# First Report of Plastic Fragments in the Lanternfishes Collected from the Sea of Oman

**Laith A. Jawad**

**Abstract** The result presented in this chapter underlines for the first time the occurrence of plastic waste in the stomachs of Sea of Oman lanternfishes (Myctophidae), *Benthosema fibulatum* (Gilbert and Cramer 1897) and *Benthosema pterotum* (Alcock 1890). Fish samples were obtained from the coasts of Muscat city at the Sea of Oman. Plastic fragments consumed were grouped into small microplastics (0.2–2 mm), large microplastics (2–5 mm) and mesoplastics (5–25 mm), chiefly with clear colours. A higher number of plastics were obtained from the stomach of *B. pterotum* (20), while 15 pieces were collected from the stomach of *B. fibulatum*. The plastic intake could lead to severe effects especially the vertical migratory lanternfishes. Ecotoxicological features related to the possible influences of pollutants on lanternfish biology and to the mobilization of contaminants throughout the marine nourishing level up to top predators should be intensified if the management of plastic in the sea is not very well controlled.

**Keywords** Fish · Muscat · Microplastic · Food · Digestive tract · Contaminants

## 1 Introduction

The majority of the marine wastes are plastic. The issue of marine debris has been recognized internationally as a source of harmful influences on the marine organisms (Derraik 2002). Plastic debris can be classified into large, medium and small. The large plastic objects can produce tangle and can be swallowed by organisms. The medium plastic pieces can harm organisms during the respiration, ingestion processes and can lead to a gastric blockade, physiological influences, chemical transfer, or nourishing changes (Lusher et al. 2015). The small fragments of plastic, which are also known as microplastic, are usually taken by organisms easy with its food, or

L. A. Jawad (✉)
Pokeno, Auckland, New Zealand
e-mail: laith_jawad@hotmail.dcom



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they were misguided being foodstuffs (DeWitte et al. 2014; Romeo et al. 2016). The smaller fragments of plastic are usually observed in the stomach of several fish including the commercially important species (Lusher et al. 2015; Boerger et al. 2010; Romeo et al. 2016).

The feeding habit of the mesopelagic fish species includes remaining during the day time at certain depth in the water column just below the photic zone, and then they start feeding on the zooplankton near the surface of the water after making a vertical migration (Clark and Levy 1988). Microplastics are usually intermingled with the preferred food items of the mesopelagic fishes and create a good possibility for the fish to intake them with the food (Lusher 2015), and it is possible to be conveyed to larger marine animals including large piscivorous fishes and different marine mammals.

The results presented in this chapter are about the first-time incident of plastic remains in the stomach contents of two Sea of Oman mesopelagic fishes belonging to the family of Myctophidae (lanternfishes): the skinnycheek lanternfish *Benthosema pterotum* (Alcock 1890) (Romeo et al. 2016) and the spinycheek lanternfish *Benthosema fibulatum* (Gilbert and Cramer 1897) (Romeo et al. 2016). Due to the vital role of lanternfishes in the trophic web in the sea, the information given in the present chapter will be a significant addition to those already present on the occurrence of plastic in the digestive tract of the myctophid fish species.

## 2 The Lanternfish Species Studied

### 2.1 *Spinycheek Lanternfish* Benthosema fibulatum *(Gilbert and Cramer 1897)*

Marine species lives in the bathypelagic region of the sea (Riede 2004) at depth range 0–2000 m (Weitkamp and Sullivan 2003). Individuals of this species are found dispersed in both the Indian and the Pacific oceans. Maximum length reached is 100 mm in total length (Paxton and Hulley 1999). Individuals infrequently visit slop areas especially during the dark nights. Allured by light like insects, shown to be unsettled and dashing hysterically in all directions (Kuiter and Tonozuka 2001).

### 2.2 *Skinnycheek Lanternfish* Benthosema pterotum *(Alcock 1890)*

A marine species living in the benthopelagic region of the sea at depth range 100–300 m (Hulley 1986). Individuals of this species are widely dispersed in the Indo-Pacific zone from off Mozambique to the Sea of Oman and eastward to the Bay of Bengal, Indonesia and Western Australia and north of Japan (Olivar et al. 1999). It attains a maximum size of 70 mm in total length (Paxton and Hulley 1999). It feeds mainly on copepods and various crustacean larvae (Gjøsaeter and Kawaguchi 1980).

## 3 Materials Obtained and Processed

Specimens of lanternfish were obtained by midwater trawler operating off shorelines of Muscat city on the Sea of Oman. Specimens were cleaned by washing them with tap water and wrapped in aluminium foil to circumvent external contamination. A total of 120 *B. fibulatum* and 150 *B. pterotum* were collected. Specimens were preserved frozen at −20 °C. Body measurements and weight were taken for each specimen. To examine the food intake by the fish, the stomach was removed and examined in the laboratory. Conferring to Lusher et al. (2015), all tools and gear used were washed and proved clean of any airborne plastic fibre using a light microscope. Plastic fragments were counted, weighed and measured (length, width, thickness) and characterized by the stereomicroscope Zeiss Discovery V.8. Bestowing to Galgani et al. (2013), plastics ingested were classified into microplastics (<5 mm) and mesoplastics (5–25 mm). Furthermore, the microplastics were in turn sorted as small microplastics (0.2–2 mm) and large microplastics (2–5 mm), as described by Collignon et al. (2014).

## 4 Data Analysis

The data analysis followed that of Romeo et al. (2016). In total, 35 plastic pieces were located in the stomach content of the two lanternfishes (15 in *B. fibulatum* and 20 in *B. pterotum*) (Table 1). The mean values and range of fish standard length (mm) and weight (g) in addition to the number of plastics retrieved for each species are shown in Table 1.

**Table 1** Fish size (mean values and range of fish standard length) and weight (W) for *Benthosema fibulatum* and *B. pterotum*

| Species | Number of stomachs examined | Mean fish standard length (mm) ± SD | Range of fish standard length (mm) | Mean fish weight (g) ± SD | Fish weight range (g) | Number of stomachs with micro- and meso-plastics |
|---|---|---|---|---|---|---|
| *Benthosema fibulatum* | 120 | 39.80 ± 6.0 | 26.1–55.0 | 1.43 ± 0.47 | 0.31–2.85 | 35 |
| *Benthosema pterotum* | 150 | 40.26 ± 5.0 | 27.3–52.3 | 1.53 ± 0.63 | 0.35–2.92 | 57 |

The number of stomach containing plastics is also reported

**Table 2** Frequency of occurrence, colour and size of plastic pieces retrieved from the stomach of *Benthosema fibulatum* and *B. pterotum* collected from Muscat city at the Sea of Oman

| Plastic debris | *Benthosema fibulatum* | *Benthosema pterotum* |
|---|---|---|
| Frequency (%) | 6.8 | 5.9 |
| Colour | Yellow, hyaline, white | Pink, hyaline, white |
| Length range (mm) | 1.59–7.55 | 1.49–6.96 |
| Mean length and SD | 4.10 ± 3.08 | 3.34 ± 3.12 |
| Width range (mm) | 1.27–3.69 | 2.20–3.54 |
| Mean width and SD | 2.12 ± 0.97 | 2.00 ± 0.85 |
| Thickness range (mm) | 0.01–0.36 | 0.02–0.35 |
| Mean thickness and SD | 0.10 ± 0.15 | 0.11 ± 0.16 |
| Weight range (g) | <0.0001–0.0021 | <0.0001–0.0020 |

Mean values, range and standard deviation (SD) are reported

The results showed that there is a slight variation in the shape of the plastic fragments from irregular to rectangular, round or elongated, and the most part of them was flat. Several colours of pieces of plastic were perceived, with light colours which were prevailing. In both lanternfish species, the hyaline and white plastics were the most frequent (41% and 36%, respectively).

Table 2 showing the incidence of existence, colour and size (mean values, range and standard deviation values) of plastic bits were obtained from the stomach substances of the two species of lanternfishes examined.

Fragments of small microplastics representing the majority of plastic material in the stomach of the lanternfishes were studied and showed variation in their number, while big microplastics were detected in equal fraction in the stomachs of *B. fibulatum* and 20 in *B. pterotum*, while mesoplastics were only found in the stomachs of *B. fibulatum*.

## 5 Remarks

Results given in this chapter are the first-time consumption of plastic fragments in Sea of Oman mesopelagic fish, belonging to the family of Myctophidae. While such species have no profitable value for fishery purposes, they have an enormous biomass and are important constituents in the marine nourishment cycle (Gjøsaeter and Kawaguchi 1980; Romeo et al. 2016). Certainly they are intricate in the transferal of energy from zooplankton to upper nourishment cycle and from epipelagic to deep waters (several lanternfish usually accomplish diel vertical movements) (Gjøsaeter and Kawaguchi 1980). Many pelagic top predators feed on lanternfishes (e.g. Springer et al. 1999; Moteki et al. 2001; Romeo et al. 2016). The problem of ingestion of plastic by lanternfish is a dilemma to their predators as the plastic debris may form a supplier of impurities which could decide bioaccumulation phenomena. Definitely, while the occurrence of plastics consumed is not high, lanternfish are often eaten by large fish (Karakulak et al. 2009; Battaglia et al. 2013; Romeo et al. 2016), which feed on their groupings, consuming a big number of individuals (Battaglia et al. 2013). This type of feeding could expand the incidence of microplastic in this top predator.

Reports on the presence of plastic consumption by mesopelagic fishes are available from different parts of the world, e.g. in the Pacific Ocean (Boerger et al. 2010; Davison and Asch 2011; Moore et al. 2001).

In the present investigation, the occurrence of incidence of plastics was equal to 6.8 and 5.9 for *B. fibulatum* and *B. pterotum*. Such slight differences might be due to the feeding habit of the fish, which regulate the level of plastic consumption. Such results were also obtained from lanternfishes from the Mediterranean (Romeo et al. 2016).

The present results showed that the colours of plastic fragments retrieved from the stomach of the two lanternfishes were mostly clear (white, hyaline, yellow, pink), comparable to those of many zooplankton species (Scotto Di Carlo et al. 1982; Battaglia et al. 2014; Romeo et al. 2016). On the other hand, the size of the fragments of the plastic is comparable to that of the copepods or other small zooplankton prey, therefore clarifying the affinity of swallowing these pieces.

The effects of intake of plastic particles on lanternfish have not been fully assessed but include two chief worries: physical and toxicological influences. The plastic fragments may gather in digestive tracts and be also maintained: minimum plastic pieces might be removed with the faeces of fish, while larger plastic (mesoplastics) may have a size problem in passing them via digestive tracts and lead fish to undernourishment and ultimate famishment (Boerger et al. 2010), also taking into consideration the small size of lanternfishes. The consumption of plastic performs a severe threat as they do their daily vertical migration and meet the plastic debris with density high than the water and found floating on or near the surface (Olivar et al. 2012). Sometimes, lanternfishes consume large amount of plastic with high buoyancy that prevent them to go back to deep waters, expressing a possible basis of mass death. The direct and unintended ecotoxicological effects of microplastics contact on the lanternfish biology and to the relocation of contaminants through the marine nourishment level up to top predators will continue or may be increased as the management of the plastic in the sea is enhanced.

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