



A call for further research on the interaction between the invasive crab *Percnon gibbesi* and the endemic Mediterranean seagrass *Posidonia oceanica*

Andrea Anton · Daniel Puentes

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We appreciate the attention given to our recent publication, “Incidence of herbivory by *Percnon gibbesi* on the endemic Mediterranean seagrass *Posidonia oceanica*” (Puentes and Anton 2025; <https://doi.org/10.1007/s10530-024-03491-3>), and the opportunity to clarify the objectives, framework, and implications of our work. While we welcome scientific discussion, we believe that several statements in the Flashpoint letter (Moranta et al.) might understate the ecological relevance of our findings, and several points in their critique require clarification. Here, we address these points and provide further context to recently published research.

The Flashpoint letter argues that spatial overlap between *Percnon gibbesi* and *Posidonia oceanica* is negligible, citing the reported retreat of *P. oceanica* meadows to depths below 5 m in some parts of the Mediterranean. While it is true that upper depth limits have declined in some impacted areas (Blanco-Murillo et al. 2022), this generalization does not

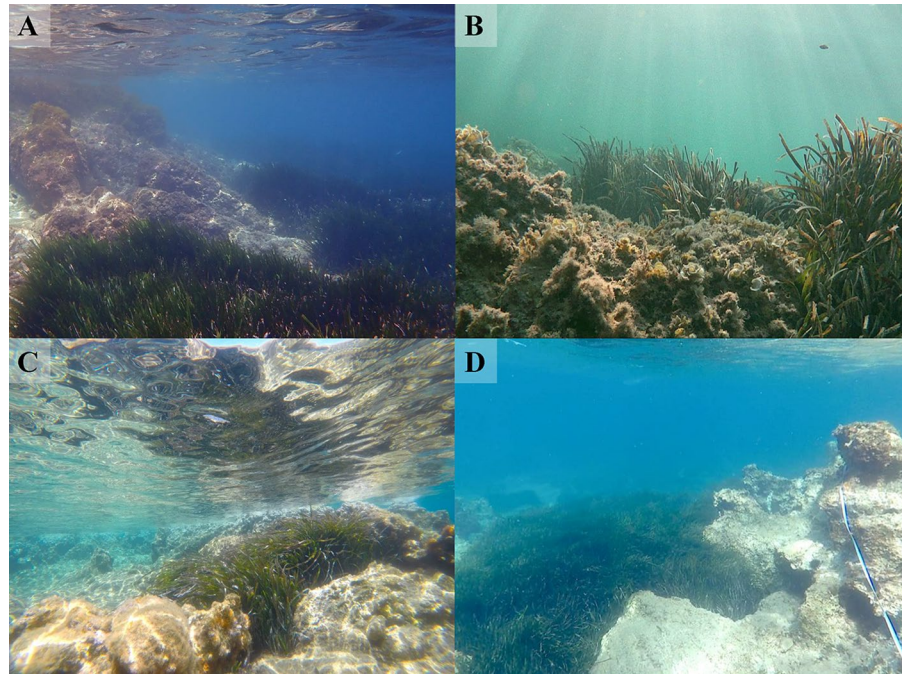
reflect *P. oceanica* conditions across the entire region. In fact, very shallow *P. oceanica* patches and upper meadow limits have been reported in numerous locations (Lopez y Royo et al. 2010; Hachani et al. 2016; Bennett et al. 2022; Holzknicht and Albano 2022; Azcárate-García et al. 2023), including mosaic habitats interspersed with hard-bottom substrates (Montefalcone et al. 2016; Mateo-Ramírez et al. 2023) where *P. gibbesi*, when present, tends to thrive. To illustrate this, we provide photographic evidence from four sites (two in Mallorca and two in Crete; Fig. 1) showing *P. oceanica* growing at depths between 0.5 and 2 m on or near rocky substrates (Fig. 1), where we also observed numerous individuals of *P. gibbesi* in the rocks adjacent to the seagrass. Thus, the assumption that these two species rarely co-occur in the wild is not supported by field observations, even though scientific information on the abundance and spatial distribution of *P. gibbesi* remains limited. We agree, however, with Moranta et al. that any interaction between the two species is likely restricted to shallow habitats (primarily between 0 and 4 m, but occasionally down to 8 m; (Deudero et al. 2005; Sciberras and Schembri 2008; Puentes and Anton 2025), a point we explicitly acknowledged in our original article published in *Biological Invasions* (Puentes and Anton 2025).

Moranta et al. criticize our experimental design for not including alternative food sources in the laboratory. This critique overlooks the primary aim of our study, which was not to replicate the full dietary

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A. Anton (✉) · D. Puentes
Global Change Research Group, IMEDEA (UIB-CSIC),
Mediterranean Institute for Advanced Studies, Esporles,
Illes Balears, Spain
e-mail: andrea.anton@imedea.uib-csic.es

Fig. 1 Pictures of shallow patches or meadows of *Posidonia oceanica* adjacent to rocky shoreline substrates populated with individuals of the invasive crab *Percnon gibbesi*. A) Illetes, Mallorca (2024; picture credit Daniel Puentes), B) Port des Canonge, Mallorca (2025; picture credit Andrea Anton), C) Makry Gialos, Crete (2025; picture credit Andrea Anton) and D) Hersonissos, Crete (2025; picture credit Andrea Anton)



breadth or feeding preferences of *Percnon gibbesi*, but rather to determine whether the species is capable of grazing on live *Posidonia oceanica* tissue. Prior to our study, evidence for this type of behavior was lacking, and an earlier study (Bada et al. 2022) had suggested that *P. oceanica* ingestion by *P. gibbesi* might be limited to detrital plant material. Demonstrating active consumption of healthy seagrass tissue was therefore a crucial question. Our controlled experiments provided evidence that *P. gibbesi* can consume multiple parts of *P. oceanica*, including leaves, fruits, and basal rhizomes. Notably, the consumption of fruits and rhizomes was documented for the first time in our study (Puentes and Anton 2025), and these findings carry potentially important ecological implications. Fruit consumption may reduce seed dispersal and recruitment, while rhizome damage could impair plant stability and long-term meadow persistence. These novel interactions expand the scope of possible ecological impacts and warrant targeted field research into their frequency and consequences. Supporting the relevance of this interaction, field data from Bada et al. (2022) show that *P. oceanica* made up nearly 25% of the stomach content of wild *P. gibbesi* individuals during autumn and winter in Algeria (22.6% and 24.3%, respectively). While these fragments were interpreted as detrital seagrass leaves, this assumption

is difficult to confirm given the degraded nature of stomach contents. It is plausible that some fragments originated from old, epiphytic leaves still attached to live shoots, suggesting potential grazing on living tissue. This is especially meaningful considering that macroalgae are seasonal in the Mediterranean and decline in abundance during the winter months (Ballesteros 1990; Piazzini et al. 2002; Pinedo et al. 2015). In contrast, *P. oceanica*, being a perennial plant, remains available year-round. This seasonal decline of macroalgae could increase herbivory pressure on *P. oceanica* during colder months. Experimental mesocosm studies, although necessarily simplified, play an important role in guiding ecological research and identifying key trophic interactions (O'Connor et al. 2009; Gherini 2015; South et al. 2017; Barrios-O'Neill et al. 2019). Dismissing them on the basis of their limitations neglects their value as a first step in understanding ecological relationships.

Finally, since the publication of Puentes and Anton (2025), new research has provided additional context for interpreting the potential impact of *P. gibbesi* on *P. oceanica*. A recent study (Pizarro-Borrull et al. 2025) indicates that *P. gibbesi* can consume large quantities of macroalgae (3.83 g WW per crab per day), exceeding by more than 200, 70 and 29 times its consumption of the leaves, rhizomes and fruits of *P. oceanica*

under comparable experimental conditions (0.019, 0.055 and 0.13 g WW per crab per day, respectively; Puentes and Anton 2025). Furthermore, by combining experimentally derived consumption rates for *P. oceanica* (from Puentes and Anton 2025) with average field densities of *P. gibbesi* in the Mediterranean (Anton et al. 2026), we estimate an annual consumption of approximately 25, 73, and 172 kg WW ha⁻¹ of *P. oceanica* tissues (leaves, rhizomes, and fruits, respectively), well below the estimated 8627 kg WW per hectare per year of macroalgal consumption. Nevertheless, the potential yearly consumption of *P. oceanica* fruits could compromise seagrass reproduction, as the species does not reproduce annually and, when it does, fruit production can be lower than this estimated consumption by the crab (e.g., average 165 kg WW fruits ha⁻¹ in northern Italy; Balestri et al. 1998; Balestri and Cinelli 2003). These findings suggest that the primary ecological pressure from *P. gibbesi* is likely exerted on macroalgal communities, and perhaps also on *P. oceanica* fruits. However, as previously discussed, reduced macroalgal availability during the colder months may increase seagrass leaf and rhizome consumption, underscoring the need for seasonal field studies to more accurately assess the risk to *P. oceanica* under varying environmental conditions.

Taken together, these findings and recent evidence challenge the assertion that *P. gibbesi* poses no threat to *P. oceanica*. While we agree that the extent of any impact at the ecosystem scale remains uncertain, declaring the interaction ecologically irrelevant without field data is premature and precaution is warranted. Our study (Puentes and Anton 2025) represents an early step in identifying a novel interaction between these two species. Rather than closing this discussion, we encourage further empirical research to clarify the ecological significance of this interaction across spatial and seasonal gradients.

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Data availability This paper does not have data.

Declarations

Competing interests The authors declare that they have no competing interests.

Ethical approval This study did not involve the collection or manipulation of animals; therefore, no ethical approval was required.

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References

- Anton A, Bachot X, Pizarro-Borrull M, et al (2026) Basin-wide patterns of abundance of a widespread invasive herbivore in the Mediterranean Sea. Res Square. <https://doi.org/10.21203/rs.3.rs-8523331/v1>
- Azcárate-García T, Beca-Carretero P, Brun FG (2023) Plant and meadow structure characterisation of *Posidonia oceanica* in its westernmost distribution range. Diversity 15:101. <https://doi.org/10.3390/d15010101>
- Bada N, Da Ros Z, Rindi F et al (2022) Seasonal trophic ecology of the invasive crab *Percnon gibbesi* (Brachyura, Plagusidiidae) in the southwestern mediterranean: insights from stomach contents and stable isotope analyses. Mar Environ Res 173:105513. <https://doi.org/10.1016/j.marenvres.2021.105513>

- Balestri E, Cinelli F (2003) Sexual reproductive success in *Posidonia oceanica*. *Aquat Bot* 75:21–32. [https://doi.org/10.1016/S0304-3770\(02\)00151-1](https://doi.org/10.1016/S0304-3770(02)00151-1)
- Balestri E, Piazzì L, Cinelli F (1998) In vitro germination and seedling development of *Posidonia oceanica*. *Aquat Bot* 60:83–93. [https://doi.org/10.1016/S0304-3770\(97\)00017-X](https://doi.org/10.1016/S0304-3770(97)00017-X)
- Ballesteros E (1990) Structure and dynamics of the *Cystoseira caespitosa* Sauvageau (Fuciales, Phaeophyceae) community in the north-western Mediterranean. *Sci Mar* 54:155–168
- Barrios-O'Neill D, Kelly R, Emmerson MC (2019) Biomass encounter rates limit the size scaling of feeding interactions. *Ecol Lett* 22:1870–1878. <https://doi.org/10.1111/ele.13380>
- Bennett S, Vaquer-Sunyer R, Jordà G, Forteza M, Roca G, Marbà N (2022) Thermal performance of seaweeds and seagrasses across a regional climate gradient. *Front Mar Sci*. <https://doi.org/10.3389/fmars.2022.733315>
- Blanco-Murillo F, Fernández-Torquemada Y, Garrote-Moreno A et al (2022) *Posidonia oceanica* L. (Delile) meadows regression: long-term affection may be induced by multiple impacts. *Mar Environ Res* 174:105557. <https://doi.org/10.1016/j.marenvres.2022.105557>
- Deudero S, Frau A, Cerda M, Hampel H (2005) Distribution and densities of the decapod crab *Percnon gibbesi*, an invasive Grapsidae, in western Mediterranean waters. *Mar Ecol Prog Ser* 285:151–156
- Geraldi NR (2015) Prey size structure diminishes cascading effects by increasing interference competition and predation among prey. *Ecology* 96:2533–2543. <https://doi.org/10.1890/14-1026.1>
- Hachani MA, Ziadi B, Langar H et al (2016) The mapping of the *Posidonia oceanica* (L.) Delile barrier reef meadow in the southeastern Gulf of Tunis (Tunisia). *J Afr Earth Sci* 121:358–364. <https://doi.org/10.1016/j.jafrearsci.2016.05.030>
- Holzknicht M, Albano PG (2022) The molluscan assemblage of a pristine *Posidonia oceanica* meadow in the eastern Mediterranean. *Mar Biodivers* 52:59. <https://doi.org/10.1007/s12526-022-01292-2>
- Lopez y Royo C, Pergent G, Pergent-Martini C, Casazza G (2010) Seagrass (*Posidonia oceanica*) monitoring in western Mediterranean: implications for management and conservation. *Environ Monit Assess* 171:365–380. <https://doi.org/10.1007/s10661-009-1284-z>
- Mateo-Ramírez Á, Marina P, Martín-Arjona A et al (2023) *Posidonia oceanica* (L.) Delile at its westernmost biogeographical limit (Northwestern Alboran Sea): meadow features and plant phenology. *Oceans* 4:27–48. <https://doi.org/10.3390/oceans4010003>
- Montefalcone M, Vacchi M, Carbone C et al (2016) Seagrass on the rocks: *Posidonia oceanica* settled on shallow-water hard substrata withstands wave stress beyond predictions. *Estuar Coast Shelf Sci* 180:114–122. <https://doi.org/10.1016/j.ecss.2016.06.024>
- Moranta J, Goauraguine A, Reviriego B, Sciberras M The herbivory of the invasive crab *Percnon gibbesi* in the Mediterranean is not a threat for the endemic seagrass *Posidonia oceanica*. *Biol Invasions*
- O'Connor MI, Piehler MF, Leech DM et al (2009) Warming and resource availability shift food web structure and metabolism. *Plos Biol*. <https://doi.org/10.1371/journal.pbio.1000178>
- Piazzì L, Pardi G, Balata D et al (2002) Seasonal dynamics of a subtidal North-Western Mediterranean macroalgal community in relation to eph and substrate inclination. *Bot Mar* 45:243–252. <https://doi.org/10.1515/BOT.2002.023>
- Pinedo S, Arévalo R, Ballesteros E (2015) Seasonal dynamics of upper sublittoral assemblages on Mediterranean rocky shores along a eutrophication gradient. *Estuar Coast Shelf Sci* 161:93–101. <https://doi.org/10.1016/j.ecss.2015.05.004>
- Pizarro-Borrull M, Font E, Marbà N, Anton A (2025) Prominent grazing rates and feeding preferences of an abundant exotic benthic herbivore in the Mediterranean Sea. *Ecol Evol* 15:e71686. <https://doi.org/10.1002/ece3.71686>
- Puentes D, Anton A (2025) Incidence of herbivory of the invasive crab *Percnon gibbesi* on the endemic Mediterranean seagrass *Posidonia oceanica*. *Biol Invasions* 27:31. <https://doi.org/10.1007/s10530-024-03491-3>
- Sciberras M, Schembri PJ (2008) Biology and interspecific interactions of the alien crab *Percnon gibbesi* in the Maltese Islands. *Mar Biol Res* 4:321–332. <https://doi.org/10.1080/17451000801964923>
- South J, Dick JTA, McCard M et al (2017) Predicting predatory impact of juvenile invasive lionfish (*Pterois volitans*) on a crustacean prey using functional response analysis: effects of temperature, habitat complexity and light regimes. *Environ Biol Fish* 100:1155–1165. <https://doi.org/10.1007/s10641-017-0633-y>

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