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First sighting of a pelagic seabird entangled in a disposable COVID-19 facemask in the Mediterranean Sea

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Abstract

Seabirds are increasingly recognized as important bio-indicators of marine ecosystems that are useful in assessing environmental disturbance on the marine biota. Over the period 2020-22 and during the first national systematic recording of the sea waters surrounding the Republic of Cyprus, we recorded the spatio-temporal presence, abundance and behaviour of seabirds using the ESAS (European Seabirds At Sea) methodology. Here we present the observation of an accidentally entangled pelagic seabird in COVID-19 material which to the best of our knowledge is the first incident in the Mediterranean Basin. The systematic recording of entangled marine birds in personal protective equipment (PPE) used to prevent COVID-19 transmission worldwide seems to be of crucial importance for one of the most important emerging threats for the conservation of seabirds at global scale.

Keywords: Marine Birds; Marine Ecosystem; marine litter; Levantine Sea; *Puffinus yelkouan*; Yelkouan Shearwater; pandemic-related debris; personal protective equipment (PPE).

Introduction

Plastic debris is recognized as one of the most insidious forms of pollution, persisting for a prolonged period of time, from intact items to degraded fragments. At global scale, the main oceanic gyres, together with the Mediterranean Sea, have been shown to retain the largest concentrations of floating micro- and macro-plastic debris (Suaria & Aliani, 2014; Cózar *et al.*, 2015; Constantino *et al.*, 2019; Soto-Navarro *et al.*, 2020). Indeed, the semi-enclosed nature of the Mediterranean, the surrounding multinational coastline and its dense human population, as well as extensive commercial shipping activities, are responsible for the formation of this plastic debris hotspot (Suaria *et al.*, 2016). Surveys of floating marine litter conducted in the Mediterranean Sea suggest a spatio-temporal variability that is largely determined by the circulation patterns between the western and eastern basins (Macias *et al.*, 2019), although, less attention has been given to the latter. Qualitative and quantitative characterization of floating macrolitter in the Levantine Sea is described in a short-term survey conducted by Constantino *et al.* (2019), south of Cyprus, and is under further assessment by an ongoing 2-year study in the waters of the Republic of Cyprus, with densities estimated between 235 items per km^2, and 217.5 items per km^2 (1st Survey's preliminary results; Savva *et al.*, unpublished data), respectively.

The high floating macrolitter densities recorded during these surveys, may have negative implications on the ecol-

ogy and biodiversity of the region, as it is home to several emblematic and protected megafaunal species, including cetaceans (Boisseau *et al.*, 2010; Snape *et al.*, 2020), seabirds (authors' unpublished data) and the critically endangered Mediterranean Monk seal (*Monachus monachus*), a small population of which is established along the coastland of Cyprus (Nicolaou *et al.*, 2021). The region is also a nesting and overwinter foraging ground for two species of sea turtles, namely, the Green turtle (*Chelonia mydas*) and the Loggerhead turtle (*Caretta caretta*), which use migratory corridors between Turkey, Cyprus and the Mediterranean Afro-Asian coastline (Stokes *et al.*, 2015; Snape *et al.*, 2016). The interaction of floating plastic debris with megafauna has been well-documented at global scale (Derraik, 2002; Kühn & van Franeker, 2020). Specifically, entanglements have been reported for almost all main marine animal taxa (Kühn & van Franeker, 2020; Høiberg *et al.*, 2022) with the incidences often associated with ghost gear (lost or abandoned fishing nets and lines), strapping bands and loop-structured plastic items (Derraik, 2002; Butterworth, 2016) that come in many forms and different plastic polymers (Wilcox *et al*., 2016; Law & Narayan, 2022).

Since 2019, a new challenge has emerged for marine biodiversity. The Severe Acute Respiratory Syndrome coronavirus 2 (SARS-CoV-2; COVID-19) outbreak has led to mass production of personal protective equipment (PPE) to prevent COVID-19 transmission (Canning-Clode *et al*., 2020). Two years after the outbreak of the pandemic, this environmental impact on the world's shorelines has become evident, with the improper disposal of COVID face masks and rubber gloves increasing the already enormous amounts of marine litter (Canning-Clode *et al.*, 2020; Benson *et al.*, 2021; Hatami *et al.*, 2022). Until recently, the impacts of discarded PPE were based on theoretical extrapolations from other, similar types of marine debris (Tesfaldet & Ndeh, 2022). Here we present the first incident of a pelagic seabird entangled in a disposable COVID-19 face mask in the Mediterranean Sea.

Materials and Methods

Study area

The study area is the island of the Republic of Cyprus located in the North-Eastern Mediterranean Sea (approx. 33° E and 35° N). Covering an area of 9,251 km², Cyprus is the third largest Mediterranean island. The region is the warmest, saltiest, and most oligotrophic part of the Mediterranean Sea (Coll *et al*., 2010).

Data collection

Data were collected during a systematic survey of seabirds for the Republic of Cyprus. Data collection followed the ESAS (European Seabirds at Sea) recording methodology (Fric *et al*., 2012; Zakkak *et al.*, 2013) with the aim to designate possible marine and coastal protected areas for seabirds (Camphuysen & Garthe, 2004). Data about human activities at sea as well as marine litter were also gathered during the fieldwork. The surveys were carried out during two consecutive years (2021-2022), each divided into three periods of 7-10 days (2021: 12-18 April, 9-18 September and 27 October - 4 November; 2022: 9-17 April, 4-10 June and 20-30 September). During the first expedition in April 2021, the study area was divided into two main buffer zones, a coastal zone (0-12 nm) and a pelagic zone (12-40 nm). Each zone was zigzag surveyed by two different vessels operating simultaneously; according to relevant studies on shipboard line transect surveys of animal populations (Strindberg & Buckland, 2004; Pettex *et al.*, 2017). The operational plan for the other sampling periods was changed and focused on coastal-coastal surveys as well as zigzag routes for the 0-12 zone since the great majority of seabirds seemed to avoid the highly oligotrophic pelagic zone.

The data obtained from on board surveys were stored in an MS Access data-base and were further spatially examined using ArcGIS 10.1 software. A map representing the location where the seabird entangled in a disposable COVID-19 face mask was found was generated using the European Marine Observation and Data Network (EMODNET) (https://www.emodnet-bathymetry.eu/) as a source for bathymetry data and the European Environment Agency (EEA) (https://www.eea.europa.eu/data-and-maps/data/eea-reference-grids-2/gis-files/cyprus-shapefile) as a reference grid for the Cypriot coastline. Minimum distance from the coastline was estimated using the 'near' proximity tool, which forms part of ESRI's ArcGIS toolboxes (ESRI, 2007).

Results

Onboard surveys covered about 4,700 nm on 42 days. In total, 18 seabird species were observed with only the Yellow-legged Gull (*Larus michahellis*) and the Mediterranean Shag (*Gulosus aristotelis desmarestii*) breeding on small satellite islets or inaccessible coastal areas of the Republic of Cyprus. On the 10th of April 2022 (2:20 p.m.), i.e., during the early stages of the breeding season, a Yelkouan Shearwater (*Puffinus yelkouan*) was observed entangled in a disposable COVID-19 face mask at a distance of about 7.3 nm south of the south coast of Cyprus (long: 34.036589° N; lat: 34.884374° E), in 700-800 m deep waters (Fig. 1). The weather conditions (<3 on the Beaufort scale) and the visibility were good (6-9 km) and allowed us to identify the entangled bird and take photos showing the negative impact of the COVID-19 waste on flight performance and behaviour (Fig. 2). Even though the bird seemed exhausted, possibly due to restrictions on effective foraging, it was not feasible to approach and capture it so as to release it from the entangled mask. It is worth mentioning that only 30 (5 ± 3.74) individuals of Yelkouan shearwater were observed during the six onboard surveys in the Republic of Cyprus, indicating a rare appearance of that pelagic species in the Levantine Sea.

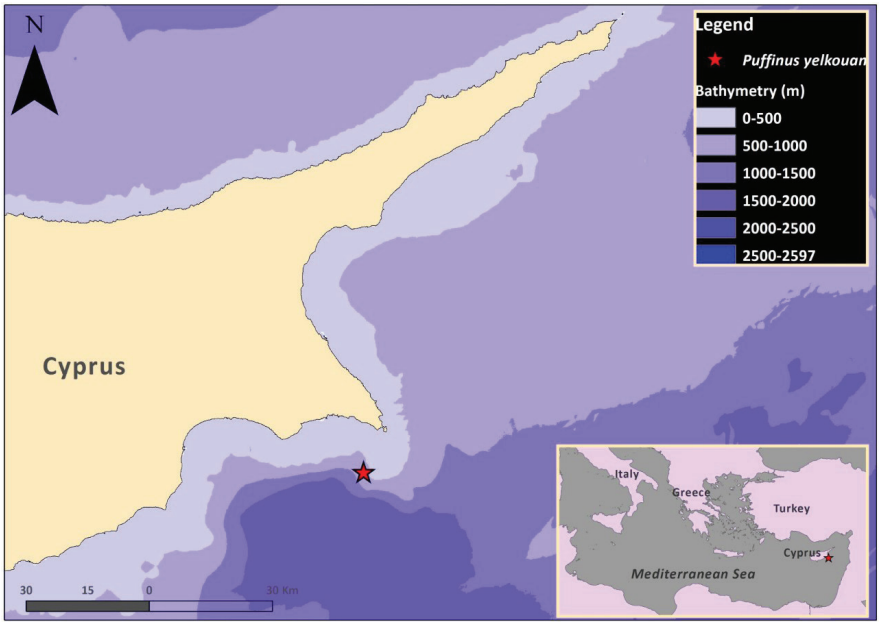

Fig. 1: Location of the Yelkouan Shearwater (*Puffinus yelkouan*) found on 10 April 2022 entangled with a disposable COVID-19 face mask (Cyprus, Levantine Sea, and Eastern Mediterranean). Sources: Bathymetry-European Marine Observation and Data Network (EMODNET) (https://www.emodnet-bathymetry.eu/); Reference Grid-European Environment Agency (EEA) (https://www.eea.europa.eu/data-and-maps/data/eea-reference-grids-2/gis-files/cyprus-shapefile).

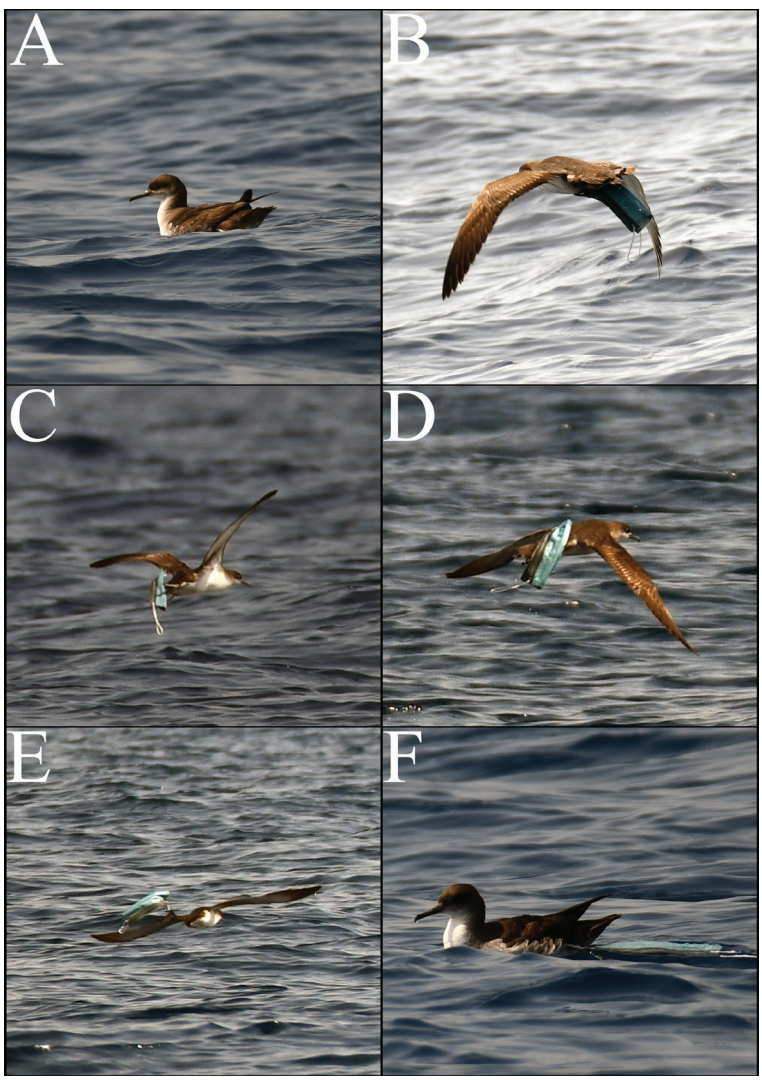

Fig. 2: **A.** Entangled Yelkouan Shearwater (*Puffinus yelkouan*) with a disposable COVID-19 face mask floating on water; **B.** Taking off while dragging mask; **C., D., E.** Flying over sea with the face mask entangled around its wing and **F.** landing again with face mask trailing.

Discussion

Seabirds are generally long-lived and are often threatened both on land and at sea by numerous factors, including invasive mammalian predators, by-catch incidental mortality in fishery gears, marine pollution and accumulation of plastics, over-fishing, and large-scale climatic phenomena (Dias *et al.*, 2019; Rodríguez *et al.*, 2019). Seabirds are increasingly recognized as important bio-indicators of marine ecosystems that are useful for assessing environmental disturbance and the effects of climate change on marine biota. Consequently, they are used as key species in conservation and management planning.

Plastic waste from disposable pandemic-related debris (e.g., medical face masks, plastic gloves) is considered a threat for the conservation of fauna in aquatic and terrestrial ecosystems (Hiemstra *et al.*, 2021; Ammendolia *et al.*, 2022). According to a recent study tracking possible impacts of COVID-19 material on wildlife, marine birds appear to be particularly susceptible to the impacts of pandemic-related litter (Ammendolia *et al.*, 2022). Such negative interactions have been reported from across the globe, in the form of entanglement, entrapment, ingestion, as well as use of PPE as nesting material (Table 1).

Here we report for the first time on the entanglement of a pelagic seabird species in the Mediterranean Sea, the Yelkouan Shearwater. It is worth mentioning that the other two documented incidents of seabirds entangled in COVID-19 material in the Mediterranean Basin refer to Northern Gannet (*Morus bassanus*) in Gibraltar and *Larus* sp. in Turkey (Table 1). The Northern Gannet is not a typical Mediterranean seabird since it breeds in the North Atlantic and occasionally can be found in the Mediterranean during winter while no specific conclusions can be drawn for the unidentified gull species (Harrison *et al*., 2021). Yelkouan Shearwaters are endemic to the Mediterranean and Black seas, although the exact spatial distribution of the species has not yet been determined accurately and population estimates are disputed (Bourgeois & Vidal, 2008; Keller *et al.*, 2020). It is listed in Appendix I of the Birds Directive and is classified as Vulnerable on the IUCN Red List (BirdLife International, 2018) due to recent population declines. At the same time, technical reports further indicate a potential decrease in survival rates in recent years (Derhé, 2012). Yelkouan Shearwaters are known to breed in the Eastern Mediterranean on offshore islets in the Aegean Sea (mainly in Greece while breeding is also assumed in Turkey), but

Table 1. Documented interactions between different seabird species and COVID-19 personal protective equipment (PPE).

Species	COVID-19 material	Interaction	Country	Reference
Herring Gull (*Larus argentatus*)	Face mask	Entanglement	UK	Ammendolia *et al.* (2022)
Herring Gull (*Larus argentatus*)	Face mask	Entanglement	Canada	Ammendolia *et al.* (2022)
Herring Gull (*Larus argentatus*)	Face mask	Entanglement	Netherlands	Ammendolia *et al.* (2022)
Herring Gull (*Larus argentatus*)	Glove	Ingestion	Canada	Ammendolia *et al.* (2022)
Herring Gull (*Larus argentatus*)	Face mask	Entanglement	USA	Ammendolia *et al.* (2022)
Atlantic Puffin (*Fratercula arctica*)	Face mask	Entanglement	Ireland	Ammendolia *et al.* (2022)
Silver Gull (*Chroicocephalus novaehollandiae*)	Face mask	Entanglement	Australia	Ammendolia *et al.* (2022)
Great black-backed Gull (*Larus marinus*)	Face mask	Nest material	Scotland	Ammendolia *et al.* (2022)
Great Cormorant (*Phalacrocorax carbo*)	Face mask	Nest material	Finland	Ammendolia *et al.* (2022)
Razorbill (*Alca torda*)	Face mask	Entanglement	Scotland	Ammendolia *et al.* (2022)
Ring-billed Gull (*Larus delawarensis*)	Face mask	Entanglement	Canada	Ammendolia *et al.* (2022)
Yellow-legged Gull (*Larus michahellis*)	Face mask	Ingestion	Italy	Ammendolia *et al.* (2022)
Common Murre (*Uria aalge*)	Face mask	Entanglement	UK	Ammendolia *et al.* (2022)
Northern Gannet (*Morus bassanus*)	Face mask	Entanglement	Gibraltar	Ammendolia *et al.* (2022)
Gull (*Larus* sp.)	Glove	Ingestion	Canada	Ammendolia *et al.* (2022)
Gull (*Larus* sp.)	Face mask	Entanglement	UK	Ammendolia *et al.* (2022)
Gull (*Larus* sp.)	Face mask	Entanglement	Turkey	Ammendolia *et al.* (2022)
Double-crested Cormorant (*Phalacrocorax auritus*)	Face mask	Nest material	Canada	Damian & Fraser (2020)
Magellanic Penguin (*Spheniscus magellanicus*)	Face mask	Ingestion	Brazil	Gallo Neto *et al.* (2021)
Gull (*Larus* sp.)	Face mask	Entanglement	Netherlands	Hiemstra *et al.* (2021)
Gull (*Larus* sp.)	Face mask	Entanglement	UK	Hiemstra *et al.* (2021)
Yelkouan Shearwater (*Puffinus yelkouan*)	Face mask	Entanglement	Cyprus	current study

long-term monitoring data on the breeding areas of the species are few and fragmentary (Derhé, 2012; Keller *et al.*, 2020). The species returns to its breeding grounds in late October-early November. Egg-laying takes place from mid-March to early April, followed by hatching in May, with the chicks fledging from July to early August (Bourgeois *et al.*, 2008). During the non-breeding period, the species spends time in Greece and possibly Cyprus as indicated by relevant studies (Borg & Sultana, 2012; authors' unpublished data) and open-access data obtained from BirdLife's global seabird telemetry database (Seabird Tracking database: http://www.seabirdtracking.org/).

The COVID-19 pandemic appears to be an emergent global challenge for marine ecosystems in the Mediterranean due to the extensive use of PPE-related material and its contribution to ongoing plastic pollution (Mghili *et al.*, 2022). Furthermore, a recent study which was conducted during the COVID-19 pandemic in 2021 established a baseline for beach litter along the Cypriot coastline (Orthodoxou *et al.*, 2022a). While the study did not focus on COVID-19 related debris, it reveals that 0.1% of the litter found on all 20 sites was PPE. According to the supplementary material (Orthodoxou *et al*., 2022b) and our calculations, PPE densities along the entire Cypriot coastline are estimated at 0.0005 ± 0.0001 items per m^2 for 2021. However, a more detailed study is currently ongoing and will tackle this particular question in depth. Pelagic seabirds, such as the Yelkouan Shearwater, are already susceptible to marine plastic pollution worldwide and, therefore, the increase in plastic waste in the marine environment caused by disposable pandemic-related debris has become an additive risk that contributes and plausibly amplifies the overall threat (Wilcox *et al.*, 2015; Fadare & Okoffo, 2020). The current study highlights additional direct impacts of COVID-19 PPE material on marine birds as well as the urgent need to assess possible relevant incidental entanglements and the rates of pandemic-related plastic exposure at a national, regional and global scale.

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