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Isola Rossa (Iscra Ruja) of Capo Comino (eastern Sardinia): botanical notes after a short visit in late spring

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ABSTRACT A list of the vascular plants growing on Isola Rossa di Comino (eastern Sardinia) is presented. This census derives from a survey carried out in June 2022 and also provides useful information to characterise the local vegetation, the habitats of Community interest according to EU Directive 92/43, as well as the main disturbance factors affecting the islet, on which no botanical data were currently available, and which is little known from a biological point of view. The populous colonies of the Mediterranean herring gull (*Larus michahellis*) and the tufted plover (*Phalacrocorax aristotelis*) significantly influence the current patterns of vascular flora and vegetation over large surfaces of the islet.

KEY WORDS: Disturbance factors; microinsular biota; plant biodiversiity; small island; vegetation.

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INTRODUCTION

In 16 June 2022, a workshop entitled "Sardinian Islands" was held in Siniscola (Province of Nuoro), organised by LEA Hydromantes and the CEAS Environmental Education Centre of Siniscola and promoted by the PIM (Petites Îles de la Méditérranée) Initiative and the MAVA Foundation. The event aimed to raise the awareness of local stakeholders on the need and usefulness of identifying economic development strategies that respect the biological-environmental peculiarities of the small circum-Sardinian islands. At the end of the workshop, together with M. Delaugerre, the author explored an islet from where no floristic-vegetational data were available so far. This is Isola Rossa (or Iscra Ruja). Located near Capo Comino at latitude 40°32'21" North and longitude 9°49'07" East, it falls within the territory of the municipality of Siniscola (Sheet 483, Section IV of the new IGMI cartography) and within the SCI (Site of Community Interest) ITB020012 "Berchida e Bidderosa".

Isola Rossa (Fig. 1) shows a very gently sloping profile and bears several small rocky outcrops, the highest being at 5 m a.s.l. The emerged surface of the islet is about 2.73 hectares; its coastal perimeter is rather sinuous and its overall outline appears strongly elongated, following a WSW–ENE axis, with a maximum length of about 510 m and a maximum width of about 100 m.

Isola Rossa is separated from Sardinia by an about 100 m-wide stretch of seawater (Fig. 2), whose bed is sandy and 100–150 cm deep in the 20–30 m close to Sardinia, becoming instead rocky-stony close to the islet, where the water depth drops down to just 30–40 cm. Based on the most recent and authoritative reconstructions of the sea level variation following the Last Glacial Maximum (Vacchi et al., 2021), it can therefore be assumed that the separation of the islet from Sardinia oc-

curred in extremely recent times. At low tide, the distance between Isola Rossa and Sardinia is significantly reduced and probably only exceeds 50 cm in depth for a short stretch, just a few tens of metres wide. This explains why until about 50–60 years ago, local shepherds used Isola Rossa for cattle grazing during the summer season (M. Sfacteria, *pers. comm*.). It should also be noted that for at least 5–6 consecutive years (around 2010) Isola Rossa was connected to Sardinia by a massive banquette of rotting leaves of seagrass, *Posidonia oceanica* (L.) Delile (N. Baccetti, *pers. comm*.).

As for the local climate, the average annual rainfall does not exceed 530 mm, while the average annual temperature is 16.8 °C (https://it.climate-data. org/europa/italia/sardegna/capo-comino), the average temperature being 25.1 °C in the hottest month (August) and 9.9 °C in the coldest month (February). The dry season lasts from May to September.

The Capo Comino area is of great geological and tectonic interest. Also known as the "Comino wedge" and bounded by a fault of regional importance, this coastal sector is in fact affected by intense restraining or transpressive processes: strong pressures perpendicular to the fault plane have deformed and compressed the area, which is characterised by outcrops of equigranular leucogranites (i.e., formed by granules of homogeneous size) dating back to the Upper Carboniferous-Permian, i.e., approximately 300–250 million years ago (Carmignani et al., 2012). Even Isola Rossa consists entirely of highly altered leucogranites. Along the northern coast of the islet, there are several small inlets, the result of the erosive action of the sea, which was more incisive in correspondence with a system of fractures orthogonal to the major axis of Iscra Ruja.

The herpetofauna of the islet has been investigated since the late 1970s, as testified by the sampling material collected by C. Corti and B. Lanza (April 1979, May 1981, C. Corti, *pers. comm*.) and by P. Malenotti, A. Ancori, G. Bittini and N. Bittini in May 2003 (Lotti et al., 2012). The consulted herpetological literature (Borri et al., 1988; Poggesi et al., 1996) reports the local presence of *Euleptes europaea* Gené, 1839, *Chalcides ocellatus* (Forsskål, 1775) and *Podarcis tiliguerta* Gmelin, 1789.

Being one of the potential breeding sites of the Corsican seagull (*Ichthyaetus audouinii* Payraudeau, 1826), Isola Rossa is probably the most regularly monitored satellite islet of Sardinia in terms of avifauna, having been surveyed annually since at least 1997 (N. Baccetti, *pers. comm*.). During the period in which Isola Rossa was linked to Sardinia, the Mediterranean herring gull *Larus michahellis* Naumann, 1840, the cattle egret *Bubulcus ibis* Linnaeus, 1758, the mallard (*Anas platyrhynchos* Linnaeus, 1758) and the shelduck (*Tadorna tadorna* Linnaeus 1758) had stopped nesting on the islet because it had become a destination for easy and frequent incursions by foxes (N. Baccetti, *pers. comm*.).

No scientific publication seems to refer to a first floristic exploration of the islet, carried out by C. Ricceri in the 1980s. These data, promptly communicated to B. Lanza and R.E.G. Pichi Sermolli, could have been included in a popular article written by the two scholars, which however could not be identified (C. Ricceri and C. Corti, *pers. comm*.). As for the adjacent Sardinian coast, an organic study of the local vascular flora is lacking to date, while the vegetation was surveyed between the 1980s and the late 1990s by Mayer (1995) and Arrigoni (1996). Further information on the vegetation and habitats of the coastal area facing the islet can be found in the doctoral thesis of Balducci (2012) and in the Management Plan of the aforementioned Natura 2000 site (Soriga et al., 2013).

MATERIAL AND METHODS

The visit to the Isola Rossa took place in the late afternoon of 16 June 2022. The time spent there was 70–80 minutes. The frequency of the plant species surveyed was assessed using the following semi-quantitative scale: cc = very common, c = common, lc = locally common, nc = uncommon, r = rare, rr = very rare.

Samples were collected only for plant taxa whose identity required further verification. In these cases, the classification was refined using the dichotomous keys proposed by Pignatti et al. (2017–2019). This latter source was also used to homogenise the nomenclatural treatment of the taxa mentioned in the list. In the following text, the families and life forms (Raunkiaer, 1934) of each listed plant taxon are reported, too.

Figure 1. View of Isola Rossa di Comino from the Sardinian coast (photo credit: L. La Fauci, 18 June 2022).

Figure 2. The stretch of sea separating Sardinia from Isola Rossa di Comino (photo credit: L. La Fauci, 16 June 2022).

The interpretation of the ecological significance and phytosociological interpretation of the observed plant communities was facilitated by consulting the European-scale synthesis work carried out by Mucina et al. (2016).

RESULTS

Vascular Flora

The list of vascular plants observed on Isola Rossa is presented below.

Allium cfr. *roseum* L. – rr – G bulb – Amaryllidaceae
Allium commutatum Guss. – cc – G bulb – Amaryllidaceae
Amaranthus blitum L. – nc – T scap – Amaranthaceae
Amaranthus graecizans L. – rr – T scap – Amaranthaceae
Anthemis maritima L. – lc – H caesp – Asteraceae
Asparagus acutifolius L. – lc – G rhiz – Asparagaceae
Asparagus albus L. – r – G rhiz – Asparagaceae
Asphodelus ramosus L. – G rhiz – Asphodelaceae
Atriplex patula L. – r – T scap – Amaranthaceae
Atriplex prostrata Boucher ex DC. – lc – T scap – Amaranthaceae
Avena cfr. *barbata* Link – c – T scap – Poaceae
Beta vulgaris L. subsp. *maritima* (L.) Arcang. – cc – H ros – Amaranthaceae
Brachypodium retusum (Pers.) P. Beauv. – lc – H caesp – Poaceae
Cakile maritima Scop. – lc – T scap – Brassicaceae
Galactites tomentosus Moench – c – H bienn – Asteraceae
Carlina corymbosa L. – nc – H scap – Asteraceae
Catapodium pauciflorum (Merino) Brullo, Giusso, Miniss. & Spamp. – r – T scap – Poaceae
Chenopodium album L. – lc – T caesp – Amaranthaceae
Chenopodiastrum murale (L.) S. Fuentes, Uotila & Borsch – lc – T caesp – Amaranthaceae
Cistus salviifolius L. – nc – Ch frut – Cistaceae
Crithmum maritimum L. – lc – Ch suffr – Apiaceae
Cynodon dactylon Pers. – lc – G rhiz – Poaceae
Cytisus laniger DC. [= *Calicotome villosa* (Poir.) Link] – lc – Ch frut – Fabaceae
Dactylis glomerata L. s.l. – lc – H caesp – Poaceae
Daucus carota L. s.l. – c – G rhiz – Apiaceae
Dysphania pumilio (R. Br.) Mosyakin & Clemants [= *Chenopodium pumilio* R. Br.] – rr – T scap – Amaranthaceae
Echium plantagineum L. – cc – H scap – Boraginaceae
Euphorbia segetalis L. var. *pinea* (L.) Lange – nc – H scap – Euphorbiaceae
Frankenia hirsuta L. – lc – Ch suffr – Frankeniaceae
Fumaria cfr. *parviflora* Lam. – r – T scap – Papaveraceae
Glaucium flavum Crantz – lc – T caesp – Papaveraceae
Glebionis segetum (L.) Fourr. – c – T scap – Asteraceae
Heliotropium europaeum L. – nc – T scap – Boraginaceae
Hordeum murinum L. – lc – T scap – Poaceae
Hypochoeris achyrophorus L. – rr – T ros – Asteraceae
Juniperus turbinata Guss. – rr – P caesp – Cupressaceae
Limbarda crithmoides (L.) Dumort – r – Ch suffr – Asteraceae
Lobularia maritima (L.) Desv. – rr – H scap – Brassicaceae
Lotus cytisoides L. – cc – Ch suffr – Fabaceae
Malva arborea (L.) Webb & Berthel. – lc – H bienn – Malvaceae
Malva parviflora L. – rr – T scap – Malvaceae
Matthiola tricuspidata R. Br. – lc – T scap – Brassicaceae
Orobanche cfr. *sanguinea* C. Presl – nc – T par – Orobanchaceae
Pancratium maritimum L. – rr – G bulb – Amaryllidaceae
Phillyrea angustifolia L. – c – P caesp – Oleaceae
Pistacia lentiscus L. – c – P caesp – Anacardiaceae
Plantago weldenii Rchb. – nc – H ros – Plantaginaceae
Portulaca oleracea L. – lc – T succ – Portulacaceae
Reichardia picroides (L.) Roth – c – H ros – Asteraceae
Salsola kali L. s.l. – rr – T scap – Amaranthaceae
Senecio leucanthemifolius Poir. s.l. – lc – T scap – Asteraceae
Senecio vulgaris L. – r – T scap – Asteraceae

Silene succulenta Forssk. subsp. *corsica* (DC.) Nyman – c – T ros – Caryophyllaceae
Smilax aspera L. – c – P lian – Smilacaceae
Solanum nigrum L. – nc – T scap – Solanaceae
Sonchus asper L. subp. *asper* – rr – T scap – Asteraceae
Sonchus tenerrimus L. – nc – T scap – Asteraceae
Spergularia marina (L.) Besser – lc – T scap – Caryophyllaceae
Sporobolus arenarius (Gouan) Duval–Jouve – cc – G rhiz – Poaceae
Thinopyrum junceum (L.) Á. Löve = *Elytrigia juncea* (L.) Nevski – cc – H caesp – Poaceae

The list of the vascular flora includes 60 taxa. The most represented plant families, namely Asteraceae (11 taxa), Amaranthaceae (9) and Poaceae (8) alone, account for almost half of the surveyed flora. In terms of the life form spectrum, annual plants (T) count 28 taxa, hemicryptophytes (H) 13, geophytes (G) 9, chamaephytes (Ch) 6 and phanerophytes (P) 4.

Vegetation features and habitats of Community interest

Several nuclei of low, dense and rather poor scrubland were observed, referable to the *Oleo-Ceratonion siliquae* alliance and mostly concentrated on the hilltops of the portion of the islet facing Sardinia. They are dominated by *Pistacia lentiscus*, *Cytisus laniger* and *Phillyrea angustifolia*; *Smilax aspera* and *Asparagus acutifolius* are common co-occurring species, too, while the presence of *Cistus salviifolius*, *Asparagus albus* and *Juniperus turbinata* (the latter represented by a single individual) is discontinuous or extremely sporadic.

The patches of low scrubland are often surrounded (or connected to each other) by fragments of perennial grassland dominated by *Brachypodium retusum*, where *Dactylis glomerata*, *Reichardia picroides* and *Carlina corymbosa* frequently co-occur. On the other hand, the annual swards typical of acidic substrates, referred to the class *Helianthemetea guttatae*, are completely absent, probably because of the high nutrient intake due to the presence of colonial seabirds and - perhaps - to the intense and prolonged predation of seeds and seedlings by black rats (*Rattus rattus* Linnaeus, 1758; M. Delaugerre, *pers. comm.*). As a result, these xerophytic communities are replaced by numerous nitrophilous and hypernitrophilous plant assemblages.

On the rocky coasts, the areas most exposed to wind and saltwater host very simplified and impoverished aspects of salt-tolerant lithophilous vegetation (*Crithmo-Staticion* alliance) characterised by *Lotus cytisoides*, *Crithmum maritimum* and, locally, *Limbarda crithmoides*. No species belonging to the genus *Limonium* were observed.

On the rocky ledges of the portion closest to Sardinia, where the supply of nutrients and trampling by seabirds appears less intense, small and very localised nuclei of open vegetation linked to inundated soils are observed, referable to the class *Saginetea maritimae*, dominated by *Frankenia hirsuta*, *Spergularia marina* and with the sporadic presence of *Plantago weldenii*.

As far as the psammophilous communities are concerned, *Sporobolus arenarius*, *Thynopyrum junceum* and *Silene succulenta* subsp. *corsica* are common throughout the islet, colonising the thin sandy soil resulting from the intense alteration of the granite. Perhaps due to the reduced thickness of the sandy ground, or to predation by the black rat, *Elytrigia juncea* is very small in size (max. 40–50 cm) almost everywhere and only rarely forms denser patches, which however never exceed 1.5 m in diameter.

Along the southern side of the islet, several few metres-wide stretches of sandy beach occur, but they are too small to give rise to true dune systems and, therefore, to host more mature psammophilous plant communities like those growing along the adjacent sand shores of the Sardinian coast (Arrigoni, 1996; Ginesu et al., 2010; Balduzzi, 2012). In the portion of Isola Rossa furthest from the main island, a formation dominated by *Glaucium flavum*, *Matthiola tricuspidata*, *Anthemis maritima*, *Beta vulgaris* subsp. *maritima*, *Atriplex prostrata* and *Cakile maritima* was recorded. This pioneer psammophilous community, referable to the class *Cakiletea maritimae*, is often intermixed with a nitrophilous community characterised by large hemicryptophytes and geophytes such as *Malva arborea*, *Daucus carota s.l.*, *Echium plantagineum* and *Allium commutatum*, which take advantage of the nutrient intake due to the seasonal presence of the seabird colonies.

In the microsites that are most ridged and/or shaded, numerous nuclei of nitrophilous and ruderal vegetation can be observed, dominated by annual summer-growing species, typical of the irrigated crops of the nearby coast (*Cynodon dactylon*, *Heliotropium europaeum*, *Amaranthus* spp., *Chenopodium* spp., *Solanum nigrum*, etc.), while in the sunnier and more ventilated areas, *Hordeum murinum*, *Glebionis segetum* and/or *Avena* cf. *barbata* prevail.

An attempt to correlate the observed vegetation units with the habitats identified by the EU Habitats Directive 92/43 is provided in Table 1.

DISCUSSION

Flora, Vegetation and Habitat

The survey was conducted at the end of the spring season. Since some herbaceous species with autumn and late winter life cycle may have been overseen during this census, further visits should be done to complete the floristic inventory of the islet. The available data show an unequivocal predominance of herbaceous species, a trend common to the small circum-Sardinian islands

Phytosociological classification of identified plant communities: class and alliance (in brackets)	**Corresponding official Habitat Code and Designation according to 92/43 Directive**	**"Quality" (integrity, representativeness, extent) of the habitats**
-	**1170** Reefs	low
Cakiletea maritimae (*Euphorbion peplidis*)	**1210** Annual vegetation of drift lines	medium
Crithmo-Staticetea (*Crithmo-Staticion*)	**1240** Vegetated sea cliffs of the Mediterranean coasts with endemic *Limonium* spp.	low
Saginetea maritimae (?)	**1310** *Salicornia* and other annuals colonizing mud and sand	low
Ammophiletea (*Ammophilion*)	**2110** Embryonic shifting dunes	low
Quercetea ilicis (*Oleo-Ceratonion siliquae*)	**5330** Thermo-mediterranean and pre-desert scrub	low
Lygeo sparti-Stipetea tenacissimae (*Reichardio maritimae-Dactylidion hispanicae*)	**6220** Pseudo-steppes with grasses and annuals of the *Thero-Brachypodietea*	low
Digitario sanguinalis-Eragrostietea minoris (*Eragrostion*)	-	-
Chenopodietea (*Hordeion murini*)	-	-
Chenopodietea (*Chenopodion muralis*)	-	-
Chenopodietea (*Echio-Galactition*)	-	-

Table 1. Synoptic overview of plant communities and habitats found on Isola Rossa di Comino.

(Arrigoni & Bocchieri, 1996) and Mediterranean coastal areas in general. In fact, based on the available data, therophytes represent 46.7% of the plants surveyed, followed by hemicryptophytes (21.7%) and geophytes (15.0%), while woody species make up about one sixth of the local floristic assemblage (chamaephytes 10.0%, phanerophytes 6.6%).

The typical formations of coastal rocky substrates exposed to the marine aerosol, referred to the classes *Crithmo-Staticetea* (habitat 1240) and *Saginetea maritimae* (habitat 1310), are particularly discontinuous and impoverished. Since habitat 1310 does not appear among those reported for the SCI ITB020012 "Berchida e Bidderosa" (Soriga et al., 2013), the corresponding vegetation would deserve to be surveyed in the spring period in order to provide a more detailed characterisation.

Some perennial plants, such as *Lotus cytisoides*, *Daucus carota* and *Malva arborea* are particularly frequent and probably play a key role in the strategies (foraging, thermoregulation) of the local *Rattus rattus* population and perhaps also for *Podarcis tiliguerta*. Indeed, these plants provide edible biomass even during the dry summer season, when their stems and fruits constitute valuable sources of water and food, and their canopies (and the litter of dry leaves in the case of *Malva arborea*) can provide shade and shelter during the hottest hours of the day.

The distribution of the nitrophilous communities observed on the islet seems to be controlled by soil depth and microclimatic conditions, with a clear predominance of *Echio-Galactition tomentosi* in deeper soils, *Eragrostion* (rich in thermo-cosmopolitan or exotic species that exploit the C4 photosynthetic pathway) in wetter sites, and *Hordeion murini* in more xeric contexts.

Impact of disturbance factors on local plant communities

The presence of a large colony of Mediterranean herring gulls and tufted warblers induces a high increase of the soil nutrient content (nitrates, phosphates), a factor that seems to hinder the establishment of woody species. In fact, despite the widespread presence of huge quantities of olive pits and a few pinecones, the result of gulls' incessant active dispersal, no trees are present on the islet.

With the exception of the pioneer communities of the sandy beaches (*Cakiletea maritimae*), all other vegetation units found on the islet are impoverished representatives due to their fragmentation and degradation due to seabird disturbance. The most structured and varied vegetation patterns can be observed in the sector of the islet closest to the main island, while the portion towards the sea appears more disturbed, monotonous, and mainly characterised by pioneer, nitrophilous and ruderal plant assemblages, rich in alien species, a pattern common to other circum-Sardinian micro-insular contexts (Fois et al., 2020). Breeding birds are concentrated on this sector of the Isola Rossa, which is less exposed to occasional visits by seasonal bathers. The eastern end of the islet, including some stacks close to it, is heavily exposed to storm surges and winds and looks like a bare, rocky surface where there is a significant accumulation of guano. The rocks are used as a resting and roosting place by various birds. During the visit, for example, two individuals of Cattle Egret and more than 50 individuals of Crested Plover (*Phalacrocorax aristotelis* Linnaeus, 1758), also nesting on the islet, (N. Baccetti, *pers. comm.*), were observed. The small gently sloping and shady inlets on the northern side of Isola Rossa are instead characterised by the exclusive presence of nitrophilous and hyper-nitrophilous plant communities.

The beach in front of Isola Rossa is one of the most renowned and popular in north-eastern Sardinia. However, anthropogenic pressure is concentrated in two months (July and August), while it is completely negligible in the months before and after. On the flat isthmus preceding the eastern end of Isola Rossa, a rudimentary hut made of wooden beams was built (between the end of summer and this year, N. Baccetti, *pers. comm*.): this is the only artefact present on the islet. The widespread presence of easily identifiable and walkable tracks suggests a rather frequent landing of bathers during the summer period; however, it could also derive from the passage of the black rats, whose presence on the islet had not previously been recorded (Masseti, 2019). The periodic accumulation of non-biodegradable rubbish along the shores of Isola Rossa (https://www.lanuovasardegna.it/nuoro/cronaca/2021/07/15/news/un-quintale-di-plastica-recuperato-all-isola-ruia-1.40503231) largely depends on the passive transport of waste

abandoned on the Sardinian coasts due to local marine and wind circulation patterns, while the widespread presence of fragments or small plastic and glass objects is due to the active transport of herring gulls.

Falco peregrinus Tunstall, 1771, reported as nesting on Isola Rossa by Cherchi et al. (2013), undoubtedly uses the islet as a hunting territory. The discovery of numerous carcasses of young gulls suggests that the hawk contributes to regulating the size of the colony of *Larus michahellis*, which currently (June 2022) counts around 130 individuals, corresponding to about 90 pairs, and appears to be constantly growing following the dismantling of the posidonia bank that connected the islet to Sardinia (N. Baccetti, *pers. comm.).*

As for the impact of the black rat on the local faunal assemblage, its effect on reptiles appears less marked than that observed in other micro-insular contexts, considering that the brief survey confirmed the presence all of the three reptile species already reported by Borri et al. (1988) and Poggesi et al. (1996). The apparent stability of the local herpetofauna is perhaps due to an ancient coexistence of the rat with reptiles (Escoriza, 2020), a predictable fact considering the easy accessibility of the islet.

CONCLUSIONS

The vascular plant inventory of Isola Rossa di Comino presented here would deserve further floristic investigations to be achieved. Moreover, no data have been collected on the bryological and lichen component, which are certainly present and would therefore need a dedicated expedition.

The short distance from Sardinia and the simultaneous presence of the black rat and the Mediterranean herring gull induces to suppose that local invertebrate fauna does not include any species of particular conservation or biogeographical interest. The Managing Authority should however promote an *ad hoc* census to confirm this hypothesis.

To quantify the role and impact of the herring gull colony on the composition of the local vascular flora, it would be necessary to undertake an analysis of the plant strategies spectrum (Grime, 2011) and of the ecological indicator values of Ellenberg-Pignatti (Guarino et al., 2012). Such an approach could provide even more interesting results when performing such analysis at a broader scale, i.e., considering all the small Mediterranean islands that host populations of reptiles (lacertids, geconids and/or scincids), rats and gulls at the same time.

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