

# Chapter 11

## The Nuragic People: Their Settlements, Economic Activities and Use of the Land, Sardinia, Italy<sup>1</sup>

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### 11.1 Introduction

Sardinia is the second largest island in the Mediterranean (Fig. 11.1) and is well-known for its Nuragic society, which developed in the Bronze and Early Iron Ages from 1900 to 730 BC (Nuragic Age, Table 11.1).

Past studies of this civilization were based primarily on the analysis of buildings and artefacts. The distribution of the various settlements was analyzed in detail only in relatively limited areas, and generally with particular interest being paid to their use for military purposes. The relationships between the human societies and the terrain have been mainly overlooked, in part because of the absence of collaboration between archaeologists and Earth scientists. The aim of this chapter is, therefore, to explore and partly remedy this lack of knowledge of these relationships.

### 11.2 Geology and Geomorphology of Sardinia

Sardinia is approximately 240 km long from north to south and 140 km wide, and has a varied landscape. The island has had a complex geological history since Paleozoic times (Fig. 11.2). It is characterized by rugged mountain ranges and massifs which are up to 1834 m high, with Paleozoic metamorphic and intrusive rocks mainly in the center and Northeast of the island, and localities of deformed Mesozoic carbon-

ate, particularly along the East coast. The latter have been intensely affected by karst. Several major volcanic eruptions have occurred, primarily during the Oligocene–Miocene (primarily andesite, rhyolites and pyroclastic materials) and the Pliocene–Pleistocene (primarily basalt) periods in the central-western part of the island. Due to erosion, the ancient volcanic rocks now form several high wide plateaus with steep sides. Extensional and transtensional tectonic movements during the Pliocene–Quaternary reactivated older faults systems and dissected the island in NE–SW and NW–SE directions. These led to the formation of several graben including the Campidano Graben in the central-south part of the island (Fig. 11.3) partially filled with more than 600 m of syntectonic deposits. Most valleys of Sardinia have relatively flat bottoms and relatively steep sides. There are Quaternary alluvial deposits, travertines, aeolianites, coastal deposits, and lagoonal sediments in several areas. Flat lowlands are few and small in size, the larger ones being in the lower areas of the Campidano Graben and in some coastal zones, primarily in the northwest where they are often covered by aeolian sands. There are a few torrential rivers in the island. One of the largest is the Tirso River in the central west. It is 151 km long and there is a small fertile alluvial plain in the lower reaches.

Sardinia has a Mediterranean climate with dry, hot summers and mild winters. The mountain areas are colder, with annual snowfalls in the higher areas and occasional ones elsewhere. The island is swept by strong winds, particularly the cold Mistral from the

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See Plates 9b, 10 in the Color Plate Section; also available at: [extras.springer.com](http://extras.springer.com)

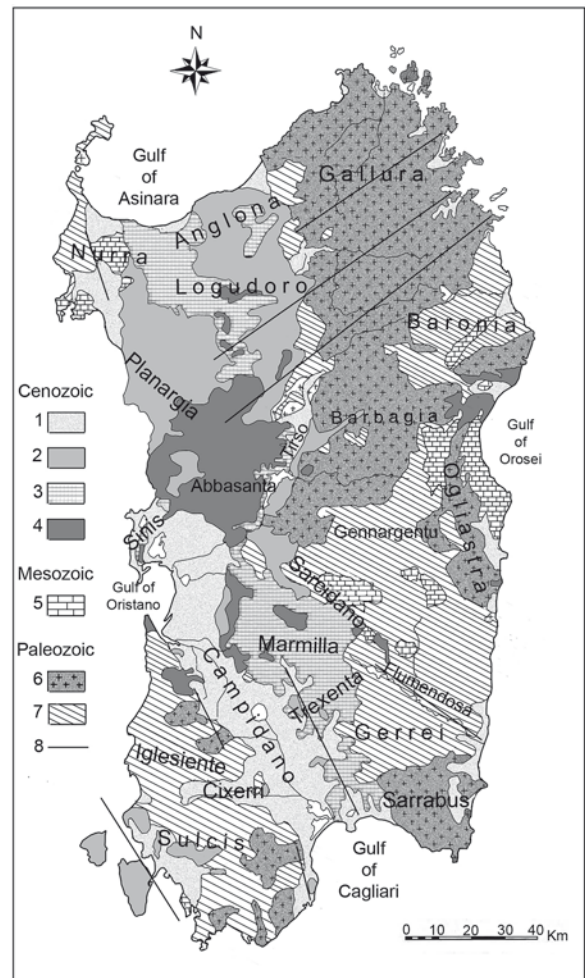


**Fig. 11.1** Location of Sardinia in the West Mediterranean

northwest and the hot Scirocco from the south, which occasionally causes dust storms. At present there are some local cases of desertification due to global climatic changes and intense human exploitation of the land. Similar conditions have occurred in the past, when they were due, for example, to the exploitation and cutting down of the ancient forests of ilex, oak, chestnut, and carob, partly to create more pastureland for grazing. This contributed to the intense erosion of soil in the highlands such as the many currently barren carbonate hills. At the moment only one sixth of the total land area (approximately 475,000 ha) is forested (mainly *Quercus ilex*, *Quercus suber*, but also *Quercus pubescens* and *Juniperus phoenicea*).

### 11.3 The Nuragic Civilization

The Nuragic civilization developed in Sardinia in the 2nd millennium BC and was primarily characterized throughout most of its existence (until about 1150 BC) by the round stone towers called nuraghe, many of which are still standing (Table 11.1). The structures changed over time. These changes, and also other arte-



**Fig. 11.2** Schematic geological map of Sardinia. **Cenozoic:** 1 Continental and marine deposits (alluvial, colluvial, aeolian and littoral gravels, sands, and silts) (Holocene–Pleistocene), 2 alkaline, transitional and subalkaline volcanic cycle (Plio–Pleistocene), 3 marine succession and continental deposits (marls, sandstones, marly sandstones, silstones, calcarenites, silty, conglomerates, and sandy marls) (Upper Miocene, Lower Middle Miocene, and Lower Miocene), 4 calkalinic volcanic cycle (andesites, andesitic basalt, ignimbrites, and epiclastic deposits) (Oligocene–Miocene). **Mesozoic:** 5 marine and transitional successions dolomitic limestones, limestones, dolostones, marly dolostones (Upper Cretaceous, Middle Triassic, Lower Cretaceous). **Paleozoic:** 6 intrusive complex (equigranular leucogranites, equigranular monzogranites, and tonalites) (Upper Carboniferous, Permian), 7 Hercynian metamorphic complex (shales, micashistes, metasilstones, metasandstones, metalimestones, and limestones) (Carboniferous, Devonian, Ordovician, Silurian, Cambrian), 8 faults

facts, allow us to identify different societies and their habits (Table 11.2).

The nuraghe are essentially conical, several-storied, dry-stone towers. There are two main types, the early ‘corridor’ nuraghe or proto-nuraghe (Fig. 11.4),

**Table 11.1** Chronology of Sardinian archaeology from the Lower Paleolithic to the end of the Roman Empire based on calibrated datations. The definition of the Nuragic civilization in five phases (Nuragic I-V) is after Lilliu (1999)

Paleolithic	Lower		Rio Altana (?) Codrovulos (?)	450000-200000 B.P. (?) 200000-150000 B.P. (?)	
	Upper		Grotta Corbeddu	20000-12000 B.P.	
Mesolithic			Grotta Corbeddu Grotta Su Coloru Su Carroppu	9000-6500 B.C. 7000-6200 B.C. 5900-5500 B.C.	
Neolithic	Early	Fillestru - Grotta Verde		5500-4900 B.C.	
		Fillestru B			
		Bonu Ighinu			
	Middle	San Ciriaco		4900-4400 B.C.	
	Late	San Michele di Ozieri		4400-4100 B.C.	
Eneolithic (Copper Age)	Early	Sub Ozieri		4100-3500 B.C.	
		Filigosa	Abealzu	3600-2800 B.C.	
			Monte Claro	2900-2200 B.C.	
	Full	Beaker A <sub>1</sub> Beaker A <sub>2</sub> (Facies Sulcitana) Beaker B		2500-2100 B.C.	
	Bronze Age	Middle	Initial	Bonnannaro A <sub>1</sub> Bonnannaro A <sub>2</sub> Sant'Iroxi	2300-1700 B.C.
			Full	Sa Turricula Muru Mannu, San Cosimo Tamuli (?)	Nuragic I 1700-1600 B.C. Nuragic II 1600-1350 B.C.
Late		Recent	- facies "a pettine" (North Sardinia) - Antigori - Su Mulinu (South Sardinia)	Nuragic III 1350-1200 B.C.	
		Final	Proto-geometric	Nuragic IV 1200-1000 B.C.	
Iron Age	Early	I	Geometric	Nuragic IV 1000-730 B.C.	
			Orientalizing	730-580 B.C.	
		II	Archaic	Nuragic V 580-500 B.C.	
	Late	Punic		525-238 B.C.	
		Roman	238-1 b.C.		
		Roman	Imperial	1 d.C.-476 d.C.	

and the later 'tholos' nuraghe. The latter can be further subdivided into nuraghe with either a single tower (mono-tower) (Fig. 11.5) or multiple towers (complex) (Fig. 11.6). In later times the use of the nuraghe diminished as increasingly complex villages developed, either around the ancient structures or in other areas in the countryside (Fig. 11.7; Depalmas 2003; Dyson and Rowland 2007). The ancient sites were rarely abandoned and the structures may have been used for different purposes, in different areas. The dry-stone constructions for civil purposes in the rest of the Mediterranean (Corsica and the Balearic Islands) are markedly different in their construction techniques, despite apparent similarities (Contu 1997).

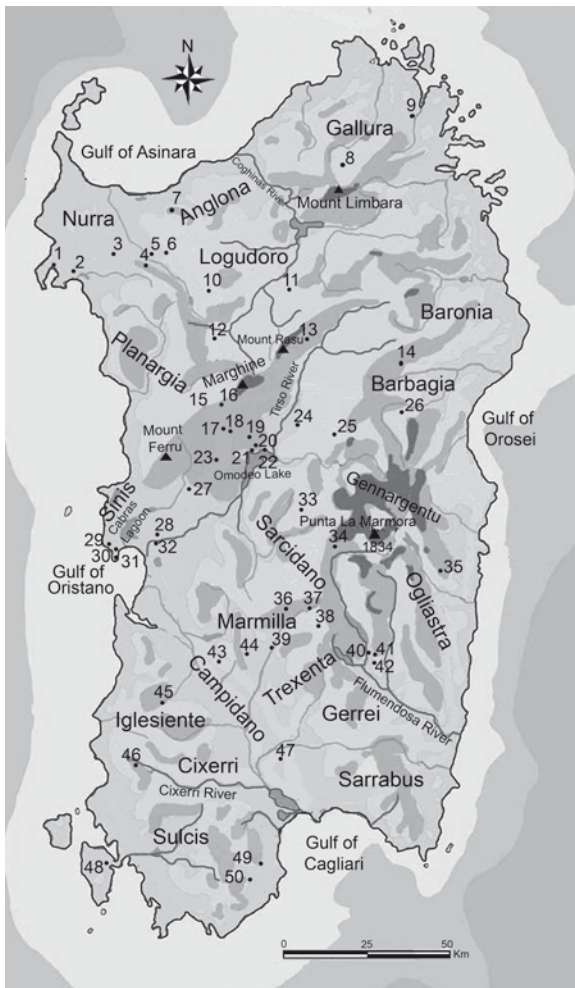
### 11.3.1 Early Middle Bronze Age

The early stages of the Middle Bronze Age were characterized by the corridor nuraghe. These are buildings

with strong rough stone walls and smaller internal areas (Fig. 11.4). There is no typical floor plan and some are elliptical, some quadrilateral, and some circular. All of the monuments have an internal corridor which is either straight or elbow ('a gomito'). The buildings may have two entrances. Sometimes, apart from the corridor, there are other small spaces. It is not rare to find a stone stairway in the corridor, which leads up to an upper terrace. We hypothesize that the original buildings were between eight and fifteen meters high.

Village construction began during this first phase. These consisted of groups of stone huts, or, in the plains where no stone was available, perishable material and/or crude mud bricks. Some of the huts were half buried in the earth. In the earliest phase while rectangular huts are found, such as Sa Turricola, Muros (Fig. 11.3), circular huts were most common.

The greatest density of corridor nuraghe occurs in central Sardinia on basalt plateaus. They are less com-



**Fig. 11.3** Map of Sardinia, showing major regions, rivers, mountains and principals sites mentioned: 1 Sant’Imbenia, Alghero; 2 Palmavera, Alghero; 3 Olmedo; 4 Chessedu, Uri; 5 S’Iscia ’e sas Piras, Usini; 6 Sa Turricola, Muros; 7 Serra Niedda, Sorso; 8 Nuchis; 9 Li Lolghi, Arzachena; 10 Sant’Antonio, Siligo; 11 Ozieri; 12 Giave; 13 Bonotta, Bultei; 14 Su Tempiesu, Orune; 15 Tamuli, Macomer; 16 Santa Barbara, Macomer; 17 Toscono, Borore; 18 Duos Nuraghes, Borore; 19 Ulinu, Sedilo; 20 Lighei, Sedilo; 21 Iloi, Sedilo; 22 Talasai, Sedilo; 23 Abbasanta; 24 Ottana; 25 Sarule; 26 Predu Zedda, Oliena; 27 Crabia, Paulilatino; 28 Santa Vittoria, Nuraxinieddu; 29 Funtana Meiga; 30 Tharros; 31 Su Murru Mannu, Cabras; 32 Oristano; 33 Talei, Sorgono; 34 Funtana Raminosa, Gadoni; 35 Ilbono; 36 Brunku Madugui, Gesturi; 37 Is Paras, Isili; 38 Santa Vittoria, Serri; 39 Su Mulinu, Villanovafranca; 40 Gasoru, Orroli; 41 Arrubiu, Orroli; 42 Su Putzu, Orroli; 43 Sant’Anastasia, Sardara; 44 Genna Maria, Villanovaforru; 45 San Cosimo, Gonnosfanadiga; 46 Iglesias; 47 Su Stradoni di Deximu, San Sperate; 48 Sulci-Sant’Antioco; 49 Antigori, Sarroch; 50 Perda ’e Accuzzai, Villa San Pietro

mon in other landscapes, such as granite or volcanic rock areas. These nuraghe are not found in valley bottoms or on plains.

During these times the deceased persons were buried in specially constructed tombs a short distance away from the nuraghe and villages. The relationship between the number of nuraghe and tombs has not been calculated, and probably cannot be estimated precisely. One to five tombs (funerary constructions) have been so far found in the areas of highest density of nuraghe. These buildings, called Giant’s tombs, have funerary chambers and concave stone fronts (‘exedrae’) (Fig. 11.8).

The oldest tombs (Early Middle Bronze Age) date from the same period as the corridor nuraghe, and are made of vertical slabs of stone with flat roofs. The exedrae are delimited by stone slabs fixed in the soil and at the center there is a large and imposing stele with a rounded top (Fig. 11.8a). This type of tomb is often imposing and had a collective or communal structure.

In the Early Middle Bronze Age (Sa Turricola facies) the most common artefacts were pans with low sides and flat bottoms (Fig. 11.9a) although milk-boilers—cylindrical containers with inside-listel for inserting perforated diaphragms (Fig. 11.9e)—were also widely used. The cooking dish—a type of bell-shaped pan with a convex top—also appears, and this is found throughout the whole Nuragic period (Fig. 11.9f–g). Apart from these various open (dishes and bowls) and closed (clay jars and vases with necks) forms, other different types are found throughout the whole Nuragic period (Fig. 11.9b–d).

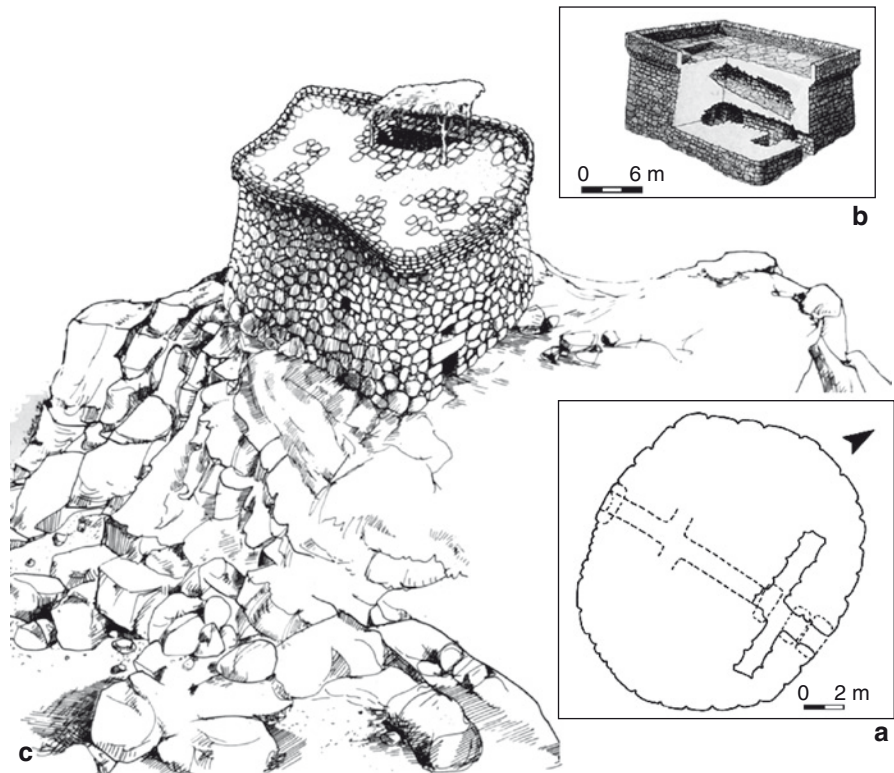
There are insufficient data to accurately reconstruct the economy of this phase. Analysis of the remains found inside the corridor nuraghe Brunku Madugui shows that goats and sheep (sheep, *Ovis aries* L.; mufion, *Ovis musimon* Pallas; goat, *Capras hircus* L.) were the most frequently found species (58.5% of the total, with 33 animals identified). These were followed by swine (pigs and wild boar, *Sus scrofa* ssp. L.) (20.2%, 8 animals), deer (*Cervus elaphus* L.) (6.4%, 6 animals), and oxen (*Bos taurus* L.) (15%, 5 animals). The sheep and goats were slaughtered still young, usually between one and three years of age as were most of the swine (less than two years of age) whereas the age of the slaughtered oxen varied more, from one to eleven years of age (Fonzo 1987).

**Table 11.2** A summary of the main aspects of Nuragic civilization

	← Nuragic Age →				
PERIOD	Early Middle Bronze Nuragic I	Late Middle Bronze Nuragic II	Recent Bronze Nuragic III	Final Bronze Nuragic IV	Early Iron age Nuragic IV (Geometric/Phoenician) End of Nuragic Age Nuragic V
Time (1700 ~ 580 BC)	1700–1600	1600–1350	1350–1200	1200–1000	1000–580 (510 BC Phoenician occupation)
Climate	Wet and cool (?)	Wet, cold and xeric (?)	Wet, cold and xeric (?)	Drier (?)	Drier (?)
Building Nuraghe	corridor nuraghe <i>used for family habitation</i>	Single tower tholos nuraghe Local concentrations of nuraghe <i>indicating agglomeration of few families</i>	Development of some complex nuraghe with multiple towers in selected sites. <i>Development of tribes</i>	Intense development of hut villages; decreased importance of nuraghe ( <i>used for religious purposes or storage</i> )	Intense development of hut villages; decreased importance of nuraghe ( <i>used for religious purposes or storage</i> )
Villages	<ul style="list-style-type: none"> <li>• huts without stone walls</li> <li>• huts with stone walls (rarer), sometimes rectangular</li> </ul>	<ul style="list-style-type: none"> <li>• circular huts with stone walls</li> <li>• huts without stone walls</li> </ul>	<ul style="list-style-type: none"> <li>• circular huts with stone walls</li> <li>• huts without stone walls</li> </ul>	<ul style="list-style-type: none"> <li>• villages of stone walled huts: – isolated, – around the nuraghe, – around a cult site</li> <li>• multi roomed buildings</li> </ul>	<ul style="list-style-type: none"> <li>• villages of stone walled huts: – isolated, – around the nuraghe, – around a cult site</li> <li>• multi roomed buildings</li> </ul>
Graves structures	‘Giants’ tombs with slabs set edgewise and “stele centinata”	‘Giants’ tombs’ with blocks in rows and monumental front in rugs or squared blocks.	‘Giants’ tombs’ ‘corridor tombs’ without exedra	‘Giants’ tombs’ and corridor tombs till used but also personal tombs as trench or pits (‘a fossa or ‘a pozzetto’)	‘Giant’s Tombs’ and corridor tombs still used but also personal tombs as trench or pits
Sacred structures	–	<ul style="list-style-type: none"> <li>• Square temples with central hall (“megaron”)</li> <li>• external area of tombs (exedra)</li> </ul>	<ul style="list-style-type: none"> <li>• Sacred springs (?)</li> <li>• Square temples with central hall (“megaron”)</li> </ul>	<ul style="list-style-type: none"> <li>• Sacred springs</li> <li>• Sacred wells</li> <li>• Square temples with central hall (“megaron”)</li> </ul>	<ul style="list-style-type: none"> <li>• Sacred springs</li> <li>• Sacred wells</li> <li>• Square temples with central hall (“megaron”)</li> </ul>
Manufactured items	Bread pan, cooking dish, milk-boiling, bronze ax	Bread pan, pots, milk-boiling, bronze ax	Bread pan with comb decoration; storage jars	High density More intense deforesting	Metallurgical activity; specialized workshops, bronze figurines Jugs, storage jars Reduction in density More intense deforesting, degradation of the environment
Demography	Low density	Rapid increase in population	High density	High density	Reduction in density
Forest	Extensive cover, low human impact	Still extensive, small human impact	Reduction in forested areas due to fires and human use of land for agriculture	More intense deforesting	More intense deforesting, degradation of the environment
Agriculture	Cereals, grazing	Cereals, legumes ( <i>Vicia faba</i> )	Cereals, wild fruit animal husbandry	Cereals (wheat, barley), wild grapes, animal husbandry	Cereals, cultivated grapes
Animal Husbandry	Goats, pigs	Cattle, pigs, goats/sheep	Pigs	Pigs, goats/sheep	Cattle, goats/sheep, pigs
Hunting	Deer	Deer	Deer	Prolagus	Deer, Prolagus, Birds
Site Distribution	Generally low, with concentrations on high basalt plateaus, near water courses	Widespread all over the island, with intense occupation of high basalt plateaus	Widespread all over the island, with intense occupation of high basalt plateaus	Widespread all over the island, with intense occupation of high basalt plateaus	Widespread all over the island, with intense occupation of high basalt plateaus (?)
Landscapes					

The five Nuragic phases (Nuragic I–V) are after Lilliu (1999).

**Fig. 11.4** The corridor nuraghe of Ulinu (Sedilo). **a** Plan. **b** Idealised section. **c** Idealised reconstruction of a corridor nuraghe. (After Tanda 1990, 1996)



### 11.3.2 Late Middle to Recent Bronze Age

In the late Middle Bronze Age and the Recent Bronze Age, single towered tholos nuraghe predominated (Fig. 11.5). This type of nuraghe has an entrance corridor, an opening on a side for a stairway which leads up to the upper floor(s), and a niche on the opposite side. The corridor leads into a circular chamber covered with a false cupola (tholos), with one to three niches in the walls. The upper floor may contain a similar chamber to that on the ground floor or else an open terrace. This floor originally had a wooden structure supported by stone projections which extended upwards from the last layer of stones. It is hypothesized that these towers were originally 20 m high or so.

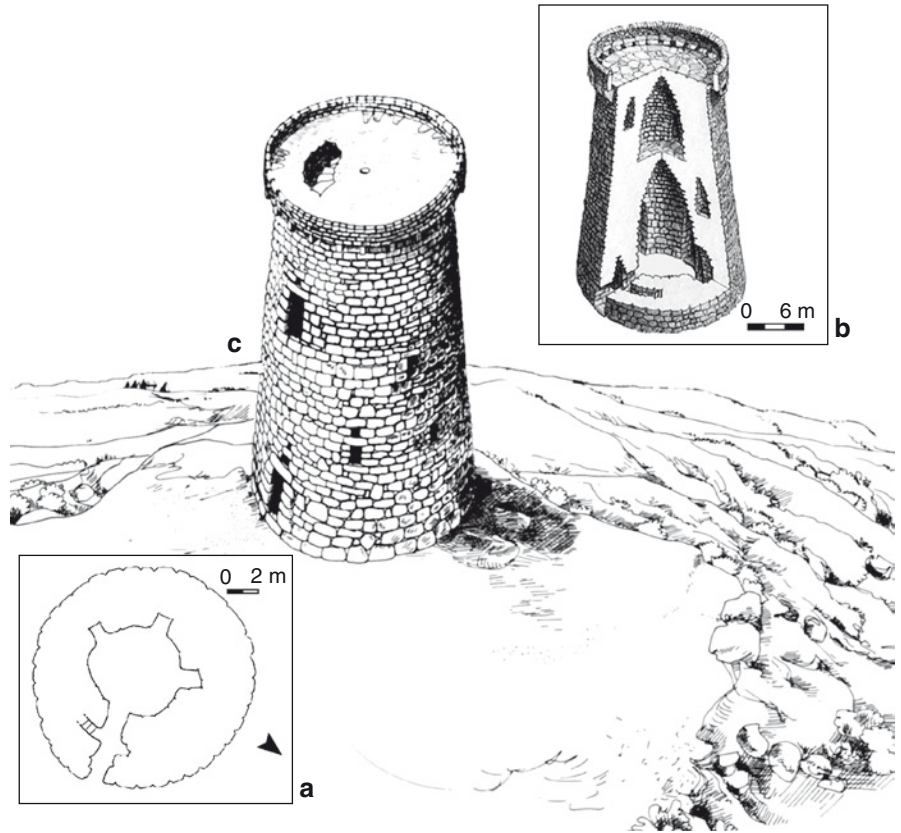
This type of building was constructed first as single tower in the Late Middle Bronze Age and later in Recent Bronze Age as complex nuraghe with two and five towers (Fig. 11.6). Their use may have varied, but on the whole they can be considered to have always been principally dwelling places. Villages may also have grown around the nuraghe even though one also finds villages not associated with nuraghe during this period.

The village huts were circular with basal stone walls 0.80–1.70 m high (Fig. 11.7a). The huts usually had beams and small cross beams supported by the stone walls and wooden roofs or, on rare occasions, flat stone slab roofs; at the center of the hut there was a fireplace or a nether millstone. Sometimes there was an outer stone wall surrounding the settlement.

In this period there was a marked increase in the number of single tower tholos nuraghe. A number of about 9000 units was suggested (Contu 1997). They were built everywhere including valley bottoms, although they were more common on basalt plateaus and in areas of volcanic rock. There were fewer complex tholos nuraghe. Where present they are found on the same landscapes as the single tower nuraghe.

The discovery of ceramic materials of this period in rectangular structures ('megaron' temples) and in springs and wells, which have been identified as cult ritual sites, may indicate that sacred architecture may have already started in this period. During the Middle and Recent Bronze Age the places used for religious ceremonies seem to coincide with burial places. Communal ceremonies also took place in the

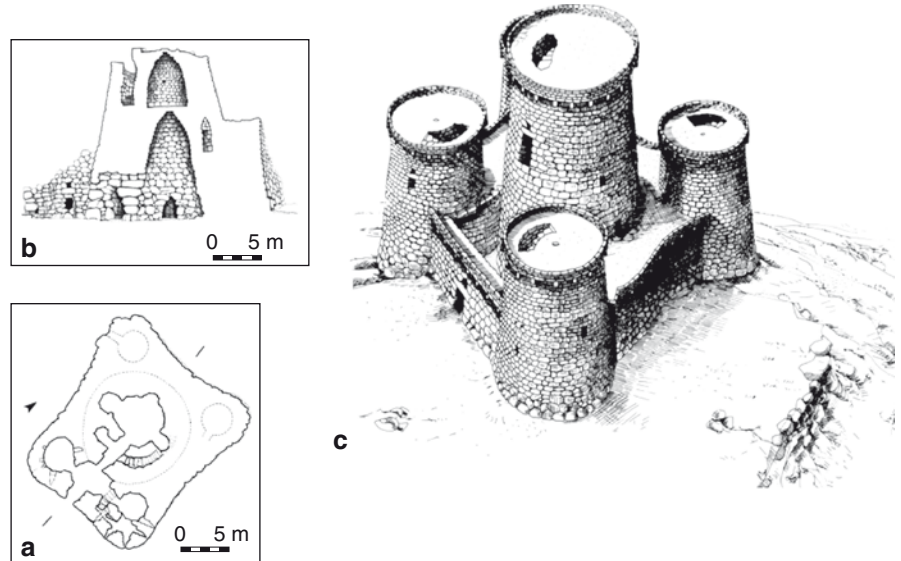
**Fig.11.5** The single tower tholos nuraghe. **a** Plan of nuraghe Lighei (Sedilo). **b** Idealized section. **c** Idealized reconstruction of a single tower two-storey tholos nuraghe. (After Tanda 1990, 1996)

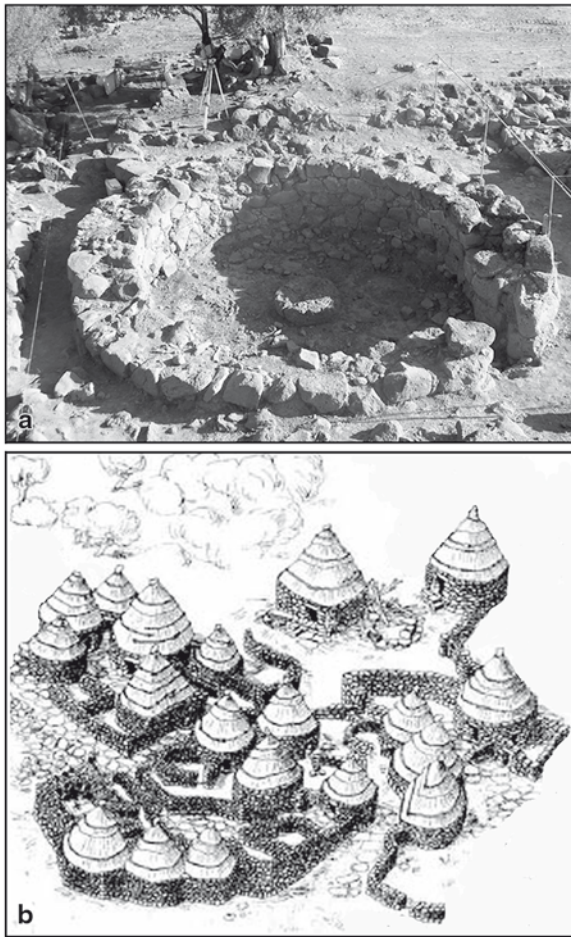


exedra of the tombs and the spaces where offerings were left. The presence of conic stones ('betils') near the tombs suggest that ancestor worship may have been practiced.

The Giant's tombs of this period have exedra made with courses of rough or squared stones and the funerary corridors are roofed with projecting courses and ogival sections (Figs 11.8b, c).

**Fig.11.6** The complex tholos nuraghe. **a** Plan. **b** Section of nuraghe Santa Barbara, Macomer (After Moravetti 1998b). **c** Idealized reconstruction of a complex three-storey tholos nuraghe. (After Tanda 1990)



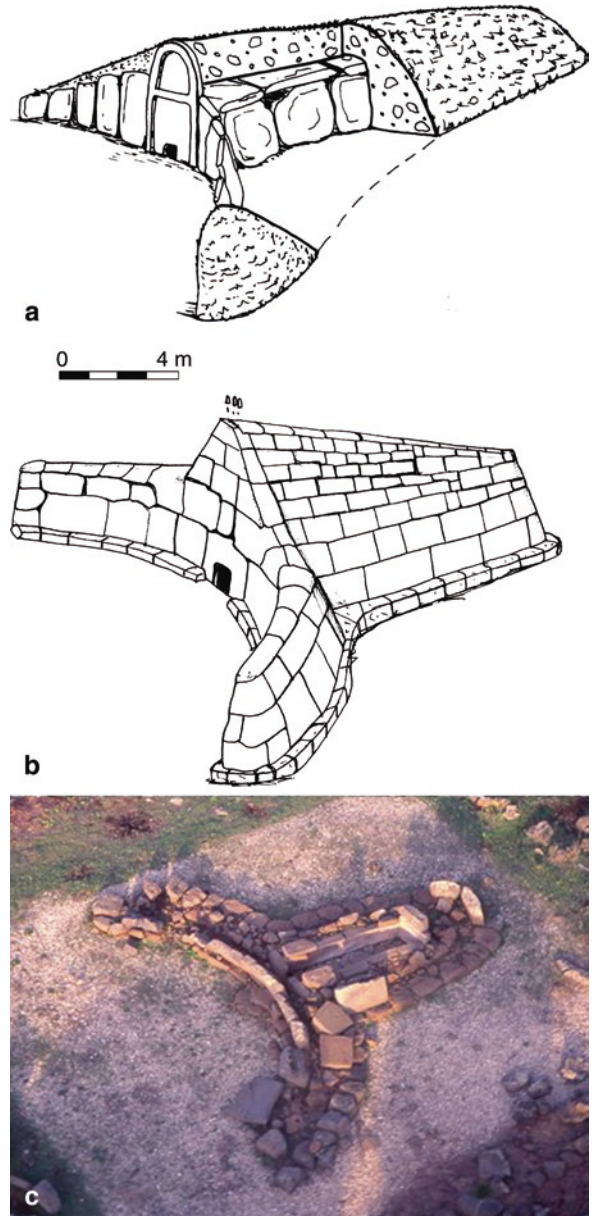


**Fig.11.7** The Nuragic village. **a** Hut 3 of Iloi village (Sedilo). **b** Idealised reconstruction of village huts of Serra Orrios (Dor-gali). (After Moravetti 1998a)

The ‘pan’ continues to be the main type of pottery in the Recent Bronze Age. In central and North Sardinia the internal base of the vases of this age is decorated with impressions of a comb determining the ‘comb phase facies’ (Fig. 11.9h). Large vases (‘dolii’) start to appear in significant numbers during this phase (Fig. 11.9i).

The Recent Bronze Age is the only period in which differences can be established in the ceramic production of the southern and northern parts of the island. In the south, Antigori (undecorated) facies were produced and comb facies in the north. The reasons for this difference are still not clear, but it may be due to the influence of the Mycenaean, as the south of the island had more contact with them.

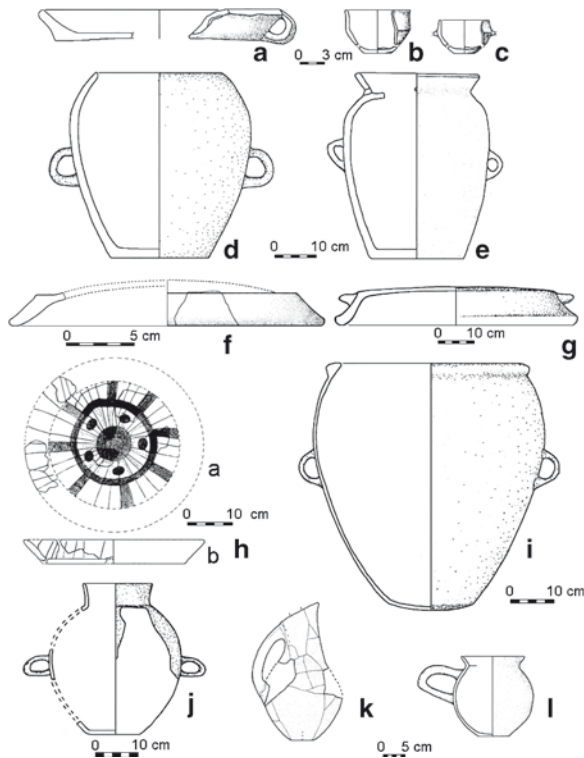
In the Middle Bronze Age Sardinia had more contacts with the Eastern Mediterranean and Cypriot style



**Fig.11.8** Giant's Tombs. **a** Reconstruction of Early Middle Bronze Age type. **b** Reconstruction of Middle Bronze Age Type. **c** Giant's Tomb of Iloi (Sedilo). (After Tanda 2003)

arms, utensils, and new technologies that influenced the development of metallurgy in the island. The Nuragic people had a wide range of tools at their command that could be used to smelt bronze and manufacture utensils such as pincers, coal shovels, hammers and small anvils. These types of manufactured goods show that there were many connections with Aegean and Cypriot metallurgy and perhaps the rest of the





**Fig. 11.9** Ceramic vessel forms of Middle Bronze Age: bread pan (a), carenated bowls (b–c), storage jar (d), milk-boiling vessel (e), “cooking dish” (f); Ceramic vessel forms of Final Bronze Age-early Iron Age: “cooking dish” (g); Ceramic vessel forms of Recent Bronze Age: bread pan with comb decorations (ha top view, hb profile), storage jar (i); storage jar (j), askoid jug (k), large handled milk-boiling vessel (l). [From nuraghe Talei, Sorgono (a–c), Giant’s tomb of Li Lolghi, Arzachena (d), village of Santa Vittoria, Nuraxinieddu (e), nuraghe Brunku Madugui, Gesturi (f), village of Palmavera, Alghero (g, l), nuraghe Chessedu, Uri (h), tomb of Perda ’e Accuzzai, Villa San Pietro (i), village of Brunku Madugui (j), village of Castello, Lipari (k). (After Fadda 1998 (a–c); Badas 1993 (f); Moravetti 1992 (g, l); Bagella et al. 2000) (d–e, h–j); drawing by Depalmas (k)]

Mediterranean world. It is therefore hypothesized that at first the mining and smelting was supervised by people from the Aegean and later it was continued by locals. In any case objects continued to be imported from the Eastern Mediterranean and then imitated until the Iron Age.

We have no precise information on the organization of Nuragic societies particularly during the early stages of their development. Some deduction, however, can be arrived at by analysing the distribution of the settlements. The absence of firm evidence indicating a hierarchical system leads us to hypothesize that it was primarily a family based society, although after

the great increase in population during the Late Bronze Age these family groups developed into territorially based tribes.

We do not have enough data to reconstruct accurately the climate and the agricultural practice of the Nuragic people. However on the basis of the scanty botanic data available, and after comparison with other Mediterranean areas (Van Joolen 2003), we can hypothesize that during the Bronze Age Sardinia had a Sub-Boreal temperate and wet climate, wetter than the present.

The information we have about the agricultural produce, such as the carbonised remains of grains found in some nuraghe, indicates that it was varied and influenced by the geological and geomorphologic settings. Few grain species were found in the Middle Bronze Age Duos Nuraghes complex on the basalt plateau of Abbasanta. They consist of remains of herbaceous plants, such as *Triticum dicoccum*, *Vicia faba* and *Olea europaea* (olive) that could not be determined whether cultivated or wild. However cultivated barley is found but not the naked barley variety whose cultivation, according to the evidence from the rest of the Western Mediterranean, ended during the Early Bronze Age just before the Middle Bronze Age (Bakels 2002).

In the Recent stage of Nuragic culture more species are found. These include *Hordeum vulgare* and *Triticum durum*. The oats may have been wild or domesticated. No *Vicia faba* was found, but very few samples have been analyzed. On the other hand four types of fruit have been identified. These are *Prunus spinosa* L. (sloe) and *Rubus sp.* (blackberry), which were collected in the wild, *Ficus carica* L. and *Vitis vinifera* L., which may have been either wild or domesticated (Bakels 2002). There are also numerous herbaceous species with a marked abundance of clover and forage grasses.

The paleo-palynological analyses carried out in central south Sardinia at the nuraghe of Arrubiu, Orroli (Sarcidano) (López et al. 2005) on the basalt plateau (550 m above sea level) that is bordered by the deep valley of the Flumendosa River, indicate that at the end of the Middle Bronze Age there was a heavily wooded environment (80% of total pollen is from trees/bushes). This was mainly oak trees and, to a greater or lesser extent, olive trees. However there were also alders, ash, elms and poplars. There are few rockroses, which are indicators of forest degradation. Grasses cover only 13% of the area and among these

graminaceae predominate. The corresponding climate must have been cold and dry.

The situation continued to change with an increase in the amount of heather and a reduction in the number of oaks and olive trees. This indicates that deforestation was taking place, as can be seen from the presence of *Glomus cf. fasciculatum*, and this is also confirmed by the increase in the number of grass species and cereals. Among the non-pollen microfossils there are some which indicate that fires had taken place (*Chaetomium* sp.). This phenomenon increased with time and in the Recent Bronze Age the percentage of tree/bush pollens fell still further to 10% leaving more space to the Mediterranean maquis. There was a fall in the cultivation of cereal crops and an increase in pasture.

Other research in the same area at the Gasoru nuraghe, Orroli, about 2.3 km northeast of Arrubiu, has found that in the Recent Bronze Age the countryside was characterized by open oak forests with extensive cultivation of cereals around the monuments. The high percentage of *Chaetomium* sp. suggests that fires were used to increase the area available for cultivation.

Coprophilous fungi have been found among the microfossils, which leads us to hypothesize that animal husbandry took place near the building.

During the Bronze Age domestic animals became smaller in size and this was also the case in Sardinia (Wilkens 2003). This was due to changes in the climate and perhaps also to more intensive grazing (Fonzo 1987). The cattle at the Arrubiu nuraghe are estimated to have had an average height of 95 cm (Fonzo 2003). Cattle were the most important source of protein at the Arrubiu nuraghe of Orroli, followed by swine, sheep, and goat. In the Late Bronze Age swine became more important and very young animals were eaten. Hunting was of great importance as can be seen from the large quantity of deer remains found on the site.

Studies of human bones from the Nuragic period have discovered that the population suffered from various diseases. Hyperostosis porosity appears to have been very common. This disease is closely linked to chronic forms of anaemia, such as those linked to malaria, or to severe malnutrition. Malaria was reported to be present in the island in ancient times (it was already there in the Late Neolithic period) and traces of this are still evident today from the large number of patients who suffer from lack of glucose-6-phosphate dehydrogenase (G-6-PD). This pathology originated in persons who had successfully overcome

attacks of malaria (Floris and Sanna 1999). The widespread diffusion of thalassaemia in the island is also due to the earlier presence of malaria, as the dimensions and shapes of the red cell globules in patients with thalassaemia provide a natural protection against malaria. Bone tuberculosis (at Predu Zedda, Oliena) and rickets (such as at S'Ischia 'e sas Piras, Usini) have also been reported. General analysis of the remains indicates, however, that the population was healthier and on average taller (males: 165.2 cm; females: 153.5 cm) than in earlier periods. In the Middle Bronze Age there were also cases of cranial trepanation, degenerative arthritis and, in rare cases, dental caries (Germanà 1999).

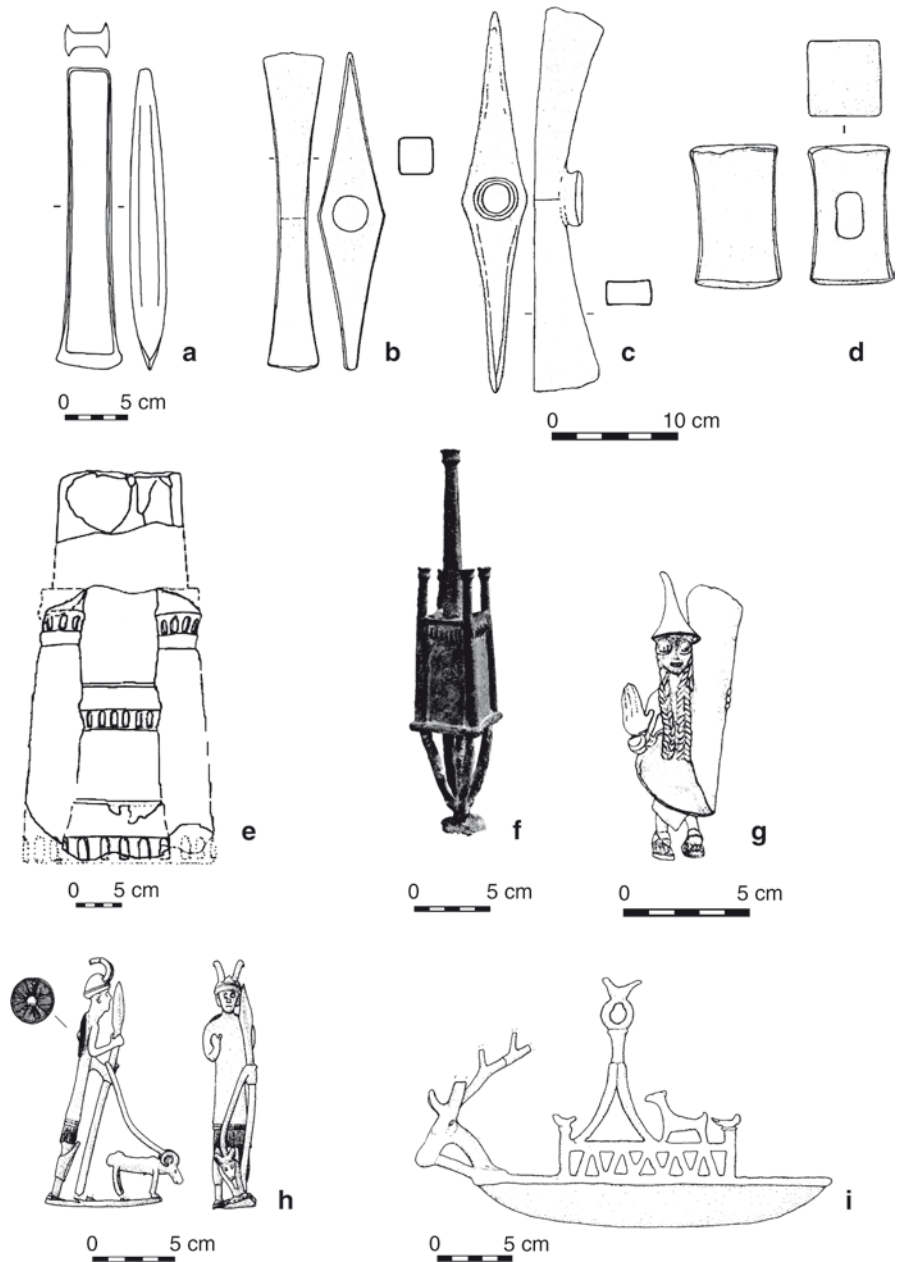
### 11.3.3 Final Bronze Age–Early Iron Age

In the Final Bronze Age (1200–1000 BC) the construction of nuraghe slowly stopped and the population moved into villages. The nuraghe were used as food stores or for cult rituals, although in rare cases they continued to be inhabited. When the walls of the nuraghe deteriorated and the upper parts of the walls fell down, rather than rebuild them the people used the stones for building their huts. These were built around the nuraghe and sometimes even inside the courtyard or bastion of the nuraghe. There are also many villages which grew up far away from a nuraghe.

In this phase the ground plan of the huts were not only circular in form but also trapezoid, rectangular, elliptical and other shapes. There were central courtyards in the groups of huts that formed the villages, as mentioned earlier (Fig. 11.7b). In the villages there is generally also a large circular hut with seats around the inside walls. These are called the 'meeting huts'. Inside them stone models of nuraghe are often found, which evidence of the cult of the nuraghe as works of their ancestors (Fig. 11.10e–f). This is the phase when the sacred architecture, represented by megaron temples, circular structures, and sacred wells and springs, was fully developed (Fig. 11.11). Around the temples small groups of huts were built. These were probably only used during festivals.

In the Final Bronze and Early Iron Age the Giant's Tombs were still used, but different types of sepulchre were also built as well as collective (corridor) or individual (trench or pit) tombs.

**Fig. 11.10** Bronze ax (a), double axes (b-c), hammer (d); carved-stone model (e) and bronze model (f) of a complex nuraghe, bronze figurines of a pugilist/priest (g) and a warrior/shepherd (h), bronze-boat lamp with figure-head and dog/bird gun-wale figures (i) from Ilbono (a), Sarule (b), unknown provenance (c), Nuchis (d), Su Stradoni di Deximu, San Sperate (e), Olmedo (f), Ponte Rotto/Cavalupo, Vulci (g), Serra Niedda, Sorso (h), Bonotta, Bultei (i). After Lo Schiavo 2005 (1-4); Lilliu 1999 (5-6); Pacciarelli 2000 (7); Rovina 2002 (8); Depalmas 2005 (9)



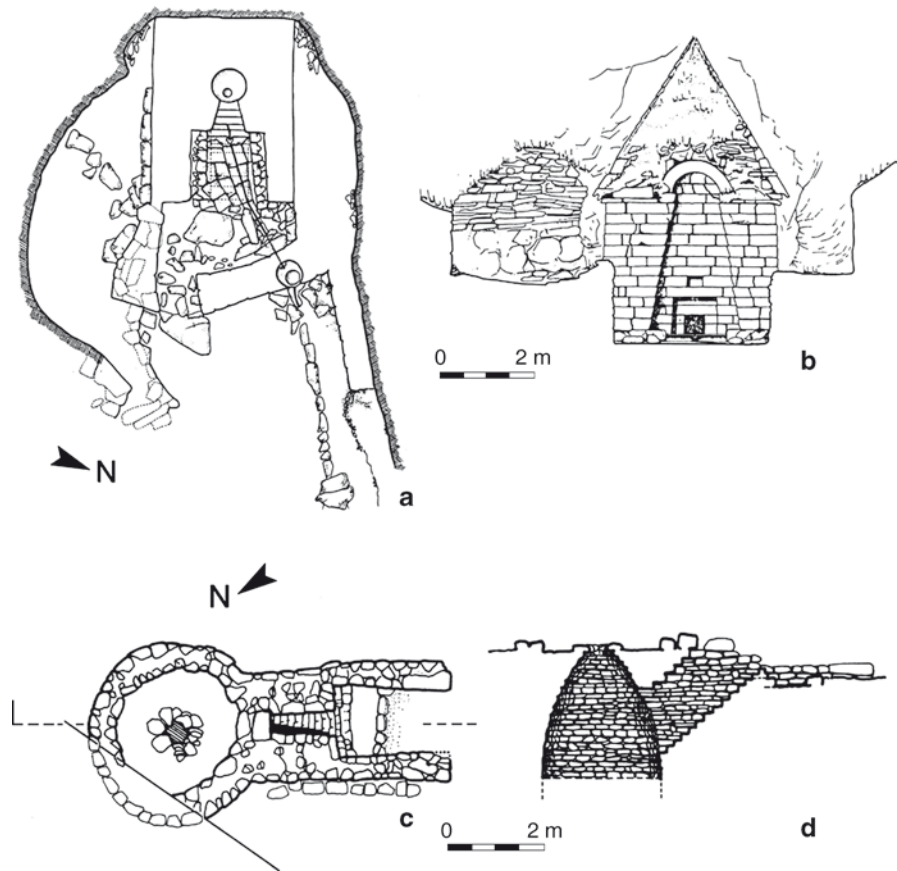
In this phase large containers (dolii) were widely used. These were in the form of jugs with large handles and askoid jugs, closed vases with narrow asymmetrical necks (Fig. 11.10m). These were often finely decorated.

Metallurgy also developed greatly during this period, and this provides us with important information on the technology used in the economic activities of the Nuragic people (Lo Schiavo 2005). Axes

(Fig. 11.10a-c), chisels, awls, wedges, drills, files and saws have been found which were used for working wood, while scrapers, blades, borers and punches were used for working leather.

In the Final Bronze and Early Iron ages there was a great increase in the tools used in agriculture due to the developments in metallurgy. This can be seen from the advances in crop cultivation, which seems, together with animal husbandry, to have been the basis of the

**Fig. 11.11** Sacred constructions. **a** Plan of sacred spring of Su Tempiesu di Orune. **b** Prospect of the same (After Fadda 1988). **c** Plans of sacred well of Santa Vittoria, Serri. **d** Longitudinal profile of the same. (After Santoni 1985)



Nuragic economy. Sickles, pickaxes and hoes were used in agriculture. Sickles are the agricultural tools which are most often found.

The use of animals and ploughs is also documented in certain bronze figures of yoked oxen.

Examples of carved wood are extremely rare, although not unknown, obviously because of the climate and the fact that wood perishes (Lo Schiavo 1981).

In the Final Bronze and Early Iron Age one also finds bronze figures of men, women, animals, and objects. These are often found in places where cult rituals took place which indicate that they were particularly valuable gifts and offerings. The figures provide valuable information about the clothing, arms and equipment in the Nuragic period (Fig. 11.10g–h). The representation of wheels, carts and boats provide information on the means of transport used (Fig. 11.10i).

The location of Sardinia in the center of the Mediterranean and its resources of valuable metals favored considerable commerce. Some of this was short dis-

tance but some was medium distance such as to the Tyrrhenian coast, the Eolic Islands, and Sicily, but also to farther areas such as to Greece, Cyprus and the Levant to the east and Spanish peninsula to the west.

In the Final Bronze Age and Early Iron Age there were substantial changes in society. Social stratifications appear. This can be seen from the use of individual tombs and also from the bronze statuettes of warriors, priests, priestesses, craftsmen, and people making offerings (Fig. 11.10g–h). Direct evidence of how the land was used has been found at the Gasoru nuraghe at Orroli. Here the passage from the Final Bronze Age to the Iron Age seems to have been characterized by increased deforestation and a marked increase in pasture of graminacea and other nitrophile species. The high incidence of *Chaetomium* sp. suggests that the woods were burnt. A similar situation for the Final Bronze Age is found at Su Putzu (López et al. 2005). The deforested land still had some remaining trees and the pasture consisted of anthropic nitrophile grasses and cultivated graminacea.

Studies in other Mediterranean areas indicate that the climate at the beginning of the Iron Age (Early Sub-Atlantic Iron Age 1000–600 BC) was arid (Van Joolen 2003). Oak acorns were found in a large vase in the village of Genna Maria, Villanovaforru (Marmilla zone), which dates from the Early Iron Age. By an extraordinary chance the external coverings of these acorns had been preserved. Apart from *Hordeum vulgare* (hulled six-rowed barley) a single grain of *Triticum monococcum* L. (einkorn) has been recovered, and also *Triticum* sp. (naked wheat) which, according to Corrie Bakels, could be macaroni wheat (Bakels 2002). Other data on the cultivation of wheat, barley and, perhaps, legumes, have been found at the Early Iron Level of the Toscono di Borore nuraghe (Wetterstrom 1987). The grape seeds found at Duos Nuraghes at the Final Bronze Age level are the squat type with short stalks which are characteristic of *Vitis vinifera* L. var. *sylvestris*. This is a wild species which was often used in this period. Discoveries at Genna Maria indicate however that in the Early Iron Age there were cultivated as well as wild species.

At the Arrubiu nuraghe at Orroli in the Final Bronze Age swine were increasingly important while there was a marked reduction in the number of cattle as well as in the number of deer. The number of sheep and goats remained constant and made up half of the total livestock. Among the wild species that were hunted there were many examples of *Prolagus*. In the Final Bronze and Early Iron Age there was once again an increase in the number of cattle and wild animals (deer, *Prolagus*, birds). There were fewer sheep than goats. However the presence of adults indicates that they were used more for their skins, wool and milk than for their meat. Deer hunting also increased (Fonzo 2003).

Remains of paleofauna have been found at the Toscono di Borore nuraghe. These have allowed us to establish an economic framework in which mufions were used more and indeed made up 50% of the domestic and hunted animals. Cattle made up only 19% and swine 17%.

25% of the animal remains were deer and roebuck (25%) (Webster 1996). In general, from analysis of the paleofauna remains one can see that the number of domestic animals of different species was better balanced than in the previous period, although often there were more sheep and goats or cattle.

The paleofauna remains from the Early Iron Age at Genna Maria and Sant'Anastasia also indicate that

there were more sheep and goats, with swine, cattle and deer the next most numerous. However it is clear that cattle followed by swine, deer and roebuck were the most valuable animals, as they provided more meat. The domestic animals were slaughtered young as can be seen from the low percentage of old animals. Their presence however indicates that they were used for other purposes than meat, such as skins, milk or motive power. The high percentage of wild animals in some sites such as Genna Maria and Sant'Anastasia shows that while animal husbandry was the main occupation, hunting was also of great importance.

The remains of shellfish and rare remains of fish show that the sea was also a resource that was exploited, and in some settlements near the sea such as Sant'Imbenia, Alghero they make up a high percentage of the animal remains. They were also found, albeit in smaller quantities, in internal or non-coastal villages such as Sant'Antonio, Siligo and Is Paras, Isili (Wilkins 2003). The rarity of such finds may however be due to the inadequate methods used for examining the sediments.

Analysis of the human remains from the Final Bronze Age in the Gallura region show that there were anthropological differences between the groups buried in tafoni, or natural caves, and those buried in Giant's Tombs. The former suffered from rickets, alveolar pyorrhea, tartar and severe dental wear, while the latter have traces of tumours and hyperostosis (Germanà 1999).

### 11.3.4 End of the Nuragic Age (Phoenician Influence and then Conquest of the Island)

The Nuragic age seems to have definitely ended with the establishment of Punic coastal settlements in the VI Century BC and then the Carthaginian total conquest of the island in 510 BC. Previous contacts with the Phoenicians in the IX century BC do not seem to have caused substantial changes in the culture, but rather, indeed, to have stimulated other contacts with the Eastern Mediterranean and the Etruscan world. An example of this is the centers of Sulci in the south and Sant'Imbenia in the north. Here there is evidence of both materials imported for the Aegean and the Levant and changes in local production influenced by foreign shapes and technology.

In the later stages of the Early Iron Age there was a marked reduction in the population evidenced by a smaller number of archaeological data. The indigenous community was unable to respond to this crisis, and in later stages it is no longer possible to distinguish with certainty between the processes and actions of the local population and those of people arriving from other places.

## 11.4 Distribution of the Different Types of Settlements in the Various Landscapes

The Nuragic settlements are found on all types of terrain, although the differences in their density do depend on the type of terrain.

### 11.4.1 Mountainous Landscape

This is the landscape of mountain ranges and massifs with crests and steep slopes, interrupted by large stretches of table land. The soils have suffered from leaching and erosion. In this terrain alluvial plains cannot be extensive. Here corridor and tholos nuraghe and villages are common. They are not found only on the summits of the reliefs but also along the slopes and in the valley bottoms.

On granite mountain ranges one finds mainly corridor nuraghe that blend into the landscape. Their walls are often supported by rock outcrops and natural forms originating from weathering (tafoni) are incorporated in the nuraghe structure. In addition the presence of broken granite blocks and tors (heaps of rocks) without doubt encouraged construction of the nuraghe by providing ideal building material. Natural shelters (such as caves and tafoni) were used both for living spaces and funeral purposes. The granite terrains with sandy soils have been particularly well adapted to a mixed activity combining agriculture and pastoralism. Evidence of pastoral activity is evidenced by the discovery of milk-boilers used to process it.

In the mountainous areas with a metamorphic substrate such as Gennargentu, Gerrei, and Sulcis Iglesiente there is not a very high density of nuraghe and villages. The softer rocks and clay-rich soils are not

suitable for high buildings. Tholos and complex nuraghe are found near the tops of the highest plateaus. These may have been seasonal sites occupied during transhumance. Some of these areas, such as Gerrei and Sulcis-Iglesiente, are rich in minerals (copper, lead, silver, iron and some tin). The nuraghe may have been used to store the metals and even for the first processing of them as indicated by the finding of primary slag in three of the ten nuraghe in the mines areas (Arca and Tuveri 1993). In the mining basin of Iglesias, instead, the density of nuraghe is not particularly high despite the great richness in lead and zinc. This may be due to the low fertility of the soil and the very rough terrain (Giardino 1995).

Sarrabus is another area where there is a clear relationship between the Nuragic settlements and the mineral resources. In this area there is a marked density of complex nuraghe and villages near the silver and copper deposits. However here too, apart from the discovery of casting slag in one nuraghe, there is no definite evidence of the exploitation of the mineral resources in the proto-historic epoch (Usai 1991).

The Mesozoic and Paleozoic limestone rock areas, such as Barbagia and Baronia, are very rugged, with deep canyons and almost vertical slopes. There are many caves in these areas. Although few of the caves have been explored, the little information that we have supports the hypothesis that they were used for cult rituals and, more rarely, were inhabited. In these areas one finds tholos nuraghe and villages, although not at a particularly high density.

### 11.4.2 Plateau Landscapes

Numerous extensive plateaus exist in Sardinia underlined either by limestone or basalt. Every type of nuraghe and villages occur both on the summits and on their slopes.

The highest and most impressive plateaus are the limestone ones of Sarcidano and Ogliastra, affected deep karst. On the tops of the plateaus rocky outcrops predominate, and poor clay soil is mainly found in low-lying areas. The density of settlement is much lower than on the basalt plateaus.

The highest density of nuraghe is found on the basalt plateaus, with more than one per square kilometer. The plateaus have rocky outcrops and thin but

rich soil (at the present the Andosols are in the highest plateau, about 800 m). There is abundant water thanks to the many springs and marshes. The marshes provide water for the livestock and do not dry up even in the driest seasons. The basalt substrate is also broken up into blocks of various sizes which are suitable for use as building material. These plateaus are of different heights, ranging from 75 to 700 above sea level, but the intensity of distribution of settlements does not seem to be influenced by the altitude.

High, and sometimes very large and isolated, basalt plateaus are typical of the central-west Sardinian landscape. On these plateaus there is a high density of nuraghe, both on their edges and in their interior. More than 50% of the 350 corridor nuraghe of Sardinia are found on these plateaus. Abbasanta is an important example of a basalt plateau. It is 456 km<sup>2</sup> in area and overlooks the valley of the Tirso. During the start of the Middle Bronze Age 101 corridor nuraghe were built here. They are mainly on the flat top of the plateau near the edge, on the slopes, and near streams. There are fewer settlements in the center of the plateau.

Between the end of the Middle Bronze Age and Recent Bronze Age, 293 tholos single tower were built. These were also built in the central areas of the plateau which had previously been little used for settlement. Furthermore, in the Recent Bronze Age 48 single tower nuraghe on the edges and in the center of the plateau were modified into complex nuraghe by the addition of additional towers. There are 125 villages of various sizes on the plateau. They are almost all on the flat top. They may be from the Final Bronze Age as is also the case in other parts of Sardinia, but this cannot be confirmed because of lack of good chronological data (Depalmas 2003).

### **11.4.3 Hilly Landscapes**

In Sardinia there are extensive hilly terrains especially in Nurra, Logudoro, Anglona, Planargia, Marmilla, and Trexenta. The landscape varies, depending on the geology. The areas of sedimentary or volcanic rock are characterized by rocky ridges and gentle hills with rounded to flat summits, of varying heights. Wide, sometimes swampy, valleys separate the hills. In these areas the distribution of the nuraghe often depends on the surface rocks and the soil. High densities of tho-

los single tower and complex nuraghe and villages are found in areas underlined by as sandstone, limestone, and particularly volcanic rocks with fertile soil.

### **11.4.4 Lowland Landscapes**

Sardinia has a limited amount of lowlands, just 18.5% of the whole island. The largest plains in Sardinia, the Campidano and Cixerri, are of tectonic origin, whereas the smaller ones, such as the plains of Giave and Ozieri, result from the drying out of ancient lakes. Campidano is the largest plain. On its borders there are alluvial fans which extend into the center of the plain, creating wide piedmont slip faces. The western border is noteworthy for its alluvial fans that originate from Paleozoic mountains. Their soil is mainly acid, poor and coarse. The few tholos single tower and complex nuraghe are found near small volcanic outcrops such as those found in the north of Campidano. On the eastern border of the plain there are alluvial fans originating from limestone hills and once again the density of nuraghe is low. The central part of Campidano alluvial plain is characterized by soils with high fertility, flat morphology and wetlands reclaimed in the recent past. There are not many nuraghe but Middle, Recent and Final Bronze Age villages, built with remains of perishable material (logs, branches, packed clay) deep-set in the soil are common.

### **11.4.5 Coastal Landscape**

The coast has a marked variety of landscapes. Most of the coast is rocky. There are high cliffs in the limestone areas and deep inlets and bays in the granite areas with long beaches bordered by wide areas of dunes on the west coasts. There are few coastal plains and they develop preferentially near river mouths and mainly on the east and north coasts of the island. These landscapes are characterized by lagoons, sandbars, and coastal dunes. There are not many nuraghe in coastal areas. Tholos complex nuraghe that are present are preferentially located on slightly higher lands near lagoons and river mouths. They rarely occur on rocky headland areas.

## 11.5 Case Studies

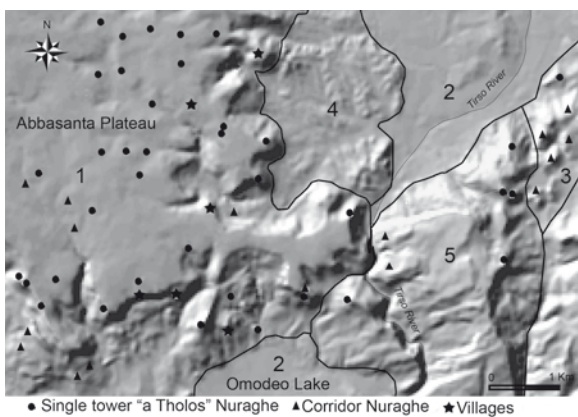
In order to evaluate the relationship between the Nuragic sites and the landscape we examine in some detail two areas with different environments and high density of settlements: the Tirso valley and the Sinis peninsula.

### 11.5.1 The Tirso Middle Valley

The Tirso middle valley is located in central Sardinia between the volcanic massif of Monti Ferru and the River Tirso. It is in the southern part of the Ottana Graben. This area is characterized by pyroclastic materials such as ignimbrite and tuffs, basaltic lava, and by fluvial sandstones. There are granite outcrops in the northeastern part of the area.

The morphologic elements of the region consist of a basalt plateau, the Tirso alluvial plain, granite hills, other hilly area, and escarpment areas (Fig. 11.12).

The basaltic plateau has mainly flat top and variable slopes. The plateau top is characterized by small furrowed paleovalleys, depressions, and swamps. The soil is rich and easy to work but very thin, and there are large areas of bare rock. The deeper soils are found in the swampy areas and are hydromorphic and clayey. There are many seasonal springs all over the plateau. There is a high density of nuraghe all over the top of the plateau, including groupings of three to seven nuraghe. The highest concentrations are found along



**Fig. 11.12** Digital terrain model (DTM) of the central Tirso valley showing morphologic units and distribution of nuraghe in the Sedilo area: 1 basalt plateau, 2 alluvial plain, 3 granite hills, 4 gently hills, 5 cuestas

the small paleovalleys and near the swamps. The corridor nuraghe are mainly found near the edges of the plateau. Paleobotanic studies of nearby nuraghe such as Toscono and Duos Nuraghes have found that the area was used for grazing and for the cultivation of cereals.

The upper parts of some slopes have rock scarps subject to rockfall. This has affected the nuraghe built near the edge during the Bronze Age, as indicated by the presence of supporting walls and repairs to some walls (Fig. 11.13). The middle and lower slopes have been subjected to water erosion. There are small flat areas of deep rich soil on which corridor nuraghe and villages were built, although less than on the plateau itself.

The plain of the River Tirso is separated into two parts by highlands (Fig. 11.12). The northern upper part is an alluvial plain subject to flooding terraces with generally poor acid soils. No nuraghe are present. The southern lower part is presently occupied by a water reservoir (Omodeo Lake), the rest has alluvial terraces with rich soils and many single tower tholos nuraghe have been built there.

Low granite hills with gently sloping sides and wide valleys with flat bottoms are found in the north-eastern sector of the area. There is widespread intense erosion in the hills and the soil is very thin with areas of bare



**Fig. 11.13** The Talasai nuraghe of Sedilo with its supporting wall along the edge of the basalt plateau, suffering from subsidence. (After Tanda 1996)



rock. The only nuraghe present are of the corridor type and these are concentrated on the middle and upper slopes, near springs and small flat areas where the soil is deeper.

Between the basalt plateau and the valley of the Tirso River there are gently rolling hills with volcanoclastic and sandstone substrate. There is intense erosion and leaching and the soils are thin and of poor quality. There are no nuraghe in this area, also because there was no suitable building material.

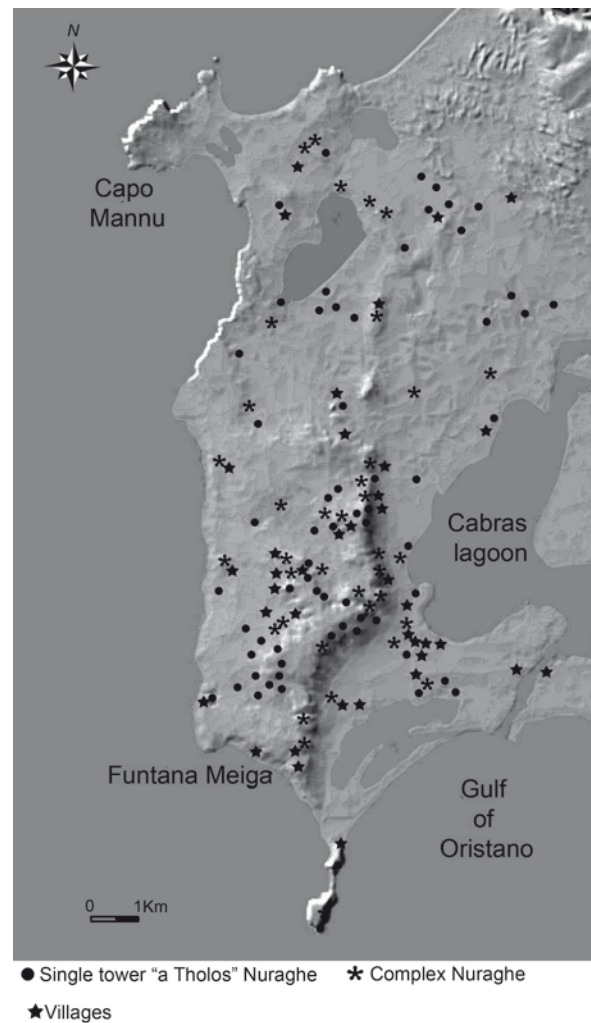
The escarpment area is characterized by cuestas (asymmetric ridges, steep on one side and gently sloping on the other) of ignimbrite and tuffs. Rock falls and rill erosion affect the steepest slopes. The soils are very thin with areas of rocky outcrops. The nuraghe are almost exclusively of the corridor type and are found on the slopes facing the Tirso River, on small flat areas, and near springs (Melis 1998).

### 11.5.2 Sinis Peninsula

The Sinis peninsula is located at the north-west end of the Campidano plain, north of the Gulf of Oristano. It is underlain by a variety of Tertiary rocks and sediments including andesites and basalts, limestones, and Quaternary continental to coastal and marine deposits, mainly calcareous sands.

The Sinis peninsula is mainly characterized by gently rolling hills with an average elevation of sixty meters above sea level. There are clear differences in the geomorphology of the northern and central-southern parts (Fig. 11.14). The northern part is a flat plain with large lagoons or freshwater marshes delimited to the north by high cliffs and aeolian dunes. The southern-central part by contrast has gently rolling hills with flat limestone tops, loamy in the central section. These are separated by wide paleovalleys. There is a small north-south oriented basaltic plateau in part of the southern area. The eastern side of this has a straight concave slope that faces toward the coastal Cabras lagoon. The western side slopes gradually to the coastline. The coastline is mainly low and sandy with rocky headlands. There is great variety of soils, the richest ones being developed on top and slopes of the basalt and on limestone terrains.

On the peninsula there are numerous single tower and complex tholos nuraghe, particularly in the



**Fig. 11.14** Digital terrain model (DTM) of the Sinis area and distribution of nuraghe

southern part, but no corridor nuraghe (Fig. 11.14). The oldest example of the Nuragic village is that of Murru Mannu that dates from the early Middle Bronze Age. Most (45%) of the 69 single tower tholos nuraghe are found on top and slopes of the plateau. On the slopes the density is particularly high with more than two per square kilometer. Most of the remaining nuraghe (43%) occurs on hills near wetlands, and the rest near the low-lying coasts (9%) and on coastal headlands (3%). In the ratio is one complex nuraghe (total number: 37 units) for every three single tower nuraghe.

In the Final Bronze Age and Early Iron Age there were two significant changes. One was the establish-

ment of 31 new villages. Some of these were also built on the plains near the lagoons and the coast.

## 11.6 Discussion

At the beginning of the Middle Bronze Age the formative period of Nuragic culture was marked by the construction of corridor nuraghe. Data from the few excavations indicate that they were used as dwelling places for family groups. The low density of these nuraghe also indicates that the society was still not very cohesive and consisted of isolated, small family groups. Most of these nuraghe were located in places such as basalt plateaus where the land could be used for pasture and, to a lesser extent, agriculture.

During this phase, bronze axes become a very important weapon. One of the possible interpretations of this is their use for more intense deforestation to obtain open spaces for agriculture and grazing. Another indication of increasing agricultural activities is the widespread use of pans. These are particularly suitable for cooking and preparing cereal foods, as are the bell-shaped pans, which can be used for baking sheets of bread. In addition the many milk-boilers have been found that were used for processing milk and for preparing milk based products. The lack of paleobotanic and stratigraphic data from this period makes it difficult to evaluate what impact the human population and their use of the land may have had on the area. The prevalence of sheep and goats, but also swines and deer among the paleofauna may indicate that the economy was still linked to exploitation of the forests.

In the final phase of the Middle Bronze Age a more elaborate architecture developed with more advanced techniques. This was an important moment in the development of Nuragic civilization. The spread of single tower tholos nuraghe was associated with a great increase in the population. This can be seen from the way in which the buildings spread out all over the island and were built on different landscapes and in areas not inhabited in preceding periods. The occurrence of small groups of nuraghe may reflect the tendency of families to associate in larger communities.

The distribution of nuraghe suggests possible hypotheses about their functions. These monuments on highlands did not always occupy the optimal defensive position. They did not occupy the highest eleva-

tion in an area and did not have the best view of the surrounding land. In contrast to the settlements of the Italian Peninsula that were built for defensive purposes (di Gennaro 1996), the Nuragic community did not generally appear to be particularly worried about possible threats from outsiders. The nuraghe built along the coast are not planned in such a way as to form part of a defensive network (Depalmas 2002).

Although the paleobotanic and pollen data show that agriculture, in particular the cultivation of cereals and legumes (*Vicia faba*), was developing, the terrain was still heavily wooded. Thus agriculture did not significantly degrade the terrain and humans had little impact on the environment. Indeed the remains of game are consistently found, and confirm that the island was still covered with well-developed forests. Different factors played a part in creating the new situation, whose effects can be seen not only in the more advanced architecture but also in the growth in population, the spread of economic activities throughout the island, and the improvements in the economic conditions of the population and their quality of life. The result was the increase in the average stature of the individuals and an overall reduction in diseases, even if a widespread presence of porotic hyperostosis—which may also have been due to malaria—is recorded.

In the Recent Bronze Age, society was more complex as indicated by construction of complex nuraghe. These structures are often controversially interpreted as proof that there was an increased stratification of society, made evident by the building of what may have functioned as palaces and castles, the residences of chieftains. For the entire Nuragic period there is, however, no strong evidence of differences in social status in the community. Indeed no indicators have been found of role distinctions either in the artefacts connected to powerful figures, or in the single tombs, or in distinctive grave goods. On the other hand the complex towers were built using the same system of construction as the simple towers, but with the addition of service areas such as courtyards and staircases. In addition there are no areas particularly designed for administrative or ceremonial functions. Nuraghe of this type are found in zones where the surrounding resources were abundant. An example of this is the Sinis peninsula where there is a large number of complex nuraghe in areas rich in resources. Their distribution seems to be connected to a society that had moved beyond the family group and was already organized

in territorially based tribes. The increased use of the land can be seen from the reduction in the size of the forests—including deliberate burning—and further increases in the area under cultivation or pasture.

Major changes in the society continued in the period between the Recent and Final Bronze Age. We do not know whether they were fuelled by any economic or environmental reason. The new society of the last part of the Bronze Age lived in villages, although they also continued to use, or rather reuse the nuraghe as storehouses or for religious rituals. It was a particularly flourishing society which also developed many specialised crafts, among which metal-working is a prominent example. In the Final Bronze and Early Iron Age villages there were places that can be considered specialised workshops as indicated by the way that they were equipped and the tools that were used in them. The new villages often grew up around the nuraghe. The occupation of new areas for farming and grazing was the result of increased deforestation by burning. There was more variety in the crops that were grown, and wild berries and fruit were also consumed. Although grapes were probably used for wine, as can be seen from the widespread discovery of askoid jugs, these may not have been domesticated grapevine species. The numerous agricultural and craftsmen's tools found in these phases confirm that productive activity developed, as does the establishment of grain stores and the widespread use of large storage vases.

In the Final Bronze Age and Early Iron Age not only was animal husbandry, especially of cattle, widely practiced, but hunting also acquired new vigour. This may have been connected to the habits of the elite. The discovery of the remains of adult domesticated animals may be due to increased use of wool and leather. The increase in the number of cattle, and especially adult animals that were thus used for all their working lives, perhaps as draught animals, may be another indication of the increase in agriculture. The human bones found in Gallura allow us to hypothesize that there were social differences between different groups in the area. Malnutrition was found mainly in those occupied in pastoral activities and buried in caves, while those buried in Giant's Tombs were better fed. The presence of bronze statuettes showing different social categories, such as warriors, priests and craftsmen supports this hypothesis.

In the advanced stages of the Early Iron Age the population decreased. It is uncertain whether this was

caused by the climate becoming more arid, or by environmental degradation due to overuse of the land, or by combination of the two effects. At present there is insufficient data to fully explain the phenomenon.

## 11.7 Conclusions

The typical constructions and products of Nuragic civilization, such as nuraghe, Giant's tombs, cult sites, pottery and metal objects are homogeneous all over Sardinia. This cultural homogeneity is preserved even if some changes occurred during the different historical phases. Thus in general one can say that local conditions did not vary so greatly that they negated this homogeneity. By contrast strong local differences are noted in other islands such as Sicily or Corsica. Indeed, in the nearby Corsica, towers are found almost exclusively in the south of the island, and their almost complete absence in the north of the island suggests that there were great cultural differences.

Nuraghe are found all over Sardinia but a closer examination of the situation in different areas shows that there were differences in their concentration or scarcity. This was linked to the landscape. Analysis of the relationship between the monuments and the settled areas allows one to state that the presence of nuraghe was mainly determined by the environmental resources and the possible economic exploitation of the area, rather than any defensive consideration. Although paleoenvironmental data are limited, a trend emerges of the populations of local areas expanding and occupying—in regions with more resources—every available ecozone. The intensive exploitation for agriculture and grazing of these areas was achieved by reducing the forested area, both by cutting down trees and by burning. This was a gradual process which substantially modified the landscape. The strategy employed to use the land profitably involved using a wide range of bronze and stone tools and animal power (draught animals). This human impact may have caused a significant degradation of the environment, which occurred primarily in the final stages of Nuragic civilization.

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## References

- Arca M, Tuveri C (1993) Nota sulle miniere di rame in Sardegna. In: Kirova TK (ed) *L'uomo e le miniere in Sardegna*. Edizioni Della Torre, Cagliari, pp 21–24
- Badas U (1993) Il nuraghe Brunco Madugui di Gesturi: un riesame del monumento e del corredo ceramico. *Quaderni della Soprintendenza Archeologica per le province di Cagliari ed Oristano* 9:31–76
- Bagella S, Depalmas A, Manunza MR et al. (2000) Forme vascolari dell'età del Bronzo in Sardegna. In: *Atti Congresso Nazionale Criteri di nomenclatura e di terminologia inerente alla definizione delle forme vascolari del Neolitico/Eneolitico e del Bronzo/Ferro*, Octavo, Firenze 2000, pp 491–503
- Bakels C (2002) Plant remains from Sardinia, Italy, with notes on barley and grape. *Vegetation History and Archaeobotany* 11:3–8
- Contu E (1997) *La Sardegna preistorica e nuragica*. La Sardegna dei nuraghi, 2, Chiarella, Sassari, 520 pp
- Depalmas A (2002) Approdi e insediamenti costieri nella Sardegna di età nuragica. In: *Atti del Quinto Incontro di studi Paesaggi d'acque*. Preistoria e Protostoria in Etruria, Milano, pp 391–402
- Depalmas A (2003) Scelte insediative e aspetti del popolamento nella Sardegna di età nuragica. *Histria Antiqua* 11:13–21
- Depalmas A (2005) Le navicelle di bronzo della Sardegna nuragica. *Gasperini, Cagliari*, 398 pp
- di Gennaro F (1996) L'Italia centrale e meridionale (part of chapter by Cardarelli A, di Gennaro F: L'Italia). In: *Belardelli C, Neugebauer JW, Novotná M, Novotny B, et al. (eds) The Bronze Age in Europe and the Mediterranean (XIII International Congress of Prehistoric and Protohistoric Sciences, Forlì)*, pp 259–266
- Dyson SL, Rowland RJ (2007) *Archaeology & history in Sardinia from the Stone Age to the Middle Ages: Sheperds, sailors, and onquerors*. UPenn Museum of Archaeology, Philadelphia, 240 pp
- Fadda MA (1988) *La fonte sacra di Su Tempiesu*. Guide e itinerari. Delfino, Roma, 41 pp
- Fadda MA (1998) Nuovi elementi di datazione dell'Età del Bronzo Medio: Lo scavo del Nuraghe Talei di Sorgono e della tomba di giganti Sa Pattada di Macomer. In: *Balmuth MS, Tykot RH (eds), Sardinian and Aegean Chronology*. Studies in Sardinian Archaeology V. Oxbow Books, Oxford, 179–193
- Floris G, Sanna E (eds) (1999) *L'Uomo in Sardegna*. Aspetti di Antropologia ed Ecologia umana. Zonza Editori, Quartu Sant'Elena, 219 pp
- Fonzo O (1987) Reperti faunistici in Marmilla e Campidano nell'età del bronzo e nella prima età del ferro. In: *Atti del II Convegno di studi La Sardegna nel Mediterraneo tra il secondo e il primo millennio A.C.* Stef, Cagliari, pp 233–242
- Fonzo O (2003) *L'ambiente e le sue risorse: la caccia e l'allevamento del bestiame*. In: *Cossu T, Campus F, Leonelli V, et al. (eds) La vita nel nuraghe Arrubiu*. Grafica del Partecola, Dolianova, pp 113–133
- Germanà F (1999) *Malattie e culture della Sardegna preistorica*. In: *Floris G, Sanna E (eds) L'Uomo in Sardegna – Aspetti di antropologia ed ecologia umana*. Zonza, Quartu Sant'Elena, pp 21–39
- Giardino C (1995) *Il Mediterraneo occidentale fra XIV ed VIII secolo A.C.: cerchie minerarie e metallurgiche*. British Archaeological Reports, International Series 612, Oxford, 368 pp
- Lilliu G (1999) *La civiltà nuragica*. Carlo Delfino, Roma, 242 pp
- López P, López Sáez JA, Macías R (2005) Estudio de la paleovegetación de algunos yacimientos de la Edad del Bronce en el SE de Cerdeña. Ruiz-Gálvez M (ed) *Territorio nurágico y paisaje antiguo la Meseta de Pranemuru (Cerdeña) en la Edad del Bronce*. Fernández Ciudad, Pinto, pp 91–105
- Lo Schiavo F (1981) *Economia e società nell'età dei nuraghi*. In: *Atzeni E, Barreca F, Ferrarese Ceruti, et al. (authors) Ichnessa: la Sardegna dalle origini all'età classica*. Garzanti-Scheiwiller, Milano, pp 255–347
- Lo Schiavo F (2005) *Archaeometallurgy in Sardinia: from the origins to the early iron Age*. Monique Mergoill, Montagnac, 412 pp
- Melis RT (1998) *La ricostruzione paleo-ambientale come strumento di indagine archeologica*. In: *Tanda G (ed) I monumenti nel contesto territoriale*. Antichità Sarde. Studi e Ricerche, 3/III, Soter, Villanova Monte Leone, pp 9–20
- Moravetti A (1992) *Il complesso nuragico di Palmavera*. Guide e Itinerari. Delfino, Roma, 139 pp
- Moravetti A (1998a) *Ricerche archeologiche nel Marghine-Planargia, I*. Delfino, Roma, 714 pp
- Moravetti A (1998b) *Serra Orrios e i monumenti archeologici di Dorgali*. Guide e Itinerari. Delfino, Roma, 123 pp
- Pacciarelli M (2000) *Dal villaggio alla città. La svolta protourbana del 1000 A.C. nell'Italia tirrenica*. All'Insegna del Giglio, Firenze, 210 pp
- Rovina D (2002) *Il santuario nuragico di Serra Niedda a Sorso (SS)*. Beta Gamma, Viterbo, 31 pp
- Santoni V (1985) *I templi di età nuragica*. In: *Atzeni E, Contu E, Sardegna, et al. (authors) Sardegna preistorica*. Nuraghi a Milano, Electa, pp 181–207
- Tanda G (ed) (1990) *Ottana: Archeologia e territorio*. Studio Stampa, Nuoro, 232 pp
- Tanda G (ed) (1996) *Sedilo 1: I monumenti del progetto "Iloi" nel contesto territoriale comunale*. Antichità Sarde. Studi e Ricerche, 1/III, Soter, Villanova Monte Leone, 268 pp
- Tanda G (ed) (2003) *Sedilo 7: La tomba di giganti 2 di Iloi (Sedilo-OR)*. Antichità Sarde. Studi e Ricerche, 1/IV, Soter, Villanova Monte Leone, 258 pp
- Usai D (1991) *Modelli d'insediamento nel Sarrabus dal Neolitico all'età del Bronzo*. Quaderni della Soprintendenza Archeologica per le province di Cagliari ed Oristano 7:117–134
- Van Joolen E (2003) *Archaeological land evaluation, a reconstruction of the suitability of ancient landscapes for various land uses in Italy focused on the first millennium B.C.* Phd Thesis, Groningen Institute of Archaeology, Groningen, 291 pp
- Webster GS (1996) *A Prehistory of Sardinia 2300-500 B.C.* Sheffield Academic Press, Bath, 223 pp
- Wetterstrom W (1987) *A preliminary report on the plant remains from nuraghe Toscono*. In: *Michels J, Webster GS (eds) Studies in Nuragic Archaeology: Village Excavations at Nuraghe Urpes and Nuraghe Toscono*. British Archaeological Reports, International Series 373, Oxford, pp 93–103
- Wilkins B (2003) *La fauna sarda durante l'Olocene: le conoscenze attuali*. Sardinia, Corsica et Baleares Antiquae I:181–197