

Plastic content in *Xyrichtys novacula* digestive Systems

Presència de plàstics en el sistema digestiu de Xyrichtys novacula

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Resum: *Xyrichtys novacula* és una espècie objectiu a la pesca recreativa de les Illes Balears, a més d'una de les espècies més cares del mercat. La seva relació amb el bentos ve del seu costum d'enterrar-se en el sediment, a més de la seva alimentació, que es basa majoritàriament en invertebrats que viuen dins la sorra. La gran abundància i ubiqüitat dels microplàstics (MP) facilita la seva ingestió, tant passiva (amb el menjar) com activa (confós amb menjar). Els microplàstics son susceptibles a fouling, i per tant tendeixen a enfonsar-se, on espècies que s'alimenten al bentos els poden ingerir. Els resultats d'aquest estudi mostren noves evidències de la ingestió de microplàstics a *Xyrichtys novacula* a les Illes Pitiüses. Aquesta ingestió és evident al 90% dels individus capturats, i amb una mitja de $3,790 \pm 2,614$ items/individu, aquesta espècie té una quantitat molt alta. No es trobà relació entre longitud del peix i MP. Prop del 50% dels MP eren blaus, i 24% eren negres. S'assumeix que els colors són deguts a confusió amb preses. Un anàlisi dels sediments mostrà la presència de MP en altes quantitats, suggerint que la ingestió pot ser degut a l'alimentació d'espècies del bentos.

Paraules clau: *Xyrichtys novacula*, Illes Balears, microplàstics, ingestió de plàstics, Illes Pitiüses.

Abstract: *Xyrichtys novacula* is a target in the recreational fishery of the Balearic Islands, and one of the most expensive fish in these islands. Its benthic behaviour is due to its burying habit, and its feeding, which consists mostly of sand-dwelling invertebrates. Microplastic (MP) ubiquity and abundance greatly favours ingestion, passively (attached to food) or actively (mistaken for food). Microplastics being very susceptible to fouling, might sink and be found in sediments, where benthic-feeding species could ingest them. Results from this study provide newfound evidence of the ingestion of microplastics by *Xyrichtys novacula* in the Pityusic islands. This ingestion is evident as over 90% of individuals had microplastic content in their gastrointestinal tract. With an average of $3,790 \pm 2,614$ items/individual, *X. novacula* presents a very high average of MPs. No relation between size and MP content was found, although almost 50% of the ingested MPs were found to be blue, and 24 were black. It is assumed that these colours are preferred due to the similarity to prey. A further analysis of MPs in sediments show the presence of these in high quantities, which suggests the ingestion might be due to the sediments which enter the digestive system with foraging.

Key words: *Xyrichtys novacula*, Balearic Islands, microplastics, plastic ingestion, Pityusic Islands.

INTRODUCTION

Plastics in our oceans are a growing problematic, which can affect growth, reproduction, feeding and survival of marine life (Foley *et al.*, 2018). Plastics do not biodegrade, but instead break into small pieces, which can end up being microplastics. These particles, generally defined as smaller than 5mm, are found in aquatic systems all over the world. Microplastics being so ubiquitous, marine life is affected: due to their small size, microplastics become bioavailable via ingestion to marine organisms (Andrady, 2011). In addition, plastics also have additives in their composition. These additives become available to the food chain and can enter cells, and there can interact and generate endocrine system disruptions (Alomar *et al.*, 2017), as well as generate oxidative stress (Solomando *et al.*, 2020).

MATERIAL AND METHODS

A total of 48 razorfish individuals were fished in the locations for Cala Jondal and Es Freus, by line fishing. The fish were measured, sexed and then sacrificed, after which the digestive system was extracted. The experimental procedure with fish has been carried out in accordance with the EU Directive 2010/63/EU for animal experiments and has been

approved by the Ethics Committee for Animal Experimentation of the University of the Balearic Islands (Ref. 020/06/AEXP). The digestive tracts were weighed and put in Erlenmeyer flasks, where 20 mL of KOH at 10% was added for each gram of weight. After 24 hours the samples were digested and they were filtrated with a Büchner funnel, with filtering paper of 47mm Ø and 10 µm of pore size (ALBET LabScience). Samples were then observed and photographed through a Leica EZ4 stereomicroscope with a HD camera (optical enhancement up to 11.5x) to search for plastic particles in the digestive tract. During the handling process, measures to avoid microplastic contamination were adopted (Woodall *et al.*, 2015). All the material was rinsed, surfaces cleaned, and lab coats made of 100% cotton were always worn.

RESULTS AND DISCUSSION

This study provides newfound evidence of the ingestion of microplastics by *Xyrichtys novacula* in the Pityusic islands. Over 90% of individuals had microplastic content in their gastrointestinal tract. These results are higher than many of the reported results for other studies, that ranged from 19 to 68% of plastic infected fish, with only two studies in Asian countries reporting higher plastic pollution. As for quantity of MPs found per individual, with an average of $3,790 \pm 2,614$ items/individual, *X. novacula* presents a very high average of MPs, similar to that found in *B. boops* by Nadal *et al.*, 2016 (3.75 ± 0.25 items per fish). Nadal found higher MP abundance in bogues captured in the island of Ibiza, versus those in Mallorca (Nadal *et al.*, 2016), and Portugal (Neves *et al.*, 2015). As for the type of plastics ingested, 81% of MPs found in raor were fibers. This might be due to the large quantity of fibers from washing discharge around the Balearic Islands. In 2016, 23 water treatment plants are found around Ibiza, some discharging directly into the sea, many with no tertiary treatment (Del Valle *et al.*, 2017) so this could explain the large proportion of fibers. No correlation between size and MP content was seen in this study. Therefore, it is assumed that the presence of MP in the gastrointestinal tract of fish is ephemeral, as older and therefore larger fish do not present a larger number of MPs. Because microplastics are not digested by fish, these results are not surprising. Due to *X. novacula*'s varied diet and wide predatory strategy, it feeds from both the water column and the sediment, thus capturing MPs from both areas. Because of *X. novacula*'s diet, we know that raor does not eat prey small enough for the MPs to be confused with food, which suggests an accidental capture. We found almost 50% of the ingested MPs to be blue, and 24 were 38 black. Similar data was obtained by Alomar *et al.* (2017) and Guven *et al.* (2017). This study highlights the ubiquity of plastic in the marine environment, as well as the importance of studying the ingestion of said plastic by marine species so as to better understand the effects it might have.

REFERENCES

- Alomar, C., Sureda, A., Capó, X., Guijarro, B., Tejada, S. and Deudero, S., 2017. Microplastic ingestion by *Mullus surmuletus* Linnaeus, 1758 fish and its potential for causing oxidative stress. *Environmental research*, 159, pp. 135-142.
- Andrady, A.L., 2011. Microplastics in the marine environment. *Marine pollution bulletin*, 62(8), pp. 1596-1605.
- Del Valle, L., Murray, I., Pons, G.X., and Calvo, J., 2017. Capacidad de carga socioambiental de la isla de Eivissa. Estado de la cuestión. *Monografies de la Societat d'Història Natural de les Balears*, 26: 206 pp. ISBN: 978-84-697-8889-9
- Foley, C.J., Feiner, Z.S., Malinich, T.D. and Höök, T.O., 2018. A meta-analysis of the effects of exposure to microplastics on fish and aquatic invertebrates. *Science of the Total Environment*, 631, pp. 550-559.
- Nadal, M., Alomar, C. and Deudero, S., 2016. High levels of microplastic ingestion by the semipelagic fish bogue *Boops boops* (L.) around the Balearic Islands. *Environmental Pollution*, 214, pp. 517-523.
- Neves, D., Sobral, P., Ferreira, J.L. and Pereira, T., 2015. Ingestion of microplastics by commercial fish off the Portuguese coast. *Marine pollution bulletin*, 101(1), pp. 119-126.
- Solomando, A., Capó, X., Alomar, C., Álvarez, E., Compa, M., Valencia, J.M., Pinya, S., Deudero, S. and Sureda, A., 2020. Long-term exposure to microplastics induces oxidative stress and a pro-inflammatory response in the gut of *Sparus aurata* Linnaeus, 1758. *Environmental Pollution*, 266, pp. 115295.