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Phytotoponymy and Flora of Nuraghes monuments (Sardinia)

Abstract

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Nuraghes are megalithic structures with a truncated conic tower, even more than twenty metres tall, with a circular plan and a central chamber covered by a faux vault. Some of these towers were fortified with turreted ramparts, often bordered by large walls to create imposing structures. Built from the sixteenth to the twelfth century BC, with over 7,000 monuments, they characterise the whole of Sardinia. These structures, which have been reused for various purposes up to this very day, feature a very diverse flora ranging from lichens to bryophytes and from small herbs to large trees. There are 385 nuraghes with plant names belonging to 80 different species. The analysis of the flora at 21 sites, located in the various parts of the island, ranging from sea level up to a maximum altitude of 1200 m, has led to the identification of 220 species living on the walls of the towers, on the ramparts and walls and on the roofs. The various components of the life-forms and the role that plants play in the broader ecological and landscape context are highlighted.

Key words: archaeology, floristic analysis, landscape.

Introduction

*a - Nuraghes**

Sardinia is characterised by the presence of stone edifices without cementing material known by the local name of *nuraghe or nurake*, built from about the year 1,600 to 1,000 BC, when a new culture developed in Sardinia - the nuragic "civilization" - which takes its name from the nuraghes, the most representative and original form of architecture of the new times (Lilliu 1963, 2006; Contu 1985,1990; Moravetti & al. 2015). The nuraghes, in fact, spread throughout the island, particularly in the central and northern parts. Numbering at least seven thousand (Fig. 1), they would go on to become the salient feature of Sardinia's ancient, historical and current landscape (Moravetti 2018). Their importance is such that they are already remembered in the ancient world in an engraving of the third century BC by a Pseudo-Aristotle (in *On Marvellous Things Heard*, 100) from the Siceliot world. It read: "They say that on the island of Sardinia there are buildings built according to the ancient Greek custom, and many other beautiful complexes and in particular tholoi with a magnificent balance of proportions." It is common opinion that reference is made here to

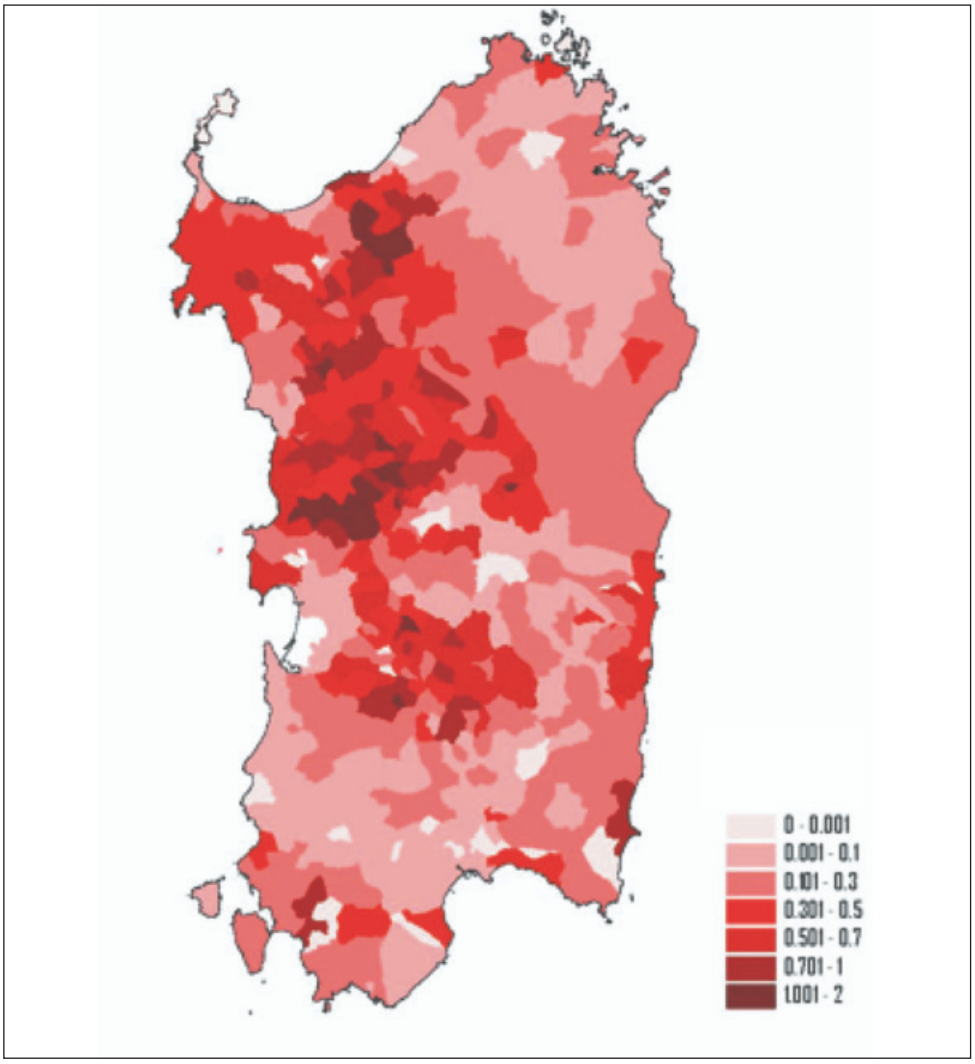

Fig. 1. Map of Sardinia with the spread of the nuraghes, density per sq. km (Melis 2017).

the nuraghes. However, on the island of towers there are also countless villages, megalithic tombs, temples and sanctuaries, and sculptural artefacts, as well as a rich production of metalwork and earthenware.

There are two types of nuraghes, identical in terms of the dry construction technique but different in the form and organisation of the interior spaces: the proto-nuraghe - or archaic nuraghe - and the classic tholos nuraghe.

The former, counting about 500 tower constructions to date, with rather simplified architectural style, feature a variety of shapes and rough masonry and are no more than ten metres tall.

The interior is articulated into corridors, small rooms, niches and stairs to reach the terrace.

The latter, the tholos nuraghe, of which more than 7,000 are known (Contu 1994; Melis 2017; Scanu, 2003; Scanu & Podda 2015), are a natural evolution of the former and respond to a standardised construction module: a truncated conic tower over twenty metres tall, circular plan, with central chamber - up to 11 metres tall - covered with false vaults. The tower could have up to three superimposed chambers, connected by a helical staircase ending on the terrace, which protruded on corbels not unlike medieval towers. The stone corbels found at the base of the buildings and the discovery of numerous models of nuraghe - in bronze, stone and clay - allow us to know something about that part of the building that is no longer extant. The tower could also have turreted ramparts, often bordered by large walls to create grandiose fortified structures.

The function of the nuraghes, which has always aroused interest and curiosity, has always been the subject of bizarre and extravagant hypotheses over time. At present, it is believed that they were multi-functional buildings designed to watch over the surrounding territory and its resources. At times they were simple "farms" of family groups, but in some cases, they were real fortresses, thus indicating a hierarchy of settlements in a land organised into cantons, within a tribal system with competitive communities and growing social differences.

The settlement was centred - but this was not always the case - around the nuraghe, and consisted, at least in the early stages, of mostly circular, single-cell huts with stone base and cover made of wood and branches. Later on, the tendency began to spread to aggregate several huts, in contact with one another, around a central space, thus creating blocks.

Some of these buildings, whether simple or complex, are almost entirely preserved, while others have left less important traces. In all of them though, it is possible to find many plants that often characterise the physiognomy of the landscape.

The nuraghes are spread throughout Sardinia, on all substrates, from sea level up to 1200 m above sea level, using the stone material present on site, but the constructions in basalt or trachyte are undoubtedly more common and are also those with more complex structures (Fig. 2). Su Nuraxi of Barumini, one of the most important nuragic sites in the island, was declared a World Heritage Site in 1997, as a representative of an architecture of particular originality in the dry stone construction of the Mediterranean basin in protohistoric times. Nuragic towers spread in the whole island and with high landscape value and identity for the Sardinians. The nuraghes, together with other architectural manifestations of the nuragic world (well temples and giants tombs), constitute an important tourist attraction for tens of thousands of people, and for this reason a particularly careful management is essential for their protection.

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b - Flora in archaeological studies on nuragic sites

There are numerous studies on the archaeology of the nuraghes, either of a general nature or regarding specific sites and individual monuments, and on the flora and vegetation of Sardinia, as well as studies on the presence of flora on these monuments. In archaeological research, flora has been given little attention in the past. Wetterstrom (1987) cited a number of seeds, including *Prunus avium* and several ruderal nitrophilous species, found in the excavations of the Toscono and Urpes nuraghes (Borore, central Sardinia). But there is no doubt that, at present, in archaeological excavations greater importance is being

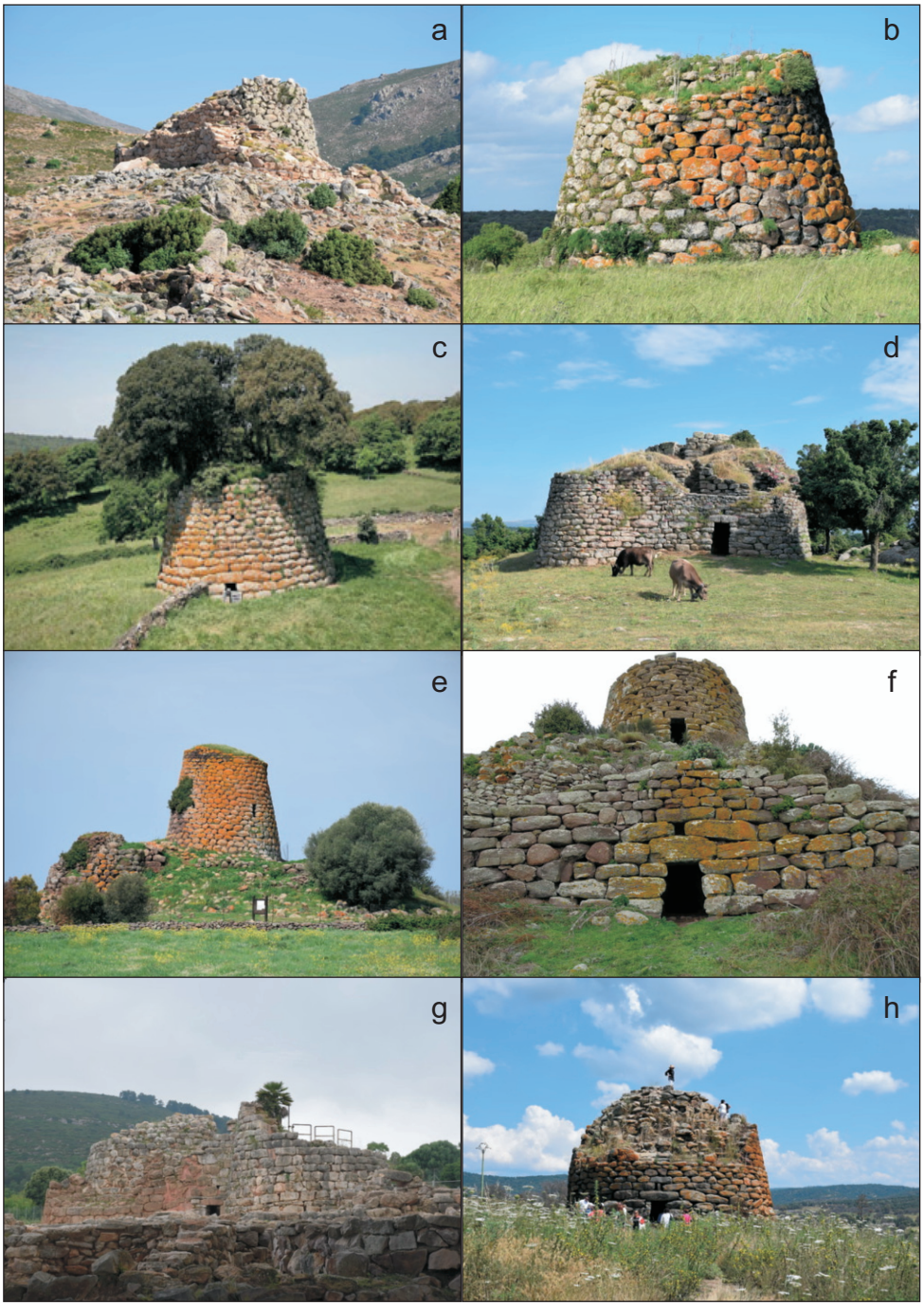

Fig. 2. a) Nuraghe Orruinas; b) Nuraghe Sa Jua; c) Nuraghe Erismanzanu; d) Nuraghe Loelle; e) Nuraghe Nuraddeo; f) Nuraghe Orolo; g) Nuraghe Palmavera; h) Nuraghe Ola.

Fig. 3. Nuraghe Adoni in the picture by Alberto Della Marmora (1826).

attached to the identification of botanical finds thanks to the collaboration of experts in the field of botany. In particular, excavations in the nuragic areas of Sa Osa, in Sinis, (Sabato 2014; Usai & al. 2016) have revealed significant deposits of seeds and remains of tree species (including *Pinus pinea, Pinus halepensis, Myrtus communis*), *Pistacia lentiscus, Juniperus oxycedrus, Triticum aestivum/durum, Olea europaea, Vicia faba, Prunus* sp.*, Rubus ulmifolius, Rubus ulmifolius*, *Malva* sp. *Linum* sp.*, Vitis vinifera, Ficus carica* subsp. *carica* and *Cucumis melo,* which are also of great interest from a historical, cultural and phytogeographical point of view. This seems to demonstrate the presence of some species cultivated before the island's colonization by the Phoenicians (tenth century BC), a period that also marked the end of the construction of the nuraghes (Barreca 1988; Mastino 2005). In the past, the presence of nuraghes has interested scholars mainly from the archaeological and historical point of view (Angius 1843; Spano 1867) and only in some cases, with the notable exception of Della Marmora (1826), has it been possible to find references to the presence of plants, if only in the illustration of the nuraghes.

Table 1. Nuraghes studied, flora survey points, geographical coordinates and altitude in meters.

Nuraghe	Sites of releve	Coordinate	Altitude m a.s.l.	Municipality	Substrate
1- Santa Sabina	1a-Tower Walls, 1b-Cover	40°16’30.17"N 8°53’0.80”E	382	Silanus	Basalt
2 -Nuraghe Loelle	2a-Tower Walls, 2b Cover	40°34'7.16"N 9°18'55.14"E	796	Buddusò	Granite
3 - Nuraghe Orruinas	3a-Walls ramparts, 3b-Walls ramparts and cover	39°56’13.57”N 9°19’52.97”E	1200	Arzana	Porphyry
4 - Nuraghe Palmavera	4a-Tower Walls, 4b-Walls ramparts	40°35’42.06"N 8°14’33.96”E	50	Alghero	Limestone
5 - Nuraghe Losa	1a-Tower Walls	40° 7’0.78"N 8°47’24.86”E	315 ,	Abbasanta	Basalt
6 - Nuraghe Bainzu	6a-Tower Walls, 6b-Cover	40°13’1.79"N 8°50’1.99”E	384	Borore	Basalt
7 - Nuraghe Tolinu	7a-Tower Walls	40°12’43.57"N 8°56’0.09”E	282	Noragugumene	Basalt
8 - Nuraghe Miuddu	8a-Walls ramparts	40°15'59.1"N 8°49’29.4”E	473	Birori	Basalt
9 - Nuraghe Ola	9a-Tower Walls, 9b-Cover	40°18'06.3"N 9°10’34.7”E	342	Oniferi	Basalt
10 - Nuraghe Santu Antine	10a-Tower Walls, 10b-Walls ramparts	40°29’11.59"N 8°46’10.93”E	360	Torralba	Basalt
11 - Nuraghe Sa Jua	11a-Tower Walls, 11b-Walls ramparts, 11c-Cover	40°10'15.90"N 8°51’9.96”E	320	Aidomaggiore	Basalt
12 - Nuraghe Ghispa	12b-Walls ramparts	440°28’45.18"N 9°14’53.74”E	698	Nule	Granite
13 -Nuraghe Adoni,	13b-Walls ramparts, 13c-Cover	39°47’8.82"N 9°10’23.51”E	800	Villanovatulo	Limestone
14 - Nuraghe Voes	14a-Tower Walls, 14b-Walls ramparts	440°28’45.18"N 9°14’53.74”E	698	Nule	Granite
15 - Nuraghe Ardasai	15a-Tower Walls, 15b-Walls ramparts, 15c-Rampants and tower cover	39°53'36.04"N 9°20’21.17”E	1002	Seui	Limestone
16 - Nuraghe Ruiu	16a-Tower Walls	40°45’14.48"N 8°50’44.36”E	316	Perfugas	Basalt
17 - Nuraghe Elighe	17a-Tower Walls, 17b-Cover	40°17'4.68"N 8°44’58.84”E	656	Macomer	Basalt
18 - Nuraghe Semestene	18a-Tower Walls	40°19'27.7"N 8°48’48.6”E	736	Bortigali	Basalt
19 - Nuraghe Santa Barbara	19a-Tower Walls, 19c-Walls ramparts	440°16'33.48"N 8°46'58.83"E	640	Macomer	Basalt
20 - Nuraghe Orolo	20a-Tower Walls	40°17'15.38"N 8°48’48.34”E	785	Bortigali	Basalt
21 - Nuraghe Erismanzanu	21a-Tower Walls, 21c- Cover	40°24’10.87”N 8°57’19.77”E	800	Esporlatu	Basalt

Materials and methods

Alongside lichens and bryophytes, also vascular plants, whether herbaceous or woody, are able to colonize any type of rock and can live in practically soil-free conditions, on walls, roofs and lithic artefacts of any nature. The presence of plants in these contexts is an important element to better identify the ecology of individual species that vegetate in other habitats as well and provide tangible evidence when identifying the initial stages of a plant succession.

With specific reference to the nuraghes, up to now the main focus has been on lichens in relation to the identification of hydrometric indices on the various lithic substrates (Tetriach & al. 1991a, 1991b). The lichen component has also been analysed on the prehistoric monument of Sa Covecada (Cossu & al. 2015).

Preliminarily, it was deemed necessary to analyse in detail the toponymy referring to the nuraghes, highlighting those related to plants. Phytoponyms are *per se* a first sign of the presence of a certain species on nuraghes and refer to both woody plants and mostly perennial herbaceous species. Camarda (1992) was the first to carry out a survey on lichens, which was considered important here to expand to vascular plants.

The research was mainly focused on the basaltic stone towers by taking into account the plants that live both on the walls (a-walls), on the ramparts (b-ramparts) and on the cover (c-cover) of the towers. Often the ramparts and walls are in a state of ruin, as well as the cover, so it was not possible, in many cases, to carry out the surveys on all three parts. The spontaneous flora on these stone monuments without mortar includes numerous ecological niches fertile for the growth of hundreds of different species, from small *Sedum* to large oak and holm oak trees.

The plants growing at the foot of the nuraghes are often ruderal and nitrophilous because strongly influenced by the presence of domestic animals, which often graze around or even inside them and were therefore not considered.

The lithic substrate consists mainly of basalt and effusive rocks, granite, porphyry or various kinds of limestone. The distribution in altitude was taken into account, from sea level (Nuraghe Palmavera at 50 m a.s.l.) to the highest altitude (Orruinas at 1200 m a.s.l.) in Gennargentu, in the centre of Sardinia (Table 1). The geographical coordinates and height of each monument are indicated, as well as the main types of lithic material (basalt, granite, limestone, porphyry) and the municipality in which it falls from an administrative point of view.

The nuraghes do not have cement material and the very thin layer of soil that forms on the interstices of the stone blocks and surfaces is solely due to the build-up of material carried by the wind and rainfall, especially when it is carried by wind from the Sahara. On the various levels, the dry plants favour the presence of a minimum layer of humus and therefore the formation of micro-pseudo-steppe also in the presence of total cover. The nuraghes are also a refuge for bats and other small mammals and are also often nesting sites for various bird species that release organic material on both the walls and cover.

The flora found in the individual nuraghes, differentiated where possible into the three ecologically significant parts, has been included, as well as in individual tables, in a summary table that highlights the different components of the life-forms that are considered particularly significant to explain their presence. The surveys were carried out in the period from April to June 2018 on 21 nuraghes and represent a first contribution to the research, which is intended to extend to a statistically more significant sample among the approximately 7,000 monuments surveyed.

Results

a - The phytoponomymy of the nuraghes.

The analysis of the toponyms related to the nuraghes, obtained from the information system of the Sardinia Region (www.sardegnageoportale.it), is reported in the Electronic

Supplementary File 1 (ESF1), which highlights the phytototoponyms related to lichens (*Nuraghe Arrubiu/Orrubiu/Rubiu/Ruiu*) for the abundance of *Xanthoria parietina,* which gives a typical yellow-reddish colour to the monument (of which 31 phytotoponyms are recorded here), and vascular plants.

Among the 384 phytoponyms of the nuraghes, taken from *I nomi di Luogo della Sardegna* (Paulis 1987) and from the official website of Sardinia www.GeoportaleSardegna.it, as many as 79 of them refer to different vascular species taking into account their variants in local dialects (*Nuraghe, Naracu, Nurache, Nuracheddu, Nuraxi, Nuraci, Nuragi, Nurasci, Nurachi, Nuraghi, Nuraxeu, Nurechi, Runache, Nurasci, Nurazze*). The most represented woody species are *Ficus carica* (25), *Quercus ilex* (17), *Pyrus communis* (15), *Olea sylvestris* (14), *Olea europaea* (7), *Arundo donax* (12), *Ruscus aculeatus* (12), *Myrtus communis* (11), *Prunus domestica* (11), *Quercus suber* (11), *Ferula communis* (9), *Malus domestica* (9), and *Ulmus minor* (9); while among the herbaceous species, *Typha latifolia, Asphodelus microcarpus,* and *Holschoensu australis* appear 3 times each, followed by all the others with 1 or 2 mentions each. As many as 30 nuraghe toponyms (*Nur. Arrubiu/Orrubiu//Rubiu/Ruiu*) refer to *Xanthoria parietina/ocroleuca* because of the prevailing reddish colour which it typically gives to basaltic rock (Camarda 1992). In relation to life-forms, the most represented categories are phanerophytes, hemicryptophytes and lichens.

These plants, besides giving the name to the toponym, were also present in the nuraghes under investigation, with some exceptions. Indeed, it is likely that *Nuraghe Uda* = Nuraghe of *Typha latifolia* indicates in this case the proximity and not the existence of the plant on the nuraghe, while other names (Piras, Chessa, Ligios) may also refer to anthroponyms. All 79 species were found in various nuraghes, regardless of the 21 species specifically surveyed. The most represented life-forms are phanerophytes in the scapose (*Quercus ilex, Olea sylvestris, Sambucus nigra*), cespitose (*Anagyris foetida*), and lianose (*Clematis cirrhosa, Hedera helix*) sub-forms, camephytes (*Helichrysum microphyllum*), bulbous and rhizomatous geophytes (in particular *Ruscus aculeatus*), and scapose hemicryptophytes (*Foeniculum vulgare* and *Ferula communis*). Therophytes (*Vicia villosa*) are quite rare. In addition to the species, the phytoponyms often indicate a type of vegetation: *Sinibridaxiu* (juniper), *Cannedu* (reed-bed), *Feruledu* (*Feruletum*), *Arridelaxiu* (*Phillyretum*), *Lavredu* (*Lauretum*), *Luargiu* (*Euphorbietum*), *Iscopalzu* (*Ericetum*) *Eligosu* (*Quercetum ilicis*), *Ortigosu* (*Quercetum suberis*), *Zippiriu* (*Rosmarinetum*) and so on.

b - The flora of the nuraghes

ESF2 and ESF3 illustrate the surveys that take into account the three fundamental microhabitats that can originate on the nuraghes, while ESF4 shows the overall list of flora found on the 20 nuraghes studied. The number of species per nuraghe varies from 20 to 52 species taking into account the different microhabitats (tower wall, rampart and cover), but in many cases, it is necessary to bear in mind, in addition to the period of the survey, also the difficulty to access the monuments for an exhaustive survey.

There is a total of 220 species, in alphabetical order and with their life-forms, in ESF4. The table shows a clear prevalence of terophytes, followed by hemicryptophytes and geophytes, while the number of camephytes and phanerophytes is more limited. The most represented species among the terophytes are *Avena barbata* (20), *Andryala integrifolia* (16),

Fumaria capreolata (16), *Sedum coeruleum* and *Hordeum leporinum* (15), (*Raphanus raphanistrum* (14), *Sonchus tenerrimus* (13), *Vulpia myuros* (11), *Lamarckia aurea* (10), *Silene gallica* (10), *Hypochoeris achyrophorus* (9), *Vicia disperma* (9) *Bromus madritensis* (9), and *Sedum album* (8). Small therophytes that flourish in winter, such as *Arabis verna*, *Anagramma leptophylla*, *Erophila verna*, *Teessdalia coronopifolia*, and *Hornungia petraea*, which are mineralised in a short time in warmer areas, are probably underestimated. Among the hemicryptophytes, there is a prevalence of *Poa bulbosa* var. *vivipara* (8), *Scrophularia trifoliata* (7), *Ferula communis* (7), and *Parietaria giudaica* (7). The most represented geophytes are *Umbilicus rupestris* (20), *Silene vulgaris* (10), *Allium ampeloprasum* (8), *Convolvolvolus arvensis* (5) and among the ferns *A, Polypodium australe* (15) and *Asplenium obovatum* (7) and *Asplenium ceterach* (3) on limestone. The most common camephytes are *Helichrysum microphyllum*, *Phagnalon saxatile*, *Stachys glutinosa*, and *Teucrium marum*. The presence of phanerophytes is almost constant. *Quercus ilex* (6) is sporadic on the walls of the towers, but can give life to real wooded formations oon the most degraded monuments, especially when they are accompanied by the ruins of ancient villages (Nuraghe sa Ghispa), or on the covers as in the case of the Nuraghe Erismanzanu; *Quercus pubescens/congesta* and *Hedera helix* are present in 3 cases, while *Rubus ulmifolius* (2) is more common. The endemic component, both upland and rupestral (*Arrhenatherum sardoum*, *Scrophularia trifoliata*, *Herniaria litardieriì*, *Ptilostemon casabonae*, *Santolina insularis*, *Sesleria barbaricina*, *Stachys glutinosa*, *Thymus catharinae*), is significant as well, including the nitrophile *Urtica atrovirens* and *Arum pictum*, whilst the exotic component is almost negligible, with the exception of the *Opuntia ficus-indica*, which may colonise the ramparts and covers entirely.

The list of species is probably incomplete, both because of the limited number of surveys, and because of the period (as demonstrated by the analysis of phytototoponyms that highlights rare species such as the *Euonymus europaeus*). However, this first contribution already shows the importance of the nuraghes for the presence of about 10% of the native flora of Sardinia. Moreover, these monuments are an important field of analysis of the phenomena of colonization of extreme environmental contexts in microclimatic and pedological terms, representing the succession that, from the initial stages of evolutionary processes, leads to the formation of grasslands and forest vegetation with most of the elements of the maquis and all the species constituting the island's forests.

Spontaneous flora also plays a role in containing the monument's state of ruin. In fact, the roots of the plants often penetrate between the stone blocks and help to maintain a balance that the weather conditions would tend to alter. The presence of a grove of holm oaks, certainly more than a hundred years old, on the cover of the nuraghe Erismanzanu does not seem to threaten its stability. There is no doubt that their degradation is often accelerated when the excavations reveal the precarious structures of the monument by removing the roots that constitute a sort of protective adhesive that secures stability. Other times, the elimination of the herbaceous cover and soil layer formed on the roof of the main tower in the Abbasanta nuraghe has favoured the penetration of rainwater into the main chamber. Finally, it should be noted that the elimination of lichens and herbaceous plants colonising the recesses of these imposing and rustic monuments does not cause any damage to them, while on the contrary it helps to remove a natural element lasting thousands of years and that at the same time gives the local landscape its unique charm.

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