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The Intermittent History of Exploitation of Terrestrial Biotic Resources on the Small Islands of the Western Mediterranean Basin

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Abstract
We provide a synthesis of the history and the extent of human impact on the terrestrial ecosystems of the small islands and islets of the western Mediterranean. We focus on the exploitation of islands smaller than a few thousand hectares. The use of microinsular biotic resources (e.g., timber, soda ash, wild mammals) began as early as the Upper Palaeolithic, intensified during the Neolithic, and expanded during the Iron Age, peaking around the end of the nineteenth to the mid-twentieth century. As a consequence of long-lasting land exploitation, in many cases local terrestrial ecosystems were severely damaged and some of their living components disappeared. In other cases, even with uninterrupted human occupation over millennia, several insular resources have been sustainably managed. Although these small islands are currently under less pressure compared with neighbouring mainland coastlines, their protection or even the restoration is unquestionably necessary.

Keywords Biological homogenisation · Cultural landscapes · Environmental collapse · Historical ecology · Insular ecology · Species introduction · Western Mediterranean islands

Introduction

Privileged (is)lands

Isolated uninhabited islands posed great challenges to colonizing human groups, requiring a set of distinct adaptations and innovations (Napolitano et al., 2021) that generated deep changes in the structure and the composition of their fragile ecosystems. The Mediterranean Sea has around 11,100 islands and islets (< 1 ha) (Médail, 2022), mainly located off Greece (c. 7,580) and along the coast of Croatia (c. 1,250), but some 1,500 islands and islets are in the western part of the basin (Fig. 1).

There is evidence of one-off or long-term exploitation of local natural resources on even the tiniest islets, some less than a few hundred hectares wide, that may date back 1000 years. Occasionally, human occupation created links with the islands' biodiversity that resulted in so-called 'cultural' landscapes (Blondel, 2006). In many other cases, however, human exploitation caused irreversible environmental degradation, and several small islands were drastically transformed within an extremely short time with the loss of many plants, animals, and habitats. Although most of the ecological studies conducted to date have focused on large or medium-sized islands, smaller ones encompass a wide range of environmental and biogeographical features, representing formidable 'experimental laboratories' to test the putative consequences of global environmental changes in the face of several anthropogenic and natural drivers (Médail, 2017).

Most archaeological research has focused on the largest islands (Napolitano et al., 2021; Rick et al., 2013), but several recent studies suggest that "ancient peoples regularly and readily occupied and/or accessed many smaller islands for both terrestrial and marine resources" (Fitzpatrick et al., 2016). Here we address islands of less than a few thousand

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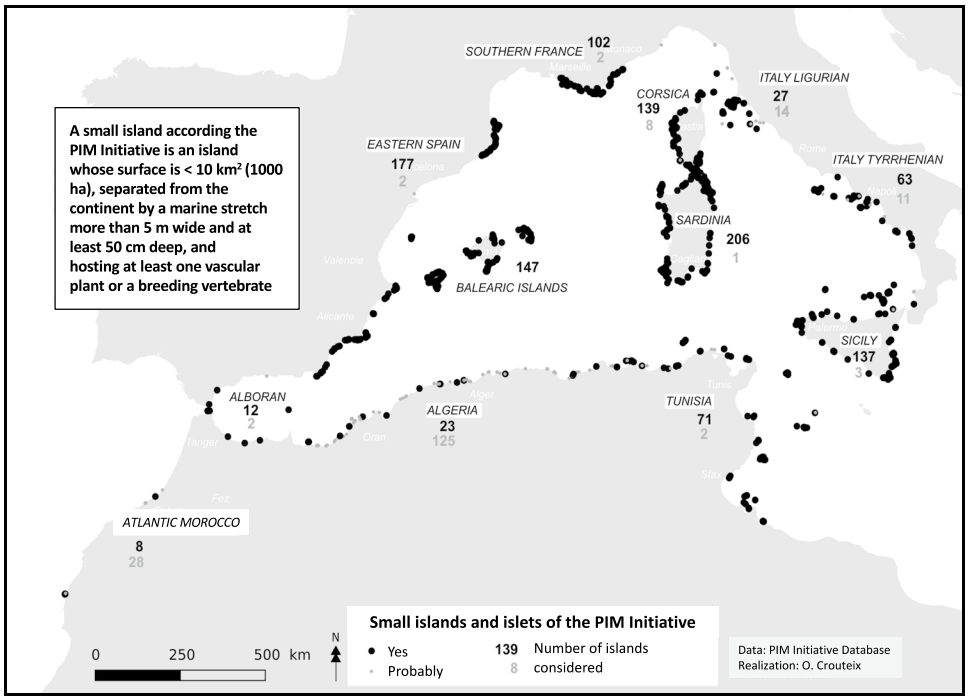

Fig. 1 The global location of the small islands and islets of the western part of the Mediterranean Basin as defined by the NGO PIM Initiative (from Marin, 2021, *modified*)

hectares (with the exception of a few medium-sized islands, e.g., Pantelleria, Elba, Asinara, Djerba, and Formentera).

There is an increasing awareness of the importance of historical ecology in enabling a better understanding of the processes leading to current microinsular ecosystems and landscapes (Braje et al., 2017; Médail, 2021). Some of the examples we discuss were taken from a recent synthesis (Marin, 2021; Mayol, 2020) targeted by the Initiative for Small Mediterranean Islands (PIM Initiative) (http://initiative-pim.org) (Fig. 1). We provide a diachronic overview of human exploitation of animal or plant terrestrial resources in the small islands of the western Mediterranean Basin from the Palaeolithic to modern times (1950s).

Changing Sea Level and Shifting Geography

Many small-sized Mediterranean islets have 'disappeared' or 'appeared' even during the last millennia due to various geological processes and gradual sea-level changes (Benjamin et al., 2017; Kopaka & Kossyva, 1999; Vacchi et al., 2018). Our lack of knowledge probably leads us to underestimate the effects on these microinsular landscapes of coastal dynamics and of the presence of humans since their early colonizations. Some small islands are gradually sinking due to bradyseismic processes, and were still connected to the mainland when they were first described and occupied by ancient colonizers (e.g., Ognina in SE-Sicily) or until very recently (e.g., Capo Passero and Rocca di San Nicola in Sicily). Erosion caused by waves and storms can cause small islands to shrink and even disappear in a very short time (e.g., Lisca Nera in the Aeolian archipelago, Isola dei Porri in S-Sicily).

Some islets have exceptionally spectacular and short lives. For instance, the ashes of the volcanic islet Ferdinandea were wiped out by winter storms just a few months after it emerged from the shallow waters of the Strait of Sicily (Coltelli et al., 2016). Some islets are created on purpose: Isola delle Palme, now the city centre of Augusta, was permanently separated from SE-Sicily for military reasons, while the small islet of Zavorra (=ballast) gradually formed from the eighteenth century due to the accumulation of sand and gravel discarded by ships during their manoeuvres in the port of Trapani. Some other islets connect to the mainland as a consequence of natural processes (e.g., Vulcanello in the Aeolian archipelago, Isola Bella in NE-Sicily, Magnisi-Thapsos in SE-Sicily) or anthropogenic interventions: several small islets now forming Isola Lunga near Marsala were connected through saltpans during the seventeenth century, and the same happened to Isola Calcara near Trapani, still separated from the W-Sicilian coast in the 1820s. Many islets are now incorporated in the harbours and piers near maritime cities, for example, near L'île Rousse in Corsica and Monastir in Tunisia.

What Makes a Small Island Attractive to Humans? From the First Seafarers to the Neolithic Agropastoral Revolution

Basic environmental and geographic traits played a key role in the history and intensity of human impact on islands.

Accordingly, several factors influenced the first settlers' choices: 1) key 'ecological filters', including water, food, and wood availability: islands with fresh water, woodlands and shallow marine waters were best suited to sustain stable human colonies; 2) distance from the mainland: isolated islands are harder to discover and more difficult to defend; 3) the coastline shape: bays and inlets well protected from gales and storms are ideal harbors; 4) the surface and altitude: larger and higher islands host a larger number of habitats for plant and animals, crops are better sheltered from salt spray and, since the Neolithic, humans had more places suitable to build villages or to escape in case of a sudden attack by enemies; 5) the slope: the steeper the islands, the easier they are to defend, but provide less area for settlement and agriculture during the Neolithic; and 6) the frequency and intensity of natural disasters: active volcanic islands have been venerated as sacred and frequently visited since protohistoric times (e.g., some satellite islets off Panarea in the Aeolian archipelago).

The early colonization of western Mediterranean islands lacks clearly identifiable traces (Alcover, 2008; D'Anna et al., 2021). The largest islands (Sicily, Corsica, and Sardinia), which had already been visited by humans in the upper Palaeolithic and Mesolithic, were the first to be colonized (D'Anna et al., 2021; Pasta et al., 2022). However, as far as we know no small islands in the western and central Mediterranean were colonized before the Mesolithic (Speciale, *pers. comm.*), and microinsular settlements became stable only during the early Neolithic. The Neolithic revolution had a significant impact on the microinsular biota (Leppard, 2017) due to irreversible changes in local soil characteristics, biotic homogenization triggered by deforestation, and plant and animal introduction and breeding (e.g., Poher et al., 2017; Speciale et al., 2021).

Plant Resources

Wood and Forest Resources

The recurrent exploitation of woody resources for several purposes and forest clearing for the cultivation of agricultural crops have strongly modified the composition of vegetation and the structure of landscape in many large Mediterranean islands, such as Mallorca (Burjachs et al., 2017) and Malta (Djamali et al., 2013). However, few palaeoecological or historical data are available to estimate the extent of anthropogenic disturbance on smaller islands (e.g., Poher et al., 2017 for Cavallo, S Corsica; Poggiali et al., 2012 for Favignana, W Sicily).

The nature and the history of disturbance may have had very different effects on microinsular vegetation. Islands affected only by occasional wood harvesting or partial cutting of the forest cover certainly had greater chance for recovery, especially in light of the robust resprouting capacity of most Mediterranean woody species and perennial grasses adapted to cutting, fire and grazing (Quézel & Médail, 2003). In these cases, the physiognomy of recovered forests may resemble the primary forests even though some species may have disappeared. On the other hand, on islands where there has been systematic and extensive destruction of shrub and forest communities to make way for agricultural crops, the definitive disappearance of a large percentage of woody species severely compromised both the speed and the final stage of succession processes (e.g., Pasta & La Mantia, 2003).

In several cases, the first impacts on the biodiversity of small Mediterrean island took place during the Neolithic. On Cavallo Island (Lavezzi archipelago, Corsica), analyses of pollens and fossil arthropod remains indicate that *Erica arborea* dominated local woodlands between 7000 to 6100 cal. yr B.P., while around 4700 cal. yr B.P. the opening of landscapes through burning and agropastoralism favoured the development of grass-dominated pastures (Poher et al., 2017). On the eastern Tunisian islands, the presence of ancient woody remnants of juniper (*Juniperus phoenicea* subsp. *turbinata*) and lentisc (*Pistacia lentiscus*) from a site in Djerba dated to 4200–4300 cal. yr B.P. (Damblon & Vanden Berghen, 1993) suggests the prior existence of sclerophyllous *matorral* or open presteppic forest, with the possible presence of native Aleppo pine (*Pinus halepensis*) and olive tree (*Olea europaea*) on some of the largest islands now completely deforested (Médail, 2017).

Bronze Age data from the Aeolian Islands suggest that woody resources were already scarce during the III-II millennium BCE (Speciale, 2021). After the destruction of local forest stands, mostly dominated by conifers and evergreen and semideciduous oak trees, islanders confronted with a timber wood shortage started to focus on smaller woody species. The names *Erikousa* (=dominated by *Erica arborea*) and *Phoinikousa* (=covered with dwarf palm, *Chamaerops humilis*), used by Helladic settlers of Filicudi and Alicudi, respectively (Lo Cascio & Pasta, 2000), suggest that these islands lost their forest cover earlier than others and were already dominated by these shrubs and small trees. Several other shrubs were regularly used for fuelwood for heat or cooking, such as *Genista tyrrhena* or *Cytisus aeolicus*, a tall broom now extinct in Lipari and almost vanished from Alicudi and Vulcano over the last two centuries (Zaia et al., 2020). Deforestation rates probably reached a peak during the first millennium BCE, when the straight trunks of fir and pine trees were favoured for ship building. Based on some historical Roman texts we can assume that a large proportion of these conifers was destroyed before and during the Punic Wars (fourth-third centuries BCE) with the surviving forests experiencing a definitive collapse before

and during Arab dominion (seventh-eleventh centuries CE), and then during the eleventh-fourteenth centuries CE due to the growing demand for timber to maintain the fleets of the powerful maritime cities of the NW Mediterranean. Even allowing for local variations, all the W-Mediterranean small islands shared a similar history. As a result, it is likely that their forest cover was already destroyed or greatly reduced between the fourteenth and sixteenth centuries.

Very few data are available on small islands' land use and forest exploitation until the beginning of the eighteenth century. Analyses of charcoal fragments found in the soils of Lampedusa (Giraudi, 2004) indicate two major burning events impacting local vegetation: one around 1530–1690 CE, when the deserted island must have been occasionally visited by charcoal burners, and one in the early nineteenth century. After being recolonized during the second half of the seventeenth century, the Egadi islands experienced very rapid deforestation due to clearing for fruit orchards and olive groves. Similarly, at the end of the eighteenth century, detailed maps and reports of agronomists and forestry agents document the overexploitation of Ustica (Speciale et al., 2021) and Levanzo, where as many as 96,000 vines were planted after clearing the vast Fossa plain, whose remnant shrubs were used as fuelwood for the towns of Marsala and Trapani (Smyth, 1824). Lampedusa and Linosa suffered a similar fate in the mid-nineteenth century, when their wood and charcoal were exported to the mainland of North Africa (Pasta & La Mantia, 2003).

Place names, legal documents, travelogues, and reports of early botanic explorations further testify to the shrinkage and local extinctions of many woody species (especially lauriphylls, such as *Arbutus unedo*, *Phillyrea latifolia* and *Rhamnus alaternus*) during the last two centuries. The final blow to the woody component occurred during the Second World War. In eastern Tunisia in the 1950s there were still about 20 lime kilns on the Kerkennah archipelago, and their imposing size (4m high and 3m in diameter) reflects the enormous amount of wood (probably imported) needed to produce eight tonnes of lime weekly (Louis, 1961). Charcoal production in the Balearic Islands lasted for centuries on the islands of Es Vedrà and Cabrera, while the 'cooking' of limestone to make lime or plaster on Cabrera put further pressure on local fuelwood resources (Mayol, *pers. comm.*).

Small Island Agriculture: A Culture of Extremes

At certain times, small island agriculture was a key element in the subsistence of local island populations and those on the nearby mainland, provided that the islands had a relatively favourable geomorphology and some fertile land. The agricultural imprint on the landscape of Formentera is clearly underlined by its name, stemming from the Latin term *frumentarium* (= wheat crop field, granary). The subsistence livelihoods of the Massaliotes (the Helladic settlers of Marseille), who founded a village in Porquerolles (Provence) at the end of the second century BCE, relied on fishing and agriculture; the discovery of a cereal threshing floor, millstones, and cultivation terraces above this village shows that the inhabitants cultivated cereals, olive, and almond trees (Chabal, 1991). Until the 1950s and 1960s, some of the largest satellite islands of the Kerkennah archipelago (Gremdi and Sefnou) and Djerba (Gataia el Gueblia) hosted many terraced fields regularly cultivated, mainly with barley. In the Balearic Islands, some of the small islands, such as Colom and Sargantana (Menorca), Dragonera and Cabrera (Mallorca), Espalmador and Tagomago (Ibiza) were also cultivated (Mayol, 2020). Even some tiny circum-Sicilian islets, such as Lachea (eastern coast), Lisca Bianca and Basiluzzo (Aeolian Islands), and Isola dei Conigli near Lampedusa were cultivated up to the nineteenth-twentieth centuries, and some of them are still cultivated today, such as San Pantaleo and Santa Maria near Marsala. The mineral-rich and fertile soils of volcanic islands were probably been considered a valued resource by early farmers. Not surprisingly, many circum-Sicilian volcanic islands (Linosa, Ustica, and the Aeolian islands) were inhabited by farmers who have shaped and cultivated large portions of them since prehistoric times (Martinelli et al., 2021; Speciale et al., 2021).

Cereal crops, olive, grapes for wine and raisins, capers, lentils, and fruits were the most valued by small islands' farmers and plant breeders so that over millennia many ancient varieties have been preserved and many new - mostly stress-tolerant – ones have been selected for. Wheat (*Triticum aestivum* and *T. turgidum*) and barley (*Hordeum vulgare*) were the most common cereal crops cultivated on these islands (Hammer & Laghetti, 2007). Rye (*Secale cereale*) played a key role on many volcanic islands until the twentieth century, as testified by the large number of fairy tales and superstitions stemming from the regular, unconscious consumption of the hallucinogens produced by its parasitic fungus, *Claviceps purpurea*, on the island of Alicudi (Maffei, 2002).

Macroremains from microinsular archaeological sites confirm the introduction - or at least the spread - of several trees of agronomic interest by the Greeks and Phoenicians. For example, olive (*Olea europaea*) was already cultivated for fruit consumption on Ustica by 2000 BCE or even earlier (Speciale et al., 2021) and on Motya Island around the sixth century BCE. As far as we know, this W-Sicilian islet is also home to the first documented case of cultivation of the pomegranate (*Punica granatum*) and the stone pine (*Pinus pinea*) in the whole western Mediterranean area (Moricca et al., 2021).

Vineyards represented the cornerstone of the rural economy of many small islands. Tree-habit grapevines were a special case; they were grown in hollows dug into the soil

to reduce moisture loss on the small islands on both sides of the Strait of Sicily. Caper cultivation continues to play an important role in some southern islands, such as the Sicilian islands of Pantelleria and Salina, as well as in Linosa and Ustica (Barbera et al., 1991). Until the end of the nineteenth century, caper cultivation on the island of Zembra (N-Tunisia) represented a significant percentage of the entire Tunisian production. Perceived elsewhere as just an 'iconic foreigner' turned invasive, the prickly pear (*Opuntia ficus-indica)* has long played an unexpected key role in microinsular agroecosystems, enabling local farmers to perform sustainable farming under severe climatic constraints. For instance, during the last two centuries, this cactus has been planted in rows to protect vegetable gardens from wind, its cladodes used to supply water to summer-growing vegetables by capturing overnight dew accumulation (La Mantia, *pers. comm.*). On the island of Linosa, prickly pears were even more important, as they represented the main (if not the only) source of water and fodder for local domestic herbivores (La Mantia, *pers. comm.*). Some more specific crops were cultivated; for example, most of the seven hectares of Bendor Island (Provence) were used to grow the eastern everlasting (*Helichrysum orientale*), a highly rentable activity at the end of the nineteenth century (Jahandiez et al., 1933).

Small Islands as 'Oases' of Plant Resources: Seasonal Grazing and Bee Farming

Many satellite islands and islets were favoured for livestock grazing or for isolating undesirable animals (goats). This grazing concerned goats, sheep, cows, donkeys, and even pigs (especially on islands hosting oak forests), rabbits in the Balearic Islands, and camels in eastern Tunisia (Louis, 1961). For example, the first written name given to Levanzo (Egadi, Sicily) suggests its exploitation as herb-rich pastureland. In fact, the ancient Greek *Phorbantia* seems to be related to the verb *phérbomai* (=to pasture, feed) which in turn has the same root as the term 'forb'.

The 'herbaiges and pasturgaiges' (grassland and pasture) of the archipelagos of Riou and Frioul in Marseille were marketed in 1589 to serve as pasture for small livestock (Rigaud, 2003). Winter grazing was often accompanied by regular burning of the scrublands by shepherds to trigger the resprouting of edible shoots, forbs, and grasses, as in the Cerbicale islands (Corsica). Such 'microinsular transhumance' often involved remarkable sea crossings. In southern Corsica, the herds were transported to the Lavezzi Islands from the small port of Piantarella near Bonifacio. Sheep were transferred on boats at a rate of about 30 per crossing, whilst cattle were herded to swim across the stretch of sea to the islands (Vigne, 1994). This practice was carried out in many other circum-Sardinian islands until the end of the twentieth century and explains several island zootoponyms, such as Isola del Toro, Isola della Vacca, Isola Cavallo, and Asinara. Sheep and goats were brought to Lisca Bianca and Bottaro among other circum-Sicilian islets in the nineteenth century (Lo Cascio & Pasta, 2020) and to Basiluzzo and Isola delle Femmine, near Palermo, until the 1990s (Caldarella et al., 2010).

For centuries, the Kerkennah islands boasted renowned grazing lands, as evidenced by the "withdrawal" of 15,000 sheep during an expedition of Christian corsairs in 1576 (Mahfoudh, 2000). The largest satellite islands (Gremdi, Roumadiya, Sefnou, Charmadia) have provided grazing not only for goats and sheep until the present day, but also for camels. Louis (1961) paid special attention to the transhumance of dromedaries, still ubiquitous and representing the main support for the local daily workers in the 1950s. As they required a large amount of grazing land and grass was scarce on greater Kerkennah, all the domestic herbivores, especially dromedaries, were frequently transferred to the small islands, especially during the summer, when these large animals were less needed for agricultural work and transport (Louis, 1961). Nowadays, sheep and goats are taken there by small boats.

Beekeeping was widely practiced throughout the Eastern Mediterranean islands (Mavrofridis, 2018). Over the last two millennia, some central and Western-Mediterranean islands have become famous for the high quality and quantity of honey they produced. While the relation between the ancient island names of both Malta and Mljet (Croatia) and the Latin name *Melita* (=honey sweet) is still disputed, many island areas (for instance Maltese and Egadi archipelagos) strongly influenced by the Helladic and Phoenician cultures were unquestionably renowned for honey production until a few centuries ago (Hatjina et al., 2017). In the nineteenth century, the inhabitants of Panarea (Aeolian archipelago) used to set up their "rudimentary but profitable hives" in the natural cavities on Dattilo rock offshore (Smyth, 1824).

The Peak and Decline of Soda Production

Until industrial synthesis methods were developed, the main source of potash (K_2CO_3) and soda (Na_2CO_3), salts needed to produce glass and soaps, were the ashes obtained by burning several salt-tolerant shrubs and annual herbs growing in the coastal saltmarshes. Interestingly, the term alkaline comes from al-Kali (=*Salsola kali*), while soda probably derives from *sawdā* (=dark, referring to the colour of the ashes) and gave origin to *Salsola soda* and to the genus name *Suaeda*.

Most of the ashes produced in central and southern Mediterranean countries were sent to Marseille, Genoa, and Leghorn in the N-Tyrrhenian and Venice and Trieste in the N-Adriatic. Ninety-eight percent of the soda ash unloaded

in the harbours of Marseille came from Sicily (Bardiot, 2009). 'Barilla' (=*Salsola kali*) was also produced in Salina, Vulcano, and Panarea (Smyth, 1824), while the high yield and the prized quality of the soda ash of Ustica became the driver of the local economy until its sudden collapse around 1790s (Giacino, 2012). Even Lachea, the biggest of the Cyclopes Islands (E-Sicily), produced some soda ash from *Mesembryanthemum crystallinum* (Brocchi, 1820) and from *Salsola kali* a few years later (Smyth, 1824). At the beginning of the nineteenth century, some islands in Provence (Porquerolles, Port-Cros, Les Embiez) were chosen as locations for soda factories, which had become far too polluting for the Marseille region (Daumalin *in* Marin, 2021), leading to profound changes in the forest cover of these islands (Médail et al., 2013). On the Kerkennah islands, several "Salsolaceae" (probably *Suaeda* spp. and *Salsola* spp.) were collected by residents to make soda and produce traditional soap (Doûmet-Adanson, 1888). The name Coucha (=oven), also given to Roumadiya Island, is said to have originated from this activity, gradually declining by the end of the nineteenth century, when people of Linosa still produced soda from *Mesembryanthemum crystallinum* and exported it to Pantelleria (Solla, 1885).

Orchil, a Paradigmatic Case of Unsustainable Trade

'Orchil' is the name given to several lichen species belonging to the genus *Roccella*, such as *R. tinctoria* DC., *R. phycopsis* Ach., and *R. fuciformis* DC., which look like filamentous, pale grey-green tufts usually found on shady cliffs or dry-stone walls near the coast. Called *orseille* in southern France, *orcina* or *urxella* in the Balearic Islands, and *oricello* in Italy, it was highly prized from the Middle Ages, especially between the fifteenth and seventeenth centuries (Harsch, 2020) as a raw material to obtain dyes of various shades of purple, red and pink, as well as one of the ingredients needed to obtain browns and lavender greys. It has also been used as food coloring and for its healing properties.

The trade and exploitation of orchil enriched one of the wealthiest merchant corporations of Florence, the *Oricellai* or *Rucellai* (Lefranc, 1874). Merchants from Genoa, Barcelona, and Valencia controlled the orchil trade in the Balearic Islands, while Pisa bought it from Provence (Giagnacovo, 2014). In the early fifteenth century, its harvesting on the island of Sa Dragonera (Mallorca) was regulated through annual permits granted from January to Easter by the Bishop of Barcelona, the lord of the island (Mayol, 2020). In the same period, Sicilians collected orchil on the Egadi archipelago (Maurici, 2001). *Roccella* was probably collected also on the Maltese archipelago, as suggested by the local vernacular name *ħażis ta żebgħa* still in use until the beginning of the twentieth century, whose memory and meaning (=moss-like organism used for dyeing) seems to have been lost forever (Fiorentino, 2015). Orchil was also collected in Elba and in Sardinia where it was given different names, such as 'petralana' (=wool-stone) or 'erba tramontana' (=herb of the North-facing cliffs).

Some stories show how voracious the trade of this precious resource was, and its collection, ruthless and highly competitive. An attempt at orchil trade was made by the inhabitants of the Maddalena archipelago (N-Sardinia) in the second half of 18th century (Sanna, 2011). Attracted by the excellent quality of the material received from this archipelago, a London firm asked for exclusive exploitation rights. During the following decades, orchil harvesting reached impressive rhythms: around 30 tonnes of Sardinian lichens were exported annually. The lichen cover of the rocks was stripped out, allowing these slow-growing lichens no time to regrow and, thus, depleting natural populations (Zedda, 1996). Some Sicilians still risked their lives to pick the last lichens until the beginning of the twentieth century, when this dangerous activity was still seen on Favignana (Romano, 2021).

Other Plant Resources

The use and direct consumption of island plants have been reported since ancient times, for instance in Greek literature: the famous *lotos* of the Odyssey, which sowed confusion in the minds of the companions of Ulysses when they tasted it on Djerba, very likely corresponds to the wild jujube, *Ziziphus lotus* (Bellakhdar, 2016). Nowadays, this shrub has completely disappeared from this Tunisian island.

Several edible wild plants that were particularly common on some small islands were harvested as food, for example, wild leeks (*Allium* spp.), chards (*Beta* spp.), cabbages (*Brassica* spp.), fennels (*Foeniculum* spp.) or sea fennels (*Crithmum maritimum*). Other plants were sought for artisanal purposes and their occurrence gave origin to several island and islet names. This was the case of the dwarf palm, whose fibrous leaves were collected until a few decades ago on several islands: Palmaria (Liguria), Palmaiola (Tuscan archipelago), and Palmarola (Pontine archipelago); and of many tussock grasses, such as *Stipa tenacissima* and *Lygeum spartum,* in the Balearic archipelago (de Arellano Tur *in* Marin, 2021). The silky pappus of the seeds of *Periploca angustifolia* was collected in Linosa (Strait of Sicily) to fill cushions, pillows, and matrasses (Calcara, 1852).

Certain plants acquired strong symbolic value for their properties. A germander endemic to Marseille's islands, *Teucrium polium* subsp. *purpurascens*, known as "island grass", was highly regarded in the local pharmacopoeia (Médail, 2021). The so-called Maltese mushroom (*Cynomorium coccineum*), a healing plant supposedly with magic powers, was jealously guarded on the islet Fungus Rock (near Gozo Island) by the Knights of the Order of Saint John of

Jerusalem, who had the monopoly of its harvest (Lo Cascio, 2020). Considered to be very effective against impotence and other sexual diseases, the astringent properties of this peculiar parasite were also well known to Sicilians (Cupani, 1696), who collected it on Favignana Island and on several tiny islets, such as Borea (now part of Isola Lunga in the Stagnone Lagoon) and Ronciglio (today incorporated into the port of Trapani), and used the powder obtained from its dried tissues against bleeding. In the south of Sardinia, it was also used on the island of Sant'Antioco to color wooden objects or, in the region of Cagliari, as a dark reddish brown fabric dye (Atzei, 2003).

Used to dealing with chronic resource shortage, small island dwellers developed in-depth knowledge of the potential uses of local plants, even the very localised endemic species (Carrió & Vallès, 2012). As a result, small Mediterranean islands are the only or the last places where the peculiar usages of specific plants have been documented on a regional or national scale. For instance, Smyth (1824) mentions a "small species of carob" (probably *Anagyris foetida*), whose tamarind-like pods were used by the people of Alicudi to prepare a decoction against kidney stones. Alicudi was also the last place where *Euphorbia lathyris*, the so-called caper spurge, was still cultivated for medicinal purposes a century after having disappeared from most of southern Italy (Pasta & Troia, 2019).

Animal Resources

Wild Animals

Since the Mesolithic, human hunters on small islands have contributed to the rapid extermination of endemic vertebrate fauna, especially large herbivores and ground-nesting birds (van der Geer et al., 2021; Wood et al., 2017). As a result of increasing human pressure, most fauna on small Mediterreanan islands has undergone significant extinctions and biotic homogenization (Masseti, 2009). For example, the Balearic mouse-goat *Myotragus balearicus*, which persisted until ca. 3650 yrs BCE on the small island of Cabrera (Bover & Alcover, 2003). In Corsica, bone remains dated to the Late Neolithic (ca. 4500 cal. yrs B.P.) identified as 'rabbit' - but most likely corresponding to the Corso-Sardinian rabbit-rat, *Prolagus sardus* - were discovered on Lavezzu Island (Vigne, 2004). On Gargalu Island (western Corsica), an archaeological survey revealed the presence of *Prolagus* and an endemic Corso-Sardinian field mouse, *Rhagamys orthodon*, both now extinct. These circum-Corsican islands may have represented the last refuges for these species, dwindling in the face of the increasing human pressure over the first millennium CE (Vigne et al., 1993).

The concentration of migratory birds on small islands has led to large-scale seasonal hunting for thousands of years. Many of these isolated lands still represent important stopovers for medium-sized passerine migrations (e.g., turtle dove, oriole, hoopoe), but also for gallinaceous birds (e.g., quails) and birds of prey (e.g., falcons). On the Pontine Islands, in Ventotene and Ponza, the Romans had even modified the environment of certain bays (still called 'cale coturnarie' in Italian) by levelling the rocks and cutting the vegetation to channel the flight direction of migrant birds and facilitate their capture (Baccetti, *pers. comm.*). Human pressure was lethal to many ground-nesting birds. The current name of Ortigia, the islet hosting the heart of ancient Syracuse, comes from *órtyx*, the Greek name of the common quail *Coturnix coturnix*, a trans-Saharan migratory species that used to be so abundant in Sicily between April and May that a spring hunting season was dedicated to it until recently (Massa, *pers. comm.*).

Seabird eggs (notably those of *Larus michahellis*) have long been collected by islanders who included them in their usual diet to make omelettes flavoured with the bulbs of the island wild leek (*Allium commutatum*). At the end of the nineteenth century, the ornithologist and hunter Lord Lilford reported the destruction of the Audouin's gull colony on the islet of Toro (Sardinia) as a result of this practice (Trevor-Battye, 1903). Until the 1970s, the inhabitants of Linosa held an annual 'competition' to collect huge numbers of Scopoli shearwater eggs, scoffing the people of Lampedusa who ate the meat of adult shearwaters and vice versa (Marcenò, *pers. comm.*). The fishermen of Ponza, in their vast area of influence encompassing Tunisia, France, used shearwater corpses to bait their lobster traps (Baccetti, *pers. comm.*).

A more selective use concerns the taking of birds of prey from the islands for falconry, a practice that was quite frequent because it was highly profitable. The sale of young peregrine falcons, *Falco peregrinus,* removed from nests in Montecristo (Tuscany) provided a regular income for the island's monks during the Middle Ages. On the islands of Marseille, falcons were the gift of choice offered by the city to kings and nobles; thus, one can imagine the impact of this practice known locally from the middle of the twelfth until the end of the seventeenth century (Richard, 2018). The peregrine falcons of the island Sa Dragonera near Mallorca were highly sought after throughout the Middle Ages and their exploitation was regulated by the barony of the bishops of Barcelona. In medieval times, even the circum-Sicilian islands were considered an important place for collecting birds of prey for hunting purposes (Bresc, 1980). The chicks of Eleonora's falcon, *Falco eleonorae,* were also taken on the island of Tagomago to the northeast of Ibiza (Mayol, *pers. comm.*).

The massive presence of doves (*Columba livia*) and turtle doves (*Streptopelia* spp.) on small islands near the mainland

has been recorded since ancient times, as evidenced by the zootoponyms referring to these species. This is the case of two islets facing the Trapani, i.e., Scoglio *Palumbo* and Isola *Colombaia*, already called *Peliades* (from the ancient Greek *péleia* = dove) by Diodorus in the first century BCE, and of Marzamemi (probably from the Arabic *mars al-hamāma* = port/harbour of the turtle doves) and its adjacent islets located near the southeastern shore of Sicily.

Since Roman times, several islands have also acted as natural enclosures for exotic game birds. For instance, under Medici rule, pheasants (*Phasianus colchicus*) were introduced on Gorgona Island (Tuscan archipelago) and the same happened around the end of the seventeenth century at the behest of King Louis XIV in Porquerolles and in the Lérins islands near Cannes (Gurney, 1901).

In the past, land snails have been actively harvested and even traded by island dwellers. For example, on the ancient Neolithic site of Zafrín in the Chafarinas Islands (NW Africa), several species of snails were eaten by prehistoric humans, notably the endemic North African Helicidae *Dupotetia arabica* (Gibaja et al., 2012; Rojo Guerra et al., 2010). As testified by Pliny the Elder, land snails from the Balearic Islands and Capri were brought to Rome and bred into 'snail parks' called *cochlearia*.

Some classical authors wrote about the astonishing number of snakes inhabiting the island of *Ophioússa* or *Colubraria* (= 'hosting snakes' in ancient Greek and Latin, respectively), corresponding to Illa Grossa, the main island of the Columbretes archipelago (Bernis, 1968). Phoenicians probably introduced snakes, even the poisonous ones, on the most remote islands. Later, they harvested them for use in naval warfare. The distribution of 'snake island' names (e.g., Serpentara near the SW coast of Sardinia) suggests that this 'special' breeding was probably quite widespread throughout the Mediterranean. Also, land tortoises (*Testudo* spp.) have likely been subject to repeated introductions on several small islands, perhaps brought there by N-African and/or East-Mediterranean hermits (De Grossi Mazzorin & Minniti, 2000) or sailors to be used as food reserves.

Biotic Homogenisation Induced by Feral or Wild Vertebrates

Since the Neolithic, several herbivores have been deliberately introduced and allowed to roam free on small islands to serve as a permanent 'meat reserve' for the inhabitants or passing sailors. The names of many of these islands reflect their previous importance as hunting reserves. After the Knights of St. John became the owners of the Maltese archipelago (1530), the Grand Master used Comino as his private hunting ground. At that time, this island, now totally devoid of woodlands, probably hosted plant communities that were dense enough to sustain wild boars and hares (Cassar, 2018).

Perfectly adapted to stand severe environmental stress, the rabbit (*Oryctolagus cuniculus*) and the feral goat (*Capra hircus*) have had particularly significant impacts on small island ecosystems due to their browsing and grazing activities. Rabbits were repeatedly introduced in many Mediterranean islands (Masseti & De Marinis, 2008) and numerous island names are related to their presence (e.g., Sa Conillera near Ibiza; Isola dei Conigli near Lampedusa; Conigliera in the Kuriate archipelago, E-Tunisia). On the Riou archipelago, hunting bans were enacted in the 1330s (Rigaud, 2003). Several islands, such as Sefnou (Kerkennah archipelago), were used for the breeding of rabbits. On the islands of Hyères, a charter of 1056 mentions "the tithe of island rabbits" on Porquerolles, and this right to hunt was confirmed in 1309 for the islands of Port-Cros and Levant; in the middle of the nineteenth century, a hunting lease still existed on the island of Bagaud, but it was left freely open to the inhabitants of the adjacent island of Port-Cros. Until the beginning of the twentieth century, a licence was given to the marquis of Modica to hunt rabbits on Isola dei Porri (SE-Sicily), whilst rabbits were repeatedly introduced after the Second World War on Isola delle Femmine near Palermo before being eradicated during the last decade.

The historical presence of feral goats during the Middle Ages has been reported for many islands, such as Pantelleria and Vulcano (Maurici, 2008). Between the eighteenth and nineteenth centuries, these animals became extinct on the islands of Tavolara, Lampedusa and La Galite (Masseti, 2009, 2016). There were some feral goats on the Aeolian islet of Basiluzzo until the mid-1990s (Pasta & Lo Cascio, *pers. obs.*), and there are still some on several small islands, such as Cabrera and Sa Dragonera in the Balearic Islands, Palmaria in Liguria, Montecristo in Tuscany, Stromboli, and Zembra in northern Tunisia. Local adaptation over generations has led these introduced goats to become morphologically close to the phenotype of the ancestral East Mediterranean goat (*Capra aegagrus*) or even to be treated as distinct subspecies, such as *Capra aegagrus dorcas* in Mallorca and *Capra aegagrus pictus* in Montecristo. Consequently, a growing number of people, including the hunters of Mallorca (Seguí Campaner et al., 2014), are now fighting to conserve these supposedly 'ancient' goat breeds and oppose eradications recommended by most island biologists and botanists (Capó et al., 2022).

The early introduction of pigs in Sardinia and Corsica led some scientists to consider local populations as a separate subspecies, *Sus scrofa meridionalis* (Masseti, 2007). Small populations of wild boars have been able to deal with limited resources and survive for decades even on some small islands like Spargi in Sardinia. The occasional presence of wild boars is also reported on a Provençal island: "The first island is commonly called Porqueyroles or Porqueroles because there are a lot of wild boars there,

who swim across from the mainland to eat the acorn of the holm oaks, which are found there in abundance" (*Encyclopédie* of Diderot and d'Alembert, 1751–1780). Even the introduction of *Ovis orientalis musimon* in Sardinia and Corsica dates back to very ancient times and, since their introduction in the 1970s, the Asiatic mouflon has been able to survive and multiply on several Italian islands. The mouflons of Zannone (Pontine archipelago) derive from repeated introductions of individuals from Sardinia (1920s), Turkey, and former Yugoslavia (1970s).

Red deer and gazelle hunting on island reserves has probably been a common feature throughout the Mediterranean Basin from the last two millennia until the seventeenth-eighteenth centuries (Albarella et al., 2021; Masseti, 2016). However, only few cases are known of islands with a surface of less than 25 km^2 that have sustained such practice over decades (e.g. Masseti & Zava, 2021).

Cows, hares, and sheep are the least stress-adapted herbivores, and their independent survival on small islands is unlikely as they need large, gently sloping or flat surfaces, grass- and herb-rich pastures, and permanent water availability. Undoubtedly, hares were introduced on Isola di Capo Passero under the Arab rule, when the island was called al Jazirat el-Arnab (=the island of hares) (Masseti, 2016). The large flock (more than 300 adults) of free-ranging sheep foraging across the steepest slopes of Alicudi since the 1990s suddenly vanished when local shepherds stopped providing them with freshwater (Lo Cascio, *pers. comm.*).

Conclusions

Our synthesis focuses on the role of human activities on the small western Mediterranean islands as part of a long-lasting process affecting entire ecosystems that probably started in the Upper Palaeolithic and was expanded during the Neolithic and through the last three millennia, with the development of agropastoral activities. During this extended span of time, these small- or medium-sized islands, especially those of the central Mediterranean, have experienced cycles of interaction and isolation with their nearby mainland since the Neolithic and played a key role as hubs of the Mediterranean exchange network in different periods (Copat et al., 2010; Dawson, 2014). Such uses have altered, sometimes irreversibly, these microinsular landscapes and their biodiversity. We highlight that human impact on small island ecosystems started very early and concurrently with the human colonization of other larger islands throughout the world (Rick et al., 2013). There are important issues of scale and island physical characteristics, however, that make human ecodynamics on islands variable through space and time.

Only very few small Mediterranean islands and islets represent unspoiled spots of "pristine wilderness". Rather, they are territories where original ecological dynamics are expressed, which can lead to metastable ecosystems under the main constraint of local environmental characteristics, provided that extrinsic pressures remain moderate. While many small islands and islets in the western Mediterranean were still under strong human pressure a few decades ago, most of these uses have now ceased. Indeed, many small inhospitable islands shelter the last shreds of undisturbed coastal ecosystems in the Mediterranean Basin, thus playing a very important role in nature conservation (Médail, 2017, 2022), especially considering the worrying situation of continental coasts at the global scale (Williams et al., 2022). We do not forget the uses and impacts of islanders on the abiotic and marine resources, which have been addressed elsewhere (Médail, 2021) and require further research.

Therefore, this multitude of small- and medium-sized islands deserves ambitious interdisciplinary historical ecological research, combining nature and culture to better understand and preserve these exceptional territories and their singular history. We are convinced that in-depth studies focused on microinsular landscape history will significantly improve the current management and conservation policies of such territories.

Although we focused on the Western Mediterranean islands, we hope our contribution will inspire future multidisciplinary research for the many Eastern Mediterranean islands, especially in the Aegean area, but also in the Adriatic Sea, aiming at filling the knowledge gaps among and within the archipelagos of this *Mare Nostrum*.

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