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Research article

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Insights into the late-Sixties taxocenosis of Oniscidea from the Pontine islands (West Mediterranean) (Peracarida: Isopoda)

Gabriele GENTILE[1,]*, Roberto ARGANO[2], Stefano TAITI[3,4]

[1] *Dipartimento di Biologia, Università di Roma Tor Vergata - Via della Ricerca Sientifica 1, 00133 Rome, Italy*
gabriele.gentile@uniroma2.it
[2] *Dipartimento di Biologia e Biotecnologie "Charles Darwin", Università degli Studi "La Sapienza" - Viale dell'Università 32 00185 Rome, Italy*
[3] *Istituto di Ricerca sugli Ecosistemi Terrestri, Consiglio Nazionale delle Ricerche - Via Madonna del Piano 10, 50019 Sesto Fiorentino (Florence), Italy*
[4] *Museo di Storia Naturale dell'Università di Firenze, Sezione di Zoologia "La Specola" - Via Romana 17, 50125 Florence, Italy*
* Corresponding author

Abstract

We report and discuss faunistic data of Oniscidea inhabiting the Pontine islands, a group of five small volcanic islands and several islets in the Tyrrhenian Sea, located about 60 km from the Italian mainland. Data here presented were primarily obtained from the examination of the material collected during a three-year (1965-1968) research program supported by the Italian National Council of Research and aimed at investigating Mediterranean small island faunas, including Oniscidea. Despite the sampling was not specifically directed at Oniscidea, these data may provide insights into the structure of the Oniscidean taxocenosis of the islands as it existed fifty years ago. Thirty-five species belonging to 11 families, 8 ecological and 7 biogeographical classes were found on these islands. Such number of species of Oniscidea is very high, if we consider the low number of islands and their small sizes. Changes in climate and environmental conditions occurred in the last fifty years would call for a new investigation.

Keywords: Island biogeography, terrestrial isopods, Crustacea, small islands.

Introduction

Islands are adversely affected by environmental changes due to both direct human impact and climate change (Mimura et al. 2007; Lal et al. 2002). Effects on Mediterranean island ecosystems can include exacerbate inundation, storm surge, erosion, water resource depletion or alteration, species altitudinal shifts (Vogiatzakis et al. 2016). Biological responses to these alterations may involve changes in species phenology (Gordo & Sanz 2010), richness (Araújo et al. 2006), range (Roberts et al. 2011), persistence (De Montmollin & Strahm 2005), as well as the expansion of alien species (Thuiller et al. 2007). Small-size island systems are particularly prone to such impacts. This is the case of the Pontine archipelago, a group of five small volcanic islands and several islets in the Tyrrhenian Sea, located about 60 km from the Italian mainland (Fig. 1).
Since the late Sixties, the Pontine islands underwent more or less profound environmental changes, directly or indirectly mediated by man. For example, in August 1978, the central part of Ponza island was impacted by a severe fire that destroyed vegetation and crops on an area that represents roughly one third of the surface of the island, irreparably altering the physiognomy of the area (Veri et al. 1979). Increasing tourism also represents a serious threat for the fragile ecosystems of these small islands. However, very little is known about the ecological consequences of changes occurred, primarily because of the lack of reference data.

Between 1965 and 1968 the Italian National Council of Research (CNR) supported a project aimed at investigating the fauna of Mediterranean small islands for both inventory and biogeographic purposes (Pasquini & Consiglio 1971). Despite sampling was not specifically directed at terrestrial isopods, the collected data represented an opportunity to investigate the structure of the Oniscidea taxocenosis of the archipelago as it existed before the impacts of environmental and climatic changes occurred in the islands over the last fifty years. In this short note we report and discuss faunistic data of Oniscidea inhabiting the Pontine islands, as resulting from the complete examination of the Oniscidean specimens collected in the frame of that program. These data contribute some reference for comparisons in future studies.

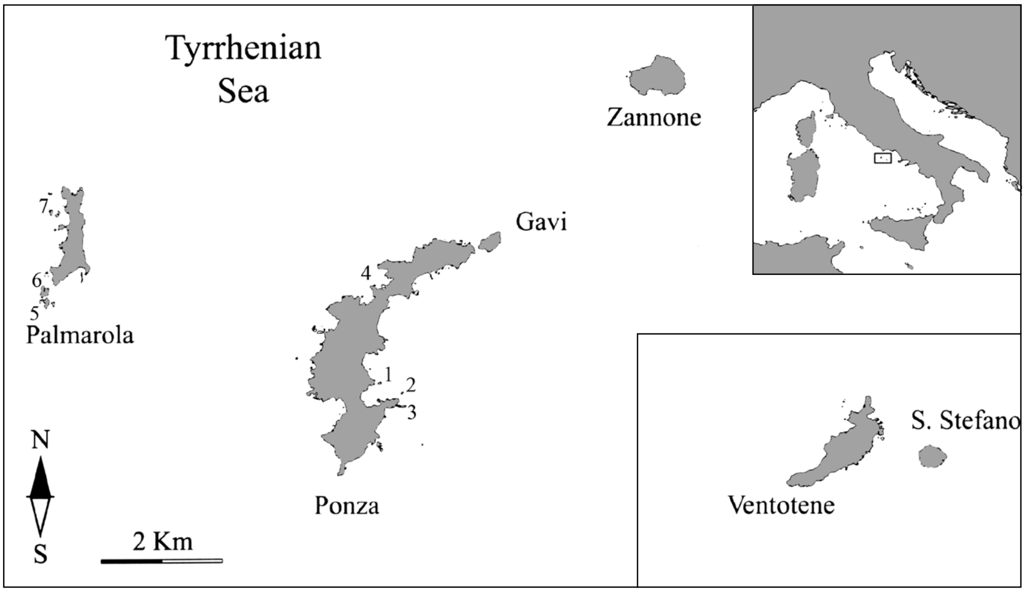

Fig. 1 – Pontine archipelago. The six largest islands are showed. The geographic distance between Ventotene-S.Stefano and the rest of the islands is not in scale. **1**, Scoglio Ravia; **2**, Scoglio di Pilato; **3**, Faraglioni della Madonna; **4**, Scogli della Cantina; **5**, Scoglio Cappello; **6**, Faraglioni di Mezzogiorno; **7**, Scogli Le Galere.

Materials and methods

Sampling

The Oniscidea specimens examined for this paper were obtained from the material collected from 70 sampling sites in more than 15 visits. Different sampling techniques were used (Berlese funnels, soil rinsing, soil sifting, direct collecting, traps). However, the non-specificity of the sampling raised some doubts to which extent the whole Oniscidea fauna of the archipelago could be represented in the sample. To answer this question, we performed a rarefaction analysis (species collected/number of visits) for each of the major islands visited at least seven times (Ponza, Zannone, Palmarola, and Ventotene). Given the non-specificity of the sampling, we did not use a model-based rarefaction algorithm, but we simply bootstrapped the raw data 1000 times. We also performed rarefaction analyses on three random presence/absence datasets of 30, 20, and 10 species (S), respectively. Curves obtained from simulated random presence/absence data sets imply that species have the same probability (50%) to be collected during each visit (sampling event). Such curves may provide indications of the expected curve shape when species have the same catchability. CURSAT ver 2.0 (Gentile 2019) was used for rarefaction analyses.

Results and discussion

Species richness and biogeographical composition

Thirty-five species belonging to 11 families, 8 ecological and 7 biogeographical categories were found in the Pontine archipelago. Species occurrence in the islands, along with ecological and biogeographical characteristics of each species are reported in Table 1. The proportion of species in each ecological and biogeographical class in the five larger islands is reported in Figs 2 and 3.

Saturation curves from rarefaction analysis are shown in Fig. 4. Contrary to the expected distributions, all the observed curves show a smooth trend with standard deviations, although decreasing, do not reaching zero. This indicates that species have different probabilities of being sampled in relation to their rarity. The curves of the largest Pontine islands Ponza, Zannone, Palmarola, and Ventotene seem to be reaching a plateau. Thus, our data set could represent relatively well the Oniscidea fauna occurring in the archipelago at the time during which sampling was performed. Using the smallest sampling effort (7 visits) to compare richness values, it is apparent that Ponza has a larger number of species compared to the other three main islands (Palmarola, Ventotene and Zannone), which have virtually the same number of species.

The identification of all specimens from the conspicuous material available resulted in an unexpectedly high number of species, comparable to the number of species found in West Mediterranean small-island archipelagos, such as those close to Sardinia and Sicily. Some species inhabiting the archipelago are extremely interesting from a biogeographical point of view because they are spottily distributed across the Mediterranean area, revealing some unusual characteristics of the fauna of Pontine islands. In particular, *Bathytropa granulata* is limited to a few areas of the Mediterranean basin whereas *Nesiotoniscus* cf. *helenae* was reported only for Sicily before the present study.

Table 1 – Species occurrence on the islands. Species ecological and biogeographical categories are reported in the last two columns. Acronyms as in Figures 2 and 3. Species absence and presence are indicated by 0 and 1, respectively.

Family	Species	Palmarola	Ponza	Santo Stefano	Ventotene	Zannone	Gavi	Scoglio della Cantina	Scoglio di Pilato	Faraglioni della Madonna	Scoglio Ravia	Scogli Le Galere	Scoglio Cappello	Faraglioni di Mezzogiorno	Ecology	Distribution
Ligiidae	*Ligia italica* Fabricius, 1798	1	1	1	1	1	1	0	0	0	0	0	0	0	HAL	MA
Tylidae	*Tylos ponticus* Grebnitzky, 1874	0	1	0	0	1	0	0	0	0	0	0	0	0	HAL	MA
	Tylos europaeus Arcangeli, 1938	0	1	0	1	0	0	0	0	0	0	0	0	0	HAL	MA
Trichoniscidae	*Nesiotoniscus* cf. *helenae* Brisolese & Caruso, 1974	0	1	0	0	0	0	0	0	0	0	0	0	0	EDG	WM
	Trichoniscus cf. *provisorius* Racovitza, 1908	1	1	0	0	1	0	0	0	0	0	0	0	0	HUM	E
	Haplophthalmus danicus Budde-Lund, 1880	0	1	0	0	0	0	0	0	0	0	0	0	0	EDG	E
Stenoniscidae	*Stenoniscus carinatus* Silvestri, 1897	1	0	0	0	0	0	0	0	0	0	0	0	0	LIT	WMA
Platyarthridae	*Platyarthrus schoblii* Budde-Lund, 1885	0	1	0	0	0	0	0	0	0	0	0	0	0	MYR	WM
	Platyarthrus lerinensis Vandel, 1957	0	0	0	0	1	0	0	0	0	0	0	0	0	MYR	T
	Platyarthrus costulatus Verhoeff, 1908	1	1	0	1	1	0	0	0	0	1	0	0	0	EDG	WMA
	Platyarthrus caudatus Aubert & Dollfus, 1890	1	1	1	1	1	0	0	0	0	0	0	0	0	MYR	WM
	Platyarthrus aiasensis Legrand, 1954	1	1	0	1	0	0	0	0	0	0	0	0	0	MYR	WMA
Detonidae	*Armadilloniscus candidus* Budde-Lund, 1885	0	0	0	0	1	0	0	0	0	0	0	0	0	HAL	WMA
Halophilosciidae	*Halophiloscia ischiana* Verhoeff, 1933	1	1	0	0	1	0	0	0	0	0	0	0	0	HAL	WM
	Halophiloscia couchii (Kinahan, 1858)	0	1	0	0	0	0	0	0	0	0	0	0	0	HAL	MA
	Halophiloscia hirsuta Verhoeff, 1928	1	1	0	1	1	1	0	0	1	0	0	0	1	HAL	WM
Philosciidae	*Stenophiloscia glarearum* Verhoeff, 1908	0	1	0	0	1	0	0	0	0	0	0	0	0	HAL	MA
	Chaetophiloscia elongata (Dollfus, 1884)	1	1	0	1	0	0	0	0	0	0	0	0	0	HUM	HM
	Chaetophiloscia cellaria (Dollfus, 1884)	0	1	0	0	0	0	0	0	0	0	0	0	0	HUM	WM
	Philoscia affinis Verhoeff, 1908	1	1	0	1	1	0	0	0	0	0	0	0	0	HUM	WM
Bathytropidae	*Bathytropa granulata* Aubert & Dollfus, 1890	0	1	0	1	0	0	0	0	0	0	0	0	0	HUM	HM
Porcellionidae	*Agabiformius lentus* (Budde-Lund, 1885)	0	1	0	0	0	0	0	0	0	0	0	0	0	XER	C
	Porcellionides pruinosus (Brandt, 1833)	1	1	1	1	1	0	1	0	1	0	0	0	0	SYN	C
	Porcellionides sexfasciatus (Budde-Lund, 1885)	1	1	1	1	1	0	0	1	1	0	0	0	0	SYN	WMA
	Acaeroplastes melanurus (Budde-Lund, 1885)	0	1	1	1	0	0	0	0	0	0	0	0	0	XER	WMA
	Leptotrichus panzerii (Audouin, 1826)	0	1	0	1	0	0	0	0	0	0	0	0	0	LIT	HM
	Porcellio dilatatus Brandt, 1831	0	1	0	0	0	0	0	0	0	0	0	0	0	EUR	E
	Porcellio laevis Latreille, 1804	1	1	1	1	0	0	0	0	0	0	0	0	0	SYN	C
	Porcellio lamellatus Budde-Lund, 1885	1	1	0	0	1	0	0	1	1	0	1	1	1	LIT	WMA
Armadillidiidae	*Alloschizidium eeae* (Argano & Utzeri, 1973)	0	1	0	0	0	0	0	0	0	0	0	0	0	EDG	T
	Paraschizidium coeculum (Silvestri, 1897)	1	1	0	0	0	0	0	0	0	0	0	0	0	EDG	AA
	Armadillidium cf. *nasatum* Budde-Lund, 1885	1	1	0	1	1	1	1	0	0	1	1	1	0	EUR	E
	Armadillidium vulgare (Latreille, 1804)	1	1	1	1	1	0	0	0	0	0	0	0	0	SYN	C
	Armadillidium depressum Brandt, 1833	1	1	0	0	1	0	1	0	0	0	0	0	0	EUR	WMA
	Armadillidium granulatum Brandt, 1833	0	1	1	1	0	0	0	0	0	0	0	0	0	LIT	T

This last species would deserve further investigation in the light of its affinities with *N. delamarei* from Algeria. Two species of endogean Armadillidiidae occur in the archipelago. This is a remarkable outcome because *Alloschizidium eeae* is endemic to Ponza, and *Paraschizidium coeculum* shows a scattered distribution.

Interestingly, we found a number of species belonging to the genus *Platyarthrus* in the Pontine archipelago. Species belonging to this genus are in general myrmecophilous. In agreement with the literature, we found no species-specific association between species of *Platyarthrus* and particular species of ants. In none of the Pontine islands different *Platyarthrus* species occurred in syntopy. Thus, the lack of more than one species in the same locality might suggest interspecific competition for habitat resources.

Oniscidean fauna from the Pontine archipelago predominantly consists of species characterized by Mediterranean-Atlantic and West-Mediterranean distributions (Fig. 3). This percentage ranges from 50% (S. Stefano) up to 70% (Zannone). Holo-Mediterranean species, which is a considerable proportion of the fauna at Ventotene (~ 17%), are absent from Zannone and S. Stefano. The remaining part of the fauna is composed of species characterized by European, Alpine-Apennine, Tyrrhenian, and mostly cosmopolitan distributions.

Species ecology

Isopodologists often characterize species by using a few discrete ecological categories that identify the major environments inhabited by the species studied (Vandel 1960). The pie charts in Fig. 4 show the ecological composition of the Oniscidean fauna in the Pontine archipelago as described by those categories. In general, the fauna can be assorted into eight ecological groups. In Ponza's fauna these groups are uniformly represented with the only exception of the xerophilic and halophilic species, which are less and most abundant, respectively. Faunas at Ventotene and Palmarola are slightly different from the fauna at Ponza. Palmarola is characterized by the lack of xerophilic species. Xerophilic species also lack from Zannone, where the main component of the fauna is represented by halophilic species. Very different is the ecological composition in S. Stefano, where half of the few species found

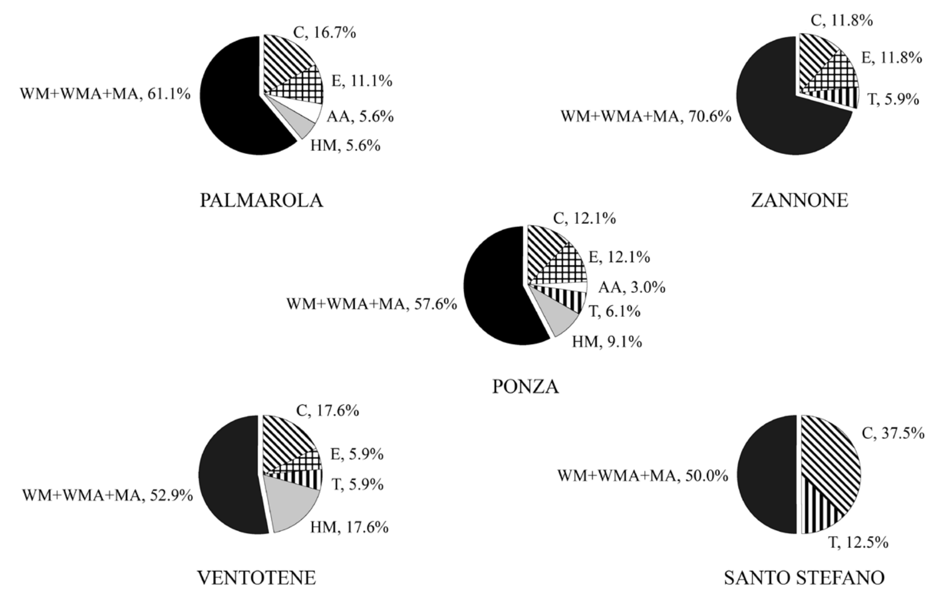

Fig. 2 – Percentages of chorological categories in the Pontine archipelago. West-Mediterranean-Atlantic (WMA); Mediterranean-Atlantic (MA); West-Mediterranean (WM); Holo-Mediterranean (HM); Tyrrhenian (T); Alpine-Apennine (AA); European (E); Cosmopolitan (C).

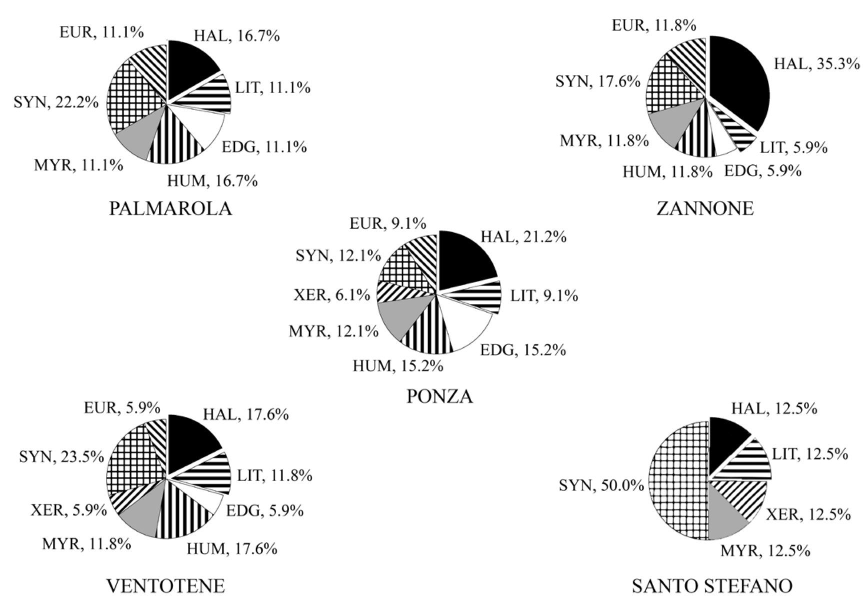

Fig. 3 – Percentages of ecological categories in the Pontine archipelago. Euryoecious (EUR); Halophilic (HAL); Littoral (LIT); Endogean (EDG); Humicolous (HUM); Myrmecophilic (MYR); Xerophilic (XER); Synanthropic (SYN).

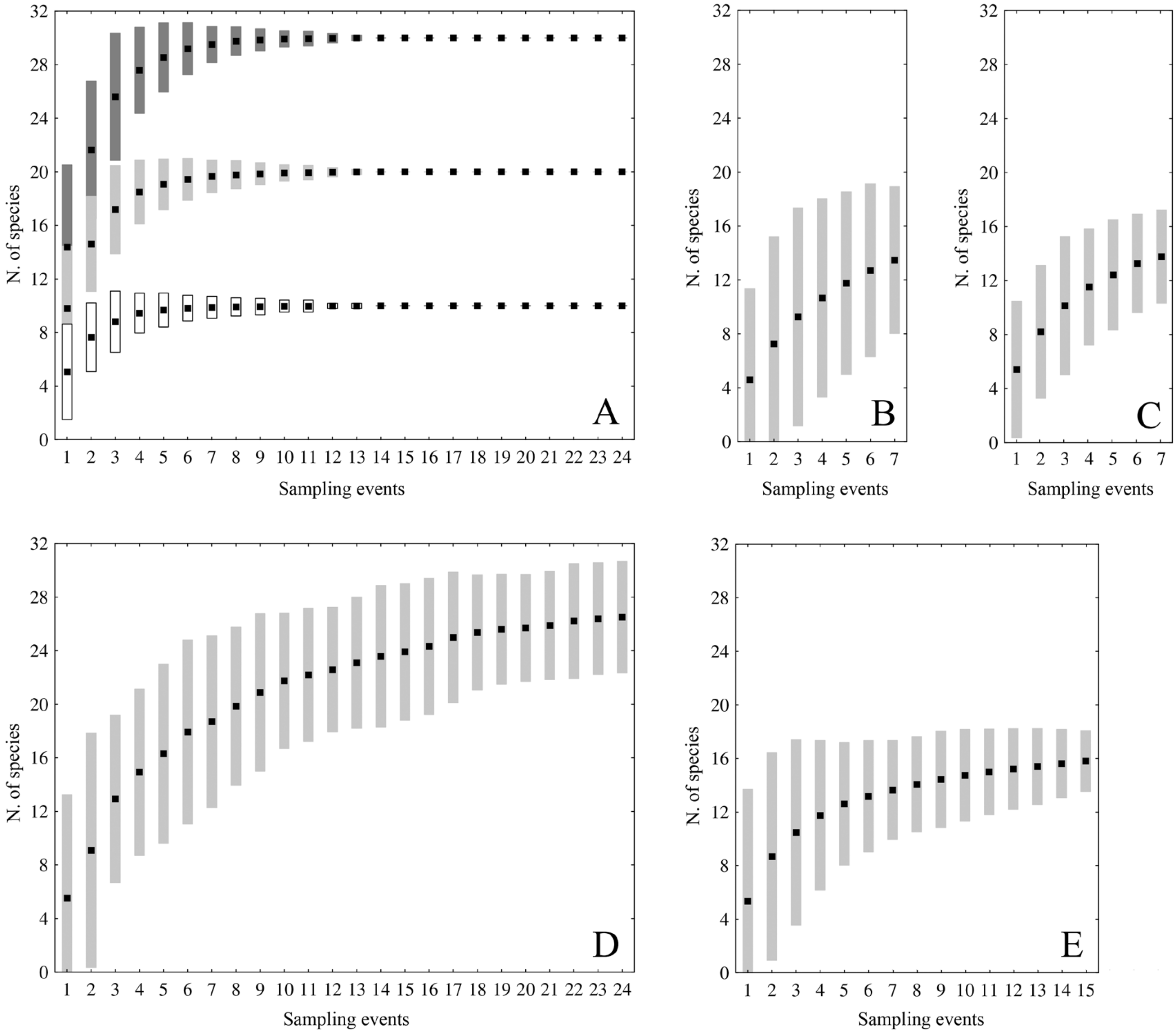

Fig. 4 – Bootstrapped saturation curves. A) Rarefaction analyses conducted on three random presence/absence datasets of 30 (dark grey), 20 (light grey), and 10 (white) species. Random data simulate equal catchability of species. Under the assumption of equal catchability, the curves can be approximately interpreted as the expected saturation curves for the indicated number of species. B) Palmarola; C) Ventotene; D) Ponza; E) Zannone. Square dots and boxes indicate means and standard deviations of the bootstrapped distributions, respectively.

are synanthropic. Differences in the ecological composition among island are also partially due to the spotted occurrence of endogean species as *Nesiotoniscus* cf. *helenae, Haplophthalmus danicus, Alloschizidium eeae,* and *Paraschizidium coeculum.*

Two xerophilic species, *Agabiformius lentus* and *Acaeroplastes melanurus,* were not found in some of the largest islands. This is difficult to explain, because they are very common and their geographical distribution is wide. Furthermore, they occur in most small islands in the West-Mediterranean Sea (Argano & Manicastri 1996; Caruso 1987; Cazzolla Gatti et al. 2018; Ferrara & Taiti 1978). The hypothesis that the absence of these species is due to a sampling bias might still be reasonable for Palmarola visited only 7 times, but it appears to be extremely unlikely for Zannone, where 15 sampling visits were performed.

Gravid females for most species were also collected during the samplings. We combined these data to detect possible breeding peaks during the year, as represented in Fig. 5. Gravid females were collected over the whole year, which is consistent with the climatic characteristics of the archipelago, where the average winter temperature rarely reaches values below 10°C. Nevertheless, the graph shows two peaks, suggesting that most species breed during the spring months (March-June), with a few ones breeding at the end of summer. *Halophiloscia couchii* and *Armadil-*

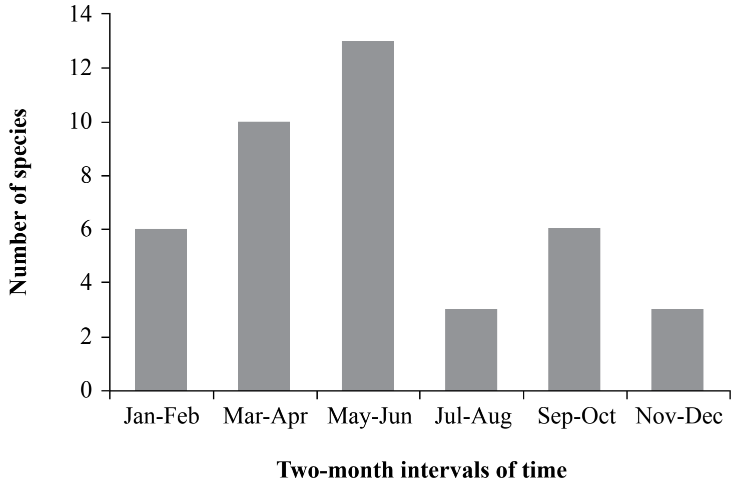

Fig. 5 – Breeding season in Oniscidea from the Pontine archipelago. The histogram shows the number of species breeding (Y-axis) at a certain time of the year (X-axis).

lidium granulatum would breed only in spring. Two species *Bathytropa granulata* and *Agabiformius lentus* seem to breed only in July-August. Other species seem to prefer breeding in spring and autumn *(Porcellio laevis, Armadillidium* cf. *nasatum, Armadillidium vulgare).* Two species *(Philoscia affinis, Porcellionides sexfasciatus)* have extended the breeding period to winter, which in turn would represent the only breeding season for *Armadillidium depressum*.

Conclusions

The Oniscidea fauna of the Pontine islands appears to be well known, at least as it existed fifty years ago. Since these data predates the heaviest human impact occurred in the most recent years, they can provide a reasonable picture of the "original" fauna (at least in relative terms, since the islands have a long history of human colonization and exploitation). The biogeographic composition of the Pontine archipelago is very similar to the composition of most West-Mediterranean archipelagos (Gentile & Argano 2005). In fact, a predominance of species with Mediterranean-Atlantic and West-Mediterranean distributions, as well as the presence of a few Holo-Mediterranean species, have also been found in circum-Sardinian, Tuscan, and circum-Sicilian archipelagos (Argano & Manicastri 1996; Caruso et al. 1987; Cazzolla Gatti et al. 2018; Ferrara & Taiti 1978; Taiti & Ferrara 1980; 1989). However, synanthropic species are an important component in all islands, which is consistent with the millenary presence of humans on these islands. The islands with the lowest percentage of synanthropic species are Ponza (which can be explained by its higher environmental diversity as a reflection of a larger area) and Zannone (which suggests a good conservation status for this island, which has always been virtually uninhabited and is part of the Circeo National Park). By contrast, the high proportion of synanthropic species on S. Stefano can be explained by the fact that this small island has been strongly impacted by the settlements of a 18th century penitentiary, now dismissed. Although most species are more or less thermophilic, only a few of them reproduce in July-August, the hottest months of the year, suggesting that they are sensitive to the summer aridity. Thus, they might be negatively affected by the ongoing climate change.

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