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BREVI NOTE / SHORT NOTES

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A FOLLOW-UP CYCLE OF OBSERVATIONS ON THE ENDEMIC *PAMPHAGUS ORTOLANII* (*Acridoidea Pamphagidae*)

RATIONALE

A preliminary field visit to Lampedusa was conducted in April 2019, during which, field observations carried out on the acridid *Pamphagus ortolanii* Cusimano & Massa, 1977, confirmed its presence in four locations. A second field visit, on which the present communication is based, was carried out between May 31st and June 4th. From the onset, it ought to be pointed out that the research visits presented opportunities for ‘snapshot’ appraisals of the species’ status, regarded as meaningful assessments but within a limited time-window. Both field visits were covered by appropriate permits issued by the relevant Italian authorities¹.

BACKGROUND

Insularity is key in defining the biotic make-up of island ecosystems. Evolutionary development, leading to speciation, is largely determined by an organism’s capacity to adapt to new environmental conditions, coupled by a sustained disjunction from its centre-of-origin (LOMOLINO, 2000). Insular systems also provide useful insights into biological processes, biogeography and species distribution patterns (QUAMMEN, 1996), in particular on the consequences of habitat fragmentation and patch-matrix dynamics (DRAKE *et al.*, 2002). Such an understanding is especially beneficial for conservation management (CASSAR *et al.*, 2019). Insular biodiversity plays a critical role in demonstrating how ecological refugia function and how evolutionary processes and endemism come about (MÉDAIL & QUÉZEL, 1999); the island of Lampedusa is no exception. Located in the central Mediterranean area between north Africa and southern Europe, and forming part of the Pelagian Block, Lampedusa is of relative importance from the biogeographical point of view (MASSA, 1982; HUNT & SCHEMBRI, 1999; CASSAR *et al.*, 2007; MASSA & CANALE, 2009).

As the Mediterranean experienced a series of marine regressions, some quite major, such as the

¹ The research visit of 2019 was authorised via *Protocollo nr. 7442 (2019) PNM - Direzione Generale per la Protezione della Natura e del Mare* on the basis of derogation DPR 357/97 and on subsequent advice from ISPRA; access to the reserve during the 2021 field visit was granted by Legambiente (Lampedusa) via *Autorizzazione per ricerca scientifica N. 2 del 27/5/2021, trasmessa con nota Prot. N. 152/RN/LAM del 27/5/2021*.

one that occurred at the end of the Miocene epoch when the Basin is thought to have largely dried up (HSÜ, 1983; KRIJGSMAN *et al.*, 1999; GARGANI & RIGOLLET, 2007), followed by other significant episodes during the Pleistocene, a number of physical connections were established, albeit intermittently. These allowed terrestrial biota to disperse from surrounding land masses. As eustatic sea levels continued to fluctuate during the Quaternary, terrestrial corridors extended from the shores



Fig. 1 — *Pamphagus ortolanii* female (A) and male (B) (Photo credit: G. Bonetti).

of the Mediterranean during continental glaciations allowing dispersal to occur. Conversely, the interglacials led to protracted periods of isolation as sea levels rose, giving rise to the evolutionary development of endemic taxa on the resultant islands (HUNT & SCHEMBRI, 1999; CASSAR *et al.*, 2007; CASSAR, 2010). The endemic *Pamphagus ortolanii*, a micropterous orthopteran exclusive to Lampedusa (MASSA *et al.*, 2012; MASSA & FONTANA, 2020), is one such case (Figure 1). The species thrives on rocky shrubland biotopes that colonise the island's extensive karstland and is of particular interest from the point of view of island biogeography and conservation.

APPROACH

Biotopes, mostly characterised by garrigue and steppic elements, were reconnoitred via walk-over searches in numerous locations across the island's shrubland-dominated karst topography. These included: the region between the military base (flanking Contrada Capo Ponente) and Dammuso Casa Teresa (Contrada Albero Sole), to the clifftop at Punta Parise on the western segment; various areas within the *Riserva naturale* and the steppe on either side of Strada di Ponente on the central and southern parts of the island; the clifftop areas adjacent to Via Giulio Bonfiglio on the north-facing segment; and the clifftop from Punta Alàimo to Capo Grecale on the island's eastern segment. Afforested areas, notably at Capo Ponente, Albero Sole, the northernmost headwaters of Valle della Forbice, around the airport's southern perimeter adjacent to Cala Francese, and various areas on the town's rural fringe were also investigated, as was a large parcel of derelict land opposite the entrance to the airport, which was densely colonised by a suite of ruderal species and ornamental plants (garden-escapees). A mesic grassland, colonised by a host of ruderal species and located near the main harbour, was also sampled. Biotopes are listed according to characterising species (as per the Palaeartic habitat classification - DEVILLERS-TERSCHUREN J. & DEVILLERS P., 2001), or relevant floristic units (association, alliance, order or class) in Table 1.

Georeferenced coordinates were recorded for all sightings (Figure 2), as were corresponding meteorological conditions (Table 2), calculated from 08:00 to 18:00 (GMT+2) and listed in tables below as Daytime Observation sessions, in chronological order [DTOn]. A visual island-wide representation is provided in Figure 1, encompassing observations for both 2019 and 2021.



Fig. 2 — GPS-tracked records where *Pamphagus ortolanii* individuals were observed (Base map source: ESRI).

FINDINGS

The first field inspection during this second visit was carried out at Cala Francese, immediately after the research team's arrival on the island, where, in 2019, *P. ortolanii* occurred in relatively significant numbers (CASSAR *et al.*, 2019). A thorough walk-over examination across the same virtual transect (approx. 2000 m²) that had yielded high patch occupancy during the first visit in 2019 resulted in only one adult female specimen being recorded. Adjacent areas were also searched, without success. In fact, whilst the species was encountered in a considerable number of areas across the island, the vast majority of which occurred outside the Isola dei Conigli reserve (Figure 2), patch occupancy was consistently low in each location, numbering a very few individuals at most and mostly single observations (Table 1).

Most individuals were encountered on the ground or on low shrubbery, while on a few other occasions, adult insects were observed on trees. Two females were noted on *Acacia karoo* - these individuals were observed on different trees on the southern flank of the airport runway, adjacent to Via Cala Francese - while an adult pair was noted on *Tamarix africana* (the pair was observed on the same tree in the limits of Monte Imbriacola). The height above ground at which these were encountered varied between 175 and 190 cm.

As indicated, the majority of sightings occurred on karstic terrain, comprising mostly exposed rocky outcrops and extensive ground armour (loose surficial stony material resulting from soil erosion), where vegetation was relatively sparse. These areas were colonised by a suite of biotopes, including *Critbmo-Limonietum* (based upon *Limonietum lopadusani* and *Chiliadenetum lopadusani*, with other species of the aerohaline communities of sea-cliffs, such as *Daucus lopadusanus*) as at Punta Parise and Capo Grecale, elements of *Triadenio-Chiliadenetum*, with labiate garrigue, and assemblages of *Pegano-Salsoletum* and *Cakiletea maritima* at the two Cala Francese sites. A fairly similar floral composition was noted near Punta Ruperta, although this northern site was also colonised by steppic elements, including annual species characterised by *Polygono-Poetea annuae* and *Ermes*. Another site harbouring steppic assemblages (notably elements of *Ermes* communities and *Lygeo-Stipetea*), and forming a mosaic with labiate garrigue, included the area of relatively high ground on the limits of Dammuso Casa Teresa on the western segment of the island. Two other localities investigated where karstic terrain prevails and where afforestation programmes have been implemented, include the headwaters of Valle delle Forbice and the area overlooking Spiagga dei Conigli. Both sites occur on the western segment of Lampedusa and are characterised by exposed rugged terrain, consisting of a gorge-type valley (Valle delle Forbice) and acutely sloping sea-cliffs (Spiagga dei Conigli). The natural vegetation of both sites includes elements of *Periploco-Euphorbietum dendroidis* and of the labiate garrigue, together with woodlots that pertain to afforestation strategies undertaken over the years, with planting at Spiagga dei Conigli being more recent. Conversely, the woodlots at Valle delle Forbice are more mature, with evidence of regeneration, in places forming a mosaic with the naturally occurring maquis characterised by *Periploco-Juniperetum turbinata*. In the case of the more exposed rocky cliffs overlooking Spiagga dei Conigli, other communities present belong to the *Triadenio-Chiliadenetum* association.

The remaining areas within which *Pamphagus ortolanii* was recorded consisted of synanthropic environments, ranging from abandoned agricultural land, where grasses and ruderal assemblages abounded (*Polygono-Poetea annuae*, *Hordeion-leporini* and *Onopordion-illyrici*), together with garden-escapee species (notably *Lantana* sp., which was, in each case, rather large and well-established) and extensive stands of *Foeniculum vulgare*, to degraded habitats in a semi-urbanised context. The localities surveyed include the large parcel of land between Villaggio Aeronautica and Via Cala Creta (in the vicinity of the airport), ecologically degraded tracts of land on the main town's northern rural fringe, at Via Taccheri and Via Firenze, and a mesic meadow-type grassland located near a soccer pitch in the vicinity of the harbour. The latter site, which had the appearance of a field lying fallow or one that was recently abandoned, was colonised by a mosaic of lush grass swards and accompa-

nying ruderals, comprising elements of the following floral alliances: *Taeniatbero-Aegilopion geniculatae* and *Hordeion-leporini*, with *Echio-Galaction*, *Chenopodion muralis* and *Malvion parviflorae*. Table 1 provides a list of locations surveyed across the entire island of Lampedusa, and includes details of *Pamphagus ortolanii* records, as well as a summary of habitat-types (brief description of main landforms) and biotopes.

Table 1
Walk-over field survey details of daily observations. Sightings are of adult individuals unless indicated by nymphal instar level

Day	Field records	Location, landform and biotope
DTO1	♀ + 2 nd instar	Cala Francese (east) – gently sloping karstic coastline
		Labiatae garrigue (typified by <i>Thymbra capitata</i>); elements of <i>Triadenio-Chiliadenetum</i>
DTO1	♀ + 2 nd instar	Cala Francese (west) – karstic coastal embayment
		Mosaic comprising assemblages of <i>Pegano-Salsoletum</i> , <i>Cakiletea maritima</i> and <i>Triadenio-Chiliadenetum</i>
DTO1	♂	Capo Grecale (NNE-facing sea-cliffs)
		<i>Crithmo-Limonietum</i> on clifftop, with extensive <i>Daucus lopadusanus</i> coverage on the sheer cliffs overlooking the sea
DTO2	4 th instar	Punta Parise (NNW-facing sea-cliffs)
		<i>Crithmo-Limonietum</i> on karstic clifftop
DTO2	♀ + 3 rd instar	Open karstland - limits of Dammuso Casa Teresa (Contrada Albero Sole)
		Mosaic comprising labiate garrigue, with elements of <i>Ermes</i> communities (characterised by <i>Drimia maritima</i> and <i>Carlina sicula</i>) and <i>Lycio-Stipetea</i>
DTO2	♂	Headwaters of Valle delle Forbice (upper slopes of gorge-type valley)
		<i>Periplocion angustifoliae</i> (<i>Periploco-Juniperetum turbinatae</i> ; <i>Periploco-Euphorbietum dendroidis</i>) and woodlots (resulting from afforestation efforts)
DTO2	3♂♂	Via Cala Francese (south of the airport runway)
		Labiatae garrigue (typified by <i>Thymbra capitata</i>); afforestation (mostly <i>Acacia karoo</i>)
DTO2	2♂♂	Land parcel north of Villaggio Aeronautica
		Derelict land, mostly colonised by ruderal assemblages and garden-escapee flora (e.g., <i>Lantana</i> sp.)
DTO2	4♀♀	Land parcel north of Villaggio Aeronautica, on the limits of Via Cala Creta
		Derelict, mainly with stands of <i>Foeniculum vulgare</i> and a host of ruderals
DTO3	♀	Contrada Spiagga dei Conigli
		<i>Periploco-Euphorbietum dendroidis</i> ; <i>Triadenio-Chiliadenetum</i> ; labiate garrigue together with sparse patches of <i>Caralluma europaea</i> ; and, recent afforestation
DTO3	♂♀	Mesic grassland and ruderal assemblage north of Via Cameroni
		Grass swards comprising a mosaic with elements of <i>Taeniatbero-Aegilopion geniculatae</i> and <i>Hordeion-leporini</i> , with <i>Echio-Galaction</i> , <i>Chenopodion muralis</i> and <i>Malvion parviflorae</i>

Day	Field records	Location, landform and biotope
DTO4	♂	Via Tacceri (on main town's northern rural fringe) – derelict land parcel
		Ruderal assemblage (<i>Polygono-Poetea annuae</i>) with <i>Foeniculum vulgare</i> and <i>Lantana</i> sp.
DTO4	♂	Via Firenze (on main town's northern rural fringe)
		<i>Foeniculum vulgare</i> and roadside ruderal assemblage (<i>Hordeion-leporini/Onopordion-illyrici</i>)
DTO4	♂♀	Limits of Monte Imbriacola
		Mosaic comprising elements of <i>Lygeo-Stipetea</i> and <i>Echio-Galaction</i> , together with Oleo-lentisc brush and planted <i>Tamarix Africana</i> trees
DTO4	♀	Via Giulio Bonfiglio (limits of Punta Ruperta)
		Mainly <i>Crithmo-Limonietum</i> and <i>Triadenio-Chiliadenetum</i> with elements of <i>Polygono-Poetea annuae</i> and <i>Ermes</i> communities

The weather conditions throughout the four days of field investigations on the island were relatively variable (Table 2). A light breeze and clear skies were registered on the first afternoon [DTO1]. The morning of the second day was characterised by light rain showers and light-to-moderate winds, while overcast skies developed during the afternoon, when higher temperatures were nevertheless registered [DTO2]. The meteorological conditions of the third day of fieldwork were dominated by strong easterly winds [DTO3]. The fourth day of fieldwork was rather sunny for the most part, with a lighter easterly wind [DTO4]. As to be expected from ectothermic organisms, insects in general were very active during sunny spells but practically disappeared from view during cloudy spells. This was also the case for the relatively large and robust *P. ortolanii*, given its dependence on ambient heat sources for thermoregulation. It may be added that Lampedusa experienced a somewhat dry year, registering a very few precipitation episodes during the last wet season, so the rain showers during this year's fieldwork session were significant in that respect (pers. comm. Massa/Cassar & Pisani).

Table 2
Meteorological conditions registered for daytime observation sessions during the field visit (source: SYNOP WMO: 16490)

Daytime Observation session	Mean day temperature	Mean wind speed(Km/h)	General wind direction	Humidity	Cloud cover
DTO1	22.4 C	8.55	SSW	82.5%	35%
DTO2	21.0 C	9.91	SE	87.3%	90%
DTO3	22.4 C	21.45	E	87%	50%
DTO4	22.8 C	19.6	E	83.4%	50%

DISCUSSION AND CONCLUSIONS

It is evident that *P. ortolanii* is fairly widespread across Lampedusa; not only does it occur in its characteristically rocky and sparsely vegetated habitat, but it also appears to occupy synanthropic and semi-natural habitat patches, as was revealed during the field visit under review. It is also apparent that the species' numbers fluctuate from season to season, even within the same habitat patch.

As was the case in April 2019, both adults and nymphs (second, third and fourth nymphal instars occurred at the time of the visit) were found concurrently within common habitat patches (at Cala Francese, Contrada Albero Sole and Punta Parise) during the 2021 field visit. This phenomenon, in the case of a closely related species in Tunisia, *Pamphagus tunetanus*, is uncommon (CASSAR *et al.*, 2019), and can potentially be attributed to high fecundity on the part of *P. ortolanii*, coupled by a capacity to produce offspring all year-round as an adaptation to survive in an insular environment, where it is known to be significantly exposed to June-July predation by *Falco eleonorae* (CUSIMANO & MASSA, 1977; LO CASCIO *et al.*, 2015; BUZZETTI *et al.*, 2016). It is also likely that the species is predated upon by Yellow-legged Gull (*Larus m. michabellis*), as these omnivorous and quasi-synanthropic birds forage opportunistically inland within rural and semi-natural parcels of land. Similarly, as in 2019, cooler temperatures, exposure to strong winds and, particularly, overcast skies seemed to trigger a withdrawal from view, with the species noted to take refuge within thick shrubbery. Then, as clouds cleared and the day became progressively warmer, individuals would 'reappear' on shrubbery that had been thoroughly searched during overcast skies, as if seemingly from nowhere.

Clearly, much more work is required on the ecology of *P. ortolanii*, as well as on patch occupancy and connectivity between habitat patches. An understanding of minimum viable population (MVP) and predator-prey relationships will also shed light on the level of the species' vulnerability, undoubtedly vital for policy formulation and conservation strategies. Regular field surveillance, through an established monitoring protocol, would be ideal and a key recommendation for relevant authorities and other entities to pursue, to ensure a long-term positive conservation outcome for the species in question.



Fig. 3 — The authors with Bruno Massa in the limits of Sanguedolce, on the south-eastern coast, above Punta Secca (Photo credit: J.J. Borg).

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