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Baseline

Low prevalence of microplastic contamination in planktivorous fish species from the southeast Pacific Ocean

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ABSTRACT

The gut contents of 292 planktivorous fish, from four families (Atherinopsidae, Clupeidae, Engraulidae and Scombridae) and seven species, captured along the coast of the southeast Pacific, were examined for microplastic contamination. Only a small fraction of all studied fish (2.1%; 6 individuals) contained microplastic particles in their digestive tract. Microplastics found were degraded hard fragments and threads, ranging from 1.1 to 4.9 (3.8 ± SD 2.4) mm in length, and of various colours, which suggests that the planktivorous fish species examined herein did not capture microplastics on the basis of their colour. The low prevalence of microplastic contamination in planktivorous fishes found in this study suggests that the risk of accidental ingestion by these species might be limited in the coastal upwelled waters of the southeast Pacific, perhaps due to small human population and highly dynamic oceanographic processes.

Microplastics (< 5 mm) are ubiquitous in most marine environments, raising increasing concerns as their impacts on the ecosystems are still unknown (Bergmann et al., 2015). Floating microplastics can remain for many years at the surface of the ocean, where they can be ingested by a wide variety of organisms (reviewed by Lusher, 2015). Numerous recent studies have reported microplastic ingestion by marine fish (e.g. Collard et al., 2017; Lusher, 2015; Rummel et al., 2016). The proportion of fish found with small plastic fragments in their gastrointestinal tract ranges from a few percent (e.g. Bråte et al., 2016; Cannon et al., 2016; Foekema et al., 2013; Liboiron et al., 2016) to more than two-third of all fish examined (e.g. McGoran et al., 2017; Naidoo et al., 2016; Ory et al., 2017; Tanaka et al., 2013). The reasons of such contrasting microplastic prevalence among marine fish species are still unclear, and need to be clarified to better understanding the pathways of microplastics within marine food webs.

The abundance of microplastic in fish guts is often high in river and estuarine systems near urban areas (e.g. McGoran et al., 2017; Naidoo et al., 2016), in coastal seas with high anthropogenic activity (e.g. Bellas et al., 2016; Foekema et al., 2013; Rummel et al., 2016), or in the open ocean close to the gyre accumulation zones of microplastics (e.g.

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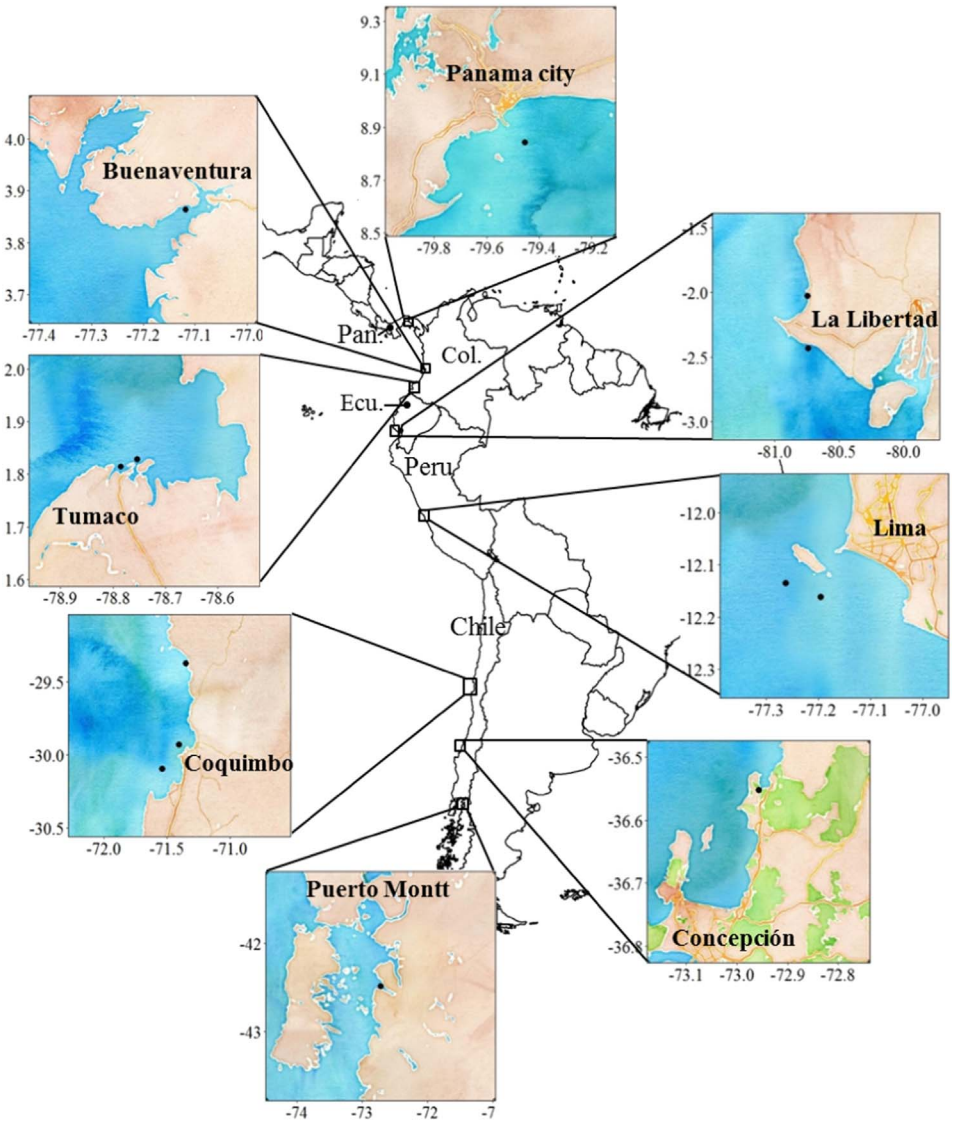

Fig. 1. Study areas (insets) and sampling sites (black dots) along the SE Pacific coast.

Boerger et al., 2010; Ory et al., 2017). In studies from remote areas with low human population densities (SE Australia, New Foundland, Norway), only a small proportion of the examined fish had ingested microplastics (Cannon et al., 2016; Liboiron et al., 2016), but incidence of microplastic contamination increased when samples were taken close to populated areas (Bråte et al., 2016).

Pelagic fish feeding on small planktonic organisms are particularly susceptible to accidental ingestion of microplastics suspended in the water column, which can reach abundances exceeding those of plankton (Moore et al., 2001, 2002), and often look similar in colour, size, and shape to many planktonic organisms. For example, microplastics were reported in about 70% of all anchovies (*Engraulis japonicus*; Engraulidae) from Tokyo Bay (Tanaka and Takada, 2016), in 40 − 50% of three clupeiform fish species (*Sardina pilchardus*, *Clupea harengus* and *Engraulis encrasicolus*) from the Atlantic coast of France (Collard et al., 2017), or in 80% of 20 *Decapterus muroadsi* (Carangidae) fish from Easter Island (Ory et al., 2017). Microplastics may enter and be transferred along marine food webs through planktivorous fish species, many of which are of commercial and ecological importance.

Plastic contamination is well documented in many coastal waters of the world's ocean, but still poorly known in the coastal waters of the Eastern Boundary Upwelling Systems (EBUS). Within these current systems, large masses of subsurface waters are upwelled near the coast, and transported offshore once reaching the surface (e.g. Marín et al., 2003); microplastics floating at the sea surface near coastal urban centres may thus be transported offshore by these upwelling currents. A recent study found no difference in microplastic abundances between upwelled and non-upwelled subsurface waters in the eastern Atlantic Ocean, but confirmed relatively low overall microplastic abundance in these coastal waters (Kanhai et al., 2017). Other studies confirmed low microplastic abundance in superficial waters along the eastern Pacific Boundary Currents (Eriksen et al., 2014; Law et al., 2014), suggesting that fish feeding within the water column, such as planktivorous species, may be exposed to low risk of plastic ingestion.

One of the most productive EBUS is the Humboldt Current System (HCS), which extends from southern Chile to Ecuador in the SE Pacific (Thiel et al., 2007). Herein we examined the incidence of microplastic ingestion by planktivorous fish species captured along the coasts of the eastern Pacific, ranging from Panama and Colombia to southern Chile. This study aims to establish the first baseline of microplastic contamination in fish from the South American Pacific coast.

A total of 292 planktivorous fish from 7 species and 4 families were captured between the 3rd of July and the 7th of December 2016 off the coasts of Panama, Colombia, Ecuador, Peru, and Chile (Fig. 1, Table 1 and Supplementary Table 1). Fish were captured with throw net or gillnet, between 1 and 220 m water depth (Table 1 and Supplementary Table 1). All fish were acquired directly from fishermen or in local markets < 8 h after their capture, stored in a clean cooler box, and