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From the Aegean Sea to the Parisian Basin:
Spondylus shell exchange in Europe during the process of Neolithisation

ABSTRACT: *Artefacts made of the Mediterranean shell Spondylus gaederopus are a well-known example for prehistoric exchange. While the general distribution of Spondylus adornments from the Aegean Sea to Central Europe was recognized about one hundred years ago by Rudolf Virchow and Ludwig Pfeiffer, a detailed analysis of the objects is still missing. The exchange was associated with gift exchange as described by Marcel Mauss and Karl Polanyi. Furthermore, Polanyi classifies three transaction modes (reciprocity, redistribution, and market trade) to distinguish pre-modern embedded from modern capitalistic economies. Until today, there was no critical discussion on the possibilities of a transfer to prehistoric societies. In the following, an alternative theory shall be applied for premodern exchange: This model separates exchange into a social, a material, and a time dimension. The aim of the paper is to reconstruct the economic aspects of Spondylus gaederopus exchange during the Neolithic in Europe with the modern foreign trade theory.*

Bracelets, pendants and different types of beads made of Spondylus were used in Europe between 6500 and 3500 BC. The greatest expansion of these artefacts was within the Linear Pottery Culture from 5500 to 5000 BC between the Aegean Sea and the Parisian Basin. As it is shown in the paper, economic aspects played a decisive role for the distribution: The shell became scare in Central Europe, regional price differences emerged, there were possibilities to gain a profit at geographical bottlenecks and cultural borders, and different regions of Spondylus usage can be detected.

KEYWORDS: SPONDYLUS EXCHANGE, PREHISTORIC EXCHANGE, FOREIGN TRADE THEORY, NEOLITHIC EUROPE

Introduction

Exchange is an elementary component in everyday life and integrated in social as well as in economic actions: Regardless of whether we buy something in the supermarket or give a gift, whether we pay taxes or order a book in the internet. Even in the course of human evolution, the transfer of objects played a decisive role (Ambrose, 1998; Horan and Bulte, et al., 2005). Within prehistoric societies, the importance of exchange is manifested by the sharing hunted animals (Gurven, 2004), the distribution of jadeite axes during the Neolithic (Klassen and Pétrequin, et al., 2011), prehistoric salt trade (Stöllner, 2012) or the Mediterranean imports of the Hallstatt period (Kimmig, 2000). One of the earliest examples of prehistoric exchange is the distribution of the Mediterranean shell *Spondylus gaederopus,* which was used for the production of ornaments during the Neolithic in Europe between 6500 and 3500 BC; this example shall be analysed in detail in this paper (Fig. 1).

Distribution is characterized as the transmission of valued objects between different parties and can be subcategorized into several principles and actions (Rössler, 2005, pp.182-208). The probably best-known model of transactional principles was developed by the economic historian and sociologist Karl Polanyi in his work *'The Great Transformation'* (Polanyi, 1978, pp.71-87). Polanyi differentiated between reciprocity (defined as mutual exchange between different parties), redistribution through a central authority, and the allocation of goods and services on a market. Although the unambiguous distinction between these modes of exchange appears simple at first glance, nevertheless, an intensive consideration as well as a critical reflection is needed, if the model is applied on past societies. On the one hand, social aspects, such as the institutional context, uncertainty, social distinction or perception of prestige as well as status are an inherent part of every market transaction (Beckert, 2003; Granovetter, 1985; König, 2008, pp.19-22). On the other hand, it is possible to explain social actions, like gift-giving or marriage, with an economic framework (Akerlof and Shiller, 2009; Becker, 1976; Görlich, 1997).

The archaeological adoption of Polanyi's model leads to an evolutional thinking from reciprocity during the

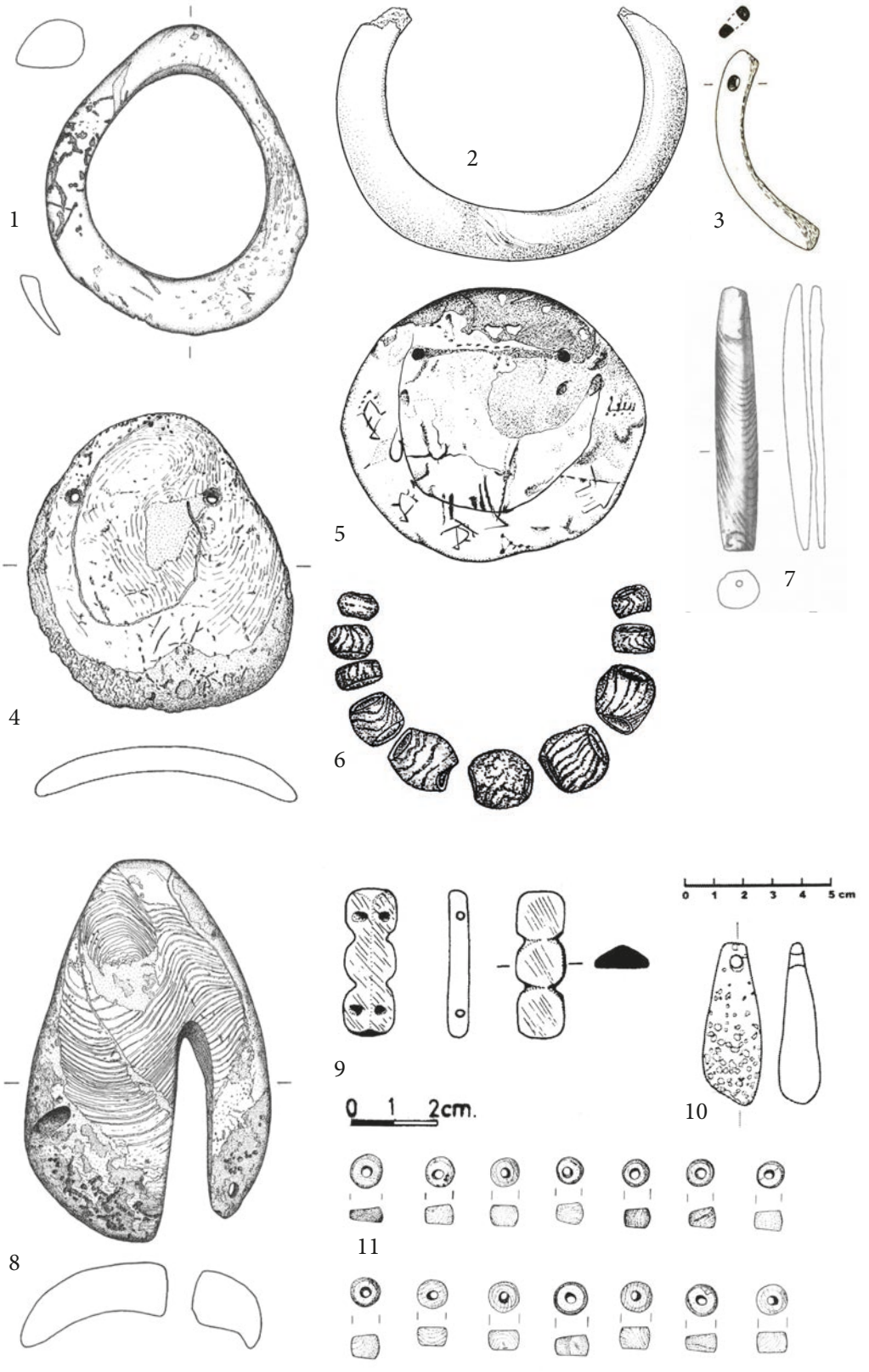

Fig. 1. Different artefacts made of Spondylus gaederopus: 1.Complete bracelet – Aiterhofen-Ödmühle, Grave 1 (Nieszery 1995, p.322, table 2.1); 2. Fragmented bracelet – Dikili Tash (Treuil, 1992, table 166.b); 3. Curved pendant – Flomborn, Grave 44 (Richter, 1968/69, p.169, fig.6.C1); 4. Round pendant – Aiterhofen-Ödmühle, Grave 68 (Nieszery, 1995, p.347, table 27.2); 5. Round pendant with intentional scratches (Karmanski, 1977, table 7); 6. Disc-shaped and round beads – Mezőkövesd-Mocsolyás, Grave 17 (Kalicz and Koós, 2001, p.59, fig. 11.1); 7. Elongated bead – Halberstadt, Feature 139 (Fritsch,Classen, et al., 2008, p.221, table 17.7); 8. V-Klappe – Aiterhofen-Ödmühle, Grave 18 (Nieszery, 1995, table 8.1); 9. Slider bead – Aşağı Pınar (Özdoğan and Parzinger, 2000, p.88, fig. 5); 10. Elongated pendant – Vedrovice "Široká u Lesa", Grave 81ab/79 (Ondruš, 2002, p.80, fig.81.4); 11. Disc-shaped beads – Essenbach-Ammerbreite, Grave 18 (Brink-Kloke, 1990, p.471, fig. 11.2).

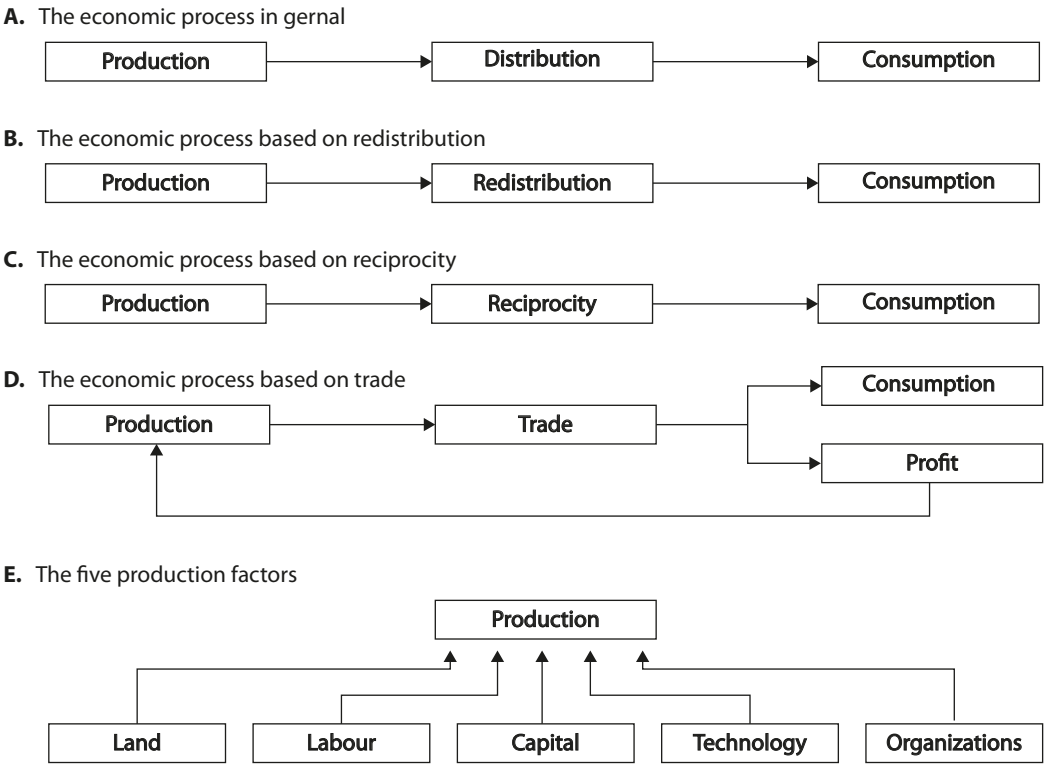

Fig. 2. Different modes of economic organization (acc. to Swedberg, 2009, p.89, fig. 3.1).

Neolithic (cf. Müller, Hofmann, et al., 2011, p.101) to a developed market influenced by the forces of supply and demand in the metal-ages (cf. Earle, Ling, et al., 2015, p.639; Frank, 1993, p.385), and to a dualistic approach between gift exchange of prestige goods (cf. Hansen, 1995, p.78; Klimscha, 2014, pp.157-158) and commercial trade of subsistence goods (cf. Kristiansen and Larsson, 2005, pp.34-35; Renfrew, Dixon, et al., 1966, p.51). Furthermore, his theory was used to separate pre-modern "socially embedded" from modern, market-based economies (Bernbeck, 2009, pp.32-36; Hansen, 1995, p.67) – a separation that has become obsolete, due to sociological theory (Beckert, 2003; Granovetter, 1985). On the basis of these economic and sociological researches, the dualism between gift and commodity exchange as well as the trichotomy of reciprocity, redistribution, and market has to be critically evaluated with regard to its archaeological application (Appadurai, 2013; North, 1977; Rössler, 2005, p.198). The discussion on the different modes of exchange is the first aspect of this paper.

The distribution of artefacts made of the Mediterranean shell *Spondylus gaederopus* is used as a case study to evaluate the potential of a modern economic theory – the foreign trade model – and to analyse prehistoric exchange. While Spondylus valves were used for the production of ornaments between 6500 until 3500 BC, the objects primarily occur in Central and Western Europe within the Linear Pottery Culture, between 5500 and 4900 BC, and were imported from the Adriatic or Aegean coasts – hence, this period is of special interest for the application of the foreign trade theory.

Gift, market and redistribution

The economic process is characterized by the chain of production, distribution and consumption, and it is necessary to analyse the allocation of goods and services in order to understand an economic system. On a theoretical level, there is a distinction between transactional principles and actions: While the principles illustrate the social relationship between different exchange parties and can be categorized into reciprocity, redistribution and market exchange, transactional actions can be divided into gift giving, barter and commodity exchange, and they examine the transfer of valuable objects. A direct link between principle and action is possible, for example gift giving is related to reciprocity (Rössler, 2005, pp.182-184). According to Richard Swedberg (2009, pp.88-89), transactional principles are the key for analysing different modes of economic organization. Redistribution is a characteristic feature of state-controlled economies such as Ancient Egypt, whereas reciprocity predominates in kinship-based societies. In both modes of exchange, production is driven by consumption, by contrast, trade is associated with a market-based capitalistic economy and production is connected to consumption as well as profit (Swedberg, 2009, pp.88-89) (Fig. 2). However, as Polanyi (1957,

pp.255-256) noticed, several transactional principles occur within every society, but the economic structure is determined by the distribution of land and labour. In modern national economies, both are distributed via the market, while their allocation in ancient societies was embedded in social structures by means of reciprocity and redistribution. Nevertheless, a critical discussion on the possibilities to adopt his model to interpret prehistoric exchange is necessary (cf. Garraty, 2010).

Barter or the transmission of two objects between two exchange partners seems uncomplicated to be analysed: Two persons, two objects, both persons desire the other object, they trade and afterwards they are more sophisticated. However, Arjun Appadurai (2013) as well as Caroline Humphrey and Stephen Hugh-Jones (1992) recognize the complexity of barter and define it as a simultaneous exchange between weakly integrated groups. The objects are usually quite different from each other and, as a neutral observer, it is impossible to judge on their equivalence. Often, but not always, the partners are members of different groups and belong to several "regimes of value". Yet, during the exchange process, both actors are equal, have the same rights and are able to leave the economic relationship after a successful transaction. The absence of an exchange medium (e.g. money) makes the difference to a market-based transaction; the minimization of the social, cultural, political or personal costs forms the distinction between barter and gift exchange (Appadurai, 2013, pp.9-12).

Essential contributions concerning the gift and reciprocity are made in *'Argonauts of the Western Pacific'* by Bronisław Malinowski (2007) in 1922 and *'The Gift'* by Marcel Mauss (1990) in 1923/24. Both are part of almost every discussion on these issues in sociology (Adloff and Mau, 2005, p.12) – a statement that can easily be transferred to archaeology. The gift is characterized by the equality of the involved persons, the importance of their relationship, the inherent obligations and the time delay between the transactions (Mauss, 1990). But two other aspects of the ceremonial gift exchange in Melanesia – the *kula*-ring – induced a long and controversial discussion:

1. The objective of increasing the personal prestige (Godelier, 1999, p.135).
2. In addition to the ceremonial exchange of *mwali* (bracelets made of shells) for *soulava* (necklaces), barter takes place between different islands of Melanesia (Malinowski, 2007, pp.229-231).

Both, the increase of the personal prestige and the exchange of commodities, allow describing the *kula*-ring with regard to an economic framework and a game theoretic model (Görlich 1997). Furthermore, reciprocity can be seen as a substitute for barter and trade in times of high transactions costs – costs which occur by the transaction itself and the enforcement of property rights (Godelier, 1999, pp.152-153; North, 1977, pp.708-710). The ongoing discussion on gift exchange is summarized by Adloff and Mau (2005, p.46); they state, that the interpretation of reciprocity oscillates between pure altruism and pure egoism.

The flow of goods and services within redistribution economies is controlled by a central authority which can be a priest, a king or a group of clerks. Polanyi (1957, pp.253-254) developed a simplified model, where the authority only manages the in- and outcome of goods to a centre. According to the historical sources, e.g. in Mycenae, the centre additionally reallocates labour forces and the production of goods (Nakassis, Parkinson, et al., 2011, pp.181-182). A characteristic feature of redistribution is the social impact of the economic system on the society – social hierarchies and inequality are inherent attributes of redistribution economies (Fried, 1967, pp.116-118).

Modern economic theory is not as much a theory about the institutional arrangements of markets, but rather a mathematical theory of prices, quantities and exchange (Swedberg, 2009, p.133). The discussion on prices dates back to antiquity and was part of a general debate on fairness,[1] and from a scientific point of view, prices were connected to the involved labour until the middle of the 19th century (Ricardo, 1817, chapter 1; Marx, 1883, p.71; Smith, 1776, chapter 7). This notion changed during the "marginal revolution" and nowadays prices and quantities emerge from the interaction between supply and demand (cf. Marshall, 1898, Book 3, chapter 6; Swedberg, 2009, p.133). Supply is determined by production which is usually a mathematical function of capital, labour and ground, whereas demand is driven by the utility of consumers. For the understanding of prices, the market structure is essential: Are there several suppliers and demanders and do they compete with each other? Or is there just one supplier and a monopoly is evolving (Pindyck and Rubinfeld, 2003, pp.465-466)? Anyhow, a clear distinction between market exchange and gift giving is problematic if social behaviour is explained with the homo oeconomicus model (Akerlof and Shiller, 2009; Becker, 1976).

Frank Hillebrandt (2009, pp.92-96) criticizes the contraposition between a perfect market and a pure gift exchange and concludes that the dichotomy is not useful for a study of exchange. Therefore, he classifies the practice of exchange into a social, a material and a time dimension. So, a gift has got a significant social dimension, while the economic aspects are of minor importance, and there is a delayed return of the transferred object. On a market, however, the personal relationship between demander and supplier is insignificant, the material dimension is high and there is a simultaneous return of the equivalent (Hillebrandt, 2009, pp.214-219). Due to the specific archaeological sources and the imprecise dating, for archaeological contexts it seems reasonable to replace the time by an institutional dimension. In its institutional dimension, the gift is only specified by cultural norms; market trade, on the other hand, is protected by laws and courts and it is possible to enforce property rights within a judicial system.

The purpose of this article is to analyse the economic dimension of *Spondylus gaederopus* exchange in Europe between 5500 and 5000 BC. Therefore, the foreign trade theory, a standard economic model, will be applied and combined with statistical methods.

Foreign trade theory

In 1817, David Ricardo published *'On the Principles of Political Economy and Taxation'* and introduced the foreign trade theory to explain specialization between different countries and the benefits of trade as well. The theory based on the assumption of a comparative advantage. When the simplistic model is adapted to prehistoric societies, only two different countries/regions are regarded within the model, e.g. Central Europe and the Aegean Sea. Both produce two goods, e.g. Spondylus and an unknown good B with labour as the only input factor under the presumption of a restricted time budget. Furthermore, trade between these regions is possible, but there are some transportation costs; the utility function the actors want to maximize for both areas is the same. The main advantage of such a model is the absence of prestige goods and the intrinsic and different valuation of objects – in contrast, different goods can, but must not, be weighed in the same way. The Aegean Sea is able to produce both, Spondylus as well as good B, whereas in Central Europe, only the production of good B is possible.

Without a mathematical derivation, the results of the model can be summarized with different aspects.[2] On the basis of the time budget and the utility function, individuals can maximize their benefits by producing and consuming a certain amount of Spondylus and good B. But with the specialization of each region on only one product and with foreign trade, actors are able to obtain a higher degree of utility in both regions. Due to the theory, the production function and the transportation costs, Spondylus is cheaper and occurs more frequently in the Aegean Sea than in Central Europe. A merchant can take an advantage from different prices in Europe to obtain a trade surplus measured in Spondylus shells or good B.

In order to compare the results of the foreign trade theory with the archaeological remains, four different hypotheses can be formulated:

1. Because of transportation costs, the number of consumed shells should decrease from the Aegean Sea to Western Europe – in economic terms: The farther from the origin it is, the scarcer Spondylus becomes.
2. Regional price differences will develop because of the scarcity of Spondylus.
3. In the short-term, the price differences can be used by a merchant to make a profit. In the long-term, new merchants can enter the market and the differences will disappear.
4. Several regions using Spondylus will emerge, because of different prices – there should be a production area, a consumer area and a trade area.

There will be a discussion on the methodology and the use of Spondylus shells during the Neolithic in the next sections; the last part of the paper deals with the synthesis between economic theory and archaeological remains.

Methodology

The bases of this study are artefacts made of the Mediterranean shell *Spondylus gaederopus*. In total, 422 sites were analysed ranging in time from the Paleolithic of Spain to the Iron Age in Greece and with a regional distribution from Spain to Turkey and Ukraine and from Greece to Northern Germany and Western France (Fig. 3). Every site is linked to an archaeological culture and dates with a probability into a certain century.[3] The Linear Pottery Culture (LPC) for example has a range between 5500 and 4900 BC (Lüning, 2005, p.72, fig. 23) and, as a consequence, with a probability of 16.6 %, sites of the LPC can be dated to every century of this period. If a site dates more precisely, e.g. to the oldest LPC between 5500 and 5300 BC (ibid.), there is a probability of 33.3 % for every century. This approach was necessary to select sites with a probability of more than 20 % between 5500 and 5000 BC and to analyse their Spondylus artefacts in detail. In total, 8105 objects from 192 sites, classified by different researchers as made of Spondylus, were stored in a SpatiaLite-Database.[4] 6999 artefacts with a probability of 50 % or more date back to this period, and several statistical methods were used to investigate them. As a first step, a kernel density estimation weighted with the site probabilities was done to study the development of the distribution over Europe between 6500 and 3500 BC. The same procedure was performed with the artefacts from the centuries between 5500 and 5000 BC. To evaluate regional differences and similarities within the artefact distribution, a correspondence analysis was performed. Furthermore, the number of artefacts and the used valves were analysed in relation to the distance from the Aegean coast.

The Distribution of Spondylus gaederopus artefacts during the Neolithic of Europe

Although the pan-European distribution of artefacts of the Mediterranean shell *Spondylus gaederopus* is known for more than a century (Pfeiffer, 1914, p.91; Virchow, 1884), a precise investigation of the objects is still missing. Spondylus shells are noted in Paleolithic contexts in Spain, too (Arrizabalaga, Álvarez-Fernández, et al., 2011), but most of the valves were used for the production of ornaments during the Neolithic of Europe between 6500 and 3500 BC and a temporal shift within this

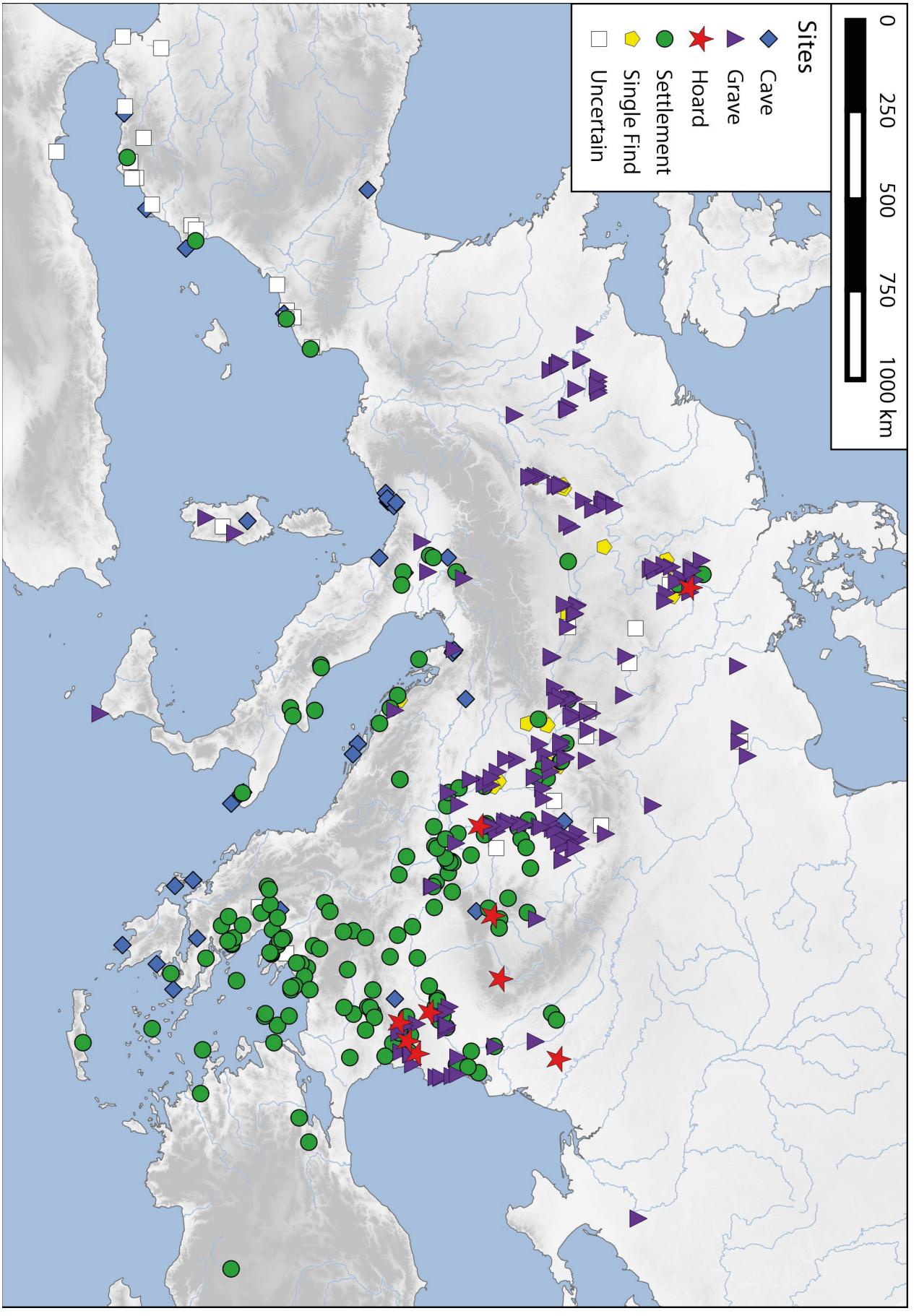

Fig. 3. Distribution of Spondylus artefacts in prehistoric Europe (graphic: Arne Windler).

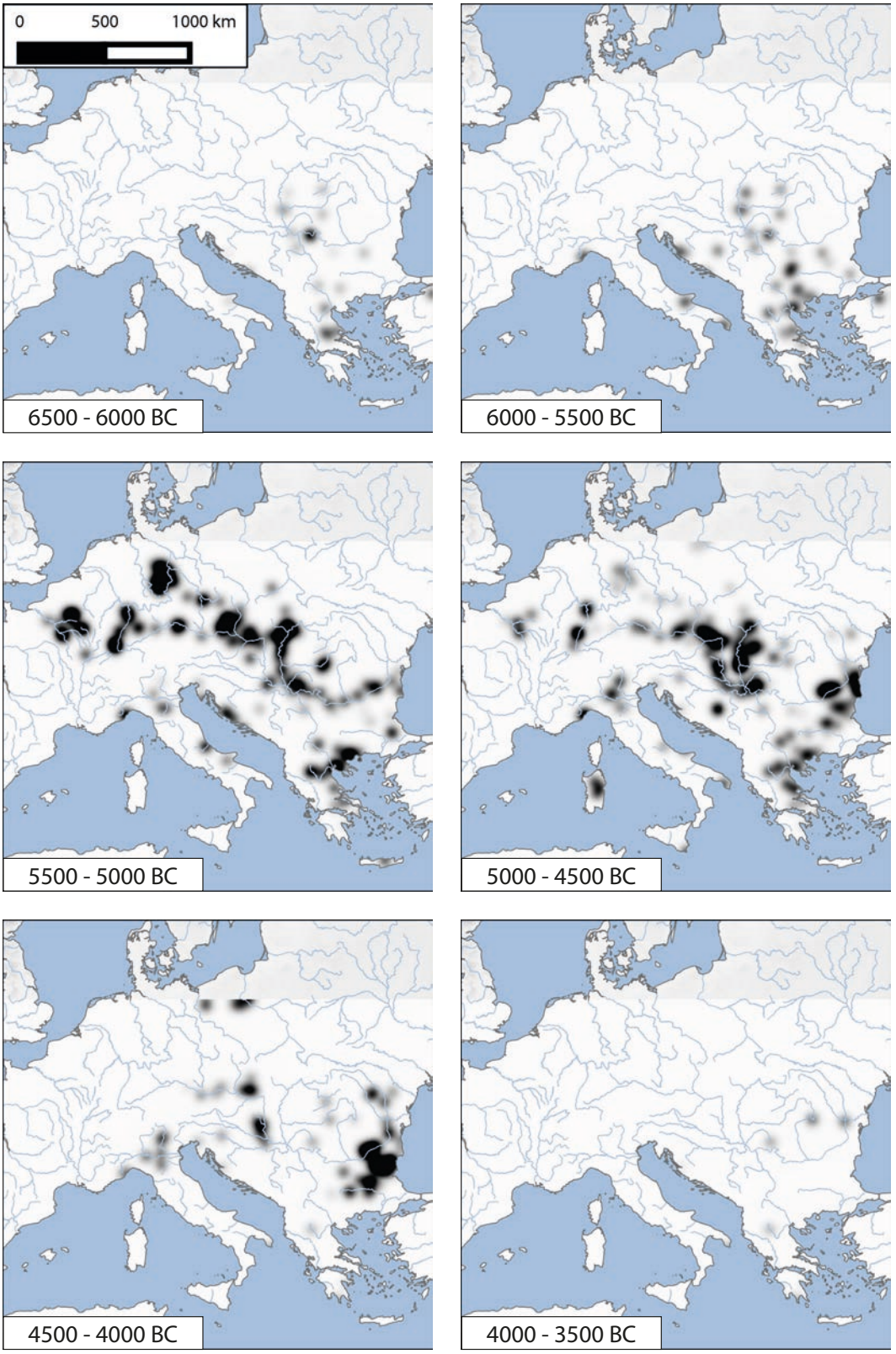

Fig. 4. The density of sites with Spondylus artefacts between 6500 and 3500 BC (graphics: Arne Windler).

period is observable (Fig. 4). The first evidences of Spondylus for the production of adornments are attributed to Early Neolithic settlements between the Aegean coast and the surrounding hinterland. While most of the sites can be dated towards the end of the 7th millennium BC, an hourglass-shaped pendant from stratum C of Sesklo (Wijnen, 1981, p.47) can be dated earlier, namely between 6591– 6048 cal BC (Perlès, 2001, pp.100-106, tab. 6.1). Apart from these artefacts found in settlements, Spondylus beads were also recovered from burials:

Beads from Lepenski Vir (Borić, 2008, p.44) and Vlasac (Borić, French, et al., 2014, p.14, tab. 3) indicate an exchange with the Balkans around 6000 BC. In concordance with the Neolithisation of South-Eastern and Central-Eastern Europe from 6000 BC onwards, artefacts made of Spondylus occurred more frequently at the Danube and the distribution reaches Endrőd-Öregszőlők in the Carpathian Basin (Siklósi, 2004, p.14). Yet, in contrast to the previous period, they were found exclusively in settlements. Between 5500 and 5000 BC, Spondylus artefacts are distributed between Greece and the Parisian Basin, Italy and Northern Germany – this is the widest spread of the shell during the Neolithic. Spondylus bracelets, beads, pendants and belt ornaments were used as grave goods within the LPC, while fragmented bracelets predominantly appear in settlements of South-Eastern Europe. During the 5th Millennium BC, Spondylus ornaments disappear from Central Europe: Now the main distribution area is displaced first to the Carpathian Basin along the Tisza and the Danube as well, and later to Bulgaria and Romania, during the Kodjadermen-Gumelniţa-Karanovo VI-culture. Only four different sites containing Spondylus artefacts are known in Europe after 4000 BC, and the shell ornaments eventually disappear during the 4th millennium BC. Using the probabilities of dating for the sites, the curve indicates an increase in the fabrication of Spondylus shell ornaments at the beginning of the second half of the 6th millennium BC (Fig. 5). This development is parallel to the emergence of Spondylus as a grave good within the LPC communities of Central Europe. At the scale of the sites, the centuries between 5300 and 5000 BC are the peak of the Spondylus fabrication in Europe and there is a constant decrease of sites containing Spondylus towards the end of the 5th millennium. While graves prevail over set-

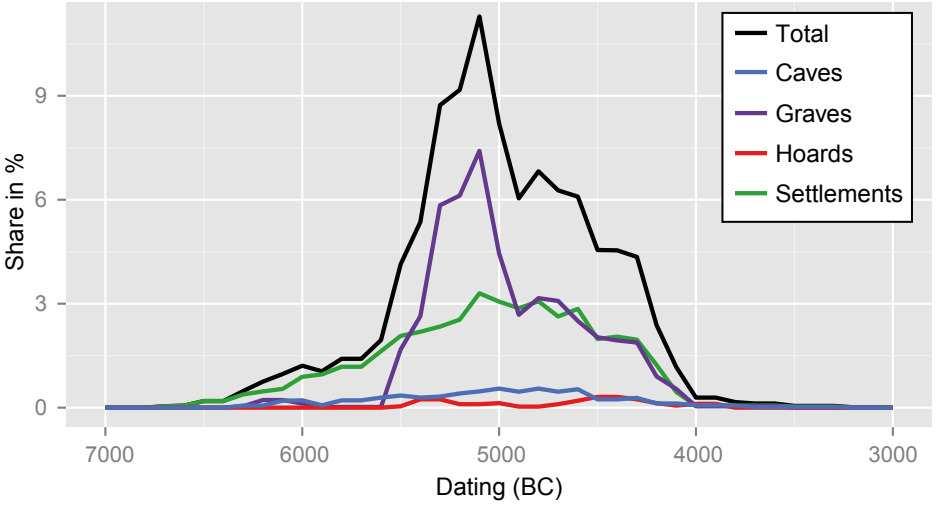

Fig. 5. The share of sites containing Spondylus artefacts per century (graphic: Arne Windler).

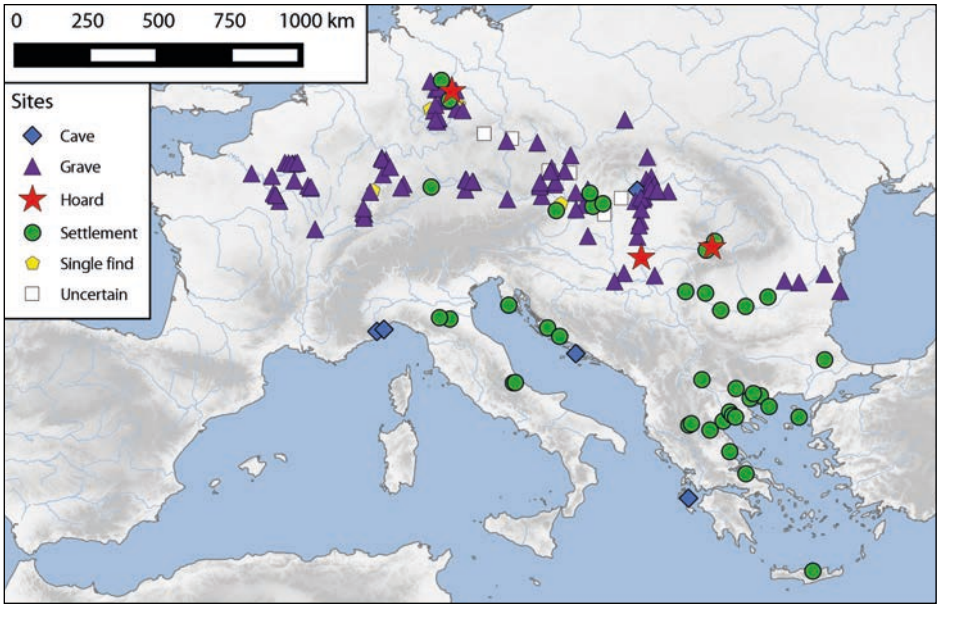

Fig. 6. The distribution of Spondylus artefacts between 5500 and 5000 BC (graphic: Arne Windler).

tlements during the time of the LPC, from 4900 BC onwards, they are divided equally. Due to the widest distribution and the most intensive use of Spondylus shells, the period between 5500 and 5000 BC is of special interest for a study of prehistoric exchange (Fig. 6).

In total, 8105 artefacts made of *Spondylus gaederopus* are taken into consideration for this study, but only 6999 objects are analysed in detail, because their contexts have a probability of at least 50 % for the period of interest. 3303 objects belong to the Vinča-culture, and are predominantly related to the hoard of Čoka-Kremenjak with 3238 Spondylus artefacts. 2511 of these artefacts are found in LPC contexts and only 482 artefacts can be attributed to the Aegean Neolithic.

Remarkable differences are not only visible in the course of the whole period, but also in the second half of the 6th millennium BC: These differences are observable at the European distribution, the sex of the deceased persons or the position of the ornament inside the graves. While in the eastern part of the LPC, Spondylus artefacts are related to male as well as to female individuals, in France and Central Germany they are almost exclusively found in female graves (Fig. 7). Grave 100 from Bucy-le-Long "la Fosselle" is the only exception in the entire Parisian Basin, but the remains of the male individual are disturbed. Due to the position of distinct artefacts within the burials of the LPC, regional differences are observable: While the so called V-Klappen are connected to the pelvis in most parts of the LPC (e.g. Aiterhofen-Ödmühle, Nieszery, 1995), they can be found next to the head in the western part, e.g. in Vert-la-Gravelle and Larzicourt (Bonnardin, 2009, Annex 2).

Not only the different contexts, but also the statistical analyses of artefacts indicate several spheres of con-

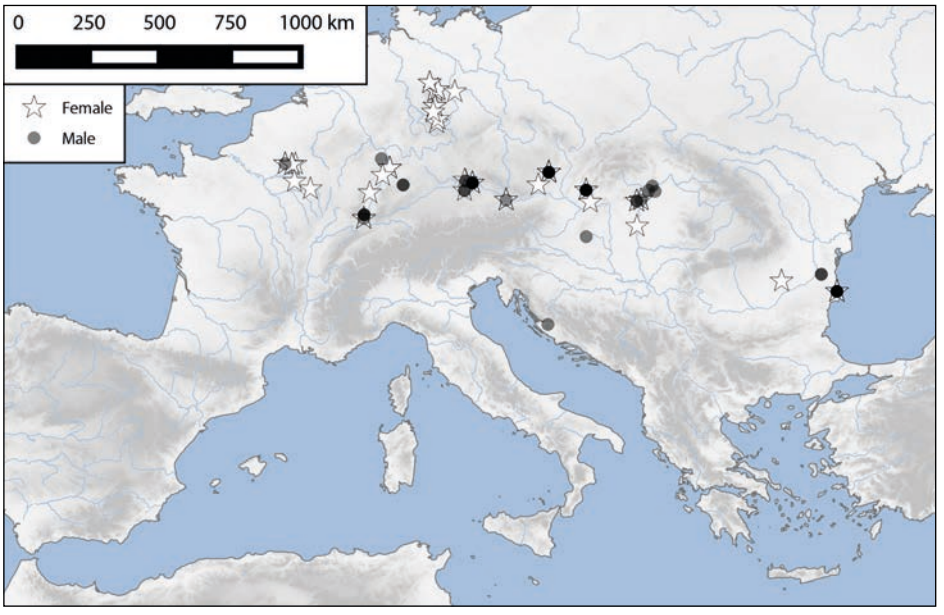

Fig. 7. The sex of the deceased who had Spondylus artefacts inside their grave (graphic: Arne Windler).

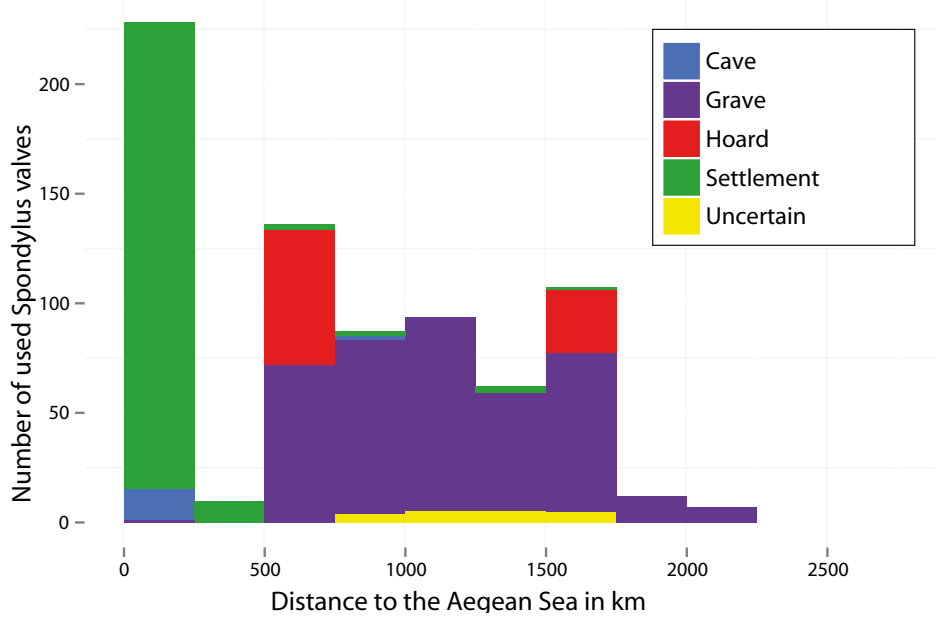

Figure 8. Histogram of used Spondylus valves between 5500 and 5000 BC in relation to the distance from the Aegean Sea (graphic: Arne Windler).

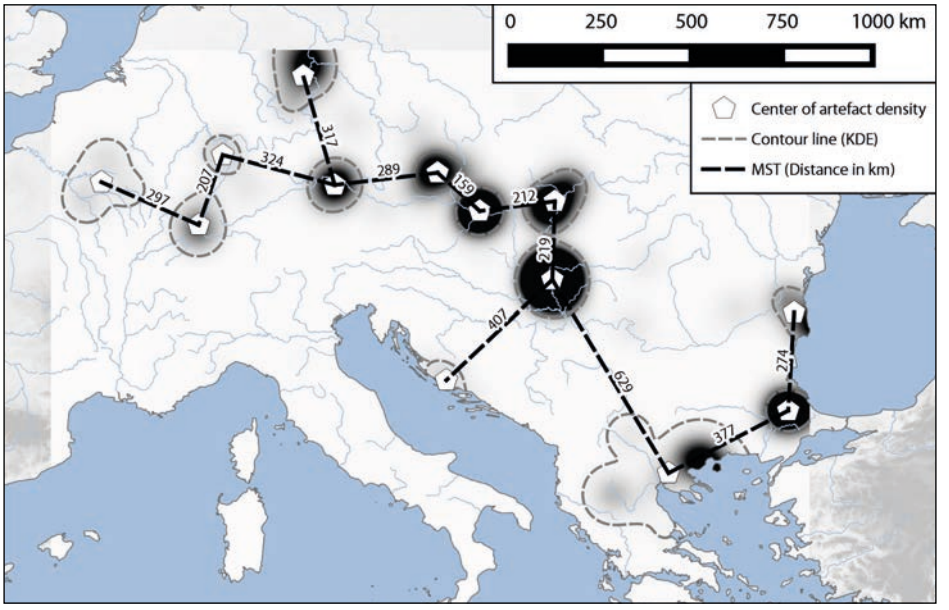

Fig. 9. Density map of Spondylus artefacts in Europe, the minimum-spanning-tree between the European artefact cluster and their distances. (graphic: Arne Windler).

sumption in Europe. The histograms of the sites and the number of used Spondylus valves in relation to the distance to the Aegean Sea reveal a relationship to the context: Along the shore of the Aegean Sea, Spondylus only occurs in settlements, while, at a distance of about 500 km from the coast, shell artefacts are related to graves as well as to hoards. In a next step, based upon the artefact numbers, used valves are calculated and included to the analyses:[5] Next to the origin of Spondylus, the valves prevail in settlements, while, at a distance of about 750 km, graves dominate the distribution. On the one hand, used shells were common at the Aegean Sea, but on the other hand, the use declines towards the Balkan and remains constant in the Central European graves (Fig. 8). The transition area between South-Eastern and Central Europe is marked by the hoard of Čoka-Kremenjak and can be considered a regional focus of the Spondylus distribution – this is more remarkable, because the hoard is at the border zone between the Vinča culture and the LPC. The density map and the minimum spanning tree between different artefact concentrations in Europe indicate a regular distance of about 200 to 300 km (Fig. 9). This distance coincides with a supply zone, the distance within an individual or a group can exploit the resources themselves, as it is postulated by Colin Renfrew, J. E. Dixon and J. R. Cann (1969).

The differences are not only related to the sites, but also to the used objects. This is clearly indicated by the distribution maps and by the correspondence analysis of the artefacts (Fig. 10). So, the V-Klappen and the circular pendants are connected to the LPC. Another apparent difference concerns the bracelets: While fragmented objects are usually known from South-Eastern Europe, complete ones are more common in Central Europe. However, most of the artefacts are beads (their share in total artefacts is 88.5 %), and they are known all over Europe with different shapes and sizes (their length varies between 0.25 and 12.0 cm). The distribution of different types in Europe is likewise demonstrated by the correspondence analysis: On the first two axes, representing 30 % of the variability, the sites of South-Eastern Europe are separated from Central Europe and the LPC (Fig. 10). While the Aegean Neolithic is associated with fragmented bracelets and raw material, Central Europe is linked to different types of pendants, complete bracelets, V-Klappen and a higher variability of beads. The map of the sites combined with the results of the first two axes highlights different places in Europe (Fig. 11). Due to its vessels, the hoard of Čoka-Kremenjak is part of the early Vinča culture, while the Spondylus artefacts show a connection to Central Europe. This is even more astonishing as this hoard is next to the cultural boundary between Vinča and LPC and has the highest amount of Spondylus artefacts of all contexts considered here.

Summarizing, the distribution of artefacts made of Spondylus differs not only in the course of the Neolithic, but also in the period between 5500 and 5000 BC. This is observable at different scales: The sites, the number of artefacts and the use of different types.

Synthesis

A direct synthesis between the economic theory and the archaeological sources is not realizable, but there are some arguments supporting the method of applying the foreign trade theory to explain the distribution of artefacts made of the Mediterranean shell *Spondylus gaederopus*. A closer look at the hypotheses posed above is inevitable and reveals some similarities between prehistoric exchange patterns and the economic model.

The histogram indicates the scarcity of Spondylus artefacts in Central Europe. Spondylus shells are quite

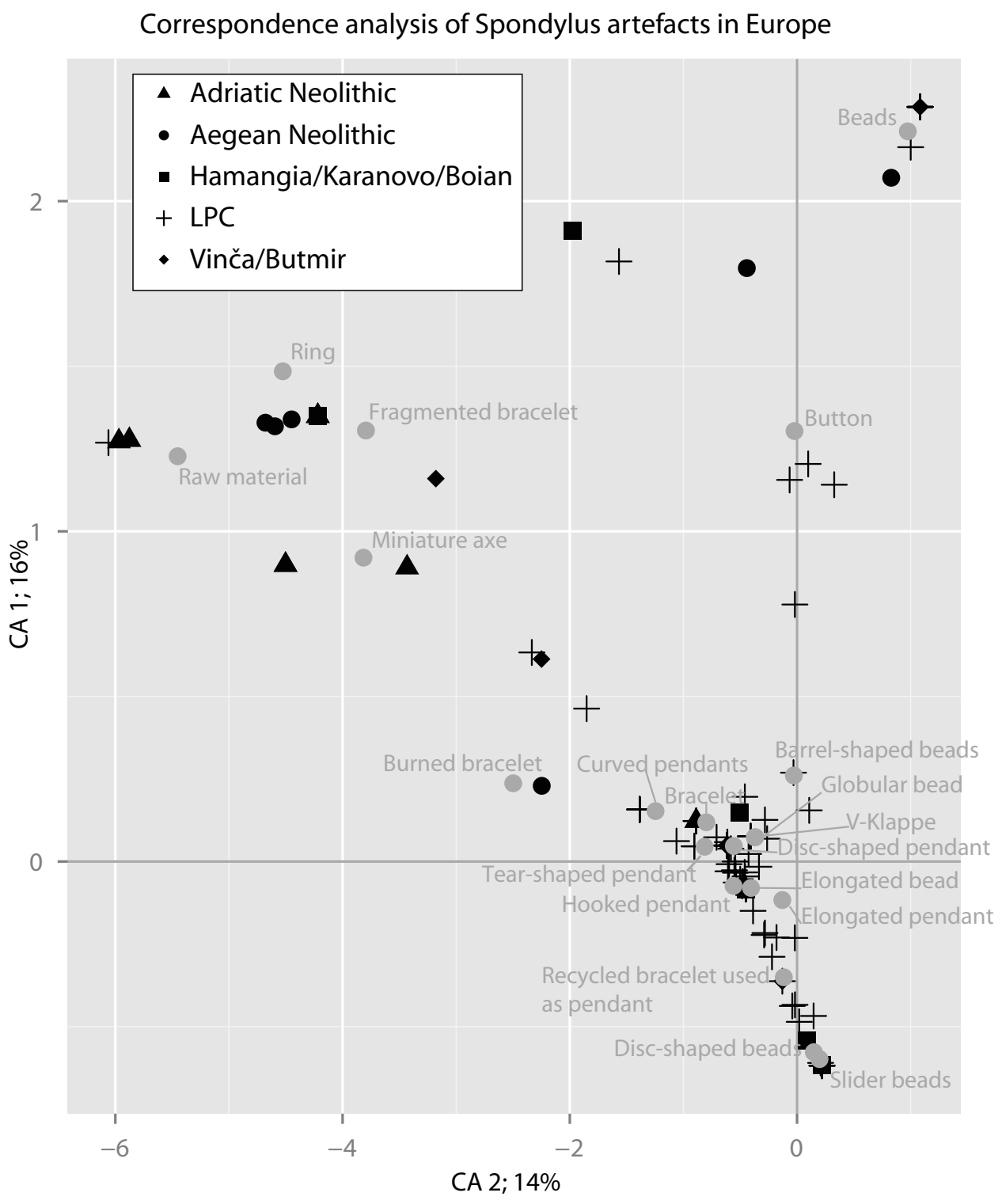

Fig. 10. Results from the first two axes of the correspondence analysis (graphic: Arne Windler).

common at the Aegean coast, but at a distance of about 250 km and at the border of the Vinča culture to the LPC, their frequency decreases. While within a distance of about 250 km from the Aegean Sea, 228 valves on average were used for the artefacts, between 500 and 750 km, the total amount declines to 136 valves. In central Europe and between 500 and 1750 km, the amount of used valves is stable and varies between 62 and 136 every 250 km.

The regional price differences are illustrated in different contexts by the map of Spondylus. In the vicinity of the Aegean coast, Spondylus exclusively occurs in settlements, whereas in Central Europe graves prevail. This can be an indication of an increase in value as it was

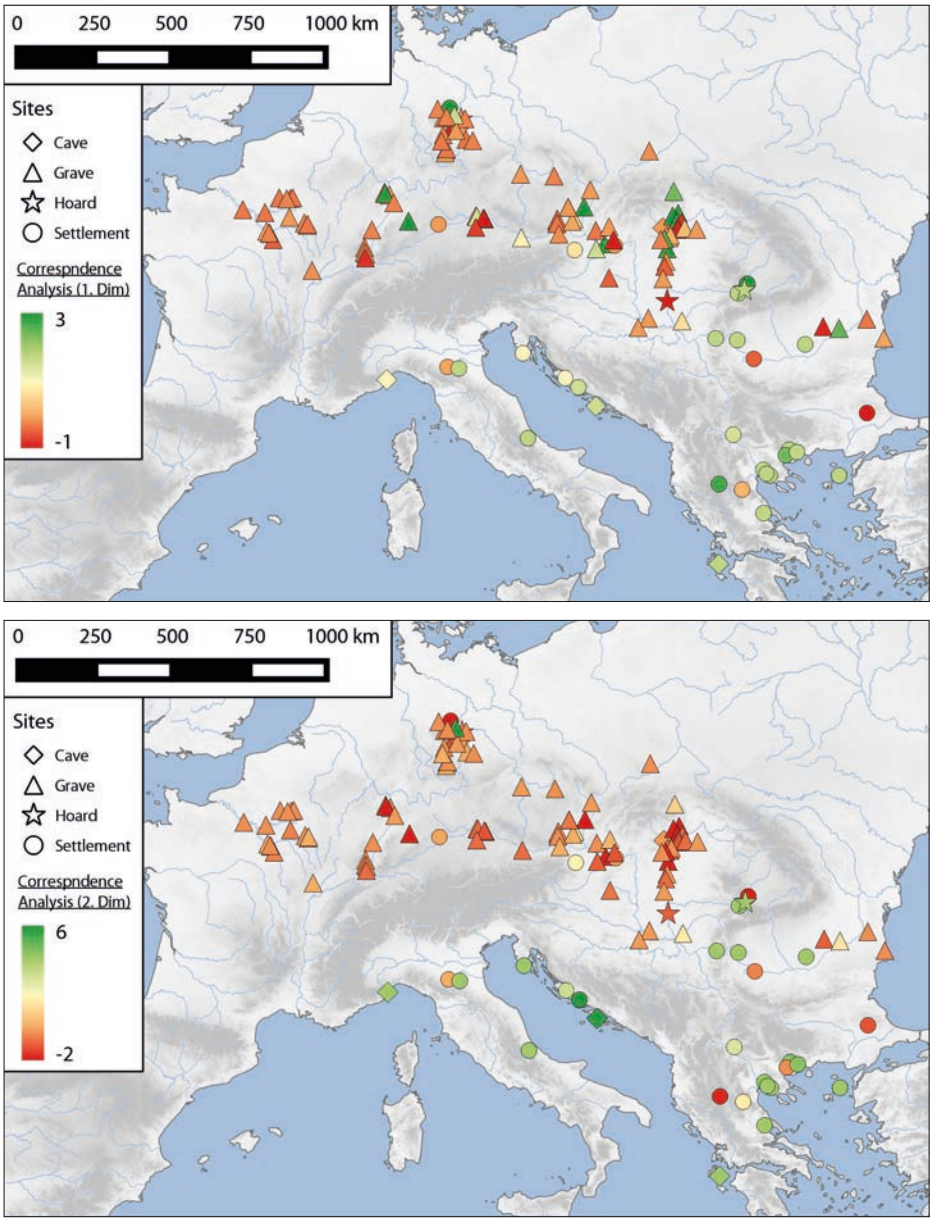

Fig.11. Results from the first two axes of the correspondence analysis, connected to the single sites (graphics: Arne Windler).

suggested by Johannes Müller (1997, p.97). In economic terms, this phenomenon is related to the transportation costs as well to the scarcity of the shell.

Price differences at an inter-regional scale could be used to gain a profit – this is visible in archaeological contexts like the deposition of large numbers of Spondylus artefacts, e.g. in graves and hoards. Topographical bottlenecks or cultural border zones are crucial to make use of price differences. The density map of the used valves shows several distinct points: the hoard of Čoka-Kremenjak at the border between Vinča culture and LPC, two clusters along the Danube between the Western Carpathians and the Eastern Alps and another one in Southern Germany around the graveyard of Aiterhofen-Ödmühle. Due to the economic theory, new merchants would enter the market for profit expecting reasons; the shells would then become cheaper in Central Europe. The density maps plotted for the time between 5500 and 5000 BC show this effect: The increase of Spondylus supply is what paves the way for the expansion of the artefacts into the Parisian Basin (Fig. 12).

In the light of the distribution maps, the correspondence analysis and the histogram, different use regions of Spondylus valves are observable, but this is also obvious, however, because of the shell's origin: While the sites of the Aegean coast can be seen as a production region for Spondylus, Central Europe is more a consumer area and the sites of the Balkan and along the Danube fulfil the role as a transmitting region. The correspondence analysis and the analyses of individual artefacts lead to the conclusion that complete valves were transported to Central Europe and the artefacts were then processed in that region. A clear demarcation between production and consumption region is not that obvious, because Spondylus was consumed all over Europe. Nevertheless, there are differences in Europe with regard to

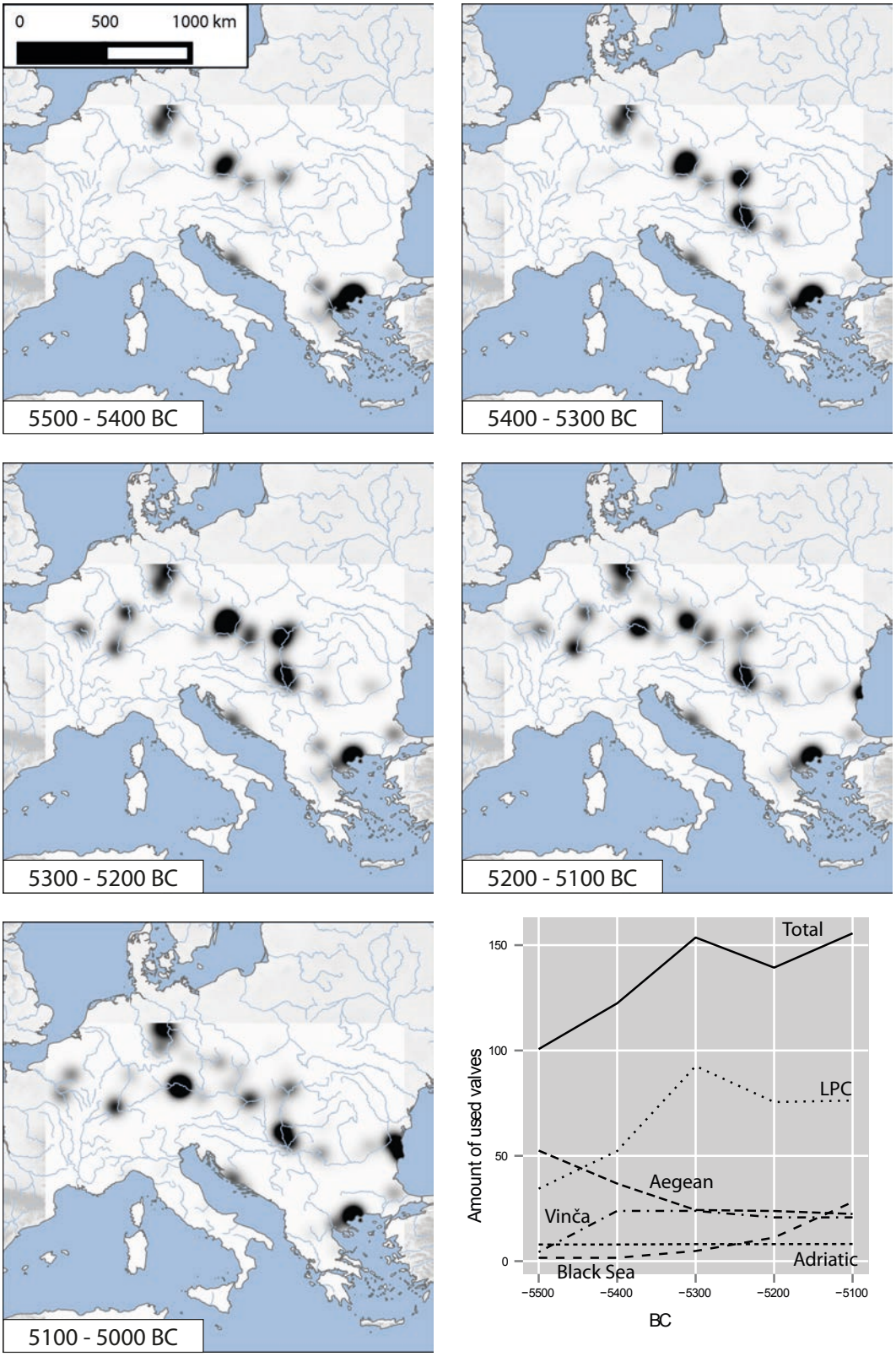

Fig. 12. The development of the artefact distribution between 5500 and 5000 BC with a weighed kernel density estimation (graphics: Arne Windler).

the frequency of consumption. Different spheres of use in Europe are suggested by the contexts themselves: the occurrence of Spondylus artefacts in South-eastern Europe within settlements and in graves of the LPC.

The analysis of Spondylus artefacts in Europe illustrates similarities between the distribution of the Mediterranean shell and the applied foreign-trade model: The scarcity of Spondylus in Central Europe, the emerging

price differences from which someone gained profit, and the different use regions can be explained with the foreign trade model as well.

Conclusion

As it was shown in this paper, applying the foreign trade theory can help analysing the distribution of Spondylus artefacts in Europe. Although trade is never exclusively economic because social or religious and similar spheres are interlinked, the foreign trade theory illuminates the economic dimension of exchange. While social aspects must have played a decisive role within the European Spondylus distribution (John, 2011; Müller, Herrera, et al., 1996; Müller, 1997; Siklósi, 2004), the topic of this article is the economic dimension. The importance of the economic sphere is shown by the decreasing number of artefacts and the increasing value of the shell in Europe. The regional price differences were used to gain a profit from the Spondylus exchange and this profit took place at topographical bottlenecks and cultural borders. While in South-eastern Europe the shell was found exclusively in settlements, in Central Europe graves dominate with regard to depositional contexts. Therefore, the two regions can be understood as different use regions for Spondylus. This conclusion is supported by the correspondence analysis, which, in addition, shows the use of different artefact types in Europe.

Notes

1 Plat. Leg. 917d.

2 For a mathematical derivation of the foreign trade theory see: Krugman and Obstfeld, 2010, chapter 3.

3 See Nakoinz, 2012 for a further discussion.

4 Sites from Spain were excluded here, because it is unlikely that they are linked to the European Spondylus network.

5 See Siklósi and Csengeri, 2011, pp.50-53 and Todorova and Vajsov, 2001, pp.17-18 for the used values.

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