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ACORN GATHERERS: FRUIT STORAGE AND PROCESSING IN SOUTH-EAST ITALY DURING THE BRONZE AGE

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ABSTRACT – *The analysis of archaeobotanical assemblages recovered in recent and older archaeological excavations conducted at several sites in southeastern Italy (Apani, Torre Guaceto - Br; Rocavecchia, Melendugno - Le; Piazza Palmieri, Monopoli - Ba; Scalo di Furno, Porto Cesareo - Le), have revealed the importance of acorn gathering and use in Bronze Age societies. A number of documentary sources describe the use of acorns as food, in both human and animal diets, although various other uses have been reported (as a tanning agent, medicine and so on). On the other hand the charred acorns from Bronze Age sites examined in this study were associated with domestic fireplaces, being found next to griddles and mixed with other edible plants such as cereals, legumes and other edible tree fruits). These observations suggest they played an important part in protohistoric economies.*
In order to address the role of oak fruits and to investigate processing methods we conducted biometric analyses and ethnobotanical comparisons. Data collected during morphometric studies were compared with modern acorns in order to identify the specific taxonomy of the archaeological cotyledons. Reference is made to ethnographic observations in order to decode the archaeological, archaeobotanical and taphonomical evidence regarding the manner of gathering and processing acorns in Bronze Age societies.

KEYWORDS: Acorn, Apulia, Bronze Age, gatherers.

RIASSUNTO – Durante gli ultimi decenni, le indagini archeobotaniche compiute nei siti dell'età del Bronzo della Puglia centro-meridionale hanno consentito di ampliare il panorama di conoscenze dell'ambiente naturale e delle pratiche di sussistenza delle comunità protostoriche. Nuovi dati provenienti da ricerche sistematiche, contribuiscono a delineare alcuni caratteri peculiari di quest'area in cui lo sfruttamento delle risorse arboree, in particolare delle querce, sembra essere sistematico e diretto a scopi alimentari.
Numerose sono le fonti documentarie, storiche ed etnografiche, che attestano i diversi usi delle ghiande di quercia in varie zone del mondo; tra questi importanti sono i riferimenti alla *balanofagia*, ossia all'abitudine di consumare le ghiande quale cibo nella dieta umana.
Prescindendo dalla documentazione letteraria, è possibile isolare un carattere ricorrente negli assemblaggi archeobotanici in cui la concentrazione di ghiande è alquanto consistente: ossia la loro stretta correlazione con evidenze archeologiche strutturali o con associazioni vegetali specifiche, che rimanda ad un presumibile uso alimentare.
Il presente contributo illustra i risultati ottenuti utilizzando l'analisi biometrica dei frutti (antichi e moderni) e l'adozione di protocolli sperimentali, tecniche finalizzate all'identificazione tassonomica delle specie, anche sulla base dell'attuale areale di distribuzione delle querce in Puglia.
Nel lavoro inoltre l'illustrazione delle catene operative/fasi di processamento utilizzate per rendere edibili le ghiande, definite sulla base di osservazioni etnografiche connesse alle pratiche di *balanofagia*, ha avuto come obiettivo quello di decodificare le evidenze archeologiche, archeobotaniche e tafonomiche in grado di attestare lo sfruttamento alimentare delle risorse arboree, in particolare delle ghiande, durante l'Età del Bronzo nella Puglia centro-meridionale.

PAROLE CHIAVE: *Ghianda, Puglia, Età del Bronzo, raccoglitori.*

INTRODUCTION

Over the last few decades, the archaeobotanical investigations conducted at the Bronze Age sites of central-southern Puglia have enhanced our knowledge of the natural environment and subsistence farming among protohistoric communities (Fiorentino 1998, 2010; Fiorentino *et alii* 2004; Primavera *et alii* in press). New data resulting from systematic research conducted at the sites of Scoglio di Apani (Torre Guaceto-Br), Roca (Melendugno-Le) and Scalo di Furno (Porto Cesareo-Le) have helped to delineate some of the distinctive features of this area, where the use of products from trees, particularly oaks, seems to have been systematic and primarily for nutritional purposes. This hypothesis was first put forward in connection with the discovery of a large number of burnt acorns at the site of Piazza Palmieri (Monopoli-Ba) (Fiorentino 1995), and the more recent data would appear to rule out purely occasional collection by protohistoric communities. This was a period in which the gathering of wild fruits appears to be associated with precise eating habits throughout peninsular Italy (Fiorentino *et alii* 2004). This led to the development of tree cultivation practices in the late Bronze Age and early Iron Age, with interesting repercussions on the ancient landscape and land management by complex societies (Peroni 1998; Di Fraia 1998; Fiorentino *et alii* 2004; Zohary, Hopf 2000).

Numerous documentary, historical and ethnographic sources attest to the various uses of acorns in many parts of the world (Jørgensen 1977; Mason 1992, McCorrison 1994), including extensive references to *balanophagy*[1], i.e. the consumption of acorns in human diets (Basgall 1987; Facciola 1998; Gifford 1936; Homma 1991; Mason 1995; Mason, Nesbitt 2009; Usai 1969). Among the ancient sources we shall cite Ovid, who, in the *Fasti* (IV. 399) attributes to Ceres (who was also said to have introduced cereals into the human diet) the replacement of human beings' original food, made up of leaves and wild herbs, with something more substantial: acorns.

395 *Panis erat primis virides mortali bus herbae, quas telluss nullo sollicitante dabat; et modo carpebant vivax e cespite gramem, nunc epulae tenera fronde cacumen erant. Postmodo glans nata est: bene erat iam glande reperta,*
400 *duraque magnificas quercus habebat opes. Prima Ceres homine ad meliora alimenta vocato Mutavit glandes utiliore cibo.*

The edibility of this fruit depends on its tannin content. Tannins give acorns their bitter taste and astringent properties; their concentration varies from one species to another and reduce or block the assimilation of proteins and other nutrients (Chung *et alii* 1998). Various processing techniques are used to make acorns edible (Salkova *et alii* 2011). Leaving aside the literary documentation, a recurring feature in the archaeobotanical assemblages is the presence of

[1] Strabo wrote of people in Spain who used to eat a type of bread made of acorns for much of the year (Strabo, Geography 3.3.7); Herodotus also speaks of eaters of acorns in reference to Arcadia and the Peloponnese (Herodotus 1.66, translation by Godley, 1946).

acorns in specific contexts and together with other edible plants that indicate they were used for food. Indeed, in the four contexts investigated here, the burnt acorns, whether they are whole or fragmentary, hulled or otherwise, are associated with cooking hearths and/or closed containers. Alternatively they are found next to the remains of other fruits, either cultivated plants such as *Hordeum vulgare* (barley), *Triticum monococcum* (einkorn wheat), *T. dicoccum* (emmer wheat) and *Vicia faba* var. *minor* (a small variety of broad bean), or tree fruits such as *Ficus carica* (fig) and *Olea europaea* (olive). These aspects suggest that acorns played more than a marginal role in the economy of central-southern Puglia, in a clearly defined chronological phase.

Ethnographic studies of Italy show that until the Second World War, the consumption of acorns in the form of "bread" was practised in many areas, including the Lazio region around Rome (Guarrera 1994), Basilicata (Caneva *et alii* 1997), Calabria (Pignone, Laghetti 2011), Sardinia (Atzei 2003; Usai *et alii* 2011), the province of Lucca (Pieroni 2000) and Maremma (Mearelli, Tardelli 1995). More recent research has shown how in these "cultural islands", often mountainous areas or places where grazing prevailed over agriculture (Pignone, Laghetti 2011), the memory of the knowledge linked to the use of this food currently survives only among the older generations (Hammer *et alii* 1992, Laghetti *et alii* 2008). In the light of the traditional knowledge that is still conserved, it is important to isolate those aspects that may help to archaeologically clarify the real use of acorns in human diets and thus determine the role of this practice in the protohistoric economy of Puglia.

The carpological analysis of the ancient remains and the adoption of experimental protocols based on modern material served primarily to taxonomically identify the ancient cotyledons, taking account of the distribution of the various oak species in Puglia: the biometric data for the archaeobotanical remains were compared with the data for modern cotyledons, which were subjected to controlled combustion in order to identify the relative species for each archaeological context studied. This aspect is key to establishing their degree of palatability and thus their food potential.

Having established that the acorns were from edible species, the contextual characteristics of the archaeobotanical assemblages were compared with the various phases of processing/storage/preparation, determined on the basis of ethnographic observations (Mason 1992; Mason, Nesbitt 2009; Usai 1969). The objective was to decode the archaeological, archaeobotanical and taphonomic evidence in order to establish for each of the studied sites, the actual nutritional exploitation and degree of processing of these arboreal resources.

CULTURAL AND NATURAL BACKGROUND

Acorn gatherers: the Archaeobotanical evidence

Chronologically, the remains of charred or waterlogged acorns have been discovered in contexts from the Palaeolithic to the Middle Ages (Deforce *et alii* 2009; Mason 1992; Vencl 1985, 1996, Renfrew 1966). The most ancient discovery was made in Acheulian site of Gesher Benot Ya'aqov, in Israel (Early-

Middle Pleistocene); acorns and other edible nuts were found in association with pitted hammers and anvils (Goren-Inbar *et alii* 2002). Other evidence of acorns gathering in prehistoric Israel comes from the site of Ohalo, dated to 17,000 years BC (Kislev *et alii* 1992). In the earliest agricultural villages of the Near East, the remains of acorns are anything but rare; an emblematic example is the site of Çatal Hüyük, where Helbaek (1964) observed the fruits in relation to a hearth and interpreted the discovery as a clear reference to roasting. In the western Mediterranean, the Tyrrhenian islands of Corsica and Sardinia have yielded evidence of the use of acorns in the late Neolithic and throughout the Chalcolithic (Lewthwaite 1982). A strong indication that acorns were used in human diets is provided by the Bronze Age site of Raskopanitza in Bulgaria. Here they were associated with cereals (barley and wheat) and were found above a grindstone, as if they were to be ground together to produce a mixed flour (Renfrew 1973).

In the Italian peninsula, particularly the northern area, the remains of acorn cotyledons seem to have been widespread, though found in small quantities, throughout the Neolithic, with a certain continuity in the subsequent phases[2]. These discoveries become more significant in the Bronze Age[3], although their value should be seen in relation to evidence of the contemporary exploitation of another wild fruit, the drupes of the dogwood *Cornus mas*, probably used for the production of fermented drinks (Fiorentino *et alii* 2004).

In southern Italy, particularly its most eastern part, the current data show that the evidence of the use of acorns is attributable exclusively to the Bronze Age, starting from the middle centuries of the second millennium BC. The acorns discovered at the site of Piazza Palmieri-Monopoli (Fiorentino 1995) are from two distinct levels of occupation but there are no clear elements with which to associate them with storage structures. The greatest concentration of these fruits (98.6% of the total) is in the Appenninic levels (Mid Bronze Age), characterised by the presence of a circular hearth and a hole for disposing of ashes and charcoal, interpreted as an area for cooking food (Principalli 2010). Here the acorns are associated with the remains, albeit in small quantities, of other food crops such as *Hordeum vulgare* (barley), *Triticum monococcum* (einkorn) and *T. dicoccum* (emmer). In general the acorns in the assemblage of Monopoli are whole or split into single cotyledons or parts of these, sometimes with other parts of the fruit such as peduncles and small fragments of charred pericarp (Fiorentino 1995). The acorns recovered from the site of Scoglio di Apani are also linked to levels of occupation: the cotyledons, fragmented and combusted, were found near a cooking

[2] For the Early Neolithic: Sammardenchia, Piancada and Lugo di Romagna; for the Mid and Late Neolithic: Arene Candide, Casalnoceto, Isolino di Varese, Lagozza di Besnate, Monte Covolo, Palù di Livenzia, Bannia di Palazzine di Sopra and Maserà; for the Chalcolithic: Monte Covolo, Bressanone-Millan, Meduno (see Rottoli, Castiglioni 2009).

[3] For example the Middle Bronze Age levels of Luni sul Mignone (see the note by Hans Helbaeck in Östenberg 1967) and Grotta Misa (see Tongiorgi 1947).

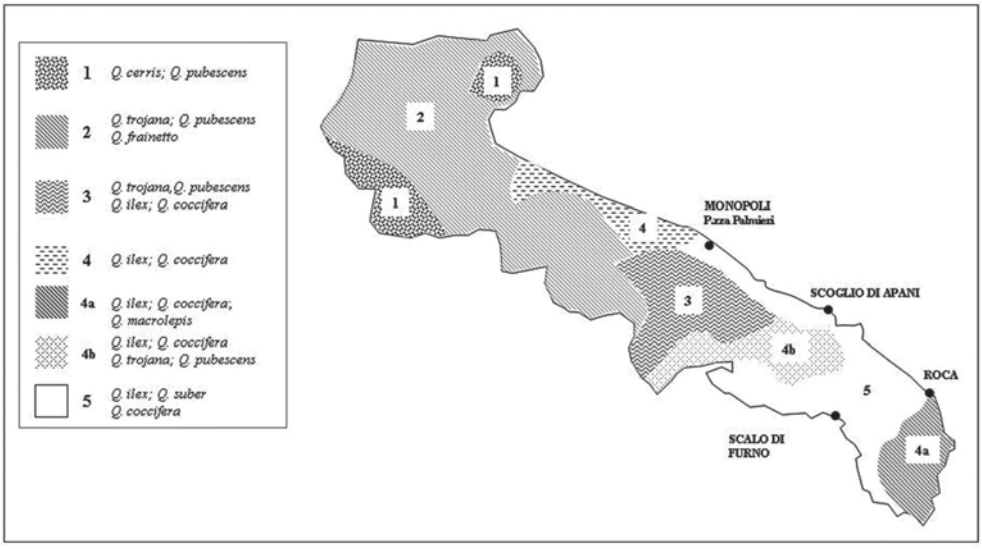

Fig 1 – Distribution of different species of oak in Puglia region.

hearth in Hut 2, around which were numerous fragments of ceramics, apparently belonging to medium-sized closed containers (Scarano *et alii* 2009; Cinquepalmi *et alii* 2010). The finds from *Scalo di furno* were located inside a small pit; the excavation identified chromatic alterations on the walls of the cavity resulting from contact with fire. A special context is that of the acorns of the site of Roca: the area was investigated by Area IX, in a sector characterised by religious ritual throughout the site's occupation (Primavera 2012). The cotyledons were intentionally placed, following combustion, in a small votive pit of the late Bronze Age, together with other materials. Although this context is distinct from the clearly domestic environments, it is interesting to consider the association with the other charred botanical remains deposited at the same time, which are of species commonly used in human diets such as emmer, einkorn, barley, beans and figs. In addition to their religious and symbolic meaning, this also shows the economic value of acorns.

Woodland resources in Puglia during the second millennium BC: Palaeoenvironmental data

Oaks (genus *Quercus*, family Fagaceae) are one of the most characteristic components of the modern Mediterranean landscape. In Italy, oak forests are particularly important in view of the high number of *taxa* present in the forest undergrowth. The Puglia region currently hosts more than 10 different species of oak (fig. 1), whose distribution is determined by climatic and pedological gradients (Campanile, Cocca 2005). In those areas of the world where the consumption of acorns by human beings is ethnographically attested, e.g. among the hunter-gather communities of California (Gifford 1936) or in Japan (Homma

1991), the taxonomic richness of the *Quercus* genus is fundamental, since the productivity of oaks varies from year to year, and a diversified presence reduces the probability of adverse factors affecting the yield of all the trees at once (Mason 1995). The concept of *continuity* in the availability of a product is fundamental in a subsistence economy; this continuity can be ensured not only by the presence of that genus in the area, but also by its species richness: the greater the number of species, the greater the possibility of gathering fruits even in adverse periods.

The anthracological and pollen data available for Puglia in the second millennium BC paint a rather homogeneous picture in which the Mediterranean maquis vegetation is characterised by the presence of both deciduous and evergreen oaks (Fiorentino 1998, 2010; Caroli, Caldara 2006; Di Rita, Magri 2009). The taxonomic resolution of the palaeobotanical data (anthracological and palynological) do not however enable us to clearly determine the species richness beyond reference to two distinct groups of oaks: deciduous (*Quercus* of the *cerris* and *robur* types) and evergreen (of the *ilex type*). In addition, the presence of woods of varying degrees of maturity seems to be attested by the abundance of wild animals that are typical of forest environments such as red deer, boar and roe deer (De Grossi Mazzorin 2010). The pollen diagrams of lacustrine sequences from Puglia show that oak forests (both deciduous and evergreen) rapidly recovered after a brief but intense dry period at the beginning of the 3rd millennium (Caroli, Caldara 2006; Di Rita, Magri 2009). The anthracological data for the proto-Appenninic and Appenninic phases indicate a temperate climate, with deciduous woods and the typical elements of a humid environment (Fiorentino 1995, 2010). In some cases the woods seem to have extended as far as the coast, characterised by long stretches of wetland (Boenzi *et alii* 2004) often exploited by the protohistoric communities (Caldara *et alii* 2003). In the middle centuries of the second millennium the plant coverage declined due to a drier period in which the more xerophile elements of the maquis, including the evergreen oaks, tended to expand (Primavera *et alii* in press). It is precisely during this phase that the acorns are most abundant in the sites being studied.

MATERIAL AND METHODS

Biometric analyses of ancient and modern acorns: comparison of charred material

The fruit of the oak is enclosed in a leathery pericarp (hull), and is ovoid in shape. Inside the pericarp are two valves, called cotyledons, whose external surface is marked by more or less evident fibrous vascular bands. The base of the fruit is rounded, and is set in the so-called cupule, while the apex, inside which is the radicle, is more or less pointed (fig. 2).

From the archaeological point of view, acorns are usually attested by the presence of cotyledons, whole or fragmented. Well-conserved finds are sometimes found still whole, with the hull still attached but without the cupule (fig. 3), which usually detaches from the fruit when it reaches maturity. In general, detailed studies of intraspecific differences

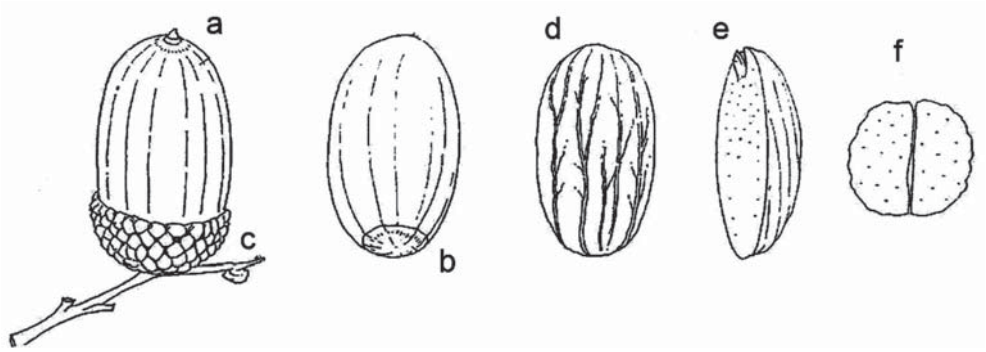

Fig. 2 – Acorn morphology: a) apex; b) pale area at the base; c) cupule; d) membranous skin with pronounced branching veins; e) half of a kernel (one cotyledon) showing the embryo; f) kernel in transversal section showing both cotyledons.

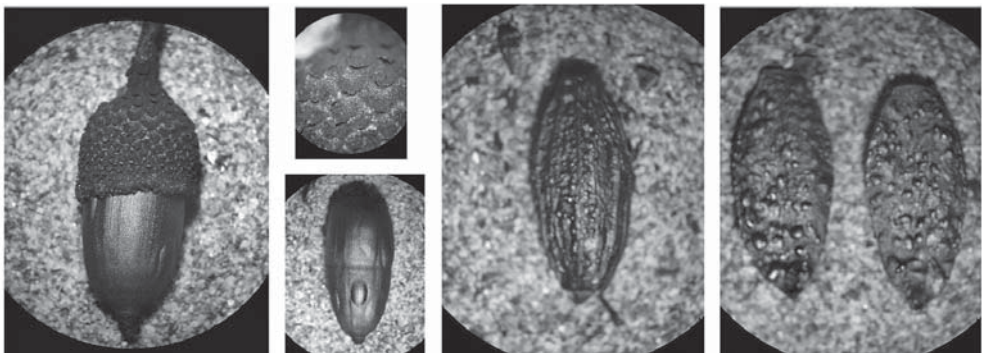

Fig. 3 – Modern acorn of *Quercus ilex* after charring in a controlled environment (400°C for about 60 minutes).

are based on the morphology of the cupule and the leaves (Renfrew 1973), and it is thus very difficult to determine the exact taxonomy of the ancient material, among which there are no traces of these elements. Taxonomic resolution is key however to recognising the use of acorns as food, since not all species are considered edible[4].

To this end, morphometric studies were conducted on the cotyledons of the ancient and modern acorns, using the species attested by the anthracological analyses performed in the same sites (*Quercus* of the *robur* and *cerris* types; *Quercus* of the *ilex* type) as a reference, seeking to determine the current distribution of the various species (Fiorentino 1998; Macchia *et alii* 2000; Campanile, Cocca 2005). The modern acorns of *Q.*

[4] In his description of the various kinds of oak, Theophrastus (3.8) states that the acorns of the holm-oak (*Q. ilex*) are sweeter than those of the kermes oak (*Q. coccifera*), but more bitter than those of the English oak (*Q. robur*). In Sardinia, as in other regions of the western Mediterranean, ethnographic studies report the use of holm-oak acorns for making bread (Usai 1969; Prance, Nesbitt 2005). A detailed list of the tannin content and palatability of the various species found in the Mediterranean can be found in Mason 1995.

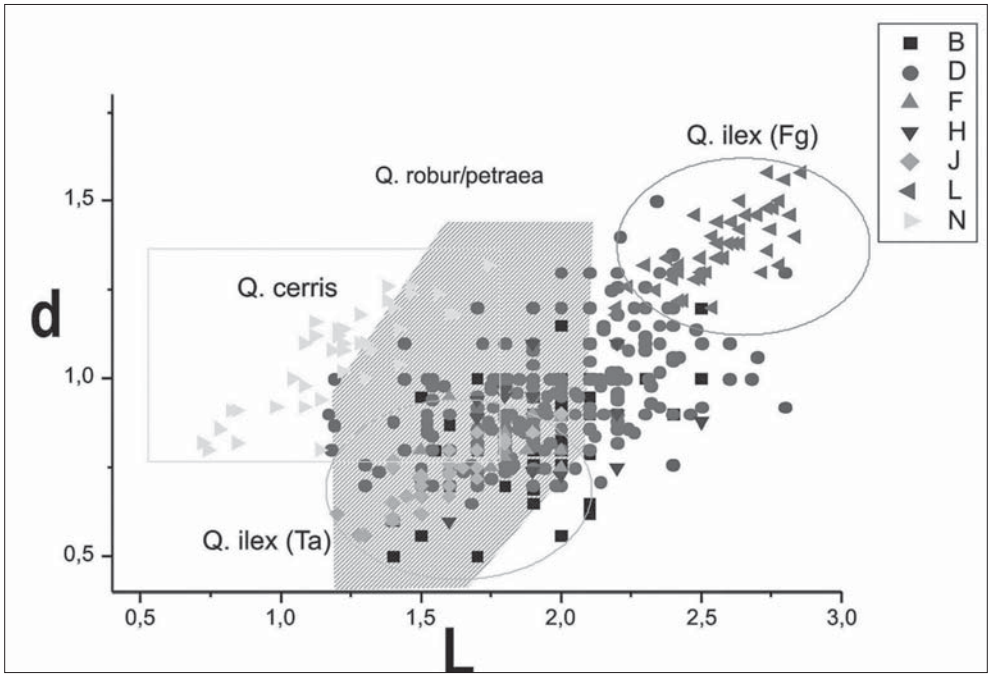

Fig. 4 – Dispersion diagram showing L/d ratio of charred acorns: modern (N = *Q. cerris*; L = *Q. ilex* from Bosco di Tagliacantoni, Vieste; J= *Q. ilex* from Taranto) and ancient (B = Scalo di Furno; D = Piazza Palmieri; F = Roca; H = Scoglio di Apani). The green area illustrates that value in *Q. robur/petraea* acorns according to Jørgensen (1977).

cerris and *Q. ilex* were gathered at a ripe stage in late October in various areas of Puglia with contrasting micro-climates: the *cerris* sample was gathered in the forest of Bosco Quarto, Monte Sant'Angelo (FG, 796 m above sea level). The two *ilex* samples were gathered in the forest of Bosco di Tagliacantoni, Vieste (20 m above sea level) and in a sub-coastal wood near Taranto (5 m above sea level). After gathering, the fruits were dried in order to reduce their residual humidity; this procedure caused the separation of those cupules that were still attached to the cotyledons.

Morphometric investigations were conducted on the three dried samples, measuring the length (L) and maximum width (d) and calculating the ratio of the two measurements (L/d). These parameters were measured again after a process of charring in a controlled environment by exposing the acorns to 400°C for about 60 minutes. For the comparison with *Q. robur* reference was made to the data reported in Jørgensen (1977) and used by Fiorentino (1995).

Verification of the variations in the biometric features of the cotyledons induced by charring made it possible to establish certain fundamental aspects:

– inside the fruit itself, the individual length (L) and width (d) parameters are modified by combustion, with a reduction of 14-18% with respect to the initial value;

– charring does not modify the L/d ratio, showing that this parameter is not influenced by fire and can thus be adopted as a criterion for the recognition of species.

The L/d ratio calculated for the three modern groups of cotyledons (two from *ilex* and one from *cerris*) was subsequently compared with the ratio calculated for the ancient remains on the basis of the measurements conducted (Fiorentino 1995). The data are plotted together and visualised in a dispersion diagram (fig. 4); the clusters of points belonging to the seven samples (modern: N-L-J; ancient: B-D-F-H) indicate that the L/d ratio of the ancient cotyledons corresponds closely to that of the modern holm-oak cotyledons. Specifically, they are distributed within a range between the acorns from the coastal area near Taranto and those from the Gargano.

Acorn processing and storage: archaeological markers based on ethnobotanical information

Knowledge of the methods used for gathering, processing and preparing acorns can clearly help us in the recognition of the archaeobotanical, archaeological and taphonomical evidence associated with their use. Ethnographic comparisons, widely available in the literature for many areas of the world (Mason, Nesbitt 2009; Mason 1995; Usai 1969), can help to accurately define all the intermediate operations that serve to transform the fruit into food. The diagram based on these observations[5] (fig. 5) shows the individual steps, from the gathering of the fruits to the preparation of the dishes (cakes, bread, broth, pap). For each phase the diagram indicates the specific operations in which the use of fire, by exposing the acorns to the risk of combustion, can convert the intended food into archaeobotanical material.

Phase I The gathering of the acorns usually takes place at the end of October, when the fruit is ripe and tends naturally to detach itself from the plant and fall to the ground without its cupule. The ethnographic observations reveal that the most common practice was to gather the acorns from the ground without needing to remove the cupules. In a small number of cases however it has been observed that the acorns were gathered from the tree, with the cupule removed there and then. In order to avoid carrying material that could not be used to the village, the fruits affected by parasites[6] were eliminated by floating them in a basin of water. The operations linked to this initial phase took place off-site, thus leaving no trace in terms of archaeological evidence.

Phase II concerns practices related to pre-storage, i.e. a) discarding worm-eaten fruits if this had not been done previously; b) drying in order to reduce the

[5] The observations concern the three main preparation methods reported by Mason and Nesbitt (2009), which are associated with distinct geographical and cultural traditions: boiling (Sardegna); roasting (south-east Turkey); leaching of the flour (California).

[6] Damage by parasites (generally *Balaninum glandium*) can occur even while the fruit is still on the tree; traces of such damage in fossil acorns does not therefore constitute evidence that they were gathered from the ground.

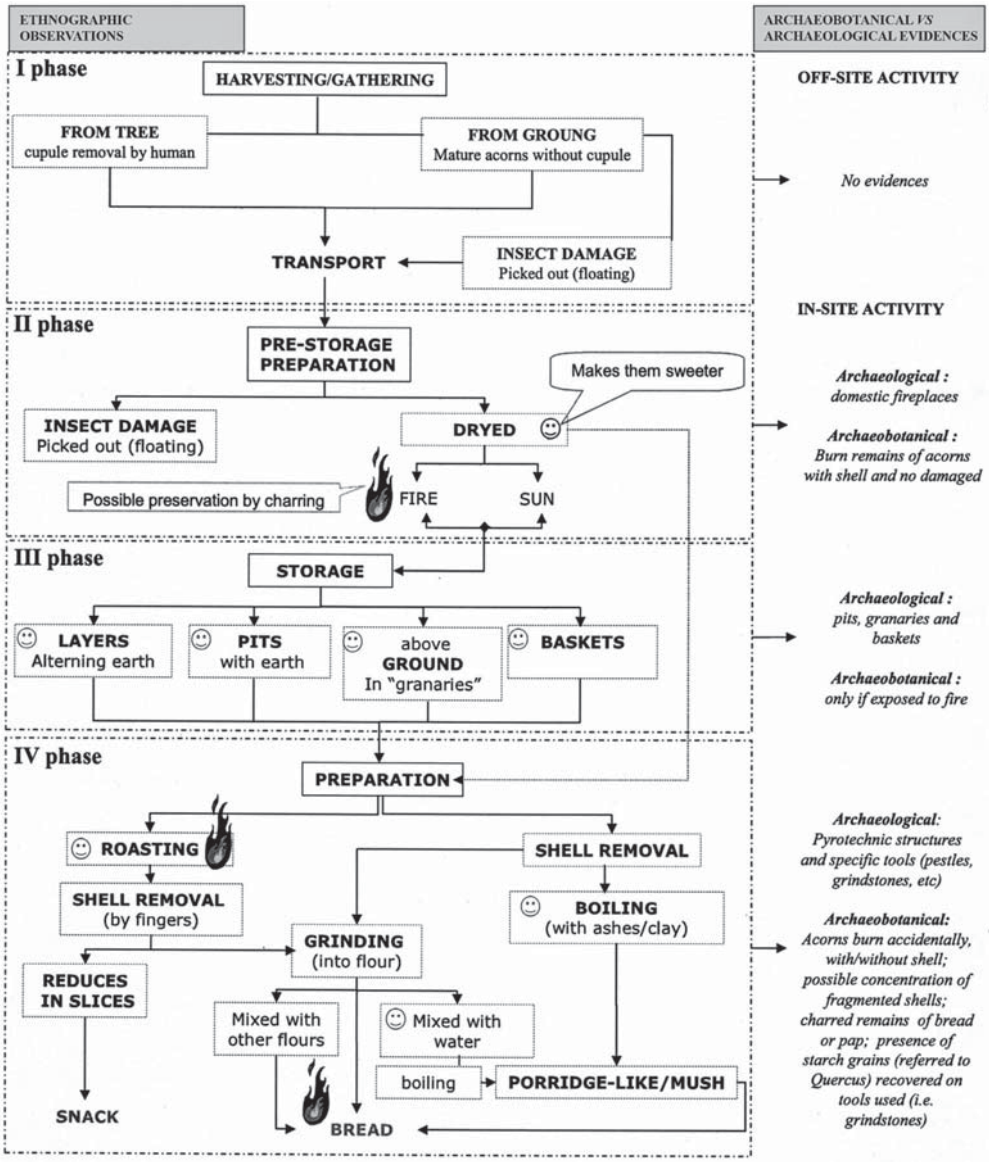

Fig. 5 – The diagram, based on ethnographic observations, shows the individual steps, from the gathering to production: for each phase the diagram shows the possible archaeological and archaeobotanical evidences.

tannin content. The latter operation was accomplished by leaving the fruits in the sun, on the roofs of houses (as happens in Turkey), or by moderate exposure to fire. From the archaeological point of view Phase II may be attested by the presence of pyrotechnic structures (griddles, fires, hearths) in association with the burnt remains of sound acorns still in their hulls.

Phase III includes all the storage operations. The available evidence attests to the practice of mixing the acorns with soil, either in alternate layers or in pits; this not only caused the acorns to lose their "bitter" taste but also to be preserved for long periods, from a few weeks to many months. Other attested forms of storage include silos and baskets made of plant fibre. In archaeological terms, the presence of these structures may indicate that acorns were stored while still in their hulls. In reality these would be conserved in the archaeological deposit only if the structure (dwelling and/or storehouse) was subject to a fire.

Phase IV The acorns were made into flour, bread or dough for other uses by various methods. The first operation was the removal of the hull by roasting over hot coals[7] (which allows manual removal and further elimination of tannins) or by beating and subsequent ventilation (the method used by the native Californians). The toasted and hulled acorns can be broken into pieces and eaten directly as a crunchy snack, which was the custom in Turkey until the 1940s. In the Ogliastra region of Sardinia, acorn bread was prepared by cooking the fruits for many hours in a pot with water and clay or ash. From the resulting pap the larger pieces of acorn were then removed to make the *lande* (an agglomerate of soft but still recognisable acorns) and the remainder was boiled down even further to produce a sort of *polenta* called *fitta*. Both the *lande* and the *fitta* were allowed to cool and then consumed as flat cakes, the former by the adults and the latter, more easily digested, by the children. Another common method of preparation was to grind the acorns finely to a flour, which could then be mixed with flour from other cereals (barley, wheat, maize) for making bread. Hulled acorns that have not been toasted can also be made into flour (fig. 6). The native Americans of California placed the flour in a receptacle fixed to the ground and repeatedly soaked it in water to eliminate the soluble tannins.

Fig. 6 – Hupa of California processing acorns (Photo from hastingreserve.org).

This operation (leaching) took many hours and was completed only when the colour of the flour had changed from yellow to white. At this point the filtered

[7] Before subjecting the acorns to roasting, an incision is made in each fruit in order to prevent it from exploding.

Site	Context information	Age	acorns measured (whole)	Reference
Scalo di Furno (Porto Cesareo, Le)	Small pit	M.B.A.	52	D'Oronzo *i.r.*
Piazza Palmieri (Monopoli, Ba)	Cooking area	M.B.A.	253	Fiorentino 1995
Roca (Melendugno, Le)	Votive pit	L.B.A.	16	Primavera 2012
Scoglio di Apani (Carovigno, Br)	Cooking hearth	M.B.A.	14	Scarano *et alii* 2009

Tab. 1 – Archaeological sites, contexts and archaeobotanical material analyzed.

flour was cooked in water by the stone-boiling method to obtain a pap that could be eaten hot or cold, and cut into smaller pieces.

The archaeological traces that these operations can leave on the ground include pyrotechnic structures (griddles, hearths, etc.), as well as specific tools such as kettles, pestles, grindstones etc[8]. The archaeobotanical record is characterised by the presence of: a) acorns burnt accidentally during roasting, with or without the hull; b) concentrations of fragments of acorn hulls in the areas where the acorns were cleaned; c) remains of accidentally charred bread or pap.

ACORNS IN CONTEXT: DECODING CROP PROCESSING AND FOOD STRATEGIES

The first interesting data concerning the verification of the use of acorns for food in the subsistence strategies of the protohistoric communities of south-east Italy emerges from the biometric analysis of the ancient acorns and from the comparison with their modern equivalents. The experimental approach based on modern acorns showed that the archaeobotanical samples analysed all belonged to a single species, the holm-oak (*Quercus ilex*), whose fruits are considered by both the ancient authors and the ethnographic sources as being among the "sweetest" and, thus potentially edible.

The construction of a reference model (fig. 5) on the basis of ethnographic information regarding the harvest, storage and preparation as food of acorns made it possible to determine the archaeological evidence (structures, tools, contexts) and archaeobotanical evidence (products and sub-products) for each phase of the process. This evidence was then compared with the contextual characteristics of our samples (Tab. 1).

For those archaeological contexts that were clearly associated with domestic activities, the comparison highlighted the phases of the process linked to the preparation and consumption of food:

i) the sample of acorns from Scalo di Furno (made up of whole and frag-

[8] Clear confirmation of the use of these tools in the processing of acorns may come from chemical analyses that highlight the presence of starch from *Quercus*, for example on the Mesolithic grindstone discovered in the site of Donghulin, north of China (cfr. Liu *et alii* 2010).

Species	Protein (raw)	Fat	Carbohydrate	Fibre
Quercus ilex	4.2	8.2	82.5	3.3

Tab. 2 – Nutritional value of acorns of *Quercus ilex* (from Mason, Nesbitt 2009).

mented fruits as well as fragments of hulls) seems to reflect the characteristics of Phase III (storage);

ii) the remains from Apani (composed of hulled acorns found concentrated around a cooking hearth) seem to be linked to phase IV (preparation).

In the first case, the holm-oak acorns may have been subject to storage, being kept in a hole that was subsequently accidentally affected by fire. In the second case the acorns may have been subject to "uncontrolled" roasting; the remains of acorns from the site of Monopoli, which were also found near a cooking hearth, have been interpreted in the same way (Fiorentino 1995). The discovery of Roca, which was not made in a clearly domestic context, cannot be directly associated with any of the above-mentioned phases. Given the characteristics of the archaeological context and the archaeobotanical assemblage, it appears to belong to the "symbolic sphere" as a part of a ritual deposition together with other plant and animal remains.

What emerges from the analysis of the contexts is that like figs and olives, acorns were the object of systematic and specific harvesting from trees found among the natural vegetation of south-east Italy in the mid second millennium BC. The use of this fruit entailed consumption after specific techniques for preparation, designed to make it palatable, and storage, designed to meet the demand for food in the periods following the harvest.

In nutritional terms acorns have a high energy value and are rich in carbohydrates, fats and proteins, with an overall nutritional value comparable to that of cereals (Tab. 2)[9].

The chronological horizon in which the intensive exploitation of acorns occurred poses an interesting though as yet unresolved question: this was a period when the systematic harvest of the fruits of certain trees (such as olives, vines and figs) soon led to the organised planting of these trees as crops (Peroni 1998; Di Fraia 1998; Fiorentino *et alii* 2004; Zohary, Hopf 2000), but the habit of eating acorns did not lead to the same result in terms of domestication. There may be a number of explanations. An initial hypothesis concerns the slow growth of the plant, which requires at least 10 years to become productive; a decade is an extremely long time, although the olive tree, which fruits after 3 years, only be-

[9] Numerous studies have looked at the productivity and yield of oaks and the nutritional value of their fruits. To cite a few by way of example, Parsons (1962) estimated an average yield of 5-700 kg of acorns per hectare for the holm-oak forests of south-west Spain; the ethnographic observations of Goldchmidt (1974) on the native Americans of the Hupa reservation include interesting data concerning the preparation of 21 kg of gruel from 2.7 kg of hulled acorns; in a series of replicated experiments on acorn harvesting and hulling, Petruso and Wickens (1984) established that the cost in terms of hours varied between 0.7 h/kg and 8.3 h/kg for two different species of oak; the return in terms of calories was estimated at between 290 kcal/h and 3500 kcal/h (excluding the phases of filtering and cooking).

comes fully productive after 10 years. Another explanation, in some ways more plausible, is linked to the genetic characteristics of the *Quercus* genus: the difficulty of selecting a type of oak that produces fruit with suitable characteristics for a human diet, particularly its palatability, which is linked to its tannin content, derives from the oaks' high degree of hybridisation.

At the current stage of the research, the analyses of the archaeological contexts in Puglia have highlighted a probable use of acorns as food in the second millennium BC, but it is necessary to clarify the processes and the time-scale associated with the rise and subsequent decline of this practice in the Bronze Age. Also of interest is its relationship with the natural vegetation and any link it may have had with the short-term climatic variations that characterised this phase of the Holocene. The experimental reproduction of the processing techniques and the ethnographic research have also shown the need for further archaeobotanical research, in association with chemical analyses of the ceramic containers and tools (grindstones and pestles) that were commonly used for certain operations, in order to gain a better understanding of ancient dietary habits and the use of plant-based foodstuffs that have no immediate parallels with modern food practices.

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