# Conservation status of *Paramuricea clavata* (Risso, 1826) (Anthozoa, Alcyonacea) in the Chafarinas Islands (Mediterranean Sea)

L. Sánchez–Tocino, A. de la Linde Rubio, M. J. López–Rodríguez, J. M. Tierno de Figueroa

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**Abstract**

*Conservation status of* Paramuricea clavata *(Risso, 1826) (Anthozoa, Alcyonacea) in the Chafarinas Islands (Mediterranean Sea).* The red gorgonian *Paramuricea clavata* (Risso, 1826) is affected by the combined effects of environmental stress factors and diseases in the Mediterranean area. Samplings at different depths in two sites of Chafarinas Islands (South–Western Mediterranean Sea) were carried out to quantify the degree of injuries on red gorgonian colonies. The results showed that shallow colonies displayed a higher rate of injuries than deep colonies. Overall, the conservation status of the population was worse than previously considered in this area.

Key words: Red gorgonian, *Paramuricea clavata*, Health status, Northern Africa

**Resumen**

*Estado de conservación de* Paramuricea clavata *(Risso, 1826) (Anthozoa, Alcyonacea) en las islas Chafarinas (mar Mediterráneo).* En la zona del Mediterráneo, la gorgonia roja *Paramuricea clavata* (Risso, 1826) sufre los efectos combinados de factores de estrés ambiental e infecciones. Se realizaron muestras a diferentes profundidades en dos sitios de las islas Chafarinas (mar Mediterráneo sudoccidental) para cuantificar el grado de daño que presentaban las colonias. Los resultados mostraron que las colonias de aguas más superficiales presentaban una mayor tasa de daño que las colonias de aguas más profundas. En conjunto, el estado de conservación de la población era peor de lo que se había considerado previamente en esta zona.

Palabras clave: Gorgonia roja, *Paramuricea clavata*, Estado de salud, Norte de África

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*L. Sánchez–Tocino, J. M. Tierno de Figueroa, Departamento de Zoología, Facultad de Ciencias, Universidad de Granada, Campus Fuentenueva, 18071 Granada, Spain.– A. de la Linde Rubio, Urbanización los Delfines, Pl 4, 2º, 11207 Algeciras, Cádiz, Spain.– M. J. López–Rodríguez, Departamento de Ecología, Facultad de Ciencias, Universidad de Granada, Campus Fuentenueva, 18071 Granada, Spain.*

Corresponding author: J. M. Tierno de Figueroa, E–mail: jmtdef@ugr.es

Mass mortality events of gorgonians and other marine macroinvertebrates have been repeatedly reported in the last decades in the Mediterranean Sea (e.g. Cerrano et al., 2000; Garrabou et al., 2009). These events, usually, but not only, have been associated with episodes of positive water temperature anomalies. One of most affected species is the red gorgonian *Paramuricea clavata* (Risso, 1826) (e.g. Cerrano et al., 2000; Martin et al., 2002; Huete–Stauffer et al., 2011). Several authors have noted that the combined effect of environmental stress and microorganism infections may be jeopardizing the conservation status of the *P. clavata* populations (e.g. Vezzulli et al., 2013). Moreover, water warming anomalies are

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generally related to a decrease of oxygen availability, enhancing the necrosis of coenechyme (Previati et al., 2010).

During the sampling conducted in summer 2015 to evaluate a mass mortality of the white gorgonian *Eunicella singularis* (Esper, 1791) in the Chafarinas Islands (North Africa, Western Mediterranean Sea), related to a high temperature event in 2014, some damaged colonies of *P. clavata* were also observed (de la Linde Rubio et al., 2018). Particularly, de la Linde Rubio et al. (2018) carried out a sampling in Tajo del Cementerio (Rey Island, 35º 10' 50.02" N, 2º 25' 1.11" W) between 20 and 30 m depth to assess the number of affected colonies of *P. clavata* (identified by being partially covered by epibionts). They found that more than 50 % of the colonies were affected (most of them displaying less than 50 % of their surface with epibionts) but none were dead. They noted that the studied population had been less affected than populations in other Mediterranean areas where mortality events of this species were reported (e.g. Cerrano et al., 2005; Crisci et al., 2011).

In order to better evaluate the conservation status of *P. clavata* in the Chafarinas Islands, we carried out a new study in two localities and at different depths: (1) Rey Island, between Tajo del Pirata and Tajo del Cementerio (35º 10' 48.08" N, 2º 25' 09.10" W), 29 VIII 18, depths: 22, 20 and 17 m East exposure; (2) Isabel II Island, North, under the lighthouse (35º 11' 02.97" N, 2º 25' 50.96" W), 01 IX 18, depths: 25, 23, 20 and 18 m, North exposure.

Records of water temperature from the buoy of Melilla (the nearest place with available data) at 15 m depth in 2017 showed a maximum temperature of 28.6 ºC in mid–August (*Puertos del Estado* webpage, http://www.puertos.es/es–es/oceanografia/Paginas/portus.aspx). At each depth, we quantified the number of healthy (with 0 % epibiosis or necrosis), affected

Fig. 1. *Paramuricea clavata* colony partially covered by epibionts.

*Fig. 1. Colonia de* Paramuricea clavata *parcialmente cubierta por epibiontes.*

Table 1. Mean (± SD) number of healthy, non–healthy and dead colonies at each depth at both study sites. Note that the number of samples considered for their calculation has been reduced to five at each depth at Isabel II Island to balance the estimates.

*Tabla 1. Número medio de colonias (± DE) saludables, no–saludables y muertas a cada profundidad en ambas localidades de estudio. Nótese que el número de muestras consideradas para su cálculo se han reducido a cinco en todas las profundidas de la isla de Isabel II para equilibrar las estimas.*

| | Depth (m) | N | Number of colonies | Mean ± SD | | |
|---|---|---|---|---|---|---|
| | | | | Dead | Non–healthy | Healthy |
| Rey Island | 17 | 10 | 49 | 1.40 ± 1.43 | 3.20 ± 1.81 | 0.3 ± 0.48 |
| | 20 | 10 | 70 | 1.50 ± 1.27 | 4.80 ± 1.32 | 0.70 ± 1.25 |
| | 22 | 10 | 71 | 0.20 ± 0.42 | 1.90 ± 1.66 | 6.10 ± 3.31 |
| Isabel II Island | 18 | 5 | 42 | 0.60 ± 0.55 | 3.80 ± 1.10 | 4.00 ± 2.12 |
| | 20 | 5 | 37 | 0 | 1.20 ± 0.84 | 6.20 ± 3.19 |
| | 23 | 5 | 28 | 0 | 0.60 ± 0.55 | 5.00 ± 1.87 |
| | 25 | 5 | 28 | 0 | 0.60 ± 0.55 | 5.00 ± 2.74 |

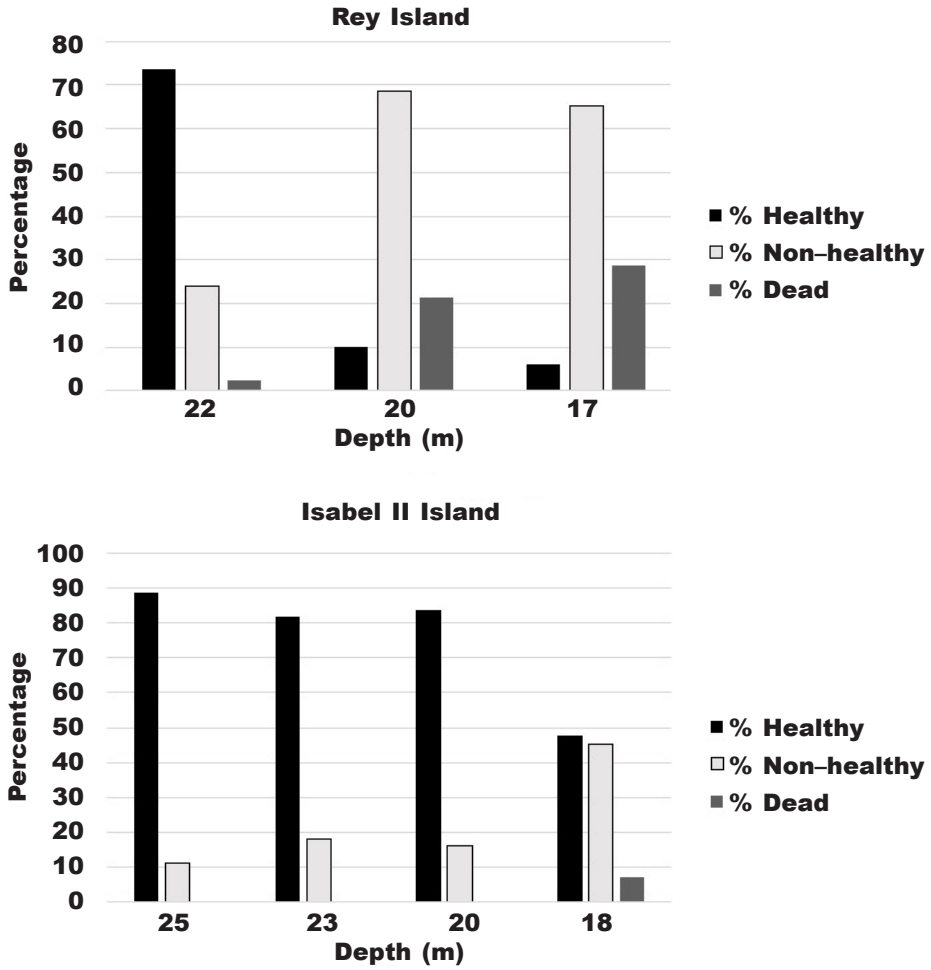


Fig. 2. Percentage of healthy, non–healthy and dead colonies of *Paramuricea clavata* at each study site.

*Fig. 2. Porcentaje de colonias de* Paramuricea clavata *saludables, no saludables y muertas en cada lugar de estudio.*

(with 1–99 % epibioisis or necrosis), and dead colonies (with 100 % epibiosis or necrosis) of *P. clavata* (fig. 1) using 10 squares of 50 x 50 cm, except at Isabel II island at 20 and 18 m deep, where only five squares were sampled at each depth. A total of 202 colonies were assessed in Rey Island (83 colonies at 22 m depth, 70 colonies at 20 m depth, and 49 colonies at 17 m depth) and 196 colonies in Isabel II Island (62 colonies at 25 m depth, 55 colonies at 23 m depth, 37 colonies at 20 m depth, and 42 colonies at 18 m depth). The results showed that dead colonies were more frequent in shallower waters and the general conservation status of the colonies increased with depth (fig. 2; table 1), as in shallower waters the effects of high temperature episodes are more noticeable. For example, Martin et al. (2002) experimentally demonstrated that necrotic diseases significantly speed up from a certain temperature value in two studied gorgonian species, one of them *P. clavata*, and Bally and Garrabou (2007) experimentally demonstrated the causal role of the thermodependent bacteria *Vibrio coralliilyticus* as an infectious agent in the Mediterranean *P. clavata* colonies.

The results obtained for the Chafarinas Islands also show that, when studied in a shallower range, the conservation status of *P. clavata* colonies is worse than previously considered (de la Linde Rubio et al., 2018). This could also be related to the highest peak in temperature occurring in summer 2017 compared with that of summer 2014 after which de la Linde Rubio et al. (2018) carried out their study. Finally, it should be noted that, in addition to the effect of increases in temperature, the health of *P. clavata* populations in the Mediterranean have been affected by injuries caused by anchoring and fishing (Barvestrello et al., 1997), but this is not the case in the Chafarinas Islands where *P. clavata* colonies are found in vertical coastal slopes, relatively far from the fishing activity.

The fate of the partially damaged colonies could be a total or partial recovery of the necrotic tissue or the fragmentation of affected branches. Further surveys could clarify how the affected population will recover and whether thermal anomalies are leading to a general loss of structural complexity of the benthic assemblages. Moreover, the application of restoration measures such as pruning could contribute to their faster recovery, as has been demonstrated in other gorgonian species as *Ellisella paraplexauroides* (Sánchez–Tocino et al. 2017).

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