2 Typology, chronology, and geographical distribution

2.1. A note on the selection of the sample

The sampling strategy was not aimed at collecting an exhaustive sample of weighing devices in pre-literate Bronze Age Europe, but rather at filling significant voids in the available documentation, in way that would make it possible to achieve four main objectives:

- assess the overall typological variability of weighing devices;
- assess the diachronic spread of weighing technology;
- assess associations in archaeological contexts;
- reconstruct weight systems.

In the initial phase of data collection, I could rely on a few published studies that systematically addressed the identification of weighing devices in northern Italy (Cardarelli *et al.* 2001; 2004), Sardinia (Ialongo *et al.* 2015), Central Europe (Pare 1999), France (Roscio *et al.* 2011; Roscio 2018), Switzerland (Feth 2014), and Portugal (Vilaça 2003; 2011; 2013), and an unpublished database collecting *Kannelurensteine* from pile-dwelling settlements in Switzerland, kindly provided to me by its author, M. Trachsel. Further published evidence was collected by screening archaeological literature, in particular large publications of settlements and burial sites. The sample of published data, however, left a few conspicuous blind spots that demanded further investigation.

The first and most conspicuous gap to be filled was the absence of systematic research in southern Italy and the consequent, almost complete lack of available data. Verifying the presence of weighing devices was then of utmost importance, especially in consideration of the frequent contacts between southern Italy and the Aegean in the first half of the 2nd millennium BCE (Jones *et al.* 2014), where weighing technology was already adopted in the early 3rd millennium BCE (Rahmstorf 2010). Hence, ascertaining the potential presence of weighing devices in southern Italy would have played a crucial role in testing the hypothesis of a gradual diffusion of the technology from east to west (Rahmstorf 2011). Starting from hints provided by old publications – *i. e.*, pictures of unidentified objects that somehow recalled similar ones already identified as balance weights elsewhere in Europe – I systematically reviewed the published and unpublished finds of some of the most important Bronze Age excavations in southern Italy: the several Bronze Age settlements on the Aeolian Islands (sites no. 3-6, the materials are preserved at the Museo Archeologico Eoliano 'Luigi Bernabò Brea' on Lipari; Bernabò Brea/Cavalier 1968; 1980; 1991) (Ialongo 2019), the necropolis of Thapsos in south eastern Sicily (site no. 2, Museo Archeologico Regionale 'Paolo Orsi' of Syracuse; Orsi 1895) (Ialongo 2022), and the fortified settlement of Coppa Nevigata in northern Apulia (site no. 21, Museo delle Origini, Rome), the latter thanks to the kind collaboration of G. Recchia and A. Cazzella, directors of the ongoing excavations at the site (*e. g.*, Cazzella *et al.* 2012). In all three cases, the investigation returned very positive results, and led to the identification of *c.* 60 unpublished balance weights ranging from the Early to the Final Bronze Age (*c.* 2300-950 BCE).

Another problem left open by the available data was the uneven state of the documentation available for the so-called *Kannelurensteine*, one of the most widespread types of balance weights between southern Italy and the Baltic Sea (Horst 1981; Cardarelli *et al.* 2001; Ialongo/Rahmstorf 2022). While the graphic documentation was already sufficient to assess typological variability and geographical distribution, almost all the objects that had been published in Germany were lacking mass values, which, in turn, prevented assessing the variability of their metrological structure. Therefore, the second phase of data collection was devoted to the first-hand documentation of *Kannelurensteine* in Germany, mostly focussing on the collection of the Museum for Pre- and Early History in Berlin, and the Schloss Gottorf Museum in Schleswig.

Further first-hand documentation was also required to integrate the available documentation for the Terramare settlements in northern Italy. Previous research, in fact, had only identified heavy balance weights (*Kannelurensteine* and piriform weights; Cardarelli *et al.* 2001; 2004), but none that could be compared to the small weights common in southern Italian settlements and in Central European burials. Reviewing the unpublished materials from several old and new excavations – preserved in the storerooms of the Museo Civico Archeologico Etnologico of Modena – provided the opportunity to fill this gap, also thanks to the indications kindly provided by A. Cardarelli.

2.2. The identification of prehistoric balance weights: methodological challenges

2.2.1. Form and function

In principle, mass is the only relevant attribute in defining the function of a balance weight, everything else is secondary. No matter what they look like, the only requisite of balance weights is to comply with the weight systems they are meant to represent, and to occur in a quantitative range that is wide enough to assess the value of many different substances. It follows that, as far as its function is concerned, the shape of a balance weight is largely irrelevant. This, in turn, very often determined objective difficulties in their identification (Petruso 1992; Alberti *et al.* (eds.) 2006; Rahmstorf 2010).

Defying any functional expectations dictated by common-sense, the second most common shape of balance weights in Middle Bronze Age Mesopotamia was that of a sleeping duck: weights ranging from less than 1 g to almost 10 kg were crafted in order to comply with a remarkably strict aesthetic canon which had absolutely nothing to do with aiding their function (*e. g.*, Ascalone 2022, cat. no. 546-617). Granted, duck weights – always made of stone – always have a flattened base that allowed them to sit stably on the balance pan, preventing them from moving around and potentially disturbing weighing operations. Curiously, the overwhelmingly most common shape of balance weights in use between the Persian Gulf and the eastern Mediterranean did not even have such a convenient feature: Most sphendonoid weights have a round cross-section and a thickened middle point, and nothing prevented them from rolling all over the balance pan at any given time (*e. g.*, Pulak 1997; Kulakoğlu 2017; Ascalone 2022, cat. no. 2-527). Moreover, some weights even present perforations that could be used to hang them directly on one of the extremities.

All in all, the Near Eastern documentation stands as a warning that relying on functional features is not necessarily a viable strategy for the identification of balance weights. Throughout the 2,000 years or so following their invention, balance weights have been spheres, parallelepipeds, cubes, pyramids, cylinders, pear-shaped and spool-shaped objects, sphendonoids, discs, truncated cones, octahedra – not to mention ducks, frogs, lions, and seashells – and yet, their formal traits seem to have never negatively affected their functionality. The inevitable conclusion is that literally any object of any shape could have fulfilled the function of a balance weight.

Of course, the inherent formal indeterminacy of balance weights affects our ability to identify them in the archaeological record. Differently from, say, swords, not being able to associate form and function creates an objectively difficulty, that can eventually lead to over- or under-identification, which is precisely one of the historically most challenging problems in pre- and protohistoric metrological studies (Petruso 2019). However, it is nonetheless legitimate to expect that – just like any other kind of functional object – balance weights will eventually tend to follow recurrent shapes in a given cultural setting. Past research demonstrates that balance weights indeed behave in a similar way, showing that different regions of Western Eurasia developed a relatively small quantity of widespread canonical types that archaeologists, today, can recognise quite easily (Petruso 1992; Pare 1999; Cardarelli *et al.* 2004; Vilaça 2011; *e. g.*, Ascalone 2022; Rahmstorf 2022). The obvious starting point for new research, then, is to focus on those types and expand the available dataset.

The general criteria I followed to identify and classify the balance weights collected in this book are based on a revision of previously-proposed strategies (Rahmstorf 2010; Ialongo/Rahmstorf 2019). Balance weights are expected to be a class of relatively standardised objects whose function is not unequivocally indicated by their shape, whose occurrence is documented by several objects from several sites in which they occur in sets, at least occasionally. Most importantly, their mass range should span at least one order of magnitude.

Construction materials have somewhat lax requisites too. In principle, the only requisite is that they should not be easily subject to substantial mass loss in a short period of time. This is to say that, for example, wood is not a suitable material, as the mass of the object can substantially change over time due to loss of water or splintering. Any material whose mass is not easily controlled during manufacture is also not a good fit, such as clay, which loses water during firing. Theoretically speaking, fired-clay objects could still be used as balance weights, provided that they are turned into weights *after* firing, for example by grinding a pottery sherd down to the desired mass. To my knowledge, however, clay was never used as base material for balance weights, at least not in the Bronze Age.

The best materials – and the only ones attested in prehistory – are metals and rocks. In the Bronze Age of Western Eurasia, metallic weights are either made of lead or bronze, with the former being majority in the Aegean (Petruso 1992), and the latter somewhat commonly attested in Central and Atlantic Europe (Pare 1999; Vilaça 2011). Stone weights, however, make by far the overwhelming majority of balance weights overall in Western Eurasia. The rocks used for balance weights tend to be relatively soft and easy to work – such as hematite in Mesopotamia and sandstone or steatite in Europe – but harder rocks, such as marble and porphyry, are also attested (Cardarelli *et al.* 2001). While both perfectly suitable, metals and rocks have opposite manufacturing processes: While the former must be weighed before giving them shape, the latter must be ground down by removing matter.

Further criteria – such as use-wear and inscriptions – are sometimes mentioned (see *e. g.* several contributions in Alberti *et al.* (eds.) 2006), but their reliability is questionable. Due to their frequently basic appearance, many balance weights can phase in and out of different functions several times during their lifetime. As a consequence, use-wear traces that are not connected to weighing operations are often documented on balance weights, even when clear quantity marks are present (Petruso 1992, 4; Rahmstorf 2016a). Quantity marks and inscriptions, in turn, are so rarely documented on balance weights – even in Bronze Age Mesopotamia, where inscribed weights are only 3 % of the total (Ialongo *et al.* 2021) – that their absence cannot be considered a relevant criterion.

As a matter of fact, there is nothing in the function of balance weights that is inevitably connected to their appearance, and very few indications are provided by their construction material. Their only defining attribute is their mass. It follows that the only meaningful way to determine whether or not a class of object is, in fact, a class of balance weights is to test whether or not their mass values are 'quantally-configured', *i. e.*, if they are approximate multiples of a single *quantum*, an analytical concept that can be roughly assimilated to that of 'unit of measurement' (see Chapter 4). This is to say that the identification of balance weights is entirely a statistical problem (Pakkanen 2011; Ialongo 2019; Petruso 2019), which means, in turn, that, at least for the time being, research on prehistoric balance weights must cohabit with two inherent limitations: 1) one can only hope to identify a relatively small part of all the objects that may have fulfilled the function of balance weights, and 2) one can never be absolutely sure that all the identified objects are – or were at any given time – actually balance weights.

This, in turn, implies that not all the objects classified in this book may have been, in fact, balance weights. Some of them can have been crafted as balance weights and used as such for some time, and then converted to some other use, such as hammers, grinders or whetstones. The opposite can also have happened: Tools that were originally meant to serve as hammers, grinders or whetstones – and potentially any other kind of hard tool, as well as beads and pendants – may have been eventually turned into balance weights. Overall, however, the results of the statistical tests confirm that a statistically significant portion of all the objects that form the dataset of this book were – at one point or another – indeed balance weights, all complying with the same weight system.

2.2.2. Pebble-weights and the indeterminacy problem

The realisation that form is not a requisite inevitably comes with the conclusion that literally anything can be used as a balance weight. This, in turn, exposes the biggest blind spot in our understanding of prehistoric weighing tools: natural pebbles used as balance weights. The cover photo of a recently published book perfectly exemplifies the puzzle of 'pebble-weights' (Chambon/Otto 2023). The photo portraits a street vendor in Iran selling oranges, and weighing them on a two-pan balance scale against what appear to be natural stones. Just like all known prehistoric weights, these stones seem to have no visible feature providing any indication about their mass, or that could even identify them as balance weights. Some of them even appear to have been broken, perhaps to bring them down to the desired mass. Most interestingly, customers do not seem to care.

Aside from the social implications of the utter unimportance of formally-standardised weighing tools, the very possibility of the existence of pebble-weights in the Bronze Age presents a clear problem for archaeologists trying to identify them in the material record. To be sure, pebble weights are among the earliest types of balance weights, appearing in the Near East at the onset of the 3rd millennium BCE, where some of them can be identified thanks to the rare occurrence of quantity marks appearing on their surfaces as incised lines (*e. g.*, Rahmstorf 2022, fig. 97,15.17, 110,4.17). It is when marks are not present that the challenge becomes hard to overcome. For Bronze Age Europe, L. Rahmstorf (2014) discussed the possible identification of two sets of pebble-weights that were found in association with balance beams, but unfortunately the data are not sufficient to confirm the existence of an underlying weight system. In these particular cases, the available excavation data do not even provide conclusive information that could allow one to exclude that such pebbles were simply part of the local soil.

As they pose specific methodological problems, research on pebble-weights was not within the scope of this book. A possible strategy to work around these uncertainties would be to collect a large number of natural pebbles from controlled excavations, analyse their mass values, and verify if they comply with multiples of a unit. We still would not be able to separate pebble-weights from pebbles that were used for different purposes – or that were not used at all – but at least we would have the confirmation of their existence. Unfortunately, natural pebbles are very often discarded during excavations, and even when they are not, they are very seldom published.

In synthesis, we will never be able to positively identify pebble weights except in those rare cases in which they come with quantity marks, which in turn only seem to occur in the Near East, and only in early periods. The logical consequence is to admit that pebble weights likely existed in pre-literate Bronze Age Europe, even though there is not much one can do to identify them. When trying to imagine the actual spread of weighing technology and its impact on the everyday lives of people, one must take into account that a large amount of weighing devices must have existed, that we will never be able to appreciate fully: A sort of dark matter that we know must have existed, but that we cannot possibly quantify.

2.3. Typology and orders of magnitude

The sample collected in this book includes 696 balance weights and 18 balance beams, unevenly distributed between Italy, Eastern Europe, Central Europe, Western Europe and the British Isles, roughly encompassing the whole duration of the Bronze Age and the very beginning of the Early Orientalizing period, *c.* 2300-700 BCE. Three

Fig. 2.1. Balance beams: morphological variants.

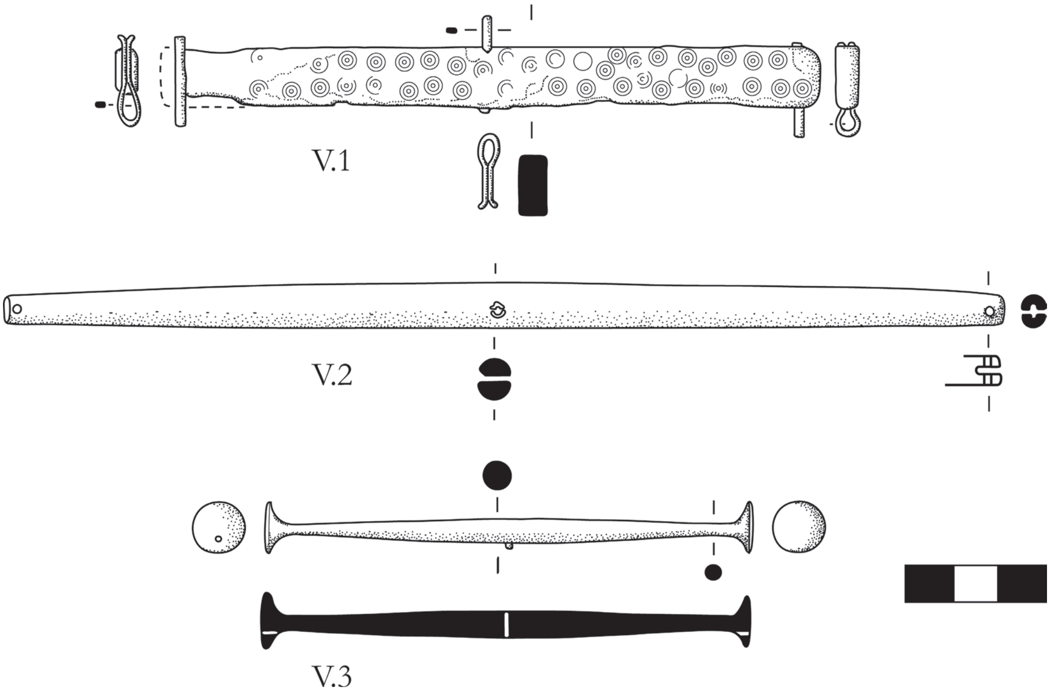
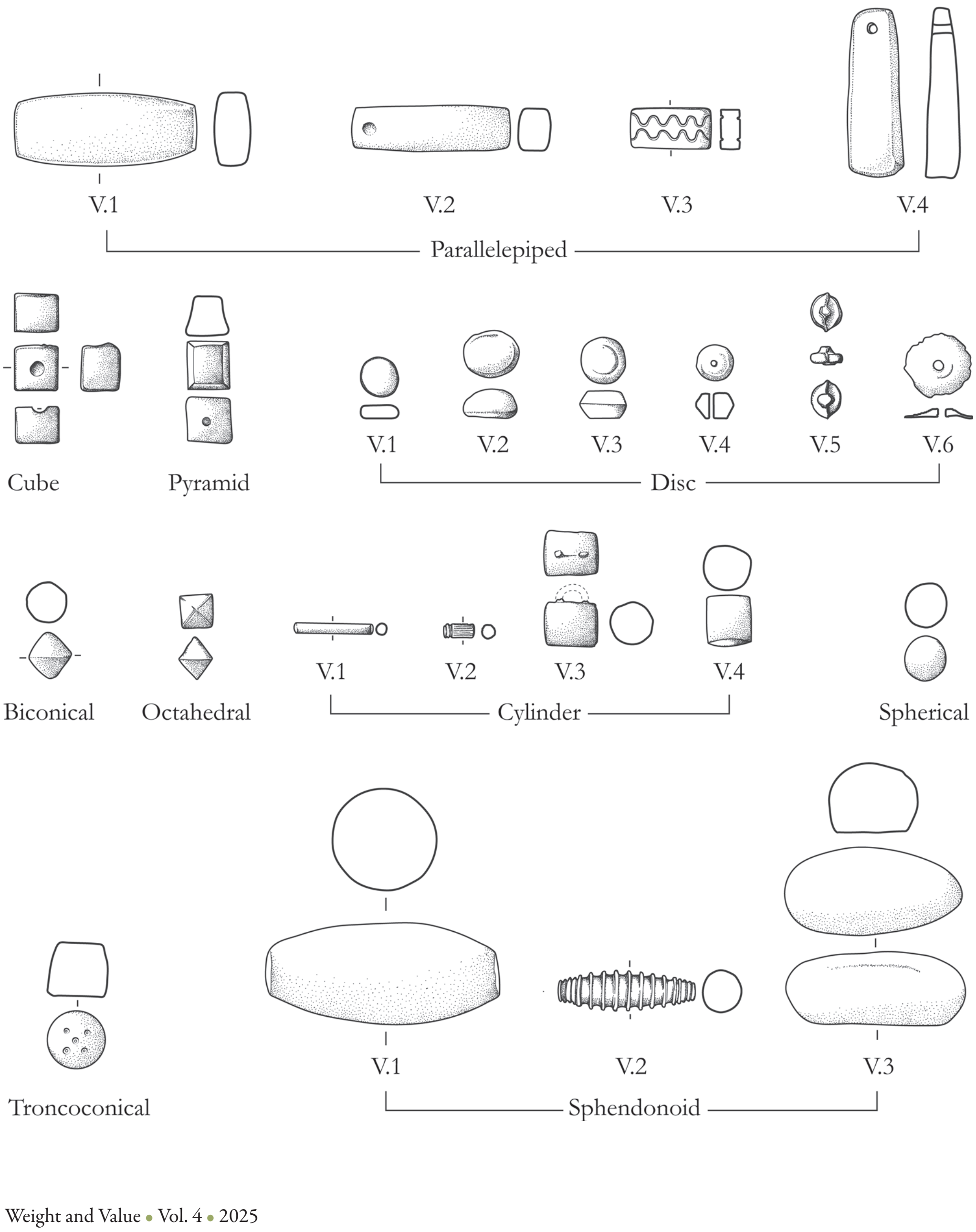


Fig. 2.2. Balance weights of the shekel-range: morphological types and variants. Scale: 1:3.



types of balance beams could be singled out, all made of bone (Fig. 2.1.), while balance weights attested in Bronze Age Europe belong to 13 distinct morphological archetypes, most of which show rather basic and unremarkable shapes (Fig. 2.2.-3.). General quantitative information on typology, chronology, orders of magnitude, contexts, and materials is shown in Fig. 2.5.-8. The detailed description for each morphological type is provided in Chapter 5.

Balance beams are always made of bone, and are divided into three main morphological types (Fig. 2.1.). V.1, represented by a single object (object no. 1) has a rectangular cross-section and is provided with three bronze loops, two for each pan and one to hang the balance itself. V.2 and V.3 both have circular cross-section, but while the extremities of the beam in V.2 are plainly cylindrical, the extremities of V.3 have with trumpet-shaped terminations.

A preliminary analysis of the mass distribution shows that balance weights form two rather sharply-defined clusters on typological ground. The first cluster of 'light' weights is mostly comprised between *c.* 3-100 g (Fig. 2.4.; from parallelepiped to sphendonoid), while the second cluster of 'heavy' weights is mostly concentrated between *c.* 300-1,000 g (Fig. 2.4.; from *Kannelurensteine* to 'other hanging weights'). These clusters seem consistent with what is known about the structure of weight systems in pre-literate Bronze Age Europe. Similarly to the largely contemporary Mesopotamian system (Powell 1979; Parise 1981), the European weight system was probably based on specific units for different orders of magnitude. Past research has identified at least two of such units (see Chapter 4): a lighter unit of *c.* 10 g – the so-called 'Pan-European unit' (Ialongo *et al.* 2021) – and a heavier one ranging *c.* 400-450 g, slightly oscillating according to region and chronology (Ialongo/Rahmstorf 2019; 2022). In order to maintain the standard terminology in use in Near Eastern metrology, I will use the terms *'shekel'* and *'mina'* to identify, respectively, the lighter and the heavier unit.

Interestingly, the theoretical values of the European *shekel* and *mina* cross the light and the heavy clusters of balance weights towards the lower part of their respective distributions (Fig. 2.4.). This seems to support the hypothesis that the balance weights in the light cluster were meant to com-

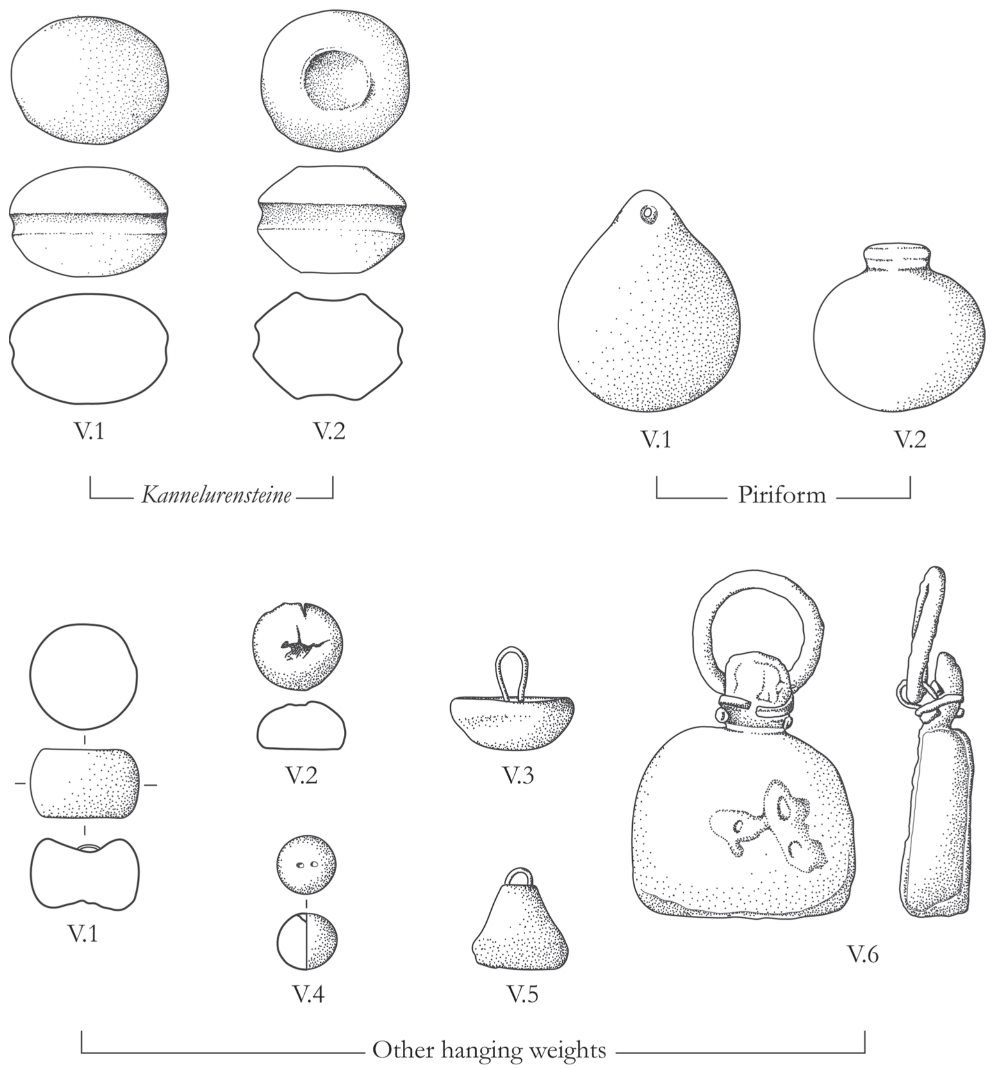
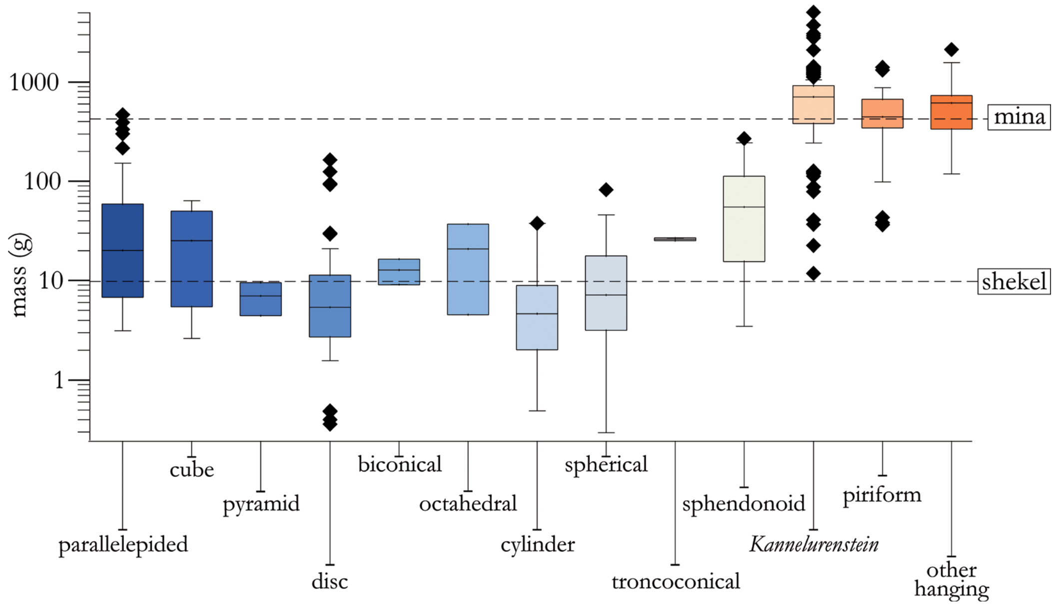
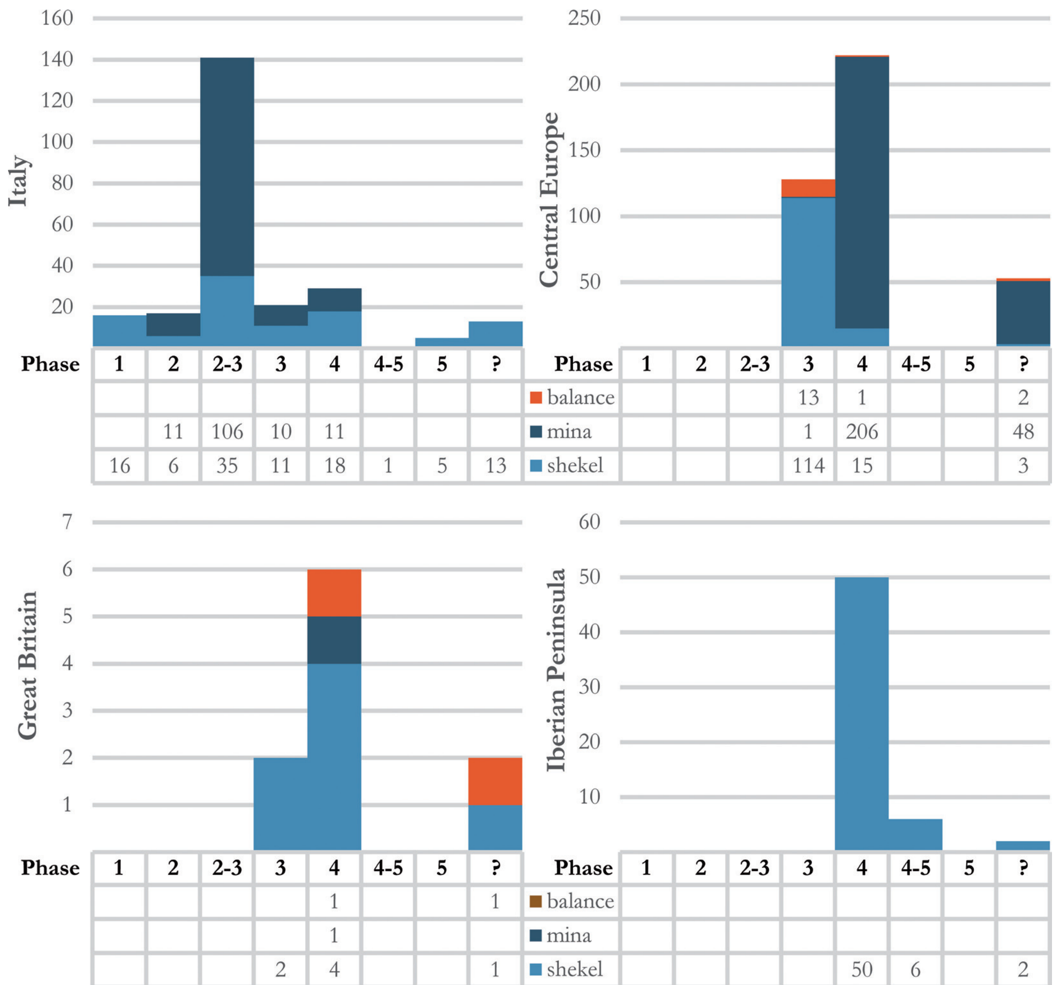


Fig. 2.3. Balance weights of the mina-range: morphological types and variants. Scale: 1:4.



▶ *Fig. 2.4. Box-and-whiskers plot: comparative chart of the distributions of the mass values of each morphological type of balance weights. Blue-gray gradient: types of balance weights in the shekel-range; orange gradient: types of balance weights in the mina-range. The vertical axis is displayed in logarithmic scale. The dashed lines indicate the theoretical value of the European shekel and mina.*



Italy:

Phase	1	2	2-3	3	4	4-5	5	?
balance								
mina		11	106	10	11			
shekel	16	6	35	11	18	1	5	13

Central Europe:

Phase	1	2	2-3	3	4	4-5	5	?
balance				13	1			2
mina				1	206			48
shekel				114	15			3

Great Britain:

Phase	1	2	2-3	3	4	4-5	5	?
balance					1			1
mina					1			
shekel				2	4			1

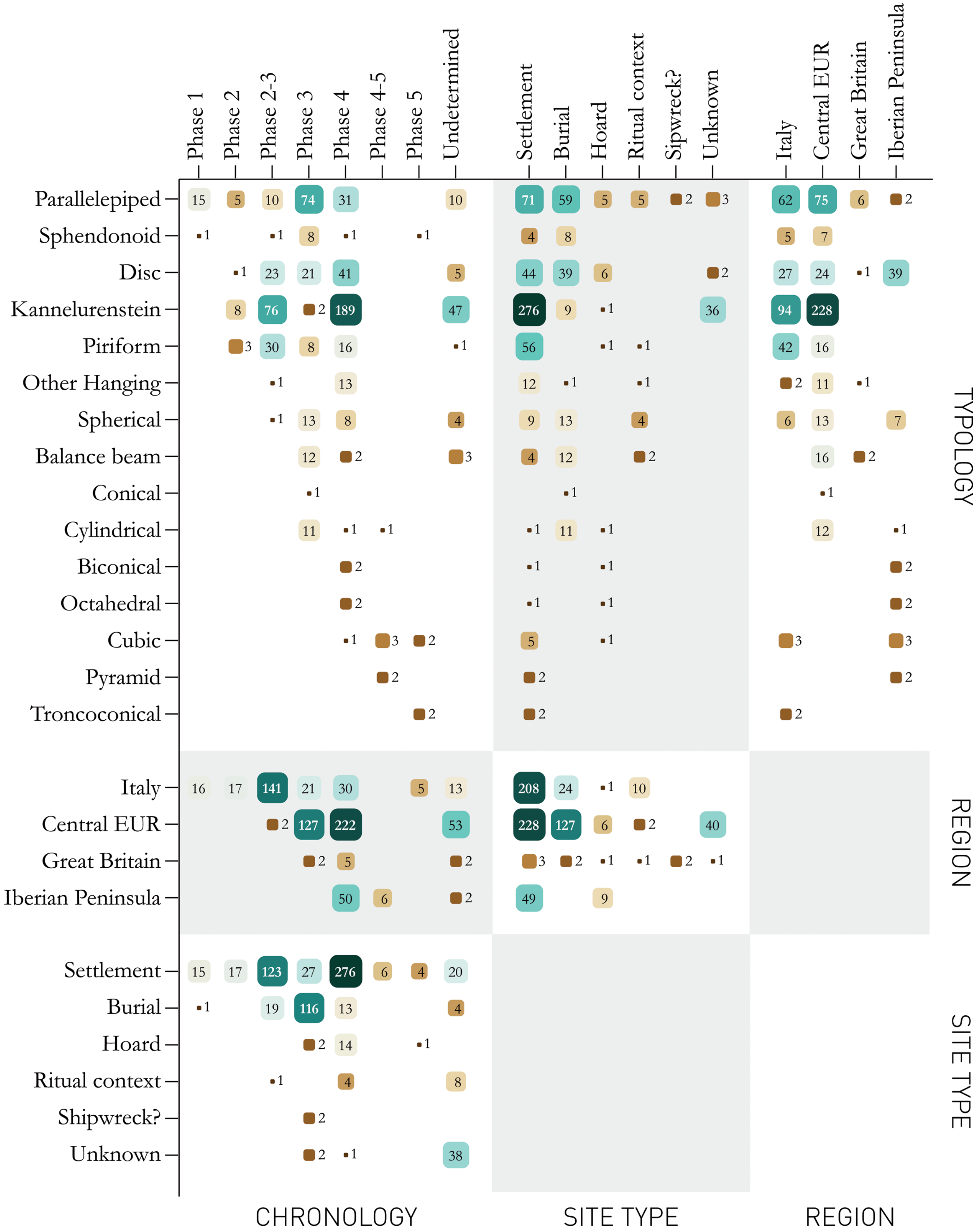
Iberian Peninsula:

Phase	1	2	2-3	3	4	4-5	5	?
balance								
mina								
shekel					50	6		2

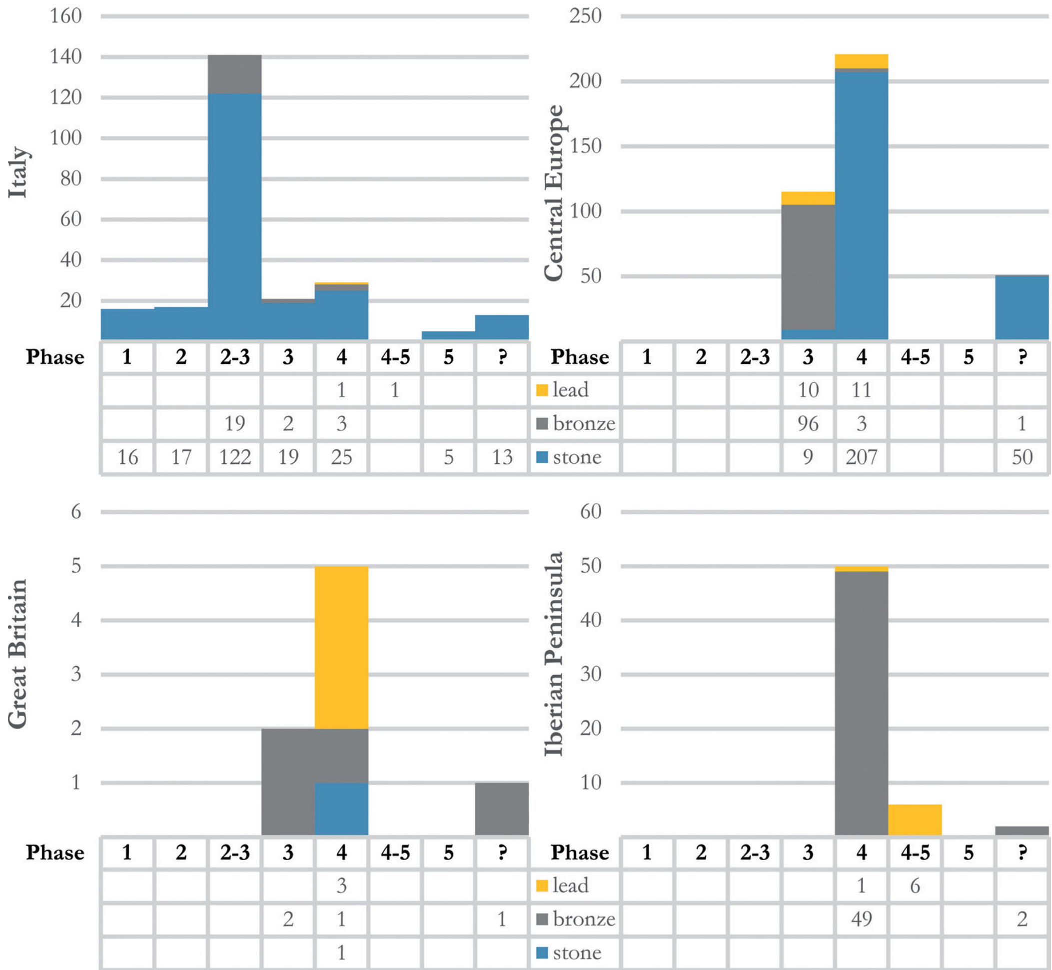
▶ *Fig. 2.6. Diachronic quantification of weighing devices (balance beams, shekel-range weights, mina-range weights) in the four main macro-regions.*

ply with multiples of the *shekel*, while those in the heavy cluster were rather organized according to multiples of the *mina*. This, in turn, also suggests that different orders of magnitude also had their dedicated formal types of balance weights. Based on these observations, I will refer to these type-based clusters of balance weights as the '*shekel*-range' and the '*mina*-range'.

The *shekel*-range includes 302 objects, articulated into nine distinct morphological types, some of which are further divided into typological variants (V.) (Fig. 2.2.). Most objects do not have distinc-



▲ *Fig. 2.5. Matrix chart summarizing general quantification of several aspects of balance weights: typology, chronology, site type, and region. The size of the squares is proportional to quantity.*



Italy – Phase	1	2	2-3	3	4	4-5	5	?
lead					1	1		
bronze			19	2	3			
stone	16	17	122	19	25		5	13

Central Europe – Phase	1	2	2-3	3	4	4-5	5	?
lead				10	11			
bronze				96	3			1
stone				9	207			50

Great Britain – Phase	1	2	2-3	3	4	4-5	5	?
lead					3			
bronze				2	1			1
stone					1			

Iberian Peninsula – Phase	1	2	2-3	3	4	4-5	5	?
lead					1	6		
bronze					49			2
stone								

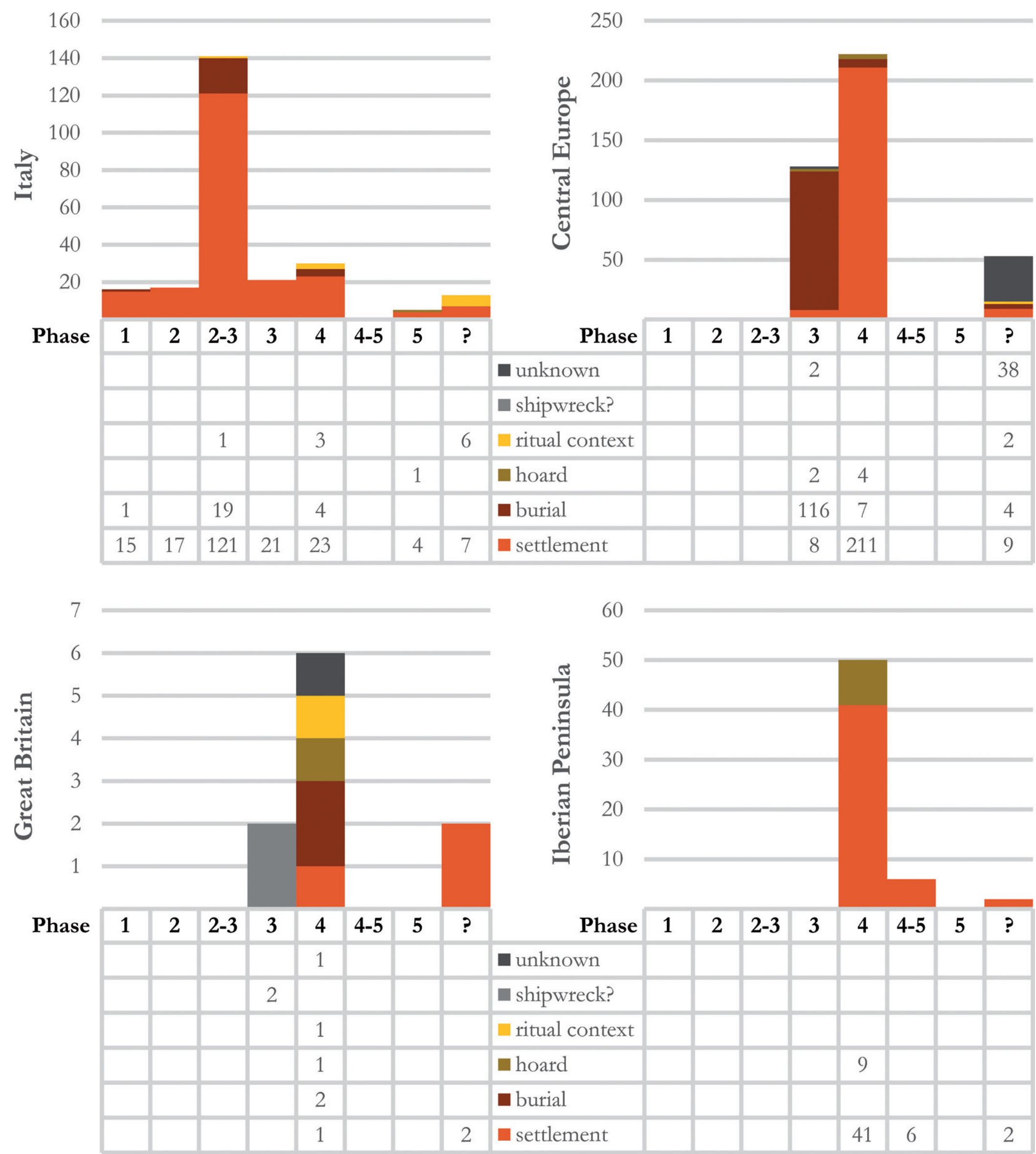
Fig. 2.7. Diachronic quantification of balance weights and their construction materials in the four main macro-regions.

tive functional features, and all of them could be used simply by being laid on a balance pan, or any container hanging from one of the scale's extremities. Four variants are characterized by perforations or loops (rectangular V.4; disc V.4, 6; cylinder V.3), that could be used to hang the weight directly on one of the balance's arms. Concerning the weights securely dated to the Bronze Age, marks and decorations are in general extremely rare (parallelepiped V.2-3; sphendonoid V.2), and there is no evidence that they represent quantity marks or that they are in any way connected to mass values. On the other hand, a few objects dated to the 8th century BCE present markings that could be connected to multiples and fractions of weight units. These weights, however, always occur in regions (Sardinia and south-western Iberia) where Phoenician presence is attested, and could be also connected to eastern Mediterranean standards. Even in this case, however, the evidence is not conclusive (see Chapter 4).

The *mina*-range includes 394 objects, divided into three main morphological types (Fig. 2.3.). *Kannlurensteine* are probably the most characteristic formal types of balance weights in Bronze Age Europe, as they do not seem to occur anywhere else in the central and eastern Mediterranean. They are attested in two variants: V.1 with plain surfaces and V.2 with circular indentations, the former appearing in Phase 2 in Italy and the latter characterized by an overall later chronology (mostly Phase 4; see Chapter 5). Piriform weights are attested in a variant with perforation (V.1) and one with an upper knob (V.2). Finally, a last heterogeneous category includes six variants of heavy weights provided with perforations or metal loops.

2.4. Diachronic spread of weighing technology

The synchronisation of local chronological sequences in Europe is notoriously a problem, as cross-regional indicators are not always available and absolute dates are often offset (*e. g.* Pacciarelli 2001; Primas 2008; Roberts *et al.* 2013). For the purpose of this study, I rely on a broadly-defined synchronisation scheme, divided into four phases. Phase 1 (*c.* 2300-1700 BCE) and 2 (*c.* 1700-1400/1350 BCE) correspond, respectively, to the Italian EBA and MBA, since weighing equipment, for the moment, is not attested elsewhere. Phase 3 encompasses the Italian Recent Bronze Age (RBA) and BzD in Central Europe (*c.* 1400/1350-1200 BCE). The often-unclear chronology of the finds from the Terramare settlements in northern Italy poses a definition problem for a clear break between Phases 2 and 3. The many finds from this area frequently come from old excavations of long-lived settlements, often encompassing both chronological



Italy

	1	2	2-3	3	4	4-5	5	?
unknown								
shipwreck?								
ritual context			1		3			6
hoard							1	
burial	1		19		4			
settlement	15	17	121	21	23		4	7

Central Europe

	1	2	2-3	3	4	4-5	5	?
unknown				2				38
shipwreck?								
ritual context								2
hoard				2	4			
burial				116	7			4
settlement				8	211			9

Great Britain

	1	2	2-3	3	4	4-5	5	?
unknown					1			
shipwreck?				2				
ritual context					1			
hoard					1			
burial					2			
settlement					1			2

Iberian Peninsula

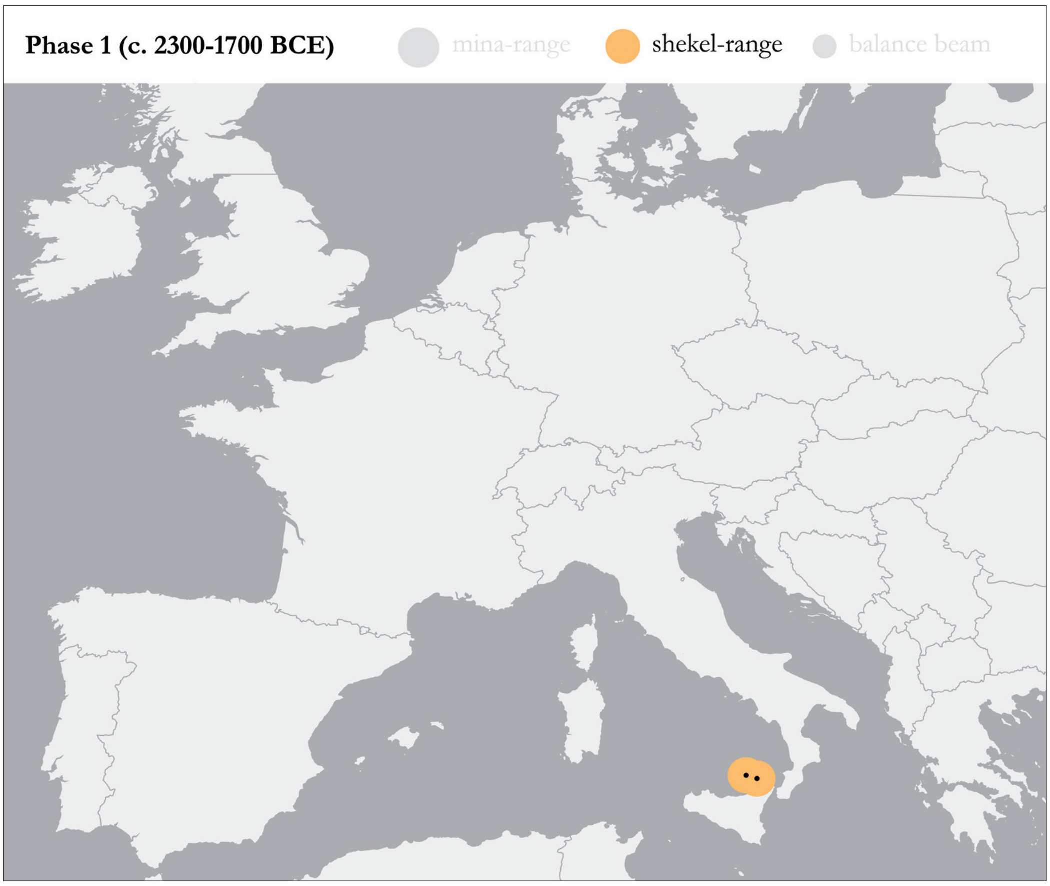
	1	2	2-3	3	4	4-5	5	?
unknown								
shipwreck?								
ritual context								
hoard					9			
burial								
settlement					41	6		2

Fig. 2.8. Diachronic quantification of weighing devices and site types in the four main macro-regions.

phases, which in turn makes it impossible to attribute each find to a specific horizon. The abrupt end of the Terramare culture *c.* 1200 BCE, however, provides a solid *terminus ante quem* (Cardarelli 2009). Phase 4 includes the Italian Final Bronze Age (FBA; *c.* 1200/1150-950 BCE) and Early Iron Age 1-2A (EIA; *c.* 950-730 BCE), Hallstatt A-B in Central Europe and Period IV-V in northern Germany (*c.* 1150/1100-800 BCE), Wilburton and Ewart Park in the British Isles (*c.* 1150/1100-800 BCE), and Bronce Final III in the Iberian Peninsula (*c.* 1150/1100-800 BCE). Finally, Phase 5 includes only a handful of objects coming from late contexts in Italy and the Iberian Peninsula, dated between the late 8th and the 7th century BCE. While in some cases well-dated contexts allow for greater detail, the majority of the available data rely on broadly-defined chronological horizons. Therefore, it is necessary to scale down the chronological detail in order to allow comparability between different regions. Higher accuracy will be likely possible once a much bigger sample is available.

2.4.1. Phase 1 (c. 2300-1700 BCE)

West of Greece, balance weights are first attested on European territory on the Aeolian Islands (Fig. 2.9.), a small archipelago off the north-eastern coast of Sicily, in two settlements and a burial site dated to the early phase of the Capo Graziano horizon (sites no. 3, 5), corresponding to the Italian Early Bronze Age, *c.* 2300-1700 BCE (Ialongo 2019). The nearest region in which weighing technology was already widespread before this period is the Aegean, where weighing equipment is attested at least since *c.* 2800 BCE (Rahmstorf 2016b). Since all available data converge in showing a gradual diffusion pattern of weighing technology from Mesopotamia and Egypt towards other regions of Western Eurasia (Ialongo *et al.* 2021), it would make sense that the technology was first imported in Europe from the Aegean. The validity of this hypothesis must be evaluated against three observations that might appear to contradict it. First, the appearance of balance weights in the Aeolian Islands precedes the earliest secure attestations of



▶ *Fig. 2.9. Phase 1 (c. 2300-1700 BCE): geographical distribution of weighing devices.*

Aegean pottery in southern Italy, usually dated to the early phase of the Italian Middle Bronze Age (*c.* 1700-1500 BCE), corresponding to the Late Helladic II in Aegean chronology (Jones *et al.* 2014). Second, 15 out of a total of 16 weights attested in the Aeolian Islands in this phase belong to the parallelepiped type, and one to the sphendonoid type, neither of which is documented in this period in the Aegean (Rahmstorf 2022, 21-202). And third, the Aeolian weights already comply with the weight system that will later characterise Europe in the 2nd millennium BCE (Chapter 4; see also Ialongo 2019).

While the evidence does not unequivocally support transmission from the Aegean, the alternative would be even less likely. It is difficult to imagine, in fact, that weighing technology was discovered and developed independently in southern Italy. As already noted, the clear diffusion pattern observable between Mesopotamia and Europe is itself a strong hint of gradual technological transmission. Furthermore, one has to consider that the periodization of the Aeolian stratigraphy between *c.* 2300-1700 BCE is very loose, and that there is no reliable way to collocate our finds precisely within this long time-span. A third way, then, is to posit that the balance weights attested in the Early Bronze Age contexts of the Aeolian Islands belong to an already mature stage of the use of weighing technology in southern Italy, that in turn predates the earliest *visible* traces of contacts with the Aegean. In other words, the existence of weighing technology in the Early Bronze Age in southern Italy suggests that commercial contacts with the Aegean may predate the earliest evidence of Aegean pottery in Italy.

As already mentioned, only two types of weights are attested in the Aeolian Island in Phase 1: parallelepipeds (15 objects) and sphendonoids (one object), all made of stone and belonging to the *shekel*-range. Parallelepiped weights – together with *Kannelurensteine* and piriform weights in the *mina*-range – are the 'hallmark' of weighing equipment in pre-literate Bronze Age Europe. Attested throughout the whole Bronze Age everywhere in the study area, they are extremely rare in other regions of Western Eurasia (see Rahmstorf 2022 for an overview of morphological types between Western Asia and the Aegean). They are also the type most frequently occurring in sets (see below). Sphendonoid weights, on the other hand, are quite rare in Europe (although attested in every period) and extremely common in the Near East. All parallelepiped weights come from settlement contexts, while the sphendonoid weight is part of the grave goods of a burial (cat. no. 319).

2.4.2. Phase 2 (c. 1700-1400/1350 BCE)

Balance weights appear in northern Italy in Phase 2 (Fig. 2.10.). The Terramara settlement of Gaggio (site no. 40) provides a reliable stratigraphy with layers dating to the Italian Middle Bronze Age, which yielded eleven balance weights: three

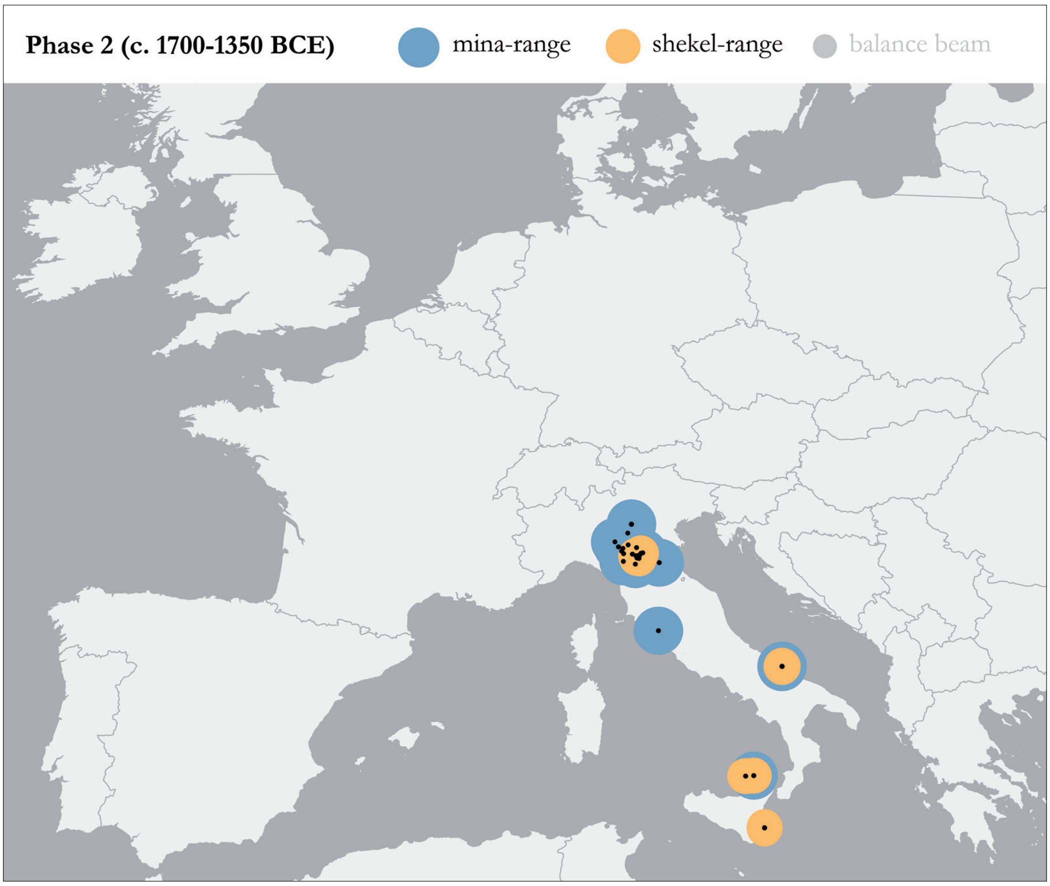


Fig. 2.10. Phase 2 (c. 1700-1350 BCE): geographical distribution of weighing devices.

parallelepipeds, five *Kannelurensteine*, and three piriform weights. The parallelepiped weights from Gaggio (cat. no. 34, 52, 151) belong to the same morphological type attested in the previous phase (and still attested in Phase 2) in the Aeolian Islands, and undocumented in the Aegean. *Kannelurensteine* are attested in this phase both in northern Italy and in the Aeolian Islands, and represent a peculiar European type that has no parallels in the eastern Mediterranean. Once again, the appearance of weighing technology generally predates the earliest visible proof of Aegean contacts, testified in north-eastern Italy by the local production of Italo-Mycenaean pottery (Jones *et al.* 2014). In this case, however, eastern Mediterranean contacts are not even necessary in the first place to explain the technological transmission, which could have happened mostly via Italian routes, either maritime or terrestrial, as the typology and metrological structure of balance weights seem to suggest (see Chapter 4; see also Ialongo/Rahmstorf 2019; 2022).

Weights in the *mina*-range are first attested in Phase 2 in Italy – both on the Aeolian Islands in the south and in the Po Plain in the north – with the appearance of *Kannelurensteine* and piriform weights. Both types will be later widespread between Italy and Central Europe until Phase 4, and both have scarce parallels in other regions of Western Eurasia. Disc weights are first attested in Phase 2, and they will become one of the most common types in subsequent periods, especially in the Iberian Peninsula. All balance weights attested in Phase 2 come from settlements.

2.4.3. Phase 3 (c. 1400/1350-1150/1100 BCE)

In Phase 3, weighing technology is widespread in Italy, Central and Eastern Europe, and across the Channel (Fig. 2.11.). Bone balance beams are first documented in this phase, in several burials in Central Europe and in the fortified settlement of Fort Harrouard in northern France (site no. 121). Since balance weights are useless without balance scales, it follows that the appearance of balance beams only in Phase 3 is entirely dependent on preservation issues. It is in fact very likely that most balance scales were made of perishable materials, and – as Egyptian depictions and cuneiform texts attest (Peyronel 2011; Rahmstorf 2022, 533-534) – their beams were mostly made of wood. Even though seemingly scanty, the European documentation actually stands out as exceptional when compared to other regions of Bronze Age Western Eurasia. In Mesopotamia, only one bone beam is documented throughout the entire Bronze Age, in the Aegean and on Cyprus only balance pans are generally preserved (Pare 1999; Rahmstorf 2022), and in the Indus Valley no balances are known, in spite of the presence of thousands of balance weights (Rahmstorf 2022).

In Phase 3, the use of metals (bronze and lead) is documented for the first time in the construction

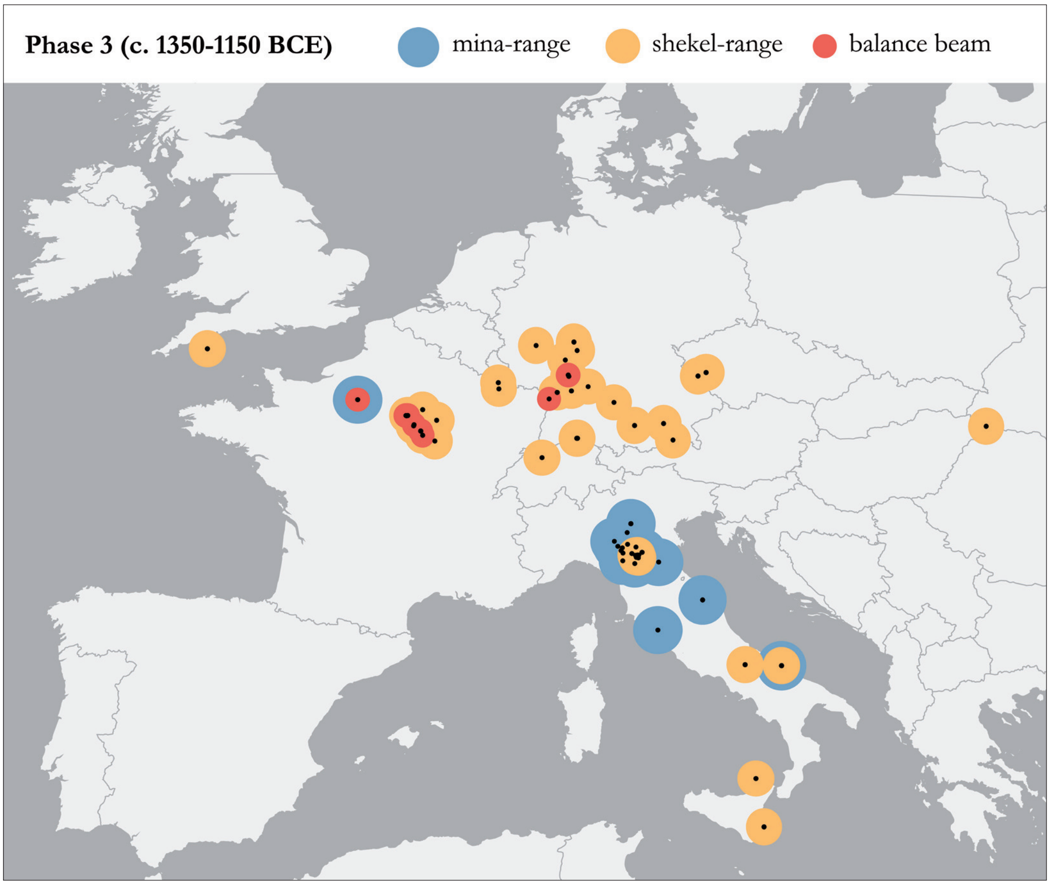


Fig. 2.11. Phase 3 (c. 1350-1150 BCE): geographical distribution of weighing devices.

of balance weights (Fig. 2.7.), and new morphological types appear, such as spherical and cylindrical weights. A peculiar variant of metallic parallelepiped weights with characteristic wavy mouldings appears in Central Europe (V.3), and a variant of disc weights with tubular protrusions (V.5) is attested in the necropolis of Thapsos, in Sicily. Italy and Central Europe differ substantially in terms of typological distribution and contexts. In Italy, most weights come from settlements – most of which are located in the Po Plain – and most of them belong to the *mina*-range. On the contrary, weighing equipment in Central Europe mostly comes from burials, and almost entirely belongs to the *shekel*-range. Such an uneven distribution does not necessarily have any cultural meaning, and likely depends on factors that are unrelated to the reasons why Bronze Age people chose one type of weighing equipment over another. One of these factors are the specific lines of research that characterised different regions of Europe. Most balance weights from the Terramare area in the Po Plain, for example, come from old, extensive excavations that collected large amounts of archaeological materials (Cardarelli *et al.* 2001; 2004). The high numbers of *Kannelurensteine* and piriform weights (both in the *mina*-range) are not counterbalanced by comparable numbers of light weights, likely because the latter were not recognised as significant artefacts and discarded during excavation or simply not published in preliminary excavation reports. This, in turn, underscores another significant challenge that could greatly hinder our ability to evaluate the true distribution of weighing equipment during the Bronze Age: The often unremarkable appearance of Bronze Age balance weights across Western Eurasia frequently leads to them being overlooked, misinterpreted, or discarded, and as a result, they are not prioritized in publication strategies (Petruso 1992; Rahmstorf 2010).

Finally, in Phase 3, balance weights are attested for the first time across the Channel, with two parallelepiped weights (both made of bronze) from the underwater deposit of Salcombe, off the coast of Devon, in England (site no. 135). One of them (cat. no. 123) represents the only attestation of the variant with wavy mouldings known to date outside of Central Europe.

2.4.4. Phase 4 (c. 1150/1100-800 BCE)

Phase 4 sees the definitive spread of weighing equipment everywhere in the study area, with balance weights now attested in the Iberian Peninsula (Fig. 2.12.). At the same time, the overall distribution of types and contexts changes substantially from the previous phase. Balance weights are first attested in the Iberian Peninsula in settlements and hoards, albeit only in Portugal and in south-western Spain. New morphological variants are introduced in this area, such as disc weights with biconical profile (both plain and perforated, V.3-4), along

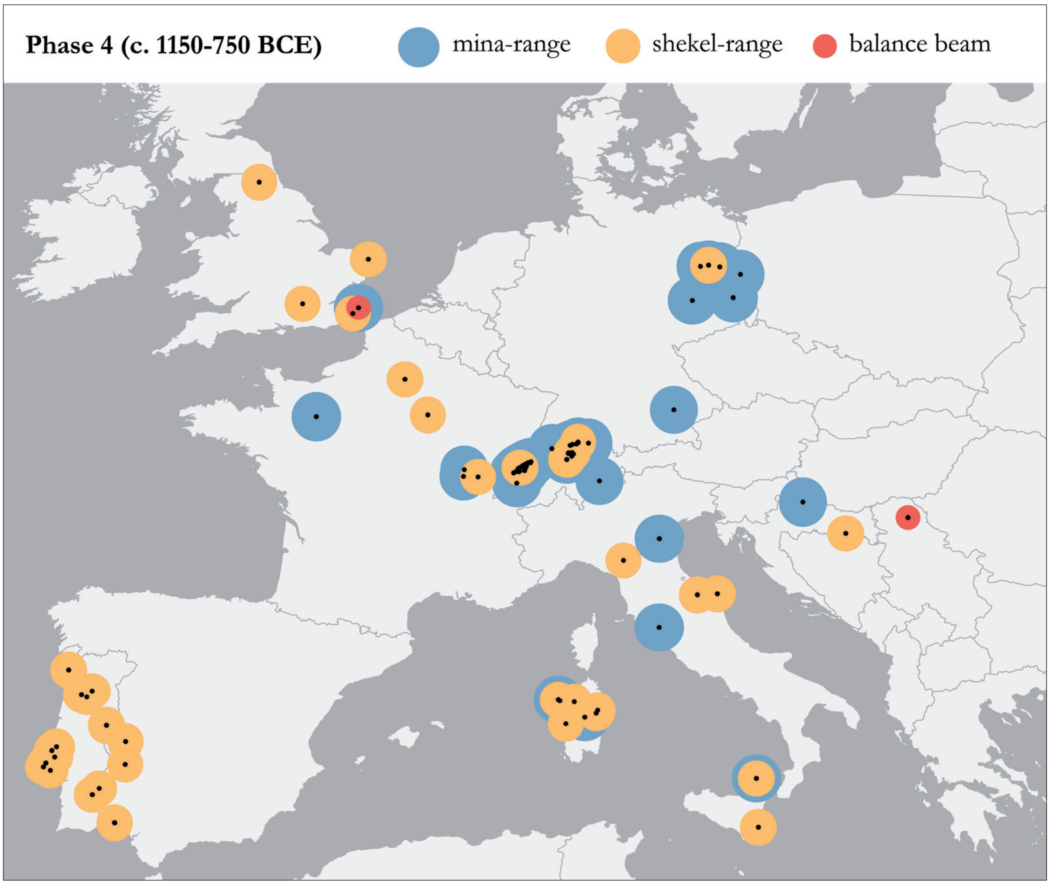


Fig. 2.12. Phase 4 (c. 1150-750 BCE): geographical distribution of weighing devices.

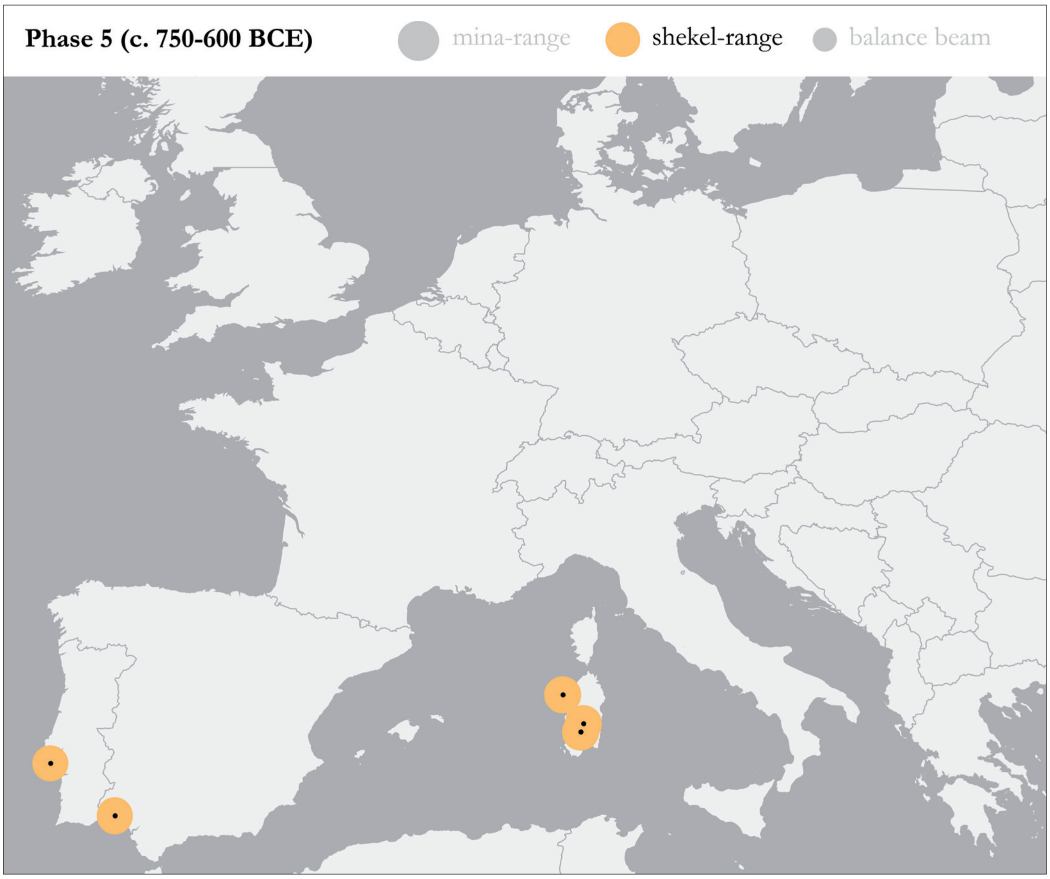
with peculiar types such as biconical and octahedral weights. All balance weights from the Iberian Peninsula are made of bronze, and all belong to the *shekel*-range. The concentration of finds in this area is, once again, likely dependent on the history of research. The weights of western Iberian Peninsula were, in fact, the object of systematic data collection in the past 20 years, which likely skewed the documentary framework in favour of this region (Vilaça 2003; 2011; 2013).

With the end of the Terramare culture *c.* 1200 BCE, finds of weighing equipment in the Po Plain – and in Italy overall – substantially diminish, but the evidence is more uniformly spread out, also as a consequence of the appearance of balance weights in Sardinia.

Compared to the previous phase, the overall distribution of the *shekel-* and *mina*-ranges is inverted: most of the Italian data still comes from settlements, but the majority of weights now belongs to the *shekel*-range; in Central Europe, weights in the *mina*-range are now the vast majority, and are equally present in burials and settlements. Bone balance beams are now attested only in the British Isles and Eastern Europe. The documentary framework in Central Europe in Phase 4 is highly discontinuous. The region between eastern France and southern Germany, which provided a wealth of evidence from burial contexts during Phase 3, now completely lacks data. The near totality of find spots are located in two distant concentrations: in the south, the pile-dwelling settlements of the western Alpine region provide most of the data; on the north, cremation burials and sporadic finds in north-eastern Germany document the first appearance of weighing equipment in the Baltic region. Most balance weights attested in both regions are now *Kannelurensteine* – heavy weights belonging to the *mina*-range – whereas in the previous phase weighing sets were mainly composed of small objects in the *shekel*-range. For many pile-dwelling settlements in Switzerland – whose finds come from old excavations – it is likely to expect the same kind of bias towards heavy weights hypothesised for the Terramare settlements.

2.4.5. Phase 5 (c. 800-625 BCE)

All the balance weights illustrated here come from Sardinia and south-western Iberia, and all come from contexts dated between the 8th and 7th centuries BCE (Fig. 2.13.). Cubic and pyramid weights appear for the first time, and those attested in contexts with a substantial presence of Phoenician materials – such as Huelva in Spain (site no. 189) and Sant'Imbenia in Sardinia (site no. 7) – are all made of lead. A peculiar type of troncoconical weights is documented in Sardinia. The earliest reliable attestation of balance weights with quantity marks is also recorded in Phase 5. Four stone weights from Sardinia (cat. no. 164-165, 307-308) bear inscribed signs that seem to be correlated to counting systems. Objects cat. no. 164, 307-308 are part of a set



▶ *Fig. 2.13. Phase 5 (c. 750-600 BCE): geographical distribution of weighing devices.*

from the settlement of Santu Brai (site no. 7). The troncoconical weights cat. no. 307-308 both bear five incised points on their base, while the cubic weight cat. no. 164 has an X sign across two faces, and a straight line on a third face. The cubic weight cat. no. 165 from the hoard of Forraxi Nioi has five parallel lines on one face. Two more lead weights – a cubic weight from the Sardinian settlement of Nuraghe Sant'Imbenia (site no. 8), and a pyramid weight from the Spanish settlement of Huelva-Plaza de las Monjas (site no. 189) – both have a single circular indentation on one face. As I am going to discuss further on (see Chapter 4), all these weights are compatible with the Pan-European *shekel* of *c.* 9.4-10.2 g, as well as with other weight systems allegedly attested in the eastern Mediterranean.

2.4.6. Diachronic spread: summary

The available evidence shows clear signs of a gradual diffusion of weighing technology, starting in the Early Bronze Age in southern Italy and progressively reaching Atlantic Europe by the end of the 2nd millennium BCE (Fig. 2.9.-13.). Balance weights are first attested in southern Italy on the Aeolian Islands, in settlements dated to the early phase of the Italian Early Bronze Age (EBA; *c.* 2300-1700 BCE), and subsequently appear in northern Italy in the Terramare area, at the beginning of the Middle Bronze Age (MBA; *c.* 1700/1600-1350 BCE). Complete sets of weights, often associated with balance beams, are widespread in Central Europe in the Bronze D phase (*c.* 1350-1200 BCE), and attested in Eastern Europe as well. In the same chronological horizon, at least one balance weight is attested in an underwater deposit off the south-western coast of England, at Salcombe (site no. 135). Weighing equipment is finally attested in northern Germany during the Hallstatt A-B/Nordic Periods IV-V (*c.* 1150/1100-800 BCE), mainly in burials, sporadically in Great Britain during the Wilburton/Ewart Park phases (*c.* 1200-725 BCE), and in settlements and hoards in western Iberia during Bronce Final III (*c.* 1200-800 BCE).

2.5. Chapter highlights

- Sample size: 696 balance weights and 18 balance beams;
- Two orders of magnitude, with exclusive morphological types: *shekel*-range (*c.* 1-100 g), and *mina*-range (*c.* 300-1,000 g);
- Five chronological phases: Phase 1 (c. 2300-1700 BCE); Phase 2 (c. 1700-1400/1350 BCE); Phase 3 (*c.* 1400/1350-1200/1100 BCE); Phase 4 (*c.* 1200/1100-800 BCE); Phase 5 (*c.* 800-625 BCE);
- Gradual diffusion of weighing technology throughout Europe: Phase 1: southern Italy; Phase 2: northern Italy; Phase 3: Central Europe, Eastern Europe, and the British Isles; Phase 4: western Iberia; Phase 5: no new regions are reached;

- Although not provable, it seems likely that weighing technology was first imported in southern Italy from the Aegean in the Early Bronze Age. Once the technology is adopted, however, balance weights are locally manufactured with original morphological types;
- The diffusion of weighing technology from one European region to another does not require further inputs from the eastern Mediterranean to be explained. Every time balance weights appear in a new region, the morphological types are similar to those attested in the closest region where weighing technology was already attested in the previous phase. Theoretically speaking, the transmission can have happened entirely via short-distance contacts on European territory;
- Weighing technology, once adopted, is never abandoned;
- Quantity marks appear only at the beginning of the Iron Age;
- The uneven distribution of weighing equipment is caused by factors that are independent from how weighing technology was used: *e. g.*, research traditions, general state of preservation, completeness of excavation reports;
- Balance beams are not as widely attested as balance weights simply because they are not preserved.