasting the data extracted from the archaeological contexts with the data from ancient texts and traditional fishing techniques.³⁰ But being aware that it is still very risky to establish a clear relationship between weight types and network types and that, in the best of cases, this constitutes only a plausible hypothesis.

In Antiquity, the use of nets is briefly mentioned by Homer in some passages of the Iliad (II.V.487)⁵ and the Odyssey (Od. XXII.383-389):⁵¹

A millennium later, Opiano, when referring to fishing instruments (Hal. III, 80-84), states that nets were divided into two large groups: throwing nets (*amphiblestron*), and drag nets (*gríphoi*). Among the latter, he distinguishes the trawls (*gángamon*) for sponges, oysters and sea urchins, the rounded bag nets (*periégées hipochaí*), and the barrier nets (*sagena*); others are called cover nets (*calýmmata*). Among the trawl nets there are the so-called floor nets (*pézas*). In the group of the *amphiblestron* are the rounded throwing nets (*sphairónas*) similar to the modern cast net, and the curved nets that can contain all kinds of fish (*scolión pánagron*).³ All of them could have a large number of variants.

Considering the findings on the island of Ibiza, we can see that there are several gears that could have been used, according to the study of the lead weights that are preserved in the MAEF.

In the case of piece SC1, due to its characteristics, specially its moderate weight, we believe that it could be attached to a barrier rig. It would be, therefore, the only true testimony of fishing with nets in the Phoenician settlement of Sa Caleta.

The net sinkers from Cala Olivera show a more marked wear on one of their sides, on the upper hinge, undoubtedly the one that would drag along the bottom of the sea. Therefore, the rope to which they were attached corresponds to the rope of a net that had to be dragged along the bottom, while, in the upper part of the gear, a series of corks would allow it to be kept open and suspended. Although this type of net weight has sometimes been identified as sinkers for almadrabas (specific gear for tuna fishing), in our opinion, given the size and weight of the tuna, the trap needs to be ballast with larger and heavy weights. For this reason, given their weight and small size, in our opinion it is more likely that these pieces belonged to some type of smaller rig, perhaps from the gríphoi group and similar to the seine nets (jabega or boliche), or their small versions. These are tackles for inshore fishing, which are set from a boat in a circular fashion, surrounding the shoal of fish, and being characterized by small-sized trawls. They consist of two long lateral arms made up of several sections, which together always exceed one hundred and seven fathoms in length in the case

⁵In this case it seems that the net would be a hunting gear.

of the seine (jábega), that end in a crown or codend in the shape of a central sack where the catches are concentrated, while de two wings or net arms ends in a long rope (Figure 10).

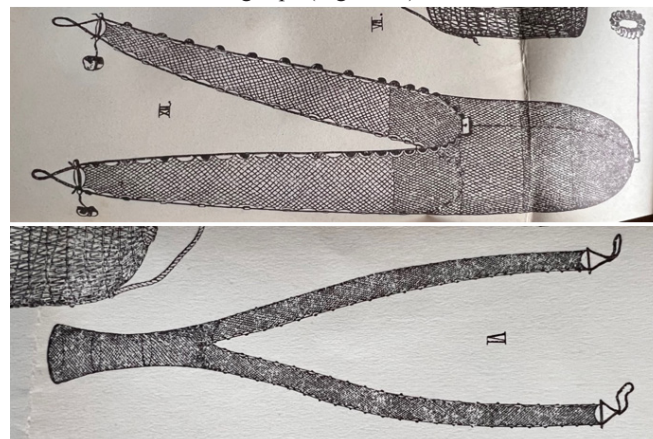


Figure 10 Seine nets: a) Boliche. b) Small Boliche (since Archduke Ludwig Salvador of Austria, Die Balearen in Wort und Bild Geschildert, 1897).

The boat that casts the net does so in a semicircular fashion, starting from the beach, where one of the capes remains, and returning to the coast or sending a second boat a few meters ahead to leave the cape after rounding the bank. Then the gear is dragged by the force of the fishermen's arms. At this time, the pullers charge the gear by pulling the ropes and taking the codend to the beach with the fish inside (Figure 11).

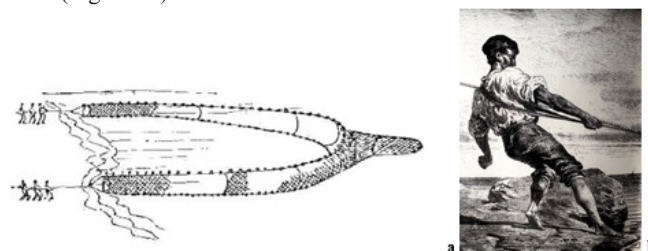


Figure 11 a) Diagram of hauling a seine from the shore. b) Fisherman pulling the boliche from the beach in Majorca (since Archduke Ludwig Salvador of Austria, Die Balearen in Wort und Bild Geschildert, 1897). c) Scene of hauling a seine from the shore in a Roman mosaic dated to the end of the 2nd century AD. The Bardo Museum (Tunis).

In the case of smaller versions of the rig, it can be hoisted from the boat itself by the force of the fishermen's arms just like portrayed in several Roman mosaics (Figure 12) as, for example, at the Maison de la Cascade in the ancient city of Utica in Tunisia,⁵⁸ or the *Domus of Hyppolitus* in *Complutum* (Alcalá de Henares, Spain),⁵⁹ among many others (Figure 12).



Figure 12 Pulling the seine from fishing boats. a) Mosaic from the «Maison de la Cascade», Utique (Tunisia). b) Detail of the Mosaic of the fish from the Domus of Hyppolitus, in Complutum (Spain), from the end of the 3rd-beginning of the 4th century AD.

Due to their dimensions and characteristics, these gears are designed for small fish that move in large schools, such as sardines, but which in the Pityusai Islands are mainly picarel (*Spicara smaris*) and mackerel (*Trachurus trachurus*).

On the other hand, and although we do not rule out other possibilities, its characteristics, especially its low weight and the small internal diameter of the pieces from Es Culleram, lead us to conclude that they belong to a finer and smaller net, possibly to a barrier gear, perhaps similar to a traditional trammel net for fishing on sandy bottoms.³⁰ It is a gear that it has been, and still is, very present on the Mediterranean coast as one of the main methods of artisanal fishing. This net, at least in recent times, is made up of a central canvas with a very fine mesh and two sides with a wider mesh that are folded over the first. They are divided into “clears”, which have a lighter mesh central area (like the cuttlefish net), and “blind”, which have a smaller mesh central area (like the shrimp or mullet net). The net is kept taut as a curtain that stands in the way of the fish, because the upper rope that holds the fabric has a large number of corks regularly arranged along it that pull it upwards, while the footrope sinks to the bottom due to the weight of the plumb bobs that are also regularly attached

As for the four weights of unknown origin, they are typologically the same as SC1, however, they are longer and heavier, so we consider that they could have been part of a trawl gear, without ruling out a purse seine gear either.⁶¹

Conclusion

From the study of four sets of lead net weights, we have documented the use, on the island of Ibiza, of different types of nets throughout the Phoenician-Punic era. This would undoubtedly allow the capture of species in different ecosystems, both on the coastal platform (trammel nets) and in the open sea with trawl gear, possibly similar to the seine type or its derivatives.

The type of net weight formed by a rolled lead sheet (type L2.2 by Galili, Rosen and Sharvit = PLII2 by Bernal), appeared in Ibiza in the 7th century BC and was brought to the island by the Phoenicians, as evidenced by specimens of Sa Caleta. We do not have any information on the fishing techniques of the pre-Phoenician inhabitants of the Pityusai Islands, but current evidence shows that net fishing was introduced to Ibiza by the Phoenicians.

Unfortunately, we do not have criteria to date the specimens of unknown provenance UP1-4, but due to their characteristics we believe

to it. This type of gear is usually used for shallow depth fishing close to the coast, often on the dividing line between sand and seaweed.⁶⁰ However, in Antiquity, the simple model of a single piece of mesh was probably more used, in which the capture was made because the fish inserted its head into the opening of the mesh (Figure 13a, Figure 13b) and then could not withdraw when it was hooked by the operculum (Figure 13c). This supposes a very selective fishing and always of adult specimens, that is to say, completely ecological and sustainable. This attribution to this class of rig based on the weights of the net is also based on the consideration that fewer but heavier weights are used on rocky bottoms, often stone in Antiquity, because it is easy for them to get hooked and get caught loose. For this reason, they must be attached to the dragrope with thick thread, which must be long (1 or 2 meters) so that the dragrope remains above the rocks when setting the net.

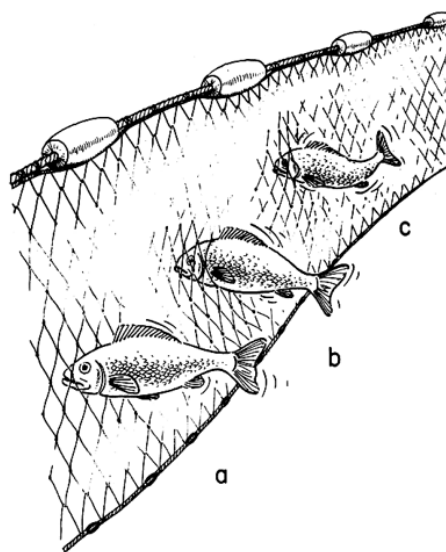


Figure 13 Fishing with a barrier net consisting in a simple piece of mesh. Illustration by S Maugeri.

that they may belong to the full Punic period (V-III centuries BC). The specimens from the Es Culleram sanctuary, made from a simple sheet folded longitudinally, and possibly belonging to a simple barrier net, must be dated to the 3rd-2nd centuries BC, but by now suppress we have been mounted on a drag gear we have no evidences to know if this model of lead weight was used in the island before. And regarding the thickest, shortest and heaviest net sinkers of Cala Olivera, that could have been mounted on a drag gear, the archaeological context set them in a wide range between the 3rd century BC and 1st century AD.

The use of different types of gear implies different capture strategies, different work organization and also different productivity: from collective fishing (trawling or seine gear) to fishing carried out by two or even a single individual (trammel net or other simple barrier gear). This last form of fishing would allow enough catches to supply a family or a small group, while the other, very much productive, would provide large catches to supply the market and even the centers for the elaboration of products derived from fish.

To understand the real importance of fishing in a society we need to know the consumption patterns. These could afford clues to see specific social developments. But, unfortunately, for Phoenician-Punic Ibiza we are still far from this target, so research must go on and deepen in ancient fishing subject.

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Conflicts of Interest

Author declares there are no conflicts of interests.

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