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mgambi@ogs.it**BORER ISOPODS (LIMNORIIDAE) IN POSIDONIA OCEANICA BEDS OFF USTICA AND PANAREA ISLANDS****ISOPODI PERFORATORI DI PRATERIE DI POSIDONIA OCEANICA DELLE ISOLE DI USTICA E PANAREA**

**Abstract** - Occurrence of isopods borers of *Posidonia oceanica* sheaths is here reported in a survey on various *P. oceanica* beds off the islands of Ustica (August 2021) and Panarea (September 2022). In Panarea the *P. oceanica* beds investigated thrive under ocean acidification (OA) conditions (pH generally >7.9) due to intense CO<sub>2</sub> venting in three hydrothermal systems (Bottaro crater, Camp 21, and Black Point) from 8 to 23 m depth, while at Ustica *P. oceanica* beds occur under normal pH conditions and were sampled from 6 to 32 m depth. All beds were settled on rocky substrates. Borer isopods, represented by *Limnoria mazzellae*, were observed in shoots from all sites and depths (a total of 504 specimens in 335 shoots examined). The Index of Colonization (IC = traces or animals present over the total shoot examined) was very high, ranging between 80% and 100%, and represents the highest frequency index recorded along the Italian coast.

**Keywords:** *Isopods, borers, Posidonia oceanica, ocean acidification, Tyrrhenian Sea.*

**Introduction** - The borers invertebrates, living inside *Posidonia oceanica* (L.) Delile sheaths (bases of the old leaves which persist along the rhizome after leaf fall) consist of polychaete Eunicidae (genera *Lysidice* and *Marphysa*) and isopods Limnoriidae (Gambi *et al.*, 2003). These latter represented up to date by a single exclusive species, *Limnoria mazzellae* Cookson & Lorenti, 2001. Borers exploit a unique niche in the *P. oceanica* system since they live and consume a portion of the plant necromass not used directly by any other metazoan organism. The sheaths in fact represent a highly lignified tissue, and borers thus contribute to degradation and recycling of this source of detritus. These organisms, and in particular the isopods, bore into the sheath typical "alveolar" galleries starting from the sheath ligula (Fig. 1A-B) and form inside the sheath entire families (Fig. 1C). The occurrence of borers has been studied in various *P. oceanica* beds along the Italian coasts (Gambi *et al.*, 2005; Lorenti, 2006), including the coasts of Sicily, where their presence was related to the good environmental conditions of the meadows (Di Maida *et al.*, 2004). Generally borer isopods have been observed more abundant in shallow beds, settled on rocky substrates and during the summer season (Gambi & Cafiero, 2001; Gambi *et al.*, 2005). The purpose of the present paper was to carry out a pilot study in some *P. oceanica* meadows around the Marine Protected Area of the island of Ustica and in the island of Panarea, to verify the presence of these organisms and to quantify their frequency and abundance according to depth and to special conditions in some of the Panarea hydrothermal vents.

**Material and Methods** - Sampling was conducted in July 2021 by SCUBA diving at four sites around Ustica at different depths: Piramidi bank and Africa bank on the north side of the island; Cala Galera on the southern side of the island and Falconiera Cape, at depth from 6 to 32 m (Tab. 1). All the *P. oceanica* meadows are settled on rocky substrates, and while some are patchy and discontinuous (Piramidi, Africa bank), others are continuous and more extended along depth (Cala Galera, Punta Falconiera) (Tab. 1). At Panarea *P. oceanica* shoots were sampled in September 2022 in three

hydrothermal vent systems where the plant is thriving under ocean acidification conditions due to intense CO<sub>2</sub> bubbling from the bottom (Fig. 2): i) Bottaro crater near the rim of the crater (st. B2) and at about 30-40 m apart from the crater (st. B1) (Esposito *et al.*, 2022), ii) Campo 21 and iii) Black Point, from 8 to 21 m depth (Tab. 1).



Fig. 1 - A-B) *P. oceanica* sheaths with "alveolar" traces of borer isopods; C) A family of the borer isopod *Limnoria mazzellae* inside a *P. oceanica* sheath (photos Gambi M.C.).

A-B) Scaglie di *P. oceanica* con tracce alveolari di isopodi perforatori; C) Famiglia dell'isopode *Limnoria mazzellae* dentro una scaglia di *P. oceanica* (foto Gambi M.C.).



Fig. 2 - A picture of the Camp 21 vent site at Panarea, showing the geiger of gasses surrounded by *P. oceanica* meadows where isopod borers were observed. Note the white deposition of sulphur bacteria around the gas emissions (photo Gambi M.C.).

Immagine dei vents di Panarea a Campo 21, che mostra il geiger di gas circondato da *P. oceanica* dove sono stati osservati gli isopodi perforatori. Si notino le deposizioni bianche di solfuri dovute a batteri attorno alle emissioni di gas (foto Gambi M.C.).

From 12 to 29 orthotropic *P. oceanica* shoots were sampled at each site and depth and analyzed fresh within one hour from sampling. When traces and/or the presence of borers organisms on the sheaths were visually observed, the sheaths were separated and fixed in 70% alcohol; then the sheaths were analyzed under the stereomicroscope for identification and counting of the borer organisms. The colonization index (IC) was calculated as the number of rhizomes with traces/or animals present with respect to the total number of shoots analyzed for each site/depth (Gambi, 2002) (Tab. 1).

**Results and Discussion** – Borer isopods, represented by *Limnoria mazzellae*, were observed in *P. oceanica* shoots from all sites and depths (504 specimens on 335 shoots analysed). The IC index was very high, ranging from 80% to 100%, except at the Panarea Bottaro vents (B1 and B2), where lower values were observed (Tab. 1). In 58% of the examined sheaths only 1 borer was observed, while 40% of the sheaths hosted 1-3 specimens, and up to 8 individuals were observed in a single sheath. Families with various juveniles were often present (Fig. 1C), while at Ustica two ovigerous females were recorded. At Ustica, where a large depth gradient was considered (6-32 m), isopods showed highest frequency and abundance in the shallower *P. oceanica* stands (6-20 m, Tab. 1) respect to deeper ones. This pattern is consistent with previous observation around the Ischia island (Gambi & Cafiero, 2001) and along the Sardinia coast (Gambi *et al.*, 2005). At Panarea borers were less abundant, however they represent the few invertebrates observed in association with *P. oceanica* shoots in this extreme environmental conditions, since due to intense venting and ocean acidification the *P. oceanica* shoots are deprived of most epiphytic invertebrates typically associated to this seagrass.

Tab. 1 – Frequency data of borer isopod colonization in *P. oceanica* meadows off Ustica and Panarea islands at various depths (n.m.= not measured).

*Dati di frequenza degli isopodi perforatori nelle praterie di P. oceanica di Ustica e Panarea a varie profondità (n.m. = non misurato).*

Site	Depth (m)	N rhizomes examined	N isopods	IC (%)	Average ind./shoot	Average ind./sheath
<b>Ustica (July 2021)</b>						
Punta Falconiera	10	12	n.m.	100	n.m.	n.m.
	20	23	49	95.6	2.2	2.5
Piramidi	14	14	38	100	2.7	2.2
	17	22	18	91	0.9	1.8
	30	21	16	95	0.8	1.3
Secca d’Africa	15	23	45	95.6	2.0	1.8
	20	20	n.m.	80	n.m.	n.m.
	32	19	15	80	1.0	1.2
Cala Galera	6	29	113	100	5.1	2.0
	10	12	28	100	2.3	1.7
	12	25	87	100	3.4	1.9
	27	22	60	100	2.7	1.8
<b>Panarea vents (Sept. 2022)</b>						
Campo 21	16	20	25	100	1.3	1.1
	21	10	10	50	2.0	2.0
Bottaro (B1)	10	29	18	58.6	1.1	1.1
Bottaro (B2)	8	34	16	47	1.0	1.0
Black Point	21	20	8	100	0.9	1.0

Overall, borer isopods resulted frequent in *P. oceanica* beds off Ustica and Panarea islands, and the IC values recorded represent the highest to date measured for *P. oceanica* borer isopods along the Italian coasts (Di Maida *et al.*, 2004; Gambi *et al.*, 2005). This pattern could be also related to the fact that all the meadows studied were settled on hard substrates, and in relatively pristine conditions (at least the Ustica

beds), and also this pattern seems consistent with previous studies (Di Maida *et al.*, 2004; Gambi *et al.*, 2005).

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## References

- COOKSON L. J., LORENTI M. (2001) - A new species of limnoriid seagrass borer (Isopoda) from the Mediterranean. *Crustaceana*, **74**: 339-346.
- DI MAIDA G., PIRROTTA M., CALI P., CASCINO F., TOMASELLO A., CALVO S. (2004) - Distribuzione dei borers nelle praterie di *Posidonia oceanica* della Sicilia. In: Casagrandi R., Melià P. (eds), *Atti XIII S.It.E. Aracne*, Roma: 10-16.
- ESPOSITO V., AURIEMMA R., DE VITTOR C., RELITTI F., URBINI L., KRALJ M., GAMBI M.C. (2022) - Structural and functional analyses of motile fauna associated to *Cystoseira brachycarpa* along a gradient of ocean acidification in a CO<sub>2</sub> vent system off Panarea island (Aeolian Islands, Italy). *J. Mar. Sci. Engen.*, **10**: 451.
- GAMBI M.C. (2002) - Spatio-temporal distribution and ecological role of polychaete borers of *Posidonia oceanica* (L.) Delile scales. *Bull. Mar. Sci.*, **71**: 1323-1331.
- GAMBI M.C., CAFIERO G. (2001) - Functional diversity in the *Posidonia oceanica* ecosystem: an example with polychaete borers of the scales. In: Faranda F.M., Guglielmo L., Spezie G. (eds), *Mediterranean Ecosystems: Structure and Processes*. Springer-Verlag, Milano: 399-405. [https://doi.org/10.1007/978-88-470-2105-1\\_52](https://doi.org/10.1007/978-88-470-2105-1_52)
- GAMBI M.C., VAN TUSSENBROEK B., BREARLEY A. (2003) - Mesofaunal borers in seagrasses: world-wide occurrence and a new record of boring polychaetes in the Mexican Caribbean. *Aquat. Bot.*, **76**: 65-77.
- GAMBI M.C., TRANI B., BUIA M.C. (2005) - Taxonomic diversity and distribution of polychaete and isopod borers on the sheaths of the seagrass *Posidonia oceanica*: analysis at regional scale along the coast of Sardinia (Italy). *Europ. Zool. J.*, **72**: 141-151.
- LORENTI M. (2006) - Isopod crustaceans inside Mediterranean seagrasses: borers, miners and intruders. *Biol. Mar. Medit.*, **13** (4): 154-156.