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Research Article

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Beach and Fish Plastics Method for Tracing Sources of Pollution

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Abstract
This paper examines beach plastics in a pie chart by proportionality using previous studies that developed characterisation techniques. These techniques include inferring industrial sources of plastic pollution. This paper combines these methods with a comparison of industry patent statistical proportion for geographical origin inference.

Keywords: Fish, Marine, Pollution, Plastic

Introduction

This paper presents the results of a study on the plastics and microplastics in the Eastern Ionian Islands of Greece, in particular focused around Kalamos Island. Beach plastic on Kalamos Island on several beaches at the perimeter were also collected and analysed.

Plastics and microplastics have been found across the world in seas, landscapes and even the Arctic ice. Most plastic will naturally break down after approximately 5000 years.

As the rate of production of plastic is currently greater than the rate of safe recycling or disposal, more plastic is entering the earth's ecosystems. Microplastics are defined as eroded microscopic remnants of a plastic product and have even been found in human stomachs. It is clear that plastics are working up the food chain.

Ingesting plastic or microplastics is very dangerous for a human or animal. Many marine species have been found washed ashore having died from a ruptured stomach due to ingestion of an indigestible plastic mass. Plastic also is very strong and once an animal becomes entangled in plastic, it will not be able to free itself and may have restricted movements or even incision into the flesh from growth around the plastic or chafing.

Microplastics also cause problems in the body as they can accrue in the organs such as the intestines or liver. Here they cause malfunction or blockage. Microplastics have also been shown to be carcinogenic to both humans and animals.

As plant and insect populations rely on the other levels of the ecosystems they too are affected by plastics.

No study has yet been conducted for the Mediterranean Sea on the combined presence of micro and beach plastic or comparison with EPO statistics. The Mediterranean Sea is an enclosed sea which receives the flow of ocean currents from the Atlantic Ocean and the Black Sea. The Ionian Sea receives currents directly from a number of neighbouring countries as well as a direct flow that comes from the Atlantic, below the heel of Italy. Due to the narrow inlet, much plastic ocean pollution can accrue in the Mediterranean Sea from elsewhere. For this reason this analysis can reveal the likely sources of much plastic pollution in the world. The Ionian Inlet is a good source for accrued plastics and has a high level of pollution.

Table 1: plastics properties reproduced from Coyle et al. and shows likely sources and properties of various types of plastic.

Resin Type	Common Applications	Specific gravity	
Low density polyethylene (LDPE)	Containers, tubing, bags, six-pack rings, wrappings	0.92–0.93	Float
Polyethylene (PE)	Plastic bags, storage containers, microbeads in personal care products	0.94–0.95	Sink
High density polyethylene (HDPE)	Bottles (milk and detergent), pipes, geomembranes	0.94	
Polypropylene (PP)	Rope, bottle caps, fishing gear, strapping, packaging, carpets, drinking straws, microbeads in personal care products	0.90–0.92	
Polystyrene (Expanded) (PS)	Cool boxes, floats, cups	0.01–1.05	
Seawater Specific Gravity~ 1.025			
Polystyrene (PS)	Utensils, containers, commercial packaging, medical devices, microbeads in personal care products	1.04–1.09	
Polystyrene Acrylonitrile (PSA)	Packaging material, containers, bottles	1.06–1.07	
Acrylonitrile butadiene styrene (ABS)	Printers, computer monitors, musical instruments, drainage pipes	1.06–1.08	
Polyamide (Nylon) (PA)	Fishing nets, rope, textiles, toothbrush bristles, automotive industry, microbeads	1.13–1.15	
Polymethyl methacrylate (Acrylic) (PMMA)	Transparent sheets, glass alternatives, microbead abrasives in personal care products, cleaning products, drilling fluids and air-blasting media	1.14–1.2	
Polyvinyl Chloride (PVC)	Film, pipe, containers, window frames, flooring, shower curtains	1.16–1.30	
Polylactic acid (PLA)	3D printing, moulds, films and sheets, biodegradable medical devices	1.24	
Polycarbonate (PC)	CDs and DVDs, electronics, lenses, construction industry	1.19–1.25	
Polyethylene terephthalate (PET)	Bottles, strapping, food packaging, thermal insulation, microbeads	1.34–1.39	
Polyoxymethylene (POM)	Mechanical and electrical engineering, vehicle and furniture components	1.35–1.44	
Polyester (Poly)	Textiles, abrasives in cleaning products, drilling fluids and air-blasting media	1.4	
Cellulose acetate	Cigarette filters	1.22–1.24	

Table 2: This table is reproduced from Sharma et al. and tells the sources of currents around the Ionian Area.

Major sources of marine litter in the mediterranean sea			Pollution intensity (Tons/year)
Cities/Country	Barcelona	Spain	1787
	Izmir	Turkey	1562
	Algiers	Algeria	1.22
	Alexandria	Egypt	2209
	Tel Aviv	Israel	3278
Rivers and water-way system/Country	The Po Delta	Italy	1350
	Ceyhan	Turkey	5109
	Seyhan	Turkey	3465
	Nile	Egypt	6772
	Rhone	France	1454
	Buyuk Menderes River	Turkey	2406
Shipping lanes	International		20,000

The table was constructed after extracting data from Liubartseva et al. (2018).

Table 1 shows clearly that pollutants neighbouring Greece in the Ionian Sea can be narrowed down to the following countries which I assign country codes to:

Turkey: TR
Egypt: EG
Israel: IL
Italy: IT
Algeria: DZ
Spain: ES,
Greece: GR.

These codes allow comparison to the patenting data shown below. The European Patent Office published global statistics for patent filings and grants which indicates to a degree proportional industrial activity of those countries' economie.

Patent Statistics

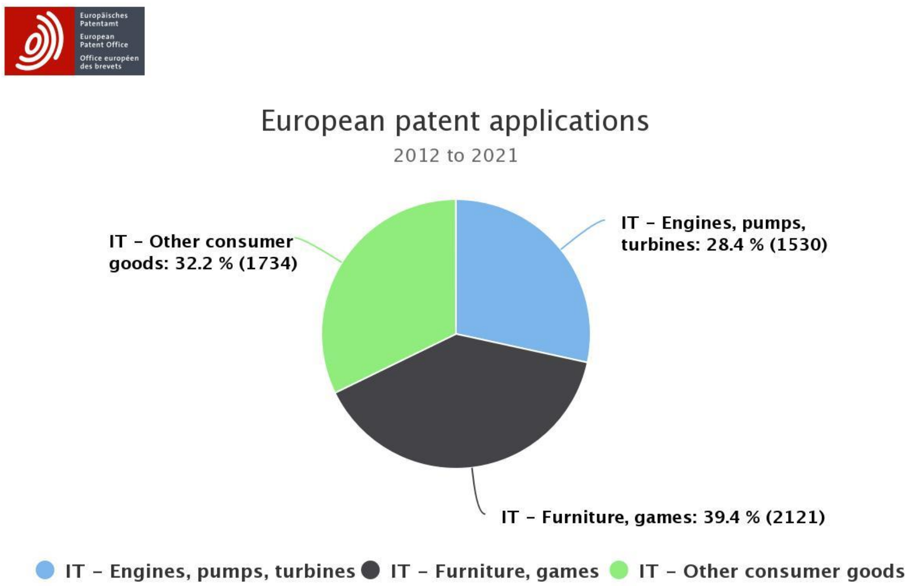


Figure 1: EPO statistics for three categories from Italy.

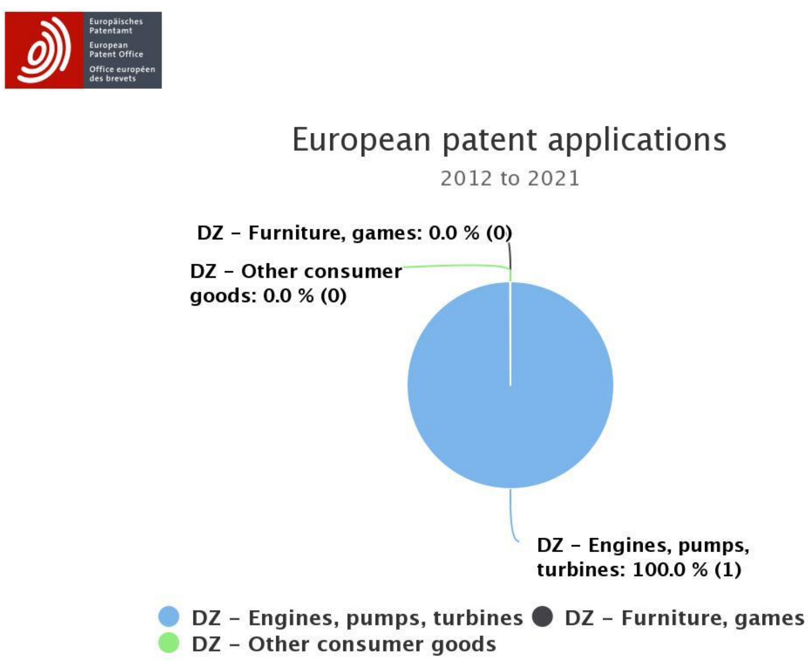


Figure 2: EPO statistics from 3 categories for Algeria.

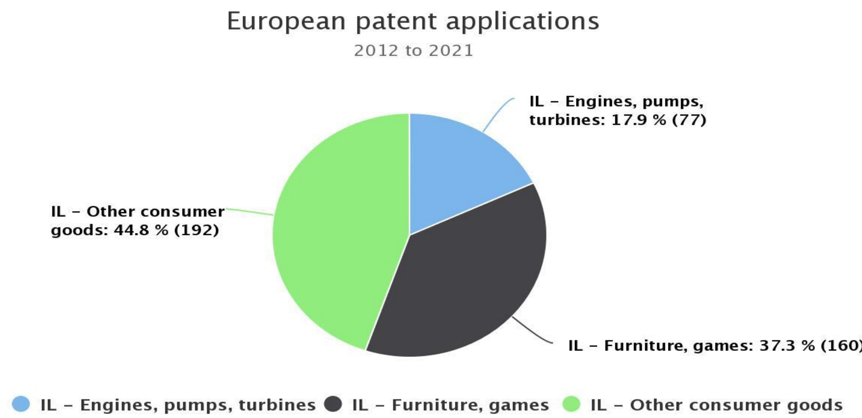


Figure 3: EPO statistics from three categories from Israel.

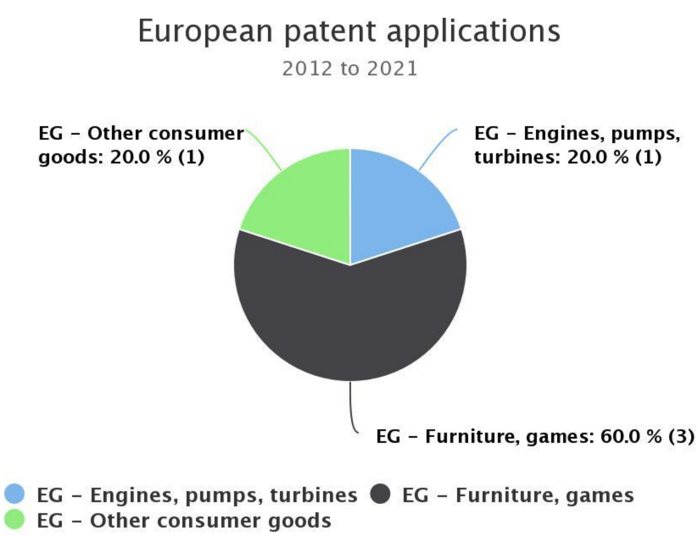


Figure 4: EPO statistics for three categories from Egypt.

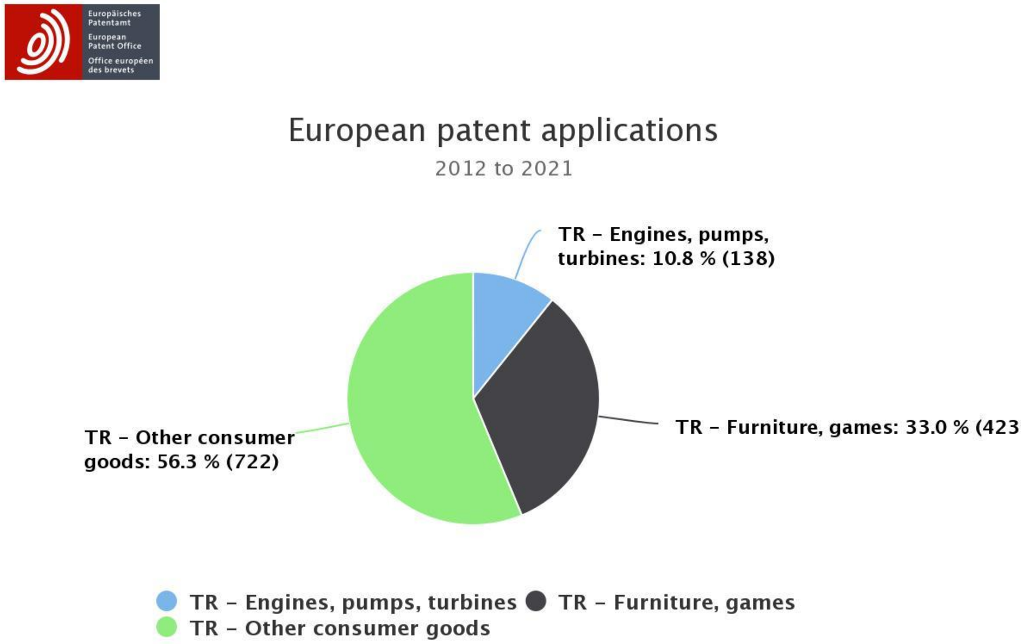


Figure 5: EPO statistics for three categories from Turkey.

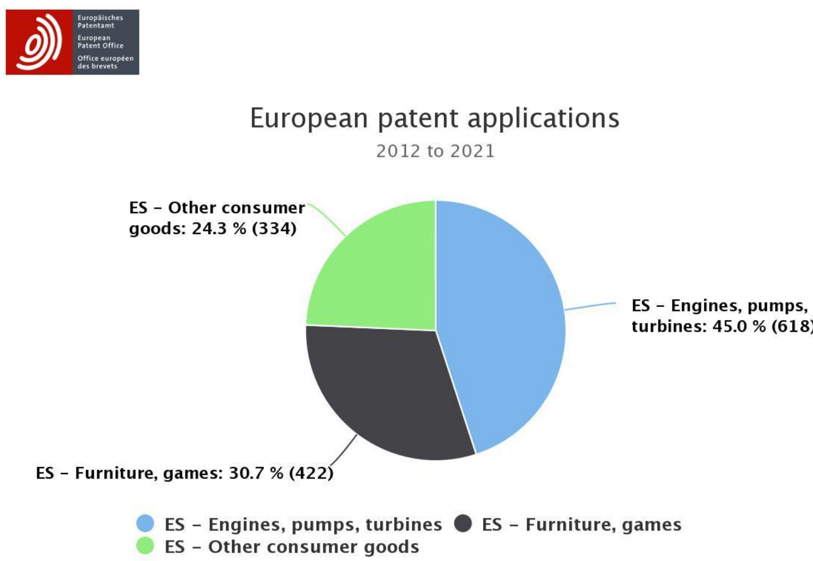


Figure 6: EPO statistics from three categories from Spain.

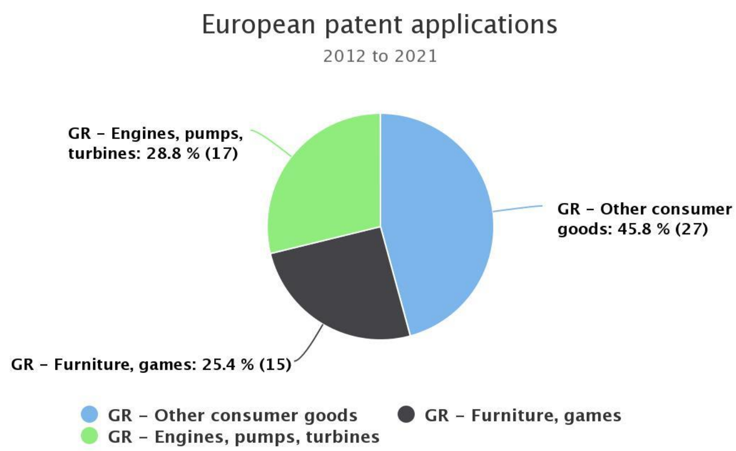


Figure 7: EPO statistics from three categories for Greece.

Methods

Feces have been found to be up to 50% water soluble (Rose, 2015). This is also true of dried organic matter. Dry ashing is a common technique and the methods of this study were to dry ash fish innards, dissolve the ashed component in water, detergent and stabilise the sample with isopropyl alcohol (IA) and weigh the plastics component, or to dissolve the plastic component in acetone after dry ashing and IA treatment and take the negative weight as the plastics content. Thus, studying fish innards by dry-ashing also creates a water soluble non-plastic component of the samples, the dissolution of the non-studied organic material in the sample is aided by various solvents use in negative solution or positive solution removal processes.

Common septic cleaner can be used to remove the biological sludge from the samples as it leaves plastic intact [2].

Beach plastic was collected from various locations on the island. This was recorded for the colour and likely product industry.

The fish were bought from local fishermen caught in the waters directly around the island. The fish were weighed and frozen for later processing.

Microscope sample glass plates were washed and rinsed with isopropyl alcohol and acetone and allowed to dry before use.

Innards on coffee filter substrates were oven baked below 150C (typically 120C) for no more than 4 hours to dry ash the biological material.

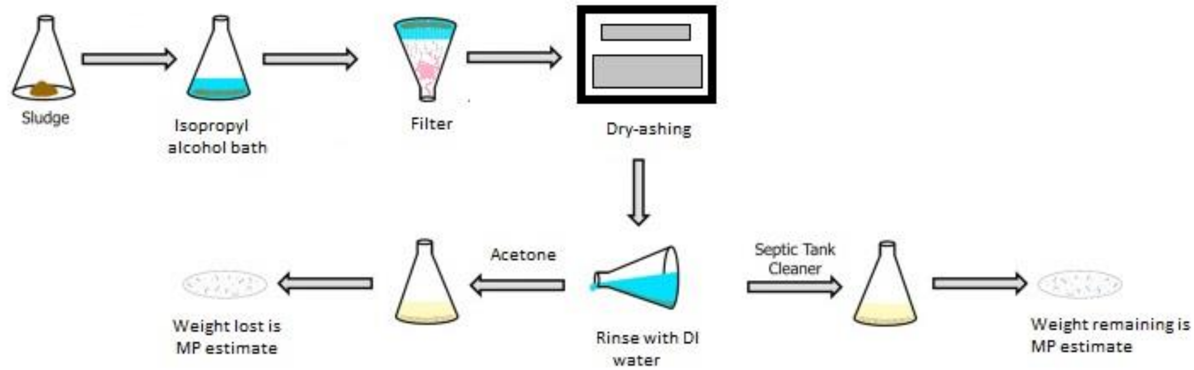
The fish innards or bird feces on the coffee filter substrate were washed with DI water to dissolve the charred/dried bio-material. This removed or thinned the amount of bio-material on the substrate.

A random sample subset of washed samples on the substrates were partially transferred to microscope glass plates and viewed at x4, x20 and x200. Images were digitally recorded for each sample donor species at x20 and x200. The results of the visual analysis in size, colours and general remarks are recorded. As results of random sampling, the microplastics in fish are not quantitative but qualitative.

To assess the weight per weight proportions the sample donor fish, gross innard weight, gross fecal sample weight and estimated sample donor bird species weights are compared to a post-processing weight.

The post-processing weight is weighed after the samples are treated as above and washed with DI water and IA until the solvate is the same colour and clarity as the solvent. This is an indicator of the amount of plastics and metals remaining in the samples. Metals can also enter the eco-system as a result from pollution. Further washing of this first post-processed material with acetone can also indicate the plastic content, by subtracting the final weight from the first post-processed weight as acetone dissolves many common plastics.

These numbers serve as upper or lower limits and will be understood to be accurate measurements within 20% error of the materials. Further information is only available with more advanced techniques for processing as are not available to a citizen scientist.



Schematic 1: Method used shown schematically.

Materials

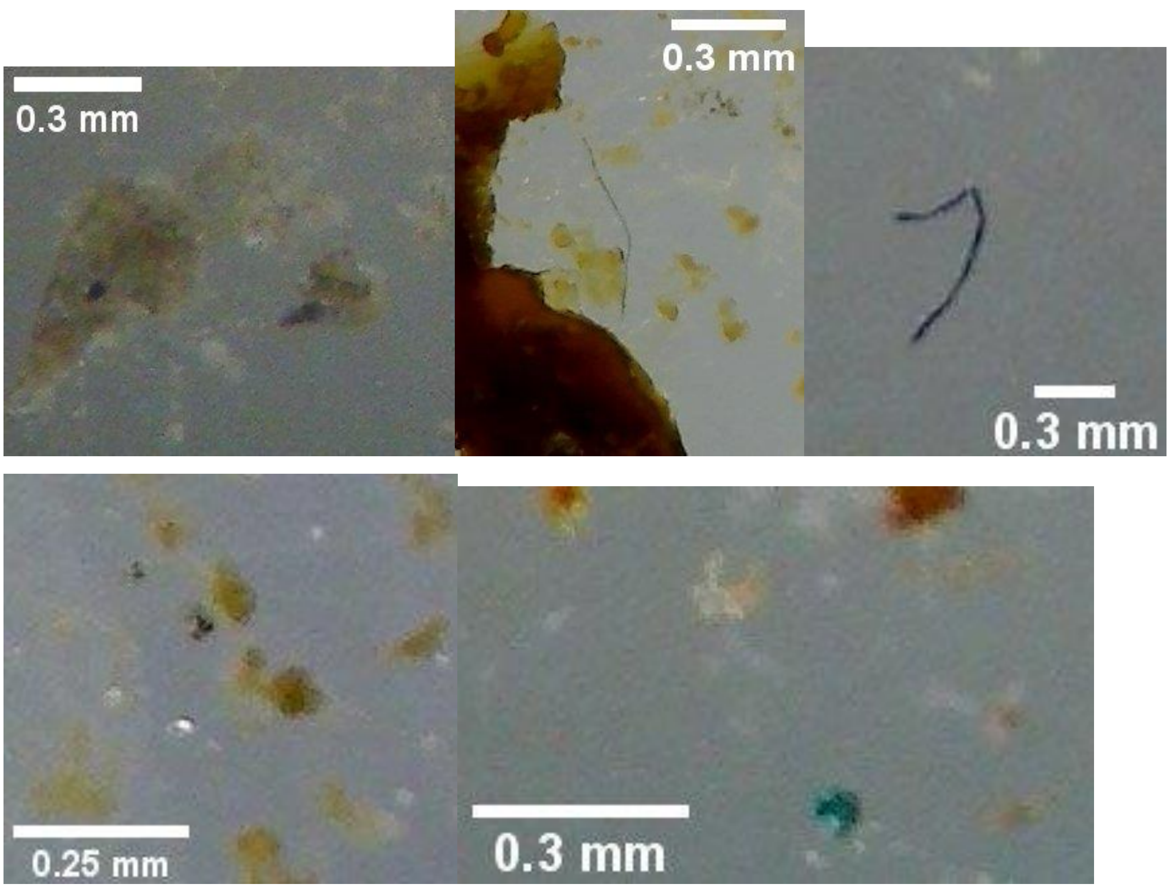
The filter papers used were Melitta coffee filters 1x2,. These filters have a mesh size that allows all particles below the size of the smallest coffee grind achievable. Coffee ground sizes are 5-500 um. Microplastics are those at anything below 5mm. The ash will wash through the filter and larger pieces, detectable by microscopy, will remain.

Isopropyl alcohol lighter fluid from LavStar was used. The acetone used was obtained from SmileBeauty Care Brand. The isopropyl alcohol and acetone used are considered at least 90% pure. Off the shelf generic washing detergent was used.

The fish were sourced fresh at local markets around Kalamos Island and came from the Ionian Sea.

Results

Images were taken using a digital microscope and processed in imageJ to insert scale bars at two magnifications of x20 and x200. The entire dataset of images is shown in the supplementary information. The following images are selected to show examples of the array of microparticles that were observed which are recorded.



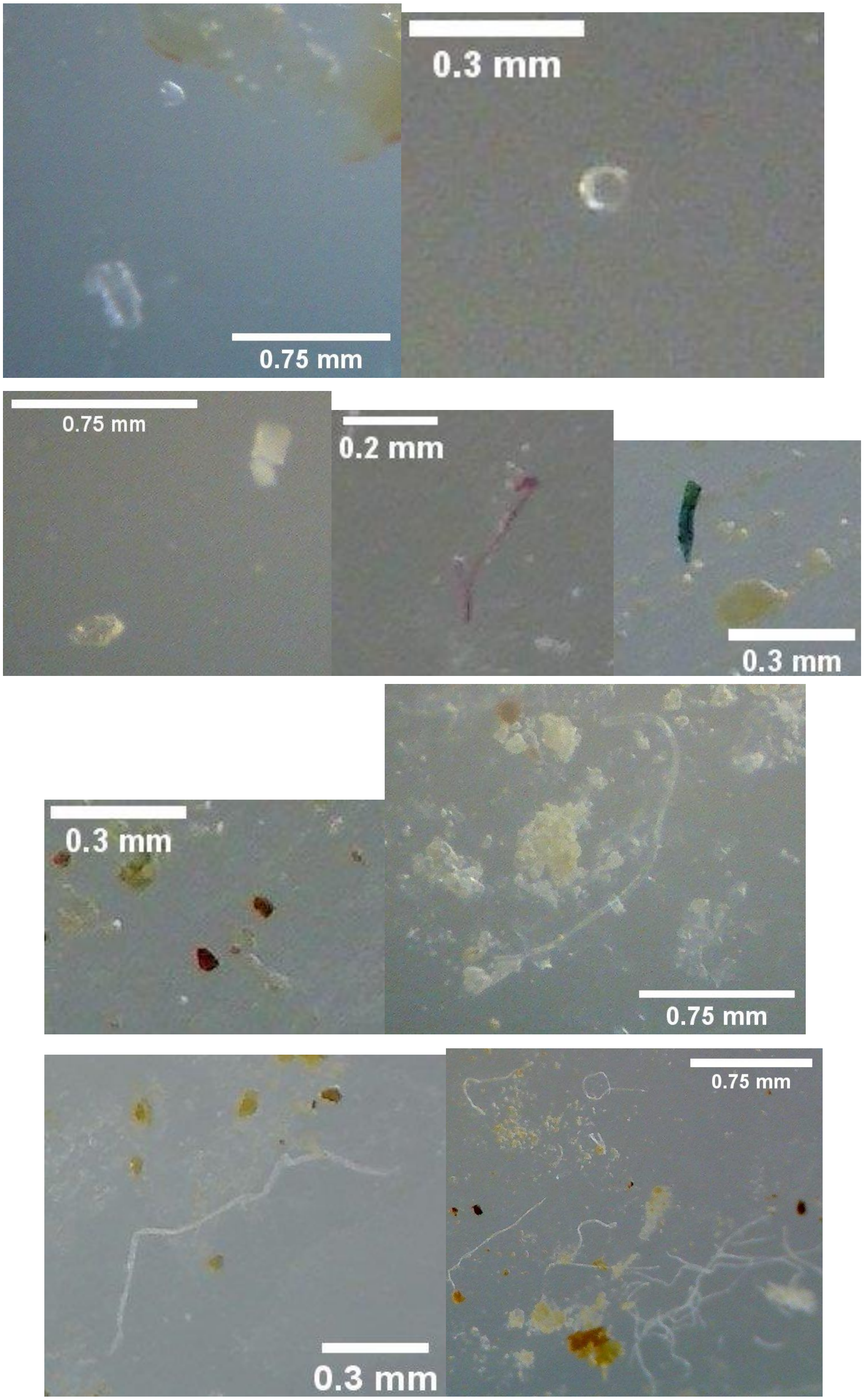


Figure 8: Images of exemplary MPs identified in the tuna samples.

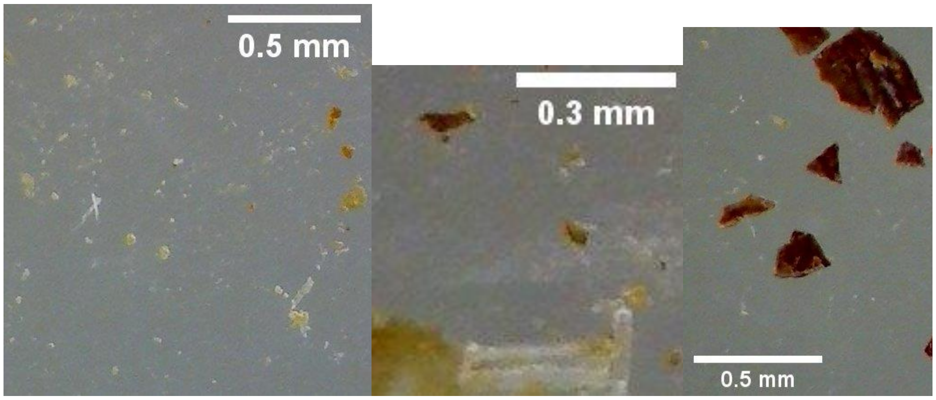


Figure 9: Images of exemplary solid masses that were categorised as non-MPs, but as biomatter remnants.

Using the characterisation methods of Blair et el we have found correlations between the types seen. With the inference of the industry origins of plastics in this area from EPO statistics, the potential originator of the pollution on separate beaches can be correlated. From Sharma et al it can be deduced that the fibres are most likely the result of ghost nets, the fragments are most likely from food, beverage or household waste [1]. It is clear that certain microplastic candidates are identifiable through microscopy owing to the inarguably unnatural origin of objects such as coloured fragments, white wire-like fibres or black wire-like fibres which remain after dry ashing and solution treatment. However, white and black fibres may come from natural sources such as bird feathers while yellow fragments are all assumed to be from sand excepting the translucent rounded edge yellow fragments.

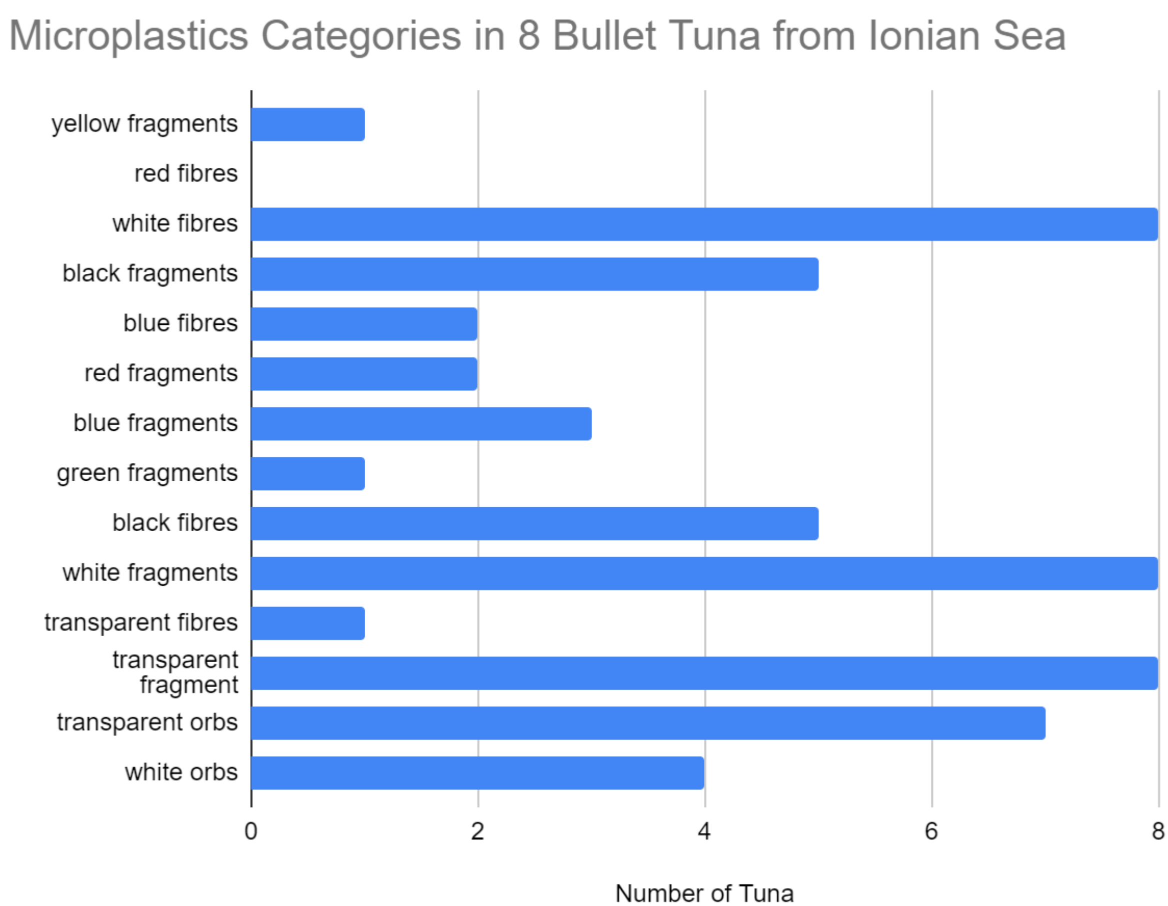


Figure 10: A plot of the types of MP observed in the tuna innard samples versus the number of tuna in which they were seen.

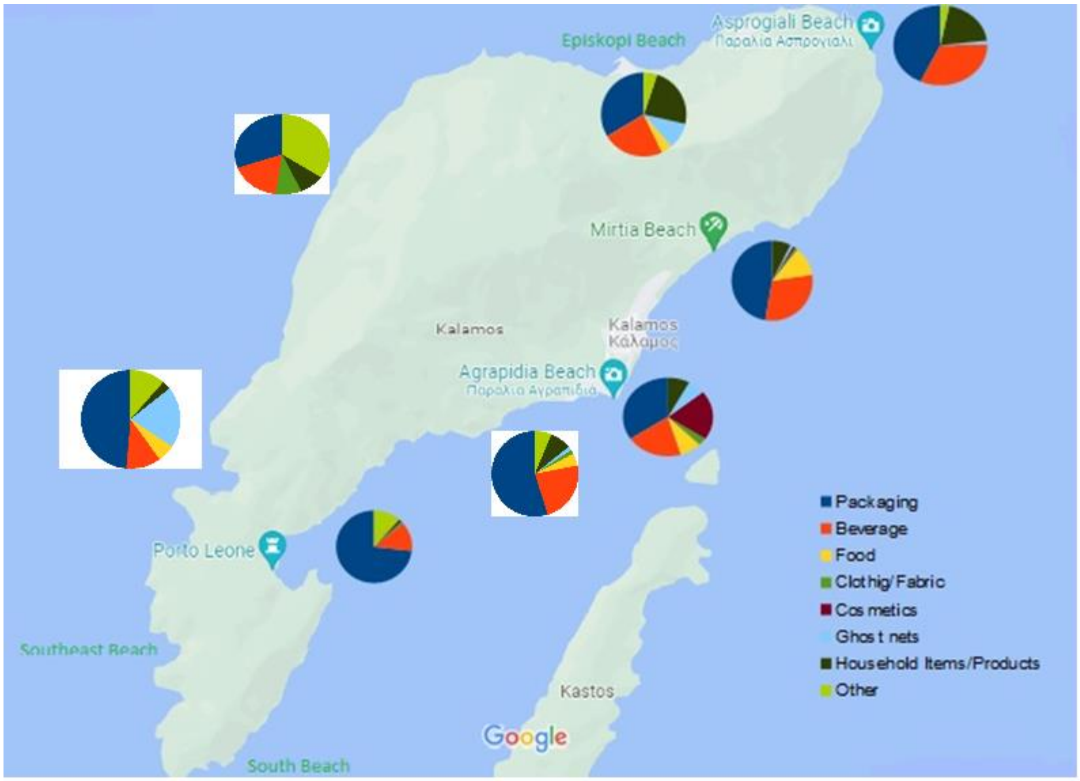


Figure 11: a map of Kalamos Island showing pie charts for industrial origins of beach plastics shown at their geographical origin.

Reproductions of the method by gathering and analyzing beach plastic proportions at two beaches showed a reproduced pi-chart with sampling one month after the first sampling shown in figure

Conclusions and Analysis

The microplastics found in the fish show that significant pollution occurs in the Ionian Sea with a total weight per fish of plastic averaging 5mg. The microplastic study however does not pinpoint the source of the plastic. As the population is relatively small in this area (circa 200 on Kalamos Island) the monthly pollution rate is most likely owing to ocean currents originating in other parts of the Mediterranean. The concentration of beverage sourced plastic is higher on the side of the island closest to the mainland. The different classes of plastic seen on the side furthest from the mainland is most probably being brought by the sea currents from the Ionian, Aegean and Red Sea directions. It is clear that the pie chart proportions of each side of the island correlate with the country origin patent statistics of the currents incident on that beach.

If the beach plastic categories are further classed into the patent statistic categories, we see the following pi chart correlations: other consumer goods: beverage, food, cosmetics, fabric;
furniture, games: household, packaging engines pumps turbines: ghost nets, other.

Comparing figures 1-7 and 11 using table 2 we see a match between beaches and exposure to either the Greek mainland of the wider mediterrenean using data from NASA [3].

North beach: Italy, North East beach: Greece; South East Beaches: Egypt, Syria and Israel; South West Beach; Libya, South Central Beach: Spain, Syria; North West beach Croatia.

Therefore looking at the patents starting from Figure 1, Italy is even thirds while the North beach is also approximately even thirds in the new combined categories.

Figure 2 shows Algeria being mostly engines pumps and turbines and figure 6 shows Spain being half engines pumps and turbines with a quarter in furniture and games and a quarter in other consumer goods, comparing this to the South Central Beach we see an unusual proportion of "other" hinting at unusual objects such as from engines pump and turbines. This pollution channel is most infiltrated owing to the large distance from Spain and Syria to travel but there are still qualitative similarities suggesting indeed that the pollution fingerprint is commensurate with the patent data.

The same analysis holds for the remaining beaches and strongly suggests that the correlation between patent statistics, ocean currents and beach plstics categorization can be used to identify sources of beach plastics in a wider and more detailed study.

Ethical Approval

Not required, all fish and materials were commercially acquired.

Consent to Participate

All parties consented to participate in a volunteer capacity.

Consent to Publish
Terra Sylvestris and the sole author have consented to this publication.

Authors Contributions
EH solely wrote this manuscript.

Funding
This project was self-funded by the author.

Competing Interests
None known.

Availability of data and materials
The data is available from the author on request.

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Conflict of interest
The author is not aware of any conflict of interest.

References

1. Sharma, S., Sharma, V., & Chatterjee, S. (2021). Microplastics in the Mediterranean Sea: sources, pollution intensity, sea health, and regulatory policies. Frontiers in Marine Science, 8, 634934.
2. Lavoy, M., & Crossman, J. (2021). A novel method for organic matter removal from samples containing microplastics. Environmental Pollution, 286, 117357.
3. Coyle, R., Hardiman, G., & O'Driscoll, K. (2020). Microplastics in the marine environment: A review of their sources, distribution processes, uptake and exchange in ecosystems. Case Studies in Chemical and Environmental Engineering, 2, 100010.