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The beetle fauna of the coastal lagoon of Punta Lingua (Salina island, Aeolian Archipelago), half century later

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Abstract. In 1972, the Italian entomologist Alessandro Focarile published a pioneer paper on the beetle community of a small wet coastal environment of the Aeolian Islands. Further investigation allows to update the faunal knowledge of the site and to compare the structure and composition of its current assemblage with the previous data, assessing the changes that have occurred over the last fifty years, with particular reference to the aquatic and stenotopic species.

Riassunto. *La coleotterofauna della laguna costiera di Punta Lingua (Isola di Salina, Arcipelago delle Eolie), mezzo secolo dopo.* Nel 1972, l'entomologo Alessandro Focarile aveva pubblicato uno studio sulla comunità di Coleotteri presente in un ambiente umido costiero delle Isole Eolie. Nuove indagini hanno permesso di aggiornare le conoscenze faunistiche sul sito e di confrontare struttura e composizione del suo attuale popolamento con i dati progressi, analizzando i cambiamenti intervenuti nel corso degli ultimi cinquanta anni, con particolare riferimento alle specie acquatiche e stenotopiche.

Key words. Coleoptera, turnover, wet coastal habitat, small islands, Mediterranean.

Introduction

At the end of the 1960s, the “Piccole Isole” research programme initiated by the C.N.R. (National Research Council) (PASQUINI, 1971) and the growing attention to the biogeographic aspects of the circum-Sicilian islands, culminating in the celebration of the 18th symposium of the S.I.B. (Italian Society of Biogeography) held in Lipari in 1972 (FRANCINI CORTI & LANZA, 1973), have made it possible to greatly improve the entomological knowledge of these territories. As part of these contributions, the one published in 1972 in the “*Memorie della Società Entomologica Italiana*” entitled “*La coleotterofauna dello stagno salmastro a Punta Lingua nell’Isola di Salina*” [The beetle fauna of the brackish pond at Punta Lingua in Salina Island] (FOCARILE, 1972) summarizes both the faunistic data and the observations on the ecology and phenology of the communities of beetle occurring in the most important and vast humid coastal environment of the Aeolian Archipelago. This article was also one of the pioneering Italian works on this type of habitat and had a significant influence on the scientific literature of the time.

This study was also motivated by conservation reasons: the site was in fact threatened by the construction of a marina, and therefore – as pointed out by the author himself – it was considered “*opportuno svolgere accurate ricerche onde poter lasciare almeno una documentazione sul suo*

popolamento entomo-faunistico” [appropriate to carry out careful research in order to leave at least a documentation on its entomological fauna] (FOCARILE, 1972: 19).

Luckily, the project of the marina was abandoned. Currently, the coastal lagoon of Punta Lingua is included in two sites of the Natura 2000 Network (SPA ITA030044 and SAC ITA030029) and in the B zone of the Oriented Nature Reserve “Le Montagne delle Felci e dei Porri”, established by DA no. 87 in 03/14/1984; it should also fall within the boundaries of a National Park whose establishment, even if provided by Law no. 222 of 12/24/2007, still appears rather remote.

Although preserved from strong transformations, this site has nevertheless undergone some changes over time, mainly due to the tourist exploitation that has constantly increased in the following decades, both on a local scale and throughout the archipelago.

Since 1995, we have carried out further entomological investigations on the Aeolian Islands, including several field sessions at Punta Lingua improving the faunistic knowledge. Hence, the idea of a comparison between the context described by FOCARILE (1972) and the more recent one, in order to evaluate any changes in the structure and dynamics of the beetle communities, in particular on their component more closely linked to the coastal and brackish habitats.

Materials and methods

Study area

Punta Lingua is located south-east of the island of Salina (38.321558°N, 14.521027°E) and is the largest coastal lagoon of the Aeolian archipelago (Fig. 1). It covers an area of 27,000 m², and is bordered by two side barriers that do not exceed 2.5 m in height and which were formed by sea currents. The southern one reaches a maximum width of 35 m and is composed of pebbles with a diameter >10 cm and small patches of thin soil covered with dry deposits of marine phanerogams; the eastern barrier has a width between 50 and 85 m and is composed of a mixed substrate of pebbles and coarse sand with a grain size >0.5 mm. A large area of the latter is occupied by the former football field pitch (currently used as a parking lot), bordered along the shore by a perimeter wall that also extends along the north side, separating the lagoon from a road. A lighthouse was built on the southern tip in 1953. From the 1st and 2nd century AD, the lagoon was exploited as a saltpan (BERNABÒ BREA & CAVALIER, 2001) and this activity continued until the early 1970s. The comparison between the chemical-physical analyses carried out in the 1930s (CANNICCI, 1939) and about 15 years ago (LO CASCIO, 2017) shows a decrease in salinity (from 33.6-45.4 to 29.0-32.5‰), with a transition from hyperaline to myxo-polyaline conditions, and an increase in dissolved oxygen values (from 2.3-7.2 to 8.7-11.4‰); in the 1990s an artificial connection was installed between the sea and the lagoon, in order to regulate the level of the latter. In the lagoon, there are large meadows of *Nanozostera noltei* (Hornem.) Toml. & Posl. and *Ruppia maritima* L. The southern barrier has only sparse vegetation cover, consisting mainly of *Limbarda crithmoides* subsp. *longifolia* (Arcang.) Greuter; in the eastern one, this species is associated with *Crithmum maritimum* L. and *Helichrysum litoreum* Guss., together with ephemeral communities dominated by *Catapodium balearicum* (Willk.) H. Scholz, *Parapholis incurva* (L.) C.E. Hubb., *Eragrostis barrelieri* Daveau and *Spergularia rubra* (L.) J. Presl & C. Presl.; some individuals of *Tamarix africana* Poir. also occur along the trail to the lighthouse. Along the lagoon banks, the flooded soils host mainly halophilic plants such as *Soda inermis* Fourr., *Suaeda vera* J.F. Gmel. and *Atriplex prostrata* Boucher ex DC.

LOJACONO (1878) recorded the presence of *Medicago marina* L., *Pancratium maritimum* L., *Polygonum maritimum* L. and *Eryngium maritimum* L., and still half a century ago FOCARILE (1972) here observed *Echinophora spinosa* L. and *Convolvulus soldanella* L.; their local extinction could be correlated to a gradual process of degradation of the psammo-halophyte communities which seems to be due to the growing anthropic disturbance. The site has been colonized in recent decades by alien species such as *Euphorbia maculata* L., *Carpobrotus acinaciformis* (L.) L. Bolus and *Phragmites australis* (Cav.) Trin. ex Steud., the latter currently widespread along the banks of the internal lagoon side.

Field sampling and faunistic account

The data provided by FOCARILE (1972) were based on the results of four field sessions (August 1963, May 1969, March and May 1970) and consisted of a list of 26 species, two of which identified only at the genus level; some of them have already been recorded, without any indication of the locality of origin, in the contributions of MAGISTRETTI (1967, 1971), BUCCIARELLI (1971) and FOCARILE (1969) himself; two other records are in RAVIZZA (1972) and MAGNANO & OSELLA (1973). All have been reported in Table 1 for the period 1963-1972.

The comparative data are due to the study of the material collected between 1995 and 2022 in more than 10 sessions, distributed over a wider seasonal span and carried out with different sampling methods (direct searching, soil and litter sampling, beating and netting with a sweep net on different plant species, and light traps) with the exception of pitfall and Moericke traps, considered excessively invasive for this small and fragile habitat. The collected samples covered a wide variety of habitats: the lagoon water body, its sandy and muddy coasts, the bare and dry trampled soil, the rocky habitat, the halophytic and ruderal plants, and the dry *Posidonia oceanica* (L.) Delile deposits. Some data have already been provided in previous contributions (LO CASCIO & MAGRINI, 1998; CECCHI *et al.*, 1999; CECCHI & LO CASCIO, 2000; ARNONE *et al.*, 2001; LO CASCIO *et al.*, 2006; BORDONI, 2014; ZAMPETTI & TOMA, 2020) or still in publication (LO CASCIO *et al.*, in press); moreover, those referring to the period 1995-2022 include a record of Curculionidae provided by BAVIERA & CALDARA (2020).

In Table 1, the systematic and nomenclature of the supragenera taxa follow BOUCHARD *et al.* (2011) while for genera and species the nomenclature follows the “Catalogue of Palaearctic Coleoptera” (LÖBL & SMETANA, 2007; LÖBL & LÖBL, 2015, 2016, 2017; DANILEWSKY, 2020; IWAN & LÖBL, 2020) and the “Cooperative Catalogue of Palaearctic Coleoptera Curculionoidea” (ALONSO-ZARAZAGA *et al.*, 2017).

Ecological characterization and data analysis

The species have been assigned to the category of stenotopic species from the ecological information provided by a large literature (see AUDISIO, 2002; DAJOZ, 2002; FATTORINI & VIGNA TAGLIANTI, 2002; VIGNA TAGLIANTI & FATTORINI, 2002; RATTI, 2004; AUDISIO & VIGNA TAGLIANTI, 2010; NERI & MAGRINI, 2010; FRANK & AHN, 2011; CONTI *et al.*, 2012; ZANELLA, 2017; HANSEN *et al.*, 2018).

The turnover rate (BROWN & KODRIC-BROWN, 1977) was calculated as $t = (b+c)/(S_1+S_2)$, where b and c are the number of species detected exclusively in the periods 1963-1972 and 1995-2022, respectively, while S_1 and S_2 correspond to the overall lists of fauna for each period; the obtained values are expressed as a percentage.

Results

The list of the Coleoptera recorded for Punta Lingua is shown in Table 1 and includes a total of 70 species (2 of which identified only at genus level) belonging to 20 families; their largest number (11) belongs to the Carabidae, followed by Tenebrionidae (8), Staphylinidae, Melyridae and Curculionidae (7). The species found in 1963-1972 and 1995-2022 are respectively 28 and 53, but only 11 of them have been found in both periods.

Similarly, stenotopic elements (highlighted in bold in Table 1) are widely represented in the whole assemblage (about 42%), but only 6 out of 30 species have been confirmed by recent surveys. For this group, the turnover rate is 66.6%; t differs significantly between the beetle families: the highest values were found for Carabidae (69.2%) and Staphylinidae (100%), while the lowest values were found for Tenebrionidae (27.0%).

Discussion

The comparison between faunal data collected fifty years ago and more recent ones offers interesting insights to understand the variations over time of the communities of beetles inhabiting a coastal lagoon and the surrounding environment on a small Mediterranean island.

In the context described by FOCARILE (1972) the stenotopic species are more represented (64.2%), since the samplings were carried out only along two transects. The list reported for the period 1995-2022 includes twice as many species, but our investigations have been extended over time and have also concerned the vegetation belt that grows on the barriers; therefore, the list also includes several beetles not strictly related to the coastal wet habitat. If only the stenotopic elements are considered, however, there are no quantitative differences between 1963-1972 and 1995-2022, with 18 species detected for both periods.

Apart from the two morphospecies belonging to the genus *Astenus* Dejean, 1833, there are some doubts about two records provided by FOCARILE (1972). One is *Paracymus relaxus* Rey, 1884, subsequently referred to *P. aeneus* (Germar, 1884) by ROCCHI (2005) because it was considered probable junior synonym of this species (see also ROCCHI, 2011); this latter is the only species belonging to this genus that we found in 1995-2022, according to the identification of our specimens given by S. Rocchi. The other is *Colotes obsoletus* Erichson, 1840, for which the Focarile's record was based on the identification made by the late specialist E.J. Evers; however, this eastern Mediterranean species seems to be extremely localized in Italy (FRANZINI, 2015), and once again we cannot confirm its presence, since during the recent sampling only the closely related *C. punctatus* Erichson, 1840, was found.

In the last half century, beetle communities have suffered a certain instability, as revealed by the high turnover rate (66.6%) found for the stenotopic species. It seems particularly relevant for some groups, such as Staphylinidae (all recent records are new for the site) and Carabidae, for which 7 previously recorded species (of which 5 clearly stenotopics) were not subsequently confirmed. The cause is not always clear: for example, it is difficult to explain the disappearance of *Parallelomorphus laevigatus* (Fabricius, 1792), since this psammo-halobiontic beetle is a specialized predator of the amphipod *Talitrus saltator* (Montagu, 1808) which is still very common today in the intertidal zone around the lagoon; less surprising appears instead, *Bembidion (Lymnaeum) nigropiceum* (Marsham, 1802), as this subgenus includes purely riparian marine species, which appear in rarefaction within their range due to the disturbance induced by the anthropogenic pressure on their elective habitat (TRAUTNER, 2000; LEMAIRE *et al.*, 2016; JIROUX, 2019).

On the contrary, 5 of 7 species of Tenebrionidae recorded by FOCARILE (1972) have been confirmed by recent findings and only one stenotopic species, the psammophilous *Trachyscelis aphodioides* Latreille, 1809, appears to be locally extinct in recent times.

Together with the changes in the composition, some groups have also shown a faunal impoverishment: especially for the Carabidae, the richness of species has significantly decreased (from 9 to 4). Ground beetles are known to be extremely sensitive to habitat alterations (see DESENDER *et al.*, 1991; AVGIN & LUFF, 2010; SCHIERDING *et al.*, 2013), but it should be noted that the same usually also occurs for the tenebrionids (DAJOZ, 2002; CARTAGENA & GALANTE, 2002; PARDO *et al.*, 2008), while those detected at Punta Lingua seem to be more stable and resilient.

Aquatic beetles are different: apart from the extinction of *Nebrioporus ceresyi* (Aubé, 1836), which appears to be related to the decrease of salinity (see AGUESSE & BIGOT, 1959; VELASCO *et al.*, 2006; GIORIA, 2014), persistence of a small community composed of *Enochrus bicolor* (Fabricius, 1792) and *Paracymus aeneus* is confirmed by our findings up to 1996; furthermore SCHÖDL (1998) recorded the first from specimens collected in 1992, and ROCCHI (2005) the last from unpublished specimens collected in 1968 and from those provided by FOCARILE (1972). In recent years, no larval or adult stages of these species have been observed, while the only one found was *Anacaena limbata* (F., 1792), a widely distributed pelophagous beetle known as colonizer of temporary or instable wet environments (WILLIAMS & HYNES, 1976; WILLIAMS, 1997). It is therefore possible that at the end of the 1990s the lagoon was subjected to some insecticide treatment against mosquitoes, as was the case in similar environments where a significant impoverishment of the local fauna was observed (PONEL & GABIOT, 2021).

On the other hand, a dynamic response to these processes is suggested by some recent faunal acquisitions: *Halacritus punctum* Aubé, 1842, *Actinopteryx fucicola* (Allibert, 1844), *Cryptophagus fasciatus* Kraatz, 1852, *Styphloderes exsculptus* (Boheman, 1843) and all the recently recorded Staphylinidae are in fact halobionts or psammo-halobionts, often associated with deposits of dry

Posidonia oceanica (L.) Delile (see AUDISIO & VIGNA TAGLIANTI, 2010; FRANK & AHN, 2011; ZANELLA, 2017; HANSEN *et al.*, 2018), The missing species in recent samplings have therefore not been replaced by generalists, and the local beetle population still maintaining a distinctive character in the archipelago's faunal scenario, even if significantly modified over time from a compositional and structural point of view.

That assumes particular importance, in the light of the growing anthropogenic disturbance that has affected the site in the last fifty years: the construction of a wall along a portion of the lagoon banks, the alteration of the natural cycles of variation of the water level, the trampling for the massive influx of tourist, but also for the occasional spill of waste and pollutants. Furthermore, the abandonment of the salt pan and the relative change in the chemical-physical conditions of the lagoon have certainly had a strong ecological impact on the local fauna.

These communities of beetles constitute only a small part of the overall species of Coleoptera documented for the archipelago (about 8%: LO CASCIO *et al.*, in press), but especially among the stenotopes many of them have been found locally exclusively in this site at local level. One of these is the saproxylophagous weevil *Styphloderes exsculptus*, associated with logs and wood transported by the sea, a species of conservation interest included as "Vulnerable" in the Red List of saproxylic beetles (AUDISIO *et al.*, 2014).

Punta Lingua is also the "*terra typica*" of the recently described *Bruchidius salinaensis* Zampetti & Toma, 2020; moreover, the local population of *Phaleria bimaculata* (L., 1767), together with the others inhabiting the Aeolian Islands, was referred to an endemic infraspecific *taxon* (ssp. *marcuzzii* Aliquò, 1993) whose validity, still awaiting clarification, is confirmed from recent analyses (MARRONE *et al.*, 2014).

The lagoon and its surroundings, which according to EU Directive 43/92 is classified as priority habitat 1150, therefore represents a "key site" for the beetles diversity within the archipelago.

Finally, our results confirm once again how beetles can be used as effective indicators for assessing the conservation status and temporal evolution of coastal wetland on island areas (LAPIANA & SPARACIO, 2008), which today are among the ecosystems most threatened in the Mediterranean.

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Fig. 1 – Overall view of the study area.

Table 1 - Checklist of the Coleoptera found at Punta Lingua during 1963-1972 and 1995-2022 (aquatic and stenotopic species are indicated in bold).

Data from literature: 1) FOCARILE, 1972; 2) RAVIZZA, 1972; 3) MAGNANO & OSELLA, 1973; 4) LO CASCIO & MAGRINI (1998); 5) CECCHI et al. (1999); 6) CECCHI & LO CASCIO (2000); 7) ARNONE et al. (2001); 8) ROCCHI (2005); 9) LO CASCIO et al. (2006); 10) BORDONI (2014); 11) BAVIERA & CALDARA (2020); 12) ZAMPETTI & TOMA (2020); 13) LO CASCIO et al. (in press).

Unpublished data: a) 9.IV.1995, leg. P. Lo Cascio; b) VIII.1995, leg. P. Lo Cascio; c) 28.VII.1996, leg. P. Lo Cascio; d) 21.XII.1996, leg. P. Lo Cascio; e) 10.V.2009, leg. P. Lo Cascio; f) 20.III.2010, leg. P. Lo Cascio; g) 8.XI.2016, leg. P. Ponei; h) 8.XI.2016, leg. P. Lo Cascio; i) III.2021, leg. P. Lo Cascio.

	1963-1972	1995-2022
CARABIDAE		
<i>Bembidion (Lymnaeum) nigropiceum</i> (Marsham, 1802)	1	
<i>Calathus cinctus</i> Motschulsky, 1850	1	
<i>Cryptophonon tenebrosus</i> (Dejean, 1829)		5
<i>Dicheirotichus obsoletus</i> (Dejean, 1829)	1	4
<i>Dyschiriodes apicalis</i> (Putzeys, 1846)	1	
<i>Microlestes negrita</i> (Wollaston, 1854)	1	
<i>Parallelomorphus laevigatus</i> (Fabricius, 1792)	1	
<i>Pogonus chalceus</i> (Marsham, 1802)	1	
<i>Pogonus gilvipes</i> Dejean, 1828	2	
<i>Tachys dimidiatus</i> Motschulsky, 1849	1	4
<i>Tachyura parvula</i> (Dejean, 1831)		4
DYTISCIDAE		
<i>Nebrioporus (Zimmermannius) ceresyi</i> (Aubé, 1836)	1	
HYDROPHILIDAE		
<i>Anacaena limbata</i> (Fabricius, 1792)		13
<i>Enochrus bicolor</i> (Fabricius, 1792)	1	a, d
<i>Paracymus aeneus</i> (Germar, 1884)		8, b, c
<i>Paracymus relaxus</i> Rey, 1884	1	
HISTERIDAE		
<i>Halacritus punctum</i> Aubé, 1842		13
<i>Pactolinus major</i> (Linnaeus, 1767)		9
PTILIIDAE		
<i>Actinopteryx fucicola</i> (Allibert, 1844)		13
STAPHYLINIDAE		
<i>Astenus</i> sp. 1	1	
<i>Astenus</i> sp. 2	1	
<i>Cafius (Pseudoremus) xantholoma</i> (Gravenhorst, 1806)	1	
<i>Halobrecta flavipes</i> (Thomson, 1861)		10
<i>Myrmecopora (Paraxenus) laesa</i> (Erichson, 1839)		13
<i>Myrmecopora (Xenus) sulcata</i> (Kiesenwetter, 1850)		13
<i>Remus sericeus</i> Holme, 1837		13
SCARABAEIDAE		
<i>Anoxia (Mesanoxia) matutinalis</i> Laporte de Castelnau, 1832		7
<i>Oxythyrea funesta</i> ssp. <i>funesta</i> (Poda, 1761)		7
<i>Pleurophorus caesus</i> (Creutzer, 1796)		13
<i>Tropinota squalida</i> ssp. <i>squalida</i> (Scopoli, 1783)		7
ELATERIDAE		
<i>Mulsanteus guillebelli</i> (Mulsant & Godart, 1853)		13
DERMESTIDAE		
<i>Dermestes (Dermestinus) frischii</i> Kugelann, 1792		13
<i>Thoricus grandicollis</i> Germar, 1817	1	

PTINIDAE		
<i>Ozognathus cornutus</i> (LeConte, 1859)		13
MELYRIDAE		
<i>Aplocnemus pectinatus</i> (Küster, 1849)		e
<i>Attalus</i> (A.) gr. <i>sicanus</i> Erichson, 1840		13
<i>Colotes</i> (<i>Antidipnis</i>) <i>punctatus</i> Erichson, 1840		13
<i>Colotes</i> (<i>Psauter</i>) <i>obsoletus</i> Erichson, 1840	1	
<i>Dasytes</i> (<i>Hypodasytes</i>) <i>productus</i> Schilsky, 1894		9
<i>Ebaeus ruffoi</i> Pardo Alcaide, 1962		13
<i>Psilothrix melanostoma</i> (Brullé, 1832)		9
CRYPTOPHAGIDAE		
<i>Cryptophagus fasciatus</i> Kraatz, 1852		9
COCCINELLIDAE		
<i>Nephus</i> (<i>Bipunctatus</i>) <i>kiesenwetteri</i> Mulsant, 1850		13
TENEBRIONIDAE		
<i>Isomira melanophthalma</i> (Lucas, 1846)		9
<i>Opatrum obesum</i> Olivier, 1811	1	b, d
<i>Pachychila</i> (<i>Pachychilina</i>) <i>dejeani</i> ssp. <i>dejeani</i> (Besser, 1832)	1	d, g
<i>Phaleria bimaculata</i> (Linnaeus, 1767)	1	c
<i>Pimelia rugulosa</i> ssp. <i>rugulosa</i> Germar, 1824	1	a
<i>Stenosis intermedia</i> (Solier, 1838)	1	
<i>Tentyria grossa</i> Besser, 1832	1	d
<i>Trachyscelis aphodioides</i> ssp. <i>aphodioides</i> Latreille, 1809	1	
OEDEMERIDAE		
<i>Nacерdes melanura</i> (Linnaeus, 1758)		13
<i>Oedemera flavipes</i> (Fabricius, 1792)		13
ANTHICIDAE		
<i>Cyclodinus minutus</i> ssp. <i>minutus</i> (La Ferté-Sénéctère, 1842)	1	e, h
<i>Hirticomus quadriguttatus</i> (Rossi, 1792)		f
CERAMBYCIDAE		
<i>Parmena pilosa</i> ssp. <i>inclusa</i> Mulsant, 1862		6
CHRYSOMELIDAE		
<i>Bruchidius salinaensis</i> Zampetti & Toma, 2020		12
<i>Colaspidea globosa</i> (Küster, 1848)		9
<i>Diorhabda elongata</i> (Brullé, 1832)	1	
BRENTIDAE		
<i>Corimalia tamarisci</i> (Gyllenhal, 1838)		g
<i>Eutrichapion</i> (E.) <i>viciae</i> (Paykull, 1800)		9
<i>Holotrichapion</i> (<i>Legaricapion</i>) <i>gracilicolle</i> (Gyllenhal, 1839)		9
<i>Oxystoma pomonae</i> (Fabricius, 1798)		9
CURCULIONIDAE		
<i>Acentrus histrio</i> (Schoenherr, 1837)	3	e
<i>Coniatus tamarisci</i> (Fabricius, 1787)	1	a, i
<i>Hypera postica</i> (Gyllenhal, 1813)		13
<i>Mesites pallidipennis</i> Boheman, 1838		13
<i>Rhinusa depressa</i> (Rottenberg, 1872)		11
<i>Sitona humeralis</i> Stephens, 1831		13
<i>Styphloderes exsculptus</i> (Boheman, 1843)		13